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(54) **Bushing having an oil impregnated paper grading capacitor with a valve system allowing to filter its oil without need to dismount it**

(57) A bushing (1) comprising a body (2) enclosing a central conductor (8), a grading capacitor (9) made by oil impregnated paper surrounding the central conductor (8), a gap (12) between an exterior surface of the grading capacitor (9) and an interior surface of the body (2), a ring seal (18) surrounding the grading capacitor (9) to separate the gap (12) into a first and a second part (19, 21), at least on valve system (13) and :
- a first valve (14) allowing communication of the first part

(19) with the exterior plant when in the open position during the treatment process ;
- a second valve (16) allowing communication of the second part (21) with the exterior plant when in the open position during the treatment process ;
- a third valve (17) closed during the treatment process, and open during the normal service to allow communication of the first and second parts (19, 21).

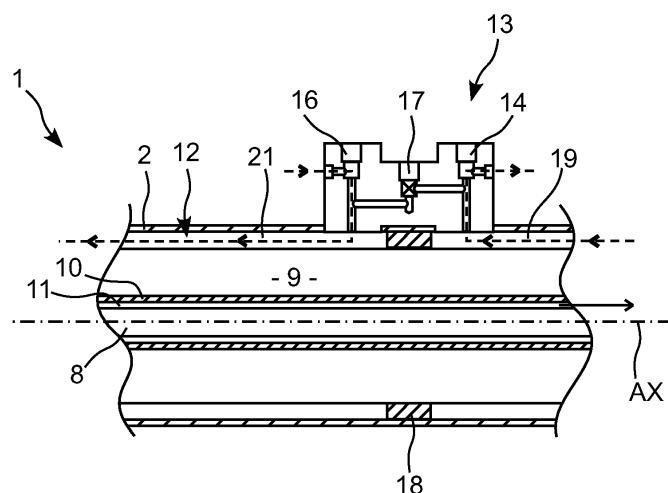


FIG. 2

Description

TECHNICAL FIELD

[0001] The invention relates to bushings for high voltage and ultra-high voltage for direct current or alternated current for transmission systems, where the main insulator of the bushing, i.e. its grading capacitor, is based on the oil impregnated paper (OIP) technology.

BACKGROUND OF THE INVENTION

[0002] In such systems, it is fundamental to maintain appropriate insulation level of the bushing by a periodical purification and treatment of the impregnating oil contained in the bushing. This process is necessary to remove moisture, dissolved gases and any other kind of solid contamination like residuals coming from the bushing manufacturing process or from the natural decay of the paper or the oil.

[0003] Such a bushing comprises a central tube generally made of aluminium, covered by a solid cylinder manufactured by wound paper which includes several aluminium foils. This solid cylinder component named grading capacitor is generally encased in a cylindrical body, named insulator, which realizes the external insulation system of the bushing.

[0004] To allow the oil circulation inside the bushing, a cylindrical gap is provided between the grading capacitor and the body, while an oil channel is realized inside the grading capacitor central tube. The conductor carrying the current can be the central tube or an additional solid bar or tube coaxial with the grading capacitor.

[0005] With this arrangement, if the bushing is installed vertically or inclined with appropriate angle, the oil can circulate inside the bushing, improving the cooling during normal operation conditions.

[0006] In the case of ultra-high voltage alternated current applications, the purity of the oil is not so critical as in ultra-high voltage direct current applications, but with the normal bushing arrangement there is no possibility to perform the oil filtering and treatment operation at site. If this operation is necessary, it is required to dismount the bushing from the equipment, for example an ultra-high voltage power transformer, and to send it to the bushing manufacturer facilities for reprocessing.

[0007] In the case of ultra-high voltage direct current applications, the traditional technology is often based on a grading capacitor that is not segregated at the transformer side. With this solution, the oil in the bushing is the same that fills also the transformer. The result is that in such a design, it is necessary to reprocess the oil of the bushing together with the oil of the transformer, without possibility to perform this operation on the bushing only.

[0008] Since transformers contain a significant amount of oil, the oil filtering process requires a long time, and the maintenance of the bushing is subjected to the peri-

odical maintenance of the oil of the transformer, without any possibility to plan it differently.

[0009] Finally, there is a need to provide a solution that renders the process of filtering and treating the oil of an oil impregnated paper bushing easier, more flexible, more efficient and less time consuming.

PRESENTATION OF THE INVENTION

[0010] To this end, the invention relates to a bushing comprising a body which encloses a central straight conductor extending along a longitudinal direction and a grading capacitor made by oil impregnated paper surrounding the central conductor, with a gap between an exterior surface of the grading capacitor and an interior surface of the body to allow circulation of oil for cooling the bushing, a ring seal which surrounds the grading capacitor to form a barrier separating the gap into a first part and a second part which do not communicate directly one with the other, at least on valve system fixed to the body at the level of the ring seal and comprising :

- a first valve allowing communication of the first part of the gap with the exterior when in the opened position ;
- a second valve allowing communication of the second part of the gap with the exterior when in the opened position ;
- a third valve allowing communication of the first part and the second part of the gap when in the opened position.

[0011] The invention allows to extract the oil to an external treatment and filtering plant and to return it into the bushing after filtration. This can be performed not only during the installation phase, but also with the bushing installed on the transformer during normal maintenance operation with the transformer not energized. The invention significantly reduces the time required for maintenance procedures, since the entire transformer is not involved in this operation. This results in a great reduction of the time required for filtering the oil of the bushing during the periodic maintenance, in addition to the efficient cooling of the conductor during normal operation of the bushing.

[0012] The invention also relates to a bushing such as defined above, wherein the valve system is integrated into a block comprising a first channel connecting the first part of the gap to the first valve which communicates with the exterior, a second channel connecting the second part to the second valve which communicates with the exterior, and a third channel connecting the first channel to the second channel and wherein the third valve is mounted to open or close the third channel.

[0013] The invention also relates to a bushing such as defined above, comprising several blocks carried by the

body and regularly spaced one from the other around the body, each block being at the level of the ring seal and comprising a valve system.

[0014] Method for filtering and/or treating the oil of a bushing such as previously defined, comprising the steps of:

- connecting a filtering and/or treating plant to the first and to the second valves of at least one of the valve systems of the bushing;
- opening the first valve and the second valve of the valve system to ensure that the oil can flow from the bushing to the plant treatment and back to the bushing;
- closing the third valve of the valve system to ensure that the oil cannot flow from the first part of the gap to the second part of the gap, so as to force the oil to flow from the bushing to the plant treatment and back to the bushing ;
- treating the oil in the filtering and/or treating plant during a predetermined duration or until the oil has electrical and physical parameters corresponding to predetermined values;
- opening the third valve;
- closing the first valve and the second valves and disconnecting the filtering and/or treating plant from the bushing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Figure 1 is a general view showing a valve system mounted onto the external body of a bushing according to the invention;

Figure 2 is a sectional view showing the components of the bushing according to the invention configured as for oil treatment and filtering operation;

Fig. 3 is a sectional view showing the components of the bushing according to the invention configured as for bushing in normal operation.

DETAILED PRESENTATION OF PARTICULAR EMBODIMENTS

[0016] The invention is based on the idea of a valve system carried by the body of the bushing which on the basis of two different open-close configurations, allows the bushing oil filling under vacuum operation, the realization of appropriate circulation of the filtered oil during the filtering process, and the realization of the appropriate

oil circulation for cooling during the bushing normal operation.

[0017] As seen in fig. 1, the bushing 1 according to the invention comprises an external body 2 generally cylindrical made of several parts 3, 4, 6, 7 connected to each other.

[0018] As seen in fig. 2, this external body or housing 2 which extends along a longitudinal direction AX, encloses a central straight conductor 8 such as a rod or a tube extending along direction AX and which is surrounded by a grading capacitor 9 which has a cylindrical shape and extends along direction AX. This grading capacitor 9 is made by oil impregnated paper which is wound onto an internal metallic tube 10.

[0019] There is a first gap 11 between the exterior surface of the central conductor 8 and the internal surface of the metallic tube 10, and a second gap 12 between the exterior surface of the grading capacitor 9 and the interior surface of the external body 2.

[0020] These two gaps 11 and 12 define a central cylindrical path and a peripheral cylindrical path which allow circulation of oil in two opposite directions, in order to cool the bushing during normal operation.

[0021] Four valve blocks 13, or valve systems, are fixed to the housing to provide the ability to easily set up the oil circulation for filtering process or for normal operation of the bushing. Each valve system 13, which is embedded into a metallic casing, comprises a first valve 14, a second valve 16 and a third valve 17.

[0022] The bushing comprises a ring seal 18 which surrounds the grading capacitor 9 at the level of the valve systems 13, and which forms a barrier to separate the cylindrical gap 12 into a first part 19 and a second part 21. By virtue of this ring seal 18, the first part 19 and the second part 21 are distinct and cannot communicate directly one with the other.

[0023] First valve 14 communicates with first part 19 by means of a first channel of the block and it communicates with the exterior plant: when this first valve 14 is opened as in fig. 2, the first part 19 of gap 12 communicates with the exterior plant. Second valve 16 communicates with second part 21 of gap 12 by means of a second channel of the block, and it communicates with the exterior: when the second valve is opened as in fig. 2, the second part 21 of gap 12 communicates with the exterior of the bushing.

[0024] The third valve 17 is mounted onto a third channel of the block which is connected to the first and the second channel. In the closed position as in fig. 2 valve 17 does not allow oil to flow from the first to the second channel of the block.

[0025] Accordingly, in the situation of fig. 1, the first and second valve 14 and 16 are open while the third valve 17 is closed, thus forcing the oil to flow in first part 19 of gap 12 towards a filtering plant, not visible on the figures and connected to the opened valve 14 by means of a flexible hose or pipe connecting the filtering plant to this first valve 14. Once this oil has been filtered in the

plant, it is returned by another flexible hose or pipe to the second opened valve 16, to be transferred in the second part 21 of the gap 12.

[0026] Accordingly, the filtering of the oil does not require to dismount the bushing from the transformer since it can be performed directly at site by connecting the filtration and treatment plant to the first and second valves and to set up these valves appropriately.

[0027] When the filtering process is considered as being finished, the operator opens the third valve 17 and after that closes the first and second valves 14 and 16. In this situation that corresponds to fig. 3 the third valve 17 acts as a bypass: the oil entering in first part 19 is blocked by the seal 18 and passes through first third and second channels of the block, reaching the second part 21 of the gap 12, which corresponds to normal operation of the bushing. In other words, in this situation the valve blocks act as bypass to allow indirect communication between first and second part of the cylindrical gap.

[0028] The valves blocks of the bushing according to the invention are easily accessible externally by the operators and reliable to guarantee proper oil circulation for the cooling of the bushing and proper oil circulation for filtering when requested by the maintenance operation.

[0029] Since the system guarantees optimal recirculation of the oil during the filtering process: no stagnant oil remains trapped in any part of the bushing. The oil of the bushing is segregated from the oil of the transformer allowing to perform specific tests on the oil of the bushing such as dissolved gas analysis, particle counting, dielectric tests and moisture content to identify problems specifically in the bushing.

Claims

1. Bushing (1) comprising a body (2) which encloses a central straight conductor (8) extending along a longitudinal direction (AX) and a grading capacitor (9) made by oil impregnated paper surrounding the central conductor (8), with a gap (12) between an exterior surface of the grading capacitor (9) and an interior surface of the body (2) to allow circulation of oil for cooling the bushing (1), a ring seal (18) which surrounds the grading capacitor (9) to form a barrier separating the gap (12) into a first part (19) and a second part (21) which do not communicate directly one with the other, at least on valve system (13) fixed to the body (8) at the level of the ring seal (18) and comprising :

- a first valve (14) allowing communication of the first part (19) of the gap (12) with the exterior when in the opened position ;
- a second valve (16) allowing communication of the second part (21) of the gap (12) with the exterior when in the opened position ;
- a third valve (17) allowing communication of

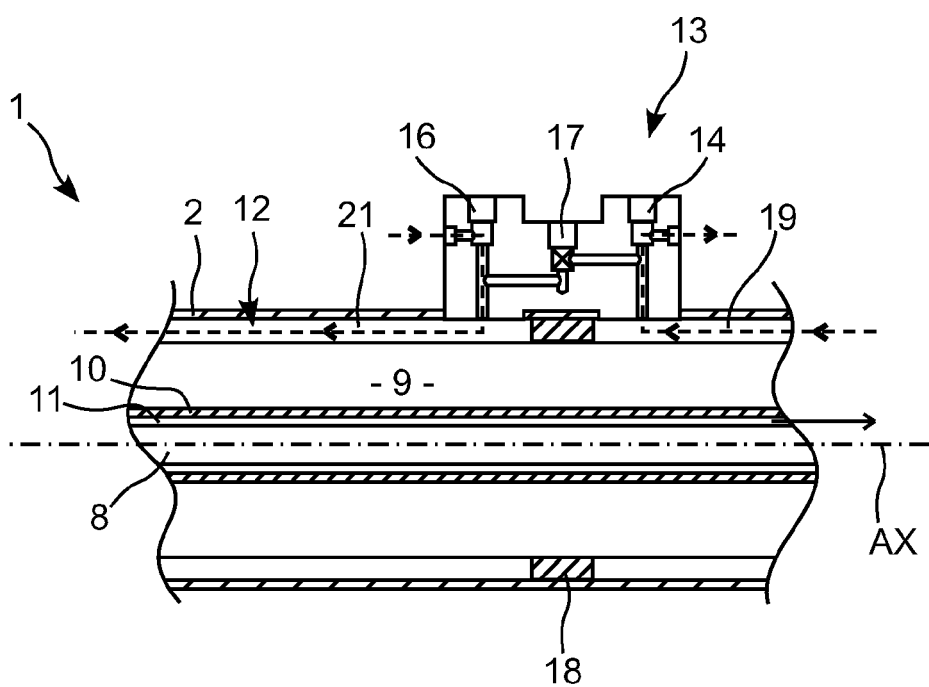
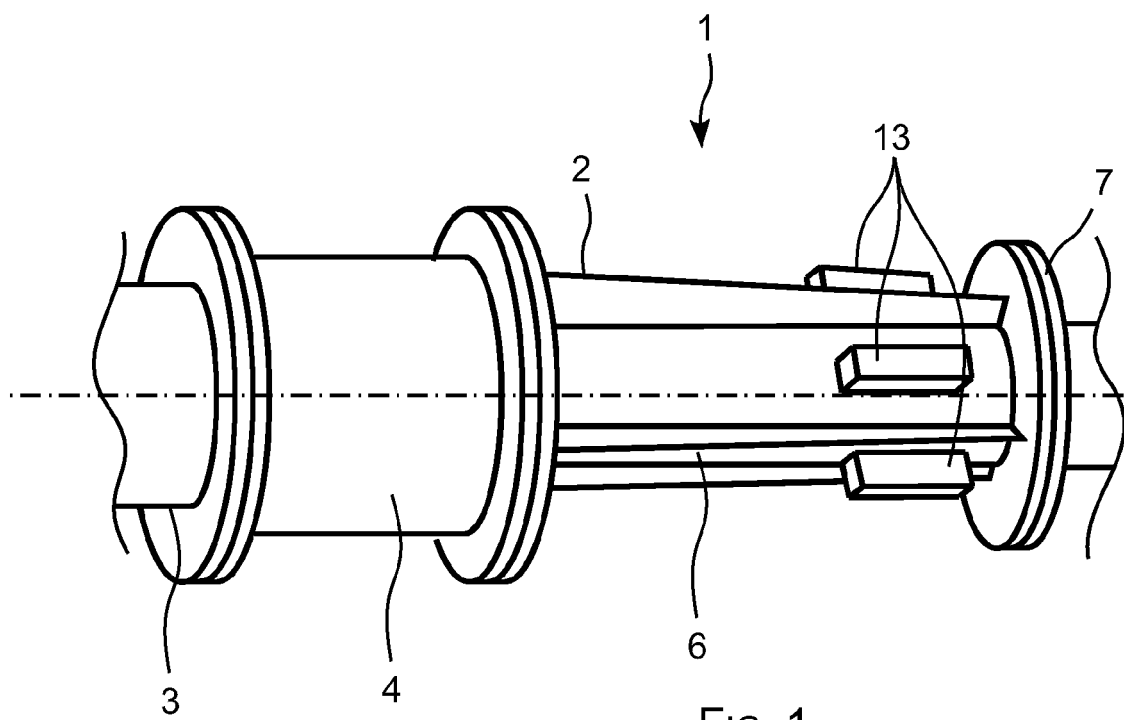
the first part (19) and the second part (21) of the gap (12) when in the opened position.

2. Bushing (1) according to claim 1, wherein the valve system is integrated into a block comprising a first channel connecting the first part (19) of the gap (12) to the first valve (14) which communicates with the exterior, a second channel connecting the second part (21) to the second valve (16) which communicates with the exterior, and a third channel connecting the first channel to the second channel and wherein the third valve (17) is mounted to open or close the third channel.

3. Bushing (1) according to claim 2, comprising several blocks carried by the body (2) and regularly spaced one from the other around the body (8), each block being at the level of the ring seal and comprising a valve system.

4. Method for filtering and/or treating the oil of a bushing (1) according to any of claims 1 to 3, comprising the steps of:

- connecting a filtering and/or treating plant to the first and to the second valves (14, 16) of at least one of the valve systems of the bushing;
- opening the first valve (14) and the second valve (16) of the valve system to ensure that the oil can flow from the bushing (1) to the plant treatment and back to the bushing (1);
- closing the third valve (17) of the valve system to ensure that the oil cannot flow from the first part (19) of the gap (12) to the second part (21) of the gap (12), so as to force the oil to flow from the bushing (1) to the plant treatment and back to the bushing (1) ;
- treating the oil in the filtering and/or treating plant during a predetermined duration or until the oil has electrical and physical parameters corresponding to predetermined values;
- opening the third valve (17);
- closing the first valve (14) and the second valve (17) and disconnecting the filtering and/or treating plant from the bushing.



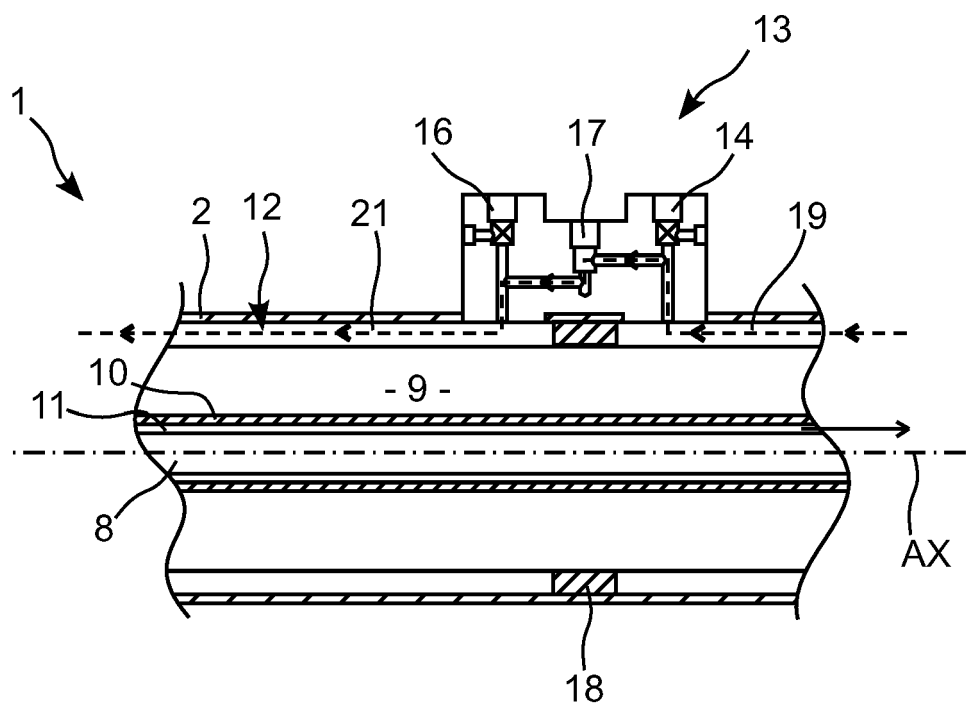


FIG. 3



EUROPEAN SEARCH REPORT

Application Number
EP 14 18 3449

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 27 January 2015	Examiner Salm, Robert
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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