

BUSHING FOR TRANSFORMERS**Field of the invention**

The present invention concerns a bushing for electrical distribution transformers with mineral oil insulation.

5 Prior art

Bushings for electrical distribution transformers with mineral oil insulation have for some time now been fitted on the cover or on the side walls of transformers immersed in oil, for example distribution transformers, to obtain the outputs of the electrical terminations.

- 10 The bushings of known type comprise two ceramic bodies which, once assembled, are held together and fixed to the transformer wall by means of a threaded pin which passes through them longitudinally, and appropriate washers and tightening nuts.

- 15 One of the two ceramic bodies is on the outer side of the wall that separates the inside of the transformer from the outside; the other ceramic body is located on the inner side of the wall and, during operation, is immersed in the cooling oil of the transformer; the two ceramic bodies are held together by means of a pin which passes through the two bodies, and tightly packed by means of tightening nuts.

- 20 It is therefore necessary to fit gaskets on the bushing to prevent the various leaks of oil to the outside (for example via the play between the through pin and the walls of the through holes of the ceramic bodies, or between the internal or external ceramic body and the transformer wall).

- 25 In the bushings of known type, said gaskets are generally flat or toric annular gaskets with semicircular section, of appropriate dimensions, which are tightly packed between the ceramic bodies and the transformer wall, or between the ceramic body and any washers, nuts or other elements compacted together by means of a central pin in order to form the assembled bushing; as a result of the compacting compression, said gaskets expand towards the outside where, in contact with the sunlight, and also as a result of the compacting pressure, they
30 deteriorate fairly rapidly, losing their elasticity, undergoing permanent plastic deformation, becoming thin, cracking and no longer guaranteeing a good seal; this deterioration is emphasised by the fact that normally, for oil bath transformers,

manufacturers prefer to use nitrile rubber which, although on the one hand is more suitable than other types of rubber to check oil leaks, on the other is more rapidly deteriorated by the sunlight and ultraviolet rays.

The aim of the present invention is to provide an improvement in the bushings for electrical transformers with mineral oil cooling, of known type, with particular
5 reference to deterioration of the seal gaskets.

Summary of the invention

Said aim is achieved, according to a first aspect of the present invention, with a bushing suitable for being used as electrical input and/or output of a transformer
10 with fluid insulation, said bushing comprising:

- a first electrically insulating body suitable for being positioned outside the transformer and fixed on a wall of the transformer which separates the outside from the inside;

- at least one annular gasket;

- 15 -a packing system suitable for fixing the first electrically insulating body on the transformer wall and tightly packing the at least one annular gasket together with the first electric insulating body and at least one second body;

- a seat for the at least one annular gasket;

wherein the bushing further comprises at least one protecting edge that externally
20 surrounds said at least one annular gasket and is suitable for enclosing and protecting the at least one annular gasket from the sunlight when the bushing is installed and tightly packed.

The annular gasket, or the annular gaskets, if there are several of them, protected at least partly from the sunlight by means of one or more protecting edges, is less
25 subject to deterioration and has a longer working life.

The above aim is achieved, according to a second aspect of the present invention, with a bushing suitable for providing the electrical input and/or output of a transformer with oil insulation, said bushing comprising:

- 30 - at least one electrically insulating ceramic body, suitable for being positioned on the outside of said transformer on a wall of said transformer which separates the outside from the inside, said electrically insulating ceramic body defining a first through hole;

- a first annular gasket;
- a pin inserted in said first through hole to fix said ceramic body on said wall and secure said first annular gasket between said ceramic body and said wall, where said ceramic body defines, at a second end:

5 a) an annular groove positioned crosswise to said pin and which houses said first annular gasket;

- b) a first protecting edge which externally surrounds said first annular gasket where said annular groove and said first protecting edge, when said bushing is installed and tightly packed, are suitable for enclosing and protecting said first
- 10 annular gasket from the sunlight.

The first annular gasket, protected from the sunlight by means of the annular groove and the first protecting edge, is less subject to deterioration and has a longer working life.

The above aim is achieved, according to a third aspect of the present invention, with a bushing suitable for providing the electrical output of a transformer with oil insulation, said bushing comprising:

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- an electrically insulating ceramic body, suitable for being positioned on the outside of said transformer on a wall of said transformer which separates the outside from the inside, said electrically insulating ceramic body defining a first
- 20 through hole;

- a pin inserted through said first through hole to tightly pack and fix on said wall said ceramic body which defines, at its first end, a supporting surface which lies substantially crosswise to said pin;

- a second body suitable for being positioned outside said transformer on said wall and in its turn comprising a second hole through which said pin is inserted, where said second body defines a slanting surface with respect to said pin;

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- a second annular gasket inserted on said pin and tightly packed between said ceramic body and said slanting surface of said second body which defines a second annular protecting edge which extends in a longitudinal direction to said
- 30 pin in order to protect said second annular gasket from the sunlight when said bushing is installed and tightly packed.

The second annular gasket, since it is protected from the sunlight by means of

said slanting surface and the second annular protecting edge, is less deteriorated and has a longer working life.

Further advantages of the present invention will become more evident, to a person skilled in the art, from the following detailed description of a non-restrictive embodiment, with reference to the following figures.

List of figures

Figure 1 shows a schematic view, partially in section, of a bushing for oil-cooled transformers according to the present invention - Figure 1 shows, side by side, a first embodiment of a pin which terminates at the lower end like a normal conductor (on the left in Figure 1) and a second embodiment of a pin that terminates like a "spade" connector (on the right in Figure 1);

Figure 1A shows a first detail of the bushing of Figure 1, when the bushing is not compressed and tightly packed;

Figure 1B shows the first detail of Figure 1A, when the bushing is compressed and tightly packed;

Figure 1C shows a second detail of the bushing of Figure 1, when the bushing is not compressed and tightly packed;

Figure 1D shows the second detail of Figure 1C, when the bushing is compressed and tightly packed;

Figures 2, 3 show schematically a side view in section and an overhead view respectively of the first annular gasket of the bushing of Figure 1;

Figures 4, 5 show schematically a top and bottom view respectively of the third insulating body of Figure 1;

Figure 6 shows a side view of the pin of the bushing of Figure 1, in the version to obtain a "spade" connector;

Figure 7 shows a front view of the pin of Figure 6, to obtain a "spade" connector.

Detailed description of the invention

Figure 1 shows a side view, partially in section, of a preferred but non-limiting embodiment of a bushing for obtaining the electrical input and/or output of a transformer with oil insulation according to the present invention.

Said bushing comprises an electrically insulating ceramic body 1, -hereinafter also referred to as first electrically insulating body 1- suitable for being positioned on

the outer side of the wall P of the transformer which separates its inside from the outside, and another insulating body 2, indicated hereinafter as third insulating body 2 and suitable for being positioned on the side of the wall P inside the transformer; inside the ceramic body 1 and the third insulating body 2 a first and a
5 second hole are provided respectively through which a threaded pin 3 is inserted, which passes through the entire bushing and comes out of both ends of it. By tightening the fastening nut 4 on the pin 3 it is possible to tightly pack the ceramic body 1 and the third insulating body 2 together, fixing them on the wall P of the transformer.

10 The bushing of Figure 1 is fixed to the wall P of the transformer, placing between the wall P and the ceramic body 1 a first annular gasket 9 (Figures 1, 1A) which is compressed by the ceramic body 1 tightly packed against the wall itself; Figure 1B shows schematically a detail of the area of the first annular gasket 9 compressed and tightly packed to the bushing installed.

15 In other embodiments, not shown, the threaded pin 3 and the fastening nut 4 can be replaced with other suitable packing systems, suitable for packing together the ceramic body 1 and the annular gasket 9, and for fixing the whole bushing to the transformer wall P, and/or the ceramic body 1 can be replaced with an electrically insulating body 1 made also of non ceramic materials.

20 Turning back to embodiment of Figure 1, the ceramic body 1 is provided with:

- an annular groove 10 (Figure 1A) positioned crosswise to the pin 3 and housing the first annular gasket 9;
- a first protecting edge 11 which externally surrounds the first annular gasket 9.

25 Furthermore, the annular groove 10 and the first protecting edge 11, when the bushing is tightly packed and installed on the wall P, are suitable for enclosing and protecting the first annular gasket 9 from the sunlight.

The annular groove 10 and the edge 11 furthermore are shaped in order to limit the radial expansion of the first annular gasket 9 when it is compressed, avoiding excessive stress, cracking or plasticisation of the gasket rubber. The protection
30 against sunlight provided by the groove 10 and the edge 11 further contribute to reducing deterioration of the material of the first annular gasket 9.

Advantageously the first annular gasket 9, without deformation, is substantially

torus-shaped with quadrangular transverse sections with convex sides (Figure 1A), where quadrangular shape means, for example, an approximately square or rectangular shape.

The convexity of the sides of the sections of the first annular gasket 9 means that,
5 with respect to a toroidal gasket with rectangular or square transverse sections with straight sides (rubber washer), the pressure of the gasket 9 against the wall P is more concentrated in the middle of the sides of the gasket guaranteeing a better seal, while with respect to a toroidal gasket with circular transverse sections (for example like a large O-ring), with the same compression and sealing force, there
10 is less radial expansion of the gasket compressed towards the outside and a more uniform distribution of the compression in the gasket body.

Advantageously the first annular gasket comprises a number of centring protrusions 12 – for example blades, semispherical bosses, pins, protuberances or lobes of various shape – which protrude towards the inside of the ring defined by it
15 in order to maintain the first annular gasket 9 positioned with respect to the ceramic body 1, when the bushing has not yet been assembled or prior to installation, with nil tolerances (i.e. also with a slight interference between ceramic body 1 and protrusions 12) or in any case much lower tolerances than with gaskets with simple circular holes of the known type; in the present embodiment
20 example the Applicant has left a radial gap of between approximately 0 mm and 0.5 mm between the centring protrusions 12 and the ceramic body 1, whereas according to the state of the art the radial play between the circular hole of a rubber washer and the ceramic body, due to the high ceramic working tolerances, is usually not below approximately $\pm 10\%$ of the diameter of the hole, i.e. ± 1.4
25 mm for a hole with diameter 28 mm.

In bushings for transformers of known type, positioning a rubber washer gasket quite eccentric with respect to the ceramic means that the part of the gasket protruding farthest is particularly subject to the above-mentioned phenomena of deterioration due to the sunlight, and therefore during installation a manual
30 centring operation is necessary; thanks to the centring protrusions 12, said manual centring operation is now eliminated.

In the bushings of known type, to prevent oil seeping through the passage

between the pin 3 and the through hole of the ceramic body 1 a toroidal gasket is used – the transverse sections of which are a semicircumference – which is compressed, in a direction parallel to the pin 3, positioning it between two metal bodies inserted onto the same pin 3 and tightly packed: in this way the gasket
5 expands radially pressing against the circumference of the pin 3.

The coupling area of each of the above-mentioned two bodies inserted on the pin 3 with the toroidal gasket of known type is generally a truncated cone-shaped or in any case flared recess which, if made directly on the end of the ceramic body 1, would be much more expensive than on the two metal bodies inserted on the
10 same pin 3; this makes it necessary to fit a further gasket - generally a flat rubber washer - between one of the two metal bodies inserted on the same pin 3 and the ceramic body 1.

In the bushings of known type, neither of the gaskets are retained radially; due to the tightening pressure, they expand considerably in a radial direction, stretching and becoming more exposed to the sunlight and therefore rapidly deteriorating.
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In the present embodiment of the invention, the bushing furthermore comprises (Figures 1, 1C):

- an outer second body 5 – hereinafter also referred to as cap 5, and for example made of brass, bronze, aluminium, zamak or more generally other alloys of
20 copper, aluminium or zinc or other metals - suitable for being positioned on the outside of the transformer and on which a second hole is provided through which the pin 3 is inserted, where said outer second body 5 defines a slanting surface 6 - for example truncated cone-shaped - with respect to the pin 3;

- an annular gasket 7 - indicated hereinafter as second annular gasket 7 - suitable
25 for being inserted on the pin 3 and tightly packed between the ceramic body 1 and the slanting surface 6 of the outer second body 5.

Moreover, the outer second body 5 defines a second annular protecting edge 8 (Figure 1C) which extends in a longitudinal or parallel direction to the pin 3 in order to protect the second annular gasket 7 from the sunlight when the bushing is installed and tightly packed, reducing deterioration of the gasket material.
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Figure 1D shows a detail of the area of the gasket 7 when the bushing is installed and tightly packed: the slanting surface 6 encloses and compresses the second

annular gasket 7 both around and against the pin 3 and against the supporting surface 13 which is provided on the end of the ceramic body 1 facing towards the outside of the transformer and lies substantially crosswise to the pin 3; preferably, as in the embodiment example shown, the second annular gasket, without
5 deformation, is substantially torus-shaped with circular transverse section (Figure 1C).

In this way the second annular gasket 7 provides a double seal against oil leaks, preventing oil seeping around the pin 3 along the through hole of the ceramic body 1 and also preventing oil seeping into the passage between the supporting surface
10 13 and the outer second body 5, reducing the number of components with respect to the state-of-the-art bushings.

Furthermore the slanting surface 6 prevents or however limits excessive radial expansion of the first annular gasket 7 when it is compressed, avoiding excessive stress in the gasket body and consequent cracking and fissuring.

15 As already pointed out above, the bushings of known type are provided with a third insulating body 2 suitable for being positioned on the side of the wall P inside the transformer (Figures 1, 4, 5).

Advantageously the third insulating body 2 is made of plastic material, for example nylon: the plastic material can be tightly compressed by resting it directly against
20 the wall P of the transformer without the need to insert intermediate rubber or cardboard gaskets.

In the present embodiment, a supporting flange 14 is provided on the third insulating body 2 suitable for being rested against said wall when the bushing is installed and tightly packed; advantageously the supporting flange 14 is provided
25 with four straight sides 15 two by two substantially parallel suitable for aligning and positioning the third insulating body on the wall P of the transformer (Figure 4).

Advantageously, knurling, thin ribbing or small bosses 16 can be provided on the upper contact surface of the flange 14, with which the flange 14 contacts the transformer wall P, for distributing the contact pressure between flange 14 and
30 wall P of the transformer more uniformly.

On the upper surface of the flange 14 four grooves or channels 17 are also provided to permit passage of the cooling oil from and towards the pin 3 and the

inside of the bushing.

Advantageously on the lower end of the third insulating body 2 a seat or recess 18 (Figure 5) is provided - the example shows a seat 18 for a hexagon nut - which can house and couple a corresponding radially protruding part 19 of the pin 3 - in
5 the example of Figure 1, the hexagonal head 19 integral with or fixed to the threaded pin 3 - in order to block the related rotation of the pin 3 with respect to the insulating body 2.

The coupling between seat 18 and hexagon head 19 is particularly advantageous for quick accurate installation of the bushing if pins have to be used - like those
10 shown in Figures 6, 7 - to obtain a so-called "spade connector" 20, known in the state of the art: in fact in some assembly cases spade connectors cannot be fitted in any direction - they must be accurately aligned with appropriate references. In the embodiment example described here, the hexagonal head 19 permits accurate rapid alignment with respect to two of the positioning sides 15 of the flange 14,
15 and permits accurate positioning of the spade connector 20 in six predefined angular positions.

In other embodiments the seat 18 can be shaped in order to receive and couple with heads 19 which can be not only hexagonal but also square, octagonal, splined couplings etc.

20 The present embodiment example described above can be modified and varied in numerous ways while remaining within the protective scope of the present invention: more generally, a bushing according to the present invention comprises:
- a first electrically insulating body 1, suitable for being positioned outside the transformer and fixed on a wall P of the transformer which separates the outside
25 from the inside;

- at least one annular gasket 7, 9;

- a packing system 3, 4 suitable for fixing the first electrically insulating body 1 on the transformer wall P and tightly packing the annular gasket 7,9 -or the annular gaskets- together with the first electric insulating body and at least one second
30 body;

- a seat for the annular gasket -or gaskets;

such bushing further comprises at least one edge 8,11 that externally surrounds

said at least one annular gasket and is suitable for enclosing and protecting - at least partly- said at least one annular gasket from the sunlight when the bushing is installed and tightly packed; the second bodies P, 5 do not need to be embodied only by the above described transformer wall P and the cap 5, but in other
5 embodiments can be other suitable bodies to which the first electrically insulating body is fixed and/or packed.

In further embodiments, not shown, for example the first annular gasket 9 can be a toroidal gasket with triangular transverse sections with convex sides; the transformer not necessarily need to be provided with oil insulation, but can be
10 insulated also with other dielectric liquids or fluids; the supporting flange 14 can be provided in general with one or more sides 15 –not necessarily only four sides- or other positioning and orienting means suitable for allowing aligning, positioning and orienting the third insulation body 2 with respect to the transformer wall P; in general the pin 3 and the third insulating body 2 can be provided with respective
15 orienting coupling zones or other suitable orienting means, suitable for engaging together or anyway blocking the rotation of the pin 3 with respect to the third insulating body 2.

All modifications and variations falling within the meaning and field of equivalence of the claims are understood to be included in them.

CLAIMS

- 1) Bushing suitable for being used as electrical input and/or output of a transformer with fluid insulation, said bushing comprising:
- a first electrically insulating body suitable for being positioned outside the
 - 5 transformer and fixed on a wall of the transformer which separates the outside from the inside;
 - at least one annular gasket;
 - a packing system suitable for fixing the first electrically insulating body on the transformer wall and tightly packing the at least one annular gasket together with
 - 10 the first electric insulating body and at least one second body;
 - a seat for the at least one annular gasket;
- wherein the bushing further comprises at least one protecting edge that externally surrounds said at least one annular gasket and is suitable for enclosing and protecting the at least one annular gasket from the sunlight when the bushing is
- 15 installed and tightly packed.
- 2) Bushing according to claim 1, wherein the first electrically insulating body comprises a ceramic material.
- 3) Bushing according to claim 1 or 2, wherein the first electrically insulating body comprises the at least one protecting edge.
- 20 4) Bushing according to one or more claims from 1 to 3, wherein the first electrically insulating body comprises a first through hole and the packing system comprises a pin inserted in said through hole.
- 5) Bushing according to one or more claims from 1 to 4, wherein the at least one second body is said transformer wall.
- 25 6) Bushing according to claim 4 or 5, wherein the seat for the annular gasket comprises an annular groove positioned crosswise to said pin and in which said first annular gasket can be housed.
- 7) Bushing according to one or more claims from 1 to 6, wherein said at least one annular gasket is substantially in the shape of a torus with quadrangular
- 30 section with convex sides.
- 8) Bushing according to one or more claims from 1 to 7, wherein said at least one annular gasket comprises a number of centring protrusions which protrude

towards the inside of the ring defined by said annular gasket.

- 9) Bushing according to one or more claims from 1 to 8, wherein said protecting edge and/or eventually said annular groove are suitable for limiting the radial expansion of said at least one annular gasket when the bushing is installed and tightly packed.
- 10) Bushing according to one or more claims from 4 to 9, comprising at least one second body suitable for being positioned on the outer side of the transformer wall, wherein the at least one second body comprises:
- a second hole through which the pin can be inserted;
 - a slanting surface with respect to the pin, and
 - the at least one protecting edge,
- wherein the at least one annular gasket is inserted on the pin and tightly packed between the first electrically insulating body and the slanting surface of the second body.
- 11) Bushing according to claim 10, wherein the at least one annular gasket is compressed by and adheres to the pin and to a supporting surface of the first electrically insulating body, so as to provide a seal both around said pin and against said supporting surface when the bushing is installed and tightly packed.
- 12) Bushing according to claim 10 or 11, wherein the at least one annular gasket is substantially in the shape of a torus with circular section.
- 13) Bushing according to one or more claims from 1 to 12, further comprising a third insulating body, suitable for being positioned inside the transformer on the transformer wall and defining a second through hole, the third insulating body being made of plastic material.
- 14) Bushing according to one or more claims from 1 to 13, wherein the third insulating body comprises positioning and orienting means suitable for allowing aligning, positioning and orienting the third insulation body with respect to the transformer wall.
- 15) Bushing according to claim 14, wherein the third insulating body comprises a flange suitable for being rested against the transformer wall when the bushing is installed and tightly packed, said flange comprising four straight sides two by two

substantially parallel suitable for aligning, orienting and positioning the third insulating body on the transformer wall.

16) Bushing according to claim 15, wherein knurling, ribbing or small bosses are provided on the contact surface of the flange, with which the flange contacts and
5 rests against the transformer wall.

17) Bushing according to one or more claims from 13 to 17, wherein a radially protruding part is fixed on or integral with said pin, the protruding part being suitable for engaging with a corresponding seat provided on said third insulating
10 body.

18) Bushing according to claim 17, wherein said radially protruding part comprises a nut or a hexagon head, and said corresponding seat provided on said third insulating body is substantially a hexagonal seat.

19) Bushing suitable for providing the electrical input and/or output of a transformer with oil insulation, said bushing comprising:
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- at least one electrically insulating ceramic body, suitable for being positioned outside said transformer on a wall of said transformer which separates the outside from the inside, said electrically insulating ceramic body defining a first through hole;

20 - a first annular gasket;

- a pin inserted through said first hole to fix said ceramic body on said wall and tightly pack said first annular gasket between said ceramic body and said wall, where said ceramic body defines, at a second end

c) an annular groove positioned crosswise to said pin and in which said first
25 annular gasket is housed;

- d) a first protecting edge that externally surrounds said first annular gasket wherein said annular groove and said first protecting edge, when said bushing is installed and tightly packed, are suitable for enclosing and protect said first annular gasket from the sunlight.

20) Bushing suitable for providing the electrical input and/or output of an electrical transformer with oil insulation, said bushing comprising:

- an electrically insulating ceramic body, suitable for being positioned on the

outside of said transformer on a wall of said transformer which separates the outside from the inside, said electrically insulating ceramic body defining a first through hole;

- a pin inserted through said first hole to tightly pack and fix on said wall said
- 5 ceramic body which defines, at a first end, a supporting surface which lies substantially crosswise to said pin;
- a second body suitable for being positioned on the outside of said transformer on said wall and in its turn comprising a second hole through which said pin is inserted, where said second body defines a slanting surface with respect to said
- 10 pin;
- a second annular gasket inserted on said pin and tightly packed between said ceramic body and said slanting surface of said second body which defines a second annular protecting edge which extends in a longitudinal direction to said pin in order to protect said second annular gasket from the sunlight when said
- 15 bushing is installed and tightly packed.

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