OIL-TO-OIL BUSHINGS SERIES PCTO
SINGLE FLANGE TYPE
VOLTAGE FROM 72,5 kV TO 420 kV

STORAGE, OPERATING
AND MAINTENANCE INSTRUCTIONS

INDEX

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1. DESCRIPTION

1.1 GENERAL

These instructions are applicable to the OIP (oil-paper) condenser bushings of series:

“PCTO” - Rated voltage 72,5 kV to 420 kV

single flange type, according to IEC 60137 Standard, and give all general information to be followed from the receipt of bushings until their installation on the transformer. Other information are given regarding their service and maintenance.

These bushings are manufactured and tested in compliance with the Standard IEC 60137-2008 ed.6, “Insulated bushings for alternating voltages above 1000 V”.

Design, components and manufacturing technology guarantee an average lifetime longer than 30 years, in normal operating conditions.

The designation of the bushing is made as in the following example:

PCTO.245.1050.1000

P	Condenser bushing (“P” from Italian word “Passante”)
CT	Cable to transformer type
O	Oil paper insulation (OIP)
245	Rated voltage (in kV)
1050	BIL – Basic Insulation Level (in kV)
1250	Rated current (in A)

1.2 SAFETY

This manual must be available to the personnel responsible of the installation, operation and maintenance of the bushings.

The installation, operation and maintenance of the bushing present conditions of no safety and it is necessary to follow carefully specific procedures and instructions. No compliance with these procedures and instructions can involve very severe and dangerous conditions for the personnel and the property.

1.3 TECHNICAL CHARACTERISTICS

These bushings are capacitance-graded type, oil impregnated type (OIP), designed for operation one side immersed in the transformer oil, the other one in the cable oil - fig. 1.

The body of the bushing (condenser core), is a continuous sheet of pure kraft paper, wound around conductor rod or tube and oil impregnated, with aluminium foils inserted within the paper layers; this condenser execution improves radial and longitudinal distribution of electric gradients.
They are manufactured with conic envelopes, epoxy resin made, on both sides, and a central metallic body having a single flange. Versions with under flange sleeve in transformer oil side for CT accommodation are available upon request.
The schematic design is showed in figure 1.

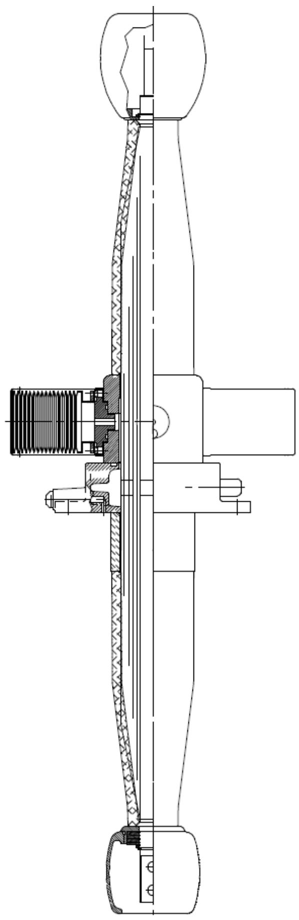


Fig. 1

Mechanical coupling among all the components is obtained by compression springs placed at one side of the bushing.

All the gaskets are O-ring type, in fluorinated elastomer.

Flat gaskets are also provided in order to prevent the contact between the fragile insulators and the metal parts.
The bushings of this series can be mounted in every position.
Both sides are shielded by suitable electrodes, made of aluminium alloy casting or aluminium sheet for the bigger ones. They have the function of reducing the electric gradient in oil.

The flange is equipped with the following accessories:

- Power factor tap;
- Buchholz relay connection;
- Oil drain / oil sampling valve.
- Threaded eyebolts for the handling.

1.4 TYPE OF DIELECTRIC

The impregnation is made with a top quality inhibited super grade mineral oil, fully complying to Standards IEC 60296 and ASTM D3487, with the following outstanding characteristics:

- High dielectric strength (>70 kV/2,5mm);
- Very good low temperature properties (pour point typically <-60°C);
- Low viscosity even at the lowest temperatures;
- Very good oxidation stability;
- Extremely good heat transfer.

1.5 NAME PLATE

Each bushing is provided of a name plate, with serial number and all the electrical data, in accordance with the prescription of IEC Standard.
The plate (fig. 2) is made of aluminium and is placed on the flange by nails. On the plate the following information are indicated:

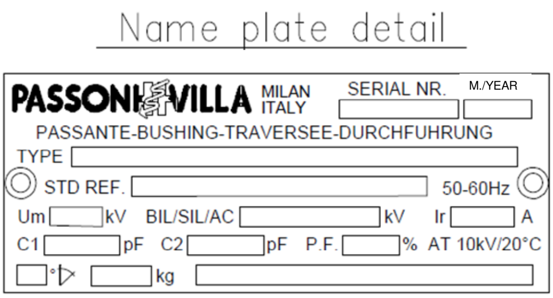


Fig. 2

The month is indicated by a code, as follows:

A = January	L = July
B = February	M = August
C = March	P = September
D = April	R = October
E = May	S = November
H = June	T = December

2. MOUNTING INSTRUCTIONS

2.1 ACCEPTANCE

Upon receipt of the goods the Customer should operate as follows:

- Check the external surfaces of the packing cases:

  - No sign of damage shall be found;

  - The shock indicator, placed in the external part of each packing case (fig. 3), must be white.

Fig. 3

If the shock indicator is red don't refuse shipment, make a notation on delivery receipt and inspect for damage as follow:

- Open the packing case by removing its cover;
- Make sure that the anchoring elements are in order and securely fixed;
- Make sure that there are no leaks from the bushings, especially in the joints between epoxy resin insulators and metal parts and that there are no breaks or broken parts. Please consider that each bushing has been tested completely immersed in oil, therefore some oil traces can be found.

In case any damage is found, leave the original packaging and request an immediate inspection from carrier within 15 days of delivery. Moreover, give the forwarding agent a written claim and notify the manufacturer with the details of the packing list, including the number of the case and the serial number of the bushing.

2.2 STORAGE

Every bushing is protected with a polyethylene bag hermetically sealed and containing a silica gel desiccant cartridge; in such a way the bushing is protected in dry air against the humidity of the ambient.

Although there are no preclusions for the bushings remaining in the open air, it is suggested to store them in a closed room, paying attention to avoid any damage to the plastic bag.

On request, for a long period storage (greater than one year) the bushings can also be shipped with both ends protected by a rigid container, hermetic and containing silica gel desiccant cartridge, or by metallic containers, oil filled and hermetic: bushings so protected can be shipped and stored for a long time even in the most unfavourable weather conditions.

The temperature range acceptable for the storage is from -25 to +50 °C.

For special requirements regarding low ambient temperatures (see paragraph 5), where special o-rings are foreseen, the bushings can be stored at temperature up to – 55°C.

When the bushings are taken out from the storage is necessary to make a visual check to be sure about the good conditions of any part.

2.3 LIFTING AND TRANSPORTATION

The bushings type PCTO are sturdy, nevertheless, in order to avoid dangerous movements, and/or damage some parts, it is better to follow the suggested options.

CAUTION
During the period prior the final installation of the bushing on the transformer, special care must be taken in order to avoid that the both sides of the bushing remain outside and in very humid places for long periods; both sides of the bushing are enclosed in a resin-moulded envelope, which is not hygroscopic: nevertheless it is better to keep the bushing in a dry ambient. Until the bushing is not installed on the transformer it has to be considered as an apparatus for indoor installation.

Packed bushing

The case containing the bushings can be easily lifted with a tackle by applying the ropes on the points and with the inclination as indicated in fig.4. Some indications appear also in the packing case.

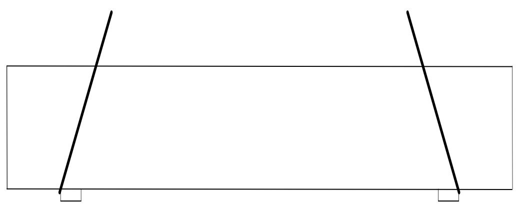


Fig. 4

Unpacked bushing

To take the bushing out of the case, it is possible to follow two different methods.
For small bushings (up to 170 kV) operate as indicated in fig. 5 (<u>first method</u>).
The eyebolts screwed on the flange (fig. 5) can be used to fix a rope, with which the bushing will be taken out of the case. Pay attention that the bushing normally is not equilibrated, being more weighty on one side. For this reason, during the extraction from the case it must be accompanied by hand, avoiding the shift on one side due to its non equilibrated weight.

FIRST METHOD

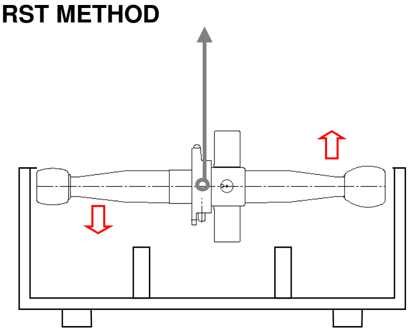


Fig. 5

In case of bushing in which the presence of the bellows will interfere with the described operation (bushings rated 245 kV or more), it is better to use the second method: take out the bushing from the case by placing a rope (NOT METALLIC) around the epoxy resin insulator, on the bottom part of the cable side ending flange, just below the shield fixings plate, according to the fig. 6, paying attention, before this operation, to dismount the shield (for this make reference to the following chapters).
Take care also to place, between the bushing bottom part and the case, a soft cushion, in order to avoid any bushing damage).

SECOND METHOD

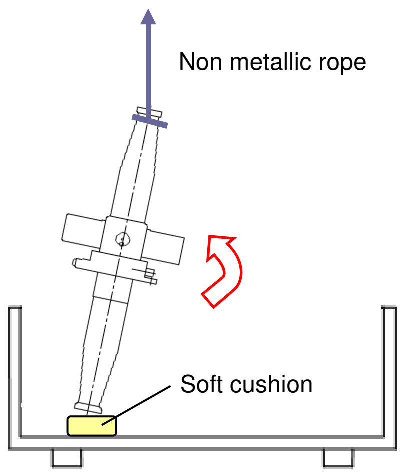


Fig. 6

WARNING
This is a delicate operation, to be made only by EXPERT PEOPLE. Before to start the handling, be sure that the ropes are well fixed. Take care to handle carefully the bushing, avoiding to bump the bellow covers, placed on the flange: they are made by thin aluminium sheet (fig. 8), and can be easily damaged, with the risk to seriously compromise the bushing behaviour during service.

Generally, the best way to transport the unpacked bushing is to keep it in vertical position (fig. 7).

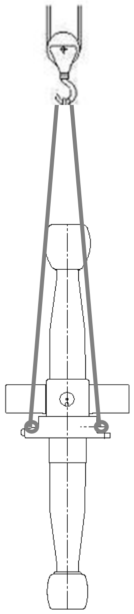


Fig. 7

2.4 SHIPMENT TO THE END USER

The shipment of bushings eventually dismounted from the transformer after its factory tests, has to be made either with the original packing or with a new one, made with the same concepts.
Take care during the bushing handling, specially to avoid damaging the bushing bellows placed on the flange (fig. 5c).

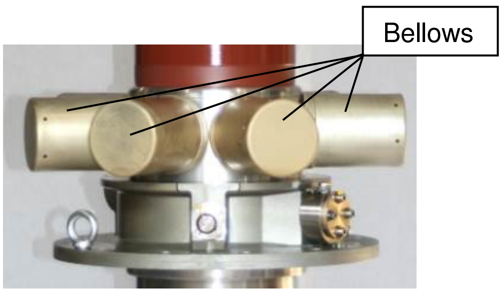


Fig. 8

2.5 INSTALLATION ON THE TRANSFORMER

This type of bushing can be installed in the transformer in any position: vertical or horizontal or any other.
The installation of the bushing on the transformer and the fixation to the insulated connection coming from the winding, must be executed according to the following information, depending of the bushing's type.

2.5.1. DRAW LEAD CONNECTION

In this type of execution, the current in the bushing is carried out directly by the lead coming from the transformer's winding, entering in the bottom part of the bushing, up to the lug placed in the upper part of the bushing (fig. 9).

Use one or more copper leads having total section that gives a current density not higher than 2÷2.5 A/mm^2.

Carry out the assembly as follows, referring to fig. 6:

- The lug must be removed from the head of the bushing in order to make the connection:
  - Disassemble the shield cable side shield (1), by unscrewing the M6 screwed pins (1A) at its base (optional step, in the sense that this operation can also be avoided if the further steps can be done);
  - Disassemble the HV top terminal cap (2), removing the 4 x M8 screws and lock washers (3), which secure it to the bushing head (4). Pull the HV top terminal (2) from the lug (5), keeping the terminal well centered on the axis of the bushing. The necessary force is small (about 10 kg) because the multi-contact blades, located inside the terminal, press softly on the smooth surface of the lug (5). Verify that the o-ring (6) remains seated in the gasket retention groove.
  - Remove the locking pin (7) from the lug hole.

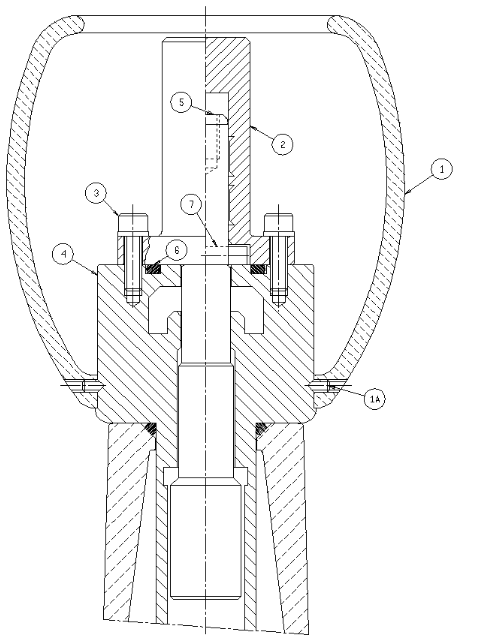


Fig 9

  - Remove the copper lug (2) from the central tube of the bushing;
  - Cut the connection at a right size Lcut plus 20 mm for the soldering of the lug; note that the size Lcut is indicated on the "bushing overall dimensions" drawing, supplied with the bushing's order confirmation;
  - Make a hole, in the lug (fig. 10), having diameter at least 2 mm higher than that of the connection and max. 2 mm lower than that of the lug;

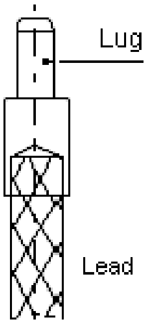


Fig. 10

- Make the connection, through brazing, of the draw lead to the copper lug;
- Fix a threaded eyebolt to the lug, using the M12 hole (fig. 9);
- Place the gasket on the flange on the transformer;
- Slide inside the central bushing's tube from the bottom the lug with the lead;
- Lift the bushing according to the instructions of par. 3.
- Align the hole in the lug with the hole in the central tube and secure the lug in position by reinstalling the locking pin (7);
- Be sure the pin is centred;
- Mount the terminal on the lug as described hereunder;
- Place the bolts on the flange of the bushing.
- Insert the HV terminal (2) on the lug, keeping the terminal well centered on the axis of the bushing. The necessary force is small (about 10 kg) because the multi-contact blades, located inside the terminal, press softly on the smooth surface of the lug. The top terminal cap will hold the pin in place. Tighten the 4 screws with a torque of 20 Nm. The gasket placed between the two pieces assures the transformer oil tightness and for this reason it is necessary to block the terminal before filling the transformer with oil. The gasket which is necessary to assure the tightness between the oil of the bushing and the oil of the transformer is not involved in this assembly.

- Clean well the HV terminal, then mount the HV shield, screwing the pins with a torque max of 10 Nm.

For a better bushing's tail insulation, it is advisable to protect the lead coming from the winding of the transformer with paper (fig. 11); it is suggested to insulate with a minimum layer of 1,5 mm and a maximum diameter of 2 mm smaller than the internal one of the bushing tube, to allow the oil circulation.
The draw lead must be centred at the exit of the bushing tail in order to avoid imperfect shielding.

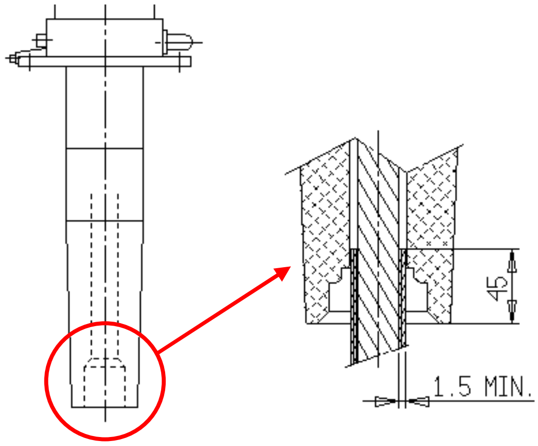


Fig. 11

2.5.2. DRAW ROD CONNECTION

In this type of execution, the conductor is rigid and removable (fig. 12).

The rigid conductor can be sectioned in two parts (fig. 12 and fig. 13), in order to make easier the transport of the transformer.

The two parts are fixed by means of four M8 screws, to be tightened wit ha torque of 20 Nm.

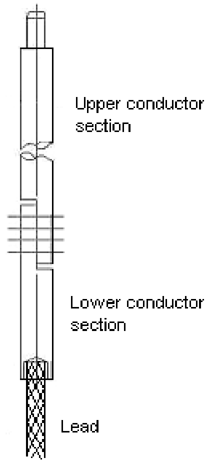


Fig. 12

The connection coming from the transformer must be brazed to the lower extremity of this rod conductor (fig. 12).

The procedure is similar as for the draw lead connection one, explained above, but now instead of a lug it is used a conductor which is placed inside the bushing all along it and coming out from the bottom part.

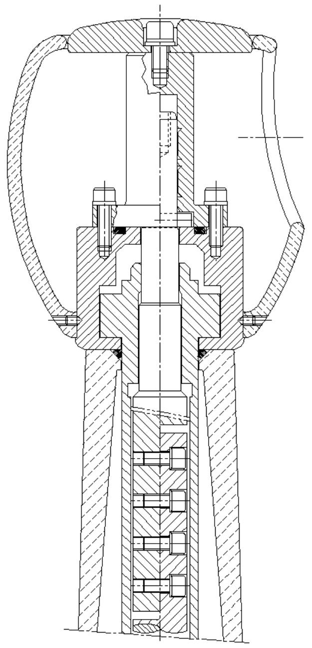


Fig. 13

2.5.3. BOTTOM CONNECTION

In this type of execution, the current is carried directly by the central bushing on-piece conductor from the cable side terminal (fig. 14) to the transformer side one (fig. 15, and fig. 16 for two different voltage classes).

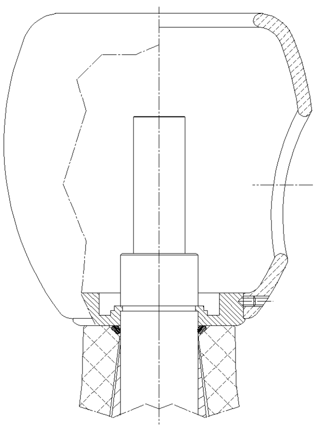


Fig. 14

In this case the HV top terminal, cable side, has not to be dismounted.

CAUTION
In the bottom connection execution, the cable side HV terminal has not to be dismounted.

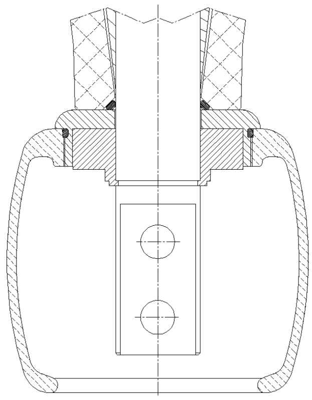


Fig. 15

Fig. 16

2.6. DIELECTRIC SHIELDS

The ends of the bushing are shielded by suitable aluminium electrodes. They have the function of reducing the electric field both sides.
These deflectors are removable (except for the lower voltage classes bushings, see fig. 16) to facilitate the connection.

The fixing system of the shield to the bushing can be realized in two different ways:

1. The shield is fixed by means of some screwed pins. This system is used when the HV connection is realized laterally (fig. 9, fig. 13, fig 14).
2. The shield is directly screwed on the bushing closing flange. This system is used when the HV connection is realized on the bushing axis (fig. 15).

The advantage of the configuration n. 1 is that the lateral shield hole can be oriented in any direction, according to the Customer needs.
To turn or remove the shield it is sufficient to loosen the screwed pins, rotate the shield in the right position, tighten the pins (max torque of 10 Nm).
The second configuration (screwed shield) is the standard one used in all the other bushings. To avoid any possible deflector’s movement in this configuration due to vibrations during service, an o-ring is placed in the thread (fig. 16a and fig. 17).

Fig. 17

Before screwing the threaded shield on the closing plate, we recommend cleaning accurately both threads with alcohol and compressed air and put a layer of Vaseline on them.
If for mounting reasons the shield needs to be disassembled more than three times, it is better to substitute this O-ring with a new one,

CAUTION
Do not remove the threaded shield with the bushing in horizontal position: this could cause the fall of the shield over the closing plate or the terminal, thus damaging the threads.

Normally all bushings shields, up to 245 kV class, are painted with a polyurethane varnish (fig. 16); for upper voltages they are covered by an epoxy resin layer of 2-3 mm thickness (fig. 18).

CAUTION
During handling, take care to avoid damaging the external finishing coat of the shields, important in the dielectric strength of the bushing oil side.

Fig. 18

From the class 245 kV, in case of shield with lateral HV connection exit, the axial hole of the shield is screened by a suitable electrode, with a surface painted or epoxy resin covered in the same manner as the shield. This solution has been made to reduce the local electric field on the shield hole border, present when the hole is not used for the HV connection.
This electrode is fixed to the HV connection pin by means of a M10 screw (fig. 13), and has to be dismounted if the shield needs to be removed.
At the end of the connecting operations made by the customer, this cover must be repositioned and the M10 screw tightened with a max torque of 25 Nm.

To resume, table 1 gives the max. tightening torque for the different types of screws used in these bushings.

Screw type	*Torque (N m)*
M6	10
M8	20
M10	25
M12	40

Table 1

2.7. TEMPERATURE LIMITS

Bushings of the series PCTO are designed for operation at temperatures, according to IEC 60137, table 2.

- Ambient temperature max. ≤ + 40°C
- Daily average value. ≤ + 30°C
- Ambient temperature min. ≥ - 25°C
- Oil temperature average value. ≤ + 90°C
- SF6 temperature max. ≤ + 70°C

For special requirements regarding low ambient temperatures (up to –60°C) special o-rings are foreseen, made of fluorinated-silicone mixtures for low temperatures.
The spring closing system is calibrated in order to maintain the bushing hermeticity at these extreme conditions and the oil maintains its proprieties. For any other special or different condition please inform the manufacturer and ask for the permission to put in service the bushings.

2.8. OIL FILLING OF TRANSFORMER

Bushings can withstand the vacuum conditions and temperature (up to 90°C) which occur during the treatment of the live part made inside the transformer case.
The oil filling level has to reach at least the bushing flange, during the oil filling of the transformer under vacuum (for dielectric reasons).
In case the oil filling is made from the top of the transformer without the vacuum treatment, it is necessary to check that the oil level reaches the bushing flange, without the presence of air bubbles.
For this purpose, the flange is provided with a plug which allows the air (if present) to flow out.

CAUTION
The characteristic of withstanding vacuum and temperature refers to new bushings. In case of old bushings, it must be considered the natural de-rating and ageing of the gaskets

2.9. CONNECTION TO BUCHHOLZ RELAY

A 1/2" GAS threaded plug is placed on the bushing flange (fig. 19) in order to:

- connect the relay tube;
- eliminate the air pocket which may be formed during some executions and by the filling of the upper part of the transformer not under vacuum. In this case we suggest unscrewing the plug and leave that the air flows out. When the oil begins to come out, close it.

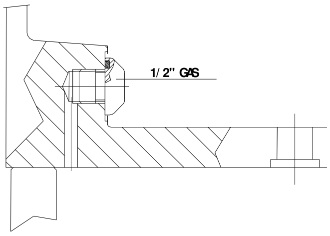


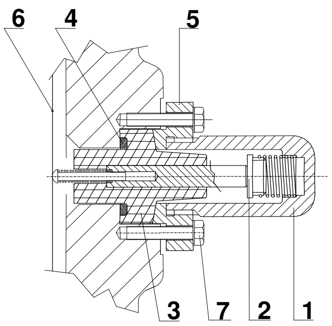
Fig. 19

2.10. POWER FACTOR TAP

Each bushing is equipped with a power factor tap, put on the flange.

The PF tap is schematised in fig. 20.

WARNING
The PF tap has to be grounded during the normal operation of the bushing. Do not apply voltage to the bushing if the PF cap is removed. The cap grounds the tap connection. It is advisable to check that the cap of the PF tap (see fig. 20) is well screwed (by hand). A forgetfulness of this generates during service a voltage on the tap that exceeds the insulation dielectric strength: this may lead to a catastrophic failure.



1 - Closing and grounding cap (removable)
2 - Measurement electrode
3 - Insulating bushing
4 – Gaskets
5 - Mounting flange
6 - Last layer
7 – Fixing screw (irremovable)

Fig. 20

On request a special connection to bring outside of the cable turret the PF cap can be supplied (fig. 21).
In such a way the PF tap will be always accessible for measurements, during the transformer / bushing life.
This special PF tap requires a modification on the cable turret: a hole must be done and a special flange has to be soldered, according to the drawings which will be supplied (fig. 22, red part).
In this case the bushing will be equipped with a special PF connection, to which the cable supplied with the kit must be screwed (fig. 22, blue part), taking care to unscrew before the grounding cap (fig. 23).
In such a way the kit for the PF external prolongation (fig. 22, green part) can be mounted: on the bushing side it will be screwed to the PF tap of the bushing, on the other side it will be fixed, by means of four M6 screws, to the suitable flange made on the cable turret (tightening torque according to the table 1).

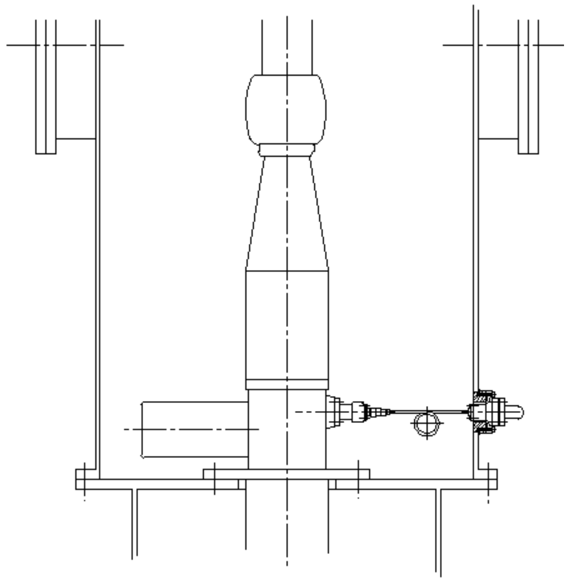


Fig. 21

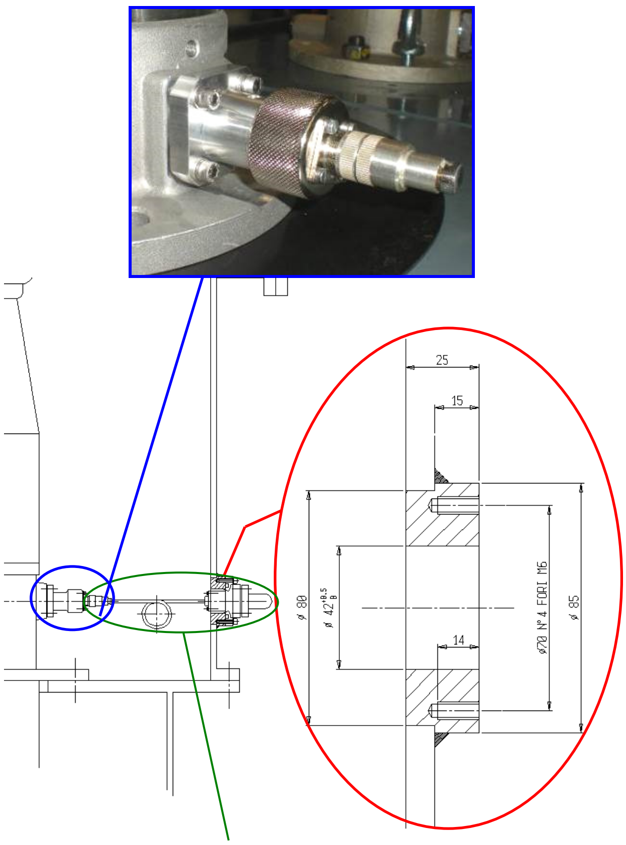


Fig. 22

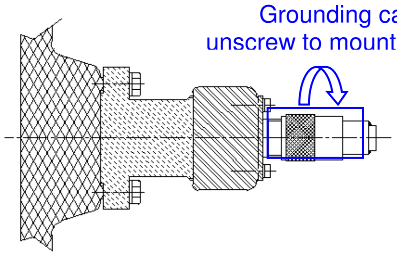


Fig. 23

3. SERVICE AND MAINTENANCE

3.1 METAL PARTS

The flange and the metallic components of the oil expansion vessel of the bushings are made of Aluminium alloy casting and do not require any special surface treatment / maintenance. Only in case of installation in aggressive environment (i.e.: coastal, high pollution, high salinity), it's recommended to protect said metal parts with a layer of antirust coating.

3.2 CHECKS AFTER INSTALLATION

After the installation on the transformer it is advisable to make a check of the bushing capacitance and tgδ.

Normally the measurement must be carried out between the HV terminal and the Power Factor tap.

The capacitance values measured in manufacturer's HV laboratory are shown in the test report of the bushings.

During the operation, the connection tap must be grounded or directly by screwing the tap cap or through the measuring instrument connected to the power factor tap.

WARNING
Don't unscrew the screws item 7 of fig. 20, which fix the PF flange to the bushing. If accidentally this operation happens some oil goes out from the bushing and the electrical contact between the internal condenser body and the flange can be damaged.

3.3 MAINTENANCE

The bushings PCTO are hermetically sealed and therefore an excellent preservation in time of the dielectric properties of the oil paper is ensured.
As for the preservation of the active part, these bushings require no maintenance.

It is recommended to perform every 5 years the measurement of the dielectric losses (tgδ) following the instruction under par. 7.

Check the proper location of the tap cap and its suitable complete screwing in order to prevent entrance of moisture.

WARNING
The bushing is fully filled with oil and is provided with one or more bellows for the compensation of oil volume variations due to the temperature changes during the operation. Bellows are located on the flange and are protected with special covers, made of aluminium thin sheet. These covers are not to be opened for any reason, to avoid damages on them and also the risk of unscrewing the bellows themselves, with oil exit and consequent risk of internal flashover in the bushing during service.

4. DISASSEMBLY OF THE BUSHING

To disassemble the bushing operate according to the constructive solution adopted for the transformer, in parallel with the following suggestions:

- Bring the oil until a level lower than the bushing flange;
- Remove the top and bottom connections;
- Fix the bushing as indicated in par. 2.3;
- Remove the bolts that fix the flange;
- Finally lift the bushing following the indication given in par. 2.3.

5. MEASUREMENT OF DIELECTRIC LOSSES

The Standard - IEC Publication 60137 states that the oil-paper bushings must have a tanδ less than 7×10^{-3}.

The measurement is performed in the RPV Test Laboratory by means of a Schering bridge (Tettex type) at the voltages requested by the Standards.

All values are shown in the Routine Test Report.

Measurement at the voltage of 10 kV is carried out in order to have a reference value for comparison with measurements made at site during the service of the bushing.

With the bushing already installed on the transformer and the cable terminal disconnected, the measurement can be performed by means of a bridge, by applying a voltage of 10 kV between the HV terminal and PF tap, maintaining grounded the flange (C1 measurement). The bushing is considered good if a tgδ less than the maximum one established by the Standards is measured.

If a tgδ higher than the above one is measured, please contact the manufacturer, who will decide if it is necessary to make other tests before removing the bushing from service or to ship it back, in order to make a complete check and eventually to carry out an oil treatment or eventually to replace the active part with another of new manufacture.

In order to measure the Co value (capacitance between the PF tap and flange) the flange has to be supplied with a voltage maximum of 2 kV and the PF tap has to be connected to the bridge.

A field measurement of tgδ and capacitance can differ from the measurements carried out in the factory due to the different conditions of test and relevant accuracy: for this reason a light shifting (10-15% for tgδ) is acceptable. Furthermore the installation conditions can affect the capacitance value.

The presence of the kit which brings outside of the cable turret the PF tap will further slightly modify the value of capacitance.

For all the previous reasons it is suggested to measure capacitance and tgδ upon the installation and use these values as base for future comparison measurements.

5.1. CHECKS ON OLD BUSHINGS

Before reinstalling an old bushing, it is advisable to carry out the following checks:

- Mechanical checks: check that no leakages occur on all the surface;

- Electrical checks: put the bushing at 10 kV and measure capacitance and tgδ. It will be suitable for service if, as regards the values of reception test, there are no increase higher than (note: values only indicatives):
  - 1% for the capacitance C1 (this assure that there isn't a perforation between two layers);
  - 30% for tgδ of capacitance C1;
  - 100% for tgδ of capacitance Co.

An increase of the last value means a deterioration of the dielectric characteristic of the external layers of the paper and/or of the oil in the interspaces between the condenser body of the bushing and the external housing. This is not a dangerous problem, because normally the most external layer is grounded, and this fact puts in short circuit the dielectric involved in this increase of tgδ.

5.2. EXTRAORDINARY CHECKS

If the electric measurement detects a tgδ higher than the limits it is suggested to carry out an oil sampling (see par. 6) and to perform the following tests:

- Humidity content;
- Dielectric strength;
- Dielectric losses;
- Gas chromatography.

The indicative values to be found are here below described,

- Humidity content:

  Original value: ≤ 10 ppm
  During service: ≤ 20 ppm

- Dielectric strength:

  Original value: ≥ 62 kV/2,5 mm
  During service: ≥ 45 kV/2,5 mm

- Dielectric losses (tgδ):

  Original value: $\leq 7{*}10^{-3}$
  During service: $\leq 12{*}10^{-3}$

- Gas chromatography (DGA):

  Make reference to Standards (IEC 60599, IEC TR 61464).

If these checks give negative results, it is necessary to ship back the bushing to the manufacturer, who will perform a complete set of electrical tests and eventually will decide to make an oil treatment to the bushing or to replace the active part with another one of new construction.

6. OIL SAMPLING

6.1 EQUIPMENT

To carry out oil sampling, we need the following tools (see fig. 26):

- A semi-rigid pipe (item 3);
- A two-way valve (item 4) with a suitable connection to the syringe;
- A 150 cm^3 oil syringe (item 5), lab. type;
- An appropriate plug that can be screwed in one side at the bushing valve, placed on the flange, and at the other side on the tube (item 2).
- A syringe cap;
- Adhesive tape.

NOTE

Depending on the bushing type, the valve can be of two different types.

The first one is the classical type, as shown in fig. 24. To operate it is needed to remove the protecting plate by unscrewing the four M8 screws on the front.

The connection is a threaded hole, 1/4” GAS type, at which a suitable connection has to be screwed.

Fig. 24

The second type is composed by a special system with a lateral ¼” GAS threaded hole, as for the first type. A suitable connection must be threaded on this hole, by unscrewing before the protecting cap (fig. 25).

The valve will be opened (and closed) by unscrewing the central opening screw (fig. 25).

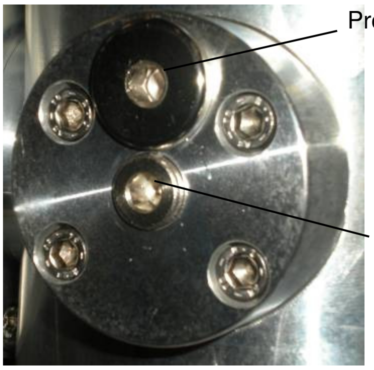


Fig. 25

6.2 OIL SAMPLING

The operation is to be carried out when the line is off.

Preparation

Operate as follows (refer to fig. 26):

- Clean the plug zone accurately;
- Prepare all the syringe apparatus, with the valve (item 4) and the pipe (item 3);
- Be sure that the sampling valve, on the bushing flange, is closed (item 1);
- Unscrew the oil sampling plug or flange and screw the connecting cap (item 2), on which the tube (item 3) is to be applied in sequence.
- Open the 2nd way of the valve (item 4);
- Open the 1st way, shut off the 2nd way of the valve (item 4);
- Open a little and slowly the valve or the screw, depending on the valve type (item 1), to let the oil go out from the bushing;
- Drain oil from the bushing letting it flow out until there are no more air bubbles;
- Shut off the 1st way and open the 2nd way of valve (item 4).
- Wash the syringe with oil two times by repeating the following operations:

  -Open 2nd way of valve (item 4);

  -Fill in the syringe with some oil (about 10 cm^3);

  -Open 1st way of valve (item 4);

  -Empty the syringe;

  -Close 1st way of valve (item 4).

Oil sampling

For the oil sampling please follow these instructions:

- Open 2nd way of valve (item 4);
- Let oil get in the syringe up to the appropriate volume (approx. 60-100 cm^3);
- Shut off both 2nd way of the valve (item 4) and the bushing valve (item 1);
- Remove the syringe by unplugging the valve (item 4) from the tube (item 3);
- Set the syringe (item 5) with the valve (item 4) being up;
- Unplug the valve (item 4) and place a closing cap;
- Clean the syringe (item 5) and block it with adhesive tape on which you will write down the bushing part number;
- Overturn the syringe and keep it with its cap down.
- Clean the valve zone, close it with its protecting cap or flange and seal it again.

The abovementioned operations involve, on the whole, a sampling of less then 0.20-025 litres of bushing oil.

In case of need of oil sampling, on the market it is possible to find a kit for the oil sampling, completed of syringe, two ways valve, connecting tube, bottles and containing box, suitable for transportation (fig. 27).

WARNING
For bushings up to 170 kV, it is possible to make oil sampling only one/two times, trying to take the smallest quantity of oil (one time only for the class 72.5 kV), to avoid that the bushing looses too much oil. For further oil sampling, it will need to fill up the oil (please contact the manufacturer to ask about the filling up of the oil: this is a very delicate operation)

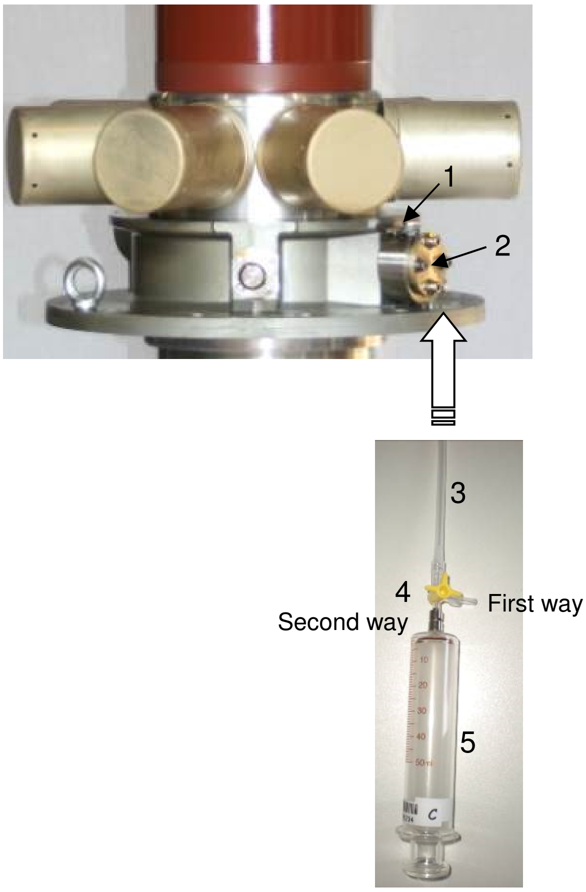


Fig. 26

Fig. 27

7. DISPOSAL AT THE END OF LIFETIME

The bushing consists of the following materials:

Component	Material	Action
Winding conductor	Copper or aluminium alloy	Dismount and recycle
Terminals and bottom plates	Copper, aluminium alloy or brass; optional silver or tin coating	Dismount and recycle
Insulating oil	Mineral oil acc. IEC60296	Recycle
Winding	Cellulose paper and thin aluminium foils	Dispose or thermo-destruction
Nuts, bolts, washers and springs	Stainless steel, carbon steel	Dismount and recycle
Oil expansion bellows and covers	Stainless steel and aluminium alloy	Dismount and recycle
Flange and extension	Aluminium alloy	Dismount and recycle
PF tap and cover	Nickel or tin coated brass, tin coated copper, stainless steel	Dismount and recycle
Insulators	Epoxy resin	Dispose or thermo distruction
Shields	Aluminium alloy covered with either epoxy paint or epoxy resin	Dismount and recycle