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AIR TO SF6 BUSHINGS SERIES PABS

VOLTAGE OF 420 kV AND 550 kV



**INSTRUCTION FOR STORAGE, TRANSPORTATION,
INSTALLATION AND MAINTENANCE**



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1 DESCRIPTION

1.1 GENERAL

These instructions are applicable to the air to SF₆ type bushings of the series:

“PABS” for rated voltage of 420 kV and 525 kV

according to IEC 60137 Standard “Insulated bushings for alternating voltages above 1000 V”, and give all general information to be followed from the receipt of bushings until their installation on GIS, GIL or dead tank Circuit Breakers. Other information are given regarding their service and maintenance.

The designation of the bushing is the following:

PABS 420.1425.4000

P	Condenser bushings (“P” from Italian word “Passante”)
AB	Air to GIS (“B” from Italian word “Blindato”)
S	SF ₆ insulation
420	Rated voltage (in kV)
1425	BIL class -Basic Insulation Level (in kV).
4000	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 bushings 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.

Please follow carefully all the instructions of the manual and pay attention to the WARNING (severe hazard), and CAUTION (minor hazard) signs.

1.3 TECHNICAL CHARACTERISTICS

SF₆ gas (1), at certain density, is used as the main insulation. Until 362 kV rated voltage simple shield(s) are used to achieve the proper electric field distribution over the bushing’s housing.

Bushings of rated voltage 420/550 kV have semi-graded insulation (2) made from synthetic films impregnated with gas SF₆. This insulation not only ensures a better distribution of the electrical field along the porcelain (3) and protective tube (4), (or composite insulator), but, also, a reduction of it’s radial dimensions.

The standard HV terminal (5) is a \varnothing 40/50/60 mm aluminium stud, fixed to the top plate (6), without any gasket in the conductor (high temperature) region.

The high voltage part of the bushing is adequately screened with a shield (7).

Other type of HV terminal, like tinned copper stud or NEMA type, is available on request.

Central conductor (8), aluminium or copper type, is fixed to the top plate, while the opposite extremity, usually silvered, is intended for connection with GIS, GIL or CB. The type of bottom connection is done according to the request.

The flange (9) is adaptable to customer’s fitting.

In transportation and storage the bushing 420/550 kV is always under the small overpressure of dry N₂ (0.2 – 0.3 bar) its lower part is closed with a protective cap (10) equipped with automatic-non-return valve (11) (type DILO DN8).

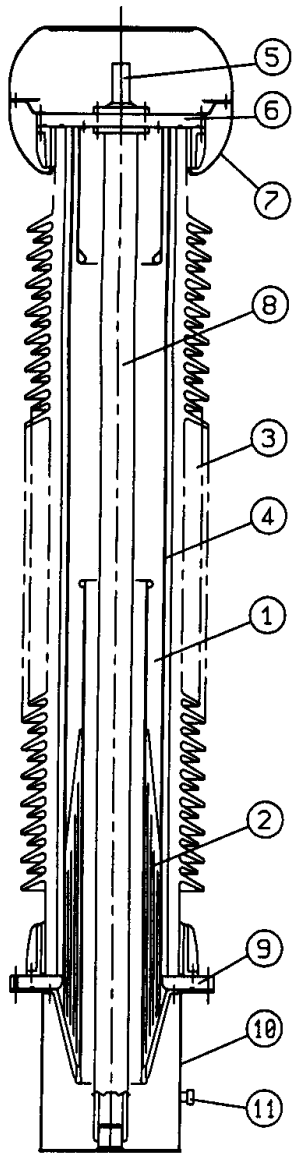


Fig. 1

1.3.1 SF₆ INSULATION

The basic insulation is gas Sulphur-hexafluoride (SF₆), which is known as:

- poison less;
- inert;
- non-inflammable;
- good dielectric and arc-quenching medium.

In comparison with oil paper-insulated bushings, the SF₆ bushings are less sensitive on the humidity and air presence, what leads to a shorter production time and a more reliability in the service.

1.3.2 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 Standards.

The plate (fig. 2) is made of aluminium and is placed on the flange by nails. On the name plates the following information are indicated:

- Type of bushing
- Insulating voltages
- Rated current
- Max. mounting angle (in degrees from vertical)
- Weight
- Serial number
- Month and year of production
- Number of outline drawing
- Minimum operating. Filling, design pressure

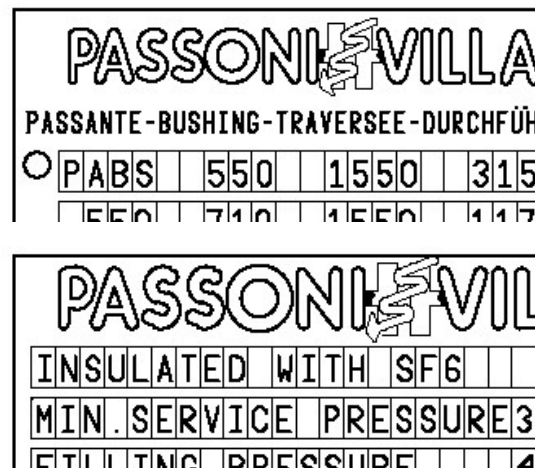


Fig. 2

The month is indicated by a code, as follows:

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

2 PACKING AND STORAGE

2.1 PACKING

Transport of the bushings 420/525 kV is performed in horizontal position. Only one bushing is packed in a wooden case. During transportation and storage the bushing is always under a small overpressure (0.2 – 0.3 bar rel.) of dry N₂.

Preferable vehicle for land transport is truck. Maximum recommended transportation velocity is 70 km/h. Care has to be paid to avoid strong vibrations and bumps. To verify this, check the shock indicator (with value of 25g x 50m.s.) attached on the transport assembly; if it indicates irregular transport conditions, or if the



wooden case is visibly damaged, make a note in the presence of the transport company responsible person. Inform immediately the manufacturer's representative.

2.2 ACCEPTANCE

Upon receipt of the goods, before taking the bushings down from the truck, customer should operate as follows:

- Check the external surfaces of the packing cases:
 - No sign of damage have to be found;
 - The shockwatch indicator (with value of 25g x 50 ms), placed in the external part of each packing case (fig. 3), must be white.



Fig. 3

If the shockwatch 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 breaks or broken parts.

In case any damage is found, leave in original packaging and request an immediate inspection from carrier within 15 days of delivery.

Moreover give the forwarding agent a written claim and notify Passoni&Villa with the details of the packing list, including the number of the case and the serial number of the bushing, to the following address:

Grid Solutions Spa- Unit RPV
Via Nuova Strada di Piano PPR Vulcano
20099- Sesto San Giovanni (ITALY)
PHONE: +39-02-24105001

2.3 STORAGE

Every bushing with composite insulator is protected with a polyethylene bag hermetically sealed and containing a silicagel bag; in such a way the bushing is protected in dry air against the humidity of the ambient. Although there is no preclusions for the bushings remaining in the open air, it is better to store them in a weather proof ambient.

The bushing must be kept in its original packing, under the small overpressure (0.2-0.3 bar) originally foreseen, until the installation.

If the bushing has to be opened and used for some tests, at the end of use it is recommended to close it with its protective cover, to make the vacuum for minimum 2 hours (pressure less than 10 Pa), and to fill it with dry N₂ at 0,2-0,3 bar relatives.

3 LIFTING AND TRANSPORTATION

The bushing type PABS is sturdy, nevertheless, in order to avoid dangerous movements, it is better to follow the suggested options.

3.1. PACKED BUSHING

The case containing the bushing can be easily lifted with a tackle by applying the ropes on the points and with the inclination as indicated in fig.4, or using a fork vehicle.

Some indications appear also in the packing case.

3.2. UNPACKED BUSHING

Before unpacking check the delivery documentation on the packing list fixed on the wooden case.

After unpacking, check the porcelain (or composite insulator) and the other parts of bushing. Any damage, especially on the porcelain must be carefully analysed. Inform the manufacturer's representative for further instructions.

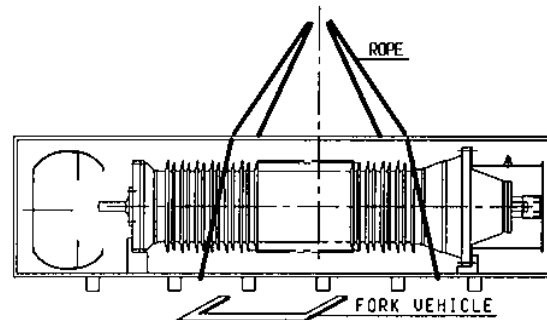


Fig. 4

CAUTION



Bushing with broken or partially broken porcelain is not for usage and is very dangerous for personnel and surrounded equipment.

To take the bushing out of the case, operate as indicated in fig. 5 and fig. 6.

Pay attention to following items:

- Handling with porcelain or composite insulator bushing has to be very careful, with special attention not to damage the sheds of the insulator
- Use only "nylon" lifting ropes.
- Never lift the bushing putting the lifting rope over sheds or between the sheds, but over the metal flange or over the silicon body, with a soft protection strip (for example rubber strip thickness ≥ 2 mm) between the silicon and lifting rope.
- In the local transport or during putting the composite insulator bushing in horizontal position, don't use any kind of supporters, between sheds and base. Soft rubber sheds could be highly deformed or even broken. Support the bushing only at the metal flanges.
- Plastic sheet cover on the composite insulator has to be removed carefully. If a blade is used, be careful that insulator will not be cut.

CAUTION

This is a delicate operation. Before to start the handling, be sure that the ropes are well fixed.

Make all these operations only by expert people.



On the flange of bushings four holes M12 are foreseen. They can be used for the connection to earth, or if necessary to apply eyebolts for lifting, or to tighten two screws working as extractors during the dismant of the bushing, in case of difficulties.

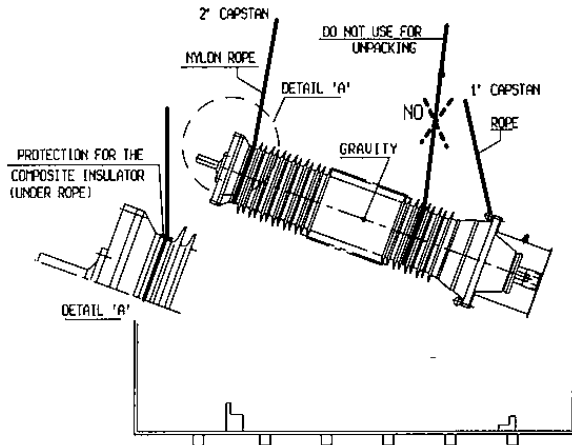


Fig. 5

3.3. SHIPMENT TO THE END USER

The shipment of the bushings by the GIS or CB manufacturer to the final destination, must be made with the original packing or with a new one, made with the same principles, under the small overpressure (0.2-0.3 bar) originally foreseen, until the installation.

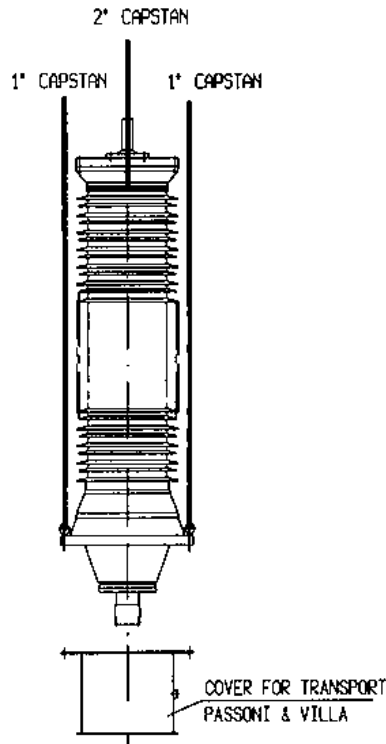


Fig. 6

4 INSTALLATION

The outdoor installation can be done only during good weather conditions without rain, snow, and very high humidity.

Before the installation, reduce the inside (transport) pressure, pressing the automatic valve on the transport cover (item 1 - fig. 7).

Put the bushing in vertical position, using two cranes, according to fig. 6.

When the bushing is in vertical position take off the protective metallic (transport) cap by unscrewing the M12 screws that fix the cap to the bushing's flange.

WARNING

Remember that the conductor is fixed only in the upper part of the bushing, so in this phase of mounting procedure do not incline the bushing.

In some cases, particularly when the bushing is very long, the central conductor (item 2 - fig. 7) is fixed in the lower part of the bushing in order to prevent damages during transportation. This mechanical action is realised through some Belleville springs (3) placed in the bottom part of the protective cap (4).

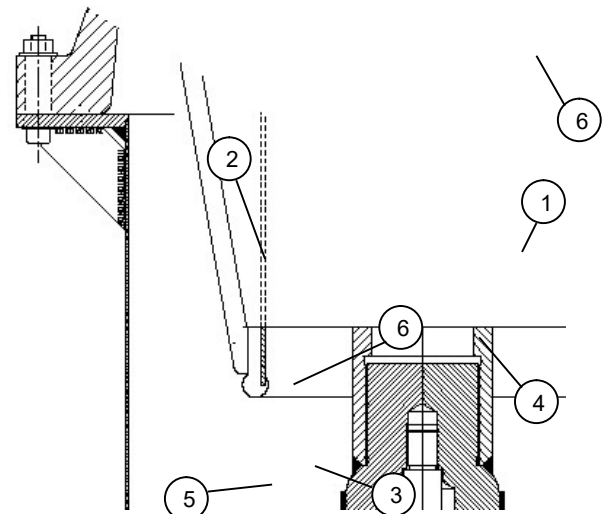


Fig. 7

In this case, the dismanting procedure is the following:

- Unscrew the bolt (5) (M30 screw);
- Take off the springs (3) with their metallic guide;
- Unscrew the M12 screws (6) that fix the protective metallic cap to the bushing's flange;
- Take off the metallic protective cap (4);



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- Unscrew from the central conductor the screwed stem (6), with a key 25 mm.



Make than a control of the followings things:

- Diameter of fixing holes;
- Conductor dimensions in the lower part (for multi contact GIS connection);
- The state of contact surfaces;
- The state of insulation surfaces (PP winding...);
- Dimensions and state of groove(s);
- Dimensions of HV upper terminal.

Clean the bottom part of the bushing conductor with clean cloth and alcohol.

During the coupling of bushing with GIS, in vertical position, control the centring of bushing conductor, that is fixed only in upper part and can not to be perfectly in centre line.

For service condition it is allowed a conductor eccentricity of ± 1 mm. If it is necessary, use some clean and soft tools to centre the conductor inside the contact, which is sensitive to mechanical damages.

If the bushing installation is performed under an angle (in respect to vertical line, until 90°), it is necessary to use the assembling tool showed in fig. 8 and in fig. 9. Two parts of assembling tool are inserted between conductor and floating shield, fixed together with screw (furnished only on request).

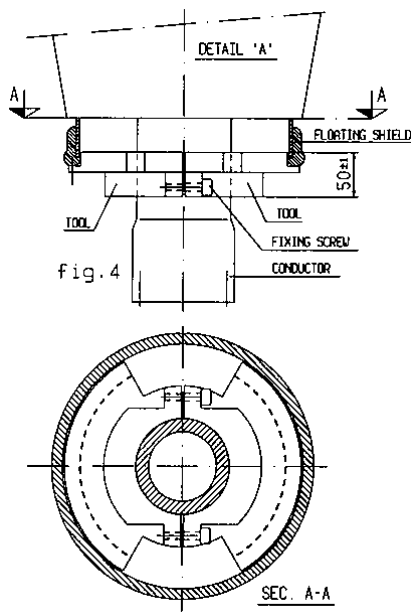


Fig. 8

After connecting the bushing with GIS, the assembling tool has to be removed through the GIS window (fig. 9).

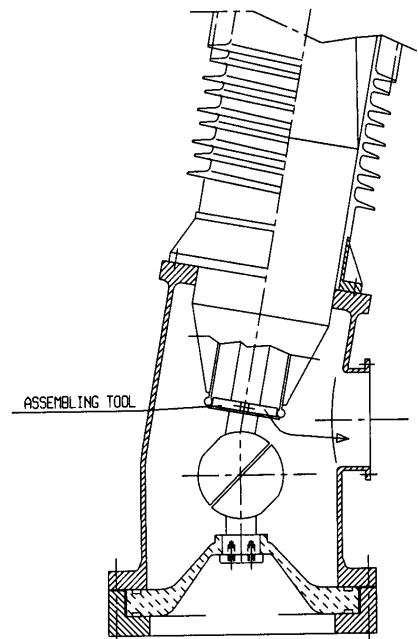


Fig. 9

4.1 HV EXTERNAL SHIELD

On the porcelain type bushing the external HV shield (fig. 10) is composed of three pieces, of which the lower part is cut in two pieces, to enable assembling on the flange, while the upper part is a single piece.

The mounting procedure is the following:

- Disassemble the part 3 of the shield (fig. 10A-B);
- Assemble the remained part of the shield on the bushing, supporting it on the three small plates (item 6 - fig. 10C).
- Add the shield's part 3, placing it on the 4th plate (fig. 10C).
- Fix all screws (item 4 – fig. 10C).
- Control the junction places of the parts of HV shield, which have to be in the same plane.

4.2 FLANGE EXTERNAL SHIELD

Bushing 550 kV, porcelain design, with high requested withstand switching impulse ≥ 1300 kVp and low radio interference voltage level (R.I.V. $< 500 \mu V$), is equipped with a bottom shield made from two pieces (items 7-8 - fig. 11).

The assembling has to be performed by fixing each shield part on the six "Z" shaped plates (item 9 - fig. 11), already fixed to the bottom flange. The two shield parts are then to be fixed together through two additional plates (item 10 – fig. 11 detail A), positioned on their junction place.

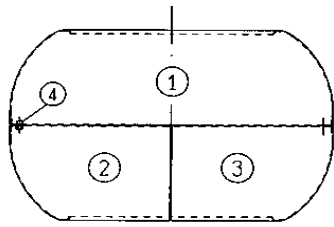


Fig. 10A

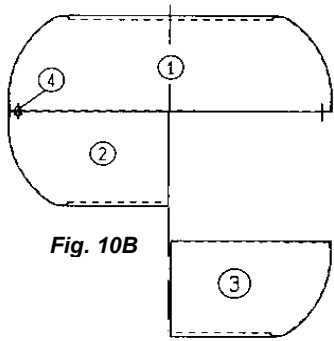


Fig. 10B

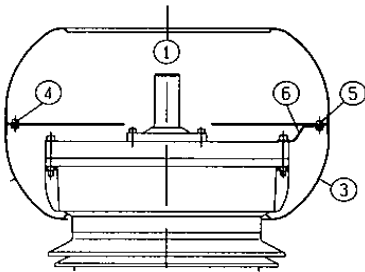


Fig. 10C

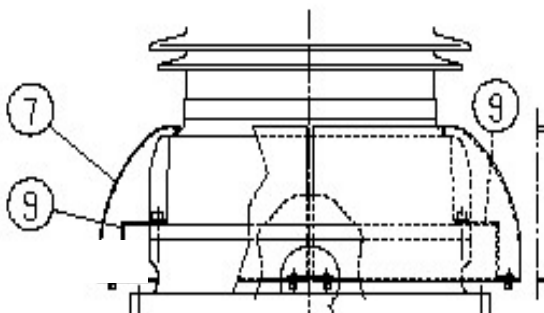


Fig. 11

When the bushing is equipped with a composite insulator, the HV external shield is made in a single piece, and its assembling on the bushing top plate is very easy.

The assembling of the external shield has to be performed only when the object is already installed on the GIS, GIL, CB.

4.3 HV TERMINAL

If the bushing's HV terminal is aluminium made, remove the oxide thin layer from bushing (aluminium) terminal, brushing it (with steel brush) under the right angle direction and put immediately over the brushed surface a thin layer of contact grease in order to prevent further oxidation.

Fix then the air line terminal to the bushing.

5 FILLING-REFILLING TREATMENT

When the bushing, with proper gasket, is installed and fixed to the GIS (CB), perform the following treatment:

Case a - The bushing has been left open less than 1h at an umidity level $\leq 60\%$:

- Make the vacuum at least 3 hours, at a vacuum level $\leq 10\text{Pa}$.

Case b - The conditions of case a are not fulfilled:

- Vacuuming at least 1hour ($\leq 10\text{ Pa}$);
- "Washing" with dry N_2 , at least 2 hours, at a pressure equal to the filling one;
- Vacuum at least 2 hours ($\leq 10\text{ Pa}$).

After a) or b) fill the bushing with gas (SF6-IEC 60376 or SF6/N2; N2 – 99,998% purity) until the pressure reaches the value indicated on the nameplate (fig. 2). Bushing has to be maintained under pressure for at least 4 hours, before applying the voltage.

In case the bushing is intended to operate under SF6/N2 mixture, for example 60% - 40%, filling has to be performed with an already prepared mixture or making it with partial pressures:

60% x 6 bar (abs) SF6 = 3.6 bar (abs) (2.6 bar rel.);
40% x 6 bar (abs) N2 = 2.4 bar (until a filling pressure of 6 bar abs). SF6 acc. to IEC 60376; N2 : 99,998%.

NOTES

- As the bushing has normally a common gas zone with GIS/GIL, vacuum and filling plug is on the GIS body.
- The prescribed treatment is referred to the volume of approximately 800 litres. If the total volume is significantly higher, the time of treatment has to be extended proportionally.

When during service the pressure drops at minimum operating pressure, under normal leakage $< 1\%$ (alarm signal appears), the bushing needs to be refilled up to the filling pressure indicated on the nameplate.



The filling with pure SF6 or mixture SF6/N2 has to be done through the automatic valve, which is placed on the GIS part. The user can make the refilling from SF6 device or simply from SF6 bottle paying high attention to the cleanliness of the connecting tube and valves.

direction and put immediately over the brushed surface a thin layer of contact grease in order to prevent further oxidation.

WARNING

The bushing cannot be maintained in service if the gas filling pressure drops at a value less than the minimum one indicated on the nameplate.

Metal parts

It is advisable after a period of 10 years to give a further paint coating.

7 SPARE PARTS

No spare parts are delivered with the bushing.

6 SERVICE AND MAINTENANCE

The bushings PABS are considered as maintenance free.

Control periodically the system pressure through a temperature compensated manometer, to be sure that the internal bushing pressure be greater than the minimum working one.

As for the preservation of the external surfaces, generally is recommended to perform the following inspections.

8 LIFE TIME

The lifetime of bushing depends of various factors (ambient conditions, service conditions....).

In normal ambient conditions (-25/+40°C, normal pollution...) and normal service conditions, the estimated lifetime of the bushing is about 30 years.

Lifetime of composite insulator is estimated at around 25 years, based on the experience and severe tests, made on this new material (acc. to IEC 61462).

Porcelain

Check for chips, cracks and contamination. Minor chips maybe painted with an insulating varnish to obtain a glossy finish which will prevent dirt and moisture attack. Bushings with major chips or cracks which appreciably decrease the creepage distance should be removed from service and replaced.

Clean periodically with alcohol the porcelain surfaces, on which dust, saline compounds, combustion residues, dirt, oil and other deposits may easily collect and reduce consequently the flashover value.

Composite insulator

Clean periodically with alcohol the composite insulator surface and wait at least 24 hours before energising, to allow the silicon to recover its hydrophobicity.

In case of small damages on silicon sheds, it is possible to make acceptable repairs.

WARNING

Bushing washing under voltage is NOT allowed.

HV terminal

Check and fasten the connection in order to avoid poor contacts and consequent overheating.

If the bushing's HV terminal is aluminium made, remove the oxide thin layer from bushing (aluminium) terminal, brushing it (with steel brush) under the right angle