

INSTRUCTIONS

GEH-1627C Supersedes GEH-1627B

APPARATUS BUSHINGS TYPE U

550 BIL and Higher

GENERAL

These instructions apply mainly to a series of type U bushings which comply with the mechanical and electrical characteristics of the American Standards Association standards, C76.1a, for transformer and circuit breaker bushings in the range from 550 BIL through 1300 BIL. A limited number of other designs, which are constructed similar to the ASA line but are beyond the scope of ASA in either ampere or voltage rating are also covered by this publication.

The type U bushing has an oil-impregnated, paper-insulated core with a multiplicity of electrodes (Rescon* equalizers) embedded in the paper for proper distribution of electrical stresses. The core, after extensive vacuum treatment and oil impregnation, is immersed in high dielectric strength transil oil inside a center-clamped, gasket-sealed structure consisting principally of a metal expansion chamber, top porcelain, a ground sleeve, a bottom porcelain and the necessary spring-loaded, center-clamping hardware. Sufficient clamping pressure is applied in the factory to make these assembled outer parts a sealed housing for the core and the immersion oil, and for a nitrogen gas cushion above the oil level.

Unpacking

Bushings are shipped ready for installation (Figs. 1 & 2). The shock-mounted crate designed for shipment of single bushings can be disassembled easily by removing the nails attaching the slatted unit to the base. The top and sides of the crate can be lifted off in one piece, and the base can then be used as a sled for moving the bushing. Open the shipping crate or box carefully to avoid damage to the contents.

As soon as a bushing is received, it should be examined for damage incurred during shipment. If damage or rough handling is evident, file a claim with the transportation company, and notify your General Electric Sales Representative immediately.

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Fig. 1. Shock-mounted shipping crate for individual bushings.

Note the oil level as explained under the heading "Liquid Level Indication"; and examine the surface of the porcelain for small breaks or cracks which might cause leakage later, but which will not immediately effect the oil-level indication.

Although surface oil is carefully removed from Type U bushings after electrical tests, occasionally bushings show evidence of an oil film when received. While this is cause for concern, the following information should be considered.

- Type U bushings are pressure tested at 30 psi oil pressure prior to shipment.
- 2. The presence of an oil film on the surfaces or joints of a bushing can be residual oil remaining after the immersion of the bushing for apparatus electrical test.
- 3. To determine hidden damage to gasket seals and porcelains which might permit leakage, wipe all bushing surfaces and joints clean and dry and observe for the appearance of free oil during a 48-hour period.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.



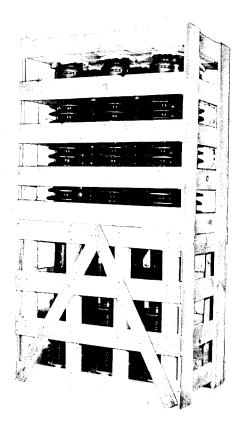


Fig. 2. Six-unit shipping crate.

Storage

Type U bushings may be stored outdoors in their shipping crates. For long storage, it is suggested that the gasket surface on the underside of the ground sleeve mounting flange be greased heavily for protection against the elements.

NEVER LAY A HIGH VOLTAGE TYPE U BUSHING FLAT; ALWAYS KEEP THE DOME HIGHER THAN THE REST OF THE BUSHING.

Because of the nitrogen cushion in the dome, a bushing in a horizontal position will have part of the core insulation above the level of the filling oil. The shock-mounted crates, in which bushings are shipped individually, provide a 7° elevation of the top of the bushing. If a bushing is removed from its crate before it is put into storage, adequate oil coverage will be obtained by positioning the dome one foot higher than the bottom end of the bushing.

Hondling

Bushings within the scope of this instruction are provided with lifting eyes in the support flange. Because of the weight and dimensions of bushings, the main lifting tackle should always be attached to the lifting eyes when moving them. If a rope is bound around the top of the porcelain and under the top petticoat, an auxiliary tackle can be attached to it to guide the bushing or to hold it in any desired position (Fig. 3). Very large, heavy bushings will have eyes at the top end in addition to the lifting eyes in the flange; these eyes may be used only for auxiliary guide tackle and MUST NOT BE USED FOR LIFTING TACKLE.

INSTALLATION

Cleaning

Before installing the bushing, wipe the porcelain off with a cloth to remove dust and dirt accumulated during transit and storage.

Mounting

When mounting type U bushings either in a vertical position or at an angle, the method of handling already described should be used for lifting the bushings into position.

Inclined Bushings

All bushings mounted at an angle should have the liquid-level gage facing from the lowest point of the dome to insure proper indication of the filler level.

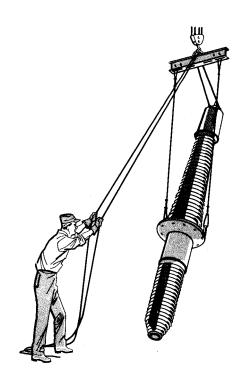


Fig. 3. Method of lifting bushings equipped with lifting eyes.

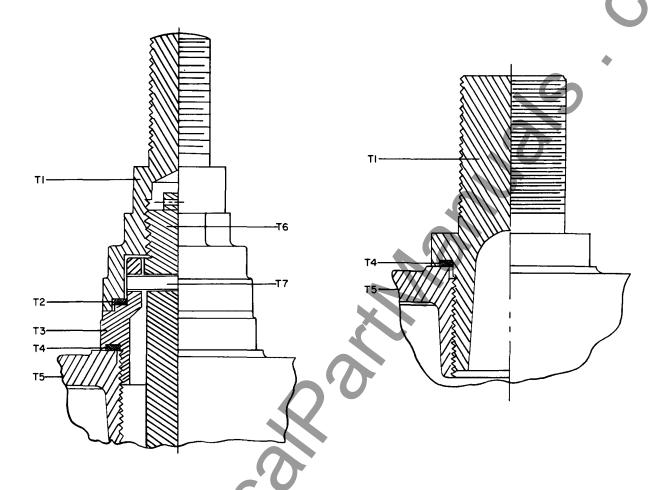


Fig. 4. Details of top end construction for circuit-breaker and transformer bushings.

Bolting

Tighten the mounting bolts a fraction of a turn at a time, working progressively in one direction around the bolt circle until the bolts are uniformly tight. Tighten sufficiently to seal the bushing to the apparatus. Normally, the torque values listed below will provide adequate gasket compression for sealing:

| SIZE OF BOLT | | TORQUE | |
|--------------|--------|-------------|--|
| Inch | Thread | Foot-Pounds | |
| 1/2 | 13 | 25 | |
| 1/2 5/8 | 11 | 30 | |
| 3/4 | 10 | 35 | |

CONNECTIONS

INTERNAL ELECTRICAL CONNECTIONS

The method used in making connections between a

bushing and the apparatus on which it is mounted will depend upon the type of connection used in the apparatus.

Bottom-connected Bushings

Bushings rated 1200 amperes and higher are designed so that the core is the conductor. A circuit breaker interrupter or transformer terminal may be bolted to the bolting collar, see Fig. 7.

Draw-lead Connected Bushings

Bushings with current ratings to 800 amperes are generally designed with a hollow core, through which a flexible cable can be pulled. The cable is considered a component of the apparatus on which the bushing is mounted and is not supplied with the bushing.

Refer to Fig. 4. Remove the terminal cap T1, the steel pin T7 and the stud T6. Pass a wire or cord through the bushing core, and attach it to the

hole in the top end of the terminal stud on the flexible cable. Lower the bushing into the opening in the cover, simultaneously pulling the cable up through

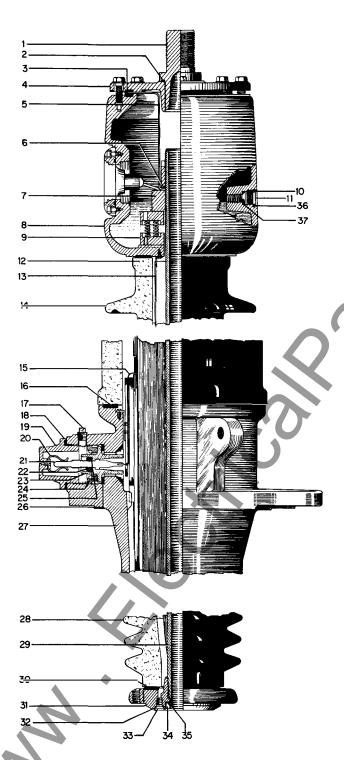


Fig. 5. Sectional view of typical type U bushing.

the core. Secure the cable terminal stud to the top cap by replacing the steel pin T7. Coat the gasket T2 with a thin film of light oil, and assemble it in position. Screw the terminal cap onto the terminal stud until the outside rim of the cap makes a metalto-metal seat on the bushing cap. Avoid excessive tightening, since it will only bend the pin.

EXTERNAL ELECTRICAL CONNECTIONS

External connections to the bushing must be sufficiently slack or flexible to avoid putting a mechanical strain on the bushing parts.

LIQUID LEVEL INDICATION

The oil level in the bushing is adjusted in the factory to the normal level at approximately 25 C. Unless there is subsequent mechanical damage to the bushing, which results in loss of oil, the filler level should be satisfactory for the life of the bushing. Since fluctuations in oil level will necessarily occur with changing temperatures, the column of oil in the bushing is topped with a compressible cushion of nitrogen gas to fill any space left by a varying amount of oil.

The liquid level gage in the dome will give an accurate indication of the filler level under normal conditions.

This gage is actuated by the effect on a float arm of the rise and fall of the filler level in the bushing. Fluctuations in the readings can be expected because of expansion and contraction of the filler with both ambient and operational temperature changes. Variations in level will be indicated by the position of the pointer on the band of the dial. A bushing is

- Cover Terminal cap Gasket Grounding clip Low-voltage contact stud Gasket 21. Sealing nut 22 Cover Flexible seal 23. Low-voltage insulator 24. Nut Core seal gasket 25. Gasket 7. Clamping nut 26. Gasket 8. Dome Spring assembly 27. Support Bottom porcelain 28. 10. Gasket (outerseal) Core 29. 11. Plug (innerseal) Gasket 12. Gasket 30. Bottom washer Terminal shield 31. 13. 32. Gasket Top porcelain Plug Low-voltage tap lead 33. ₹4 Spanner nut Gasket Plug 35. Gasket 17. Gasket (innerseal) 18. Gasket
 - 37. Plug (innerseal)

considered to have a satisfactory oil level as long as the pointer is between the red sections of the band indicating Low or High level. If the pointer moves into the red section indicating Low, the bushing should be examined for possible loss of oil which could result in eventual electrical failure.

CAPACITANCE TAP

(And Power Factor Measurements)

Standard type U bushings rated 450 BIL and higher have, just above the mounting flange, a small housing containing a capacitance tap outlet. While the purpose of this capacitance tap outlet is to provide connection to a bushing potential device, it also provides a convenient means for making connections for measuring Power Factor by the U.S.T. (Ungrounded Specimen Test) Method.

Many bushing users make it a practice to measure the U.S.T. Power Factor at the time of installation. This practice is endorsed by the General Electric Company and discussed in more detail under the heading of *Maintenance*.

When a connection is to be made to the capacitance tap, either for use with a potential device or power factor measurement, open the housing by unscrewing the plug-like cover, Part 19 of Fig. 5. Catch the filling compound (A13A1B) in a small, dry, clean container. Assemble the potential device cable tightly in place, or proceed with power factor measurement. Remove the Lok-Thread† (†product of National Screw and Mfg. Co.) filling plug, and fill the chamber with the filling compound, previously removed, to a level which will leave an air space of approximately ½" over the liquid. Replace and firmly tighten the filling plug to prevent the entrance of moisture.

The terminal in the capacitance tap is grounded to the outlet cover by means of a spring clip. NEVER OPERATE THE BUSHING WITH THE COVER REMOVED, EXCEPT WHEN USING A POTEN-TIAL DEVICE.

ENERGIZING

If it becomes necessary to energize a type U bushing, for normal operation, within 48 hours after it has been in a horizontal position, gently rock the bushing to release any gas or air which may have been trapped in the insulation. If proof-testing overvoltage is to be applied to the bushing, rock it to release entrapped air or gas, and keep it vertical for 48 hours prior to testing.

TRANSFORMER-BREAKER INTERCHANGE-ABLE (TBI*) BUSHINGS

An outstanding feature of this line of bushings is the fact that the 1200 ampere and 1600 ampere bottom-connected bushing (ASA standard for circuit breakers) can be converted to an 800 ampere, drawlead connected bushing which complies with ASA standards for transformers.

Identification of TBI Bushings

TBI bushings are identified by a supplementary nameplate stating, "convertible by change of top and bottom terminals." The following pairs of catalog numbers identify the same basic (TBI) bushing with the exception of being equipped with different terminals.

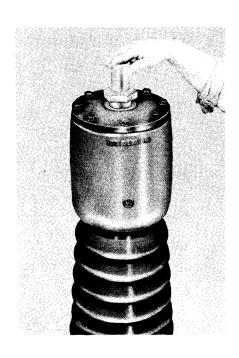
| | | With Terminal Accessories For | | |
|-----|----------|-------------------------------|-----------|-----------|
| BIL | Basic | 800 | Bottom | Bottom |
| | Ampere | Ampere | Connected | Connected |
| | Capacity | Draw Lead | 1200 Amp | 1600 Amp |
| 550 | 1200 | 11B590 | 11B591 | |
| | 1600 | 11B592 | | 11B593 |
| 650 | 1200 | 11B609 | 11B610 | |
| | 1600 | 11B611 | | 11B612 |
| 750 | 1600 | 11B692 | •• | 11B693 |
| 900 | 1600 | 11B708 | | 11B709 |

Interchangeable bushings are also identified by the letter H preceding the voltage rating in the nameplate class.

CONVERSIONS

The series of pictures in Figure 6 show the stepby-step procedure for conversion of a bushing used on circuit breakers to use on transformers. As indicated, the conversion is accomplished by replacement of the breaker bushing terminal parts with parts suitable for use on transformers. It will be noted that internal connection of the bushing to the transformer is accomplished by means of a cable which is threaded through the bushing core and pinned to the adapting cap at the top end of the bushing. This cable is a component of the transformer and is not furnished with the bushing. For assembly, pass a wire or cord through the hole in the stud attached to the end of the cable, and, by means of the wires, draw the cable into the bushing core as the bushing is being lowered into position in the transformer.

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A. Removal of the breaker bushing top terminal.



Pulling the transformer lead with attached stud up through the bushing core



B. Assembly of the adapting cap



D. Assembly of the pin to hold the transformer lead in place

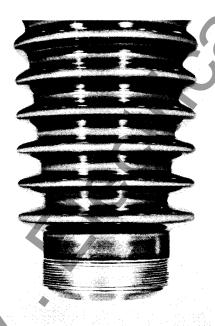
Fig. 6. Conversion of an interchangeable type U bushing from use on a circuit breaker to use on a transformer.



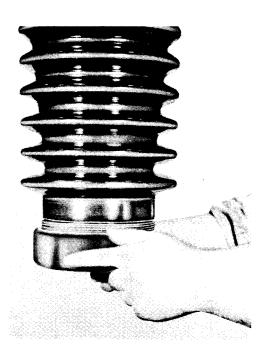
E. Assembly of the transformer bushing top terminal



F. Removal of the breaker bushing bolting ring



G. Bushing with bolting ring removed



H. Assembly of the transformer bushing bottom spinning to shield

A variety of bottom-end constructions is shown clearly in Fig. 7, and there should be no difficulty in making the changes necessary. Note that the removable ring is positioned by means of a setscrew. In the case of the breaker ring, where the setscrew bottoms on the thread, remove the setscrew, and remove any burrs from the thread with a ½" drill before attempting to disassemble the ring.

Conversion of a transformer bushing to a breaker bushing is accomplished by reversing the procedure just described. Note that the metal adjacent to the setscrews should be peened over with a punch to lock the setscrews in place on both breaker and transformer rings.

AMPERE RATINGS

Interchangeable bushings are available in current ratings of 800, 1200 and 1600 amperes. ALL DRAW-LEAD TYPE BUSHINGS (within scope of these instructions) ARE LIMITED TO OPERATION AT 800 AMPERES.

Examination of the illustration in Figure 4 will show two possible current paths from the conductor to the terminal cap (T1).

In the case of draw-lead accessories, the current flow is from the transformer draw-lead to the stud (T6), through the threads and into the terminal cap (T1). This current path is limited to 800 amperes.

In the case of 1200 and 1600 ampere bottom-connected bushings, the current flow is up the center of the bushing into the cover (T5), through the threads and into the terminal cap (T1). Although the 1200 and 1600 ampere top-end accessories are identical bushings, they should not be operated at currents higher than nameplate rating.

The maximum current rating for each interchangeable bushing is shown on the nameplate. This rating applies only when the bushing has accessories for use when bottom connected; it does not apply to draw-lead accessories.

CAUTION: If the draw-lead accessories are inadvertently used when the bushing is bottom connected, a discontinuity in the current path may develop. In this case, the current flow will be up the center conductor to the cover (T5), through the threads into the adapting cap (T3) and across the joint just under the gasket (T2) into the terminal cap (T1).

This joint under the (T2) gasket is not a current carrying contact. The draw-lead top accessories must not be used when the bushing is bottom connected even at currents less than 800 amperes.

NAMEPLATE DATA

Some of the nameplate data are of special importance in answering questions about bushings.

It will expedite the handling of requests if the factory has the serial number, the catalog number and group number as stamped on the nameplate for all bushings about which there need be any discussion. It is ABSOLUTELY NECESSARY FOR THE FACTORY TO HAVE AT LEAST THE SERIAL NUMBER.

The catalog number identifies the bushing by type and rating. In most cases, the catalog number stamped on a nameplate will include a group designation, i.e., Gr. 1--Gr. 2, etc. The group number is of importance only to the factory and indicates minor design changes. All bushings of the same catalog number are completely interchangeable regardless of the group number.

The class letters identify certain characteristics of the bushing to the factory, and you need not be concerned about them. The class numerals indicate the circuit rating of the bushing corresponding to the BIL.

However, since many bushings are applied at reduced BIL, the maximum kV to ground is shown. This is the maximum allowable steady state voltage terminal to ground (System $kV/\sqrt{3}$)

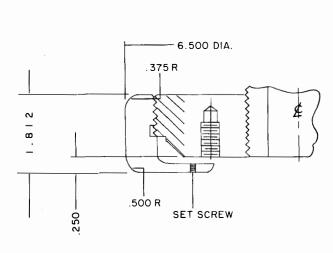
Nameplate Data (TBI)

Since TBI bushings are made available in pairs, one of the pair is equipped with terminals suitable for use on circuit breakers. The other has terminals suitable for use on transformers. However, two catalog numbers are assigned to the same basic design. If, at a later date, a user decides to apply a TBI transformer bushing to a circuit breaker, he must order terminal parts suitable for circuit-breaker use; or he must use parts removed from the bushing being replaced. There is no replacement of nameplates. When finally assembled on the breaker, the nameplate still identifies the bushings as one designed for use on either a transformer or a breaker.

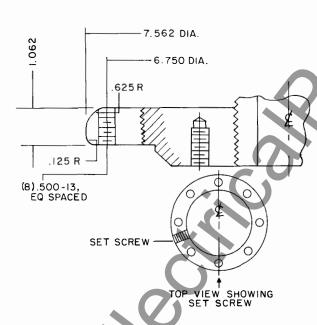
A careful record should be kept for these interchangeable bushings, and complete information about the application of the bushing must be given in any correspondence with the factory concerning the bushings.

ORDERING ACCESSORIES

Accessories for conversion purposes may be taken from bushings being replaced in the field or may be ordered from the factory. In ordering, give the following information:

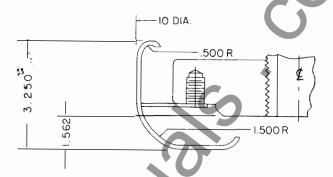


1. Transformer bushings

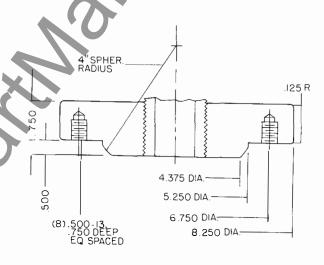


2. Breaker bushings

A. Bottom washer with bolting ring for 115, 138 and 161 kv interchangeable bushings

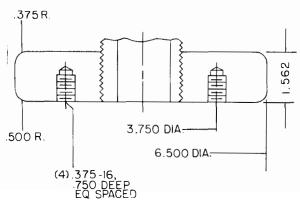


1. Transformer bushings



2. Breaker bushings

B. Bottom washer for 180 and 196 kv interchangeable bushings



C. Bottom washer for 92, 115, 138 and 161 kv transformer bushings

Fig. 7. Transformer and circuit-breaker bottom-end accessories.

- 1. Cat. number of the bushing being converted.
- Type of apparatus on which the bushing will be used.
- 3. Operating voltage and current rating of the bushing.

MAINTENANCE

Type U bushings require little or no maintenance other than periodic checking of the oil level as indicated in the sight glass or by the gage, and the measuring of the power factor. Bushings exposed to salt spray, cement dust and other abnormal deposits are subject to a special hazard and must be cleaned regularly to prevent flashover.

Should it become necessary to add oil to a bushing, the fill plug in the dome may be removed. Insertion of a clean standpipe, with an outside diameter of slightly less than the diameter of the hole, will provide a means of adding small quantities of oil to the bushing.

However, because of the inconvenience and possible service interruptions resulting from bushing outages, many users have programs of *Planned Preventative* Maintenance. The General Electric Company endorses such programs and recommends:

Measurement of UST Power Factor and capacitance at time of installation. Such measurement is a good first point for comparison with future readings since it correlates test data made under the variable conditions encountered in field measurements with those made

- under controlled conditions in the factory and recorded on the nameplate.
- 2. Continued measurement of UST power factor and capacitance at various intervals depends upon the importance of the particular installation and the data accumulated on the bushing. A steadily increasing P.F. or capacitance is cause for concern; an increase in P.F. to 1.5% or, an increase in capacitance to 110% of the original value, is cause for corrective action. General Electric publication GET-908 should be consulted for more detailed information on bushing maintenance.

FIELD REPAIR

The General Electric Company recommends that any repair of type U bushings be done in the factory because of the danger of contamination of the insulation if the seal is broken. In addition, the very high vacuums and clamping pressures required necessitate the use of equipment not usually available in a service shop.

Any damage to a bushing which might make repair either desirable or necessary should be reported in detail. MAKE NO ATTEMPT TO REPAIR A BUSHING WITHOUT SPECIFIC RECOMMENDATION FROM THE GENERAL ELECTRIC COMPANY.

In special cases, as in replacement of capacitance taps and gages, it is possible to make repairs in the field, and specific instructions for these operations are available from your General Electric Sales Representative.

MAN CORE CORE

POWER TRANSFORMER DEPARTMENT

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PITISFIELD, MASS.