

APPARATUS BUSHINGS

TYPE U

550 BIL and Higher

INTRODUCTION

These instructions apply mainly to a series of Type U bushings (Fig. 1) that comply with the mechanical and electrical characteristics of the American National Standards Institute standards, C76.1, for transformer and circuit breaker bushings in the range from 550 BIL through 1800 BIL (Basic Insulation Level). A limited number of other designs, which are constructed similar to the ANSI line but are beyond the scope of ANSI 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 embedded in the paper for proper distribution of electrical stress. The core, after extensive vacuum treatment and oil impregnation, is immersed in oil of high dielectric strength inside a center-clamped, gasket-sealed structure consisting principally of an 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 the assembled outer parts a sealed housing for the core, for the immersion oil, and for a nitrogen gas cushion above the oil level.

RECEIVING

The bushing is shipped ready for installation (Fig. 2). The shock-mounted crate designed for the shipment of a single bushing, as shown in Fig. 2B, 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.

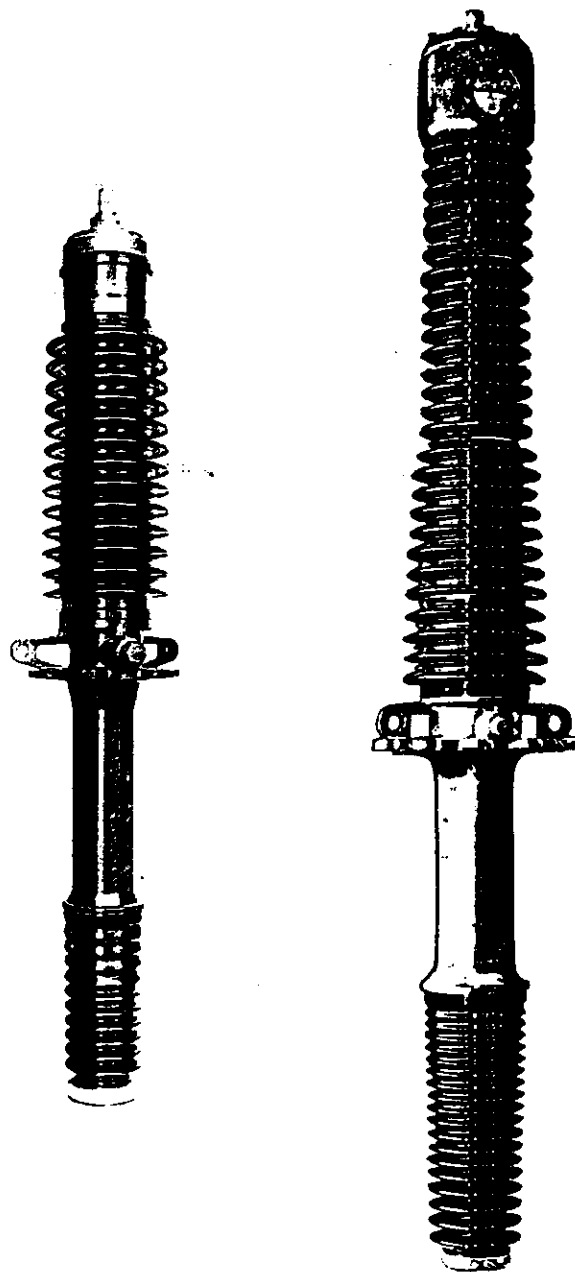
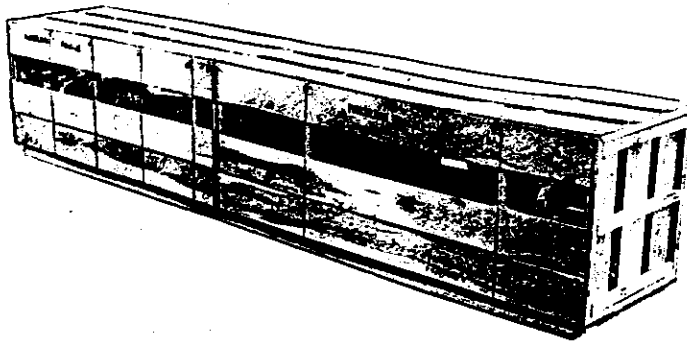


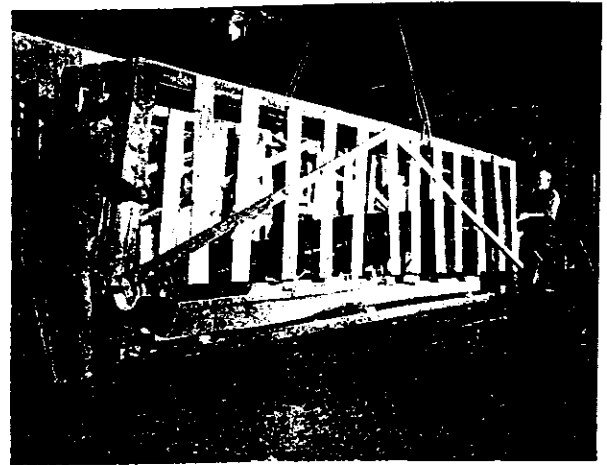
Fig. 1 Typical Type U bushings

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.

GENERAL  ELECTRIC



A. Small bushing



B. Large bushing

Fig. 2 Bushing shipping crates

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

Although surface oil is removed carefully 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.

1. 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 bushings can be residual oil remaining after the immersion of the bushings for apparatus electrical tests.
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.

STORING

A Type U bushing can be stored outdoors in the shipping crate. 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-degree elevation of the top of the bushing. If a bushing is removed from the 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.

HANDLING

UNDER 500 KV

A bushing rated under 500 kv is provided with lifting eyes in the support flange. Because of the weight and dimension of the bushing, the main lift-

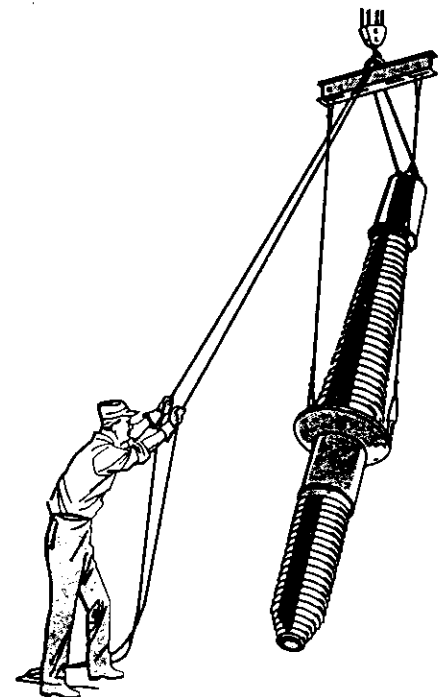


Fig. 3 Method of lifting a bushing rated under 500 kv

ing tackle should always be attached to the lifting eyes. 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). A large bushing has eyes at the top end in addition to the lifting eyes in the flange; the upper eyes must be used only for auxiliary guide tackle and **MUST NOT BE USED FOR LIFTING TACKLE.**

500 KV AND ABOVE

Each bushing is shipped in a special shock-mounted cradle-and-skid that holds the upper (dome) end above the lower end. The bushing is held seven degrees above the horizontal.

The seven degree or greater angle must be maintained; otherwise, air or gas may become entrapped in the insulation.

Remove any banding iron, clamps, or mounting flange bolts holding the bushing to the skid; then, using two crane hooks, lift the bushing as shown in Fig. 4. Proceed as follows:

1. From one crane hook pass a sling through each upper guide bracket which is bolted to the dome.

Use a spreader bar or lifting beam to keep the slings nearly parallel above the dome guide brackets.

Attach the lower end of the slings to the mounting support lifting lugs, 180 degrees apart. Use clevises or "S" hooks in the lifting lug eyes.

2. Hook two slings, or a doubled sling, over the second crane hook and attach to two mounting flange bolt holes, using clevises.

3. Raise both crane hooks simultaneously, maintaining the seven degree or greater angle until ready to lower the mounting flange end.

4. After the bushing is vertical, remove the slings and clevises attached to the mounting flange bolt holes.

INSTALLATION

PAINTING

Some of the top end parts may be aluminum. The aluminum parts are anodized and painted for protection against the weather. Care should be used to prevent scratching these painted surfaces. If the metal becomes exposed because the paint is scratched or chipped, the exposed area should be wiped with a commercial safety solvent, such as Du Bois Zolv, and then wiped dry. The cleaned area should be coated with an outdoor enamel, such as du Pont Safety Color Code, PPG Fire Protection Red, or Sherwin Williams Kem F IR4175-R (Flame Red Truck Enamel).

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

Refer to the bushing Outline drawing and remove any temporary shipping parts below the mounting flange. Install any parts that were removed for shipment.

Lower the bushing into position slowly, being sure it clears the internal apparatus structure.

INCLINED BUSHING

When a bushing is mounted at an angle, the alignment of the liquid-level gage with respect to the low side of the dome varies with the construction of the gage. A float-actuated gage, as shown in Fig. 6A, should face the low side. A prismatic liquid-level gage, as shown in Fig. 6C, should be positioned at a 90-degree angle from the low side. Any alignment of the glass dome of Fig. 6B is satisfactory.

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
3/4	11	30
3/4	10	35

CONNECTIONS

INTERNAL ELECTRICAL CONNECTION

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.

Draw-Lead-Connected Bushing

A bushing with a current rating to 800 amperes is generally designed with a hollow core, through which a flexible cable can be pulled. The cable is

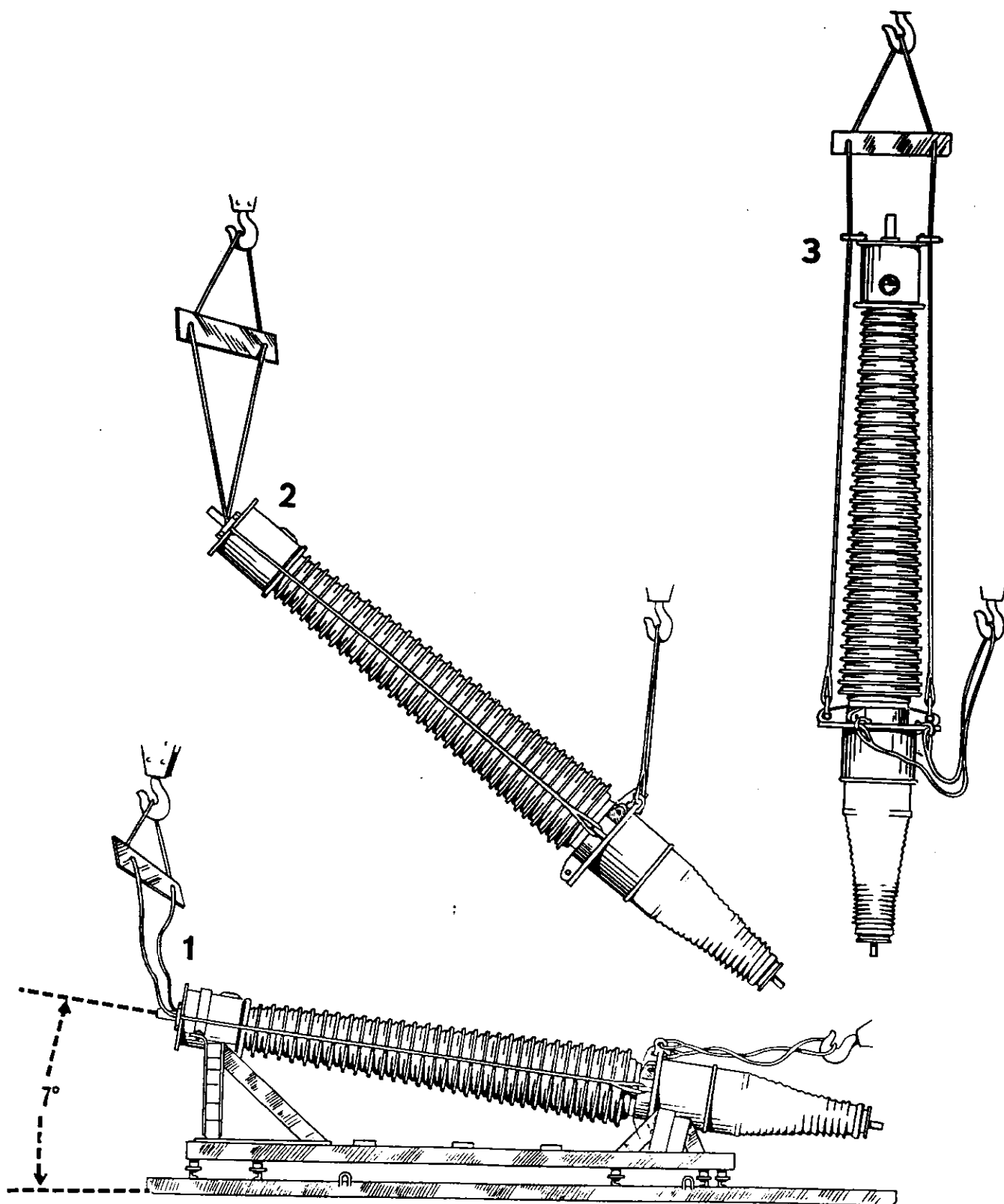


Fig. 4 Method of lifting a bushing rated 500 kv and above

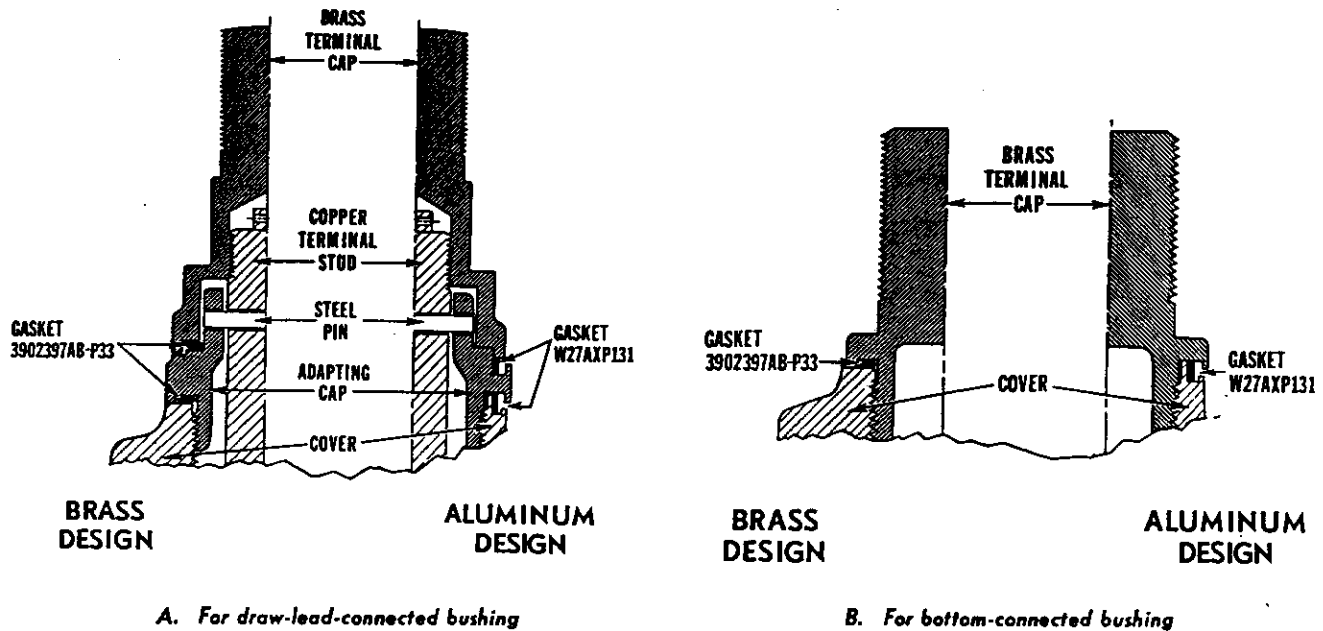


Fig. 5 Details of top end construction

considered a component of the apparatus on which the bushing is mounted and is not supplied with the bushing.

Refer to Fig. 5. Remove the terminal cap, the steel pin, and the stud. 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 the core. Secure the cable terminal stud to the top cap by replacing the steel pin. Coat the gasket 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 metal-to-metal seat on the bushing cap. Avoid excessive tightening, since it will only bend the pin.

Bottom-Connected Bushing

A bushing rated 1200 amperes or more is 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.

EXTERNAL ELECTRICAL CONNECTION

The external connection 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 at 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.

Fig. 6 shows three ways of indicating the oil level in bushings rated 115 kv and above.

Fig. 6A shows a bushing dome equipped with a float-actuated liquid level gage. The oil is con-

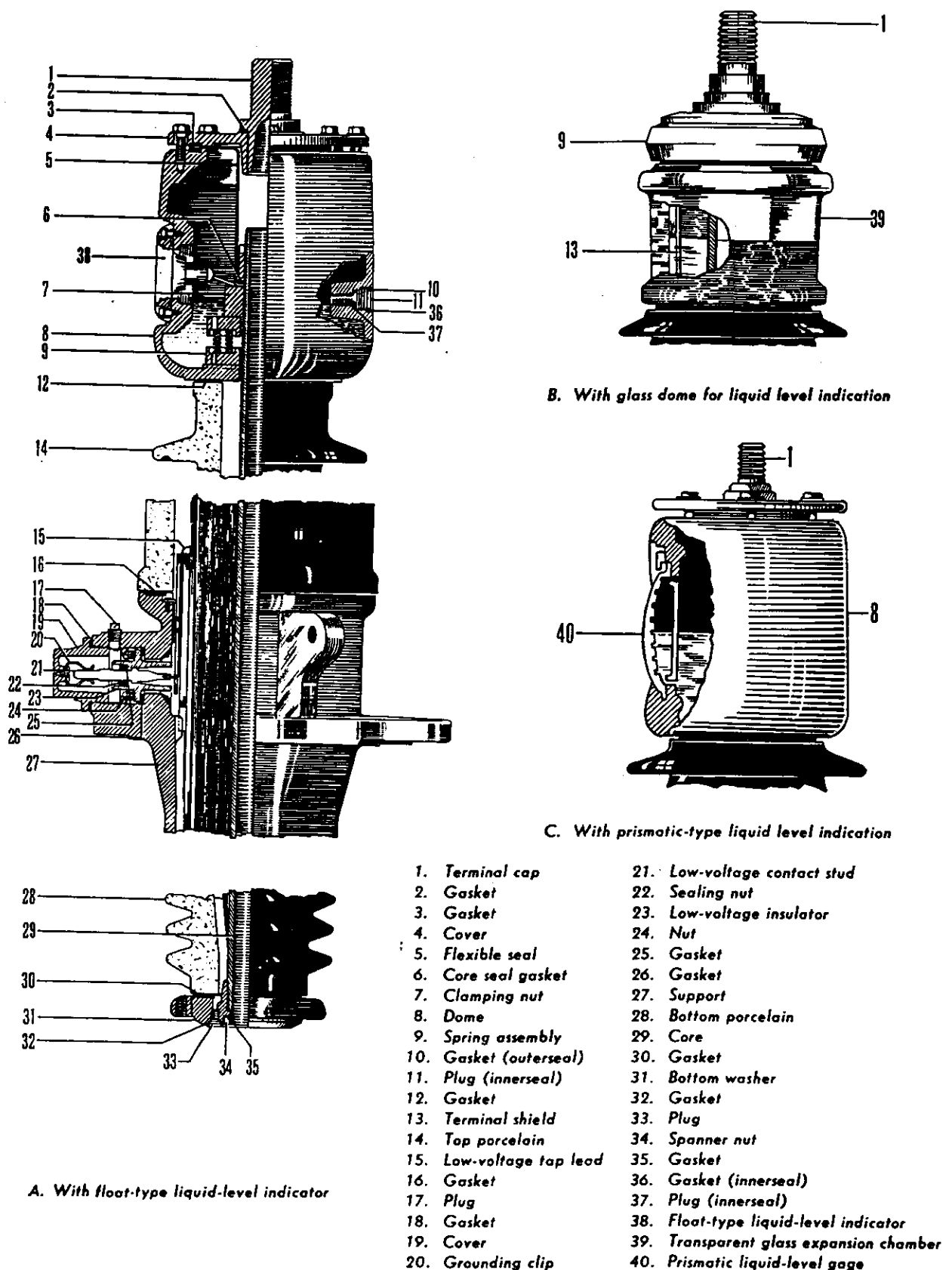


Fig. 6 Sectional views of bushings

sidered at a satisfactory level when the pointer is between the red sections of the band that indicate a LOW or HIGH level.

The actual oil level can be seen on a bushing equipped with: 1, a glass dome, Fig. 6B; or 2, a prismatic oil level gage shown in Fig. 6C. As long as the oil level can be seen, the level is at a satisfactory height.

When a low oil level is indicated, examine the bushing for possible loss of oil which could result in eventual electrical failure. A low level exists when either the pointer indicates LOW, or the level has disappeared below the glass dome or prismatic gage.

CAPACITANCE TAP

(And Power-Factor Measurements)

A standard Type U bushing rated 450 BIL or higher has, just above the mounting flange, a small housing containing a capacitance tap outlet. The terminal in the capacitance tap is grounded to the outlet by means of a spring clip. While the purpose of the 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 UST (Ungrounded Specimen Test) method.

Many bushing users make it a practice to measure the UST 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 for power-factor measurement, open the housing by unscrewing the plug-like cover (19, Fig. 6). Catch the oil in a container. Assemble the potential device cable tightly in place, or proceed with power-factor measurement.

After the testing connection to the capacitance tap has been removed, replace the cover and re-fill the chamber with 10C* oil after removing the filling plug (17, Fig. 6). When filling, leave an expansion space approximately a quarter of an inch above the oil in the chamber. Coat the threads with sealer, and firmly replace the filler plug.

NEVER OPERATE THE BUSHING WITH THE COVER REMOVED, EXCEPT WHEN USING A POTENTIAL DEVICE.

ENERGIZING

If the bushing has been moved inadvertently to a horizontal position anytime within 48 hours before

energizing at rated conditions, gently rock the bushing to release any gas or air which may have been trapped in the insulation. If proof-testing over-voltage 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 INTERCHANGEABLE (TBI*) BUSHINGS

An outstanding feature of this line of bushings is the fact that the 1200 ampere and 1600 ampere bottom-connected bushings (ANSI standard for circuit breakers) can be converted to 800 ampere, draw-lead connected bushings which comply with ANSI 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.

BIL	BASIC AMPERE CAPACITY		CATALOG NUMBER	
	CKT. BRKRS.	TRANS.	BOTTOM CONNECTED C.B. OR TRANS.	WITH 800 AMP DRAW LEAD ACCESSORIES
550	1600	1200	118401	118400
	2000	1600	118568	-
650	1600	1200	118411	118410
	2000	1600	118660	-
750	1600	1200	118421	118420
	2000	1600	118651	-
900	1600	1200	118431	118430
	2000	1600	118432	-

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

CONVERSION

Converting a bottom-connected bushing to a draw-lead-connected bushing is accomplished by replacing the top and bottom terminal parts. 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. The 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 wire,

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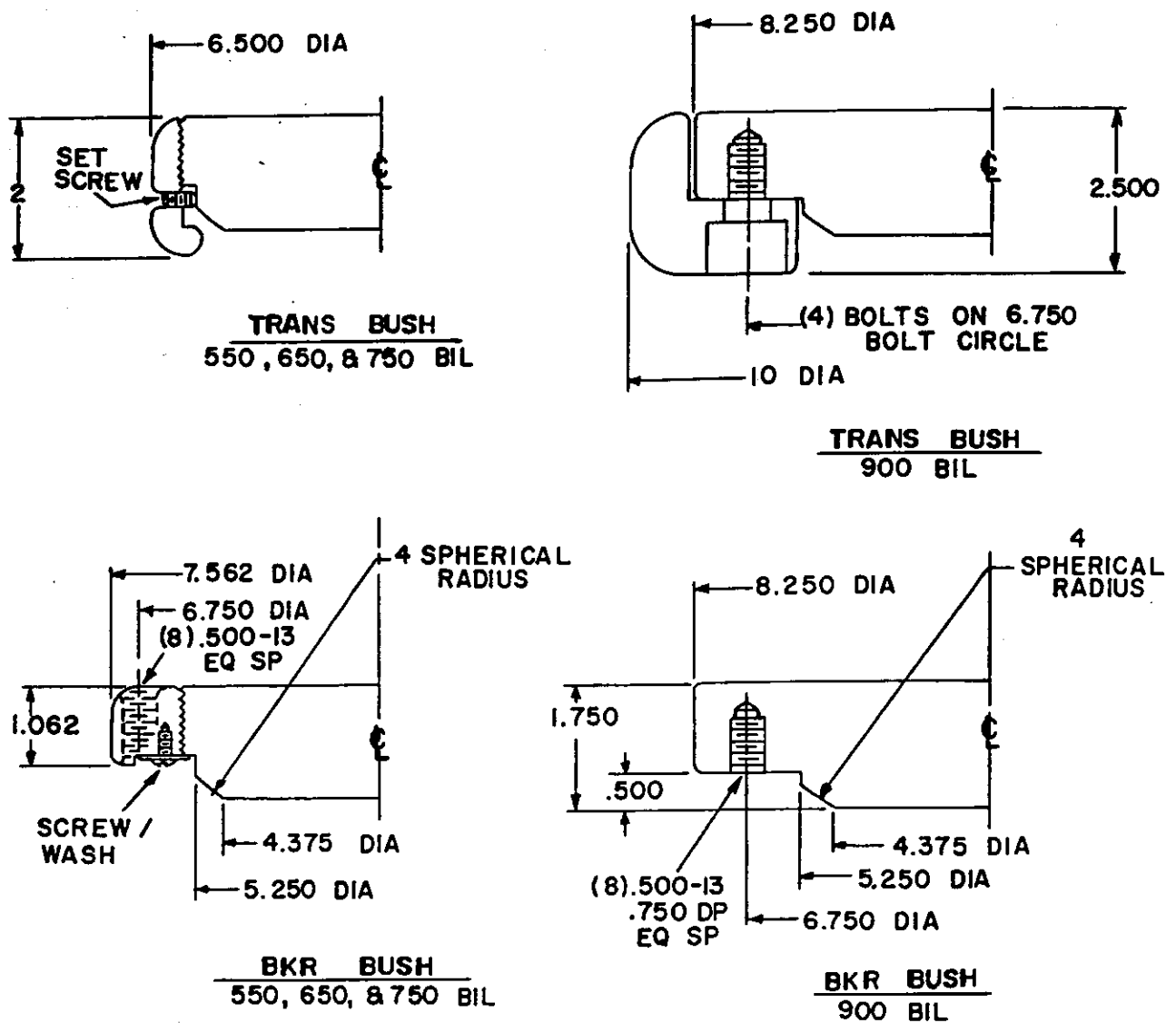


Fig. 7 Transformer and circuit breaker bottom-end accessories

draw the cable into the bushing core as the bushing is being lowered into position in the transformer.

A variety of bottom-end constructions is shown clearly in Fig. 7, and there should be no difficulty in making the change-over. Conversion of a draw-lead bushing to a bottom-connected bushing is accomplished by reversing the procedure.

Several parts of the top end hardware on Type U bushings have been changed from brass to aluminum. These changes are another step in the long-range conversion of bushing parts to aluminum. The external appearance of the top end of both draw-lead-connected bushings and bottom-connected bushings is similar when either brass or aluminum parts are used.

On a draw-lead-connected bushing, Fig. 5A, the adapting cap, cover, and spring assembly are now made of aluminum instead of brass. Also, O-ring gasket 3902397AB-P33 has been replaced by neoprene gasket W27AXP131 which has a rectangular cross section and measures 0.375" x 2.375" ID x 2.625" OD. The two types of gaskets are not interchangeable; therefore, in cases where the bushing is shipped separate from the terminal cap and gasket, it is important to see that the correct gasket is used at assembly. At assembly, lubricate the edges of gasket W27AXP21 with petroleum jelly or 10C oil so that the gasket will not be distorted when installing the cap. All other parts remain unchanged. Similar changes to the cover, spring assembly, and

gasket have been made on bottom-connected bushings, Fig. 5B.

The method for making connections between a bushing with aluminum top-end parts and the apparatus on which it is mounted is basically the same as the method for bushings with brass parts. However, when it is necessary to change connections, it is imperative that the proper gasket, W27AXP131, be installed when the top-end parts are reassembled. Also, the adapting cap and terminal cap should be tightened until contact is made between the internal stops machined on the mating parts. Compression of the gaskets is preset by these internal stops.

AMPERE RATINGS

Interchangeable bushings are available in current ratings of 800, 1200, 1600, and 2000 amperes. **ALL DRAW-LEAD TYPE BUSHINGS** (within the scope of these instructions) **ARE LIMITED TO OPERATION AT 800 AMPERES.**

Examination of the illustration in Fig. 5 will show two possible current paths from the conductor to the terminal cap (1).

In the case of draw-lead accessories, the current flow is from the transformer draw-lead to the stud (6), through the threads, and into the terminal cap (1). This current path is limited to 800 amperes.

In the case of bottom-connected bushings, the current flow is up the center of the bushing into the cover (5), through the threads, and into the terminal cap (1). Although the top-end accessories are interchangeable physically, the bushings should not be operated at currents higher than the nameplate ratings.

The maximum current rating for each interchangeable bushing is shown on the nameplate as a "T" for transformers, and as a "B" for breakers. The 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 (5), THROUGH THE THREADS INTO THE ADAPTING CAP (3), AND ACROSS THE JOINT JUST UNDER THE GASKET (2) INTO THE TERMINAL CAP (1).

The joint under the gasket (2) 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.

ORDERING ACCESSORIES

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 draw-lead bushing to a bottom-connected use, he must order terminal parts suitable for the bottom-connected use; or he must use parts removed from the bushing being replaced. There is no replacement of nameplates. A careful record should be kept for the interchangeable bushings since complete information about the application of the bushings must be given in any correspondence with the factory concerning the bushings.

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

1. Catalog number of the bushing being converted.
2. Type of apparatus on which the bushing will be used.
3. BIL and current rating of the bushing.

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 any bushing 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* ($\text{System kv} \div \sqrt{3}$).

MAINTENANCE

A Type U bushing requires 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. A bushing exposed to salt spray, cement dust, and other abnormal deposits is subject to a special hazard and must be cleaned regularly to prevent flashover.

The new aluminum parts are anodized and painted for protection against the weather. Care should be used to prevent scratching these painted surfaces. Refer to the "Painting" paragraph under "Installation."

Due to 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:

1. Measurement of UST power factor and capacitance at the time of the installation. Such measurements are good first points for comparison with future readings since they correlate 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 pf or capacitance is cause for concern; an increase in pf to one percent, or an increase in capacitance to 110 percent 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 a Type U bushing be done in the factory because of the danger of contamination of the insulation if the seal is broken. In addition, the very high vacuum and clamping pressure 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. Specific instructions are available from your General Electric Sales Representative.

NOTES

TBI BUSHINGS

Ser. No.	Cat. No.	Where Used	Dates	Remarks

GENERAL ELECTRIC INSTALLATION AND SERVICE ENGINEERING OFFICES

FIELD SERVICE OFFICE CODE KEY

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- † Electrical & Electronic Service
- ‡ Marine Service
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 * (Detroit) Riverview 18075 Krause Ave.
 * Flint 48505 1506 E. Carpenter Rd.

MINNESOTA
 * Duluth 55807 50th Ave. W. & St. Louis Bay
 * Minneapolis 55430 2025 49th Ave., N.

MISSOURI
 * Kansas City 64120 3525 Gardner Ave.
 * St. Louis 63110 1115 East Rd.

NEW JERSEY
 * New Brunswick 08902 3 Lawrence St.

NEW MEXICO
 * Albuquerque 87109 4420 McLeod Rd. NE

NEW YORK
 * Albany 12205 1097 Central Ave.
 * (Buffalo) Tonawanda 14150 175 Milens Rd.
 * (Long Island) Old Bethpage 11804 183 Bethpage-Sweet Hollow Rd.
 * (New York City) North Bergen, N.J. 07012 6001 Tonnelle Ave.
 * (New York City) Clifton, N.J. 07012 9 Brighton Rd.
 * Schenectady 12305 1 River Rd.
 * Syracuse 13208 1015 E. Hiawatha Blvd.

NORTH CAROLINA
 * Charlotte 28208 2326 Thrift Rd.

OHIO
 * Akron (Canton) 44720 7900 Whipple Ave. N. W.
 * Cincinnati 45202 444 West 3rd St.
 * Cleveland 44125 4477 East 49th St.
 * Columbus 43229 6660 Huntley Rd.
 * Toledo 43605 405 Dearborn Ave.
 * Youngstown 44507 272 E. Indiana Ave.

OKLAHOMA
 * Tulsa 74145 5220 S. 100th East Ave.

OREGON
 * Eugene 97402 570 Wilson St.
 * Portland 97210 2727 NW 29th Ave.

PENNSYLVANIA
 * Allentown 18103 668 E. Highland St.
 * (Delaware Valley) Cherry Hill, N.J. 08034 1790 E. Marlton Pike
 * Johnstown 15802 841 Oak St.
 * Philadelphia 19124 1040 East Erie Ave.
 * (Pittsburgh) West Mifflin 15122 4930 Buttermilk Hollow Rd.
 * York 17403 54 N. Harrison St.

SOUTH CAROLINA
 * (Charleston) No. Charleston 29401 2490 Debonair St.

TENNESSEE
 * Knoxville 37914 2621 Governor John Sever Hwy.
 * Memphis 38107 708 North Main St.

TEXAS
 * Beaumont 77705 1490 W. Cardinal Dr.
 * Corpus Christi 78401 115 Waco St.
 * Dallas 75235 3202 Manor Way
 * Houston 77036 5534 Harvey Wilson Dr.
 * Houston 77036 6916 Harwin Dr.
 * Midland 79701 704 S. Johnston St.

UTAH
 * Salt Lake City 84110 301 S. 7th West St.

VIRGINIA
 * Richmond 23224 1403 Ingram Ave.
 * Roanoke 24013 1004 River Ave., SE

WASHINGTON
 * Seattle 98134 3422 First Ave., South
 * Spokane 99211 E. 4323 Mission St.

WEST VIRGINIA
 * Charleston 25328 306 MacCorkle Ave., SE

WISCONSIN
 * Appleton Menasha 54910 1725 Racine St.
 * Milwaukee 53207 235 W. Oklahoma Ave.

* Electrical/Mechanical Service Shop * Instrumentation Shop * Special Manufacturing Shop



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