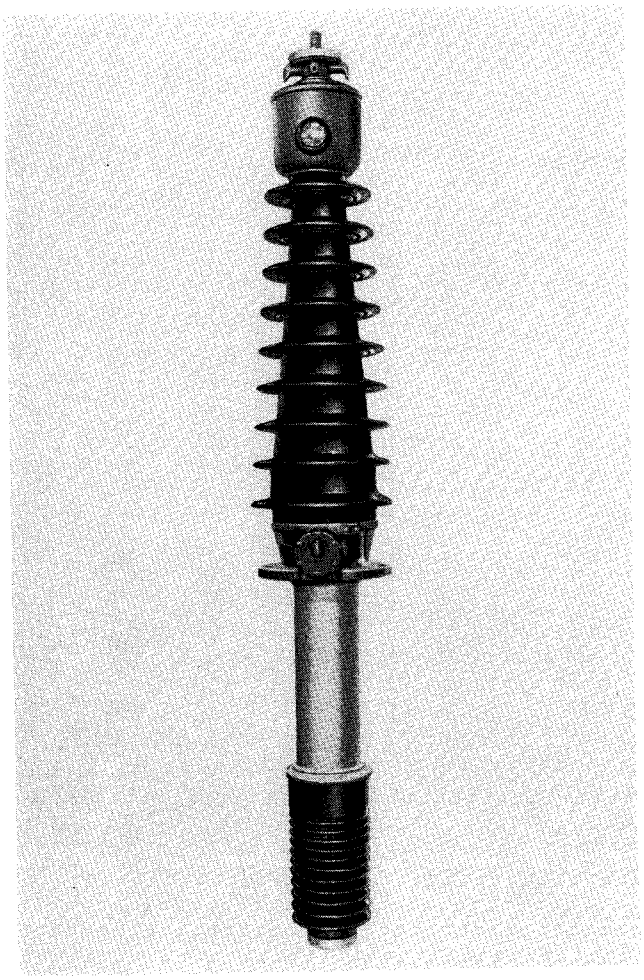
RECEIVING • INSTALLATION • MAINTENANCE

INSTRUCTIONS

OUTDOOR CONDENSER BUSHINGS

Type "O"



THE TYPE "O" CONDENSER BUSHINGS are designed for oil circuit breaker and transformer applications.

Westinghouse bushings for circuit breakers are made by the Circuit Breaker Division at East Pittsburgh, Pennsylvania, while transformer bushings are made by the Transformer Division at Sharon, Pennsylvania. For this reason identical and interchangeable bushings will be identified by different drawing numbers or different style numbers. They also will be identified by identical "Key" numbers. A "Key" number is a Westinghouse designation applied to all bushings which are interchangeable with respect to voltage and current rating, internal dimensions and flange mounting.

These bushings have an oil-impregnated kraft paper condenser inside an oil-filled chamber as shown in Fig. 6. This chamber consists of an expansion bowl, an upper porcelain weather casing, a metal mounting flange, a lower porcelain and a bottom terminal porcelain support. All parts are held under pressure by a spring assembly. The entire chamber is sealed. All joints above oil level are sealed by soldering, brazing or welding. Joints between porcelain and metal parts are made with cork-neoprene sealing gaskets encircled by asbestos-neoprene gaskets and held in compression by the springs in the expansion bowl.

The expansion bowels are constructed as shown in Fig. 6-A. All joints are either soldered, brazed, or welded. Heating of parts is prevented by use of non-magnetic materials and insulating against short circuiting paths in the magnetic field.

The upper porcelain weather casing and the lower porcelain are held in place by compression on their ends. Springs of the proper number and dimensions to provide the desired pressure are supplied in the bushings to meet all test requirements and the maximum operating and shipping requirements of the equipment for which the bushings are designed.

The flange is provided with a voltage tap receptacle and oil valve as shown in Figs. 6-D and 6-E.

The bushing is filled with degassed Wemco "C" oil. Sufficient gas space is left in the expansion bowl to prevent excessive pressures from being built up by the thermal expansion of the oil. The oil is not exposed to light and the expansion space is filled under low pressure with nitrogen so that there is no oxidation of the oil. The oil level reads correctly on the magnetic oil gauge when the bushing is vertical. The reading on the dial will be at a higher or lower level if the bushing is inclined from the vertical position.

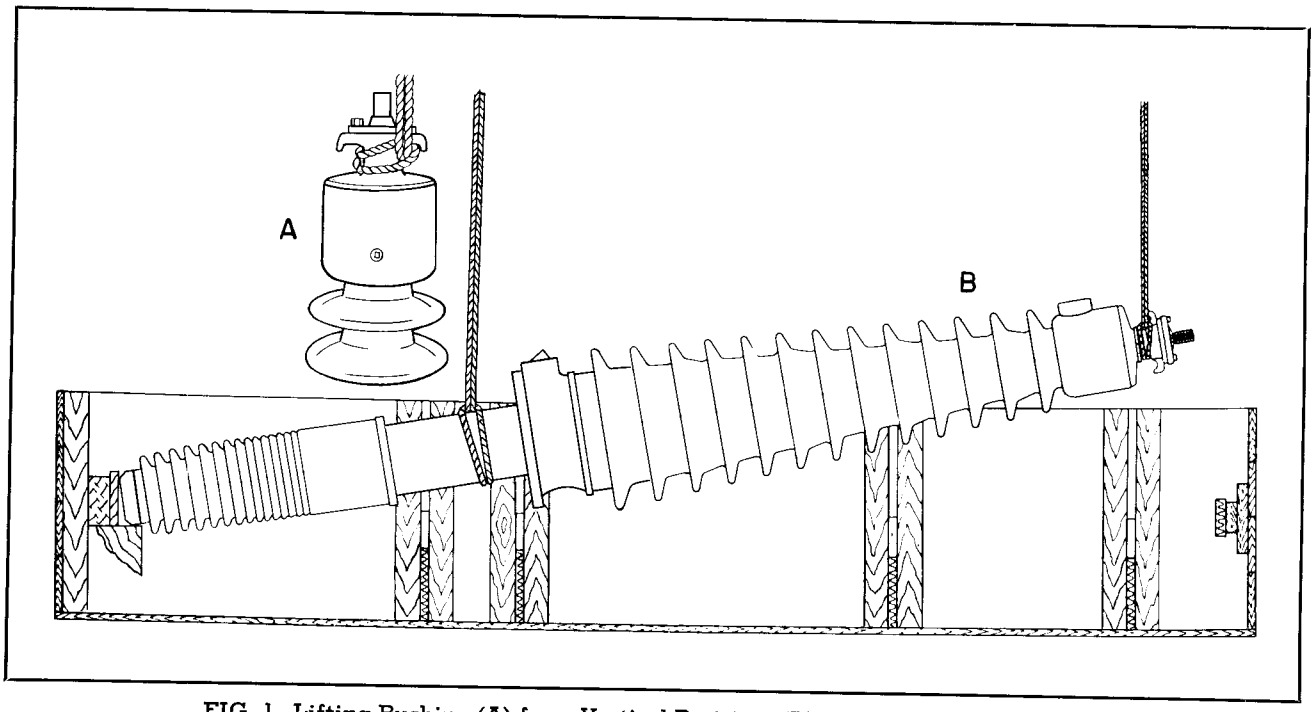


FIG. 1. Lifting Bushing (A) from Vertical Position, (B) from Horizontal Position

RECEIVING, LIFTING AND STORAGE

Receiving. Some bushings are bolted at the flange to a heavy framework and shipped several to a crate in a vertical position. Other bushings are packed in boxes, supported at both ends and on the flange and shipped in a horizontal position.

General instructions for unpacking and handling are fastened to the outside of the crate.

Lifting. The type "O" bushing can be lifted from a horizontal to a vertical position and lifted in a vertical position by a rope or steel cable looped around the top nut under the lifting lugs. See A, Fig. 1.

When lifting from the blocking in a horizontal packing case it is desirable to use a double hoist with one lift at the flange and one looped around the top under the lifting lugs. See B, Fig. 1. When upending the bushing keep the lower end on felt or wood, braced to protect threads and prevent slipping and keep porcelain away from the floor.

A recommended method of suspending the bushing at the proper angle for installing is illustrated in Fig. 2.

Storing. Bushings should be stored, preferably in a rack and in a vertical position or with the top end at least 18 inches higher than the bottom end, in a place where they will not be damaged mechanically. No special precautions need to be taken as to moisture or temperature. A check of oil height, and of power factor and capacitance should be made before putting the bushings into service after prolonged storage.

INSTALLATION

Before installing in the apparatus, wipe the bushing clean of all dust, grease or particles of packing material using cloths wrung out of gasoline or transformer oil and finishing with a dry cloth.

Installing Transformer Bushings. Transformer bushings are provided with rounded surface static shields to cover the threads and sharp corners of bottom terminals (See Figs. 6-G and 6-H). These should always be securely in place on the bushing before it is put into the transformer.

Transformer cover bosses (See Fig. 3A) are flat with a recess to retain the gasket and limit its compression. Both sides of the gasket should be covered with gasket cement before it is installed. The bushing should be correctly rotated and carefully centered as it is lowered against the boss so that clearances from internal parts of the transformer are adequate.

Spare bushings furnished for a given transformer are supplied without cable leads if they are duplicates of the bushings to be replaced. In this case the cable inside the transformer will fit the bushing without alteration. If replacement bushings require new cables, they will be furnished as a length of cable attached to a stud terminal. In order to install such a bushing it will be necessary to cut off the old cable and splice the new cable to the old one. The splice

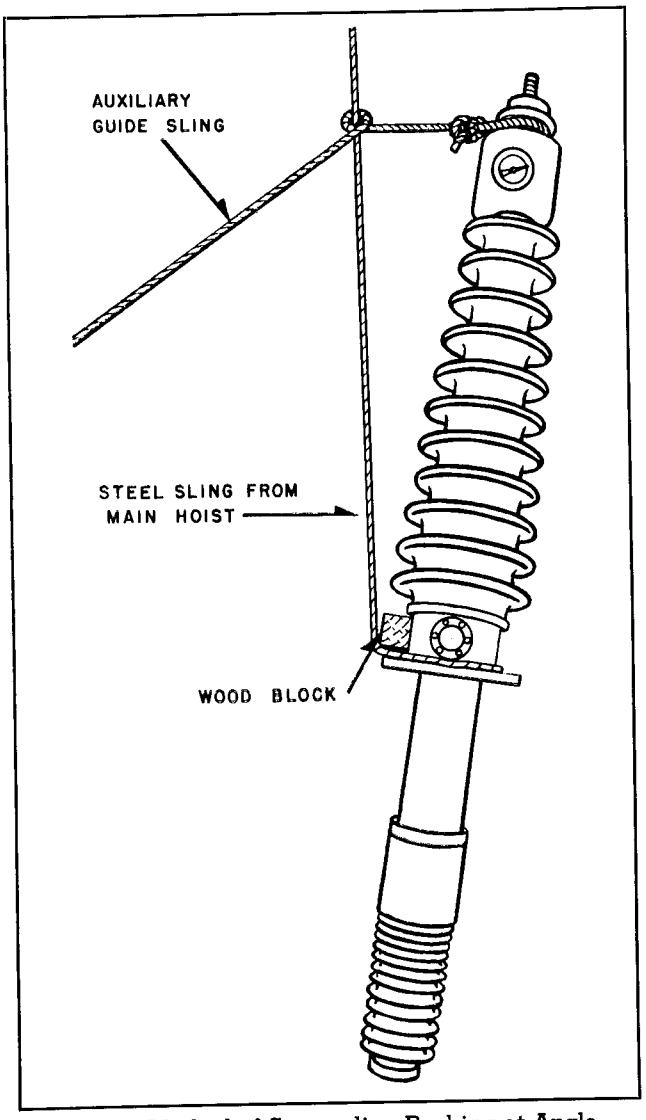


FIG. 2. Method of Suspending Bushing at Angle for Installation

should be brazed or soldered. The spliced joint should preferably be within the condenser tube, provided there is sufficient clearance. The location of the splice may be obtained by measuring the length of the bushing above the bushing cover boss and the length of the cable to the surface of the cover boss. Add two inches to this measurement to give the proper slack in the cable.

Bushings on transformers are supplied with draw-through leads unless the current exceeds the value set by safe thermal considerations, in which case the transformer leads are connected to the lower end of the bushing and the current is carried in the central copper tube. When bushings are removed for shipment on transformers the draw-through leads are coiled up and securely tied to the underside of the blind flange on the bushing boss or to a loop on the underside of the transformer cover conveniently located near the bushing hole so that the bushing may be installed without lowering the oil level in the transformer.

A stout cord or wire should be fished through the bushing tube and attached to a 3/8 bolt screwed into the top threaded hole in the terminal on the end of the draw-through lead. The lead should be drawn taut so that it is free of twists and kinks and the bushing then is slipped over it. If a lead appears to be too short it indicates that something prevents its free passage through the tube and the condition should be cleared.

After the bushing is bolted down, place a drift pin or screw driver through the lower hole in the lead terminal to hold it while the draw cord is removed. Turn the locking nut and the terminal cap (with gasket cemented in place) on the lead terminal and lock the two together. Remove the drift pin and bolt the terminal cap to the cap nut on the bushing.

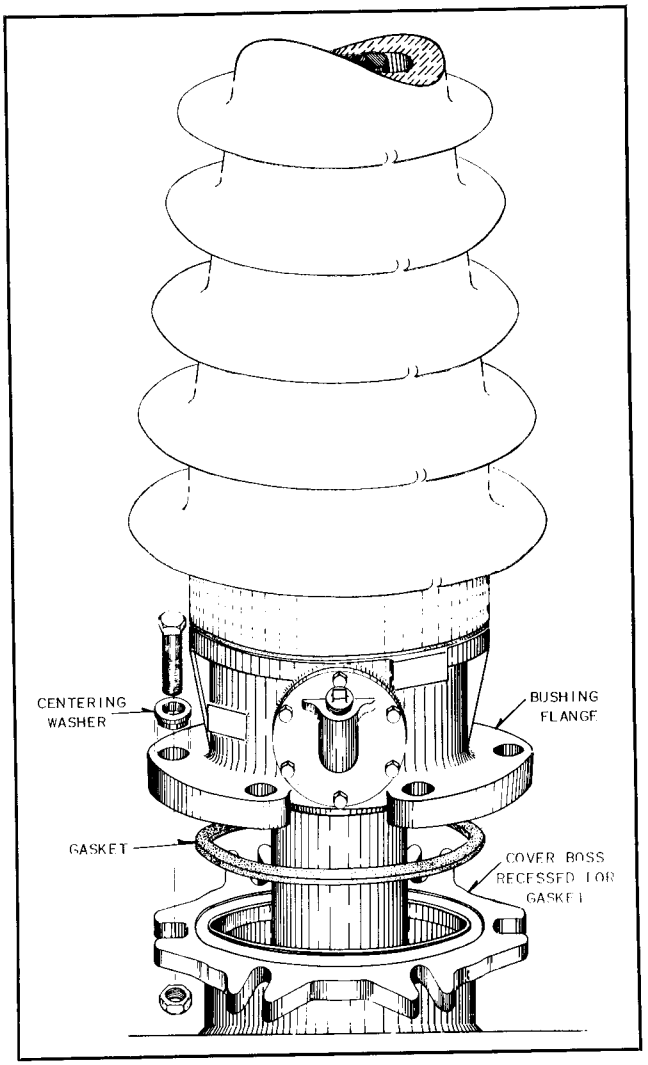


FIG. 3-A. Installing Bushing on Transformer

Installing Breaker Bushings. See Fig. 3-B. Circuit breaker cover bosses for bushings are flat with a machined groove in the flat surface to retain the bushing gasket. Cement gasket into tank groove and apply vaseline between gasket and the bushing. The vaseline will permit shifting the bushing without damage to the gasket. Three eccentric bushings are used on flange bolts to shift bushing for contact adjustment. Have all bolts tight for final assembly.

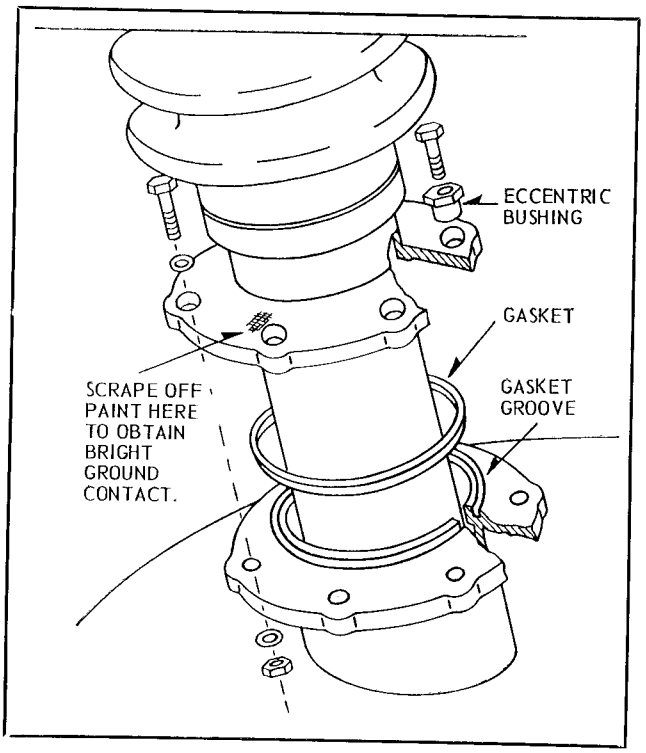


FIG. 3-B. Installing Bushing on Circuit Breaker

Important. See that outside connections do not throw strains on the bushing.

Voltage Tap. Type "O" bushings are furnished with a voltage tap located at the flange. See Fig. 6-E. The voltage tap receptacle is filled with Wemco "C" oil when potential device is not used, and is filled with petrolatum when the potential device is attached. See Fig. 4. The voltage tap is never grounded and the receptacle should always be filled as specified before putting the bushing in service.

Potential Device Connection. Type "O" bushings are furnished with two layer potential tap for use with PB-2 or PBA-2 (high capacity) bushing potential devices. By making some modifications, type "O" bushings can be used with old PB-1 or PB-11 devices normally designed for single layer tap. For these special cases see the Bushing Manual or contact your Westinghouse Representative.

To connect Potential Device Cable (See Fig. 4) remove the cover from the bushing tap receptacle. This will allow approximately 1 pint of transformer oil to drain out. Pack the receptacle with petrolatum and bolt the cable termination in place.

MAINTENANCE

General Maintenance of Bushing

1. Clean all exposed surfaces including weather casing and magnetic oil gauge face at regular intervals.

2. Watch oil gauge. Any abnormal change in oil level indicates a leak in the bushing and should be investigated. The magnetic oil gauge needle should be horizontal when the bushing is vertical and the average temperature of the bushing is approximately 20 to 25°C (68 to 77°F).

Power Factor and Capacitance Tests

Where Power Factor testing schedules have been adapted make power factor and capacitance tests the first year and recheck every second year. External damage or the collection of dirt on insulating surfaces may make other occasional tests desirable.

Important. It should be noted that the normal inherent power factor of these bushings is so low that the correct values of the bushing power factor may be greatly distorted if either of the porcelain surfaces are dirty or wet, if tests are made with the bushing near wet or grounded surfaces, or if external parts are connected to the bushings, such as the interrupter.

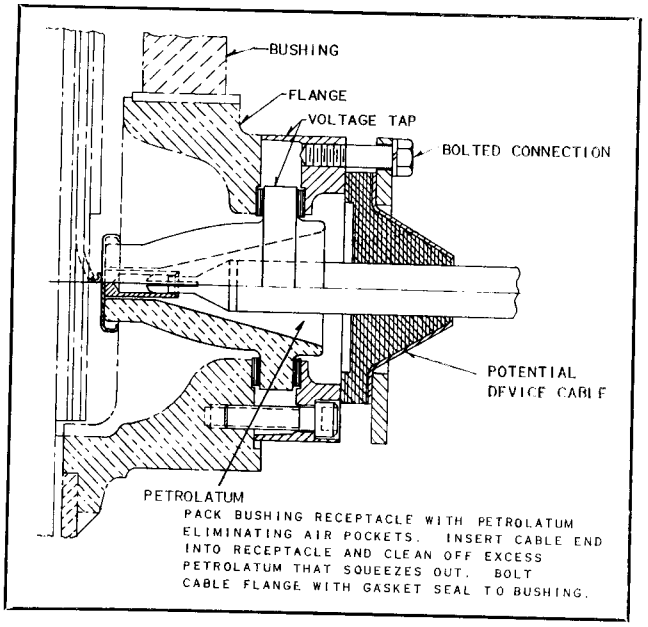
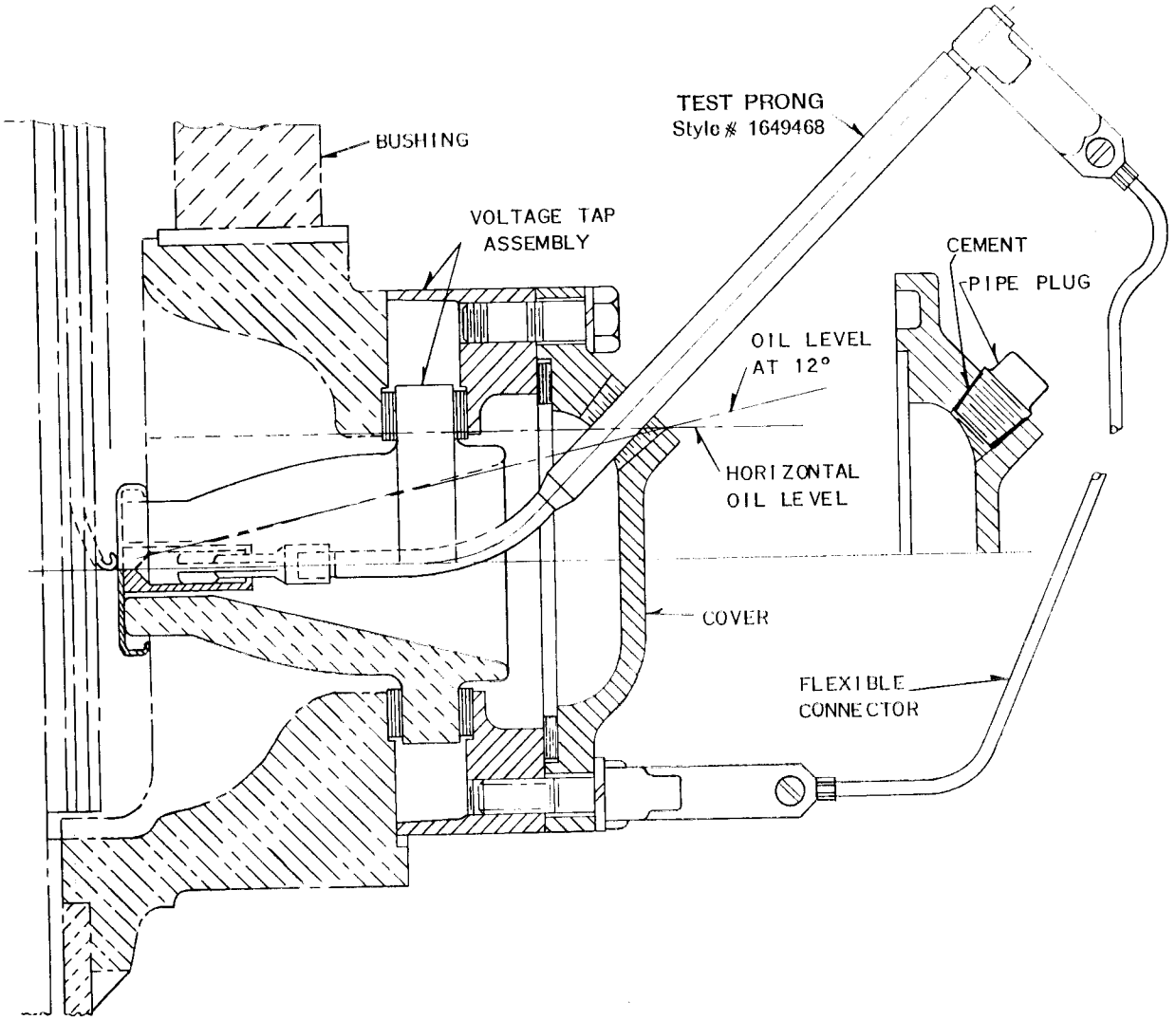


FIG. 4. Voltage Tap Receptacle with Potential Device Cable Connected



TEST PRONG FOR MAKING UNGROUNDED P.F. TESTS THROUGH VOLTAGE TAP ON TYPE "O" BUSHINGS

INSTRUCTIONS _____ AFTER BUSHING IS DISCONNECTED FROM THE HIGH VOLTAGE LINE AND GROUNDED

THE PROCEDURE FOR USING THE TEST PRONG IS:

1. REMOVE THE PIPE PLUG IN THE VOLTAGE TAP COVER.
2. CONNECT THE TERMINAL END OF THE TEST PRONG TO GROUND WITH A FLEXIBLE CONNECTOR, SO AN ELECTROSTATIC CHARGE LEFT ON THE BUSHING AFTER IT HAS BEEN REMOVED FROM SERVICE WILL BE DISCHARGED TO GROUND WHEN THE TEST PRONG IS INSERTED IN THE VOLTAGE TAP.
3. INSERT THE PRONG THROUGH THE HOLE IN THE COVER TO MAKE CONTACT WITH THE FEMALE CONTACT IN THE REAR OF THE VOLTAGE TAP ASSEMBLY.
4. DISCONNECT THE TEST PRONG FROM GROUND AND CONNECT IT TO THE PROPER POWER-FACTOR TEST LEAD.
5. PROCEED TO MAKE A POWER-FACTOR TEST IN THE CONVENTIONAL MANNER USED FOR TESTING UNGROUNDED SPECIMENS.
6. AFTER COMPLETING THE POWER-FACTOR TESTS. REMOVE THE TEST PRONG.
7. IF NECESSARY ADD NEW WEMCO "C" OIL TO HAVE LEVEL EVEN WITH BOTTOM OF HOLE IN COVER. IF NECESSARY.
8. REPLACE THE PIPE PLUG IN A WEATHER-PROOF MANNER IN THE COVER.

FIG. 5. Test Prong for making Ungrounded Power Factor Tests through Voltage Tap on Type "O" Bushings

Power Factor Tests and capacitance measurements can be made by the "Ungrounded Specimen Method" by connecting to the potential tap (see Fig. 5). This eliminates the necessity for disconnecting the transformer winding, grid, or the line lead from the bushing. Ground the insulated test prong while it is inserted through the pipe plug hole in the cover to dissipate any charge that may be left when contact is made to the potential tap. The power factor and capacitance between the tap and central conductor, and between the tap and the flange can then be measured. After tests the oil level in the receptacle should be adjusted with transformer oil and the pipe plug replaced and sealed.

For more complete information and limits on power factor tests see Westinghouse Bushing Manual, T. D. 33-360.

Oil Tests. The type "O" bushing is hermetically sealed with the oil not exposed to light or oxygen, uses no materials harmful to the oil, and has no spots of high voltage concentration. It is therefore strongly recommended that no samples of oil for oil test be taken unless power factor test casts suspicion on the bushing. Sampling removes internal gas pressure and to refill means unsoldering the sealed plug in the cap allowing oxygen to enter.

When inspection or power factor test indicates that samples should be taken, draw the sample from the valve at the flange.

Important. If low dielectric oil is found, make a thorough investigation for tightness. Air or nitrogen, if used in testing, should be known to be dry, and not used at over 20 pounds pressure per square inch.

Summary. Required maintenance is "keep outside clean, watch oil gauge, examine for loose connection, broken porcelain, oil leaks, and make power factor tests and capacitance measurements periodically."

DISMANTLING THE BUSHING

Bushings of this type will rarely have to be rebuilt. Occasionally due to an accident a bushing may be damaged. In such cases Westinghouse has adequate facilities for repairing bushings and best results will generally be obtained by returning them to the factory. However, the dismantling procedure is as follows (see Fig. 6):

1. Remove the bushing from the apparatus. Lay bushing on its side on horses having clean cushion-covered tops.

2. Unsolder the disc over the cap pipe plug and remove the pipe plug. Open the oil valve at the flange and allow all oil to drain out. Put a steel plate over the lower end of the bushing tube and clamp it to the bushing flange by from four to eight tie rods. Tighten enough to hold pressure on gaskets of lower porcelain when spring assembly is removed.

Caution. These bushings contain oil which is flammable under favorable conditions. Flooding the interior of the bushing with dry nitrogen is recommended just before soldering or unsoldering operations are begun.

3. Through the cap hole take feeler gauge measurment of space between spring plate and gauge rod. Record this measurement for use during reassembly of bushing.

4. After removing the adapter cap, unsolder joints at lifting lug, copper tube and diaphragm shown in Fig. 7.

5. For bushings with copper expansion bowl—(see Fig. 7), after copper diaphragm is removed insert bolts and tighten to compress springs. Unscrew pressure nut, remove gauge float, and take spring assembly from cap.

6. The junction of the cemented gasket to the bowl and the porcelain can best be broken by heating and lightly hammering the bowl. Any prying or wedging at the joints is likely to break the porcelain. The gasket joint at lower end of the top weather casing is broken in a similar manner, or it may be sawed, and the top weather casing removed.

7. If the lower porcelain must be removed, remove the steel plate and tie bolts. Unsolder and unscrew the bottom terminal and remove the lower porcelain. The gaskets joints at top and bottom of lower porcelain are broken as specified for the top porcelain weather casing.

8. Remove the voltage tap insulation between the condenser and the porcelain receptacle.

9. Unscrew the six bolts and remove the voltage tap cover. Remove the four hexagon hollow head screws. Screw six 3/8—16 x 2 bolts in cover holes and turn until the gasket seal is broken around the porcelain receptacle. The porcelain receptacle may then be pried out or removed by cutting the gasket.

10. The condenser may then be removed from the flange.

Important. The condenser and tap insulation should be kept in a dry and clean place if they are to be rebuilt back into the bushing within 36 hours. If condenser and tap insulation are to be kept out of the bushing for a longer period of time they should be stored under oil.

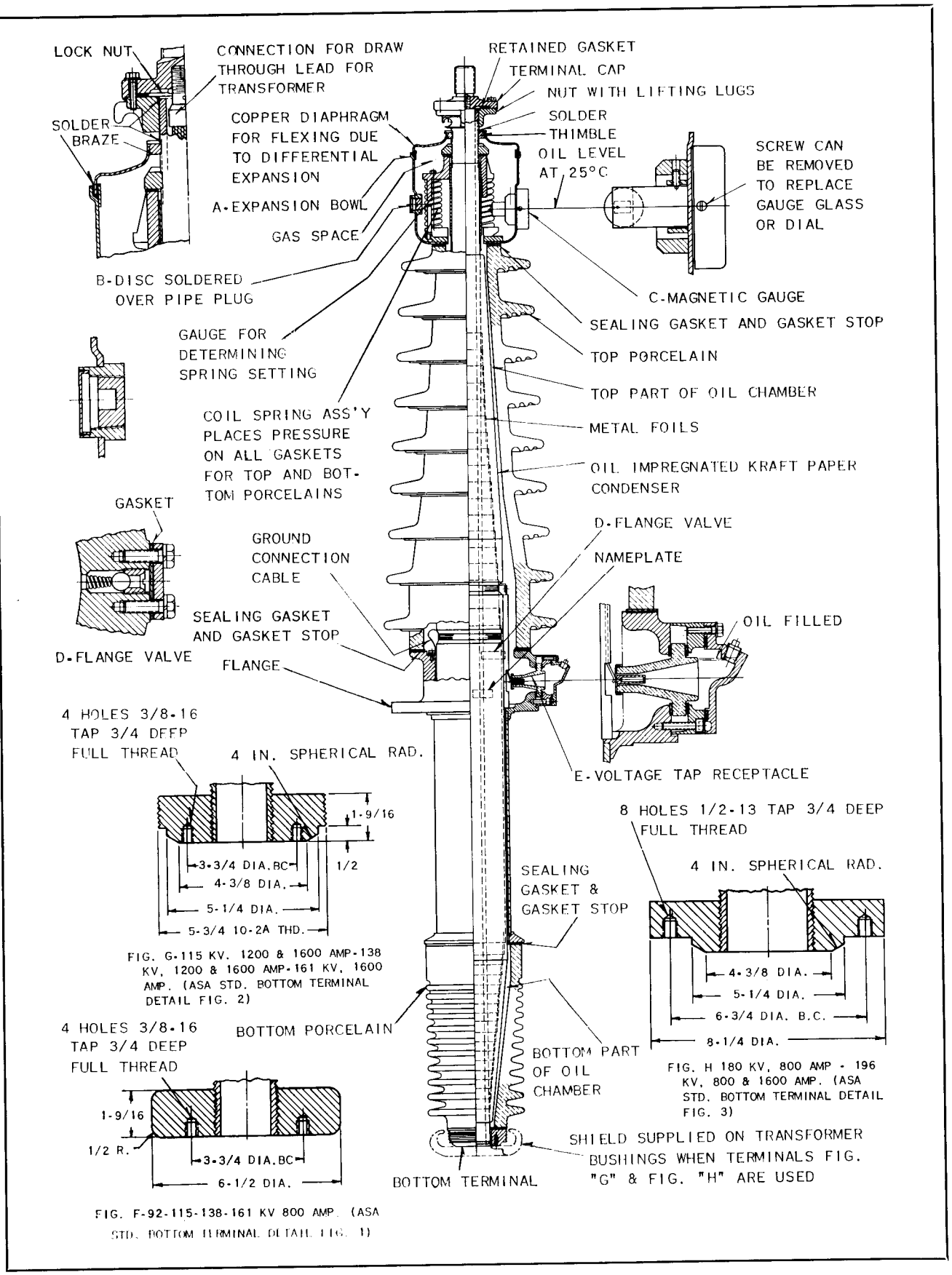


FIG. 6. Sectional View—Condenser Bushing, Type "O"

REBUILDING THE BUSHING

In rebuilding, all surfaces must be thoroughly clean and free of oil. New gaskets must be used in making all joints. It is recommended that gaskets be obtained from Westinghouse as the gasket materials are carefully selected for their purpose and location.

In handling all parts of a bushing, extreme care is required to keep them clean and dry. Clean canvas gloves should be worn by workmen while handling the condenser. The porcelains should be clean and dry before reassembling.

The procedure for rebuilding the bushing is as follows (see Fig. 6):

1. Place the condenser inside the flange.

2. Place lower porcelain over condenser with gaskets between main flange and porcelain coated with cement.

Note. Both cork neoprene sealing gasket and asbestos neoprene stop gasket are applied at ends of upper and lower porcelain with a light even coat of gasket cement (Westinghouse #1887) on both sides. If gaskets tend to slip when pressure is applied, then hold off until the cement is slightly tacky.

3. Place gasket on bottom end of lower porcelain but do not cement at this time. Screw on bottom terminal until flush with end of copper tube lead. Align so two tapped holes in bottom terminal straddle center line of voltage tap. With lower porcelain and gaskets pulled away from the bottom terminal, solder the bottom terminal to the copper tube lead oil tight. In this soldering, as in all other on the bushing, only alcohol and resin flux (Westinghouse 751) should be used. Use no more heat than necessary to make a good solder joint. Use small flame and keep away from porcelains.

4. Now coat gaskets between bottom terminal and lower porcelain with cement and with steel plate and tie rods between lower end of bushing tube and main flange, compress the gaskets so that a .006 inch feeler gauge will not go between the stop gasket and the porcelain. Leave clamps in place until assembly is complete. Before clamping lower porcelain have the center of the voltage tap line up between two tapped holes in the bottom terminal.

5. Assemble the voltage tap insulation, the voltage tap porcelain and gaskets. Connect condenser ground cables tight to flange.

6. Assemble in order the gaskets at bottom of porcelain weather casing, the weather casing, and the gaskets at the top of the weather casing. The stop gasket (neoprene asbestos) should be painted all over with a metallic aluminum paint and dried previous to this time. All gaskets are coated with gasket cement (Westinghouse 1887) at the time they are applied.

7. Adjust bolts on cap spring to give approximately 1/8" less than measured between gauge rods (x-spacing) before dismantling the bushing. Place the cap in position and tighten with pressure nut (Fig. 7). Remove bolts on spring assembly. It may be necessary to repeat the operation of clamping the springs and adjusting pressure nuts to obtain the desired setting on the gauge rods. Contact your Westinghouse representative if there are any questions about setting of gauge rods or compressing springs.

8. Solder joints at lifting nut, diaphragm, etc., as shown in either Fig. 7 to seal cap.

9. Bake the bushing at 90°C for 8 hours to set the cement.

10. The above applies if the old condenser has a good power factor and is to be rebuilt into the bushing.

Important. If a new condenser is required return the bushing to Westinghouse Electric Corporation (circuit breaker bushings to East Pittsburgh and transformer bushings to Sharon), as special equipment is necessary for evacuating, degassing oil and impregnating to insure the best results.

11. Test the bushing assembly for leakage, using nitrogen or air known to be dry, and at 20 pounds pressure per square inch. Test for leaks with soapy water.

12. With the bushing horizontal, fill with Wemco "C" oil through the hole in side of cap. Place pipe plug in filling hole and solder the copper cupped disc over this plug.

13. With the bushing in the vertical position, enter nitrogen through the flange valve at approximately 5 pounds pressure and then adjust the oil level. Repeat until the oil gauge shows the correct level and the nitrogen pressure is 5 pounds, if degassed oil was used, or 3 pounds if non-degassed oil was used in filling.

14. Paint over all joints and possible leak points with whiting. Set the bushing vertical for one day and then horizontal for one day, so that oil will be sure to cover all places where leaks might occur.

15. If no leaks are found remove whiting, and paint, covering the edges of all exposed gaskets and all soldered joints. Add adapter cap with cork neoprene gasket. Use a light coat of cement 1887 on the gasket and apply the gasket while the cement is still fresh.

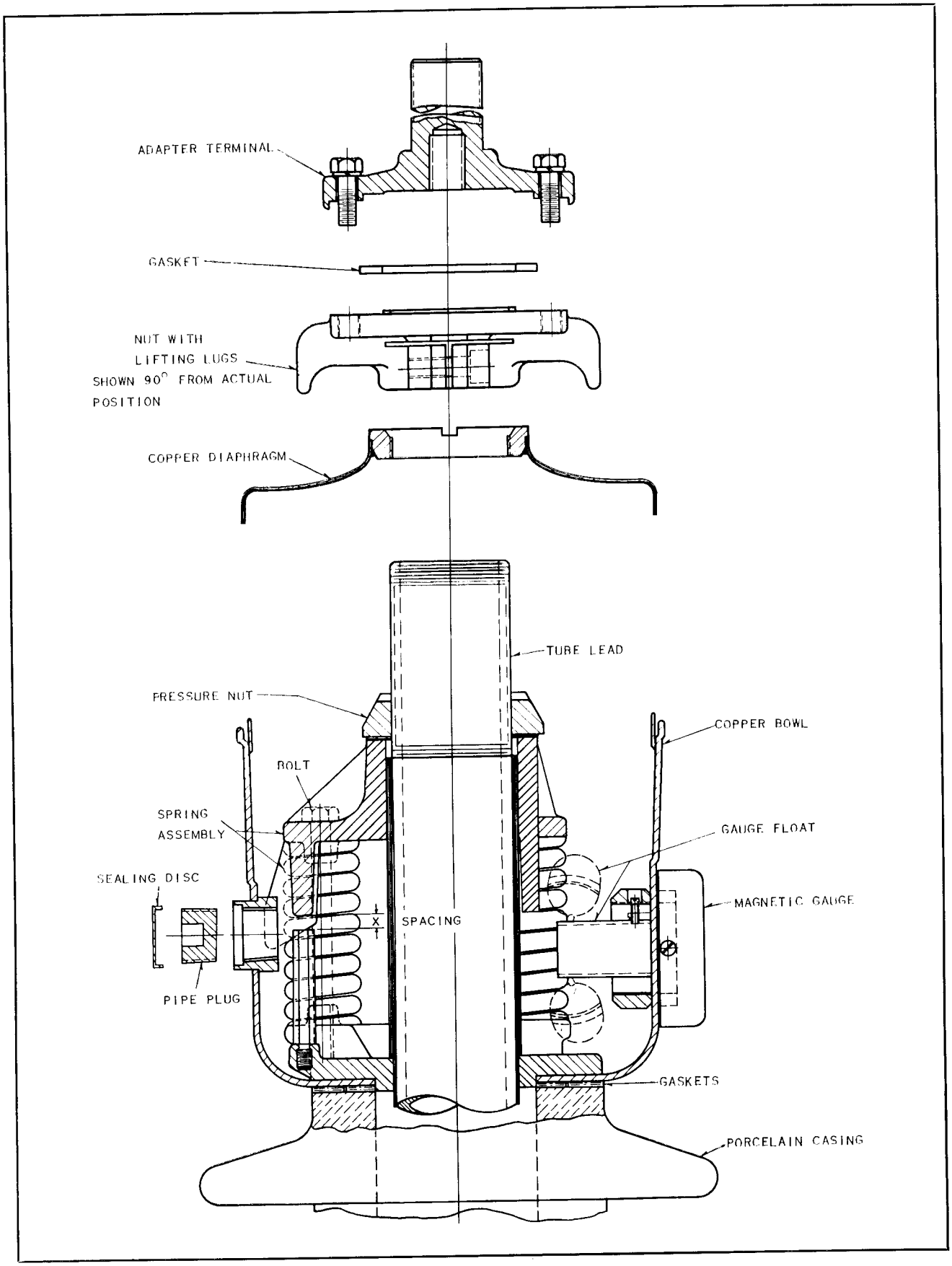


FIG. 7. Sectional View—Bushing Expansion Bowl

Rebuilding Precautions

The following precautions are to be observed when rebuilding a bushing.

1. Keep the condenser under clean dry oil if it is not assembled back into bushing within 36 hours.

2. Use new clean Wemco "C" oil of not less than 25 KV strength and preferably degassed, for filling the bushing.

3. Keep all materials dry and clean and gasket surfaces free of oil.

4. Carefully clean and tin all surfaces to be soldered. This is the first essential of a good soldered joint.

5. Center the porcelains with the bushing lead and center gaskets with the porcelain.

6. Refill voltage tap with Wemco "C" oil.

7. If facilities are available, give completed bushing standard insulation tests for its class and make power factor and capacitance tests. Make power factor test on condenser before rebuilding and do not rebuild if power factor is over 1 percent. If power factor is high, a new condenser should be wound and the rebuilding done at the factory.

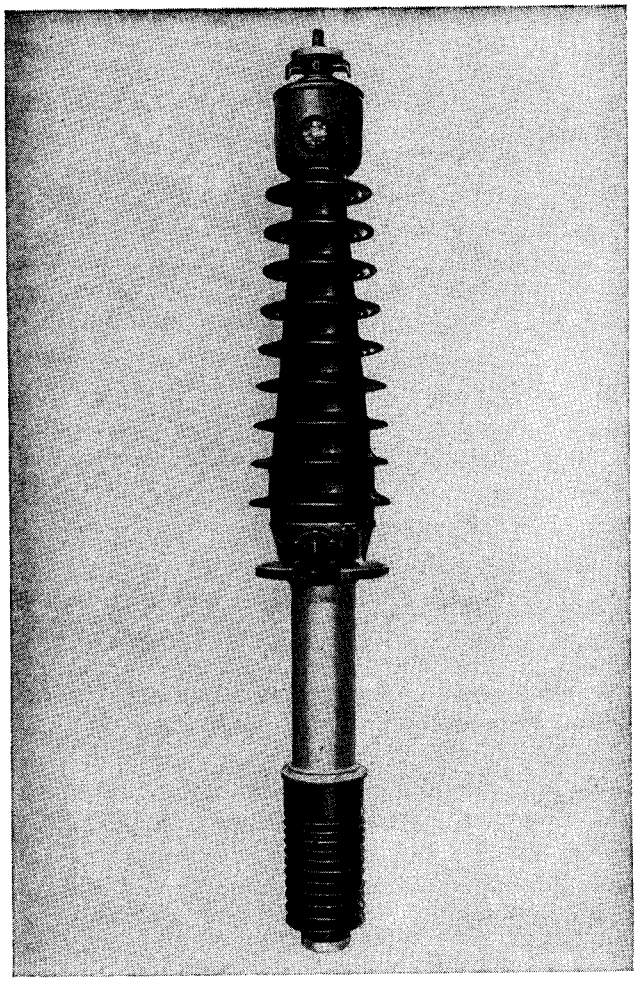
WESTINGHOUSE ELECTRIC CORPORATION
EAST PITTSBURGH PLANT • SWITCHGEAR DIVISION • EAST PITTSBURGH, PA.
Printed in U.S.A.

MEMORANDUM


WESTINGHOUSE

Instructions for Type "O" 115 KV and Above Outdoor Condenser Bushings

I.L. 33-354-1C



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Westinghouse bushings for circuit breakers are made by the Circuit Breaker Division at Trafford, Pennsylvania, while transformer bushings are made by the Transformer Division at Sharon, Pennsylvania. For this reason identical and interchangeable bushings will be identified by different drawing numbers or different style numbers. They also will be identified by identical "Key" numbers.

A key number has been assigned to most of the outdoor bushings for the purpose of identifying the principal mounting dimensions, internal dimensions, and nominal current ratings. Superseding key numbers are catalog numbers. Bushings of the same catalog number are exactly identical. The catalog number is used to relate to standards, correlate between circuit breaker and transformer (IC) bushings, and compare to other manufacturers bushings. For specifics concerning identification of replacement bushings refer to T.D. 33-360.

These bushings (Type "O") have an oil-impregnated kraft paper condenser inside an oil-filled chamber as shown in Fig. 6. This chamber consists of an expansion bowl, an upper porcelain weather casing, a metal mounting flange, a lower porcelain and a bottom terminal. All parts are held under pressure by a spring assembly. The entire chamber is sealed. All joints above oil level are sealed by soldering, brazing or welding. Joints between porcelain and metal parts are made with cork-neoprene sealing gaskets encircled by asbestos-neoprene gaskets and held in compression by the springs in the expansion bowl.

The expansion bowls are constructed as shown in Fig. 7. All joints are either soldered, brazed, or welded. Heating of parts is prevented by use of non-magnetic materials and insulating against short circuiting paths in the magnetic field.

The upper porcelain weather casing and the lower porcelain are held in place by compression on their ends. Springs of the proper number and dimensions to provide the desired pressure are supplied in the bushings to meet all test requirements and the maximum operating and shipping requirements of the equipment for which the bushings are designed.

The flange is provided with a voltage tap receptacle and oil valve as shown in insets D and E in Fig. 6. This I.L. does not apply to the 69 kv type "O" where the voltage tap receptacle is replaced by a power factor tap.

The bushing is filled with degassed Wemco "C" oil. Sufficient gas space is left in the expansion bowl to prevent excessive pressures from being built up by the thermal expansion of the oil. The oil is not exposed to light and the expansion space is filled under low pressure with nitrogen so that there is no oxidation of the oil. The oil level reads correctly on the magnetic oil gauge when the bushing is vertical. The reading on the dial will be at a higher or lower level if the bushing is inclined from the vertical position.

Effective May, 1970. Supersedes I.L. 33-354-1B, November, 1969

the current is carried in the central tube. When bushings are removed for shipment on transformers the draw-through leads are coiled up and securely tied to the underside of the blind flange on the bushing boss or to a loop on the underside of the transformer cover conveniently located near the bushing hole so that the bushing may be installed without lowering the oil level in the transformer.

A stout cord or wire should be fished through the bushing tube and attached to a 3/8 bolt screwed into the top threaded hole in the terminal on the end of the draw-through lead. The lead should be drawn taut so that it is free of twists and kinks and the bushing then is slipped over it. If a lead appears to be too short it indicates that something prevents its free passage through the tube and the condition should be cleared.

After the bushing is bolted down, place a drift pin or screw driver through the lower hole in the lead terminal to hold it while the draw cord is removed. Turn the locking nut and the terminal cap (with gasket cemented in place) on the lead terminal and lock the two together. Remove the drift pin and bolt the terminal cap to the cap nut on the bushing.

Installing Breaker Bushings

See Fig. 3-B. Circuit breaker cover bosses for bushings are flat with a machined groove in the flat surface to retain the bushing gasket. Cement gasket into tank groove and apply vaseline between gasket and the bushing. The vaseline will permit shifting the bushing without damage to the gasket. Eccentric bushings are used on flange bolts to shift bushing for contact adjustment. Have all bolts tight for final assembly.

IMPORTANT

See that outside connections do not throw strains on the bushing in excess of those specified by standards.

Voltage Tap

Type "O" bushings 115 kv and above are furnished with a voltage tap located at the flange. See Fig. 6-E. The voltage tap receptacle is filled with Wemco "C" oil when potential device is not used, and is filled with petrolatum when the potential device is attached. See Fig. 4. The voltage tap is never grounded and the receptacle should always be filled as specified before putting the bushing in service.

Potential Device Connection

Type "O" bushings are furnished with a two layer potential tap for use with PBA-2 bushing potential devices.

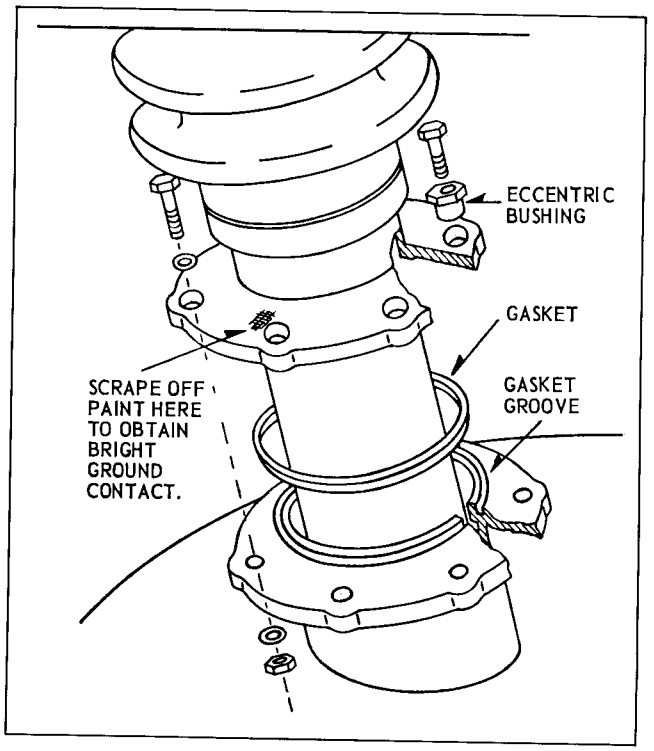


Fig. 3-B. *Installing Bushing on Circuit Breaker*

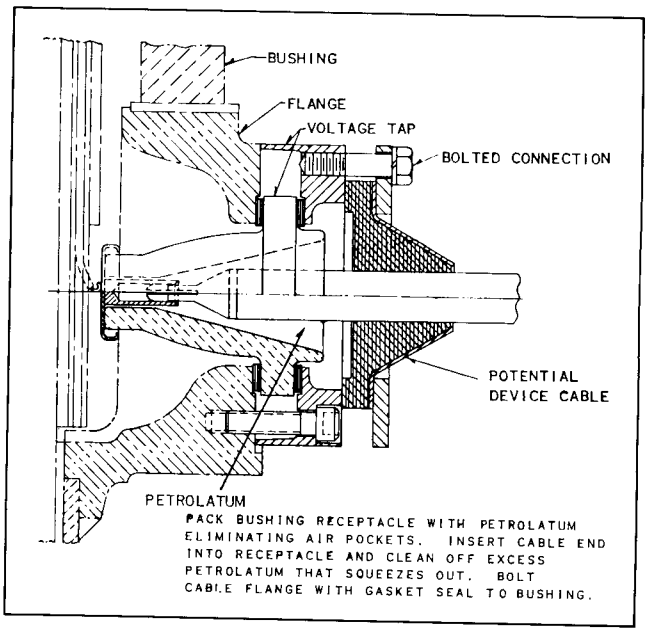
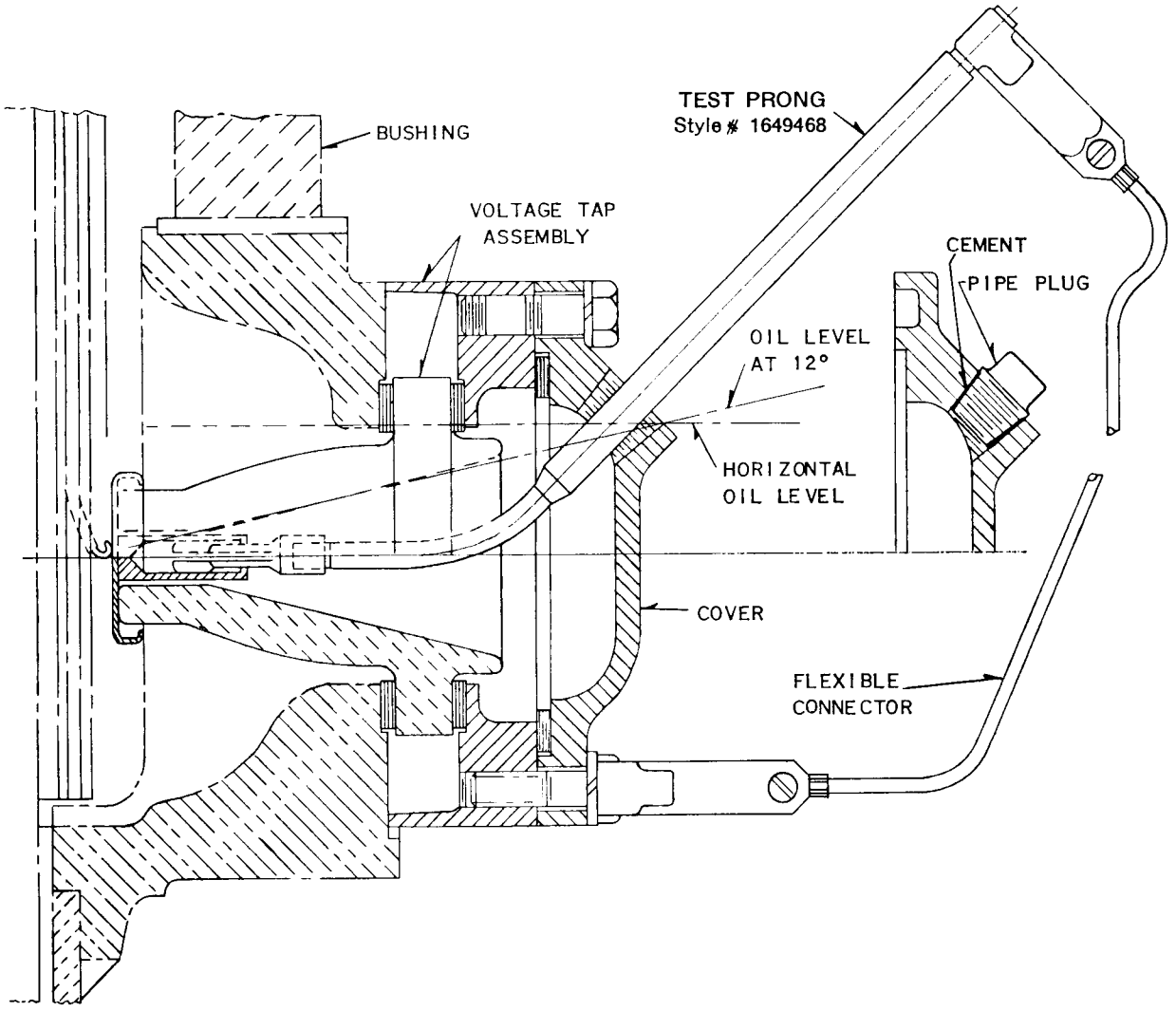


Fig. 4. *Voltage Tap Receptacle with Potential Device Cable Connected*

To connect Potential Devices Cable (See Fig. 4) remove the cover from the bushing tap receptacle. This will allow approximately 1 pint of transformer oil to drain out. Pack the receptacle with petrolatum and bolt the cable termination in place.



TEST PRONG FOR MAKING UNGROUNDED P.F. TESTS THROUGH VOLTAGE TAP ON TYPE "O" BUSHINGS

INSTRUCTIONS _____ AFTER BUSHING IS DISCONNECTED FROM THE HIGH VOLTAGE LINE AND GROUNDED

THE PROCEDURE FOR USING THE TEST PRONG IS:

1. REMOVE THE PIPE PLUG IN THE VOLTAGE TAP COVER.
2. CONNECT THE TERMINAL END OF THE TEST PRONG TO GROUND WITH A FLEXIBLE CONNECTOR, SO AN ELECTROSTATIC CHARGE LEFT ON THE BUSHING AFTER IT HAS BEEN REMOVED FROM SERVICE WILL BE DISCHARGED TO GROUND WHEN THE TEST PRONG IS INSERTED IN THE VOLTAGE TAP.
3. INSERT THE PRONG THROUGH THE HOLE IN THE COVER TO MAKE CONTACT WITH THE FEMALE CONTACT IN THE REAR OF THE VOLTAGE TAP ASSEMBLY.
4. DISCONNECT THE TEST PRONG FROM GROUND AND CONNECT IT TO THE PROPER POWER-FACTOR TEST LEAD.
5. PROCEED TO MAKE A POWER-FACTOR TEST IN THE CONVENTIONAL MANNER USED FOR TESTING UNGROUNDED SPECIMENS.
6. AFTER COMPLETING THE POWER-FACTOR TESTS, REMOVE THE TEST PRONG.
7. ADD NEW WEMCO "C" OIL TO HAVE LEVEL EVEN WITH BOTTOM OF HOLE IN COVER. IF NECESSARY.
8. REPLACE THE PIPE PLUG IN A WEATHERPROOF MANNER IN THE COVER.

Fig. 5. *Test Prong for Making Ungrounded Power Factor Tests through Tap on Type "O" Bushings*

MAINTENANCE

General Maintenance of Bushing

1. Clean all exposed surfaces including weather casing and magnetic oil gauge face at regular intervals.

2. Watch oil gauge. Any abnormal change in oil level indicates a leak in the bushing and should be investigated. The magnetic oil gauge needle should be horizontal when the bushing is vertical and the average temperature of the bushing is approximately 20 to 25°C (68 to 77°F).

Power Factor and Capacitance Tests

Where Power Factor testing schedules have been adapted make power factor and capacitance tests the first year and recheck every second year. External damage or the collection of dirt on insulating surfaces may make other occasional tests desirable.

IMPORTANT

It should be noted that the normal inherent power factor of these bushings is so low that the correct values of the bushing power factor may be greatly distorted if either of the porcelain surfaces are dirty or wet, if tests were made with the bushing near wet or grounded surfaces, or if external parts are connected to the bushings, such as the interrupter.

Power Factor Tests and capacitance measurements can be made by the "Ungrounded Specimen Method" by connecting to the potential tap (See Fig. 5). This eliminates the necessity for disconnecting the transformer winding, grid, or the line lead from the bushing. Ground the insulated test prong while it is inserted through the pipe plug hole in the cover to dissipate any charge that may be left when contact is made to the potential tap. The power factor and capacitance between the tap and central conductor, and between the tap and the flange can then be measured. After tests the oil level in the receptacle should be adjusted with transformer oil and the pipe plug replaced and sealed.

For more complete information and limits on power factor tests see Westinghouse Bushing Manual, T.D. 33-360.

Oil Tests

The type "O" bushing is hermetically sealed with the oil not exposed to light or oxygen, uses no materials harmful to the oil, and has no spots of high voltage concentration. It is therefore strongly recommended that no samples of oil for oil test be taken unless power factor test casts suspicion on the bushing. Sampling removes internal gas pressure and to refill means unsoldering the sealed plug in the cap allowing oxygen to enter.

When inspection or power factor test indicates that samples should be taken, draw the sample from the valve at the flange.

IMPORTANT

If low dielectric oil is found, make a thorough investigation for tightness. Air or nitrogen, if used in testing, should be known to be dry, and not used at over 20 pounds pressure per square inch.

Summary

Required maintenance is "keep outside clean, watch oil gauge, examine for loose connection, broken porcelain, oil leaks, and make power factor tests and capacitance measurements periodically."

DISMANTLING THE BUSHING

Bushings of this type will rarely have to be rebuilt. Occasionally, due to an accident, a bushing may be damaged. If the power factor is greater than one percent, a new condenser should be wound. In such cases Westinghouse has adequate facilities for repairing bushings and best results will generally be obtained by returning them to the factory. However, the dismantling procedure is as follows (See Fig. 6):

1. Lay bushing in horizontal position on horses having clean, covered, cushioned tops.

2. Remove voltage tap and drain oil in the following manner:

Unscrew the six bolts and remove the voltage tap cover. Remove the four hexagon hollow head screws. Screw six 3/8-16 x 2 bolts in cover holes and turn until the gasket seal is broken around the porcelain receptacle. The porcelain receptacle may then be pried out or removed by cutting the gasket.

Roll bushing over and drain all oil.

3. Remove the draw lead adapter terminal and unsolder the joint at the lifting lug *or* remove the breaker top terminal (See Fig. 7).

CAUTION

These bushings contain oil which is flammable under favorable conditions. Flooding the interior of the bushing with dry nitrogen is recommended just before soldering or unsoldering operations are begun.

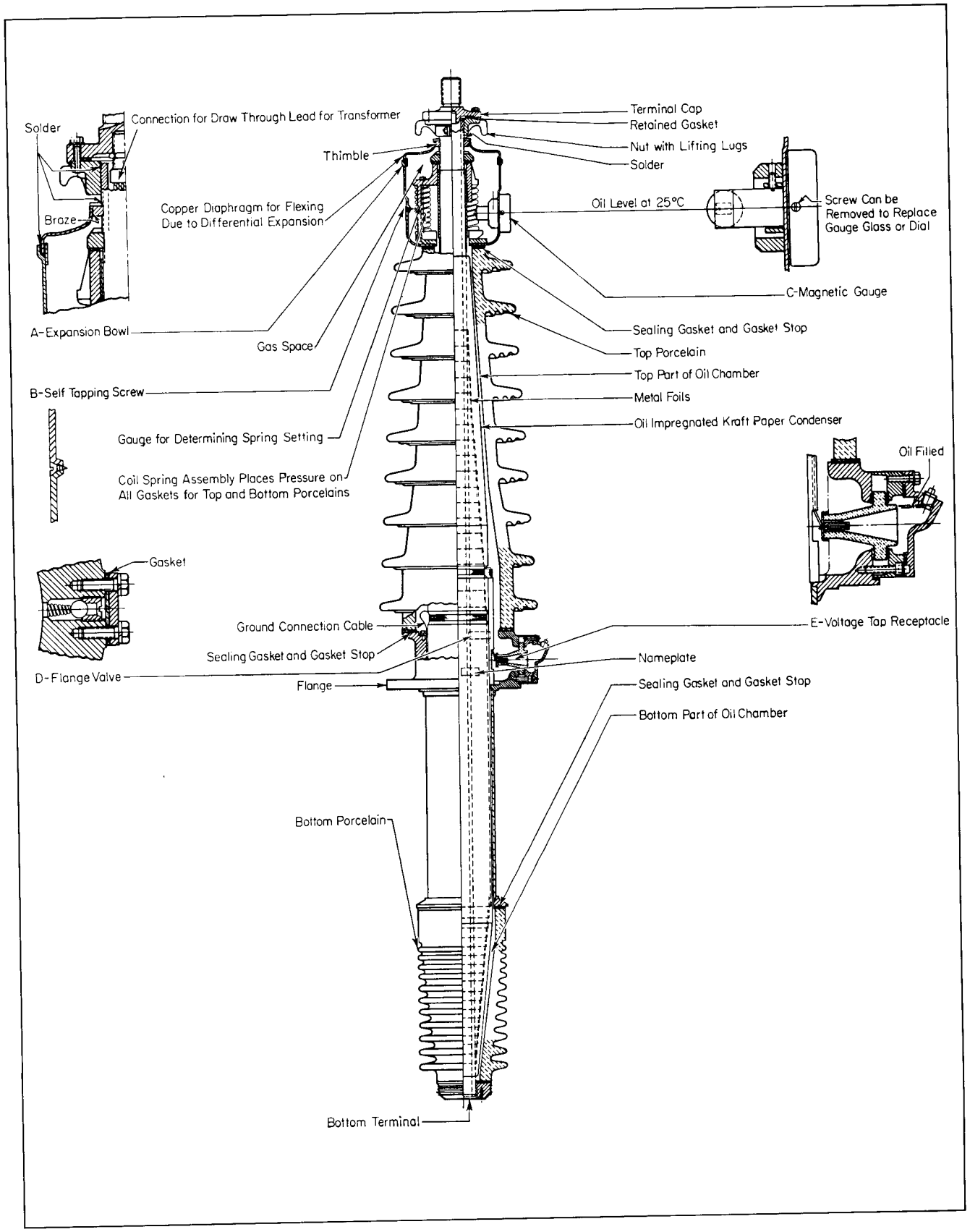


Fig. 6. *Sectional View–Condenser Bushing, Type "O"*

4. Unsolder the joints at the (diaphragm - tube lead) and (diaphragm - bowl) per Fig. 7. Be sure to burn and buff all solder from the threads in the tube lead above the top of the bowl.

5. Remove the diaphragm with a spanner wrench.

6. Put a steel plate over the lower end of the bushing bottom terminal and clamp it to the bushing flange by using from four to eight tie rods. Tighten enough to hold pressure on gaskets of lower porcelain before spring assembly is removed.

7. Measure distance between spring plates (Shown in Fig. 7).

8. Insert six bolts (could be 1/2-13 or 5/8-11) of the length measured in #7 above in each spring hole and turn each a little at a time to compress the springs enough to relieve press on pressure nut. Remove Pressure Nut and Spring Assembly. Hit bottom of cap upward with a rawhide hammer to break gasket seal from top of porcelain. If necessary heat around side of cap bowl with soft torch flame while tapping with hammer to help break gasket seal.

CAUTION

Take care not to get flame on porcelain.

9. Place a rope sling around the top porcelain and pull or lift up while applying a torch around the flange to soften and break gasket cement. Remove porcelain from bushing.

10. Clean gasket surfaces on porcelain and flange.

11. If the lower porcelain must be removed, remove the steel plate and the bolts. See Step 6 Above. Unsolder and unscrew the bottom terminal and remove the lower porcelain. The gasket joints at top and bottom of lower porcelain are broken as specified for the top porcelain weather casing.

12. Remove the voltage tap insulation between the condenser and the porcelain receptacle.

13. The flange may then be removed from the condenser.

IMPORTANT

The condenser and tap insulation should be kept in a dry and clean place if they are to be rebuilt back into the bushing within 36 hours. If condenser and tap insulation are to be kept out of the bushing for a longer period of time, they should be stored under oil.

REBUILDING THE BUSHING

In rebuilding, all surfaces must be thoroughly clean and free of oil. New gaskets must be used in making all joints. It is recommended that gaskets be obtained from Westinghouse as the gasket materials are carefully selected for their purpose and location.

In handling all parts of a bushing, extreme care is required to keep them clean and dry. Clean canvas gloves should be worn by workmen while handling the condenser. The porcelains should be clean and dry before reassembling.

The procedure for rebuilding the bushing is as follows (See Fig. 6):

1. Place the condenser inside the flange and attach voltage tap insulation.

2. Place lower porcelain over condenser with gaskets between main flange and porcelain coated with cement.

NOTE

Both cork neoprene sealing gasket and asbestos neoprene stop gasket are applied at ends of upper and lower porcelain with a light even coat of gasket cement on both sides. If gaskets tend to slip when pressure is applied, then hold off until the cement is slightly tacky.

3. Place gasket on bottom end of lower porcelain but do not cement at this time. Screw on bottom terminal until flush with end of copper tube lead. Align so two tapped holes in bottom terminal straddle center line of voltage tap. With lower porcelain and gaskets pulled away from the bottom terminal, solder the bottom terminal to the copper tube lead oil tight. In this soldering, as in all other on the bushing, (Westinghouse 53301AA) should be used. Use no more heat than necessary to make a good solder joint. Use small flame and keep away from porcelains.

4. Now coat gaskets between bottom terminal and lower porcelain with cement and with steel plate and tie rods between lower end of bushing tube and main flange, compress the gaskets so that porcelain rests on the stop gasket. Leave clamps in place until assembly is complete. Before clamping lower porcelain have the center of the voltage tap line up between two tapped holes in the bottom terminal.

5. Assemble the voltage tap insulation, the voltage tap porcelain and gaskets. Connect condenser ground cable tight to flange.

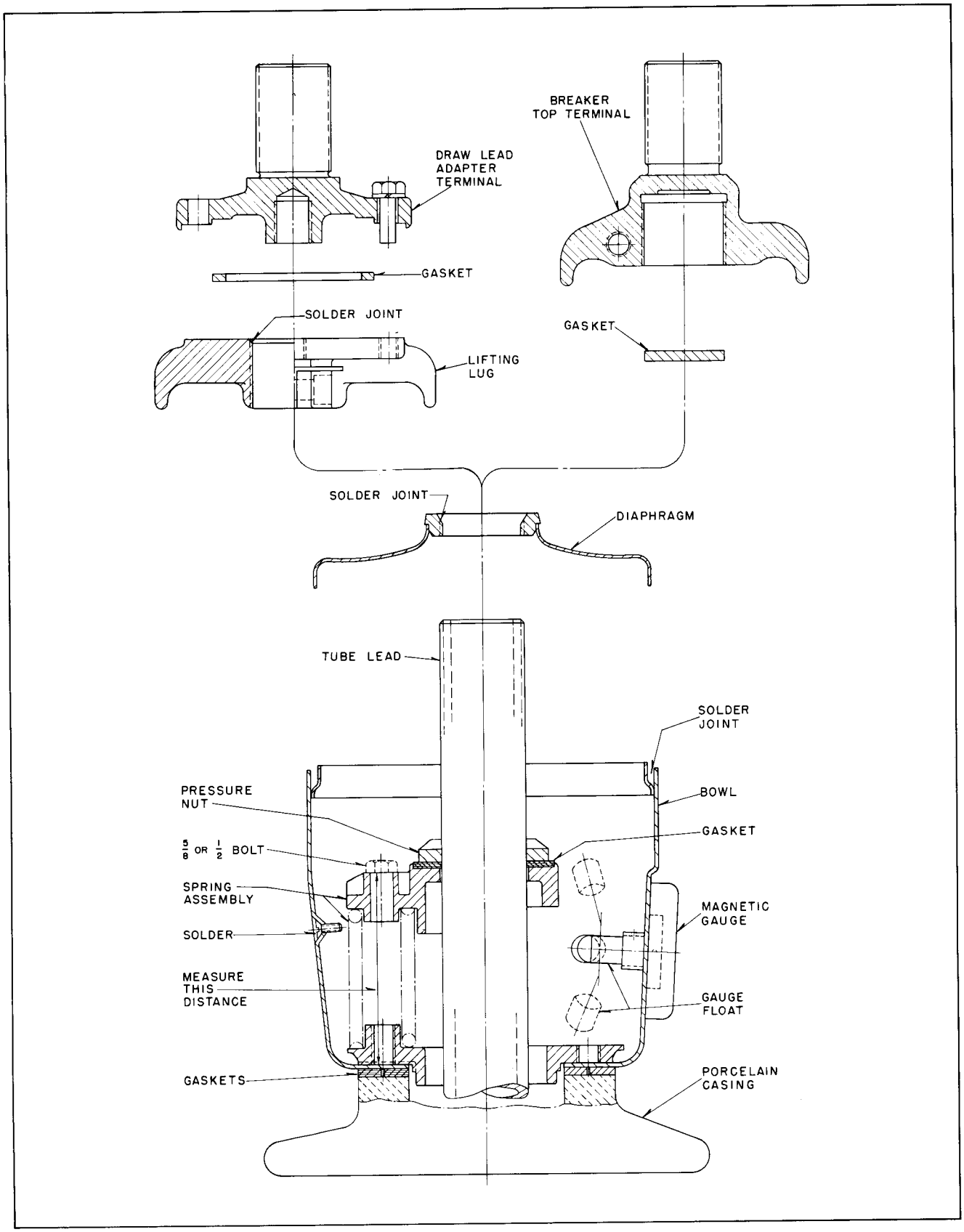


Fig. 7. *Sectional View–Bushing Expansion Bowl*

6. Assemble in order the gaskets at bottom of porcelain weather casing, the weather casing, and the gaskets at the top of the weather casing. The stop gasket (neoprene asbestos) should be painted on the outer edge with metallic aluminum paint and dried previous to this time. All gaskets are coated with gasket cement (Westinghouse 32101AA) at the time they are applied.

7. Adjust bolts in the spring assembly to give 3/32 less than measured in step #7 under dismantling. Place the spring assembly in the cap and position it on the top porcelain. Tighten the pressure nut (Fig. 7). Remove the bolts in the spring assembly. It may be necessary to repeat the clamping and adjusting of the spring pressure nut to attain the desired setting - distance measured less 3/32 (Fig. 7). Contact your Westinghouse representative concerning questions about the setting or compression of the springs.

8. Solder joints at lifting nut, diaphragm, etc., as shown in either Fig. 7 to seal cap.

9. Bake the bushing at 90°C for 8 hours to set the cement.

10. The above applies if the old condenser has a good power factor and is to be rebuilt into the bushing.

IMPORTANT

If a new condenser is required return the bushing to Westinghouse Electric Corporation (circuit breaker bushings to Trafford and transformer bushings to Sharon), as special equipment is necessary for evacuating, degassing oil and impregnating to insure the best results.

11. Replace the potential tap assembly and test the bushing assembly for leakage, using nitrogen (tool 169C892G01) at 20 pounds pressure per square inch. Test for leaks with soapy water or a leak detector.

12. With the bushing horizontal, fill with Wemco "C" oil using 169C892G01 and instructions on Dwg. 170C587.

13. If no leaks are found, paint over the edges of all exposed gaskets and all soldered joints. Add the top terminal.

14. If possible give bushing 1 minute dielectric withstand or make a power factor check.

Rebuilding Precautions

The following precautions are to be observed when rebuilding a bushing.

1. Keep the condenser under clean dry oil if it is not assembled back into bushing within 36 hours.

2. Use new clean Wemco "C" oil of not less than 25 KV strength and preferably degassed, for filling the bushing.

3. Keep all materials dry and clean and gasket surfaces free of oil.

4. Carefully clean and tin all surfaces to be soldered. This is the first essential of a good soldered joint.

5. Center the procelains with the bushing lead and center gaskets with the porcelain.

6. Refill voltage tap with Wemco "C" oil.

7. If facilities are available, give completed bushing standard insulation tests for its class and make power factor and capacitance tests. Make power factor test on condenser before rebuilding and do not rebuild if power factor is over 1 percent. If power factor is high, a new condenser should be wound and the rebuilding done at the factory.

Memorandum

Westinghouse Electric Corporation

Power Circuit Breaker Division, Trafford, Pa.
Power Transformer Division, Sharon, Pa.

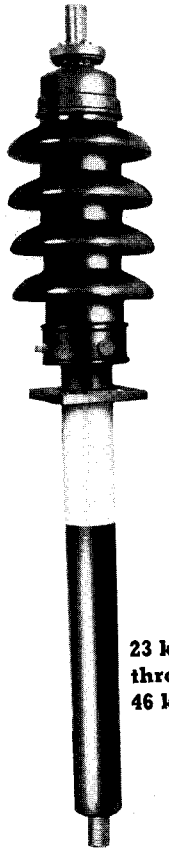
Printed in U.S.A.

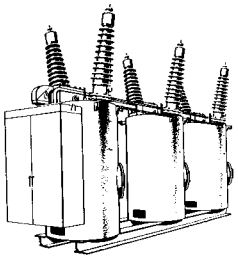
condenser bushings

types S and O • 15 to 345 kv

for power circuit breakers and large power transformers • indoor • outdoor

type S

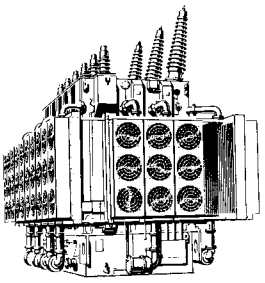




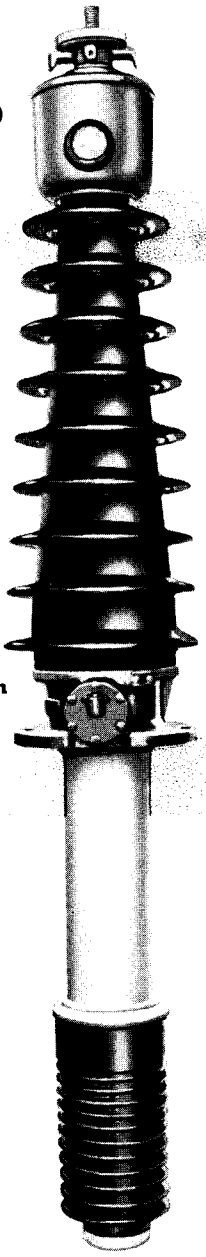
23 kv through 46 kv

type O

69 kv



type O



115 kv through 196 kv

application

Westinghouse condenser bushings for incoming and outgoing power lines provide high grade insulation from grounded metal structures.

All IC (interchangeable) bushings are interchangeable between circuit breakers and transformers of Westinghouse design and other manufacturers' equipment.

advantages

uniform voltage stress low power factor radio and television interference free high safety factor great cantilever strength high puncture strength light weight

February, 1963
supersedes descriptive bulletin 33-354, dated August, 1957
mailed to: E/1139/DB; D/811/DB; C/333/DB

introduction

Insulation, moisture, voltage stress, power factor, cantilever strength and size are inseparably tied together in the problem of isolating high-voltage conductors from ground.

The condenser bushing design provides high grade insulation by scientific control of voltage gradient. It is small in size with high cantilever strength, designed and built to prevent moisture penetration.

The condenser bushing is a Westinghouse development first used in 1907. Since that time, outstanding improvements have been made in structural design, manufacturing processes and materials. Factory tests have been made more and more severe. The modern bushing is the result of manufacturing and operating experience gained from many years service, with the fundamental theory of the bushing design unchanged.

The condenser bushing is a series of equal capacity condensers spaced concentrically around a conducting lead, this lead being the innerplate of the condenser.

factory tests

Tests and inspections listed below are made on each bushing. These are in addition to many production tests on paper, foil, porcelain and metal parts before assembly.

1. Visual inspection during manufacture to insure uniformity of material and workmanship.
2. Outdoor condensers up to 46 kv, after varnishing and pressing on flange, are tested for tightness with high pressure air.
3. All complete outdoor bushings are given dry nitrogen pressure test to insure tightness of seals.
4. All bushings are given one minute 60 cycle withstand test in line with ASA standards.
5. All bushings are given power factor test to insure proper quality control and low dielectric losses in the bushings.
6. All bushings given capacitance test to insure adherence to calculated design.
7. Check made on voltage tap ratio (92 kv and above).
8. Power factor tap on 69 kv and below are tested for electrical connection and insulation.

The above are routine tests to check materials and workmanship. Each design has been verified by exhaustive electrical, mechanical and life tests.

type IC interchangeable bushings

kv class	kv BIL	ampere rating	creepage distance inches minumum	60 cycle withstand		catalog number
				dry 1-min	wet 10-sec	
23/25	150	1200	17	70	70	2312C29
34.5	200	1200	26½	95	95	3412C31
46	250	1200	35	120	120	4612C33
69	350	1200	48½	175	175	6912C37
115▲	550	1600	79	280	230	11516C43
138▲	650	1600	92	335	275	13816C46
161	750	1600	114	385	315	16116C50
196/230	900	1600	135	465	385	19616C59

▲ The 1600 ampere bushing is interchangeable with and can be used as a spare for the ASA standard 1200 ampere bushing. These bushings are interchangeable between transformers and circuit breakers, and standard ASA bushings of other manufacture.

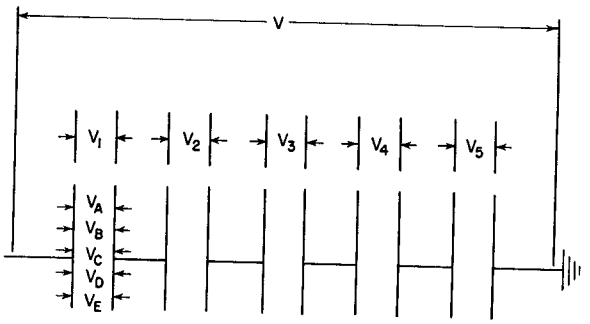
the condenser principle

A series of condensers divide the voltage in inverse ratio to their capacity. Equal capacity condensers in series divide the voltage equally.

The equal capacities prevent concentration of voltage stress radially from the stud to ground flange through the insulation or longitudinally over the surface of the condenser or porcelain weather casing. The voltage gradient is well below that which will produce insulation breakdown of the condenser or produce internal corona.

The condenser, not porcelain weather casing or filling material, provides the main insulation.

This means long life of the dielectric material, negligible radio interference and minimum size.



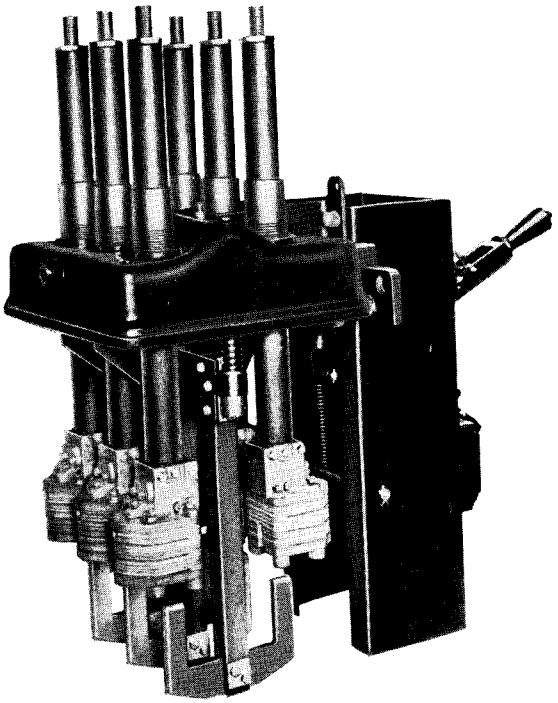
$V = V_1 + V_2 + V_3 + V_4 + V_5$

$V_1 = V_2 = V_3 = V_4 = V_5$ when capacity of condenser is same

$V_A = V_B = V_C = V_D = V_E$ because of uniform dielectric and even spacing

indoor 15 kv

The indoor bushing construction consists of a conducting lead, condenser and flange. No weatherproof fittings are furnished on the air end of the bushings as they are for mounting in locations free from excessive moisture or injurious atmospheric conditions.



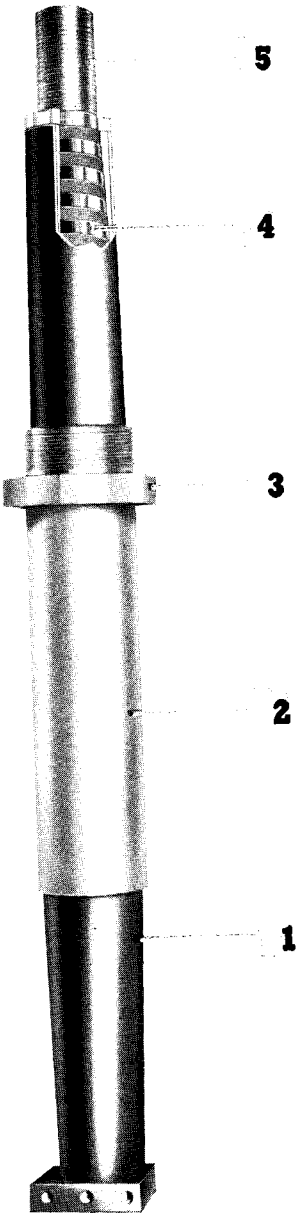
1 condenser: The condenser construction and treating processes are the same as for outdoor bushings 15 to 46 kv. The bushing is effectively sealed against moisture penetration and is finished with a hard smooth surface for easy cleaning.

2 brass ground sleeve

3 flange: Flanges are pressed on, eliminating cement. The flange tube serves as the outer or grounded plate of the condenser. Studs are of such size and flanges of such design and material as to insure temperature rises well within AIEE temperature limitations.

4 aluminum foil: Foil is carefully inserted to supply equal capacitance for each condenser section, and foil thickness is kept to a minimum to prevent formation of voids.

5 copper stud



15 kv condenser bushing

test values

bushing withstand△

kv class	dry 1 min. 60 cycle	impulse 1½ 40
5	21	60
7.5	27	75
15 (small)	35	95
15 (large)	50	110
34.5	80	200

△ Values apply to bushings only, not necessarily to the apparatus in which the bushings are assembled.

outdoor type S 15 to 46 kv

For outdoor applications of 15 to 46 kv, the bushing consists of a treated paper condenser wound on a copper tube or stud, metal mounting flange, and one-piece flexibly mounted porcelain weather casing hermetically sealed at each end by the solder seal process.

On bushings suitable for draw leads provision is made in the cap for attaching these leads. The seal of the bushing is not disturbed when connecting the draw-through leads. Outside terminals are in line with ASA standards when they apply.

High-current oil circuit breaker bushings are wound on solid copper studs with the upper and lower ends threaded. When specified, clamp or tube terminals or contact nuts are provided for connecting to line leads.

1 condenser

After winding and curing, the condenser is turned down on a lathe to the desired dimensions. Coats of a special varnish seal the condenser with a baking after each coat which give the surface a higher resistance to "treeing" or "tracking". The finish to smooth and hard, prevents holding of dust, carbon or other foreign substances, and is easy to clean.

2 mounting flange

For bushings rated 1200 amperes and higher, flanges are of non-magnetic material. The flange is pressed onto the condenser.

3 power factor test tap

Accurate power factor testing of the complete bushing, in pace, is simplified by an ungrounded test-tap. The power factor tap is grounded to the bushing flange while the bushing is in service. For testing, the ground is removed. The power factor of the insulation can then be measured by using an ungrounded test set and eliminating the effects of the oil, interrupters, transformer windings and line, thus giving an accurate measurement of the bushing power factor.

4 porcelain seals

A flexible copper cap and a copper ring at the bottom are soldered directly to this metallic casing glaze.

This assembly of cap, casing and ring is screwed onto the lead until the lower ring rests in a groove in the flange plate. The groove is filled with solder and the cap soldered to the lead.

5 aluminum foil

Foil is carefully inserted to supply equal capacitance for each condenser section, and foil thickness is kept to a minimum to prevent formation of voids.

6 porcelain weather casing

The weather end is protected by a one piece wet process porcelain casing, flexibly mounted and hermetically sealed to the flange and lead by the solder seal process. The solder seal between flange, porcelain, cap and stud or tube is a metallic seal throughout and has an indefinite life. A metallic glaze on the upper end and lower end of the porcelain is applied by an exclusive Westinghouse process, and on firing, becomes an integral part of the porcelain. The cap and flange are then soldered to this glaze, giving a completely hermetically sealed unit.

7 filling material

The space between the condenser and weather casing is filled with insulating medium (allowing space for expansion in the cap). The filling and breather holes are plugged and soldered over completing the metallic seal and permanently protecting the bushing from entrance of moisture.

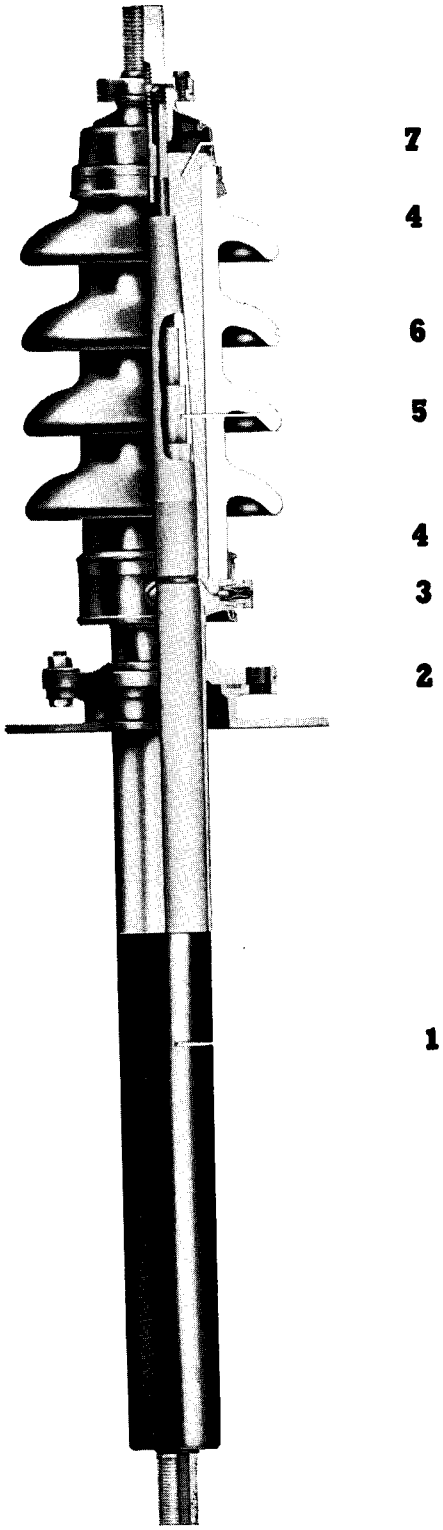
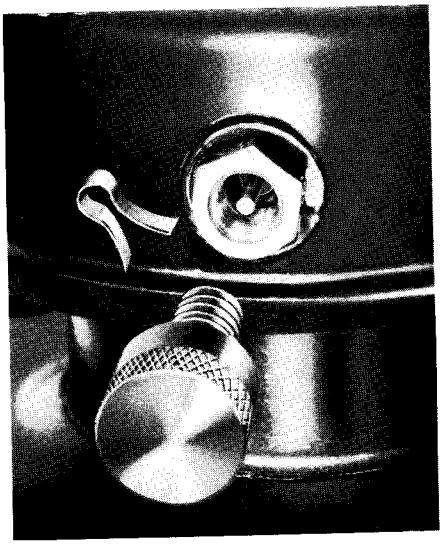


figure A: **power factor test tap**



test values

bushing creepage and overpotential△

kv class	withstand tests		impulse 1½ 40	external creepage, inches minimum
	dry 1 min. 60 cycle	wet 10 sec. 60 cycle		
15	50	45	110	11
23/25	70	70	150	17
34.5	95	95	200	26½
46	120	120	250	35

△ Values apply to bushings only, not necessarily to the apparatus in which the bushings are assembled.

outdoor type O 69 kv to 345 kv

For service voltages 69 to 345 kv oil-impregnated condenser bushings are supplied. The bushing consists of a central copper tube, oil-impregnated condenser, metal mounting flange, and porcelain and enclosures.

Type O bushings may be stored indoor or outdoor, preferably in a vertical position, without special precautions except against mechanical injury, since the condenser is completely enclosed in a metal and porcelain housing.

1 oil impregnated condenser

The condenser, or heart of the bushing, consists of alternate layers of high grade Kraft paper and metal foil wound on a central copper tube. The condenser is then evacuated and thoroughly impregnated with dried and degassed Wemco C oil under pressure. The oil impregnation increases the dielectric strength of the paper.

2 flange

Designed to provide ASA mounting dimensions where applicable.

3 gasket

All gaskets are below the oil level in the expansion cap precluding the possibility of entrance of moisture into the insulation. All joints in the cap and between cap and stud are soldered or brazed; permanently moisture proof.

4 potential device tap

The basic condenser design of multi-step insulation with voltage distribution across each step being equal, facilitates the use of type PBA-2 bushing devices to provide low cost line potential indication, except for 69 kv class where a power factor test tap is provided per page 4, paragraph 3.

5 porcelain weather casings

Main portion of the bushing shell consists of an upper and lower weatherproof wet-process porcelain casing.

6 2-part magnetic oil gauge

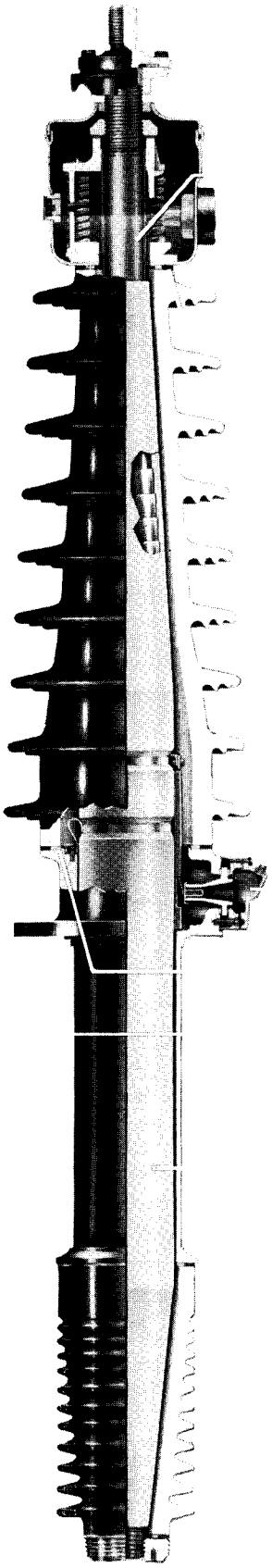
Oil level in the bushing is indicated continuously by a magnetic oil gauge located in the cap. The dial is black with yellow markings for ease of reading.

7 oil chamber

The space between the condenser and the metal and porcelain housing is filled with Wemco C oil. This reservoir of oil insures that the condenser will always be completely impregnated and surrounded by oil. The vent in the cap is plugged and soldered over.

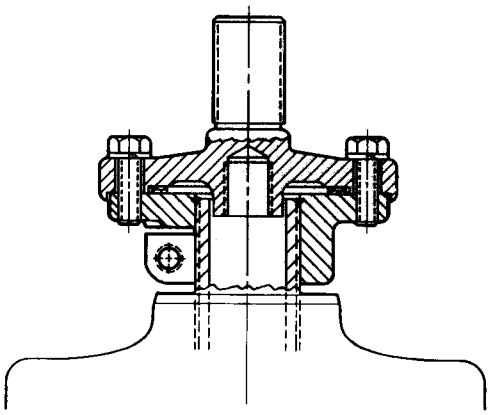
8 bushing cap

The cap has a copper diaphragm which is flexible, to allow for differential expansion. The bushing cap serves as the housing for the springs which place the gaskets under compression. These springs apply a pressure of several tons, depending on the bushing size, on the bushing gaskets, thus assuring a tight seal. Before assembly, the coil springs inside the cap are partially compressed, and on assembly further compressed. The cap also provides oil expansion space.



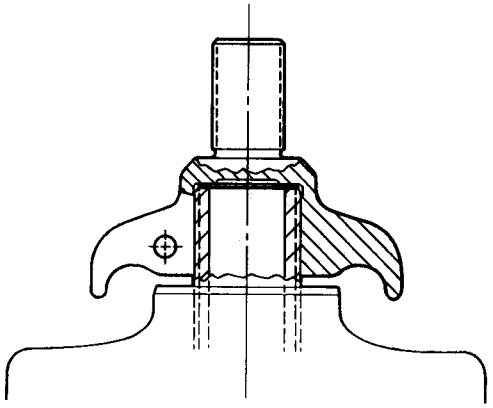
terminal caps

figure B:



top terminal cap for transformer and all type "O" IC bushings 115 kv and above

figure C:



top terminal cap for circuit breakers

test values

bushing creepage and overpotential△

kv class	withstand tests		impulse 1½ 40	external creepage, inches maximum
	dry 1 min. 60 cycle	wet 10 sec. 60 cycle		
69	175	175	350	48
92	225	190	450	66
115	280	230	550	79
138	335	275	650	92
161	385	315	750	114
180	....	....	.....	....
196✣	465	385	900	135
230	545	445	1050	170
287.5◆	680	555	1300	205

△ Values apply to bushings only, not necessarily to the apparatus in which the bushings are assembled.

✣ Used in 230 kv breakers.

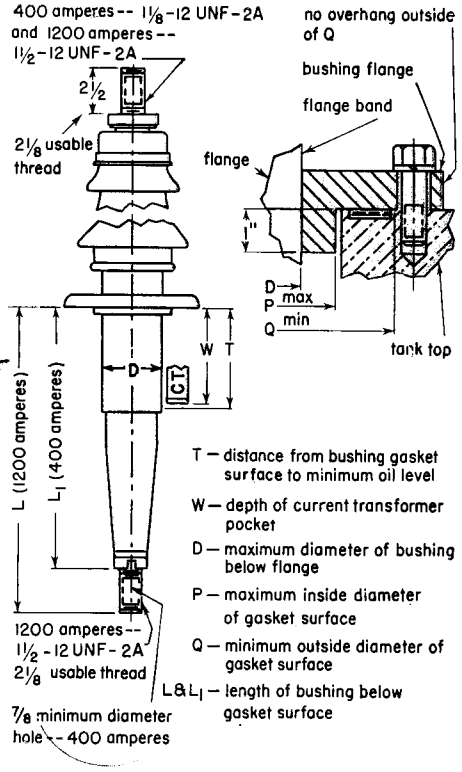
◆ Used in 345 kv breakers.

ASA standards dimensions in inches • approximate

23 kv to 69 kv condenser bushings

kv	BIL	400 amp L_1	1200 amp L	circuit breaker W and T	transformer W	transformer T	transformer D	provision for bolts no. of bolts	provision for bolts bolt hole	provision for bolts bolt circle	Westinghouse catalog number
23/25	150	16½	....	...	10	10	3⅛	4	⅞	7¼	2304S16
23/25	150	23	....	....	16½	16½	3⅛	4	⅞	7¼	2304S23
23/25	150	27½	....	....	21	21	3⅛	4	⅞	7¼	2304S27
▲23/25	150	29½	29½	16½	16½	21	3⅛	4	⅞	7¼	2312C29
23/25	150	....	30½	....	21	21	3⅛	4	⅞	7¼	2312S30
23/25	150	....	36½	....	27	27	3⅛	4	⅞	7¼	2312S36
34.5	200	18½	....	....	10	10	3½	4	⅞	7¼	3404S18
34.5	200	25	....	....	16½	16½	3½	4	⅞	7¼	3404S25
34.5	200	29½	....	....	21	21	3½	4	⅞	7¼	3404S29
▲34.5	200	31½	31½	16½	16½	21	3½	4	⅞	7¼	3412C31
34.5	200	....	32½	....	21	21	3½	4	⅞	7¼	3412S32
34.5	200	....	38½	....	27	27	3½	4	⅞	7¼	3412S38
46	250	20½	....	....	10	10	4	4	⅞	8¼	4604S20
46	250	27	....	....	16½	16½	4	4	⅞	8¼	4604S27
46	250	31½	....	....	21	21	4	4	⅞	8¼	4604S31
▲46	250	33½	33½	16½	16½	21	4	4	⅞	8¼	4612C33
46	250	....	34½	....	21	21	4	4	⅞	8¼	4612S34
46	250	....	40½	....	27	27	4	4	⅞	8¼	4612S40
69	350	30½	....	....	16½	16½	5¼	6	⅞	9¼	6904S30
69	350	35	....	....	21	21	5¼	6	⅞	9¼	6904S35
69	350	41	....	....	27	27	5¼	6	⅞	9¼	6904S41
▲69	350	37½	37½	16½	16½	21	5¼	6	⅞	9¼	6912C37
69	350	....	38	....	21	21	5¼	6	⅞	9¼	6912S38
69	350	....	44	....	27	27	5¼	6	⅞	9¼	6912S44

▲ IC bushings—interchangeable between circuit breakers and transformers

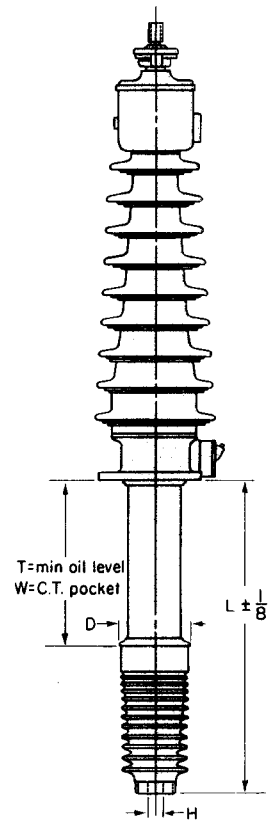


92 kv to 196 kv condenser bushings

kw	BIL	amp	L	W and T	D	tube I.D. H	provision for bolts no. of bolts	provision for bolts bolt hole	provision for bolts bolt circle	top terminal usable thread	top terminal thread class UNF 2-A	Westinghouse catalog number
92	450	800	40½	23	8¾	1½	6	1¼	13¼	2	1½-12	9208P40
▲115	550	800/1200	43	23	8¾	1½	6	1¼	13¼	2	1½-12	11512C43
▲115	550	1600	43	23	8¾	1½	6	1¼	13¼	2	1½-12	11516C43
✣115	550	2000	43	23	10¾	...	6	1¼	14¼	2½	2-12	.....
▲138	650	800/1200	46¾	23	9¾	1⅝	6	1¼	14¼	2	1½-12	13812C46
▲138	650	1600	46¾	23	9¾	1⅝	6	1¼	14¼	2½	2-12	13816C46
✣138	650	2000	46¾	23	12	...	8	1¼	15¾	2½	2-12	.....
▲161	750	800/1600	50¼	23	12	1⅝	8	1¼	15¾	2½	2-12	16116C50
✣161	750	2000	50¼	23	12	...	8	1¼	15¾	2½	2-12	.....
180	825	800	56¾	26¾	14⅝	2	12	1¼	21	2	1½-12	18008P56
▲196	900	800/1600	59½	26¾	14⅝	2	12	1¼	21	2½	2-12	19616C59
✣196	900	2000	59½	26¾	14⅝	...	12	1¼	21	2½	2-12	.....

▲ IC bushings—interchangeable between circuit breakers and transformers

✣ proposed standards



further information

prices: price list 33-320

technical data: technical data 33-360

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