



**Transformer Business
Department**

Network Transformers

Oil-Immersed



Network Transformers (Oil Immersed) with Switch

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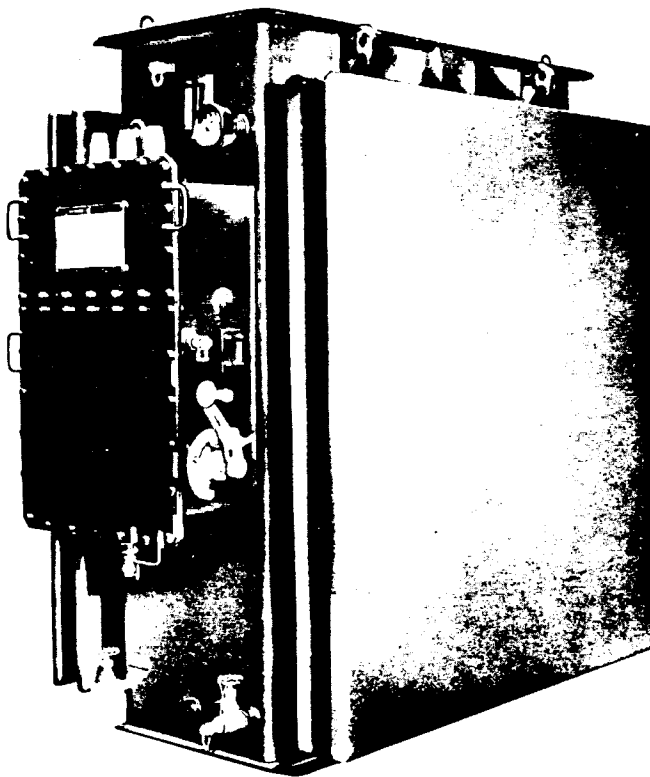
The equipment covered by these operating instructions should be operated and serviced only by competent technicians familiar with good safety practices, and these instructions are written for such personnel and are not intended as a substitute for adequate training and experience in safe procedures for this type of equipment.

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.



**Transformer Business
Department**

Oil Immersed Network Transformers



INSTALLATION

ACCESSORIES

MAINTENANCE

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OIL IMMERSED NETWORK TRANSFORMERS INSTALLATION, ACCESSORIES, MAINTENANCE

INTRODUCTION

The network transformer covered by these instructions was shipped filled with insulating liquid and as completely assembled as possible. Unless moisture has accidentally entered the tank during transit, drying of the transformer after installation will not be required.

SUPPLEMENTARY INSTRUCTIONS

Copies of instruction leaflets referred to but not included in this text may be obtained from the nearest G-E Apparatus Sales Office.

RECEIVING, HANDLING, AND STORAGE

RECEIVING

Immediately upon receipt of the equipment, examine the packages and parts for any damage that might have been sustained in transit. Check the materials with the shipping memorandum for possible shortage. If injury or rough handling is evident, file a damage claim with the transportation company immediately, and notify the nearest General Electric Apparatus Sales Office promptly.

The valves at the base of the tank were sealed with ordinary lead seals which should be unbroken when the transformer is received.

A can of air cure touch-up paint is shipped with each transformer. If the outer coat of paint has been abraded during shipment or handling, sand the abraded area lightly, then clean thoroughly and apply several coats of touch-up paint with brush or spray gun allowing 16 hours drying time between coats. If the initial damage is such that bare metal or primer shows through, then refinish as described in Instructions GEI-70047 "Refinishing Underground Transformers in the Field".

HANDLING

Lugs are provided for lifting the complete transformer, and where necessary, additional facilities

are supplied for lifting the various parts. Lift transformers by means of the lugs provided, and use proper spreaders to obtain a vertical lift.

Jacking space is provided in the base of the transformer to facilitate lifting by means of jacks. The transformer must never be moved or lifted by placing jacks or tackle under the drain valve, radiator connections, or other attachments.

If the transformer is supplied with removable junction boxes, these boxes may be detached to facilitate lowering the tank into a vault.

STORAGE

It is advisable to completely assemble and set the liquid-filled transformer in its permanent location as soon as it is received, even though it is not to be placed in service for some time. Before storing a transformer, check to see that the oil is at the proper level. Store renewal coils and insulation under oil in a container that can be sealed from the air. The storage room should be clean and dry, and when possible, without extreme temperature changes. Before a transformer is placed in service from storage, instructions given under "Inspection" should be observed, particularly with regard to moisture.

INSTALLATION

FOUNDATION

The only foundation necessary for the installation of a network transformer is a level floor strong enough to support the weight.

INSPECTION

Sealed network transformers, shipped oil filled, are filled at the factory to the 25 C liquid level shown on the nameplate adjacent to the liquid-level gage sight glass and are ready to install upon arrival. Make an external inspection. Tighten any parts which may have worked loose, such as nuts and leads. No internal inspection is required if there is no evidence of external damage.

If the transformer is to be installed at a high altitude (3000 feet or more above sea level) open a fitting above the liquid level, either the top sampling valve or the filling plug in the cover, to equalize the internal and external pressures at approximately 25 C before the transformer is placed in operation.

INTERNAL INSPECTION

If a transformer must be opened for inspection outdoors on a damp or stormy day, take proper precautions to prevent the entrance of moisture.

If internal damage is suspected or internal inspection desired, the following procedure is recommended.

Lower the liquid to the top of the core and carefully inspect the interior to see that no damage has

occurred. It is not necessary to untank the transformer for inspection since inspection made through the liquid (using a weighted sealed-beam lamp) will show displaced or broken parts if damage enroute has occurred. To prevent scattering of the glass in case the lamp is accidentally broken, enclose the lamp in fine wire mesh before lowering it through the handhole into the tank. Use a cord with approved synthetic rubber insulation for the lamp to prevent contamination of the oil.

Examine the top of the core and coils and the underside of the cover for signs of moisture. If moisture is found inside the tank, arrangements should be made to dry the transformer. The recommended method used for drying is found in the leaflet on drying transformers.

After inspection, replace the insulating liquid, adding it through the main cover. In completing the filling to the normal level, the end of the hose must be on top of the core. Direct the liquid flow parallel to and along the top of the core. Filling in this manner prevents aeration of the liquid, insulation, or coils below the level of the initial liquid filling.

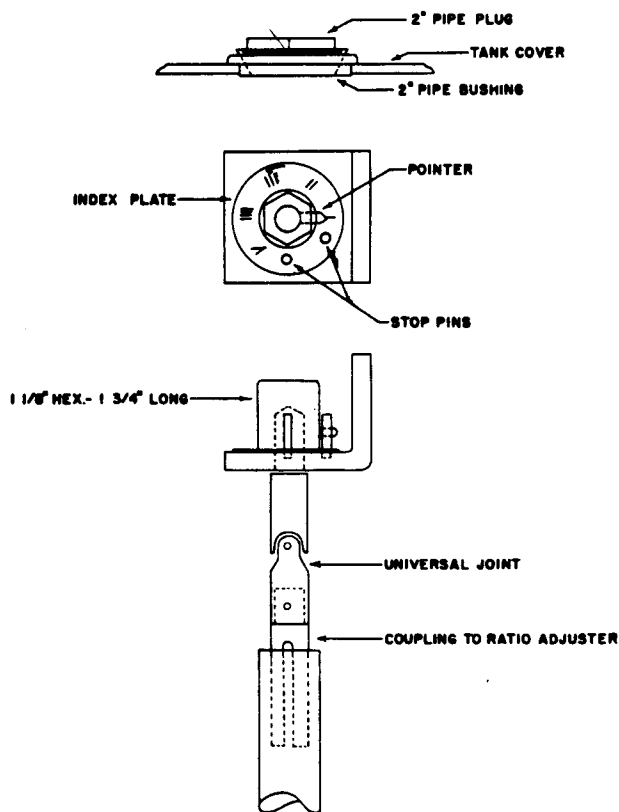


Fig. 1. Outline of tap-changer drive

TESTING INSULATING LIQUID

Test a sample of oil taken from the bottom of the tank for dielectric strength. The dielectric strength should preferably be 26 kv or higher. If the dielectric strength of the oil, before placing in service is below 26 kv, or if it gets as low as 22 kv while in service, filter the oil. If the dielectric strength is very low, or if there is evidence of free water, dry the core and coils. Recommended methods for accomplishing the above are contained in supplementary leaflets.

CONNECTIONS

Do not change connections on a transformer that is under excitation, or make any connections except those authorized by the diagram or nameplate accompanying the transformer.

Tap leads are normally connected to a tap changer for de-energized operation, the handle of which is usually located under a two-inch pipe plug.

Make certain that all leads not in use are insulated from ground and all other leads.

Regardless of the floor or foundation on which the transformer is placed, ground the tank permanently and effectively by connecting to the grounding lug at the bottom of the tank, unless prevented by special operating conditions. A good, permanent, low-resistance ground is essential for adequate protection. A poor ground may be worse than no ground at all since it gives a false feeling of safety to those working on or near the equipment, and may result in loss of life or damage to the apparatus.

When a transformer is specially designed for use on a system having a solidly grounded neutral, be sure that the neutral lead, as indicated on the nameplate, is permanently and solidly grounded without resistance.

Line connections must not bring any strain on the terminals which will cause the joints or contacts to become loose, or bring undue strain on the bushing porcelains.

PRESSURE TEST

Pressure test all sealed transformers before placing them in service. This is done by first subjecting the tanks to an internal pressure of five pounds per square inch when the installation is completed, using dry compressed air or dry nitrogen introduced through the pressure test fitting. When this pressure has been attained, shut off the supply and allow the transformer to stand for twelve hours. Observe the pressure reading during this period, and examine the tank and fittings for leaks. If the pressure holds

constant, the joints are satisfactory. Leaks above the liquid level can be located by applying a solution of soap and glycerine to all gasketed joints, pipe fittings, and cable connections.

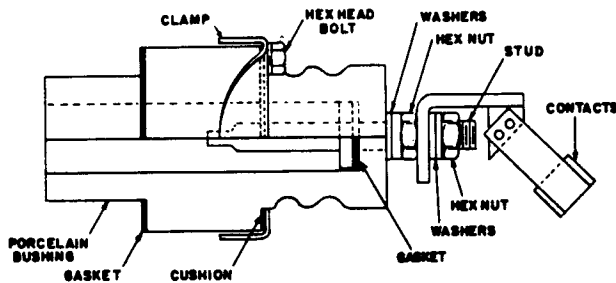


Fig. 2. High-voltage bushing (externally removable) with switch contacts

VAULT VENTILATION

When large, self-cooled network transformers are installed in vaults or compartments, it is necessary to ventilate the compartments thoroughly. Provide cool air inlets in or near the floor and outlets in or near the roof.

The number and size of air outlets required will depend on their distance above the transformer, and

on the efficiency and load cycle of the apparatus. In general, provide about 20 square feet each of inlet and outlet opening for each 1000 kva of transformer capacity. If the transformer will be required to operate for considerable periods at continuous full load, the areas of openings should be increased to about 40 square feet per 1000 kva of transformer capacity.

Arrange the air inlets and outlets so that they are permanently open. Do not use as ventilators, windows or doors which may be opened or closed by attendants, because of the danger of excessive heating in case they are inadvertently left closed during periods of heavy load or high temperature.

If forced ventilation is used, supply about 5000 cubic feet of air per minute for each 1000 kva of transformer capacity, and conduct the incoming air directly to the transformers so that it will flow up through and around the radiating members of the tank. If this cannot be done, and the air is merely moved through the room, provide about 10000 cubic feet per minute for each 1000 kva.

Do not allow the temperature of the room in which the transformer is installed to exceed the temperature of the air entering the room by more than 5 C. The entering air should come from the outside, or at least from a source not much warmer than the outside air.

ACCESSORIES

THERMOMETERS

The thermometers normally supplied on network transformers are mounted in a sealed well. The sealed well permits removal of the thermometer without lowering the level of the liquid in the transformer tank.

Each thermometer is equipped with a maximum reading hand. The maximum reading hand can be reset by removing the permanent magnet attached to the side of the case and wiping it across the face of the dial glass so as to make the maximum reading hand rest against the instantaneous indicating hand.

TAP CHANGERS

The tap changer must not be operated while the transformer is excited. Serious personal injury or damage to the transformer may result if this is attempted.

Tap changers furnished with network transformers are usually of the "drum" type.

A change in voltage with a drum-type tap changer is made by a partial turn of the operating shaft. The tap-changer shaft is terminated in a hex shaped head directly under a two-inch pipe plug in the transformer cover or casing. A small pointer is attached to the hex head, and an indicating plate which shows the tap-changer position is mounted below the pointer. See Fig. 1.

To operate the tap changer, remove the pipe plug and insert a socket wrench to turn the hex head to the desired position. The operator can tell by the

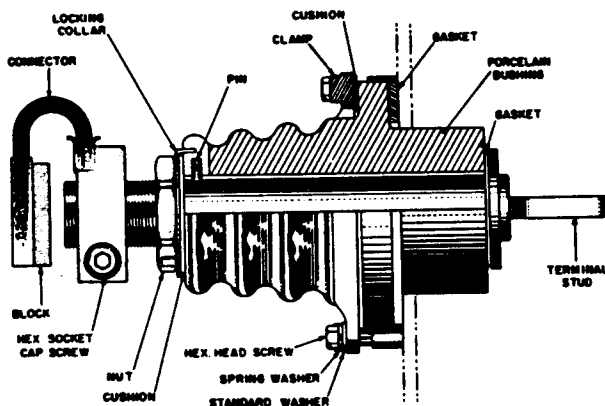


Fig. 3a Low-voltage bushing (externally removable) 1/4 of porcelain removed

“feel” of the wrench when the tap changer moves from one position to the next. After removing the wrench, check the position of the tap changer by observing the pointer position through the pipe-plug hole.

Indicating marks on stationary and rotating parts of all tap changers must be in alignment when the tap changers are on the first position.

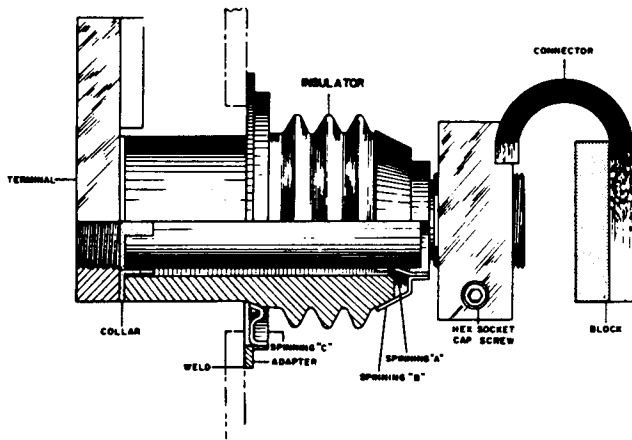


Fig. 3b Low voltage bushing with welded seal

BUSHINGS

Externally removable high-voltage bushings, as shown in Fig. 2, are used between the switch case and the transformer tank. The bushing can be removed through the switch case by unscrewing the terminal block which carries the switch contacts, and then removing the clamp bolts and clamp. The porcelain can then be removed and the stud will remain attached to the transformer leads inside the tank.

Transformers manufactured prior to 1959 are equipped with externally removable low-voltage bushings between the transformer tank and a network protector as shown in Fig. 3a. To remove this bushing, loosen the clamp screws on the split terminal, unscrew the terminal, and remove the brass nut and washers on the stud. Pull out the locking pin by means of a hooked wire inserted into the small hole in the end of the pin. Then remove the clamp bolts and clamp. The porcelain can now be removed, leaving the stud attached to the low-voltage bars of the transformer.

Transformers manufactured after 1958 are equipped with low-voltage bushings having permanently welded seals, as shown in Fig. 3b. Aside from an occasional cleaning these bushings require no field servicing.

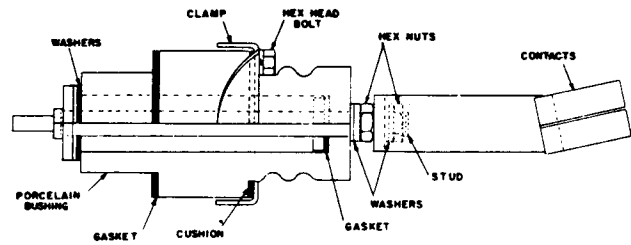


Fig. 4. High-voltage switch-line bushing

Fig. 4 shows a typical terminal-chamber bushing used between the switch case and the high-voltage terminal chamber. It can be removed or replaced from the switch case. This bushing carries switch-line contacts on its lower end, and care should be taken to line up these contacts with the collector ring on the switch rotor when the bushing is bolted in the switch case.

Fig. 5 shows a “spark plug” type interlock bushing which is mounted in back of the switch case adjacent to the main transformer high-voltage bushings. Power to operate an interlock coil is supplied through the bushing. The “spark plug” type bushing substitutes a pipe thread for the customary gasket. The “spark plug” type bushing is of the self-connecting type and there is no internal lead to disconnect before it can be removed.

When replacing a bushing other than the “spark plug” type interlock bushing, use new gaskets installed in accordance with Instructions GEI-41727, “Gaskets and Gasketing Procedures for Network Transformers.”

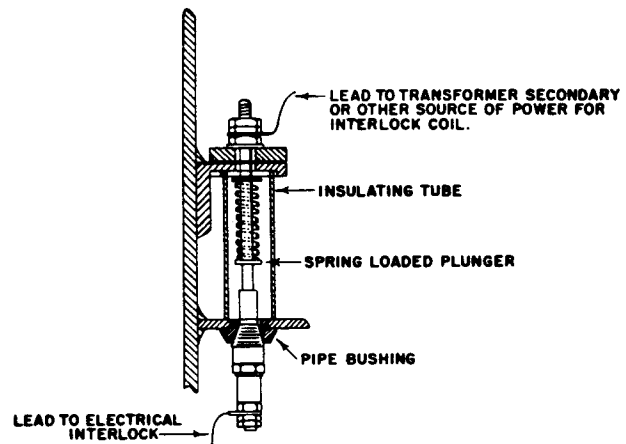


Fig. 5. Interlock bushing

MAINTENANCE

FILLING TRANSFORMERS

If it is necessary to refill a transformer with oil, proceed as follows.

Make sure that all joints are tight. Open all air vents. In order to prevent aeration of the oil, fill the transformer through the drain valve by means of a filter press. Continue the pumping until the oil level reaches the 25 C mark on the gage. If a transformer is to be filled without running the oil through a filter press and tests on the oil are satisfactory, fill the transformer by straining the oil through two or more thicknesses of muslin or other closely woven cotton cloth which has been thoroughly washed and dried to remove the sizing. Use at least one new set of cloths for each transformer.

If a transformer must be opened outdoors on a damp or stormy day, take proper care to prevent the entrance of moisture into the transformer.

PERIODIC INSPECTION

Since moisture may be absorbed by the transformer, test the oil after the first few days of operation. It is also recommended that oil samples be drawn and tested according to a regular schedule. For complete information, refer to Instructions GEI-28004, "No. 10-C Insulating Oil."

The condition of the external transformer surfaces should be examined at regular intervals. If it is found that weathering is taking place, the surface should be cleaned thoroughly and repainted with a good grade of durable paint recommended by the General Electric Company.

It is recommended that periodic pressure tests be made to make sure that a complete seal is maintained.

Time and expense will be saved if spare units are kept in readiness for instant use. Inspect the following items during periods of idleness: oil level, oil dielectric strength, fan control, and conduit. Also, inspect frequently for condensation in all cabinets and junction boxes.

FILTERING AND DRYING TRANSFORMER OIL

The transformer oil drier and filter covered by Instructions GEH-754 is recommended for drying and filtering G-E transil oil. The oil is treated in a filter press by being forced through a number of

layers of filter paper which remove all moisture and solid matter held in the oil. By this method, from 850 to 1200 gallons of oil can be treated in one hour, depending on the size of the filter press.

DRYING A NETWORK TRANSFORMER

The short-circuit method is recommended for drying a network transformer. This method consists of heating the windings, while under oil, by circulating current in them, and removing the moisture by ventilation. For complete information, refer to Instructions GEI-28005, "Drying Oil-Immersed Transformers."

GASKETS

Three different types of gaskets may be used on General Electric network transformers. These are: hard cork, nitrile rubber, and spiral wound. Each of these types of gaskets has its own field of application, and best results will be obtained if the procedures outlined for each are adhered to. These procedures are covered in detail in Instructions GEI-41727, "Gaskets and Gasketing Procedures for Network Transformers."

PIPE FITTINGS

When assembling pipe fittings, clean the threads thoroughly to remove all oil, grease, old compound, and dirt. Apply a coating of G-E compound No. A15A11A to the threads and screw the mating parts tightly in place.

WELDED COVERS

Welded covers are most easily removed by an oxyacetylene torch. For information, refer to Instructions GEK-16575 on "Removing and Rewelding Covers."

REFINISHING

Should it become necessary to refinish a transformer after it has been placed in service refer to Instructions GEI-70047, "Refinishing Underground Transformers in the Field."

RENEWAL PARTS

Whenever ordering supply or renewal parts, or asking for information regarding a particular trans-

former, always state the serial number. The serial number, in addition to being on the nameplate, will

be found stamped on the top core frame, the top band of the tank, and also on the cover directly above the number on the tank band. A sketch showing the exact location of coils, insulation, or other parts required, will greatly facilitate the filling of the order. This sketch must always state which side of the trans-

former is shown.

Any additional information as to the electrical or mechanical construction, operation or installation of a particular transformer can be obtained by applying to the nearest local office of the General Electric Company, mentioning the serial number and rating.



***Transformer Business
Department***

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Hickory, North Carolina 28601*



Gaskets and Gasketing Procedures

Network Transformers (Oil or Silicone Immersed)

Three different types of gaskets may be used on General Electric Network Transformers. These are:

1. Hard composition cork
2. Nitrile rubber
3. Spiral wound

Each of these types of gasket has its own field of application and best results will be obtained if the procedures outlined for each are adhered to.

COMPOSITION CORK GASKETS

Composition cork gaskets will not hold liquid unless treated or coated; that is, the liquid will seep very slowly through the cork and flow along the joint. For this reason, a suitable compound is essential with composition cork gaskets.

When necessary to apply a replacement cork gasket, proceed as follows:

Remove all traces of the old gasket material and cementing compound adhering to the gasket surfaces.

Brush the gasket surfaces which are to be joined, and all surfaces including the edges of the gasket itself, with a generous coat of G-E compound No. A15A11A.

Suspend the gasket in the air until it is perfectly dry for handling. Such drying usually requires less than four hours. (If necessary, a small amount of talc may be sprinkled over the dry compound as an added precaution against sticking when handling.)

The sealing compound is of the proper consistency as supplied in the can. If the compound has been exposed to the air and has thickened, thin it with denatured alcohol.

All surfaces should now be given a second coat of the compound. Bolt or clamp the gasket surfaces together immediately with uniform pressure at all points until they are reasonably tight. Give a second tightening after four hours.

Extra gasket material and compound may be obtained from the General Electric Company.

NITRILE-RUBBER GASKETS

Nitrile-rubber gaskets are made of a special grade of oil-resistant rubber. Although they require no adhesive to make a liquid-tight seal, adhesive A50P68 may be applied as a thin film in a few places when required to hold a gasket on a vertical surface. Also, a small amount of this adhesive is required to make a scarfed joint in a gasket.

Before applying a nitrile gasket to any surface, make sure the gasket and the surfaces involved are cleaned of all rust, water, grease, insulating liquid, loose paint, scale, or any other foreign material.

Place the gasket in the proper location. As stops and retainers are used on most gasketed joints, it is essential that gaskets of proper width and thickness be used so that correct compression can be maintained.

Tighten the bolts, drawing each down in small increments. Proceed around the bolt circle several times until the metal stops are reached, or if no stops are provided, until the gasket is compressed to at least $\frac{3}{4}$ but not more than $\frac{2}{3}$ of its original thickness. No subsequent tightening of the bolts is necessary.

The resilience of nitrile rubber makes possible the reuse of the gaskets in forming a seal if the gasket has not been damaged.

Store spare nitrile-rubber gaskets flat and in a dark place away from high temperatures, such as those caused by steam radiators.

Gaskets should be purchased to size from the General Electric Company. If made up by the customer and joints are required, they should be of the scarfed type made up as follows:

Scarf at an angle equal to the rate of one inch of length to each quarter-inch of thickness. Surfaces must be flat and make a neat fit. Clean the surfaces carefully with Solvaton. Do not touch the surfaces with the fingers after cleaning. To the clean scarfed surfaces apply a smooth even coat of G-E A50P68 adhesive. Allow to air dry for seven minutes. In that time the adhesive should have developed a firm aggressive tack, but should not lift off the rubber

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surfaces. Bring the surfaces together and roll under pressure to displace all air. Do not distort the shape of the gasket excessively. Joints can be cured immediately or any time within a week.

To cure the joint, place the gasket in a heated press or vulcanizer and clamp together. Apply only enough pressure to insure a joint of uniform contact. Avoid excessive distortion of the gasket. Cure the joint in the press for 35 minutes at 130 C or 20 minutes at 150 C. Do not heat over 160 C. Remove the gasket at the end of the curing cycle and dip in cold water if needed immediately.

A properly prepared joint is sufficiently strong to withstand sharp bending, twisting and elongation of 100 percent. There should be no gap or projections at either end of the scarf and the adhesion should be uniformly good.

Extra gasket material and adhesive may be obtained from the General Electric Company.

SPIRAL-WOUND GASKETS

Spiral-wound gaskets are made up of alternate strips of V-shaped stainless steel and a special rubber or paper compound. The stainless steel is spot welded at start and finish to form the complete gasket.

Spiral-wound gaskets, like nitrile rubber, require no adhesive to make a liquid-tight seal.

To replace a spiral-wound gasket proceed as follows:

Clean all foreign material from the gasket surfaces involved. It is very important that these surfaces be perfectly clean and smooth, otherwise the gasket will not make a liquid-tight joint.

The spiral-wound gasket must first be centered on the gasket surface. When these gaskets are supplied by the General Electric Company, filler rings for readily accomplishing this are also supplied.

Tighten the bolts, drawing each down in small increments. Proceed around the bolt circle until all bolts have been drawn down tightly.



**Transformer Business
Department**



Network Transformer Switches

Oil or Silicone Immersed

THREE-POSITION ROTARY DISCONNECTING AND GROUNDING SWITCH

INSTALLATION

The three-position rotary disconnecting and grounding switch, Fig. 1A, is contained in a switch case which is normally welded to the transformer tank. The cable connection to the switch is through a terminal chamber.

If there is a terminal chamber on the top or on the bottom of the switch case, remove the terminal chamber cover to make the cable connection. It is not necessary to remove the cover of the switch case or to remove the liquid from the switch to make the cable connections. Make up cable connections, phase out the cables, and replace the terminal chamber cover. Then fill the terminal chamber with cable oil or compound. The necessary instructions may be found in supplementary leaflets.

OPERATION

The three positions of the switch are OPEN, CLOSED, and GROUND. In the OPEN position, the high-voltage cable terminals are disconnected from the transformer and from ground. In the CLOSED position, the high-voltage cable terminals are connected to the transformer terminals. In the GROUND position, the high-voltage cables are short-circuited and solidly grounded to the switch case, but the transformer terminals are not grounded.

Disconnecting switches must not be used to interrupt load current, and can be used to interrupt transformer exciting current only when designed for that purpose (see "Three-Position Switch for Interrupting Exciting Current").

To operate the switch, first make sure that the power is OFF. The switch is normally equipped with an electric interlock which will prevent operation of the switch when the transformer is energized

from either the high-voltage or low-voltage side. It is recommended that an engineer's stethoscope be used to insure that the transformer is not energized.

To close the switch from the OPEN position, pull the latch on the operating handle (Fig. 2) and move the handle to the CLOSED position. The handle will strike the stop pin in the CLOSED position and the spring-operated latch will drop into the slot provided for it. To proceed to the GROUND position, rotate the latch 180 degrees so that the arrow on the latch points in the direction the handle is to move. Then pull out the latch and move the handle to the GROUND position. The latch cannot be rotated when it is pulled out. The function of the latch and stop pin is to compel the operator to hold the switch in the CLOSED position while turning and pulling out the latch. This gives the electric interlock time to operate if the high-voltage cable is energized and thus protects the operator.

The handle can be locked in any position by a padlock inserted in the holes provided for it in the latch and handle casting.

If necessary, the switch can be removed from the case as follows: Remove the taper pins holding the switch rotor assembly to the handle shaft. Loosen the bolts on the handle packing gland. This handle and shaft can then be withdrawn and the switch assembly (rotor) can be removed. To replace the switch, reverse the above procedure, see that the rotor is pinned securely to the shaft, and check the contact alignment with the position of the operating handle.

THREE-POSITION SWITCH FOR INTERRUPTING EXCITING CURRENT

The three-position switch with OPEN, CLOSED, and GROUND positions is sometimes provided with auxiliary quick-break contacts so that the switch can be used to interrupt transformer exciting current.

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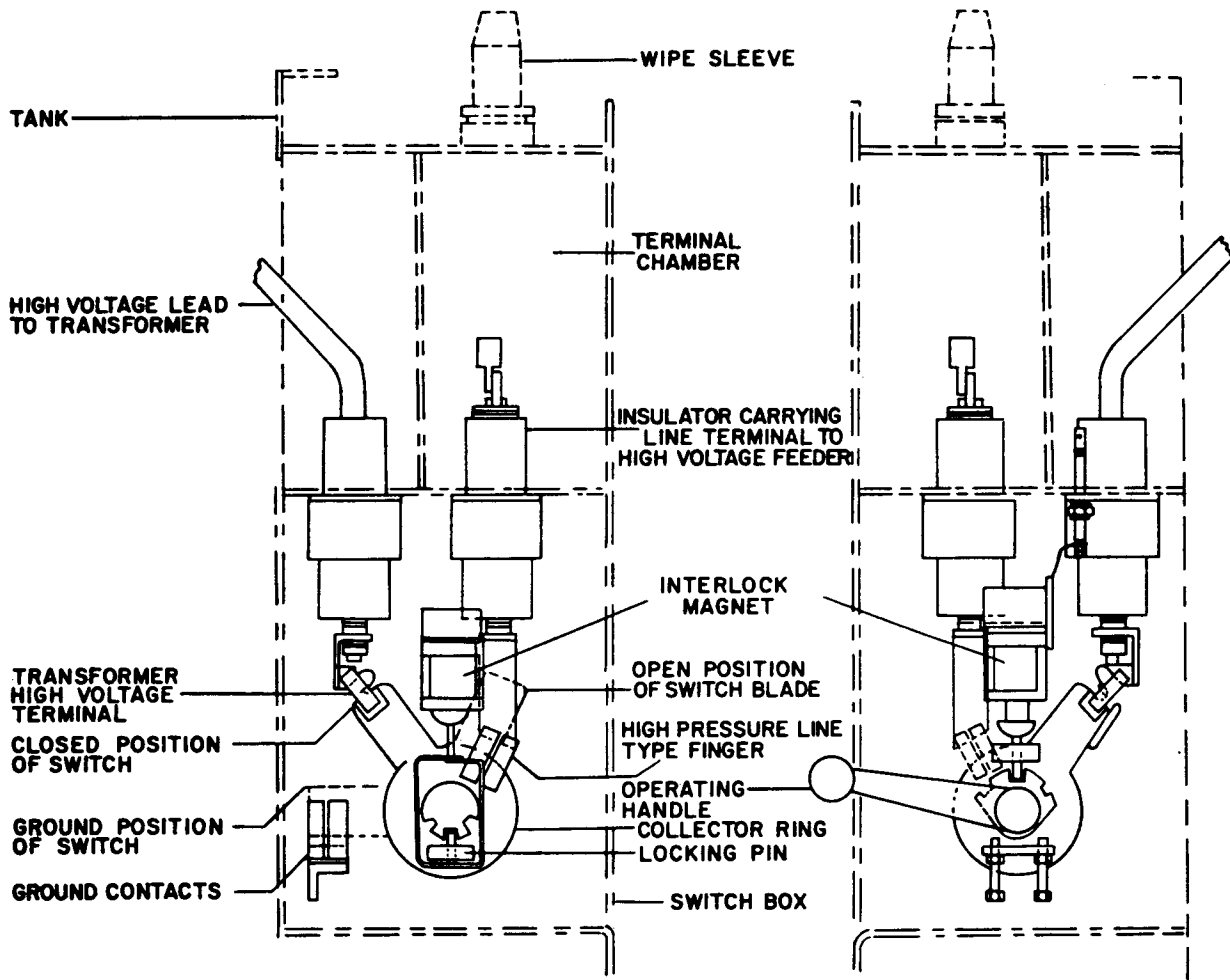


Fig. 1. Three-position rotary disconnecting and grounding switch

OPERATION

The operation of the switch is similar to that of the three-position disconnecting switch without quick-break contacts, except that the electric interlock, which is connected to the transformer winding, prevents operation from the CLOSED to GROUND positions when the transformer is energized, but permits operation from CLOSED to OPEN, or OPEN to CLOSED. The interlock is shown at "A" in Figures 3 and 4. The "A" coil in both circuits is energized when the transformer is energized.

This type of switch is provided with a second electric interlock to prevent using the switch to interrupt load current. The second electric interlock is shown at "B" in Figures 3 and 4. In the type of circuit shown by Fig. 3, the "B" coil is energized when the main contacts of the network protector are

open. The "B" coil shown in Fig. 4 is energized when the main contacts are closed.

The "B" electric interlock must be connected to the low-voltage grid. This is accomplished by connecting an auxiliary switch on the network protector to the spark-plug type bushing provided for that purpose and located in the low-voltage throat adjacent to one of the low-voltage bushings.

TWO-POSITION DISCONNECTING SWITCH

The installation of this switch is the same as that of the disconnecting and grounding switch. The two positions of the switch are OPEN and CLOSED. In the OPEN position, the high-voltage cable terminals are disconnected from the transformer terminals, and in the CLOSED position, the high-voltage cable terminals are connected to

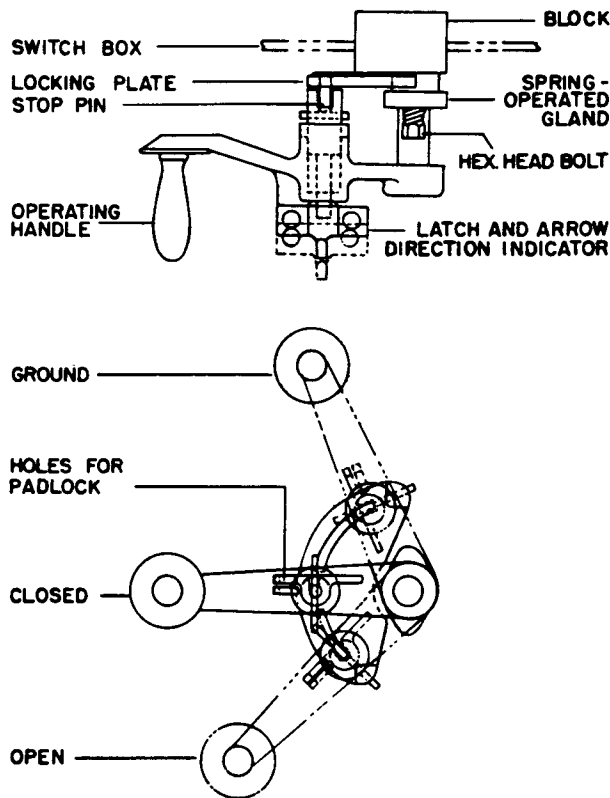


Fig. 2. Operating handle for three-position disconnecting and grounding switch

the transformer terminals. The handle is provided with padlock hasps to permit locking it in either position.

The switch is normally provided with an electric interlock which prevents operation of the switch when the transformer is energized. The interlock coil is connected to the low-voltage winding of the transformer, so that the interlock coil is energized and the handle locked when the transformer is energized.

TWO-POSITION SWITCH FOR INTERRUPTING EXCITING CURRENT

When the two-position disconnecting switch is equipped with quick-break contacts for interrupting transformer exciting current, the electric interlock is connected through an auxiliary switch on the network protector to the low-voltage grid. The interlock then operates in the same manner as the second interlock described previously.

The two positions of this switch are GROUND and OPEN. In the GROUND position, the switch short-circuits and grounds the cable terminals and transformer high-voltage terminals. In the OPEN

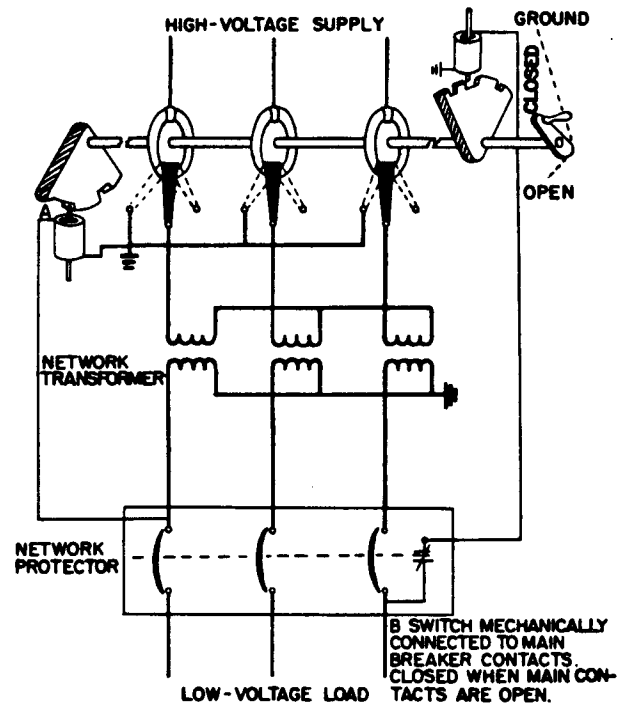


Fig. 3. Connection diagram for interlock coils of disconnecting and grounding switch. "B" interlock locks when de-energized.

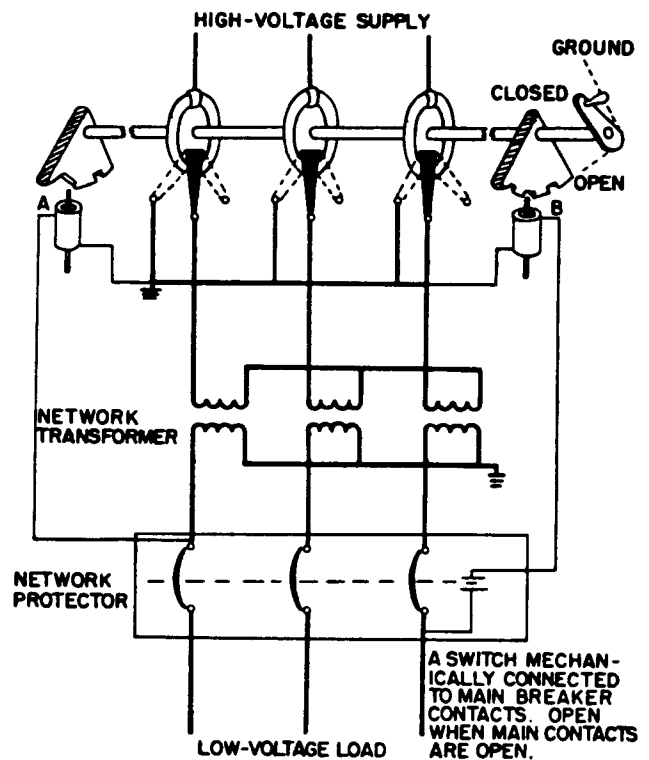


Fig. 4. Connection diagram for interlock coils of disconnecting and grounding switch. "B" interlock locks when energized.

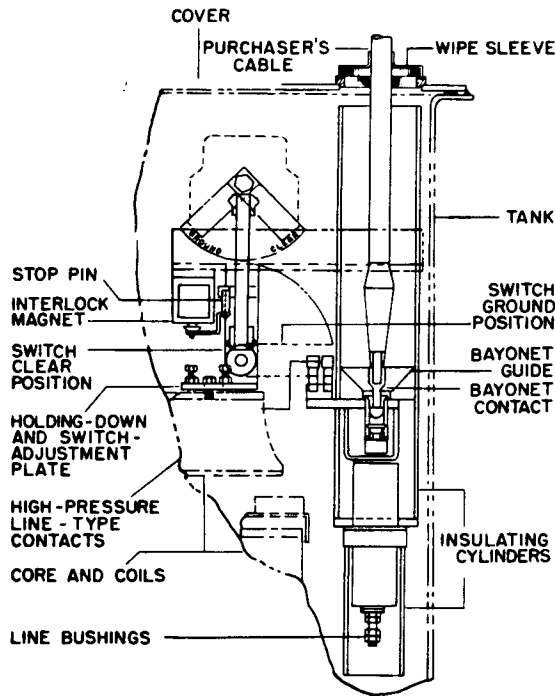


Fig. 5. Two-position internal grounding switch (oil-immersed transformer)

position, the cable terminals remain connected to the transformer terminals. An electric interlock is provided to prevent operation of the switch when the transformer is energized.

When mounted in an external switch case, the installation is the same as that of a disconnecting and grounding switch.

TWO-POSITION INTERNAL GROUNDING SWITCH

The grounding switch is occasionally mounted inside the transformer tank and may be attached to the core and coil assembly, as shown in Fig. 5. The operating handle is located on the side of the tank or on the cover, and a packing gland is provided on the operating shaft which is part of the handle.

A common type of internal grounding switch with bayonet-type cable connection is shown in Fig. 5. The cable ends are made up as described in a supplementary leaflet under "Wiping-Sleeve Cable Connection", and the bayonet-tipped cable assembly is plugged into the female contacts on the switch. Suitable cable potheads are furnished for use in Pyranol immersed transformers.

The switch assembly is bolted to the transformer clamp structure and can be removed only by untanking the transformer. A small handhole cover is provided near the switch handle for access to the electric interlock.

When the switch and the transformer interior are returned to the tank after being removed for any reason, the switch bayonet receptacles must be lined up with the switch operating handle. Adjusting screws are provided on the switch frame where it is attached to the transformer clamp structure to obtain proper position and alignment of the switch bayonet receptacles with respect to the wiping sleeves.

PACKING GLANDS

Pressure-tight packing glands are furnished with all switch-handle shafts which project through the tank wall or cover. Fig. 6 shows a switch-handle packing gland. There is a support through which the shaft passes, in which the opening has been enlarged to receive the packing. The packing is wrapped around the shaft in a spiral, and the gland is forced down against the packing by means of screws provided for the purpose, until the gland is pressure tight. It is often necessary to cut the packing in several pieces and force each piece in separately in order that the threads on the screws catch. The amount of packing necessary for any particular transformer can be obtained from the General Electric Company, Pittsfield, Mass.

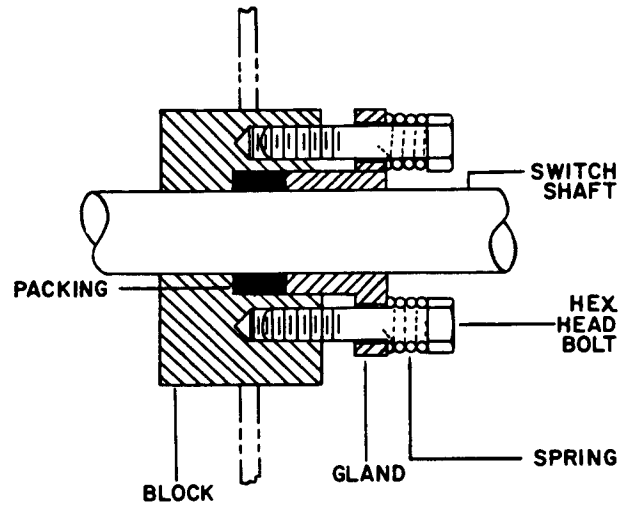


Fig. 6. Switch-handle packing gland



Transformer Business Department

General Electric Company
Hickory, North Carolina 28601



Network Transformer Cable Connections

JUNCTION BOXES

When a transformer is equipped with junction boxes for making cable connections to the terminals of any winding of the transformer, the transformer terminals are brought into the junction box through pressure-tight bushings.

The junction box may be oil, silicone, or compound-filled or dry. A junction box can be operated dry when the circuit voltage is below 1000 volts, and should be filled with oil, silicone, or compound when the circuit voltage is above 1000 volts, unless the transformer Outline drawing specifically states otherwise, or unless the box is specially designed for dry operation. Boxes with potheads for circuit voltages above 1000 volts should be filled with oil or silicone. Boxes with wiping sleeves, or types of cable entrance in which the cable insulation comes in contact with the filling material, should be filled with compound unless the transformer Outline specifically states otherwise.

The types of cable entrance fittings commonly used are:

1. Single- or three-conductor potheads.
2. Wiping sleeves (see Figs. 1 and 2).
3. Packing glands (see Fig. 3 and other miscellaneous clamp-type connections.

To make a cable connection to a junction box, first make certain that the box is empty. If the box is filled with oil or silicone, remove the liquid through the drain plug or valve in the bottom of the box into clean, dry containers. Then remove the junction-box cover. If there are potheads on the box, remove them and attach cables to the potheads and fill with compound or cable oil in accordance with instructions furnished by the pothead manufacturer. If there are wiping sleeves, prepare cable ends and attach the sleeves in accordance with the instructions under "Wiping-Sleeve Cable Connection." Attach the assembled cable and pothead, or wiping sleeve, to the junction box, and connect the cable terminals or pothead terminals to the transformer terminals in the junction box.

Prepare the gasket surface and replace the junction box gasket and cover as described in a supplementary leaflet "Gaskets and Gasketing Procedures." If the box is to be oil or silicone filled, fill it with clean, dry liquid to the 25C level on the gage, or until it runs out the bottom level indicator if there is no gage. For compound filling, refer to instructions under "Terminal Chambers."

Pressure test junction boxes before applying voltage to the transformer.

TERMINAL CHAMBERS

Terminal chambers are cable entrance compartments attached to switch cases or junction boxes. Terminals from the switch or the transformer are brought into the terminal chambers through pressure-tight bushings.

Cables are normally brought into a terminal chamber through wipe sleeves (Figs. 1 and 2), packing glands (Fig. 3), or other miscellaneous clamp-type connections.

To connect paper-insulated or varnished-cambric-insulated cable to a terminal chamber, proceed as follows. Remove the terminal-chamber cover. Prepare the cable ends as described under "Wiping-Sleeve Cable Connection", and attach wiping sleeves and the

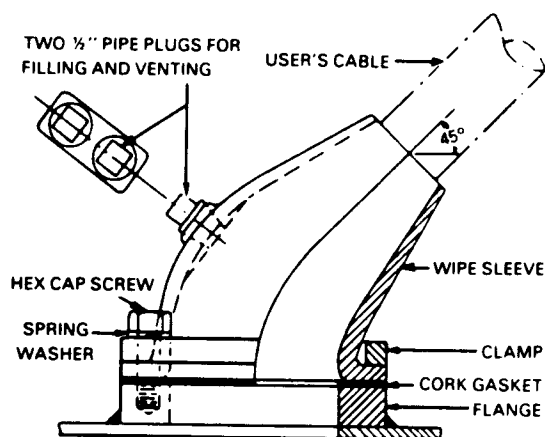


Fig. 1 Wiping sleeve (45 degree)

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.

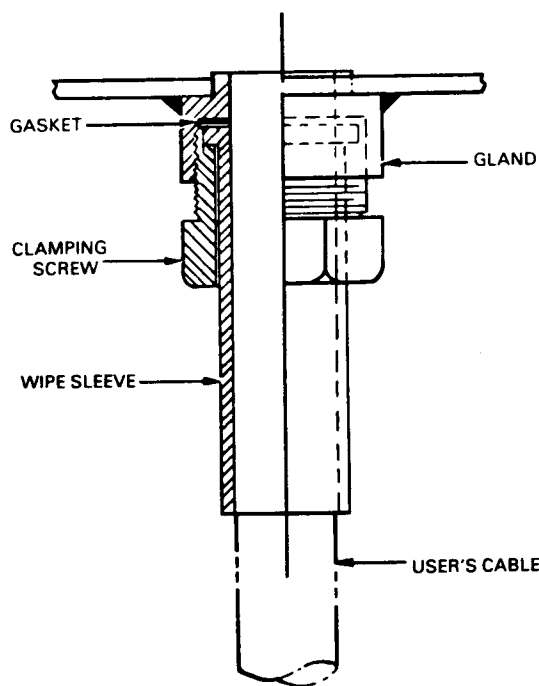


Fig. 2 Wiping sleeve

prepared cable ends to the terminal chamber. Connect the cable terminals to the terminal-chamber bushings. Tape the bare terminals with three half-lap wraps of varnished-cambric tape, brushing each layer with cable oil. Extend the tape one and one-half inches beyond the penciled portion of the cable insulations, and one and one-half inches over the end of the porcelain insulator.

Prepare the gasket surfaces and replace the terminal-chamber cover as described in a supplementary leaflet "Gaskets and Gasketing Procedures."

Pressure test the terminal chamber before applying voltage to the transformer.

Top-connected terminal chambers for paper-insulated or varnish-cambric-insulated cables should be filled with cable oil heated to 100C. Bottom-connected terminal chambers for paper or varnish-cambric insulated cables should be filled with an oil-insoluble resin compound to prevent loss of compound by migration into the cable insulation. Follow the compound manufacturer's application and pouring recommendations. A pipe plug is provided in the top of the terminal chamber for filling. On some top-connected terminal chambers with large, tapered wiping sleeves, a pipe plug may be provided in the body of the wiping sleeve for filling and venting the terminal chamber and the wiping sleeve (see Fig. 1).

Terminal chambers for rubber-covered cable may be operated dry (air filled) if the circuit voltage is less than

1000 volts or if the voltage is higher than 1000 volts and the terminal chamber was specifically designed for dry operation. Rubber-covered cable may also be used in terminal chambers filled with solid, asphaltic-type compounds. Do not use rubber-covered cables in oil or silicone. It is recommended that the cable or compound manufacturer be consulted for specific recommendations as to proper choice of compound, pouring temperature, use of stress cones on shielded cables, etc. The nearest General Electric Company Sales Office may also be consulted for specific recommendations.

WIPING-SLEEVE CABLE CONNECTION

Single-conductor, lead-covered, paper-insulated, or varnished-cambric-insulated cable can be connected to a top- or bottom-connected terminal chamber or junction box as follows: (Refer to Fig. 4 which shows a typical top-connected terminal chamber with wiping sleeve for single-conductor cable).

1. Remove the wiping sleeve.
2. Remove the terminals from the bushings.
3. If the tapered end of the wiping sleeve is smaller than the outside diameter of the cable, cut off the end of the wiping sleeve to fit the cable used.
4. Slip the wiping sleeve over the end of the cable.
5. Strip the lead sheath from the end of the cable to point (B), which is located at the level shown.
6. Bell the end of the lead sheath as indicated at (B).
7. Remove sufficient insulation from the end of the cable to attach the terminals; then attach the terminals.
8. Pencil the paper insulation as indicated at (C).
9. "Boil out" the paper insulation.

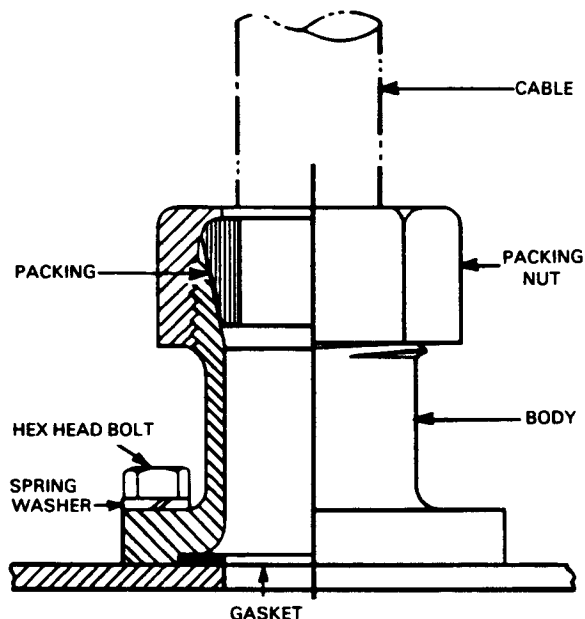


Fig. 3 Cable packing gland

10. Build up a bumper by wrapping a cone of varnished cambric tape treated with cable oil, to a diameter of about four times the thickness of the paper insulation, plus the bare diameter of the conductor.

11. Apply one layer of copper mesh tape with a lap of 1/16 inch starting at the maximum diameter of the bumper and extending upwards to a point beneath the bell in the lead sheath at (B). The lower edge of the copper mesh tape should extend at least one inch below the underside of the terminal chamber top plate as shown.

12. Dress the end of the lead sheath down on the copper tape, and solder the sheath to the copper. The

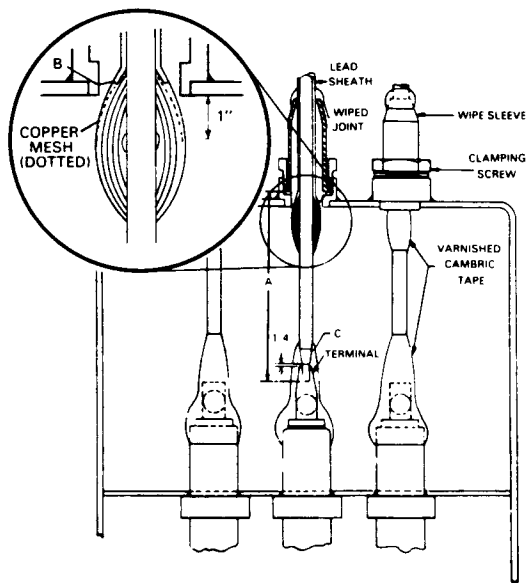


Fig. 4 Terminal chamber

copper mesh should be bound down to the bumper with varnished cambric tape, and the tape should extend from the lead sheath to the end of the bumper.

13. Build up the penciled portion (C) of the insulated bare conductor and beveled section of the terminal with varnished cambric tape treated with a thorough application of cable oil between each layer.

14. Locate the wiping sleeve on the cable so that the gasket surface of the wiping sleeve is distance A (Fig. 4) from the end of the cable. This distance can be obtained by direct measurement or from the transformer Outline. Make the wiped joint between the wiping sleeve and the cable sheath.

15. Attach the sleeve and cable to the terminal chamber or junction box. Refer to the sections "Junction Boxes" and "Terminal Chambers" for information pertinent to filling with compound, etc.

Three-conductor, lead-covered cable can be connected to top- or bottom-connected terminal chambers or

junction boxes in the same manner as single-conductor cable. The bushing terminals shown in Fig. 5 are located on the arc of a circle having a radius (A), so that all three cables can be cut to the same length. Both straight wiping sleeves (Fig. 5) or angle wiping sleeves (Fig. 1) are attached to the cable in the same manner.

COMPRESSION GLANDS AND MISCELLANEOUS CABLE CONNECTIONS

One type of compression gland or packing gland is shown in Fig. 3. Rubber-covered cables are usually brought into dry (air filled), or asphaltic-type-compound-filled terminal chambers through this type of gland.

To attach unshielded, rubber insulated, cable when the voltage is below 1000 volts, remove the terminal-chamber cover and the packing nuts and packing. Slip a packing nut and packing over the end of each cable. Remove enough insulation from the end of the cable to attach the cable terminal, and fasten the terminal to the cable end. Run the cable into the terminal chamber and attach the terminal to the bushing. Push the packing down into the gland and tighten the packing nut (see Fig. 3). Wrap the cable terminal and bushing with three half-lap wraps of rubber tape. Extend the tape one and one-half inches beyond the bare conductor on the cable, and one and one-half inches over the end of the insulator. Finish with a half lap of wrapping using friction tape.

Prepare the gasket surfaces and replace the terminal-chamber cover as described in a supplementary leaflet "Gaskets and Gasketing Procedures."

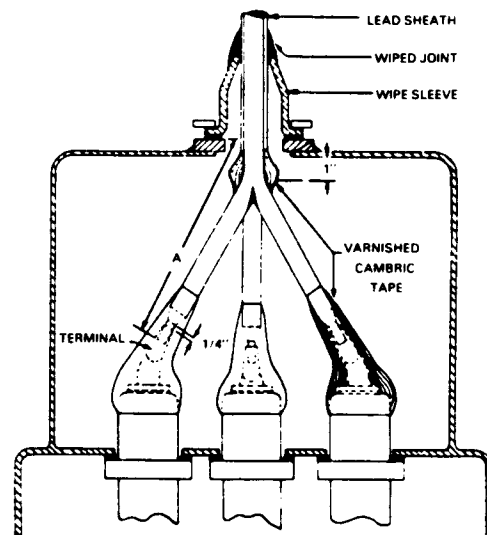


Fig. 5 Terminal chamber

Pressure test the terminal chamber.

If the terminal chamber or junction box is to be filled with compound, refer to the sections "Junction Boxes" and "Terminal Chambers" for information pertinent to filling with compound.

A suggested procedure for preparing cable ends when connecting shielded rubber covered cables to terminal chambers having bushings with bayonet-type terminals, and designed for dry operation (air filled) is as follows:

Because of the wide variety of shielded, rubber insulated cables available, it is recommended that the cable manufacturer be consulted as to the best method of terminating the cable and for minimum recommended insulating distances.

1. Remove the terminal-chamber cover and the compression-gland packing nut and packing.

2. Make reference marks as shown (refer to Fig. 6). Dimension (A) is a function of the height of the terminal chamber and the compression gland used. It should be arrived at by temporarily assembling a piece of cable in the compression gland and terminal chamber and marking it just below the rubber bushing in the gland.

3. Assemble the compression gland packing nut, and packing, on the cable and push it back out of the way.

4. Clear the end of cable down to the bare strands for a distance of 1-1/2 inches from the end. Clean the strands and sweat the cable to the bayonet connector. Fill the strands with solder.

5. Remove rubber jacket, metallic shield, and *all traces of semi-conducting tape to point (B)*. Pencil insulation at point (C) for 3/4 inches.

6. Fill between shoulder of insulation and bayonet connector with dry varnished cambric or rubber tape. Build up the lowest part first to avoid wrinkled tapes.

7. Apply two 1/2 lap wraps of tape from point (B) to 1/4 inches over the bayonet connector.

8. Starting at (B), build the stress cone with tape. Remove the rubber jacket 1/2 inch back from (B). Solder the copper mesh tape to the cable ground shield. Use the tape to extend the ground to the maximum diameter of the stress cone. Solder the copper mesh tape back on the previous wraps. Allow a sufficient length of tape for its extension back along the cable

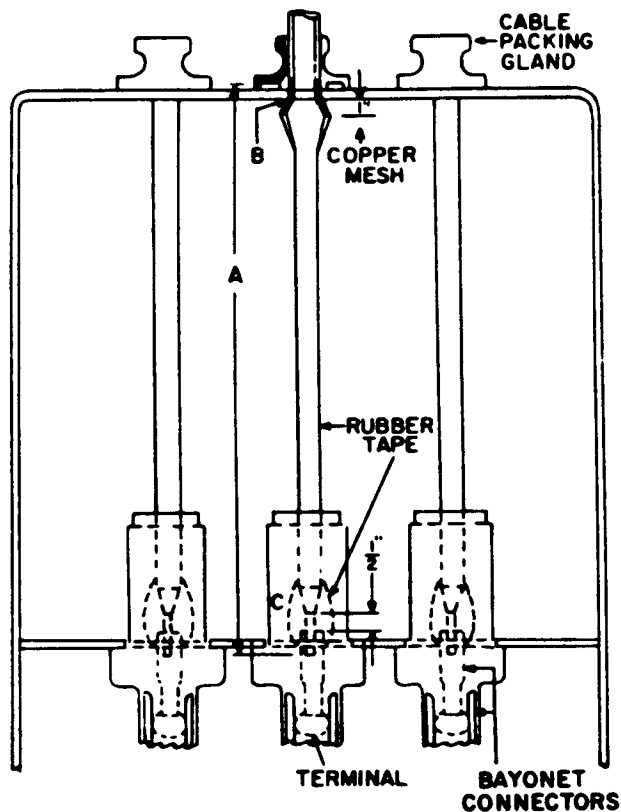


Fig. 6 Terminal chamber

toward the top of the box and subsequent connection to the ground terminal.

9. Apply two 1/2 lap wraps of tape over the stress relief cone and cable down to the bayonet connector. Bring the copper mesh out to the ground connection.

10. Insert bayonet terminal into the female receptacle at the base of the porcelain insulator. Fill the space between the insulator and the cable end with a soft potting compound, such as G&W Novoid No. 224, to a level approximately one inch below the top end of the insulator.

Assemble the stuffing gland in place; then prepare the gasket surfaces and replace the terminal chamber cover as described in a supplementary leaflet "Gaskets and Gasketing Procedures." Pressure test the terminal chamber.

When cable terminations other than those manufactured by the General Electric Company are used in conjunction with the equipment covered by these instructions, refer to the manufacturer's instructions covering the particular device.





Refinishing Subway & Network Transformers with GE Epoxy-Acrylic or Melaprene Paint Systems



Fig. 1 INSPECTION BETWEEN PANELS need only be done at infrequent intervals since areas are protected from most nicks and scratches.

New GE underground transformers are finished with a high build, four coat epoxy-phenolic and acrylic paint system. Transformers shipped prior to 1974 were finished with a Melaprene paint system. The refinishing procedures and materials described here can be used for the repair of both old and new transformers.

Normally the original finishes will not need maintenance except when exposed to extremely corrosive conditions. Occasionally, while in storage or during installation, the paint may be damaged by sharp objects or abrasion. In such cases, it is recommended that only the damaged areas or places that show rust should be refinished. As a matter of fact, it would be quite difficult as well as unnecessary to remove the paint in undamaged areas.

To refinish these transformers, proceed as follows:

STEP 1. CLEANING

Clean areas that need repainting with a liquid detergent (such as Turco No. 3752*). The detergent should be followed by a high-pressure water rinse to remove contaminants such as grease and soil loosened by the detergent.

NOTE: Steam cleaning could also be used, but might be difficult to handle safely. A small portable washer (such as a Porta Washer) can be used effectively with either detergent or emulsion cleaners.*

STEP 2. DRYING

Dry the unit thoroughly, preferably using a hose connected to a heated air source.

STEP 3. RUST & LOOSE PAINT REMOVAL

Wire brush or hand scrape any area showing rust or loose paint. The inner surfaces of panel radiators and the tank surface behind the panels will not ordinarily need refinishing since they are protected from most nicks and scratches. If repainting is necessary, however, rust and loose paint can best be removed with a wire brush or a sanding tool attached to a long handle. Enough room has been designed between the panels for such work.

When using a wire brush, best results will be obtained with a flue brush having short, stiff bristles and best sanding results will be obtained using a medium grit, garnet paper. In either case the operation can be performed at ground level, working from either end of the transformer as shown in Fig. 2 or from the top of the transformer. A suitable wire brush extension can be easily constructed from $\frac{1}{2}$ -inch iron pipe.

After brushing, wash off any contaminants that are present with a solvent such as Varsol. Then blow or wipe the area clean of any dust.

An application of a proprietary phosphoric acid-type solution (such as Turco WO#1* is recommended to convert any remaining rust to an inert iron phosphate. This retards further corrosion and provides a base for good paint adhesion. Apply the solution, mixed one part acid to three parts water, to the scraped area with a small paint brush. After five or ten minutes all the rust will be chemically dissolved. Remove the remaining liquid with a lint-free cloth and rinse off thoroughly with water.

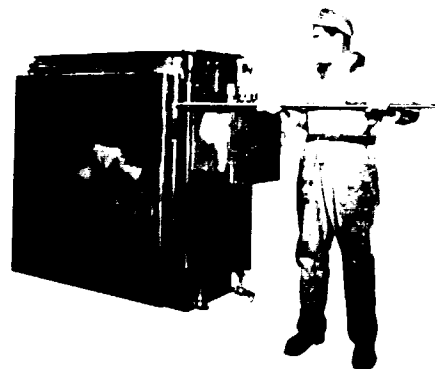


Fig. 2 WIRE BRUSHING can be done with an extension handle for any rusting or loose paint.

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.

GEI-70047E Refinishing Subway & Network Transformers

STEP 4. PRIMING

When primer is applied in a vault, a hot-air dryer capable of removing moisture and raising the vault temperature to 80F is suggested. A canopy should be installed over the vault as a shield. A minimum of 4 hours drying time is required before repainting. This drying period can be shortened to one-half hour if infrared lamps are used.

Primer for repainting is GE A50P229B epoxy primer. This is a two-part epoxy-polyamide primer consisting of a base component (pigmented) A50P229B Part A and a converter (clear) A50P229B Part B. Mix Part A and Part B as furnished in equal parts. Allow the material to stand for twenty minutes after mixing. Thin epoxy mixture with CE-991C thinner in the ratio of two parts of epoxy to one part thinner by volume to obtain the recommended spray viscosity of 25 to 35 seconds as measured with a Zahn #2 Viscosimeter at 25°C (77° F). The catalyzed epoxy mixture has a useful pot life of 16 to 24 hours. Do not use after this period - discard as material will solidify. Make sure that catalyst converter has been added. When brushing or roller-coating application is desired, use epoxy primer without thinning. Addition of CE-991C thinner for less drag when brushing should not exceed 5 percent by volume.

Material GE A50P229B should be sprayed with a pressure type spray unit at 30-40 PSI air pressure and 10-12 PSI fluid pressure. Apply spray with uniform passes and cross-coat. Repeat several times with short waiting periods of up to twenty minutes to allow solvent to flash off. Measure film thickness after air drying overnight. Film thickness should be 4 to 5 mils over bare metal or 1 mil over previously painted surfaces as measured using an Elcometer or similar magnetic film thickness gauge. Apply additional spray coats if necessary to reach recommended film thickness. Do not apply at temperatures below 50°F unless supplemental heating, such as infrared heaters, is available. The primer may be applied to clean, grit-blasted metal or to the factory finish. Remove all traces of moisture, oil or grease with a clean wiper and an approved safety solvent to assure a clean surface.

STEP 5. FINISHING COATS

After primer has air dried for 24 hours, GE A50P319B black acrylic finish paint may be applied by spray or brush.

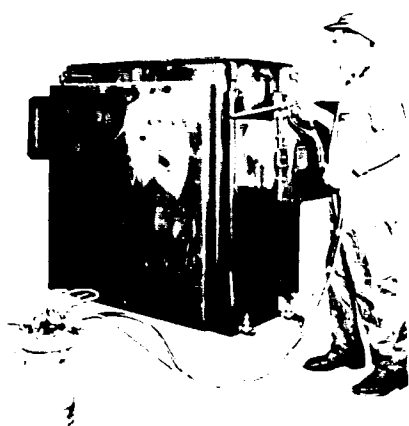


Fig. 3 PAINTING WITH EXTENSION SPRAYER is a fast way of applying each paint.

This finish air dries rapidly, and spraying is the preferred method.

Thin A50P319B using Xylol as a thinner. Equal parts of A50P319B and Xylol by volume are recommended to provide a viscosity of 16 to 18 seconds as measured with a Zahn #2 Viscosimeter at 25°C (77° F). Use at this viscosity for spray or brush coating. Limit use of brush application to small areas.

After thinning to above viscosity, spray application should be done with a uniform spray pattern and cross-coating, using a pressure type spray unit at 30 to 40 PSI air pressure and 10-12 PSI fluid pressure. Repeat spraying and cross-coating step to achieve a 1/2-1 mil dry film build. Total dry film thickness should measure 4 1/2-5 mils, after an overnight air dry. Allow finish to air dry overnight before handling. Full hardness of the paint will take place over a period of one week at 70° F. Do not put transformer into wet vaults before this period of air drying has elapsed. Spray with good ventilation. Flash points of paints are below 80° F.

This refinishing process should approximately restore transformers to their original factory condition. As such, they should provide extremely good corrosion resistance with little, if any, further refinishing needed.

NOTE: All of these finishes can be oven baked if facilities are available. One-half hour at 300F is suitable for all materials.

If the inner surfaces of panel radiators or the tank surface behind the panels are being refinished, they can be reached two ways. As shown in Fig. 3, an extension spray head** can be used or as shown in Fig. 4, the areas can also be reached by a paint roller† mounted on a long handle. It is recommended that the roller have a maximum outside drum diameter of 1-1/2 inches.

Paints can be obtained from the General Electric Transformer Division, 100 Woodlawn Avenue, Pittsfield, Massachusetts 01201.

*Turco Products Company—Newark, N.J.—Patterson, N.J.—Schenectady, N.Y.

**DeVilbiss PMBX No. 4210 Extension Spray head obtainable from the DeVilbiss Company—Factory Branch, Newark, N.J. or Jeffco Distributors, Springfield, Mass.

†Paint Roller and extension Model 1719T or paint roller Model 719, obtainable from the Hanlon and Goodman Company, 212 Main Street, Bellville, N.J.

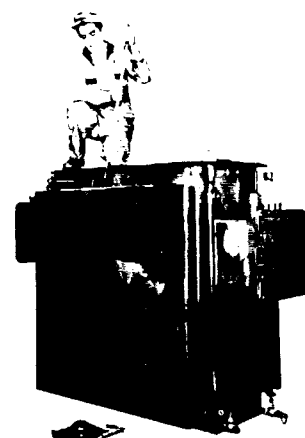


Fig. 4 PAINTING WITH ROLLER is probably the easiest and most economical approach.



Transformer Business Department



Field Testing of Secondary Network Transformers Oil or Silicone Immersed

A-C TESTS

These instructions cover the field testing of Secondary Network Transformers which at the factory are given low frequency dielectric test in accordance with voltages established by American Standards Association (ASA), Publication for distribution, Power and Regulating Transformers C-57.12 - Section 12 - 02 - 110.

When testing network transformers in the field, ASA recommended test values should be applied. These values are less than the factory test values and are given in Table I. These recommendations relate to dielectric tests applied between windings and ground, and for induced voltage tests. These are taken from ASA Publication C-57.12, Section 12 - 92.042.

Field Test Classification	Percent of A-C Factory Test (1 minute)
Acceptance Test (New or re-built Apparatus)	75
Periodic Service Test	65

TABLE I

For convenience, factory test voltage values and the corresponding recommended field tests values are tabulated in Table II. The table gives values

Winding Voltage Class	Factory Test Voltage	RECOMMENDED VOLTAGE FOR FIELD TEST	
		Field Acceptance Test (75% of Factory Test)	Periodic Field Test (65% of Factory Test)
1200	10000	7500	6500
5000	19000	14250	12350
8660	26000	19500	16900
15000	34000	25500	22100
25000	50000	37500	32500
34500	70000	52500	45500

60 cycle, 1 minute High Potential Tests from each Winding to other Windings and Ground

TABLE II

for 60 cycle, 1 minute high potential test for winding-voltage classes 1.2 through 34.5 kilovolt.

Table III gives the original factory test voltage values and the recommended field test values for induced voltage tests. Induced voltage tests should be made with at least double rated frequency. Duration of tests should not exceed 7200 cycles. If this test produces a voltage between the terminals of any winding in excess of values given for field tests in Table II, the induced voltage should be limited to the specified high potential test voltage for that winding.

Original Factory Test	Field Test	
	Field Acceptance Tests	Periodic Field Test
Twice Rated Voltage	1.5 times Rated Voltage	1.3 Times Rated Voltage

Induced Voltage Test

TABLE III

D-C TESTS

Under some conditions it may be necessary or desirable to subject the transformer to periodic

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insulation tests using direct voltage from kenotron sets. In such cases, the direct voltage should not exceed the factory test RMS alternating voltage; For example, if the factory test on the transformer was made at 34-kv RMS, direct voltage should not exceed 34-kv. Periodic kenotron tests should not be made on transformers rated above 34.5-kv.

Test Duration

Referring to NEMA "Standards for Transformer" TRI-1954, Section TRI-2.064 the duration of the foregoing transformer insulation tests should not exceed the factory a-c test duration. If an alternating or direct voltage test is applied to the transformer for 5-minutes, its value should not be more than 90% of the 1-minute test voltage value.

D-C Primary Cable Testing

G.E. Network transformers are usually equipped with 3-pole, 3-position disconnecting and grounding

or 2-position disconnecting switches. The dielectric strength of these liquid-filled switches in the open position is such as to permit d-c, 5-minute cable tests with kenotron sets in the field as is indicated in Table IV for the common switch voltage classes. When using the voltage values from Table IV for primary cable tests the switch must be in the open position and the terminal chamber filled with oil or cable compound.

<i>Switch Voltage Class</i>	<i>D-C Cable Test Voltage</i>
<i>15000 and below</i>	<i>45000</i>
<i>25000</i>	<i>65000</i>
<i>34500</i>	<i>80000</i>

Permissible 5-Minute D-C Dielectric Test Voltage (Liquid-Filled Switch in Open Position)

TABLE IV



**Transformer Business
Department**

*General Electric Company
Hickory, North Carolina 28601*



**Transformer Business
Department**

*General Electric Company
Hickory, North Carolina 28601*