INSTRUCTIONS

GEK-45220

CONTENTS

MEDIUM TRANSFORMER PRODUCTS DEPARTMENT, GENERAL ELECTRIC CO., ROME, GA. 30161

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Secondary Unit Substation Transformers

LIQUID-FILLED

RECEIVING, HANDLING, AND STORING

RECEIVING

Secondary Unit Substation transformers are normally shipped completely assembled, liquid-filled and ready to install. Immediately upon receipt of the equipment, examine the packages and parts for any damage which may have occurred during shipment. If injury or rough handling is evident, file a damage claim with the transportation company and notify the nearest Apparatus Sales Office of the General Electric Company.

Tighten any parts which may have worked loose, such as nuts and leads and check the materials against the shipping list for possible shortages.

HANDLING

Lugs are provided for lifting the complete transformer, and where necessary, additional nuts and eyes are supplied for lifting the various parts. Lift the transformer by means of the main lifting lugs, using cables long enough to obtain cable pull angles not over 30 degrees from vertical. When lifting the transformer, the cover should be securely fastened in place to prevent buckling the tank walls.

Jacking space is provided in the base of the transformer. Do not attempt to move the unit by placing jacks under drain valves, cooling tubes or other attachments. Junction boxes, when provided, can be removed to facilitate moving the transformer.

STORING

Before placing a transformer in storage, make sure the insulating liquid is at its proper level, add *dry* nitrogen in the gas space until the pressure reaches 3 psi and then seal the unit. Before placing a transformer in service after a period of storage, relieve the internal gas pressure by venting to the atmosphere. See paragraph on "Venting".

Transformers stored for use as spares should be maintained in the same condition as those in service. Make periodic inspections of the liquid level, its dielectric strength, and when furnished, fans, alarms, and control circuits. Also check the pressure gage to make sure the transformer seal is being maintained and inspect junction boxes and other compartments for evidence of moisture condensation.

INSTALLATION

The only foundation necessary is a level floor strong enough to support the weight of the transformer. The transformer should be located at least six inches and preferably a foot or more away from walls and other obstructions which might prevent free circulation of air around the unit. Provisions have been made for moving valves and gages from the high-voltage to the low-voltage front and vice versa in the event that it becomes necessary to reverse the position of the transformer. Refer to the Outline drawing. Transformer finishes and components are designed for normal life in a non-corrosive atmosphere. Atmospheres which include corrosive agents may require additional protective measures.

If the transformer is to be opened outdoors on a damp or stormy day, take precautions to prevent entrance of moisture. CAUTION—Before removing a handhole cover, shipping plate, or other device, vent the transformer to atmospheric pressure.

Drilled flanges are provided on both the high- and low-voltage ends of the transformer for making connections to switchgear or terminal compartments. Terminal compartments, when provided, can be removed to facilitate installation of the transformer. To disassemble a compartment, remove the bolts around the edge of the front panel and

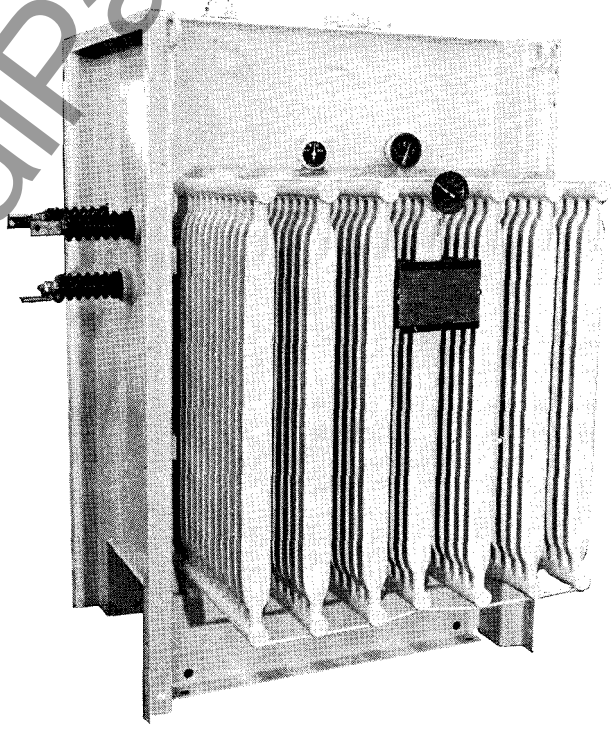


Fig. 1. Secondary unit substation transformer

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

GENERAL ELECTRIC

pull it away at the bottom until the top slides out from under the cover. The cover and side panels can then be removed as required. Protective covers on bushings should not be removed until the unit is ready for connection in order to prevent damage to the bushings.

Before placing the transformer in service, check the level and dielectric strength of the insulating liquid in all compartments as explained under "Sampling" and "Testing".

At higher altitudes, decreased air density reduces transformer cooling efficiency and lowers bushing arc-over voltages. Lower atmospheric pressures may require venting of the transformer before placing in service in order to equalize internal and external pressures. If the transformer is to be installed at an elevation above 3300 feet, consult the nearest Apparatus Sales Office of the General Electric Company relative to the transformer's suitability for operation at the higher altitude.

CONNECTIONS

The necessary hardware for making interconnections between a transformer and its co-ordinated switchgear is supplied with the switchgear. Bus bar joints should be properly aligned before bolting to prevent undue strain on the bushings. Connections to threaded bushing studs should be made as described under "Bushings" and as shown in Fig. 12. When making line connections, long sections of unsupported conductor should be avoided and leads should be flexible enough to allow for expansion and contraction. Make no connections except those authorized by the transformer nameplate.

Transformers having internal terminal boards are normally shipped connected for the highest rated voltage. When shipped otherwise, a tag fastened to the nameplate will indicate the connections that have been made. Before applying voltage to a transformer, see that all connections are tight and that the windings are connected for the desired voltage.

Ground the transformer permanently and effectively by means of the ground pad located at the bottom of the tank. Unit substation transformers can usually be connected to the common substation bus. A reliable, low-resistance ground is essential for adequate protection. A poor ground may be worse than none at all as it gives a sense of false security to those working around the equipment and may result in serious personal injury or damage to the transformer.

When a transformer is designed for use on a system having a solidly grounded neutral, be sure that the neutral lead is permanently and solidly grounded.

PIPE FITTINGS

When assembling pipe fittings, clean the threads thoroughly to remove all insulating liquid, grease, old compound and dirt. Apply G-E Compound No. A15A11A or Teflon tape to the threads and screw the mating parts tightly in place.

LEAK TESTS

Inspect the entire transformer for evidence of leaks and make the following pressure test. Introduce dry nitrogen through the pressure test valve (located on the tank wall opposite the pressure-vacuum gage) until the pressure in the transformer reaches 5 psi. Seal the tank at this pressure and make an examination for leaks over a period of 12 hours. Leaks above the liquid level can be located by applying a liquid soap solution to all gasketed joints, pipe fittings, etc.

VENTING

The transformer should be vented to the atmosphere before it is placed in service if it has been pressurized for leak tests or storage, or if the unit has been opened and resealed. Venting should take place with the liquid temperature at 25 C. If it is necessary to vent at other temperatures, re-vent as soon as the unit returns to 25 C. This operation is necessary to prevent excessive operating pressures or vacuums.

VAULT VENTILATION

If the transformer is to be installed in a vault, provide ventilation which is adequate to keep the room temperature from exceeding that of the incoming air by more than 5 C. 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 openings for every 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 and 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 transformer 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 10,000 cubic feet per minute for each 1000 kva.

GASKETS

A number of different types of gaskets are used on secondary unit substation transformers, depending on the application. Gaskets used to maintain the transformer seal have been selected for their ability to resist deterioration by the insulating liquid and to avoid any contamination of the liquid. No substitution should be made for these original gasket materials without the approval of the General Electric Company. Replacement or spare gaskets can be purchased to size through the nearest Apparatus Sales Office of the General Electric Company. Identify the parts wanted as explained under "Renewal Parts".

All of the gaskets used to maintain the transformer seal can be reused many times unless damaged. Before installing a new gasket or replacing an old one, thoroughly clean the gasket surfaces. Although no stickers are required, the compound furnished with the gaskets may be used on all but the "O" rings to hold them in place during assembly. Compress the gasket approximately one-third, or to the stops when provided in either the mating parts or in the gasket itself. Gaskets are compressed to the stops when there is a noticeable increase in the torque required to tighten the bolts. A leak test is recommended following the opening and closing of any gasketed joint affecting the transformer seal.

WEATHERPROOF JOINTS

A length of sponge rubber gasket is furnished with each outdoor unit for the purpose of weatherproofing the joints

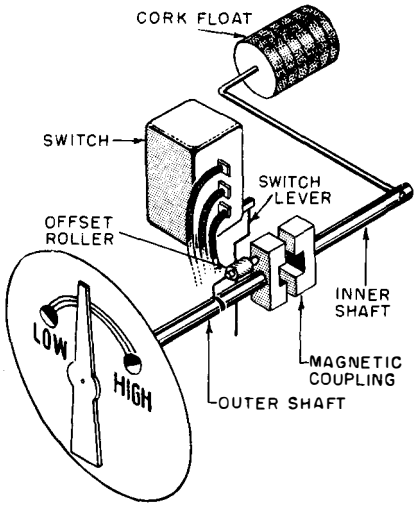


Fig. 2. Schematic view of magnetic liquid-level gage with alarm switch

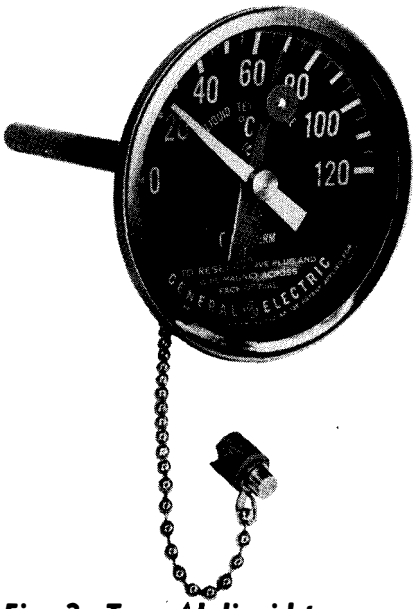


Fig. 3. Type AL liquid temperature indicator

between the transformer and its associated air-filled compartments. Install this gasket just outside the mounting studs or bolt holes and for the best weather-resistant joint allow the piece across the top to overlap the two side pieces.

To install a sponge rubber gasket, clean the surface on which it is to be mounted and apply a thin coat of the adhesive furnished to both the metal and the gasket. (*Do not* apply adhesive to the edges or outside surface of the gasket.) Allow the adhesive to dry until it is no longer tacky and then press the gasket against the metal with enough pressure to make a good contact.

When a retaining strip is provided the gasket should be assembled with its inner edge in contact with the strip. Tighten the gasket down to this stop or in the absence of a stop, compress it to approximately ½ size.

ACCESSORIES

LIQUID-LEVEL GAGE

A magnetic liquid level gage is used to indicate the level of the insulating liquid in the main transformer tank and in associated compartments. It consists of a float arm and magnet on one side of a liquid-tight partition and a second magnet and indicating pointer on the other side. See Fig. 2. The gage can be removed whenever the liquid is at or below the 25 C level.

Gages which have a snap-action switch can be wired to give an alarm when the liquid level approaches a point too low for safe operation of the transformer. A cam on the indicator shaft will operate the switch when the pointer drops to the "LOW" mark on the dial. As the liquid level rises the pointer indicates the change, but the switch will not clear the alarm circuit until the pointer has advanced from five to ten degrees above the "LOW" mark.

LIQUID TEMPERATURE INDICATOR

The liquid temperature indicator is used to indicate the top liquid temperature of the transformer and those having internal switches can be used to control fans and/or initiate an alarm. The standard type AL thermometer is shown in Fig. 3. When alarm contacts are required a Type ALR thermometer as shown in Fig. 4 will be furnished.

The thermometer is mounted with its temperature sensitive bulb in a well which extends into the transformer's top liquid and is secured with a union nut. The well is liquid-tight thus permitting removal of the thermometer without lowering the liquid level or breaking the transformer seal.

Dial calibration is in degrees centigrade with a yellow or white pointer to indicate top liquid temperature and a red pointer to show the maximum temperature which has been attained since last reset. To reset the maximum reading pointer, remove the magnet and wipe it across the face of the dial.

Type ALR indicators are equipped with two snap-action switches which are operated by cams on the indicating pointer shaft. Switch No. 1 is intended for fan control and Switch No. 2 can be used in an alarm or control circuit. Switch contacts are normally set to operate on rising temperatures as follows: Switch No. 1, 65C; Switch No. 2, 90C. With falling temperatures the switches operate between 5C and 10C below these settings. When Switch No. 1 is used for fan control, a separate "Hand-Auto" switch is included in the control circuit for manual operation.

To check operation of the thermometer or the temperature at which the switches operate, remove the unit and place the detector bulb in a container of liquid. Heat the liquid and using an accurate centigrade thermometer, compare readings and check switch operating temperatures. If the unit is not operating satisfactorily consult the nearest Apparatus Sales Office of the General Electric Company regarding repairs or replacement.

PRESSURE-VACUUM GAGE

The pressure-vacuum gage furnished with the transformer (Fig. 5) is of the compound type and is normally calibrated in psi. Gage readings should vary

Fig. 4. Type ALR liquid temperature indicator - relay

as the transformer temperature changes and should normally indicate a positive pressure. (The instrument should not be expected to read accurately near the zero point.) When the transformer is de-energized or is operating under light or no-load conditions in a low ambient temperature, the gage may indicate a vacuum within the tank. A lack of any change in reading with changes in temperature is an indication of a leak in the transformer seal and should be investigated.

PRESSURE-RELIEF DEVICE

A mechanical, self-resetting pressure relief device (Fig. 6) is normally supplied with transformers filled with Pyranol® insulating liquid and is used to protect the tank against excessive internal pressures such as those which may accompany an arc under the insulating liquid. It consists primarily of a mounting flange, cover, two trigger springs, and an "O"-ring gasket.

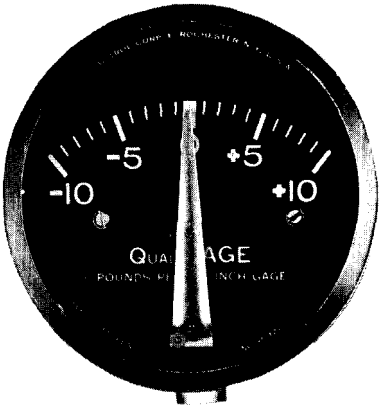


Fig. 5. Pressure-vacuum gage

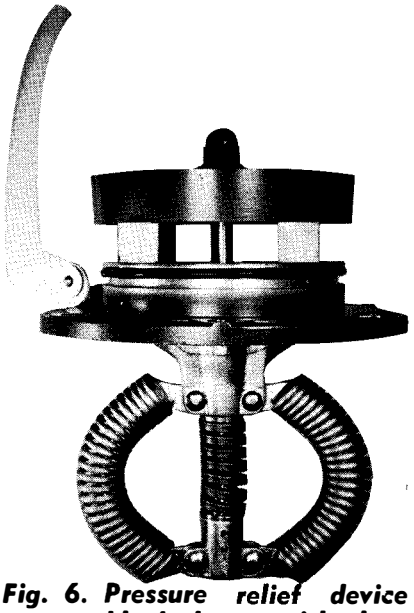


Fig. 6. Pressure relief device blocked open with alarm in vertical position

The relief cover is used as the means of sensing pressure and tripping the device. The gas pressure within the transformer is applied over the entire area of the relief cover which in turn exerts a force against two trigger springs. When the pressure increases to a critical value, the springs will bow out, permitting the cover to open and relieve the excessive gas pressure within the transformer tank. A bumper spring assembled on the center shaft cushions the opening shock and limits travel of the device. When the transformer pressure has returned to normal the device will return to its original position, automatically resetting itself and resealing the transformer.

The transformer seal is maintained by an "O" ring gasket between a vertical section of the mounting flange and the cover. The compression forces are at right angles to those acting on the cover to trigger the device and, therefore, have no effect on its calibration. To keep drag at a minimum, a wider-than-normal gasket groove is used which permits the "O" ring to roll rather than slide during the first part of the tripping action. By the time the "O" ring reaches the top of the groove the trigger springs have bowed beyond their critical point and sufficient force is then readily available for sliding the cover over the gasket.

The pressure relief device is provided with a mechanical alarm to give local indication of relief operation. The alarm consists of a plastic vane pivoted on a bracket and is normally removed for shipment. To install the alarm, remove a nut from one of the relief mounting studs, place the bracket over this stud with the vane resting on top of the relief cover, and replace the nut. The vane will then remain in a *horizontal* position until the pressure-relief device operates, at which time the cover will push the vane into a *vertical* position. After tripping, the vane must be reset in order to indicate subsequent operations.

Gas Absorbers and Vent Pipes

If a Pyranol-filled transformer is located in a poorly ventilated indoor area, provisions should be made to either absorb or carry off any discharged gases. Refer to the National Electric Code for regulations pertaining to the indoor installation of Pyranol-filled transformers.

Gas absorbers are designed for mounting directly on top of the pressure relief device using the same mounting studs. Instructions for installing and filling the absorber are furnished with that device. A special adapter flange and gasket (Items 2 and 3, Fig. 7) are available upon request for connecting vent pipes to the relief device. Order by drawing number 112A4035 G1 through the nearest Apparatus Sales Office of the General Electric Company.

The reducer (1) is to be made by the user and should have a maximum outside diameter of 10.20" in order to fit the 10.25" inside diameter of the adapter. The height to the first bend must be at least 6.50" to clear the relief device cover when it opens and the other dimensions can be made as required.

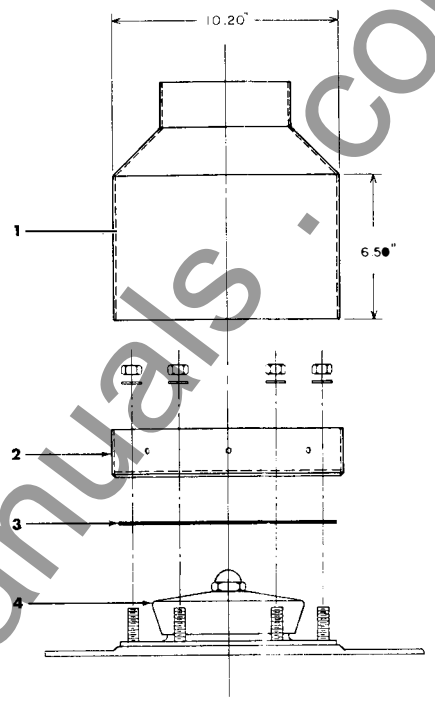
ELECTRICAL ALARMS

When electrical alarms are furnished with the various devices, the arrangement of contacts and color-coding of the leads will be as shown in Fig. 8 and on the transformer Connection Diagram. Switch No. 1 of the liquid temperature indicator is rated to carry 15 amps at 115 or 230 volts a-c. All other snap-action switches are rated as follows:

Circuit	Type of Load	Circuit Volts	Amperes
AC	Inductive and Non-Inductive	115	10
		230	5
DC	Inductive	125	0.05
		250	0.03
	Non-Inductive	125	0.25
		250	0.20
AC or DC	Inductive	125 And 250	Restrict starting inrush currents to values below
			Already Closed Contacts: 30
			Closing Contacts: 15

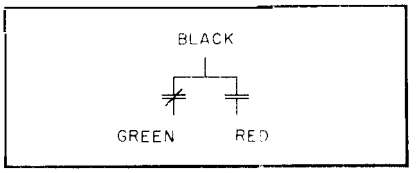
WEDGE-TYPE TAP CHANGER

The wedge-type tap changer, Fig. 9, provides a means of changing the voltage ratio of a de-energized transformer without breaking the transformer seal. It is shipped in place and is set on the position corresponding to the rated voltage shown on the transformer nameplate unless otherwise requested by the user.

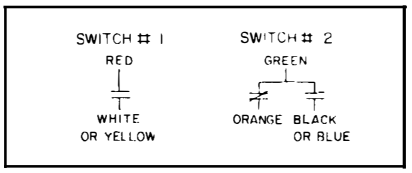


1. Reducer
2. Adapter flange
3. Gasket
4. Pressure-relief device

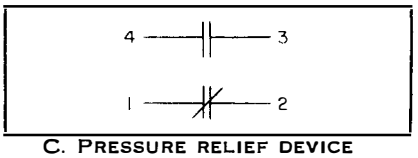
Fig. 7. Exploded view of vent pipe accessories



A. Liquid level gage



B. Liquid temperature indicator



C. Pressure relief device

NOTE—Color coding of one lead may differ. Unless otherwise specified by user, connections will be made to the normally open contacts and leads from the normally closed contacts will be taped up.

Fig. 8. Switch and cable connections for alarm contacts (when furnished)

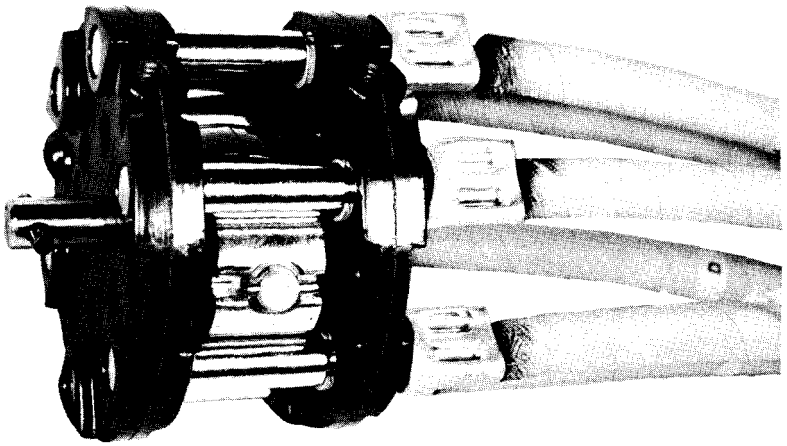


Fig. 9. Wedge-type tap changer

Tap leads from the transformer windings are connected to a circular group of nickel-plated copper rods which are held together between two insulating heads. A wedge in the middle can be moved by a crankshaft to wedge between any two adjacent rods. A spring between the wedge and crankshaft maintains a high-pressure line contact between current carrying components.

When the crankshaft is turned to move the wedge from one operating position to another, pressure is gradually reduced on the spring and the wedge is withdrawn from between rods. A "U"-shaped guide on the opposite side then pivots the wedge around to the next set of rods. As the crankshaft continues to turn, pressure is again applied to the spring and the wedge is forced into position with a wiping action, insuring positive contact.

The drive mechanism, Fig. 10, is located on the side or cover of the transformer and is connected through an insulator to the crankshaft of the tap changer. The cap covering the mechanism is gasketed to the mounting flange and an "O"-ring gasket is used between the mounting flange and drive shaft to maintain the transformer seal. One of the screws used to hold the cap in place has an oversize head with a hole in it for padlocking if desired. When requested, provisions can also be included for interlocking with the primary circuit breaker (or high-voltage disconnect switch) as explained under "Interlocks". Position indication is provided by an arrow on the mounting flange and a corresponding number on the cap.

Operation

CAUTION! The tap-changer must not be operated while the transformer is energized! Serious personal injury and/or damage to the transformer may result if this is attempted.

A table on the transformer nameplate gives the voltage and current rating for each tap position. TO CHANGE TAPS REMOVE THE TAP CHANGER CAP and use a wrench to turn the hex-head drive mechanism. The mechanism must be rotated through 5/6 of a turn to make a change of one tap. With the cap removed, the tap position can be observed through a slot in the indicator cams (See Fig. 10). Although the drive mechanism can be turned continuously in either direction placing the wedge in any one of six different positions, only five positions are numbered for use as shown on the transformer nameplate. The unnumbered position is unauthorized and should not be used.

After the desired change has been made, make sure that the cap gasket is in good condition and replace the cap. Note that the slots in the two indicator cams must coincide before the cap can be seated properly. This is to insure that the cap is not replaced until the tap changer is on position and also serves to align an appropriate position number on the cap with the arrow on the mounting flange.

Interlocks

Upon request, the operating mechanism can be mechanically interlocked with the circuit breaker or disconnect switch feeding the transformer. This can be done either by means of a special padlock inserted through the head of the oversize cap screw or by means of a captive key-operated plunger-type lock as shown in Fig. 11. The key for this lock is normally held in a similar lock on the primary circuit breaker and can be removed only by opening the breaker and locking it open. This de-energizes the transformer and permits the key to be removed and used to unlock the tap changer.

To place the transformer back in service after the desired tap change has been made, lock the tap changer in position, remove the key, and unlock and reclose the primary circuit breaker.

NOTE: A duplicate key is furnished with the transformer. This key is for emergency use only and should be removed from the operating area to insure the effectiveness of the interlock system.

Removing and Reassembling

If it becomes necessary to disconnect or remove a tap changer drive mechanism it should be placed on position 1 before removal in order to facilitate reassembly. To remove the drive mechanism, unbolt the flange and lift the device out as an assembly. Note that drive mechanisms are not interchangeable! When two or more are removed at the same time, care should be taken to reassemble them in the same location from which they were removed.

When replacing, see that the tap changer and the drive mechanism are both on position 1. The tap changer is on position 1 when the wedge bridges tap leads A and B and the index marks on the drive shaft and support structure are in line with one another. To reassemble, place the drive shaft through the opening in the mounting flange and slide the coupling over the tap changer shaft. The slotted end of the coupling should engage a pin in the tap changer

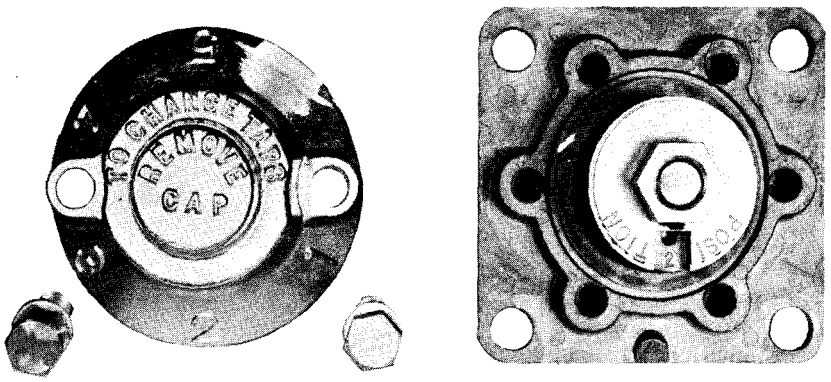


Fig. 10. Tap changer drive mechanism with cap removed

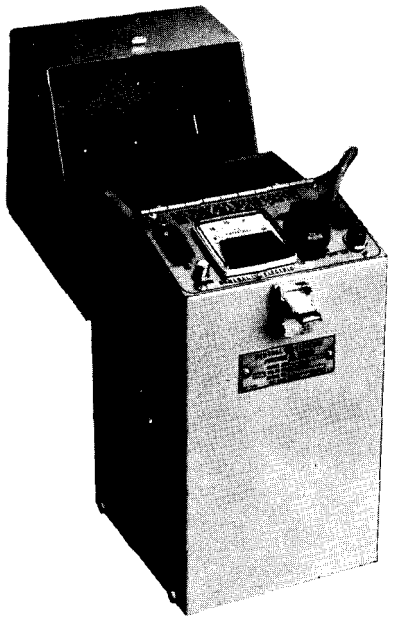


Fig. 13. Typical portable dielectric test set

If tests on the insulating liquid are satisfactory and no filter system is available, fill the transformer through a cover opening. Strain the liquid 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 set of cloths for each transformer.

SAMPLING INSULATING LIQUIDS

In the sampling and testing of insulating liquids, strict attention should be given to the cleaning and drying of sampling and testing receptacles. Samples should be taken when the insulating liquid is at least as warm as the surrounding air to avoid the possibility of moisture condensation. If the transformer or drum is outdoors, the sample should be taken on a clear day with precautions being taken to guard against contamination by windblown dust, etc. Observe the following procedure to obtain consistent results from samples taken either for field or factory tests.

Sampling From Transformers

1. Impurities which tend to affect the dielectric strength of 10C oil will generally be found at the bottom of the transformer, while those affecting Pyranol will be at the top. Therefore, on oil-filled transformers the sampling valve is located on the main drain valve and on Pyranol transformers it will be found on the side of the tank, about one inch below the 25C liquid level.

2. Three types of containers are recommended for sampling purposes — a one-quart, small-neck brown glass bottle; a clear glass bottle in a lightproof carton; or a one-quart tin can that has had the solder seams thoroughly cleaned to remove all traces of soldering flux. Do not use rubber stoppers or rings. If desired, glass sampling bottles may be obtained from the General Electric Company as explained under "Testing Service."

3. To clean the bottles, rinse with non-leaded, oil-free gasoline. Then wash with strong soapsuds, rinse thoroughly with distilled water, and dry in an oven at 105C to 110C for at least 8 hours. After drying, the bottles must be tightly sealed with glass stoppers or with clean corks protected by clean metal foil. Store them in a dry, dust-free cabinet or compartment.

4. Carefully clean the sampling valve or plug and allow enough insulating liquid to run out to remove any moisture or foreign matter which may have collected.

5. Rinse the bottle carefully, at least three times, with small portions of liquid drawn from the sampling valve. Allow the sampling bottle to drain thoroughly between rinses.

6. Draw a sample into the bottle, leaving sufficient air space to allow for possible expansion of the liquid. Reseal the transformer and carefully seal the container to prevent exposure to the atmosphere.

7. When making repeated samplings, observe the transformer liquid level and add make-up as required.

Sampling From Drums

1. Drums should remain undisturbed for at least eight hours before being sampled. Take oil samples from the bottom and Pyranol samples from the top, using a chemically clean thief. Observe sampling precautions previously outlined.

2. Glass thieves should be cleaned, dried, and stored in the same manner as outlined for bottles.

TESTING INSULATING LIQUIDS

Dielectric Strength

A variety of high-voltage dielectric testing equipment may be purchased from the General Electric Company. A typical portable test set (Model No. 9T11Y8454) is shown in Fig. 13 and various console models are also available. Follow the technique specified by the American Society for Testing and Materials, Designation: D877. The following paragraphs give a general outline of the procedure.

1. Set the spacing of the 1.0 inch diameter electrodes at 0.100 inch.

2. Wipe the test cup and electrodes clean with dry, calendered tissue or clean, dry chamois and thoroughly rinse with non-leaded, oil-free, dry gasoline.

3. Fill the test cup with dry gasoline and make a breakdown test under standard conditions of voltage applications (3 kv per second rise). If the cup has a dielectric strength above 25 kv, it is considered suitable for testing purposes. Observe the usual precautions in handling gasoline.

4. Immediately after the final rinsing with gasoline, rinse the test cup with the sample under investigation, and proceed with the test at once.

5. *The temperature of the sample when tested should be the same as that of the room, which should be between* 20 *C and* 30 *C* (68*F and* 86 *F*). Tests made on samples above this temperature can be misleading. Under no circumstances should the test cup be colder than the sample being tested.

6. Agitate the sample gently before each filling to prevent variations in results due to a settling of contaminants. Pour the liquid into the receptacle slowly to avoid the formation of air bubbles and fill to overflowing. If air bubbles are present, gently rock the test cup a few times and wait at least 3 minutes before applying voltage.

7. Fill the cup at least five times, making one test per filling, and average the results.

Since the liquid is a major portion of the insulation system in the transformer, its dielectric strength should be maintained as high as possible. A low breakdown voltage is an indication that impurities such as moisture, conducting dust, lint, or carbonized particles have entered the liquid. Oil or Pyranol testing lower than 26 kv (30 kv when new) should either be filtered to bring it back to its original condition or be replaced, depending on the condition of the liquid and economic considerations.

Other Tests

Although a low dielectric strength indicates the presence of contaminants, a high value is not always a certain indication of their absence. A number of other tests can be performed on an insulating liquid to determine its condition and therefore no one test should be considered conclusive. ASTM Designation: D117 defines the standard tests and contains cross references to other ASTM Designations for detailed descriptions of each method.

Field Test for Moisture Content

The following field test can be used to detect the presence of excessive

amounts of moisture in the insulating liquid:

1. Obtain a sample of the insulating liquid when the transformer is at operating temperature. (Preferably above 40 C.)

2. Starting with the hot sample, rinse a clean, dry test tube with the liquid to be tested, fill half full and stir continuously with a centigrade thermometer while cooling to approximately 20 C. Cool as much as possible in the ambient air and complete the cooling by momentarily dipping the test tube in an ice bath, removing and stirring and then redipping, etc.

3. Observe the sample carefully and note the temperature at which initial cloudiness appears. Wipe the outside of the tube with a clean rag or paper towel to facilitate observation of the slight moisture cloud that may form. Compare to clean insulating liquid at ambient temperature in a similar tube if necessary. Examination for the presence of a cloud should preferably be made against a dark background and not directly into the sunlight.

4. If cloudiness appears at 20 C or above, high to excessive moisture content is indicated.

A. Inspect the unit for free water —on the bottom for oil, on the top for Pyranol.

B. If free water is not present, a sample should be forwarded to the Laboratory for a quantitative analysis and recommendations on treatment of the unit. See "Testing Service."

5. If cloudiness does not appear until the temperature is below 20 C, an acceptable moisture content range is indicated.

6. This field test for moisture should be regarded as a rough test only and if there is any reason to question the condition of the insulating liquid, a sample should be sent to the Laboratory for an accurate analysis.

FILTERING AND DRYING INSULATING LIQUIDS

If test results indicate that moisture or other contaminants are present, they can usually be removed by passing the liquid through a filter system. Any free water in the transformer should be removed before the filter operation is started. For details of the procedure to be followed refer to instructions GEH-754 for oil, or GEH-1031 for Pyranol. Copies of these publications can be obtained from the nearest Apparatus Sales Office of the General Electric Company.

A transformer contaminated with moisture will not only have moisture suspended in the insulating liquid, but also in the windings and insulation. The most efficient temperature for filtering moisture from the transformer is between 20 C and 40 C, but at this temperature the transfer of moisture from the windings and insulation to the insulating liquid is quite slow. In order to completely dry the transformer, the filtering operation should be followed by a short-circuit heat run.

DRYING A TRANSFORMER

Recommendations regarding the drying of any particular transformer can be obtained from the nearest Apparatus Sales Office of the General Electric Company. Requests for this information should include the serial number of the transformer and the voltages and kva available for drying, including any available step-up or step-down transformers, etc. A more detailed explanation of drying procedures can be found in instructions GEI-65070 for oil-filled transformers and GEI-65080 for Pyranol-filled units, copies of which can also be obtained through the Sales Office.

The first step in drying a transformer consists of removing any free water and the water in solution as previously explained under "Filtering and Drying Insulating Liquids." The moisture remaining in the windings and insulation can then be driven off by heating the transformer. *Exercise caution when heating the transformer to avoid damaging the insulation.* The maximum winding temperature as determined by resistance measurements should not be allowed to exceed 95 C. CAUTION—Any drying method which involves heating an oil-filled transformer when it is exposed to the atmosphere also creates a serious fire hazard. No smoking or open flames should be permitted near the transformer and suitable fire extinguishers, preferably the carbon dioxide type, should be on hand before beginning the dryout.

Heating the transformer can be accomplished by shorting one winding and applying a suitable voltage on the other. Full-load current can be obtained by applying the impedance volts of the transformer. *Be sure to load the entire winding.* If the transformer is at room temperature at the start of drying, 125 per cent load may be applied until the top liquid temperature reaches 65 C. At this point, the current should be reduced in accordance with the following table:

Max. Allowable Short-Circuit Amps in Percent of Full Load	Maximum Top-Oil Temperature in Degrees C
100	75
85	80
50	85

Since the windings are at a higher temperature than the insulating liquid, the insulation may be damaged if these values are exceeded. Filtration during the heat run will not greatly hasten the drying process, because at these temperatures the filter press loses its ability to remove any appreciable amount of moisture.

The air space in the transformer must be thoroughly ventilated to remove the water vapor given off. This can be done by removing manhole covers, the pressure-relief device, or the entire cover. If drying is done indoors, provide good ventilation to exhaust vapors from the room. If the cover is left in place, it should be thoroughly insulated to prevent condensation. The required temperatures can be more readily obtained by blanketing the transformer with heavy paper, cloth, building felt, etc.

Take liquid samples every four hours and make tests of the dielectric strength. Oil-filled transformers should be sampled from both the top and bottom. Pyranol-filled units require sampling at the top only. To determine the drying progress, plot curves of load current, top liquid temperature, and dielectric strength versus time. A decrease in dielectric strength indicates that moisture is passing from the windings and insulation into the insulating liquid. As the moisture is driven out of the liquid, the dielectric strength will increase, indicating that the drying process is progressing satisfactorily.

Continue the drying until four consecutive samples test at least 26 kv and preferably 30 kv or higher and until a satisfactory "cloud" test is obtained as outlined under "Moisture Content." When the drying operation has been completed, the liquid removed for sampling must be replaced. To avoid the possibility of entrapping air bubbles in the windings, it is recommended that the liquid be returned through the upper filter press connection.

MAINTENANCE

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.

If it should become necessary to untank the core and coils, remove the weld bead around the cover as outlined under "Removing and Rewelding Covers" and then remove the tap changer drive mechanism as explained under "Wedge-Type Tap Changer." Lift off the cover and drain the insulating liquid. Disconnect the winding leads at the bushings

and remove the bushings using the "Removing and Replacing" procedure outlined under "Bushings." Remove the liquid level gage, top filter-press connection, thermometer well (on those where it protrudes into the tank), and any other parts which might get damaged or interfere with removal of the core and coils.

Take out the tanking wedges and remove the core and coil assembly. After reassembling the transformer, it may be necessary to conduct a drying run as explained in the preceding paragraphs. Questions concerning the necessity of drying a particular transformer should be referred to the nearest Apparatus Sales Office of the General Electric Company.

REMOVING AND REWELDING COVERS

Welded covers can be removed by chipping out the weld bead with diamond-point chisels and a pneumatic hammer or by the oxygen gouging method. The latter method is considerably faster and is recommended for all welds of 5/16" and over where adequate precautions can be taken for the fire hazard which exists with oxy-acetylene cutting operations.

When removing the weld bead, the cover should be clamped to the tank flange to hold it in place and prevent chips or welding slag from entering the transformer. Protect all openings against the entrance of foreign matter. Before oxygen gouging on oil- or Pyranol-filled transformers, thoroughly flush out the air space inside the tank with *dry* nitrogen or carbon dioxide gas and maintain a small flow of the gas during the gouging operation.

The entire weld may be removed in one pass, providing care is taken to avoid deep gouging of the edge of the cover or tank flange. The joint should be ground or chipped clean for rewelding before the cover is removed. Oxy-acetylene cutting torch equipment is necessary with gouging tips similar to Air Reduction Style No. 183. For best performance of the gouging operation, a cutting torch similar to Airco Series 3000 having a graduated control of the high-pressure oxygen flow is recommended. Tip sizes and gas pressures recommended for various fillet weld sizes are as follows:

Fillet Weld Size	Tip Size	Oxygen Pressure	Acetylene Pressure
5/16-in.	No. 8	60 psi	8 psi
3/8 and 7/16-in.	No. 10	70 psi	9 psi
1/2-in. and up	No. 12	75 psi	9 psi

REWELDING THE COVER

Before replacing the cover, remove all traces of dirt, grease, and oil from the areas to be welded. Cement a gasket to the tank flange or cover by applying a coat of water glass (sodium silicate) to both surfaces. The gasket should consist of a piece of 3/8-inch loose-twist glass or asbestos roving or a strip of 1/16 x 1½-inch dry asbestos folded to make it ¾-inch wide and should be located approximately ½-inch from the outer edge of the cover. To prevent spatter from entering the transformer during rewelding, compress this gasket by clamping the cover against its mounting flange and seal off all other external openings in the tank. Thoroughly flush out the air space with dry nitrogen and maintain a small flow of gas during the welding operation.

The arc-welding process, using 3/16" or ¼" diameter electrodes, is recommended for rewelding the cover. The fillet should be built up with a series of passes to a thickness comparable to that of the original weld. In order to make a pressure tight joint, slag and spatter should be completely removed before each succeeding pass and at each point where the arc is interrupted.

When the welding has been completed, remove all scale and pressure test the joint as explained under "Leak Test." After a satisfactory test, clean the weld and adjacent surfaces and apply one priming coat and two finish coats of paint.

RENEWAL PARTS

Orders for renewal or supply parts should be placed with the nearest Apparatus Sales Office of the General Electric Company. Specify the quantity required and give the catalog or drawing number along with the part numbers, whenever possible. If these numbers are not available, describe the parts in detail. When ordering a bushing, specify whether it is to be supplied separately or as an assembly with the adapter ring welded into place. Always include the serial number appearing on the transformer nameplate when requesting information or ordering parts for a particular transformer.

The only recommended spare part is the gasket for the handhole opening (or pressure relief device flange when provided.)

Materials that are unaffected by Pyranol have been used in constructing Pyranol transformers and no substitution should be made for these materials without the approval of the General Electric Company. Any renewal parts supplied will be manufactured from the same or similar materials as those used for new transformers. Successful operation of the renewal parts is contingent upon proper field assembly, the condition of the remaining parts and a thorough drying cycle if moisture has entered the transformer.

WHEN YOU NEED SERVICE

If you need to repair, recondition, or rebuild any electric apparatus, a G-E Service Shop near you is available day or night, seven days a week, for work in the shop or on your premises. Latest factory methods and genuine G-E renewal parts are used to maintain the original performance of your G-E equipment. For full information about these services, contact the nearest Apparatus Sales Office or General Electric Service Shop.

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GENERAL ELECTRIC COMPANY
ROME, GEORGIA 30161

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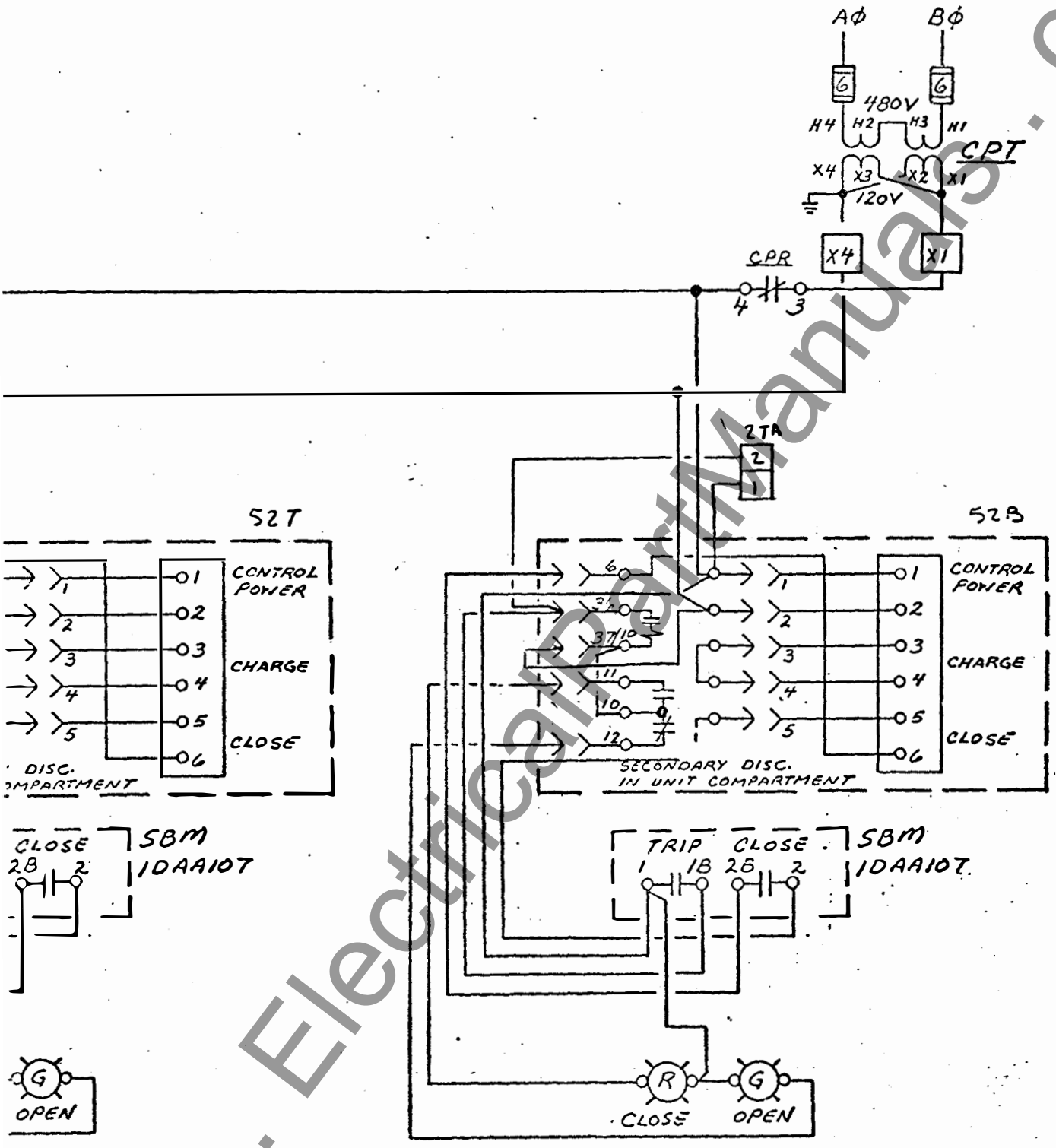
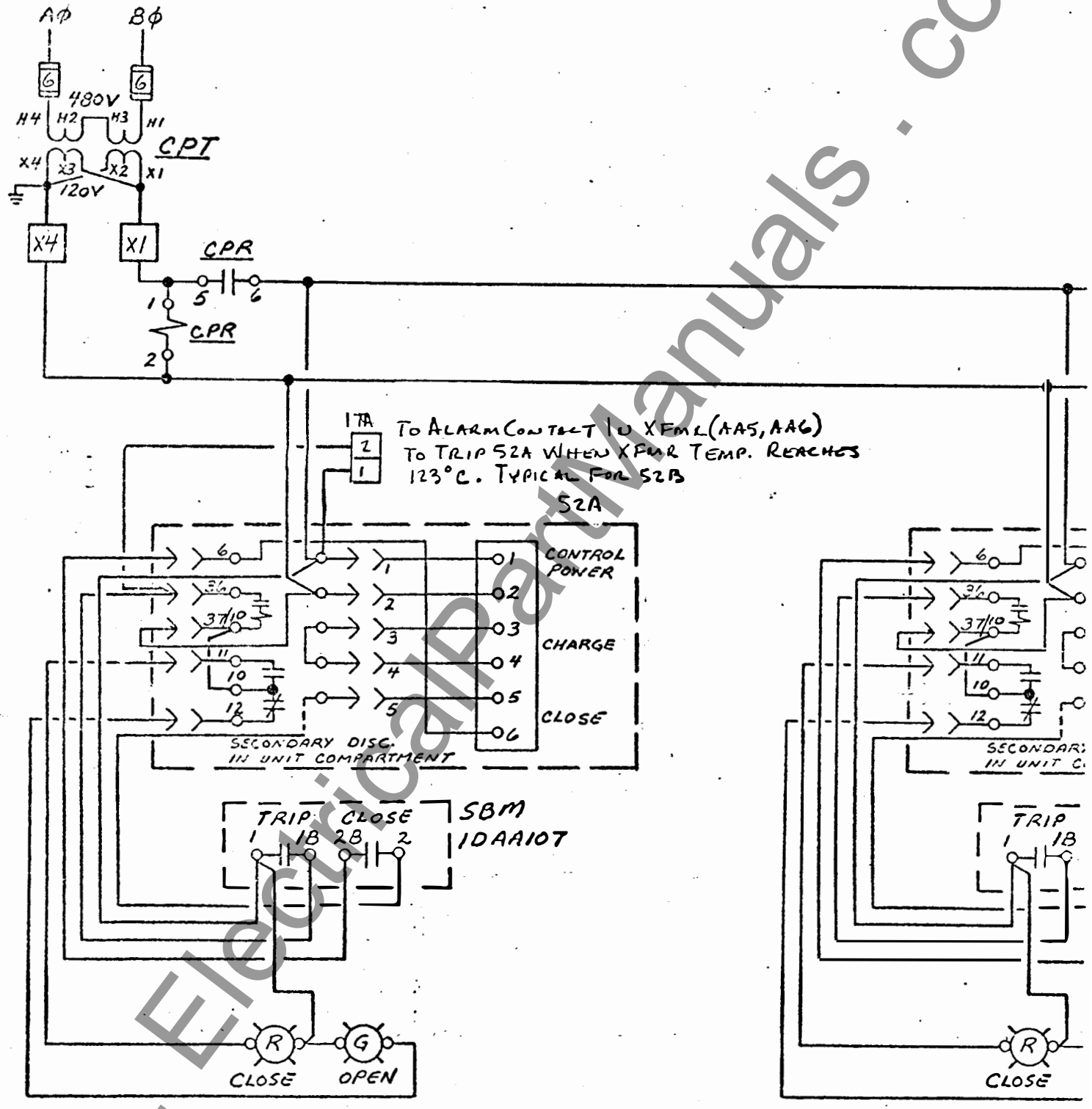
CONT. ON SHEET 2 SH. NO. 1



ANSFER RELAY

ROL WIRING

ADE BY Carl Parker 11-12-75	ISSUED LS MC COY 8-352-4413	177BL82333	
		CONT. ON SHEET 2	SH. NO. 1



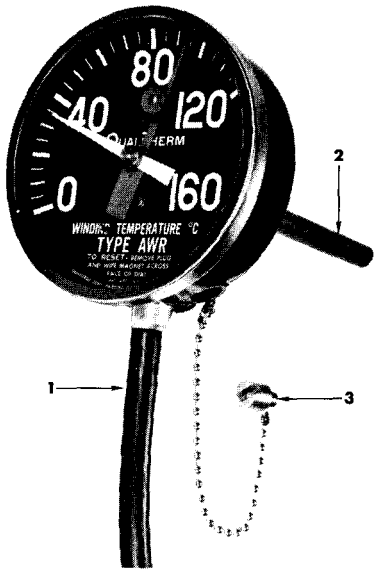
CPR- Control Power Tr

Circuit Breaker Cont.

TAG #10

Winding Temperature Equipment

LOCAL, EYE-LEVEL, AND REMOTE



1. CABLE
2. TEMPERATURE DETECTOR
3. RESET MAGNET

Fig. 1. Local winding temperature indicator.

INTRODUCTION

Winding temperature equipment is used to provide a means of reading an equivalent of the transformer winding hot-spot temperature. Two types of instruments are used, the indicator (Type AWR) and the detector (Type AW). The indicator provides visual indication at the transformer and the detector permits remote indication when connected to suitable external equipment.

Furnished with each of these devices are a heater well located in the top liquid of the transformer, a current transformer to supply a current proportional to that of the winding and, when necessary, a calibrating resistor connected in parallel with the heater.

Where the effects of unbalanced three-phase loading need to be determined, separate equipment is used in each phase.

DESCRIPTION

INDICATOR

The winding temperature indicator consists of a thermometer with either two or three snap-action switches. The switches permit the instrument to be used to start transformer cooling equipment and to initiate an alarm in the event winding temperatures become excessive. Thermometer dials are calibrated in degrees centigrade with a white pointer to indicate the winding hot-spot temperature and a red pointer to show the maximum temperature which has been obtained since last reset.

Two types of thermometers are used, the local device (Fig. 1) mounted at the top liquid level and the eye-level device (Figs. 2 and 3) mounted at an easily readable and accessible height above ground level. The temperature-sensitive bulb of the local thermometer consists of a helix-wound, bi-metallic coil enclosed in a sealed tube at the back of the case. The temperature-sensitive bulb of the eye-level thermometer contains a liquid which expands or contracts with variations in temperature. These changes are transmitted through capillary tubing to a Bourdon tube which operates the indicator shaft.

Switches

Snap-action switches in the thermometer are operated by cams on the indicating pointer shaft. Transformers having self-cooled/forced-air-cooled ratings are normally provided with a two-switch thermometer in which Switch No. 1 is used to control fans and Switch No. 2 is available for use in an alarm or control circuit. A three-switch device is also available upon request for use on transformers with the above rating. Switches are set to operate on rising temperatures as follows:

	2-Switch	3-Switch
Switch No. 1	85C	85C
Switch No. 2	120C	90C
Switch No. 3		120C

Transformers having a self-cooled/forced-air/forced-oil-cooled ratings are provided with a three-switch device having slightly different switch settings. In this thermometer Switches Nos. 1 and 2 are used to control the transformer cooling equipment in two stages and Switch No. 3 is used for the alarm circuit. Switch contacts are set as follows:

Switch No. 1	80C
Switch No. 2	85C
Switch No. 3	120C

With falling temperatures the switches operate between 5C and 10C below these settings. Switch contacts are wired to a multiconductor cable and are color coded as shown on the transformer connection diagram. Unless otherwise specified by the user, connections will be made to the normally open contacts and leads from the normally closed contacts will be taped up.

The switches in the thermometer are rated as follows:

AWR Device	Switch	Switch Ampere Rating				
		A-C Volts			D-C Volts	
		125	250	480	125	250
Two-Switch, eye-level	No. 1	15	15	15	.50	.25
	No. 2	5	5	—	.25	.20
Two-Switch, local Three-Switch, eye-level Three-Switch, local	All	15	15	15	.50	.25

When the thermometer switch contacts are used to control operation of the transformer cooling equipment, one or more separate "Hand-Auto" switches will be furnished for manual control and a magnetic contactor will also be included if the connected load exceeds the switch rating or if three-phase motors are employed. Refer to the transformer connection diagram for wiring details.

DETECTOR

The winding temperature detector consists of a non-inductively wound copper coil having a resistance of 10 ohms at 25C. The coil is assembled inside a stainless steel bulb with leads brought out through a receptacle as shown in Fig. 4. Leads are normally wired down to a junction box or to a condulet and are identified as A (black), B (green), and C (red or white). Leads B and C are common to the same point at one end of the resistor as required for connection to the remote instrument. More than one detector may be connected to a single indicator through the use of a selector switch. For further information concerning the remote indicator and its connections, refer to the instructions furnished with that device, or contact the nearest Apparatus Sales Office of the General Electric Company.

HEATER WELL AND CURRENT TRANSFORMER

The heater well consists of a stainless steel tube surrounded by an outer brass shell with an air space between tube and shell. The assembly is mounted near the top of the transformer in the hottest part of the insulating and cooling liquid. The tube itself is used as the heating element by connecting each end of it to the secondary of a current transformer. See Fig. 5.

The air between the tube and brass shell acts as a thermal insulator and permits the heater to raise the temperature of the detector bulb above that of the surrounding cooling liquid. Since the well is liquid tight, the detector bulb can be inserted or removed without lowering the liquid level or breaking the seal of the transformer. A union nut is used to secure the detector in the well.

The current transformer is located inside the main tank. CAUTION: *The secondary circuit of an energized current transformer MUST NOT be opened at any time.* If any work needs to be done on the wiring of the AWR, the current transformer must be short-circuited.

When required for calibration purposes, a resistor is connected in parallel with the heater (Fig. 5). The calibrating resistor is normally mounted inside the transformer control center. If the transformer is not equipped with a control center, the resistor is mounted on the underside of the main cover. Note that these leads must be disconnected whenever the cover is to be removed.

When more than one winding temperature indicator is used, the elementary connections for each instrument will be the same as those shown in Fig. 5 for a single unit. If an indicator and detector are both required in the same phase, their heater wells will be connected in series and separate calibrating resistors will be provided for each well as shown in Fig. 6. Similar connections are used for each pair required.

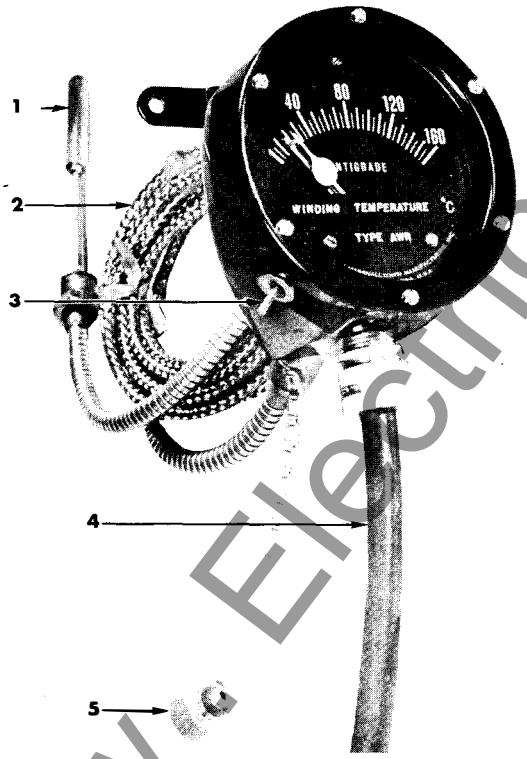
INSTALLATION

Thermometers and detectors are normally shipped in place on the transformer. When a device is removed for shipment, it will be identified by an appropriately marked copy of the shipping list. The temperature-sensitive bulb of each device is covered with a material to furnish electrical insulation between it and the heating tube. Use care when inserting the bulb in the well to prevent damage to this insulation. Make sure the gasket is in place between the shoulder of the detector and the well before tightening the union nut.

To install the eye-level device, mount the thermometer on the transformer as shown on the outline drawing. Remove the plug from the well and insert the temperature detecting bulb. Attach the capillary tubing along the side of the transformer, coiling any excess and securing with the clips provided. The minimum safe bending radius for this tubing is 2 inches and undue bending and other abuses should be avoided. Make cable connections as indicated on the transformer connection diagram.

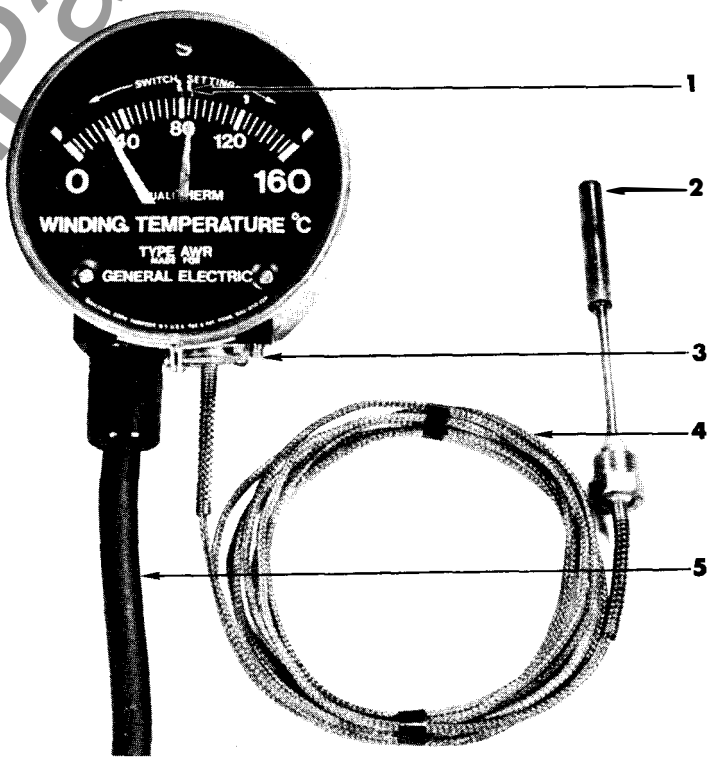
OPERATION

The hot-spot temperature of a transformer winding is determined by the load it carries, its thermal characteristics, and the temperature of its cooling liquid. From the relationship between these factors a heater can be designed which, when supplied with a current proportional to that in the winding, will duplicate the winding hot-spot rise over top liquid. Placing such a heater around a well in the top liquid permits this rise to be added to the top liquid temperature. An equivalent of the winding hot-spot temperature can thus be measured by inserting the temperature-



1. Temperature detector
2. Capillary tubing
3. Reset shaft
4. Cable
5. Reset shaft cap

Fig. 2. Two-switch eye-level winding temperature indicator.



1. Switch setting indicator
2. Temperature detector
3. Reset button
4. Capillary tubing
5. Cable

Fig. 3. Three-switch eye-level winding temperature indicator.

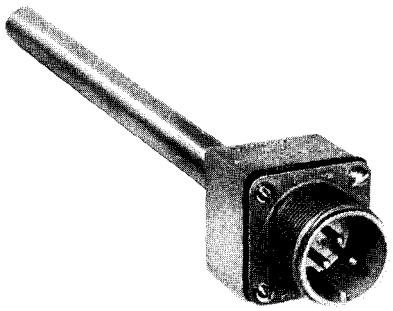


Fig. 4. Winding temperature detector.

sensitive element of either the indicator or detector in this well.

In the case of the detector, its resistance coil readily assumes the temperature of the well and therefore changes resistance in conformance with changes in well temperature. These variations in resistance are interpreted by the remote instrument in terms of degrees centigrade to indicate the heater-well temperature and thus the winding hot-spot temperature.

RESETTING MAXIMUM—READING POINTER

To reset the red pointer on the local thermometer, remove the magnet (No. 3, Fig. 1) from its recess and place it over the magnetic disk mounted on the red pointer. Slowly wipe the magnet to the left across the face of the dial, keeping the magnet and disk aligned. The red pointer will follow the magnet across the dial until it rests against the white indicating pointer. When the magnet is not in use, replace it in the recess and magnetic action will hold it in place.

On the two-switch eye-level device remove the chained cap at the bottom of the case and pull the projecting shaft (No. 2 on Fig. 2) *slowly* until the red pointer rests against the white pointer. Replace the cap immediately to reseal the case.

To reset the pointer on the three-switch eye-level device push the button (No. 2 on Fig. 3) on the bottom of the case until the red pointer rests against the white pointer.

TESTING AND ADJUSTING

To check the operation of an indicator and its switches or the detector and its remote indicator, remove the temperature detecting bulb from the well. Immerse the bulb in a container of liquid along with an accurate centigrade thermometer, heat to a constant temperature, and compare the instrument reading with that of the test thermometer.

INDICATOR

The reading of the indicator and the test thermometer should be within plus 3C minus 1C of one another at any temperature on the dial. Switch operation can be checked by connecting a test light or alarm across the contacts and heating the bulb. Each switch should operate within ± 2C of its setting when compared with the indicator dial.

The instruments are factory calibrated and no changes are recommended. However, the following provisions have been made for making adjustments when necessary.

Local, Two-Switch

Slotted plugs in the top of the indicator case can be removed to provide access to the switch adjusting screws. After making the necessary adjustments, reseal the case using G-E compound A15A11A or Teflon tape on the plug threads. The adjusting screw for Switch No. 1 is on the right, facing the dial, and the Switch No. 2 adjustment is on the left. To raise the temperature setting, turn the No. 1 screw counterclockwise, and the No. 2 screw clockwise. Switch No. 1 can be adjusted through a range of 75C to 90 C and Switch No. 2 from 100C to 125C.

Local, Three-Switch

Access for adjustment is through plugs in the case as with the two-switch instrument. Switches Nos. 1 and 2 have a common adjustment on the right and their settings are raised by turning the screw in a counterclockwise direction. The Switch No. 3 adjustment is on the left and is raised by turning the screw clockwise. Switch No. 1 has an adjustment range of 75C to 85C and Switch No. 2 is fixed at 5C above the setting of Switch No. 1. Switch No. 3 has a range of 100C to 125C and must be set at least 15C above Switch No. 2.

Eye-Level, Two-Switch

Provisions have been made at the rear of the case for adjusting the pointer with relation to the dial.

To change switch settings, the glass face and nameplate must be removed. The set screws can then be loosened to permit adjustment of the switch operating cams on the indicating pointer shaft. Switch No. 1 can be adjusted through a range of 60C to 100C and Switch No. 2 has a range of 95C to 130C. When replacing the glass, be sure the gasket is in place to seal the case.

Eye-Level, Three-Switch

To adjust the pointer with relation to the dial, remove the glass face and nameplate, loosen the set screw at the base of the pointer, rotate the pointer as required, and retighten the screw.

To change the switch settings, move the switch setting indicator (No. 3 on Fig. 3) to a notch above the temperature indicated on the dial at which the switch is to operate. The switch adjustment range extends from 0 to 160C.

When replacing the glass, be sure the gasket is in place to seal the case.

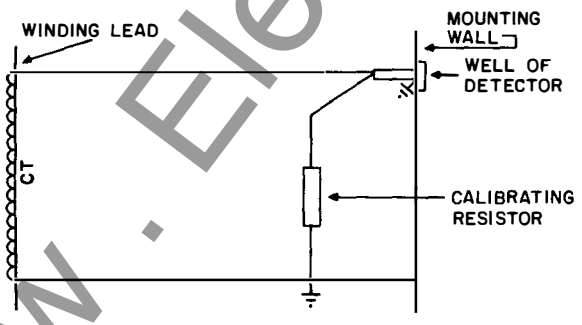


Fig. 5. Elementary diagram for one heater well.

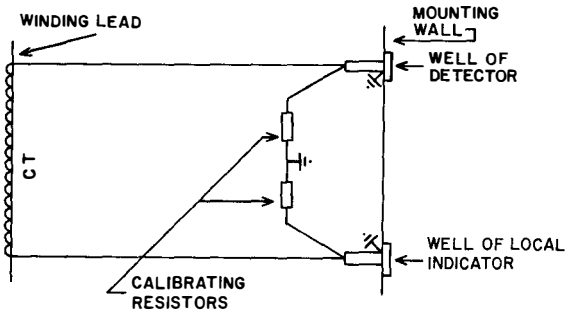


Fig. 6. Elementary diagram for indicator and detector heater wells in series in the same phase.

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ROME, GEORGIA 30161

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CAUTION

THE PYRANOL* INSULATING LIQUID IN THIS TRANSFORMER CONTAINS POLYCHLORINATED BIPHENYLS (PCB'S). CARE SHOULD BE TAKEN TO PREVENT ANY ENTRY INTO THE ENVIROMENT THROUGH SPILLS, LEAKAGE, USE, DISPOSAL, VAPORIZATION OR OTHERWISE.

The information on Pyranol contained in instructions GEI-65074C should be disregarded and instead, the user is referred to instructions GEI-65080B for details on shipping, handling, sampling, testing, filtering, disposing, etc.

* Registered trademark of the General Electric Company

Pyranol® Insulating Liquid

INTRODUCTION

Pyranol insulating liquid is an askarel which has been compounded to General Electric Company specifications and contains polychlorinated biphenyls (PCB's). **Care should be taken to prevent any entry of this material into the environment through spills, leakage, use, disposal, vaporization or otherwise.**

Materials that are unaffected by Pyranol have been selected for use in constructing Pyranol transformers and no substitutes should be made for these materials without the approval of the General Electric Company.

These instructions contain certain excerpts from NEMA Publication No. TR-P6-1973 and/or ANSI standards C107.1 concerning techniques for handling and disposing of askarels and askarel-contaminated materials. For further information on this subject the user is referred to the latest revisions of these publications.

SAFETY PRECAUTIONS

Based on a long period of safe industrial usage, it is generally thought that exposure to Pyranol is relatively harmless to humans. However, it is still recommended that exposure be held to a minimum.

VAPORS

Breathing of concentrated vapors in poorly ventilated areas or of fumes from heated Pyranol should be avoided. High concentrations of vapors can cause irritation of the eyes, nose, throat and upper respiratory tract.

CAUTION - Hydrogen chloride gas is formed when Pyranol is decomposed by an electrical arc. Although a scavenger is added to chemically neutralize any of this gas dissolved in the liquid, some free gas may be present. This gas is an irritant and the inhalation of large quantities can be dangerous and harmful to personnel. The presence of hydrogen chloride gas even in small quantities is readily detectable by its strong odor and irritant action on the nasal membranes. Should anyone be exposed to a quantity of this gas, immediately escort him to fresh air.

If exposure to high concentrations of Pyranol or its arced products is necessary under emergency conditions, an approved gas mask of the organic canister-type or self-contained breathing apparatus must be worn. Such exposure should be under the surveillance of other personnel capable of rescue in case of accident. If the odor of Pyranol or its arced products is detected by the person wearing protective equipment, he should immediately go into fresh air. All gas masks, respirators and replacement parts should have Bureau of Mines approval and be maintained on a regular schedule in accordance with the manufacturer's recommendation.

LIQUID

Unlike mineral insulating oil, there is no fire hazard in handling Pyranol. A limited solvent action (similar to that for paint thinner) on the fats and oils of the skin with prolonged contact may lead to drying and chapping of the skin. As with insulating oil, some people are allergic to Pyranol and continued exposure may result in skin irritation. Both the liquid and vapor are moderately irritating to eye tissue.

Operating procedures should require avoidance of contact with Pyranol. The use of porous gloves which can absorb and retain Pyranol is to be avoided. Resistant gloves and aprons of the neoprene, polyethylene, viton type should be used if contact is unavoidable. In case of spillage on the clothing, the clothing should be removed as soon as practical, the skin washed and the clothing laundered.

Medicinal washes or mild detergents followed by the application of cold cream will reduce the irritation resulting when Pyranol comes in contact with an open cut or abrasion.

Safety glasses with side shields or a face shield should be worn when handling Pyranol. Eyes which have been exposed to the liquid should be irrigated immediately with large quantities of running water for 15 minutes and then examined by a physician if the irritation persists. (A drop of castor oil has been found to reduce irritation.)

Persons developing a skin irritation or respiratory tract irritation while working with Pyranol should be placed under supervision of a physician.

Ingestion or swallowing of Pyranol is not generally regarded as a problem of the industry. Should accidental ingestion occur, a physician should be consulted. Hands should be washed with warm water and soap before eating, drinking, smoking or using toilet facilities.

RECEIVING, HANDLING AND STORING

RECEIVING

Immediately upon receipt of a Pyranol-filled transformer or shipping drums containing Pyranol an examination should be made for leaks. If leakage is evident either at this time or at any time thereafter, the cause should be corrected and the spillage soaked up with absorbent materials such as sawdust or fuller's earth, followed by a clean-up of the affected area with rags soaked with kerosene or other approved solvent such as perchloroethylene or trichloroethylene. All materials used should be collected for proper disposition as described under "Disposal".

HANDLING

On those infrequent occasions when the Pyranol is removed for shipment, the transformer will be shipped gas filled and is to be liquid filled at installation. (Refer to separate installation instructions for filling procedures.) If the transformer is located outdoors, adequate precautions must be taken to insure that no dirt or moisture enters

the Pyranol during the filling operation. Before opening a container of Pyranol allow it to stand until the liquid is at least as warm as the surrounding air.

Before placing the Pyranol in the transformer take a sample from each container and make dielectric test as outlined under "Sampling" and "Testing". If the tests are unsatisfactory, restore the dielectric strength before placing the Pyranol in the transformer. When transferring from containers to the transformer it is recommended that the liquid be passed through a filter press to remove any undetected moisture or sediment which may be present.

Pyranol must be handled in containers, pipes, all-metal hoses, etc., which are free from oil, grease, pitch, or other foreign materials, since these contaminate the liquid and decrease its nonflammable properties. All apparatus used in sampling, filtering, storing, or transporting Pyranol must be maintained for exclusive use with Pyranol, since it is extremely difficult to remove all traces of oil or other Pyranol contaminants from equipment of this type. Also, mineral oil is completely miscible in Pyranol, and it is practically impossible to separate the two liquids after they have been mixed.

All-metal hose must be used in handling Pyranol since rubber and rubber-lined hoses are dissolved by Pyranol. This is also true of synthetic rubber hose.

Use kerosene or other approved solvent to remove all traces of Pyranol on the outside of the transformer tank. This precaution should be taken since Pyranol has a tendency to soften the paint. Examine the external surfaces of the transformer at intervals to see that the paint is unharmed. If places are found where the paint has been attacked, thoroughly clean the surface and repaint with a good grade of durable paint recommended by the General Electric Company. All Pyranol-contaminated materials are to be collected for proper disposition as outlined under "Disposal".

Shipping Notice

Whenever any Pyranol-filled transformer or shipping drum is placed in transit it should be identified with a prominent label containing the following warning or words to this effect:

NOTICE TO CARRIER

CAUTION - YOU ARE HANDLING A TRANSFORMER (OR DRUMS) FILLED WITH PYRANOL INSULATING LIQUID. THIS PRODUCT CONTAINS POLYCHLORINATED BIPHENYLS (PCB'S). CARE SHOULD BE TAKEN TO PREVENT ITS ENTRY INTO THE ENVIRONMENT. IF A SPILL OR LEAK DOES OCCUR NOTIFY THE PROPER FEDERAL AND STATE AGENCIES IMMEDIATELY.

STORAGE

Shipping drums should be stored indoors in an area especially selected for this purpose. A curb should enclose the area to provide a basin for containing the Pyranol from one or more drums should they become damaged. The area must not have a drain which is connected to a sanitary or storm sewer.

If necessary to store drums or cans containing Pyranol outdoors, protect the containers from the weather and direct contact with water. Regardless of location, all drums should be stored in a position which results in the bungs being under a positive pressure. Do not open a drum or can until the Pyranol is actually needed. Any change in temperature while the containers are open will cause an exchange or air with the possibility of moisture entering the Pyranol. Partially emptied drums must be tightly resealed and stored in the same manner as above.

PERIODIC INSPECTION

The insulating liquid must be maintained at the proper level (see nameplate) and for the longest possible service life of the transformer, the dielectric strength of the Pyranol should be maintained at a high value. It is recommended, therefore, that the liquid be sampled and tested after the first few days of operation, again after six months, and yearly thereafter. Keep accurate records of the tests and filter or replace the liquid as indicated.

The entire transformer should also be thoroughly checked for leaks at these same intervals.

SAMPLING

Pyranol samples should be taken in a manner to avoid any contamination of the environment. All rinsings and contaminated materials should be collected in suitable containers for disposition as outlined under "Disposal".

The accuracy of test data can be seriously affected by improper sampling. In order to obtain consistent results it is recommended that the methods outlined in the following paragraphs be observed.

Strict attention should be given to the cleaning and drying of sampling and testing receptacles. Samples should be taken when the insulating liquid is at least as warm as the surrounding air to avoid the possibility of moisture condensation. If the transformer or drum is outdoors, the sample should be taken on a clear day with precautions being taken to guard against contamination by windblown dust, etc. Observe the following procedure to obtain consistent results from samples taken either for field or factory tests.

SAMPLING FROM TRANSFORMERS

1. Impurities which tend to affect the dielectric strength of Pyranol will generally be found at the top and therefore the sampling valve is located on the side of the tank about one inch below the 25C liquid level.

2. Samples should be collected in one quart, small neck, brown glass bottles with foil lined screw caps. If desired, glass sampling bottles may be obtained from the General Electric Company as explained under "Testing Service."

3. To clean the bottles, rinse with non-leaded, oil-free gasoline. Then wash with strong soapsuds, rinse thoroughly with distilled water, and dry in an oven at 105C to 110C for at least 8 hours. After drying, the bottles must be tightly sealed. Store them in a dry, dust-free cabinet or compartment.

4. Carefully clean the sampling valve or plug and allow enough insulating liquid to run out to remove any moisture or foreign matter which may have collected.

5. Rinse the bottle carefully, at least three times, with small portions of liquid drawn from the sampling valve. Allow the sampling bottle to drain thoroughly between rinses.

6. Draw a sample into the bottle, leaving sufficient air space to allow for possible expansion of the liquid. Reseal the transformer and carefully seal the container to prevent exposure to the atmosphere.

7. When making repeated samplings, observe the transformer liquid level and add make-up as required.

SAMPLING FROM DRUMS

1. Drums should remain undisturbed for at least eight hours before being sampled.

2. Glass thieves should be cleaned,

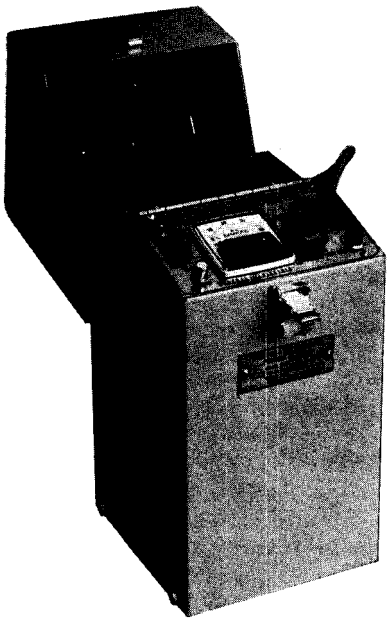

Fig. 1 Typical portable dielectric test set

dried, and stored in the same manner as outlined for bottles.

3. Take the sample from the top of the drum, observing the precautions previously outlined.

TESTING

Field and laboratory test samples, washings, etc., should also be collected for proper disposal. Prior to testing, the sample should be examined visually for the presence of moisture, either in the form of separate droplets or as a cloud dispersed throughout the Pyranol, and for particles of insulation, evidence of carbonization, etc.

DIELECTRIC STRENGTH

A variety of high-voltage dielectric testing equipment may be purchased from the General Electric Company. A typical portable test set (Model No. 9T11Y8454) is shown in Fig. 1 and various console models are also available. Follow the technique specified by the American Society for Testing and Materials, Designation: D877. The following paragraphs give a general outline of the procedure.

1. Set the spacing of the 1-inch diameter electrodes at 0.100-inch.

2. Wipe the test cup and electrodes clean with dry, calendered tissue or clean, dry chamois and thoroughly rinse with non-leaded, oil-free, dry gasoline.

3. Fill the test cup with dry gasoline and make a breakdown test under standard conditions of voltage application (3kV per second rise). If the cup has a dieleetric strength above 25 kV, it is considered suitable for testing purposes. Observe the usual precautions in handling gasoline.

4. Immediately after the final rinsing with gasoline, rinse the test cup with the sample under investigation, and proceed with the test at once.

5. The temperature of the sample when tested should be the same as that of the room, which should be between 20 C and 30 C (68 F and 86 F). Tests made on samples above this temperature can be misleading. Under no circumstances should the test cup be colder than the sample being tested.

6. Agitate the sample gently before each filling to prevent variations in results due to a settling of contaminants. Pour the liquid into the receptacle slowly to avoid the formation of air bubbles and fill to overflowing. If air bubbles are present, gently rock the test cup a few times and wait at least 3 minutes before applying voltage.

7. Fill the cup at least five times, making one test per filling, and average the results.

Since the Pyranol is a major portion of the insulation system in the transformer, its dielectric strength should be maintained as high as possible. A low breakdown voltage is an indication that impurities such as mositure, conducting dust, lint, or carbonized particles have entered the liquid. Pyranol testing lower than 26kV (30 kV when new) should either be filtered to bring it back to its original condition or be replaced, depending on the condition of the liquid and economic considerations. Under normal operating conditions values of 30 kV and above can be maintained.

FIELD TEST FOR MOISTURE CONTENT

The following field test can be used to detect the presence of excessive amounts of moisture in the insulating liquid:

1. Obtain a sample of the insulating liquid when the transformer is at operating temperature. (Preferably above 40 C.)

2. Starting with the hot sample, rinse a clean, dry test tube with the liquid to be tested, fill half full and stir continuously with a centigrade thermometer while cooling to approximately 20 C. Cool as much as possible in the ambient air and complete the cooling by momentarily dipping the test tube in an ice bath, removing and stirring and then redipping, etc.

3. Observe the sample carefully and note the temperature at which initial cloudiness appears. Wipe the outside of the tube with a clean rag or paper towel to facilitate observation of the slight moisture cloud that may form. Compare to clean insulating liquid at ambient temperature in a similar tube if necessary. Examination for the presence of a cloud should preferably be made against a dark background and not directly into the sunlight.

4. If cloudiness appears at 20 C or above, high to excessive moisture content is indicated.

   A. Inspect the unit for free water on the surface of the Pyranol.

   B. If free water is not present, a sample should be forwarded to the Laboratory for a quantitative analysis and recommendations on treatment of the unit. See "Testing Service."

5. If cloudiness does not appear until the temperature is below 20 C, an acceptable moisture content range is indicated.

6. This field test for moisture should be regarded as a rough test only and if there is any reason to question the condition of the insulating liquid, a sample should be sent to a laboratory for an accurate analysis.

TESTING SERVICE

Where suitable equipment and qualified personnel are not available for conducting the necessary tests, the user may wish to avail himself of the following testing service offered by the General Electric Company. This service includes preparation of the sample bottle, laboratory analysis, report of test results and recommendations on continued use or treatment.

Upon receipt of an order through one of its apparatus Sales Offices, the Company will furnish the required one-quart sample bottles. These will be cleaned and dried at the factory and to insure dryness will be shipped containing a small desiccant which is to be discarded prior to sampling. Since reliable tests are dependent upon reliable samples, the sampling procedures described under "Sampline" **and on the bottle itself** should be carefully observed.

Return sample containers to the Laboratory, Medium Transformer Pro-

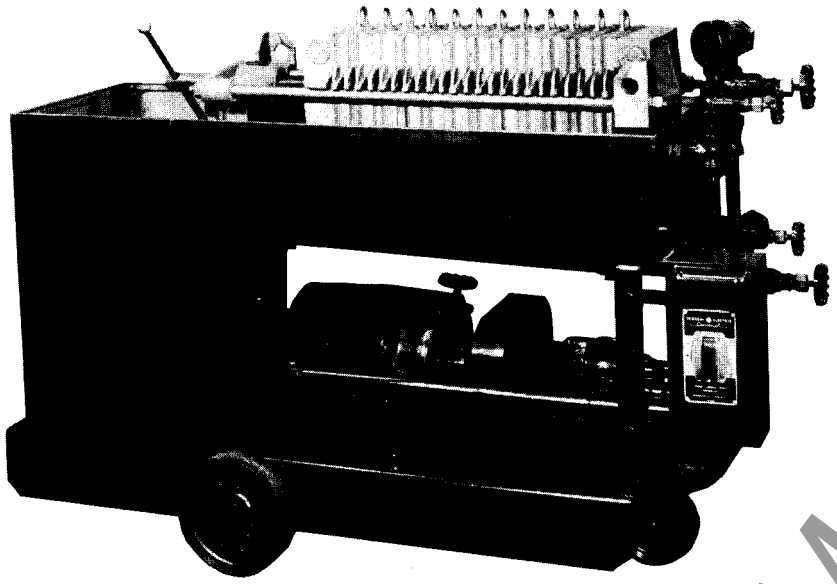

Fig. 2 Typical Pyranol purifier

ducts Department, General Electric Company, Rome, Georgia 30161. Pack these samples carefully to avoid breakage in transit. Recommendations for continued use or treatment will be furnished based on the following tests conducted in accordance with the indicated ASTM methods.

1. Dielectric strength, D877
2. Acidity, D974
3. Water content, D1533
4. Color, D2129
5. Condition (Visual), D1702
6. Scavenger content (when requested), D1701

Be sure to answer the questions on the sample bottle label. This information is essential if conclusions or recommendations are to be made concerning the sample. For further information concerning specific problems, consult the nearest apparatus Sales Office of the General Electric Company. If the Pyranol in question is known to be highly contaminated, transactions concerning sampling, testing, returning for reclamation or credit, etc., should be handled directly with the Monsanto Chemical Co., St. Louis, Missouri.

FILTERING

If test results indicate that moisture or other contaminants are present, they can usually be removed by passing the insulating liquid throuh a Pyranol purifier (Fig. 2). This device may be used either as a paper filter press for drying or with fuller's earth and paper for purifying. For details of the filtering procedure refer to instructions GEH-1031, copies of which are available upon request. For information on drying and filtering equipment contact the nearest apparatus Sales Office of the General Electric Company.

When filtering or conditioning Pyranol, all of the precautions previously described for handling and disposal also apply to the filter papers, fuller's earth, etc. involved in this operation. See "Disposal".

Filtration can be accomplished in the transformer or other container by circulating the Pyranol from the top to the bottom through a filter press. However, this method is quite slow since the filtered Pyranol is continuously being mixed with the unfiltered. Filtering can be done faster and more efficiently by passing the liquid from the transformer, through the filter and into a separate, clean, dry container and then back through the filter again to refill the transformer. In this manner all of the Pyranol will be given two complete passes through the filter press. If additional filtering is still required, the entire procedure can be repeated.

The filter press will not remove large quantities of free water from the Pyranol. When a large quantity of free water is introduced into the filter it will be passed on through, emerging as finely divided droplets dispersed throughout the Pyranol. Therefore, if free water is present it should be removed before filtering is started. As moisture is extracted from the Pyranol during the drying process, the filtering medium will become wet. Frequent samples of the outgoing Pyranol should be tested to determine when the filtering medium should be replaced.

NOTE - A scavenger has been added to the Pyranol to chemically neutralize any hydrogen chloride gas which may be absorbed by the liquid as a result of arcing. A portion of this scavenger may be lost during filtering operations, especially if the Pyranol is passed through fuller's earth. A test should therefore be made following filtering to determine how much of the scavenger has been lost and the quantity required to restore the Pyranol to its original condition. Laboratory testing facilities are available through the General Electric Company as outlined under "Testing Service."

A transformer contaminated with moisture may not only have moisture suspended in the insulating liquid, but may also have it in the windings and insulation. The most efficient temperature for filtering moisture from the Pyranol is between 20 C and 40 C, but at this temperature the transfer of moisture from the windings and insulation to the insulating liquid is quite slow.

If the dielectric strength of the Pyranol is still below 30 kV after filtering, consult the nearest apparatus Sales Office of the General Electric Company for additional information including possible recommendations on drying the entire transformer.

DISPOSAL

Disposal of Pyranol and Pyranol-soaked materials should be accomplished by means in which there is no significant release of Pyranol to the environment. Methods employed for this purpose include incineration of liquids and soaked software under carefully controlled conditions at very high temperatures and by controlled landfill burial of apparatus and other hardware. A number of commercial firms have established Pyranol disposal facilities of this type as indicated under "Disposal Services".

The ultimate disposal of a Pyranol-filled transformer may be accomplished by draining the Pyranol and then thoroughly flushing the interior with kerosene or other approved solvent such as perchloroethylene or trichloroethylene. After removal of the PCB's in this manner the transformer is to be dismantled with the burnable solids such as wood, cellulosic insulation, gaskets, etc. being set aside for proper disposal along with the accumulation of all liquids, washings, soaked rags, etc. The remaining metallic components

can then be handled as normal scrap.

Shipping drums should likewise be drained and flushed before being handled as normal scrap.

DISPOSAL SERVICES

In addition to the supervised dry landfill sites which may be used for the disposal of Pyranol-contaminated scrap, the following organizations may be contacted concerning use of their incineration and/or landfill facilities. These firms offer a variety of services at a number of locations and therefore it is generally advisable to make several inquiries in order to determine which is best suited to handle a particular disposal problem. Specific disposal procedures, shipping instructions and cost should be discussed. Other firms may also offer suitable facilities from time to time so additional inquiries may be in order. If preferred, any of the General Electric Company Apparatus Service Shops may be contacted to serve as an intermediary. Known home officies and phone numbers include:

Chem-Trol Polution Services, Inc.
4818 Lake Avenue
Blasdell, New York 14219
716*826-5850

Monsanto Company
800 N. Lindbergh Blvd.
St. Louis, Missouri 63166
314*694-3352

Nuclear Engineering Company
P. O. Box 146
Morehead, Kentucky 40351
606*784-6611

Rollins-Purle, Inc.
P. O. Box 3349
Wilmington, Delaware 19899
302*478-5150

MEDIUM TRANSFORMER PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
ROME, GEORGIA 30161

GENERAL ELECTRIC

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PRESSURE RELIEF DEVICE

The mechanical self-resetting pressure relief device is used on transformers to protect the tank against excessive and dangerous pressures which may build up inside the transformer tank. When a predetermined pressure is exceeded, the force of the pressure build-up lifts the diaphragm and vents the tank. The pressure relief device is normally mounted on top of the transformer either on the main cover or on a manhole cover. It is occasionally used on associated liquid-filled compartments.

DESCRIPTION

The pressure relief device consists of a dome-shaped stainless steel diaphragm held in place by compression springs, suitable gaskets, a protective hood, and a lightweight plastic pin which gives visual indication that the unit has operated. See Fig. 1.

OPERATION

When the force of the pressure build-up within the tank against the stainless diaphragm in the pressure relief device exceeds the force of the compression springs, the diaphragm lifts slightly and gas is exhausted through the space between the diaphragm and the lower casting. The tank pressure then spreads over the entire diaphragm area, causing the device to open rapidly and remain open until the pressure within the tank falls well below the tripping pressure. Then the diaphragm reseats and seals the tank to prevent entrance of moisture or foreign material.

As the diaphragm rises during operation it lifts and brings into view a color-coded plastic pin located in the center of the cover. This indicates that the relief device has operated. This pin will remain visible until reset manually by being pushed down flush with the top of the pressure relief cover. The pin is yellow for oil-filled units and red for Pyranol® filled units.

The pressure at which the relief is set to operate is determined by the operating pressure of the transformer tank. The tank operating pressure is shown on the transformer nameplate and is also embossed on the relief device. Tanks operating up to 5 psi have reliefs set at approximately 8 psi, and 7.5 psi tanks have their reliefs set at approximately 11.5 psi.

GAS ABSORBERS AND VENT PIPES

If a Pyranol® filled transformer is located in a poorly ventilated indoor area, provisions should be made either to absorb or to carry off any discharged gases. Refer to the National Electric Code for regulations pertaining to the indoor installation of Pyranol® filled transformers.

Gas absorbers are designed for mounting directly on top of the pressure relief. Instructions for installing and filling the absorber are furnished with that device.

A special adapter flange with gasket and reducer, is available upon request for connecting a vent pipe to the relief device. See Fig. 2. If the vent pipe adapter flange is ordered with the transformer, the bolt circle shown in Fig. 2 is furnished. If the vent pipe adapter is not furnished with the transformer and added as a supply part, studs will have to be added to the cover to give bolt circle shown. Order vent pipe adapter by drawing number 112A4035 G4 through nearest Apparatus Sales Office of the General Electric Company.

CAUTION

Painting. If pressure relief device is painted in the field, care must be taken that paint is kept away from the space between diaphragm and flange, and away from the indicator bushing.

Disassembly. Should it be necessary to disassemble the pressure relief device, caution must be exercised when removing the protective cover because the springs are under compression. If the device is mounted on the transformer, the internal tank pressure is also acting on the diaphragm. Bleed the pressure out of the tank before removing the pressure relief device.

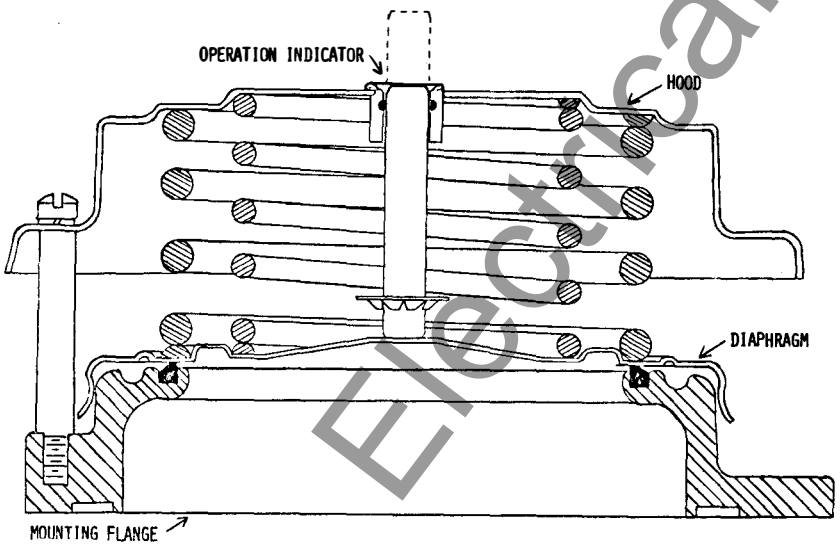


FIG. 1. PRESSURE RELIEF DEVICE

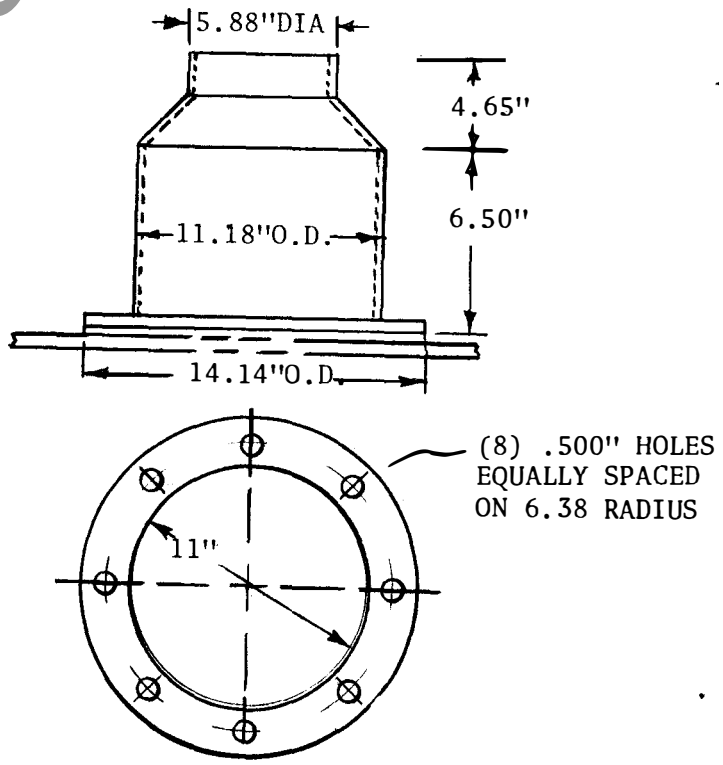


FIG. 2. VENT PIPE ADAPTER

Fusible Air-Interrupter Switch Equipment

INTRODUCTION

Fusible air-interrupter switch equipment, Fig. 1, is available in nominal voltage ratings of 4.8 and 13.8 kV and provides an economical method of protecting and switching medium voltage circuits on systems rated 2.4 through 13.8 kV. For short circuit protection the air-interrupter switch mechanism can be placed in series with either expulsion or high-speed, current-limiting power fuses, according to circuit requirements.

RECEIVING, HANDLING AND STORING

RECEIVING

Immediately upon receipt, make a thorough inspection for any damage sustained while en route. This should preferably be done before unloading and if damage or rough handling is evident, file a claim with the transportation company promptly and notify the nearest Apparatus Sales Office of the General Electric Company.

All parts shipped separately are tagged with an identification number and are listed accordingly on the packing slip enclosed in one of the boxes. To avoid the loss of small parts when unpacking, the contents of each case should be carefully checked against the packing slip before discarding the packing material.

HANDLING

Removable lifting plates are provided on top of the compartment for convenience in handling with a crane. A spreader bar should be used to obtain a vertical pull on these lifting plates. If crane facilities are not available, the equipment can be moved into position using rollers under the base. Make sure the base remains fully supported by the rollers.

STORING

If it becomes necessary to place the equipment in storage, the following precautions should be taken to prevent corrosion:

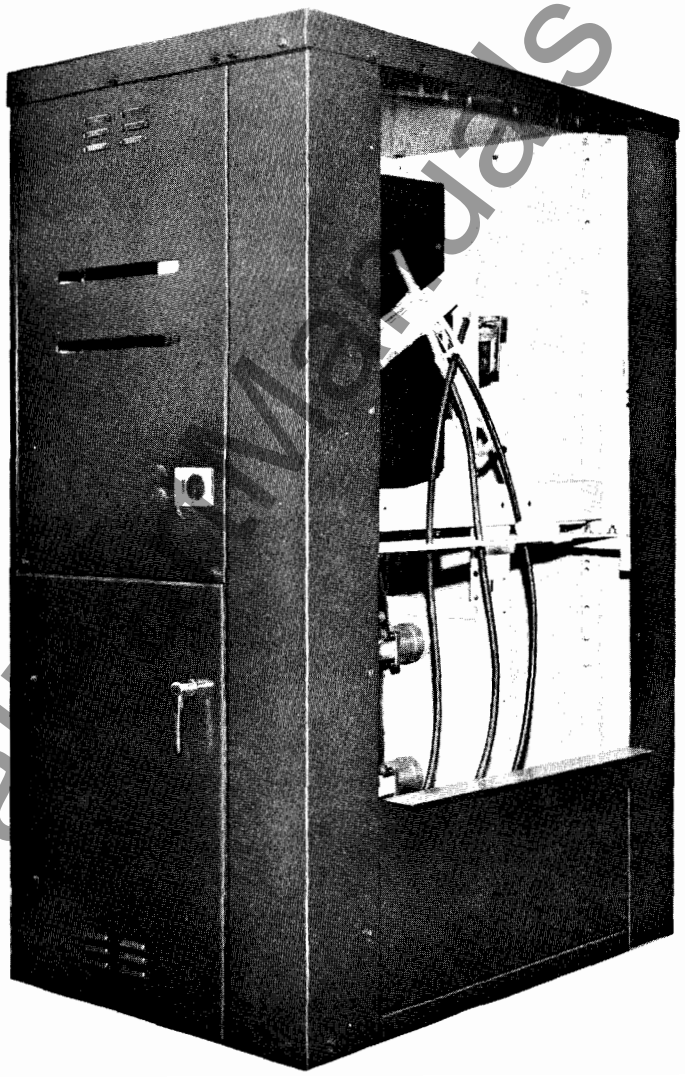


Fig. 1. Typical fusible air-interrupter switch equipment

1. Unpack the equipment.

2. Coat all gears and moving machine-finished parts with a heavy oil or grease.

3. Store in a clean, dry place with a moderate temperature and cover with a suitable canvas to prevent deposit of dirt or other foreign substances upon movable parts and electrical contact surfaces.

4. If dampness or condensation is expected, it is recommended that a heater be placed inside the unit. On outdoor units this may readily be accomplished by isolating the heater already installed and connecting it to a temporary power supply. CAUTION—Move all cartons and other packing materials away from the heater before energizing.

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

GENERAL ELECTRIC

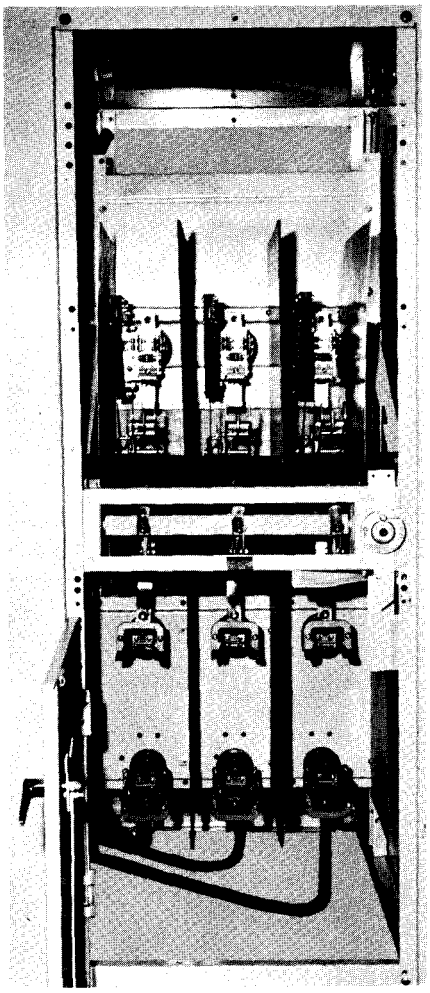


Fig. 2. Fuse compartment located below switch

DESCRIPTION

Switch compartments are designed for indoor or outdoor service with provisions for incoming lines to enter from above or below, using either potheads or clamp-type terminals. Two windows are provided on the upper front cover of switch units so that a flashlight can be used to observe the position of the switch without a reflecting glare in the operator's eyes. Simple instrumentation may also be furnished upon request.

When fuses are furnished, they are located in the lower half of the compartment and access is provided by means of a hinged door as shown in Fig. 2. A mechanical interlock between this door and the air-interrupter switch serves to prevent access to the fuses while the switch is closed. Once the fuse compartment door has been opened, the interlock will also prevent closing of the switch until the door is reclosed. Fig. 3 shows the interlock linkage and also the switch position indicator which is normally visible through the escutcheon on the switch compartment door.

AIR-INTERRUPTER SWITCH

The air-interrupter switch furnished with this equipment is a three-pole, two-position (OPEN-CLOSED) disconnecting switch with an integral interrupter capable of breaking load currents within its rating. It is operated by means of a removable handle inserted through an opening on the front of the switch compartment and in the OPEN position, provides a visible air break in the primary circuit. See Fig. 4A. For a complete description of the switch and its operating characteristics, refer to separate instructions furnished for the switch.

AIR-INTERRUPTER/SELECTOR SWITCH

The air-interrupter/selector switch consists of a two-position (OPEN-CLOSED) air-interrupter switch in series with a two-position (LINE 1/LINE 2) selector switch. See Fig. 4B. The selector switch is a dead-break device and is mechanically interlocked so that it cannot be operated unless the interrupter switch is OPEN.

The switch is applied where there are two separate incoming lines and provides three positions (LINE 1/OPEN/LINE 2), allowing the operator to switch from one incoming line to the other in case of a failure of a primary feed, or to OPEN for planned maintenance.

DOUBLE AIR-INTERRUPTER SWITCH

The double air-interrupter switch consists of a pair of two-position (OPEN-CLOSED) air-interrupter switches connected in parallel on the load side (see Fig. 4C) and key-interlocked to prevent both switches from being CLOSED at the same time. The double switch can be furnished as an alternate to the selector switch and has the advantage of separate compartments for each incoming line, thus permitting maintenance of one line while the other is energized and reducing the probability of transfer of a fault on one cable to the other.

INSTALLATION

FOUNDATION

In locating the equipment, consideration should be given to the front and rear aisle space requirements as indicated on the Outline drawing. The space at the front must be sufficient to permit the opening of doors and at the rear space is needed for removing covers, installation of cables, inspection, and maintenance. Check local codes for special aisle space requirements.

The foundation or support must be level and strong enough to carry the weight of the transformer and switch equipment without sagging. If the foundation is subject to vibrations, special mountings should be provided to reduce or eliminate transmission of vibrations to the equipment. Switch equipment is furnished with built-in channels, eliminating the need for floor channels when mounted on a smooth, level floor.

ASSEMBLY

After the transformer has been set in position on the foundation, move the switch equipment into place and bolt to the transformer, using the sponge rubber gasket when supplied. Refer to the transformer instructions for the procedures to use in making gasketed weatherproof joints.

Remove any shipping bracing. Remove the temporary lifting plates from the front and rear of the switch compartment and store for possible future movement of the equipment. Anchor the compartment to the foundation using bolts and clips as shown on the Outline and other drawings. On outdoor units, the floor plates can be removed to permit installation of the anchor bolts.

CONNECTIONS

Connect the strip heaters, if furnished, as shown on the Connection Diagram, and complete any other control or instrument wiring as required. Before incoming primary line connections are made, the cables should be identified to indicate their phase relationship with respect to the switch connections. This is necessary in order to insure that motors will rotate in the proper direction and in the case of two incoming lines, that the phase rotation will remain the same when switching from one to the other.

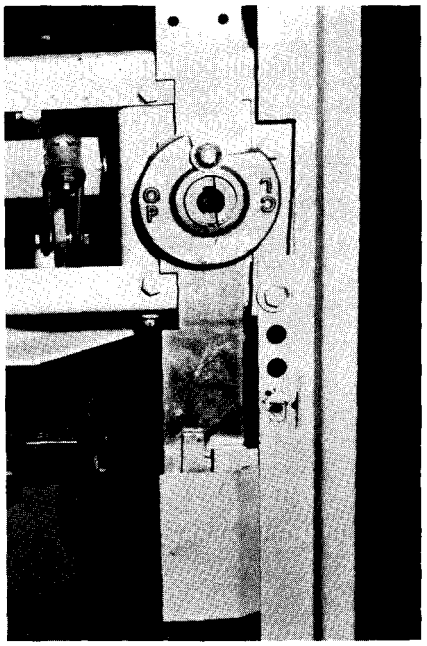
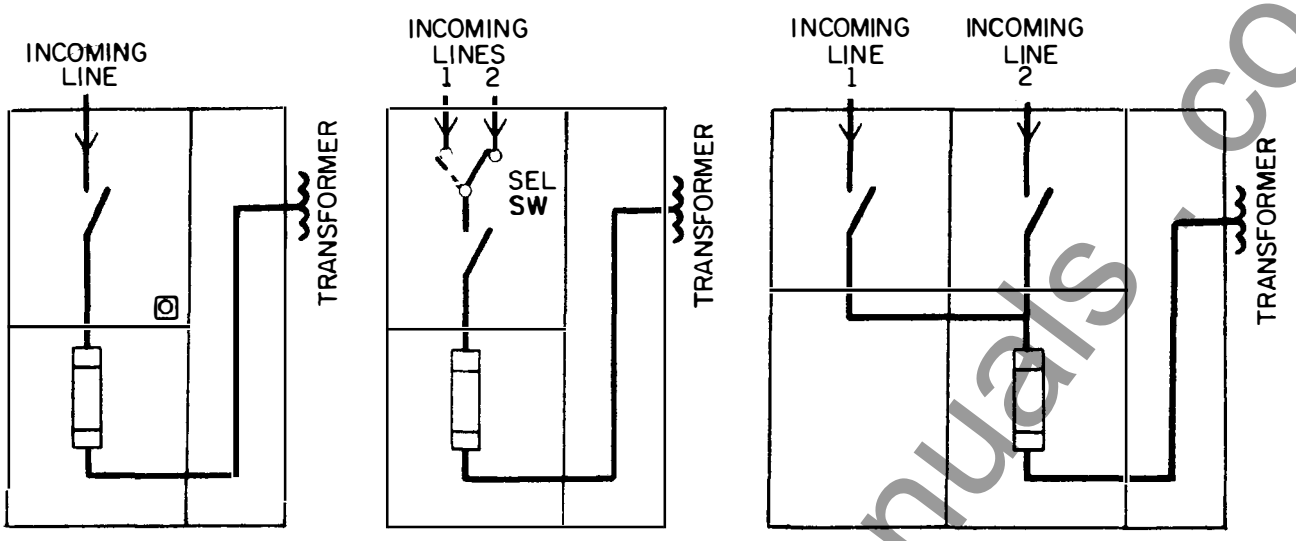


Fig. 3. Fuse compartment interlock and position indicator



A. Air-Interrupter Switch

B. Air-Interrupter Switch with Selector Switch

C. Double Air-Interrupter Switch

Fig. 4. One-line compartment elementary diagrams

Cable connections are normally made using either clamp-type terminals or potheads. Potheads serve to protect the cable ends against the contaminating effects of weather, entrance of moisture and leakage of impregnating oil, and their insulating compounds improve the electrical characteristics of the joint.

Stress relief cones are normally required on all shielded cables, both in potheads and on bare cables terminated without potheads. On lower voltage cable, belling out the end of the lead sheath will ordinarily provide sufficient stress relief. In all cases, carefully follow the instructions furnished with the pothead and by the cable manufacturer for actual installation details such as minimum cable bending radius, stress cone application requirements and dimensions, etc.

INSPECTION AND TESTING

Make a final inspection to see that there are no tools, construction materials or other foreign objects left in the switch compartment. Although the equipment has been tested at the factory, a final field test should be made to be sure that the switch has been properly installed and that the connections are correct. The primary equipment must be completely de-energized while the tests are being made.

The extent of the tests performed will depend on the nature of the installation and the requirements of the user but in general should include at least phasing and grounding tests plus an operational check of the air-interrupter switch as outlined in the switch instructions. If desired a high potential test at not over 75% of the voltage set by industry standards for factory testing can be made to check the integrity of the insulation system.

Interlocks

After initial installation of the switch equipment, all necessary interlock keys should be inserted into the appropriate locks and all spare keys should be placed in the hands of a responsible person. This precaution is necessary since improper use of spare keys will defeat the purpose of the interlock system. When provided, also make an examination of the mechanical interlock between the fuse compartment door and interrupter switch to see that it functions as outlined under "Description."

MAINTENANCE

CAUTION — De-energize the equipment before removing any panel or opening any door which provides access to the high-voltage components.

WARNING — In order to complete the insulation system within the compartment, a certain amount of air gap is normally required in addition to the solid insulation on the conductors. *Therefore, do not rely upon the solid insulation to provide adequate protection to personnel.* Inserting a tool or part of the body in this space when the circuit is energized may cause a breakdown of the insulation system and produce serious personal injury and/or damage to the equipment.

A regular maintenance schedule should be established to obtain the best service and reliability from the switch equipment. The actual frequency of inspection should be adjusted for each application according to the importance of continuity of service and as experience dictates. For specific information regarding maintenance of the switch, lightning arresters, meters, etc., refer to the instructions furnished for each device.

A permanent record of all maintenance work should be kept for future reference. It is recommended that the record include reports of tests made, the condition of equipment and repairs and adjustments that were made. The switch equipment and connections should be given the following overall maintenance at least annually:

1. Thoroughly clean the interior of the compartment, using a vacuum cleaner and clean rags only. Do not use steel wool or oxide papers.

2. Inspect cables for evidence of overheating and check connections to see that they are tight.

3. Check any control wiring and see that all heaters are working properly.

4. Check mechanical and key interlocks.

RENEWAL AND SUPPLY PARTS

Orders for renewal or supply parts should be placed with the nearest Apparatus Sales Office of the General Electric Company. Specify the quantity required and give the catalog or drawing number along with part numbers whenever possible. When requesting information or ordering parts, always include the serial number appearing on the transformer nameplate.

MEDIUM TRANSFORMER PRODUCTS DEPARTMENT

GENERAL ELECTRIC COMPANY

ROME, GEORGIA 30161

GENERAL ELECTRIC

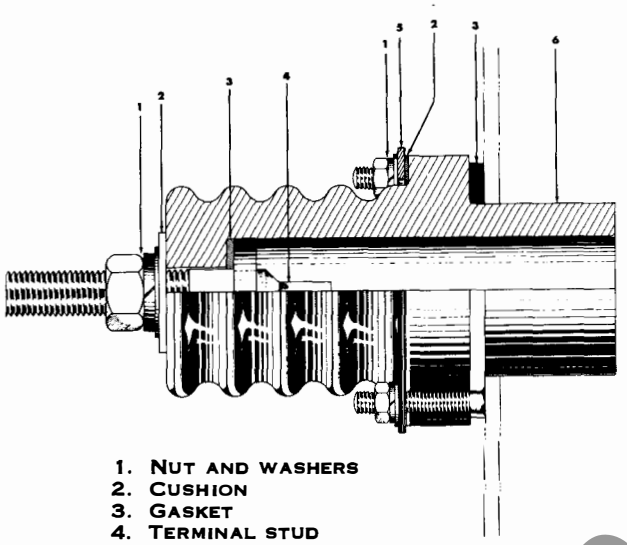
3-70 (1M)

PRINTED IN U.S.A.

INSTRUCTIONS

GEI-54043

SIDEWALL BUSHINGS



1. NUT AND WASHERS
2. CUSHION
3. GASKET
4. TERMINAL STUD
5. CLAMP
6. PORCELAIN

Fig. 1. Detachable-cable type bushing

GENERAL

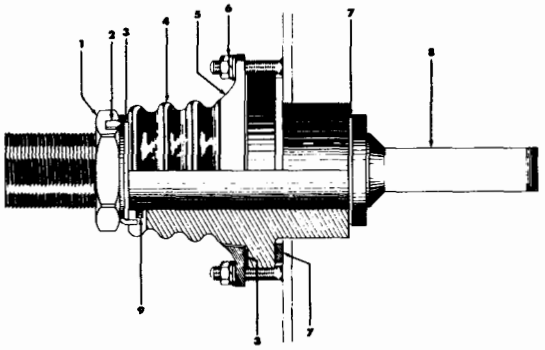
Porcelain is used as the major insulation in sidewall bushings and upon receipt, an inspection should be made for chips and cracks. If there is evidence of damage or rough handling, file a claim with the transportation company promptly and notify the nearest Apparatus Sales Office of the General Electric Company. If it becomes necessary to replace a porcelain, the change can be made externally after the liquid level has been lowered below the bushing.

DETACHABLE-CABLE TYPE

To remove the porcelain on a detachable-cable bushing as shown in Fig. 1, remove nuts and washers (1), cushion (2) and clamp (5). The porcelain (6) can then be removed and stud (4) will remain attached to the transformer leads from inside the tank. When installing a new porcelain, use new cushions (2) and gaskets (3).

STUD TYPE

To replace the porcelain on a stud type bushing as shown in Fig. 2, bend locking collar (2) back and remove it along with nut (1) and the adjacent cushion (3). Pull out pin (9) by inserting a hooked wire in the end and then remove nut and washers (6) and clamp (5). Porcelain (4) can then be removed, leaving stud (8) attached to the winding leads. Replace cushions (3) and gaskets (7) when installing a new porcelain.



1. HEX-HEAD NUT
2. LOCKING COLLAR
3. CUSHION
4. PORCELAIN
5. CLAMP
6. NUT AND WASHERS
7. GASKET
8. TERMINAL STUD
9. PIN

Fig. 2. Stud type bushing

MEDIUM TRANSFORMER PRODUCTS DEPARTMENT

GENERAL ELECTRIC

ROME, GEORGIA

4-63 (1M)

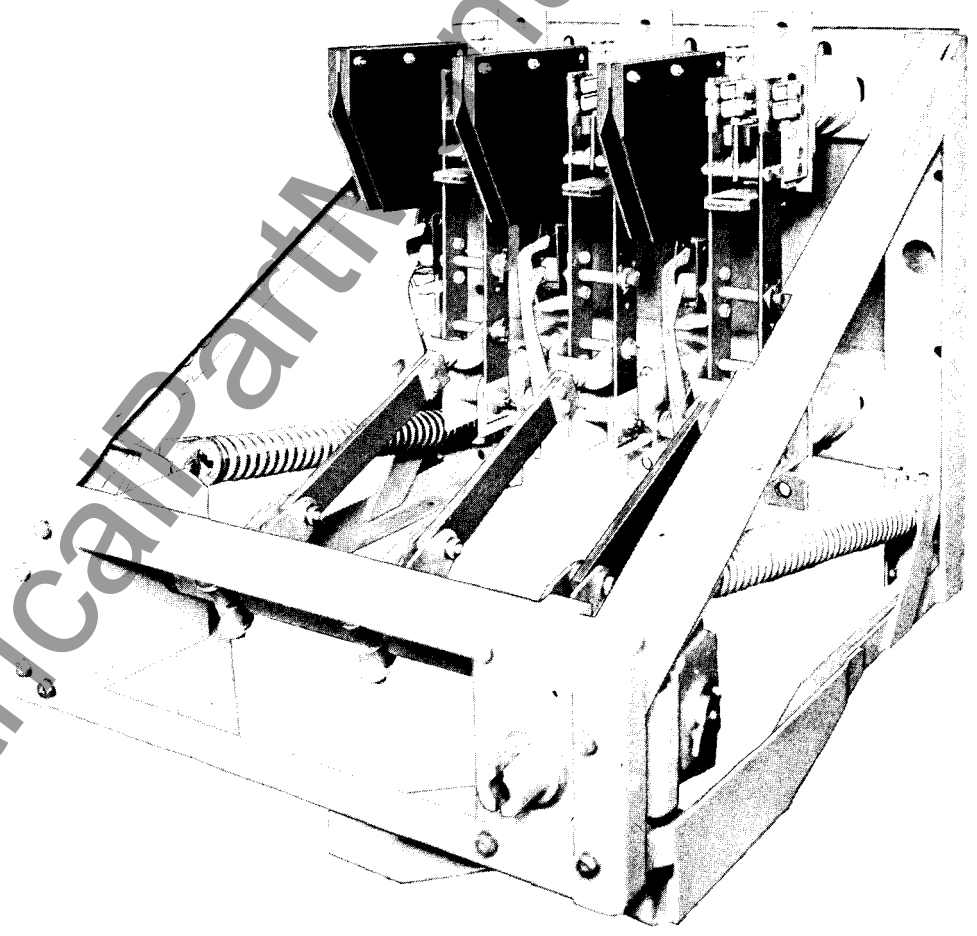
PRINTED IN U.S.A.

INSTRUCTIONS
AND
RENEWAL PARTS

GEI-88767D
Supersedes GEI-88767C

LOAD BREAK SWITCH

SE-100E
SE-100M
SE-100S



CONTENTS

SWITCHGEAR PRODUCTS DEPARTMENT

GENERAL ELECTRIC

PHILADELPHIA, PA.

LOAD BREAK SWITCH

TYPE SE-100

INTRODUCTION

The type SE-100 Load Break Switch is manually or electrically operated, triple pole disconnecting switch with an integral interrupter that has capability of interrupting transformer magnetizing and load currents within its rating.

The SE-100S has a manually charged, spring stored energy operating mechanism capable of closing the switch against maximum rated short circuited current.

The SE-100E has an electrically charged, spring stored energy operating mechanism with the same closing capabilities as the SE-100S.

The SE-100M is a manually closed and opened switch with load break abilities as indicated on the nameplate.

Refer to the nameplate for complete ratings of any particular switch. Do not apply the switch for any duty where voltage or current levels are greater than those given on the nameplate. The chart below gives the ratings for the basic switches.

SE-100 Switch Ratings

	Nominal Voltage KV	Max. Design Voltage KV	BIL KV	Continuous Current Amps	Load Break Current Amps	Close & Latch Current Amps	Momentary Current KA
SE-100E SE-100S	4.8	5.5	60	600	600	40,000	40
	4.8	5.5	60	1200	1200	61,000	61
	13.2	15.5	95	600	600	40,000	40
	13.2	15.5	95	1200	600	61,000	61
SE-100M	4.8	5.5	60	600	400	400	40
	13.2	15.5	95	600	100	100	40

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, operating 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.

The switch is normally furnished with outside and interphase insulating barriers in a metal-enclosed housing for connection either directly to

the incoming side of a power transformer, the primary bus, or to cables by the use of potheads. When applied with power fuses, the combination serves as a successful switching and fault protection device.

Operation of the switch is accomplished by manual rotation of a handle through an arc of 180°. The SE-100S switch has a positive closing and opening operation supplied from the stored energy of springs. The SE-100M handle must be operated manually with a full positive motion to assure proper closing and opening with the direct drive mechanism. The operating handle is often interlocked with other devices such as secondary circuit breakers in order to assure sequential operation.

The SE-100E switch is normally operated by energizing an integral electric motor that charges the springs for positive closing and opening similar to the handle of the SE-100S. The switch can be quickly converted from electrical to manual operation with a handle for normal maintenance or emergency use.

The interrupting ability of the switch is accomplished by the use of an arc chute type interrupter (5) Fig. 4 and an auxiliary blade (3). When the switch is opened the auxiliary blade contacts (2 & 3) are the last to part and will initiate an arc in the chute. The hot arc releases gases from the plastic chute in such volume that the arc is blown away from the rapidly moving auxiliary blade and cooled by contact with the large area of the chute sides. After the arc has been extinguished, the blade will continue to open producing a sufficient air gap to isolate the terminals.

RECEIVING, HANDLING, AND STORAGE

Receiving and Handling

Immediately upon receipt of the switch, an examination should be made for loss or damage sustained in transit. If injury or rough handling is evident, a damage claim should be filed immediately with the transportation company and the nearest General Electric Apparatus Sales Office should be notified.

Although damage due to handling is minimized because of the metal enclosure, it is expected that due care will be exercised in the unpacking and installation of the switch unit so that no damage will occur from careless or rough handling, or from exposure to moisture or dirt. Care should be exercised to prevent tools from striking any part of the housing or switch itself.

Loose parts associated with the switch are always included in the same crate. Check all parts against the packing list to be sure that no parts have been overlooked.

Storage

It is recommended that the switch be placed into service immediately in its permanent location. If this is not possible, the following precautions should be taken to insure proper storage conditions:

1. The switch should be stored in a warm dry location to protect the insulation parts from condensation.

2. The switch should be stored in a clean location free from corrosive gases or fumes. Particular care should be taken to protect the equipment from moisture and cement dust, as this combination has a very corrosive effect on many parts.

3. Machined parts of the operating mechanism should be coated with a heavy oil or grease to prevent rusting.

If the switch is stored for long periods of time, periodic inspections should be made to insure that corrosion of metallic parts or deterioration of insulation parts has not begun. Should the switch be stored under unfavorable conditions, steps should be taken to dry out or replace insulation parts before placing in service.

INSTALLATION

Mounting

The switch must be mounted in the housing by supporting at both the front and rear. Care should be taken not to distort the frame by mounting on unflat or out-of-square surfaces as twisting may cause misalignment of the contacts. If necessary, shims should be used to prevent twisting.

Connection

The connections on the 600 ampere switch may be made from above or below the insulator support. The 1200 ampere switch must have the upper connections above the upper insulator support and the lower connection below the hinge support insulator. Connection of bus bars to this terminal can easily be made using the provided terminal bolts. After connections to the switch have been made, the switch alignment should be checked as listed below.

When furnished as a complete housing, the connections directly to the switch have been made at the factory. On these units, connections are made using the provided potheads, cable terminal connectors, etc.

Switch Alignment

Prior to placing the switch in service the following adjustments and alignment checks should be made to insure proper operation.

1. Before operating the SE-100E or SE-100S switch with the normal spring load, a slow closing of the blades should be made to check alignment. The power springs should be blocked as described under Spring Blocking and the three poles of the switch operated slowly by the maintenance handle to assure freedom of motion and to check alignment. A slow closing operation can be made on the SE-100M switch with the normal operating handle.

2. Check all items listed under Adjustments before the switch is put in operation and during each period of maintenance.

DESCRIPTION OF OPERATION SE-100E AND SE-100S

On the SE-100E and SE-100S switches both the closing and opening operation is accomplished by the spring-charged mechanism (6) Fig. 1 located on the front of the switch assembly. The mechanism is manually or electrically charged but is completely disengaged from the operating handle as it begins to operate the switch. In this way the actual operation of the switch is independent of the operator.

When operating either switch manually, the handle should be rotated with a positive motion throughout its entire stroke.

Closing Operation

Closing the SE-100S switch, and the SE-100E switch set for manual operation, is accomplished by inserting the operating handle (1) Fig. 3 into the handle socket provided in the operating hub (7) Fig. 1 in the enclosure and rotating in a counterclokwise direction as far as possible (approximately 180 degrees).

After a few degrees of handle rotation, the mechanism will engage the primary spring (4) Fig. 1 located on the right side and compress it fully. Continued rotation of the handle will push the spring over the toggle position and it will start to discharge. A driving lug (5) Fig. 2 will engage the drive crank (3), which is directly connected to the main crank shaft (11) Fig. 2, just as the primary spring leaves the toggle position. When the main crank shaft has rotated a few degrees, the fully charged booster spring, located on the left side, (5) Fig. 1 will pass its toggle position and the full energy of both springs will close the switch with sufficient force to close and latch against the current rating on the nameplate.

During the closing operation the auxiliary blade will be held out of the chute until just before the arcing contacts (6) Fig. 7 are engaged, then it is released to enter the chute and latch into the arc chute contacts (2) Fig. 4. This sequence of operations will prevent prestrike in the interrupting area of the arc chute.

At any time during the operation, until the primary spring reaches its toggle position, the handle can be returned to its starting position and removed. The mechanism will completely reset to the starting position.

The SE-100E switch is normally electrically operated by energizing a motor (2) Fig. 10. An internal gear driving mechanism will charge the springs and operate the switch in the same manner as the mechanical handle drive.

When the closing switch contacts are made the start-stop relay (3) Fig. 10 will close contacts and energize the motor in the proper direction. At the same time a closing seal-in relay (4) assures a complete operation without hesitation and mades the closing of the SE-100E switch independent of the operator. During the closing operation an auxiliary switch (1) will open the motor circuit and arrange a series of contacts for an opening operation. It will also de-energize the start-stop relay that will close a set of contacts in the motor circuit, shunting the field coils around the armature, there by effecting a dynamic brake. Refer to wiring diagram Fig. 12.

Opening Operation

To open the SE-100S switch, and the SE-100E switch set for manual operation, the operating handle is inserted into the handle socket and rotated in a clockwise direction as far as possible (approximately 180°).

After a few degrees of handle rotation, the mechanism will engage the primary spring (4) Fig. 1 and compress it fully. Continued handle rotation will push the spring over the toggle position and it will start to discharge. A driving lug (5) Fig. 2 will engage the drive crank (3) at the toggle position of the primary spring and will turn the main crank shaft (11). When the main crank shaft has rotated a few degrees past the primary spring toggle position, the spring will discharge, opening the switch, and charging the booster spring (5) Fig. 1 for the next closing operation.

The primary blade (11) Fig. 7 travel will cause the primary contacts (5) to part first and the arcing contacts (6) a few degrees later. The spring loaded auxiliary blade (3) Fig. 4 will remain latched to the contacts (2) inside the arc chute. At a predetermined position of the primary blades, the auxiliary blade will be released and will snap open at a high velocity.

As the arc chute contacts part, an arc is established between the auxiliary blade tip (3) Fig. 4 and the finger contacts (2). The hot arc releases gases from the plastic arc chute material dispersing the arc over a large area of the chute sides. The rapidly cooled arc is extinguished in the chute and the auxiliary blade will continue to travel until a sufficient air gap is achieved to withstand BIL voltages.

The SE-100E switch when opened electrically by the motor drive will have the same sequence of operations as when the manual handle is used. The electrical sequence is the same as described in the closing operation except seal-in relay (5) Fig. 10 is used.

ADJUSTMENTS SE-100E AND SE-100S

Spring Blocking

For most of the adjustments it will be necessary to operate the switch slowly with the maintenance handle. To do this the power springs must be blocked using the following procedure. Refer to Fig. 2.

1. Remove the rear bolt from position (1A) of the spring stop (2) located on the upper right angle frame. On 1200A switches it may be necessary to loosen the front bolts of the right hand barrier to have access to the bolts.

2. Rotate the stop until it is vertical, replace the bolt that had been removed in the lower location (1) and tighten.

3. The SE-100E mechanism must be put into the manual operation condition before operating with the manual handle. Disengage the electrical operator by sliding the yellow pawl block toward the center hub using a screw driver or other small tool Fig. 10. When the switch is closed the pawl will appear in the left hole, when open the right hole.

4. Using the normal operating handle rotate in a counterclockwise direction (direction of close) until the spring yoke on the right contacts the stop.

5. Remove operating handle and insert maintenance handle (2) Fig. 3 on main square shaft and screw the blocking pins (3) Fig. 3 in the left and right spring guide at (4) Fig. 2. The springs are now safely blocked and the maintenance handle will open and close the switch for adjusting purposes.

Upper (Closed) Mechanism Stop

The upper buffer stops (3) Fig. 5 located on either side of the mechanism at the ends of the main crank shaft, must be adjusted to position the operating rod cranks when the switch is closed. Operate the switch to the fully closed position.

The operating rod must go over toggle approximately $\frac{1}{4}$" at the crank connection when the switch is closed. A simple means of measuring the correct toggle angle is to place a straight edge along the upper side of the operating rod and extend it until it is over the square main shaft (10) Fig. 6. The dimension from the straight edge to the closest corner of the square shaft should be 1/4" to 3/8".

If adjustment of the stop is necessary, remove the cotter pin holding the stop (3) Fig. 5 and move washers and metal shims from the front to the rear (or the reverse) until the proper toggle angle is obtained. Adjust the stops at both ends of the main shaft the same amount to keep them balanced.

Primary Wipe

The operating rod must fully close the switch primary blades to obtain the correct primary finger wipe.

With the switch in the closed position, pull the top of the primary blades to the front with your hands to remove connection clearances. There should be 1/64" to 1/32" clearance between the buffer (8) Fig. 7

and the primary blade buffer stop (1) Fig. 1. There should also be 3/16" to 1/4" between the edge of the primary blade and the front of the primary contact support.

Adjust the length of the rod by use of the adjusting nuts (6) Fig. 6 to obtain the 3/16" to 1/4" gap then adjust the buffer (8) Fig. 7 by adding or removing shims to get the 1/64" to 1/32" clearance.

Primary Gap

The primary gap should be measured with the primary blades in the normal position. A measurement should be made from the buffer stop or spacer (3) Fig. 9 to the primary finger (2). The same primary finger, the bottom finger, should be used on both 600A and 1200A switches. The dimension should be 11" plus or minus 3/8". If this dimension is not correct, the lower buffer stop (6) Fig. 5 should be adjusted in a similar manner to the adjustment on the upper stop. Move shims and washers from the top to the bottom of the stop (or the reverse) as required. Adjust the stops at both ends of the main shaft the same amount to keep them balanced.

Primary and Arcing Contact Alignment

Close the primary blades (12) Fig. 8 slowly by the use of the maintenance handle and note the engagement of the primary contacts (4), arcing contacts (6 & 8), and guide block (10). The blades should center around the guide block without bearing heavily on either side. They should also be centered in the primary and arcing contact fingers.

If the blades press hard against the sides of the guide block, loosen the (2) bolts (11) Fig. 8 holding the block. Again check the contact alignment. If the contacts are properly aligned, reposition the guide block and bolt securely.

If the contacts are not in alignment, loosen the bolts holding the top insulator and position the insulator to center the contacts. After securing the insulators, reposition the guide blocks and tighten the bolts.

Be certain the insulator is moved only in a horizontal direction. Vertical displacement may cause misalignment of the auxiliary blade contacts.

Arc Chute Alignment

The arc chute must be positioned to allow entry of the auxiliary blade; to latch, and finally, to release the auxiliary blade at the proper time.

With the operating springs blocked, turn the contact arm (12) Fig. 7 slowly closed and check the entry of the auxiliary blade (7) into the arc chute (1). The blade should enter smoothly and be in the center of the opening. If the blade scrapes heavily on the sides of the chute, loosen the (2) bolts at the top (2) Fig. 7 and the (2) bolts

(10) Fig. 7 at the bottom of the chute. Position the chute so that the blade will travel the full length without binding or heavy scraping, and tighten the bolts.

A dimension of 1-1/6" should be maintained from the rear edge of the arc chute to the front edge of the primary finger contact support at all times when moving or re-aligning the chute. Refer to Fig. 7. The auxiliary blade contacts (2) Fig. 4 inside the chute should be properly positioned to latch the auxiliary blade when this dimension is maintained.

The auxiliary blade must be released by the contacts when the primary blade has been opened to a predetermined gap. With the operating springs blocked, open the primary contacts and slowly move the primary blade until the auxiliary blade is released. At the point of release the gap from the lower edge of the primary finger (the bottom finger (2) Fig. 9 to the buffer stop or spacer (3) should be 4-7/8" to 5-3/8" on the 4.8KV and 7-1/8" to 7-3/4" on the 13.2 KV switch. If the gap is not correct the vertical location of the chute must be changed. For gaps greater than the above range, the chute must be lowered, for gaps that are less the chute must be raised. To adjust the chute, remove the upper and lower mounting bolts (2 & 10) Fig. 7. Move shims (3) from the bottom to the top of the support to decrease the gap. To increase the gap, move some of the top shims to the bottom support.

When the release gap is properly set, check again the dimension from the back edge of the chute to the primary contact finger support and the alignment of the auxiliary blade in the chute opening.

Auxiliary Blade Release

The auxiliary blade release hook (14) Fig. 7 should be adjusted to hold the blade out of the arc chute until a predetermined position in the closing operation.

Close the switch slowly with the maintenance handle and note the position of the primary blades when the auxiliary blade is released by the hook. The hook should be adjusted by setting the camming screw (8) Fig. 4 to release the auxiliary blade within the range of 1/2" before Primary contacts touch. After adjustment is made the lock nut (9) Fig. 4 should be tightened.

Primary Contact Pressure

The primary finger pressure has been adjusted at the factory to be 12 pounds per contact on the 600A switch and 24 pounds per contact on the 1200A. This can be measured with a pull scale exerting a pressure against the contact surface. The contact pressure of each finger (5) Fig. 7 should be measured individually. Increase or decrease the contact pressure by loosening or tightening the contact bolts (4) Fig. 7.

Arcing Finger Contact Pressure

The arcing finger contact pressure should be 12 pounds on all 600A and 16 pounds on all 1200A switches. This pressure can again be measured

with a spring scale against the contact surface. Loosen or tighten the contact bolts (7) Fig. 8 as necessary.

Primary Blade Hinge Pressure

The correct hinge pressure is essential for proper operation of the switch. The hinge pressure is difficult to measure, but a required torque to move the primary blades can be easily measured and can be substituted for a pressure measurement. The break away torque of the hinge (the torque required to start the blades moving) should be between 60 pound-inches to 90 pound-inches on 600A and 85 pound-inches to 110 pound-inches on 1200A switches. This can be measured by pulling at the buffer stop or spacer (1) Fig. 1 on the primary blade with a spring scale without the primary contacts, arcing contacts, and auxiliary blade contacts engaged. The scale reading should be $5\frac{1}{2}$ to $8\frac{1}{4}$ # on 600A and 8 to 10 # on 1200A switches. If adjustment is necessary, remove a cotter pin from either side of the hinge pin (16) Fig. 7 and tighten or loosen the nut as required. Move the nut in increments of one sixth of a turn to assure line-up of cotter pin hole and slot in the nut.

Control Power Check SE-100E

After the switch has been opened and closed several times with the maintenance closing handle and all adjustments have been checked as described, the operating voltage should be checked at the motor terminal board. For electrical operation of the mechanism, the control power may be either an alternating or direct current source. The nominal range for the closing and opening voltages are given on the motor nameplate. The following ranges are standard.

Nominal Voltage	Closing and Opening Voltage Range
125V d-c	90 - 130V d-c
250V d-c	180 - 260V d-c
115V a-c	95 - 125V a-c
230V a-c	190 - 250V a-c

Auxiliary Switch

The auxiliary switch (1) Fig. 10 is mounted in the mechanism area and is operated by several links from the main shaft. The switch consists of "a" contacts that are open when the SE-100E switch is open and "b" contacts that are open when the SE-100E switch is closed. The contacts are used for relay operation and setting up the motor circuits for close and open operations. Several "a" and "b" contacts are available for special applications by the customer.

LUBRICATION

In order to maintain reliable operation, it is important that all parts of the mechanism be properly lubricated at all times. All bearings and other parts of the mechanism subjected to wear have been properly lubricated, during assembly at the factory, using the finest grades of lubricants available. However, even the finest oils and greases have a tendency to oxidize with age, as evidenced by hardening and darkening in color. Elimination of the hardened lubricant is essential for the proper operation of the switch. Also frequent operation of the device causes the lubricant to be forced out from between the bearing surfaces. A simple lubrication will often clear up minor disturbances which might be mistaken for more serious trouble.

A definite lubrication schedule should be set up taking into consideration the frequency of operation of the switch and local conditions. Until such a schedule is worked out, the switch should be lubricated at each periodic inspection and also whenever it is overhauled, in accordance with the lubrication chart, Fig. (11). It is also recommended that the device be operated at regular intervals to insure the user that the equipment is operating freely.

The lubrication chart, Fig. (11) is divided into two methods of lubrication. The first method outlines the maintenance lubrication which should be performed at the time of periodic maintenance, and requires no disassembly. The second method outlines a lubrication procedure similar to that performed on the device at the factory, but should be used only in case of a general overhaul or disassembly for other reasons.

General Electric Lubricants D50H15 and D50H47 are available in 1/4# collapsible tubes. It is so packaged to insure cleanliness and to prevent oxidation.

Method of Cleaning Bearings

Whenever cleaning is required, the bearings should be placed in a container of clean petroleum solvent or similar cleaner. DO NOT USE CARBON TETRACHLORIDE. If the grease in the bearings has become badly oxidized, it may be necessary to use alcohol (type used for thinning shellac) to remove it. Ordinarily, by agitating the bearings in the cleaning solution, and using a stiff brush to remove the solid particles, the bearings can be satisfactorily cleaned. Do not handle the bearings with bare hands as deposits from the skin onto the bearings are inductive to corrosion. If the bearings are touched, the contamination can be removed by washing in alcohol. After the bearings have been thoroughly cleaned, spin them in clean new light machine oil until the cleaner or solvent is entirely removed. Allow this oil to drain off and then repack them immediately with G-E lubricant D50H15 being sure all metal parts are greased.

NOTE: If it becomes necessary to clean the bearings in alcohol (shellac thinner), be sure the alcohol is perfectly clean, and do not allow the bearings to remain in the alcohol more than a few hours. If it is desir-

able to leave the bearings in the alcohol for a longer time, an inhibited alcohol such as is used for anit-freeze should be used. Even then the bearings should be removed from the alcohol within twenty-four hours. Esso Anti-Freeze and Du Pont Zerone are satisfactory for this purpose. Precautions against the toxic effects of the alcohol must be exercised by wearing rubber gloves and by using the alcohol in a well ventilated room; excessive exposure to the fumes is sometimes unpleasant to personnel. Washing the bearings in the light oil and draining should follow immediately, then apply the lubricant.

The hinge of the primary contact arm (16) Fig. 7 should be disassembled cleaned, and lubricated with G.E. D50H47 lubricant at general overhaul periods. A thin film of G.E. D50H47 should also be applied to the silvered area of the primary contact arm where it enters the primary fingers (5) Fig. 7, and the arcing contact blade where it enters the arcing contact fingers (6) Fig. 7.

NOTE: Do not grease auxiliary blade (7) Fig. 7.

DESCRIPTION OF OPERATION SE-100M

The SE-100M switch has a direct mechanical drive and the closing and opening energy is supplied by the operator.

When operating the switch, the handle should be rotated with a positive motion throughout its entire stroke.

Closing Operation

Closing the switch is accomplished by inserting the operating handle (1) Fig. 3 into the handle socket provided in the operating hub (7) Fig. 1 in the enclosure and rotating in a counterclockwise direction as far as possible (approximately 180°).

During the closing cycle the auxiliary blade (7) Fig. 7 will be held out of the arc chute until the primary blades (11) are almost closed. Just before the primary contacts (5) Fig. 7 touch, the auxiliary blade is released and will be the first part to close.

The mechanism has a direct gear drive to the main shaft of the switch and depends entirely on the operator to produce a smooth and positive motion to satisfactorily close.

Opening Operation

To open the switch insert the operating handle into the handle socket and rotate in a clockwise direction as far as possible (approximately 180 degrees).

The primary contacts (5 & 11) Fig. 7 will part first. When the primary blade gap is sufficient, the auxiliary blade (3) Fig. 4 will be released and will snap open at high velocity.

ADJUSTMENTS SE-100M

Upper (Closed) Mechanism Stop

Refer to Page 6.

Primary Wipe

When the switch is in the closed position, there should be no clearance between the primary blades and the primary finger support. The length of the operating rod should be adjusted so that there is noticeable force involved when the operating rod goes over center near the end of the closing stroke. When the switch is fully closed it should require between 30 and 40 pounds force to break the toggle. This force is applied at the bolt in the mechanism end of the operating rod and is applied downward perpendicular to the long axis of the operating rod. This force may be increased by lengthening the rod and decreased by shortening the rod.

Primary Gap

Refer to Page 7.

Primary Contact Alignment

Close the primary blades (12) Fig. 8 slowly by the use of the maintenance handle and note the engagement of the primary contacts (4), and guide block (10). The blades should center around the guide block without bearing heavily on either side. They should also be centered in the primary contact fingers.

If the blades press hard against the sides of the guide block, loosen the (2) bolts (11) Fig. 8 holding the block. Again check the contact alignment. If the contacts are properly aligned, reposition the guide block and bolt securely.

If the contacts are not in alignment, loosen the bolts holding the top insulator and position the insulator to center the contacts. After securing the insulators, reposition the guide blocks and tighten the bolts.

Be certain the insulator is moved only in a horizontal direction. Vertical displacement may cause misalignment of the auxiliary blade contacts.

Arc Chute Alignment

Refer to Page 7.

Auxiliary Blade Release

The SE-100M hook release should be adjusted to release the auxiliary blade when the primary contacts and blade are 1/2" to 1" apart. Be certain the auxiliary blade latches into the arcing contacts in the chute on each operation. The auxiliary blade is released before the primary contacts are closed so that it will close first and give a positive closing action even when the switch is inadvertantly operated slowly.

Primary Contact Pressure

Refer to Page 8.

Primary Blade Hinge Pressure

Refer to Page 9.

Lubrication

Refer to Page 10.

FINAL INSPECTION ALL SWITCHES

Before placing the SE-100 into service, a final inspection should be made consisting of the following:

1. Check all nuts, washers, bolts, cotter pins and terminal connections for tightness.
2. See that all bearing surfaces of the mechanism have been lubricated.
3. Operate the device slowly several times by hand and note that there is no binding or excessive friction.
4. See that any place where the surface of the paint has been damaged during installation is repainted immediately.
5. Replace all barriers, covers, and any other parts that may have been removed during installation.

Hi-Potential Test

If the device has been stored for a long period of time before installation, it is recommended that the insulation be checked before it is placed in service. A standard 60 cycle high potential test at 14,000 volts RMS for the 4.8KV switch and 27,000 volts RMS for the 13.2 KV switch will normally indicate whether the device is satisfactory for service. With the switch contacts in the fully opened position, apply the high potential to each terminal individually for one minute with all other terminals and the frame grounded. After high potential tests

are made all organic insulating materials should be inspected for visible leakage current paths, and necessary action must be taken to replace insulation that may have been affected by moisture absorption.

The high potential test is also recommended for devices which have been removed from service and stored over an extended period of time under unfavorable atmospheric conditions.

NOTE: Before applying a hi-potential test make certain that the switch has been disconnected from both the source and load.

If the SE-100E secondary wiring is to be given a hi-potential test at 1500 volts, remove both of the motor leads from the terminal board. Failure to disconnect the motor from the circuit may cause damage to the winding insulation.

RECOMMENDED RENEWAL PARTS					
DESCRIPTION	AMP RATING	QUAN. PER SWITCH	CAT. NO.		
			SE-100E	SE-100S	SE-100M
Primary Contact Finger	600	24	121A7458 P-2	121A7458 P-2	121A7458 P-2
Primary Contact Finger	1200	48	161A4219 P-2	161A4219 P-2	Not Avail.
Primary Contact Spring	600	12	456A806 P-1	456A806 P-1	456A806 P-1
Primary Contact Spring	1200	48	456A806 P-1	456A806 P-1	Not Avail.
Primary Contact Finger Retainer	600	12	105C9352 P-5	105C9352 P-5	105C9352 P-5
Primary Contact Finger Retainer	1200	24	105C9352 P-5	105C9352 P-5	Not Avail.
Primary Contact Blade	600	6	105C9365 P-3	105C9365 P-3	105C9365 P-3
Primary Contact Blade	1200	3	105C9366 P-13	105C9366 P-13	Not Avail.
Arcing Contact Finger	600	6	105C9360 P-1	105C9360 P-1	Not Req.
Arcing Contact Finger	1200	6	105C9360 G-2	105C9360 G-2	Not Req.
Arcing Contact Spring	All	6	161A5829 P-1	161A5829 P-1	Not Req.
Arcing Contact Blade	600	3	105C9366 P-4	105C9366 P-4	Not Req.
Arcing Contact Blade	1200	3	105C9366 G-1	105C9366 G-1	Not Req.
Arc Chute Assembly 4.8KV	600	3	105C9350 G-1	105C9350 G-1	105C9350 G-2
Arc Chute Assembly 4.8KV	1200	3	105C9350 G-1	105C9350 G-1	Not Avail.
Arc Chute Assembly 13.2KV	All	3	105C9350 G-2	105C9350 G-2	105C9350 G-2
Auxiliary Blade 4.8KV	All	3	114C5395 G-2	114C5395 G-2	114C5318 G-9
Auxiliary Blade 13.2KV	All	3	114C5395 G-1	114C5395 G-1	114C5318 G-9
Motor 115V-ac - 125V-dc	All	1	105C9393 P-5	Not Req.	Not Req.
Motor 230V-ac - 250V-dc	All	1	105C9393 P-6	Not Req.	Not Req.
Relay 115V-ac	All	3	137A7575 P-5	Not Req.	Not Req.
Relay 125V-dc	All	3	137A7575 P-1	Not Req.	Not Req.
Relay 230V-ac	All	3	137A7575 P-2	Not Req.	Not Req.
Relay 250V-dc	All	3	137A7575 P-3	Not Req.	Not Req.
Auxiliary Switch	All	1	137A9192 G-7	Not Req.	Not Req.
Operating Rod	600	3	114C5394 G-1	114C5394 G-1	114C5394 G-1
Operating Rod	1200	3	114C5394 G-2	114C5394 G-2	Not Avail.

PART	LUBRICATION AT NORMAL MAINTENANCE PERIOD	ALTERNATE LUBRICATION REQUIRE DISASSEMBLY
Sleeve Bearings (Operating rod ends Aux. Blade Hinge, Release Hook, etc.)	Light application of SAE 20-30 oil	Clean bearings then apply D50H15 grease.
Roller & Needle Bearings	Light application of SAE 20-30 oil	Clean bearings then apply D50H15 grease.
Worm and Wheel Miter Gears	Apply D50H15 grease	Wipe clean and apply D50H15 grease.
Motor	Light application of SAE 20-30 oil at rear oil hole only	Light application of SAE 20-30 oil at rear oil hole only

Fig. 11 LUBRICATION CHART

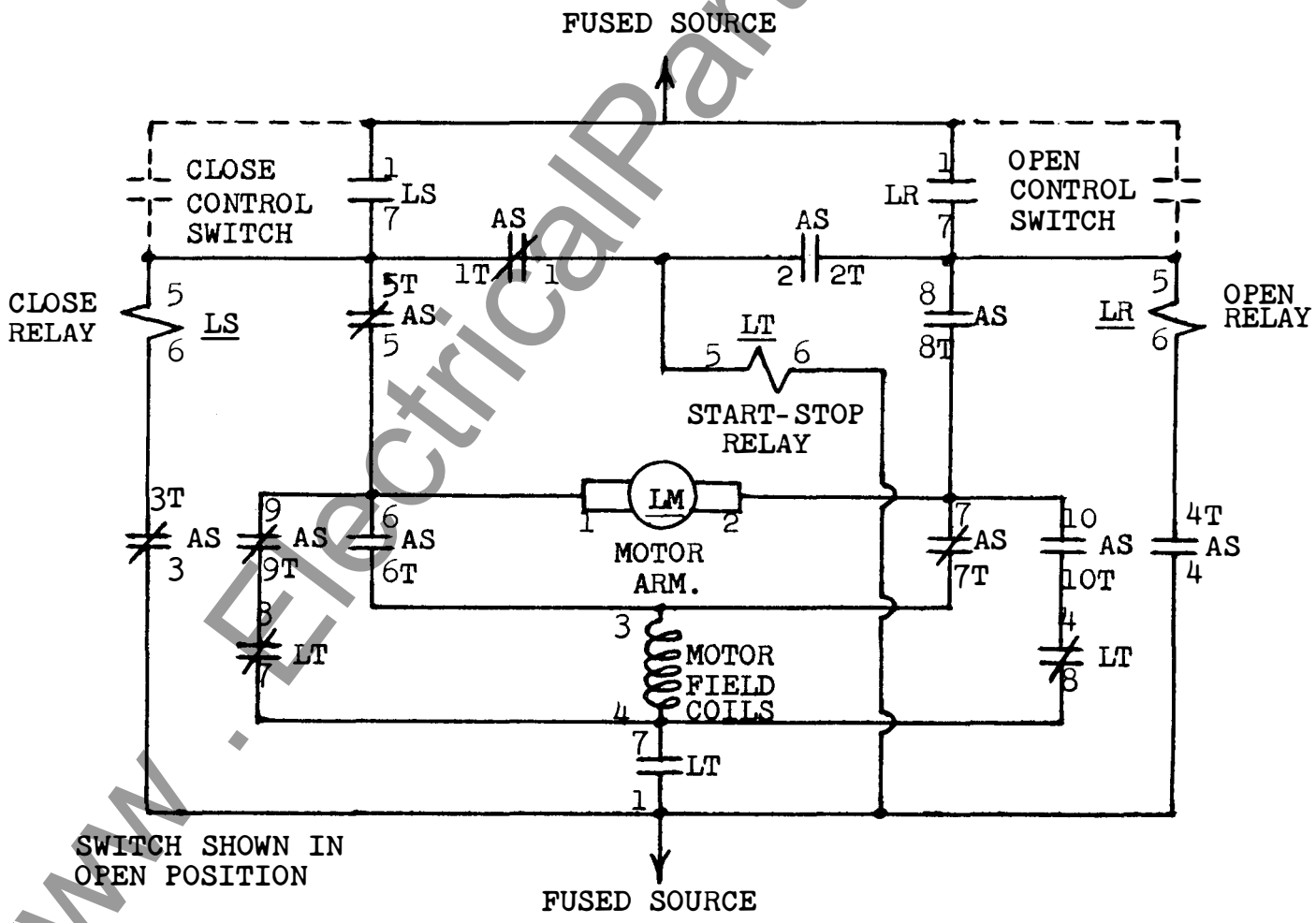
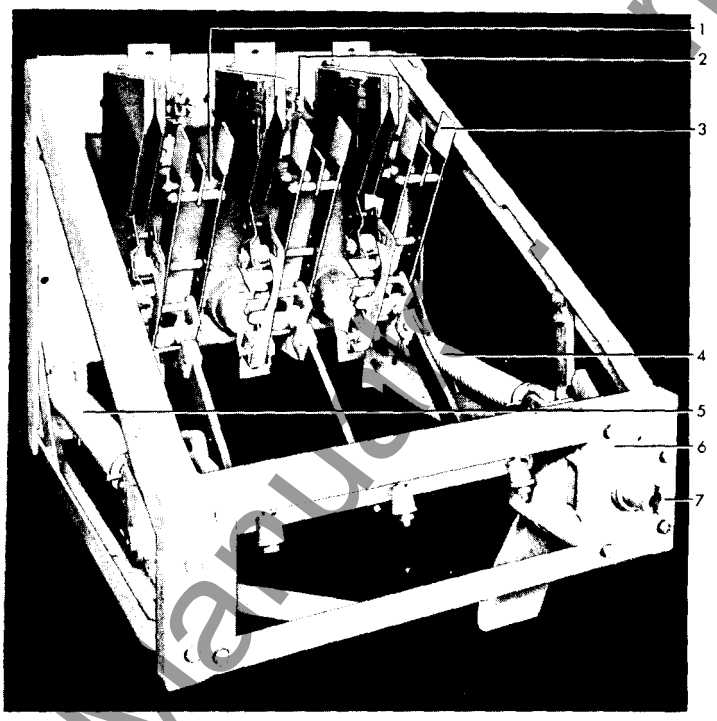
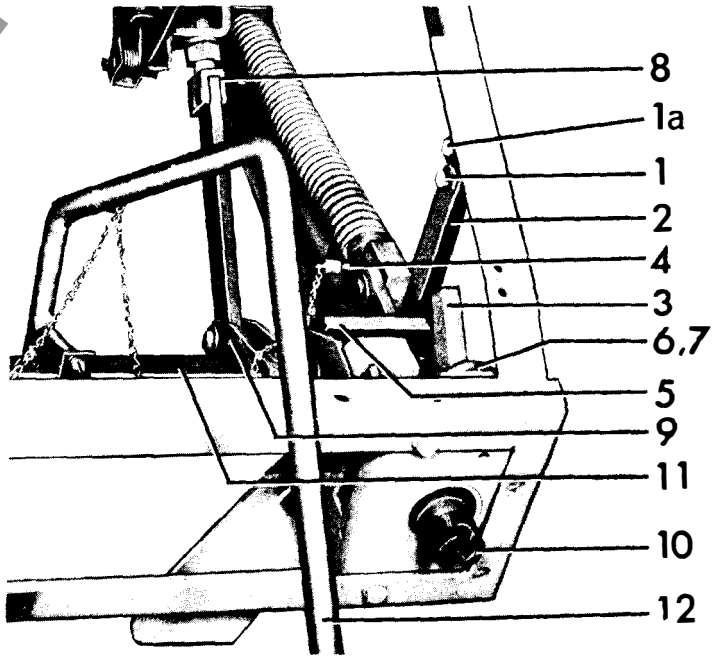


Fig. 12 ' SCHEMATIC WIRING DIAGRAM



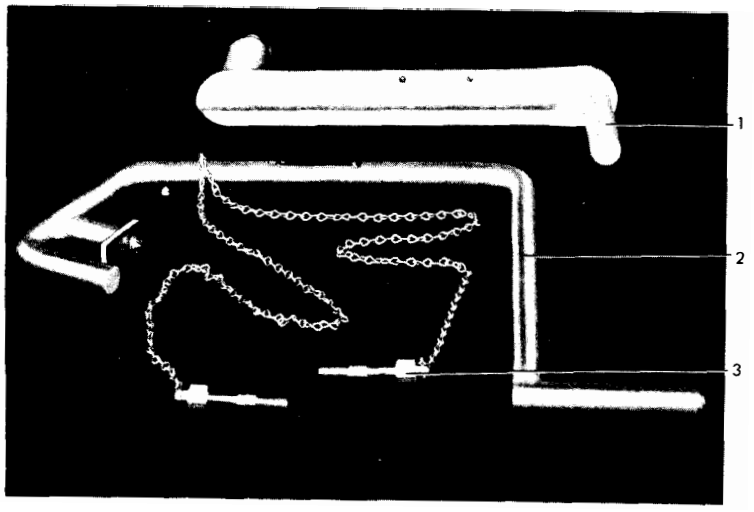
1. Primary Blade Stop
2. Primary Contact Fingers
3. Primary Contact Blade
4. Primary Spring
5. Booster Spring
6. Operating Mechanism
7. Operating Hub

Fig. 1 SE-100S Switch Partially Open



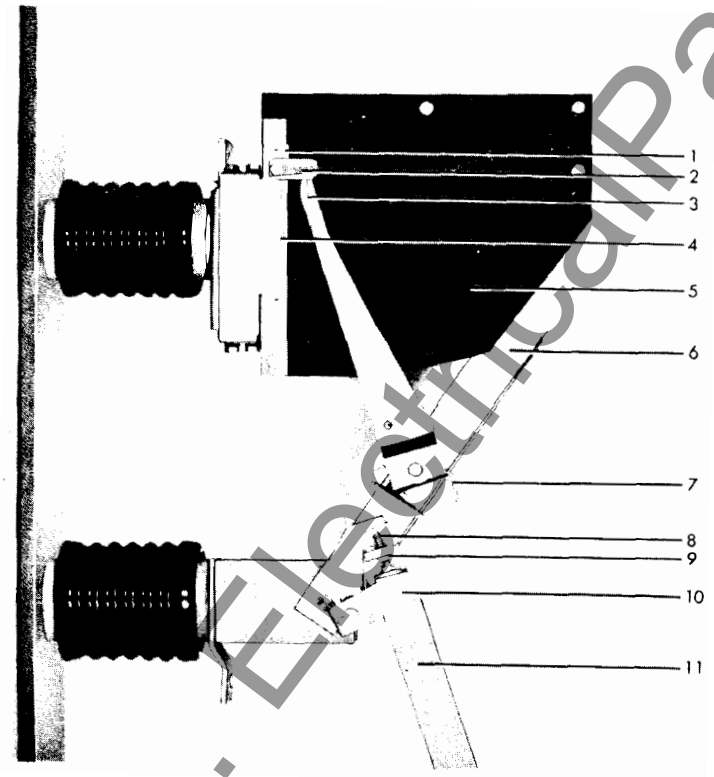
1. Spring Stop Bolt
1A. Spring Stop Bolt
2. Spring Stop
3. Driving Crank
4. Hole for Spring Blocking Pin
5. Driving Lug
6. Buffer Rubber
7. Buffer Stop
8. Operating Rod
9. Operating Rod Crank
10. Operating Hub
11. Main Crank Shaft
12. Maintenance Handle

Fig. 2 Spring Drive Mechanism



1. Operating Handle
2. Maintenance Handle
3. Spring Blocking Pin

Fig. 3 Operating and Maintenance Handles



1. Blade Stop Block
2. Arc Chute Contacts
3. Auxiliary Blade
4. Spacer
5. Arc Chute Side
6. Primary Contact Blade
7. Auxiliary Blade Spring
8. Camming Screw
9. Lock Nut
10. Auxiliary Blade Release Hook
11. Operating Rod

Fig. 4 Unit Pole Opening

1. Collar
2. Buffer Rubber
3. Upper Buffer Stop
4. Booster Crank
5. Buffer Rubber
6. Lower Buffer Stop

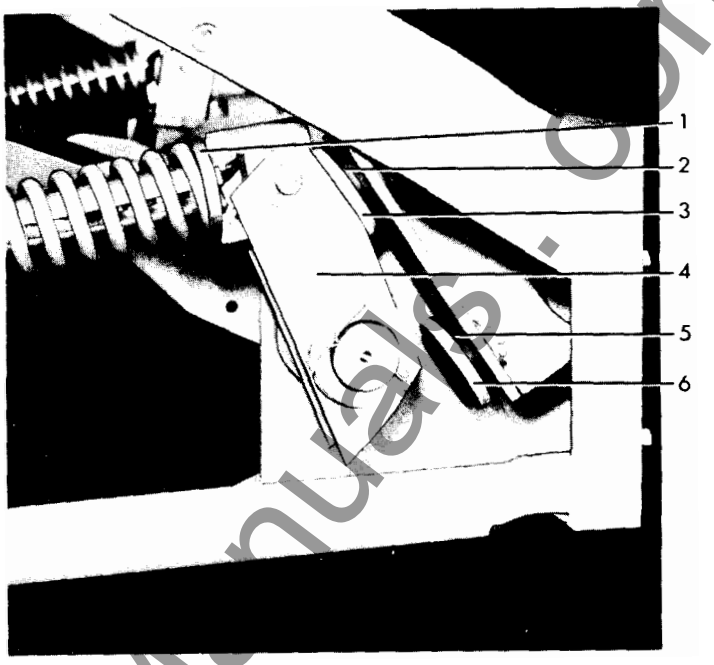


Fig. 5 Buffer Assembly

1. Auxiliary Blade Spring
2. Auxiliary Blade Release Hook
3. Spring Stop
4. Camming Screw
5. Lock Nut
6. Adjusting Nut
7. Release Hook Spring
8. Operating Rod
9. Operating Rod Crank
10. Main Crank Shaft

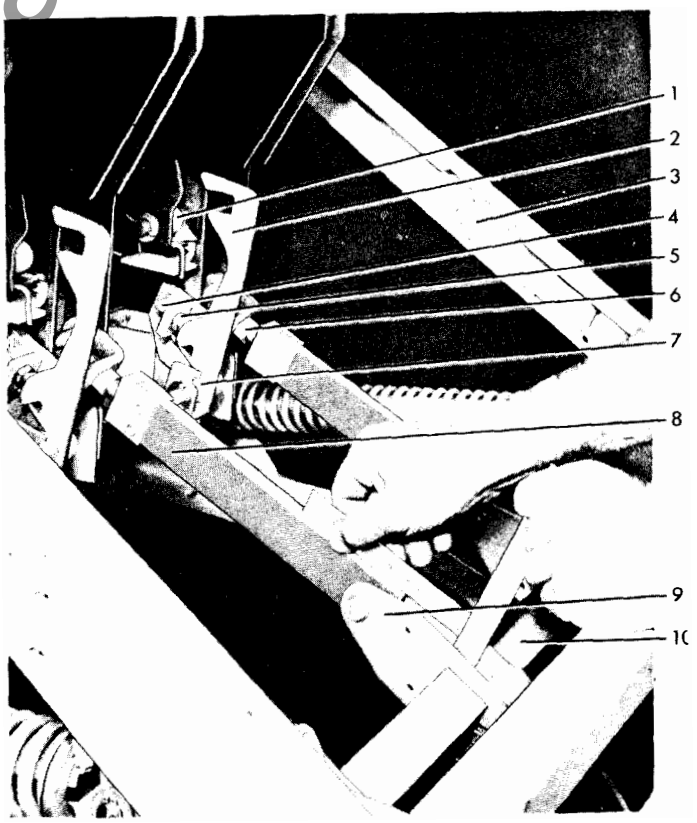


Fig. 6 Switch Blade Adjustments

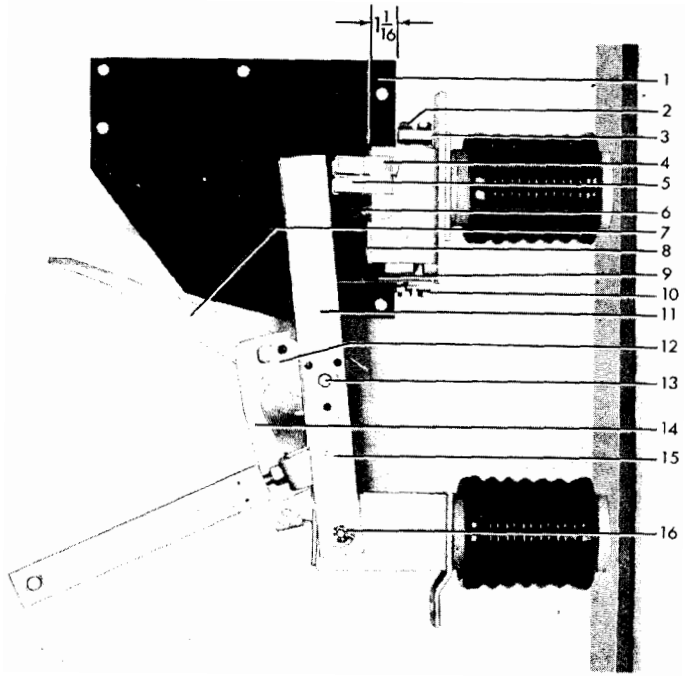


Fig. 7 Unit Pole Closing

1. Buffer Stop
2. Arc Chute Mounting Bolts
3. Shims
4. Contact Bolt
5. Primary Contact Fingers
6. Arcing Contact Fingers
7. Auxiliary Blade
8. Buffer Stop
9. Guide Block
10. Arc Chute Mounting Bolts
11. Primary Contact Blade
12. Auxiliary Contact Blade
13. Rivot Pin for Auxiliary Blade
14. Auxiliary Blade Release Hook
15. Operating Rod Clevis Pin
16. Hinge Pin

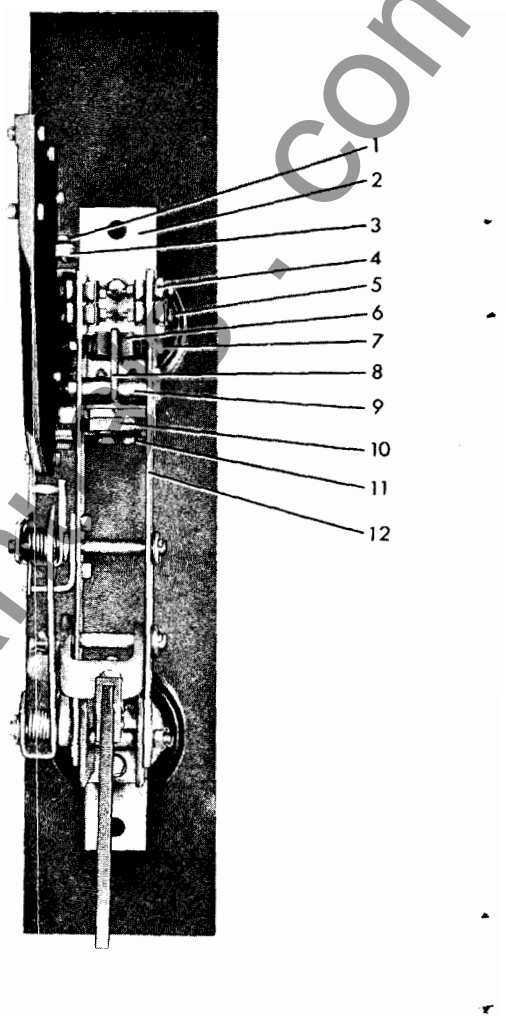


Fig. 8 Contact Arrangement

1. Arc Chute Mounting Bolts
2. Upper Terminal
3. Shims
4. Primary Contacts
5. Contact Bolts
6. Arcing Contact Fingers
7. Contact Bolt
8. Movable Arcing Contact
9. Tube Spacer
10. Guide Block
11. Buffer Block Bolts
12. Primary Contact Blades

1. Arc Chute
2. Stationary Primary Contact
3. Primary Blade Stop
4. Primary Blade

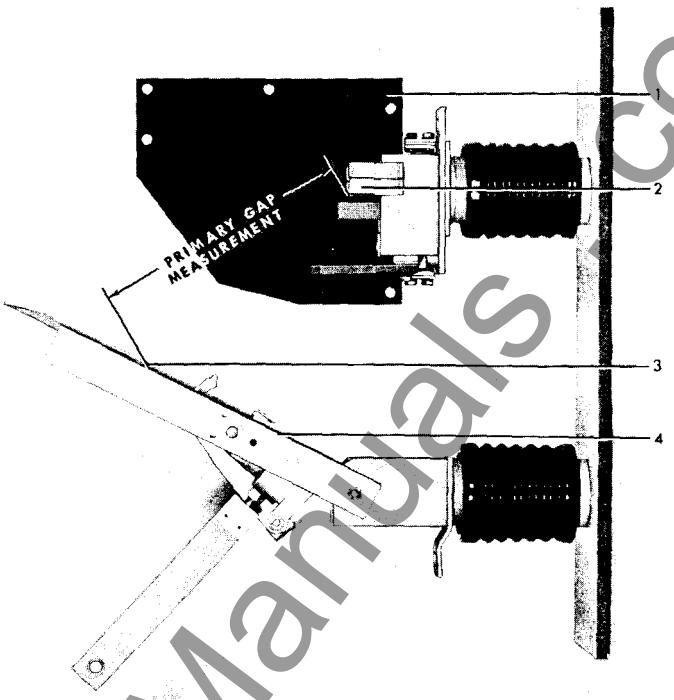
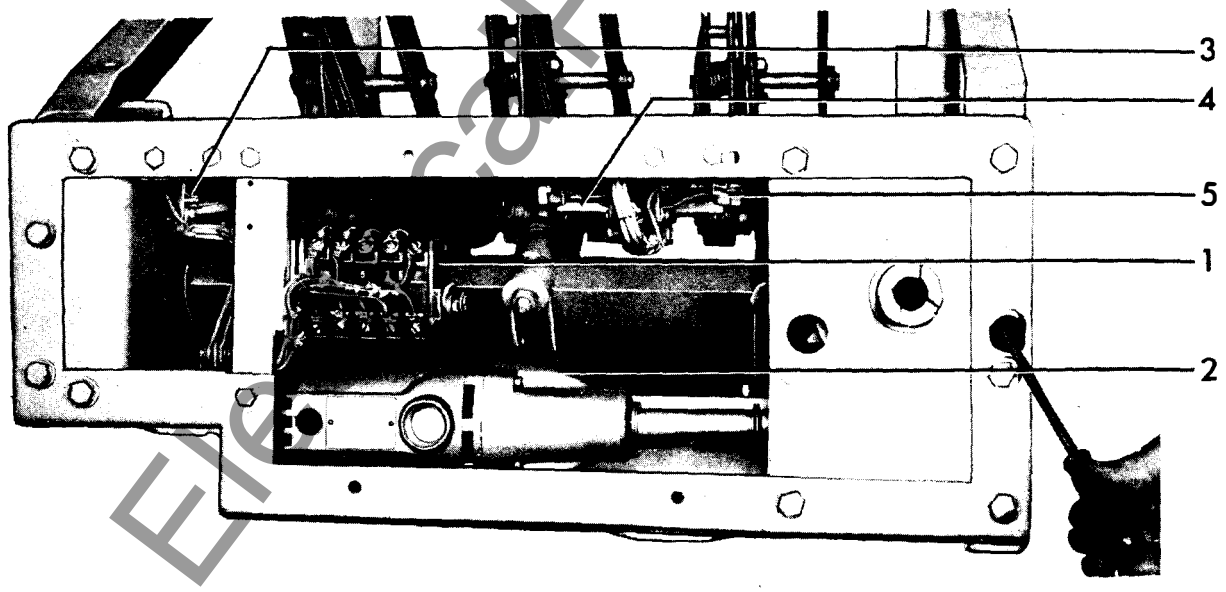


Fig. 9 Unit Pole Fully Open



1. Auxiliary Switch
2. Motor
3. Start-Stop Relay
4. Close Relay
5. Open Relay

Fig. 10 Electrical Operator

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INSTRUCTIONS

GEK-34527
Supersedes GEK-33269

ALUGARD® II STATION ARRESTERS

MODEL 9L11M-SERIES 3-312 KV

MODEL 9L16B-SERIES ABOVE 312 KV

CAUTION: THE EQUIPMENT COVERED BY THESE INSTRUCTIONS SHOULD BE INSTALLED AND SERVICED ONLY BY COMPETENT PERSONNEL FAMILIAR WITH GOOD SAFETY PRACTICES. THIS INSTRUCTION IS WRITTEN FOR SUCH PERSONNEL AND IS NOT INTENDED AS A SUBSTITUTE FOR ADEQUATE TRAINING AND EXPERIENCE IN SAFE PROCEDURES FOR THIS TYPE OF EQUIPMENT.

The ALUGARD II Station Arrester is of single-phase design, suitable for outdoor service. Three arresters are required for three-phase installations. Smaller, lower-rated models are shipped assembled, while the larger, higher-rated models consist of four to six individual units which must be assembled. The arresters require no testing before being placed in service, and are completely self-supporting.

Each ALUGARD II arrester unit contains a number of THYRITE® valve and alurite gap elements permanently sealed in a porcelain housing provided with pressure-relief construction. Metal end fittings, cemented to the housing, provide a means for bolting the arrester units together or to a foundation.

APPLICATION

Arresters are designed to limit surge voltages to a safe value by discharging the surge current to ground, and to interrupt the power-frequency follow current. The ability to interrupt power-follow current is limited to applications where the power-frequency voltage at the arrester never exceeds the arrester's continuous or short-time rating. In case of doubt concerning application, consult your local General Electric Company representative.

INSTALLATION

INITIAL INSPECTION

ALUGARD II arresters are designed to withstand severe shipping shocks. In addition, each unit is shipped in a carefully designed container. If the crate or carton shows signs of rough handling upon receipt, the porcelain housing should be inspected for chips or cracks. If damage is apparent, the arrester should not be installed. Claims for such damage should be registered immediately with the common carrier.

The model number and continuous voltage rating of each complete arrester are identified on the nameplate which is attached to the lower end fittings. The nameplate information should be checked against the shipping memorandum. If at any time it is necessary to correspond with the General Electric Company, complete nameplate data should be furnished in order to expedite replies.

LOCATION

Install the arrester electrically as close as practicable to the apparatus being protected. Keep line and ground connections short and direct.

FOUNDATION

The footings of all outdoor piers or supports should extend below the frost line and be elevated above the ground line sufficiently to meet personnel safety requirements.

ASSEMBLY

Single-unit Arresters

Each arrester, except those requiring grading rings, is shipped completely assembled. When grading rings are needed, bolt them securely on the line end, before electrical connections are made.

All single-unit ratings can be suspension mounted if the line connection is made to the top of the arrester. The top cap of each standard ALUGARD II unit has provisions for attaching an insulator clevis fitting. Special ALUGARD II arresters rated 258 kV and below can be supplied for rigid suspension mounting from station structural members.

Install the arrester on the foundation, using care to see that it is perpendicular, shimming under one or two feet if necessary. It is important that all three feet rest solidly on the foundation before the foundation bolts are drawn down to avoid unnecessary stresses in the castings. Tighten the bolts firmly. The opening for pressure-relief should be oriented so as to minimize damage to adjacent equipment by incandescent gases in the remote event of arrester failure.

Multi-unit Arresters

It is important that the individual arrester units be erected in the exact order specified on the outline drawing shipped with each arrester. The model number of the arrester unit is given on the unit nameplate which is attached to the bottom end casting. The base unit also bears the larger arrester nameplate.

Install the base unit on the foundation, using care to see that it is perpendicular, shimming under one or two feet if necessary. It is important that all three feet rest solidly on the foundation before the foundation bolts are drawn down to avoid unnecessary stresses in the castings. Tighten the bolts firmly. The opening for pressure-relief should be oriented so as to minimize damage to adjacent equipment by incandescent gases in the remote event of arrester failure.

Select the next unit carefully by reference to the outline drawing and bolt it securely to the base unit. The end fittings are carefully affixed at the factory to assure parallelism, so no further shimming should be required provided it was carefully done when the base unit was installed.

The line terminal cap has a central lifting hole and it may be used, if desired, as an aid to erection by bolting it temporarily to each unit in turn.

Be sure to install the grading rings at the points called for on the outline drawing.

LINE AND GROUND CONNECTIONS

Connect the arrester ground to the apparatus ground and the main station ground, utilizing a reliable common ground network of low resistance.

Connection to the line should be made through a suitable line connector. Line connections should be made in such a manner that no excessive mechanical stress is placed on the arrester. When connecting the arrester to an energized line, it is imperative that a quick, positive, continuous action be made to avoid possible damage to the arrester.

CAUTION: ALWAYS BE CERTAIN THAT THE GROUND CONNECTION IS FIRMLY MADE BEFORE CONNECTING THE ARRESTER TO AN ENERGIZED LINE. IF AN INSULATING UNIT IS USED AT THE GROUND END TO PERMIT USE OF A DISCHARGE COUNTER, THE DISCHARGE COUNTER MUST BE CONNECTED (OR THE INSULATING UNIT SHORTED OUT) BEFORE CONNECTING THE ARRESTER TO AN ENERGIZED LINE.

CLEARANCE

The term "clearance" means the actual distance between any parts of the arrester at line potential and any object at ground potential or other phase potential.

Clearances listed in the appropriate outline print packed with each arrester are the minimum recommended for conventional outdoor substations. Arresters rated 96 kV and below may be enclosed completely using the same clearance values. The values shown are suitable for altitudes up to 3300 feet (1000 meters). At higher altitudes, add 3 percent for each additional 1000 feet of elevation. The arrangement of the foundation plans shown on the outlines can be modified if proper clearances are maintained.

ALTITUDE

3-48 kV models 9L11M arresters can be used from 0-18,000 feet altitude.

60-312 kV arresters can be used from 0-10,000 feet altitude. ALUGARD II arrester sealing would allow these units to be applied to 18,000 feet, but they must be limited to 10,000 feet because reduction of air density increases the possibility of external flashover on these 9L11MHA series arresters.

ALUGARD II arresters, 9L16B series can be used from 0-10,000 feet altitude.

PERIODIC INSPECTION AND MAINTENANCE

Before inspecting or handling, disconnect the arrester from line and, as a safety precaution, ground the line end. *Remove this temporary ground before reconnecting the arrester onto the line.*

ALUGARD II arresters require no special care. They may be hot-washed, subject to the usual care and techniques used in hot-washing insulation to avoid external flashover.

These arresters do not require testing, and no test which applies power voltage in excess of maximum arrester voltage rating should be made without consulting the General Electric Company. There is no single field test which will indicate the complete operating characteristics of the arrester.

PORCELAIN TOP UNITS

Porcelain top arresters with center line terminals are available and are particularly suited for use in metal cubicles. These arresters can be mounted in any position when installed in a reasonably clean and dry indoor location.

DISCHARGE COUNTERS

An insulating base is required when installing a discharge counter with arresters. Both of these are accessories and are described in Handbook Section 5920. Install the discharge counter and insulating base as shown on the outline drawing furnished with the counter.

INSTRUCTIONS

GEH-3286A
Supersedes GEH-3285, GEH-3286

ALUGARD® INTERMEDIATE SURGE ARRESTERS

MODEL 9L12L- SERIES
RATED 3 THROUGH 120 KV

CAUTION: THE EQUIPMENT COVERED BY THESE INSTRUCTIONS SHOULD BE INSTALLED AND SERVICED ONLY BY COMPETENT PERSONNEL FAMILIAR WITH GOOD SAFETY PRACTICES. THIS INSTRUCTION IS WRITTEN FOR SUCH PERSONNEL AND IS NOT INTENDED AS A SUBSTITUTE FOR ADEQUATE TRAINING AND EXPERIENCE IN SAFE PROCEDURES FOR THIS TYPE OF EQUIPMENT.

DESCRIPTION

The ALUGARD ® Intermediate Arrester consists of a stack of one or more arrester units connected in series, the number depending on the voltage and operating conditions of the circuit. Terminals for line and ground connections are furnished.

Three single-pole arresters are required for a three-phase installation. They are suitable for indoor or outdoor service for altitutes of 0-10,000 feet.

Each arrester unit consists essentially of a permanently sealed porcelain housing equipped with pressure relief, and containing a number of THYRITE valve disks and Alurite gap elements in series. Metal fittings cemented on the housing provide means for bolting the arrester units together or to a foundation. Arrester units of the 9L12L series may not be used in series with other units bearing model numbers 9LA2D, E, F, G, H or 9L12H.

The stainless steel unit nameplate on one *bottom bolting lug* of each individual unit applies to the arrester unit only. The main arrester nameplate shows the model number and voltage rating of the completely assembled arrester. It is fastened in place with one of the foundation mounting bolts.

APPLICATION

Arresters are designed to limit surge voltages to a safe value by discharging the surge current to ground, and to interrupt the power-frequency follow current. The ability to interrupt power follow current is limited to applications where the power-frequency voltage at the arrester never exceeds the arrester's rating.

The best protection will be obtained by installing the arresters as close as possible to the apparatus being protected. Line and ground connections should be short and direct. The arrester ground should be connected to the apparatus grounds and to the main station ground, utilizing a reliable common ground network of low resistance.

INSTALLATION

INITIAL INSPECTION

ALUGARD Intermediate Arresters are designed to withstand severe shipping shocks and vibration. In addition, each unit is shipped in a carefully designed container. If the carton shows signs of rough handling, upon receipt the porcelain housing should be inspected for chips or cracks. If damage is apparent, the arrester should not be installed. Claims for such damage should be registered with the common carrier.

FOUNDATION

The footings of all outdoor piers or supports should extend below the frost line and be elevated above the ground line sufficiently to meet personnel safety requirements.

CLEARANCES

The term "clearance" means the distance between any part of the arrester at line potential, and any object at ground potential or other phase potential. The clearances given on the outline drawing packed with each arrester are the minimum recommended. The arrangement of the foundation plan can be modified if desired.

ASSEMBLY

Install the base unit on the foundation, using care to see that it is perpendicular, shimming under one or two feet if necessary. It is important that all three feet rest solidly on the foundation before the foundation bolts are drawn down to avoid unnecessary stresses on the end fittings. Tighten the bolts firmly. The opening for pressure-relief should be oriented so as to minimize damage to adjacent equipment by incandescent gases in the remote event of arrester failure.

Select the next unit carefully (if it is a multi-unit arrester) by reference to the outline drawing, and bolt it securely to the base unit. The end fittings are carefully affixed at the factory to assure parallelism, so no further shimming should be required provided it was carefully done when the base unit was installed.

Be sure to install the grading ring (if required) as called for on the outline drawing.

SUSPENSION MOUNTING

ALUGARD Intermediate Arresters may be suspension mounted if the line connection is made to the top of the arrester. Suspension cap, Model 9L12HAW709, is available for this purpose.

ENERGIZING THE ARRESTERS

Connection to the line should be made through a suitable line connector. Line connections should be made in such a manner that no excessive mechanical stress is placed on the arrester. When connecting the arrester to an energized line, it is imperative that a quick, positive, continuous action be made to avoid possible damage to the arrester.

CAUTION: ALWAYS BE CERTAIN THAT THE GROUND CONNECTION IS FIRMLY MADE BEFORE CONNECTING THE ARRESTER TO AN ENERGIZED LINE. IF AN INSULATING UNIT IS USED AT THE GROUND END TO PERMIT USE OF A DISCHARGE COUNTER, THE DISCHARGE COUNTER MUST BE CONNECTED (OR THE INSULATING UNIT SHORTED OUT) BEFORE CONNECTING THE ARRESTER TO AN ENERGIZED LINE.

PERIODIC INSPECTION AND MAINTENANCE

Before inspecting or handling the arrester, disconnect the arrester from line and, as a safety precaution, ground the line end. *Remove this temporary ground before reconnecting the arrester to the line.*

ALUGARD Intermediate Arresters require no special care. They may be hot-washed, subject to the usual care and techniques used in hot-washing insulation to avoid external flashover.

These arresters do not require testing, and no test which applies power voltage in excess of maximum arrester voltage rating should be made without consulting the General Electric Company. There is no single field test which will indicate the complete operating characteristics of the arrester.

PORCELAIN TOP UNITS

Porcelain top arresters with center line terminals are available and are particularly suited for use in metal cubicles. These arresters can be mounted in any position when installed in a reasonably clean and dry indoor location.

DISCHARGE COUNTERS

An insulating base is required when installing a discharge counter with arresters. Both of these are accessories and are described in Handbook Section 5920. Install the discharge counter and insulating base as shown on the outline drawing furnished with the counter.

GENERAL ELECTRIC COMPANY
PROTECTIVE EQUIPMENT PRODUCTS DEPARTMENT
PITTSFIELD, MASS. 01201

GENERAL ELECTRIC

6-72 (10M)-S

INSTRUCTIONS

GEH-2906B
Supersedes GEH-2906A and GEH-2903A

DISTRIBUTION SURGE ARRESTERS

CAUTION: THE EQUIPMENT COVERED BY THESE INSTRUCTIONS SHOULD BE INSTALLED AND SERVICED ONLY BY COMPETENT PERSONNEL FAMILIAR WITH GOOD SAFETY PRACTICES. THIS INSTRUCTION IS WRITTEN FOR SUCH PERSONNEL AND IS NOT INTENDED AS A SUBSTITUTE FOR ADEQUATE TRAINING AND EXPERIENCE IN SAFE PROCEDURES FOR THIS TYPE OF EQUIPMENT.

GENERAL

The nameplate rating should be checked to ascertain that the maximum circuit line-to-ground voltage under any condition of operation, including fault conditions, will not exceed the voltage rating of the arrester. Application of higher-than-rated power voltages may result in the failure of the arrester.

Efficient operation of the lightning arrester requires a permanent low-resistance ground. The best protection is obtained by connecting the arrester directly across the line and ground terminals of the apparatus being protected, using a common ground connection for both apparatus and arrester. If this is not physically possible, the arrester should be so connected that its grounding resistance does not exceed five ohms.

INSTALLATION

CAUTION: CARE SHOULD BE TAKEN IN HANDLING ARRESTERS TO AVOID BREAKAGE.

The arrester preferably should be mounted vertically and installed as close as possible to the apparatus being protected. Line and ground connections should be short and direct. Line and ground terminal nuts or bolts should be tightened firmly on their respective leads, but with no more than 15 lb-ft torque.

The arrester should be clamped securely in its hanger and in a location where it will not be subjected to sustained vibration.

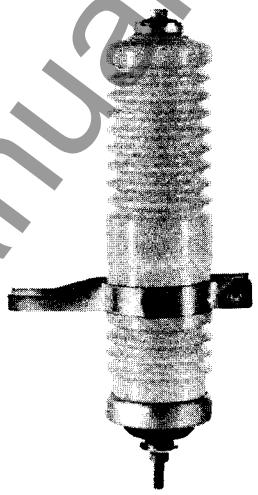


Fig. 1. Distribution arrester with disconnector.

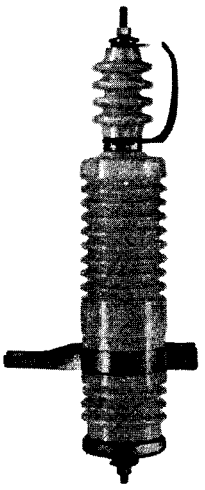
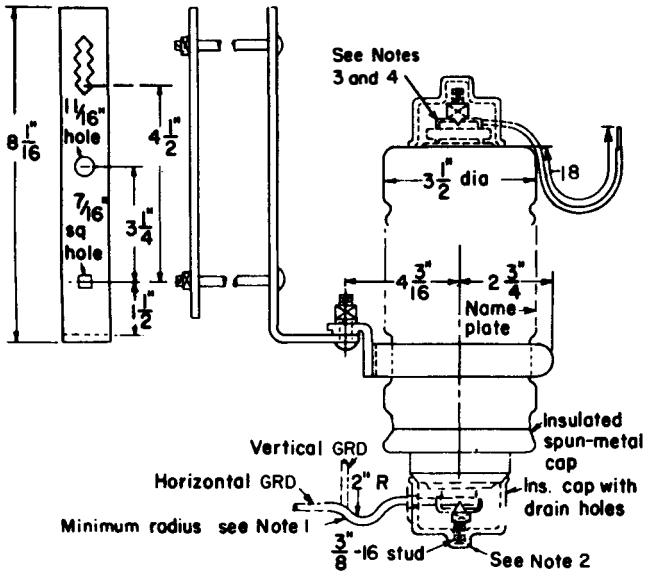


Fig. 2. Distribution arrester, externally gapped.

Arresters may also be mounted horizontally. However, a slight inclination with the line end elevated may be desirable.

NOTE: Precautions to be taken in installing direct-connected arresters are shown in Fig. 3.



NOTES

1. The Ground connection should have flexibility as shown, to assure proper disconnector operation. Care should be taken to keep the Ground connection a minimum of one (1) inch away from spun-metal cap, to avoid shorting out disconnector.
2. For proper operation of this arrester, there should be a minimum of four (4) inches clearance directly below the bottom of the arrester.
3. To remove the line lead, lift up the edge of the bird-proofing cap off the line lead and unscrew the insulating cap off the stud.
4. Replace the bird-proofing cap. Push the cap on the stud as far as it will go.

Fig. 3. Outline drawing of a direct-connected arrester with bird-proofed terminals, insulated bottom cap, insulated line lead and standard EEI-NEMA mounting bracket. Some models do not include all of these accessories.

In addition to the above, the installation of arresters for protection of dry-type transformers and rotating machines should be made in accordance with NFPA No. 70 National Electrical Code, and local ordinances where applicable.

OPERATION

The arrester is energized unless disconnected from the line. Where guard rails or screens are used or required, they should be grounded and suitable electrical clearances maintained.

MAINTENANCE

Before inspecting or handling the arrester, disconnect it from the line; and, as a safety precaution, ground the line terminal. The arrester should be completely disconnected electrically and removed from the hanger for a more thorough examination. There is no simple field test which will check the protective characteristics of the arrester.

STORAGE

Arresters, if left in shipping containers, should be stored indoors and in a dry location for protection of the cartons. The arresters themselves are weatherproof.

RE-USE

While field practice has shown that arresters are often reinstalled with no testing, for trouble-free performance it is recommended that arresters be tested as described in GET-2529 after the unit is removed from a system and before re-use.

GENERAL ELECTRIC COMPANY
PROTECTIVE EQUIPMENT PRODUCTS DEPARTMENT
PITTSFIELD, MASS. 01201

GENERAL ELECTRIC

3-72 (10M)-S

INSTALLATION INSTRUCTIONS FOR PLM POTHEADS

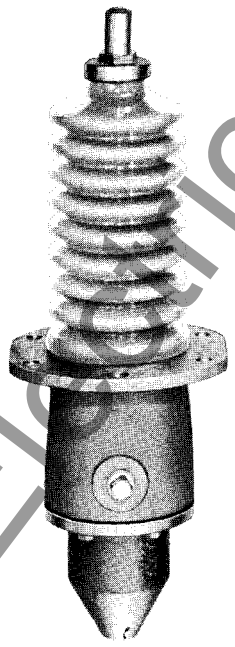
Single Conductor Flange and Bracket Mounted

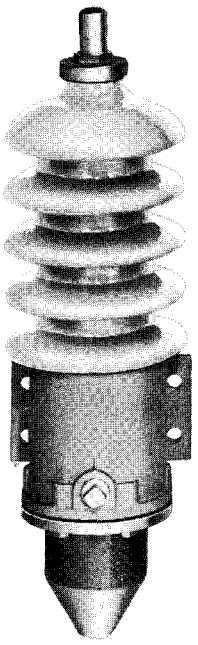
NOTES:

1. These instructions assume that the installer has acquired the appropriate compound to suit the cable insulation material and that the stress cone is installed in accordance with the manufacturer's recommendation. The stress cone procedure should deal with the precise positioning of insulation build up and shielding braid.

2. It is vital that the installer uses clean and dry tools and makes sure that all pothead materials are dry and ready at hand so that installation can proceed without interruptions. The installer should familiarize himself with these instructions by reading them completely prior to starting the pothead installation.

3. Pothead should be mounted temporarily in its final position to determine sufficient clearances are available. The cable should be trained into final location and cut so that the end extends 2'' beyond the top of the pothead.



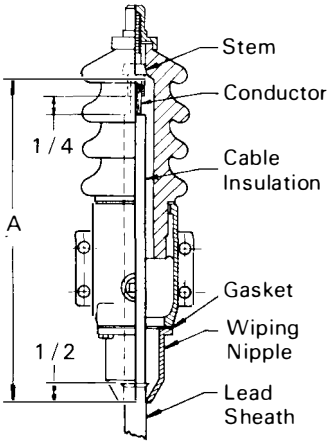


SUBJECT TO CHANGE WITHOUT NOTICE

PLM Products
Division Of The Scott & Fetzer Company
4799 W. 150th St., • Cleveland, Ohio 44135
Phone: 216/267-7080 Telex: 98-5334

INSTALLATION INSTRUCTIONS - SINGLE CONDUCTOR POTHEAD
(FOR USE WITH LEAD SHEATHED CABLES)

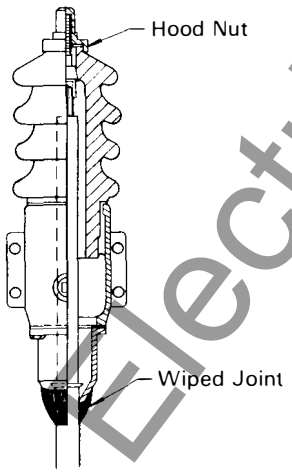
NOTE: THE ILLUSTRATION SHOWS AN OUTDOOR TYPE PORCELAIN. THE INDOOR TYPE IS SIMILAR BUT WITH GREATER NUMBER OF SMALLER SKIRTS.



1. PREPARATION OF CABLE

A. Cut the wiping nipple to fit over the cable. Mark a point on the Lead Sheath about 1/2'' above the bottom of the wiping nipple and allowing 2'' of spare cable above porcelain.
B. Remove the Lead Sheath from the end of the cable to the point marked using a chipping knife, care being used not to damage the insulation.
C. Remove the wiping nipple and gasket from the pothead and slip these parts back over the cable.
D. By means of a blunt tool, bell out the Lead Sheath where it has been cut off.
E. Measure the distance ''A'' from the bottom of the wiping nipple to the bottom of the hole in the stem using a stiff wire and cut cable to length.
F. Remove the cable insulation from the end of the conductor a distance 1/4'' more than the depth of the hole in the stem.
G. Thoroughly tin the exposed conductor strands.
H. Remove the stem from the pothead and thoroughly solder to the conductor.

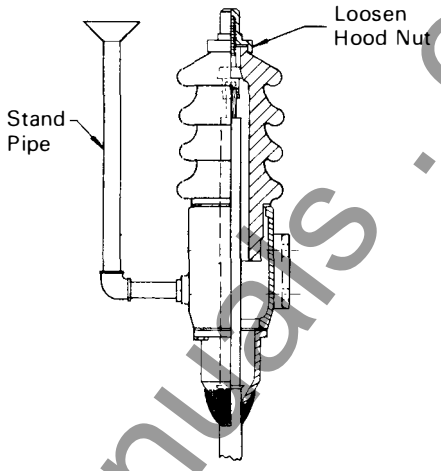
BUILD A STRESS CONE ON THE INSULATED CONDUCTOR IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS.



2. INSERTION OF CABLE

A. Slip the body and its porcelain in place over the cable.
B. Adjust the stem in the insulator to obtain proper seating. This is important since it affects subsequent alignment.
C. Bolt the wiping nipple on to the body insuring that the gasket is properly seated.
D. Slip the hood nut gasket over the stem and screw the hood nut tightly in place insuring it fits square and tight on the porcelain top shoulder.
E. Make a plumbers wiped joint between the wiping nipple and the Lead Sheath **after** the sheath has been scraped clean with a shave hook or rasp for a distance of about 3'' **and** then cleaned with stearine flux.

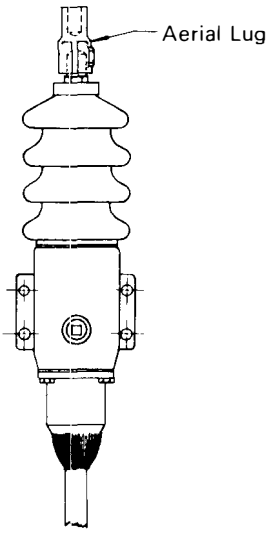
NOTE: WHEN THE STRESS CONE HAS BEEN INSTALLED ENSURE AT LEAST 3/16'' CLEARANCE BETWEEN CONE AND PORCELAIN TO FACILITATE COMPOUND POURING.



3. FILLING WITH COMPOUND

A. Bolt the pothead with cable attached into its final position.
B. Remove the pipe plug from the body and insert a standpipe with filling funnel of sufficient length to extend above the top of the porcelain insulator.
C. Loosen the hood nut to allow escape of air.
When filling, air should naturally egress as the compound rises.
D. Completely fill with compound heated in accordance with the compound manufacturer's instruction up to the neck of the porcelain.
E. Screw the hood nut tightly in place.
F. Leave the standpipe in place maintaining heat on to it until the pothead body cools.

NOTE: THE CORRECT GRADE OF COMPOUND MUST BE SELECTED CONSISTENT WITH THE CHARACTERISTICS OF THE CABLE. THE POTHEAD SHOULD BE PREHEATED TO INSURE COMPOUND DOES NOT CONGEAL UPON CONTACT WITH COLD SURFACES. USE CARE WHEN HEATING TO INSURE FLAME NOT DIRECTLY APPLIED TO PORCELAIN.



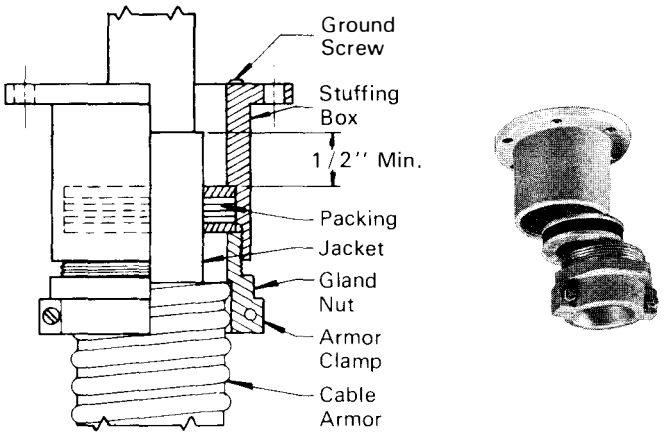
4. FINAL CONNECTION

A. When the compound has cooled sufficiently as evidenced by the pothead body temperature being cool to the touch i.e., below body temperature, remove the standpipe and replace pipe plug in the body.
B. Re-tighten the hood nut and entrance fitting bolts.
C. Bolt the aerial lug with the aerial lead on to the hood nut post and tighten securely.
D. The installation is complete.

It is considered good practice to tape over the aerial lug and hood nut to present a rounded surface to the aerial conductor thus minimizing external corona effects.

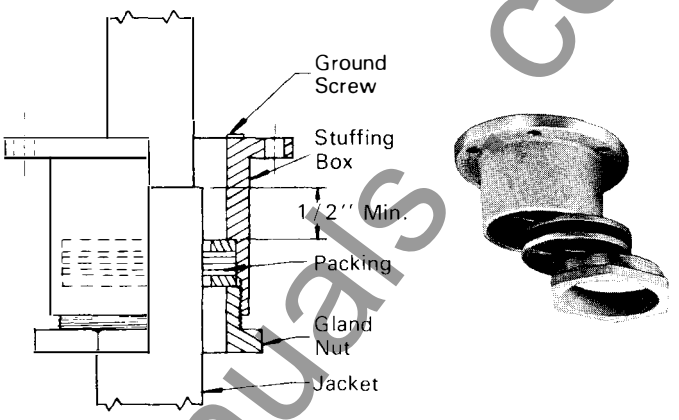
INSTALLATION INSTRUCTIONS FOR POTHEADS WITH ENTRANCE FITTINGS OTHER THAN LEAD WIPING SLEEVE

NOTE: STEPS 3 AND 4 OVERLEAF ARE IDENTICAL FOR POTHEADS WITH ANY ENTRANCE FITTING. THE FOLLOWING INSTRUCTIONS THEREFORE COVER STEPS 1 AND 2 ONLY.



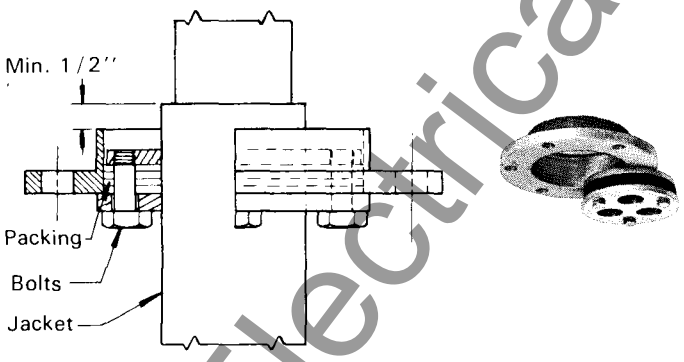
TYPE "RSO" ENTRANCE FITTING FOR ARMORED CABLES

1. A. Allowing 2" spare cable above top of the porcelain mark a point on the armor corresponding to the shoulder within the armor clamp and remove the armor to this point.
   B. Mark a point on the jacket 1/2" above the top plate of the seal and remove any shielding material from the cable insulation to a point 1/2" above the cut jacket.
   C. Slip the armor clamp, packing and entrance fitting over the cable.
   D. Screw the stuffing gland in place compressing the packing around the cable to form a tight seal.
   E. Secure the armor clamp on to the armor.
   F. Measure the distance from the lower flange of the pothead body to the bottom of the hole in the stem and cut cable to this length.
   G. Remove the cable insulation from the end of the conductor 1/4" more than the depth of the hole.
   H. Thoroughly tin the exposed conductor.
   I. Remove the pothead stems and solder onto the conductors.
   J. Install stress cone in accordance with manufacturer's instructions or proceed to Step 2 if not required.



TYPE "RSQ" ENTRANCE FITTING FOR NON ARMORED CABLES

1. A. Allowing 2" spare cable above top of the porcelain mark a point on the jacket 1/2" above the top plate of the seal and remove jacket to this point.
   B. Remove any shielding material from the cable insulation to a point 1/2" above the cut jacket.
   C. Remove the stuffing box from the pothead and assemble it over the cable by screwing the stuffing gland nut tightly into the stuffing box.
   D. Measure the distance from the lower flange of the pothead body to the bottom of the hole in the stem and cut cable to this length.
   E. Remove the cable insulation from the end of the conductor a distance 1/4" more than the depth of the hole in the stem.
   F. Thoroughly tin the exposed conductor.
   G. Install stress cone or proceed to Step 2 if not required.

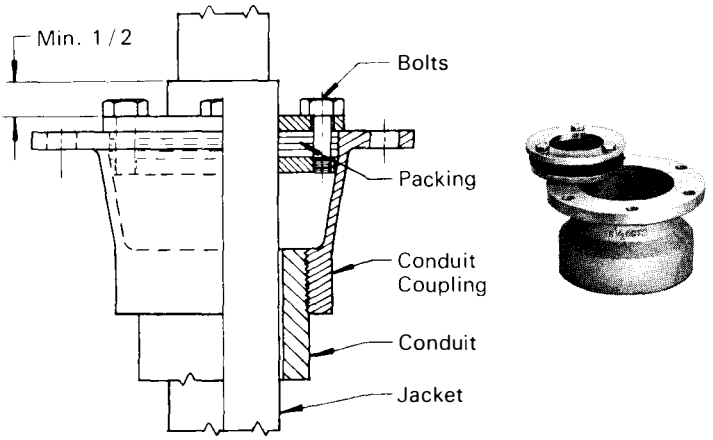


TYPE "RSL" ENTRANCE FITTING FOR NON ARMORED CABLES

1. A. Allowing 2" spare cable above top of the porcelain mark a point on the jacket 1/2" above the top of the entrance fitting and remove jacket to this point.
   B. Remove any shielding material from the cable insulation to a point 1/2" above the cut jacket.
   C. Remove the stuffing box from the pothead and assemble it over the cable by tightening the bolts to compress the packing "sandwich".

   Note: When installed correctly the jacket should protrude 1/2" above top.

   D. Measure the distance from the lower flange of the pothead body to the bottom of the hole in the stem and cut cable to this length.
   E. Remove the cable insulation from the end of the conductor a distance 1/4" more than the depth of the hole in the stem.
   F. Thoroughly tin the exposed conductor.
   G. Remove the pothead stem and solder on to the conductor.
   H. Install stress cone or proceed to Step 2 if not required.

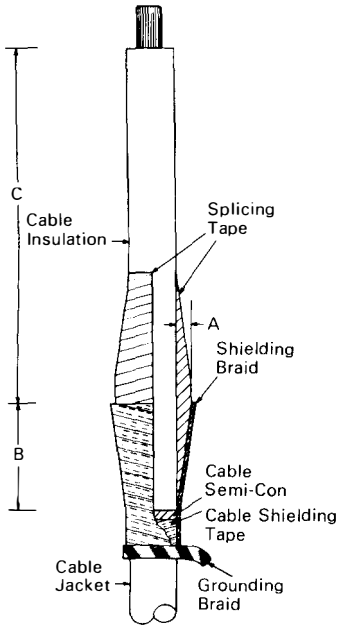


TYPE "RSN" ENTRANCE FITTING FOR CONDUIT COUPLING

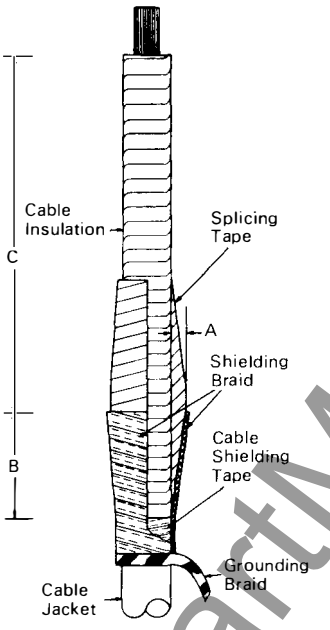
1. A. Allowing 2" spare cable above top of the porcelain mark a point on the jacket 1/2" above the top flange and remove jacket to this point.
   B. Remove any shielding material from the cable insulation to a point 1/2" above the cut off length.
   C. Remove the pipe connection and the packing sandwich from the pothead and screw the pipe connector on to the pipe to allow cable jacket to protrude.
   D. Place the packing sandwich over the cable and compress it down into the pipe connector by means of bolts.
   E. Measure the distance from the bottom of the pothead body to the bottom of the hole in the stem and cut cable to length.
   F. Remove the insulation from the end of the conductor a distance 1/4" more than the depth of the hole in the stem.
   G. Thoroughly tin the exposed conductor.
   H. Remove the pothead stem and solder on to conductor.
   I. Install stress cone or proceed to Step 2 if not required.

NOTE: THE OPERATION OF INSERTING THE PREPARED CABLE END PLUS STEMS INTO THE POTHEAD IS SIMILAR TO THE POTHEAD WITH WIPING NIPPLE EXCEPT FOR STEP 2-B WHICH WILL READ "BOLT ENTRANCE FITTING INTO POSITION" AND STEP 2-E WHICH DOES NOT APPLY.

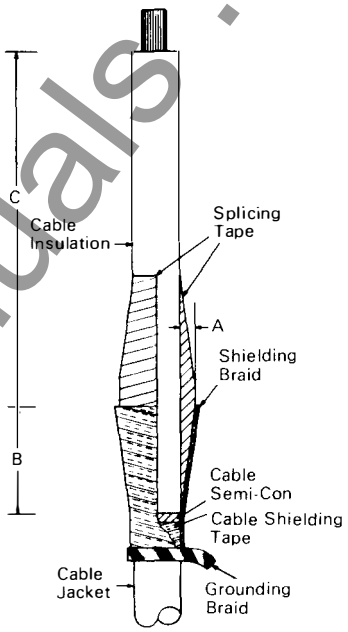
TYPICAL STRESS RELIEF CONES FOR POTHEADS



EXTRUDED INSULATED CABLES — DACRON GLASS CONES			
Voltage	A	B	C Min.
5,000	1/8	1¾	3
8,000	3/16	2½	4
15,000	1/4	3½	5
25,000	5/16	4	8
35,000	3/8	4¾	12
46,000	1/2	5½	18



VARNISHED CAMBRIC OR PAPER INSULATED CABLES — DACRON GLASS CONES			
Voltage	A	B	C Min.
5,000	1/8	1½	3
8,000	3/16	1¾	4
15,000	1/4	2¼	5
25,000	5/16	3	8
35,000	3/8	3½	12
46,000	1/2	4½	18



EXTRUDED INSULATED CABLES — RUBBER TAPE CONES			
Voltage	A	B	C Min.
5,000	3/16	1¾	3
8,000	1/4	2¼	4
15,000	3/8	3½	5
25,000	1/2	4½	8
35,000	3/4	6½	12

DIMENSIONS:

"A" Thickness of applied insulation
"B" Length of cone
"C" Minimum creepage from live conductor to end of shielding.

NOTE: Distance for "C" in these tables are minimum creepage distances. Locating of the stress cone is very important (see dimensions). Sufficient clearance between the porcelain wall of the pothead, cable insulation, and/or stress cone should be 3/16" minimum to allow free passage of the insulating compound.

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IPL M Products
Division Of The Scott & Fetzer Company
4799 W. 150th St., • Cleveland, Ohio 44135
Phone: 216/267-7080 Telex: 98-5334

INSTALLATION INSTRUCTIONS FOR PLM POTHEADS

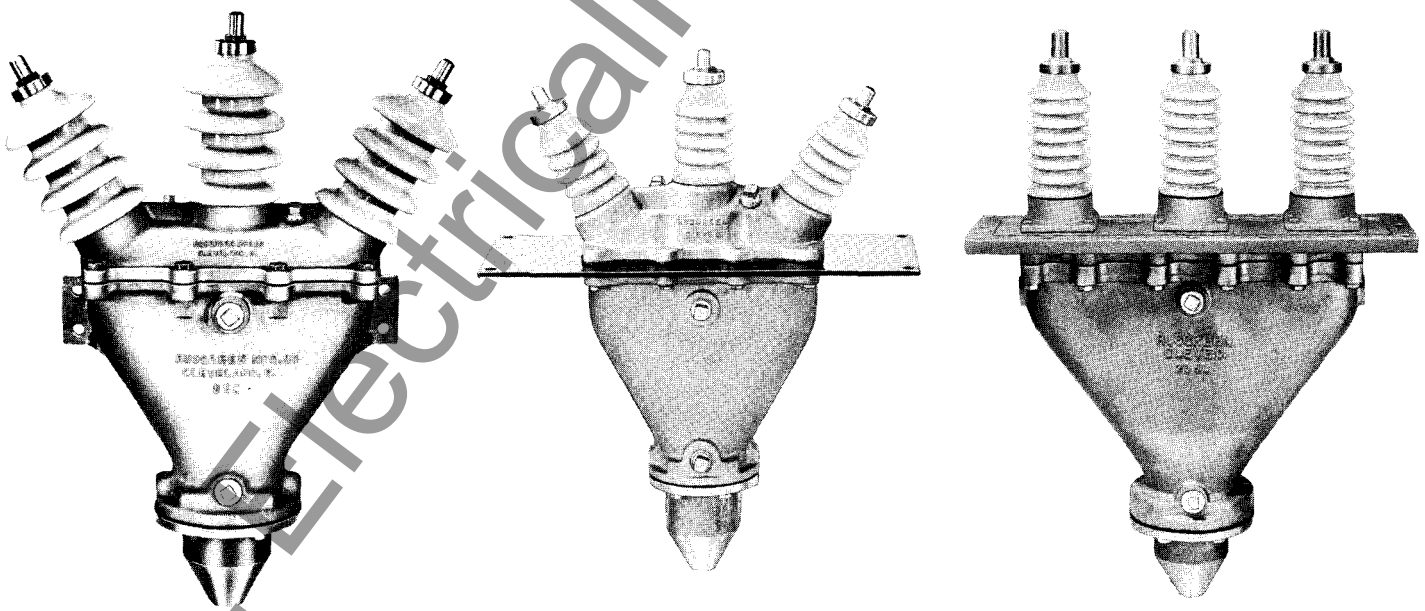
Three Conductor
Bracket-Plate- Flange Mounted

NOTES:

1. These instructions assume that the installer has acquired the appropriate compound to suit the cable insulation material and that the stress cone is installed in accordance with the manufacturer's recommendation. The stress cone procedure should deal with the precise positioning of insulation build up and shielding braid.

2. It is vital that the installer uses clean and dry tools and makes sure that all pothead materials are dry and ready at hand so that installation can proceed without interruptions. The installer should familiarize himself with these instructions by reading them completely prior to starting the pothead installation.

3. Pothead should be mounted temporarily in its final position to determine sufficient clearances are available. The cable should be trained into final location and cut so that the end extends 2'' beyond the top of the pothead.



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PLM Products
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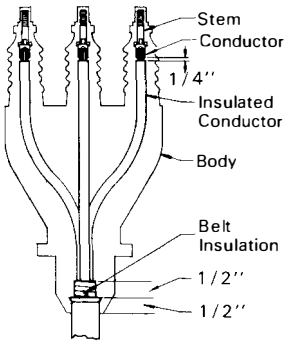
INSTALLATION INSTRUCTIONS-THREE CONDUCTOR POTHEAD
(FOR USE WITH LEAD SHEATHED CABLES)

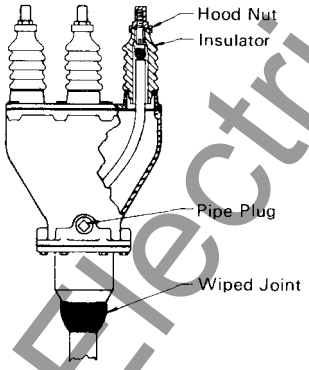
NOTE: THE ILLUSTRATION SHOWS AN INDOOR TYPE. THE OUTDOOR TYPE HAS MORE DISTANCE BETWEEN SKIRTS FOR RAIN DISSIPATION.



1. PREPARATION OF CABLE

A. Cut wiping nipple to fit over cable then mark a point on the Lead Sheath about 1/2'' above the wiping nipple having first allowed sufficient cable to spread the individual conductors into their final position.
B. Remove the Lead Sheath from the end of the cable to the point marked using a chipping knife care being taken not to damage the insulation.
C. Remove the wiping nipple from the pothead body and slide it over the cable and bell out the Lead Sheath with a blunt tool.
D. For Belted Cable, remove the Belt Insulation from the cable to a point 1/2'' above the Lead Sheath. For Shielded Cables, remove the shield to within 1/2'' of the Lead Sheath.
E. Fan out the insulated conductors into their final positions taking care to avoid sharp bends.
F. Using a stiff wire bend it and measure the exact length from the bottom of the wiping nipple to the bottom of the hole in the stem and cut individual conductors to the appropriate length.
G. Remove the cable insulation from the end of the conductors a distance 1/4'' more than the depth of the hole in the stems.
H. Thoroughly tin the exposed conductors.
I. Remove the stems from the pothead and thoroughly solder to the conductors.

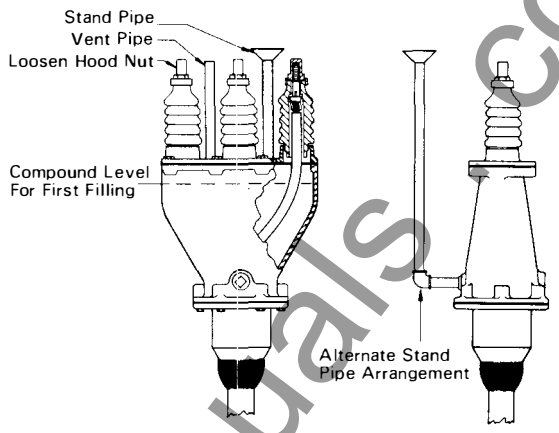
BUILD STRESS CONES ON THE INSULATED CONDUCTORS IN ACCORDANCE WITH THE MANUFACTURER'S INSTRUCTIONS.



2. INSERTION OF CABLE

A. Place the body over the cable and bolt it into its final position.
B. Bring the wiping nipple and gasket into position and bolt to the body.
C. Slip the lid and porcelains in place over the individual cables, adjust the stems to obtain proper seating and then bolt the lid and gaskets tightly to the body.
D. Slip the hood nut gaskets over the stems and screw the hood nuts tightly in place insuring they fit square and tight on the top shoulder of the porcelains.
E. Make a plumbers wiped joint between the wiping nipple and the Lead Sheath **after** the sheath has been scraped clean with a shave hook or rasp for a distance of about 3'' then cleaned with stearine flux.

NOTE: WHEN STRESS CONES HAVE BEEN INSTALLED INSURE AT LEAST 3/16'' CLEARANCE BETWEEN THE CONES AND THE PORCELAINS TO FACILITATE COMPOUND POURING.



3. FILLING WITH COMPOUND

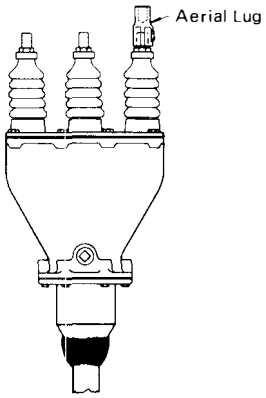
A. Remove the pipe plugs from the lid and insert a standpipe with filling funnel of sufficient length to extend beyond the top of the insulators.
B. Loosen the hood nuts to allow escape of air.

Note: When filling, air should naturally egress as the compound rises.

C. Fill with compound heated in accordance with manufacturer's instructions to the level indicated above and allow to cool.
D. Place vent pipe in the lid and fill the pothead with compound up to the neck of the porcelains.
E. Screw the hood nuts tightly in place and plug vent pipe tightly.
F. Leave the standpipe in place maintaining heat on to it until the pothead body cools

NOTE: THE CORRECT GRADE OF COMPOUND MUST BE SELECTED CONSISTENT WITH THE CHARACTERISTICS OF THE CABLE. THE POTHEAD SHOULD BE PREHEATED TO INSURE COMPOUND DOES NOT CONGEAL UPON CONTACT WITH COLD SURFACES. USE CARE WHEN HEATING TO INSURE FLAME NOT DIRECTLY APPLIED TO PORCELAINS.

The alternate method of filling with the standpipe connected at the lower pipe plug requires the pothead to be filled to the neck of the porcelains at the first filling venting as above and then maintaining heat on fill pipe until pothead cools.



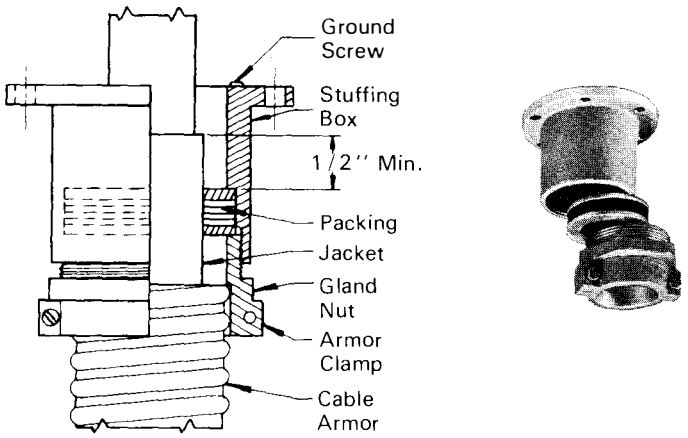
4. FINAL CONNECTION

A. When the compound has cooled sufficiently as evidenced by the pothead body temperature being cool to the touch i.e., below body temperature, remove the stand and vent pipes and replace pipe plugs.
B. Re-tighten the hood nuts, the lid and entrance bolts.
C. Bolt the aerial lugs with the aerial leads attached on to the hood nut posts and tighten securely.
D. The installation is complete.

It is considered good practice to tape over the aerial lugs and hood nuts to present a rounded surface to the aerial conductors thus minimizing external corona effects.

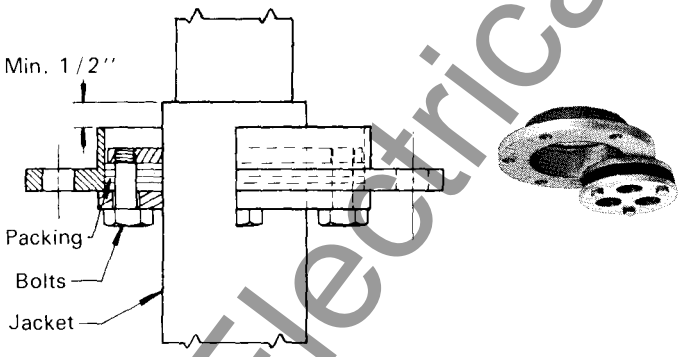
INSTALLATION INSTRUCTIONS FOR POTHEADS WITH ENTRANCE FITTINGS OTHER THAN LEAD WIPING SLEEVES

NOTE: STEPS 3 AND 4 OVERLEAF ARE IDENTICAL FOR POTHEADS WITH ANY ENTRANCE FITTING. THE FOLLOWING INSTRUCTIONS THEREFORE COVER STEPS 1 AND 2 ONLY.



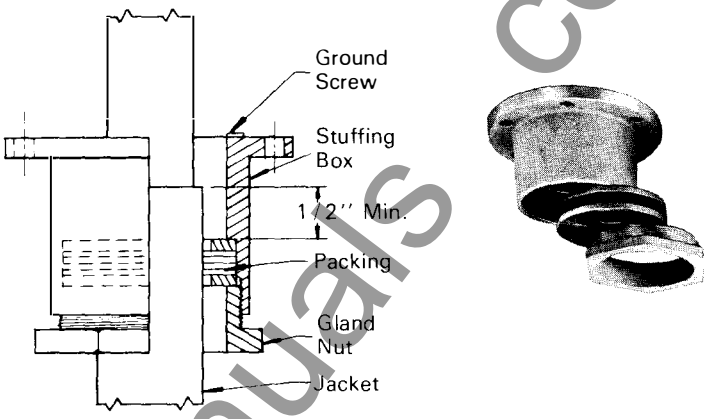
TYPE "RSO" ENTRANCE FITTING FOR ARMORED CABLES

1. A. Allowing 2" spare cable above top of the porcelain mark a point on the armor corresponding to the shoulder within the armor clamp and remove the armor to this point.
   B. Mark a point on the jacket which will enable correct location of the stress cone and remove the jacket to this point. Remove any shielding material from the cable insulation to a point 1/2" above the cut jacket.
   C. Slip the armor clamp, packing and entrance fitting over the cable.
   D. Screw the stuffing gland in place compressing the packing around the cable to form a tight seal.
   E. Secure the armor clamp on to the armor.
   F. Measure the distance from the lower flange of the pothead body to the bottom of the hole in the stem for each conductor and cut cables to these lengths.
   G. Remove the cable insulation from the end of the conductor 1/4" more than the depth of the hole.
   H. Thoroughly tin the exposed conductor.
   I. Remove the pothead stem and solder on to the conductor.
   J. Install stress cones or proceed to Step 2 if not required.



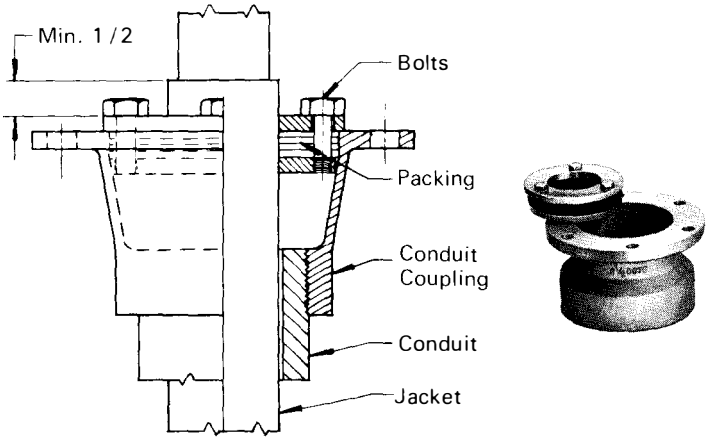
TYPE "RSL" ENTRANCE FITTING FOR NON ARMORED CABLES

1. A. Allowing 2" spare cable above top of the porcelain mark a point on the jacket which will enable correct location of the stress cone and remove jacket to this point.
   B. Remove any shielding material from the cable insulation to a point 1/2" above the cut jacket.
   C. Remove the stuffing box from the pothead and assemble it over the cable by tightening the bolts to compress the "sandwich".
   D. Measure the distance from the lower flange of the pothead body to the bottom of the hole in the stem for each conductor and cut cables to these lengths.
   E. Remove the cable insulation from the end of the conductor a distance 1/4" more than the depth of the hole in the stem.
   F. Thoroughly tin the exposed conductor.
   G. Remove the pothead stem and solder on to the conductor.
   H. Install stress cones or proceed to Step 2 if not required.



TYPE "RSQ" ENTRANCE FITTING FOR NON ARMORED CABLES

1. A. Allowing 2" spare cable above top of the porcelain mark a point on the jacket which will enable correct location of the stress cone and remove jacket to this point.
   B. Remove any shielding material from the cable insulation to a point 1/2" above the cut jacket.
   C. Remove the stuffing box from the pothead and assemble it over the cable by screwing the stuffing gland nut tightly into the stuffing box.
   D. Measure the distance from the lower flange of the pothead body to the bottom of the hole in the stem for each conductor and cut cables to these lengths.
   E. Remove the cable insulation from the end of the conductor a distance 1/4" more than the depth of the hole in the stem.
   F. Thoroughly tin the exposed conductor.
   G. Remove the pothead stem and solder to conductor.
   H. Install stress cones or proceed to Step 2 if not required.

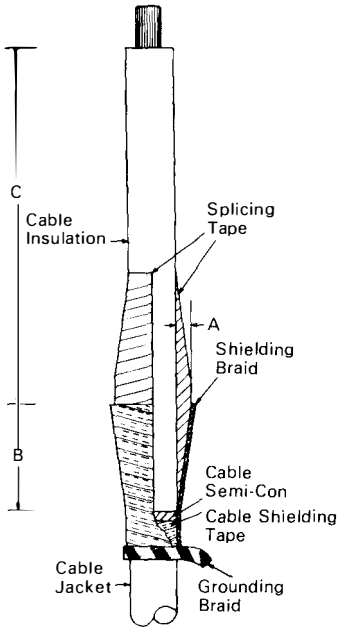


TYPE "RSN" ENTRANCE FITTING FOR CONDUIT COUPLING

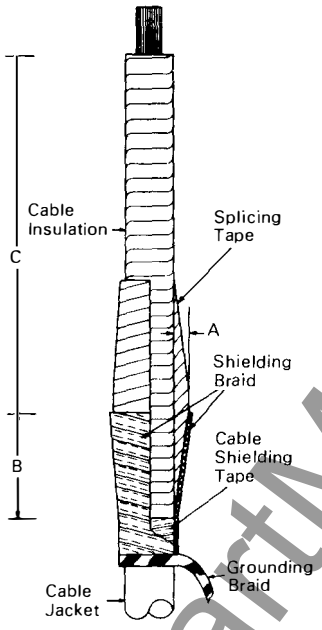
1. A. Allowing 2" spare cable above top of the porcelain mark a point on the jacket which will enable correct location of the stress cone and remove jacket to this point.
   B. Remove any shielding material from the cable insulation to a point 1/2" above the cut jacket.
   C. Remove the pipe connection and the packing sandwich from the pothead and screw the pipe connector on to the pipe to allow cable jacket to protrude.
   D. Place the packing sandwich over the top and compress it down into the pipe connector by means of the flange bolts.
   E. Measure the distance from the bottom of the pothead body flange to the bottom of the hole in the stem for each conductor and cut cables to length.
   F. Remove the insulation from the end of the conductor a distance 1/4" more than the depth of the hole in the stem.
   G. Thoroughly tin the exposed conductor.
   H. Remove the pothead stem and solder on to conductor.
   I. Install stress cones or proceed to Step 2 if not required.

NOTE: THE OPERATION OF INSERTING THE PREPARED CABLE END PLUS STEMS INTO THE POTHEAD IS SIMILAR TO THE POTHEAD WITH WIPING NIPPLE EXCEPT FOR STEP 2-B WHICH WILL READ "BOLT ENTRANCE FITTING INTO POSITION" AND STEP 2-E WHICH DOES NOT APPLY.

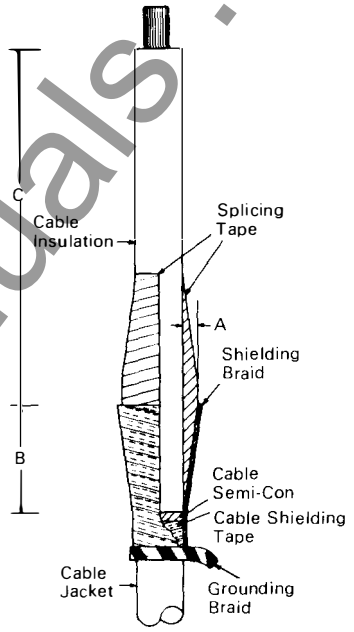
TYPICAL STRESS RELIEF CONES FOR POTHEADS



EXTRUDED INSULATED CABLES — DACRON GLASS CONES			
Voltage	A	B	C Min.
5,000	1/8	1¾	3
8,000	3/16	2½	4
15,000	1/4	3½	5
25,000	5/16	4	8
35,000	3/8	4¾	12
46,000	1/2	5½	18



VARNISHED CAMBRIC OR PAPER INSULATED CABLES — DACRON GLASS CONES			
Voltage	A	B	C Min.
5,000	1/8	1½	3
8,000	3/16	1¾	4
15,000	1/4	2¼	5
25,000	5/16	3	8
35,000	3/8	3½	12
46,000	1/2	4½	18



EXTRUDED INSULATED CABLES — RUBBER TAPE CONES			
Voltage	A	B	C Min.
5,000	3/16	1¾	3
8,000	1/4	2¼	4
15,000	3/8	3½	5
25,000	1/2	4½	8
35,000	3/4	6½	12

DIMENSIONS:

''A'' Thickness of applied insulation
''B'' Length of cone
''C'' Minimum creepage from live conductor to end of shielding.

NOTE: Distance for ''C'' in these tables are minimum creepage distances. Locating of the stress cone is very important (see dimensions). Sufficient clearance between the porcelain wall of the pothead, cable insulation, and/or stress cone should be 3/16'' minimum to allow free passage of the insulating compound.

SUBJECT TO CHANGE WITHOUT NOTICE

INSTRUCTIONS

FUSING AND RE-FUSING

CAUTION: Refill units should be stored in a dry place and kept in the carton until used.

Storage indoors, in a clean, dry place, is required for indoor style holders and recommended for outdoor style holders. If an unloaded outdoor holder is stored outdoors, it must not be left in such a position that the glass-epoxy tube inside the porcelain housing can get wet. Store the holder in an upright position and keep the lower ferrule opening closed by the cork inserted at the factory.

The rain shield on the lower ferrule of the outdoor holder helps to prevent water or dirt from entering the holder when it is left hanging open for *short* periods of time. However, since the rain shield is not a positive sealing device, the holder should be removed from the mounting when it is not in service.

Handle *loaded* holders with care – do not drop or throw them.

FUSING

WITHOUT SNUFFLER, MUFFLER, or SNEEZER

Step 1. Remove the hexagonal clamping nut from the end of the holder.

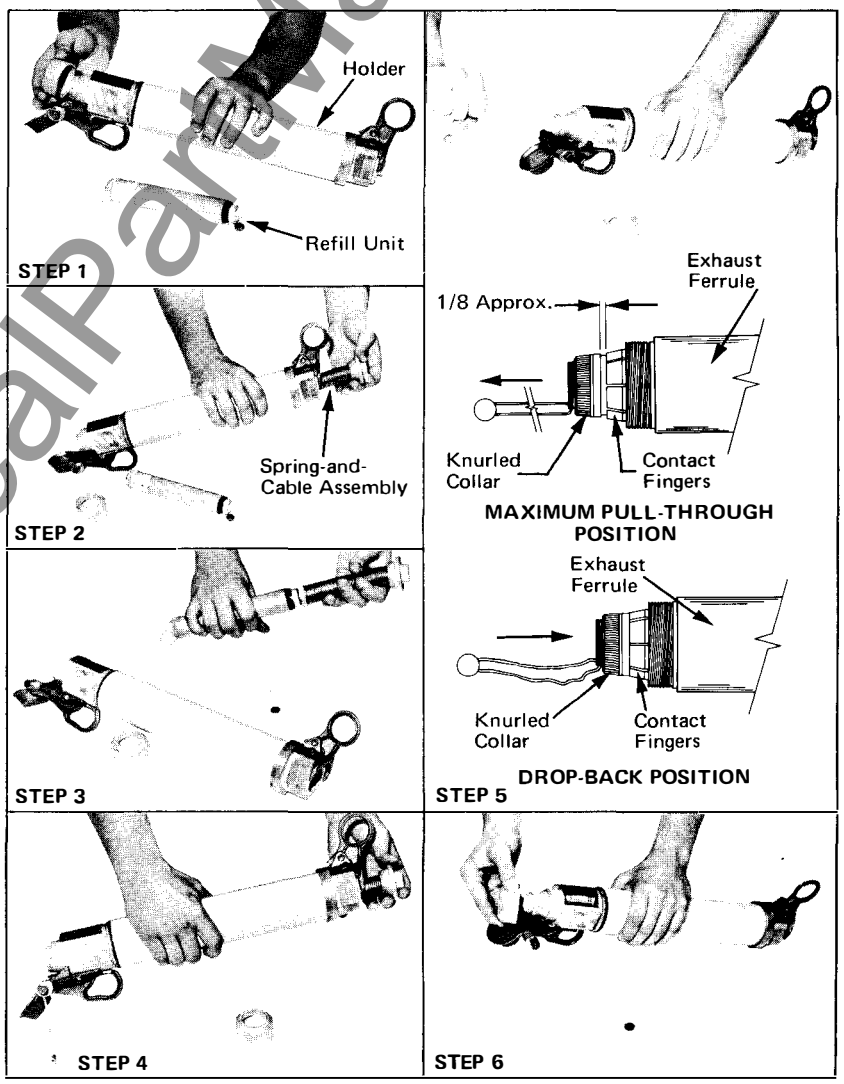
Step 2. Unscrew and withdraw the holder cap – to which is attached the spring-and-cable assembly.

Step 3. Screw a refill unit of correct ampere and voltage rating tightly onto the lower end of the spring-and-cable assembly. Do not use a wrench. Before proceeding to Step 4, check to see that the knurled collar at the other end of the refill unit is tight against the shoulder of the refill-unit ferrule.

Step 4. Insert this combination into the holder and screw the cap down tight. The final fractional turn should be made with a wrench.

Step 5. Carefully draw the refill pull-cord out through the holder, against spring tension, until the contact fingers of the holder latch behind the knurled collar of the refill unit. Avoid jerking and excessive overtravel, which may damage low-ampere refills. Release refill pull-cord slowly, permitting collar to rest on the spring contact fingers. Remove and discard the cord.

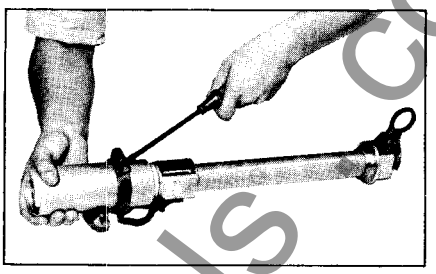
Step 6. Replace the hexagonal clamping nut, screwing down firmly to lock the refill unit in place. To ensure adequate electrical contact, the final fractional turn should be made with a wrench.



FUSING

WITH SNUFFLER, MUFFLER, or SNEEZER — DISCONNECT STYLE

1. Loosen clamp bolt and pry clamp apart slightly,* as illustrated in Step 1.
2. Unscrew and remove snuffler.† A bar or wrench handle can be used to loosen the snuffler.† (See Step 2.)
3. Install refill unit as described in Steps 2 through 5 on page 1.
4. *REPLACE SNUFFLER,*† screwing in firmly. Final fractional turn should be made with a bar or wrench handle.
5. Tighten clamp bolt.



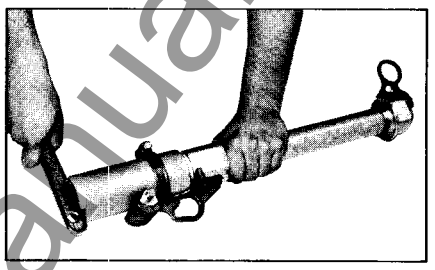
Step 1

WITH SNUFFLER, MUFFLER, or SNEEZER — NON-DISCONNECT STYLE

Proceed as above, omitting Steps 1 and 5.

WITH RAIN SHIELD (used on outdoor horizontal mountings)

1. Loosen clamp and remove rain shield.
2. Proceed as in Steps 1 through 6, page 1.
3. Replace rain shield, positioning it for maximum weather shielding.
4. Tighten clamp.



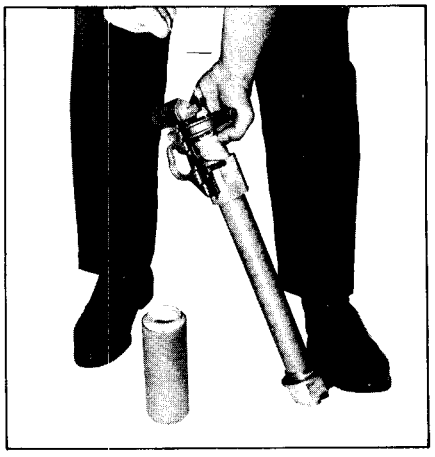
Step 2

RE-FUSING BLOWN FUSES

1. Remove the hexagonal clamp nut, or the snuffler,† as described under "Fusing."
2. Remove and discard the blown refill unit.
3. Unscrew holder cap as illustrated in Step 2, page 1. Withdraw the spring-and-cable assembly.
4. Unscrew and discard the arcing terminal of the blown refill unit. Wipe clean all contact surfaces but do not clean with an abrasive as the silver plating may thus be damaged. If the spring is damaged, install a new spring-and-cable assembly.
5. After a heavy fault, the interior of the glass-epoxy tube of the fuse holder should be wiped clean to remove any dust and metallic particles that may be present.
6. After a heavy fault, the snuffler† should be washed in water and carefully inspected before reusing. If the internal parts are badly burned as a result of an extremely high fault, replacement of the entire snuffler† is recommended.
7. Using a new refill unit of correct ampere and voltage rating, fuse and reassemble as described under "Fusing."

RE-FUSING UNBLOWN FUSES

1. Remove the hexagonal clamp nut, or the snuffler,† as described under "Fusing."
2. Insert a cord or wire through the small hole in the projecting threaded portion of the ferrule of the refill unit. Pull refill unit outward about 1/8 inch.
3. Unscrew and remove the knurled collar from the refill unit and allow the refill unit to slide *slowly* back into the holder.
4. Unscrew the holder cap as illustrated in Step 2, page 1. Withdraw the spring-and-cable assembly and refill unit. Unscrew refill unit from spring-and-cable assembly, replace with refill unit of desired ampere rating, and reassemble as described under "Fusing."
5. Replace the knurled collar that was removed in Step 3. To simplify reapplication of the replaced refill unit, insert a cord 28″ in length through the hole referred to in Step 2.



Steps 2 and 3

Important: If the replaced refill unit is *not* to be used immediately, place it in a polyethylene bag and then in a refill-unit carton; mark carton with correct ampere rating and store in a dry place.

* SM-4 holders only.
† Or muffler or sneezer.

INSTRUCTIONS

GEI-10951M
Supersedes GEI-10951L
and GEI-18020

CURRENT-LIMITING FUSE UNITS TYPES EJ-1, EJO-1, AND EJO-3

INTRODUCTION

A Type EJ-1 fuse unit --for indoor use-- or a Type EJO-1 fuse unit--for indoor or outdoor use--consists of a fuse tube having metal ferrules at each end and containing current-responsive elements surrounded by a quartz filler. When the fuse functions, the arc resulting from the melting of the current-responsive elements is cooled by the adjacent filler and extinguished without any expulsion of gases or material from the tube. The maximum current passing through the fuse before the arc is extinguished is limited to a value considerably lower than the maximum short-circuit current usually available in the circuit.

APPLICATION

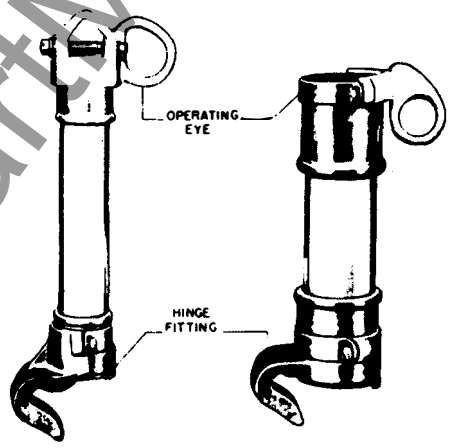
Fuse unit, Types EJ-1 and EJO-1, with suffix "E" on the current rating conform with ANSI Power Voltage Fuse Standards. They will carry current up to their "E" ampere rating continuously; fuse units rated 100E amperes and below will melt at a current between 200% and 240% of the rating in five minutes, and fuse units rated 125E amperes and above will melt at a current between 220% and 264% of their rating in ten minutes.

For a given application the recommended voltage rating of the fuse unit is that nearest to, but greater than, the line-to-line circuit voltage. In no case should the line-to-line voltage be less than 70 per cent of the nominal voltage of the fuse unit nor greater than the maximum design voltage rating.

When the fuse units are rated 25/60 cycles, they may be used on systems from 25 to 60 cycle frequency. When rated for 60 cycles only, they may be used on frequencies of either 50 or 60 cycles.

The "E" current rating must be equal to or larger than the maximum load current in the circuit, and at the same time, the current-responsive element must also be of sufficient size so as not to be damaged by magnetizing inrush current of associated transformers. For detailed application data, and also for time-current and current-limiting curves, refer to the nearest General Electric Sales Office.

Fig. 1 (354210)



Size C 4800 Volts Size D 2400 Volts

Fig. 1 Type EJ-1 Fuse Units Assembled with Fittings for Type EK-3C and EK-3D Fuse Disconnecting Switches

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.

DISTRIBUTION PROTECTIVE EQUIPMENT DEPARTMENT
PITTSFIELD, MASS.

GENERAL ELECTRIC

RATINGS

Fuse units are made in several different diameters of tube and ferrule assemblies. Each ferrule diameter is designated by a "size" letter, with the relation between size and letter being shown in Table 1. The tabulation also shows the voltage ratings for which each size is manufactured.

TABLE 1

Size	Ferrule Diameter	Maximum Design Rating, Volts
A	13/16"	600, 2750
B	1 9/16"	2750, 5500, 8250, 15,500
C	2"	2750, 5500, 8250, 15,500, 25,800
D	3"	2750, 5500, 8250, 15,500, 25,800 38,000
DD	2-3" in Parallel	2750, 5500, 8250, 15,500, 25,800 38,000
EE	2-4" in Parallel	15,000

INSTALLATION

A suitable fuse support is required to use the fuse unit. With Type EK-3 and EKO-3 fuse disconnecting switches, fittings for the fuse unit are furnished to make it suitable for use as a disconnecting blade. To attach these fittings to a Size C or Size D fuse unit, slide them on the ferrules of the fuse unit and clamp in place in the position shown in Fig. 1. With a Size DD fuse unit, attach the hinge fitting to the bottom ferrule of one tube and the operating eye to the top ferrule of the other tube, as shown in Fig. 2. In all cases, the hinge fitting should be located at the end of the fuse containing the indicating target, for ease of viewing from below. The target end of Size D, DD and some C fuse units has a concave appearance (see left side of Fig. 3 as distinguished from the flat cap closing the other end, or ends in the case of Size DD) of the fuse tube. The remaining C size fuses and the B size fuses have button indicators.

Unless special means are provided for disconnecting the entire fuse support or switch from all sources of power, the fuse unit should be removed and inserted only with insulated fuse tongs.

OPERATION

When a fuse unit functions, it should be replaced by a complete new unit. Always use a fuse tongs for handling unless special means are provided for disconnecting the fuse support from all sources of power. If used in a fuse disconnecting switch, the fittings should be removed from the blown unit and transferred to a replacing unit. The time required to replace a blown fuse unit in a disconnecting switch may be considerably shortened if a spare fuse unit with fittings in place is kept on hand at each installation.

The indicating target provided at one end of the larger sizes of fuse units, operates when the fuse unit functions. Its operation is provided by a separate mechanism within the fuse tube, and is not due to any pressure developed by the main fuse elements in functioning. The appearance of the target for some size C and larger fuse units is shown, before and after operation, in Fig. 3. Size B and the remainder of the size C fuse units have an indicator consisting of a small plunger which projects from the end of the fuse unit after the fuse unit functions.

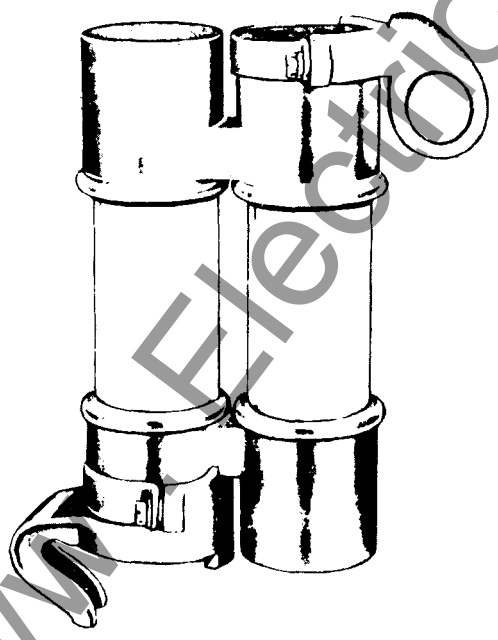
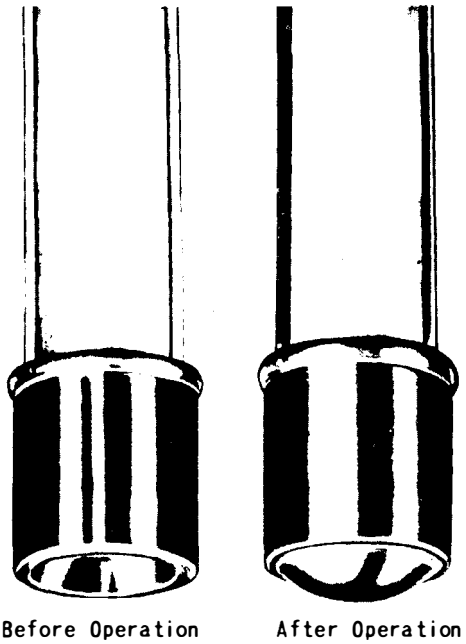


Fig. 2 Size DD Fuse Unit Assembled with Fittings for Type EK-3DD Fuse Disconnecting Switch



Before Operation After Operation

Fig. 3 Indicating Targets of Size C Fuse Units

RENEWAL PARTS

SECONDARY SUBSTATION TRANSFORMERS

Item Number	Description
101	High-Voltage Bushing
102	Low-Voltage Bushing
103	Neutral Bushing
104	Liquid Temperature Indicator
105	Liquid Level Gage
106	Pressure-Vacuum Gage
107	Fan
108	Fault-Pressure Relay
109	Gaskets, High-Voltage Bushing
110	Gaskets, Low-Voltage Bushing
111	Gaskets, Neutral Bushing
112	Gaskets, Liquid Temp. Ind.
113	Gasket, Liquid Level Gage
114	Gasket, Fault Pressure Relay
115	Gasket, Drain Valve
116	Gaskets, Tap Changer
117	Gasket, Pressure-Relief/Handhole

Refer to the transformer outline drawing for the location of these parts and for any unlisted items. Note that neutral bushings, fans, and the fault-pressure relay are optional features and may not be included with all transformers.

Orders for Renewal Parts should be placed with the nearest Apparatus Sales Office of the General Electric Company. Specify the quantity required and give the TRANSFORMER SERIAL NUMBER, and DESCRIPTION of the desired parts. If the required items are not identified on this list or the outline drawing, describe the part(s) in detail and include the SERIAL NUMBER of the TRANSFORMER.

MEDIUM TRANSFORMER PRODUCTS DEPARTMENT
GENERAL ELECTRIC COMPANY
ROME, GEORGIA 30161

GENERAL ELECTRIC