

# Westinghouse

## INERTEEN TRANSFORMERS

Instruction Book

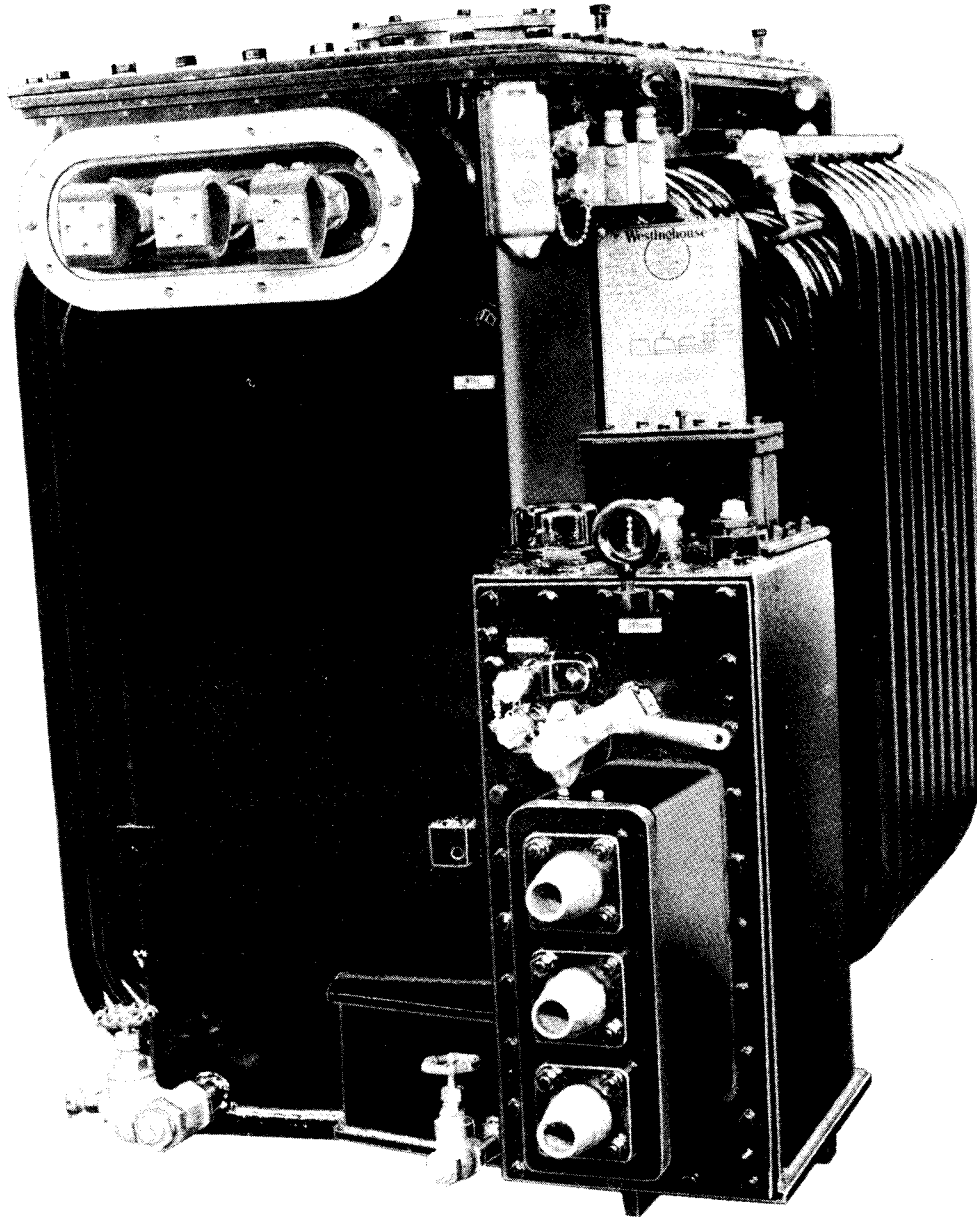


FIG. 1—500 KVA. INERTEEN TRANSFORMER

Westinghouse Electric & Manufacturing Company

Sharon Works

Sharon, Pa.

I. B. 5802  
Filing No. 00-200

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# I N E R T E E N

Inerteen, developed by Westinghouse Engineers, is a synthetic non-inflammable and non-explosive insulating and cooling liquid used in Westinghouse Inerteen Transformers.

## CHARACTERISTICS

Color . . . . .	.Straw-Yellow
Odor . . . . .	.Slightly Aromatic
Viscosity at 100°F. (Saybolt). . . . .	.50 Seconds
Flash Point. . . . .	.None
Fire Point . . . . .	.None
Boiling Point. . . . .	.440°F.
Freezing Point . . . . .	.-40°F.
Specific Gravity at 60°F . . . . .	.1.555
Coefficient of Expansion per °C. . . . .	.00078
Specific Heat (Cal./cc). . . . .	.40
Dielectric Constant. . . . .	4.42
Dielectric Strength. . . . .	35 to 40 K.V.

Mineral oil is completely miscible with Inerteen. It is practically impossible to separate mineral oil and Inerteen; therefore, it is important to avoid contamination of Inerteen with any oil as the presence of such materials markedly changes the non-inflammable and non-explosive characteristics of Inerteen.

Inerteen is chemically stable. It is not affected by reaction with other materials used in the manufacture of Inerteen Transformers. It is non-oxidizing and non-corrosive at temperatures considerably above those normally obtained in transformers. Inerteen will not form sludge under any conditions.

Inerteen exerts a strong solvent action on most of the ordinary varnishes, gums and paints commonly used in oil-insulated transformers. Such materials, therefore, cannot be used in the design and construction of Inerteen Transformers. It is necessary to use such materials as pure cellulose, cotton, paper and porcelain. This requirement, coupled with the necessary use of tight-tank construction for Inerteen Transformers tends to give improved operating characteristics.

If Inerteen is decomposed by an electric arc, hydrogen chloride gas is evolved. In case of arcing, the products of arc decomposition are definitely harmful and the Inerteen will have to be reconditioned. Where severe arcing occurs, the solid insulation of the transformer would become saturated with the products of arc decomposition and the affected parts must be removed from the transformers.

With reference to the dielectric strength of Inerteen it compares favorably with and under average normal conditions will be found higher than that of transformer oil. The same precautions are necessary with Inerteen as are taken with transformer oil. Inerteen should be kept free of moisture, lint and dirt.

## INERTEEN

Inerteen has an irritating effect upon the skin. This is more pronounced to some persons than to others. Especially the eyes, nose and lips are affected when coming in contact with Inerteen and certain safety precautions must be observed when handling it. When working with the hands in Inerteen, it will irritate skin abrasions or the tender parts between the fingers. Continued exposure may cause skin eruptions with certain individuals due to absorption of the Inerteen through the pores of the skin. Cleanliness among workmen handling Inerteen is essential and a very good safeguard against such effects. An application of castor oil is recommended for the eyes and castor oil or cold cream for the nose and lips. In case Inerteen comes in contact with the skin, the part should be thoroughly washed and cleaned. A supply of these materials should be kept available at all times where men are working with Inerteen.

Hot transformers should not be opened except in well ventilated places. Large quantities of Inerteen should be handled in a closed system. Workmen should be protected from frequent contact with any appreciable vapor concentration and from frequent skin contact with Inerteen.

In case Inerteen is spilled on one's clothing, it should be changed as soon as possible and the soiled clothing laundered before it is worn again. Special gloves, M-7530-6, which are resistant to Inerteen, should be worn where parts of transformers are handled wet.

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### SHIPMENT

Inerteen Transformers are always constructed in tight tanks which permit no breathing.

Inerteen Transformers are shipped properly filled with Inerteen and ready for installation. This prevents the entrance of moisture into the windings during transit and usually makes it unnecessary to dry the transformers prior to installation.

Transformers equipped with switch or terminal chamber which must be opened for installation, are always shipped with the Inerteen for these chambers in separate cans or steel drums.

Inerteen must always be kept in sealed containers to prevent the loss of its more volatile constituents by evaporation or possible contamination from dirt or moisture.

### MOVING TRANSFORMERS

Lugs are provided for lifting the complete transformer, and when necessary, additional means are provided for lifting the different parts. The transformer should be lifted by the means provided and when necessary, spreaders should be used to obtain a balanced lift. Transformers should not be moved or lifted by placing jacks or other devices against or under cooling tubes, radiators, valves or other fittings. Skids should be used to distribute the stresses properly over the base when transformers are moved on rollers.

### INSPECTION

Carefully inspect the transformers for possible damage during shipment.

This should include a check of the Inerteen level and at least the removal of the manhole to determine whether any parts have become loose or out of place and whether there is any evidence of moisture present. Insulation tests of the Inerteen should be made and if the dielectric strength is less than 22 K.V. or if there is any evidence of moisture, the transformer should be dried.

Inerteen Transformers are carefully tested at the Factory and in good condition when shipment is made but it is desirable to inspect every transformer carefully before placing it in service.

### GROUNDING AND MAKING CONNECTIONS

No matter what the type of floor or foundation on which the transformer is to rest, the tank should be definitely and permanently grounded by connecting to the grounding connection provided for that purpose near the bottom of the tank.

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Terminal board, tap changer and other connections should never be changed with voltage on the transformer. Do not make any connections except those indicated on the diagram or the diagram nameplate shipped with the transformer.

Any lead or connector not in use should be insulated from any other leads and connectors and from ground.

### GASKETS

Gaskets used on Inerteen Transformers are made from a high grade cork and, it is recommended, in replacing any gaskets that they be made of cork. Before replacing a gasket, all gasket surfaces should be thoroughly cleaned free of rust, oil, grease, paint or other foreign materials. The cleaning may be done by scraping or wire-brushing and then wiping the gasket surface with denatured alcohol.

Gasket Cement, M-7386, especially developed for use with Inerteen, should always be used in applying gaskets to Inerteen Transformers. Thoroughly brush the cement on the tank surface, place the gasket in position and apply weights or other means to obtain good adhesion of the gasket to the metal surface. The gasket should be allowed to set approximately one-half hour before the weights are removed. Cement M-7386 should then be applied to the top surface of the gasket. The gasket surfaces must immediately be bolted together under a uniform pressure.

Some transformers are equipped with terminal or switch compartments into which cables enter by means of potheads. In such cases, it will be necessary to remove the switch-cover.

When transformers are designed for bayonet connections, it is only necessary to remove the bayonet pothead, make the cable connections and replace the pothead.

Extra gaskets with Cement M-7386, are furnished with all Inerteen Transformers where their installation requires the removal of any gaskets. Additional gaskets and cement should be ordered from the manufacturer.

### PIPE FITTINGS

Care should be used to see that threads of pipe fittings are not damaged. Their threads should be thoroughly cleaned to remove all dirt, grease, etc. After cleaning, apply Cement M-7386 to the threads of each fitting. Immediately screw the proper fittings together tightly.

### PRESSURE TESTING

Inerteen Transformers should be pressure tested before they are put into service. The tanks, including all compartments, should be subjected to a pressure of 7 lbs. per square inch for

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at least six hours. Preferably, this test should be made after the transformer installation is complete and before voltage is applied to it. It is suggested that the air space above the Inerteen be blown out by using a nitrogen-cylinder, after which all vents should be closed and the pressure test applied. The test-pressure, in order to avoid subjecting the tank or compartment under test to excessive pressure, can best be limited by a regulating valve on the nitrogen-cylinder. A check for leaks above the Inerteen level can be made with a solution of soap and water applied to all gasketed joints, pipe fittings and wiping sleeve connections.

### PAINT

Inerteen Transformers are finished with a special paint which is resistant to the solvent action of Inerteen. A sufficient quantity of this paint, M-7664-1, is furnished with each transformer to "touch up" any damage caused during the normal process of installation.

### STORAGE

Inerteen Transformers must always be stored filled with Inerteen, otherwise a certain amount of moisture will most certainly accumulate on account of variations of air temperature. The Inerteen level should always be checked to see that it is at the proper point. Inerteen Transformers should be stored in a dry place, one where minimum temperature changes will occur.

If there is any reason to store coils, insulation or other parts for the complete core and coil assembly of an Inerteen Transformer, they should be immersed in Inerteen to prevent any moisture absorption. If such storage is necessary for a long period of time, the tank or storage container must be sealed to prevent the evaporation of Inerteen.

Inerteen Transformers which have been idle or stored for an appreciable length of time, should be put into service only after making certain that the transformer is dry and that the dielectric strength of the Inerteen tests 22,000 volts or higher.

### MAINTENANCE

#### Inerteen Equipment

Care must be exercised in handling Inerteen to prevent contamination since impurities alter its non-inflammable and electrical characteristics. It must be handled in thoroughly clean containers free from oil. If there is any question concerning the cleanliness of the containers, they should be thoroughly washed with Trichlorobenzene, M-6872, and dried before any Inerteen is placed in them. The transformer tank or any of its compartments in which Inerteen is used, must be free from oil.

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Inerteen should not be mixed with vegetable oils since these materials affect the deterioration, D.C. resistance and otherwise contaminate it. Compounds of asphaltic nature, paraffin and ordinary soldering flux are particularly harmful to Inerteen.

For soldering, a solution of rosin in alcohol is recommended.

All-metal hose must be used in handling Inerteen since the lining used in most hose is soluble in Inerteen.

### Filling Inerteen Transformers

When it is necessary to fill a transformer with Inerteen one should make sure that all joints are tight; Cement M-7386 should be used for this purpose. Steel pipe or metal hose should be used, and preferably the transformer should be filled through the drain valve. This will keep aeration of the Inerteen to a minimum. See that air vents are open as the transformer is filled.

It is desirable to fill a transformer by passing the Inerteen through an Inerteen Conditioner. If this cannot be done and the Inerteen tests satisfactorily, fill the transformer by passing the Inerteen through three thicknesses of tightly woven white cloth, which has first been washed in Trichlorobenzene M-6872, and dried to remove any sizing. New cloths should be used for at least every two transformers.

When it is necessary to fill Inerteen Transformers out-of-doors and particularly on damp days due precaution must be taken to prevent the entrance of moisture into the transformer.

### PERIODIC INSPECTIONS

Inerteen - It is desirable that top and bottom samples of Inerteen be taken from each transformer and tested after a short period of operation. When operating conditions permit, routine sampling of the Inerteen at intervals of six months is recommended. Accurate records should be kept of such inspections and tests, and if the Inerteen shows a dielectric strength of less than 16 K.V., the Inerteen Conditioner may be used. This depends somewhat on the transformer load cycle and climatic conditions. If no facilities are available for making dielectric tests on Inerteen, samples should be sent to the Westinghouse Electric & Manufacturing Company, Sharon Works, Sharon, Penna. Each sample of Inerteen should be properly identified by the transformer serial number and it should be recorded whether taken from the top or bottom of the tank or from a tank-compartment. Samples should be carefully packed to avoid breakage in transit. When any appreciable amount of Inerteen is removed from a transformer, it should be replaced with an equal amount of new Inerteen of proper dielectric strength so that the liquid level in the transformer is maintained.



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Operation of Transformers - It is recommended that a periodic check be made of the operating temperatures of Inerteen transformers and that the temperature of the Inerteen be kept below 90°C. for a maximum-rated self-cooled transformer.

Paint - The external tank surfaces of Inerteen Transformers should be examined regularly for signs of corrosion. If appreciable corrosion is found, its cause should be determined and, if possible, remedied. Inerteen Transformer tanks are made from corrosion-resisting, copper-bearing steel, and they are finished with a high grade Inerteen-resisting paint which is baked on at high temperature. Any surface which is found corroded should be thoroughly cleaned to the bare metal and refinished with one coat of paint, M-6930, and two coats of paint, M-7664-1. Allow twelve hours drying time between each coat of paint.

### TAKING SAMPLES OF INERTEEN

All sampling and testing equipment must be thoroughly dry and clean. It is recommended that sampling and testing equipment used for Inerteen Transformers be used for no other purpose. Care must be used in obtaining and sealing samples of Inerteen taken from a transformer.

Use only small tin containers with screw-metal gasket caps or small glass bottles with sealed glass stoppers for holding Inerteen samples.

If it becomes necessary to use other than Factory sampling containers, such containers should be thoroughly rinsed with clean gasoline, washed with strong soap suds and rinsed thoroughly in hot water, and then dried in an oven at approximately 110°C. for one hour. If the containers are not used immediately after cleaning, they should be sealed tightly and stored in a dry, clean place.

Inerteen sampling packages may be obtained from the Westinghouse Electric & Manufacturing Company, Sharon, Penna. This package consists of two 1-pint cans of Inerteen, packed and shipped in cardboard cartons. This Inerteen may be used to replace that removed from a transformer as a sample. If samples are not taken immediately after emptying the containers, the empty containers should be kept capped snugly to prevent admittance of moisture. The containers and carton should be used to return the samples of Inerteen to the Westinghouse Company.

It is desirable that samples of Inerteen be removed from a transformer tank or from a drum on clear days only and when the Inerteen is at least as warm as the surrounding air.

The sample of Inerteen should preferably be removed from the top of the tank and at a point 2 or 3" under the level of the Inerteen. It is recommended that a sample be taken also from the

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bottom of the tank. If the sample is withdrawn through a valve connection, this connection should be flushed by allowing a small amount of Inerteen to run out before collecting the sample. The sample should be immediately placed in the container and the cap screwed on tightly. The sticker on each container should be marked to identify the sample of Inerteen with the transformer from which it was taken.

Before taking samples from a drum, the Inerteen should be allowed to settle for approximately twelve hours. Samples from the top of the drum should be removed by means of a clean glass sneak-thief.

The same precautions to prevent moisture contamination should be used in sampling Inerteen as are observed in taking transformer oil samples.

The samples of Inerteen properly identified and packed in cardboard cartons should be shipped to the Westinghouse Electric & Manufacturing Company, Sharon Works, Sharon, Penna.

### DIELECTRIC TESTING OF INERTEEN

The same rules and precautions as normally followed in testing oil should be used in testing Inerteen, except as herein stated.

The test cup should be wiped clean with a clean, dry chamois and thoroughly rinsed with clean gasoline and allowed to dry before being used. The electrode spacing should be checked.

To determine whether the test cup is suitable for testing Inerteen, fill it with dry gasoline and test this under a standard voltage rise of 3 K.V. per second. If the dielectric strength of the gasoline is not less than 22 K.V., the test cup is suitable for testing Inerteen, after the cup has been dried in an oven to remove all traces of gasoline. Care should be exercised in handling gasoline. In testing, do not make but one "shot" per filling of the test cup. Five different fillings should be made and the average result used.

### DRYING AND FILTERING INERTEEN

Inerteen may be dehydrated and filtered by means of an oil filter press but in order that it may not be contaminated, it is necessary that the filter press be used for Inerteen only.

A different procedure than that followed for oil is required to purify Inerteen. Contamination in Inerteen cannot be removed entirely by filter paper alone. To clean Inerteen thoroughly it must be filtered through "activated clay" which absorbs impurities. In practice, it is only necessary to pass the Inerteen through the clay and to separate the clay mechanically from the Inerteen to obtain clean Inerteen of proper dielectric strength.

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### THE INERTEEN CONDITIONER

The equipment recommended for conditioning Inerteen consists of a filter press with suitable inlet and outlet connections and the necessary fittings.

The clay is contained in five frames mounted in a yoke. Plates are used on both sides of these frames between which one piece of blotting paper is used to provide a gasket-seal and to remove fine particles of clay from the Inerteen.

The discharge in the plate incorporates a trap to avoid pumping into the transformer air which might result from a leak in the suction line. A strainer is provided on the suction side of the pump, so constructed that all dirt collected is removed with the screen. A by-pass connection fitted with a needle valve is used for testing the suction line from the transformer for leaks.

A pressure gage and a by-pass valve indicate the operation of the conditioner and they also serve as a check to avoid overloading and stalling the motor. The valve is set to by-pass the Inerteen at a pressure of 60 to 70 lbs. per square inch. Another pressure gage and by-pass valve are provided on the discharge side of the conditioner connecting to the transformer. This by-pass valve, releasing at a pressure of approximately 5 lbs per square inch, will avoid breaking the transformer relief diaphragm when no other relief is provided.

### TO PREPARE THE CONDITIONER FOR OPERATION

Release the pressure-screw and remove the frames. Fill each frame with activated clay, M-6934, to within 1/2" of the cover. Replace the frames in the conditioner, placing one sheet of "A" size blotting paper between the face of each frame and plate. Care should be used to see that the holes through the plates, frames and paper are in proper alignment before the pressure-screw is tightened. Close the discharge, suction and suction-test valves. Pour sufficient Inerteen into the drip pan to fill the conditioner and to wet the clay. This will require approximately 8 gallons of Inerteen. Start the motor and open the drip-pan valve so that not less than 5 minutes are required to fill the conditioner, saturating the clay with Inerteen. With the valve at the transformer closed, open the suction-test valve to check the suction line for leaks.

Since the density of Inerteen is considerably greater than that of water, moisture will float on the surface of the Inerteen. It is therefore considered advisable to condition Inerteen from the top and return it to the bottom of the tank. To begin conditioning Inerteen in a transformer, close the suction test valve and stop the motor. Open the transformer valves. Open the conditioner discharge and suction valves. Close the drip pan valve and start the motor.

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One charge of clay will condition approximately 3000 gallons of Inerteen, depending upon the amount of contamination present. To change the clay, remove the frames and turn them over to allow any free Inerteen to drain out of the openings at the top. Dump the used clay and fill the frames with fresh clay as previously described.

When it is necessary to change the blotters or the clay, first close the valve in the suction line, then stop the motor and close the discharge valve before releasing the pressure-screw. Follow the procedure outlined above when starting up the conditioner again.

If the system-seal is not broken, it will only be necessary to open the discharge and suction valves and start the motor to again resume conditioning the Inerteen.

### TO DRY INERTEEN TRANSFORMERS

Inerteen Transformers above 100 Kv-a. should be dried by the short-circuit method with the transformer in its tank immersed in the Inerteen. During the heating and drying process, the top of the tank should be vented to the air to prevent moisture condensation. The desired load current should be obtained by short-circuiting one winding and impressing the proper voltage on the other winding. If the full load impedance of the transformer is not known or not engraved on the transformer nameplate, it should be obtained from the Westinghouse Electric & Manufacturing Company by identifying the transformer with its serial number.

Transformer windings in Inerteen should first be heated under a partial load. A higher top Inerteen temperature can be obtained more quickly by blanketing the tank with the cover removed to prevent condensation.

If the transformer is at or lower than room temperature at the start of the drying process, from 125% to 150% full load current will hasten the heating. The temperature should be carefully watched and when the Inerteen reaches a temperature of 60°C., the load should be reduced to obtain an approximately constant Inerteen temperature based on the following table. These temperatures should not be exceeded for a given load.

<u>Short Circuit Amperes in Percent of Load</u>	<u>Max. Temperature of Top Inerteen</u>
50	80
75	75
85	70

The transformer may be dried more quickly if it is possible to filter the Inerteen during the drying process. If the

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filtering is continuous, care should be taken to avoid letting the Inerteen temperature become too low. If any moisture condenses on the underside of the cover, the temperature should be decreased until it stops, and it should not be increased again until after a period of time of approximately four to eight hours, depending upon the size of the transformer.

The drying should be continued until dielectric tests of samples of the Inerteen taken from the top and bottom of the tank show 22 K.V. or higher. The tests should be made in a standard test cup and it is recommended that at least two consecutive tests of both the top and bottom Inerteen be made at least 24 hours apart while the Inerteen is near a maximum temperature. Tests of the Inerteen should not be made during the filtering process.

### DRYING TRANSFORMERS BY HOT AIR

Inerteen transformers may be dried by blowing clean, dry hot air through them. The air should be at a temperature of approximately 90°C. and it should be blown through the core and coils from the bottom of the transformer and allowed to pass out at the top. The amount of air required to dry the transformer must be such that the temperatures of the ingoing and outgoing air are approximately alike.

### IF INERTEEN TRANSFORMERS FAIL IN SERVICE

Should an Inerteen transformer fail in service, the nearest W. E. & M. Company District Office should be notified as soon as possible. Give the rating of the transformer and its serial number and, if possible, the conditions under which the failure took place. Samples of the Inerteen should be taken so that an analysis of it can be made. The transformer should be kept immersed in Inerteen and it is recommended that no work be done on the transformer except under advice from the District Office.

### ACCESSORIES FOR INERTEEN TRANSFORMERS

Pressure Relief Diaphragms - All transformers of ratings larger than 25 Kv-a., are furnished with pressure relief diaphragm. This device is made in different sizes to provide ample venting for different ratings.

Relief diaphragms are regularly supplied with covers arranged for a pipe connection to carry the gases to the outside atmosphere in case of a transformer failure and after the diaphragm ruptures. It is recommended that this type of installation be used for indoor transformers. For outdoor transformers, the relief device is regularly provided with a perforated outlet which allows the gases to escape directly to the outside atmosphere. The outlet is covered by a hood which prevents the entrance of moisture and dirt. A screen under the diaphragm prevents broken pieces from falling into the transformer.

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The relief diaphragm unit assembly, which is bolted to the transformer cover or other suitable place, consists of a supporting flange in which the glass diaphragm is mounted between two cork gaskets. A tight joint between gasket and diaphragm on the supporting flange is made by a pressure-ring against the lower gasket, all of which is clamped in place by stud bolts.

It is necessary to be very careful bolting down the pressure-ring to avoid breakage of the glass diaphragm for its rupture strength depends largely upon having an even distribution of clamping pressure applied to the diaphragm.

Make sure that gasket seats are thoroughly clean. Apply Cement M-7386 to both sides of the upper gasket and put the glass diaphragm in place, being sure that both the gasket and the diaphragm are centrally located in the supporting flange. Lay the cushion or lower gasket in place over the glass diaphragm and assemble the pressure-ring over this gasket. Then tighten the assembly by means of the nuts and lock washers on the stud bolts.

An even distribution of pressure on the glass diaphragm can be obtained only by tightening the nuts uniformly. This should be done by tightening alternate nuts until the lock washers are nearly compressed. The other nuts should then be tightened in a similar manner. This alternate nut tightening should be continued until the face of the pressure-ring is against the metal gasket-stop.

Diaphragm relief devices are assembled on the transformer at the factory and they are then pressure-tested at 7 lbs. per square inch and shipped in place.

Two spare diaphragms and the necessary gaskets and cement are shipped with each transformer. Additional diaphragms, if needed, should be ordered from the W. E. & M. Company, Sharon, Pennsylvania, identified by the serial number of the transformer.

Gas Absorbers for Inerteen Transformers - When Inerteen transformers are equipped with gas absorbers, separate instructions are shipped with each transformer describing the device and its installation, operation and maintenance.

### RENEWAL PARTS

When information is required concerning a transformer, always give its serial number, particularly whenever renewal or stock parts are ordered. The serial number will be found engraved on the nameplate attached to the transformer tank and on the small nameplate attached to the top or end of the core and coils assembly. Whenever possible, a sketch showing the part or parts and their exact locations, will materially help to assure that the proper parts are supplied by the Factory. This sketch should always indicate the direction or side of the transformer from which the view is made.

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NOTE: Some transformers are ordered designed for Iner-  
teen but are to be operated first as oil-insulated transformers.  
Consequently, they are shipped from the factory filled with oil.  
Whenever it is desired to operate these transformers with Inerdeen,  
complete instructions for the removal of the oil, the cleaning of  
the transformer and filling it with Inerdeen should be obtained  
from the W. E. & M. Company, Sharon, Pennsylvania.