



INSTRUCTION BOOK

Air Cooled

INDUCTION VOLTAGE REGULATORS

Type "SA"

Westinghouse Electric Corporation

12-5-24

SPECIAL INQUIRIES

When communicating with Westinghouse regarding the product covered by this Instruction Book, include all information contained on the nameplate attached to the equipment.*

Also, to facilitate replies when particular operational data is desired, be sure to state fully and clearly the problem and attendant conditions.

Please address all communications to the nearest Westinghouse representative as listed in the back of this book.

* For a permanent record, it is suggested that all nameplate data be duplicated and retained in a convenient location.



RECEIVING • INSTALLATION • MAINTENANCE
INSTRUCTIONS

Air Cooled

INDUCTION VOLTAGE

REGULATORS

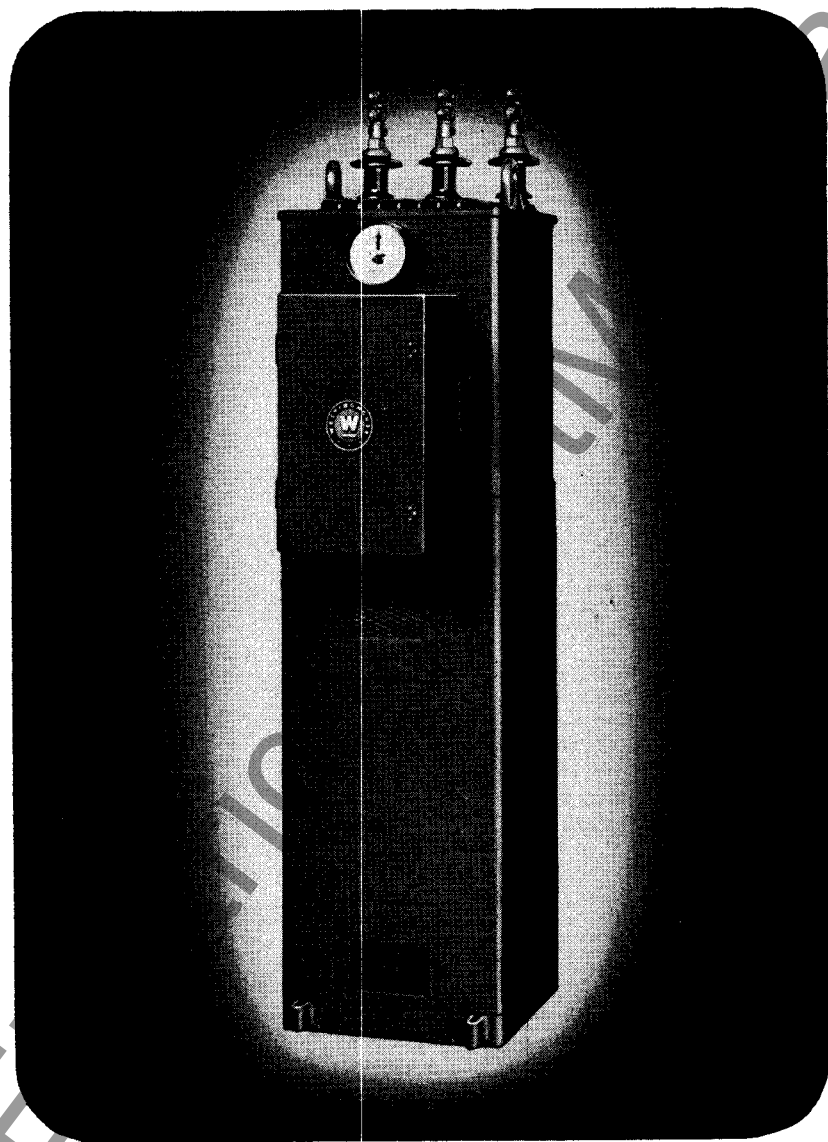
Type "SA"

WESTINGHOUSE ELECTRIC CORPORATION
TRANSPORTATION AND GENERATOR DIVISION
EAST PITTSBURGH WORKS • EAST PITTSBURGH, PA.

FORMER I.B. 5921 REVISED

EFFECTIVE FEBRUARY, 1947

Printed in U.S.A.



INDUCTION VOLTAGE REGULATORS TYPE "SA"

The Westinghouse single phase Type "SA" Induction Regulators are provided with the necessary accessories to make them self-contained units. In making an installation, it is only necessary to connect the power terminals.

These regulators are built in two standard voltage classes: 2400 volts and 4800 volts. Both classes are insulated for use in 3-phase, star-connected circuits of 4160 and 8320 volts respectively.

On the 4800-volt ratings, terminals, located above the rotor winding, are provided for changing the connections for normal operation on a 2400 volt circuit. Access to these connections is obtained by removing the bolted-on screens on the sides of the stator frame. In changing either stator or rotor connections, it is only necessary to change the main windings since this change also makes the necessary changes in the transformer circuits.

Openings are provided in the case for the internal circulation of air. Therefore, this type of regulator is only suitable for indoor service where it is well protected from the weather and from dripping water.

Cooling is accomplished by the natural circulation of air over the external surfaces of the stator core and internally over the coil ends and through ducts.

The hood over the regulator is mounted on rubber pads. This mounting prevents vibration from the regulator core from being transmitted to the hood, thus reducing the amount of noise that otherwise might be emitted.

Mounting the control cabinet from the side of the hood also prevents vibration from reaching the control panel.

RECEIVING, HANDLING AND STORING

RECEIVING

When regulators are first received, they should be examined carefully to make certain no damage was caused by shipping. Inspect the internal parts, control elements, bushings and external parts. Notify the carrier immediately if any damage is found due to transportation.

HANDLING

These regulators are normally shipped bolted to skids long enough to give stability in moving. Transverse bracing is made against the sides of the stator frame, (the parts welded to the punchings) and not against the top of the case or against the lifting eyes. The reason for this method of bracing lies in the fact that the hood over the regulator is mounted on rubber pads.

The lifting eyes on top of the regulator are screwed onto studs which go down to the main core of the regulator. They are, therefore, amply strong for a vertical lift. If the hood cover has been removed by taking off the lifting eye nuts and loosening connections to the bushings, care must be used

to see that the nuts on the lifting studs are in such a location that pressure exerted on the cover (by tightening down the eye nuts) will be supported by the stud nuts. There should be no pressure between the hood cover and the hood. If this should occur, the effect of the cushion mounting of the hood would be lost and noise and vibration would be increased.

STORING

Since the windings are exposed to the surrounding air, these regulators must be protected from the weather or excessive moisture during handling, transportation and storage as well as when they are permanently installed. The windings are protected by multiple coats of moisture-resisting varnish which will prevent excessive absorption of moisture for a reasonable time under normal conditions of atmosphere. However, if a regulator has been de-energized for a considerable period, a sufficient amount of moisture may be absorbed by the windings to make operation hazardous. When stored, these regulators should be indoors in a location that is dry and with as little temperature variation as possible.

INSTALLATION

INSULATION RESISTANCE

Before the Type "SA" regulator is installed, make a "megger" test of the windings to ground. In making this test, connect the three bushing terminals together as one connection to the instrument and the frame of the regulator as the other. If the resistance reading is less than 50 megohms for the 2400-volt machine or less than 75 megohms for the 4800-volt machine at 25°C, they must be dried out until the insulation resistance exceeds the above values.

Drying Out. The most desirable method for drying is to place the entire regulator in a venti-

lated oven at approximately 110°C. Drying for a period of 72 hours will generally be sufficient. During the drying period, it is desirable to make insulation resistance readings at intervals. By plotting these values, the increase of resistance with time can be noted, and when they reach a constant value, the regulator is dry.

CONNECTIONS

Fig. 1 shows the Type "SA" induction regulator with the rear plate and screen removed. This gives access to the Series-Parallel connections of the stator leads.

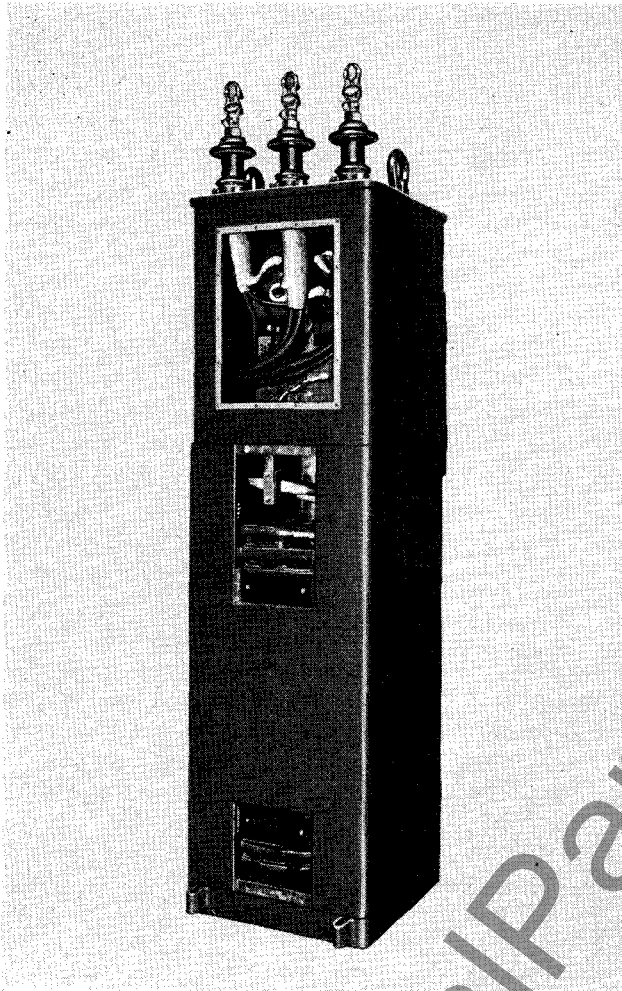


FIG. 1. View Showing the Rear Plate and Screen Removed

When installing a regulator, check the diagram sent with the regulator for special connections which may be different from the standard diagram shown in Figures 2 and 3. The rating on the regulator nameplate should also be checked with the capacity of the circuit in which the regulator is to be operated to avoid improper loading. If regulators are to be used in a delta circuit, either two in open delta or three in closed delta, the selector screws in the rear of the control panels must be placed in correct respective locations according to the diagrams and instructions given for different connections.

To connect a single-phase regulator to a live circuit, first check to make sure it is in the neutral position. The primary or exciting winding may then be connected across the line and the secondary or series winding may be connected in parallel with a by-pass switch. Opening the by-pass then

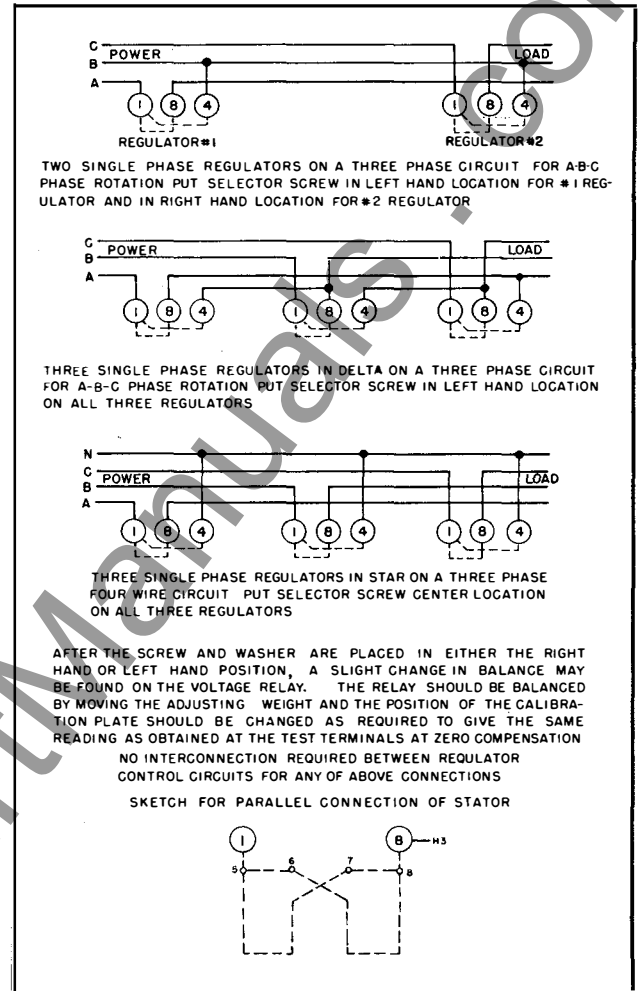


FIG. 2. Customary Wiring Circuits

puts the regulator in the circuit ready for operation. To disconnect a single-phase induction regulator from the circuit without interrupting service, it should first be run to the neutral position by hand control and then the control supply switch opened. The secondary or series winding of the regulator may then be by-passed after which the primary or exciting winding may be opened and then the regulator entirely disconnected from the line.

Important. The primary of an induction regulator should never be opened when the secondary is in series with the line and carrying load current because high voltages may be induced in the windings.

Induction regulators should always be protected against excessive voltage surges. This can usually be done best by the use of lightning arresters. They should be mounted as near to the regulator as pos-

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ADJUSTMENTS

Automatic Operation Check. With the regulator connected in the circuit and carrying load, the automatic operation may be checked. With the Control switch "on" (see Fig. 4), the Automatic-Manual switch on Automatic and the Compensation Adjusting Knobs set at zero, connect a portable voltmeter to the Output Voltage Testing Terminals to read the regulated voltage. Operating the Raise-Lower switch will cause the regulator to change voltage to the point where the voltage relay will make contact and the regulator will operate automatically to bring the voltage back to a balance value. Operating the regulator, both raise and lower in this manner and reading the voltages on the portable voltmeter at which the regulator operates will determine the "band width". If the "band width" is not of the value desired, it may be made smaller by turning the slotted adjusting screw to increase the gap between the pole tips of the Permanent Compounding Magnet and the moving armature. In a similar manner, the "band width" may be increased by making this gap smaller. A minimum of $\frac{3}{4}$ volt above or below the balance voltage and a maximum of $2\frac{1}{2}$ volts are recom-

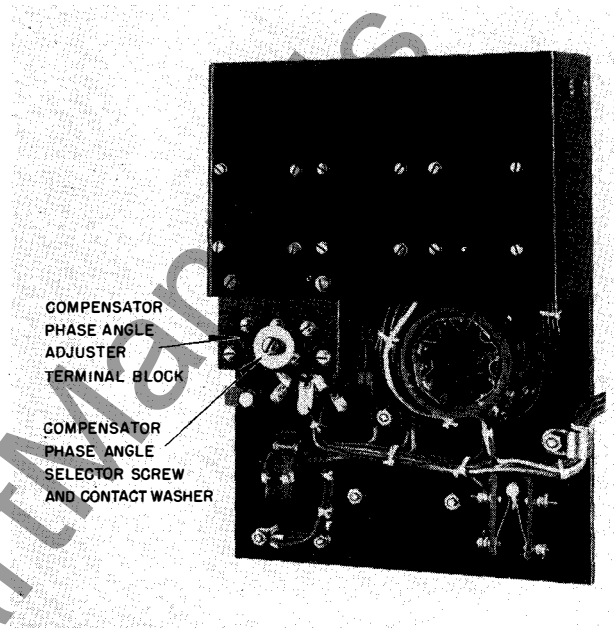


FIG. 5. Rear View of Control Panel

mended as limits for the operating "band width". The value of voltage at which the relay balances may be adjusted to the desired value by moving the Voltage Adjusting Weight by means of the Voltage Setting Adjustment Screw. The final setting of the balance voltage should be made after several hours of continuous operation so that the relay will have reached a stable condition. At that time, adjustment of the position of the Voltage Calibration Plate may be made so its reading, as registered by the vertical line on the Voltage Adjusting Weight, will agree with that obtained at the same time with a portable voltmeter when the relay is in the balance position. It should also be noted that when the regulator operates, either raising or lowering the voltage, it will stop so the regulated voltage is at a value midway between that which is required to cause the voltage relay to make contact.

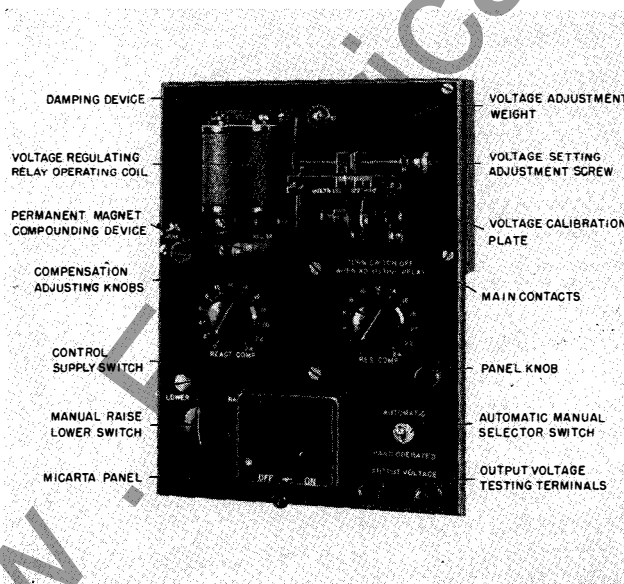


FIG. 4. Front View of Control Panel with Voltage Relay Cover Removed

Line Drop Compensation. Resistance line drop compensation is adjusted by means of a rheostat operated by a knob on the front of the panel at the right-hand side. The knob is held in the position at which it has been set by friction and may be

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operated at any position. Reactive line-drop compensation is adjusted by means of a tap switch controlled by a knob on the front of the panel on the left-hand side. The use of preventive resistors, in the current circuit to the compensator reactor, provides intermediate points of compensation and allows operation at any position of the knob.

Correct settings for line-drop compensation are most commonly obtained from calculated values of reactance and resistance line drop from the regulator to the load center reduced to full load regulator rating and 120 volts and then later corrected if found necessary. This is determined from voltage charts taken at the load center. Calculated values are likely to be sufficiently accurate in ratio of resistance to reactance drop. The compensation for both should be increased if load-center voltage falls at periods of high loads; both should be decreased if load-center voltage rises at periods of high load.

Voltage Relay. If the voltage relay fails to perform satisfactorily or a complete readjustment is required, checking the following points will be found useful in obtaining correct operation:

1. Press down the balance arm firmly into the pivot bearings. By moving the left-hand tip of the balance arm from front to rear, note that there is a definite location where the balance arm shaft fits in the "V" of the stationary bearing near to the center of its movement. This movement is limited by the clearance of the plunger inside the operating coil.

Note: If the plunger is not centered in the coil, it may be corrected by loosening the two screws which hold the bearing to the balance arm bar, moving the arm into a central position and with the bearing held down into the groove, retighten the screws.

2. With the rear washer of the damping device pushed back and resting on the steady pin, and the arm balanced by applied voltage, note that when the control switch is opened and closed, the arm should swing freely up and down without being restricted by friction. If it moves slowly or sluggishly under this condition, look for points of friction such as dirt in the bearings or some part of the balance arm rubbing against a stationary part. Any abnormal friction of this kind must be removed before proceeding with the other adjustments.

3. With the contacts adjusted so they will engage when the left-hand tip of the arm is approximately $\frac{1}{8}$ inch above (or below) the tips of the compounding magnet, adjust the compounding magnet gap

so the tip of the balance arm will break away from the compounding magnet when the applied voltage is raised or lowered by the amount of the desired operating band width. Reducing the gap increases the amount of voltage change required. Increasing the gap reduces the amount of voltage change required.

4. Replace the rear damping device washer to its normal position. Adjust the damping device spring so enough pressure is supplied to stabilize the balance arm within approximately four swings when the control switch is thrown "off" and "on".

5. Adjust the contact spacing so the regulator will restore the voltage (raising or lowering) to a value midway between those required to cause operation. At the mid-voltage value, the left tip of the balance arm will stand slightly above the center of the compounding magnet pole tips. Increasing the contact spacing causes the voltage to be corrected farther after contact is made. Decreasing the spacing causes it to be corrected less.

Contacts. The contacts on both the voltage relay and the motor operating relays are silver and

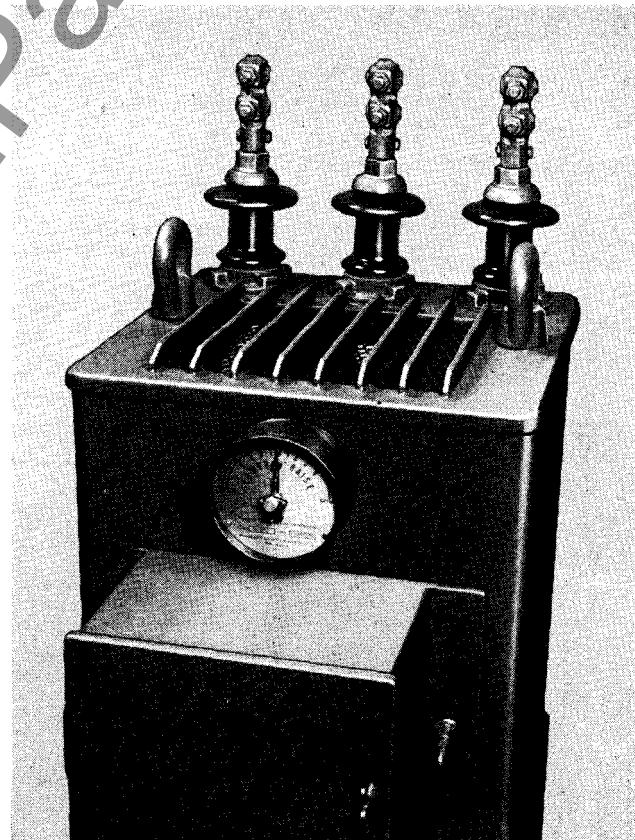


FIG. 6. Top View of Type "SA" Voltage Regulator

do not require dressing or polishing. Only inspection is required to be sure that contacts meet evenly and that the contact material has not been worn away. On the SG motor-operating relays, the contacts should cause at least $\frac{1}{32}$ inch spring deflection when they are closed.

The contact switch located inside the upper hood of the Type SA regulator (36 to 72 kva inclusive), which controls the braking circuits of the operating motor, requires maintenance only when a general inspection is given the regulator. At such a time, the switch should be examined to determine whether any burning of the contacts appears, or undue wear on the friction-operating device has taken place. When replacing the Micarta friction blocks due to wear, be sure the outer block slides freely on the two supporting pins. There must be no tendency for sticking and the pressure of the block against the disc will be only due to the pressure of the two springs. If the block does not slide freely on the pins, ream out the holes in the block slightly so that free movement will be obtained. No adjustment of this device is required and a normal operating life of several years should be obtained without replacement of parts.

Limit Switch. The limit switch is also located inside the hood and is operated directly by pins in the worm gear. This is a simple type of switch with silver contacts welded to stainless steel springs and no adjustment or maintenance will normally be required.

LUBRICATION

Lubrication fittings are accessible by opening the door in the hood on which is mounted the control cabinet. The cabinet is thus swung to one side as the door is opened. The fittings are for lubrication of the top main bearing, worm shaft bearings and the idler gear bearing. A soft cup grease or heavy oil is satisfactory for these points. This lubricant should be applied at intervals of one to six months depending upon the amount of operation.

The worm and worm gear are lubricated by means of a felt rimmed wheel which is pressed against the worm and rotates when the regulator is operated. The lower portion of this wheel dips into the oil contained in a reservoir. The wheel then carries the oil up to the gear teeth and deposits a film of oil on them by wiping over the threads of

the worm. It is only necessary to keep the oil in this reservoir replenished to provide ample lubrication of the worm gears. A heavy grade of motor oil or a light grade of transmission oil is satisfactory for this purpose.

The bearings of the operating motor are waste-packed and contain sufficient lubricant to last between times when the regulators are cleaned and given general inspections. A light grade of motor oil is satisfactory for use in the motor bearings.

The lower main bearing is packed in lubricant during assembly at the factory and this need be replenished only at times when the regulator is dismantled for major overhauling or repairs. This is made possible by the fact that the lower bearing operates practically at room temperature and, therefore, there is very little deterioration of the lubricant. The lower side of the bearing is enclosed so a considerable amount of lubricant is also retained in the bearing.

PERIODIC INSPECTION

At regular intervals, Type SA induction regulators should be disconnected from the line and given a general inspection and cleaning. The frequency in which these inspections are required will depend largely upon the conditions of service such as the amount of operation; the amount and kind of foreign substance in the atmosphere in which the regulator is operating; and the amount of routine maintenance provided. Once a year would be a satisfactory inspection period on a new installation. This may then be varied as requirements are indicated by the conditions found. At these inspections, particular attention should be given to gearing and contacts to determine whether any replacements or repairs are required. Also examine the flexible rotor leads for any signs of cracking or chafing of insulation. Remove all accumulations of dirt. Dust should be blown from the windings and ventilation ducts with compressed air and a slender nozzle that will reach the inner parts of the windings and core. After cleaning, the lubrication should be checked in line with lubrication instructions.

At periods of approximately ten years of operation, the regulators should be dismantled and given a complete inspection. At such times, a thorough cleaning and complete lubrication should be made and all parts examined for wear or signs of deterioration.

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