

Westinghouse
Type SU
Induction Voltage
Regulators

INSTRUCTION BOOK



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INDEX

	Page No.
HANDLING AND STORAGE.....	3
INSTALLATION AND CONNECTIONS.....	3
Connections for Use with Older Types of Regulators...	4
ADJUSTMENT AND MAINTENANCE OF ACCESSORIES..	4
MAINTENANCE OF OIL AND PERIODIC INSPECTION...	11

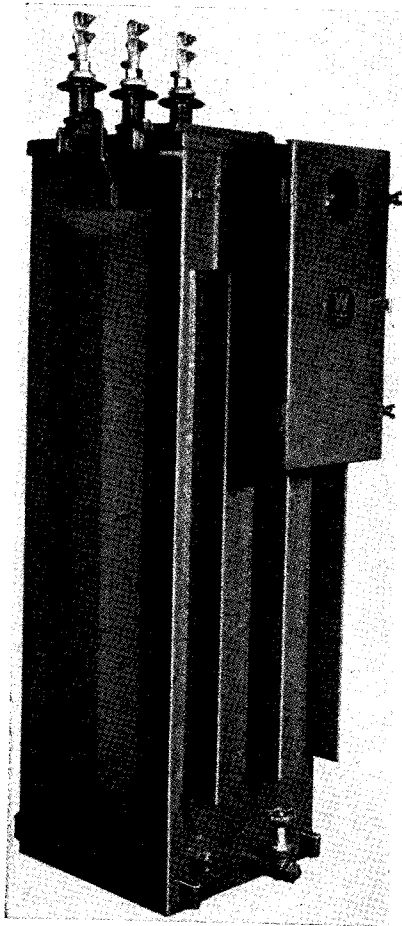


FIG. 1—48 KV-A., TYPE SU, INDUCTION
VOLTAGE REGULATOR

Westinghouse

Type SU

Induction Voltage

Regulators

INSTRUCTIONS

HANDLING AND STORAGE

1. Type SU induction regulators are shipped filled with oil. When regulators are received, they should be checked carefully to be sure that the oil level is at the proper height and that no damage has occurred during shipment or handling. At room temperature or approximately 25°C., oil should show about 1" in the gauge. The voltage relay moving element should be inspected to be sure that it is properly supported so that it cannot be shaken during shipment or handling which may cause damage to the bearings or other parts. Tanks on this type of regulator are not sealed oil tight at the top and should not be tipped during moving to such an extent that oil will come above the position indicator shaft.

2. If regulators are stored for a considerable length of time, they should be indoors, if possible, and preferably where the temperature is nearly uniform. Wide changes in temperature of regulators that are not operating tend to cause moisture condensation. After a regulator has been stored for a considerable time, a test should be made of the oil for dielectric strength before the regulator is put in service. Oil should test at least 20,000 volts using a 1-10" test gap.

INSTALLATION AND CONNECTIONS

3. Type SU induction regulators have all accessories self contained. It is only necessary to make connections to the power circuits during installation. If regulators are to be used in delta circuit, either two in open delta or three in closed delta, the position of the selector screw in the rear of the control panel should be placed in the proper location according to the diagram and instructions given for different connections. The diagram sent with the regulator should be checked for special connections which may be slightly different than the standard diagram shown in Figs. No.

5 or 6. 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 prevent improper loading.

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

5. On both the 2400 and 4800 volt ratings, provision is made for series-parallel connections of the series windings. A change of these connections may be made from the hand hole in the tank cover, if sufficient care is exercised to prevent dropping parts into the regulator, or it may be made by removing the plate on the rear side of the tank. In the latter case, the oil must be lowered before the plate is removed and a new gasket must be applied when the plate is replaced. See Fig. No. 2. On 4800 volt ratings only, series-parallel connections on the primary are provided for by means of bolted terminals located near the winding. By this means the regulator may be connected for operation on either 2400 or 4800 volts. Only the main regulator connections need to be changed since changing them changes the transformer connections also. It is necessary to remove the regulator from the tank to make this change. Unless otherwise specified, regulators will be shipped connected in series with the nameplate marked accordingly.

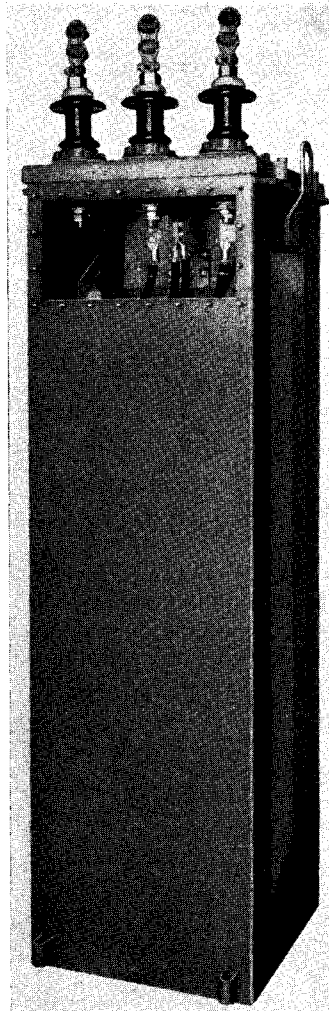


FIG. 2—48 KVA., TYPE SU REGULATOR SHOWING PROVISION FOR SERIES-PARALLEL CONNECTIONS OF STATOR LEADS. CONNECTIONS MAY BE MADE BY REMOVING PLATE AS SHOWN OR THROUGH HAND HOLE IN COVER.

Type SU Induction Voltage Regulators

6. Induction regulators should always be protected against voltage surges by means of lightning arresters. They should be mounted on the tank, or as near to the regulator as practical, with an arrester connected to each regulator terminal and the arrester ground wires connected directly to the regulator tank. Tapped holes are provided in the plate on the rear of the tank for mounting arrester brackets. It is recommended that 3 Kv. arresters should be used on 2400 volt regulators and 6 Kv-a. arresters should be used on 4800 volt regulators.

7. After connections are made, the blocking and supports on the voltage relay should be removed and a check of the balance of the relay should be made with the selector screw of the compensator phase angle adjuster placed in each of the three positions. The difference in the value of balance voltage for each of these three positions should not exceed one volt. This test should be made as a check on the connections and the ap-

paratus which is part of the compensator phase angle adjuster.

Connections For Use With Older Types of Regulators

8. On the type SU regulator (36 to 120 Kv-a. inclusive) a current ratio and phase angle transformer is included, by means of which these regulators may be operated in delta with older type regulators which are not equipped with the compensator phase angle adjuster. When this is done, the phase angle selector screw should be in the center position. Connections for this purpose will be furnished when required to suit the type of old regulator involved.

9. The type SU regulator of 12 and 24 Kv-a. ratings, is not equipped with a current transformer for a 5 ampere secondary winding, but has one in which the secondary current rating is that required by the line drop compensator. With this type of regulator, therefore, cross connections cannot be made for use with old regulators not equipped with compensator phase angle adjuster.

ADJUSTMENT AND MAINTENANCE OF ACCESSORIES

10. Before the regulator is put in final operation, the following points should be checked. By pressing down on the voltage relay balance arm so that the pivot shaft is held firmly in the grooved bearing, the clearance between the balance arm and the inside of the operating coil, and the clearance between the balance arm and the sides of the supporting bearing may be noted. The voltage relay contacts should be in line and the adjustment of the stationary contacts should be such that after contact has been made and the regulator has operated, the relay comes back to the balance position. If the regulator tends to over-travel so the relay goes past the balance point, the stationary contact should be moved closer to the moving contact. If the regulator stops too soon so the relay does not come back to the balance point, the stationary contact should be moved farther from the moving contact. The

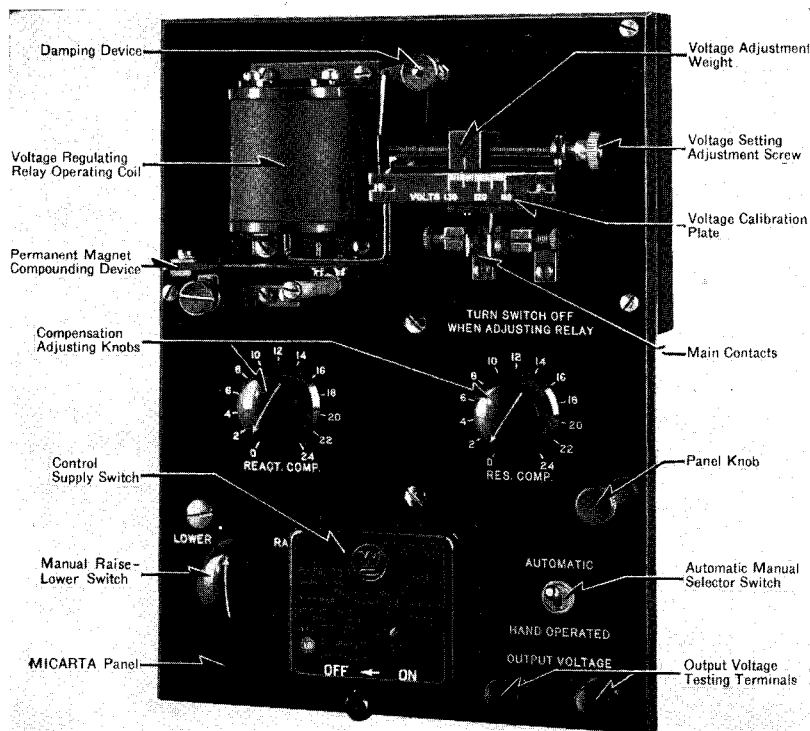


FIG. 3—FRONT VIEW OF CONTROL PANEL

Type SU Induction Voltage Regulators

balance weight on the moving element of the voltage relay should be set, by means of the calibrated plate, for the value of non-compensated or load center voltage it is desired to maintain. After the regulator has operated several hours continuously and the voltage relay is at exact balance with zero line drop compensation, the value of voltage shown on the calibrated plate may be checked against that read on a voltmeter connected to the test terminals. If a discrepancy is found, the plate may be adjusted by loosening the screws in the slotted holes and moving the plate as required to indicate the same value as that read on the voltmeter.

11. A damping device mounted at the rear of the balance arm of the voltage relay and connected to the arm by a link is for the purpose of supplying the required amount of friction to give stability to the relay. This should not require adjustment and if the relay appears to be slow or sluggish in operation, the relay should be checked carefully for friction at other points before changing the adjustment of the damping device. If the

voltage relay balance arm moves too freely and swings excessively, the spring tension should be increased on the damping device by moving the adjusting nut a fraction of a turn.

12. The two type SG motor operating relays are mechanically interlocked so both cannot be closed at the same time. The clearance between the relays and the interlocking bar is adjustable by means of a slotted hole in the bottom of the control box in which the interlock bar is mounted. The location of the bar should be such that with one relay completely closed, any movement of the other relay in closing will be stopped by the interlock but each relay should be able to close separately without binding.

13. The change in voltage required to cause the voltage regulating relay to make contact is controlled by the setting of the permanent compounding magnet. To increase the width of the band, the magnet should be moved closer to the soft iron armature on the moving element giving a smaller gap between the magnet and the armature. To decrease

the width of the operating band the permanent magnet should be moved farther away from the moving element giving a larger gap between the magnet and the soft iron armature. For usual operating bands such as 1 to $1\frac{1}{2}$ volts \pm from the balance voltage, the gap just mentioned should be approximately $\frac{1}{32}$ ". If wider operating bands are required than can be obtained with the magnet as it is received, the iron washer which holds the magnet in place may be replaced with a brass washer, thus increasing the strength of the magnet so that wider bands may be obtained without using air gaps which are too small to give reliable operation.

14. 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 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

(Cont'd on page 10)

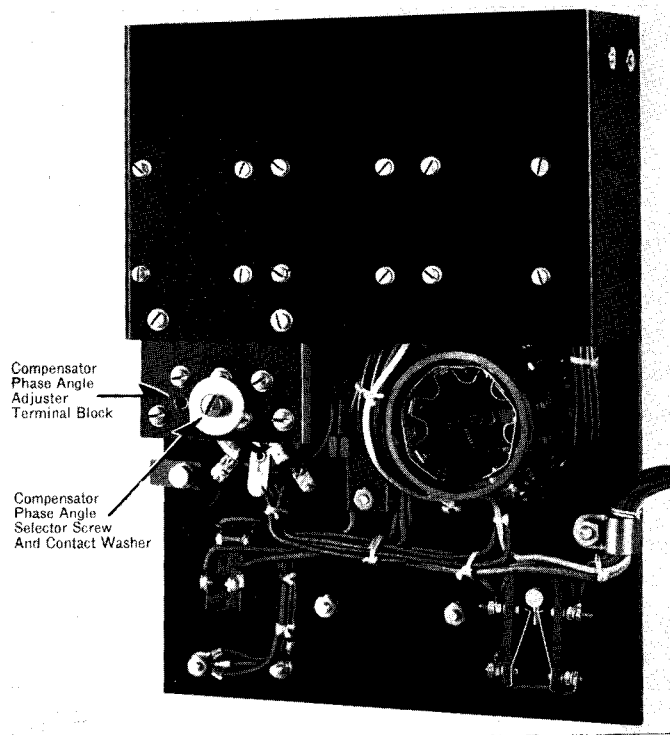


FIG. 4—REAR VIEW OF CONTROL PANEL

Type SU Induction Voltage Regulators

Compensator Phase Angle Adjuster Terminal Block Viewed From Rear of Panel See Notes At Right For Correct Location Of Selector Screw And Washer. Screw Should Be In Central Location When Regulator Is Used On A Single Phase Circuit

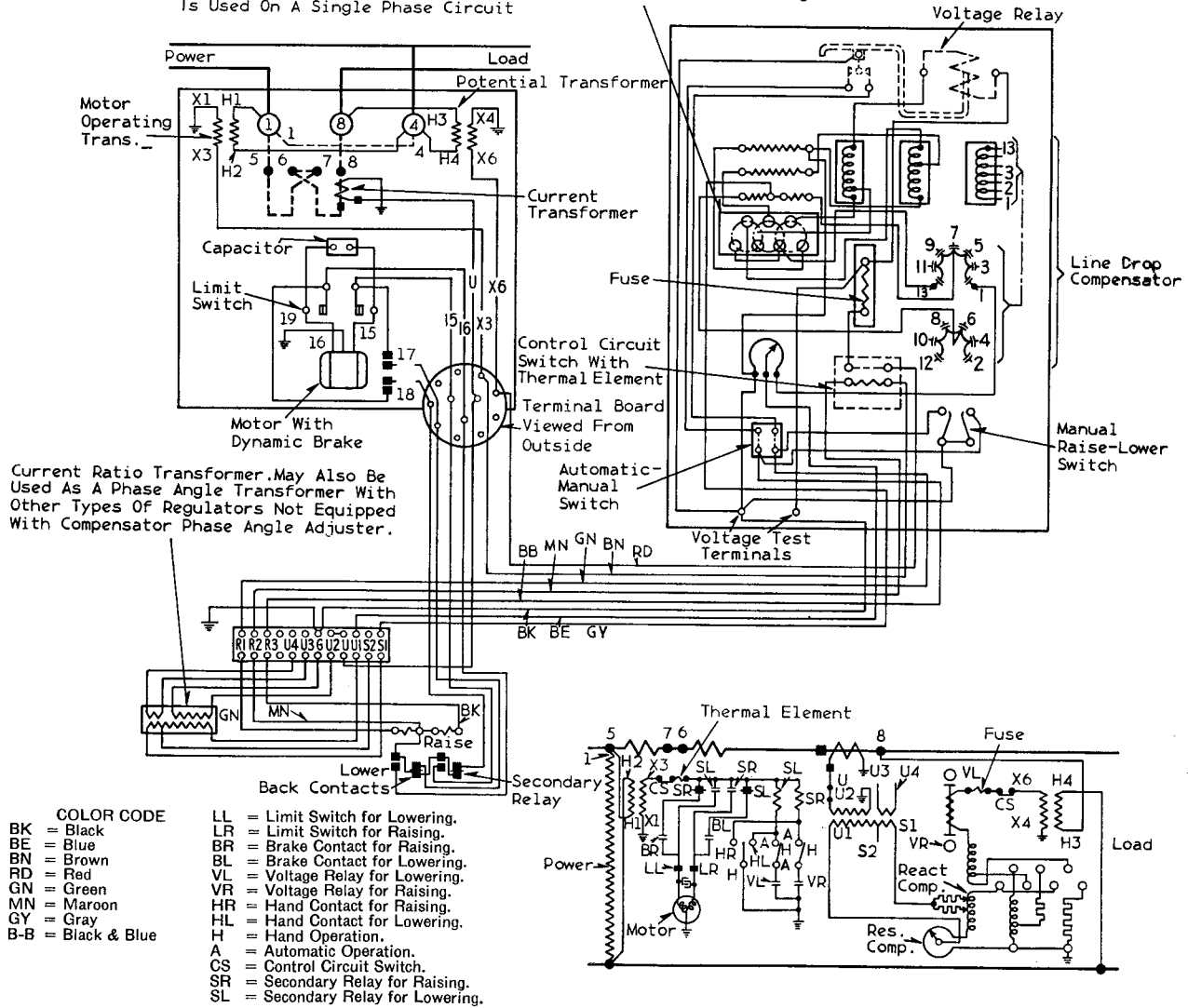
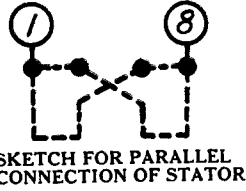
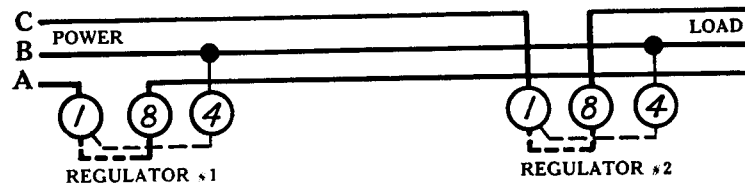


FIG. 5—CONNECTION DIAGRAM FOR STANDARD TYPE SU REGULATORS, 2400 VOLTS, 36 TO 120 KV-A. RATINGS. ON 4800 VOLT RATINGS CONNECTION FOR 2400 VOLT OPERATION MAY BE MADE AT THE ROTOR WINDING AFTER THE REGULATOR HAS BEEN REMOVED FROM THE TANK. SEE DIAGRAM FURNISHED WITH REGULATOR FOR DETAILS OF CONNECTIONS.

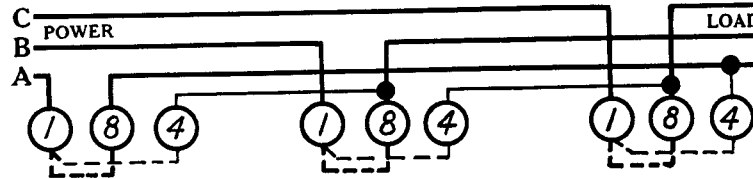
Type SU Induction Voltage Regulators



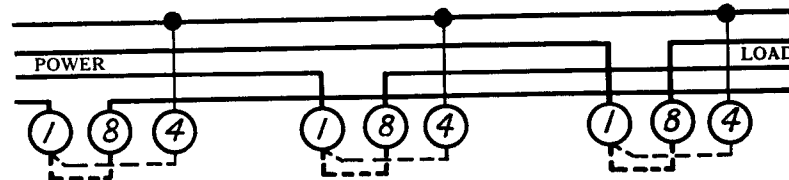
SKETCH FOR PARALLEL CONNECTION OF STATOR



TWO SINGLE PHASE REGULATORS ON A THREE PHASE CIRCUIT FOR A-B-C PHASE ROTATION, PUT SELECTOR SCREW IN LEFT HAND LOCATION FOR #1 REGULATOR AND IN RIGHT HAND LOCATION FOR #2 REGULATOR.



THREE SINGLE PHASE REGULATORS IN DELTA ON A THREE PHASE CIRCUIT FOR A-B-C PHASE ROTATION PUT SELECTOR SCREW IN LEFT HAND LOCATION ON ALL THREE REGULATORS.



THREE SINGLE PHASE REGULATORS IN STAR ON A THREE PHASE FOUR WIRE CIRCUIT. PUT SELECTOR SCREW IN CENTER LOCATION ON ALL THREE REGULATORS.

AFTER THE SCREW AND WASHERS ARE PLACED IN EITHER THE RIGHT HAND OR LEFT HAND POSITION A SLIGHT CHANGE IN BALANCE MAY BE FOUND ON THE VOLTAGE RELAY, THE RELAY SHOULD BE BALANCED BY MOVING THE ADJUSTING WEIGHT AND THE POSITION OF THE CALIBRATION PLATE SHOULD BE CHANGED AS REQUIRED TO GIVE THE SAME READING AS OBTAINED AT THE TEST TERMINALS AT ZERO COMPENSATION.

NO INTERCONNECTION REQUIRED BETWEEN REGULATOR CONTROL CIRCUITS FOR ANY OF ABOVE CONNECTIONS.

FIG. 5A

Type SU Induction Voltage Regulators

Compensator Phase Angle Adjuster Terminal Block Viewed From Rear of Panel See Notes At Right For Correct Location of Selector Screw And Washer. Screw Should Be In Central Location When Regulator is Used On A Single Phase Circuit

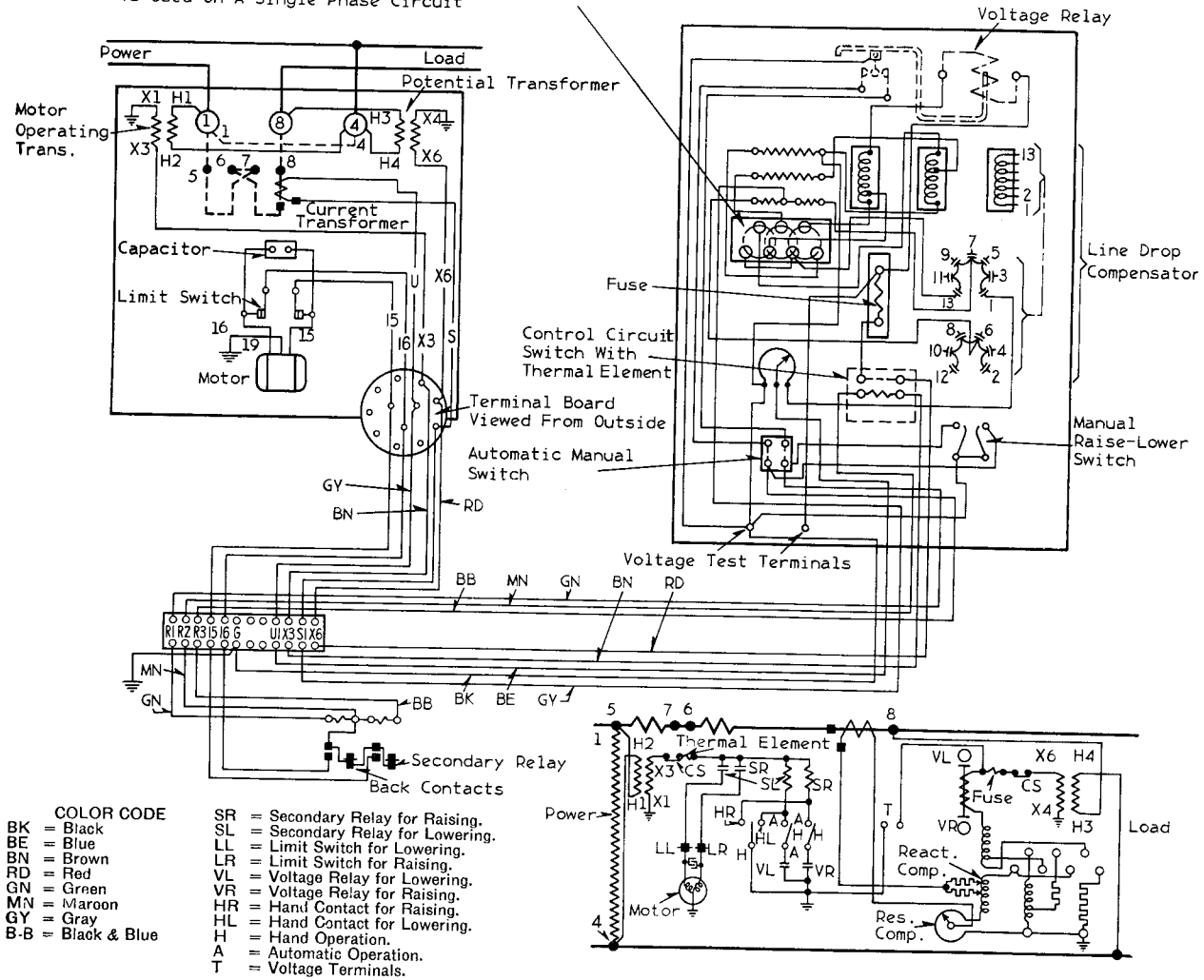
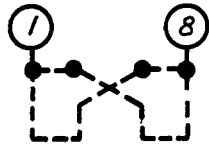
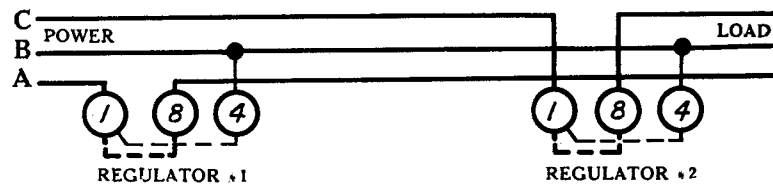


FIG. 6—CONNECTION DIAGRAM FOR STANDARD TYPE SU REGULATORS, 2400 VOLTS, 12 AND 24 KV-A. RATINGS. ON 4800 VOLT RATINGS CONNECTION FOR 2400 VOLT OPERATION MAY BE MADE AT THE ROTOR WINDING AFTER THE REGULATOR HAS BEEN REMOVED FROM THE TANK. SEE DIAGRAM FURNISHED WITH REGULATOR FOR DETAILS OF CONNECTION.

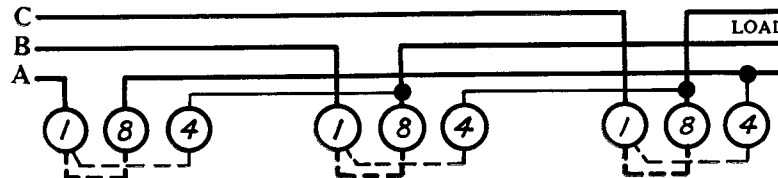
Type SU Induction Voltage Regulators



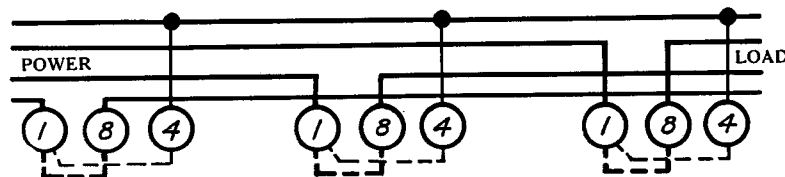
SKETCH FOR PARALLEL CONNECTION OF STATOR



TWO SINGLE PHASE REGULATORS ON A THREE PHASE CIRCUIT FOR A-B-C PHASE ROTATION, PUT SELECTOR SCREW IN LEFT HAND LOCATION FOR #1 REGULATOR AND IN RIGHT HAND LOCATION FOR #2 REGULATOR.



THREE SINGLE PHASE REGULATORS IN DELTA ON A THREE PHASE CIRCUIT FOR A-B-C PHASE ROTATION PUT SELECTOR SCREW IN LEFT HAND LOCATION ON ALL THREE REGULATORS.



THREE SINGLE PHASE REGULATORS IN STAR ON A THREE PHASE FOUR WIRE CIRCUIT. PUT SELECTOR SCREW IN CENTER LOCATION ON ALL THREE REGULATORS.

AFTER THE SCREW AND WASHERS ARE PLACED IN EITHER THE RIGHT HAND OR LEFT HAND POSITION A SLIGHT CHANGE IN BALANCE MAY BE FOUND ON THE VOLTAGE RELAY. THE RELAY SHOULD BE BALANCED BY MOVING THE ADJUSTING WEIGHT AND THE POSITION OF THE CALIBRATION PLATE SHOULD BE CHANGED AS REQUIRED TO GIVE THE SAME READING AS OBTAINED AT THE TEST TERMINALS AT ZERO COMPENSATION.

NO INTERCONNECTION REQUIRED BETWEEN REGULATOR CONTROL CIRCUITS FOR ANY OF ABOVE CONNECTIONS.

FIG. 6A

Type SU Induction Voltage Regulators

circuit to the compensator reactor, provides intermediate points of compensation and allows operation at any position of the knob.

15. 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 later corrected if found necessary from voltage charts taken at the load center. Calculated values are likely to be sufficiently accurate in ratio of resistance to reactance drop and the compensation for both should be increased if load center voltage falls at periods of high loads and both

should be decreased if load center voltage rises at periods of high load.

16. The contacts on both the voltage relay and the motor operating relays are of silver and 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 $\frac{1}{32}$ " spring deflection when they are closed.

17. The contact switch located inside the type SU regulator (36 to 120 Kv-a. 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 ascertain whether any burning of the contacts has taken place or any wear of the operating shaft or cam. The spacing between the contacts normally should be $\frac{1}{32}$ ". The spring supports for the two inside contacts should rest lightly against the operating cam. If the motor has a tendency to overtravel when stopped, this is an indication that the springs just mentioned exert too great a pressure against the cam. If the motor should have a tendency to reverse after the relay opens, this may be caused by insufficient pressure of the two inside contact springs against the cam. Dynamic braking is not supplied in type SU regulators of 12 and 24 K.V.A. ratings and this paragraph does not apply.

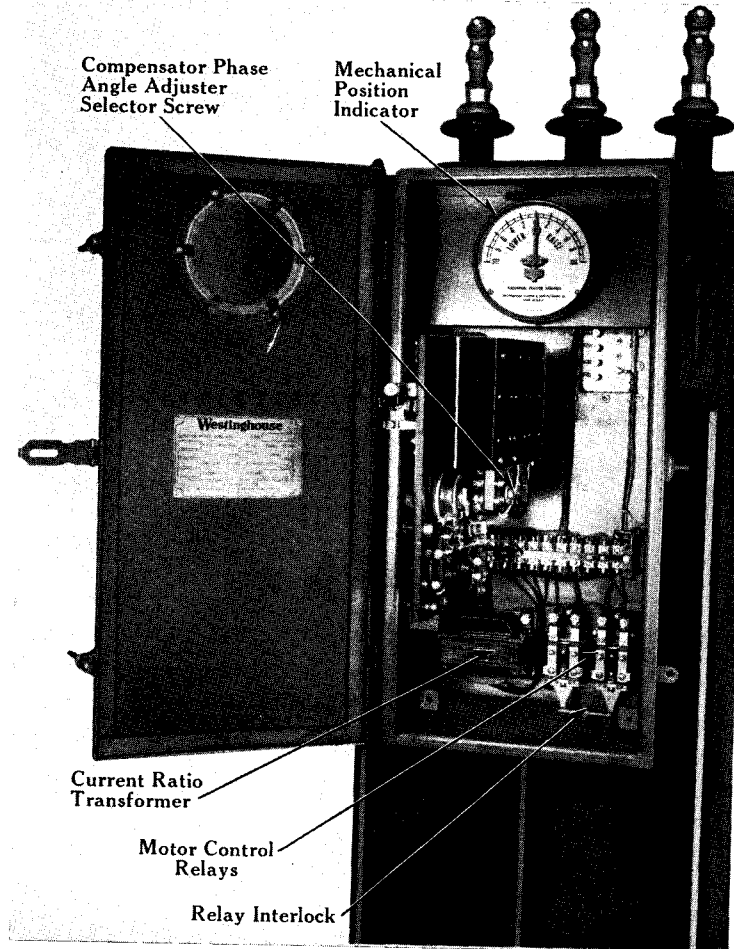


FIG. 7—TYPE SU REGULATOR WITH CONTROL BOX DOOR OPEN, CONTROL PANEL SWUNG OUT, AND MOTOR OPERATING RELAY COVERS REMOVED.

Type SU Induction Voltage Regulators

MAINTENANCE OF OIL AND PERIODIC INSPECTION

18. Approximately once a year, or oftener if operating conditions warrant, an inspection should be made to determine whether the oil level is correct and the oil of sufficient dielectric strength. In checking the oil level, allowance should be made for the temperature at which the regulator is operating, allowing $\frac{1}{2}$ " increase in oil level for each 10° of oil temperature above 25°C .

19. A test of the oil should give a breakdown value of at least 15,000 volts on a

$\frac{1}{10}$ " test gap. If the oil strength is found to be lower than this value, the oil should be filtered after which the dielectric test will probably come back to normal value. It should also be noted whether the oil is clear or whether it has been darkened due to foreign matter which may have gotten into the regulator. If the oil does not give a suitable test after being filtered, it should be removed and replaced with new oil.

20. After ten years of operation and at ten year periods, a complete inspection of the regulator should be made by tak-

ing it to a suitable service shop where it should be completely dismantled. During this inspection the following points should be checked. The rotor leads should be inspected for chafing or weakened points which may later cause breakages, deformed coils due to short circuit stresses or other abnormal operating conditions and worn parts such as gears, bearings, etc. A check should be made of the air gap which should measure not exceeding .005" difference at any position around the rotor and for any position of the rotor.

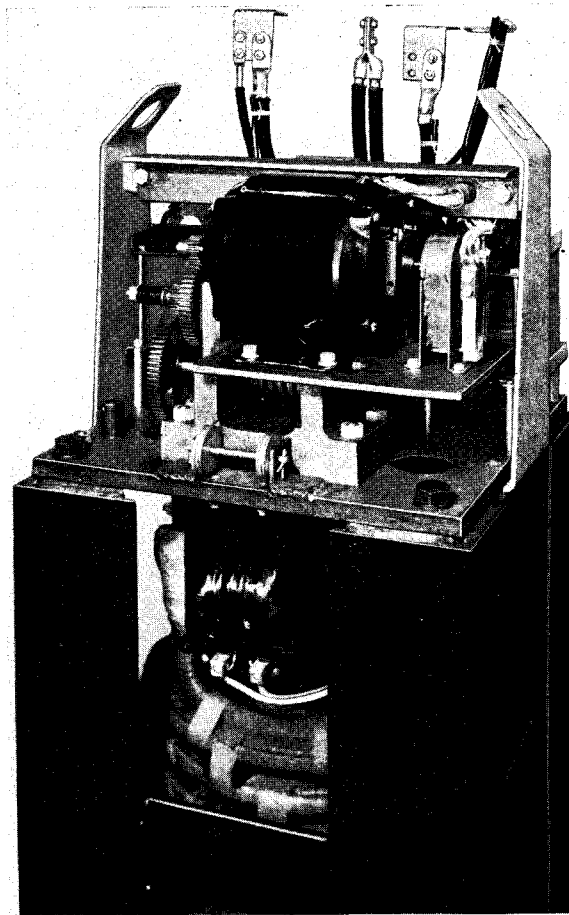


FIG. 8—TYPE SU REGULATOR REMOVED FROM THE TANK SHOWING CURRENT TRANSFORMER, OPERATING MOTOR, GEAR REDUCTION AND BRAKING SWITCH.

