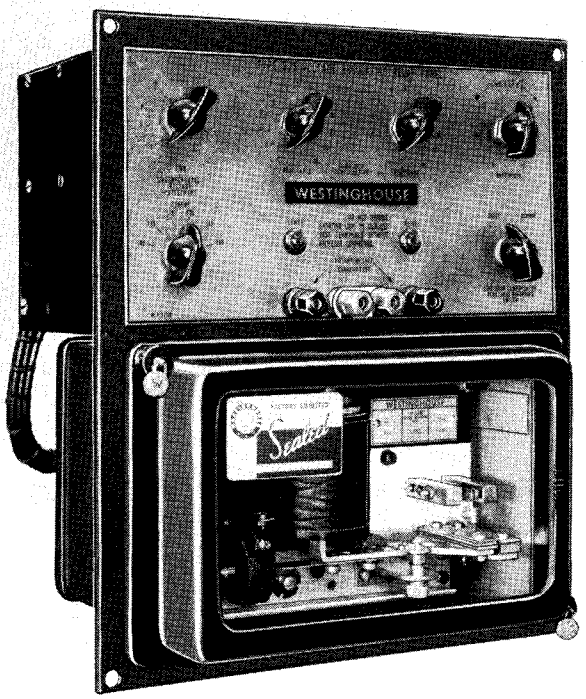
DESCRIPTION • INSTALLATION • OPERATION

INSTRUCTIONS

VOLTAGE REGULATING RELAY TYPE SJS FOR LOAD TAP CHANGERS



The TYPE SJS VOLTAGE REGULATING RELAY for automatic control of load tap changers is of the balanced beam, alternating current, solenoid type. The voltage sensitive element is factory adjusted and sealed in a case having a tight fitting cover with a glass front.

The TYPE SJS VOLTAGE REGULATING RELAY PANEL contains the circuit components for electrically setting the balance voltage, band width, and line-drop compensation. Settings may be made quickly and conveniently from the front of the panel by means of the respective knobs.

RATING

The SJS voltage regulating relay and the SJS voltage regulating relay panel have been designed for operation on 60 cycle alternating current systems. The balance voltage can be set at any value desired within the range of 105 to 135 volts and the band width may be set at any value between ±1.0 volt and ±3.0 volts.

Separate R and X compensator elements permit independent setting of the 24 volts resistance and the 24 volts reactance compensation (both on a 120 volt base) which is available with the standard current of 5 amperes flowing in the current circuit of the relay. The 120 volt potential circuit has a burden of 25 volt-amperes and the 5 ampere current circuit has a 15 volt-ampere burden.

DESCRIPTION

Voltage Regulating Relay. Detailed pictures of the SJS voltage regulating relay are shown in Figs. 1, 2, 3, and 4. The main coil, mounted on the front of the Micarta® base, provides a balance pull on the armature at a specific voltage. A ballast reactor, in series with the main coil to minimize temperature effects, is mounted on the rear of the Micarta® base. The armature which provides the voltage sensing movement is supported by a hinge spring assembly as shown in Fig. 5. The hinge spring is of reinforced, solid leaf construction, held to close tolerances in production to obtain the cor-

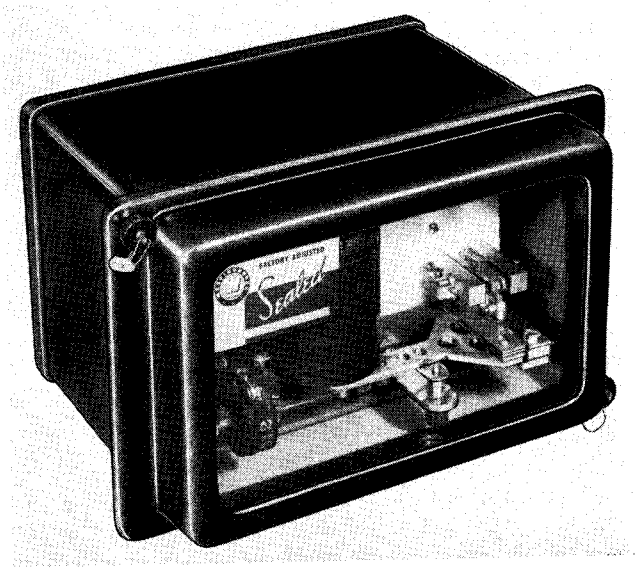


FIG. 1. Type SJS Voltage Regulating Relay

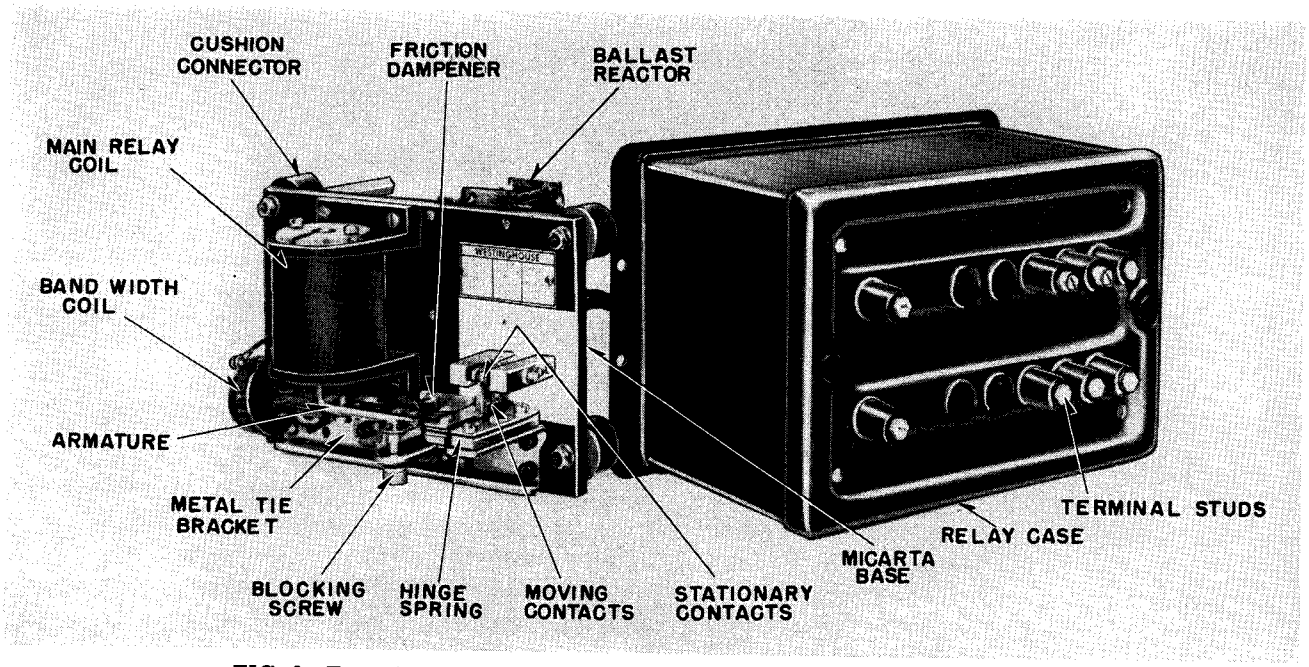


FIG. 2. Front View of SJS Relay Element Assembly and Rear View of Case

rect spring rate for the desired sensitivity of the relay. The hinge spring is supported from a metal tie bracket which also supports the band width coil, insuring accurate control of the setting of the gap between the band width pole and the armature extension tip. A friction damper gives sufficient damping action to insure stable operation of the moving element.

The moving contact is fastened to the armature while the stationary contacts are mounted on the Micarta® base. A white background behind the contact assembly allows better observation of the contact operation during routine inspections. The factory adjusted back-up leaf spring on each of the stationary contacts assures proper operation of the contacts and consequently prolongs their life. The contact spacing has been set at the factory to provide adequate compounding. Contact material is of silver, and the contacts have been designed to give trouble free operation for the life of the relay.

The micarta base is fastened to the metal case through cushion connectors which provide a shock absorbing mounting for the relay element assembly. This gives added protection to the unit during shipment in addition to reducing vibration effects when in operation on the tap changer. A tight fitting glass front cover encloses the voltage regulating relay which has been properly adjusted at the factory and which requires no further adjustment or maintenance in the field. The moving element is secured during shipment by means of a locking screw arrangement easily accessible through the small hole in the bottom of the cover. The hole through which the locking is removed, is closed with a convenient snap cover.

Voltage Regulating Relay Panel. External circuit components for electrically setting the balance voltage, the band width, and the line drop compensation are mounted on the SJS voltage regulating relay panel as shown in Figs. 4 and 6. The panel is designed for use as a unit in the complete tap changer control assembly.

An auto-transformer with five-volt taps from 105 to 130 volts plus an additional five-volt vernier tap provides balance voltage settings from 105 to 135 volts. The balance voltage selection is made by means of a non-shorting rotary tap switch for five volt steps and a potentiometer for vernier settings to give intermediate values. Mounted on the back of the panel with control knobs in front are rheostats for setting the band width and line drop compensation, plus a rotary type shorting switch for reversing the reactance compensation. Intermediate current transformers for the line drop compensator are located in back of the relay panel. A calibrating resistor and a potential dividing resistor are included in the panel assembly. A no-voltage relay is just below the connector receptacles. Neon lights on the front of the panel show when the relay contacts are closed.

Electrical connections between the SJS relay and the SJS relay panel are made through the terminal studs on the rear of the relay case. Current and

potential test terminals are conveniently located on the front of the panel.

A General Radio type 274MB plug is supplied and may be used as an ammeter plug to connect the ammeter to the current test terminals before the shorting link is removed or (with a wire connecting the sides of the plug) as a shorting bar while the shorting link is removed and the ammeter is connected with spade terminals.

RECEIVING—HANDLING—STORING

The SJS relay and relay panel will usually be shipped assembled as a unit of the complete tap changer control assembly and the instructions for receiving, handling and storing the control will suffice. However, it may be desirable to have such information more readily available; it is, therefore, recorded here for convenience.

Receiving. Immediately upon receipt of the SJS relay panel, make a careful examination for any evidence of damage sustained in transit. If any damage is found or suspected, file a claim promptly with the transportation company and notify the nearest Westinghouse Sales Office.

Handling. The SJS voltage regulating relay is in fact an instrument and should be handled as such. It has been designed with cushion connectors, a reinforced hinge spring and other items to make it as rugged as possible, but the fact remains that it has better than 1% accuracy and is thus equivalent to the better, more accurate laboratory voltmeters and should consequently be handled with reasonable care, free from excessive shock and vibration.

This relay has been adjusted and tested before leaving the factory to insure that it meets the required high standards of operation considered essential for such equipment. Whether or not it continues to meet these standards depends upon the treatment accorded it after it leaves the factory.

Note: The armature should be blocked at any time that the SJS relay panel is moved, or at any time that the control or unit, on which the SJS relay panel is mounted, is moved. Blocking instructions are given under the heading of "ARMATURE BLOCKING".

Storing. If the SJS relay panel is to be stored, it should be kept in a clean, dry, moderate temperature location, protected from excessive dust, from atmospheres conducive to condensation and corrosion, and from moisture and the elements.

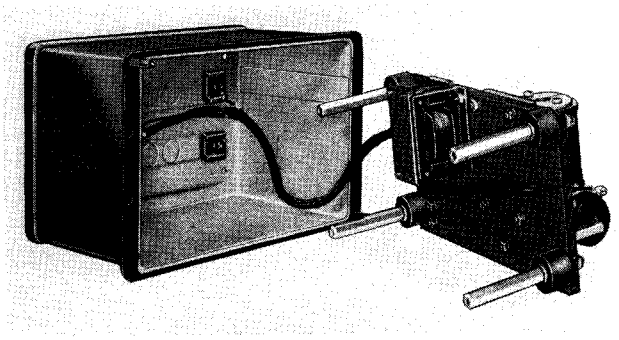


FIG. 3. Back of SJS Relay Base and Inside View of Relay Case

INSTALLATION

Since the SJS voltage regulating relay panel will usually be shipped assembled as a unit of the complete tap changer control, the SJS relay panel will have been installed at the factory and further installation will be required only for the complete unit equipment as described in its instruction book. However, since the SJS voltage regulating relay panel has been designed with the drawout feature to permit removal for meter room or laboratory setting or testing, where this feature is desired, instruction for installation will be useful.

To install the SJS voltage regulating relay panel in the control, place the back projections of the relay panel into the cutout provided in the control (insert from the front of the control) and bolt in place at the four corners with the bolts provided for this purpose. Insert the plug connectors from the back of the swinging control panel into the receptacles on the back of the SJS relay and installation is complete.

To remove the SJS voltage regulating relay panel from the control, disengage the two plug connectors from the receptacles and remove the four bolts from the corners of the relay panel. The four pole connector contains self shorting terminals so that the current transformer is automatically shorted when the plug is removed.

Note: The armature should be blocked at any time that the relay panel is moved, or at any time that the control or unit, on which the relay is mounted, is moved. Blocking instructions are given under the heading of "ARMATURE BLOCKING".

To prepare for use simply unblock the armature as described under the heading of "ARMATURE BLOCKING". It is unnecessary to remove the relay cover or break the seals to inspect, install or remove, block or unblock, or to operate the relays or to make the required settings.

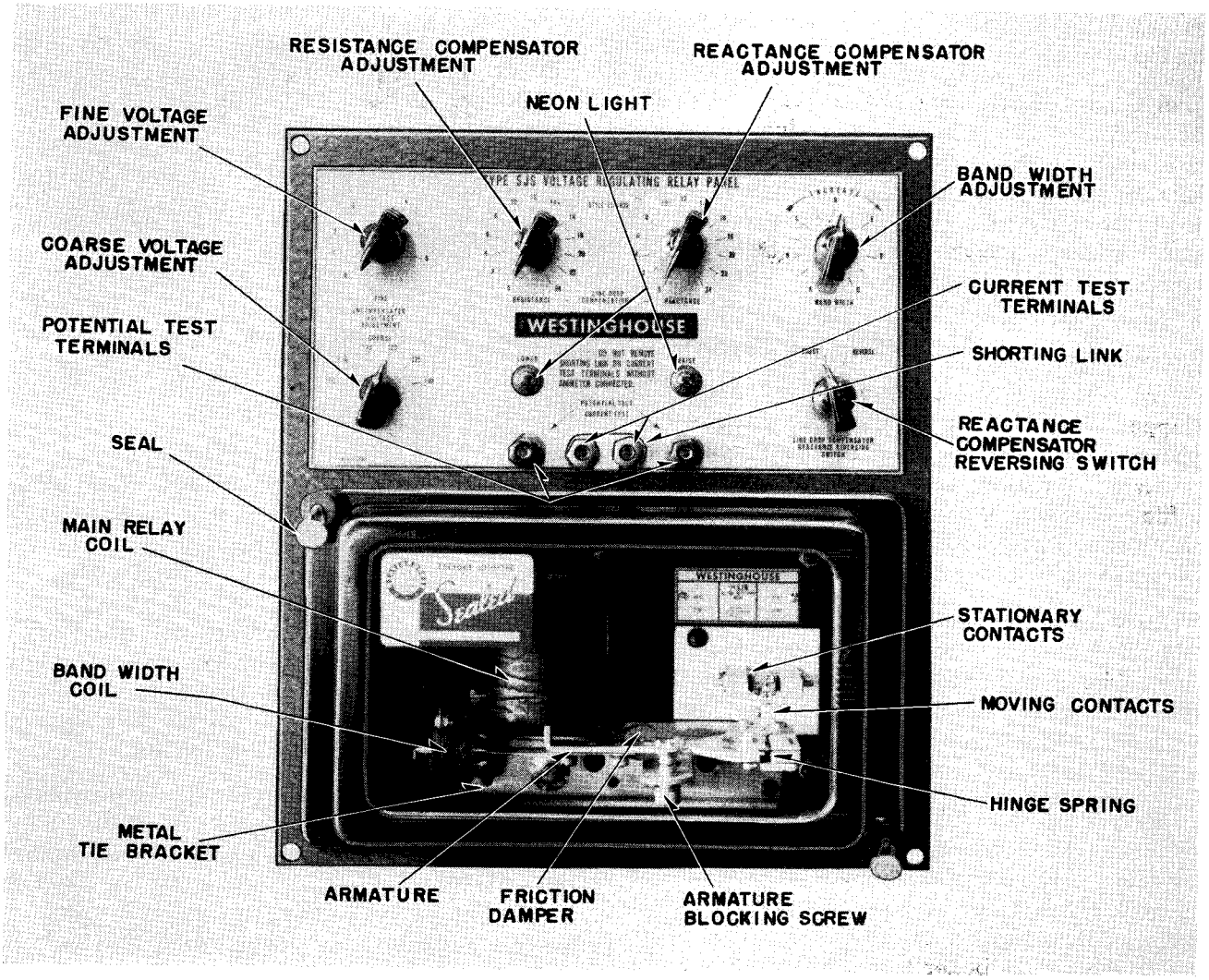


FIG. 4. Front View of SJS Relay and SJS Relay Panel

ARMATURE BLOCKING

Caution: Before blocking or unblocking the SJS relay be sure that the control breakers are in the "OFF" position; for when the control circuit is energized, there is a potential of 120 volts between the blocking screw and the case (the case is grounded).

To Block Armature: See Fig. 7.

1. Open the control breakers.

2. Remove the snap button hole plug from the bottom of the cover.

3. Advance the 5/16 inch cap screw until it lifts the armature to the horizontal position where the armature tip is directly opposite the center pole of the band width coil. It is necessary to have the armature in this horizontal position before final clamping to prevent damage to the hinge spring on final clamping.

4. Screw the #6-32 machine screw (inner captive screw) into the armature, using a small screw driver (1/8 inch wide blade), and tighten securely.

5. Replace the snap button hole plug in the bottom of the cover.

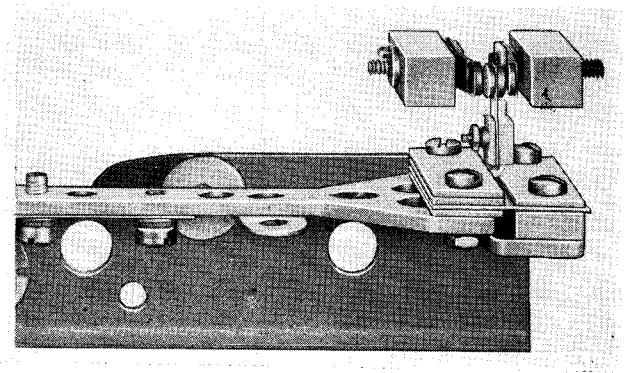


FIG. 5. Hinge Spring Assembly

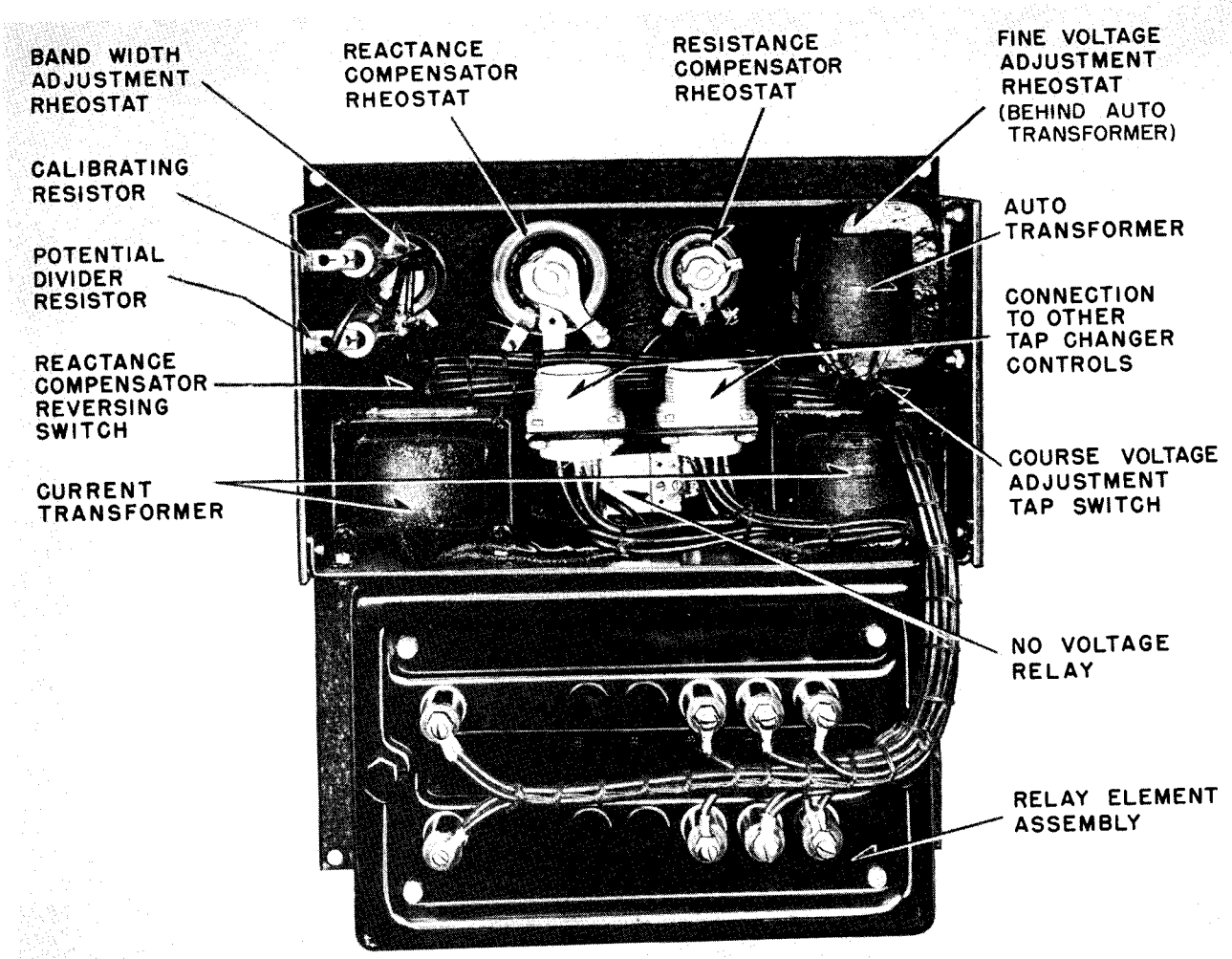


FIG. 6. Back View of SJS Relay and SJS Relay Panel with Back Cover Removed to Show External Electrical Components

To Unblock Armature: See Fig. 7.

1. Open the control breakers.

2. Remove the snap button hole plug from the bottom of the cover.

3. Unscrew the #6-32 machine screw (inner captive screw) from the armature.

4. Retract the 5/16 inch cap screw until the retaining ring comes in contact with the screw bracket. It is necessary to retract the cap screw to allow the armature freedom of movement.

5. Replace the snap button hole plug in the bottom of the cover.

OPERATION

The voltage sensing action of the SJS relay is basically a function of the solenoid pull of the main coil and the attraction of the band width electromagnet on the hinge spring supported armature. Compounding is accomplished by the action of the band width coil and is determined by the amount of armature travel from balance position. Line drop compensation is provided by introducing a voltage which is directly proportional to the actual voltage drop on the line.

With the proper balance voltage applied to terminals A_4 and B_4, Fig. 8, the armature is held in a balance position by the main coil solenoid action. At balance, the rotational force of the armature, due to its weight, just exactly balances the solenoid action of the main coil, and the hinge spring is undeflected. As the applied voltage is either increased or decreased a sufficient amount, this balance no longer exists and the armature is either raised above or dropped below balance position, closing either PL or PR contacts. The amount of voltage change necessary to cause the armature to change from balance position is determined by the excitation of the band width coil and the gap

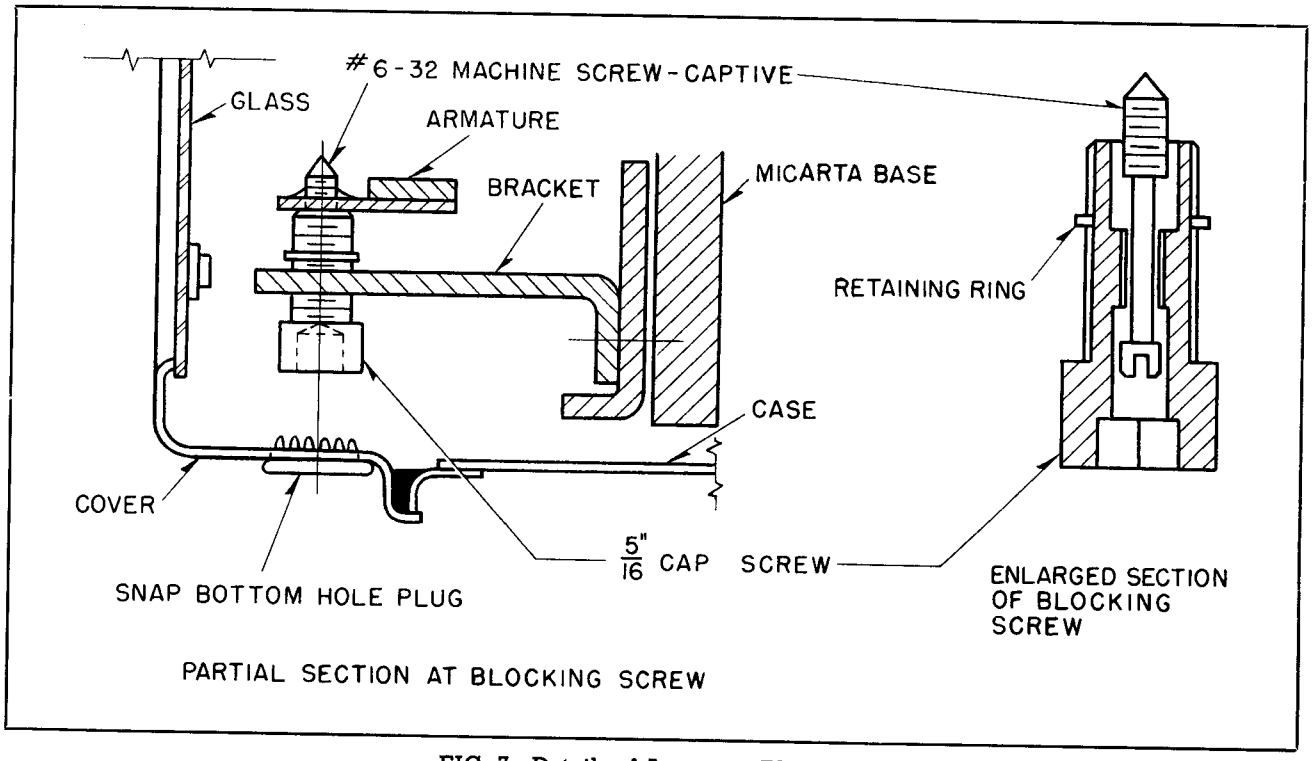


FIG. 7. Details of Armature Blocking

between the band width center pole and the armature extension tip. The magnetic attraction of the band width pole on the armature extension tip, combined with the action of the hinge spring, causes a snap-action deflection of the armature, thus giving a positive contact make and break. The voltage change required to return the armature to balance is determined by the distance the armature travels and has been set at the factory to provide proper compounding.

Input balance voltages from 105 to 135 volts are made possible by an auto transformer with taps on the input side. A vernier (R1, Fig. 8) provides intermediate values which are added to the tap selection. A rheostat (R2, Fig. 8) is used to vary the excitation to the band width coil (BW, Fig. 8), allowing a band width selection from ± 1.0 volt to ± 3.0 volts.

Line drop compensation is accomplished by causing a voltage drop to appear across R5 and the ballast reactor which is proportional to the magnitude and phase of the actual drop on the line. Intermediate current transformers supply the current for the compensator network. The compensator can be set to give from 0 to 24 volts (on 120 volt base with 5 amperes flowing in the primary of the intermediate current transformers) resistive and reactive compensation by adjusting rheostats R5 and R6 respectively. Reverse reactance compensation as required for certain installations can be obtained by the reversing switch shown in Fig. 8.

The ballast reactor also serves to introduce a large reactance relative to the resistance in the circuit containing the main coil. This makes the effect of resistance change due to temperature variations virtually negligible.

A no-voltage relay (P-NV) with contacts in the common lead of the PR and PL contacts prevents a voltage-change signal in the event of a potential failure to the voltage regulating relay.

SETTINGS

The SJS relay settings for balance voltage, band width, and line drop compensation are all electrical settings made with the unit mounted in the tap changer control cabinet, using either the potential transformer or an external voltage source for excitation. If it is desired to check the relay out of the tap changer control cabinet, the entire SJS relay panel may be easily removed by taking out the four bolts at the corners of the relay panel and disconnecting the plugs at the rear of the panel.

Apply normal voltage to the relay and relay panel for a period of three hours before making settings, to allow all parts to become stabilized at the operating temperature.

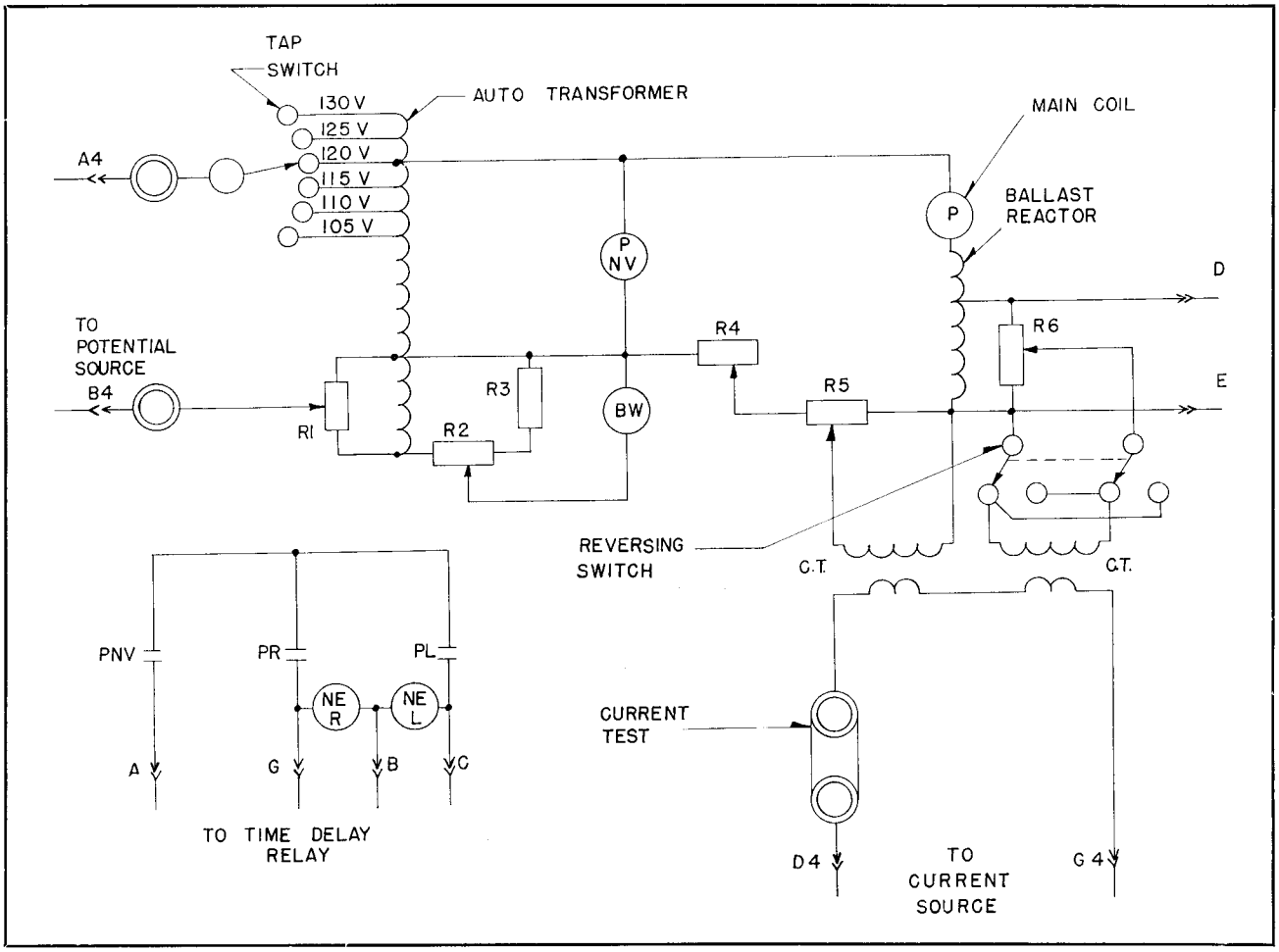


FIG. 8. Schematic Diagram of Type SJS Voltage Regulating Relay and Controls

Balance Voltage and Band Width Settings Using External Voltage Source. Place the control breaker in the "OFF" position, and apply an external regulated power source to the potential test terminals. If the unit is carrying load, set the compensator dials on zero while the balance voltage and band width settings are made. The balance voltage and band width settings are made as follows:

1. Turn the band width dial to the full clockwise position.

2. Set the coarse-voltage adjustment dial to the dial calibration just below the desired balance voltage. (For example, set on 115 volts for 117 volt balance).

3. Next turn the fine-voltage adjustment dial to the value which when added to the setting above give the desired balance voltage. (In the example, set on 2 volts).

4. To set the band width and check with the balance voltage setting above, adjust the applied voltage to the value below balance at which it is desired to have the relay close its PR contacts. (For example, if a band width of ±1.5 volt with balance voltage of 117 volts is desired, adjust the voltage to 115.5 volts).

5. Rotate the band width dial slowly in a counterclockwise direction until the PR contact closes. These settings now should give the proper balance voltage and band width and may be checked in the step below.

6. Increase the applied voltage to the value above balance voltage at which the relay should close its PL contact. (118.5 volts in the example above.) The PL contact should close at this value of voltage; however, a slight readjustment of the fine-voltage dial and the band width dial may be necessary. If the contact closes at less than the desired voltage, it indicates a balance voltage setting and a band width setting slightly less than the desired values. If the contact closes at higher than the desired value the reverse is indicated. In all

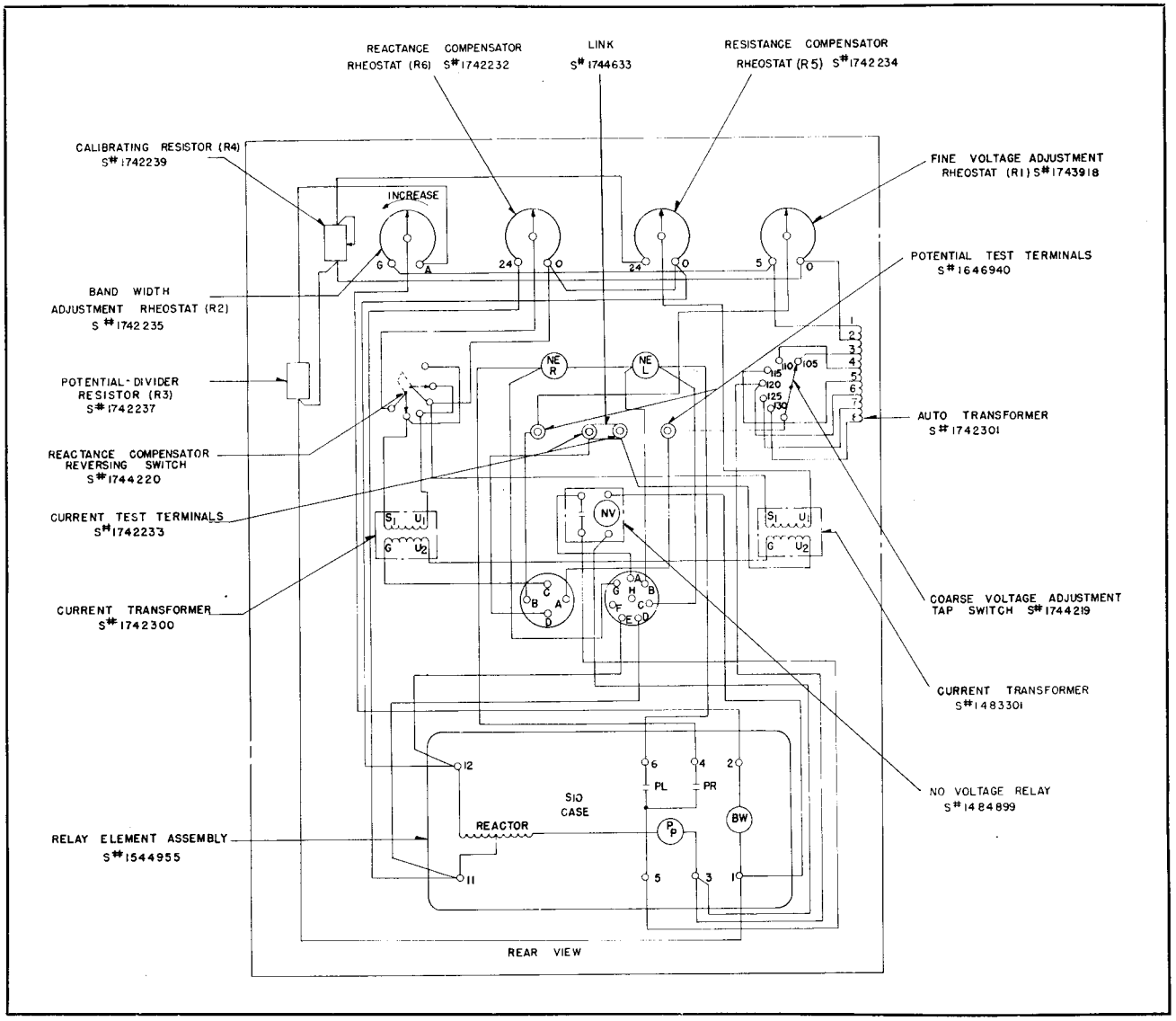


FIG. 9. Wiring Diagram of Type SJS Voltage Regulating Relay and Panel

cases, only a very minor adjustment will be necessary. Both balance voltage and band width can be increased by a clockwise rotation of the fine-voltage adjustment dial and band width adjustment dial respectively.

Balance Voltage and Band Width Settings Using Internal Voltage Source. To use the internal potential transformer as a voltage source for setting the balance voltage and band width of the SJS relay, place the control breaker in the "ON" position and the automatic-manual switch in the "MAN" position. If the unit is carrying load, set the compensator dials on zero while the balance voltage and band width settings are made. Operate the tap changer manually to give approximately the balance voltage desired at the test terminals. Then proceed as follows:

1. Turn the band width dial to the full clockwise position.

2. Using both the coarse—and fine—voltage adjustment dials, set to a value above the applied voltage which will cause the PR contact to just make. Record the dial settings, adding the fine value to the coarse value.

3. Next, reduce the voltage adjustment settings below the applied voltage to a value which will cause the PL contact to just make. Record the dial settings, adding the fine value to the coarse value.

4. Take the average of the two dial settings in steps 2 and 3. Add to this average value the side band desired, that is, one-half the total voltage band. Set the resultant value on the voltage adjustment dials. (Example: An average of settings in steps 2

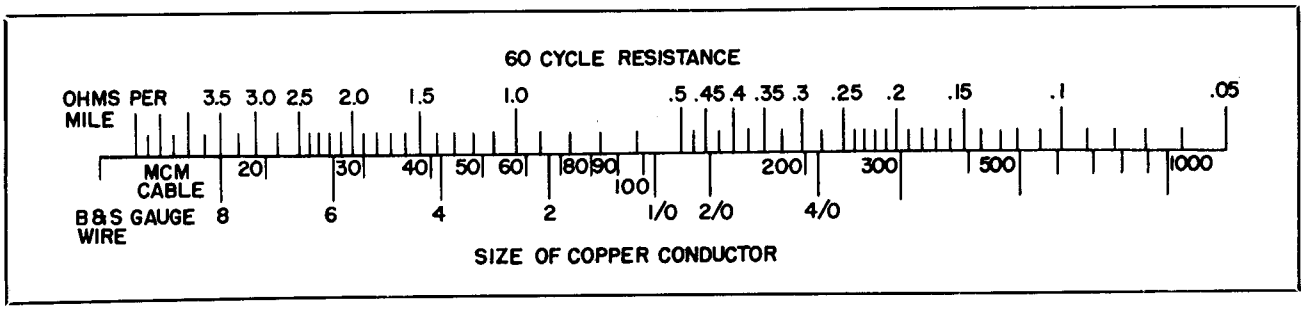


FIG. 10. Resistance Chart, Showing Ohms per Conductor, per Mile, 60 Cycle Circuit

and 3 might be 120 volts. A band width of ±1.5 volts is desired. Therefore set the dials to read 121.5 volts).

5. Rotate the band width dial slowly in a counterclockwise direction until the PR contact just closes. This setting of the band width dial will now give the desired band width.

6. Now, reset the voltage adjustment dials to the balance voltage desired, adding the fine setting to the coarse setting.

7. Put the automatic-manual switch in the "AUTO" position.

Line-Drop Compensator Setting. The line-drop compensator for use with the voltage regulating relay consists of two rheostats, one for resistance compensation and one for reactance compensation. The dials of these rheostats are so designed that the settings represent the amount of bias voltage on the primary relay with 5 amps flowing in the line-drop compensator circuit and are proportional to the volts of compensation at the load center. The rheostats are connected to the voltage regulating relay coil series reactor and two small intermediate current transformers, the secondaries of which supply the required current to the compensator. The primary windings are arranged for connecting to the main current transformer supplying the compensator circuit.

The compensator is mounted in the same chassis with the primary relay so as to form a single unit. The rheostats for the resistance and reactance compensation are mounted on the rear of the primary relay panel and are operated by dials accessible from the front. These are set to a desired degree of compensation as indicated by an engraved steel plate having a graduated scale.

The two intermediate current transformers are mounted on a plate suspended from the primary relay panel and their secondaries are connected to the compensation reversing switch so that when in the normal position as shown in Fig. 9, normal compensation is obtained.

The settings on the line-drop compensator may most satisfactorily be made by field adjustments, but if the data on the particular line is known, the curves in Figs. 10 and 11 may be used, and values calculated.

The proper line-drop compensator settings can be derived by the use of the following expressions:

Dial Setting for Resistance Compensation =

$$5 \times \frac{N_{C.T.}}{N_{POT.}} \times R_L \times d.$$

Dial Setting for Reactance Compensation =

$$5 \times \frac{N_{C.T.}}{N_{POT.}} \times X_L \times d.$$

Where

$N_{C.T.}$ = current transformer ratio $= \frac{\text{primary current}}{\text{secondary current}}$

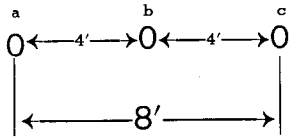
$N_{POT.}$ = potential transformer ratio $= \frac{\text{primary voltage}}{\text{secondary voltage}}$

R_L = resistance per conductor from unit to load center, in ohms per mile.

X_L = inductive reactance per conductor from unit to load center, in ohms per mile.

d = miles from unit to load center.

A typical three-phase example is as follows:



500,000 CM copper conductor, with flat spacing shown above.

Line Voltage = 12000 volts

Current Transformer Ratio = 600/5

Potential Transformer Ratio = 6928/120

Distance from unit to load center = 3.5 miles.

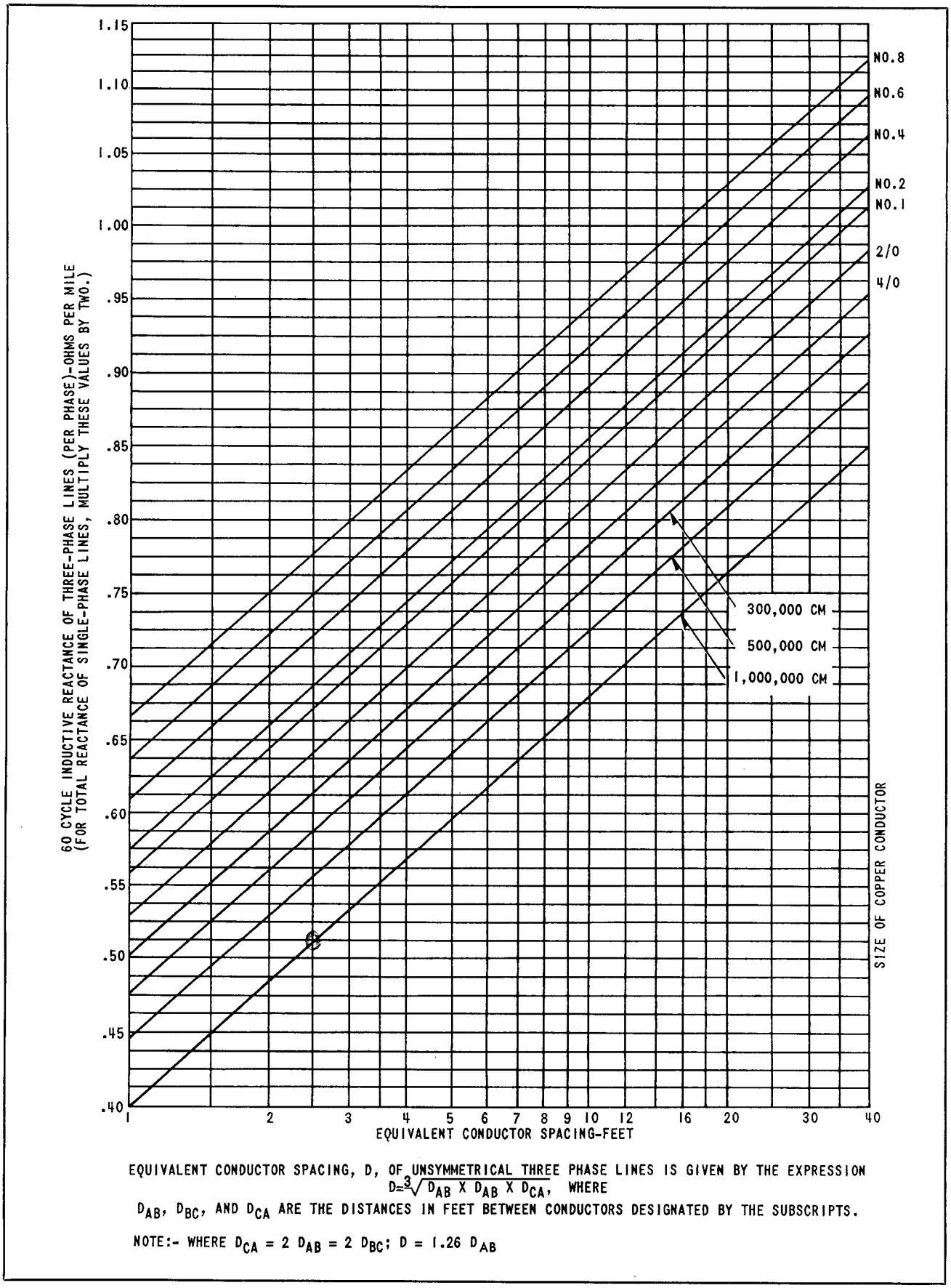


FIG. 11. Reactance Chart, Size of Conductor and Spacing, for 3-Phase Lines (per Phase), 60 Cycle Circuit

A unit energizes a typical distribution circuit whose characteristics are given above. Determining the contants for this circuit on a per phase basis,

From Fig. 11:

$R_L = 0.12$ ohms per mile

From Fig. 10:

$D = \sqrt[3]{4 \times 4 \times 8} = 5.04$ feet

$X_L = 0.64$ ohms per mile

The line-drop compensator resistance setting is:

$$\frac{5 \times 600/5}{6928/120} \times .12 \times 3.5 = 4.36$$

The line-drop compensator reactance setting is:

$$\frac{5 \times 600/5}{6928/120} \times .64 \times 3.5 = 23.3$$

These settings may be adjusted as found necessary as shown by load center voltage measurements.

If reverse reactance compensation is necessary, it may be obtained by merely changing the reactance reversing switch to the reverse position. This is a shorting-switch which keeps the current circuit closed until the switching is completed.

MAINTENANCE

The proper adjustments to insure correct operation have been made at the factory and should not be disturbed. The relay element assembly has been sealed for guaranteed performance and should be returned to the factory with the seal unbroken in case the relay does not operate satisfactorily. The large, silver contacts have been designed to operate for the life of the relay without maintenance. They do not need to be polished.

In the event the SJS relay itself should become inoperative, do not break the seal or remove the relay from the panel, but return the entire SJS relay and panel to the Sharon Plant through the nearest District Engineering and Service Office.

In the event any of the components on the relay panel other than the SJS relay itself become inoperative, they may be replaced with renewal parts ordered from the nearest Westinghouse Sales Office or from the Sharon Plant. Should parts be ordered, give the Style or Stock Order number of the equipment as stamped on the nameplate together with the Style number and description of the parts required as identified in Fig. 9.

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