Instructions for Type CVR-1 Voltage Regulating Relay

Westinghouse Electric Corporation

Power Transformer Division, Sharon, Pa.

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General

The type CVR-1 Voltage Regulating Relay is in reality a "control package" designed to control load tap changers. The major components of the CVR-1 relay are an induction disk type voltage sensitive relay, two auxiliary or pilot relays, two motor control relays, line drop compensator, and a reactor. All components are in a drawout chassis (Figures 1 and 6) so that the complete relay may be interchanged from unit to unit or removed for testing and inspection. The Flexitest® switch base is made an integral part of the CVR-1 relay to facilitate connecting and testing the relay. The case in which the relay is mounted for tap changer control is equipped with the mating portion of the Flexitest● switch.

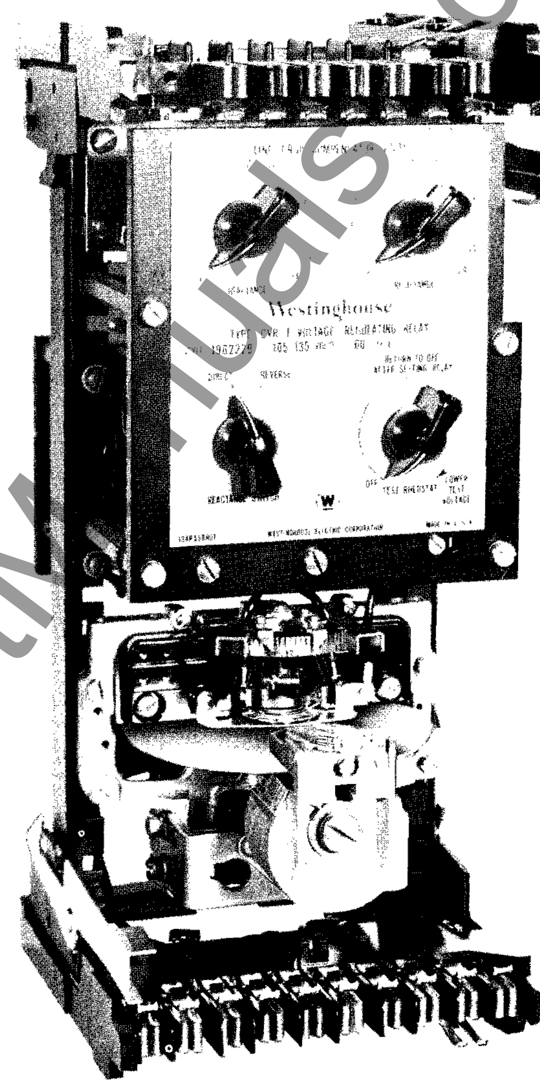


Fig. 1 - CVR-1 Relay Removed from Case

Installation

The CVR-1 relay is usually mounted in the tap changer control panel. Before putting the relay in service, remove any blocking inserted for the purpose of securing parts during shipment; make sure that all parts operate freely, and inspect the contacts to see that they are clean and close properly. Check the gaps of the permanent magnet and of the electromagnet and clean them if any foreign material is present. Operate the relay to check the settings and electrical connections.

Operation

The sensing element of the CVR-1 relay is an induction disk voltage relay with a set of single pole double throw contacts. Sealing circuits for the auxiliary relay are incorporated into the circuit to insure long contact life and positive operation.

Figure 2 shows schematically the relation between the principle components of the CVR-1 relay voltage sensing circuit, while Figures 3 and 4 show the internal schematic and internal wiring of the actual CVR-1 relay.

A reactor connected in series with the voltage sensing element is a large portion of the impedance of this circuit. This feature minimizes the effect of resistance variations due to temperature changes. The reactor is also used in the line drop compensator circuit.

The voltage coil on the lower pole of the voltage sensing element supplies a current to the coil on the upper pole by transformer action. The alternating fluxes induced in these poles are in quadrature. The alternating flux cutting the induction disk induces eddy currents in the disk of the relay which react with the flux in the air gap producing a torque. This torque is balanced against a spring torque to determine the balance position of the relay disk and its associated contacts.

Assume 120 volts has been applied to the relay long enough for the moving contact to come to rest at the 120 volt point on the relay scale. If the applied voltage were increased to 121 volts, the increased electro-magnetic torque would move the moving contact to the 121 volt point on the scale. If the voltage were reduced to 119 volts the decreased electro-magnetic torque would allow the spring torque to move the contacts to the 119 volt position.

A permanent damping magnet is mounted on the relay with the induction disk between the pole faces of this magnet and the magnet keeper. Whenever the induction disk moves through the unidirectional flux produced by this permanent magnet a restraining force is produced to control the time required to change from one balanced position to another for a given change in voltage.

The position of the stationary 90R and 90L contacts determines the voltage level at which they will be closed to initiate tap changer operation to correct the voltage.

If the voltage falls below the setting of the left hand contact long enough for the disk operated 90R contact to close, the relay AR is energized and seals itself in through the normally closed 120Y relay contact. Closing the AR motor control relay contact operates the tap changer to raise the voltage. Before the tap changer arcing contact has opened, a cam operated 120 switch in the tap changer closes to energize the 120X relay, which in turn takes over the sealing of the AR relay through its 120X contact and also operates the 120Y slug delayed relay. The normally open 120Y relay contact closes and shunts the reactor with a 3,000 ohm resistor which increases the current through the voltage coil 90 and tends to rotate the disk to open contact 90R. Thus for small voltage deviations there will be a short delay between successive tap changer operations. After the tap changer arcing contact has closed on position, the 120 pilot switch opens, allowing the 120X relay to release the AR relay. The tap changer motor is stopped by the motor brake. If the voltage is not corrected, the sequence is repeated until the voltage is corrected or a tap changer limit position is reached.

A rise in voltage to close the right hand contact 90L would initiate a similar sequence of operations to lower the voltage. In the latter instance the closing of the 120Y normally open contact will place a shunt through another 3000 ohm resistor around the potential coil 90 to produce compounding that tends to rotate the disk to open contact 90L.

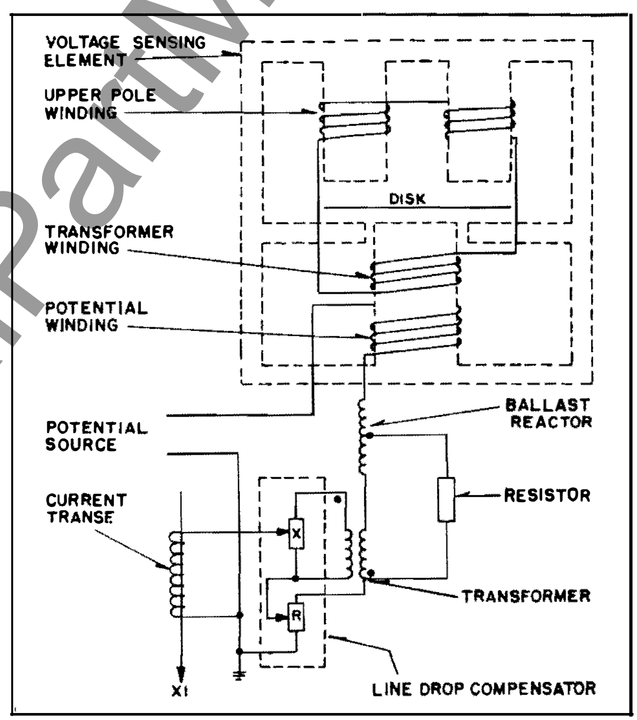


Fig. 2 - Schematic Diagram of the CVR-1 Relay Voltage Sensing Circuit

Bandwidth and Balance Voltage

The bandwidth of the voltage regulating relay is the difference in volts between the 90R and 90L contact setting.

Balance voltage is defined as the voltage midway between the 90R and 90L voltage

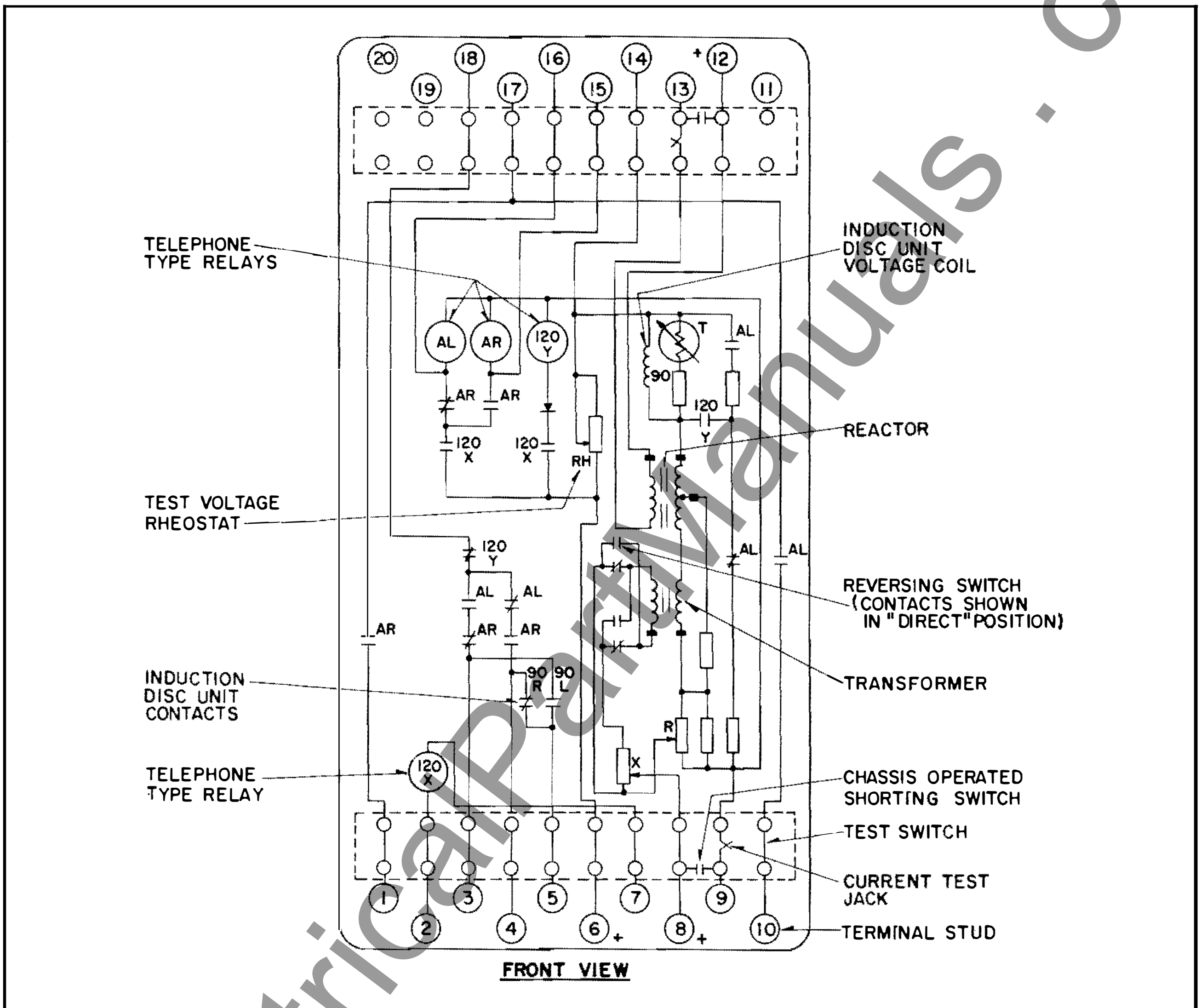


Fig. 3 - CVR-1 Voltage Regulating Relay Internal Schematic

settings and is the voltage which the relay will tend to maintain. A line drop compensator incorporated in the relay enables the relay to adjust the tap changer to regulate the voltage at the load center rather than at the tap changer itself. A current transformer installed in the main transformer provides a small secondary current proportional to the current flowing through to the load. By thus circulating current proportional to the load through resistance and reactance elements, an impedance voltage is produced which is combined with the control voltage to match the relation between the transformer output voltage and the line impedance drop. In this manner the resultant voltage applied to the voltage coil is made to match the load center voltage. When these resistance and reactance drops are properly selected to match the line impedance drop, the CVR-1 relay will respond to and regulate load center voltage rather than the transformer output voltage.

Setting the CVR–1 Relay by Applying an External Voltage

It is most convenient to set the CVR-1 relay in its mounting on the tap changer panel. The relay operating points may be set by means of its scale which is calibrated in

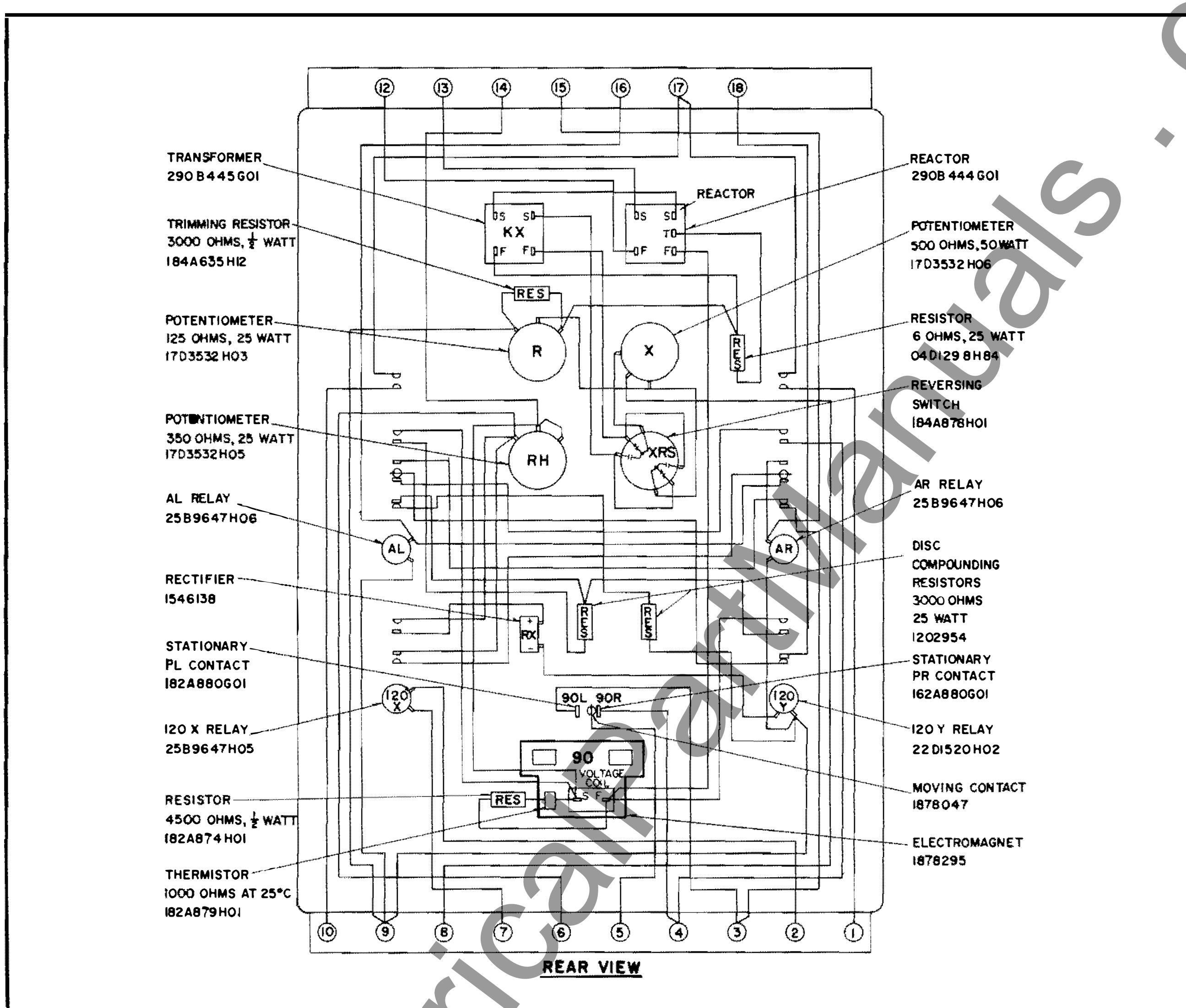


Fig. 4 - CVR-1 Relay Internal Connection Diagram

volts. This method is adequate for most conditions of operation and where settings within ± 1% of desired values are satisfactory.

For more exact setting a voltmeter of better than 1% accuracy class should be connected from PTT1 to PTT2 as shown in Figure 5. It is convenient to apply an external variable voltage source to PTT1 and PTT2, reading on the voltmeter the voltage at which the 90R and 90L contacts close. If desired, a constant voltage source may be applied between PTT2 (ground) and the load side of the potential breaker on the main control panel. This, in conjunction with the Test Rheostat (RH), will furnish a variable voltage across PTT1 and PTT2. Turning the Test Rheostat knob (RH) clockwise inserts resistance between the potential supply terminals and the CVR-1 sensing circuit. From this point the procedure is exactly as outlined on Page 7 under the heading "Setting the CVR-1 Relay with Load Tap Changer Energized". Observe the following cautions before attempting this procedure.

CAUTION: Extreme care must be taken to insure that the breaker in the potential circuit is in the OFF position and that the ground side of the test source is connected to PTT2. These

precautions are necessary to avoid the possibility of energizing the transformer in reverse through the potential transformer and to avoid short circuiting the external supply through the ground connection.

To make the settings proceed as follows:

1. Set resistance and reactance compensator dials both on zero. Set 90R lower and 90L higher than their final settings.

NOTE: Always adjust 90R and 90L contacts by moving the handles attached to the stationary contact assemblies. See Figure 7.

2. If the relay is not in service apply approximately 120 volts for one hour before making settings. This allows the relay to reach normal operating temperatures. If the relay is in service proceed immediately with step number 3.

3. Apply to the test terminals the exact voltage at which the tap changer is to operate in the raise direction. For example, consider 119 volts. Since the CVR-1 is very highly damped the voltage should be held at this level for about one minute. The disk contact will now be at its 119 volt position. Set the control selector switch on "AUTO" and move the left hand scale pointer until the 90R contact just touches the moving contact, picking up the auxiliary control relay and operating the tap changer in the raise direction. Place control selector switch in "MAN" position.

4. Apply to the test terminals the exact voltage at which the tap changer is to operate in the lower direction. For example, consider 121 volts. Hold the test voltage at 121 volts for about one minute to allow the disk contact to reach its 121 volt position. With the control selector switch on "AUTO" move the right hand scale pointer until the 90L contact just touches the moving contact, operating the tap changer in the lower direction.

5. The CVR-1 relay is now set to hold regulated output between the limits of 119 and 121 volts or at a nominal 120 volt level (balance voltage) with a 2 volt (±1 volt) bandwidth.

6. The CVR-1 relay will operate satisfactorily with any combination of contact settings between 105 and 135 volts and the tap changer will provide excellent quality regulation with set bandwidths of 2 volts or greater, that is, balance voltage ±1 volt.

7. For any other settings, determine the limit settings for 90R and 90L of the voltage regulating relay and proceed as outlined in 2 through 6.

8. Refer to Time Voltage Curve Figure 10 and set damping magnet for desired time delay characteristic.

9. Set resistance and reactance compensation dials as required (see page 14).

10. When tests are completed return the test Rheostat Knob to the "OFF" position.

Setting the CVR—1 Relay with Load Tap Changer Energized

A test voltage adjustment rheostat (RH) is located on a control panel inside the CVR-1 case for your convenience. It makes possible setting the relay by using the control voltage with the tap changer energized. Turning the Test Rheostat knob clockwise will adjust the voltage applied to the relay by means of the rheostat which is in series with the control voltage and is located ahead of the test terminals. (See Diagram Figure 5). Proceed as follows:

1. Set resistance and reactance compensator dials both on zero. Set 90R lower and 90L higher than their final desired settings.

NOTE: Always adjust 90R and 90L contacts by moving the handles attached to the stationary contact assemblies. See Figure 7.

2. If the relay has not been in service for at least an hour, allow up to an hour before making settings in order for the relay to reach normal operating temperature.

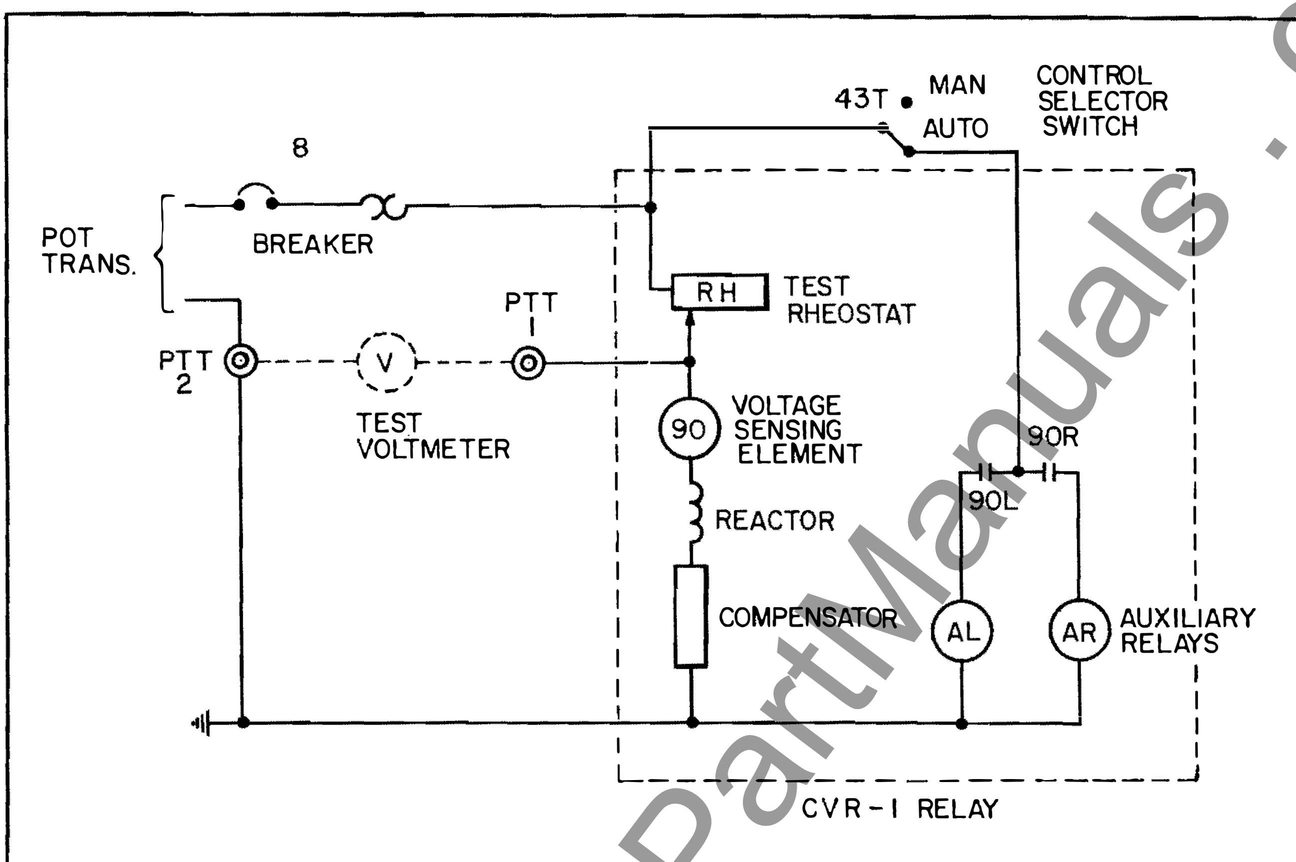


Fig. 5 - Simplified Control Schematic with CVR-1 Relay

3. Manually operate the tap changer in the raise direction until a voltage 2 or 3 volts in excess of the 90L contact setting is read by means of a voltmeter connected to test terminals PTT1 and PTT2.

Now cut in resistance on the Test Rheostat until the voltage on the test terminals is at the desired value for the 90R setting. After 60 seconds set the control selector switch on "AUTO" and move the 90R stationary contact until it picks up the auxiliary control relay. Set control selector to "MAN".

4. Adjust the Test Rheostat for the desired value of the 90L setting and again, after 60 seconds, set the control selector on "AUTO". Move the 90L stationary contact until it picks up the motor control relay.

5. Refer to Time Voltage Curve (Figure 10) and set damping magnet for desired time delay characteristic.

6. Set resistance and reactance compensator dials as required. (See Page 14)

7. Return Test Rheostat knob to the "OFF" position.

Setting the CVR-1 Relay while Removed from Flexitest Case

When removed from its case, the type CVR-1 relay may be checked conveniently by means of a pair of Flexitest● plugs, Style No. 1164046, which may be plugged into the jacks in top and bottom of the relay chassis. The circuit may also be made by means of clip leads connected to corresponding terminals on the relay.

Preparatory to making this test, jumper numbered terminals 5 to 6, 4 to 15, 3 to 16, 5 to 18, and 7 to 9 on the CVR-1 chassis. Apply a variable voltage to points 14 and 9 (corresponding to PTT1 and PTT2 on the con-

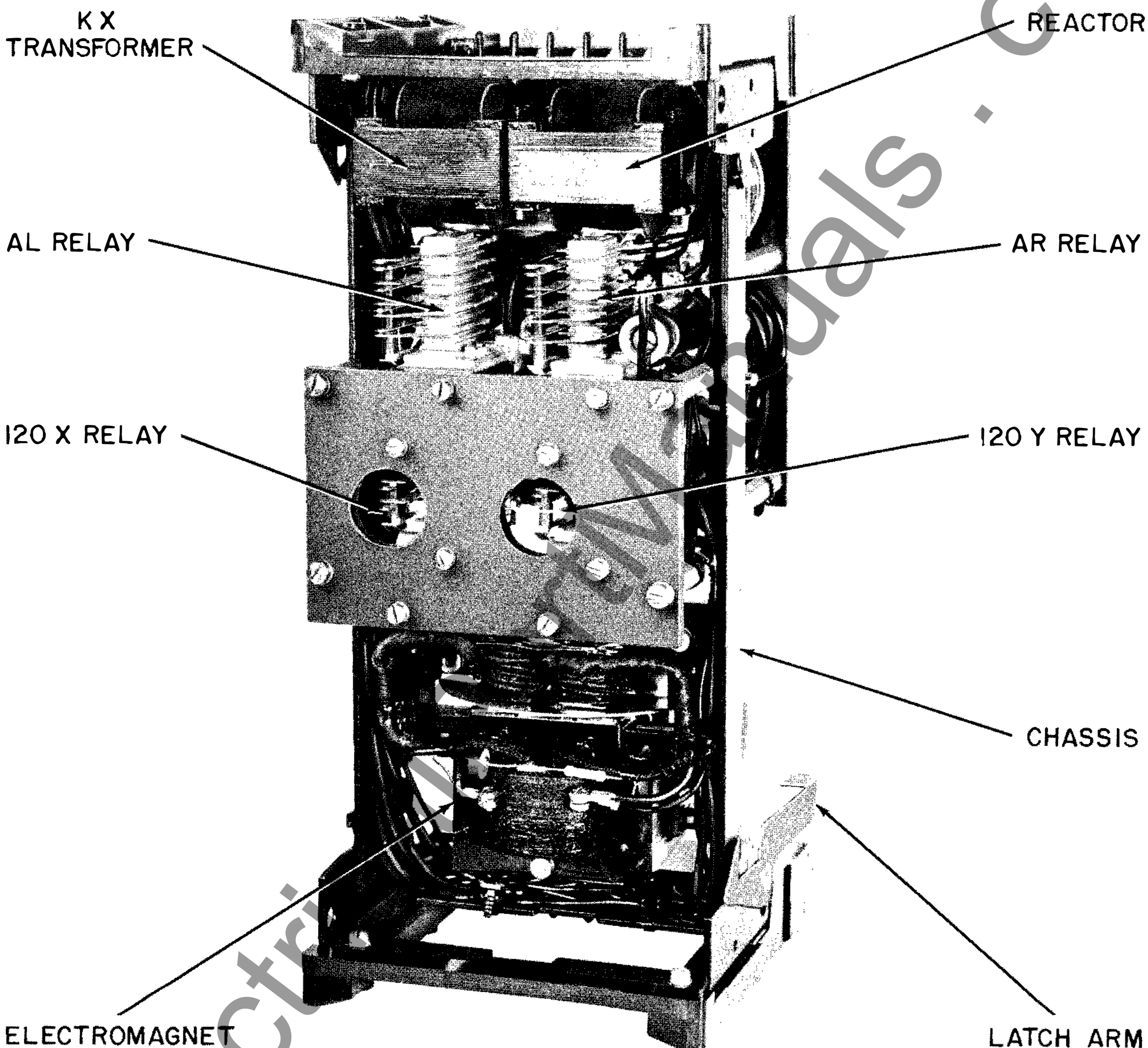


Fig. 6 - CVR-1 Relay Removed from Case (Rear View)

trol panel) and follow the procedure under "Setting the CVR-1 Relay by Applying an External Voltage". The self-sealing circuit of the CVR-1 relay may be cleared by momentarily connecting a jumper from 2 to 5. The 120 switch performs this function in the tap changer, clearing the self-sealing network and applying negative compounding to the disk of the CVR-1 relay. If desired, a constant voltage may be applied at points 6 and 9 with the Test Rheostat being used to obtain a variable voltage. A voltmeter connected across 9 and 14 will indicate the voltage actually applied to the voltage sensing coil.

A somewhat more intricate test circuit is indicated in Figure 8. Such a reconnection following removal of the original jumpers will provide all switching and indication required to calibrate the relay and check its performance while removed from the tap changer control panel. Lights Rp and Lp indicate operations of contacts 90R and 90L

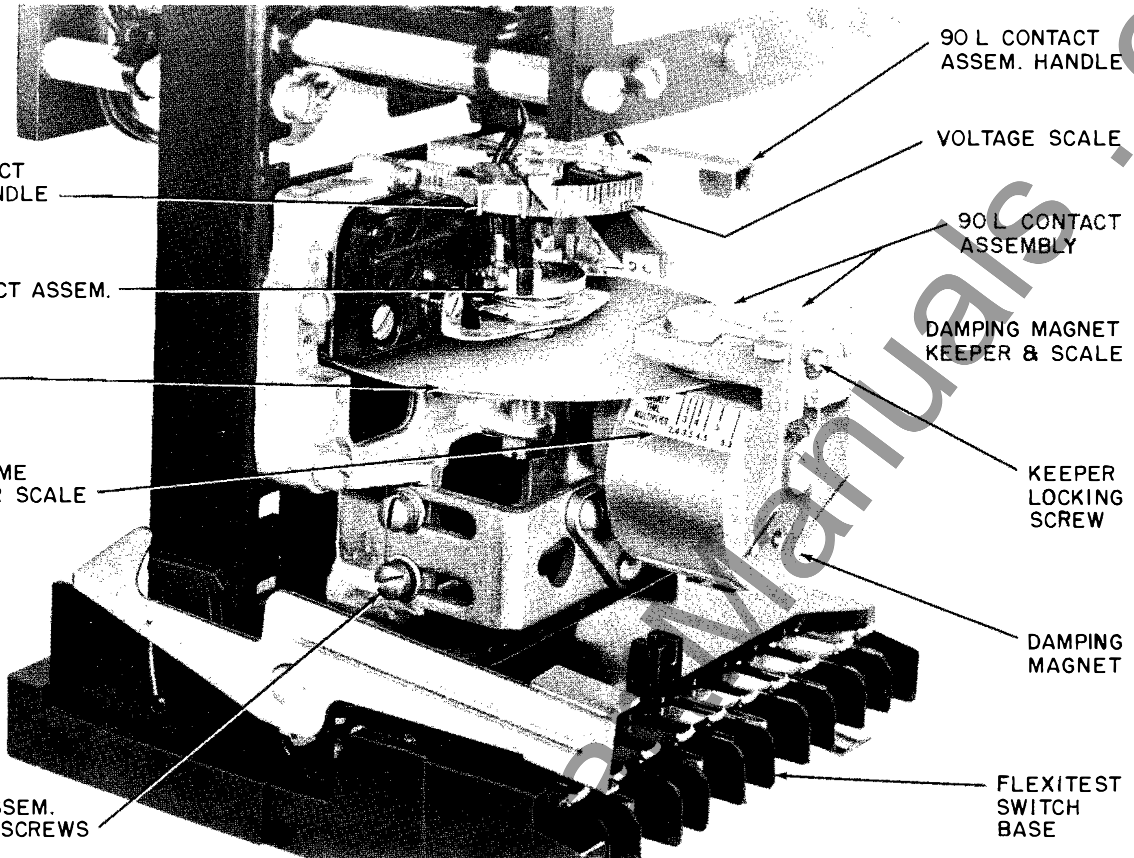


Fig. 7 - Close-up of CVR-1 Relay Adjustments

while lights Ro and Lo indicate operation of the motor control relay contacts AR and AL.

With the switch in the "CAL" position, the operation of 90R and 90L contacts is indicated by lights Rp and Lp.

With the switch on "AUTO" position the relay functions in response to applied voltage as it would under fully automatic regulation. Operations are indicated by all four lights.

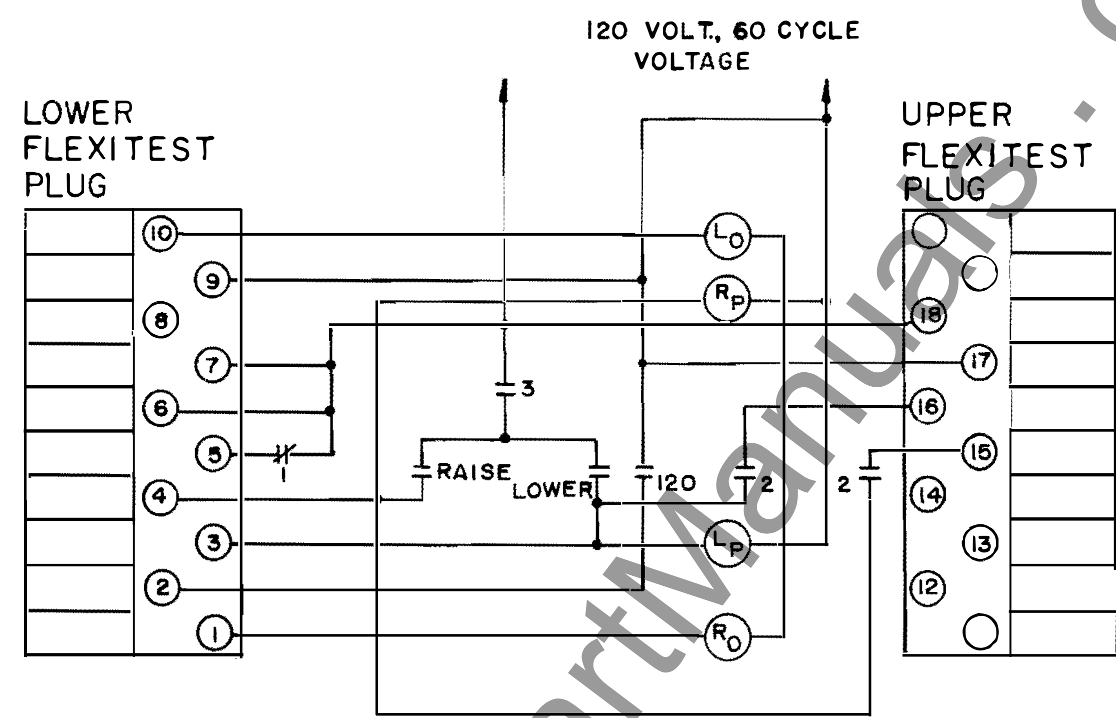
With the switch on "MAN" position the raise and lower switches control the motor control relays. Rp and Lp now indicate closing of the raise and lower pushbuttons. Ro and Lo still indicate operation of AR and AL contacts.

General operating data for the relay on 60 cycles is as follows:

Burden of the potential
circuit at 120 volts - - - - - - - - 10VA
with auxiliary relays energized 39VA
Separate R and X compensation - 24 volts
100% load compensation current - .2 amps
Burden on the current circuit at 100%
load - - - - - - - - - - - - - - - 13 VA

Time Delay Adjustment

The inverse time delay characteristic of the CVR-1 relay enables it to maintain regulated voltage within close tolerance. Figure 7 shows the relay adjusted for a damping factor of 2.4. Figure 9 shows a curve of relay adjustment versus damping factors and Figure 10 shows a curve of relay performance when adjusted for a damping factor of one. As can be seen from Figure 10, at least three different factors control the amount of time delay that precedes the initial operation of the tap changer on a change



NORMALLY OPEN SPRING RETURN
SWITCHES OR PUSH-BUTTONS
RAISE
LOWER
120 (CLOSE TO RESET RELAY)

INDICATING LIGHTS *
R_P = RAISE DISK CONTACT
L_P = LOWER DISK CONTACT
R_O = RAISE OPERATE
L_O = LOWER OPERATE

* USE 1/25 OR 1/4 WATT NEON LAMPS WITH PROTECTIVE RESISTORS

CAL-AUTO-MAN
3 POSITION SELECTOR SWITCH SEQUENCE

	SWITCH POSITION		
CONTACT	CAL.	AUTO	MAN
1	X	X	
2		X	X
3			X

X= INDICATES CONTACTS CLOSED

Fig. 8 - Circuit for Checking and Calibrating the CVR-1 Relay Removed from Case

of voltage. For example, any one of the following conditions contributes to a shorter time delay.

1. A lower damping factor.

2. A greater voltage deviation from the center of the set bandwidth.

3. A lower bandwidth.

Should the conditions be reversed, a longer time delay is indicated. It is difficult to make a general statement about time delay except that it is not fixed. It can be said, however, that for step deviations from the band center equal to 75% of total set bandwidth, time delay may be varied from 11 to 60 seconds by adjustment of the damping magnet and keeper. Correction for greater deviations lowers this time band while correction for lesser voltage deviations raises the time band.

In some cases where cycling loads or other load conditions produce large voltage changes of short duration it may be desirable to increase the damping to obtain longer time delay and avoid unnecessary tap changer operation. The time delay may be increased by decreasing the gap between the permanent magnet and its keeper. Relays are shipped set for a damping factor of 1.0. The magnet keeper is set with its top even with the 1.0 graduation on the keeper time multiplier. The magnet engagement setting is at the 2.4 graduation on the magnet time multiplier. This gives a damping factor of 5.3.

Variations in damping factor between 1.0 and 2.4 are obtained by changing the gap distance between the magnet keeper and the damping magnet, with the latter set at 2.4. To increase the damping factor from 1.0 to 2.4, the gap must be decreased. To change this setting the keeper locking screw must first be loosened. If, after loosening this screw, the keeper does not turn easily, remove the keeper locking screw completely and check the copper thread protector under the locking screw to see that it is free. After making certain that the keeper locking screw turns easily, a damping factor of 1.0 to 2.4 can be secured by lining up the top of the magnet keeper with the desired graduation on the keeper time multiplier scale.

Variations in damping factor between 2.4 and 5.3 are obtained by varying the amount of engagement of the damping magnet and disc, with the magnet keeper set at 2.4. To reduce the damping factor from 5.3 down to 2.4 this engagement must be decreased to the position shown in Figure 7. This is done by loosening the four magnet assembly mounting screws (See Figure 7) and sliding the magnet assembly to its new position. A magnet time multiplier scale is attached to the permanent magnet to facilitate setting the magnet engagement. This scale is referenced to the edge of the disc directly above it. To raise the damping factor after it has once been lowered, use a reversal of the above procedure.

CAUTION: The keeper magnet should never be turned down below the 2.4 graduation. When the keeper magnet is at or near the 2.4 setting, care should be exercised to see that mechanical binding does not take place between magnet and disc. Too close proximity of keeper magnet and disc could result in overdamping and possible stopping of disc movement entirely.

The maximum keeper setting is shown in Figure 7. After this adjustment has been completed the locking screw should again be tightened; but before tightening, be sure that the piece of copper is still in the hole so that the keeper adjusting threads will not be damaged by the keeper locking screw.

The damping factor of any relay as set may be determined easily by the following procedure.

1. De-energize the relay.
2. Set 90R scale handle at 105 volts.
3. Set 90L scale handle at 135 volts.
4. Manually rotate the disk to close 90L contacts.
5. Release the disk and measure the time to close the 90R contact.
6. Divide the number of seconds measured in step 5 by 5.4. The quotient is the damping factor for the relay as adjusted.
7. Move the 90R and 90L scale handles to the desired limits for voltage band.

Having determined the relay damping factor, a new curve for relay performance may be plotted by multiplying the time values read from the curves in Figure 10 by the damping factor.

Example:

Assume 10.8 seconds measured in step 5 above. $10.8 \div 5.4 = 2$, the relay damping

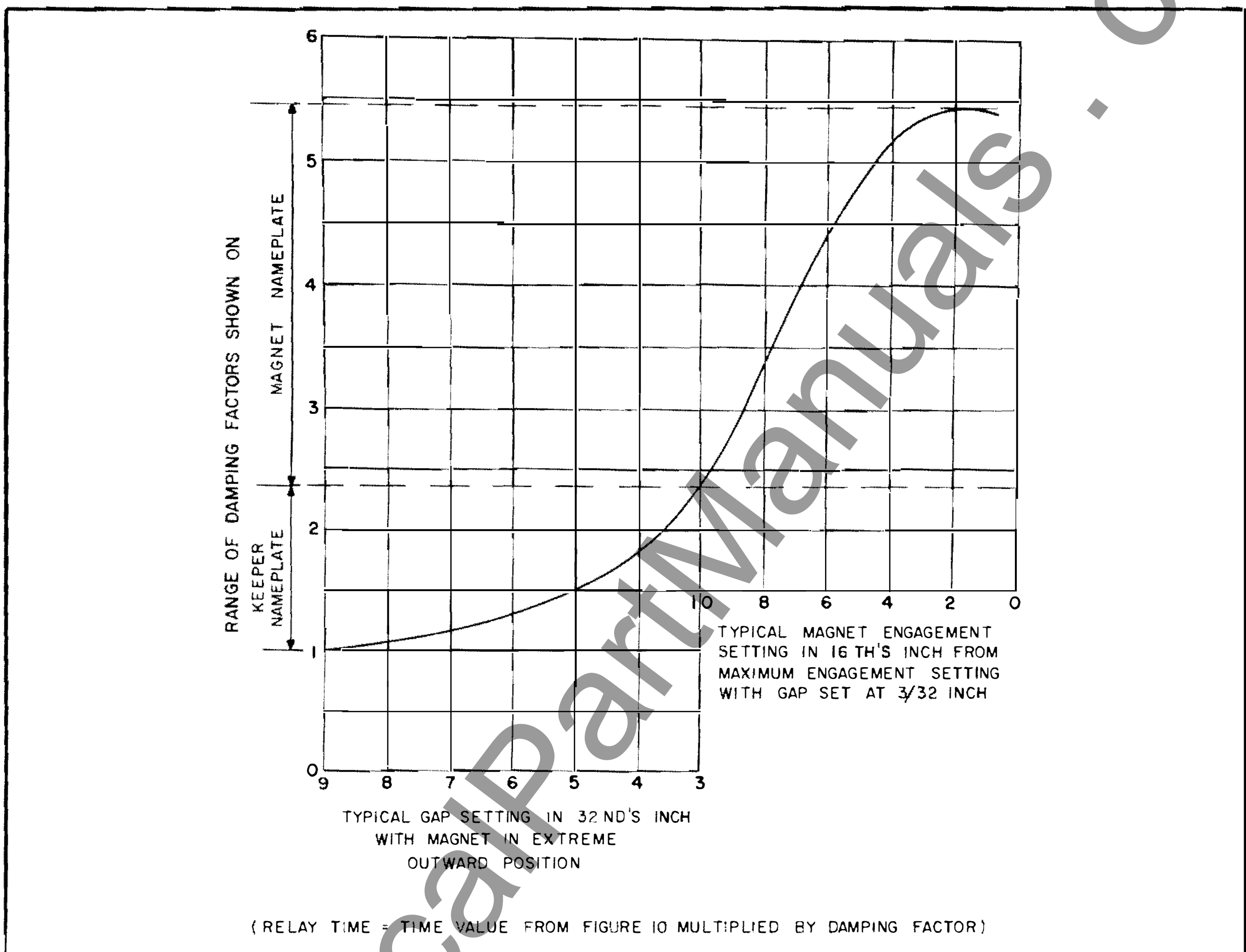


Fig. 9 - Typical Damping Factors Versus Gap Setting and Magnet Engagement

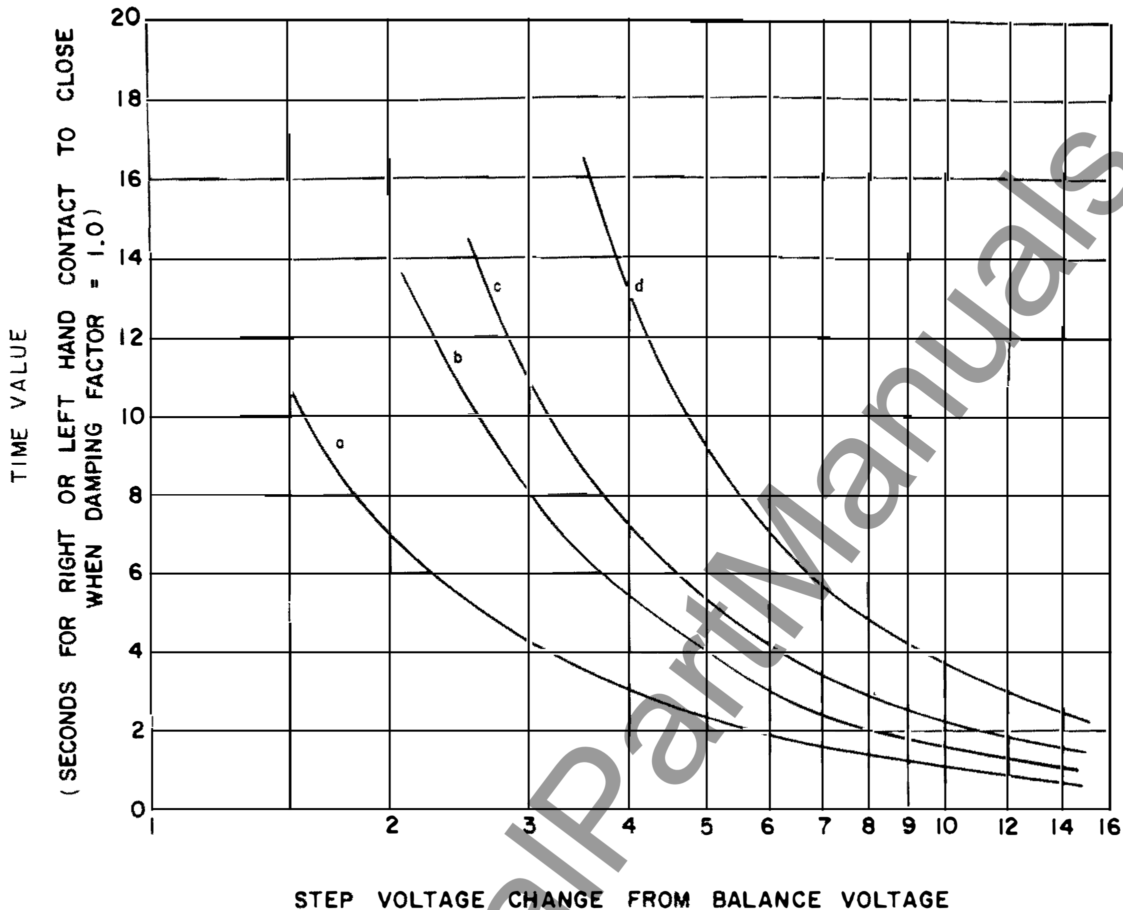
factor. In Figure 10 we find that for a 2 volt bandwidth the time delay would be 3 seconds for a 4 volt change.

To determine the actual time to close relay contacts multiply 3 (seconds) x 2 (damping factor) = 6 seconds actual time delay.

CVR–1 Relay Control Adjustments

Figure 11 shows the CVR-1 Relay Control Panel as seen facing the front of the relay with the cover removed. The adjustments for resistance and reactance compensation, the switch for reversing the polarity of the reactance compensation, and the Test Rheostat are all contained on this sub-panel. A control breaker, potential and current test terminals, and the selector switches for automatic-manual and raise-lower tap changer control are separately mounted on the larger steel panel containing the CVR-1 relay. These have been touched briefly in an earlier discussion but are not within the scope of this instruction book.

1. Test Rheostat. The Test Rheostat on the CVR-1 sub-panel facilitates checking and setting the relay voltage sensing element, as described earlier under two different methods of setting. Under actual conditions of operation it is left in the "OFF" position, in which there is zero resistance between the potential supply source and the CVR-1 voltage sensing element.



CURVE	BAND WIDTH
a	2 VOLTS
b	3 VOLTS
c	4 VOLTS
d	6 VOLTS

(RELAY TIME = TIME VALUE MULTIPLIED BY DAMPING FACTOR FROM FIGURE 9)

Fig. 10 - Typical Time Delay Versus Step Change in Voltage Level for Type CVR-1 Relay

2. <u>Line Drop Compensator.</u> Separate rheostats permit independent setting of the 24 volts resistance and 24 volts reactance compensation (both on a 120 volt base). This value of compensation is available only when the main current transformer is delivering a full 5 amperes to the tap changer control. (An auxiliary current transformer (ACT) steps this current down from 5 amperes to the .2 ampere rating of the compensator elements. Line drop compensation is obtained by circulating a current, proportional to the load current, through the line drop compensator network to simulate the actual voltage drop in the line for which the compensator is adjusted. The compensator voltage, when subtracted from the output voltage of the transformer or regulator, gives a resultant which is equivalent in magnitude and phase angle to the load center voltage.

3. <u>Reactance Reversing Switch.</u> For normal line drop compensation the Reactance Switch (XRS) on the CVR-1 sub-panel is left

in the "direct" position. Reversed reactance compensation is obtained by placing it in the "reverse" position, which reverses the polarity of the reactance element.

"Reverse reactance" compensation is a method used to reduce the circulating current that might flow when two or more transformers are paralleled. It is a requirement of ASA Standards C57.12-37.236.1. Instead of running toward opposite extreme positions, tap changers having "reverse reactance" compensation tend to move toward whatever positions cause the least amount of circulating current to flow. This is accomplished at some sacrifice of normal line drop compensation, but is generally satisfactory when units paralleled are not located in close proximity to each other, or where the supply is from different sources.

4. Line Drop Compensator Settings. The final settings on the line-drop compensator are usually made by field adjustments, but if the data on the particular line is known, the curves in Figs. 12 and 13 may be used, and initial values calculated.

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

Dial Setting for Resistance Compensation =

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

Dial Setting for Reactance Compensation =

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

Where

$N_{C.T.}$ = main current transformer ratio

= $\frac{\text{primary current}}{\text{secondary current}}$

N_{POT} = potential transformer ratio

= $\frac{\text{primary voltage}}{\text{secondary voltage}}$

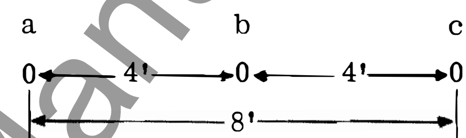
R_L = resistance per conductor from unit to load center, in ohms per mile.

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

d = miles from unit to load center.

n = 120/balance voltage setting.

A typical three-phase example is as follows:



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

Line Voltage = 12000 volts

Main Current Transformer Ratio = 600/5

Potential Transformer Ratio = 6928/120

Distance from unit to load center = 3.5 miles.

Balance voltage setting = 117 volts.

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

From Figure 12:
R = 0.12 ohms per mile.

From Figure 13:
D = 1.26x4 = 5.04 feet.

X_L = 0.64 ohms per mile.

The line drop compensator resistance setting is:

$$\frac{5 \times 600/5}{6928/120} \times 0.12 \times 3.5 \times \frac{120}{117} = 4.47$$

The line drop compensator reactance setting is:

$$\frac{5 \times 600/5}{6928/120} \times 0.64 \times 3.5 \times \frac{120}{117} = 23.9$$

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

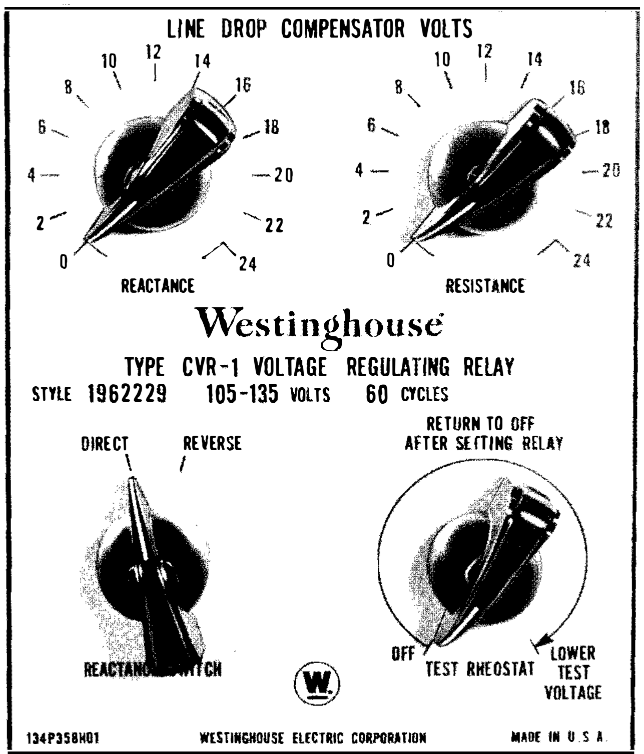


Fig. 11 - CVR-1 Relay Control Adjustment Panel

Flexitest Case

The type FT (Flexitest)® case is a dustproof enclosure combining relay units and knife-blade test switches in the same case. This combination provides a compact flexible assembly easy to maintain, inspect, test and adjust. There are three main units of the type FT case: the case, cover, and chassis. The case is an all-steel welded housing containing the hinge half of the knife-blade test switches and the terminals for external connections. The cover is a molded phenolic frame with a clear glass window, a thumb nut, and a hinge. The hinge fits over the top flange of the case. The thumb nut, which fastens to a stud on the bottom flange of the case, holds the cover securely in place on the case. The chassis is a steel frame that supports the relay elements and the contact-jaw half of the test switches. This slides in and out of the case. The electrical connections between the base and chassis are completed through the closed knife-blades. The case designation is type FT-32.

REMOVING CHASSIS

To remove the chassis, first remove the cover by unscrewing the captive thumb nut at the bottom and lifting the cover hinge off the top flange of the case. This exposes the relay units and all the test switches for inspection and testing. The next step is to open the test switches. In opening the test switches, they should be moved all the way back against the stops. With all the switches fully opened, release the cam action latches and pull the chassis outward. One cam latch is located at the upper right and must be pulled downward for release. The other cam latch is located at the lower left of the chassis and must be pushed upward for release. The chassis can be set on a test bench for easy inspection, maintenance and test.

After removing the chassis a duplicate chassis may be inserted in the case or the blade portion of the switches can be closed and the cover put in place without the chassis. The chassis-operated auxiliary shorting

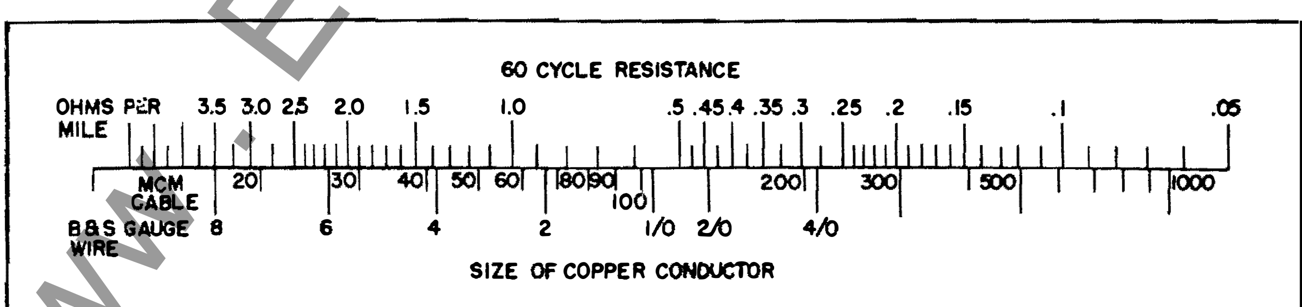
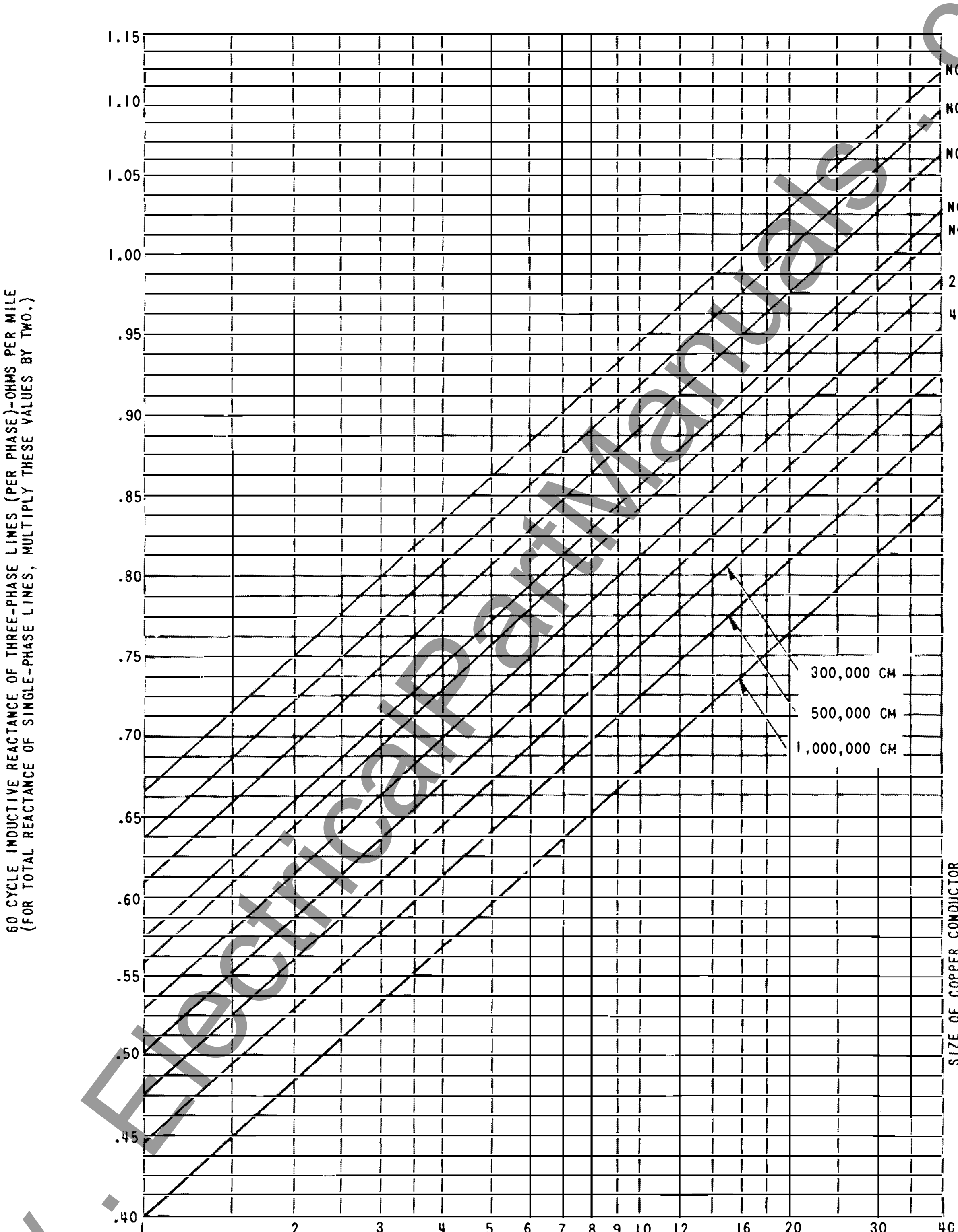


Fig. 12 - Resistance Chart Showing Ohms per Conductor per Mile 60 Cycle Circuit



EQUIVALENT CONDUCTOR SPACING, D, OF UNSYMMETRICAL THREE PHASE LINES IS GIVEN BY THE EXPRESSION $D = \sqrt[3]{D_{AB} \times D_{BC} \times D_{CA}}$, WHERE

D_{AB}, D_{BC}, AND D_{CA} ARE THE DISTANCES IN FEET BETWEEN CONDUCTORS DESIGNATED BY THE SUBSCRIPTS.

NOTE:- WHERE $D_{CA} = 2\ D_{AB} = 2\ D_{BC}$; $D = 1.26\ D_{AB}$

Fig. 13 - Reactance in Ohms per Conductor per Mile Versus Spacing for Single Phase or 3 Phase Lines

switches (see Figure 16) between terminals 8-9 and 12-13 remain closed with the chassis out to prevent open circuiting the current transformers when the current test switches are closed.

When the chassis is to be put back in the case the above procedure is to be followed in the reversed order.

CAUTION: Be sure to operate the cam latches into their original horizontal position before attempting to replace cover. Failure to do so may crack the cover.

ELECTRICAL CIRCUITS

Each terminal in the base connects through a test switch to the relay units in the chassis as shown on the internal schematic diagram Fig. 3. The relay terminals are identified by numbers marked on the outside of the case. The test switch positions are identified by numbers marked on the molded blocks.

The potential and control circuits through the relay are disconnected from the external circuit by opening the associated test switches. A current test switch is illustrated in Figure 15. Opening both current test switches short-circuits the current transformer secondary and disconnects one side of the relay circuit but leaves the other side of the relay circuit connected to the external circuit through the current test jack jaws. This circuit can be isolated by inserting an ammeter test plug S#1164047 (without external connections), or by inserting ten-circuit test plugs S#1164046.

TESTING

The relays can be tested in service, in the case but with the external circuits isolated, or out of the case as follows:

TESTING IN SERVICE

The ammeter test plug S#1164047 can be inserted in the current test jaws after opening the knife-blade switch to check the current through the relay, as shown in Fig. 14. This plug consists of two conducting strips separated by an insulating strip. The ammeter is connected to these strips by terminal screws and the leads are carried out through holes in the back of the insulated handle.

Voltages between the potential circuits can be measured conveniently by clamping #2 clip leads on the projecting clip lead lug on the contact jaw.

TESTING IN CASE

With all blades in the full open position, the ten circuit test plug S#1164046 can be inserted in the contact jaws, per Figure 17. This connects the relay units to a set of

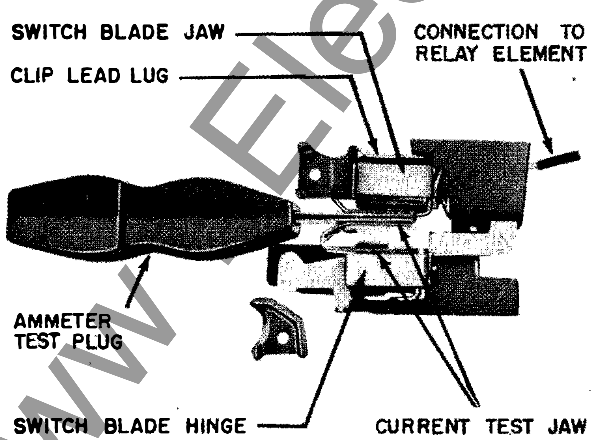


Fig. 14 - Ammeter Test Plug in Testing Positions

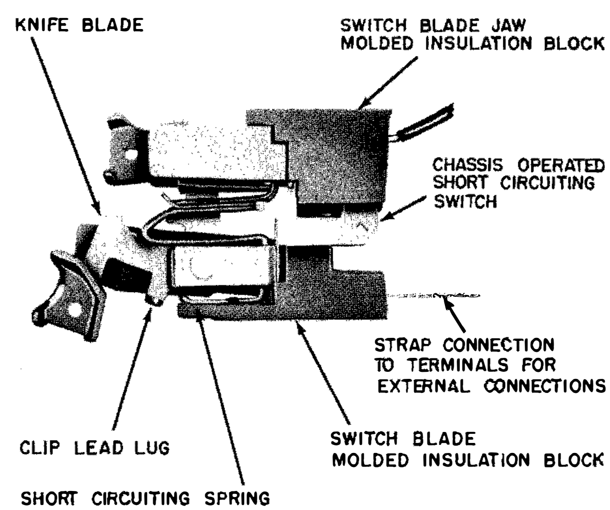


Fig. 15 - Short Circuiting Switch

binding posts and completely isolates the relay circuits from the external connections by means of an insulating barrier on the plug. The external test circuits are connected to these binding posts. The plug is inserted in the bottom test jaws with the binding posts up and in the top test switch jaws with the binding post down.

The external test circuits may be made to the relay units by #2 test clip leads instead of the test plug. When connecting an external test circuit to the current elements using clip leads, care should be taken to see that the current test jack jaws are open so that the relay is completely isolated from the external circuits. Suggested means for isolating this circuit are outlined above under "Electrical Circuits".

TESTING OUT OF CASE

With the chassis removed from the case, relay units may be tested as per description included on page 8.

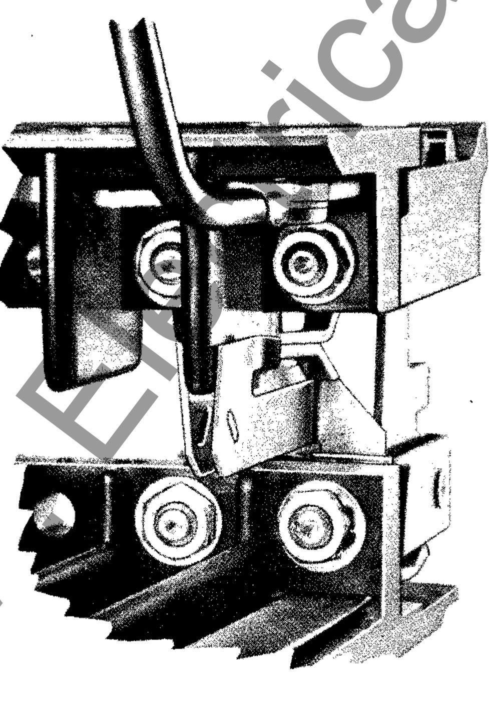


Fig. 16 - Auxiliary Short Circuiting Switch (Enlarged View)

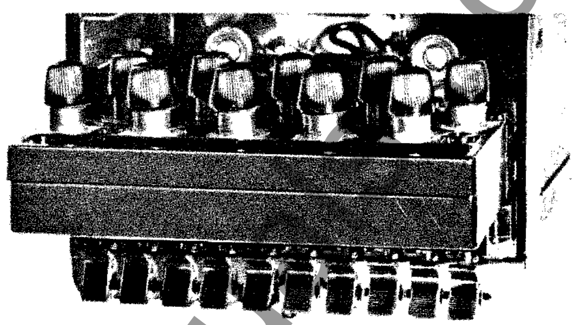


Fig. 17 - Multi-Circuit Test Plug in Testing Position

An internal schematic for the relay is shown in Figure 3.

Maintenance

The proper adjustments to insure correct operation of this relay have been made at the factory and should not be disturbed after receipt by the customer (with the exception of bandwidth or time delay settings). Repair work can be most satisfactorily done at the factory. If it is desired to check the adjustment at regular maintenance, the following instructions should be followed:

NOTE: Before opening the test switches turn the power supply off.

Refer to previous description of the Flexitest case for method of removing cover and relay.

When contacts require cleaning, they should be cleaned with a fine contact file similar to S#1002110 or a contact burnishing tool. Abrasive material should not be used because any small particles embedded in the contact surface will impair the contact operation.

In the event any of the components 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 Shop Order number of the equipment as stamped on the nameplate, together with the style number and description of the parts required as identified in Figure 4 and on the following list.

Relay Complete S#1962229

Relay Case S#182A901G24.

Relay Cover S#1877784.

Switch Blades on Block (Top) S#58C8373G33

Switch Blades on Block (Bottom) S#1877021

Switch Jaws on Block (Top) S#57D7876G13

Switch Jaws on Block (Bottom) S#1877307

Potentiometer (50 Watt 500 Ohm) (X Control) - S#17D3532H06

Potentiometer (25 Watt 125 Ohm) (R Control) - S#17D3532H03

Reversing Switch (XRS) S#184A878H01

Potentiometer (25 Watt 350 Ohm) (RH) - S#17D3532H05

Rectifier - S#1546138

Disc Compounding Resistors (3000 Ohms 25 Watt) - S#1202954

Resistor (6 Ohms 25 Watt) - S#04D1298H84

Trimming Resistor (3000 Ohms .5 Watt) - S#184A635H12

Resistor (Self-Supporting) (4500 Ohms .5 Watt) - S#182A874H01

Thermistor (Self-Supporting) - S#182A879H01

Transformer (KX) - S#290B445G01

Reactor - S#290B444G01

Telephone Relay (AR) and (AL) - S#25B9647H06

Telephone Relay (120X) - S#25B9647H05

Telephone Relay (120Y) - S#22D1520H02

Electromagnet for Disc Type Element - S#1878295

Moving Contact, Spring & Adjuster - S#1878047

Stationary Contact and Spring - S#182A880G01

Knob for Potentiometers and Reversing Switch - S#184A883H01

Top Bearing Screw - S#1009811

Bottom Bearing Screw - S#214869

Steel Ball (10 in bottle) - S#100R533G01

Permanent Magnet - S#184A185G02

Disc and Shaft Assembly - S#1732852