WESTINGHOUSE

INSTRUCTION BOOK

Single-Phase, Pole-Type

VOLTAGE REGULATOR

Type URL-8

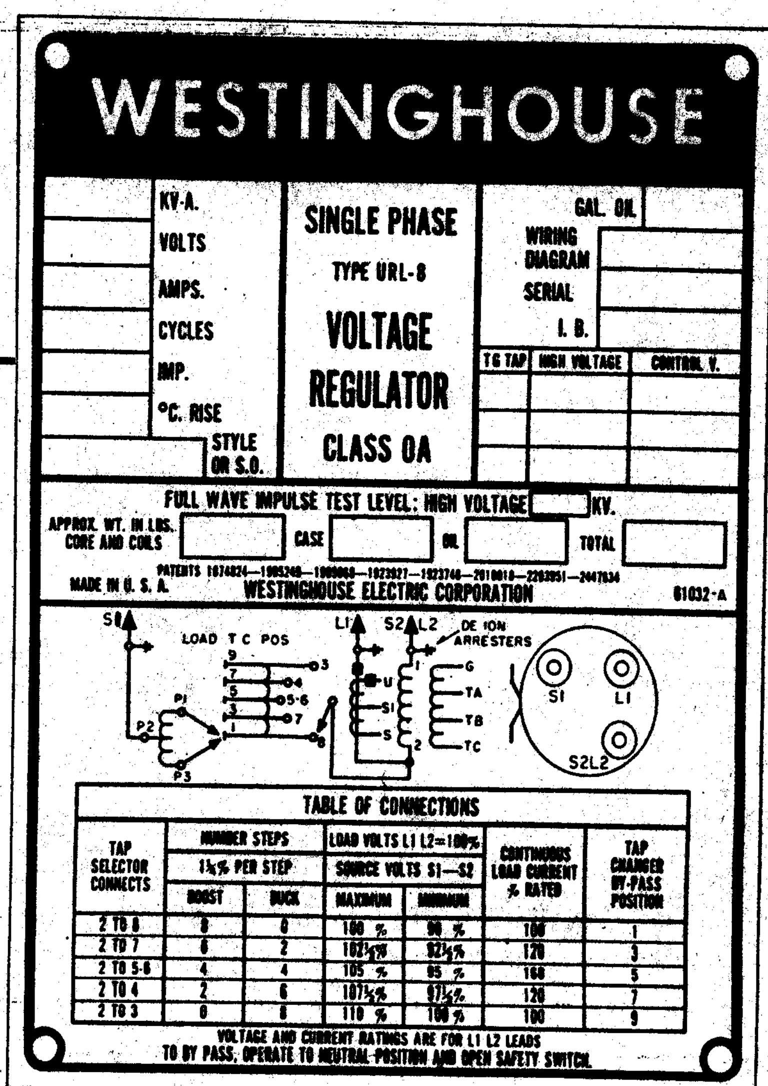
Westinghouse Electric Corporation

I.B. 47-4[illegible]

SPECIAL INQUIRIES

When communicating with Westinghouse regarding the product covered by this Instruction Book, include all data contained on the nameplate attached to the equipment.* Also, to facilitate replies when particular information is desired, be sure to state fully and clearly the problem and attendant conditions.

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



TAP SELECTOR CONNECTS	NUMBER STEPS 1¼% PER STEP		LOAD VOLTS L1 L2=100% SOURCE VOLTS S1—S2		CONTINUOUS LOAD CURRENT % RATED	TAP CHANGER BY-PASS POSITION
	BOOST	BUCK	MAXIMUM	MINIMUM		
2 TO 8	8	0	100 %	90 %	100	1
2 TO 7	6	2	102½%	92½%	120	3
2 TO 5-6	4	4	105 %	95 %	160	5
2 TO 4	2	6	107½%	97½%	120	7
2 TO 3	0	8	110 %	100 %	100	9

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

DESCRIPTION • OPERATION • MAINTENANCE

INSTRUCTIONS

Single-Phase, Pole-Type

VOLTAGE REGULATOR

Type URL-8

WESTINGHOUSE ELECTRIC CORPORATION
SHARON PLANT • TRANSFORMER DIVISION • SHARON, PA.

SUPERSEDES ADVANCE I.B. 47-430-1

EFFECTIVE JUNE, 1951

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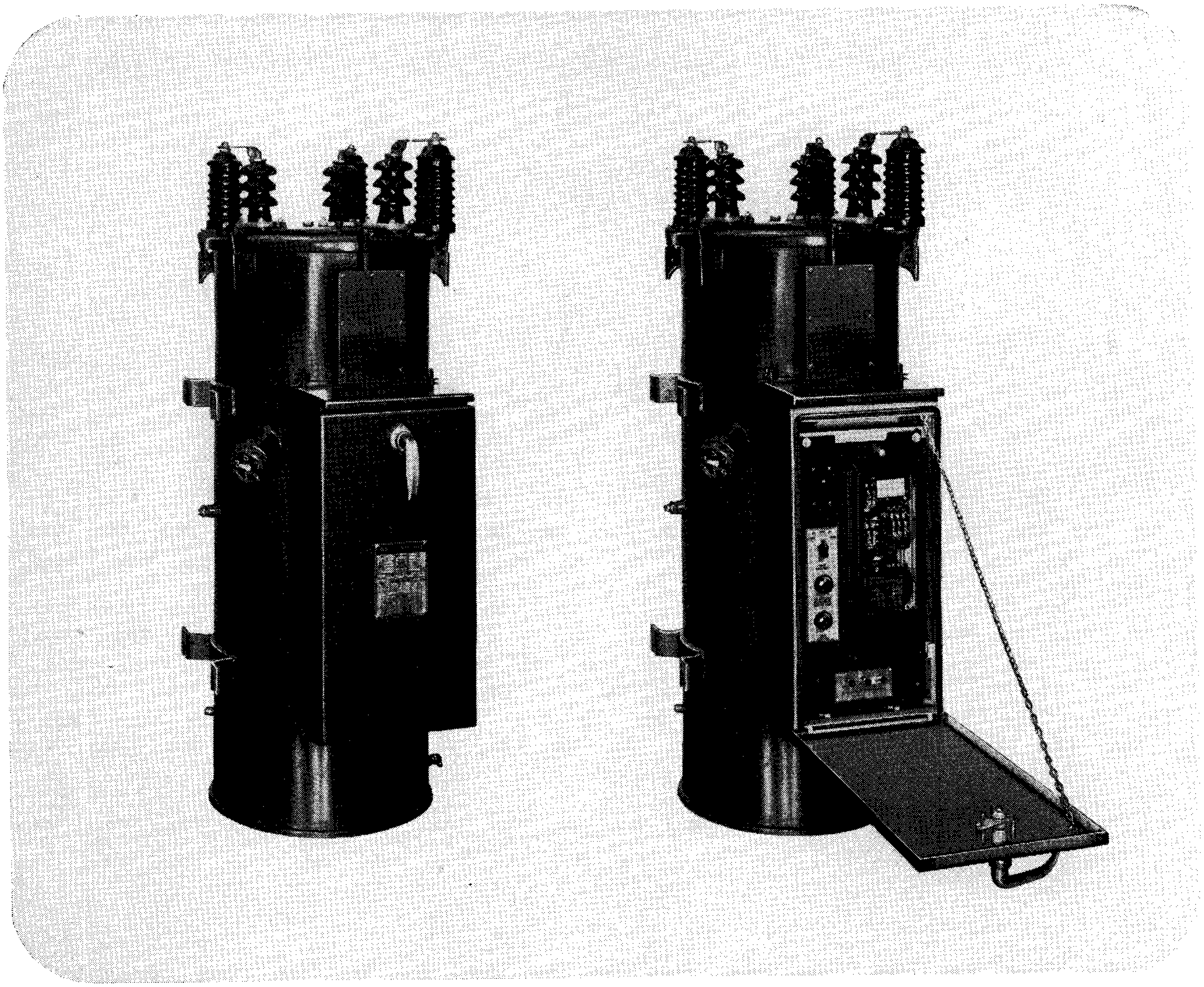


URL-8 VOLTAGE REGULATOR

This instruction book has been prepared to assist the purchaser in properly installing, operating, and maintaining the Type URL-8 Feeder Voltage Step Regulator supplied by Westinghouse. The methods and recommendations presented are based on the best practical judgment of Westinghouse engineers, from their experience in design and installation of this apparatus, and the reports of experience from purchasers of similar or related apparatus.

This book applies to all standard regulators. However, it must be recognized that a publication of this type cannot cover exact construction details of all possible voltage and kva ratings and all other modifications which may be furnished on special orders. The information contained herein, together with additional information supplied on the instruction plate, wiring diagram, and outline drawings should permit satisfactory operation of the regulator.

DESCRIPTION

The Type URL-8 Pole Type Voltage Step Regulators are used to maintain constant normal voltage on feeder and rural distribution lines. They are built single-phase for 10 percent regulation in eight 1¼ percent steps.

The URL-8 Regulator is a tapped auto transformer with automatic tap-changing-under-load equipment. A detailed description of the entire assembly will follow.

These regulators are shipped as a unit complete with oil. It is only necessary to remove the blocking from relays and inspect the apparatus as described in this book under "Installation", Part Two of this book, before connecting to the line. The very limited maintenance necessary is generally in the nature given in Part Four on "Maintenance".

COMPONENT PARTS

The Pole Type Voltage Regulator consists essentially of (1) a closed magnetic core upon which is wound a shunt or exciting winding and a tapped series winding; (2) an under-load tap changer combined with a preventive auto-transformer to perform under-load tap changing duty; (3) a tank for containing the insulating and cooling oil in which the unit is immersed; (4) cover bushings for bringing the incoming and outgoing leads into the interior of tank; (5) a control cabinet and panel to provide automatic control of the TCUL equipment.

OPERATING LIMITS

Unless specifically ordered otherwise, this apparatus has been built in conformance with current A.S.A., A.I.E.E., N.E.M.A. and E.E.I.-N.E.M.A. Standards.

Care should be used that the following major operating limits are not exceeded:

1. The regulator is designed to operate over a voltage range as specified by E.E.I.-N.E.M.A. "Preferred Voltage Ratings for A-C Systems and Equipment".

2. The URL-8 Regulator has the following continuous current carrying capacity at the various ranges of regulation: (This information is included on the instruction plate). The regulation ranges are stated in 2½ percent steps, and should be differentiated from the eight automatic 1¼ percent regulation steps.

10% Boost—100% Rated Current
7½% Boost—2½% Buck—120% Rated Current
5% Boost—5% Buck—160% Rated Current
2½% Boost—7½% Buck—120% Rated Current
10% Buck—100% Rated Current

3. For regulators which do not have factory coordinated lightning protection, line arresters should be provided, since bushing flashover is not considered as adequate protection against all forms of natural lightning.

4. Elevation at installation should not exceed 3300 feet (1000 meters) unless regulator was designed for this service.

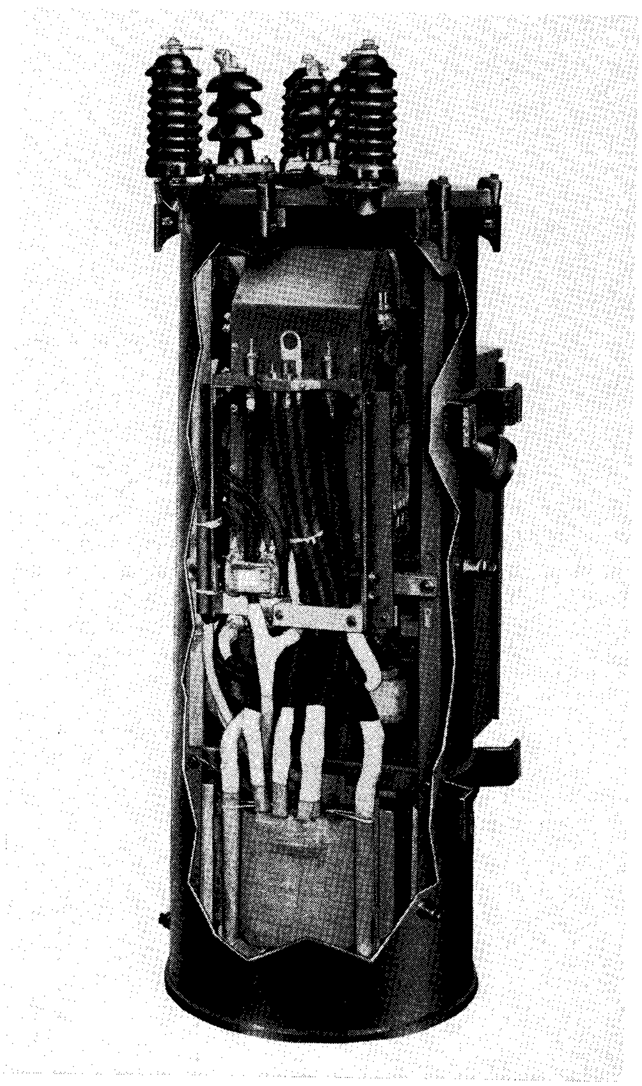


FIG. 1. Cutaway View of URL-8 Regulator.

5. Ambient temperatures should not exceed 40 degrees Centigrade (104°F).

6. Three-Phase Applications:

a. On three-phase three-wire circuits, two URL-8 Regulators may be operated in open delta, or three units may be connected in delta. When connected in delta, there is a resultant phase shift between source voltage and load voltage characteristic of all auto-transformers and this connection should not be used where this is objectionable.

b. On three-phase four-wire circuits, three URL-8 Regulators may be wye connected provided the neutral of the regulator bank is connected to the system neutral (whether or not the system neutral is grounded). If there is no system neutral, three regulators cannot be wye connected. See "Installation", Part Two of this book, for connection diagrams.

DETAILED DESCRIPTION

The Type URL-8 Regulator consists of three main parts:

1. The regulating transformer core and coils, a preventive auto-transformer and a control supply.

2. The tap changer mechanism which is a direct motor driven, quick break, nine-position tap changer.

3. The control for automatic and manual operation, which is mounted on a steel panel and housed in a weather-proof control cabinet.

The entire equipment is mounted as a unit for outdoor service. No auxiliary apparatus is required and it is only necessary to connect the regulator to the line as outlined in the sections on "Installation" and "Operation".

Tank. The tanks for the URL-8 Regulators are of the familiar cylindrical distribution transformer type making them ideal for direct pole mounting with E.E.I.-N.E.M.A. Type C adapter plates or for cross-arm mounting using Type C-1 hanger irons. They are given a special rust-preventive treatment followed by a "baked on" primer and final paint coat which provide a very durable and attractive finish. The tank houses the complete regulator assembly including the tap changer. However, interchange of oil between the tap changer and the rest of the unit is prevented, and the oil in the tap

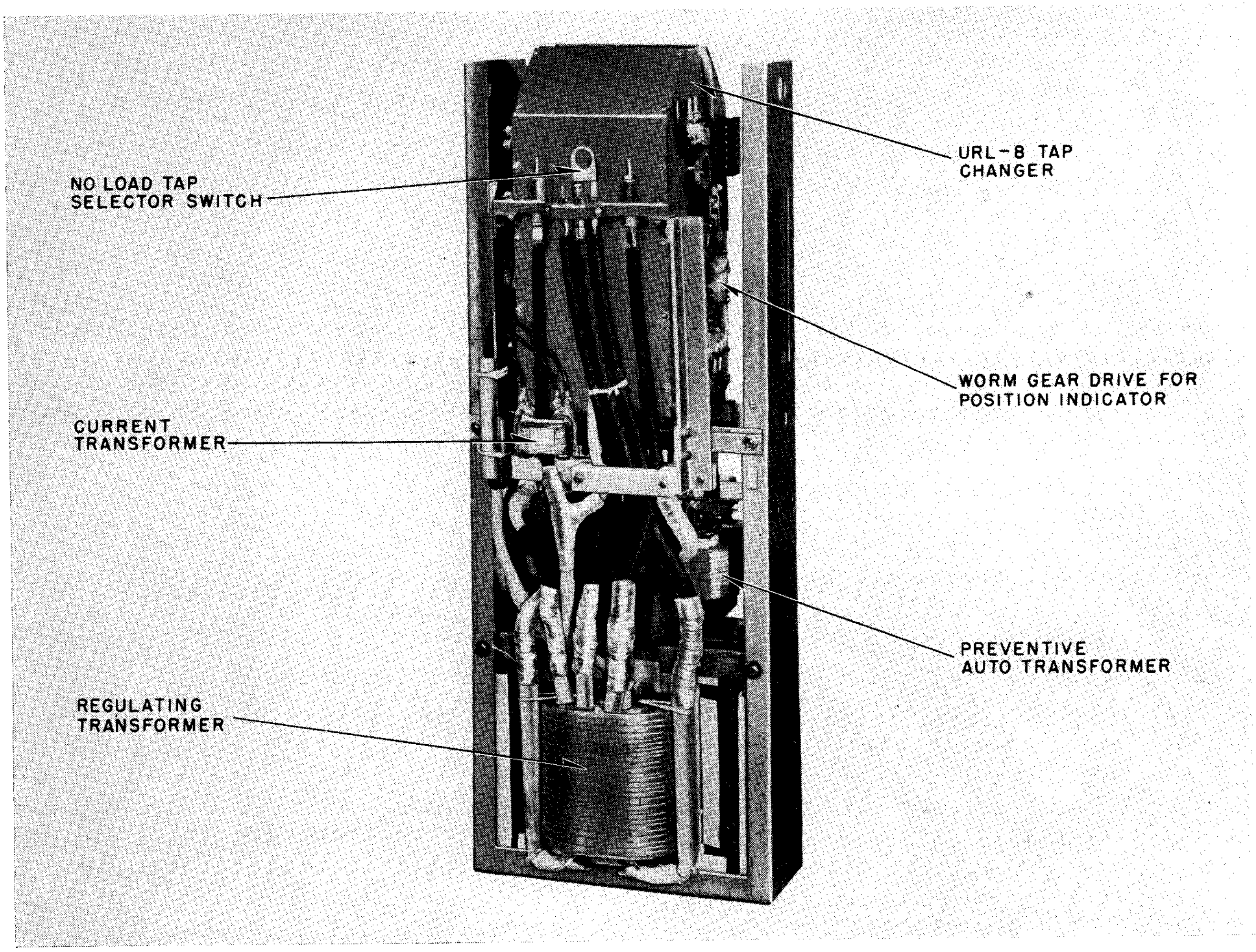


FIG. 2. URL-8 Regulator Core and Coil Assembly.

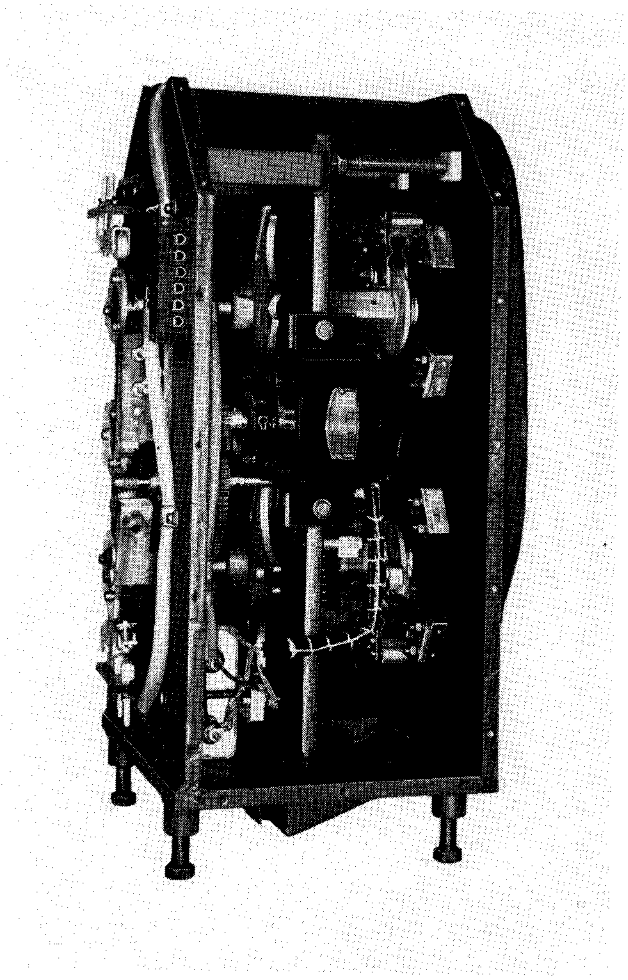


FIG. 3. URL-8 Load Tap Changer Mechanism.

changer compartment may be drained by means of a special sump and drain pipe without disturbing the oil in the remainder of the tank. The three power leads are brought out through cover-type bushings, and the control leads are brought out through the tank wall by means of oil-tight bushings into a junction box on the side of the tank. A hand-hole in the cover provides an adequate opening for inspection of the tap changer and for selecting the range of regulation. The tank is also provided with a magnetic-dial type position indicator easily read from the ground, a ground pad, drain plugs and sampling valve, lifting lugs and brackets for attaching hanger irons for pole mounting.

Regulator Core and Coil Assembly. The regulator core and coil assembly (see Fig. 2) consists of a tapped regulating auto-transformer with a Type C Hipersil core, a preventive auto-transformer, a load tap changer and a no-load tap selector switch, all mounted on a common frame.

The preventive auto is designed to withstand continuous duty on bridging position or, if the tap changer becomes inoperative during the time when one arm is moving to another tap, it will carry load current through one leg continuously without damage.

The under-load tap changer and the no-load tap selector switch are mounted above the core and coils and the entire assembly is lowered into the tank and fastened into place as a complete unit.

The regulator transformer winding consists of an exciting winding (1-2), a series winding 3 to 8, and a third winding T-G which supplies the auxiliary low voltage power for operating the voltage regulating relay and tap changer motor and control. Details are covered in "Operation", and Fig. 16.

Load Tap Changer Mechanism. The Type URL-8 Under-Load Tap Changer (see Figs. 3 and 4) is a quick break, geneva-gear mechanism with direct connection to the driving motor. The mechanism, completely enclosed to prevent any free interchange of tap changer oil with the transformer oil, is bolted securely to braces connecting the vertical upright. A sump arrangement at the bottom of the tap changer compartment, along with a drain pipe through the outside tank wall, allows the tap changer compartment alone to be drained. (See cutaway Fig. 1, Fig. 3, and exploded view Fig. 5.)

A magnetic-type position indicator, that requires no packing glands in the tank wall, is located at a 25 degree angle from the horizontal to make it readable both from the control panel and from the ground. The position indicator is driven by a flexible shaft coupled to the idler shaft on the tap changer by a worm gear.

The stationary contacts of the tap changer are mounted in two circles on a Micarta insulating panel which forms the rear wall of the tap changer. Each of the moving contacts are mounted on the

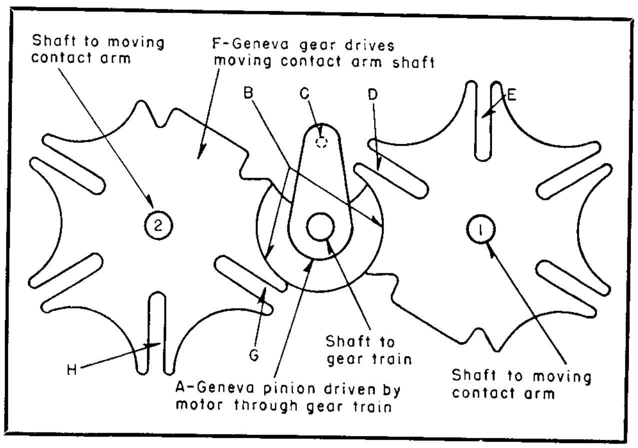


FIG. 4. Schematic Operation of Tap Changer Driving Mechanism.

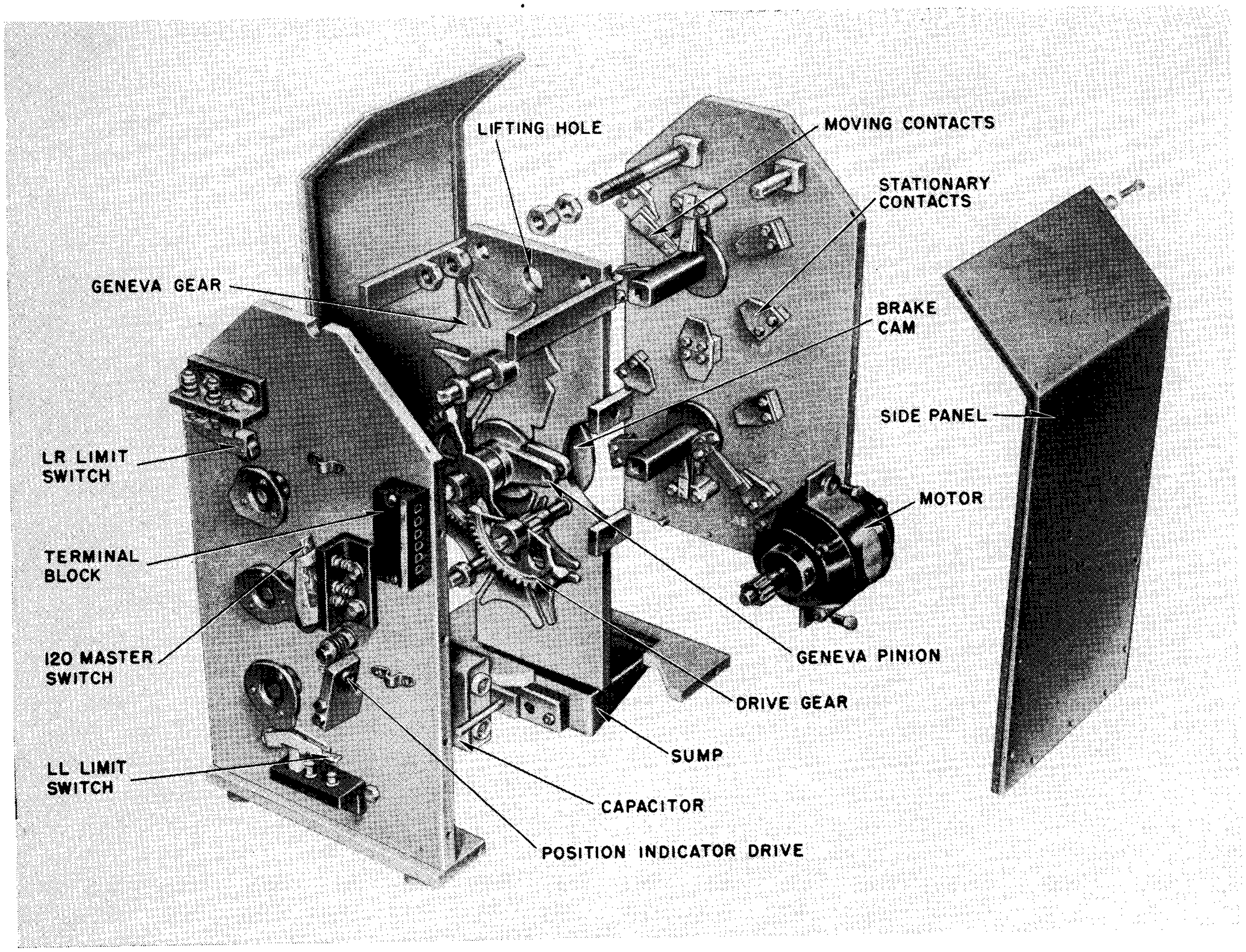


FIG. 5. Exploded View of URL-8 Tap Changer.

preventive auto-transformer bus attached to rotating shafts. To make a tap change, one shaft moves its contact to the next tap. This is termed "bridging" position, since the preventive auto-transformer is connected across two taps of the series winding. The next tap change is made when the other shaft moves its contact to the corresponding tap. This shorts the preventive auto and connects the line directly to the tap of the series winding. The preventive auto is designed electrically for continuous duty on the "bridging" position. The stationary contacts are copper blades tipped with a special arc resisting alloy. The moving contacts are also made of a special arc resisting alloy and are self-aligning for minimum contact wear and maintenance.

The mechanism is driven by a capacitor-type motor which is directly geared to the Geneva pinion. For one bridging tap change there is one-half of a complete revolution of the Geneva pinion, but only a sixty-degree movement on one Geneva gear and tap changer contact. The moving contact arm is locked into position during the greater part of the movement of the Geneva pinion, and therefore the motor and Geneva pinion do not have to stop in an exact position, but may drift within certain limits without moving the tap changer arms. A brake consisting of a spring loaded arm riding on a heart shaped cam insures that the Geneva pinion stops within these limits. No friction devices which require frequent adjustments are used.

The schematic operation of the tap changer driving mechanism is shown in Fig. 4. Geneva pinion (A) is positively geared to the operating motor. Geneva gears (F) drive the moving contact arm shafts and are always locked at points (B), except when pin (C) enters one of the slots as (D). When pin (C) engages slot (D), the Geneva gear shaft (1) is turned one notch so that slot (E) is in the position just previously occupied by slot (D). This motion moves one of the contact arms to the next

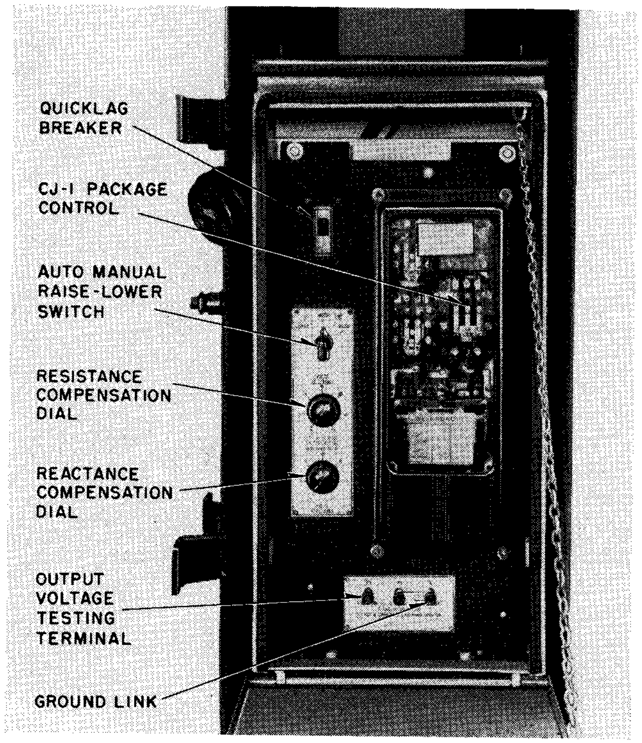


FIG. 6. URL-8 Control Cabinet Panel.

stationary contact. This constitutes a complete bridging tap change or a 1¼ percent step. To make the next tap change, pin (C) enters slot (G) turning the Geneva gear shaft (2) until slot (H) is in the position just previously occupied by slot (G), and the Geneva pinion stops when the pin (C) is again in the position shown, midway between the two Geneva gears. This motion moves the other contact arm to the next stationary contact. The tap changer has now gone through two positions and changed the voltage 2½ percent in two 1¼ percent steps. Additional steps in the same or reverse direction are made in the same manner. Limit switches operated by cams on the tap changer prevent overtravel of the arms in either direction, and other switches operated by cams on the Geneva-pinion shaft operate in conjunction with the control relays to start the motor and stop it when the contact arm is on position.

Control. Control equipment for automatic and manual operation of the Type URL-8 Regulator is mounted on a hinged steel panel housed in a weatherproof cabinet (Fig. 6). The control cabinet is supplied mounted on the main tank, but if desired, can be removed and mounted at the base of the pole without requiring additional hanger irons.

Conduit connections are supplied on the control junction box and control cabinet, so that necessary connections between the tap changer and control panel can be made when the control cabinet is mounted separately from the regulator. When the control cabinet is mounted remotely, additional conduit and eight No. 14 wires must be provided as these items are not supplied as part of the standard regulator as listed. See instructions under "Installation".

Control Equipment mounted on the control panel includes:

1—CJ-1 Voltage Regulating Relay, including motor control relays.
1—Line Drop Compensator, which includes: 0-12 volt resistance compensation dial, 0-12 volt reactance compensation dial.
1—Automatic-Manual Raise-Lower Switch.
1—Single-Pole Quicklag Breaker for winding protection.
2—Output Voltage Testing Terminals.
1—Terminal link to isolate permanent ground when an external test voltage is applied.

CJ-1 VOLTAGE REGULATING RELAY

Automatic operation is initiated by means of the CJ-1 Voltage Regulating Relay, which is responsive to changes in the load voltage. The CJ-1 relay is energized from an auxiliary winding on the regulating transformer which supplies voltage proportional to the load side of the regulator.

The CJ-1 Relay is a "package control" which includes the voltage regulating relay as well as all auxiliary and motor control relays mounted on a common drawout-type chassis of an M-10 semiflush Flexitest case. The voltage regulating relay is of the induction disk type which has an inherent time delay characteristic that allows a suitable time delay before its contacts close.

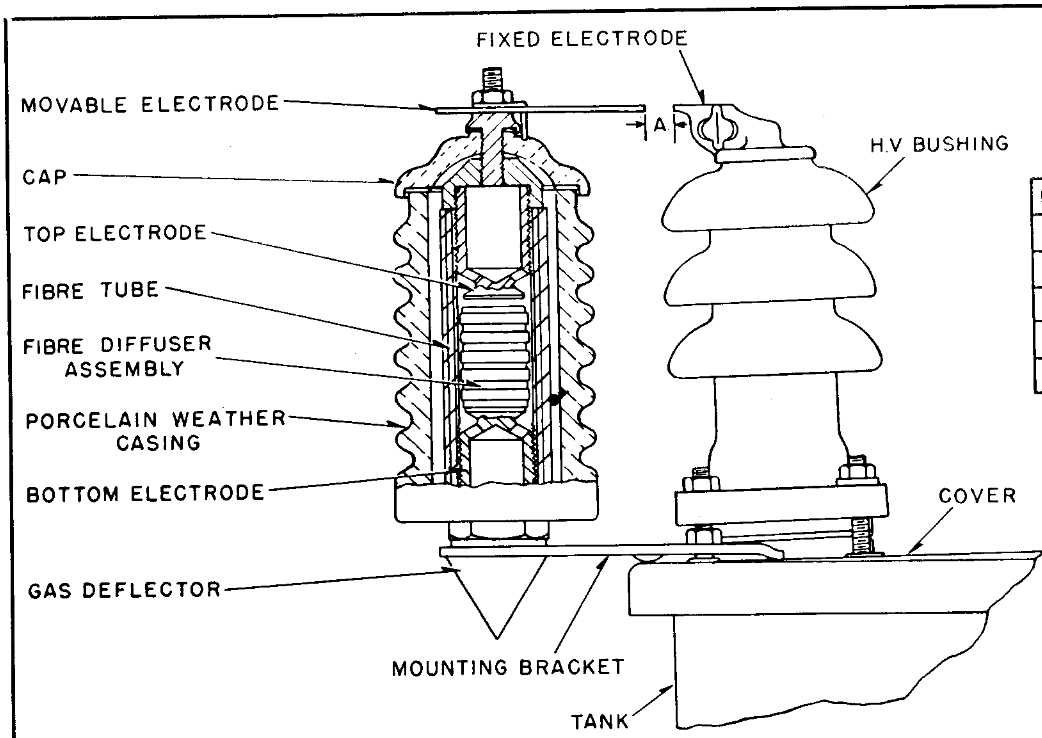
Note: For complete information on the CJ-1 Relay, see I.L. 47-431-1 in Part Five, Supplementary Data.

The CJ-1 Relay may be removed for bench testing or repairs and replaced temporarily by another CJ-1 Relay control assembly.

Line Drop Compensator. The function of a voltage regulator is to maintain a constant voltage at some point of the system. However, if this point is some distance away from the regulator, the line-drop compensator serves to increase the regulator output voltage to overcome the impedance drop in the line due to an increase in load current.

Separate resistance and reactance dials may be adjusted for any value from 0 to 12 volts. See I.L. 47-431-1 for dial settings for various conductor sizes and spacing.

Output Voltage Testing Terminals. Output voltage terminals (TT1-TT2) are used for reading the



KV	"A" GAP SETTING
3/4	1/4
3	1/4
6	3/8
9	1/2
15	3/4

FIG. 7. **Externally Mounted De-ion Arrester and Gap Adjustment.**

regulated output voltage, or for applying a separate voltage for testing the control.

Caution: **The Quicklag Breaker is a single-pole, single-throw switch. Link G-TT2 must be disconnected to remove the permanent ground (G) before applying an external voltage.**

Care should be taken to insure that the Quicklag Breaker is open and the link disconnected before applying a voltage to prevent energizing the unit through the auxiliary winding.

Cover-Type Bushings and De-ion Arresters. The URL-8 Regulator has cover type bushings which are arranged in accordance with A.S.A. Standards. De-ion arresters mounted adjacent to the bushings provide surge protection which is co-ordinated with the basic impulse level of the winding. The arresters will discharge at a surge voltage well under the impulse strength of the windings, thereby "spilling over" to the tank the incoming surges which exceed in value the discharge settings of the arrester, eliminating the possibility of a breakdown between the windings and the core or tank which might otherwise occur. De-ion arresters are designed to control the power follow current after spilling over, so that circuit outages do not follow the discharge of the arresters. Since regulators are not connected to service lines, discharge gaps between the tank and ground are not necessary. A ground pad is provided for solidily grounding the unit.

INSTALLATION

RECEIVING, HANDLING AND STORING

The URL-8 feeder voltage regulators are normally shipped completely assembled (except for hanger irons which are ordered separately). All shipments should be checked immediately upon receipt and the transportation company notified of any shipping damage.

The URL-8 Regulators may be lifted by means of the combination lifting and cover lugs welded to the tanks. When handling the units before removal from the crate, it is often convenient to use these same lugs. Do not use the two cover lugs for lifting.

Since these regulators are built for outdoor service, no unusual storing precautions are necessary other than care must be taken to prevent being submerged in water. They should preferably be stored in locations where the relative humidity is not extremely high.

PREPARATION FOR INSTALLATION

The URL-8 feeder voltage regulator has been very carefully inspected and tested at the factory before shipment. However, a thorough inspection should be performed upon receipt of the units being careful to observe the following items:

1. If inspection indicates that the transformer has absorbed moisture for any reason, remove the oil and dry the unit. However, this is seldom necessary as these regulators are filled with Wemco C oil at the factory and given a vacuum treatment in their own tanks, after which the oil is not disturbed. It is only by this treatment that the coils obtain high dielectric strength comparable to that obtained after long periods of service. A check should be made to see that the oil level is at the cold oil level mark stenciled on the tank wall.

2. For proper operation of the "De-ion" arresters, the air gaps should have spacings as shown on Fig. 7. These settings have been made at the factory and require no adjustment, unless they have been tampered with or damaged during shipment.

3. Unless specifically ordered otherwise, URL-8 voltage regulators will be shipped connected for full boost; that is, the no-load tap selector switch will be set connecting 2 to 8. Reference should be made to the nameplate located on the control cabinet for other connections and for neutral position for by-passing. A diagram of the no-load tap selector switch will be found on the underside of the handhole cover.

4. Before installation the control should be checked for loose connections and breakage incurred during shipment and the blocking should be removed from all relays. Electrical tests can then be made by supplying a variable voltage source (115 to 130 volts) to the test terminals of the control panel.

Caution: Extreme care must be taken to insure that the safety switch is in the "OFF" position, and link TT2-G disconnected, before applying test voltage, otherwise the regulating transformer may become energized in reverse through the auxiliary winding, producing high voltages. (See Fig. 16).

The following sequence of tests is recommended:

a. Apply 120 volts, or voltage at which the voltage regulating relay is balanced, to the test terminals, and then place the auto-manual switch on raise or lower. (If the position indicator is on position 1, place the auto-manual switch on Raise; if position indicator is on position 9, place auto-manual switch on Lower). The tap changer will run through the nine consecutive positions

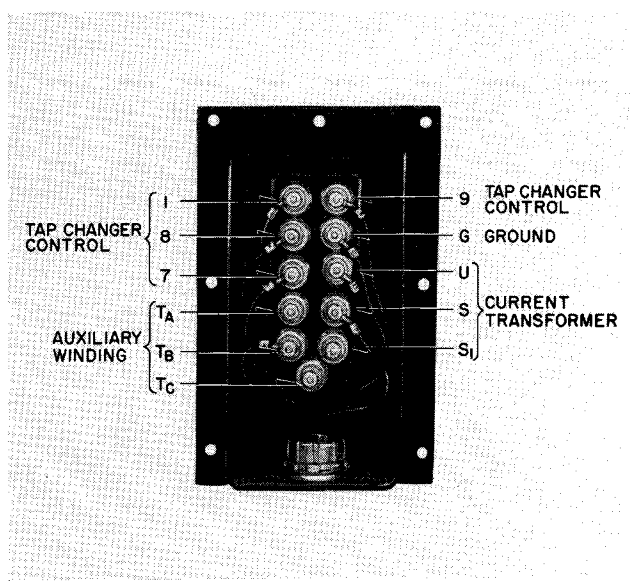


FIG. 8. Front View of Control Lead Junction Box.

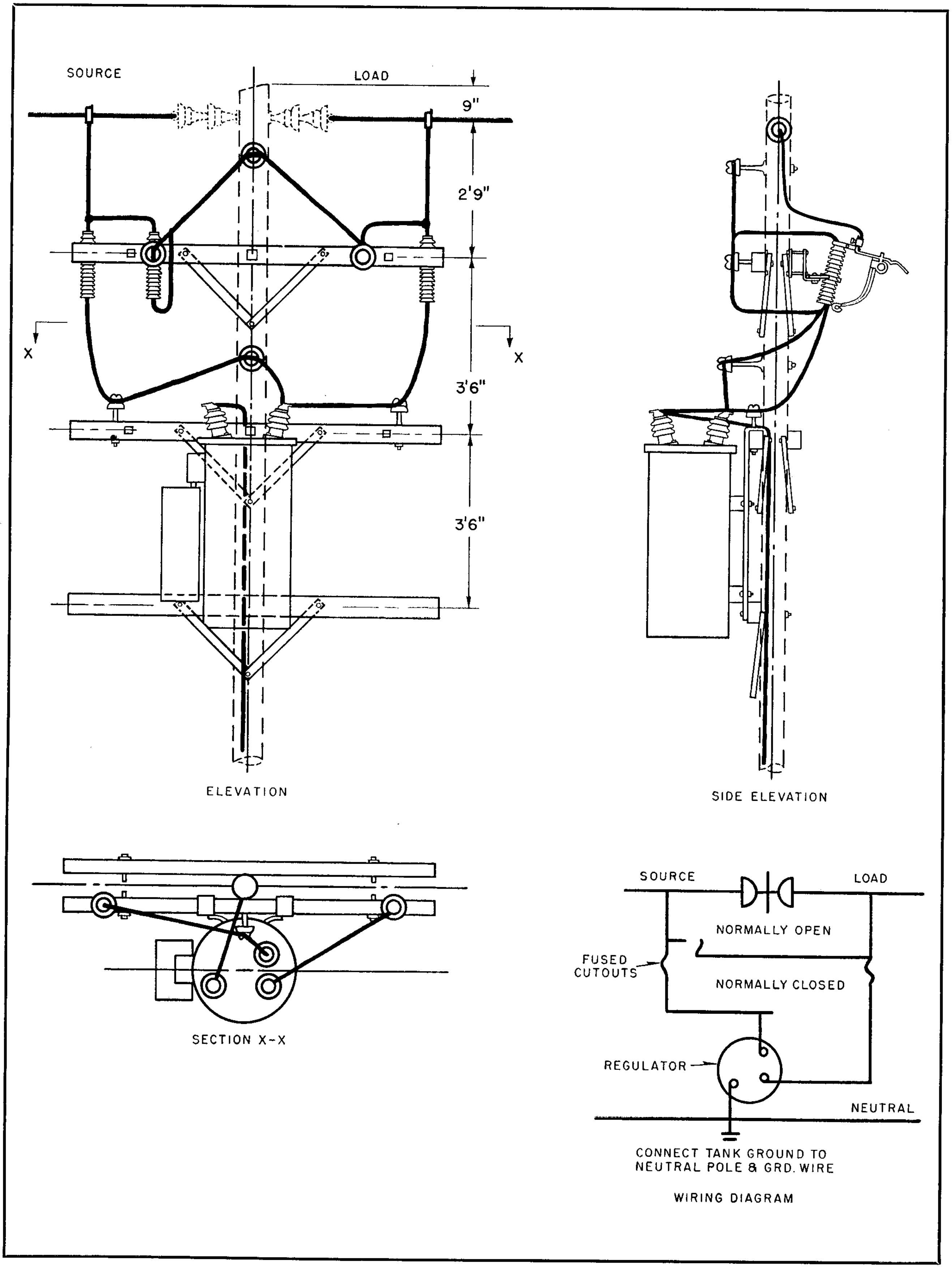


FIG. 9. Typical Installation of URL-8 Voltage Regulator.

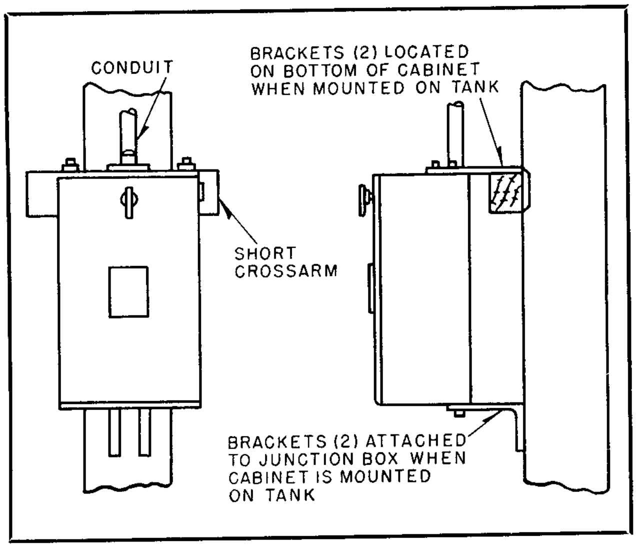


FIG. 10. Control Cabinet Mounted at Base of Pole.

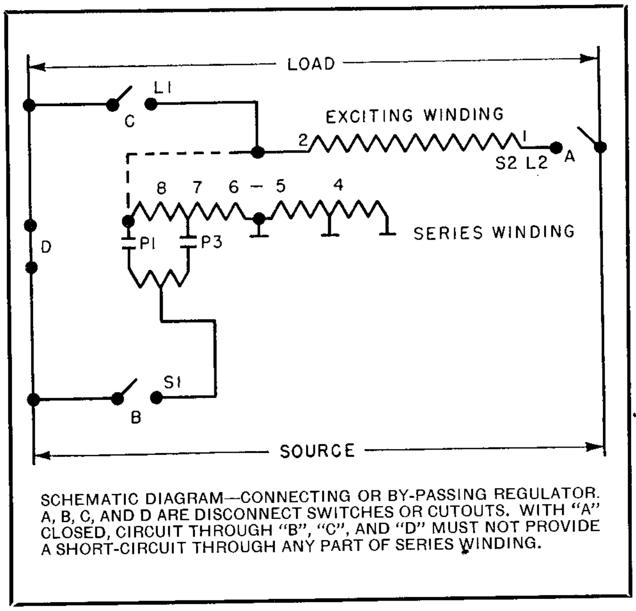


FIG. 11. Connections for By-Passing Switches.

without pause when the auto-manual switch is left on one position.

b. Place the auto-manual switch on "Auto" and reduce voltage 2 volts below balance voltage. After a time delay the CJ-1 relay contacts will close and a tap change will take place in the raise direction. With a short pause between steps the sequence of operations will then be repeated until the limit position is reached.

c. Raise the voltage to 2 volts above balance voltage and a similar sequence of operations will take place in a lower direction.

Caution: Put regulator on neutral position for by-passing before connecting to line.

5. Figure 8 shows the front view of the standard control lead junction box with the cover removed. Reference should be made to the wiring diagram received with the regulator (its number appears

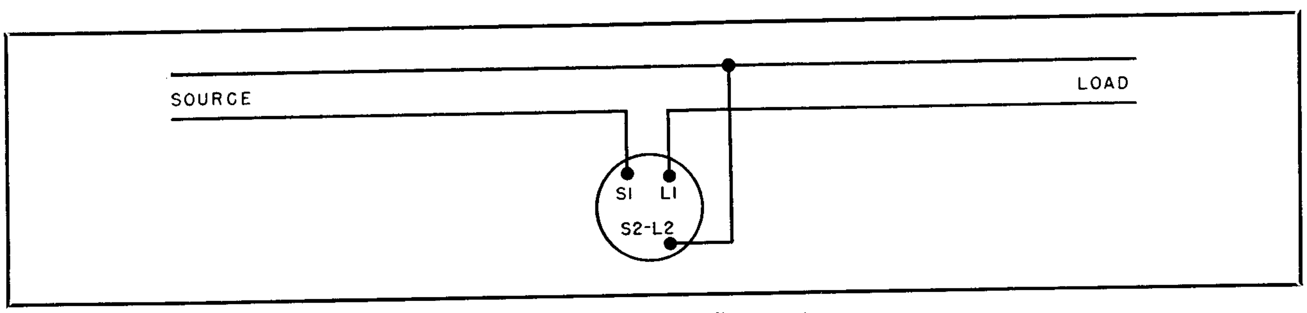


FIG. 12. Single-Phase Connections.

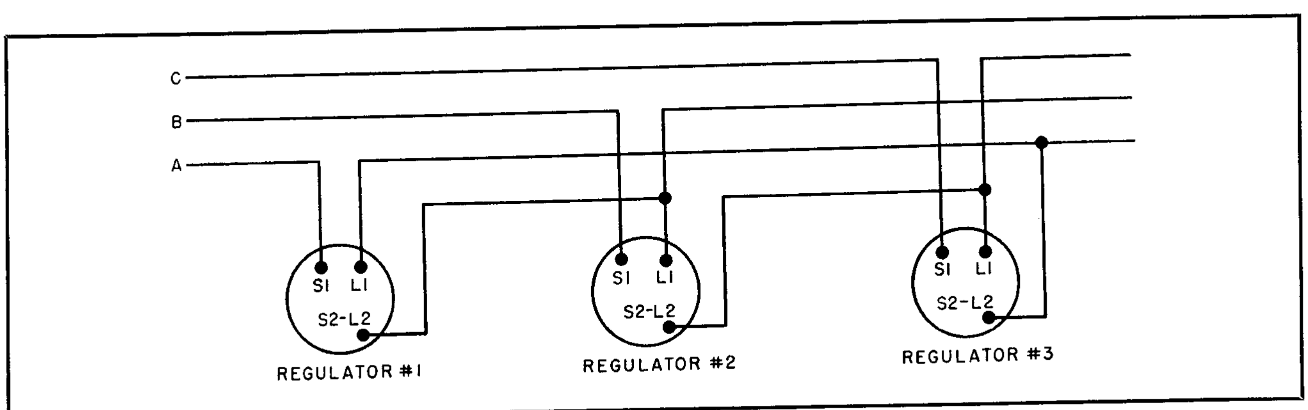


FIG. 13. Three Units Connected Delta on a Three-Phase, Three-Wire, Circuit—Phase Sequence A B C.

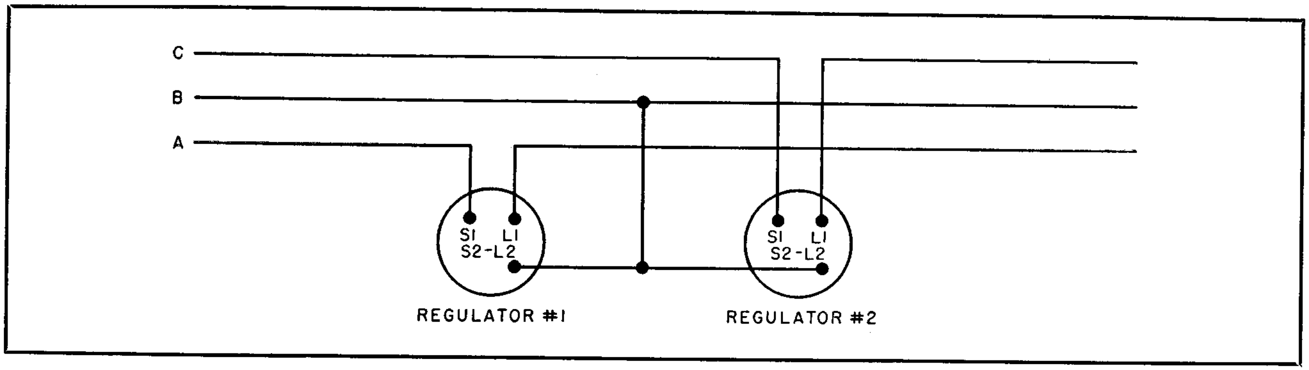


FIG. 14. Two Units Connected Open Delta on a Three-Phase, Three-Wire, Circuit—Phase Sequence A B C.

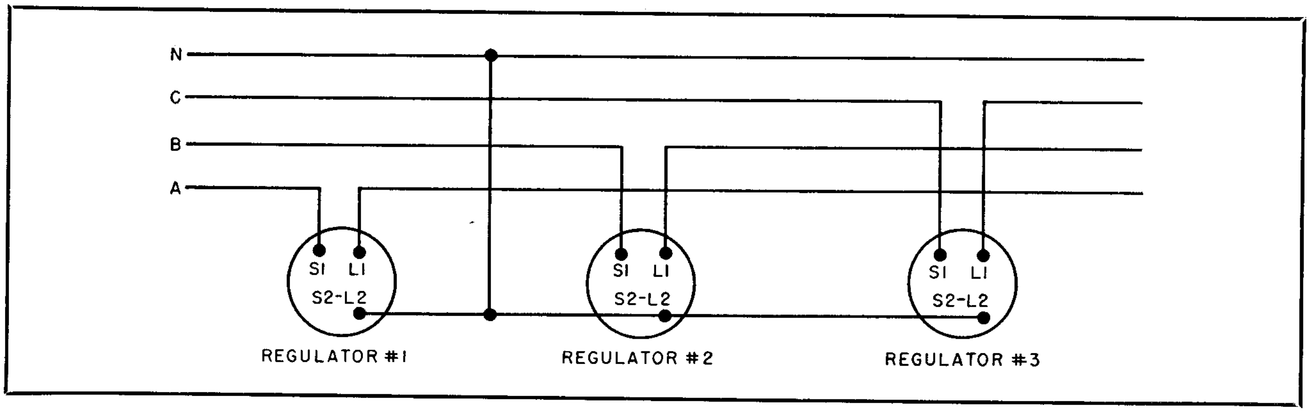


FIG. 15. Three Units Connected Wye on a Three-Phase, Four-Wire, Circuit—Phase Sequence A B C.

on the nameplate) to check the exact location of the studs. Exact control voltage magnitudes are indicated on the nameplate.

a. The 2500 volt URL-8 regulator has just one control voltage which appears across G and T. In the junction box T_A becomes T; T_B and T_C are not connected electrically.

b. The 5000 volt regulator has three control voltages. Use the control voltage appearing across G and T_A when the unit is connected to a 5000 volt line, G and T_B on a 4330 volt line, and G and T_C for a 2500 volt line.

c. The 7620 volt regulator has a tap on the auxiliary winding. When the regulator is used on a 6900, 7200 or 7620 volt line, use the control voltage between G and T_B; and on a 7960 volt line, use the control voltage between G and T_A. A standard 7620 volt unit is set at the factory for operation on a 7200 volt line and the voltage regulating relay balanced at 120 volts, unless specified otherwise by the customer. If the unit is to be used on a line other than 7200 volts, the voltage regulating relay must be rebalanced at the voltage specified on the nameplate.

A card on the inside of the control cabinet door gives all the pertinent information.

6. Line Drop Compensation:

The current transformer U-S provides 12 volt resistance and 12 volt reactance compensation with 100% rated current flowing in the regulator.

A 67% tap on the current transformer S_1 permits 12 volt resistance and reactance compensation when the compensator is connected between U and S_1 with 67% rated current flowing in the regulator. (See "Setting" in I.L. 47-431-1, Part Five of this Book.)

MOUNTING THE REGULATOR

Fig. 9 shows a typical installation of a Type URL-8 regulator using two crossarms and Type C-1 hanger irons. The hangers may be fastened to the regulator before raising from the ground. The unit may then be lifted by means of lifting lugs until the hooks on the hanger irons hook over the upper crossarm. The lower portion of the hanger will then rest against the lower crossarm and hold the regulator in a vertical position. If desired, lag screws may be inserted through the holes in the bottom of the hanger into the lower crossarm to prevent the regulator jumping off the pole in case of an impact. The URL-8 may be direct pole-mounted, if desired, using Type C adapter plates.

It is desirable at times to have the control cabinet installed separately near the ground for convenience in servicing and inspecting the control. To do this proceed as follows:

1. Replace blocking in the relays if they have been removed, open the cabinet door, swing out the panel, and disconnect the control leads from the terminal block on the back of the panel.

2. Remove the cover plate on the junction box and disconnect the leads.

3. Pull out the leads and remove the conduit fitting on the inside of the junction box.

4. Remove the control cabinet brackets. The brackets may now be inverted and used at the new location as shown in Fig. 10.

5. After locating the cabinet in the new position, connect cabinet to junction box with conduit and pull in eight new leads (using not smaller than No. 14 wire).

6. Connect like number of studs on the two terminal blocks and tape the leads together in the control house, allowing enough slack in the leads so that control panel will drop down.

For the convenience of the operator, it is desirable to use three sets of disconnect switches to connect or disconnect the Type URL-8 Regulator from the power supply, since the use of such switches allows him to perform this operation without taking the line out of service. When such a system is used, the source side of the regulator is connected to one side of the line through a disconnect switch, the load side of the regulator is connected to another disconnect switch. The source line and the load line are connected together by a third disconnect switch. Refer to Figure 11.

Caution: When this method is used to connect a regulator to the line, it is very important that the regulator be operated to "neutral" position. See Table of Connections, Page 17. The Quicklag Breaker on the control panel should be opened before attempting to connect or disconnect the regulator from the line. If this procedure is not strictly followed, there is danger of short circuiting the series winding of the regulator.

Assuming that the regulator has been operated to "neutral" position and the breaker opened, the disconnect switches connecting the regulator to the source are closed. The by-passing disconnect switch is already closed if the line is in service. The disconnect switch connecting the load side of the regulator is then closed. The by-passing disconnect switch is then opened and the regulator is on the line. It is then only necessary to close the breaker and to turn the automatic manual switch to "automatic" or the "manual" control position.

In disconnecting the regulator from the line the reverse procedure must be followed; that is, the regulator must be operated to the "neutral" position and the breaker opened. The by-passing switch is then closed, the load side disconnect switch opened, and finally the source side disconnecting switch is opened and the regulator is off the line.

See instructions for by-passing, on the nameplate and wiring diagrams. The regulators are connected in series with the lines and, therefore, are protected by line fuses or breakers and it is not necessary to fuse the URL-8.

THREE-PHASE INSTALLATION

For three-phase three-wire circuits, two single-phase units may be used in open delta or three single-phase units may be connected in delta. Figs. 13 and 14 illustrate these connections. Single-phase URL-8 Regulators are insulated for operation in banks of three units connected in wye on three-phase four-wire circuits provided the neutral of the regulator bank is connected to the system neutral regardless of whether or not this system neutral is grounded. If there is no system neutral, then the URL-8 Regulators must not be connected in wye. See Fig.15.

When connected for three-phase operation, each regulator operates independently from the other regulators in the bank and may be treated as a single-phase unit and directions for by-passing are the same as for single units.

PART THREE

OPERATION

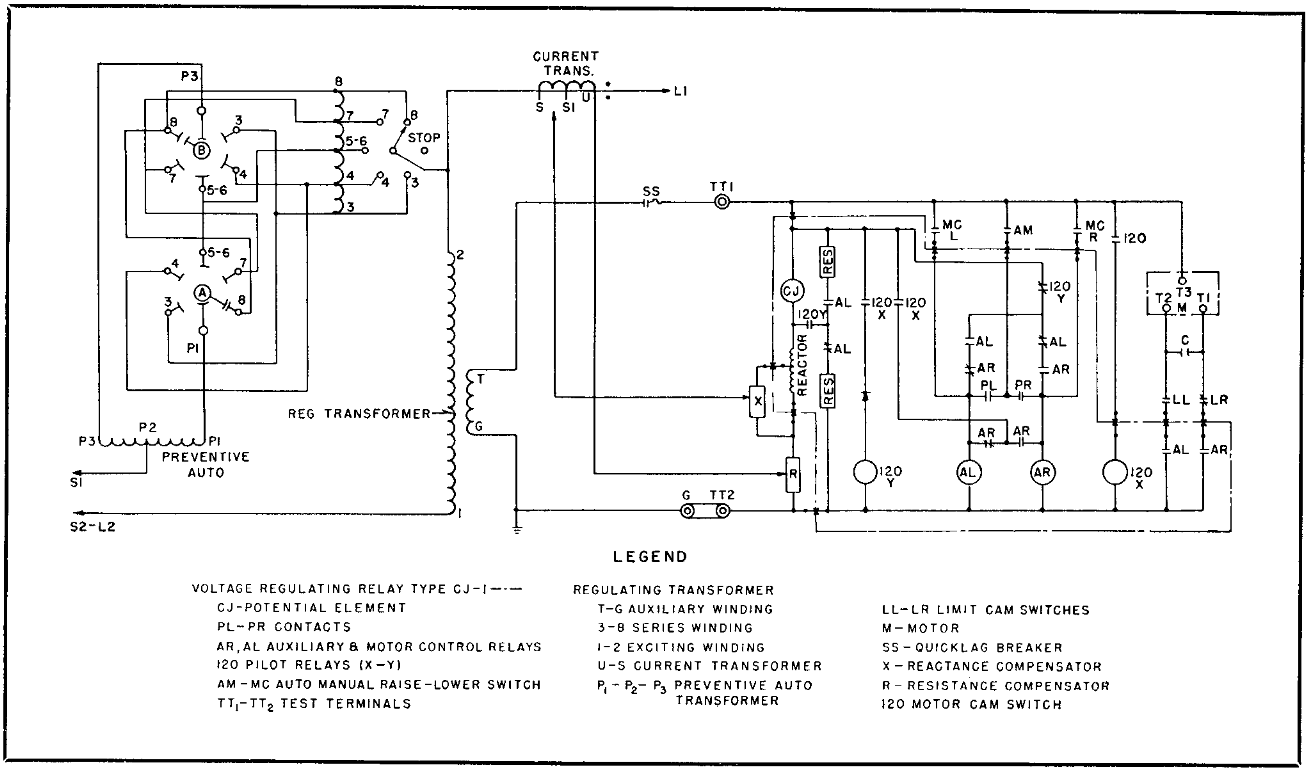


FIG. 16. Schematic Diagram of URL-8 Voltage Regulator.

PRINCIPLES OF OPERATION

Tap Changer. The diagram of connections of the Type URL-8 Voltage Regulator is shown schematically in Fig. 16. This diagram may vary slightly with different installations. For any particular regulator, the diagram as listed on the regulator instruction plate should be used for detail connections. The connections given on the instruction plate do not show the control circuits.

The taps from the regulating windings of the transformer (leads from 2 through 8) are brought to the no-load tap selector switch (See Figs. 16 and 17) for manual selection of the range of regulation, and to the load tap changer contacts for automatic tap changing within the range selected. The various combinations of buck and boost are shown in the Table of Connections, page 17. The last column of this table shows the neutral position that applies to each operating range of the tap selector. When by-passing the regulator, operate the load tap changer to the neutral position by means of the manual raise-lower switch on the control panel. Also see discussion of by-passing under "Mounting the Regulator" on page 15.

The tap changer performs all of the load switching operations, and all arcing is therefore confined to these switches. A Micarta barrier separates the oil in the tap changer compartment from that in the transformer compartment so that the arcing of the tap changer contacts does not cause any deterioration in the transformer compartment oil.

In a typical sequence of operations starting with the contacts connected to Tap 8 (position one on the position indicator), the operation of the motor causes the geneva pinion to move through 180 degrees and move one arm of the tap changer to tap 7. This is position two on the position indicator, and on this position the preventive auto is connected in parallel with or bridging one section of the series winding. The preventive auto is designed to withstand continuous duty on bridging position, or, if the tap changer becomes inoperative during the time when one arm is moving to another tap, it will carry load current through one leg continuously without damage. The next operation of the motor moves the

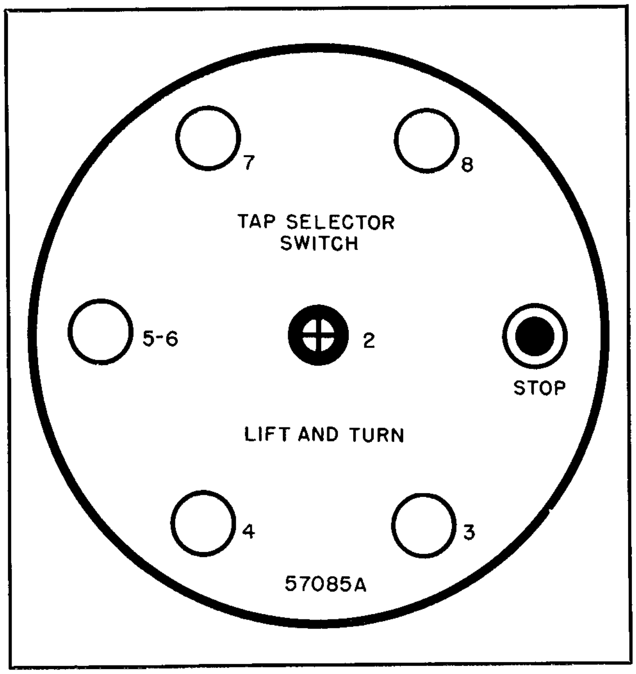


FIG. 17. Nameplate of Tap Selector Switch. (Located Beneath Hand Hole Cover.)

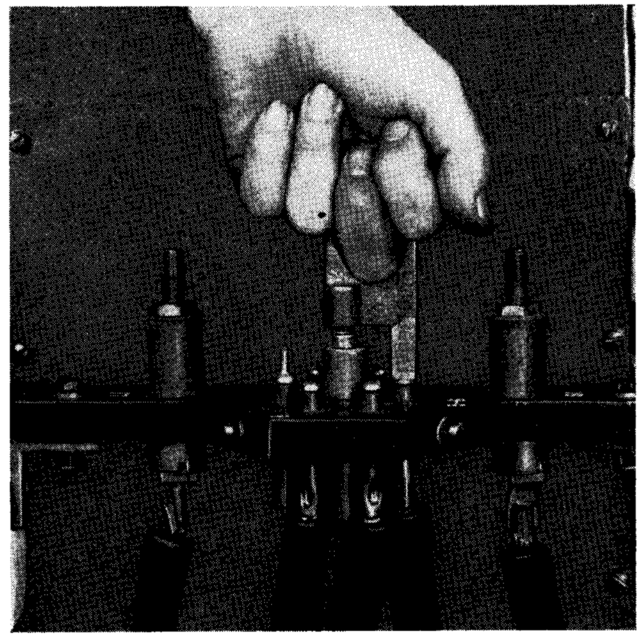


FIG. 18. Setting the Tap Selector Switch.

geneva pinion through 180 degrees, and thus moves the other arm of the tap changer from tap 8 to tap 7. This is position 3, and on this position the preventive auto is out of the circuit effectively, except for a small impedance drop across the preventive auto.

Control Equipment. The details of the control may vary slightly for different special installations (shown by wiring diagram supplied with the particular equipment), but in general the control functions as follows:

The automatic-manual switch (Fig. 6) has five positions: one automatic operation (AUTO), two off (OFF) positions, and one position each for manual raise (RAISE), or lower (LOWER). For manual control in the lower direction, placing the dial switch on "lower" closes the MCL contact and energizes the (AL) relay which closes contacts AL, operating the tap changer in a lower direction. Similarly, placing the dial switch on "raise" closes MCR and operates (AR) which closes contacts AR, operating the tap changer in the raise direction.

For automatic operation the dial switch is turned to "Auto," closing the AM contact, and connecting the curcuit so that the CJ-1 voltage regulating relay initiates the tap changer operation. See Fig. 16 and I.L. 47-431-1.

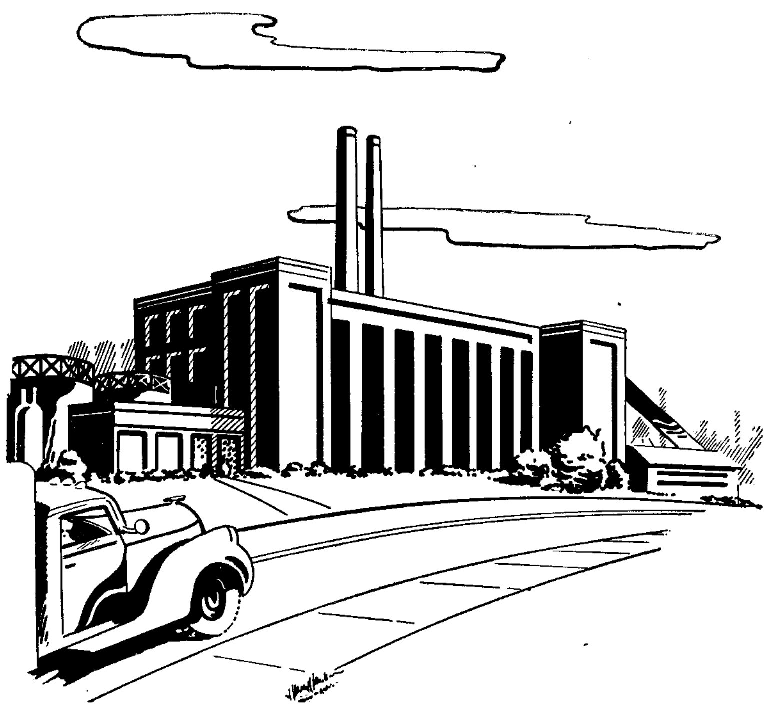
If the voltage falls below the PR (left hand) contact setting long enough for the disk operated PR contact to close, the auxiliary relay (AR) is energized and seals itself in through the normally closed 120Y relay contact. Closing the (AR) relay motor contacts causes the tap changer to move to raise the voltage. Before the tap changer arcing contact has

TABLE OF CONNECTIONS

TAP SELECTOR CONNECTS	NUMBER OF STEPS 1¼% PER STEP		LOAD VOLTS L1 L2=100% SOURCE VOLTS S1—S2		CONTINUOUS LOAD CURRENT % RATED	TAP CHANGER BY-PASS NEUTRAL POSITION
	BOOST	BUCK	MAXIMUM	MINIMUM		
2 to 8	8	0	100%	90%	100	1
2 to 7	6	2	102½%	92½%	120	3
2 to 5-6	4	4	105%	95%	160	5
2 to 4	2	6	107½%	97½%	120	7
2 to 3	0	8	110%	100%	100	9

opened, the 120 cam operated pilot switch closes to energize the (120X) relay which takes over the sealing of the AR relay by operating the (120Y) slug delayed relay. The normally open 120Y relay contact closes and shorts the reactor with a 3000 ohm resistor to cause the disk to rotate and open contact PR, so that there is only one tap changer operation at a time. After the tap changer arcing contact has closed on the next position, the 120 pilot switch opens allowing the 120X relay to release the AR relay. The tap changer motor is then stopped by the spring operated brake cam. If the voltage change is not corrected, the sequence is repeated after time delays until the voltage is corrected, or a tap changer limit is reached. If the voltage rises until the right hand, PL, contact closes, a similar sequence operates to lower the voltage.

In case the tap changer should stop between positions, due to the failure of voltage at the time of a tap change, the 120 switch is closed. When voltage is restored, 120X is energized, closing its contacts and energizing (AL), which closes the AL motor contact to move the tap changer to the next lower position.



MAINTENANCE

INSPECTION

The Type URL-8 Regulators are designed to operate with a minimum amount of maintenance, but should be given a periodic inspection at least once a year, giving special attention to the condition of the oil, the inspection of relays, and a check to insure that all connections are tight.

Oilless bushings are used for the high voltage leads. The operating mechanism is entirely immersed in oil and is thereby protected against rust and proper lubrication is insured.

Maintenance of the main switch contacts will depend upon the load which the regulator is called upon to carry. The arcing tips of the switch contacts are made of Elkonite, a special arc resisting alloy, to insure long life. These contacts should be inspected and replaced, if necessary, at the time of the periodic inspection.

The oil in the tap changer compartment should not be allowed to deteriorate to the point where it tests less than 15 Kv in the standard test cup shown in Instruction Book I.B. 44-820-1 covering Wemco C oil. The oil level in the tank should be checked at the time of the periodic inspection. A combination sampling and drain valve for the oil is provided at the bottom of the tank. A drain plug for changing the oil in the tap changer is located between the hanger iron lugs.

The adjustments and settings of the voltage regulating relays and maintenance of the motor control and auxiliary relays are described in the CJ-1 Relay Instruction Leaflet I.L. 47-431-1, included in this book.

The diagram of connections for control equipment is shown on the wiring diagram furnished with the apparatus and listed on the nameplate. The internal high-voltage connections for the transformer and tap changer are shown on the diagram nameplate.

CORRECTION OF MINOR TROUBLES

In case the motor fails to operate the following procedure is suggested:

1. Check voltage on voltage testing terminals with a voltmeter. If there is no voltmeter handy, the "CJ-1" voltage regulating relay will indicate the magnitude of the voltage. If the voltage is high, the right hand contact of the "CJ-1" will close, and if the voltage is low, the left hand contact of the "CJ-1" will close.

2. If the voltage is low, the tap changer should be on full raise position. If not, the voltage may not be high enough to operate control relays. These relays, as well as the tap changer, will work positively at 80% of rated voltage.

3. If motor control relay is closed, check to see that all contacts on the relay are making contact and that voltage appears across the motor leads (T3-LL or LR in Fig. 16.)

4. If there is voltage at motor terminals, but it does not start:

a. Motor may be open circuited. Each half of the motor winding should have about 25 ohms resistance for motor S# 954 939.

b. Capacitor may be open. Capacitor is 15 mfd. 300 volt, 60 cycles. For emergency, substitute capacitor of at least this value.

c. There may be dirt between motor pinion and gear, causing gears to bind.

5. If the voltage regulating relay is energized, but does not respond to voltage changes, refer to Instruction Leaflet I.L. 47-431-1 for information.

MAJOR OVERHAUL AND REPAIR

When the periodic inspection shows that the arcing contacts will have to be replaced, the following procedure is recommended:

1. Put regulator on by-pass position, disconnect from the line and remove from the pole. Remove the oil from both the transformer tank and the tap changer tank, and store, being careful to keep clean and free of moisture.

2. Remove the handhole cover on the cover of the regulator. Disconnect the three bushing leads inside the regulator tank, loosen the cover lugs, and remove the cover.

3. Disconnect the control leads from the junction box and remove bolts clamping the vertical uprights to the tank. Disconnect the flexible shaft running from the tap changer to the position indicator.

4. Remove the tap changer sump drain plug on outside of tank immediately below the top hanger iron lug. Then remove the tap changer sump drain pipe with a pair of pliers.

5. The complete core and coil assembly, including the tap changer, can then be lifted out of the tank.

6. Removing one side panel from the tap changer will provide room enough to replace arcing contacts.

7. Reassembly should be carried on in the reverse of the process outlined. Care should be taken to insure that the position indicator points to the position corresponding to the actual location of the tap changer. Be sure to refill both tanks with oil.

Test After Overhaul and Repair.

1. After changing arcing contacts, the tap changer should be moved by hand through its entire range to check against binding and to insure that the mechanism has been correctly reassembled.

2. Apply 120 volts to motor and run tap changer through its entire range and return. Be sure there is no binding and that the moving contacts change rapidly.

SPARE PARTS

The customer will find that only a minimum of spare parts will be required for the Type URL-8 voltage regulator. It is recommended that a complete set of stationary and moving arcing contacts for the relays and tap changing switches be kept in stock for replacement when necessary. These are the only parts which will be required normally, but the following additional list is recommended if the customer desires a more complete stock of spare parts:

One Set Cover Gaskets
One Bushing
One De-ion Arrestor

PART FIVE

SUPPLEMENTARY DATA

Supplementary Data consists of the following Instruction Leaflet I.L. 47-431-1

DESCRIPTION • OPERATION • MAINTENANCE

INSTRUCTIONS

CJ-1 VOLTAGE REGULATING RELAY

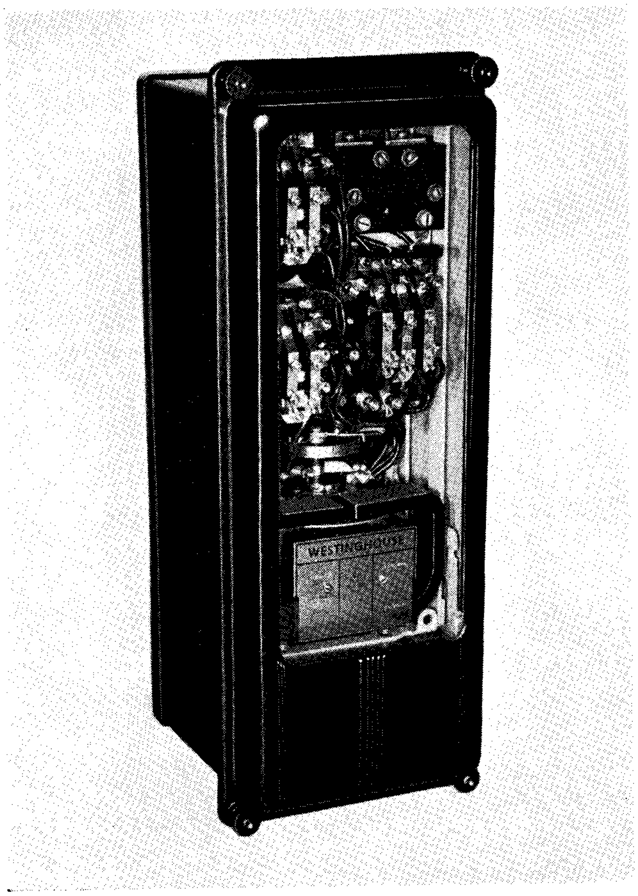


FIG. 1. CJ-1 Voltage Regulating Relay

THE CJ-1 VOLTAGE REGULATING RELAY is a "control package" designed to control the URL-8 Tap Changer. The relay consists of an induction disk type of voltage relay with auxiliary relays and equipment mounted in a M-10 semiflush Flexitest case. All that is necessary to complete the regulator control is to add QUICKLAG® breaker for short circuit protection, a manual control switch, and if desired, a line drop compensator.

The voltage sensitive element of the relay has a scale marked in one volt divisions from 105 to 135 volts. Response of the relay to a voltage change requires a time inversely proportional to the magnitude of the change. (See typical time-voltage curves). That is, the greater the change in voltage, the less time it requires for relay reaction.

Provision is made for an artificial line type line drop compensator with separate resistance and reactance controls. Terminals 15 and 16 are used for this purpose.

The general operating data for the relay on 60 cycles is:

Burden of the potential circuit at 120 volts	9 VA
100% load compensation current	0.12 Amp
Maximum volts across compensator at 100% load	42 Volts

INSTALLATION

The relays are usually mounted on the tap changer control panel. Before putting into service,

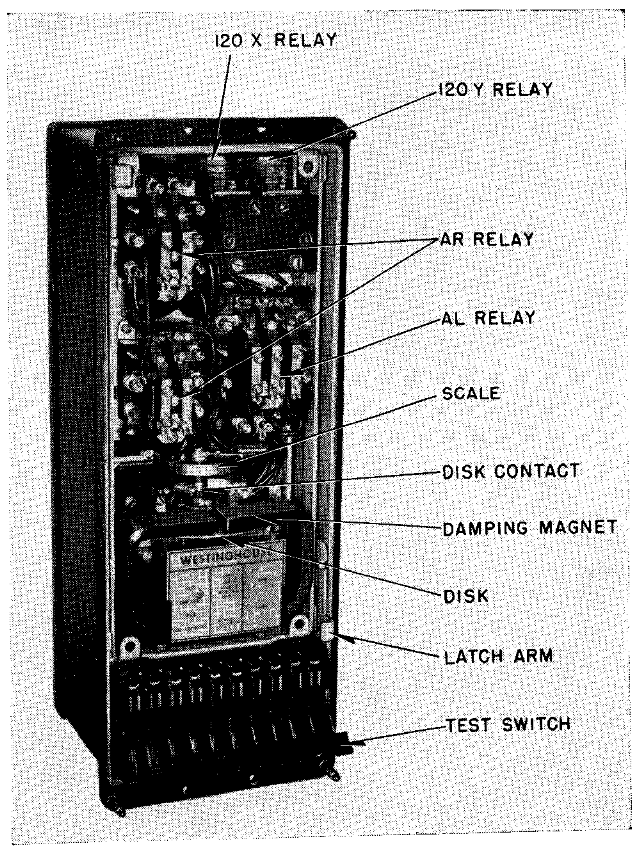


FIG. 2. CJ-1 Relay with Cover Removed, Showing Equipment Location

EFFECTIVE DECEMBER, 1950

WESTINGHOUSE

INSTRUCTION BOOK

Single-Phase
Automatic, Step-Type
VOLTAGE REGULATOR
Type URS

Westinghouse Electric Corporation

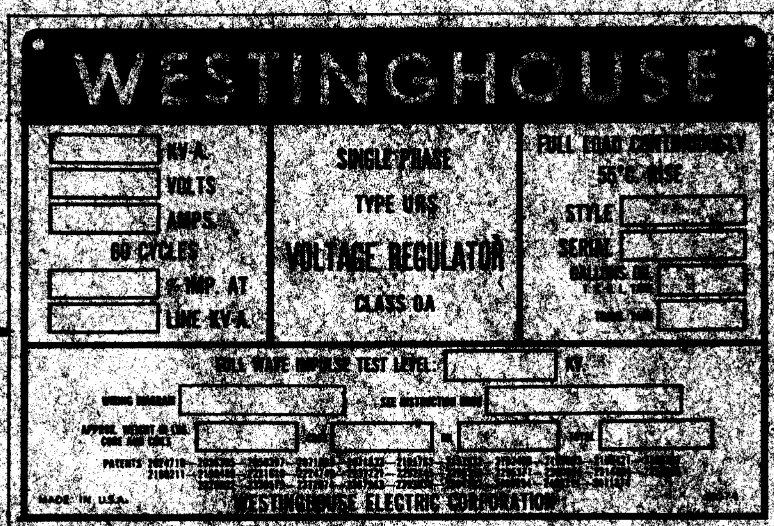
I.B. 47-410-2

SPECIAL INQUIRIES

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

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

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.

DESCRIPTION • INSTALLATION

INSTRUCTIONS

LIQUID LEVEL INDICATORS

Magnetic Type

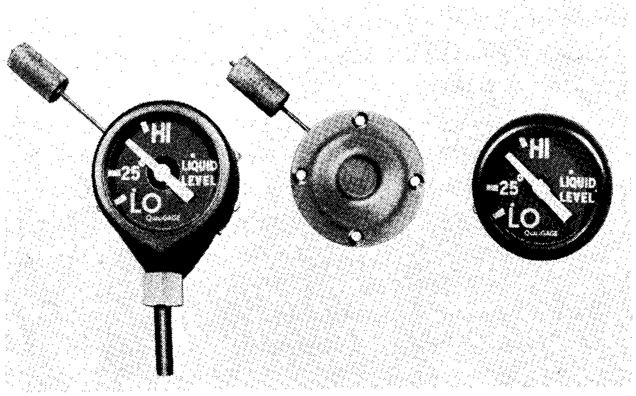


FIG. 1. Bezel with Alarm (left); Body with Float and Rod at Back (center); Bezel without Alarm Contacts.

MAGNETIC TYPE LIQUID LEVEL INDICATORS, designed for application on Westinghouse transformers or related apparatus, are self-contained, dial-reading, weatherproof, submersible, shock-proof, float-operated instruments suitable for use with oil or Inerteen.

Contacts for operating the alarm circuits of a bell, light, or small relay systems can be furnished as integral parts in either size of level indicator.

These indicators are usually shipped mounted on the transformer case, or equipment, and require no maintenance.

DESCRIPTION

These indicators are precision instruments consisting of two main parts, the bezel and the body, and are interchangeable for the same size of device. See Fig. 1. The bezel, or outer assembly, includes the calibrating dial and indicating needle. It is hermetically sealed and should not be subjected to a vacuum since the internal pressure might break the glass. The dial has a black background with yellow markings for high visibility. The indicating needle, also painted yellow, is directly mounted on the forward end of a shaft, the other end of which carries a powerful actuating magnet. The bezel, when in place, covers and protects the mounting screws with which the body is attached to the flange on the transformer tank wall or equipment.

The body is sealed against oil leakage to the outside and encloses another powerful magnet opposite the magnet in the bezel and is coupled through a shaft to the float arm. See Fig. 2. In operation, any motion of the float arm rotates the body magnet, which in turn positively displaces the bezel magnet, thus moving the indicating needle.

In indicators with alarm contacts, a micro switch enclosed in the bezel is actuated at a predetermined position by the motion of the needle shaft. Micro switch ratings are given in Table No. 1. Alarm leads are brought through the underside of the bezel by means of a new triple seal connector, Fig. 3, which consists of the following:

1. Three protruding terminals molded in the case and a locating pin to prevent making incorrect connections.

2. A rubber insulator which has three terminals to mate with the terminals in the case and a hole

TABLE NO. 1

VOLTAGE	NON-INDUCTIVE LOAD—AMPS.	INDUCTIVE LOAD AMPS. L/R = .026*
125 AC	5	5
250 AC	2.5	2.5
125 DC	0.5	0.05
250 DC	0.25	0.025

*Equal to or less than .026. If greater, refer to factory for adjusted ratings.

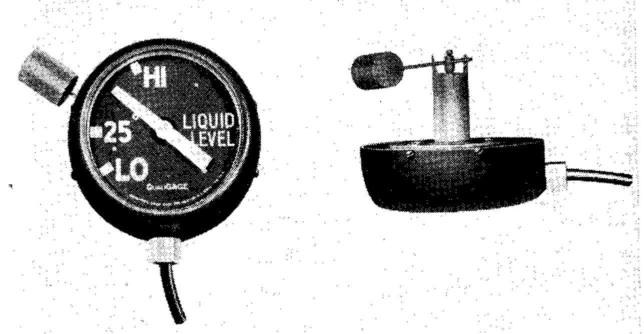


FIG. 2. Side and Front View, Medium Size Float Directly Connected.

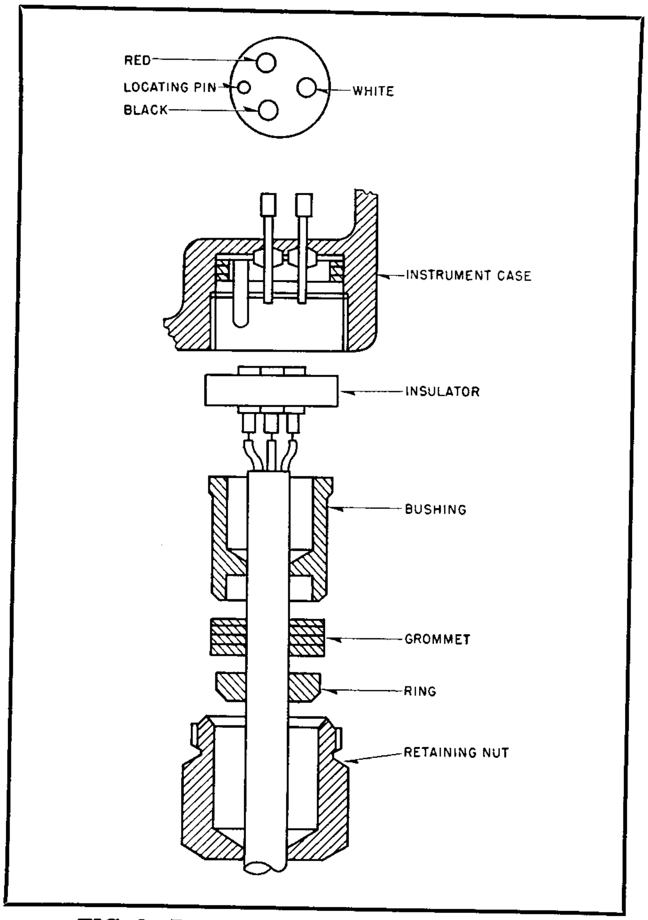


FIG. 3. Diagram of Triple Seal Connector.

through the rubber insulator for location of the locating pin. The ends of the lead wires are tinned and crimped into the terminals on the insulator.

3. A bushing to compress the insulator against the instrument case.

4. A grommet to make a seal between the rubber covered cable and the bushings.

5. A ring to compress the grommet against the cable.

6. A retaining nut, to hold the component parts of connector tight in the case. This retaining nut is screwed into place.

The connection diagram is shown in Fig. 4.

For indicators that are installed at the factory, the tank is filled to the level which corresponds to a liquid temperature of 25 degrees C, and this level is considered normal. Should the tank be filled at any other temperature, Table No. 2 should be used to determine plus or minus levels from normal. If these allowances are not made, excessive pressures may be built up in sealed tanks or excessive breathing may be produced in Inertaire units, causing a high rate of loss of nitrogen, or the low level alarm may be caused to operate unnecessarily due to the insufficiency of liquid.

If any part of it is damaged, the bezel can be replaced without disturbing the rest of the instrument and without loss of oil. Bezels with alarm contacts can replace the ones without such contacts and vice-versa, if desired.

INSTALLATION

Instruments are usually shipped in place. If shipped separately or if replacement of the body is made, check the operation of the float over its entire range to see that it operates freely and that the needle follows the movement of the float. Draw up the body tightly against the gasket between it and the mounting flange to make a tight joint.

Coat the gasket on both sides and edges with red gasket cement (S# 1150 419, pint can or S# 471 880, quart can). Allow to dry for 15 minutes. Apply a second coat of cement, wipe off excess from the edges and put gasket in place. Mount the instrument and tighten the bolts. Put the bezel in place and tighten the holding screws on the side. If alarm contacts are used, make proper connections to the conduit box.

Important: When checking circuits through this instrument it is necessary to follow Table 1. This means that a low voltage bell ringer cannot be used unless switched through a high impedance relay. An indicating light type device is generally recognized as best for checking circuits through instruments containing micro-switches of similar capacities.

RENEWAL PARTS

If repairs to the instrument are necessary, contact the nearest Westinghouse Office.

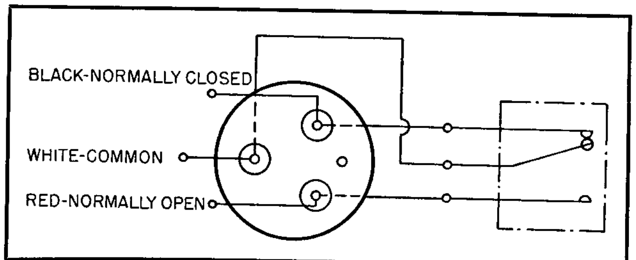


FIG. 4. Connection Diagram for Alarm Leads.

TABLE NO. 2

AVERAGE LIQUID TEMP. (°C)	CORRECT FILLING LEVEL (PERCENT OF SCALE ABOVE OR BELOW 25° C LEVEL)
85 (High)	100
70	75
55	50
40	25
25 (Normal)	0
10	-50
-5 (Low)	-100

DESCRIPTION • INSTALLATION

INSTRUCTIONS

TEMPERATURE INDICATORS

Dial Type

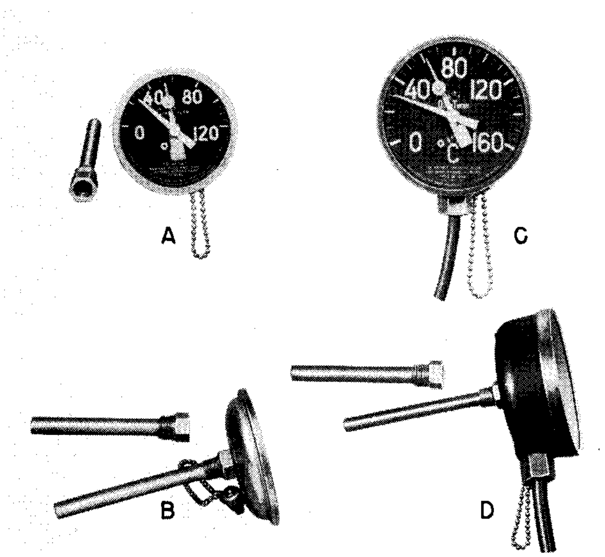


FIG. 1. (A) Front and (B) Side View of Indicator Without Alarm Connections; (C) Front and (D) Side View of Indicator With Alarm Connections

TEMPERATURE INDICATORS, designed for application on Westinghouse transformers or related apparatus to indicate liquid temperatures, are self-contained, weatherproof and submersible instruments of the dial type, operated by means of bimetallic elements immersed in the liquid.

They are usually shipped mounted on the transformer cases, require no maintenance, and are suitable for oil or Inerteen.

DESCRIPTION

This indicator is a dial type precision instrument whose needle is directly coupled to a bimetallic spiral actuating element in the stem, which fits closely into a well. The well is of thin-walled construction and screws into a fitting on the transformer case making an oil-tight connection. The instrument is weatherproof and submersible. The dial is calibrated in degrees centigrade and is easily read because of the contrasting purple face with yellow characters, graduations, and indicating pointer.

A maximum indicating pointer, red in color, is used to indicate the maximum temperature reached between readings. This hand is reset by wiping a magnet across the face of the dial. The magnet must be held with the poles in the proper position so as to attract the maximum indicating pointer. The magnet is attached to a small chain on the instrument case to prevent misplacing after using and is self-supporting in a metallic socket on the under side of this case. The method of resetting the maximum indicating pointer is shown in Fig. 3.

There are two types of thermometers available—one without alarm connections shown in Fig. 1, A and B, and one with alarm connections shown in Fig. 1, C and D. When alarm connections are required, the latter one will be supplied with the new triple seal connection, the details of which are shown in Fig. 2. This connector consists of:

1. Three protruding terminals molded in the case and a locating pin to prevent making incorrect connections.

2. A rubber insulator which has three terminals to mate with the terminals in the case and a hole through the rubber insulator for location of the

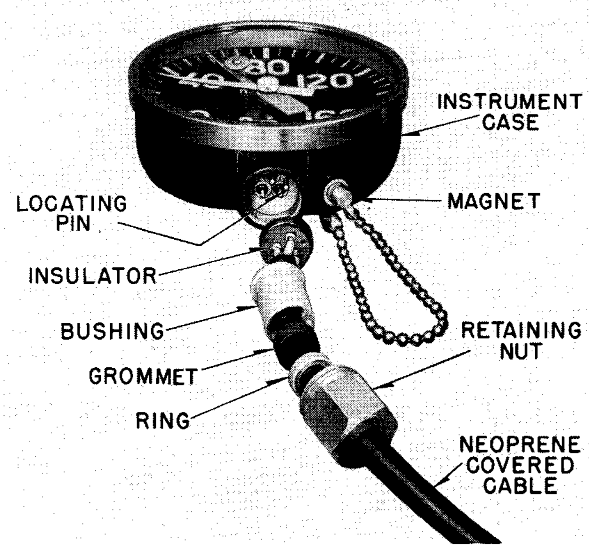


FIG. 2. Triple Seal Connection Details

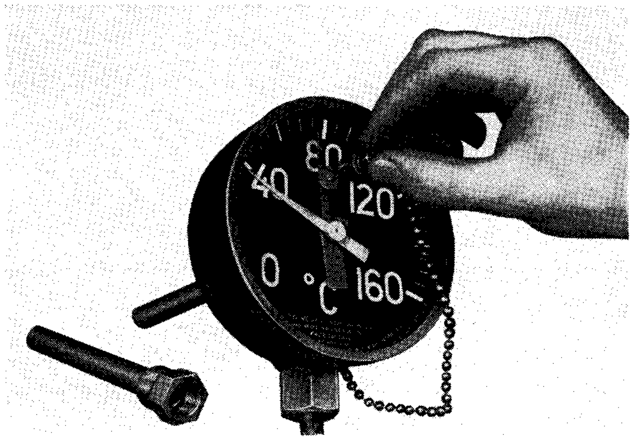


FIG. 3. Method of Resetting Maximum Indicating Pointer

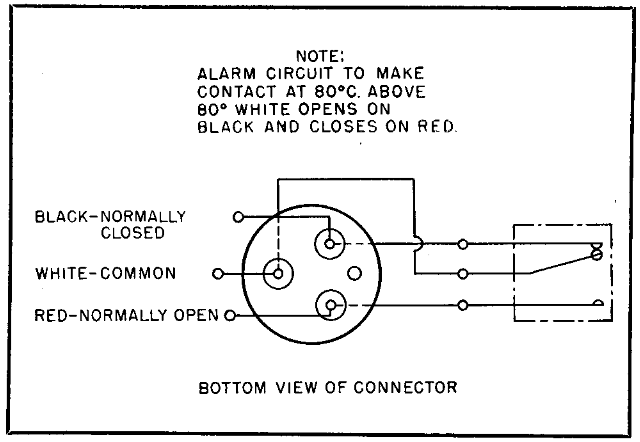


FIG. 4. Connection Diagram for Alarm Contact Leads

locating pin. The ends of the lead wires are tinned and crimped into the terminals on the insulator.

3. A bushing to compress the insulator against the instrument case.

4. A grommet to make a seal between the rubber covered cable and the bushing.

5. A ring to compress the grommet against the cable.

6. A retaining nut, to hold the component parts of connector tight in the case. This retaining nut is screwed into place.

The micro-switch in the indicator with alarm connections is factory set to operate at 80 degrees C. ***This setting cannot be changed.*** The ratings for this switch are given in Table No. 1 while the connection diagram is shown in Fig. 4.

INSTALLATION

The indicators are usually shipped mounted in place. To install them when shipped as a separate item, remove the pipe plug from the mounting coupling. Treat threads on the well-to-wall connection with Westinghouse thread cement (Style No. 1150 419, pint can or Style No. 471 880, quart can) and screw the well securely in place, making an oil-tight connection. Then screw the indicator in place being careful that the dial is in reading position. The indicator can be removed from the well in the tank wall without the loss of liquid.

The instrument may be mounted at eye level (A, Fig. 5) or can be mounted at a higher level and tilted so that it can be read easily when mounted high (B, Fig. 5).

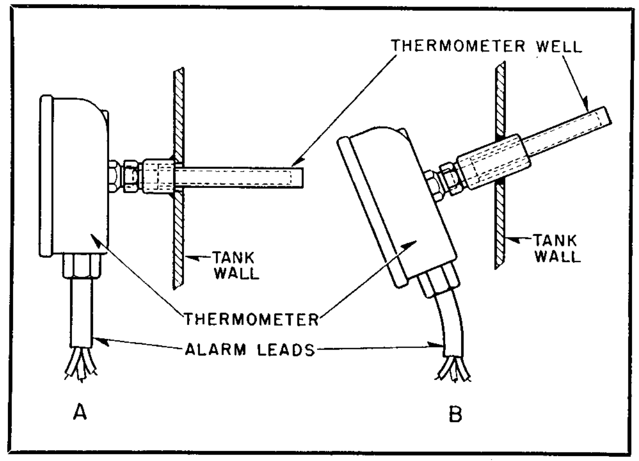


FIG. 5. Indicator Mounted (A) Vertical and (B) Tilted Downward

TABLE NO. I

VOLTAGE	NON-INDUCTIVE LOAD—AMPS.	INDUCTIVE LOAD AMPS. L/R = .026*
125 A-C	5	5
250 A-C	2.5	2.5
125 D-C	0.5	0.05
250 D-C	0.25	0.025

*Equal to or less than .026. If greater, refer to factory for adjusted rating.

RENEWAL PARTS

If it becomes necessary to repair the instrument, contact the nearest Westinghouse District Office. Complete instructions will then be given by the District Engineering & Service Division for the return of the instrument to the factory at Sharon, Pa., to have it repaired and placed in first class condition.

WESTINGHOUSE ELECTRIC CORPORATION
SHARON PLANT • TRANSFORMER DIVISION • SHARON, PA.
(Rep. 6-51) Printed in U.S.A.

HANDLING • INSTALLATION • MAINTENANCE

INSTRUCTIONS

BULK TYPE BUSHINGS

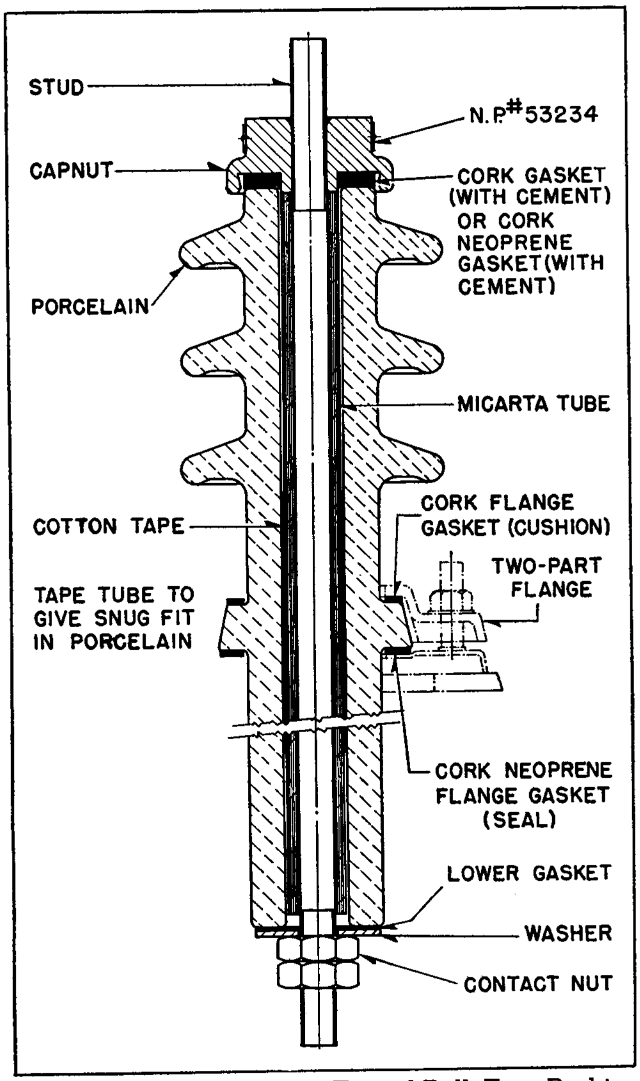


FIG. 1. Cross Section of a Typical Bulk Type Bushing.

BULK TYPE BUSHINGS are used for voltage classes of 25 Kv and lower. The standard bulk type bushings consist of single-piece wet-process porcelains with a lead through the center. Type J-2 bushings have solid copper studs while Type J-1 bushings have copper tubes through which a bare copper cable carries the current. For low voltage classes the leads are centered within the porcelains with cotton tape. For higher voltage classes a Micarta tube is inserted between the leads and the porcelains. The lead and the metal cap are sweated together to form a solder-seal joint. A gasket cemented to the cap and porcelain forms a gas-tight seal. At the lower end a cushion gasket is placed between the porcelain and the washer against which the locknut is tightened to complete the assembly of the porcelain and the lead.

Note: Cork-neoprene sealing gaskets are used on bushings for oil-filled transformers and cork gaskets for Inerteen-filled transformers.

HANDLING AND STORING

Care must be taken in handling not to crack the porcelain or damage its surface. Instead of a solid lead, some of the older bulk-type bushings have a cable lead on which the insulation may be damaged if not handled properly.

Store spare bulk-type bushings in a clean dry place.

INSTALLATION

Bulk type bushings are usually shipped mounted in place on the transformer. The bushing is mounted on the cover by a collar on the porcelain which fits into a recess in a pressed metal boss welded to the cover. A gasket cemented between the collar and the boss provides a cushion for the porcelain and forms a gas-tight joint. Care must be taken to prevent breaking or chipping the mounting collar where the gasket seat is made when it is necessary to install the bushings after delivery. Two gaskets are used, one above and one below the collar. The upper one acts as a cushion between the split clamping flange and the collar; the lower gasket is a seal between the porcelain and the cover boss.

When tightening down the split flange, there should be no pressure contact between metal and porcelain. Tighten the nuts gradually all the way around until both gaskets are evenly compressed.

SUPERSEDES I.L.46-718-1

EFFECTIVE JANUARY, 1949

MAINTENANCE AND REPAIR

Inspect the bushings periodically for broken or cracked porcelains and faulty gaskets. Power factor tests are not necessary since they will not show defects in these bushings.

For all bulk-type bushings for 6600 volts and over the exposed metal parts below the cover should be under oil.

Damaged porcelains and gaskets can be replaced in the field with new parts. When there is further damage, a complete bushing should be ordered from the factory. Include the stock order and serial number of the transformer as well as the data on the bushing nameplate when ordering spare parts or complete bushings.

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SHARON PLANT • TRANSFORMER DIVISION • SHARON, PA.

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INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

"DE-ION" ARRESTERS

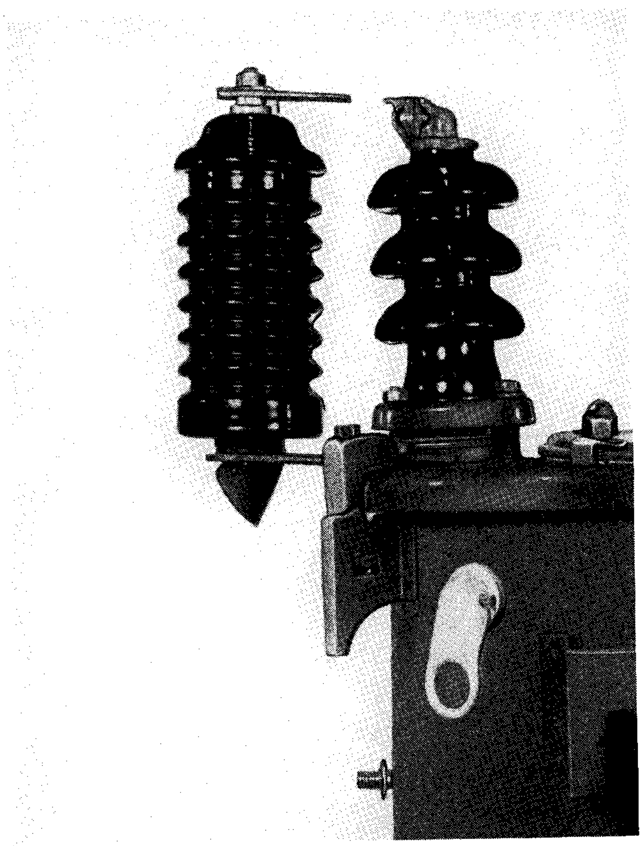

FIG. 1. Cover Mounted De-Ion Arrester.

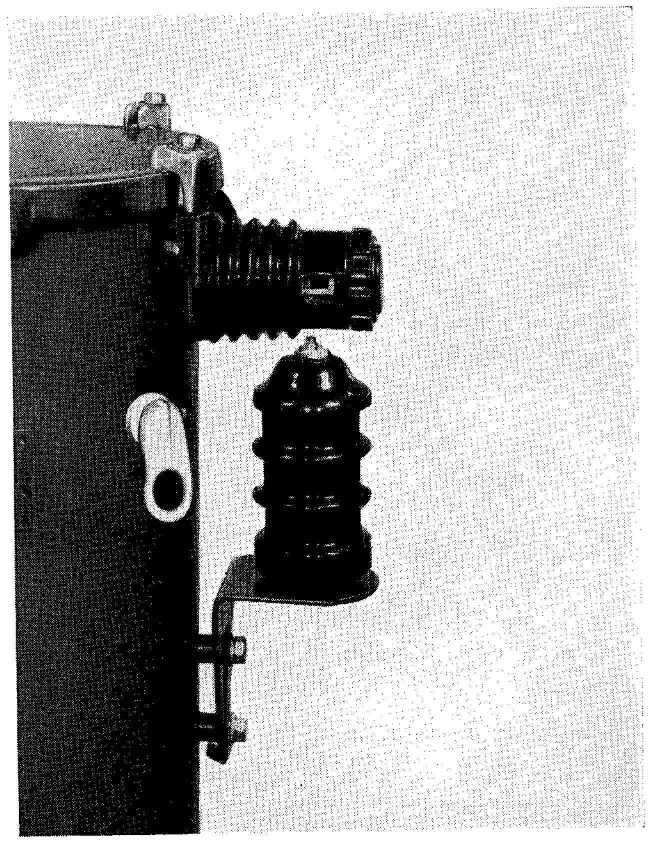

FIG. 2. Wall Mounted De-Ion Arresters.

THE DE-ION ARRESTER is a device which provides surge or lightning protection for electrical equipment. It differs from a plain gap in that it interrupts any power follow current within one-half cycle. It is designed to handle exceptionally high surge currents and will even discharge direct strokes of lightning successfully. Cover and wall mounted units are shown in Figs. 1 and 2, respectively.

RECEIVING

"De-ion" arresters will normally be shipped assembled with the apparatus with which they are to be used. When installed on apparatus in service, the variations of weather conditions have no deteriorating effect. However, the extended temperature or humidity conditions imposed by storage, whether by storage on apparatus, or storage individually, may impose conditions that should be avoided. See that they are not stored in any place having an extreme humidity or high temperature. Avoid storing where water may enter discharge vent of arrester or where the packaging may become water soaked. Exposure of arrester in storage to relative humidity in excess of 70 per cent or below 30 per cent or to heat output of space heaters or radiators for extended periods is not recommended.

SUPERSEDES I. L. 46-727-1

EFFECTIVE SEPTEMBER, 1951

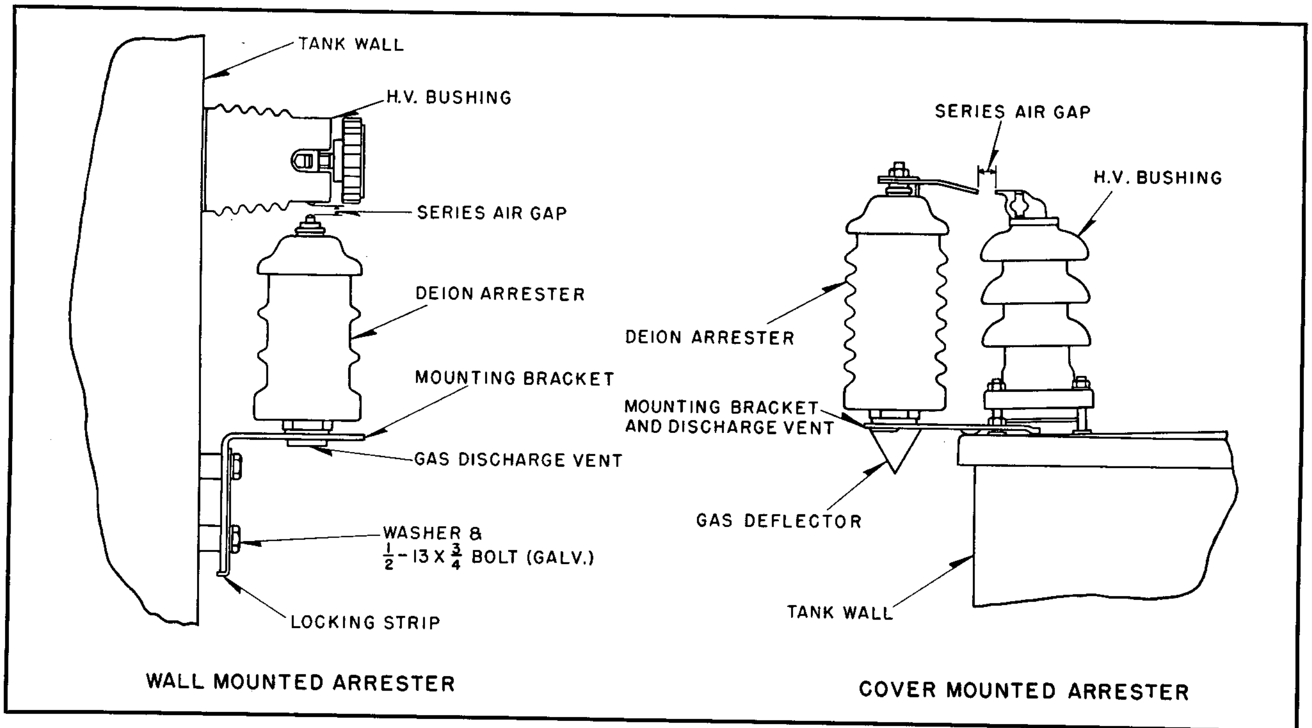

FIG. 3. Schematic Drawing of Typical De-Ion Arresters.

INSTALLATION

The "De-ion" arresters will normally be installed and adjusted at the factory on the apparatus with which they are to be used. However, when received, the air gaps should be checked to make certain that they still are in adjustment. The series gap should be set according to the following tabulation:

VOLTAGE CLASS	GAP SPACING
3 kv	¼ inch
6 kv	⅜ inch
9 kv	½ inch
15 kv	¾ inch

The sketches in Fig. 3 show typical cover and wall mountings; mechanical details will differ on some apparatus.

OPERATION

The "De-ion" arrester consists of a heavy walled vulcanized fibre tube into which steel electrodes are fitted at top and bottom. Between these is mounted a diffuser. This diffuser is made up of a stack of interleaved rings and disks of vulcanized fibre, forming an electrical and mechanical barrier which almost fills the bore of the tube. When an excessive voltage appears across the terminals of the arrester, a sparkover occurs from one electrode around the diffuser and over to the other electrode. This establishes a by-pass for the surge, so that the voltage on the terminal drops immediately to a low value. Simultaneously, a current flows in the arrester under the pressure of the surge voltage, which of course follows the narrow path between the outer surface of the diffuser and the inner wall of the fibre tube.

This preliminary action could be obtained on a simple rod gap which would safely divert the surge to ground. However, a secondary action is required, because after the path to ground is broken down by the surge discharge, the 60 cycle current can flow to ground also. A rod gap will not arrest this flow of current. But when this flow takes place within the narrow fibre-lined annular space between the top and bottom electrode, this power arc is extinguished very rapidly—usually at the first current-zero in the wave.

The explanation for this is found in the reaction of vulcanized fibre when in contact with an arc. Instead of "tracking" - i.e., burning with a resulting deposit of carbon, it evolves large quantities of gas. This is driven out in the arc stream, where it mixes with the ionized particles of the arc. This "de-ionizing" action neutralizes the conducting particles and restores to the electrode space its former insulating qualities in an exceedingly short space of time. The fibre walls themselves remain clean and free of any deposit, ready to function in the same way on the next discharge.

The series air gap at the top or line end of the arrester is for isolating it from the line. That is, it prevents the passage of any leakage current, reduces the electrical stress on the fibre and eliminates mechanical attachment to the line, with a corresponding improvement in convenience and safety.

MAINTENANCE

Normally, no maintenance is required of "De-ion" arresters. If the apparatus to which the "De-ion" arresters are applied is reconditioned, care should be taken to keep paint off all porcelain surfaces. If the outer surface of the fibre tube is refinished, a quick-air-drying synthetic varnish should be used which retains the high insulation necessary over the arrester. This is important because this external or "flashover" level must always be higher than the internal or "sparkover" level.

RENEWAL PARTS

In case renewal parts are required, these should be ordered through the nearest Westinghouse office. A description should be given of the parts wanted, as well as the serial and stock order or style number appearing on the nameplate of the complete apparatus. Due to manufacturing problems, repair part details except as noted will not be furnished for the "De-ion" arrester proper; instead, a complete new arrester will be shipped. Repair porcelains or mounting details may be ordered, however. When installing "De-ion" arresters, care should be used to mount the arresters in the same position as the original arresters so that adequate electrical clearance will be maintained from the high voltage end of the arrester, as well as the proper adjustment at the series gap.

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WESTINGHOUSE

INSTALLATION • ADJUSTMENT • MAINTENANCE

INSTRUCTIONS

VOLTAGE REGULATING RELAY

Style No. 1511 723 With Compensator

For Step Type Regulators

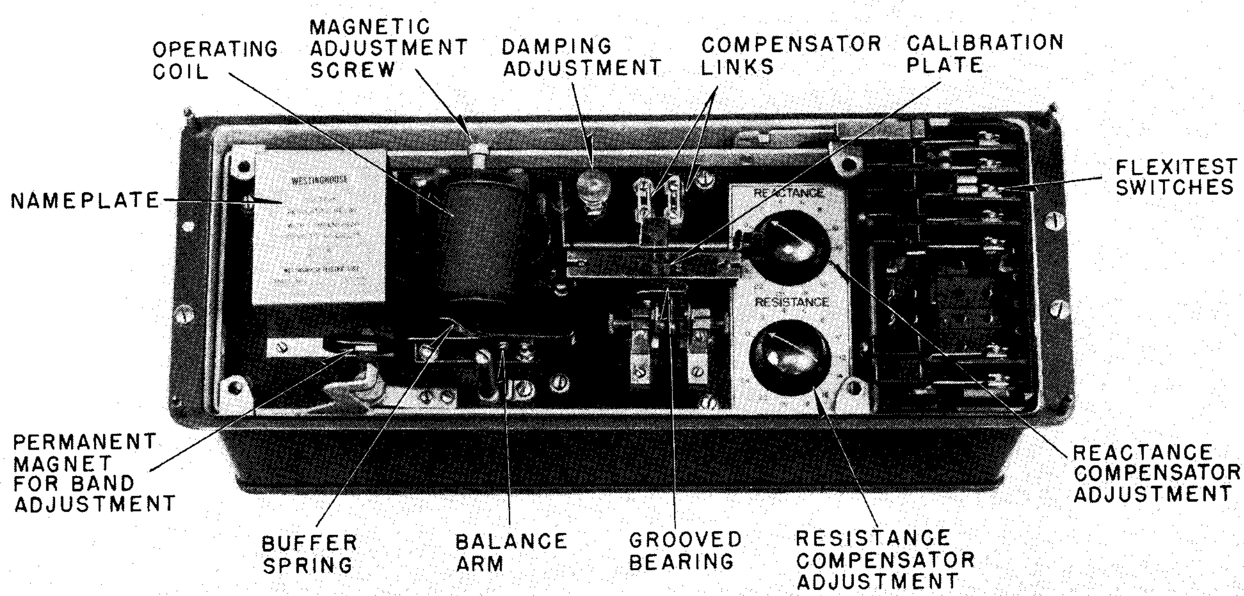

FIG. 1. Front View with Relay in Case (Cover Removed)

VOLTAGE REGULATING RELAY Style No. 1511 723 is of the alternating current solenoid type. Compounding is obtained by means of a permanent magnet. Adjustments for different values of balance voltage are made by shifting a counterweight along a scale which is calibrated in volts.

CONSTRUCTION

The Flexitest type of construction employs a metal case with a tight-fitting removable cover having a glass front. Fig. 1 shows the voltage regulating relay with the cover removed. The complete relay unit is mounted on a chassis which is readily removable from the Flexitest case by opening all the test switches at the right of the case and pulling out the holding levers at the top and bottom. This disengages the chassis from the case and the complete relay is then lifted out by means of the holding levers. See Fig. 2.

The operating parts have been combined into a single moving element which is mounted on a square shaft resting on a knife edge. This construction provides a very sturdy bearing with a negligible amount of friction. The shaft and bracket are made of nitrided steel which is exceptionally hard and resistant to wear and corrosion. A damping device is attached to the beam and is adjustable to provide stability to the action of the relay.

The contacts are made of silver, which results in long life and smooth contact points. They are designed to eliminate contact "sticking".

A "no-voltage" device is included as part of the main assembly with its operating coil connected across the potential source of the voltage regulating relay, and its contacts in series with the common point of the voltage regulating relay contacts. See Fig. 4. This device prevents control mechanism operation in case of voltage failure supplying the voltage regulating relay coil.

SUPERSEDES I.L. 46-736-7

EFFECTIVE JUNE, 1950

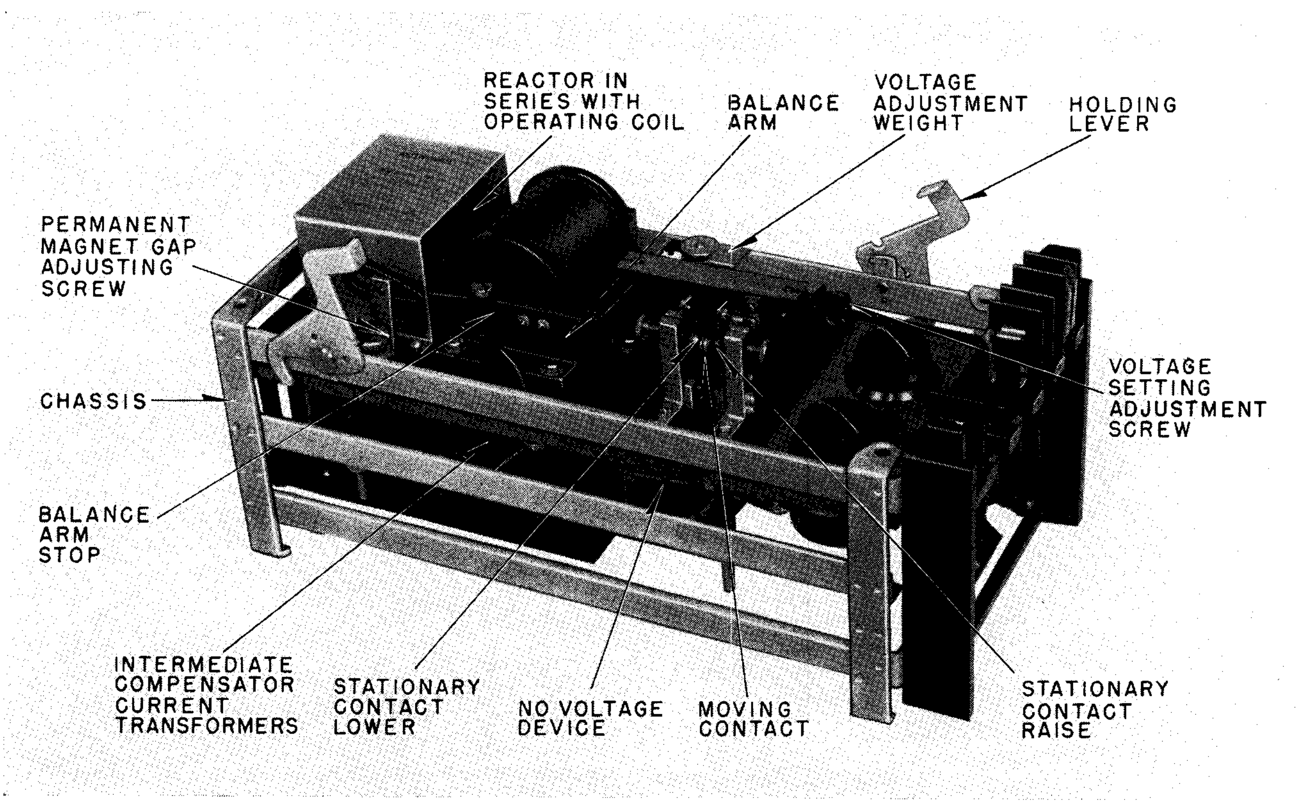

FIG. 2. View of Voltage Regulating Relay and Compensator (Removed from Case)

INSTALLATION

This relay is usually shipped mounted on the tap changer control panel. Before putting into service, the blocking should be removed and its operation checked as follows:

Press down on the relay balance arm so that the pivot shaft is held firmly in the grooved bearing. There should be clearance between the balance arm and the inside of the operating coil, also clearance between the balance arm and the sides of the supported bearing. To adjust the clearance, loosen the two screws which hold the balance arm to the moving part of the bearing and move the arm until it lines up and then retighten these screws. The relay contacts should be in line and should not require any other adjustment, except as specified in the adjustment procedure.

A damping device mounted at the rear of the balance arm 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 device 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.

ADJUSTMENT

The voltage regulating relay is usually adjusted to make contact on a plus or minus 1½ or 2-vol change across the relay coil.

To change the adjustment of the relay, it is desirable to have a source of variable voltage with a range of approximately +5 volts from the normal voltage on the regulator control circuit. A 50-ohm, 25-watt variable rheostat Model H, No. 0149, supplied by the Ohmite Manufacturing Company, Chicago, Ill., can be conveniently used for making the voltage change as described herein. Connect this rheostat in series with the voltage regulating coil and vary it as required. If the regulator is carrying load, the line compensator if used should be set at zero. Be sure to place the Type AB supply circuit breaker in the "off" position before applying an external voltage to the control circuit test terminals.

Fig. 3 shows a voltage regulating relay with its various parts identified. Each part has an important function which should be clearly understood. As the steps in adjusting this relay are

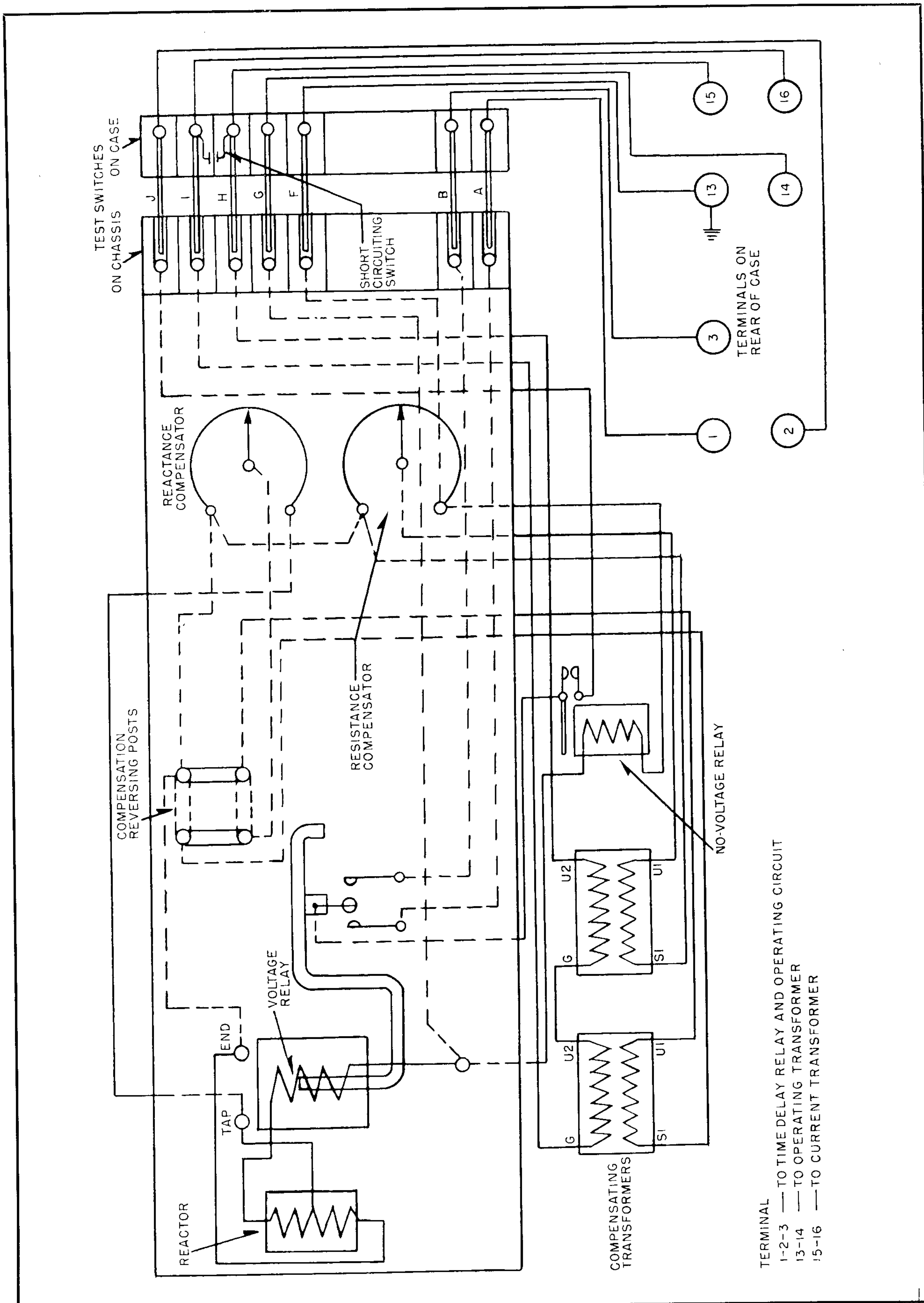

FIG. 4. Diagram of Voltage Regulating Relay and Compensator

pushing the operating handle downward and then closed by raising handle. On multipole units, the separate trip mechanisms are connected by an insulated common trip bar so that an overload on one element will trip all elements.

MAINTENANCE

The entire mechanism is enclosed in its moulded case and sealed at the factory against tampering and to insure permanent calibration. As the contacts are protected by the de-ion chamber against burning, no maintenance is necessary.

RENEWAL PARTS

In case the breaker should become inoperative or damaged a new one should be ordered from the nearest Westinghouse Electric Corporation Sales Office or directly from the Sharon, Pa. Plant giving serial and stock order number as stamped on the transformer nameplate, and style number and rating of breaker.

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SHIPPING • UNPACKING

INSTRUCTIONS

SHIPMENT OF TRANSFORMERS IN OIL

SHIPMENT

When transformers are shipped in oil they are usually shipped in their own tanks, but sometimes when other requirements make it desirable the transformers may be shipped in a special shipping tank.

Transformers with radiators are usually shipped in their own tank, but with some or all of the radiators removed. The radiator flanges on the tank are covered by blind flanges. The detached radiators are always crated and shipped separately. Where radiator valves are used it is unnecessary to drain the oil from the tank to install the radiators. The additional transformer oil for the removed radiators is usually shipped in tightly sealed drums.

Some of the bracing in a transformer may be put on for shipment only. The transformer core is always braced or tied securely to the tank wall in large transformers to take care of shocks received in shipment. If the transformer is removed from the tank for inspection during installation, it is unnecessary to replace these tie plates if there is no possibility of reshipment.

Sometimes special blocking or bracing that may interfere with normal operation is used for shipment. In such cases, it is essential that this special bracing be removed before the transformers are placed in service. Where special bracing is to be removed, the outline drawing will contain notes of instruction regarding it. The outline drawing should always be checked for such instructions.

The general practice is to ship as many detail parts and bushings in place as is safe and as shipping clearances will permit. Where it is necessary to remove bushings, the openings in the cover or tank wall are covered with blind flanges for shipment. Any bushings and detail parts removed for shipment are always boxed separately and are to be mounted when the transformers are installed.

Core Form Transformers. In most cases core form transformers can be shipped in their own tanks in an upright position.

It is occasionally necessary with large transformers to have a joint in the tank so that the top section may be removed for shipment. Either the regular cover or a special shipping cover is bolted on the top of the lower section of the tank for shipment. If a special cover is used it is sometimes made with a box-like structure which makes room for terminal boards, etc., which extend up beyond the top of the lower section of the tank. The tank is usually filled until the oil extends up into this box. **Care must be taken to lower the oil below the joint before removing this cover.**

Shell Form Transformers. Shell form transformers are usually made with form-fit tanks. When the form-fit tank is used, transformers may be shipped in the upright position or lying down in a horizontal position. The bracing for units in the form-fit tanks is usually arranged so that it need not be removed. In exceptional cases, particularly when the transformer is shipped horizontally, it may be necessary to use additional bracing for shipment. In such cases, the outline drawing will contain notes calling attention to the necessity of removing any special bracing.

Occasionally, shell form transformers are placed in octagonal or rectangular tanks. The larger sized units may require sectionalized tanks with special covers to meet height limitations in shipment. If a hat-shaped cover is used, care must be taken to lower the oil below the joint before removing this cover. The outline drawing will indicate when special covers are used in shipment.

UNPACKING

When a transformer is shipped in its own tank with oil, unpacking is a simple matter. It is ready to be set in place when the crating or bracing is removed.

The transformer should be examined carefully to ascertain whether it has been damaged in shipment and whether all parts are in place and in good condition.

SUPERSEDES I. L. 3160

EFFECTIVE JANUARY, 1947

SHIPMENT OF TRANSFORMERS

All bushings and accessories that are shipped separately should be thoroughly protected against moisture until they are installed. Care should be exercised during the installation of these parts to protect the transformer against the possibility of any moisture entering. As an extra precaution against moisture having entered the transformer during shipment or installation, the dielectric strength of the oil should be tested before the transformer is put in service. The dielectric strength of the oil when tested in a standard cup should be not less than 22 kv.

If a transformer is shipped with oil in a shipping tank, the shipping tank should not be opened until the transformer case is in place ready to receive the transformer. The shipping tank should not be opened until temperature of the transformer is the same or higher than the air temperature, to avoid moisture from condensation. The greatest care should be taken to avoid getting moisture in the transformer while transferring it from the shipping tank to its case.

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INSTRUCTIONS

DETERMINATION OF DRYNESS and METHODS OF DRYING OUT

All transformers are dry when they leave the factory, but since they may absorb more or less moisture during shipment and storage, they should not be put into service until it has been determined that the oil and insulation are dry enough for safe operation. The higher the voltage, the more chances there are of trouble from moisture, and the greatest care should be exercised to make sure that the moisture is practically eliminated.

DRYNESS OF OIL AND WINDINGS

When a transformer has been shipped assembled in its case with the oil, four or five samples of oil should be drawn from the bottom of the case and tested. If the average of these tests shows a breakdown value of not less than 22,000 volts on a standard 1/10″ gap test-cup, the insulation and oil are in a satisfactory condition for service. If the average breakdown value is less than 22,000 volts, the oil must be dried. Whether the windings must also be dried should be determined as described under "Insulation Resistance" after the oil has been drawn off. If the insulation resistance is of the proper value, drying of the windings is unnecessary and the transformer may be put into service as soon as the dry oil has been put into the case, provided there has been no delay in drying the oil and returning it to the case.

When a transformer is shipped without either oil or dry nitrogen gas, drying out will be necessary, except in the cases of transformers 500 kva, and under, and of less than 7500 volts. These latter transformers should be tested for dryness before being put into service.

There is no absolute method of determining when the insulation of a transformer is dry, but proper measurements of insulation resistance will serve as an approximate indication of its condition.

Insulation Resistance. Insulation resistance measured with the transformer cold is greater than when measured with it hot and is also greater out of oil than when immersed in oil. It is the out-of-oil resistance that is used as the standard of comparison. Therefore in order to determine the condition of the insulation, the transformer should first be heated to a temperature of 60° to 70°C. After it has reached this temperature, it should be maintained there for 24 hours. The insulation resistance out of oil may then be taken and, in general, it may be said that if it does not measure less than 1 megohm for every 1,000 volts of rated line voltage, drying out will usually be unnecessary. If it measures less than this, drying out will usually be necessary.

INSULATION RESISTANCE CORRECTION TABLES

TABLE A	TABLE B CORRECTION FACTORS (Use either column)	
Resistance Measured in Air At:	To determine Resistance in Air at 75°C DIVIDE by:	To determine Resistance in Air at 75°C MULTIPLY by:
—15°C	64.0	.0156
—10°C	51.0	.0196
—5°C	40.3	.0248
0°C	32.0	.0312
5°C	25.4	.0393
10°C	20.1	.0497
15°C	16.0	.0625
20°C	12.7	.0787
25°C	10.1	.0990
30°C	8.00	.125
35°C	6.35	.157
40°C	5.04	.198
45°C	4.00	.250
50°C	3.17	.315
55°C	2.52	.397
60°C	2.00	.500
65°C	1.59	.629
70°C	1.26	.794
75°C	1.00	1.00
80°C	.794	1.26
85°C	.629	1.59
90°C	.500	2.00
95°C	.397	2.52
100°C	.315	3.17
105°C	.250	4.00
110°C	.198	5.04
115°C	.157	6.35
120°C	.125	8.00

SUPERSEDES I.L. 47-600-10

EFFECTIVE DECEMBER, 1951

There may be cases where conditions prevent heating up the transformer, but facilities are available for removing the oil from the transformer. In this case the insulation resistance should be corrected to a reference temperature of 75° centigrade using the tables shown on Page 1. These correction factors are suggested for insulation out of oil. Insulation in oil will have a resistance that will be approximately 1/2 to 1/4 of the resistance of the same unit out of oil at the same temperature.

METHOD OF MEASUREMENT

Megger. The most satisfactory method of measuring the insulation resistance is by a megger. This instrument is very convenient to use and indicates the megohm resistance directly. In order to secure uniform results, measurements of insulation resistance with the megger type of instrument should follow a regular procedure.

The recommended practice in measuring insulation resistance is to always ground the tank and the core iron or be sure they are grounded. Short-circuit each winding of the transformer at the bushing terminals. Resistance measurements are then made between each winding and all other windings grounded. Windings are never left floating for insulation resistance measurements. Solidly grounded windings must have the ground removed in order to measure the insulation resistance of the winding to other windings grounded. If the ground cannot be removed as in the case of some windings with solidly grounded neutrals, the insulation resistance of the winding cannot be measured. It is then treated as part of the grounded section of the circuit.

For example, in the case of a three-winding transformer, the high-voltage, tertiary-voltage, and low-voltage windings are each short circuited by connecting their terminals together. The high voltage winding insulation resistance is measured by connecting the high voltage terminals to the line or resistance terminal of the megger. The low voltage and tertiary-voltage windings are connected together and to ground and to the ground terminal of the megger. The guard terminal of the megger, if the instrument has a guard terminal, is not used but left floating. The resistance measured is commonly designated the H-LTG resistance. Likewise the other windings are measured and the measurements called T-HLG and L-HTG resistances. Two-winding transformers would have only two resistances, H-LG and L-HG.

The instrument used to measure the resistance should have a voltage output of at least 500 volts. The maximum insulation resistance to be measured must be less than the megohm rating of the instrument. Resistance readings at the extreme upper end of the instrument scale are not reliable. Where this condition exists an instrument capable of measuring a higher resistance should be used. The measuring lead should be air insulated from all other leads and from ground and grounded objects in order to prevent misleading results due to measuring conductor insulation resistance instead of the transformer insulation resistance.

The megger type of instrument may be motor driven, hand cranked or supplied by a rectifier built in the instrument. If a motor driven or a rectifier instrument is used the insulation resistance indicated by the instrument should be recorded approximately one minute after the voltage from the instrument is applied to the transformer. In other words the voltage from the instrument should be applied for one minute before recording the resistance value. In the case of the hand cranked instrument the time interval after starting to crank the instrument until recording the resistance value indicated should not be less than 30 seconds and preferably should be approximately one minute. This reduction in time is permissible due to the difficulty of cranking a megger continuously for one minute. In any case the time interval during which the voltage is applied should be consistent throughout the tests and should be recorded with the insulation resistance values. All measurements should be made with the same procedure to avoid errors and to obtain comparative results.

Voltmeter. In the absence of a megger or similar type of instrument a high resistance voltmeter, usually specially designed for the purpose, may be used. These voltmeters usually have an internal resistance of one megohm. Sufficiently accurate results cannot be obtained using an ordinary voltmeter. Five hundred to six hundred volts should be used in making measurements by the voltmeter method. The usual precautions are necessary to prevent hazards due to the high voltage.

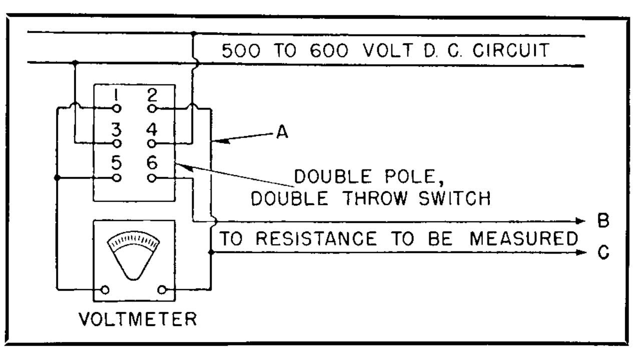

FIG. 1. Connections for Measuring Insulation Resistance.

The number of heating and vacuum drying cycles necessary will depend upon the amount of insulation to be dried and on its moisture content. The minimum number of drying cycles will be at least three, the maximum may be as many as seven or more complete cycles in extreme cases. Drying time will require from one to two or more weeks depending on the number of drying cycles necessary.

Drying may be accelerated by obtaining more uniform heat distribution in the insulation where facilities are available for readily transferring and storing the oil in the transformer.

The procedure is as follows: The transformer, in its own tank and filled to the normal oil level, is heated by circulating full load or 1¼ times full load current through the full windings as described in method 1. Self-cooled units with radiators may be heated by closing the radiator valves on all except 2 or 3 radiators. These valves are left open to allow oil circulation through the transformer thereby obtaining more uniform heating of the insulation by the hot oil. Forced-oil-cooled units should have at least one oil pump running.

The temperature of the windings should not be allowed to exceed 80° to 90°C as measured by winding resistance. If check measurements during the heating period indicate that this temperature range will be over-shot, the current should be reduced.

Top oil temperature serves as a good indication of the heating of the internal parts of a transformer. A constant value of top oil temperature indicates that the heating for a constant input has reached an equilibrium condition. Thus, after the top oil temperature has been constant for four hours and the winding temperature constant in the range of 80° to 90°C the heating may be assumed to have reached an equilibrium condition. The current is then shut off and the oil transferred from the transformer to the storage tank as rapidly as possible. The insulation resistance is measured and the tank sealed. Vacuum is then applied as previously described.

When the temperature of the windings as measured by resistance drops to about 40°C the oil is allowed to flow back into the transformer without releasing the vacuum. The vacuum increases the rate of oil transfer but considerable care is necessary to prevent oil from being drawn over into the vacuum line. Extreme care should be used in this regard if a reciprocating type of vacuum pump is being used as they have very small clearance compared to air compressors. A slight amount of oil in the cylinder may result in a blown gasket or fractured or blown cylinder head.

The vacuum is released after the transformer is filled to the normal oil level and the heating cycle started. If facilities are available for maintaining an oil temperature of about 90°C during the storage period the heating cycle of the transformer will be shortened.

DRYING OUT PROCEDURE.

Time Required. There is no definite length of time required for drying out a transformer. One to four weeks or more will generally be required for methods 1, 2 and 3 depending upon the condition of the transformer, the size, the voltage and the method of drying used. Method 4 will generally be more rapid than methods 1, 2 or 3. In general, any power transformer will require at least one week of drying time regardless of the method used.

Details to be Regarded. If the initial insulation resistance be measured at ordinary temperatures, it may be high even though the insulation is not dry, but as the transformer is heated up it will drop rapidly. An insulation resistance of 100 megohms measured at 25°C is only 9.9 megohms at 75°C. The one megohm rule applies only in the range of 60° to 80°C.

The insulation resistance measured at a constant temperature will generally have a gradually increasing trend as the drying proceeds. Towards the end of the drying period the increase will become more rapid. Sometimes the resistance will rise and fall a short range one or more times before reaching a steady high point. This is caused by moisture working its way out from the interior of the insulation through the outer portions of the insulation which were dried first. Large changes in the measured insulation resistance may be caused by temperature variations. Insulation resistance measurements should be made at the same temperature in so far as it is possible to do so. Measurements should be taken at about four-hour intervals when drying by methods 1, 2, or 3 and at the end of each heating cycle after the oil is drained but before applying vacuum when using method 4.

Resistance Curve. A curve of the insulation resistance measurements should be plotted with time as abscissa and resistance as ordinates. The resistance points plotted should be the measured resistance corrected to a temperature of 75°C. The drying curve will generally show wide variations in the resistance values during the first part of the drying period. The variation of plotted resistance values from the mean curve becomes less as the moisture works out of the insulation. The drying should be continued until consistently high values of resistance are obtained for at least four consecutive measurements covering a period of at least sixteen hours of the drying period. (See Fig. 2)

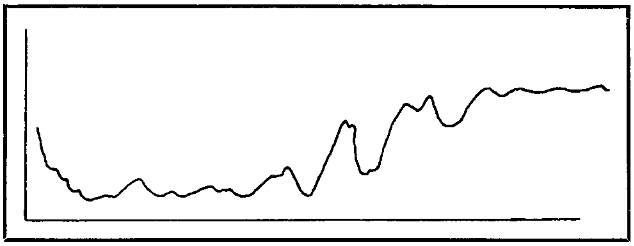

FIG. 2 Typical Drying Curve.

Precautions To Be Observed In Drying Out. As the drying temperature approaches the point where organic fibrous materials deteriorate, great care must be taken to keep the winding temperature as measured by winding resistance below 90°C. It is considered good practice to try to keep from exceeding 80°C. This allows a 10°C margin for errors in measurement and for the difficulty of controlling the temperature.

Caution. When the transformer is received from the factory it is soaked with oil and in an inflammable condition. It may be ignited very easily by an arc, spark or flame of any kind. Smoking near a transformer during the process of drying out should not be permitted. It is essential that adequate fire fighting equipment be at hand during the drying process. It is recommended that only an inert gas be used for extinguishing a fire if one should occur. Carbon tetrachloride, soda-acid, foamite or water type fire extinguishers should not be used as they cause considerable additional damage. The extinguishing equipment may be in the form of several large fire extinguishers or cylinders of inert gas; such as, carbon dioxide or nitrogen. The gas may be piped direct to the transformer tank in order to flood the tank rapidly with gas if a fire starts. All personnel concerned with the work of drying should be fully informed as to the procedure to be followed if a fire occurs. Each person should know exactly what to do if a fire starts. Alertness in extinguishing a fire may mean the difference between a total loss and only minor damage and will greatly reduce the expense and time required to repair a transformer.

It is not safe to attempt the drying out of transformers without constant attention by competent personnel.

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INSTRUCTIONS

STANDARD OUTSIDE FINISH

for Westinghouse Oil Insulated Transformer Tanks

The standard outside finish for Westinghouse medium and large transformer tanks consists of three air dried coats of paint. Each coat is usually flowed on. The color of the first and second coats are different so as to obtain a contrast between adjacent coats, thus insuring that each coat is continuous and of sufficient thickness. The third or final coat is of a dark blue-gray color.

*Note. The second or intermediate coat is a **mixture** of the primer and finish paints, one part primer paint to three parts finish paint by volume. These paints can be applied satisfactorily by flowing, dipping, spraying or brushing.*

The transformer tanks and many of the accessories attached, being constructed of steel, are normally susceptible to rusting. Therefore, in order to prevent rusting of exposed steel surfaces on all Westinghouse transformers, careful attention must be given to the following fundamental steps when repainting exposed steel surfaces:

1. All exposed steel surfaces must be thoroughly cleaned and prepared for the application of the protective coats of paint since the proper preparation of the surfaces to be finished is an important factor to securing a satisfactory and lasting finish.

Regardless of how good the paint may be, it will fail as a protector if applied over a wet, dirty, rusty or greasy surface. Rust and scale will absorb and hold moisture. Therefore, in order to obtain a durable finish, it is absolutely essential that no moisture be sealed in by the application of paint. For large areas, a clean dry surface with sufficient roughness for good adhesion of the priming coat can be obtained by shot or sand blasting the exposed surfaces of the transformer tank.

2. The careful application of a high grade durable quality paint is essential to guarantee a lasting finish.

The two factors that determine the quality of any paint are the pigment and vehicle. The pigment gives the color and body of the paint and the vehicle holds the pigment particles in place and forms a continuous adherent film. Although attention is generally centered upon the selection of the pigment, many tests show that the vehicle of a paint is the first of these two components to disintegrate. Therefore, it is important that a paint of this quality be used to obtain a satisfactory finish. Westinghouse primer paint No. 7164-1 and finish paint No. 7165-1 meet these requirements and are recommended.

Important. Any portion of the paint film damaged during shipment or installation must be repaired as quickly as possible.

To do this, clean the damaged portion by means of scraper or sandpaper, applying a coat of Primer Paint No. 7164-1 and allow it to dry for at least 24 hours, then apply a coat of Finish Paint No. 7165-1.

Note. For small marred spots which do not penetrate the paint film to the parent metal, only the finish paint is necessary after cleaning, although due to the indefinite life of this finish, a protective coating should be applied as soon as possible.

Finish paint is packaged in one-pint containers and designated as style number 302509.

Primer paint No. 7164-1 is not packaged in small quantities but if required, can be purchased through the nearest sales or service office.

WESTINGHOUSE ELECTRIC CORPORATION
SHARON PLANT • TRANSFORMER DIVISION • SHARON, PA.

SUPERSEDES I.L. 3151

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EQUIPMENT • PROCEDURE

INSTRUCTIONS

REMOVING AND REPLACING A WELDED-ON COVER OR A FORM-FIT TOP SECTION

REMOVING THE WELD

There are times when it becomes necessary to remove a welded-on cover from a transformer tank or the top section from the bottom section of a form-fit tank. This may be done by either chipping out the joining weld or cutting out the weld with a gas cutting torch. The equipment required and a suggested procedure to remove the weld is described below.

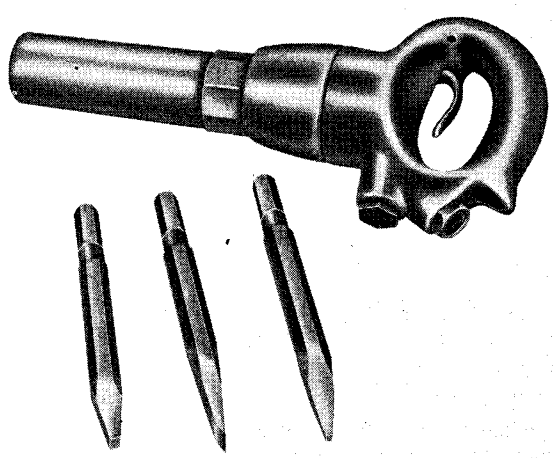


FIG. 1. Recommended Equipment.

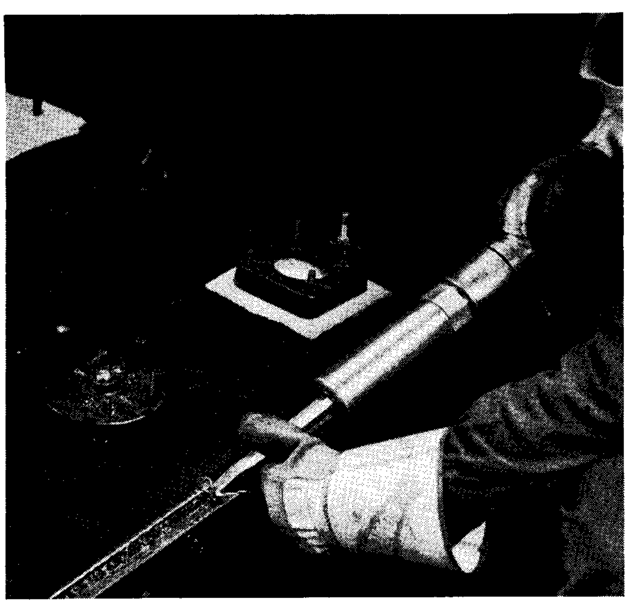


FIG. 2. Removal Procedure.

CHIPPING OUT A WELD

Equipment. The equipment recommended to remove a weld by chipping is:

1. A heavy pneumatic chipping hammer.

2. Three-eighths and 1/8 inch diamond-pointed chisels. The chisels should be forged tools, hardened and tempered so that the edges will not turn or spall. The cutting edges of the diamond-pointed chisels should be ground straight with no chamfer.

3. Flat chisels. The flat chisel should have the flat side relieved 1/64″, approximately 1/8″ back from the cutting edge. This prevents the chisel from "digging-in" and allows the operator better control of its cutting.

4. Gloves and safety glasses should be worn by the operator for his personal protection.

Procedure. To remove a weld by chipping, apply machine oil or grease to the surface of the weld to lubricate the cutting. A 3/8 inch diamond-point chisel is used in the pneumatic hammer and the chisel is held so that the diamond is pointed into the root of the joint. The chisel should cut along the vertical edge of the fillet weld, that is, along the fusion zone of the top flange, and remove

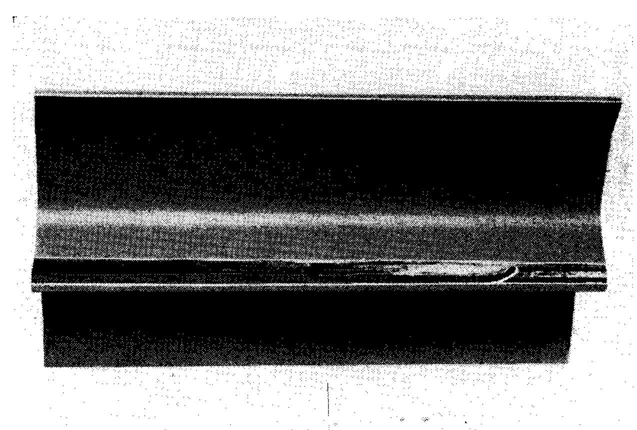


FIG. 3. Weld Partially Removed.

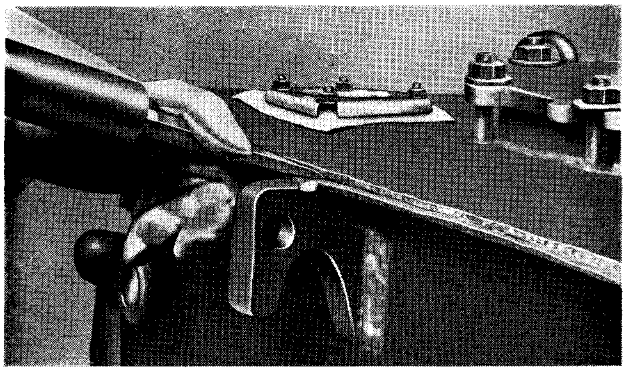


FIG. 4. Carefully Breaking the Seal.

as much of the weld as possible. Should the weld not be completely removed in one pass with the 3/8 inch diamond-point chisel, more oil or grease should be spread over the remaining weld and the flat chisel used to cut the weld flush with the horizontal and vertical surfaces of the joint. The small diamond-point chisel should then be used to remove any remaining weld metal from the root of the joint.

The flat chisel is then driven directly into the root of the joint to crack the seal, as shown in Fig. 4. To prevent the chisel from being driven between the joint and deforming the plates, it is moved slowly along the joint. A lifting force upon the cover or the top section will help to break the seal.

WELD REMOVAL BY GAS CUTTING

Equipment. The equipment recommended to remove a weld by gas cutting is:

1. A heavy duty gas cutting torch, preferably of the oxy-acetylene type.

2. Heavy duty flame cutting tips or Airco #6 or #8, Style 183 or Oxweld #19, Style 1511 gouging tips.

3. A number of C-clamps.

4. A heavy machinist's or pneumatic hammer and a flat chisel to break the weld seal.

5. Protective equipment such as gloves and colored goggles for safety protection of the operator, nitrogen to purge the transformer tank and hand operated carbon dioxide fire extinguishers.

Procedure. To remove a weld by gas cutting the following procedure is suggested. Connect a bottle of dry nitrogen to the filling plug opening and flush the gas space with nitrogen. Keep nitrogen flowing into the gas space while the weld is being removed to blanket the core and coils and to prevent combustible gases collecting within the transformer case.

The cutting or gouging tip is assembled to the cutting torch. The gas pressures should be adjusted to the recommended pressures for the size tip used. Usually 60 to 80 psi oxygen pressure and 5 to 6 psi acetylene pressure. The torch is lighted and the flame adjusted to give a neutral flame. Heat the weld at one corner of the tank to a white heat, then simultaneously set the torch in motion along the weld and release the cutting oxygen. Move the torch axially along the weld with an oscillating motion, forward slowly an inch or two, then backward quickly about one-half inch, to permit the flame to fan out and wash the molten weld metal from the root of the joint. Continue along the weld in this manner, gauging the depth of the cut so that the entire cross-section of the weld is removed in one pass.

Apply C-clamps to clamp the side or sides from which the weld has been removed to prevent the joint opening prior to complete weld removal.

After the weld has been removed completely around the tank, remove the C-clamps and drive the flat chisel directly into the root of the joint to break any remaining weld seal, as shown in Fig. 4.

REPLACING A WELDED-ON COVER

To replace a welded-on cover that has previously been removed as described above, the following is recommended:

Preparing the Cover for Replacement.

1. Chip or grind any irregularities around the cover edge left during the weld removal operation when the cover was removed from the case. The cover edge should be square and expose clean metal.

2. Clean the underside of the cover three inches back from the cover edge to a smooth surface. A disc grinder is recommended for this operation.

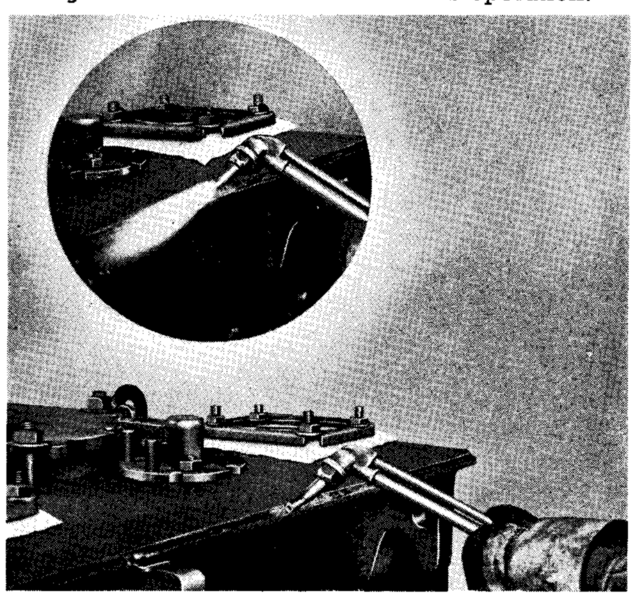


FIG. 5. Removing Weld by Gas Torch.

3. Remove and wipe all foreign material from the cover, especially from the underside to prevent dirt falling into the transformer when the cover is placed in position on the transformer case.

Preparing the Case Flange to Receive the Cover.

1. Place a blanket of clean paper or cloth over the entire transformer a few inches below the case flange. This blanket should be attached and continuously sealed with wide masking tape around the entire interior of the case. This is necessary to prevent any foreign material falling into the transformer.

2. Remove any raised irregularities from the top surface of the flange by chipping or grinding. A sanding disc will do the job very effectively, or a grinder may be used; in either case, it should be used so that the material removed from the flange will be thrown away from the transformer case rather than into it. This surface must be smooth to permit the cover to fit tightly and uniformly around the case.

3. Gently brush cuttings and debris collected on the blanket over the transformer to the center of the blanket. Remove this debris, then carefully pull the sealing tape from the case walls to free the blanket. Make certain that the edges of the blanket are kept above the center of the blanket at all times so that any foreign material on the blanket will not roll into the transformer.

Applying the Asbestos Sealing Gasket to the Case Flange.

1. Brush a ½″ wide coating of (#7386) red cement 1½″ to 2″ back from the edge of the flange completely around the case. Care must be observed to prevent any cement extending onto the weld area as it will cause weld porosity.

2. Place a ⅛″ diameter asbestos rope (#3879) completely around the case flange in the center of the freshly applied cement. There must not be any openings in the gasket. Use a good butt joint, or allow one end to extend a little in back of the other.

Positioning the Cover and Preparing for Welding.

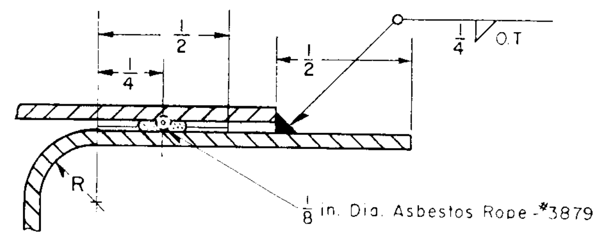
1. Lower the cover onto the case flange so that it is in its approximate final position without sliding across the asbestos gasket. Normally the flange will extend approximately ½″ beyond the cover edge.

2. Clamp the cover and flange tightly together around its entire periphery with C-clamps. Place the C-clamps near the edge of the cover so that the welding operator can weld under the clamps. The cover edge should be tight against the flange before any welding is done at that point.

Welding the Cover to the Flange.

1. Cover all openings in the cover.

2. Apply a ⅛″ fillet sealing weld around the cover starting at one corner of the case and welding around it. Use Westinghouse $^5/_{32}$″ diameter DH-coated electrodes (#972 076 for 50# packages). This is an American Welding Society Type E-6020 electrode and is recommended for horizontal fillets or downhand welding. It is recommended for this weld because of its high penetrating properties. Either a-c or d-c (reverse polarity preferred) current may be used with a current setting of 155 to 175 amperes.



1. APPLY A ½ IN. WIDE COATING OF #7386 CEMENT TO THE TANK FLANGE.
2. PLACE THE GASKET (ASBESTOS ROPE) IN THE CENTER OF THE STRIP OF CEMENT.
3. CLAMP COVER AND FLANGE TIGHTLY TOGETHER BEFORE WELDING.
4. BE SURE THERE IS NO OPEN SPACE NOT FILLED WITH GASKET MATERIAL.

FIG. 6. Method of Joining Cover to Flange.

3. Remove the C-clamps from the cover and flange.

4. Remove the slag from the weld bead and wire brush.

5. Weave a ¼″ fillet weld over the ⅛″ fillet weld using Westinghouse $^5/_{32}$″ diameter FP electrodes and a welding current of 150 to 160 amperes. This electrode (S#1528 912 in 50# packages) is also a coated electrode. It is an American Welding Society Type E-6012 and may be used with a-c or d-c (straight polarity preferred) current.

6. Clean the slag from the weld and brush.

Paint the weld, the flange and the edge of the cover with primer and touch-up paint.

FORM-FIT TANK TOP SECTIONS

To replace the top section of a form-fit tank that has been previously removed as described above, the following is recommended:

Preparing the Top Section for Replacement.

1. Chip or grind any remaining irregularities left along the bottom face and edge of the flange of the top section. The flange edge should be square and expose clean metal. The bottom side of the flange should be smooth.

2. Wipe all foreign material from the flange.

Preparing the Flange of the Bottom Section to Receive the Top Section.

1. Wrap and attach with masking tape an 8″ to 12″ wide strip of heavy paper or cloth around the iron directly above the flange.

2. Remove any irregularities from the top surface of the flange by chipping or grinding. When grinding, one should use the grinder so that the material removed is thrown away from the transformer rather than against the iron core. Brush and wipe all foreign material from the flange with a dry cloth. This surface must be smooth to permit the top section to fit tightly and uniformly around the case.

3. Remove the 8″ to 12″ wide protecting material previously placed around the iron.

Applying the Sealing Gasket to the Flange of the Bottom Section.

1. Brush a 1/2″ wide coating of (#7386) red cement 1 1/2″ to 2″ back from the edge of the flange of the bottom section. Care must be observed to prevent any cement extending onto the weld area as it will cause weld porosity.

2. Place the sealing gasket #9854-1 upon the freshly applied cement with the tape edges outward, completely around the flange. There must not be any openings in the gasket. Use a good butt joint or allow one end to extend a little in back of the other.

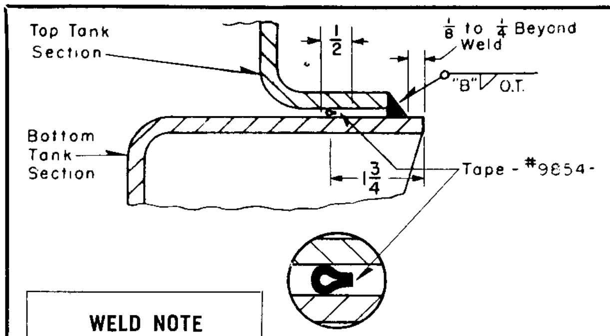
Positioning the Top Section and Preparing for Welding.

1. Lower the top section slowly over the transformer assembly until it is seated on the flange of the bottom section.

2. Clamp the flanges of the top and bottom sections together tightly around its entire periphery with C-clamps. Place the C-clamps near the edge of the flange so that the welding operator can weld behind the C-clamps. The two flanges must be tight together before any welding is done at a given point.

Welding the Top Section to the Bottom Section.

1. Apply a 1/8″ fillet sealing weld around the top



WELD NOTE

Top Tank Section Thickness	Weld Size "B"
1/4	1/4
5/16	1/4
3/8	5/16
7/16 + 1/2	3/8

1. BRUSH A 1/2″ WIDE COATING OF #7386 CEMENT ON THE FLANGE OF THE BOTTOM TANK SECTION 1 3/4″ BACK FROM THE TANK EDGE.
2. PLACE THE #9854-1 GASKET ON THE FRESHLY APPLIED CEMENT WITH THE TAPE EDGES OUTWARD.
3. CLAMP FLANGES TOGETHER TIGHTLY BEFORE WELDING.
4. BE SURE THERE IS NO OPEN SPACE NOT FILLED WITH GASKET MATERIAL.

FIG. 7. Joining of Flanges, "Form-Fit" Tank.

section starting at one corner of the case and weld around it. Use Westinghouse 5/32″ diameter DH-coated electrodes S#972 076 for 50# packages. This is an American Welding Society Type E-6020 electrode and is recommended for horizontal fillets or downhand welding. It is recommended for this weld because of its high penetrating properties. Either a-c or d-c (reverse polarity preferred) current may be used with a current setting of 155 to 175 amperes.

2. Remove the C-clamps from the cover and flange.

3. Remove the slag from the weld bead and wire-brush.

4. Weave a 1/4″ fillet weld over the 1/8″ fillet weld for top sections made of 1/4″ and 5/16″ thick plate, a 5/16″ weld for 3/8″ thick top sections and a 3/8″ weld for 7/16″ or 1/2″ thick top sections. Deposit this weld with Westinghouse 3/16″ diameter FP electrodes and a welding current of 190 to 210 amperes. This electrode is a coated electrode S#1528 913 in 50# packages. It is an American Welding Society Type E-6012 and may be used with a-c or d-c (straight polarity preferred) current.

5. Clean the slag from the weld and brush.

6. Paint the weld and the flanges with primer and touch-up paint.

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INSTRUCTIONS

CLEANING TRANSFORMER INSULATION

There are times when it may become necessary to clean transformer insulation because of the accumulation of dust, grease, sludge or carbon deposits. The method for cleaning varies with the type of transformers.

DRY-TYPE TRANSFORMERS

Dust, free of oil or grease, may be removed by wiping with a clean dry rag or by using a vacuum cleaner equipped with a brush attachment. The vacuum cleaner is preferred for large areas. Dust may be blown from inaccessible parts, but any dust removed by blowing is scattered and much of it will settle on other parts from which it must be removed as outlined above. The air must contain no moisture and care must be observed so that the insulation materials are not damaged by excessive air velocity.

Should grease or oil get upon the insulation it may be removed by wiping dry with a clean dry cloth.

Loose carbon deposits may be removed by brushing and/or wiping with clean dry cloths. Defective insulation should be replaced.

OIL-FILLED TRANSFORMERS

Loose coatings of sludge and dirt may be removed by wiping with cloths saturated with transformer oil. Tightly adhering or heavy coatings of sludge may require a light brushing with a bristle brush, followed by a wash with transformer oil.

Sludge, dirt and oil-carbon deposits may often be effectively removed by spraying clean, dry, transformer oil upon and around the insulation with sufficient velocity to thoroughly wash and clean it. An air-ejector type nozzle should be used. Defective insulation should be replaced.

Important: Do not use knives, screw drivers or other sharp objects to clean coils since the use of these objects may cut the insulation.

INERTEEN-FILLED TRANSFORMERS

Normally, the cleaning of insulation is not necessary for Inerteen transformers because Inerteen does not sludge. However, should it be necessary to remove a deposit of dirt, it may be done by wiping with a cloth saturated with clean Inerteen or trichlorbenzene.

When arcing occurs in Inerteen, the insulation is attacked by the products of decomposition of the Inerteen and usually requires replacing. The products of decomposition of Inerteen 7336-8 now used in transformers have less effect on insulation than those from the earlier types of Inerteens. Hence it is more likely that the insulation in these transformers, not affected by direct arcing, may be used again.

For precautions in handling Inerteen refer to instruction book on Inerteen Transformers.

Important: Carbon tetrachloride should never be used for cleaning the insulation of either liquid filled or dry type transformers because it is nearly impossible to remove all of the carbon tetrachloride used for cleaning purposes, and during the natural operation of the transformers, the remaining carbon tetrachloride will form hydrochloric acid which will cause corrosion of metal parts and detrimentally affect the insulation.

This general procedure is not to be followed when specific instructions accompany the apparatus.

WESTINGHOUSE ELECTRIC CORPORATION

SHARON PLANT • TRANSFORMER DIVISION • EMERYVILLE PLANT
SHARON, PA. EMERYVILLE, CALIF.

SUPERSEDES I.L. 47-600-23

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INSTRUCTIONS

REPAIRING WELD LEAKS

This instruction leaflet is intended to give general instructions concerning recommended practices for repairing a weld leak in power transformers or their auxiliaries. Variations of these instructions may be desirable for special repair tasks, but normally the weld leak may be successfully sealed if these instructions are followed.

TRANSFORMER CASES AND FITTINGS

Transformer cases and their fittings are fabricated from 3/16″ to 1/2″ thick welding quality low carbon steel. The welds are deposited manually using shielded arc welding electrodes, other than some case seams which are automatically welded by the submerged arc welding process.

To repair a weld leak in a case seam or around one of the fittings the following is recommended:

1. Check the liquid level in relation to the area to be welded. It should be 4″ or more above the area to be welded. Should the area to be welded be above the liquid level or if the liquid has been removed from the case, blanket the transformer with dry nitrogen.

2. De-energize the transformer and pull a vacuum of several pounds per square inch above the liquid to stop the liquid leak. This may be done with a vacuum pump or by sealing all fittings on the case and draining sufficient oil to obtain the necessary vacuum.

Note: Vacuum is not always required, especially when a sweating leak is to be repaired and the case wall is relatively thick.

3. Peen the weld leak closed, if possible, with the ball end of a ball-peen hammer or with a blunt or round-nosed chisel.

4. Grind or scrape the paint from the area to be welded and prepare a suitable point for attaching the ground lead to the arc welding machine.

5. Select several Westinghouse 1/8″ diameter type FP electrodes, S# 1528 911, for 50# packages. This is an all-purpose, coated electrode adaptable to down-hand, horizontal or vertical welding. It is classed as an E-6012 type by the American Welding Society. Either a-c or d-c welding current may be used. When d-c power is used, straight polarity is preferred, that is, the electrode is negative.

The welding machine is adjusted to supply the desired welding current. Some value between 115 to 125 amperes should be used, depending upon the welding operator's ability and the individual task at hand.

6. Apply a string bead sealing weld over the weld defect in a single, quick pass. This weld should be deposited horizontally or vertically depending upon circumstances. If the weld is deposited vertically, it is recommended that it be made downward to drive any liquid seepage ahead of the weld.

Successive beads are deposited adjacent and over the first sealing bead, or a single pass may be weaved across it to complete the weld. If the beads are deposited horizontally, deposit these beads from the top down if any liquid seepage is present; otherwise they may be deposited upward if preferred. Remove the slag from the deposited weld before depositing each successive weld bead or pass.

Liquid interferes with the welding operation and the quality of the deposited metal. It should be wiped off with a dry cloth. All welds should be deposited in a sequence as above to prevent any liquid seepage interfering with the welding operation other than the final sealing at the lowest point of the weld leak.

7. Clean and brush the repaired area and apply touch-up paint.

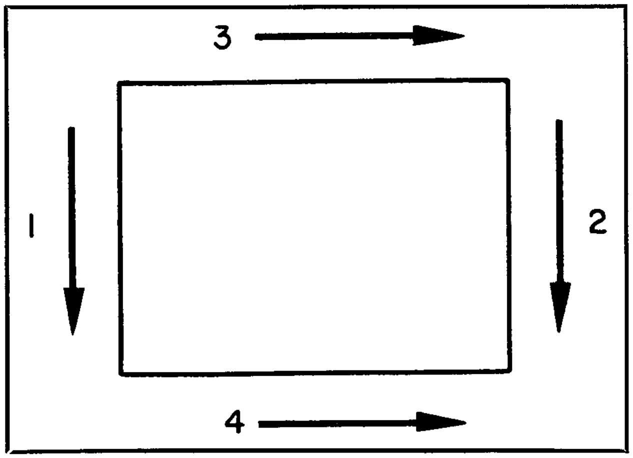

FIG. 1. Welding Sequence for Patch

Alternate Method Using a Patch. A patch may be welded to the transformer case to repair a leak as an alternate to the method above. The recommended method is as follows:

1. De-energize the transformer and pull a vacuum, peen the weld, clean the weld area, check the liquid level, select the 1/8″ FP electrodes and adjust the welding machine as above.

2. Fit a patch of 3/16″ or 1/4″ thick steel over the area to be sealed. Tack this patch in place, then weld it to the transformer case by welding the sides first, vertically downward, then horizontally across the top of the patch and finally horizontally across the bottom. This welding sequence is recommended to prevent any liquid interfering with or contaminating the weld. (See Fig. 1.)

3. Clean and brush the repaired area and apply touch-up paint.

TUBULAR COOLERS

The Westinghouse swaged tube cooler consists of from two to ten 2″ diameter x .063″ wall thickness riser tubes with swaged ends inserted into, and arc welded to, two 2 3/8″ diameter x .093″ wall thickness header tubes for assemblies of eight riser tubes or less and 2 3/8″ diameter x .125″ wall thickness header tubes for assemblies of nine or ten riser tubes. The wall thickness of the swaged end of the riser tube at the point it is welded to the header tube is approximately .093″.

Tube cooler assemblies without swaged riser tubes are made from 1 1/2″ extra-heavy pipe or 9/64″ or 5/16″ wall thickness tubing welded to 2″ extra-heavy-pipe headers.

To repair a weld leak in a tube cooler assembly or in the weld attaching the headers to the case the following is recommended:

1. De-energize the transformer and pull a vacuum above the liquid to stop the liquid leak. This is essential when repairing the swaged tube coolers.

2. Peen the weld leak closed if possible with blunt or round-nosed chisels.

3. Scrape the paint from the area to be welded and prepare a suitable point for attaching the ground lead to the arc welding machine. Remove any liquid on the surface to be welded.

4. Select several Westinghouse 3/32″ diameter type S Welectrodes, S# 1082 207, for 50# packages. This is a coated electrode with low penetrating characteristics designed for sheet metal welding. It is classed as an E-6013 type electrode by the American Welding Society. It may be used with either d-c (straight polarity preferred) or a-c. The recommended current setting is 50-60 amperes.

5. Seal the leak with a single, quick weld bead. Apply the bead horizontally, vertically or overhead as the occasion demands. If vertically, weld downward. When sealing a weld joining the header to the case, start at the top of the header and weld downward around its periphery to the bottom of the header. Always weld so that any oil seepage will flow away from the weld rather than into it.

Weld beads must be small and made quickly to prevent burning through the tube walls. An arrangement of mirrors may aid in repairing a weld that can be reached, but is not in the welding operator's direct line of vision.

6. Clean and brush the repaired area and apply touch-up paint.

FIN-TYPE RADIATORS

The Westinghouse fin-type radiator consists of inflated elements gas welded to each other and to a .109″ thick formed header. A 1″ thick flange is arc welded to each header. The elements are made from two sheets of .057″ thick mild steel continuously resistance welded along their outer edges and with two intermediate seams to cause lobes to form in the element during the inflating operation.

Repairing an intermediate seam between elements is not recommended in the field. The radiator should be returned to the Sharon Plant so that a new element may be assembled.

To repair weld leaks around the header flange, along the outer edge of the elements or in the edge weld where the elements join the header or each other, the following procedure is recommended:

1. Close the radiator valves between the radiator and the transformer case. Drain the liquid from the radiator and remove the radiator from the transformer case.

2. Grind or scrape the paint from the area to be repaired. Also remove any liquid, dirt or foreign matter.

3. If the weld to be repaired is around the header flange use 1/8″ diameter FP electrodes with current settings between 115 to 125 amperes. Weld horizontally around the flange.

4. If the weld to be repaired is along the edge of the elements or is the weld joining the elements to each other or the header—gas welding should be used. Use a slightly reducing flame. Preheat the area to be welded then concentrate the flame on the weld seam, about 2″ away from the weld leak, and bring a local area to the welding temperature. As the edges of the adjacent parts melt and flow together move forward slowly with a slight weaving motion until 2″ past the weld leak. If a filler metal must be added use a 1/16″ diameter soft iron gas welding rod (PDS# 5793) or a 1/16″ wide strip sheared from a 1/16″ thick clean mild steel sheet.

When repairing the resistance weld along the edges of the radiator elements the welding operator must make certain that the edges of the elements are fused sufficiently deep to penetrate into the resistance weld.

5. Clean and brush the repaired area and apply touch-up paint.

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to emulsification. The carbon alone may not be detected by the dielectric test, particularly if the oil is free from moisture.

In cold weather, a larger amount of carbon is formed than in warm weather because of the increased viscosity of the oil at low temperatures. Also the carbon is not as readily dispersed through the oil.

SAMPLING OIL FROM SHIPPING CONTAINERS

The dielectric strength of oil is affected by the most minute traces of certain impurities, particularly water. It is important that the greatest care be taken in obtaining the samples and in handling them to avoid contamination. Many of the low dielectric test results reported from the field have been caused by carelessness in sampling. The following instructions, based on the specifications of the American Society for Testing Materials, must be followed to assure accurate results:

Sample Bottle. The sample container shall be made of clear glass, of at least 8 oz. capacity, and shall be cleaned and dried. The glass bottle is preferable to the metal container as it may be examined to see if it is clean. It also allows visual inspection of the oil before testing, particularly as regards free water and solid impurities. However, any samples to be tested for color or sludge-forming characteristics must be kept in the dark, as light produces changes in these properties. This is not necessary for any other tests. Use only good quality cork and use new cork for each sample.

The clean, dry bottle shall be thoroughly rinsed with benzine or dry lead-free gasoline which has previously withstood a dielectric test of at least 25 kv in a standard test cup, and shall be allowed to drain. It is preferable to heat the bottle and cork to a temperature of 100°C (212°F) for one hour after thoroughly draining. The bottle shall then be tightly corked and cork and neck of the bottle dipped in melted paraffin.

Important: Glass jars having rubber gaskets or stoppers should not be used. Oil can easily become contaminated from the sulphur in natural rubber.

Thiefs for Sampling. A convenient and simple thief (see Figure 1) for use with 50 gal. drums may be made of tin as follows:

Length 36 in., diameter 1¼ in. with cone shaped caps over the ends and openings at the ends ⅜ in. in diameter. Three legs equally spaced around the thief at the bottom, and long enough to hold the opening ⅛ in. from the bottom of the container being sampled, aid in securing a good representative sample. Two rings soldered to the opposite sides of the tube at the outer end will be found convenient for holding the thief by slipping two fingers through them and leaving the thumb free to close the opening. In an emergency a piece of glass tubing 36 in. long may be used. For the tank cars, a thief employing a trap at the bottom may be used. (See Figure 2.)

The thief shall be suitable for reaching the bottom of the container and the sample shall be taken with the thief not more than about ⅛ in. from the bottom.

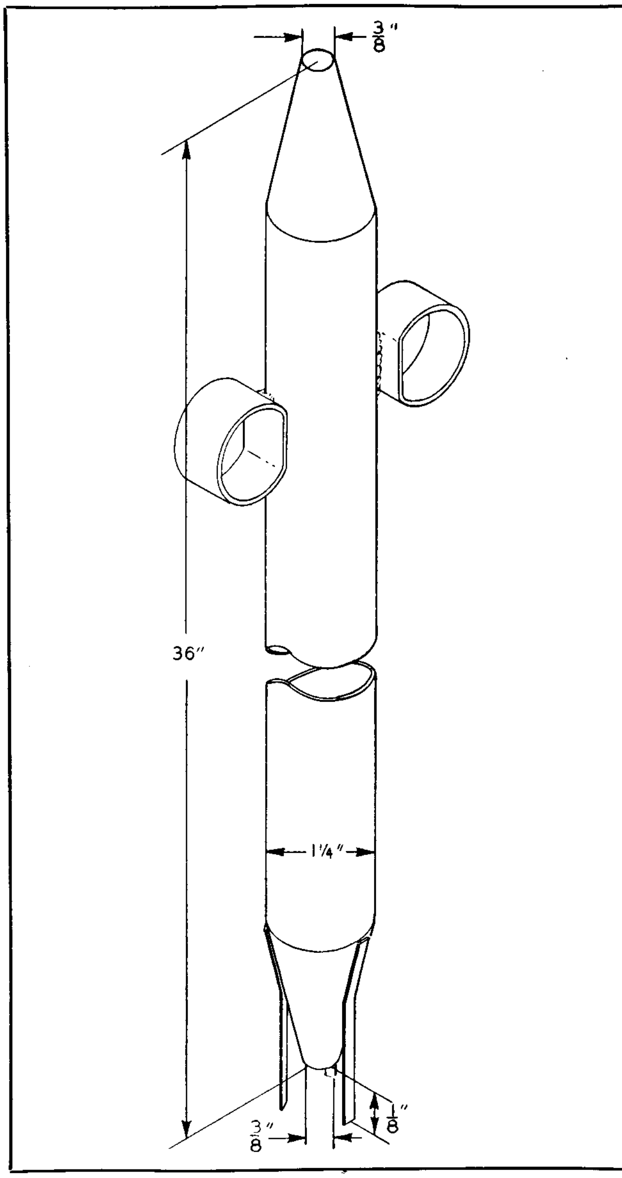

FIG. 1. Drum Thief

Procedure. Thiefs should be cleaned *before and after use* by rinsing with dry lead-free gasoline; be sure that no lint or other fibrous material remains on them. When not in use they should be kept in a hot, dry cabinet or compartment at a temperature not less than 37.8°C (100°F), and shall

MECHANICAL STOP FOR "URS" TAP CHANGER

The stop bar is a rectangular bar of steel which is spring loaded and is held in its normal position by a tripping latch. The tripping latch is counter-balanced by a spring so that the normal rest position of the latch roller is at the horizontal center line of the stop bar. The latch roller rests in the slot in the stop bar. The slot in this bar has circular ends so that the roller is forced to the horizontal center of the slot even without the spring counter-balance. When the mechanical stop adjusting screw strikes the tripping latch, the latch roller is forced out of the slot in the stop bar permitting the compression spring on the stop bar to push the bar into the wide space between the stop bosses positively stopping the tap changer from any further movement. The stop bar is supported in a front and rear guide. A keeper holds the bar in the rear guide; a retaining roller keeps the bar down in the channel provided for the front guide. The retaining roller is free to move along its axis at right angles to the length of the stop bar, being held in place by the channel in which the stop bar slides. The front guide channel is held in a balanced position between two heavy springs which serve to absorb the energy of the system when the stop disk strikes the stop bar. A collar near the front end of the stop bar limits its forward thrust into the stop disk when it is tripped. An instruction plate which gives the procedure for resetting the mechanical stop is mounted on the stop bar between the spring compression collar and the stop collar.

When the mechanical stop is tripped, the stop collar releases the mechanical stop switch, and the spring compression collar drives the switch to the open position, de-energizing the motor as an added safety feature.

Moving the hand crank shaft into operating position also de-energizes the motor circuit so that electrical operation is prevented while the hand crank is engaged.

From the above it will be seen that the mechanical stop bar must be cocked, and the hand crank shaft pinned in the disengaged position for the motor to operate. The screw in the switch bracket may be adjusted to insure the switch being closed when these conditions are met.

When major maintenance operations are performed on the control mechanism, the setting of the mechanical stop must be rechecked and, if necessary, adjusted to agree with the tap changer

ADJUSTMENT

The mechanical stop may be adjusted for earlier or later operation as outlined by the following procedure. However, it should always be in conformity with the sequence chart. If any parts of the tap changer are disassembled and reassembled, alignment should be checked carefully in accordance with the match marks as described on page 3.

1. De-energize the control circuit and turn the tap changer beyond its limit positions by hand. With the location of the 120 switch cam roller on the center of the lobe of the 120 cam, as a reference check the angular movement of the 120 cam shaft, as the mechanical stop is tripped. The set-screw locking the adjusting screw should then be released and the adjusting screw should be turned in or out to make the stop trip correspondingly later or earlier as required. The mechanical stop should trip with the 120 cam shaft at 30° from its reference position (check the sequence chart). One-fourth turn of the adjusting screw will change the tripping position by approximately 6 degrees of rotation of the 120 cam shaft.

2. After adjusting the tripping position for hand operation, by-pass the LL and LR switches and block the 124 and 125 contacts open. Set the tap changer for manual operation and energize the control circuit. Now start at least one position from the limit positions and hold the raise-lower switch closed to run the tap changer through the limit positions to trip the mechanical stop. Readjust the trip as necessary to insure that the mechanical stop will trip at the correct angular position of the 120 cam shaft. Lock the adjustment by means of the set screws and recheck.

It is important that the stop bar enter the wide space between the bosses on the stop disk so that the tap changer contacts are still made. When the stop enters the narrow space between the bosses on the stop disk, one contact is already open stopping the tap changer with one leg of the preventive auto transformer disconnected. The narrow space is provided only to insure that if the adjustment is incorrect the mechanism will be stopped before the tap change is completed. If the tap change were allowed to be completed the regulating winding would be connected across the preventive auto impressing excessive voltage on

RESETTING

The mechanical stop is an additional safety feature set to trip only when some trouble develops in the mechanism or in the control circuit. Each time the mechanical stop trips, the unit should be very carefully inspected and the trouble corrected before the unit is placed in service again.

The mechanical stop must be reset manually. The following suggestions will serve as a guide for resetting the mechanical stop:

1. De-energize the control circuit.

2. Hold the stop bar to the left with its loading spring fully compressed.

3. Permit the latch to reset by hand cranking the tap changer to position 3 or 31 (2 or 16 for a 17 position tap changer).

4. Energize the control circuit of the tap changer and check its operation.

5. Eliminate any possible troubles and place tap changer in service.

MATCH MARKS

The following simultaneous conditions constitute proper adjustment of the tap changer as indexed at the factory.

1. The tap changer is set on the neutral position (position #17 for 33 position tap changers and position #9 for 17 position tap changers).

2. The selector contacts are exactly on position.

3. A straight edge placed across the wide space between bosses on the stop disk is parallel to the side wall of the tap changer compartment.

4. The match marks (small arrows) on the front of the stop disk are in a vertical line with similar match marks to the right of the hand crank shaft on its front bearing support.

5. The cam assembly is lined up with the 120 cam switch roller on the center of the 120 cam lobe which has the arrow on its bottom surface.

6. The position indicator is in agreement with the location of the tap changer contacts (on the neutral position).

7. The match marks on the gears between cam shafts of the control switch assembly are in line.

8. The large end of all taper pins is toward the front of the tap changer with the smaller end to the back.

Note: It is recommended that whenever any component parts of the tap changer are disassembled or assembled ALL parts be put on position #17, where ALL match marks are in line.

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SHARON PLANT • TRANSFORMER DIVISION • SHARON, PA.

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DESCRIPTION • ADJUSTMENT • MAINTENANCE

INSTRUCTIONS

DynAC Brake*

The Alternating Current Dynamic Brake

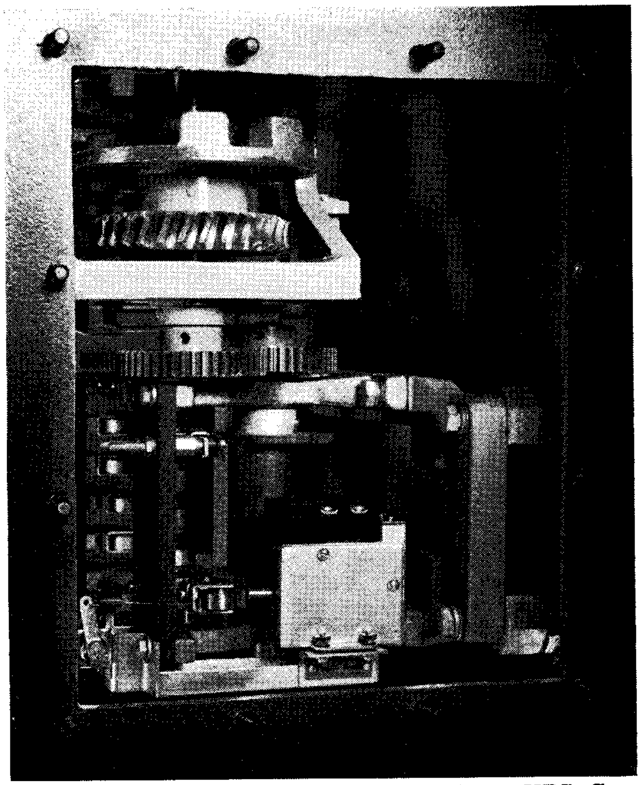

FIG. 1. "DynAC Brake" As Installed on URS Cam Switch Assembly

THE "DYNAC BRAKE" (pronounced "dine-ack") is a totally new means for the rapid deceleration of reversible capacitor type motors as used on tap changer drive mechanisms or other applications where quick acting electrical braking is required.

The "DynAC Brake" operates instantly when driving power is removed to give a smooth application of braking power with a minimum of strain on the motor shaft.

DESCRIPTION

The "DynAC Brake" is available in two styles: "Type M" where mechanical operation is desirable (see Fig. 2), and "Type E" solenoid-operated for other applications (Fig. 3).

The "Type M DynAC Brake" consists of the "DynAC" time delay relay complete with the mounting bracket, a cam operated brake arm, and brake resistors. The time delay relay and mounting bracket constitute one assembly and the resistors constitute another assembly. These assemblies are mounted in the cam switch compartment (air chamber) of the tap changer.

The "Type E DynAC Brake" consists of a solenoid operated time delay relay and its accompanying resistors mounted on a common base. It is normally mounted back of the control panel in the control compartment.

The basic mechanism of both types is the "DynAC" time delay relay (Fig. 4). This is a pneumatically controlled device which gives an application of power for braking of exactly the right duration. It has a built-in overtravel feature on the bellows operating plunger to ensure proper operation at all times, without necessity of exacting travel adjustments.

SEQUENCE OF OPERATION

The contacts of the "DynAC" time delay relay are closed mechanically or electrically by the cam switch assembly of the tap changer. This sets up the braking circuit which is completed by the closing of the back contacts of the motor control relay when the relay is de-energized. The "DynAC Brake" thus applies single-phase a-c power directly to both windings of the motor from the same supply leads for a sufficient length of time (as determined by the time delay setting) to permit the motor to come to rest. This braking power is removed by the "DynAC" time delay relay, after the mechanical or electrical force, which closed the contacts, has been removed by the proper positioning of the tap changer.

This gives alternating current dynamic braking action, bringing the motor to a quick, smooth stop.

NEW INFORMATION

EFFECTIVE JANUARY, 1951

* Trade-Mark

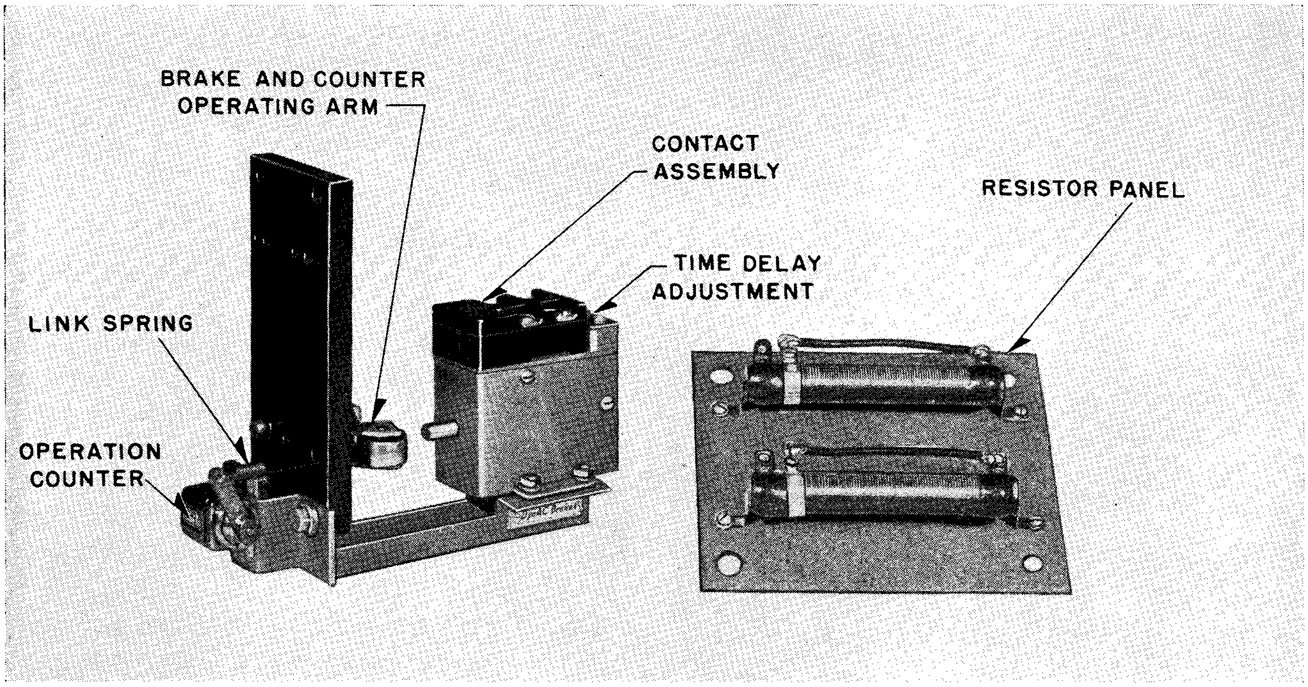

FIG. 2. "Type M DynAC Brake" for Mechanical Operation, with Mounting Bracket, Cam-Operated Brake Arm, and Brake Resistor Panel

ADJUSTMENT

The only major adjustment necessary is on the length of the time delay. The time from the removal of pressure from the plunger until the opening of the contacts of the "DynAC" time delay relay (snapping of the switch) should be approximately one half to one second. Turning the adjusting screw clockwise decreases the time delay, counter-clockwise increases the time delay. An approximate adjustment is made by turning the adjusting screw to the maximum delay setting and then reducing the delay by four full turns of the adjusting screw. See Fig. 4.

The XR and XL resistors serve two functions. One function is to prolong the life of contacts "SL1" and "SR2" of the motor control relay by limiting the capacitor discharge current when the capacitors are short circuited by these contacts. The other function is to control the positioning of the cam switch rollers on the lobes of the cams. This fine adjustment, which in the majority of cases is not required, may be desirable because of slight variations in different motors and mechanisms or extremely wide variations in voltage supply. The resistance is divided between leads 124 and 125 to balance the braking torque in the two directions of operation.

Increasing the XL resistance (Fig. 5) decreases the braking torque applied as the motor is stopped after an operation in the "Lower" direction, hence the unit will stop with the "120" cam roller further onto the lobe of the "120" cam. Increasing the XR resistance gives the same effect in the raise direction. Since there is an interaction of the currents which pass through these resistors, it is sometimes necessary to readjust the XL resistance after the XR is adjusted, and vice versa.

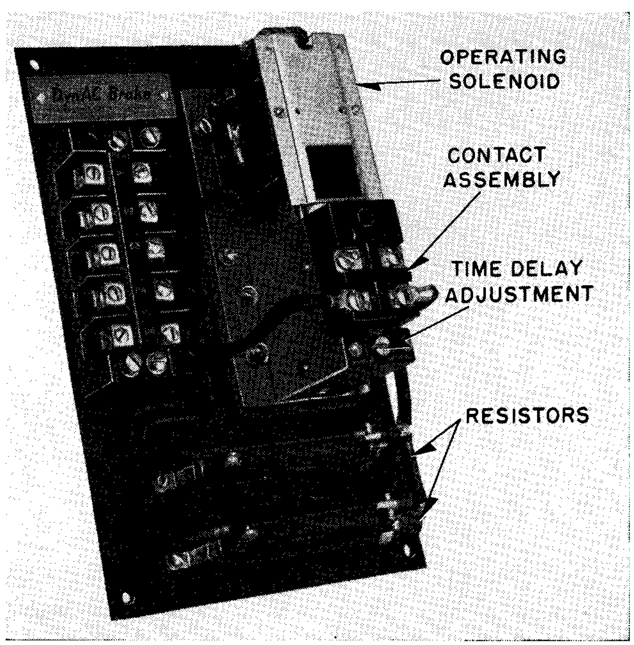

FIG. 3. "Type E DynAC Brake", Solenoid-Operated, with Brake Resistors on Common Base

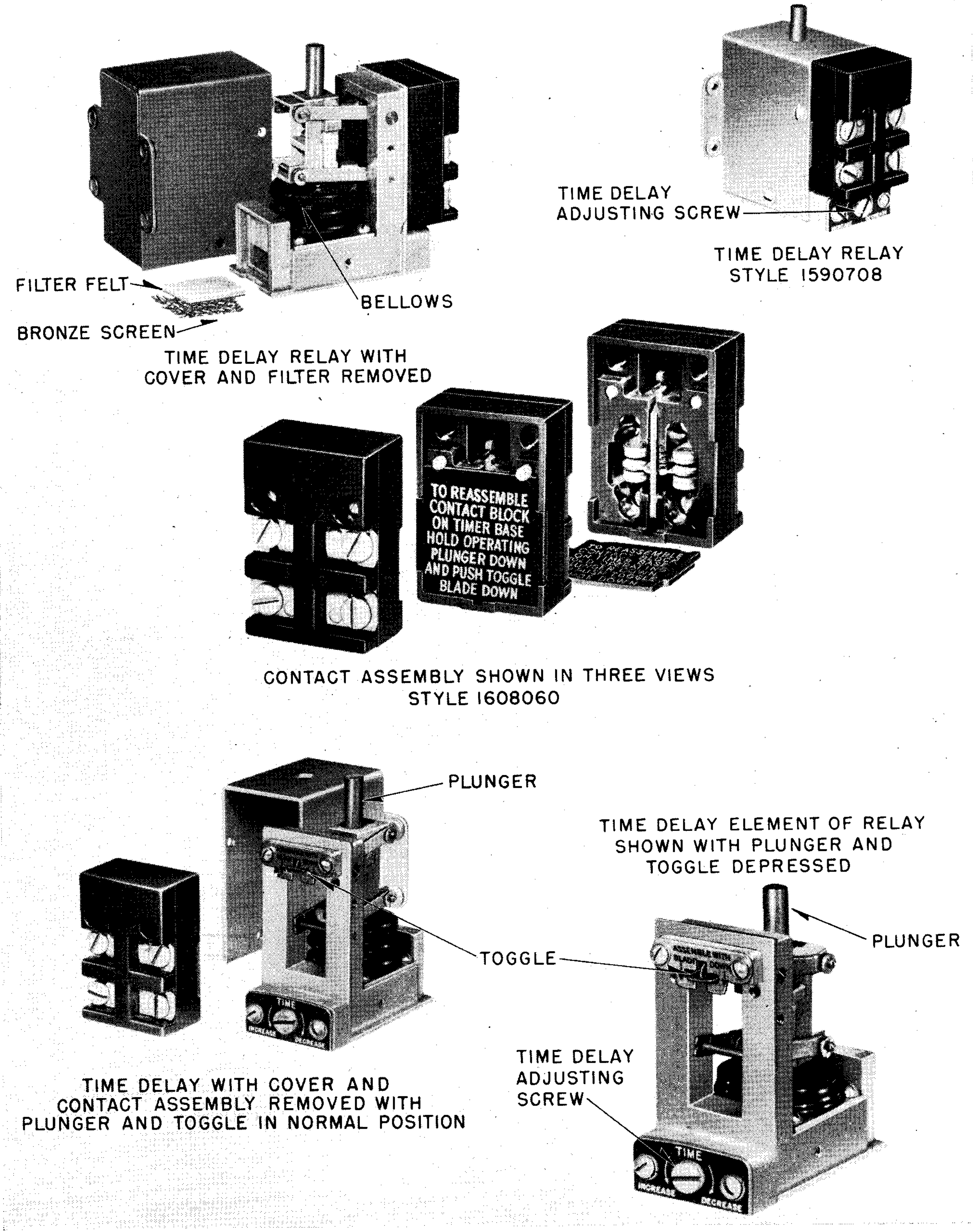

FIG. 4. Various Views of "DynAC Brake" Time Delay Relay and Contact Assembly

MAINTENANCE

The contacts of the time delay relay should be checked for cleanliness and future life at regular maintenance periods. It is recommended that this be done each time the selector contacts of the tap changer are inspected. This inspection may be accomplished by removal of the two mounting screws which fasten the contact assembly to the time delay mechanism. The plunger and toggle must be depressed when the contact assembly is being replaced (Fig. 4).

In extremely dusty locations the time delay mechanism should be removed from its case by the removal of the four screws, two on each side of the case, and the case thoroughly cleaned. The bronze screen should be removed from the recess and the filter felt cleaned with carbon tetrachloride prior to assembly (Fig. 4).

RENEWAL PARTS

The following renewal parts are available from the Sharon Works, Westinghouse Electric Corporation, through the nearest Westinghouse Sales Office:

Complete Solenoid Operated Time
Delay Relay (110 Volt Coil). . S# 1590 746 (Fig. 7)
Time Delay Unit. . . . . S# 1590 708 (Fig. 4)
Contact Assembly. . . . . S# 1608 060 (Fig. 4)
Resistor. S# 1590 776 (Fig. 5)

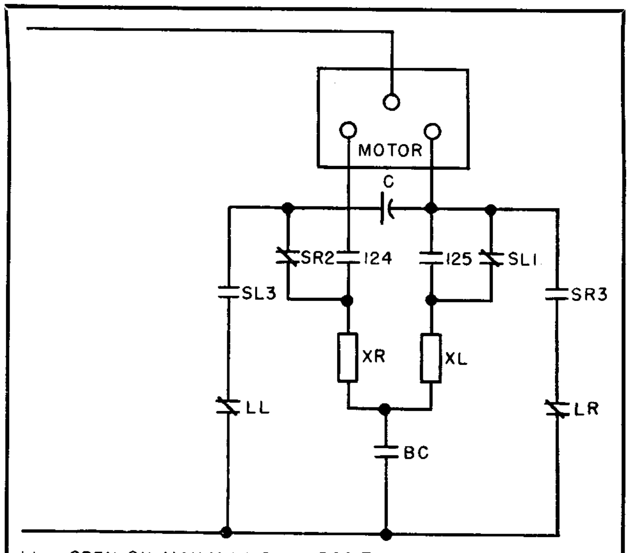

FIG. 6. Schematic Diagram of "DynAC Brake" Connections

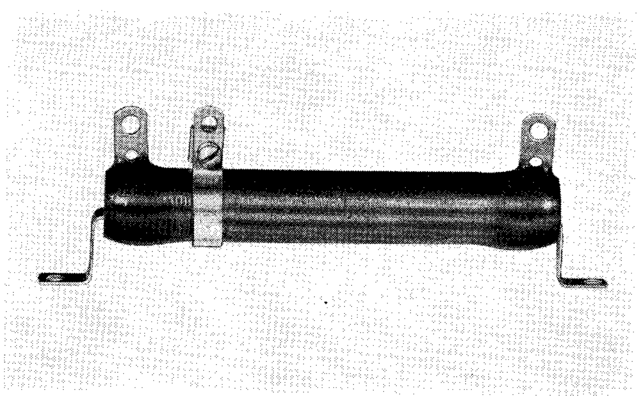

FIG. 5. Resistor S# 1590 776

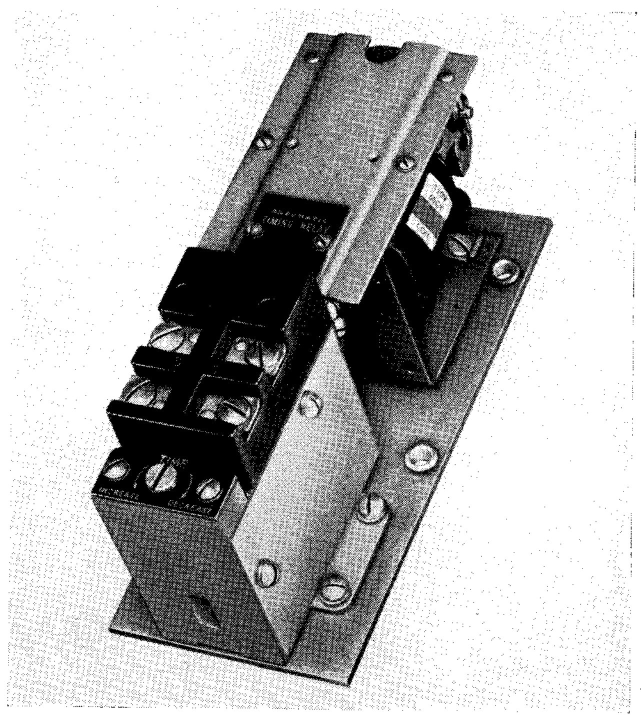

FIG. 7. Complete Solenoid Operated Time Delay (110 Volt Coil) S# 1590 746

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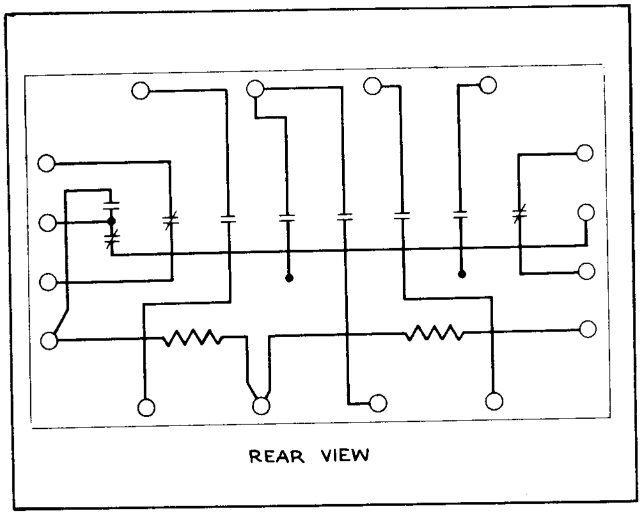

Fig. 1—Internal Schematic of S#1274697 Type SG Relay in the Projection Case.

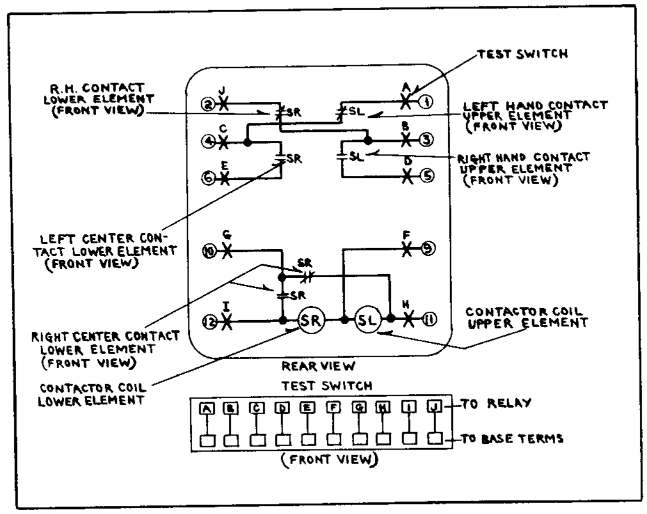

Fig. 2—Internal Schematic of S#1339369 A Type SG Relay in the Type FT Case.

which fits over the front of the case with the switches closed. The chassis is a frame that houses the relay elements and supports 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.

Removing Chassis

To remove the chassis, first remove the cover by unscrewing the captive nuts at the corners. This exposes the relay elements and all the test switches for inspection and testing. The next step is to open the test switches.

The order of opening the switches is not important. In opening the test switches they should be moved all the way back against the stops. With all the switches fully opened, grasp the two cam action latch arms and pull outward. This releases the chassis from the case. Using the latch arms as handles, pull the chassis out of the case. The chassis can be set on a test bench in a normal upright position as well as on its top, back or sides 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. When the chassis is to be put back in the case, the above procedure is to be followed in the reversed order.

Electrical Circuits

Each terminal in the base connects thru a test switch to the relay elements in the chassis as shown on the internal schematic diagram. The relay terminal is identified by numbers marked on both the inside and outside of the base. The test switch positions are identified by letters marked on the top and bottom surface of the moulded blocks. These letters can be seen when the chassis is removed from the case.

The potential and control circuits thru the relay are disconnected from the external circuit by opening the associated test switches.

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

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

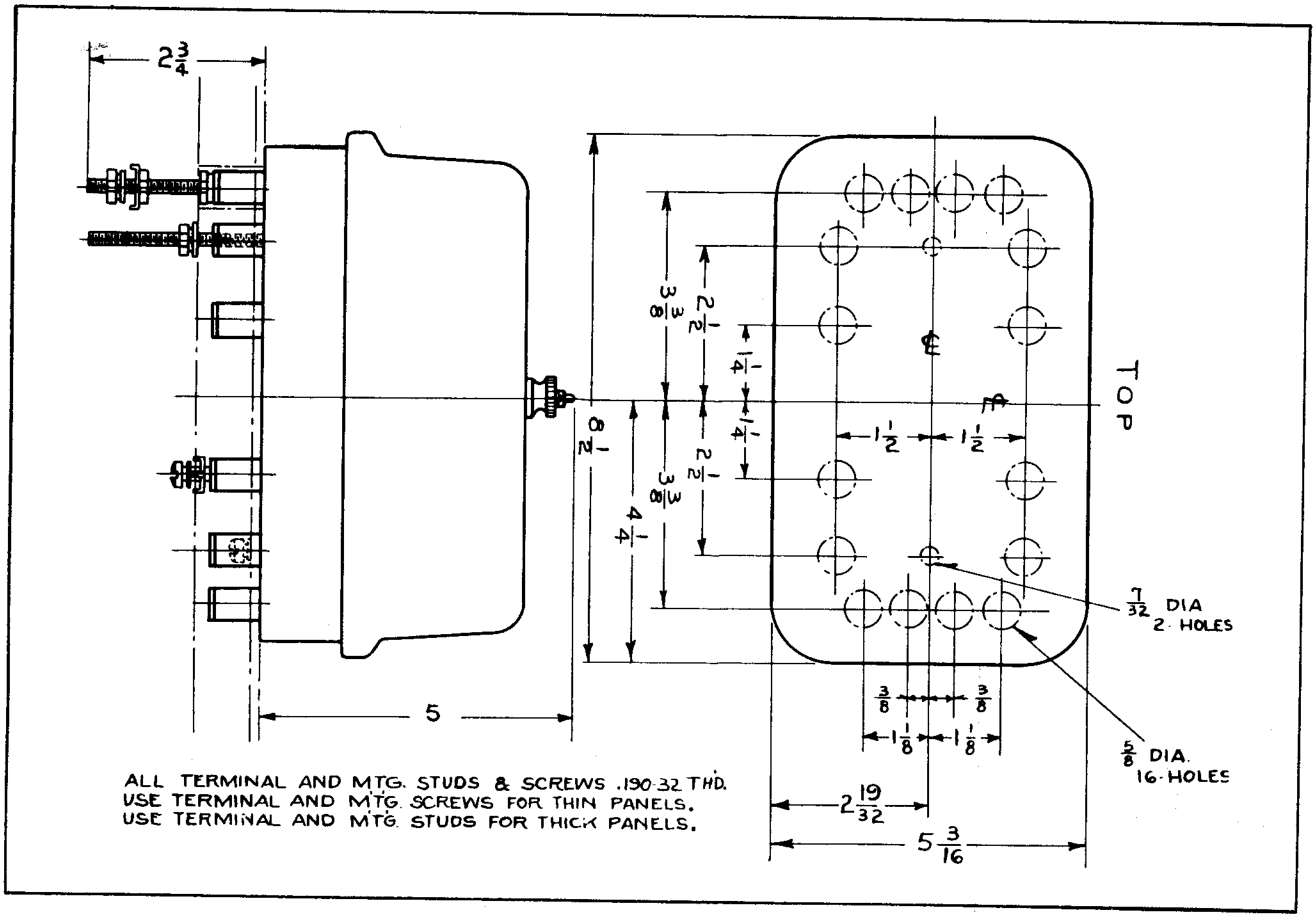

Fig. 3—Outline & Drilling Plan for the Projection Case. For Reference Only.

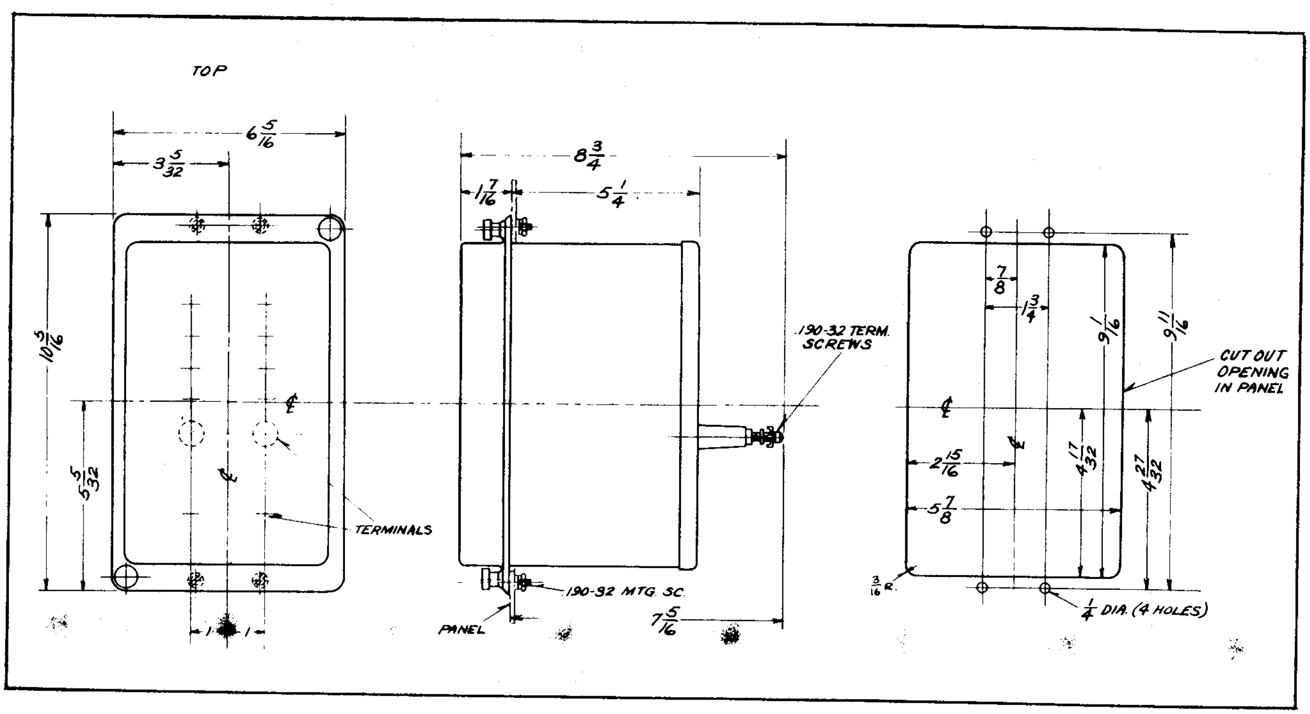

Fig. 4—Outline & Drilling Plan for the S10 Semi-flush Type FT Case. For Reference Only.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE TH THERMAL TIMING RELAY

CAUTION Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

APPLICATION

The type TH thermal timing relay is a simple and rugged time delay device devoloped expressly to meet the requirements of Westinghouse tap-changing-under-load equipment, where reliability of operation and freedom from maintenance are items of major importance. The relay also may be used in other applications where its characteristics are suitable. As adjusted at the factory, the time delay on a recycling basis can be varied from approximately 15 seconds with the control knob set on the MIN dial position, to approximately 60 seconds with the knob on the MAX position, with 120 volts applied to the relay. A 105 to 135 volt variation of applied voltage has negligible effect on the relay timing when the control knob is set on the MIN position. When set on the MAX position, the effect of voltage variation is more noticeable, but the relay timing is still within the calibration limits. The standard relay is designed for use on a 120 volt 60 cycle circuit. Special relays can be supplied for certain other voltages and frequencies if required.

Two timing elements are required in the control of a tap-changing equipment. The type TH relay is available both with a single timing element in a projection mounted case (Fig.1), and as a duplex timing relay containing two timing elements in an 8 terminal Flexitest case (Fig.4).

The complete operating cycle of the relay is composed of two parts; (1) the time required for the bimetal actuating system to deflect under the influence of heat and operate a micro switch, and (2) the time required for the bimetal system to cool until the micro switch resets. The mechanical construction of the relay is rugged, simple and reliable, with a minimum number of moving parts. The entire assembly is enclosed in a dust-proof case and after installation will require only a routine inspection to keep it in operating condition.

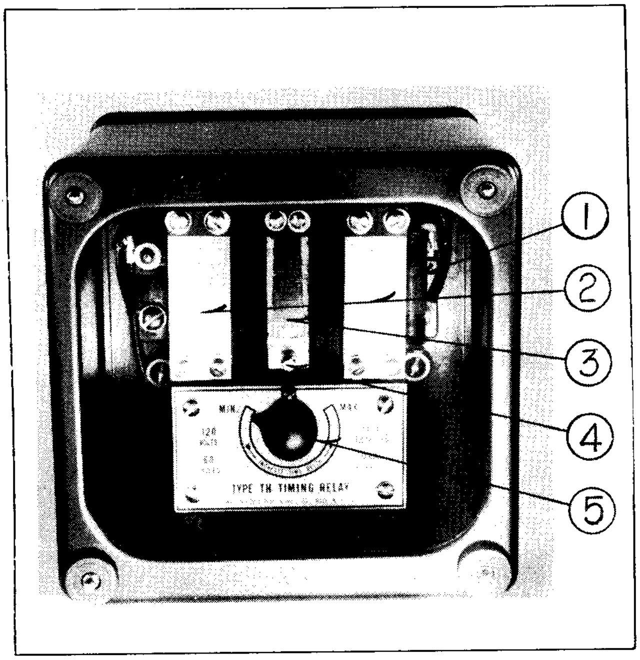

Fig. 1—Type TH Single-Element Thermal Timing Relay. 1—Resistor, 2—Side Bimetal Strips, 3—Heater Coil and Center Bimetal Strip, 4—"F" Bimetal Screw, 5—"T" Timing Screw.

CAUTION The relay is designed specifically for application on Westinghouse regulators and tap-changing-under-load equipment and when so used should give a minimum of well over a million operations. If used otherwise, the effect of possible higher current in the controlled circuit upon the life of the relay should be considered.

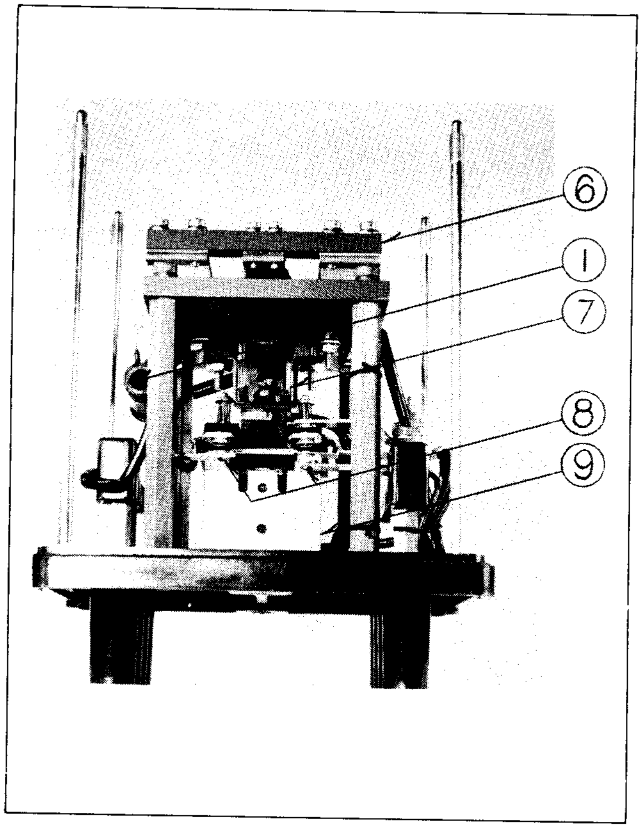

Fig. 2—Top Views of the Type TH Single-Element Thermal Timing Relay. 1—Resistor, 6—Bimetal Assembly, 7—Micro Switch, 8—Contacts, 9—Auxiliary Contactor.

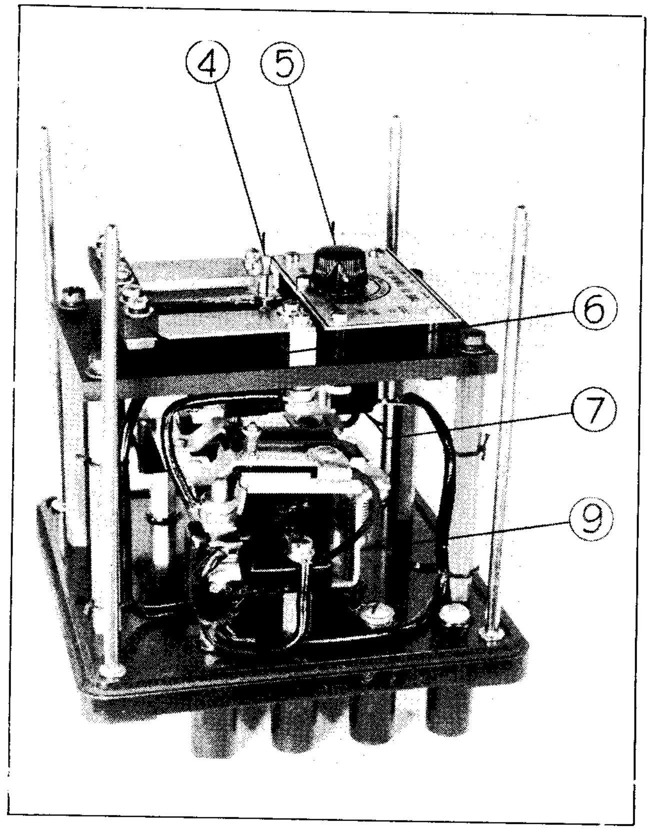

Fig. 3—Side View of the Type TH Single-Element Thermal Timing Relay. 4—"F" Bimetal Screw, 5—"T" Timing Screw, 6—Bimetal Assembly, 7—Micro Switch, 9—Auxiliary Contactor.

CONSTRUCTION

The type TH relay consists essentially of three elements: (1) a bimetal actuating system, (2) a micro switch operated by the pressure exerted by the bimetal system, and (3) an auxiliary magnetic contactor.

The Bimetal System

The bimetal system of the single-element relay consists of three elements mounted in the front part of the relay, directly behind the glass cover of the case. The center strip is equipped with a heater coil and represents the actuating element of the relay. On heating, this strip bends and exerts a pressure on the operating plunger of the micro switch. The two side bimetal strips eliminate the effect of ambient temperature on the relay operation. The moving end of the center bimetal is equipped with a self-locking adjusting screw. The position of this screw is properly adjusted before the relay is shipped from the factory and should not require any readjustment in the field. The duplex relay has a bimetal system consisting of four bimetal strips. The two inside strips are equipped with heater coils and actuate separate micro switches, while the two outside strips provide compensation for ambient temperature changes. The heater coils are never energized simultaneously by the tap changer control, and the two timing elements have a negligible effect on each other.

The Micro Switch

The micro switches are mounted on the rear of a Micarta panel and in front of the magnetic contactor. The micro switch is a snap action single-pole double-throw switch, operated by the pressure exerted by the bimetal assembly. The normally-open contact is fixed

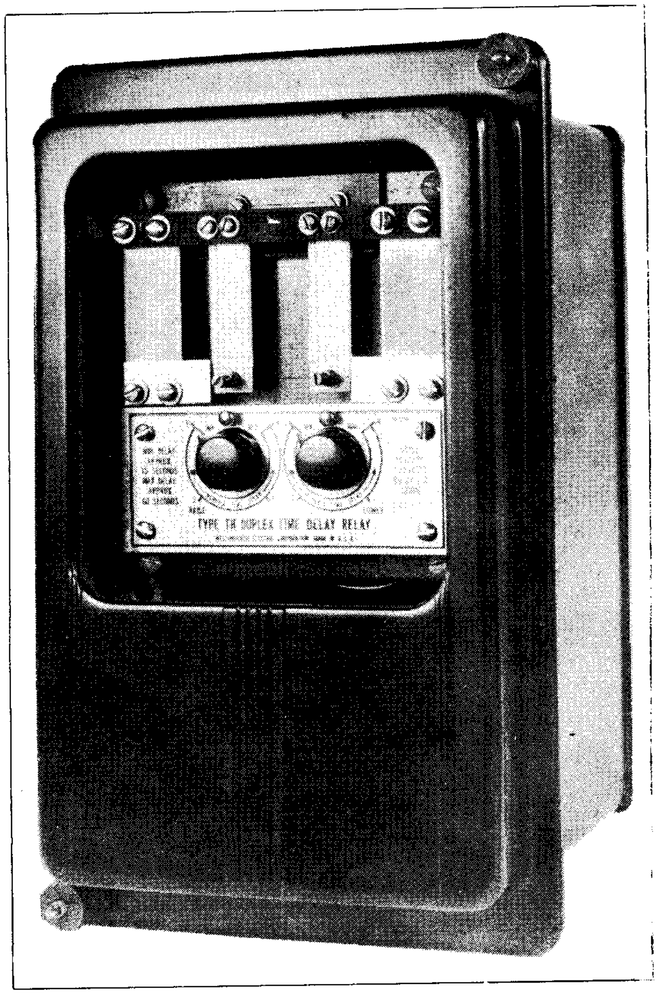

Fig. 4—The Type TH Duplex Thermal Timing Relay.

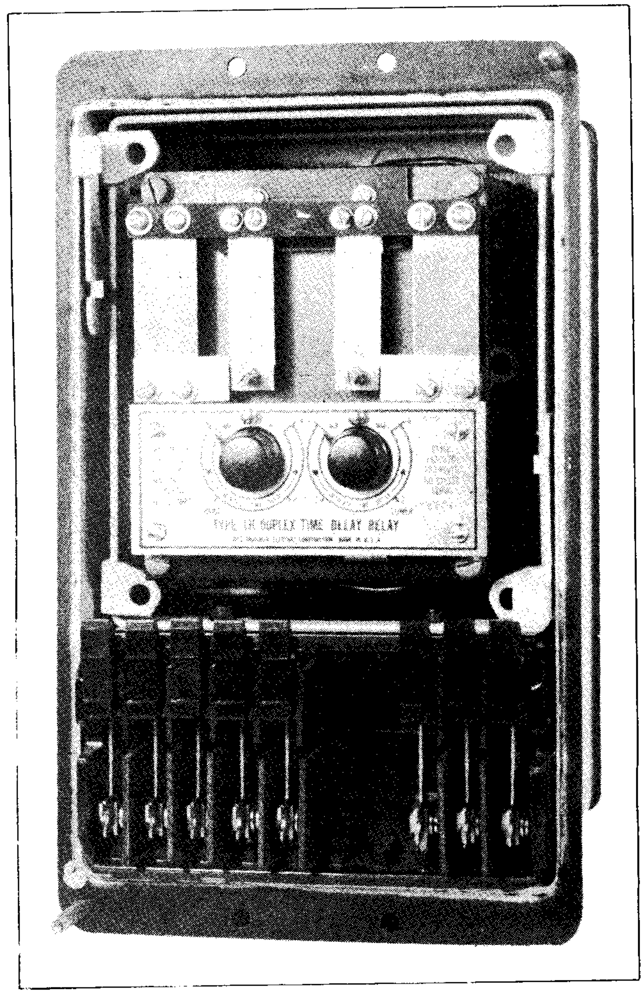

Fig. 5—The Type TH Duplex Thermal Timing Relay With Cover Removed, Showing Test Switches.

while the normally-closed contact is movable, thus providing for adjustment of the relay timing cycle. The normally-closed contact is mounted on the end of the timing screw which extends forward through a bushing in the Micarta panel and has an adjusting knob on its front end. Variation of timing is obtained by turning the knob to the required position as determined by the indication of the pointer on the dial.

The Auxiliary Contactor

The auxiliary contactor of the single-element relay is mounted on the relay base behind the micro switch. It carries the necessary contacts to enable the utilization of both the heating and cooling periods for timing. The two contactors of the duplex relay are similarly mounted on the relay sub-base.

OPERATION

The circuit controlled by the single-element relay is included between terminals 3 and 8 as shown in Fig. 7. This circuit is opened at contact A-3 when the relay is de-energized. The relay is energized by placing voltage on terminals 3 and 6, thus initiating the bimetal heating period. When the bimetal temperature rise reaches a pre-determined value, the micro switch operates, opening the circuit between terminal 3 and contact A-3 and closing the circuit through the coil of the auxiliary contactor. Operation of the latter closes contacts A-11, A-12, and A-3, and opens contact A-2, which discontinues the heating of the bimetal. When the bimetal has cooled to a predetermined temperature rise above ambient, the micro switch returns to its original position,

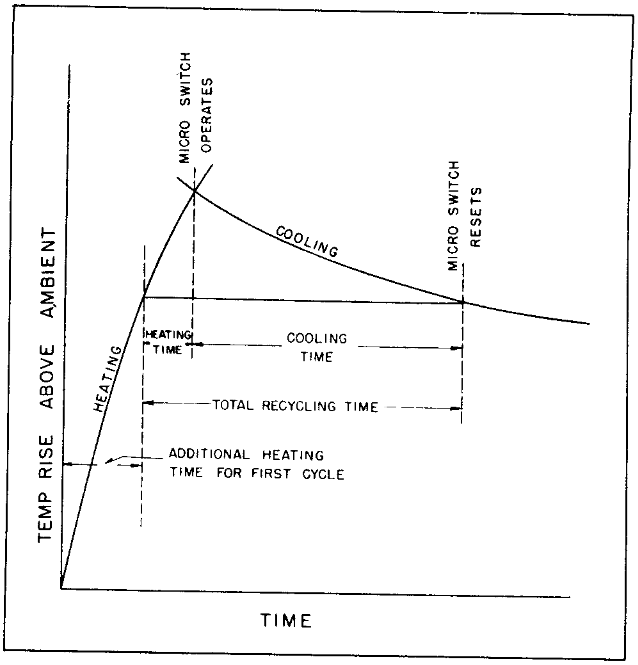

Fig. 6—The Time-Temperature Characteristic of the Type TH Relay.

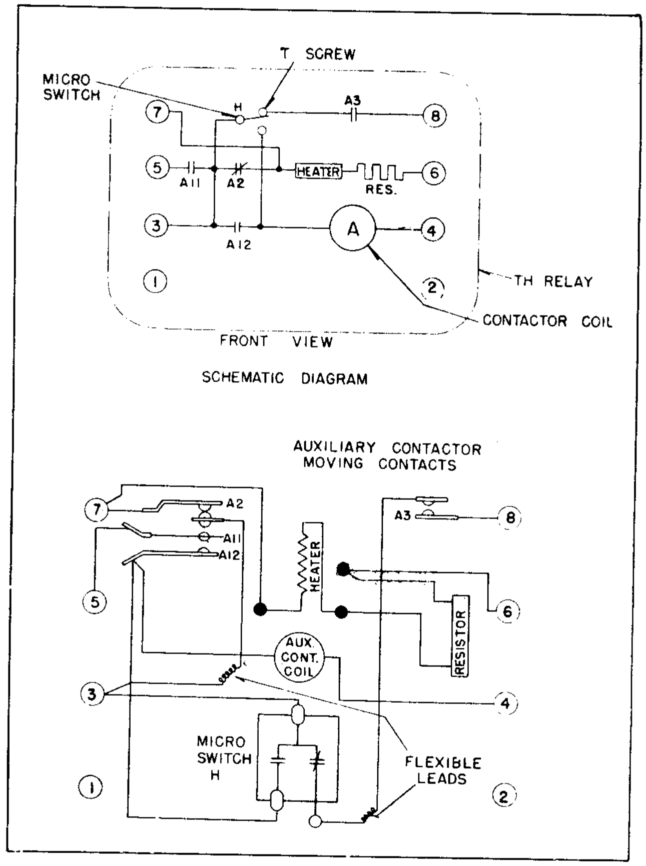

Fig. 7—Schematic and Wiring Diagrams of the Type TH Single-Element Relay.

thus closing the circuit between terminals 3 and 8. The relay is reset by de-energizing the coil, of the auxiliary contactor.

The controlled circuits of the duplex relay are between terminals 1 and 3, and between 2 and 4 (Fig. 8). The duplex relay does not have contacts corresponding to contact **A**-11 of the single-element relay.

RELAYS IN TYPE FT CASE

The type TH duplex timing relay is supplied in the S size FT case. The type FT cases are dust-proof enclosures combining relay elements 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 welded steel housing containing the hinge half of the knife-blade test switches and the terminals for external connections. The cover is a drawn steel frame with a clear window which fits over the front of the case with the switches closed. The chassis is a 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.

Removing Chassis

To remove the chassis, first remove the cover by unscrewing the captive nuts at the two corners. This exposes the relay elements 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, grasp the two cam action latch arms and pull outward. This releases the chassis from the case. Using the latch arms as handles, pull the chassis out of the case. The chassis can be set on a test bench in a normal upright position as well as on its top, back or sides 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.

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

Electrical Circuits

Each terminal in the base connects thru a test switch to the relay elements in the chassis as shown on the internal schematic diagrams. The relay terminal is identified by numbers marked on both the inside and outside of the base. The test switch positions are identified by letters marked on the top and bottom surface of the moulded blocks. These letters can be seen when the chassis is removed from the case.

The potential and control circuits thru the relay are disconnected from the external circuit by opening the associated test switches.

A cover operated switch can be supplied with its contacts wired in series with the trip circuit. This switch opens the trip circuit when the cover is removed. This switch can be added to the existing type FT cases at any time.

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

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 can be inserted in the contact jaws. This connects the relay elements to a set of binding posts and com-

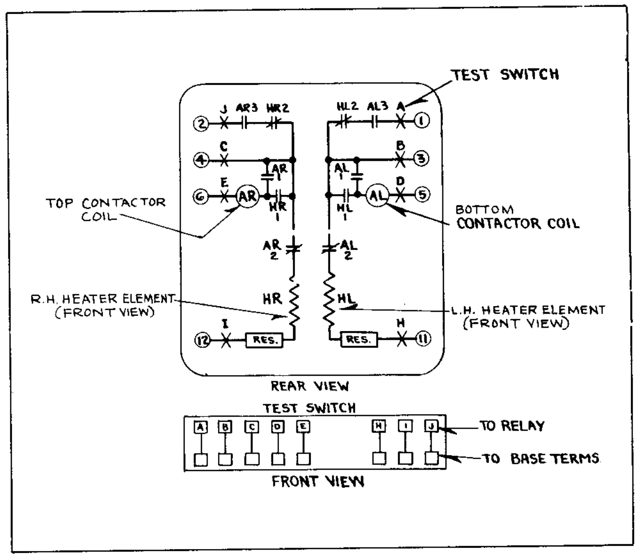

Fig. 8—Schematic Diagram of Type TH Duplex Relay.

pletely 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 posts down.

The external test circuits may be made to the relay elements by #2 test clip leads instead of the test plug.

Testing Out of Case

With the chassis removed from the base, relay elements may be tested by using the ten circuit test plug or by #2 test clip leads as described above. The factory calibration is made with the chassis in the case and removing the chassis from the case will change the calibration values of some relays by a small percentage. It is recommended that the relay be checked in position as a final check on calibration.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the two mounting studs. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony-asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

ADJUSTMENTS AND 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. If the adjustments have been changed, the relay taken apart for repairs, or it it is desired to check the adjustments at regular maintenance periods, the instructions below should be followed:

All contacts should be periodically cleaned with a fine file. S#1002110 file is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

All moving contacts of the duplex relay, and the RH moving contact of the single-element relay, should deflect 3/64" when the armature is closed. The inner end of the terminal strip for the LH make contact of the single-element relay should just touch the contact back-up spring when the armature is open. Both the moving and the stationary LH make contacts will deflect when the armature closes and the moving contact deflection should be approximately 1/32". Sufficient contact deflection is important, both to provide good electrical circuits and to avoid any possibility of having residual magnetism hold the armature closed when de-energized, after the plating has been worn from the pole faces by numerous operations. The contact gaps should be 1/8" to 5/32" (sum of both gaps on LH side of single-element relay) and the outward travel of the armature should be limited by the back stationary contact and not by the tongue of the yoke which projects through the opening in the armature between the hinge points.

If the adjustment of the timing screw or the bimetals is disturbed, the instructions below may be used as a guide in restoring the normal adjustment of the relay. If only the bimetal assembly requires replacement, no re-adjustment should be necessary in the timing dial but only in the adjusting screws at the movable end of the center bimetal. Should the timing screw assembly be replaced, the only adjustment required should be in the timing screw, none in the bimetal system. But if the micro switch is replaced, both the timing screw and the bimetal screw will have to be readjusted.

1. Equipment Required

   a) A source of 120 volt, 60 cycle power.

   b) A high impedance circuit tester. An ohm meter or a neon glow lamp connected as a circuit indicator is recommended.

WARNING: - If any appreciable current is passed through the micro switch contact during adjustment, the switch contacts may be damaged.

2. To Adjust Timing Screw "T"

   a) Connect circuit tester in series with power source and apply to terminals 3 and 4 of the single-element relay, or terminals 3 and 5 or 4 and 6 of the duplex relay.

   b) Check operation of micro switch by pressing bimetal screw "F". The micro switch should close the circuit and operate the indicator. When "F" screw is released, micro switch should open indicator circuit.

   c) Remove knob from timing screw "T". Turn screw clockwise until circuit indicator shows that micro switch normally-open contacts are just barely closed. From this position turn screw counter-clockwise slightly over one-eighth (1/8) turn. This is the approximate MIN setting. Replace knob on screw shaft with pointer at MIN position and tighten set screw.

d) Recheck micro switch operation.

3. To Adjust Bimetal Screw "F"

a) Follow instructions given in section 2-a and 2-b.

b) Turn screw "F" clockwise until circuit indicator shows that micro switch normally-open contacts just barely stay closed when "F" screw is pressed down and then released. From this position, turn screw counter-clockwise one and one-quarter (1-1/4) complete turns. The center bimetal strip must be at the same temperature as the side strips during this adjustment.

4. To Check Timing Adjustment

(Note: Contact designations and terminal numbers in the following paragraphs apply to the single-element relay. Refer to Figs. 7 and 8 and make corresponding connections when checking the duplex relay).

a) Place a short-circuiting jumper across contact A-3. Insulate contact A-12 with a piece of stiff paper. Place cover on relay.

b) Connect circuit indicator as follows: If ohm-meter is used, connect between terminals 3 and 8: if glow lamp circuit tester is used, connect between terminals 4 and 8 of relay. Place a test jumper between terminals 4 and 6 and connect 120 volt, 60 cycle power source to terminals 3 and 6.

c) Timing cycle will begin when supply voltage is turned on. The heating portion of the cycle will be complete when the indicator shows that its circuit has been opened.

d) Note that the first cycle will take longer time than subsequent cycles, due to the additional time required for the bimetal temperature rise and resultant deflection to reach the point at which the micro switch resets. This is shown diagramatically in Fig. 4. Adjustment should not be made on the basis of the first cycle but on the average of several subsequent cycles following immediately after the first. All times referred to in this leaflet are "re-cycling" time defined as the average time consumed by a complete cycle consecutively following the first cycle.

e) When properly adjusted the time of one complete re-cycling operation should be between 11 and 16-1/2 seconds with pointer on "T" set at MIN, and between 54 and 69 seconds with pointer set at MAX. Individual readings should not vary more than approximately 2 seconds at MIN or 3 seconds at MAX. If the re-cycling times for these two positions of the knob are both high or both low, correction may be made by changing the position of the knob on screw "T".

f) If adjustment of "F" screw has been made closer adjustment may be affected when necessary by turning screw "F" in 1/16 revolution steps. Clockwise rotation will increase re-cycling time; counter-clockwise rotation will decrease time.

IMPORTANT: Readjustment should not be made on either element unless its factory adjustment has been disturbed.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete name-plate data.

ENERGY REQUIREMENTS

At 120 volts, 60 cycles, the contactor element burden is 11 voltamperes at approximately 50% power-factor. The heater circuit burden is 18 watts.

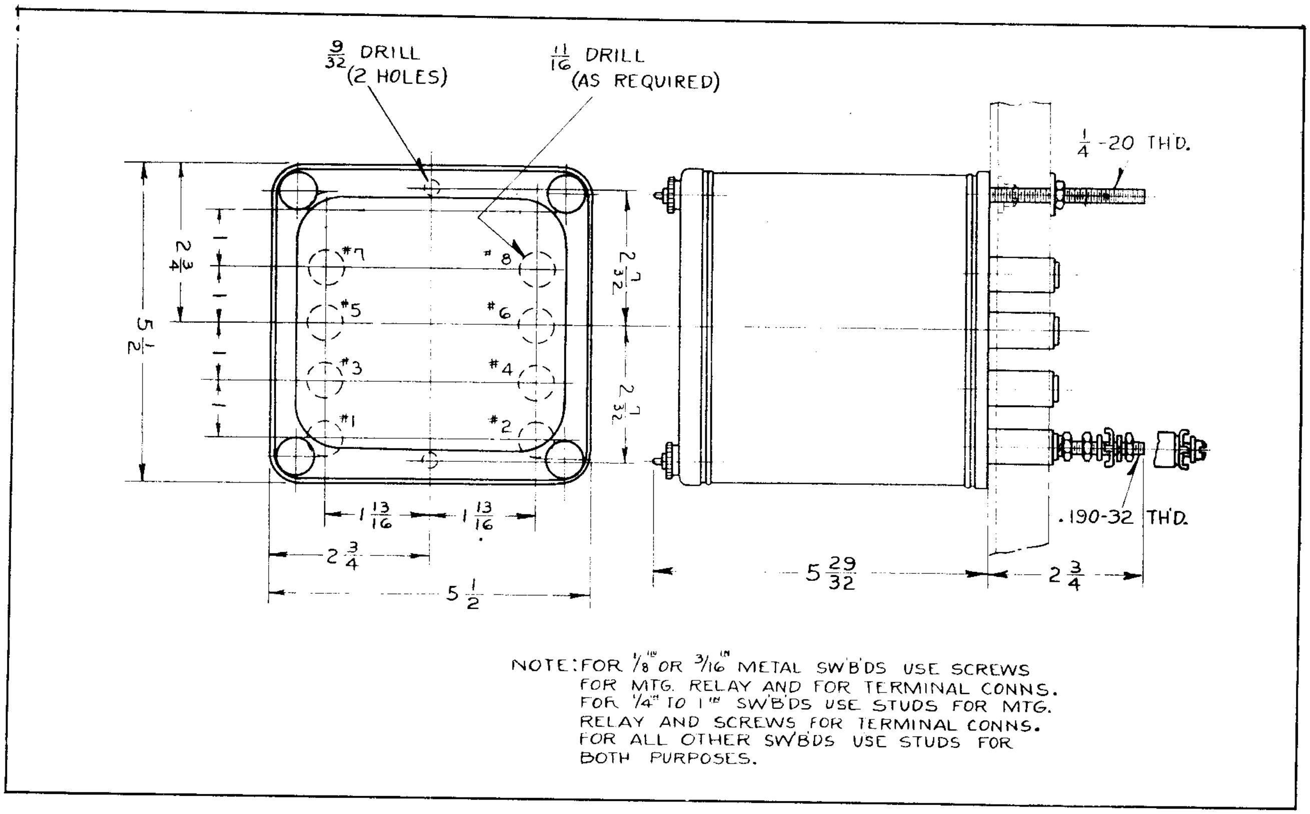

Fig. 9—Outline and Drilling Plan for the Type TH Single-Element Relay.

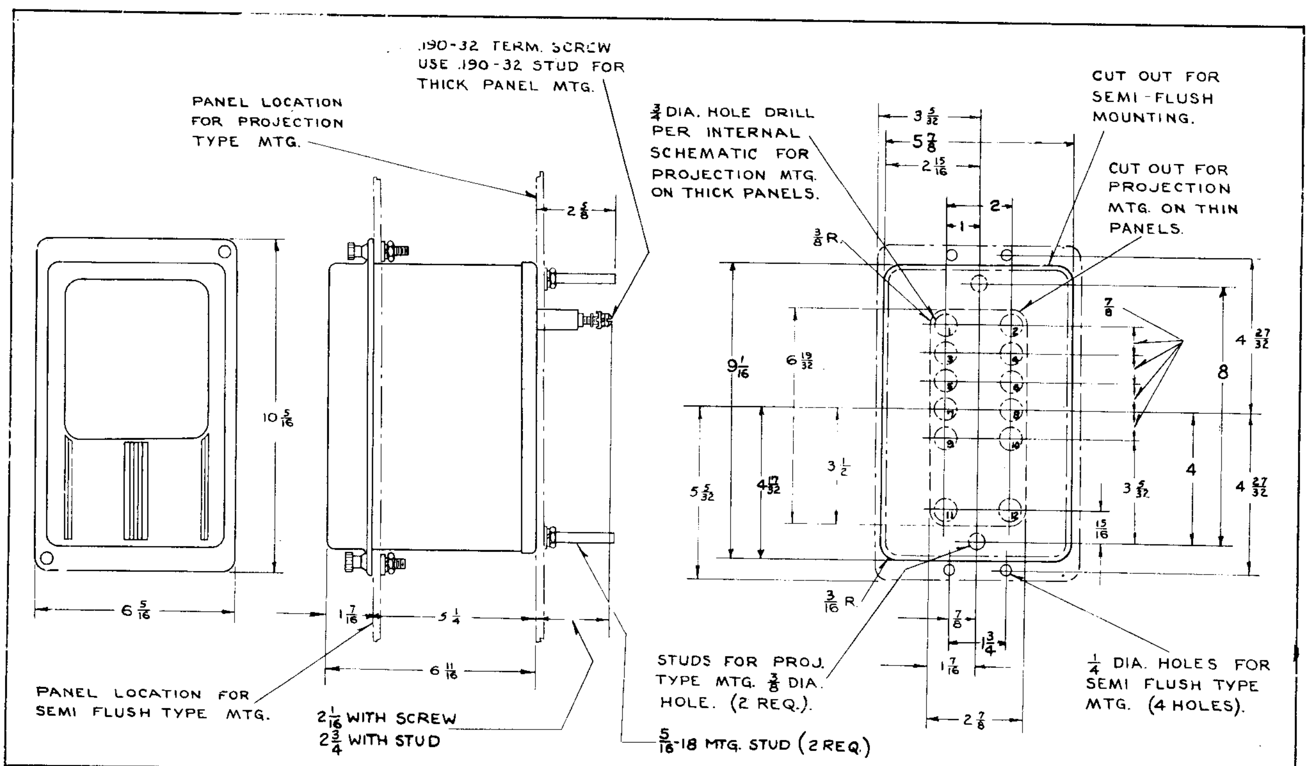

Fig. 10—Outline and Drilling Plan for the Type TH Duplex Relay. See Internal Schematic for the Terminals Supplied. For Reference Only.

HANDLING • INSPECTION • MAINTENANCE

INSTRUCTIONS

WEMCO C

INSULATING OIL

P. D. S. 2772

for

Electrical Apparatus

WESTINGHOUSE ELECTRIC CORPORATION

SHARON PLANT
SHARON, PA.

EAST PITTSBURGH PLANT
EAST PITTSBURGH, PA.

SUPERSEDES I. B. 65-000-1

EFFECTIVE JUNE, 1947
(Rep. 1-52)

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WEMCO C INSULATING OIL

P. D. S. 2772

Wemco C insulating oil is a development of the Westinghouse Electric Corporation in cooperation with oil refiners. It has proven its suitability for use in all Westinghouse oil-insulated apparatus. In order to insure the proper performance of the apparatus, only Wemco C oil should be used.

This publication gives the instructions for handling, inspection and maintenance which experience has shown are important in obtaining the best service from the insulating oil.

PART ONE

RECEIVING, STORING AND HANDLING

SHIPMENT

Wemco C oil is shipped in tank cars, drums or cans. The modern tank cars are usually lagged to prevent rapid fluctuations in temperature during transit and thus reduce the amount of expansion and contraction of oil. Changes in the volume of the oil due to temperature changes tend to cause breathing in of moist air resulting in condensation of moisture inside the tank, and lowering of the dielectric strength of the oil.

The oil and the drums are both heated above room temperature while the drums are being filled, and the bungs are tightened immediately after filling. After cooling to normal temperature, the bungs are again tightened. The drums are provided with screw bungs having gaskets to prevent admission of water.

The cans are of metal. The cans as well as the oil are heated above room temperature while being filled and are hermetically sealed immediately after filling.

STORING

Drums. As soon as a drum of oil has been unloaded the bung should be examined and tightened if it is loose. It is possible for bungs to become loosened by change in temperature or rough handling in transit.

It is very desirable that oil in drums be stored in a closed room. Outdoor storage of oil is always hazardous and should be avoided if at all possible. If it is necessary to store oil outside, protection against direct precipitation of rain and snow should be provided. Drums stored outdoors should be placed on timbers so as to be clear of the ground. They should always be placed on their sides, with bungs approximately 45 degrees from the bottom. *Drums should never be turned up on end.* It is desirable to cover them with a tarpaulin.

Cans. Cans containing oil must not be exposed to the weather. Seals should be kept intact until the oil is actually needed. It is not necessary to make dielectric tests on oil in sealed cans.

Screw caps are provided on the cans to use when the oil is only partially removed after hermetic seal has been broken. By replacing the screw caps, contamination by moisture and dirt will be retarded.

Storage Tank. The storage tank should be mounted on piers so that it will not touch the ground, and will be accessible to all points for inspection for leakage.

It is desirable to maintain the temperature of the oil and tank a little above the temperature of the surrounding air as this prevents condensation of moisture in the tank which would affect the dielectric strength of the oil.

The tank should preferably have a convex bottom, allowing the installation of a drain cock at the lowest point for removing any free water or dirt which might settle out. When a cylindrical tank is installed with its axis horizontal, one end should be a little lower than the other, with a drain cock at the lowest point, and the oil supply pipe should enter at the opposite end of the tank. The oil may enter and leave the tank by the same pipe, but this should be at some distance from the bottom to prevent stirring up any settlings when the tank is being filled. It is desirable that the pipe be provided with a swing joint and float, so that it will automatically move with the change in oil level and remain near the surface of the oil.

FIRE PROTECTION

Important: While the Wemco C oil furnished with circuit breakers and transformers will not take fire unless brought to a very high temperature, it should be remembered that under abnormal conditions such a temperature can be reached, so that proper precaution against fire should be taken. Suitable means should always be provided for drawing off oil from storage tanks and extinguishing fire. The best way to extinguish burning oil is to smother the flames so that the supply of fresh air is cut off. Chemical fire extinguishers are effective, but water should not be used unless it is applied by a special atomizing spray nozzle.

HANDLING

Note: The oil should be sampled and tested, except when received in cans, before being transferred from the container to the apparatus, particularly in cases where the wire lock-seal has been broken. In cases where the apparatus is received with the oil installed, the oil should be sampled and tested before the apparatus is put into service, as described later in this book.

When putting a new circuit breaker or transformer into service, see that the tank is free from moisture and foreign material.

When carbonized oil is removed from a circuit breaker or transformer in service, thoroughly clean the interior of the apparatus so that the new oil will not be contaminated. This may be done by flushing with clean insulating oil and wiping with clean, dry, lint-free cotton cloths. Cotton waste is undesirable because of the lint which may be introduced into the oil.

Although the drums and tank cars are thoroughly washed and dried at the refinery before filling, a certain amount of scale is sometimes loosened from the inside in transit. Therefore, oil which has not been filtered should be strained through two or more thicknesses of muslin, or other closely woven cotton cloth which has been thoroughly washed and dried to remove the sizing. The straining cloths may be stretched across a funnel of large size and should be renewed at frequent intervals.

Important: Extreme precautions must be taken to insure the absolute dryness and cleanliness of the apparatus before filling it with oil, and to prevent the entrance of water and dirt during the transfer of the oil to the apparatus.

The preparation and filling of outdoor apparatus should preferably be done on a clear, dry day; if this is not practicable, protection against moisture must be provided.

All vessels used for transferring the oil should be carefully inspected to see that they are absolutely dry and free from dirt.

Important: Always use a metal or oil proof hose when handling the oil. A hose made of natural rubber should not be used. Oil can easily become contaminated from the sulphur in the natural rubber, and should not be allowed to come in contact with it.

When it is necessary to transfer oil from warm surroundings to apparatus exposed to extremely cold weather, even when the dielectric strength at room temperature is high, it is desirable to circulate the oil through a blotter press or centrifuge at room temperature. A similar procedure is also advisable in the case of apparatus erected inside and later exposed to cold weather; the reason being that oil will dissolve more water at higher temperatures which will be thrown out of solution at lower temperatures. The excess will appear in suspension in the oil and will lower the dielectric strength.

A drum of cold oil when taken into a warm room will "sweat", and the resulting moisture on the surface may mix with the oil as it flows from the drum. Before breaking the seal the drum should therefore be allowed to stand long enough to reach room temperature, which may require eight hours, or even longer under extreme temperature conditions.

Cleaning Contaminated Drums. The cleaning of drums which have contained used insulating oil requires great care in order to insure a thoroughly clean drum. It is preferable to return such drums to the refinery where adequate cleaning facilities are available, rather than to attempt to clean them. If it is necessary to clean such drums, the following procedure is recommended:

Rinse the drum thoroughly with gasoline or benzine, using about one gallon each time, until the solvent shows no discoloration after using. Allow it to drain, then pump out the last traces of solvent with a vacuum pump, using a brass pipe flattened at the lower end to explore the corners of the drum.

Caution: Do not use a steel pipe because of the danger of a spark igniting the vapor.

Heat the drum with bunghole down, in a ventilated oven at a temperature of at least 88°C (190°F- for sixteen hours. Screw the bung on tightly before removing drum from the oven. Use a new washer with the bung to insure a tight seal. A simple oven for this purpose may be made from sheet metal and heated with steam or an electric heater.

Caution: An open flame must always be kept away from the oven to prevent igniting inflammable gases.

Refilling Drums. The practice of refilling drums with oil is undesirable and should be avoided whenever possible, for unless the utmost precautions are taken, the oil is likely to become contaminated.

If it is necessary to refill them for storage, drums which have been used only for oil in good condition should be reserved for this purpose. They should be closed immediately after being emptied, to exclude dirt and water. After refilling, they should be examined to see that they do not leak.

Whenever a drum is to be filled with oil, the temperature of the drum and of the oil should be at least 5.5°C (10°F) higher than the air, but the temperature of the drum need not be the same as that of the oil.

A new washer should be used with the bung each time the drum is refilled, to insure a tight seal. These washers may be obtained from the oil refineries and it is recommended that a supply be kept on hand. Natural rubber composition washers should never be used as they would be attacked by the oil.

Drums to be refilled with oil for storage should be plainly marked with paint for identification.

PART TWO

SAMPLING AND INSPECTION

REQUIREMENTS FOR INSULATING OIL

The requirements for good insulating oil used in transformers are not inconsistent with the requirements for oil used in circuit breakers. Wemco C oil is particularly well suited for both applications and for either indoor or outdoor service. In transformers the oil provides an electrical insulating medium which also will carry the heat away from the windings. In circuit breakers, the oil serves primarily as an electrical insulating medium which interrupts the arc when the circuit breaker operates. Wemco C oil meets these requirements:

1. High dielectric strength.

2. Freedom from inorganic acid, alkali and corrosive sulphur (to prevent injury to insulation and conductors).

3. Low viscosity (to provide good heat transfer in transformers; in circuit-breakers, to aid in dissipating the products formed by the arc when the circuit is interrupted).

4. Good resistance to emulsification (so that any moisture entering the apparatus, or carbon formed by arcing in the circuit-breaker, will settle to the bottom of the tank; water in suspension is a menace to safe operation).

5. Freedom from sludging under normal conditions.

6. Low pour point.

7. Low specific gravity.

CAUSES OF DETERIORATION OF OIL

Transformers. The principal causes of deterioration of insulating oil in transformers are:

1. Presence of water.

2. Oxidation.

Condensation from moist air due to breathing of the transformer, especially when the transformer is not continuously in service, may injure oil. (The moist air drawn into the transformer condenses moisture on the surface of the oil and inside of the tank.) The oil may also be contaminated with water through leakage such as from leaky cooling coils or covers.

Sludge is an oxidation product, the amount formed in a given oil being dependent upon the temperature and the time of exposure of the oil to the air. By careful refining, the components of oil which are most readily oxidized to form sludge can be removed, so as to provide an insulating oil which will not sludge under normal operating conditions.

Note: Excessive temperatures may cause sludging of any transformer oil regardless of how well it is refined.

Transformer oil which has begun to sludge will continue to do so after it has been reconditioned by means of the centrifuge or filter press, as these methods of reconditioning do not remove the deterioration products which are in process of formation but have not yet been precipitated as sludge. Proven and accepted methods are not yet available in the field that will completely remove the oxidation products which are encountered in transformer service and bring sludged oil back to its original condition. (It is not economical to send used oil to the refinery for re-refining as they will allow only fuel oil price, which would probably be less than the cost of transportation.)

Another effect of oxygen is to gradually produce organic or "fatty" acids in oil in service. These should not be confused with the mineral acids such as sulphuric acid used in refining, as in small amounts the former do not have a deteriorating effect upon insulation.

Circuit Breakers. The principal causes of deterioration of insulating oil in circuit breakers are:

1. Presence of water.

2. Carbonization of the oil (caused by operation of the circuit breaker).

Insulating oils may receive water through condensation on the surface of the oil or on the inside of the tank due to the entrance of moist air, and, of course, by direct leakage.

All oil in circuit breakers is subject to carbonization due to arcing between the contacts. Part of the carbon formed is deposited on the mechanism and at the bottom of the tank while the remainder continues in suspension in the oil.

Carbonization takes place not only when the circuit breaker opens heavy short circuits, but also whenever an arc is formed, even during such light service as the opening of the charging current of the line, and this latter service, repeated, may eventually produce enough carbon to be a source of trouble.

The carbon reduces the dielectric strength of the oil, lowers the surface resistance of the insulation if water is present, and also lowers resistance

DESCRIPTION • OPERATION • MAINTENANCE

INSTRUCTIONS

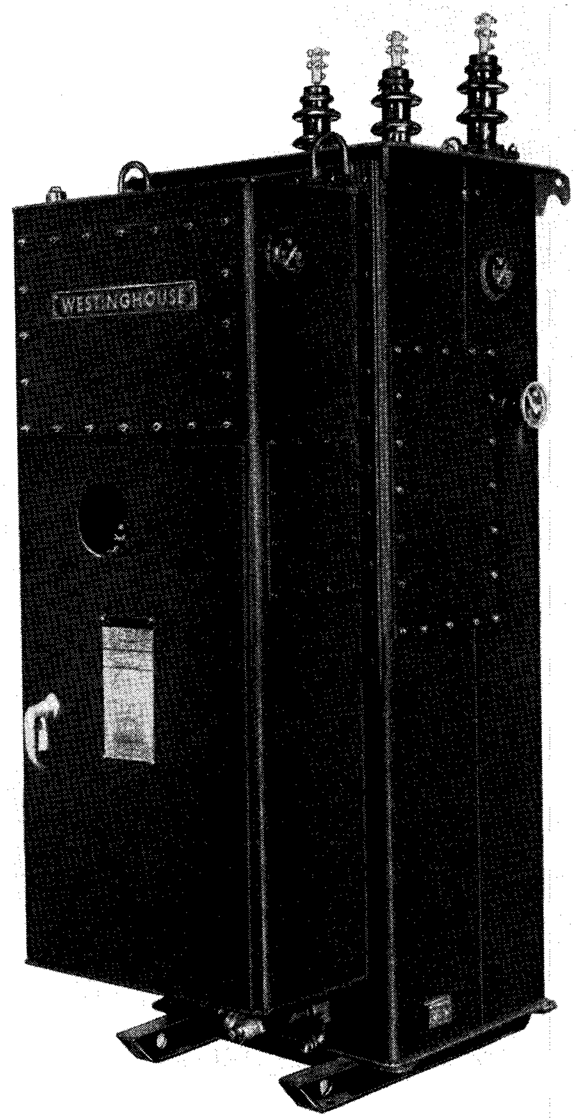
Single-Phase
Automatic, Step-Type
VOLTAGE REGULATOR
Type URS

WESTINGHOUSE ELECTRIC CORPORATION

SHARON PLANT • TRANSFORMER DIVISION • SHARON, PA.

SUPERSEDES ADVANCE I.B. 47-410-2

EFFECTIVE FEBRUARY, 1952


WESTINGHOUSE

TYPE URS VOLTAGE REGULATOR

The purpose of this Instruction Book is to familiarize the user with the construction of the Type URS single-phase automatic step-type voltage regulator, and to provide a guide for its installation, operation, and maintenance.

This regulator is used primarily to maintain a constant normal voltage on transmission lines and distribution feeders. Regulation is accomplished by the use of a Type URS tap changer which operates over a tapped regulating autotransformer, selecting the proper voltage tap and polarity relation to obtain the desired range of regulation.

The Type URS single-phase regulator is of the latest design and tap-changing-under-load is accomplished with a minimum of attention or maintenance in service, because of the incorporation of proven principles in design.

Surge Protection. Standard Type "URS" Step-Voltage Regulators are designed to meet the basic impulse level corresponding to the regulator voltage class in accordance with the NEMA, ASA and AIEE standards. The basic impulse level is obtained by adequate insulation of the core and coils and the use of by-pass arresters.

Thus the insulation of the "URS" Regulators is guaranteed to withstand the surge voltages specified by NEMA, ASA and AIEE standards. Therefore, it is necessary that the magnitude of surge voltages on S and L terminals be limited to the values specified for the particular voltage class and basic impulse level of the regulator.

Protective apparatus properly installed at the line terminals will provide this lightning protection. In the event detailed information is desired, please consult the nearest Westinghouse Office.

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*The supplementary instruction leaflets are assembled ***in numerical order*** in the back of the book.

DESCRIPTION

The Type URS Single-Phase Voltage Regulator consists of a regulating auto-transformer, a preventive auto-transformer, auxiliary transformer, Type URS Single-Phase tap changer, and all necessary control components. It is a 33 position Regulator which provides ten percent buck and ten percent boost of voltage in thirty-two steps. On units which exceed the maximum current or voltage rating of the tap changer, a series transformer is included to bring these factors within the prescribed tap changer limits.

These parts are designed and assembled into an integral sealed unit of weatherproof construction for outdoor service. Completely assembled, it is only necessary to connect the unit to the line for placing into service. No further auxiliary equipment other than that built into the unit is required.

A completely assembled Type URS single-phase regulator is shown in the frontispiece. Regulating auto, preventive auto, potential and current transformers are all mounted on a common frame and located in the main tank. The tap changer comprises two distinct compartments; the oil compartment containing the selector switch and gear reduction assembly, and the air compartment containing the cam switch assembly and automatic control equipment. The tap changer is bolted on the main tank using a gasketed flange, and the oil compartment is separated from the main tank by an oil tight insulating barrier.

Both the transformer tank and the tap changer compartment are fabricated from heavy steel plate with all seams welded. Lifting lugs are provided for handling the regulator with a crane. A structural steel base supports the regulator and is arranged with jack pads for convenience in installing or moving.

Sufficient inspection plates in both tap changer and main tank have been provided to facilitate maintenance and ease of inspection. All inspection plates are gasketed and made oil tight, while the cover of the main tank is welded.

Filter press connections, drain valves, and magnetic type oil gauges are provided in each oil compartment. A dial type thermometer is mounted on the transformer tank.

Three vertical bulk type bushings are provided for connection to the line.

Standard finish, consisting of two primer coats followed by a final coat of grey paint, is used for protection of all external surfaces of the regulators.

TRANSFORMER CORE AND COILS

The regulating and preventive auto-transformers are of the Type "C" core construction, while the potential transformer is of standard construction. The winding conductors are special electrolytic oxygen-free copper. All units are designed to withstand AIEE impulse and low frequency dielectric tests.

TAP CHANGER

A cutaway view of a completely assembled Type URS single-phase tap changer, is shown in Figure 1.

The tap changer compartment contains the motor operated driving mechanism, polarity reversing switches and the selector switches. The selector switches, the function of which is the selection of voltage magnitude, are connected to the regulating transformer taps. The reversing switch has the function of changing polarity, that is, shifting the vector relationship of the regulating winding to obtain boost or buck voltage.

The selector switches of the Type URS tap changer consist of the stationary contacts, two moving contacts, and two sliding contact connections to the moving contacts.

Each stationary contact consists of a copper alloy foot mounted on the main isolating and insulating Micarta barrier between the transformer and the tap changer housing. Each foot is held in place by two bolts through the barrier, and is connected to its transformer tap by means of a separate copper stud through the barrier. Each foot supports two contact blades having special arc resisting alloy inserts at the edges, the two blades being in different planes to match with their respective moving contacts.

The rear moving contact consists of a set of fingers with special arc resisting alloy shoes. These are mounted on a Micarta insulating arm which is rotated by the central shaft.

The sliding contact connection to the rear moving contact consists of a set of fingers with copper shoes, connected to the rear moving selector fingers. These are mounted on the Micarta arm, which carries the rear moving contact, and arranged to

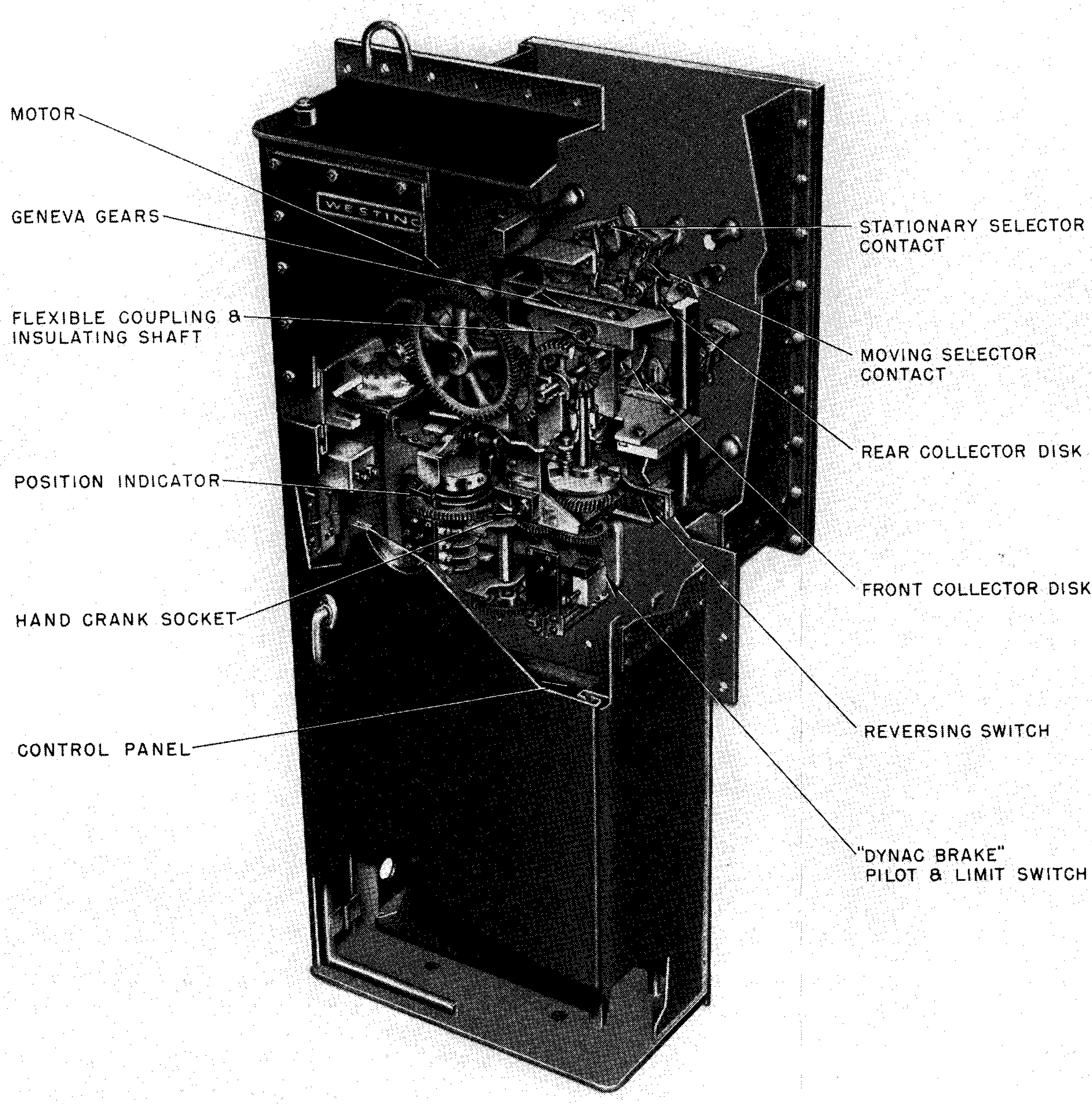


FIG. 1. Cutaway View of URS Single-Phase Tap Changer.

slide on a central collector disc. This copper disc is mounted on the main barrier plate and connected to the transformer in the same manner as are the stationary selector contact feet.

The front moving contact consists of a set of fingers identical to the rear moving contact fingers. These are mounted on an arm which is rotated by a shaft concentric about the central shaft.

The sliding contact connection to the front moving contact consists of a set of fingers with copper shoes mounted from two of the corner posts which support the shaft assembly. The mechanical parts and main frame are at the potential of the front moving contact. The mounting is of copper and the posts are cast from a high conductivity alloy, and connection to the transformer is made through the main barrier plate in the same manner as the stationary selector contacts. These fingers slide on a copper alloy collector disc connected to the front moving selector contact.

The selector switch assembly is driven from its horizontal shaft. In the cast steel frame is mounted a pinion shaft carrying two geneva pinions. The front pinion engages a bronze geneva gear mounted on the central shaft to operate the rear moving selector contact arm. The rear pinion engages a bronze geneva gear mounted on the outer concentric shaft to operate the front moving selector contact. The action of these geneva gears imparts a very rapid motion to the moving contacts at the time of switching, thus obtaining the contact parting speed requisite to efficient switching with smooth acceleration and deceleration to assure long mechanical life.

REVERSING SWITCH

The reversing switch moving contacts consist of two sets of fingers with copper shoes, connected together and mounted on an insulating Micarta arm. This arm is pivoted on a stub shaft, and its motion is related by gearing to the motion of the rear moving selector contact. The rear moving reversing switch contact slides on a continuous copper blade connected to stationary selector contact R. The front moving reversing switch contact moves between two copper alloy blades. Each of these blades is mounted on one of the conducting supporting posts and the posts make connection to the transformer through the main insulating barrier plate as previously described.

Figure 1 shows the URS single-phase tap changer and operating mechanism with parts cut away to illustrate the construction and operation of those portions normally hidden in a single view.

OPERATING MECHANISM

The operating mechanism consists of the motor, gears, and shafts for operating the tap changer. The motor and the gearing between the motor and tap changer are contained in the oil-filled compartment. A shaft is extended through the bottom of the oil compartment into an air compartment which houses the "DynAC Brake", switches, and auxiliary gears for their operation, and control panels.

The driving motor is a 230-volt, a-c single-phase, reversible, capacitor-start, capacitor-run motor especially designed for operation under oil. Its capacitor is mounted in the air compartment. For positive stopping, the "DynAC Brake" is used.

Through one Micarta to steel and one steel to steel spur gear reduction, the motor is coupled to the selector switch assembly. A Micarta insulating shaft is used between the gear reduction unit and the selector switch assembly. At each end of the Micarta shaft are discs of special alloy arranged to act by flexure in the manner of a universal joint and thus minimize alignment difficulties. The discs are attached to the square Micarta shaft with clamp type fittings and to the steel shafts by a pinned collar.

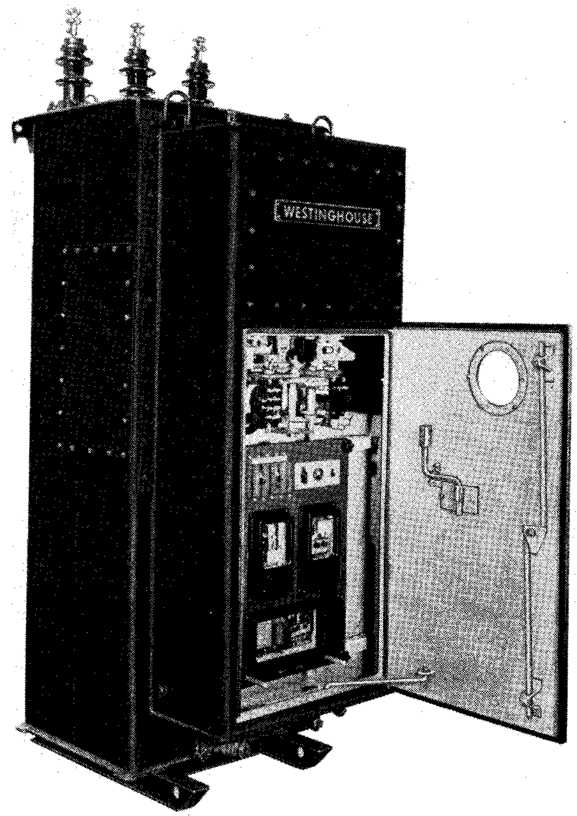


FIG. 2. Type URS Single-Phase Voltage Regulator with Door Open, Showing Control Panel.

CAM SWITCH ASSEMBLY

The air compartment contains the cam switches, position indicator, mechanical stop, "DynAC Brake", hand cranking arrangements, and control panels. Electrical connections from the motor are brought into the air compartment through a twelve point junction block.

A vertical operating shaft extends downward from the oil compartment through a spring loaded synthetic rubber oil-seal into the air compartment. To it is coupled, by a worm pivotable from an out-of-mesh position, a short shaft with socket for insertion of a crank for hand operation of the tap changer. A socket and clip are provided on the inside of the air compartment door for the crank when not in use. An interlocking switch is provided which removes all power from the motor when the worm is moved from its out-of-mesh position.

Through steel spur gears, auxiliary shafts are driven at the several speeds required for the auxiliary functions. One travels 180 degrees per position. On it are cams actuating switches to insure completion of each operation and stopping of the tap changer only on operating positions. A cam on this shaft operates the "DynAC Brake" and a mechanical operation counter to record the number of tap changer operations.

A shaft is included which travels ten degrees per position. This shaft turns a drum engraved with the tap changer position numbers. A stationary pointer indicates tap changer position. A transparent window in the air compartment door permits observation of the position indicator without opening the door. Friction retarded pointers indicate maximum and minimum travel of the tap changer. On this same shaft are cams which actuate limit switches to prevent electrical operation of the tap changer beyond its end position in either direction.

Note: These cams do not limit mechanical operation by the hand crank.

From this shaft, also, is driven a cam which releases a spring actuated mechanism should the tap changer be moved appreciably beyond its end position in either direction. This mechanism inserts a steel plunger into a slot in a bronze disc mounted on the main operating shaft, providing a definite mechanical stop which prevents further motion. The motion of the plunger also opens an auxiliary switch, removing all power from the motor circuit. The mechanical stop must be manually reset before the tap changer may be operated either electrically or by hand crank.

Other cams, switches, etc., are provided to suit such optional auxiliary functions as may be included in the particular control circuit design.

The disc-shaped Micarta cams which operate the cam switches are permanently and accurately aligned on their shafts by the close fit between their hexagonal center hole and the hexagonal shaft. For replacement or modification, any individual complete shaft assembly may conveniently be removed as a whole, including the factory match-marked gears. For replacement or modification purposes, accurately interchangeable parts may be obtained from the Westinghouse Electric Corporation.

All interlocking switches are of self-aligning, bridging contact type with heavy silver contact buttons. A wiping contact action assures reliable operation.

The principal parts of the operating mechanism are shown in Figure 1.

HOUSING

The Type URS single-phase tap changer is enclosed in a housing fabricated from 3/16" steel plate with a gasketed flange for connection to the opening in the transformer tank. Gasketed cover plates in the front and sides provide ready access to all parts for inspection or maintenance. The selector switch compartment is separated from the regulator with an oil-tight barrier, but the tap changer and main tank have a common gas space.

An oil drain is provided from the bottom of the oil compartment to ensure complete drainage. This drain is piped to a valve at the bottom of the air compartment.

INSTALLATION

RECEIVING AND HANDLING

Immediately upon receiving the regulator, an inspection should be made of all parts to make sure that no damage has resulted during shipment. If damage or injury is evident, file a claim with the Transportation Company at once, and promptly notify the nearest Westinghouse Office. If the unit is to be stored for a time before installing, a dry place should be selected.

Care must be taken in handling and installing the regulator. Where possible, the regulator should be handled with a crane. Lifting lugs have been provided on the tank for this purpose. Where a crane is not available, or is impractical to use, the unit may be skidded or moved into place on rollers. Jack pads have been provided on the base for convenience in lifting the unit. A jack should not be used on any other part of the regulator.

When handling or working on the regulator, care must be taken not to crack or damage the surfaces of the porcelain bushings.

INSTALLING

The standard Type URS Single-Phase Regulator is shipped as a complete unit and is entirely self-contained. Both transformer and tap changer compartments are usually shipped filled with WEMCO "C" Oil to the required level. The following procedure is recommended to insure that the regulator will function properly and require little maintenance after being placed in service.

Remove any blocking from the relays on the control panel. These relays are thoroughly inspected at the factory, but if another inspection is desired, refer to the Instruction Leaflets included in this Instruction Book.

Crank the tap changer over its entire range by hand, in order to make sure that the mechanism is not binding at any point. A hand crank is provided for this purpose.

Operate the tap changer over its entire range electrically by means of an external source of voltage. Open the potential and auxiliary sources at the AB control breakers and connect the external 110/220-volt, single-phase source to the control circuit side of the breakers.

Caution: The Control Breakers must be in the open position, otherwise the external source voltage may feed back into the main transformer, causing a high voltage to develop across the line bushings and overload the potential-auxiliary transformers. Refer to the wiring diagram furnished with each unit. Turn the "automatic-manual" switch to the "manual' position and operate the tap changer over its entire range by means of the "raise-lower" switch.

Check the voltage regulating relay balance by applying normal secondary voltage of the potential transformer to test terminals TT1 and TT2. Refer to the regulator instruction plate for this voltage value.

Set the line drop compensator dials for proper resistance and reactance compensation of the line between the regulator and the load center. Refer to I.L. 46-736-7 for detailed information on the compensator adjustment.

Remove the test voltages.

The oil level in both the transformer tank and the tap changer tank should be checked to make sure that it is filled to the 25 degree level as indicated by the oil gauges. The oil used with Westinghouse Regulators should be WEMCO "C" oil, which is supplied with them, or an oil specifically approved by Westinghouse.

Important. All oil should be carefully inspected and tested before using, regardless of the length of time the unit has been idle or in storage. The oil in each compartment should be tested prior to energization of the unit. For methods of testing and handling oils, see I.B. #44-820-1.

The Type URS single-phase regulator may be connected as follows:

On three-phase three-wire circuits, two regulators may be operated in open delta, or three units may be connected in delta. When connected in delta, there is resultant phase shift between source and load voltage which is characteristic of all auto transformers and thus this connection should not be used where this phase shift would be objectionable.

On three-phase four-wire circuits, three regulators may be connected wye, provided the neutral of the regulator bank is solidly connected to the system neutral.

Connect the regulator to the line making sure to connect the "S" leads to the source and the "L" leads to the load, regardless of whether the regulator is to be connected to the sending or receiving end of the line. The metal diagram instruction plate, attached to the air compartment door, shows the terminal connections. Care should be taken to see that all connections are properly made, as a wrong connection may cause serious damage. If possible, the voltage should be brought up slowly so that any trouble may be found before damage can result.

Close the AB control breakers and turn the "automatic-manual" switch to the "manual" position and operate the tap changer over its entire range and back to the neutral position by means of the "raise-lower" switch.

OPERATION

PRINCIPLE OF REGULATOR OPERATION

A typical diagram of connections of the Type URS Single-Phase Regulator is shown in Figure 3. The sequence of operations of the Type URS single-phase tap changer is shown in Figure 4. A series transformer (not shown) is used in the larger current or voltage classes. The schematic diagram of connections shown in Figure 4 shows more clearly the principle of operation.

The tapped section of the transformer winding is shown between 3 and 12, with taps 4 to 11 inclusive connected to the stationary contacts of the selector switches of corresponding numbers. Taps 3 and 12 are connected to the reversing switch stationary contacts, and tap 2 to the stationary selector contact R, and reversing switch moving contact R. Terminals P1 and P3 of the preventive auto-transformer are connected to the two moving contact fingers of the selector switches.

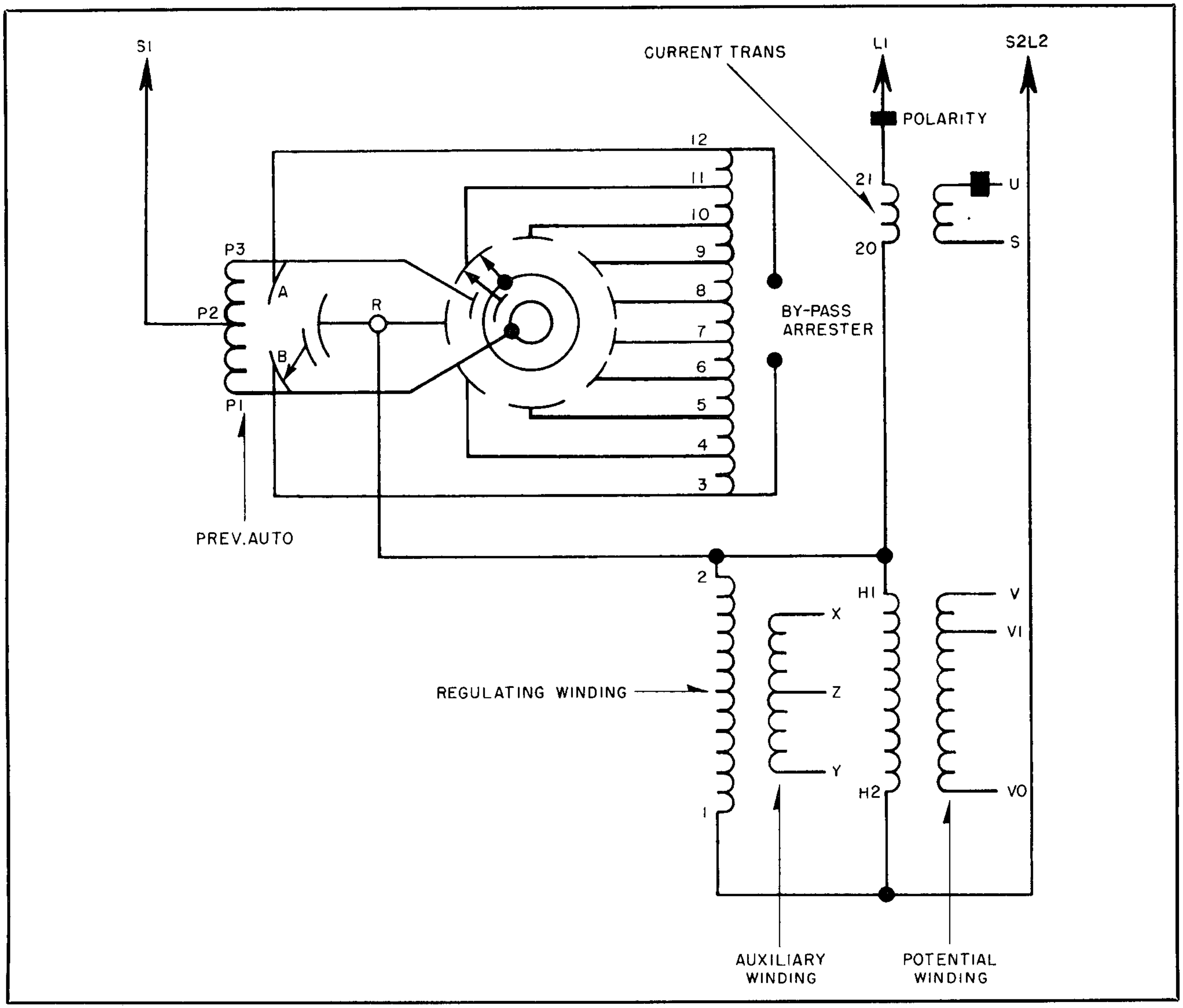


FIG. 3. Type URS Single-Phase Voltage Regulator Connection Diagram.

Figure 4 shows the tap changer in its neutral position, with both moving contacts on stationary contact R, the preventive auto short-circuited, the reversing switch connecting R to A, and none of the tapped section of transformer winding connected into the circuit. This is position 17.

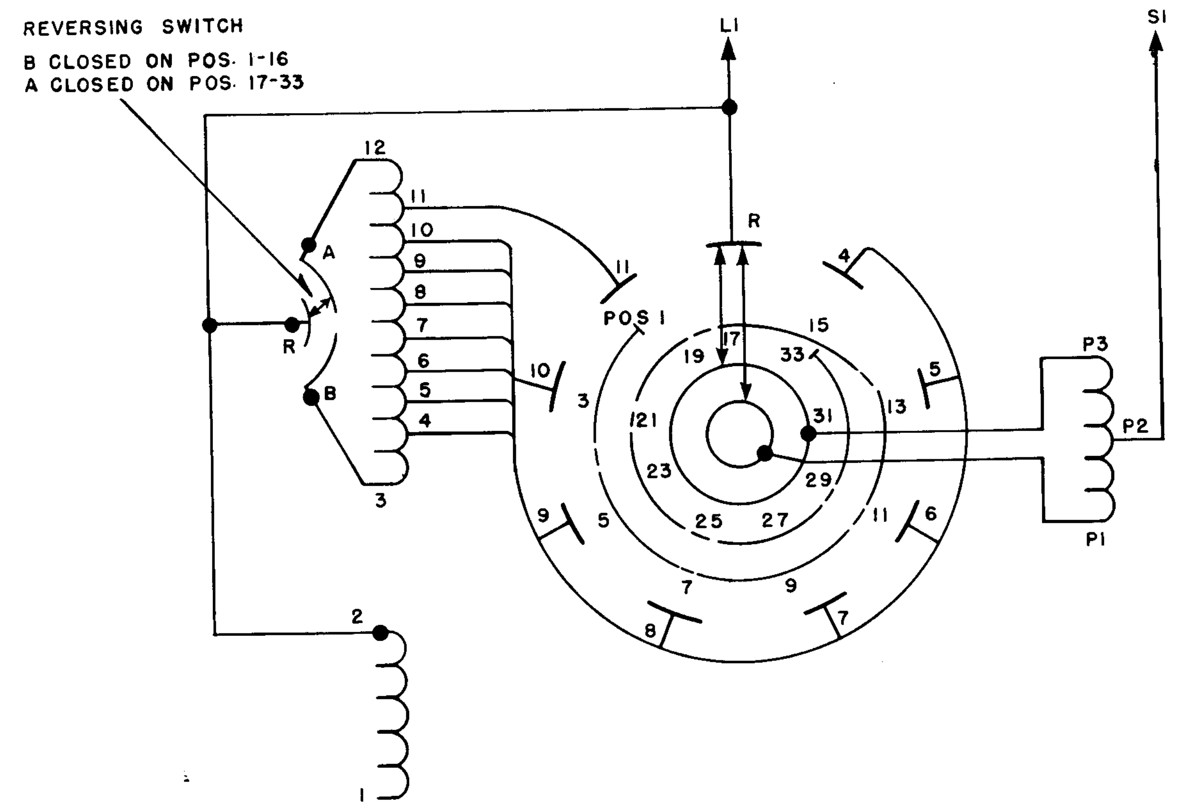
When the unit is to be placed in service with automatic control, turn the "automatic-manual" switch to "automatic" and the voltage regulating relay will operate to maintain the proper voltage as previously determined and set.

In changing from position 17 to position 18, the moving contact connected to P3 leaves stationary contact R and moves to stationary contact 11. This connects the preventive auto-transformer across taps 12 and 11, and causes the number of effective turns in the winding between S1 and 1 to be decreased by half the number of turns on the tapped section 11-12. By thus increasing the volts per turn in the fixed winding between 1 and 2, the voltage appearing between L1 and S2L2 is increased.

Continuing the operation from position 18 to position 19, the moving contact connected to P1 leaves stationary contact R and moves to stationary contact 11. This short-circuits the preventive auto-transformer and the number of effective turns in the winding between S1 and 1 is again decreased by half the number of turns in the tapped section 11-12.

By continuing the same sequence of operations of the selector switches, the connection is moved successively from tap 11 to 10 . . . to tap 4, which represents the minimum turns between S1-1, or maximum voltage position between L1-S2L2.

In changing from position 17 to position 16, the reversing switch first acts to select the opposite polarity for the tapped section of the winding. Before



CONTACT	POSITION																																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
P1 CONNECTS TO	11	11	10	10	9	9	8	8	7	7	6	6	5	5	4	4	R	R	11	11	10	10	9	9	8	8	7	7	6	6	5	5	4
P3 CONNECTS TO	11	10	10	9	9	8	8	7	7	6	6	5	5	4	4	R	R	11	11	10	10	9	9	8	8	7	7	6	6	5	5	4	4
R CONNECTS TO	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A

FIG. 4. Typical Schematic Connection Diagram of Regulator and Sequence Chart of Tap Changer Positions.

contact P1 leaves stationary contact R, the reversing switch moving contact moves from stationary contact A to stationary contact B. Prior to completion of this motion, the moving contact connected to P1 leaves stationary contact R, and after tap 3 is connected to tap 2, contacts stationary contact 4. This connects the preventive auto-transformer across taps 3 and 4, and causes the number of effective turns between S1 and 1 to be increased by half the number of turns in the tapped section 3-4. By thus decreasing the volts per turn in the fixed winding between 1 and 2, the voltage between L1 and S2L2 is decreased.

Continuing the operation from position 16 to position 15, the moving contact connected to P3 leaves stationary contact R and moves to stationary contact 4. This short-circuits the preventive auto-transformer, and the number of effective turns between S1 and 1 is again increased by half the number of turns in the tapped section 3-4.

By continuing the same sequence of operations of the selector switches, the connection is moved successively from tap 4 to tap 5 . . . to tap 11, which represents the maximum turns between S1 and 1, or minimum voltage between L1 and S2L2.

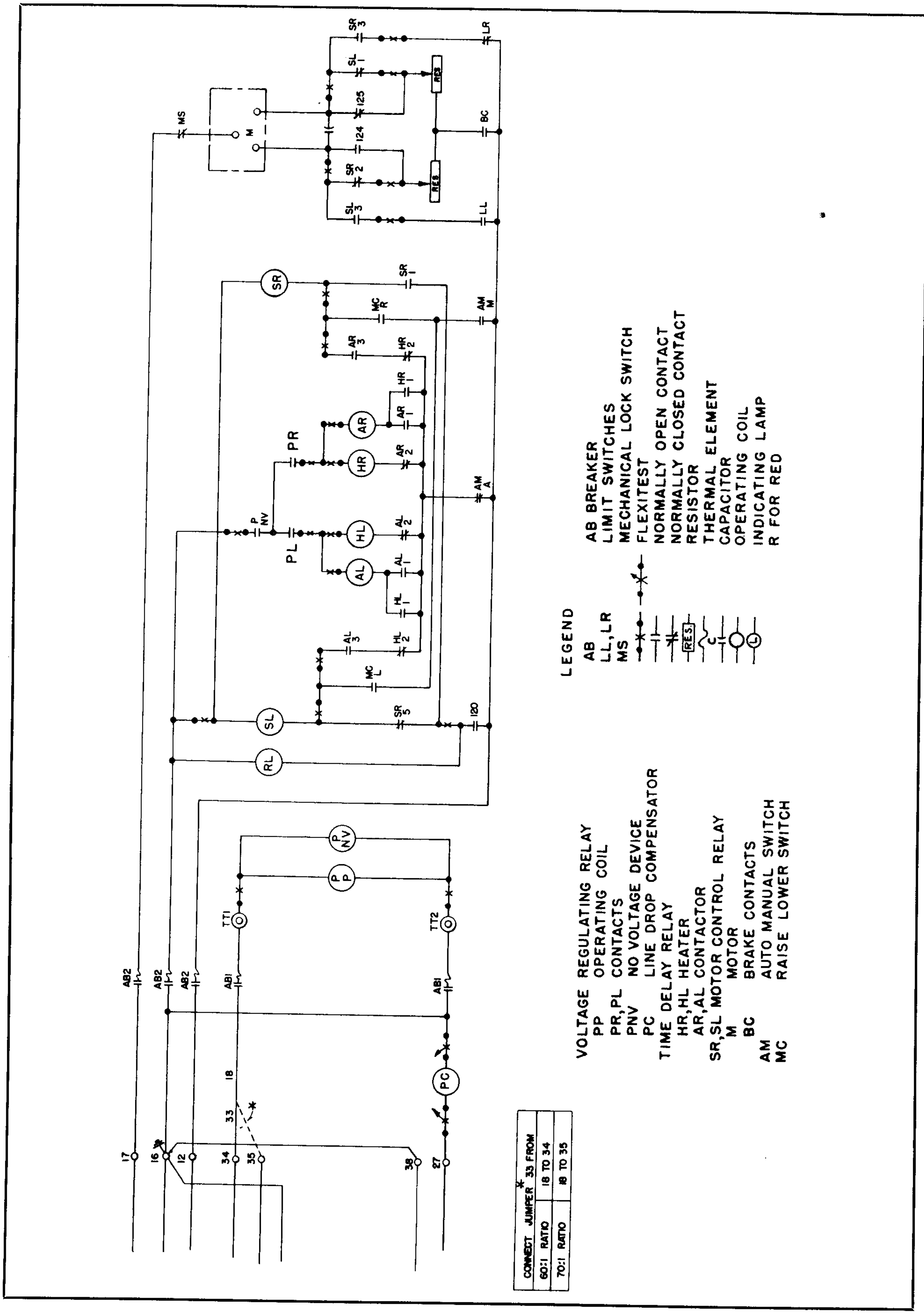


FIG. 5. Schematic Diagram of Type URS Single-Phase Voltage Regulator Control.

PRINCIPLE OF CONTROL OPERATION

A typical control panel for the Type URS Single-Phase Regulator is shown in Figure 2. The control circuit is shown schematically in Figure 5.

The panel is of steel and is located behind the hinged door as shown in Figure 2. A hinged mounting is used so that both front and rear of the panel are readily accessible for inspection and maintenance. The control relays and equipment are all of the Flexitest case construction for semi-flush mounting. A Type FT test plug is recommended for use with the Flexitest relays for ease of testing. The Flexitest case construction allows the relay mechanism to be easily disassembled for inspection, testing, adjusting and remounting.

FUNCTIONS

In general, the control system to be completely adequate must perform five distinct functions:

1. Initiate the operation of the tap changer motor to cause a tap change.

2. Provide means for ensuring that once a tap change is initiated it will be carried through to completion.

3. Protection of the source of auxiliary power and the potential transformer in case of short circuit.

4. The prevention of the tap changer mechanism running past the limit positions.

5. Indication of tap position, number of operations, etc.

In the description of control circuit operation which follows, the equipment which performs the above functions is described and its operation is outlined.

The schematic control circuit for automatic or manual control of a Type URS Single-Phase Tap Changer is shown in Figure 5. An automatic manual switch, "AM", enables the selection of automatic or manual operation by the closing of "AMA" or "AMM" respectively. The voltage regulating relay "PP" is responsive to voltage changes in the regulated line and initiates tap changer operations automatically. "PNV" is the no voltage relay, connected to prevent automatic operation to maximum boost if AB1 is inadvertently opened, or purposely opened for testing.

Type TH time delay relays are provided to override minor voltage fluctuations and avoid many needless tap changer operations. The heater operated contacts HR and HL operate to give the time delay. AR and AL are auxiliary units of the TH relay.

A manual control switch, "MC", mounted on the control panel, is provided to enable operation of the tap changer by the closing of "MCR" for raising or "MCL" for lowering the tap changer position.

An interlock switch MS is mounted in such a manner that either the operation of the mechanical stop or the moving of the hand crank shaft from its out-of-mesh position will de-energize the motor. Thus the unit will not attempt to operate electrically while the crank is engaged.

Type AB control breakers are provided to disconnect the control circuits from the potential transformer and tertiary winding, and also to protect the potential transformer and tertiary winding from short-circuits. Terminals 17, 16, 12, 34 and 35 receive their potential from the tertiary winding and potential transformer and terminals 27 and 37 receive current from the current transformer.

BC is the "DynAC Brake" contact. The "DynAC Brake" is a pneumatic time delay relay, operated by a cam in the cam switch assembly.

The following switches are cam operated and are contained in the air compartment of the tap changer:

120 is an auxiliary switch which is closed when the tap changer is off position. It acts to seal in the motor contactor to ensure completion of a tap change once the tap changing sequence is initiated.

LR is a limit switch, open on position 33 and beyond, and closed on positions 1 through 32.

LL is a limit switch, open on position 1 and below, and closed on positions 2 through 33.

124 is a braking limit switch, closed on position 33 and beyond, and open on positions 1 through 32.

125 is a braking limit switch, closed on position 1 and below, and open on positions 2 through 33.

XL and XR are the brake resistors (RES in Figure 5) in series with SL1 and SR2 respectively.

SR and SL are the coils of an interlocked double throw motor contactor mounted on the panel. The coils act to open and close contacts of the same designation (i.e., SL1, SR2, etc.).

The motor capacitor is mounted in the air compartment of the tap changer.

RL is a red lamp on the control panel which indicates when the tap changer is off position, or when the voltage regulating relay calls for either a raise or lower operation from positions 33 or 1 respectively.

A mechanical operation counter located in the cam switch compartment is provided to supply a record of the number of tap changer operations.

CONTROL CIRCUIT OPERATION

Automatic Operation. Before the regulator can be operated automatically, both AB control breakers must be closed. Closing AB2 energizes the control circuit, except for the voltage regulating relay PP and the PNV relay. When AB1 is closed, the PNV relay coil is energized closing the PNV interlock contacts; also the coil PP of the voltage regulating relay is energized. Closing AMA of the Automatic-Manual selector switch completes the set-up for automatic operation.

The voltage regulating relay PP is the initiating element for tap changes when the control is set for "automatic" operation. The relay is sensitive to voltage changes on the line which are transmitted to its coils through a voltage transformer connected between L1 and S2L2. The relay is usually used with a line drop compensator when it is necessary to compensate for the line impedance drop between the regulator and the load center. The line drop compensator is supplied by a current transformer in the regulated line. For some conditions of parallel operation, reverse reactance compensation may be needed. Links on the front of the line drop compensator provide convenient means for accomplishing reversal of the reactance element of the compensator.

When Voltage Drops: A drop in voltage causes voltage regulating relay "raise" contact PR to close, energizing time-delay relay heater HR. If the heater in this relay remains energized long enough, the bimetal will operate a Micro Switch. Operation of the Micro Switch opens contact HR2 and closes contact HR1. Closing contact HR1 energizes the auxiliary contactor coil AR, which operates to open contact AR2 and close contacts AR1 and AR3. Opening contact AR2 de-energizes the bimetal heater HR, allowing the bimetal to cool. Closing contact AR1 shunts the Micro Switch contact HR1 and holds the auxiliary contactor AR closed as long as PR remains closed. When the bimetal has cooled to the temperature determined by the time setting, it allows the Micro Switch to return to its original position, opening HR1 and closing HR2.

If the auxiliary contactor AR is still held closed by PR through AR1, then AR3 is still closed and the reclosing of HR2 completes the circuit, energizing the motor control relay SR. Energizing the motor control relay, SR, opens contacts SR2 and SR5, and closes contacts SR1 and SR3. Closing contact SR3 energizes the motor to operate the tap changer in the "raise" direction.

While the motor is operating, a cam keeps the "DynAC" time delay relay contact BC closed. When the auxiliary contactor is de-energized, SR2 is closed, short-circuiting the capacitor through SL1, and applying single-phase power to both windings of the motor in parallel, bringing the motor to a smooth, quick stop. After a momentary delay, the "DynAC Brake" contact opens, and the unit is ready for further operation.

The reason for using back contact SR5 for lowering operation in preference to a front contact on SL is to return the tap changer to an "On Position" condition, following a power failure during a tap change. When power is restored after such a failure, the motor control relay coil SL is energized through back contact SR5 and cam switch 120 (which is closed when the tap changer is off position), thus returning the tap changer to its next lower position. From this point, voltage adjustment can take place in the usual manner.

Protection Against "No-Voltage": The no-voltage relay (PNV) is connected across the voltage regulating relay voltage. The "make" contact of this no-voltage relay is connected in the automatic control circuit and is closed when the relay is energized.

When voltage is removed from the voltage regulating relay circuit the voltage regulating relay closes PR, which will initiate a tap change in the raise direction. The tap changer would operate to the extreme raise or boost position as long as the voltage remained off on the voltage regulating relay circuit only. To prevent this condition, the no-voltage relay contact is inserted in the automatic control circuit so that, upon failure of voltage on the primary relay, the automatic circuit is also opened. The tap changer will remain on the position it is on at that time. When voltage is restored, the no-voltage relay is re-energized, closing the "make" contact. The automatic control then resumes its operation in the normal manner.

The standard Type URS tap changer control is designed for 33-position sequential operation only. When a control is "sequential" the motor control relay will remain energized as long as the voltage regulating relay contacts remain closed. There is only the initial time delay.

Manual Operation: AB2 control breaker must be closed if the tap changer is to be operated manually. AB1 control breaker may be either open or closed. For manual control, contact AMA of automatic manual switch is open and contact AMM is closed. When higher voltage is desired, contact MCR of raise-and-lower switch is closed, energizing motor control relay coil SR. From this point on, the tap changing, braking, and positioning are the same as for automatic control.

If a voltage lowering operation is desired, contact MCL is closed, energizing motor control relay coil SL. The operation then continues as for automatic control.

MAINTENANCE

Type URS Regulators are designed to operate with a minimum amount of maintenance, but should be given regular periodic inspections. When maintenance is required, no special tools are necessary.

Most of the operating mechanism operates under oil. All bearings in the main tap changer mechanism are oil immersed, but bearings in the air compartment require occasional lubrication with an anticorrosive lubricant. Lubriplate #130-A is recommended.

A periodic inspection of the relays and relay contacts should be made. It is not necessary to keep the contacts of the relays used in this control polished as on the older types of relays. If the contacts should become worn to an uneven shape, they may be smoothed and re-shaped with a very fine file and readjusted.

The rate of braking, that is, the point at which the tap changer stops, is adjusted at the factory and should not be changed unless the circuit constants change.

To change the rate of braking, adjust resistors XR and XL. Slower braking and, consequently, later stopping is achieved by increasing the resistor setting, which adds more resistance to the circuit. Faster braking and earlier stopping may be obtained by decreasing the resistor setting, which decreases the resistance of the circuit. See I.L. 46-713-7 for detailed "DynAC Brake" information.

Maintenance of the selector switch contacts will depend to a great extent on the current which they carry.

All main contacts are of the wedge and finger type. With this type of contact, the mechanical forces in the circuit under heavy overload do not tend to open the contacts since the forces are in quadrature with the contact pressure forces.

All contacts subject to arcing are faced with or are made of arc-resisting and high-melting-point alloy giving long life to the contacts.

Replacement should be made before the moving finger shoes have burned sufficiently to reduce the smooth flat contact area by more than half, and before the insert of arc resisting material at the edges of the stationary contacts is burned away. It is recommended that the entire tap changer be thoroughly inspected at the end of its first year of service, or after its first 35,000 operations, whichever is earlier; and that the frequency of subsequent inspections be based on the facts found by this inspection. A complete inspection of the contacts and the operating mechanism should be made at least every third year after the initial inspection.

The oil in the tap changer compartment should not be allowed to deteriorate to the point where it tests less than 15 Kv in the standard test cup. The oil level in both compartments should be checked at the time of the periodic inspection.

Whenever oil is drained from the tap changer for inspection or maintenance, it is preferable that new, clean, dry, and filtered oil be returned to the tap changer compartment. If for any reason it is found necessary to replace the same oil which was drained from the tap changer, the following precautions must be taken:

1. Be sure the drums used for oil storage are absolutely clean and dry. Inspection of the drums will save much grief.

2. Be sure the oil is filtered before it is returned to the tap changer compartment to remove any carbon, metal particles, or water which might have been present or introduced in handling.

3. The oil should be free of carbon before it is considered satisfactory.

4. After filling the tap changer compartment with oil and before energizing the unit, test at least three representative samples in the standard test cup. The test value should be 25 Kv or better.

5. The tap changer should never be energized when the oil in the housing tests less than 15 Kv in the standard test cup.

The diagram of connections for the control equipment is shown on the wiring diagram furnished with the apparatus and the internal connections for the main regulator are shown on the diagram nameplate.

If for any reason the core and coil assembly should be removed from the tank, it should be stored in a dry place and protected from moisture. Before replacing the core and coil assembly, a determination of the dryness should be made by a megger or a specially designed high resistance voltmeter.

Gaskets should be checked for tightness. Inspection plate gaskets may be used repeatedly if cemented only to the removable cover and if care is used when the cover is removed.

SPARE PARTS

Only a minimum of spare parts are required for Type URS tap changer, but it is recommended that a complete set of moving selector contact finger assemblies and stationary selector contact blades be kept in stock for replacement if necessary.

If a more complete stock is desired, the following parts are recommended:

One Motor.

One Set of "DynAC Brake" Contacts.

One Motor Contactor Complete.

One Set Inspection Plate Gaskets.

SUPPLEMENTARY DATA

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This part of the book consists of the supplementary instruction leaflets listed in the Table of Contents, page 2. The leaflets, which follow, are assembled in numerical order.

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INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

RELAYS IN TYPE FT CASE

The type FT cases are dust-proof enclosures combining relay elements 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 welded steel housing containing the hinge half of the knife-blade test switches and the terminals for external connections. The cover is a drawn steel frame with a clear window which fits over the front of the case with the switches closed. The chassis is a 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.

Six different size cases are available to accommodate the various relay elements and flexible terminal arrangements for either flush or projection mounting. These are designated as S10, S20, M10, M20, L10, L20. S refers to the small; M, the medium; and L, the large size chassis frame. The numbers refer to the possible number of test switch positions, 10 or 20.

Removing Chassis

To remove the chassis, first remove the cover by unscrewing the captive nuts at the corners. There are two cover nuts on the S size case and four on the L and M size cases. This exposes the relay elements and all the test switches for inspection and testing. The next step is to open the test switches. Always open the elongated red handle switches first before any of the black handle switches or the cam action latches. This opens the trip circuit to prevent accidental trip out. Then open all the remaining switches. The order of opening the remaining switches is not important. In opening the test switches they should be moved all the way back against the stops. With all the switches fully opened, grasp the two cam action latch arms and pull outward. This releases the chassis from the case. Using the latch arms as handles, pull the chassis out of the case. The chassis can be set on a test bench in a normal upright position as well as on its top, back or sides 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 shorting switch located behind the current test switch prevents open circuiting the current transformers when the current type 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. The elongated red handle switch should not be closed until after the chassis has been latched in place and all of the black handle switches closed.

Electrical Circuits

Each terminal in the base connects thru a test switch to the relay elements in the chassis as shown on the internal schematic diagrams. The relay terminal is identified by numbers marked on both the inside and outside of the base. The test switch positions are identified by letters marked on the top and bottom surface of the moulded blocks. These letters can be seen when the chassis is removed from the case.

The potential and control circuits thru the relay are disconnected from the external circuit by opening the associated test switches. Opening the current test switch short-circuits the current transformer secondary and disconnects one side of the relay coil but leaves the other side of the coil connected to the external circuit thru the current test jack jaws. This circuit can be isolated by inserting the current test plug (without external connections), by inserting the ten circuit test plug, or by inserting a piece of insulating material approximately 1/32" thick into the current test jack jaws. Both switches of the current test switch pair must be open when using the current test plug or insulating material in this manner to short-circuit the current transformer secondary.

A cover operated switch can be supplied with its contacts wired in series with the trip circuit. This switch opens the trip circuit when the cover is removed. This switch can be added to the existing type FT cases at any time.

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 can be inserted in the current test jaws after opening the knife-blade switch to check the current thru the relay, as shown in Fig. 1. 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 thru 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, as shown in Fig. 2.

Testing In Case

With all blades in the full open position, the ten circuit test plug Fig. 3 can be inserted in the contact jaws. This connects the relay elements to a set of 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 posts down.

The external test circuits may be made to the relay elements 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 base, relay elements may be tested by using the ten circuit test plug or by #2 test clip leads as described above. The factory calibration is made with the chassis in the case and removing the chassis from the case will change the calibration values of some relays by a small percentage. It is recommended that the relay be checked in position as a final check on calibration.

An internal schematic is available for each individual relay showing the schematic internal wiring. The outlines of the various cases are as follows:

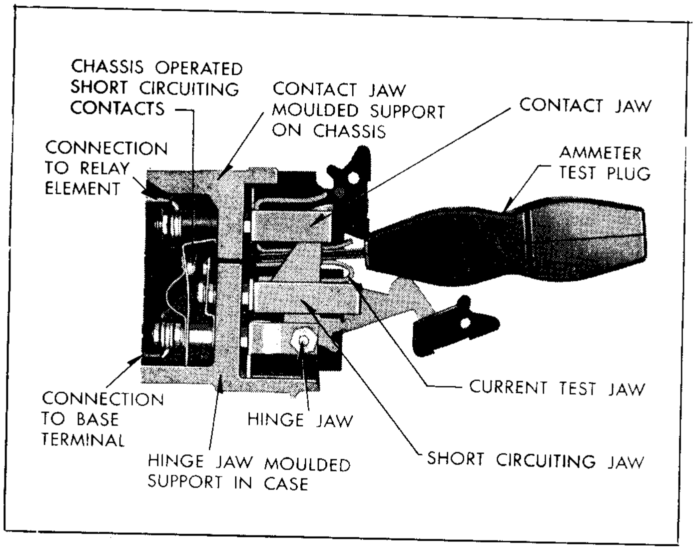


Fig. 1—Ammeter Test Plug In Testing Position.

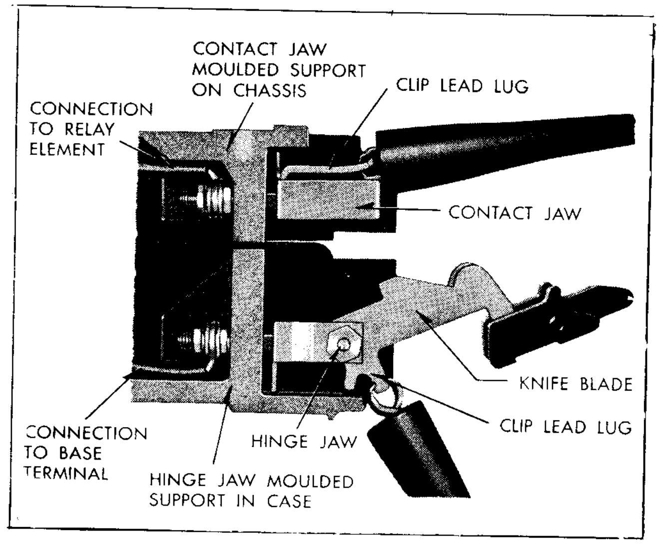


Fig. 2—Spring Clip Leads May Be Used For Testing.

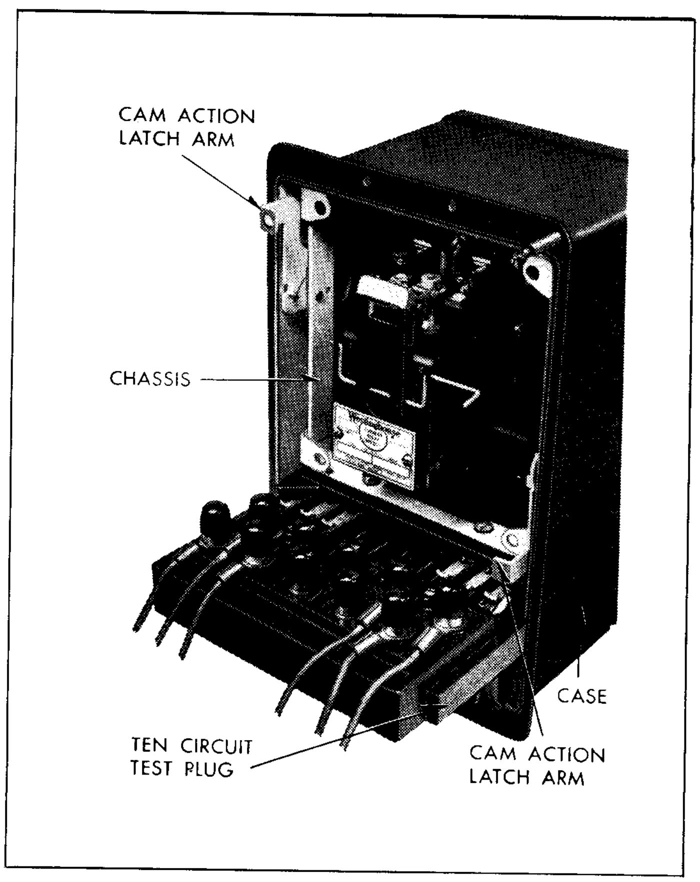


Fig. 3—Multi-Circuit Test Plug In Testing Position.

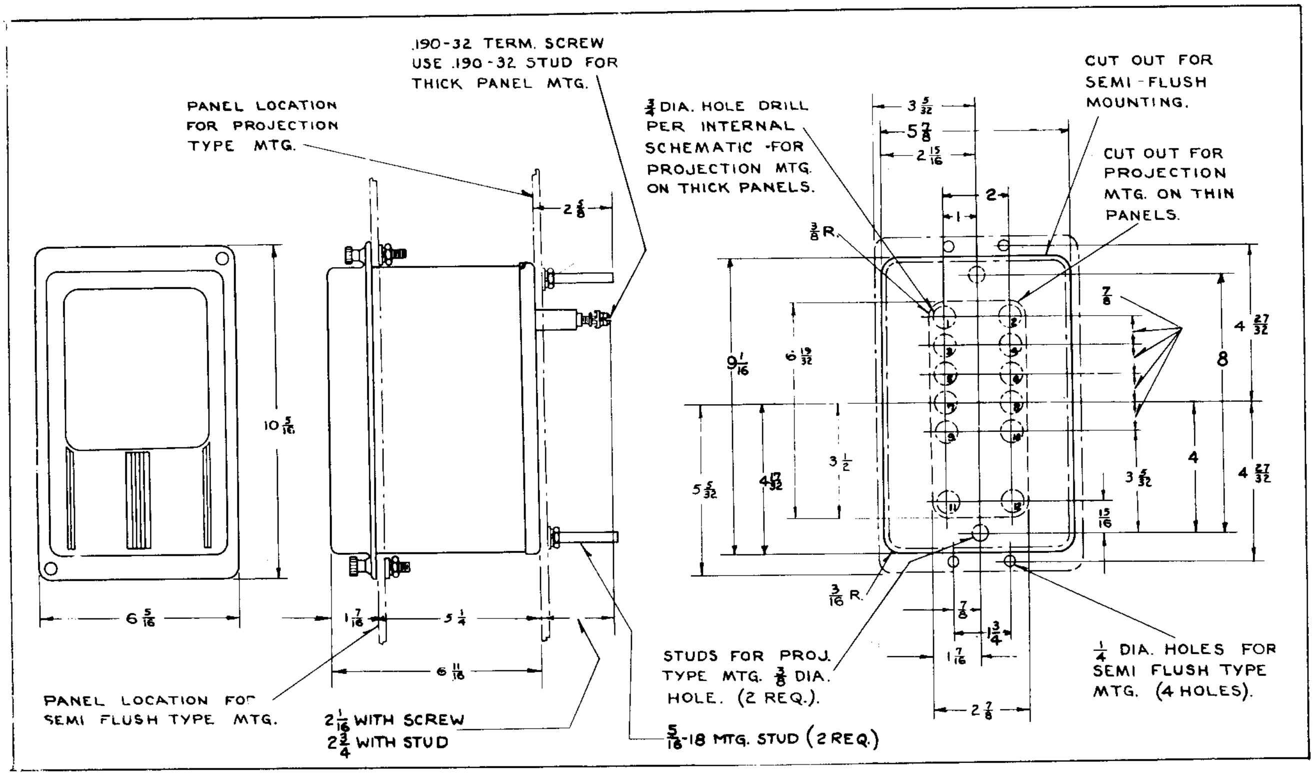


Fig. 4—Outline and Drilling Plan for the S10 Semi-flush (9B-1901) or Projection (9B-2020) Type FT Case. See the Internal Schematic for the Terminals Supplied. For Reference Only.

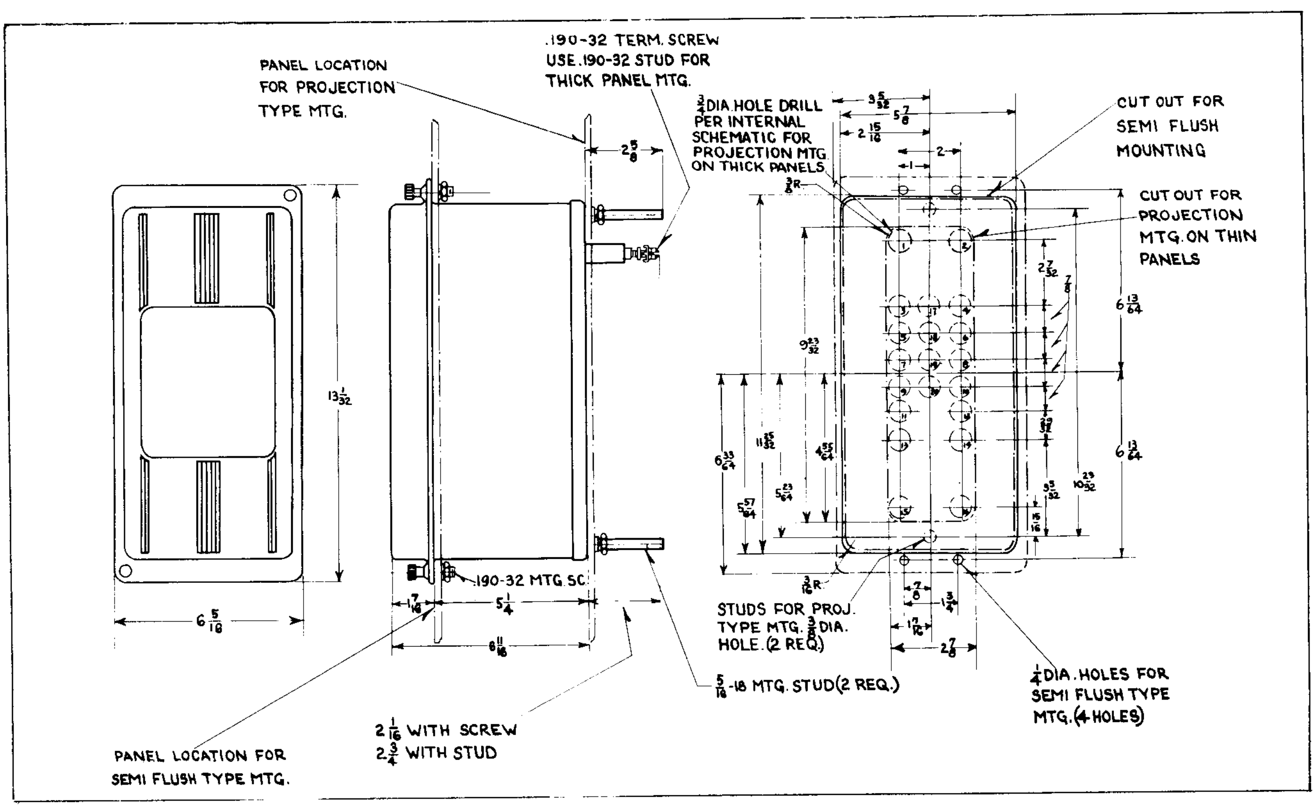


Fig. 5—Outline and Drilling Plan for the S20 Semi-flush (9B-2040) or Projection (9B-2041) Type FT Case. See the Internal Schematic for the Terminals Supplied. For Reference Only.

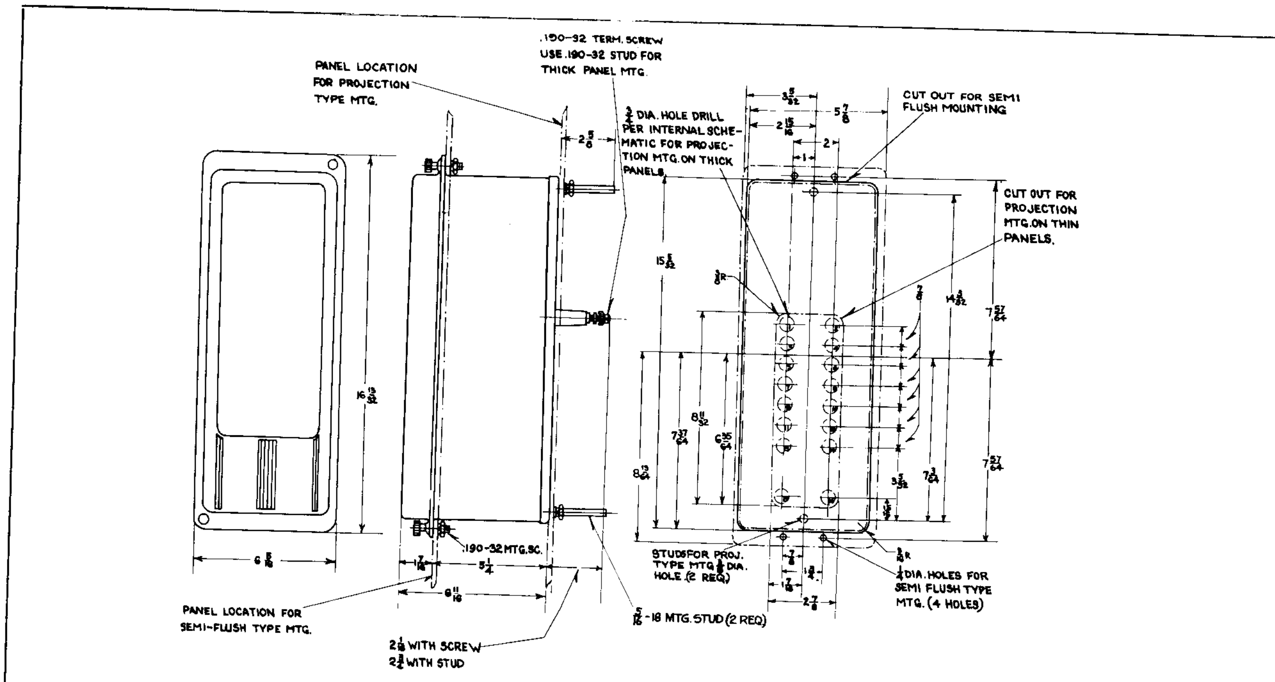


Fig. 6—Outline and Drilling Plan for the M10 Semi-flush (9B-1903) or Projection (9B-2021) Type FT Case. See the Internal Schematic for the Terminals Supplied. For Reference Only.

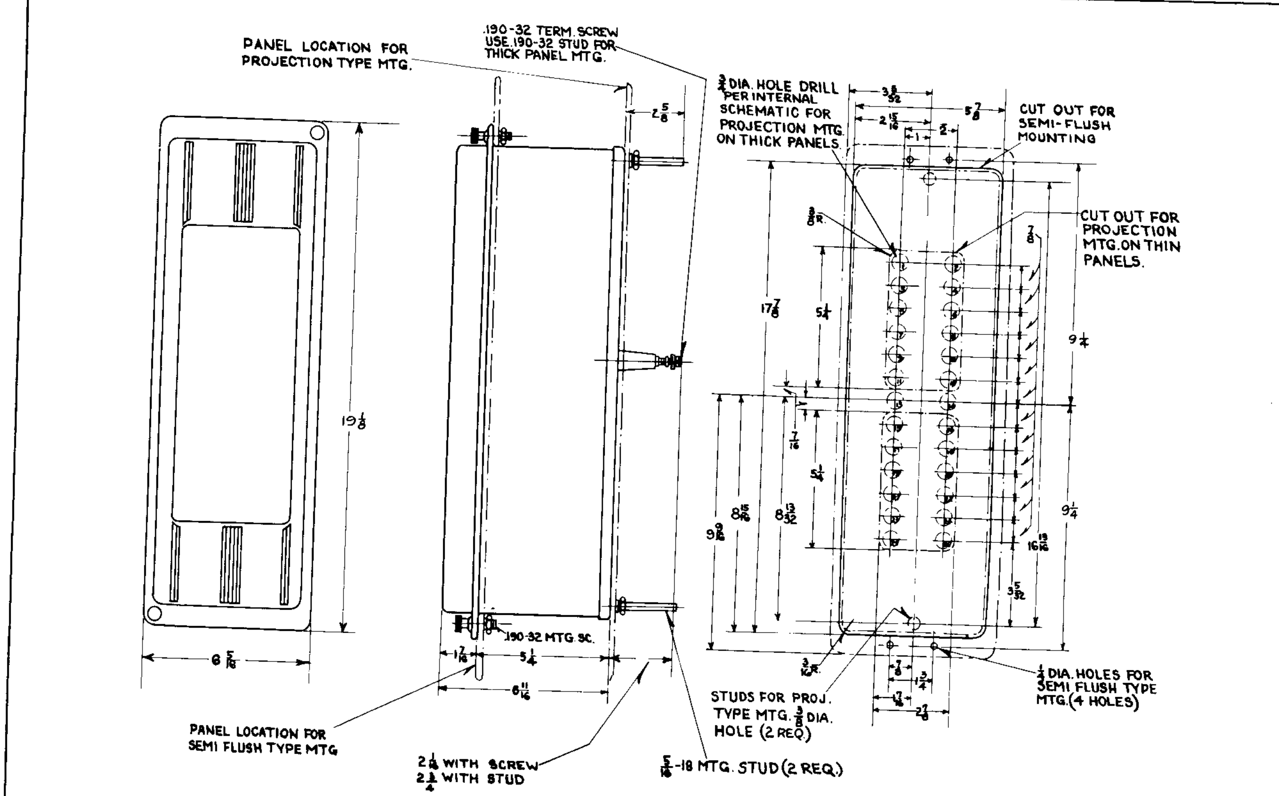
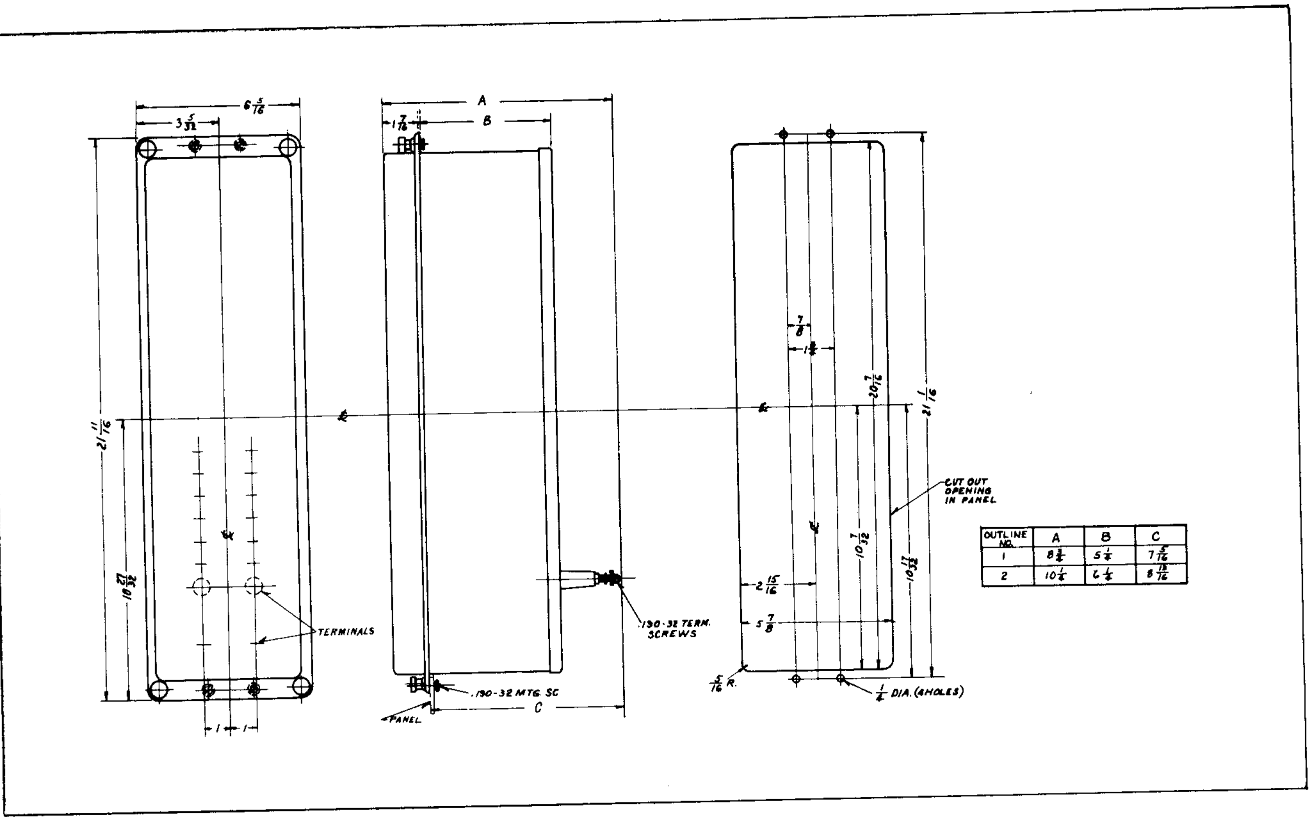


Fig. 7—Outline and Drilling Plan for the M20 Semi-flush (9B-1905) or Projection (9B-2022) Type FT Case. See the Internal Schematic for the Terminals Supplied. For Reference Only.



OUTLINE NO.	A	B	C
1	8¾	5¼	7 5/16
2	10¼	6¼	8 15/16

Fig. 8—Outline And Drilling Plan For The L10 Semi-Flush Type FT Case. For Reference Only. (9-B-2042)

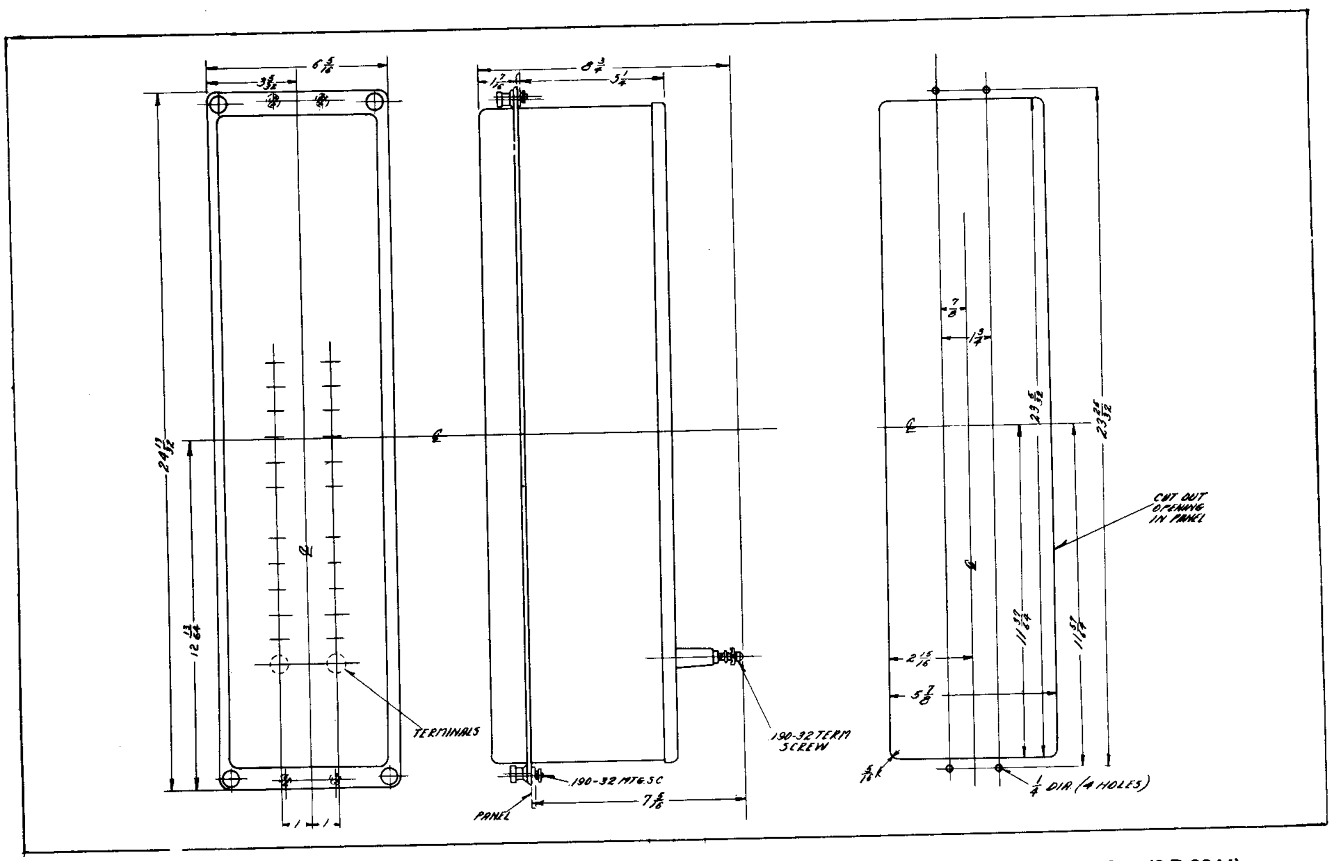


Fig. 9—Outline And Drilling Plan For The L20 Semi-Flush Type FT Case. For Reference Only. (9-B-2044)

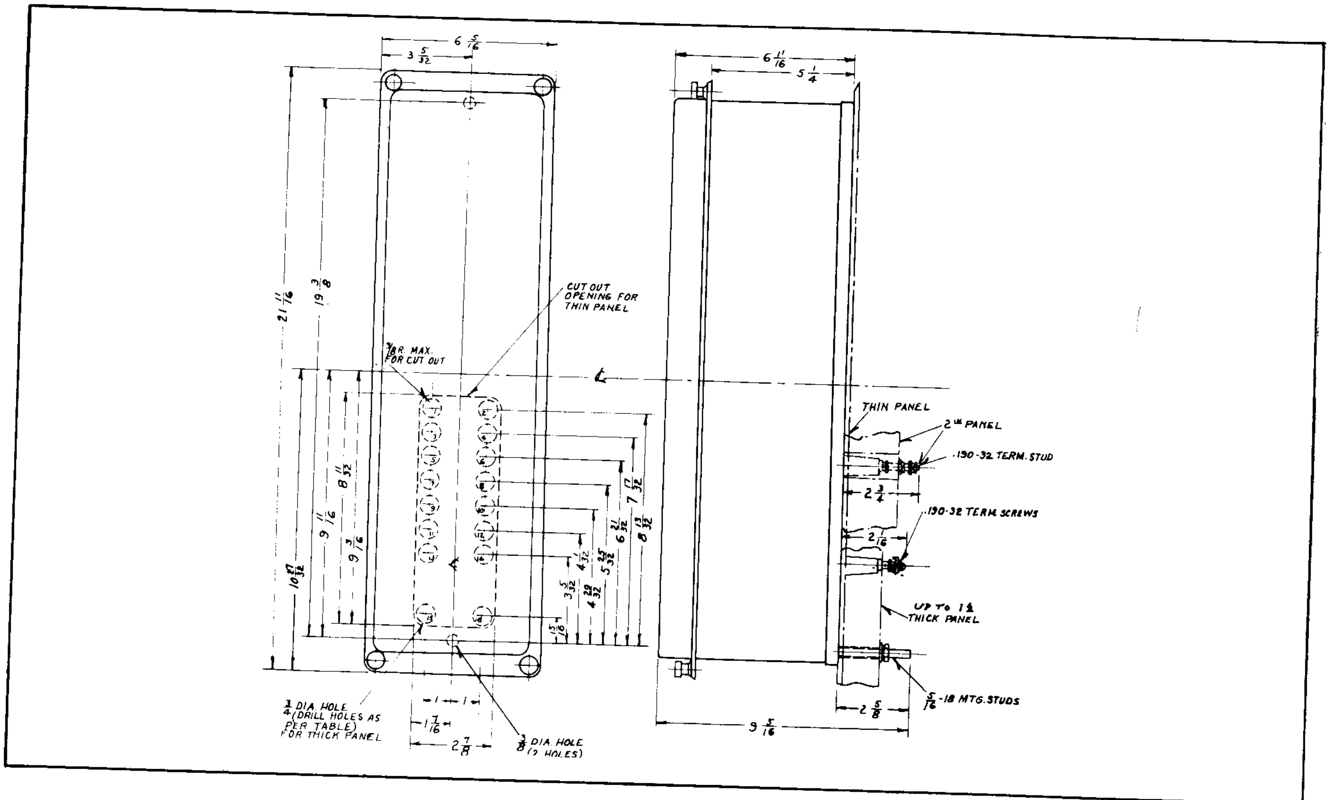


Fig. 10—Outline And Drilling Plan For The L10 Projection Type FT Case. See The Internal Schematic For The Terminals Supplied. For Reference Only. (9-B-2043)

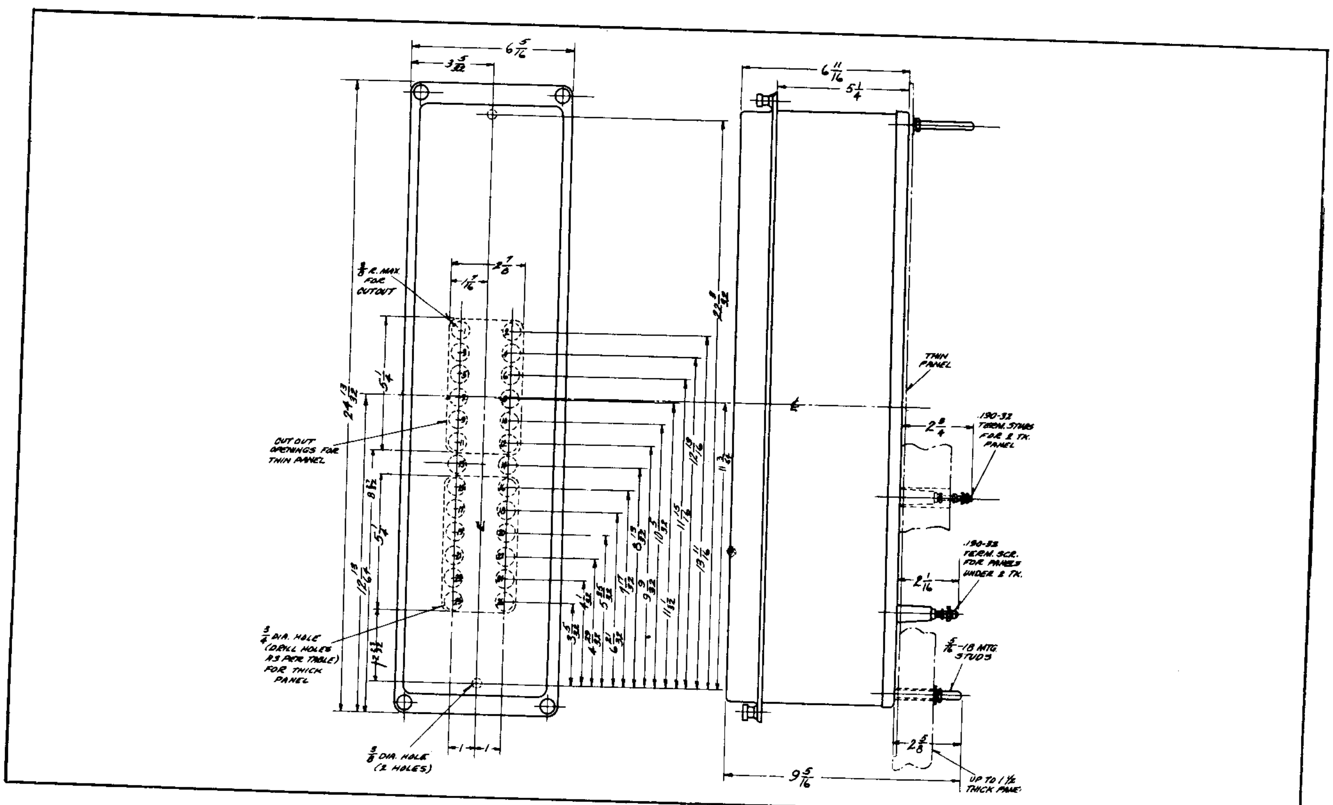


Fig. 11—Outline And Drilling Plan For The L20 Projection Type FT Case. See The Internal Schematic For The Terminals Supplied. For Reference Only. (9-B-2045)

WESTINGHOUSE ELECTRIC CORPORATION

METER DIVISION

NEWARK, N.J.

Printed in U.S.A.

INSTALLATION • OPERATION • MAINTENANCE
INSTRUCTIONS

TYPE SG MECHANICALLY INTERLOCKED AUXILIARY RELAY FOR STEP VOLTAGE REGULATORS STYLES 1274697 AND 1339369

CAUTION Before putting relays into service, remove all blocking which may have been inserted for the purpose of securing the parts during shipment, make sure that all moving parts operate freely, inspect the contacts to see that they are clean and close properly, and operate the relay to check the settings and electrical connections.

APPLICATION

The type SG mechanically interlocked auxiliary relay is used in the control circuit of step voltage regulators to energize the tap changer motor in the "raise" or the "lower" directions after other relays in the circuit indicate that a tap change should be made. It consists of two magnetic contactors which can be energized individually, with their armatures mechanically interlocked so that both armatures can not be closed simultaneously. It may be used in any other application for which its construction and electrical circuits make it suitable.

CONSTRUCTION

NOTE: This instruction leaflet pertains only to the style numbers given in the title. For general instructions on the type SG auxiliary relay, see I.L. 41-350.

The type SG mechanically interlocked auxiliary relay consists of two electromagnets mounted on a common insulating sub-base with a bar centrally pivoted between the two armatures so that both armatures can not be closed simultaneously. The armature of each element of relay S#1274697 carries four moving contact fingers. These engage stationary contacts to provide a total of six make and three break contacts, as shown in the internal wiring diagram. This relay is assembled in a cast iron base with glass cover. The armature of one element of relay S#1339369 has four moving contact fingers similar to relay S#1274697, although only three fingers are used. The second element has a two-contact armature as in the standard SG auxiliary relay. A total of two break, two make, and one break-make contacts are provided. Relay S#1339369 is assembled in the type FT case, which provides test switches in the relay circuits and permits easy removal of the relay element for inspection or maintenance.

CHARACTERISTICS

Each element of the relay will pick up at a voltage 80% or less of the rated voltage, provided the other element is deenergized. Because of the heavier armature and larger number of contacts, and because the application does not require continuous duty, the energy consumption is allowed to be somewhat greater than in the standard SG auxiliary relay and the coils should not be energized continuously. The burden of each electromagnet is approximately 19 v.a. at 115 volts, 60 cycles. The contacts will carry 12 amperes and will interrupt 30 amperes at 115 volts, 60 cycles.

RELAYS IN TYPE FT CASE

The type FT cases are dust-proof enclosures combining relay elements 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 welded steel housing containing the hinge half of the knife-blade test switches and the terminals for external connections. The cover is a drawn steel frame with a clear window

TYPE SG RELAY

Testing In Case

With all blades in the full open position, the ten circuit test plug can be inserted in the contact jaws. This connects the relay elements to a set of 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.

The external test circuits may be made to the relay elements by #2 test clip leads instead of the test plug.

Testing Out of Case

With the chassis removed from the base, relay elements may be tested by using the ten circuit test plug or by #2 test clip leads as described above.

INSTALLATION

The relays should be mounted on switchboard panels or their equivalent in a location free from dirt, moisture, excessive vibration and heat. Mount the relay vertically by means of the two mounting studs for the standard cases and the type FT projection case or by means of the four mounting holes on the flange for the semi-flush type FT case. Either of the studs or the mounting screws may be utilized for grounding the relay. The electrical connections may be made direct to the terminals by means of screws for steel panel mounting or to terminal studs furnished with the relay for ebony-asbestos or slate panel mounting. The terminal studs may be easily removed or inserted by locking two nuts on the studs and then turning the proper nut with a wrench.

ADJUSTMENTS AND 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. If the adjustments have been changed, the relay taken apart for repairs, or if it is desired to check the adjustments at regular maintenance periods, the instructions below should be followed.

The position of the break contact posts should be adjusted to obtain approximately 1/8 inch gap (except approximately 3/16 inch gap for the make contact of the two-pole element of S#1339369-A relay) between the moving contact and the make contact. The make contacts should have 3/64" to 1/16" follow and the break contacts should have 1/32" follow or more. All make contacts or all break contacts on the same element should close at approximately the same armature position. The position of the interlock arm post should be adjusted so that with either armature closed and the interlock arm touching it, the opposite end of the arm will be approximately 1/64" from the second armature. The interlock arm should not permit the make contacts of one element to touch until the make contacts of the other element are open approximately 1/16" or more.

The armatures and the interlock arm should operate freely, and the moving contact arms should operate freely on their guide pins.

All contacts should be periodically cleaned with a fine file. S#1002110 file is recommended for this purpose. The use of abrasive material for cleaning contacts is not recommended, because of the danger of embedding small particles in the face of the soft silver and thus impairing the contact.

RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable parts can be furnished to the customers who are equipped for doing repair work. When ordering parts, always give the complete nameplate data.

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