

IB-47-430



INSTRUCTIONS

TYPE "URL-8"
SINGLE PHASE POLE-TYPE
VOLTAGE REGULATOR

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



I.B. #47-430

I N S T R U C T I O N S

TYPE URL-8
FEEDER VOLTAGE REGULATOR

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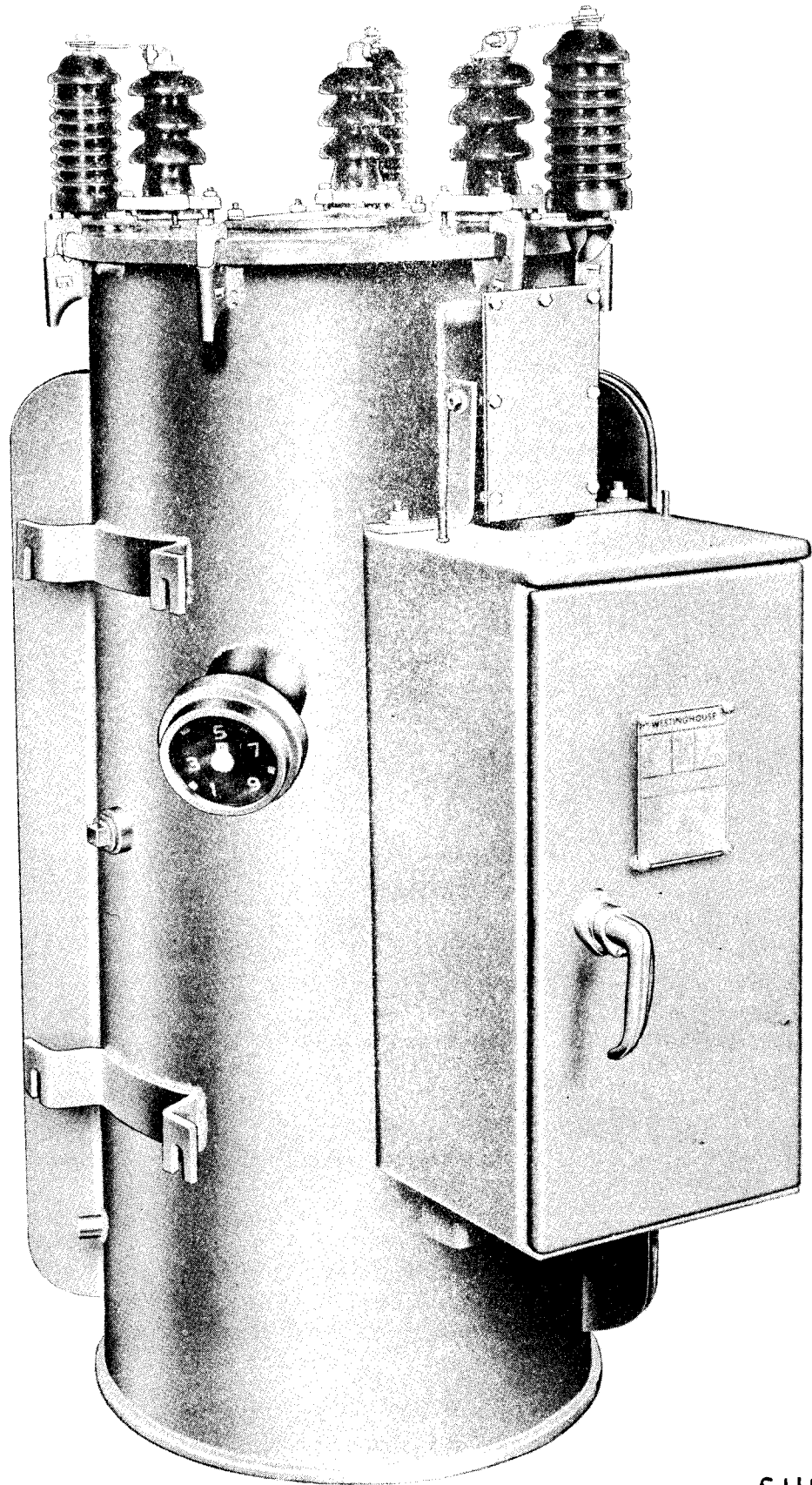
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URL-8

FEEDER VOLTAGE STEP 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.



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URL-8 REGULATOR

PART I

INTRODUCTION

The Type URL-8 Feeder Voltage Step Regulators are used to maintain constant normal voltage on feeder and rural distribution lines. They are built single phase for 10% regulation in 8, $1\frac{1}{4}\%$ 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 "Receiving, Handling and Storing" and refer to the section on "Installation" before connecting to the line. The very little maintenance necessary is generally in the nature given in Part Five on "Maintenance".

Component Parts

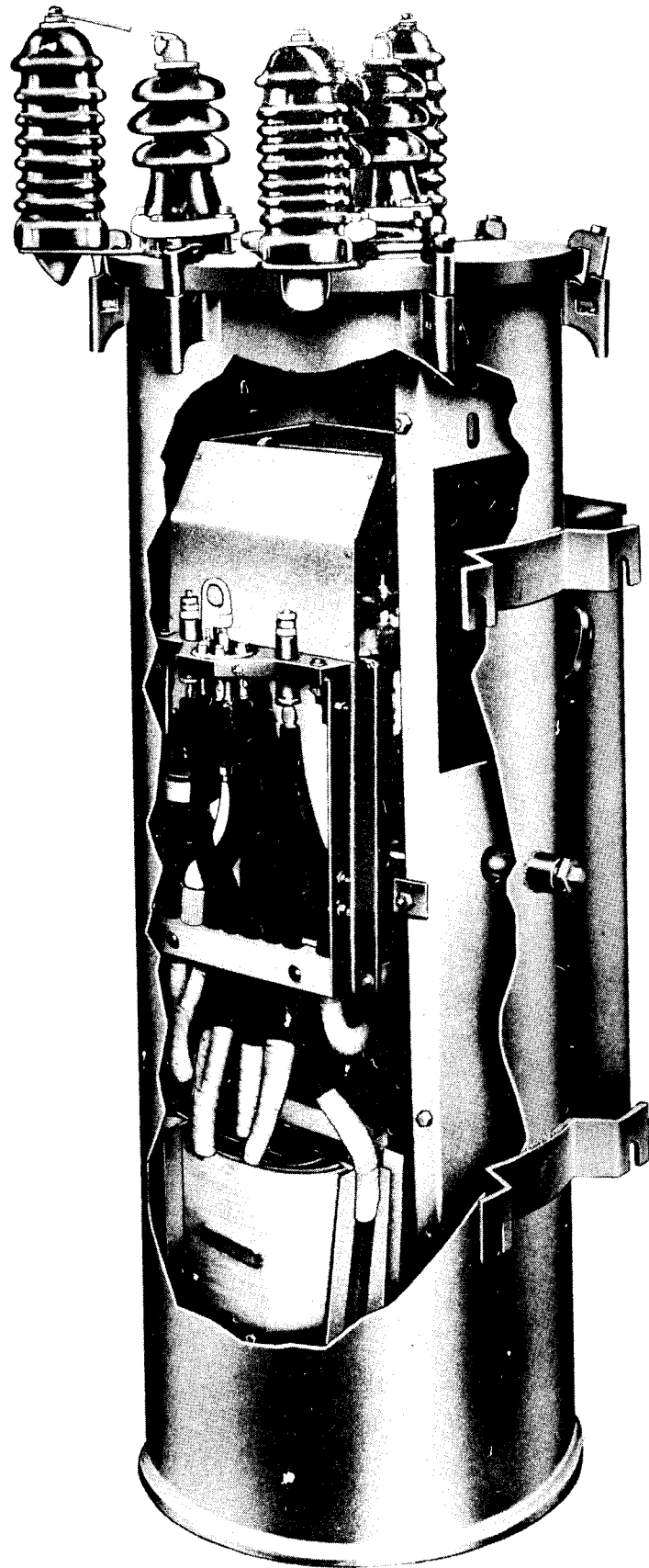
The feeder voltage regulator consists essentially of (1) a closed magnetic core upon which is wound a shunt or exciting winding and a tapped series winding, (2) an under load tap changer combined with a preventive auto to perform under load tap changing duty, (3) a tank for containing the insulating 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

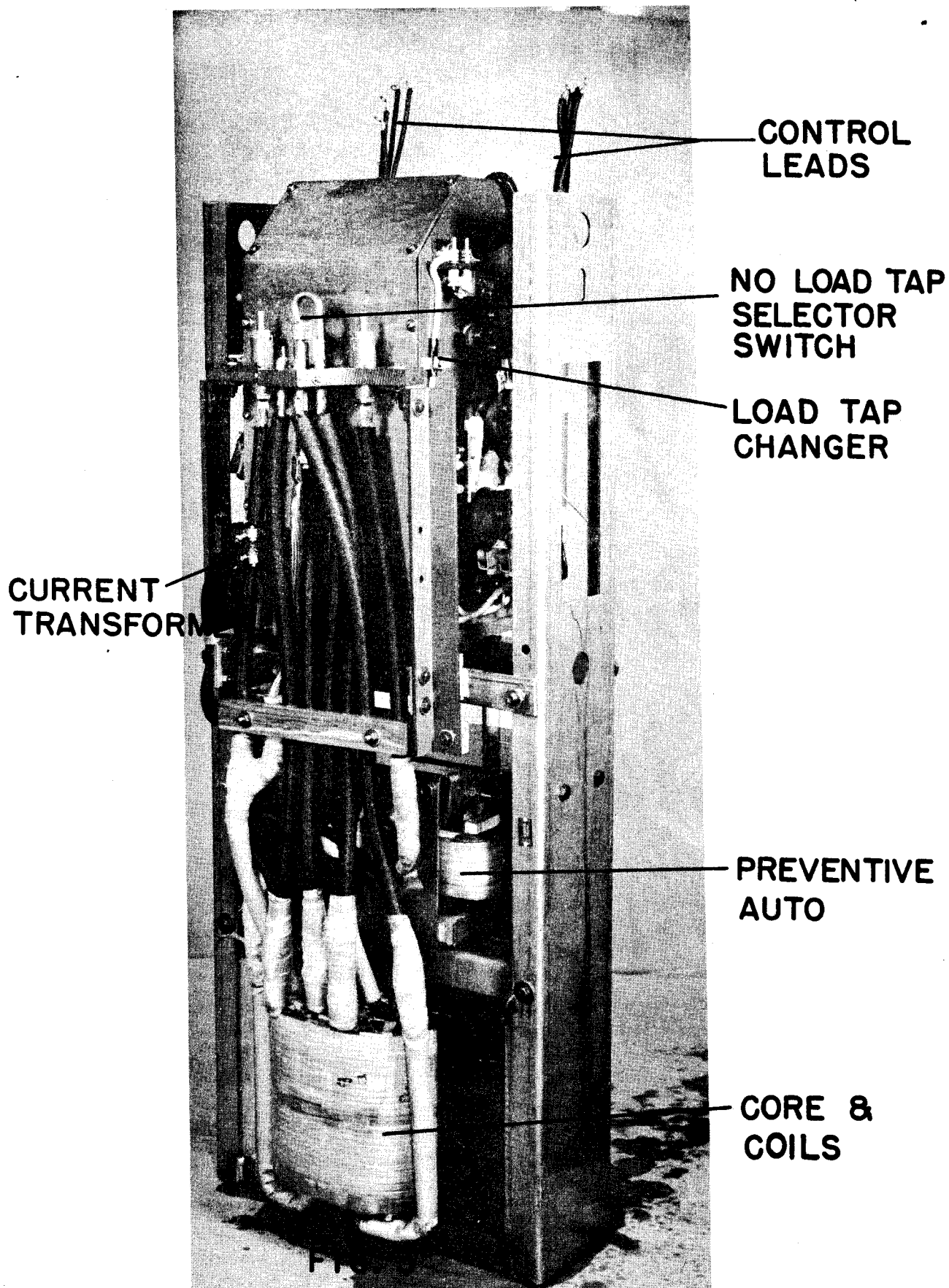
Unless specifically ordered otherwise, this apparatus has been built in conformance with current ASA, AIEE, NEMA and EEI-NEMA Standards.

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 EEI-NEMA "Preferred Voltage Ratings for AC Systems and Equipment."
2. When operating at reduced or increased voltage neither the current nor the Kva rating can be exceeded.



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 3,300 feet (1000 meters) unless regulator was designed for this service.
5. Ambient temperatures should not exceed 40 degrees centigrade.
6. Three Phase Application:
 - (a) On three-phase three-wire circuits, two URL-8 Regulators may be operated on open delta.
 - (b) On three-phase four-wire circuits, three URL-8 regulators may be connected wye 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 section on "Installation" for connection diagrams.



URL-8 REGULATOR CORE & COIL ASSEMBLY

PART II

DESCRIPTION (General)

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

- (1) The regulating transformer core and coils, a preventive auto 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 EEI-NEMA 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 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 handhole 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 & Coil Assembly

The regulator core and coil assembly consists of a tapped regulating auto transformer with a Type "C" Hiper-sil core, a preventive auto transformer, a load tap changer and a no load tap selector switch, all mounted on a common frame. See Figure 3.

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.

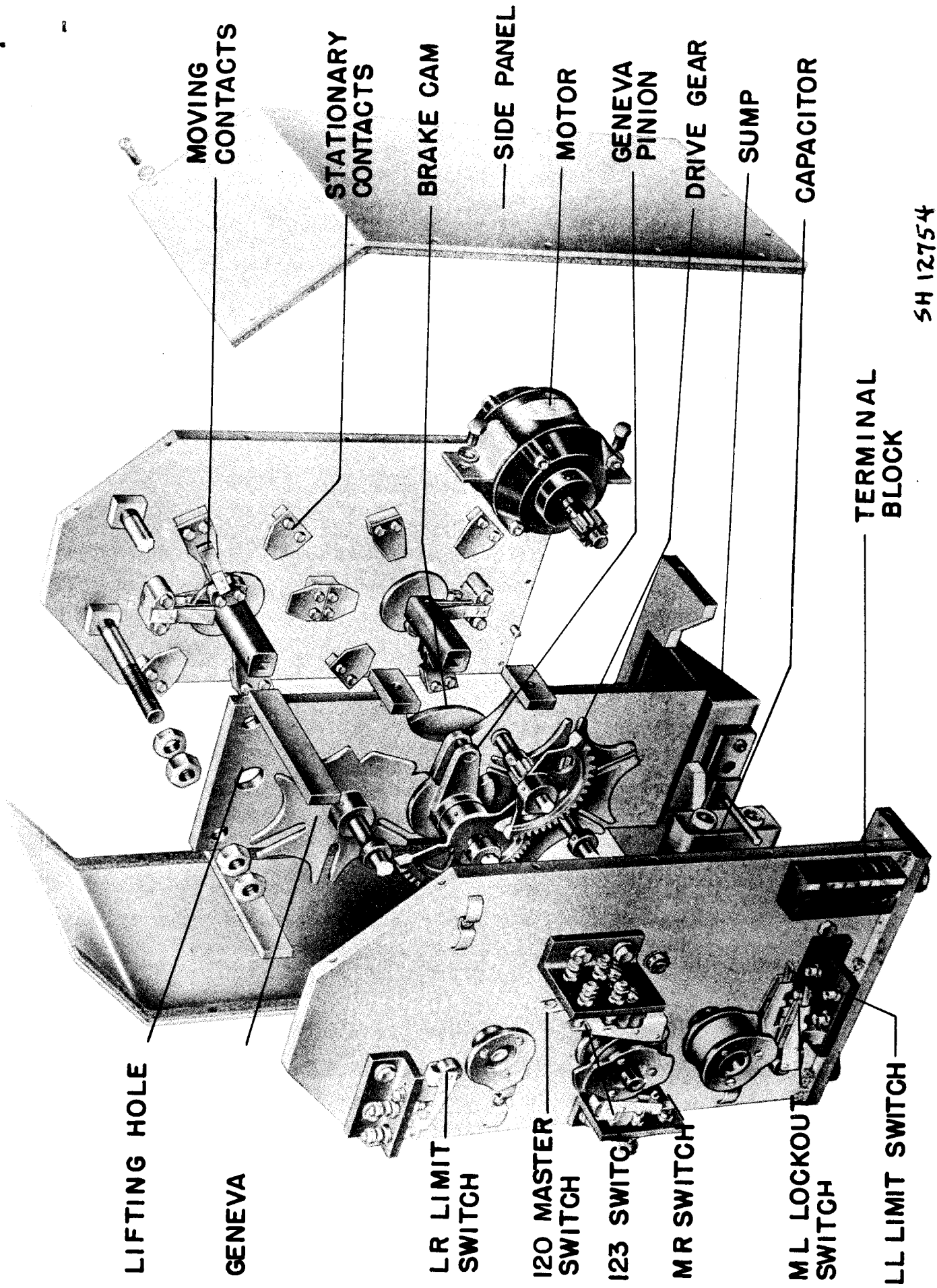
The under load tap changer and the no load tap selector switch are mounted above the core and coils and the entire assembly is lowered into the tank and fastened into place as a complete unit.

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

URL-8 Load Tap Changer Mechanism

The Type URL-8 underload tap changer is a quick break, geneva gear mechanism with direct connection to the driving motor (see Fig. 5). The mechanism, completely enclosed to prevent the 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 Figure 2 and exploded view Figure 4.)

A magnetic type position indicator that requires no packing glands in the tank wall, is located at a 25° 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.



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URL-8 TAP CHANGER MECHANISM

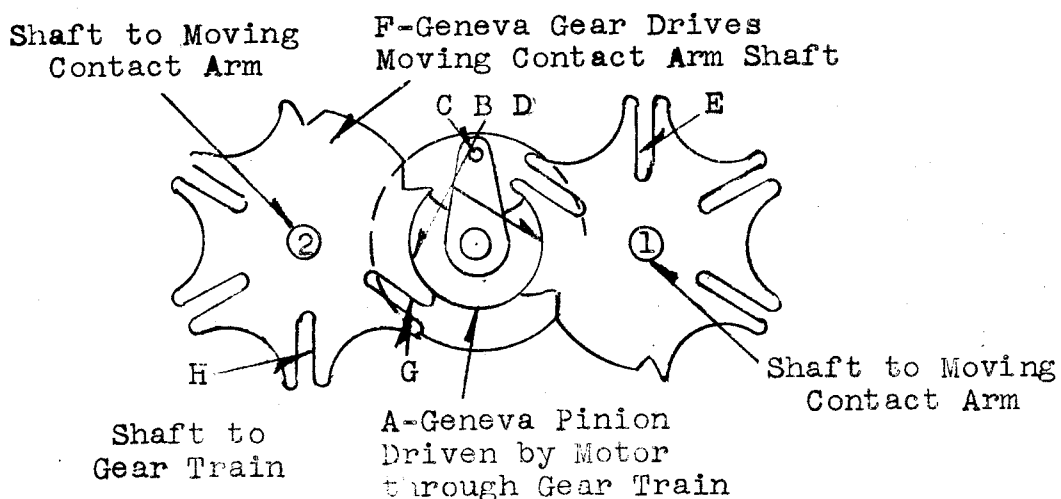
The stationary contacts of the tap changer are mounted in two circles on a Micarta insulating panel which forms the rear wall of the tap changer. Each of the moving contacts are mounted on the preventive auto bus attached to rotating shafts. To make a tap change, one shaft moves its contact to the next tap. This is termed "bridging" position, since the preventive auto 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.

Schematic Operation of Tap Changer Driving Mechanism



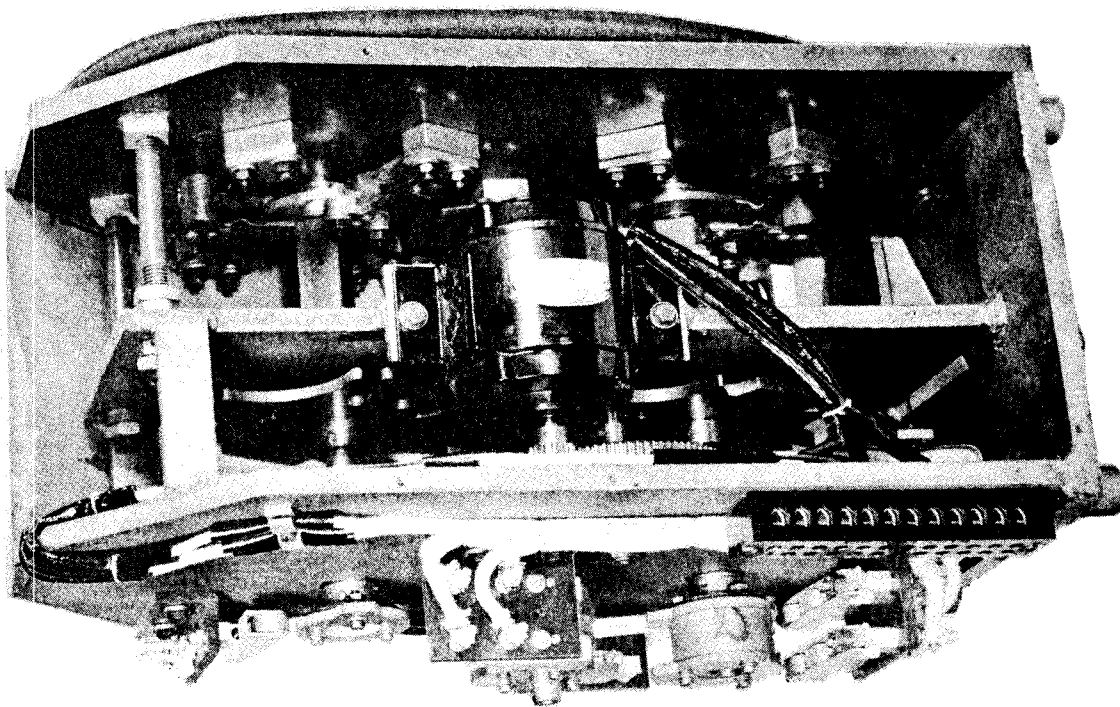


FIG. 5 URL-8 TAP CHANGER MECHANISM

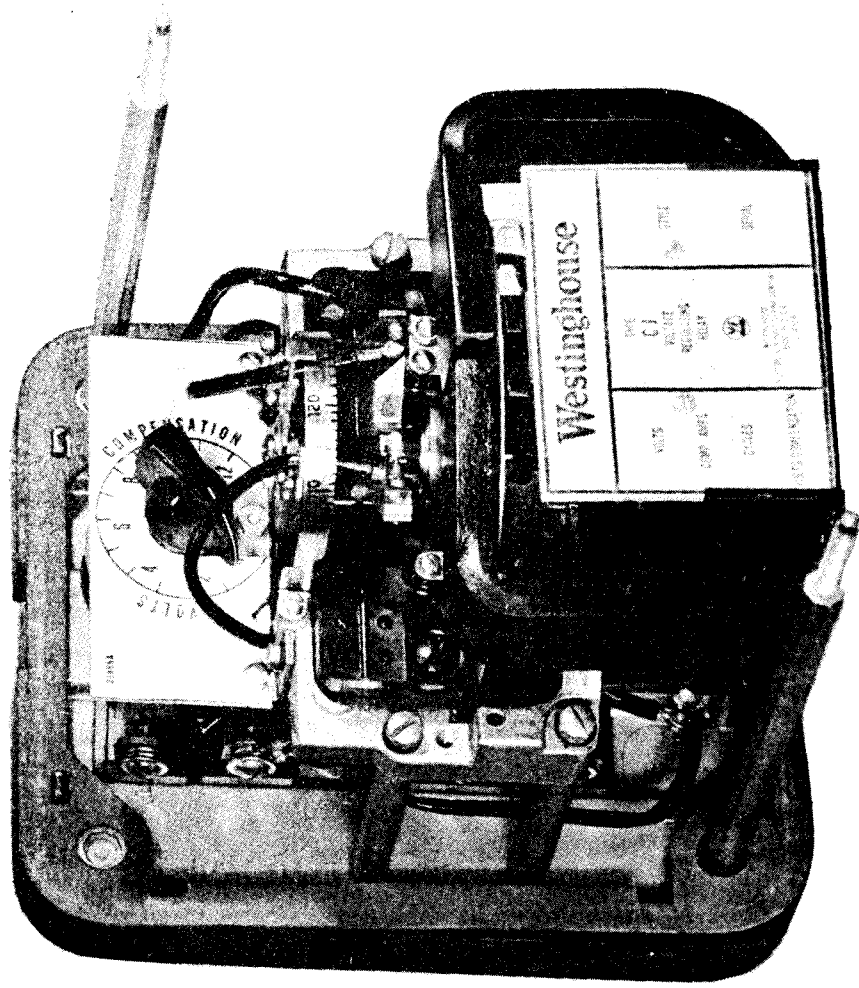


FIG. 6 CJ VOLTAGE REGULATING RELAY

The schematic operation of the tap changer driving mechanism is shown. 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 stationary contact. This constitutes a complete bridging tap change or a $1\frac{1}{4}\%$ 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 $2\frac{1}{2}\%$ in two $1\frac{1}{4}\%$ 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. 7 & Fig. 8). 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 #14 wire must be provided as these items are not supplied as part of the standard regulator as listed. See instructions under "Installation".

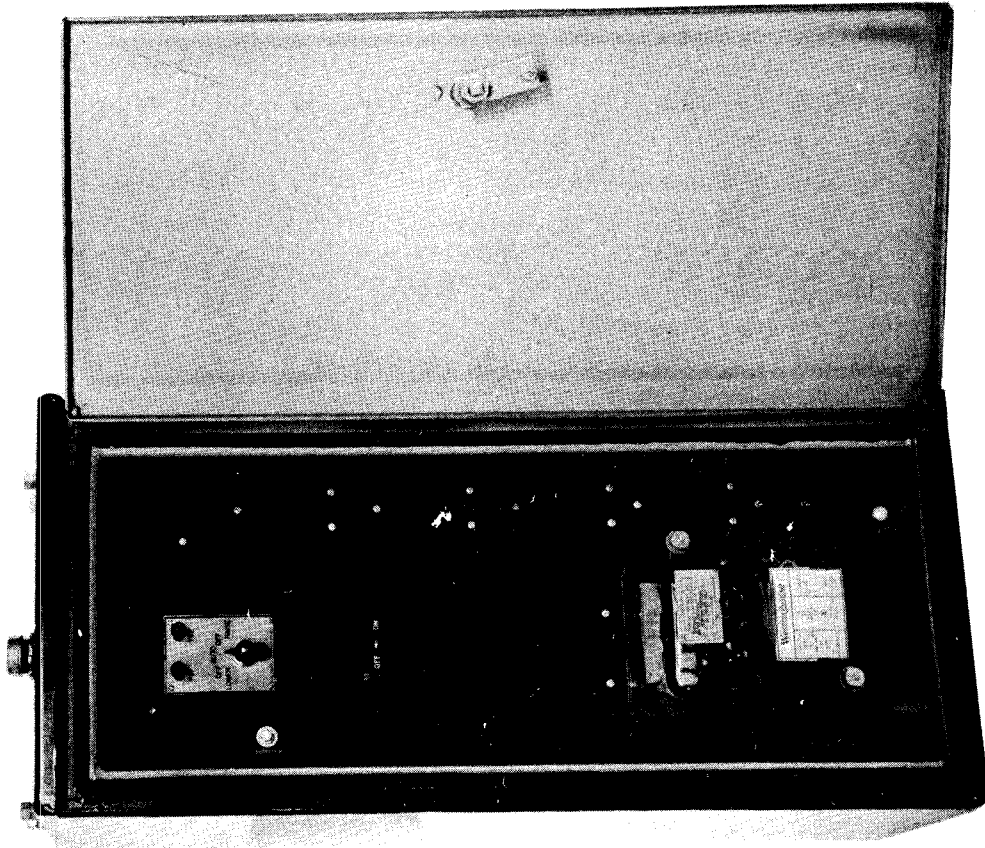


FIG. 7
FRONT VIEW OF CONTROL
PANEL MOUNTED IN CABINET

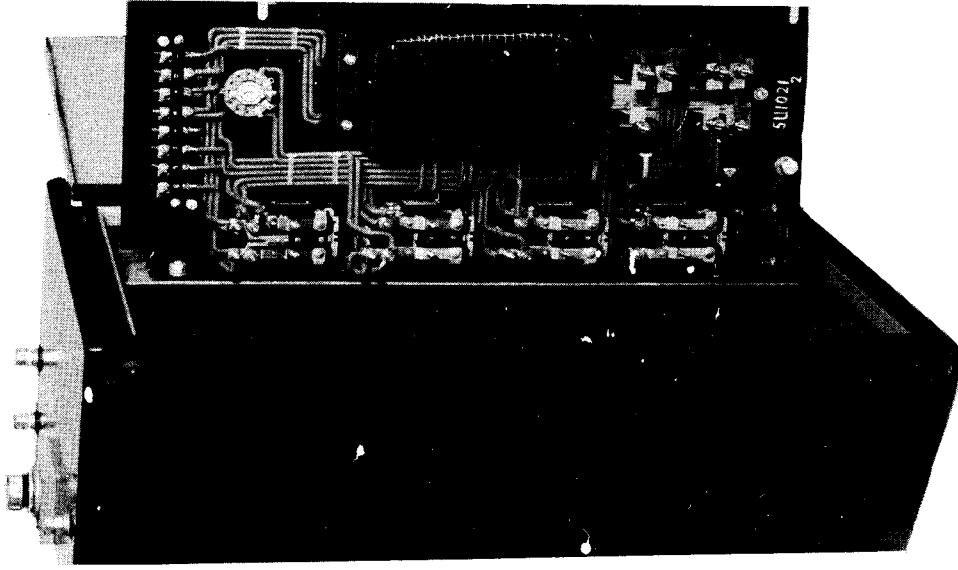


FIG. 8
REAR VIEW OF CONTROL
PANEL WITH PANEL SWUNG OUT

Control equipment mounted on the control panel includes:

- 1 CJ Voltage Regulating Relay with built-in line drop compensator and external reactor.
- 2 Low Energy Relays.
- 3 Motor Control Relays.
- 2 Compounding Resistors.
- 1 Automatic-manual raise-manual lower switch.
- 1 Control supply switch with automatic overload trip.
- 2 Output voltage testing terminals.

The "CJ" Voltage Regulating Relay

Automatic operation is initiated by means of the voltage regulating relay which is responsive to changes in the load voltage. The relay (as well as the control and tap changer motor) is energized from an auxiliary winding (TG) on the regulating transformer which supplies voltage proportional to that on the load side of the regulator.

The "CJ" voltage regulating relay (Fig. 6) inherently has an inverse time delay characteristic which provides for a suitable time delay before its contacts close. A line drop compensator which is easily adjusted for any value up to 13 volts by a single dial located on the face of the relay makes the control responsive to load current as well as load voltage. See Instruction Leaflet #41-299 on the "CJ" voltage regulating relay.

Low Energy Relays

The voltage regulating relay contacts carry only the current necessary to operate the low energy relays. They have exceedingly fast response and serve to energize the motor control relays.

Motor Control Relays

The Type "SG" motor control relays are interposed between the low energy relays and tap changer motor, and serve to carry the motor current and provide for the control interlocking circuits. See Instruction Leaflet IL-41-350 on the SG relay.

Compounding Resistors

The compounding resistors controlled by the "120" SG relay provide negative compounding for the primary relay to insure positive opening of the raise or lower contacts after the tap changing cycle has been started.

The Automatic Manual Switch

The automatic manual switch is a dual purpose switch serving either to connect the control circuit for full automatic operation or to allow manual operation of the control to raise or lower the position of the tap changer.

Output Voltage Testing Terminals

Output voltage testing terminals are used for reading the regulated voltage or as a connection for applying a separate control voltage for testing the control. When used for testing purposes, care must be exercised to open the safety switch and thus prevent the test voltage from feeding back into the main transformer unit.

Cover Type Bushings and De-ion Arresters

The URL-8 Regulator has cover type bushings which are arranged in accordance with ASA 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 solidly grounding the unit.

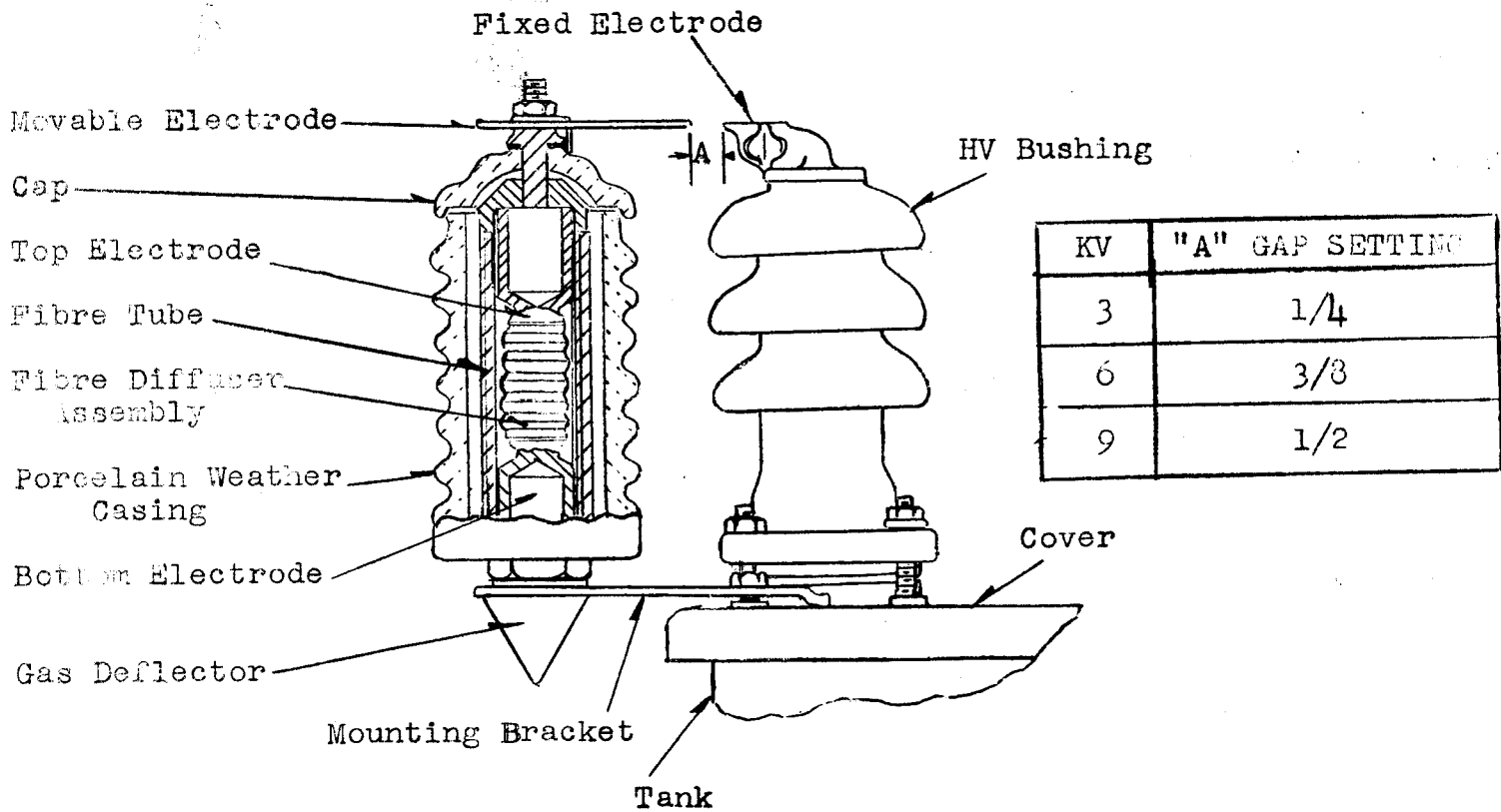


Figure 9

Externally Mounted "De-ion" Lightning Arrester and Gap Adjustment

PART III

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 Figure 9. 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 bypassing. 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. Warning: Extreme care must be taken to insure that the safety switch is in the "OFF" position before applying test voltage. Otherwise, the regulating transformer may become energized through the auxiliary winding.

The following sequence of tests is recommended:

- A. Apply 120 volts or voltage at which primary 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 without pause when the auto-manual switch is left on one position.
- B. Place the auto-manual switch on "Auto" and reduce voltage 3 volts below balance voltage. After a time delay the "CJ" 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 3 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. The 5000 volt URL-8 Regulator is provided with 3 taps on the auxiliary winding so that the regulator will have suitable control voltages when applied on 2500 and 4330 volt lines at reduced capacity. Likewise, the 7620 volt unit has two taps on the auxiliary winding for suitable control voltages when the regulator is applied on 7200 and 7960 volt lines.

Simply remove junction box cover on side of tank and move the "T" lead to the appropriate stud as indicated by the wiring diagram. Control voltages will be indicated on the nameplate.

Mounting the Regulator

Figure 10 shows a typical installation of a Type URL-8 regulator using two crossarms and Type "C1" 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 transformer 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 transformer 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: 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. Remove the cover plate on the junction box and disconnect the leads. Pull out the leads and remove fitting on the inside of the junction box and also remove the control cabinet brackets.

TYPICAL INSTALLATION OF URL-B REGULATOR

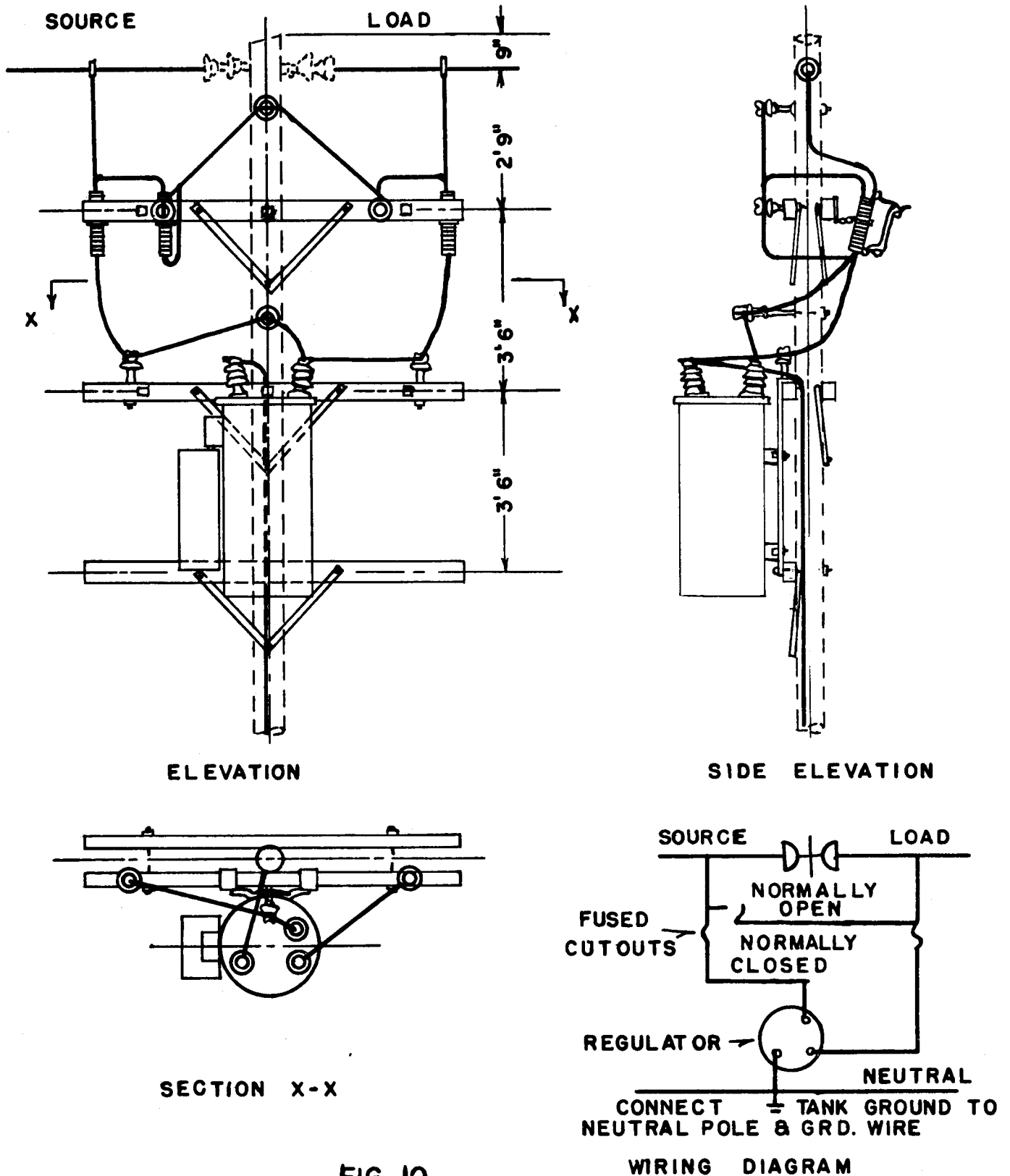
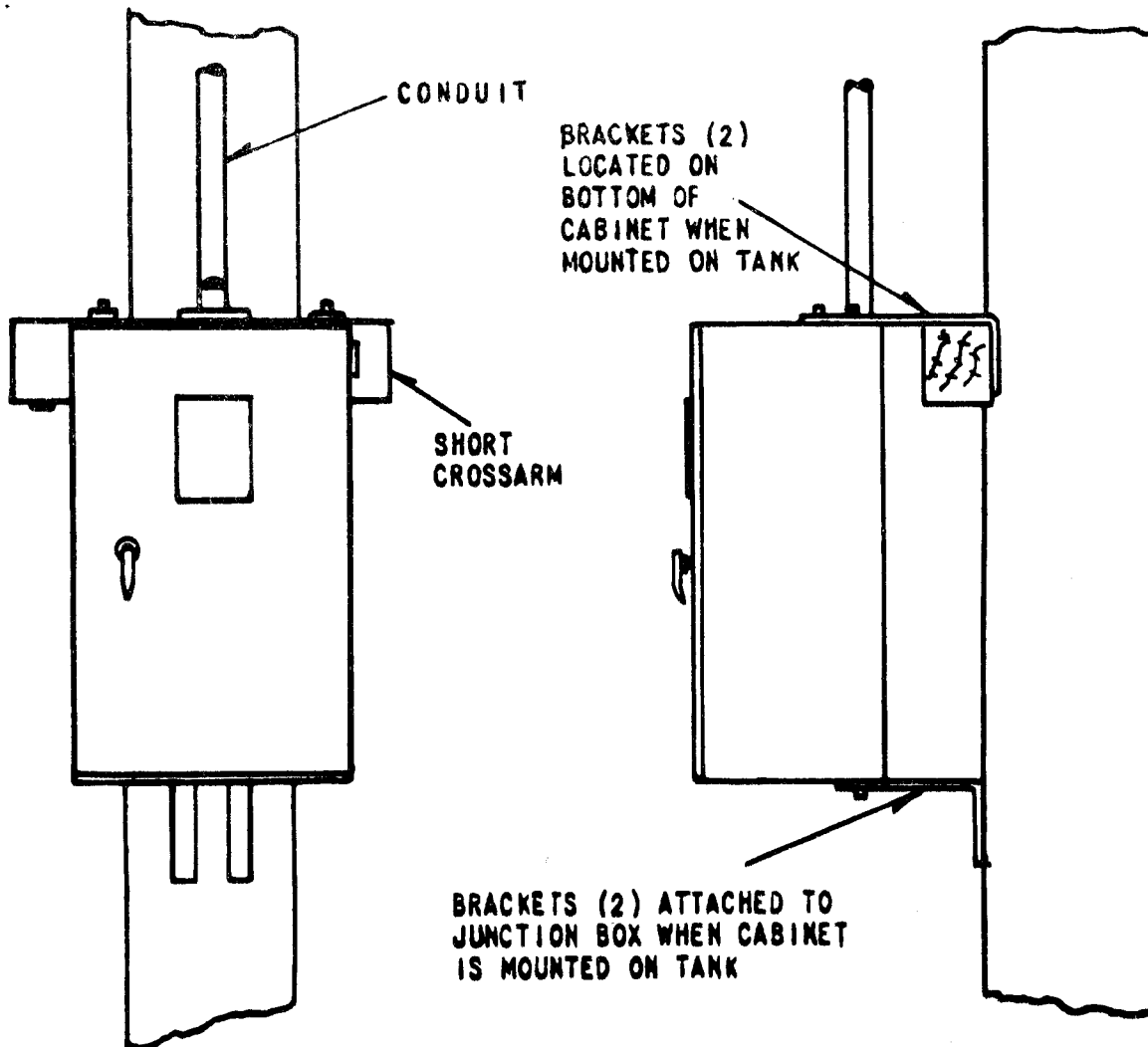
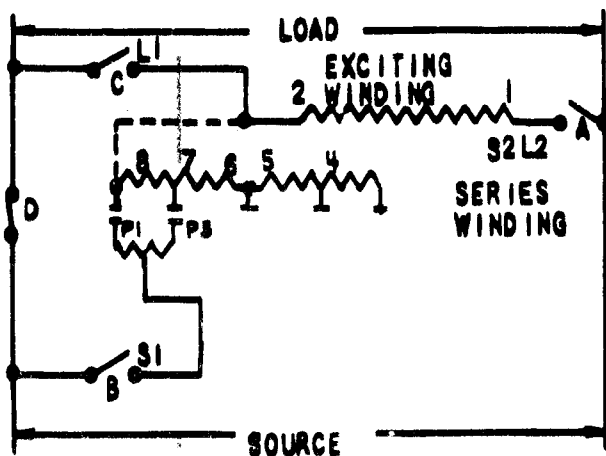


FIG 10



CONTROL CABINET MOUNTED AT BASE OF POLE



SCHEMATIC DIAGRAM, CONNECTING OR BY-PASSING REGULATOR. A-B-C-D DISCONNECT SWITCH OR CUTOUT. CAUTION: SET CONTROLS FOR BY-PASSING TO CORRESPOND TO CONNECTIONS ON TERMINAL BOARD AS CALLED FOR ON NAMEPLATE AND SPECIFIED DIAGRAM. WITH "A" CLOSED, THE CIRCUIT THROUGH "B", "C" AND "D" MUST NOT PROVIDE A SHORT CIRCUIT THROUGH ANY PART OF SERIES WINDING.

CONNECTIONS FOR BY-PASSING SWITCHES

The brackets may then be inverted and used at the new location as shown in Fig. 11. After locating the cabinet in the new position, connect cabinet to junction box with conduit and pull in new leads using not less than #14 wire. Connect like number studs on the two terminal blocks and tape the leads together in the control house. Be sure to allow enough slack in the leads so that control panel will swing out, yet not too much so as to interfere with the relays on the back of the panel.

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 do 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 12.

When this method is used to connect a regulator to the line, it is very important that the regulator be operated to "neutral" position.

The safety switch 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 safety switch 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 safety switch and to turn the automatic manual transfer 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 safety switch 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 diagram. The regulators are connected in series with the lines and therefore are protected by line fuses of 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. Single phase URL-8 regulators are insulated for operation in banks of three units connected in star 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 star.

When connecting in open delta or star 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.

Single Phase Installation

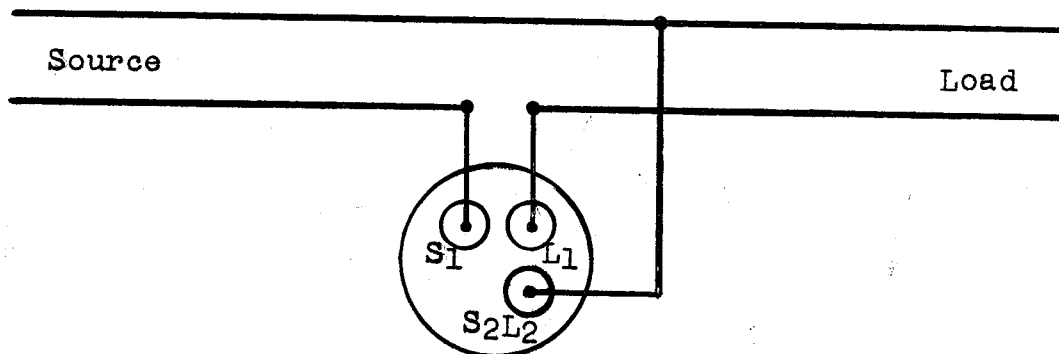


FIG. 13

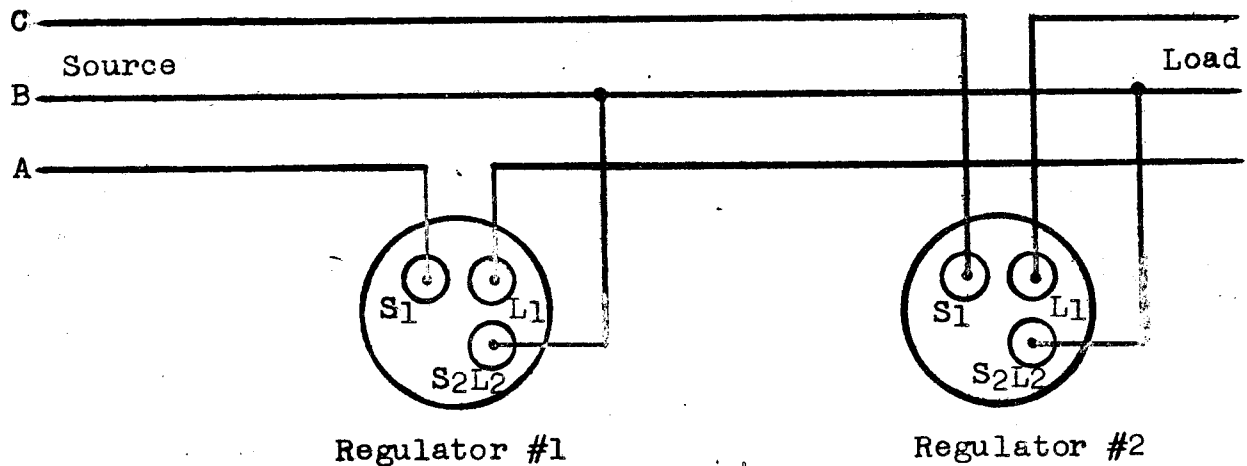


FIG. 14

Three Phase 3-Wire Circuit
 Units Connected Open Delta
 Phase Rotation A - B - C

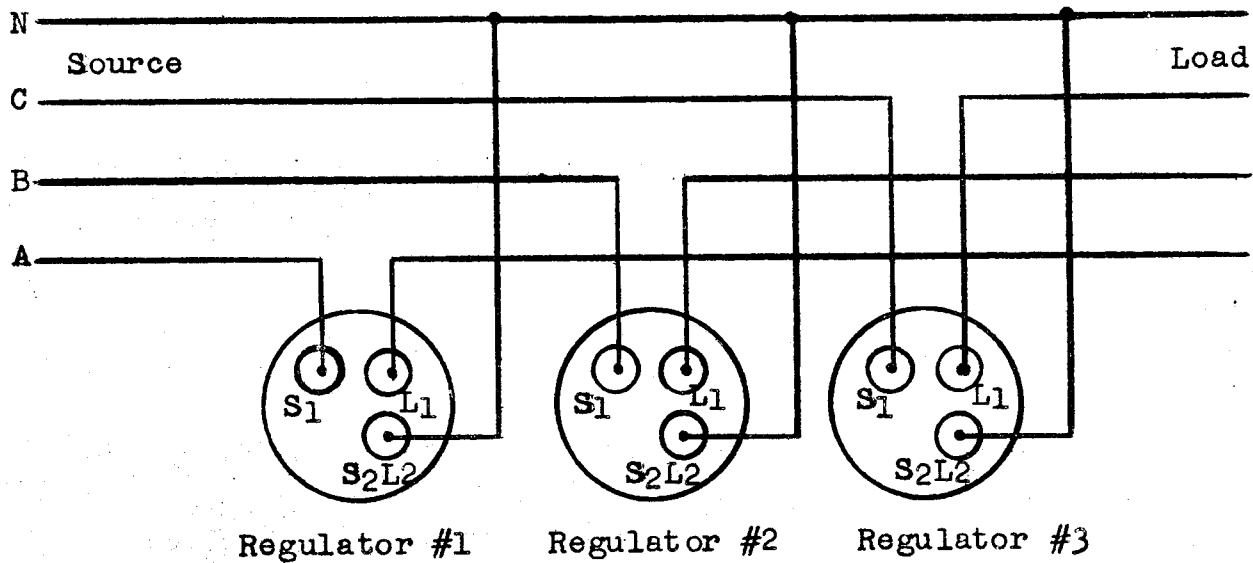


FIG. 15

Three Phase 4-Wire Circuit
 Three Units Connected on a 3-Phase
 4-Wire Circuit
 Phase Rotation A - B - C

PART IV

OPERATION

Principles of Operation

The diagram of connections of the Type URL-8 voltage regulator is shown schematically in Figure 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 2 to 8) are brought to the no load tap selector switch for manual selection of the range of regulation, and to the load tap changer contacts for automatic tap changing within the range selected. Tables showing the various combinations of buck and boost are shown in Figure #17.

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° 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 geneva pinion through 180° , 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.

Principle of Operation of 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 auto-manual switch 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 MC-L energizing the SL relay which closes the SL-3 contact, operating the tap changer in a lower direction. Similarly placing the dial switch on RAISE closes MC-R operating, closes SR-3 contact, 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 circuit so that the CJ voltage regulating relay initiates the tap changer operation. If the voltage becomes too low the PR contacts of the CJ relay close, operating the low energy relay AR. The time delay after the voltage change until PR closes depends upon the magnitude of the voltage change and the band width setting of the relay. Due to the inverse time characteristics of the CJ relay, a small voltage change will take a relatively longer time, or a large voltage change will require a relatively shorter time to close the CJ relay contact.

The operation of AR closes AR-1, which seals the AR relay in closed position and removes burden from PR contact and closes AR-3 which operates the SR relay.

The operation of SR closes SR-3 to start the tap changer motor. The tap changer movement closes the 120 pilot switch and later opens the 123 pilot switch. The 120 pilot switch closing operates the 120 SG which closes 120 SG-1 and 120 SG-3. 120 SG-1 seals in the SR relay until the tap change is completed. 120 SG-3 applies negative compounding to CJ relay by connecting resistor R1 across reactor which causes PP coils before completion of tap change to anticipate the voltage change which will result from the tap change.

If the voltage unbalance requires more than one tap changer the necessary changes will be made with slight pauses between steps. A similar sequence of operations takes place for tap changes in lower direction.



FIG. 17 SETTING TAP SELECTOR SWITCH

TABLE OF CONNECTIONS					
TAP SELECTOR CONNECTS	1 1/4 % PER STEP		LOAD VOLTS	L1 L2 = 100 %	NEUTRAL POSITION FOR BY-PASSING
	NO STEPS BOOST	NO STEPS BUCK	MAXIMUM SOURCE VOLTS S1 S2	MINIMUM SOURCE VOLTS S1 S2	
2 TO 8	8	0	100 %	90 %	1
2 TO 7	6	2	102 1/2 %	92 1/2 %	3
2 TO 5-6	4	4	105 %	95 %	5
2 TO 4	2	6	107 1/2 %	97 1/2 %	7
2 TO 3	0	8	110 %	100 %	9

PART V

MAINTENANCE

Inspection

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

Oilless bushings are used for the H.V. 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 periodical 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 the instruction leaflet on 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 hanger iron lugs.

The adjustments and settings of the primary relay are described in the leaflet on the "CJ" voltage regulating relay. Maintenance of the motor control relays is covered in the instruction leaflet on "SG Relays". If relay contacts should need dressing use only a very fine file.

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.

Overhaul and Repair

Correction of Minor Troubles:

- A. 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" voltage regulating relay will indicate the magnitude of the voltage. If the voltage is high, the right hand contact of the "CJ" will close and if the voltage is low, the left hand contact of the "CJ" 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).
 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#954939.
 - b. Capacitor may be open. Capacitor is 10 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 the Instruction Leaflet for the relay.

Major Overhaul and Repair

General Discussion

1. When the periodical inspection shows that the arcing contacts will have to be replaced the following procedure is recommended:
 - a. Put regulator on by-pass position, disconnect from the line and remove from the pole.
 - b. 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.
 - c. 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.
 - d. Remove the tap changer sump drain plug on outside of tank immediately below the hanger iron lugs. Then remove the tap changer sump drain pipe with a pair of pliers.
 - e. The complete core and coil assembly including the tap changer can then be lifted out of the tank.
 - f. Removing one side panel from the tap changer will provide room enough to replace arcing contacts.
 - g. 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.

Test after Overhaul and Repair

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

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 Arrester



IB-47-430-1

INSTRUCTIONS

TYPE "URL-8"

SINGLE PHASE POLE-TYPE

VOLTAGE REGULATOR

WESTINGHOUSE ELECTRIC CORPORATION

SHARON PLANT

TRANSFORMER DIVISION

SHARON, PA.

URL-8 POLE TYPE VOLTAGE REGULATOR
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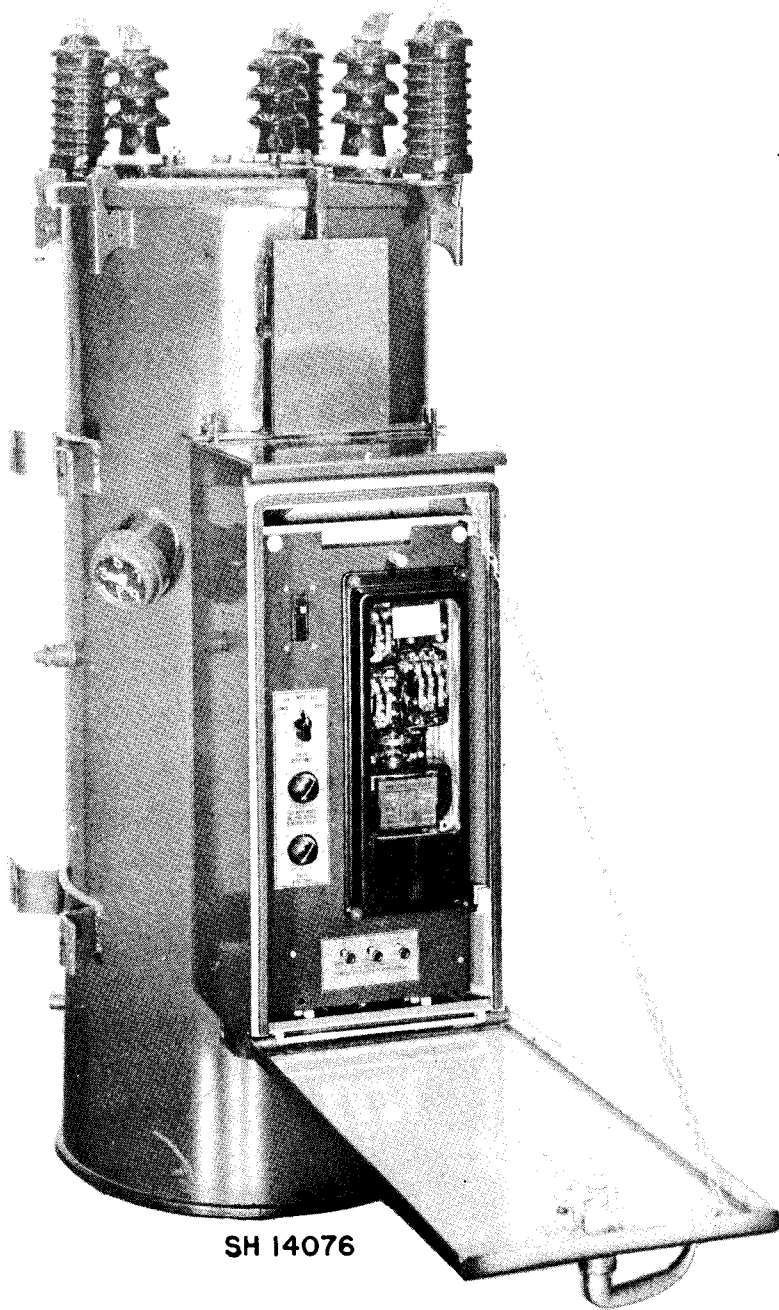
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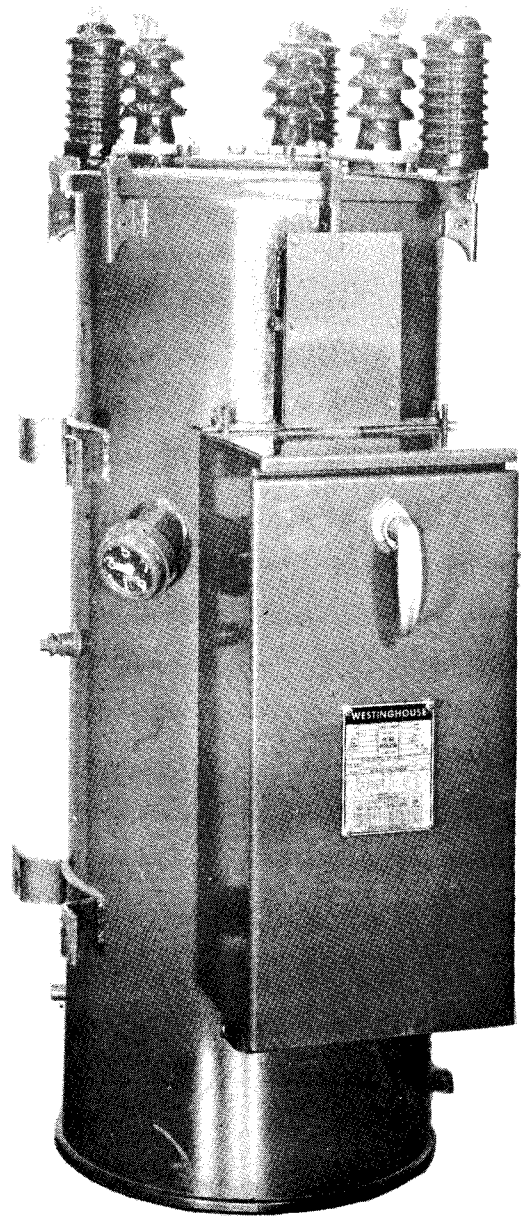
URL-8 POLE TYPE VOLTAGE REGULATORS

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.



SH 14076



SH 14075

URL-8 POLE TYPE VOLTAGE REGULATOR

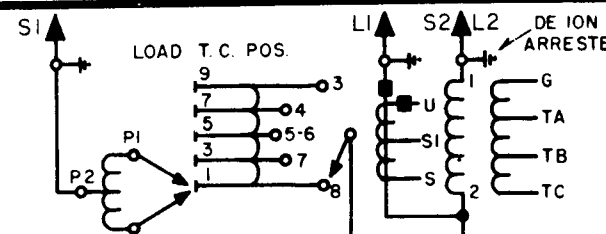
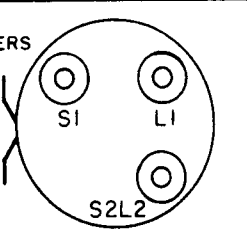
WESTINGHOUSE

	KV-A.	SINGLE PHASE TYPE URL-8 VOLTAGE REGULATOR CLASS 0A	GAL. OIL		
	VOLTS		WIRING DIAGRAM		
	AMPS.		SERIAL		
	CYCLES		I. B.		
	IMP.		TG TAP	HIGH VOLTAGE	CONTROL V.
	°C. RISE				
	STYLE OR S.O.				

FULL WAVE IMPULSE TEST LEVEL: HIGH VOLTAGE KV.

APPROX. WT. IN LBS. CORE AND COILS CASE OIL TOTAL

PATENTS 1874824—1905249—1909068—1923927—1923748—2010018—2293951—2447634
 MADE IN U. S. A. **WESTINGHOUSE ELECTRIC CORPORATION** 61032-A

TAP SELECTOR CONNECTS	NUMBER STEPS		LOAD VOLTS L1 L2=100%		CONTINUOUS LOAD CURRENT % RATED	TAP CHANGER BY-PASS POSITION
	1½% PER STEP		SOURCE VOLTS S1—S2			
	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

VOLTAGE AND CURRENT RATINGS ARE FOR L1 L2 LEADS
 TO BY PASS, OPERATE TO NEUTRAL POSITION AND OPEN SAFETY SWITCH.

FIG.1-A TYPICAL URL-8 INSTRUCTION PLATE

PART ONE

INTRODUCTION

Application

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% regulation in 8, $1\frac{1}{4}$ % 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 "Receiving, Handling and Storing" and refer to the section on "Installation" before connecting to the line. The very little maintenance necessary is generally in the nature given in Part Five 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 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 ASA, AIEE, NEMA and EEI-NEMA Standards.

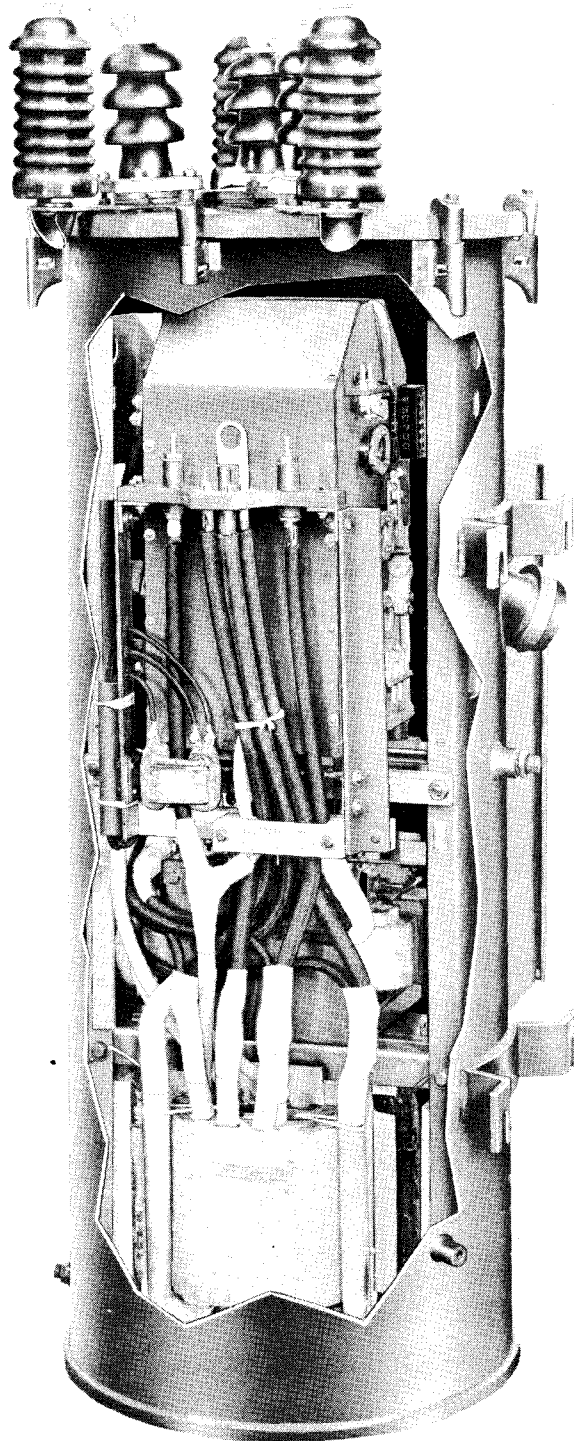
Care should be used that the following major operating limits are not exceeded:

1. The regulator is designed to operate over a voltage range as specified by EEI-NEMA "Preferred Voltage Ratings for AC 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 in the instruction plate.)

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.
5. Ambient temperatures should not exceed 40 degrees centigrade.
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 and load voltage characteristics 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 connected wye 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 section on "Installation" for connection diagrams.



**FIG. 2 CUTAWAY OF THE URL-8 POLE TYPE
VOLTAGE REGULATOR**

PART TWO

DESCRIPTION

General

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

- (1) The regulating transformer core and coils, a preventive auto, 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 EEI-NEMA 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 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 handhole 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.

DESCRIPTION

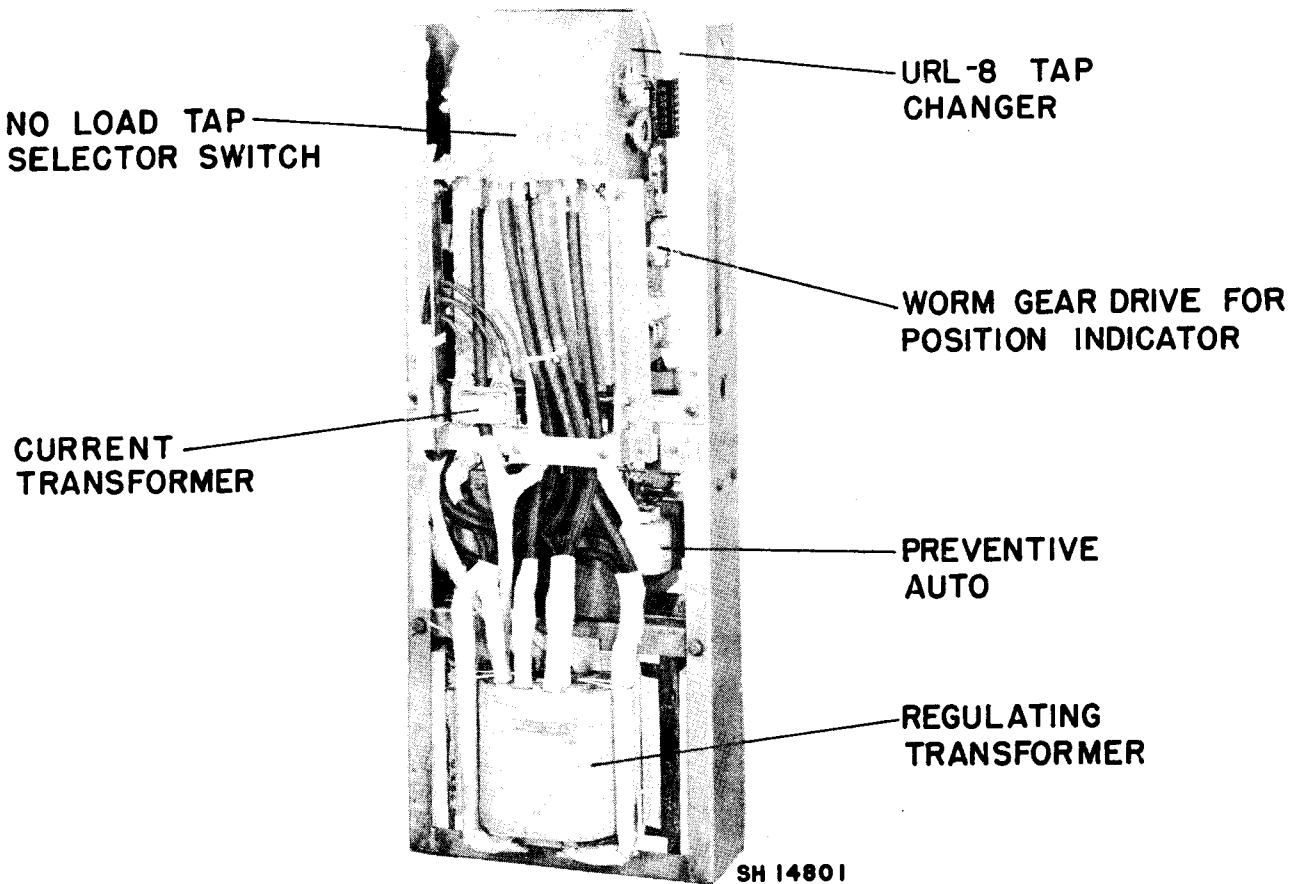


FIG. 3 REGULATOR CORE AND COIL ASSEMBLY

The regulator core and coil assembly 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."

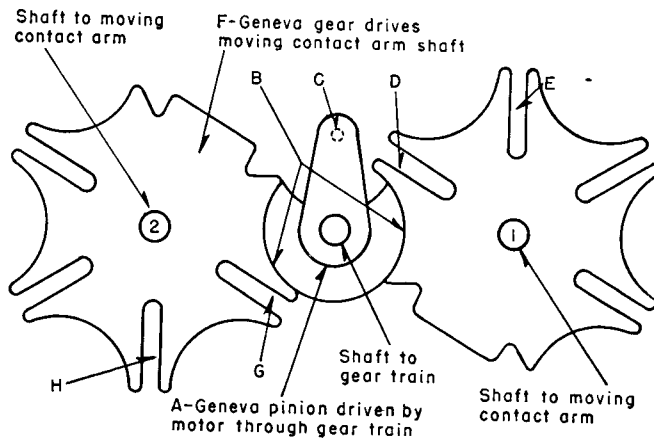
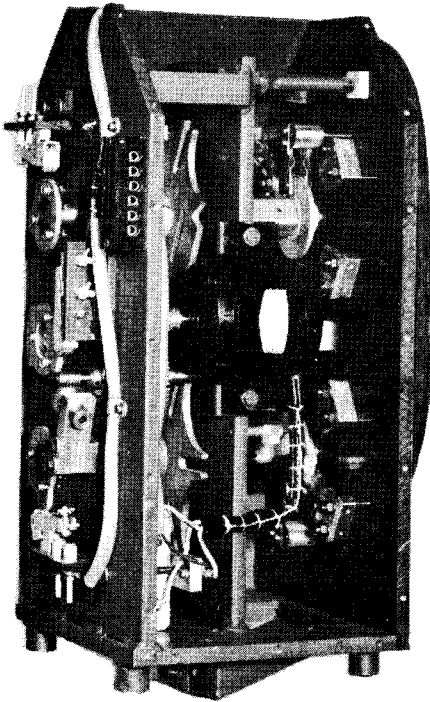


FIG. 5 SCHEMATIC OPERATION OF
TAP CHANGER DRIVING
MECHANISM

FIG. 4 THE URL-8 LOAD TAP CHANGER MECHANISM

The Type URL-8 Underload Tap Changer is a quick break, geneva gear mechanism with direct connection to the driving motor (see Fig. 4). The mechanism, completely enclosed to prevent the 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 Figure 2 and exploded view Figure 6.

A magnetic type position indicator, that requires no packing glands in the tank wall, is located at a 25° 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.

DESCRIPTION

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 preventive auto 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 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. 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 stationary contact. This constitutes a complete bridging tap change or a $1\frac{1}{4}\%$ 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 $2\frac{1}{2}\%$ in two $1\frac{1}{4}\%$ 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.

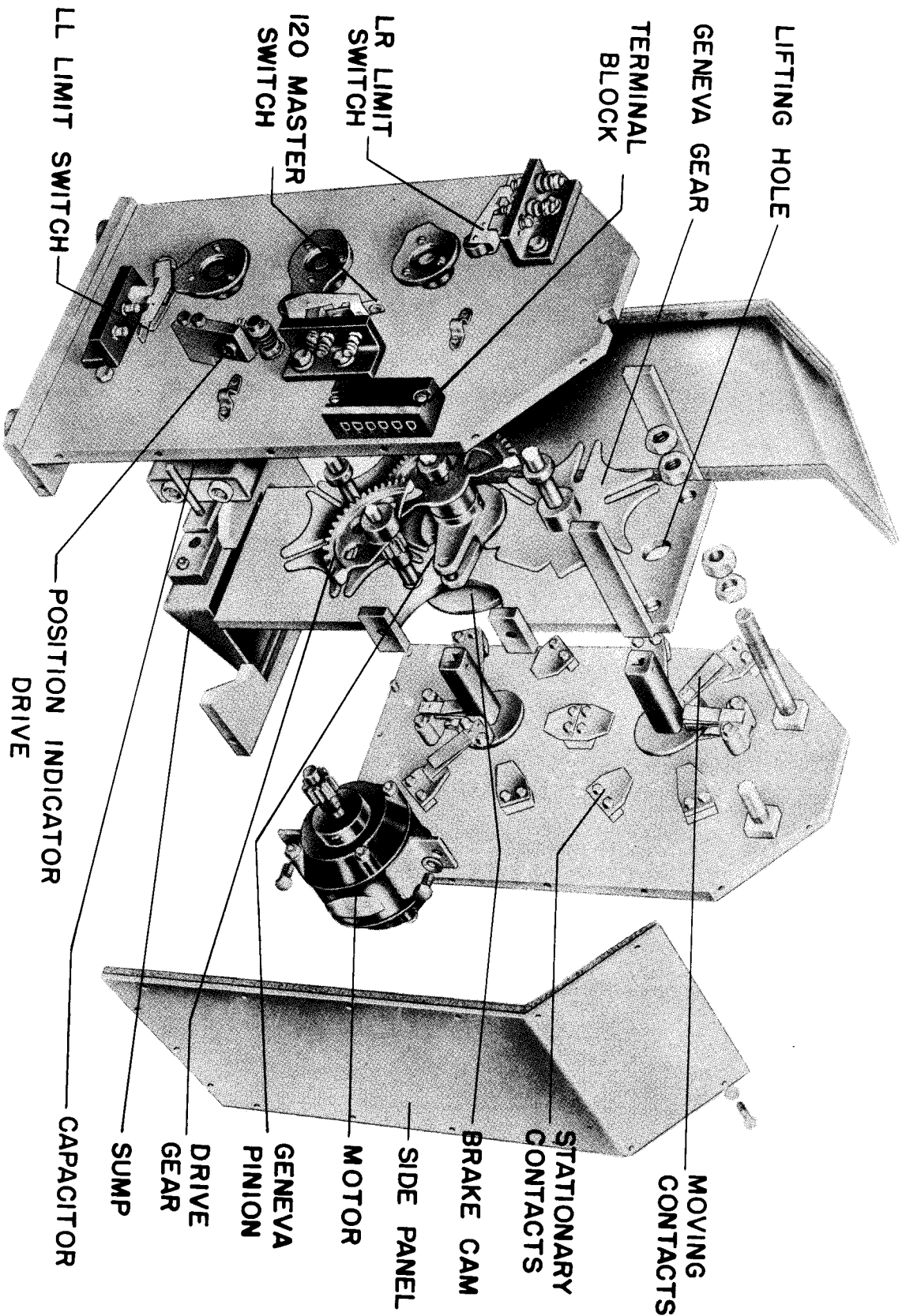
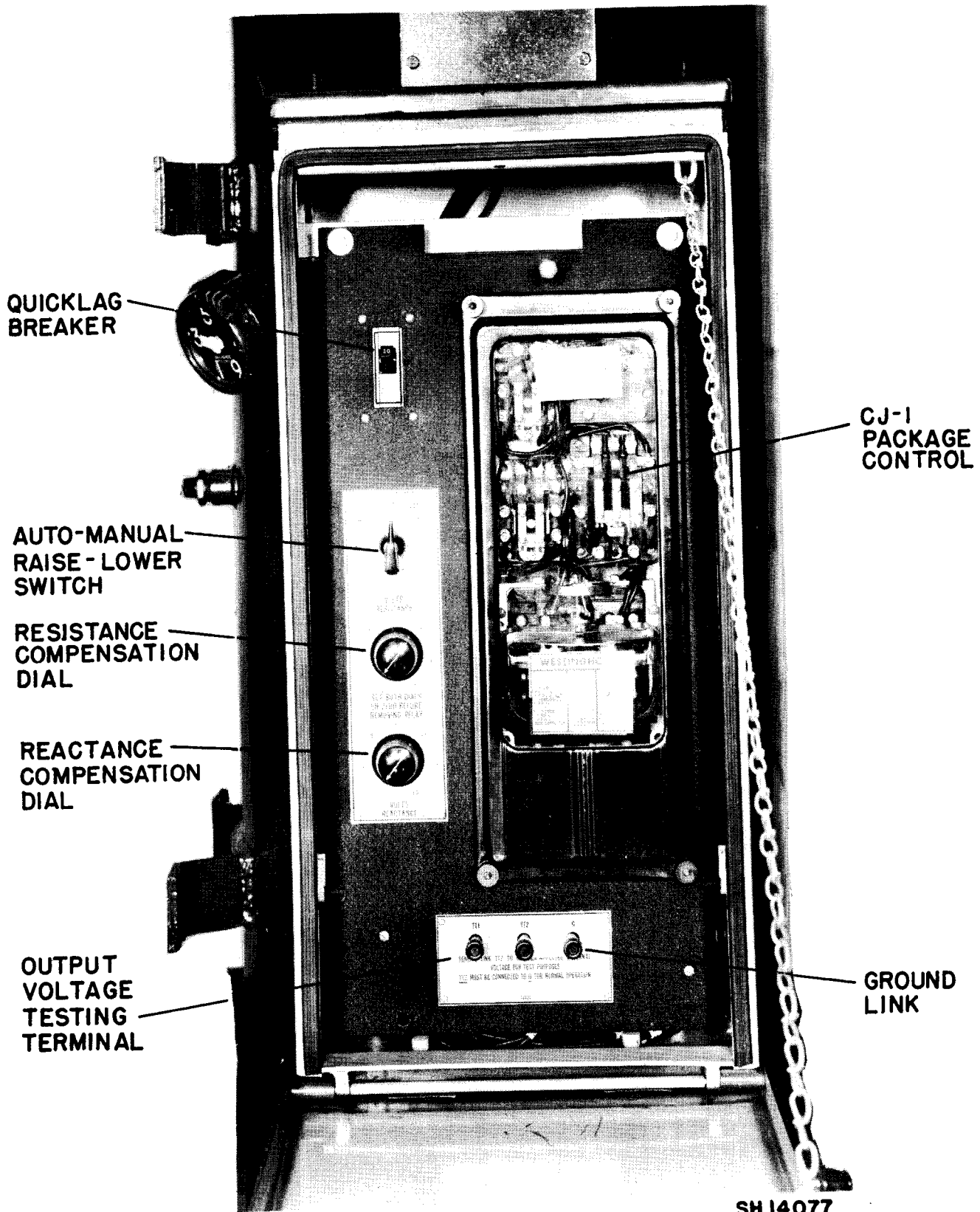


FIG.6 EXPLODED VIEW OF URL-8 TAP CHANGER MECHANISM

DESCRIPTION

FIG.7 URL-8 CONTROL CABINET PANEL



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. 7). 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 #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-Manual 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.

The 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 the 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.

DESCRIPTION

Line Drop Compensator

The function of a voltage regulator is to maintain a constant voltage at some point on 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 for dial settings for various conductor sizes and spacing.

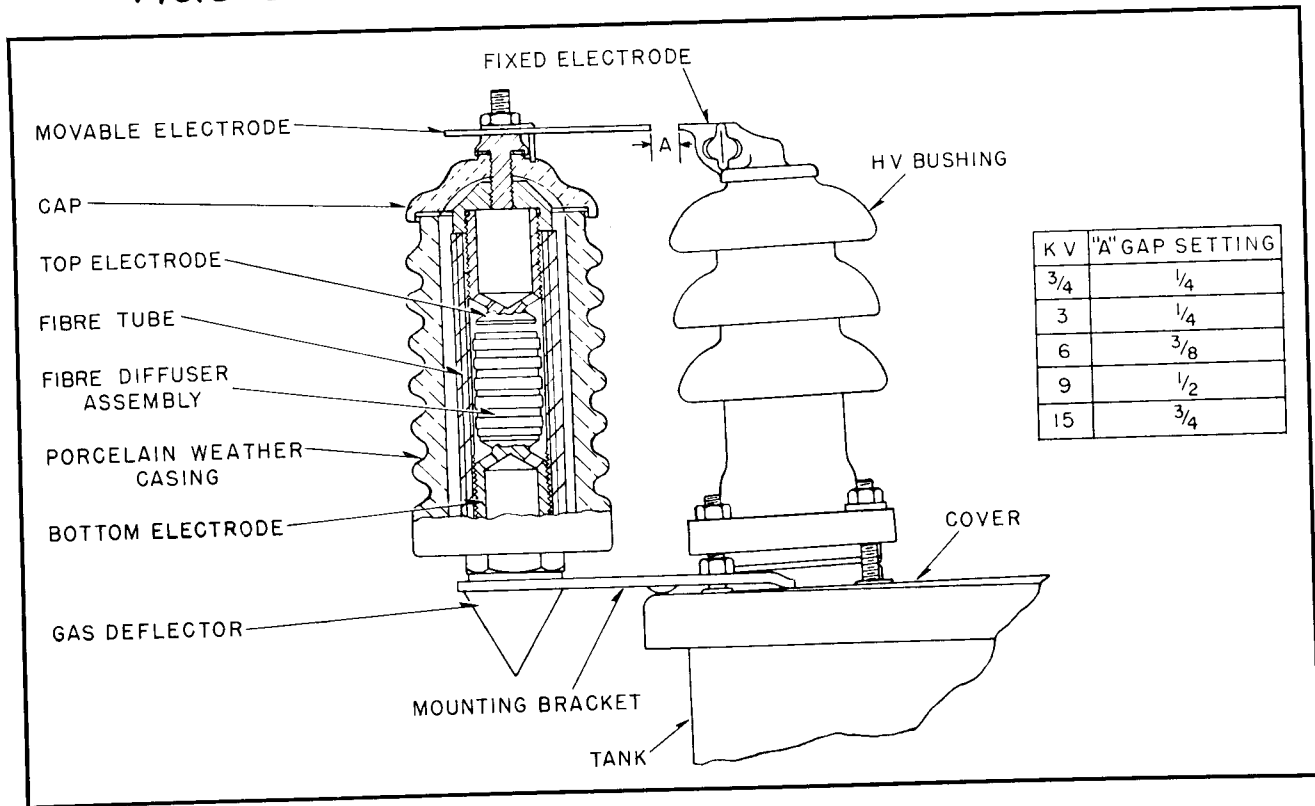
Output Voltage Testing Terminals

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

FIG.8 EXTERNALLY MOUNTED DEION ARRESTER



Cover Type Bushings and De-ion Arresters

The URL-8 Regulator has cover type bushings which are arranged in accordance with ASA 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 solidly grounding the unit.

PART THREE

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:

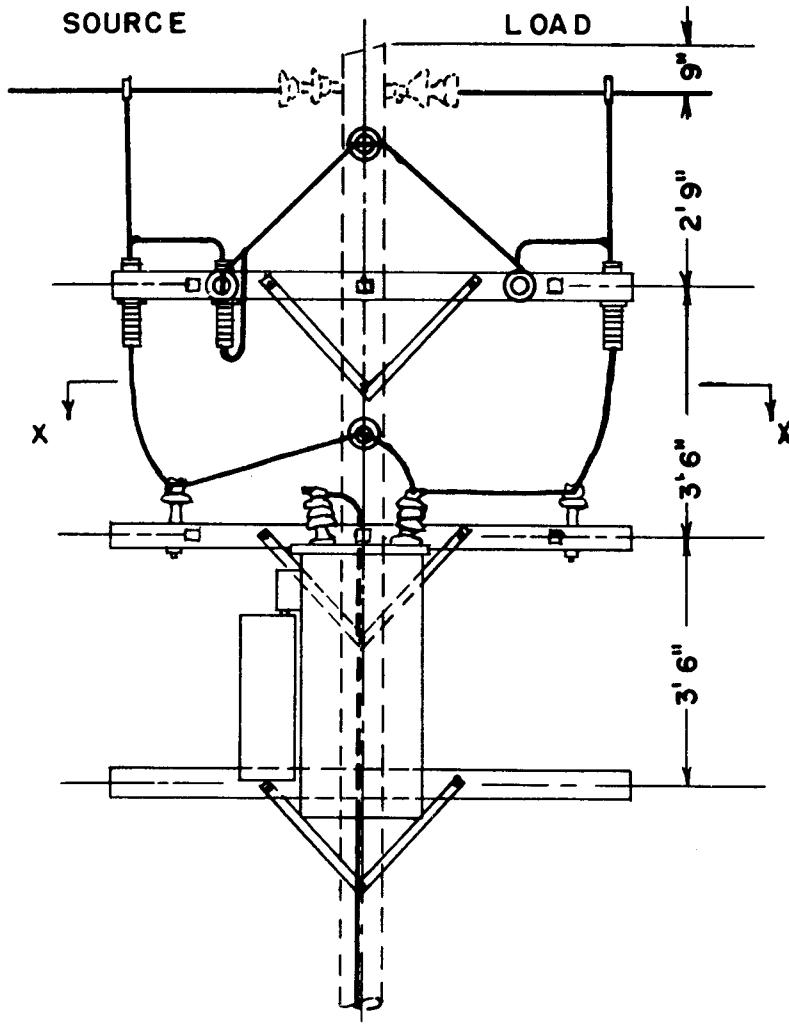
1. If inspection indicates that the transformer has absorbed moisture for any reason, remove the oil and dry the unit. However, this is seldom necessary as these regulators are filled with Wemco C oil at the factory and given a vacuum treatment in their own tanks, after which the oil is not disturbed. 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 Figure 8. 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 bypassing. 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.
Warning: 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 through the auxiliary winding.

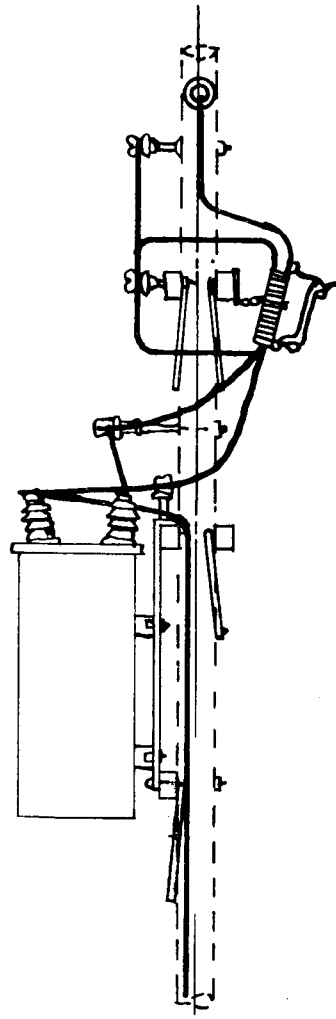
The following sequence of tests is recommended:

- 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 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.

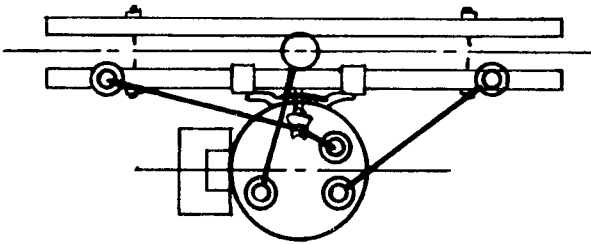
INSTALLATION



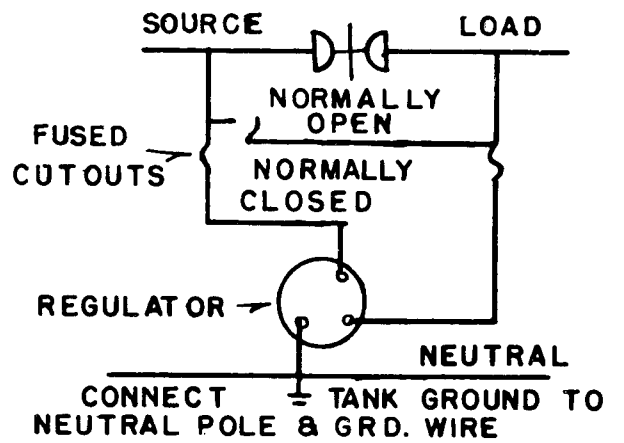
ELEVATION



SIDE ELEVATION



SECTION X-X



WIRING DIAGRAM

FIG.9 TYPICAL INSTALLATION OF URL-8 REGULATOR

5. The 5000 volt URL-8 Regulator is provided with 3 taps on the auxiliary winding, so that the regulator will have suitable control voltages when applied on 2500 and 4330 volt lines at reduced capacity. Likewise, the 7620 volt unit has two taps on the auxiliary winding for suitable control voltages when the regulator is applied on 7200 and 7960 volt lines.

Simply remove junction box cover on side of tank and move the "T" lead to the appropriate stud as indicated by the wiring diagram. Control voltages will be indicated on the nameplate.

Mounting the Regulator

Figure 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 transformer in a vertical position. If desired, lag screws may be inserted thru the holes in the bottom of the hanger into the lower crossarm to prevent the transformer 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: 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. Remove the cover plate on the junction box and disconnect the leads. Pull out the leads and remove the conduit fitting on the inside of the junction box. Also remove the control cabinet brackets.

The brackets may then be inverted and used at the new location as shown in Figure 10. After locating the cabinet in the new position, connect cabinet to junction box with conduit and pull in eight new leads using not less than #14 wire. 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.

INSTALLATION

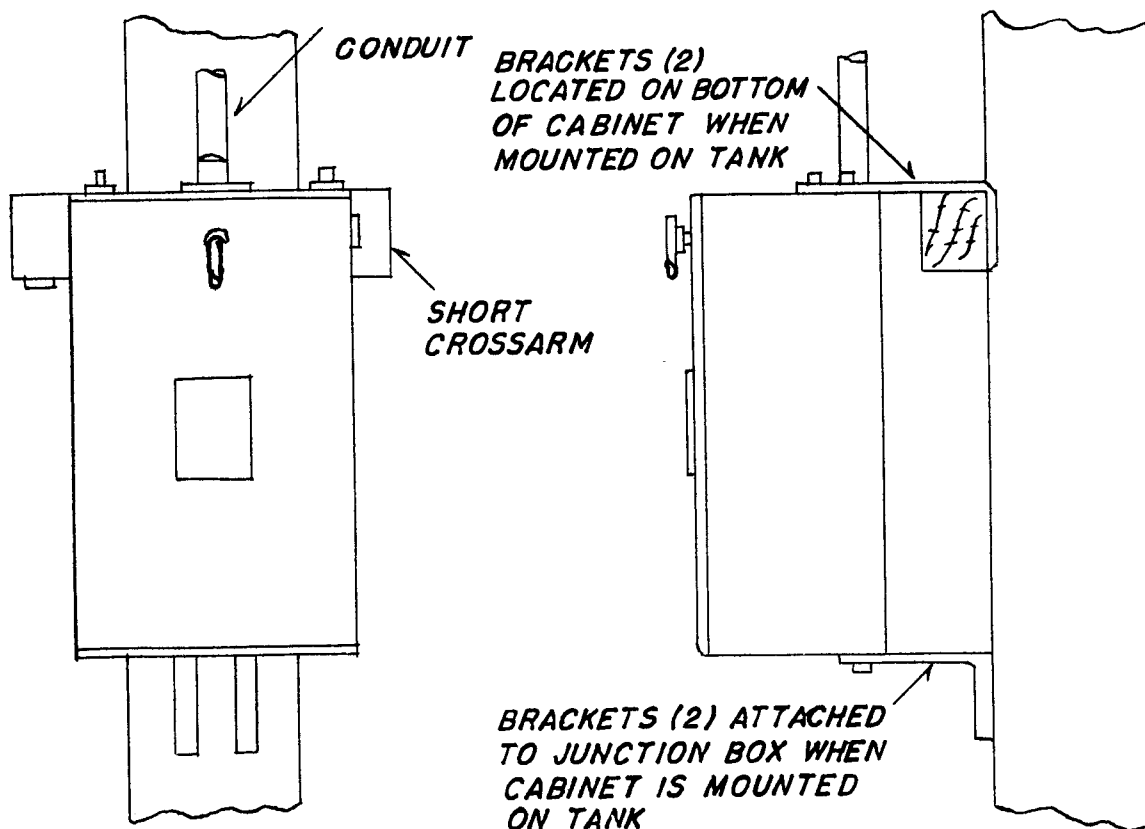
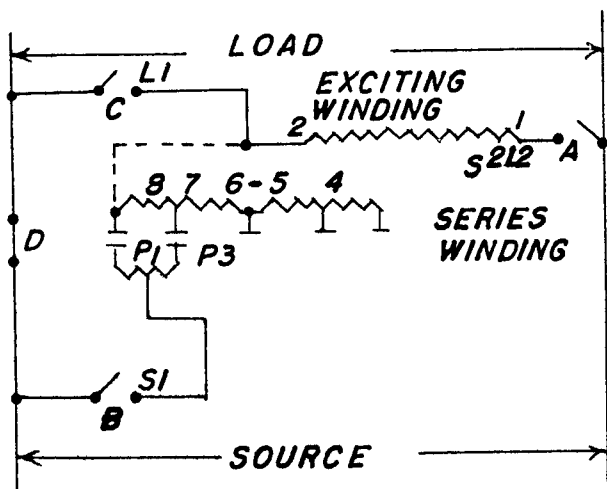


FIG. 10 CONTROL CABINET MOUNTED AT BASE OF POLE



SCHEMATIC DIAGRAM, CONNECTING OR BY-PASSING REGULATOR. A-B-C-D DISCONNECT SWITCH OR CUTOUT. WITH "A" CLOSED THE CIRCUIT THROUGH "B", "C" AND "D" MUST NOT PROVIDE A SHORT CIRCUIT THROUGH ANY PART OF SERIES WINDING. SOME CONNECTIONS OF SERIES WINDING CANNOT BE BY-PASSED.

FIG. 11 CONNECTIONS FOR BY-PASSING SWITCHES

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 do 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.

Warning: When this method is used to connect a regulator to the line, it is very important that the regulator be operated to "neutral" position. 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.

INSTALLATION

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. Figures 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 star. See Figure 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.

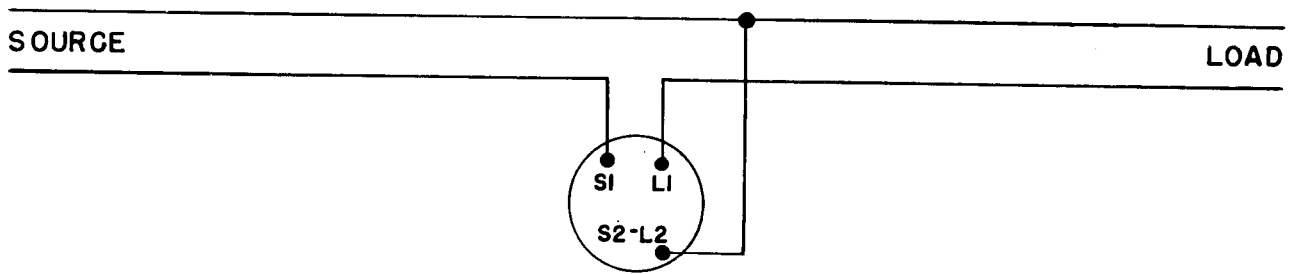


FIG. 12 SINGLE PHASE CONNECTIONS

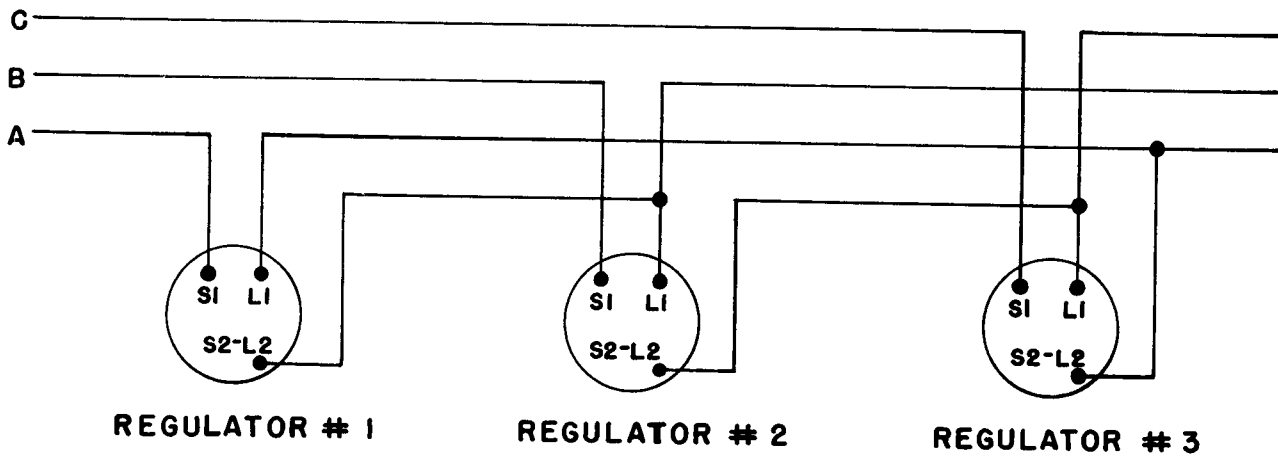


FIG. 13 THREE UNITS CONNECTED DELTA ON A THREE PHASE, THREE WIRE, CIRCUIT-PHASE SEQUENCE ABC.

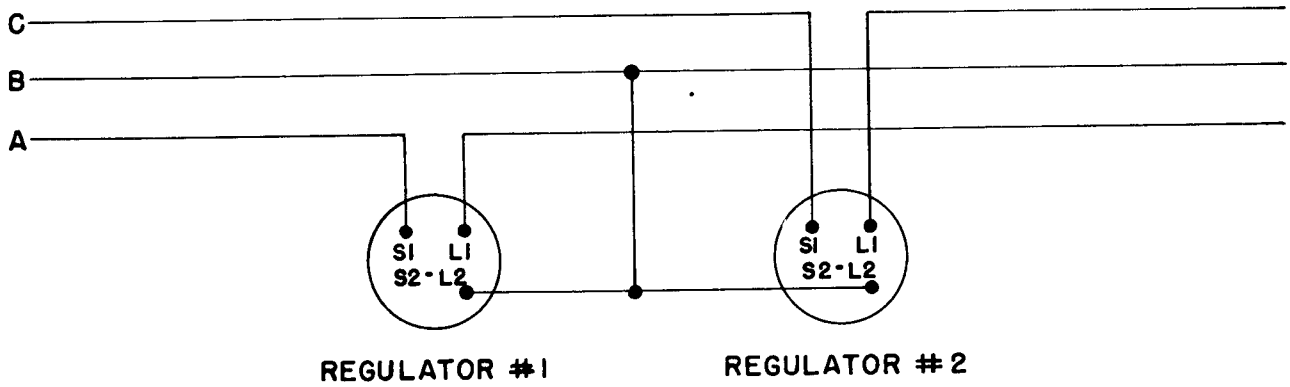


FIG. 14 TWO UNITS CONNECTED OPEN DELTA ON A THREE PHASE, THREE WIRE, CIRCUIT-PHASE SEQUENCE ABC.

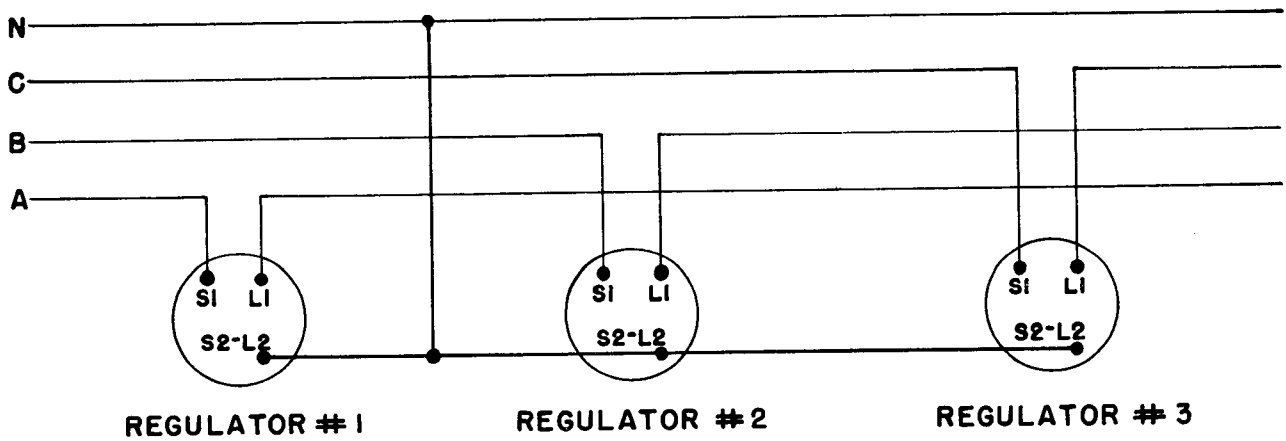


FIG. 15 THREE UNITS CONNECTED WYE ON A THREE PHASE, FOUR WIRE, CIRCUIT-PHASE SEQUENCE ABC.

PART FOUR

OPERATION

Principles of Operation of the Tap Changer

The diagram of connections of the Type URL-8 Voltage Regulator is shown schematically in Figure 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 2 to 8) are brought to the no load tap selector switch for manual selection of the range of regulation, and to the load tap changer contacts for automatic tap changing within the range selected. Tables showing the various combinations of buck and boost are shown in Figure 19.

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° 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 geneva pinion through 180° , 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.

Principle of Operation of the 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:

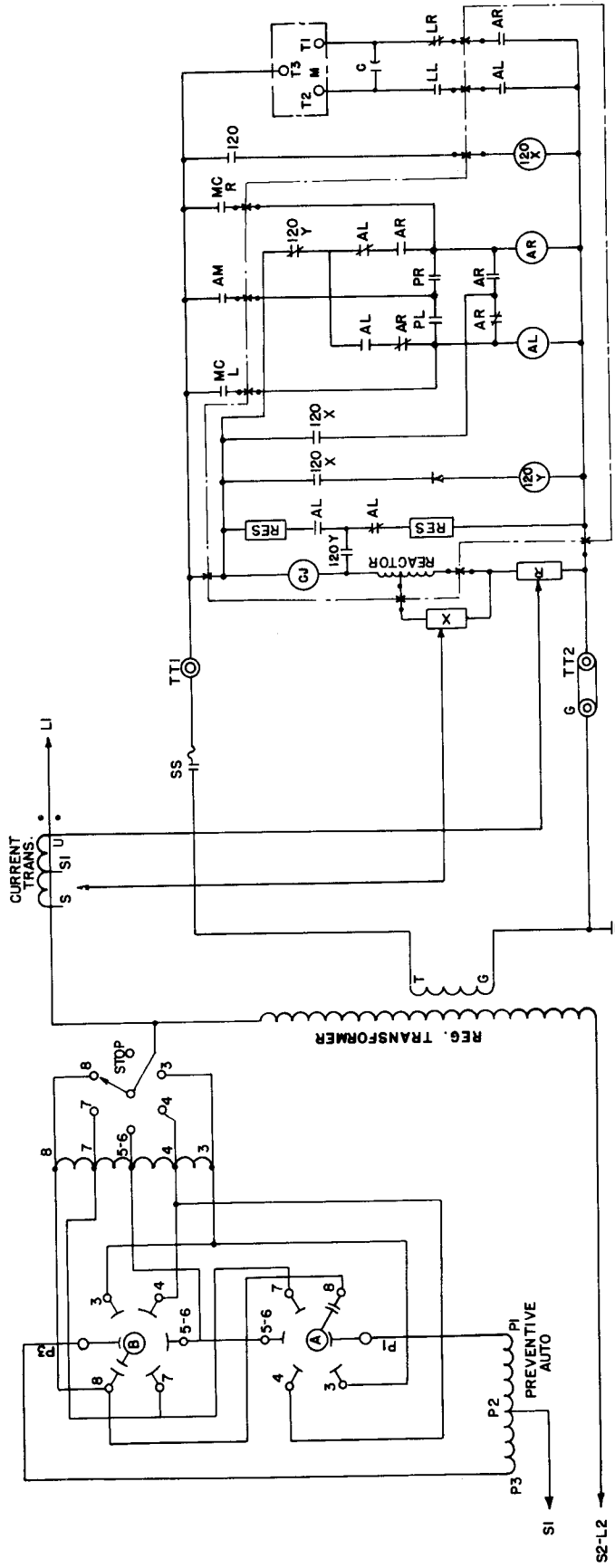
The automatic-manual switch has five positions: one automatic operation (AUTO), two off (OFF) positions, and one position each for manual raise (RAISE), or Lower (LOWER). For manual control in the lower direction, placing the dial switch on lower closes the MCL contact and energizes the (AL) relay which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

For automatic operation the dial switch is turned to "Auto," closes the AM contact, and connects the circuit so that the CJ-1 voltage regulating relay initiates the tap changer operation.

If the voltage falls below the left hand, PR, 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 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 (120) 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.

OPERATION



LEGEND

- | | |
|--|--|
| VOLTAGE REGULATING RELAY TYPE CJ-1 | REGULATING TRANSFORMER |
| CJ - POTENTIAL ELEMENT | T-G AUXILIARY WINDING |
| PL - PR CONTACTS | 3-8 SERIES WINDING |
| AR, AL AUXILIARY & MOTOR CONTROL RELAYS | I-2 EXCITING WINDING |
| 120 PILOT RELAYS (X-Y) | U-S CURRENT TRANSFORMER |
| AM-MC AUTO MANUAL RAISE-LOWER SWITCH | P ₁ - P ₂ - P ₃ PREVENTIVE AUTO TRANSFORMER |
| TT ₁ - TT ₂ TEST TERMINALS | |
| LL-LR LIMIT CAM SWITCHES | |
| M - MOTOR | |
| SS - QUICKLAG BREAKER | |
| X - REACTANCE COMPENSATOR | |
| R - RESISTANCE COMPENSATOR | |
| I20 MOTOR CAM SWITCH | |

FIG. 16 SCHEMATIC OF URL-8 REGULATOR

FIG. 17 NAMEPLATE OF TAP SELECTOR SWITCH LOCATED UNDER THE HAND HOLE COVER.

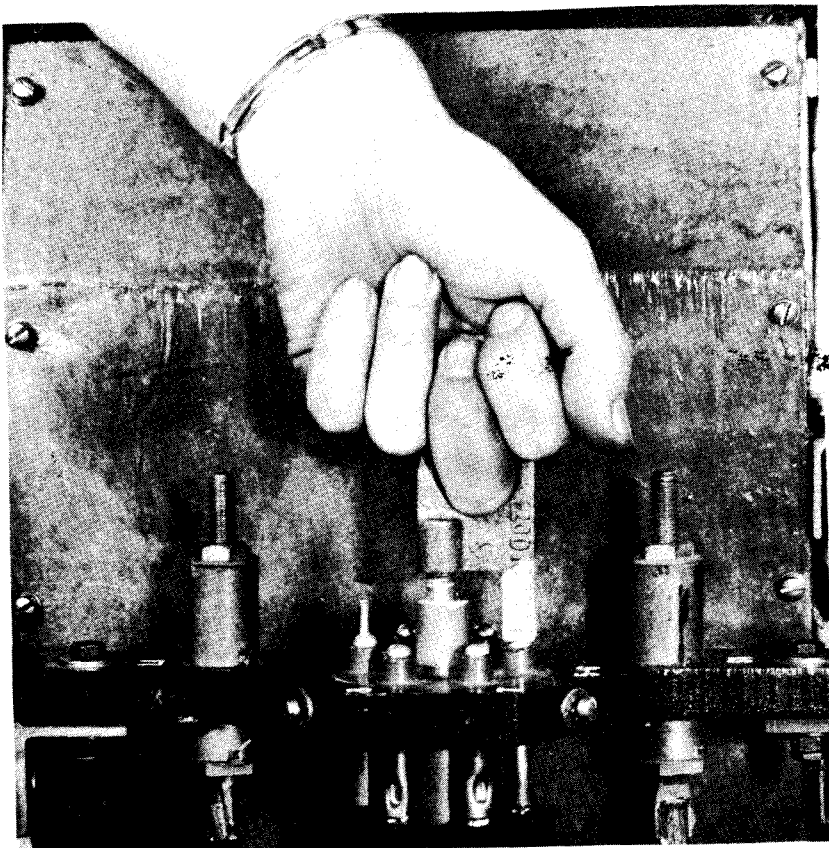
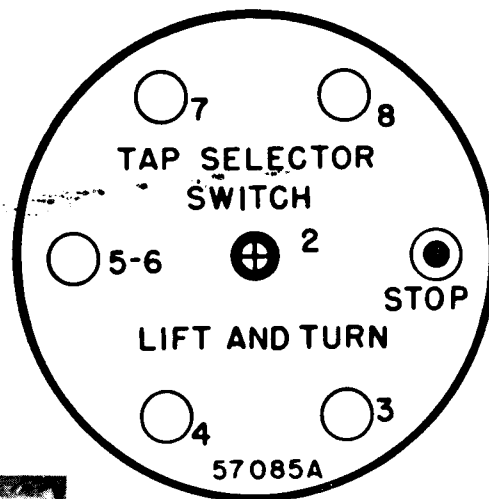


FIG. 18 SETTING THE TAP SELECTOR SWITCH

FIG. 19 TYPICAL TABLE OF CONNECTIONS

TABLE OF CONNECTIONS						
TAP SELECTOR CONNECTS	NUMBER STEPS		LOAD VOLTS L1 L2=100%		CONTINUOUS LOAD CURRENT % RATED	TAP CHANGER BY-PASS POSITION
	1¼% PER STEP		SOURCE VOLTS S1—S2			
	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

PART FIVE

MAINTENANCE

Inspection

The Type URL-8 Regulators are designed to operate with a minimum amount of maintenance, but should be given a periodical inspection at least once a year, giving special attention to the condition of the oil, the inspection of relays, and a check to insure 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 periodical 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 the instruction leaflet on 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 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 No. 47-431.

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.

Overhaul and RepairCorrection of Minor Troubles:

A. 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).
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#954939.
 - b. Capacitor may be open. Capacitor is 10 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 the Instruction Leaflet 47-430 for the relay.

MAINTENANCE

Major Overhaul and Repair

General Discussion

When the periodical 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.
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.

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 Arrester

