Westinghouse

Type "LR" Automatic Feeder-Voltage Booster Regulator

Installation

Operation Maintenance

INSTRUCTION BOOK

CAUTION

Read instructions carefully before applying power to regulator or by-passing.

Do not apply test voltage to test terminals unless safety switch "SS" is open.

Refer to individual Instruction Leaflets before lubricating.

Inspect relays at regular intervals.

Keep covers on relays except when making adjustments.

Always block relays before moving control cabinet or regulator.

Ground tank of regulator.

Never turn tap changer gears by hand without first opening switch "SS" or removing power from test terminals. If this is not done, motor will operate electrically in certain positions and fingers of the operator may be caught in the gears.

Westinghouse Electric Corporation
Sharon Works, Sharon, Pa.

Supersedes I. B. 5357-28

I. B. 47-420-1

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ADDITIONAL INSTRUCTIONS INCLUDED IN THIS BOOK

Westinghouse

Type "LR" Automatic Feeder-Voltage Booster Regulator

GENERAL

This Instruction Book describes the type "LR" Automatic Voltage Regulator and gives instructions for its installation, operation, maintenance and repair.

The type "LR" automatic motor operated regulators are used to maintain constant normal voltage on distribution feeders and are built single-phase for 10% regulation in 4 steps in the following standard 60 cycle ratings:

	50 and 100 ampere—2400 volt
12.5—	25-50 and 100 ampere—4800 volt
12.5—	25-50-75 and 100 ampere—6900 volt
12.5—	25-50 and 100 ampere—7960 volt

These regulators are shipped as a complete unit with oil and it is only necessary to remove the blocking from the relays and inspect the apparatus, as described in this book in section on Installation, before connecting to the line. Very little maintenance is required and in general is in the nature of routine inspection. Complete instructions for maintenance are given in a section under the heading "Maintenance".

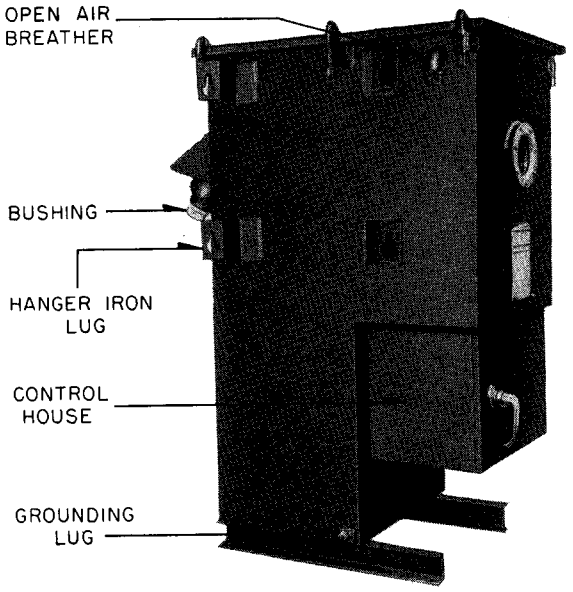


Fig. 1—Complete Type "LR" Feeder Voltage Booster-Regulator

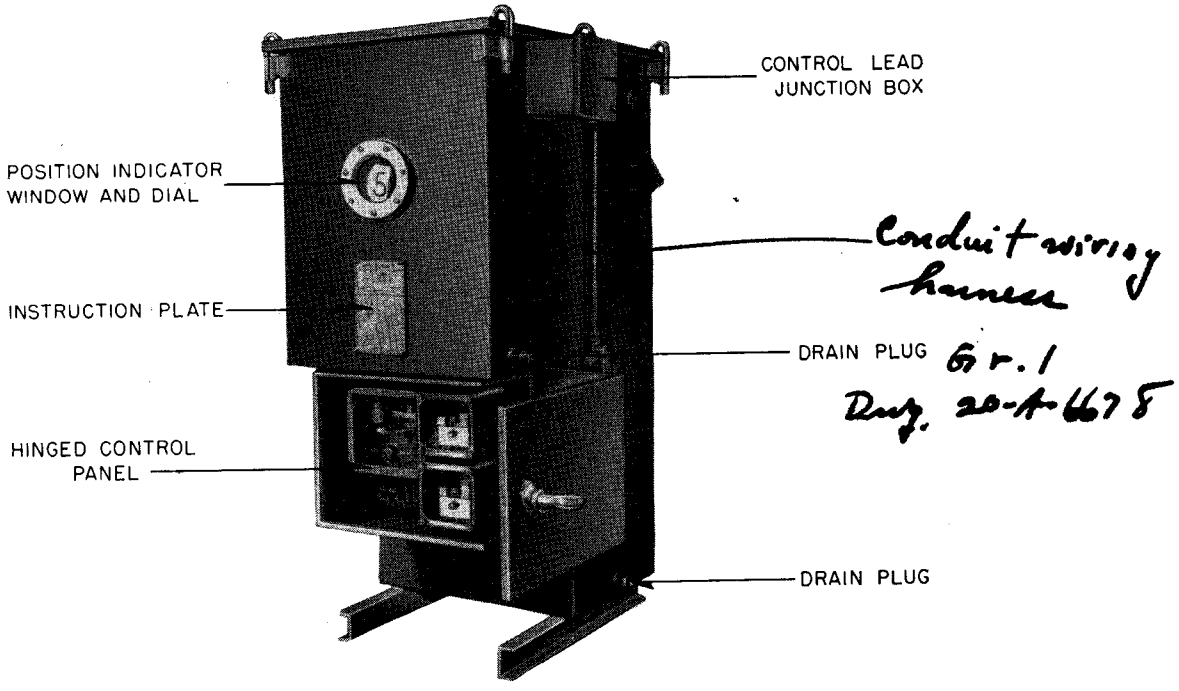


Fig. 2—Complete Type "LR" Feeder Voltage Booster-Regulator—Control House Door Open

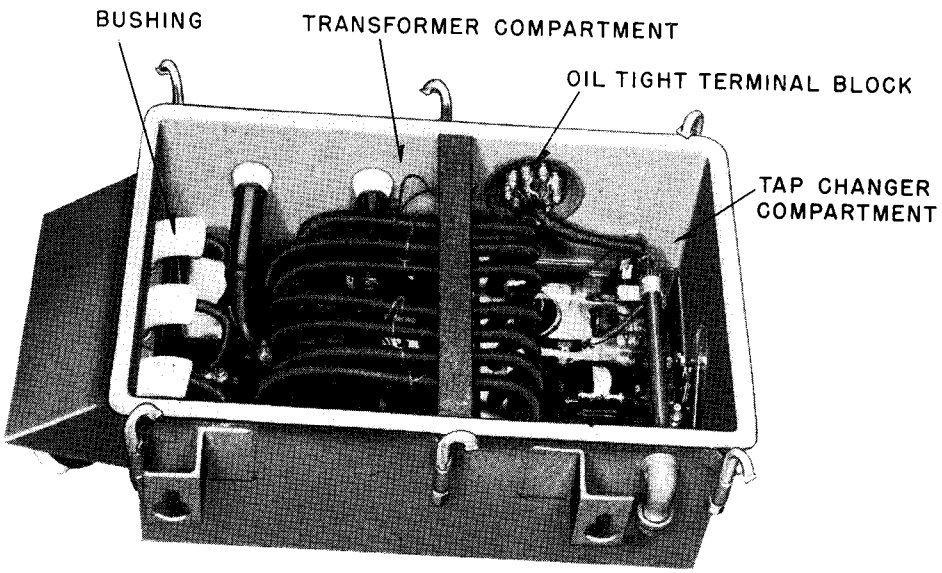


Fig. 3 View Looking into Top of Type "LR" Feeder Voltage Booster-Regulator Cover Removed

CONSTRUCTION

General

The type "LR" regulator consists of a regulating auto-transformer, a preventive auto, a motor operated load tap changer, and an enclosed control panel built into an integral unit designed for outdoor operation. The regulators are arranged for pole or platform mounting except a few of the larger sizes which are only platform mounted. No auxiliary apparatus other than that built into the equipment is required, and it is only necessary to connect the apparatus to the line to put it into

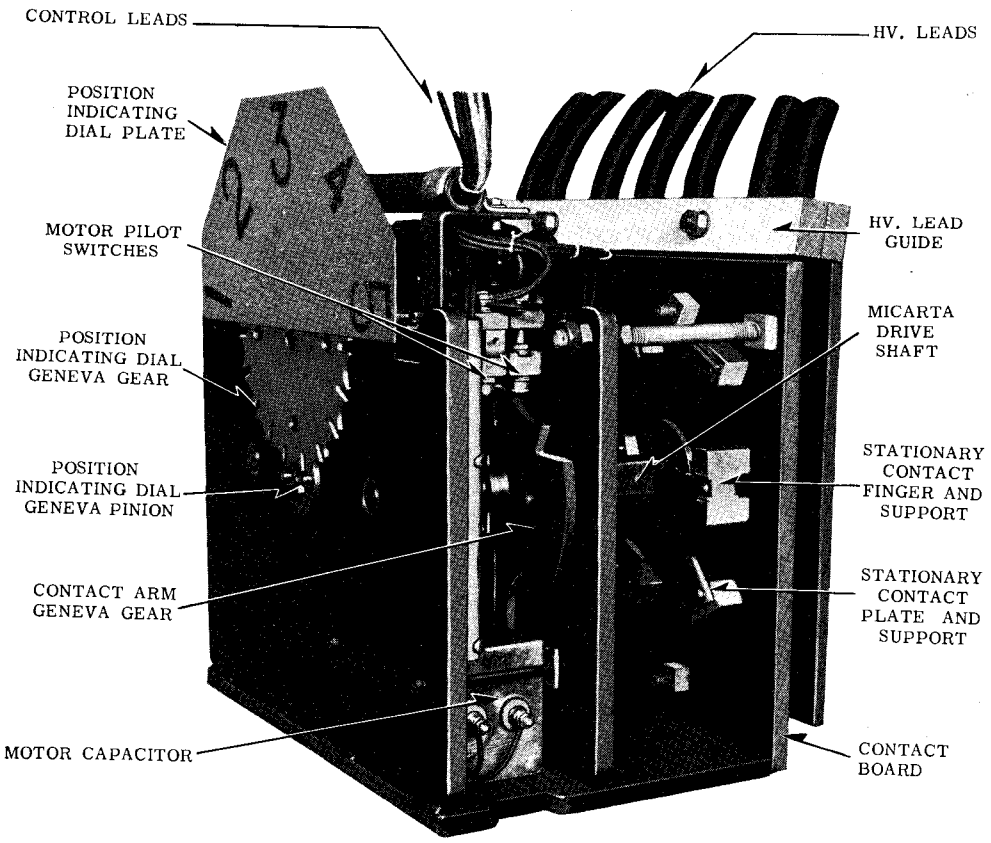


Fig. 4 Type "LR" Booster-Regulator Tap Changer End View

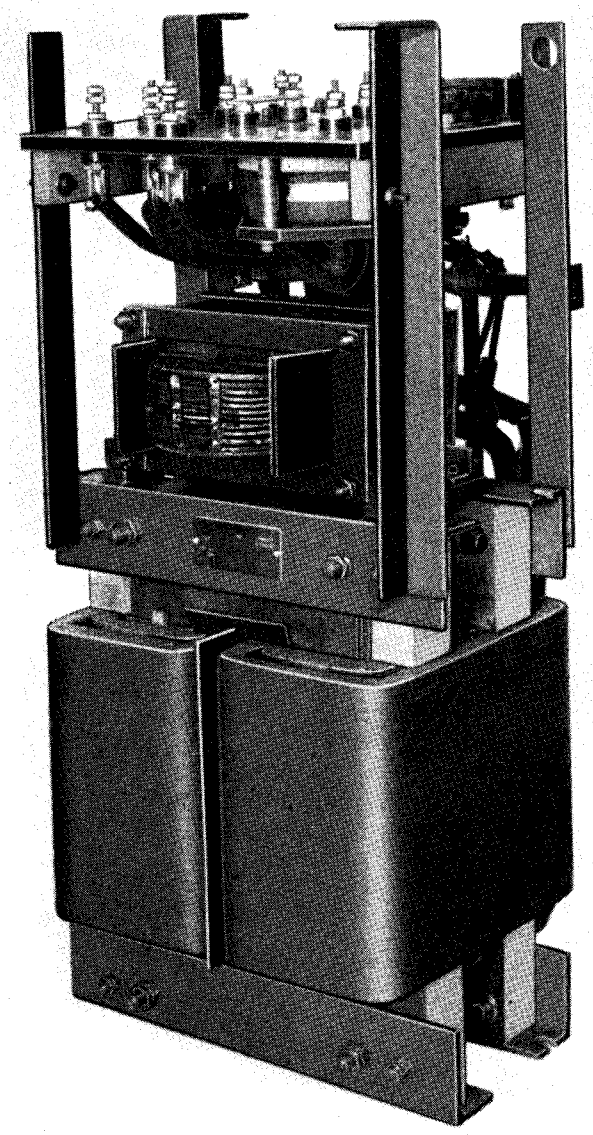


Fig. 5—Type "LR" Booster-Regulator Core and Coil Assembly

service. The approximate weights and dimensions are given on the outline drawing. Regulation of the circuit is accomplished by changing taps under load on the regulating auto-transformer. The completely assembled type "LR" regulator is shown in Figs. 1, 2 and 3.

The regulator tank is divided into two compartments by means of an oil-tight barrier. The tap changing mechanism is mounted in one of these compartments and the transformers in the other. A common breather in the tap changer tank and a drain plug for each compartment are provided. The automatic control equipment is in a separate cabinet bolted to the outside tank wall of the regulator, below the tap changer compartment. If desired, it may be removed for separate mounting on the pole near the ground.

The transformer tap leads are connected to the proper tap changer contacts by means of cables insulated for the full voltage of the winding in which the taps are located. These cables pass through the barrier between the two compartments above the oil level and are held in place by insulating clamps. These clamps also serve to make the barrier splash-proof.

The leads between the tap changer and control house are in conduit, the upper end terminating in a junction box where the control connections to the tap changer are made through an oil-tight terminal block.

The core and coil assembly of the regulating auto-transformer and the preventive auto-transformer is shown in Fig. 5. The assembled tap changer mechanism is shown in Figs. 4 and 6. The automatic control panel is shown in Fig. 7 and Fig. 8.

Only three high voltage leads are brought out of the tank through disconnect pocket type bushings, since one lead is common to both source and load. Various combinations of a total of 4 steps from 4—2½% steps buck to 4 —2½% steps boost

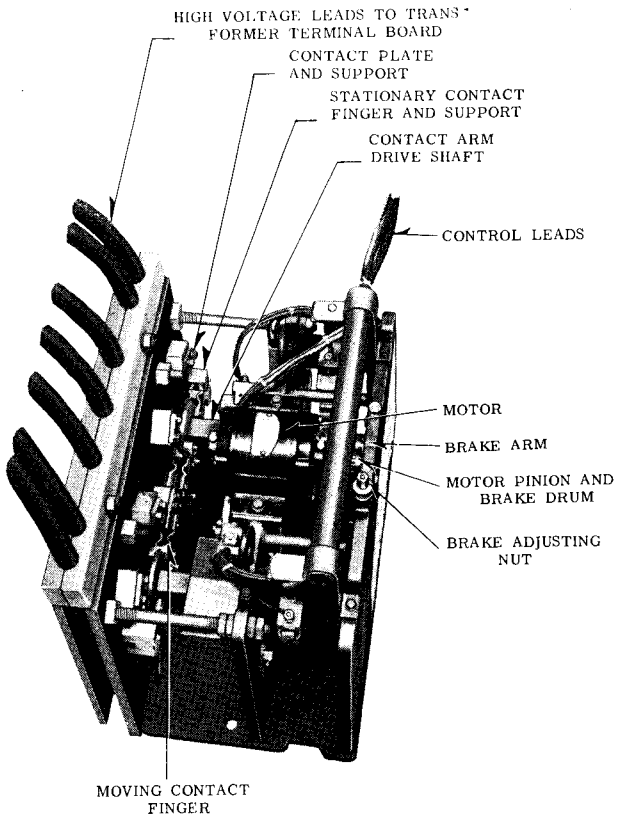


Fig. 6—Type "LR" Booster-Regulator Tap Changer Top View

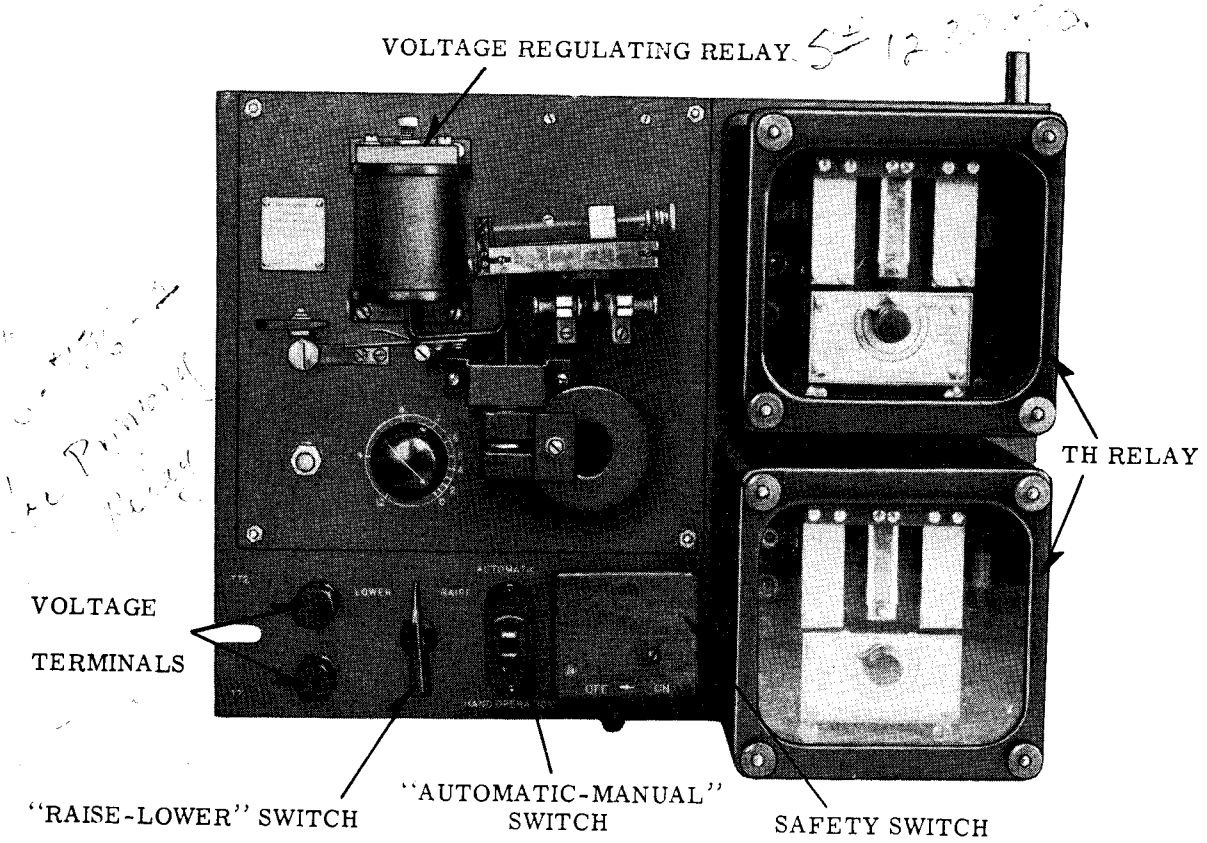


Fig. 7—Type "LR" Booster-Regulator Control, Front View

can be made by changing links on the terminal board.

Insulation

The boosters are insulated to withstand the latest disruptive tests recommended by the Transformer Sub-Committee of the A.I.E.E.

"De-ion" arresters, when supplied for protection against lightning and switching surges are connected to the common line lead and at each end of the series winding. These arresters are designed to discharge at a surge voltage well under the impulse strength of the booster windings thereby "spilling over" to the tank, incoming surges that exceed in value the discharge settings of the arrester, and

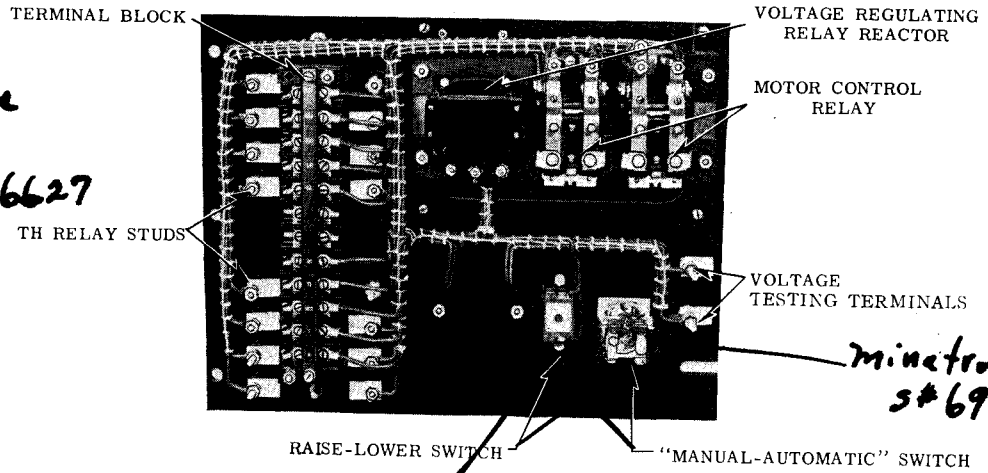


Fig. 8—Type "LR" Booster-Regulator Control Panel, Rear View

1 to 8	—Regulating Transformer
T-G	—Auxiliary Winding
P1-P3	—Preventive Auto Transformer
U-V	—Tap Changer
SS	—Safety Switch
TT1-TT2	—Voltage Testing Terminals
P	—Voltage Regulating Relay Coil
PR	—Voltage Regulating Relay Contacts—Raise
PL	—Voltage Regulating Relay Contacts—Lower
THR	—Time Delay Relay Heater—Raise
THL	—Time Delay Relay Heater—Lower
HR1-2	—Time Delay Relay Micro Switch Contacts—Raise
HL1-2	—Time Delay Relay Micro Switch Contacts—Lower
AR	—Time Delay Relay Auxiliary Contactor Coil—Raise
AL	—Time Delay Relay Auxiliary Contactor Coil—Lower
AR1-2-3	—Time Delay Relay Auxiliary Contactor Contacts—Raise
AL1-2-3	—Time Delay Relay Auxiliary Contactor Contacts—Lower
SR	—Motor Control Relay Coil—Raise
SL	—Motor Control Relay Coil—Lower
SR1-2-3	—Motor Control Relay Contacts—Raise
SL1-2	—Motor Control Relay Contacts—Lower
LR	—Limit Switch Contacts—Raise
LL-ML	—Limit Switch Contacts—Lower
120-123	—Pilot Switches
C	—Capacitor
M	—Tap Changer Motor
AM1-AM2	—Automatic-Manual Switch
MC1-MC2	—Raise and Lower Switch
MR	—Lockout Switch

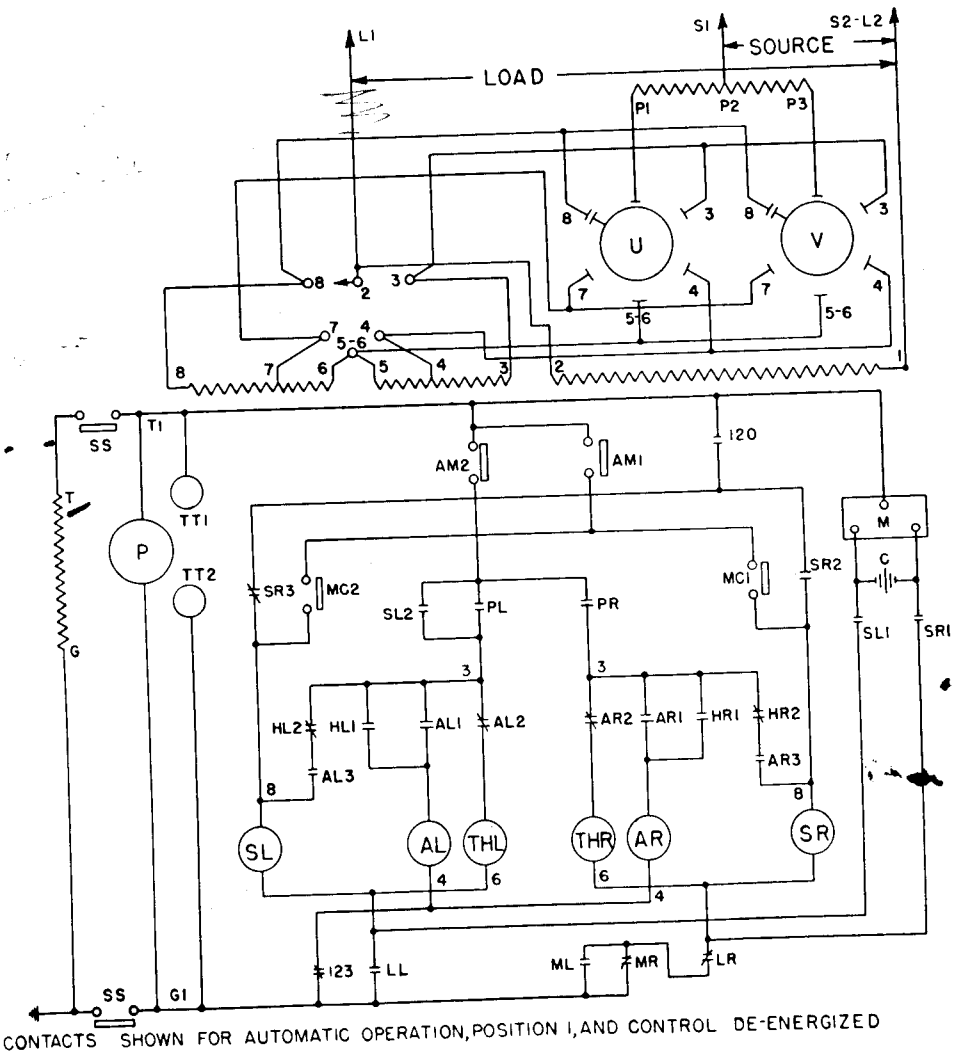


Fig. 9—Schematic Diagram—Type "LR" Booster-Regulator

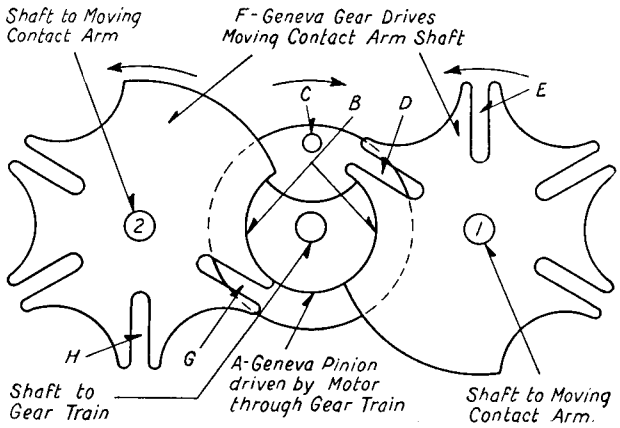


Fig. 10—Schematic Operation of Tap Changer Driving Mechanism

eliminating the possibility of a breakdown between the windings and the core or tank which might itherwise occur. Inasmuch as the "De-ion" Arresters are so designed that power current does not follow the "spilling over" of the surge current, outages of the circuit do not follow discharge of the arresters. See Instruction Leaflet on "De-ion" Arresters in rear of this book. Since the boosters are not connected to service lines, discharge gaps between the tank and ground and between the bushings and tank are not required. The boosters are connected in series with the line and therefore are protected by the line fuses or breakers and it is not necessary to fuse the booster.

Regulator Cores and Coils

The regulator core and coil assembly consists of a regulating auto-transformer and a preventive auto-transformer complete with terminal board, all mounted in a common frame, which can be lowered into the tank and fastened in place as a complete unit. Each unit in this assembly is constructed in exactly the same manner as a standard transformer of equivalent rating. The regulator transformer winding consists of an exciting winding 1—2, a series or booster winding 3 to 8 and a third winding T-G which supplies the auxiliary low voltage power for operating the voltage regulating relay, tap changer motor and control. See Fig. 9.

Tap Changer Mechanism

The type "LR" regulator tap changer is shown in Figs. 4 and 6. The stationary contacts of the load tap changer are mounted in two circles on an insulating panel. The moving contacts are mounted on the preventive auto-transformer bus attached to the rotating shafts. When the tap changer is on position, it connects the line through the preventive auto-transformer buses to the corresponding transformer tap. To make a tap change, one shaft moves its contact to the next tap and then the other shaft moves its contact to the corresponding tap, thereby effecting a tap change with a minimum voltage dip and without dropping the load. The preventive auto-transformer carries the load current during the transition period when the moving contact is between taps.

The tap changer is operated by Geneva gears attached to the drive shafts. See Fig. 10. The Geneva pinion is driven directly through reduction gears by a small motor. For one tap change, there is one complete revolution of the Geneva pinion, but only a sixty-degree motion of each Geneva gear and tap changer contact arm. The moving contact arm is locked in 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.

The schematic operation of the tap changer driving mechanism is shown in Fig. 10. 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 slots (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. Following this, 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 made one complete tap change and changed the voltage one 2-½% step. Additional steps in the same or reverse direction are made in the same manner.

The operating motor is a reversible, split phase capacitor type motor especially designed for this application. The motor operates under oil and the insulation is selected for this condition. The capacitor used with this motor is rated 10mfd 300 volt and is mounted in the bottom of the tap changer frame.

A drag brake operating on a combination motor pinion and brake drum serves to stop the motor after the control circuit is opened and prevents excessive drift of the motor. The brake pressure is maintained by a helical spring acting on the brake arm. Adjusting nuts provide means for varying the pressure of the spring.

A small Geneva pinion on the end of the main Geneva pinion shaft drives a position indicating dial plate located on the front of the tap changer. The dial plate can be seen through a window located above the oil level in the front of the tap changer compartment.

Limit switches operated by cams on the tap changer contact arm shafts prevent overtravel of the arms in either direction and the other switches operated by cams on the Geneva pinion shaft

operate in conjunction with the control relays to start the motor and to stop it when the contact arm is on position.

The entire tap changer mechanism is mounted on a base plate and is held in place in the tap changer compartment by two locating pins in the bottom and clamps on the walls of the tank. After the cover is removed and the high voltage cables disconnected from the transformer terminal board and the control leads from the terminal block, the entire mechanism may be lifted from the tank as a unit.

All main contacts are of the wedge and finger type and have inserts of special arc resisting material. 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.

The speed of separation of the arcing contacts is such as to keep arcing to a minimum, consistent with good mechanical design.

Control Equipment

All control equipment is mounted on a hinged steel panel enclosed in a separate, weather-proof housing bolted to the outside-tank wall of the regulator. The equipment may be operated by either manual or full-automatic control. The following accessories are mounted on the panel for the operation of the equipment.

One voltage regulating relay—Tyye SU
Two time delay relays—Type TH
Two motor control relays—Type SG
One safety switch with automatic thermal overload trip
One automatic manual transfer switch
One raise and lower switch
Two voltage testing terminals

Voltage Regulating Relay

Automatic operation is initiated by means of the voltage regulating relay which is responsive to a change in the load voltage. The relay is energized from an auxiliary winding (TG) on the regulating transformer which supplies voltage proportional to that on the load side of the regulator.

With the voltage regulating relay and compensator, the control is responsive to load current as well as load voltage. See Instruction Leaflet on voltage regulating relays.

Time Delay Relay

The type "TH" time delay relay supplies a time interval between the closing of the voltage regulating relay contacts and the starting of the tap changer motor, thus preventing needless operation of the tap changer on voltage fluctuations of short duration. This relay may be set for any time delay between 15 seconds and 60 seconds. See Instruction Leaflet on TH relay.

Motor Control Relay

The type "SG" motor control relays are interposed between the time delay relay and the tap changer motor and serve to carry the motor current and provide for the control interlocking circuits. See Instruction Leaflet on SG Relay.

Safety Switch

The sentinel breaker safety switch serves to disconnect all control circuits from the auxiliary transformer winding. The thermal automatic overload trip feature dispenses with the need of standard fuse protection.

Automatic-Manual Switch

This switch functions to connect the control circuit for either manual or full automatic control. The two systems of control cannot exist simultaneously.

Raise and Lower Switch

This switch is used to operate the regulator manually in either the "raise" or "lower" direction as desired.

Voltage Testing Terminals

These 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.

OPERATION

Principle of Operation of Regulator

The diagram of connections of the type "LR" voltage regulator is shown schematically in Fig. 9. This diagram may vary slightly with different installations, and 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 and leads from the regulating autotransformer are brought to the terminal board studs designated as 1 to 8 inclusive. By changing the connector shown between 2 and 8 on this board, various combinations of buck and boost can be obtained as shown in the tables of Fig. 11. From the transformer terminal board, leads pass over the oil barrier to the studs on the back of the tap changer contact board. The high voltage bushings snd "De-ion" arresters are also connected to studs on the terminal board.

The tap changer, as the name implies, performs all the of load switching operations, and all arcing is therefore confined to these switches. The 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. Any gases generated by the arc escape through the breather pipe.

Referring to the schematic diagram, Fig. 9, the load voltage "L_1L_2" is a maximum when the tap

changer arms are connected to tap 3 and the connector is in the position 2 to 8. This is position 5 for the 5 position tap changer. To change to position 4, the moving contacts rotate to tap 4 one at a time. Continuing the same process gives position 3 on tap 5-6, position 2 on tap 7, and position 1, the minimum load voltage, on tap 8. In going from position 1 to position 5, the above sequence is reversed.

During the transition period, when only one tap changer contact is closed, the load current is carried by one-half of the preventive auto winding. During the interval when one tap changer arm is on one tap and the other arm on the next tap, the preventive auto acts to bridge the regulating auto transformer taps, thus keeping the regulator load uninterrupted.

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 automatic manual switch, "AM" functions to connect the control circuit for either manual control or automatic control. For manual control, contacts "AM 1" are closed and operation of the tap changer is initiated by the raise-and-lower switch, "MC". Closing contacts "MC1" energizes the "SR" relay for raising the line voltage, and closing contacts "MC2" energizes the "SL" relay for lowering the line voltage.

For automatic operation, contacts "AM2" are closed. The voltage of the auxiliary winding is impressed on the voltage regulating relay "P". If this voltage becomes too high, contacts "PL" will close, energizing the "THL" relay, and if the voltage becomes too low, contacts "PR" will close, energizing the "THR" relay.

The operating cycle of the time delay relay consists of two parts, a heating and a cooling period. See Instruction Leaflet for Type TH relays. The heating cycle begins whenever the bimetal heater coil THR or THL is energized by action of PR or PL. Refer to schematic diagram Fig. 9. When THR is energized, the sequence of operation is as follows:

If the heater remains energized long enough, the bimetal will reach a temperature, determined by the relay setting, where its deflection operates the microswitch HR. This marks the end of the heating period. Operation of the microswitch opens contact HR2 and closes contact HR1. Closing contact HR1 energizes the auxiliary contactor AR. Operation of the auxiliary contactor AR opens contact AR2 de-energizing the bimetal heater coil THR, allowing the bimetal to cool; it also closes contact AR1 which shunts the microswitch contact HR1 and holds the auxiliary contactor AR closed as long as PR remains closed; it also closes AR3. When the bimetal has cooled to a temperature determined by the relay setting, it allows the microswitch 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 closing of HR2 completes the circuit energizing the motor control relay SR, causing the motor to operate and make a tap change. When, instead THL is energized, the same description applies except with L substituted for R in the symbols above.

The motor control relays are shown on the back of the panel in Figure 8 and the coils are designated on the diagram as SL and SR. SR has a back contact SR3 connected to pilot switch 120. In case the tap changer should stop between positions due to failure of voltage at time of tap changing, leaving

Connect on Board	LOAD VOLTS=100%		BOOSTING APPLIED VOLTAGE			BUCKING APPLIED VOLTAGE			By-Pass Position
	Maximum Source Volts	Minimum Source Volts	% Total	No. Of Steps	Per Step Per Cent	% Total	No. Of Steps	Per Cent Per Step	
2 to 8	100	90	10	4	2½	0	0	2½	1
2 to 7	102½	92½	7½	3	2½	2½	1	2½	2
2 to 5, 6	105	95	5	2	2½	5	2	2½	3
2 to 4	107½	97½	2½	1	2½	7½	3	2½	4
2 to 3	110	100	0	0	2½	10	4	2½	5

Position	Tap Changer Connects		Source Volts (Load Volts=100%) Terminal Board Connections				
	P1	P3	2 to 8	2 to 7	2 to 5, 6	2 to 4	2 to 3
1	8	8	100	102½	105	107½	110
2	7	7	97½	100	103½	105	107½
3	5,	5, 6	95	97½	100	102½	105
4	4	4	92½	95	97½	100	102½
5	3	3	90	92½	95	97½	100

Fig 11—Table of Terminal Board Connections

switch 120 closed, back contact SR3 being closed, the motor control relay SL is then energized when voltage is restored, and the motor operates the tap changer to the next lower position. This prevents the tap changer from locking out between positions.

Contact SL2 provides against false operation on lowering. If the voltage is too high, the voltage regulating relay closes its left-hand or "lowering" contact PL. Under certain conditions when the motor starts, the voltage across G1-T1 might drop enough to open contact PL. However, when SL has closed to start the motor, SL2 contact bridges around PL so that the momentary dip in voltage does not drop out the time delay relay and stop the motor before completing a tap change. The time delay relay is reset by the action of pilot switch "123" as explained in the next paragraph.

The pilot switch "120" closes soon after the tap changer Geneva pinion starts to move and locks in the motor control relays SL or SR so that the tap change will be completed. At the end of the tap change the "120" switch opens to stop the tap changer arm on position. The pilot switch "123" opens between positions shortly after "120" has closed and resets the time delay relay so that the full time delay is effective between successive tap changes. There is an overlap between "123" and "120" so that SL or SR will have positive action and be sealed in before "123" opens.

The limit switch "LR" opens on positions 5 and 'LL" and "ML" open on position 1 and prevent operation of the motor beyond the extreme positions. Lock out switch "MR" opens and closes for each tap change and is closed on each position but is shunted by limit switch "ML" except at position 1 when "ML" is open. If due to a loose brake, the motor pinion shaft should drift below # 1 position, then "MR" switch will open and lock out the control before the Geneva drive hits the mechanical stop and will keep the tap changer in the "locked out" position until the trouble has been corrected.

Voltage Regulating Relay

The voltage regulating relay is described and instructions for adjustment and maintenance are given in Instruction Leaflet in the back of this book.

On standard regulators having 4—2½% steps the voltage regulating relay is set to balance at 120 volts for 2400 and 4800 volt ratings, at 115 volts for 6900 and at 113.8 volts for 7960 volts. The auxiliary windings of the transformers are designed to give these control voltages with normal voltage on the load side.

The relay contacts are adjusted to close on 3 volts change from the balance voltage and the compounding is set to release at 2 volts change from balance voltage. These settings have been found to be very satisfactory for most applications of the type "LR" voltage regulators and should not be changed. To change the balanced voltage up or down from normal setting, adjust the balance weight as described in the Instruction Leaflet for the voltage regulating relay.

Assuming that the voltage regulating relay is set to keep the voltage at 120 volts plus or minus 2½ %, then the operation will be as follows:

With 120 volts across the voltage regulating relay the arm supporting the contacts will be in the horizontal or mid-position. If the voltage as impressed on the regulator rises, the main coil of the voltage regulating relay will pull up the plunger, and as soon as the voltage reaches 123 volts, the moving contact will touch the left hand stationary contact. Then through the circuit already described, the motor will operate the tap changer to bring the voltage back to normal. If the voltage drops to 117 volts, the right hand contact of the voltage regulating relay will close and the motor will operate the tap changer in the opposite direction to bring the voltage back to normal.

INSTALLATION

Standard Type "LR" Voltage Regulators are entirely self-contained and, except in special cases, shipped complete with oil. In order to put such regulators into service, it is only necessary to inspect them and check the oil level before connecting them to the line to be regulated. It is sometimes desirable to have the control cabinet installed separately near the ground for convenience in servicing and inspection of the control.

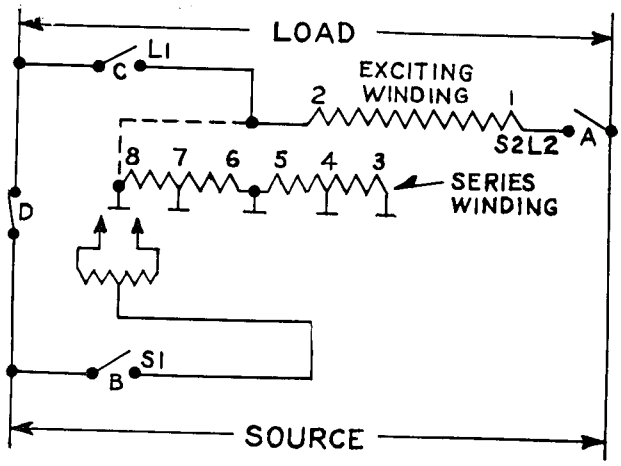
To do this, proceed as follows: Replace blocking in relays if it has been removed, open the cabinet door, swing out the panel, and disconnect the control leads from the terminal block on the back of the panel. Remove cover plate on the junction box and disconnect the leads. Pull out the leads and remove the conduit. After locating cabinet in new position, connect cabinet to junction box with new conduit and pull in new control leads using not less than # 18 wire. Connect like number studs on the two terminal blocks and tape together the leads in the control house. Be sure to allow enough slack in the leads so that the control panel will swing out, yet not too much so as to interfere with the relays on the back of the panel.

Remove all blocking from the relays on the control panel, swinging out the panel to check the SG relays on the rear of the panel. Inspect relays for loose nuts and screws and check operation by hand as described in Relay Instruction Leaflets at the back of this book.

Remove the tank cover and examine equipment to make sure that no damage has resulted during shipment. Especially check for loose nuts or screws.

Inspect the high voltage bushings and "De-ion" Arresters, if used insulators, and resistors. Remove wrappings from the "De-ion" external resistors. If an external "De-ion" Arrester is used, connect the terminal lead of this arrester to bushing lead S2L2 as per the diagram instruction plate.

Operate tap changer over entire range by hand in order to make sure that mechanism is not binding at any point. To do this, lift up brake arm against the tension of the compression spring and



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 name plate 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. Some connections of series winding cannot be by-passed.

Fig. 12—Connections for By-Passing Switches

then the tap changer can be turned easily by moving the first large gear which is driven by the motor pinion. When facing the indicator plate, turning this gear clockwise will move the tap changer arm to a lower position and turning counterclockwise will move the tap changer arm to a higher position.

Caution: When through with this test, leave tap changer in the neutral or by-pass position.

If 110 or 125-volt, single phase, a-c. source is available, throw the safety switch to "off" and connect the separate source to voltage testing terminals.

Caution: Open safety switch, whenever applying voltage to voltage testing terminals, otherwise transformer will be excited.

Turn the automatic-manual switch to the manual position, and operate tap changer over entire range by means of the raise-lower switch. Turn automatic-manual switch to the "Automatic" position and close voltage regulating relay contacts manually to operate tap changer one step in each direction.

See that both transformer and tap changer compartments are filled with Wemco "C" oil to the 25°C. oil level as indicated on the tank walls.

Check the operation of brake before replacing the cover. The brake has been set to stop the motor so that the driving pin (C) on the Geneva pinion (see Fig. 10) is about midway between the Geneva gears. See that the brake screws and nuts are tight. If pin (C) is drifting into the Geneva gear slots instead of stopping as it should, it will be noticed that the dial plate will stop on position and then an instant later move a slight distance more in the same direction, as the pin starts into the next slot. In this case, tighten the brake slightly by turning the nuts one turn at a time. Be sure to lock the nuts after making adjustment.

If the tap changer drifts by position in the raise direction, contact SR3 will close and reverse the motor and return the tap changer to position and if the brake is loose it may continue to operate all the way to # 1 position and below and there lock out, due to lock out switch "MR" opening. If this occurs, it will be necessary to bring the tap changer back to position # 1 by hand. To do this, (FIRST OPEN CONTROL SWITCHES "AM" AND "MC" AND REMOVE POWER FROM TEST TERMINALS) turn motor pinion clockwise by hand until dial plate indicates above # 1 position. Connect power to test terminals and set control for "manual raise". Adjust tension on brake spring until the pin (C) stops a little past the vertical in either direction of operation.

If tap changer fails to operate, refer to section "Correction of Troubles".

Caution: Do not set brake too tightly as it will cause useless wear on the brake lining and the motor may not start during cold weather when oil is thicker. Remove test voltage from test terminals after making sure that the tap changer is in the by-pass position.

For convenience of the operator, it is desirable to use three sets of disconnecting switches to connect or disconnect type "LR" regulators from the power supply since the use of such a system of disconnecting switches enables him to connect or disconnect the regulator without taking the line out of service. When such a system is used, the source side of the regulator is connected to the line through one set of the disconnecting switches, the load side of the regulator is connected through a second set of disconnecting switches, and these two sets of disconnecting switches are connected together by the third set. Refer to Fig. 12.

When using this method to connect a regulator to the line, it is very important that the regulator be operated to the "Neutral" position. The "Neutral" position for by-passing is obtained by positioning the tap changer noving contacts to connect to the same transformer tap as terminal # 2 on the transformer terminal board is connected. The safety switch on the control panel should be opened before attempting to either connect or disconnect the regulator from the line. If these rules are not strictly followed, there is danger of short-circuiting the series winding of the regulator.

Assuming that the regulator has been operated to the "Neutral" position and the safety switch opened, the disconnecting switches connecting the regulator to the source are closed. The by-passing disconnecting switch is, of course, closed if the line is in service. The disconnecting switch connecting the load side of the regulator to the line is then closed. The by-passing disconnecting 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 switch

to either the "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 disconnecting switch opened and finally the source side disconnecting switch opened, and the regulator is off the line.

See also instructions for by-passing, on name plate and diagram.

MAINTENANCE

The type "LR" 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, the brake on the motor, and seeing that all connections are tight.

Oil-less 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 the regulator is called upon to carry. The arcing tips of the switch contacts are made of special alloys having a high conductivity and also a high melting point so as to resist burning. These contacts should, however, 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. The oil level in both compartments should be checked at the time of the periodic inspection.

The adjustments and settings of the control equipment are described in the section "Principle of Operation of Control Equipment", Page 8, and no adjustment of this equipment should be made until after this section has been carefully read.

If the relay contacts should need dressing, use only a very fine file.

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

Caution: Keep covers tight on all relays.

CORRECTION OF TROUBLES

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

(1) Is tap changer below position #1? If so, it is locked out and it will be necessary to remove cover and adjust brake as described under installation.

(2) Check voltage on voltage testing terminals with voltmeter, if available. If there is no voltmeter handy, snap safety switch SS on and off several times. If voltage is normal, the voltage regulating relay beam will balance, or if voltage is high, the left hand contact of the voltage regulating relay should close. These tests will indicate presence of control voltage. Note that the SS switch may be reset by moving handle all the way to the left before closing switch to the right.

(3) If voltage is low, and the tap changer is not on the extreme raise position, the voltage regulating relay right hand contact may be closed and the TH relay auxiliary contactor AR will try to close during successive cooling periods of the bimetal. This contactor and the motor control relays will operate on 85 per cent voltage. If the contactor closes when assisted by hand, then voltage is too low to operate.

(4) Does motor control relay close? Auxiliary contactor of the TH relay may be making poor contact, or circuit may be open between contact and terminal in the TH relay.

(5) 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.

d. Brake may be too tight. If so, adjust as described under "Installation".

(6) If motor operates in one direction but not in reverse, motor pinion may be out of line. If too loose, gears will jam; and if too tight, will bind.

(7) If the voltage regulating relay is energized but does not respond to voltage changes refer to the Instruction Leaflet for the relay.

SPARE PARTS

The customer will find that only a minimum of spare parts will be required for the type "LR" 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 Motor Complete
One Capacitor for Motor
One Set Cover Gaskets
One Bushing
One Type TH Time Delay Relay

MEMORANDA

MEMORANDUM
WEST[illegible]RM 2478 H

LEAVE SPACE ABOVE THIS LINE BLANK FOR FILING

TO Buffalo O. WORKS D. O. DATE 3-16-49

DEPT. Engineering Service MR. C. G. Archibald

Reference your Memorandum of 2-17-49 and 3-2-49.

The following data has been obtained on the Voltage (Primary) Relay, S# 1239230, which is used in the "LR" Relay Unit. IL-46-736-2. IB-47-420-1

Data (107) file -

With 100 % current in current transformer primary the following readings were taken -

% Compensation	Volts U-S	Current V-S	Comp Coil Amps	Primary Relay Amps	Volts reqd to Balance Relay
50	1.87	0.147	0.0562	0.167	123.6
100	2.2	0.147	0.147	0.173	126.3

The relay was set to balance at 115 Volts, (0) Zero Compensation. The primary relay Amps were measured at balance position.

With 100 % current in current transformer primary the following readings were taken for the output of the rectox.

% Compensation	[illegible] Volts	[illegible] Amps
50	0.62	0.147
100	0.74	0.141

Amps in primary relay coil at 120 Volts 0.154 Amps.

The rectox used on the Primary relay has four discs and is the bridge type -

NAME W.J.W.

FROM DEPT., WORKS OR D. O.

1351-2

Make it brief; make it clear; make it legible!

MEMORANDA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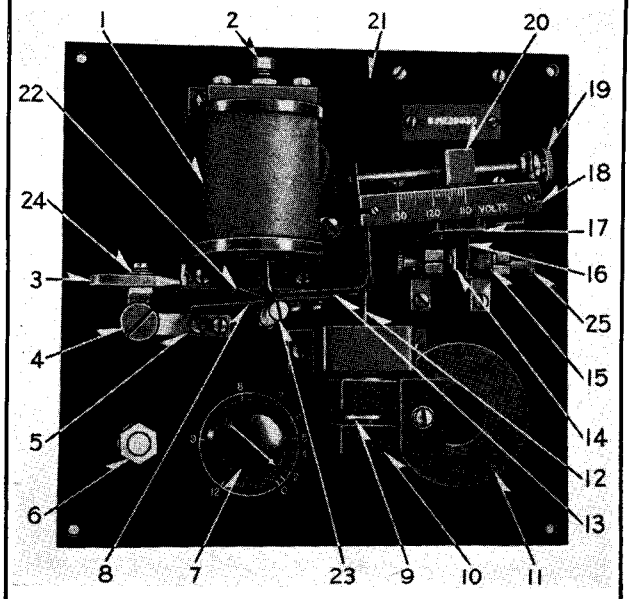
INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

VOLTAGE REGULATING RELAY

S# 1239930

For Step Type Regulators With Dynamic Line-Drop Compensator



1. Relay main operating coil
2. Magnetic circuit holding screw
3. Permanent magnet for band adjustment
4. Permanent magnet air gap adjusting screw
5. Permanent magnet supporting bracket
6. Mounting stud for rectox unit for compensator
7. Compensating rheostat operating knob
8. Soft iron armature
9. Compensator operating coil
10. Compensator magnet poles
11. Compensator permanent magnet
12. Link connecting compensator coil to balance arm
13. Balance arm
14. "Lower" contact
15. "Raise" contact
16. Moving contact
17. Bearing block
18. Voltage calibrated plate
19. Voltage setting adjusting screw
20. Voltage adjusting weight
21. Micarta panel
22. Buffer spring
23. Balance arm stop
24. Permanent magnet clamping washer and screw
25. Contact adjusting screw

FIG. 1. Voltage Regulating Relay—Cover Removed.

THE VOLTAGE REGULATING RELAY

S# 1239930, for step type regulators with dynamic line-drop compensator is of the alternating current solenoid type. Compounding is obtained by means of a permanent magnet rather than electro-magnets. Adjustments for different values of balance voltage are made by shifting a counter weight along a scale which is calibrated in volts. In addition, a small coil, energized by rectified current from a current transformer, and attached to the balance arm and operating in a permanent magnetic field, provides a means for compensating for line drop.

CONSTRUCTION

These relays as used on step type regulators are mounted on individual panels and provided with a tight fitting cover having a glass front (See Figure 1). Figure 2 shows a schematic diagram of the relay connections, the rectox unit and adjusting rheostat. The operating parts have been combined into a single moving element which is mounted on a

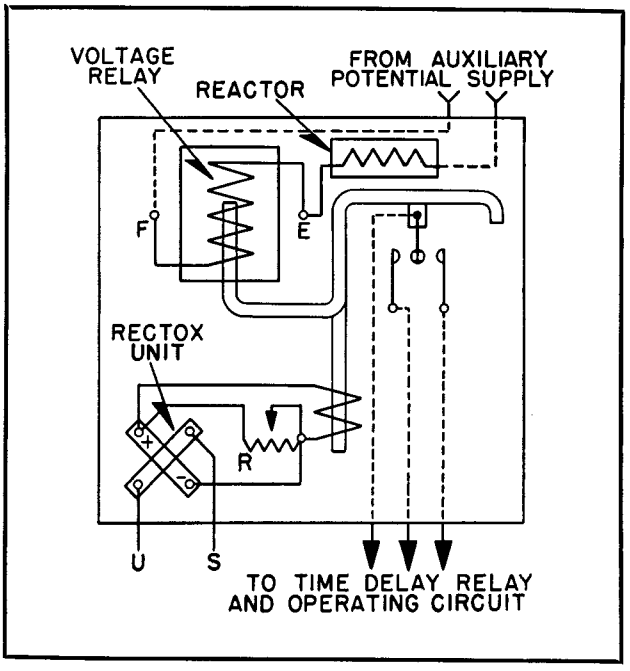


FIG. 2. Wiring Diagram of Voltage Regulating Relay.

square shaft resting on a knife edge. This construction provides a very sturdy bearing with a negligible amount of possible friction. The shaft and bracket are made of nitrided steel which is exceptionally hard and resistant to wear and corrosion.

The contacts are made of silver which results in long life and smooth contact points. They are designed in such a way that contact sticking is eliminated.

The relay includes a simple dynamic type line-drop compensator. A small coil is attached by a link to the relay balance arm and is located in a permanent magnetic field. A small rectox unit is mounted on the back of the relay panel to rectify the current from the secondary of a current transformer located in the output circuit of the regulator. A rheostat on the back of the panel and operated by a knob on the front, shunts the output of the rectox unit and regulates the current to the compensating coil, thereby providing means for varying the amount of compensation. The scale around the knob is calibrated in volts when referred to a 120 volt circuit. The compensating device also acts as a dampening device to give stability to the relay. When checking operation of the compensator, it will be necessary to have a load on the regulator in order to get current from the current transformer to operate the compensator.

INSTALLATION

The relays are usually shipped mounted on the control panel. Before putting in service, the blocking should be removed from the relays and they should be 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 supporting 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 tighten the screw again. The relay contacts should be in line and should not require any other adjustment, except as specified in the adjustment procedure.

ADJUSTMENT AND OPERATION

Adjustment. The voltage regulating relay is usually adjusted to make contact on plus or minus two or three volts change across the relay coil, the exact value depending upon the type of regulator on which it is used and the circuit conditions. The contacts will break and the relay will return to neutral position when the voltage returns to within approximately one volt of balance voltage. Both values of voltage, the one at which the contact makes and the one at which it breaks are adjustable independently, as explained below. For values of setting of relays for regulators, refer to the general instructions in the regulator Instruction Book.

To change the adjustment, it is necessary to have a source of variable voltage with a range of 5 volts plus or minus 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 changes 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 drop compensator, if used, should be set at zero. Be sure to place the AB switches in the "off" position before applying an external voltage to the control circuit test terminals.

If only a small change in the balancing, or normal voltage is required, this can be accomplished by means of changing the position of the balance weight. (The balanced voltage setting, of the relay is determined by the position of the movable weight on the relay balance arm. The setting may be changed through the use of a knurled adjusting screw which engages the movable weight). Apply the exact value of the desired balancing voltage to the control circuit and shift the weight until the moving arm balances directly opposite the permanent magnet. Then, ascertain the central position of the balancing voltage with respect to the relay voltage band, by varying the voltage in the positive and negative direction until the "lower" or the "raise" contact is made. The same amount of voltage deviation from normal should be required for the "raise" and the "lower" contact to close. If this condition does not obtain, further shifting of the weight will be required.

To make a complete adjustment of the relay, proceed as follows:

Figure 3 represents a voltage regulating relay for use on step type regulators with its various parts identified. Each part has an important function which should be clearly understood. As the steps in adjusting this relay are followed, the effect that each part contributes to the successful operation of this relay will be apparent.

The first check is for mechanical friction. If friction is present, it will result in a sluggish or erratic relay. To make this check, the following steps should be taken, with the compensator dials placed at zero compensation:

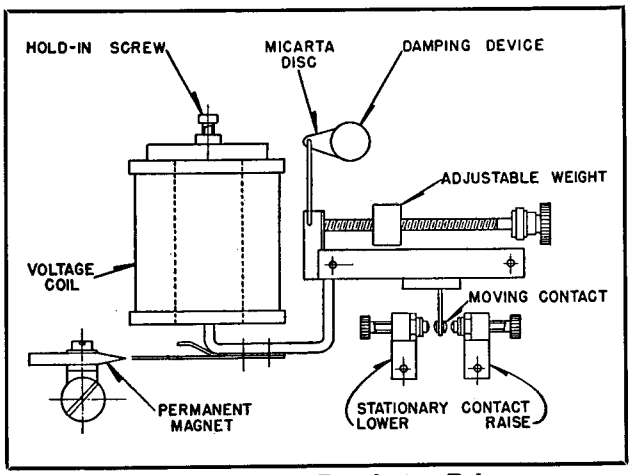


FIG. 3. Voltage Regulating Relay.

1. Revolve the permanent magnet about 90 degrees or, preferably, remove it completely.

2. Lift the small round Micarta disk on the damping device to relieve the damping effect caused by the tension spring. This can be easily done by pulling this disk back and then catching it onto the pin that protrudes backward to keep this disk in place.

3. Remove the "hold in" screw atop the voltage coil.

4. Open the stationary contacts wide, seeing that the leaf spring on each stationary contact has a travel of approximately $\frac{3}{32}$ inch.

5. Apply voltage to the test terminals until the relay beam balances.

Under these conditions and if no friction is present, the beam will float without any apparent interference, moving slowly with any slight voltage fluctuation.

If the beam is struck lightly it should oscillate up and down and then come to a gradual halt. However, if friction is present, no movement will be apparent as a result of slight voltage fluctuations; also, if one strikes the beam it will generally come to an abrupt stop after a short attempt to oscillate.

If the latter is the case, check the balance arm "knife bearing" for bits of refuse, or maybe poor alignment. Examine the compensator coil to be sure there is no friction between it and the permanent magnet. Before proceeding further, this difficulty must be cleared up. A close investigation will probably suggest the proper measures that must be taken in making the relay "friction free".

When the relay is free of friction, it is ready to be adjusted for proper operation. Since all the influencing factors have been removed; i.e., the damping device, permanent magnet and "hold in" screw—set the voltage to the relay (by voltmeter) to the desired "relay balancing" value. If a balance does not result, slowly change the position of the adjustable weight until this is accomplished. Proper weight adjustment is indicated when the tip of the beam settles approximately in line where the point of the permanent magnet would be if it were assembled in place.

After the relay is balanced, next proceed to make it less susceptible to slight voltage fluctuations or flutter This can be done by the damping disk and spring assembly. Replace this disk in its proper position, and then turn the small nut at the end of the spring until enough spring tension is exerted on the disk to satisfy this requirement. This is generally a very light tension. Now notice that the "floating" effect of the beam is no longer evident and the relay no longer responds to voltage fluctuations smaller than can be observed on the scale of the ordinary portable voltmeter.

The next step is to increase the voltage, to the relay, to the value at which it is desired that the "lower" contacts should close. This value must be at least one volt above the balancing voltage. Here, notice that the relay beam will rise into the voltage coil. With the beam at this level, bring the left stationary contact up until its leaf spring is depressed about $\frac{1}{2}$ its travel. Next replace the "hold in" screw atop the voltage coil, and turn it into the coil until its effect upon the beam is such that it begins to raise the beam slightly further. Turn screw in another 5 degrees and lock it. Next, lower the voltage to "balancing voltage". The beam should again return to its original position. If it does not do so, the effect of the "hold in" screw should be lessened by backing it up slightly.

Now replace the permanent magnet to its normal position, in line with the beam of the relay. The influence of this magnet will hold the beam in direct line with its tip.

With the relay held in this position, the left-hand stationary contacts should be not less than $\frac{1}{16}$ inch from the moving contact. Again increase the voltage to a contact closing value as before. The beam should again rise into the voltage coil and the moving contact should make positively with the left stationary contact. If it does not do so, gradually draw the magnet away from the beam until it does, and lock the magnet in place. (If very close voltage regulation to the relay is available when making this test, the position of the permanent magnet should be so adjusted that its influence upon the beam is lost when the voltage is varied as much as one volt above or below the balancing voltage.) This gives maximum operating band setting.

Next decrease the voltage to a "raise" contact closing value. The beam should drop. Bring the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right-hand stationary contact up until its leaf spring is depressed ½ its travel. Since the influence of the permanent magnet on the beam is the same in both directions, it should need no further adjustment.

Return the voltage to "balancing voltage". The beam should return as before and the right contacts should open at least 1/16 inch. If it does not return, move up the right-hand stationary contact with its set screw until the added effect of its leaf spring pushes the beam nearer the field of the permanent magnet. Care should be taken when this is done not to move this stationary contact up so far as to have this contact closed when the relay is in the balancing position.

For very narrow bands, replace the brass washer holding the permanent magnet with an iron washer. The iron washer will by-pass a part of the magnet flux and allow smaller air gap setting.

A properly adjusted relay should give a positive non-chattering operation even on extremely slow and small changes of voltage. The arm movements should make and break contact with a positive snap action. Should this not be the case, the strength of the permanent magnet (#3, Figure 1) should be checked. The latter should be strong enough to lift a weight of 2 oz. at its tips.

Adjustment of Compensator. The action of the compensator is such that when rectified current is passed through the coil, on the lower end of the plunger, a force is produced on the plunger in opposition to that produced by the field of the main operating coil, thus requiring a higher voltage on the operating coil to maintain a balance. The result is a compensation effect which is substantially proportional to the load and which, at a given load and compensator setting, is a constant value independent of the phase relation of the current and voltage of the load.

No provision is made for independent adjustment of resistance and reactance compensation as this device has a fixed ratio of these values, but the total amount of compensation may be readily adjusted to any value within the usual range. On feeders of small capacity a resistance drop equal to twice the reactance drop is a common ratio. With this ratio the compensation of the dynamic compensator is within the accuracy of setting of a standard full size line-drop compensator with both X and R compensation for load power factors between 70 and 98 percent.

The correct setting is found by the following formula:

$$C = \frac{120}{\text{Line Voltage}}(IX \sin \varnothing + IR \cos \varnothing)$$

C = Compensator setting volts

$\varnothing$ = Angle of lag of current behind voltage at the prevailing full-load power factor.

*IX = Reactance voltage in line to be compensated

*IR = Resistance voltage in line to be compensated

* = For single-phase circuits, use twice the values found for a single wire.

Operation. The compounding is accomplished by the use of a permanent magnet acting on a soft iron armature attached to the moving element. The action of the magnet is to hold the relay element in a neutral position until a sufficient change in voltage has taken place to overcome the magnetic pull in the balance position. The moving element requires a predetermined unbalanced force to overcome the magnet pull which results in a quick and positive movement and contact. After the voltage has been corrected a sufficient amount to cause the contacts to separate, the relay moving element is again drawn back to a neutral or balanced position by the permanent magnet.

The sensitivity of the relay or the amount of voltage change required to close the relay contacts is determined by the air gap between the magnet poles and the moving iron armature. The gap spacing is made adjustable to vary the voltage band setting of the relay. If the gap is decreased, the magnet pull is greater and a greater change of voltage on the solenoid coil is required to operate the relay. If the gap is increased, the magnet pull is less and operation is obtained with a smaller voltage deviation. In this way, the relay sensitivity to voltage change may be controlled.

MAINTENANCE

The amount of relay maintenance which may be required will depend largely upon the voltage conditions existing on the circuit and the degree of sensitivity to which the voltage regulating relay is adjusted. It is recommended that during the first few months of service, inspection be made at rather frequent intervals to prevent excessive tap changer operation. After satisfactory operation is once established, inspections at periods of six months to one year should be sufficient.

It is not necessary to keep the contacts on this relay polished as on older types of relays, since the contacts on this relay are made by rolling rather than by sliding action.

If the contacts on the relay should become worn to an uneven shape, they may be smoothed and reshaped with fine sandpaper and readjusted.

Caution: Do not lubricate bearings. Keep cover on tight.

Renewal Parts: Order renewal parts from the nearest Westinghouse District Office or from the Sharon, Pa., Works giving style or S.O. number and serial number as stamped on name plate of regulator and description of parts required. Refer to Figure 1.

WESTINGHOUSE ELECTRIC CORPORATION
SHARON WORKS • TRANSFORMER DIVISION • SHARON, PA.
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Westinghouse

TYPE TH THERMAL TIMING RELAY

INSTRUCTIONS

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 developed 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 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.

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.

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.

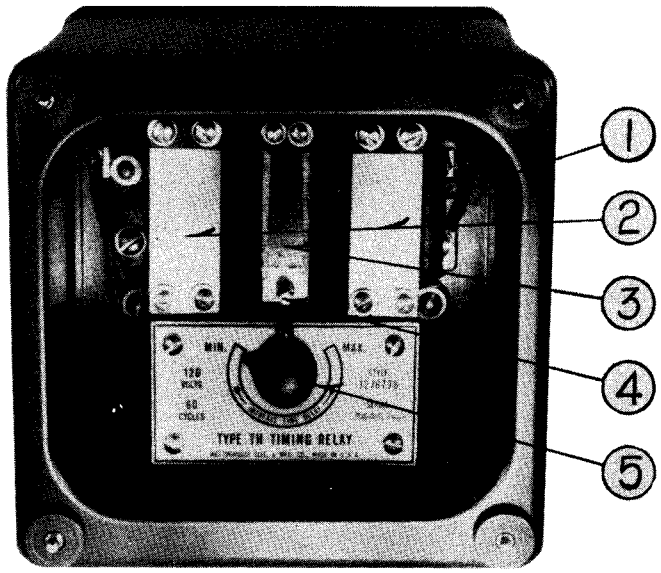


Figure 1
The Type TH Thermal Timing Relay. 1-Resistor, 2-Side Bimetal Strips, 3-Heater Coil and Center Bimetal strip, 4-"F" Bimetal Screw, 5-"T" Timing Screw.

The Bi-Metal System

The bimetal system 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 Micro Switch

The micro switch is mounted on the rear of a Micarta sub-base and in front of the magnetic contactor. The micro switch is a snap action single-pole double-throw switch, operated

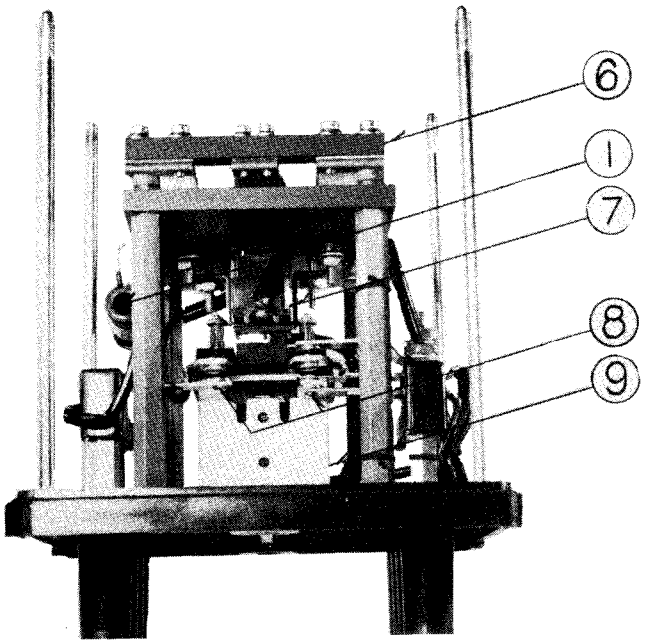


Figure 2
Top Views of the Type TH Thermal Timing Relay.
1-Resistor, 6-Bimetal Assembly, 7-Micro Switch,
8-Contacts, 9-Auxiliary Contactor.

by the pressure exerted by the bimetal assembly. The normally-open contact is fixed 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 sub-base 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 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.

OPERATION

The circuit controlled by the relay is included between terminals 3 and 8 as shown in Fig. 5. 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 pre-determined temperature rise above ambient, the micro switch returns to its original position, thus closing the circuit between terminals 3 and 8. The relay is reset by de-energizing the coil of the auxiliary contactor.

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.

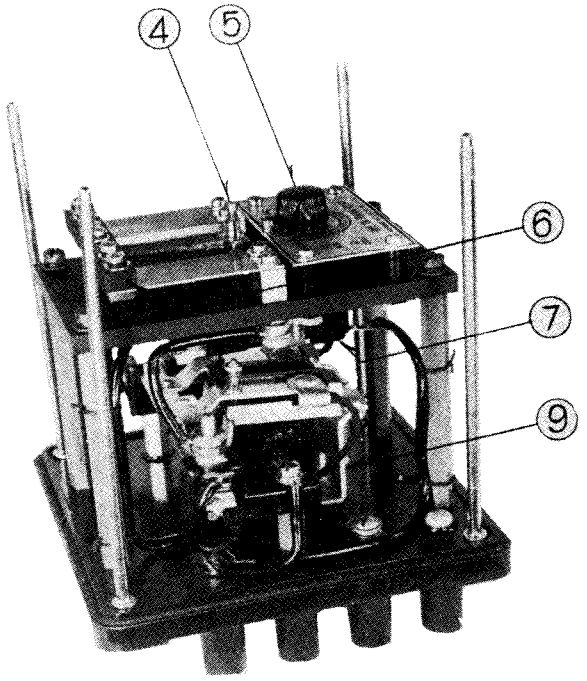


Figure 3
Side View of the Type TH Thermal Timing Relay.
4-"F" Bimetal Screw, 5-"T" Timing Screw, 6-Bimetal
Assembly, 7-Micro Swtich, 9-Auxiliary Contactor.

ADJUSTMENT 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:

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.

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.

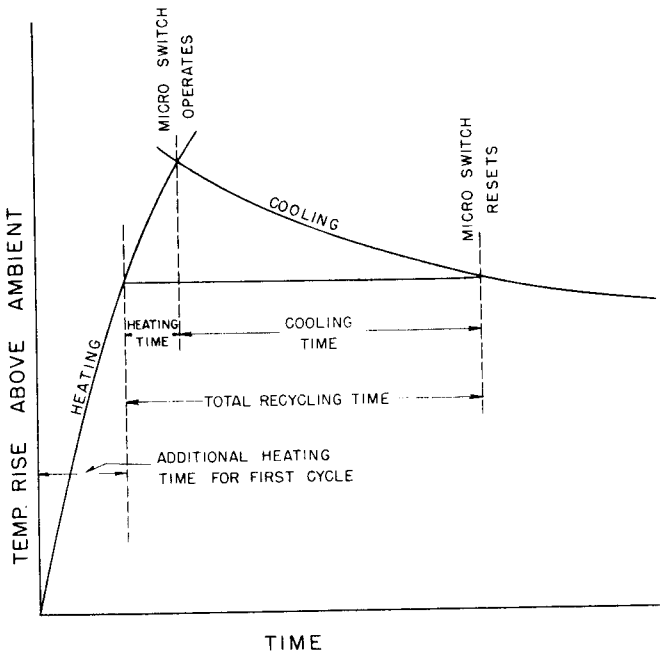


Figure 4
The Time-Temperature Characteristic of the Type TH Relay.

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 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

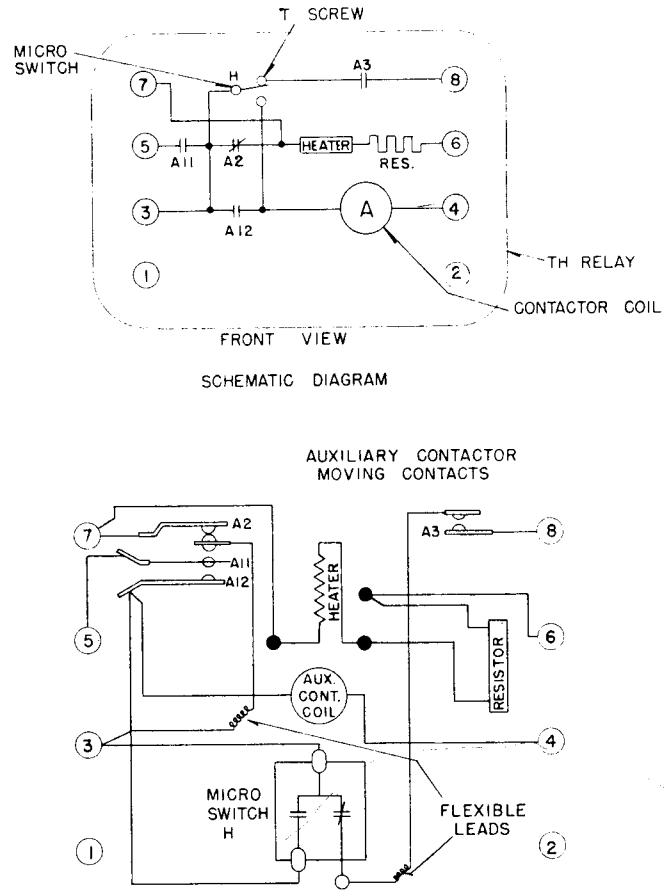


Figure 5
Schematic & Wiring Diagrams of the Type TH Relay.

counterclockwise 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

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 the circuit has been reclosed.

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 13-1/2 and 16-1/2 seconds with pointer on "T" set at MIN, and between 54 and 66 seconds with pointer set 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.

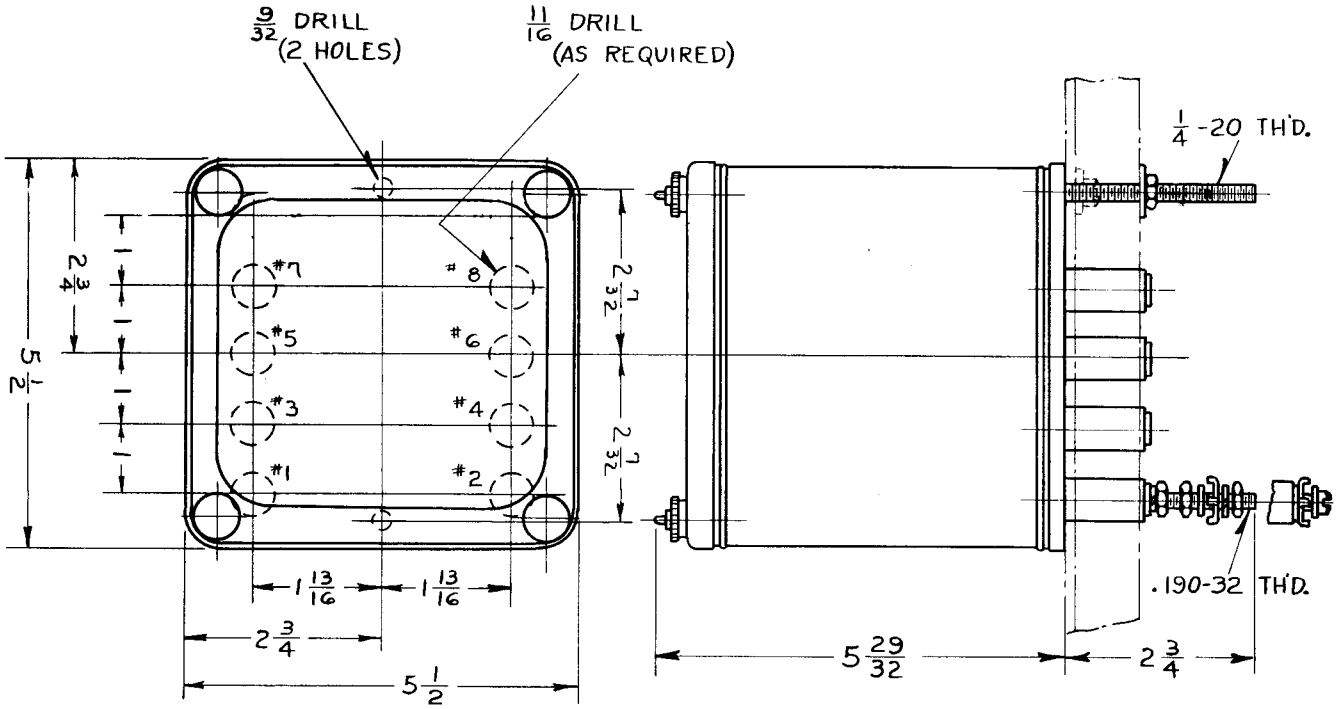
IMPORTANT: Readjustment should not be made on either element unless its factory adjustment has been disturbed.

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 nameplate 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.



NOTE: FOR 1/8 IN. OR 3/16 IN. METAL SW'BDS USE SCREWS FOR MTG. RELAY AND FOR TERMINAL CONNS. FOR 1/4 IN. TO 1 IN. SW'BDS USE STUDS FOR MTG. RELAY AND SCREWS FOR TERMINAL CONNS. FOR ALL OTHER SW'BDS USE STUDS FOR BOTH PURPOSES.

Figure 6
Outline & Drilling Plan for the Type TH Relay.

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

TYPE SG AUXILIARY RELAY

Caution Remove blocking between armature and core of relay before placing in service.

INSTALLATION

Inspect the relay carefully after unpacking to see that no damage has been done in shipment. Operate the relay by hand several times to see whether the moving element is properly aligned and free from friction. Check the nameplate rating to see that it agrees with conditions under which relay will be used. The SG for use on A-C has a rectangular copper loop clamped in the top of the core, over which the coil is placed. The D-C relay has no loop, but has a small bronze button in the center of the core front to prevent the armature from being held closed by residual magnetism.

Mount the relay with the base against a vertical plane so that gravity helps hold the armature away from the core. The SG relay is designed to operate correctly only when in this position.

Relays having a voltage rating which requires a resistor in series with the coil are supplied with a vitrified tube resistor which has heavy screw-type terminal lugs. The resistor is assembled on an insulated mounting stud by which it can be mounted either directly on a panel or any convenient bracket.

When sheet metal cabinets are ordered for open-type relays, the relays and cabinets are shipped separately. The relays can be assembled on the tapped mounting holes in the bottom of the case by means of the mounting screws which are provided. The cabinets have knockouts for conduit connections on top, bottom and sides.

APPLICATION

The relay can be supplied for use on the following voltages without an external resistor by the use of suitable coils.

48 Volts D-C
125 Volts D-C
115 Volts - 25 Cycles
230 Volts - 25 Cycles
115 Volts - 50 or 60 Cycles
230 Volts - 50 or 60 Cycles
440 Volts - 50 or 60 Cycles
575 Volts - 50 or 60 Cycles

and for higher D-C or 25-cycle voltages with an external resistor. For further information regarding application consult Westinghouse Relay Catalog, Section #41-350 or the nearest Westinghouse Sales Office

The relay is intended for use as an auxiliary relay for miscellaneous automatic and remote control switching. It is suitable for many industrial applications also.

The operating and reset time of the type SG at rated voltage or current is 1 to 2 cycles (60 cycle basis).

CONSTRUCTION

The standard relay is furnished in two forms: A front-connected, open-type and a rear-connected, enclosed-type. The operating elements are identical in the two types and consist of four parts: core, yoke, armature and coil.

The open-type relay normally is provided with two contacts and is shipped with both stationary contacts arranged to close when the relay is energized. However, either or both contacts can be converted quickly into a break

contact merely by removing the screw which holds the stationary contact bracket and turning the bracket over. After tightening the screw, the contact bracket may be bent slightly with the fingers if necessary to change the back contact follow or alignment. When the make contacts are closed, the moving contact fingers should be deflected approximately 3/64" measured at the contacts, or slightly over 1/32" measured at the upper edge of the molded armature block. The assembly of the moving contact fingers on the armature block is arranged to provide spring follow with either make or break stationary contacts. The closed-type relay is provided with two make and two break stationary contacts with the moving contacts common, and the open-type relay is provided with such a contact arrangement for applications which require it.

Relays for use on A-C are assembled with a thin bronze washer between the yoke and core. A brass screw holds the yoke and core together. This washer helps to prevent the armature from being held closed by residual magnetism after the relay is de-energized. In case the relay should be dismantled, it is important that this washer be replaced on re-assembling it.

CHARACTERISTICS

All relays should pick up on 80% of the nameplate voltage rating. No adjustments are provided for varying the pick-up. The armature will open at 30% or less (on D-C) and at 60% or less (on A-C).

The volt-ampere burden at rated voltage (60 cycles) is 10, at a power-factor of approximately 50%. The watt consumption at rated D-C voltage is 3.5.

Each contact will carry 12 amperes continuous and 30 amperes for one minute.

The contact interrupting ratings are as follows: All values are non-inductive currents.

External connections may be made with the contacts in series if desired.

INTERRUPTING RATING IN AMPERES

Volts	D-C 1 Contact	D-C 2 Contacts in Series	A-C. 1 Contact
24	15	50	50
48	8	35	45
115	2.4	20	30
230	0.75	2.5	20
550	0.25	0.5	10

REPAIRS AND RENEWAL PARTS

Major repairs can be most satisfactorily done at the factory or Westinghouse Service Shops. However, for customers equipped to do their own work, parts may be furnished on order. In ordering any part or requesting any other information, always give entire nameplate reading.

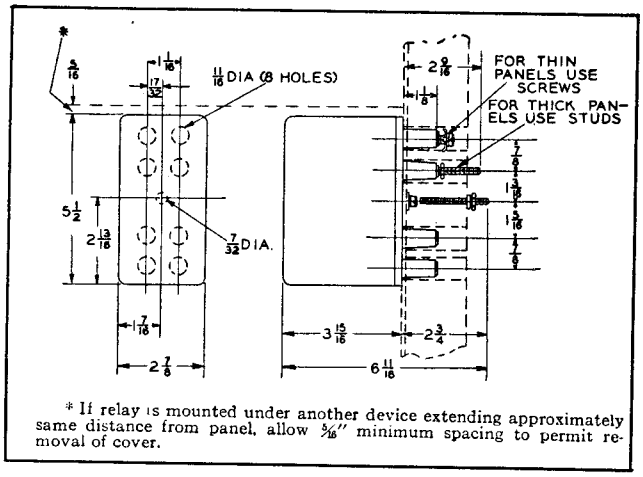


Fig. 1—Outline and Drilling Plan for the Closed Type SG Auxiliary Relay. For Reference Only.

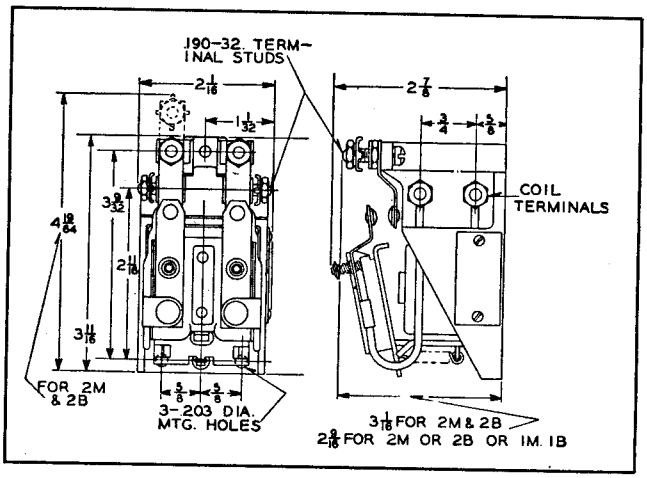


Fig. 2—Outline and Drilling Plan for the Open Type SG Auxiliary Relay. For Reference Only

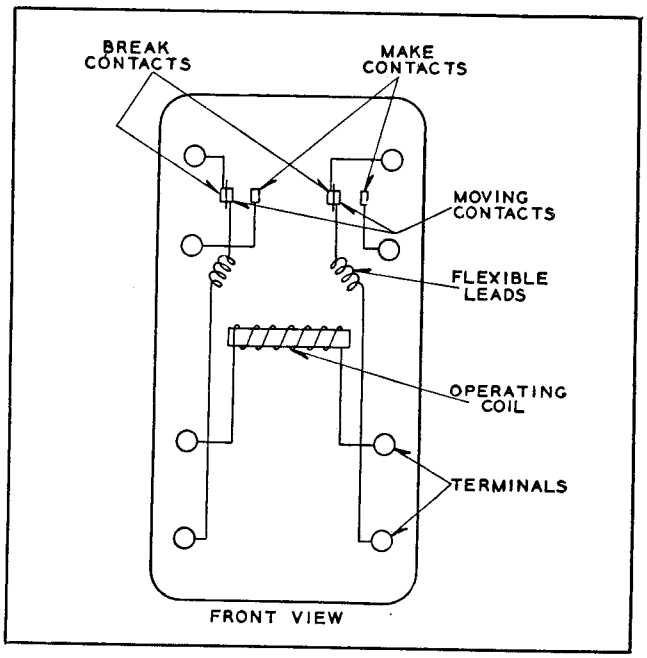


Fig. 3—Internal Connections for Closed Type SG Relay.

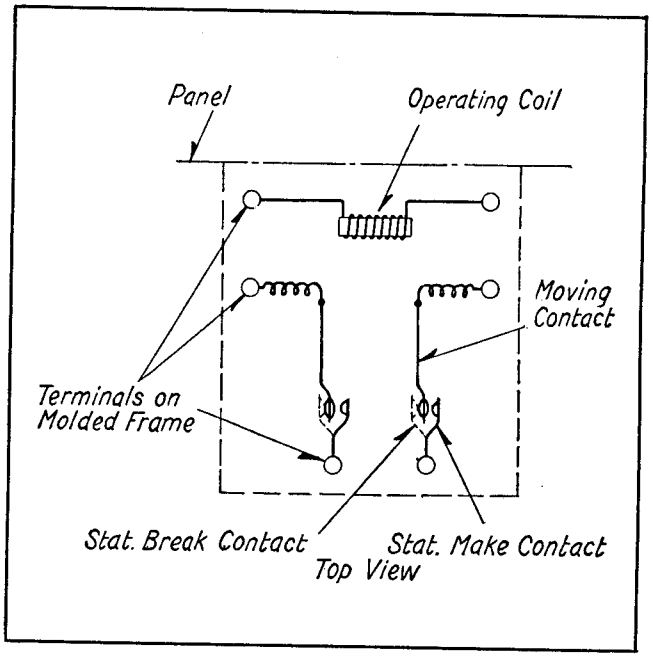


Fig. 4—Internal Connections for Open Type SG Relay.

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INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

"DE-ION" ARRESTERS

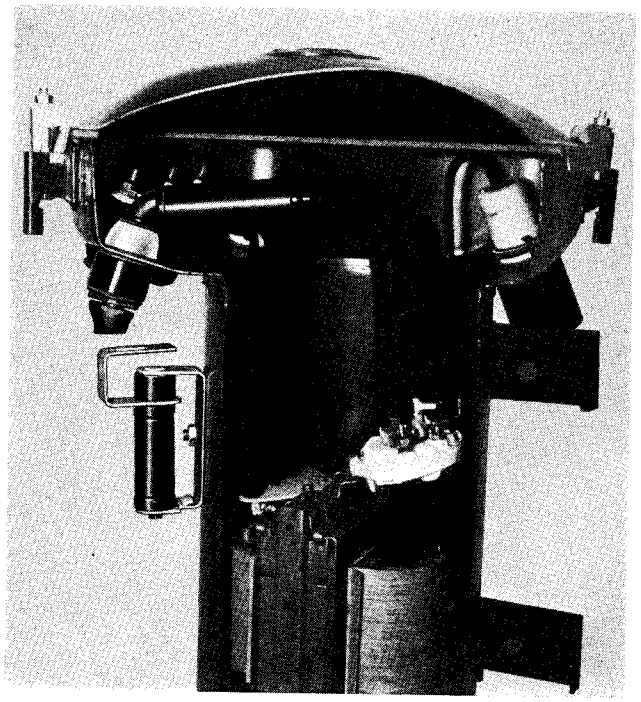

FIG. 1. "De-ion" Arrester Mounted Internally

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. Internally and externally mounted units are shown in Figures 1 and 2, respectively.

RECEIVING

"De-ion" arresters will normally be shipped assembled with the apparatus with which they are to be used. In any case where they are not, care should be taken to see that they are not stored in any place where water could enter the discharge opening of the arresters or where their packing may become water soaked. Humidity should also not be excessive (over 80% R.H.) for extended periods of time.

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 at $\frac{1}{2}$ inch and the shunt gap at $\frac{9}{16}$ inch as shown in Fig. 3.

The sketches in Figure 3 show typical internal and external mountings; mechanical details will differ on some apparatus.

OPERATION

The "De-ion" arrester consists of two metal electrodes separated by a slotted fiber diffuser section. When an excessive voltage appears across the terminals of the arrester, a flashover takes place from one electrode through the slots of the diffuser section to the other electrode. The voltage between the two electrodes then drops immediately to a very low value. Should this flashover

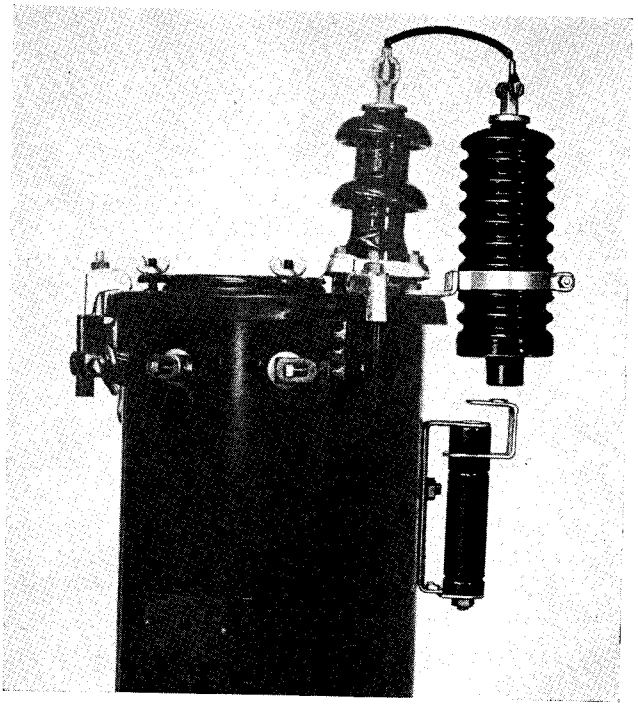

FIG. 2. "De-ion" Arrester Mounted Externally

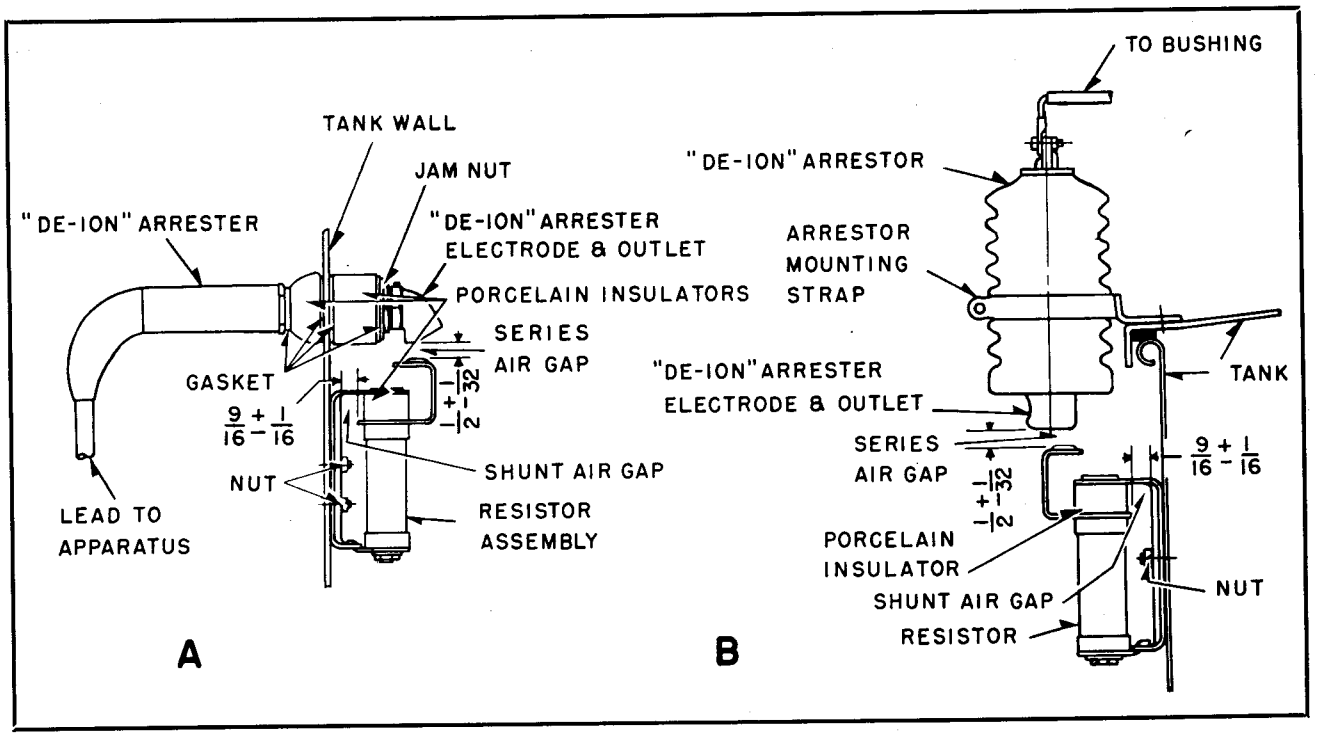

FIG. 3. "De-ion" Arrester: (A) Typical Internal Mounting; (B) Typical External Mounting

take place at a time when the power voltage is of sufficient magnitude to produce and maintain an arc against the deionizing action of the arrester, a flow of power current will follow the surge. This power current is limited to a value less than 500 amperes by the resistor which is in series.

The heat from the current which flows through the slots of the fiber diffuser causes gas to be driven off from the slot walls. This gas mixes into the electrical discharge in such a way that at the first current zero of the power current, the discharge is deionized by the un-ionized gas and the current is not built up in the opposite direction. There is no minimum power current below which the arrester will not interrupt.

There is a series air gap between the "De-ion" arrester and resistor. The purpose of this gap is to prevent any possibility of leakage current through the "De-ion" arrester.

The resistor is provided with a shunt protective gap which flashes over when the surge current reaches about 10,000 amperes. This limits the voltage, due to IR drop, which would be applied to the electrical equipment and also by-passes around the resistor the large amount of energy in a direct stroke. Experience has shown that when surge currents are in excess of 10,000 amperes, the deionizing action of the surge current alone is sufficient to prevent power follow current so that the resistor is not needed and it can be shunted out by the gap.

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. Neither the resistor nor the arrester proper (internal mounted arresters) should be refinished with a type of paint which might have electrical conduction properties.

RENEWAL PARTS

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

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RECEIVING • INSTALLATION • MAINTENANCE

INSTRUCTIONS

TRANSFORMER OPEN AIR BREATHER

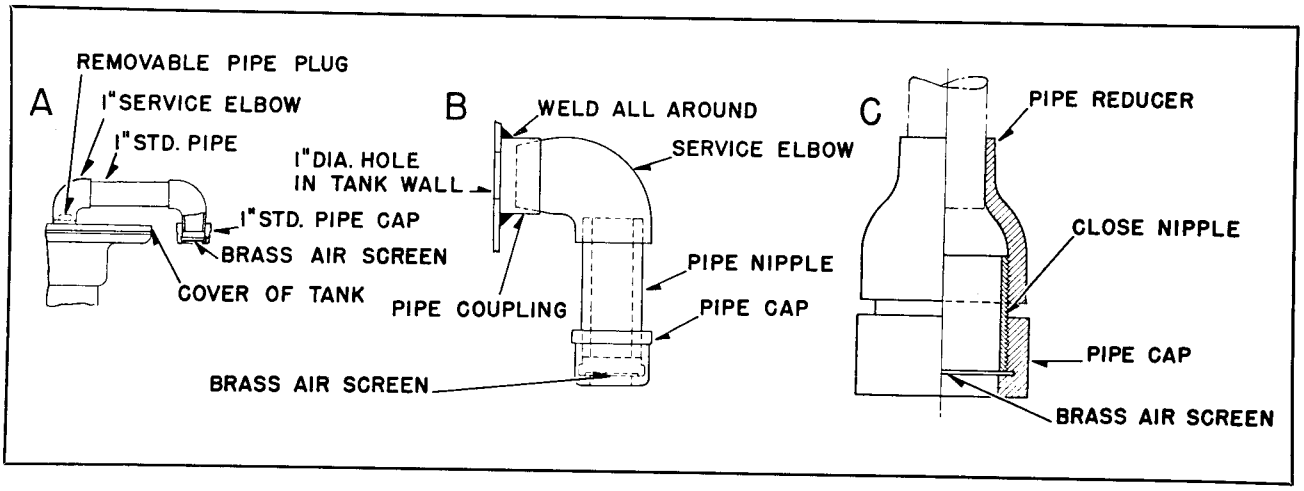

Fig. 1 (A) For Mounting on Main Cover, Manhole or Handhole Covers; (B) For Mounting on Tank Wall; (C) For Special Mounting and Attaching to Standard Pipe.

OPEN AIR BREATHERS are used where it is necessary to provide for free breathing to the inside of transformer tanks and for venting gases generated in tap changer compartments of regulators where taps are changed under load. The device consists of pipe fittings and a fine screen at the vent end to exclude insects or foreign matter.

The breather is assembled in several different arrangements to fit the particular application. See Figure 1. The fittings have standard pipe threads and the brass air screen is held in place by a pipe cap with the end drilled out.

RECEIVING

The breather is shipped as a detail. The mounting hole in the tank cover or tank wall is plugged with a removable pipe plug.

INSTALLATION

Remove pipe plug and screw the service elbow of breather into place on the cover or tank wall as shown in Figure 1 and then complete the assembly. The brass air screen must be at the bottom.

MAINTENANCE

Normally the only maintenance required is the periodic cleaning of the brass air screen. This screen may be removed and cleaned by first removing the pipe cap holding it.

When ordering renewal parts, include all information contained on the name plate attached to the transformers. Address all correspondence to the nearest Westinghouse District Office.

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