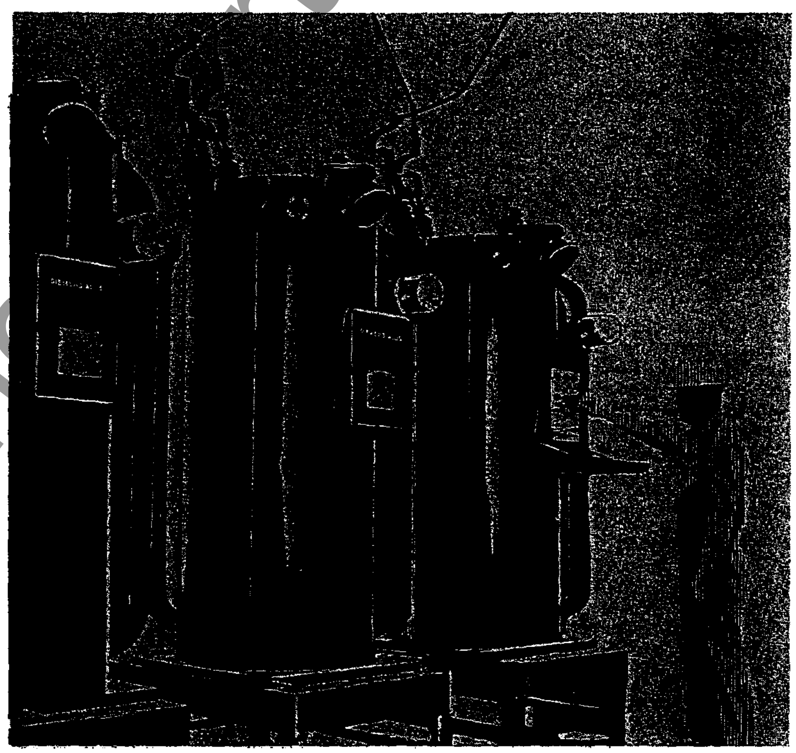
SIEMENS-ALLIS

JFR DISTRIBUTION VOLTAGE REGULATORS



USERS MANUAL

21X1263-10

SIEMENS-ALLIS

JFR DISTRIBUTION VOLTAGE REGULATORS

CONTENTS

USERS MANUAL

Summary of Procedures

PLACING REGULATOR IN SERVICE
(without interrupting the load)
For detailed instructions see page 9.

1. The by-pass switch 1, Fig. (7, 10, 13), is in series with the line and will of course, be closed if the line is carrying load. Close the disconnect switch 2, Fig. (7, 10, 13), on the source side of the regulator. This excites the regulator to full line voltage.
2. Run the tap changer to "Neutral" position.
3. Turn transfer switch and voltage source switch to "off".
4. Remove both fuses on front of control panel.
5. Close the disconnect switch 3, Fig (7, 10, 13), on the load side of the regulator.
6. Open the by-pass switch 1. The regulator then carries load.
7. Replace fuses on front of control panel.
8. Set voltage source switch to "Normal".
9. Adjust the control (see Page 13) and set the transfer switch to "automatic" position.

CAUTION

Source (S), load (L) and neutral (SL) designation of bushings stamped on cover. Check before connecting to line.

CHECKING REGULATOR *ACCU/STAT* CONTROL
For detailed instructions to check band width and voltage see page 10.

1. Move transfer switch from "automatic" to "raise" position and allow regulator to operate about five steps.
2. Return the transfer switch to "automatic" operation. After a short time delay the regulator will operate, and come to rest.
3. Check the regulator operation in the "lower" direction in the same manner.
4. If the control operation is satisfactory, return the transfer switch to the "automatic" position.

REMOVING REGULATOR FROM SERVICE
(without interrupting service)

1. Run the regulator to the "Neutral" position.
2. Turn transfer switch and voltage source switch to "off".
3. Remove both fuses on front of the control panel so the regulator cannot operate.
4. Close the by-pass switch 1, Fig. (7, 10, 13), thus shunting the regulator.
5. Open disconnect switch 3, Fig. (7, 10, 13), on load side.
6. Open disconnect switch 2, Fig. (7, 10, 13), on source side.

CAUTION

When removing the regulator from service, never open the neutral disconnect switch until the source disconnect switch has been opened. Failure to observe this rule may cause a high enough voltage to be induced in the windings to damage the insulation.

NOTE: Above instructions and those on Page 9 based on using individual switches for source, load and by-pass. If combination type regulator by-pass switch is used, the by-pass switch No. 1, Fig. (7, 10, 13) is the by-pass element of the combination switch. The source and load switches, No. 2 and 3, are the source and load blades of the combination switch.

WARRANTY

Company warrants title to the product(s) and, except as noted below with respect to items not of Company's manufacture, also warrants the product(s) on date of shipment to Purchaser, to be of the kind and quality described herein, merchantable, and free of defects in workmanship and material.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS, AND CONSTITUTES THE ONLY WARRANTY OF COMPANY WITH RESPECT TO THE PRODUCT(S).

If within one year from date of initial operation, but not more than eighteen months from date of shipment by Company of any item of product(s), Purchaser discovers that such item was not as warranted above and promptly notifies Company in writing thereof, Company shall remedy such nonconformance by, at Company's option, adjustment or repair or replacement of the item and any affected part of the product(s). Purchaser shall assume all responsibility and expense for removal, reinstallation, and freight in connection with the foregoing remedies. The same obligations and conditions shall extend to replacement parts furnished by Company hereunder. Company shall have the right of disposal of parts replaced by it.

ANY SEPARATELY LISTED ITEM OF THE PRODUCT(S) WHICH IS NOT MANUFACTURED BY THE COMPANY IS NOT WARRANTED BY COMPANY and shall be covered only by the express warranty, if any, of the manufacturer thereof.

THIS STATES PURCHASER'S EXCLUSIVE REMEDY AGAINST COMPANY AND ITS SUPPLIERS RELATING TO THE PRODUCT(S) WHETHER IN CONTRACT OR IN TORT OR UNDER ANY OTHER LEGAL THEORY, AND WHETHER ARISING OUT OF WARRANTIES, REPRESENTATIONS, INSTRUCTIONS, INSTALLATIONS OR DEFECTS FROM ANY CAUSE. Company and its suppliers shall have no obligation as to any product which has been improperly stored or handled, or which has not been operated or maintained according to instructions in Company or supplier furnished manuals.

Introduction

Type JFR regulators are designed to give dependable on-the-line service and to make installation, operation and maintenance as simple as possible.

High quality materials and careful workmanship have been combined to give you the best regulator available. Your regulator has been carefully inspected and adjusted at the factory. However, successful operation depends on proper installation and care.

The manual has been written to help you obtain long and economical service from your regulator. If you follow these instructions carefully, your unit will give the best in regulating service. *Read this manual before installing or operating your regulator.*

INSPECTION FOR DAMAGE IN SHIPPING

As soon as the regulator arrives, check each item with the shipping manifest. Should any shortage or damage be found, call the local freight agent of the carrier over which the shipment arrived, and make proper notation on the freight bill. Claim should be made immediately with the carrier, and Siemens-Allis should be notified.

STORAGE

If the regulator is not to be put into immediate use, it can be stored inside or outside without any particular precautions, provided the control compartment is tightly closed and the breather plugs are removed to allow normal breathing.

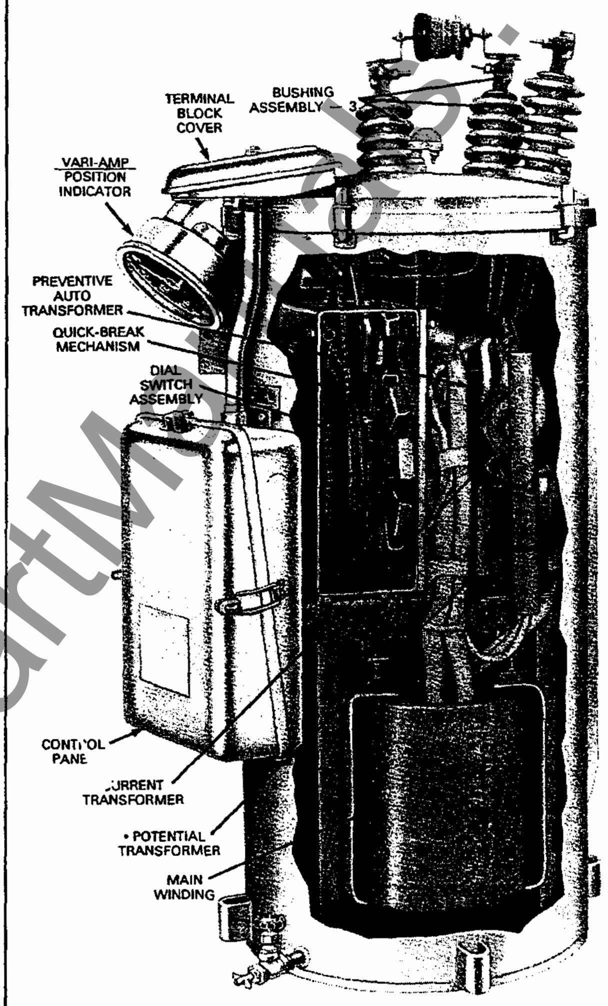
Oil may splash into the lower breather pipe during transit, so a container should be placed under the opening when the plug is removed. About a quart of oil may be drained out.

PROTECTIVE MEASURES

By-Pass Arresters: All standard regulators are equipped with by-pass arresters which should be mounted on the bushings and connected across the series winding. By-pass arresters limit the voltage across the series winding, but are not meant as a protection from line to ground.

Lightning Protection: For better protection of both regulator and line, install a lightning arrester of the proper rating between line and ground. For best results, install lightning arresters on the mounting lugs located between the source and load bushing and the source and neutral bushing at the top of the tank. Ground the arrester and the regulator tank solidly to the same ground connection with the shortest lead possible.

Fusing: When fuses are used with single phase regulators, place in source line leads only, never in the neutral or common lead. Fuse manufacturers have standard fuses for protection of circuits of various ampere and voltage ratings. Manufacturers' recommendations should be followed.



*Type JFR regulators utilizing the inverted design do not have potential transformers.

Fig. 1 Cutaway view of typical JFR regulator identifying internal and external components.

CAUTION

The regulator outline drawing, furnished with each regulator shipped, should be reviewed to verify it is built for pole mounting (hanger brackets) or platform mounting.

WARNING — Before connecting regulators on the line: Check nameplate for control and motor voltages and markings on main cover for proper bushing location.

LOCATION

Siemens-Allis regulators are designed to permit indoor or outdoor installation, on platforms or on poles. There are limitations that should be considered prior to installation:

1. The regulators should not be located in an air locked room or enclosure because they need circulating air for cooling.
2. The regulators should have adequate clearance to permit complete inspection and maintenance.

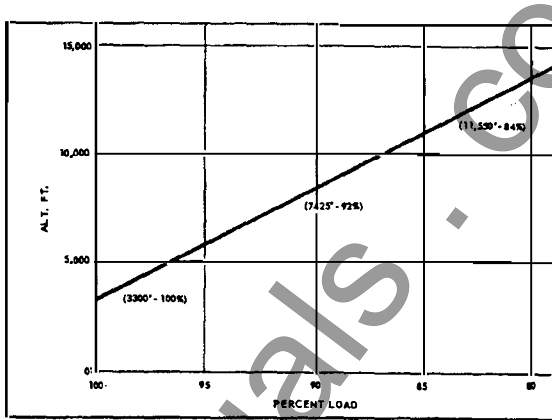


Fig. 2 When regulators are used at altitudes above 3300 feet, operating kVA should be reduced as specified in ANSI Standards. This chart indicates reduction in kVA rating for increase in altitude at which the regulator is to be operated.

Installation Diagrams

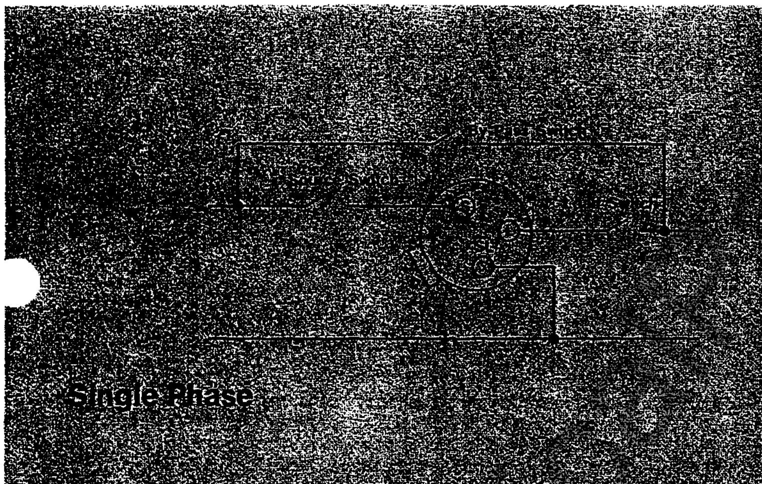


Fig. 3 Connection of one single-phase JFR regulator on single-phase line.

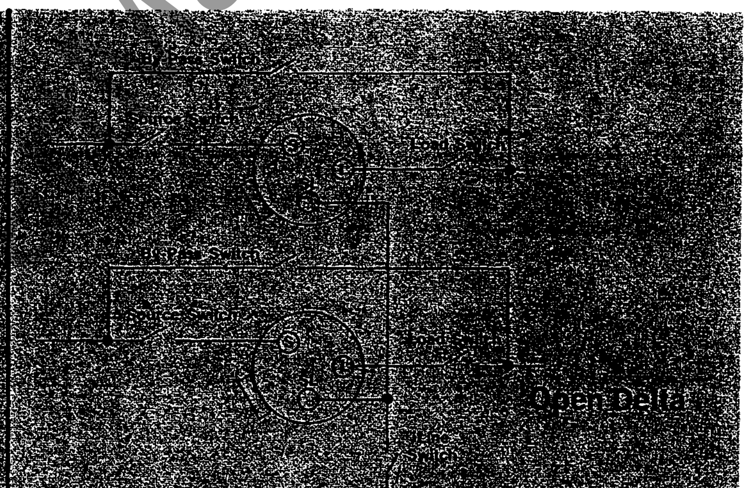


Fig. 4 Connection of two single-phase JFR regulators in open delta on a three-phase, ungrounded line.

Fig. 5 Connection of three JFR regulators in closed delta on three-phase ungrounded system providing 15% regulation.

Fig. 6 Connection of three single-phase JFR regulators in wye on a three-phase grounded neutral system.

Straight Design

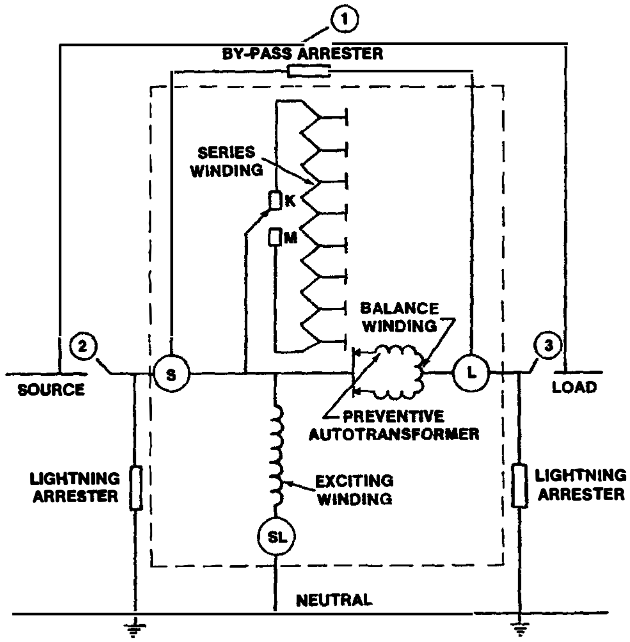


Fig. 7 Wiring diagram of typical regulator showing both external and internal connections.

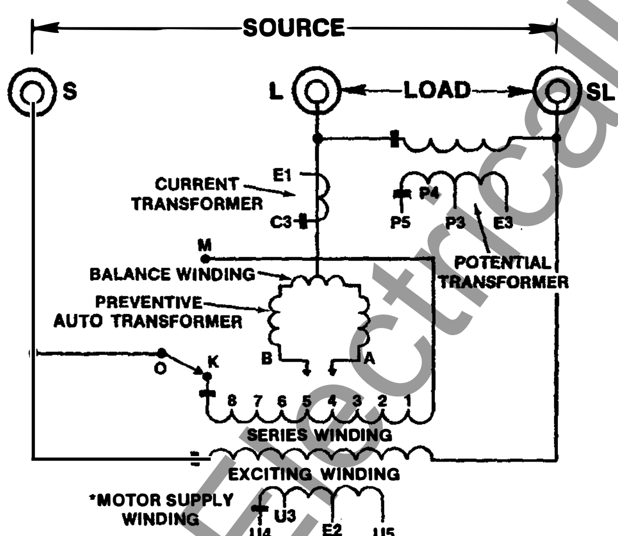


Fig. 8 Schematic diagram of typical JFR regulator with separate potential source for control.

** Note: Other typical motor supply winding configurations.*

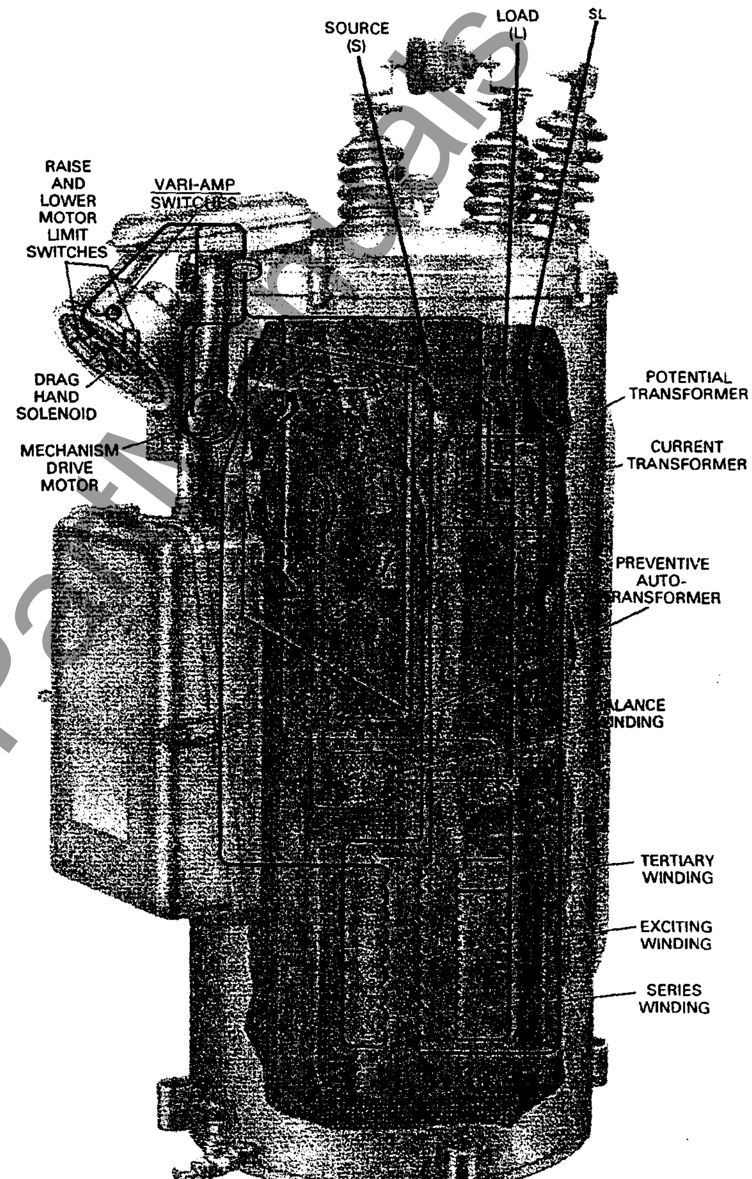


Fig. 9 Typical arrangement of windings and connections of JFR regulators.

NOTE: Straight Design units may or may not be equipped with balance winding. Refer to regulator nameplate.

Connection Diagrams: Inverted Design

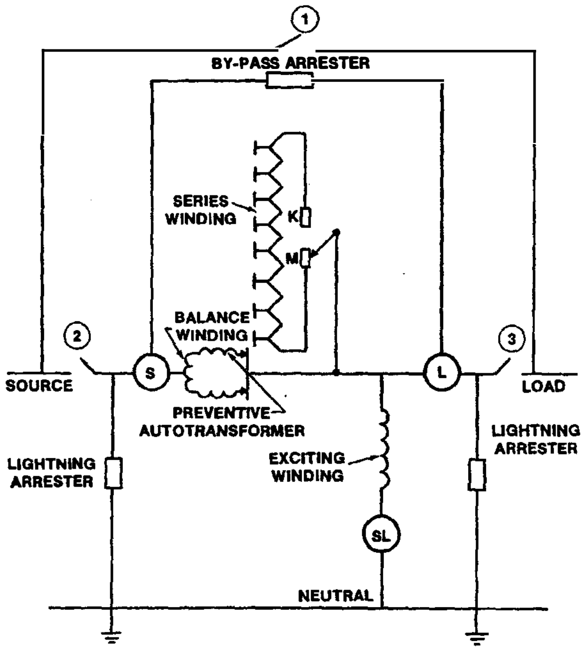


Fig. 10 Wiring diagram of typical regulator showing both external and internal connections.

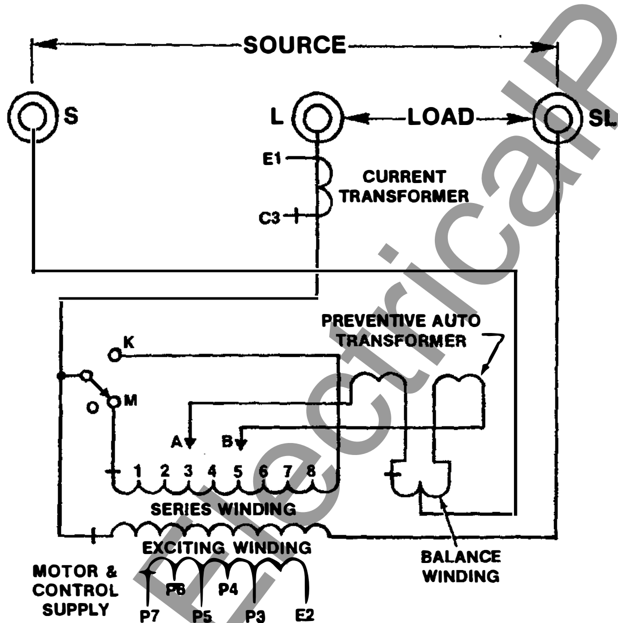


Fig. 11 Schematic diagram of JFR regulator utilizing single potential source for motor and control circuit.

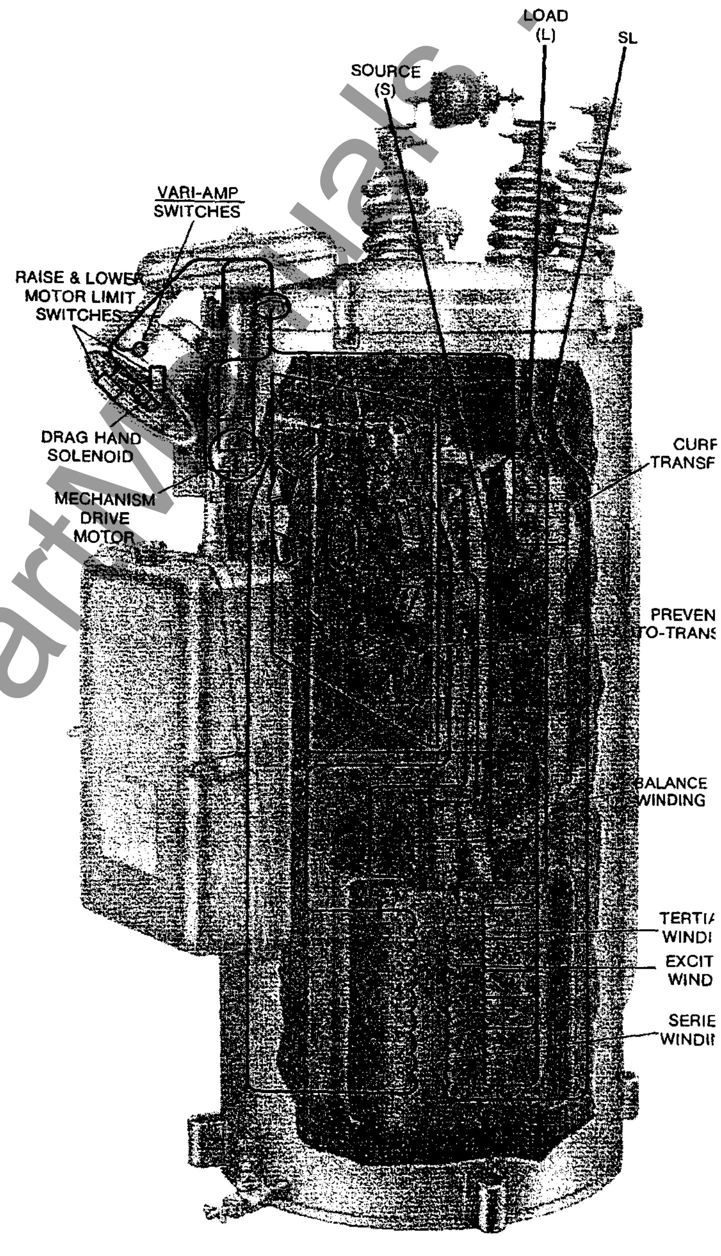


Fig. 12 Typical arrangement of windings and connections of JFR regulator.

NOTE: Inverted Design units may or may not be equipped with balance winding. Refer to regulator nameplate.

CAUTION

Before regulator is energized, refer to nameplate to be sure that all connections to terminal block on cover and, where applicable, to terminal block in control are correct for the line voltage.

BANDWIDTH CHECK

The bandwidth may be checked with the regulator energized and control supplied by the built-in regulator power supply. This method requires no external power source and may be used even when the regulator is carrying load.

1. Connect an ac voltmeter to the voltmeter test terminals.
2. Set the "R" and "X" compensation to zero.
3. Set the voltage source switch to "Normal" and the panel transfer switch to "Auto".
4. Set the voltage level dials to the value which most nearly corresponds to the voltage that is read at the voltmeter test terminals. The band indicator hand should center to the "IN" position.
5. Set the bandwidth dial at the position to be checked.
6. Gradually decrease the voltage level setting in one volt increments until the band indicating meter hand deflects. It will move to the UPPER limit when the voltage level has been decreased by an amount equal to ½ the bandwidth setting.
7. The LOWER LIMIT may be checked similarly by increasing the voltage level setting in one volt increments until the band indicator hand deflects.

The regulator source voltage should not fluctuate during this test. If it does the bandwidth limits can not be accurately determined using this method.

If necessary, the band limits may be checked by an alternate means using a variable 120V-ac external source. The external source should be connected to the control panel in the same manner as described in the preceding paragraph on "EXTERNAL POWER SUPPLY."

Adjust the variable voltage source until the voltmeter connected to the voltmeter test terminals reads the same voltage as set on the voltage level control dials. Place the transfer switch to the "AUTO" position and set the bandwidth dial to the position to be checked.

The band indicating meter hand should be centered on the "IN" position, indicating that the applied voltage is within the preset band limits. Gradually increase the supply voltage until the band indicator deflects to the UPPER LIMIT indicating the voltage has exceeded the upper bandwidth limit. This should occur when the supply voltage has been increased by an amount equal to ½ the bandwidth setting.

The lower limit can be similarly checked with the exception that the supply voltage is decreased until the band meter hand moves to the LOWER LIMIT.

VOLTAGE LEVEL CHECK

The voltage level setting is equal to the average of the upper and lower bandwidth settings as determined by the above test.

Note: Accuracy of many portable indicating voltmeters is adversely affected by low temperatures.

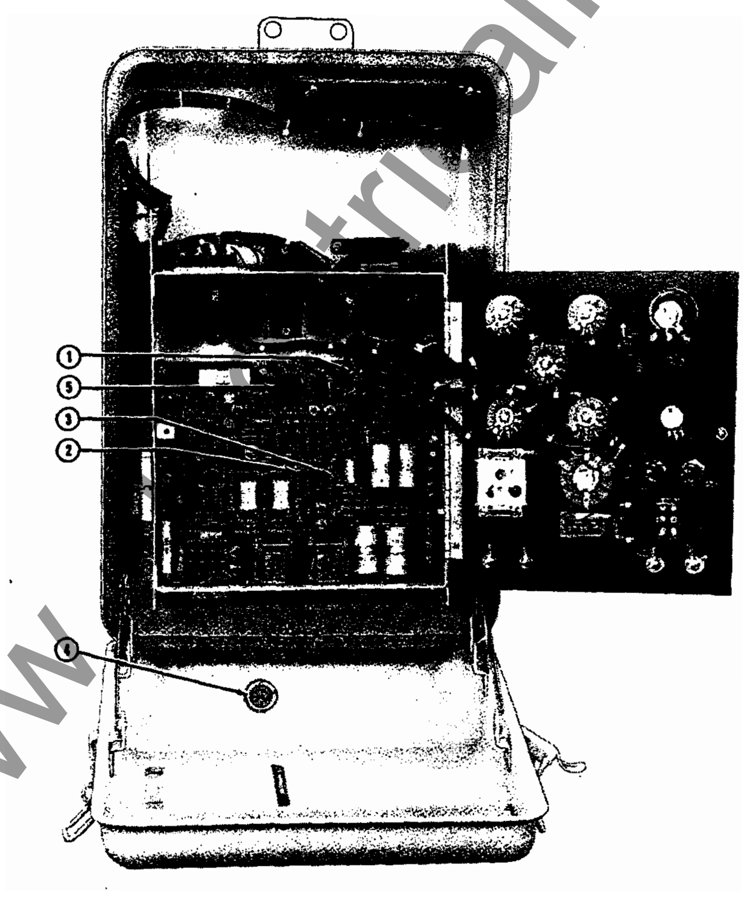


Fig. 16 Calibrating test points and calibration rheostat.

* 1 Calibrating rheostat

* 2 Test point (8)

* 3 Test point (0)

4 Control breather

5 Time delay selection knob

* Reference IJ-2 Instruction Manual pages 10 & 11.

CAUTION: The *Accu/Stat* control is precalibrated at the factory. These calibrations should not be changed.

Control Diagrams

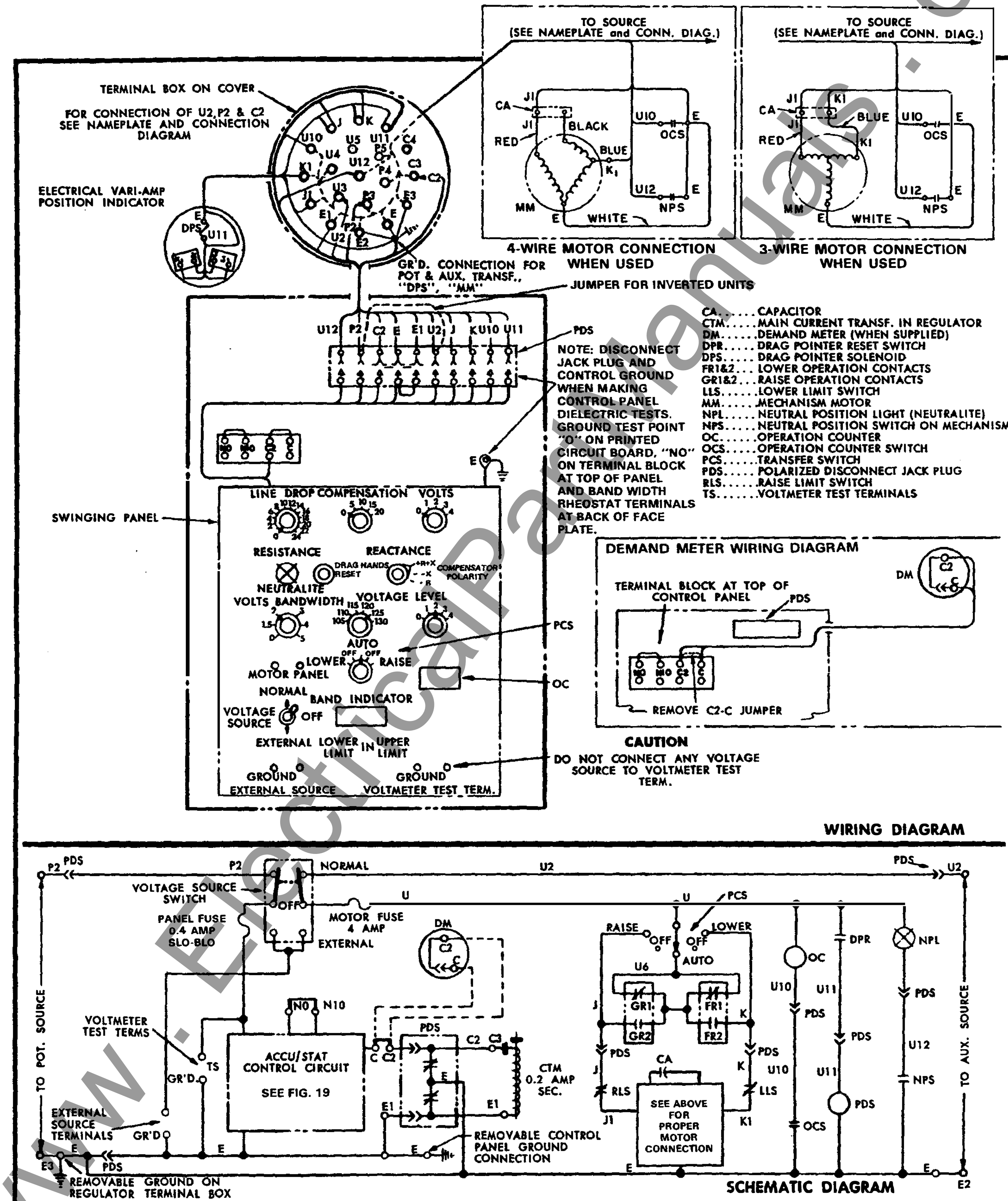


Fig. 17 Typical IJ-2 regulator control.

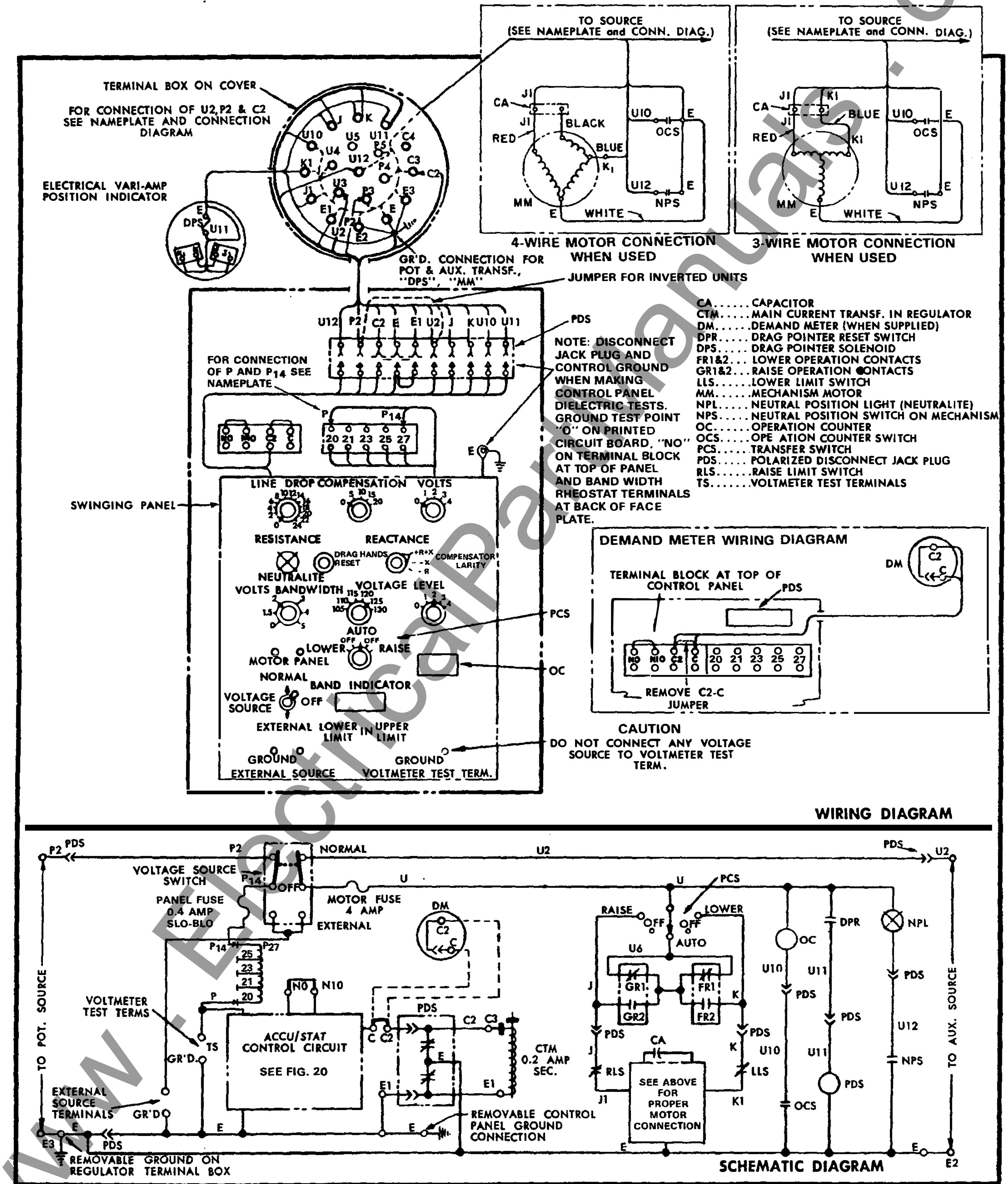


Fig. 18 Typical IJ-2A regulator control.

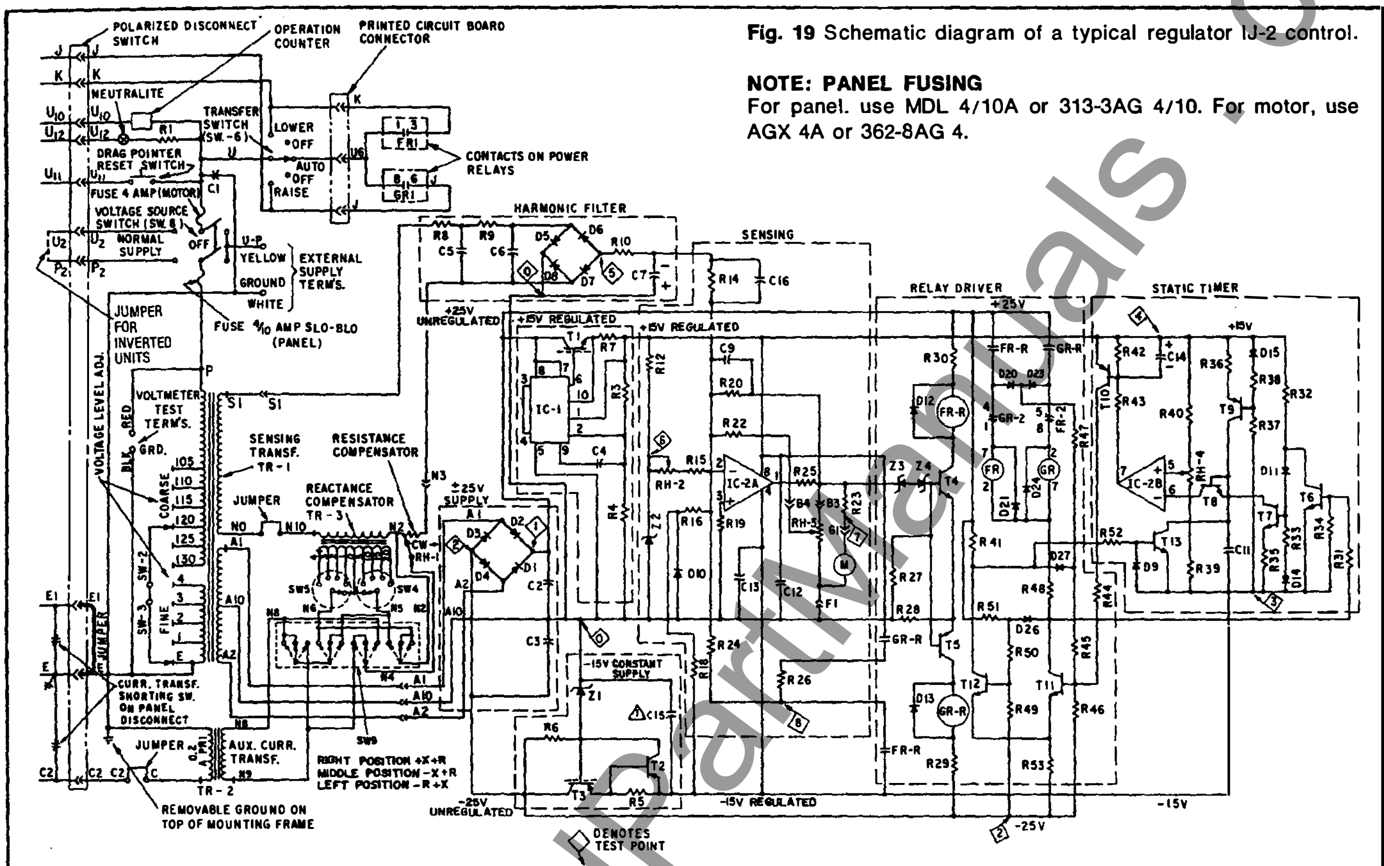
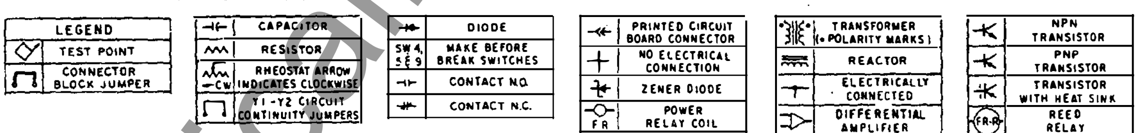


Fig. 19 Schematic diagram of a typical regulator IJ-2 control.

NOTE: PANEL FUSING
For panel. use MDL 4/10A or 313-3AG 4/10. For motor, use AGX 4A or 362-8AG 4.



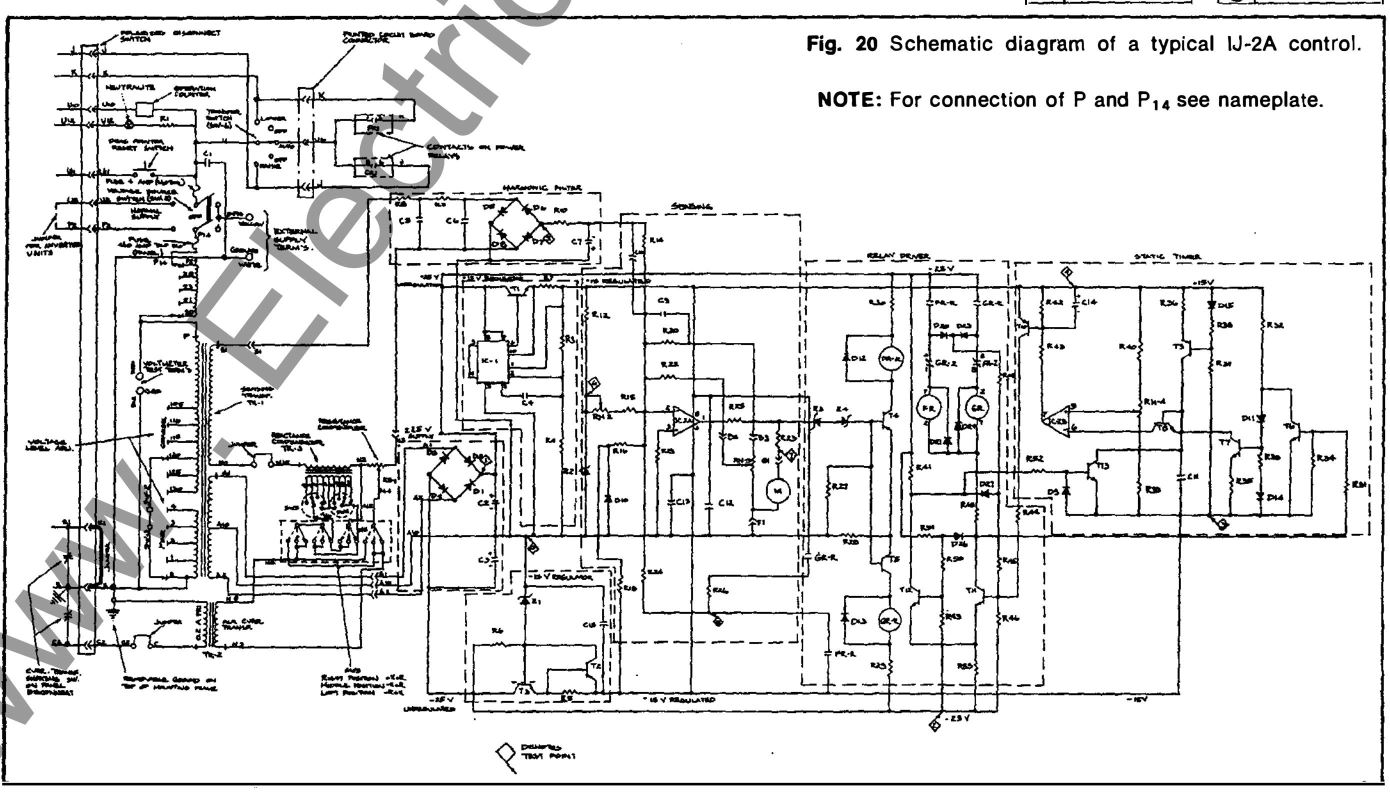


Fig. 20 Schematic diagram of a typical IJ-2A control.

NOTE: For connection of P and P_{14} see nameplate.

Setting the ACCU/STAT Controls

INTRODUCTION

Accu/Stat control panels consist basically of a static sensing device, a line drop compensator, and a static voltage integrator time delay relay. The entire *Accu/Stat* control is self contained and can be installed or removed from the control box as one unit. Each is interchangeable with the SJ-6, SJ-5, SJ-4 and UJ-5A control panels.

Accu/Stat control is completely calibrated at the factory, and all adjustments can be made directly by turning the calibrated control knobs to the desired setting. No instruments or tools are necessary to make any of the settings. All necessary control knobs are securely locked by a thumb screw on each knob. The control does not require any warm-up time and will hold better than accuracy class I over a wider ambient temperature range than required by standards.

Note: Before turning any control knobs, loosen the knob lock by turning the thumb screw on knob approximately three turns counterclockwise. Refer to Figure 21 for control knob locations.

VOLTAGE LEVEL

The voltage level setting consists of a coarse and a fine adjustment of two knobs located on the face of the *Accu/Stat* control panel. A combination of these adjustments yields a voltage level range from 105 volts to 134 volts in one-volt steps.

BANDWIDTH

Bandwidth is adjusted by turning a calibrated knob on the face of the *Accu/Stat* panel and total bandwidth can be set from 1½ to 6 volts.

TIME DELAY

Accu/Stat controls are shipped from the factory set for a time delay of 45 seconds. To change the time delay setting, loosen the thumb screw on the left hand side of the panel face and open the face plate. A calibrated time delay selection knob is on the top of the printed circuit board. See (Figure 16). Standard type *Accu/Stat* controls allow continuous time delay settings of 15 thru 120 seconds.

SETTING LINE DROP COMPENSATOR

The Line Drop Compensator is set to compensate for the line drop between the regulator and the load center. In other words, it adjusts the voltage supplied to the control circuit to duplicate the voltage appearing at the load center, or at some point out on the line.

The increase in voltage at the voltage regulator produced by line drop compensation is a function of the resistance (R) and reactance (X) settings on the control panel and the amount of line current flowing through the regulator. There are several different methods used to determine the actual line drop compensation settings on the control panel. Two of the more common methods are the Load Center Method and the Average Increase Method.

LOAD CENTER METHOD

Using the Tables on Page 16, the resistance and reactance settings can easily be determined as follows:

1. In Table I, locate the Conductor Size column, resistance of the line per mile, and under the Conductor Center Distance column ("D"), the reactance of the line per mile.
2. Find the appropriate compensator multiplier from Table II.
3. Multiply the resistance or reactance found in Step I by the compensator multiplier, and by the distance in miles to the load center to obtain the line drop compensator setting.

EXAMPLE: LOAD CENTER METHOD

Name Plate: 76.2 kVA, line voltage 7200 volts, control voltage 120 volts.

C.T. primary rating 100 amps.

Connection: 3 single phase units in wye on a three phase line.

Conductor: No. 0000 stranded copper, 36″ symmetrical triangular spacing.

Distance to Load Center: 2 miles.

Regulator Rated Load: 100 amps.

From Table I, the resistance is 0.303 ohms per mile and the reactance is 0.630 ohms per mile.

From Table II, the multiplier is 1.67. Multiplying 0.630 by 1.67 gives a setting of 1.05 volts per mile. Multiply by 2 miles to get reactance setting of 2.10 volts or 2 volts.

The actual resistance setting is found in similar manner.

AVERAGE INCREASE METHOD

Many times voltage regulators are placed on electrical circuits when a specific "Load Center" does not exist. It is often desirable in those situations to adjust the line drop compensation settings to produce a predetermined increase above rated voltage at periods of heavy loading.

Using the Tables on Page 16, the resistance and reactance settings can be easily determined as follows:

1. In Table 1, locate the conductor size column, resistance of the line per mile, and under the conductor center distance column (D), the reactance of the line per mile.

2. Determine the percent increase in line voltage desired at peak load and multiply that percent by the control panel voltage to determine the actual voltage increase desired.

   Note: The vector summation of the resistance and reactance values must equal the increase in voltage desired. Therefore, the R and X values become two legs of a right triangle with the hypotenuse being the increase in voltage desired.

3. Determine an angle θ which is the tan of the ratio of reactance to resistance.
4. To calculate the resistance value desired, multiply the desired voltage increase by $\cos\angle\theta$. The reactance value is determined by multiplying the desired voltage increase by $\sin\angle\theta$.
5. Find the primary current rating of the regulator C.T. This is shown on the regulator nameplate.
6. Determine the peak load current in the circuit.
7. Multiply the resistance value by the ratio of the regulator C.T. primary to the peak load current, round off to the nearest volt and this becomes the resistance setting. Do the same with the reactance value to determine the reactance setting.

EXAMPLE:

AVERAGE INCREASE METHOD

Name Plate: 76.2 kVA, line voltage 7200 volts, control voltage 120 volts.
C.T. primary rating 100 amps.

Connection: 3 single phase units in wye on a three phase line.

Conductor: No. 0000 stranded copper, 36″ symmetrical triangular spacing.

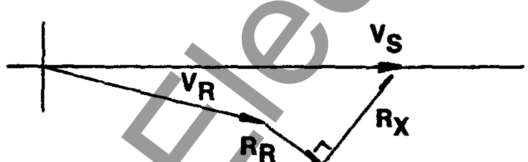
Distance to Load Center: 2 miles.

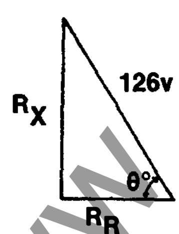
Peak Load: 80 amps.

Regulator Rated Load: 100 amps.

From Table I, the resistance is 0.303 ohms per mile and the reactance is 0.630 ohms per mile.

The actual voltage increase desired at peak load is 6 volts.





$R_X = 0.630\ \Omega/\text{mile}$

$R_R = 0.303\ \Omega/\text{mile}$

$$\text{Tan}\ \theta = \frac{R_X}{R_R} = \frac{0.630}{0.303} = 2.079$$

$$\theta = \text{Arc Tan } 2.079 = 64.3°$$

$$R_X = (126v\text{-}120v)\ (\sin\theta) \times \frac{\text{CT primary rating}}{\text{peak load amps}}$$

$$= (6v)\ (\sin 64.3°) \times \left(\frac{100 \text{ amps}}{80 \text{ amps}}\right)$$

$$= (6v)\ (0.901)\ (1.25)$$

$$R_X = 6.75v \text{ or } 7 \text{ volts}$$

$$R_R = (126v\text{-}120v)\ (\cos\theta) \times \frac{\text{CT primary rating}}{\text{peak load amps}}$$

$$= (6v)\ (\cos 64.3°) \times \frac{100 \text{ amps}}{80 \text{ amps}}$$

$$= (6v)\ (.433)\ (1.25)$$

$$R_R = 3.25v \text{ or } 3.0 \text{ volts}$$

For single phase or three phase four wire connections, set the values obtained directly on the compensator controls and set the compensator polarity switch on +R+X. For open or closed delta systems follow the procedure below:

When single phase distribution regulators are connected in open or closed delta, no interconnection between control panels is necessary. With closed delta connected regulators, the current either leads or lags the regulator voltage of all three units 30 degrees, depending on the regulator connections. With ABC phase rotation, if the regulator which has its "L" bushing connected to phase A has its "SL" bushing connected to phase C, the connections are leading. If the same regulator has its "SL" bushing connected to phase B, the connections are lagging. The resistance and reactance settings are found as outlined above.

These settings, however, must be corrected because of the phase shift between the line current and control voltage. Corrected compensator settings for leading or lagging regulators (in either closed or open delta) are obtained from the following formulas:

$$R_1 = 0.866R - 0.5X \qquad X_1 = 0.866X + 0.5R$$

$$R_2 = 0.866R + 0.5X \qquad X_2 = 0.866X - 0.5R$$

R & X = the resistance and reactance drop as found on Page 16 or 17.

R_1 & X_1 = the resistance and reactance setting of lagging regulator.

R_2 & X_2 = the resistance and reactance settings of leading regulator.

Compensator settings can also be found in Table III on Page 17.

EXAMPLE:

With a line reactance drop of 10 volts and a line resistance drop of 8 volts, the corrected settings obtained from Table III are:

lagging regulator: R setting = 2 volts, X setting = 13 volts.

leading regulator: R setting = 12 volts, X setting = 5 volts.

Negative settings are made by means of the compensator polarity switch on the control panel set to the appropriate position.

TEST FOR DETERMINING LEADING AND LAGGING REGULATOR (OPEN DELTA)

To determine the phase relationship on a three phase system the following method may be used. This method is applicable only with two regulators connected in open delta on a three phase system. There must be sufficient load on the line at the time of the test to activate the line drop compensator sufficiently to give good positive results.

1. Set the voltage level control on both panels to the same value, i.e. 120 volts.
2. Turn the resistance (R) compensation to zero on both units.
3. Turn reactance (X) compensation on both panels to the same value, i.e. 12 volts.
4. Set the transfer switch to AUTO.

After the regulators come to rest, the regulator with the higher output voltage, nearer maximum raise position, is the lagging regulator and the other regulator is the leading regulator.

FURTHER RESULTS OF TEST

If the power factor of the load is anywhere between .81 lag and .91 lead:

a. The lagging regulator will raise its output voltage.
b. The leading regulator will lower its output voltage.

If the power factor of the load is lower than .81 lag:

a. Both regulators will raise their output voltage.
b. The lagging regulator will have the higher output voltage.

If the power factor of the load is lower than .91 lead:

a. Both regulators will lower their output voltages.
b. The lagging regulator will still have the higher output voltage.

Regardless of load power factor the output voltages of the lagging regulator will always be higher. Within the range of .81 lag to .91 lead (which will take in almost all feeders) the indication is more positive because the regulators will move in opposite directions.

SETTING COMPENSATOR WITH CAPACITORS ON THE LINE

The line drop compensator is designed to give proper compensation when the power factor at the load center and at the regulator is equal. When the compensator settings are adjusted to match the impedance of the line, the correct load center voltage will be maintained.

If capacitors are installed at the regulator source side or installed at the load center, a regulator control will give proper compensation.

Sometimes, of course, it is desirable to install capacitors beyond the regulator but not at the load center. This will, of course, upset the load center voltage, but usually the regulator can be adjusted to give satisfactory results. This may be done by increasing voltage level setting of voltage control relay. The easiest solution is by trial and error. A few sketches of the vector diagram for existing conditions may help in obtaining the correct setting.

1 External Source Connection Terminals
2 Voltage Source Switch
3 Fuses
4 Bandwidth Adjustment
5 Neutral Indicating Light *(Neutralite)*
6 Electrical Reset Button for Drag Hands
7 Resistance Compensator
8 Polarized Jack Plug
9 Reactance Compensator (Coarse)
10 Reactance Compensator (Fine)
11 Compensator Polarity Switch
12 Voltage Level Adjustment (Coarse)
13 Voltage Level Adjustment (Fine)
14 Automatic-Manual Transfer Switch
15 Operation Counter
16 Band Indicator
17 Voltmeter Test Terminals
18 Breather

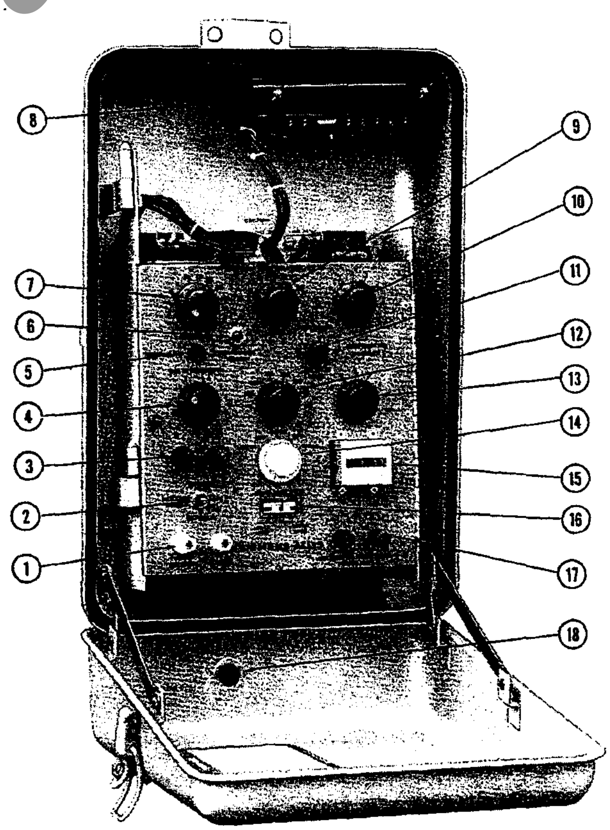


Fig. 21 Front view of JFR regulator control.

TABLE I DISTRIBUTION LINE RESISTANCE AND REACTANCE

OHMS PER CONDUCTOR PER MILE AT 60 Hz

COPPER — HAND DRAWN										ALUMINUM — STEEL REINFORCED									
CON-DUCTOR SIZE	RESISTANCE AT 50°C	REACTANCE* DISTANCE "D" BETWEEN CENTERS OF CONDUCTOR								CON-DUCTOR SIZE	RESISTANCE AT 50°C	REACTANCE* DISTANCE "D" BETWEEN CENTERS OF CONDUCTOR							
MCM		18"	24"	30"	36"	42"	48"	54"	60"	MCM		18"	24"	30"	36"	42"	48"	54"	60"
1000	.0685	.449	.484	.511	.533	.552	.568	.593	.595	1272.0	.0851	.421	.456	.483	.505	.524	.540	.555	.567
750	.0888	.466	.501	.529	.550	.569	.585	.600	.612	954.0	.1128	.439	.474	.501	.523	.542	.553	.573	.585
600	.1095	.481	.516	.543	.565	.584	.600	.615	.627	795.0	.1373	.450	.485	.512	.534	.553	.569	.584	.596
500	.1303	.492	.527	.554	.576	.595	.611	.626	.638	556.5	.1859	.469	.504	.531	.553	.572	.588	.603	.615
400	.1619	.507	.542	.569	.591	.610	.626	.641	.653	477.0	.216	.479	.514	.541	.563	.582	.598	.613	.625
350	.1845	.515	.550	.577	.599	.618	.634	.649	.661	397.5	.259	.490	.525	.555	.574	.593	.609	.624	.636
300	.215	.525	.560	.587	.609	.628	.644	.659	.671	336.4	.306	.500	.535	.562	.534	.603	.619	.634	.646
250	.257	.536	.571	.598	.620	.639	.655	.670	.682	266.8	.385	.514	.549	.576	.598	..617	.633	.648	.660
AWG										AWG									
4/0	.303	.546	.581	.603	.630	.649	.665	.630	.692	4/0	.592	.630	.665	.692	.714	.733	.749	.764	.776
3/0	.382	.554	.589	.616	.638	.657	.673	.688	.700	3/0	.723	.670	.705	.732	.754	.773	.789	.804	.816
2/0	.481	.581	.616	.643	.665	.684	.700	.715	.727	2/0	.895	.690	.725	.752	.774	.793	.809	.824	.836
1/0	.607	.595	.630	.657	.679	.698	.714	.729	.741	1/0	1.12	.705	.740	.767	.789	.808	.824	.839	.851
1	.757	.609	.644	.671	.693	.712	.728	.743	.755	2	1.69	.714	.749	.776	.798	.817	.833	.848	.860
2	.964	.623	.658	.685	.707	.726	.742	.757	.769	4	2.57	.708	.743	.770	.792	.811	.827	.842	.854
4	1.518	.648	.683	.710	.732	.751	.767	.782	.794	6	3.98	.722	.757	.784	.806	.825	.841	.856	.868
6	2.41	.677	.712	.739	.761	.780	.796	.811	.823										
8	3.80	.714	.749	.776	.798	.817	.833	.848	.860										

*60 Hertz reactance in ohms per mile of each conductor of a single phase, or of a three phase, symmetrical triangular spacing. For other arrangements of conductors see below. The reactance for other frequencies is F/60 times the table values. Reactance values are for concentric stranded copper conductors and are approximately correct for aluminum cable conductors.

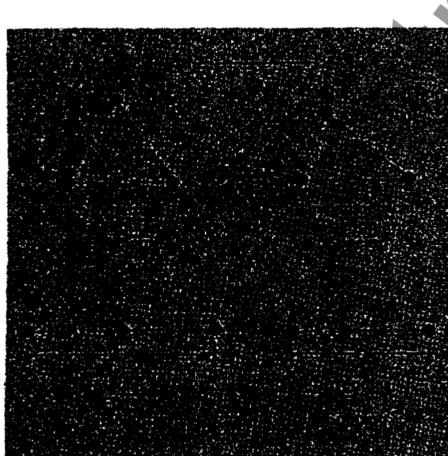


TABLE II COMPENSATOR MULTIPLIER TABLE

Regulator Operating Data (See nameplate)		Circuit Connection*		
Regulator Operating Kv and (Potential Trans. Ratio)	Regulator Current Rating	Single	Delta	Wye
19.9 (166/1)	50	.60	.52	.30
	100	1.20	1.04	.60
	167	2.40	2.08	1.20
	200	2.40	2.08	1.20
14.4 (120/1)	50	.83	.72	.42
	100	1.67	1.44	.83
	200	3.34	2.88	1.67
	300	5.01	4.32	2.49
	400	6.68	5.76	2.52
13.8 (115/1)	50	.87	.75	.44
	100	1.74	1.50	.87
	150	2.61	2.25	1.31
	200	3.48	3.00	1.74
7.62 (63.5/1)	50	1.57	1.36	.79
	75	2.36	2.04	1.18
	100	3.15	2.72	1.57
	150	4.72	4.08	2.36
	219	7.87	6.82	3.94
	328	12.60	10.90	6.30
	438	12.60	10.90	6.30
	548	12.60	10.90	6.30
7.2 (60/1)	50	1.67	1.44	.83
	75	2.50	2.16	1.25
	100	3.34	2.89	1.67
	150	5.00	4.33	2.50
	219	8.34	7.22	4.17
	328	13.33	11.55	6.67
	438	13.33	11.55	6.67
	548	13.33	11.55	6.67

Regulator Operating Data (See nameplate)		Circuit Connection*		
Regulator Operating Kv and (Potential Trans. Ratio)	Regulator Current Rating	Single	Delta	Wye
5.0 (40/1)	100	5.00	4.33	2.50
	150	7.50	6.49	3.75
	200	10.00	8.66	5.00
	250	17.50	15.15	8.75
	334	17.50	15.15	8.75
	500	35.00	30.30	17.50
	625	35.00	30.30	17.50
	668	35.00	30.30	17.50
	835	35.00	30.30	17.50
4.16 (34.7/1)	100	5.76	4.98	2.88
	150	8.64	7.48	4.32
	200	11.53	9.97	5.76
	250	20.20	17.48	10.10
	334	20.20	17.48	10.10
	500	40.40	34.96	20.20
	625	40.40	34.96	20.20
	668	40.40	34.96	20.20
	835	40.40	34.96	20.20
2.5 (20/1)	200	20.00	17.30	10.00
	300	30.00	25.96	15.00
	400	40.00	34.60	20.00
	500	70.00	60.55	35.00
	668	70.00	60.55	35.00
	1000	140.00	121.10	70.00
	1250	140.00	121.10	70.00
	1332	140.00	121.10	70.00
	1665	140.00	121.10	70.00

*Above multipliers are based on regulator C.T. ratings (see nameplate). C.T. rating is not always the same as regulator rating. To compute compensator multiplier for ratings not given above the basic formula is (C.T. Primary rating) ÷ (Reg. KV ÷ Control operating volts) or P.T. ratio expressed on a line to neutral basis

1. Single phase (C.T. rating ÷ P.T. ratio) x 2.
2. Delta connected = (C.T. rating ÷ P.T. ratio) x 1.73.
3. Wye connected = (C.T. rating ÷ P.T. ratio) x 1.0.

TABLE III LINE DROP COMPENSATOR SETTINGS FOR REGULATORS CONNECTED IN DELTA

LINE REACTANCE (X)

LINE RESISTANCE (R)		0	1	2	3	4	5	6	7	8	9	[redacted]	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0	▲R_1	0	−1	−1	−2	−2	−3	−3	−4	−4	−5	[redacted]	−6	−6	−7	−7	−8	−8	−9	−9	−10	−10	−11	−11	−12	−12
	▲X_1	0	1	2	3	3	4	5	6	7	8	[redacted]	10	10	11	12	13	14	15	16	16	17	18	19	20	21
	R_2	0	1	1	2	2	3	3	4	4	5	[redacted]	6	6	7	7	8	8	9	9	10	10	11	11	12	12
	X_2	0	1	2	3	3	4	5	6	7	8	[redacted]	10	10	11	12	13	14	15	16	16	17	18	19	20	21
1	▲R_1	1	0	0	−1	−1	−2	−2	−3	−3	−4	[redacted]	−5	−5	−6	−6	−7	−7	−8	−8	−9	−9	−10	−10	−11	−11
	▲X_1	1	1	2	3	4	5	6	7	7	8	[redacted]	10	11	12	13	13	14	15	16	17	18	19	20	20	21
	R_2	1	1	2	2	3	3	4	4	5	5	[redacted]	6	7	7	8	8	9	9	10	10	11	11	12	12	13
	X_2	−1	0	1	2	3	4	5	6	6	7	[redacted]	9	10	11	12	12	13	14	15	16	17	18	19	19	20
2	▲R_1	2	1	1	0	0	−1	−1	−2	−2	−3	[redacted]	−4	−4	−5	−5	−6	−6	−7	−7	−8	−8	−9	−9	−10	−10
	▲X_1	1	2	3	4	4	5	6	7	8	9	[redacted]	11	11	12	13	14	15	16	17	17	18	19	20	21	22
	R_2	2	2	3	3	4	4	5	5	6	6	[redacted]	7	8	8	9	9	10	10	11	11	12	12	13	13	14
	X_2	−1	0	1	2	2	3	4	5	6	7	[redacted]	9	9	10	11	12	13	14	15	15	16	17	18	19	20
3	▲R_1	3	2	2	1	1	0	0	−1	−1	−2	[redacted]	−3	−3	−4	−4	−5	−5	−6	−6	−7	−7	−8	−8	−9	−9
	▲X_1	2	2	3	4	5	6	7	8	8	9	[redacted]	11	12	13	14	14	15	16	17	18	19	20	21	21	22
	R_2	3	3	4	4	5	5	6	6	7	7	[redacted]	8	9	9	10	10	11	11	12	12	13	13	14	14	15
	X_2	−2	−1	0	1	2	3	4	5	5	6	[redacted]	8	9	10	11	11	12	13	14	15	16	17	18	18	19
4	▲R_1	3	3	2	2	1	1	0	0	−1	−1	[redacted]	−2	−3	−3	−4	−4	−5	−5	−6	−6	−7	−7	−8	−8	−9
	▲X_1	2	3	4	5	5	6	7	8	9	10	[redacted]	12	12	13	14	15	16	17	18	18	19	20	21	22	23
	R_2	3	4	4	5	5	6	6	7	7	8	[redacted]	9	9	10	10	11	11	12	12	13	13	14	14	15	15
	X_2	−2	−1	0	1	1	2	3	4	5	6	[redacted]	8	8	9	10	11	12	13	14	14	15	16	17	18	19
5	▲R_1	4	4	3	3	2	2	1	1	0	0	[redacted]	−1	−2	−2	−3	−3	−4	−4	−5	−5	−6	−6	−7	−7	−8
	▲X_1	3	3	4	5	6	7	8	9	9	10	[redacted]	12	13	14	15	15	16	17	18	19	20	21	22	22	23
	R_2	4	5	5	6	6	7	7	8	8	9	[redacted]	10	10	11	11	12	12	13	13	14	14	15	15	16	16
	X_2	−3	−2	−1	0	1	2	3	4	4	5	[redacted]	7	8	9	10	10	11	12	13	14	15	16	17	17	18
6	▲R_1	5	5	4	4	3	3	2	2	1	1	[redacted]	0	−1	−1	−2	−2	−3	−3	−4	−4	−5	−5	−6	−6	−7
	▲X_1	3	4	5	6	6	7	8	9	10	11	[redacted]	13	13	14	15	16	17	18	19	19	20	21	22	23	24
	R_2	5	6	6	7	7	8	8	9	9	10	[redacted]	11	11	12	12	13	13	14	14	15	15	16	16	17	17
	X_2	−3	−2	−1	0	0	1	2	3	4	5	[redacted]	7	7	8	9	10	11	12	13	13	14	15	16	17	18
7	▲R_1	6	6	5	5	4	4	3	3	2	2	[redacted]	1	0	0	−1	−1	−2	−2	−3	−3	−4	−4	−5	−5	−6
	▲X_1	4	4	5	6	7	8	9	10	10	11	[redacted]	13	14	15	16	16	17	18	19	20	21	22	23	23	24
	R_2	6	7	7	8	8	9	9	10	10	11	[redacted]	12	12	13	13	14	14	15	15	16	16	17	17	18	18
	X_2	−4	−3	−2	−1	0	1	2	3	3	4	[redacted]	6	7	8	8	9	10	11	12	13	14	15	16	16	17
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1	1	0	0	−1	−1	−2	−2	−3	−3	−4	−4	−5	−5
													14	14	15	16	17	18	19	20	20	21	22	23	24	
													12	13	13	14	14	15	15	16	16	17	17	18	18	19
													6	6	7	8	9	10	11	12	12	13	14	15	16	17
9	▲R_1	8	7	7	6	6	5	5	4	4	3	3	2	2	1	1	0	0	−1	−1	−2	−2	−3	−3	−4	−4
	▲X_1	5	5	6	7	8	9	10	11	11	12	13	14	15	16	17	17	18	19	20	21	22	23	24	24	
	R_2	8	8	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20
	X_2	−5	−4	−3	−2	−1	0	1	2	2	3	4	5	6	7	8	8	9	10	11	12	13	14	15	15	16
10	▲R_1	9	8	8	7	7	6	6	5	5	4	4	3	3	2	2	1	1	0	0	−1	−1	−2	−2	−3	−3
	▲X_1	5	6	7	8	8	9	10	11	12	13	14	15	15	16	17	18	19	20	21	21	22	23	24		
	R_2	9	9	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21
	X_2	−5	−4	−3	−2	−2	−1	0	1	2	3	4	5	5	6	7	8	9	10	11	11	12	13	14	15	16
11	▲R_1	10	9	9	8	8	7	7	6	6	5	5	4	4	3	3	2	2	1	1	0	0	−1	−1	−2	−2
	▲X_1	6	6	7	8	9	10	11	12	12	13	14	15	16	17	18	18	19	20	21	22	23	24			
	R_2	10	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22
	X_2	−6	−5	−4	−3	−2	−1	0	1	1	2	3	4	5	6	7	7	8	9	10	11	12	13	14	14	15
12	▲R_1	10	10	9	9	8	8	7	7	6	6	5	5	4	4	3	3	2	2	1	1	0	0	−1	−1	−2
	▲X_1	6	7	8	9	9	10	11	12	13	14	15	16	16	17	18	19	20	21	22	22	23	24			
	R_2	10	11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22
	X_2	−6	−5	−4	−3	−3	−2	−1	0	1	2	3	4	4	5	6	7	8	9	10	10	11	12	13	14	15
13	▲R_1	11	11	10	10	9	0	8	8	7	7	6	6	5	5	4	4	3	3	2	2	1	1	0	0	−1
	▲X_1	7	7	8	9	10	11	12	13	13	14	15	16	17	18	19	19	20	21	22	23	24				
	R_2	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23
	X_2	−7	−6	−5	−4	−3	−2	−1	0	0	1	2	3	4	5	6	6	7	8	9	10	11	12	13	13	14
* 14	▲R_1	12	12	11	11	10	10	9	9	8	8	7	7	6	6	5	5	4	4	3	3	2	2	1	1	0
	▲X_1	7	8	9	10	10	11	12	13	14	15	16	17	17	18	19	20	21	22	23	23	24				
	R_2	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20	21	21	22	22	23	23	24	24
	X_2	−7	−6	−5	−4	−4	−3	−2	−1	0	1	2	3	3	4	5	6	7	8	9	9	10	11	12	13	14

▲R_1, ▲X_1 } Compensator settings of lagging regulator

R_2, X_2 } Compensator settings of leading regulator

*For values of R greater than 14 refer to formula Page 17

Maintenance

PERIODIC INSPECTION

Operation of the regulator can be checked without removing it from service. Simply run the mechanism with the transfer switch until the voltage output is outside the bandwidth as set on the panel. By putting the regulator back on automatic control, the operation of the voltage integrator and mechanism can be checked. After the predetermined time delay, the motor switch will close to operate the motor. The quick break mechanism makes a "click" when a step is made. These "clicks" occur uniformly at about 4 second intervals. Check both directions of travel..

Test the limit switches by operating the mechanism to number 16 raise and lower to make sure that the limit switches open the circuit on the two extreme positions. If the limit switch fails to open the circuit, the motor will be stalled against the mechanical stop. The motor is so designed that it can be stalled continuously without damage.

Never, under any circumstances, energize the regulator unless it is filled with oil to the proper level. It should always be kept filled to the proper level as indicated on the oil sight gauge. Use ASTM D-3487 Type II insulating oil.

Check the dielectric strength of the oil from time to time while the regulator is in service, and if found to test below 22 kV, filter immediately.

ACCU/STAT CONTROL MAINTENANCE

All parts and circuits of the *Accu/Stat* static control are accessible for ease of inspection and maintenance.

Once the *Accu/Stat* control settings have been made, no further adjustments are required. Should trouble develop, it is necessary only to disconnect the jack plug and remove the control. All parts are then accessible for inspection and tests.

An IJ-2, IJ-2A, SJ-6, SJ-5, or SJ-4 *Accu/Stat* control can be attached or a type UJ-5 voltage regulating relay control can be installed until repairs can be made. A Siemens-Allis Instruction and Service Manual (for IJ-2A and IJ-2, Book 21X4992; SJ-6, Book 21X4410; SJ-3, SJ-4, SJ-5, Book 21X3197) would be of further assistance in trouble shooting the control panel. Readings should be made with a good multimeter or individual good quality meters. If the trouble cannot be determined, contact your Siemens-Allis representative.

REMOVING THE REGULATOR FROM SERVICE

To remove the regulator from service without interrupting the load, proceed as follows:

1. Run the regulator to the "NEUTRAL" position. (When regulators are in closed delta, Figure 5, all three units must be run to neutral.)
2. Turn transfer switch and voltage source switch on the control panel to "OFF" (all three if in delta.)
3. Close the by-pass switch 1, Fig. 7, 10, 13, thus shunting the regulator.
4. Open disconnect switch 3, Fig. 7, 10, 13, on load side.
5. Open disconnect switch 2, Fig. 7, 10, 13, on source side.

UNTANKING

An inspection jack is available to untank the mechanism portion of the regulator for inspection. This can be done at the installation site by partially untanking without draining the oil.

To untank JFR regulator proceed as follows:

1. Remove the three mounting bolts holding the *Accu/Stat* control panel onto the main tank.
2. Loosen all cover bolts and turn 180 degrees.
3. The regulator can now be pulled from the main tank by the lifting hooks provided on the main cover, or it can be raised with the inspection jack as shown in Fig. 22.

Time intervals between internal inspections will depend upon frequency of operation and loads being carried. Regulators subjected to numerous overloads and a high load factor may require more frequent inspections than those carrying normal loads. While internal inspection is not a necessity, preventive maintenance inspections will pay dividends in uninterrupted service.

When inspecting, make sure all nuts, bolts, and connections are tight. The results of the first inspection should determine the best inspection program to follow for the type of service involved.

CAUTION

Do not make internal inspection while the regulator is energized.

OVERLOADING REGULATOR

Regulators can be overloaded as prescribed in proposed ANSI Guide C57.95. *Caution:* Before overloading, check the guides for loading limits.

Short Circuit: Standard regulators are designed to withstand 25 times base current for a period of 2 seconds and 40 times base current for 0.8 second without injury per ANSI C57.15. Refer to Siemens-Allis Service and Engineering Manual 2860.233 for greater short circuit capacities.

CAUTION

WHEN REPLACING AN IJ-2 OR EARLIER CONTROL WITH AN IJ-2A, connect leads "P" and "P_{14}" from the sensing transformer to terminal "20" on the IJ-2A control.

WHEN REPLACING AN IJ-2A WITH AN IJ-2 OR EARLIER CONTROL, the voltage level knobs must be set equal to the "Control and Motor" volts (E-P_2) shown on the nameplate.

WHEN REPLACING AN IJ-2A WITH AN IJ-2A, be sure to connect the "P" and "P_{14}" leads from the control sensing transformer to the proper terminals corresponding to the operating voltage. Refer to the regulator nameplate for these connections.

Special Features

POLARIZED JACK PLUG AND HINGED PANEL

The *Accu/Stat* control panel is hinged and may be removed completely from the regulator control box by removing the wing nuts on the polarized jack plug and pulling the jack from its fixed portion. This will automatically de-energize the entire panel and will also short circuit the secondary of the current transformer.

VARI-AMP POSITION INDICATOR

The *Vari-Amp* feature provides a method of operating the regulator at increased load by decreasing the range of operation. It provides greater flexibility by allowing the regulating range to be decreased in 1¼ percent increments. The various regulation ranges together with the corresponding current capacities are listed on Table V, Page 21 for standard regulators. All that is necessary to adjust the range of regulation anywhere from ± 5 percent to ± 10 percent is to turn the adjusting knobs until the proper range of regulation is shown on the side of the position indicator. The upper and lower limits need not be the same. *(It is not necessary to remove the regulator from service to make this adjustment. Do not adjust the* Vari-Amp *selector switch while the tap changer motor is energized.)*

MOUNTING

The *Accu/Stat* control may be remotely mounted and since its voltage sensing circuit has no moving parts, operation of the control is not affected by mounting position.

OPERATION AT LESS THAN RATED VOLTAGE

JFR regulators can be provided with potential transformer with taps to permit operation at less than rated voltage. The transformer taps provide proper voltage for the control and motor circuits. When this feature is supplied, reconnect the potential transformer leads through the terminal block located under the terminal block cover as shown on the regulator name plate.

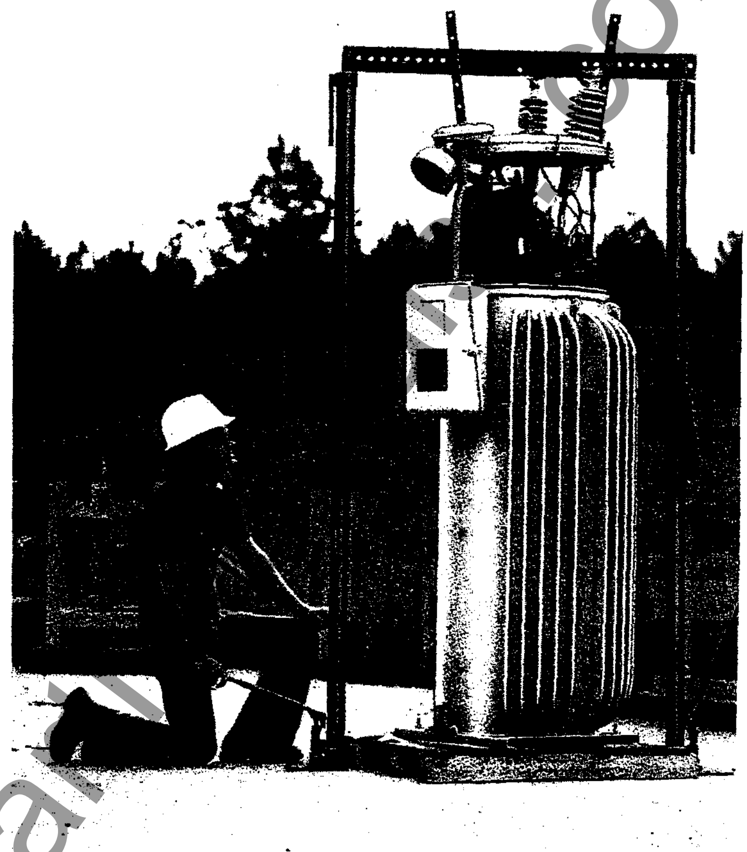
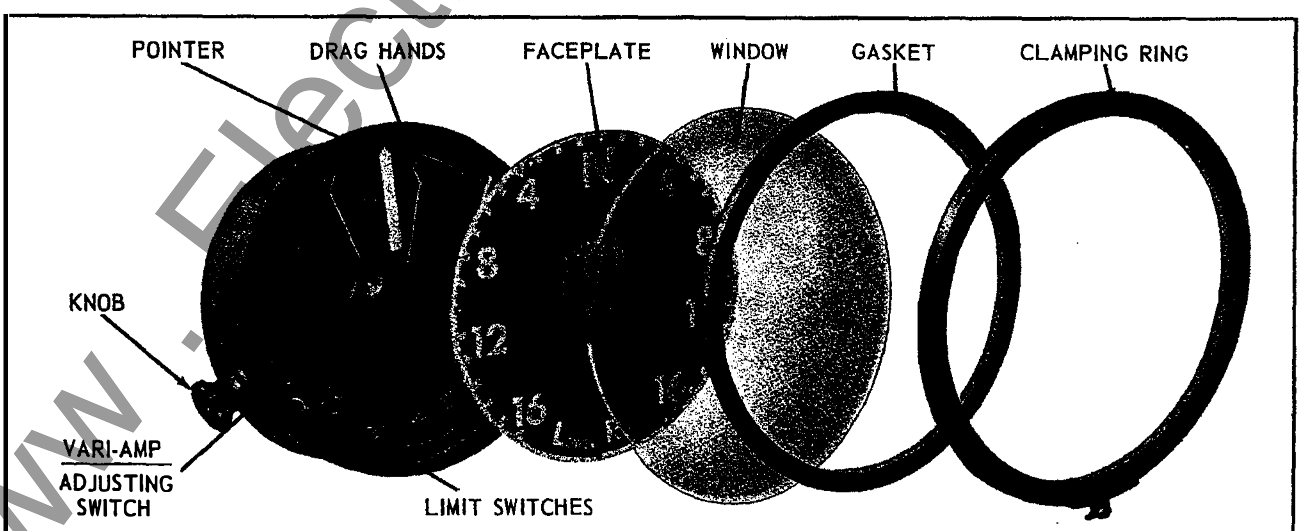


Fig. 22 Untanking JFR regulator with portable inspection jack.

When operating the regulator at reduced voltage, it is necessary that the regulator be operated at reduced capacity. *The current rating of the regulator must not be exceeded except as noted in Table V, Page 21.*



Special Features

UNIDIRECTIONAL BREATHER

The unidirectional breather is standard equipment on all regulators employing the open breathing system.

A unidirectional breather, which differs from ordinary breathers, protects the regulator and reduces the number of times filtering is necessary. Near perfect ventilation lowers the possibility of moisture condensation and rust formation, by providing a continuous flow of warm air over the oil.

The breather consists of a pipe with a screened opening near the bottom of the regulator tank, extending up through and projecting above the surface of the oil. On the top of the tank is a screened gooseneck breather outlet. Air enters the lower breather, is warmed by the hot oil in the regulator, rises in the pipe, flows across the air space, and out the upper breather. Movement of the air effectively reduces condensation and keeps the tank walls dry and free from rust.

RESET DRAG HAND

To reset drag hand on position indicator, press the drag hand reset button on the control panel. Drag hands will reset automatically.

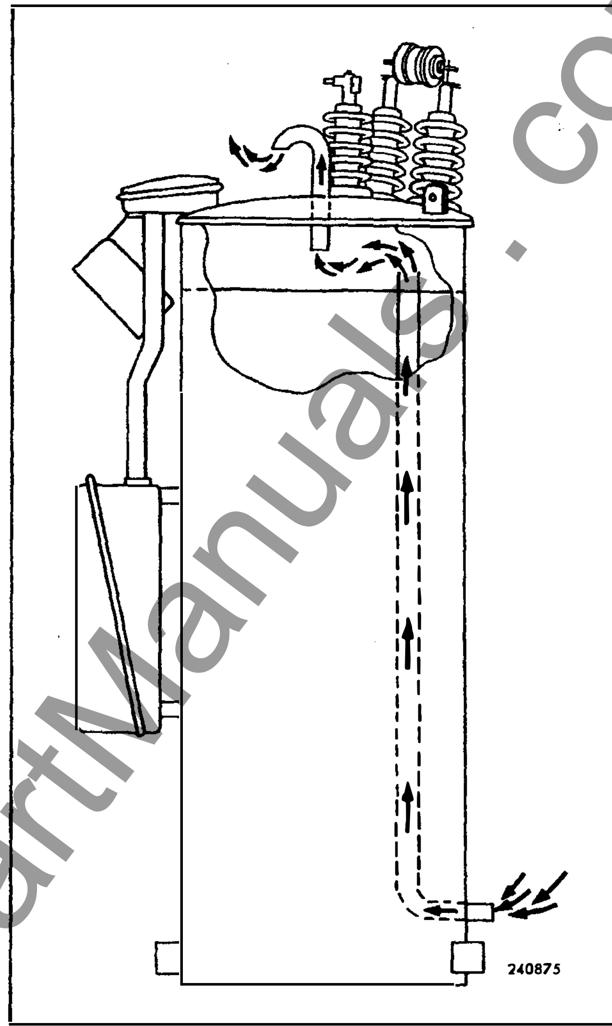


Fig. 24 Circulation of air through unidirectional breather.

TABLE IV SYSTEM OPERATING VOLTAGES

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2160	3750	4320	6480	6860	7200	10800	12420	12960	17928	108
2280	3960	4560	6840	7240	7600	11400	13110	13680	18924	114
2400	4160	4800	7200	7620	8000	12000	13800	14400	19920	120
2500	4330	5000	7500	7940	8330	12500	14375	15000	20750	125
2640	4580	5280	7920	8380	8800	13200	15180	15840	21912	132

TABLE V REGULATING RANGES AND CURRENT CAPACITIES

Rating		Range and Current Ratings Available				
Volts	kVA	10%	8 3/4%	7 1/2%	6 1/4%	5%
2500	50	200	220	240	270	320
	75	300	330	360	405	480
	100	400	440	480	540	640
	167	668	668	668	668	668
	250	1000	1000	1000	1000	1000
	333	1332	1332	1332	1332	1332
	416.3	1665	1665	1665	1665	1665
5000	50	100	110	120	135	160
	100	200	220	240	270	320
	167	334	367	401	451	534
	250	500	550	600	668	668
	333	668	668	668	668	668
	416.3	835	835	835	835	835
7620	38.1	50	55	60	68	80
	57.2	75	83	90	102	120
	76.2	100	110	120	135	160
	114.3	150	165	180	203	240
	*167.0	219/282	241/255	263/278	296/313	351/371
	*250.0	328/347	361/381	304/416	443/468	585/555
	*333.0	437/463	482/509	526/556	598/625	668/668
	*416.3	548/570	602/635	658/668	668/668	668/668
	509.0	668	668	668	668	668
	*667.0	875/926	875/926	875/926	875/926	875/926
	*877.0	1151/1218	1151/1218	1151/1218	1151/1218	1151/1218
13800	69	50	55	60	68	80
	138	100	110	120	135	160
	207	150	165	180	203	240
	276	200	220	240	270	320
14400	72	50	55	60	68	80
	144	100	110	120	135	160
	288	200	220	240	270	320
	333	231	254	277	312	370
	432	300	330	360	405	480
	576	400	440	480	540	640
	720	500	550	600	668	668
	833	578	636	668	668	668
19900	100	50	55	60	68	80
	200	100	110	120	135	160
	333	167	184	200	225	267
	400	200	220	240	270	320
	667	335	368	402	452	536
	833	418	459	551	600	600

*Regulators rated 167kVA and above at 7620/13200 Y volts are capable of carrying current corresponding to rated kVA when operated at 7200/12470 volts.

FORCED AIR COOLING

For forced air cooling, fans are mounted on radiators and are usually automatically controlled by means of changes in oil temperature (see Connection Diagram.)

The thermometer located in the top transformer oil contains two identical switches which control fan operation when fan control switch is in "Auto" position.

The switches are normally set to start the fans at 65° C and to stop them at 55° C top oil temperature, but may be adjusted plus or minus 5° C.

A thermal overload relay is mounted on each fan motor. With this arrangement any fan that develops trouble will be automatically disconnected from the line without affecting the other fans of the system. One fan can be removed from the radiators without affecting the operation of the others. When fans are out of service, care must be exercised to prevent overloading the regulator. Fans should be removed and replaced carefully to prevent damage to the radiators.

The fans used for cooling require a minimum of attention. Fans with plain sleeve bearings or Oil-Lite sleeve bearings should be oiled at least once a year with a good grade of SAE 10-W mineral engine oil which does not thicken in cold weather. Oil must be added to sleeve bearings before starting the motor for the first time after installation.

Fans equipped with ball bearing motors are packed with grease before shipment and should be greased at least once a year with a soda soap ball bearing grease of medium consistency furnished by a reliable supplier.

For fans that are seldom used, the frequency of greasing or oiling may be less than outlined above, but it is recommended that this lubrication be placed on a yearly schedule. It is often possible to determine by inspection whether lubrication is required.

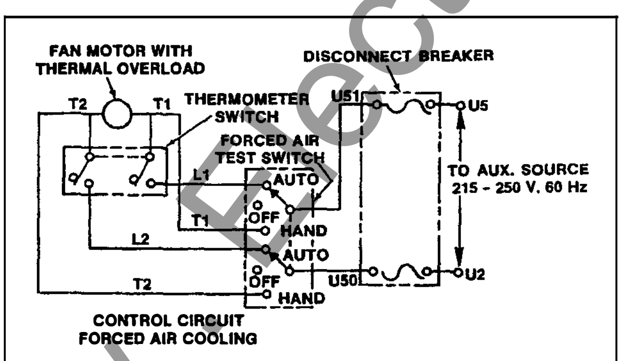


Fig. 25 Control circuit forced air cooling.

REMOTE MOUNTING OF CONTROL EQUIPMENT

When the JFR regulator is pole mounted, the *Accu/Stat* control compartment may be remotely mounted with the use of a remote control kit. This kit consists of oil and moisture resistant color coded wires, which are 20', 25', or 30' in length. These wires are enclosed in a steel flexible conduit covered with a plastic coating to prevent moisture from entering.

Installation of the Remote Mounting Kit: Remove the *Accu/Stat* control panel, steel conduit, and control wires from regulator. Then connect the remote mounting kit to the cover and connect the control leads to the terminal block on top of the cover. After the kit has been connected to the regulator, connect the other end of the remote mounting kit to the control panel and then fasten the leads to the polarized jack plug inside the control compartment. When this is completed, the regulator is then suitable for operation with the control panel remotely mounted.

Fig. 26 Remote mounted control compartment.

Optional Features

METER SOCKETS

A voltage regulator contains both a potential transformer and a current transformer as inputs for the control panel. These same transformers can be used to provide various inputs for metering equipment. Meter sockets can be provided from the factory to accommodate a variety of specific meters including the following:

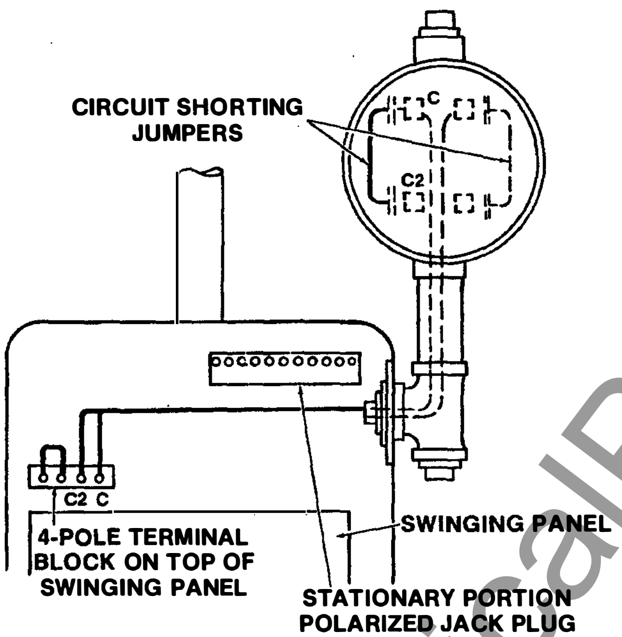
Current Demand Ammeter (Sangamo Type ADS or equal)

Max-Min Voltmeter (Sangamo Type V4s or equal)

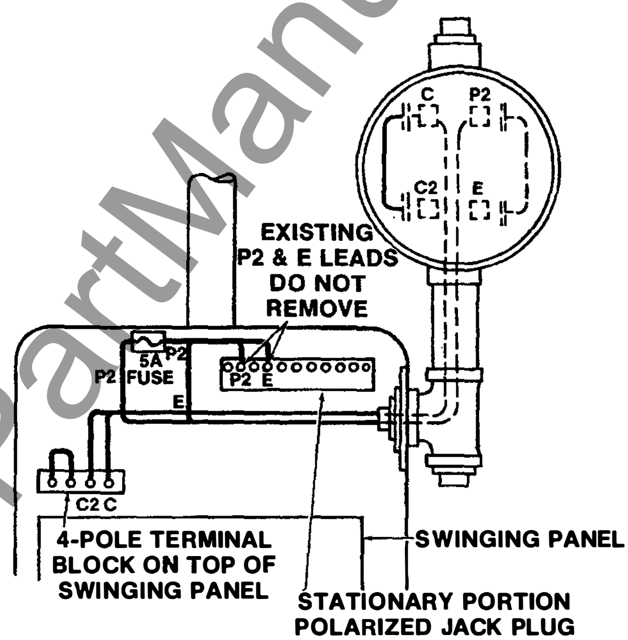
kW-kVAR Meter (Sangamo Type CCW/CCVAR or equal)

The meter socket will be provided with a 0-0.2 amp current input and a 120 volt potential input from the polarized jack plug as standard, depending on which is required. Specific wiring arrangements are shown below. An auxiliary 0.2-5.0 amp current transformer may also be provided to effectively provide a 0-5.0 amp input to the meter socket.

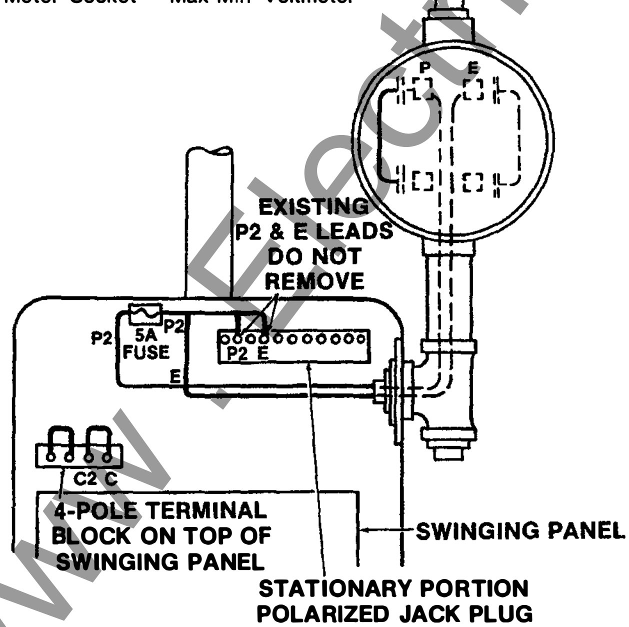
Meter Socket — Current Demand Meter



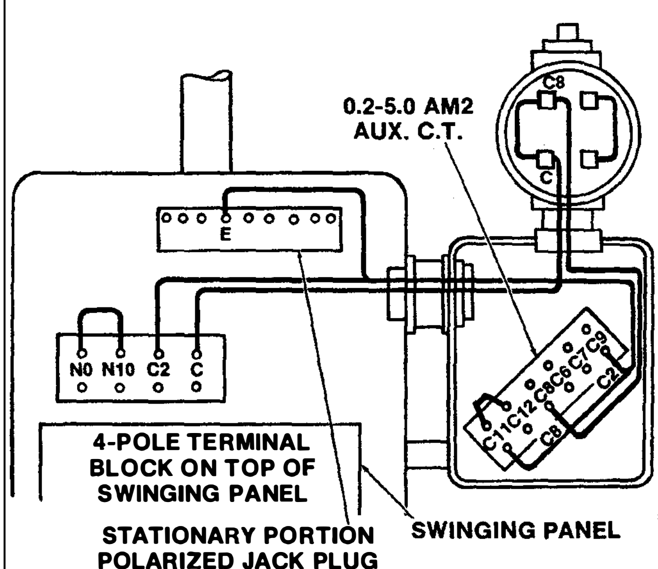
Meter Socket — kW/kVAR Meter



Meter Socket — Max-Min Voltmeter

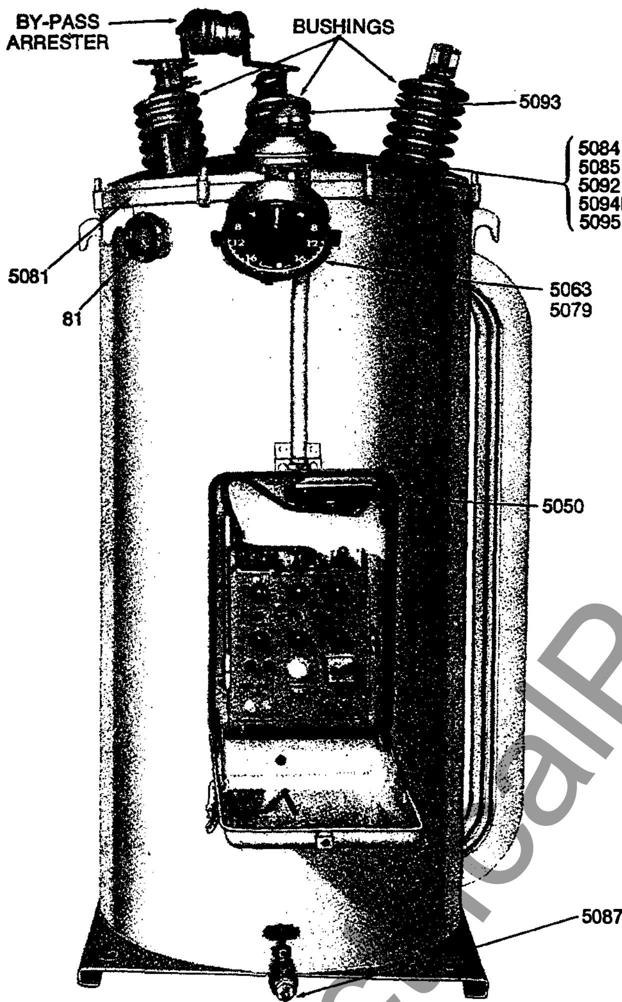


Meter Socket — Demand Meter with Auxiliary Current Transformer



Parts List

Major Components



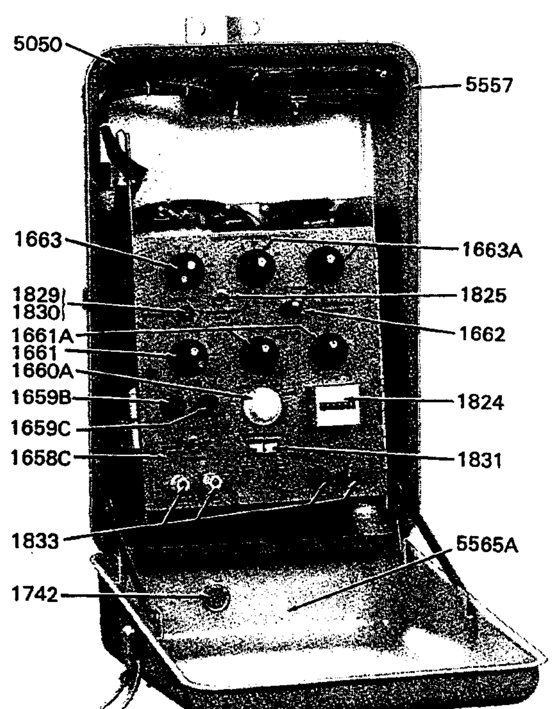
INSTRUCTIONS FOR ORDERING PARTS

When ordering parts, give the quantity of parts required, the regulator serial number, parts list item number, complete description, and method of shipping. State whether for emergency repair, maintenance, spare parts, etc.

All shipments will be made F.O.B. Factory.

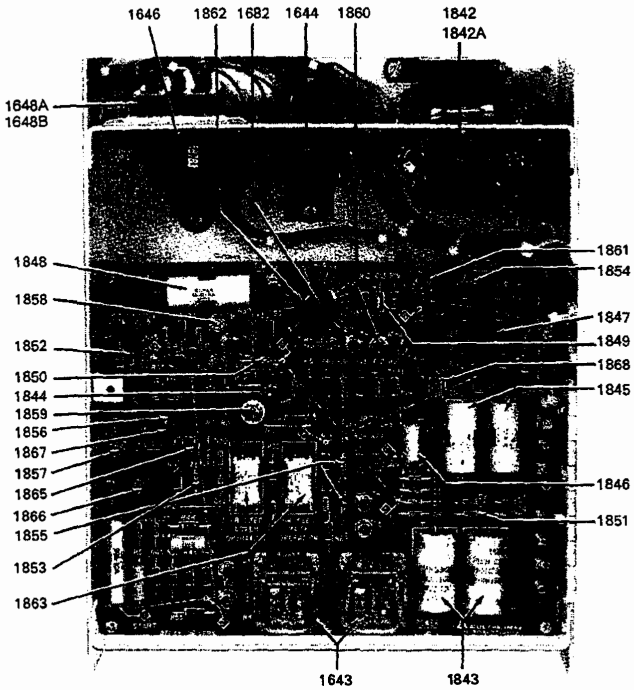
[illegible]	[illegible]
[illegible]	Control Compartment Gasket
[illegible]	Vari-Amp Position Indicator Assembly
[illegible]	Position Indicator Gasket
[illegible]	Main Cover Gasket
[illegible]	Terminal Box Cover
[illegible]	Terminal Box Gasket
[illegible]	Nameplate (not shown)
[illegible]	Sampling Device
[illegible]	Grounding Lug Terminal (not shown)
[illegible]	Terminal Block Clamp
[illegible]	Breather Assembly
[illegible]	Terminal Block with Studs
[illegible]	Terminal Block Gasket
[illegible]	Oil Sight Gauge

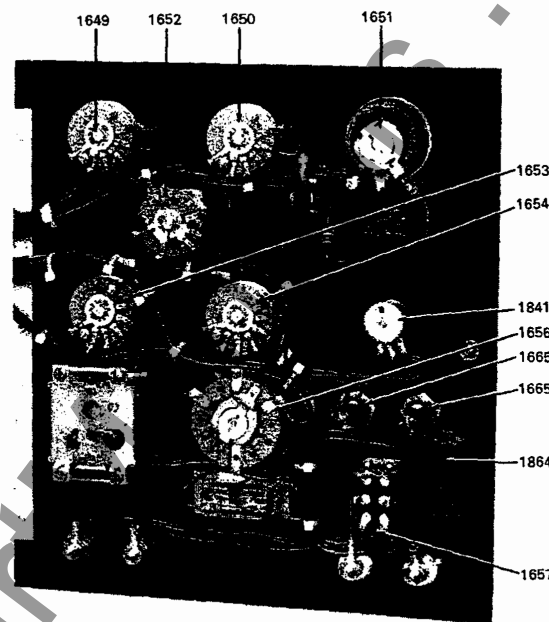
Accu/Stat control panel door is hinged at bottom of weathertight compartment and opens to provide a workshelf. (See parts list description on Pages 24, 25).



ACCU/STAT Control Panel

Types IJ-2, IJ-2A



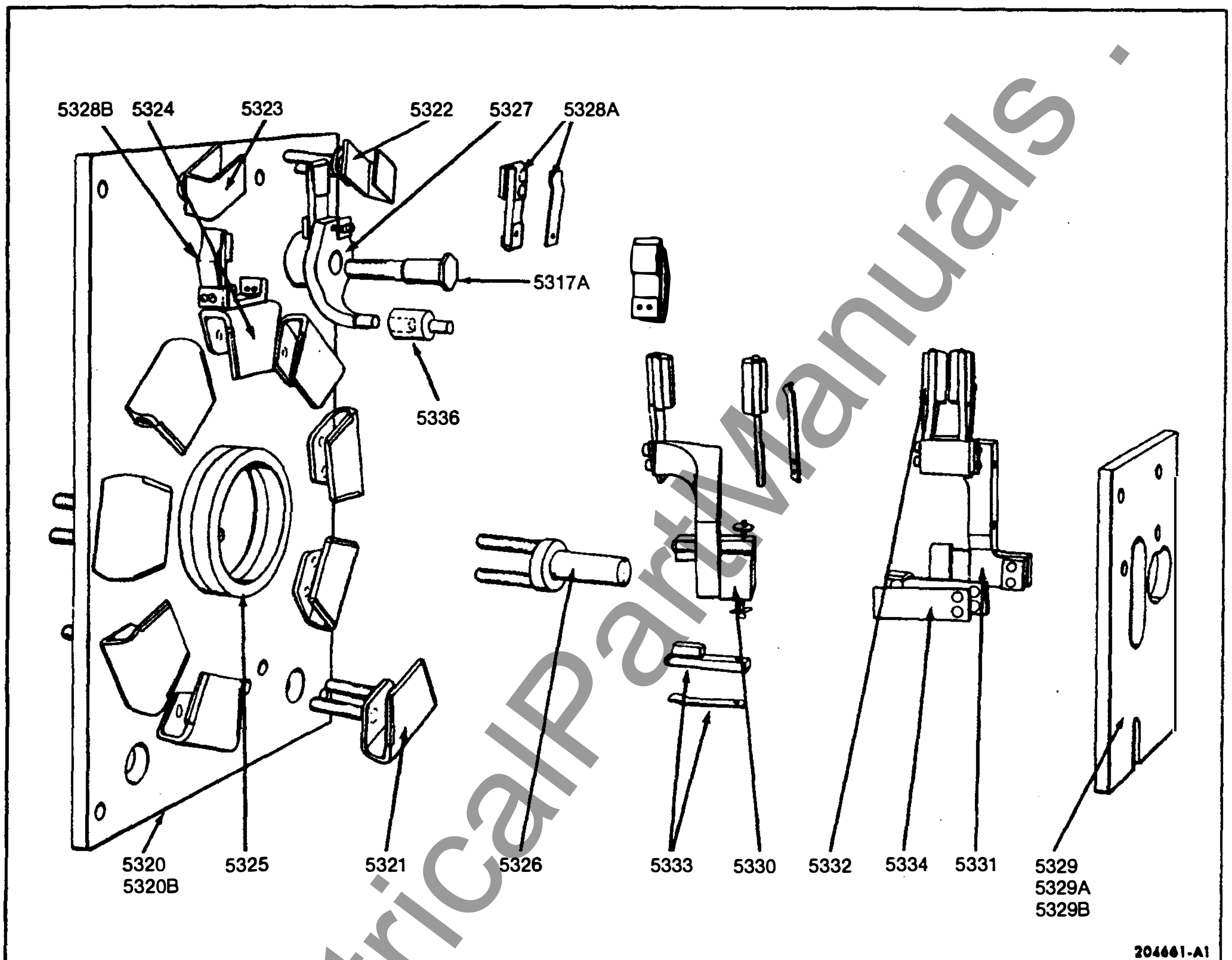


Accu/Stat control equipment is mounted in compact, easily accessible cabinet. Entire unit can be lifted from its hinges for shop testing.

[illegible]	*Accu/Stat* Control Panel Complete
[illegible]	*Accu/Stat* Control Panel (Less Cabinet)
[illegible]	Printed Circuit Board Complete
[illegible]	Motor Relay
[illegible]	Line Drop Compensator Reactor TR-3
[illegible]	Auxiliary Current Transformer TR-2
[illegible]	Terminal Block — 4 Pole (IJ-2)
[illegible]	Terminal Block — 9 Pole (IJ-2A)
[illegible]	Reactance Rotary Switch (Fine)
[illegible]	Reactance Rotary Switch (Coarse)
[illegible]	Resistance Rheostat
[illegible]	Compensator Polarity Switch
[illegible]	Voltage Level Switch (Fine)
[illegible]	Voltage Level Switch (Coarse)
[illegible]	Transfer Switch
[illegible]	Voltage Source Switch
[illegible]	Panel Faceplate
[illegible]	4-Amp Motor Fuse
[illegible]	4/10 Amp *Slo-Blo* Panel Fuse
[illegible]	Control Knob (Transfer Switch)
[illegible]	Control Knob (Black) Bandwidth Adjustment
[illegible]	Control Knob (Black) Voltage Level
[illegible]	Control Knob — Compensator Polarity Switch
[illegible]	Control Knob (Red) Resistance Rheostat
[illegible]	Control Knob (Red) Line Drop Compensator Switch
[illegible]	4 Amp Fuse Holder — for 1659B Fuse
[illegible]	4/10 Amp Fuse Holder — for 1659C Fuse
[illegible]	Control Knob — Time Delay Rheostat
[illegible]	Snap-in Breather Plug
[illegible]	Operation Counter
[illegible]	Drag Hand Reset Button and Switch
[illegible]	Neutral Light — Bulb Only
[illegible]	Neutral Light — Socket

[illegible]	Bandwidth Indicator
[illegible]	Terminal Posts — Specify Color
[illegible]	Bandwidth Adjustment Rheostat
[illegible]	Sensing Transformer (IJ-2)
[illegible]	Sensing Transformer (IJ-2A)
[illegible]	C-2, C-3 Capacitor
[illegible]	C-4 Capacitor
[illegible]	C-5, C-6 Capacitor
[illegible]	C-7 Capacitor
[illegible]	C-9 Capacitor
[illegible]	C-11 Capacitor
[illegible]	C-12, C-13 Capacitor
[illegible]	C-14 Capacitor
[illegible]	D-1 thru D-8, D-10, D-15, D-26, D-27 Diodes
[illegible]	D-9, D-11 thru D-14, D-20, D-21, D-23, D-24 Diodes
[illegible]	Z-1 Zener Diode
[illegible]	Z-2 Zener Diode
[illegible]	Z-3, Z-4 Zener Diode
[illegible]	T-1, T-4, T-6, T-7, T-8, T-11, T-12, T-13 Transistors
[illegible]	T-2, T-5, T-10 Transistors
[illegible]	T-9 Transistor
[illegible]	IC-1 Voltage Regulator
[illegible]	IC-2 Operation Amplified
[illegible]	RH-2 Potentiometer
[illegible]	RH-4 Potentiometer
[illegible]	FR, GR Reed Relay
[illegible]	C-1 Capacitor
[illegible]	C-15 Capacitor
[illegible]	T-3 Transistor
[illegible]	Insulating Heatsink for T-1, T-3 Transistors
[illegible]	C-16 Capacitor
[illegible]	Gasket — Control Cabinet
[illegible]	Terminal Block — 10 Pole
[illegible]	Control Cabinet

Dial Switch Type TLG



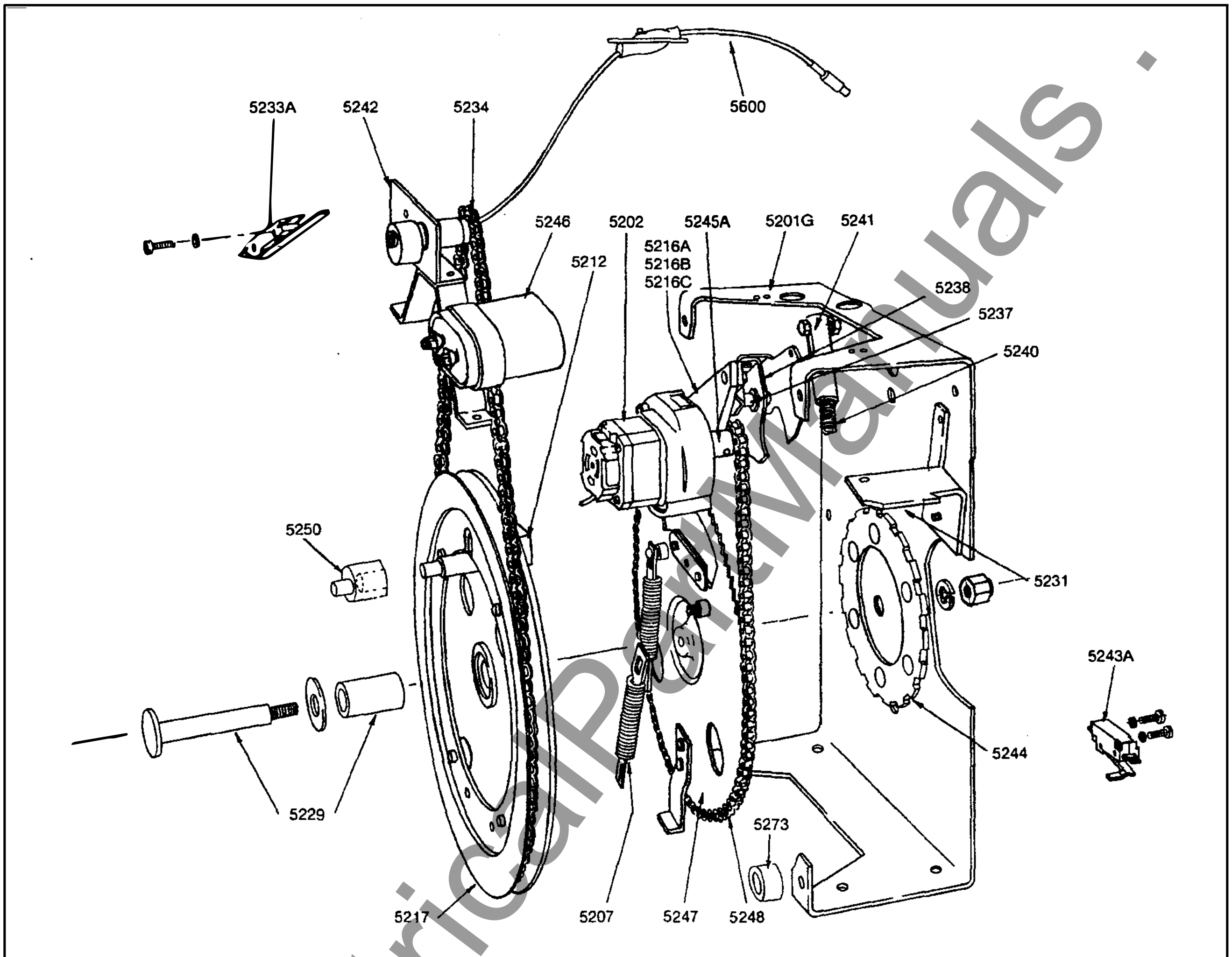
[illegible]	[illegible]
[illegible]	Bakelite Panel
[illegible]	Glass Polyester Panel
[illegible]	Reversing Main Shaft
[illegible]	Main Stationary Contacts
[illegible]	Reversing Stationary Contact R.H.
[illegible]	Reversing Stationary Contact L.H.
[illegible]	Neutral Stationary Contact
[illegible]	Collector Ring
[illegible]	Collector Hub
[illegible]	Reversing Switch Arm

[illegible]	[illegible]
[illegible]	Reversing Switch Finger Assembly
[illegible]	Reversing Switch Hub Finger Assembly
[illegible]	Drive Arm — Bakelite
[illegible]	Drive Arm — Bakelite
[illegible]	Drive Arm — Glass Polyester
[illegible]	Hub Finger Support
[illegible]	Ring Finger Support
[illegible]	Main Moving Finger Assembly
[illegible]	Hub Finger Assembly
[illegible]	Ring Finger Assembly
[illegible]	Phenolic Drive Pin

*Indicate S/N when ordering.

Quick Break Mechanism

Type TLG

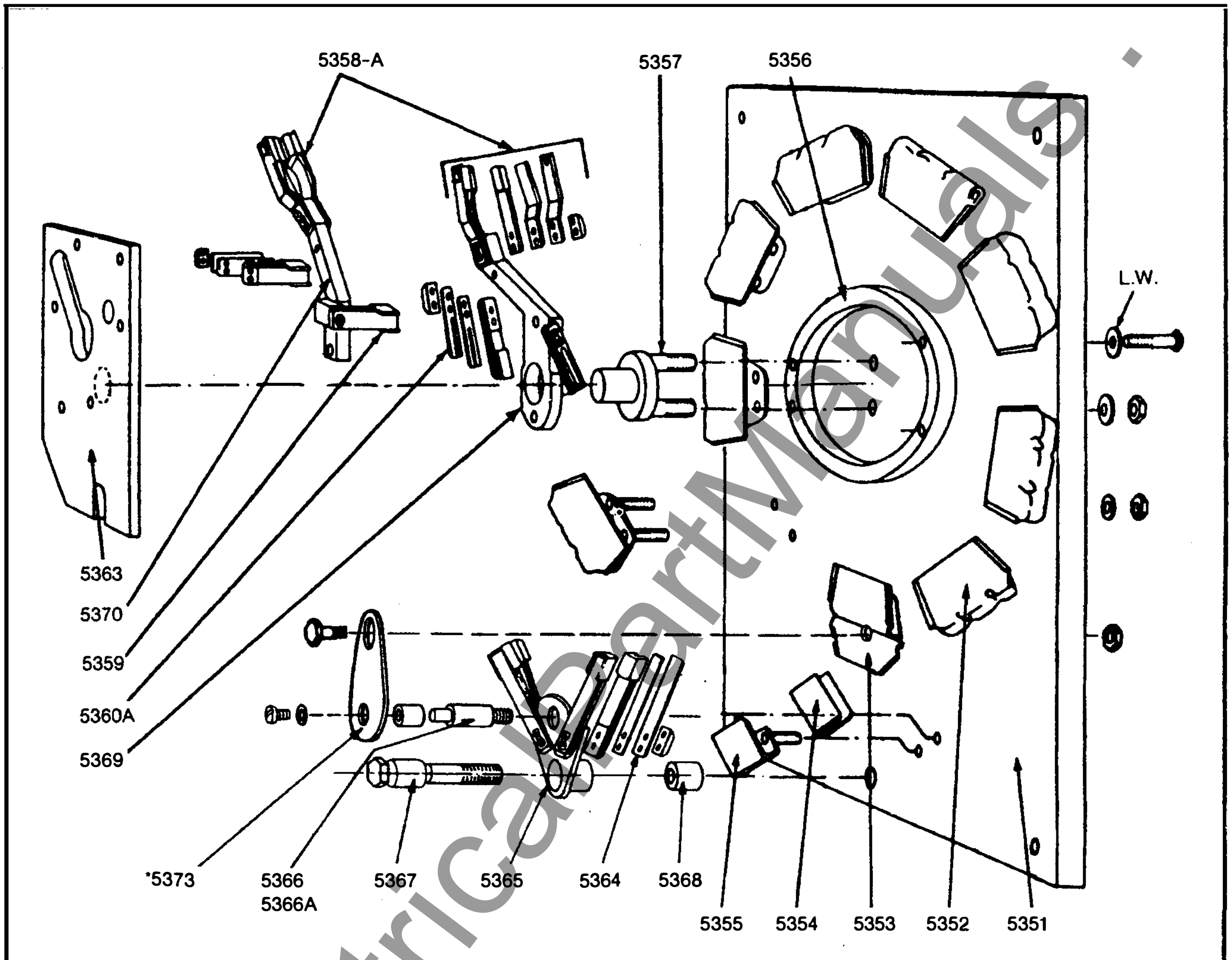


Item No.	Description
[illegible]	Mounting Frame Assembly
[illegible]	Motor
[illegible]	Drive Spring Assembly
[illegible]	Latch Assembly
[illegible]	Latch Spring (not shown)
[illegible]	Latch Pin (not shown)
[illegible]	Reversing Switch Drive Arm — Bakelite
[illegible]	Reversing Switch Drive Arm — Bakelite
[illegible]	Rev. Switch Drive Arm — Glass Polyester
[illegible]	Interlock Disc and Drive Assembly
[illegible]	Main Shaft w/Sleeve Bearing
[illegible]	Motor Mounting Bracket
[illegible]	Operation Counter Switch Assembly
[illegible]	Roller Chain Position Indicator
[illegible]	Reversing Switch Shaft

Item No.	Description
5238	Reversing Switch Assembly
5240	Spring
5241	Spring Tube
5242	Position Indicator Drive Mechanism
5243A	Neutral Switch
5244	Index Plate
5245A	Motor Sprocket
5246	Capacitor for Motor
5247	Sprocket Assembly
5248	Main Drive Chain Assembly
5250	Drive Pin
5273	Phenolic Spacer
5600	Flexible Shaft

*Indicate S/N when ordering.

Dial Switch **Type TLF**



[redacted]

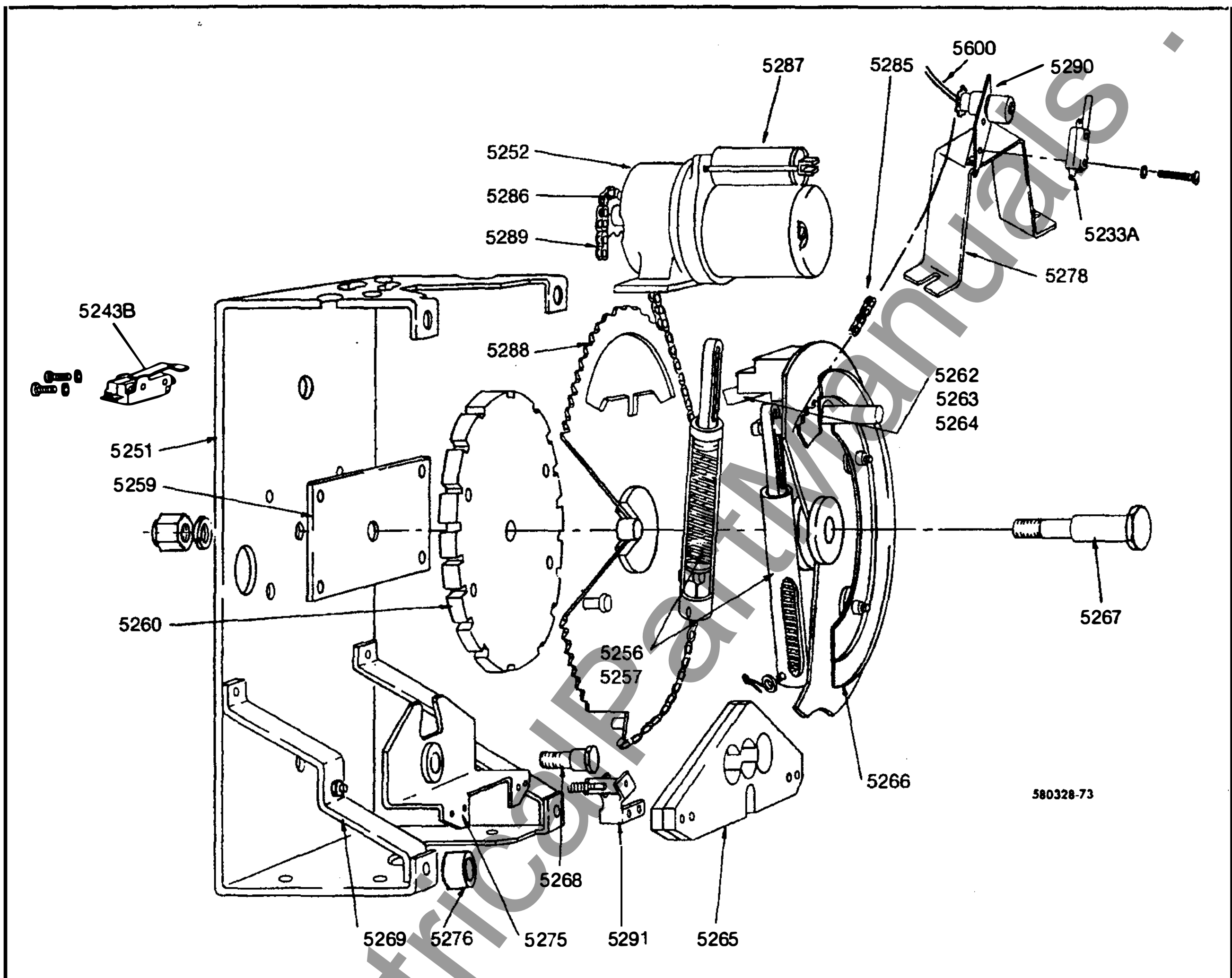
Bakelite Panel
Stationary Contact
Neutral Stationary Contact
Stationary Contact — L.H.
Stationary Contact — R.H.
Collector Ring
Shaft Assembly
Main Finger Assembly (each)
Contact Finger Assembly Collector Ring
Contact Finger Assembly Collector Hub

[redacted]

Drive Plate
Contact Finger Assembly — Rev. Switch
Contact Support Assembly
Reversing Drive Pin
Reversing Drive Pin
Reversing Shaft
Spacer
Contact Finger Support
Contact Finger Support
Reversing Switch Stop

*Indicate S/N when ordering.

Quick Break Mechanism **Type TLF**



	Counter Switch Assembly
	Neutral Switch*
	Mounting Frame
	Motor
	Drive Spring Tube
	Drive Spring
	Spacer
	Notched Index Plate
	Latch
	Latch Spring
	Latch Pin
	Reversing Switch Drive Arm

	Interlock Disc and Drive Sprocket Assembly
	Quick Break Mechanism Shaft
	Actuating Arm Assembly
	Phenolic Spacer
	A-Frame
	Drive Chain for Position Indicator
	Motor Sprocket
	Motor Capacitor
	Actuating Disc and Sprocket
	Main Drive Chain
	Position Indicator Drive Mechanism
	Reversing Switch Spring Assembly
	Flexible Shaft

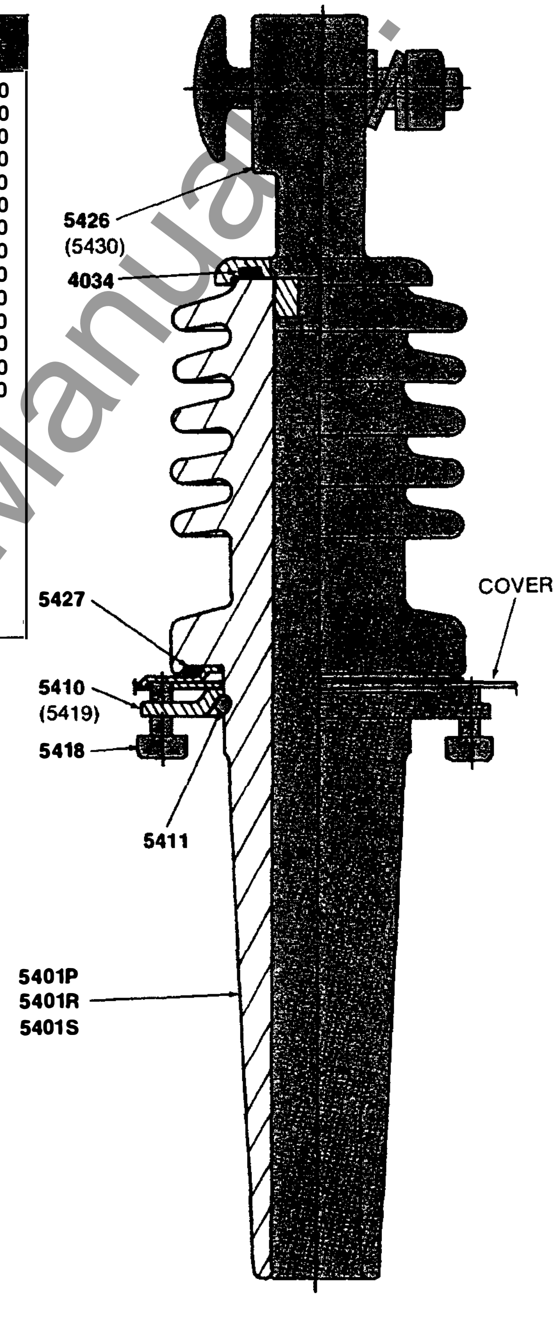
*Indicate S/N when ordering.

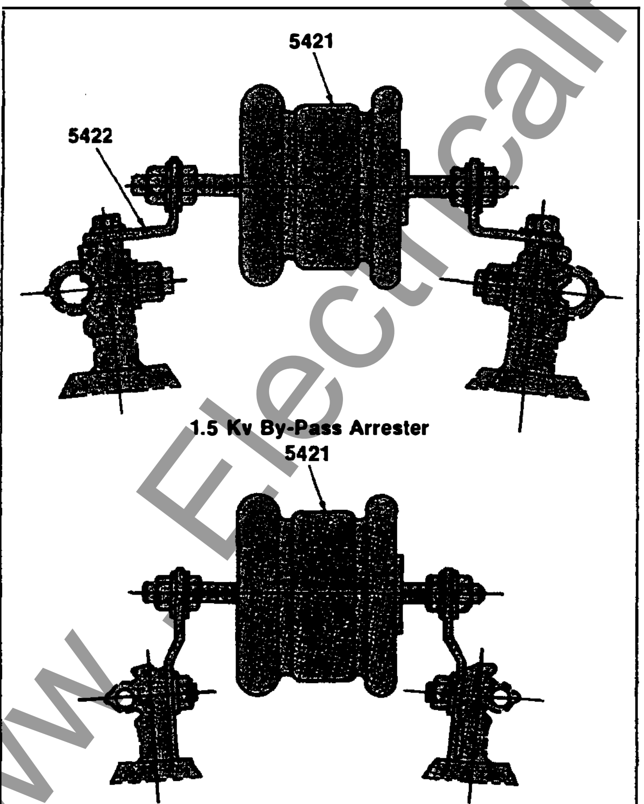
Bushings and By-Pass Arresters

BUSHINGS*

[redacted]			
[redacted]	Bushing Assembly for 15 kV	50	5000
		38.1 thru 76.2	7620
		69 thru 138	13,800
	Bushing Assembly for 15 kV	50	2500
		100	5000
		114.3 thru 167	7620
	Bushing Assembly for 15 kV	75	2500
	Bushing Porcelain for 15 kV	50	5000
		38.1 thru 76.2	7620
		69 thru 138	13,800
	Bushing Porcelain for 15 kV	50	2500
		100	5000
		114.3 thru 167	7620
	Bushing Porcelain for 15 kV	75	2500
	Clamping Ring for 5400P and R Ratings		
	Clamping Ring for 5400S Rating		
	Cushion Spring		
	Cap Screw		
	Bushing Cap Line Terminal for 5400P Rating		
	Bushing Cap Line Terminal for 5400R and S Ratings		
	Gasket		
	Gasket		

*Indicate Regulator Serial Number.





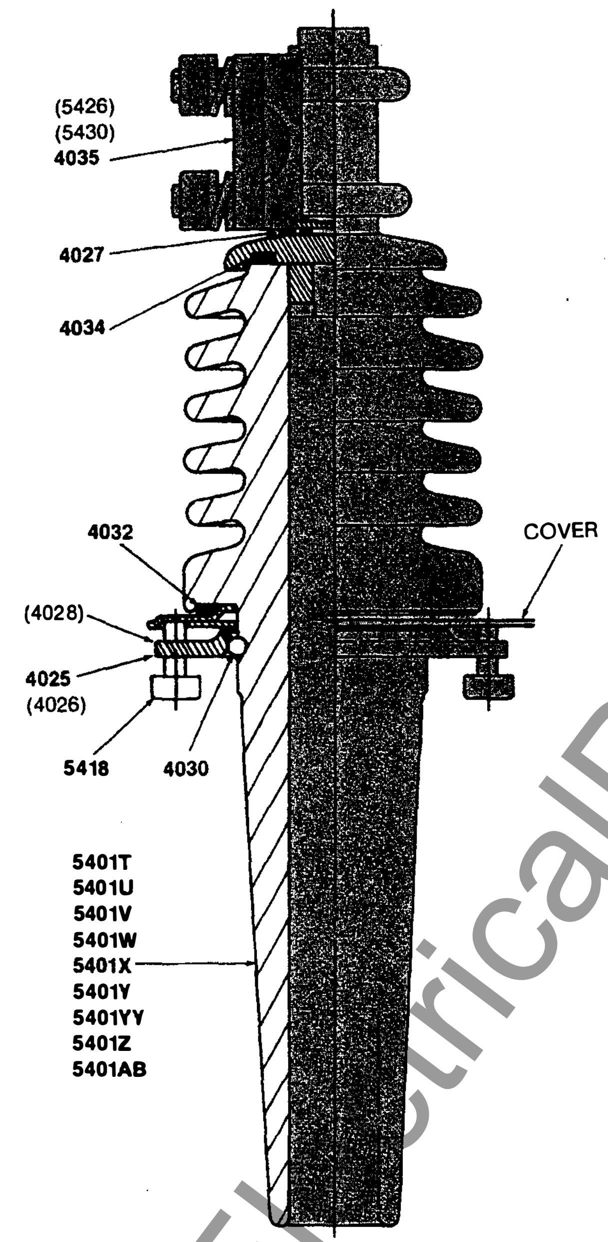
1.5 Kv By-Pass Arrester

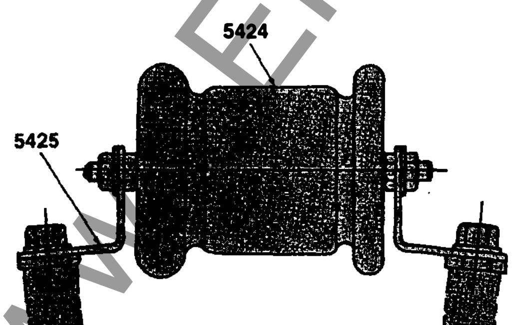
BY-PASS ARRESTER*

[redacted]		
[redacted]	By-Pass Arrester Assembly 1.5 kv	2500, 5000, 7620
	By-Pass Arrester Crystal 1.5 kv	
	Mounting Bracket Assembly	

*Indicate Regulator Serial Number.

Bushings and By-Pass Arresters





3 kv By-Pass Arrester
and
6 kv By-Pass Arrester

BUSHING*

Item Number	Description	kVA	Volts
5400T	Bushing Assembly, 15 kV	100 thru 167	2500
		167	5000
		250 thru 509	7620
5400U	Bushing Assembly, 15 kV	207	13,800
5400V	Bushing Assembly, 23 kV	72 thru 144	14,400
		100 thru 200	19,920
5400W	Bushing Assembly, 15 kV	333 thru 416.3	2500
		333 thru 416.3	5000
5400X	Bushing Assembly, 23 kV	576 thru 833	14,400
5400Y	Bushing Assembly, 23 kV	288	14,400
		333 thru 400	19,920
5400YY	Bushing Assembly, 15 kV	333	12,000
5400Z	Bushing Assembly, 23 kV	333 thru 432	14,400
5400AB	Bushing Assembly, 23 kV	667 thru 833	19,920
5401T	Bushing Porcelain, 15 kV	100 thru 167	2500
		167	5000
		250 thru 509	7620
5401U	Bushing Porcelain, 15 kV	207	13,800
5401V	Bushing Porcelain, 23 kV	72 thru 144	14,400
		100 thru 200	19,920
5401W	Bushing Porcelain, 15 kV	333 thru 416.3	2500
		333 thru 416.3	5000
5401X	Bushing Porcelain, 23 kV	576 thru 833	14,400
5401Y	Bushing Porcelain, 23 kV	288	14,400
		333 thru 400	19,920
5401YY	Bushing Porcelain, 15 kV	333	12,000
5401Z	Bushing Porcelain, 23 kV	333 thru 432	14,400
5401AB	Bushing Porcelain, 23 kV	667 thru 833	19,920
4025	Clamping Ring for 5400T X, Z and AB Ratings		
4026	Clamping Ring for 5400U V, W. (SL Bushing only), Y and YY Ratings		
4028	Clamping Ring for 5400W Rating S and L Bushings only		
4030	Cushion Spring		
4027	Gasket		
4032	Gasket		
4034	Gasket		
4035	Bushing Cap Line Terminal† for 5400T, X, YY and AB Ratings		
5426	Bushing Cap Line Terminal† for 5400U, Y and Z Ratings		
5430	Bushing Cap Line Terminal† for 5400V Rating		
5418	Cap Screw		

†Units rated 250 kVA .and above, 2500 and 5000 volts are not supplied with line terminals.

*Indicate Regulator Serial Number.

BY-PASS ARRESTER*

Item	Description	Volts
[illegible]	By-Pass Arrester Assembly, 3 kV	12,000-13,800-14,400
[illegible]	By-Pass Arrester Crystal, 3 kV	
[illegible]	Mounting Bracket Assembly	
[illegible]	By-Pass Arrester Assembly, 6 kV	19,920
[illegible]	By-Pass Arrester Crystal, 6 kV	
[illegible]	Mounting Bracket Assembly	

*Indicate Regulator Serial Number