

Westinghouse Type DT-5 Voltage Regulator

INSTRUCTION BOOK

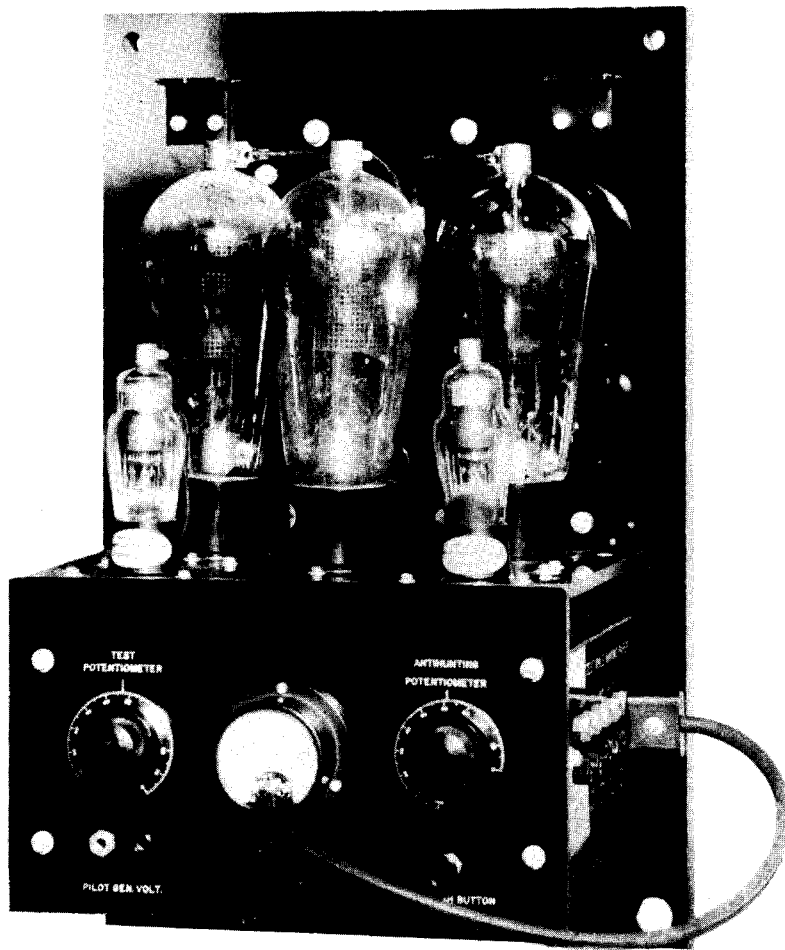


Fig. 1 - Type DT-5 Voltage Regulator - Front View
Top Cover Removed

Westinghouse Electric & Manufacturing Company

East Pittsburgh Works

East Pittsburgh, Pa.

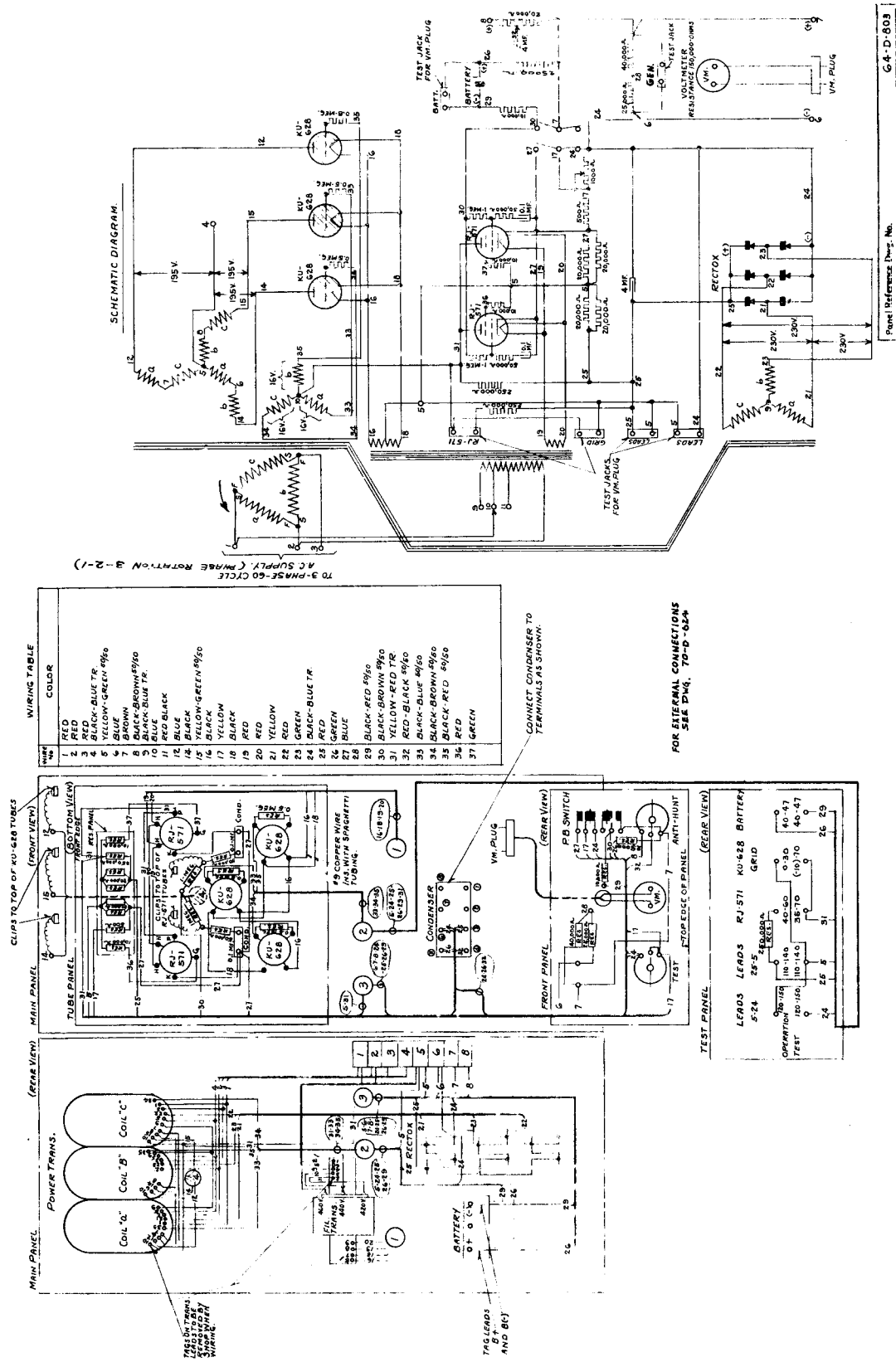
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I.B. 5670-41

5670-41

Westinghouse Type DT-5 Voltage Regulator



WIRING TABLE

TERM.	COLOR
1	RED
2	RED
3	BLACK-BLUE TR.
4	YELLOW-GREEN 49/50
5	BROWN
6	BLACK-BROWN 49/50
7	BLACK-BLUE TR.
8	BLACK
9	BLACK-BLUE TR.
10	BLACK
11	RED
12	BLACK
13	YELLOW-GREEN 49/50
14	YELLOW
15	BLACK
16	RED
17	YELLOW
18	RED
19	RED
20	YELLOW
21	RED
22	RED
23	GREEN
24	BLACK-BLUE TR.
25	RED
26	GREEN
27	BLUE
28	BLACK-RED 49/50
29	BLACK-BROWN 49/50
30	BLACK-BROWN 49/50
31	YELLOW-RED TR.
32	RED-BLACK 49/50
33	BLACK-BLUE 49/50
34	BLACK-BROWN 49/50
35	BLACK-RED 49/50
36	RED
37	GREEN

CONNECT CONDENSERS TO TERMINALS AS SHOWN.

FOR INTERNAL CONNECTIONS SEE DRAW. 70-0-624

TEST PANEL

LEADS	5-24	25-26	27-28	29-30	31-32	33-34	35-36	37
OPERATION	10-140	40-50	0-30	40-47	10-140	40-50	0-30	40-47
TEST	24	26	5	31	26	23		

Panel Reference Draw. No. 64-D-803

Fig. 2 - Wiring Diagram for Type DT-5 Voltage Regulator

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Type DT-5 Voltage Regulator

for

D-C. Generators

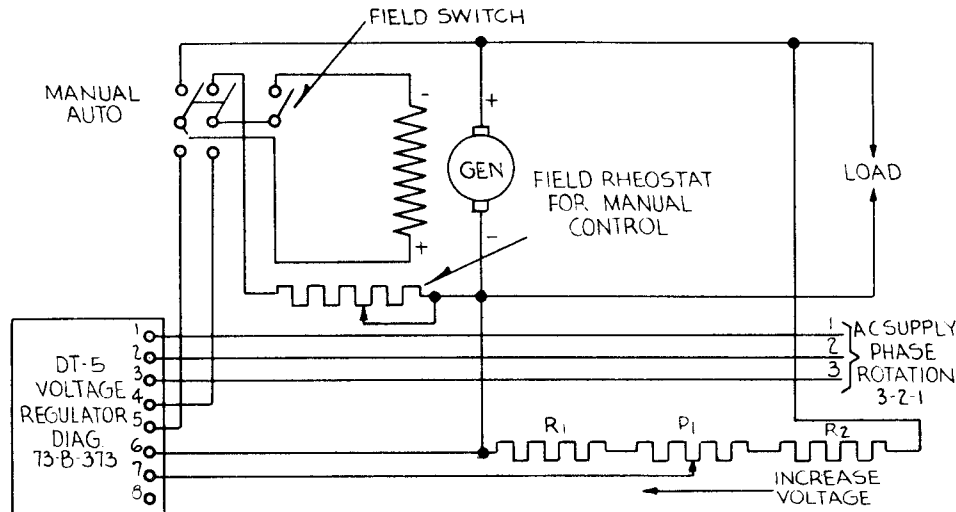


Fig. 3 - External Connections for Type DT-5 Voltage Regulator When Used without an Exciter

DESCRIPTION

- (1) The Type DT-5 voltage regulator as shown in Figure 1 consists of an assembly of three Type KU-628 grid glow tubes, two Type RJ-571 amplifier tubes and various transformers, capacitors, resistors and a battery. The equipment is assembled on a Micarta panel, with a removable front cover. Outline dimensions for the 25- and 60-cycle units are given in Figure 9 and Figure 8.

APPLICATION

- (2) The DT-5 regulator may be used to control the voltage of direct-current generators. Typical diagrams of connections are shown in Figure 3 and Figure 4. In Figure 3 are shown the external connections for the regulator when used with a generator without an exciter. Figure 4 shows the connections when an exciter is used.
- (3) A-C. Supply Voltage. A three-phase a-c. supply source with frequency and voltage as given on the regulator name plate is needed to operate the DT-5 voltage regulator. Taps are provided on the filament transformer to adapt the regulator to voltages 5 per cent above or below the rated voltage. A regulator designed for, for example 440 volts, may therefore be used on either 420, 440 or 460 volts. In order to obtain satisfactory tube life the a-c. supply voltage must not be more than 5 per cent higher than normal. The maximum a-c. supply voltage variation should not exceed 10 per cent.
- (4) Maximum Field Current. The power transformer is designed to give a maximum output current of 1.5 amperes d-c. This value must not be exceeded. If the maximum generator field current exceeds this value an exciter must be added as shown in Figure 4. The generator

field in Figure 3 and the exciter field in Figure 4 should be designed for 125 volts.

- (5) Regulated Voltage Range. When the regulator is in operation the voltage across terminals 6 and 7 will be maintained at approximately 46 volts. In order to obtain the desired generator voltage, potentiometer P_1 and resistors R_1 and R_2 should be used. The minimum generator voltage is 46 volts. This voltage is obtained when $R_2 = 0$ and the tap on P_1 is to the right on Figure 3 and Figure 4. R_1 , R_2 and P_1 should be determined as follows:— assuming maximum generator voltage being E_{max} and minimum generator voltage E_{min} .

$$R_1 = 360 \frac{E_{min.}}{E_{max.}} \quad \text{ohms}$$

$$P_1 = 500 - 360 \frac{E_{min.}}{E_{max.}} \quad \text{ohms}$$

$$R_2 = 10 E_{min.} - (P_1 + R_1) \text{ ohms}$$

- (6) Sensitivity. The sensitivity of the DT-5 voltage regulator, assuming the a-c. supply voltage does not vary more than ± 5 per cent, is $+ 0.25$ per cent. This means that after the regulator has reached normal operating temperature, which requires 3 to 4 hours, the regulated voltage will remain within ± 0.25 per cent range during any period of 4 hours.
- (7) Speed of Response. The speed of response depends upon whether or not an exciter is used. If no exciter is used the regulated voltage will be brought back to within ± 0.25 per cent of normal in from 3 to 8 cycles, if the generator load is changed 25 per cent. The response obtained depends upon the machine characteristics, primarily the inductance of the field winding. If an exciter is used the response depends to a considerable extent on the adjustment of the anti-hunting potentiometer. In most applications a response of 15

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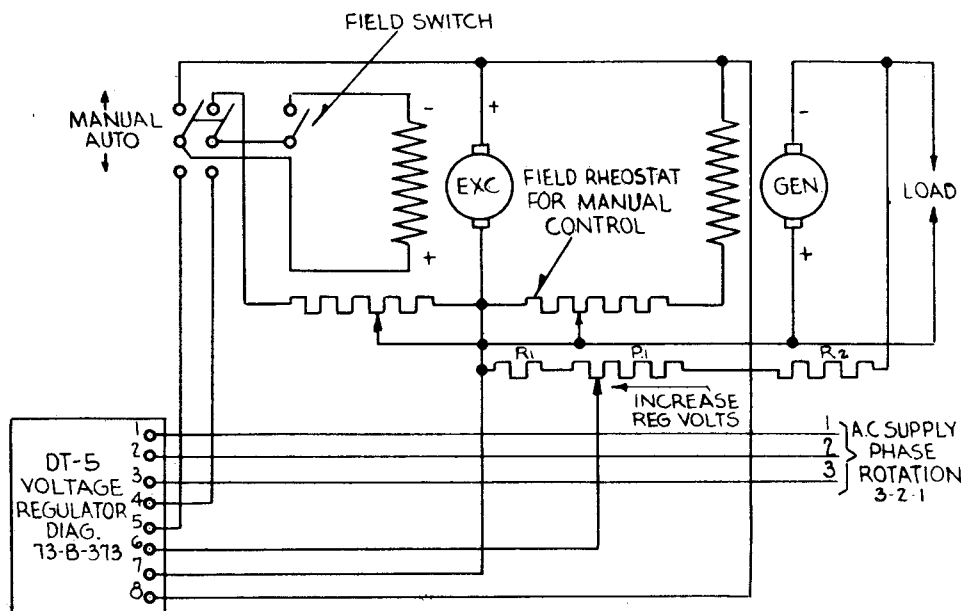


Fig. 4 - External Connections for Type DT-5 Voltage Regulator When Used with an Exciter

to 40 cycles may be expected if the generator is compound wound. For shunt wound generators, the time of response is considerably longer, and will in the average application be in the order of 20 to 60 cycles.

(8) EXCITER DESIGN

The exciter may be either shunt wound or compound wound. If the series winding is not needed to bring the exciter shunt field current within the regulating range it is recommended to omit the series field, and to connect the exciter as a shunt machine. The maximum exciter armature voltage must not exceed 250 volts.

(9) GENERATOR DESIGN

The generator should have a drooping characteristic from no-load to full-load. This is particularly important when no exciter is used, and in this case the no-load to full-load droop must be at least 15 per cent in order to obtain stable operation. When an exciter is used, a droop of 5 per cent or more is satisfactory.

(10) AUTOMATIC STARTING

Approximately one minute is needed to heat the cathodes of the KU-628 tubes. For this reason the a-c. voltage must be supplied to the regulator at least one minute before the field switch shown in Figure 3 and Figure 4 is closed. If automatic starting is needed the control should be arranged with a timing relay to give a one-minute time delay between application of a-c. voltage and closure of the field switch or contactor.

OPERATION

(11) The DT-5 Regulator as shown in Fig. 2 consists of three KU-628 tubes connected to supply current to the field winding, and two RJ-571 tubes which control the KU-628 tubes. The generator is connected to terminals 6 and 7, and a 45-volt battery is connected in the

grid circuit of the RJ-571 tubes to oppose the generator voltage so that the RJ 571 grid voltage becomes more negative when the generator voltage is decreased. The RJ-571 tube grid-control circuit may be traced, from the cathode 27 of Figure 2, to 17-24-28-7-26-29-30 grid.

(12) Resistor 26-7 and capacitor 26-32 produce the required anti-hunting action when an exciter is used. The exciter armature voltage is connected to terminals 7-8, and when the exciter voltage is varying as a result of regulator action, a voltage drop will appear across resistor 26-7. The polarity of this voltage drop is such that the variation in RJ-571 grid voltage which caused the regulator action will be opposed and stable regulator action is therefore obtained.

(13) Assuming that the generator voltage is too low, the voltage across 6-7 will be low and the grid voltage between 30 and 27 will become more negative. This increased negative voltage decreases the current through the RJ-571 tubes, and the voltage across resistor 31-25 is decreased. Since the grids of the KU-628 tubes are connected through leads 33-34-35 to the star winding of the transformer and the neutral of the transformer is connected to 5, the KU-628 grid voltage becomes more positive when the voltage across resistor 25-31 is decreased. The field winding is connected to terminals 4 and 5, and is therefore supplied with rectified current from the three KU-628 tubes. The exciter field current is increased when the KU-628 grid voltage is made more positive. For this reason, the exciter field current is increased when the voltage across 6-7 is decreased.

(14) The grid control of the KU-628 tubes is obtained as a combination of a-c. and d-c. voltage control. The a-c. grid voltage which is 16 volts, obtained from transformer winding 31, -33, -34, -35 is displaced 90 degrees relative to the KU-628 anode voltage supplied by transformer winding 4-12, -14, -15. The d-c. grid voltage component is obtained from 5-31. By varying this d-c. voltage the point

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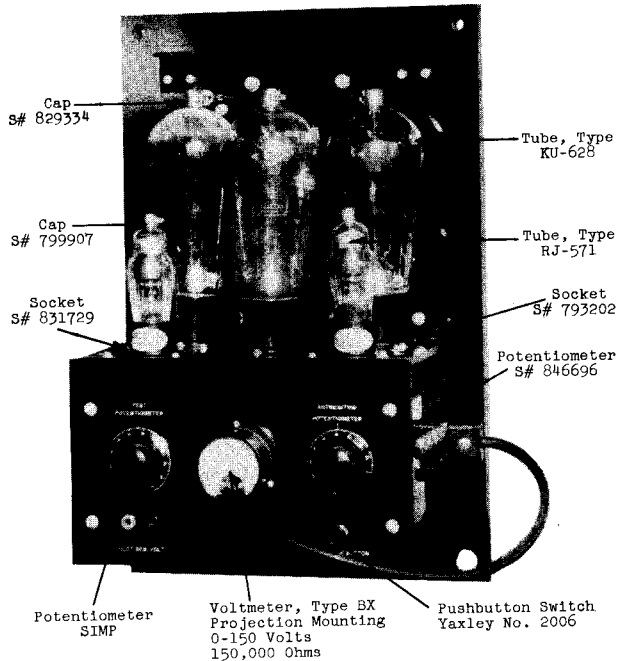


Fig. 5 - Type DT-5 Voltage Regulator, Front View
 on the a-c. anode voltage wave, at which the KU-628 tubes will break down may be shifted, and the average current through the KU-628 tubes may be varied correspondingly.

- (15) Due to the application of three KU-628 tubes and two RJ-571 tubes the regulation will not be affected appreciably, if one KU-628 tube and one RJ-571 tube should fail.

INSTALLATION

- (16) Connect the regulator as shown in Figure 3 or 4 or according to special control diagram, making sure that the phase rotation of the a-c. supply voltage is 3-2-1 and the polarities of 6-7 and 7-8 are as shown in Figure 3 and 4. Connect lead 1 to the terminals of the filament transformer, so that the maximum supply voltage will never be more than 5 per cent higher than the terminal marking.
- (17) Place the tubes in their sockets, open the field switch and apply a-c. voltage. After one minute close the field switch. If an exciter is used, turn the anti-hunting potentiometer to the 100 position, then turn the potentiometer slowly towards zero until the regulated voltage becomes unstable, then turn potentiometer clockwise until stable regulation is obtained. If no exciter is used, the anti-hunting potentiometer is not connected and no adjustments are needed. With the regulator in operation, the generator voltage as read by the voltmeter inserted in the receptacles on front of the panel should be approximately 46 volts.
- (18) Test the various voltages by inserting the test plug in the receptacles on the test panel in the "OPERATION" position. The voltages should be within the specified limits. The test plug should be inserted so that the red spot on the test plug corresponds to the red receptacle. The KU-628 tubes should glow with a fairly steady glow. If the tubes are flickering excessively, the phase rotation of the a-c. supply may not be correct. Incorrect phase rotation will also be indicated by the

"GRID" voltage on the test panel which voltage will be higher than 30 volts and will show considerable variation. To reverse the phase rotation reverse leads 1 and 2 externally to the regulator.

- (19) Shut down the generator. Depress the test pushbutton on the front of the regulator Turn the test potentiometer from the zero position towards the 100 position until the "GRID" voltage on the test panel is 70 volts. By turning the test potentiometer 25 divisions further clockwise, the "GRID" voltage should reverse and should be at least 10 volts of opposite polarity. In order to read this voltage reverse the test plug. Test the RJ-571 voltage in the same manner. This voltage should decrease from at least 70 to 30 volts or less when the test potentiometer is turned 25 divisions clockwise from the position giving 70 volts. With the test potentiometer in position 50 and the pushbutton depressed, test the voltage of 25-5 and 5-24. These voltages should be between 110 and 140 volts and 120 and 150 volts, respectively. Check the battery voltage. This voltage should be between 42 volts and 47 volts.
- (20) With the test potentiometer in the zero position and the test pushbutton depressed there should be no glow in the KU-628 tubes. As the potentiometer is turned slowly clockwise the KU-628 tubes should start to glow when the potentiometer is within the range 40 to 65. By turning the potentiometer two divisions further clockwise there should be a gradual increase in the intensity of the glow discharge in the KU-628 tubes, and a corresponding gradual increase in the field current. If this gradual increase does not obtain, but if instead the field current is suddenly increased from minimum to maximum, the a-c. phase rotation may be reversed and the tests as outlined in paragraph 18 should be carefully repeated.

WEEKLY TESTS

Each week test as follows:

- (21) Operation Test - With the generator in operation, check all voltages of the "OPERATION" receptacles on the test panel. These voltages should be within the limits specified on the

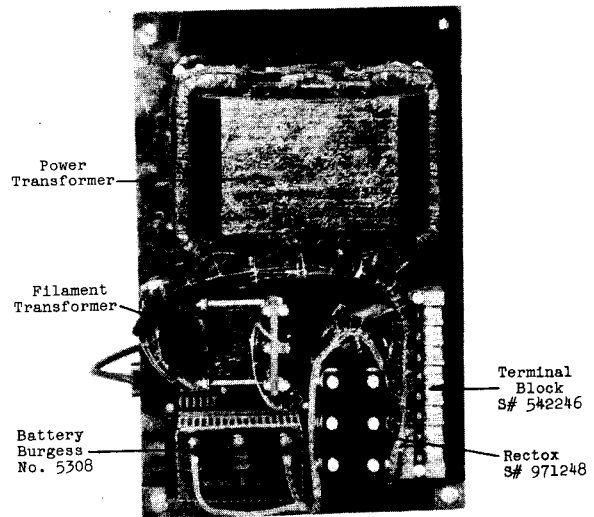


Fig. 6 - Type DT-5 Voltage Regulator, Rear View

Westinghouse Type DT-5 Voltage Regulator

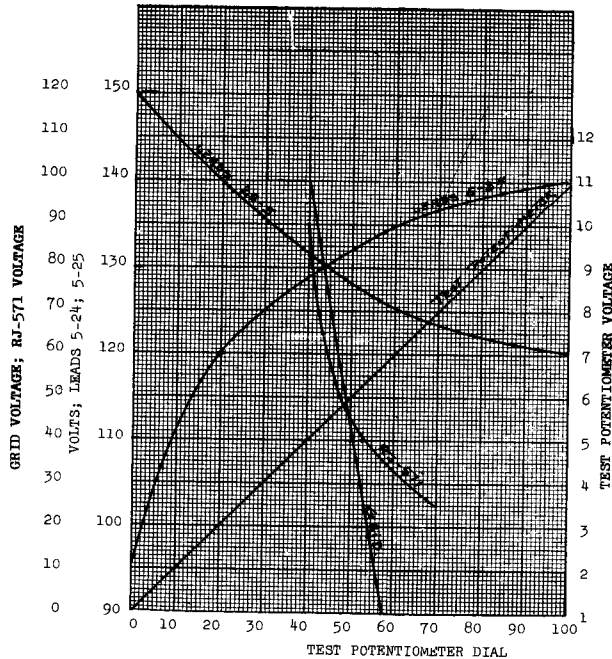


Fig. 7 - Average Test Curves for DT-5 Voltage Regulator

test panel. The generator voltage as read on the regulator voltmeter should be approximately 46 volts, providing the battery voltage is 45 volts.

(22) Tube Test - Shut down the machine and close the field switch.

(a) KU-628 Tube Test - Depress test pushbutton and turn the test potentiometer to the zero position. There should be no glow discharge in any of the KU-628 tubes, and the GRID voltage should be 40 volts or higher when the voltmeter plug is inserted in the GRID receptacle with the red dot up. If there is a glow discharge replace the KU-628 tube. Turn the test potentiometer clockwise until the KU-628 tubes start to glow. The GRID voltage should now be between zero and 30 volts. Turn the test potentiometer further clockwise until the field current is maximum, or full load value. All three KU-628 tubes should now glow. Replace any tube which does not glow.

(b) RJ-571 Tube Test - Place the voltmeter plug in the receptacle marked "GRID" with the red dot of the plug upwards. Adjust the test potentiometer clockwise from the zero position, while the test pushbutton is depressed, until the voltmeter reads 70 volts. By turning the test potentiometer 25 divisions further clockwise the grid voltage should change to 10 volts or more of opposite polarity. To read this voltage reverse the position of the voltmeter plug so that the red spot is down. Remove the left RJ-571 tube and repeat the above test. Replace the left RJ-571 tube in its socket. Remove the right

RJ-571 tube and repeat the above test. Replace the right RJ-571 tube in its socket. Replace any RJ-571 tube which does not give the voltages as specified in above tests.

(c) Plug the voltmeter plug in the receptacle marked RJ-571 with the red spot up. Depress the test pushbutton and adjust the test potentiometer to give 70 volts on the voltmeter. By adjusting the test potentiometer 25 divisions further clockwise the RJ-571 voltage should decrease to 35 volts or less.

(d) Rectox Voltage - With the test potentiometer in the 50 position and the test pushbutton depressed, check the voltage of 25-5 and 5-24. These voltages should be within limits as specified on the test panel.

(e) Battery Test - Replace the battery if the battery voltage is not within 42 volts and 47 volts.

(f) Complete Test - Depress test pushbutton and turn the test potentiometer until the field current is maximum or full load value. By turning the test potentiometer two divisions counter-clockwise from the observed position the field current should decrease to at least half the full load value.

SPARE TUBES

(23) It is recommended that the following spare tubes be kept in stock.

- 2 - KU-628 tubes
- 1 - RJ-571 tube

RENEWAL PARTS

<u>Name of Part</u>	<u>Style</u>
Power Transformer, 440 volts	920 770
Power Transformer, 220 volts	967 213
Filament Transformer, 440 volts	920 771
Filament Transformer, 220 volts	967 214
KU-628 Tube Socket	793 202
RJ-571 Tube Socket	831 729
Rectox Rectifier	971 248
Large Capacitor	829 365
KU-628 Grid-Glow Tube	KU-628
RJ-571 Amplifier Tube	RJ-571
Connector Cap for KU-628 Tube	829 334
Connector Cap for RJ-571 Tube	799 907
Resistor 0.5 megohm	860 878
Resistor 0.25 megohm	846 668
Resistor 1.0 megohm	860 003
Resistor 50,000 ohms (1" long)	860 004
Resistor 50,000 ohms (2" long)	846 669
Resistor 40,000 ohms	860 001
Resistor 25,000 ohms	860 875
Resistor 10,000 ohms	799 952
Resistor 20,000 ohms	943 633
Resistor 500 ohms	943 634
Terminal Block	542 246
Potentiometer, 20,000 ohms	846 696
Potentiometer Dial	869 654
Voltmeter Type BX, Projection Mounting, 0-150 volts, 150,000 ohms	
Burgess Battery No. 5308	
Pushbutton Switch (Yaxley No. 2006)	
Potentiometer, (Yaxley Type SIMP) 1000 ohms	
Capacitor, "Aerovox" Type 250, 0.1 MF	

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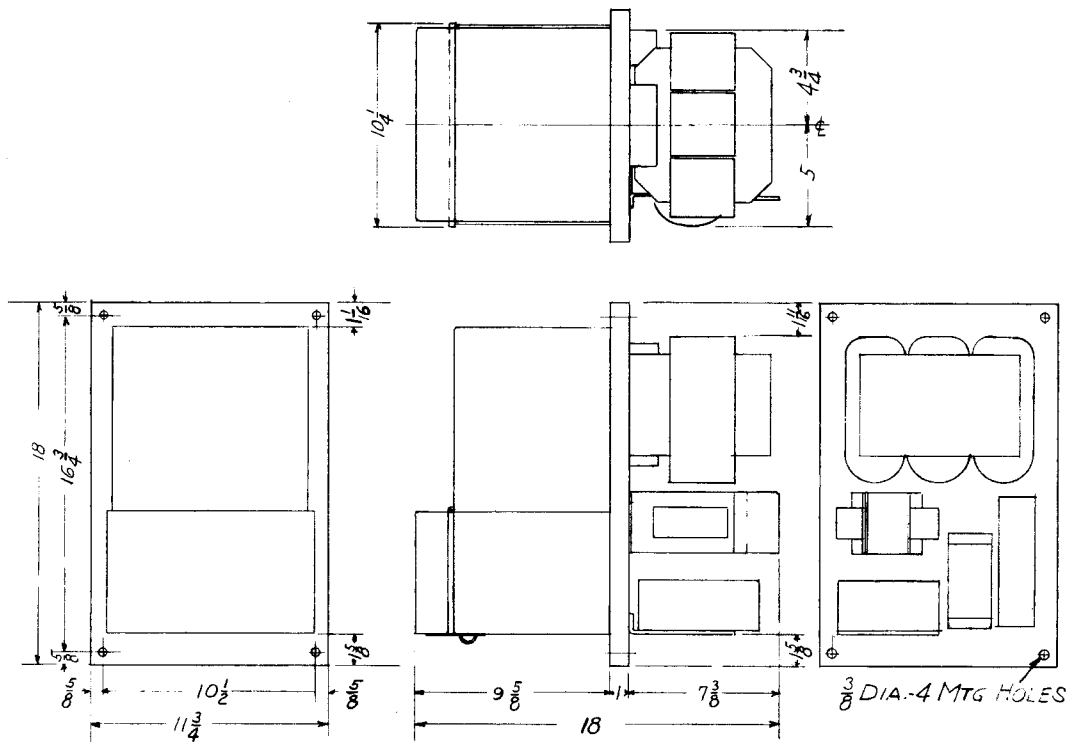


Fig. 8 - Outline Drawing for DT-5 Voltage Regulator
For 60-Cycle Operation

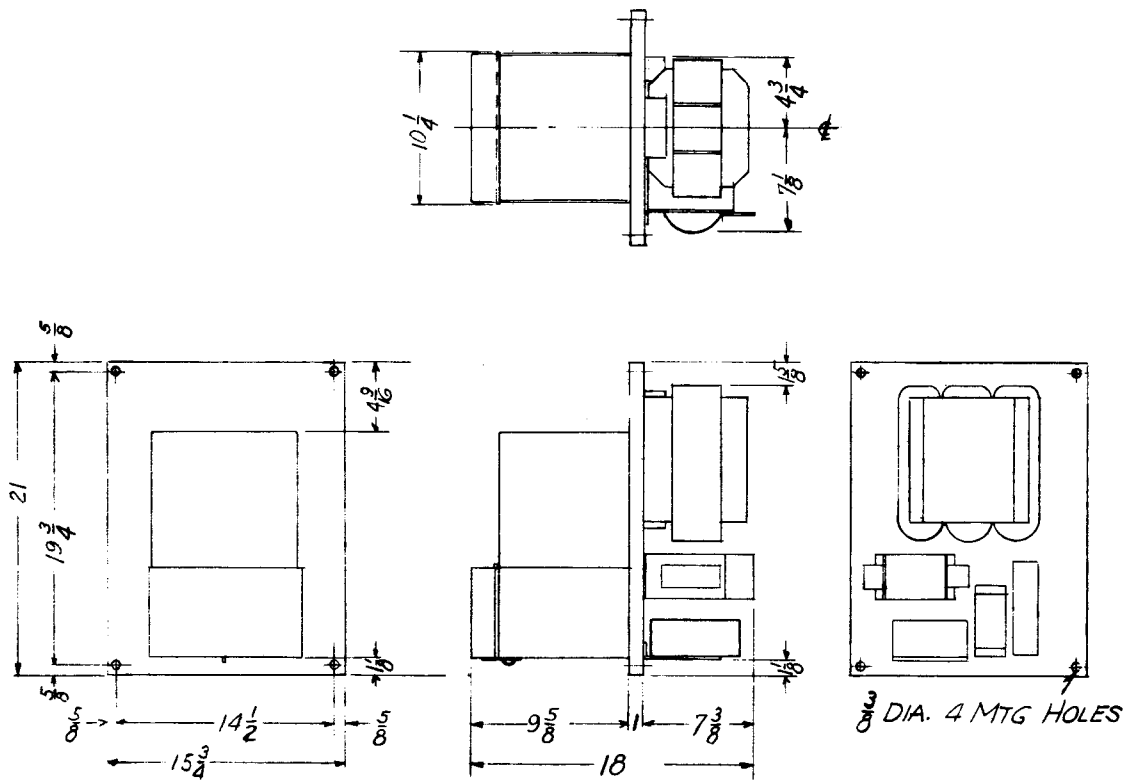


Fig. 9 - Outline Drawing for DT-5 Voltage Regulator
For 25-Cycle Operation

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- *ALLENTOWN, PA., 522 Maple St.
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- †APPLETON, WISC., 1029 So. Outagamie St.
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- †BALTIMORE, MD., 501 East Preston Road
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- *DALLAS, TEXAS, 1712 Carter St.
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- *DENVER, COLORADO, 1700 Sixteenth St.
- †DENVER, COLORADO, 2644 Walnut St.
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- xMANSFIELD, OHIO, 200 East Fifth St.
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- †*NEWARK, N. J., Haynes Ave. & Lincoln Highway
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- *NEW ORLEANS, LA., 527 Poydras St.
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- †NEW YORK, N. Y., 460 West Thirty-Fourth St.
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- *NORFOLK, VA., 254 Tazewell St.
- *OKLAHOMA CITY, OKLA., 10 E. California St.
- *OKLAHOMA CITY, OKLA., Third & Alice Sts.
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- *OMAHA, NEB., 117 N. 13th St.
- *PEORIA, ILL., 104 E. State St.
- †*PHILADELPHIA, PA., 3001 Walnut St.
- *PHOENIX, ARIZONA, 11 West Jefferson St.
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- *PITTSBURGH, PA., 435 Seventh Ave.
- x†PITTSBURGH, PA., 543 N. Lang Ave.
- *PITTSBURGH, PA., 3000 Liberty Ave.
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- *PORTLAND, OREGON, 309 S. W. Sixth Ave.
- †PORTLAND, OREGON, 2138 N. Interstate Ave.
- †PORTLAND, OREGON, 720 N. Thompson St.
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- *RALEIGH, N. C., 803 North Person St.
- ‡RALEIGH, N. C., 322 S. Harrington St.
- ‡READING, PA., 619 Spruce St.
- *RICHMOND, VA., Fifth & Byrd
- ①*ROANOKE, VA., 726 First St., S. E.
- *ROCHESTER, N. Y., 410 Atlantic Ave.
- *ROCKFORD, ILL., 130 South Second St.
- ①*SACRAMENTO, CALIF., 20th and "R" Sts.
- *SALT LAKE CITY, UTAH, 10 West First South St.
- †*SALT LAKE CITY, UTAH, 346 A Pierpont Ave.
- ‡SALT LAKE CITY, UTAH, 235 W. S. Temple
- *SAN ANTONIO, TEXAS, 212 East Houston St.
- *SAN FRANCISCO, CALIF., 1 Montgomery St.
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- †*SEATTLE, WASH., 3451 East Marginal Way
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- ‡SOUTH BEND, IND., 107 E. Jefferson St.
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- *SOUTH PHILA. WKS., P. O. Box 7348, Philadelphia, Pa.
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- *SPRINGFIELD, ILL., 130 So. Sixth St.
- †SPRINGFIELD, MASS., 395 Liberty St.
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- *WICHITA, KAN., 400 South Emporia St.
- †WILKES-BARRE, PA., 267 N. Pennsylvania Ave.
- *WORCESTER, MASS., 32 Southbridge St.
- *YORK, PA., 143 So. George St.
- *YOUNGSTOWN, OHIO, 25 E. Boardman St.

*Sales Office †Service Office xWorks #Warehouse ‡First Class Mail Only ‡Merchandising Only ‡Headquarters.

WESTINGHOUSE ELECTRIC SUPPLY COMPANY AND AGENT JOBBERS

Fully equipped sales offices and warehouses are maintained at all locations

- ABILENE, KAN., Union Electric Co.
- AKRON, OHIO, The Mook Electric Sup. Co.
- ALBANY, N. Y., 360 Broadway
- ALLENTOWN, PA., 522 Maple St.
- ATLANTA, GA., 96 Poplar St., N. W.
- AUGUSTA, MAINE, 90 Water St.
- BALTIMORE, MD., 40 South Calvert St.
- BANGOR, MAINE, 175 Broad St.
- BINGHAMTON, N. Y., 48 Wall St.
- BIRMINGHAM, ALA., Moore-Handley Hdw. Co.
- BLUEFIELD, W. VA., Superior-Sterling Co.
- BOSTON, MASS., 76 Pearl St.
- BUFFALO, N. Y., McCarthy Bros. & Ford
- BURLINGTON, VT., 208 Flynn Ave.
- BUTTE, MONTANA, 50 East Broadway
- CANTON, OHIO, The Mook Electric Sup. Co.
- CHARLOTTE, N. C., 210 East Sixth St.
- CHATTANOOGA, TENN., Mills & Lupton Sup. Co.
- CHICAGO, ILL., 113 North May St.
- CHICAGO, ILL., Hyland Electrical Sup. Co.
- CINCINNATI, OHIO, The Johnson Electric Sup. Co.
- CLEVELAND, OHIO, 3950 Prospect Ave.
- COLUMBIA, S. C., 912 Lady St.
- COLUMBUS, OHIO, The Hughes Peters Elec. Corp.
- COLUMBUS, OHIO, Pixley Electric Sup. Co.
- DALLAS, TEXAS, 409 Browder St.
- DENVER, COL., The Mine & Smelter Sup. Co.
- DES MOINES, IOWA, 218 Second St.
- DETROIT, MICH., 547 Harper Ave.
- DULUTH, MINN., 308 W. Michigan St.
- EL PASO, TEX., Zork Hardware Co.
- ERIE, PA., Star Electrical Co.
- EVANSVILLE, IND., 201-203 N. W. First St.
- FLINT, MICH., 1314 N. Saginaw St.
- FORT WORTH, TEXAS, 501 Jones St.
- GRAND RAPIDS, MICH., 507 Monroe Ave., N. W.
- GREENVILLE, S. C., 200 River St.
- HOUSTON, TEXAS, 1903 Ruiz St.
- HUNTINGTON, W. VA., Banks-Miller Sup. Co.
- INDIANAPOLIS, IND., 539 Madison Ave.
- JACKSONVILLE, FLA., 37 South Hogan St.
- KANSAS CITY, MO., Columbian Electrical Co.
- LOS ANGELES, CALIF., 905 East Second St.
- LOUISVILLE, KY., Tafel Electric Co.
- MADISON, WISC., 1022 E. Washington Ave.
- MIAMI, FLA., 1036 North Miami Ave.
- MEMPHIS, TENN., 366 Madison Ave.
- MILWAUKEE, WISC., 546 N. Broadway
- MINNEAPOLIS, MINN., 215 South Fourth St.
- MONROE, LA., Monroe Hardware Co.
- NASHVILLE, TENN., Tafel Electric Co.
- NEWARK, N. J., 152 Mulberry St.
- NEW HAVEN, CONN., 240 Cedar St.
- NEW ORLEANS, LA., Electrical Sup. Co.
- NEW YORK, N. Y., 150 Varick St.
- NEW YORK, N. Y., Times Appliance Co., Inc.
- NORFOLK, VA., 254 Tazewell St.
- OAKLAND, CALIF., Tenth & Alice Sts.
- OKLAHOMA CITY, OKLA., 10 E. California St.
- OMAHA, NEB., 117 North Thirteenth St.
- PEORIA, ILL., 104 East State St.
- PHILADELPHIA, PA., 1101 Race St.
- PHOENIX, ARIZONA, 315 West Jackson St.
- PITTSBURGH, PA., Iron City Electric Co.
- PORTLAND, OREGON, 134 N. W. Eighth Ave.
- PROVIDENCE, R. I., 66 Ship St.
- RALEIGH, N. C., 322 S. Harrington St.
- READING, PA., 619 Spruce St.
- RICHMOND, VA., 301 South Fifth St.
- ①ROANOKE, VA., 726 First St., S. E.
- *ROCHESTER, N. Y., 240 St. Paul St.
- ST. LOUIS, MO., 320 S. Broadway
- ST. PAUL, MINN., 145 East Fifth St.
- ①SACRAMENTO, CALIF., 20th and "R" Sts.
- SALT LAKE CITY, UTAH, 235 West South Temple St.
- SAN ANTONIO, TEXAS, 1201 E. Houston St.
- SAN DIEGO, CALIF., The Electric Supplies Dist. Co.
- SAN FRANCISCO, CALIF., 260 Fifth St.
- SCRANTON, PA., Penna. Elect'l Engineering Co.
- SEATTLE, WASH., 558 First Ave., South
- SIOUX CITY, IOWA, 1005 Dace St.
- SPOKANE, WASH., 152 So. Monroe St.
- SPRINGFIELD, MASS., 46 Hampden St.
- SYRACUSE, N. Y., 961 W. Genesee St.
- TAMPA, FLA., 417 Ellamae St.
- TOLEDO, OHIO, 812 Lafayette St.
- TRENTON, N. J., 245 N. Broad St.
- TULSA, OKLA., 303 East Brady St.
- UTICA, N. Y., 113 N. Genesee St.
- WASHINGTON, D. C., 1216 "K" St., N. W.
- WATERLOO, IOWA, 328 Jefferson St.
- WICHITA, KANSAS, 400 S. Emporia Ave.
- WILMINGTON, DEL., 216 E. Second St.
- WORCESTER, MASS., 24 Southbridge St.
- YORK, PA., 143 S. George St.
- YOUNGSTOWN, OHIO, Mook Elec. Sup. Co.

① Changed or added since previous issue.

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