OPERATING INSTRUCTIONS

TYPE 1205-B

ADJUSTABLE REGULATED POWER SUPPLY

Form 3003-A
March, 1959

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS, USA

Figure 1. Type 1205-B Adjustable Regulated Power Supply.

SPECIFICATIONS

DC Output Voltage:	0-300 v, continuously adjustable at 200 ma max.
Regulation:	No load to full load, 0.1 v max; max 0.75-v change for ±10% change in line voltage.
120-cps Ripple:	1 mv max.
Internal Impedance:	Approximately 0.3 ohm + 2 μh shunted by 4 μf.
Regulated Bias Voltage:	-150 v dc, 5 ma max.
Regulation:	No load to full load, 0.5 v; 2-v change for +10% change in line voltage.
Unregulated AC Voltage:	2 circuits, each 6.3 v, 5 a.
Meter Accuracy:	Voltage, 2%; current, 5%.
Input:	105-125 v, 60 cps. 250 watts, full load.
Dimensions:	Width 9-1/2 in., height 5-1/4 in., depth behind panel, 8-1/8 in.
Weight:	15 lb.

General Radio **EXPERIMENTER** reference: **Vol 33 No. 3, March 1959**

TYPE 1205-B
ADJUSTABLE REGULATED
POWER SUPPLY

1 INTRODUCTION

1.1 PURPOSE. The Type 1205-B Adjustable Regulated Power Supply (Figure 1) is a compact, high-efficiency, fast-response source of regulated power from 0 to 300 volts, up to 200 ma. The Type 1205-B also includes two 5-amp 6.3-volt supplies and a regulated -150-volt 5-ma bias supply.

1.2 DESCRIPTION.

1.2.1 CONTROLS. Three controls are mounted on the front panel: A POWER toggle switch with a standby (B + OFF) position, a METER toggle switch to select either a voltage or a current meter indication, and an OUTPUT VOLTAGE control, by which the output voltage may be varied from 0 to full voltage.

1.2.2 CONNECTORS. The front-panel output connectors are all jack-top binding posts. The three on the right-hand end are, from top to bottom, the B+, B- (or bias +), and bias (-) connectors. A binding post adjacent to the B+ and B- posts permits grounding either B+ or B-. Two pairs of binding posts, labeled 6.3 v, are the terminals for the two ac heater supplies. These terminals may be connected for either series or parallel operation (refer to paragraph 3.2).

The line-voltage cable is attached to the power supply at the left side of the instrument.

Unit Instruments being powered by the Type 1205-B may be plugged directly into the multipoint connector at the right-hand side of the power supply. Connections are shown in Figure 7.

2 PRINCIPLES OF OPERATION

2.1 GENERAL. (See Figure 2). The Type 1205-B consists basically of two parts: a series-tube regulator, and a thyratron control rectifier. The series regulator provides fast response, low-drift, and low output impedance over a wide frequency range. The usual high dissipation of such a circuit is averted by use of a thyratron control rectifier, which maintains a constant voltage drop across the series regulator.

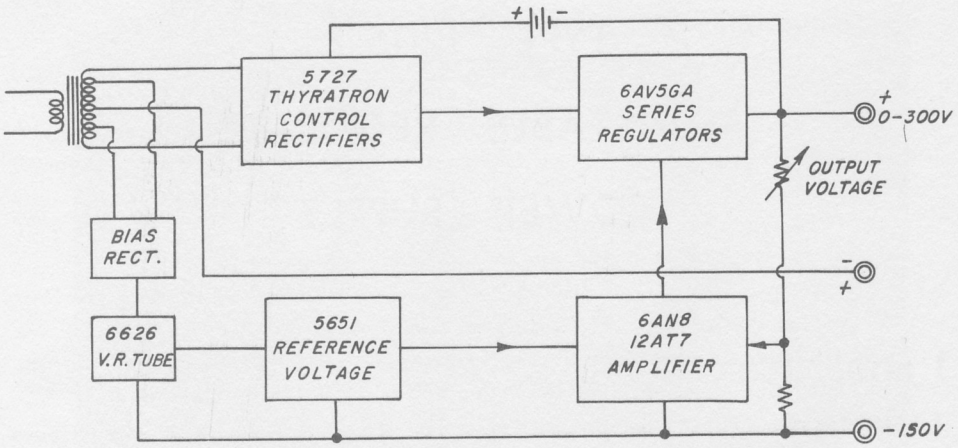

Figure 2. Block Diagram of Power Supply.

2.2 CIRCUIT DESCRIPTIONS. (See Figure 7.)

2.2.1 THYRATRON CONTROL RECTIFIER (V2, V3). A center-tapped high-voltage winding (terminals 5, 7, 9) provides plate voltage for the full-wave thyratron rectifier (V2, V3).

Control is obtained by a variation of the thyratron bias through a dc feedback path from the regulated output to the thyratron grids. Superimposed on this dc feedback is an ac bias voltage phase-shifted 90 degrees from the thyratron plate voltage for smooth control of the thyratron firing angle. A voltage source (RX5, C1) in the feedback path determines the voltage drop across the series regulator. The peak current in each thyratron is limited by a section of inductor L1.

The filtered output (C8, C9) of each half-wave rectifier supplies the series regulator circuit.

2.2.2 SERIES REGULATOR CIRCUIT (V4, V5, V6, V7, V8, V9). Power from the thyratron rectifiers is applied to the plates of the series regulator tubes (V4, V5). The two half-wave voltages are combined to provide 120-cps ripple at the screens of these tubes. The output from V4 and V5 is applied to the output binding posts and to a voltage divider (R51, R45, R57, R46, R59, R48).

A fraction of the output voltage (determined by the setting of the OUTPUT VOLTAGE control, R45) is applied to one grid (pin 7, V7) of the differential cascode amplifier (V7 and pentode section of V6). A reference voltage from V8 and V9 is applied to the other grid (pin 2, V7), and the voltages at the two grids are compared to produce a difference voltage. The amplified difference voltage (at pin 6 of V6) is applied through a cathode follower (triode section of V6) to

the grids of the series regulator tubes, V4 and V5, to maintain constant output voltage. The output of the power supply is thus controlled by a negative feedback loop.

Part of the output from the cathode follower (pin 3, V6) is connected back to the reference grid (pin 2, V7) of the differential amplifier, providing positive feedback within the negative feedback loop. The amount of positive feedback is selected to achieve essentially infinite gain in the amplifier, and thus to provide approximately zero output impedance.

2.2.3 NEGATIVE VOLTAGE SUPPLY. Selenium rectifiers, connected to taps on the high-voltage secondary of the power transformer, provide negative voltage, which is filtered and regulated at -150 volts by V8. This supply powers the differential amplifier and the reference tube V9, and affords a negative bias supply at the front panel.

2.2.4 PROTECTIVE CIRCUITS. To keep the thyratrons from conducting until their cathodes have warmed up, the thyratron grids are returned to the -220-volt supply through a 120-volt source (RX5, C1), keeping the grids at about -100 volts until the cathode follower section of V1 conducts. The delay time is controlled by a resistor (R4) in the heater of V1. When the cathode follower conducts, the thyratron grids are connected to the regulated output voltage through the 120-volt source, and the thyratrons conduct.

If a failure in the amplifier caused loss of bias on the series regulator tubes, the output voltage would rise. Since any increase in output voltage is fed back to the controlled rectifier, the output would continue to rise to maximum, about 400 volts. To prevent such runaway action, an auxiliary regulator circuit controls output from the thyratrons in case of failure in the series regulator circuit. When the output voltage rises beyond the level set by the OUTPUT VOLTAGE control, the voltage rise at R57 is applied to the amplifier section of V1. This section, normally off, then conducts, controlling the firing angle of the thyratrons and thus the output voltage.

A third fail-safe feature is the use of series filaments in the two sections of V1. Thus, if the heater of the protective amplifier fails, the heater of the cathode follower section will be cut off, reducing output voltage to zero.

Any abnormal temperature rise in the power supply causes a thermal breaker (F3) to open, removing all power. The breaker automatically resets after a few minutes.

3 OPERATING PROCEDURE

3.1 MOUNTING. The Type 1205-B may be either bench mounted or mounted in a relay rack by means of a Type 480-PU3 Adaptor Panel. Make sure that proper ventilation exists, especially at the fan air intake at the rear.

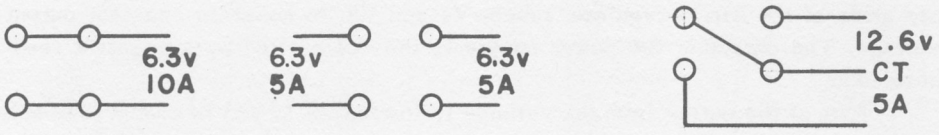

Figure 3. 6.3- and 12.6-Volt Connections.

3.2 OPERATION. To operate the Type 1205-B, simply plug the line connector into a 115-volt, 60-cps source, connect the device to be powered to the appropriate terminals for the voltages desired, and flip the POWER switch to ON.

A standby (B+ OFF) position of the POWER switch allows the user to remove B+ without turning off heater or bias voltages.

The heater terminals may be interconnected for either 6.3-v or 12.6-v operation, as shown in Figure 3.

4 SERVICE AND MAINTENANCE.

4.1 GENERAL. This service information should enable the user to locate and correct ordinary difficulties resulting from normal use. Major service problems should be referred to our Service Department, which will cooperate as much as possible by furnishing information and instructions as well as by supplying any replacement parts needed.

When notifying our Service Department of any difficulties in operation or service, specify the serial and type numbers of the instrument. Also give a complete report of trouble encountered and steps taken to eliminate the trouble.

Before returning an instrument or parts for repair, please write to our Service Department, requesting a Returned Material Tag, which includes shipping instructions. Use of this tag will insure proper handling and identification. A purchase order covering material returned for repair should also be forwarded to avoid unnecessary delay.

4.2 REMOVAL OF COVER AND ETCHED BOARD. To remove the cover of the Power Supply, loosen the two fluted screws at the left-hand side of the instrument, pivot the L-shaped cover clamp (held by the upper screw) out of the way, and pull the dust cover away from the panel.

If it becomes necessary to move the etched board to the servicing position, first remove the two screws that hold the etched board at the top of the instrument. (One of these is the upper fluted screw already loosened; the other is on the right side of the instrument, the larger screw in the upper right-hand corner.) Do not remove the two screws that hold the board at the bottom of the instrument. Remove the four screws that attach the transformer to the front panel. The etched board may now be pivoted away from the panel to the servicing posi-

tion. The instrument is still operable in this position, as all the cables remain connected. Be careful when handling the instrument not to let the etched board swing freely, as it may be damaged.

When returning the etched board to its normal position, center it between the grooves inside the cabinet so that the dust cover can slide in with proper clearance. After putting the dust cover on, clamp it securely by means of the cover clamp, and tighten the fluted screws to finger tightness.

4.3 TROUBLE-SHOOTING PROCEDURE.

4.3.1 INCORRECT VOLTAGE AT -150-VOLT BIAS SUPPLY. If the bias voltage is high, replace V8 (Type 6626). If the bias voltage is low, check the voltages across C14 and C15. If the voltage across C14 is normal but that across C15 is low, check for a short in capacitor C15 or along the -150-volt bias bus. Check for an open R27. If voltages across C14 and C15 are both low, check for a shorted C14 or open R26 or defective rectifiers RX1, RX2, RX3, or RX4. Use the schematic diagram (Figure 7) to determine normal operating voltages.

4.3.2 0-300-VOLT SUPPLY INOPERATIVE. If the output voltage is zero and does not change when the OUTPUT VOLTAGE control is rotated, check that S1 is in the ON position rather than at B+ OFF (Standby). If the fan is not operating, check fuses F1 and F2, located on the etched circuit board. If the fuses are good, check thermal breaker F3. If this has overheated, it will reset in a few minutes.

Check the protective circuit V1 (6BZ7). Voltage at the cathode (pin 8) of V1 should be slightly positive with respect to the grid (pin 7). If this voltage is not positive, and if at least 100 volts (with respect to B-) is present at the plate (pin 6), replace V1. Heater voltage between pins 4 and 5 should be 3.8 volts ac.

Check for approximately 120 volts across C1. The voltage at pin 1 of V1 should be at least +100 volts with respect to B+ (regulated output).

Check the cascode differential amplifier. A failure in the triode section of V6 (6AN8) can completely cut off the series tubes V4 and V5 (6AV5GA). Replace V6 if the voltage at the cathode pin (pin 3) of V6 is negative with respect to B-.

Measure the voltages from C8 and from C9 to B-. If these are less than +100 volts, check thyratrons V2 and V3, and check C8 and C9 for an open or short circuit.

Check the series regulator tubes, V4 and V5. Check that the resistance from the cathode (pin 3) of V4 or V5 to the positive output terminal is approximately 82 ohms.

4.3.3 0-300-VOLT SUPPLY ADJUSTABLE BUT WITH EXCESSIVE RIPPLE AND POOR REGULATION. A failure in the pentode section of V6 (12AT7) or in one half (pins 6, 7, and 8) of V7 (12AT7) would permit no current to flow through the cascode amplifier plate resistor R40, and therefore would bring the series tubes V4 and V5 to zero bias. This would cause the output voltage to be

20 to 40 volts higher than normal, with excessive ripple and poor regulation. The voltage at anchor terminal 40 (junction of R46, R57, and R58; see Figure 5) would vary from 0 to -17 volts as the OUTPUT VOLTAGE setting is changed, instead of the constant-25 volts normally measured at this point. This rise in voltage at anchor terminal 40 will cause the amplifier section of the protective circuit V1 (6BZ7) to conduct, limiting the rise in output voltage as explained in paragraph 2.2.4. This kind of failure is readily detected from the excessive ripple that exists when the supply is even lightly loaded and from the improper operating voltages at anchor terminal 40. Measurement of the voltages at V7 and at the pentode section of V6 should locate the source of the trouble.

A failure in the reference voltage amplifier half (pins 1, 2, and 3) of V7 will cause the voltage at anchor terminal 40 to vary from -25 to -65 volts as the OUTPUT VOLTAGE setting is changed, and the output voltage from the 0-300-volt supply will not go above 100 volts.

4.3.4 0-300-VOLT SUPPLY OPERATES CORRECTLY FOR SMALL LOADS BUT CANNOT SUPPLY FULL LOAD OR DOES SO ONLY WITH EXCESSIVE RIPPLE. If the ripple is mostly at 60 cycles, one of the series regulator tubes, V4 or V5, may have low emission or may be inoperative. Also check thyratrons V2 and V3. Prolonged operation with an inoperative series regulator tube or thyratron at load currents above 100 ma will usually shorten the life or degrade the performance of one of the thyratrons.

Check that the voltage across C1 is 133 volts. Measure the voltage at pin 1 of V1. This should be at least +110 volts with respect to B+ (regulated output).

4.4 ZERO-SET ADJUSTMENT. If the output voltage is not zero when the OUTPUT VOLTAGE control is set at minimum (fully counterclockwise), open the instrument and set the voltage to zero with the screw-driver adjustment R59 (see Figure 4). Note that, because of the presence of diode RX6, the output voltage cannot be set to more than a few tenths of a volt negative; therefore, the correct setting of R59 is that at which the voltage just reaches zero from a positive value.

5.5 LUBRICATION. The fan motor should be lubricated with light machine oil (SAE 20 to SAE 30) every two to six months of operation. There is an oil port in the shaft of the motor for this purpose.

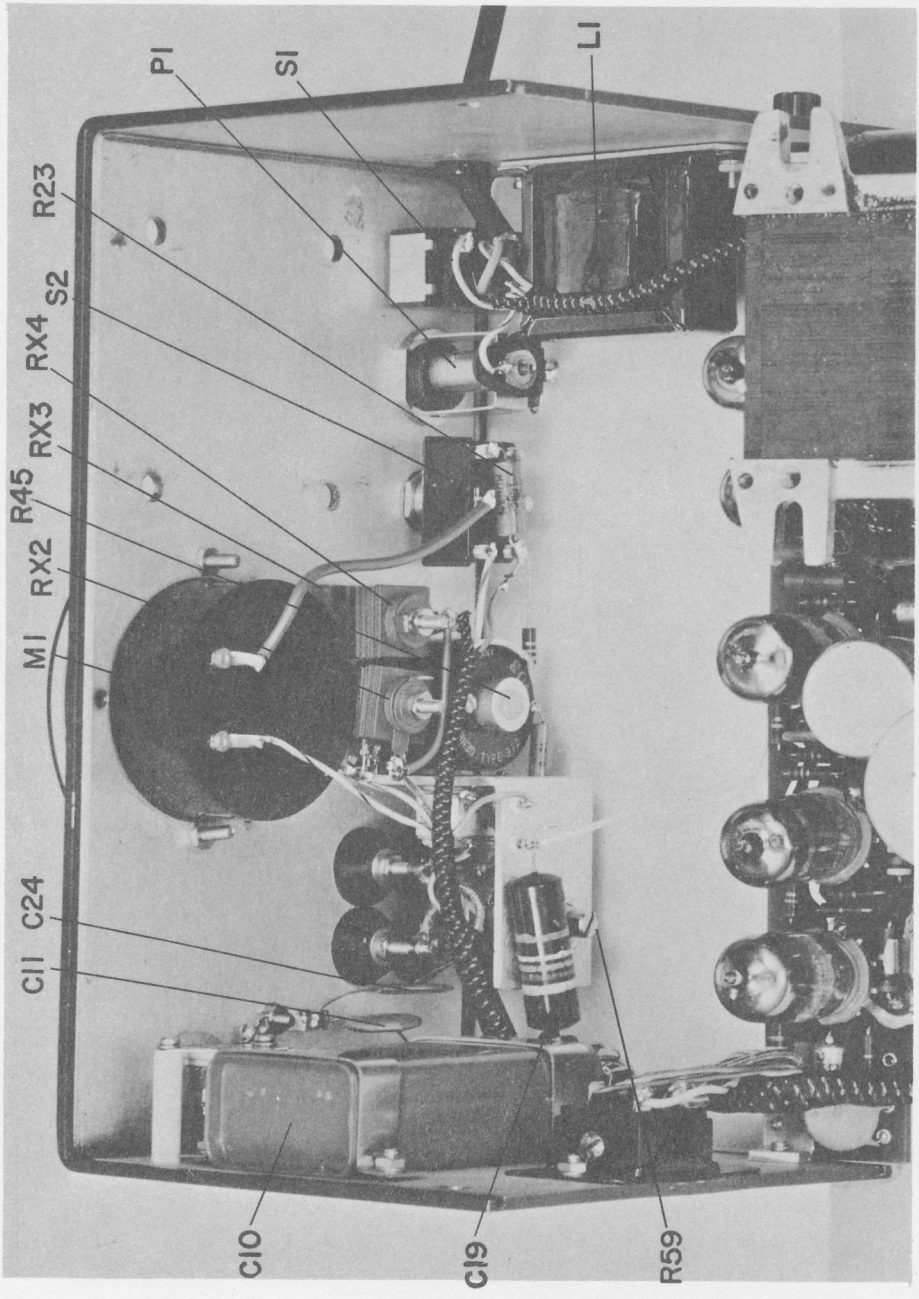

Figure 4. Top Interior View with Etched Board in Servicing Position.

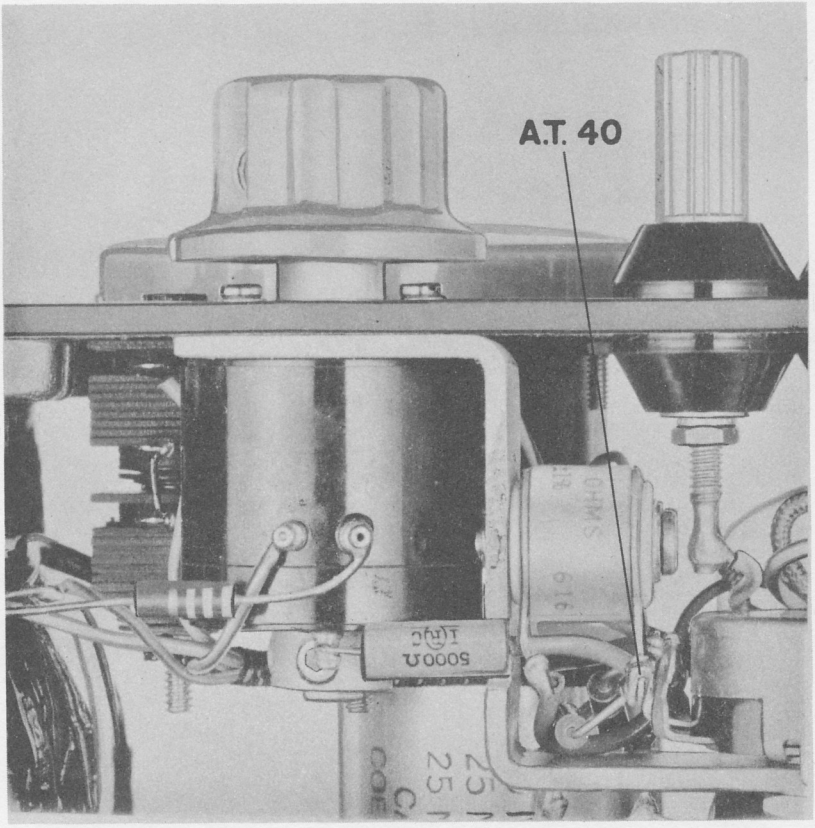

Figure 5. Partial Bottom Interior View Showing Location of Anchor Terminal 40.

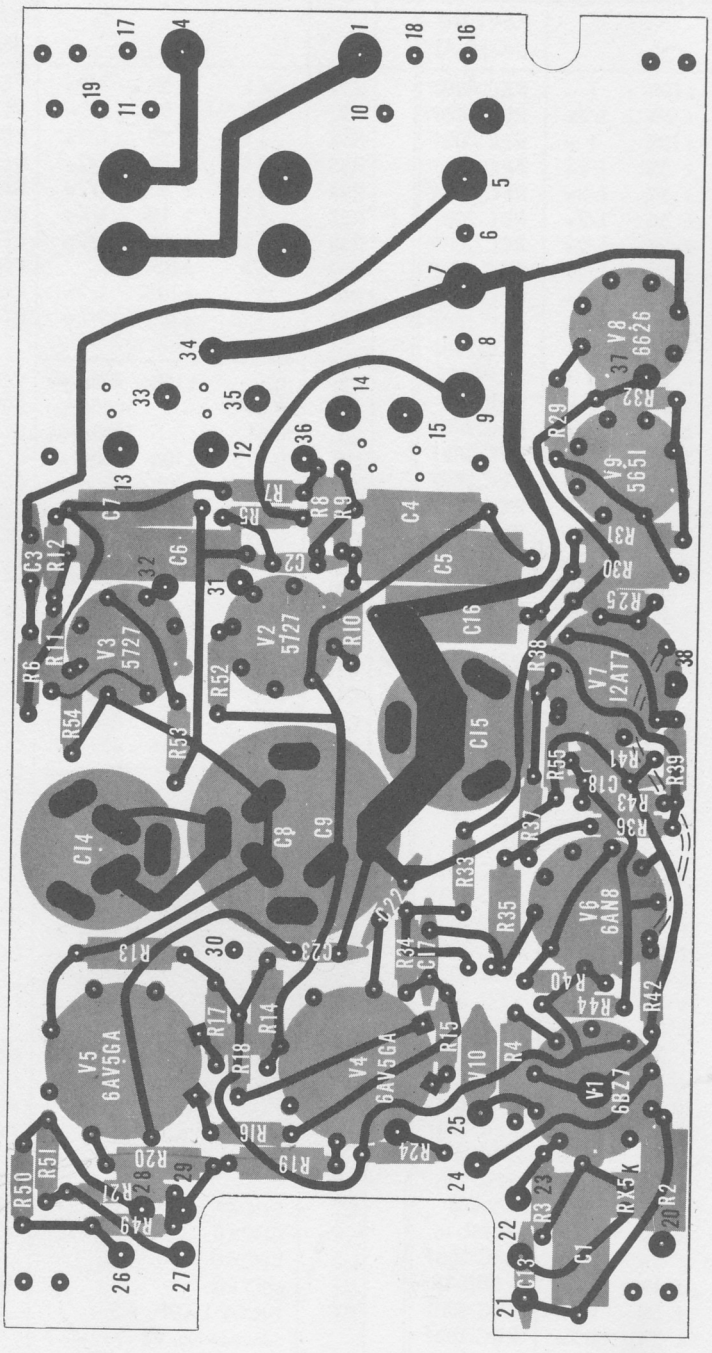

Figure 6. Etched Board Layout Diagram.

PARTS LIST

RESISTORS (NOTE B)

				PART NO. (NOTE A)
R2	560 k	±10%	1 w	REC-30BF
R3	1 M	± 5%	1/2w	REC-20BF
R4	6.8	±10%	1 w	REC-30BF
R5	4.7 M	± 5%	1/2w	REC-20BF
R6	4.7 M	± 5%	1/2w	REC-20BF
R7	2.7 M	± 5%	1/2w	REC-20BF
R8	2.7 M	± 5%	1/2w	REC-20BF
R9	470 k	± 5%	1/2w	REC-20BF
R10	1 M	± 5%	1/2w	REC-20BF
R11	1 M	± 5%	1/2w	REC-20BF
R12	470 k	± 5%	1/2w	REC-20BF
R13	1 k	± 5%	3 w	REPO-45
R14	1 k	± 5%	3 w	REPO-45
R15	1 k	± 5%	1/2w	REC-20BF
R16	1 k	± 5%	1/2w	REC-20BF
R17	100	± 5%	1/2w	REC-20BF
R18	100	± 5%	1/2w	REC-20BF
R19	82	± 5%	3 w	REPO-45
R20	82	± 5%	3 w	REPO-45
R21	0.555	± 1%		ZREPR-3
R22	25 k	± 5%	10 w	REPO-44
R23	400 k	± 1%	1/2w	REF-70
R24	10 M	± 5%	1/2w	REC-20BF
R25	10 M	± 5%	1/2w	REC-20BF
R26	100	± 5%	5 w	REPO-43
R27	1.8 k	± 5%	10 w	REPO-44
R28	1.8 k	± 5%	10 w	REPO-44
R29	30 k	± 5%	1/2w	REC-20BF
R30	600 k	± 1%	1/4w	REF-65
R31	270 k	± 1%	1/4w	REF-65
R32	4.7 k	± 5%	1/2w	REC-20BF
R33	1 M	± 5%	1/2w	REC-20BF
R34	100 k	± 5%	1/2w	REC-20BF
R35	470 k	± 5%	1 w	REC-30BF
R36	18 k	± 5%	1/2w	REC-20BF
R37	8.2 M	± 5%	1/2w	REC-20BF
R38	1 k	± 5%	1/2w	REC-20BF
R39	10 k	± 5%	1/2w	REC-20BF
R40	2.7 M	± 5%	1/2w	REC-20BF
R41	20 k	± 5%	1/2w	REC-20BF
R42	15 k	± 5%	1/2w	REC-20BF
R43	56 k	± 5%	1/2w	REC-20BF
R44	1.8 M	± 5%	1/2w	REC-20BF
R45	68 k	± 2%		972-403
R46	15 k	± 1%	1/3w	REPR-16
R47	220 k	± 5%	1/2w	REC-20BF
R48	7 k	± 1%	1/3w	REPR-16
R49	10	± 5%	1/2w	REC-20BF
R50	1.8 k	± 5%	1/2w	REC-20BF
R51	100	± 5%	1/2w	REC-20BF
R52	24 k	± 5%	1/2w	REC-20BF
R53	24 k	± 5%	1/2w	REC-20BF
R54	1 M	± 5%	1/2w	REC-20BF
R55	15 k	± 5%	1/2w	REC-20BF
R56	33 k	± 5%	1/2w	REC-20BF
R57	5 k	± 1%	1/4w	REF-65
R58	1 M	± 5%	1/2w	REC-20BF
R59	5 k	±10%		POSW-3
R60	15	±10%	1/2w	REW-3C
R61	1 M	±10%	1/2w	REC-20BF

CAPACITORS (NOTE C)

				PART NO. (NOTE A)
C1	0.1	±10%	200dcwv	COW-16
C2	0.01		1000dcwv	COC-63
C3	0.01		1000dcwv	COC-63
C4	0.022	±10%	200dcwv	COW-16
C5	0.0022	±10%	600dcwv	COL-71
C6	0.0022	±10%	600dcwv	COL-71
C7	0.022	±10%	200dcwv	COW-16
C8	50		450dcwv	COE-10
C9	50			
C10	3	±10%	600dcwv	COL-7
C11	0.01		1000dcwv	COC-63
C13	0.01		1000dcwv	COC-63
C14	30		350dcwv	COE-53
C15	30		350dcwv	COE-53
C16	0.047	±10%	400dcwv	COW-25
C17	0.01		1000dcwv	COC-63
C18	0.01		1000dcwv	COC-63
C19	0.047	±10%	600dcwv	COL-71
C20	0.22	±10%	200dcwv	COW-16
C21	0.01		1000dcwv	COC-63
C22	0.01		1000dcwv	COC-63
C23	0.01		1000dcwv	COC-63
C24	0.01		1000dcwv	COC-63
C25	470 $\mu\mu$f		1000dcwv	COC-61
C26	470 $\mu\mu$f		1000dcwv	COC-61

		PART NO. (NOTE A)
BL1	FAN MOTOR	MOD-23-2
F1	FUSE, 2.5 amp Slo-Blo	FUF-1
F2	FUSE, 2.5 amp Slo-Blo	FUF-1
F3	CIRCUIT BREAKER, Thermal	FUC-14
L1	CHOKE	745-418
L2	CHOKE	CHA-53
L3	CHOKE	CHA-53
M1	METER	MEDS-98
P1	PILOT LAMP, 6.3 v Mazda No. 44	2LAP-939

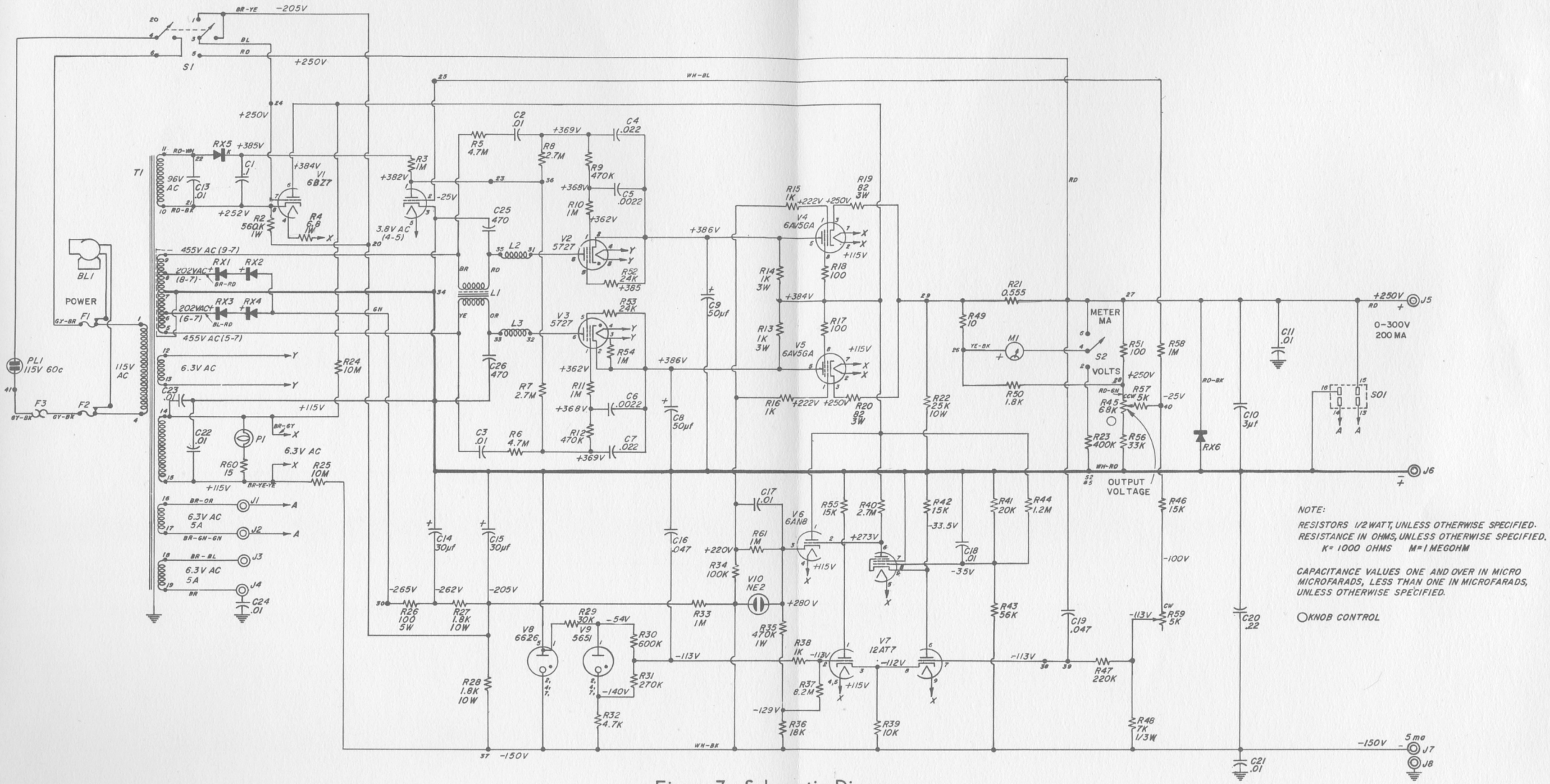

Figure 7. Schematic Diagram.

PARTS LIST (CONT)

		PART NO. (NOTE A)
RX1	RECTIFIER	2RE-31
RX2	RECTIFIER	2RE-31
RX3	RECTIFIER	2RE-31
RX4	RECTIFIER	2RE-31
RX5	RECTIFIER	2RE-40
RX6	RECTIFIER	1N1695
S1	SWITCH, Power	SWT-13NP
S2	SWITCH, Meter	SWT-335NP
T1	TRANSFORMER	365-485

NOTES:

(A) Type designations for resistors and capacitors are as follows:

COC - Capacitor, ceramic
COE - Capacitor, electrolytic
COL - Capacitor, oil
COW - Capacitor, wax
POSW - Potentiometer, wire-wound
REC - Resistor, composition
REF - Resistor, film
REPO - Resistor, power
REPR - Resistor, precision
REW - Resistor, wire-wound

(B) All resistances are in ohms, except as otherwise noted by k (kilohms) or M (megohms).

(C) All capacitances are in microfarads, except as otherwise noted by $\mu\mu$f (micromicrofarads).

TUBES

V1	6BZ7	V6	6AN8
V2	5727	V7	12AT7
V3	5727	V8	6626
V4	6AV5GA	V9	5651
V5	6AV5GA	V10	NE2