

## CONTENTS

<u>Section</u>	<u>Page</u>
SPECIFICATIONS -----	11
1. GENERAL DESCRIPTION-----	1
2. OPERATION-----	3
3. CIRCUIT DESCRIPTION-----	4
4. MAINTENANCE-----	6
5. REPLACEABLE PARTS-----	7
SCHEMATIC-----	15

*Master*

**SPECIFICATIONS****OUTPUT:**

**Voltage:** 0 to 1000 volts dc in 0.01-volt steps.

**Current:** 20 milliamperes dc maximum.

**Polarity:** Positive or negative.

**Floating:** 500 volts maximum off chassis ground.

**ACCURACY:**  $\pm 0.05\%$  of dial setting or  $\pm 1$  millivolt, whichever is greater.

**RESOLUTION:** A "Trim" potentiometer permits interpolation between steps with a resolution of better than 100 microvolts.

**RESETABILITY:**  $\pm 0.025\%$ .

**STABILITY:**  $\pm 0.005\%$  per hour with constant load, line and ambient temperature.

**TEMPERATURE COEFFICIENT OF REFERENCE:**  $\pm 10$  ppm/ $^{\circ}\text{C}$ .

**LINE REGULATION:**  $\pm 0.005\%$  or 1 millivolt for 10% line change.

**LOAD REGULATION:**  $\pm 0.005\%$  from no load to full load.

**RIPPLE AND NOISE:** Less than 1 millivolt rms above 5 cps.

**OUTPUT IMPEDANCE:** Less than 0.05 ohm at dc.

**RECOVERY TIME:** No load to full load, less than 1 second to rated accuracy.

**OVERLOAD PROTECTION:** Output is disconnected within 50 milliseconds if current exceeds approximately 24 milliamperes.

**CONNECTORS:** Output: Teflon-insulated UHF type.

**POWER:** 105-125 or 210-250 volts, 50-60 cps, 105 watts.

**DIMENSIONS, WEIGHT:** 7" high x 19" wide x 12" deep; net weight, 26 pounds.

**ACCESSORIES SUPPLIED:** Mating connectors.

**ACCESSORIES AVAILABLE:**

Model 1491 End Frames:  
adapts Model 241 for bench use

## SECTION 1. GENERAL DESCRIPTION

1-1. GENERAL. The Model 241 is the successor to dc secondary standards that employ mechanical choppers and standard cells. It offers freedom from adjustment and calibration, long term stability to voltage or temperature variations, and immunity to shock and vibration. The 241 complements the popular Keithley 240 Supply, offering greater accuracy, regulation, current output and floating operation.

1-2. APPLICATIONS. Include calibration of meters, transducers, and power supplies; testing insulation, diode, and capacitor leakage resistances; measuring dc amplifier gain, linearity, drift and common mode rejection. It can also be used as a voltage comparator, voltage reference for analog computers, and excitation potential for photo-cells and ion chambers.

### 1-3. FEATURES.

a. Extreme stability of 0.005% per hour is gained by using, as a reference standard, a highly stable zener diode with an ambient temperature coefficient of less than 0.001% per degree C. It is unaffected by rough handling or shock and cannot be damaged in ordinary use. The comparator device is a Keithley-designed photo chopper of indefinite life, having no

moving parts and requiring no maintenance.

b. High output accuracy within 0.05% is assured through the use of encapsulated wire-wound resistors with 0.02% divider accuracy.

c. From 0-1000 volts at up to 20 milliamperes - plus, minus or floating - can be dialed in 100, 10, 1, 0.1 and 0.01 volt steps with 5 calibrated panel switches. "TRIM" potentiometer permits interpolation between steps with a resolution of better than 100 microvolts.

d. Noise and hum are below 1 millivolt rms. Low line transients - excellent line regulation - make the 241 ideal for capacitor and diode testing, meter calibration.

e. Overload protection is accomplished by a fast-acting relay circuit which disconnects the output within 50 milliseconds at about 24 milliamperes. A "RESET" front panel button restores operation.

f. Other features include "STANDBY" which removes voltage from the output, making possible connections while the instrument is operating; bench or rack operation.

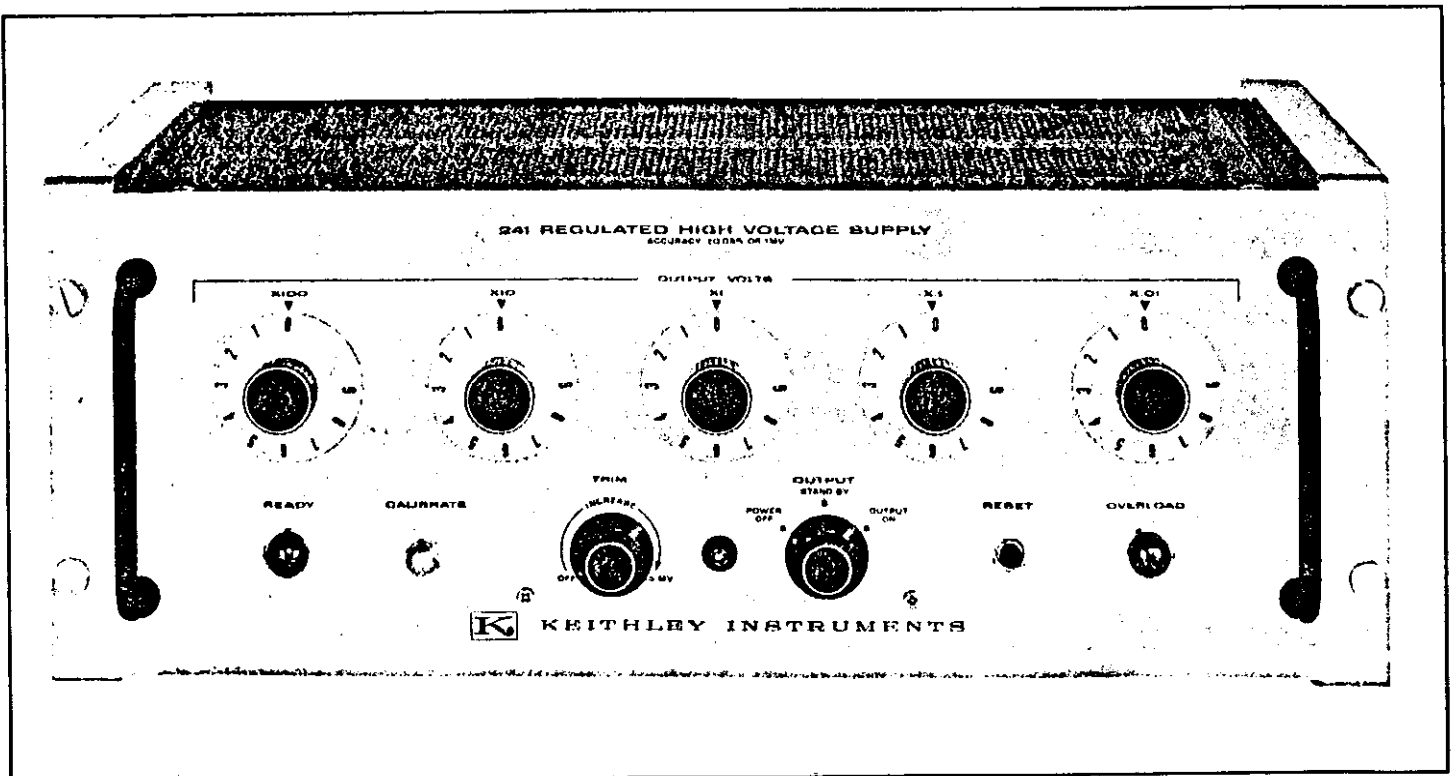


TABLE 1-1.  
Front Panel Controls

Control	Functional Description
OUTPUT Switch S1	Sets output on.
OUTPUT VOLTS	
S3	Sets output in 100V increments.
S4	Sets output in 10V increments.
S5	Sets output in 1V increments.
S6	Sets output in 0.1V increments.
S7	Sets output in 0.01V increments.
CALIBRATE Control R109	Adjusts output calibration.
RESET Switch S2	Overload reset control.
OVERLOAD Indicator DS-3	Indicates overload condition.
Power Indicator DS-1	Indicates power on.
READY Indicator DS-2	Indicates ready condition.
TRIM Control R151	Adjusts output up to 15 mV.

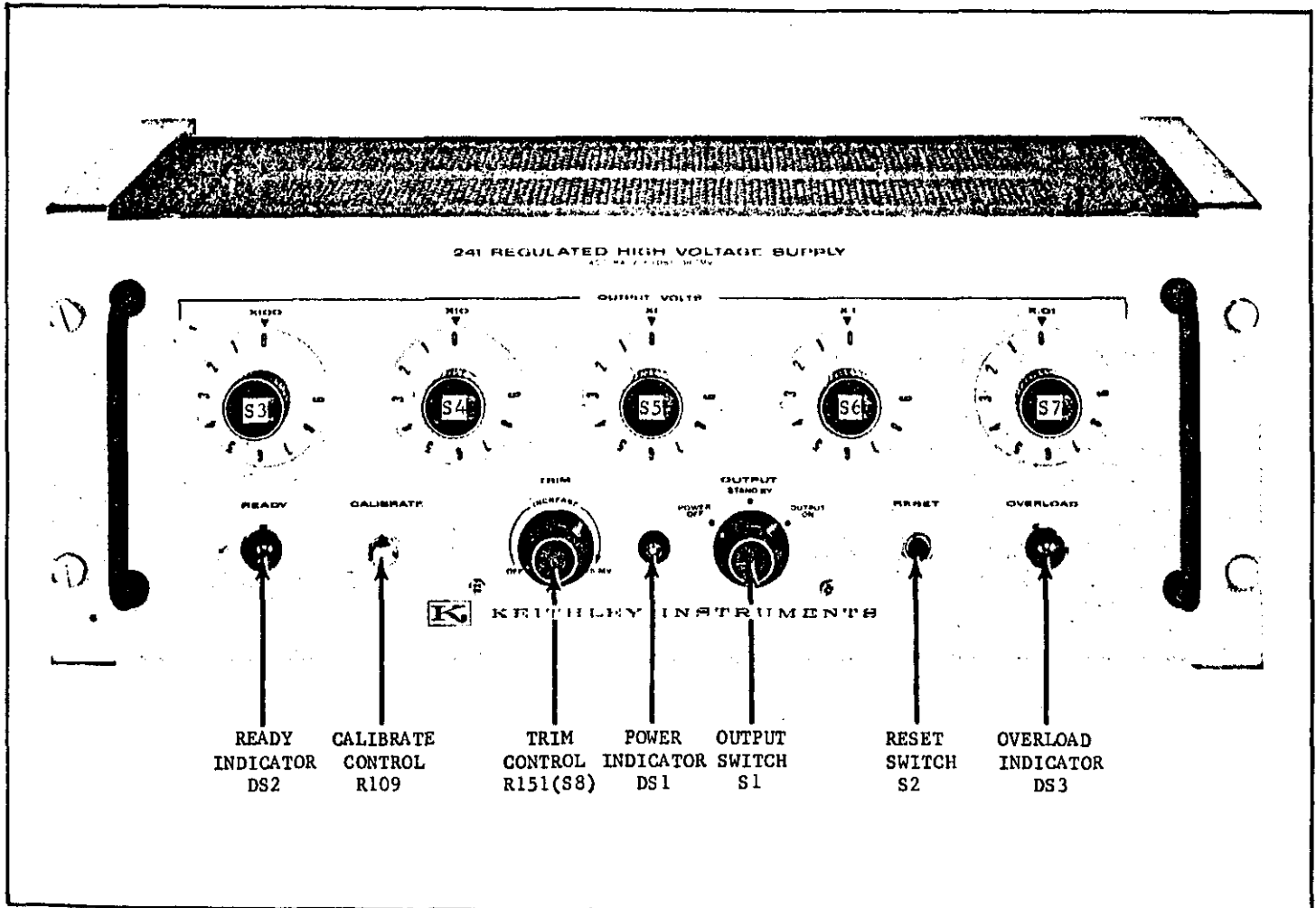


FIGURE 2. Front Panel

## SECTION 2. OPERATION

### 2-1. OPERATING CONTROLS.

a. Output Volts. The five skirted dials across the panel permit setting the voltage directly from zero to 1000 volts with an accuracy of 0.05% or 1 millivolt and a resolution to 10 millivolts.

b. Trim. Extrapolation between 10 millivolt settings is possible with the TRIM control which is below the voltage dials. The TRIM control should be set to the OFF position when not in use to avoid inaccurate output.

c. Calibrate. The calibration potentiometer is available from the front panel and is covered with an acorn nut to prevent inadvertent operation. The instrument is set to well within 0.05% accuracy at the factory. However, since the linearity of the output is within 0.02%, if the user has a potentiometer of this accuracy available, it is possible to set the calibration more closely for specific needs. This control, however, should not be touched unless proper calibration facilities are available. (See maintenance section).

d. Power Off - Standby - Output On. This switch turns on the power, places the instrument in STANDBY (power on but potential disconnected from the output terminals), and turns on the output terminals.

2-2. CONNECTIONS, POLARITY AND FLOATING OPERATION. The output connectors are located at the rear of the instrument. Two output connectors are used, one for the positive and one for the negative line. A shorting cap is provided so that either the positive or negative line may be grounded to the case. Thus, if the shorting cap grounds the negative line, the remaining connector has its center terminal at plus polarity, and the negative terminal is on the shell of

the connector. If the shell grounds the other connector, the opposite holds true. Floating operation is permissible provided that potential of either line to the case does not exceed 1500 volts. For floating operation, remove the shorting cap and use two separate coaxial cables, one for plus and one for minus. Due to the high potentials the user is cautioned to use connectors and shielded coaxial cable only.

2-3. PRELIMINARY OPERATING PROCEDURE. The Model 241 Regulated High-Voltage Supply is shipped complete with tubes and fuses and is accurately calibrated at the factory. Plug the power cord into a source of proper voltage and frequency. Unless otherwise specified, the unit is wired for 117V, 50 to 60 cps. For 220 volt operation change the jumpers on the transformer primary as indicated in the schematic diagram. After the connections have been made, turn instrument to STANDBY. The pilot light will go on but the READY light will be delayed by the internal time-delay relay for 30 seconds. After this time, the READY light will go on, and the instrument is ready to operate. If the instrument is immediately turned to the ON position, the OVERLOAD light will go on with the READY light, and it will be necessary to operate the RESET button to make voltage appear at the output terminals.

2-4. OVERLOAD CIRCUIT. If the current rating of the supply is exceeded by more than approximately 4 milliamperes, the overload circuit will disconnect the output in about 50 milliseconds turning on the red OVERLOAD light. To restore operation press RESET button. If the OVERLOAD light refuses to go out, or the relay chatters when the reset button is pushed, either the supply has become defective or the overload is still present. DO NOT PRESS RESET BUTTON MORE THAN MOMENTARILY TO AVOID DAMAGE TO POWER SUPPLY.

## SECTION 3. CIRCUIT DESCRIPTION

3-1. GENERAL. In Figure 3, two cascaded electronic series regulators furnish a high degree of load and line regulation. The first regulator reduces the effect of input voltage change while the second regulator provides a means for varying the output voltage. It provides a low output impedance, and very close regulation. Resistors R1 and R2 compare the output voltage against a silicon voltage standard. By varying R1 the voltage may be made to assume any voltage between zero and 1000. The current supply to the reference is doubly regulated. Relays RY1 and RY2 are overload protectors and RY3 and RY4 provide a 30-second time delay on turn on.

## 3-2. DETAILED CIRCUIT DESCRIPTION.

a. Refer to DR 13333D at the rear of this manual. The high voltage output of the transformer, T1 is rectified and supplied to the plate of V2, the series tube in the pre-regulator. V4 compares a fraction of the pre-regulated voltage from the divider network R127 to R129 and R131 to the 150 volts of V6. This regulator supplies approximately 1200 volts to the final regulator.

b. The final regulator consists of series tube V3, amplifier V5 difference amplifier V11, and a drift stabilizing amplifier consisting of light modulators (Keithley 1510), a two stage amplifier V10, and demodulator D13 to D16.

c. A very stable 9 volt potential is obtained at point 29 from the zener reference standard. The zener element is operated at its rated current and obtains this current regulated to better than 1% from the cascaded VR tubes V7, V8, and V9. To accomplish this, R111 is provided to adjust the rated current through the zener, the link between points 27 and 28 is removed and a 1/4% tolerance 10 ohm resistor is put at this point. With an accurate voltmeter, R111 is adjusted until the voltage across the 10 ohm resistor corresponds to the product of rated current x 10 ohms.

d. The voltage from the zener is compared against the output voltage by means of R108, R109, and R110 (these resistors correspond to R1 of Figure 1). Since the action of the feedback amplifier is to maintain point 35 exactly at ground, resistors R108 through R110 are adjusted so that exactly 1 milliampere of current flows into point 35 from the zener. This current must now flow into R151 and through R153 to R182. Since these resistors are connected between point 35, which the feedback maintains at ground and the high voltage, the output voltage must assume a value of 1 milliampere times the value of resistance chosen by the voltage dials which select resistors R151 and R153 through R182. It is so arranged that the output voltage equals one volt per thousand ohms connected between point 35 and ground.

e. The remainder of the circuit is a high gain feedback amplifier. Point 35, as mentioned above, is maintained at ground by the feedback action. This occurs because of the following:

1. If point 35 is not at ground, the light modulator converts the voltage into an ac signal which is amplified by the two sections of V10. The signal is then demodulated by synchronous demodulator D13-D16. The resultant dc signal is filtered by R147 and C124 and applied to pin 7 of V11. The signal is further amplified by V11 and V5 and applied to the control grid of V3. The signal will be of such polarity as to return point 35 to exactly zero volts. At frequencies higher than a few cycles, V10 and the associated modulator are not operative and in such a case the error signal proceeds directly to pin 2 of V11 and by-passes the modulator. C130 by-passes the comparison divider and increases the signal at high frequencies, which passes into pin 2 of V11.

2. Several safeguards are incorporated into the circuit at this point. D12 and R107 are connected between ground and the summing node, point 35. D12 is a silicon diode which is normally open but conducts if the summing point is carried more than 0.7 volt positive due to a transient. This protects the voltage reference diode. RY1 is the overload relay. It is shunted by R136 to set its pull in sensitivity at approximately 24 milliamperes. When an overload occurs and RY1 does pull in, it breaks the self-holding contact on RY2 causing it to open. To restore operation, RESET switch SW2 is pushed to momentarily reclose the RY2 self-locking circuit. The OFF, STAND BY, OUTPUT ON switch, SW1, also operates RY2 opening it in the STANDBY position by interrupting the holding circuit of RY2 by means of its first deck between points 25 and 38. SW1 re-energizes RY2 in the OUTPUT ON position. RY4 is a 30-second thermal time-delay which is recycled by RY3. If RY3 is not energized, RY2 cannot close, and the circuit remains in the overload or standby position.

3. After the signal is amplified by V11, it is further amplified by V5. This tube is arranged to supply driving voltage to V3 so that the supply can cover a range of 0 to 1000 volts. To do this the plate supply must vary over a range of about minus 50 to plus 950 volts. Therefore, the cathode of V5 is returned to minus 105 volts. The screen of V3 is supplied with a floating 105 volts bootstrapped to the cathode of V3. In this way a constant screen-to-cathode voltage is maintained, and the tube operates as a pentode. The advantage of this connection is that much less grid swing is required over the operating range, and the ac plate impedance of V2 is markedly increased. This results in a higher degree of output isolation from input transients.

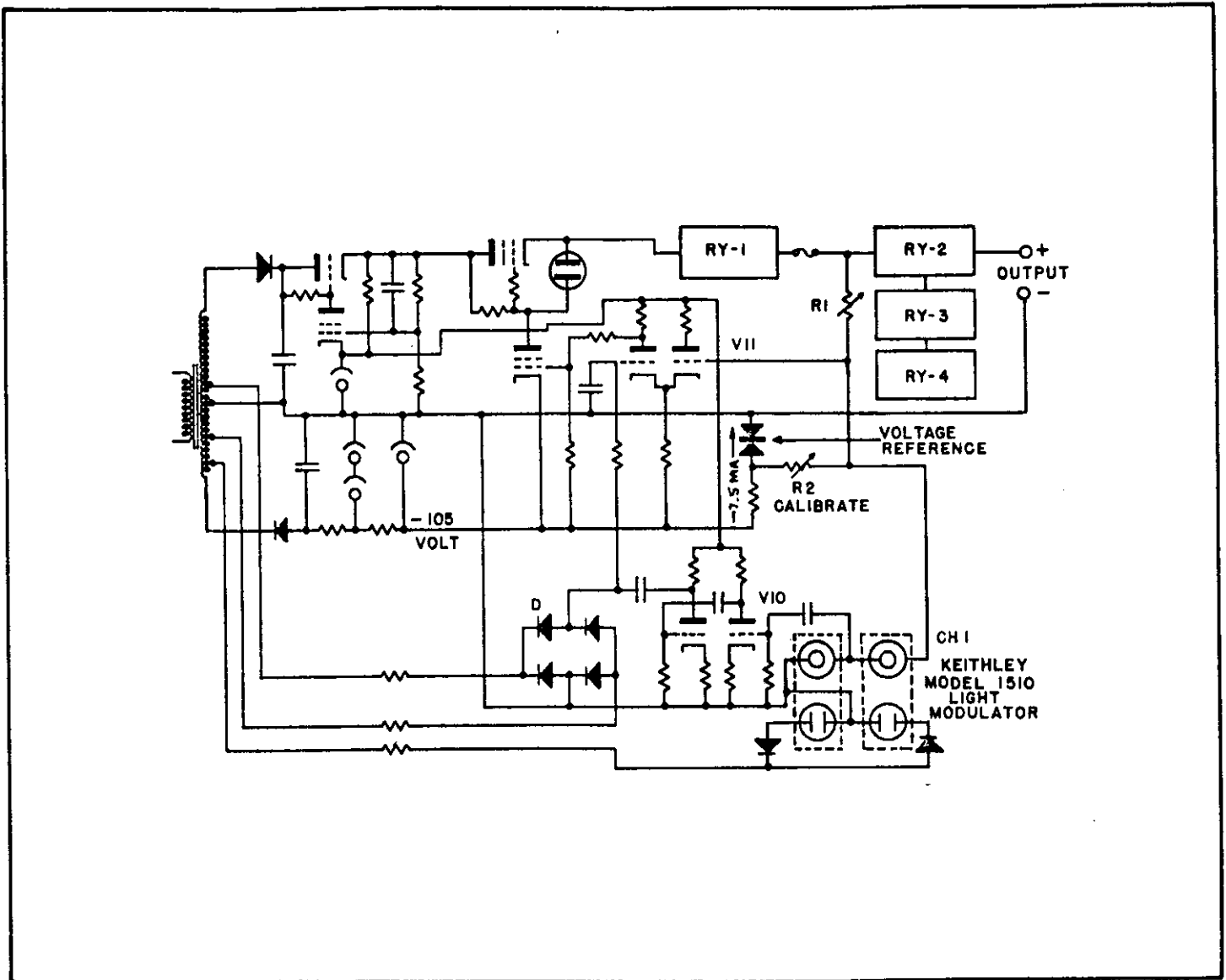


FIGURE 3. Simplified Circuit Diagram.

## SECTION 4. MAINTENANCE

## CAUTION

Be extremely careful that the regulated power supply is disconnected from the power line when unscrewing the top or bottom covers. Many circuit components are 1000 volts or more above ground. When the circuit is on negative polarity, the minus side of the circuit is 1000 volts below ground. Therefore, do not assume it is safe to touch any part of the circuit when the power is on.

4-1. TUBE REPLACEMENT. Tube replacement is non-critical. However, Ampere type ECC 83/12AX7 is recommended for V10 and V11.

4-2. ZENER REFERENCE. This element should not require replacement. If, however, it is necessary, first remove test jack jumper at point 28 and 27. Insert a 1/4% 10 ohm resistor, and adjust R111 until the voltage across the resistor is exactly the product of rated current times resistance. Then, measure the voltage across the reference. Since the tolerance of the zener elements is 8.45 to 9.45 volts, R110 is selected so that the sum of R108, R109 (set at half value equal to 50 ohms) and R110 equals in K ohms the voltage as closely as possible. Therefore, if the reference is changed, R110 will have to be changed.

4-3. RECALIBRATION. It is recommended that the calibration be adjusted initially at 500 volts output and then checked at several voltages above and below this point. The equipment used at the factory is a Leeds and Northrup Type K3 Potentiometer, and a Model 7592-S Volt Box. This equipment has a range of 0 to 1500 volts and an 0.035% limit of error.

4-4. TROUBLESHOOTING. The following general procedure is recommended: CAUTION: WHEN TROUBLESHOOTING, TURN VOLTS DIALS TO MAXIMUM READING!

1. No output: With extreme care and a voltmeter which will read at least 2100 volts dc, measure the

voltage at the plate of V2. It should be about 1700 volts. If it is not this voltage plus or minus 20%, check the input rectifiers and filter capacitor.

2. If this point checks, next check the voltage at the cathode of V2. This should be about 1200 volts. If it is much lower, either V2, V4 or possibly V6 is defective. If changing these tubes does not correct the difficulty, measure the voltage at pin 5 of V4. If the voltage is about 150 but the voltage at pin 3 of V2 is still incorrect, either R127, R128, R129 or R131 may be defective.

3. If the voltage is correct up to here but is not correct at the output, ground pin 7, V11. If approximately the correct voltage is not obtained at the output, the trouble is in the modulator circuit. The tube and the other components of that circuit should be checked.

4. If the modulator is not at fault, try changing tubes in the remainder of the circuit. CAUTION: DO NOT CHANGE TUBES WITH POWER ON.

5. If this does not eliminate the fault, check the standard resistor string for an open circuit, and check the zener diode for the correct voltage.

6. Finally, if the cause is still not discovered, with the voltage dials at their maximum setting, connect a voltage source of low internal impedance at point 35. Effectively, this shorts out the feedback. If the instrument is operational, a small variation in this voltage will drive the output full scale (zero to 1000 volts). Since there is a defect in the system, the signal will not affect the output. However, by measuring the plate and grid potentials progressively along the circuit, the point can be found where no signal is being transmitted. In this way the defective component can be located.

## NOTE

Periodically burnish relay contacts for lower noise and increased stability.



## SECTION 5. REPLACEABLE PARTS

5-1. REPLACEABLE PARTS LIST: This section contains a list of components used in this instrument for user reference. The Replaceable Parts List describes the individual parts giving Circuit Designation, Description, Suggested Manufacturer (Code Number),

Manufacturer's Part Number, and the Keithley Part Number. Also included is a Figure Reference Number where applicable. The complete name and address of each Manufacturer is listed in the CODE-TO-NAME Listing following the parts list.

TABLE 5-1.  
Abbreviations and Symbols

A	ampere	F	farad	Ω	ohm
CbVar	Carbon Variable	Fig	Figure	p	pico (10 <sup>-12</sup> )
CerD	Ceramic Disc	GCb	Glass enclosed Carbon	PC	Printed Circuit
Cer Trimmer	Ceramic Trimmer	k	kilo(10 <sup>3</sup> )	Poly	Polystyrene
Comp	Composition	μ	micro (10 <sup>-6</sup> )	Ref.	Reference
DCb	Deposited Carbon	M	Meg (10 <sup>6</sup> )	TCu	Tinner Copperweld
Desig.	Designation	Mfr.	Manufacturer	V	volt
EAL	Electrolytic, Aluminum	MtF	Metal Film	W	watt
ETB	Electrolytic, tubular	My	Mylar	WW	Wirewound
ETT	Electrolytic, tantalum	No.	Number	WWVar	Wirewound Variable

5-2. ELECTRICAL SCHEMATICS AND DIAGRAMS. Schematics and diagrams are included to describe the electrical circuits as discussed in Section 3.

or your nearest Keithley representative.

5-3. HOW TO USE THE REPLACEABLE PARTS LIST. This Parts List is arranged such that the individual types of components are listed in alphabetical order. Main Chassis parts are listed followed by printed circuit boards and other subassemblies.

b. When ordering parts, include the following information.

1. Instrument Model Number.
2. Instrument Serial Number.
3. Part Description.
4. Schematic Circuit Designation.
5. Keithley Part Number.

5-4. HOW TO ORDER PARTS.

a. Replaceable parts may be ordered through the Sales Service Department, Keithley Instruments, Inc.

c. All parts listed are maintained in Keithley Spare Parts Stock. Any part not listed can be made available upon request. Parts identified by the Keithley Manufacturing Code Number 80164 should be ordered directly from Keithley Instruments, Inc.

## MODEL 241 REPLACEABLE PARTS LIST

## CAPACITORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
C101	.00047 $\mu$ f	1000 v	CerD	71590	DD-471	C64-470P
C102	.00047 $\mu$ f	1000 v	CerD	71590	DD-471	C64-470P
C103	20 $\mu$ f	450 v	EMC	56289	TVL1714	C33-20M
C104	.00047 $\mu$ f	1000 v	CerD	71590	DD-471	C64-470P
C105	.00047 $\mu$ f	1000 v	CerD	71590	DD-471	C64-470P
C106	.00047 $\mu$ f	1000 v	CerD	71590	DD-471	C64-470P
C107	.00047 $\mu$ f	1000 v	CerD	71590	DD-471	C64-470P
C108	.00047 $\mu$ f	1000 v	CerD	71590	DD-471	C64-470P
C109	.00047 $\mu$ f	1000 v	CerD	71590	DD-471	C64-470P
C110	.00047 $\mu$ f	1000 v	CerD	71590	DD-471	C64-470P
C111	2.0 $\mu$ f	3000 v	My	99120	LK30-205	C53-2M
C112	.00047 $\mu$ f	1000 v	CerD	71590	DD-471	C64-470P
C113	.00047 $\mu$ f	1000 v	CerD	71590	DD-471	C64-470P
C114	16 $\mu$ f	600 v	EMC	14655	KR616C	C34-16M
C115A	20 $\mu$ f	350 v	ETB	12674	ME50415	C52-20M
C115B	20 $\mu$ f	350 v	ETB	12674	ME50415	C52-20M
C116	.02 $\mu$ f	1000 v	CerD	72982	841Z5V203P	C22-.02M
C117	.02 $\mu$ f	1000 v	CerD	72982	841Z5V203P	C22-.02M
C118	.02 $\mu$ f	1000 v	CerD	72982	841Z5V203P	C22-.02M
C119	.1 $\mu$ f	200 v	My	13050	SMLA	C47-.1M
C120	.01 $\mu$ f	1000 v	CerD	72982	811Z5V103P	C22-.01M
C121	1 $\mu$ f	200 v	My	13050	107-21	C66-1M
C122	1 $\mu$ f	200 v	My	13050	107-21	C66-1M
C123	.1 $\mu$ f	200 v	My	02777	P-12M	C66-.1M
C124	1 $\mu$ f	200 v	My	13050	107-21	C66-1M
C125	.0068 $\mu$ f	1000 v	CerD	72982	811Z5V682P	C22-.0068M
C126	.033 $\mu$ f	1600 v	My	14655	MGT-S33	C43-.033M
C127	.02 $\mu$ f	1000 v	CerD	72982	841Z5V203P	C22-.02M
C128	.001 $\mu$ f	1000 v	CerD	72982	801Z5V102P	C22-.001M
C129	1.0 $\mu$ f	400 v	My	99515	E4-105	C73-1M
C130	.47 $\mu$ f	1000 v	My	99515	EP-32462	C54-.47M
C131	.47 $\mu$ f	1000 v	My	99515	EP32462	C54-.47M
C132	*.033 $\mu$ f	1600 v	My	14655	MGT-S33	C43-.033M*
C150	.005 $\mu$ f	6000 v	My	14655	PKM60D5	C130-.005M

\*Nominal value, factory set.

## DIODES

Circuit Desig.	Type	Mfr. Code	Mfr. Part No.	Keithley Part No.
D1	Silicon	02735	1N3252	RF-17
D2	Silicon	02735	1N3252	RF-17
D3	Silicon	02735	1N3252	RF-17
D4	Silicon	02735	1N3252	RF-17
D5	Silicon	02735	1N3252	RF-17
D6	Silicon	02735	1N3252	RF-17
D7	Silicon	02735	1N3252	RF-17
D8	Silicon	02735	1N3252	RF-17
D9	Silicon	02735	1N3252	RF-17
D10	Silicon	02735	1N3252	RF-17
D11	Silicon	02735	1N3252	RF-17
D12	Zener	04713	1N938	14167
D13	Silicon	04713	1N1563A	RF-19
D14	Silicon	80164	1N3253	RF-20
D15	Silicon	80164	1N3253	RF-20
D16	Silicon	80164	1N3253	RF-20
D17	Silicon	80164	1N3253	RF-20
D18	Silicon	02735	1N3253	RF-20
D19	Silicon	02735	1N3253	RF-20
D20	Silicon	02735	1N3252	RF-17
D21	Silicon	02735	1N3256	RF-22
D22	Silicon	98925	4E100-8	RF-27

14168A Replace  
as a pair.

14168A Replace  
as a pair.

## MISCELLANEOUS PARTS

Circuit Desig.	Description	Mfr. Code	Mfr. Part No.	Keithley Part No.
DS1	Neon Lamp	08804	NE-2U	PL-14
DS2	Bulb	08804	47	PL-4
---	Light Assembly, READY	72765	5100	PL-16G
DS3	Bulb	08804	47	PL-4
---	Light Assembly, OVERLOAD	72765	5100	PL-16R
DS4	Neon Indicator Bulb	03797	EGOI WCBNE2V	PL-12
DS5	Not Used			
DS6	Not Used			
DS7	Neon Lamp	08804	NE-2U	PL-14

## MISCELLANEOUS PARTS (Cont'd)

Circuit Desig.	Description	Mfr. Code	Mfr. Part No.	Keithley Part No.
E101	Light Modulator Assy.	80164	---	1510
E102	Light Modulator Assy.	80164	---	1510
F1 (117 v)	Fuse, Slow-Blow 2A	75915	MDX	FU-25
F1 (234 v)	Fuse, Slow Blow, 3AG	71400	313.750	FU-10
---	Fuse Holder	75915	342012	FH-3
F2	Fuse, Slow Blow, 1/32 amp	71400	MDL	FU-11
J1	Receptacle, UHF, OUTPUT, + Mil. No. SO-239A	91737	6804	CS-64
J2	Receptacle, UHF, OUTPUT, - Mil. No. SO-239A	91737	6804	CS-64
---	Shorting Cap	91737	7907	CAP-5
---	Dust Cap	95760	EC10	CAP-1
---	(F) Plug, Mate of J1 and J2, UHF, Mil No. 49190	02660	83-822	CS-49
---	(F) Reducing Adapter, UHF, Mil No. UG-175/v	02660	83-185	CS-36
---	Binding Post, G	83330	136	BP-14
P1	Cord Set, 6 feet	93656	4638-13	CO-5
RY1	Relay	80164	---	RL-11
RY2	Relay	80164	---	RL-10
RY3	Relay	80164	---	RL-10
RY4	Relay	80164	---	RL-9
S1	Rotary Switch, OUTPUT	80164	---	SW-86
--	Knob Assembly, Output Switch	80164	---	KN-11
S2	Pushbutton Switch, RESET	82389	201S	SW-90
S3	Rotary Switch less components, OUTPUT VOLTS X100	80164	---	SW-85
--	Knob Assembly, X100 Volts Switch	80164	---	13923A
S4	Rotary Switch less components, OUTPUT VOLTS X10	80164	---	SW-85
--	Knob Assembly, X10 Volts Switch	80164	---	13923A
S5	Rotary Switch less components, OUTPUT VOLTS X1	80164	---	SW-81
--	Knob Assembly, X1 Volts Switch	80164	---	13923A
S6	Rotary Switch less components, OUTPUT VOLTS X.1	80164	---	SW-81
--	Knob Assembly, X.1 Volts Switch	80164	---	13923A

(F) Furnished accessory

## MISCELLANEOUS PARTS (Cont'd)

Circuit Desig.	Description	Mfg. Code	Keithley Part No.
S7	Rotary Switch less components, OUTPUT VOLTS X.01	80164	SW-81
--	Knob Assembly, X.01 Volts Switch	80164	13923A
--	Knob Assembly, Trim Control	80164	KN-11
T1	Transformer	80164	TR-34

## RESISTORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
R101	1 k $\Omega$	1%, 5 w	WW	91637	RS-5	R4A-1K
R102	8.2 k $\Omega$	10%, 5 w	WW	91637	CS-5	R8-8.2K
R103	100 $\Omega$	1%, 5 w	WW	91637	RS-5	R4A-100
R104	3 k $\Omega$	2%, 10 w	WW	91637	RS-10	R42-3K
R105	4 k $\Omega$	2%, 10 w	WW	91637	RS-10	R42-4K
R106	7 k $\Omega$	1%, 5 w	WW	91637	RS-5	R4A-7K
R107	1 k $\Omega$	1%, 5 w	WW	91637	RS-5	R4A-1K
R108	8.5 k $\Omega$	0.1%, 1/2 w	WW	15909	1252	R70-8.5K
R109	100 k $\Omega$	5%, 2 w	WWVar	12697	43C2	RP19A-100K
R110	*600 $\Omega$	1%, 1/2 w	WW	01686	7020	R48-600
R111	2 k $\Omega$	5%, 2 w	WWVar	12697	43C2	RP19-2K
R112	470 $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-470
R113	4.7 M $\Omega$	10%, 2 w	Comp	01121	HB	R3-4.7M
R114	470 $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-470
R115	*10 k $\Omega$	1%, 5 w	WW	91637	RS-5	R41-10K
R116	1 M $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-1M
R117	22 k $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-22K
R118	1 M $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-1M
R119	1 M $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-1M
R120	22 k $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-22K
R121	Not Used					
R122	1 M $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-1M
R123	470 $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-470
R124	80 k $\Omega$	1%, 10 w	WW	91637	RS-10	R34-80K
R125	40 k $\Omega$	1%, 10 w	WW	91637	RS-10	R34-40K
R126	8.2 k $\Omega$	10%, 2 w	Comp	01121	HB	R3-8.2K
R127	333 k $\Omega$	1%, 1 w	DCb	91637	DC-1	R13-333K
R128	333 k $\Omega$	1%, 1 w	DCb	91637	DC-1	R13-333K
R129	333 k $\Omega$	1%, 1 w	DCb	91637	DC-1	R13-333K
R130	470 $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-470

\*Nominal value, factory set

## RESISTORS (Cont'd)

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
R131	*120 k $\Omega$	1%, 1/2 w	DCb	79727	CFE-15	R12-120K
R132	330 k $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-330K
R133	4.7 k $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-4.7K
R134	330 k $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-330K
R135	470 $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-470
R136	4 k $\Omega$	1%, 5 w	WW	91637	RS-5	R4A-4K
R137	470 $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-470
R138	470 $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-470
R139	100 k $\Omega$	1%, 1/2 w	DCb	79727	CFE-15	R12-100K
R140	47 k $\Omega$	1%, 1/2 w	DCb	79727	CFE-15	R12-47K
R141	3 M $\Omega$	1%, 1/2 w	DCb	79727	CFE-15	R12-3M
R142	4.5 M $\Omega$	1%, 1/2 w	DCb	79727	CFE-15	R12-4.5M
R143	1 M $\Omega$	1%, 1/2 w	DCb	79727	CFE-15	R12-1M
R144	1 k $\Omega$	1%, 1/2 w	DCb	79727	CFE-15	R12-1K
R145	100 k $\Omega$	30%, 1/4 w	CompV	71450	45	RP12-100K
R146	75 k $\Omega$	1%, 1/2 w	DCb	79727	CFE-15	R12-75K
R147	10 M $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-10M
R148	100 k $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-100K
R149	100 k $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-100K
R150	100 k $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-100K
R151	15 $\Omega$	10%, 2 w	WWVar	12697	43	RP32-15
R152	10 k $\Omega$	2%, 10 w	WW	91637	RS-10	R42-10K
R153	100 k $\Omega$	.02%, 2 w	WW	15909	1179	R47-100K
R154	100 k $\Omega$	.02%, 2 w	WW	15909	1179	R49-100K
R155	100 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-100K
R156	100 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-100K
R157	100 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-100K
R158	100 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-100K
R159	100 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-100K
R160	100 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-100K
R161	100 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-100K
R162	10 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-10K
R163	10 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-10K
R164	10 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-10K
R165	10 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-10K
R166	10 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-10K
R167	10 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-10K
R168	10 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-10K
R169	10 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-10K
R170	10 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-10K

\*Nominal value, factory set

## RESISTORS (Cont'd)

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.
R171	2 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-2K
R172	1 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-1K
R173	4 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-4K
R174	4 k $\Omega$	.02%, 1/2 w	WW	15909	1259	R47-4K
R175	200 $\Omega$	.1%, 1/2 w	WW	15909	1252	R70-200
R176	100 $\Omega$	.1%, 1/2 w	WW	15909	1252	R70-100
R177	400 $\Omega$	5%, 1 w	WW	15909	R626	R69-400
R178	400 $\Omega$	5%, 1 w	WW	15909	R626	R69-400
R179	20 $\Omega$	.1%, 1/2 w	WW	15909	1252	R70-20
R180	10 $\Omega$	.1%, 1/2 w	WW	15909	1252	R70-10
R181	40 $\Omega$	.1%, 1/2 w	WW	15909	1252	R70-40
R182	40 $\Omega$	.1%, 1/2 w	WW	15909	1252	R70-40
R183	100 k $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-100K
R184	470 $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-470
R185	220 k $\Omega$	10%, 1/2 w	Comp	01121	EB	R1-220K
R186	Not Used					
R187	4.7 M $\Omega$	10%, 2 w	Comp	01121	HB	R3-4.7M

## VACUUM TUBES

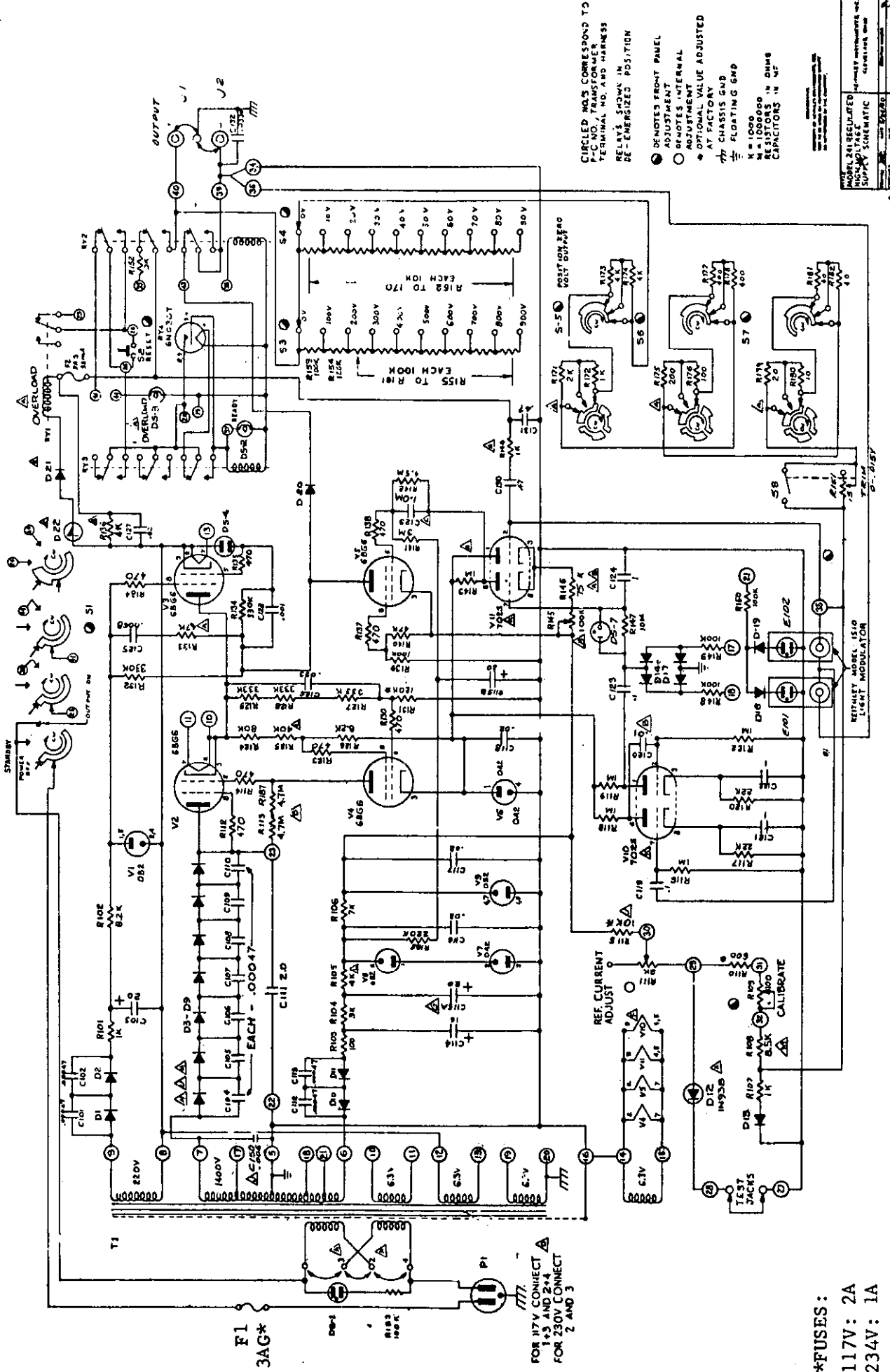
Circuit Desig.	Number	Mfg. Code	Keithley Part No.
V1	6627	86684	EV-6627
V2	6BG6	85599	EV-6BG6
V3	6BG6	85599	EV-6BG6
V4	6BG6	85599	EV-6BG6
V5	6BG6	85599	EV-6BG6
V6	6626	86684	EV-6626
V7	6626	86684	EV-6626
V8	6627	86684	EV-6627
V9	6627	86684	EV-6627
V10	7025	73445	EV-7025
V11	7025	73445	EV-7025

Code-To-Name List  
(From Federal Supply Code For Manufacturers, Cataloging Handbook H4-2)

01121	Allen-Bradley Corp. Milwaukee, Wis.	72765	Drake Mfg. Co. Chicago, Ill.
01686	RCL Electronics, Inc. Riverside, N. J.	72982	Gudeman Co. Chicago, Ill.
02660	Amphenol-Borg Electronics Corp. Broadview, Chicago, Illinois	73445	Amperex Electronic Co. Division of North American Philips Co., Inc. Hicksville, N. Y.
02735	Radio Corp. of America Commercial Receiving Tube and Semiconductor Division Somerville, N. J.	75915	Littelfuse, Inc. Des Plaines, Ill.
02777	Hopkins Engineering Co. San Fernando, Calif.	79727	Continental-Wirt Electronics Corp. Philadelphia, Pa.
03797	Eldema Corp. Compton Calif.	80164	Keithley Instruments, Inc. Cleveland, Ohio
04713	Motorola, Inc. Semiconductor Products Division Phoenix, Arizona	82389	Switchcraft, Inc. Chicago, Ill.
08804	Lamp Metals and Components Department G. E. Co. Cleveland, Ohio	83330	Smith, Herman H., Inc. Brooklyn, N. Y.
12697	Clarostat Mfg. Co., Inc. Dover, N. H.	85599	Tube Department G. E. Co. Schenectady, N. Y.
13050	Potter Co. Wesson, Miss.	86684	Radio Corp. of America Electronic Components and Devices Harrison, N. J.
14655	Cornell-Dubilier Electric Corp. Newark, N. J.	91637	Dale Electronics, Inc. Columbus, Nebr.
15909	Daven Division Thomas A. Edison Industries McGraw Edison Co. Livingston, N. J.	91737	Gremer Mfg. Co., Inc. Wakefield, Mass.
56289	Sprague Electric Co. North Adams, Mass.	93656	Electric Cord Co. Caldwell, N. J.
71400	Bussmann Mfg. Div. of McGraw-Edison Co. St. Louis, Mo.	95760	Protective Closures Co., Inc. Buffalo, N. Y.
71590	Centralab Division of Globe-Union, Inc. Milwaukee, Wis.	98925	Semiconductor Division of Clevite Corp. Waltham, Mass.
		99120	Plastic Capacitors, Inc. Chicago, Ill.
		99515	Marshall Industries Electron Products Division Pasadena, Calif.



N ECO 3823 10/69



CIRCLED MARKS CORRESPOND TO A-C AND TRANSFORMER TERMINAL NO. AND HARNESS RELAY'S SHOW IN DE-ENERGIZED POSITION

● DENOTES FRONT PANEL ADJUSTMENT  
 ○ DENOTES INTERNAL ADJUSTMENT  
 \* OPTIONAL VALUE ADJUSTED AT FACTORY  
 ≡ FLOATING GND  
 K = 1000  
 M = 1000000  
 RESISTORS IN OHMS  
 CAPACITORS IN MF

MODEL 241 REQUIRED HIGH-VOLTAGE SUPPLY SCHEMATIC  
 MODEL 241 REQUIRED HIGH-VOLTAGE SUPPLY SCHEMATIC  
 MODEL 241 REQUIRED HIGH-VOLTAGE SUPPLY SCHEMATIC

133333

\*FUSES:  
117V: 2A  
234V: 1A

F1  
3AG\*

FOR 117V CONNECT 1+3 AND 2+4  
FOR 230V CONNECT 2 AND 3

RESULT PANEL LIGHT MODULATOR

REF. CURRENT ADJUST

POSITION ZERO VOLT OUTPUT

OUTPUT

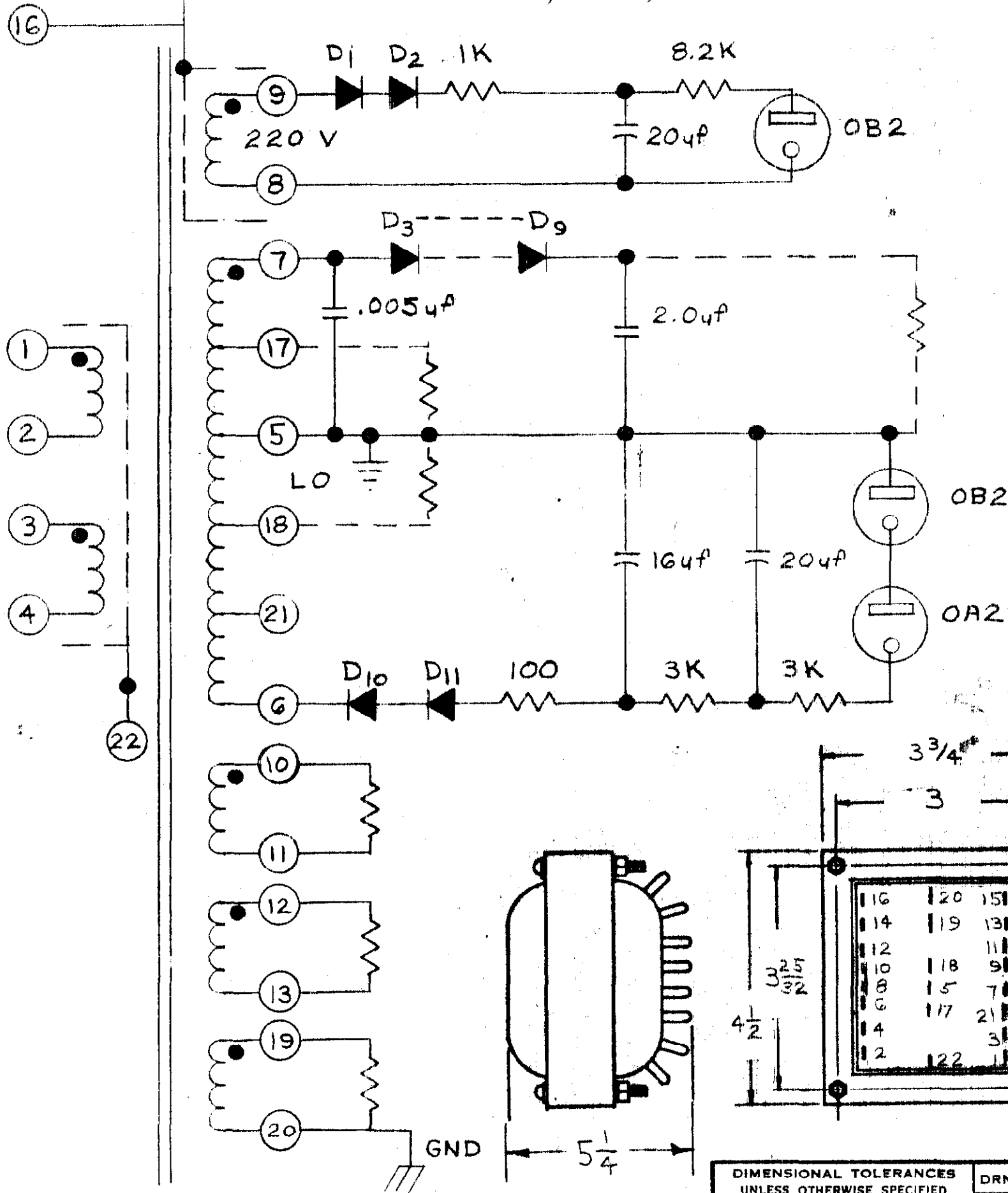
REVISIONS			
LTR	ECO No.	APPR.	DATE
A	3486	Radner	7-1-68
B	3823	W. J. W.	10-20-68

TR-34

- NOTE POLARITY DOTS.
- ALL DIODES, DI-D11, SILICON.

SPECIFICATIONS:

- General Mechanical: GS-101.
  - Keithley Part TR-34 to appear on all units.
  - Pri-Exc. Freq: 50 - 60 Hz.
  - Pri-Exc. Voltage: 105-125/210-250.
  - Max. Pri Line Amperes: a) 1.0 @ worst combination of freq., voltage and load. P.F. is 0.65 min.
  - Foil type shields (electrostatic) as noted. \* Primary & Sec. #3.
  - Temp. Rise: 55°C @ 50Hz, 125V, full load  
a) Max. Ambient: 45°C.
  - Terminations: Std. solder lug.
  - Windings to be essentially corona free.
  - Insulation: 10 - 11, 8 - 9, 12 - 13, 14 - 15 and secondary E.S.S. -4KV p-p to each other or core or any other winding.
  - Impregnation: Vacuum varnish.
- \* Primary E.S.S. connected to terminal #22 and insulated for low voltage. E.S.S. shielding winding 8 - 9 connected to terminal 16 and insulated for specified working voltages.



WINDING	VOLTS (RMS)	CURRENT (RMS)	TERM.
PRI #1	115		1-2
PRI #2	115		3-4
SEC #1	230	5 MA	5-21
SEC #1a	400	80 MA	5-6
SEC #2	1400	38-70MA	5-7
SEC #2a	260V CT	6 MA	17-5-18
SEC #3	250	27 MA	8-9
SEC #4	6.3	0.9A	10-11
SEC #5	6.3	2.6A	14-15
SEC #6	6.3	0.9A	12-13
SEC #7	6.3	0.75A	19-20

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED			DRN. RGJ	DATE 5 8 68
FRAC.	DEC.	ANG.	CKD. JG	DATE 5 8 68
± 1/64	± .005	± 1°	ENG. APPR. TAC	DATE 5 8 68
DO NOT SCALE			PILOT RELEASE TAC	DATE 5 8 68
			PROD. RELEASE TAC	DATE 5 8 68



TITLE  
TRANSFORMER

MATERIAL  
PURCHASED ITEM

PART NUMBER

TR-34

241	MODEL	NEXT ASSEMBLY	QUAN.

USED ON