

INSTRUCTION MANUAL

MODEL 420A

LOG N PERIOD AMPLIFIER

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SECTION I INTRODUCTIONModel 420-A

The Keithley Model 420-A Log n Period Amplifier consists of a logarithmic micro-microammeter for indication of reactor power level, followed by a differentiator which indicates the reactor period.

High level outputs for oscilloscopes and one-milliampere recorders, as well as 50 millivolt outputs, are provided from both the micro-microammeter and the period amplifier. One side of all outputs is at ground, making it convenient to connect associated equipment.

The features of the Log n Amplifier section include full scale voltage drop at the input of less than five millivolts, zero drift of less than 0.05 decade in 24 hours, good accuracy, and built-in calibration standards. The major panel control is the OPERATE switch; minor controls are the RECOVER button, AMPLIFIER BALANCE, SET 10^{-7} and SET 10^{-11} adjustments.

The Period Circuit features quick recovery from overloads. The controls are the OPERATE-CHECK oo switch and the SET oo adjustment.

The power switch is at the right of the meters. The pilot light indicates that power is on.

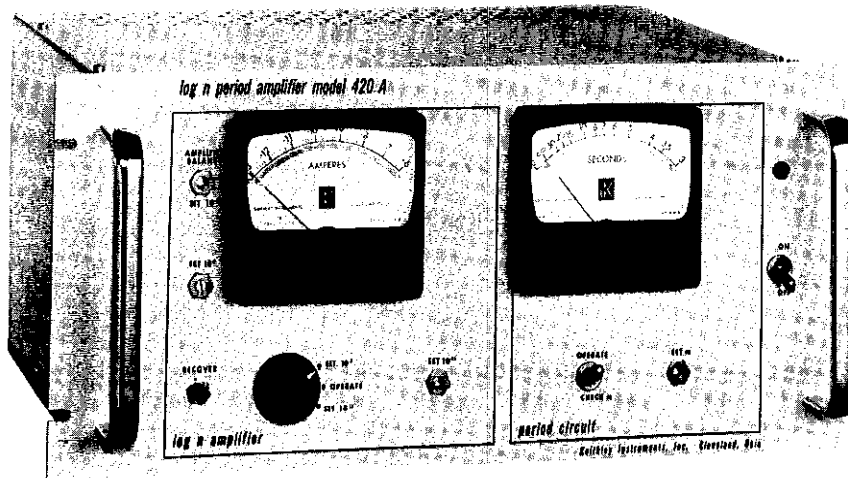


FIGURE 1. Keithley Model 420A Log n Period Amplifier.

SECTION II SPECIFICATIONSLog n Amplifier

The current range covered is 10^{-6} to 10^{-13} ampere and is displayed on a six-inch panel meter for maximum readability. Accuracy is within plus or minus 0.2 decade and the output voltage is 10.7 volts per decade plus or minus 20%. Positive currents only can be accepted; the output voltage is negative.

Calibration: The calibration is checked at the front panel by means of a control which selects either of two current sources; 10^{-11} or 10^{-7} amperes. The Log n Amplifier is adjusted to read correctly by means of screw driver controls on the front panel. The current source consists of a 10^{11} and a 10^7 ohm resistor and a mercury battery. Amplifier balance may also be checked and adjusted at the front panel.

Input impedance is decreased to a small value by negative feedback. The voltage drop across the input terminals will be less than five millivolts for any position across the meter scale provided that the amplifier balance is properly set.

Grid current is less than 5×10^{-14} ampere and will not affect operation of the instrument.

Recover Switch is located at left side of the panel. Its purpose is to short out the feedback diode and allow quick dissipation of spurious charges which sometimes accumulate on the input of a microammeter, or are caused by overloading the input.

Accuracy is within 0.2 decade.

Linear-Log Relationship is within 2% of scale length from 10^{-13} to 10^{-7} ampere; within 5% from 10^{-7} to 10^{-6} ampere.

Drift. After one hour warm-up, if the instrument is set on a 1×10^{-11} ampere, the reading will not increase to greater than 1.1×10^{-11} ampere nor decrease to less than 9×10^{-12} ampere in the following eight hours of operation.

75 Volt Negative Output is developed for full-scale meter deflection, and 1 milliamperes can be drawn without upsetting the circuits. The 75 volt Output connector is at the rear of the chassis. The connection details and suitable output attenuators are discussed in OPERATION, Section III.

50 Millivolt Output is provided for convenient, direct connection to servo rebalance recorders. The internal impedance is approximately 50 ohms.

Response Speed of the Log n Amplifier depends upon the current being measured, upon the capacitance of the external input circuitry, and upon the setting of the DAMPING control at the rear of the chassis. Because of the method application of the negative feedback, the slowing effects of capacitance from the high input terminal to ground have been greatly reduced, but are still significant. The DAMPING control varies the response time over a ten-to-one ratio. Table I, below, gives typical response speeds; viz: the time of 90% response to a step function with the DAMPING control set at its minimum position.

TABLE I

RISE TIME - to 90% of final current

Current change, amperes	With no significant external capacitance	With 5000 mmf across input
from 10^{-13} to 10^{-12}	less than 3 seconds	less than 6 seconds
from 10^{-12} to 10^{-7}	less than 1 second	less than 2 seconds

Amplifier Noise is principally power frequency, and is, at most, 2% of full scale peak to peak at the output terminals, irrespective of the current range.

Period Circuit

Range covered is from ∞ seconds to infinity to three seconds on a single scale.

Accuracy is 3% at 6 seconds.

Speed of Response is three seconds maximum.

Recovery Time is 10 seconds maximum.

Operate-Check switch, in the CHECK position, removes the signal from the Log n Amplifier to the Period Circuit. The meter should read infinity; and if not, the circuit is readjusted with the SET potentiometer. In the OPERATE position, the circuit is normal, with the Period input connected to the Log n output.

10 Volt Output is developed by the period circuit; the voltage is zero for infinite period, and 10 volts positive for three second positive period. One milliamperes can be drawn. Connection details are discussed in OPERATION, Section IV.

50 Millivolt Output is provided for convenient direct connection to servo rebalance recorders. The internal impedance is approximately 50 ohms.

General

Polarizing Potential for ion chambers: +225 volts, connector is Amphenol 80-C.

Input Connector is type HN with Teflon insulation, type UG560/U.

High Level Output Connectors are Cinch-Jones type S202.

Recorder Connectors are Amphenol 80 PC-2F.

Power Requirements: 110 or 220 V. 50-60 cps; 50 watts; unless specially requested, units wired for 110 volts. See MAINTENANCE section for voltage conversion instructions.

Tube Complement: Five 5886, one 6AV6, one 6BW4, one 6C4, two 6CB6, one 6Y6, one 12AU7, two 12AX7, one 12BH7, one 0A2, one OG3.

Accessories Supplied: Matching connectors for all outputs and inputs, six-foot power cord.

Accessories Available: 4102 Plug-in Input Assembly (replacement spare).

Cabinet is aluminum, and mounting is standard rack and panel. 19" x 8 $\frac{1}{2}$ " high x 12" deep, weight 23 pounds.

SECTION III OPERATION

Connect the input to the ion chamber, and outputs to the recorder or external indicators as desired.

Turn on power switch.

After a few minutes warm-up, turn the OPERATE switch to SET 10^{-11} and set the log n meter to 10^{-11} with SET 10^{-11} control.

Check calibration by turning OPERATE switch to 10^{-7} position. Adjust if necessary by setting meter to 10^{-7} with the SET 10^{-7} control.

Check amplifier balance by depressing RECOVER switch. Meter should read 10^{-13} . If necessary set with AMPLIFIER BALANCE control.

Return the OPERATE switch to OPERATE.

Depress the CHECK infinity switch and set the Period Circuit meter to infinity with the SET oo adjustment.

Recheck and readjust the calibration of the Log n Amplifier and SET infinity of the Period Circuit occasionally. These adjustments should require attention only occasionally after warm-up.

Input Connection

The current source should be connected to the input connector with the high impedance side of the current source associated with the central conductor of the connector. The lead-in cable should be polyethylene, polystyrene, or teflon insulated coaxial cable, and the connector should have teflon insulation.

Amphenol 82-804 is recommended for large cables, type 82-816 for small cables. During preparation of cable and connectors, it is essential that all high impedance surfaces be kept scrupulously clean to avoid lead-age. With graphite coated cable, it is necessary to avoid tracking graphite onto the high impedance surfaces of the cut end of the insulation and the teflon surface of the connector. Movement of the cable during measurement should be avoided since this will cause spurious input signals, because of capacitance changes and generation of static charges.

Recording. The Log n Amplifier and Period Circuit both have two outputs: one for 50 millivolt recorders, and the other for auxiliary panel meters of controls.

50 millivolt recorders are plugged directly into the 50 millivolt output connectors. Both 50 millivolt connectors are Amphenol 80-PC2F. The internal impedance is approximately 50 ohms. Resistor dividers for more sensitive recorders can easily be made at the recorder input.

The Log n high-level output is zero volts for 10^{-13} amperes and 75 volts negative for 10^{-6} ampere. One milliamperere can be drawn. The connector is Cinch-Jones S202.

The Period Circuit high-level output is zero volts for infinite period and 10 volts for 3 seconds period. One milliamperere can be drawn. The connector is Cinch-Jones S202.

Alarm and remote indicating circuits can easily be connected to the high-level outputs. Amplifiers and cathode ray oscilloscopes are also connected to the high-level outputs. Terminal #1 of each connector is at ground potential.

+225 Volts. A connector has been mounted on the back face of the chassis to provide +225 volts for polarizing an ion chamber. The potential is derived directly from the electronically regulated power supply. The chassis connector is Amphenol 80-C; 80-M is the mating plug.

The Speed of Response, or the time constant of the ion chamber and micro-microammeter, depends upon the speed of response of the circuitry of the instrument and also upon the capacitance of the current source and its connecting cable. Because of the way the negative feedback is applied in the Log n Amplifier the external input capacitance is not nearly as important as in the older systems using a voltmeter across a shunting resistor or diode, and quite large capacitances can be tolerated without having an impossibly slow response. Thus, a cable run from an ion chamber to the micro-microammeter is permissible.

Variable Damping of the Log n Amplifier is provided by the potentiometer on the back face of the chassis adjacent to the input connector. Maximum damping is obtained by rotating the control fully clockwise. The damping slows the response of the micro-microammeter so that it tends to average the statistical noise of the ion chamber current and the noise generated in the input cable, so that when the micro-microammeter output is differentiated in the Period Circuit, false short periods will not be indicated.

SECTION IV DESCRIPTIONCircuit Description - Log n Amplifier Section

The Circuit schematic diagram, DR 11737-C, is included at the back.

The logarithmic scale of the micro-microammeter is obtained by negative feedback from output to input through a diode whose emission is limited by negative plate-cathode voltages. The diode used is the grid-filament structure of a type 5886 electrometer tube.

The 5886 offers outstanding advantages in this application:

(1) The insulation of the grid is of a very high order since the 5886 is an electrometer tube. Therefore the diode plate has very little leakage which would cause erratic effects in the low current region.

(2) The grid and filament in this tube are extremely small, so that capacity across the diode is minimal. This results in a considerable improvement in response speed over instruments which employ more conventional diodes.

The diode used for feedback is V-1, type 5886. The grid is used as the diode anode and the filament as the cathode. R106 is placed in series with the grid to protect the tube.

The filament circuit voltage is regulated by transistor Q101 connected as an emitter follower. The Zener Diode, ZD101, provides the reference potential.

R111 is a 200 ohm, ten-turn potentiometer in series with R107 which provide a voltage drop of 2.5 volts. The feedback from the output is connected at this point so that variation of R111 will control the potential in series with the output. This potential is necessary to buck out the voltage across the diode in order that the micro-microammeter output can be kept at ground potential when the input is at ground potential.

The calibration circuit consists of a mercury battery, (RML01R), and resistors R101, R102, R103, and R104. The OPERATE switch is used to select the desired signal, either 10^{-11} or 10^{-7} ampere. With the RECOVER switch depressed, the log diode is shorted out. In this condition the logarithmic characteristic of the amplifier is removed and the circuit is simply a linear feedback amplifier whose zero corresponds to the 10^{-13} position on the meter. The AMPLIFIER BAL screw driver potentiometer adjusts the amplifier zero. With proper balance of the amplifier, dc voltage at the input will be less than 5 millivolts in normal operation.

The meter calibration is established by alternating between the 10^{-11} and 10^{-7} positions of the OPERATE switch, which causes 10^{-11} or 10^{-7} ampere to flow in the input. The corresponding potentiometers are adjusted until these calibration signals read properly on the meter. The SET 10^{-11} control adjusts the buck-out voltage in series with the diode and thus sets the static resistance of the diode at one point, while the SET 10^{-7} controls the gain of the amplifier and thus adjusts the change of the diode voltage with current, so that the rest of the scale reads correctly. Once these adjustments are made only the SET 10^{-11} control needs to be used to compensate for diode drift. The other controls will require infrequent adjustment.

The RECOVER switch shorts out the diode and allows the circuit to recover quickly from large overloads.

C102 is the damping capacitor which slows the response of the micro-microammeter. With the low impedance end of C102 connected to ground, the response is damped the least. As more and more feedback signal from the output is introduced at the low impedance end of C102, the damping is increased. R115, the DAMPING control, increases the feedback voltage until the desired amount of damping is obtained.

The amplifier of the micro-microammeter consists of two 5886 electrometer tubes, V-2 and V-3, followed by V-4 and V-5, high gain pentodes, operated as a long-tail pair. Feedback from the cathodes of V-4 and V-5 to the screens of V-2 and V-3 stabilizes the plate potentials of V-3 and V-4. Additional gain is provided by V-6a. V-7 is a constant-current coupling element between V-6a and V-6b, which is the cathode follower output for the Log n Amplifier. The constant-current coupling element eliminates attenuation so that the output will develop - 75 V for full scale. The output drives the diode feedback circuit, the panel meter, the high level and 50 millivolt outputs plus the Period Circuit. The circuit output potential is zero for 10^{-13} ampere meter indication, and negative 75 volts for 10^{-6} ampere indication. The 50 millivolt output is supplied through a resistive voltage divider.

The open loop gain of the amplifier is approximately 10,000; the feedback factor is approximately 1000.

Circuit Description - Period Section

The period circuit is an operational amplifier connected as a quasi-differentiator. C201 is the differentiating capacitor and R202 is placed in series with the capacitor so that response to very high frequencies is lessened. R207 is the feedback resistor and determine the sensitivity of the period amplifier. R207 is returned to the wiper of potentiometer R219 so that the feedback fraction can be varied. In this way the calibration of the period circuit may be adjusted. Capacitor C204 slows the circuit response to about 1 second full scale. If faster or slower response is desired, C204 may be varied accordingly.

The amplifier consists of balanced 5886 tubes followed by a 12AU7 tube connected as a differential amplifier. Feedback from the 12AU7 cathodes to the screens of the 5886 tubes stabilizes the operating point of the 5886 tube plates. V11, a cathode follower, drives the output meter and feedback loop. The open loop gain of the amplifier is approximately 200. The circuit output is 10 volts for a positive period of 3 seconds.

Check infinity switch SW3, in the check position, grounds one terminal of C201 and leaves the grid of V8 only with the feedback resistor connected. This condition corresponds to infinite period or no change in output from Log n Amplifier. If the period meter does not point to infinity in this position, it may be adjusted by R204, the set infinity control on the front panel.

ZD 201 and 202 are Zener diodes connected back-to-back to limit the amplifier input voltage in case of overload. Substantial decreases in recovery time is provided by these diodes.

Circuit Description - Power Supply

The Model 420-A utilizes an electronically regulated plus 225 volt supply and a VR tube regulated minus 150 volt supply.

The electronically regulated supply utilizes a type 6Y6 series tube (V13) which is controlled by a two stage differential dc amplifier (V14 and V17). V17 compares the B plus voltage, sampled via R312 and R315, to the voltage of reference tube V16. The output of V17 is amplified by V14 and used to control the resistance of the series tube V13. The unregulated B supply is derived from full-wave rectifier V12 and a conventional RC filter network. The minus supply is derived from a half-wave rectifier SR2, 3, 4, 5 and filtered with a three stage RC filter, R304, 5, 6 and C303, 4, 5 and finally regulated at minus 150 volts by V15. The polarizing potential which appears on the back of the chassis is taken directly from the +225 volt supply.

Unless otherwise requested, instruments are supplied wired for 110 v 50-60 cps power line operation. See schematic diagram for instructions for conversion to 220 volt operation.

SECTION V - MAINTENANCE

The Keithley Model 420-A Log n Period Amplifier has been designed to give long, trouble-free service. High quality components have been used throughout, and the circuits are stabilized by a substantial amount of negative feedback.

DR 11737-C, at the back, is the detailed circuit schematic diagram of the Model 420-A. The circuit operation was discussed in Section IV - Description.

Vacuum tubes V-2 and V-3 are two electrometer tubes and are located in an aluminum can which plugs onto the top of the chassis near the input terminals. These tubes have been selected, matched and labelled; V-2 and V-3 are Keithley parts EV5886-8. It is recommended that the complete input tube assembly, Model 4102, be kept on hand for replacement purposes.

Vacuum tubes V-8 and V-9 are also Keithley parts EV5886-8 in a Keithley Model 4102 input tube assembly.

Feedback diode V-1 is a Keithley part EV5886-6 which is tested for its logarithmic characteristic. Use normal electrometer tube care in handling the tube so that the glass at the press will not become contaminated.

INSULATION: All insulation for the high impedance conductors is made of teflon, as are the contact insulators on the range switch. This should give satisfactory service in all humidities. Occasionally, the high impedance insulators should be inspected to insure that they are free from dirt and dust, and brushed off if necessary.

CONNECTOR CAP: The cap for the input connector should be kept in place whenever the connector is not being used. In storage and in transport, it keeps the insulation from accumulating dust, dirt and moisture. Before screwing the cap back onto the connector, be certain that it is clean, so the insulation will not be contaminated and so that a low impedance bridging conductor will not be formed between the high impedance contact and the grounded cap.

Reference Voltage Battery: B1 should be replaced once yearly.

Calibrate Period: If period calibration is to be checked, a test set-up as described below will be satisfactory:

To simulate the exponential change in reactor power level, a capacitor discharge may be used to set up an electrical analog. The voltage discharge may be converted into a current by using a HI MEG resistor to connect the capacitor into the Log n Amplifier input as shown in Figure 2.

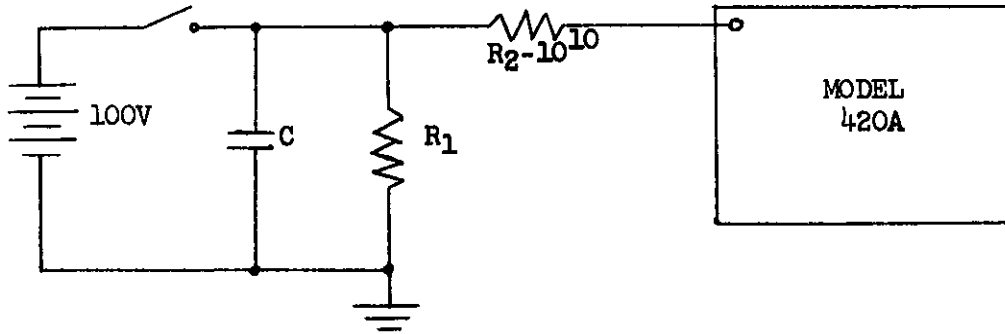


FIGURE 2

The period circuit, if correctly calibrated, should read directly the time constant of the RC network (R_1C) as C is allowed to discharge through R_1 when the key is opened. With a 100 volt source when the key is closed, the Log n Amplifier will read 10^{-8} ampere. When the key is opened, after an initial transient, the period circuit should read R_1C . In practice C should be 1 to 10 microfarads and R varied to give various period readings. A time constant or period of six seconds is a convenient calibration point. With the values shown, the period indication will be accurate from a current reading of about 5×10^{-9} to about 10^{-10} amperes and any period calibration should be made while the current is in this range.

Be sure to note that since the instrument can only be calibrated on negative period with this arrangement, the meter leads of the period meter should be reversed for this calibration.

The CALIBRATION PERIOD potentiometer is mounted on the chassis immediately behind the period meter.

SECTION VI. REPLACEABLE PARTS LIST

HOW TO ORDER PARTS. Order component parts directly from the manufacturer or from Keithley Instruments, Inc. Order all structural parts from Keithley.

The Replaceable Parts List gives the code number of the component's manufacturer in the MFG. CODE column. The name and address of the manufacturer having the code number is listed in the Manufacturers' Code Definitions Table immediately following the Replaceable Parts List. When ordering from the manufacturer, purchase only quality components meeting the listed specifications.

When ordering from Keithley Instruments, give a description of the part being ordered, the circuit designation, the Keithley part number, the instrument model number, and the instrument serial number. Send to:

Order Service Department
Keithley Instruments, Inc.
12415 Euclid Avenue
Cleveland 6, Ohio

LIST OF SYMBOLS AND ABBREVIATIONS

a	Amperes	Ω	Ohm
Cer	Ceramic Disc	P	Pica (10^{-12})
CerV	Ceramic Variable	PST	Polystyrene Tubular
Comp	Composition		
CompV	Composition Variable	R	Resistor
DCb	Deposited Carbon	Sw	Switch
EC	Electrolytic Can	μ	Micro (10^{-6})
ETB	Electrolytic Tubular		
f	Farad	V	Volts
		Var	Variable
K	Kilo (10^3)	w	Watt
		WW	Wire Wound
m	Milli (10^{-3})	WWVar	Wire Wound Variable
M	Mega (10^6)		
My	Mylar		

CAPACITORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
C101	10 pf	600 V	cer	19701	C22-100
C102	150 pf	200 V	PST	00686	C31-150
C103	.02 μ f	600 V	Cer	01121	C22-.02
C104	10 pf	600 V	Cer	19701	C22-100
C105	100 pf	600 V	Cer	72982	C22-.001
C106	50 μ f	6 V	EC	83125	C17-50
C201	1 μ f	400 V	My	00686	C37-1.0
C202	10 pf	600 V	Cer	19701	C22-100
C203	50 μ f	6 V	EC	83125	C17-50
C204	.1 μ f	400 V	My	14655	C30-.1
C301	16 μ f	600 V	EC	14655	C34-16
C302	100 μ f	15 V	ETB	80183	C11-100
C303	16 μ f	600 V	EC	14655	C34-16
C304	20 μ f	450 V	EC	37942	C7-20
C305	20 μ f	450 V	EC	37942	C7-20
C306	.02 μ f	600 V	Cer	01121	C22-.02
C307	.02 μ f	600 V	Cer	01121	C22-.02
C308	.1 μ f	400 V	My	14655	C30-.1
C309	20 μ f	450 V	EC	37942	C7-20

MISCELLANEOUS PARTS

Circuit Desig.	Description	Mfg. Code	Keithley Part No.
B1	Battery, Mercury Energizer, 1.34 V, (Vendor No. RM401R)	37942	BA8
F1	Fuse, 3a/3AG	75915	FU2
M1	Meter, 200 ma	80164	ME3
M2	Meter, 200 ma	80164	ME4
Q101	Transistor, Germanium, 2N365	01295	TG5
SR1	Rectifier, Bridge, Single phase, full wave, 20 ma, 25 V, Selenium	73506	RF6
SR2	Rectifier, Half-wave, 65 ma, 130 V	81483	RF8
SR3	Rectifier, Half-wave, 65 ma, 130 V	81483	RF8
SR4	Rectifier, Half-wave, 65 ma, 130 V	81483	RF8
SR5	Rectifier, Half-wave, 65 ma, 130 V	81483	RF8
T1	Transformer (Vendor No. K1-125)	95333	TR21
ZD101	Zener diode, 1N469	99942	DZ1
ZD201	Zener diode, 1N469	99942	DZ1
ZD202	Zener diode, 1N469	99942	DZ1

RESISTORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
R101	34 K Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-34K
R102	100 K Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-100K
R103	10 ¹¹ Ω	2%	HiMeg	63060	R20-10 ¹¹
R104	10 M Ω	1%, 1 w	DCb	00327	R13-10M
R105	22 M Ω	10%, $\frac{1}{2}$ w	Comp	01121	R1-22M
R106	10 K Ω	10%, $\frac{1}{2}$ w	Comp	44655	R1-10K
R107	50 Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-50
R108	150 Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-150
R109	100 Ω	10%, 2 w	WWVar	71450	RP3-100
R110	680 Ω	10%, $\frac{1}{2}$ w	Comp	01121	R1-680
R111	200 Ω	3%, 5 w	WWVar	73138	RP4-200
R112	100 K Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-100K
R113	300 K Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-300K
R114	1 K Ω	10%, 2 w	WWVar	37942	RP3-1K
R115	3 K Ω	10%, 2 w	WWVar	71450	RP3-3K
R116	1.5 K Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-1.5K
R117	250 Ω	1%, $\frac{1}{2}$ w	WW	77764	R18-10-250
R118	200 Ω	10%, 2 w	Var	71450	RP3-200
R119	150 Ω	1%, $\frac{1}{2}$ w	WW	77764	R18-10-150
R120	22.5 K Ω	5%, 10 w	WW	63743	R5-22.5K
R121	22.5 K Ω	5%, 10 w	WW	63743	R5-22.5K
R122	6 M Ω	1%, 1 w	DCb	01661	R13-6M
R123	10 M Ω	1%, 1 w	DCb	00327	R13-10M
R124	10 K Ω	10%, $\frac{1}{2}$ w	Comp	44655	R1-10K
R125	10 M Ω	1%, 1 w	DCb	00327	R13-10M
R126	600 K Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-600K
R127	10 K Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-10K
R128	220 K Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-220K
R129	470 K Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-470K
R130	1.14 M Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-1.14M
R131	1.4 M Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-1.4M
R132	60 K Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-60K
R133	100 K Ω	10%, 1 w	Comp	44655	R2-100K
R134	1.5 M Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-1.5M
R135	50 K Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-50K
R136	250 K Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-250K
R137	250 K Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-250K
R138	22.5 K Ω	5%, 10 w	WW	63743	R5-22.5K
R139	375 K Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-375K
R140	75 K Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-75K
R141	50 Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-50

RESISTORS CONT'D

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
R201	22 M Ω	10%, $\frac{1}{2}$ w	Comp	01121	R1-22M
R202	600 K Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-600K
R203	250 Ω	1%, $\frac{1}{2}$ w	WW	77764	R18-10-250
R204	200 Ω	10%, 2 w	WWVar	71450	RP3-200
R205	150 Ω	1%, $\frac{1}{2}$ w	WW	77764	R18-10-150
R206	47 K Ω	10%, $\frac{1}{2}$ w	Comp	44655	R1-47K
R207	5.25 M Ω	1%, 1 w	DCb	00327	R13-5.2M
R208	22.5 K Ω	5%, 10 w	WW	63743	R5-22.5K
R209	22.5 K Ω	5%, 10 w	WW	63743	R5-22.5M
R210	6 M Ω	1%, 1 w	DCb	01661	R13-6M
R211	100 K Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-100K
R212	10 M Ω	1%, 1 w	DCb	00327	R13-10M
R213	10 M Ω	1%, 1 w	DCb	00327	R13-10M
R214	3.4 K Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-3.4K
R215	100 K Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-100K
R216	1 M Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-1M
R217	60 K Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-60K
R218	1.5 M Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-1.5M
R219	22.5 K Ω	5%, 10 w	WW	63743	R5-22.5K
R220	1 K Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-1K
R221	3 K Ω	10%, 2 w	WWVar	71450	RP3-3K
R222	6 K Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-6K
R223	10 K Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-10K
R224	50 Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-50
R225	55 K Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-55K
R301	100 Ω	10%, 5 w	WW	44655	R4-100
R302	100 Ω	10%, $\frac{1}{2}$ w	Comp	01121	R1-100
R303	100 Ω	10%, $\frac{1}{2}$ w	Comp	01121	R1-100
R304	1.25 K Ω	5%, 10 w	WW	44655	R5-1.25K
R305	1.25 K Ω	5%, 5 w	WW	63743	R4-1.25K
R306	1.25 K Ω	5%, 5 w	WW	63743	R4-1.25K
R307	5 K Ω	5%, 5 w	WW	44655	R4-5K
R308	3.3 M Ω	10%, $\frac{1}{2}$ w	Comp	44655	R1-3.3M
R309	68 K Ω	10%, 1 w	Comp	01121	R2-68K
R310	2.2 M Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-2.2M
R311	2.2 M Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-2.2M
R312	1 M Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-1M
R313	1 M Ω	1%, $\frac{1}{2}$ w	DCb	44655	R1-1M
R314	1.3 M Ω	1%, $\frac{1}{2}$ w	DCb	01661	R12-1.3M
R315	600 K Ω	1%, $\frac{1}{2}$ w	DCb	00327	R12-600K

VACUUM TUBES

Circuit Desig.	Tube Number	Mfg. Code	Keithley Part No.
V1	5886-6	80164	EV5886-6
V2	5886-8	80164	EV5886-8
V3	5886-8	80164	EV5886-8
V4	6CB6	86684	EV6CB6
V5	6CB6	86684	EV6CB6
V6	12BH7	86684	EV12BH7
V7	6AV6	24446	EV6AV6
V8	5886-8	80164	EV5886-8
V9	5886-8	80164	EV5886-8
V10	12AU7	73445	EV12AU7
V11	6C4	86684	EV6C4
V12	6BW4	58854	EV6BW4
V13	6Y6	24446	EV6Y6
V14	12AX7	73445	EV12AX7
V15	0A2	73445	EVOA2
V16	0G3	73445	EVOG3
V17	12AX7	73445	EV12AX7

MANUFACTURERS' CODE DEFINITIONS

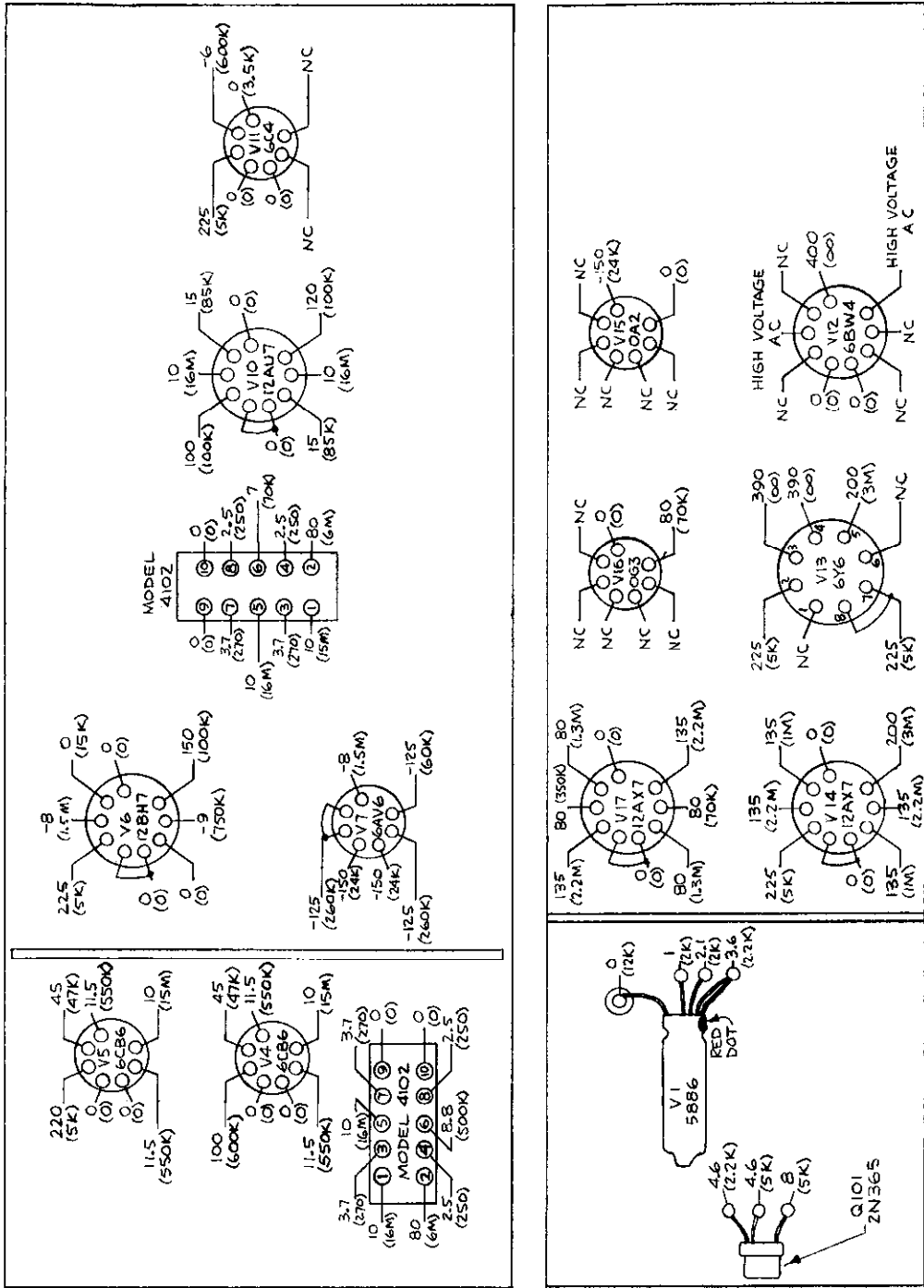
00327	Welwyn International, Inc. Cleveland, Ohio	71450	CTS Corp. Elkhart, Ind.
00686	Film Capacitors, Inc. New York, N. Y.	72982	Erie Resistor Corp. Erie, Pa.
01121	Allen Bradley Co. Milwaukee, Wis.	73138	Helipot Division of Beckman Instruments, Inc. Fullerton, Calif.
01295	Texas Instruments, Inc. Transistor Products Div. Dallas, Texas	73445	Amperex Electronic Co. Div. of No. American Philips Co., Inc. Hicksville, N. Y.
01661	Wilrite Products, Inc. Cleveland, Ohio	73506	Bradley Semiconductor Corp. Hamden, Conn.
14655	Cornell-Dubilier Electric Corp. Newark, N. J.	75915	Littlefuse, Inc. Des Plaines, Ill.
19701	Electra Mfg. Co. Kansas City, Mo.	77764	Resistance Products Co. Harrisburg, Pa.
24446	General Electric Co. Schenectady, New York	80164	Keithley Instruments, Inc. Cleveland, Ohio
37942	Mallory, P.R. and Co. Indianapolis, Ind.	80183	Sprague Products Co. North Adams, Mass.
44655	Ohmite Mfg. Co. Los Angeles, Calif.	81483	International Rectifier Corp. El Segundo, Calif.
49956	Raytheon Co. Lexington, Mass.	83125	General Instrument Corp. Capacitor Division Darlington, S. C.
58854	Sylvania Electric Products, Inc. Electronic Tubes Div. New York 19, N. Y.	86684	RCA Electronic Tube Div. of Radio Corp. of America Harrison, N. J.
63060	Victoreen Instrument Co. Cleveland, Ohio	95333	Central Transformer Co., Inc. Chicago, Ill.
63743	Ward Leonard Electric Co. Mount Vernon, N. Y.	99942	Hoffman Electronics Corp. Semiconductor Division El Monte, Calif.

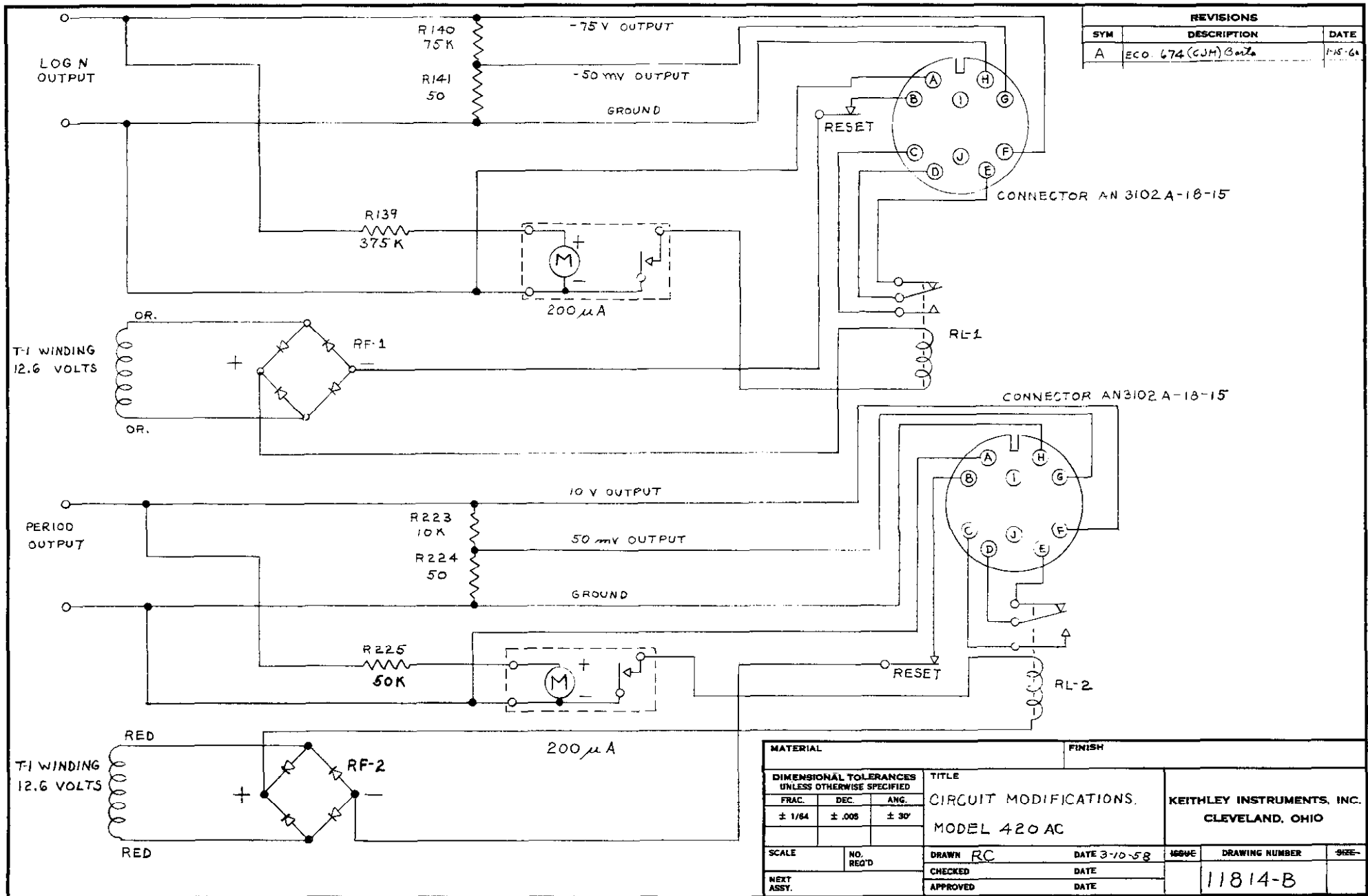
VOLTAGE AND RESISTANCE DIAGRAM - 420 A

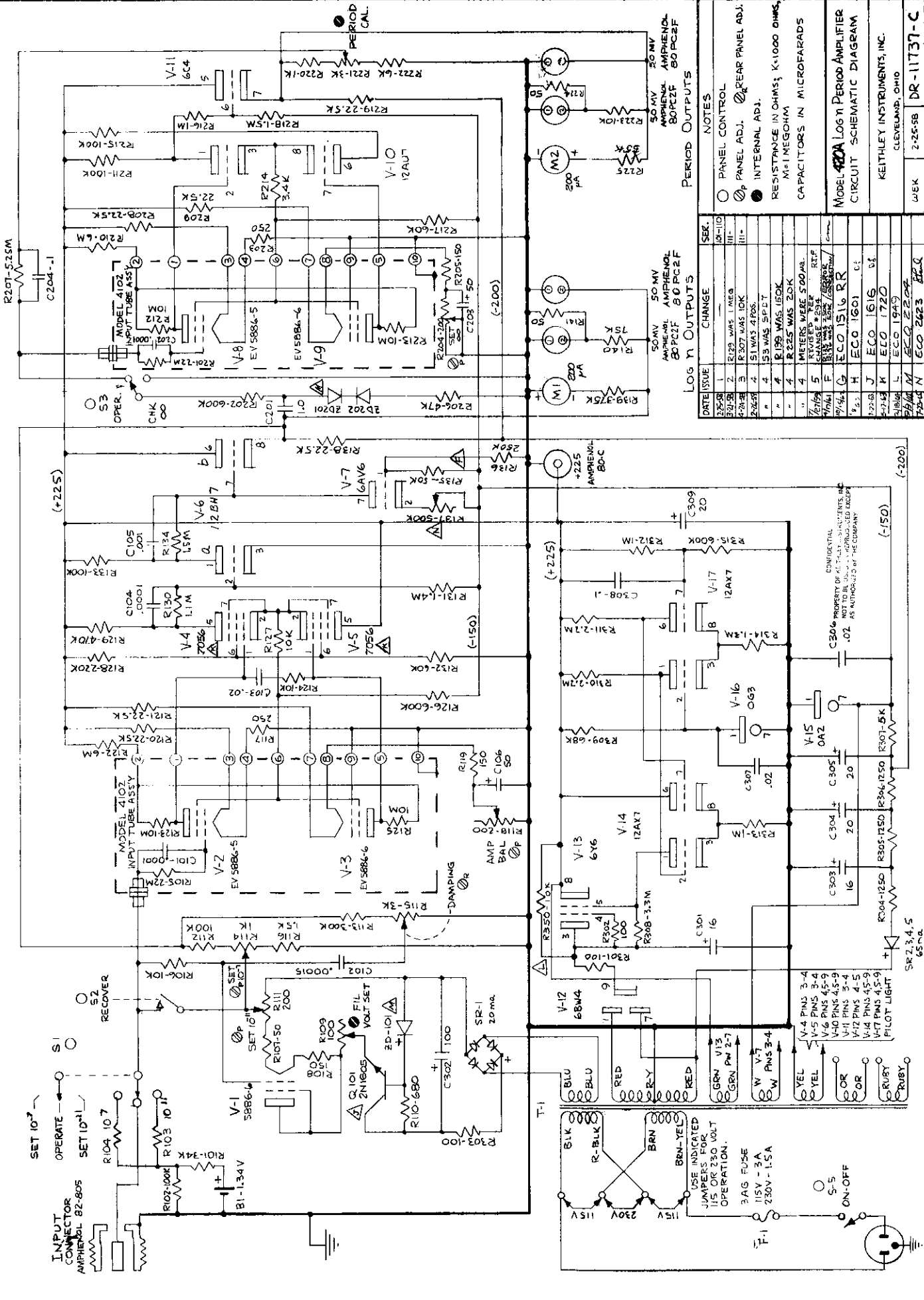
MEASUREMENTS MADE WITH VTVM FROM TUBE PIN TO GROUND. CONDITIONS: LOG Y CIRCUIT ON "AMPLIFIER BALANCE", PERIOD CIRCUIT ON "CHECK ∞", BOTH OUTPUTS SET TO ZERO.

RESISTANCE READINGS, (), ARE IN OHMS; K=1000, M=MEG OHMS.
ALL READINGS APPROXIMATE.
VIEW IS FROM BELOW CHASSIS.

OR 11840-B







DATE	ISSUE	CHANGE	SER.
2-25-58	1	10-110	10-110
3-27-58	2	R129 WAS 1.0M	III*
4-24-58	3	R307 WAS 10K	III*
2-24-59	4	S1 WAS 4POS.	
"	4	S3 WAS 5P.T.	
"	4	R199 WAS 100K	
"	4	R225 WAS 20K	
"	4	METERS WERE 500U.A.	
7-19-59	5	CHANGED *23A	REF
7-17-61	6	REPLACED *23A	REF
10-14-61	6	ECO 1516 RR	
2-2-62	H	ECO 1601 CE	
2-22-62	J	ECO 1616 CE	
5-27-62	K	ECO 1720 CE	
10-18-62	L	ECO 1849 CE	
11-14-62	M	ECO 2022 CE	
7-25-64	N	ECO 2023 CE	

LOG n OUTPUTS
 50 MV AMPHENOL 80 PC2F
 50 MV AMPHENOL 80 PC2F

PERIOD OUTPUTS
 20 MV AMPHENOL 80 PC2F
 50 MV AMPHENOL 80 PC2F

NOTES
 ○ PANEL CONTROL
 ⊙ PANEL ADJ.
 ⊙ INTERNAL ADJ.
 RESISTANCE IN OHMS; K=1000 OHMS; M=1 MEGOHM
 CAPACITORS IN MICROFARADS

MODEL 420A LOG n PERIOD AMPLIFIER
 CIRCUIT SCHEMATIC DIAGRAM
 KEITHLEY INSTRUMENTS, INC.
 CLEVELAND, OHIO

WEEK 2-25-58
 DR-11737-C

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 AS AUTHORIZED BY THE COMPANY

USE INDICATED
 JUMPERS FOR
 115 OR 230 VOLT
 OPERATION.
 3 AG FUSE
 115V - 3A
 230V - 1.5A

V-4 PINS 3-4
 V-5 PINS 3-4
 V-6 PINS 4-5-9
 V-10 PINS 4-5-9
 V-11 PINS 3-4
 V-12 PINS 4-5
 V-14 PINS 4-5-9
 V-17 PINS 4-5-9
 PILOT LIGHT