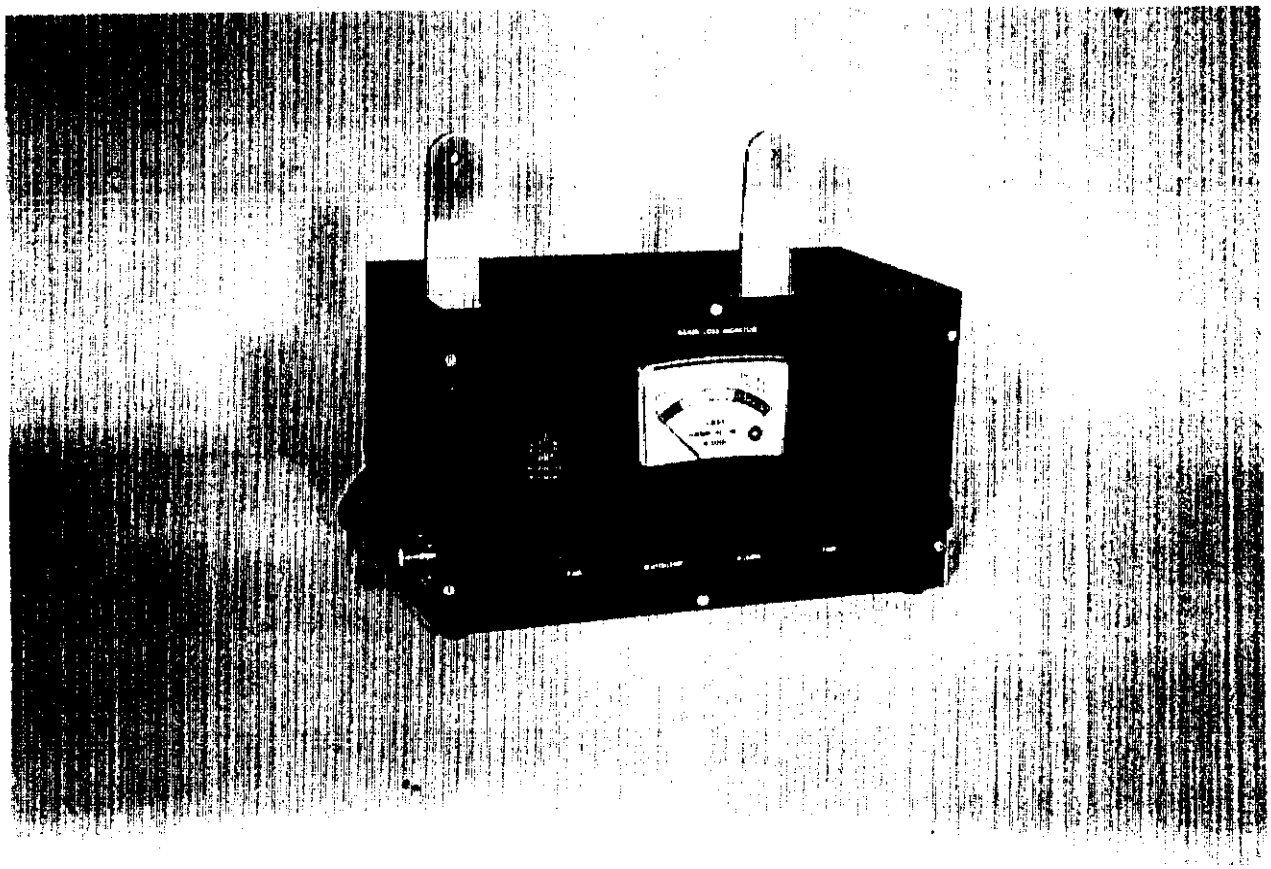
RP Note #2

ORGAN PIPE

Beam Loss Monitor

8/6/74

Duane C. Voy



ORGAN PIPE

BEAM LOSS MONITOR

CONTENTS

national accelerator laboratory

System Description

The Organ Pipe system is an ionization chamber type beam loss monitor. The system consists of two major components, the ionization chamber (with High Voltage supply) and the ionization current sensing electronics.

The Organ Pipe input is calibrated to a sensitivity of 0.1pA = 1 mRem-ft/hr with a 50pA input resulting in full scale circuit operation. A front panel level meter indicates loss levels.

Outputs include a 0-1mA current level for remote recorders and a pulse train with a maximum frequency (full scale operation) of 18.5 pps for use with MUX. Two other outputs provide for connection to Pterodactyls and Beam Interlocks.

The system has four operating states: Fail, Quiescent, Alarm and Trip. These are indicated by front panel LED displays and external Pterodactyls. A Fail or Trip operating state activates the interlock output (when used) to drop Beam.

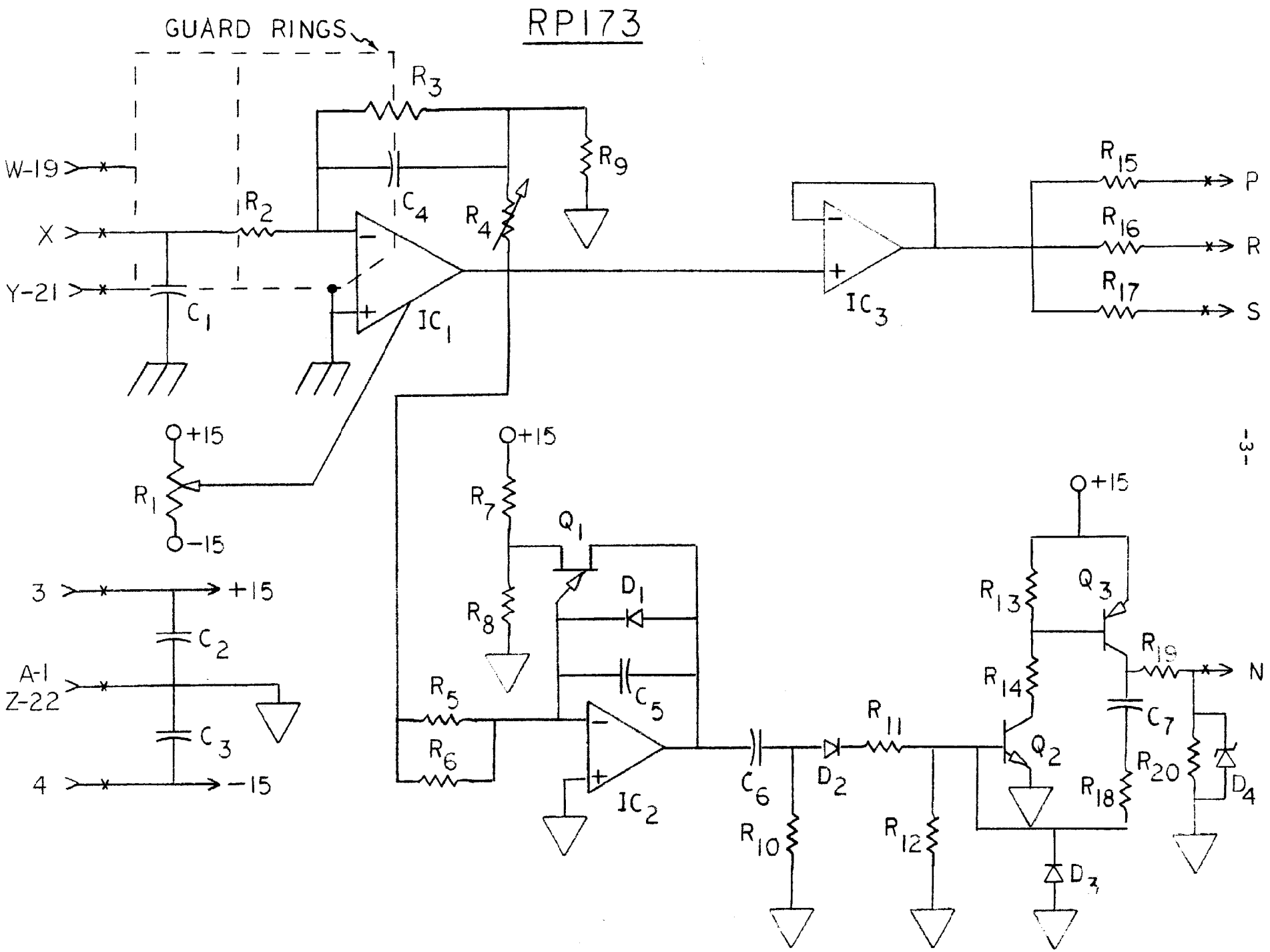
RP 173 Circuit Description

The RP 173 Circuit Board for the Organ Pipe contains a high sensitivity current amplifier, an output voltage follower, and a voltage to frequency converter digitizer circuit.

The current amplifier provides a linear output voltage vs. input current characteristic for input currents from approximately 2pA to 70pA. The output voltage of this circuit supplies the input signal for the output voltage follower and digitizer circuits. Calibration provides a 10 volt output for a 50pA input current.

The voltage follower circuit has three outputs having a 10K ohm output impedance to provide short circuit output currents of 0.04 to 1 mA (Typical Operating Range) with a calibrated input signal from the current amplifier.

The digitizer circuit provides a pulse output of 180 microseconds at 5.1 volts (no load) with a linear repetition rate versus input voltage from less than .1 volt to greater than 15 volts. Calibration provides an output frequency of 18.5 H_z $\pm$ 5% for a 10 volt input.


RP173
GUARD RINGS
W-19
X
Y-21
3
A-1
Z-22
4
+15
-15
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
C1
C2
C3
C4
C5
C6
C7
IC1
IC2
IC3
Q1
Q2
Q3
D1
D2
D3
D4
P
R
S
N
-3-

RP 173 Edge Connector

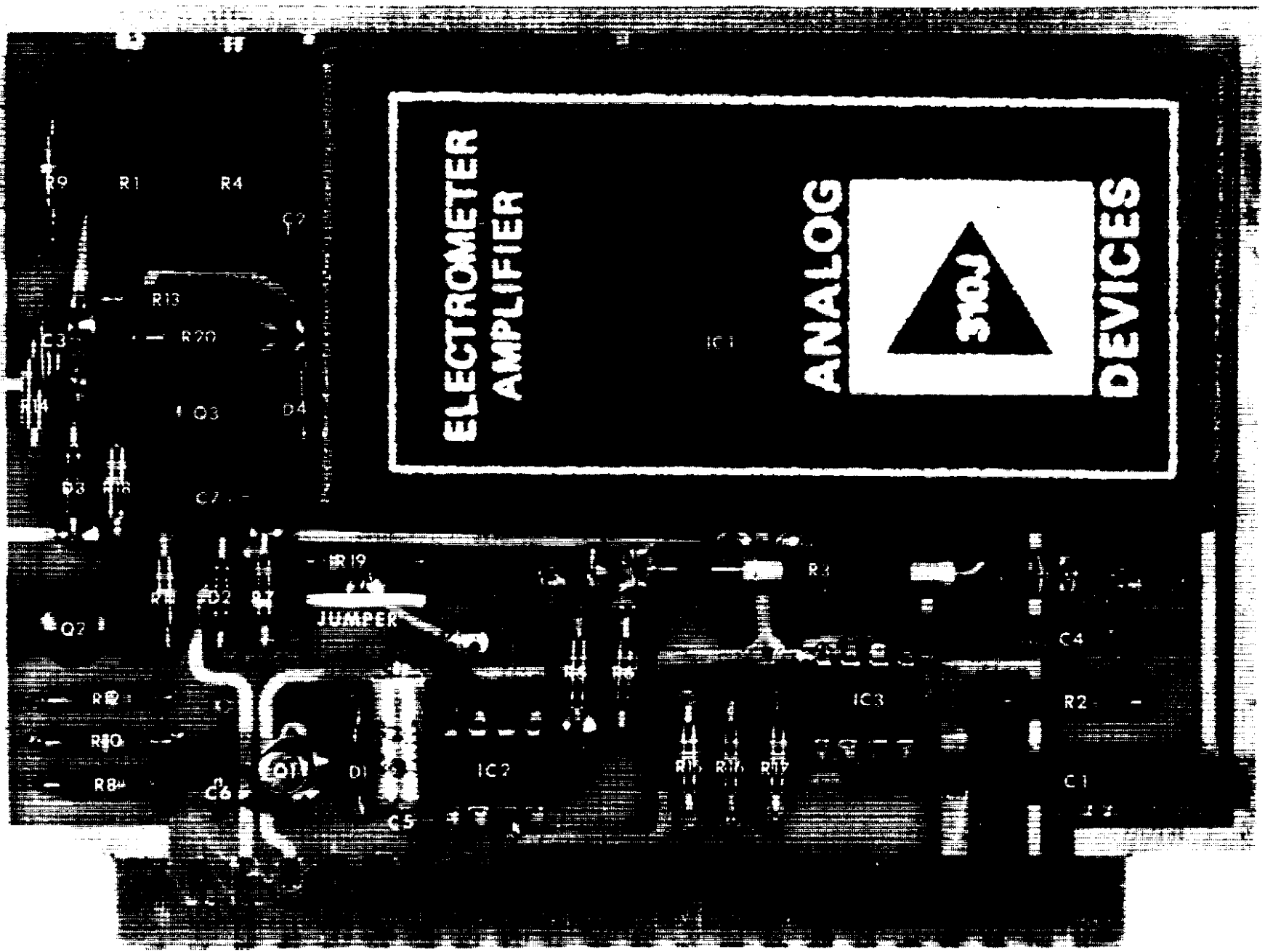
Application		Pin Number			Application
		A ----- 1	------		Ground
		B 2			
		C ----- 3	------		+15VDC
		D ----- 4	------		+15VDC
		E 5			
		F 6			
		H 7			
		J 8			
		K 9			
		L 10			
		M 11			
Mux Pulse Out	-------	N 12			
Analog Out 1	-------	P 13			
Analog Out 2	-------	R 14			
Analog Out 3	-------	S 15			
		T 16			
		U 17			
		V 18			
		W ----- 19	------		Electrometer Ground
Input	-------	X 20			
		Y ----- 21	------		Electrometer Ground
		Z ----- 22	------		Ground

RP 173 Parts List

R_1	100K Trimpot
R_2	1×10^8
R_3	10^{11} glass
R_4	200K Trimpot
R_5	20K
R_6	See note
R_7	2.4K
R_8	1K
R_9	100K
R_{10}	20K
R_{11}	10K
R_{12}	10K
R_{13}	1K
R_{14}	1K
R_{15}	10K
R_{16}	10K
R_{17}	10K
R_{18}	10K
R_{19}	300
R_{20}	1K

C_1	.01
C_2	.1
C_3	.1
C_4	220pF
C_5	4.7
C_6	.01
C_7	4700pF
D_1	1N458A
D_2	1N458A
D_3	1N458A
D_4	1N5231
Q_1	2N4851
Q_2	2N3642
Q_3	2N3638
Ic_1	310J
Ic_2	741C
Ic_3	741C

Note: R_6 is chosen for proper calibration of digitizer circuit.


ELECTROMETER
AMPLIFIER
ANALOG
DEVICES
310J
R9
R1
R4
Q2
R13
R20
C3
Q3
D4
C7
R19
D2
JUMPER
Q2
R3
C4
IC3
R2
R8
R10
R8
Q1
D1
IC2
C6
C5
C1

RP 178 Circuit Description

The RP 178 Circuit board for the Organ Pipe contains three voltage comparitors in association with three relay drivers and relay circuits.

The three comparitors compare the input signal (from RP 173) to a fixed reference voltage and through their different gains change states at three different input levels resulting in four definite output states.

The first comparitor controling K_1 switches at an input level of 0.4 volts defining the Fail-Quiescent trip point. The second comparitor controling K_2 switches states at an input signal level of 2 volts defining the Quiescent-Alarm trip point. The third comparitor controling K_3 changes states at 6.8 volts input defining the Alarm-Trip trip point.

The 'A' sections of the three relays switch a positive current to respective LEDs indicating the operating status of the Organ Pipe. The 'B' sections of the relays provide four output signals coded to drive Pterodactyls indicating the operational status of the unit. The 'C' sections of the relays provide switching to be used with an external Power supply (RP 179) to provide current for an External Beam Interlock Relay.

Table #I indicates the status of the three relays of the RP 178 board for various input signal levels.

Table #II shows the logic output codes produced by the RP 178 Relay Logic and the states that these codes represent.

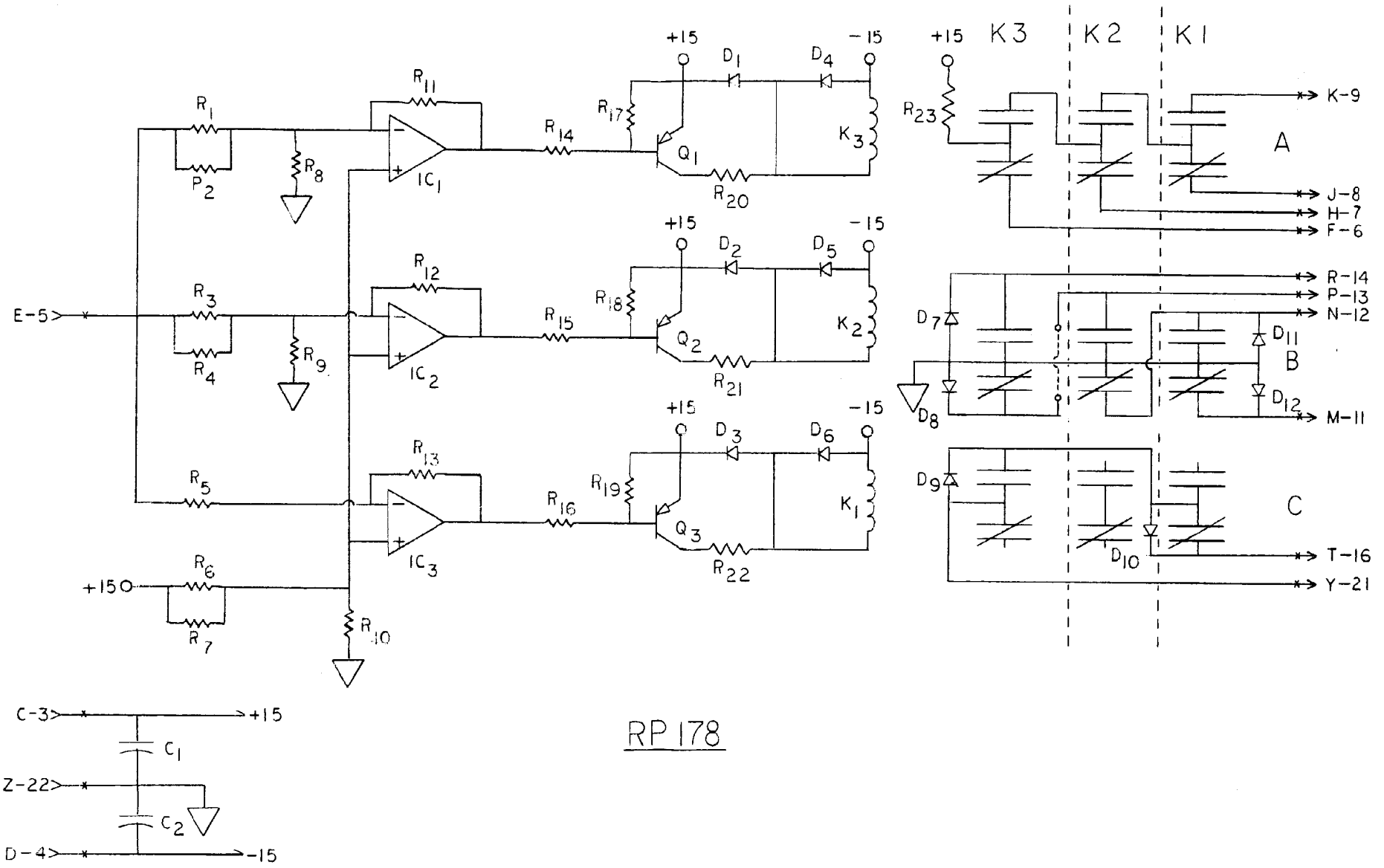
RP 178 RELAY STATUS

Mode of Operation	Relay Status K_1	K_2	K_3
Power Failure	Off	Off	Off
Fail Input - 0 to 0.4V	On	On	On
Quiescent Input - 0.4 to 2V	Off	On	On
Alarm Input - 2 to 6.8V	Off	Off	On
Trip Input - 6.8 to 10V	Off	Off	Off

Table #II

RP 178 Logic Output

Detector Status	LED	Relay Outputs Pterodactyls Logic		Interlock Trip
		With Jumper	Without Jumper	
AC Power Loss	N.A.	Trip $S_4=\bar{S}_F\bar{S}_Q\bar{S}_A S_T$	$\bar{S}_F\bar{S}_Q S_A S_T$	True = OV
Fail 0-2pA Input	Fail	Fail $S_1=S_F\bar{S}_Q\bar{S}_A\bar{S}_T$	Fail $S_F\bar{S}_Q\bar{S}_A\bar{S}_T$	True = OV
Quiescent 2-10pA Input	Quies.	Quiescent $S_2=\bar{S}_F S_Q\bar{S}_A\bar{S}_T$	Quiescent $\bar{S}_F S_Q\bar{S}_A\bar{S}_T$	False = +V
Alarm 10-34pA Input	Alarm	Alarm $S_3=\bar{S}_F\bar{S}_Q S_A\bar{S}_T$	Alarm $\bar{S}_F\bar{S}_Q S_A\bar{S}_T$	False = +V
Trip 34 + pA Input	Trip	Trip $S_4=\bar{S}_F\bar{S}_Q\bar{S}_A S_T$	$\bar{S}_F\bar{S}_Q S_A S_T$	True = OV


+15
-15
K3
K2
K1
R1
P2
R8
R11
IC1
R14
R17
Q1
R20
D1
D4
K3
R23
A
K-9
J-8
H-7
F-6
E-5>
R3
R4
R9
R12
IC2
R15
R18
Q2
R21
D2
D5
K2
R14
P-13
N-12
D7
D11
B
D8
D12
M-11
R5
R13
IC3
R16
R19
Q3
R22
D3
D6
K1
D9
C
D10
T-16
Y-21
+15O
R6
R7
R10
C-3>
C1
A-1&Z-22>
C2
D-4>
-15

RP 178

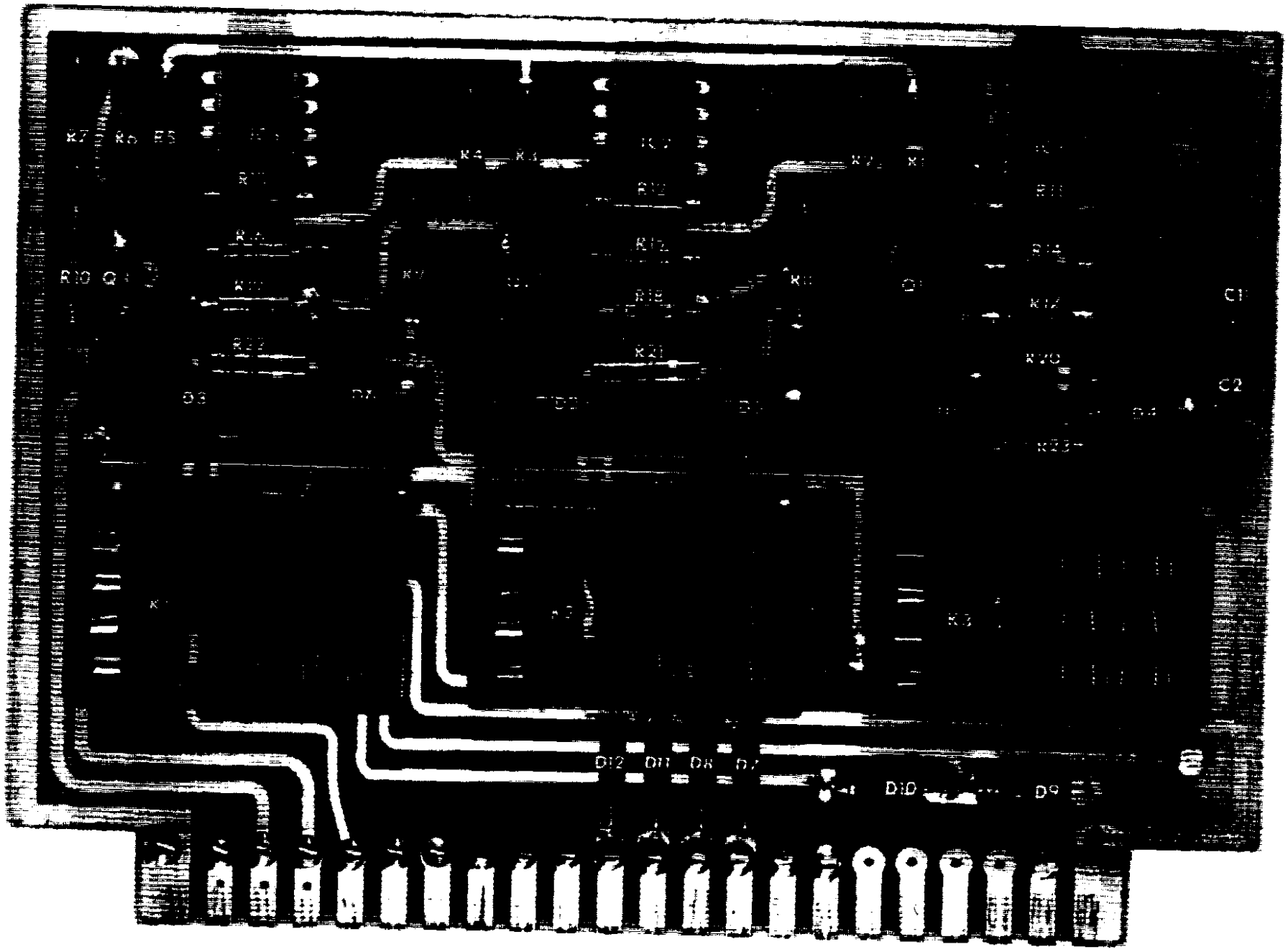
RP 178 Edge Connector

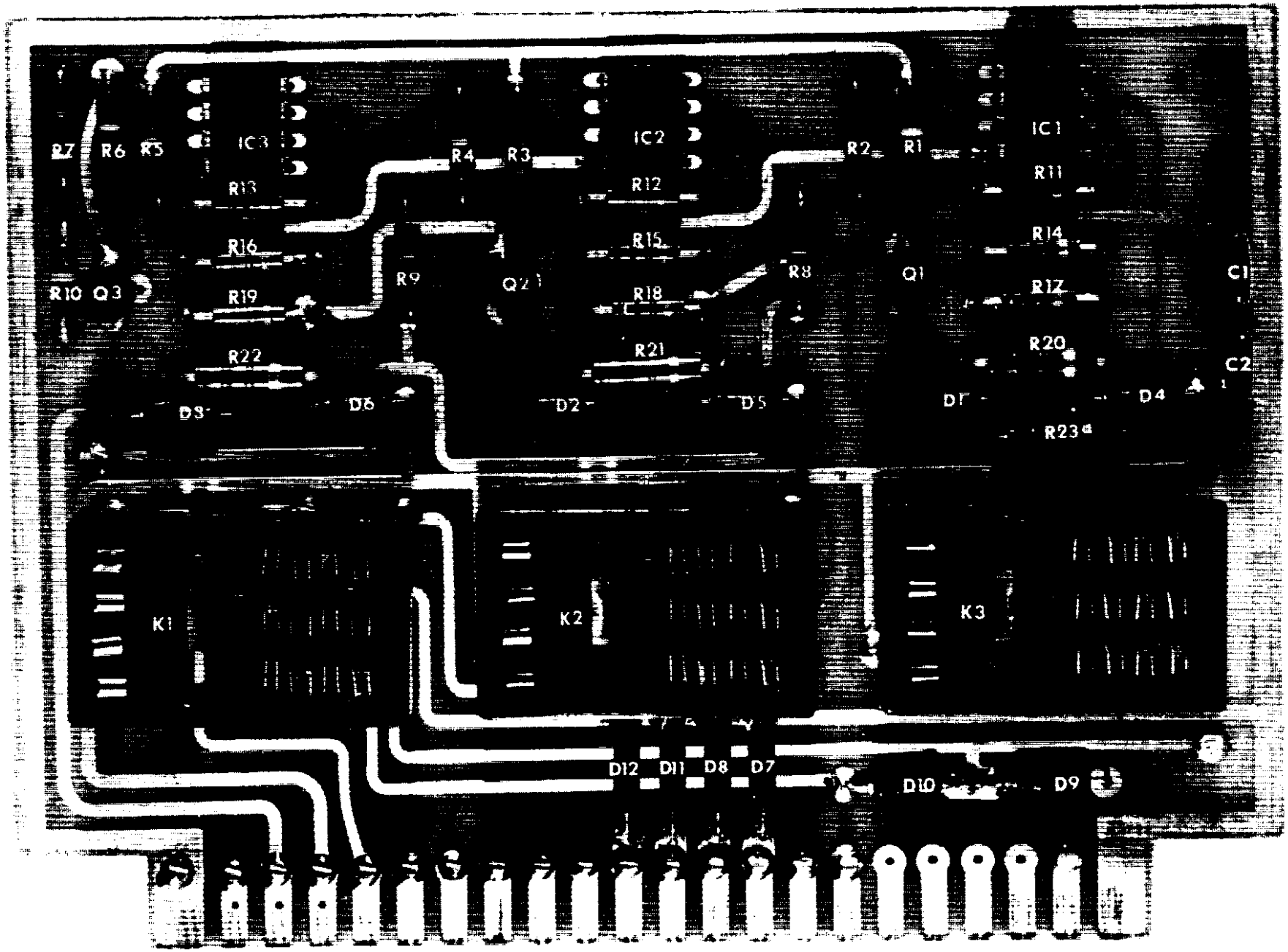
Pin Number		Application	
A ---- 1	------	Ground	
B ---- 2			
C ---- 3	------	+15VDC	
D ---- 4	------	-15VDC	
E ---- 5	------	Input	
F ---- 6	------	Trip	LED Output Pwr
H ---- 7	------	Alarm	
J ---- 8	------	Quiescent	
K ---- 9	------	Fail	
L ---- 10			
M ---- 11	------	SF	Pterodactyls Output
N ---- 12	------	SQ	
P ---- 13	------	SA	
R ---- 14	------	ST	
S ---- 15			
T ---- 16	------	Trip	Interlock Output
U ---- 17			
V ---- 18			
W ---- 19			
X ---- 20			
Y ---- 21	------	Common	
Z ---- 22	------	Ground	

RP 178 Parts List

R_1	180K	
R_2	2.2M	Nominal*
R_3	47K	
R_4	560K	Nominal*
R_5	10K	
R_6	560K	
R_7	3M	Nominal*
R_8	10K	
R_9	10K	
R_{10}	10K	
R_{11}	10M	
R_{12}	10M	
R_{13}	10M	
R_{14}	5.1K	
R_{15}	5.1K	
R_{16}	5.1K	
R_{17}	5.1K	
R_{18}	5.1K	
R_{19}	5.1K	
R_{20}	200 1/2W	
R_{21}	200 1/2W	
R_{22}	200 1/2W	
R_{23}	750 1/2W	
D_{1-12}	1N458A	
K_{1-3}	R10-E1-X4-V700	
Q_{1-3}	2N4403	
Ic_{1-3}	741C	

* These resistors are selected for proper calibration.


C1
C2


R7
R6
R5
IC3
R13
R16
R10
Q3
R19
R22
D3
D6
R4
R3
IC2
R12
R9
Q2
R15
R18
R21
D2
D5
R2
R1
IC1
R11
R14
R8
Q1
R17
R20
D1
D4
R23
C1
C2
K1
K2
K3
D12
D11
D8
D7
D10
D9

RP 76 Circuit Description

The RP 76 circuit board contains a Lambda power supply module with a rated output of ± 15VDC @ 250mA.

RP 179 Circuit Description

The RP 179 circuit board contains a ± 15VDC power supply module rated at 100mA in series with a 200 Ohm resistor to supply 24VDC @ 34 mA to drive an interlock relay.

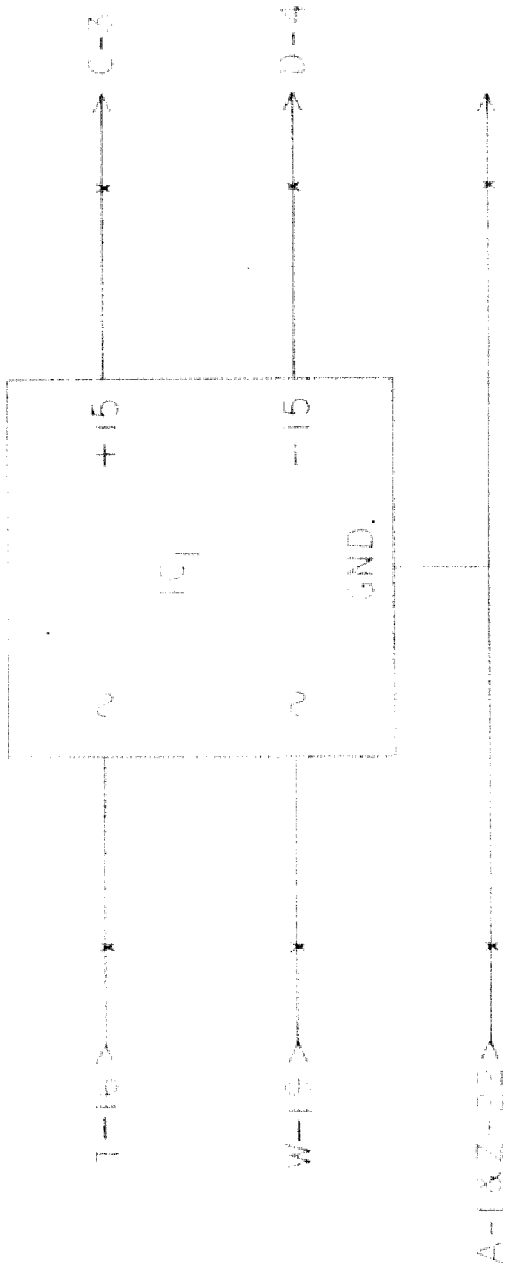
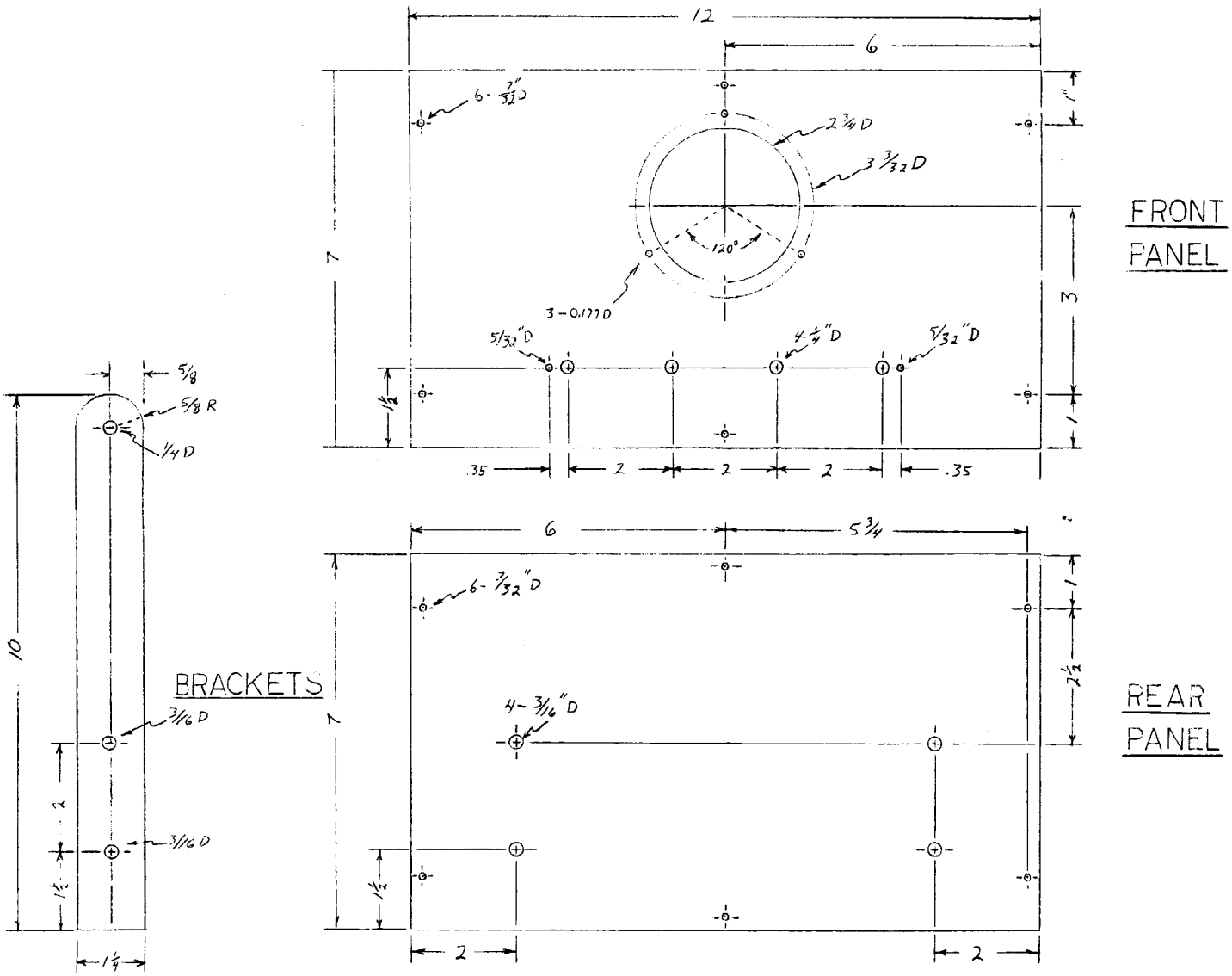
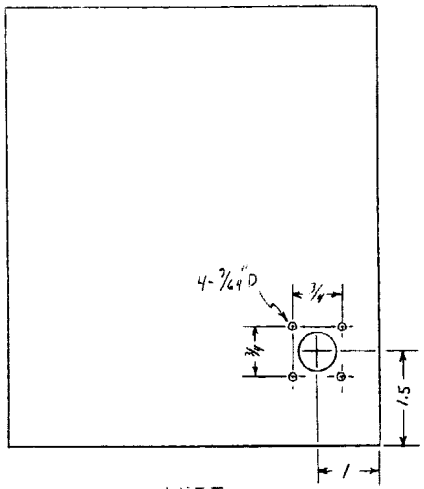
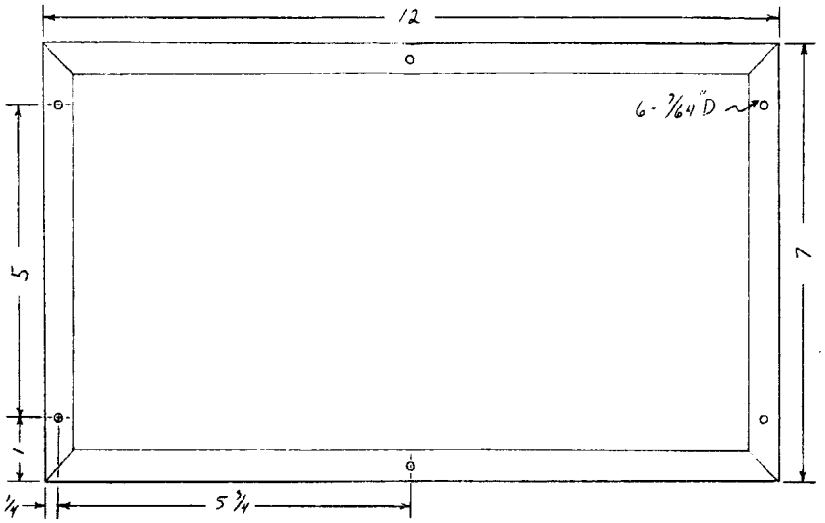


FIG 7C

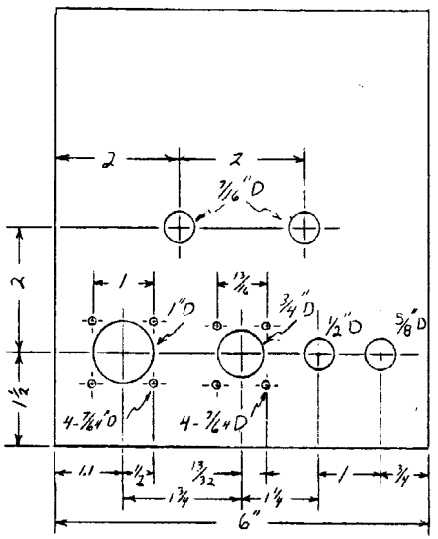

12
6
6 - 7/32 D
2 3/4 D
3 3/32 D
120°
3 - 0.177 D
5/32" D
4 1/4" D
5/32" D
1"
7
3
1 1/2
1
.35
2
2
2
.35
FRONT PANEL
6
5 3/4
6 - 7/32" D
1
2 1/2
7
4 - 3/16" D
1 1/2
2
2
REAR PANEL
10
5/8
5/8 R
1/4 D
3/16 D
2
3/16 D
1 1/2
1 1/4
BRACKETS



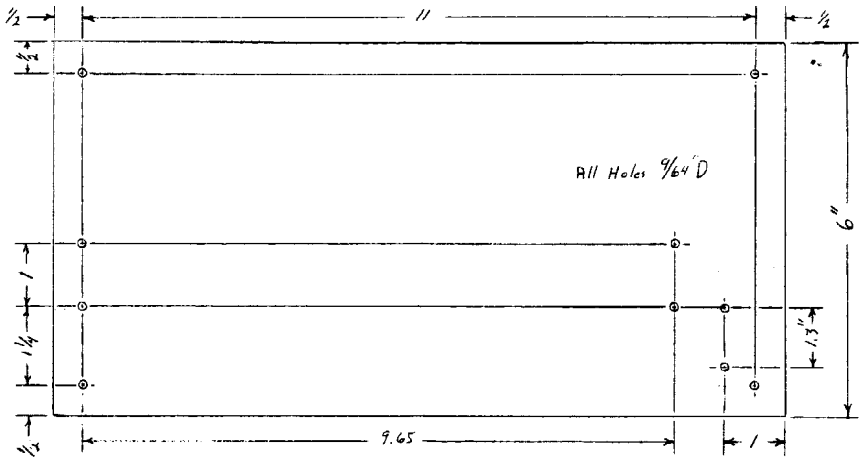
LEFT



FRONT-BACK



RIGHT



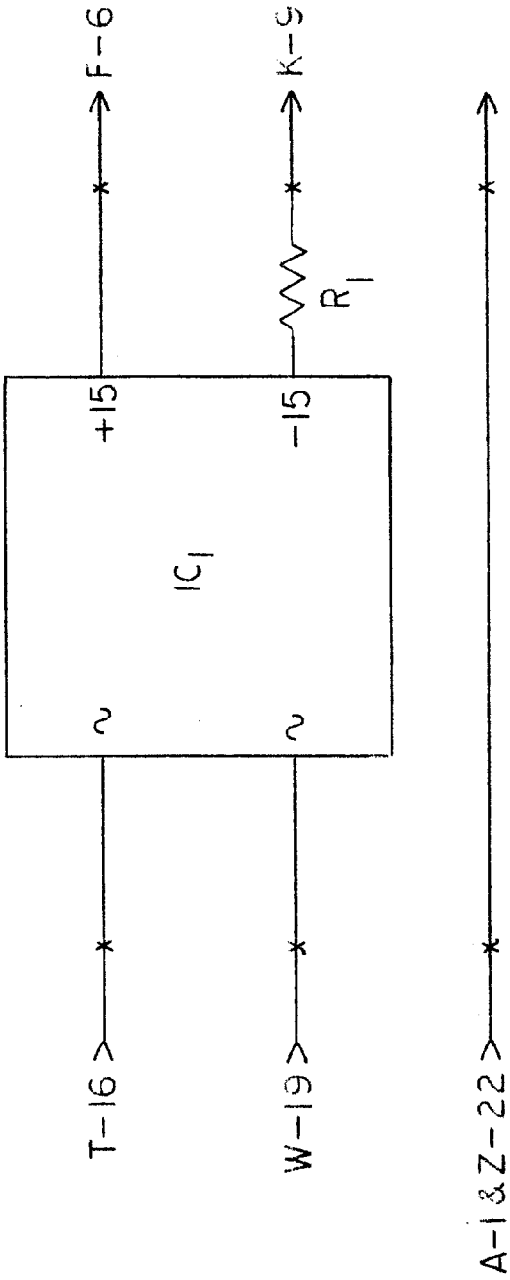
BOTTOM

RP 76 Edge Connector

Pin Number			Application
A ----- 1	-----		Ground
B 2			
C ----- 3	-----		+15VDC Out
D ----- 4	-----		-15VDC Out
E 5			
F 6			
H 7			
J 8			
K 9			
L 10			
M 11			
N 12			
P 13			
R 14			
S 15			
T ---- 16	-----		117 VAC High Input
U 17			
V 18			
W ---- 19	-----		117VAC Return Input
X 20			
Y 21			
Z ---- 22	-----		Ground

RP 76 Parts List

Ic_1	Lambda	LZD-32



RP179

RP 179 Edge Connector

Pin Number			Application
A	1	-------	Ground
B	2		
C	3		
D	4		
E	5		
F	6	-------	Interlock Output
H	7		
J	8		
K	9	-------	Interlock Common
L	10		
M	11		
N	12		
P	13		
R	14		
S	15		
T	16	-------	117 VAC High Input
U	17		
V	18		
W	19	-------	117 VAC Return Input
X	20		
Y	21		
Z	22	-------	Ground

RP 179 Parts List

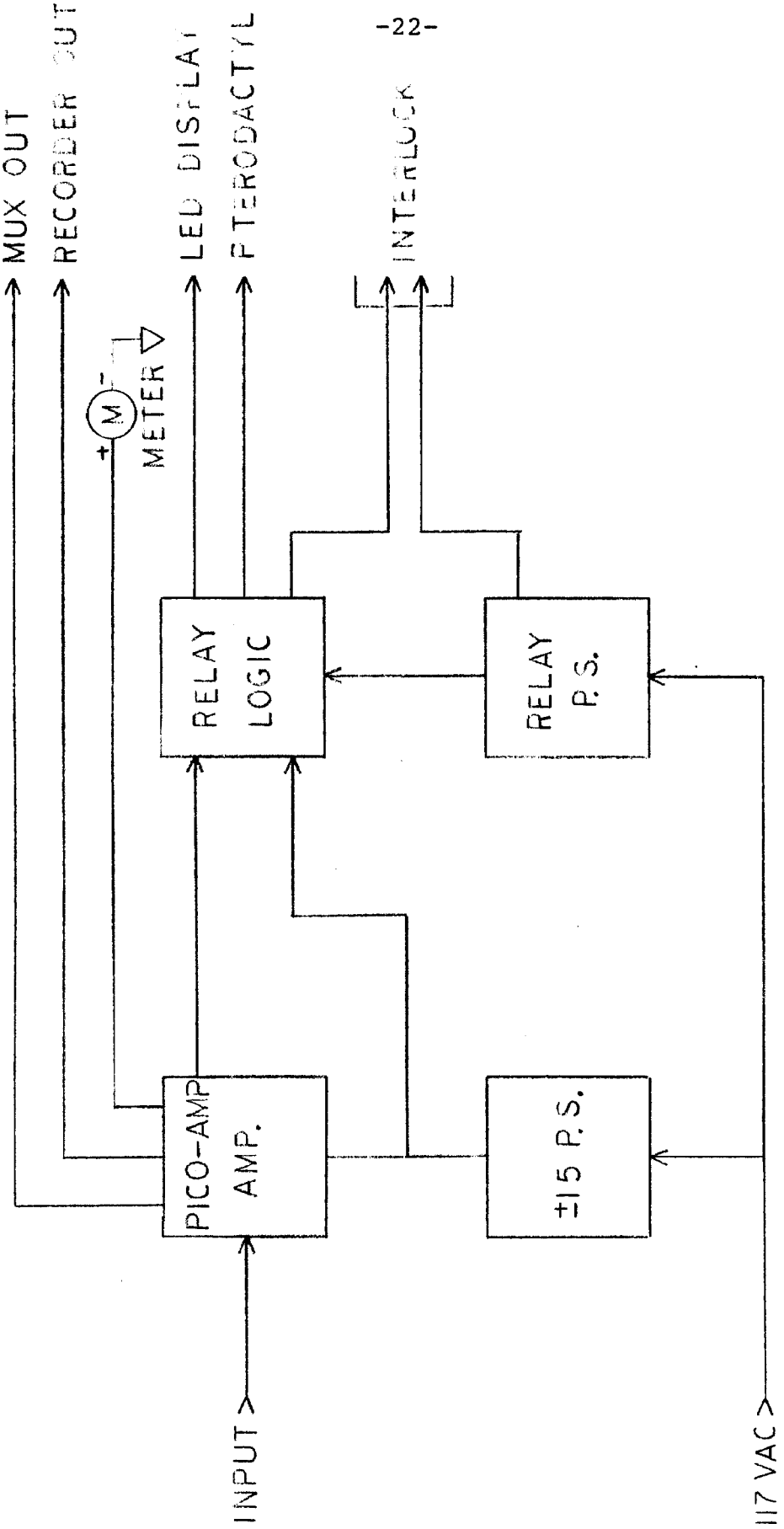
Ic_1	Intronics $\pm$15 VDC Supply
R_1	200 Ohm - 1/2W

System Interconnection

Figure #I is a block diagram at the Organ Pipe electronic system. Figure #II contains a wiring diagram of the Organ Pipe including external connector pin numbers and Scambe wiring.

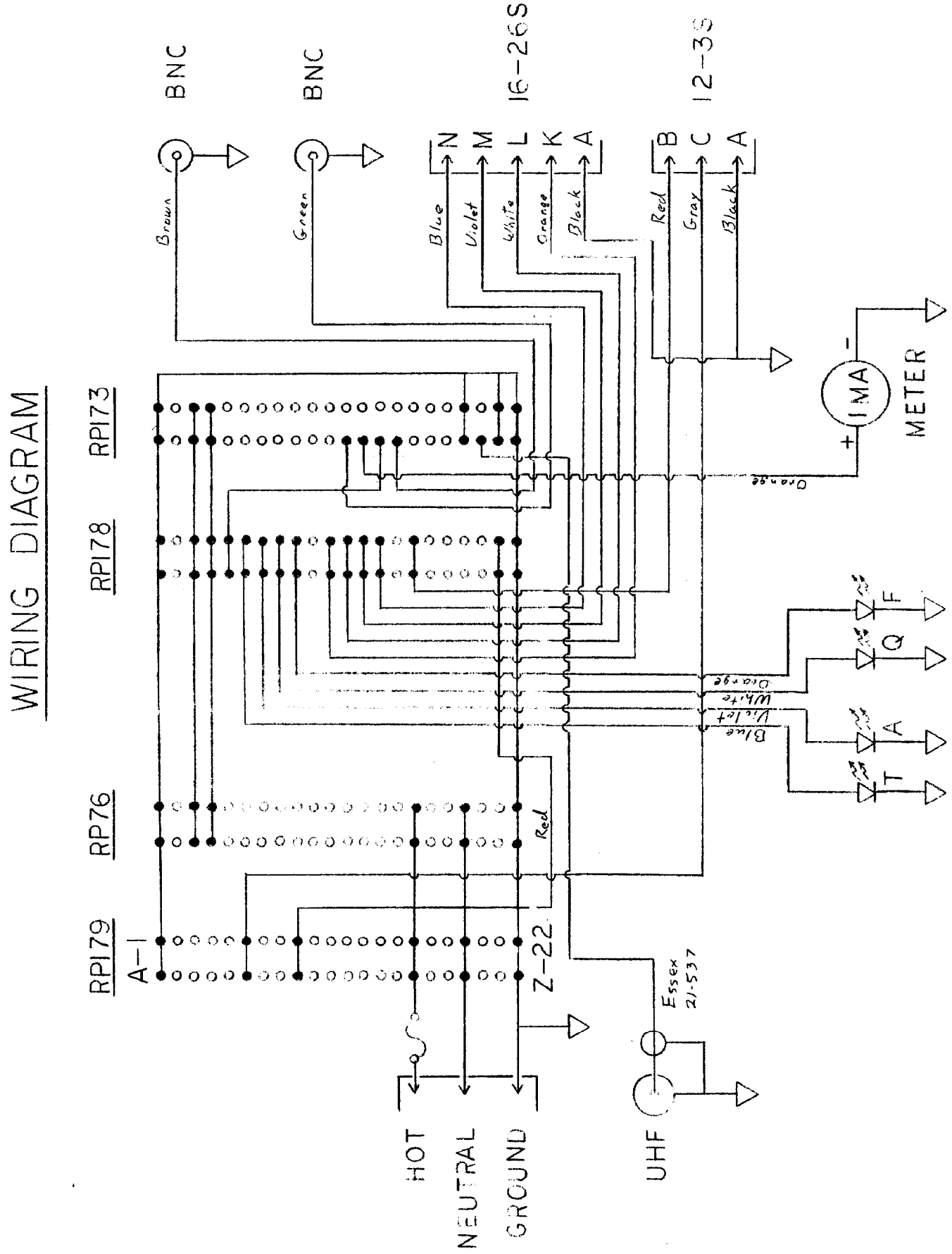
Along with wiring diagrams the following pages include mechanical layouts and construction information.

FIGURE #I

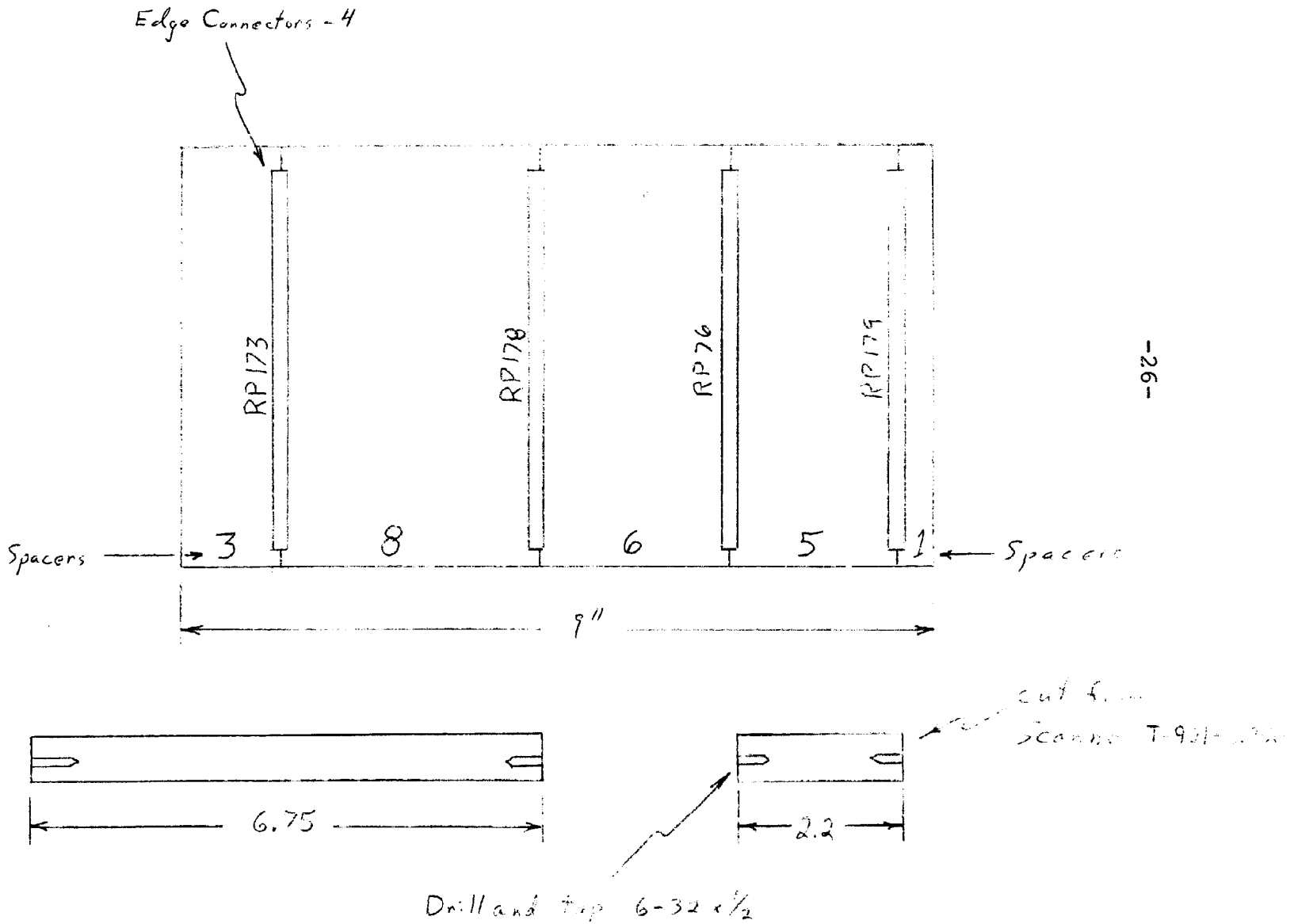


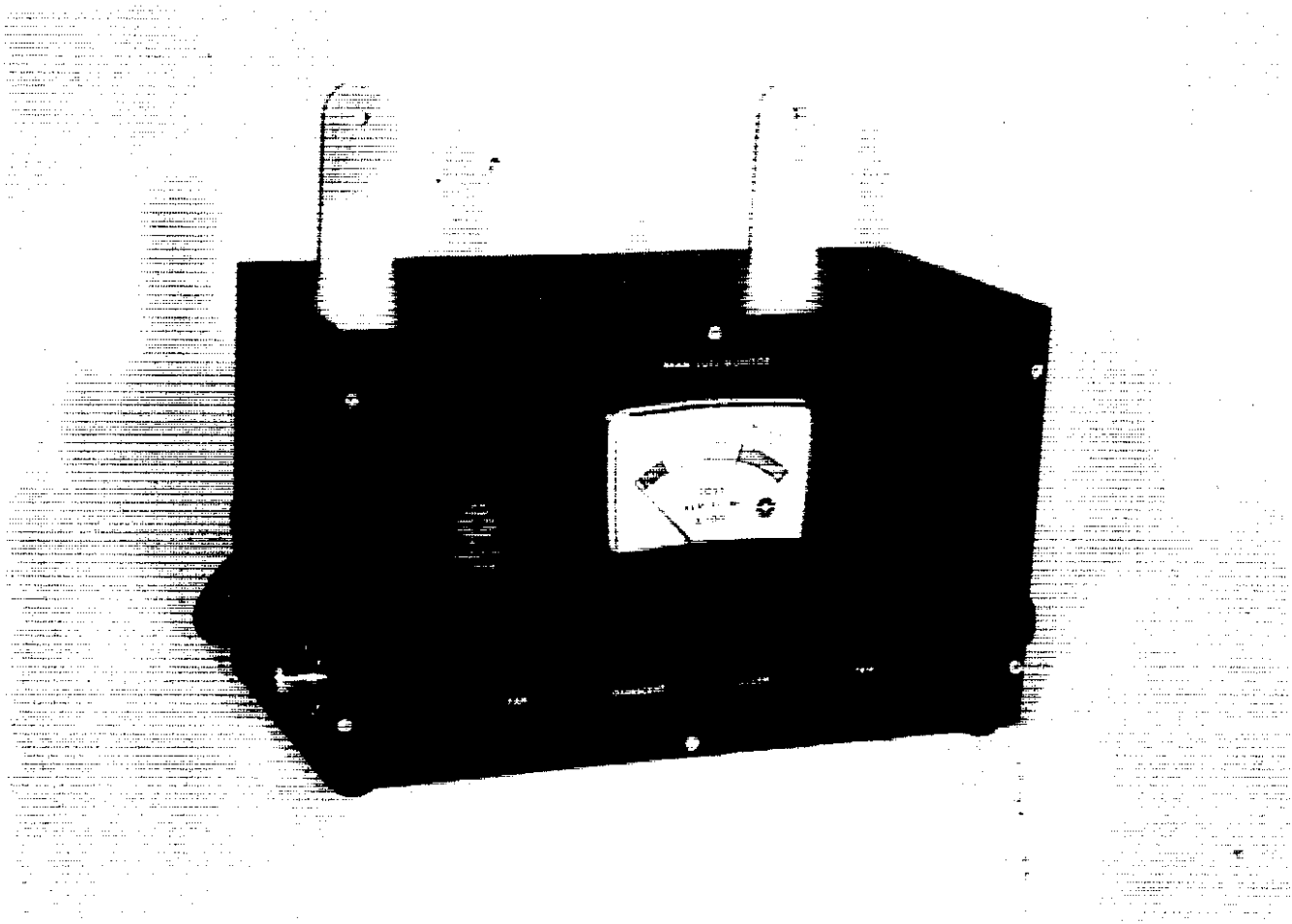
ORGAN PIPE
BLOCK DIAGRAM

FIGURE #II

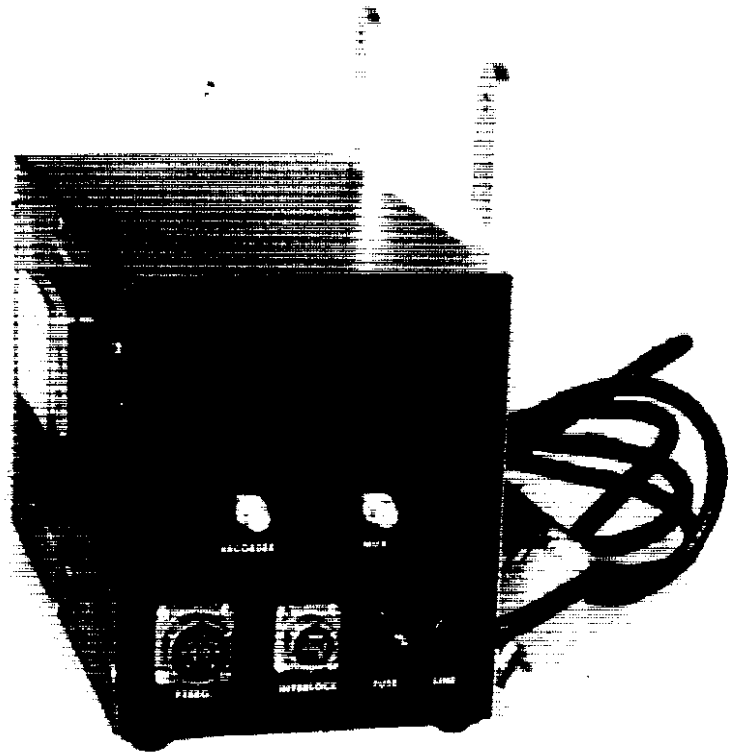

WIRING DIAGRAM
RP179
RP76
RP178
RP173
A-1
Z-22
BNC
BNC
16-26S
12-3S
Brown
Green
Blue
Violet
White
Orange
Black
Red
Gray
Black
N
M
L
K
A
B
C
A
1MA
METER
Orange
Blue
Violet
White
Orange
Red
F
Q
A
T
HOT
NEUTRAL
GROUND
UHF
Essex
21-537

SCANBE


Edge Connectors - 4
RP173
RP178
RP176
RP175
Spacers
3
8
6
5
1
Spacers
9"
6.75
2.2
Drill and tap 6-32 x 1/2



FRONT VIEW- Including Input connector



RIGHT SIDE- Including Output Connectors

Chassis Mounted Components

Quantity	Discription	Comments
1	UHF Connector	Type 83-798 Newark 39F 049
1	16-26S	NAL Stock #1430-2440
1	12-3S	NAL Stock #1430-2380
2	BNC Bulkhead	NAL Stock #1435-4050
1	Fuse Holder	NAL Stock #1120-2320
1	Fuse 1/4A. SB	NAL Stock #1120-0360
1	Line Cord	NAL Stock #1170-1350
1	Line Cord Restraint	
1	Twist-lock Plug	Pass and Segmour 4720-SS
1	Twist-lock Socket	Pass and Segmour 4730-SS
92	0.300" Spacer	Scanbe #T-101-300
8	Cardguides	Scanbe #T-211-28-1
6	Mounting Bars	Scanbe #T-901-6.750
2	End Brackets	Made by Fracar for Chipmunks
	Wire #22 guage	NAL Stock
12	4-40 x 1/4"	NAL Stock #1226-1550
18	6-32 x 1/4"	NAL Stock #1226-1575
2	6-32 x 1" Allen Skt. Hd.	NAL Stock #1226-1035
4	6-32 Nylon Nut	NAL Stock #1214-0500
4	8-32 x 1/2"	NAL Stock #1226-1610
4	8-32 Hex Nut	NAL Stock #1212-1040
4	1/2" Pillar 6-32	NAL Stock #1450-1500
12	4-40 Hex Nut	NAL Stock #1212-1000
4	Rubber Feet	NAL Stock #1450-0550
1	Enclosure	Bud Cu-1124HG
1	Terminal Strip	Mfr. type 3003 Allied #920-280
2	Mounting Bars	See drawing
4	LED	HP #5082-4440
4	LED Mtg. Clip	HP #5082-4707
1	RP 182 LED Board	

System Test Results

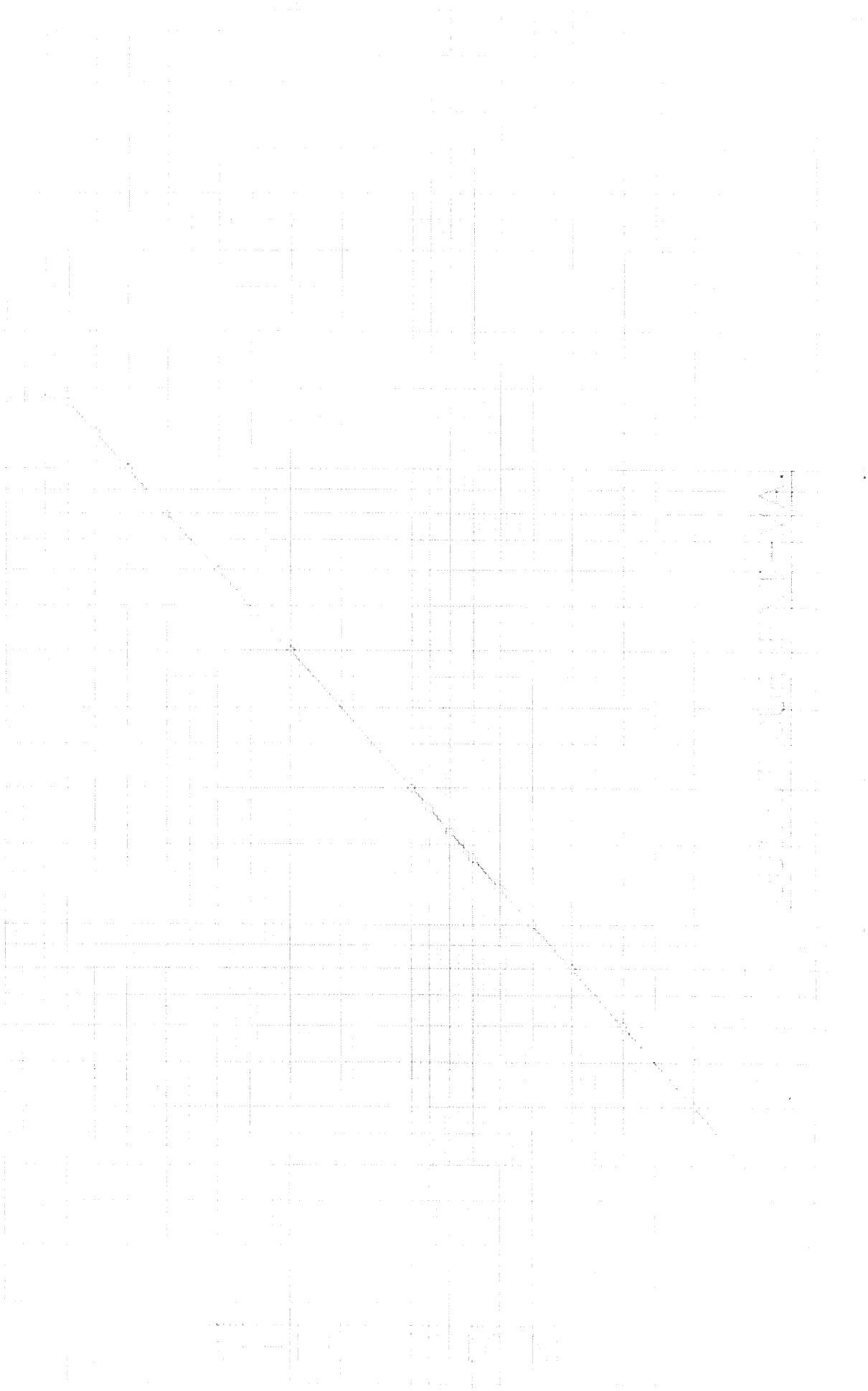
Table #III is a listing of recorder output current as a function of input current. Graph #I is a plot of this data. Table #IV is a listing of data representing the MUX output repetition rate as a function of input current, this data is plotted in Graph #II. Table #V lists the three relay logic trip points for both positive and negative sloped input currents. Graph #III is a plot of this data showing the hysteresis in each trip point.

Table #III

Recorder Output Current vs. Input Current

Input Current - pA	Output Current - mA
1	0.019
2	0.04
3	0.06
4	0.08
5	0.1
6	0.12
7	0.14
8	0.16
9	0.18
10	0.2
20	0.4
30	0.599
40	0.799
50	1.0
60	1.2
70	1.4
80	1.42
90	1.42
100	1.42

GRAPH #I



GRAPH #I

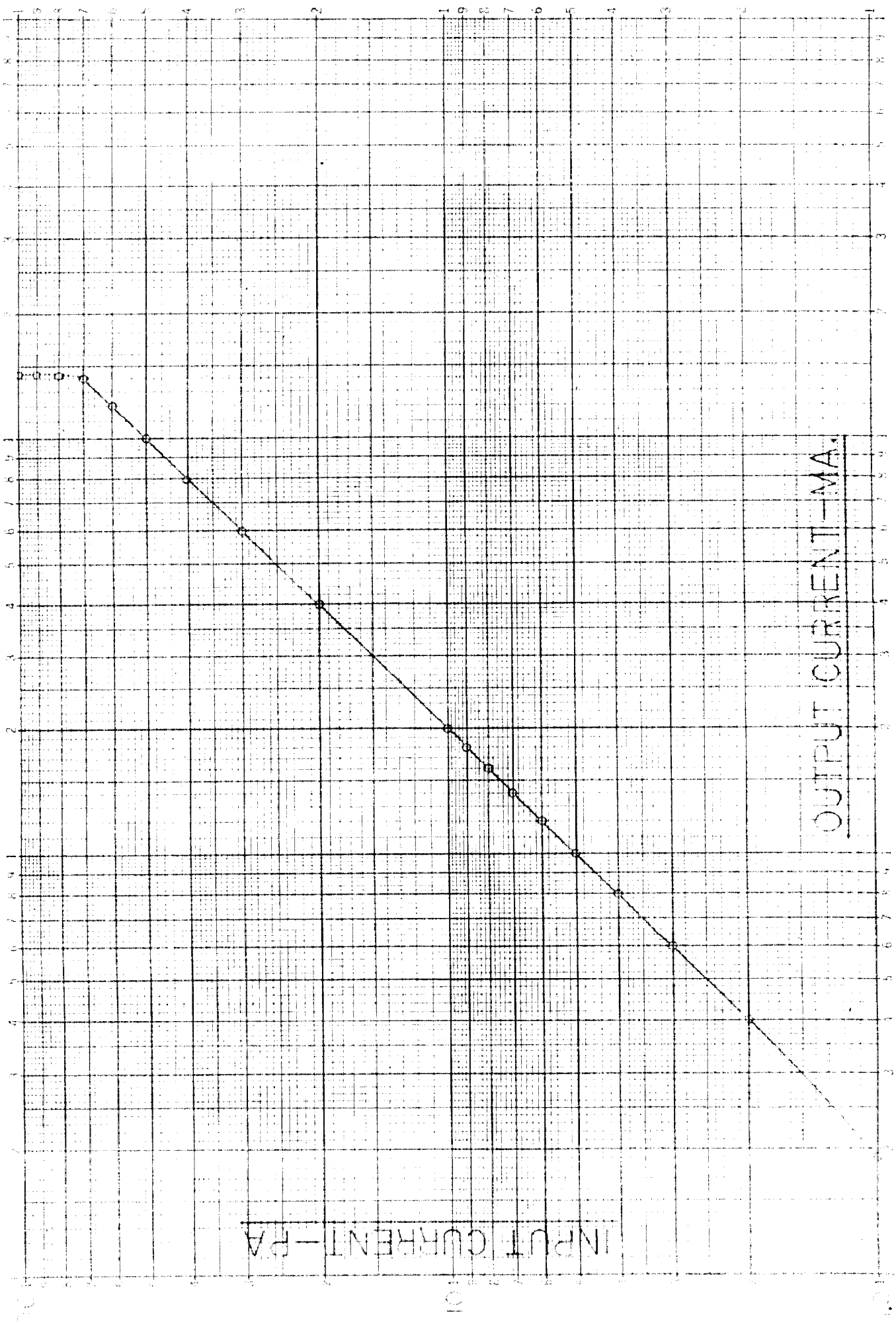


Table #IV

MUX Output Frequency vs. Input Current

Input Current - pA	MUX Frequency - Hz
1	0.4
2	0.8
3	1.2
4	1.5
5	1.9
6	2.3
7	2.7
8	3.0
9	3.4
10	3.8
20	7.6
30	11.3
40	15.1
50	18.8
60	22.6
70	26.6
80	26.6
90	26.6
100	26.6

GRAPH #II

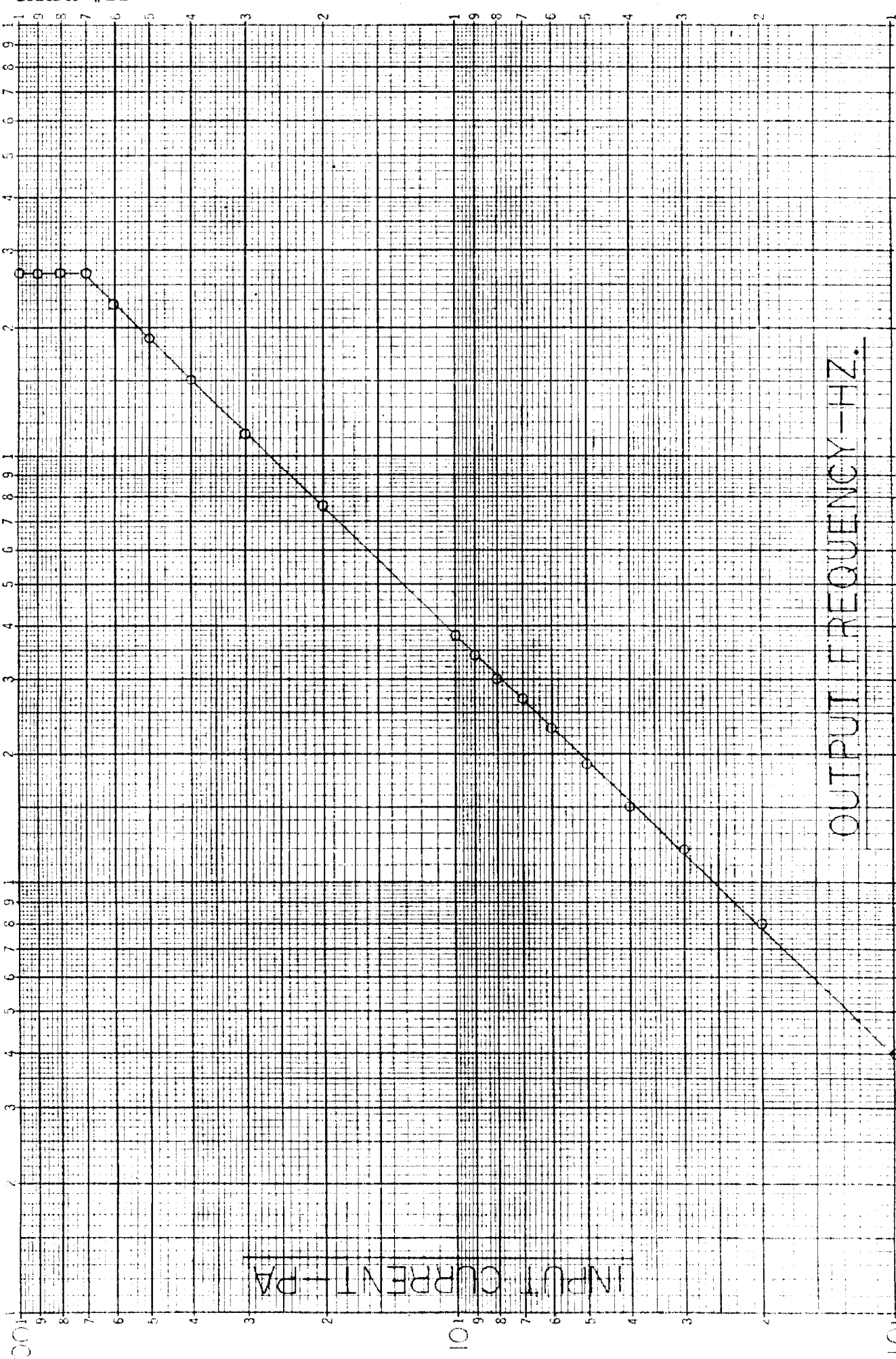
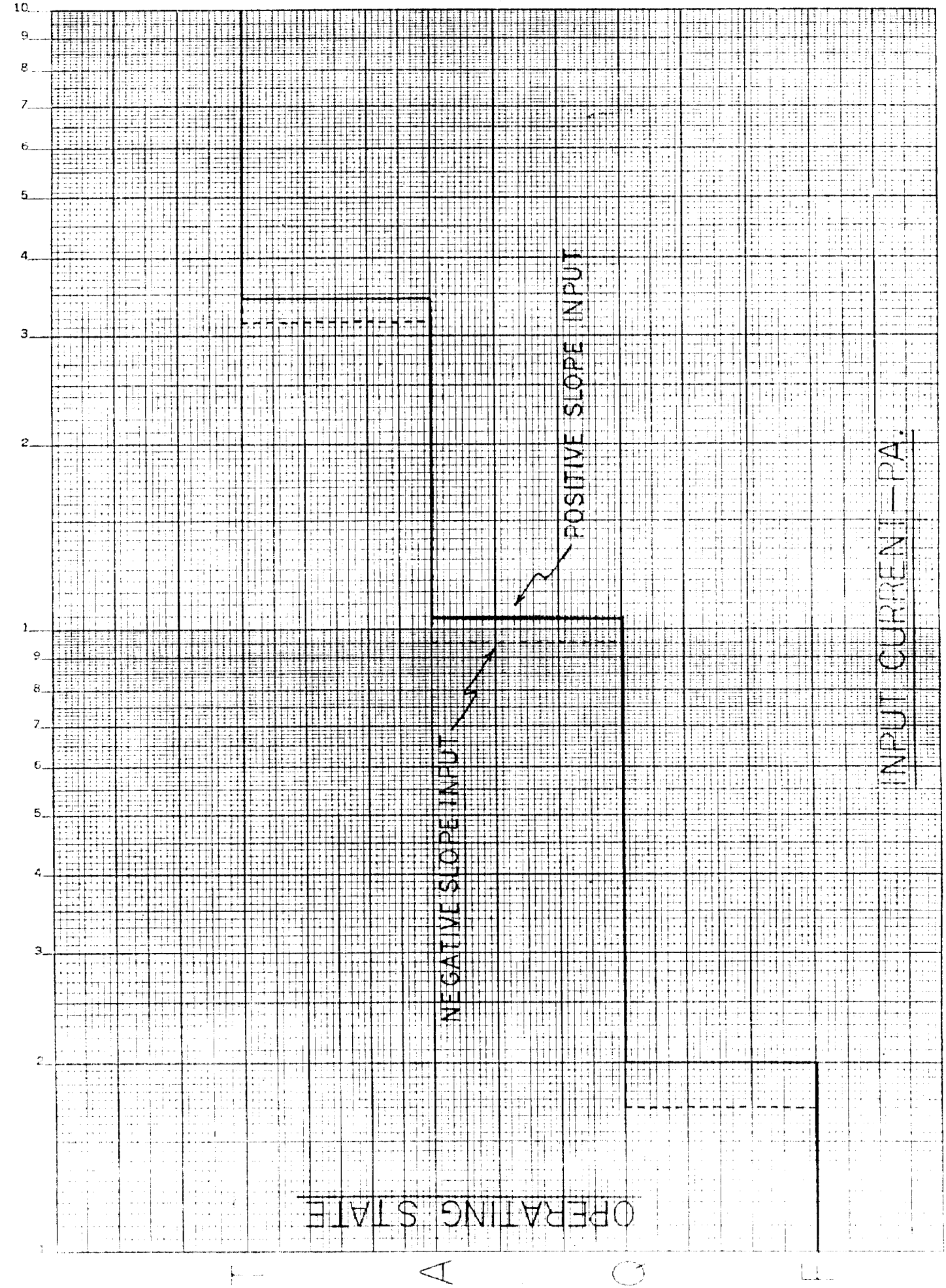


Table #V

Input Slope	Trip Points		
	Fail - Quies.	Quies.-Alarm	Alarm - Trip
Positive	2pA	10.3pA	34.5pA
Negative	1.7pA	9.5pA	31.5pA

GRAPH #III


POSITIVE SLOPE INPUT
NEGATIVE SLOPE INPUT
INPUT CURRENT — PA
OPERATING STATE
SEMI-LOGARITHMIC
46 5130
KEUFFEL & ESSER CO.

Electronic Calibration Procedures

Measure all voltages with a voltmeter with an input impedance of 1 Meg Ohm or greater such as a Fluke model 8000A DVM.

RP 173: Refer to RP 173 Schematic for the following calibration procedure.

( ) Disconnect the UHF input connector and connect the voltmeter to the Recorder Output connector of the Organ Pipe.

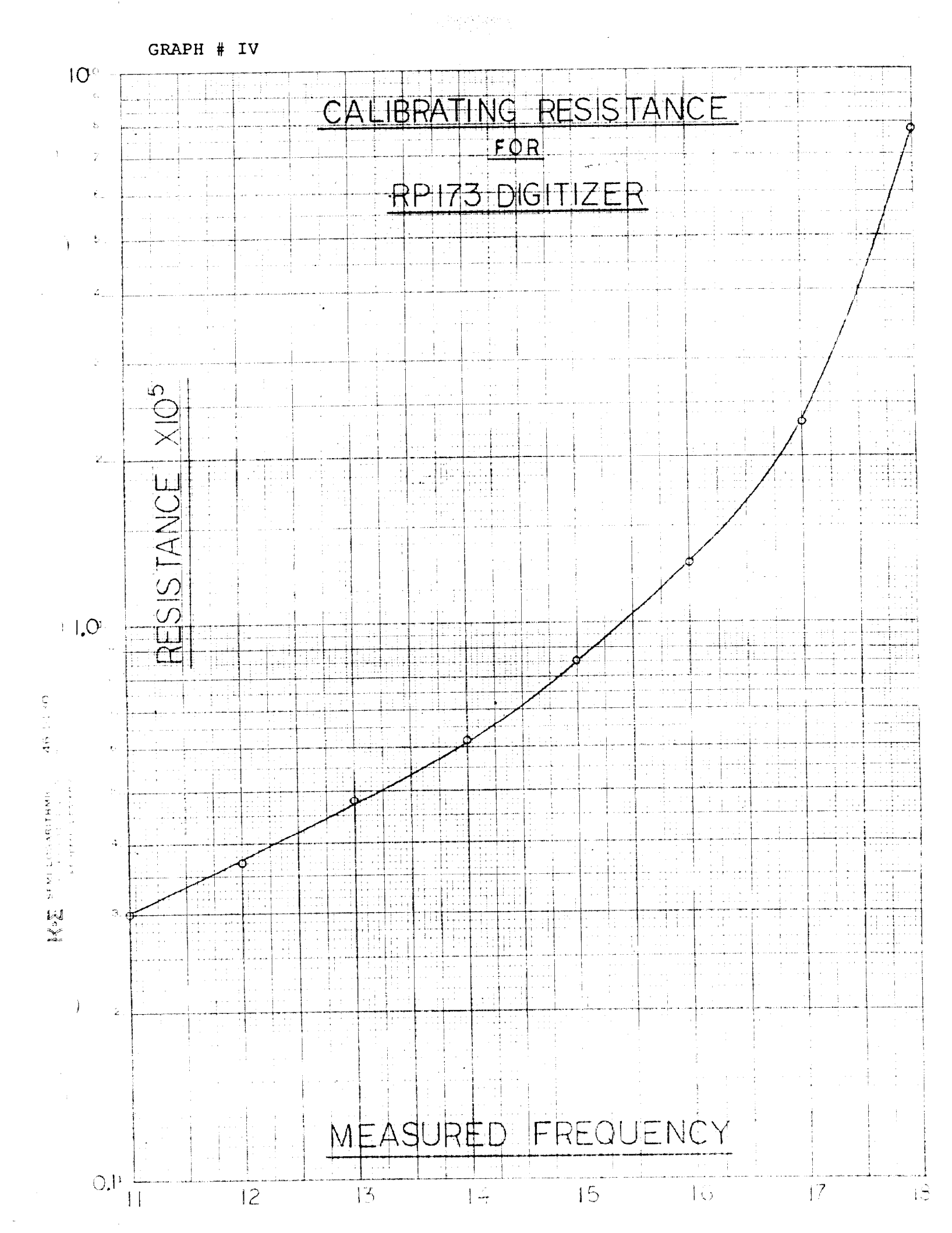
( ) Adjust R_1 (Zero adj.) for an output voltage of $0 \pm 1mV$.

( ) Connect the input to a 50pA source with an output impedance of 10^{11} ohms or greater. Adjust R_4 (50pA Cal.) for an output voltage of 10 Volts $\pm$ 1%.

( ) Remove R_6 from the circuit board and measure the frequency of the MUX. output pulse train with an input of 50 pA. Select the proper value for R_6 by the following equation:

$$\frac{\text{Measured Frequency}}{18.5H_z} = \frac{R_6}{R_5+R_6}$$

GRAPH # IV


CALIBRATING RESISTANCE
FOR
RP173 DIGITIZER
RESISTANCE X10^5
10
1.0
0.1
MEASURED FREQUENCY
11
12
13
14
15
16
17

Graph #IV is a graph of the proper value of R_6 for any measured frequency from 11 to 18 H_z. This completes the calibration of the RP 173 board.

RP 178: Refer to the RP 178 schematic for the following calibration procedure.

( ) Remove resistors R_2, R_4 and R_7 from the circuit board.

( ) Adjust the input current from Zero pA until K_1 trips and record the input current required to make K_1 trip. Determine the proper value of R_7 by the following equation:

$$\frac{\text{Measured Trip Current}}{2\text{pA.}} = \frac{R_7}{R_6+R_7}$$

( ) Install R_7.

( ) Adjust and record the input signal in a similar manner until K_2 trips. Determine the proper value of R_4 by the following equation.

$$\frac{\text{Measured Trip Current}}{10\text{pA.}} = \frac{R_4}{R_3+R_4}$$

( ) Install R_4.

( ) Adjust the input signal in a similar manner until K_3 trips. Determine the proper value of R_2 by the following equation:

$$\frac{\text{Measured Trip Current}}{34\text{pA.}} = \frac{R_4}{R_3+R_4}$$

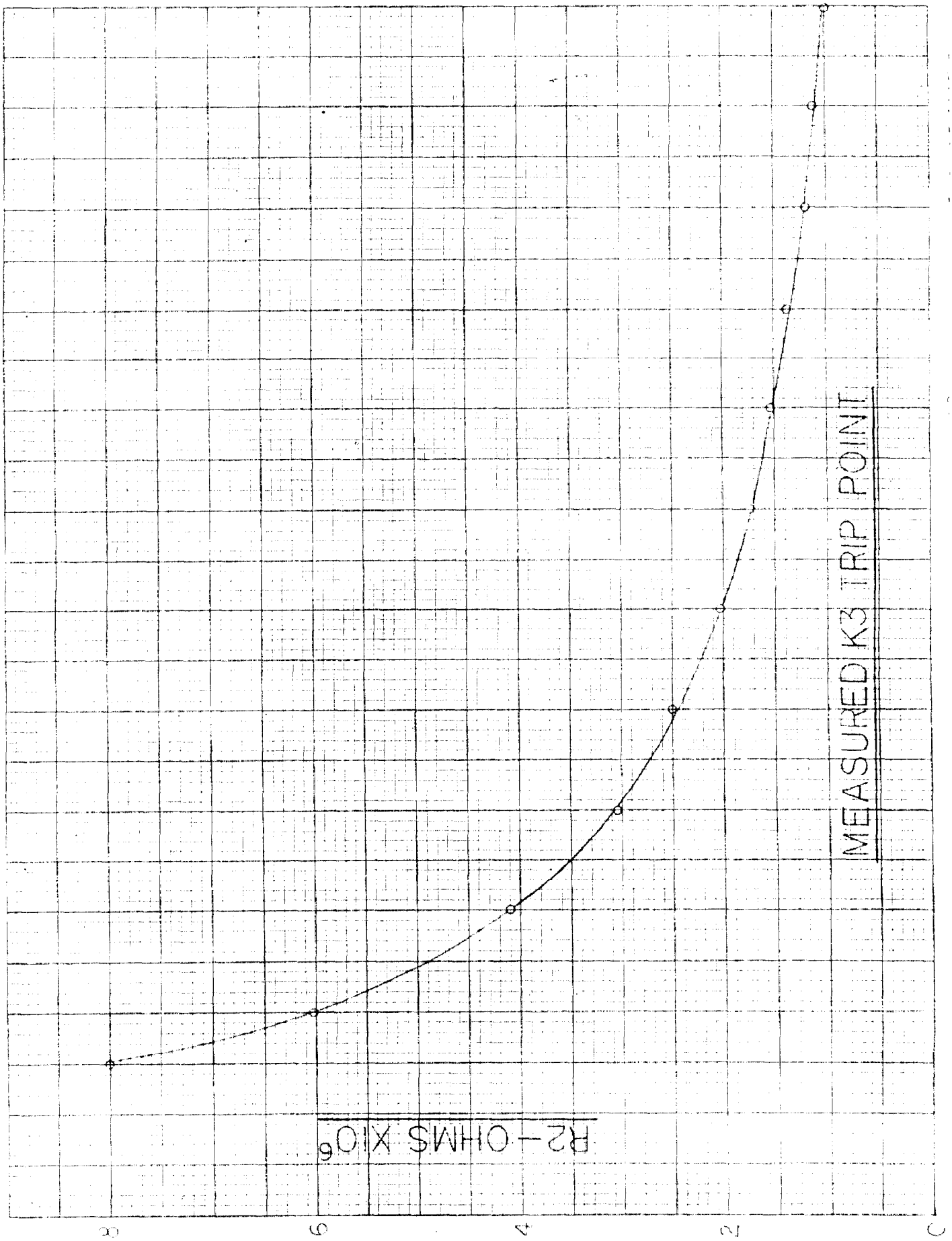
( ) Install R_2.

Graphs #V, VI and VII are graphs of the proper values of R_2, R_4 and R_7 as a function of different measured trip currents. Check the three trip currents to insure that the relays trip as follows.

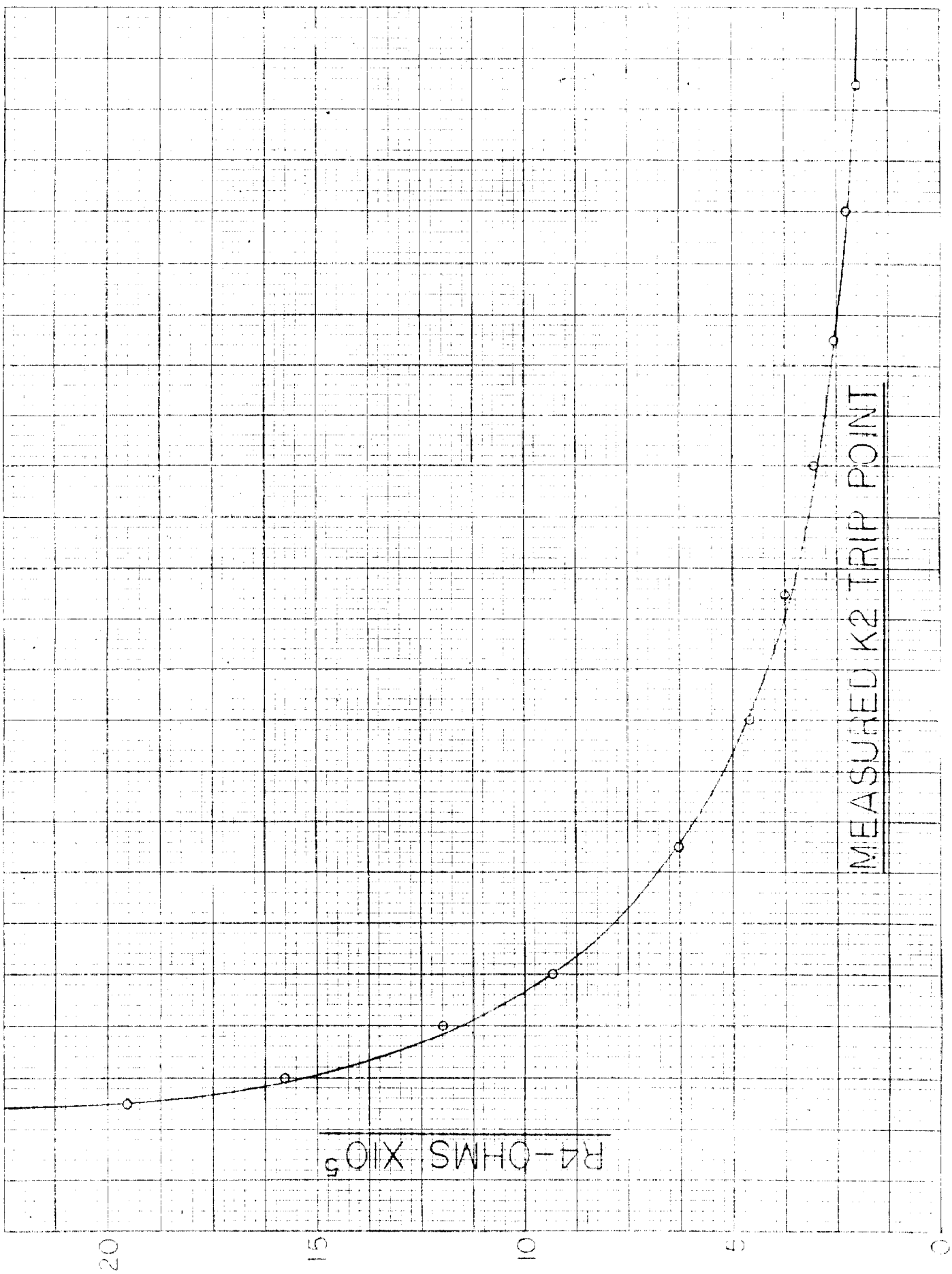
Relay		Trip Current
K_1	---------	2pA $\pm$ 5%
K_2	---------	10pA $\pm$ 5%
K_3	---------	34pA $\pm$ 5%

This completes the calibration procedures.

GRAPH #V



GRAPH #VI



GRAPH #VII