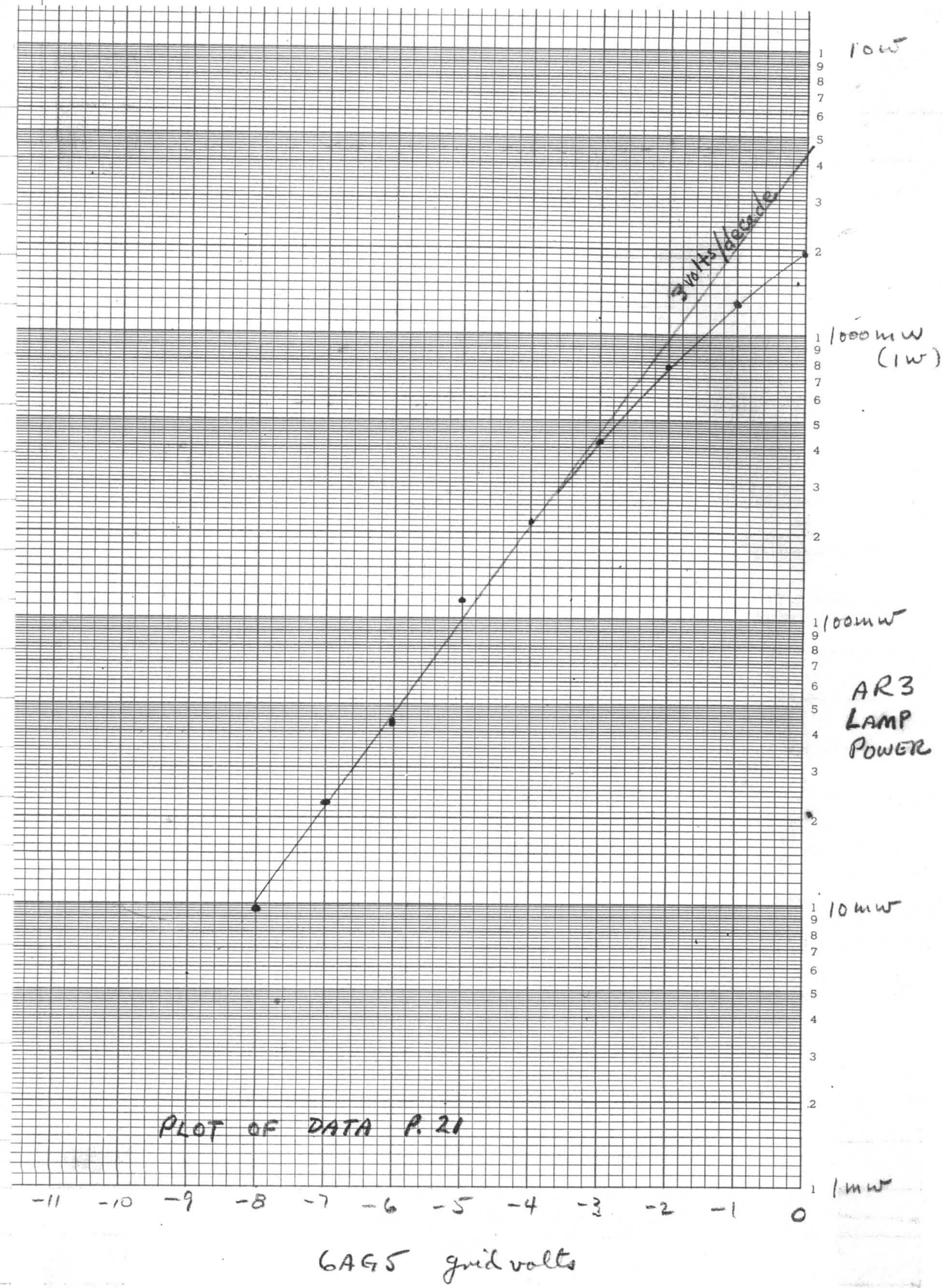
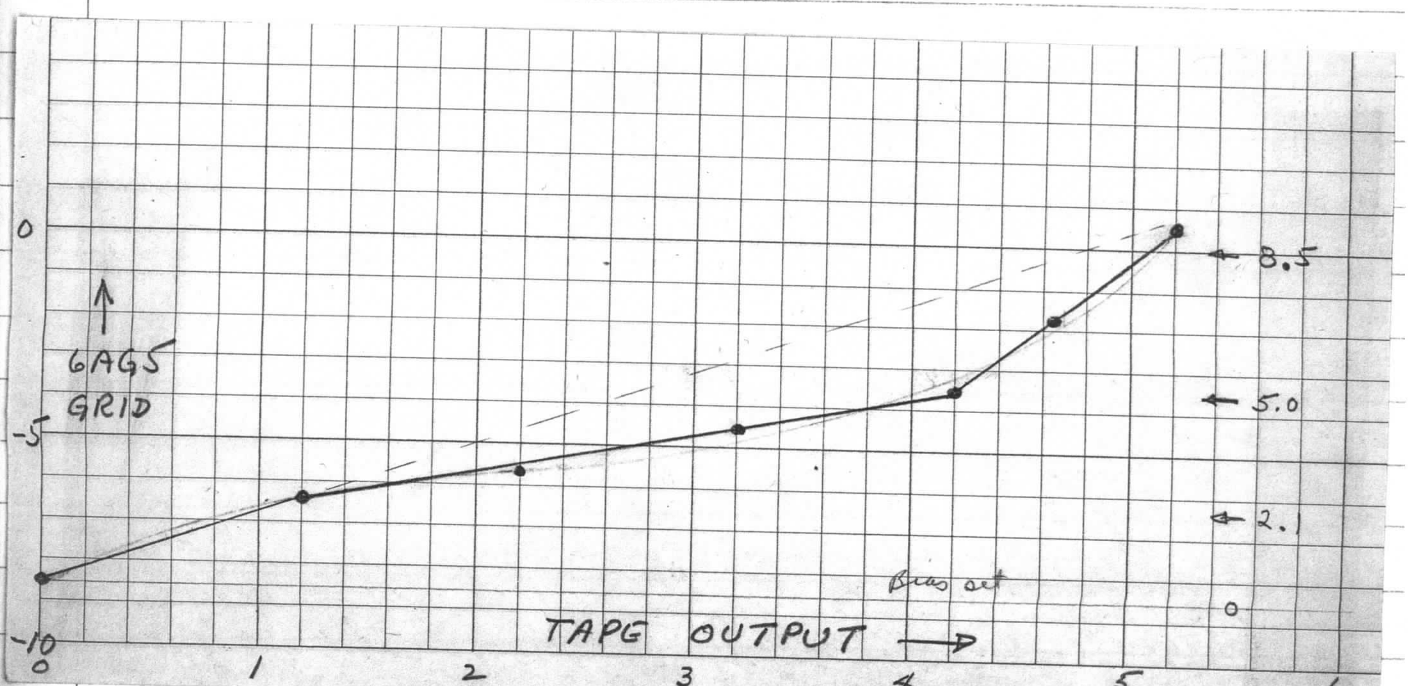
	#1	#2	Reverse Sequence #3	#4
2/14/65	5.0	4.8	4.7	4.8
	4.0	3.9	3.8	3.8
	3.5	3.5	3.4	3.4
	3.3	3.0	2.9	3.0
	2.8	2.6	2.6	2.6
	2.1	2.0	2.0	2.0
	1.8	1.8	1.7	1.7
	1.2	1.2	1.2	1.1
	0.8	0.8	0.8	0.8
	0.2	0.2	0.2	0.2

Peak-to-peak measurements at output of 1st amplifier, driver for diode network, p16 point (Q). Sync level set at 5v p-p per p.9.

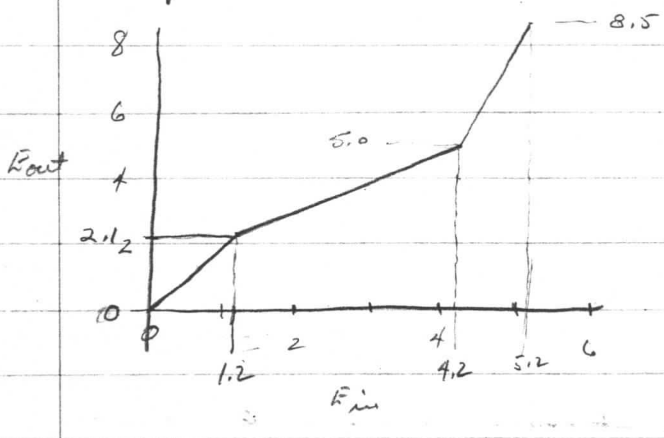

10W
1000mW
(1W)
100mW
10mW
1mW
AR3
LAMP
POWER
3volts/decade
PLOT OF DATA P. 21
-11
-10
-9
-8
-7
-6
-5
-4
-3
-2
-1
0
6AG5 grid volts

For Royal-X Pan, density range may be from 2.0 to 0.5 (30:1 or 1.5 units. This will take about 100:1 exposure range.
With the gross assumption that 10 ma corresponds to 0.1 mcs exposure, the 100:1 exposure range will require running down to -9 volts from 0 volts on 6AG5 grid.
From characteristic in handbook for Royal-X.

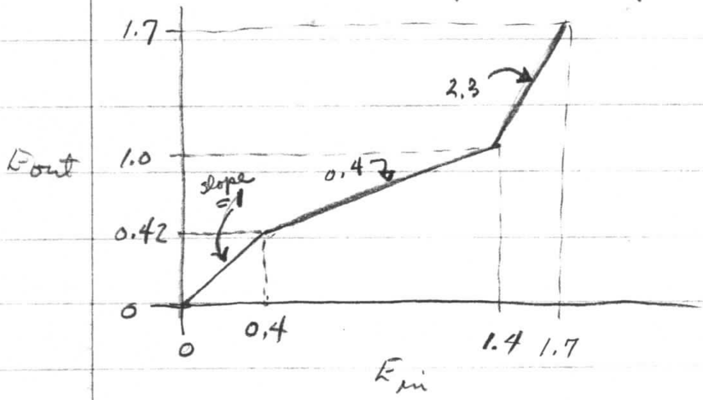
Density	log Exposure	$\log_{10}$ Illum add +2.67 for conversion to p27 data	Input Power	6AG5 grid	Gagy Level	tape output	6AG5 grid -(-8.5 bias)
2.0	-1.0	+1.67	2380 mw	0+	-1	5.2	8.5+
1.85	-1.3	+1.37	800 mw	-1.9	0	4.65	
1.7	-1.6	+1.07	300 mw	-3.5	1	4.2	5.0
1.4	-2.0	+0.67	130 mw	-4.6	3	3.2	3.9
1.1	-2.4	+0.27	57 mw	-5.7	5	2.2	2.8
0.8	-2.68	-0.01	33 mw	-6.4	7	1.2	2.1
0.5	-3.0	-0.33	7 mw	-8.5	9	0.2	0
0.2	-∞						



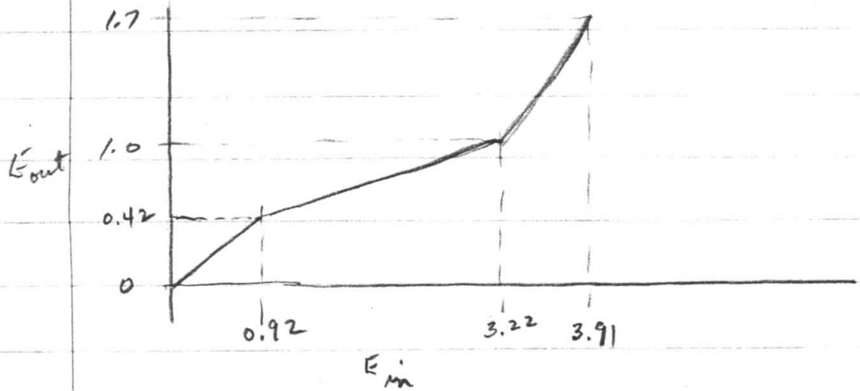
2/15/65 To produce this characteristic with 0.4 v diodes:



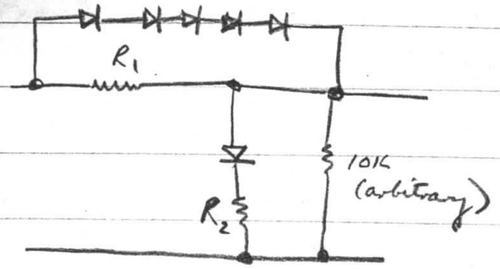
operate in circuit at a level to bring the first break to 0.4 v.
Scales are arbitrary depending on circuit gain.



Since one section has a gain of 2.3 this must be reduced to 1



2.3	2.3
1.7	1.4
161	92
23	23
3.91	3.22



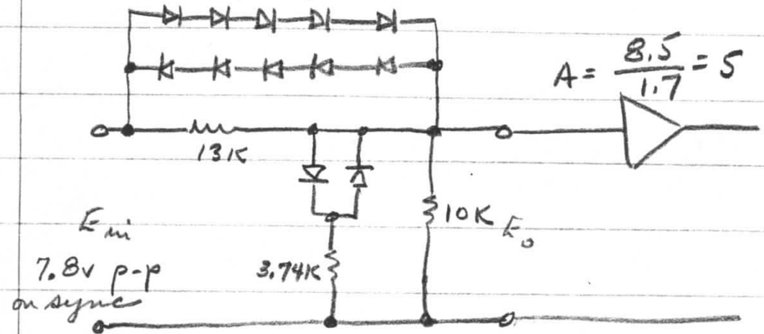
$E_0 < 0.4$ v   divider ratio is $\frac{1}{2.3}$, $R_1 = 13K$

$0.4 < E_0 < 1.0$ divider ratio is $\frac{0.4}{2.3} = 0.173$, solving; $R_2 = 3.74K$

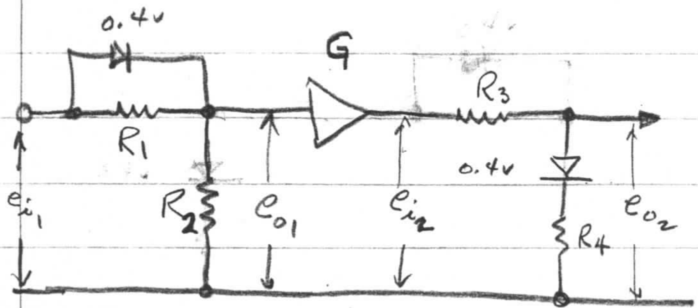
$E_0 > 1.0$ divider ratio is 1.0, at this point $E_{in} = 3.22$

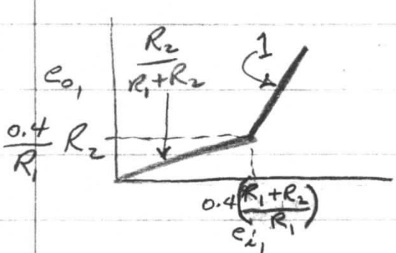
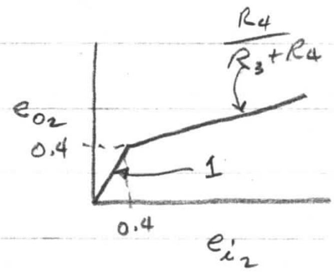
∴ diode string threshold is 2.22 volts or about 5 diodes.

Since the levels are low, this must be followed by amplification a-c preferably.

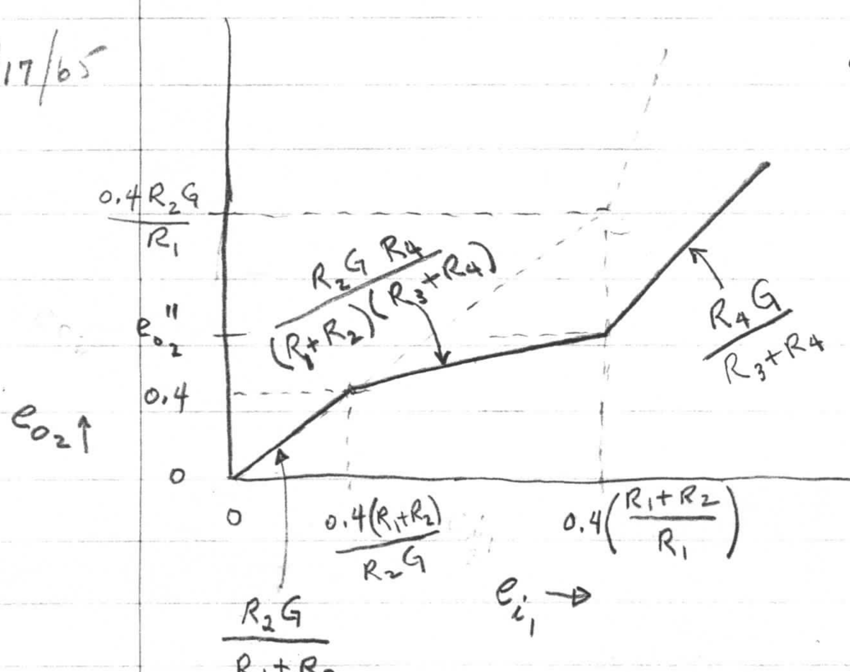


2/16/65 Alternatively the network can be broken in two with gain in between sections



2/17/65



$e_{i_2} = e_{o_1} G$

For second network

$$(e_{o_2} - 0.4) = (e_{i_2} - 0.4)\frac{R_4}{R_3+R_4}$$

$$= (e_{o_1}G - 0.4)\frac{R_4}{R_3+R_4}$$

at second break on composite; the break of the first network

$$e_{o_1} = 0.4\frac{R_2}{R_1}$$

$$e''_{o_2} - 0.4 = \left(0.4\frac{R_2}{R_1}G - 0.4\right)\frac{R_4}{R_3+R_4}$$

$$e''_{o_2} = 0.4\frac{R_2 G R_4}{R_1(R_3+R_4)} - 0.4\frac{R_4}{R_3+R_4} + 0.4$$

$$\underbrace{- 0.4\frac{R_4}{R_3+R_4} + 0.4} = + 0.4\frac{R_3}{R_3+R_4}$$

$$-0.4\frac{R_4}{R_3+R_4} + 0.4$$

$$-0.4\left(\frac{R_4}{R_3+R_4} - 1\right)$$

$$-0.4\frac{R_4-R_3-R_4}{R_3+R_4}$$

$$0.4\frac{R_3}{R_3+R_4}$$

$$e''_{o_2} = 0.4\frac{R_2 G R_4}{R_1(R_3+R_4)} + 0.4\frac{R_3}{(R_3+R_4)}\frac{R_1}{R_1}$$

$$e''_{o_2} = 0.4\left[\frac{R_2 R_4 G + R_1 R_3}{R_1(R_3+R_4)}\right] = 0.4\left[\frac{K_1 G K_2}{1-K_1} + 1 - K_2\right]$$

2/17/65

$$\frac{R_2}{R_1+R_2} \equiv K_1 \qquad \frac{R_4}{R_3+R_4} \equiv K_2$$

$$K_1 - 1 = \frac{R_2}{R_1+R_2} - \frac{R_1+R_2}{R_1+R_2} = \frac{-R_1}{R_1+R_2}$$

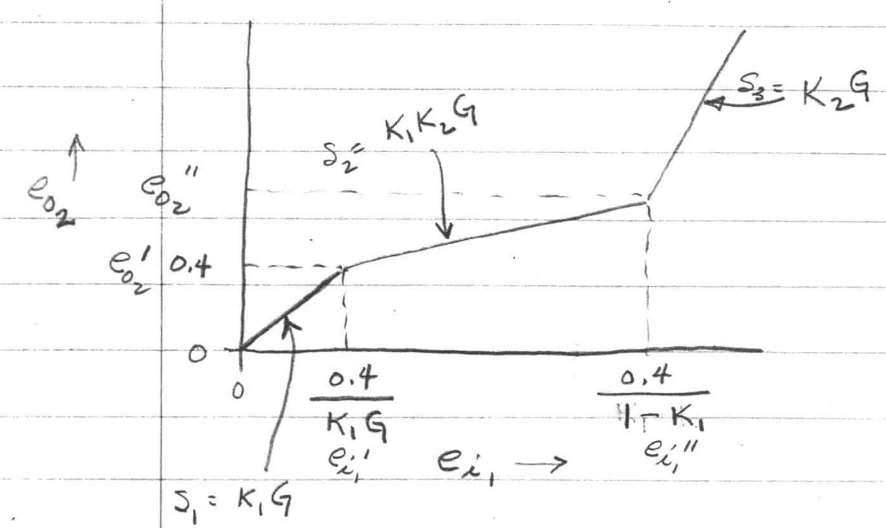
$$\frac{1}{K_1} = \frac{R_1+R_2}{R_2} = \frac{R_1}{R_2} + 1$$

$$\frac{1}{K_1} - 1 = \frac{R_1}{R_2} = \frac{1-K_1}{K_1}$$

$$e''_{o_2} = 0.4\left[\frac{K_1 K_2 G}{(1-K_1)} + (1-K_2)\right]$$

$$= 0.4\left[\frac{K_1K_2G + 1 - K_1 - K_2 + K_1K_2}{1-K_1}\right]$$

$$= 0.4\left\{\frac{K_2(K_1G + K_1 - 1)}{1-K_1} + 1\right\}$$



$$\frac{e_{i_1}''}{e_{i_1}'} = \frac{\frac{0.4}{1-K_1}}{\frac{0.4}{K_1 G}} = \frac{K_1 G}{1-K_1} = \frac{R_2}{R_1} G$$

For desired response

$$\frac{e_{i_1}''}{e_{i_1}'} = \frac{4.2}{1.2} = 3.5 = \frac{R_2}{R_1} G$$

$$S_1 = \frac{2.1}{1.2} = 1.75$$

$$S_2 = \frac{5.0-2.1}{4.2-1.2} = 0.967 \quad (2.9),\ (3)$$

$$S_3 = \frac{8.5-5.0}{1.0} = 3.5$$

$$\frac{S_2}{S_1} = K_2 = \frac{0.967}{1.75} = 0.55$$

$$S_3 = K_2 G = \frac{8.5-5.0}{1.0} = 3.5$$

$$\frac{S_3}{S_2/S_1} = G = \frac{3.5}{0.55} = 6.36$$

$$\frac{R_2}{R_1} = \frac{e_{i_1}''}{e_{i_1}'} \frac{1}{G} = \frac{3.5}{1.45} = 2.42$$

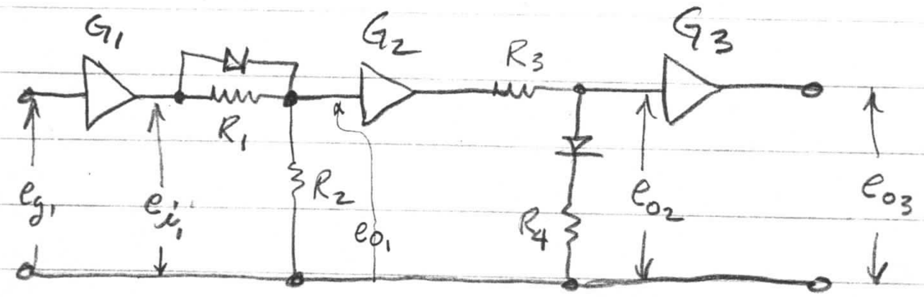
$$S_1 = K_1 G \qquad K_1 = \frac{S_1}{G} = \frac{1.75}{6.36} = 0.275$$

$$\frac{R_1}{R_2} = \frac{1}{2.42} = 0.414$$

$$\frac{R_1}{R_2} + 1 = \frac{R_1 + R_2}{R_2} = 1.414$$

$$\frac{R_2}{R_1 + R_2} = K_1 = 0.707$$ which does not check.

The above derivation cannot work unless the input and output levels are compatable with the 0.4 v break points. G_1 & G_3 must be considered.



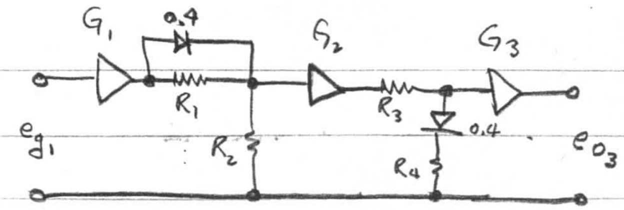
$$e_{o_2}' = 0.4\text{v} \qquad e_{o_3}' = 2.1\text{v}$$

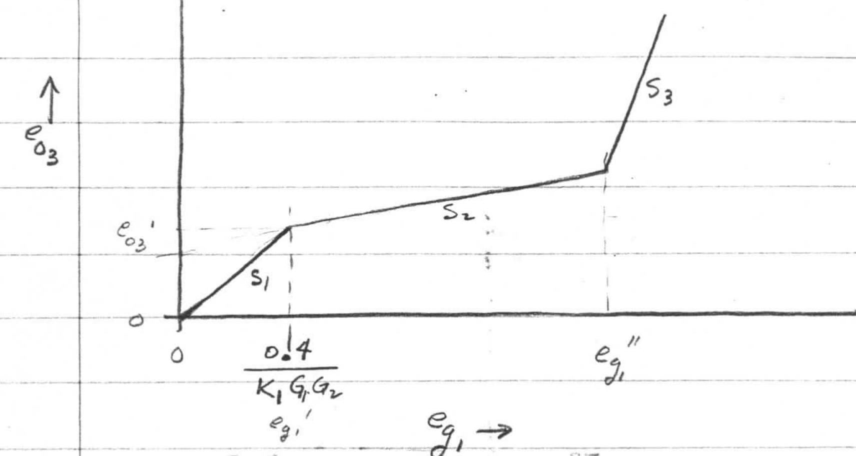
$$G_3 = \frac{2.1\text{v}}{0.4\text{v}} = 5.25$$

$$e_{o_2}'' = \frac{e_{o_3}''}{G_3} = \frac{5.0\text{v}}{5.25} = 0.954$$

$$e_{i_1}'' = \frac{0.4\text{v}}{1-K_1} = 4.2\text{v}\, G_1 \qquad e_{i_1} = e_{g_1} G_1$$

$$1 - K_1 = \frac{0.4}{4.2\, G_1}$$





$S_1 = K_1 G_1 G_2 G_3$

$S_2 = K_1 K_2 G_1 G_2 G_3$

$S_3 = K_2 G_1 G_2 G_3$

$e_{g_1}' G_1 K_1 G_2 = 0.4 \qquad e_{g_1}' = \dfrac{0.4}{G_1 K_1 G_2}$

$e_{g_1}'' (1-K_1) G_1 = 0.4 \qquad e_{g_1}'' = \dfrac{0.4}{(1-K_1) G_1}$

$e_{o_3}' = 0.4\, G_3 \qquad G_3 = \dfrac{e_{o_3}'}{0.4}$

$$\frac{S_2}{S_1} = \frac{K_1 K_2 G_1 G_2 G_3}{K_1 G_1 G_2 G_3} = K_2$$

$$\frac{e_{g_1}''}{e_{g_1}'} = \frac{\dfrac{\not{0.4}}{(1-K_1)\not{G_1}}}{\dfrac{\not{0.4}}{K_1 \not{G_1} G_2}} = \frac{K_1}{1-K_1} G_2$$

$$\frac{S_3}{S_2/S_1} = G_1 G_2 G_3$$

$$\frac{S_2}{S_3} = \frac{K_1 K_2 G_1 G_2 G_3}{K_2 G_1 G_2 G_3} = K_1$$

	e_{g_1}	e_{o_3}
	0	0
′	1.2	2.1
″	4.2	5.0
‴	5.2	8.5

$$S_1 = \frac{2.1}{1.2} = 1.75$$

$$S_2 = \frac{5.0 - 2.1}{4.2 - 1.2} = 0.967$$

$$S_3 = \frac{8.5 - 5.0}{5.2 - 4.2} = 3.5$$

$$\frac{S_2}{S_3} = K_1 = \frac{0.967}{3.5} = 0.276 \qquad 1 - K_1 = 0.724$$

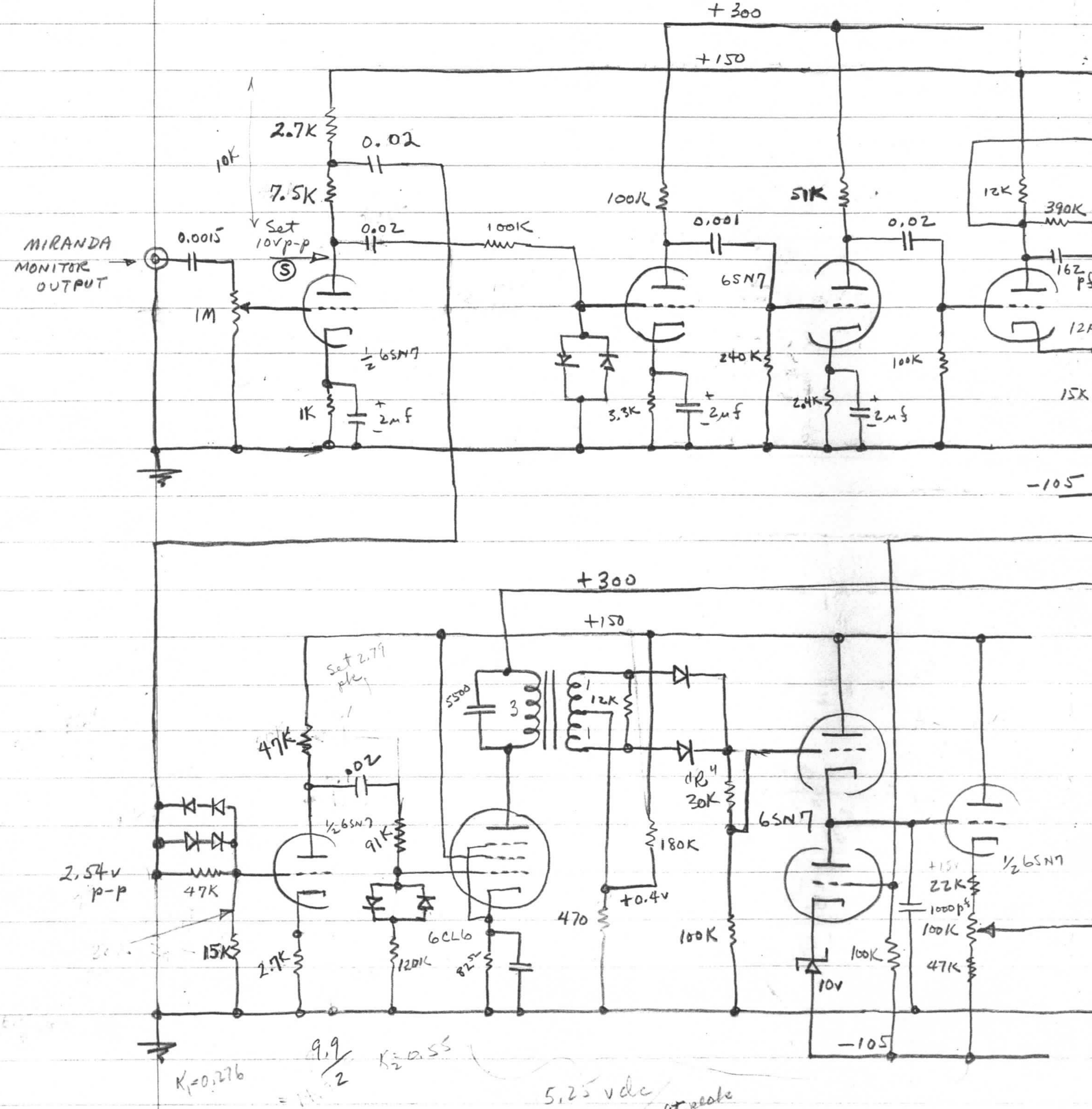
$$\frac{S_2}{S_1} = K_2 = \frac{0.967}{1.75} = 0.55$$

$$G_1 = \frac{0.4}{e_{g_1}''(1-K_1)} = \frac{0.4}{4.2(0.724)} = 0.122$$

$$G_2 = \frac{0.4}{e_{g_1}' G_1 K_1} = \frac{0.4}{1.2(0.122)(0.276)} = 9.9$$

$$G_3 = \frac{e_{o_3}'}{0.4} = \frac{2.1}{0.4} = 5.25$$

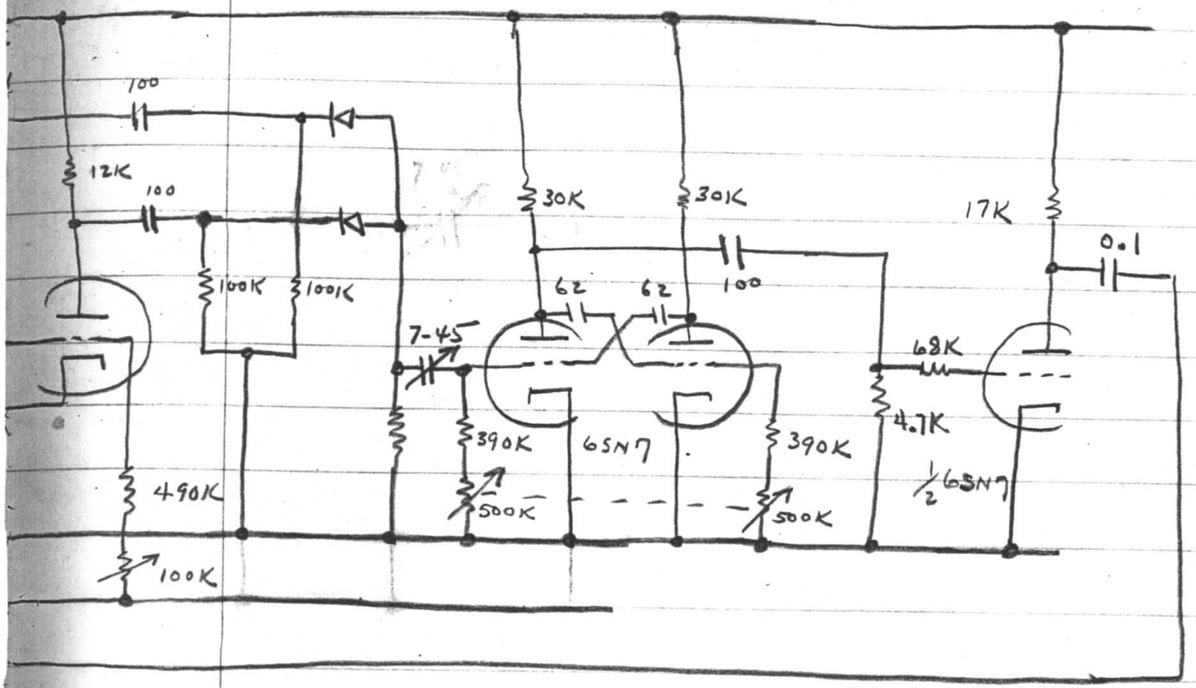
$$\frac{S_3}{S_2/S_1} = \frac{3.5}{0.55} = 6.39 = G_1 G_2 G_3 = 0.122(9.9)(5.25) = 6.31$$ (almost checks)

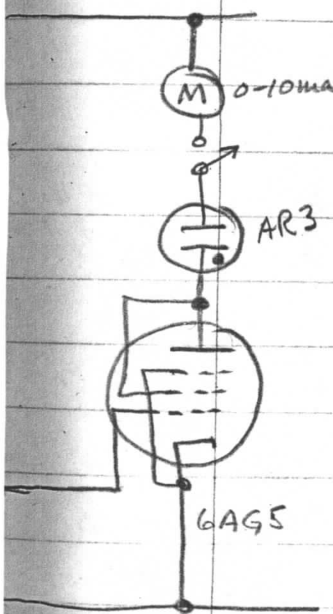


$$\frac{R_1}{R_1+R_2} = K_1$$

$$\frac{R_1}{R_2} = \frac{1-K_1}{K_1}$$

$$R_2 = \frac{0.276}{0.724}\,47K = 18K$$





To date as of 2/28/65

To mechanize the relations, G_1 is used to determine the signal level. Source impedance for the K_1 network is subtracted from R_2, computing the voltage divider action. Source impedance to K_2 is absorbed in R_3 without added loss. G_3 sets signal level at output.

A single diode network at the input requires a gain of 9.9 for G_2 increased by the losses in K_1 source impedance. This requires a 15X gain, too close to maximum achievable. With double diodes (0.8v drop) it should have more reserve.

The ½-6SN7 at input put out 5v peak to peak sync conveniently with 4.7K load resistor.

Doubling levels at K_1 network and raising load to 10K setting 10v p

Peak input 5.2v × 0.122 × 2 = 1.27v

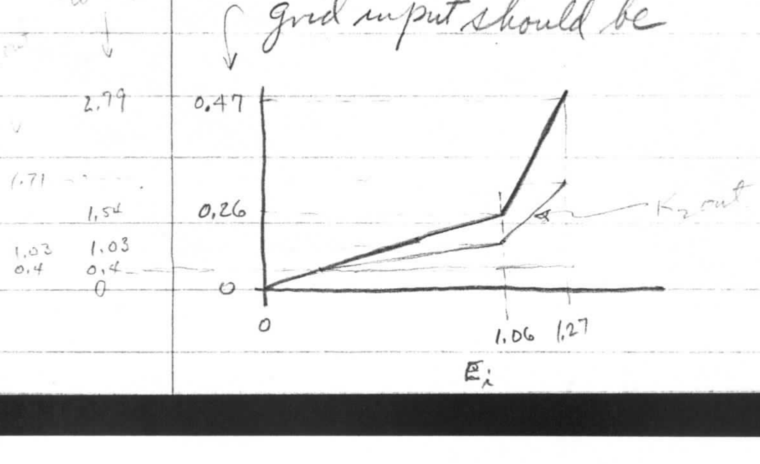
$$\frac{R}{10K} = \frac{1.27_{vp}}{5_{vp}} \qquad R = 2.54K$$

$$G_2 = 9.9 \qquad \text{gain} = \frac{9.9}{2}\,\frac{18K}{15K} = 5.94$$

$$\frac{47K}{15K+47K}\,E_i = 0.8v$$

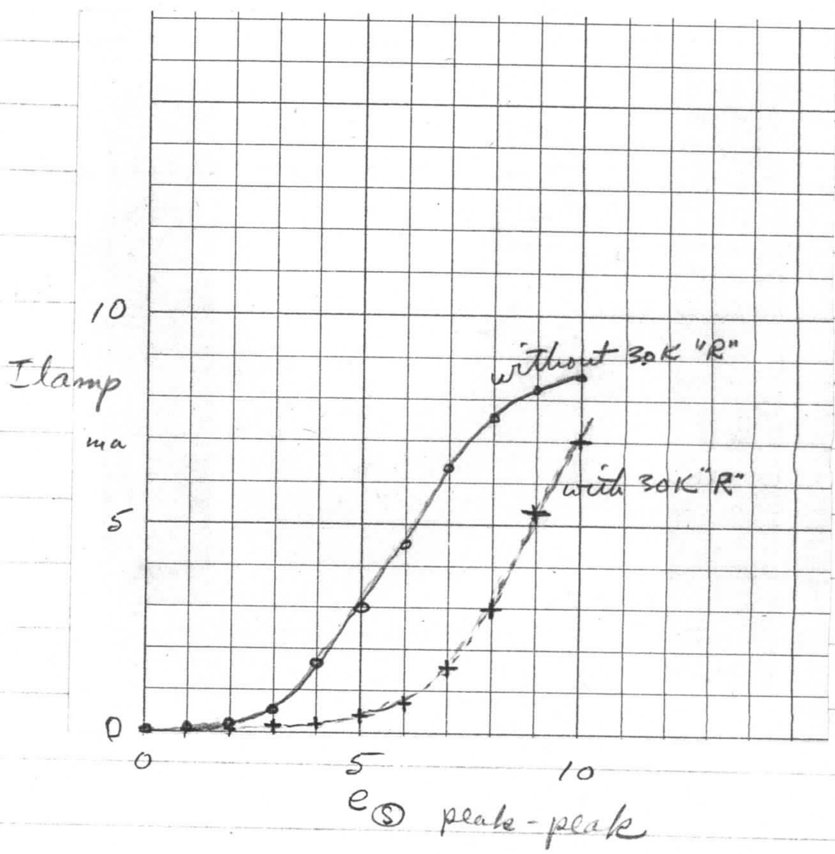
(15K+47K = 62K)

$$E_i = 0.8\,\frac{62}{47} = 1.06v$$



2/28/65 By coincidence the gain of the drive amp-rectifier-boxcars - is correct to give 8 ma on sync.
Gain between diode compensators was set by adjusting load & cathode resistors

e at (S) v p-p	I lamp ma	I lamp ma
0	0	0
1	0	0.05
2	0.05	0.2
3	0.15	0.7
4	0.2	1.7
5	0.4	3.0
6	0.8	4.5
7	1.6	6.3
8	3.0	7.6
9	5.2	8.2
10	7.0	8.6
	↑ with 30K "R"	↑ without 30K "R"



Somewhat better balancing DC level at 6AG5 grid to get 8 ma at 10 v p-p at (S) expired 11/64 got it for $4.50, Was told new price now $15 for 25.

3/7/65 Tried the Royal X pan, new traverse drive (24 TPI), and the gamma correction of the preceding pages. The base transmittance of the first pattern was 66%. This was developed in the afternoon in the presence of some light leaks from outside. The timer went off prematurely after about 3 mins development. This was 3/6/65 (A). I then tried an unexposed sheet, but with 4½ min development, same ambient light. Base 60%. This was 3/6/65 (B)

Then, at night, I ran another pattern. Changed 6AG5 bias to about −8.8v. [Through error (A) bias was −10v.] Developed for 12½ mins at 18.5°C This was the third sheet developed in the HC110 1:15 batch (one quart). According to bottle of HC110 2 gallons of 1:15 is good for 40 ea 8x10's. (5/quart) Base 52%. This was 3/6/65 (C).

3/6/65 Films

	(A)	(B)	(C)	
Dev	3	4½	12½	mins
	Day	Day	Night	
	66%	60%	52%	transmission

Using 20x hand microscope – the

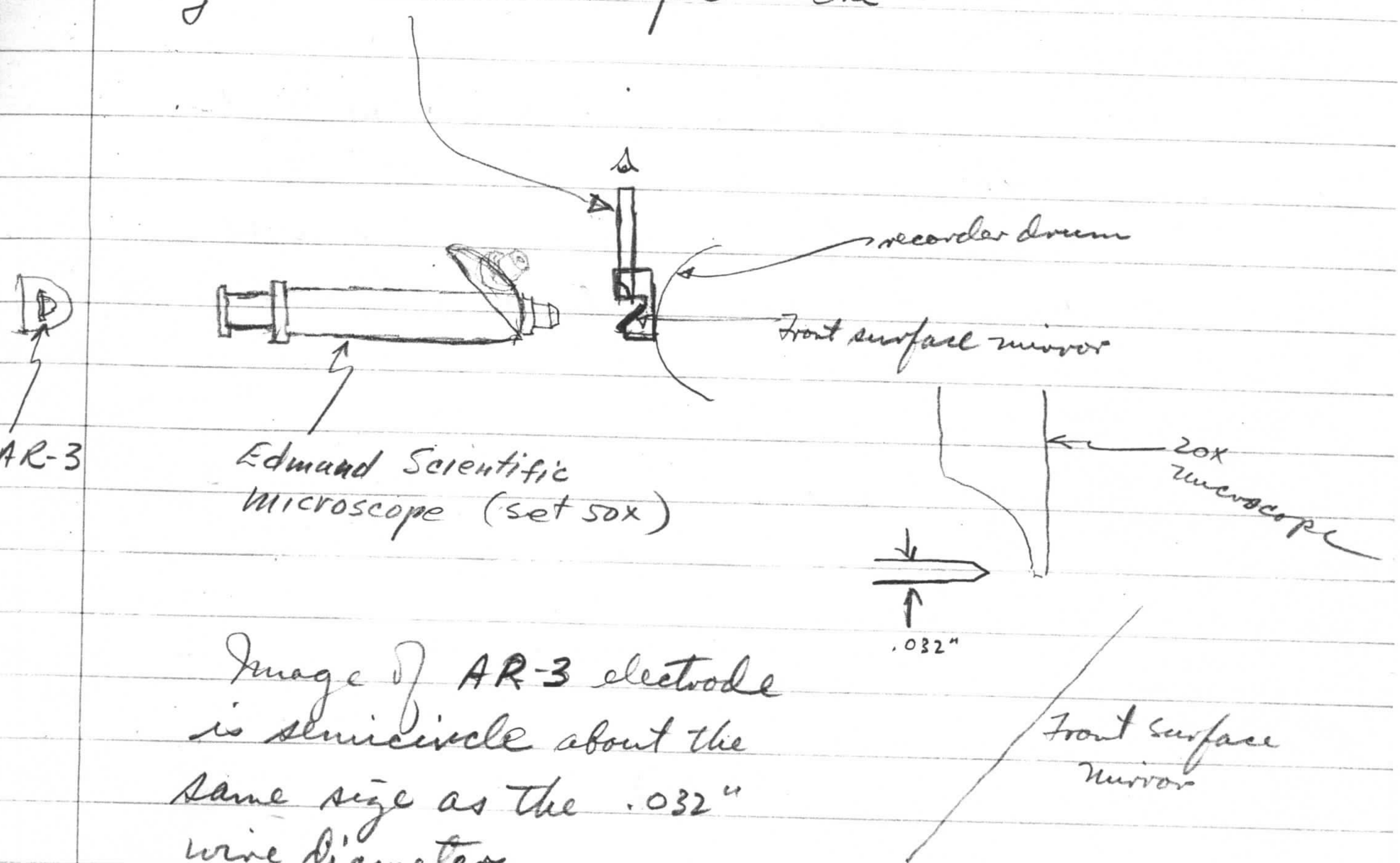


Image of AR-3 electrode is semicircle about the same size as the .032" wire diameter.