HAROLD E. EDGERTON

PAPERS

MC 25

Series III

Laboratory Notebooks

Number 17

Dated Mar. 30, 1946 to June 18, 1948

Massachusetts Institute of Technology

4-117 8-105

COMPUTATION BOOK

NAME	Number
HAROLD E. EDGERTON	17

Course .....

Used from MAR 30 1946, to JUNE 18 1948.

Notebook # 17

Filming and Separation Record

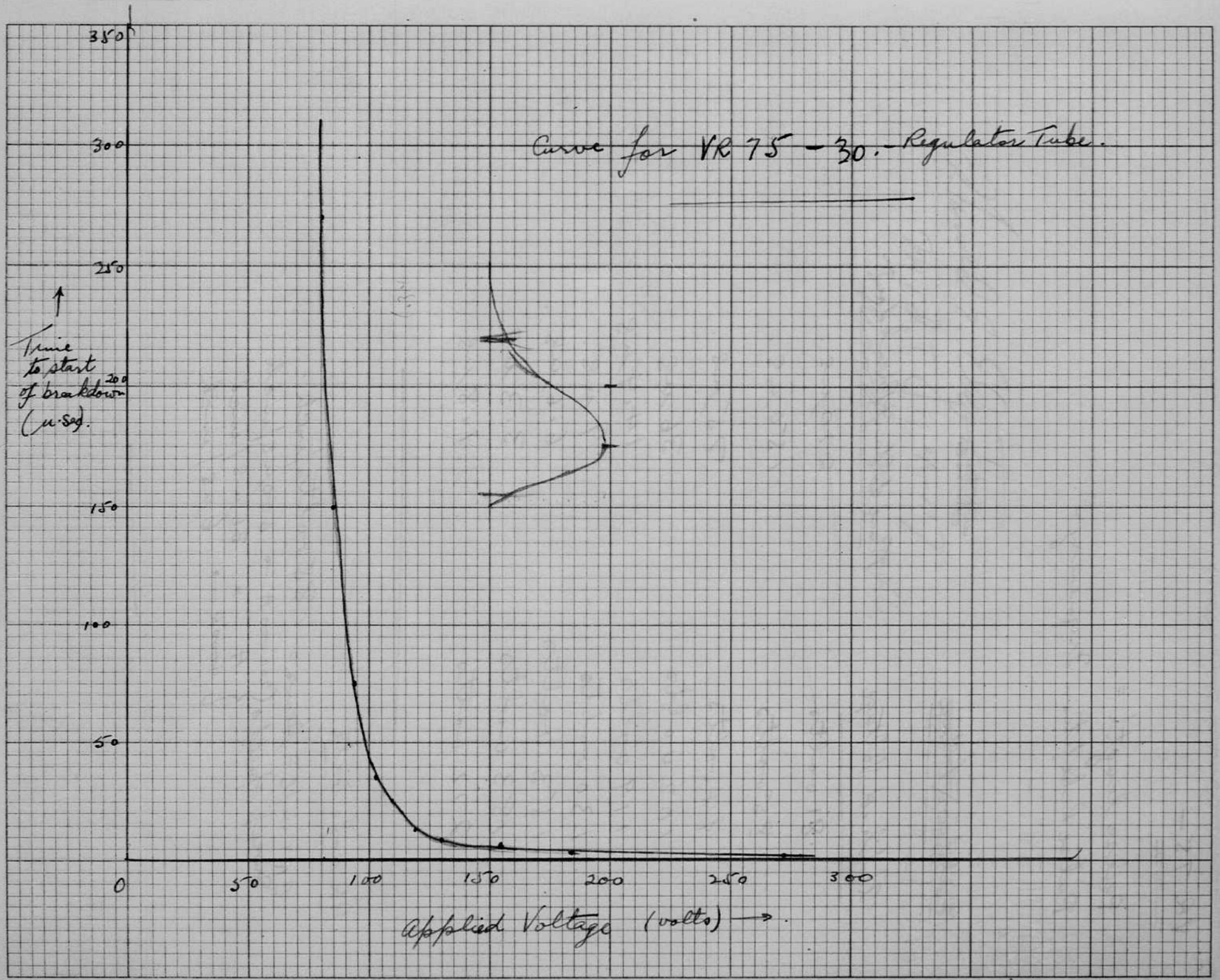
___ unmounted photograph(s)

___ negative strip(s)

1 unmounted page(s)
(notes, drawings, letters, etc.)

was/were filmed where originally located between page ___ and ___.
inside front cover

Item(s) now housed in accompanying folder.


Curve for VR 75 - 30. - Regulator Tube.
350
300
250
200
150
100
50
0
50
100
150
200
250
300
Time to start of breakdown (u.sec).
Applied Voltage (volts) →

VR 75 –

Pulse length =

Pulse Repetition Frequency = .

~~Breakdown Voltage~~ ~~Time~~

Applied Voltage	Time to Start Breakdown
81 volts	270 μs.
85 volts	150 μs.
94 volts	75 μs.
102 volts	36 μs.
119 volts	14.4 μs.
130 volts	9 μs.
153 volts	6.6 μs.
183 volts	3.3 μs.
272 volts	1.8 μs.

AR Scope Data.

CRT def = Pens = 85 volts/inch.

Sweep Speeds { 200000 A → 300 μs/inch
A → 36 μs/inch
4000 R → 6 μs/inch

Harold E. Edgerton
M. I. T. 4-117
March 30, 1946.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

COMPUTATION BOOK

GENERAL INSTRUCTIONS

In all work in which *accuracy* and *ease of reference* are important, much depends upon carrying out the computation in a systematic manner. The following instructions, taken from the *Engineering Department Figuring Book of the Allis-Chalmers Co., serve as a guide in this matter.*

"All computations, of whatever kind, are to be made in these books, except in cases where special blanks may be provided for specific kinds of computation. Computations may be made in ink or pencil, whichever may be more convenient. Pencil figuring should be done with a soft pencil. All the work of computation should be done in these books, including all detail figuring."

"Each subject should begin on a new page, no matter how much space may be left on the previous page. The subject, with the date of beginning it, should be plainly written at the top of the first page of the subject."

"Work should be done systematically, and as neatly as consistent with rapidity. The books are, however, intended for convenience, and no unnecessary work should be done for sake of appearance only. Errors should be crossed off instead of erased, except where the latter will facilitate the work. Work should not be crowded. Paper costs less than the time which would be expended in attempting to economize space in making erasures."

"Where curves drawn on section paper (or sketches) are necessary parts of a computation, they should be pasted in the book, except where specifically otherwise provided for."

"Computations should be indexed, in the back of the book, by the person using the book."

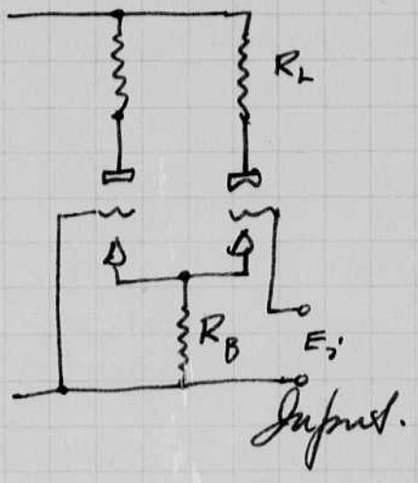
* * * * * * * "

TECHNOLOGY STORE
HARVARD COOPERATIVE SOCIETY, Inc.
40 Massachusetts Ave., Cambridge, Massachusetts

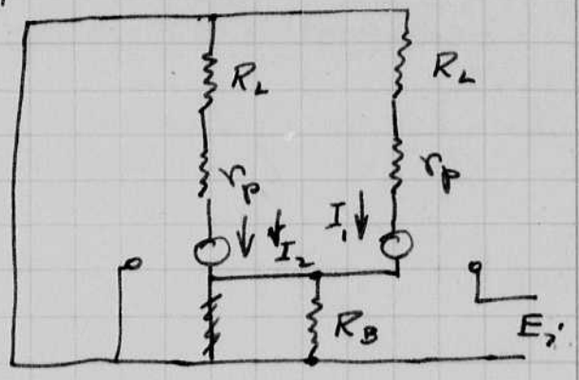
Harold Edgerton
Mar 30 1946

Analysis of circuits used in Photocell meter.

First stage.



Equivalent circuit.



Circuit equations.

$$(1) \quad -\mu (I_1 + I_2) R_B = I_2 (r_p + R_L + R_B)$$

$$I_1 = -I_2 \frac{A}{\mu R_B} \qquad A = r_p + R_L + \mu R_B + R_B$$

$$= r_p + R_L + R_B (1+\mu).$$

$$(2) \quad \mu \left(E_i' - (I_1 + I_2) R_B \right) = I_1 (r_p + R_L + R_B).$$

$$\mu E_i' = I_1 A + I_2 \mu R_B.$$

From the above equations

$$I_1 = \frac{\mu A}{A^2 - (\mu R_B)^2} E_i'$$

$$I_2 = + \frac{\mu^2 R_B}{(\mu R_B)^2 - A^2} E_i'$$

$$\frac{I_1}{I_2} = -\frac{A}{\mu R_B} = -\frac{(r_p + R_L + R_B(1+\mu))}{\mu R_B}$$

$$K_1 = \frac{I_1 R_L}{E_i'} = \frac{\mu A R_L}{A^2 - (\mu R_B)^2}$$

The signal across R_L in tube 1 will always be greater.

I suggest that R_{L2} be increased slightly to compensate for this.

then with R_{L2} and R_{L1}

$$A_1 = r_p + R_{L1} + R_B(1+\mu)$$

$$A_2 = r_p + R_{L2} + R_B(1+\mu).$$

① $\quad I_1 = -I_2 \frac{A_2}{\mu R_B}$. $\quad$ or $I_2 = -I_1 \frac{\mu R_B}{A_2}$

② $\quad \mu E_i = I_1 A_1 + I_2 \mu R_B$.

$$= I_1 A_1 + \left(-I_1 \frac{\mu R_B}{A_2}\right) \mu R_B$$

$$= I_1 \left(A_1 \mp \frac{(\mu R_B)^2}{A_2}\right)$$

$$I_1 = \frac{\mu E_i}{A_1 \mp \frac{(\mu R_B)^2}{A_2}} = \frac{\mu A_2 \; E_i}{A_1 A_2 - (\mu R_B)^2}$$

$$I_2 = \frac{-\mu E_i}{A_1 \mp \frac{(\mu R_B)^2}{A_2}} \cdot \frac{\mu R_B}{A_2} = \frac{-\mu^2 R_B}{A_1 A_2 \mp (\mu R_B)^2} E_i$$

and $\dfrac{I_1 R_{L1}}{I_2 R_{L2}} = \dfrac{\mu R_{L1}}{A_1 \mp \frac{(\mu R_B)^2}{A_2}}$

$$\frac{\mu^2 R_{L2} R_B}{A_1 A_2 \mp (\mu R_B)^2} = \frac{R_{L1}}{\mu R_{L2}} \frac{A_1 A_2 \mp (\mu R_B)^2}{\left(A_1 A_2 \mp \frac{(\mu R_B)^2}{A_2}\right)}$$

$$= \frac{R_{L1} A_2}{R_B R_{L2} \mu}$$

If this equals 1. then the next stage is balanced.

$$1 = \frac{R_{L1}}{R_B \mu R_{L2}} \left[r_p + R_{L1} + R_B(1+\mu)\right]$$

$$R_{L2} = R_{L1} \left[\frac{r_p + R_{L1} + R_B(1+\mu)}{\mu R_B}\right]$$

voltage gain of each tube

$$K = \frac{I_1 R_{L1}}{E_i} = \frac{\mu R_{L1}}{A_1 \mp \frac{(\mu R_B)^2}{A_2}}$$

R_{L1} for bias for next stage.

$\frac{1.5V}{.15ma} = 100{,}000$ ohms,

with 6C8 tube. at reduced voltage condition.

250V.	Trig. 35V	.14
-4.5	-1.	
$\mu = 36$	30?	
$r_p = 22{,}500$	50,000	
$g_m = 1600$	.4 x g_m = 640	
$I_p = 3.2$ ma.	0.15	

bias $= -1 = -0.15 \times R_B$

$R_B = \frac{1}{0.15} \times 1000 = 66{,}700$

$\frac{30}{6} = \frac{5}{1}$

$\frac{31}{1}$

$R_B(1+\mu) = 2.06 \times 10^6$

Let $K = \mathcal{X} =$

$$= \frac{30 R_{L1}}{(50{,}000 + R_{L1} + 66700(1+30)) \mp \frac{(2.06 \times 10^6)^2}{[50{,}000 + R_{L2} + 66700(1+30)]}}$$

$$= \frac{\mu}{\left(\frac{r_p}{R_{L1}} + 1 + \frac{R_B(1+\mu)}{R_{L1}}\right) \mp \left(\frac{\mu R_B}{R_{L1}}\right)\left(\frac{\mu R_B}{r_p + R_{L2} + R_B(1+\mu)}\right)}$$

Let $R_{L1} = 10^5$

$$= \frac{30}{\left(\frac{1}{2} + 1 + \frac{2}{3}\left(\frac{31}{1.5}\right)\right) \mp \left(30\frac{2}{3}\right)\left(\frac{30 \times 66{,}700}{50{,}000 + 100{,}000 + 2{,}060{,}000}\right)}$$

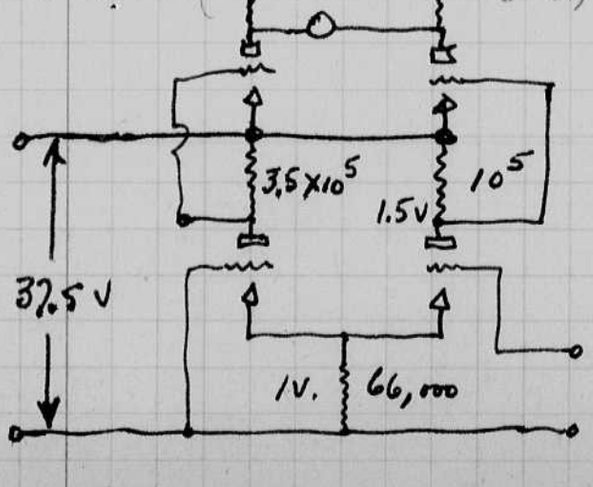
$\frac{206}{1.5}$

$\frac{30 \times 66{,}700}{2.2 \times 10^6} = \frac{2 \times 10^6}{2.2 \times 10^6} = .91$

$$= \frac{30}{22.1 - 9.1} = \frac{30}{13} = 2.31$$

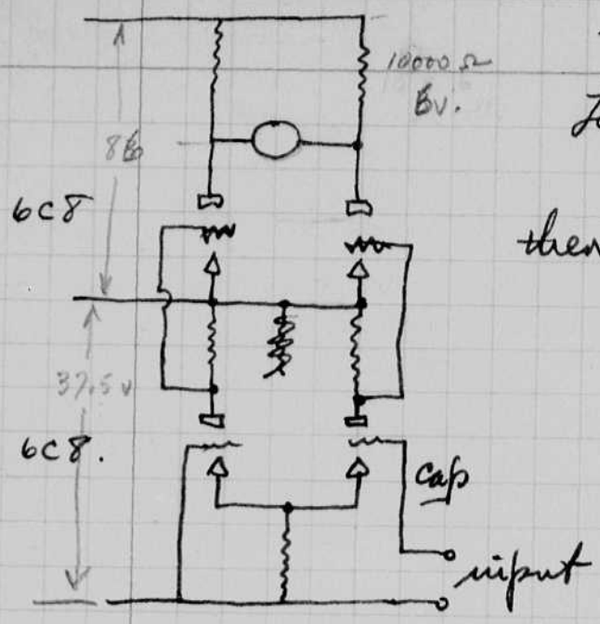
$\frac{9.1}{13.}$

$R_{L2} = 10^5\left(\frac{50000 + 100{,}000 + 66{,}600\ 31}{30\ \ 66{,}600}\right) = 10^5\left(\left(\frac{216{,}000}{66{,}000}\left(\frac{31}{30}\right)\right)\right) = 10^5\ 3.36$



The gain should be 2.3 x 2 = 4.6. since the voltages are out of phase.

4 Cont. Output stage to operate meter. See ckt. RCA circuits



meter full scale = 200 ua.

Let I_p = ~~1.5 ma.~~ 1.0 ma. | .6 ma.

E_c = -1.5 volts. | -1.5

then E_p = 80 volts. | 67 V.

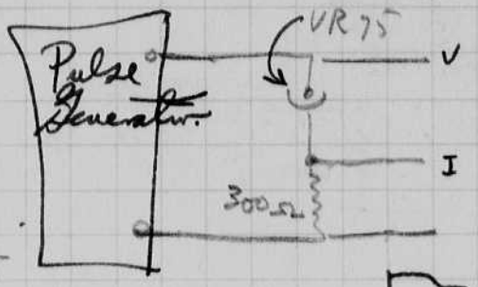
Suggested by Gray.

April 1946.

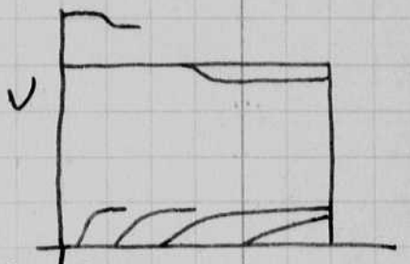
Bldg 20. Exposure tests of f 5.6 of the Recording film on Dumont Scope #341 type 256B. "A" scale range Calibration Pips. 12.2 μs.

Tests of VR75 in Brush Lab. Lab. ~~22~~ 20 - 236 ?

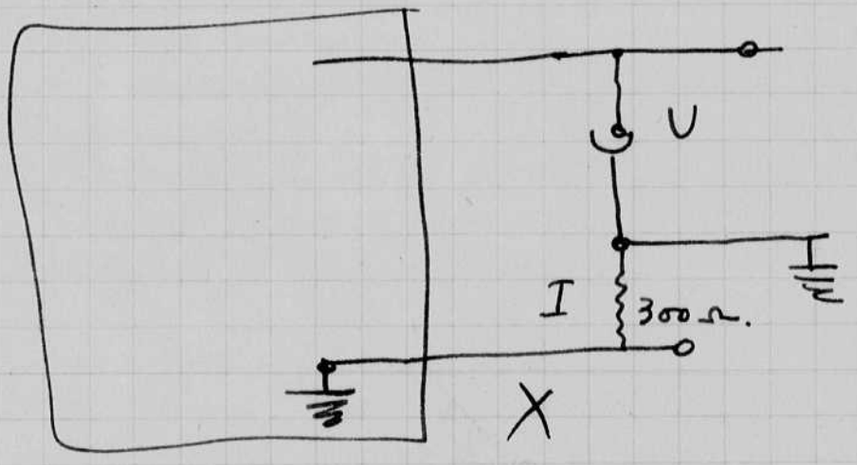
1 1 sec calib 12.2 A range.
2 1 sec
3 5 sec
4 5 sec
5 1/2
6. 1/2
7 1 sec. (98 - 11) volts per inch.
8 Voltage without tube VR75
9 " " " "
10 " " VR-75
11 Current.
12 Voltage VR-75 1 sec -
13 " " 10 sec -
Current
Current



to C.R. tube.



$I = \frac{10}{300} = \frac{1}{30} = 33$ ma.

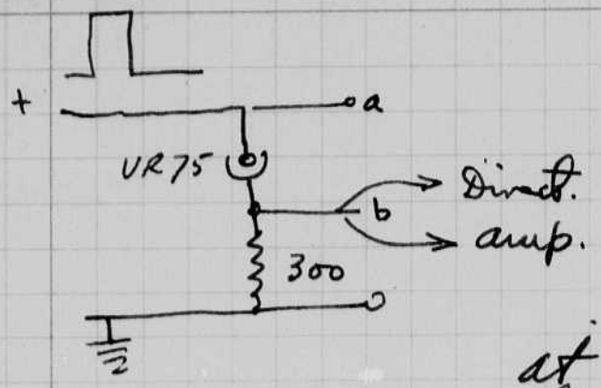


$\frac{98}{11}$ 87 volts/inch.

1 inch = $\frac{87}{300}$ = I
= .29 amps.
.029 amps.

Voltage calibration = 87 volts per inch

6 April 2 1946. V-R 75 Regulator tube
K.E. Edgerton.



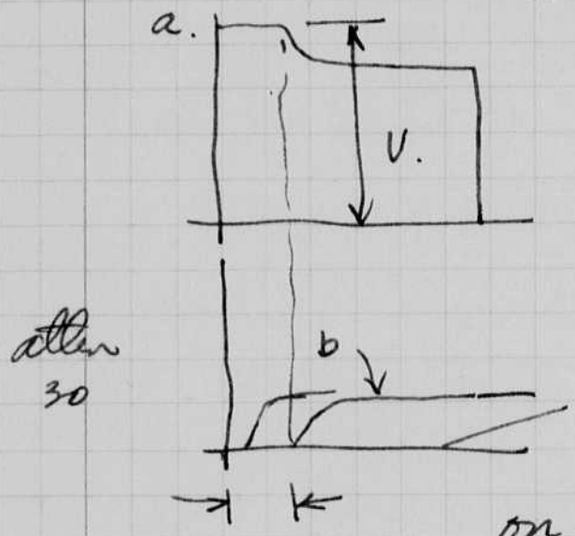
Voltage calib 87 volts/inch.
Current calib direct.

$I = \frac{87}{300} = 0.29$ amps/inch

= 0

at current = .029 amps
alter at 30 = 0.4 inch.

calib $\frac{.029}{.4} = .072$ amps/inch.



1. Calib 12.2 mA.
2. Voltage
3.

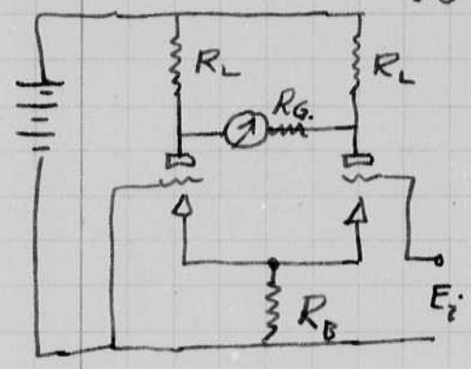
Photos on A range scale were ok with 1/sec exposure at f 5.6 on neg. recording film. 15 min. devel. in D76. on 4000 range, the time was increased to 6 seconds.

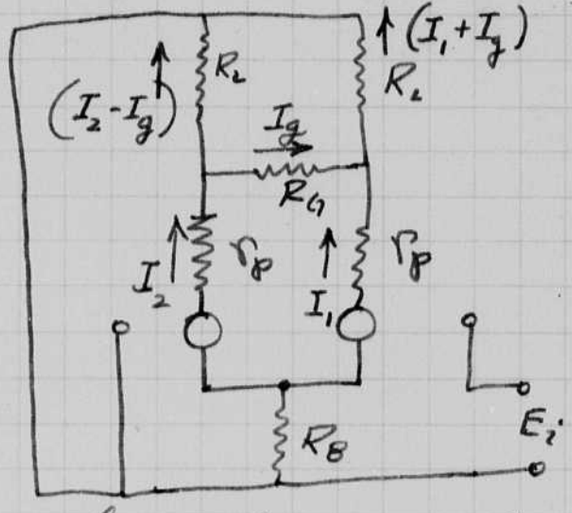
It appears advisable to put voltage, current, and a time calib. curve on the same photograph.

Check rate of current increase as a function of the final current.

April 2 1946
H.E. Edgerton

Vacuum tube circuit analysis - Push Pull type D.C. common self-bias resistor without by pass capacitor.





Problem: to find the galvanometer current I_g in terms of E_i and the constants of the circuit.

three circuit equations are needed to solve for the currents.

① $\mu E_{g2} = -\mu(I_1+I_2)R_B = (I_1+I_2)R_B + I_2 r_p + (I_2-I_g)R_L$.

② $\mu E_{g1} = E_i - \mu(I_1+I_2)R_B = (I_1+I_2)R_B + I_1 r_p + (I_1+I_g)R_L$

③ $(I_2-I_g)R_L - (I_1+I_g)R_L - I_g R_G = 0$

From ③ $\quad I_g = \dfrac{(I_2-I_1)R_L}{2R_L+R_G}$

which when substituted in to 1 and 2 give

$0 = I_1 A + I_2 B \qquad$ where $A = R_B(1+\mu) + \dfrac{R_L^2}{2R_L+R_G}$

$\mu E_i = I_1 B + I_2 A$

from which I_1 and I_2 can be solved. $\qquad B = R_B(1+\mu) + r_p + R_L - \dfrac{R_L^2}{2R_L+R_G}$

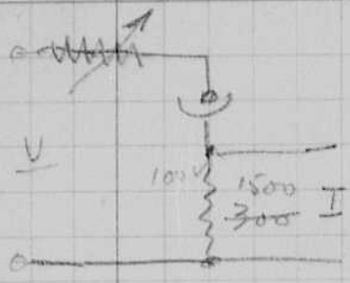
$I_1 = \mu E_i \dfrac{B}{B^2-A^2}$ and $I_2 = -I_1\dfrac{A}{B} = \dfrac{-\mu E_i A}{B^2-A^2}$

and $I_2 - I_1 = \mu E_i\left(\dfrac{-A}{B^2-A^2} - \dfrac{B}{B^2-A^2}\right) = \mu E_i\left(\dfrac{A+B}{A^2-B^2}\right) = \dfrac{\mu E_i}{A-B}$. since $A-B \times \dfrac{A+B}{A^2-B^2}$

and $I_g = \dfrac{(I_2-I_1)R_L}{2R_L+R_G} = \dfrac{\mu E_i R_L}{\left(\dfrac{2R_L^2}{2R_L+R_G} - r_p - R_L\right)(2R_L+R_G)} = \dfrac{-\mu E_i}{r_p\left(\dfrac{R_G}{R_L}+2\right)+R_G} \doteq \dfrac{-\mu E_i}{(2r_p+R_G)}$ if $R_L > R_G$

Note the I_g expression does not include R_B. Mutual conductance is about 1/2 that of a single tube.

April 4, 1946.



V - 87 volts/inch.

$I = \frac{87}{300} = .3$ amp/inch.

1030 1/10 inch.

x5

use 1500 ohms.

Scope 420

Voltage calib

140 185

98 140

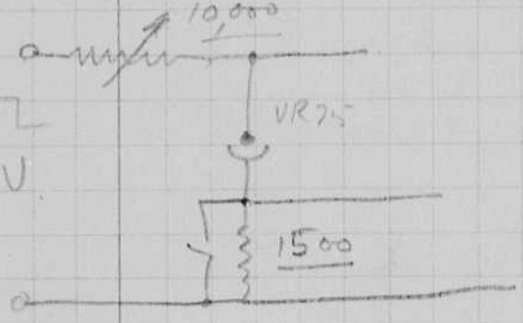
42. 45.

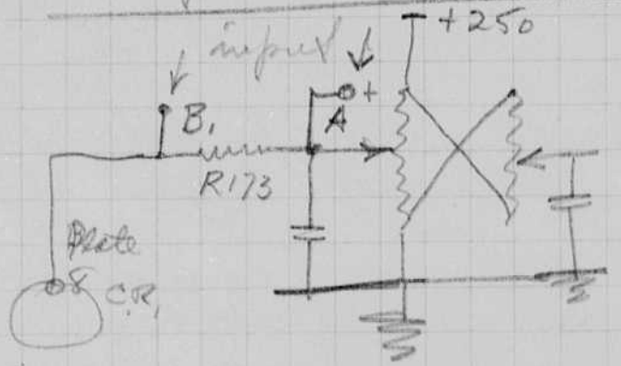
volts per inch.

to Ground.

x2

D.C. deflection of oscillograph





the direct signal is put in at A as ground and at point B which goes directly to the C.R. plate.

Note. The oscillograph case is hot 125 V +

Oscillograms 4-20 osc.

#				inches Volts. Time
1	Calib 61.1 μs.	1/sec		
2.		5 sec		
3.	50 ma. A 200 000.	1/sec 500 on #		
4	Voltage			
5	Calib.			
6.	3 above on one film to show long time effects.			
7	Blanks.			
8.	Long delay time			? ?
9	" " "		due to amp pickup!	1.05 2.5"
10				1.10 1.5
X 11	N.G. notes current			~~.5~~ .5
12				

Resistance 1500 extra was not right for above

A 200 000	13.		61.1 μs.	1.2"	.2
A 20 000	14	Ditto.	12.2 μs		

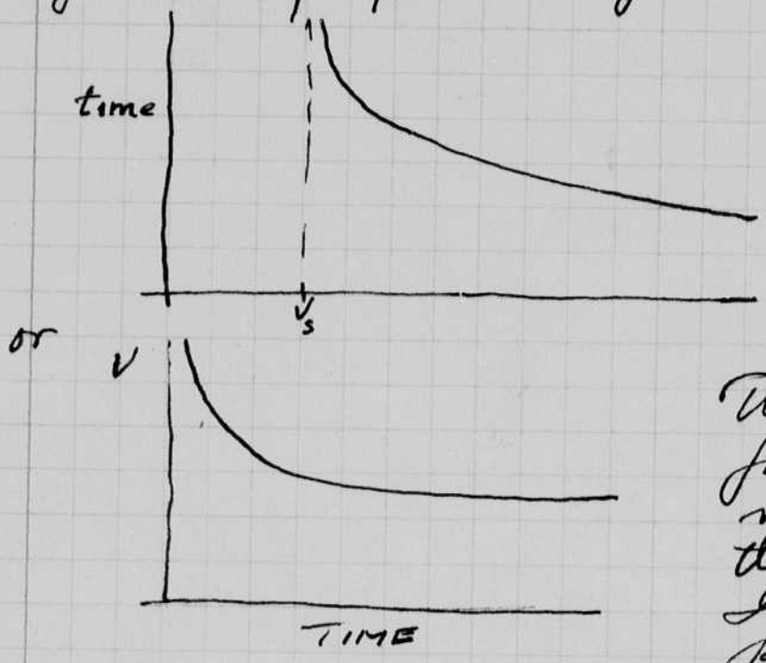
Reel No 2.

	1	Long time scale.	61.6 μs. x5 period.	1.1"	2.6
	2		"	1.14	1.75
	3			1.15	1.45
	4			1.20	1.55
	5	Sweep changed ~~to~~ A-20,000.	12.2 μs tuners top	1.22	1.75 x 5
	6		61.6 " " bot.	1.29	1.15 x 5
	7.			1.41	.65 x 5
	8			1.61	.4 x 5 ±
	9			1.90	.15
A	10	200 000 Voltage only 6 v r & curves.			
	11	20,000 range " " " " " " VR1			
	12	Ditto	different tube. VR2		
	13	OC3/VR105 jittery.	2 curves slow sweep.		
	14	"	3 " fast "		
		Blanks?.			
	16	VR90 3 curves	slow scale.		
	16.	VR90 3 "	fast scale		
	17	VR75 # 3	fast sweep.		
	18	"	faster " + 12.2 μs.		
B	20	Slow tube recorder fast sweep 12.2 μs.			
	21	meter on # Screen 30	5 sec expo.		
		40	5		
		50	5		
		60	5	70 - 5?	

Expose one or this! Fast photo of the screen lines

April 6 1946
Harold E Edgerton 43 bldg. - what do you mean?

The oscillograms of breakdown time of glow regulator tubes show a curve of the following type as a function of overvoltage.



The curve is a function of the repetition rate of the the transient. Ions left from previous conditions influence the breakdown.

It seems that the curve could be matched by an equation of the type

$$t = A(V - V_s)^b$$

or $V = \cancel{(V - V_s)}\ V_s + t^n$

$$\log V = \log (V_s + t^n)$$

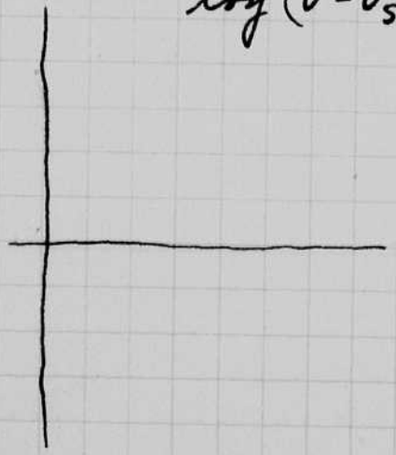
$$\log (V - V_s) = \log t^n = n \log t.$$

$$n = \frac{\Delta \log (V - V_s)}{\Delta \log t.}$$

n = probably (-1) . ?

if so then

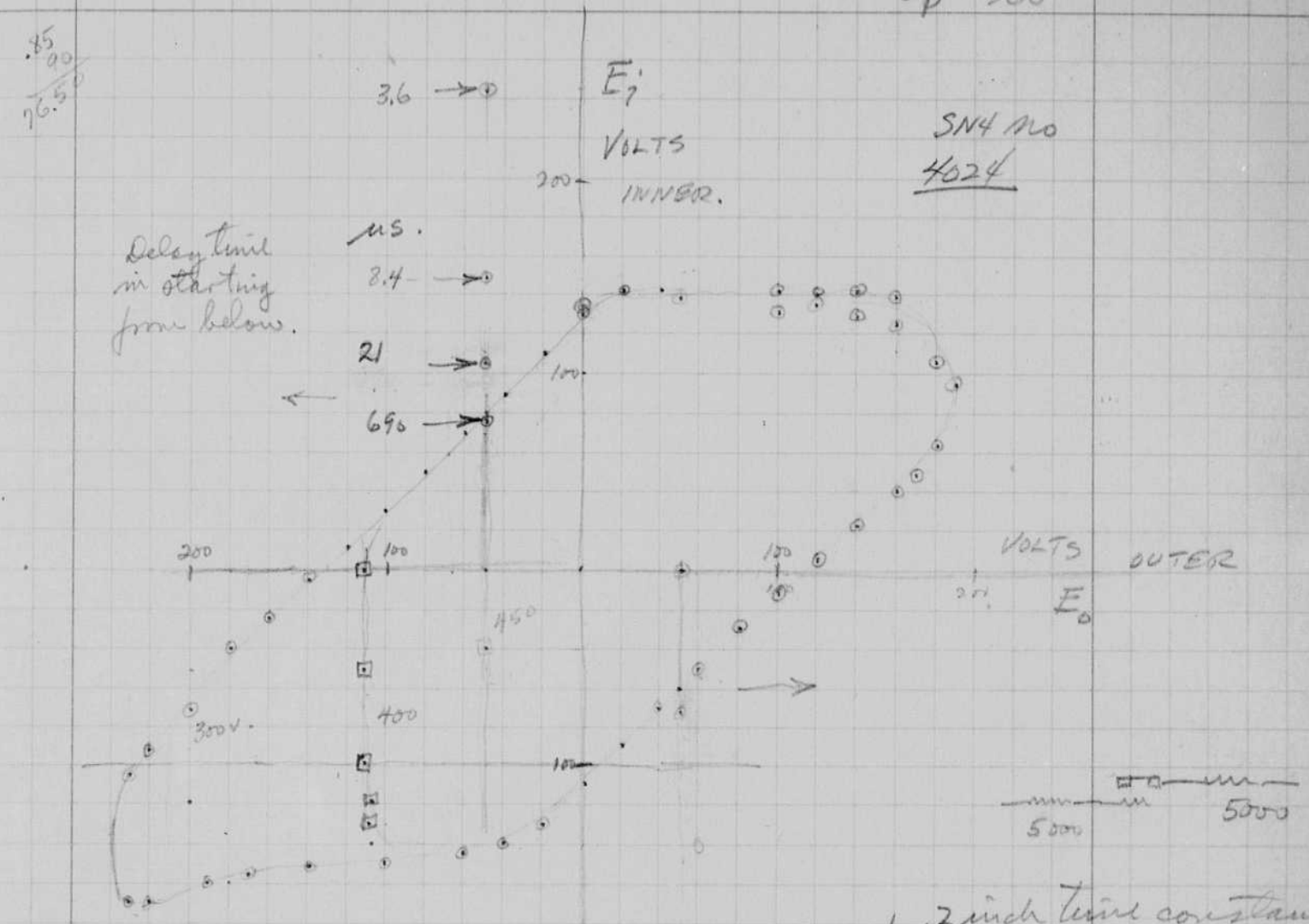
$t(V - V_s)$ = a constant.



April 9 1946
Sq.

Static Char. Strobotron.

$E_p = 300$



.2 inch time constant.

Positive ~~negative~~

Dynamic -50 volts - on outer grid. Surge on inner grid

A 200 000

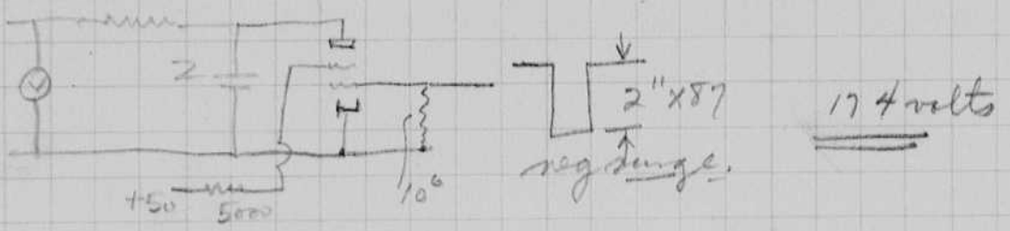
V Mod	x87.	t_{io} inches.	x300 μs.	t_{ic}	μs
.85	74	2.3	690.	—	—
.90	78	1.1	330	2.8	840
1.0	87	.25	75.	.95	284
		A 20,000			
		2. x36 72 ✓			
1.1	96.	.9	32.4	3.05	110.
1.2	105	.6	21.6	1.65	59.4
1.3	113	.45	16.2	1.10	39.6
1.4	122	.35	12.6	.70	25.2
1.5	131	.30	10.8	.55	19.8
1.6	140	.24	8.65	.42	15.1
1.6	140	2.9 x6	17.4?	2.9?	17.4
1.7	148	1.4	8.4	2.4	14.4
1.8	157.	1.3	7.8	2.1	12.6

V	V	t_{io} inch	μs	t_{ic} inch	μs
1.9	166.	1.15	6.9	1.9.	11.4
2.0	174	1.05	6.3	1.65	9.9
2.1	183	.95	5.7	1.50	9.0
2.3	200	.85	5.1	1.25	7.5
2.5	218	.70	4.2	1.05	6.3
2.7	236	.65	3.9	.85	5.1
2.8	244	.6	3.6	.8	4.8

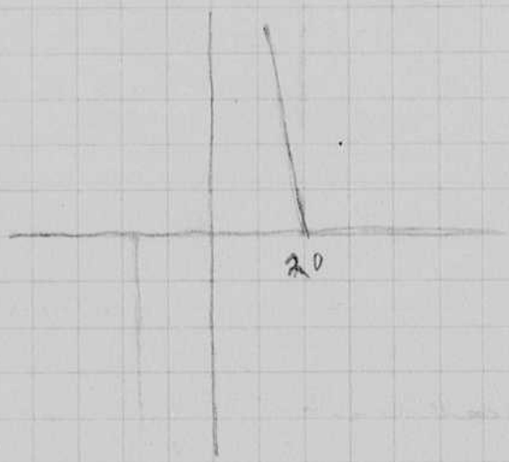
t_{io} gives the delay from the start to the breakdown ~~to the~~ between the inner grid and the outer grid.

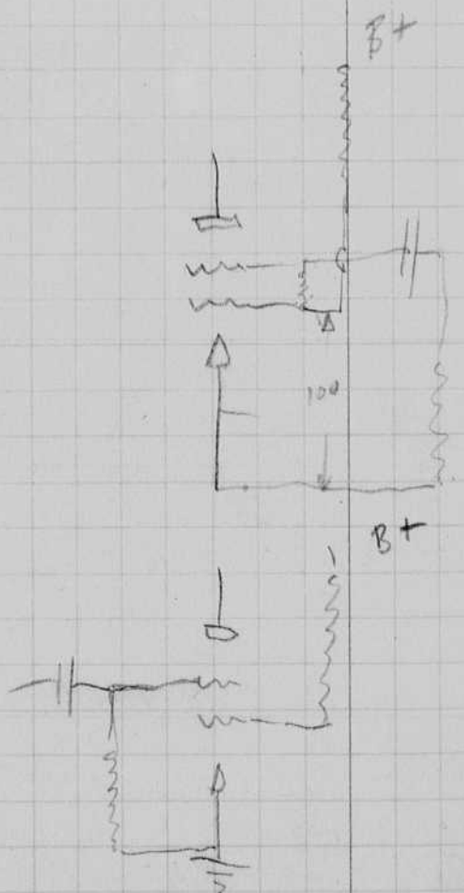
t_{ic} gives the delay from the start to the breakdown between the inner grid to the cathode

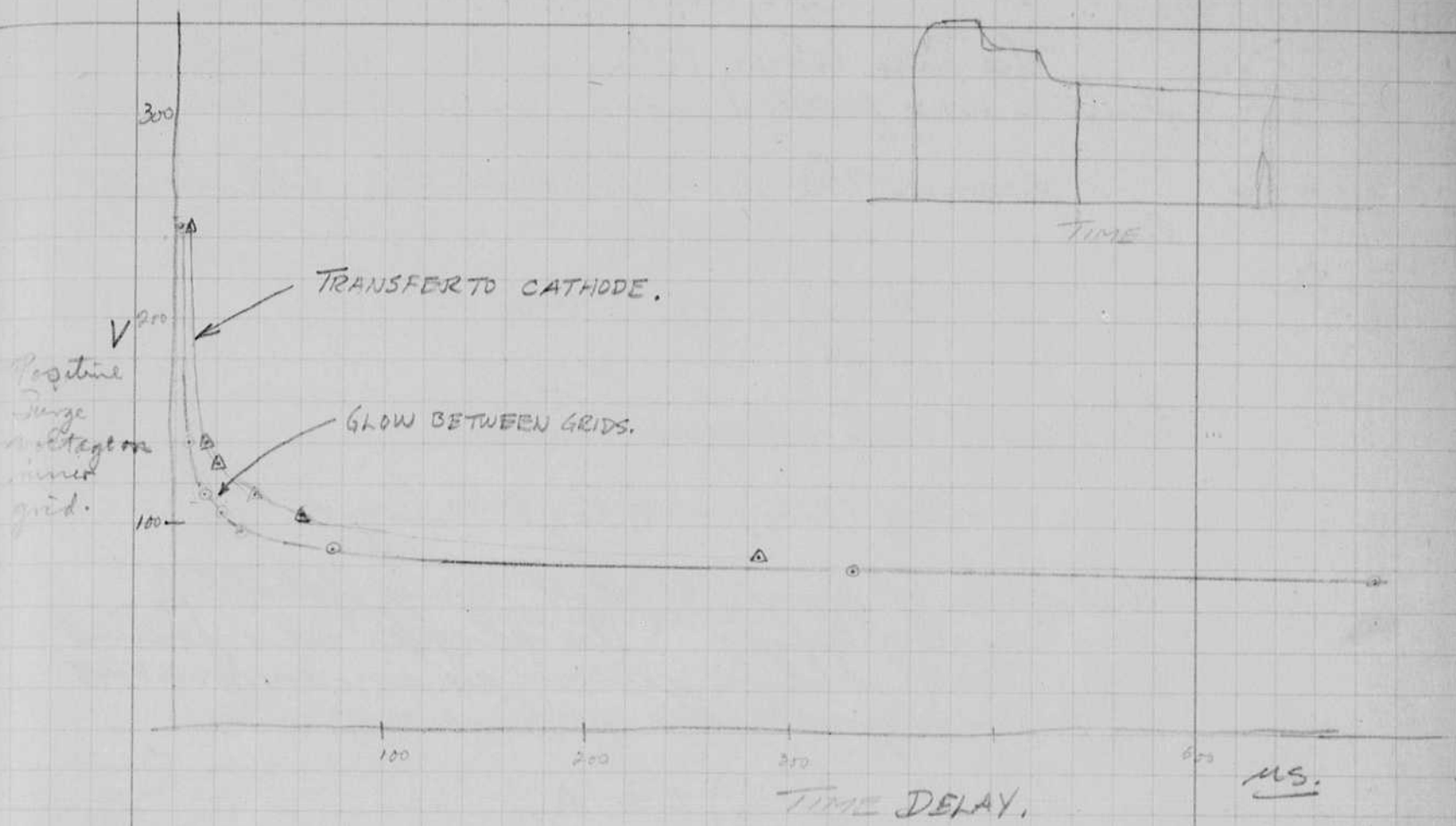
Anode delay time.

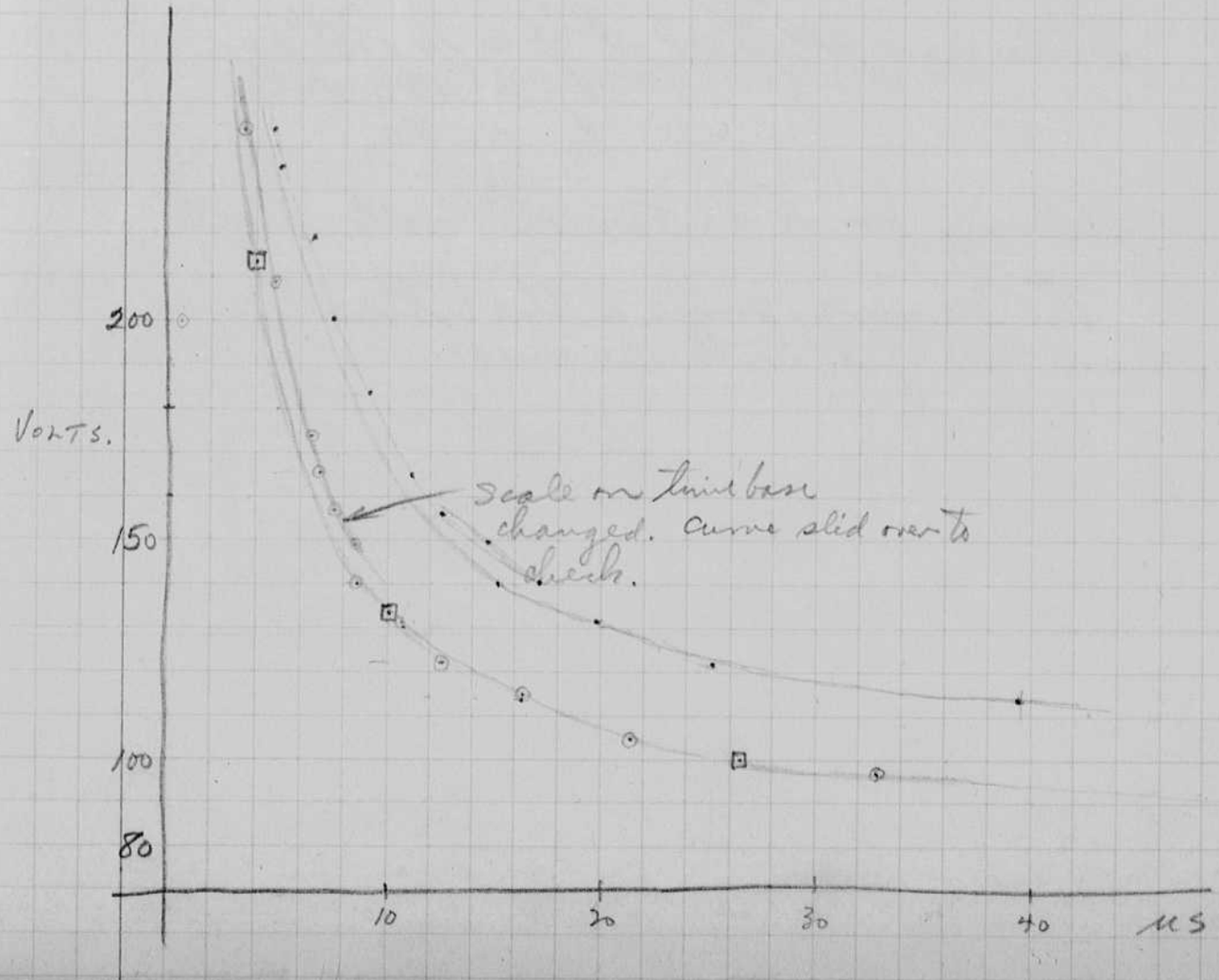


Vp	V		t	t
~~180~~	inch x87.		in x ~~300~~ 280	μs
180	1.65	144	1.35	405.
	~~1.5~~ "		1.3	390
220	2.05	179	.8	240
250	2.4	209	.5	150
275	2.6	227	.35	105 some holdover fuss.
	Main deg resistance increased ~~5~~ by 3050			
200	2.0	174	.8	240
250	2.5	218	.40	120
~~300~~	Scale 36 μs/inch.			~~?~~
300	3.1	270	1.3 x 36.	46.8
350	3.8	331	.65	23.4






300
200
100
V
Negative surge voltage on inner grid.
TRANSFER TO CATHODE.
GLOW BETWEEN GRIDS.
100
200
300
600
μs.
TIME DELAY.
TIME


200
VOLTS.
150
100
80
Scale on time base changed. Curve slid over to check.
10
20
30
40
μs
DELAY

April 8, 1946.
Harold Edgerton

Breakdown V vs time
for the Strobotron tube.

The data taken today in 20-211 with Hunton was plotted up on page 13 of this book.

Assume the data follows the following law.

$$\frac{(V-V_s)}{t^n} = A. \qquad V-V_s$$

take logs of both sides

$$\log (V-V_s) - n \log t = \log A.$$

the data of page 13 plot was plotted on log-log paper. The slope was found to be (-1) which gives as an exponent the following:

$$(V-V_s)\, t = A.$$

Data was selected at $t = 10 \times 10^{-6}$ sec
$V = 133$ volts.
$V_s = 80$

Solving for $A = 530 \times 10^{-6}$ volts seconds.

the square points on the bottom curve show the fit with the curve.

t.	4 μs	10	26.5
V	225	133	100
$V-V_s$	80	80	80
	145	53	20

$t = \frac{a}{(V-V_s)} \varepsilon$ b/b

$a = 530 \times 10^{-6}$

$b = 0$

Notebook # 17

Filming and Separation Record

____ unmounted photograph(s)

____ negative strip(s)

__1__ unmounted page(s)
(notes, drawings, letters, etc.)

was/were filmed where originally located between page 14 and 15.

Item(s) now housed in accompanying folder.

April 8, 1946.
Harold Edgerton

Breakdown V vs time
for the Strobotron tube.

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V	225	133	100	
V-V_s	80	80	80	
	145	53	20	

b/u

$$t = \frac{a}{(V-V_s)} \qquad a = 530 \times 10^{-6}$$

$$b = 0$$

Notebook # 17

Filming and Separation Record

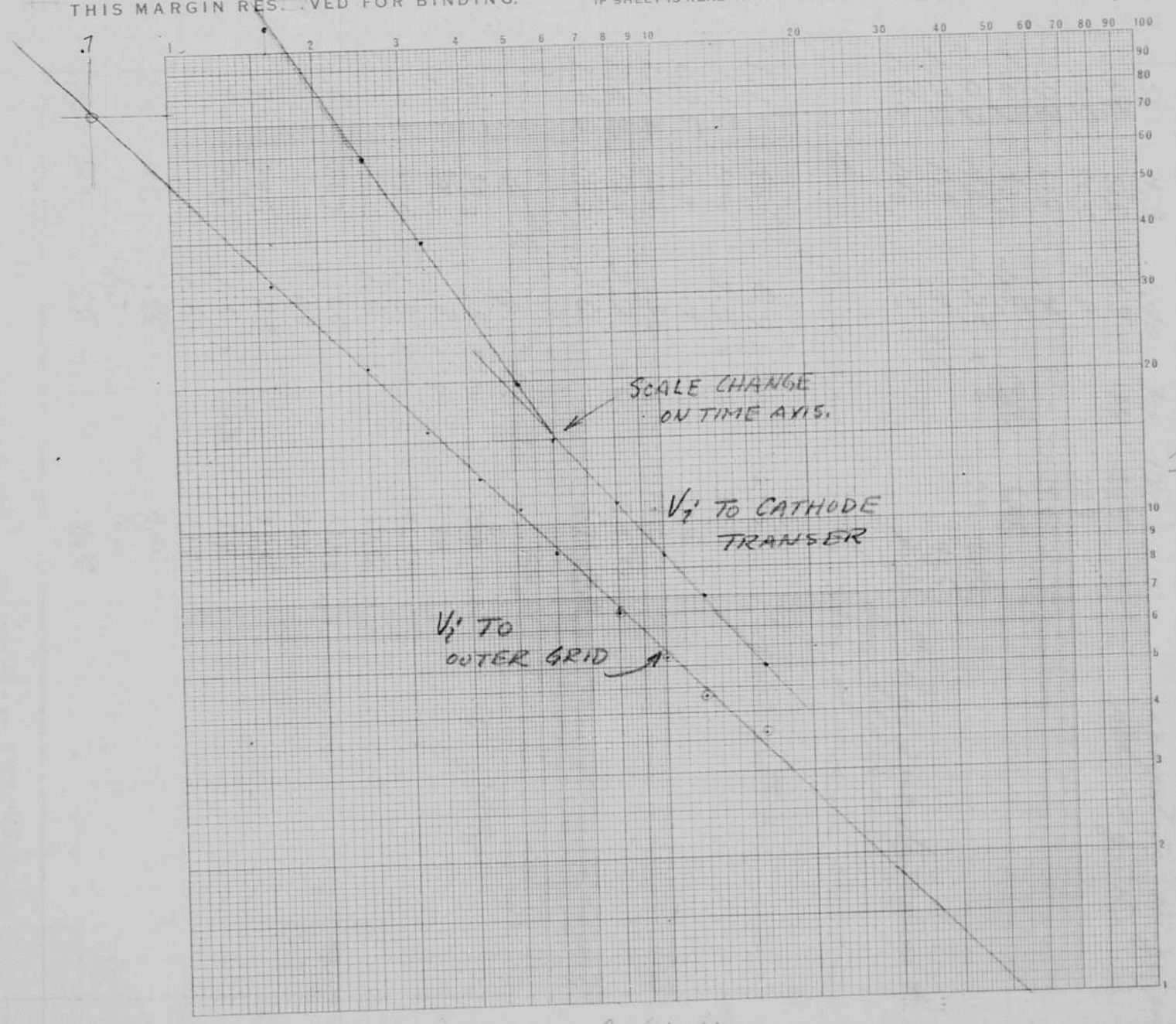
____ unmounted photograph(s)

____ negative strip(s)

__1__ unmounted page(s)
(notes, drawings, letters, etc.)

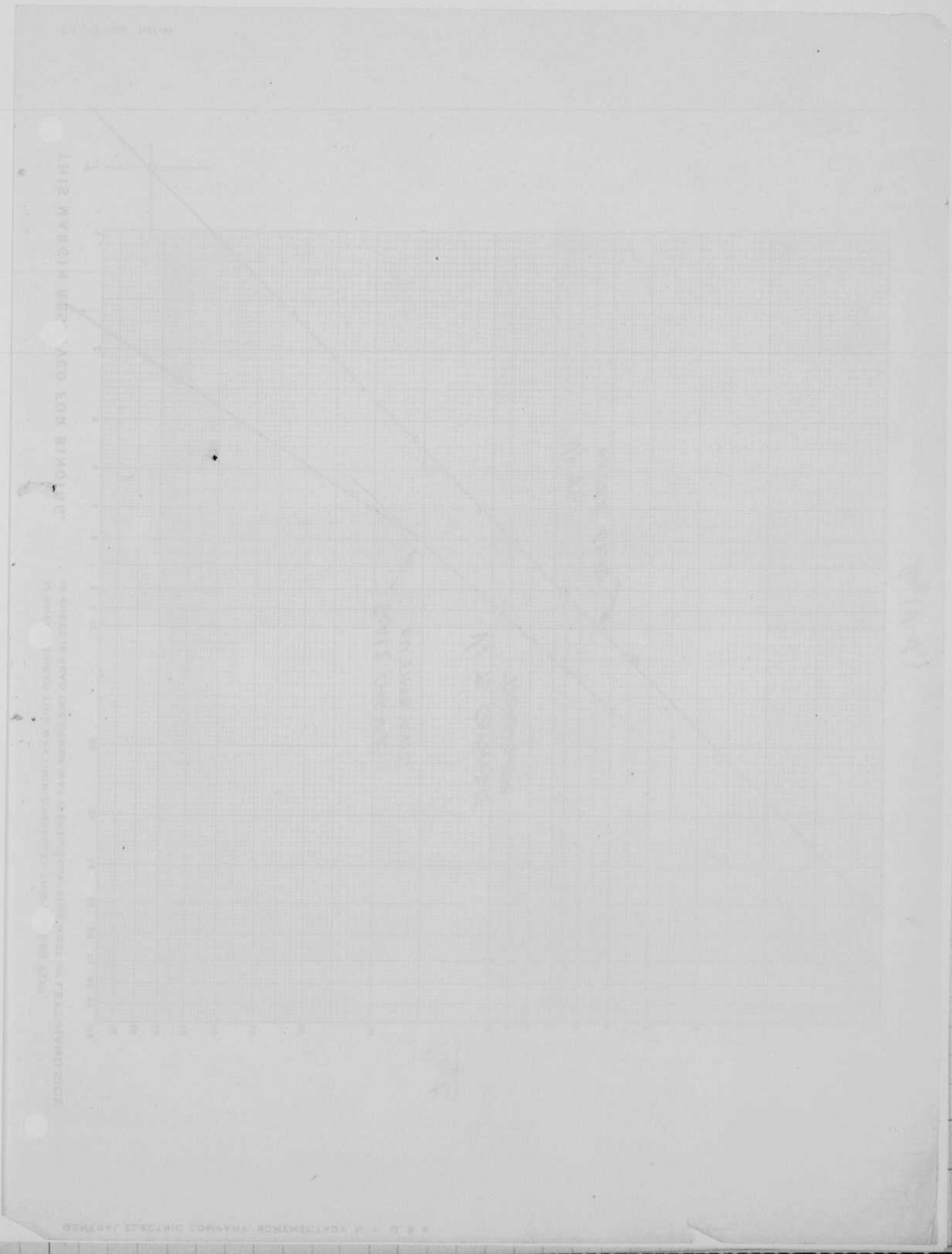
was/were filmed where originally located between page 14 and 15.

Item(s) now housed in accompanying folder.



April 9, 1926.

15



April 9. 1946.

W.E. Ekgerton & Keith Hunton 20 211 Starbotton, 4024

Start clear to time Voltage

Fourth grid = 60.

V. index 87	calib. V	t inch	calib 300 MS.		
.55	47.8	.40	300	120	negative surge on the inner grid.
.58	50.5	1.8	36	64.5	
.65	56.5	0.8		28.8	
.78	67.8	.4		14.4	
1.07	93.0	.18	5.8	6.45	
1.07	93.0	1.25 x 6		7.5	6.45
1.35	118	.9 x6			4.65
1.60	140	.6			3.1 Spot has 2 ms time cons & and double trace.

Outer grid zero with 5600 ohms in series.

1.1	95.5	0.9 x 300	270	some jitter
1.15	100.	2.3 x 36	82.5	
1.25	109	.9	32.4	
1.42	124	.35 57	12.6	
1.42	124	2.2 x6	7.9	12.6
1.60	140	1.6	5.75	9.0

Outer grid + 70. volts.

.45	39.3	.5 x300	150	} jitter
.45	39.3	.8 x300	240	
.50	43.5	1.3 x 36	46.7	
		1.6 x 36	57.5	
.65	56.7	.60	21.6x	
		.65	23.4x	
.90	78.5	.23	8.25	
.90	78.5	1.5 x6 5.8	7.8	
		1.6	8.25	
1.2	105.	.95	4.95	
		1.0	5.2	
1.45	127.	.78	4.05	

cont.

Plate voltage - delay time.

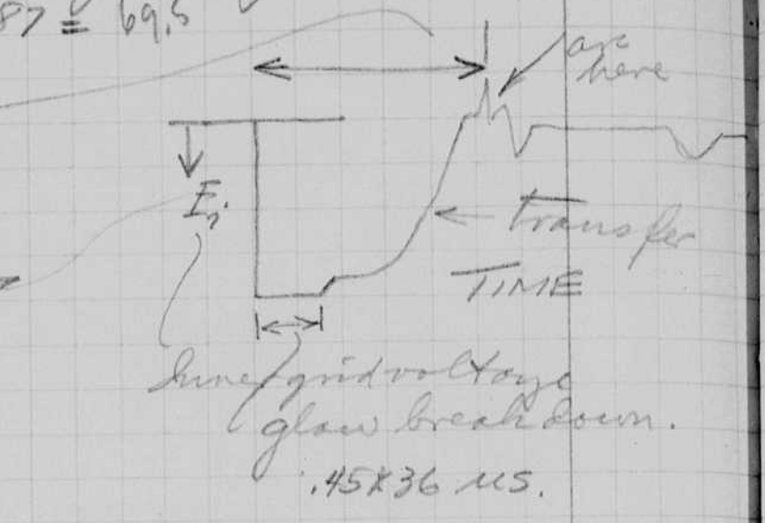
Outer grid +60 5600 ohms.

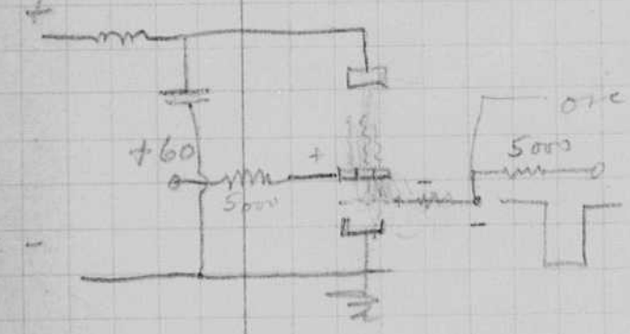
Inner grid - 5000 ohms to negative pulse.

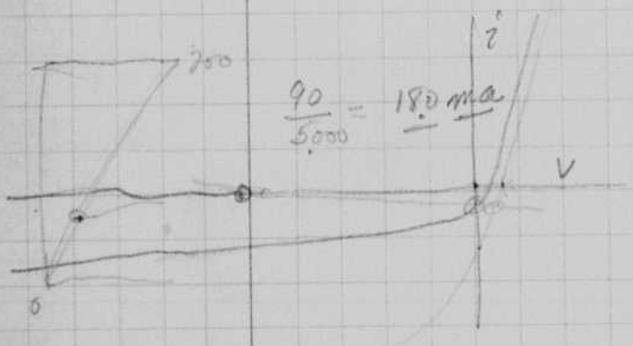
Pulse ~~0.48~~ 0.8 × 87 = 69.5

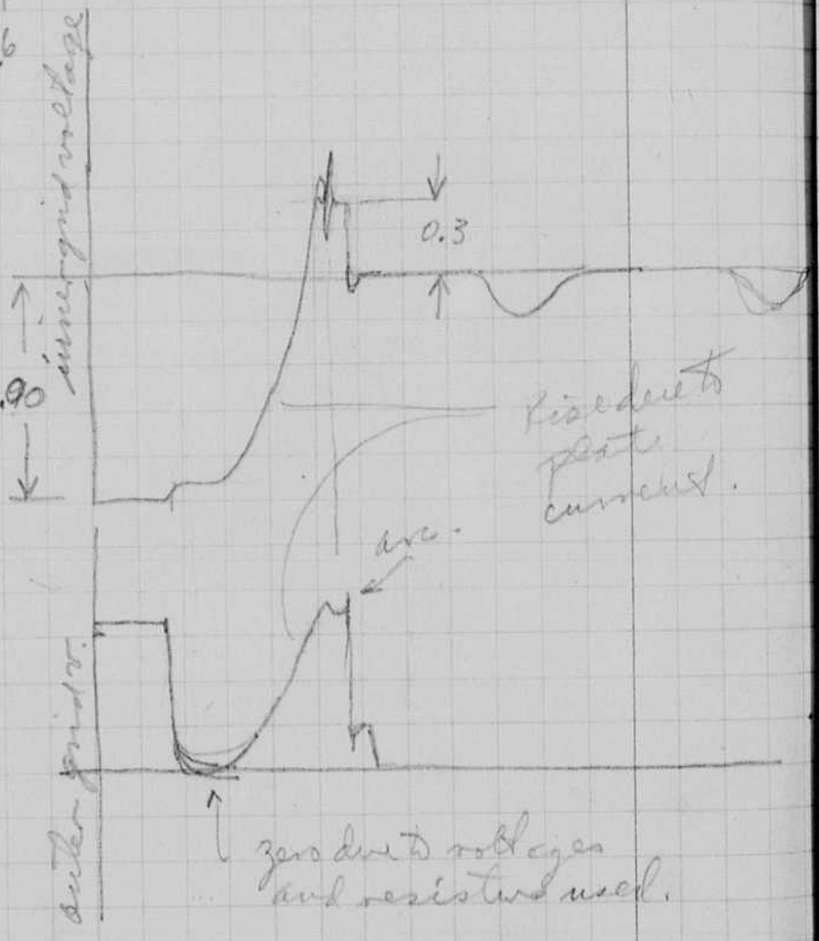
main deg carbon resistor 6000 ohms. 2 mf.

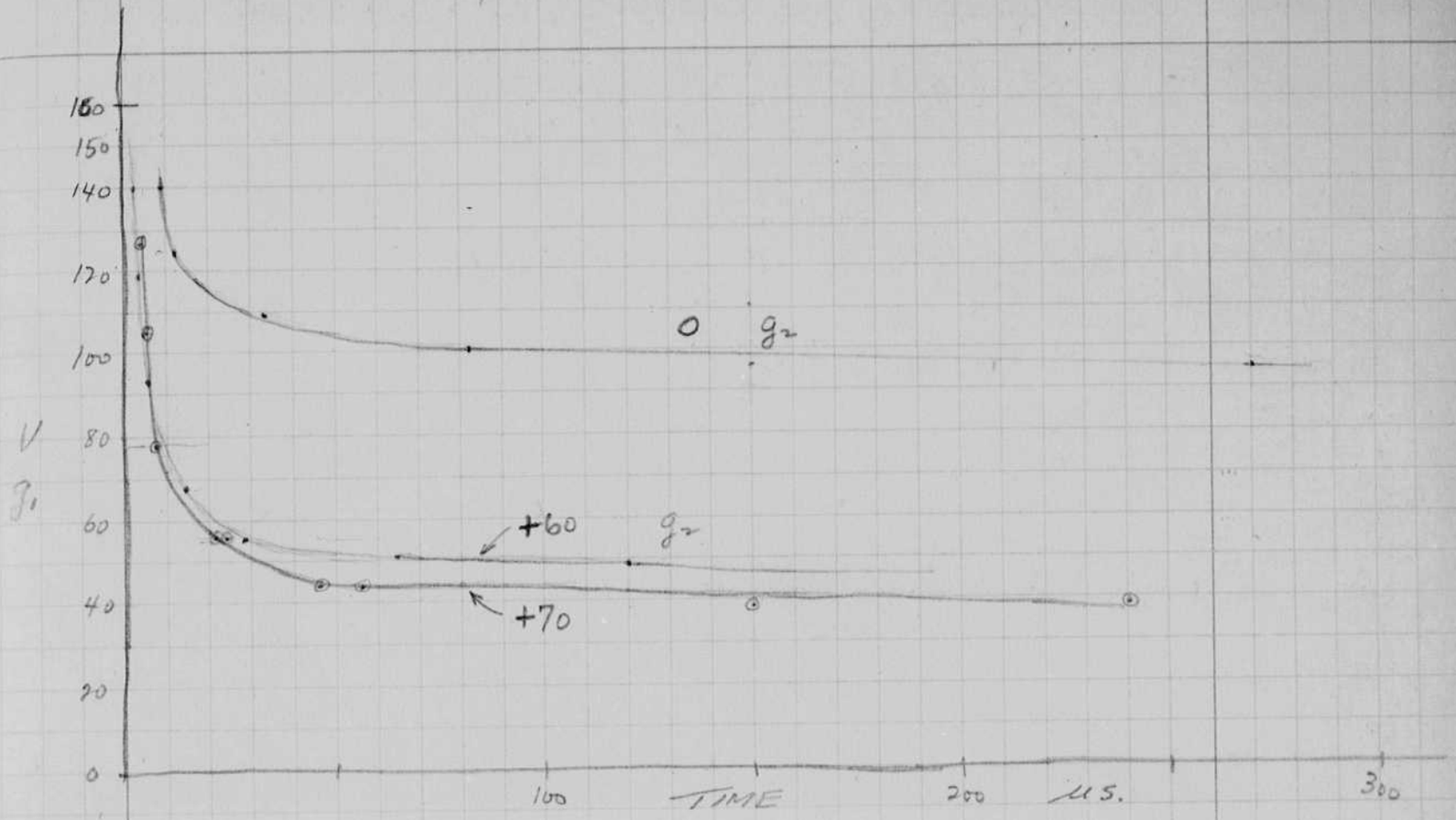
Vplate	time	
	inches	
200	2.5 × 36	90.
250	1.3	46.8
300	.85	30.6
350	.65	23.4
400	.60	21.6
450	.50	18.0
450	plate 2.9 × 6	17.5
	grid 2.0 × 6	12
500	p 2.4 × 6	14.4
	g 2.1 × 6	12.6

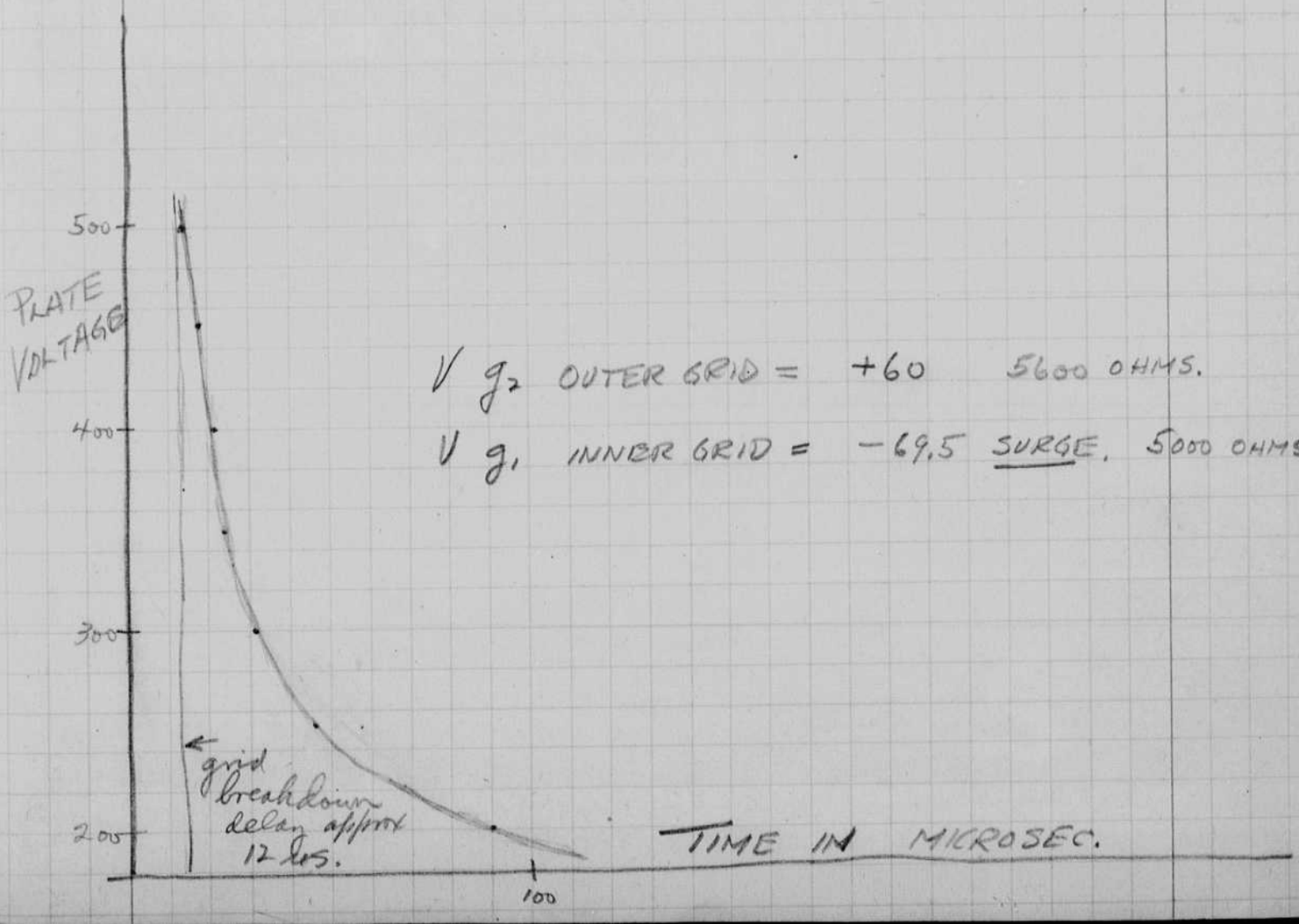








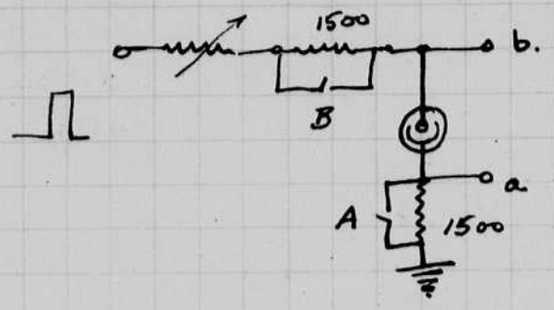




$V\ g_2$ OUTER GRID = +60 5600 OHMS.

$V\ g_1$ INNER GRID = −69.5 SURGE. 5000 OHMS.

See page 8.



Bottom curve with point a 1500 ohms.

Current calib.

$e = 1500\, i'$

$i' = \frac{87 \text{ volts/inch}}{1500 \text{ ohms}} = 58 \text{ ma/inch}$

Divisions are 0.1 inch
= 5.8 ma.

Glow tube voltage. point b to ground with switch A closed.

Calibration 78 volts per inch.

Voltage after 600+ ms. = 8×87. = 69.5

$V = 1.16 \times 87 = 101$ volts. applied. #4.

$t = 2.6 \times 61.1 = 159$ ms.

$\frac{.92 \times 87}{1500} = 80$ volts.

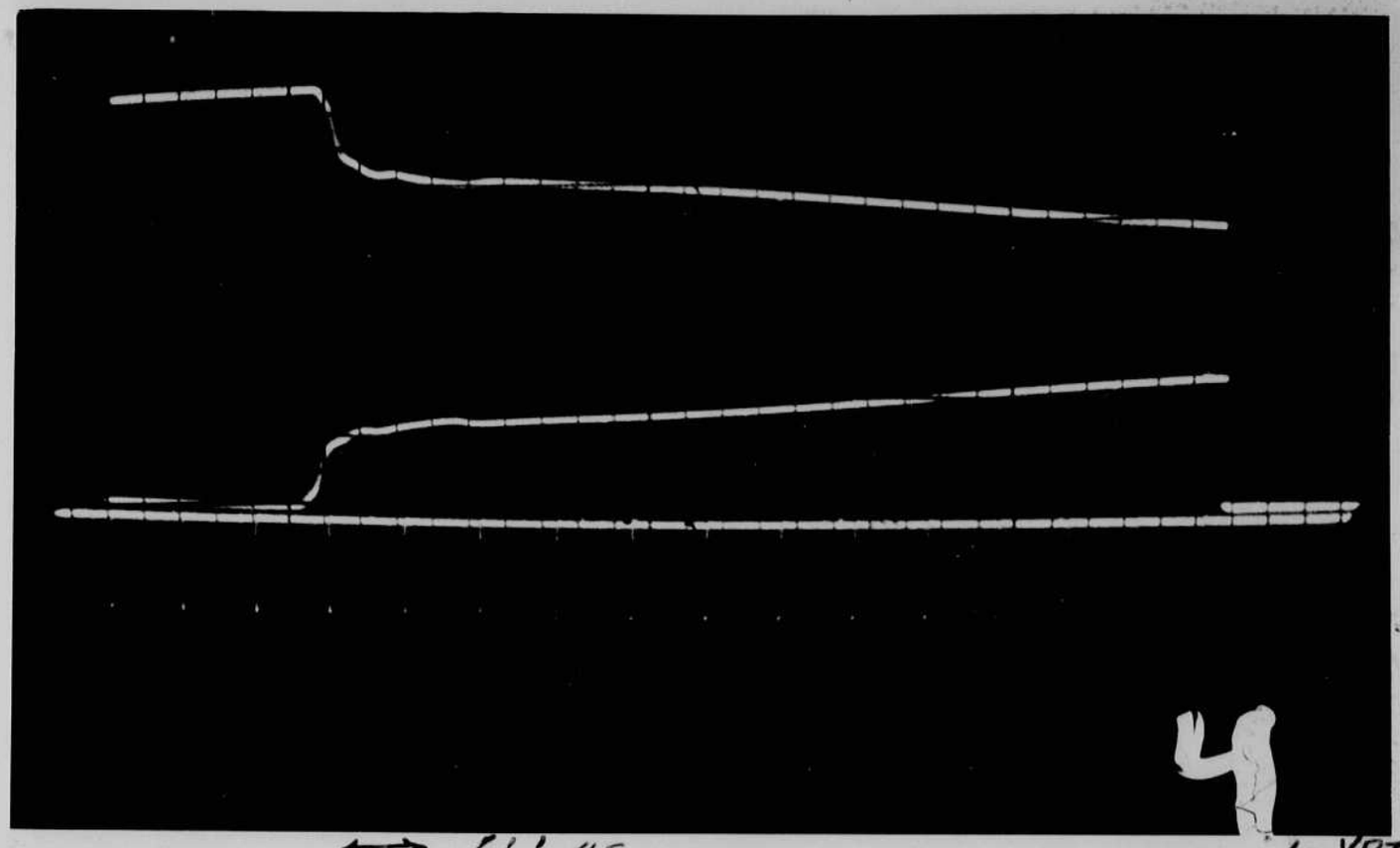
then about 60 ms is required for current to build up to. $\frac{.22 \times 87}{1500} = 1275$ ma.

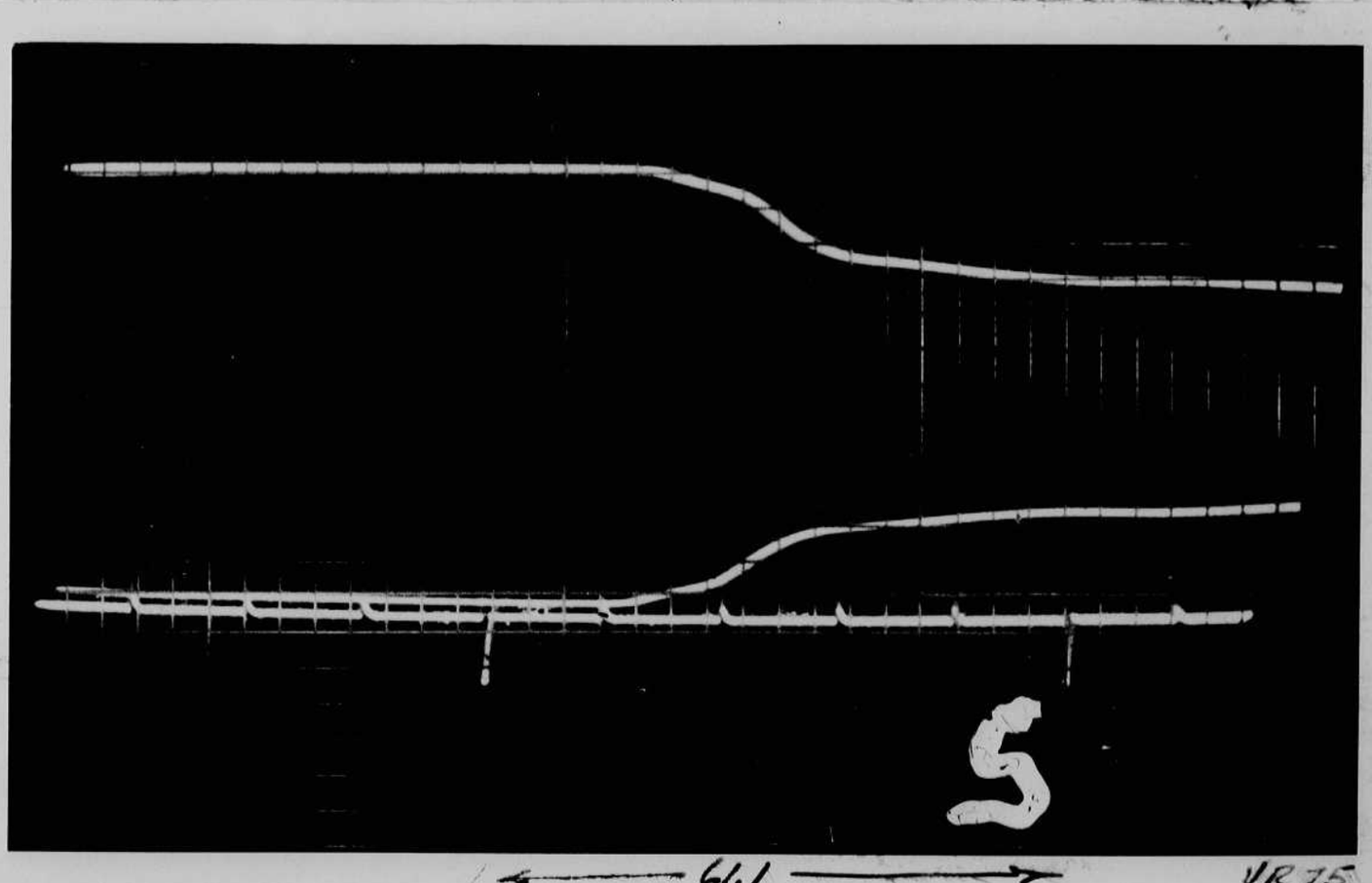
after $12 \times 61 = 730$ ms the voltage has dropped to $.8 \times 87 = 69.5$ volts.

current $= \frac{.35 \times 87}{1500} = 20$ ma.

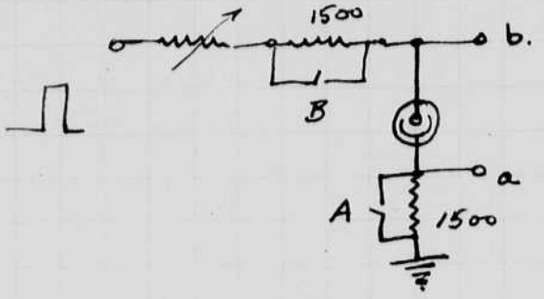
From Reel 2 April 4, 1946.

V.R. 75 tube





See page 8.



Bottom curve with point a 1500 ohms.

Current calib.

$e = 1500\, i'$

$i' = \frac{87 \text{ volts/inch}}{1500 \text{ ohms}} = 58 \text{ ma/inch}$

Divisions are 0.1 inch
= 5.8 ma.

Glow tube voltage. point b to ground with switch A closed.

Calibration 78 volts per inch.

Voltage after 600+ μs. = 8×87. = 69.5

$V = 1.16 \times 87 = 101.$ volts. applied. #4.

$t = 2.6 \times 61.1 = 159.$ μs.

$\frac{.92 \times 87}{1500} = 80$ volts.

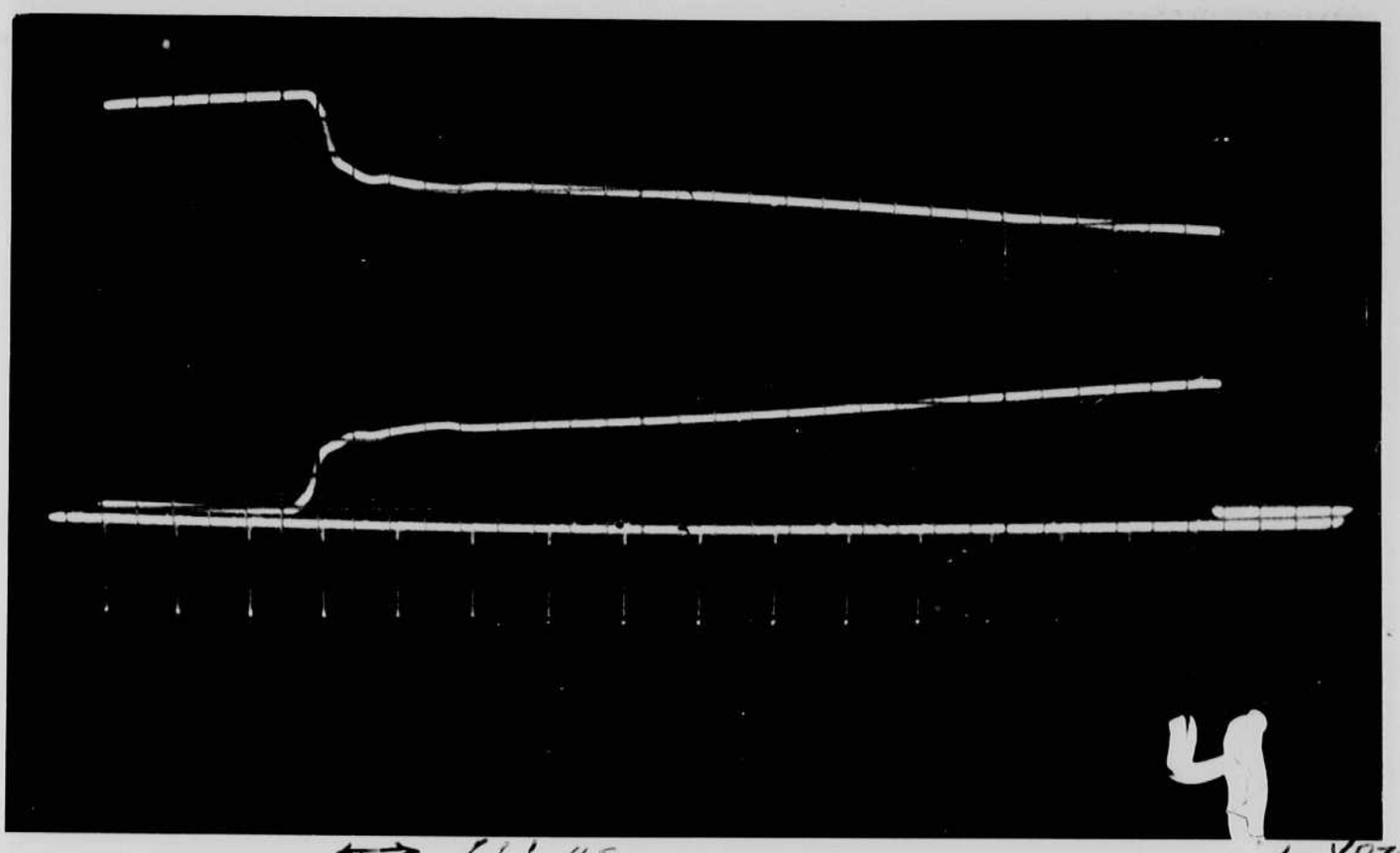
then about 60 μs is required for current to build up to. $\frac{.22 \times 87}{1500} = 12.75$ ma.

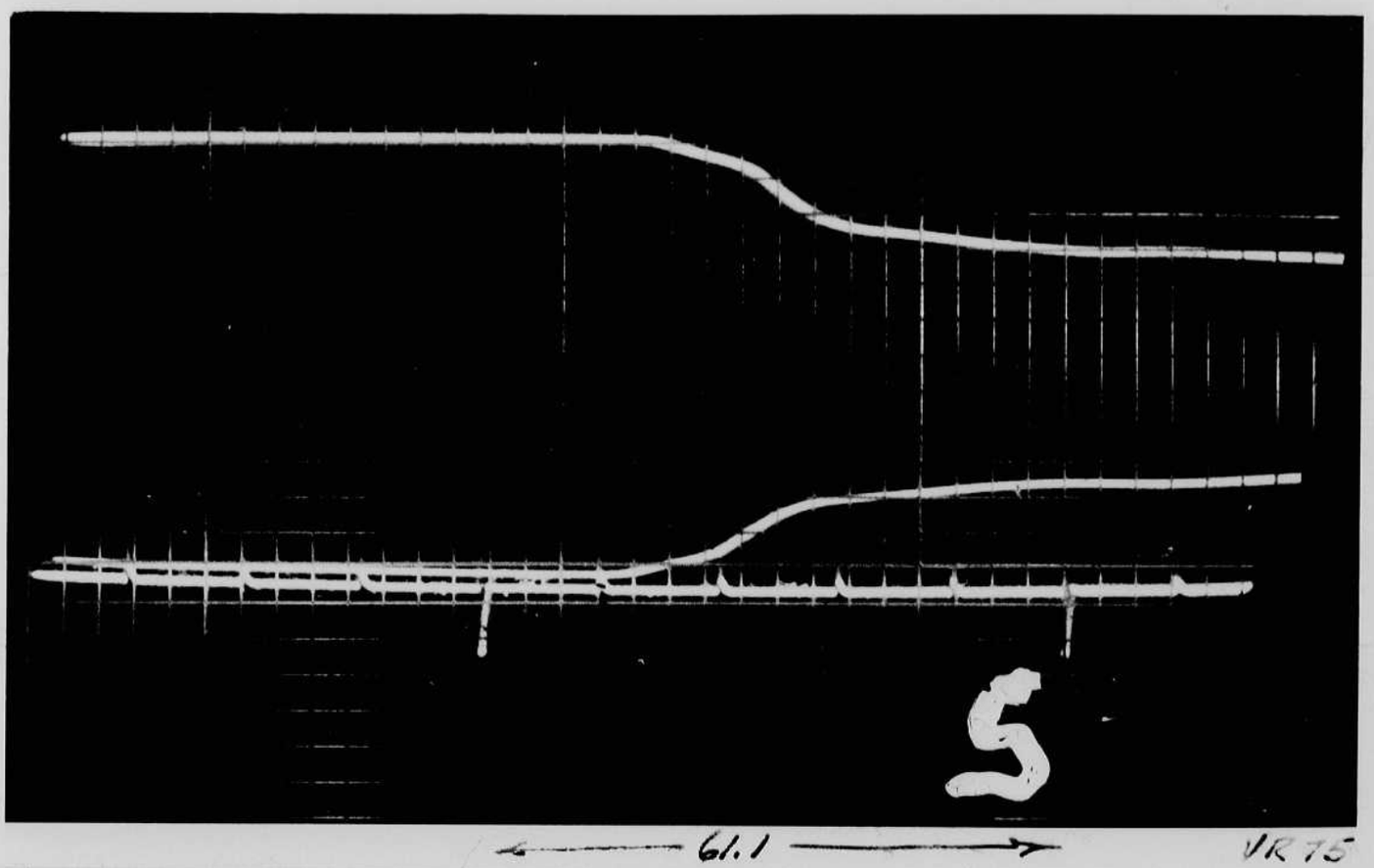
after $12 \times 61 = 730$ μs the voltage has dropped to. $.8 \times 87 = 69.5$ volts

current = $\frac{.35 \times 87}{1500} = 20$ ma.

From Real 2 April 4, 1946.

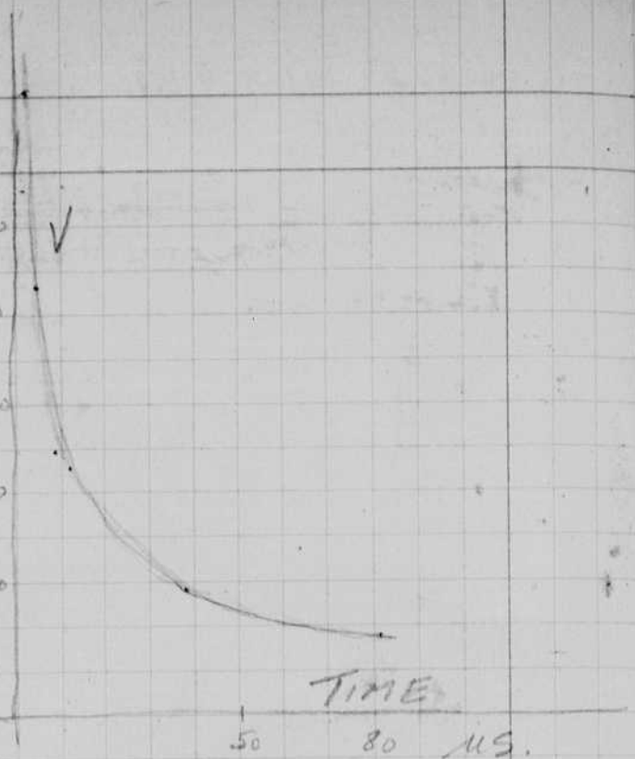
V.R. 75 tube





From osc. 16 and 17

	V		I		t
	milli	87 volts	milles		μs.
16	1.24	108.	2.1	38.3	80.5
	1.36	118	1.0		38.3
	1.71	149	.25		9.6
17	1.64	143	2.1	6.1	10.8
	2.14	186	.8		4.87
	2.66	231	.45		2.74



$t = \frac{a}{(V - V_s)} \varepsilon^{b/v}$. Take two values. $t = 5_{\mu s}$ $V = 185$ $V - V_s = 85$

$t = 80$ $108.$ $= 18$

Assume $V_s = 100$

(1) $5(85) = a\varepsilon^{b/v} = 425 = a\varepsilon^{b/185}$

$80\ 8 = a\varepsilon^{b/v} = 640 = a\varepsilon^{b/108}$

$a\varepsilon^{b/v}$ = about 500.

$5 = \frac{a}{(185 - V_s)}$ $\quad 925 - 5V_s = a$

$80 = \frac{a}{(108 - V_s)}$ $\quad 865 - 80V_s = a$

$60 + 75V_s = 0$ $\quad V_s = -1$ volt.

Try 150 V. 10 μs.

$10 = \frac{a}{(150 - V_s)}$ $\quad 1500 - 10V_s = a$.

865

$635 = 65V_s$

$V_s = 9.75$ volts.

1500

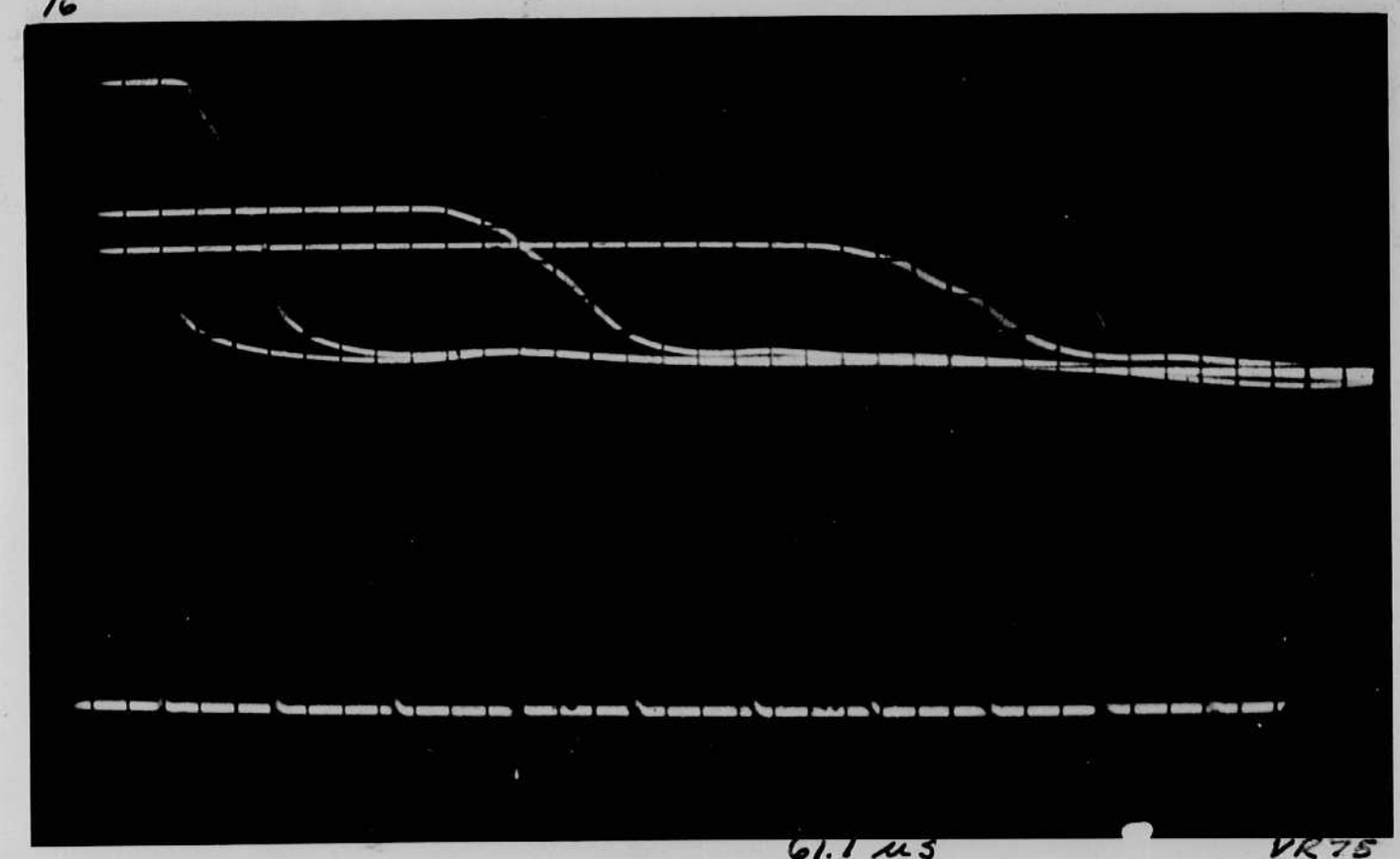
975

$525 = a$

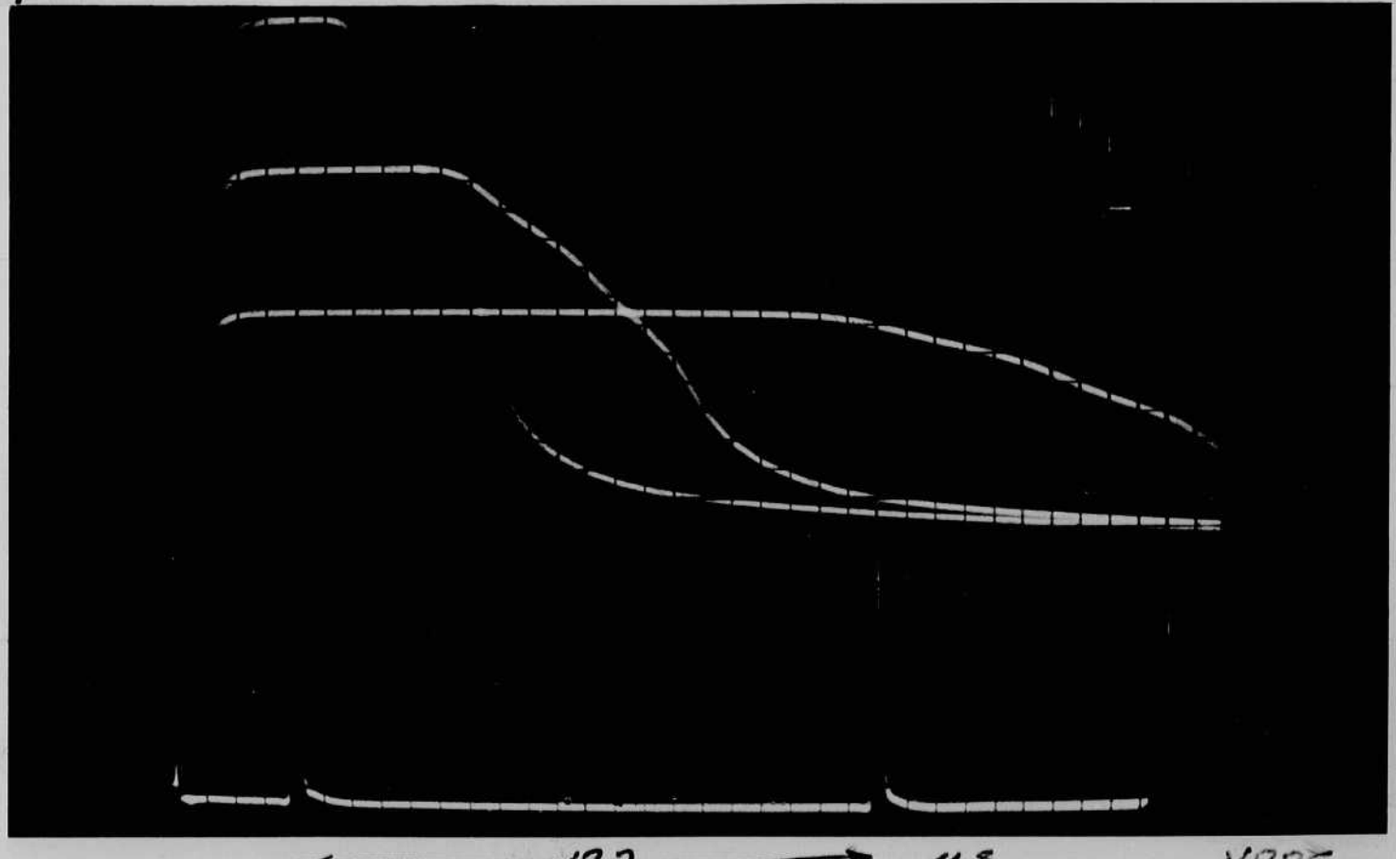
$a = 525$ volts μs.

1.6" = 61.1 ms.
1" = 38.3 ms.

16



17

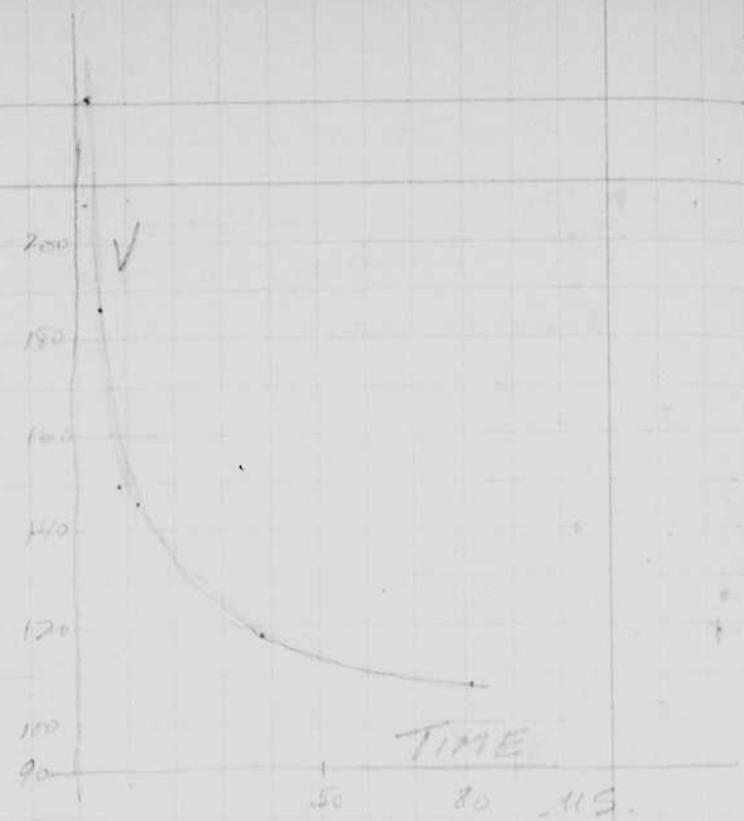


17

1" = 12.2
1" = 6.1 ms.

From osc. 16 and 17

	V			t		
	inch	~~80~~ volts		inches		μs.
16	1.24	108.		2.1	38.3	80.5
	1.36	118		1.0		38.3
	1.71	149		.25		9.6
17	1.64	143		2.1	6.1	10.8
	2.14	186		.8		4.87
	2.66	231		.45		2.74



$t = \frac{a}{(V - V_s)} \varepsilon^{b/v}$.

Take two values $t = 5_{\mu s}$ $V = 185$ $V - V_s = 85$

$t = 80$ $108.$ $= 8$

Assume $V_s = 100$

(1) $5(85) = a\varepsilon^{b/v} = 425 = a\varepsilon^{b/185}$

$80 \cdot 8 = a\varepsilon^{b/v} = 640 = a\varepsilon^{b/108}$

$a\varepsilon^{b/v}$ = <u>about 500.</u>

$5 = \frac{a}{(185 - V_s)}$ $925 - 5V_s = a$

$80 = \frac{a}{(108 - V_s)}$ $865 - 80V_s = a$

$60 + 75V_s = 0$ $V_s = -1$ volt.

Try 150 V. 10 μs.

$10 = \frac{a}{(150 - V_s)}$ $1500 - 10VS = a.$ $635 = 65V_s$

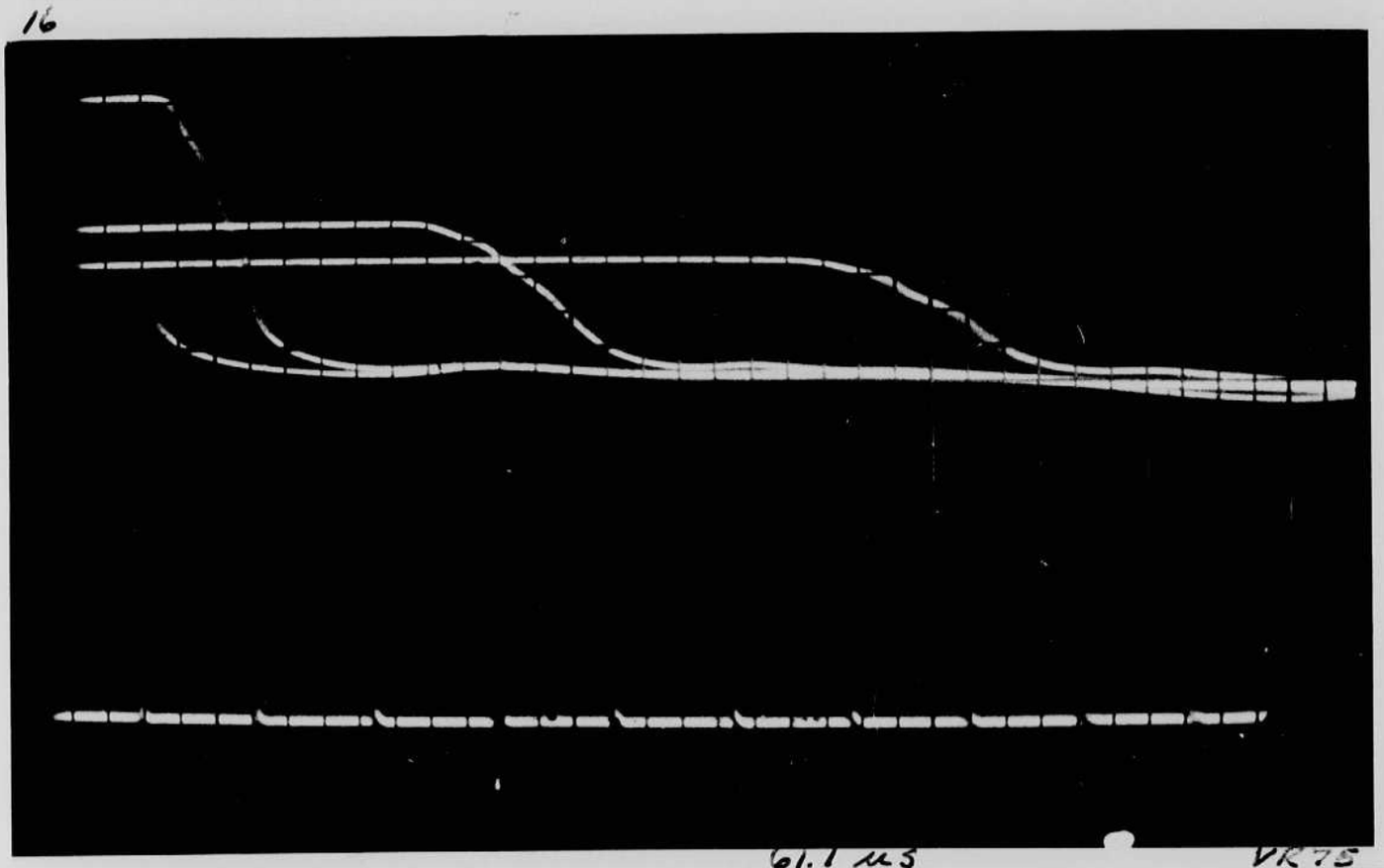
$V_s = \underline{9.75}$ volts.

$1500 - 975 = 525 = a$

$a = \underline{\underline{525}}$ volts μs.

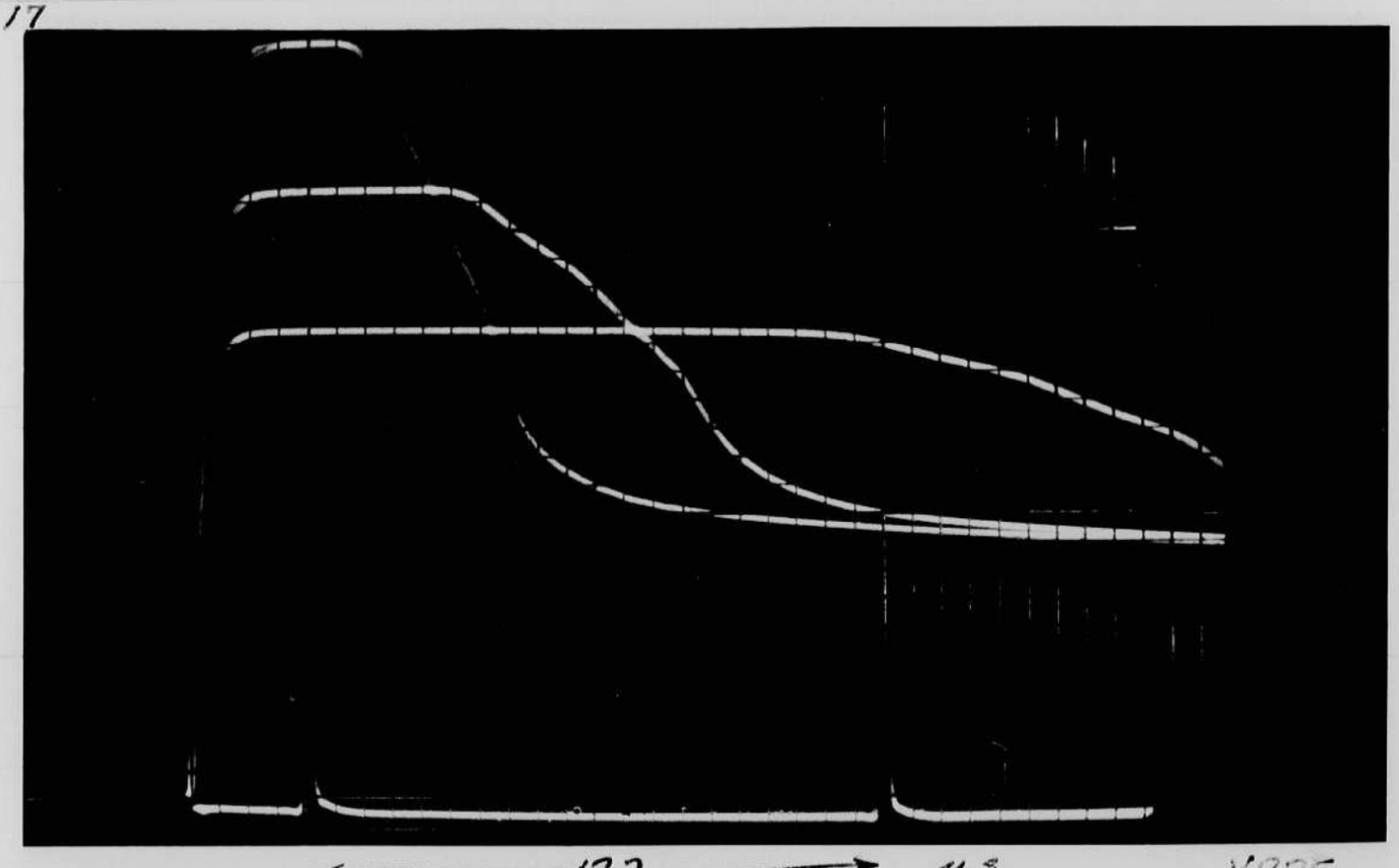
1.6" = 61.1 ms.
1" = 38.3 ms.

16



61.1 ms VR75

17



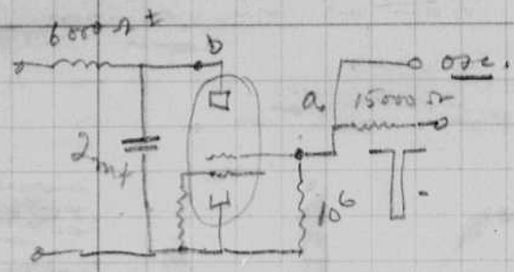
17

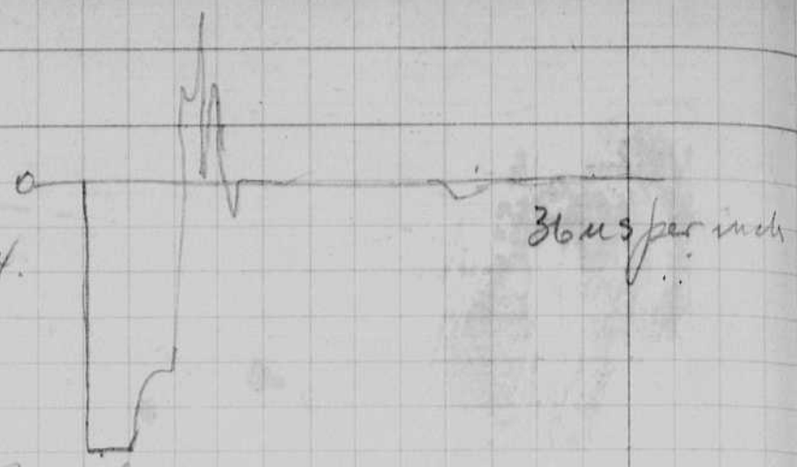
12.2 ms VR75

1" = 12.2
1" = 6.1 ms.

H.E. Edgerton.
Apr 11, 1946.
20B 236

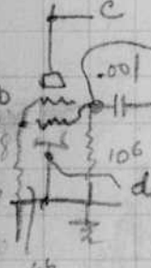
Stroboscope tests





	Strobe	Sweep. cy/inch	Osc of	Remarks.	E_p on meter	
No 14.	4024	A 20 000	36	a	in grid volts.	350
(2)	4024.	A 200 000	300	a		
3	4024	A 200 000	300	a	in grid volts.	350
4						100
5						150
6						200
7						250
8						300
9						350
10						400
11						450
12	1708.	A 200 000	300	a	in grid volts	300 Shows H.f osc.
13		A 20,000	Ditto.			
14	5417	A 200 000	300	a	in	300 Shows H.F. osc. Blue?
15	5024	A 200 000	300	b	plate voltage	350 Shows reverse I.
16		A 200 000	300	a	~~outer~~ inner	350

Starting is improved with a capacity input .001 in series.
in time.



17	5024	A 20 000 / 4000	6.	a cap	inner grid	350
18	"	4000	6	b	outer grid	350 Signal on inner.
19	"	A 20 000 / 4000	6	c d (.167 ohms)	and gnd	350
20	1708	A 20 000 / 4000	6	d (.167)	a	350.
21	1708	"	6	c b d	and d shorted	350.
22	1705	A 200 000	300	b 5600 ohms	and 50 ± volts +	350 Shows ionization decay.
23	4024	"	"	"	"	" " "

Roll #2 $E_{outer} = 50$ volts.

Film	Tube No	Sweep	us/in	Osc of	Remarks	Ep.	
1	4024	A2000	300	b 560 and zero.		350	Shows recovery time.
2		4000	6	a .001 mf & d current.		350	Starting voltage
3		"	"	d current & c volts		350	tube holds over zero.
4		"	6	"	& b	350.	
5	"	A2000	36	"	2 light 10^4	1 at 350.	
6.			36	"	" "	" "	Different zero.
7			"	"	"		"
8			"		"	10^4 1 at	350
			"			10^5 10 at	350
			"			10^6 100 at.	350 & amount'd.
9.		4000	6.	d & light		10^4 1 at	350
10			6	Light		10^4 1 at.	350 10-20-30-150 volts on photo tube Vac.
			~~6~~				
11.			6	Light		10^4 1 at	10-20-30-50-75 GHS
12			6	"		10^4 3	75-100-125-150 ?
13.							10-30-60-80-100-120 ?
14.			6.	4 mf on condenser discharge c and d.			

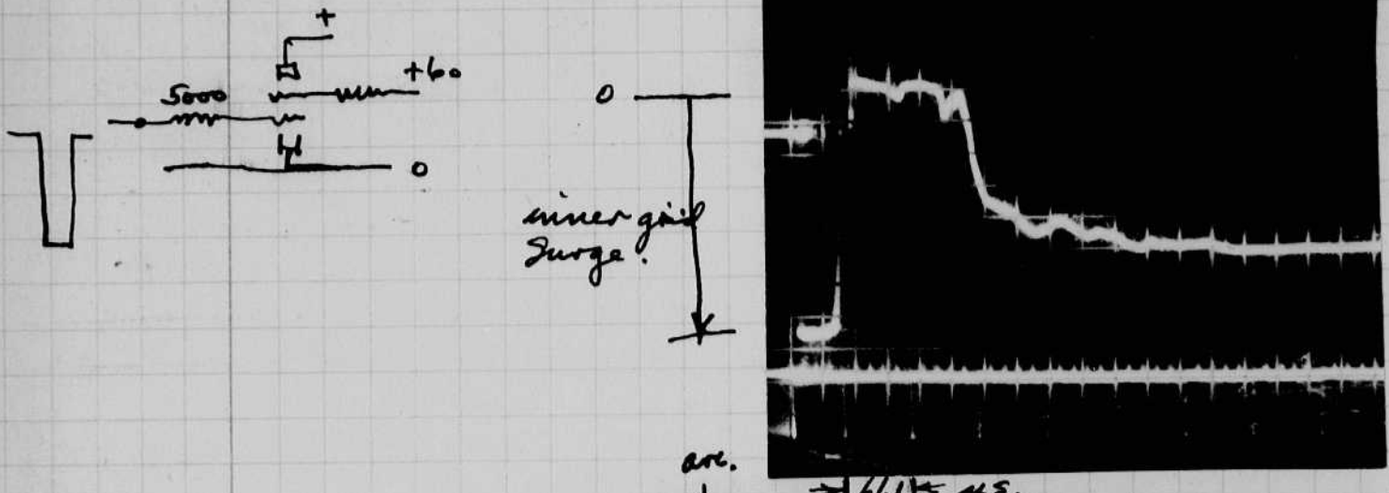
Roll 3.

1.	4000	6	4 mf 475 volts	current d and voltage c.
2.	"	"	" "	Outer grid a & outer grid b.
3.				

ARC there

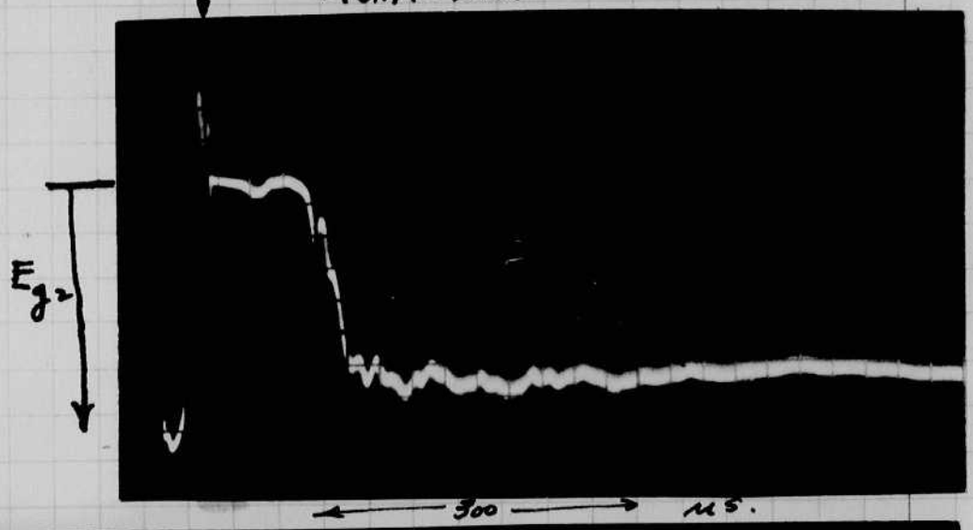
Shows deionization of gas in grid.

#2

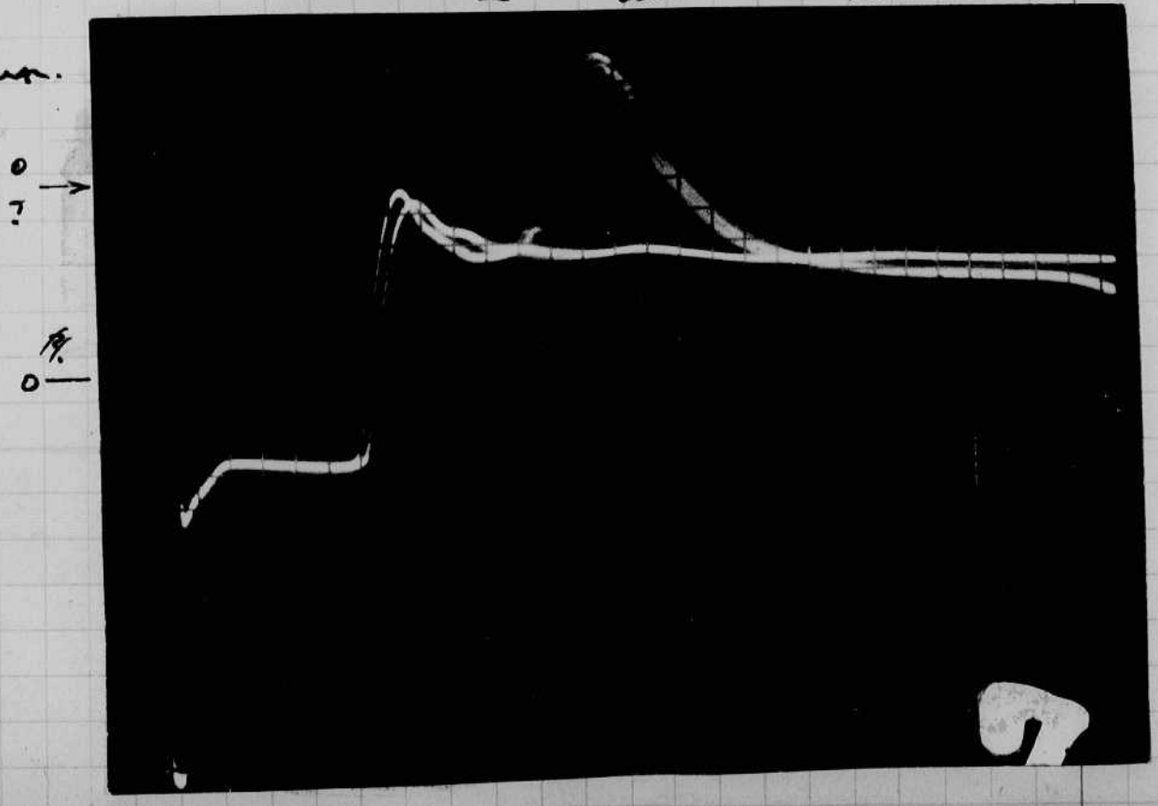


arc.

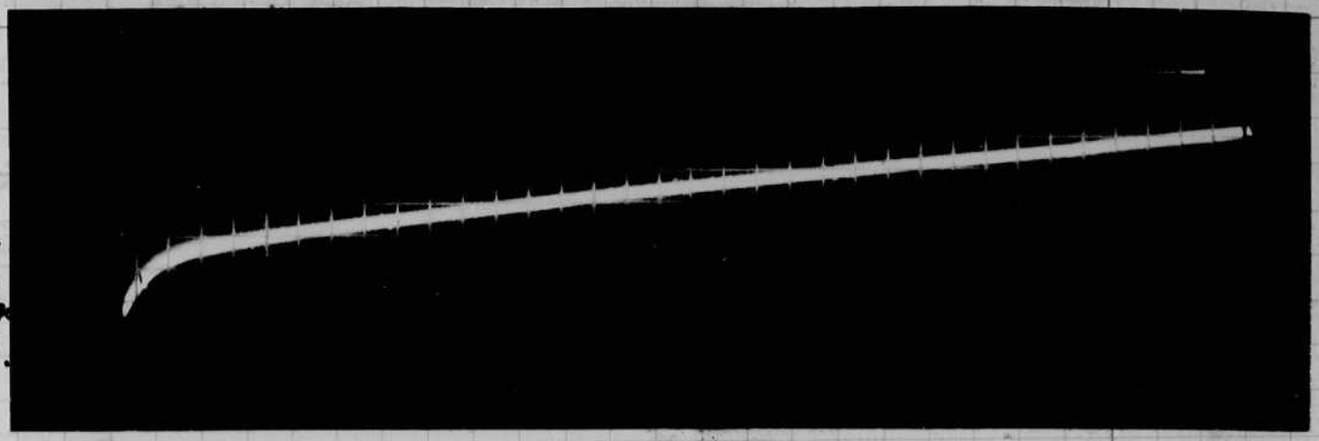
61.1 ± μs.



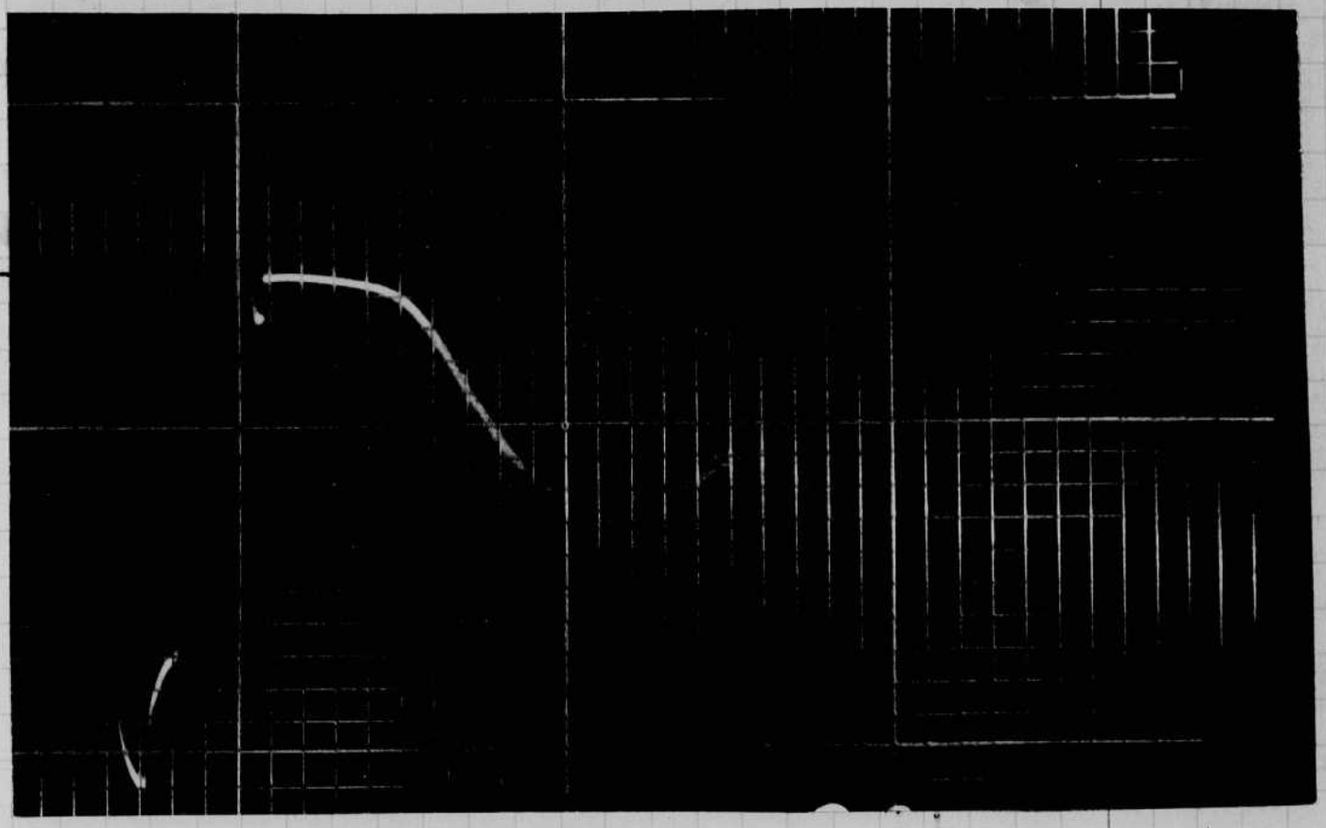
Glow breakdown.



$i = C\frac{de}{dt} = \frac{97 \times .2}{30 \times 10^6} 2 \times 10^6 = 10$ amperes 300.



0 — anode voltage after discharge.



0 — ↓ e_{g_1}.

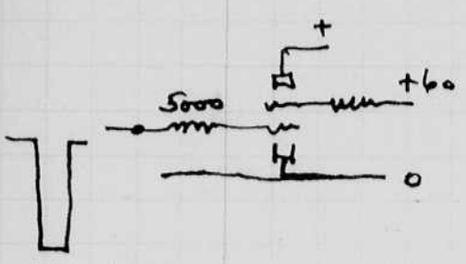
Tube 1708

Irregular start after main flash.

← 300 ms →

The grid (g_1 to g_2) breaks down into a arc at a high frequency rate after the main arc has deionized.

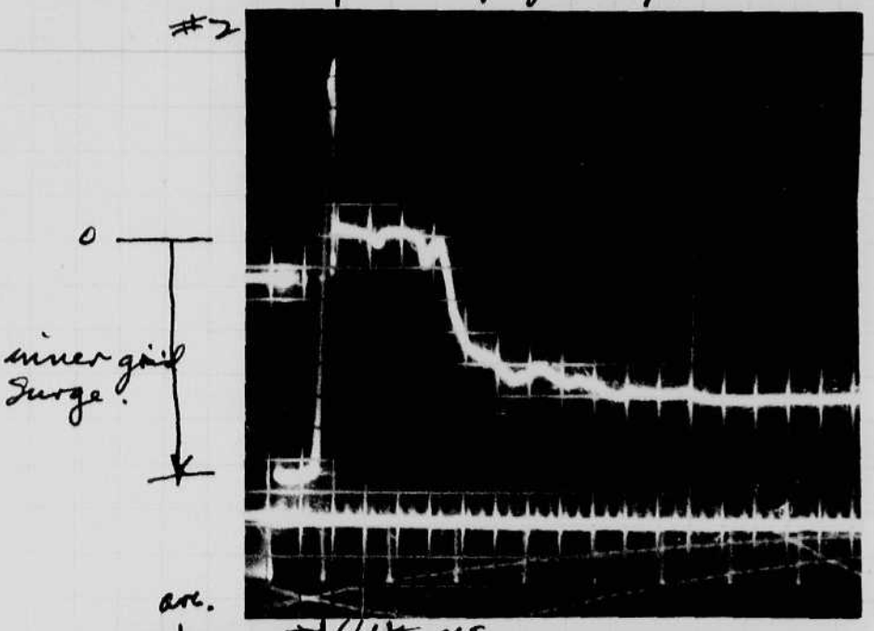
Pressure pulse from discharge travels to the wall and is reflected back to the arc where it causes a change in the grid current. There is also a slight rise of the light at this point.



ARC there

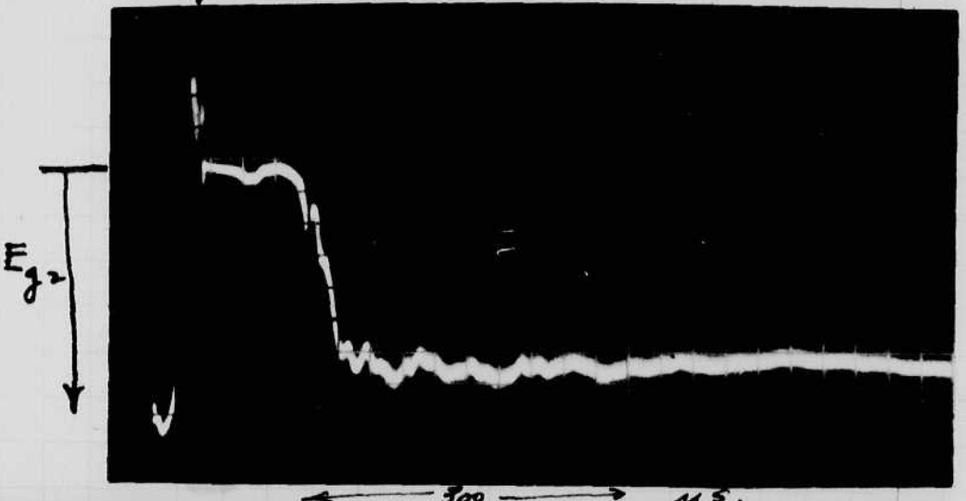
Shows deionization of gas in grid.

#2

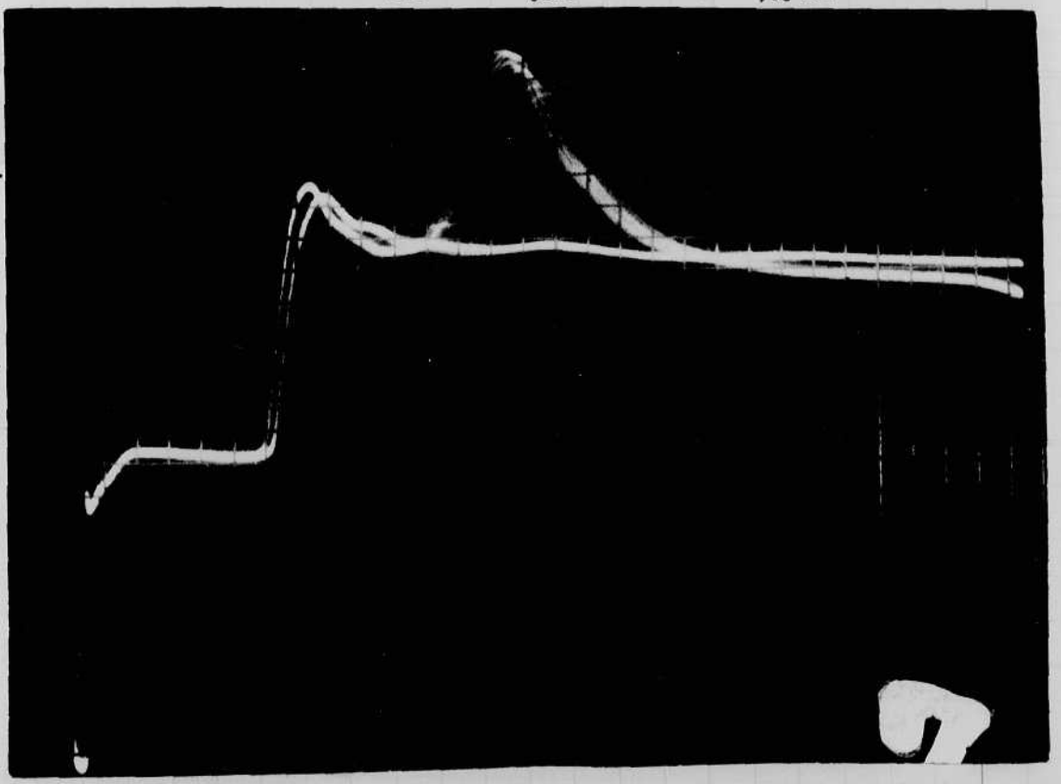


arc.

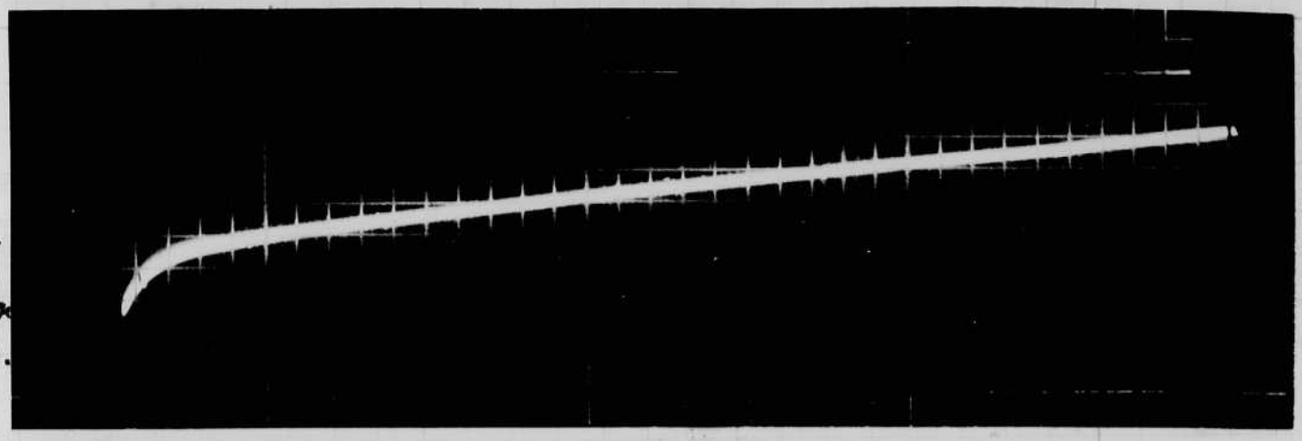
→ 161.1 ← ms.



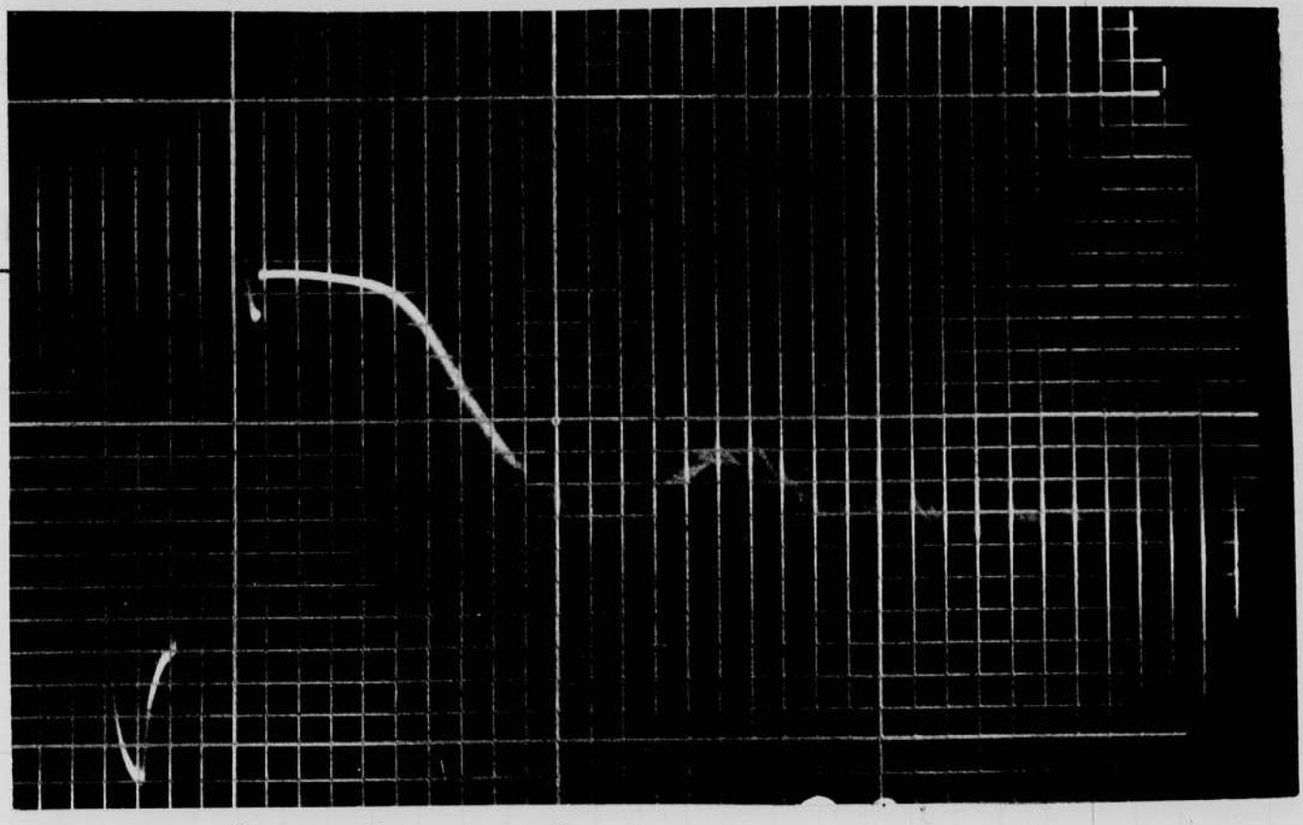
Slow breakdown.



$i = C\frac{de}{dt} = \frac{99 \times .2}{30 \times 10^{-6}} \cdot 2 \times 10^{-6} = 10$ amperes 300



0 — anode voltage after discharge.



0 — ↓ Cg1.

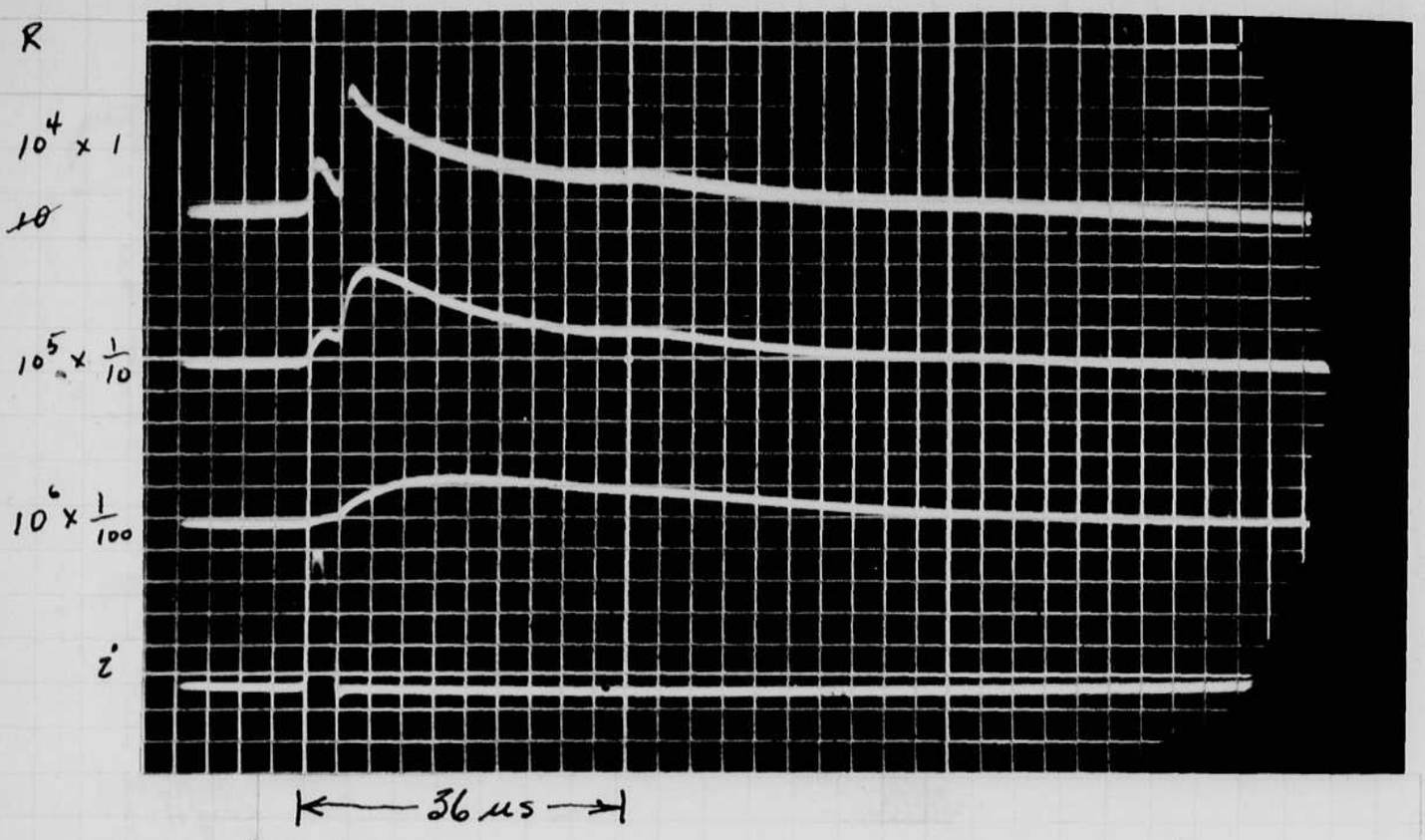
Tube 1708

Irregular start after main flash.

← 300 μs →

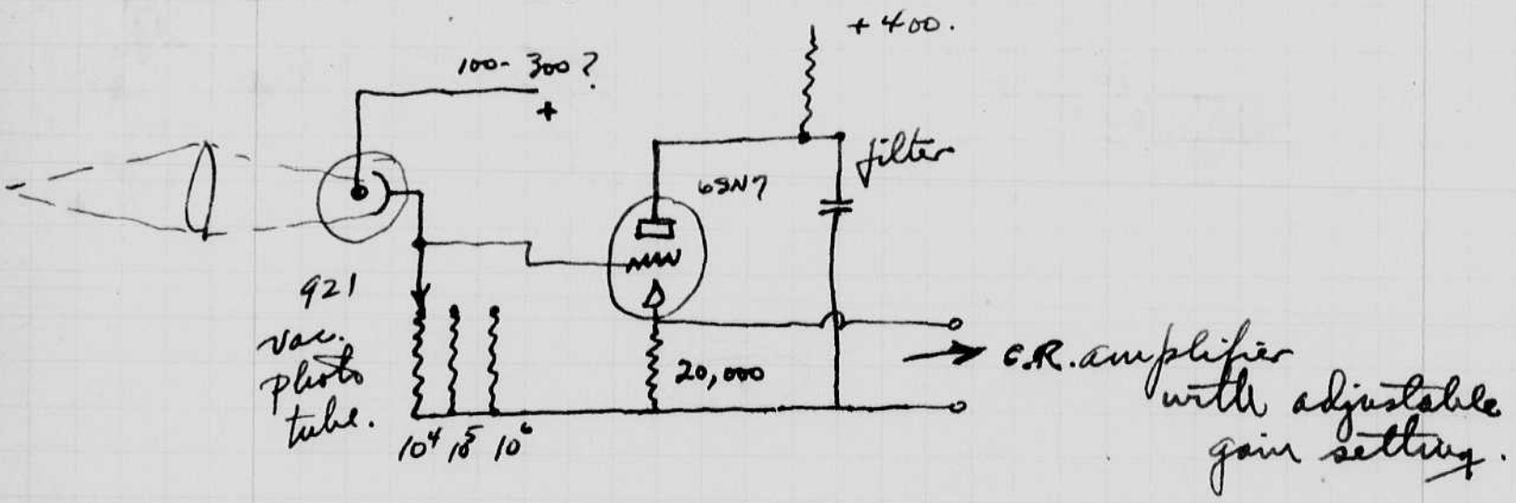
The grid (g1 to g2) breaks down into an arc at a high frequency rate after the main arc has deionized.

Pressure pulse from discharge travels to the wall and is reflected back to the arc where it causes a change in the grid current. There is also a slight rise of the light at this point.



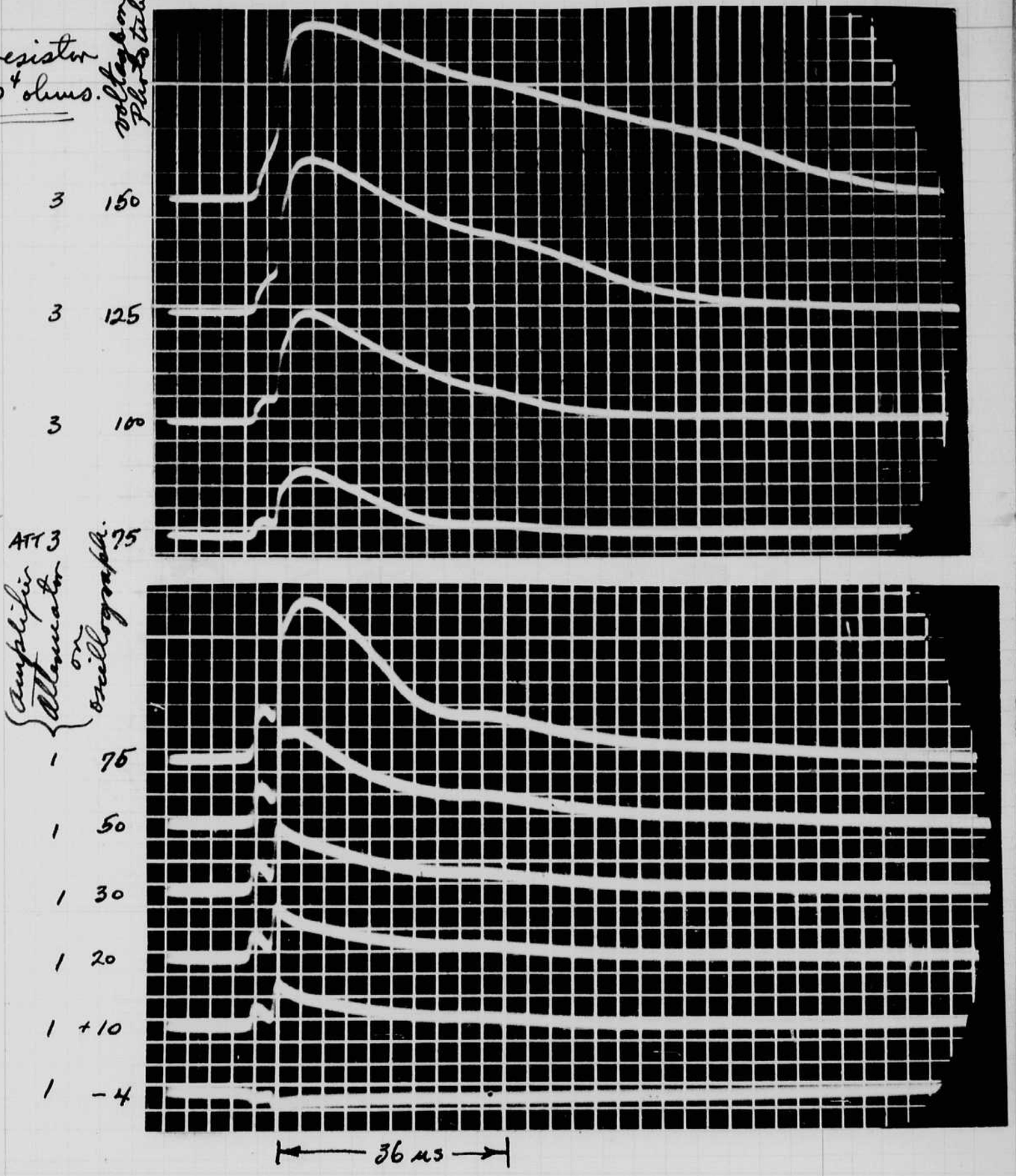
Vac. photocell with different load resistors showing effect of the input time constant.

$i = \frac{4.5\ 87.}{.167} = 234$ amperes peak. (bottom osc.)

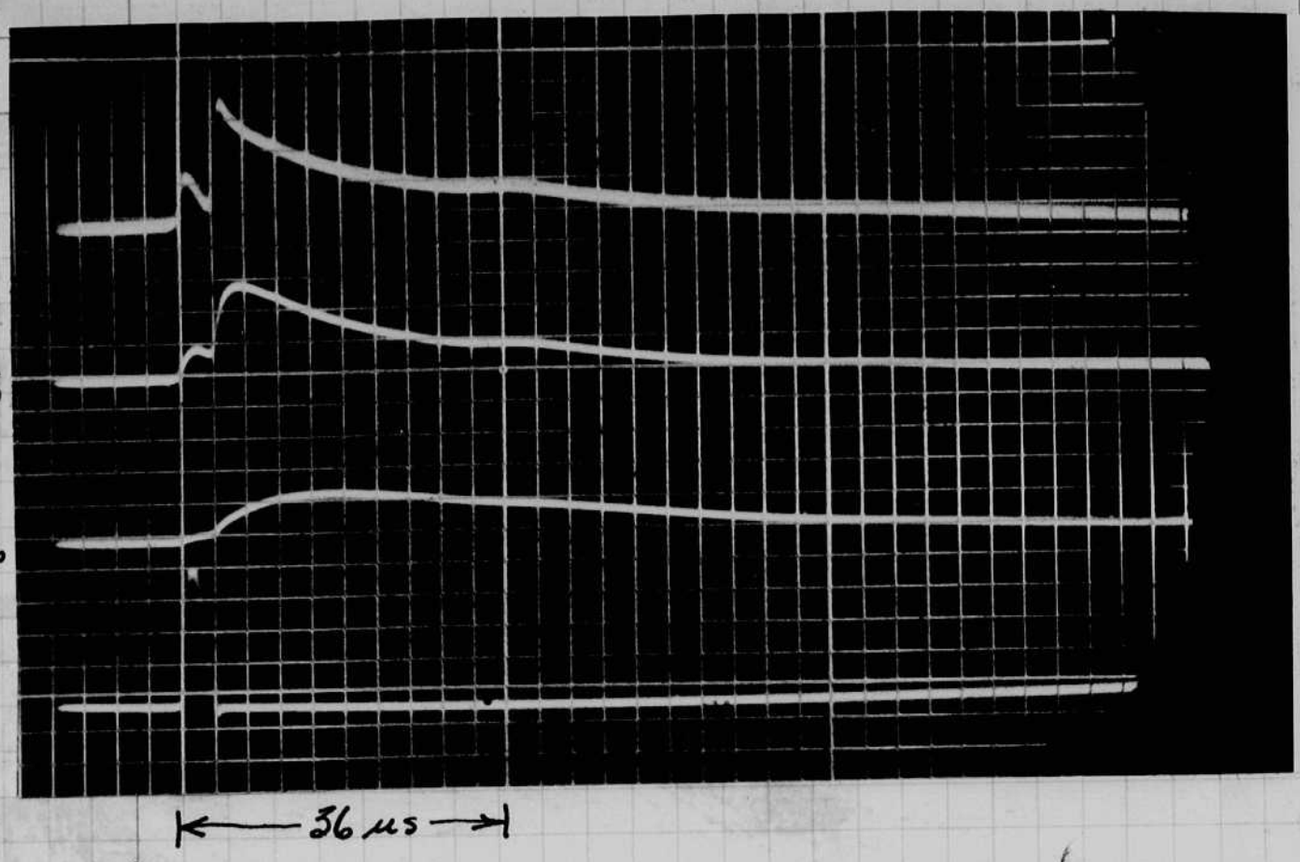


Dss (922) Photo tube.

Load resistor = 10^4 ohms.

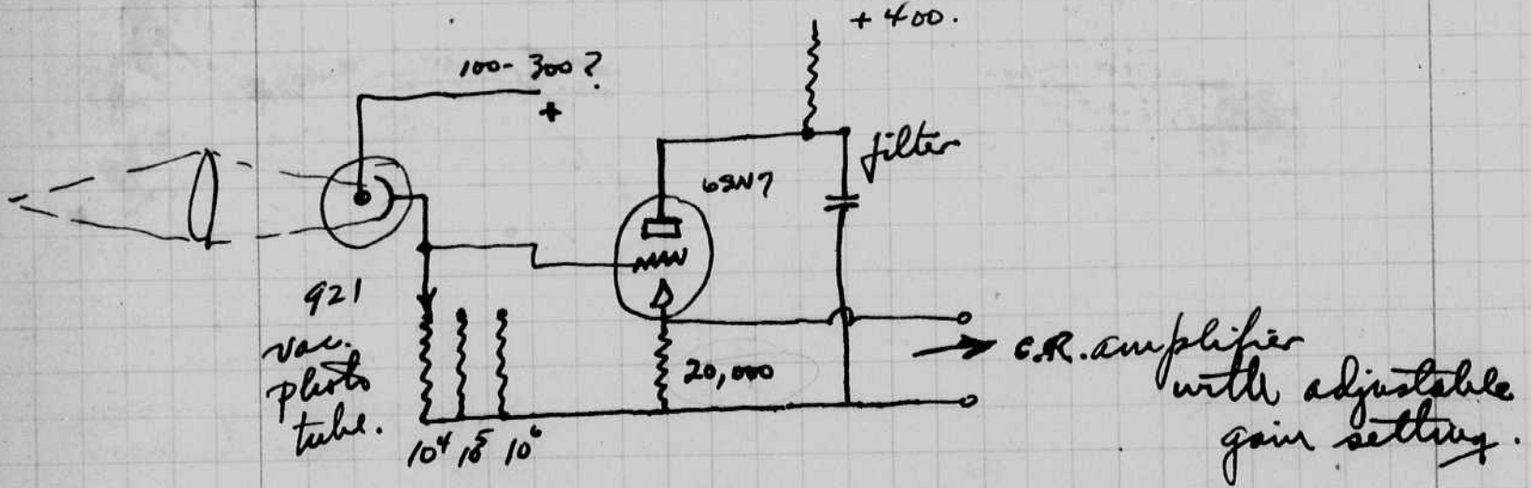


Circuit Dameas page 26.



Vac. photocell with different load resistors showing effect of the input time constant.

$i = \frac{4.5\ 87.}{.167} = 234$ amperes peak. (bottom osc.)

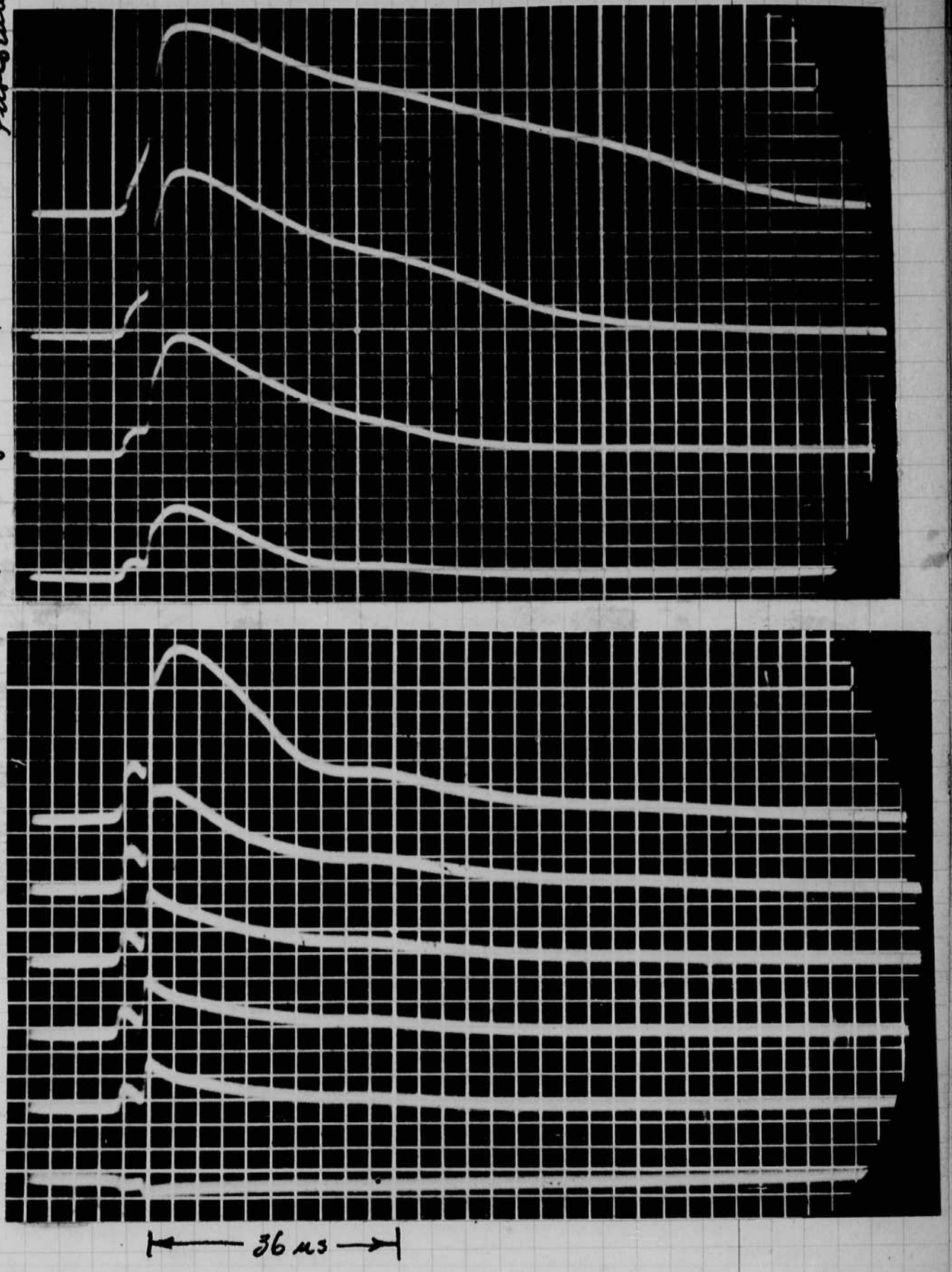


Dao (922) Photo tube.

Load resistor = 10^4 ohms.

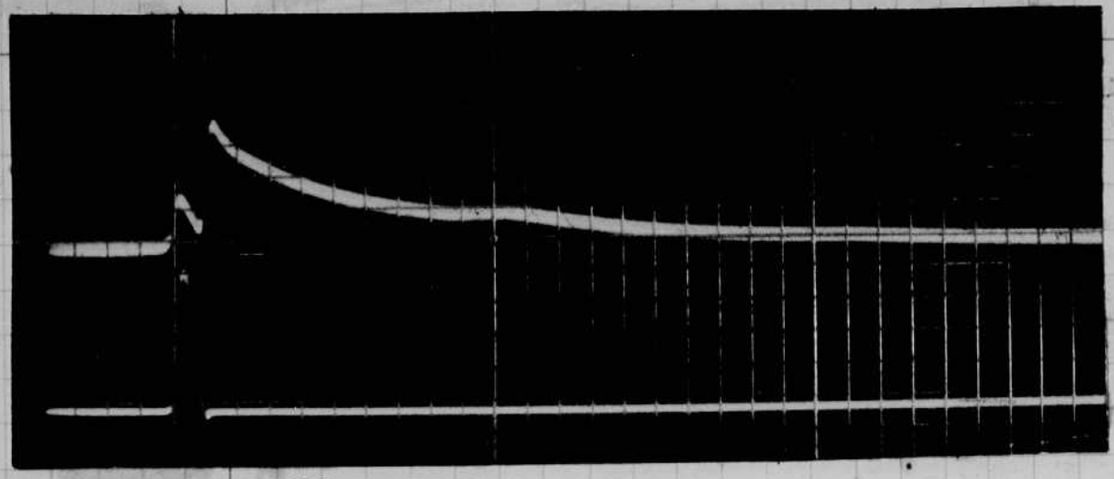
Voltage on Photo tube.

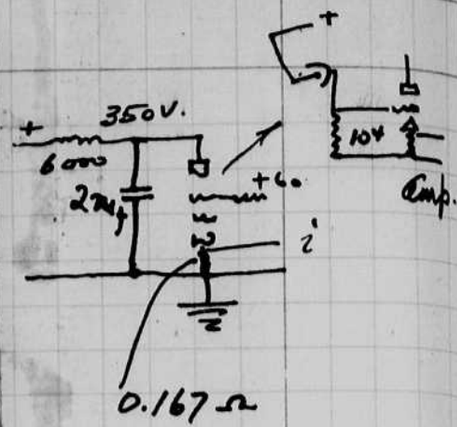
Amplifier attenuator on oscillograph	
3	150
3	125
3	100
ATT 3	75
1	75
1	50
1	30
1	20
1	+10
1	-4

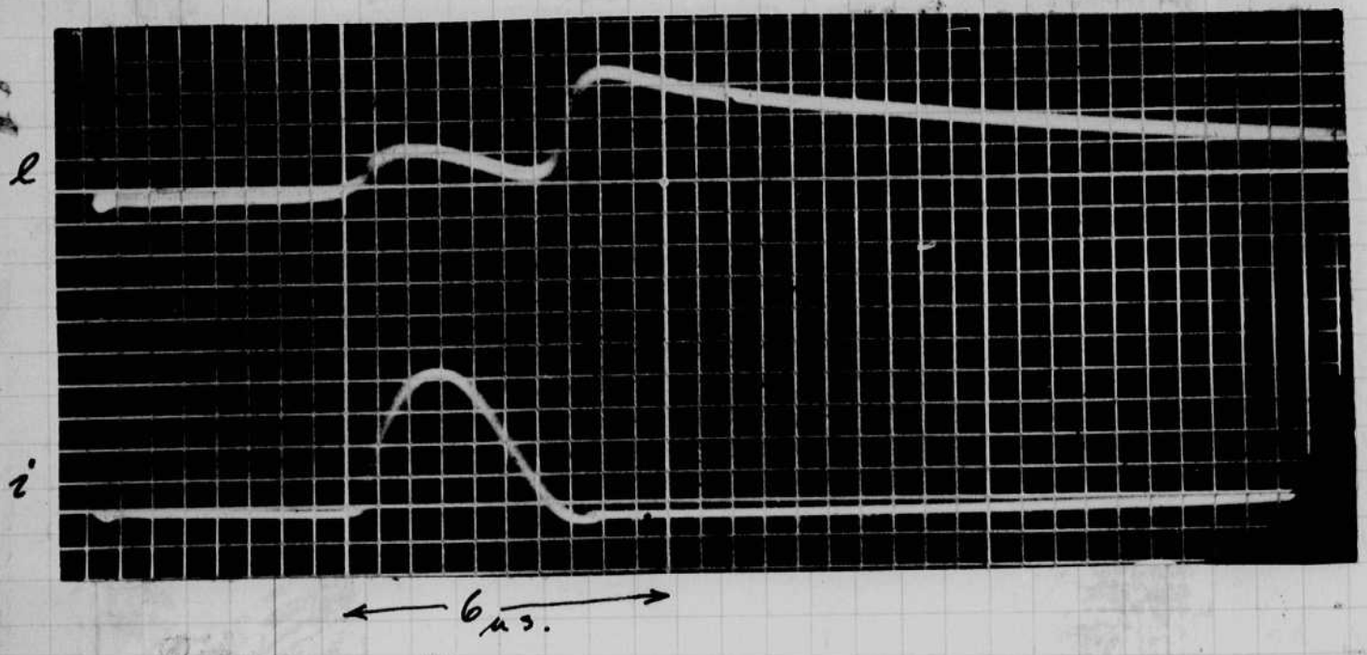


Circuit Sameas page 26.

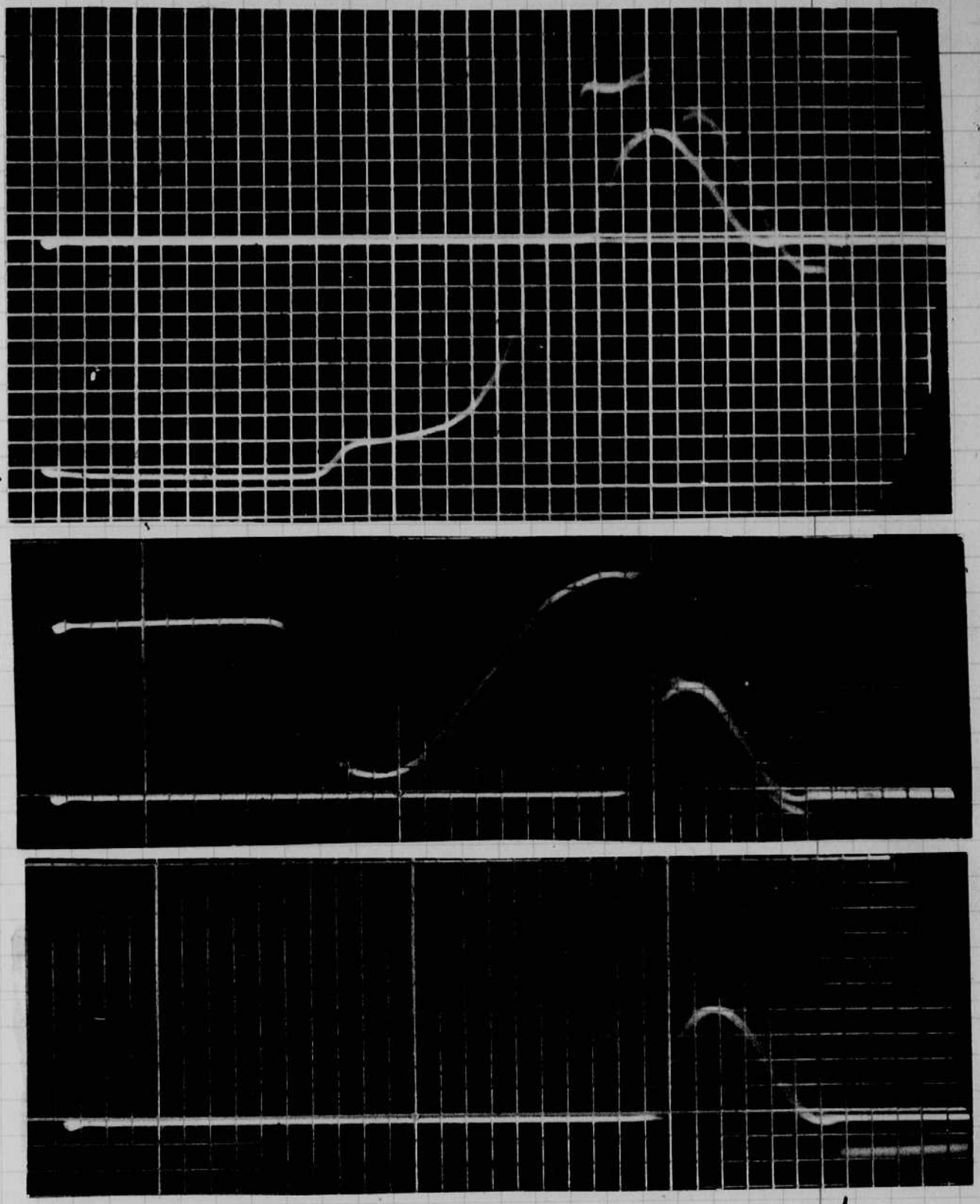
Light Output of 6371 tube.

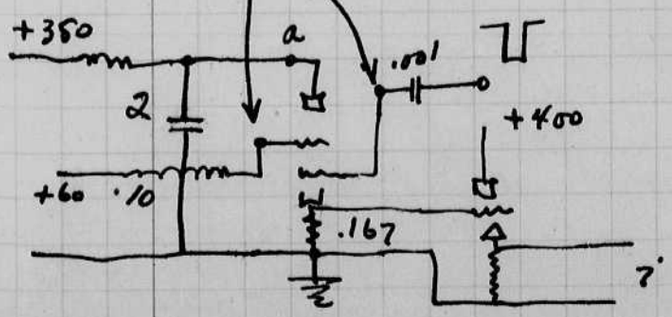






Note that light peak occurs when the current becomes zero.



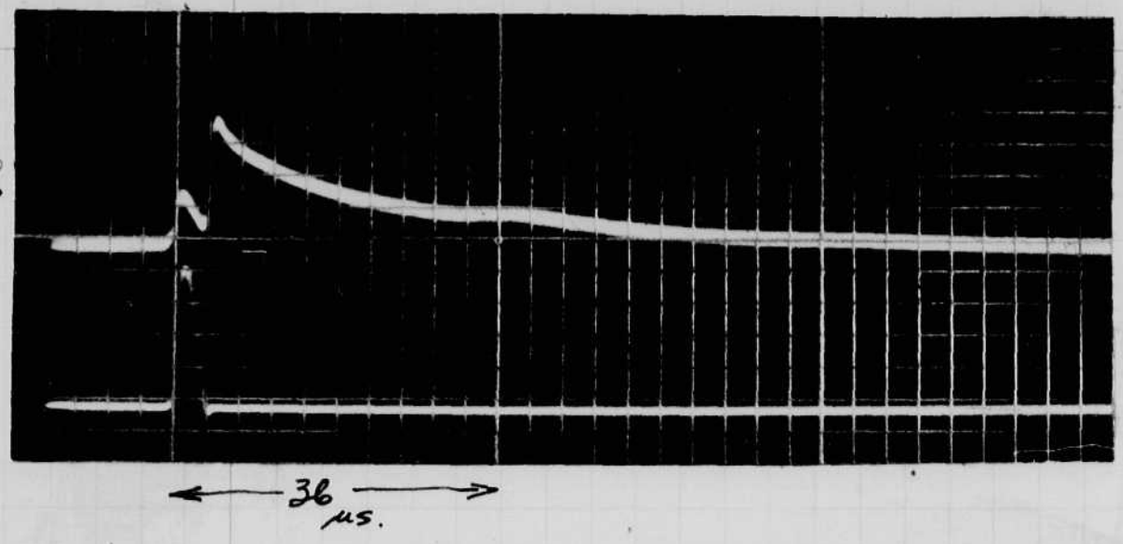


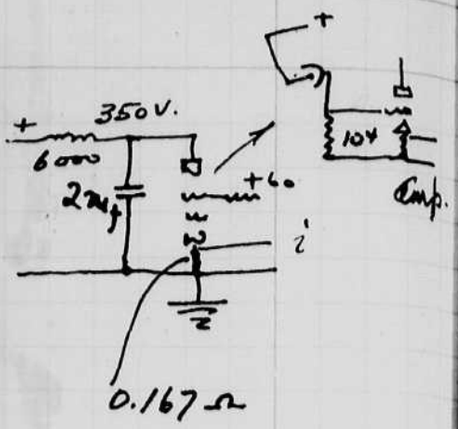
i'

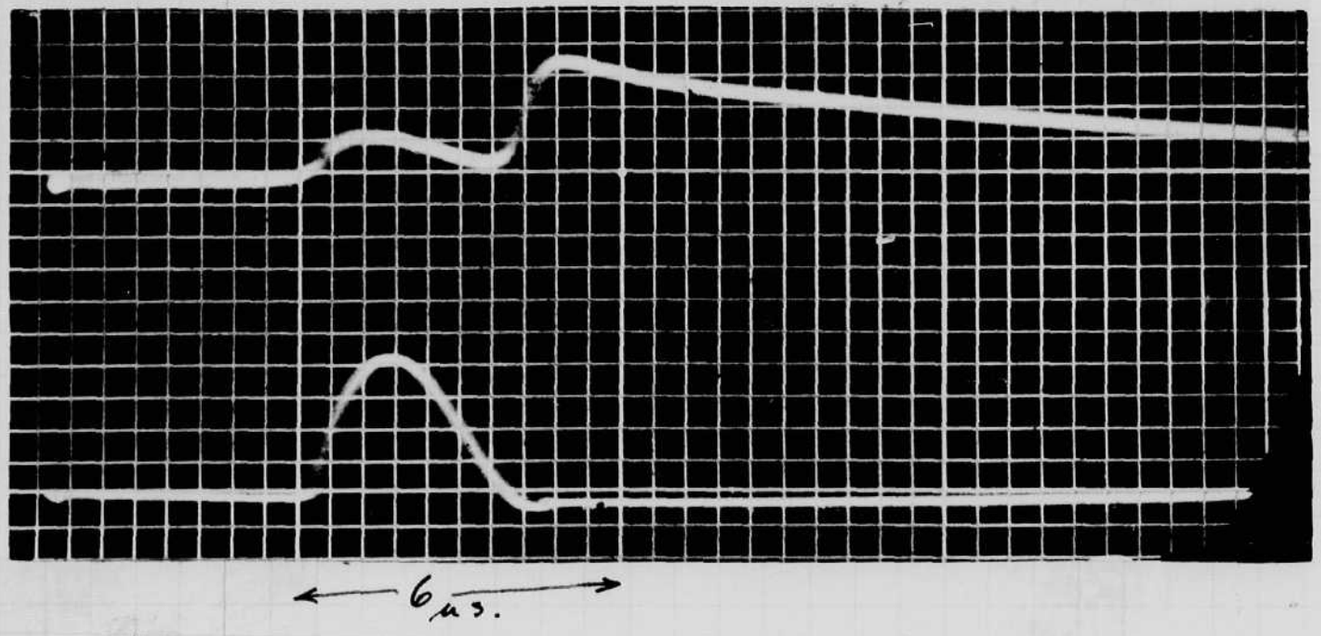
a

Plate voltage.

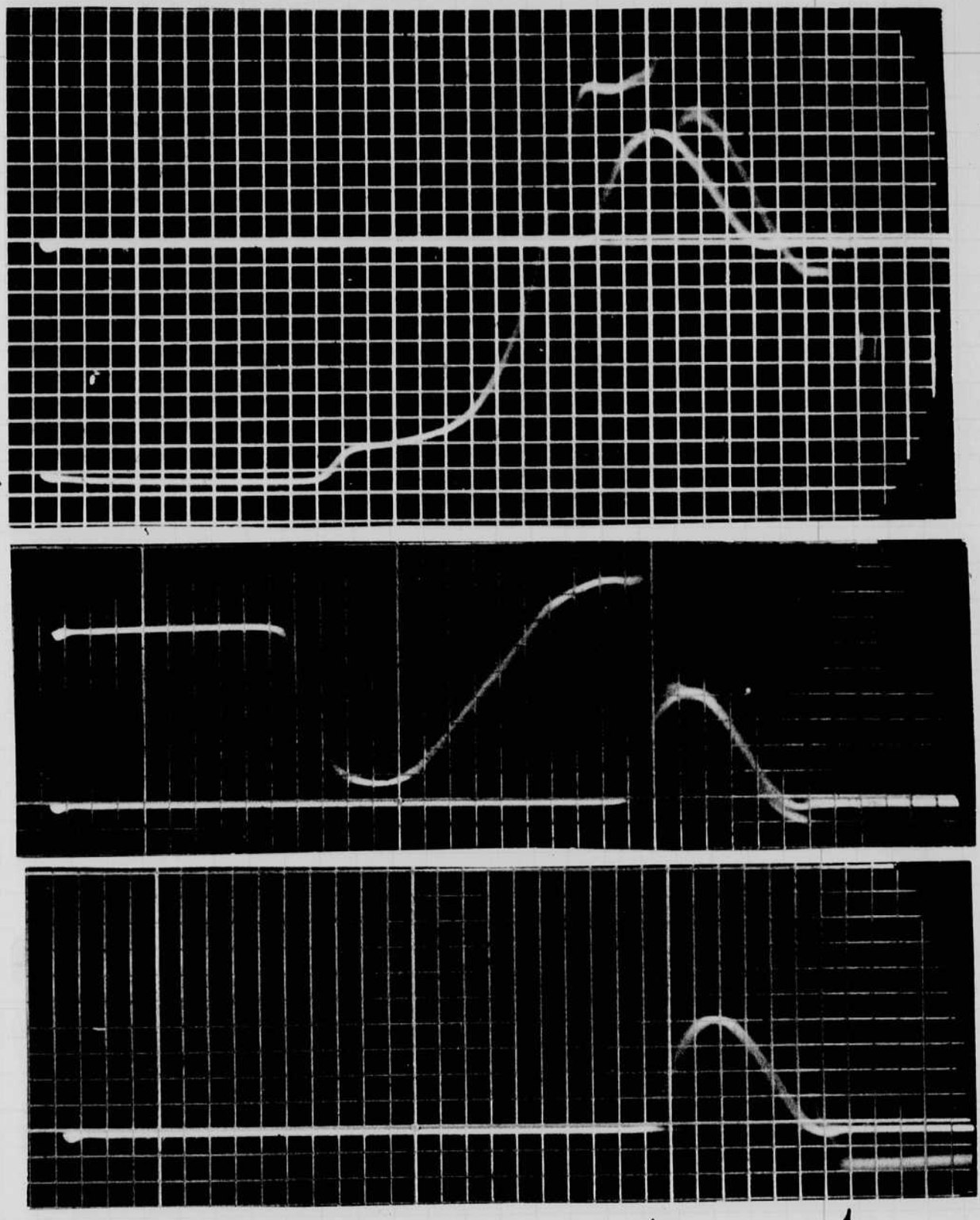
Light output of 6371 tube.





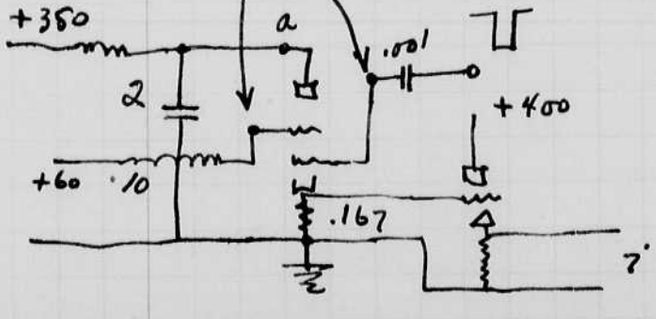


Note that light peak occurs when the current becomes zero.



i'

a
Plate voltage.



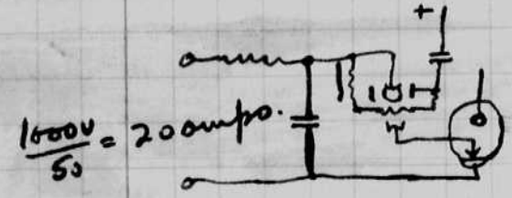
Phys Rev 1931 p 535
Dennington.

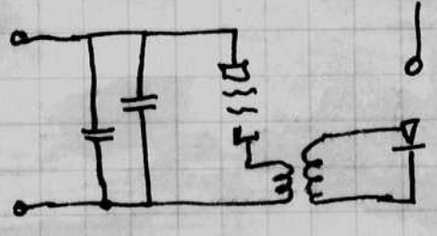
Stubstand. Inverse

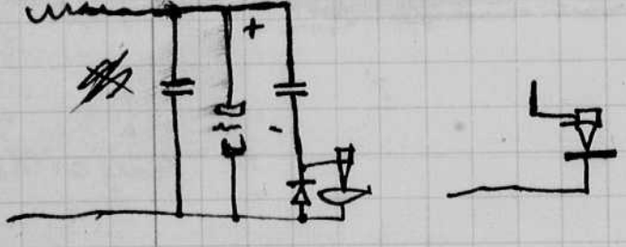
10 turns $L = 0.04 \times 100$ mh.
$= 4$ mh.
5 ft of twisted pair = about 1 to 3 mh.
Stubolux $L_p = 40$ mh.
Stub with 31 turns of No. 28. $L = 20$ mh.
$DQ = .140$

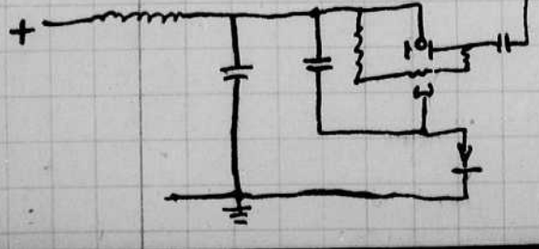
Igniters K5965322. Group 2 2 igniters.
from St. Low res. Points. K5965322 Groups. 4. 4 igniters.

Robt. Schneider.
Open House Com.



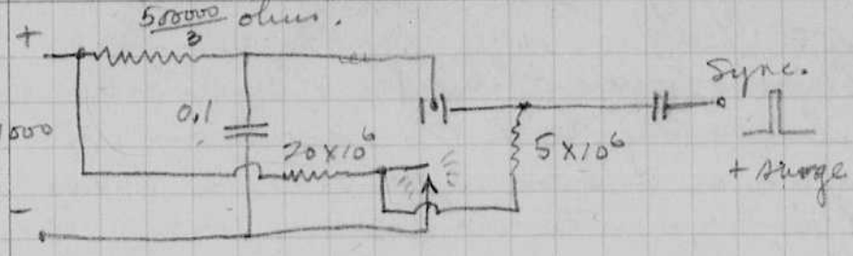






Miniature Strobotron test.

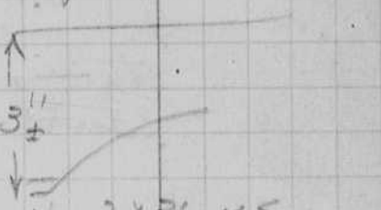
Tubes No 64 and 59.



Circuit

$RC = .01$ sec $\quad R = \frac{.01}{0.1} \times 10^6 = 100{,}000$ ohms.

Initial glow starts at 250, with D.C. input on scope 3 inches x 87 = 270 volts for start.
Pulse put in from the grid!



Light 10^4 ohms voc cell x 1 on att.
Same as Strobotron test 5, ~~Test~~
Light 0.1" at 0.1 x 36 ms time const.

Voltage to ~~start~~ discharge = 90 volts ~~+ surge~~.
Delay line = .3 x 36 ms. 1000 volts on plate.
= 10 ms.

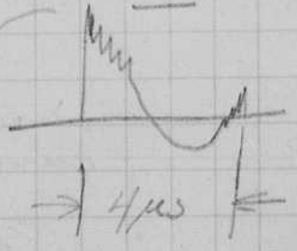
Apr 26. ~~Edge Tone~~ coil test 5

Coil test 5 0.1 mf 1000 v and std coil.
1 cycle sec.

$\frac{3.6}{\frac{10^6}{36}} = .3$

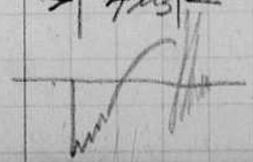
10 cycles per 36 ms.
1 3.6 ms. 300,000 cycles.

Input 700 volts 0.1 mf.



Voltage .35 x 87 = volts.
700 v
0.1
(3/8" spark on secondary.)

Copp coil Iron core 10 turns. 700 input
1 turn .6x87 output



For some reason 700 volts the tube backfires intermittently.

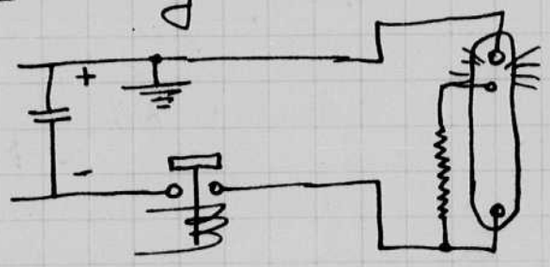
32 April 26 1946.
Harold E Edgerton.

Self firing tube.

One method of starting a flash tube is to connect it directly to a condenser with a relay. Such a scheme gives a flash of light that is relatively less than can be obtained from a flash tube that is excited by an external high voltage ionizing surge.

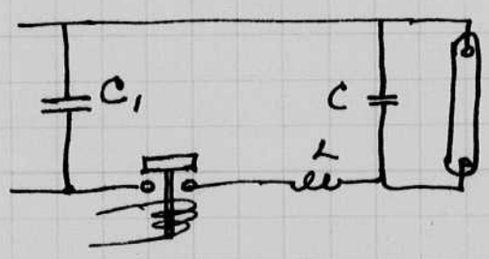
I show two ways of operating flash tubes with dead leads and a condenser switching relay.

(1)



When the switch is closed, a glow starts immediately through the resistor. The arc then transfers to the main anode.

(2)



$C < C_1$

Here a surge of double voltage appears across C due to the transient between L and C. This breaks down the lamp and allows it to start. The inductance L is an iron core one that saturates and therefore does not seriously impede the main flow of current into the flash lamp.

Explained & understood
H. E. Grier
H-26-46

April 27 1946
Harold Edgerton.

Dr. Knapp was here on the 24 to discuss electrical flash movie equipment. He showed us some 10,000 per second movies of cavitation bubbles where three Hydrogen flash units are fired in sequence. He wants to speed up the movie shots to a higher rate.

The problem was discussed at length that with Germeshausen, Grier and myself. We agreed to try to speed up the flash unit by proper design of the circuit for speed. Knapp suggested that Shapiro and another man come to Boston to help with the work.

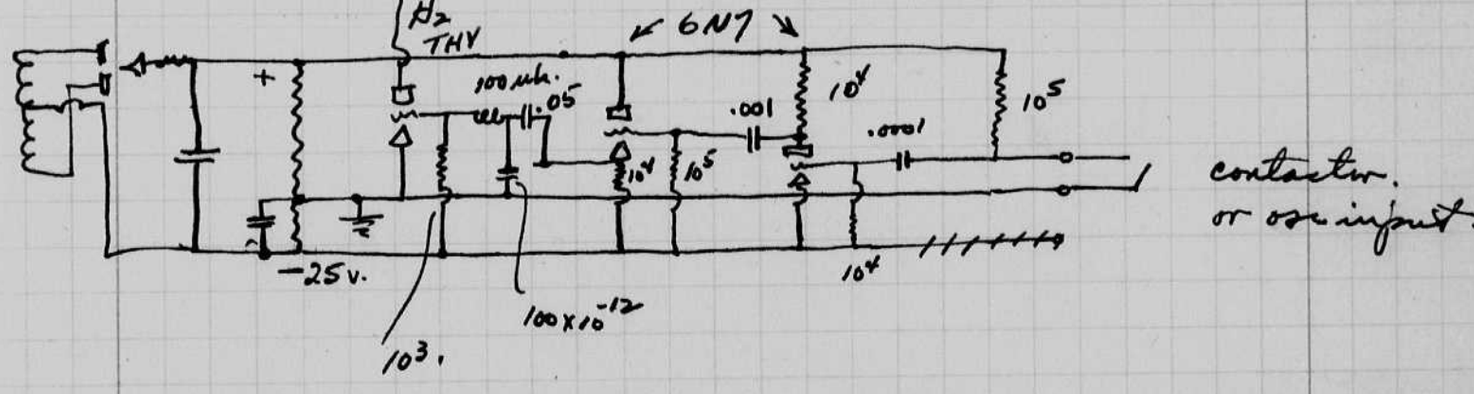
After considerable discussion in the Germs the last few days we evolved the below circuit for trial. The main features over and above the previous machine are

(1). negative bias on the Hydrogen thyratron.

(2). a filter on the thyratron grid to absorb the kick given the driver circuit when the tube fires.

(3) a preamplifier to precede the driver tube.

(4). reduction of the grid resistor of the thyratron.



May 1 1946 — 20 A 236 — Pos. Col. Exp.
Type 241

Calib. 152 volts. 2" peak to peak. Dumont #792.

$= \frac{152 \cdot 2\sqrt{2}}{2} = 215$ volts per inch.

May 4, 1946 HE Edgerton.

Heins & McCarthy were over yesterday from Sylvania to test the exposure meter that Heins made after my design. It worked ok. We calibrated it in terms of the standard FT-14 lamp on 112 mf at 2000 volts.

We also measured the output of the sylvania bulb in their a.c. model unit and found the light output =

$$\frac{\overset{56}{112}\ \overset{}{2000^2}}{2} \cdot \frac{1}{105} \cdot 39 = 8750 \text{ lumen sec } \underline{\text{standard}} \text{ lamp.}$$

$\frac{32}{105}$ for Sylv. lamp $\times 8750 = 2870$ lum. sec.

the energy for the sylv unit was 2500 v. and c = (96 watt sec).

Thus the efficiency is

$$\frac{2870}{96} = \underline{30} \text{ lumens/watt.}$$

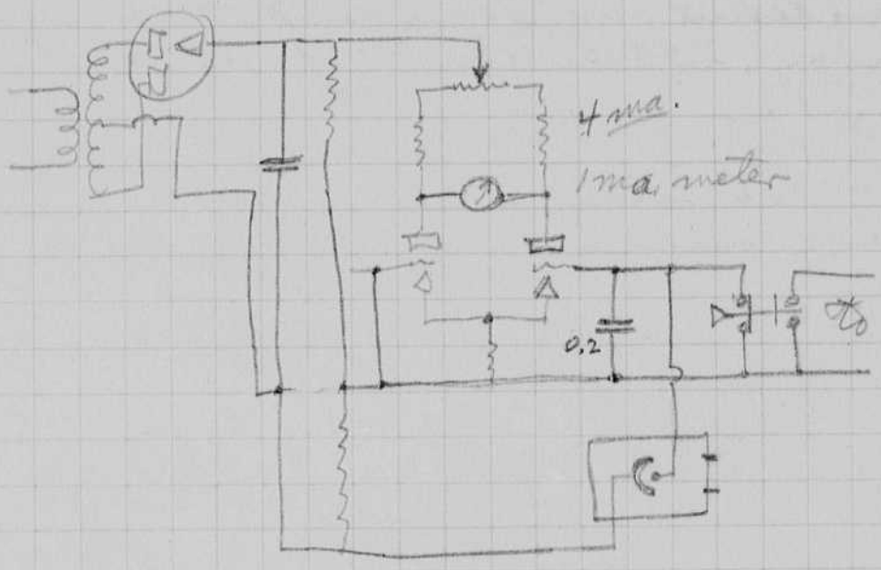
May 5. I set up the light measuring photocell in 20A 236 and calibrated with a 28 mf condenser 2000 volts FT-14 lamp standard.

Distance 48" lamp to cell.
Deflection 0.3 inches peak. 16×10^6 lumens
1.6×10^6 h.f.p.

Two CK1013 rectifiers and a G.R. transformer were connected in a power pack for charging a 28 mf condenser at 2000 v for flash tests. Transformer output = 2000 ac. A miniature strobotron was used to drive a new type coil that Germs has just finished.

Transformer from Raytheon.

The photocell meter was discussed with Edgerton and Herb yesterday following the tests made of the xenon lamp. It was concluded that the shutter was not needed since the lighting so great from the lamp. A double contact switch will be used as follows



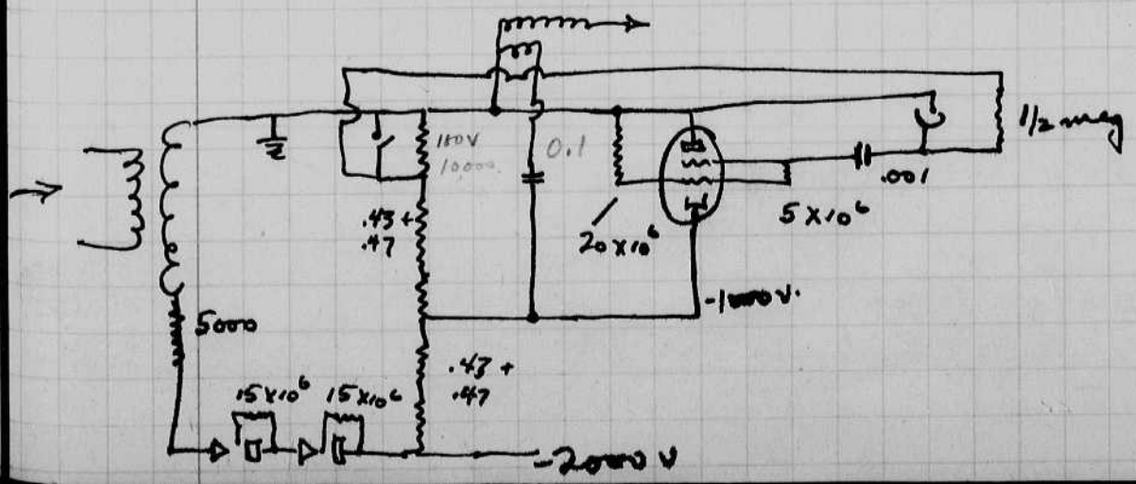
May 6, 1946.

Wilkins and Taylor brought over a microflash and two models of the new flash unit. 4 mf 2500. Photos were taken of the light time curves.

Calib FT-14 16×10^6 lumens. at 4 ft gave 0.3" peak.
1.6×10^6 h. cp. (peak)

Microflash at 20 ft gave 0.6" def.:

beam cp. = $1.6 \times 10^6 \times \left(\frac{20}{4}\right)^2 \times \frac{.6}{.3} = 80 \times 10^6$ beam c.p.



May 9. 1946.
H. E. Edgerton.

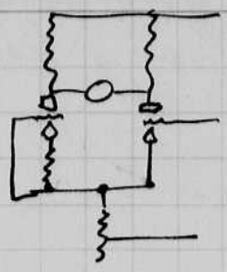
Genneshausen & I spent several hours at Sylvania in Biggs office discussing a license agreement for flash units. Present were Commons, Burns, Roche, & Biggs. Bird was busy with a group from Ord Army Enquiries.

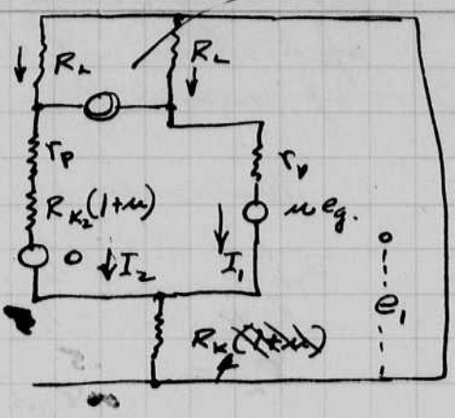
Being tested our standard #14 against their tubes R4330. The FT-14 is some efficient.

Sylv. exhibited interest with the exposure meter for flash use.

$\left(\frac{I_1+I_2}{2}\right) - I_2 = \frac{I_1-I_2}{2}$ = meter current

$\left(\frac{I_1+I_2}{2}\right)$





equiv. circuit.

① $\mu e_g = \mu\left[e_1 - (I_1+I_2)R_{K_1}\right] = (I_1+I_2)\left(R_{K_2} + \frac{R_L}{2}\right) + I_1 r_p$

$0 = \frac{\mu(I_1+I_2)R_{K_1}}{2}$

② $0 = \frac{\mu}{2}(I_1+I_2)\left(\frac{R_L}{2} + R_{K_1}\right) + I_2\left(r_p + R_{K_2}(1+\mu)\right)$

① $\mu e_1 = (I_1+I_2)\left[R_{K_1}(1+\mu) + \frac{R_L}{2}\right] + I_1 r_p.$

② $0 = (I_1+I_2)\left[R_{K_1} + \frac{R_L}{2}\right] + I_2\left(r_p + R_{K_2}(1+\mu)\right]$

① $\mu e_1 = I_1\left[R_{K_1}(1+\mu) + \frac{R_L}{2} + r_p\right] + I_2\left[R_{K_1}(1+\mu) + \frac{R_L}{2}\right]$

② $0 = I_1\left[R_{K_1} + \frac{R_L}{2}\right] + I_2\left[R_{K_1} + \frac{R_L}{2} + r_p + R_{K_2}(1+\mu)\right]$

Let $R_{K_2} = R_K = R_{K_1}$ 2.

① $\mu e_1 = I_1\left[\frac{2R_K}{2}(1+\mu) + \frac{R_L}{2} + r_p\right] + I_2\left[\frac{2R_K}{2}(1+\mu) + \frac{R_L}{2}\right]$

$0 = I_1\left[\frac{2R_K}{2} + \frac{R_L}{2}\right] + I_2\left[\frac{2R_K}{2} + \frac{R_L}{2} + r_p + R_K(1+\mu)\right]$

$R_K\left(\frac{2}{2} + 1+\mu\right) + r_p.$

$I_1 = I_2 \frac{A}{B}$

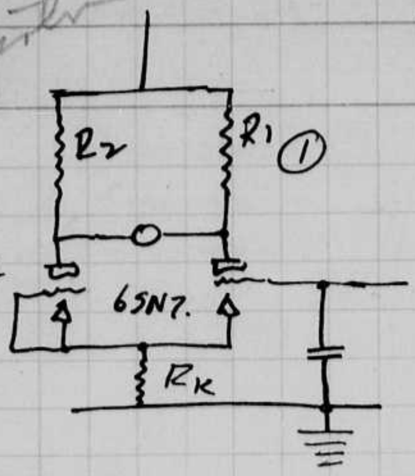
$I_2 = \frac{\mu e_1}{\left[\frac{AC}{B} + D\right]}$ $\quad = \frac{I_1-I_2}{2} = \frac{I_2}{2}\left[\frac{A}{B} - 1\right]$

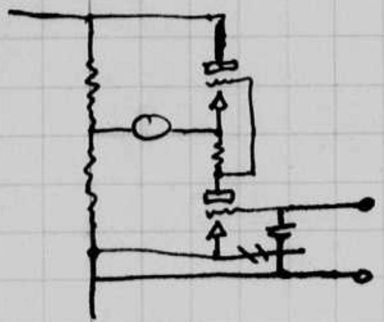
$I_m = \frac{I_1-I_2}{2} = \left[\frac{A}{B}I_2 - \frac{\mu e_1}{\frac{AC}{B}+D}\right] = \frac{I_2}{2}\left(\frac{A}{B} - 1\right)\mu e_1 = \frac{\mu e_1}{\left[\frac{AC}{B}+D\right]}\left(\frac{A-B}{B}\right)\frac{1}{2}$

$I_m = \frac{\mu e_1}{AC+BD}\left(\frac{A-B}{B}\right)\frac{1}{2} = \frac{1}{2}\mu e_1 \frac{A-B}{AC+BD.} = \frac{1}{2}\mu e_1 \frac{r_p + R_K(1+\mu)}{} =$

May 9 1946
D E Epstein

Macleod & Hansford
24 Chelsea St
Charlestown.





Balanced amplifier

obtain advantages of balanced operation without losing half of mutual conductance.

Meter has current value of 1 ma.

For circuit 2. Let $I_p = 4$ ma

$e_g = -1.5$ V.

$R_K = \frac{1.5}{.0115} = 1\cancel{88}$ ohms. × $\underline{130\,\Omega}$

$e_p = 75$ volts.

For other balance tube.

$e_g = 0$

$e_p = 75$

$i_p = 7.5$ ma.

Let $R_1 = 5000$ ohms.

$R_2 = 5000 \frac{4}{7.5} = 2660$ ohms.

$20 + 75 + 1.5 = 96.5$ volts on amp.

Use $\underline{\underline{250}}$ on P.C. 346.5 total output.

$\frac{CE^2}{2} f = \frac{3 \cdot 500^2}{2} \cdot 15 = 90$ watts.

9 ma × 2000

I went to GK this afternoon after calling Sinclair on the phone about the exposure meter. See letter and diagram to G.K. in the file. I urged that G.K. make a exposure meter for flash use. One feature was to be a three point switch to do three things in sequence

1. Short integrating condenser

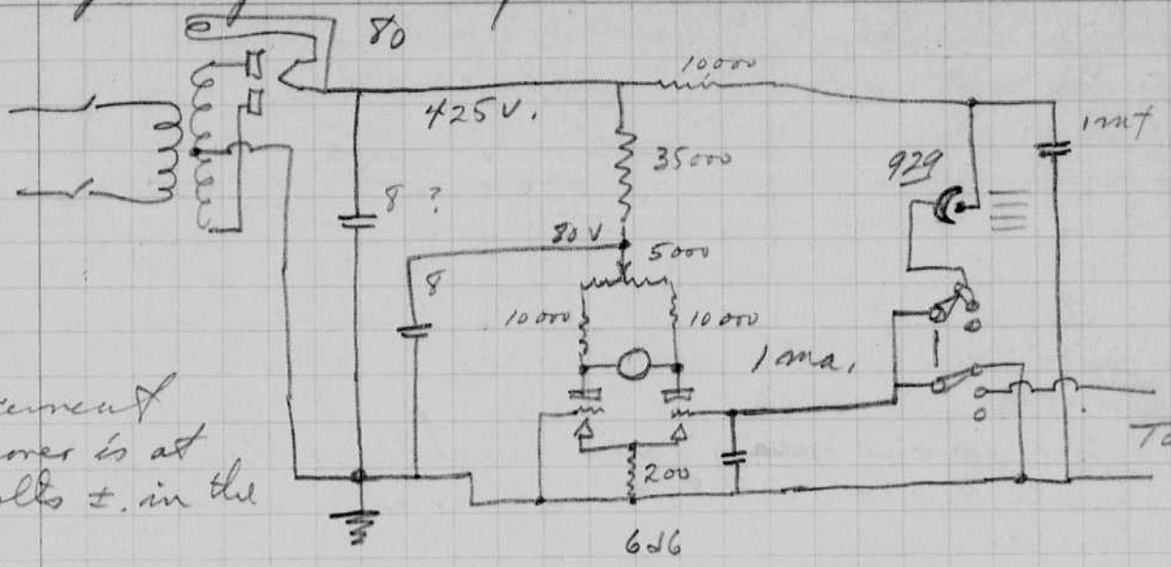
2. Flash lamps after opening short

3. Open P.C. power supply.

After a conference with Wilkins, Sinclair, & Powers we decided to make a working model and started to collect parts. A 6J6 miniature triode was suggested as the tube to use. This has a 5000 value of gm.

cont.

I remained at M.I.T. tonight and connected up the following circuit



grid current crossover is at -.9 volts ± in the 6J6.

$$e_p' = \frac{g_m}{2} e_g = 1000 \text{ ma} \qquad g_m = 5000$$

1.65 .9

$$e_g = \frac{1000}{2500} = 0.4 \text{ volt required. calc.}$$

exp shows about .8 volts.

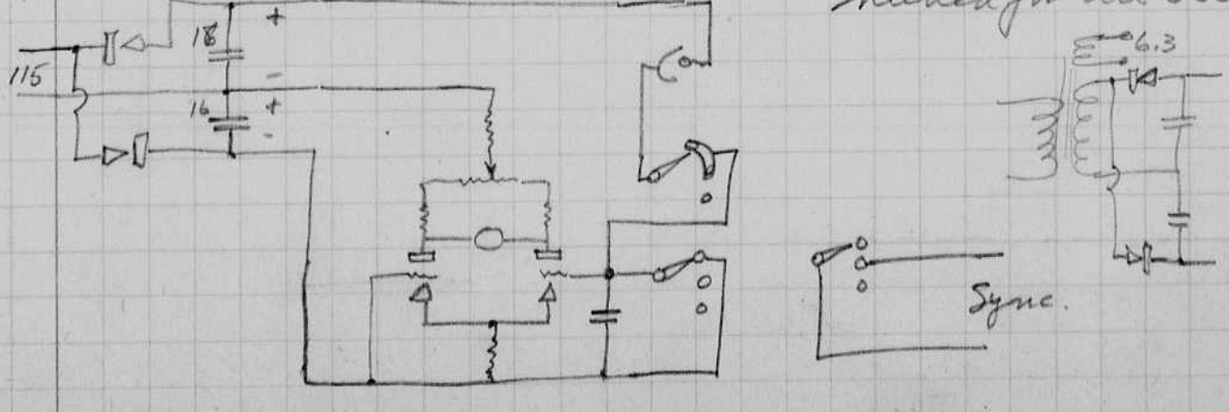
The meter went off scale with the modulation without reflector at 15 or 20 ft. I used a 1 mf integrating condenser.

Must be drift. It appears that a 1 mf condenser is required to give a small enough drift of the meter. The final stable point of the zero grid current appears to be at .8 or .9 ma on the scale.

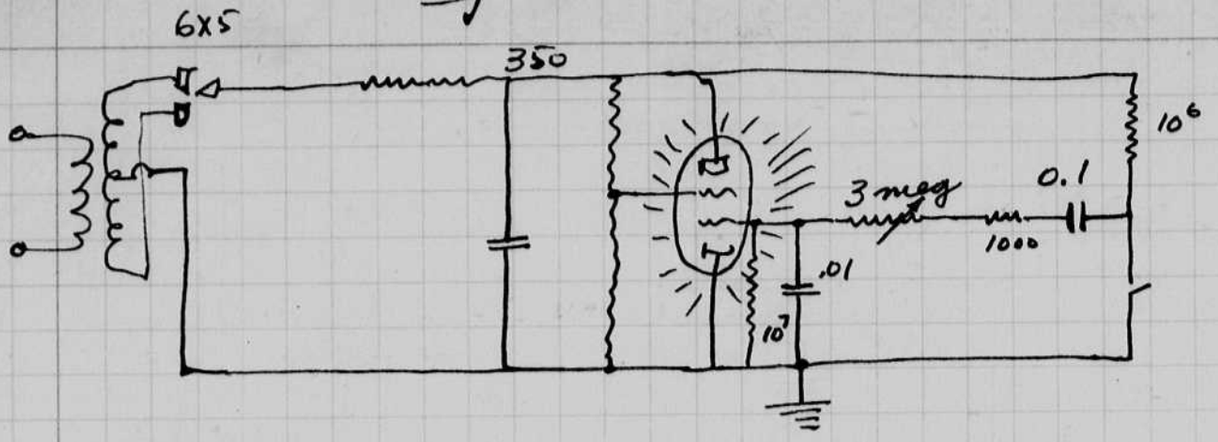
Would be found caused by leakage past tube. 1 mf is ample.

A selenium power supply should be very useful with a voltage doubler for this problem.

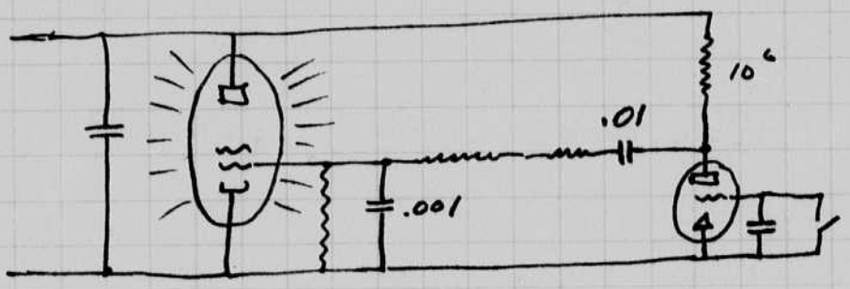
Filament transformer 115 - 6.3 .6 amp needed for the 6J6.



Time-delay flash for shutter testing.



The above may give trouble if the switch closes momentarily and then opens.



Tues. May 14. 1946
Harold Edgerton.

Mr. Feicht and Col. Goddard of the Photo Dept. at Wright Field called today and urged that development work start here on a method of taking night photos from aircraft for reconnaissance purposes. A proposal for research will be sent from W.F.

a group of men from Short and Williams co were brought in by Ed. Colson yesterday Mr. Thompson - Page, Mumford Rofft Carlson.

Colson has taken some pictures for them of the knitting needles.

1400 needles pass per second at 290 r.p.m. He had blur at 40 usec exposure with a FT-14.

The plan is to gear drive an Eastman Special 16 mm camera and use a triggered lamp to follow one needle by the use of an electrical time delay circuit. The total delay time need not exceed 1/30 sec.

May 15. Photos were made last night with an FT-17 using 1100 mf at 3500 - 4000 volts.
Fi[illegible] Daylight Kodachrome.
Filter CC-13.
distance 100 ft +
aperture f = 4.5

Also f 3.5 with portable of the front of M.I.T. Vaschrome

these

f 8. of trees up to 500± ft in court.
f 3.5
f 16.

504
1/1000

 May 20 1946

H.E. Dg

Charging time of 1100 mf 4000 volt unit.

	2000 V	3000	3500	3800
1 Kolidon type transformer	18 sec	50	–	
2 "	5	10	26	50 top.
3. Thordarson 250 VA 110 - 1600		5	10	20 45 60

Reflector factor = 17-19

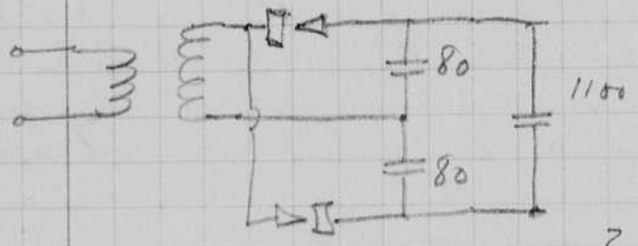
4000 4/100 2/3 80

The above is hot after a dozen flashes at 1/2 minute intervals.

$$P = \frac{CE^2}{2} f = \frac{1100 \; 4000^2 \times 10^{-6}}{2} \frac{1}{30} = \frac{8800}{30} = 294 \text{ watts.}$$

$\frac{CE^2}{2} = 8800$ watt seconds per flash.

$Q = n \frac{CE^2}{2} = 50 \times 8800 = 44{,}000$ lumen sec.



Selenium ? amps stacks 1" in diam.

$1600 \times I = 294$

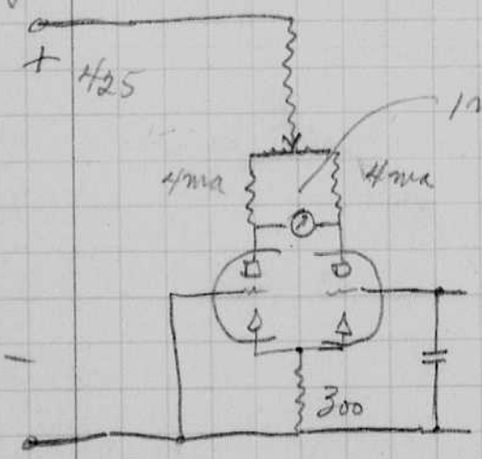
$I = \frac{294}{1600} = 0.185$ amperes, average.

Exposure meter.

$I = \frac{g_m}{2} E,$

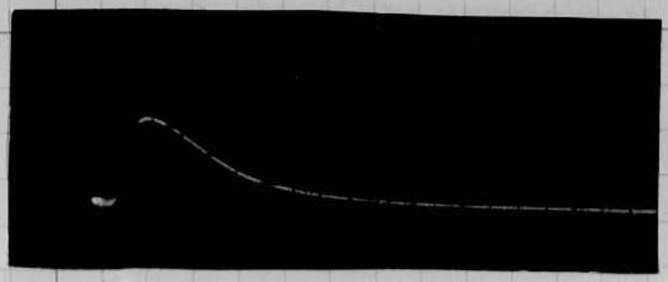
$.001 \times 10^{-6} = 2000 E$

$E = \frac{2000}{1000} = 2$ volts full scale.



See page 38

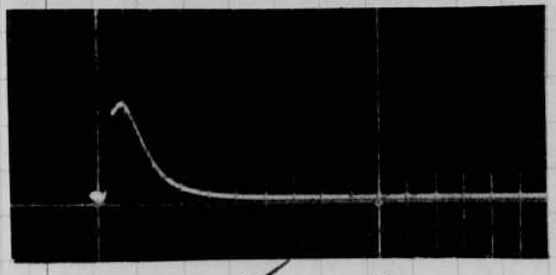
1.6 x 10 6 h.c.p.



← 300 →

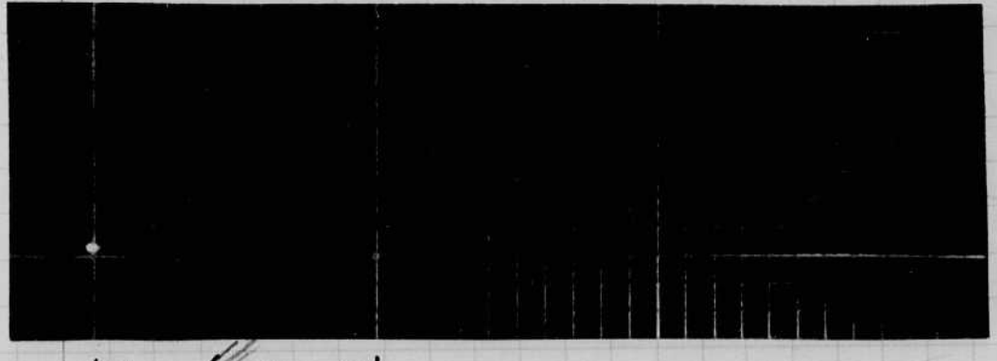
Light vs. time.

FT-14 #2.
28 mf. 2000 volts.
Peak light = 1.6 h.c.p. X 10^6



← ~~36~~ 6 ms →
300

FT-14
5 mf.
2000 volts in G.E. proposed
Doco strobo-o/l unit.



← ~~6~~ ms →
36

 May 20 1946

H. F. Dy

Charging time of 1100 mf 4000 volt unit.

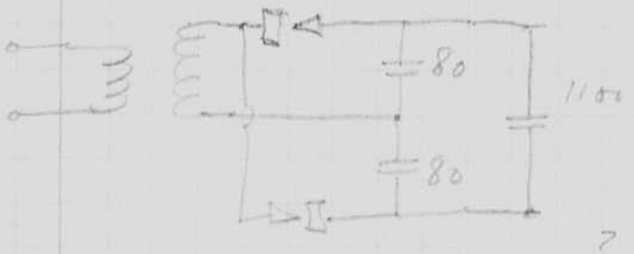
		2000 V	3000	3500	3800
for	1 Kodatron type transformer	18 sec	50	–	
Deflector plates	2 "	5	10	26	50
17 - 19	3. Thordarson 250 VA 110 - 1600	5	10	20	45

the above is hot after a dozen flashes at 1/2 minute intervals.

$$P = \frac{CE^2}{2} f = \frac{1100 \times 4000^2 \times 10^{-6}}{2} \frac{1}{30} = \frac{8800}{30} = 294 \text{ watts.}$$

$\frac{CE^2}{2} = 8800$ watt seconds per flash.

$Q = n \frac{CE^2}{2} = 50 \times 8800 = 440{,}000$ lumen sec.

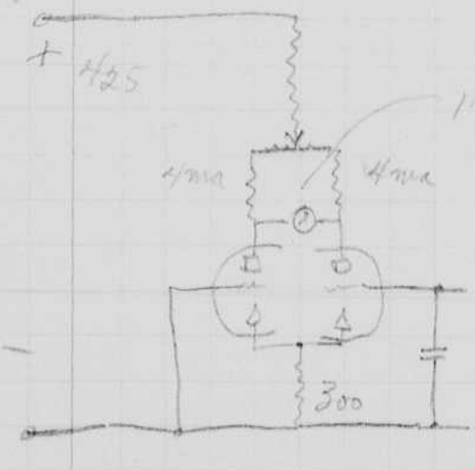


Selenium lamp studies 1" in diam.

$1600 \times I = 294$

$I = \frac{294}{1600} = 0.185$ amperes, average.

Exposure meter.



$I = \frac{g_m}{2} E,$

$.001 \times 10^{-6} = 2000\ E$

$E = \frac{2000}{1000} = 2$ volts full scale.

See page 38

1.6 x 10 6 h.c.p.

← 300 →

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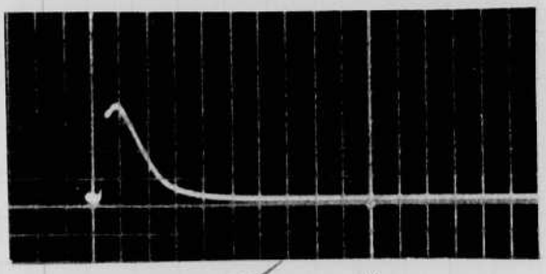
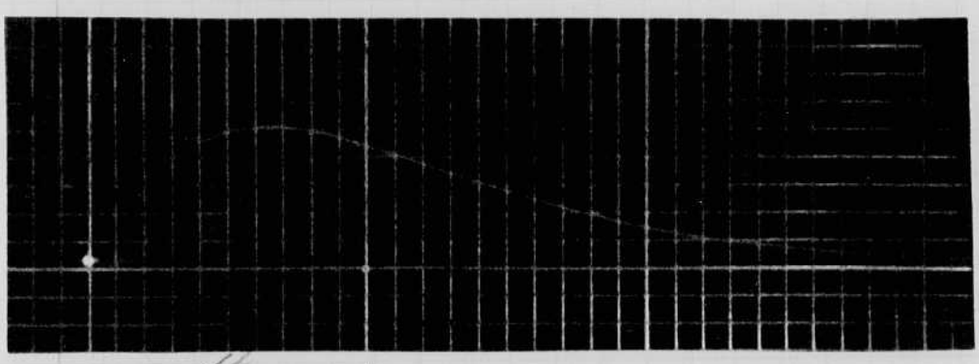


← ~~36 us~~ 300 →

FT-14
5 mf.
2000 volts in S.R. proposed slow stroboscopic unit.



← 6 us ~~36~~ →

May 24, 1946
Harold Edgerton

Kodachromes of Circus

Two trips to the Garden in Boston have been made to get color shots of the circus.

The first - a 2¼ × 3¼ camera was used with Daylight Kodachrome CC13 filter. the second - a 4×5 camera was used with a CC 15 filter. a Guide number of 350 = f 4.5 × 80 was used as a starter. f 4.5 on all shots.

The Eastman flash unit with a specular reflector has a guide no. of 40 with Daylight film Kodachrome. the Reflector factor of the Kodatron unit was measured to be 13 on the model that we have.

112 mf 2000 volts $n = 40$

$Q = 224 \times 40 = 8960$ lumen sec.

$$df = K\sqrt{QM}$$

$$40 = K\sqrt{8960 \times 13}$$

$$= K\sqrt{116{,}000} = K\,350$$

$$K = \frac{40}{350} = 0.115$$

For Black & White. 400 Index ASA 200 $d \times f = 400$

$$400 = K\sqrt{11{,}600} = K(350)$$

$$K = \frac{400}{350} = 1.15$$

...the light that reaches the film.

A suitable exposure factor for a thin negative (50% over-development) for the FT-14 tube with 56 microfarads at 2000 volts with film having an ASA speed of 50 has been found to be about 120 for interior subjects of average types, 120(feet x aperture). A reflector with a per unit increase of light at the center of the field of ~~4~~ 16 was used for this test. Expressed mathematically,

$$d\,f = \text{distance} \times \text{aperture} = 120 = K\sqrt{QM} = \text{guide factor}$$

where distance = distance in feet from subject to lamp

aperture = aperture f number

$Q = \eta \frac{CE^2}{2}$ = light in lumen-seconds

C = capacity in farads = 56×10^{-6} farads

E = voltage in volts = 2000 volts

η = efficiency of the flashtube in lumens/watt = 35, an average value.

M = light-increasing power of the reflector at the center of the field = ~~4~~ 16

All the factors except the arbitrary constant, K, are determined. Solving for K, a value is obtained of

K = ~~0.93~~ .47 or about ~~1.0~~ .5

Daylight ~~color~~ [illegible]	[illegible]	~~.22~~ ~~.12~~ 0.11

Lamps as used for Color photos f4.5 50-70'

Chisholm and Bernice on balcony

Note chow with P.C. Versuh.

May 24, 1946
Harold Edgerton

Kodachromes of Circus

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For Black & White. 400 Index ASA 200 $d \times f = 400$

$$400 = K\sqrt{11{,}600} = K(350)$$

$$K = \frac{400}{350} = 1.15$$

The guide number calculation which is outlined above assumes that the exposure is proportional to the light output regardless of the effective duration of the flash. Actually this is not the case since less exposure is obtained when a short flash is used because of the inability of the emulsion to integrate the exposure. However, the effect is not usually enough to be considered except when very large extrapolations of the exposure data are made. Experimental determination of actual exposure conditions are recommended for conditions where the exposure times are either very short or very long.

It is emphasized that K is not an exact number since it depends upon the guide number that is selected. The guide number for a particular device like that above varies both with the subject and environment, and with the personal whims of the photographer. There K can be assigned values over a range where the smaller value will result in a heavily exposed negative.

The equation for the value of K is useful for a preliminary rough estimate of the photographic performance when different electrical values and different reflectors are used. Similar relationships can be obtained with other flashtubes in various circuits and in various reflectors.

For other films, the exposure factor and K can be computed since the variation is directly proportional to the square root of the film speed. For example

Film ASA Exposure index no. Film Speed	K for a THIN ~~Average~~ negative	K for a ~~well exposed~~ normal negative
250	1.12 ~~2.24~~	0.56 ~~1.12~~
200	1.0 ~~2.0~~	0.5 ~~1.0~~
100	0.7 ~~1.4~~	0.35 ~~.7~~
50	0.5 ~~1.0~~	0.25 ~~.5~~
~~25~~	~~.707~~	~~.35~~
Daylight ~~color~~ [illegible]	—	~~.22~~ ~~.11~~ 0.11

Lamps as used for color photos f4.5 50-70'

Chisholm and Bernice on balcony

Note shown with P.C. Vasuki.

May 24, 1946
Harold Edgerton

Kodachromes of Circus

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For Black & White. 400 Index ASA 200 $d \times f = 400$

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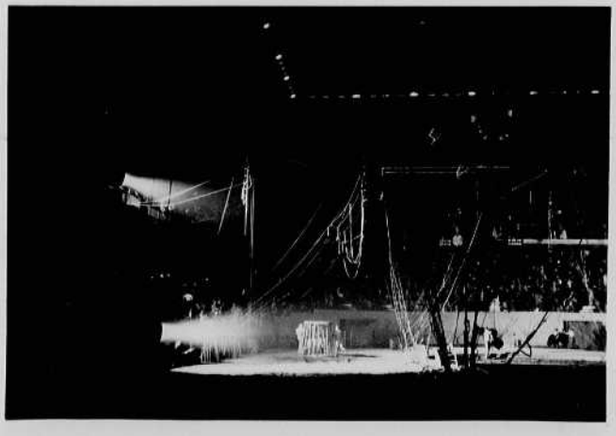
250	1.12 ~~2.24~~	0.56 ~~1.12~~
200	1.0 ~~2.0~~	0.5 ~~1.0~~
100	0.7 ~~1.4~~	0.35 ~~.7~~
50	0.5 1.0	0.25 ~~.5~~
~~25~~	~~.7~~	~~.35~~
Daylight ~~color~~ Kodachrome	—	~~.22~~ ~~.12~~ 0.11

Lamps as used for Color Photos f4.5 50-70'



Chisholm and Bernice on balcony

Note chow with P.C. Vasuki.

46 May 27 1946
H Edgerton
Wm Bayless

Strobotron test.

No	Scale				
1.	A 20000	Time calib.	12 μs/pip		
2	A 200,000	Time calib.	62 μs/pip.		
3	A 200,000	ATTEN 100	DIST 4 ft	FT-14 #1 Ref 28 mf 2000 V 16 x 10⁶ max lumens. Shows long ~~start~~ delay	
4.		~~Ditto~~.			
5	A 20000	100	4' no reflector	Ditto.	Std 648 p. 1. Camp.
6	A 20000	30	6' with reflector	Strobolux "slow" Single flash.	
7	A 20000	30	6'	" " " "	
8	"	30	6"	Top "med" Bot "High" Single flash.	600 fl at per sec
9.	"	10	6"	Top ~~Slow~~ ~~Med~~ "mid." Bot "high"	5 sec apart
10	"	"	"	" " "	3 sec
11	"	10	6'	" " "	1800 rpm
12	"	3	6'	Top med Bot High	3600 rpm.
13	"	1	6'	Top med Bot High	6000 rpm.
		1			

Xenon Strobolux 35 mm

Film 2.

1	A-20000	12 ms pips	10 sec cyls.	time calibration.	
2	"		5		
3	"		2.5		
4	"		1		
5	A 200 000	62 ms.	5		
6	"	"	1.		
7	A 20,000	Std. tube FT-14 Ref. no. 1. 28 mf 2000 v 4 fl AT 100. 5 or 6 curves on same film.			
8	A 20,000	"	One trace of curve.	4 fl.	
9	A 200 000	Strobolux AT 30	6'	Single flash Xenon	
10	A 20 000	" "	"	"	
11	A 20 000	"	30	6'	Top med. S.F. Bot. High S.F.
12.	A 20 000	"	10	6'	Top med mid-med Bot High 600 rpm
13	"	"	10	6'	Ditto 1800.
14	"	"	3	6'	Ditto ~~mid~~ ~~top~~ Bot High 3600
15	"	"	1	6	Top mid Bot High jitter. 6000
16	"	"	3	6'	2500 3600 6000 7200 (?) 9000 all on High.
17	A 200 000	Std tube 28 mf 2000 v. 4 fl AT 100.			
18	A 200 000	" "	28+82	2000 v 4 fl AT 100	

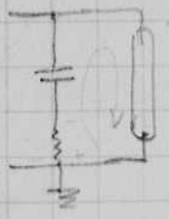
92 volts/mid

48 May 28 1946 Roll 18

Roll 1

P2 28 110

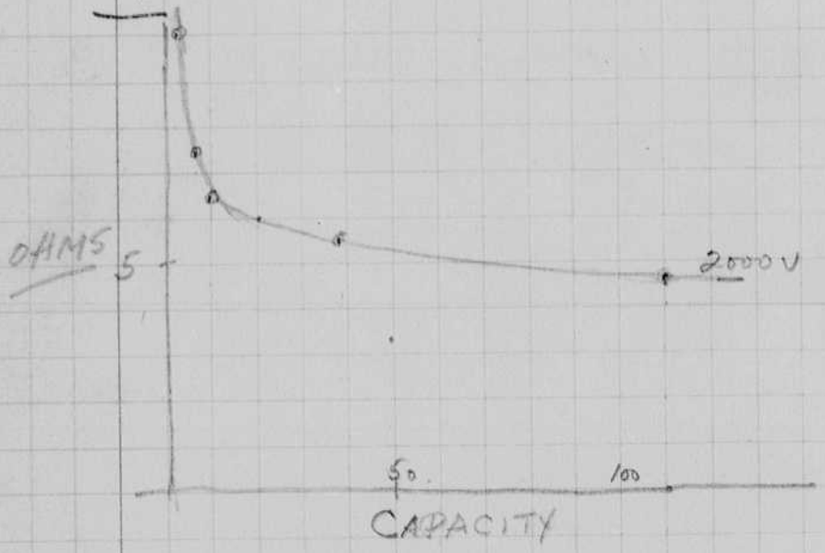
450



90 volts/inch

$R = \frac{2000}{I_{max}}$

Osc	no.	Sweep	Shunt	Tube	C	V	R	Visual Im	
1		A200000	0.1 ohms.	FT-14	110	2000	4.45	.5" = 4/5 V.	450
2				"	"	"			
3				"	"	"			
4 5 6		A 200 000	"	"	28	"			
7		A 2000	"	"	28	"			
9	10	A 20,000	12.2 ms	timing pips.					
11	12	A 20 000	0.1	FT-14	1 mf	2000 V	12.4	.18"	162
13	14				2 "		10.1	.22	198
15	16				6 "		7.4	.30	270
18	19	20			10 "		6.37	.35	315
					38		5.42	.41	370



May 29 1946 Edgerton — Roll 1. 21

926 plate tube.

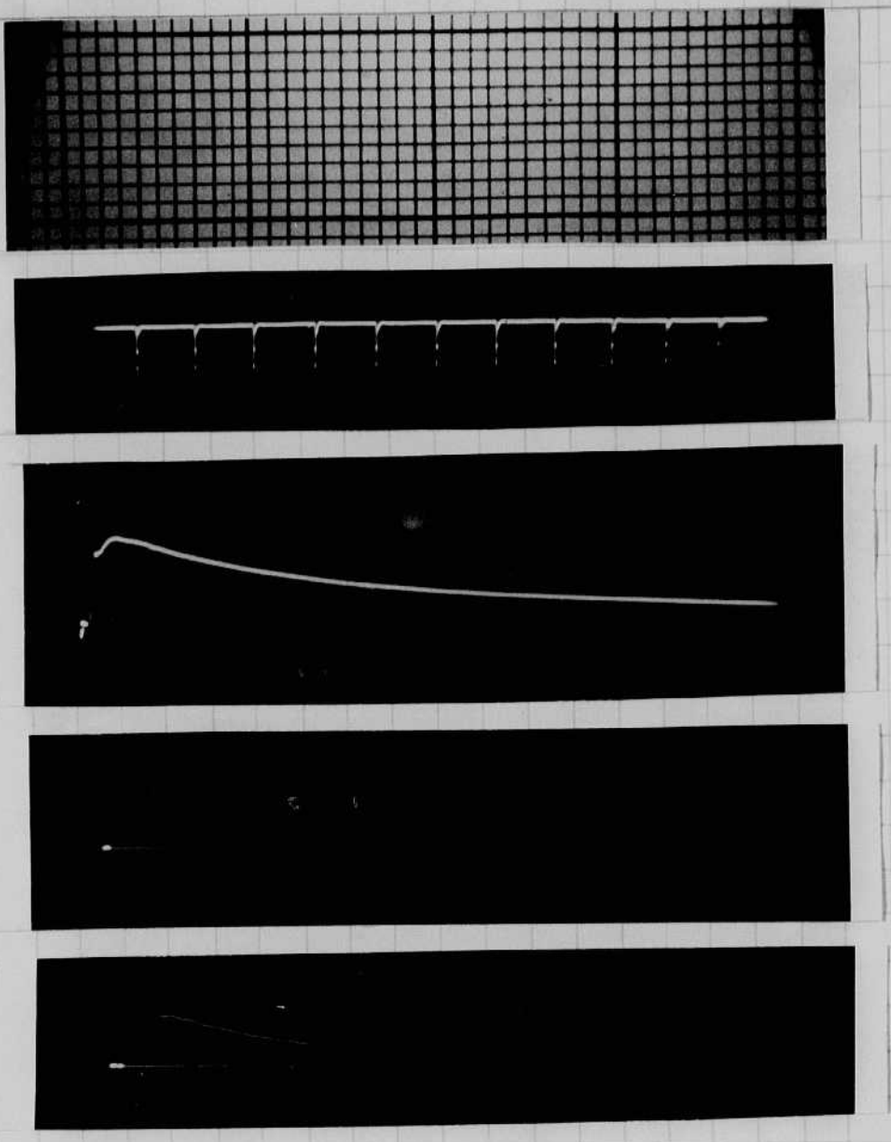
		C	J	Tube	Top	Mid	Bot	AT	Sw
	1-4	Photo of 1" screen for calib							
2	5	120	2000	FT-14 #1	Red filter 25 72	Green 12 46	Blue 15	30	A 2x10[5]
3	6	120	2000	"	plus 61.1 us markers.			100	"
4	7	"	"	" #2	with zero			100	"
	8	120	2000	FT-2	"	"		100	"
	9	120	2000	FT-2	Top Red Mid Green Bot Blue Ref B none			30 " " 100	" " "
6	10	120	2000	FT-2	Top light Bot current 0.1 Ω Several zero sweeps for each.			100 —	" "
??	11	38	2000	FT-2	Slow to flash I			—	"
8	12	38	2000	FT-14 #1	Top current Bot light 12.2 us timing on zero			— 100	A 10[4] A 10[4]
9	13	38 10 4 120	2000 "	FT-14 #1	current 12.2 us timing wave			— — — —	10[4] 10[4] 10[4] 10[4]
11 / 36½ / (10) 926	14	120-38-10-4	2000	FT-14 #1	12.2 us timing wave light			100	10[4]
11	15	"	1500	"	"	Current		—	10[4]

Im / 450 / 162 / 198 / 270 / 315 / 370

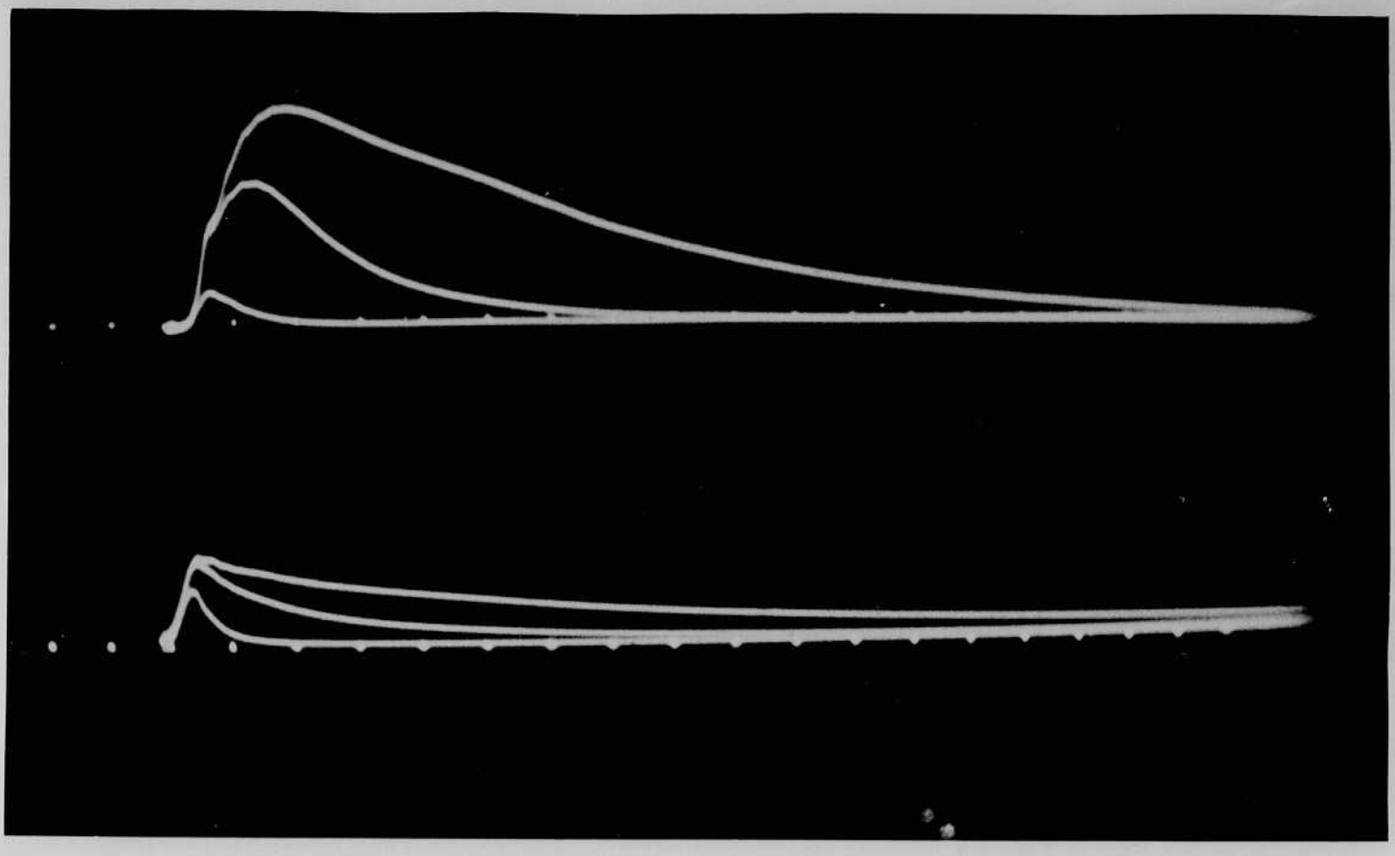
May 30 1946

		C	J	Tube			
12	16.	120	2000	FT-2	Top AT100 926 p.c.	Bot. 3 curves 1. Red. AT 30 Blue. Green.	
(13)	17	120	2000	FT-2	Top light AT-10	Bot current	120 uf 38 mf 10 mf.

See p 46.



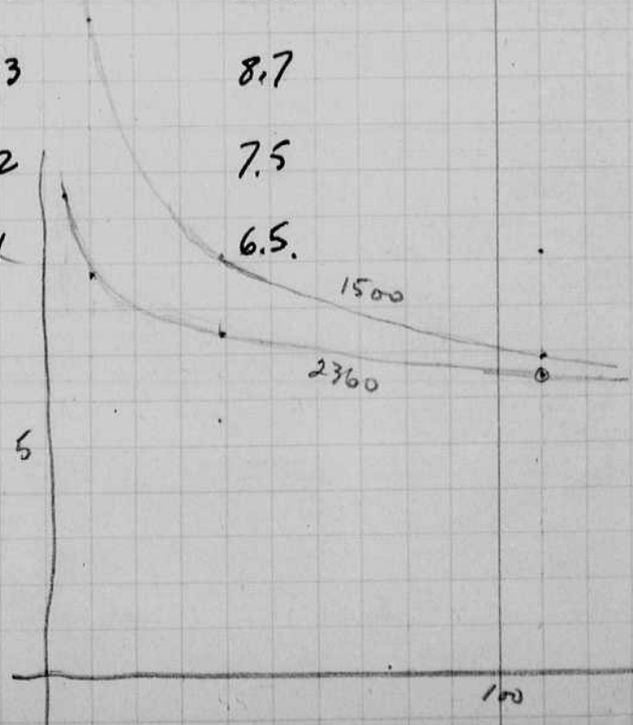
~~12 ms~~
62.2 ms.
61.2 ?



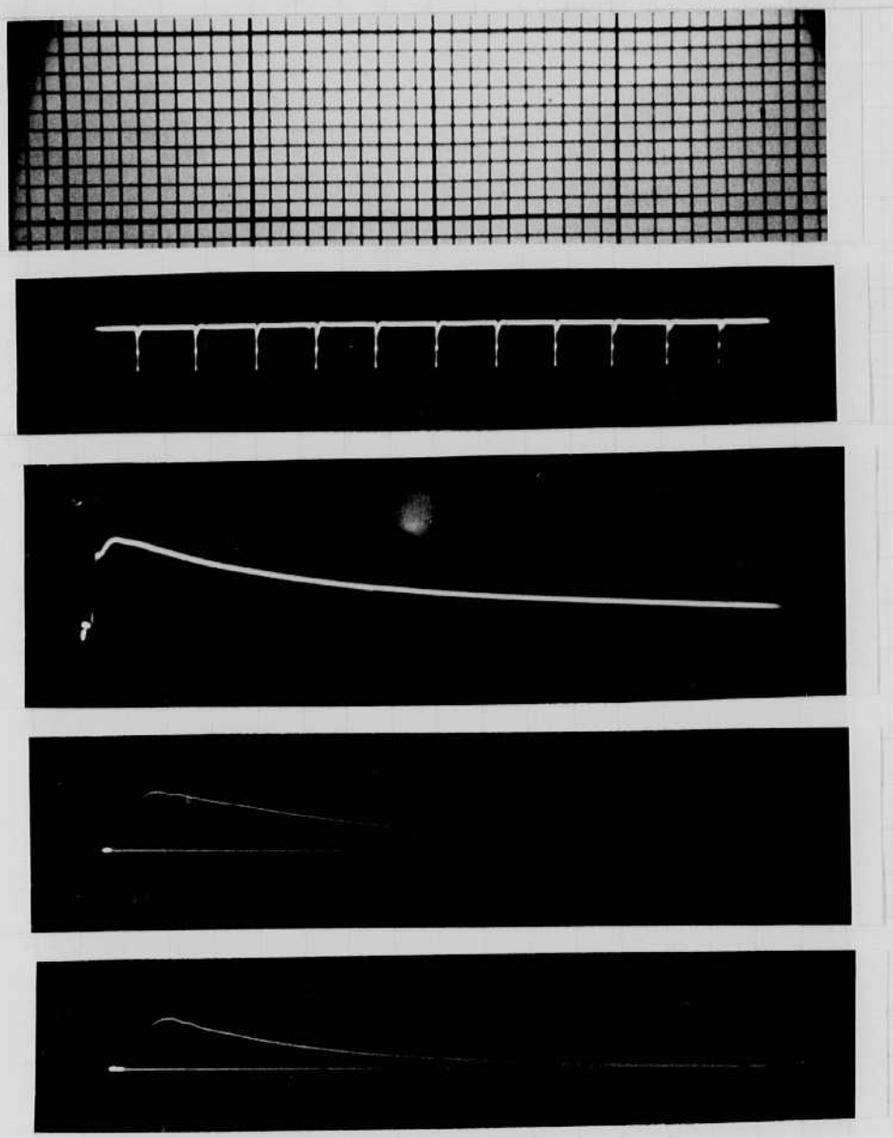
#17 Roll 18 p 49.
Top. Light 120 38 10 mf 2000 volts.
Bot. Current " " " "

Max Current vs Cap for 2360 and 1500 V with FT-14

C.	I 1500 V	I 2360 V	R = E/I max. 1500 V.	2360 V.
4.	80	232	18.5	10.5
10.	106	290	14.3	8.7
38.	160	315	9.2	7.5
120.	215 165	360	~~64~~ 9.1	6.5.

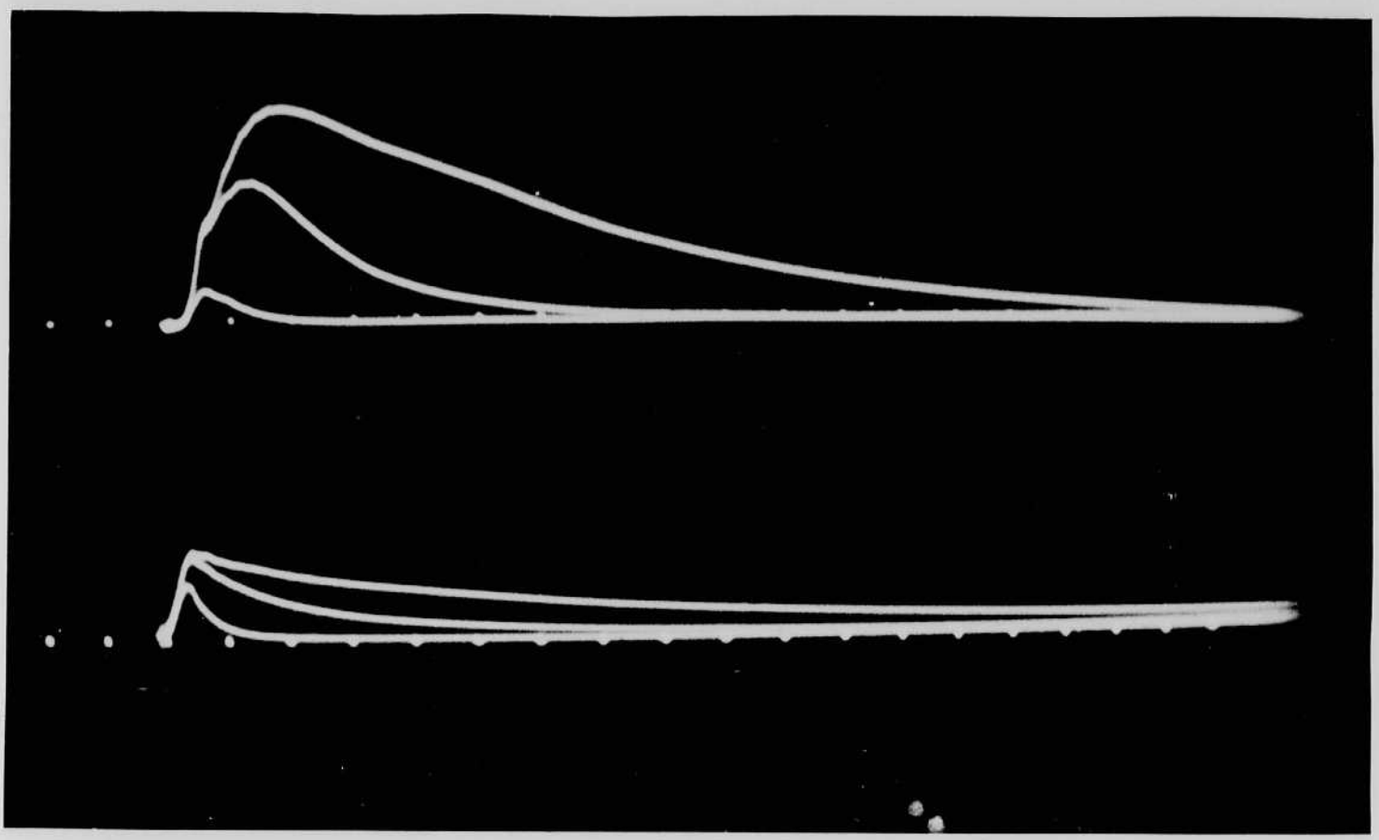


See p 46.



~~12 ms~~
62.2 ms.

61.2 ?



#17 Roll 18 p 49.
Top. Light 120 38 10 mf 2000 volts.
Bot. Current " " " "

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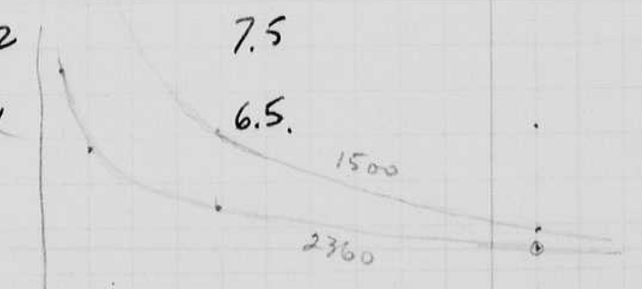
C.	I 1500 V	I 2360 V	R = E/I max. 1500 V.	2360 V.
4.	80	232	18.5	10.5
10.	106	290	14.3	8.7
38.	160	315	9.2	7.5
120.	165 (215)	360	9.1	6.5.



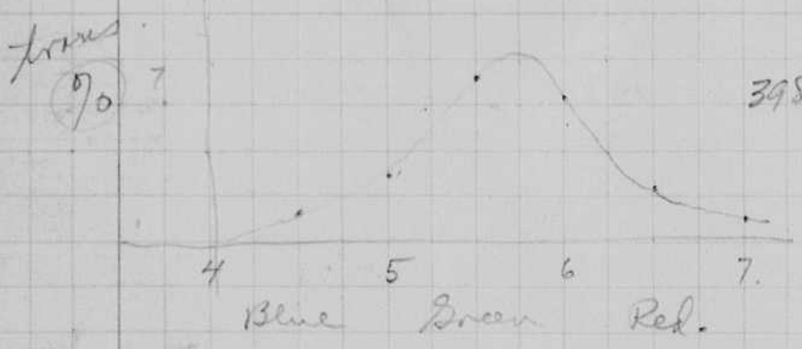
52 June 6 1946. Spectral Response.
D. E. Edgerton.

Raytheon Transformer
No. M5947. — 6 volt D.C. to 2250 v. r.m.s.
2 - 4 volt. transformers are available.

a 926 photo tube was measured by Miller. W.
Radiance = 2.3×10^{-17} amps at 4 volts with guard ring.

① Filter 398 Heat absorbing (thick) Dark.
330 Signal yellow.
Sensitivity.

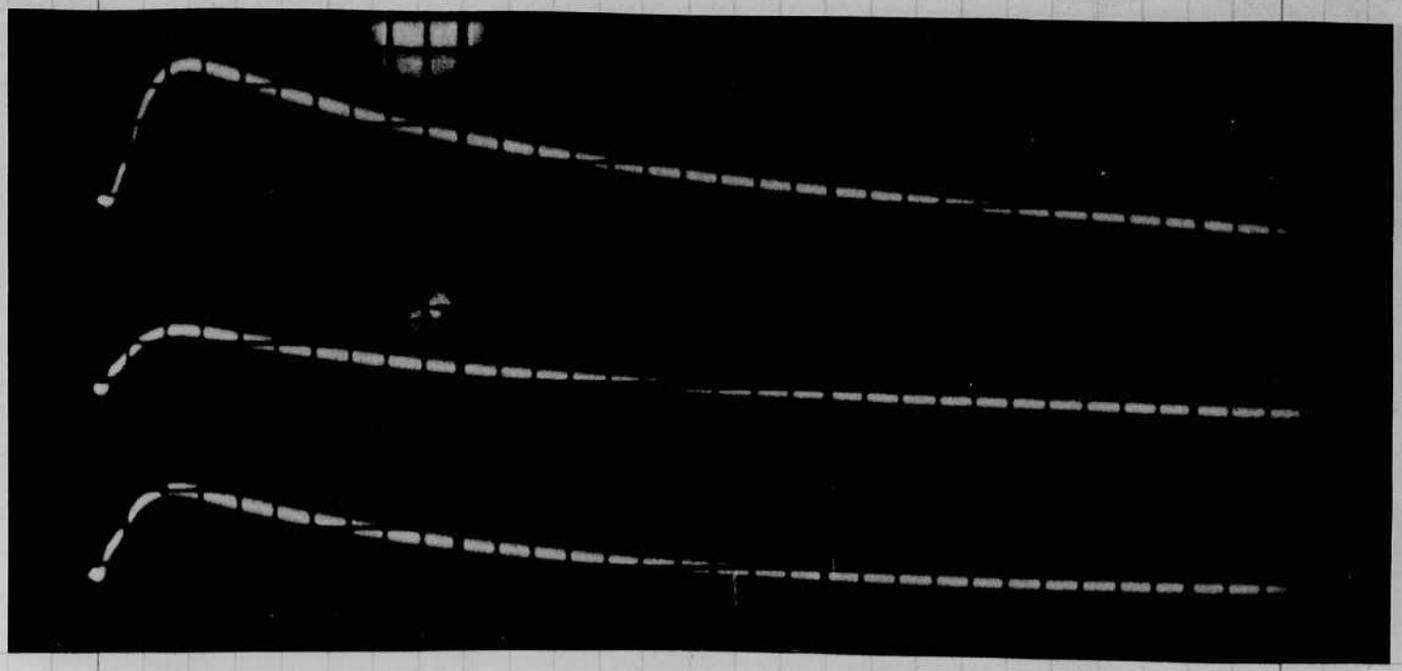
Filter 398 Heat abs.
378 Lemon yellow.



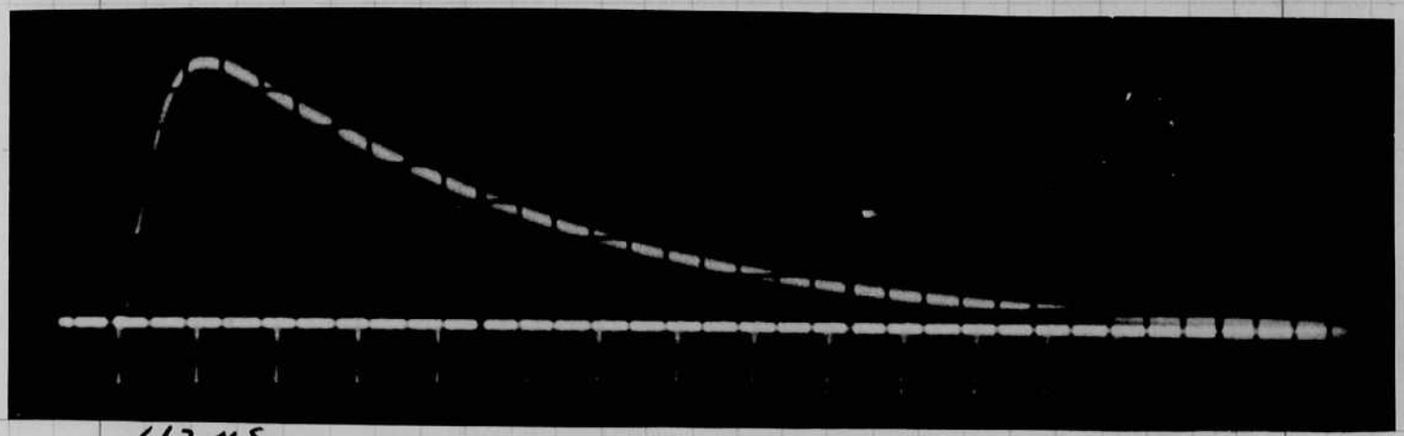
See p49.

FT-14 120 mf 2000 V

2

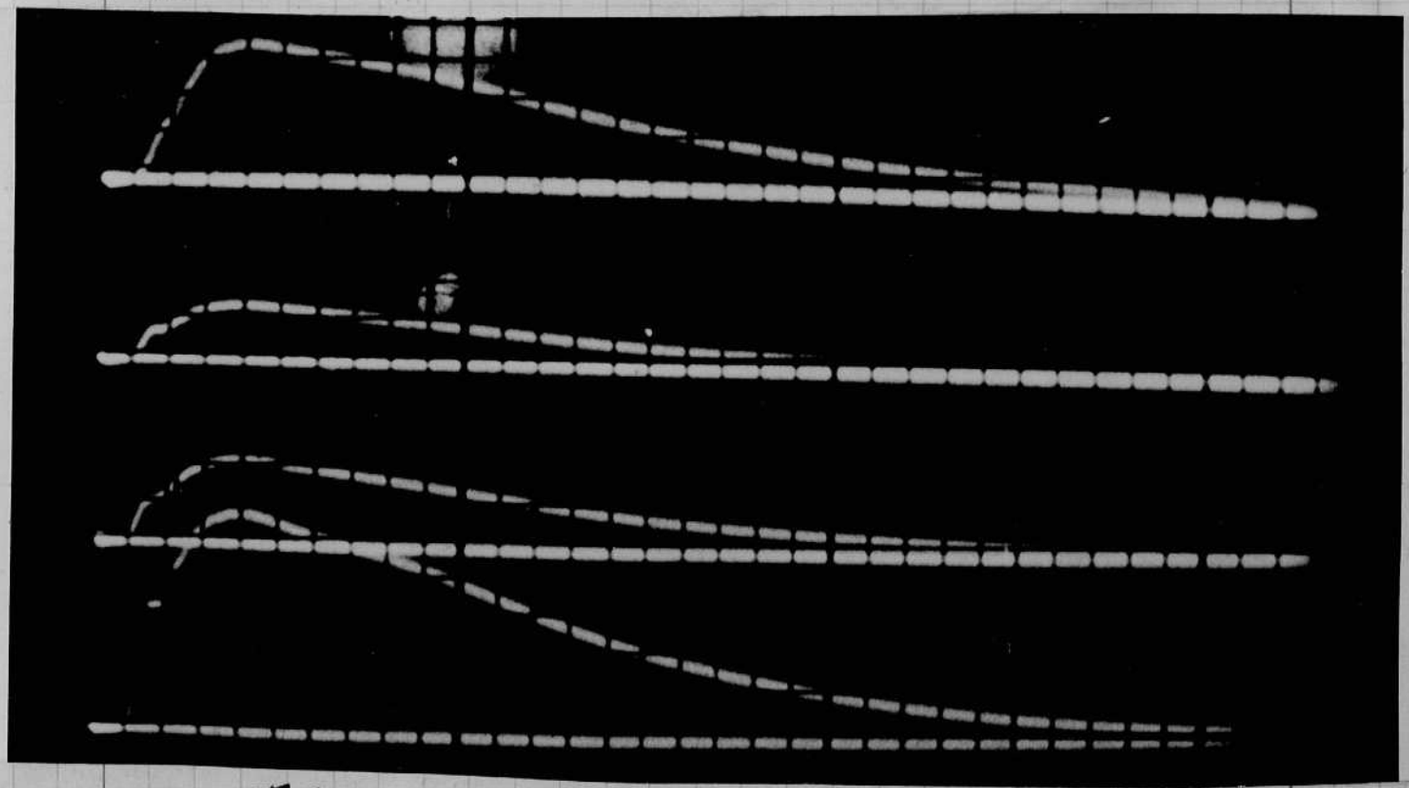


3



61.2 m.s.

5.



FT-2 120 mf 2000 V.

52 June 6 1946.
D. E. Edgerton.

Raytheon Transformer
No. M5947. — 6 volt D.C. to 2250 v T.M.S.

2 - 4 volt. transformers are available.

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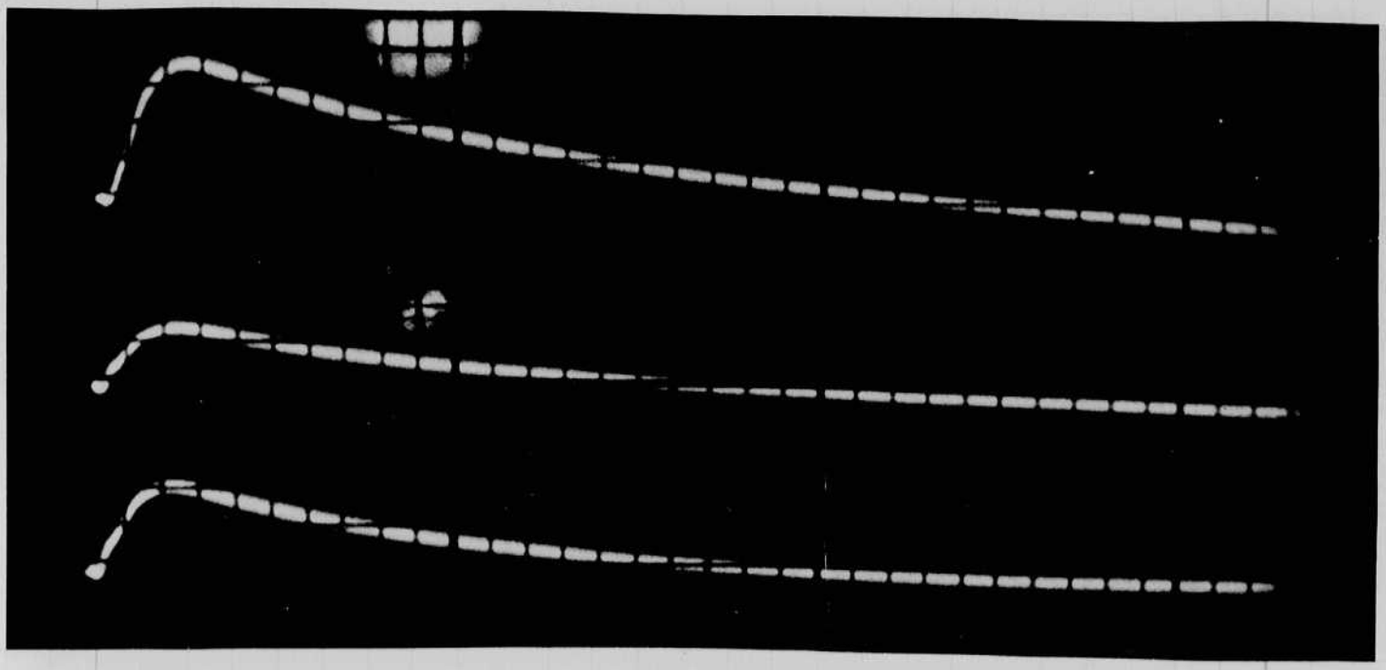
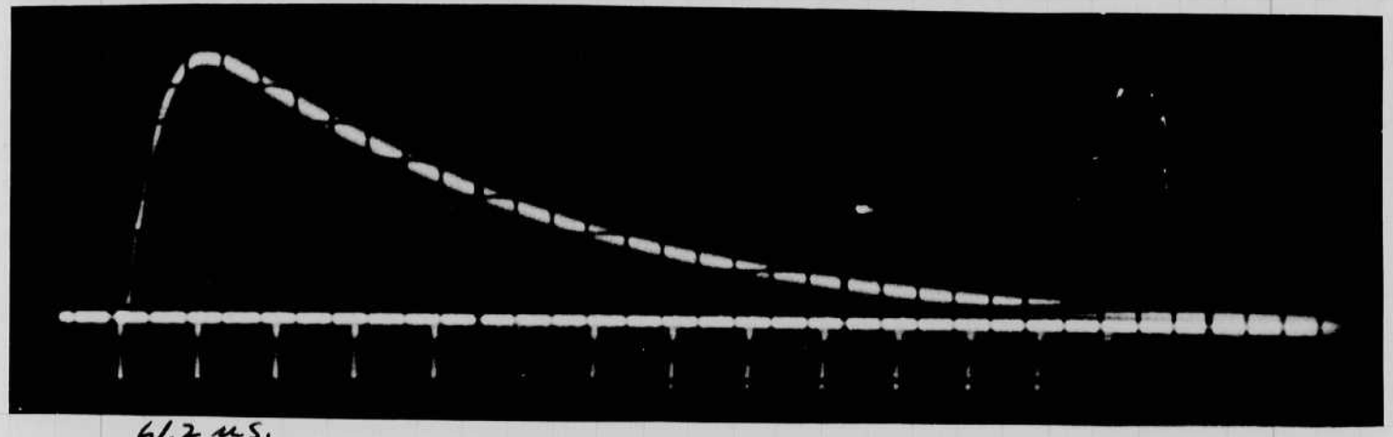
FT-14 120 mf 2000 V



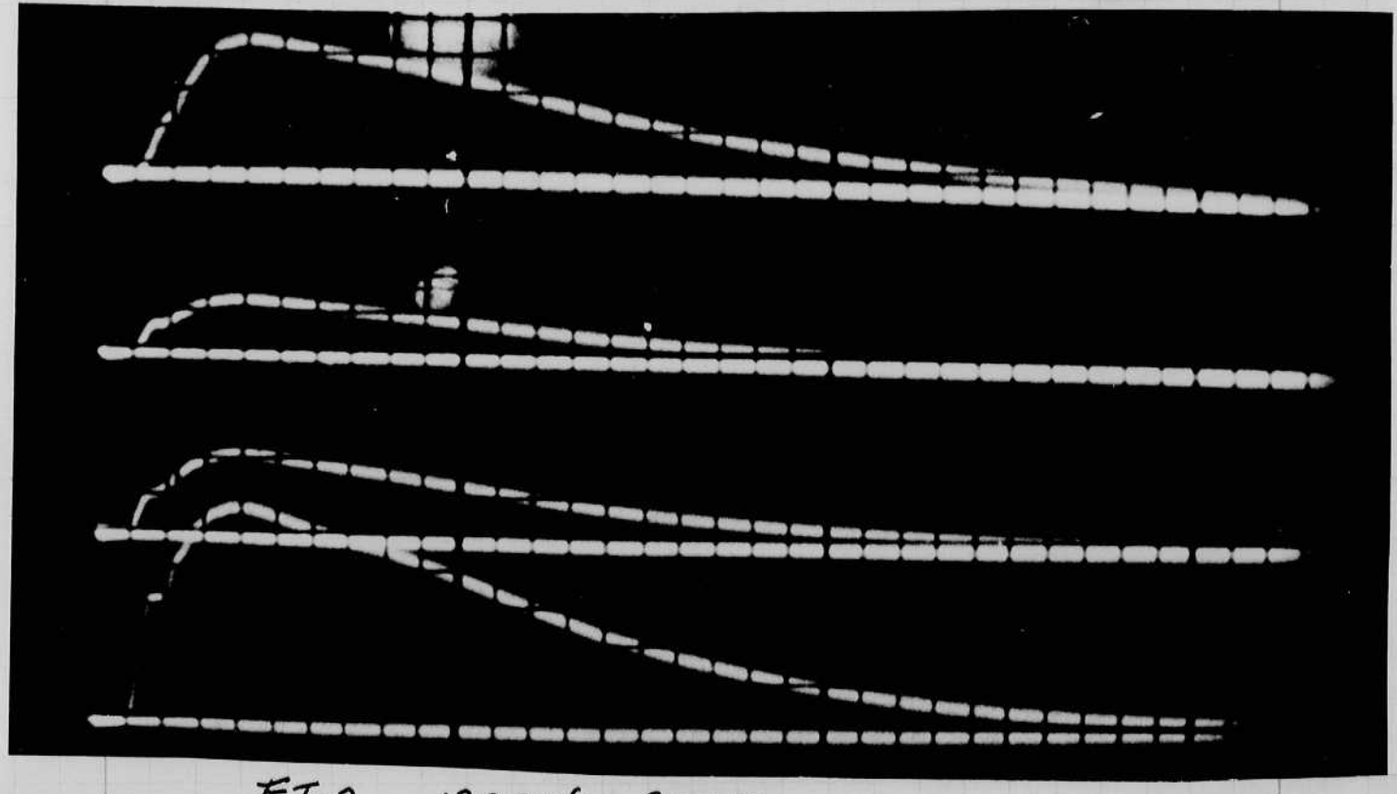
2



3

61.2 m.s.

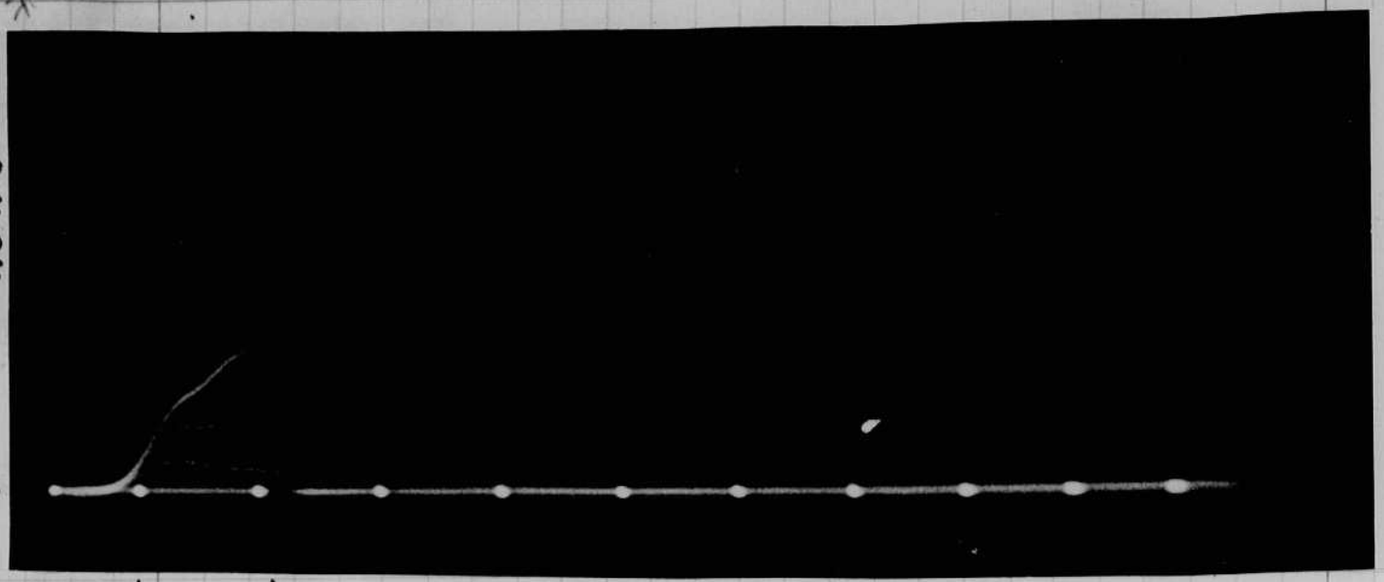
5.



FT-2 120 mf 2000 V.

FT-14 no2: Light & Current vs time

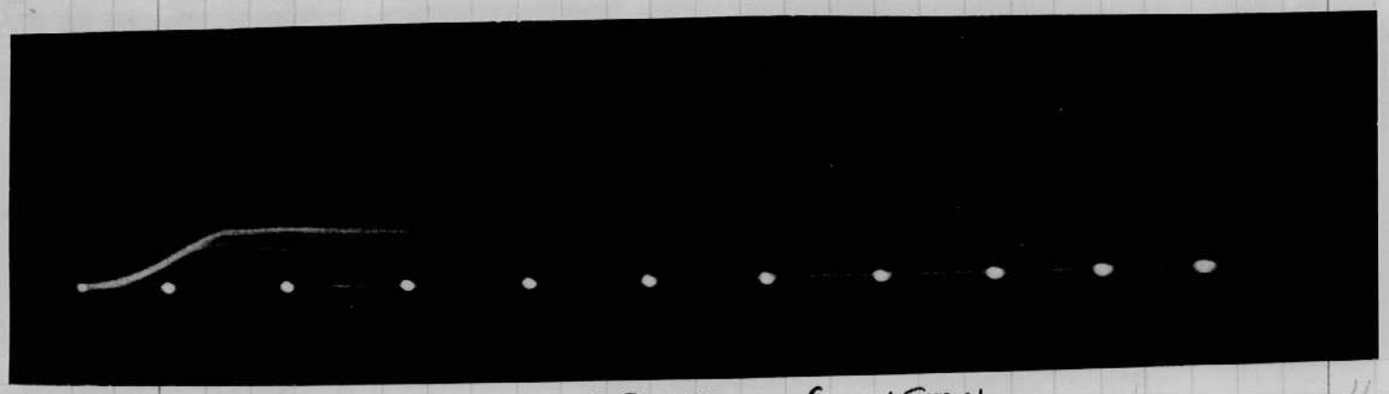
*a



12.2 ms

4-10-38-120 mf. 2000v.

10



450 amps/inch. 12.2 ms.

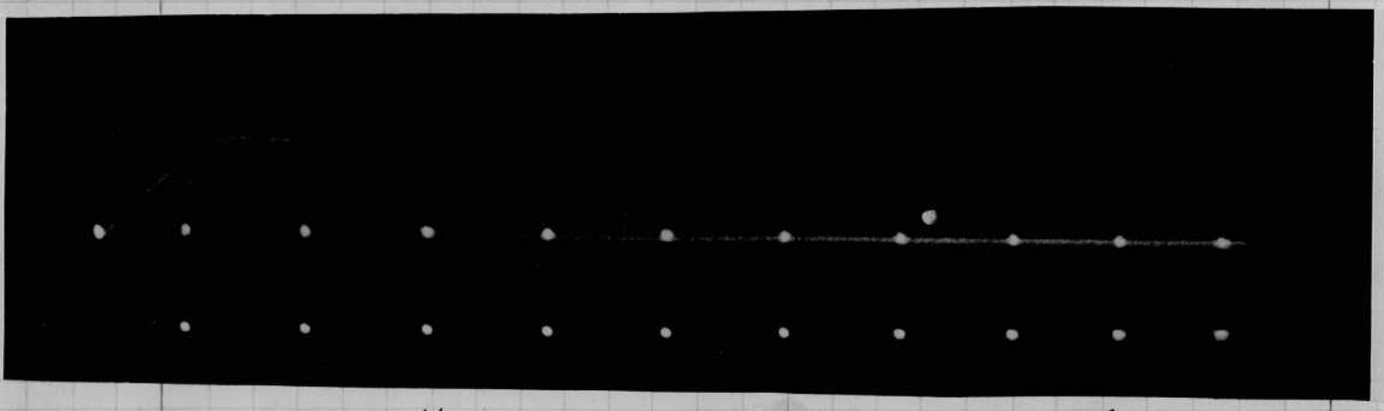
10-38-120 mf. 1500 V

11

$\frac{280 \text{ amps peak}}{2} = 140$ amps for 1500 volts.

$\frac{1500}{140} = 10.7$ ohms.

*8



4-10-38-120. mf 2000 volts.

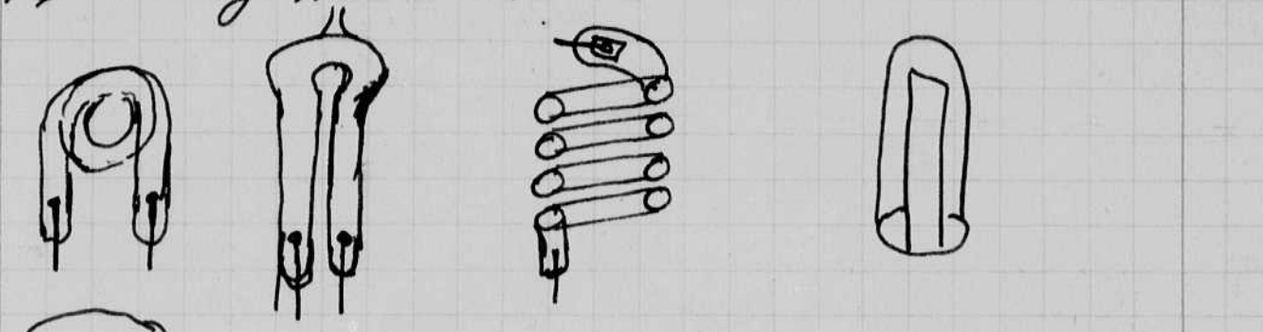
$\frac{9}{16} \times \frac{1}{2} \times 900 = 252$ amps peak

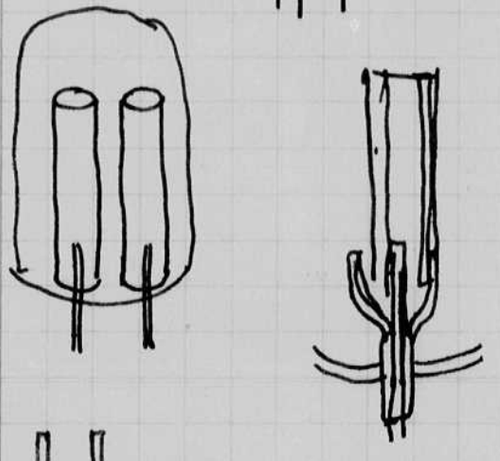
$R = \frac{2000}{250} = 8$ ohms

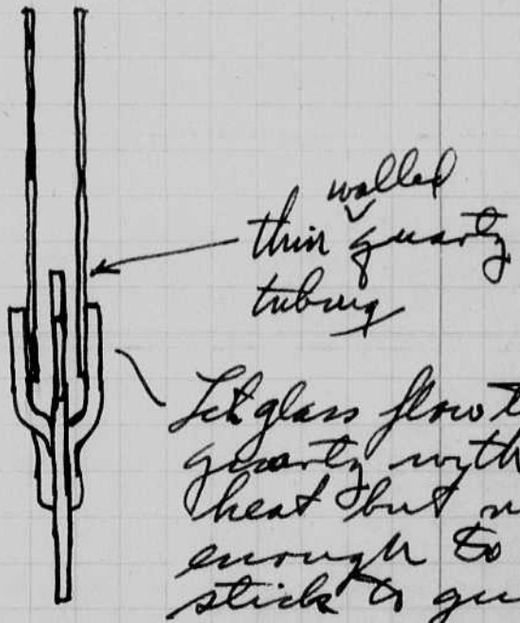
The present FT-14 consists of a 16" ± length of 5-6 mm pyrex tubing in a spiral. Tests show that it can be used on 120 mf at 2000 volts as an upper limit of energy input.

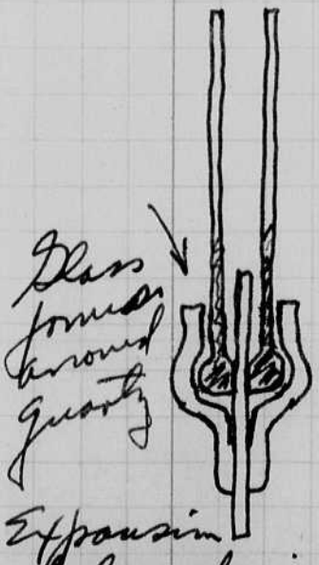
I suggest a lamp smaller by 3/4 in volume for use at 28 mf 2000 volts.

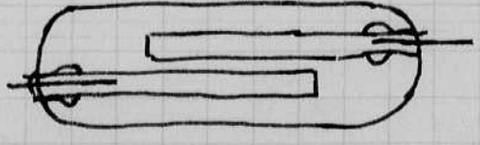
Preliminary design 4 mm tubing on 1/2" inside spiral with 4 turns. Pressure 10 cm of xenon.

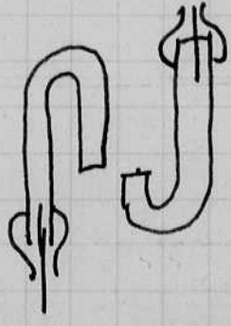


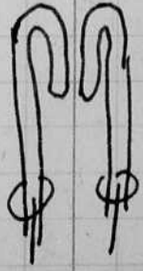






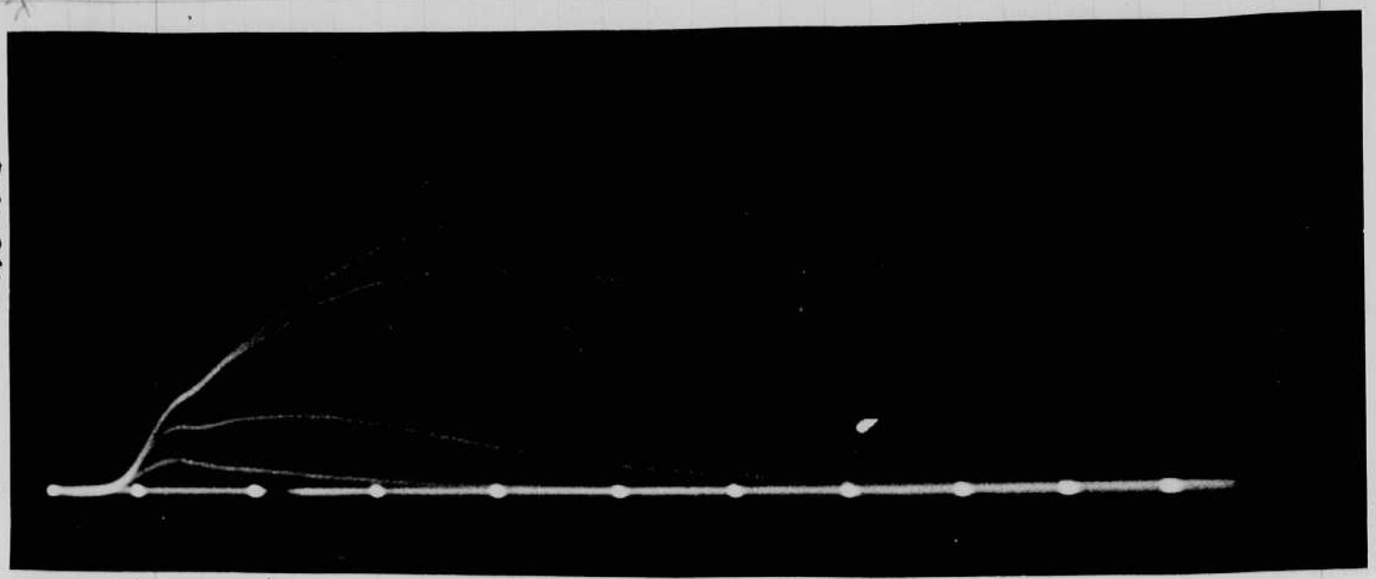


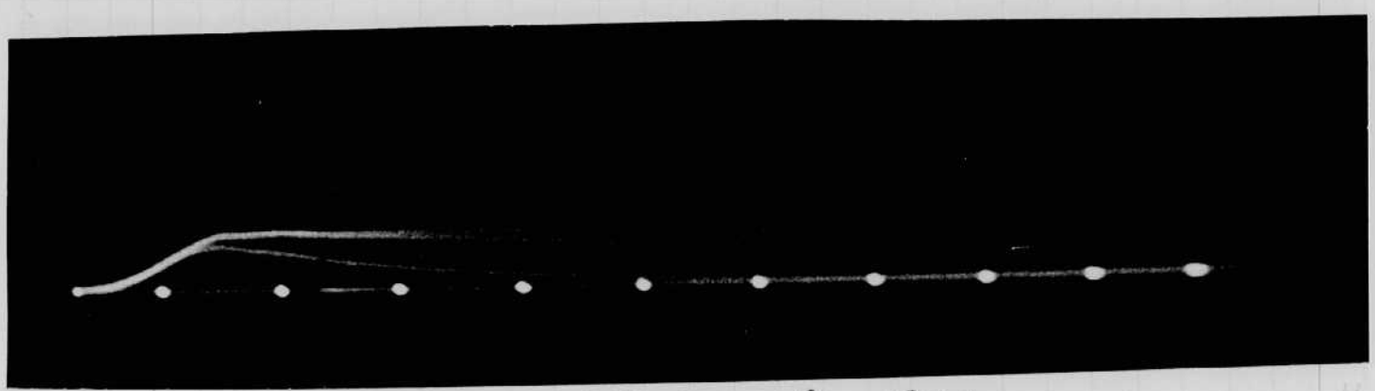




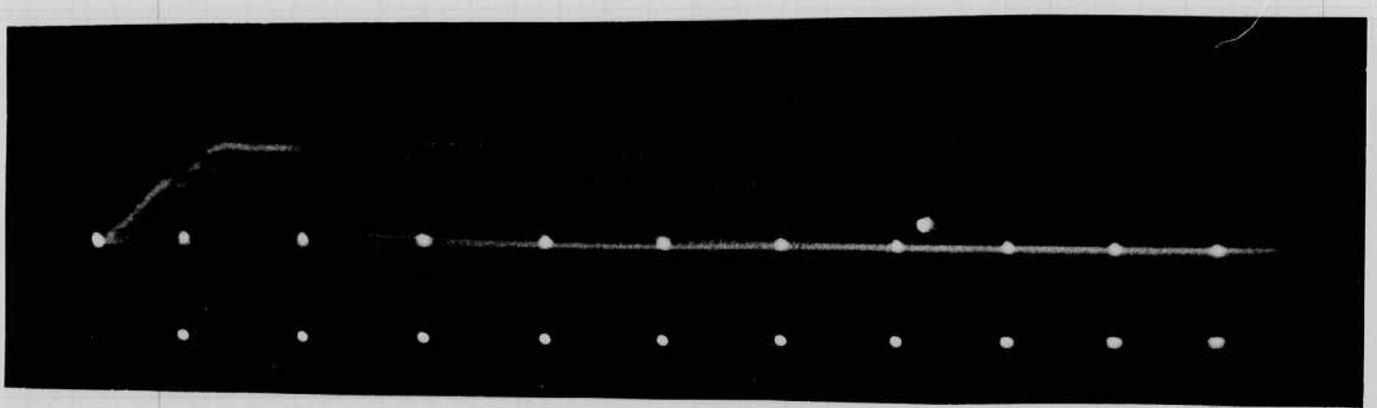
Expansion of glass during use will not break the glass since quartz has low expansion coef.

FT-14 no2: Light & Current vs time





280 amps peak. = 140 amps for 1500 volts.
2
1500/140 = 10.7 ohms.



4-10-38-120. mf 2000 volts.

9/16 x 1/2 x 900 = 252 amps peak

R = 2000/250 = 8 ohms

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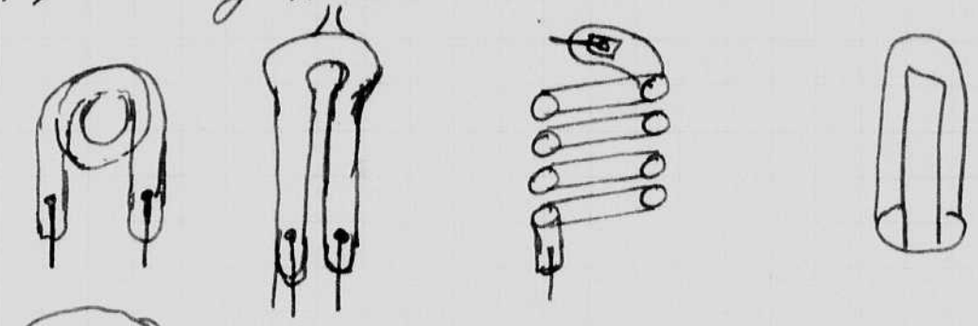
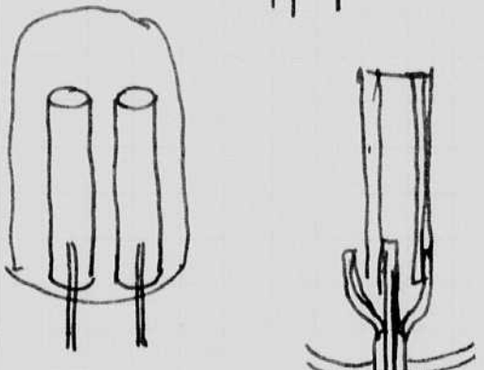
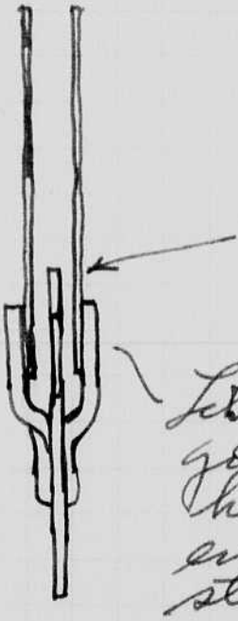
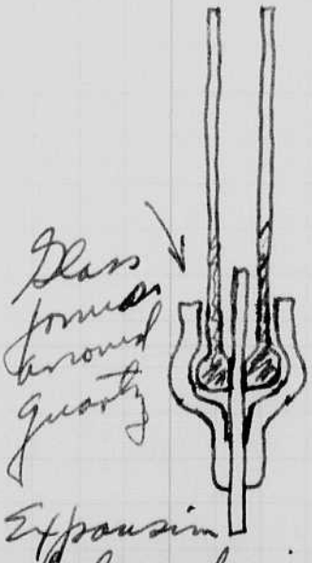
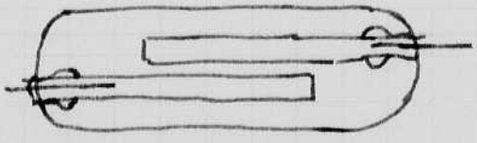


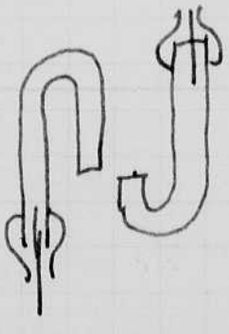


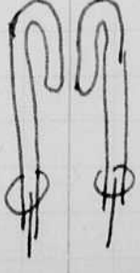


Let glass flow to quartz with heat but not enough to stick to quartz.









Expansion of glass during use will not break the glass since quartz has low expansion coef.

June 11 1946
Harold E. Edgerton

Fred and I talked to Noel this morning about a portable lamp.

Specifications

Length	3"	Coming T. Wood E. Ling
I.D.	1.5 mm	
Press	70 cm	
Form	Spiral on a 1/4" form	
	axis of spiral along ref. axis	
	" " ⊥ to ref. axis.	

Trial Exposure 20A236

1 Ranging Scope 341 with screen illuminator

New Eastwood XX film.

1	1
4	5
28	33
82	115

Exp No Subject.

1. 30 Scale or Illum 5 sec.
2. 40 " "
3. 50 " "
4. 60 " "
5. 70 " "
6. 80 " "
7. 50 " " " " + 38 mf at 2000 v Light A.T. 100
   5 seconds of dots. 61.1 ms.
8. ———
9. 50 V 5 sec scale.
   L. 115 mf 2000 V AT-100 A 20000 sweep. Light
   33 " " " " "
   5 " " " " "
   1 " " " " "
   61.1 ms dots 3 seconds. timing below zero.
   Current 115 2000 v 0.1 ohm shunt 90 v/inch.
   33 "
   5 "
   1 "

———

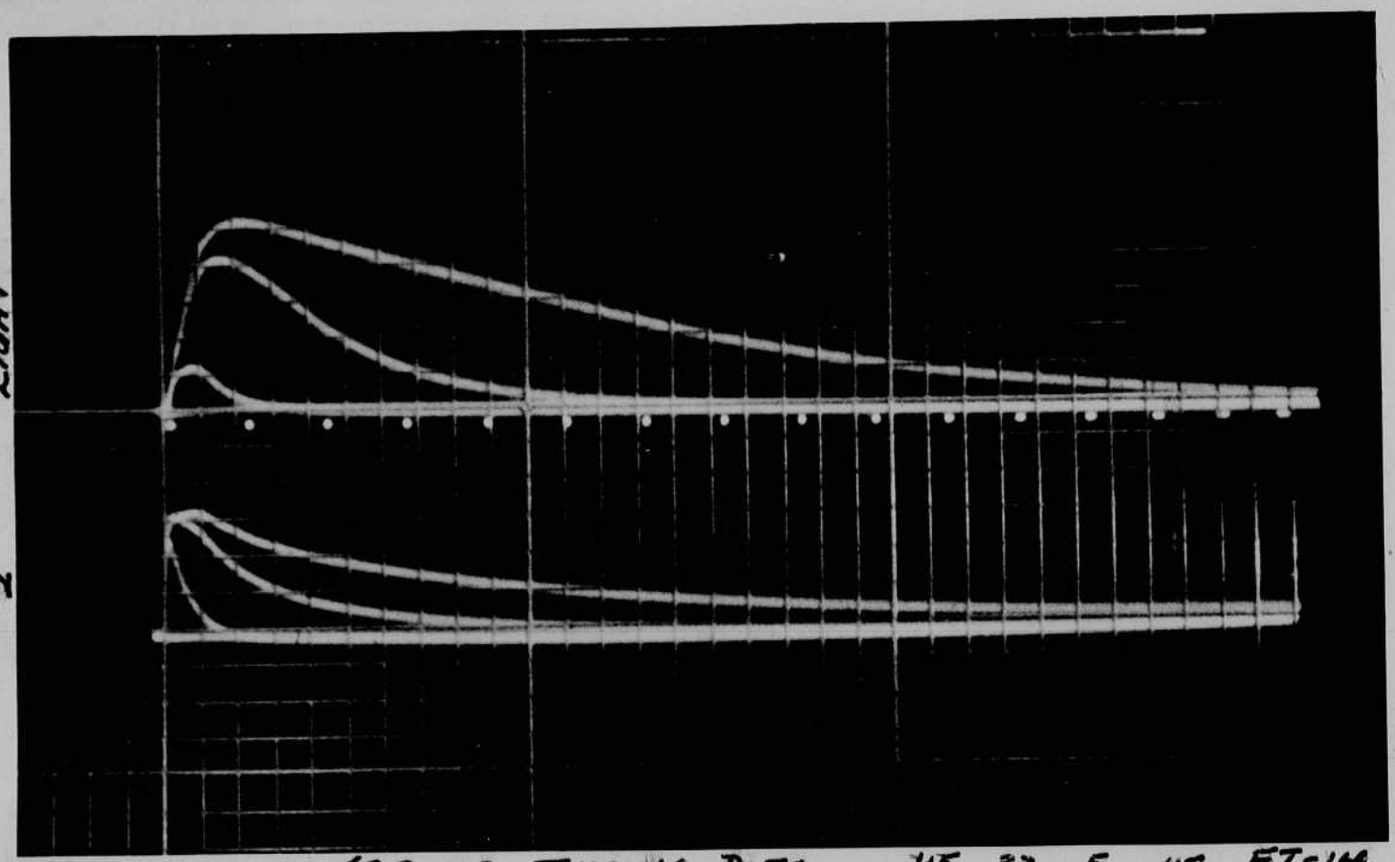
1. 0 5 sec.
2. 10 "
3. 20 "
4. 30 "
   30 2.5 sec.
   30 1.0 sec.

FT-14. 5. Scale 1. sec. 30 V. 115 mf 2000 A 20,000 Light AT100 61.1 ms.
33 " "
5 " "
0.1 ohm shunt for current.

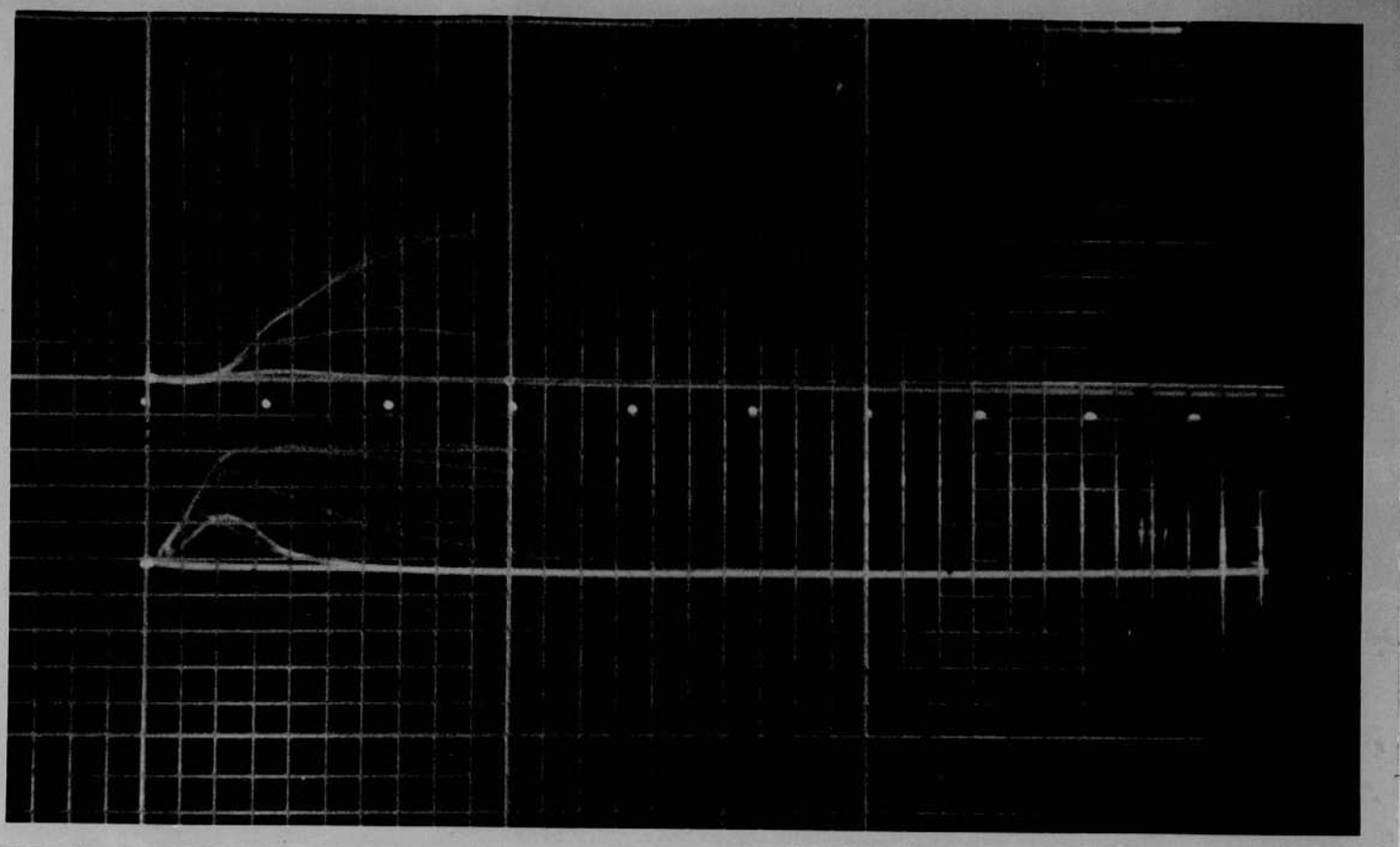
6. Ditto above except Scale A 20,000 and 12.2 ms per inch.
7. 5 mf 2000. (8 flashes) 4000 R Light AT-30. 12.2 ms pips.

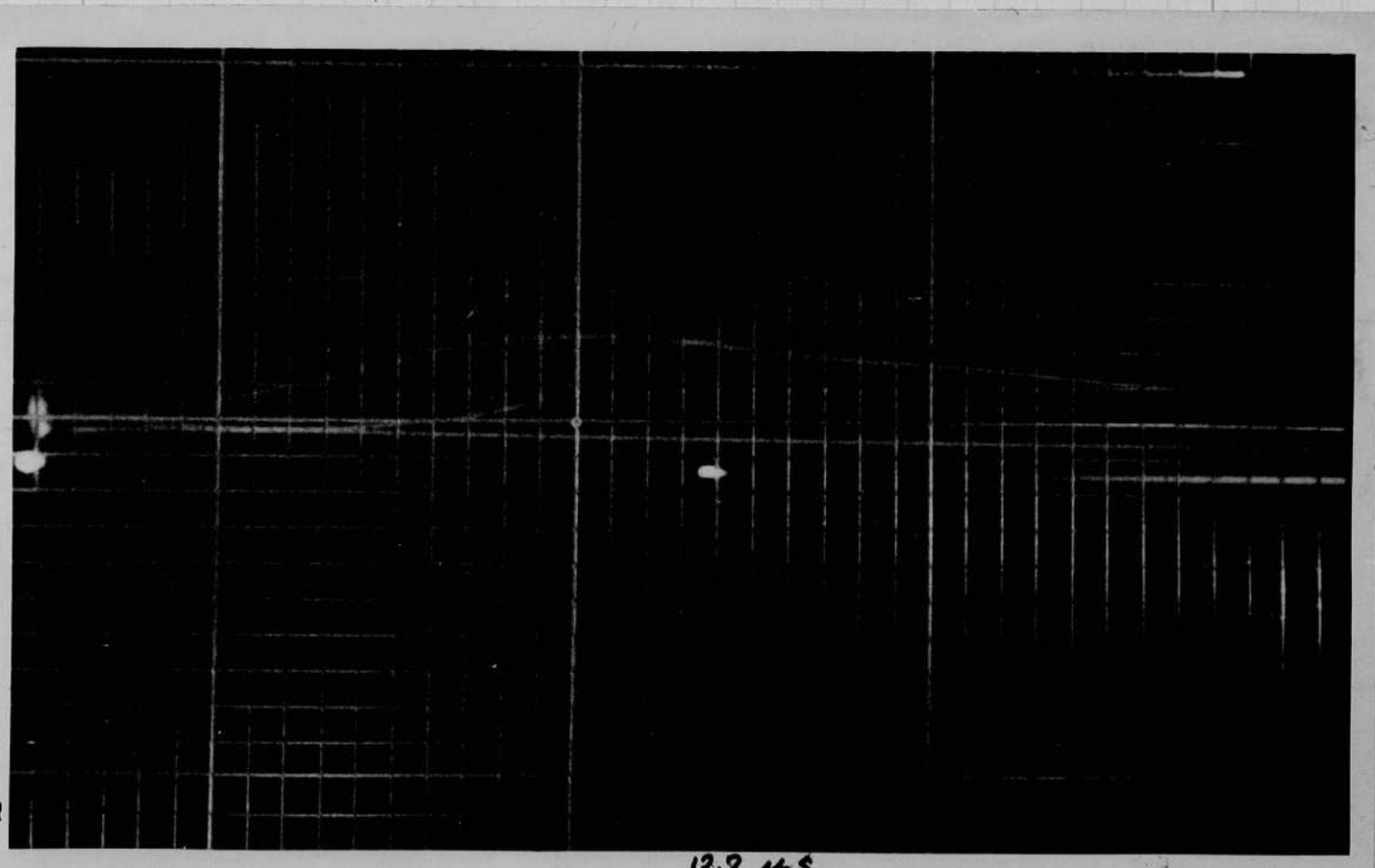
Voltage doubler wiring diagram.

A Peel Ground
B Meter 110 ac
C " " "
D Discharge gr.
E trig. 38. Sterbox
F trig Sidtrig.
HV.



+
61.2

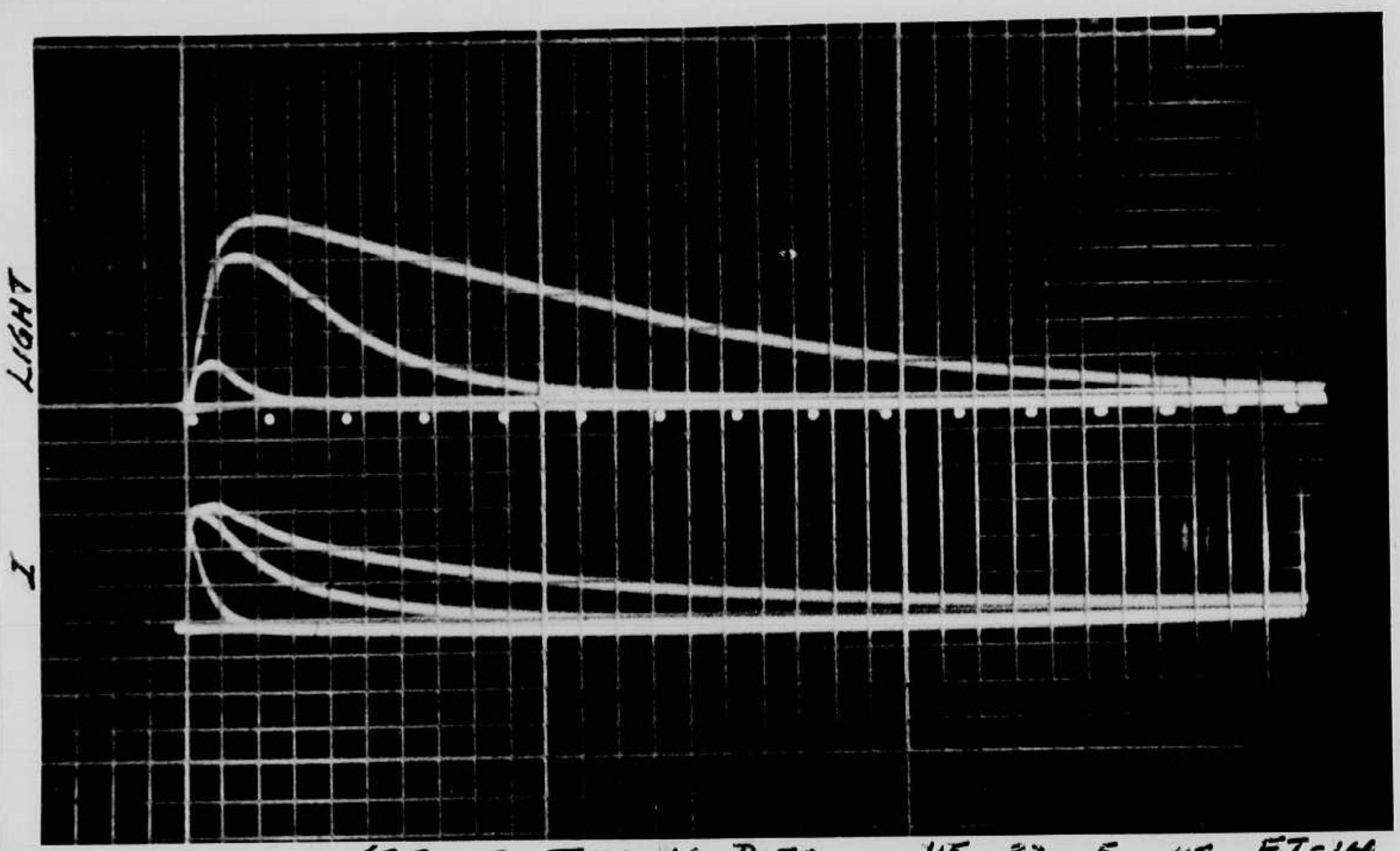




12.2 μs

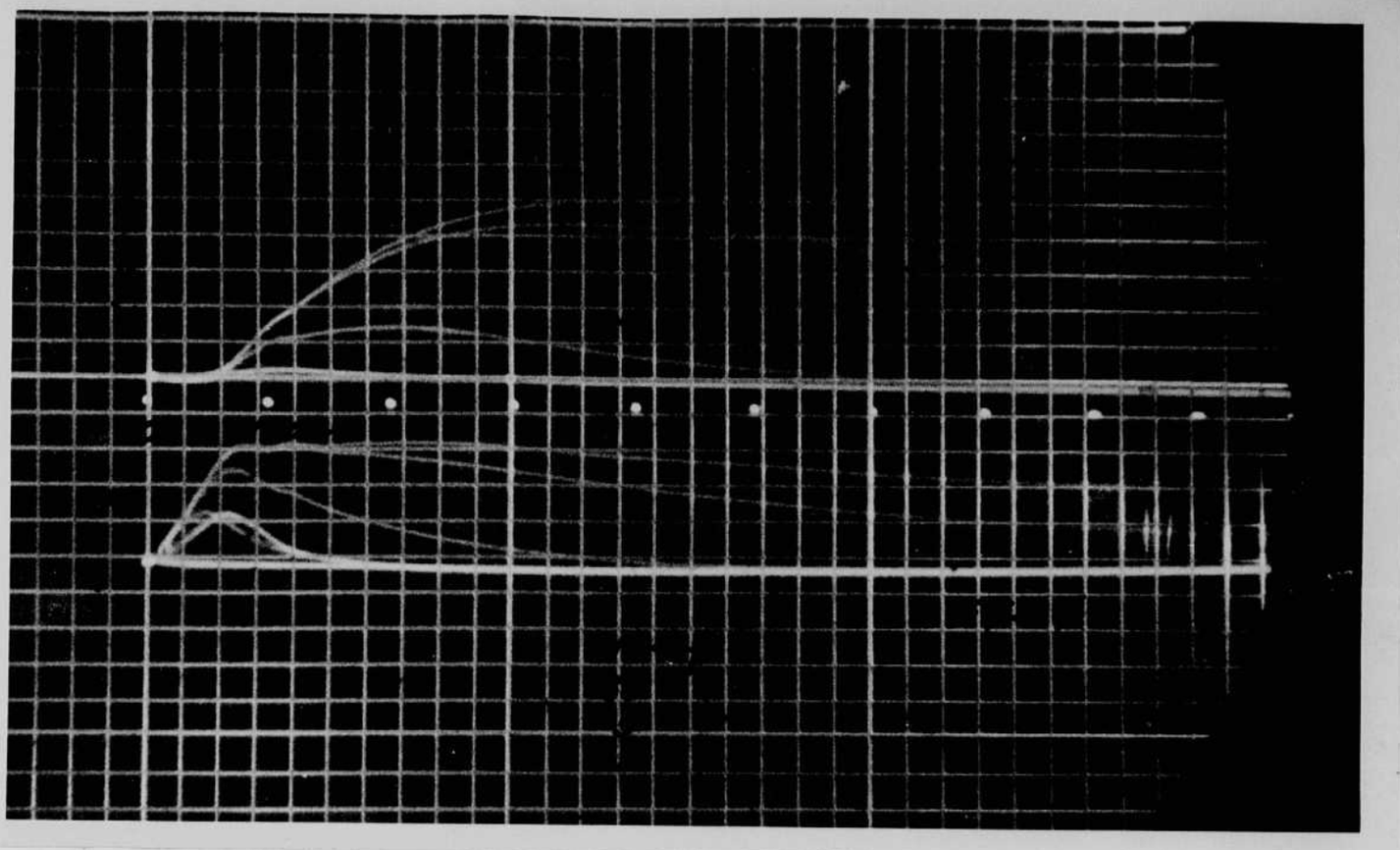
Voltage doubler wiring diagram.

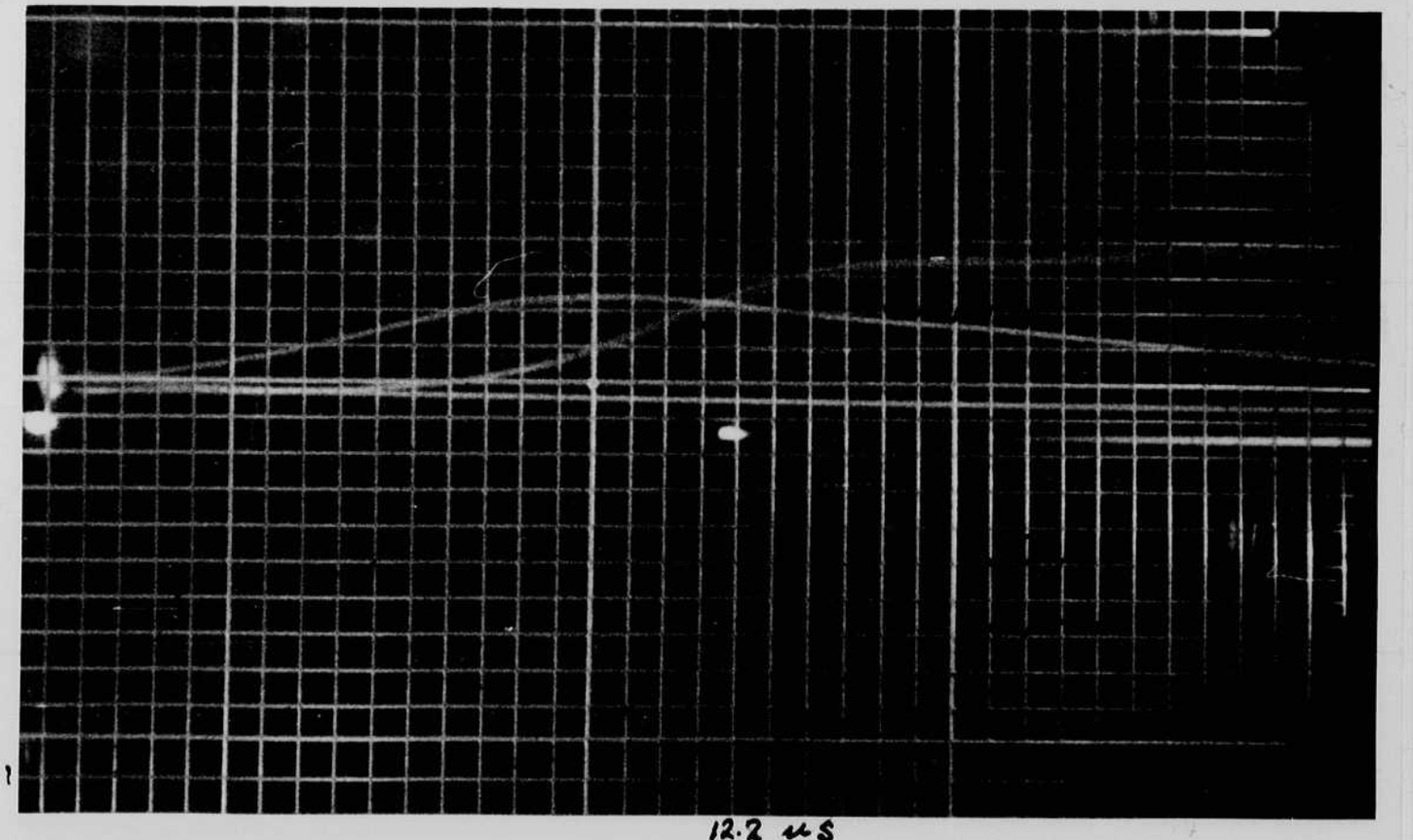
A Real Ground
B model 110 ac
C " " "
D Discharge gr
E trip. 380 [illegible]
F trip Grid trip.
HV.



62.2 us TIMING DOTS 115 33 5 us. FT-14

X
61.2





12.2 μs

July 31 1946.
Harold Edgerton

A few colored humming bird photos were taken at Holden nears N.H. on June 23. Mary Louise and Jack McNiven went along. Ok at f 11 with lamp at 1.5 ft ±.

Left June 25 for west with family in beach wagon
First night at Watkins Glen N.Y.
June 26 at corning Glass works.
C.F. Hewlett and H.P. Gage - filters
see J.O.S.I. 1937 p 159
J.P. Hoxie - colored glass covers for reflectors.
June 27 - Rochester N.Y. with Boon. the studio
28 unit was examined with McAdam.
Photos and wiring diagram are
to be submitted to people for bids.
Acting on production to be taken.
Barstow was there on the 28 with the
5½ lb portable sample.

June 28 Niagara falls then to cleveland where I saw Noll at his home in the evening.
June 29 To Dixon Ill to see Edna Gunther and family on farm south of town.
July 1. Dixon to Platte south Nebr.
2 Aurora nebr. for visiting with parents.
19 Left for east over mile Denison Iowa
22 Cleveland with Carlson most of the day.
23 Rochester with Boon to shoot exp color
24 photos with 400 mf 4500 v flash unit.
FT-24 tubes in 10" reflectors were
used. The unit makes a loud
noise when operated.

I was at Raytheon yesterday and tried series inductances in the discharge circuit. Same as used in the D-1. The noise is much less. Irving Eastman is there working with the circuit and design of the units that are to be built.

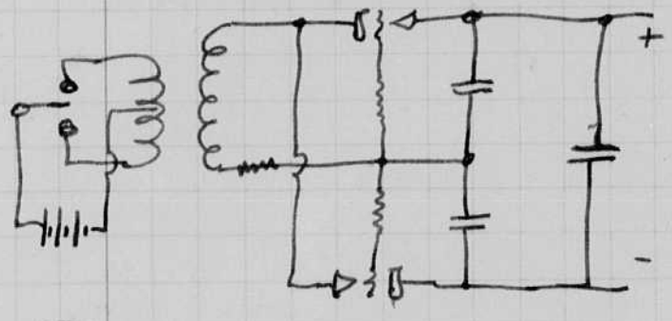
Transformer 5947M with ratio of 62-17200 turns gave 3000 volts from a 4 volt battery and vibrator with two glow rectifiers (Raytheon) CK313? I went over this with Chas Lorain yesterday. We wish a 2000 volt output from a 6 volt bat. Also a voltage doubler circuit will be used as per below.

new ratio of winding should be for half wave

$$3000 \times \frac{6}{4} \times \frac{x}{280} = 2000 \text{ volts.}$$

$$x = \frac{2000}{3000} \frac{4}{6} \times 280 = 125$$

for a voltage doubler x should equal 70.

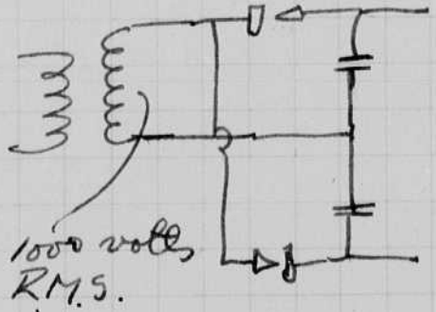


Krim says ~~~~ a 300 ma peak can be used without trouble in this tube.

$12 \times 70 = 840.$

I told Krom to try a ratio of 100 for the transformer.

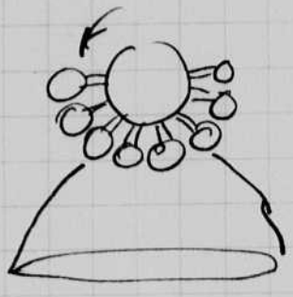
Data from Krim.

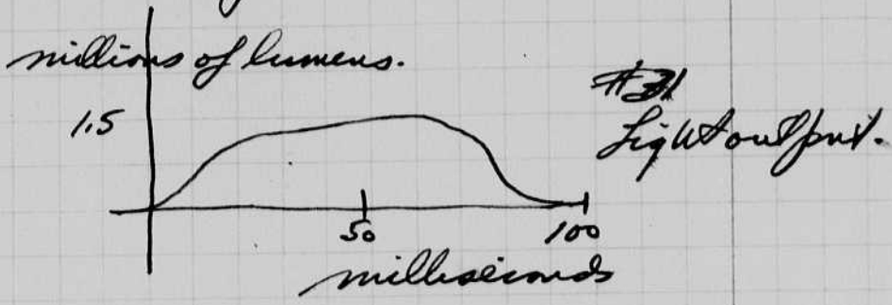


output = 2400 volts.
D.C. on no load.

Henry M. Lester | Journal of the Biological Photo assn. March 1946.

Uses arrangement of photo flash bulbs #31 so that new bulb is moved into the reflector as the other previous bulb goes out. Circular track for bulbs.





17 lamps give 1 second light

August 10 1946
Harold Edgerton.

I made a trip to Holdemess NH on Aug. 3. Sat to obtain nerve Modulations of Humming Birds. Two Rotatine units were used for lighting. a guide factor of 22 to 32 was used for closeups.

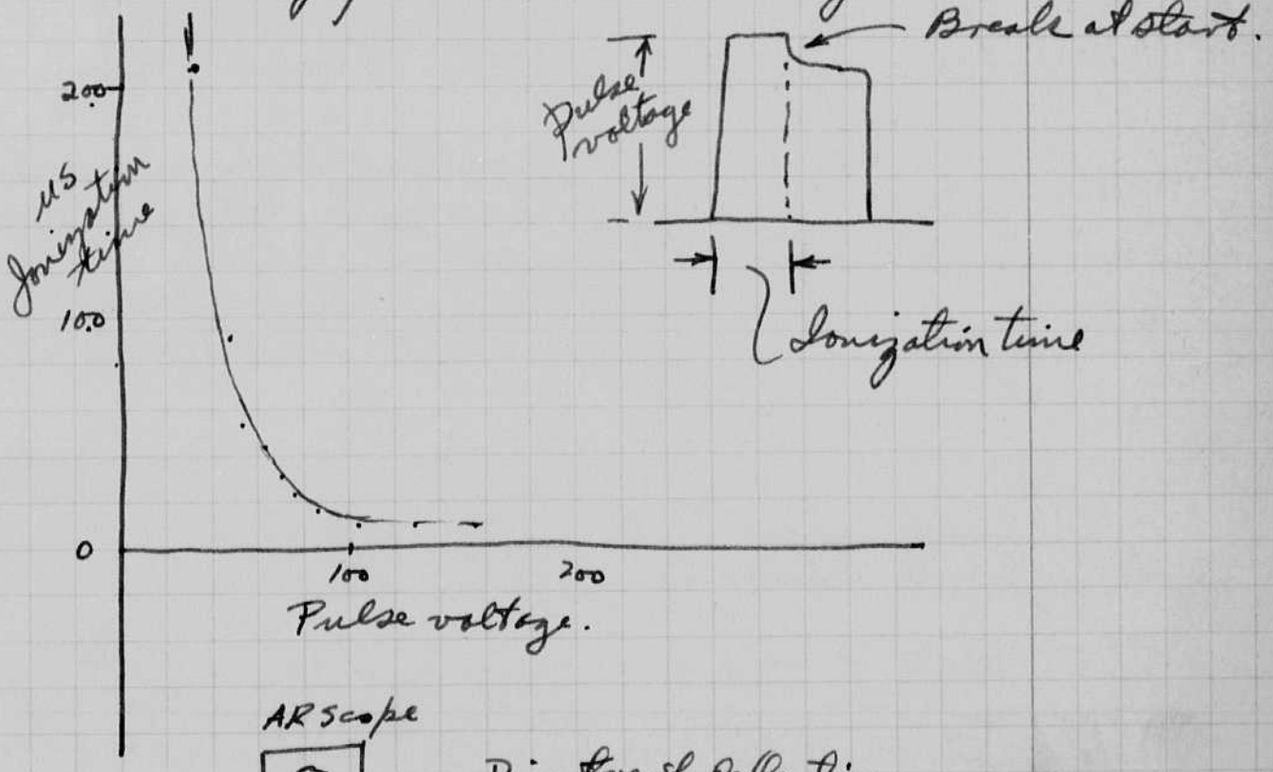
The second half of the term in 6.631 started aug. 5. with 12 students. Gray had this class the first half. Cobine's book is the text. Discussed Ionitine and inverters on Mon. Tue. Gave demonstration in 20B20? on Friday.

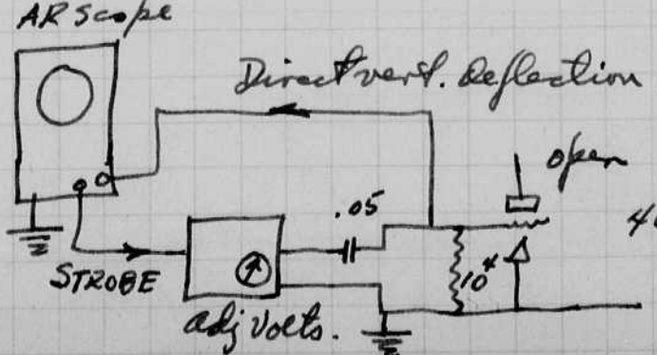
1. Osc AR scope calibration. 300 rep rate per second.
86 volts per inch vertical direct.

Tinal A 20,000 72/2 = 36 us per inch.
4000 12.5/205 = 6.1 ..
2000 7.5/2.2 = ~~6.+~~ 3.4 ..
800 2.5/2.2 = 1.14 ..

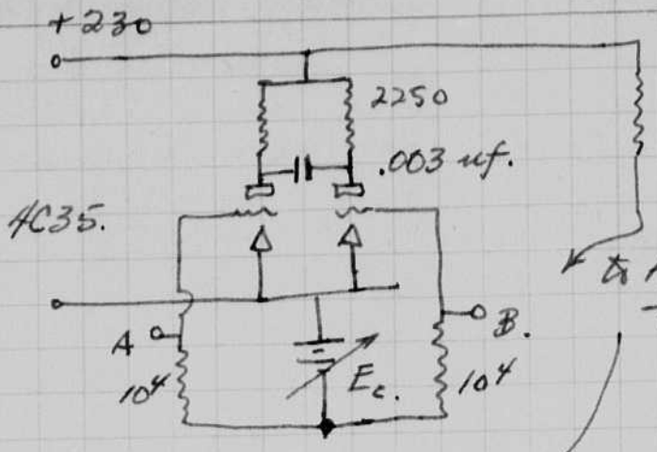
2. Ionization time of tube ~~A~~ B.L. 4C35.

Rise time of pulse about .3 us for 150 volts.





Deionization time Experiment as shown Aug 9 1946 to 6.631 class.

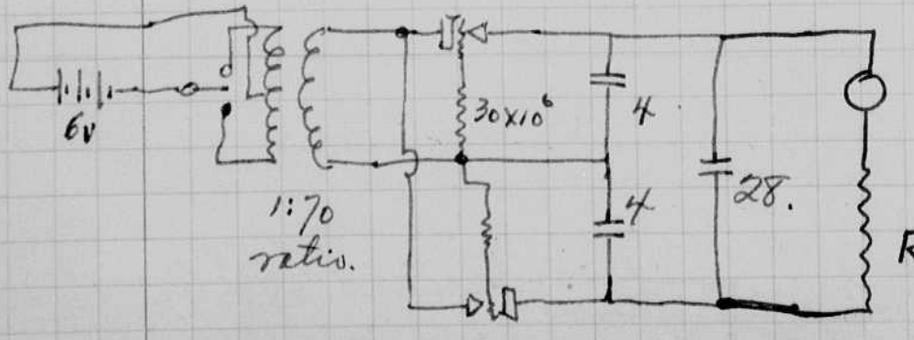


The probe switch was used to trip the tubes in succession. If the tube deionized when they extinguished when the opposite tube was fired.

For this example the time constant is
RC seconds = $2250 \times .003 \times 10^{-6} =$ 6.7 μs.
It was found that one tube did not deionize until the bias was made −20 volts. the other deionized with zero bias at this time constant.

Assuming zero drop before and the start voltage to be zero, the deion time is
.63 RC = $6.7 \times 6.3 =$ 4.2 μs.

I made some tests with Chas Eichhorn on an experimental transformer for battery operation.



with a 2 meg load the capacitor voltage reached 85% voltage in 7 sec.
6 amp. peak in d.c. from battery.
Short circuit current 20 ma
1.07 ma open circuit into 2 meg bleeder.

cont.

a series of characteristic curves were discussed with Eichhorn, which are to be obtained from the two samples which are due to be made next week.

1. Load volts - load bleeder resistance.
2. Short circuit current - dividing capacitor.
3. Voltage rise time vs time for typical applistor.

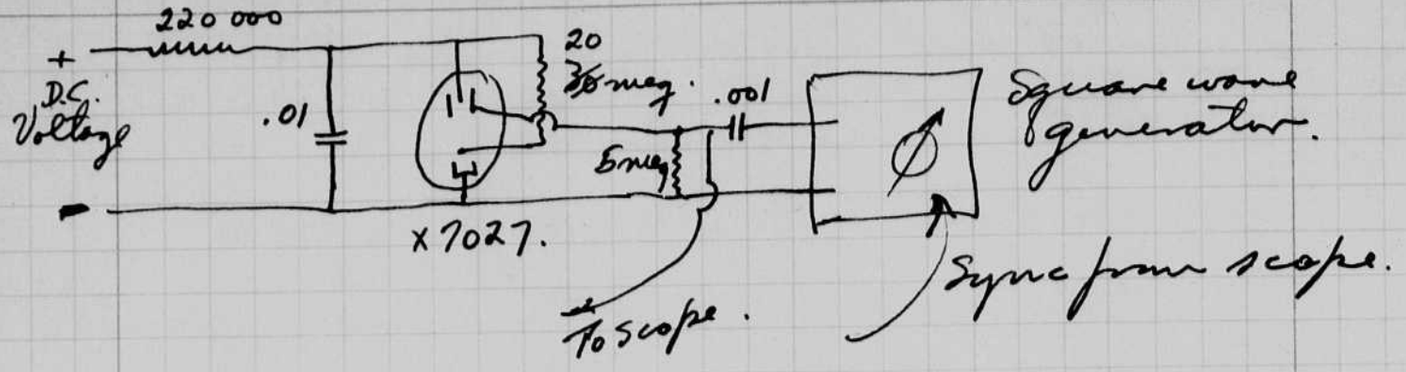
Light Meas. made at Cushing Hospital. Framingham
Capt. Marshall
Mr. Hochman ?

Signal corp camera with Dome tube.

	L	ap.	V	mf.	Ω
18"	.37	1/8 + D+6.	1850	112	
18"	.45	"	2450	24 mf.	Home made equip with Sig C. tube.
18"	.32	"	2000	28 "	Portable.
18"	.14?	"	?	?	Vibrator unit.

Aug 12 1946
Harold Edgerton

Delay tests on Helium Strobotron
Sylvania Small size, miniature.



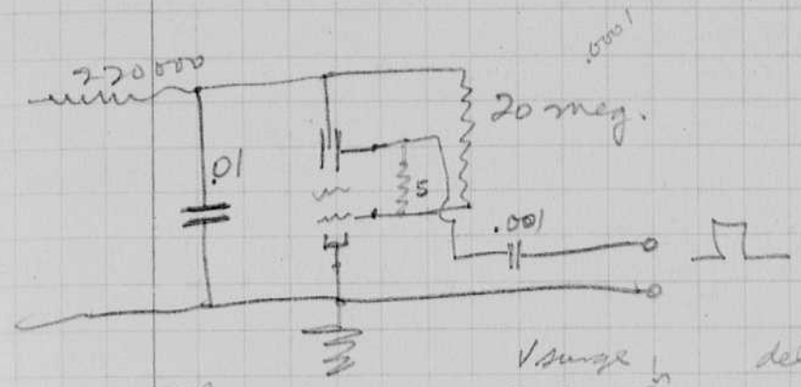
Test on tube No 64

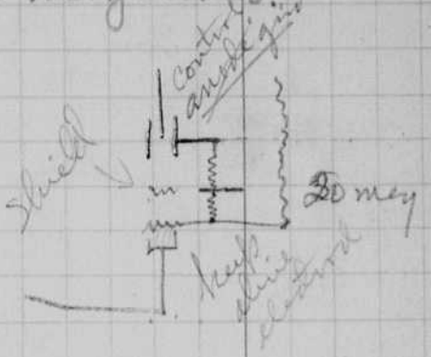
V_p	Surge E_p	Start time.	Jitter.
1000.	130	12 μs	±2
	135	6 μs	±.6
	152	3 μs	±.3
	178	1.8 μs	±.06
	113.	Some starts. long delay.	
	129.	Steady operation.	
500	143	60 or 70 μs	10 ±. jittery.
	156	12 "	
	174	4.45 "	
	178	4.3 "	
~~1500~~			
1500	104	70 ±	jitter bad.
	120	12 ±	3
	126	6 ±	3.
	178	1.55 ±	.1

Aug 13 1946
H.E. Edgerton

OA5 Stroboscope tests.

Tube 0888 self fires at 900 V with anode grid connected to glow electrode through 5 megohms.





	V surge	delay time	jitter
Tube 8261	.47 x 86 V 40%	.7 x 36 μs	± .1 x 36
	.3 x 86 V 25%	some starts delay about	70 μs.
	.61 x 86 V 52%	1.1 x 6.2	± .05 x 6.2
	.8 x 86	.5 x 6.2	± .005 x 6.2 not observable.
	1.6 x 86	.5 x 3.5	± 0
	2.0 x 86 172	.4 x 3.5	± 0 Rise time .2 x 3.5 μs.

Glow starts about 250 volts. Main arc also discharges once when the glow starts.

If input to .001 capacitor is disconnected the main arc does not start when the cathode glow starts.

Tube 07216 breaks down at 750 volts.

8195	" " "	750 volts.
8321	" " "	800 900 between glass and mica
8250	" " "	750 ±

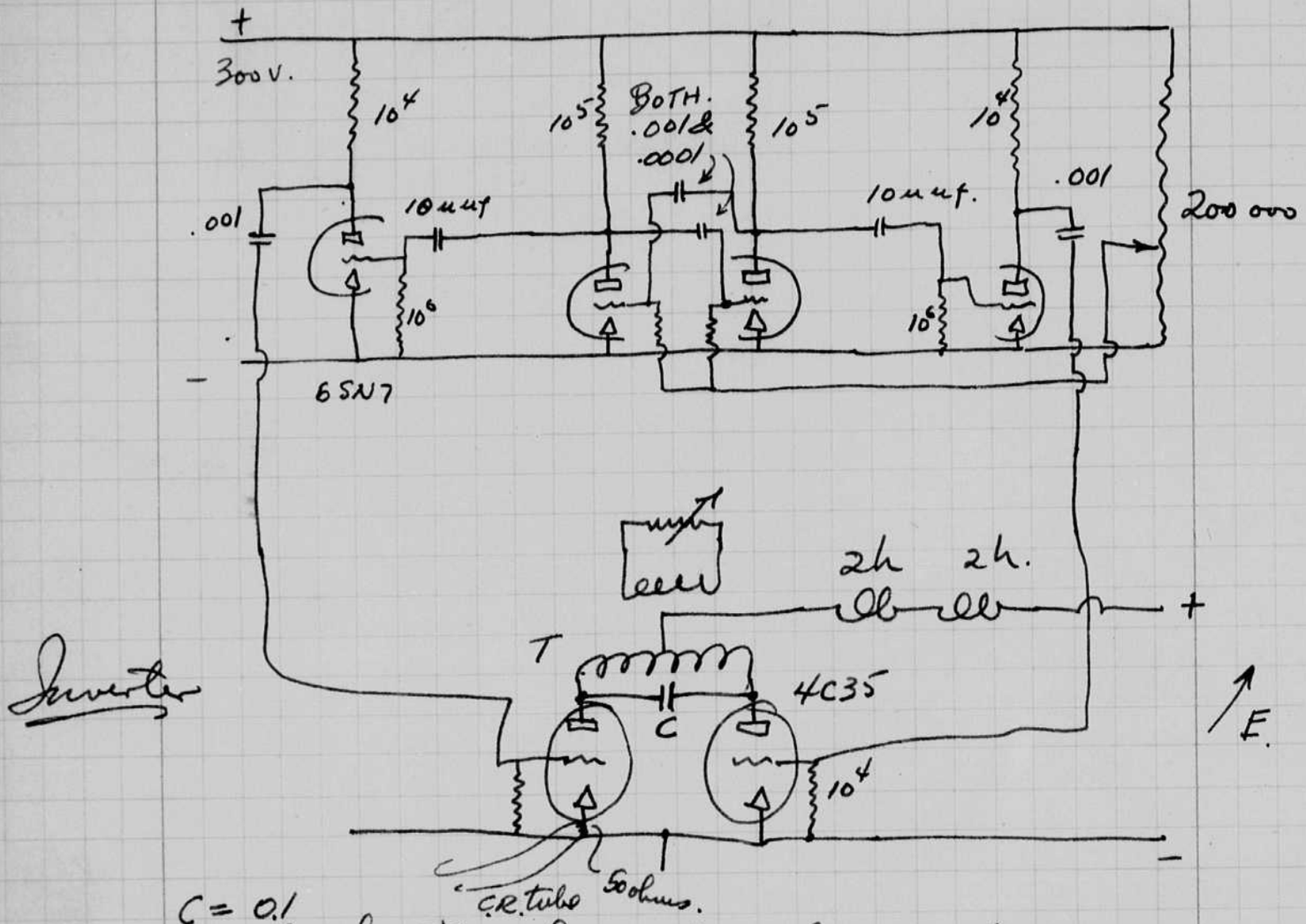
Need 8261 will do at 1500 V. +

8145	450
8270	1150
8125	600
8180	780

1500+ with anode grid returned to cathode through 5 meg.

 Aug 14 1946 Inverter
H.E. Edgerton.

oscillator to operate 4C35 grids.



Inverter

C = 0.1
T = Raythem transformer 400 cycle 110 − 3000 − 0 − 3000.

this circuit appeared to work ok at 3500 cycles at partial load on the tubes.

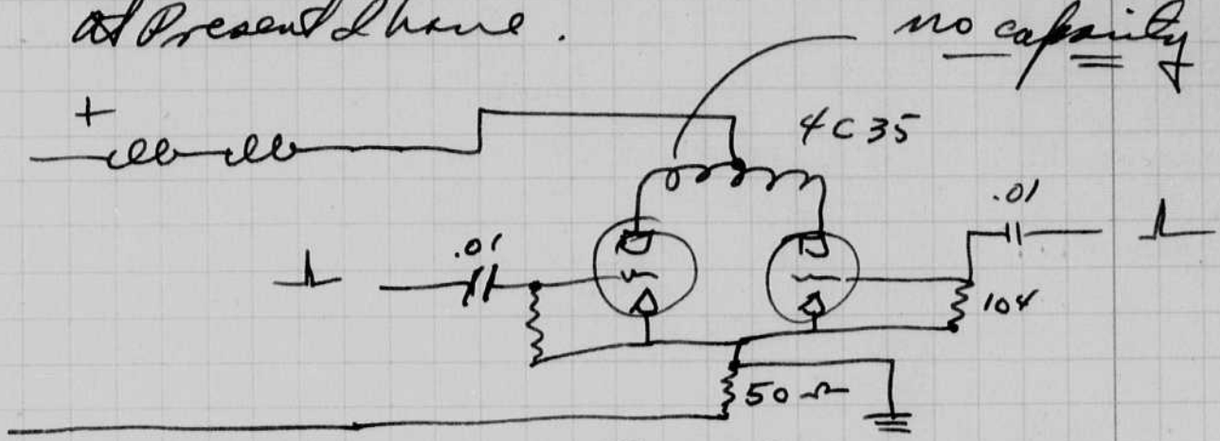
1. Measure trans Ratio.
2. Meas trans impedance O.C. and S.S. 1000 cycles
3. Meas cathode current on scope in tube $\frac{25V}{.5 amp} = 50$ ohms.
4. Use bias voltage

Aug 21 1946
H. E. Edgerton

4C35 Inverter.

Difficulty has been experienced in getting the thyratrons to fire. Hamton and I worked in our on the arrangement.

At Present I have.

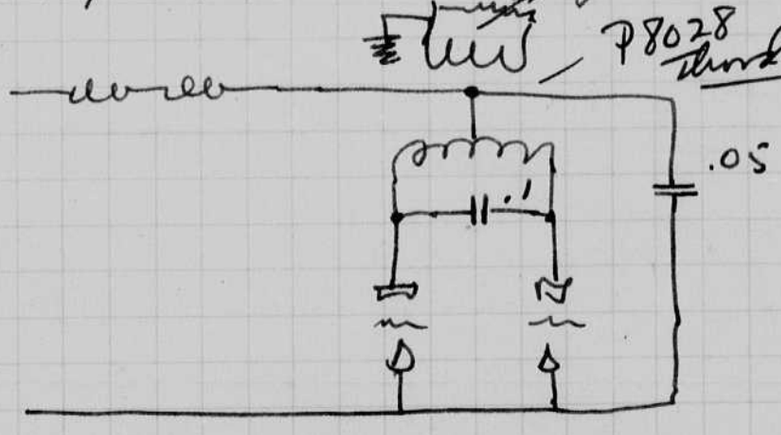


the 4C35 tube apparently start and immediately goes out. the oscillographs on the grid circuit shows an osc. also the plate voltage =

Apparently distributed capacity has a lot to do with the phenmena.

a 400 ohm resistor across the choke will enable the tubes to start.

An 05 mf was connected as follows.



Circuit now does not hold over and either 1 or both tubes fire.

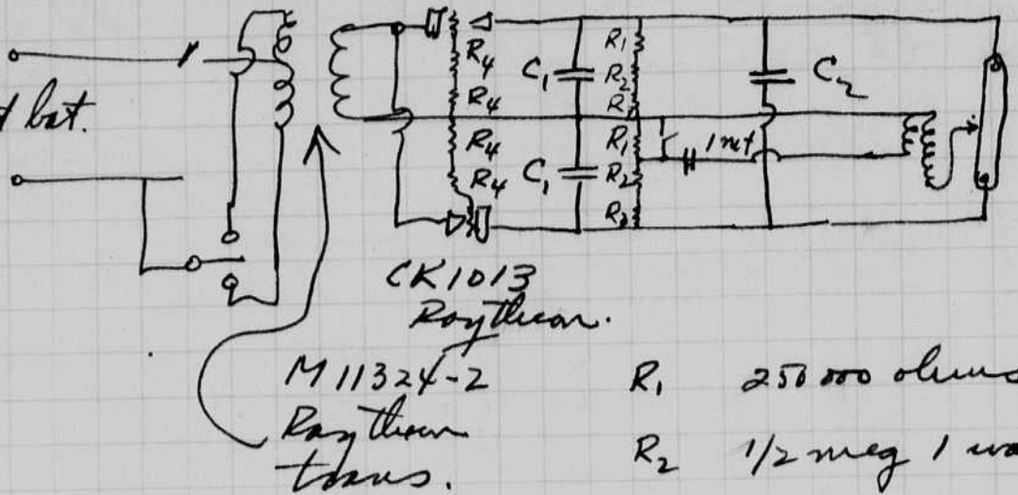
a 25 mf was put in parallel with the .05. the output wave form has about the same? why.

across the inductor it does not osc.

Aug 31 1946

~~HE Edgerton~~

Vibrator Power Supply for Harvey.



M11324-2
Raytheon
trans.

R_1	250 000 ohms 1 watt.
R_2	1/2 meg 1 watt
R_3	1/2 meg 1 watt.
R_4	10 meg 1 watt
C_1	4 mf 1200 v.
C_2	28 mf 2000 v.

A new transformer is to be designed by Clegs. Eckhorn at Raytheon which will have more short circuit current.

It will not have a shield winding between Pri and sec and will not have a tapped secondary. These two items are not necessary since the mid tap is grounded (capacitor Ckt). and therefore one end of the ~~voltage~~ transformer sec is grounded.

23 ma short ckt

Charging time to 2000 volts 7 sec with one transformer.

2400 end volts 15 sec.

33 ma short cir.

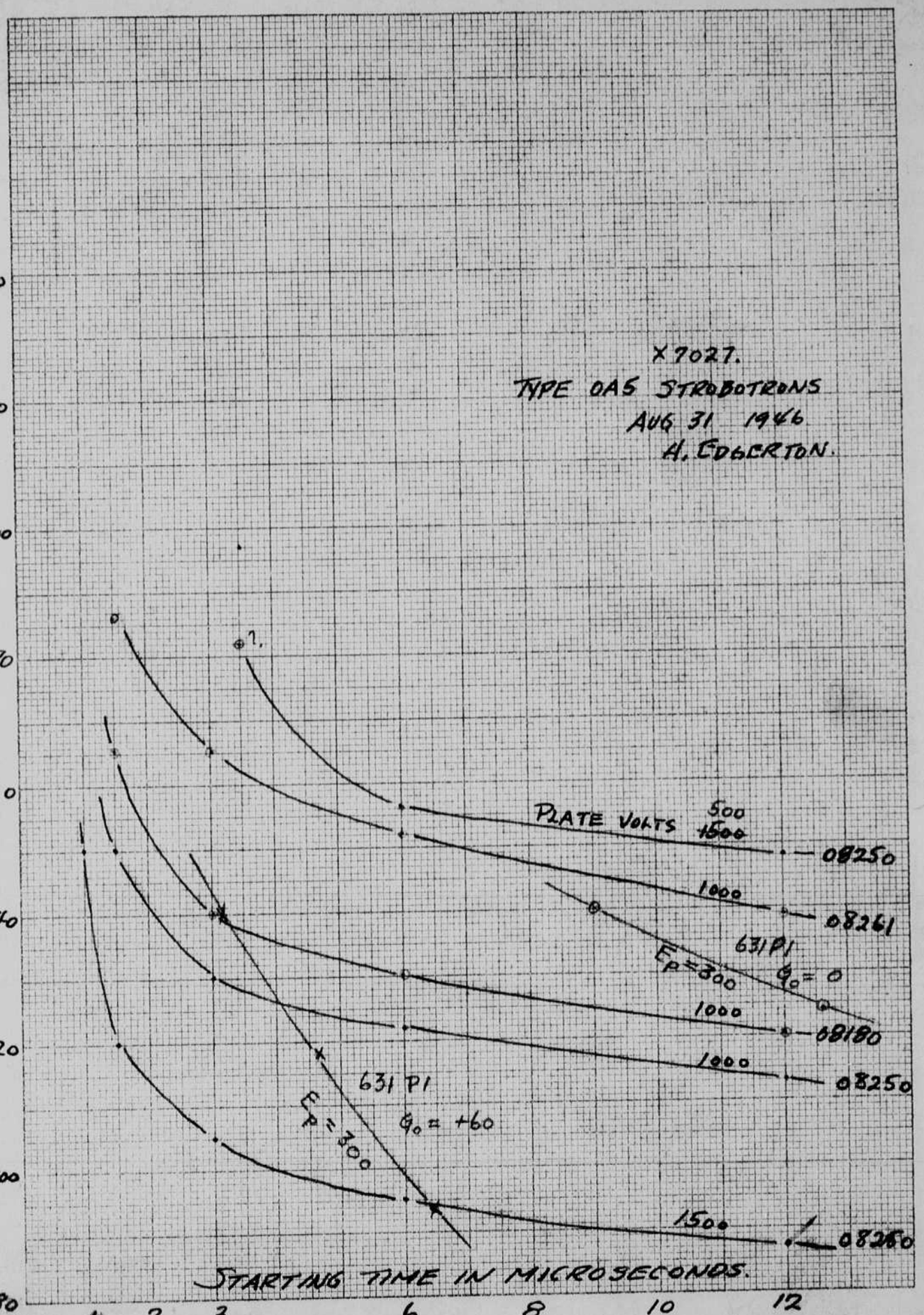
Chg time to 2000 volts - 5 sec with two trans in parallel. one vibrator.

2500 end volts 10 sec.

$C = \frac{1}{C} I t = \frac{1}{30 \times 10^{+6}} .025 \times 5 = \frac{1}{.300} \times 10^6 = 3\,000$ volts per sec. Initial rate.

$\frac{1}{1}$

OA5 Strobotron tests See pages 66 & 67.



1600 1.45 126 6.

 Aug 31 1946 Vibrator Power Supply

A B Edg[illegible]

6 volt[illegible]

A [illegible]
to be[illegible]
Clear[illegible]
which[illegible]
show[illegible]

It wi[illegible]
shie[illegible]
Pri[illegible]
will[illegible]
sever[illegible]
nece[illegible]
(capa[illegible]
of the[illegible]
grou[illegible]

23 ma short ckt C[illegible]

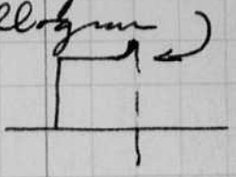
33 ma short cir. C[illegible]

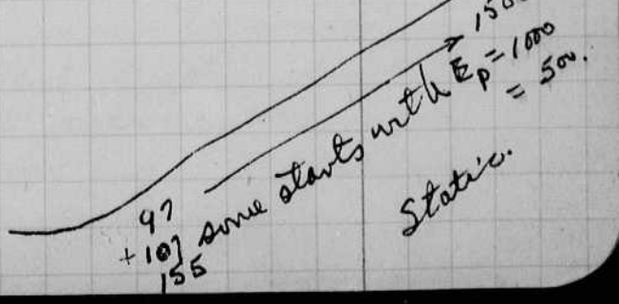
$e = \frac{1}{C} I t = \frac{1}{30 \times 10^{[illegible]}}$ [illegible]

OA5 Shrobotron tests. Seepage 66 & 67.

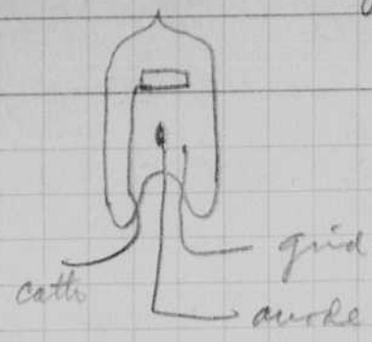
circuit as per p66. rep rate 100 per sec±.

be no.	E_p	E_g		μs. time.	jitter.	Rise time 1/2 μs. of grid volts.
08250	1000	1.3×81	113	12	.3 bad	
		1.4	122	6.	med.	RC = .01 × 1/4 × = .0025 sec.
		1.5	130	3	small	.05
		1.73 +	150	1.5		
	500	1.7 -	148	12	med.?	note transfer on grid volt oscillogram
		1.8+	156	6		
		2.1	182	3+		
	1500	1.02	87	12	jitter bad. 20%	
		1.1	95	6	" "	
		1.2	105	3	good 5%	
		1.4	120	1.5	"	
		1.7	150	1.0	" 1% est.	
08180	1000	1.4	120	12	jitter bad 20%	
		1.5	130	6		
		1.63	140	3.		
		1.9	165	1.5.		
	500	1.8	155	12	med jitter.	
		1.95+	170	6.		
		2.1	182	4.±		
	1500	1.25	109	12	jitter bad.	
		1.3	113	6		
		1.4	122	3		
		1.6	140	1.5		
		1.85	160	1.0	no jitter.	
7216	Breaks down between anode and cathode around out side					
888.	1000	arc goes between mica and glass!! N.G. mica spacer.				
18261	1000	1.6 -	139	12	shows spike.	
		1.75	152	6.	"	
		1.93	165	3.	"	
		more than 2.1	183	1.5	"	
	500	2.1	183	12		
	1500	1.3	113	12	20% jitter.	
		1.4	121	6		
		1.55	135	3		
		1.88.	163	1.5		
8195	1000	1.58	135	12		
		1.65	143	6		
		1.78	155	3		
		2.05	180	1.5		
	1500	1.45	126	6.		

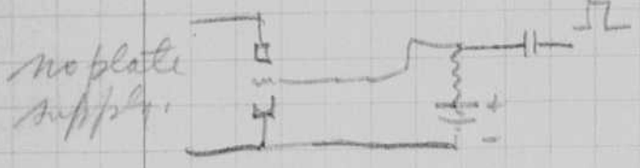




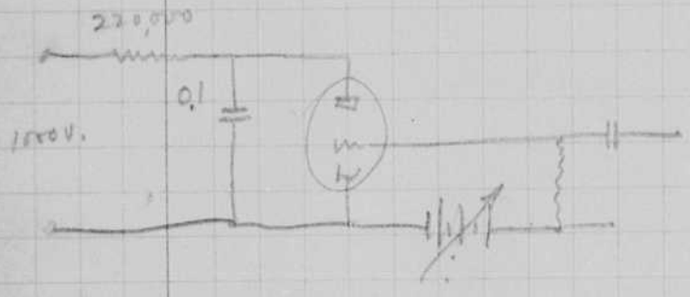
Special Strobatron for ignition.
Sylvania.



Grid start delay



Eg. DC	Pulse	μs t
300	+ 1 X .87.	3 X 36
300	+ 1.2	2 X 36
300	+ 1.85	1 X 36



260	+ 2.1 X 87.	3 X 36 108 μs.
270	+ 2.1	2 X 36
300	+ 2.1	1 X 36.

Self fires with + 300 on grid.
max ~~min~~ about 180 before self fire;
thus surge tip should be
110 + 2.1 X 87 = 296 volts ±.

Data from Coggins on Sylvania flash units.

at 15 ft. $\frac{\text{Light from Reflector}}{\text{Horizontal light.}}$ = 1¼:1 Studio plain 22°

= 4½:1 with diffuser. 50°

= 6:1 as portable. 60°

Studio unit.
Output 16,000 lumen seconds? 250? mf 2000 v.?.

Sept. 14, 1946. H.E. Edgerton.

Went to Wright Field with Col. Richard Philbrick Sept. 10 130pm in a B-25. Discussed night photo and application to the B-29. considered.

1. 4 reflectors in tail in banks of 2 at 20° angle to vertical.
2. Two K-19 cameras or f3.5 with better definition. Angle 14 to 20 degrees off vertical for more horizontal cover.

Took the night train to cleveland to attend the ~~phot~~ I.E.S. lighting affair at nela Park. Saw Merrifield, Carlson, Davis, etc. Tested a series of experimental flash tubes with Burns and Steiner and Davis. there are 30% more efficient than the FT-14 at 10 mf and 2400 volts. When put in spiral form they drop to 20% more efficient. After the celebration celebrating the rededication of the lighting institute, at which Mrs. Alva Edison spoke, I took the night train for Dayton.

On Sept 12 I was in W.F. again on conferences with Zeichardt and Mungall. Dreen and Harff of Raytheon were there also. We discussed the B-29 project.

Since it would be much easier to install a few reflectors, it was suggested that a higher input to the tube would be advantageous. It was proposed that the existing FT-14 lamps be exhaustively tested for life at different energy levels. Concurrently new lamps

designs would be made in case any advantages could be so gained.

To be stressed in the design

1. Max efficiency at rated load.
2. Large power capability.
3. Exposure time is not to exceed 1/100 sec. at this speed compensation with a moving film is possible.

300 m.p.h. 10 ft motion. max allowable motion.

$\frac{300 \times 5280}{3600} = 440$ ft/sec.

$\frac{1/440}{10} = \frac{1}{44}$ sec. exposure

A redesign of the power supply was proposed with the following changes.

1. 3 phase inverter with high voltage output so that transformers are not needed. I called Wiseman & Eland. He informed me that this should be fairly straightforward especially if we took care of the field control problem.
   Wiseman Chief Engineer
   Wickersham - Commercial.
2. Selenium rectifiers.
3. Moving film camera with intervalometer.
4. Simplified control and test circuits.
5. Photocell trip for two cameras off.

The B-29 could take 32 capacitor banks (1200 MF each) this would require 8 reflectors with FT-17A lamps. The light would be

$\frac{CE^2}{2} = \frac{32\ 1200\ 4^2}{2} = 307{,}200$ watt seconds.

38,400 mf or .0384 farads.

and at 50 lumens/watt.

$Q = 307{,}200 \times 50 = 15{,}400{,}000$ lumen seconds

$\equiv 1{,}500{,}000$ c.p. seconds.

Charging time 2 kw inverters (4).

Max current = $\frac{8000 \text{ watts}}{4000} = 2$ amps. Short circuit. say 6 or 3.2.

$$i = c\frac{de}{dt} = .038\frac{4000}{dt} = 6.$$

$$dt = \frac{.038}{6}4000 = \underline{25. \text{ seconds.}}$$

At 12,000 ft we need for no overlap about this time at a speed of 220?

$\frac{12000}{}$ x 3/4 = photo length. = 9000 ft.

300 mph x $\frac{5280}{3600}$ = 440 ft/sec.

$$\frac{9000}{440} = \underline{20,5 \text{ seconds.}}$$

Interval should be about 18 for some overlap.

Double plane operation was discussed at length with Lt Philbrick and some with Col Hausen. Philbrick was of the opinion that two planes might be a possibility with radar for plane spacing. He proposed the use of two planes with cameras and flash units in both. the camera in one plane would flash the lamp in the other plane. the planes would fly abreast with lamps and cameras tipped towards each other for best results.

10.19
30.07

Sept 11 1946. Edgerton Bruce Davis Steiner

TUBE	E	C	L	lumen sec.	CE²/2	L/watt ↓		
11.	2500	30	23.8	2856			600mm Xenon Repumped.	
11	2400	10	10.0	1200.	28.7	41.8	" "	"
			peak 28×10^6 lumens.			T = 50 to 75 MS		
14 old no 11	2400	10	6.2 x12					
			Peak 12×10^6 lumens.			T = 75 MS+		
#5. 14. new	2400	10	8.0 x12			Peak $1.3\times12\times10^6$	$\frac{10.8}{8.} = 1.35$	
S.T.	2400	10	10.8 x12			$=6\times12$		
			10.8 x12					
			10.6 x12					
1 turn.	2400	10	10.6 x12					
			10.4					
			10.2					
			10.					
2 turns	2400	10	9.4					
			9.0					
			9.0					
			8.8					
1 turn	2400	10	10.2					
			10.0					
BT 11	1800	30	17.4	2100	48.6	43.		
S.T. new			17.4					
1 turn			17.2					
			17.2					
			17.2					
2 turns			16.3					
			16.2					
			16.0					
			15.8					
			16.1					
			16.4	15.9	15.7	16.8		
FT14 no 5.			13.1					
			13.2					
			13.2					

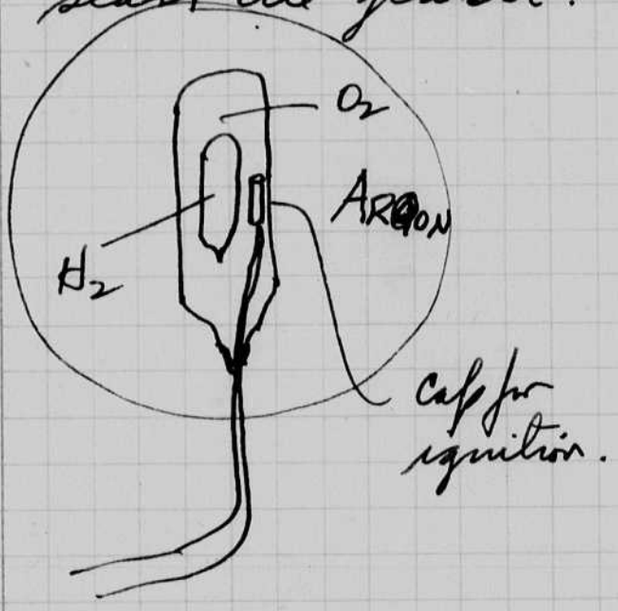
Repumped straight quartz tube after bending to 1½ turn

1½ turn	2400	10	10.2 9.8 9.7 9.6		$\frac{16.2}{13} = 1.25$	1.7×10^6
"	1800	30	15.9 16.2 16.3 16.2			
FT-14 #5	1800	30	13.0 13.0 13.0			
"	2400	10	7.6 7.5 7.6	X	$\frac{9.1}{7.5} = 1.21$	
1½ turn	2400	10	9.0 9.1 9.2	X		
1½ "	1800	30	16.2 16.3 16.3			
1½	2400	10	9.3			
FT-14 #5	2400	10	8.			
"	1800	30	13.2			
1½	1800	30	16.0			
1½	2400	10	9.3 9.4 9.4			

Sept. 19 1946.
Harold E Edgerton.

A few dynamite caps were obtained yesterday from the Dexter Chemical Co. for exploding in argon gas. An attempt will be made to measure the light output.

It might be interesting to also explode an H_2 - O mixture in an argon atmosphere since there might be a large light output. One way to do it would be to enclose a hydrogen filled pellet in an oxygen filled pellet in an argon filled tube. A dynamite cap would be used to break the hydrogen container and start the flash.



Sept 21, 1946. The Quartz flash tube 1½ turn EN 646 shows about 10% + more light than FT-14 on 28 mf 1800 volts.

Measured light from a squib and a dynamite cap in argon flash (1 liter). No light or meter that would read 4000 lumen seconds full scale. Therefore the light was less than 40 lumen sec. Argon was tank and no effort for purity was exerted.

Shapiro is due from Cal. Tech. on Tuesday next. Also Agfa group are due in on Wednesday.

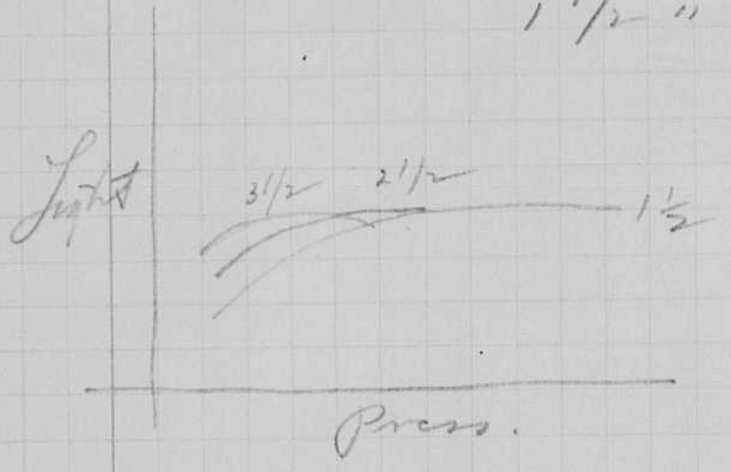
Sept 23 1946
H. E. Edgerton

Several tubes similar to the FT-14 but with different turns were tested last week as a function of pressure.

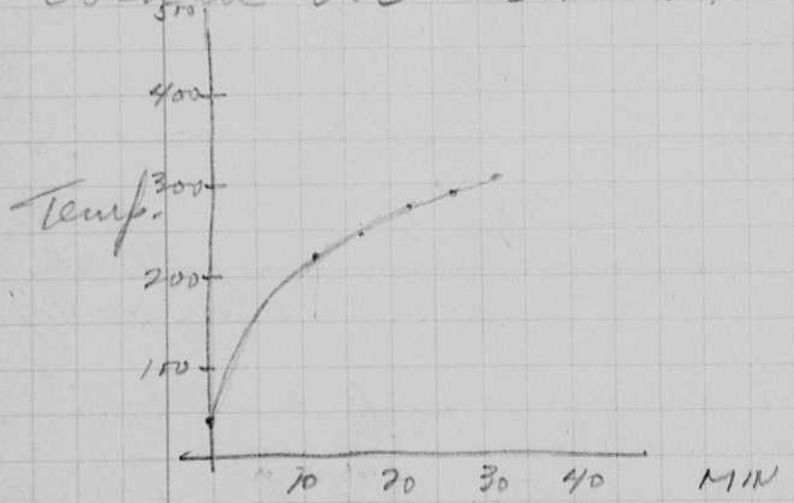
The same peak output was found for each lamp but at a higher pressure for the shorter lamps. The tubes were sealed off at 6"

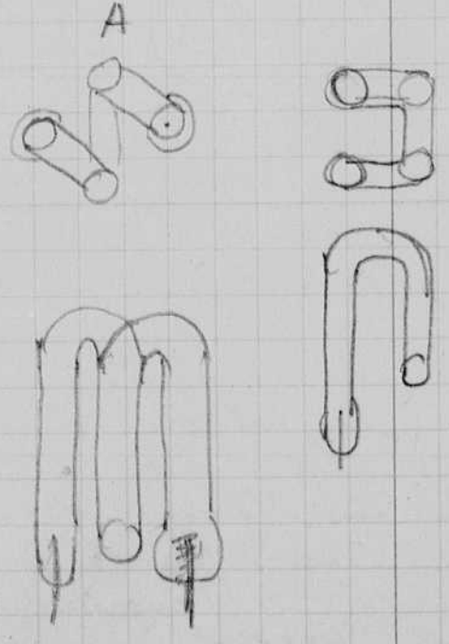
3½ turn	6"	Output
2½ turn	7"	30 MT
1½ "	12".	3800 volts.
		for all
		Tubes.

18" spring lightning FT-14



Oversize 20D203 test.





FT-14 .34 .35 .34

3 mm ID 4 1/2 inch ± see A p 75 design.

30 mf
2000 volts } Energy.

Pres	Light
9 1/2"	.42 .40+ .40
8"	.39 – .38 .39
6 1/2	.37 .36 .35 .35
1 1/2	.23
Pumped	
12"	.42 – .43 – – .42
10"	.41 .42 .40
3 3/4	.25 .25
6.75	.34 .34 .34
9.	.37 – .37 .37 –
13	.38 .39 – .41

FT-14 – Std .35 .32 .33

Hole poked with sparker
Repaired on system
Pumped and torched.
filled to 10" pressure and sealed off.

above tube.	.66	.66	.66
FT-14	.55	.56	

80 Sept 27, 1946
H B Edgerton

Hub 5682.

On Wed the 25 & 26 a group from Ansco were here to test color film with electric flash lighting.

The daylight Ivory slen film with an a K-1 filter at 50 d x t with 3 Kodaks seems the right color and exp according to Jackman.

Prints were made on Printon in the camera. ~~2 x 209 + 11 mf~~ ~~232~~ mf at 1000 volts ~~in~~ at f 4.5 gave a good exposure. (232 ?) Nearly other shots were made and were taken to Bing Hamilton for processing.

Those present: Titcomb
Silverstein
McRoda
Morse.

The four flash lamps (Kodatron type) in photo service were tested with the light meter.

Calib 30 mf 2000 volts in FT-14 Ref table.
38 lumens/watt.
$CE^2/2 u = \frac{30}{2} 4000^2 \times 10^{-6} * 38 = 1680$ lumens, or 168 c.p.s.

meter reads .17 at 5 ft 8" from lamp
aperature = 1 inch hole.

To get reading of beam c.p. sec.

$$\text{beam c.p.s.} = \text{meter reading} \times \frac{\text{Aper}}{\text{No.}} \times \left(\frac{D}{5.8}\right)^2 \times 1000.$$

Lamp	M	A	D	$(D/5.8")^2$		
124	.44	4	11'4"	4	7040	beam c.p.s.
1	.52	4	"	4	8320	"
2	.50	4	"	4	8000	"
3	.45	4	"	4	7200	"

Irving Eastman from Raytheon brought in the High Power Flash unit. I made the following measurements of light output.

V.	conditions	M	A	$(D/5'')^2$	Beam c.p.s.
3700	1 bank. 109 mf. Both lamps. FT-24 in 10" Spezular reflectors. Out from focus point.	.65	8	4	20,800
3700.	" but with one lamp obscured from p.c.	.5	4	4	8000
3700	other lamp.	.8	4	4	12,800.
	2 Banks. 218+14	.82	16	4	52,480
	4 " 436+14	.78	64 x 4		199,000.

Reflectors with collars were now substituted so that the FT-24 would be in the right position.

3700	4 Banks.	1 lamp	.65	64	4	166000
		other lamp	.75	64	4	192000
	4 "	Both	.53	64	4	with x2 filter. 273,000.

These readings may be in error due to the "A" numbers because of leakage in the photocell box. Such an error would make the beam c.p. appear too high.

Oct. 1, 1946. Conf. with Rice & Germeshausen 11-12.30. 40 Broad St. Tested Hi power flash unit with light meter. The capacitor terminal on one of the G.E. 28 volt units let go! Repaired today, and tested again.
450 mf 4000 volts. Two lamps in 10" reflectors.
Light output = $64 \times .47 \times 10{,}000 = 300{,}800$. Beam c.p.s.

or. $300{,}800 \times \frac{128{,}000}{140{,}800} = 273{,}000$ Beam c.p.s.

correction ↗

$\frac{273{,}000}{8{,}000} = 34.2$ Kodatrons.

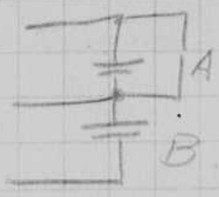
Oct 5, 1946
Light test without reflectors

Power unit P.U. + 1 Bank	0.32 Kods
2	5.0
3	11.2
4	16.0
	20.8.

Oct. 4, 1946

Raytheon High Power Short cuts

110 volts one cap shorted.



A 30 amp
B 29.5

27. amp
Pri
current.

Oct. 4, 1946.

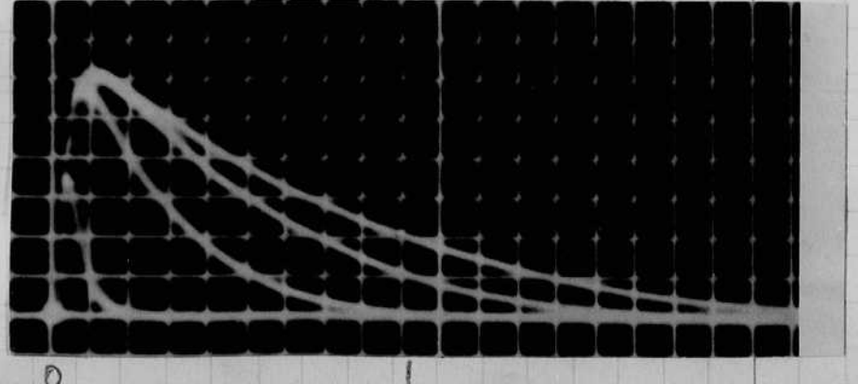
Lewis has been in a few times to discuss flash equipment. He is now a student in course VIII.

Logan from Big Springs Texas may help this year with the flash work. He was out to Raytheon with me to look over the studio unit and to fix the inductors in the capacitor banks.

Oct. 7, 1946. A series of exposure of light timewave made on Oct 5 with Logan in 20B 203.

1.09" = 5x61.1ms.
1" = 296 ms.
100ms = 0.34"

1" = 18 x 61.1ms = 1100 ms.
1000 ms = 0.91"



Roll 23.

output should be $\frac{30 \times 2000^2}{2} \times 10^{-6} \times 32$

c.p.s

860,000 h.c.p.

20B703

Oct 5 1946
Ben Logan
AEDyertone.

dist.	Atten	Sweep.	Lamp.	C	U.	Tries	
5.6 ft.	30	200000A	FT-14	30	2000.	50.	
"	"	"	"	"	"	80	(2)
				Gasoline.			3
2. "	100	"	FT503	14	4000	80	4-5
2	30					80	6-7 10g
2	100					50	8 (9)
1 "	1000	"	"	123	4000	50	10
1	100	"	"	123	"	80	11
1	100	4500	"	123	"	80	12
1	"	"	"	123	"	50	13
1	"	"	"	232	"	50	14
1	"	"	"	232	"	80	15
1	"	"	"	341	"	80	16
1	"	"	"	450	" ⊖	50	-? 17
1	"	"	"	450	"	80	18
3+	61.1 u5	4500	dimingware.			80	19 20 21
3	61.1 u5.	4 2000				line calib.	22 23 24

See osc on other book side of this.

← ck same.

Oct. 4, 1946

Rhythm High Power Short cuts

110 volts one cap shorted

A 30 amp
B 26.5

27 amp

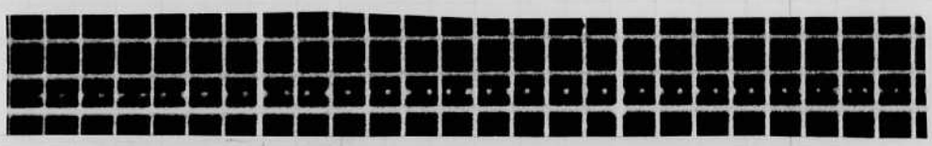
Oct. 4, 1946.

Lewis has been in a few times to discuss flash equipment. He is now a student in course VIII.

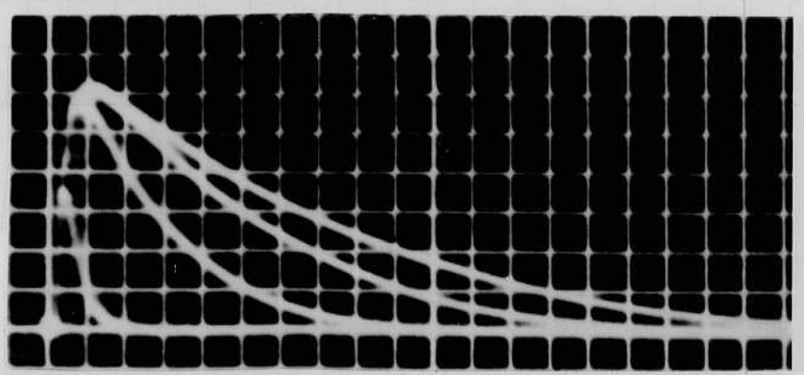
Logan from Big Springs Texas may help this year with the flash work. He was out to Rhythm with me to look over the studio unit and to fix the inductors in the capacitor banks.

Oct. 7, 1946. a series of osc of light timers were made on Oct 5 with Logan in 20B-203.

1.07" = 5 x 61.1 ms.
1" = 296 ms.
100 ms = 0.34"



1" = 18 x 61.1 ms = 1100 ms.
1000 ms = 0.91"



Roll 23.

out put should be $\frac{30 \times 2000^2}{2} \times 10^{-6} \times 32$

c.p.s

20B203

Oct 5 1946
Ben Logan
H E Edgerton.

860,000
h.c.p.

	dist.	Atten	Sweep	Lamp	C	U	Fries	
	5.6 ft.	30	200000A	FT-14	30	2000.	50.	
	"	"	"	"	"	"	80	(2)
							Zero line.	
2	"	100	"	FT503	14	4000	80	
2		30					80	
2		100					50	← 8 (9)
1	"	1000	"	"	123	4000	50	10
1		100	"	"	123	"	80	11
1		100	4500	"	123	"	80	12
1		"	"	"	123	"	50	13
		"	"	"	232	"	50	14
		"	"	"	232	"	80	15
1		"	"	"	341	"	80	16
1		"	"	"	450	" (−)	50	—? 17
1		"	"	"	450	"	80	18
3+		61.1 us 4500 dimmiquave.					80	19 20 21
3		61.1 us. 2000000A					time calib	22 23, 24

See osc on ~~other~~ back side of this.

← ed. same.

110 ~

Oct. 4, 1946.
Le
disc
stu
Loo
yel
12n
un
cap

Oct. 7, 1946.
an

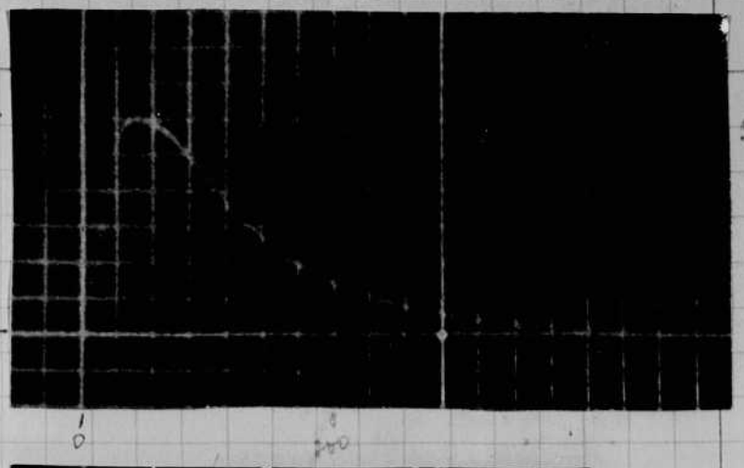
1.07" = 5x61.1m
1" = 296 ms
100ms = 0.34

1" = 18 x 61.1m
1000ms = 0.9

0 1000 ms

Roll 23.

output should be $\frac{30 \times 2000^2 \times 10^{-6} \times 32}{2}$
= 1920 lum/sec = 192 c.p.s

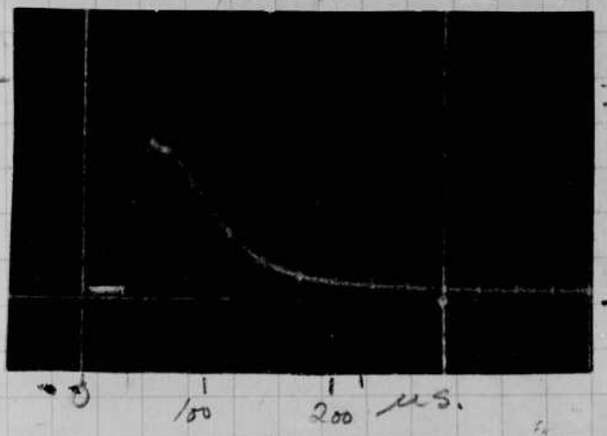


$\frac{192}{.000300} = 860{,}000$ h.c.p.

$\frac{6}{3.4} \times 100 = 176$ ms.

FT-14
~~30~~ mf.
at 2000 v

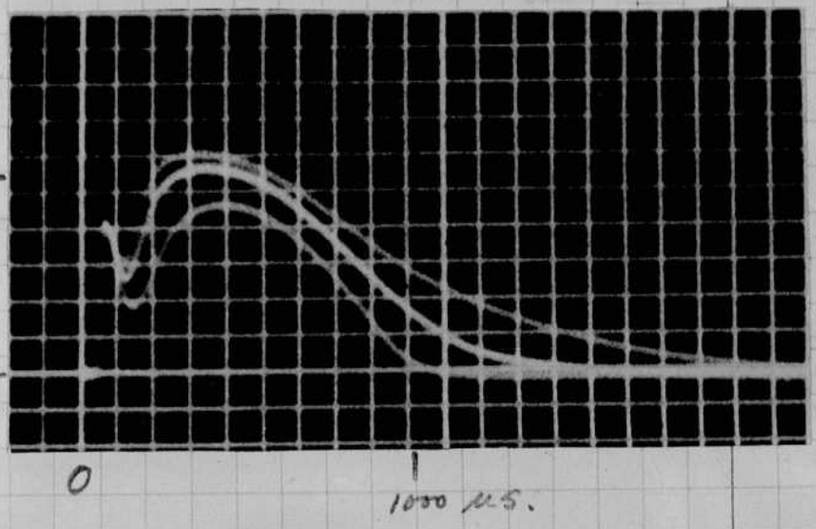
5.3×10⁶ h.c.p.
= 3.33 × 1.6 × 10⁶

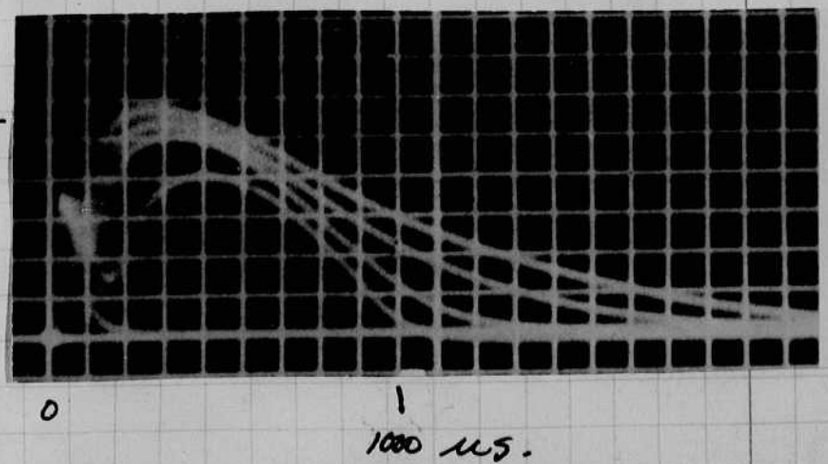


14 mf
4000 v
FT503

$\frac{2\frac{1}{2}}{3.4} \times 100 = 74$ ms. duration

450 mf
341 "
232 "





← ditto same.

Oct. 4, 1946.

Le
disc
stu

Loo
yel
12n
un
cap

Oct. 7, 1946.

an

1.07" = 5x61.1ms
1" = 296 ms
100ms = 0.34

1" = 18 x 61.1ms
1000ms = 0.9

0

1000 ms

Roll 23.

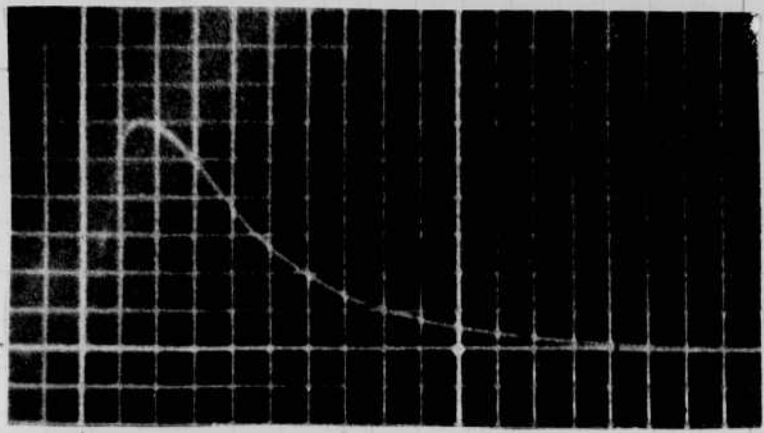
output should be $\frac{30 \times 2000^2}{2} \times 10^{-6} \times 32$

$= 1920$ lum/sec $= 192$ c.p.s

$\frac{6}{3.4} 100 = 176 \mu s.$

FT-14
30 μf.
at 2000 v

1.6 $\times 10^6$ h.c.p.



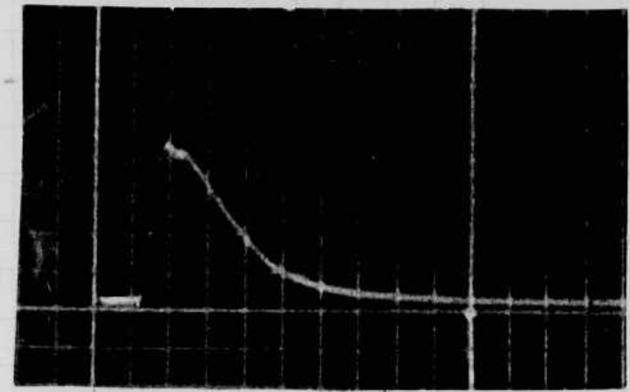
$\frac{192}{.000200} = 860,000$ h.c.p.

0   100

5.3×10^6 h.c.p. $= 3.33 \times 1.6 \times 10^6$

14 mf
4000 v
FT503

$\frac{2\frac{1}{2}}{3.4} \times 100 = 74 \mu s.$ duration

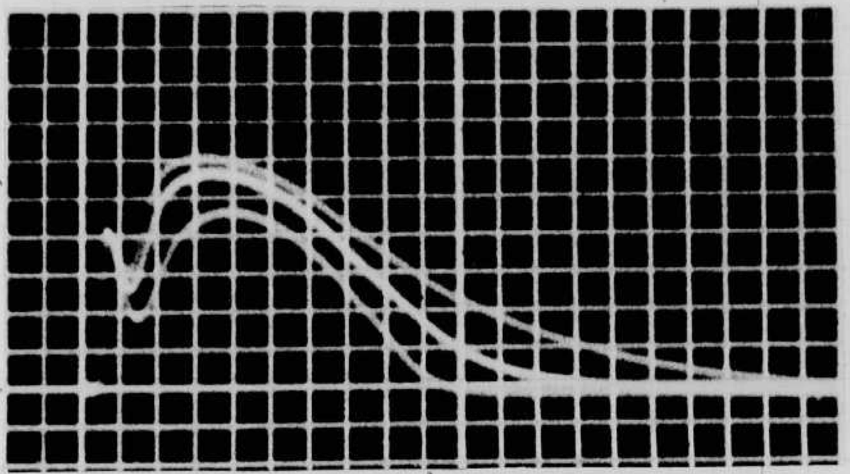


5×10^6 h.c.p.

0   100   200 μs.

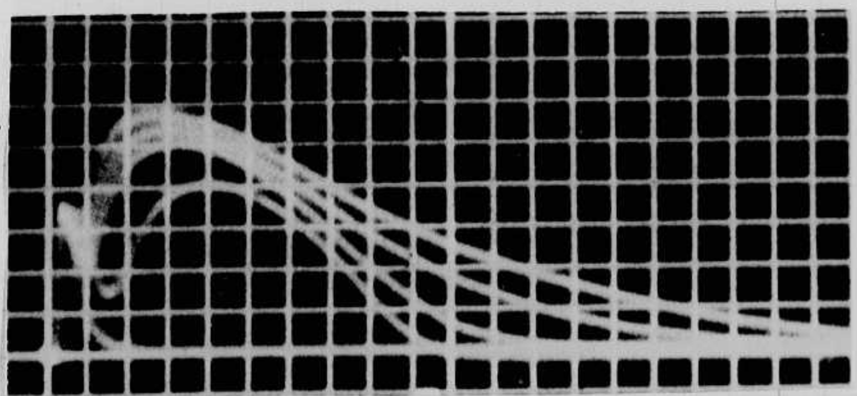
450 mf
341 "
232 "

5×10^6 h.c.p.



0   1000 μs.

5×10^6 h.c.p.



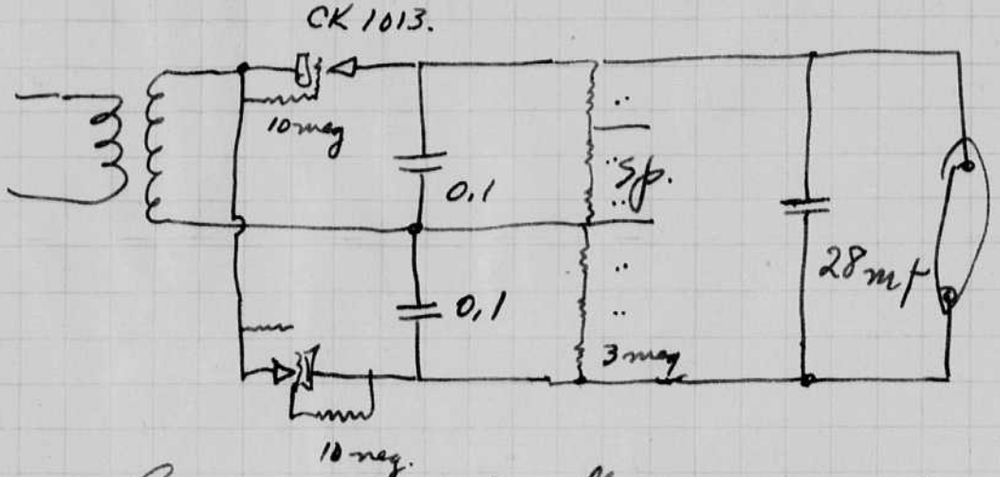
0   1000 μs.

← ed. same.

Raytheon transformer.

Data by Bill McRoberts

a.c. M 11349-1 transformer.



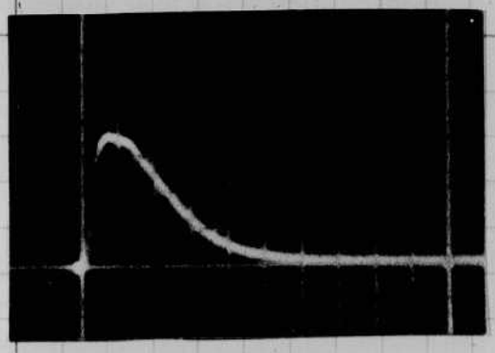
Line 122.5 Peak D.C. 2475

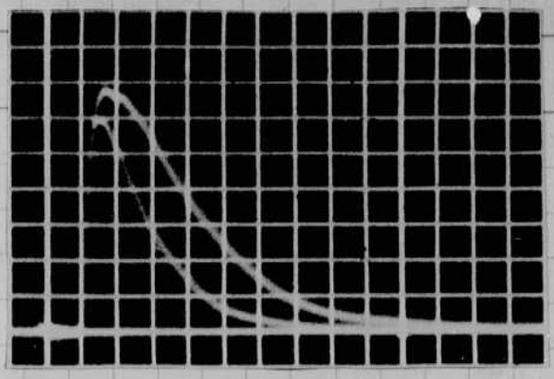
Chg time to 85% or 2125 = 4.5 sec.

2475 7-8 sec.

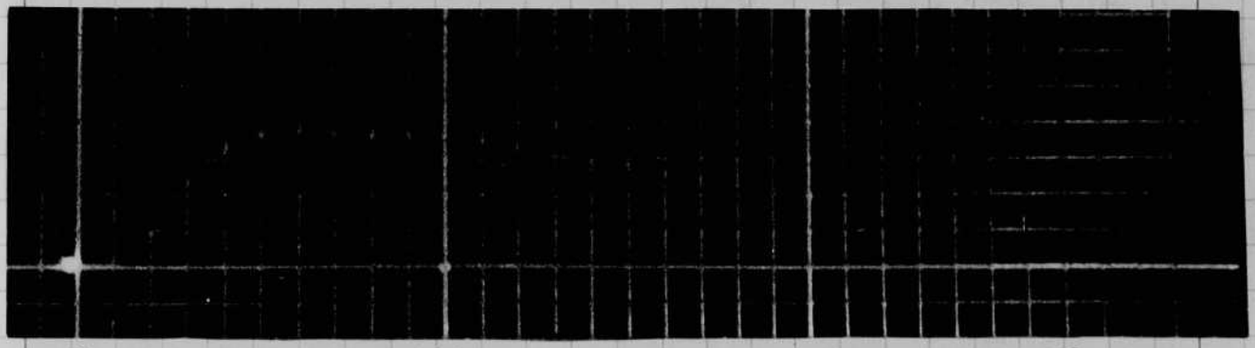
I peak 24 m.a. ?

6 volt vibrator transformer. or same circuit. M 11401-2



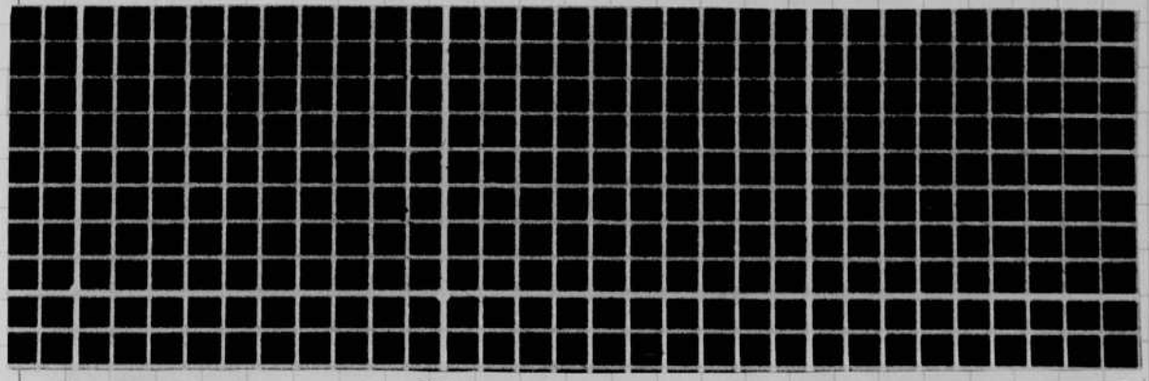


0



FT-503
14 mf
400 V.

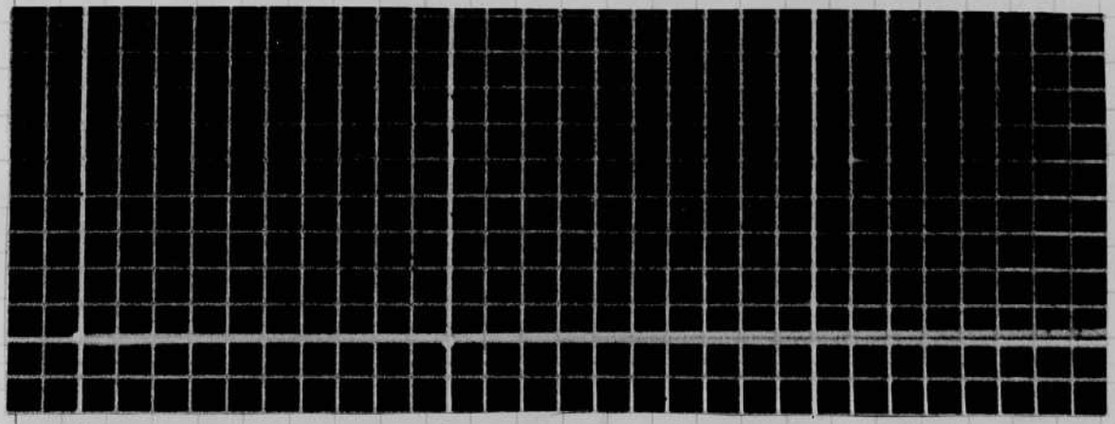
0 36 72 ms.



~~FT-28~~

Two FT-503
in parallel.

0 36 72 ms.



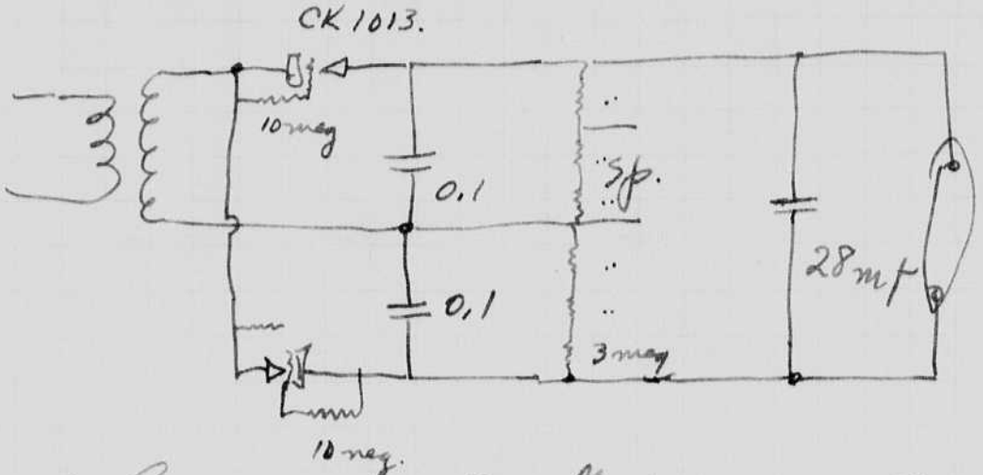
FT-28

0 36 72

Raytheon transformer.

Data by Bill McRoberts

a.c. M 11349-1 transformer.

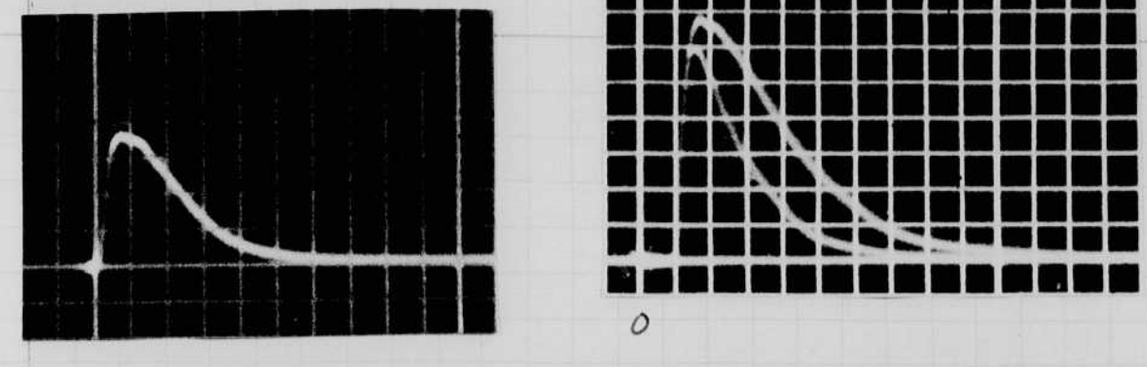


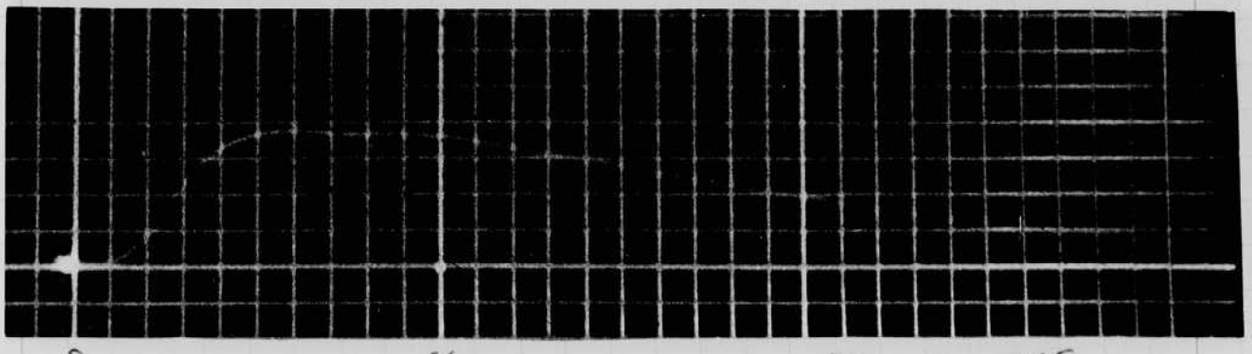
Line 122.5 Peak D.C. 247.5

Chg time to 85 % or 212.5 = 4.5 sec.
247.5 7-8 sec.

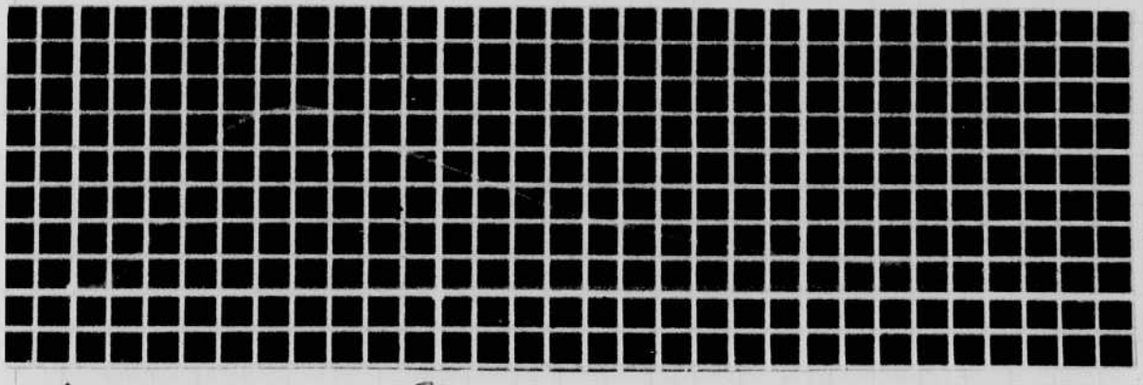
I peak 24 m.a. ?

6 volt vibrator transformer. or same circuit. M 11401-2



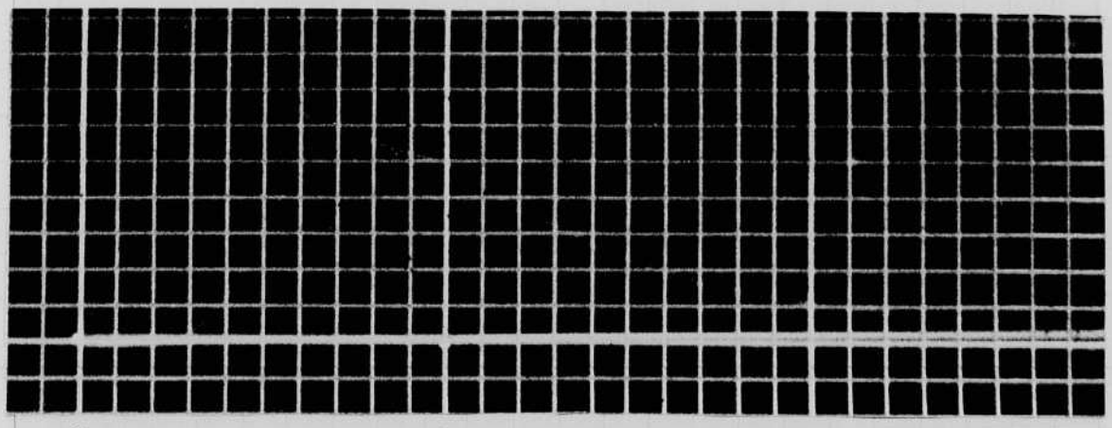


FT-503
14 mf
400V V.



~~FT-28~~

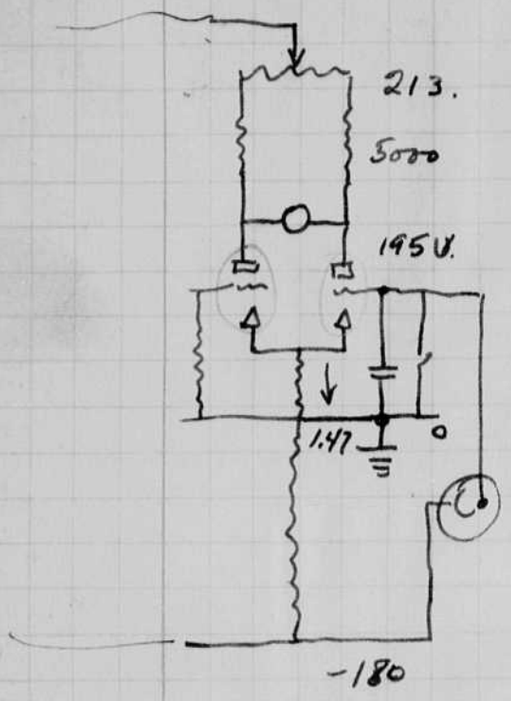
Two FT-503 in parallel.



FT-28

Oct. 16, 1946.
K. E. Edgerton.

Tests of B.R. Exp meter.



Zero grid current off scale neg by ± .37 volt.

Full scale = -1.45 volts.

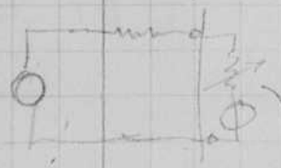
Tube.	Δt for ΔE = 0.1
Tyl 11	3
Ken 5	8
Tmg 12	10
RCA 11	15
Ken 13	40

Fil 4 ohms in series.

Ken	8	3
Tmg	15	3
Tmg	14	6
Tyl	11	3
RCA	7	20+
Tmg	8	5
RCA	12	30
RCA	9	5
Tyl	—	7
Ken	4	4
Tyl	10	7.

$\frac{2RS_p}{R+S_p} = \frac{2\ 5000\ 10,000}{15000} = \frac{10000}{15} = 6660$ ohms

To reduce sen. by 25% Increase Rb



$\frac{6600}{1} = \frac{x}{1.25}$ $x = \frac{8700}{1600}$

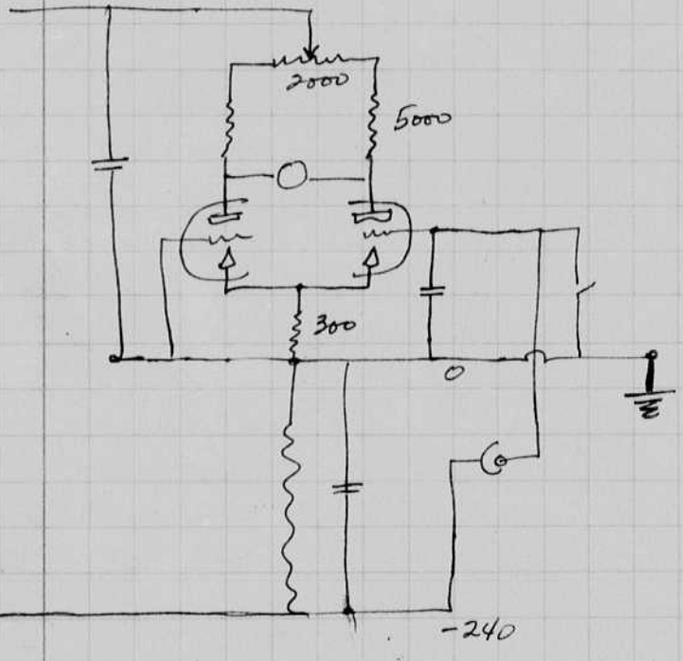
1ma × 2000 = 2 volts. $\frac{E}{6600} = 1.25\frac{E}{}$

Tests of G.R. meter to show saturation of photocell.

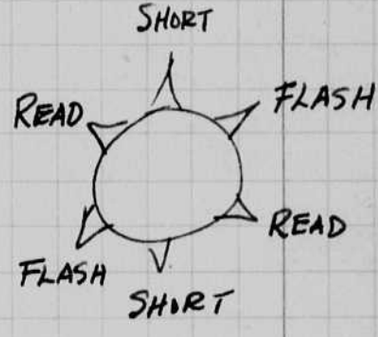
H. E. Edgerton.
Oct, 19, 1946.

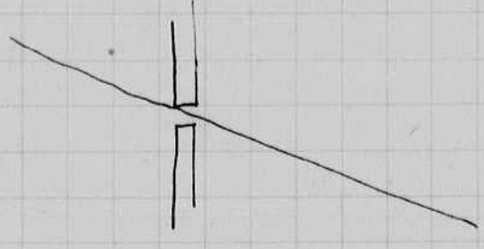
The meter was opened so that an auxillary voltage could be used in series with the supply.

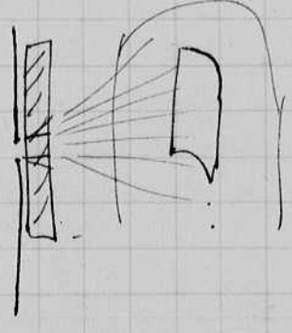
240 volts.	Reading 0.48	. 10.5 mf 2150V mits FT-2.
400 "	.48	This shows that
37	.22	100 volts is sufficient
60	.40	to give a constant
100	.47	reading with this lamp.
120	.44	
140	.47	
240	.48	



$i = c\frac{de}{dt} = 3$ ma.







Nov. 4, 1946

Harold Edgerton.

I met with Wilkins and Sinclair a week or two ago about the exposure meter. It was decided that E.E. was to make a final model for consideration as a product.

The Nottingham model was returned that day for shielding and for the elimination of an ac pickup in the shorting switch.

I was at Rochester last Fri. and Sat. at the P.S.A. convention. At 930 I gave a paper on night reco. photography.

A 3 light flash unit from Raytheon totaling 341 mf at 4000 volts was demonstrated to E.K. people. Bom, Sandell, Hamilton, Collins etc. Photos were made by Winter-mark and Foard as well as Collins.

Kodachrome photos taken by Geo. Woodruff of INP at Wellesley on Wed last were processed while I was in Rochester. They came out fine. Guide factor about 130. Daylight, CC15 filter.

Technifinish had a studio and portable unit on display at the museum at Rochester.

Nov. 23, 1946
H. E. Edgerton

O'Brian was here yesterday to discuss night photos. He has an f 1. camera 85 mm focal length. We suggested its use with a band of film and a strong reflector.

New system for charging. a series motor will drive an ac alternator. A centrifugal switch on the shaft will be set to open the field when the voltage attains 4000 or other value desired. A separate resistor will hold enough voltage to maintain the voltage.

With this system the generator will be operating at high speed at the start of the charge cycle. as the speed decreases with the energy going into the capacitor the input power will increase. The generator and motor will act as a storage device for the energy to charge the capacitor.

Many color photos have been taken with the 340 mf 4000 volt 3 lamp flash unit that I layed out last summer. Raytheon are making three of these now. three are out. Eastman has one, NPD another, and the third is here.

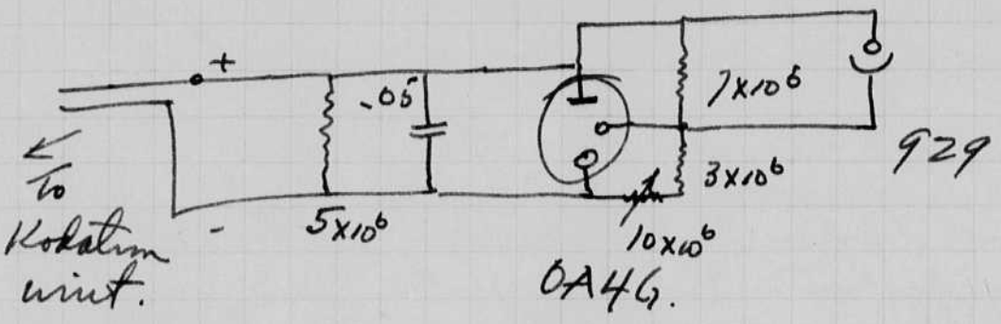
Nov. 29, 1946. Dr Castle Jordan and Carman were here on the 27th to discuss flash equipment, particularly the portable and studio models. We went to Raytheon (Barstow included) and discussed the portable with Bertram, Green, etc. Green is writing a report on the suggested and discussed changes. Barstow is drawing up a plug to be submitted to mine. St. Louis.

Dec 10, 1946 H.E. Edgerton.

Carlson from U.S. was here last week thurs. & Fri. We conferred with Raytheon on plugs etc.

Knott was here from England. (Eastman) He is on the way back after a long stay at Rochester.

Photocell trip was tried today.



the sensitivity could be increased by the 10 meg resistor until the unit self flashed.

Dec. 13, 1946 H.E.Edg. Hannar and Murtfeldt from Nela Park were here on Dec 11 to discuss an agreement concerning the consulting and royalty arrangement. A proposal was arranged which will be discussed later

— Tests by Bierd and Porter of exposure meter

FT-2 on 10.5 mf at 2100 volts.
2.R. model. 5 mf with 6SN7. 1 ma meter.
E_{dc} = 80 volts

Dillo but with FT-2 on 112 mf.
E_{dc} = 40 volts.

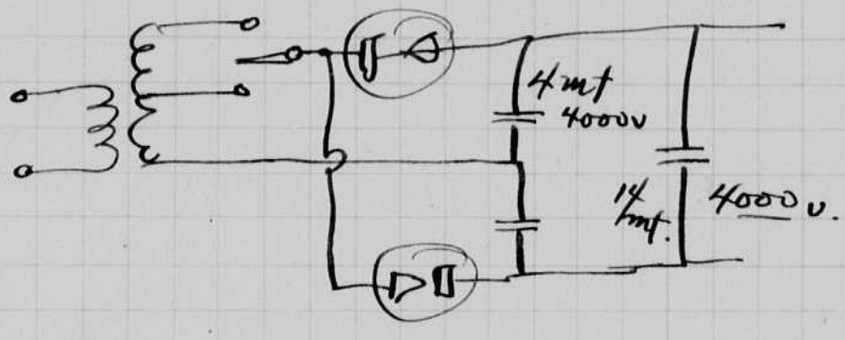
Super model exposure meter Powers model.
C = 0.1 mf volts for full scale = 0.1 ?
Microflash unit. E_{dc} = ?
C = 1. mf 6SN7 model E_{dc} = 50

Dec 26 1946.
#2 Edgerton

Jonah Bauman came from N.Y. to shoot the "call me Mister" show now at the Schubert. We set up last night in Walker using the mural as a background.

For light I used two Raytheon high power units each of 340 mf at 4000 volts. after a dozen or so pictures, the split capacitor in one unit popped. after this we used only 1 unit. See sheets on next page of the design of this unit. Photos were made at f 8 and f 5.6 with the key light at 15 ft. the other lights were erected.

I plan to redesign the power unit. as follows.



12-16-46

PRELIMINARY SPECIFICATIONS

RAYTHEON HI-POWER STUDIO FLASH UNIT

Power Unit

Input: - 110 volts, 60 cycles, average current 8 amperes, maximum surge current 29 amperes.
Capacity: - 14 mf at 4000 volts, 112 watt-seconds.
Weight, about 50 pounds.
Either one, two or three lamps can be plugged into the power unit, the total light being divided between them since the total light is approximately proportional to the watt-seconds of stored energy.
A relay and shorting resistor are installed in the unit to discharge the capacitor when the power is turned off.

Lamp House

The flashtube, FT-503, consists of a xenon-filled quartz helix enclosed in a frosted outer bulb.
Alzak-finish reflectors (10" diameter) are used which have a 40-degree beam width.
A 50-hour, 100-watt incandescent modeling lamp is located in the center of the spiral flashtube to assist in directing the beam at the subject. The incandescent lamp is changeable when the FT-503 is removed from the socket. A switch on the back of the lamp house controls the incandescent lamp.
A standard ¼-20 thread for a tripod mount is supplied on the bottom of an adjustable holder attached to the lamp house.

Auxiliary Capacitor Banks

Capacity 110 mf, 4000 volts, 880 watt-seconds. As many of these as desired can be connected in parallel. The present tentative rated limit of the FT-503 tube is 225 mf, at 4000 volts. For optimum flashtube life, it is recommended that not more than two auxiliary banks be connected per tube.
An additional relay and shorting resistor are installed in the case to discharge the capacitors when the power is turned off.
The weight of the auxiliary capacitor bank is about 80 pounds.

Extension Cables

Extension cables can be inserted either between the power unit and the condenser banks or between the condenser banks and the lamps or between the power unit and the lamps. The length of standard extension cables will be 25 feet.

Charging Time

With the power unit alone the charging time is less than one second. With 3 banks it is slightly longer than 10 seconds. In general, the charging time will be roughly proportional to the connected capacity.

Flash Duration

The duration with one lamp on three banks is the maximum and is about 1000 microseconds. With two or three lamps in parallel the duration is somewhat less. There is a 0.5-millihenry inductance in series with each capacitor bank to reduce the noise from the lamp.

This inductance influences the shape of the light-time curve, but does not materially affect the duration. There is no inductance in series with the 14 mf in the power unit. The duration with one lamp is about 70 microseconds when flashed from the power unit only. With three lamps in parallel this duration is decreased to about 30 microseconds.

IMPORTANT - The unit will not charge unless all high-voltage outlets are filled. Dummy connectors are supplied to fill unused outlets when all three lamps are not used. The dummy connectors have a circuit between pins b and c to complete the input power circuit.

Spare Parts to Keep on Hand

Flashtubes: - Quartz helix type FT-503 (General Electric Company, Lamp Department). No life rating as yet assigned by G.E. Preliminary tests indicate a life of several thousand flashes when used with 225 mf at 4000 volts.

Modeling Lamps: - Special hard glass 100 watt, 115 volt lamps with double bayonet base. Life; about 50 hours (General Electric Company, Lamp Department, Type 100 T 6½ - 115V.)

Rectifier Tubes: - RCA 1616 (available from any radio supply house).

Pilot lamps

Fuse: - 20-ampere glass cartridge type.

Relays are provided in each capacitor bank and in the power unit for discharging the capacitors whenever the filament switch is turned off.

The life of the rectifier tubes will be increased if their filaments are allowed to heat ten seconds before the plate switch is closed.

Suggested Guide Factors

Professional Daylight Kodachrome film, CC15 filter, Raytheon Flash Unit, 4000 volts:

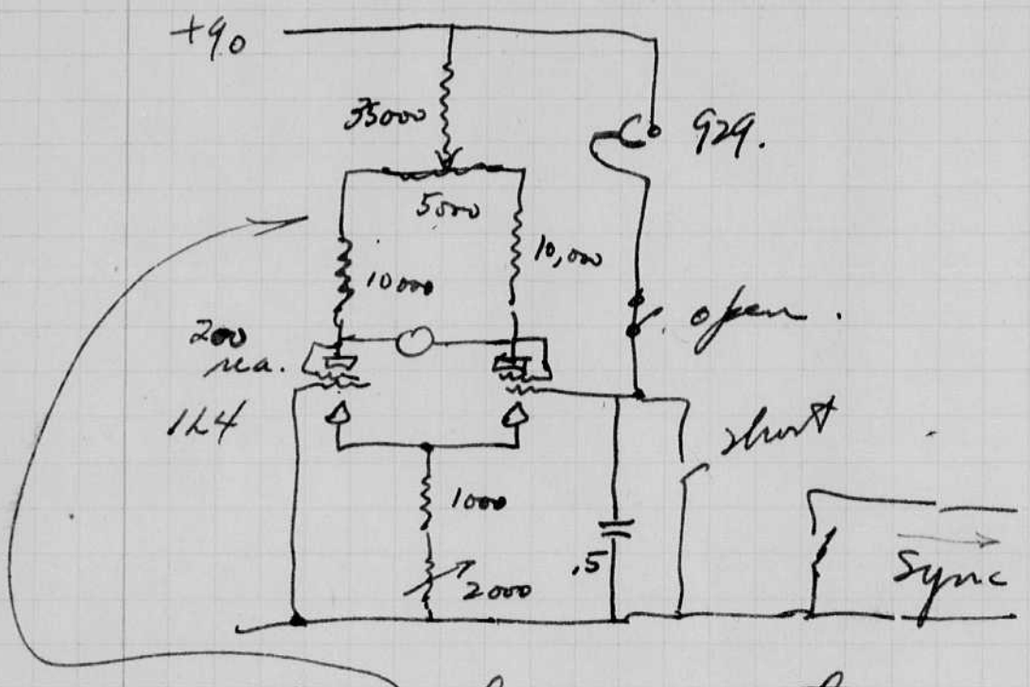
Condition	Guide Factor dxf in ft. aperture	Distance in feet at f:4.5	f:8	f:16
Power Unit alone, 14 mf	25	5.0		
Power Unit + 1 bank, 123 mf	75	16.5	9.4	4.7
Power Unit + 2 banks, 232 mf	105	23	13	6.5
Power Unit + 3 banks, 341 mf	125	28	16	8

For Panchro Press Eastman Film: Multiply suggested guide factors and distances by 10 for average subject matter.
The total light output can be distributed in one, two or three reflectors according to connections. The guide factor and distances should be decreased if the lamps are widely spread.

Dec. 31, 1946.

Harold Edgerton.

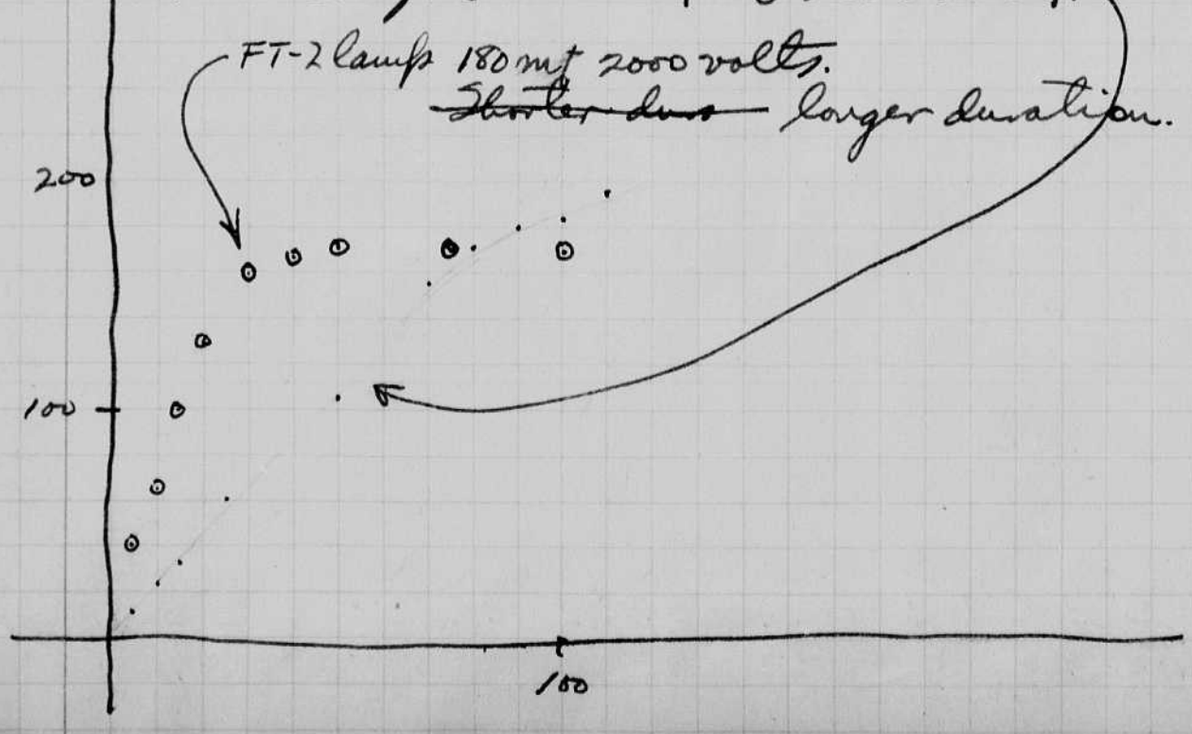
A battery operated exposure meter was mocked up a week or so ago, the circuit follows.



note: the 5000 ohms is not enough to balance all 1644 tubes. Should be 10,000 ohms.

Photo tube saturation tests by Sam DiSavino.

FT-2 lamps 10.5 mf 2000 volts.

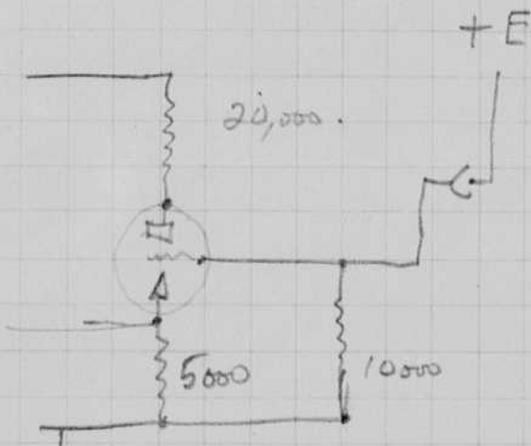


Jan 6 1946
Harold Edgerton

Most of last week was spent plotting & planning the Ice Capades in Color. I used 6 Raytheon Argus units in parallel on most of the work but the 1000 mf 4000 volt unit was used some. Milli was here on Jan 3 at a rehearsal showing. Howard Colton came Dec. 2nd. and left Jan 4 Sat. We shot Ektachrome CC33 filter and CC15 plus CC25 on Kodachrome.

I was in N.Y. yesterday with Henry Lester. At the circle of confusion club meeting Lester showed the movie unit with adapted cm similar flash tube.

Jan 14 1946. Photo tube clear 929 Transient.



$\frac{E}{10^4} = i$

45 volts 1.25 inches.
= 5 div (1/4 mil

Lamp to photocell = 10 ft. FT-14 no 1 reflector on 28 mf at 2000 volts.

E	E_a	def. div	i_{pc}	E_{pc}
100	30	3.3	3.	70
200	58	6.5	5.8	142
300	63	7.0	6.3	237
150	45	5.0	4.5	105
100	30	3.3	3.0	70
50	10.8	1.2	1.08	39.2

6.5 divisions $\times \frac{45\text{ v}}{5} =$ voltage 58.5

$i_{pc} = \frac{58.5\text{ v}}{10^4\text{ ohms}} = .0058.5 = 5.8$ ma.

Peak light from G.E. data

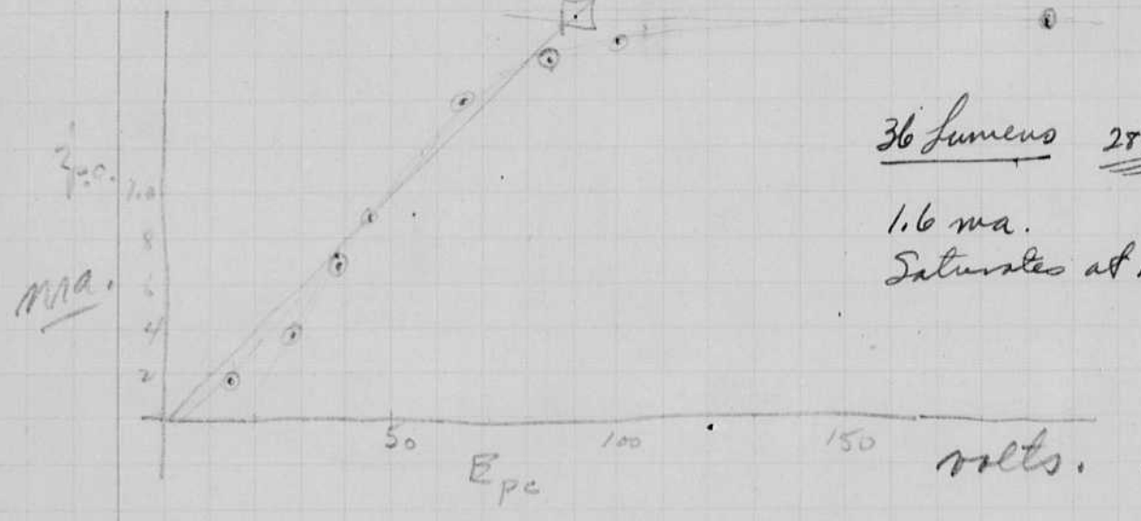
Distance increased to 20 ft.

100	2.0
200	2.0
50	1.
80	1.8
60	1.5
40	.8

Photocell resistance changed to 60,000 ohms.

Light at 20 ft.

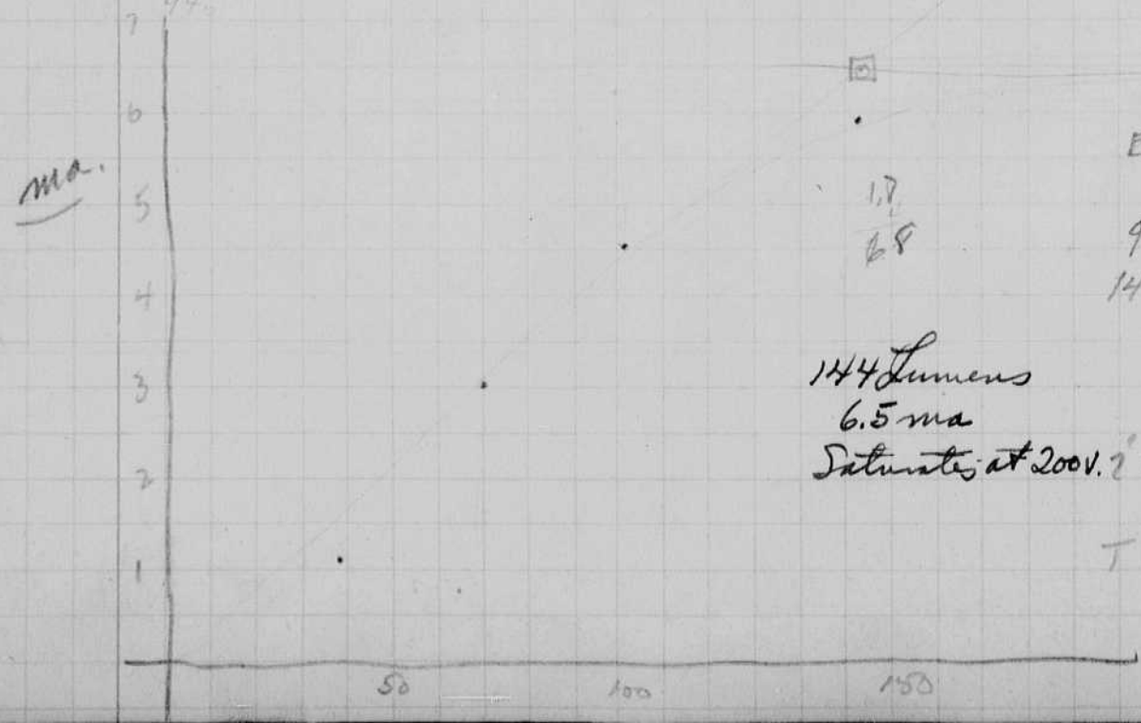
E	Defln	E_R	$E - E_R$	$\frac{E_R}{60{,}000}$
100	6.0	54	46	.9
200	11.	100	100	1.67
300	11.5	104	194	1.73
150	9.3	83.8	66.2	1.4 ~ ?
100	6.0	54	46.	.90
50	2.3	20.7	29.3	.345



36 lumens 2760° 1.7 × 4 = 6.8

1.6 ma.
Saturates at 100 volts.

25	1.2	10.8	14.2	.18
80	4.5	40.5	39.5	.675
180	10.5	94.5	85.5	1.58



E	I	L
1.7		
68	90	1.7
	140	6.5

144 Lumens
6.5 ma
Saturates at 200 V. $i = \frac{eC}{T}$

$T = \frac{0.3 \times 10^{-6}}{1.7 \times 10^{-3}}$

$= .17 \times 10^{-3} = .00017$

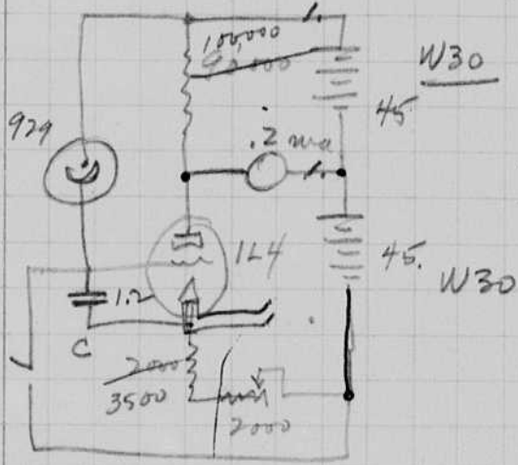
Peak light output of the FT-14 as I found from G.E. Data.

$16. \times 10^6$ lumens for 28 mf. $1.3 \times 13.13 = 17.1 \times 10^6$ lumens.

candlepower = 1.6×10^6 for 30 mf, 2000 V.

Duration to 1/3 rd light .66 x .25 M.S = 0.16 millisec.

With a photo tube meter of the below design



E_o for full scale = 0.3 volts.

C = 1 mf for 30 second drift.

this was wired up today. Works OK. I left it on when I left M.I.T. to give the battery an overnight run.

$f = \frac{CP.}{d^2} = \frac{1.6 \times 10^6}{10^2} = 1.6 \times 10^4$ lumens/sq ft = ft candles.

$= \frac{1.6}{144} \times 10^4 = 111$ Peak lumens sq inch at photo tube when FT-14 at 10 ft is flashed from 28 mf at 2000 volts

Area of photo tube $\cong$ 0.5 square inches

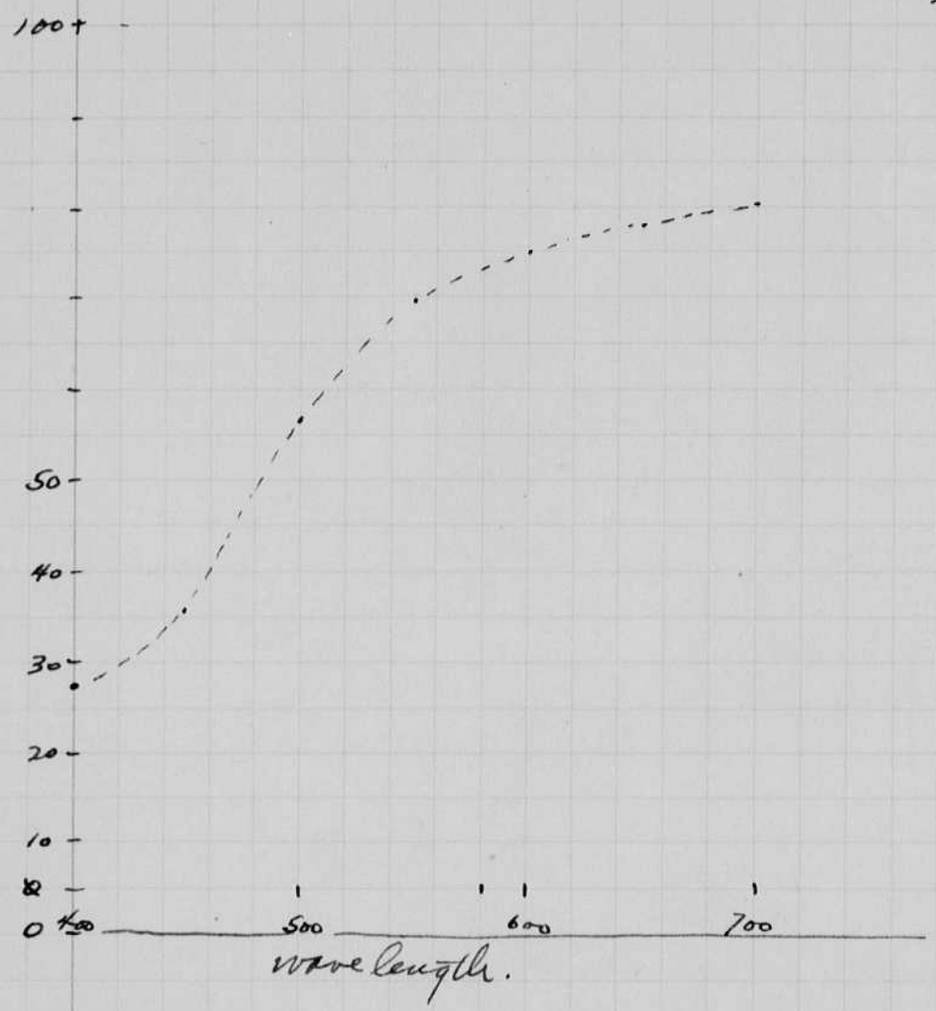
The xenon flash with a 929 photo tube receiver produces twice as much photo current as a tungsten source at 2850° K. for the same lumen output.

Jan 15 1947.

A.S.Sq. CC15 plus CC25.

Transmission data from Sandell-Tupper. E.K. Co.

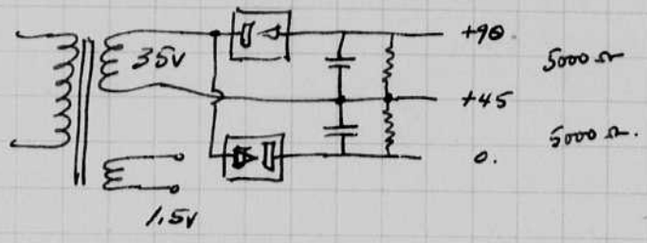
This was sent to Uleman at Pittsburgh Plate Glass at Pittsburgh.



Jan 22, 1947.
Harold E. Edgerton.

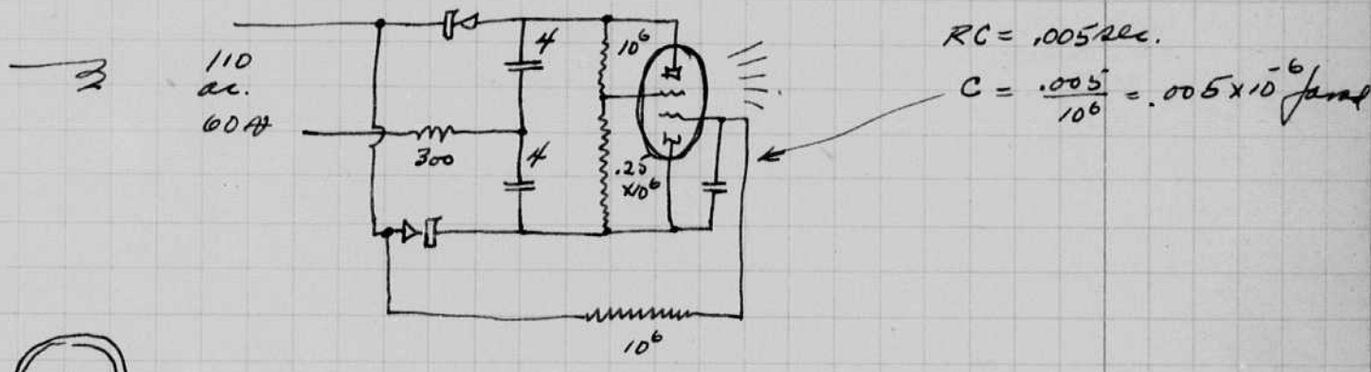
The aperture meter was put in a box by Mac Roberts with batteries. A polaroid pair was used as an aperture for adjustment. This is to be calibrated in aperture for color photography.

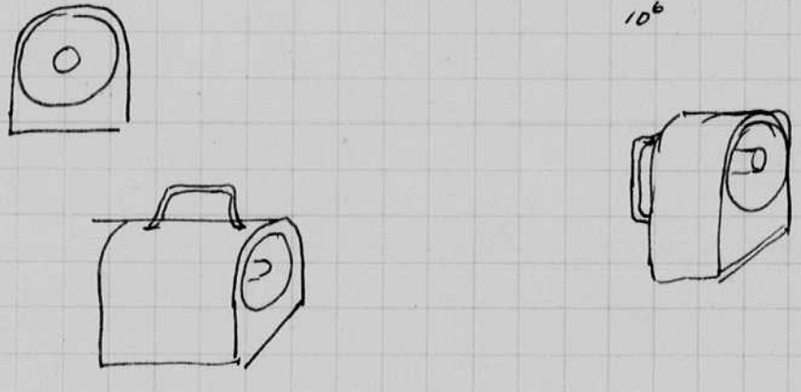
Design of an a.c. power supply for the meter.



60 cycle stroboscope.

With the new selenium rectifiers it appears that a 60 cycle stroboscope should be a convenient item to make and use.





Feb 3 1947.

H. E. Edgerton.

I gave a talk Monday Jan 27 in Cleveland at G.E. for the technical branch of the Photofon. While there I discussed tubes with Hammer mentsfeldt, Noel, Thacher, etc. From discussions I gather that not much development work is going to be done.

Next I stopped for two days at Rochester where I worked on the super studio unit that Raytheon have built. A meeting was held in the office with those present. Vaughn, Oberbetter, Foord, Booth, Sandell, Colton, Leavitt. We phoned Raytheon for a bid on the job. Incidentally this bid was mailed (and phoned) on Jan 31. Friday to Vaughn from Bertram. A complete unit of

1 power unit
3 capacitor banks
3 lamps with 10" reflectors
2 extension cords
1 photo tube

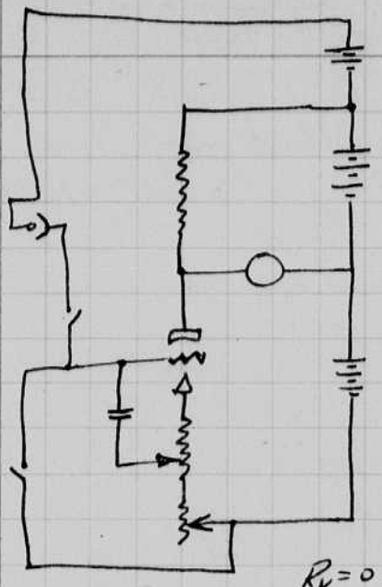
in 100 lots will cost about $1,500.

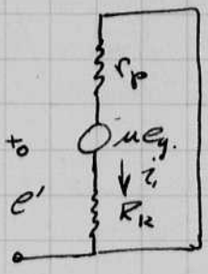
Raytheon transformer 40 DC to 2250 dc.

Chas Eichhorn. M. 11975.

Lamp Design for 3½ mt 2500 2000 volts.
1½ to 2 mm I.D. 3" long 40 amp pressure
From Fred.

$\frac{CE^2}{2} = \frac{3.5\ 2500^2}{2}$ = 11 watt seconds
η = 40 lumens/watt.
Q = 440 lumens.





$e_g = e_1 - i_1' R_K$.

$\mu e_g = \mu(e_1 - i_1' R_K) = i_1'(r_p + R_K)$.

$\mu e_1 = i_1'[r_p + R_K(1+\mu)]$

$$i_1' = \frac{\mu e_1}{r_p + R_K(1+\mu)}$$

if $R_K = 0$ then $i_1 = \frac{\mu e_1}{r_p} = g_m e_1$

$R_K = 0$ $\quad \frac{i_1'}{i_1} = \frac{g_m e_x}{e_x} = g_m$

$R_K = R_K$ $\quad \frac{i_1'}{i_1} = \frac{g_m e_x}{\frac{e_x}{1/g_m + R_K\left(\frac{1+\mu}{\mu}\right)}} = \frac{g_m}{1/g_m + R_K\left(\frac{1+\mu}{\mu}\right)}$

Let this ratio be 2. — then $1/g_m + R_K\left(\frac{1+\mu}{\mu}\right) = 2g_m$.

$R_K = g_m\left(\frac{\mu}{1+\mu}\right)$

$g_m = 650 \times 10^{-6}$ amperes/volt.

$$\frac{i_1'}{i} = \frac{g_m}{\frac{g_m}{1 + R_K g_m\left(\frac{1+\mu}{\mu}\right)}} = 1 + R_K g_m\left(\frac{1+\mu}{\mu}\right) = 2.$$

$R_K = \frac{1}{g_m}\left(\frac{\mu}{1+\mu}\right)$

$= \frac{10^6}{600}\,\frac{13}{14} = 1670$ ohms.

$R_K = \frac{r_p}{1+\mu} = \frac{r_p}{\mu}\left(\frac{\mu}{1+\mu}\right) = \frac{1}{g_m}\left(\frac{\mu}{1+\mu}\right)$

12# meter tests
.45 volts. - 200 ma no degen.

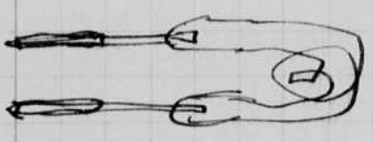
1.2 volts full scale 3500 ohms +

 Feb. 7, 1947.

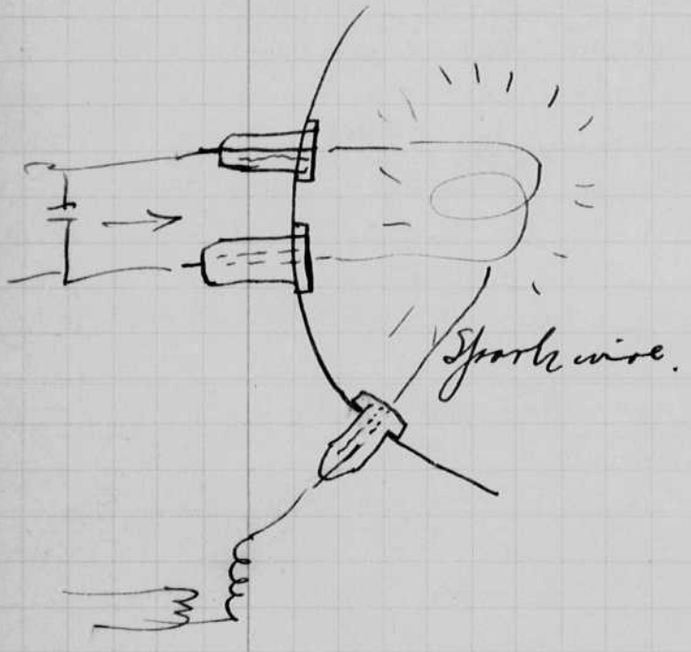
Lamp design.

Two tubes were pumped yesterday. See sketch below. 1½ turn spiral of 2 mm (+) I.D. pyrex tubing. Filled with 12" pressure of xenon gas. Tungsten electrodes. Light output just 26/13 times that of an FT-14 on 7 mf 1900 volts. Life 5000 flashes at 1 second intervals to drop output to 12/26.

Two pins were welded to the legs today for a mounting in a reflector. Pin jacks were used for connector.



Bill McRobert and Chas Wyckoff are building lamp reflectors with pin jacks now.



Feb. 24, 1947.
Harold Edgerton.

this book has been with Rines who is preparing an applen on the photo lab's integrator system with a switch. Conf with Grier Rines, and Germeshausen today on the trip to Wash next week.

I have two sections of 620 this term.

Mar 10 1947. In Washington last week with Grier & Germeshausen, Wed and Thurs. appeal action 085501 etc. Germeshausen was in N.Y. Mon. Tues.

Mar. 21. 1947 In Washington Mar. 19 with Don Coggins to discuss strobo runway installation at Navy Bldg.
Merrill of A.G.A. Amer Gas Accumulator gave a talk on his system.
Comdr. Watkins.
Mr. Douglass CAB.
Breckenridge Bur. Std.

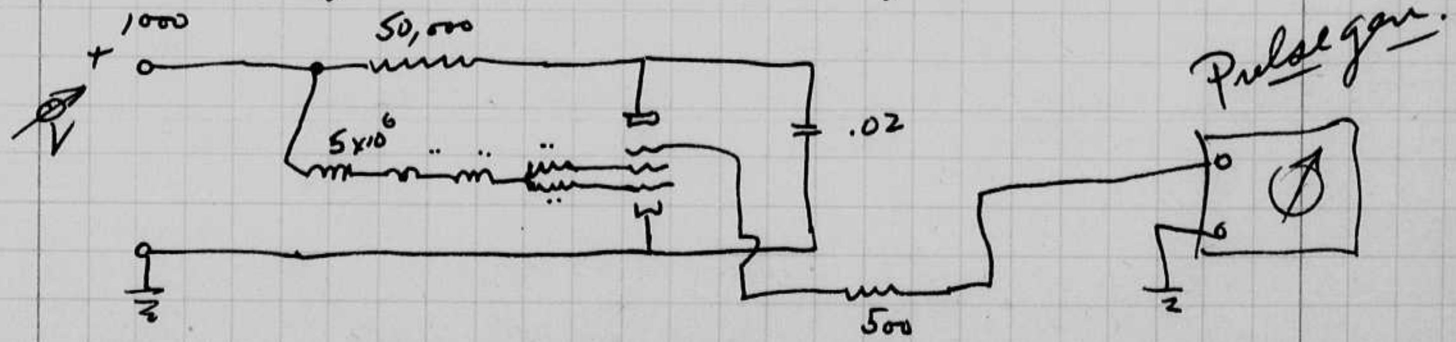
Coggins and I went to N.Y. that ~~long~~ night and stayed at the Wentworth Hotel 46 St. I saw Warnecke at the news, Barthenew, and Jester.

Today, Phil Sperry and — of Sylvania came in with Coggins to talk about exposure meters.

Conf with Wilkins and Don Sinclair about the model now being made. It resembles the existing battery model that we have been using for a month or so.

April 5, 1947. 20B-203. Ben Loganis room. Basic Research.

Set up for Strobotron delay tests OA5 tube.



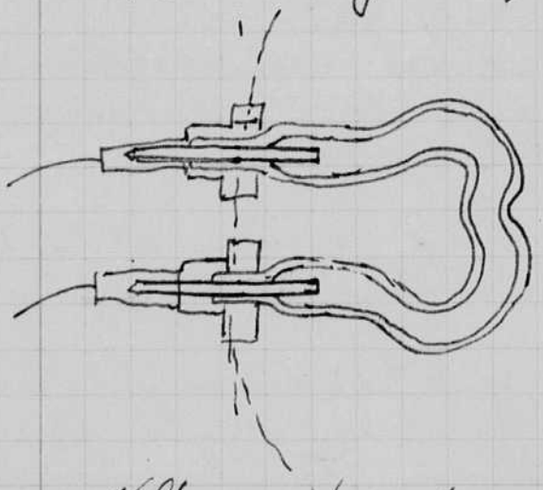
April 15 1947
Harold Edgerton

My parents were here for my birthday Apr 6 - 44 yrs.
Edgar Dillon arrived Sunday the 13. from N. Y. He is on a three month visit of U.S.A. after 17 years at Louvain Uni. Belge.

Ben Fogar measured the peak volt. out put of the F-24. 300 mf (-) 4000 volts. 40×10^6 lumens peak. or 4×10^7 c.p.

Frank Carlson was in Boston today and yesterday. He and Snyder were at M.I.T. for lunch. I had dinner with them at the Red coach. Then we went to the photographers exhibit at the John Hancock Hall. Seminar co, Sylvania, Sangamo and Mc Graw had flash equipment on display.

Flash lamp design.



Dent for a spring that will also serve as the spark trip.

Wilkinson is finishing another exposure meter for flash photography. This one has a crossed polaroid pair of discs on the front for reducing the light.

April 15 1947.
Harold Edgerton

Made two tubes yesterday and pumped this morning. Filled with 8 or 9 inches of xenon. and tested on portable model. also filled new style 203 with 3 inches of xenon.
Yafell was over for lunch. I knew him in England.

Conf. April. 18, 1947. Sims, Herb, Chas W. and Fred Barston H.E.E.
40D-102 Kossman job - enlarger. I am to get the portable.
new Stroboluxe - #14 pyrex 10:1 gain with quartz
60 cycle 5:1 " " " "
Eff'y varies directly with energy storage.
Light " as square of energy.
Quartz tube can be loaded up to increase eff'y.
Movie machine - Build sample. - Barston wants suitcase type. One lamp.
Inductive pickups 1/4 volt. 0.1 volt output
Lamp research - redesign for higher efficiency and shorter duration.
Raise pressure with 3 electrode lamp.
Discussion of lamp protection problem.
60 cycle switch push-button type?

Movie camera changes - suggested.
New Brake for top reel. less tension at beginning
Sprocket and magnetic commutator.
Footage contactor switch.
Hinged cover.
Focus arrangement
Compensating lens.
Exp meter 10 to be made by BK,
C.A.A. - Infra Red - Herb to write more
A.D. Little. - Chas going to Milwaukee next May.
Microscope illuminator. Max. brightness important.
Auto Ignition system. Ken to follow up.

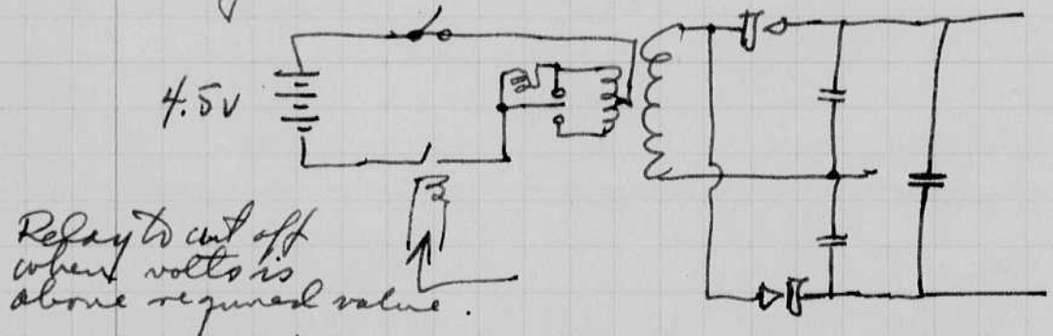
 Harold Edgerton.
April 19, 1947.

Portable flash unit.

Several days ago I started assembly of parts for a portable to be used with a 35 m.m camera. With fast film and lens combination the flash part could be fairly weak when compared to present equipment for 4x5 cameras. The accepted level of light is now obtained from a 30 mf capacitor at 2400 v.

The new unit will be set up to work at 2 to 5 mf at 2400 volts. The lamp will be especially designed so that high light efficiency results at this energy level. Thus the light will be about 1/10 that of the existing units. The guide factor will be reduced by a factor of $\sqrt{10} = 3$ if the same type of reflector is used.

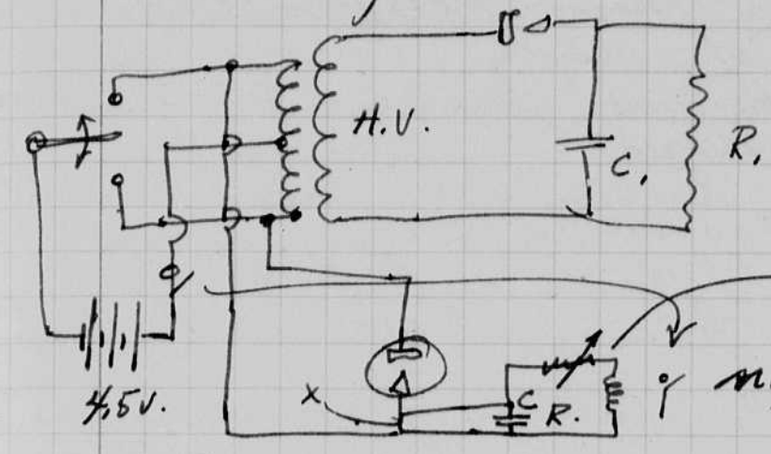
I hope to be able to use dry batteries. a shut off system would be a very desirable thing for this since the main drain is for the idling requirements.



A bleeder and relay system for the main condenser is not practical because of the small currents. There is no good relay for small currents that would be acceptable.

I suggest a low voltage capacitor with the same discharge time constant due to leakage, for the regulating circuit.

one such system.

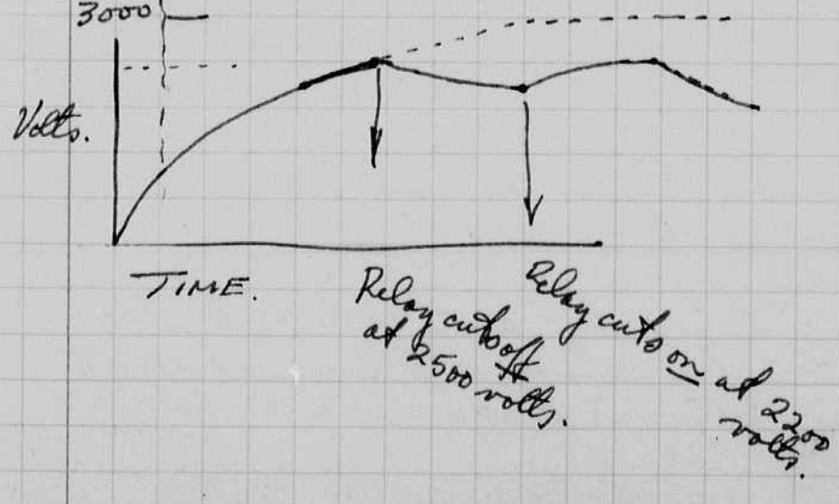


$RC = R_1C_1$

the max of the input is 9 volts.

Let current to relay be 10 ma.
then $R = E/I = 9/.01 = 900$ ohms.
Let $R_1C_1 = 10^1 \, 3\times10^{-6} = 30$ sec =
then $C = \frac{30}{900} = \frac{1}{300}$ farad. = 3300 mf. $\frac{30000}{1,000,000}$ $\frac{}{300}$

this is a rather large capacitance. With a relay that works on 1 ma instead of 10 the capacity could be reduced to 330 mf. An electrolytic of this value would be practical but it might have a leakage resistance of less than the 900 ohms. In other words its time constant might be shorter than desired.



April 21 1947.

Noel visit at Camb. – Conference note.

503 flash tubes – now filled with 15cm of Xenon.
after 5000-10,000 flashes 2000 watt sec.
350 mf.
8
2800 watt sec.
Some self flash and holdover (?).
Decided to accept 5000 ~~flashes~~ flashes.

Gap tubes 2 atmospheres of ~~Xenon~~ Krypton.

Movies – Objective
1. 24 cycle – bad on people who act.

2. Sound effects – may
use green color.
Lower voltage.

3.

Suggested mixing lamps to still see the action but not to be annoyed with the 24 cycle light.

Most sound is dubbed on the films.
except voice.

2.5 3.5 5.6 8 11 16 aperture settings
11 for meter.

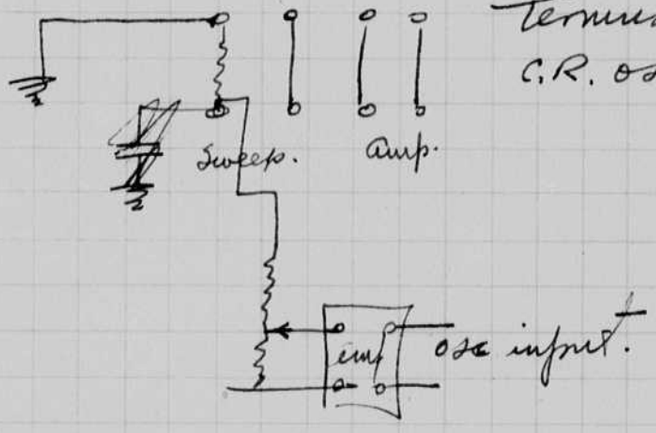
Raytheon M1909-2 transformer 4V D.C. to 2300 v.
with vibrator and 3.5 mf.
20 meg bleeder.
this was wired up by Bill Mc Roberts
and tried. The current was 0.7 or 0.8
amp. from the 4 volt source.

April 26 1947.
D. E. Edgerton. Weekly conference

Conf. time 4:30 Wednesday afternoons.
Grier states that he will not be free for a year or more. He has an important M.I.T. project on some phase of the atom bomb.
Demo reported to the conference on the Bosch system of ignition. Apparently the gap is the problem.
Edgar Biller came in for lunch with Winfield and my self at Walker. Dance last night at Walker - Assemblies.

Dumont Oscillograph lecture. Harr. Geo. Hall I.R.E..

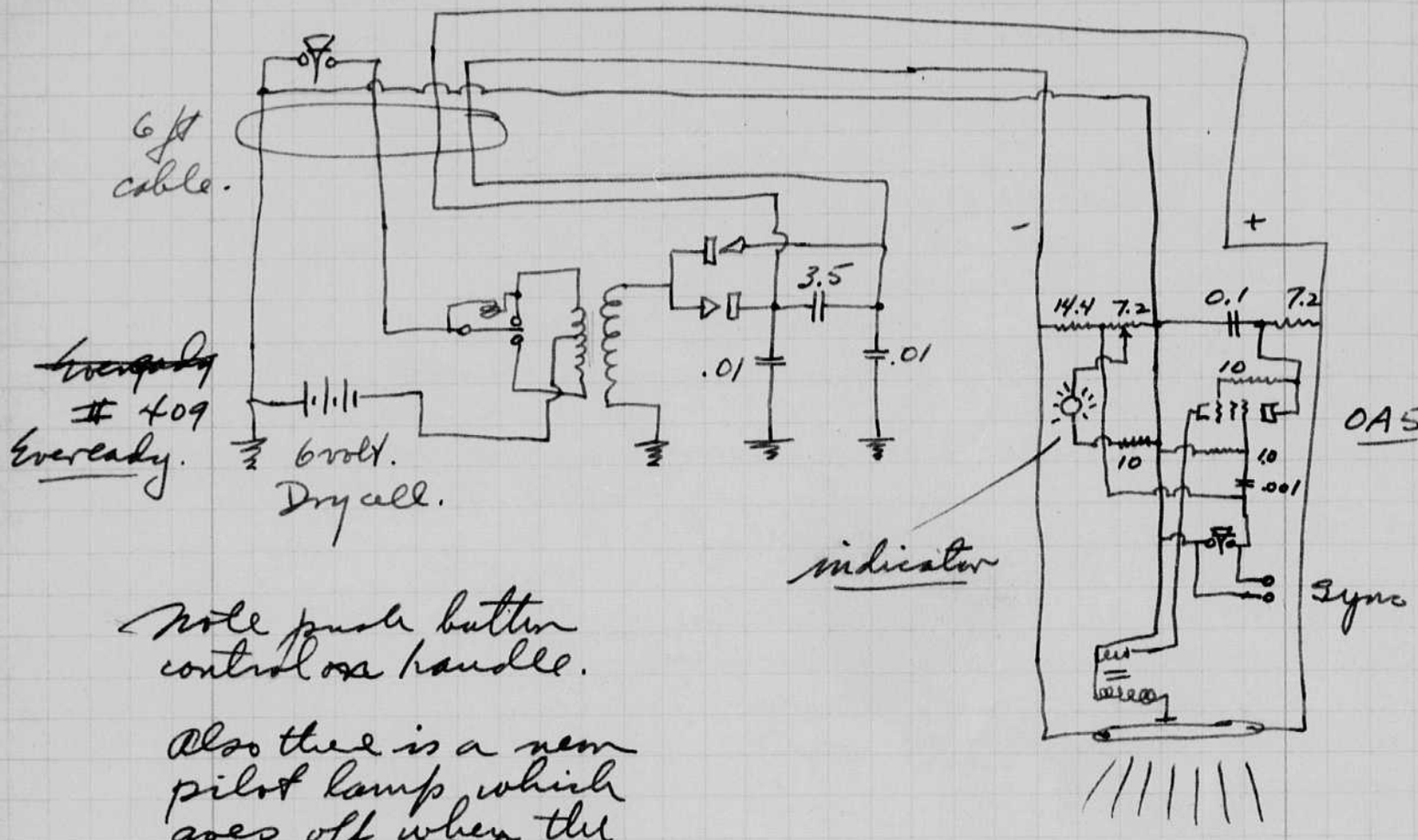
Amplifier tests by use of signal from the sweep ckt. Use resistor to one plate 1 to 5 megohms with by pass capacitor



April 1947 28 Monday

H. E. Edgerton

Possible Portable Layout.



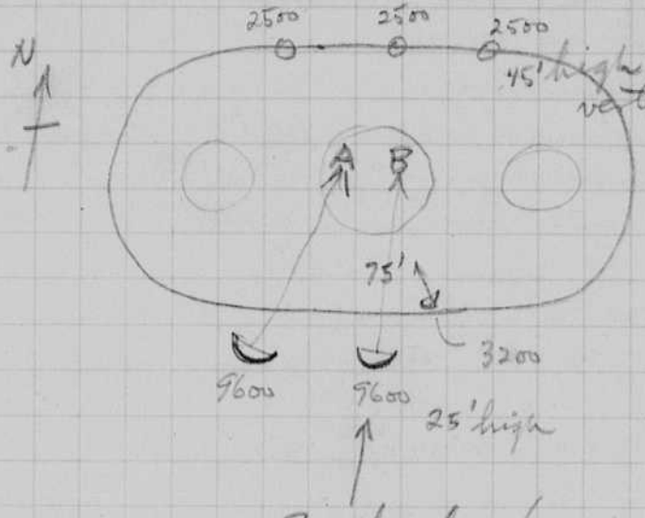
Note push button control on handle.

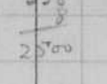
Also there is a neon pilot lamp which goes off when the battery is below some preset standard value.

All the heavy parts are in the power supply.

May 14 1947
H. E. Edgerton

Circus photo setups for Natl. Geo. Soc.
Edwin Wisherd is here from Washington to shoot the photos.





First setups.

The three Rayflex units on the bottle side were on the floor the first performance.

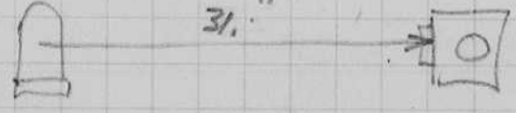
~~For~~ the first 2 performances the energy here was half due to a plug ~~capacitor~~ failure.

Meter readings were f 4.5 at A and f 3.5 at B for above with three front lights. The back lights do not influence the exposure. all 4x5 Kodachromes were taken at f 4.5. 35 mm were shot at f 5.6. f 4. and f 3.5 if action was out of the hot spots.

Cal. of light meter was accomplished as per below.

Standard condition: f 3.2 with our Kodatron model at 10 ft. from the subject 100 on meter. This was marked on the paper scale in front of the polaroids and then standard FT-14 was used to get the light level.

FT-14
Ref no 3.



H.C.P. sec. $= \frac{6180}{10} = 618.0$

Lumen sec per square inch

$= \frac{\text{H.C.P. sec.}}{(31")^2} = 0.6450$ lumen sec/sq inch

101. mf 6120 x $\frac{101}{100}$ lumen sec.
2000 v = 6180 lumen sec

$Q_f = .927$ lumen sec/sq ft.

This is the amount of light energy required for an average subject. Kodachrome color film.

f 3.2

 June 5 1947

Harold Edgerton.

I was in N.Y. at the underwriters lab at 161. 6th ave with Jerry Schiff on June 3. Tues. We saw Anderson and J. J. Kane about the Eastman color flash unit. 400 watt seconds.

The U.L. Requires
Rating and name plate data
Heat Run
Dielectric tests 1 min 2x + 1000 volts.

Tests on mech interlocks.
6000 operations of relays.

Class A ambient 90°C. 25° ambient.
Plastic 60°C.
Cotton 90 C.
phenol 150°C

Conf. at Eastman on Color Photography.
Research Laf. Stout.
~~Hansen~~
Tupper
Banter
Frank Oberkeller.

The discussion was general in nature but maybe something useful will come out.

Also in N.Y. I called on Com. Illes. and discussed the large flash unit with Kranter and Doris. It was decided to add another power supply and four lamp houses with FT-503 tubes.

June 20 1947

Tuesday — Color Photography in Symphony Hall.

Most of last week was spent on the color photography of the Pops and the M.I.T. Graduation.

First photos were taken at f5.6 on Ektachrome CC33 and ~~Kodak~~ Kodachrome CC15 and CC25 with the following lighting.

1200 wt 4000 volt FT-17A in 30" 40 degree reflector at the third isle from the front on the second balcony.

400 wt at 4000 volt FT50B in 30 degree reflector 10" located on 2nd balcony at the front of the stage. Both the above tubes were on the same side of the hall.

The Ektachrome was overexposed. f6.3 or f7. would have been better.

The Kodachrome looked ok. But had a yellow cast. f 5.6. with CC15 and CC25.

Ed Bennet finished a thesis study of the color variation of flash tubes as a function of voltage and capacity.

Two other students are starting work in the same field. Herbert Kaelwert 37 Bay State Rd C.R 8029. course VIII is to study dimensionless variables and their effect upon color. Jackson is to investigate the influence of wave form on the color. The choke coils that we use to stop the noise may also change the color enough to be of benefit there. Room 20B 203 is where this work is to be accomplished.

June 21

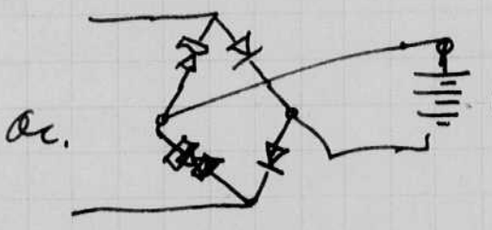
Barslow and Wyckoff left today for N.Y. to finish work on the Commercial Illustrators flash unit in the Shelton Hotel in N.Y. this studio is to obtain a 10,000 watt second flash unit for use in color photography.

The Natl. Geographic society are to sponsor a trip to Colorado and California to shoot moving picture in color. Bill McRoberts

is working now on a large portable to do the job. I plan to use 2 or 3 FT-20 flash tubes or 75 mf at 3000 volts. The battery is 12 volts, consisting of three 4 volt Willard batteries.

June 25 1947. W. Edgerton. Conf. last night with Zimmerman and Grier concerning trends of future expansion.

Battery charger for professional portable.



5 cell lead battery ER Willard cells.
almost fully charged.
13 volts

	ac volts	I dc amp.
after charged.	9.0	.00
	9.9	.04
	11.2	.13
	12.1	.2
	13.7	.39
	14.9	.55.

Discharge. Started 8 am. .5 amp. 13.5U dc.
8:5' .5 amp.

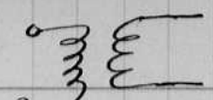
12 noon .5 amp 12.8 volts.
Green balls down on most of the cells.
Discharge rate increased to .8

2 pm	.8	12.7 volts.
5 pm	.7	10.8 "
520	.7	9.8 volts.

off at 5.45. - Green down Red up.

June 26 after over night the Red balls were down also.

Charge started 8.15.
0.4amp.



June 26 Edg & Wyckoff.

Check of light output with the meter. Simpson meter model.

Portable with FT-20 in Black case lamphouse.
½ ft. f 2.5 meter 100.

Portable with FT-15 in al can.
½ ft f 2.5 meter 50

Thus the FT-15 seems to be ½ that of the 20.

Oak box Studio Kodatron.
10 ft f 3.5 meter ~~120~~ 86.

June 27. New Prof Portable FT-20 single tube 75 mf 2800.
10 ft f 3.5 meter 70. guide factor about 30.
5 cells 2800 volts.

10 ft f 3.5 meter 95 3300 volts.
6 cells Guide factor about 35.

Test of FT220 new 74 + mf 2800 10 ft f 3.5 85 meter 140.

June 28 1917. Further tests of Professional Portable.
10 ft f 3.5 meter 97 One FT220 3500-75 mf.
" " 105 "
102 2 FT220 " "
097 3 " " "
Light from 1 - FT220 with other two on but not on meter

33.

Thus the light divides equally between lamps.

cont

30 ft of extension cable reduced the light about 20%. #23 wire 2 wires for each conductor.

Calibration of meter before this was V. Simpson 500 ma meter
June 29 1940 H.E. Edgerton. SR. Box Wood.

120 volts ac input to Kodatron model
Spencer reflector.
a new paper filter was inserted so that full
opening of the polaroid attenuator would
correspond to f 4.7. - 8 1/2 ft from bulb.
Guide factor of 40.

6180 lumens see page 111

→ FT-14 no 3 with 101.1 mf at 2000 volts
Horizontal view no reflector.

27.5" from FT-14 to front of meter.
Polaroids open meter reads 100. Half scale

Primary 60 cycle impedance $\frac{1.6\ V}{3.5\ amp} = 0.84$ ohms.

Sept. 4, 1947.
Harold E. Edgerton

I returned Sept 2 from a 2 months trip to Colorado and California to photograph Hummingbirds in the wild. On this effort I did get photos of the

Rufous - Arizona
Broadtailed Colorado.
anna Calif
Blackchinned "

In Chicago I attended the Photo convention on Aug. 29th.

Tests of portable transformer used this summer.

75 mf.
5.3 lbs.
3
15.9

Ratio 75:1 ac.
Input 21 V output 1510 volts Ratio 60:1.
An order was taken to Raytheon on Sept 4.

Sept 13 1947. Karger of Collier's will be here on Sept 15 to shoot the ballet scene of Allegro which is now being given at the Colonial theater before going to U.Y. Calvako was here yesterday to see the show and to arrange the affair.

Guide factor 250. → I plan 1200 mf 4000 V in an FT-49 on the 3rd top box next the stage. A FT 24 (504) will go on the other side with 400 mf 4000 V. *

Guide factor 125. →

I was in Rochester with Gene Isaacson on Sept. 9 to see Boon, Sandell, etc.. We are to guide on the 3 light trans portable in competition with Heiland. Their price was 2000 for a model and 230 for the unit in 1000 lots.

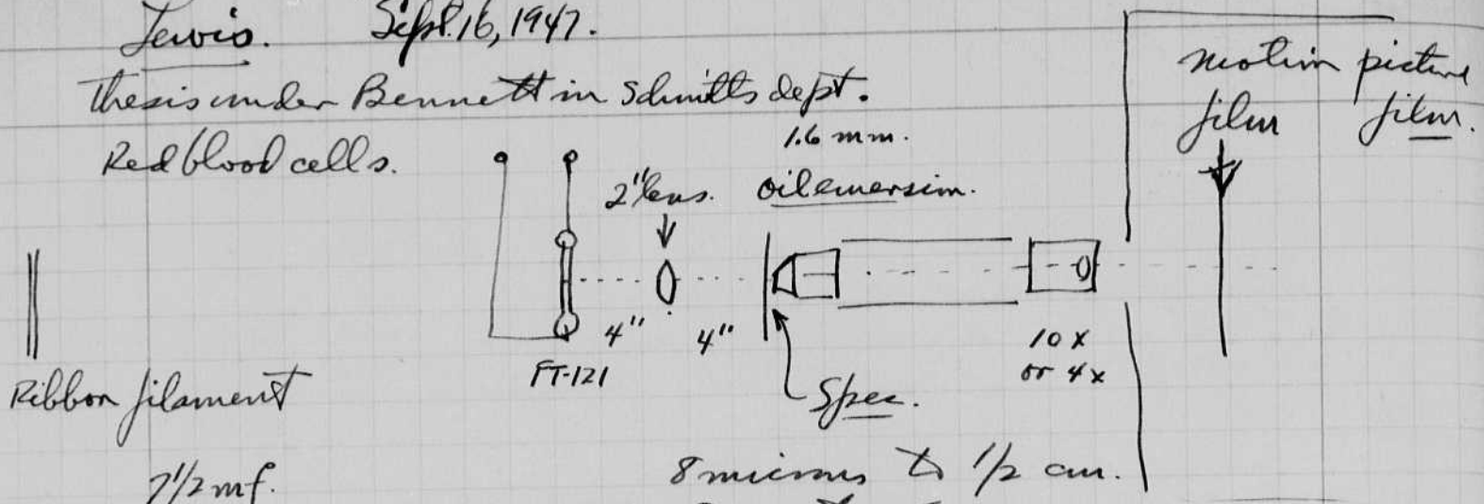
Gene and I had a conf with Wilkins and Sinclair of B.R. co about the light meter on Sept 10. We believe everything is settled so that the 10 samples can be made.

H. E. Edgerton.
Sept. 16, 1947.

Lewis.

Thesis under Bennett in Schmitts dept.

Red blood cells.



7½ mf.
2000 v.

8 microns to ½ cm.
0.000008 cm to .5 cm.

7 watt sec. per flash.
200 or 300 frames per sec.

Sept 19 1947. Conf. with Dove Nielsen, Chas. Wyckoff Genesleuser about studio rental of the large flash unit.

We concluded to put the flash equipment in Doves studio and let Lisa do samples and start production at once.

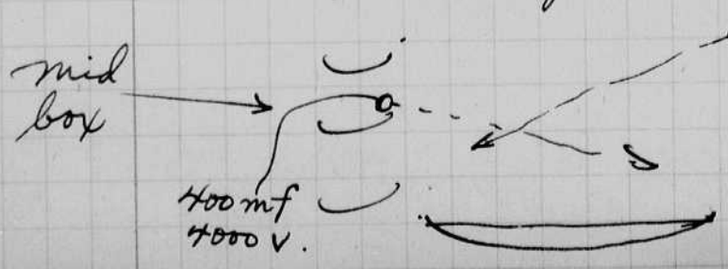
Suggested a 2000 per year rental plus 10% of gross receipts. Another method would be to put in a flash counter and charge per flash.

Sept 21. Harold Edgerton.

Geo Karger reported that the 8x10 ansco pictures (filter) were properly exposed and warm. These were taken with a ½ sec exposure (or ¼) synched by hand with the action.

The correct Ektrachrome exposure was f 4.7 or f 5.6. We took most of the pictures at f 8 so they were dark and cold.

The set up is described on p 117.



Sept 24 1947
H. E. Edgerton
Eugene Klein

Test of GR. Light meter. (GE meter 200 ma)
Utility box. 12" tube. ~~21' 6"~~ 21' 7"
8' 2"
FT-14 No.
Standard lamp no 5 10.5 mf 2150 volts (?).

21' 7" Distance with out filter or polarizer 21' 7" for 100 ma reading.
with one polaroid sheet ——— 15
with two polaroid ——— 7.

8' 7" → Distance changed to 8' 2" to give 100 on scale
with one polaroid sheet.
" two " " " 45 on scale.

with dark sheet on bench reading was 5% less ±, this cut out the specular reflection from the bench top.

Distance 5' 5" — light-meter.

5' 5" Distance with 100 on scale with two polaroid sheets in phase. Out of phase - reading ~~#~~ 2.5. ±.

$\frac{67 \text{ C.P.S.}}{(5 \times 12 + 5)^2} = \frac{67}{(65)^2} = .0158$ lumens/sec/square inch.

or $144 \times .0158 = 2.27$ lumen sec/square ft.

$10.5^{2} \text{ mf at } 2150 = 24.3$ watt sec.

$24.3 \times 27.5 = 667$ lumen sec

or 67. candle power sec.

Std lamp No. 5
10 mf. 551 lum/sec.
2000 volts.

$\frac{CP^2}{2} = \frac{10 \times 10^6 \times 10^{-6}}{2} = 20$ watt sec.

$\frac{551 \text{ lum/sec.}}{20 \text{ watt sec}} = 27.5$ lum/watt.

Battery tests for G.R. Light Meter.

A Battery reduced to 1. volt. light goes down 10%

67 c.p.s. at 36 29 64"	A	B. Bat voltage	Reading.
	1.3	117 volts.	105 - 100.
		110	100
		99	100
		87	100
		82	100
		77	end of scale zero set for tube used
		107.	105 - 103
		109	104
		100	106
		94	104
	V	92	105

1.2	109 (125)?	106	105
1.1	109 (125)	104	106
1.0	110	107	103
.9	110	105	104
.8	110	100	100 102
.9	110	105	
.9	90	103	104
.85	90	102.	
1.3	100.	103	
1.32	109 (125)	102.	

135 B
1.5 A.

Suggest make scale read volts with 100 as the battery change point. Actually will work down to 90 on both batteries with the single tube tested.

$135 \times 10^{-6} = \frac{135.}{R}$ $R = 10^6$ ohms. for B scale. ± 5% ∴ - 500,000.

~~1.5 x 1.~~ $135 \times 10^6 = \frac{1.5}{R} =$ $R = \frac{1.5}{135} \times 10^6 = 11{,}000.$

Sept. 26, 1947
Harold E Edgerton.

Visit from Roch, Thayer, Pritchard and Snyder the first three from G.E. to at Nela Park, today to discuss tubes etc. Special lamp manufacture was considered at length, especially Germeshausen's new spiral construction and the high speed movie lamp.

It was decided that the closed end FT-617 tube would be made for us if the committee would approve. I have tested this tube at 3000 mf at 4000 volts and found that the jacket could take the transient. Such a lamp with a closed end is quieter but is difficult to cool if the discharge rate of repeating flashes is high.

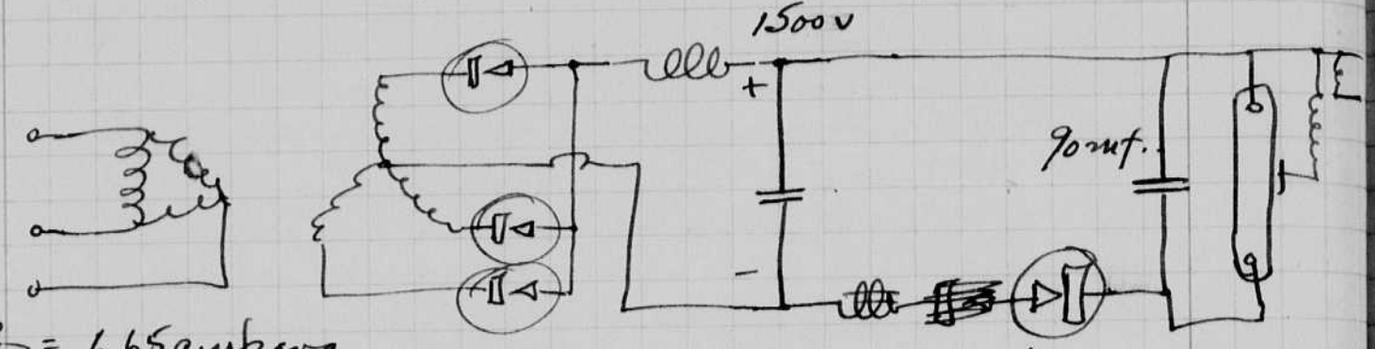
Germeshausen and Barstow pumped two a glass and two quartz tubes of the formed spiral types.

The glass tube was about 5/8" diam. and 5/8" length with equivalent tubing to the FT-14. Its efficiency at 2000 volts was less than an FT-14. At 3000 v the efficiency was about the same.

I took the G.E. crowd up to see Valley about the cloud chamber discharge lamps. A redesign of the 126 (2) tube was considered. Valley reports that some of the tubes self flash while others are hard starters. Roch may make some sample tubes with sintered cathodes using material that Germeshausen gave him.

I proposed to Pritchard that a movie lamp be built around the FT-17, attempting to reach an ~~exit pad~~ input of # 1000 watts. at 24 cycles. This lamp would be used as a key light for color or B & W movies at 3000 volts this calls for a 90 or 100 mf capacitor. Such a unit would need to be used with ordinary lamps or with daylight so that the flashing effect would not

be objectionable to the people being photographed. I suggested that such an outfit be built for one of the studios or experimentally.



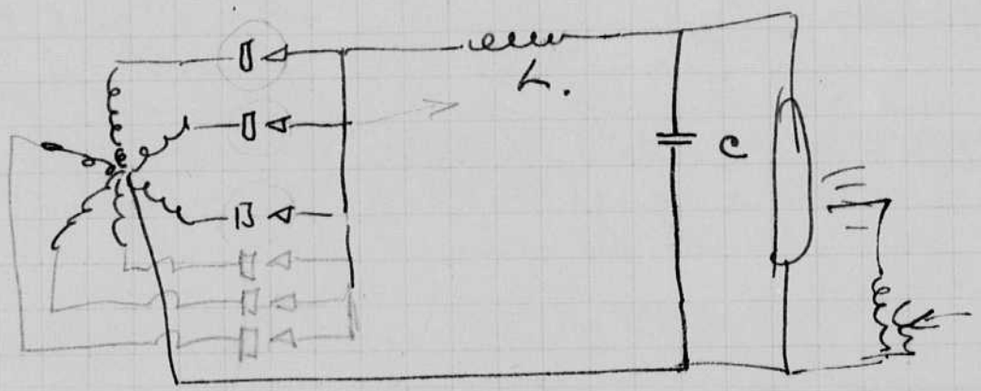
$\frac{10{,}000}{1500}$ = 6,65 amp avg.

not needed.?

Choke. $L\frac{I^2}{2} = C\frac{E^2}{2}$ =

$2\pi\sqrt{LC} = \frac{1}{2f}$

Try 6 or 12 phase with reactor without filter.



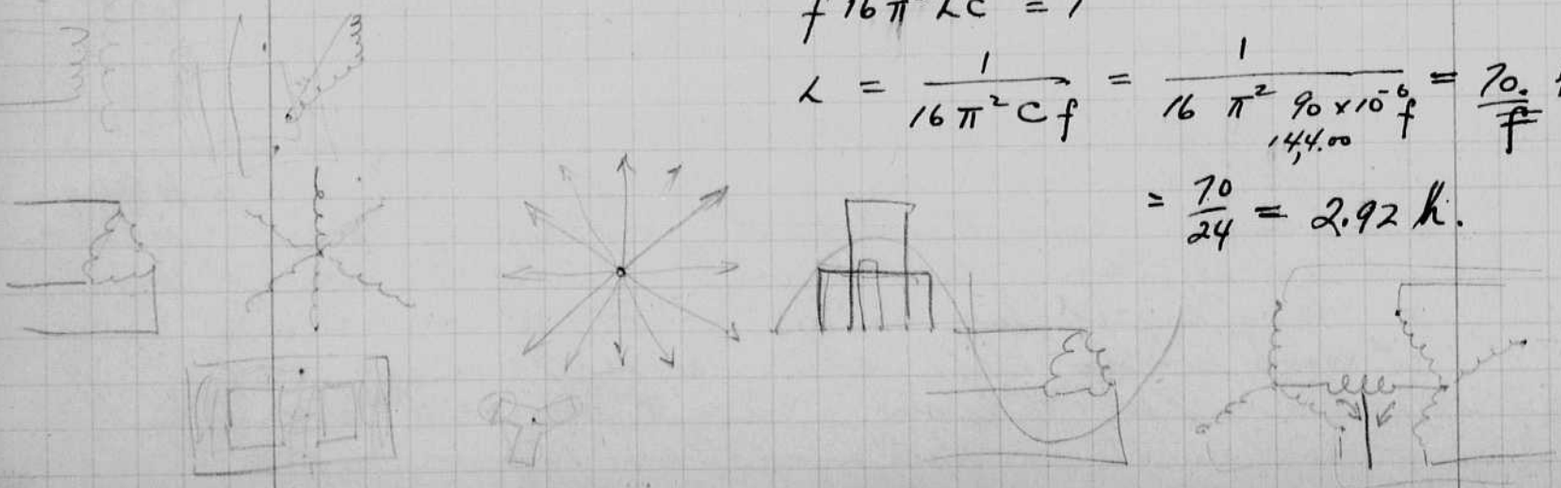
Tune L and C so that lamp fires at full charge.

$2\pi\sqrt{2C} = \frac{1}{2f}$ $\quad f4\pi\sqrt{2C} = 1$

$f16\pi^2 LC = 1$

$L = \frac{1}{16\pi^2 Cf} = \frac{1}{16\pi^2 \frac{90\times10^{-6}}{144.00} f} = \frac{70.}{f}$ h.

$= \frac{70}{24} = 2.92$ h.



H.E. Edgerton.
Sept. 27, 1947.

Ratio	Light ($\cos^2\theta$)	$\cos\theta$	angle. θ.
1	1.00	1	0.0
2	.50	.707	45
4	.25	.5	60
8	.125	.363	68.7
16	.0625	.248	75.6
32	.03125	.1765	79.8
64	.015625	.1250	82.8 ✓

This data was given to Wilkins for the first batch of ten meters.

the light attenuation depends upon the $\cos^2\theta$ of the angle between the polarizers.

aperture

3.5	1	1	0.0
4.5	.604	.777	39
5.6	.391	.625	51.3
6.3	.308	.555	56.3
8.	.191	.437	64.1
11.	.101	.318	71.4
16.	.0478	.218	77.4
22	.0253	.159	80.4

Kriebel of the Polaroid Co. says this law should work ok for the blue light over the range that we wish to work.

The exposure or light meter is due next week according to Wilkins. We have had several conferences about the project for the past few weeks.

A method of inserting the polaroid has been devised which is simple and easy to do. alignment is made by the original cutting of the sheet material. Two scales as above give the settings. Tests should be ready to make shortly on the arrival of the scale.

Oct. 4, 1947. Transportable transformer
Raytheon # 12274-1 to give 2800 V
from a 12 volt battery.

CK 1013 rectifiers
6 megohm load.

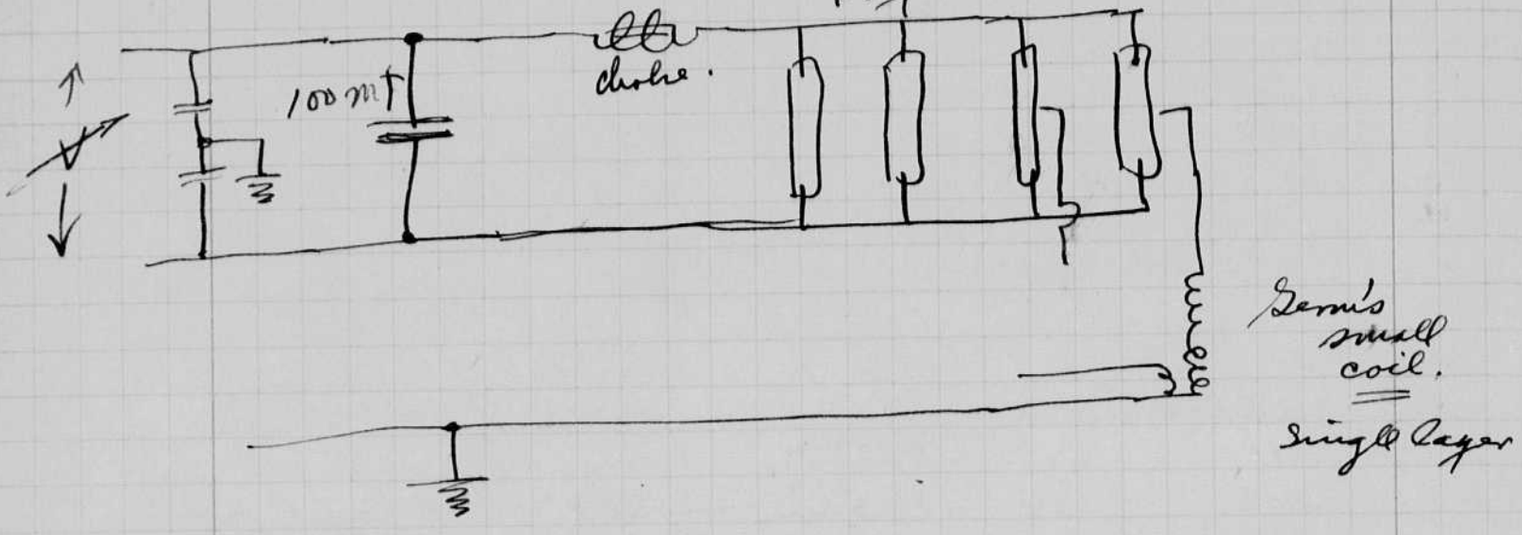
60:1 ratio.
C.T. on low voltage winding

Transistor short circuit impedance
from low volt side = 1 ohm.

 ~~A. E. Edgerton~~

Oct. 6, 1947.

Tests were made Saturday on 4 type FT-17 tubes in parallel.



The tubes would work o.k. if the voltage exceeds 1900 volts.

If a 50 ft lamp cord was inserted in one coil, that lamp would miss even with 4000 volts.

Oct 16 1947. G.R. Light meter.
#7 Eq. First of sample 10 lot. from Wilkins.

Test of Polaroid light gadget See page 123 for calc.

FT-14 2100V ± 10.5 mf at 7 ft. ±.

Polaroid	Meter.
X 1	200
1	190
2	102
2	101
4	57
4	56.
8	37
16	25
32	20
64	17.

1000 watt tungsten lamps.
10 ft 1 meg resistance.

1	198
2	102
4	57
8	34.5
16	20
32	15-
64	12

1500 H.C.P. estimated
$\frac{1500}{10^2}$ = 15 lumens/sq ft. full scale.
1 megolum.

15 ft ± away FT-14 44.3 mf 2000 V.

	X1	194.
1.96	2	99
3.4	4	57
5.39	8	36
8.42	16	23
9.7	32	20
11.4	64	17

Filter yellow 3421 233 Corning 3.95 mm
Distance decreased to 9 ft ±.

1		182
2	2.08	87.5
4	3.95	46.
8	6.75	27
16	12.1	15
32	18.2	10
64	22.7	8

Green filter Corning eye for (926) P.C. 4 ft ±
926

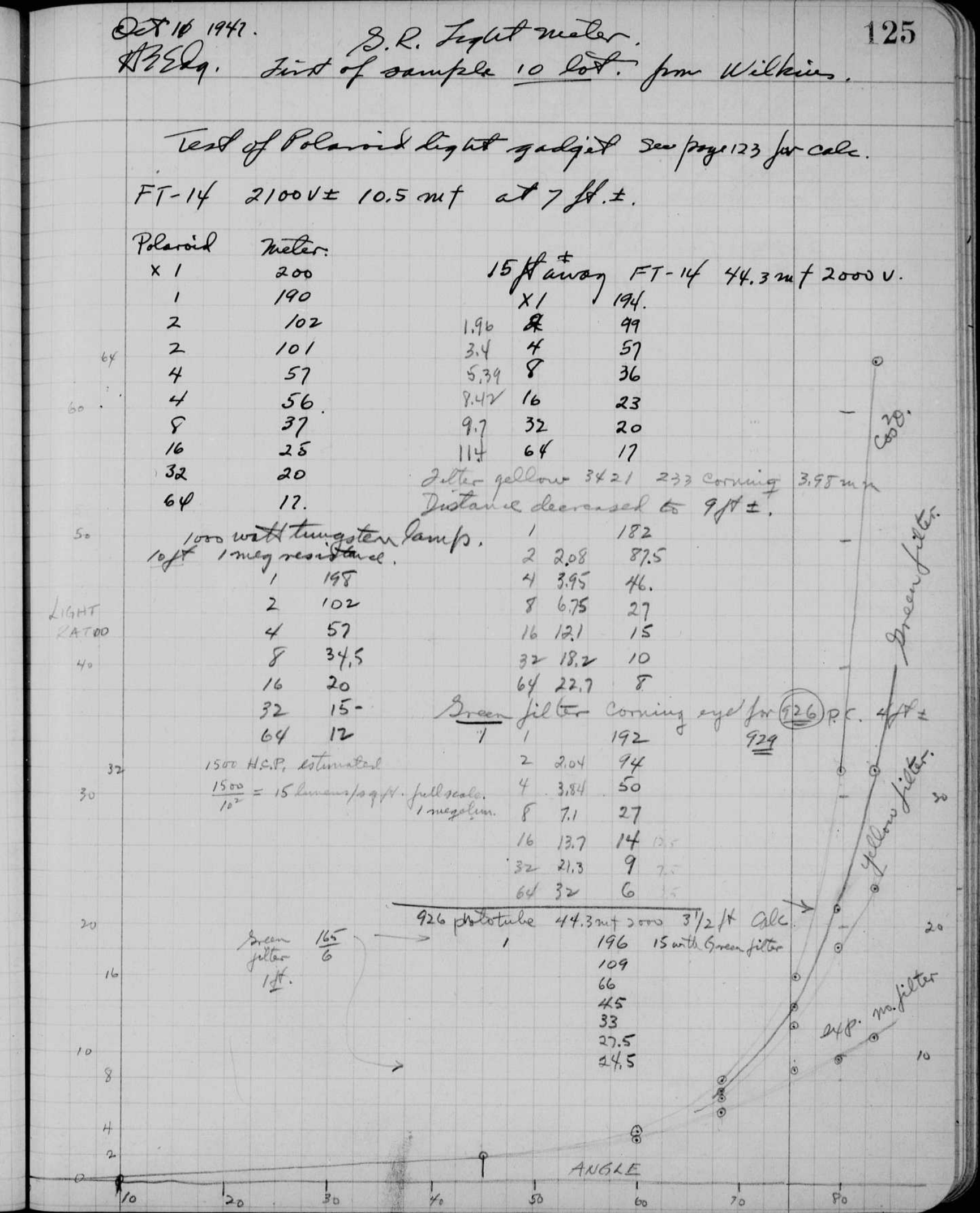
1		192
2	2.04	94
4	3.84	50
8	7.1	27
16	13.7	14
32	21.3	9
64	32	6

926 phototube 44.3 mf 2000 3½ ft calc.

1	196
	109
	66
	45
	33
	27.5
	24.5

15 with Green filter

Green filter 165/6 → 1 ft.



 Oct. 1947

H. E. Edgerton

HN 34 Polaroid. Al Mathews.
works ok. Cutler West.

190 - 2.5
1 - 64. ratio on meter.

20 x 50 panels.
about 4 sq inches per in element

5 - panels @ $50

$\frac{50}{250} = \$\frac{1}{5}$.

HN-34 Pioneer Scientific ~~Inst~~ Co
Empire State.
N. Y.

MIT meter 60.5" FT-14 10.5 mf 2150 v

1		200
2	2.12	94
4	4.25	47
8	9.1	22
16	18.7	11
32	40	5+
64	100	2+

92
47
94

4	~~200~~ 196	27.5
8	96	
16	42	
32	19	
64	8	

HN 32 Double sheet. .005

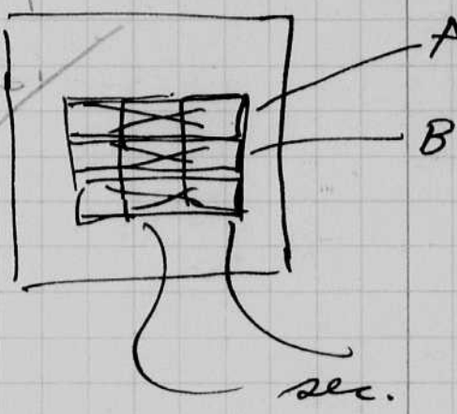
64	64.7	3
32	27.7	7
16	14.9	13
8	7.47	27
4	3.8	51
2	2.11	92
1	1.	194

1		194
2	2.09	93
4	3.9	50
8	7.2	27
16	14.9	13
32	27.8	7
1		197
2	1.97	100
4	3.86	61
8	7.6	26
16	16.4	12+
32	32.8	6
64	65.7	3
3.5	117	197
4.5		117
5.6		78
6.3		62
8		38
11		21
16		10
22		5

Power transformer
Raytheon M11612-2

Secondary Burned out in N.Y. Comm. Illus. Wyckoff.
Pmin A with taps
Pmin B - between coils.

new secondary made at Raytheon



EK?

Taken at dinner in Sept with Graflex and Dornitzer flash unit Hans Schamaker and Dornitzer.

Bachrach VandeCar. Jenon

 Oct. 1947

A. S. Edgerton

HN 34 Polaroid. Al Makens.
works ok. Cutler Hart.

140 - 2.5
441 - 64. relation meter.

20 x 50 panels.
about 4 sq inches per in almost

5 - panels. @ $50

$\frac{50}{250} = \$\frac{1}{5}$.

HN-34 Pioneer Scientific ~~Inst~~ Co
Empire State.
N. Y.

60.5" FT-14 10.5 mf 2150 v

MIT		meter
1		200
2	2.12	94
4	4.25	47
8	9.1	22
16	18.2	11
32	40	5+
64	100	2+

4	~~200~~ 196	27.5
8	96	
16	42	
32	19	
64	8	

HN 32 Double sheet. .005

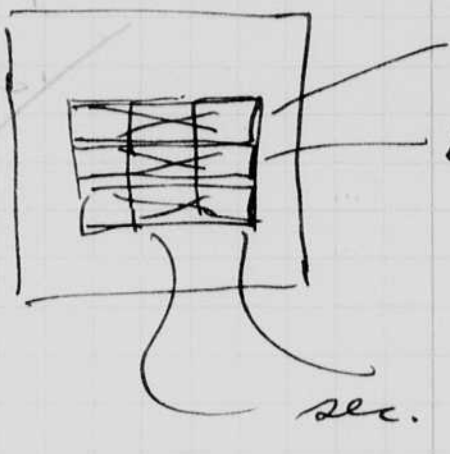
64	64.7	3
32	27.7	7
16	14.9	13
8	7.7	27
4	3.8	51
2	2.11	92
1	1.	194

1		194
2	2.09	93
4	3.9	50
8	7.2	27
16	14.9	13
32	27.8	7
1		197
2	1.97	100
4	3.86	51
8	7.6	26
16	16.4	12+
32	32.8	6
64	65.7	3
3.5	117	197
4.5		117
5.6		78
6.3		62
8		38
11		21
16		10
22		5

Powertransformer
Raytheon M11612-2

Secondary Burned out in N.Y. Comm. Illus. Wyckoff.
Prim A with taps
Prim B - between coils.

new secondary made at Raytheon



EK ?

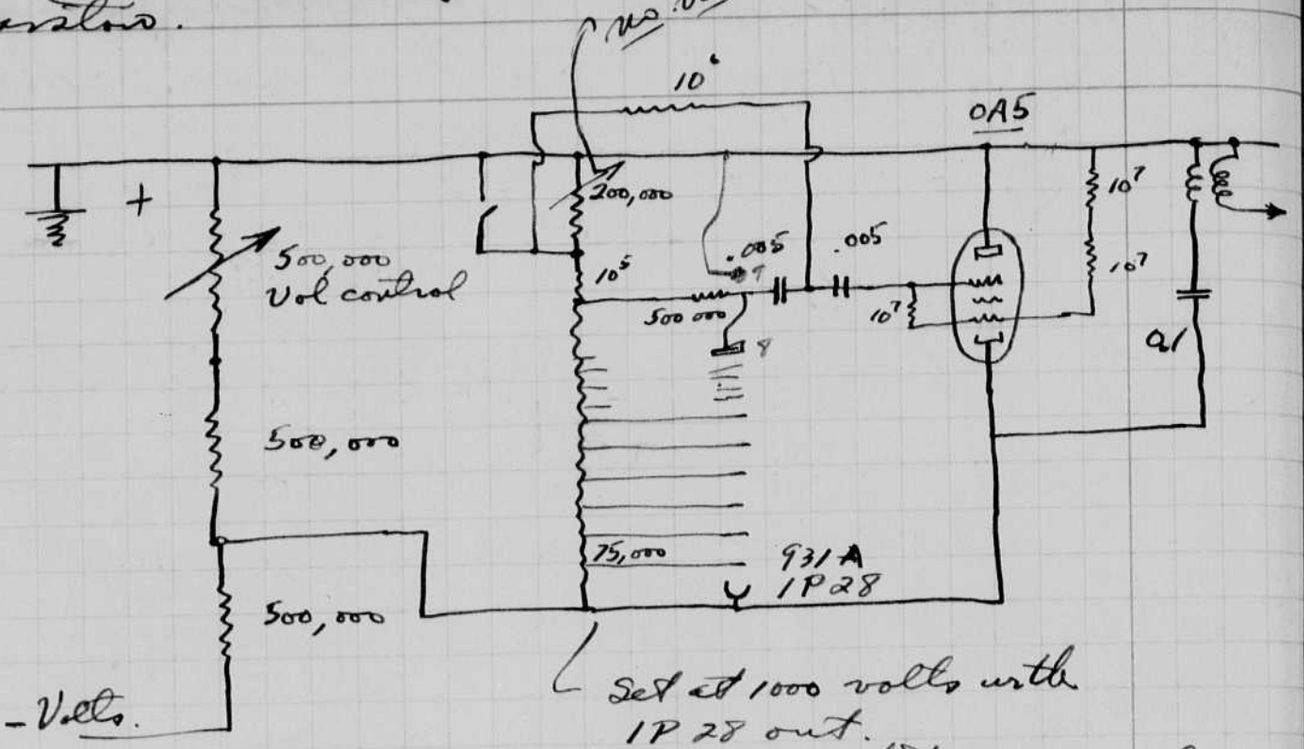
Eddy →

Taken at Chicago in Sept with Graflex and Dormitzer flash unit Hans Schumaker and Dormitzer.

Bachrach Vandecarr Leman

Photo multiplier tripout fit.

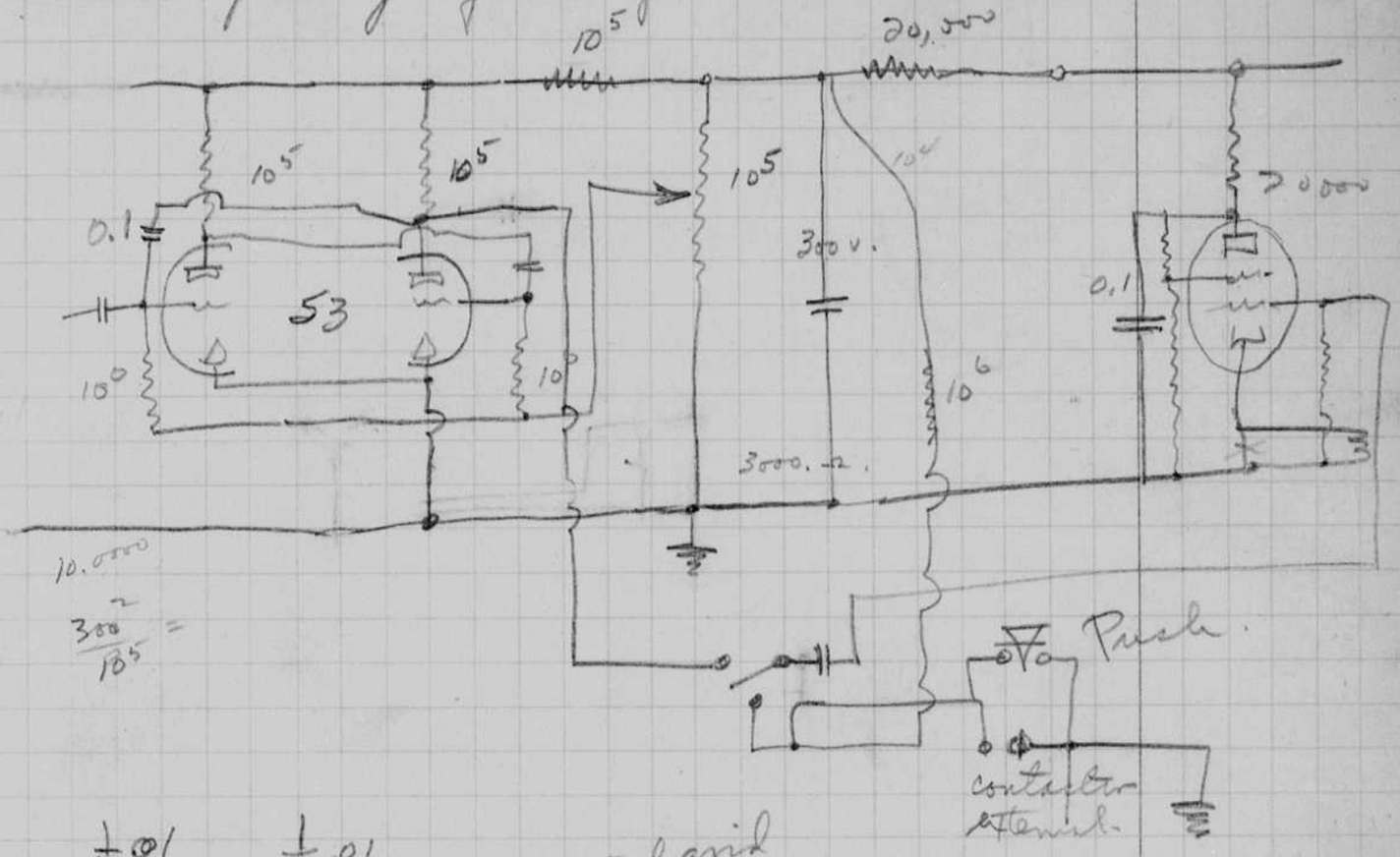
from Barstow.

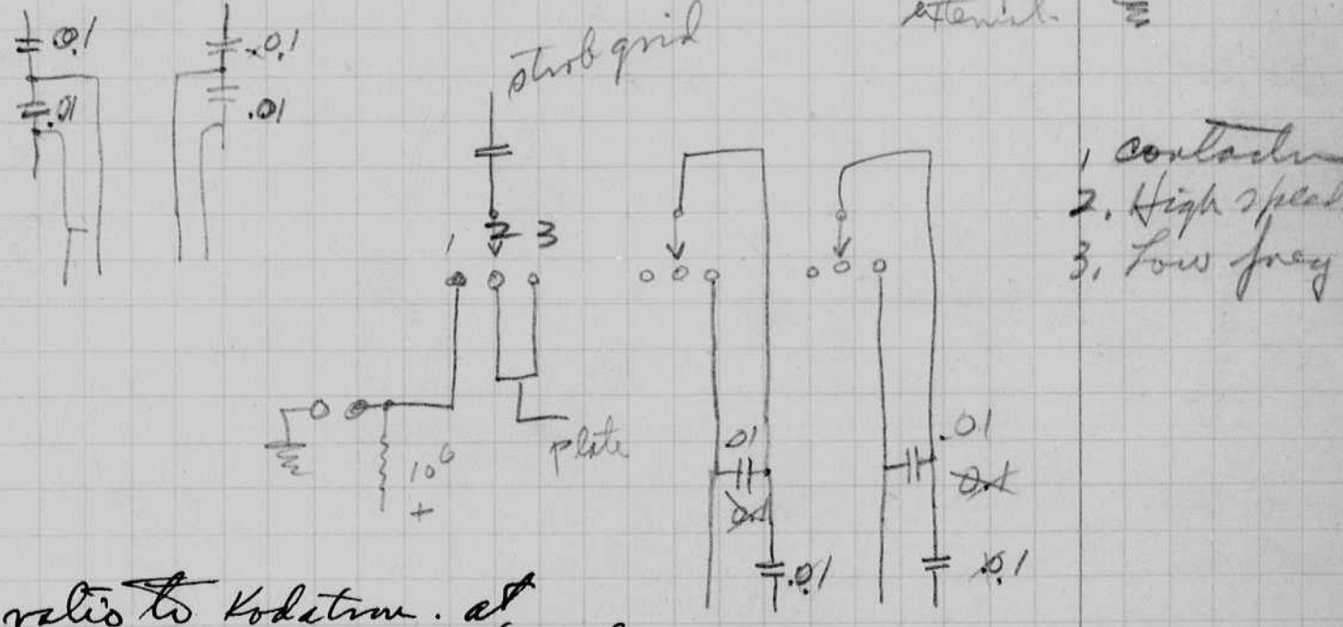


Set at 1000 volts with IP 28 out.
Vol control set to max value about 750 volts with Vol control set to 0.
this is sens. control.

Nov 1, 1947 Rebuild of multiflash unit.

Jack Reilly wired a multivibrator oscillator into the old multiflash unit for better control of the frequency.

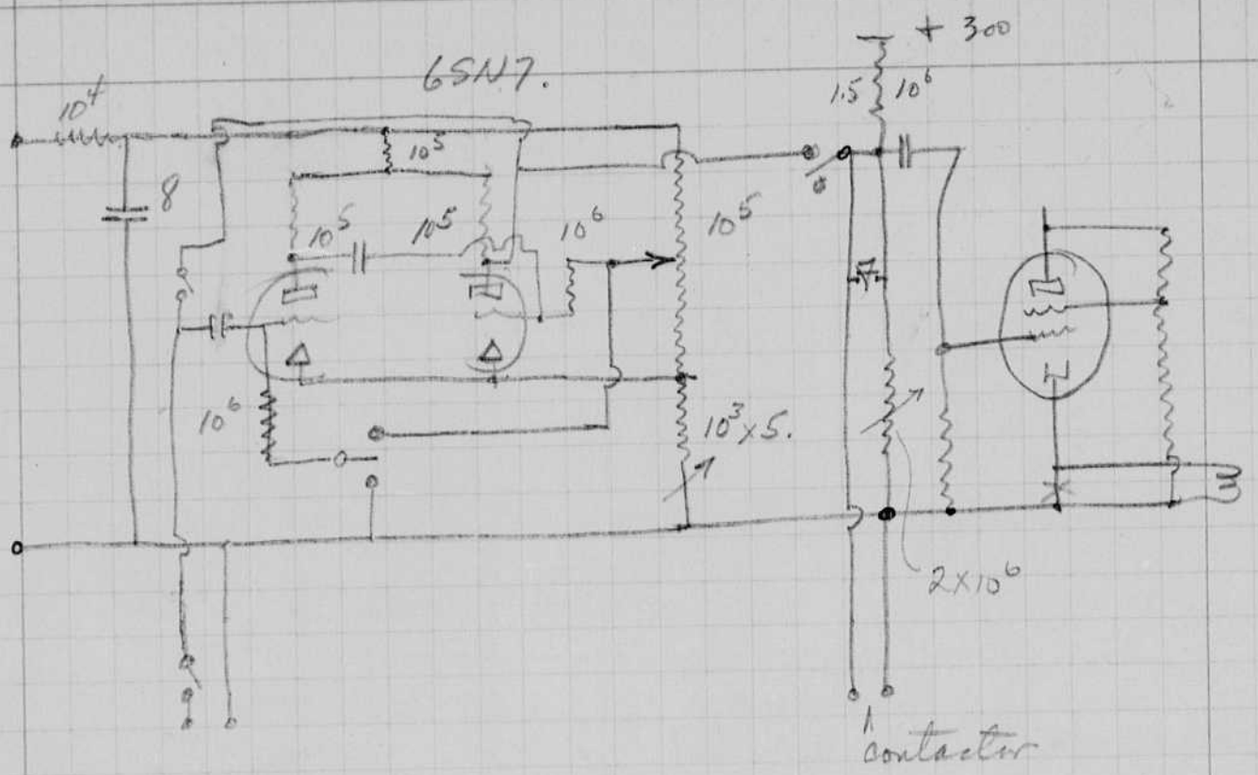


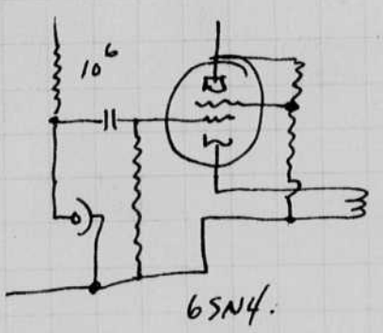


Light ratio to Kodatron. at center of Beam in 18" Bard reflector

$\frac{1/97}{18} = 1/5$

Guide factor of Kod = 400?
" " " multiflash. 200 or 100.


6SN7.
+ 300
10^4
8
10^5
10^5
10^5
10^6
10^5
10^6
$10^3 \times 5.$
1.5
10^6
2×10^6
1 contactor


10^6
6SN4.

Sat. Nov. 15, 1947 Test of D.K. Light meter.

Kodatron light source 136 mf 2000 V ± Spec. ref.
10 ft from meter in beam alternator Polaroid set at 64
Reading 84 (out of 200 ma full scale)
at 32 the meter reads 162.

f 22 setting gives meter of 150
22 → 4.5
$\left(\frac{4.5}{22}\right)^2 = \left(\frac{1}{5}\right)^2 = \frac{1}{25}$.

Comments
1. Put stop on rotating part of alternator.
2. Wider zero line triangular ◿
3. Cell zero on top of cabinet. —⊖

One layer MIT Bond paper.
f 4.5 meter 130

Tissue paper + M.I.T. paper
f 4.5 meter 80. ← about right for daylight Kodachrome color film

{10 mf 2000 V → 551 lum/sec.
30 mf 2000 V 1850 " "
from D.K.

Std lamp #5 ~~10.60~~ mf.

30.56 mf.
2060 volts.
2000 lumen sec.

30.56 mf at 1980 volts should give 1850 lum/sec.

$\frac{2000}{1850} = 1.04$ $\sqrt{1.04} = 1.02 \times 1980 = 2060$ volts.

20.25" meter-top to lamp center
Reading 100 with 2 paper filters as per above.

f 3.5	100
4.5	60
6.3	38
f 3.5	200
4.5	117
5.6	76
6.3	61
8	37
11	20
16	10
22	5

Distance 14.5"

192
→40 $\left(\frac{22}{3.5}\right)^2 = 394$

$\frac{200 \text{ c.p.s.}}{14.5^2} = .952$ lumens per sq. inch.

Proper light for f 3.5 with Kodachrome Xenon flash. meter at 200 with meter at 100 .952 × 144 = 137.0 lumen sec. sq. ft.

85% lumen-sec sq. ft.

With Guide factor of 40.

with Guide factor of 32. → See page 111 for alternate factor of 92.7.

$\frac{40}{32} = 1.25$

$\frac{92.7}{68.6} = 1.35$

A. E. Edgerton

Nov 18 1947

Willard battery ER-15-6 6795 Part No. 20.

called by Drake (22). 20 amp. hours. Wt. 9.75 lbs.

6 volt.

200 recycles.

3 ball indicators.

200 days complete discharge.

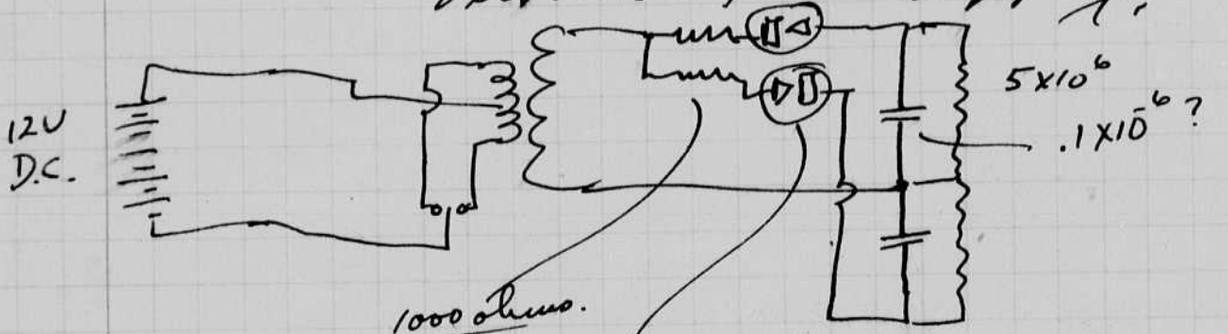
D.C. Calib of B.R. meter #24 (case)

500 ma	~~1.64~~ volts	1.325 volts for full scale.
	~~1.65~~	1.325
100 ma.	~~67~~	.67

67
2
1.34

Nov 20, 1947 Visited G.E. plant at Lynn yesterday to show them the B.R. Light meter.
Simpson showed me around and I met many there. Anderson Savage.
Knisard. Severance?
Stimpson will want a meter and is going to get one from G.R.

Vibrator Power supply.



Raytheon. CK 1013 or 5517

after 12 hours the tubes and resistors flashed over. The resistors split open due to an arc over in the desistor??

Rewired with 2500 ohm carbon type. instead of 1000 ohm.

Nov. 22.

On Nov 10 and 11 I went to Schenectady with Nottingham and several students to visit the G.E.Co.
Yarger was here this noon to discuss 2500 watt sec. flash units.
Mason & Kimm were here at 2:15 yesterday to show me a battery (dry) model flash unit 2500 V 15 mf.

6.46 Class 1947 Nov. 1947.

Zoller

— Johnson

Wm Newton

Nov 26.1947. E.R. Meter (light) has been under test for a week or so. Wychoff and Barash helped yesterday and today. The factors from the crossed polaroids do not check against the distance.

H. E. Edgerton

Nov 18 1947

Willard battery ER-15-6 6795 Part No.

called by Drake (22). 20 amp. hours. Wt. 9.75 lbs.

6 volt.
200 recycles.
3 ball indicators.
200 days complete discharge.

D.C. Calib of D.R. meter #24 (case)

~~100 ma~~ ~~1.67~~ volts 1.325 volts for full scale.

~~1.66~~ 1.325

100 ma. ~~1.67~~ .67

67
67
1.34

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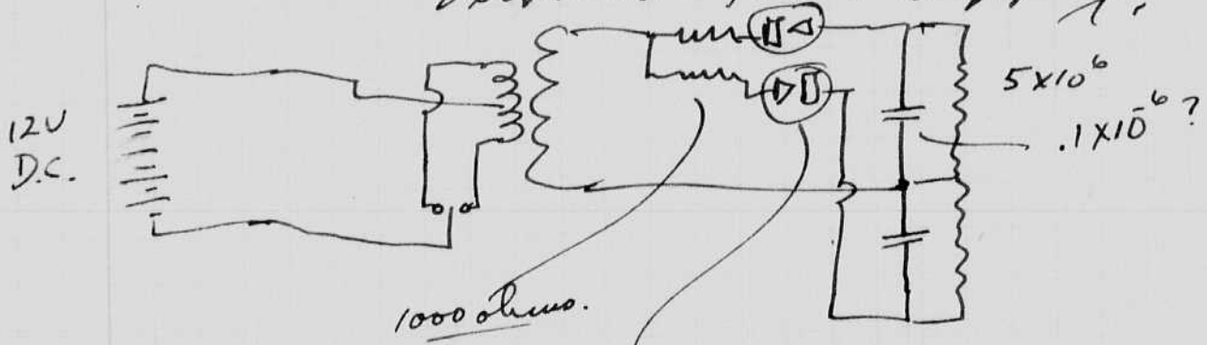

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Folder

Johnson

Wm Newton

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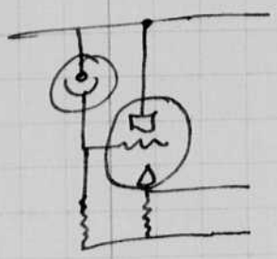
134 Nov 26 1947
Harold Edgerton

Photocell Pickups for short flashes

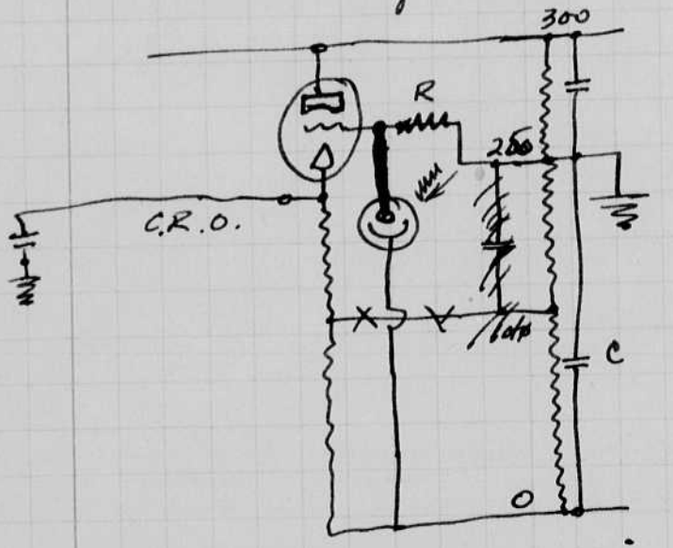
The conventional photocell pickup circuit for light pulses is shown below

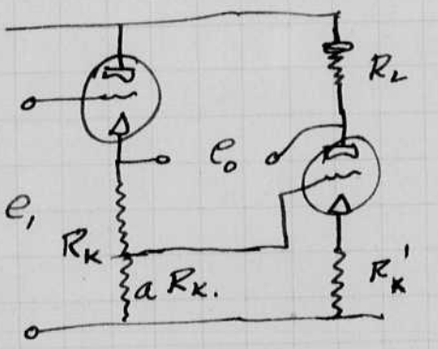


a cathode follower reduces the time constant of the circuit and permits leads to an oscillograph or an amplifier.

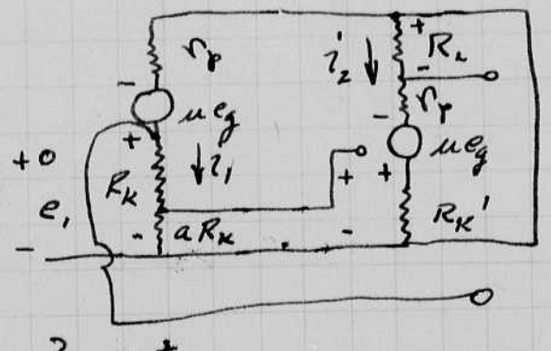
The cathode of the photocell is the largest part and therefore has the greatest capacity.

The circuit below holds the photocell cathode at constant potential by allowing the anode potential to vary with the light. Something needs to be done about the quiescent conditions.





$$\frac{\mu e_i}{r_p + R_K(1+\mu)} \qquad i_{pk}' = i_1' = \frac{\mu e_1}{r_p + R_K(1+\mu)}$$



$$i_2' = \frac{i_1' a R_K \mu}{r_p + R_L + R_K'(1+\mu)}$$

$e_1 = i_1' R_K$ balanced cond. $e_1 = -e_2$

$e_2 = i_2' R_L$

$$i_1' R_K = -\frac{R_L i_1' a R_K \mu}{r_p + R_L + R_K'(1+\mu)}$$

$$r_p + R_L + R_K'(1+\mu) = -\mu R_L a = (+\mu R_L)$$

~~$r_p + (R_L + R_K)(1+\mu) = 0$~~

$R_L(au-1) = R_K(1+u) + r_p$.

if $R_K(1+u) >> r_p$.

$R_L(au-1) = R_K(1+u)$.

and since $(1+u) \rightleftharpoons (u+1)$ if ~~u~~ u is large.

$R_L = R_K'$.

$$R_L = \frac{R_K'(1+u)}{au-1}$$

$R_L au - R_L = R_K(1+u)$.

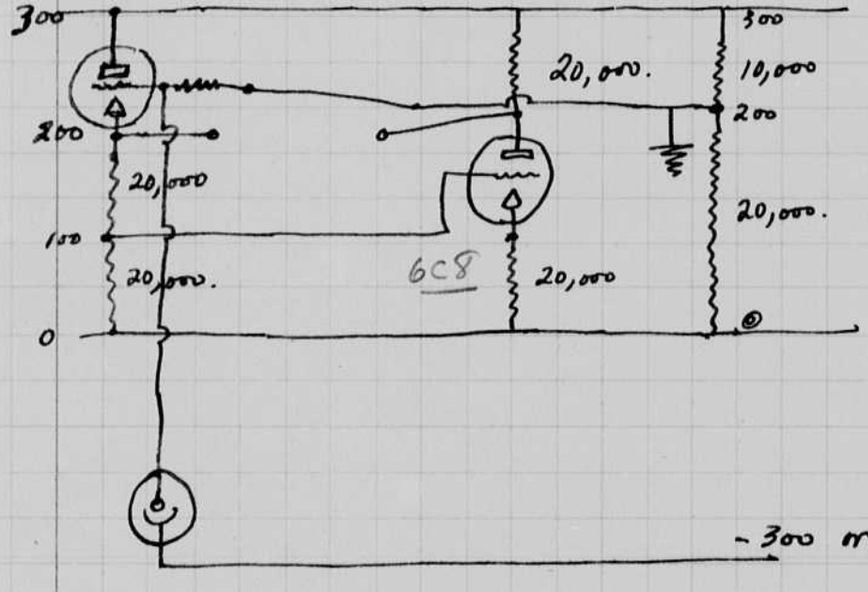
$$a = \frac{R_K(1+u) + R_L}{R_L u}$$

Try 6SN7 twin triode.

Total voltage = 300 volts. $I_p = \frac{5}{10}$ ma

E_{bo} = 100 volts ~~of~~ first tube.

$R_K = \frac{200.000}{.005}$ = 40,000 ohms.



$$R_L = \frac{R_K'(1+u)}{au-1}$$

$$= R_K' \frac{21}{9}$$

$$= .$$

use R_L = 20,000.

$I^2R = \frac{E^2}{R} = \frac{4 \times 10^4}{2 \times 10^4}$ = 2 watts

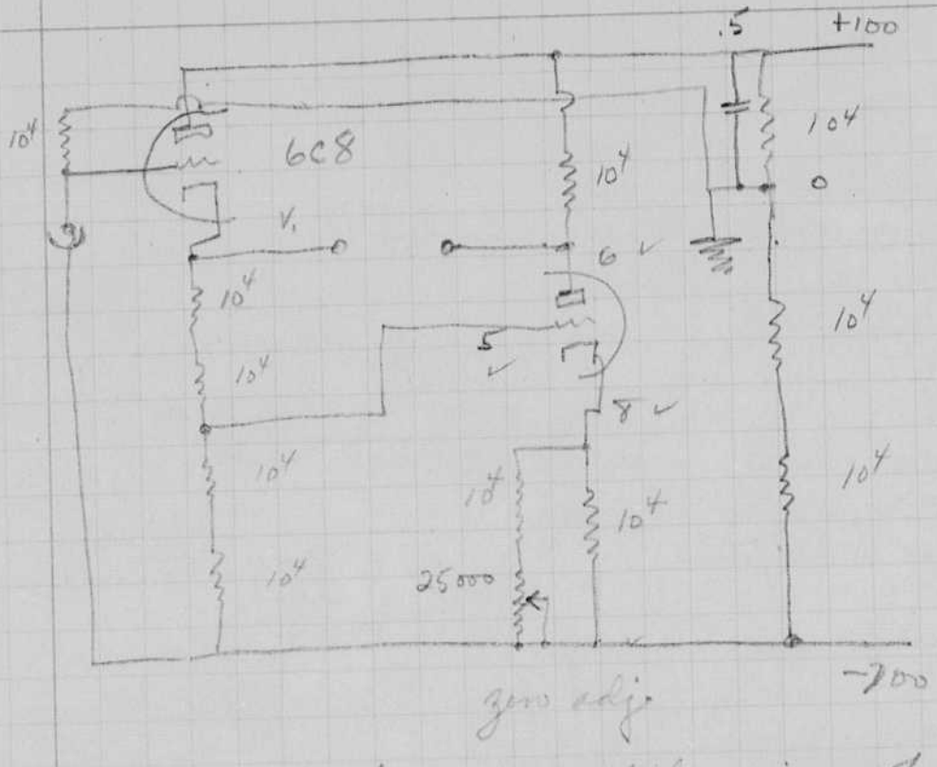
27 cathode.

Triode 2 caps grid
3 plate
4 cath
Triode #1
5 grid
6 plate
7 cath.
10 pin.

I had a conf with Zier and Fussell in the Hood Bldg. last Friday at 9 am about light pickups. an optical scheme was discussed. Peterson also had comments about it. a method to get a short flash consisted of a rotating mirror and a stationary slit to resolve a short time.

K. E. Edgerton
Nov. 29, 1947.

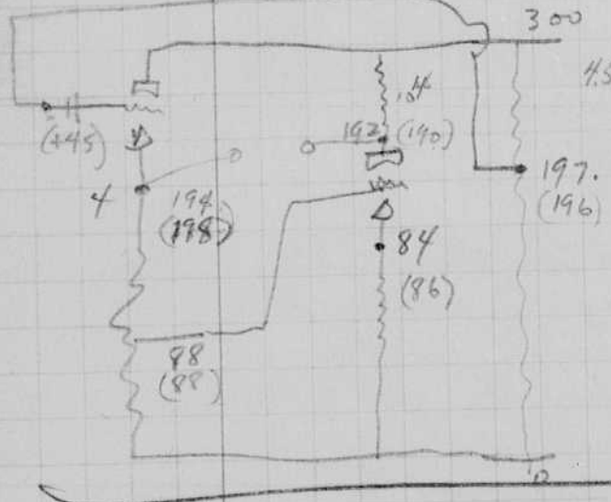
Photocell amp.



4.5 v input across 10^4 ohm input resistor

grids	
grid + 4.5	7.8 v
grid − 4.5	2.6

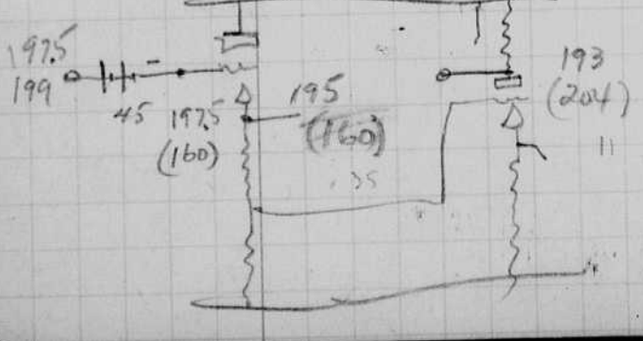
grid +4.5	
−3.1 + 3.6	V_1
6.7 v change	
+3.2 + 4.5	1.3 change



4.5 in = 9.3 volts out
1.8
7.5 volts out.

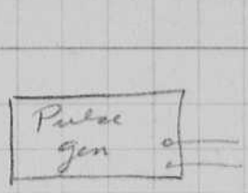
+ 4.5 volts.

$\frac{4.5}{10^4}$ = .45 ma.

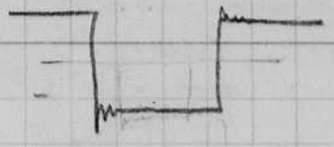


−45 in. 50 out.

.0.0300. $\frac{100}{10^4} = \frac{10^2}{10}$

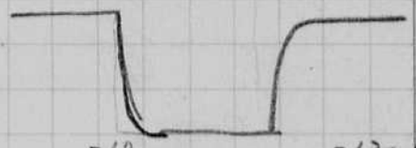


Into scope plate
8" of wire.



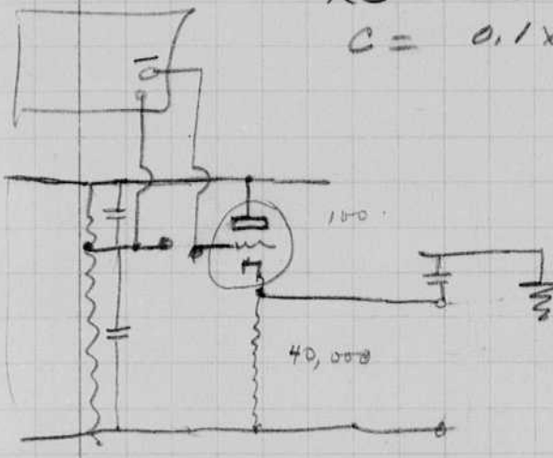
.5μs/inch

with 1000 ohms in series

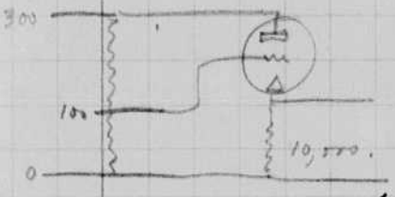


$RC = 0.1\ \mu s$ ±.

$C = 0.1 \times 10^{-6} \times 10^{-3} = 1. \times 10^{-10} = 120 \times 10^{-12}$ farads.
about or 50×10^{-12}



Time const long



Dec. 1. 1947 The cathode follower does not work well with a rapid grid swing since + and - surges produce different results.

When the grid is pulsed positive there may be grid current which helps to charge the output capacitance.

When the grid is pulsed negative the grid exceeds cutoff since the ~~g~~ cathode capacitance prevents the ~~g~~ cathode from following the grid.

The only answer is to use a low value of cathode resistance so the cathode can follow.

Daley started to work last week part time in the Electronic Lab.

Ben Logan quit his job and his course at M.I.T. last week.

Bob Deming is researching on short flash sources in Bldg 20 E 203.

Wyckoff spent today in B.R. with Wilkinson testing B.R. survey units and exposure meters.

 Dec 2. 1947

Rowe and Soroka from Aberdeen were here today to discuss flash sources. Klippinger also.

Source used at Aberdeen 0.02 mf 10,000 V. 1 watt sec

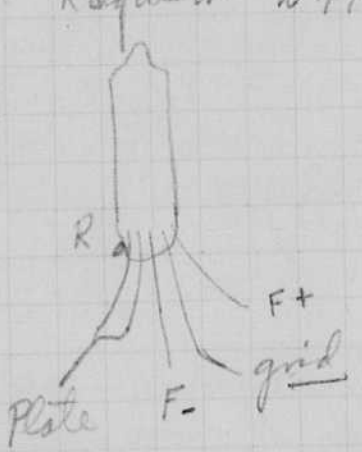
Point source.
Trouble with diffraction pattern when spacing was 22 ft with object at 11 ft.

Interferometer source
1/4 mf 15,000 volts. 30 watt sec.

We showed them Dennings experiments.
Mr. from Sylvania was here as well as ~~Denning~~ Newman.

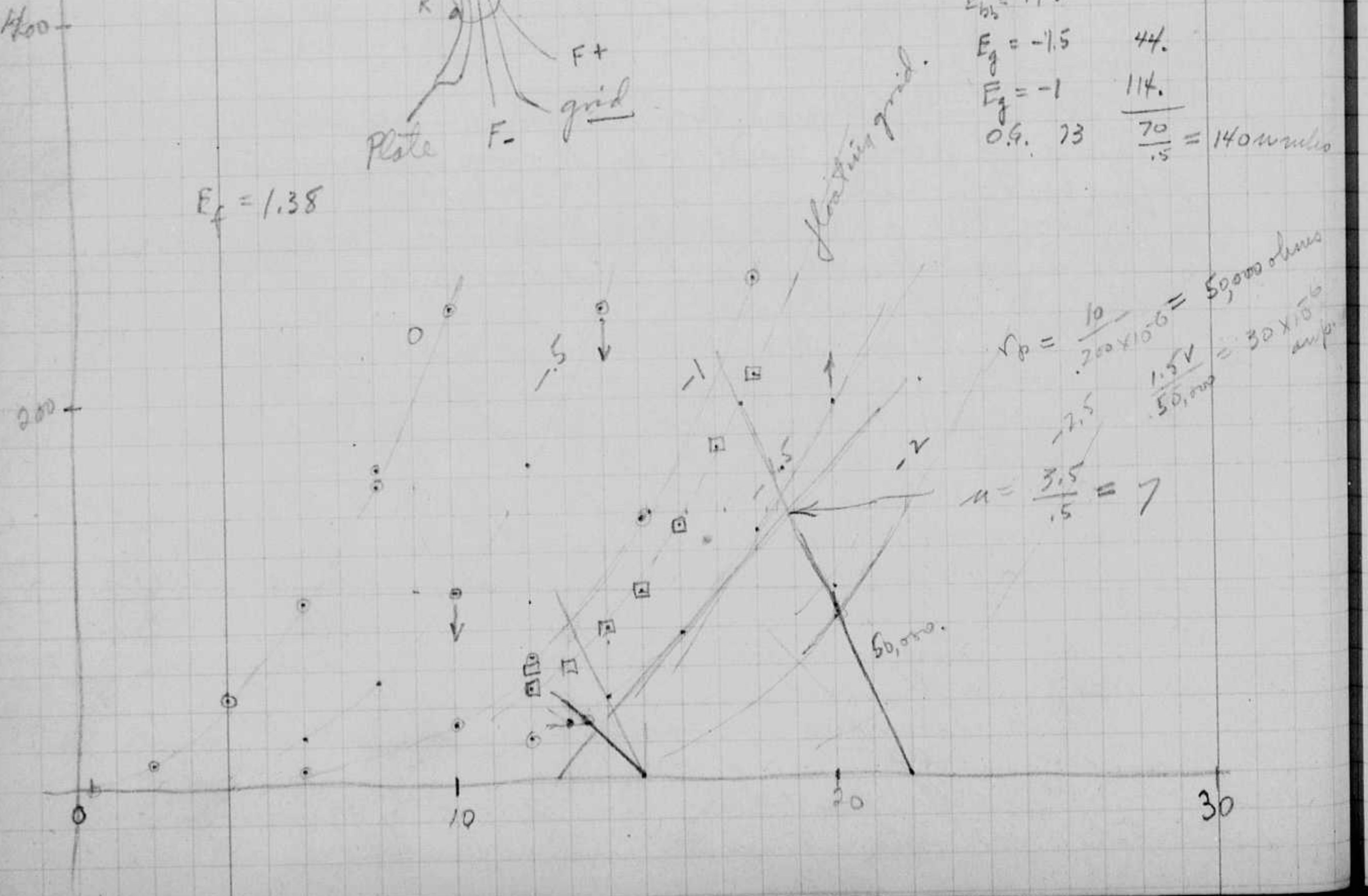
Dec 3. Visited Sylvania plant and saw H. Evaporation. Saw Juvanter working. H. Heins Soroka

Dec 6 1947 Raytheon W 497 tube characteristics



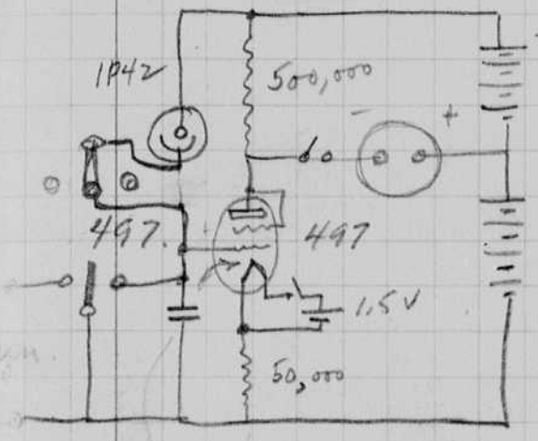
$E_f = 1.38$ I_p.
$E_{bb} = 14V$

$E_g = -1.5$	44.
$E_g = -1$	114.
O.G. 73	$\frac{70}{.5} = 140$ umhos



	#1	#1	2	3	4	5	6	
E_f	1.41	1.45	1.43		1.42		1.42	
E_g -1	115	122	137	119	62	126	113	
-1.5	45	49	59	45	22	46	41	
0	63	59.	57	46.	26	41	37	open grid

Calib of meter 1 = 12.1 ma. full scale



Sym.

.01 mf.

.002 might be ok?

I_{bo} = 30 ma

$\frac{15}{30\times10^{-6}} = .5\times10^{6} = 500{,}000$ ohms.

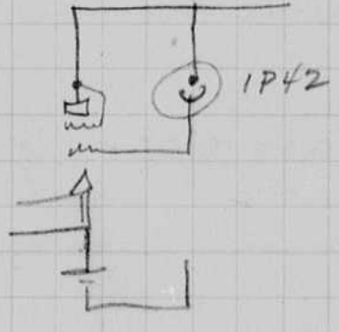
$I_g = \frac{\mu E_1}{r_p + 50{,}000\times7} = 7$ ~

350,000
500,000

$\frac{12\times10^{-6}}{\mu}\cdot 400{,}000 = E = \frac{4E}{7} = 1$ volt.
$= .7$ or 5 volt.
full scale.

$C = .01\times10^{-6}$

$eC = .7\times.01\times10^{-6} = .007\times10^{-6}$



Let $E_{bo} = 22 - E_c$
$= 22 - 2 = 20$ volts

I_b = 50 ma

$R = \frac{2}{50} = .04\times10^{6} = 40{,}000$ ohms.

Light Source for Color Motion Pictures.

Herwick Expertise
Dec. 9. 1947

The possibility of the use of electric flash lamps for motion pictures has appealed to many people since the efficiency looks good since there can be no light while the shutter is closed. The scheme has not been used because of

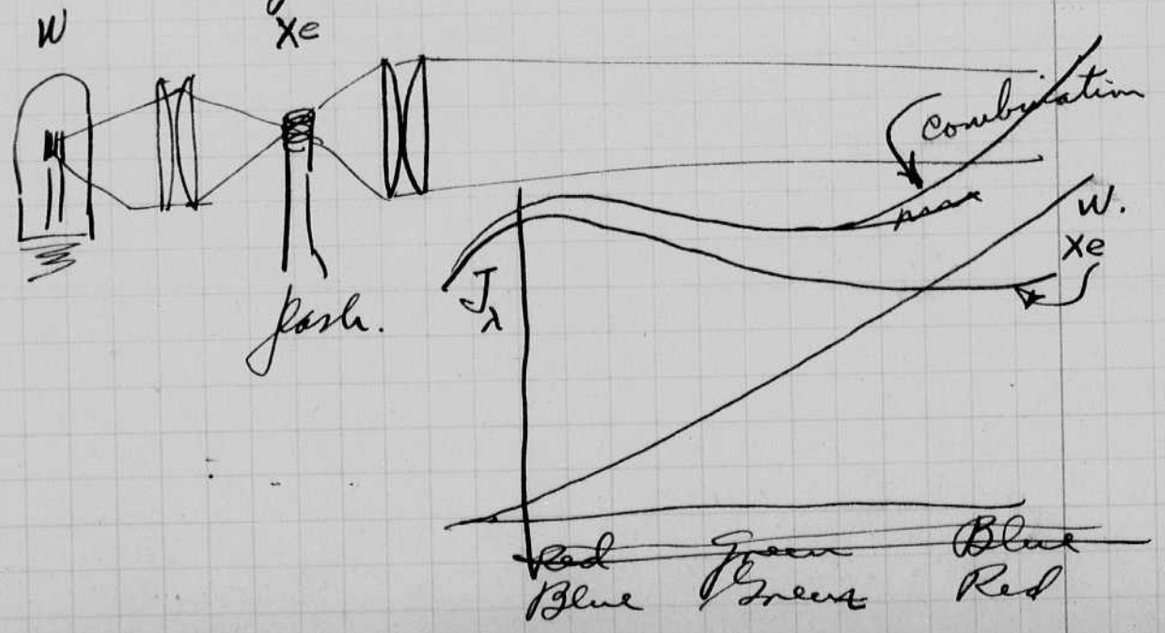
1. Flicker and
2. noise.

The tungsten lamp is very weak in the blue end of the spectrum while the xenon flash tube has an excess in this portion of the spectrum.

I now propose dual lighting where there is a balance between the two types to give the proper color rendition.

Furthermore there will be a great reduction in apparent flicker since the tungsten lamp will give considerable visual effects.

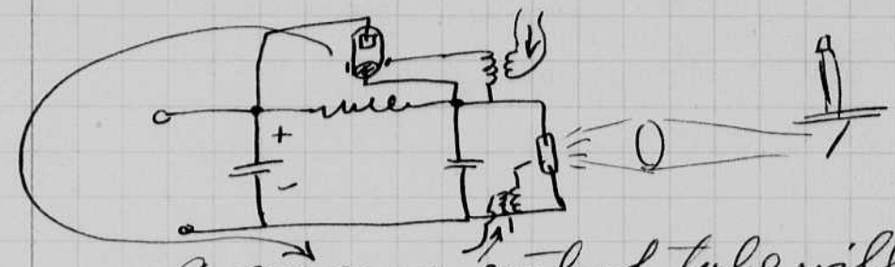
The noise problem will need to be solved by acoustic treatment and by various methods of increasing the discharge time.



Harold Edgerton.
Dec 9 1947

microscope illuminator.

Discussed with Barlow the following microscope illuminator.



A mercury control tube will be used to pass the filter capacitor into the tube that is used as a source of light.

Dec. 13, 1947. H.E. Edgerton.

Trip to Rochester Dec 11. arrived on early train. Saw Ford and delivered G.R. light meter no 102. Went to Univ of Rochester to see Brian O'Brian about his 10^7 pict per second camera. Sandell & Boon were on this trip. I gave a talk at the lecture hall on the 9th floor in the evening. J.W. Zillon and Frank Oberkoetter talked before I did on photography and flash bulb optic devices.

I was in N.Y. on the 12th of Dec. First I saw Harry Parker and then went over to his shop in Jamaica. I took an F train on the subway. 116 Merrin Blvd. Next I met Swartz at the Warsaw Studio where I met Warsaw, Sinn, Harris, etc. Saltzman was there checking the Parker & Young flash unit.

I measured the output from the lamp at 20 ft distance. The bulb was about 6 ft from the curtain. R=1 $\frac{128}{170}$ lumen per sq ft.

$$h.c.p.s. = \frac{128}{170} \times 400 = \frac{51200}{68000}\ h.c.p.s$$

$$\text{lumen sec} = \frac{512}{680,000} = \frac{53.3}{70.7}\ \text{lumens/watt.}$$

$$\text{watt sec.} = 1200\ 8 = 9600$$

With the 8" reflector supplied by Saltzman the light was 170 lumen sec per sq ft.
We tried a smaller reflector, closer and found 210 lumen sec. sq. ft.

Lsf.

142 Dec. 15, 1947 Color Tests

Hazard Elevator

Data with Chas. Wyckoff.

Kodachrome Daylight Type Emulsion 381-1
requires 100 - 120 lumen seconds / sq ft
at f 3.5 with CC 15.

$$f = \sqrt{K \text{ lum. sec/sq ft.}}$$

$$3.5^2 = K \quad 100.$$

$$K = 12.2$$

E.I. of Kodak = $3.5 \times 10 = 35$.

f 6.15 @ 5'-3"	380 lumen sec / ft²	32.3 guide factor
f 3.5 @ 9'-3"	118 "	32.3
6.15 @ 5'-9"	300 "	35.35
3.5 @ 10' 1¼	97 "	35.35.

Dec 19, 1947. The subminiature model of the exposure meter was finished by Mac Roberts on Wednesday just before my departure to Rochester on Dec 10. I tested the meter and found that a white card gave a reading of 10 ma on the meter (30 ma Westinghouse) when the level was satisfactory for color (Kodachrome). I showed the meter to Boon, Ford, Sandell, etc. on the 12th in N.Y. I showed the meter to Swarly and to Bigelow Green.
While in N.Y. I called Davis at the Commercial Illustrator's studio.

Jan 8 1948 Lohmeyer was here Jan 6 and 7 to test sync in the new Kalart camera. He left yesterday after tests showed timing trouble in the delay switch.

Notebook # 17

Filming and Separation Record

___ unmounted photograph(s)

___ negative strip(s)

1 unmounted page(s)
(notes, drawings, letters, etc.)

was/were filmed where originally located between page 142 and 143.

Item(s) now housed in accompanying folder.

142 Dec. 15, 1947

Color Tests

Harold Edgerton

Data with Chas. Wyckoff.

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requires 100 - 120 lumen seconds / sq ft
at f 3.5 with CC 15.

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= 3.5 x 10 = 35.

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Color Tests

15 December 1947
C.S.H.

f:6.15 @ 5'-3" 380 lumen sec/ft² 32.3 g.n.
f:3.5 @ 9'-3" 118 lumen sec/ft² 32.3 g.n

---

f:6.15 @ 5'-9" 300 lumen sec/ft² 35.35 g.n
f:3.5 @ 10'-1¼" 97 lumen sec/ft² 35.35

$5.25^2 = 27.6 \times 2 = 55.2$

$\sqrt{55.2} = 7.42$ ft (1 stop)

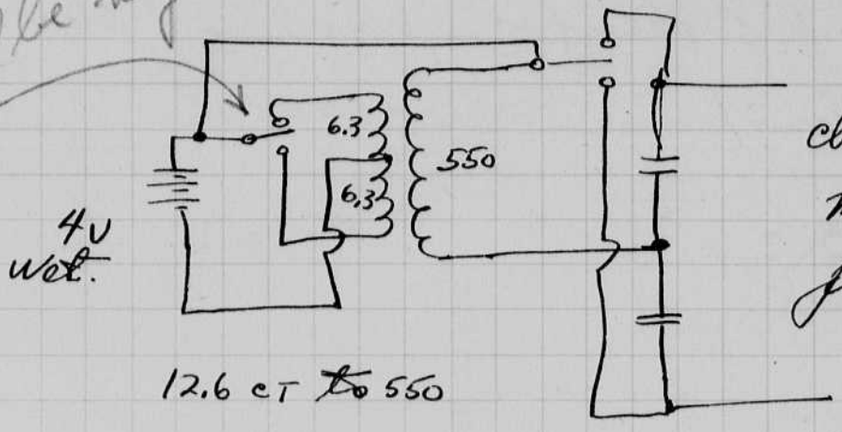
$27.6 \times 4 = 110.4$ $\sqrt{110.4} = 10.5$ ft (2 stops)

Kodachrome Daylight Type Emulsion #381-1 requires
100 - 120 lumen seconds / sq. ft at f:3.5 with a CC-15

Jan 8 1947. Portable.

Worked with Gemeshausen on portable circuit today. Tried following

should be neg



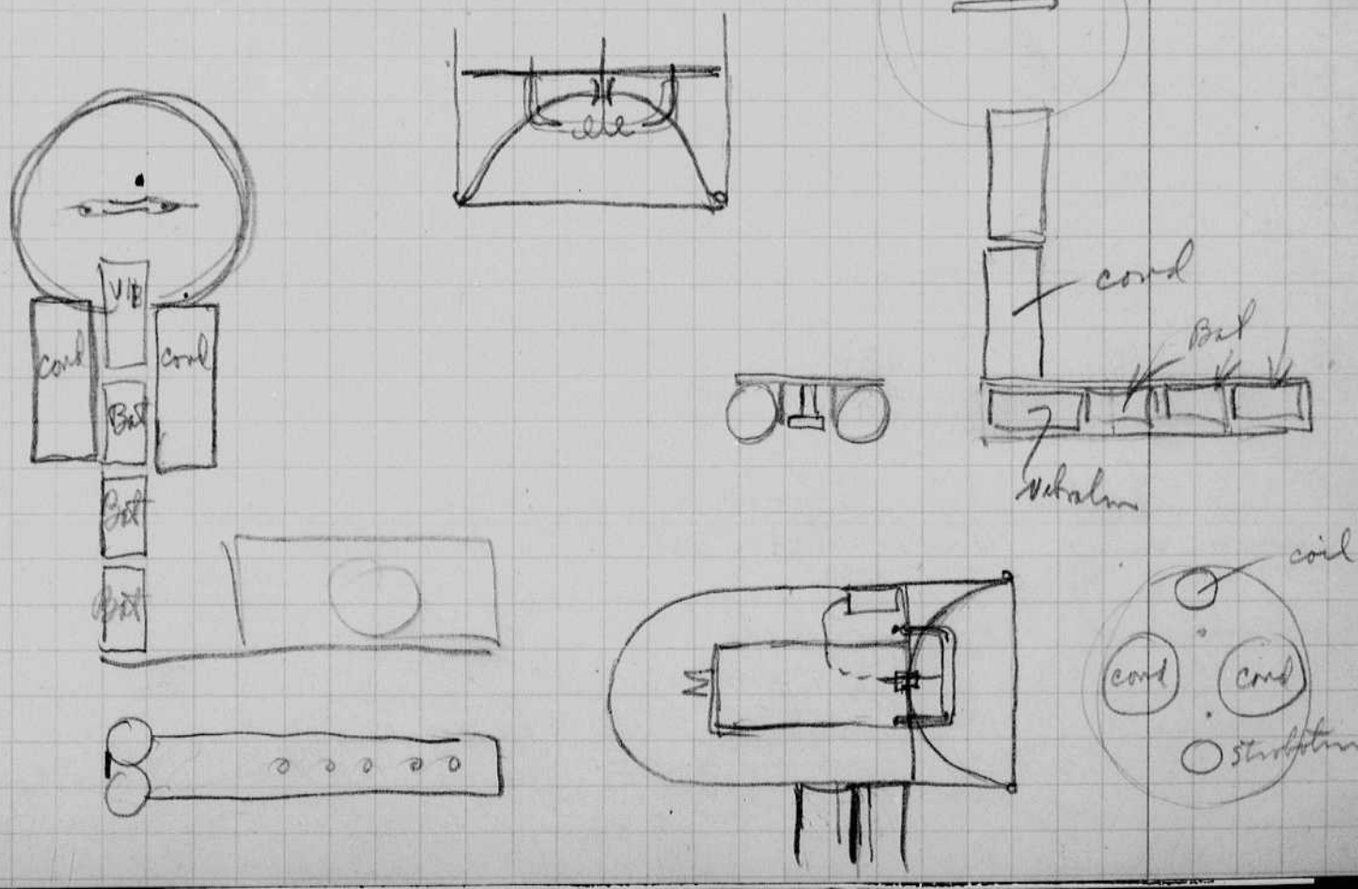
charges in 15 sec to 600-700V
max prim current = 4-6 amp
final at 600V = 0.7 or 0.8 amp.

220 + 550 windings in series.

at 705 Volts the primary drain was 1.75 amps.

Tried three D cells plain flash type Eveready. The output volts was 630 with a fresh battery if the capacitor was charged.

From a standstill point the voltage rose to 600 or 580. The load volts of the D cells was 3.8 volts (4.5 V connecting 3 cells).



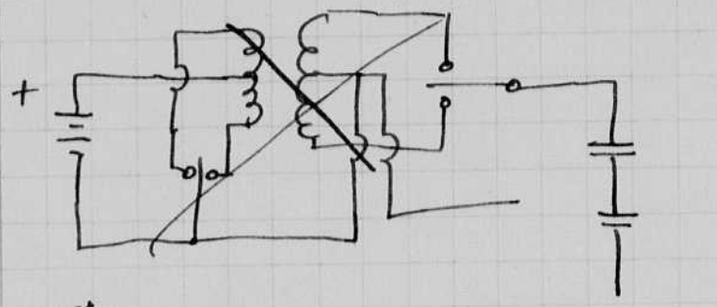
Jan. 9, 1948.

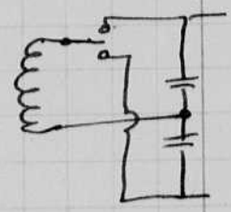
Don Willey of Mass. General went with me to see the 10,000 watt second unit at McCloud & Hanifol plant in Chelsea

McCann & Clair 6-2211

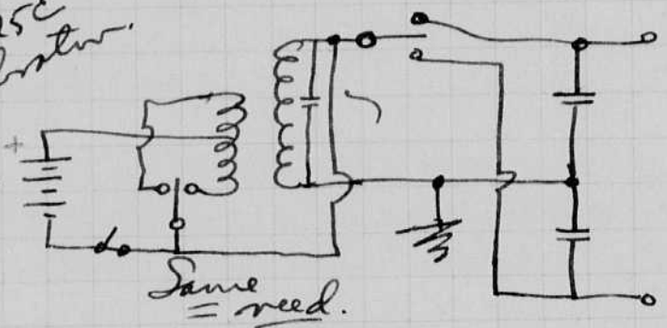
Jan 10 1948

Motorola Vibtransformer 25 B 23068-C 3C41. Portable design.





Medium 725C vibrator.



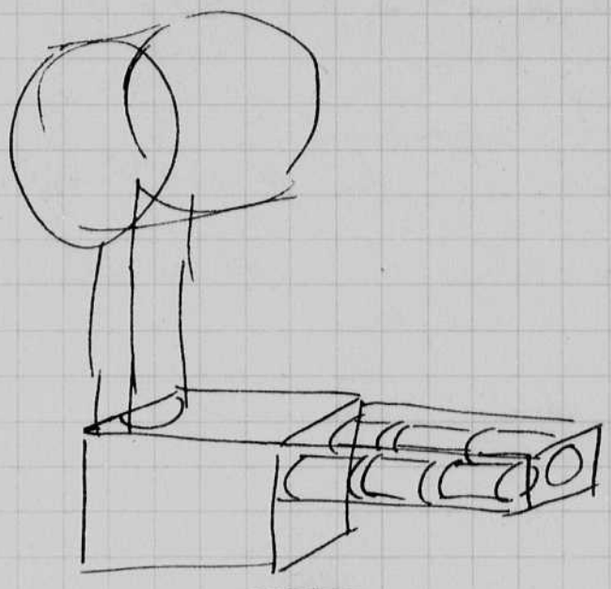
3.5 pape

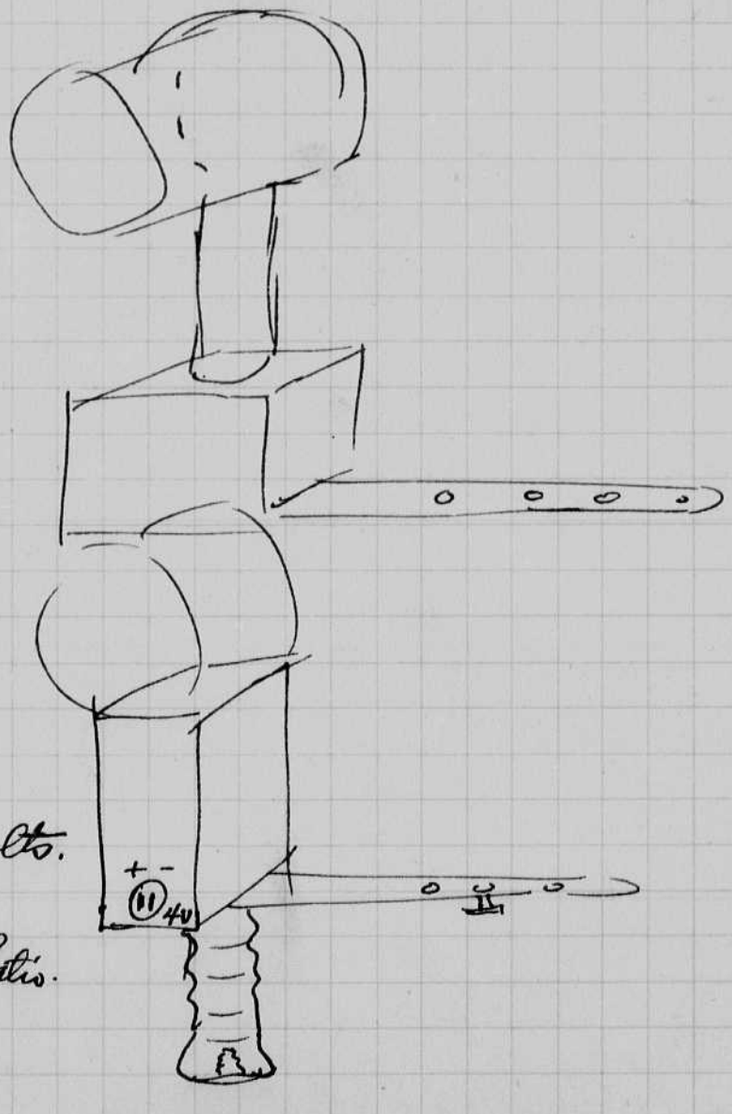
3.5 pape

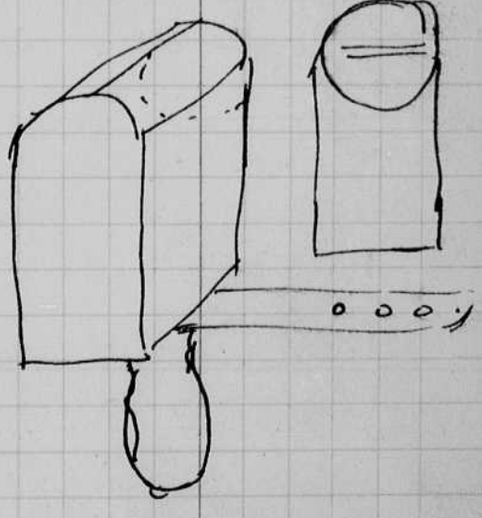
.4 amp.	4 volts input	output	600 –	.01 mf Buffer
.4 +	..		600 –	.005 .. ..
.7 +	..		550 ?	.05 .. ..
.58	6 volts.		920 V.	.01
.65	4.		530 V	.01 2 – 220 mf electrolytics in output.
.95	4V wet	2500 ohms in? series with trans sec.	650	C on transformer G2315
~~.975~~				
.88	4 W	0 ohms.	695	"
7 amps on surge		10 second charge time.	700	
4 amp surge		20 second charge 2500 ohms.	670 V	"
4 amp surge		1000 ohms.	685	"

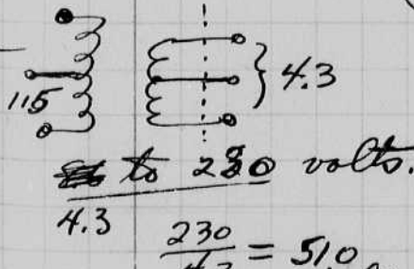
Charge time 20–30 sec with 3 – D cells in series. !!

Bat No 409 6 volts.
0.65 amps 4.2V (5.5 open cir before tests) 1000 Ω. 710 V on electrolytes.









~~6~~ to 230 volts.
4.3

$\frac{230}{4.3} = 51.0$ ratio.

Jan. 12, 1948.
Harold E. Edgerton

transformer design.

$\frac{N}{E} = \frac{10^8}{65000 \text{ sq in.} \times 110 \times 4.44} = 7.9$ table 8.

try #22 72 turns. for 4 volt input.

Ratio should be 8 to 100

Experiments shows exciting current high. 4V. 2.2 amp. 6V. 7. amp.

Second try #24 wire. and put on 140 turns with C.T.

Ratio 51, worked on data p145-146. try this on actual transformer.

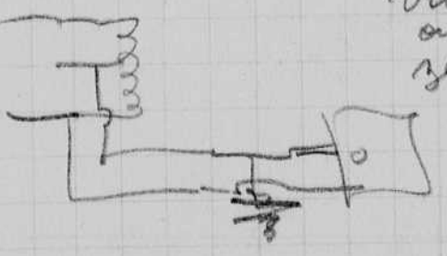
127 turns with C.T. works ok. Draws .45 amp from 4 volts with N94. 4 volt vib

with 6 volt. vibrator 75°C on 4 volts.

4V 0.22 amp into 127 C.T. trans.
6V .31 amp " " " "

Suggest $128 \times \frac{4}{6} = 84$ turns. try 100. CT

5100.

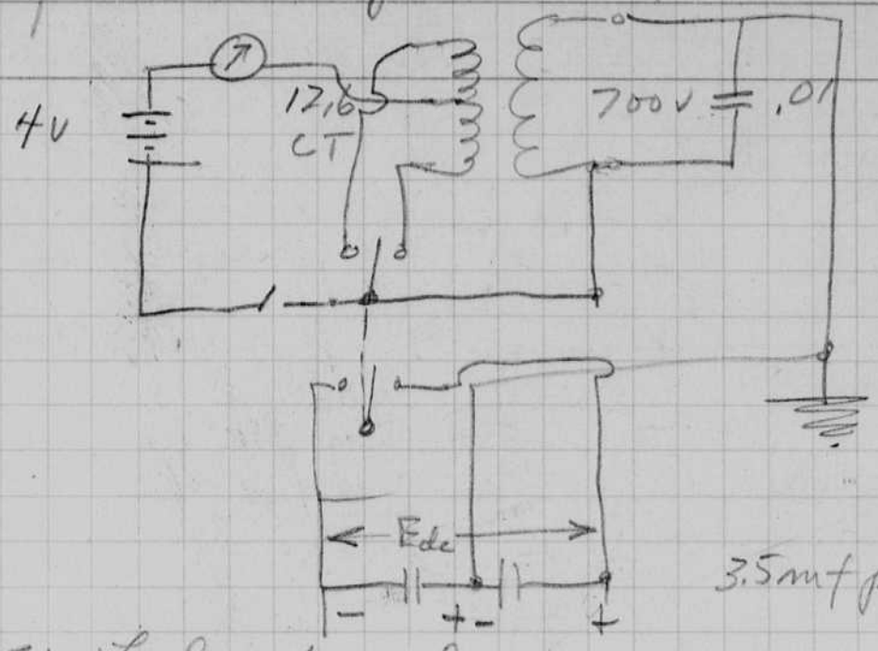


rms
4.4V = 18 div on scope.
vib = 11 div.
out.
Jensen plate.

$\frac{4.4\sqrt{2}}{18} \times 11 = 4.4\,V$

Jan 21 1948.

Mystic transformer



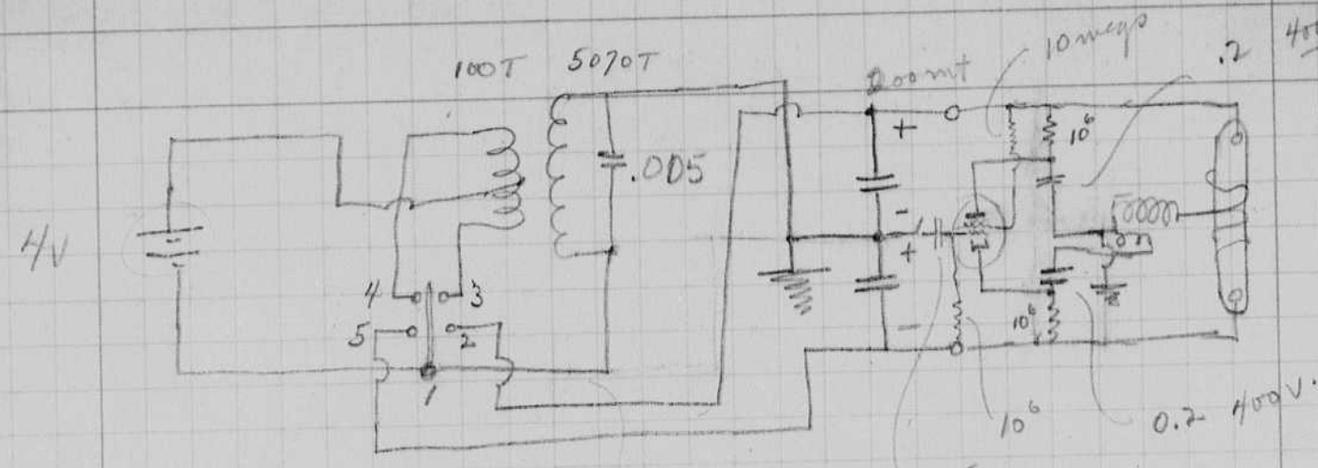
3.5 mf paper

Voc	Idc	Edc	Load and cond
4	.36	810	2-3.5 paper conds
4	.9	700	2- 200 mf 350 V electrolytic condensers
4	.8	730	" Buffer .005
4	.6	735	" after ½ hour.
4	.6	720	" .005 Buffer Bildo transformer.
4	.49	720	" .005. 5070 turns 100 C.T.
4.5	.45	700	#40 #24.
4.	.23	—	.005 buffer 1400 Ω

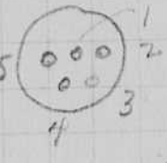
Transformer design Secondary 5070 turns
#40 wire 1400 Ω

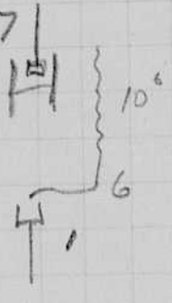
Primary 100 C.T.
#24.

250 cycle design
3000 turns of #38 wire
58 turns of #24 wire C.T. (29).
E stack.

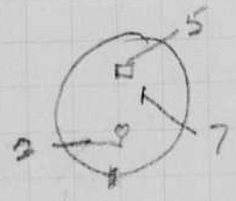


Mallory 725C
6 volt
vibrator.
works ok on 4 volts

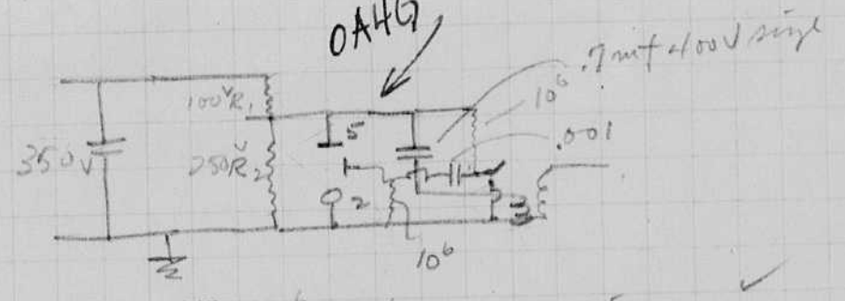




OA4G



OA4G



$\frac{R_1}{R_2} = \frac{R_1}{10^6} = \frac{100}{250}$ $R_1 = \frac{100}{250} \times 10^6 =$ ~~400,000~~ use 500,000. .5 meg.

.000 $\frac{350}{10^6}$

650 volts total reqd for start on the tube under test.

500V 8 sec
600 14 sec
700 30 sec.

Increased trip capacity to 1 mf now start with 11 seconds to charge.
530 volts on flash tube
Max current from battery = 3 amps ± at 4 volts.
Beam light is about half of old portable.

Transportable Power supply. 12 volt power supply buffer.

Unit Input 12V fully charged Raytheon trans 10 amp peak ± .5 amp 10 sec ≥ 2500 2850 fuse

Red-yellow lead

10V 9 amp .6 amp 2620

Black-yellow 10V 9 " " 2720

Green-yellow 10V 9 " .6 2420

12 3550 +

10 after 5 min. 2780

Suggest put on 10/12 of winding. 5/6.

Jan 28 1948

Harold E. Edgerton.

I was in N.Y. yesterday to attend a new committee of the Society for motion picture engineers on High-Speed Photography. John Waddell of the Bell Telephone Lab. was the organizer and the chairman.

Worked today with Lew Fussel on the project for the Pacific next spring.

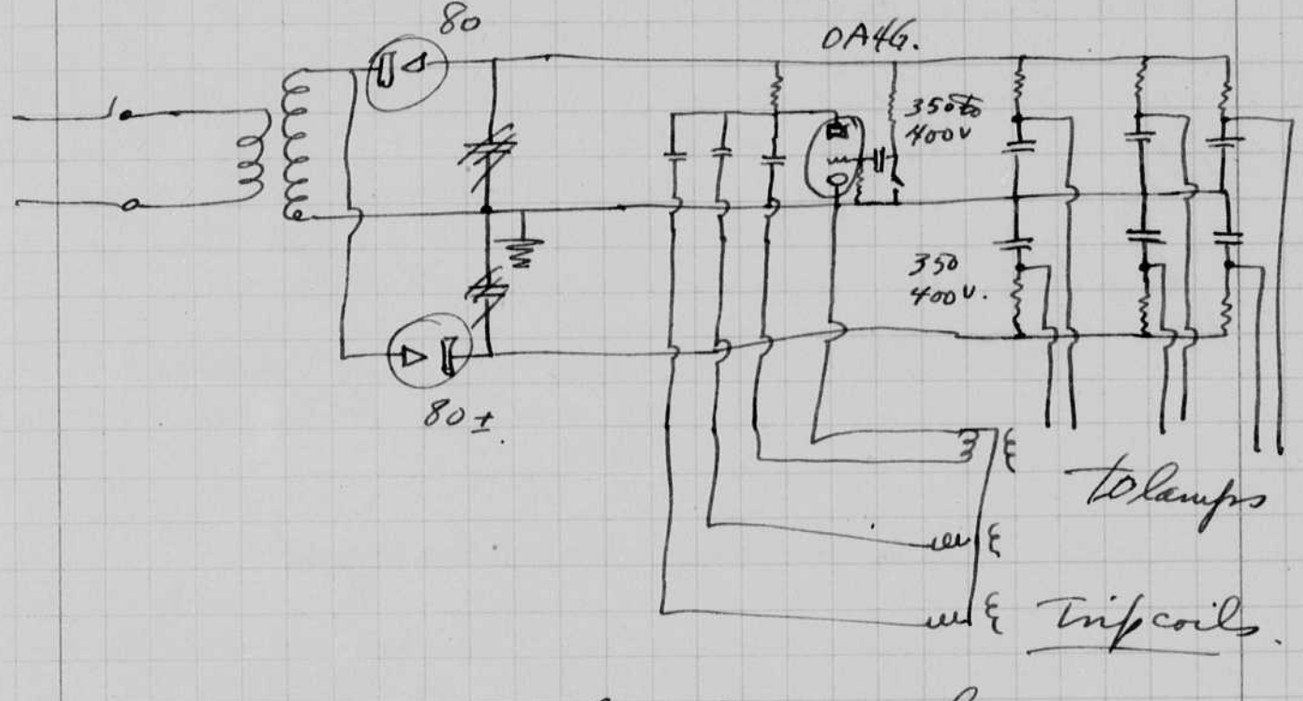
There seems to be difficulty with the oscillographs that are to be used. These were made by Dumont in N.J. A 25,000 volt accelerating voltage is used on the tube to get the light for fast photography. Apparently there is enough field emission to give a considerable exposure from the light from this field emission.

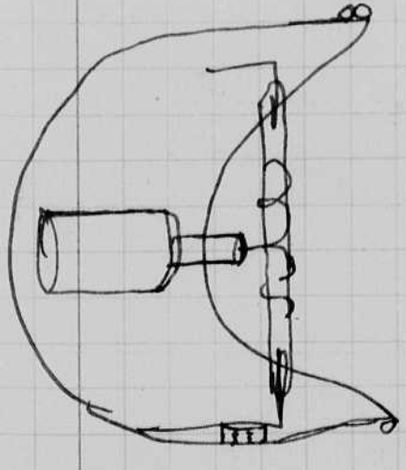
Carlson of W.E. Co Cleveland Ohio. was here last week. Friday. Bevans and I showed him the new circuit on the portable. He is going to make light distribution curves on the reflector for us in Cleveland.

Jan 28 1948
H B Lyster.

Several weeks ago I outlined an ac flash unit that will be composed of small lamps and capacitors, electrolytic, of the type shown on page 143. Data in the light meas book will show that 100 mf at 700 volts into a small straight tube will produce as much light as the old portable (25 mf 1400 V into an FT-20).

Circuit proposed.





The above is being considered as a light-source for Frank Conant's camera for identification purposes.

June 18 1948

Harold Edgerton.

I returned from Eniwetok atoll in the Marshall islands on June 8 and have since then been catching up on correspondence and other items that came up during my absence.

I went to Eniwetok with Herb Grier and others at the request of the atomic Energy Commission to help instrument three bombs. My work is covered in a note book like this. # 18

Jerry Schere called about the 2800 watt sec flash units for E.K. that are being made by Raytheon. There are 24 outfits about to be shipped by Raytheon after being slightly modified to meet the underwriters specifications.

new plant manager J.E. Smith.

1. Switch - Interlock was not marked for 110 volts. Otherwise same switch.

2. Fuse holder was changed

3. Temp rise was too much. Louvers were cut in the sides of the power supply units.

4. The insulation test as made by the underwriters lab was based on 4000 v instead of 2000 mid tap.

Notebook # 17

Filming and Separation Record

____ unmounted photograph(s)

____ negative strip(s)

__1__ unmounted page(s)
(notes, drawings, letters, etc.)

was/were filmed where originally located between page 152 and 153.

Item(s) now housed in accompanying folder.

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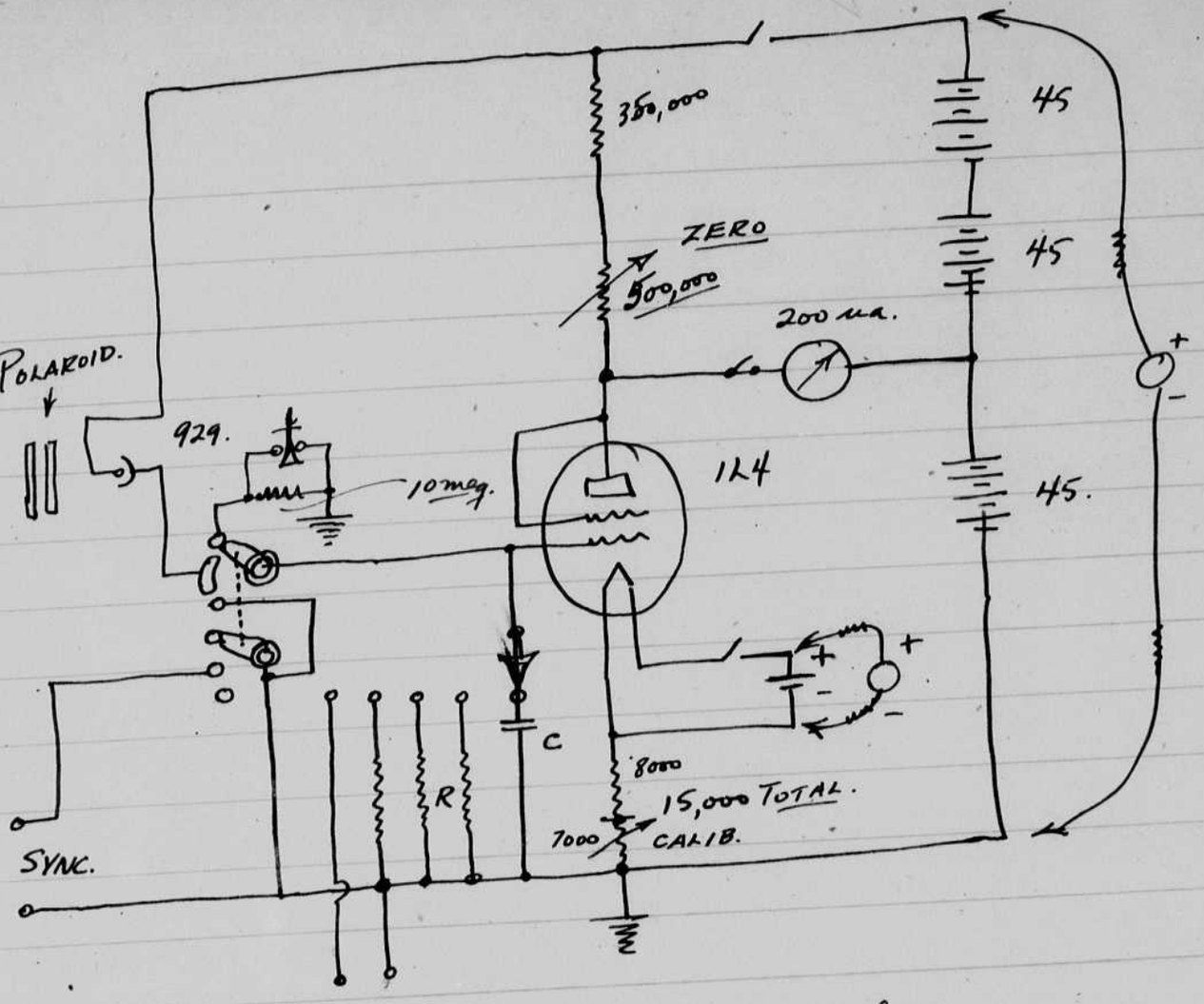

R = 0.1 1. and 10 megohms

C = 0.1×10^{-6}

RC = ~~10^{-4} 10^{-3} and 10^{-2}~~

10^{-2} 10^{-1} and 1.

Nov. 4, 1947

H. E. Edgerton

CONTINUED
ON
NEXT REEL