HAROLD E. EDGERTON

PAPERS

MC 25

Series III

Laboratory Notebooks

Number T-6

Dated August 27, 1935 to April 28, 1936

Massachusetts Institute of Technology

COMPUTATION BOOK

NAME	Number
HAROLD E. EDGERTON.	T-6.

Room 4-111 M.I.T.

Course .....

Used from AUGUST 27 1935, to APRIL 28 1936.

HAROLD E. EDGERTON
M. I. T. Cambridge, Mass.

Spark coil data p 13
New Strobotron p 36. p 150.
Imp. coil data. 42.
Synchronizer 77 - 143 - 93
Ignitron p 46.
p 127 exp.

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 BRANCH

HARVARD CO-OPERATIVE SOCIETY

76 Massachusetts Ave., Cambridge, Massachusetts

Harold E. Edgerton.
August 27 1935
Mass Inst of Tech
Room 4-111.

Aug 27 1935

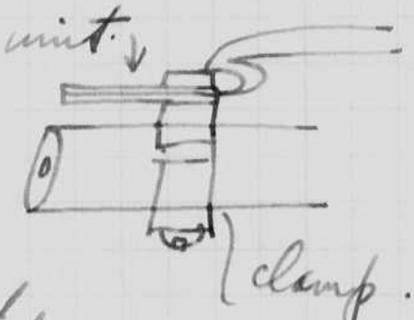
H. E. Edgerton.

I received today from the Brush Development Co Cleveland Ohio two piezo electric units. East 40th & Perkins ave.

1 # T-16 torque units.

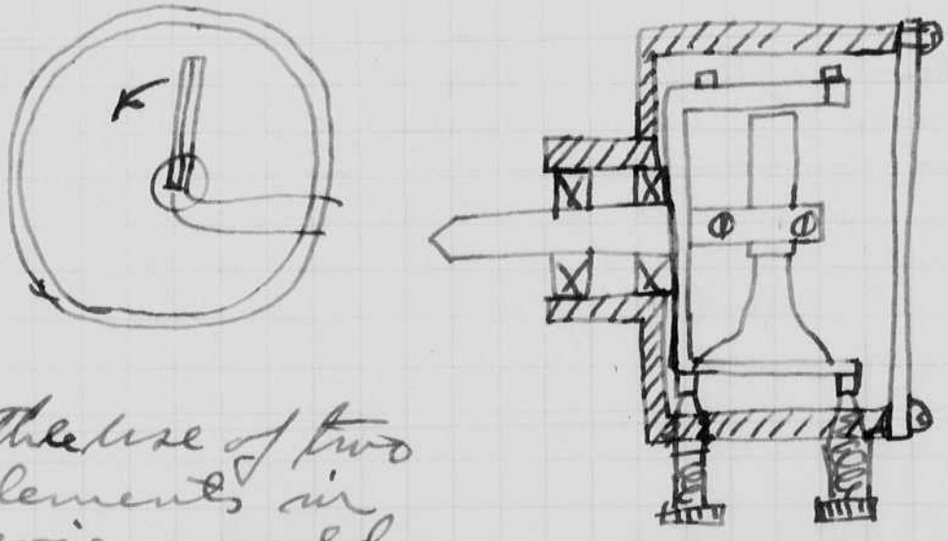
1 # B-104 Bending units. order. # 4272

Plan to use one of these for measuring the vibration in a rifle barrel for the Winchester co. the bending unit will be used.

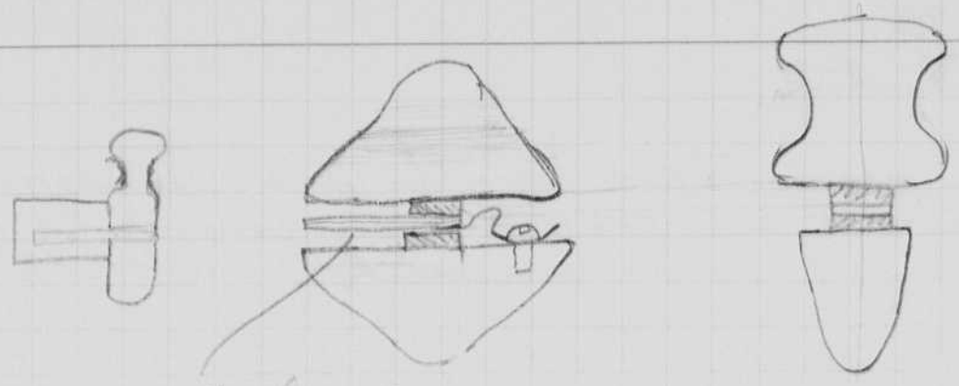


motion of the barrel moves or bends the unit and gives a voltage proportional to the displacement, if the frequency of the unit is low.

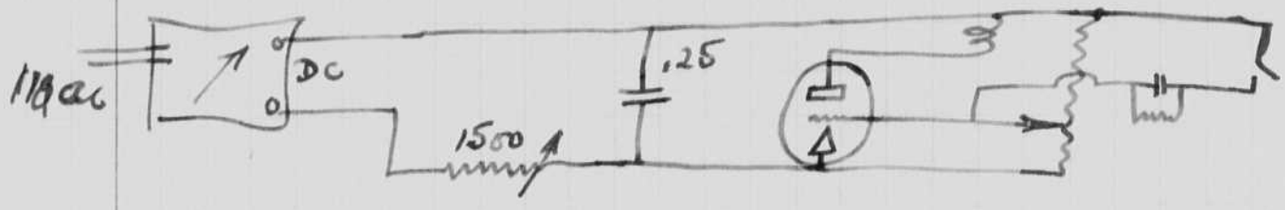
Rotation accelerometer.



The use of two elements in series would give more voltage and also balance to the arrangement.



This button will be held against a vibrating object.

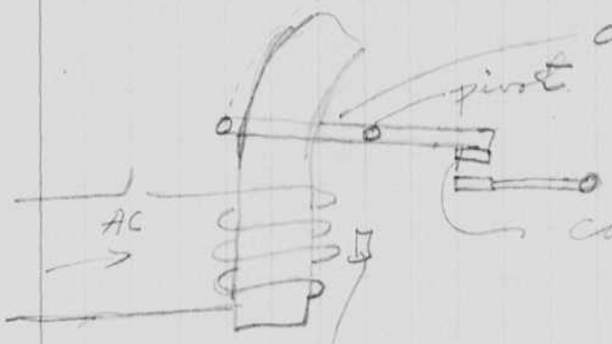


Experimented in the evening with the circuit shown above with Sennerhausen. The tube was on the pump and different pressures of neon and argon were tried. For the data in his book.

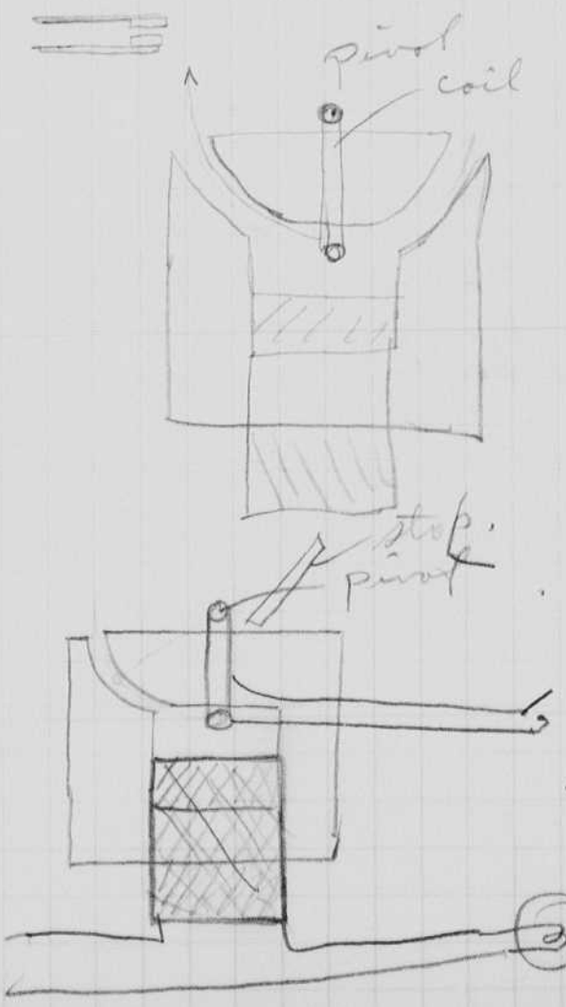
Sept 7-15 at Mt. Katahdin Maine with the Harold Hazen and Wm Hall.

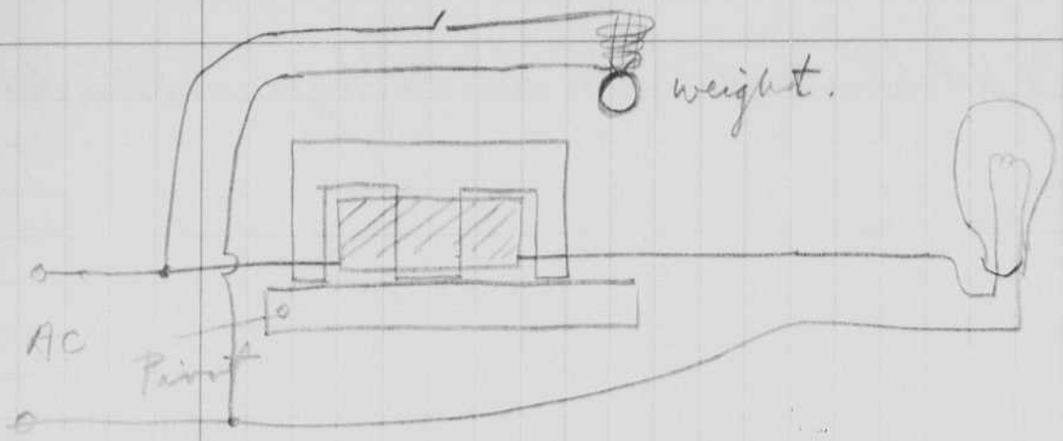
Sept. 16, 1935. H.E. Edgerton

Timer for photoflash overvoltage.



stop to catch movable contact at end of stroke.

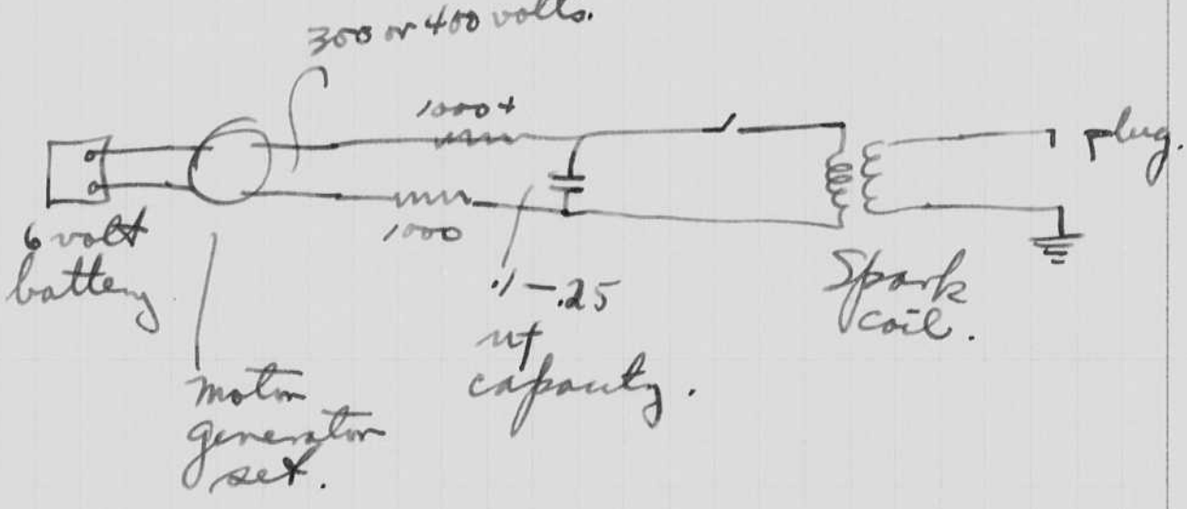




$e = \frac{d}{dt}(LI)$

Sept 17 1935.
H E Edgerton

Method of auto ignition.

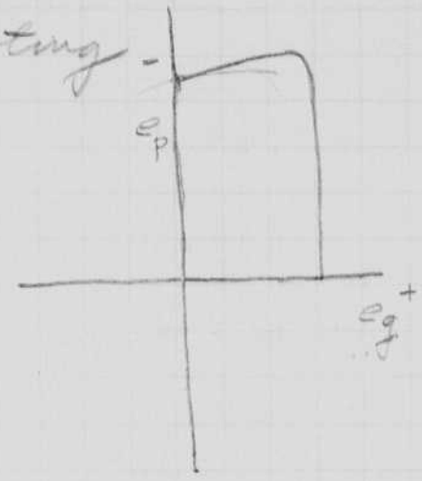


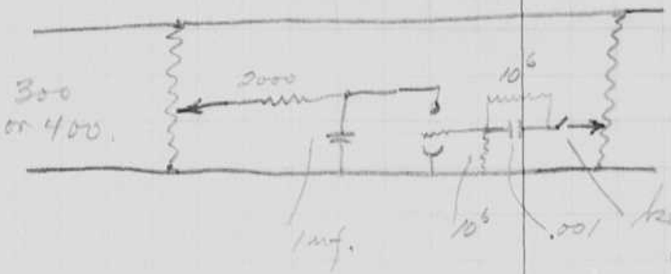
Explained 9/16/35
N. E. Friel

Gridatron.
Coldcathatron
arctron
arkstron
arctron Arcatron
Gridarctron
Sparktron
→ Spotron
Spotatron
Flashtron
Cathspotron
Cathdspotron
Coldspotron
Filesatron
Heatlesatron.

Characteristics

Starting





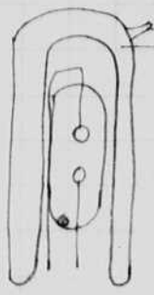
Lookup.

heatless in Greek.
Spot
Glow

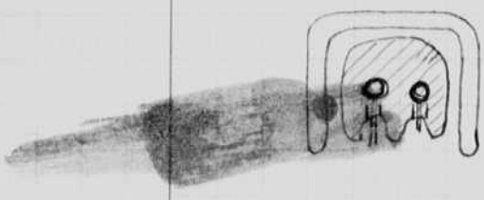
A maintained glow between the elements changes the surface conditions and will therefore change the starting conditions.

October 1, 1935.
H. E. Edgerton

Heated lamp mercury filled

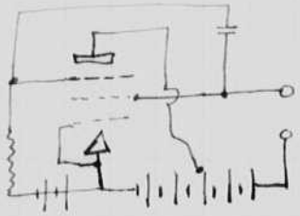


Vacuum cover for lamp to prevent loss of heat.



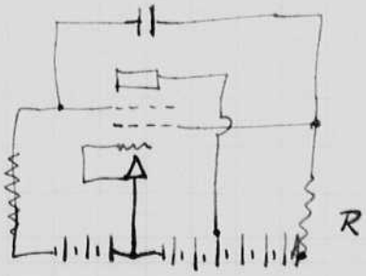
I plan to go to Aberdeen for the Ordnance Day Oct. 3, 1935.

type 57 tube as a negative resistance networks.
Application note No 45 Feb. 7, 1935. R.C.A.

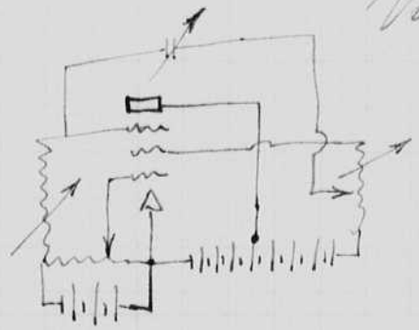


Negative transconductance.

Relaxation oscillator.



Variation.



October 6, 1935.
H. E. Edgerton.

Oct 2.

I took the "Federal" to Baltimore on Wed. night and arrived at Aberdeen on Thursday morning. Met Mr. Culverwell at the station at Aberdeen and we spent most of the day together.

Mr. Bob Kent at the laboratory showed me his cathode ray oscillographic equipment.

Camera Drum type

American Inst Co. ?

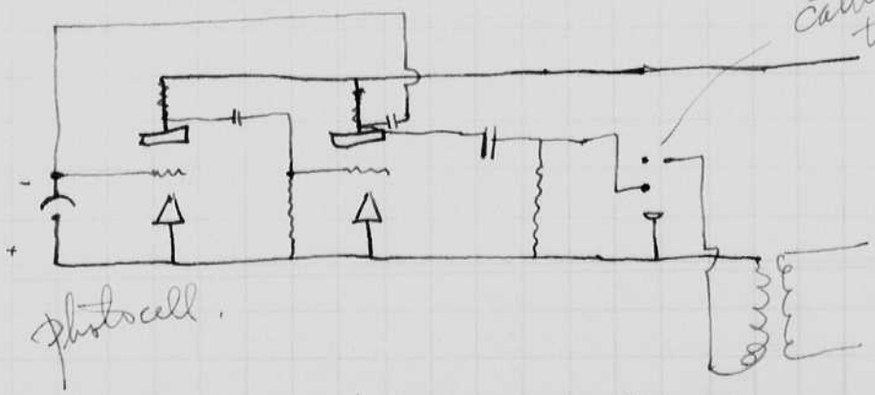
Afternoon at 3 I went out with Mr. Girdon and saw their apparatus for spark photography.

Special train to Washington. Met Mr. Sears Ordance Supply officer? for the first corps area on the train.

Margaret and Bob took me in at their new apt. that night. 1 & F apt 418 N.W.

Visited Bob Shields and Wendell Berge in morning. In aft. saw Mr. Holtzclaw and Mr Davis of the Bur of printing and engraving. They showed me their photocell system of controlling the perforations and we discussed it and stroboscopic methods. Left for Boston in the evening.

This morning I worked with Dermeshousen and Brien upon the timing problem measurement of rifle bolts for the Winchester Co.

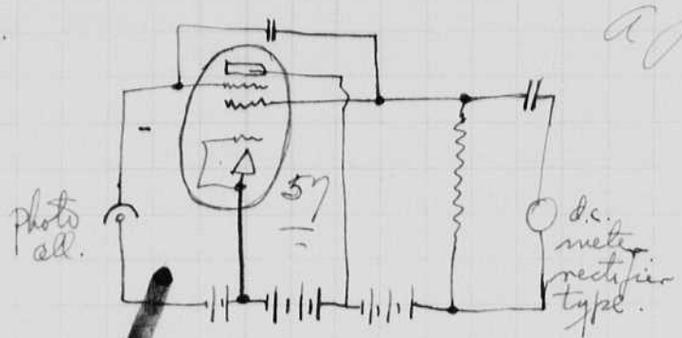


frequency a function of the light. adjust to beat with 60 cycle current to give a satisfactory exposure.

✓ ✓ ✓ ✓ ✓ ✓

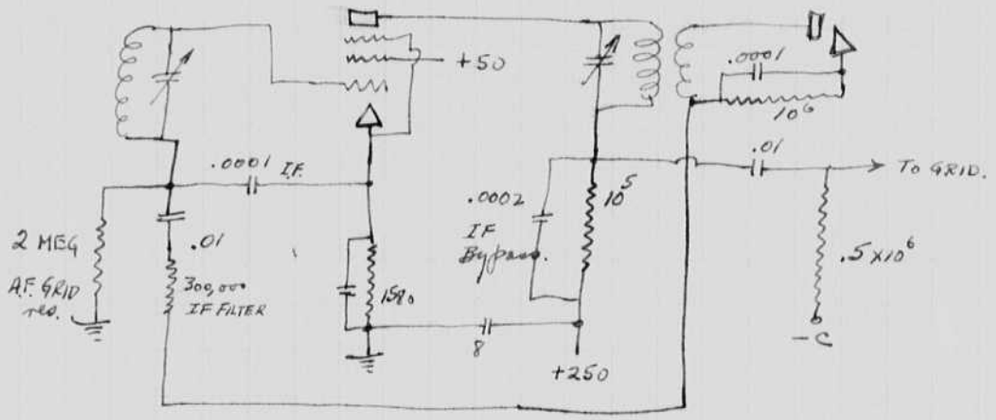
100 v / 10^5 / 10^{-3} < 1 ma.

a photometer.



Current to suppressor grid ?

Reflex circuit from R.C.A. Application Note.

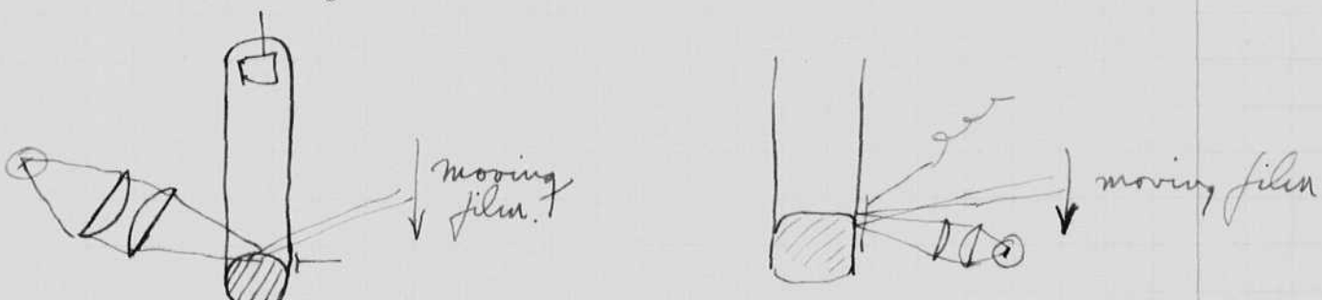


October 8 1935
H. E. Edgerton.

The mechanical action of Mercury in a tube against the glass wall may be responsible for the formation of the cathode spot at the junction of the mercury and the glass. Static electricity may be liberated by the motion of the mercury against the glass. The high voltage on the starting band causes the meniscus of the mercury to change.

An experiment to check this might be devised: for instance actually move a glass rod in the mercury or violently shake the tube. See if a spot forms.

Photograph the motion of the mercury after a high field has been applied to it.



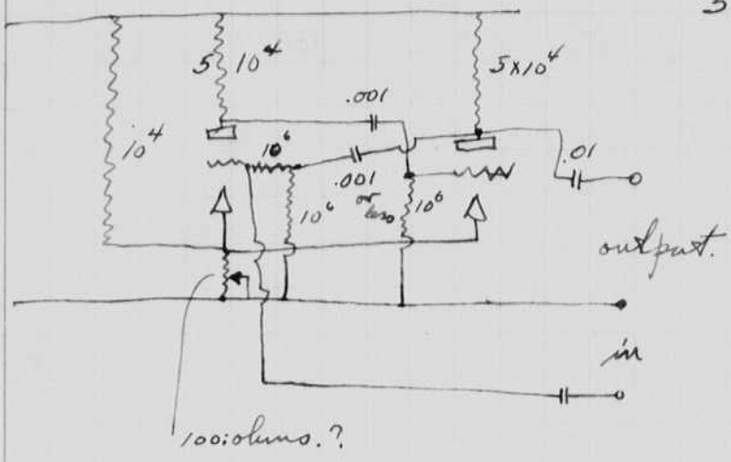
Reflection of light to show motion of the mercury when a high voltage is put on the starting band.

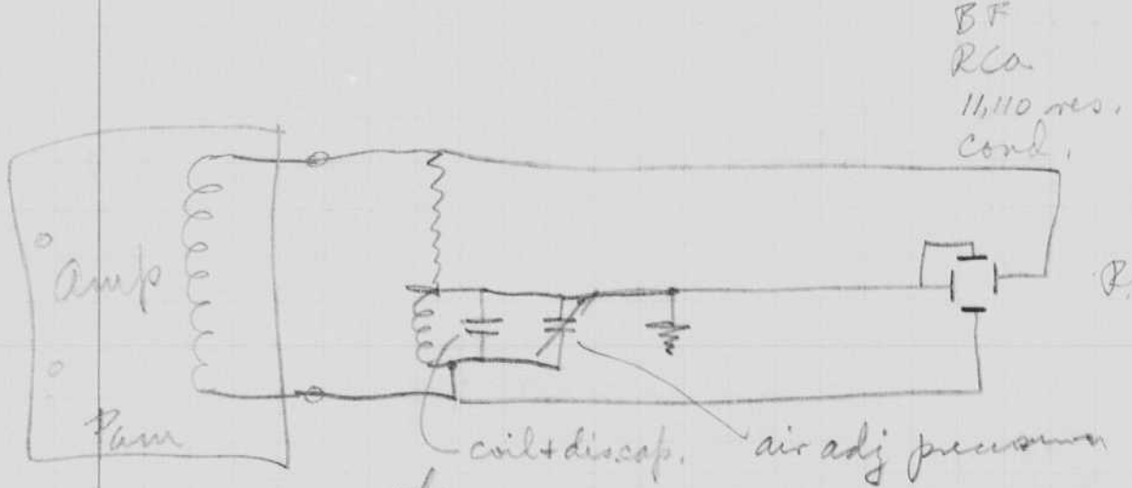
Germeshausen and Grier are going to the Foster Machine Works near Springfield tomorrow to take some movies of a winding machine. Mr. Kent and Mr. Stackpole of Fish, Richardson & Kneass (Patent lawyers) arranged for the work.

Oct. 9, 1935
H. E. Edgerton

Trigger amplifier using regeneration

53.



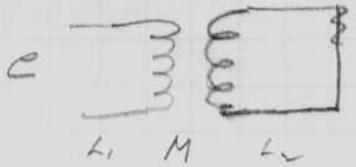


1, set frequency.

2 adjust C until CR. Pattern is a line (not an ellipse).

$\frac{1}{wc} = \frac{10^6}{377 \times 50} = 50$ ohms
$\frac{50}{1885}$
ish. ohms/mf @ 60.

Spark coil data.



$$E = j\omega L_1 I_1 - j\omega M I_2$$

$$0 = \quad - j\omega M I_1 + j\omega L_2 I_2$$

$$I_2 = I_1 \frac{\omega M}{\omega L_2}$$

$$E = j\omega \left(L_1 - \frac{M^2}{L_2} \right) I_1 = j\omega L_1 \left(1 - \frac{M^2}{L_1 L_2} \right) I_1$$

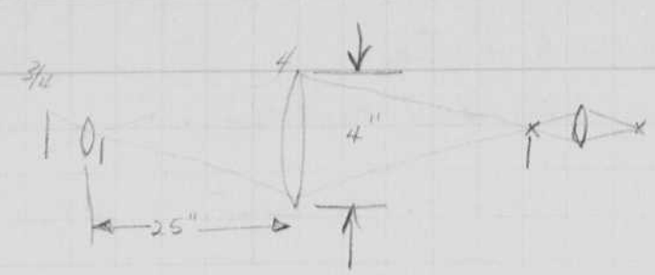
ωL_0 open cir $= \omega L_1$.

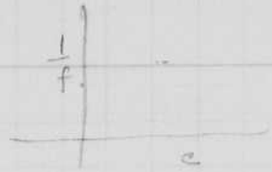
ωL_s shunted $= \omega L_1 \left(1 - \frac{M^2}{L_1 L_2} \right) = L_1 - \frac{M^2}{L_2}$

Subtract $L_0 - L_s = \frac{M^2}{L_2}$

$$T = L_1 \left(1 - \frac{M^2}{L_1 L_2} \right) = \frac{L_s}{L_0}$$

	L_{10}	Q_{10}	L_{1s}	Q_{1s}	L_{20}	Q_{20}	L_{2s}	Q_{2s}	n	r_2	T_p	T_c
Ford .18	5.4mh.	13.5	.725	3.5	23.6h	26.	3.5	3.8	.19+ .2	3,540	.134	✓
Yellow 1000	6.4mh	11.2	.79	2.6	56.	17.5	7.3	3.6	1.17	4900	.123	.13
Bosch 7-229 no core	1.375	3.75	.68	1.4	2.67	5.5	1.325	2.0	1.22	3,000	.495	✓
"	1.36	6.7	.69	2.1	2.63	5.4	1.34	1.85	1.23	3.060	.507	
R. grier	3.55mh.	14.	3.4	5.	10h	0.33	10±1 not critical.	.3	2.0	185,000		
small grier	2.59	12.	2.63	11.2	.5h ±.1	.1			7.7	open?		





mag. $\frac{4}{3/4} = \frac{16}{3} = 5.33$

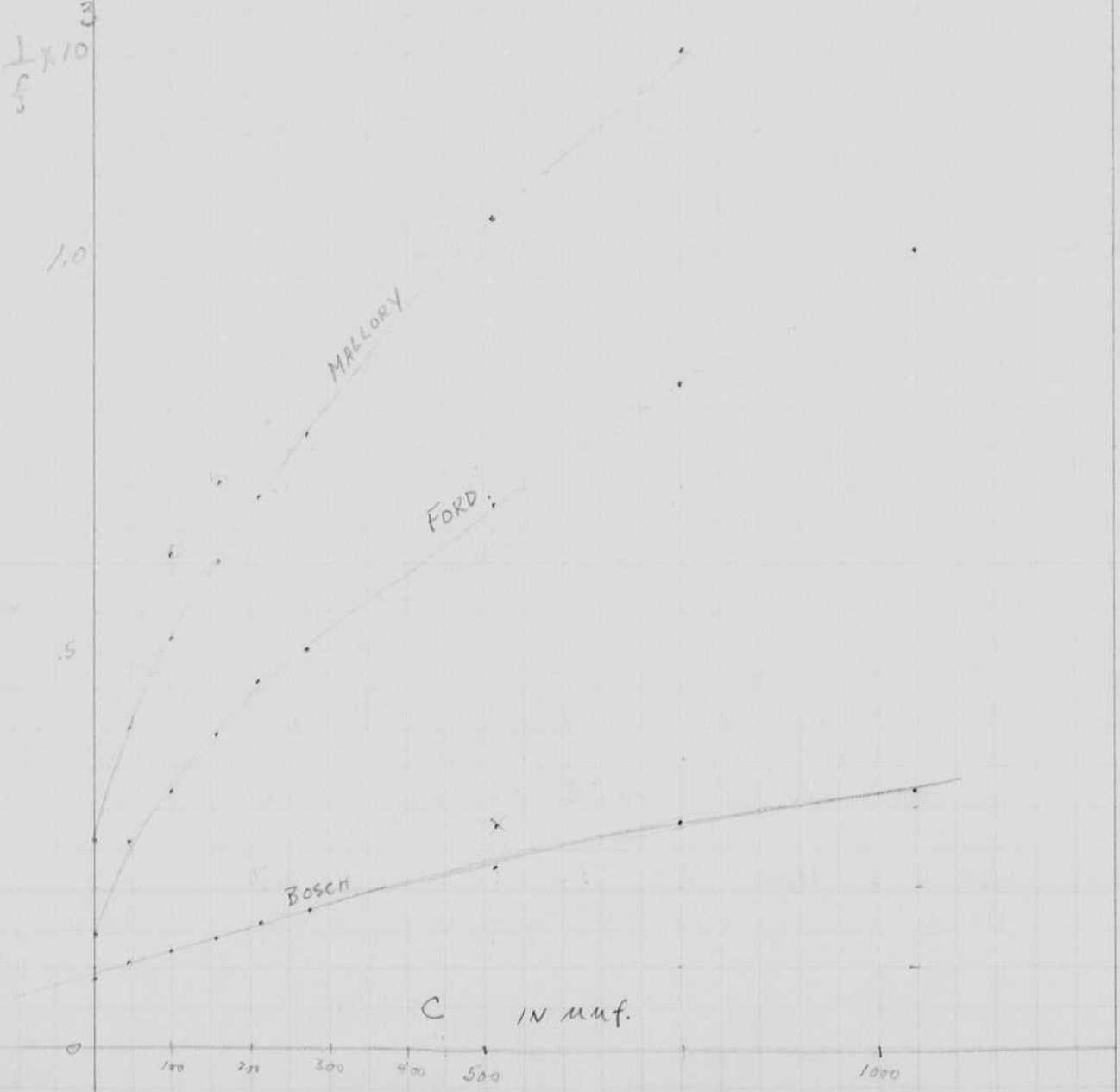
10 cm. lens.

$\frac{1}{10} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{f_1} + \frac{1}{5.33 f_1}$ $\quad \frac{(5.33+1)}{5.33 f_1} = \frac{1}{10}$

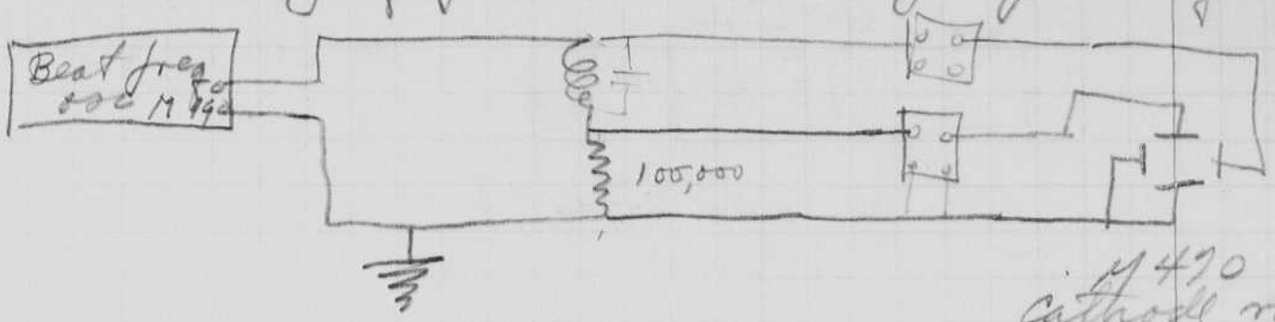
$f_1 = \frac{63.3}{5.33} = 11.9$ cm.

$f_2 = 11.9 \times 5.33 = 63.3$ cm

25. inches



Natural freq of coils and stray capacity.



470
cathode ray osc

Natural freq. Procedure

1. Adjust oscillator until the cathode ray osc shows that the two voltages are in phase.

/ in phase O out of phase

coil

R. Mallory 1000 — 3900 cycles/sec. $.256 \times 10^{-3}$

Ford V 8 6 — 6800 " " .147

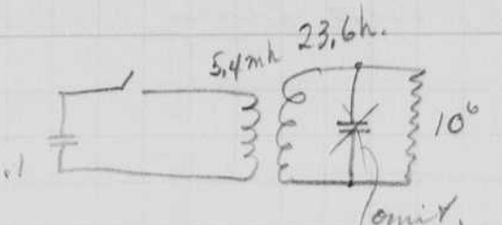
.0835

Bosch 2-229 — 12,000 " " ⏚ — Osc. goes to 12800. Prob 12,500

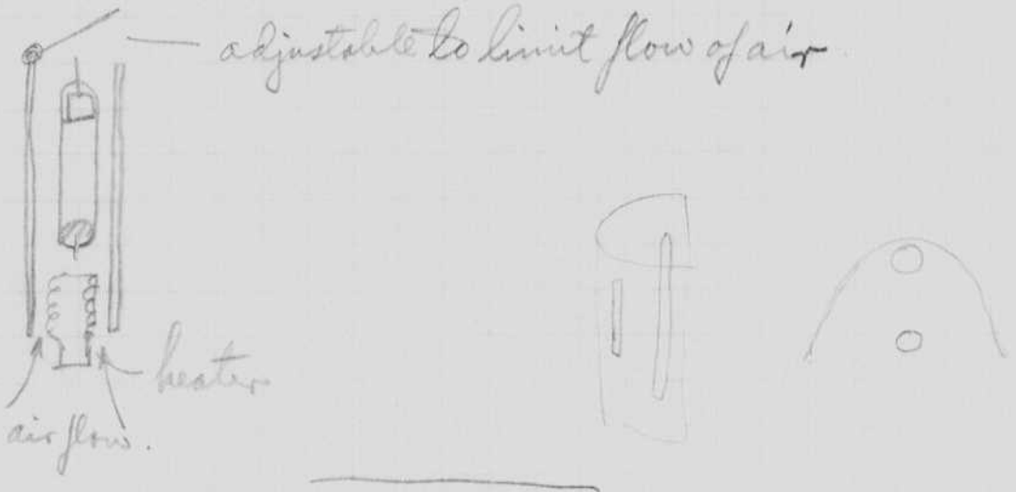
no core

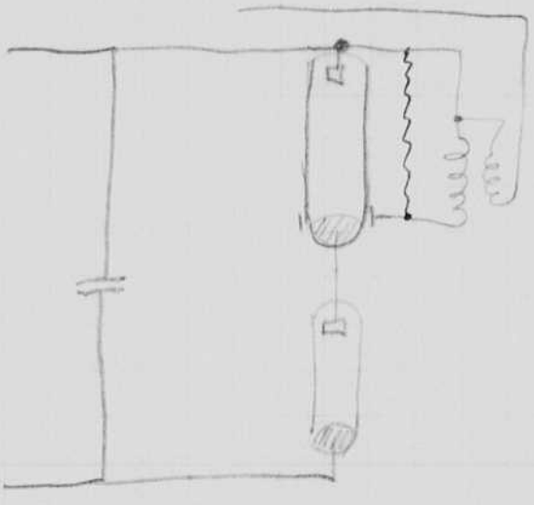
	mmf in parallel	Bosch	1/f x 10^3	Ford			1/f x 10^3
"	47	9400	.106	3800	.250	2500	4
(200)	100	7800	.124	3100	.322	1950	.512
(150)	75	8400	.115	3400		2200	.455
300	157	6800	.147	2550	.392	1650	.607
400	215	6100	.158	2200	.455	1450	.690
500	275	5550	.174	2000	.5	1300	.770
900	513	4250	.228	1470	.68	960	1.04
1300	750	3550	.277	1200	.835	800	1.25
1800	1048	3050	.317	1000	1.0	680	1.47
2500	1452	2650	.377	870	1.15	575	1.75
	0			6900		3700	

DR Prec
Cond M1



$\nabla = 0.134 = 1 - \frac{M^2}{L_1 L_2}$





Oct. 16, 1935. Transformer theory
transient

at

$\frac{di_2}{dt}$ at $t=0$ = ?

$E = L_1 \frac{di_1}{dt} + r_1 i_1 + M \frac{di_2}{dt}$

$0 = L_2 \frac{di_2}{dt} + r_2 i_2 + M \frac{di_1}{dt}$

at $t=0$ $i_1 = 0$ and $i_2 = 0$.

$E = L_1 \frac{di_1}{dt} + M \frac{di_2}{dt}$ $\qquad \frac{di_1}{dt} = \frac{E - M\frac{di_2}{dt}}{L_1}$

$L_2 \frac{di_2}{dt} + M \frac{di_1}{dt} = 0$ $\qquad \frac{di_2}{dt} = -\frac{M}{L_2}\frac{di_1}{dt} = -M\left(\frac{E - M\frac{di_2}{dt}}{L_1 L_2}\right) = -\frac{ME}{L_1 L_2} + \frac{M^2}{L_2 L_1}\frac{di_2}{dt}$

$$\frac{d i_2}{dt}\left(L_2 - M^2\right) = \frac{ME}{L_1}$$

$$\frac{d i_2}{dt} = \frac{M \quad E}{L_1\left(L_2 - M^2\right)} \qquad = \frac{-M}{L_1 L_2}\frac{E}{\left(1 - \frac{M^2}{L_1 L_2}\right)} = \frac{ME}{\left(L_1 L_2 - M^2\right)}$$ ✓

$L_1 = 5 \times 10^{-3}$ h. $\quad 5.4 \times 10^{-3}$ V-8 ford.

$L_2 = 10$ h. $\quad 23.6$

~~$L_1 L_2 - M^2 = 0$~~ $\quad 0.134 = \left(1 - \frac{M^2}{L_1 L_2}\right)$, $\quad .866 = \frac{M^2}{5.4 \times 23.6 \times 10^{-3}}$ $\quad M^2 = .1115$

$.1285$ $\quad M = .1055$ h.

$E = 500$ volts.

$$\frac{d i_2}{dt} = \frac{500 \cdot .1055}{.0054 \times 23.6 - .1115} = \frac{528}{.0170} = 31{,}000 \text{ amp/sec.}$$

$.1285$
$.1115$
$.0170$

if $R_2 = 10^6$

$t = 10^{-6}$ sec.

$i_2 r_2 = \left(\frac{d i_2}{dt}\right) dt \, r_2$

$= 3100 \times 10^{-6} \times 10^6 = 3100$ volts.

Suppose that $C = 100 \times 10^{-12}$ farads.

$e_c = \frac{1}{C}\int i \, dt.$ $\quad e = 3100$

$C = 100 \times 10^{-12}$ farads.

$i = ?$ $\quad dt = 10^{-6}$ sec.

$3100 = 10^{10} i \, 10^{-6}$

$i = \frac{3100}{10^4} = .310$ amp. $\qquad \frac{3100}{10^6} = .003$ amp.

$T = 2\pi\sqrt{LC} = \frac{1}{6800} = 2\pi\sqrt{23.6\ C}$ from the natural period

$\frac{1}{.462 \times 10^8} = 39.4 \cdot 23.6\ C \qquad C = \frac{1}{.462 \cdot 39.4 \cdot 23.6 \times 10^8}$ $\quad \frac{20}{600}$

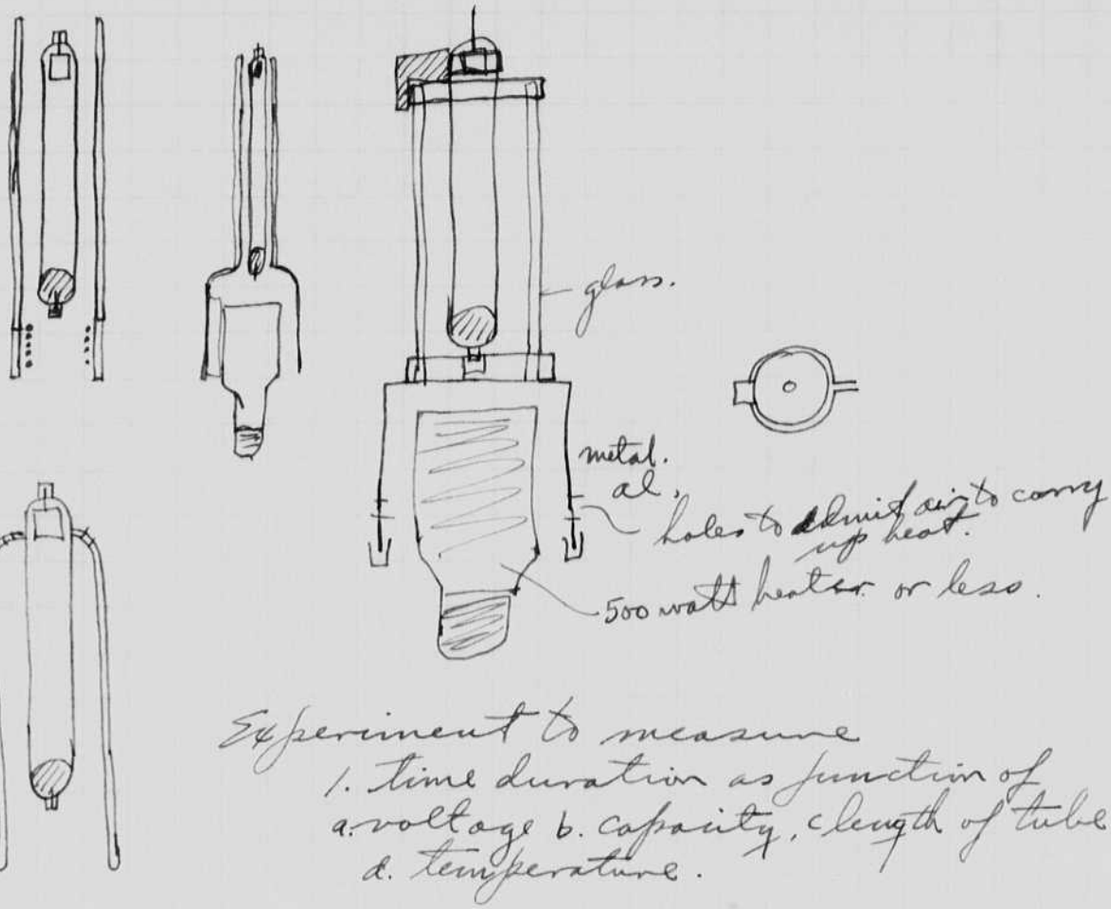
$.539 \times 10^3$

$e_c = \frac{1}{C}\int i \, dt.$

$= 1.86 \times 10^{-11} = 18.6 \times 10^{-12}$ farads.

$i = \frac{3100}{\frac{20 \times 10^{-12}}{10^6}} = .062000$ amps

~~$\frac{de_2}{dt} = \frac{M}{L_1}\frac{di_2}{dt}\frac{1}{C} = \frac{3100}{20 \times 10^{-12}} =$~~

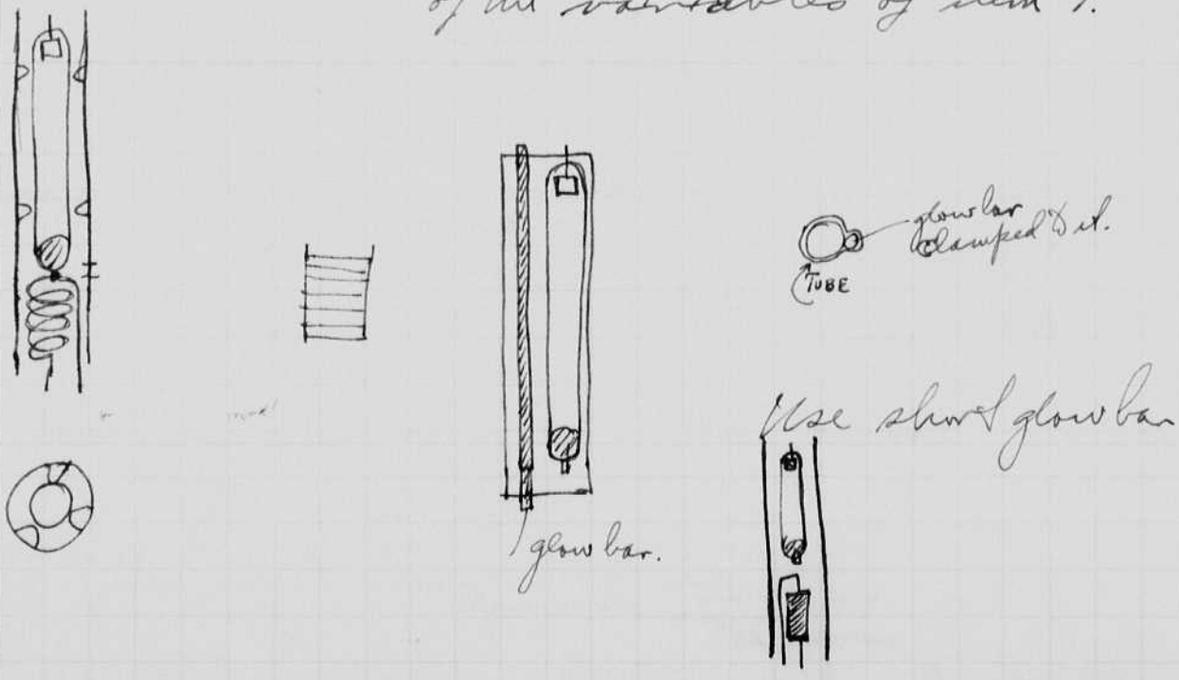


Experiment to measure

1. time duration as function of
a. voltage b. capacity, c length of tube
d. temperature.

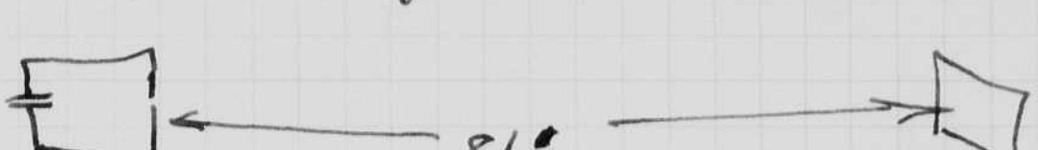
2. time constant, (thermal).

3. Intensity of the light as function of the variables of item 1.



Oct 17 1935
H E Edgerton.

Spark photos by shadows.



1/2" gap.

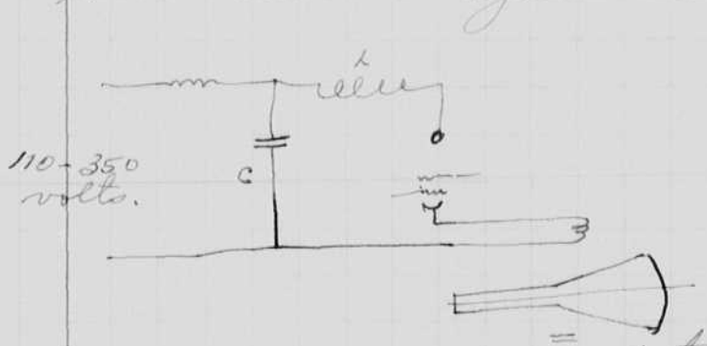
3 mf 10,000 - 15000 volts.
(5 sec. chg time)

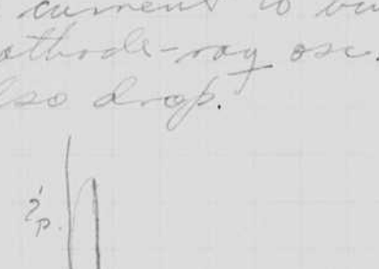
ample exposure on agfa medium bromide paper.

Oct. 22 1935.

Conditions for the formation of a cathode spot in a "Grid-controlled" Strobotron tube.

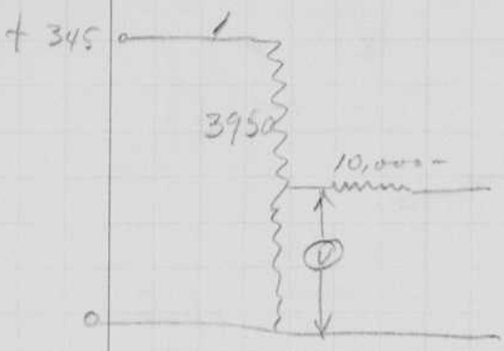
Construct a circuit that allows the current to build up periodically. arrange the cathode-ray osc. to record current against time, also drop.

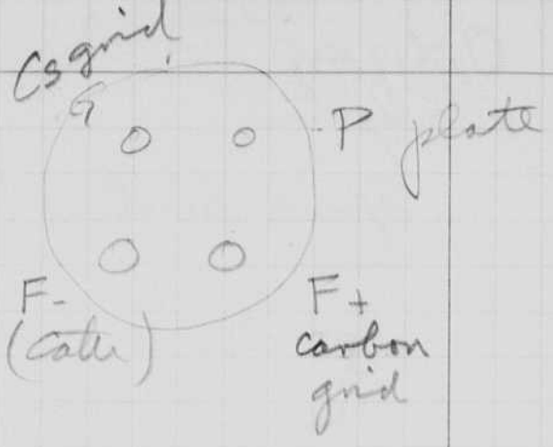




= sweep timed into synchronism with the other.

See if the current to start a discharge is independent of the voltage on the ~~plate~~ condenser

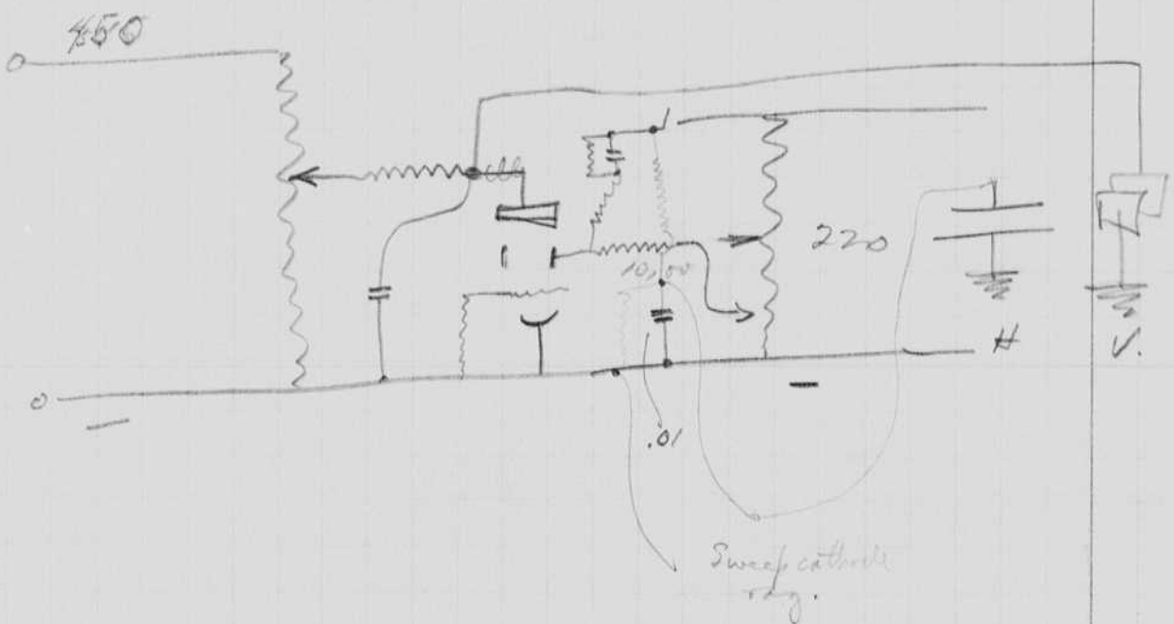


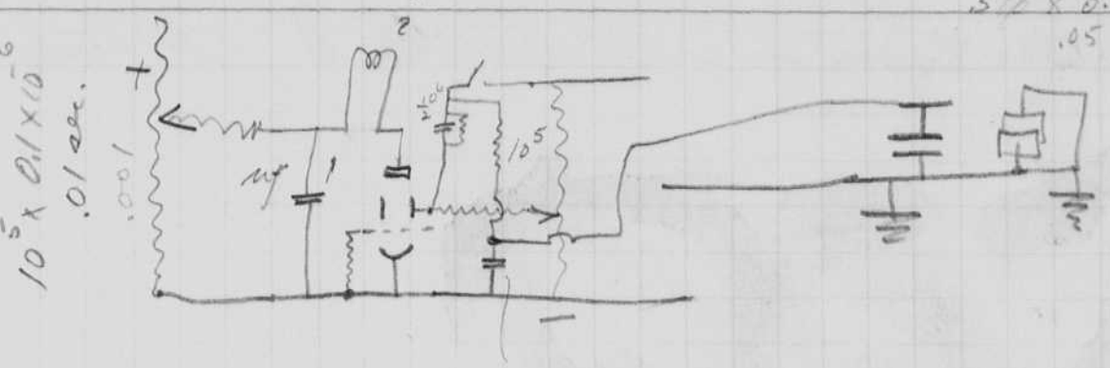


~~Cs grid to cathode. 160 volts~~
~~cath to Cs more than 450~~

Cs grid to cath	102 volts.	95	101 ✓
Cath to Cs grid.	126	190	125 ✓

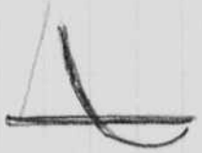
Plate to Carbon grid more than ~~300~~. 450



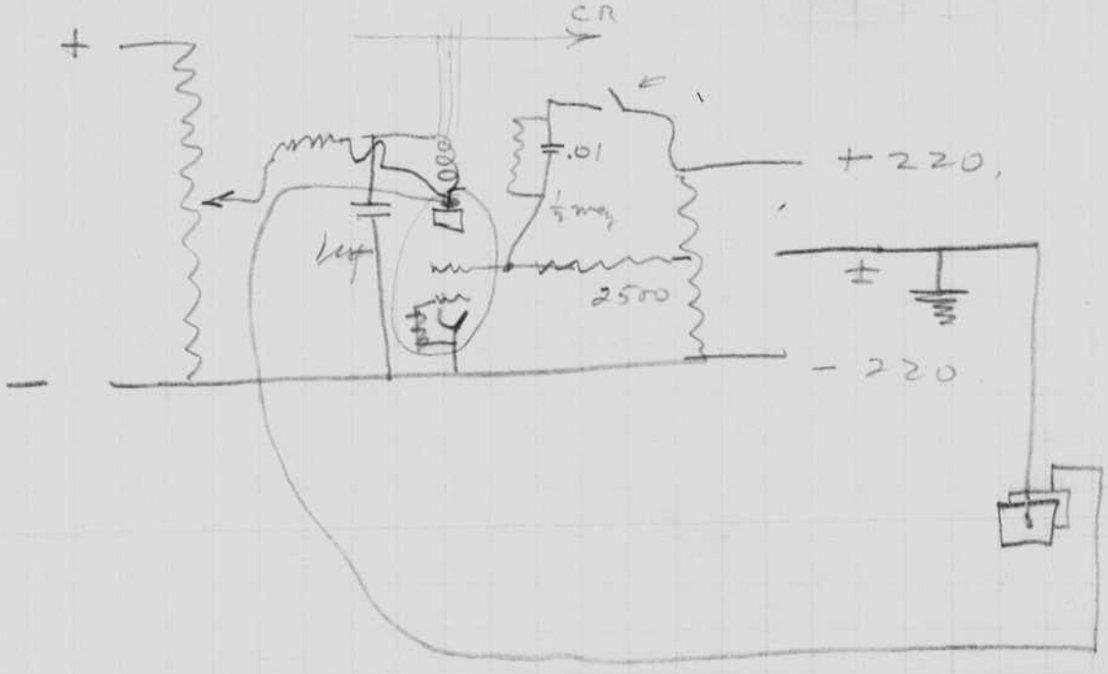


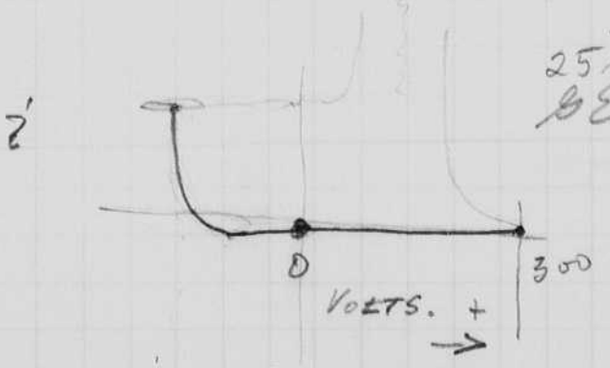
very faint.

amps.

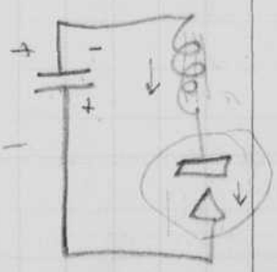


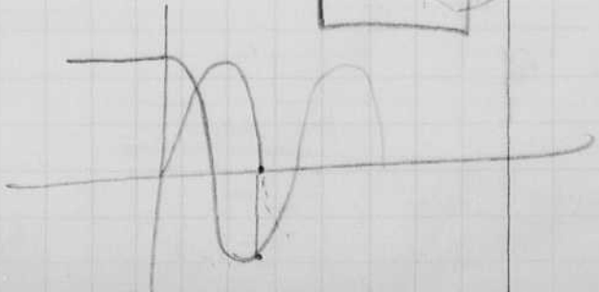
→ TIME. RC = 20,000 × .025 mf.



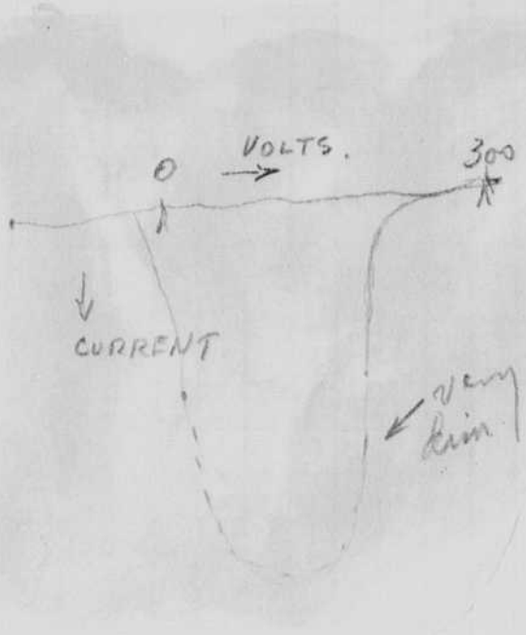


25 turns on 6" C.R.





One turn on coil of G.E. 8" CR tube.

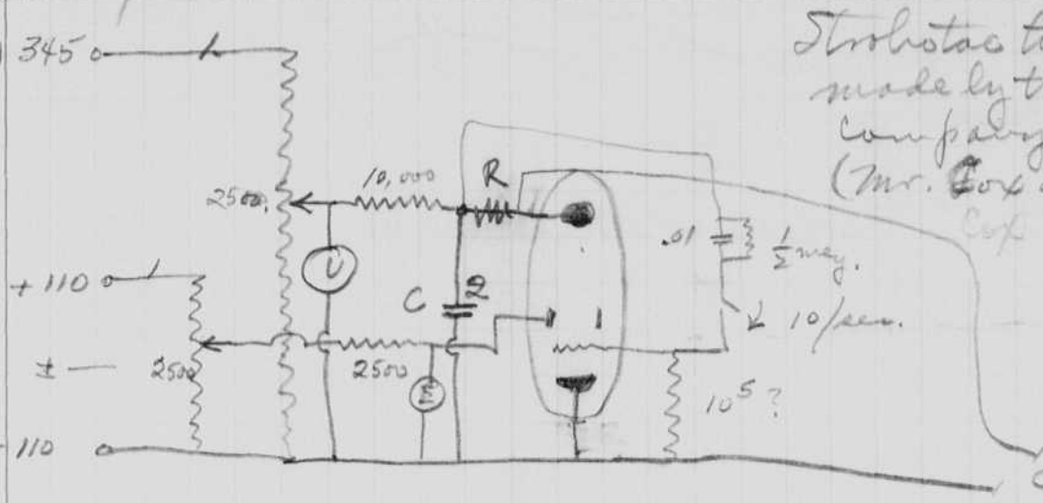


Oct 23 1935.

Hermeshausen & Brier showed stroboscopic movies of a Foster Winding Machine to the Federal judge today in the post office Bldg in Boston. Mr. Stackpole Mr. Kent of (Fish Richardson & Kneave. patent lawyers).

Mr. Ramsey Hoguet called from new York and Prof Whitman wish some movies of a gage glass in an oil plant in Brooklyn. Brier is going down thursday night and do the job.

Oct. 23 1935
Edgerton

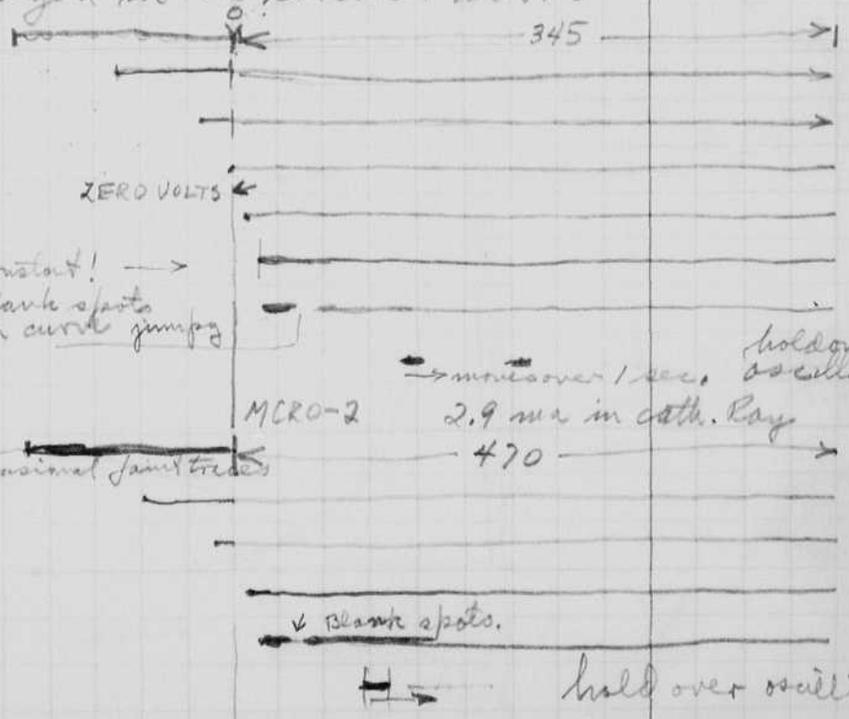


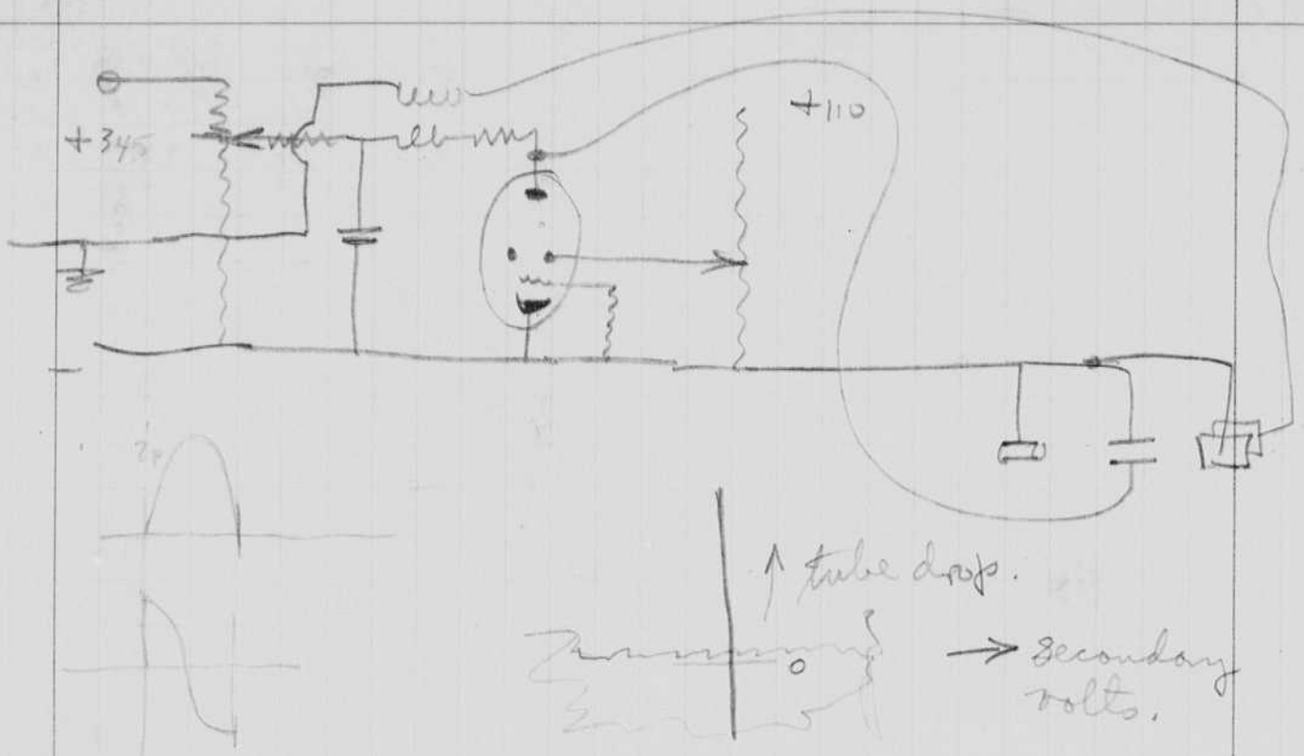
Strobotac tube, made by the Hygrade Company on Oct. 15 ± (Mr. Fox & K Gemeshausen)

R	C	V	E	
160-300	2	300	60.	
150-250	2	400	60	The carbon grid should have less than about 75 volts in order to prevent hold over and self ose in this circuit.
0	2	150	0	
		150	20	
		160	60	
		150	70	
↓	↓	110	80	
300±	2	470	70	hold over
400	2	200	70	Refuses to start. sometime.

Cathode Ray connected to record the ~~drop~~ condenser voltage as R is changed in the circuit above

C.R.	0	2	350	70.	
	.5	2	350	70	
	1.0	2	350	70	
	1.5				
	2.				
	2 to 30	"	"	"	constant! →
	30-100	"	"	"	Blank spots in curve jumps
	500±	"	"	"	
	0	2	470	70	1 occasional jump to zero
	.5				
	1.0				
	1.5				
	100				
	400±				



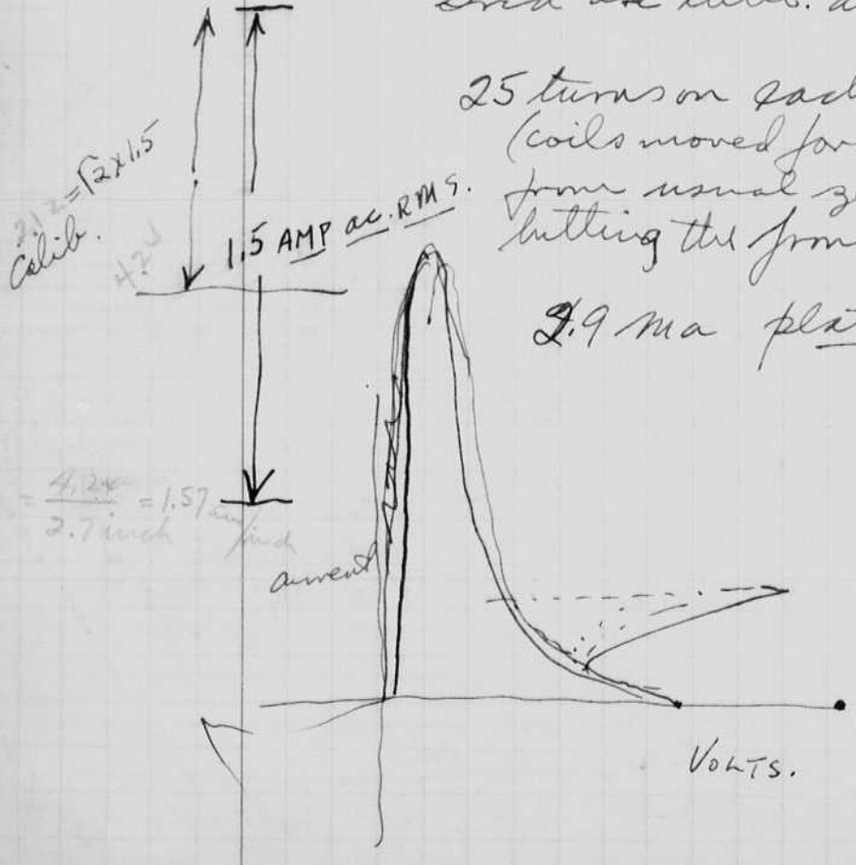


Nov 1, 1935 H E Edgerton

Calibration of current coils on M 480 X as used in experiments on the Grid-arc tube. as listed above

25 turns on each side of the CR tube (coils moved forward about 1½ or 2 inches from usual zero to keep beam from hitting the front e.s. plates).

2.9 ma plate blader. reading.



Notebook # T-6

Filming and Separation Record

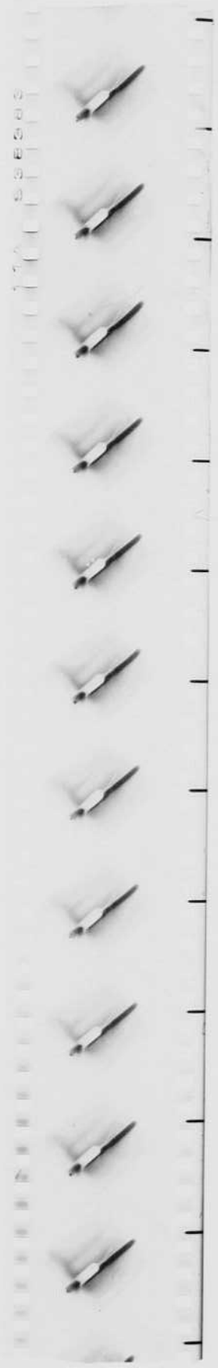
____ unmounted photograph(s)

__1__ negative strip(s)

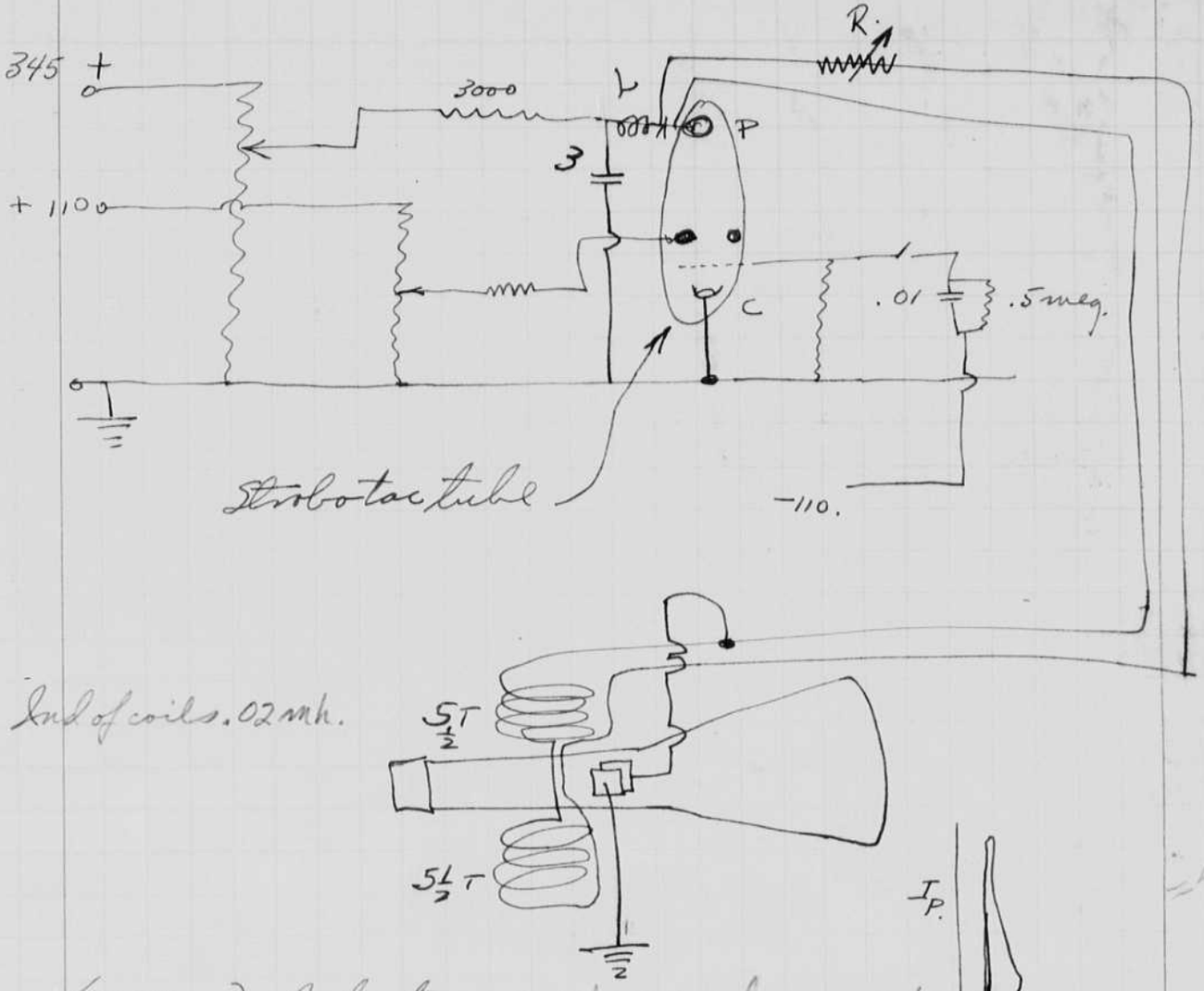
____ unmounted page(s)
(notes, drawings, letters, etc.)

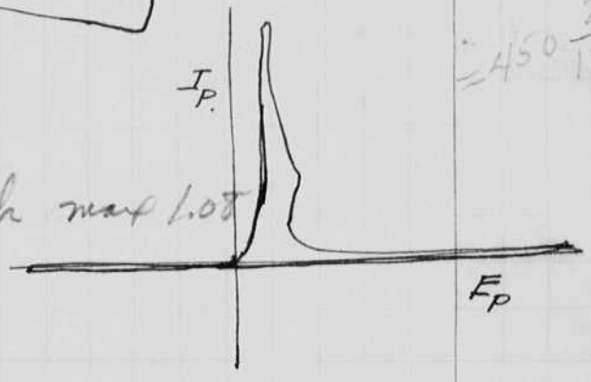
was/were filmed where originally located between page __24__ and __25__.

Item(s) now housed in accompanying folder.



2





$= 450 \frac{2.8}{12.8}$

L = (M313X) Inductor 0 set .09 mh max 1.03
Variable.

R = 111.1 ohm D.R box.

C = M662 mf and M28 1 mf.

35mm film S.S. pan old stock f 3.5 lens Zeph camera.

		R	L	C
1-6	1/2 sec	0	min	3 mf.
7	1/25 "	"	"	"
8-12	1/2 "	"	60°	"
13-17	1/2 "	"	min	"
18	25 "	"	"	"

The arc may start with as low as 1/2 amp. at these low currents the drop seems to have two values and it seems to jump back and forth between them in some peculiar way. The experiment top of page 24 showed this clearly.

7.

I

Titanium tetrachloride smoke.

Notebook # T-6

Filming and Separation Record

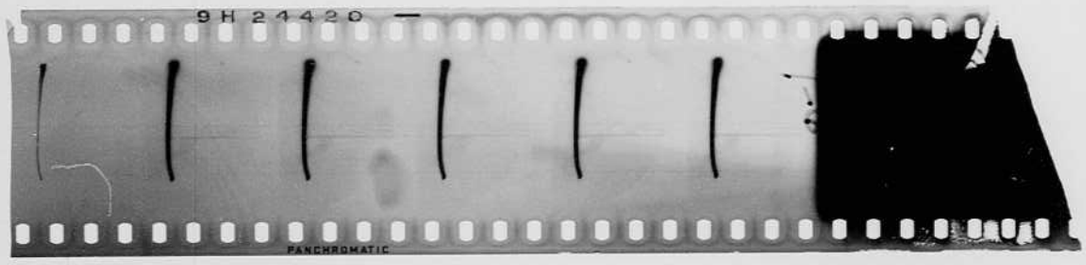
____ unmounted photograph(s)

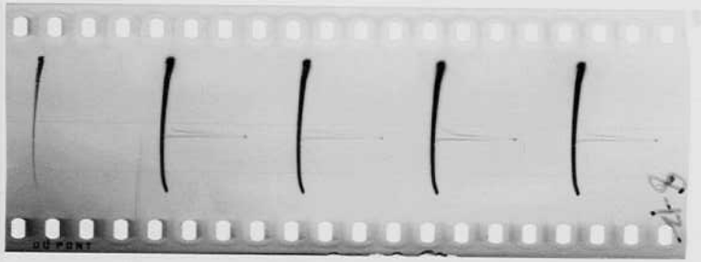
2? negative strip(s) inside mounted envelope pg 26

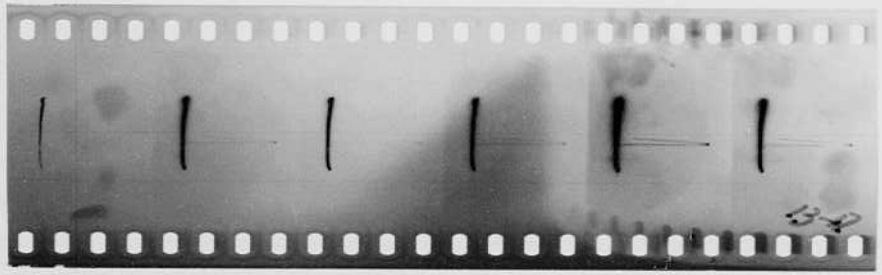
____ unmounted page(s)
(notes, drawings, letters, etc.)

was/were filmed where originally located between page 26 and 27.

Item(s) now housed in accompanying folder.


9H 21420
PANCHROMATIC


DUPONT



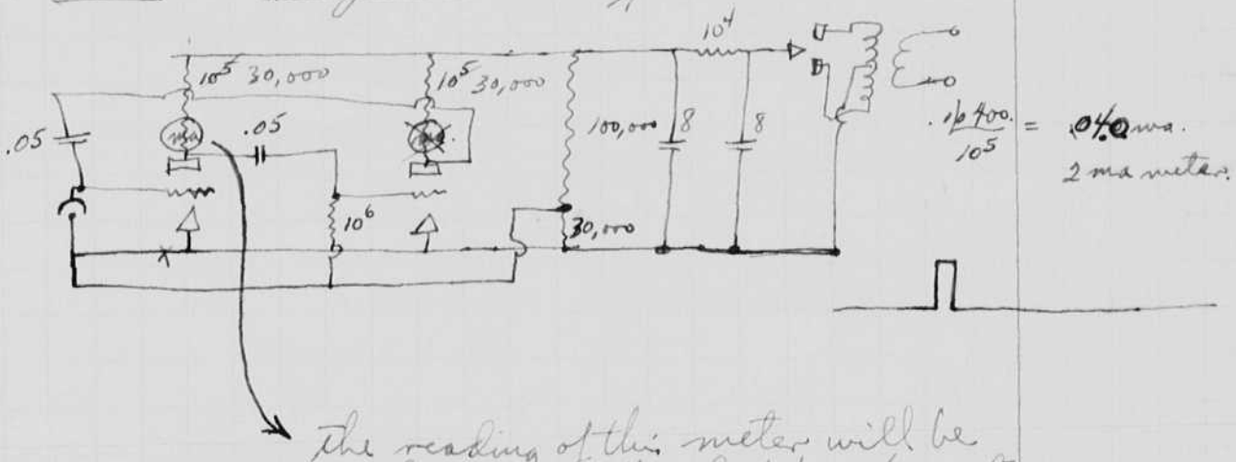
Oct 30 1935 Whitin Machine Works. Mr. Walker '07 M.I.T. II?
Mr. Potter gave a safety talk (Harvard).
Mr. Mutter. electrician.

Nov. 5. 1935 A.I.E.E. Students. Movies and talk by Turbit.

Moodey is assembling a twin triode oscillator to cover a restricted frequency range for vibrating a mechanical specimen. This circuit is a modification of the one in the Strobotac.

Spent Tuesday morning with Mr. David Rines discussing dates for interferences on synchronous motor cases.

Photocell - Light intensity indicator.



1 - 53
2 - .05 cond.
2 - 10^5
1 - 30,000
1 - transformer
1 - 280
2 - 8 mf 400 v electrolytic
1 - 1-5 ma meter. dc.
1 - photocell
1 - 10^4 resistor
2 - 30,000

The reading of this meter will be a function of the light intensity.

Nov 21 1935
H. E. Edgerton

Circuit p25.

$$E = L\frac{di}{dt} + \frac{1}{C}\int i\,dt = 0,$$

$$p = \sqrt{\frac{-1}{LC}} = j\sqrt{\frac{1}{LC}}$$

$i = A_1 \sin \omega t$, $= 0$ when $t = 0$

$$E = L\frac{di}{dt} = (\omega A_1 \cos \omega t)\,L \qquad t = 0,\ \cos \omega t = 1$$

$$E = L\omega A_1 \qquad A_1 = \frac{E}{\omega L}$$

but $\omega = j\sqrt{\frac{1}{LC}}$

$$A_1 = \frac{E}{Lj\sqrt{\frac{1}{LC}}} = -j\,E\sqrt{\frac{C}{L}}$$

$$i = E\sqrt{\frac{C}{L}} \sin \omega t.$$

$L = 0.1 \times 10^{-3}$ henries
$C = 3 \times 10^{-6}$ farads.
$E = 300$ volts.

$$i^0 = 300\sqrt{\frac{3\times10^{63}}{.1\times10^{3}}} = 300\sqrt{3.\sqrt{10^{4}}}\ \frac{1.73}{519.0} = 519.0 \text{ amp.}$$

$$\text{freq} = \frac{1}{2\pi}\frac{1}{\sqrt{LC}} = \frac{1}{6.28} \times \frac{1}{\sqrt{.1\times3\times10^{-9}}} = \frac{10^4}{6.28\ 1.73} = 10^3 = 1000 \text{ cycles.}$$

$.3\times10^{-9}$
$3.\times10^{-8}$

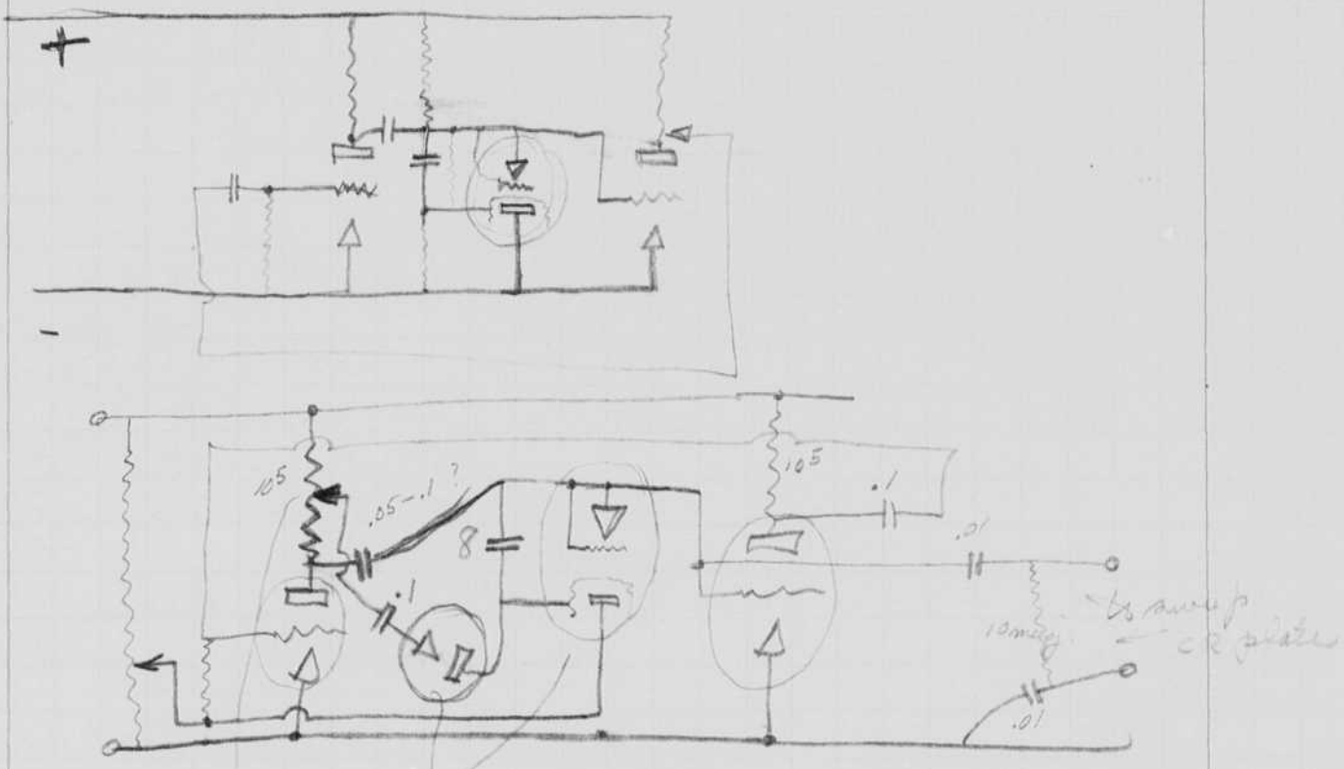
$RC = 3500 \times 3 \times 10^{-6} = .01$ sec. decaying time.

$$\left(\frac{R}{2L}\right)^2 = \frac{1}{LC} = \frac{R^2}{4L^2} \qquad R = 2\sqrt{\frac{L}{C}} \text{ critical}$$

$$= 2\sqrt{\frac{10.\times10^{-5}}{3\times10^{-6}}} = \sqrt{\frac{3.\times10}{30}} = 5.5 \text{ ohms.}$$

Sweep circuit

Nov 9 1935
H. E. Edgerton.
Heard Dawes's first lecture last night - Rogers Bldg.



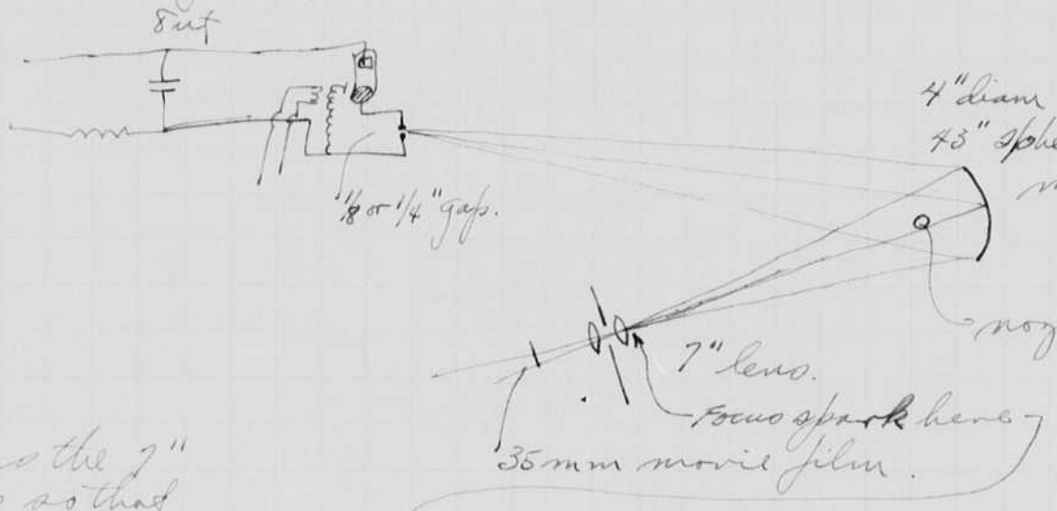
Nov. 9. Photos of beer with a glass for Stevens.
10. Home all day.
11. Printed pictures & exp with shadow 4" mirror 13" focal.
12. Some talk at a IEE Lynn. River Works 500 there.
Pres. Patton Lynn Gas & Elect. Co. Dinner at Hunts.
Tom Abbott G.E. Meter Dept.
Prof. Nelson - New Hampshire + 35 students were there.

On 11th lined up camera on the new Ernier.

Nov. 17, 1935. Sunday.
H.E. Edgerton.

I spent Thursday evening and Friday morning with Goodwin and Bullock taking pictures of oxygen coming out of a cutting torch. CCl_4 was used to increase the density of the gas for silhouette photographs.

Method used for pictures taken on thursday night



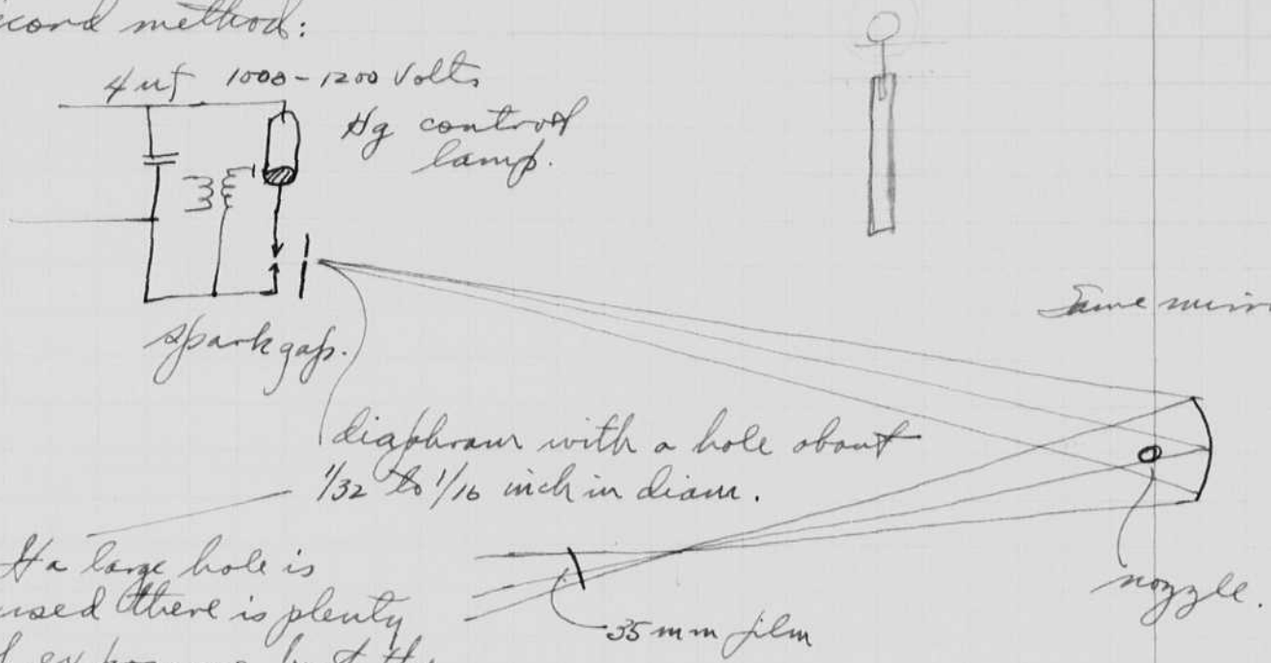
Focus the 7" lens so that it focuses on the nozzle.

and put a spot of paper about 1/8 of an inch at the center of the lens. The image of the spark gap falls upon it. Light refracted around the spot misses the spot and produces the image on the 35 mm film.

Photographs taken with the set up shown show a beaded structure to the gas in the first 1/2 inch after it comes from the tip of the nozzle. Practically nothing can be seen farther out in the jet of gas.

On Friday morning another type of set up was tried in order to be able to see more of the jet farther out in the gas stream.

Second method:



If a large hole is used there is plenty of exposure but the image is blurred since the spark is not a point source. a small diaphram limits the size of the source.

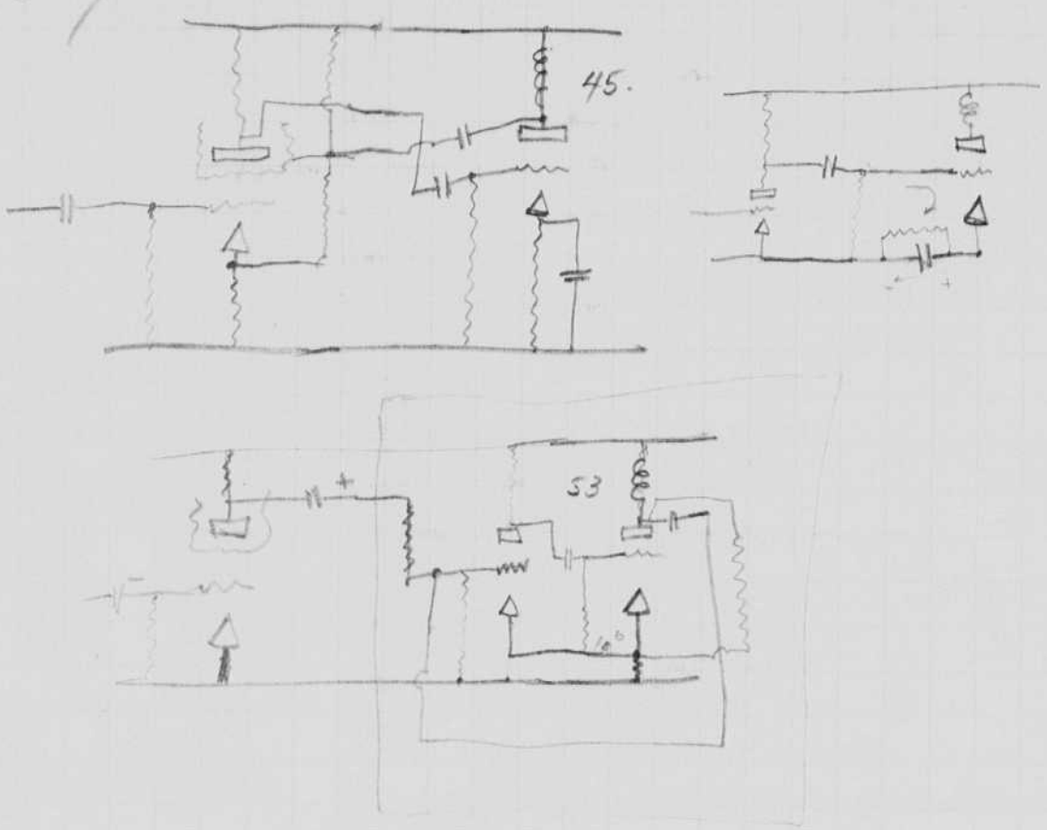
The photographs taken by this method show the boundary of the gas coming from the nozzle and show the point at which turbulance begins to appear. I hope to glue in examples later.

Nov. 18. Heard Brown of D.C. give a col. on Hg rectifiers Evening dinner at the Chamber of Commerce with the Wellesley club and gave talk with slides and movies afterward. Mr. Brown Boston Y.M.C.A. Mr. Steel Mr. Briggs pres. Mr. Bramhall sec. 46 year of club.

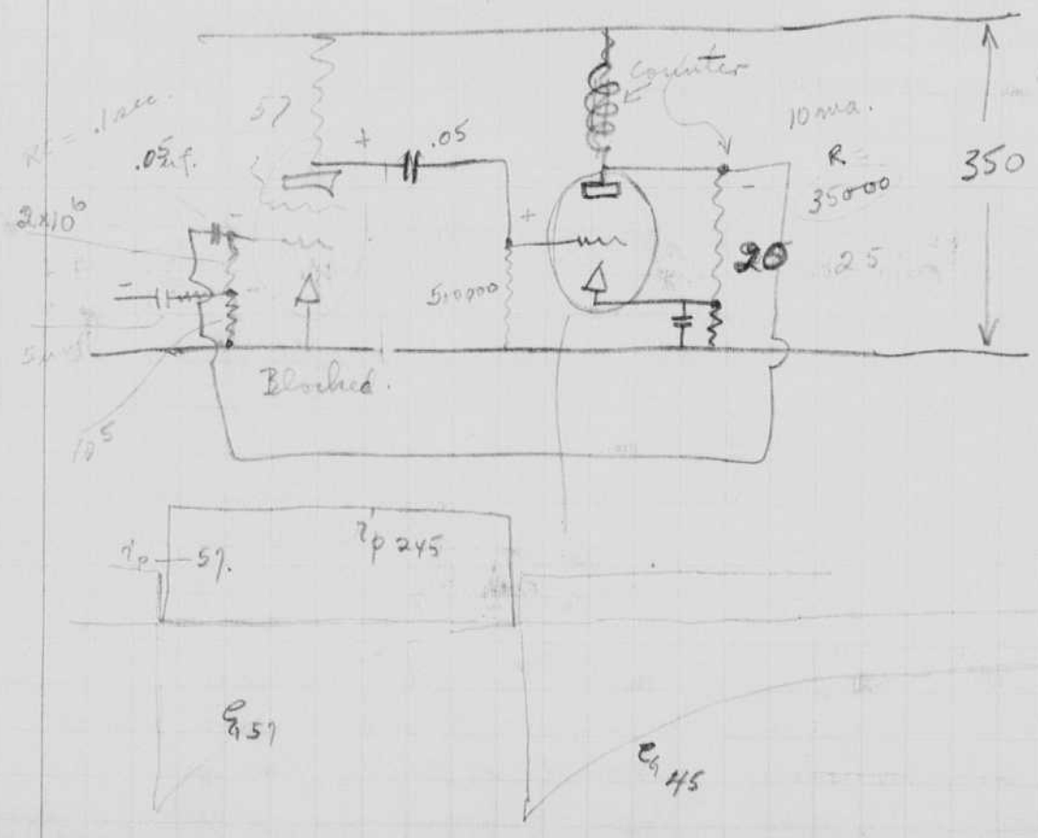
Afterd got home about 10 pm I went over to Henry Lane's house and we looked at Mr. Drogin's camera with the stroboscope for trouble in the sound system.

Bob Evans and Dinglrich came over to talk about Strobotrons tubes for use in cosmic ray counter circuits. Hope to get some from Hygrade in the next lot for the G.R.

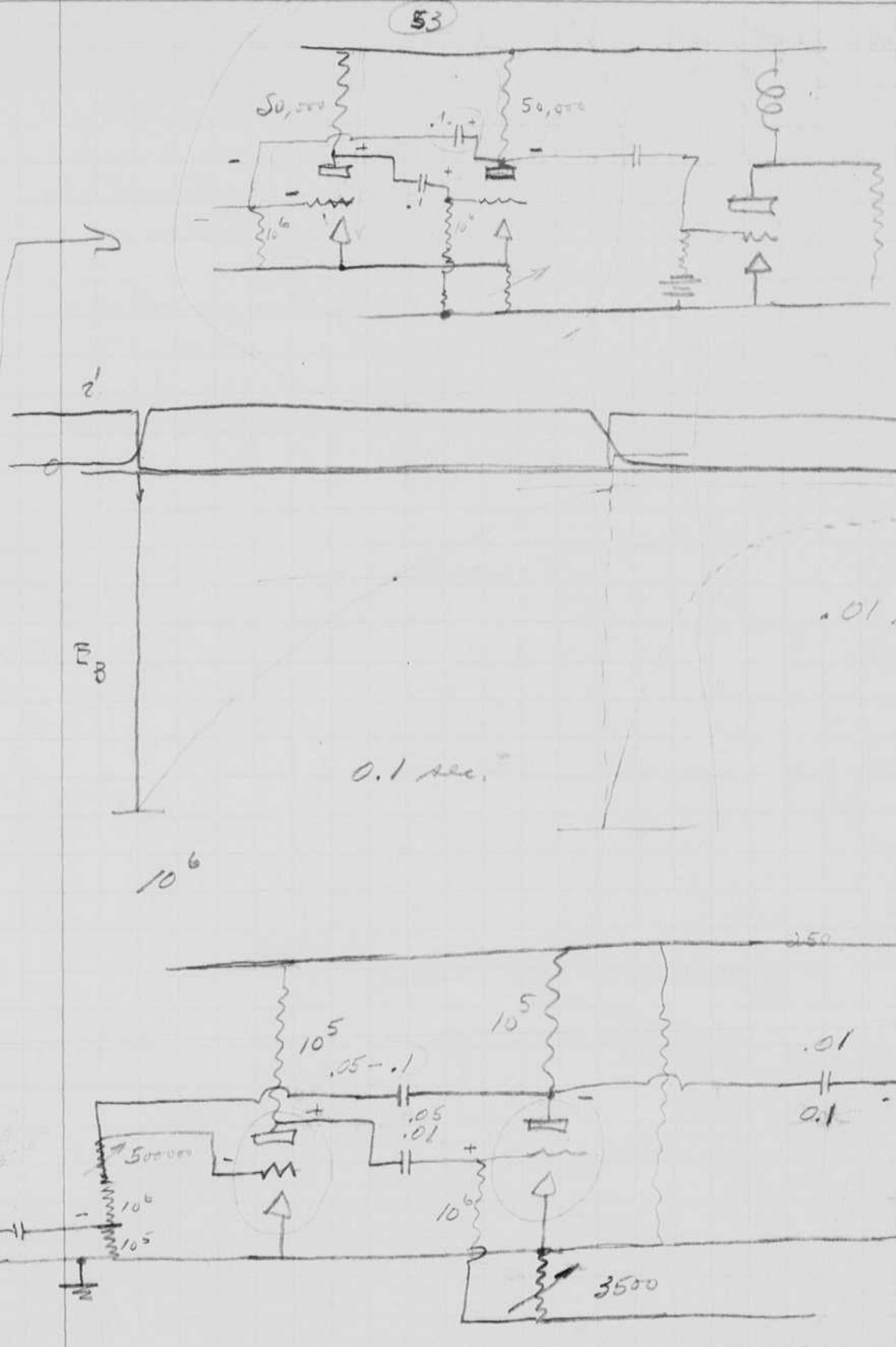
Nov 19, 1935.



To operate relay 36 ma. at .1 second ?



53



$\frac{400,000}{50,000}$ = 10 ma. 300 volts 30 volts bias

I showed the circuit to Finrich at 5 pm and he says it operates. He plans to hook up the circuit just above this week end.

Nov. 21, 1935.

Spent last night finishing drawings for a paper on the "Strobotron" by Germs & myself. Characteristics and applications of the tube.

Discussed method of making engravings with tool on metal without present chemicals. Steinhardt wished to do this or develope a scheme such as this for a thesis and as a lab. problem. I suggested a stylus producing punches in a thin metal and as used by Horsefield several years ago.

Spent morning with Bullock taking photos of a cutting torch.

O_2 60 #

CO_4 in heating noz.

O_2 90 #

Notebook # T-6

Filming and Separation Record

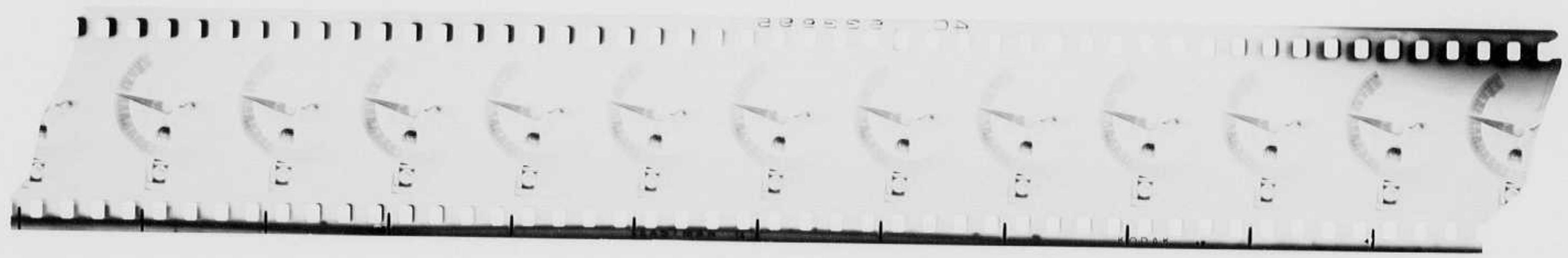
____ unmounted photograph(s)

__1__ negative strip(s)

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

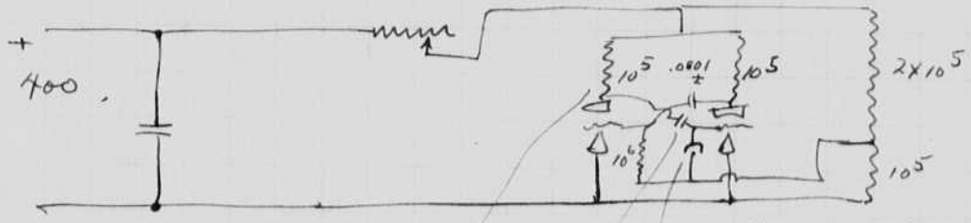
was/were filmed where originally located between page __34__ and __35__.

Item(s) now housed in accompanying folder.



Nov. 22 1935.

Mr. Schroder a junior experimented with a photo cell controlled relaxation oscillator which I set up on Friday.



type 53 tube.

photo cell.
5-50 mf. adjustable.

dc current was measured here as an indication of the amount of light. More current – more light.

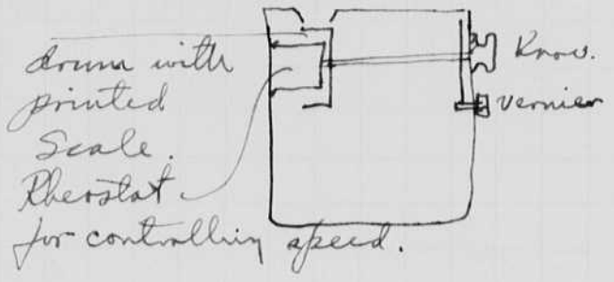
The frequency of oscillation increases with the light since the photo cell leaks off the charge at a rate determined by the amount of light.

Another pair of juniors Wood and Wiggin are trying to make a sweep circuit out of an unbalanced relaxation circuit. They are using 27 type tubes which do not seem to work so good. A higher amplification is needed.

Strobotac Suggested Changes.

Discussed with Germeshausen and Grier yesterday afternoon.

1. Change the speed dial so that it can be read from the top of the instrument without tipping it over as is now the case.



2. Eliminate transformer

3. Use of special or wire wound resistors for increasing stability.

4. Metal tubes?

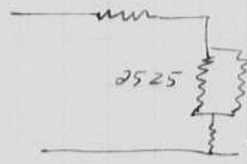
5. Rotary switch

a. Off.
b. Strobotac low scale
c. " high scale
d. " line tie in. high or low ?
e. c " Contactor " ?

Better to split into two switches

A off	A' Line in
B low	B' Strobotac
C high	C' Contactor

tubes - 2 2525 rectifier tubes.
2. metal tubes for oscillator.?
or type 6A6 glass tube. 6 V - .8 amp.
or type 79 6.3 .6 amp.



115.
31.3
83.7 volts.
.6
50.2 watts.

6A4 Power pentode. ST14 1 13/16"
6.3 V .3 amp. ST12 1 9/16 Δ = 4/16 = 1/4" in size.

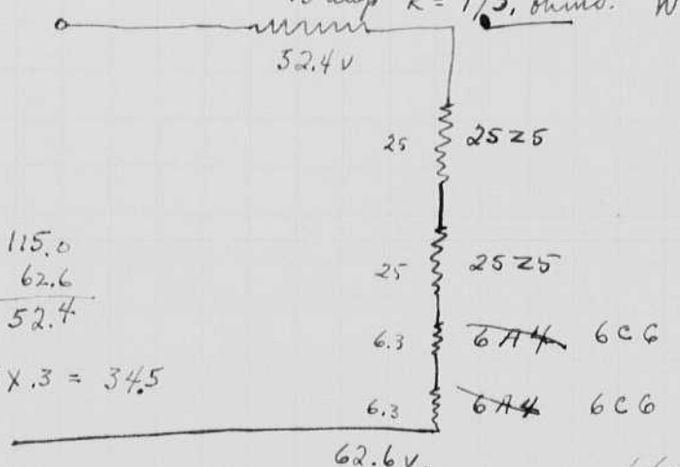
Assume 2 25-25 and 2 6A4. in a row. 26/16 = 10/10 = 5/4
2 x 1 9/16 = 3 1/8 2 x 1 13/16 = 3 3/8.
Allow 1/4 between tubes and between cabinet = 5 x 1/4 = 1 1/4"
3 1/8 + 3 3/8 x 1 1/4 = 7 3/4"

|0 0 0 0|

tubes could be staggered. —— |0 0 0 0|
total dimensions 6 inches.

$\frac{52.5^2}{17\Omega} = \frac{2750}{17\Omega} = 16.W.$

15.8
.3 amp R = 175 ohms. W = ~~175~~ watts.



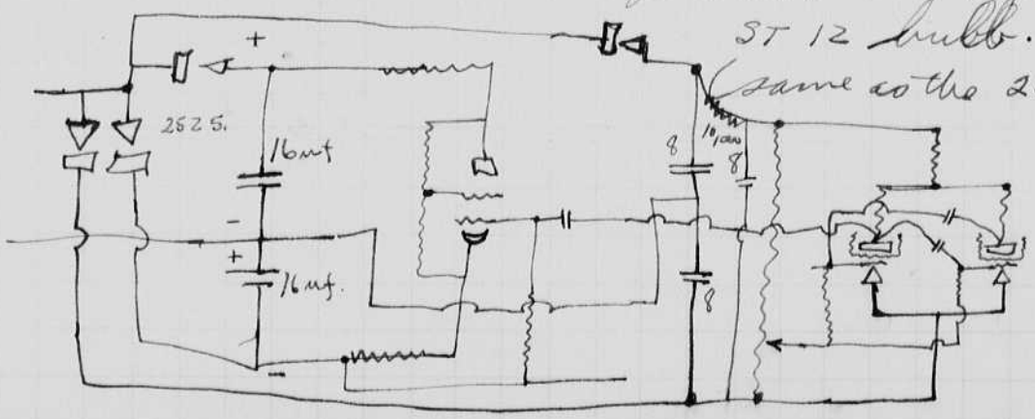
115.0
62.6
52.4

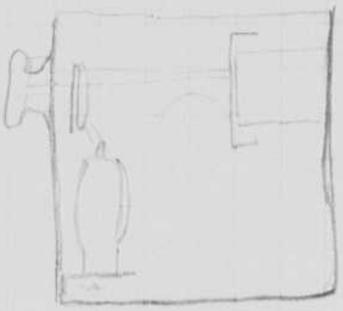
P = 115 x .3 = 34.5

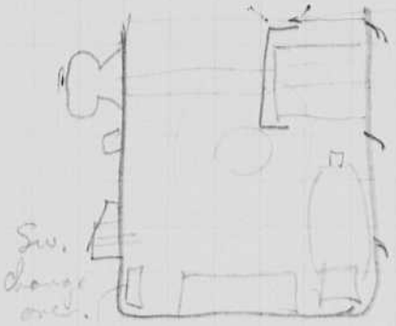
Heater diagram.

N.G. since the 6A4 does not have a heater type ~~filament~~ cathode.

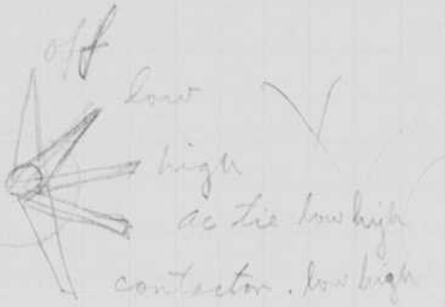
Use two 6C6 tubes as an oscillator.
ST 12 bulb. ok. (same as the 25-Z-5.) 6 prong + cap.



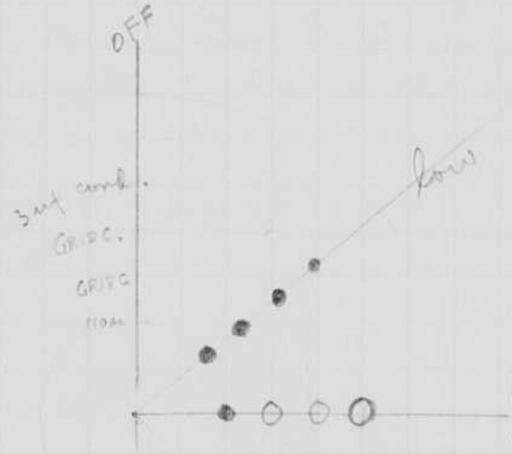


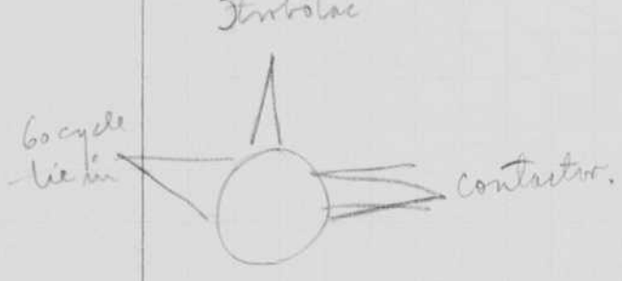

Sw.
Change
over.

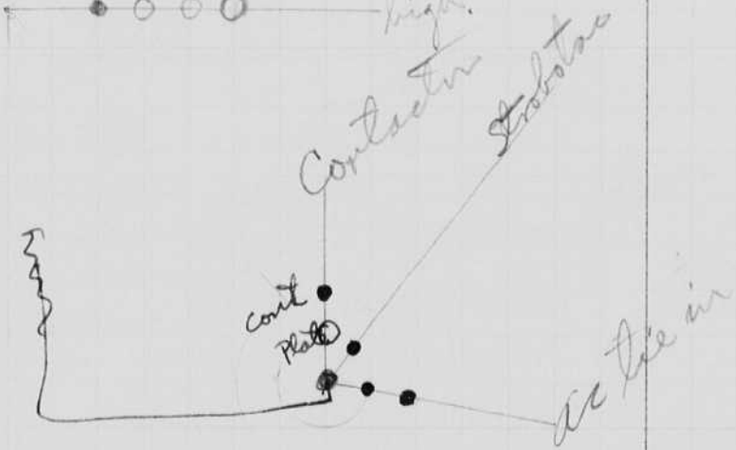
.0003 to
10 ma.

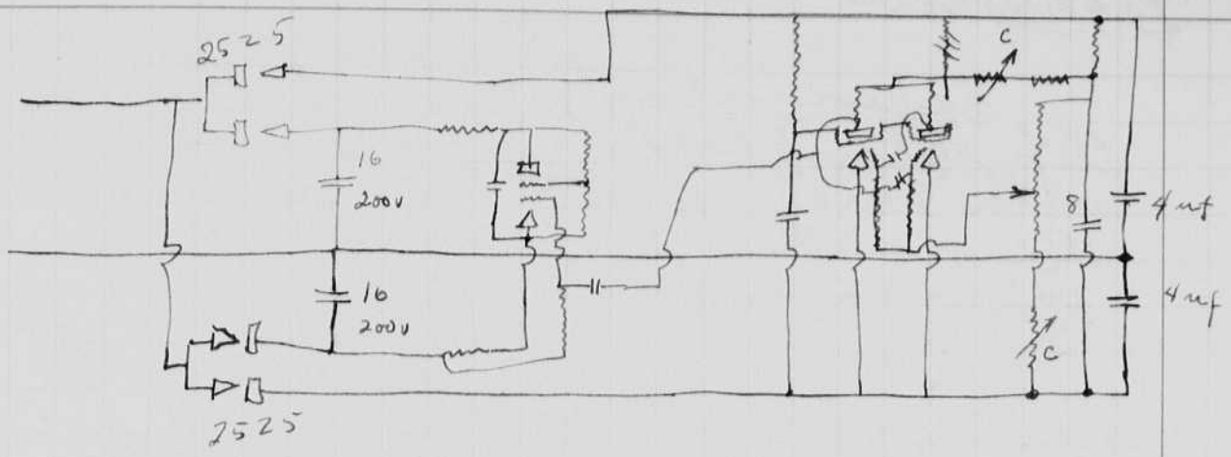

off
low
high
ac lie low high
contactor. low high


off
low
high


OFF
low
high.

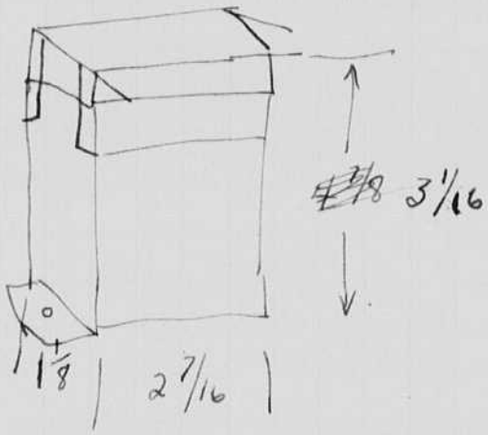

Starbstar
60 cycle
lie in
contactor.


Contactor
Starbstar
cont
Plate
ac lie in



Aerovox. 16 mf 200 volt (.62) 2 7/16 x 1 1/8 x 11/16 11262 type PB52
1.32 4 " 200 " 2 7/16 x 3/4 x 1/2. 11258
1.56 8 " 450 2 7/8 x 1 1/8 x 11/16

1.22
.64
.56
2.42



2 1/4 | 2
1 1/2 | 4
1 1/16 | 1
4 7/8

22/16
16/16
11/16

49/16 = 3 1/16.

49/32
17/16

Discussed above p 36-39 with Wilkins and McElroy at P.R. Wilkins has the above amount and is going to wire it up on a board for experimental work.

Nov 25, 1935.

Experiment with 12 lamp Hg in Elipzel lamp holder. Tank coil clamped with 1 meg 10 watt (5 .2 meg 2 watt IRC resistors in series.) 30 kw power pack.

Set up camera 15 ft./sec. approx to photograph tube at the time of blow over. Photo shows that the tube apparently breaks down due to plate voltage. f8 pro film.

With 2 mf and 400 ohms at 960/sec the condenser apparently is not becoming fully charged.

I tipped the tube over so that the plate was wet with Hg and after this the tube held over badly!

$$f = 500{,}000 \quad C = 2\times10^{-6} \quad L = ?$$

$$2\pi\sqrt{LC} = \frac{1}{.5}\times10^{-6}\ \text{sec.}$$

$$L = \frac{10^{-12}C}{.25\times4\pi^2} \qquad \frac{10^{-6}}{2\times10^{-6}} = \frac{10^{-6}}{20} = .05\times10^{-6}$$

$20\overline{)1.00}\ .05$

$$\text{Crit} \quad R = 2\sqrt{\frac{L}{C}} = 2\sqrt{\frac{.05\times10^{-6}}{2\times10^{-6}}} = 2\sqrt{.025} = .16\times2 = .32\ \text{ohm.}$$

Resistance wire tried but does not seem to help much.

Put in an 8 inch lamp and it holds over also.

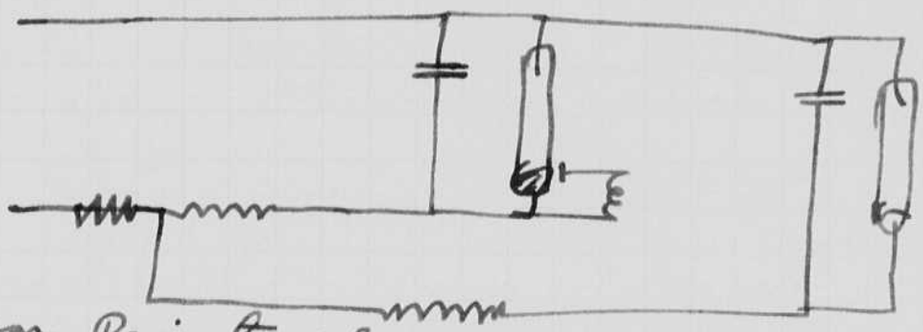
Lowered Chg res to 800 ohms (960 cycles) Works ok. Reduced C to 1 mf works ok.

$12 \times \pi \times RPS = 150$

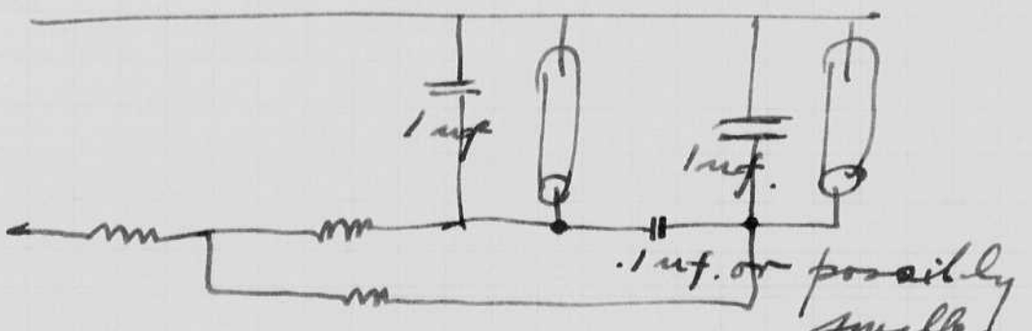
$$RPS = \frac{150}{12\pi} = 40.\ \text{sec} = 2400\ \text{r.p.m.}$$

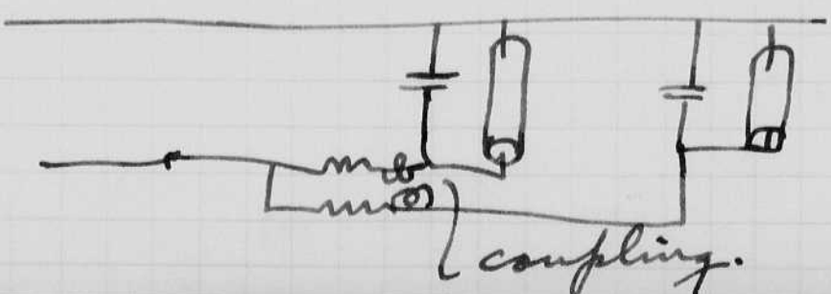
960t 1 mf 2400 12" lamp 1" anode Hot and cold. two exp. no slit
960f 1 mf " 12" " " Hot. Slit

The 800 ohm 1 mf combination seems to give more light than 800 Ω 2 mf. Some hold over with the 1200 volts from the 30 kw outfit when loaded with one lamp.



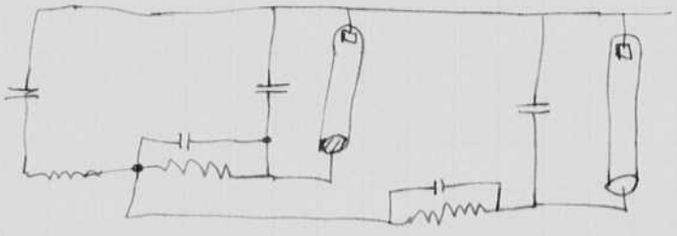
Common Resistance
to help put out tube that tend to hold over.

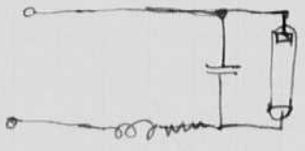




Nov. 27 1935
H.E. Edgerton.

Method of reducing hold over of the Hg lamps by using capacity on the across the charging resistors.





f = 2000 cyc./sec.

C = 1 mf.

L = ?

$2\pi\sqrt{LC} = \frac{1}{2000}$

$L = \frac{10^{-6}}{4} \frac{1}{4\pi^2} \frac{1}{10^{-6}} = \frac{1}{160} = .006$ henries

6 m.h.

$2\pi\sqrt{.006 \times 10^{-6}} = 2\pi .8 \times 10^{-4} = 5. \times 10^{-4} = \frac{10^{-4}}{.2} = \frac{1}{.2 \times 10^4}$

$\frac{1}{2000.}$

L = 6 mh. to handle 1 amp. dc.

Use an iron core that saturates at .25 amps. with an inductance of 20 mh with 0 current.

$\left(\frac{R}{L}\right)^2 = 4\frac{1}{LC}$ $\quad R = 2\sqrt{\frac{L}{C}} = 2\sqrt{\frac{.0060.}{1 \times 10^{-6}}} = 2\sqrt{6000} = 140$ ohms.

Coil marked 11-27-35 measured on D.R. Imp Bridge

.045 h	0 – outside 100 turns?	
.0215 h	0 – 75	Q = 2.3
.0105 h	0 – 50	

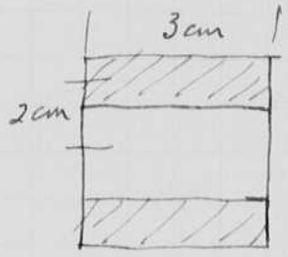
Inductance of a Single Layer Solenoid.

p 252 Cir. of Bur. of Std. # 74.

$$L = \frac{0.03948\, a^2 n^2 K}{b}$$

K = function of $\frac{2a}{b}$ Nagaoka. page 283

a = radius.
b = length of coil
= n times distance between centers of turns.



diam / Length	K.
.0	1.
.25	.901
.5	.8181
.75	.74
1.0	.6884
1.25	.638
1.5	.5950
1.75	.5575
2.	.525
2.5	.472
3.	.429
4	.3654
5	.3198
7	.2584
10	.2033.
20	.1236
30	.0910

Let $a = 2$ cm. $\quad \frac{4}{3} = \frac{a}{b} = 1.3$
$b = 3$ cm. $\quad K = .6$
$n = ?$
$K = .6$
$L = 6$ mh. = 6000 microhenries

$$n^2 = \frac{6000}{.03948 \times .6} \times 3 = 190 \times 10^3$$
$$= 190000$$
$$= 400 \text{ turns.}$$

$n =$

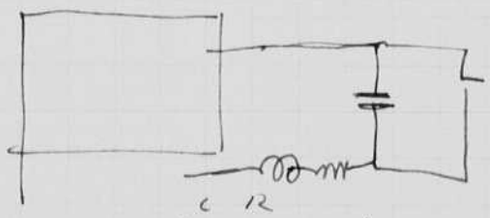
180

18 # 22 gage 3 amp. 40 miles. 25 mills

24
04
096 .1

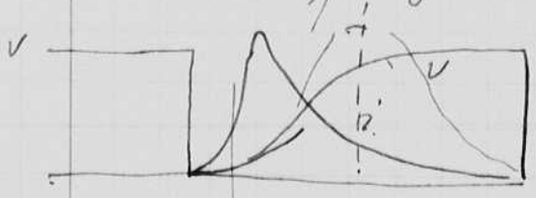
$\sqrt{400} = 20.$

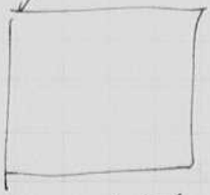
$20 \times .025 = .5$ on a side neglecting insulation.



$1 \times 200 \times 10^{-6} = .0002$ seconds.

Say $R = 200$ ohms. $i_{peak} = 5$ amp.
Saturate at 1 amp.





$f =$

$\frac{1}{2000}$

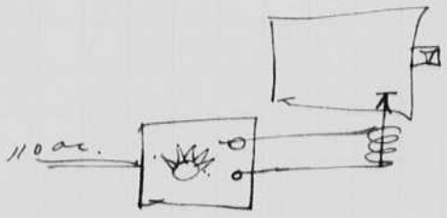
$f = \frac{1}{1000}$ of osc. initial.
$L = .012$ henries.

$$i_{max} = E\sqrt{\frac{C}{L}} = 1000\sqrt{\frac{10^{-6}}{.01}} = 1000\sqrt{10^{-4}} = 10 \text{ amp.}$$

Nov. 28 1935
H. E. Edgerton.

Show motion movies.

Use of a relaxation oscillator to trip the shutter of the camera.



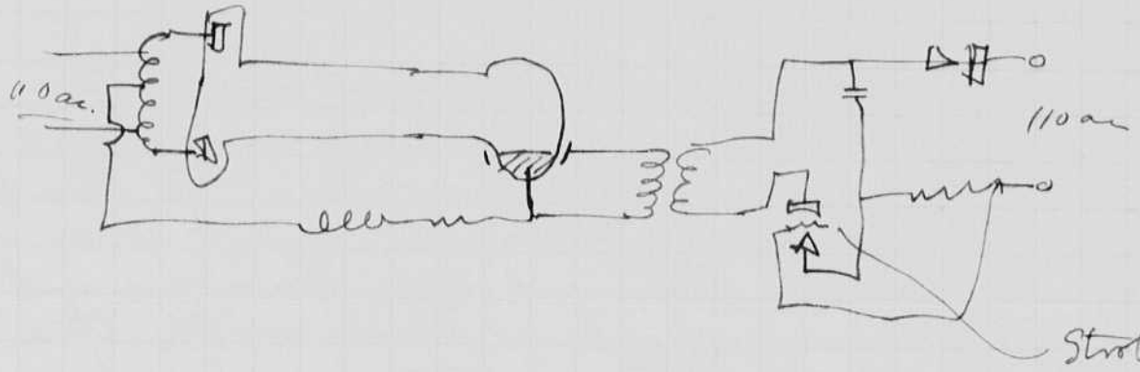
Relaxation oscillator.

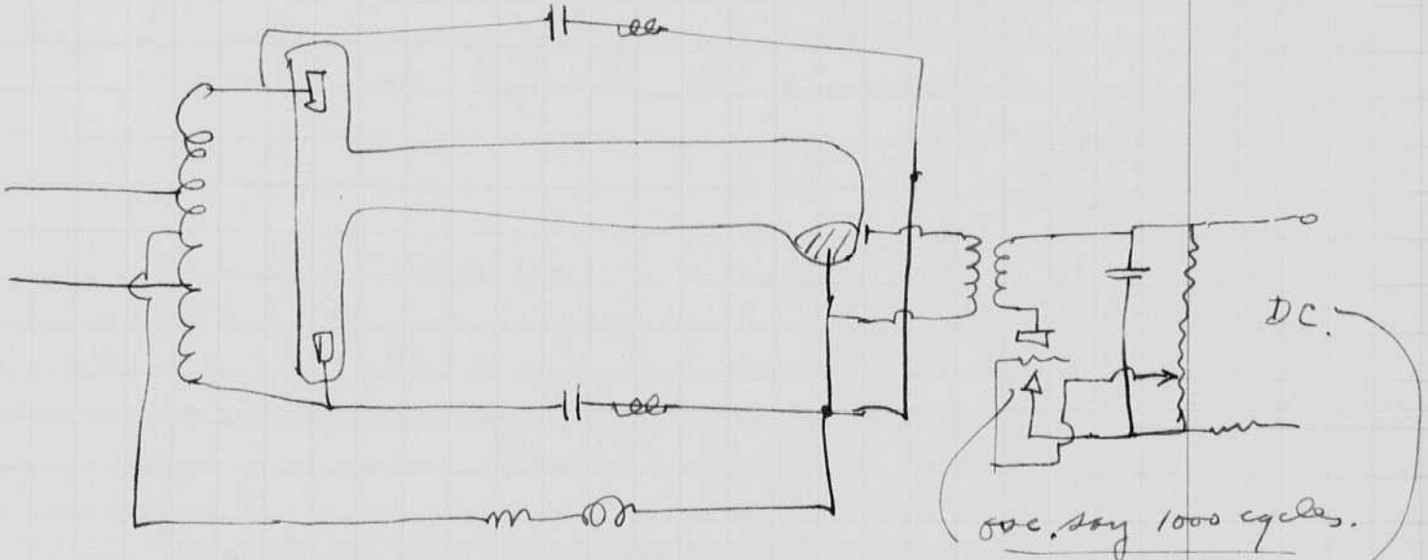
Speeds. 4/sec.
2/ ".
1/ ".
1/2 2 sec
1/4 4 seconds.
8 ".
15 ".
30 ".
1 min.
2 ".
4 ".
8 ".
15 ".
30 ".
1 hour.

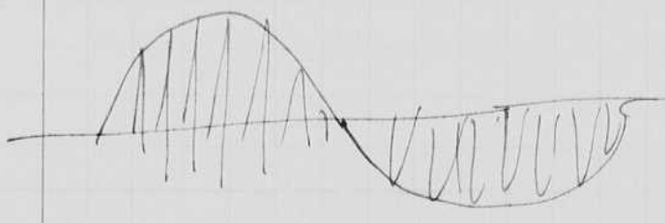
Nov 28 1935
H E Edgerton.

Mercury lamp starter.

A Strobotron tube should be ideal for starting mercury lamps. No moving parts would be needed as is now the case in the Cooper-Hewitt D.E. type. The capacity discharge method might give more light of better quality.







Rectified ac for sounds on Hg. lamp.

Nov 29, 1935
H. E. Edgerton.

Lamp house design

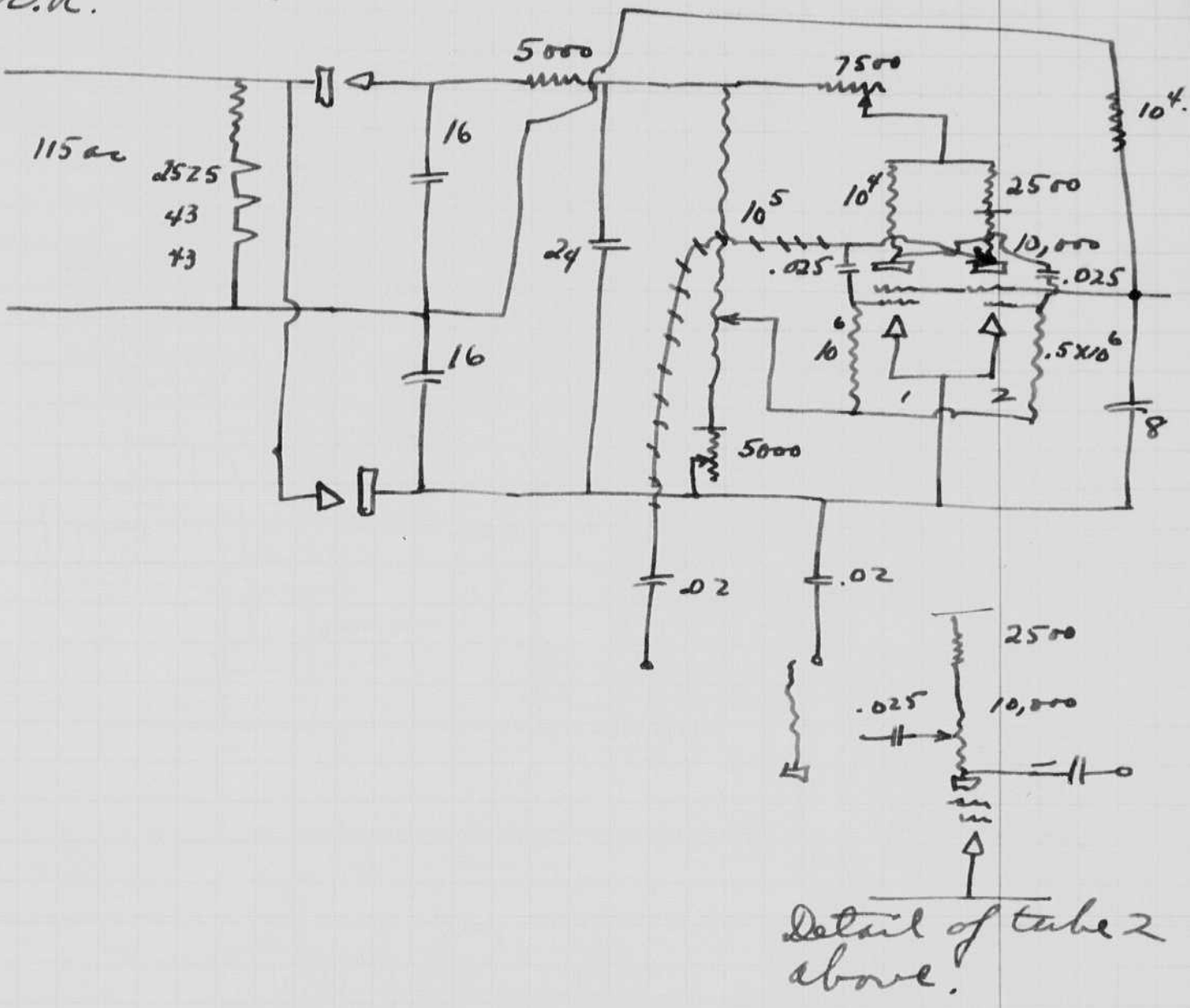
Present lamphouses have a Ford spark coil with a 1 meg 10 watt resistor to damp the wave. I used a 1 ~~watt~~ mf ~~resistor to~~ capacitor the other day and wish to again try it. Also plan to use a lamp in the lamp house to heat it up. Guess that 200 or 400 watts needed.

Tried out but did not come to any conclusions regarding wattage. One interesting observation: a lamp was holding over with 1 mf 400 v 960 cycles! I tried 200 ohms and it ran fine. I checked back with the same result. I tried a .1 mf around the charging resistor and it seemed to help in some cases.

Mr. Atherton of the Westinghouse Co. (Boston office) called yesterday regarding the conference which we had last Monday when Mr. Spooner of the Westinghouse labs. was here. Atherton wants several copies of the paper that Germeshausen and I have just completed and plan to submit shortly to the A.I.E.E. This tube is called the "Strobotron".

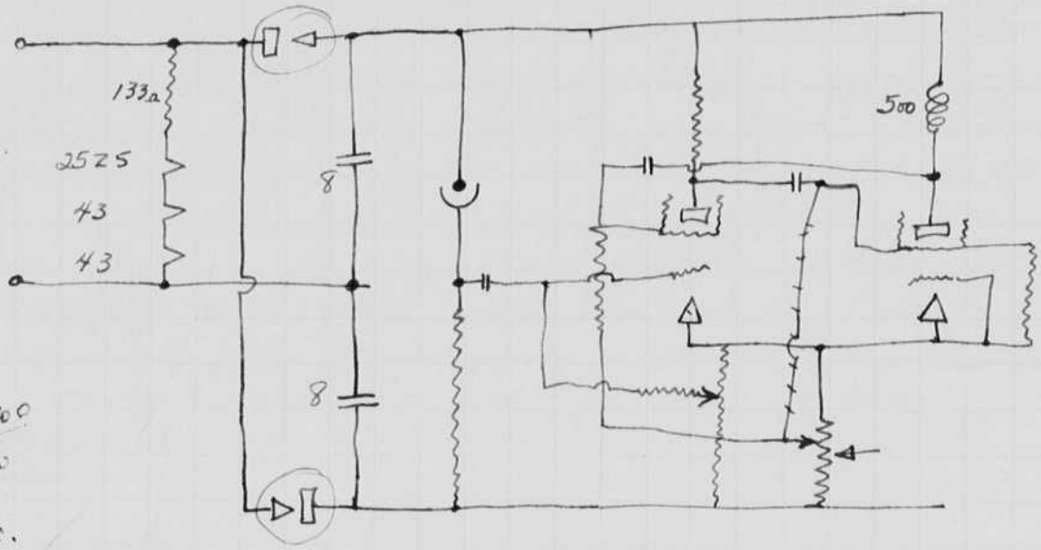
Oscillator Drive 548.B.

Single-range oscillator 600-12000 r.p.m. Dated July 10 1935. from sketch ~~that~~ was given at time to Wilkins S.R.

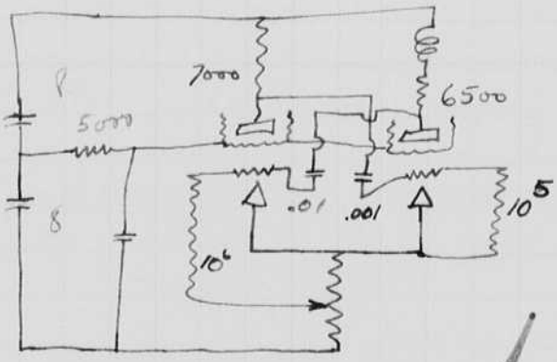


Nov. 30. 1935
H. E. Edgerton.

Counter circuit and photo cell relay counter circuit. The object of this type of amplifier is to produce a pulse of current lasting long enough to operate a counter or a relay even if the pulse initiating the ~~dis~~ amplification is very weak or very short. It is accomplished by using a two-stage back-coupled amplifier arranged to be at cutoff on one tube.



6000
.040 | 2500
30 ma.
7000.
.23 | 2500 V

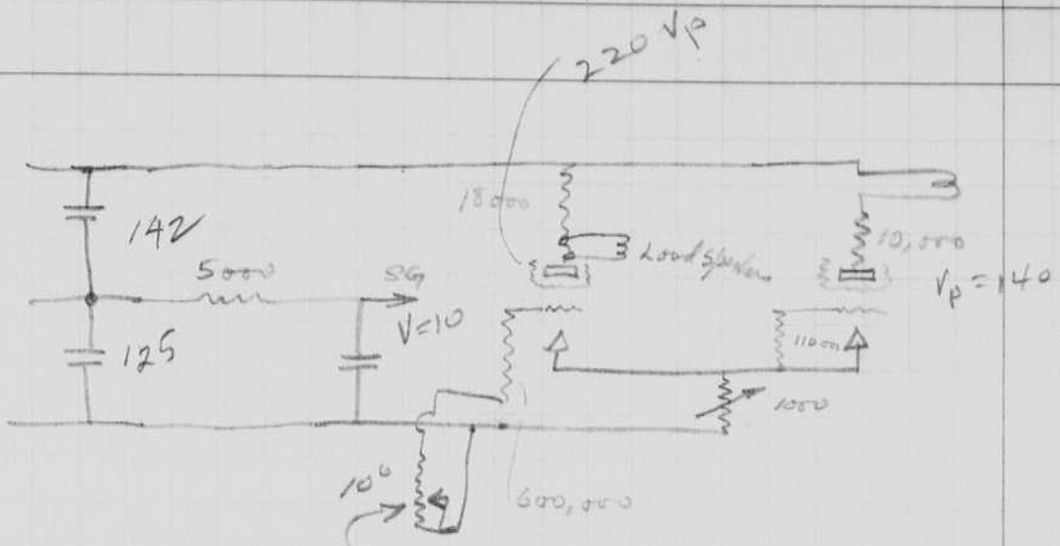


10000
.030 | 3000

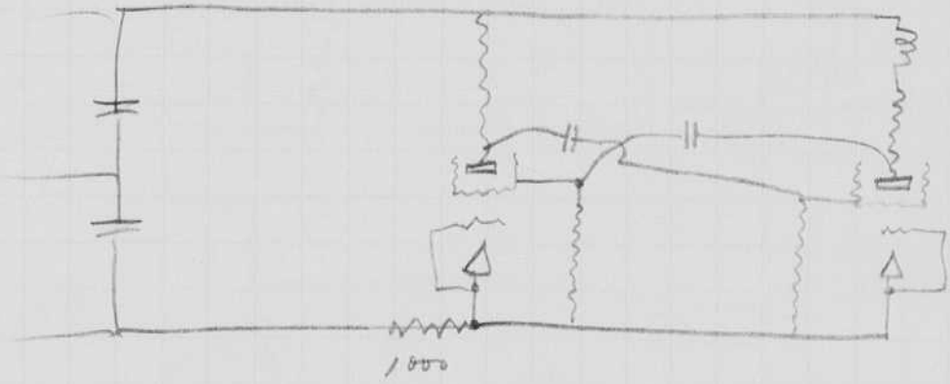
7.500.
030 | 250
.03
.03
.001

$T = 0.1$ sec $= RC = 10^6 \times C$ $\quad C = \frac{.01}{\times 10^{-6}} = .01$ mf.

Nov. 31, 1935.



Oscillates at low freq about 1-5 sec as 10° adjustable rheostat is changed. Buzzes with low if resistance is less than about 250000 ohms.

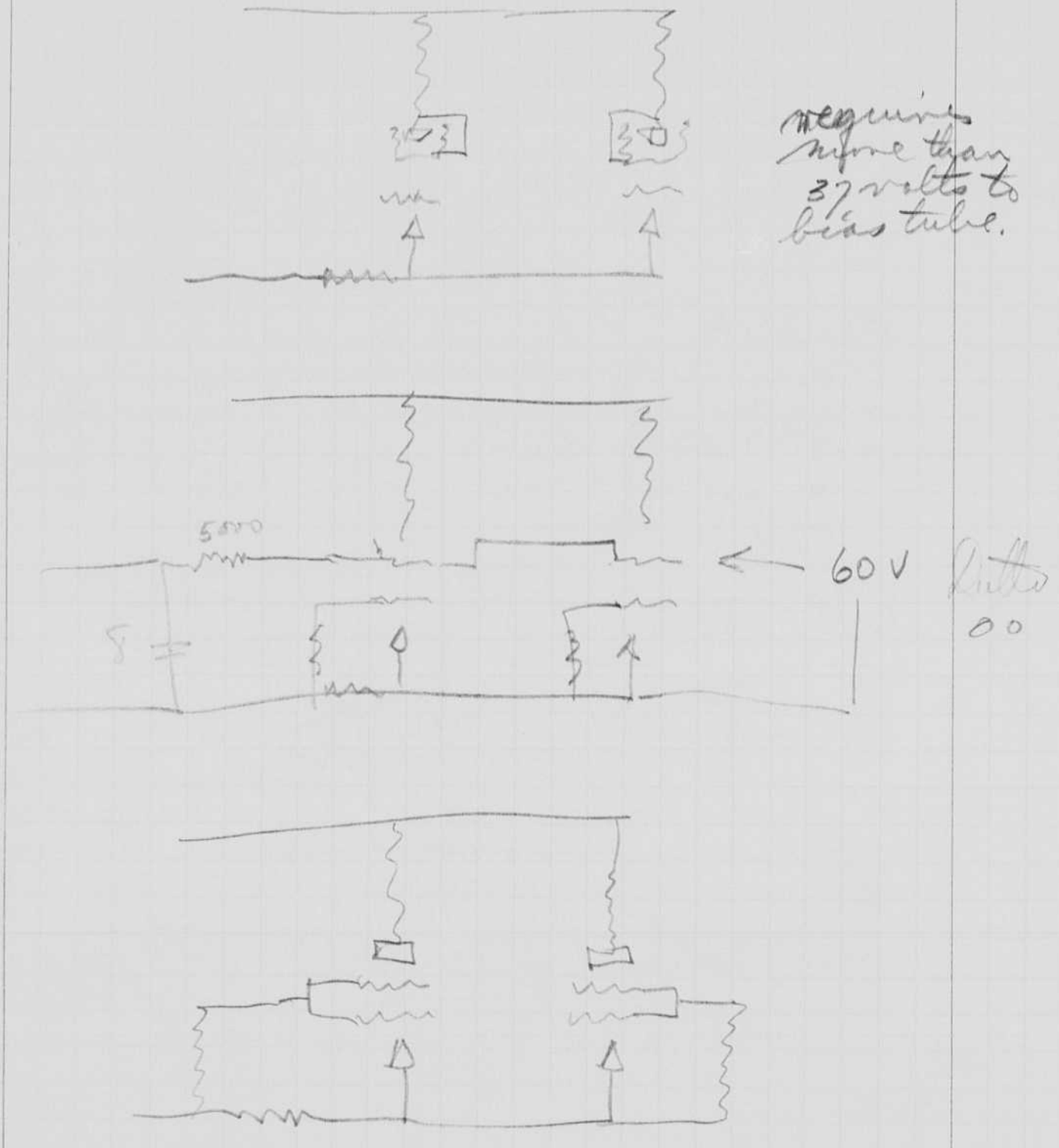


Not much plate current. Puffs but with oscillations on each puff.

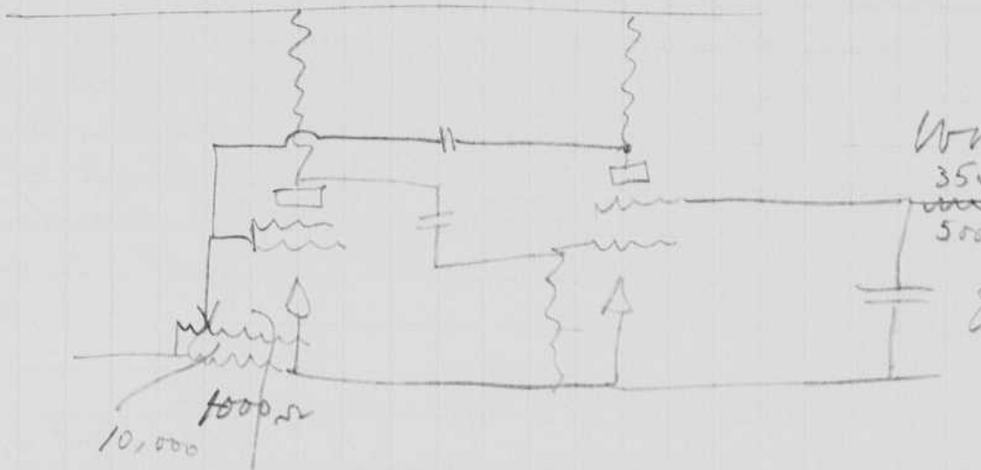
Green

blocks

Marking on base of socket



requires more than 37 volts to bias tube.



Worked ok, mid tap

40 x 40 / 10 000 Ω

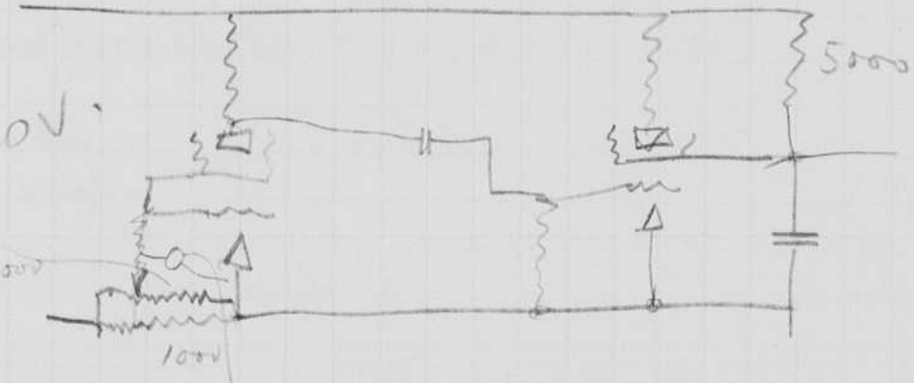
10 / 100

critical voltage about 45 volts / 2 = 23V

.035 / 5,000 =

7 ma.

Above voltage put on screen grid



220V.

105V

critical voltage now about 4 volts!

Say 40 ma needed in counter.

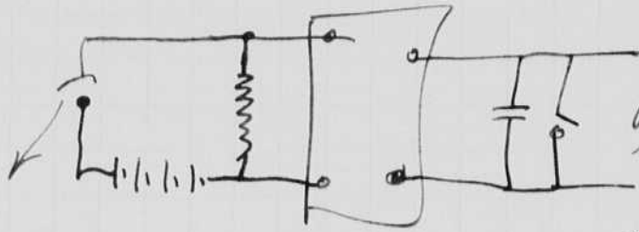
4 volts / .040 = 100 ohms. 11.6 when tried

300 ohms ok. Hold off voltage now 11.5.

Tried coil in [illegible] leak does not work.

Dec 2, 1935.
D. E. Edgerton

Conf. with Steinhart regarding his circuit for experiments to make cuts. Suggested in previous conference method of shorting condenser in photocell circuit for each punch of the die. Calculation shows that a single stage of de amplification probably would be useful to increase the gain in order to get away from contact trouble.



#600 + 44p

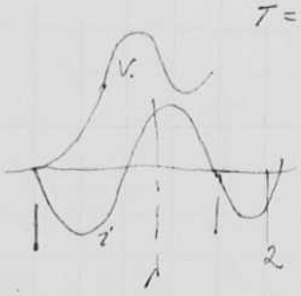
Mr. Kemp of the Anglo-Canadian Paper Co was here and discussed movies with him. He went over to the G.R. with me and talked to Burlee[illegible] and to Wilkins. Designed ~~Selenium~~ saturable choke with McElroy and designed it for experimentation

50 70 and 100 turns.

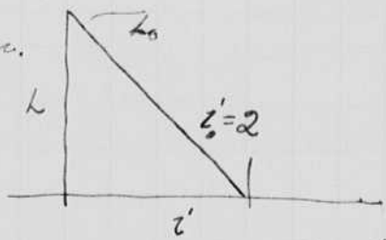
.05 henries with 0 dc. current

$T = 2\pi\sqrt{LC} = 6.28\sqrt{.05 \times 1 \times 10^{-6}} = .25 \times 10^{-3} \times 6.28$

$= .0015$ seconds.



200 ohms 1000 volts $i = 5$ amps.



$E1 = \frac{1}{C}\int i\,dt + \frac{d}{dt}Li + Ri.$

$= \frac{1}{C}\int i\,dt + \frac{d}{dt} i'\left(1 - \frac{i_0'}{i_0'}\right)L_0 + Ri'.$

$\frac{1}{C}\int i\,dt = E1 - \frac{d}{dt}\left(i' - \frac{i'^2}{i_0'}\right)L_0 + Ri'$

~~$= E1 - L_0\frac{di'}{dt} - L_0 i_0' \frac{d}{dt}(\quad) + Ri'$~~

$E_C = E1 - L_0\frac{d}{dt}i' + \frac{L_0}{i_0'}\frac{d}{dt}i'^2 + Ri'.$

$L_0\left(1 - \frac{i_0'}{i_0'}\right) = L_0\left(1 - \frac{i_0}{i}\right).$

$L = -L_0\left(\frac{i'}{i_0'}\right) + L_0\Big]$ from $i' = 0$ to $i' = i_0'$

$L = 0$ from $i' = i_0'$ to $i' = \infty$

$e_L = N\frac{d\phi}{dt}\times 10^{-8}$

$\phi = f(i)$ mag. curve.

Notebook # T-6

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 52 and 53.

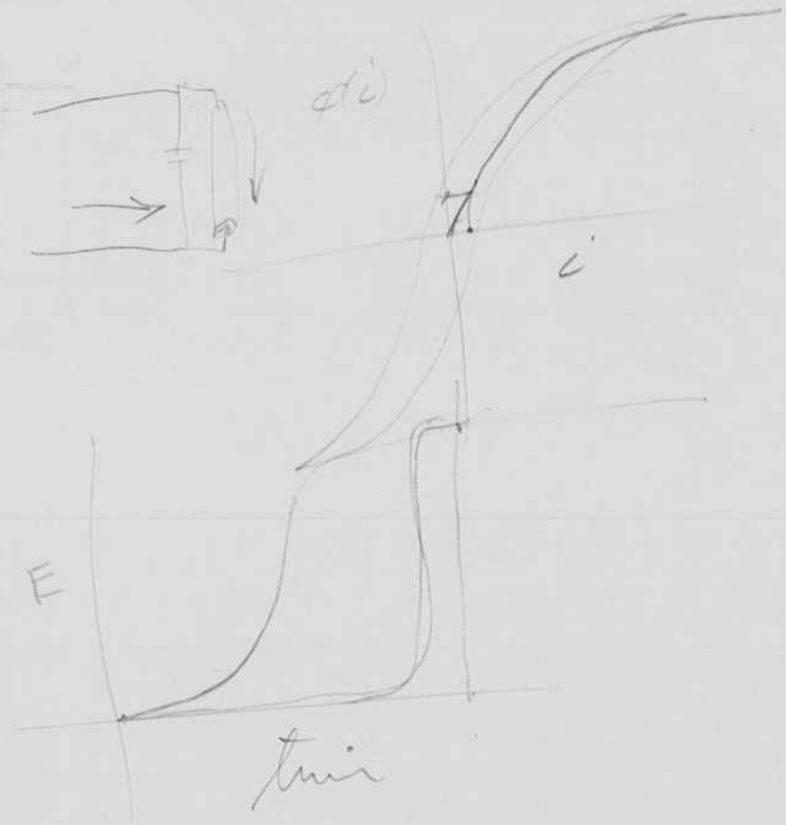
Item(s) now housed in accompanying folder.

$$e = Sq + R\dot{q} + \frac{d}{dt}(N\varphi)$$

$$N\varphi = \varphi(i)$$

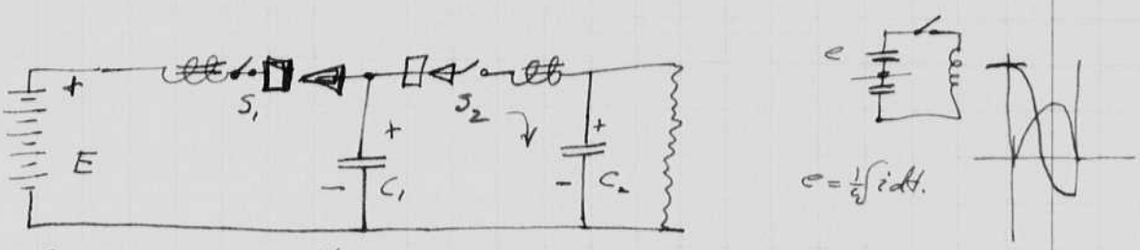
$$\frac{d}{dt}\varphi(i) = e - S\int i\,dt - Ri$$

$$\frac{d^2}{dt^2}\varphi(i) = \frac{de}{dt} - Si - R\frac{di}{dt}$$



~~P. $\frac{1}{C}$~~ The circuit shown will be set up experimentally and tried in the laboratory.

Method of obtaining high voltage.



Close S_1 with $E_{C_1} = 0$ results in a voltage of $2E$ on C_1 due to inductand and rectifier assuming zero damping

Close S_2 with $E_{C_2} = 0$ results in a voltage of $+E^{(?)}$ on C_2. and $-E$ on C_1.

Close S_1 with C_1 Voltage $= -E$ results in a voltage of $+3E!$ on C_1.

S_2 ⟶

Voltage will build up until leak balances energy input.

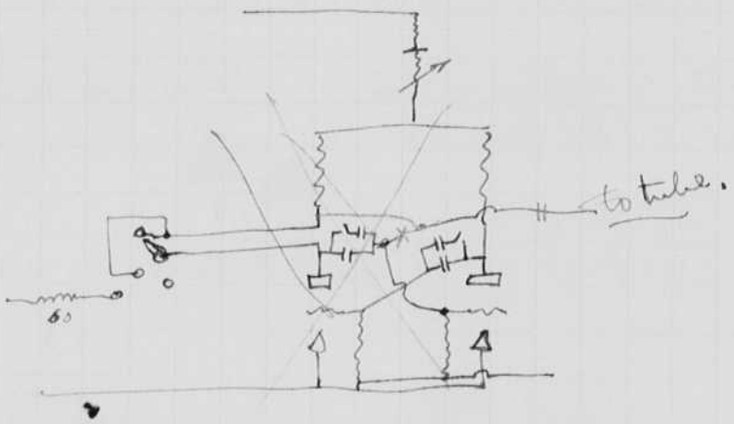
Dec. 3, 1935 Spent entire morning with Mr. Rines in his office discussing applications

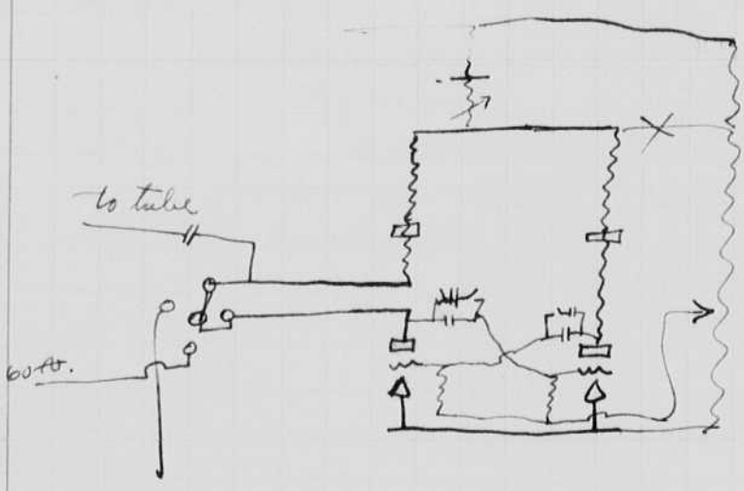
S.N.	685,501	Stroboscope
	714,978	Camera
S.N.	33,733	Camera circuits.
Int.	71,610	with Westinghouse - Gilliksen.

Dec. 4, 1935
H. B. Edgerton.

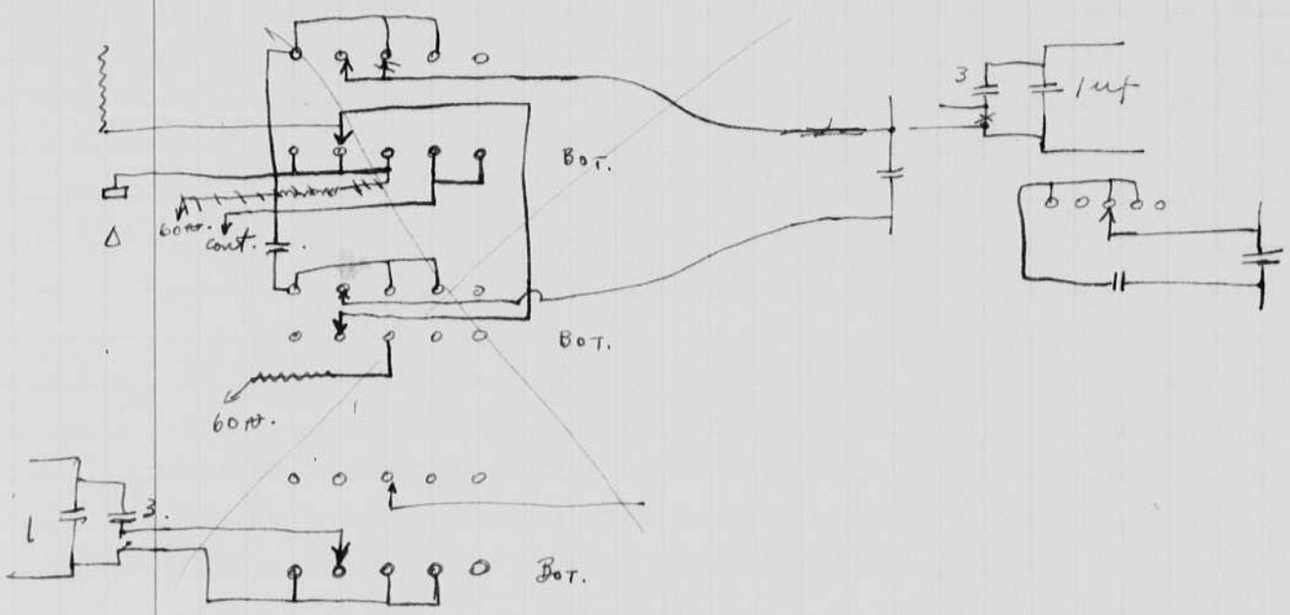
A Yaxley 3 gang two circuit switch has just been received from D.R. for use in the next model Strobotac. A circuit for same and lay out will now be made. It may be possible to mount resistors and condensers for the oscillator directly upon the switch and in this way save considerable trouble and expense in manufacture.

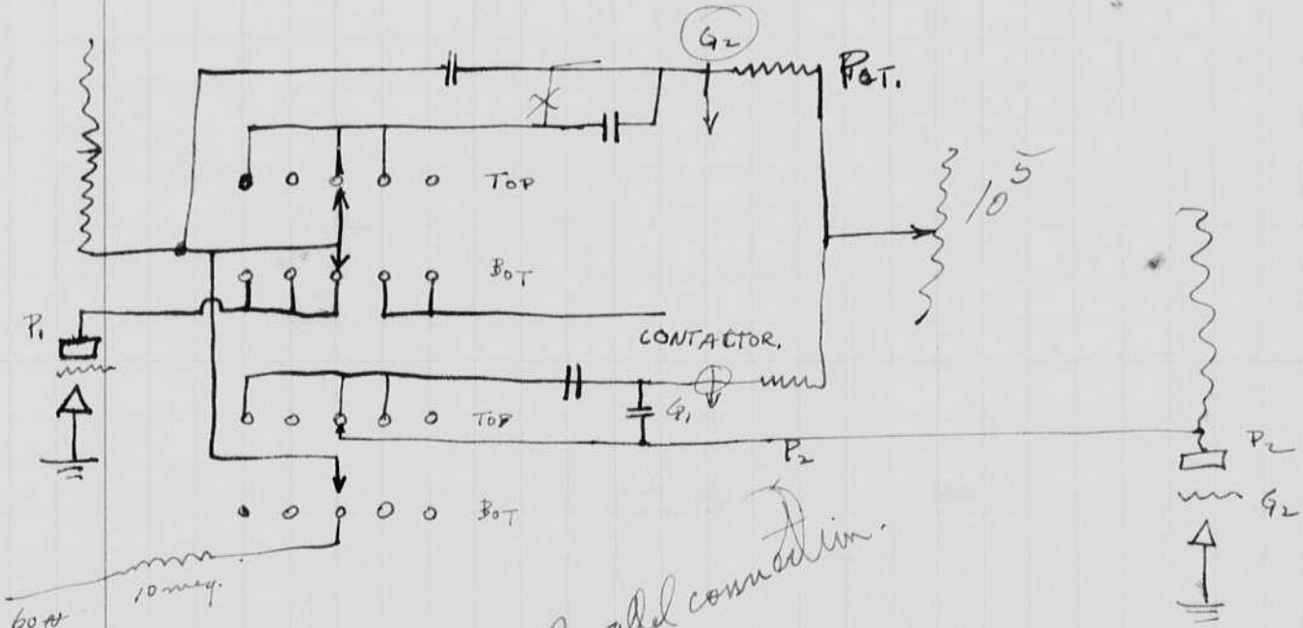
Point 1. Strobotac low speed
2 " .
3. " ac tie in
4. Contactor low speed
5 " high. "





low high or low high
K K. C C





Parallel connection.

Connected as shown on experimental model. Works fine!

I tried saturated choke built by S.R. described on page 52. Thyratron was faulty(?) and the experiments are not complete.

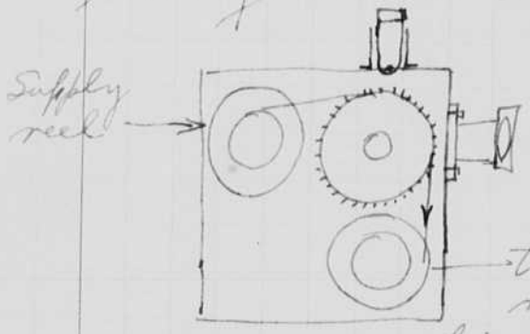
Dec. 8, 1935. Sunday
H. E. Edgerton.

On Friday Prof. Hansen (Chem. Eng.) came over and we took some photos of bullets going through rubber. A very small hole is left by the bullet. It says that with a pointed high-speed bullet, there is no trace left. In our experiment a 25 pistol bullet was used. A very small trace was left on the back side of the rubber sheet. Hemmeshausen at Salem today.

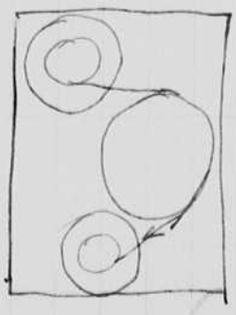
I stayed home yesterday to beat down a cold and sore throat which have been with me most of the week. About 4 in the afternoon I drove down and had a discussion with Mr. Rines regarding the Strobolyric paper and 61,045 S.N. patent application.

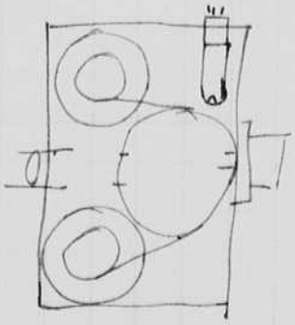
New Camera continuously moving film.

This camera will be more compact than the present one and will have provision for timing waves on the film.

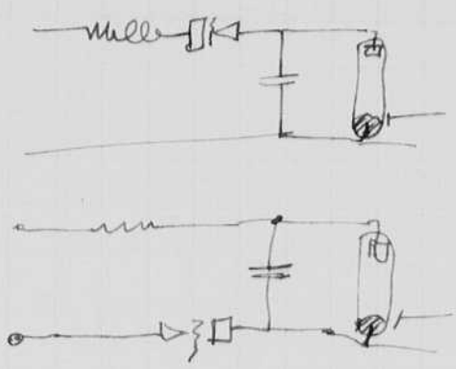


Disadvantage of this arrangement — loss of direct view through the body of the sprocket.

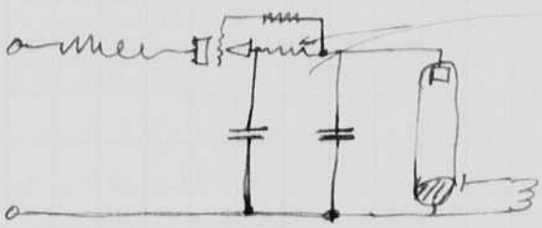




Dec. 8, 1935.
H. E. Edgerton

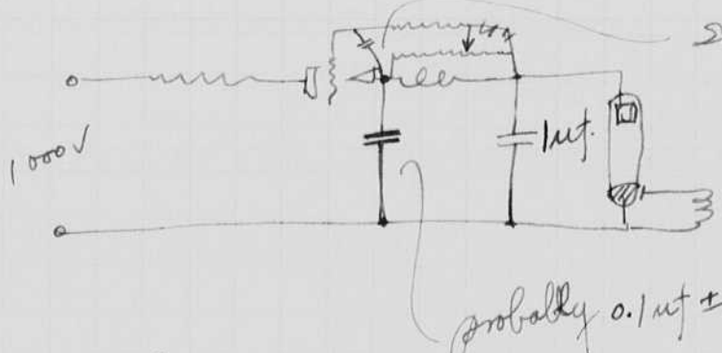


In these circuits there is a strong tendency for the spark surges to trip off the charging tube and thus cause holdover.



resistance to produce bias for short interval of time to hold off the thyratron immediately following discharge. Later the bias will decrease and the thyratron go on to pass current into the discharge condenser.

An inductance might be better than a resistance since the grid ~~voltage~~ could be actually tripped by its voltage when positive at a time determined by the frequency of oscillation of the circuit



small condenser to keep surges from initiating the discharge in the thyratron.

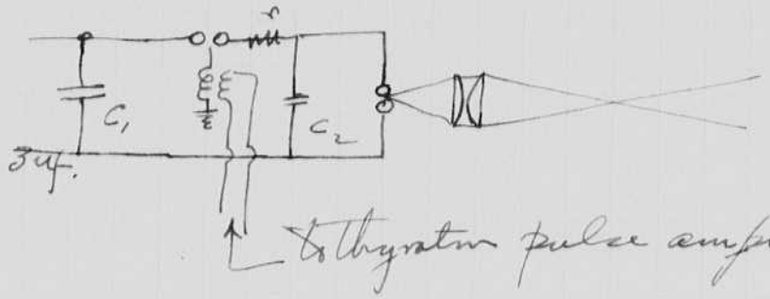
probably 0.1 mf ±.

I feel certain that this solution of the "hold over" problem can be made to work very satisfactorily but I hope that other methods can be employed that are simpler.

Dec. 8, 1935.

~~E. E. Norton~~

Silhouette high-speed photography. method of synchronism.



Say C_1 = 3 uf 16000 volts.

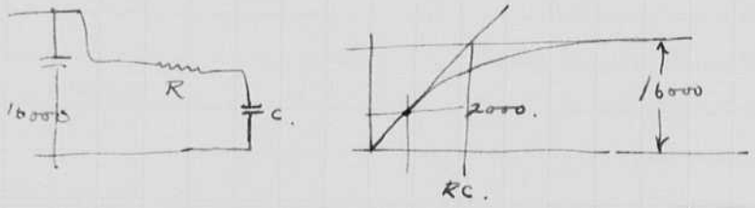
C_2 = .05 uf.

frequency of photos 100,000./sec
50 pictures.

$\frac{100000}{50} = \frac{1}{2000}$ sec.

25000 pictures a second.

1000 V Energy in flash $\frac{1000^2}{2}.05\times10^{-6} = .05$ joules
2000 V .. .. .. .2 ..



$RC = 8t$ $C = .05$ $t = \frac{1}{20,000}$

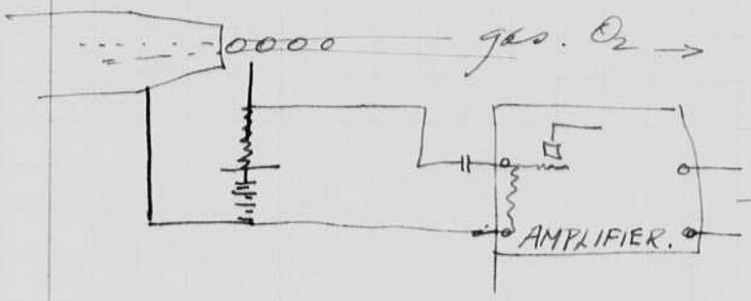
$R = 8\frac{1}{20,000}\frac{10^6}{.05\times1} = \frac{8\,10^6}{1000} = 8\times10^3 = 8000$ ohms.

$\frac{6000\text{ ft/sec.}}{20,000} = .1$ ft between pictures = 1 inch.

Drum camera. = 80 frames
16×5 = 78
160. 16
320 8 mm

at a speed of 30 sec.
10000 pict./sec.
.. .. .. of 60 r.p.s.
20,000 pict./sec.

Nozzle experiment. (Cutting torch). See page 55.



Instantaneous photographs show a series of dots comming from the nozzle. It may be possible to measure the frequency of these by some electrical method. Possibly the gas is intermittenly ionized by the nozzle or a high voltage will cause an ac component the same as the occurrence of the dots.

Dec 10,(?) Mr. Beecher & Mr. Whitcomb of the Norton co were here to see the first grinder picture.

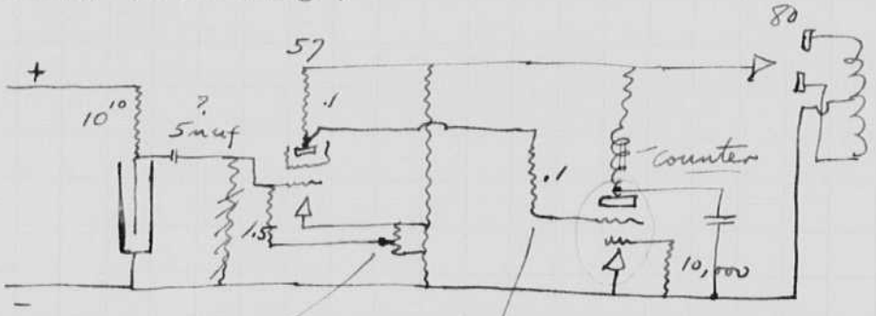
30 sec flat grinding of cold rolled steel.
" top edge "
30 sec flat
30+ sec edge.

35 mm camera driven by flexible chain. Panchromatic super speed film. f 35 lens about 1:1. 3 mf capacity on 2 condensers. 1000 volts. 2-866's power supply.

Dec 12 1935
H. E. Edgerton.

Yesterday afternoon at 5 I stopped in at Emrich's lab. in physics to see how they were getting along with the Strobotron tubes that I gave them several days ago. They had given them up according to a student, who was working there.

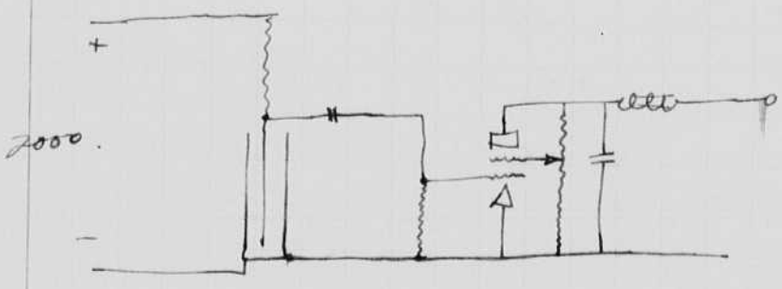
This morning another student came in first thing 9:15 and I went over with him to his lab. We made some changes in the apparatus and it worked fine. The proposed circuit which was tried is given below.



direct coupling from the 57 plate to the carbon grid of the strobotron

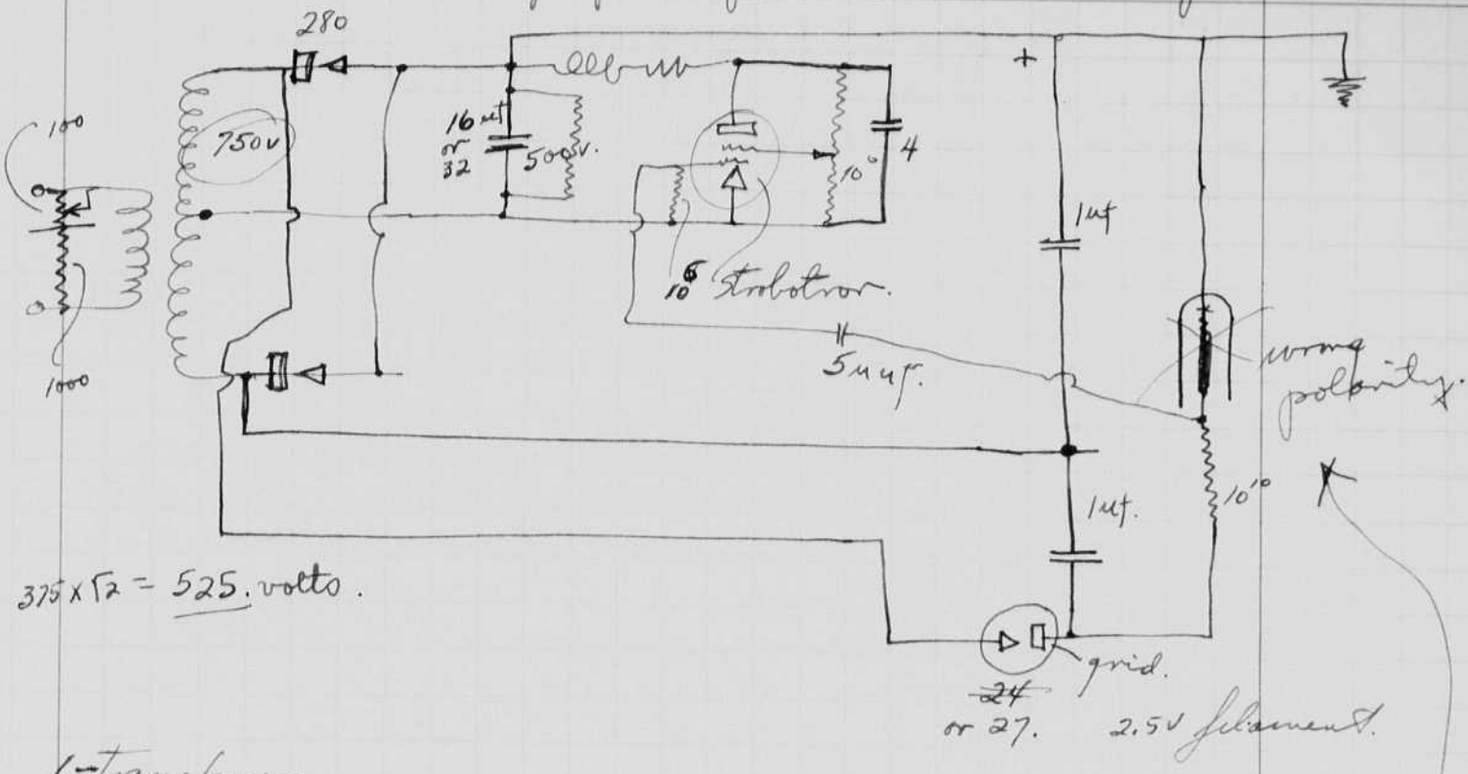
Grid biased so that the tube 57 drop was very low say about 15 or 20 volts.

I suggested several other uses and connections of the strobotron in these Geiger-Muller counter circuits.



600 v.

Design of a simple counter circuit using a Strobotron.

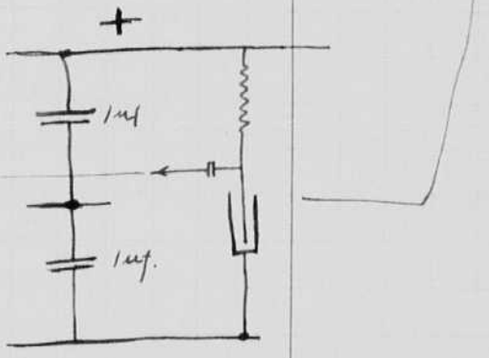


375 x √2 = 525. volts.

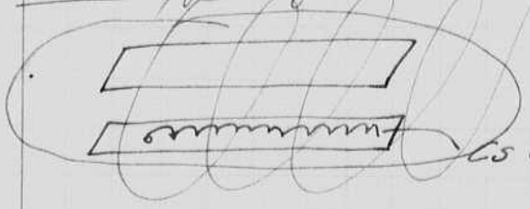
f.—transformer.

110 — 750 M.T
2.5. V
5.0 V.

1 — 16 mf 525 volt condenser.
1 — 4 mf. 500 " cond.
1 — 10^6 ohm vol. control.
1 — 10^5 " 2 watt.
1 — 280
1 — 227
1 — 4 prong socket
1 — 5 prong "
2 — 1 mf 1000 volt capacitors. 1/4 mf might be enough here.
1 — 10^{10} resistance.
1 — 1000 ohm 50 watt ohmite resistor variable.



Need type of counter. keep in dark.
magnetic field.



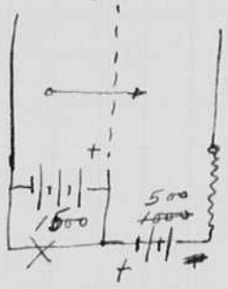
Secondary emissions of electrons from surface will cause further amplification resulting in final current of large value

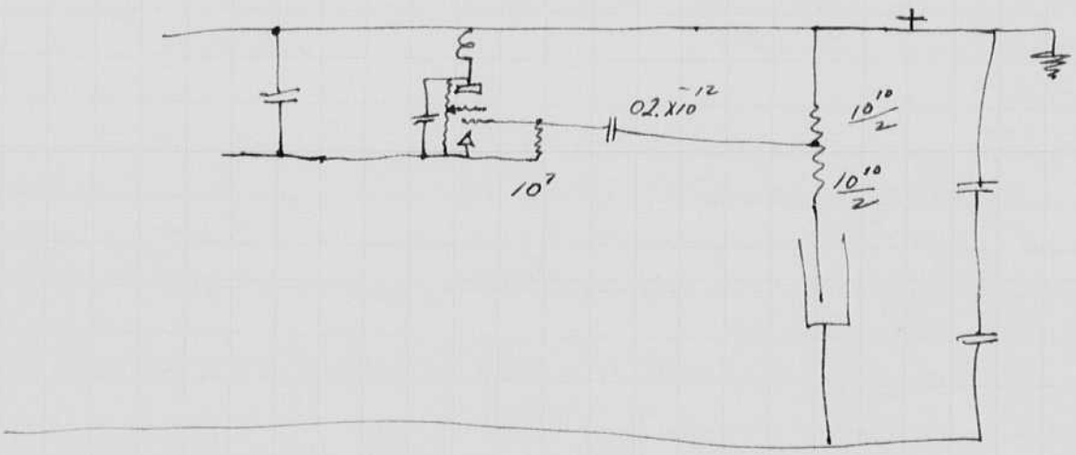
Dec. 12. cont.

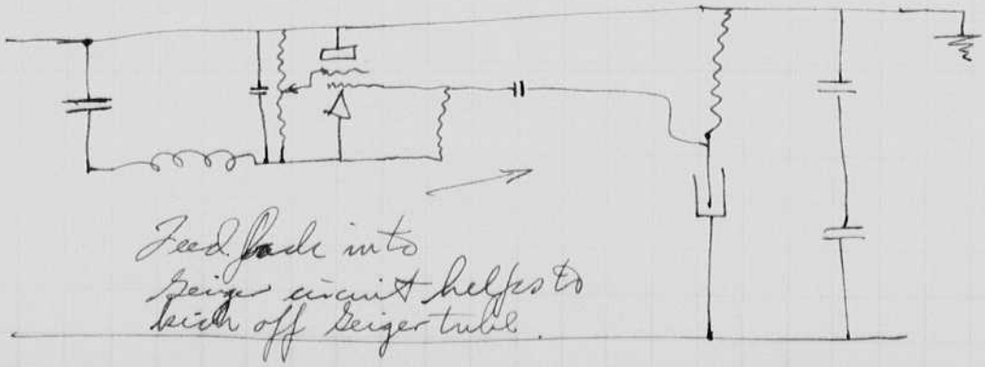
The electrons may have enough velocity to go great distances. Gas should be used in order to get a few to start things going along the path of the beams.

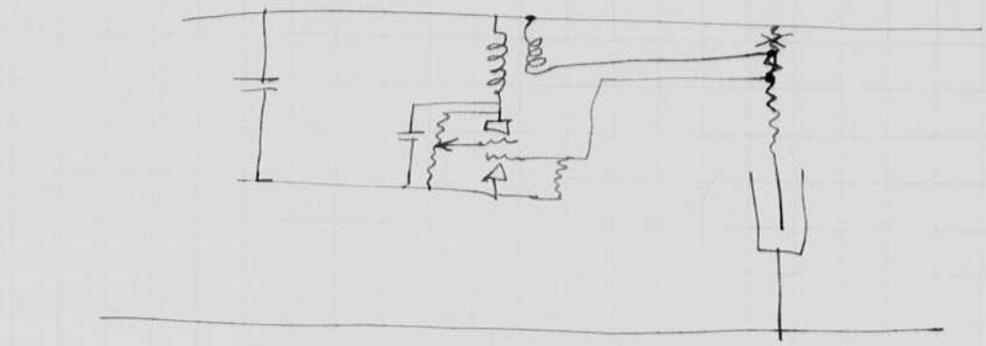
A geiger counter might work at a lower voltage if a magnetic field was caused to exist in the field between the elements. This would cause the electrons to spin and thus strike more molecules. It is possible that the tube would have a lower threshold voltage.

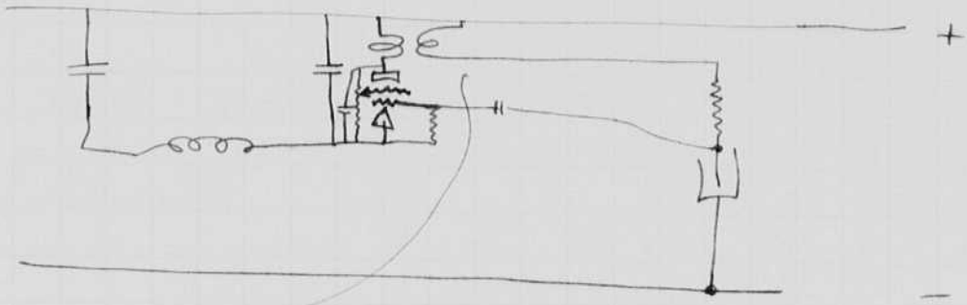
I hope to try a parallel plate geiger counter. Why the usual method of using a wire in the center?





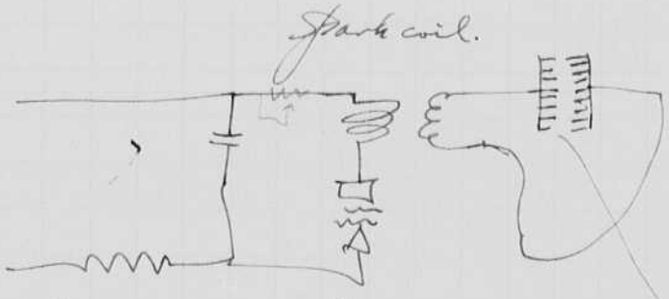






when the stroboton goes off a surge is produced which aids in putting out the arc in the geiger tubes.

Experiment with sphere or point gap.
Set nearly to breakdown voltage.
Adjust gap and count the sparks as a function of the gap distance.

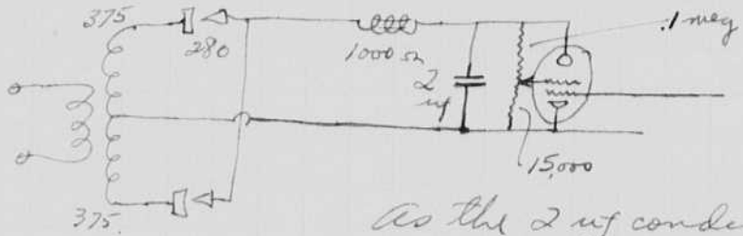


operate 100 times a second.

photoelectric or accoustic method of recording sparks.

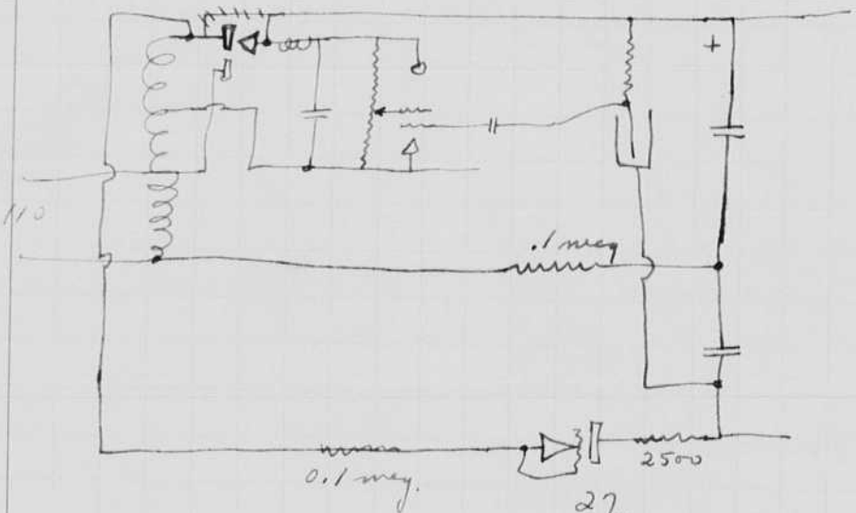
Dec 14 1935
H. E. Edgerton.

I wired up and tried the circuit shown on page 61. A few feeble counts were recorded. I believe the high voltage was not enough. The circuit for the Strobotron counter was reduced to the following which apparently is sufficient.



grid floating works ok.

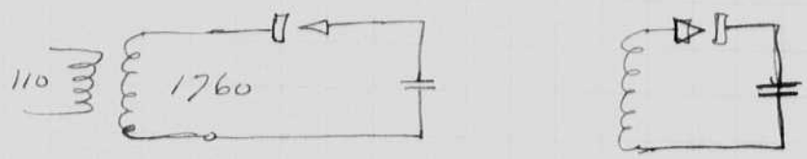
As the 2 mf condenser builds up voltage the current energizes the counting relay. The relay is limited to about 10 a second and so no filter is needed.



This circuit tried.

1. Reduce .1 meg resistor.
2. Check wiring diagram
3. Counter polarity.
4. Measure voltage of doubler.

$\frac{2500.}{\sqrt{2}} = 1760$ volts.



$\frac{13.000}{.005.} = \boxed{2.500}$

$2\pi fL. = 377 \times .005.$

2.000 ohms

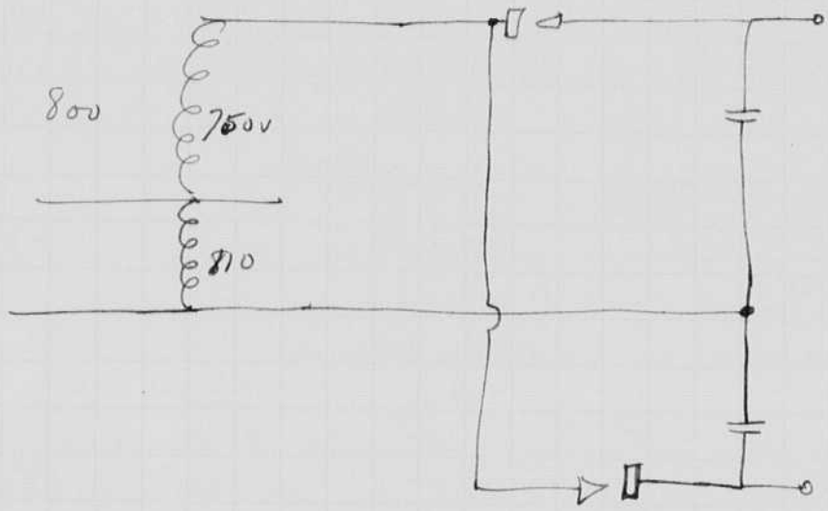
Ford coil. (turn ratio)^2 = 2500.

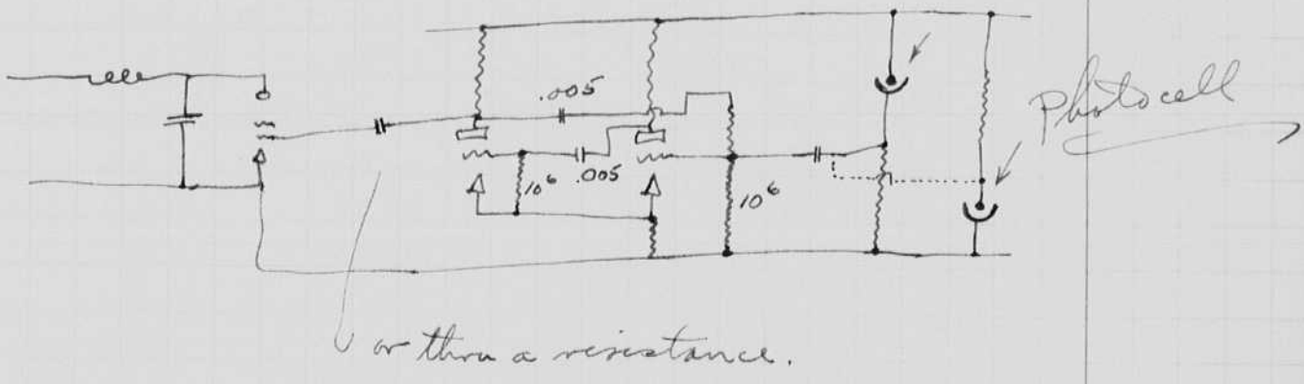
ratio = 50.

$\frac{1.25.V}{2.} =$

$50\overline{)1750}$ 35. volts.

$\frac{35}{2\omega} = 17.5$ amps.

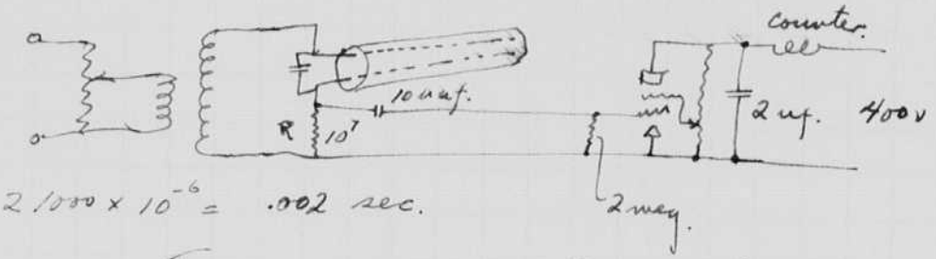




or thru a resistance.

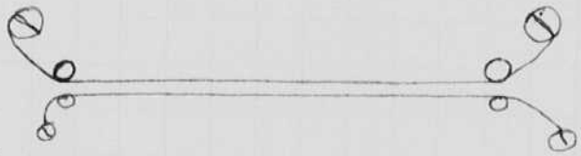
Dec 15 1935.
H. E. Edgerton. Geiger-Mueller Counter Ciruit.

Why not use A.C. on the geiger counter? The ordinary ac voltage through the coupling condenser to the Strobotron could be made lower than the tripping voltage. It might be worth while to make the counter with two wires instead of a cylinder and a wire. A resistor of as low as a megohom or 10 megohms could be used since the ac would take the voltage off 120 times a second. The capacity across the tube could be made larger so the impulse would be more powerful.



$2 / 1000 \times 10^{-6} = .002$ sec.

Fog in air at atmospheric pressure. Use two wires on a board as close together as possible

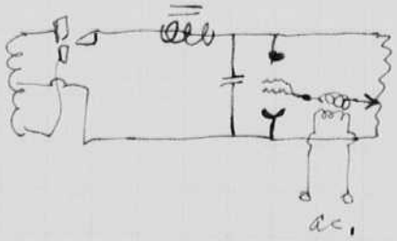


Then put in a glass tube with a connection to a pump so that the air could be exhausted.

3500×10^{-6}

$\frac{500 v}{5000 i} = 100$ ma.

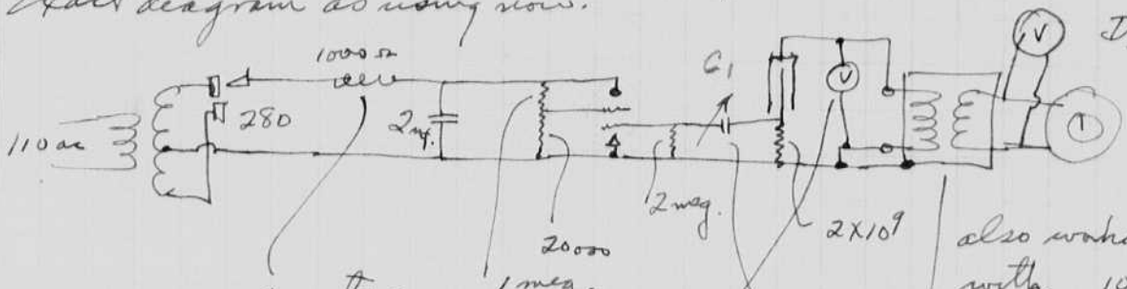
Strobotron lamps as counter.



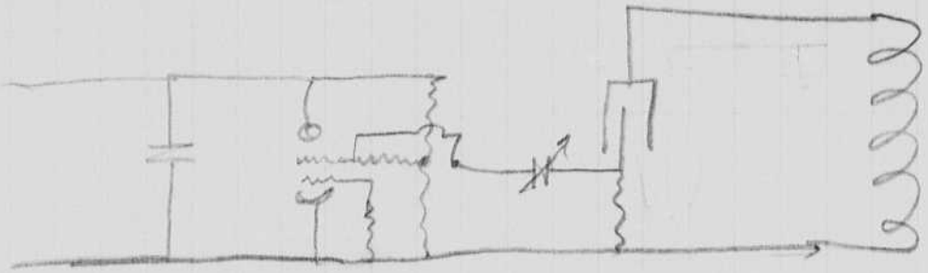
adjust ac on grid to critical point.

cont. in lab.

Experimenting with circuit on p 67. Works Ok. !!
Exact diagram as using now.

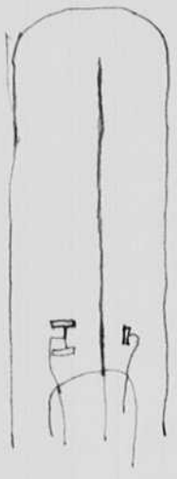


TIME	ΔT.	AC VOLTS.	COUNTER.	ΔT	C	c/min
11.~~36~~	—	48.5 threshold voltage.				
11.32		49.5	1810	5		
11.55		49.5	4455	23	2645	115
12.22		49.5	7319	27	2864	106
12.2~~2~~5	½	50.0	7457			
12.50		50.0	1528	27½	4071	148
1:11		49.8	5185	21	3657	174.
	Condenser C, cut out + ¼ way			¾ of capacity		
1:25		50.0	7200			
1:38		50.0	8926	13	1726	132.5
1:50		49.9	0287	12	1361	113.5
2:18		50.1	3005	28	2718	97.8
2:37		49.9	4720	19	1715	90.2
3:00		50.0	7056	23	2336	101.+
3:15		49.8	8992	15	1936	129.
3:45		49.7	2666	30	3674	122.
3:56		49.7	4030			
	Took atlash cathode Ray oscillograph					
4.00		49.8	4129			



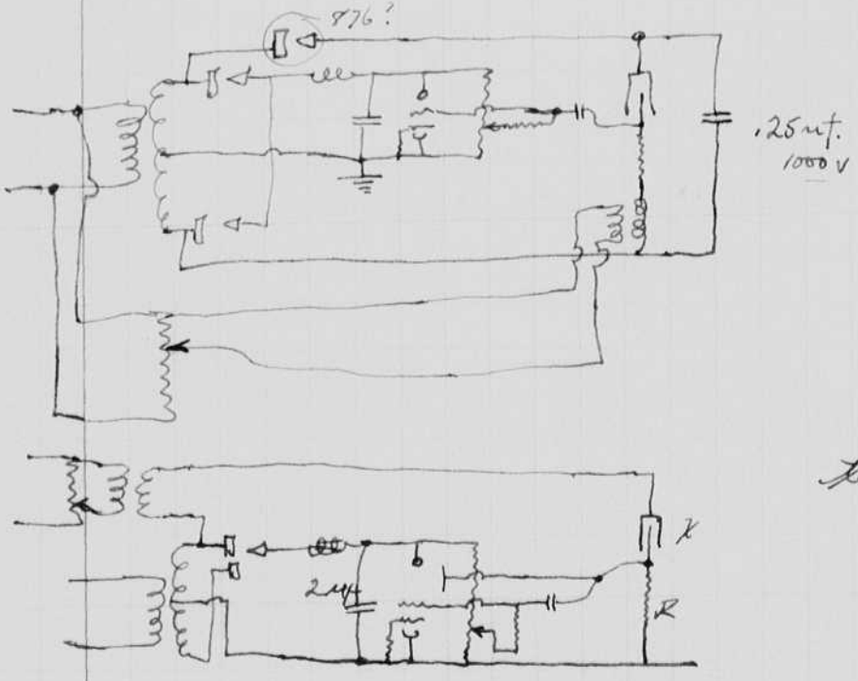
wire + to ground. Removed

works OK. CR shows that pulses are + on grid of thyratron.



1. try External wire around tube to trip by addition to internal grid. Tried this yesterday and it seemed to work OK.

2. Reduce the series resistor from 10^9 ohms to 10^7 ohms and increase the capacity across the tube.



This circuit uses a.c. + d.c. on counter the a.c. helps to put out the discharge and allows a lower ~~resistance~~ ~~voltage~~ to be used in series with the discharge.

Let R be 10^7 ohms.
X be 10^8 " $= \frac{1}{\omega C}$

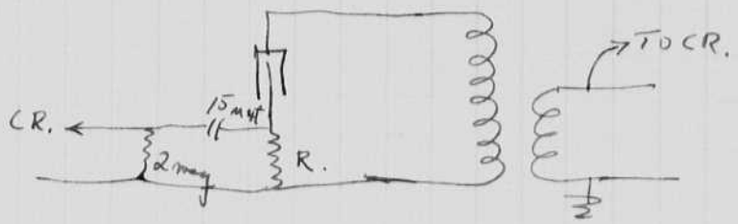
$$C = \frac{1}{\omega X} = \frac{1}{.377\ 10^8 \times 10^3} = 3 \times 10^{-11}$$

$= 30$ mmf.
(or less).

X should be 10 times R or greater.

Dec 16 1935
H. E. Edgerton.

$R = 9.4 \times 10^{+6}$ ohms in series with counter.

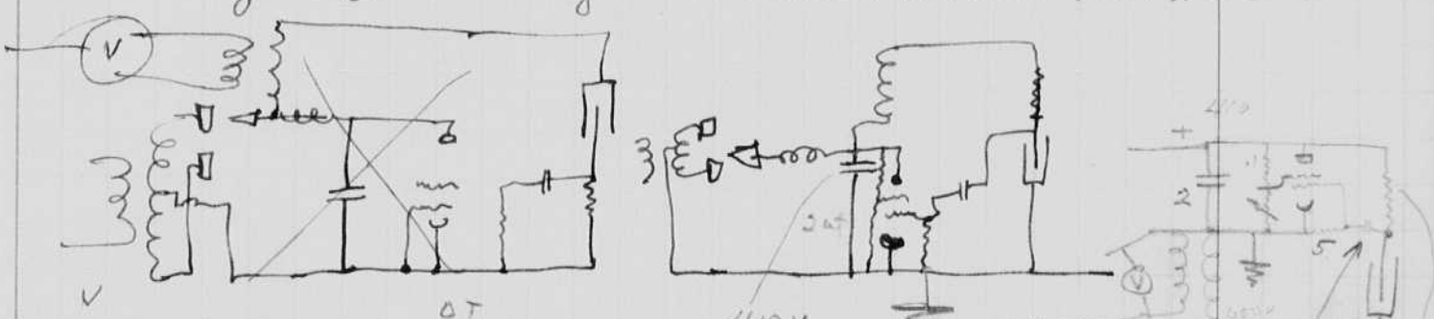


when the wire is negative the tube goes into an oscillation high frequency.

when the wire is positive the tube counts intermittently.

C.R. Pictures

R changed to 100 megs results about the same.



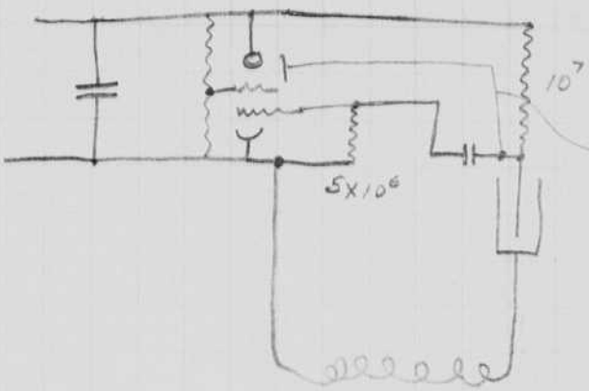
all in Small plate 25 mmf?

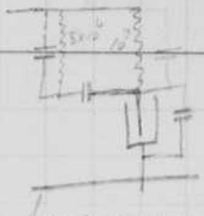
1148		7235				
12 16	48.6	1083	28	3848	138	
1219	47.5	1405				
12:48	47.2	3449	29	2544	87.5	
		dc changed				
1:33	47.5	4980				
1:55		6845	22	1565	84.7	
1:59	45.	7067	4?	222	55.5	Volts changed.
2:02	45	7290	3	223	74.3.	
2:04		7396				
2:05		7468	1	72		
2:06		7546	1	78		
2:07		7636	1	90		
2:08	45.2	7720	1	84		
209		7798	1	78		
211		7952	2	154	77	

636 / 410 / 1046 — 672 / 410 — $410 \times \sqrt{2} =$

const.

$\sqrt{P}$	T.	V	C	ΔT	ΔC	$\Delta c/\Delta T$	
1046	2:11	45.	7952				8487
	2:12	45.0	8042	1	90	159	7067
	2:13	45.0	8112		70	219	1420
	2:14		8185		73	20 min.	
	2:15	45.0	8253		68		
	2:16		8317		64		
	2:17		8380		63		
	2:18	45.0	433		53	$\frac{1470}{20} = 71$	
	2:19		487		54		
1082	2:20	47.5	8527				10280
	2:21		8608	1	81		8527
	2:22	47.6	8658	1	50		1753
	2:23		8731	1	73		
	2:24		794	1	63	23	
	2:25	47.5	872		78		
	2:28		9089	3	217	72.2	76.2
	2:43	47.5	10280	15	1191	79.5	
1117	2:44	50.0	0361				
	2:49	50.2	0930	5	569	114.	
	2:52		1300	8	939	117.5	
	253	46.1	1424				
	257	45.0	1742	4	318	80	
	3:13		2869	16	1127	70.5	
	3:31	45.1	3908 − 8	18	1031	57.3	Radium in vicinity.
	4:40	42.5	5255				
	4:59	42.8	5629	19	374	19.7	? Poor contact to coupling Cond.
	5:02	42.5	5727				
	06		823	4	96	24.	"

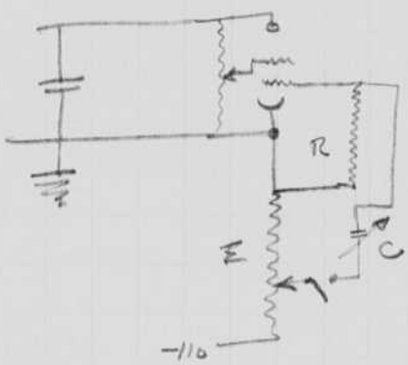




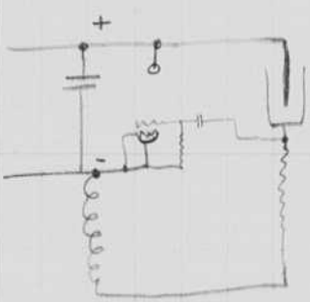
try a wire from here around stator bottom.

Sensitivity test.

Find smallest capacity to turn on stator bottom.



E C R. Remarks.



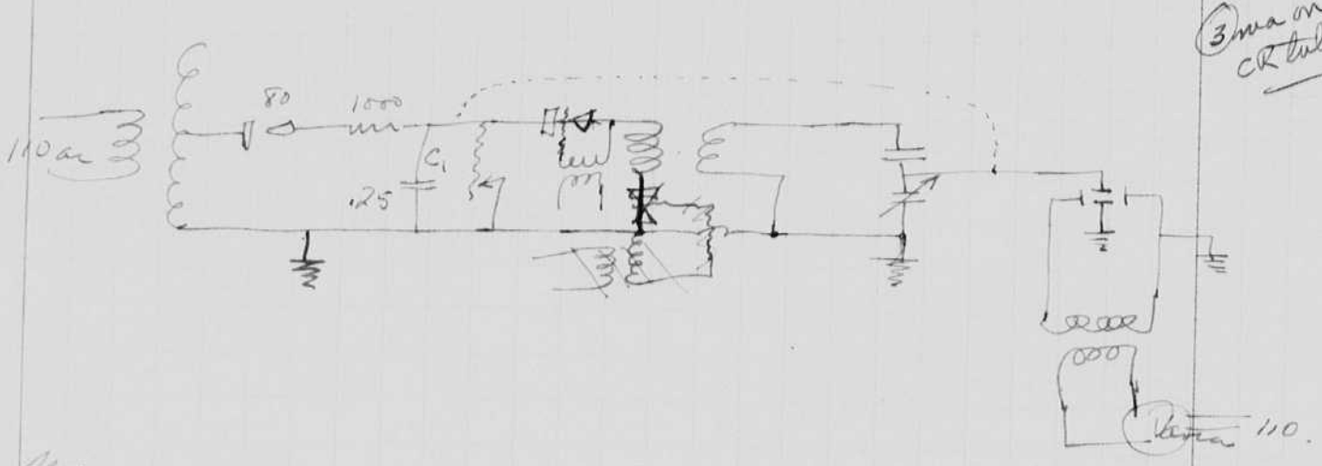
try two wire in an insulating liquid as a counter tube.
did?

Dec. 17, 1935

Worked with Dingwich on geiger counters. Took my apparatus over. His also faulty because of difficulties in the power pack.

Dec 17 1935
H. E. Edgerton
Chas. Mueller.

Measurements upon spark coils.



Osc No.

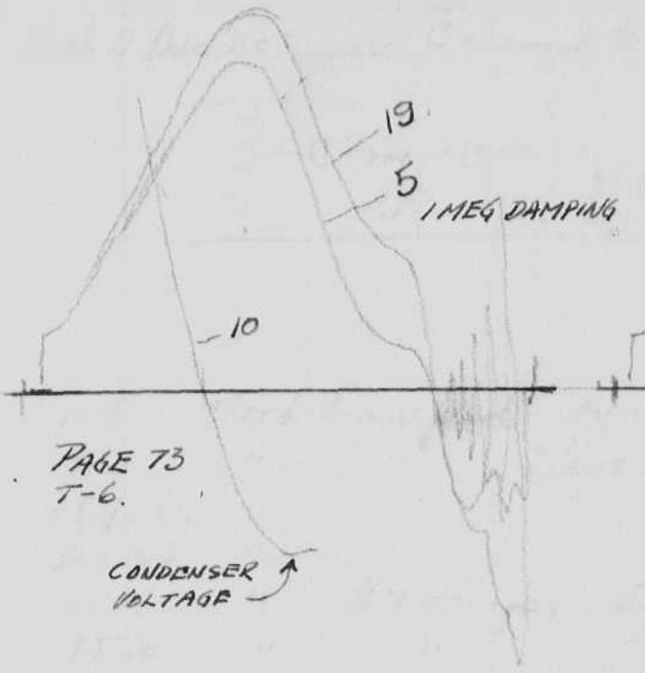
1 2 3.	½ cycle ac to edge of ER. Variac (29 V).	Bosch Brown Coil.	C. 47
4 5 6	Calibration of C_1 voltage. Dotted line.	"	
7 8 9.	Variac set at 125 V	"	
10 11 12	"	Ford Damped	
13 14 15	"	Ford Undamped	
16 17	" Calib of C_1 volts.	" "	
18 19 20 21	"	" "	
22 - 23	" Calib of C_1 volts	" "	
24	Vertical only 252 volts.		
25	201		
26	152		
27	——— 152 both plates.		

Several 28 29 30. Horizontal only 152
31 32 33. 125 V outputs. 1100 volts.

? - GR Swaps on back stroke Ford damped coil.

safety. Reloaded Camera. Dupont film.

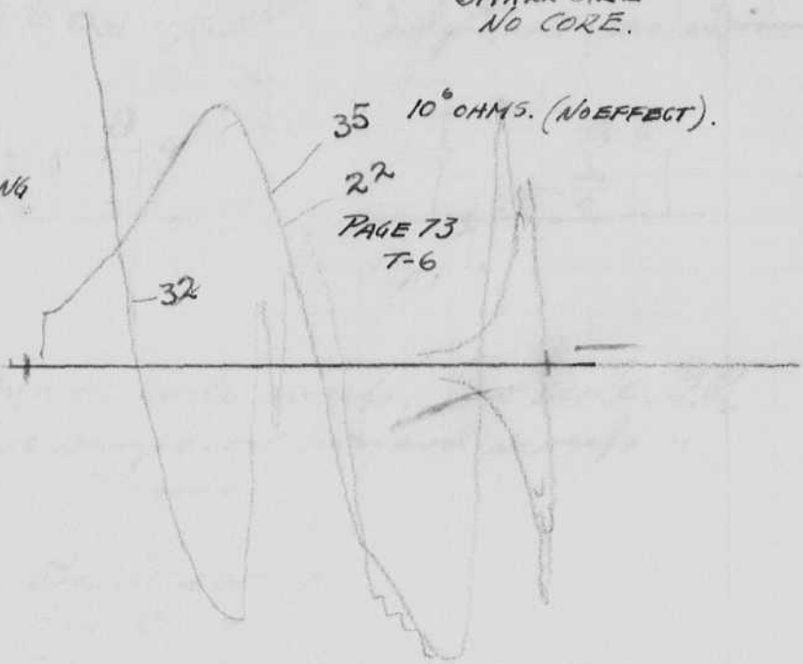
FORD V-8 COIL



PAGE 73
T-6.

CONDENSER VOLTAGE

BOSCH. (BROWN SMALL SIZE NO CORE.



PAGE 73
T-6

~~Blank~~					
1 2 3. 4 2 5	Bosch	Undamped	Low scale (2 meas.).		A
26 27 2	"	"	~~Fast~~ scale		A
28 29 2	"	"	00		B
30 31 3.	"	"	Slow scale back Sweep		B.
32 33 34 4 3 3	"	"	"	"	A. C?
35 21 5	"	Damped 1 meg	"	"	A.
		~~Sed~~	"	"	A.
		Fast Suped Front speed			A.

7
7
3
3
5
5
7
9.

Dec 17 1935
H. E. Edgerton
Chas. Mueller.

Measurements upon
Spark -

110 ac

Osc No.

1 2 3. 1/2c

4 5 6 Calib

7 8 9. Varia

10 11 12 "

13 14 15 "

16 17 "

18 19 20 21 "

22 - 23 "

24 Vertic

25

26

27

48.+ % INCREASE.

Several 28 29 30. Horizon

31 32 33. 125 V outrac

? - GR Swaps on ba

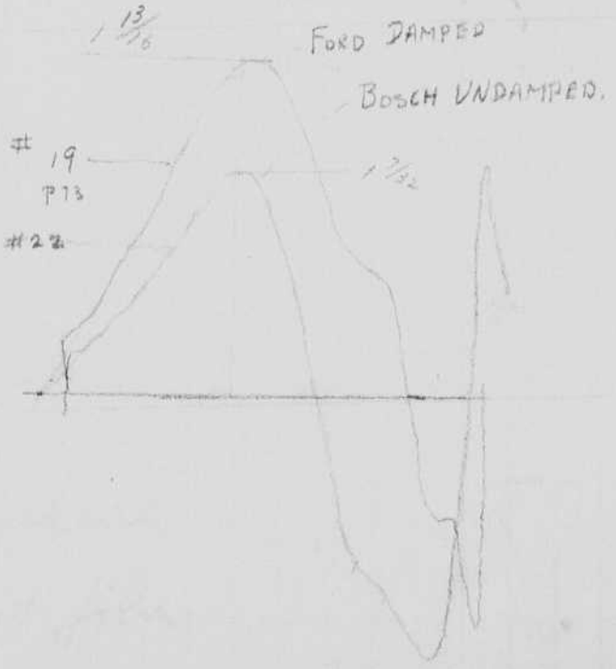
amplifier

Reloaded

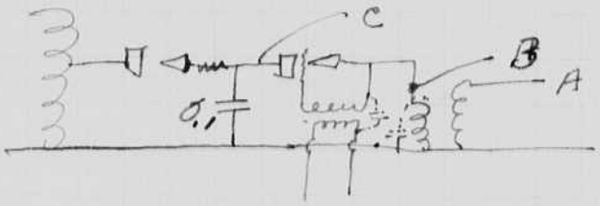
"

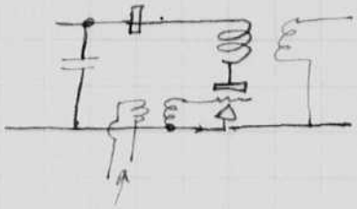
Ford Damped

Ford Undamped



Reel 2. Osc. No. C changed to 0.1 mf. Oscillograms with "Eastman" camera. "Instan. and 1 sec. exposure"





1-5	Ford Damped	syn on back sweeps. low scale G.R.		A
6 7	" "	two surges on forward sweeps "		A
8 9	" "	Primary		B
10 11 12	" "	Condenser.		C
13 14	" Undamp.	Back sweep		B
15 16	" "	Front "		B
17 18	" "	" " High sw Secondary.		A
19 20 21	" "	Back " Low Sw "		A.
~~Blank.~~				
22 23 24 25	Bosch Undamped	Low Scale (2 views.).		A
26 27 2	" "	Fast scale		A
28 29 2	" "	"		B
30 31 3.	" "	Slow scale back Sweep		B.
32 33 34 ~~4~~ 3	" "	" " " "	or B	A. C?
35 36 2	" Damped 1 meg	" " " "		A.
37 38 2	" Un Damped	" " " "		A.
39 40 41 42	Blank (43 Blank)			
44 45 2	" Un D	Fast Swept Front sweep		A.
46 47 2	1 meg.			
48 49. 2	800,000			
50 51 2	600,000			
52 53 2	400,000			
54 55. 2	200,000.			

Dec 19 1935
H E Edgerton

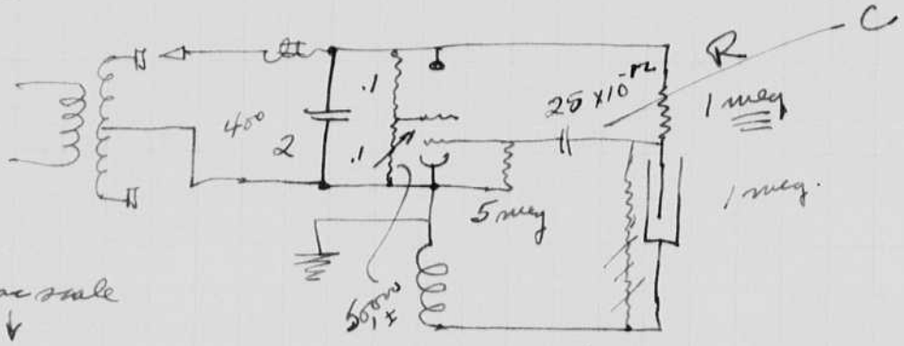
.000300.

$10^7 = \frac{1}{377C}$ =

$C = \frac{1}{377 \times 10^7} = 3 \times 10^{-10}$

$= 300 \times 10^{-12}$ farads.

Cont. from page 71. Guigrich returned apparatus today. I connected up as before



45 x Y2

Read on variac scale ↓

time	*V	C	Δt	ΔC	ΔC/Δt
7:33	51	8661			
	20.	0938			
	19	0892		46	
	18	0848		44	
↑ 7:17		795		53.	Herb here.
	16	752		42	
7:15	50	710		43	

Coupling C changed to 50×10^{-12}.

7.11		619			
7.08		466	3	153	51.
7.06	50	333	2	133	66.5
04	50	212			
7.03 (20 sec)		0131	1	81	
	50				
	55	too high.			
7.02		0004			
7.00		915	2	89	44.5
.58		825	2	90	45.
6.57		785	1	40	
56		745	1	40	
55		702	1	43	
54	50	657	1	45	
53		616		42	
52	45	574		42	
51		532			
650	45	9489	1	43	

$R = 10^6$

↑ Coupling condenser changed to .00025 mf.

6:40		9165			
6:33	51	8661	7	504	72

New Reel 115 g. Old reel 205.9 g. 215 g.R. Reels as weighed by grocer on scales.

8:14		5049.	708		
.09			3631	2 77	38½
.08			3589	42	
.07			559	30	
06			3526	33	
8.05	45		475	51	
804			439	36	
8.03			366	73	
802			284	82	
8.01			3198	86	
8.00	55		3134	64	
59			64	70	
58			3001	63.	
57			951	50	
56			896	55	
55			844	52	
7:54	50		784	60	

10.03 :: 8383

936	5047235	27 11 48	42,5	
922	6652	14 583	41.6	
859	45 5975	23 677	33.8	
845	5388	14 487	34.8	
834	4857	11 531	48.3	
8.15	3929	19928	48.8	
8.14	3865	64		
8:13	808	57		
812	756	48		
8:10	708	48		
		49		
		V.		

40 v threshold as before. can now go higher with V. R changed to 10^8

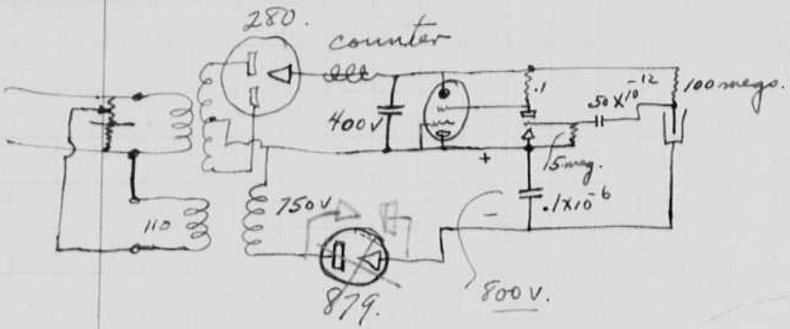
50		645			
49		623	1	22	
48		583	1	40	
47		552	1	31	
46		526	1	26	
7:45	40	490	1	36	
44		465	1	35	
42		367	2	98	49
41		320	1	47	#.
40		2279	1	41	
39		238	1	41	
38	45	183	1	55	
37		133	1	50	
36		2060	1	73	
35		2001	1	59	59.
33		1874		127	63.5.
31		1740	2	134	67
30		1665	1	75	
29.		1589	1	76	
28		1509	1	80	
7:27		1425	1	84	
7:26	50	1334.	1	91	

$R = 10^7$ $C = 50 \times 10^{-12}$

t V C Δt ΔC $\Delta C/\Delta t$.

min. Varies

Dec 20, 1935
H. E. Edgerton



Circuit to try.

The ac scheme is not good enough. Now for the D.C.

5 48		2309				
2:06	47.5	6848	222	5461.		24.6
2:05	↑	6810				38
1:54	↑	320	11	490		44.5
1:53	50	278				42
52		6247				41
51	↑	6213	1			34.
1:48	↑	6097	3	116		38.6
145	47.5	5987	3	110		36.6
142	↑	5886	3	101		33.4
131	45	5517.	11	369		33.5
130		5489	1	28		28
128		5391	2	98		49.
124		5180	4	211		52.5
108		4450?.	16	730		45.6
104	51.	4247	4	203		51.
12 49		3619				
12 35		528	24	1091		45.5
12 24	45	2410	2?	118		59

11 55		2172			
11 37	47	1104	18	1068?	59.2
11 26	42	9225	21	879	34.5
11 12	42	7689	4	1536	

Bias res is about 40,000 ohms.

11:11½ 45 7366 not running series zero.?

7259 stopped

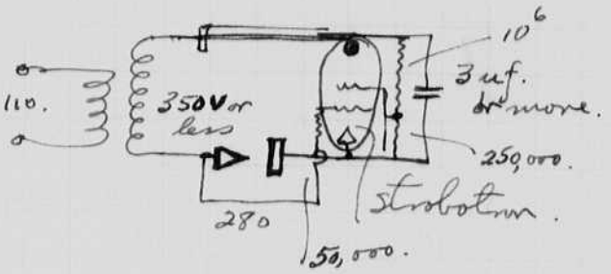
Resistance reduced from 50000 to 25000

9.50	↑	9160			
9:48	↑	978	2	182	91.
8:42	50	8483	6	495	82.5
T	V	C	ΔT	ΔC	ΔC/ΔT

$R = 10^7$ $C = 50 \times 10^{-12}$

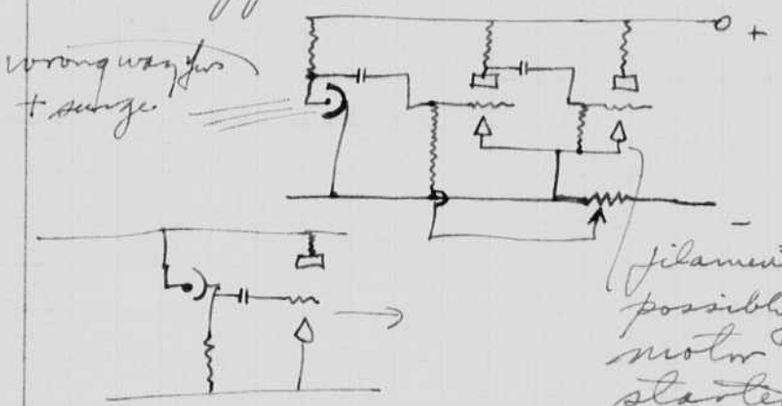
Dec. 20, 1935
H. E. Edgerton.

Angle-responsive relay method. Synchronous Motors.



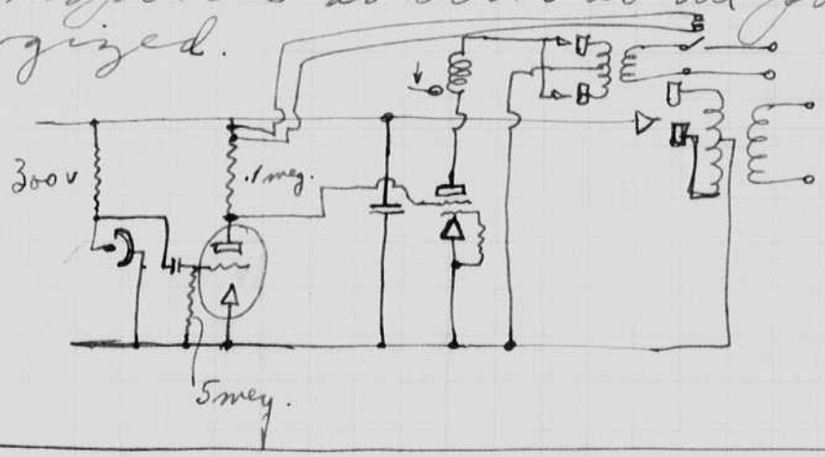
Use filament type in order to speed up action when first turned on.

The light from the stroboscope will fall on a photocell when the angle is that desired and the circuit will thus be tripped.

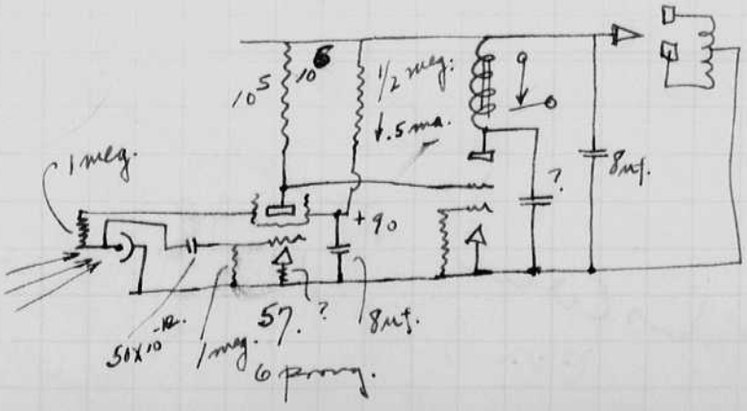


filament type tubes?
possibly not needed since the motor takes some time to get started.

Relaxation or regenerative type of circuit to give a response as soon as the photocell is energized.



$\frac{300}{.5} = 600{,}000.$

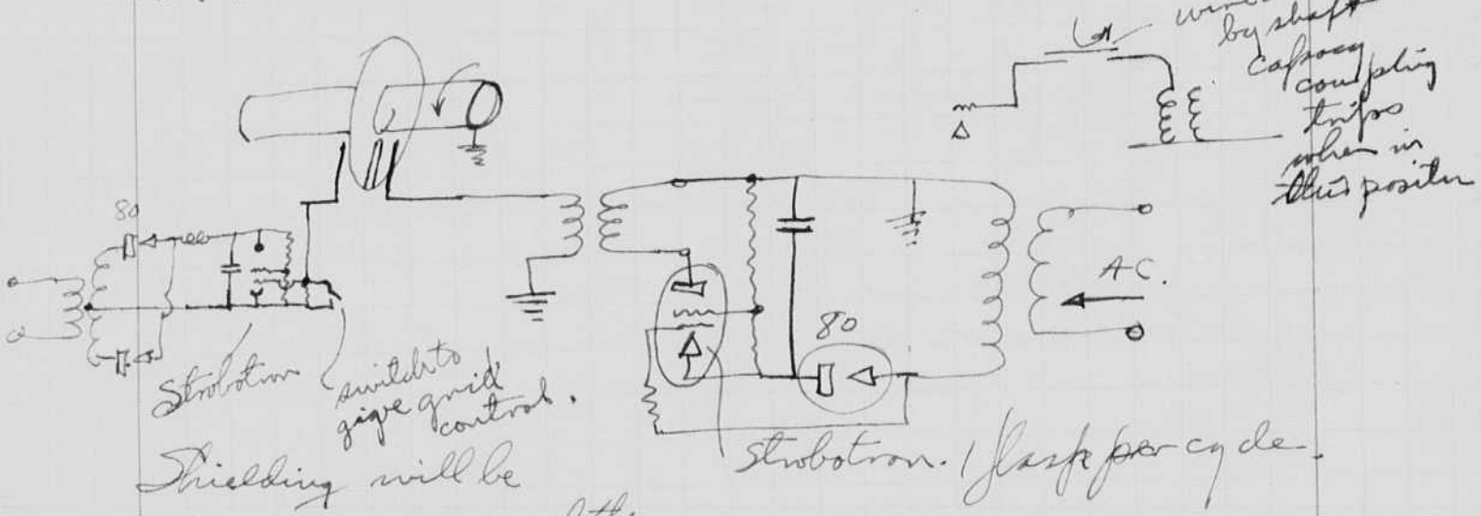


Dec. 20, 1935
H E Edgerton

Capacity method of Angle Switching of Synchronous Motors

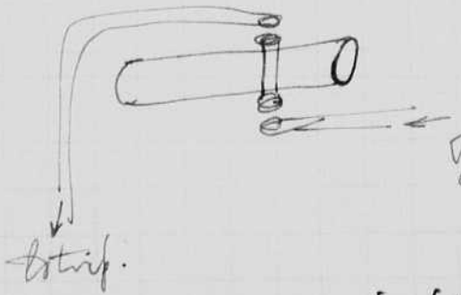
The photo cell and amplifier are somewhat complicated. I would like to devize an apparatus with only Strobotron tubes to operate the relay.

The impulse might be transfered through capacity. For instance put a disc with a slit on the rotor and arrange on each side of it a wire (radial), stationary. An abrupt potential on one side would cause a current and potential on the other only when the disc was at such a position when the slit was across the wires.



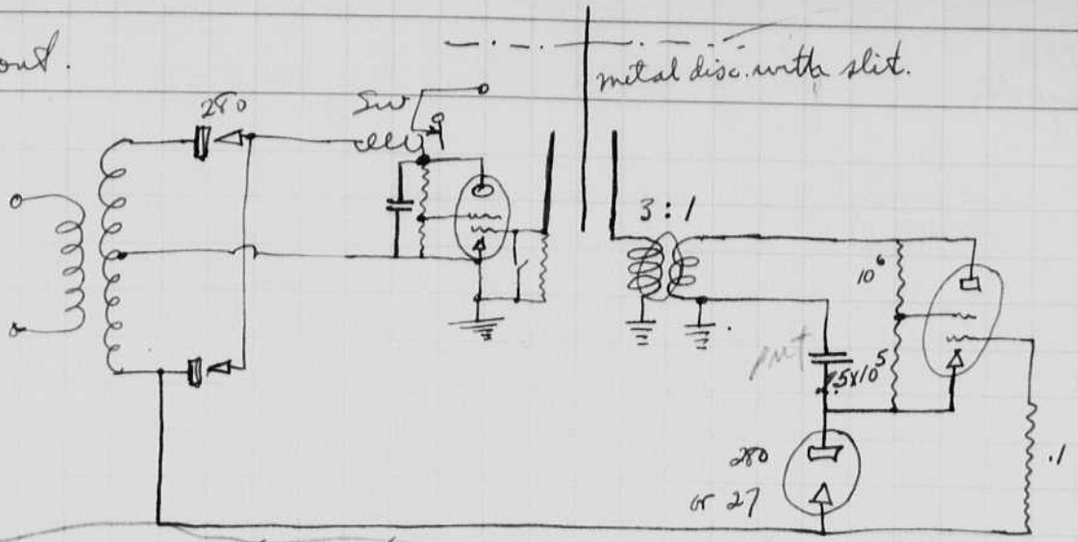
Shielding will be necessary around the transmitter and receiver.

A magnetic arrangement also might be made whereby the coupling arrangement was rotated on the shaft.



This circuit was explained to me on Dec 21, 1935 —
H. E. Edgerton
Kenneth J. Germeshausen

Cont.



Dec 20 1935

Common transformer.

5.6		9464				
5.36		7953	20	1611	80.5	cont page 81
9.37						
9.26+	105	7018	9	1253	83.	
9.25		6918			82	2B, ~~Strobotron~~
.15	105	5978	10	940	94.	
.14		5892		86	86	(2A) Strobotron
.12		5704	2	188	94.	
.08	105	5350	4	354	88.5	
.07		5253			97	
.06	105	5155			98	Ac me voltage regulator
.04		4914				
.03		4706			208	
.02		4559			147	
01		4415			144	
9.00	110	295			130	Strobotron 2-B, put in.
59		4226				
58	110	4165			61	
57		4070				see Items note book for data on tube
53	115	3580	4	490	122.	
52		3448			132	
51		3318			130	
50	115*	3199			119	
47	112	2984				
46		2850			134.	
45		2718			142	M.G. Strobotron from D.R.
44		2631			87	
8.43	110*	2556			75	Variac to input.
34		2169				
33		2009			160	
32		1862			137	
8.31	115v	1700			162	as above Dec 22. 1935

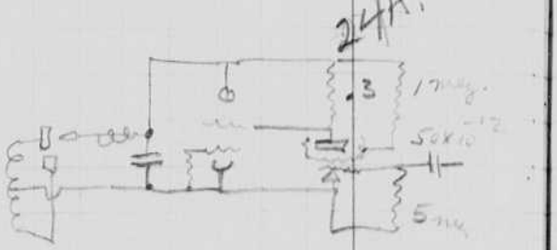
* read on Triplett 250v scale.

Circuit page 80

Jan 21 1935
D.T. Eggerton.

Geiger-counter amplifier

Connected as shown page 76 except an 81 tube was used instead of 879. and 1 meg used in place of .1 meg in plate resistance of 27.



	47	289			
	46	9204		85	
	45	9129		75	
	40	688	5	441	88.2
	38	8508	2	180	90
	37	416		92	
	36	8335		81	
	05	6930			
	03	6705	2	225	112.5
	02	6609		96	
	01	6480		129	
	00	6387		93	
	59	6291		96	
	58	6212		79	
	57	6104		108	
	56	6014		90	
	55	5931		83	
	54	858		73	
	53	784		74	
	52	710		74	
	51	631			
	50	5586		45	
	49	530		56	
	48	473		57	
	47	411		62	
	46	5364		47	
	44	293			
	43	5202		91	
	42	5089	1	113	
	41	4990	1	99	
	40	4857	1	133	

120 — 115 — 110

C reading of variac.

24A. put in place of 27.

Different stock tubes.

Other amplifier tubes tried

47

6 prong 19 2V .26a → 53 regenerative

46

45

35

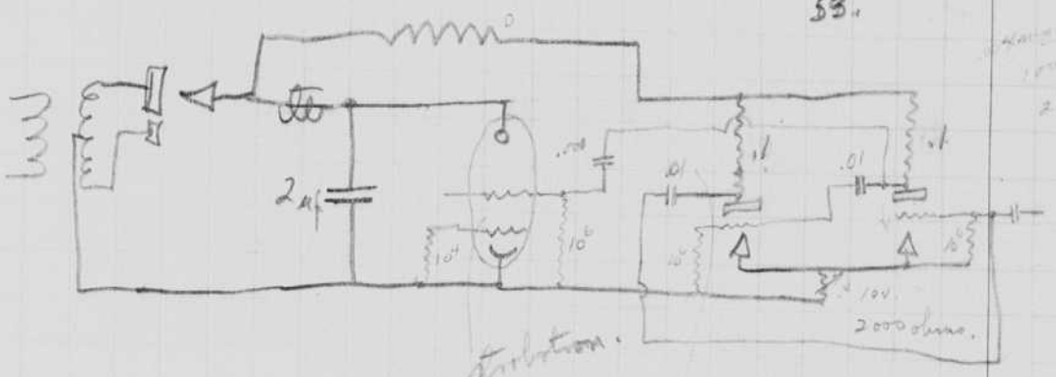
has been 27 tried.

2A6

Put 4 mf 100 V across screen grid

The voltage on the counter tube may have been higher

53.

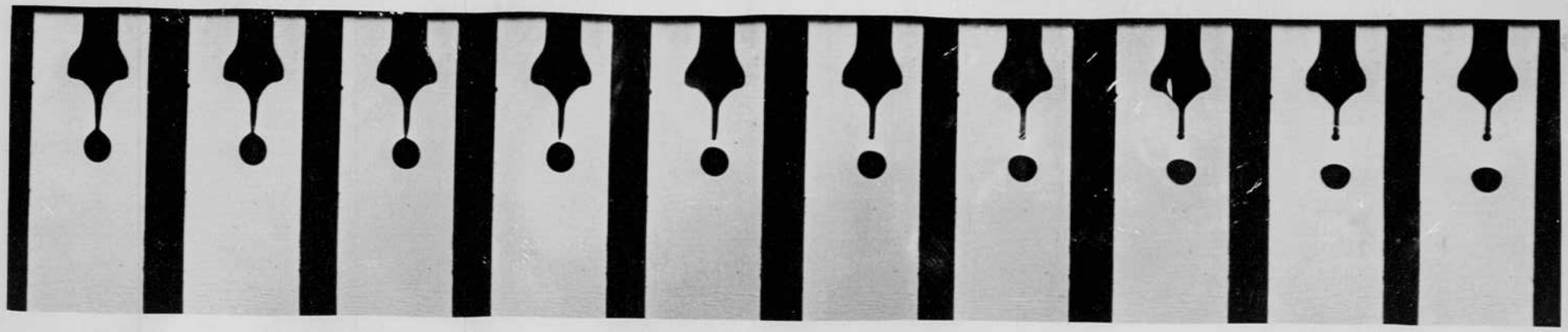


possibly .001 or even .0001

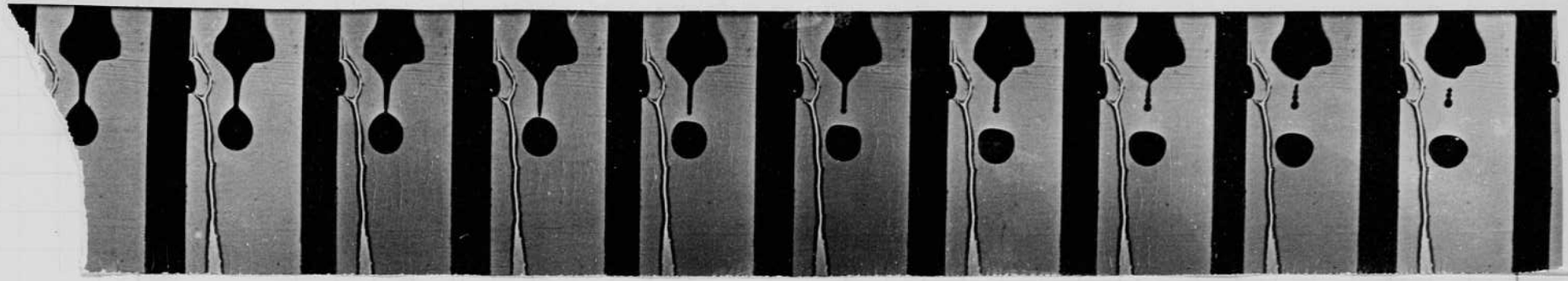
1:20		15348				
12:28	115	6470	52	8878	171.	
12:27	115	6315		165	165	
12:25		6039		276	138	Voltage increased
57		2575	28	3464	123,5	
11:55	110	12325		250	125	2A3
11:36		9888	19	2437	128	
11:35	110	9767			121	2B1
11:34	110	7388	11	1379	125	
23		8274		114	114	2A1
22		8145		129	129	
11:21		8026		119	119.	
11:19		7783	2	243	122	
11:13	110	6280	6	1503	250?	
11:09	110	5771	4	509	128	
11:08	110	5640			131	2B2
11:07	110	5511		1	129	
11:05	110	5266	2	245	122.	
10:37	110	1798	26	3468	124.	Variacon Regulation out
10:35	104	1635		Stripped sample interval		
9:56	105	9464				2A3 Strobotron Voltage regulation

Dec 22 1935

Soap.
?



H_2O.



Taken with E.A. Hausen. Chem. Eng. Dept.
A further set was taken Dec. 16 1935 with
C.E. Reed
Ben Holt
2-011.

Notebook # T-6

Filming and Separation Record

1 unmounted photograph(s)

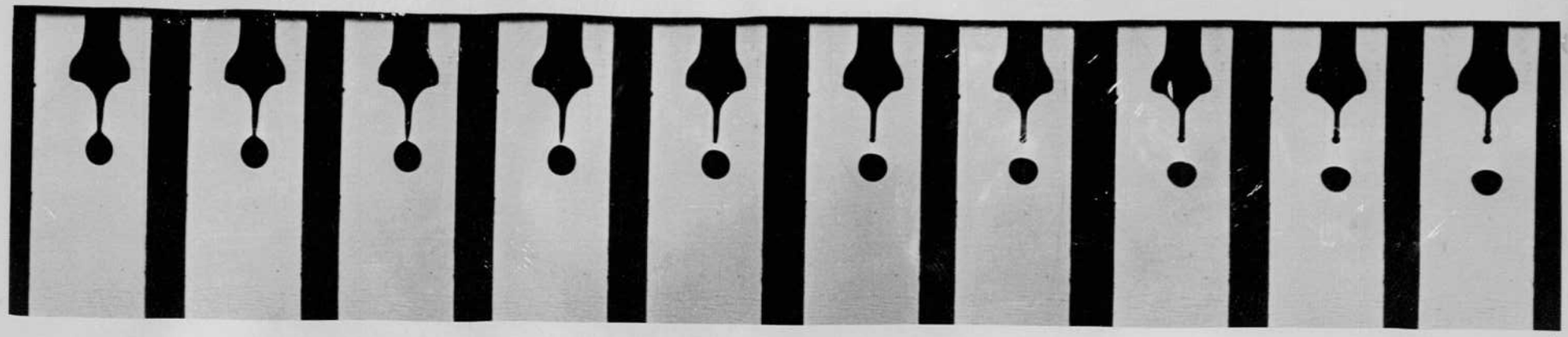
____ negative strip(s)

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

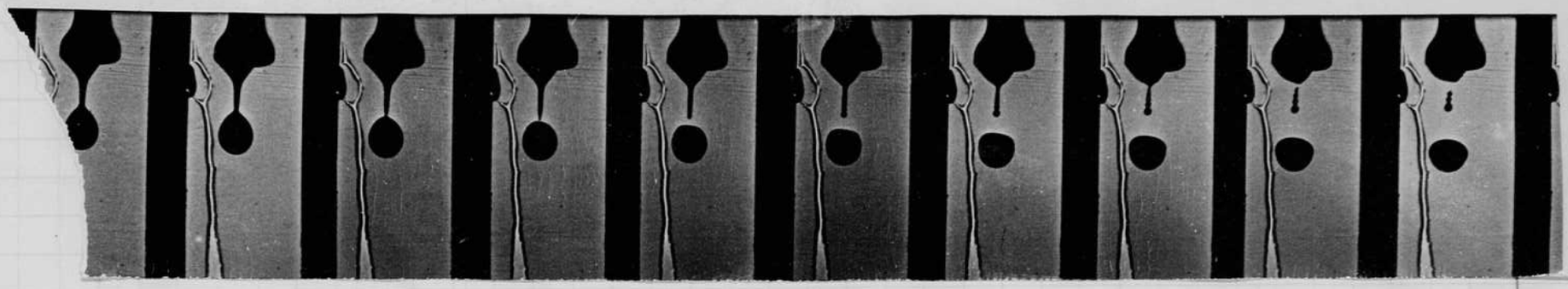
was/were filmed where originally located between page 82 and 83.

Item(s) now housed in accompanying folder.

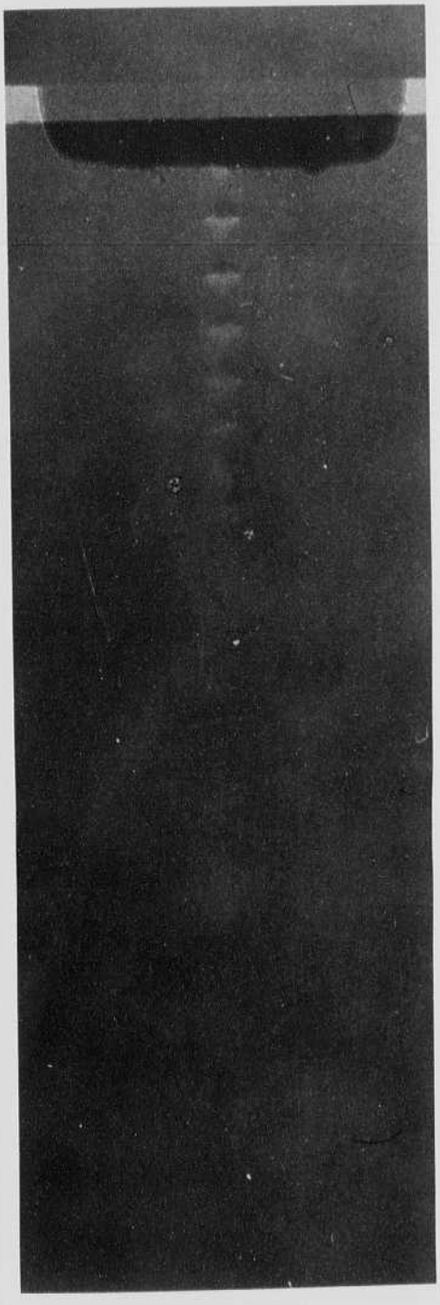
Soap.
?



H_2O.



Taken with E.A. Hansen. Chem. Eng. Dept.
A further set was taken Dec. 16 1935 with
C.E. Reed
Ben Holt
2-011.

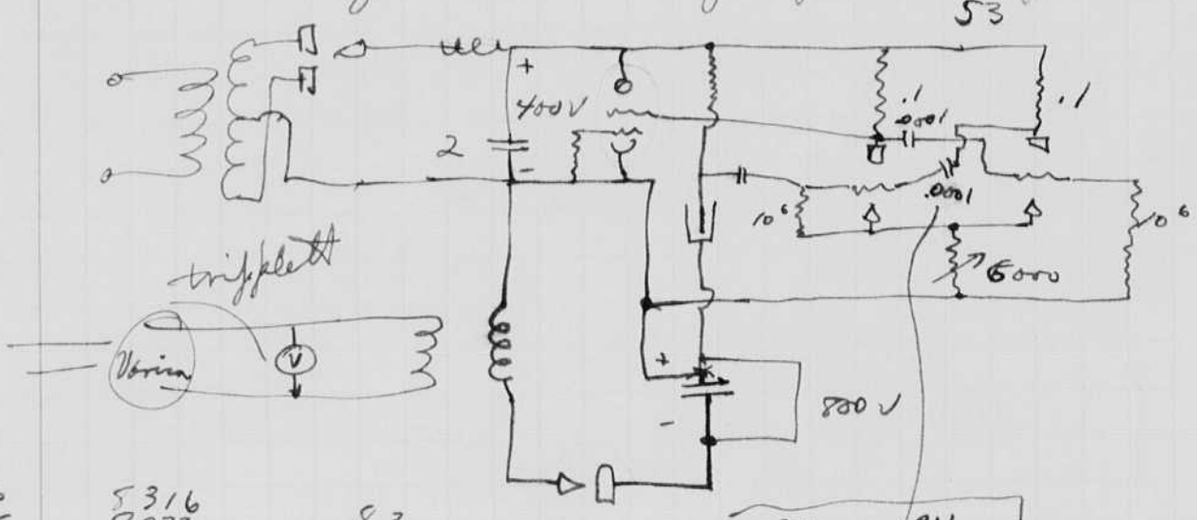


Dec 23 1935

Experiment.

Whitcomb and Ferguson(?) of the Norton Co were here today and saw the movie (100 ft) which they also took with them. They thought it to be slight and plan to send a 12-3 wheel tommmm and to take pictures on next monday.

Wired up counter circuit with a 53 as a regenerative amplifier. Design of Counter



756		5316	
755		8233	83
754		8160	73
753	105	8087	73
752		8021	66
751	100	7987	34
7:50		7956	31
749		7922	34
7:48	100	7905	23
7:47		7880	24
7:46		7795	85
7:45	130	7709	86
7:44		7608	101
7:43	125	7521	89
7:42		7438	83
7:41	120	7343	95
7:40		7255	88
7:39	125	7167	88
7:38		7080	87
7:37	110	6998	82
7:36		6905	93
135		6816	89
7:34	107 V	6742	74
P.M.	trippletts 250 V		Rate/min.

20		216		
19	120	0127		89
:17		9959	168	84
:16		9868		91
:15		9780		88
:13		9626	154	77
:12		9534		92
:11		9445		89
8.10	110	9368		77
.08		9327		82
.07		9235		89
.06		9146		2B$_2$ 81
:05		9065		81
:04		8984		79
:03		8903		95
:02		8808		89
8:01		8719		85
8: 7:60		8634		81
7:59		8553		83
	½	515	38	T6
7:58		8470	45	90
7:57		8390		80
7:56	110	8316		74

Crewood. change

cont.

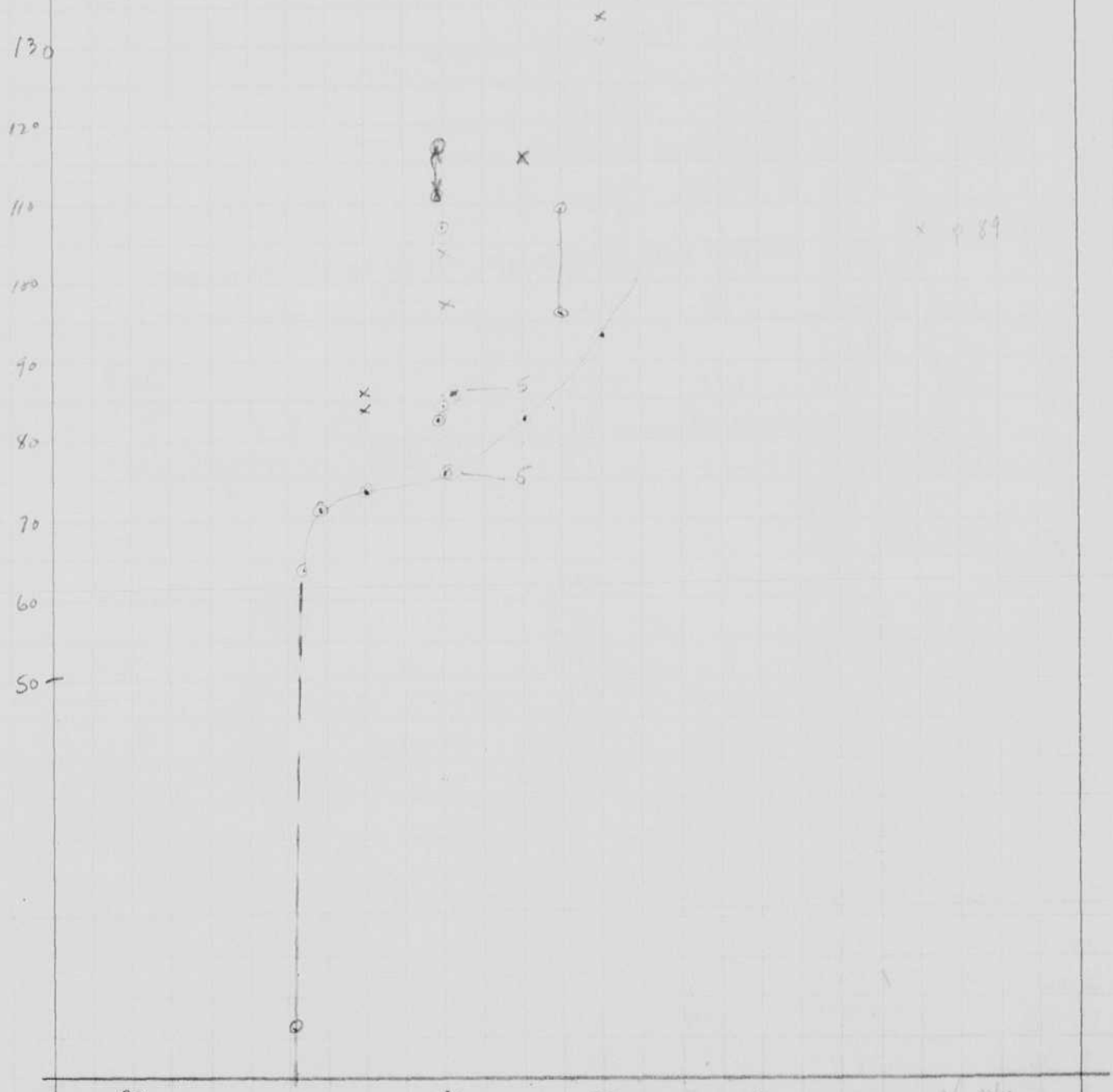
224	115	4529			
9:22		4338	191	95.	
9:21		4236		102	
9:20	115	4136		100	98
9:19		4040		96	
9:18		3951		89	
9:17	112	3827		74	85
9:16		3784		93	
9:15	107	3703		81	
9:14		3620		83	82
9:13		3580		40	
9:12		3538		42	45
9:11	103	3484		54	
8	100	~~84~~		~~54~~	threshed.
				Silent.	
.07		366			
06	120	274		112	
05		196		78	
:04		110		86	
103	110	025		85	
9:02		2936		89	
9:01		2865		71	Voltage on entire unit!
9:00		2781		84	Circuit changed again to regenerative
8.59	105	2710		71	Silent but CR shows that amplifier
.57		2664			is being excited
.50	120	2567		97	
.49		482		85	
.48		402		80	
.47	109	2317		85	
46		2241		76	entire apparatus on ✓
:45		2155		86	
:44		2081		74	
.43		1998		83	
8:42	110	1921		77	
8:34	122	1294			
8:26		385	8	709 88.	
8:25	122.	500		85	6000 ohms shorted
8:24		413		87	
8:23 PM	120V.	1341		72	Second triode entirely removed!

Dec 26, 1935

2:35	110	8990	5|435			84.0	
2:30		8565	5|434		86.7		
2:25	110	8131				84.2	
2:20	110	7710	5|421				
2:19		7632					
2:12	101.	7614	5|18		3.6		
2:10		7541					
2:05	102.	7222	5|319		63.8		
2:04		7156				7156	
2:02		7009				6800	
2:00		6868	2|141		70.5	5|358	71.2
1:59	103	6800			68		
1:53		6184					
1:46		5653	6|531		88.4	6184	
1:44		5486	2|167		83.5	9029	
12:40	109	15135	1|351		87.7.		82.3
11:27	111	9029	73|6106		83.7	87|7155	
12:26		8951			78		
:24		8810	141		70.5		
:23	105.	8731			79	8951	
:22		654			77	8583	
:21	105.5	8583	158		71	5|368	
:19		8425			79		73.
:18		8358			67		
:17		8285			73	8425	
:16		8193			92	8048	
:15		8115			88	5|377	
:14	110	8048			67		75.4
:13		7950			98		
:12		7865			85		
:11		7771			94	7950	
:10	120	7670			101	7670	
:09		7588			82	3|280	
:08		7505			83		93.3
:07		7423			82	7588	
:06		340			83	7259	
:05	115	259			81	4|329	
:04		7165			94		82.3
:03		7081			84		
11:02		994			87	7165	
11:01		6915			79	6738	
11:00	111	6833			82	5|427	
10:59	110v	6738			95		85.3

Supplied on entire apparatus.

Circuit up 9.84.


130
120
110
100
90
80
70
60
50
90
100
110
120
130
Volts.

Dec 26 1935.

42 Edgerton

Geiger-Muller counters

R Hamerschlag here from 11 to 2

Prof. Scatchard with Dr. Fidler and his wife who saw the movies at Harvard

36		5009			
35		4948		61	
5 34		4875		73	
33		4805		70	Res bias decreased from 6000 to 5000
32		4730		75	
31		4649		81	
530		4590		59	↓ this slightly lowers the voltage.
529	115	4510		80	Counter tube across amp filter.
527	115	380			
525		4161	2 | 249	109.5	
524		4044		117	
523	115	3935		109	
522	108	3820		115	
520		3624	2 | 196	98.	
519	108	3270	4 | 354	88.5	
511		2780	5 | 490	92.	
510		2695		85	
509		2617	78	78	
508	108	2515	102	102	amp with c.R and circuit
502	108	2114			
453	108	1364	10 | 750	75.0	
449	108	1000	4 | 364	91	
448	107	0922		78	Filter on amplifier
437		0585			
24	110	9386			
423		9300		86	
422	110	9217		83	
421		9124		93	
418	103	8984	3 | 140	46.	
415	103	8787	3 | 197	65.6	
406	105	8098	9 | 689	76.5	
405	117	8009	8		
401	117	7593	4 | 416	104	
332	117	5150	24 | 2443	102.	
305		2036	32 | 3114	97.5	
300	116	1555	5 | 481	96.5	
255		1006	549	109.	
250		0497	509	102.	6000 ohm shows 5000 ohm +
245	115	9980	517	103.6	
240		9503	477	95.5	
235	115	8990	5 | 513	102.6	

Notebook # T-6

Filming and Separation Record

____ unmounted photograph(s)

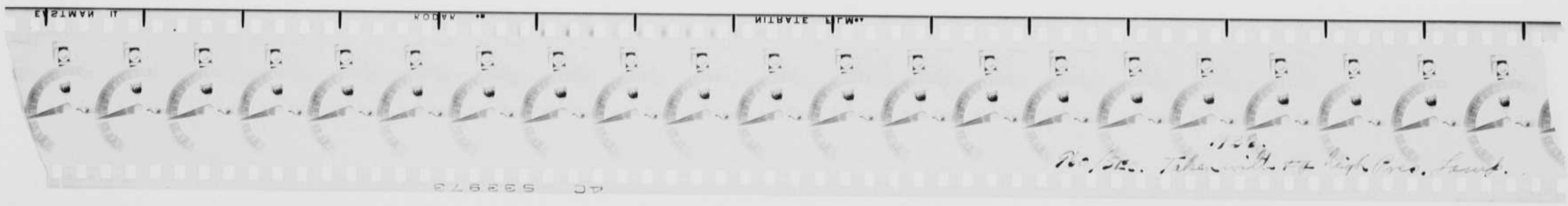
__1__ negative strip(s)

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

was/were filmed where originally located between page 88 and 89.

Item(s) now housed in accompanying folder.

carbon print.



cont

Wayne Nottingham took one home in his car.

6:20		8987			
621 PM		8907		80	8987
620	105.+	8814		93	8814
619		8627		87	2 | 173 = 86.5
6:18		8584		143	8627
6:17		8462		122	8193
6:16		8336		126	4 | 534 = 133.
6:15	120	8193		143	
614		8065		128	
6:12		7895	2 | 170	55	8065
6:11		7814		81	7481
610		7726		88	1 | 584 = 83.
609		7643		83	
607	105	7481	2 | 162	81	
606		393			
605		7280		113.	
604	115	7155		125	(116)
603		7045		110	
602		6948		97	
6:01		6851		97	6000 bias res.
6:00		6753		98	
5:59		6638		115	7045
5:57		6450	2 | 188	94	6215
56		6352		98	8 | 830 = 104.
5:55	110	251		101 ←	
	110	threshold			4500
	105				
52	↑	5156			
50		5981			
47	120	5696	3 | 285	95	
5:46	↑	5603		93	
5:45		5514		89	
44		5438		76	
5:43		5360		78	
5:42		5276		84	
5:40		5132	2 | 144	72	
5:39	115	5060		72	
Rm					

{ Counter just back to 2nd condenser which means voltage across ×.

↑ Improves stutter!
1 meg in series with starting condenser & grid.

Dec 21 1935

G-M counter Exp.
Cosmic Ray.

2:55		8913				
2:48	104	7196.	7	717	102.	
2:40	↑	8371	8	825	103.	
2:39	104	8280			threshold 91	
38	103	8239			stopped when chg leaked from Alt	
2:37	103	8141			Acme Regulator	condenser
34	108	7880				
2:33	110	7774	6		106	5000
2:29	110	5202	24	2672	107.2	
1:53		3408	17	1794	105.5	
1:52		3310			98	↑ 6000 ohms
1:57	110	3205			105	6000
1:49	110	2979	2	226	113	
1:28	111	0610	21	2369	113	
1:13	110	18918	15	1692	113	
11:57	110	9775	82	9143	111	
11:37	115	8200				
11:35	115	7998	2	202	101	
20	115	5950	15	2048	136	
11:18	115	15679	2	2989	139	
11:15	110	15290	3	389	129.+	
1030	107	10890	45	4400	97.8	
11:14		9238	16	1652	103	
11:13		130			108	
10:12	107	9050			80	
10:10	107	8820	2	130	65.	5000
10:08	105	8700	7	120	60.0	
10:02	105	8216	6	484	80.5	6000
10:01	113	8129				
9:51		6994	21	1135	113.5	6000
9:31		4760	20	2294	114.7	
9:13	115	2711	18	3989	110	5000
9:12	115	2625			84	
9:06	115	2009	6	616	103.	6000 ohms.
8:55	114	10807	11	1202	109	5000 ohms.
8:44		9848	11	1059	96.2	
43		9740		108		
8:42		9658		82		
8:41 AM	113	9544		114	6000 ohms line as from 6:02 yesterday	

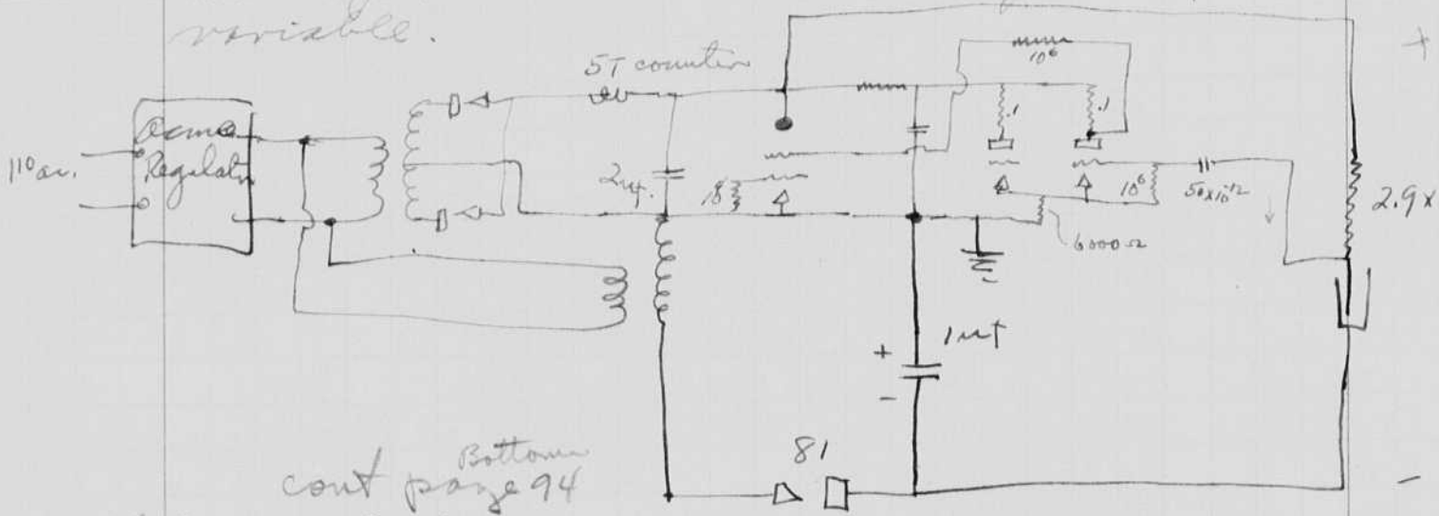
While this was running I connected up the motor Synchronizer shown on page 79.
Went home at 10 pm

9:01		5562				
857		5195	4	367	91.7	ac polarity reversed.
8:50	109	4500	7	695	99.3	
845		4043	5	457	91.4	
844		3930			113	
842		3748		182	91	
841	109	3658			90	Returned to A6 5000
838		3497				
820	109	1904	18	1593	88.4	
13		1268	7	636	91	
8:10	109	11022	3	246	82.	
7.44		8780	26	2242	86.4	
7:39		8331	5	449	89.8	
7:38		8255			76	
7:32	109	8161			94	B6 counter
734		8060				
724	109+	7175	10	885	88.5	
6,37	110	3282	47	3893	82.7	
636		3192			90	
6:34		3008	2	184	92	
6:33		2926			82	
6:32	110+	2851		75	75	C6 counter
6:29		2763				
6:08		10942	21	1821	86.7	
5.56	109+	9894	12	1048	87.1	
5:55		9816			78	
5:54		9731			85.	
552	109+	9556	2	175	87.5	I Tap Schrump
5:43	109+	8900				A6 counter
5:25	109++	6890	18	2010	111.6	
4:54	109++	3394	31	3496	112.6	
4:27	"	10321	27	3073	114.0	
312	110	1799	75	8822	117.7	
302	110	622	10	1177	117.7	
2:52	110	0040	5	582	116.4	Changed to large Acme Voltage regulator
PM						

Dec 28 1937

G-M. Counter experiments.

Rearranged circuit on bread board to simplify layout. Changed coupling condenser to 50 mmf mica fixed condenser instead of 25 mmf variable.



cont page 94 Bottom

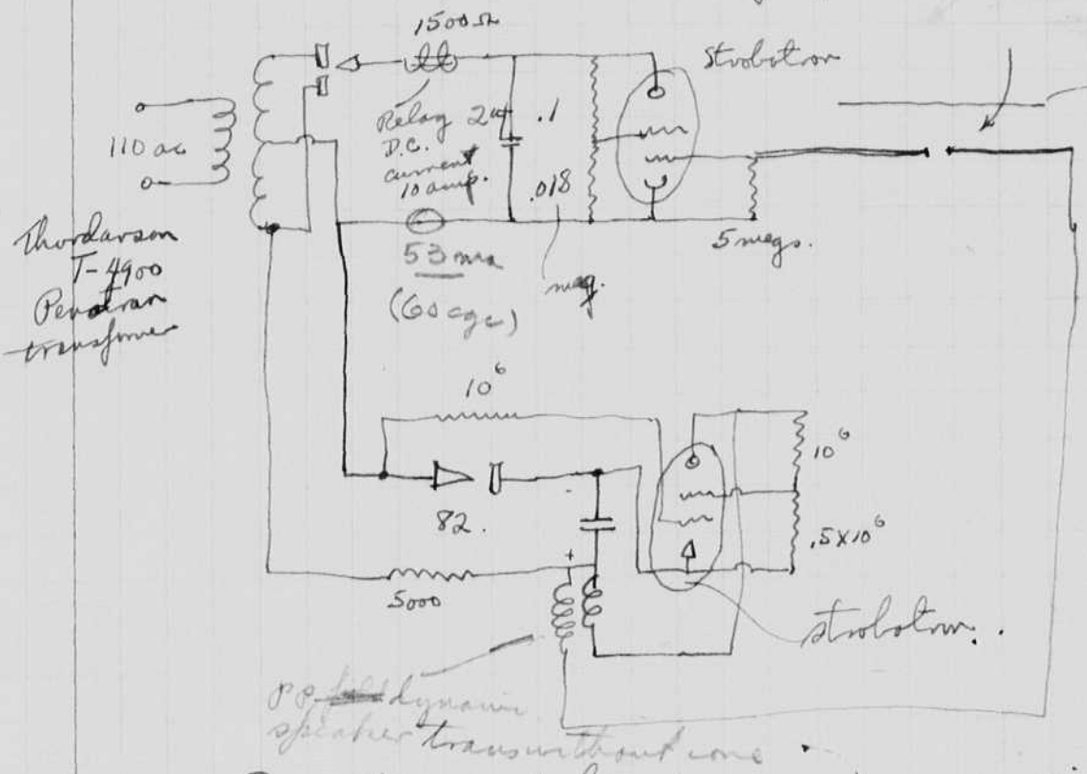
4.07	9110				
4.06	19019			91.	
01	7458	126	11561	91.5	
Dec 29 2.00 PM	7371			87	
2:10	15972				
1:12	10284				
1:11	10189			95.	
12:53	9430	8	759	93.5	
12:51	8224	12	1206	100.5	
12:50	8117			107	GM raised
12:48	7900	2	217	108.5	Cap coupling to GM reduced to min.
12:41	7239	8	631	79	
12:12	4392	24	2847	98.5	
11:28	11239	44	3153	71.5	
11:13	9593	15	1636	109	
11:12	9516			77	~~Started bosc~~.. bias increased to 60 v.
11:01	8996	"			Hygrade large bulb.
11:00	8928			68	
10:54	8460	6	468	78	Strobotron marked "Filings" loose base
:42	7489	12	971	81	
:41	7417			72	
10:40	7340			77	
10:39	7265			75	25 mmf coupling condenser put back.
:34	7115		↓ prob!		
10:32	6881		234	?	
AM 10:39	6738	2	143	71.5	A6 Counter
				c/mn	1

large Acme Regulator used as yesterday

Dec 28 1935
H. E. Edgerton.

Synchronous-motor angle-Synchronizer relay scheme.

See circuit and method on pages 78 and 79 of this book.



Seems to work fine!

Explained Dec 28th 1935 and seen in operation
Kenneth J Germeshausen

this finally turned out. and a Bosch spark coil without core was used. Enough voltage was present to spark across occasionally.

Witness:
Sam Reiss
January 16, 1936

Dec 29, 1931.

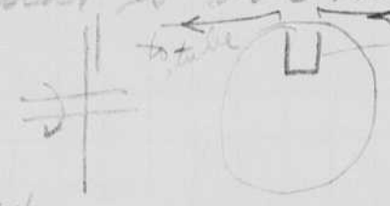
Motor Synchronizer

Angle-response field switch etc.

Cont. experiments from yesterday.

The 60 cycles transformer burned out due to over voltage. This is the transformer to produce the high voltage peaked impulses that are to go over the relay coil. I put in a Bosch coil without core such as we use with the stroboscope, damped with 200,000 ohms 2 watt resistor.

I put a bakelite disc on a small sylvania 3600 rpm set so that I could see if the method worked which it did very well. The relay would close in the correct angle every time & need apply circuit to hold it in once that it has made contact.



This showed Dec 1935. Dec 1, 1939 Ed Quarter

PM	9:13	4574				
↑	8:50	13133	23	1441	67.7	
	8:05	9470	45	3663	74.6	for ff.
	7:01	4402	64	5068	79.3	
24	6:36	2325	25	2077	82.9	
	6:35	2257			68	
	6:34	2194			63	
	6:33	12116			78	
out to Walton	6:02	9589	31	2527	84.2	
	6:01	9496			93	
	1/2	9459	37		74	
	6:00	9416	45		90	B-6 change Counter
	5 48	9366				
	5 40	7730	8			
	4 49	3055	51	4675	91.6	
	4 48	964			91	
	47	12871			93	comp. Ctr. year
	4.45	12687	2	184	92	
	4 14	9825	31	2862	92.4	
	4:07	9110	7	715	102.	A-6

Dec 30 1935

9:32		13832			
6:51	161	5606	18226	113.	
5:59	52	9051	6555	126.	
5:09	50	3424	5527		
2:00	189	2017	21407	110.5	
1:10	50	36187	5830	113.	
11:40	210	15100	21087	123	
10:46	54	8145	6955	129	
Jan 2 9:45	61	1595	6550	107.5	B-6 counter.

449		7759.			
426	27	24626	3133	116.	
226	120	12490	12136	101	
141	35	8018	4472	128	
105	39	4575	3443	88.4	
1:00	5	14110	465	93	
11:49	71	7444	6666	94	
11:12	37	4066	3378	91	
11:03	9	3237	829	92.	
11:02		3150		87	
11:01		2942		108	
AM 11:00		2950		92	B6 counter

Jan 1 1936 B

5± - turned off.

340		5152			
3:22	18	23474	18 1678	93.	
1:28	114	11930	11544	101	
12:51	37	8192	37 3738	101	
AM 12:50	1	8093		99.	B6

Dec. 31. 1935

PM 8:12		8038			
6:10		6481	122 11559	95.3	
3:39		30805	151 15676	103	
2:26		23140	73 7665	105	
11:35		4466	171 18974	111	
11:33		13964	21 202	101	the rate was very high about 10:30 as heard by ear.
10:09		2469	93 10495	112.6	B6 counter
AM 9:57		2095	3 374	124.+	Large line voltage regulator Had been coming about 1/2 hr ±

G-M Cosmic ray counter. Dec 30, 1935.

G.M. Count Continued.

Jan 4 Run about two hours — no readings. Rate est. 100.

		5 20		0933		
56/80	↑	3:04	136	7997	2'2936	94.7 or 167 ?
		12:19	165	1'7230	2'0767	125.
		10:35	104	9358	1'7872	171.
Jan 3 1936 AM.		9:59	36	3851	5507	153.

Jan 4 1936.

I worked Jan 1 with Bullock photographing the oxygen from the nozzle of a cutting torch. 40 pounds. Movies at 200/sec. The pattern is a standing one and could be taken with ordinary light. The camera stand and the optical bench which Bullock made are a great addition to the laboratory.

Yesterday Dr. Hauser and I set up a parallel sided dish I borrowed from Fletcher and took some movies showing drops falling into water. Milk was the substance used. Some movies were taken at 960/sec and some at 480/sec. These experiments were repeated today with Mr. Cox (New Orleans) using some iron salt instead of milk.

Last evening I took the 548 BR stroboscope into the dark room and tried to measure the light with a L & N. McBeth light measuring device. Readings were difficult to obtain because of the color differences. The lamps were 18" from the large white disc (factor .804).

Jan 3 1936.

Hg lamp. from tube.			Factor	Low range on Strobo		Read by. ↓
2 min	18"	1.6-2	D.	1.73 amps.	30 cycles.	
6 min.	18"	4.7	D	1.73 "	30 cycles.	
7	18"	5.1				Edg.
8	18"	5.4				Herb.
9	18	6.5				Jones
10		7				Edg.
	18" New lamp. 4 bend.					
1	18"	7.4	D	1.73	30 cyc.	Jones
2		4				Drier
3		7.3				Jones.
		4				Drier
		4.3				Edg.

cont.

$\text{lumens} = J \times 4\pi$ $\quad J$ = luminous intensity

$\frac{\text{lumens}}{\text{sq. ft}} = \frac{J \times 4\pi}{(4\pi d^2)} = \text{ft-candle} = \frac{J}{d^2}$

Inc Beth illuminometer reads ft. candles? if so.

$J = 7. \times d^2 = 7 \times 1.5 \times 1.5 = 15.8$ candle power.

For this experiment the stroboscope was run at 30 flashes a second, each flash lasting about 10 microseconds. Total time on = $30 \times 10 \times 10^{-6}$

$\text{Peak intensity} = \frac{15.8 \times 1}{30 \times 10^{-5}} = .526 \times 10^{+5} = \underline{52,600}$ candle power.

Notebook # T-6

Filming and Separation Record

____ unmounted photograph(s)

2? negative strip(s) inside mounted envelope pg 98

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

was/were filmed where originally located between page 98 and 99.

Item(s) now housed in accompanying folder.

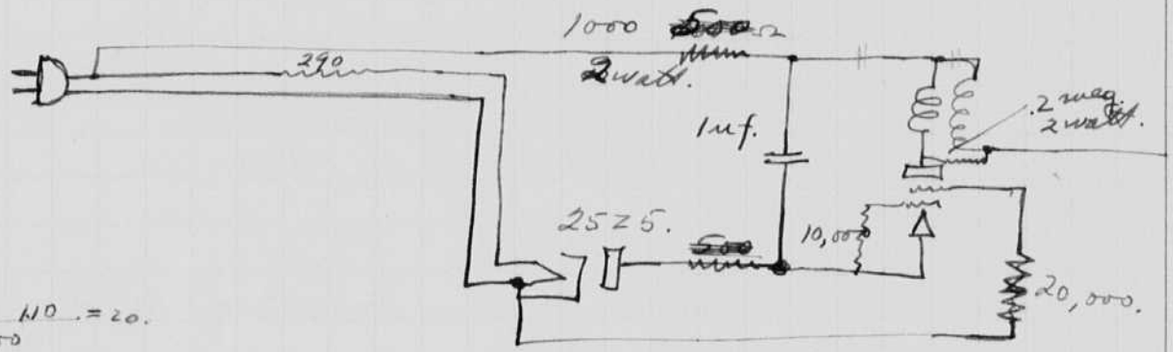
Jan. 6, 1936.
H. E. Edgerton.

Timing wave for camera.

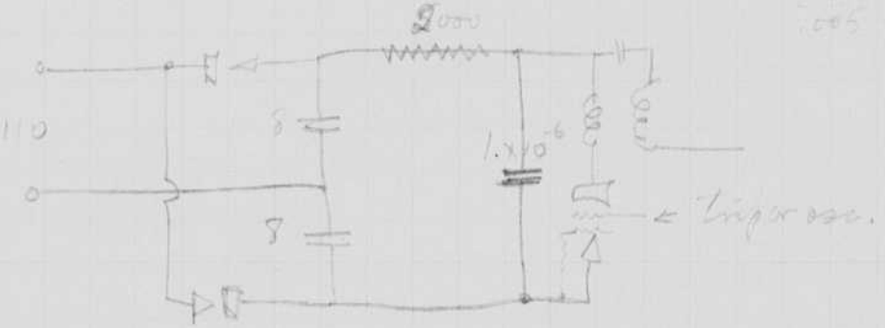
A wire from a bosch spark coil was put against the film and a voltage put on it (1/4" spark). Lichenberg figures. The 60 cycle circuit was shattering.

Took second run with lower ~~cap~~ voltage 5000 ohms charging resistance used. 1 microfarad. Coil damped with .2 megs.

Circuit for camera.



110 110 = 20.
500



Jan 12. Built up and put on camera by Grier. tried yesterday. film attached showing spots.

Jan 6 1936
Eq. Equilibrium Reflectors - Etched vs polished &c.

Weston

Started 9:11 3 min. Devcol aqueous
6.5 Weston Stirring

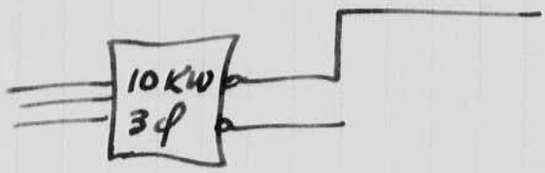
80 " Etched reflector

8.5 " Stirring

Practically no difference

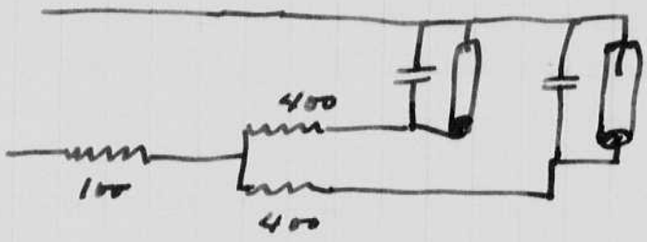
Jan. 12, 1936. High Speed Camera.

Working with H.E. Grier.



~~two~~ Lamp houses.
Ford coils damped with 1 megohm

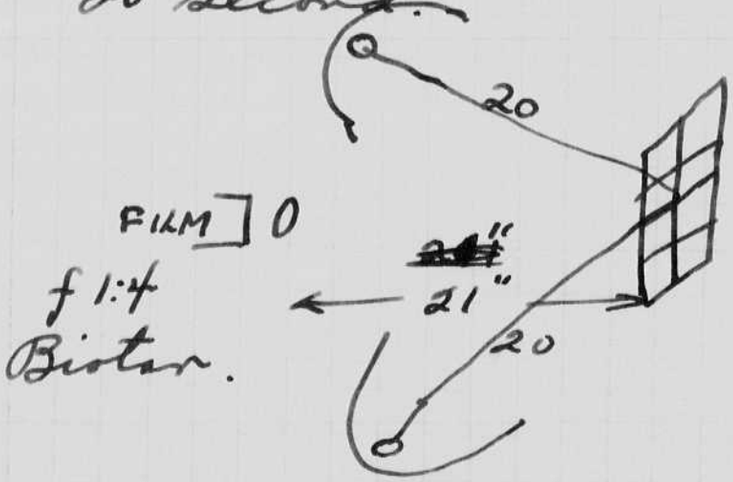
Works ok with below.



with 800 in parallel with 400. Some holdover in one lamp. Changed tubes holdover still in same lamp.

Film Spliced. 30 ft Sound Recording
5 ft. Super Pan. Eastman
5 ft. Pan. Negative.
5 ft. Background.
10 ft. Sound recording.

Set up as above. Lamps run about 20 second.



Reading with Herbo

40 ft candles

10 minute development in D 72 (one week old). had developed 1000? ft. or less.
2 gals solution for 1 gal tin.

Eastman Cine neg Pan seems best.
Measurements will be made later.
A few misses in film. Also some early or late.

cont. High-Speed movie Apparatus

Internal commutator side of sprocket appears to be jumpy. A cathode ray oscillograph was set up to observe the contact. 22½ volts in series with a resistor to the brush. Certain contacts were definately missing.

I tried the brushes with out any voltage and found that the brush takes a charge, negative due to friction of the metal brush against the moulded bakelite.

Conclusion Copper commutator rough. must be ground before it can be used. Examine for burned places?

Put on old camera with outside commutator. 220 volts dc on motor starting to bring up to speed. f 1.4 Panatomic film Same as before except an 800 ohm resistance now in parallel with each of the 400 ohms in each lamp circuit.

Jan. 15, 1936.

Several days ago I started to get neon gas (high pressure) for experimental work with high pressure concentrated stroboscopic lamps. The Matheson co do not list neon at more than atmospheric pressure. I wrote them to see if they could supply it on special order.

The camera commutator was ground and now seems to work o.k. However the spark timing wave occasionally trips the lights. I tried to fix this with a resistance across the contacts (1 meg) but it was not enough.

On Monday Jan 13 I worked with Mr. Cox of the Chem. Eng. dept, taking pictures of the tensiometer and of Iron oxide(?) solution as it dropped into water and into a cleaning solution (E-6-2?). The data on the photographs is recorded in his note book. We worked until ten p.m.

Mr. MacDonald of the Sturdevant co was over with their S.R. Stroboscope yesterday after seeing E.R. about jimpy performance. We located the trouble in the commutator, faulty insulation bakelite apparently causes premature sparking at the contact. Grier turned down the disc and it apparently worked better. We showed them how to build a larger contactor to use with their blowers.

Jan 14

I worked in the evening developing films of the surface tension experiment. Also set up camera for taking pictures of the G.E. time switch for today's pictures.

Polarizing material
Land & Friedman

Jan. 16, 1936.
H. E. Edgerton.

Left home at 7 a.m. to go to the Fiberloid Corp at Indian Orchard, near Springfield, to discuss the possibility of high-speed photographic studies of the smashing of shatter-proof glass. I was met by Mr. C. S. Webber (Course V M.I.T. 24) with whom I also talked too on the telephone last saturday. Mr. J. C. Brookes, the ~~superintendent~~ manager of the plant was out of the city for the day. Mr. E.R. Derby broke some specimens of glass so that I could see what happened. Sketches were made of the setup. Left at 11:30

About 1:30 I arrived at the Norton Co. and called on Mr. Becher. He called a conference of Charles Hudson, Wagner, England?), Whitcomb, to discuss the high-speed motion picture studies that had been made to date. I gathered from their conversation that they were very well pleased with the results to date and Mr. Becher asked me to propose a program along the following lines: 1. Estimate on cost of apparatus for use in Worcester.

2. Services and material for improvement in lighting and description such improvement to be incorporated in the apparatus for Worcester.

3. Services and materials for such further tests on wheels in Cambridge as time and convenience will permit

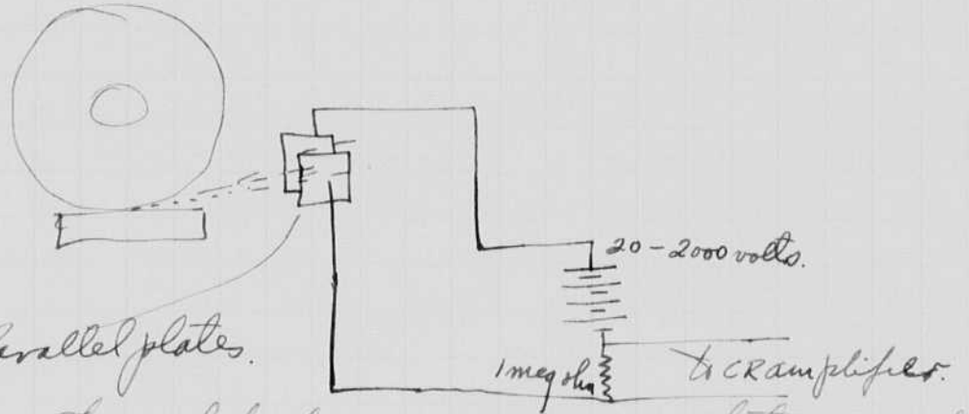
4. Consulting services in Worcester.

Mr. Saunders (vice pres in charge of engineering) dropped in and expressed his enthusiastic views of the photographs and for the extension of the work.

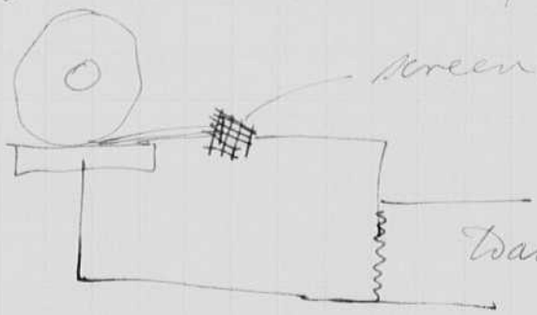
Percent Grinding time.

Methods of measurement.

1. Mechanical stroboscope. Now being tried by Mr. Wagner.
2. Photocell pickup of light from sparkes.
3. (Smoke detector) Continuous light through sparkes.
4. Piezo electric meas. of vibrations set up in grinding frame or on shaft.
5. Electrical methods.
   a. The metal clips may be charged? Collect on a screen and amplify.



The red hot material going between the parallel plates will cause a change which may be amplified sufficiently to record on the oscillograph.



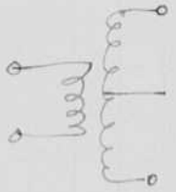
The particles coming from the wheel possibly are charged electrically and will produce sufficient electrical effect to be useful.

Strobscope Oscillator.

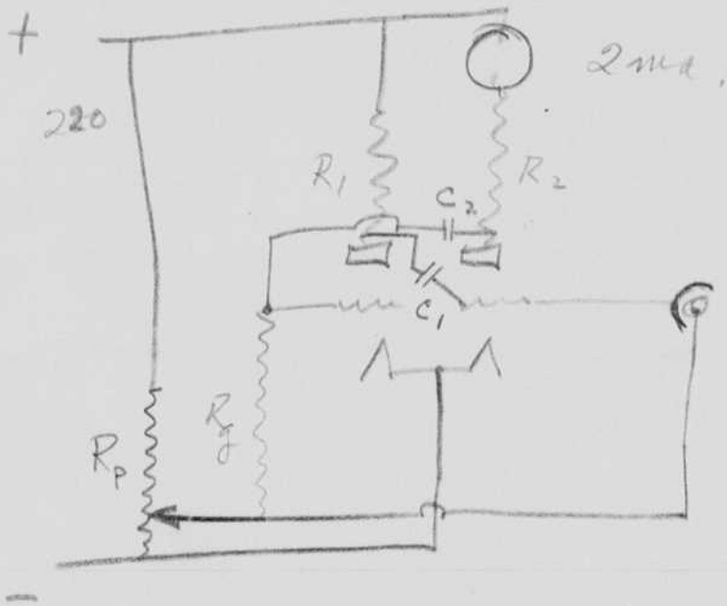
Range for ~~Stro~~ stroboscopic work.

Low Range 10 - 30 cycles 600 - 1800 R.P.M.
30 - 90. cycles 1800 - 5400 R.P.M

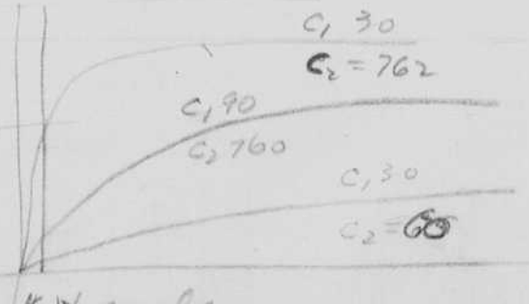
a range from 3.3 - 10 could also be included



Tried by a Stud and named. Schroeder.



R_1 R_2 50,000
R_g 5 meg.
C_1 < 25 mfd.
C_2 < 250 mmf.



Kraft. candle.

Jan 18, 1936.
H. N. Davoine
H. E. Edgerton.

Recording Movies.

FILM No	f	Stock	Lamps.		
1.	1.5	Pos.	2 - 1 inch. 1000/sec.	H_2O	Cold iron. 30 ft
2	1.5	Neg Reg	2 - 1 inch " "	H_2O	cold iron. 30 ft
3	"	"	" " "	H_2O	~~Hot~~ 1500° F 100 ft
4	"	"	" " "	H_2O	Hot 1500 later stage. 100 ft
5	"	"	" " "	Brine	Hot 1500 Start 100 ft.

Jan 19 1936. H.E.E. H.E. Grier
K.P. Bennesiansen.

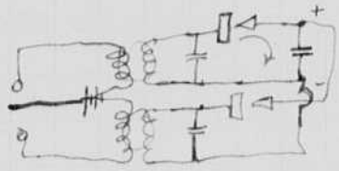
Tried experiments shown on the bottom of page 105 without success, The Dumont C.R. amplifiers ~~was~~ were used in series. If there is any charge brought off by the grinding it is quite small.

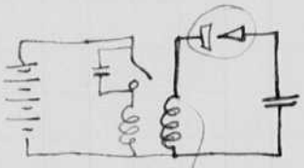
The photocell worked but considerable amplification was needed.

A rochelle salt crystal was held against the bar that holds the metal against the wheel and the output put through a singer stage of amplification to drive the C.R. osc. About 1/4 of the amplification of the amp in the R.C.A. tube was needed to give a reasonable deflection. Several photos were taken.

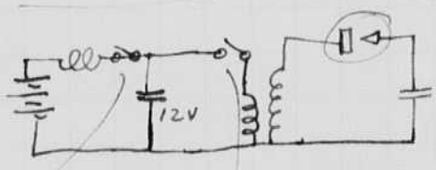
Jan 23, 1936.
L. B. Edgerton.

Demeshausen and I went out to Salem to the Hygrade Lamp Co yesterday and talked to Mr. A. M. Wise about tubes, etc. He mentioned the use of a tube as a full wave rectifier for automobile radios. Also we made arrangements for the direct purchase of stroboscope tubes ~~from~~ for the G. R. Co.





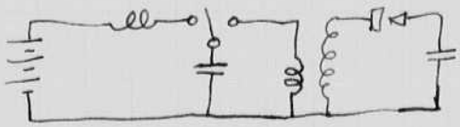
surge on this opening of the switch. rectified by the tube.



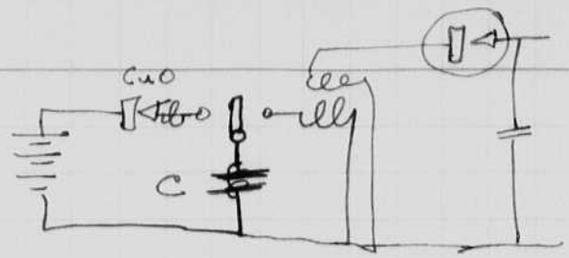
This switch to close for time that current flows in positive direction. 12 volts on condenser.

This switch closes shorting ignition coil (or step up transformer) across the 12 volt condenser. Secondary voltage rectified by strobotron tube.

Combine the two switches.

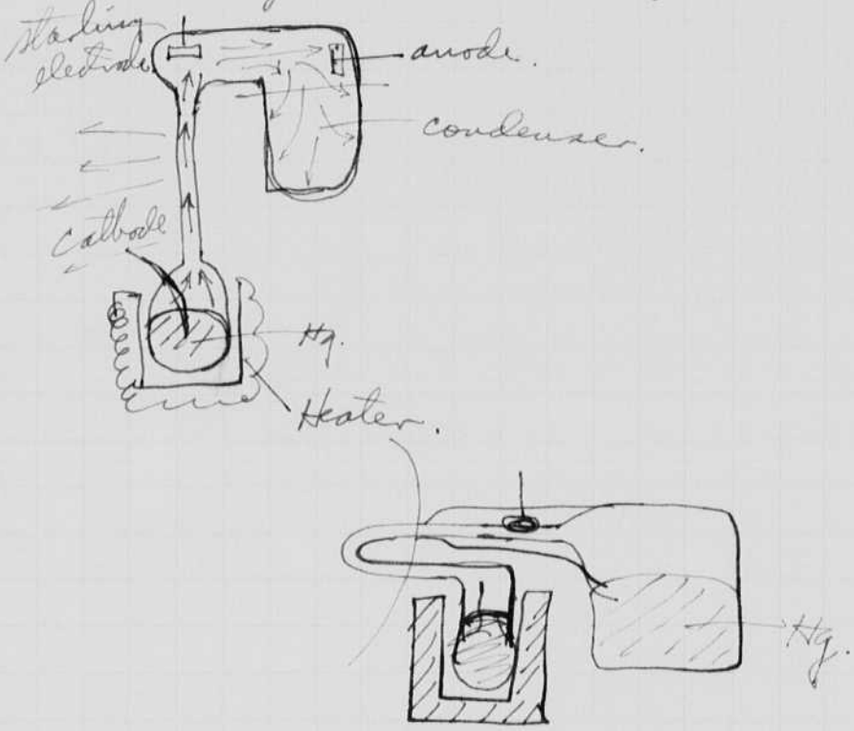


Use Copper oxide rectifier in charging up the first condenser.



Jan 25 1936.
K. L. Edgerton.

High Pressure lamp design.



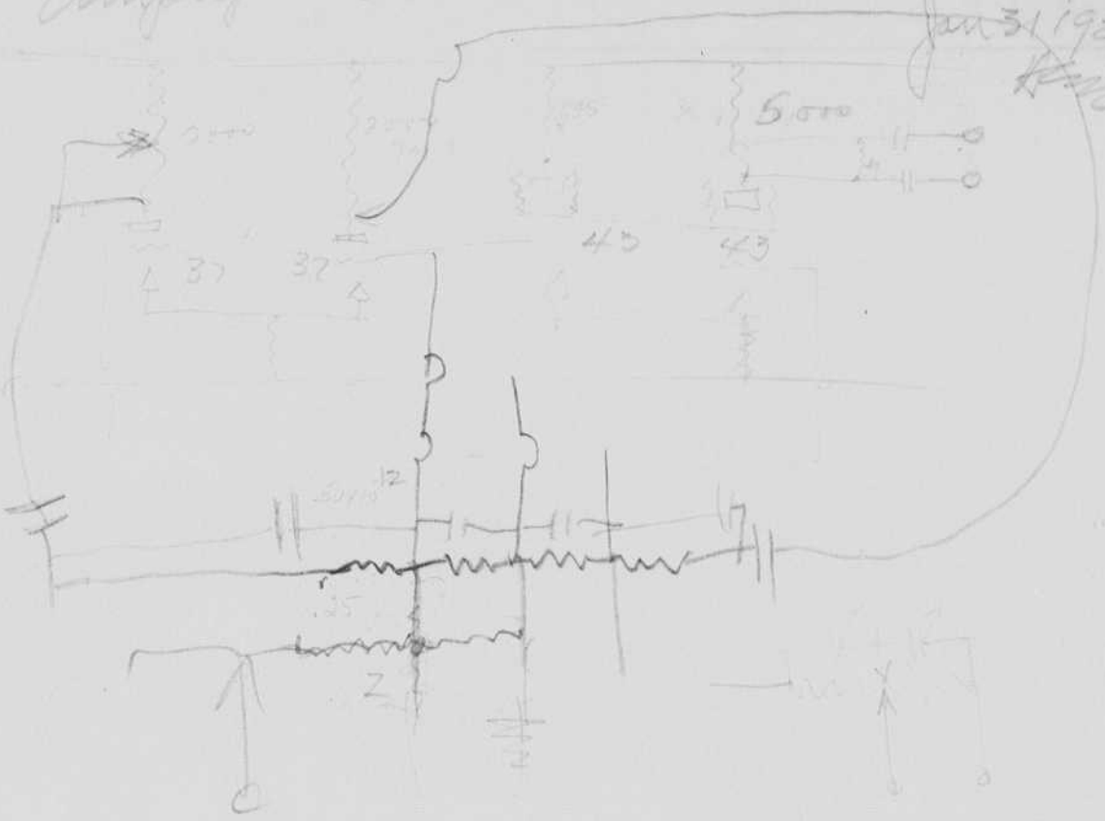
Jan 30 1936

W. E. Edgerton.

On Jan 27th I showed Crary & Halberg (G. E. Co.) the method of synchronizing a synchronous motor which is described on page 93 of this book. The motor had been disconnected by Ed Kimbark for use with his class work and was not ready to operate. A piece of wire on a stick was used to trip the contactor.

I went to New York on the 27th on the 4 pm train with F. S. Gray, stayed at the Taft Hotel 27 and 28. With Mary Ellen Pogue at 211 Summit Ave. Summit N. J. on the 29 and home last night on the 5 o'clock train.

Amplifier Circuit discussed with Jansil
Jan 31 1936.



Quench

Feb 4 36 cont of p 107.

Examine Hg Exp tube.

Poo

#6. H_2O Hot. spec. 1600 F. Ng. 60 cycle timing wg 2900 RPM. Skipping.

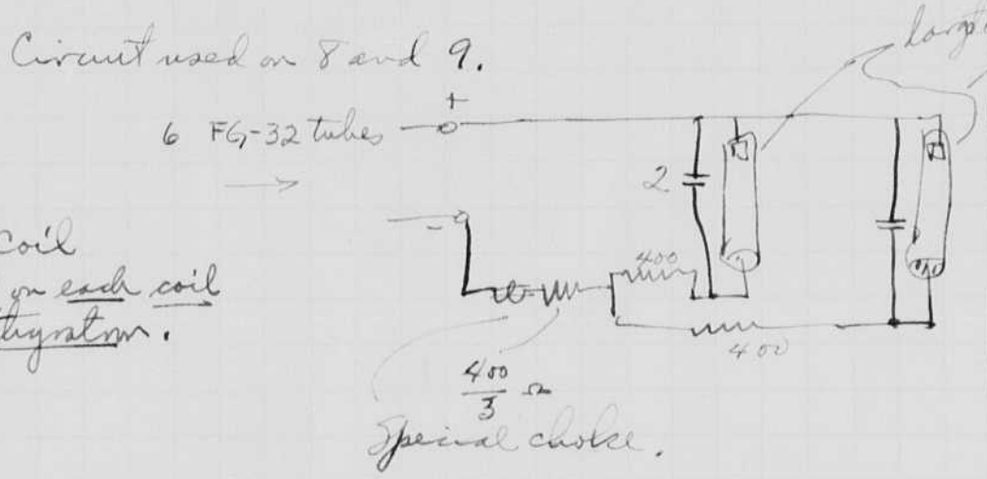
#7. " " " 1600 F Ng. " " Destroy #

Changed Hg tubes. and circuit slightly.

#8. " " 1600. Early

#9. " " " Late.

Circuit used on 8 and 9.



Ramped Ford Coil
.05+.06 = .11 mfd on each coil and thyratron.

#10 Brine 1600

#11 " "

Feb 5 1936

D72 - 15 min.

#12 Oil. 1600° Poo film +1.5 74°

#13 oil 1600 Neg. Background +1.5. "
Film broke!

#14 oil 1600 Later stage.

---

evening. 1 H_2O from jug Rus. Buell helped.
960 sec. 2. Soft ball into H_2O
3. Soft ball into H_2O.

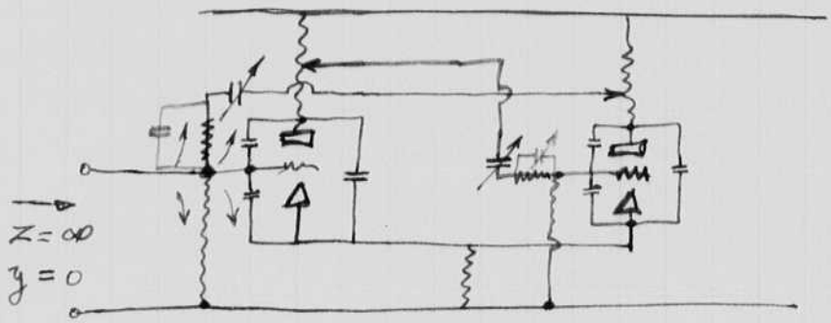
Feb. 11, 1936.

H. E. Edgerton.

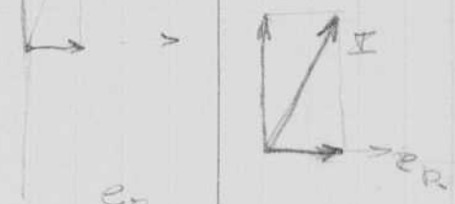
Experimented with lamps Th, Fri, and Sat. also took pictures for Morse on Sat. with Mr. Fletcher.

Demo tried high pressure lamp yesterday. Works fine and seems to have possibilities.

Feed back amplifier with zero input impedance. Output principle for cathode ray osc. work.



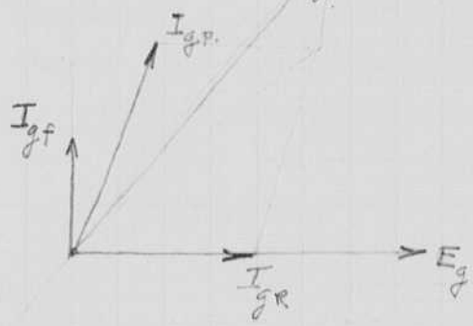
$$E_g = e_g\left(\frac{1}{r_g} + j\frac{1}{\omega C_{gf} + C_{gf}}\right)$$



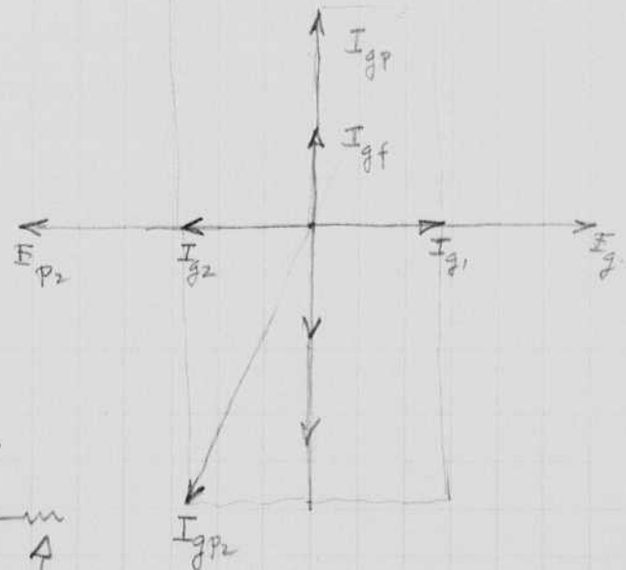
$$\frac{e_p}{r - jX_c}$$

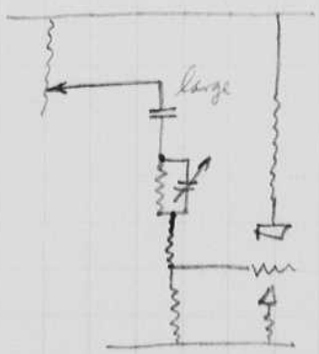
$$I = e_p\left(\frac{r}{Z^2} + j\frac{X}{Z^2}\right)$$

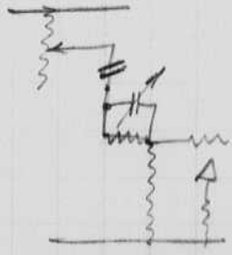
For $Z = \infty$ $\quad I_{gp_1} + I_{gf} + I_{gp_2} + I_{gR} = 0$



$+ I_{gp_2}$



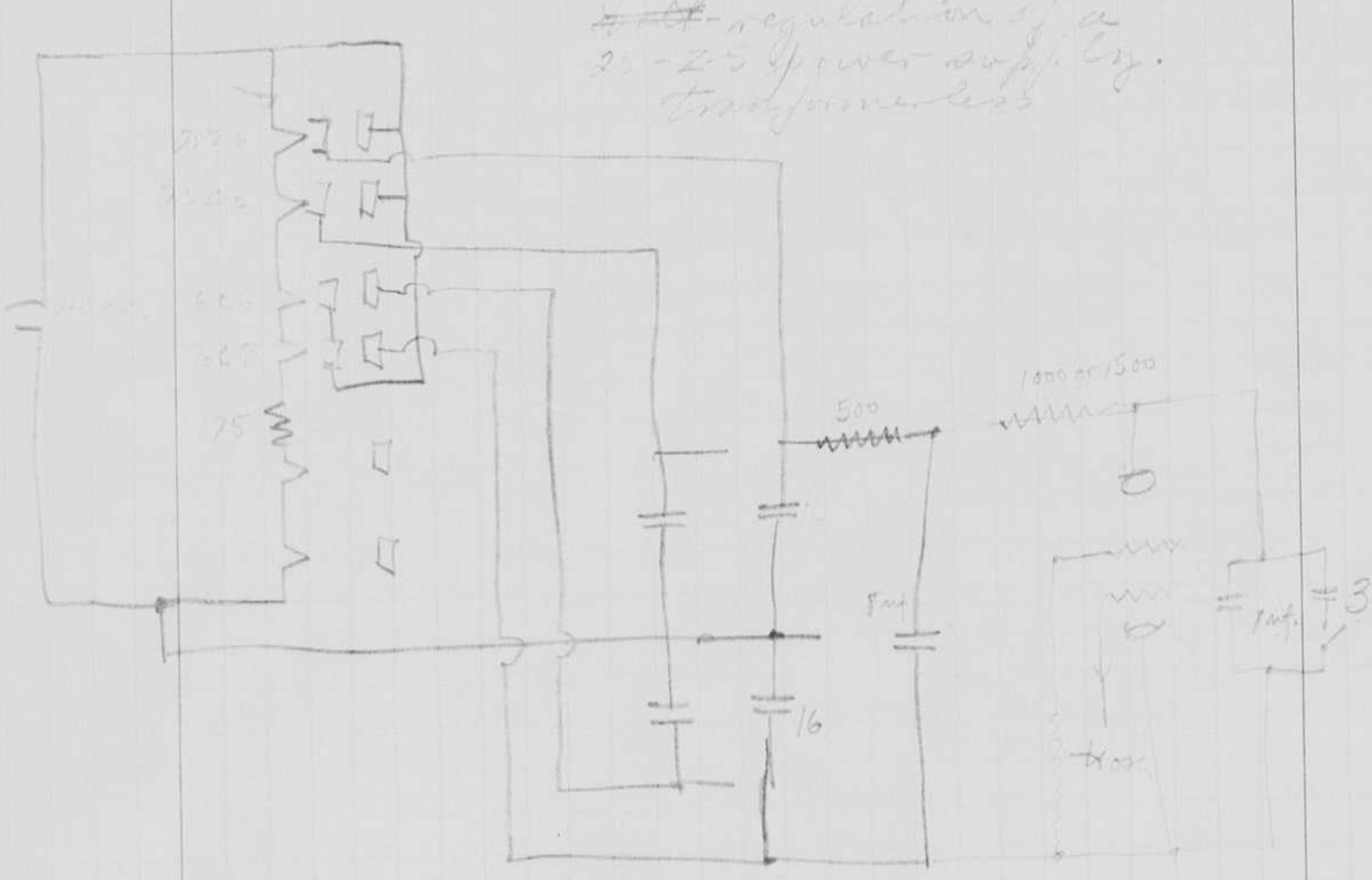




Feb 13 1936

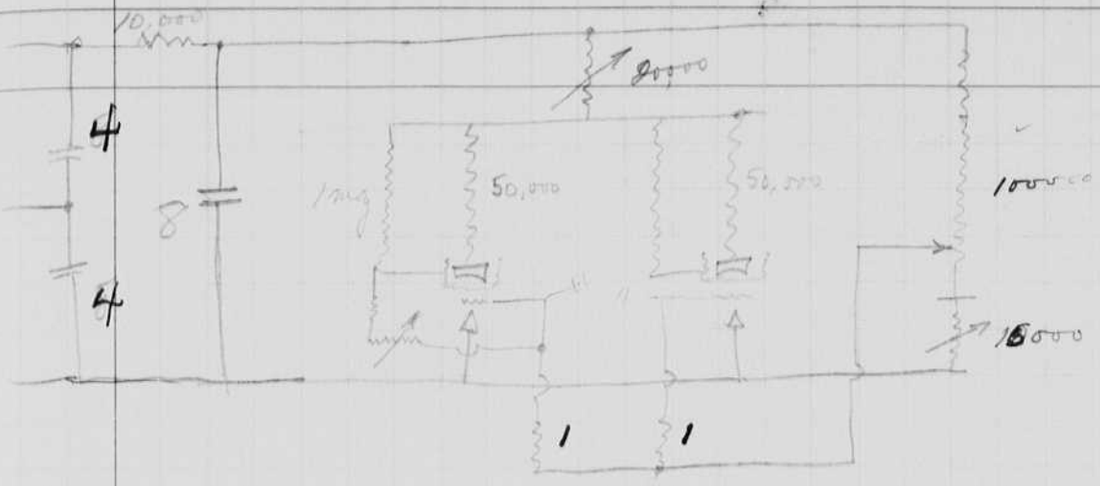
Strobotac cont page 39.

Experiment to determine the ~~[illegible]~~ regulation of a 25-25 power supply. Cy. transformerless



Regulation of power supply.

mf. across	I	V	
16	50	~~218~~ 208	1 2525
	70	197	
	90	182	
	30	219	
	20	224	
			2 2525 parallel
16	50	216	
	30	226	
	70	207	
	90	199	
	109	193	
16	50	216 ✓	Input 105.5 volts!



6 watts.

$1000 = \frac{1000^2 \times 10^{-6}}{2}$ 50 watts

$\frac{E^2}{2} \times t$

Try calib method. Variable resistor from control to screen grid. This should effect the voltage at which the tube starts.

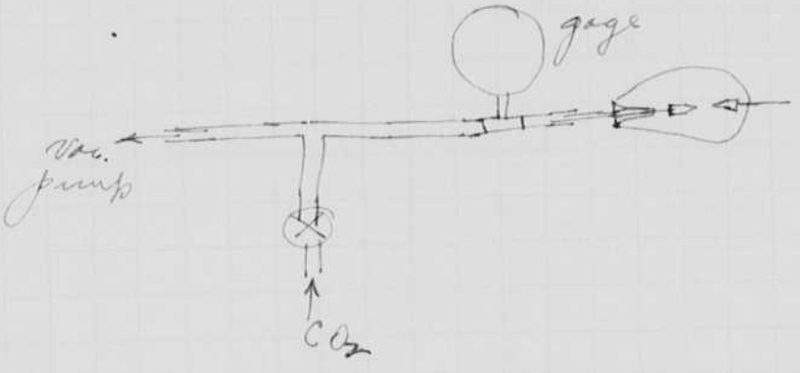
Coincidentally lie in with 60 cycle current

Feb 19 1936.

H. E. Edgerton.

James put the high pressure lamp in a reflector and connected it up with the 2000 volt M. G. set just completed. Works fine. 1200/sec. f 9 of a scale-white object. f 6.3 1200/sec of transient switch from Meas. lab. f 4.5 on positive film of sewing machine 1200/sec.

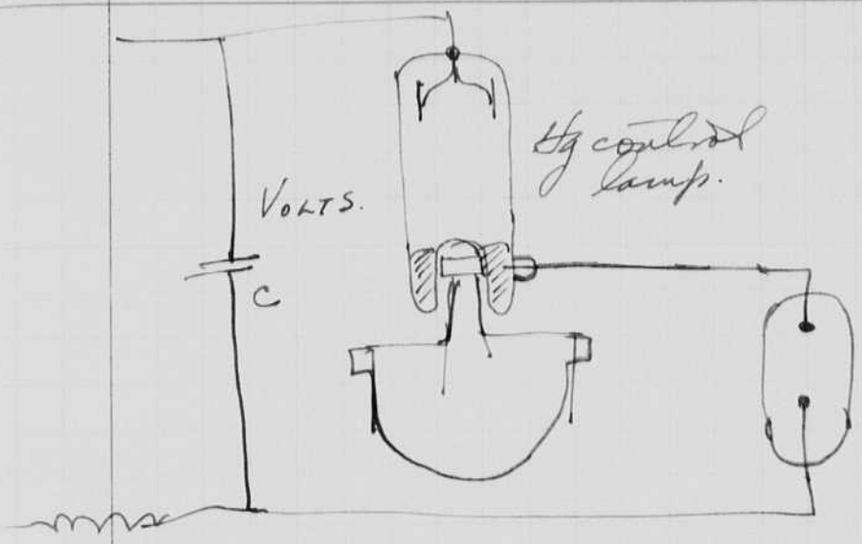
Seven lamps were made yesterday and today in large radio bulbs. Anode brought out through a seal at the top. Iron anode and cathode.



TUBE 1 CO_2 as a gas was tried. About 1/2 an atmosphere was correct for the set up that consumed 2000 volts 1200/sec. 1/4 mf. Worked o.k. but electrode got very hot and inside of tube and electrods turned brown.

TUBE 2. A second tube was filled with argon at 1/2 atmos. Arc held over going up the tube to the top of the bulb. Tried atmospheric pressure. same result. At 10# pressure the rubber hose was blown off. Then tube put on vac. system and baked out, sealed off with 1 atmos of argon. Tube darkened up. Iron electrodes.

It worked satisfactory with 500 volts at 60 times a second with 8 micro farads of capacity but turned dark as noted above after about 10 minutes. The baking was ineffective because of a faulty

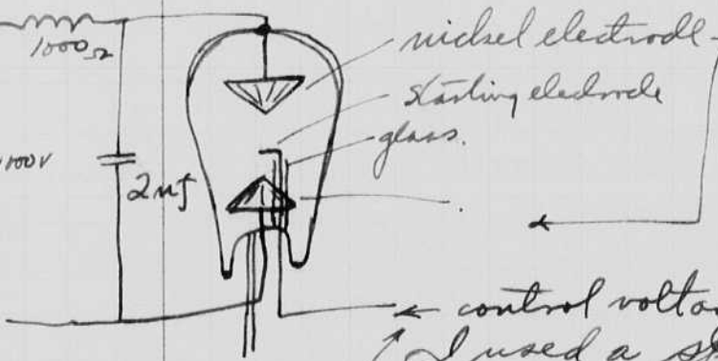


connection to the vacuum system.

The arc makes considerable noise and the convection currents in the tube carry the arc in a changing path that make it appear to flicker.

Tubes 3 and 4 had an Iron (was metal) cathode with a (cs cl - al) pill in the bottom of a hollow cylinder. the anodes were of aluminum. No 3 had 10 inches of vacuum (argon gas) and no 4 had 20 " " " " . The arc is shifty due to convection currents in the gas.

Tubes 5, 6, 7, made on Feb 21 but not completed until Feb 22 due to a leaky vacuum system. The anodes and cathode were of nickel shaped like a cone, about 1" in diam. Starting electrodes were used on two of the tubes. One broke down near the stem making it useless.



← This circuit was tested on the pump and seemed to work best about 5 or 6 cm. of argon. The tube was sealed off with this much gas in it.

↑ I used a sparker such as is used for testing vacuum. It was about 4 inches from the control wire thus controlling by induction only, that is by capacity effects.

If this method works it should give a very simple arrangement for the stroboscope.

Feb 23 1936

Dr. Edgerton.

Yesterday I again set up the 1200 per second camera arrangement for taking movies of the drops of water falling from a stagnometer(?) for surface tension experiments. Prof Hauser. Mr. Cox. Mr. Holt.

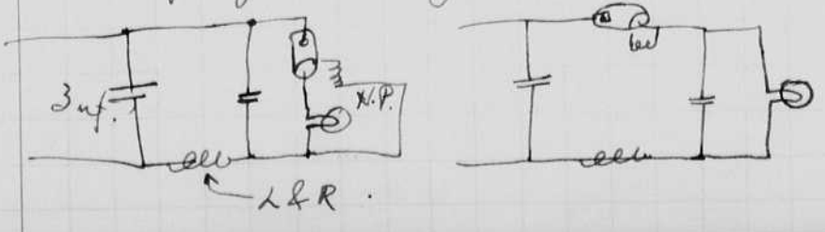
I also took spark photographs showing smoke coming off of an air foil for Prof. Obed. Aeronautics dept. Bullock helped me with this experiment. Brier is in New York this week end.

Semenhaven and I took the movies, slide and stroboscope out to the Waltham Arsenal in the evening to show them to the U.S. Assn. Mr. Warner (Welding).
Col Kirk. Manager of the works.
" Jenks. commanding officer.
Prof. Callan (Harvard Mus. school).

Col. Jenks discussed photography of bullets and we are going to try to outline a program.

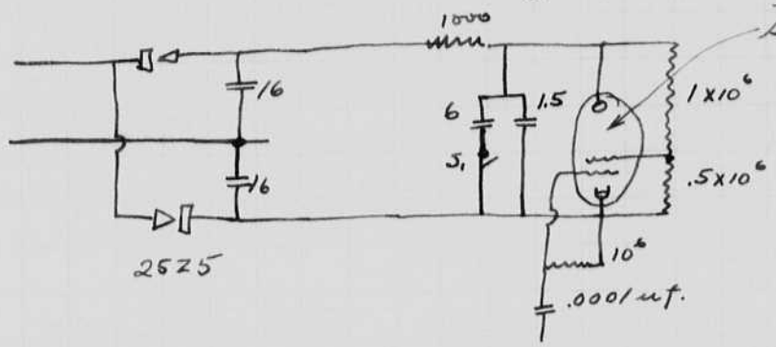
Program. — Single photos — accurately timed.
30 caliber bullets cutting armour plate.
Different stages of the action.
1:1 photographs.

Method discussed with Sems on the way home. High pressure Hg lamp with Hydrogen for damping of the after glow. Capacity about .005 m.f. Voltage 16,000. volts. Possibly high speed movies could be taken using oscillations in a condenser and charging inductance from a large condenser such as our 3 m.f. power pack.



Feb 25 1936.
H. E. Edgerton.

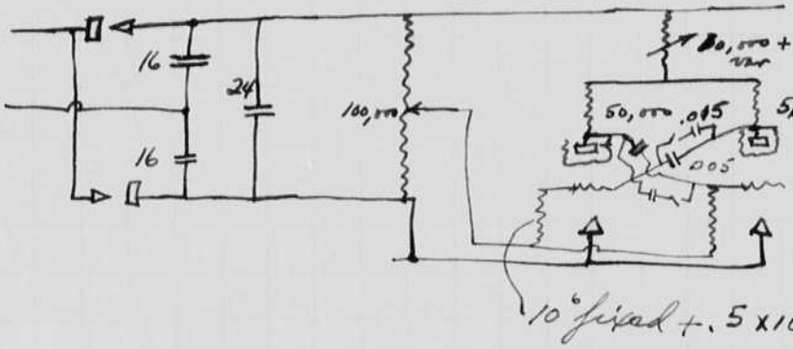
Finished wiring up strobotac circuit with 2525 rectifier tubes (see page 114).



strobotron.

6 mf. 60 cycles
draws 90 ma. 200 volts.

4 mf. 60 cycles.
draws 70 ma. 210 volts.

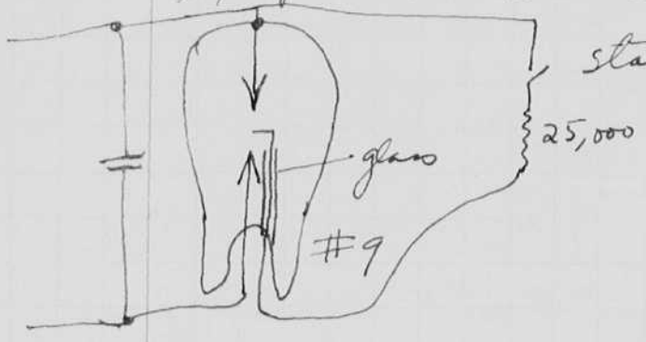


TWO 666 TUBES.
Sup/pressors to cathods.

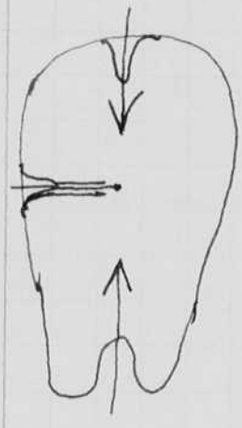
Worked this afternoon with Gunnesbausen on KV 615 Ignitron tube starting circuit using a Strobotron.

Feb. 29, 1936
H. E. Edgerton.

Made tubes # 8 and 9. Argon high pressure lamps. Tube # 8 cracked in sealing machine. # 9 pumped, baked 1/2 hour, neon 1 cm then argon 6 cm. Pumped down to 4 cm and sealed off. Does not break down on 1000 volts except when starting electrode is connected starting switch.



An arc at the bottom resulted if the pressure was increased. The stem should be built differently or the high voltage starter should be brought in at the side as shown in the sketch.



March 4 1936

At 1 pm I went to the Watertown Arsenal and spent the afternoon photographing [illegible]. Mr. La Bountz and Mr. Hartley were there. We went down to their 150 ft. range and watched several 30 cal. bullet holes and ammunition

Then I went to the Watchband Watch Co and met Mr. Bruche. He explained their trouble with electric clocks and showed me the problem with the [illegible] escapement. Mr. Bruche at the last minute, Mr. Hartley and Mr. Hamilton [illegible] Fahrenheit seems to be part of the problem. They are going to reduce the bearing clearance.

Wrote letter to Mr. Gaines from Letter of the 3rd inst in the morning.

Spent the rest of the day trying to investigate

1. Residual magnetism.
2. Vibration of the poles etc. [illegible]
3. Unbalance of the rotor.

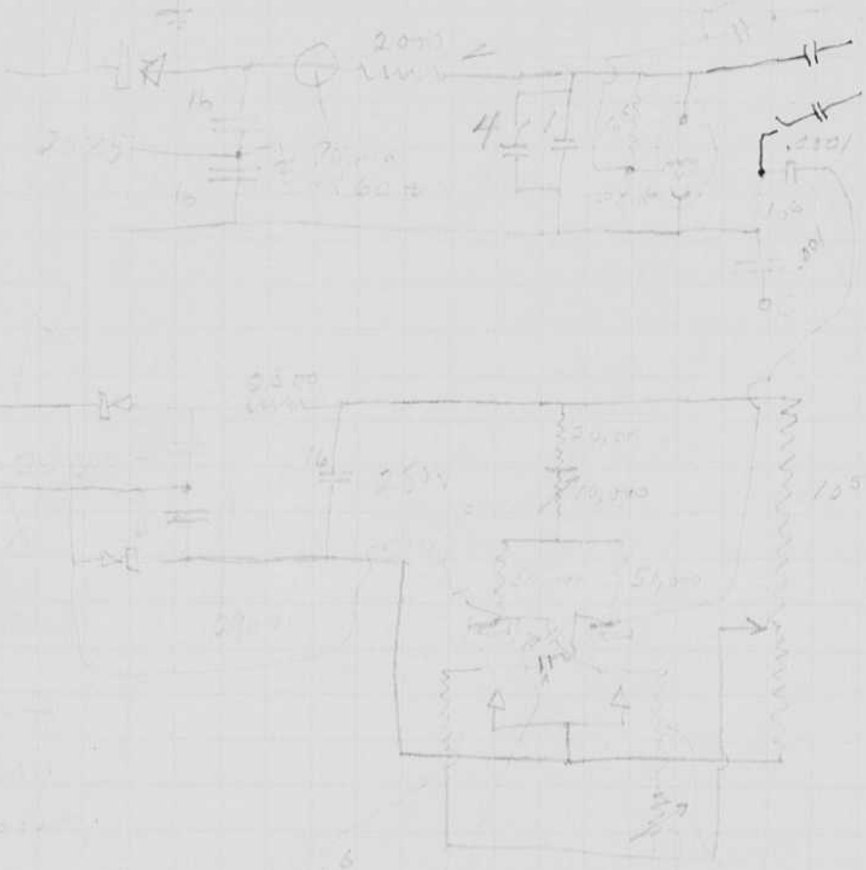
15 sheets

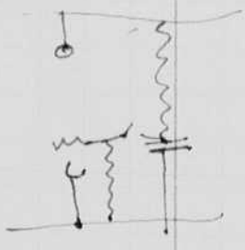
Model 5 1936

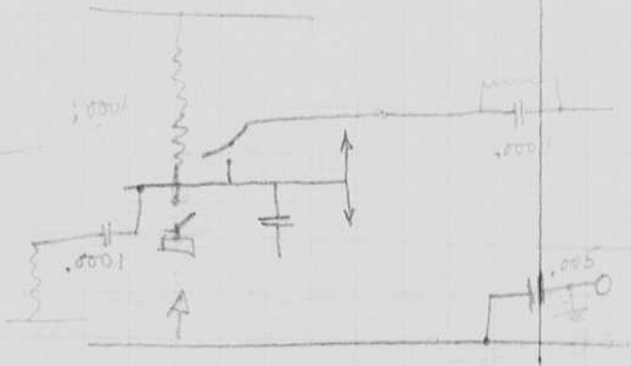
RF Section

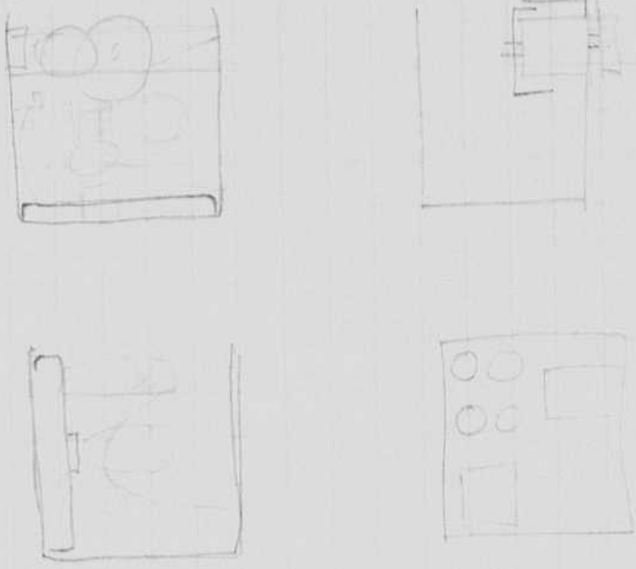
Components with Starlator without audio power. See page 114 and 34

Revised circuit, input, has been constructed by [illegible] Sheets 28 & 1



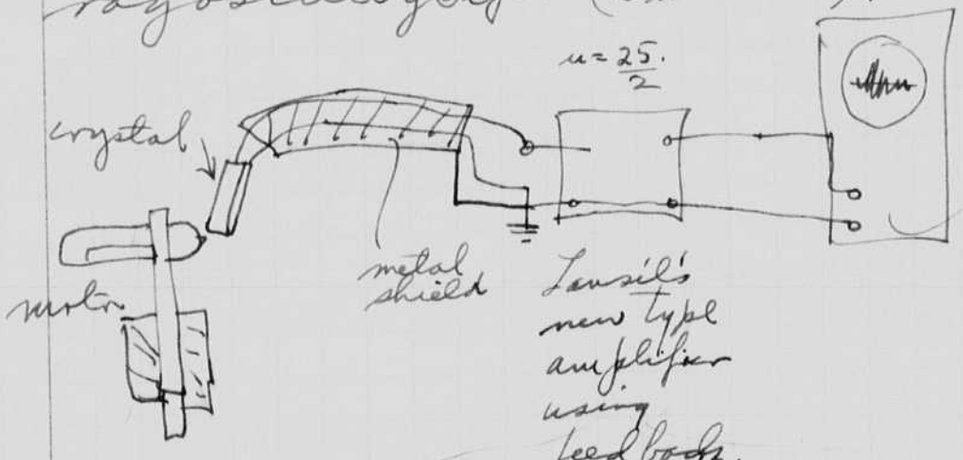




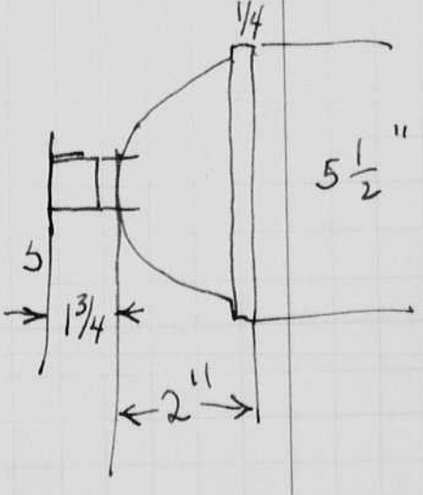


March 6 1936

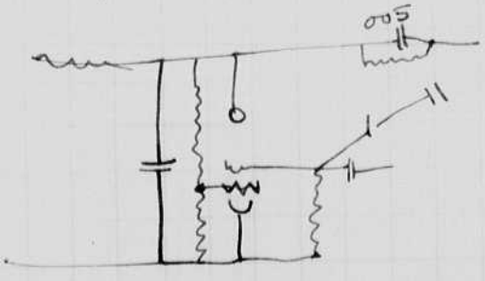
Last night I worked with Brier on the three small synchronous motors of the Waltham watch Co. A Rochelle salt crystal was used to pick up the noise and it was then put into the cathode ray oscillograph (Dumont).



Dumont 5" C.R.
either 1 or 2 of the amplifiers in this were used.



Cont. work in Am. on work p 22

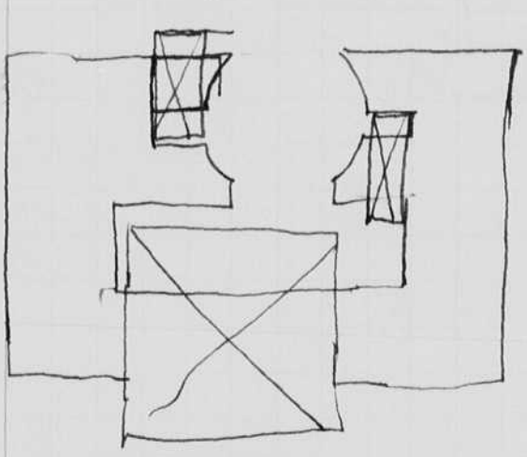


March 8, 1936

Gerneshausen, Trier and I went out to the Waltham Watch Co yesterday morning and discussed the problem further.

Observation of a noisy bearing with and oil with a stroboscope shows that there are 14 vibrations per revolution. This means that the teeth are in position for each pull of the a.c. magnetizing force. The clock motor will start and run on 70 volts which means that a lower flux density could be employed with however lower starting and synchronizing characteristics. The best way would be to increase the air gap.

The bearing assembly must be made stronger and easier to take up.



Mr. Schoen
" Balzer
" Fink

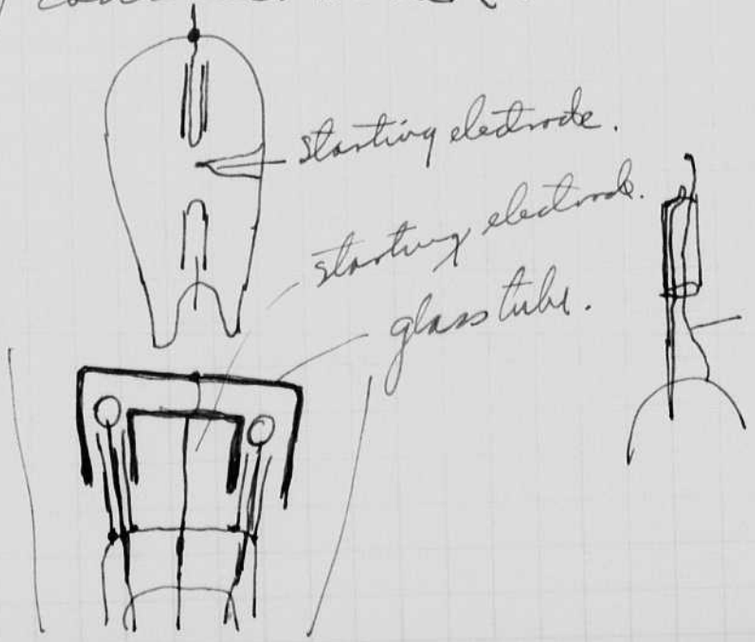
Boucher Works Manager.

March 15, 1936.

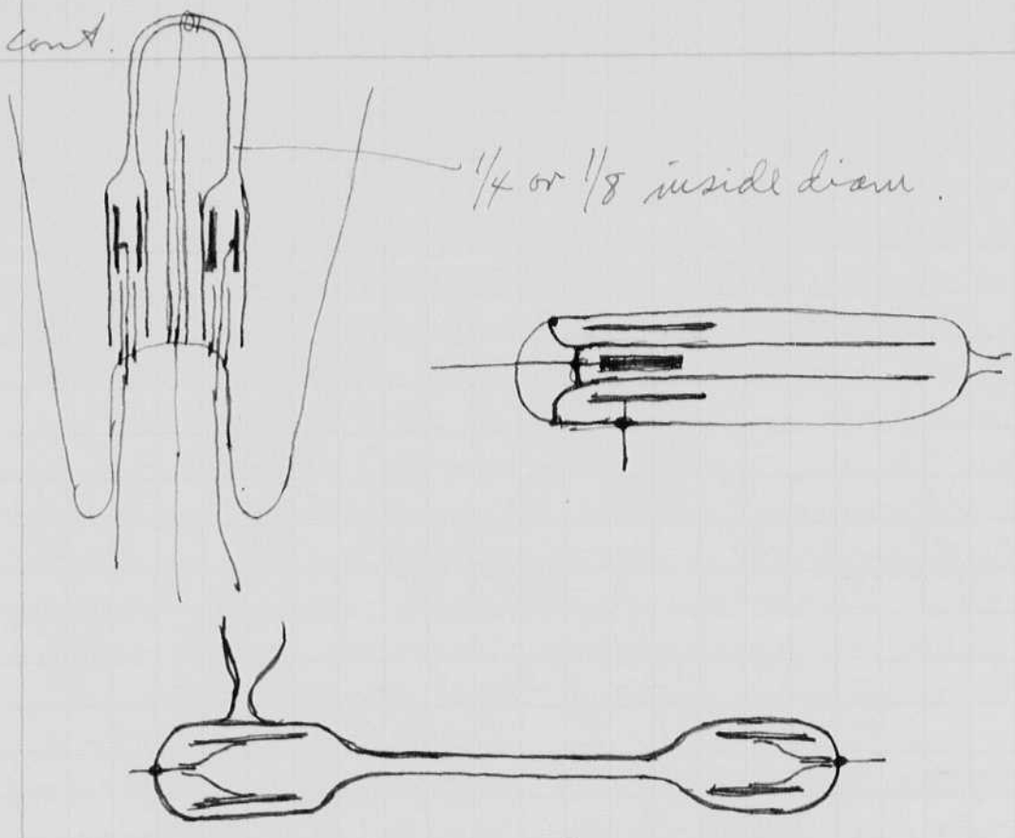
took the "Colonial" NY NH and Hartford RR to Newyork on March 12, changed to 3:15 train to Princeton and gave a lecture there that night in the Chemistry Hall at ~~10~~ 8 pm. Prof. Willis was there Dr. Harvey also. Mr. Vivelle(?) who is an instructor under Willis helped me repair a motor and set up my experiments. Prof Taylor introduced me. I saw Harnwell who is an old friend of Ralph Bennett. Mary Ellen came and after the talk ~~went~~ took me to Summit with her. A miss Kaufmann came with her.

the next morning I took a 9:27 train on the Central N. J. to Bethlehem. Pa and spent the day with Mr. Deppe discussing high speed photography and seeing some of their plant. Returned to New York that night and took the sleeper to Boston.

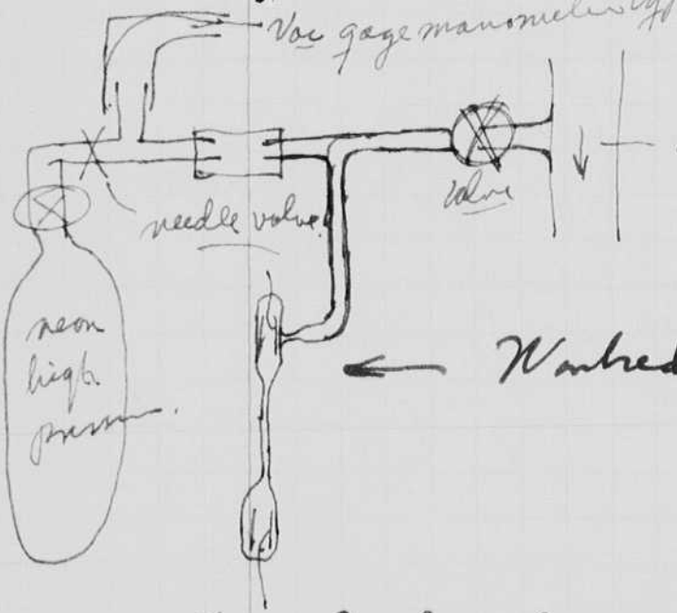
Yesterday I worked some more on the high pressure neon lamp experiment. #10 Two tubes were built but one cracked at the seal. Large bulb with cylindrical oxidized Black nickle electrodes with an iron wire tips coming through the equator. other layouts which might be worthy of consideration.



cont.



Vac gage manometer type for high pressures.



← Worked on this Wednesday afternoon

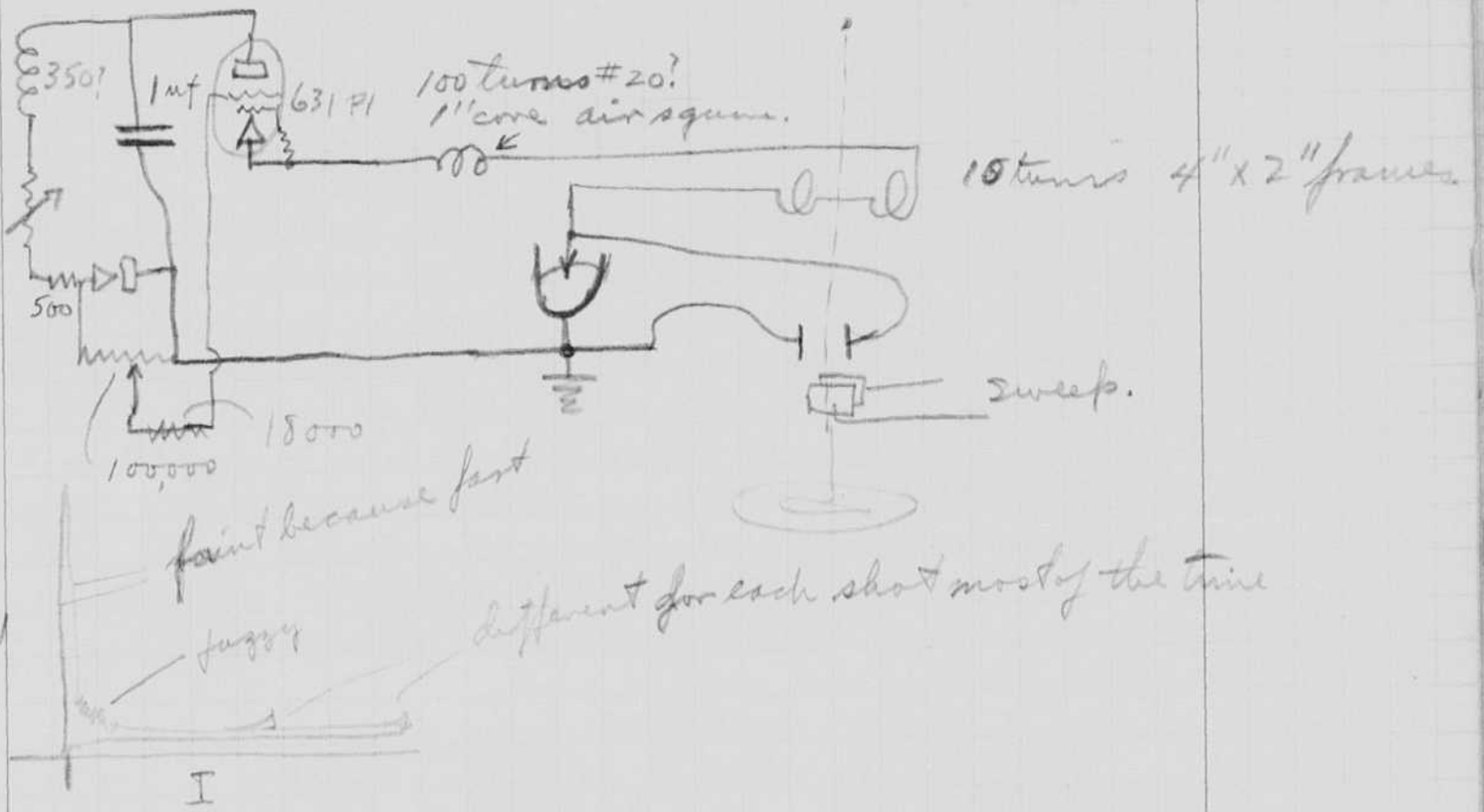
Thursday March 19, 1936.

Worked with Irie taking spark photos of 22 long rifle bullet through al. Bakelite and Iron. 3 ref 1600 open spark. f 4.5 f 5.6 1:1

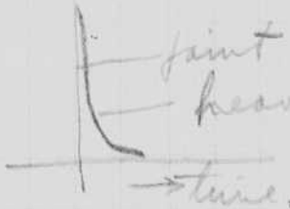
MG.

March 1936 evening.
H. E. Edgerton. Ignitron study.

A G.E. FP54 cathode ray tube was wired up as shown below in order to observe the volt-drop and volt time curves of an ignitron. Westinghouse KU 637. XL 99009.

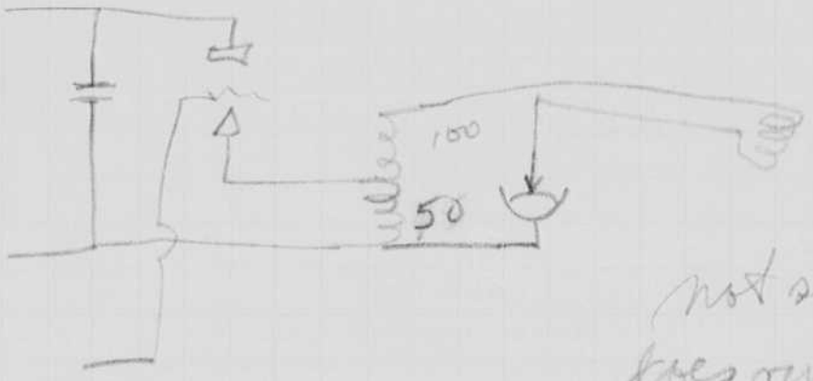


Under some conditions a spot is not formed in the ignitron and also ~~the~~ spot does not form in the strobotron. The volt drop curve is then vertical and the current is very low. a sweep shows the following.



sweep faster shows

this jog in the voltage corresponds to a change in drop in the strobotron. In some cases an arc forms here but is inconsistent and jumpy.

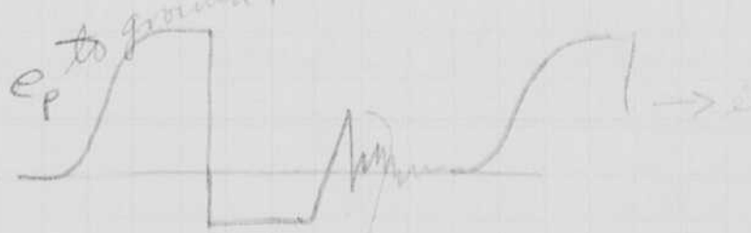


not so hot but it does run.

Changed back to circuit on previous page.

Disconnected 100,000 potentiometer. but tube 631P1 did not start at all

The .1 & 1/2 meg in series with 100000. These last two also increase the potential on the capacitor. The outfit runs 30 cycles with this connection. Cathode keep shows following

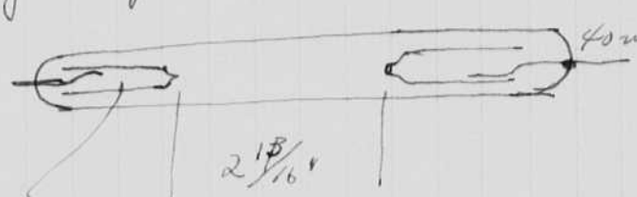


It strikes fires before the condenser is charged.

March 22 1930
H. E. Edgerton.

Worked yesterday off again on the vacuum system in Room 10-107 and had trouble with leaks in the valves and in the hoses. I made a tube of the following design

No 11



The pressure of neon put in this tube was

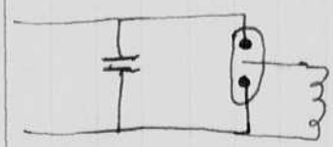
Zero of mm. on scale = 83.8 cm
press = 58.8 cm
Pressure in tube = 25.0 cm x 2 = 50 cm

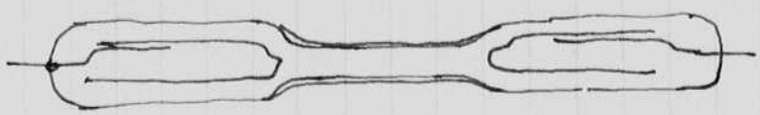
a voltage of about 1400 will discharge across this tube using a sparker on the glass to trigger it. The action however is not sure as it misses occasionally. Always try:

1. Put internal electrode through glass.

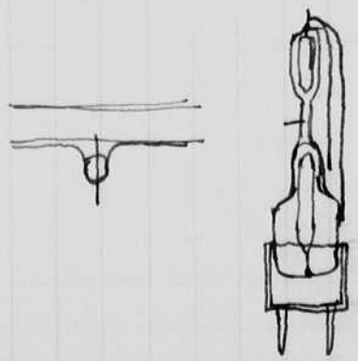
2. Decrease gap or decrease pressure so that a lower flash voltage can be used.

A 2 Mf condenser discharge 1400. fills about 1/2 of the tube. Use a smaller tube for next exp.

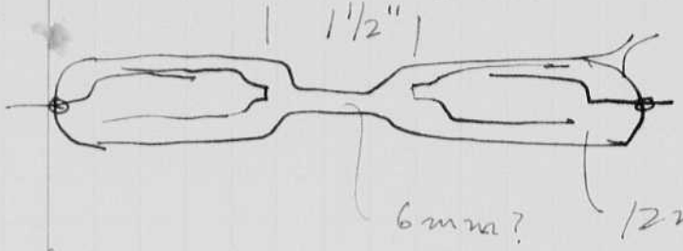




make 1 1/2" for next tube.



Tube 12 0 — 83.8 cm
35.0 cm neon gas.



Pyrex tubing

1000 volts 2 ma. Works ok at the above pressure, I tried to seal it off but the tubing blew out! due to the pressure.

I retubulated the tube with thicker glass which I plan to punch off when the glass gets hot. One anode fell off so I took it out and just let the tungsten seal project into the tube.

Pumped (leaky seal fixed).

Pressure neon about (1 cm vac), 1 atmosphere.
voltage 80 prim (110-1000 volt transformer.

$\frac{80}{110} \times 1000\sqrt{2}$ = breakdown voltage.

Arc fills about 1/2 of tube on side that sparker is on.

Light is very bright red.

Will work as low as about 40 volts on primary of trans.

Glow spots sometimes are present on cathode without breakdown. appear as red patches 1/8 of an inch across ±

The cathode spot cleans off the oxide from the iron but does not seem to sputter for a short run. This sputtering will be made with a longer run.

After running a minute or so the color now looks whiter, possibly due to gas from glass and electrodes.

Pressure increased to atmos + 23. cm.

Breakdown now 90 on variac. $90 \frac{1000}{110} \sqrt{2} = V_b$

Control ok at 50 volts with sparker.

Pressure decreased to 37 cm vac.
Breakdown 72 volts.
tendency to hold into glow discharge at 35 volts.

Gas all pumped out of tube.

Neon put in at 1 atmos + 11 cm.
Breakdown about 125 volts.
controls ok at 60 volts.

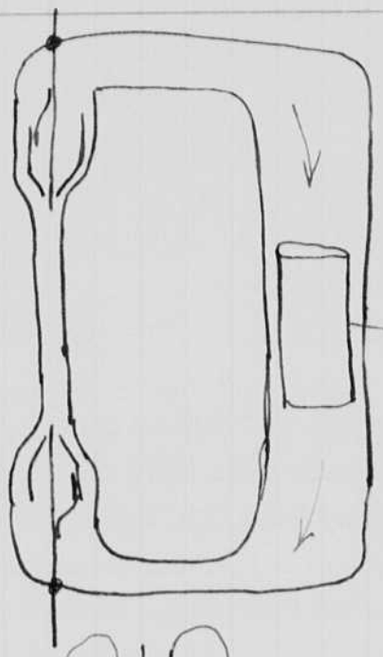
Works ok at pressures greater than I can read on manometer!!

Tried to seal off at 1 atm + 13+ cm but was unsuccessful.

tube #3. about the same as 2 with 4 cm between electrodes but with 3 mm for arc path. One large dumet electrode and one wire 40 mil tungsten
Sealed off with 1 atmos + 20 cm of neon.
Flushed once and run for several seconds at high voltage.

A capillary tube was used as a tubulation and was cut off while hot with pliers. Pinched first for a 1/2" of length and then melted in the center.

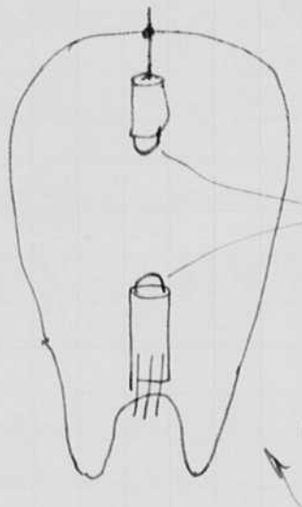
Get too hot! with 2 mf 1000+ volts at 60 ~.



Will there be a flow of gas around a tube like this if the arc discharge is present.?

radiator to take heat from gas.

Tube #14



Iron wire about #14.

Baling wire for waste paper.

March 25. 1936

OES.

Last night I worked in 10-107 on the high-pressure neon lamps. Brier Ballock and Abbott came to see the one that I made in the afternoon operate. I had 1 micro farad 1400 volts and 60 flashes a second. The electrodes were spaced about 1 inch and ~~it was~~ located in a large Radio tape bulb (#250 size). The pressure was equal to 3 cm below atmospheric. A surprisingly small amount of voltage is required to kick off the ~~arc~~ gap. I used a standard spark coil driven by a thyratron and I

could cut the amplitude down to a small value with satisfactory operation. a values of voltage from about 600-1000 ± there was a noticeable time lag between the spark and the flash.

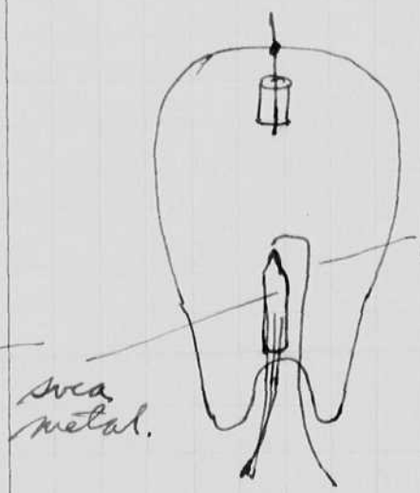
The arc is quite bright and appears as a concentrated column between the electrodes.

Today I ran the tube about ½ hour and it darkened the bulb appreciably. the electrodes are iron wire with oxidized nickle radiators.

I also made four other tubes but lost 3 of them due to a faulty sealing machine. The other was put on the pump but blew up after it was run for a while with 10 cm ± atmos pressure of neon. It blew up because I put the sparker too close to the bulb. John Mulligan was there watching it when it blew up. Rosen & Reitz were in the lab and saw the tube run.

Abbott (thesis student) is going to rebuild his two stage amplifier after the tests of last night. He worked with Grier & Ballock. the amplifier picks up a sound wave as it hits a Rieo crystal and then trips a spark coil to start another spark.

#15 Blew up.



March 26, 1936.

Mr. Kennison arranged for Glenesham Greer and myself a partnership life insurance.

I built another tube like the one on the bottom of the previous page, sealed, ran in the pump and filled with neon at 3 cm vac. #16
After sealing off it was run 15 minutes and the bulb became dark. This tube had an iron area metal cathode and a nickle wire anode.

After supper I built a tube with aluminum anode and cathode 3/4" x 1/2". It is now on the pump and will be tested shortly. #16
Yesterday I looked at the setup of Mr. Hayward in the research laboratory where he is endeavoring to measure the current from the anode of a fly stroboscope lamp.

The spacing of the electrodes was about 30% more than the previous tube 1 3/4" approx. The voltage of 130 on the variac was not quite enough to make certain starting. However it kept on flashing at a rate that was intermittent like a geiger-muller counter.

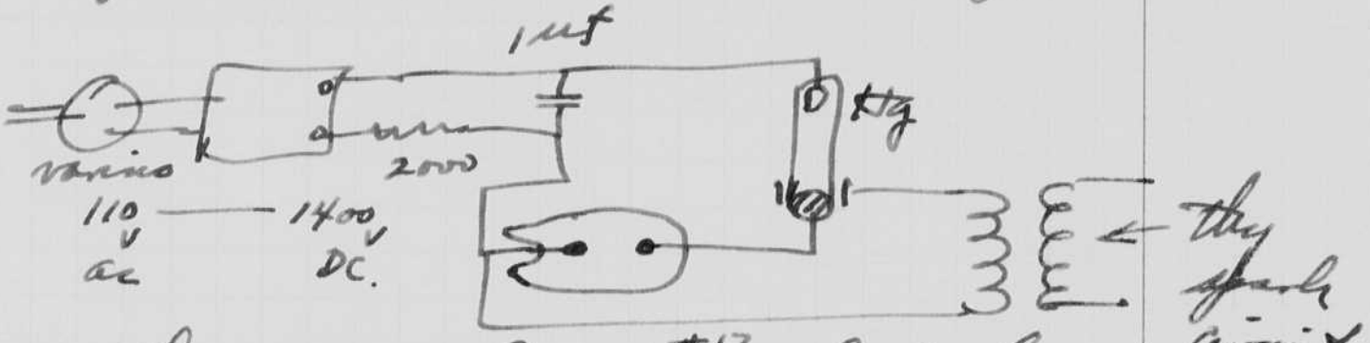
Sealed off this tube with about a 2 or 3 cm vacuum in it, that is nearly atmospheric pressure.

I changed from neon to argon and put on a tube with an iron cathode and a nickle wire anode like the one I made yesterday bottom page 133. This tube will not start with high pressure 5 or 10 cm to #17

76 (atmos) cm of argon with 2000 volts across it and a sparker for excitation. With a pressure of about 4 cm it will start but tend to hold into a glow with 2000 ohms in series 1 mf condenser.

Sealed off with a pressure of 74 or 75 cm of argon.

A neon control lamp was brought in and connected as follows



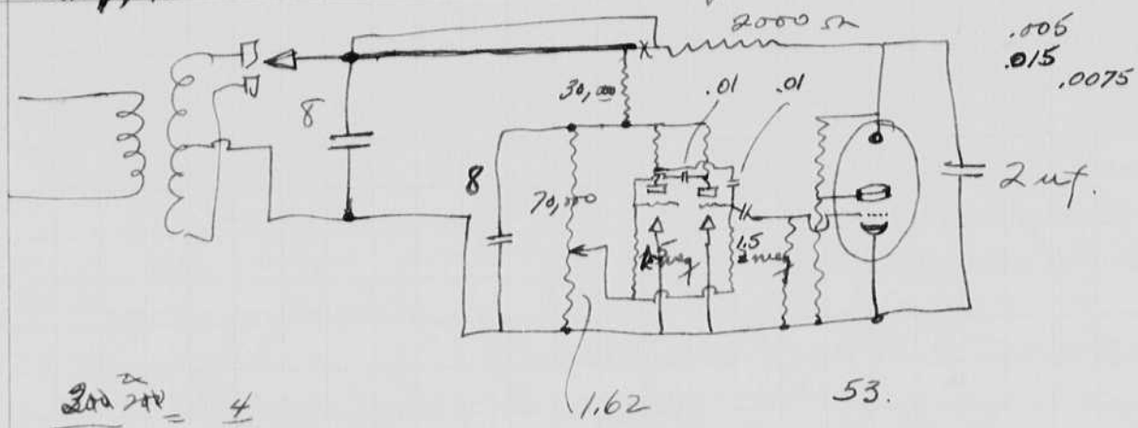
The argon lamp #17 worked fine in this circuit with voltage as low 70? on the input.

The neon lamp with the Al electrodes did not work except at 130 volts and then not regularly. The light from the argon was very blue and about as bright for the same voltage.

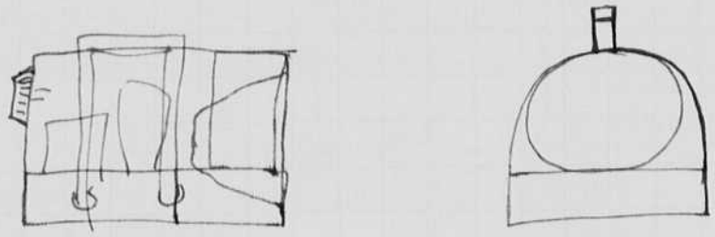
Tube no 13 (neon capillary 3 mm) was tried and it worked fine. Very bright and steady. Trailer very short! The lamp did get hot but continued to run. Abbott saw this in operation.

Repeated experiment with the argon atmosphere tube #17 and it worked for several minutes until the seal at the top let go. This was because the plate was too close the glass.

March 27, 1936. Small stroboscope



$\frac{200}{70,000} = \frac{4}{7}$



70,000. 1.62

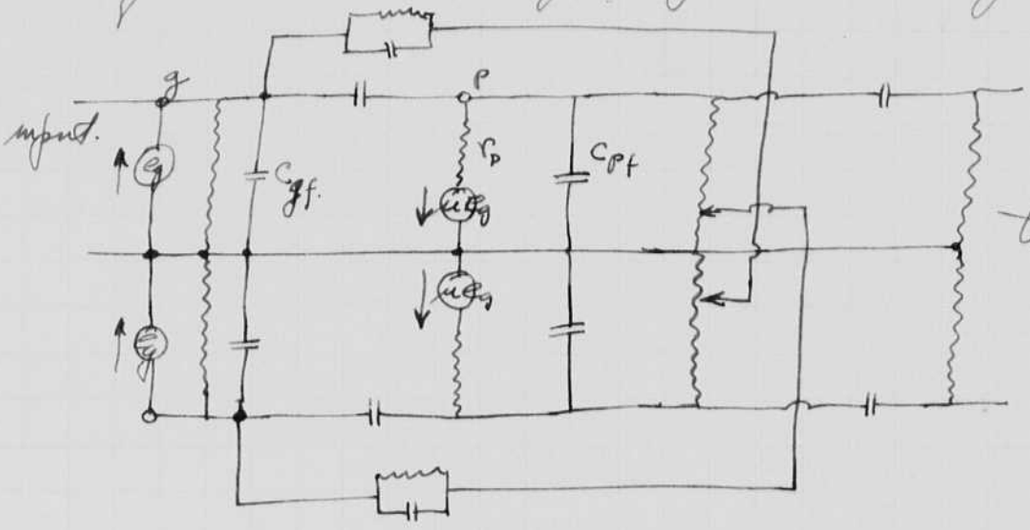
March 28. Last night I made two neon tubes
#18 had al electrodes with about 1/4" spacing.
#19 " "

#18 was run on the pump with neon an argon mixture. Seal broke after it was sealed off.
#19. Sealed off with 1 atmos (2 or 3 cm) of argon.

March 31, 1936. Germeshausen and ~~Grier~~ left last night for Buffalo to take some pictures in the Lackawanna plant of the ~~Buffalo~~ Bethlehem steel Co.

Mar 31 1936 cont.

Equivalent circuit of compensated amplifier.



April 1 1936.
H. P. Eagle.

Experimented in afternoon with argon lamp also neon at high pressure. The lamp was as follows.

#18

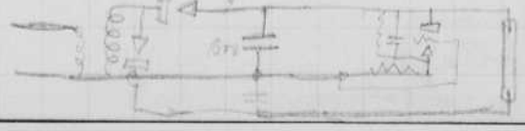
6" of 7mm Pyrex tubing

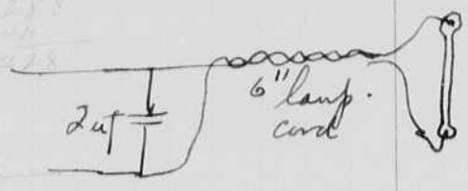
Aluminum electrodes

Best pressure seems to be about 6 cm argon for 1200 volts on power supply
120 volts a.c. variac
90 variac = 1000 volts d.c.

? When the lamp is hot running with 2 ufd at 1200 volts at 60 cycles it seems to run fine. The voltage can be pushed up to the limit of the variac with satisfactory results.

If the lamp is allowed to cool there is trouble with double firing about 1/3 of 1/60 sec after a short delay of a few seconds until it warms up.





6 ft of lamp cord in circuits today.

Showed to Geo Beatty after supper at Walton's. Both argon and neon were shown to him.

Argon last used. was pumped out about 5 minutes.

Zero press = 84.5 cm on gage manometer.

neon 75.2 cm " " " put in 90 to 105 volts ok. (fail to) arc flash back.

neon 68.0 cm manometer. requires 120 volts 2 mm (did not go all the way)

neon. 79.2 cm
35 volts ok.
60 " flash over.

argon introduced $p = 78.2$ cm manometer. light decreased but works ok to 105 volts before flash back. Starts at 70±.

Pumped out again.

neon 73.9 cm.
90 volts (no load) just starts.
105 " flash back. not running.

neon 65.6.
130 volts occasional flash.
Peculiar glow - small red spot on cathode 1/16" diam which sometimes stays put and sometimes jumps around like a cathode spot on a Hg tube.
Blue glow in tube 1/2" above cathode & the anode.
Tried again now pink glow!
Must be some argon left?

neon 70. mm
115 volt. Spark about 60 cycles.
Lamp flashes occasionally.
after a flash a puff of gas goes up the tube at a rate of about 1/4 a second for 3 inches. Below this the discharge is fuzzy. Above it is stringy. Cathode at bottom.
Continuous glow, red jumpy spots on cathode!

neon 71.8 120 volts needed but some flash backs.
" 73.0 105 starts. ok. slow test.
74.7 90 " 118 holds ok.
75.9 83 " 109 " "
75.0 95 "

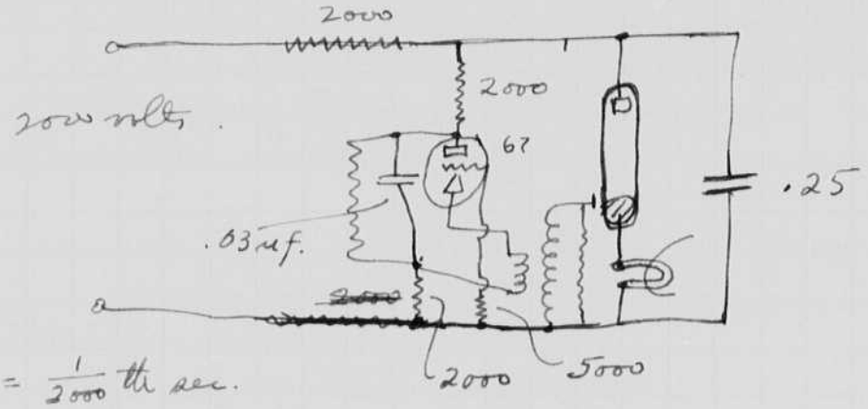
Sealed off.

then would not start!! Why?
Reversed terminals and did start at 115 volts?
Polarity now same as on pump. Cathode spot on cathode. Next tube should have hole in center and should have barium to help start spots.

Apr 2 1936 BEC

Worked on layout of strobolac with 2526 tubes and with 6C5 as ~~oscillator~~.

New Movie apparatus.



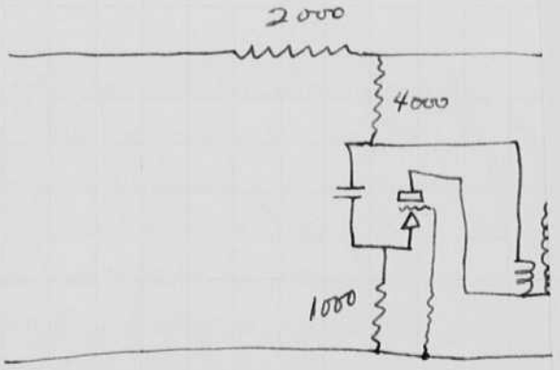
RC = $\frac{1}{2000}$ th sec.

$R = \frac{1}{2000} \times \frac{1}{.25 \times 10^{-6}} = \frac{10^6}{.500} = 2 \times 10^3 = 2000$ ohms.

1/8 = 0.125 mf.

.06 mf.

.03



Notebook # T-6

Filming and Separation Record

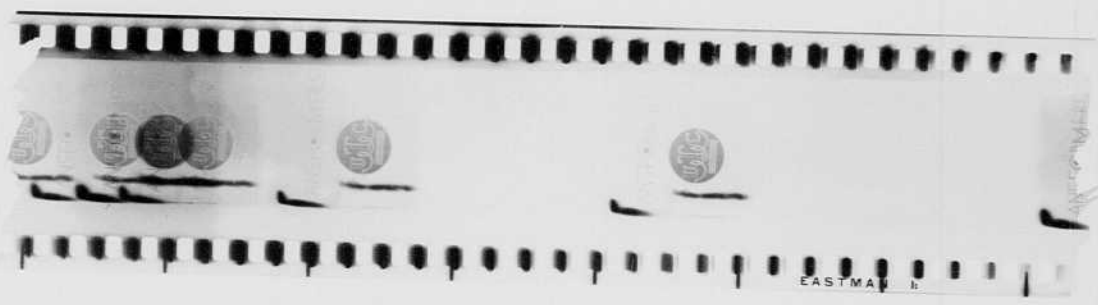
____ unmounted photograph(s)

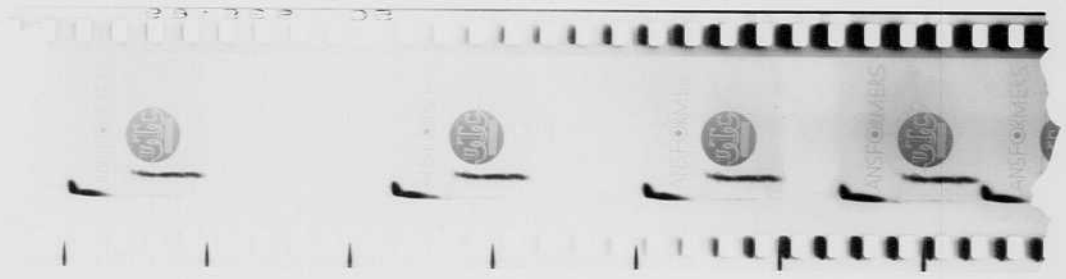
2 ? negative strip(s) inside mounted envelope Pg 140

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

was/were filmed where originally located between page 140 and 141.

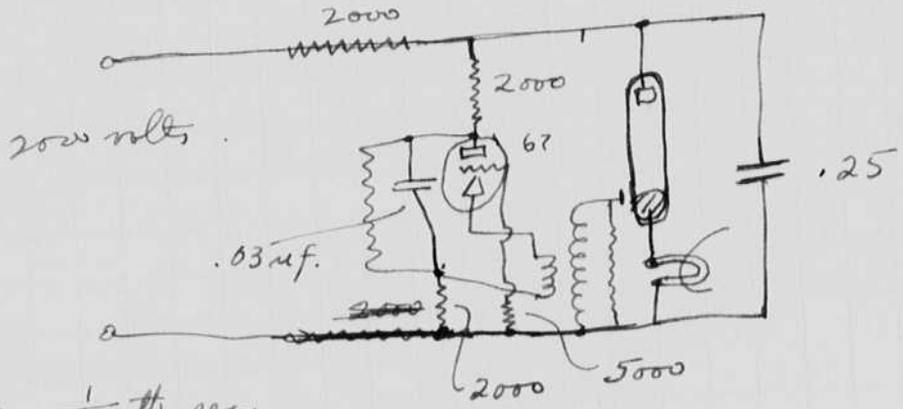
Item(s) now housed in accompanying folder.


EASTMAN



Apr 2 1936 KGH

Worked on layout of strobotac with 2526 t
and with 6C5 as ~~oscillator~~.
New Movie apparatus.

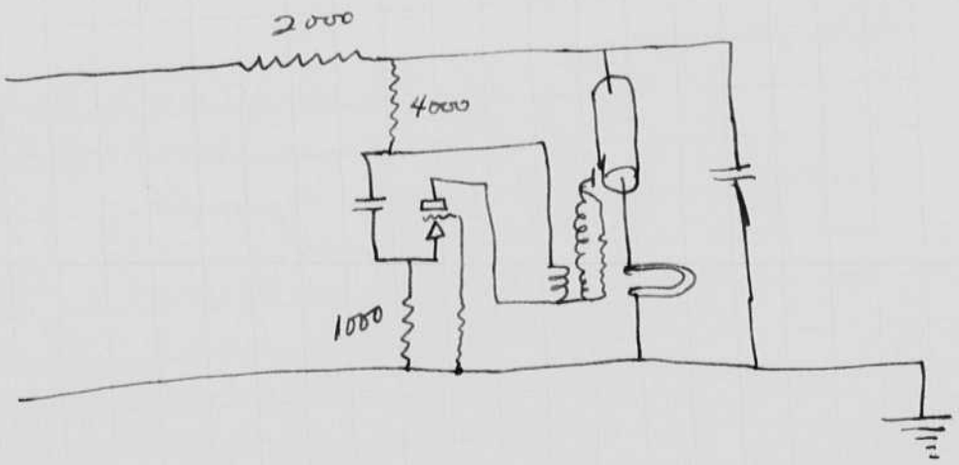


2000 volts.

$RC = \frac{1}{2000}$ th sec.

$R = \frac{1}{2000} \times \frac{1}{.25 \times 10^{-6}} = \frac{10^6}{500} = 2 \times 10^3 = 2000$ ohms.

1/8 = 0.125 mf.
.06 mf.
.03



Notebook # T-6

Filming and Separation Record

____ unmounted photograph(s)

2 ? negative strip(s) inside mounted envelope Pg 140

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

ied where originally located between page 140 and 141.

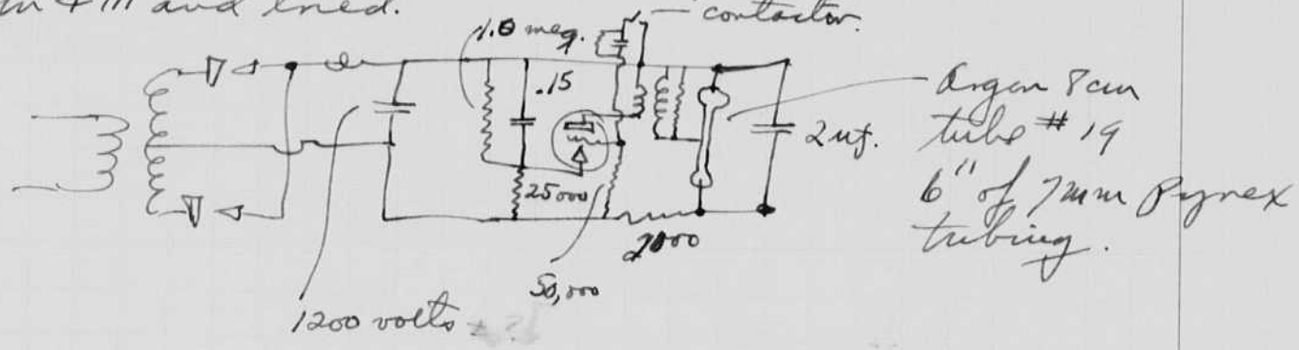
Item(s) now housed in accompanying folder.

HAROLD E. EDGERTON
KENNETH J. GERMESHAUSEN
69 MASSACHUSETTS AVENUE
CAMBRIDGE, MASSACHUSETTS

April 5 1936
H. E. Edgerton.

Yesterday I pumped another tube (#19) which was identical to #18 described on page 137 except that one of the aluminum electrodes was filled on the end with CsCl and Al filings. This was to aid the tube to start. The tube was baked out for 20 min at 400° C. Filled with argon 10 cm and run for a while then the argon was pumped out and fresh argon at 8 cm put in and the tube sealed off.

A circuit was wired up as follows in #111 and tried.

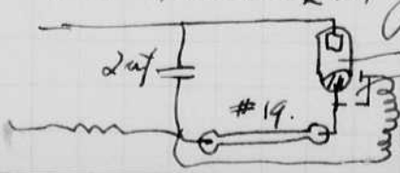


The lamp in the above circuit runs fine until the glass tube gets hot, then starts to flicker. Increasing the spark condenser helps. Apparently the glass becomes conducting and uses up the spark or voltage.

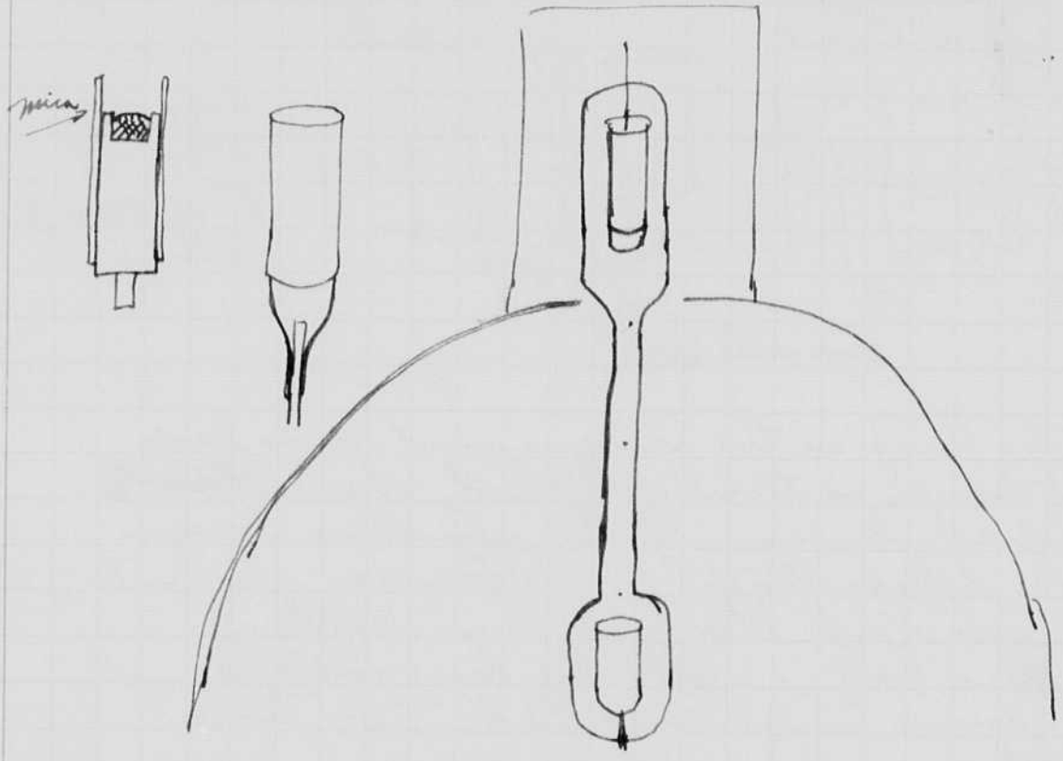
When 4 mf is used on the lamp instead of 2 it seems much more than two times brighter.

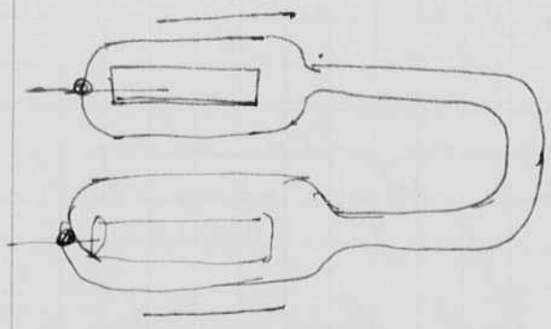
The continuously moving film camera was used to take a photo of a black U.T.C. catalog. Positive film. f 1.5. 2 mf 1200 volts. A fair exposure was obtained as shown on attached negative. There may be some uses for argon lamps for movies!

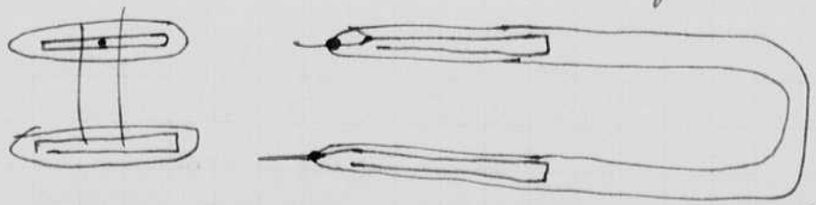
Today I ran the tube 19 again but with a regular 18" control lamp in series with it. A four foot length of lamp cord was enough to keep it from starting due to capacity. A defogger wire however made it possible to operate.



No 19 Sputtered around the cathode after ½ hour the arc did not go in the hole where the Cs_2Cl_2 was but hit the outside of the tube. New tube needed. Spec. 5" long large anode and cathode. Barium or Cs type cathode with active material close to the surface. (1/16" in the last cathode caused trouble). Possibly a mica cylinder around the cathode would help the arc to hit the right spot.







On April 11 we took a movies of the Malkin and (?) shaker with an argon tube 6" ~~cap~~ tube of 7 mm Pyrex filled with 8 cm of argon. Parabolic reflector. f 2 lens. Print ex positive on positive film. Used as background negative!

4 mf 3 kw outfit at 400 ± per sec. Reg 12" lamp for control as shown on page 141.

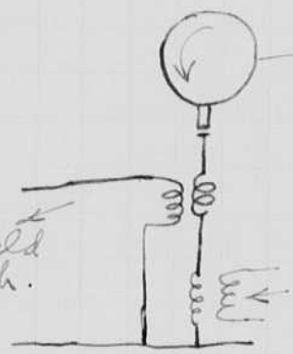
April 12 1926
H. E. Edgerton.

I spent yesterday morning with Mr. Rines discussing the synchronous motor field & relaying system

On Friday April 10. I worked with Genesham Brin Tubing mounts of the shaker slit by Balsundril of St Louis and of the Atlas pulse meter. Used High pressure Hg lamp. U tubes.

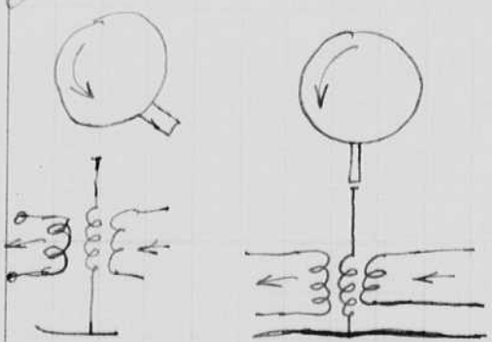
Motor Synchronizer method.

Continuation of method described on page



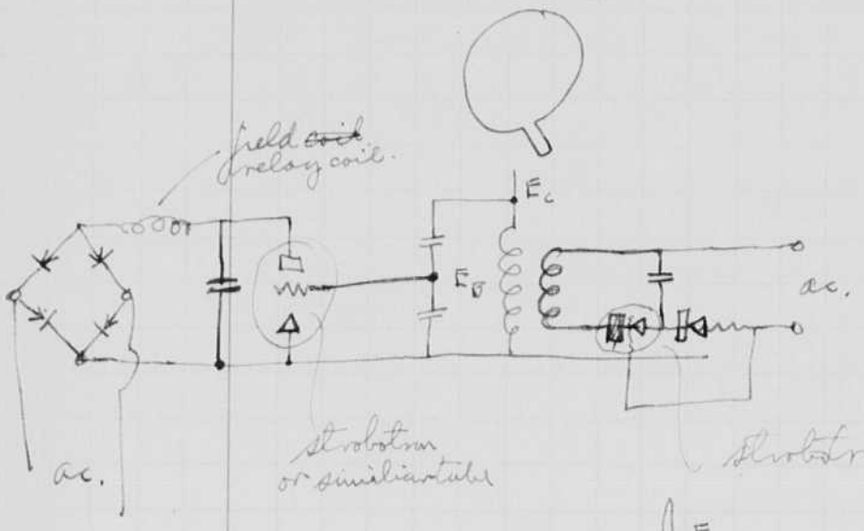
Pulse amplifier arranged to produce one flash per cycle accurately phased with respect to voltage.

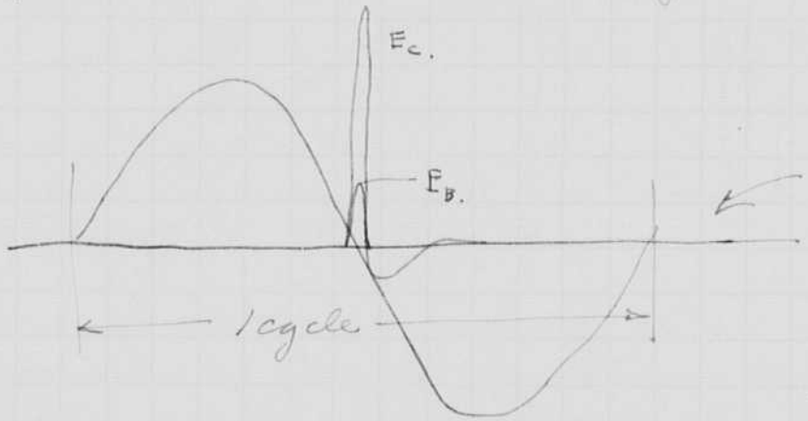
When the rotor position is at the point shown at the instant that the pulse comes through then the current due to the spark will go through the transformer and gap giving a surge in the secondary for tripping the field switch.



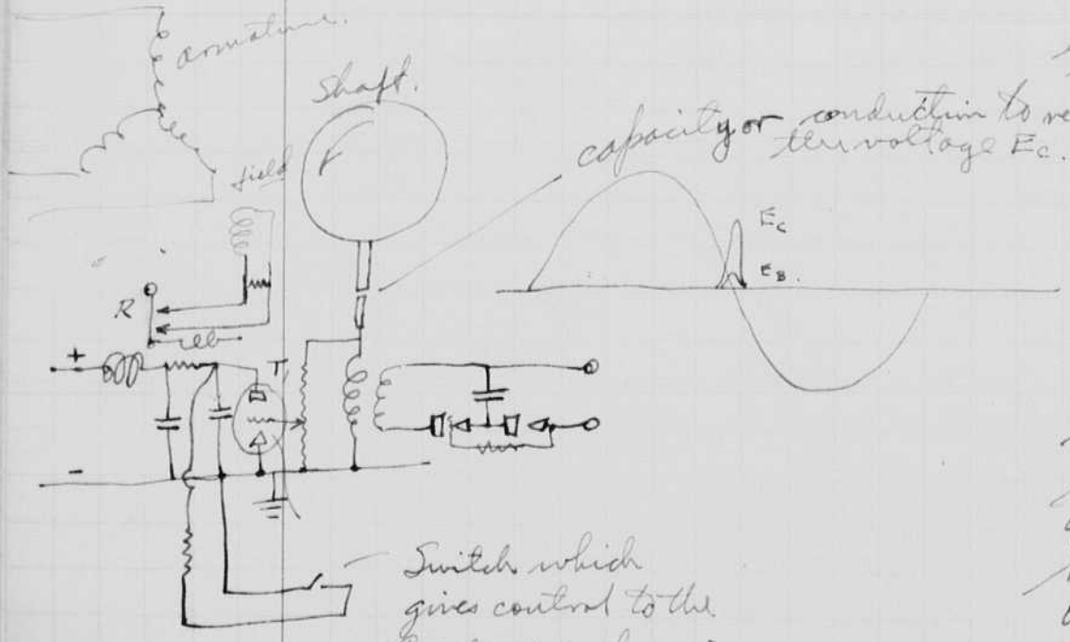
Arrange a three winding transformer as shown in the two diagrams at the left. In the left hand one ~~of the~~ the pulse comes directly through and energizes the circuit that holds open the field switch. However when the rotor is in the position of the right hand view then the secondary of the transformer is shorted and the output is reduced

thereby to such an extent that the output is insufficient to prevent the field switch from closing. It can in this way be caused to close at the correct angle





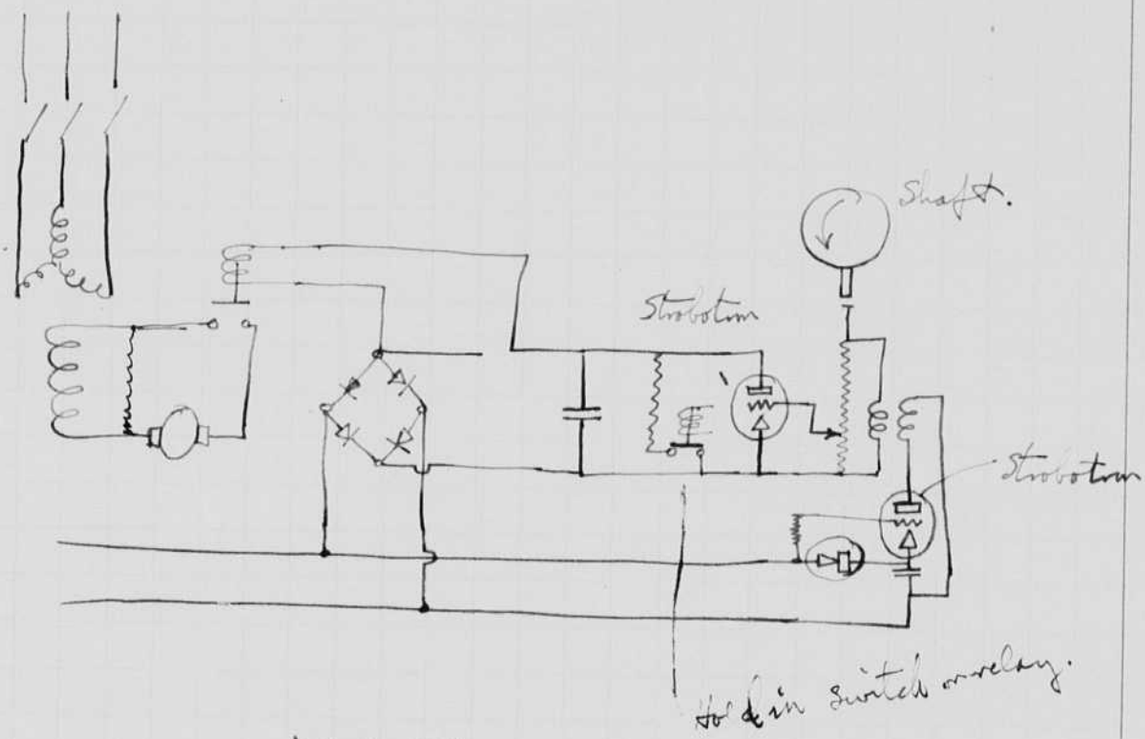
This corresponds to time when the metal segment is in the position shown above. That is not near the ~~adjustment~~ trigger potential electrode marked E_c.

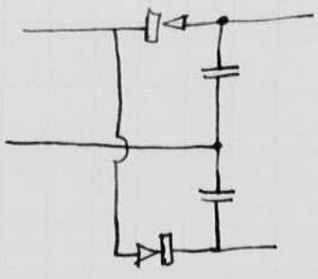


This corresponds to time when the segment is in position marked. E_B is greatly reduced and therefore T_1 does not fire. A condenser of small value may be needed around grid T_1 to keep out surges. etc.

The field switch R is held open until the tube T_1 fails

to operate which it will do only when the rotor is in the predetermined position. The circuit constants of the arrangement on the left of the previous page can be arranged to operate only after several misses have occurred. In this way the operation can be prevented while the slip becomes a certain value by arranging these constants and by changing the width of the metal index on the shaft.

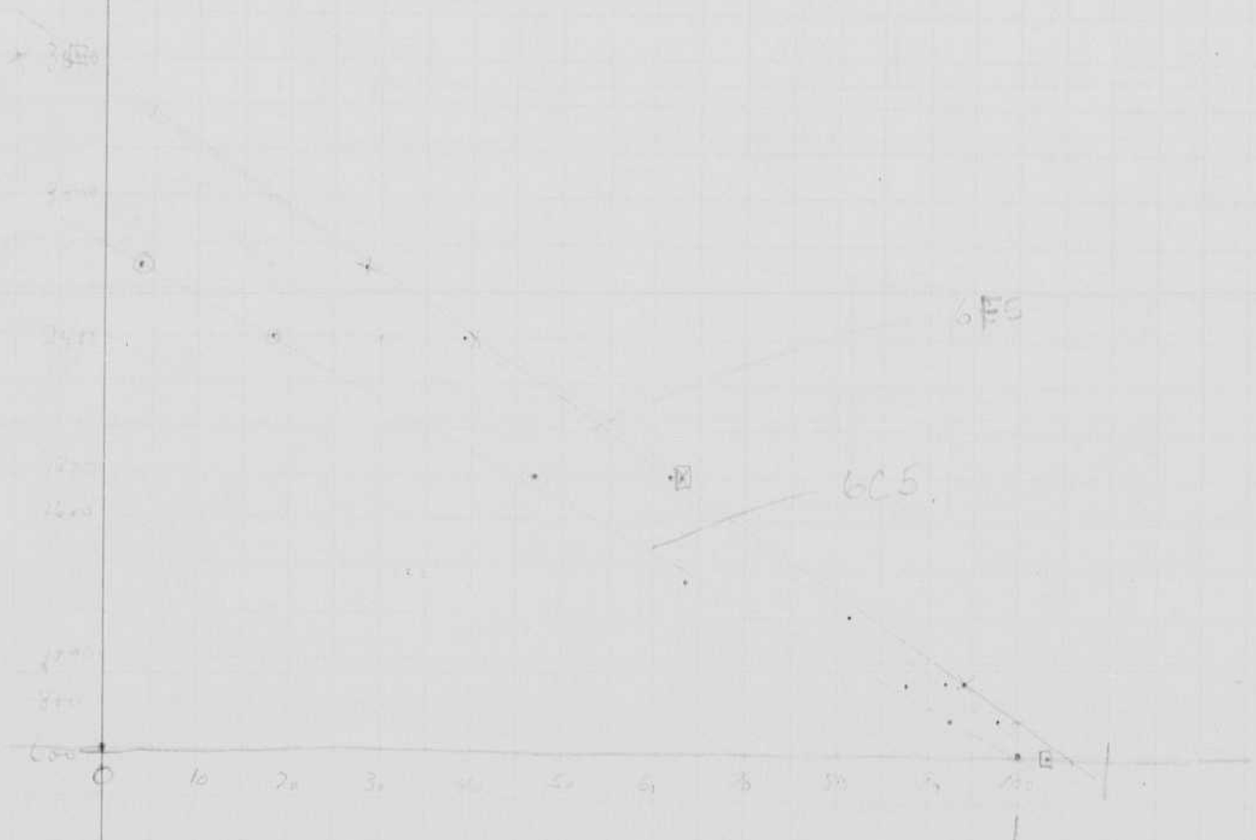




Explained
1-13-32
N. E. Sun

April 17 1936 Thu

Finished giving Stroboscope with two 6C5's as power supplies and one 6C5 for video amplifier and oscillator. Have 60 cycle sine wave output. Will have to change at low speed. Using 6F5 tube for first stage.



Apr 18 1936

C.W. Experiment. 25A6 tubes Power Sensitivity

.3 [fraction] = 50 ohms.

600 - 3000

.015 } 4 : 1
.005 }

.020 } 5 : 1
.005 }

The gain is high in the band I am not sure since the amplification is low. Screen grid and plate connected together.

1500
700 2
600 3
450 4

1.5
5
7.5
1.5
6.0

1 meg carbon in grids Calder unit

Rated end point

1.2 meg

RANGE OF VALVES covered by 25mm shunt resistor

-3 to 98 = 101 X 270° = 273 degrees

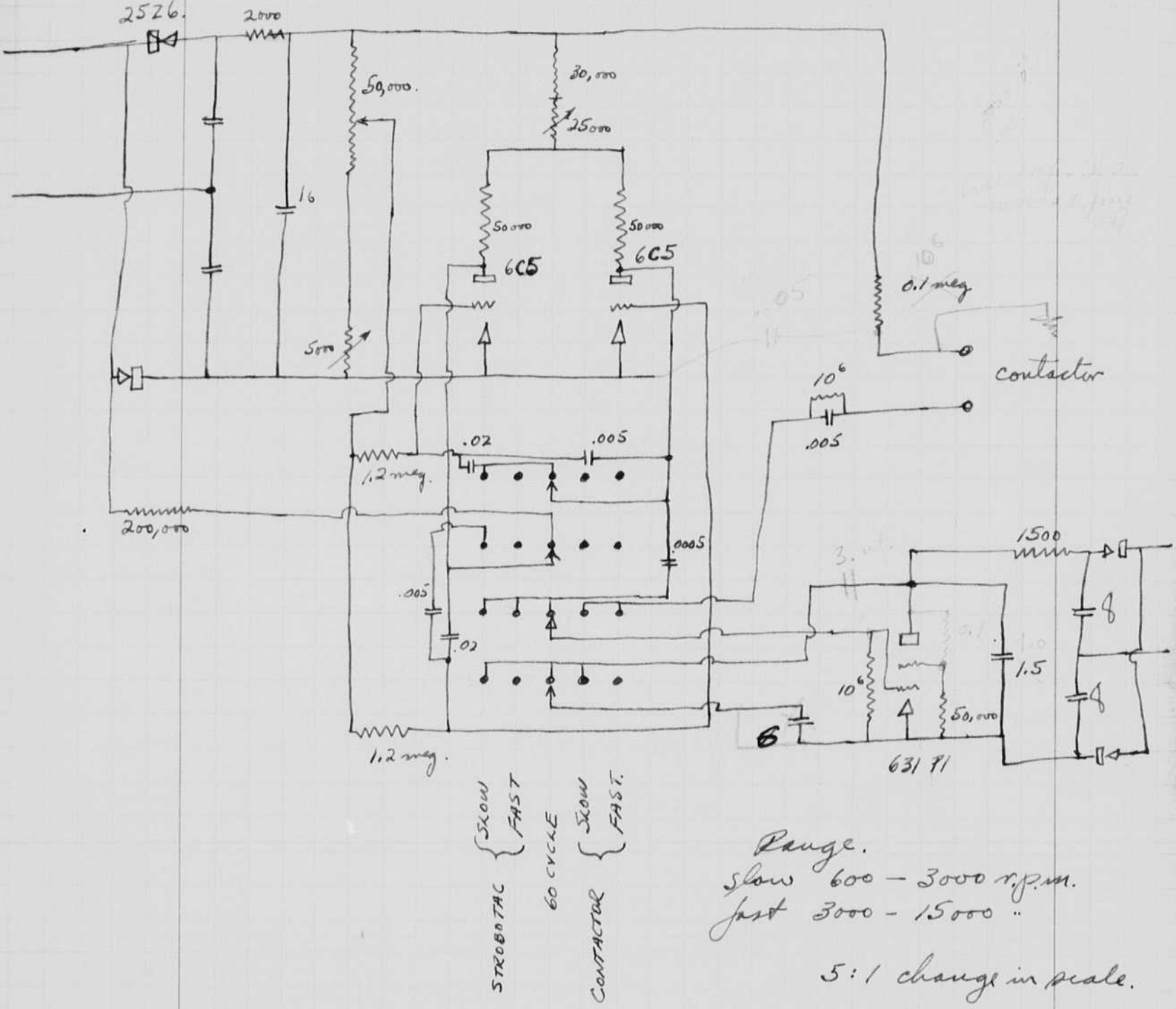
RANGE COVERED BY 50mm TRIMMER.

Integrate dash grid

-1 0 1 2 3 4 5 6 7 8 9 10

117 X 270 = 316° total spread.

April 19, 1936.
H. E. Edgerton. Stroboscopic circuit (transformerless).



Range.
Slow 600 – 3000 r.p.m.
Fast 3000 – 15000 "

5:1 change in scale.

Changes May 31 1936 HEE.
3-1 Set on transformer taps.
0.1 meg from contactor to plate

April 2036
HE. New 548 experiments.

Made argon tubes 6" Suvoy tubing 08, mm with 20 mm ends.

Baked 20 mm and Bombarded. Cs + dc fill in one end.

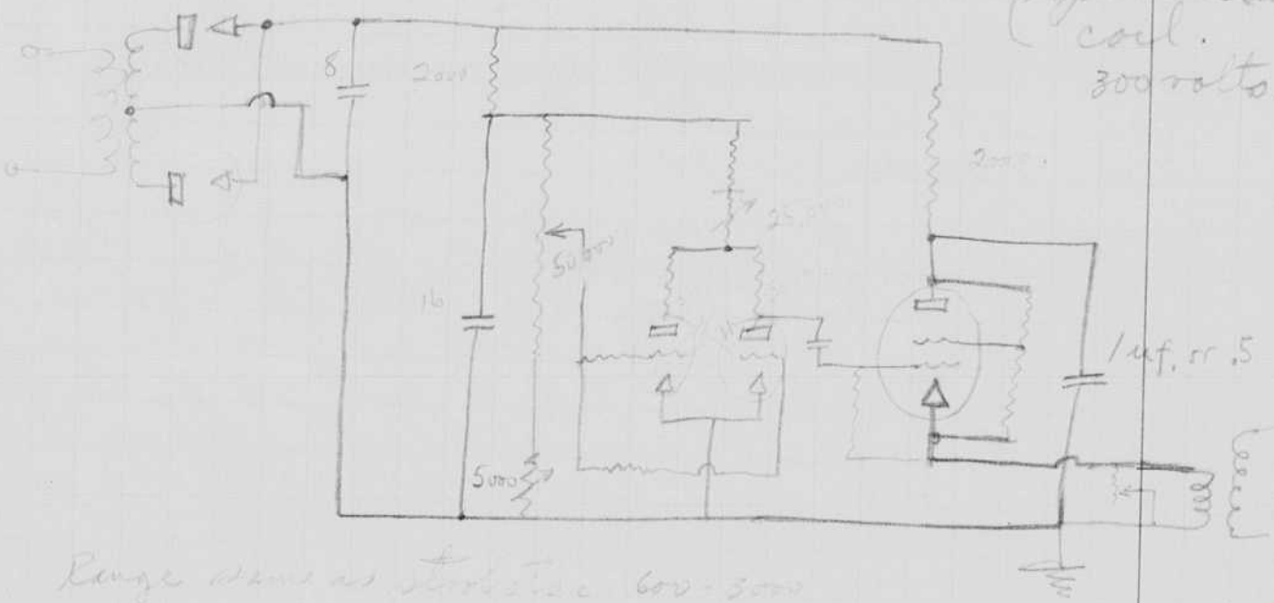
20 tube no. 20 15 cm argon.

21 " " 21 10 cm argon.

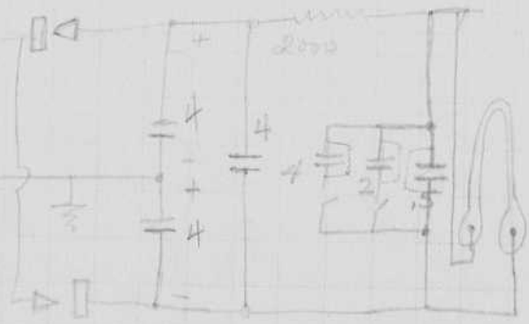
Tube 21 runs fine with 1400 volts 2 mf 4000 ohms (holdover 800 ohms). Spark needed = 1/8" which is quite small. Cs dc better used as cathode and it does keep the tube to start. 60 cycles is too much 30 oh. Misses when hot.

Tried 5 tube trans for driving external heater and it works oh.

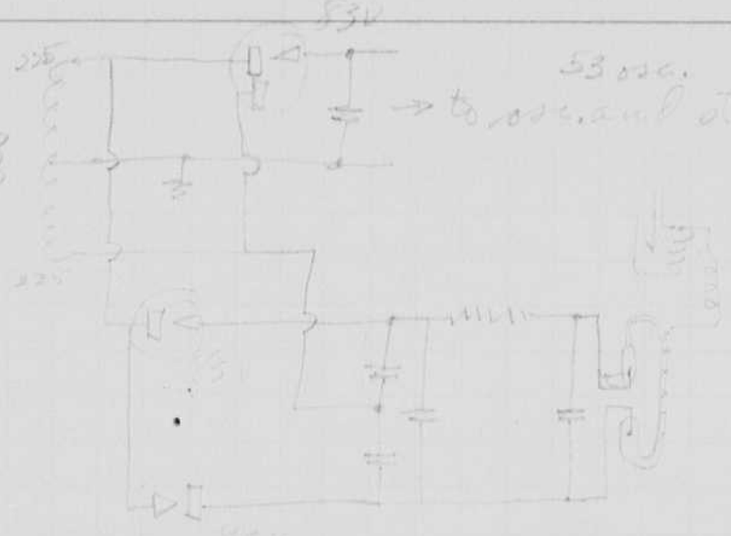
130 volts.
2 mf.
special damped coil.
300 volts.



Range same as above 600 - 3000
3000 - 15000
or how about 600 - 6000



Apr 21 36 Cont.



Apr 22 1936. H&E & H.E Brier.

freq.	H	V.	C	Power. watts.	6" 8 mm tube Argon 10 cm.
30	.105	1350	2½	140	3000 ohms in charging ckt.
15	.057	1390	"	80	
40	.135	1315	"	180	
60	.187	1310	"	250	
~~60~~	.045	1400	0.5	65	
120	.085	1385	"	115	
240.	.150	1360	"	200	

Mr Allister Brimell built two tubes #22 & 23. All powder + CSO + Hg Cl in Iron Soda metal electrodes. Tubes blew and the power and heating of the tube. I took one apart cleaned it and put on a Bal + Al filling cathode. It operated after about 6 hours running with 2 mf (part of filter 4 mf) 30 cycles 1400 V. 10 cm of argon.

On April 24 I obtained two mono tubes 24 & 25 from Mac-B. One was broken, other filled with argon 10 cm. Runs ok. Started about 1½ mf and gave spill above 230 pm. Also pumped 12 inch tube #26 for use for movie. and two 6" 20 mm Hg tubes.

A 12 mf capacitor was put across mains and given a single flash. It is quite bright. Camera arranged to photograph ~~the~~ a face f 8. (light to face 12 or 18" - camera to subject 3 ft). Verichrome. Picture ok.

Notebook # T-6

Filming and Separation Record

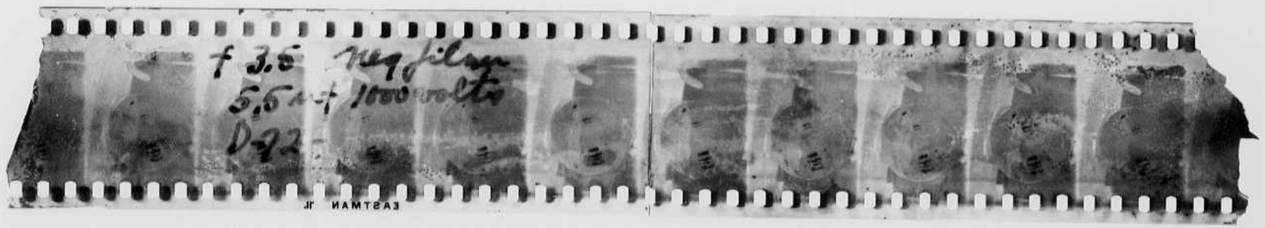
____ unmounted photograph(s)

1? ~~negative strip(s)~~ (Section of motion picture) inside mounted envelope on last page Apr. 28

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.

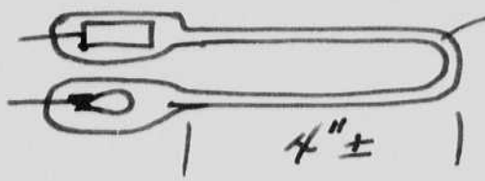

f 3.5 neg film
5.5 + 1000 volts
D-22
EASTMAN TI

P 77	Dec 20.	35.	NB 6.	Hab 3285 ⊙
93	" 28	35	"	
143	Apr 12	36	"	
	Rec			
92	Dec 21	36	NB 7.	
97	28	36	"	
98	Jan 3	37	" trip to Westinghouse.	

92. May. 14, 1931. NB S-3.

April 28.

Dick Evans in the Physics dept had two tubes made by Ryan and 2 pumped them in the afternoon.



Baked
Bombarded
and filled
with 4 cm of
argon.

Seems to work ok in their circuit.

June 2 1936 Evans returned the tube above which has run continuously since that time. Pictures taken about 30,000 per day estimate in the line counting machine.

Section of motion
picture taken April 25, 1936.
for Mr. Mallinckrodt.
6" argon lamp # 24.
200 ~~pict~~/sec 5.5 mf. 1000V.
f. 3.5 Reg negative

Thesis suggestions

1. accelerometer. development.
2. Exp. meas. of transients in induction motors starting.
3.

Thesis suggestions

1. accelerometer. development.
2. Exp. meas. of transients in induction motors starting.
3.