HAROLD E. EDGERTON

PAPERS

MC 25

SERIES 3. LABORATORY NOTEBOOKS

NUMBER: Germeshausen book 2

DATED: 4 February 1932 - 23 February 1934

Edgerton Ex. 30

Book 2

Massachusetts Institute of Technology

COMPUTATION BOOK

NAME

Course

Used from JAN 13 1940 19 , to

FEB 32 to FEB 34.

Notebook Number: Germeshausen bk. 2

Scanning and Separation Record

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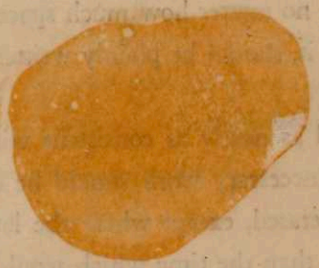
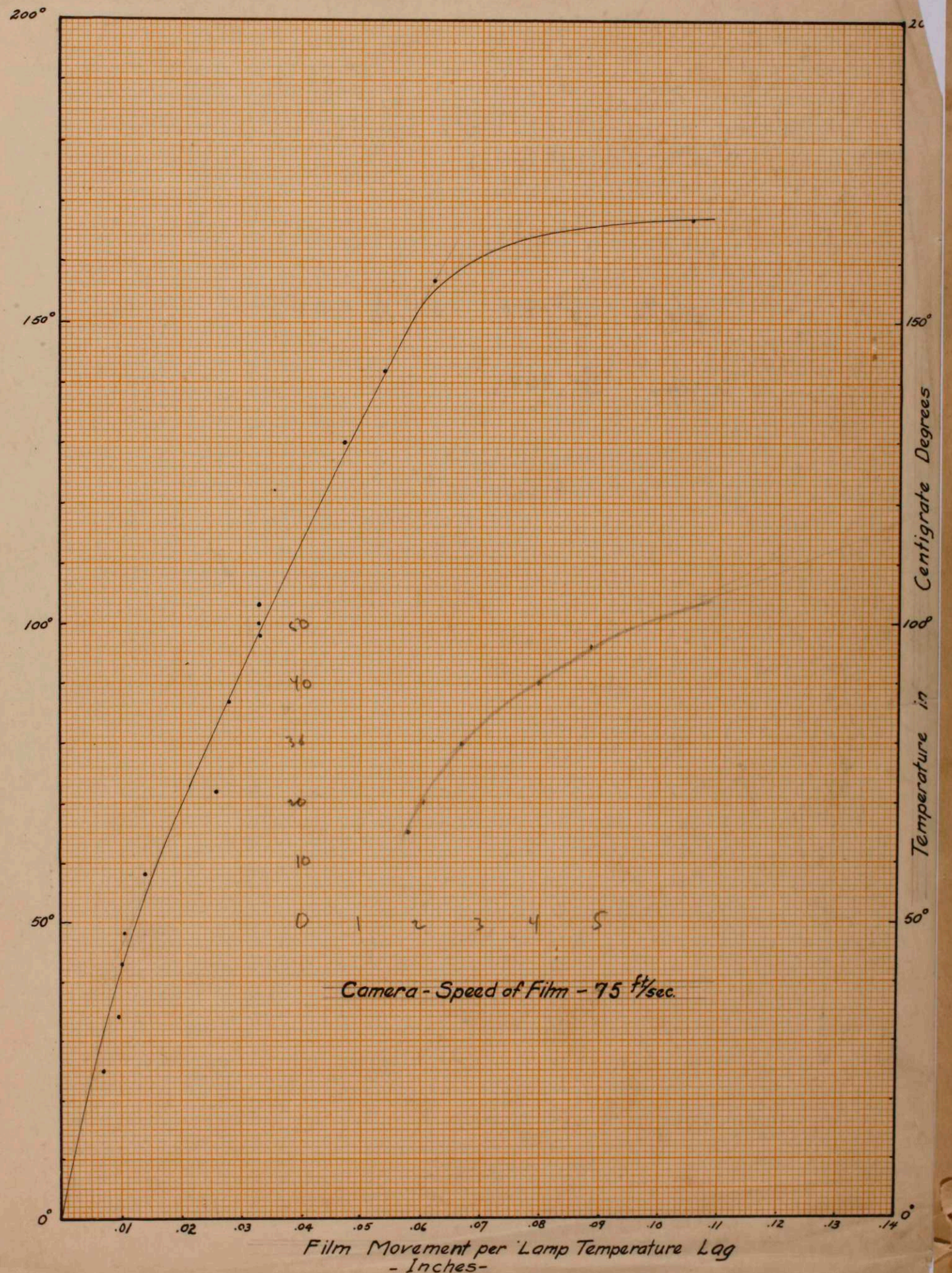


Charter members of the Luncheon club.
Oct. 28, 1932.


200°
150°
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Temperature in Centigrate Degrees
.01
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.10
.11
.12
.13
.14
Film Movement per Lamp Temperature Lag
- Inches-
Camera - Speed of Film - 75 ft/sec.
0 1 2 3 4 5

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."

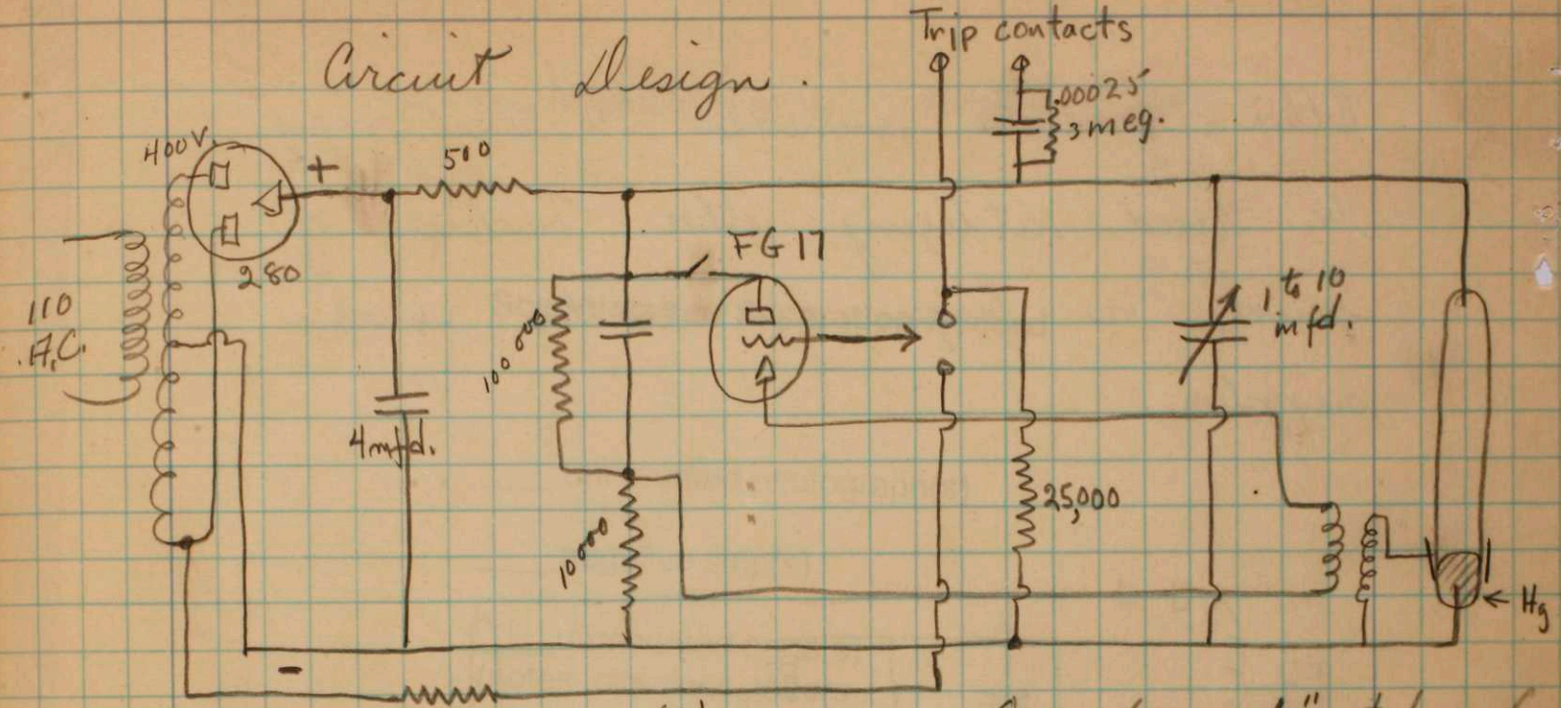
* * * * * * *"

This Book covers Stroboscope work starting February 4, 1932.
The first few pages are given over to a resumé of previous work from October 10, 1931 to February 4, 1932.

Property of Kenneth J. Germeshausen
M. I. T. Cambridge Mass.

Note. Experiment on tube types started Jan 15, 1932. Starts on page -

Circuit Design.



(1)

Operates 6" tube of
* 37 glass.

This is the conventional circuit for operation with mechanical contactors or at 60∼. With the grid connected as in fig (2) the flashes per second may be controlled with an oscillator or other source of variable frequency.

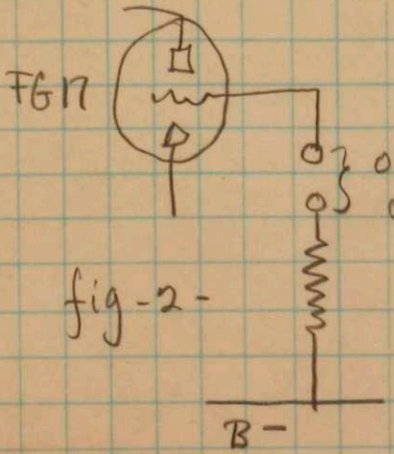
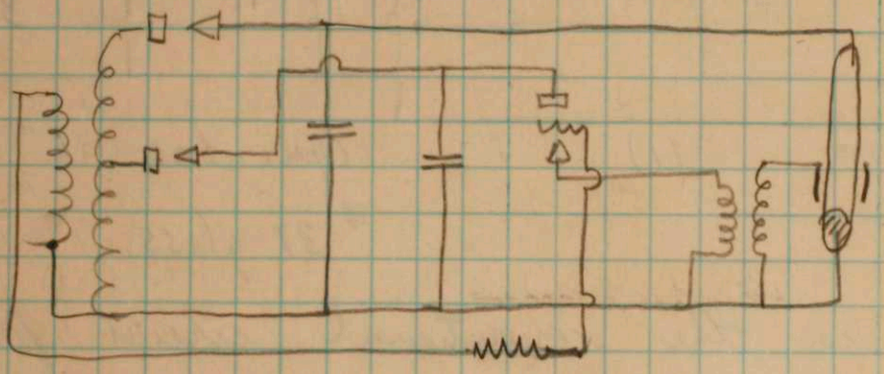


fig-2-

Other circuits similar to this may be used, utilizing other sources of power or larger or smaller power supplies.



(3)

This type of circuit is particularly suited for 60 ∿ operation.

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When it is desired to have the thyratron fire with the braking of the circuit fig 4 may be utilized

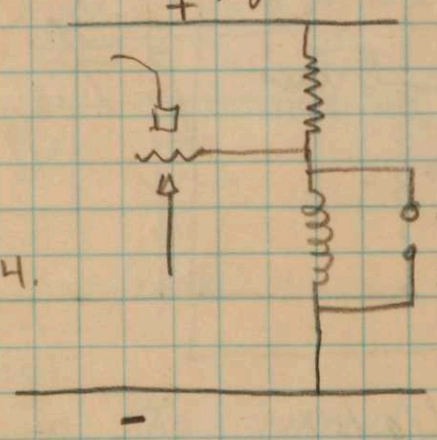


fig 4.

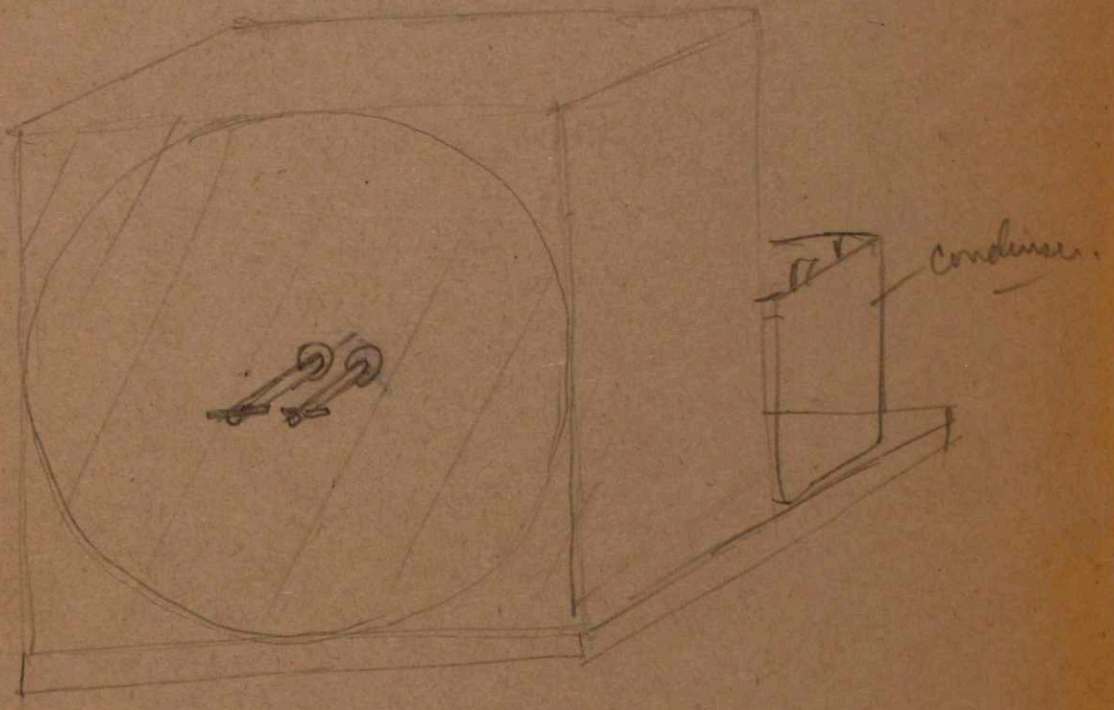
L = 250 m. h.
i = 10 m. a.

Inductances:

Though inductances in the filter circuit are more efficient it was found that they tendended to make the circuit self oscillatory hence they are avoided in most circuits.

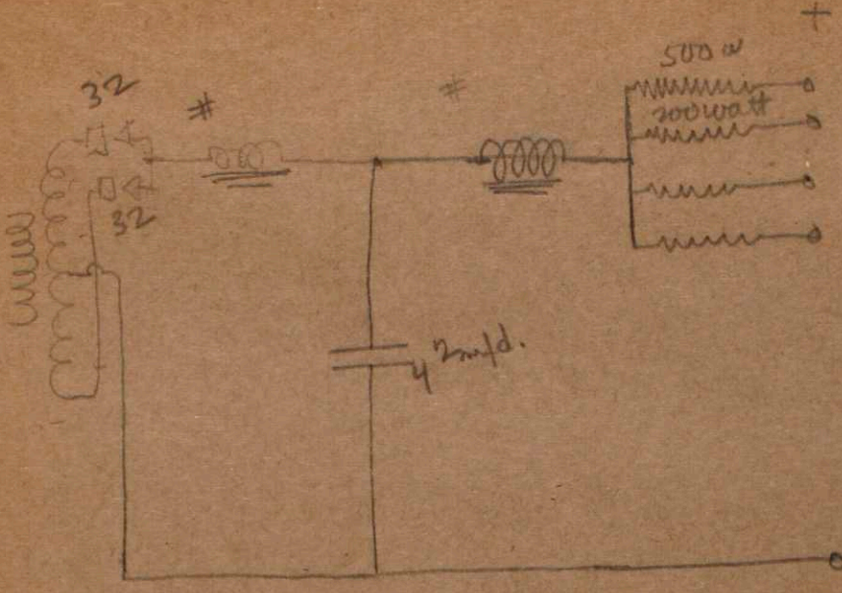
United States Patent Office
Before the Examiner of Interferences
Edgerton vs. Miller - Interference 76771
Edgerton Exhibit 30.
Page 5 of Germeshausen Notebook No. 2.
January 3, 1940 Clara Schlosky
Notary Public

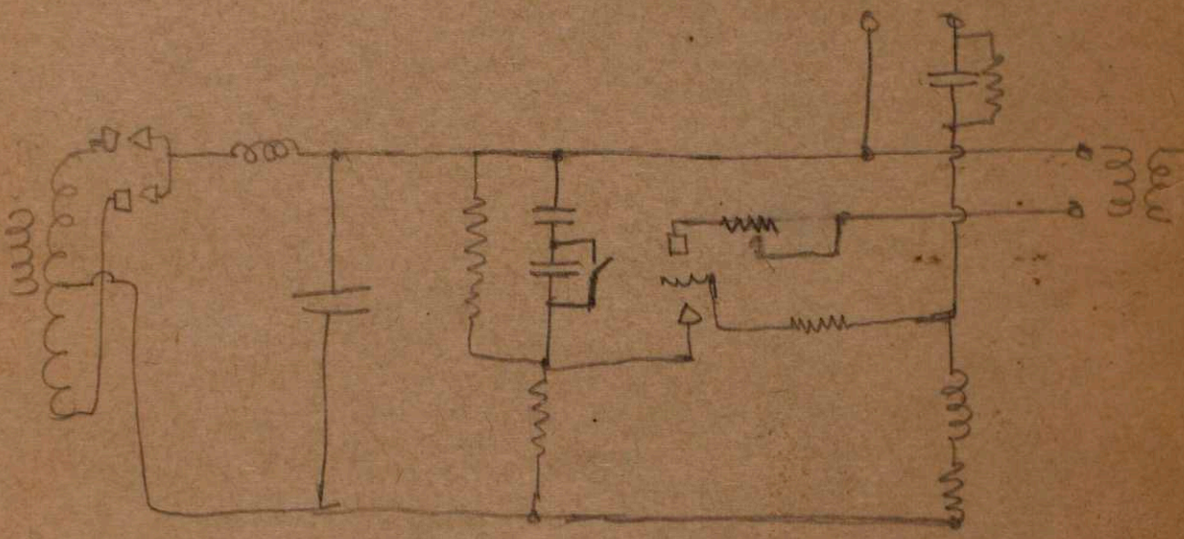
July 6 1932
H J G.
AD Little

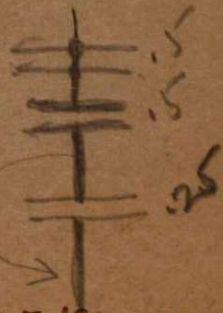


reflector and lamp assembly—
reflector case to have tight fitting glass front.

July 25 '32
Kg







United States Patent Office
Before the Examiner of Interferences
Edgerton vs. Miller - Interference 76771
Edgerton Exhibit 22
Gemeslausen Loose Sheet, July 25, 1932.

January 2, 1940. Clara Schlosky
Notary Public

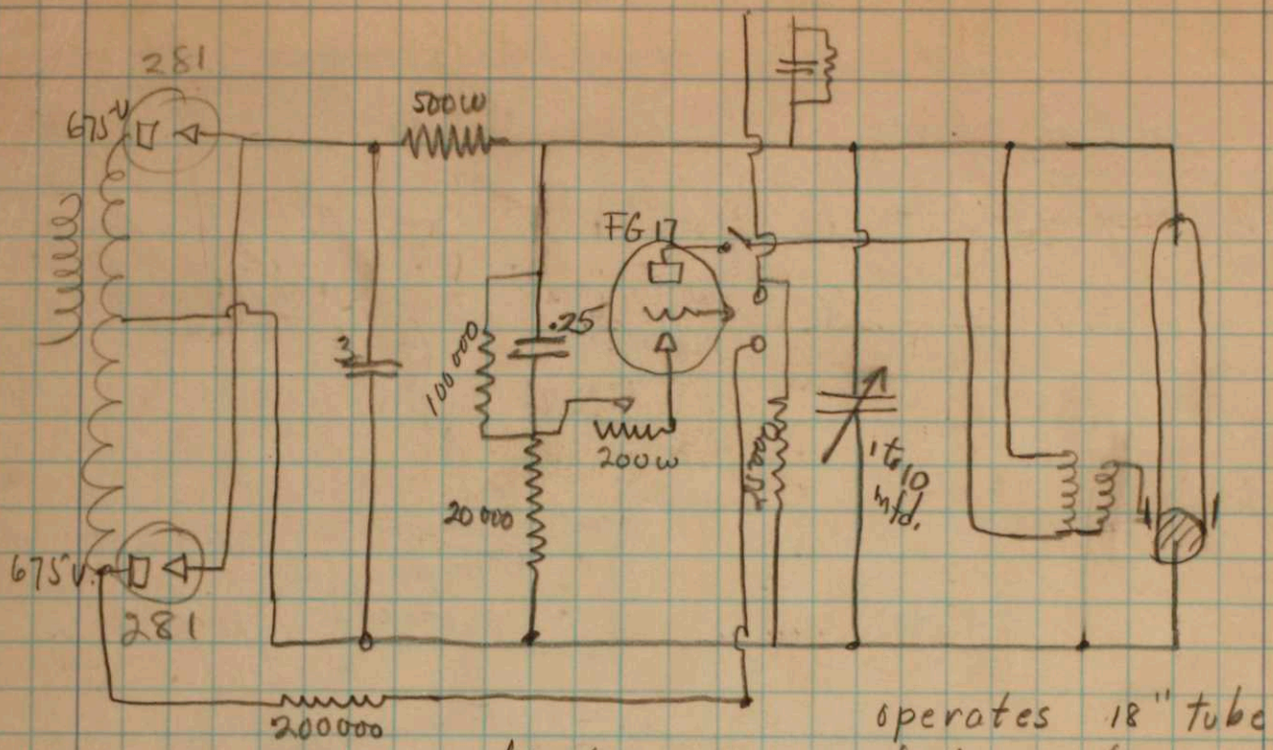


fig (5)

operates 18" tube of #44 glass

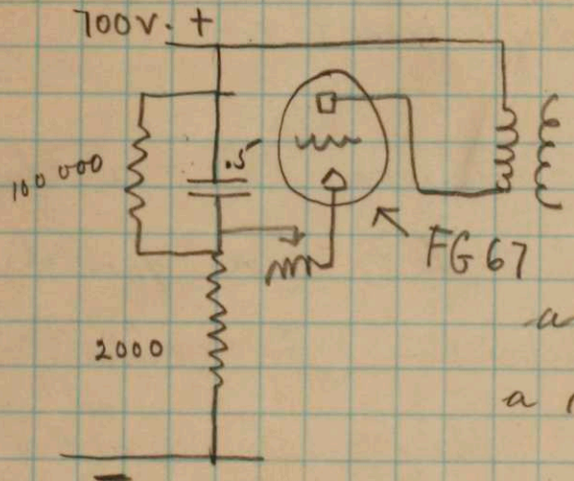


fig (6)

The 67 requires more power to trip an .02 condenser with a 100 000 ω leak works.

Figure 5 shows constants for a circuit in use.

Fig (6) shows usable values for the FG 67.

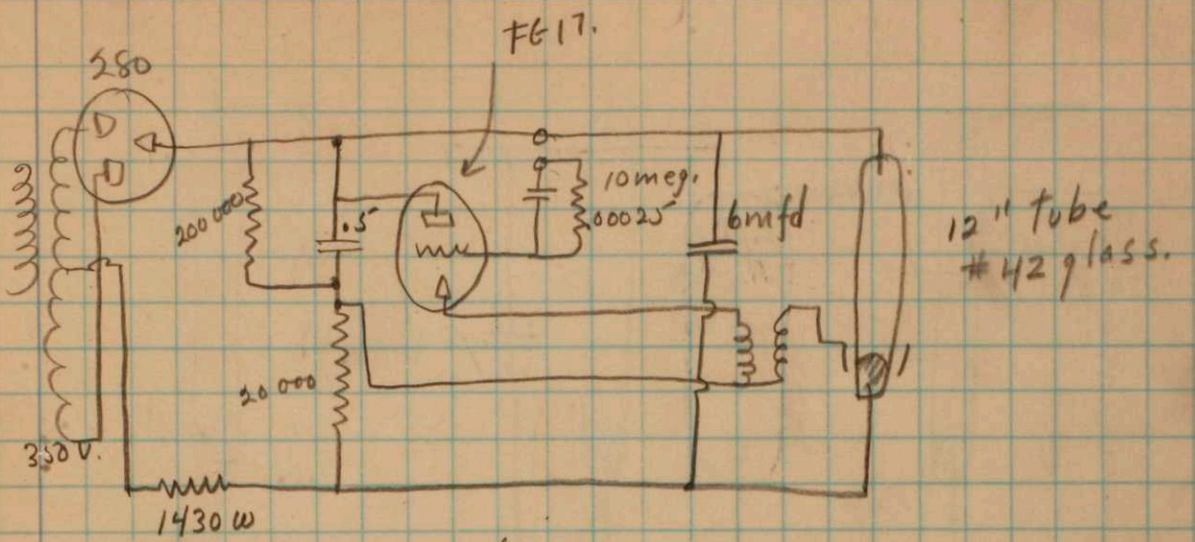


fig (7)

Fig (7) is the circuit used in the temporary apparatus for the Russel box Co (Mr. Pike).

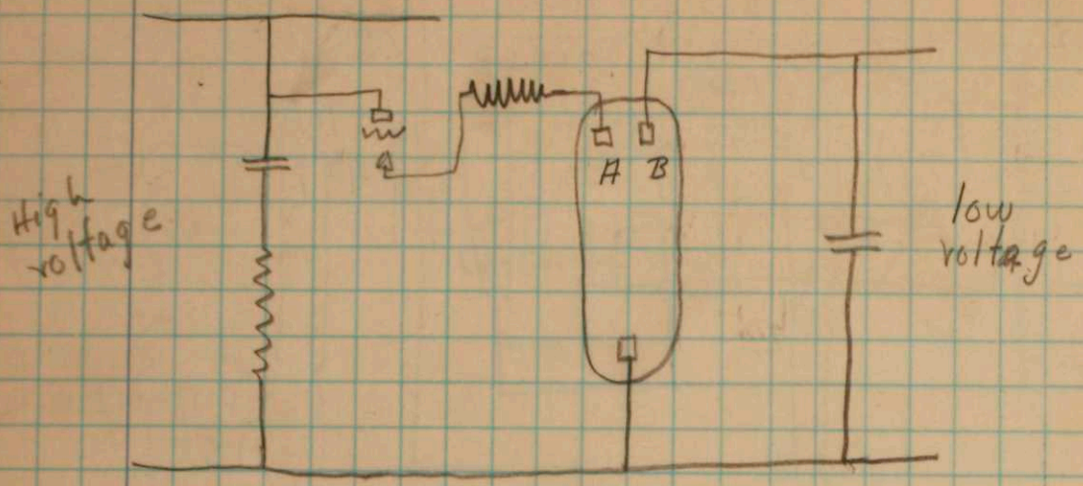


fig (8)

figure (8) is a suggested circuit for a stroboscope. A is a starting anode and B is the main anode. (See p's 84, 85 Book 1)

It is possible to operate a number of tubes in parallel separating their anodes or cathodes by suitable impeadances (500w). They can all be started with one spark coil. This is desirable in high intensity stroboscopes.

Tubes.

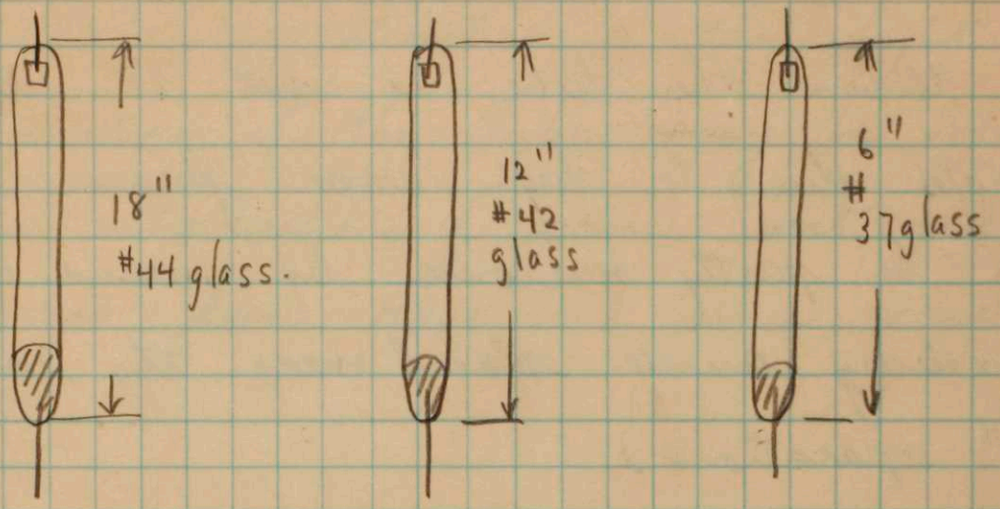


fig (9)

Fig (9) shows standard models of stroboscope lamps. Many shapes of tubes have been tried and it has been found that coils, spirals etc. will work but shielding effect of anode on cathode must be avoided.

Tubes may be of lead, lime, pyrex or other glass, evacuated hard, baked and run on the pump. Anodes of iron with hydrogen furnace treatment desirable.

The starting terminal is an external screen placed around the outside of the glass, usually at the meniscus of the mercury.

When the tube is hot it will not operate due to high vapor pressure. This can be partly overcome by means of an auxiliary anode placed near the cathode (1" separation).

One difficulty has been the sputtering of the cathode onto the glass. When this occurs the tube will not operate. An idea under trial is the introduction of an abrasive material to clean the glass surface. Succesfull operation depends on a good meniscus at the cathode. To secure this cathode shapes as in Fig (10) have been employed.

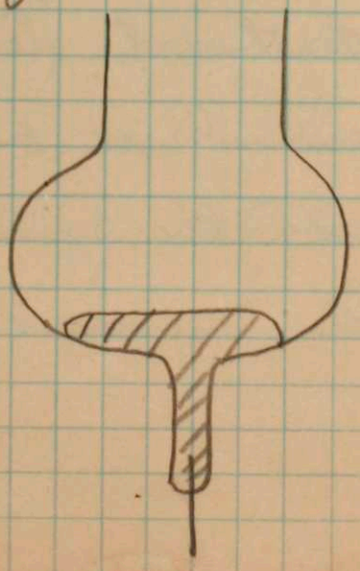
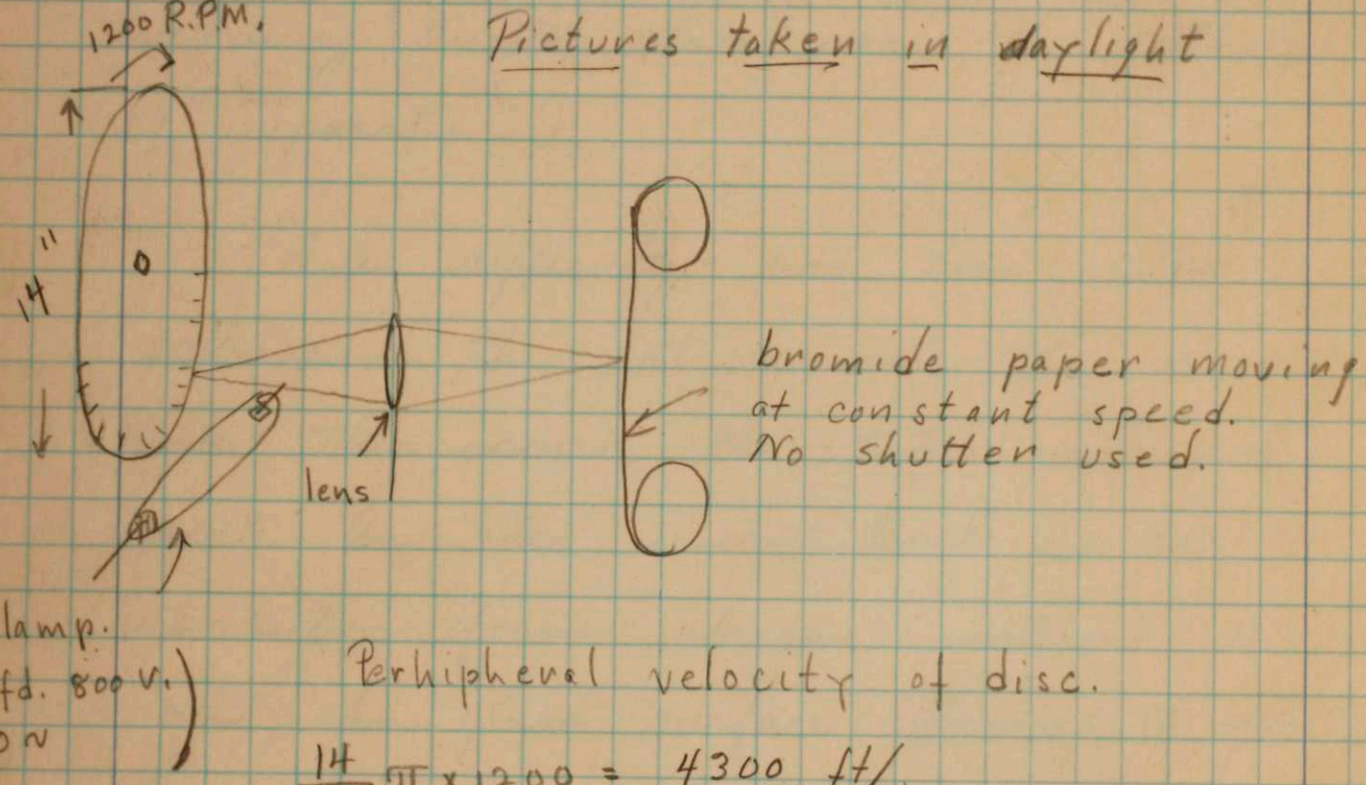


fig (10)

The characteristics of the light and the operation of the tube may be modified by the introduction of some inert gas (neon etc). This has been done in some cases.

These pictures are of a disc on the end of a synchrons motor. The diagram shows the set up.



Pictures taken in daylight

Perhipheral velocity of disc.

$\frac{14}{12} \pi \times 1200 = 4300$ ft/min.

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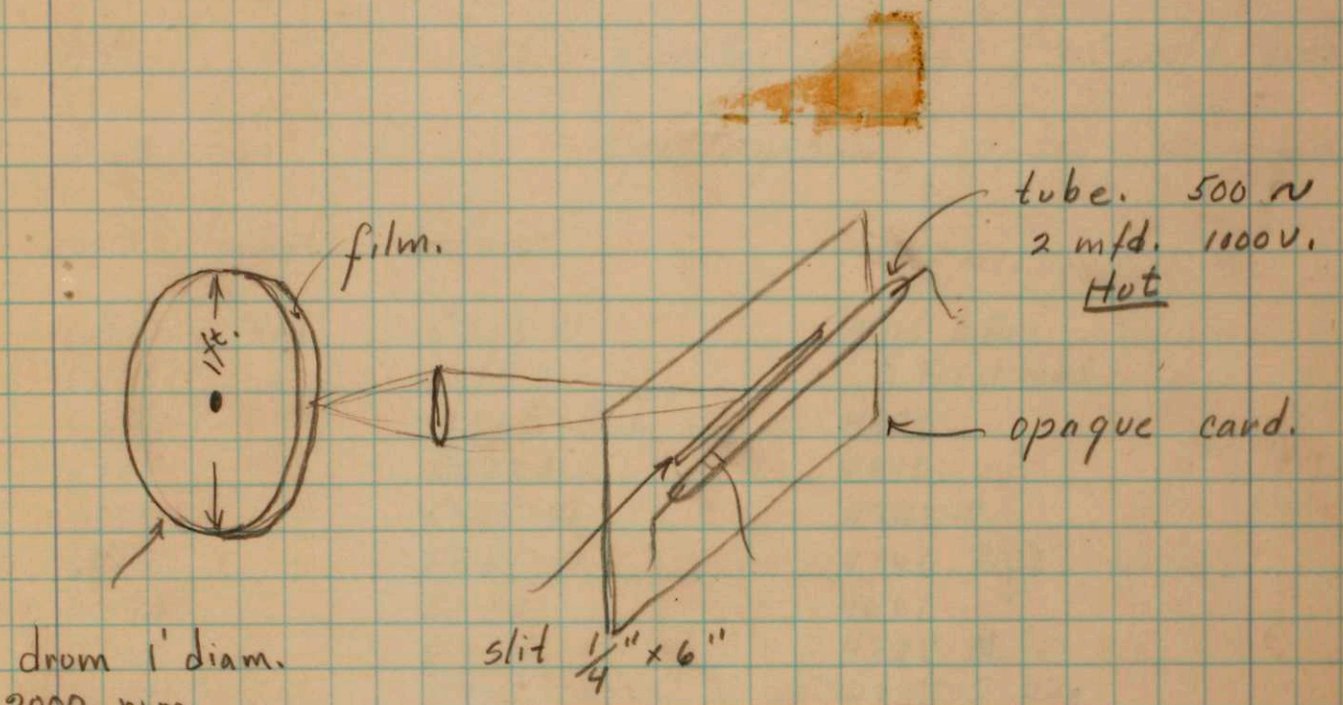
Tests on time lag of light



film speed - $\frac{1 \times \pi \times 2000}{60} = 105.$ ft/sec.

Reduction of image = $\frac{6}{.302} = 19.9$

length of image (optical) $\frac{.25}{19.9} = .0125"$

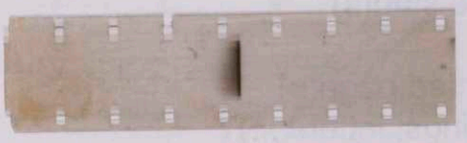
length of image actual .0125"

length of trailer = .094"

time length of trailer = $\frac{.094}{105 \times 12} = 75$ microseconds.

Allowing reading errors of .01", maximum duration of main flash is.

$\frac{.01}{105 \times 12} = 8$ microseconds.



2/4/32.

Visited Raytheon Inc. today and operated Mercury tube with quartz section (3.5 mfd. 1000 v). Took a visual spectogram, lines seen are listed below.

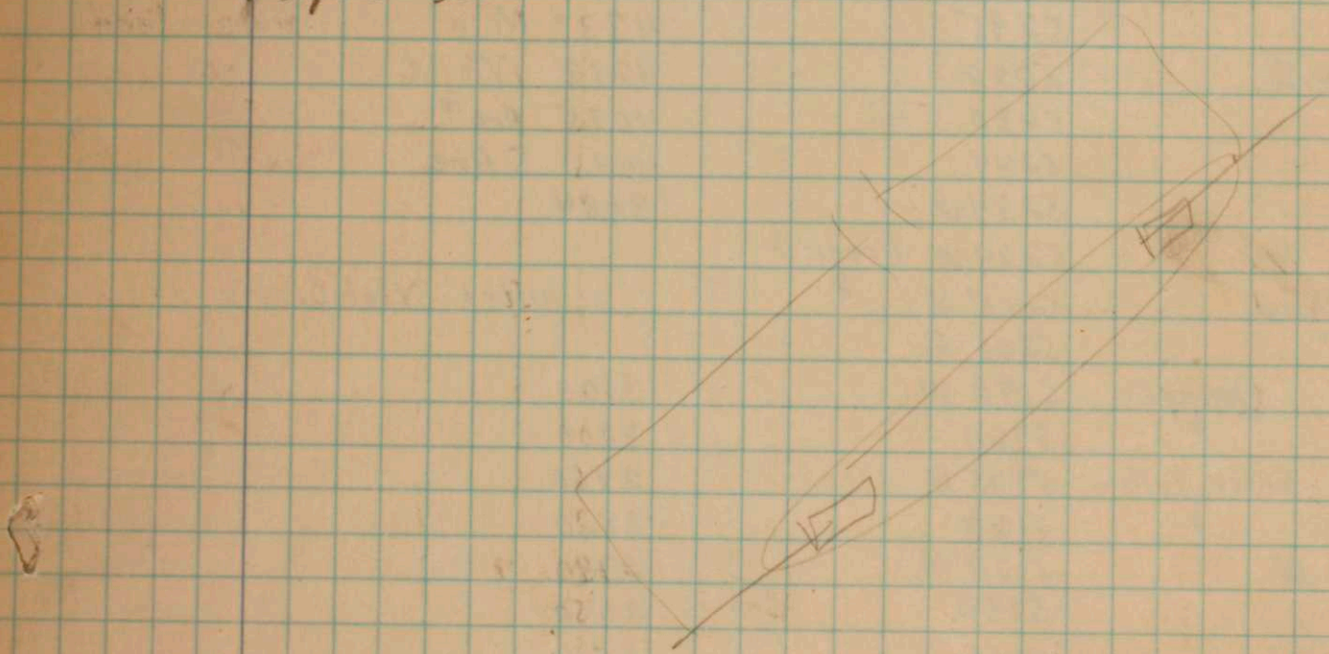
6910 Red	5555 W	4915 S Arc
6695 ↓	5512 W	↕ Faint band.
6524	5461 S Arc	4826
6400	5423 M	4810
6364	5405 W	4798 W
6319	5365 W	4740 Blue
6296	5354	4661 ↓
6245	5344	4398 M
6239	5315	4355 S Arc.
6196	5310	4345 M "
6190	5295	4337 M "
6150 - S	5288	4218 Violet
6122	5280	4075 Arc ↓
6100	5244	4045 S Arc
6089	5234 W	3984
6072 Arc.	5224 W Green	
↕ Band.	5215 M ↓	Ultra Violet.
6015	5205 M	
5960 Orange	5196 W	3100
5890 ↓	5160	3000
5869 Green Yellow	5145 W	2960
5860 ↓	5133	2820
5850 W	5128 M	2790
5816	5100	2650
5803	5066	2536
5790 S Arc	5060	2490
5770 S "	5045 Broad.	2260-2400 faint band.
5726 VW	5026 W	2220
5700 M	4982 W	2040
5676 S	4973 W	
5596 M	4960 M Blue Green	
	↓	

2/4/32.

Also operated a tube with 1 cm. Helium, nickel electrodes. The operation was remarkably uniform but the light efficiency was low.

This again brings up the question of tubes with gases other than Hg. (see p. 118 B(V)) Further experimentation along this line is desirable.

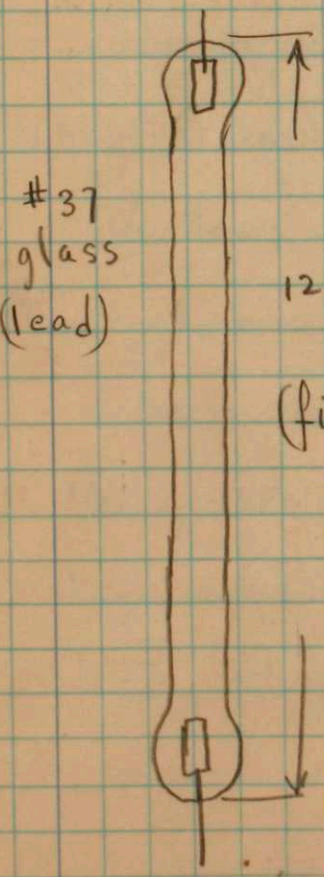
Worked on unit for International Paper Co.



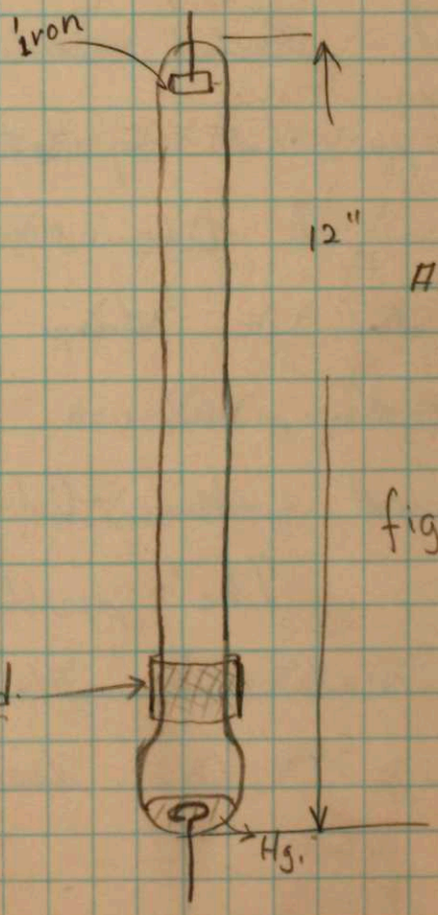
2/5/32.

Built a tube as in Fig 11. Plan to pump it and fill with Helium. Another tube is to be built as in Fig 12. and filled with Helium of 1 cm or more. It is hoped that this tube will start readily with grid placement as shown and thus obviate the difficulty of cathode sputtering

(see p 10)



(fig 11)



fig(12)

Aluminium electrodes
1/4" by 1" - Helium to
about 1 cm.

2/8/32

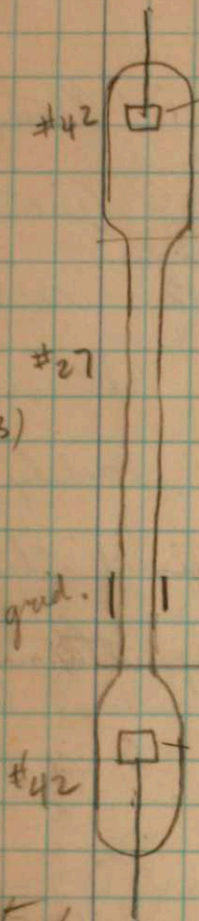


fig (13)

Built a tube as in fig 13, the cathode being partly filled with an amalgm of Hg, Ba, and Cd.

It was first evacuated hard and would not start with grid as shown. About $\frac{1}{2}$ m m air was then let in and the tube started readily forming a good stroboscope that operated well at high (1000 V) intensity. A tube was built with iron cathode and a drop of Hg but it did not operate well until a bit of Barium was added and the tube run to oxidize the barium. The results of these experiments gave data for the construction of a tube that will be described later.

2/9/32

Tried the G.R. camera today. 480 half frames per second driven by a syn. moter. The first tests were unsuccessful due to film fogging.

2/11/32

Performed some further tests on the G.R. camera, 480 f.p.s. Tests showed that voltage regulation was bad (1200-600 V) so the transformer was replaced with a 5 K.W. unit (2200 V).

There was still about 400 V. drop in the choke at full load. (3 amps). Sufficient exposure was obtained but definition was bad when film reached speed, suspect that film is throwing on the sprocket. -

Made an acceleration test. Film comes up to speed in about 2.5'.

Portion of strip. (test on thread definition)

2/12/32.

Hutchins came today and we talked over the unit. Power transformer to have 5500 V. pri. Sketches show dimensions of packing boxes. Hutchins will call us Mon. or Tues., we can get him at the plant (Livermore Falls) and can call him before next Sat.

Tried Eastman high energy developer and it gave much greater density than other developers. Used it in some pictures of water drops with good results. (480 f.p.s. GR).

2/13/32

Cleaned up the Lab in preparation for the visiting committee

2/14/32

Took 20' of milk drops at 480 f.p.s. with very good results. Talked with Draper on the construction of a new camera.

Notebook Number: Germeshausen bk 2

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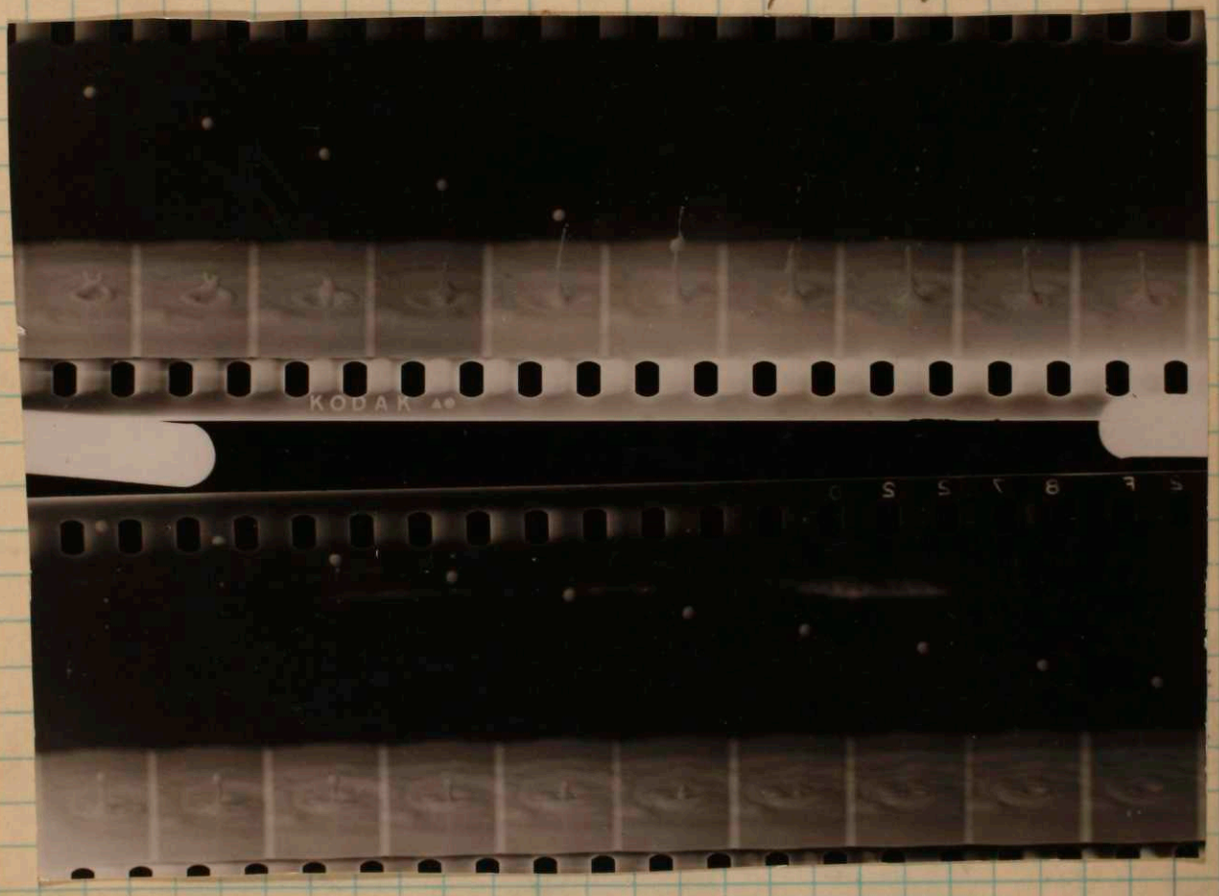
January 2, 1940. Clara Siebrecht Notary Public

The set up for the milk drop pictures and some of the results are shown below.

The power unit and lighting system used was that developed for the Int. Paper Co. and will be described on succeeding pages.



United States Patent Office
Before the Examiner of Interferences
Edgerton vs. Miller - Interference 76771.
Edgerton Exhibit 17.
Germeshausen notebook, page 21, and print and motion-picture film originally attached thereto.
January 2, 1940.
Clara Sieloff
Notary Public

January 2, 1940. Clara Liblong
Notary Public

Mar. 2, 1932

A belated write up of the trip to Livermore Falls.

We went to Livermore Falls with the outfit described below to take pictures of paper pulp for the International Paper Co.

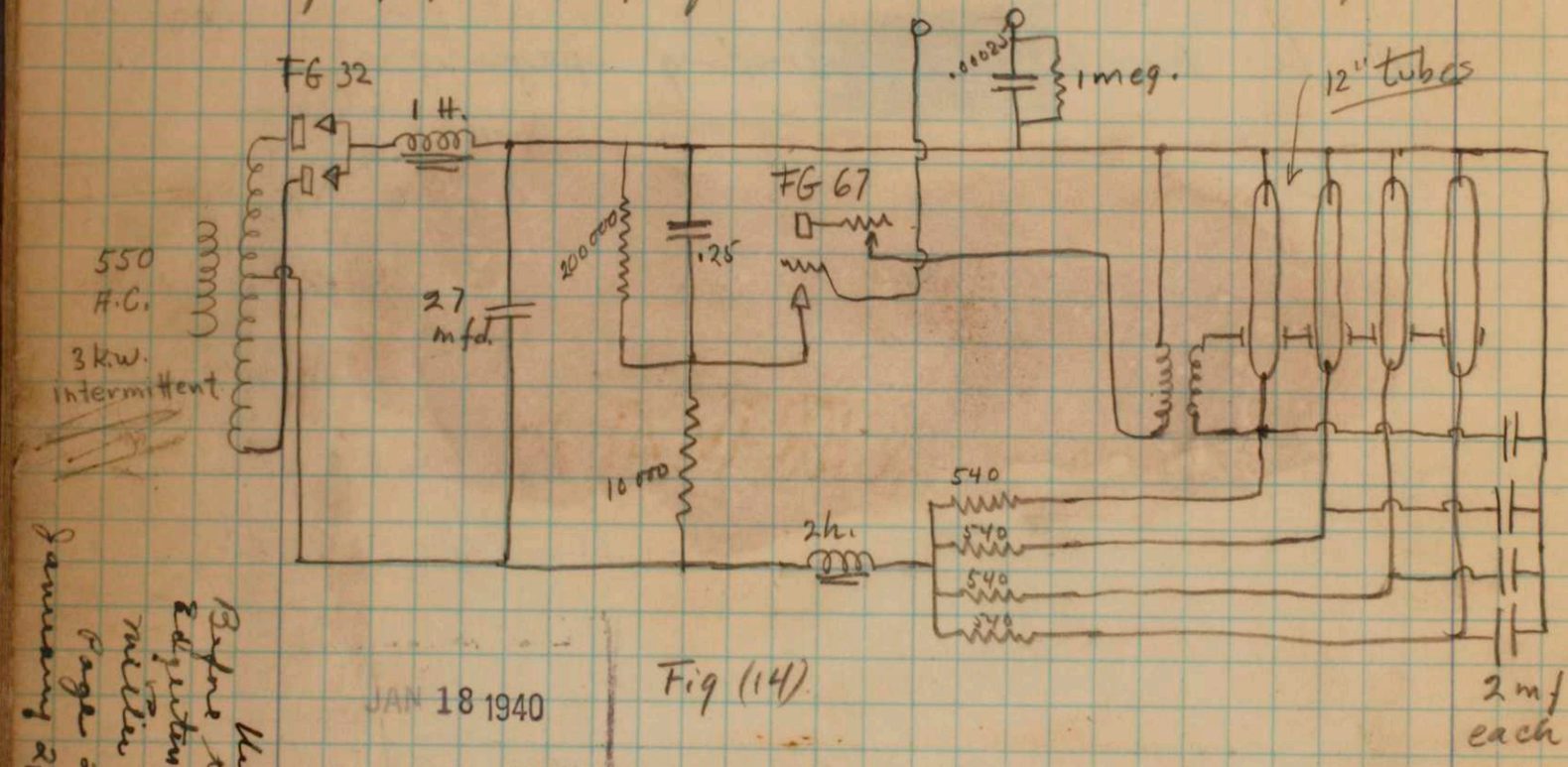


Fig (14)

The apparatus operated satisfactorily except for two annoying factors.

(1) Low line voltage - (90 v)

(2) Moisture

The low line voltage is something that may occur in many applications suggesting the use of transformers.

with tapped primaries.

The moisture is difficult to overcome and necessitates making the complete outfit as moisture proof as possible. Moisture on the camera commutator may be partially overcome by reducing the resistance in the trip circuit and increasing the trip capacity.

Below are some picture of the set up. The G.R. camera was used. Some difficulty was experienced in getting the camera up to speed suggesting the necessity of a careful check of acceleration times and actual film speed.

Before the United States Patent Office
Examiner of Interferences
Edgerton v. Miller - Interference 76,771
Edgerton Exhibit 16.
Pictures on pages 23 and 24 of
Terminal Laboratory Notebook No. 2.
(2 pages - page 23)
January 2, 1940. Nicholas Miller
Notary Public

Notebook Number: Germeshausen bk 2

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(notes, drawings, letters ...)

was/were scanned where originally ~~located between page~~ in place on page 24 ~~and ____~~.

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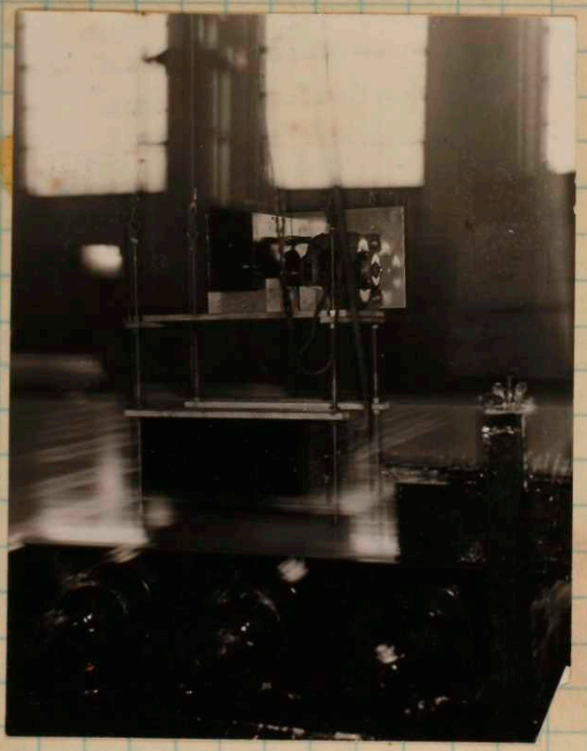


United States Patent Office
Before the Examiner of Interferences
Edgerton vs. Miller - Interference 76771
Edgerton Exhibit 16.
Pictures on pages 23 and 24 of Gennes Lausen Notebook No. 2.
(2 pages - page 24)
January 2, 1940. Clara Sibloski
Notary Public

Mar 4 1932 437 1/2

Gennerhausen.

1/4 oz = 109 grs.

Developers:

1/2 oz = 218 grs.

3/4 oz = 327 grs.

D 82. High Energy.

H_2O (125°F)	24 oz.
Wood Alcohol	1 1/2 oz.
Elon	200 grains, -150 ?
Sulphite	1.75 oz.
Hydroquinone	200 grs. 250 ?
NaOH	125 grs.
Potassium Bromide	125 grs.
Cold water to make	32 oz.

Does not keep well - Alcohol necessary to keep agents in solution.

Develop 5 min at 65° for average contrast. 3' at 80°

Glycin.

Glycin	6.3 oz.	4.2
Sodium Sulphite dry	15.8 oz	10.
Pot. carbonate dry	23.2 oz	16
H_2O to	3 gals.	2 gals

5.2

Hypo.

Hypo			6 lbs.	5
H_2O to			3 gals.	2
Hardener:				
H_2O			30 oz.	20
Sodium Sulphite			6 oz.	4
Acetic acid	28%	68% glacial	18 oz.	4.6
Pot alum.			6 oz.	4

Mar 12, 1932
Kenneth J. Germeshausen.

Hutchins of the Int Paper Co. was here from Mar 8 ~ 11 learning to operate the strobograph. The circuit operated O.K. at 480 ~ but showed a tendency to hold over at 60 ~.

The camera does not operate satisfactorily but tends to go in and out of focus. The design is wrong for such high speeds and should be changed. G.R. is working on a new camera to give 1000 f.p.s. but will take some time. G.R. have made some agreement with G.E. as to the manufacture of stroboscopes and the use of thyratrons.

During the past week we have decided to use a synchronous commutator separate from the motor drive. This is more convenient and gives more accurate timing of the pictures.

Mar. 14, 1932.

Repeated experiments of last summer on spark gap Stroboscopes (Edgerton)

This is a promising method of obtaining a high intensity concentrated source.

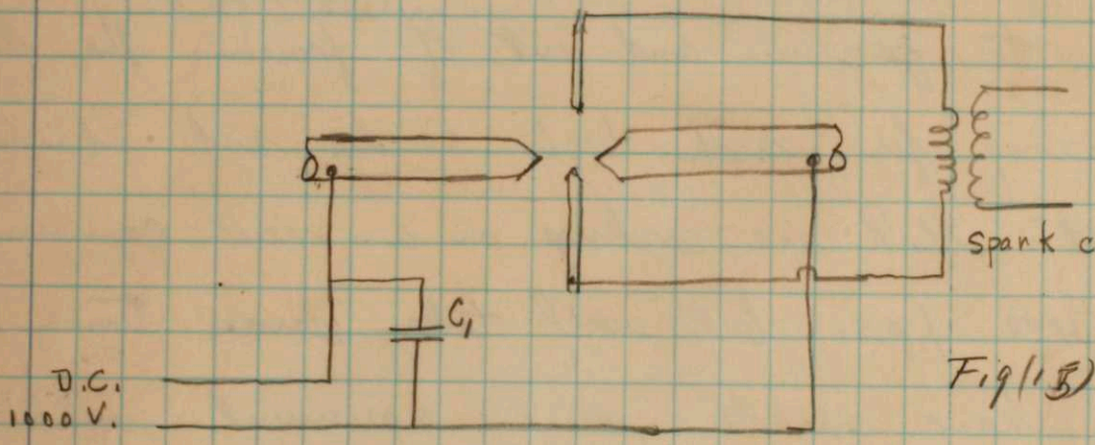


Fig (15)

It was found that condenser C_1 must be charged to quite a high voltage (1000 V) for gap separations of 1/4". The gap is triggered by an auxiliary gap operated from a spark coil by means of the conventional stroboscope circuit. Fig 15 worked better than Fig 16 being more consistent. It would probably be advisable to run voltage C_1 to some value about half the break down voltage of the gap.

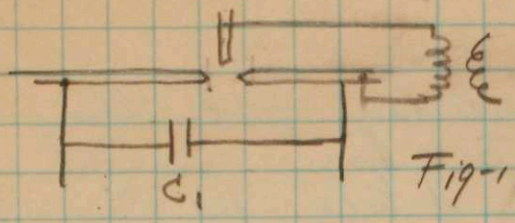


Fig-16-

It was also observed that for a given value of v and C, the discharge was more violent and the light more intense with large gaps.

Mar. 16, 1932
Kenneth J. Germeshausen

Spent yesterday and today working on a new type of tube for the stroboscope. (See page 18) The tube was as in fig 13, the cathode with Barium carbonate. It was evacuated, baked and filled with 1 cm. Helium and a small drop of Hg.

The tube would not breake into an arc with 600 V. but formed a glow. At 1000 V it operated well as a stroboscope but tended to hold into a steady arc. Probably a change in tube dimensions, gas pressure or both will obviate the difficulty of hold over and the tube will operate O.K.

(To try) (Lower voltage with variable gas pressure)

Mar 19, 1932.

Built a tube as per fig 17.-

It was run on the pumps and operated well when hot, but difficulty was experienced in starting.

These tubes have Hg in them

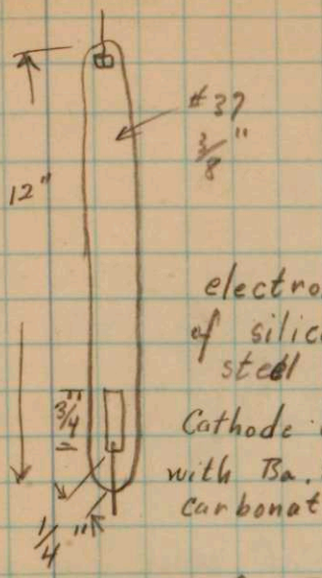


Fig 17.

Gas pressures up to 3 m.m. He were tried but tube refused to start unless heated. Bennet suggested that the erratic behavior might be due to some impurity.

Another similar tube was built but the cathode was uncoated. This tube started readily with gas pressures of from a few microns up. Pressures as high as 2 m.m. were tried. It was noted that the arc tended to form on the Nickel lead in rather than on the cathode proper suggesting that the Nickel is a good emmitter.

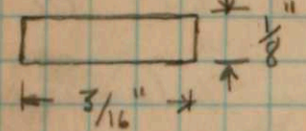
Hold over in the tube mentioned on page 30 was prevented by increasing the resistance in the charging circuit thus preventing build up before deionization.

Gas pressure control is important for maximum efficiency, probably some form of cooling vanes will be employed.

Design of a tube.

Anode.

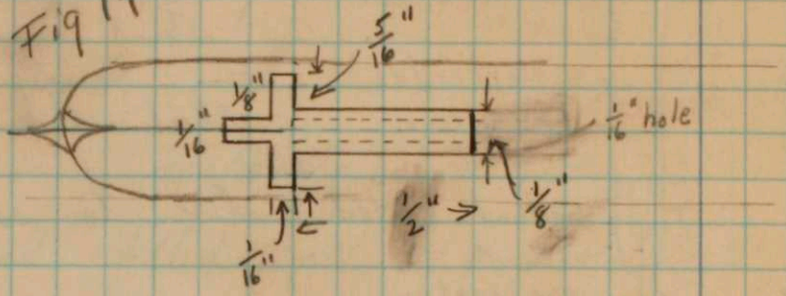
Fig 18



silicon steel.
on pure iron.

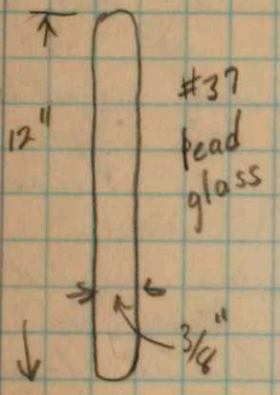
Cathode.

Fig 19



To try cathodes of iron and of copper, coated with Ba + St. carb. inside hole.

Fig 20

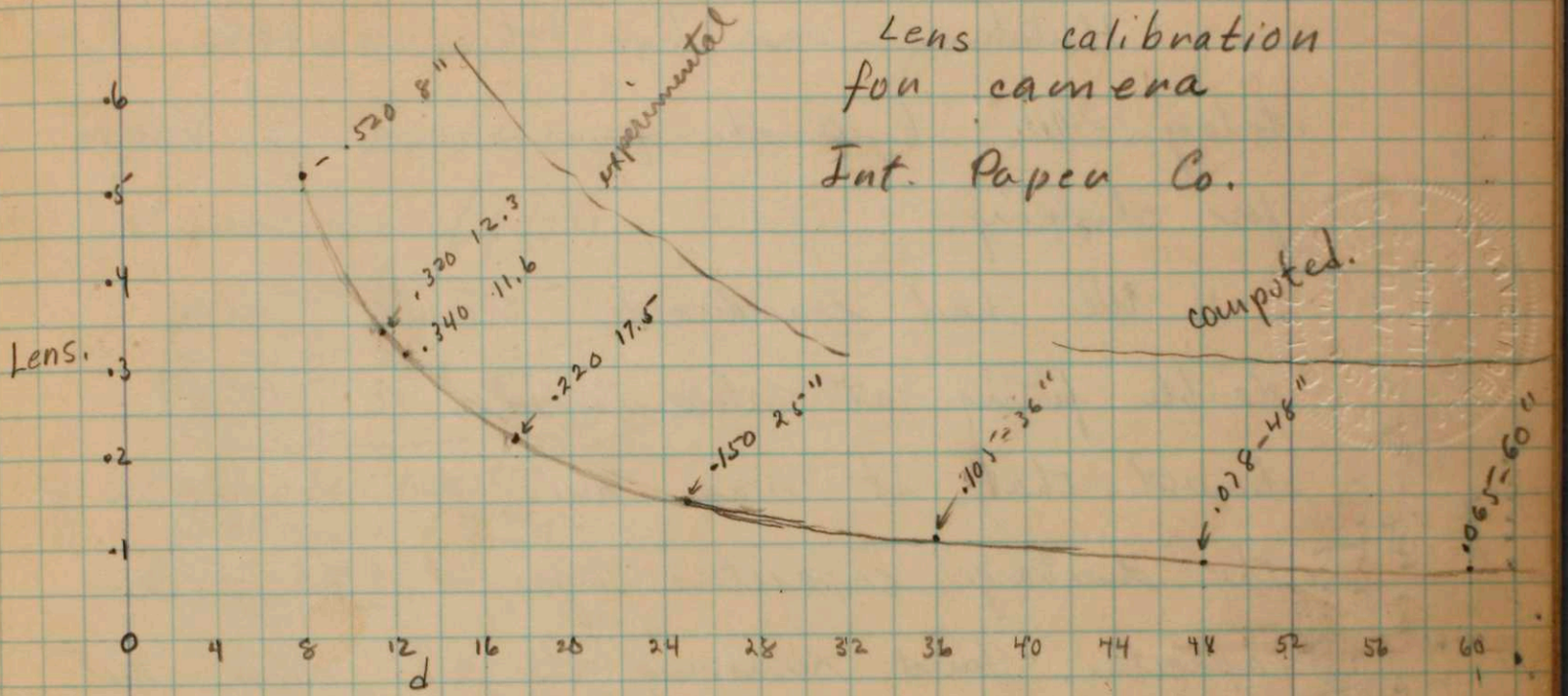


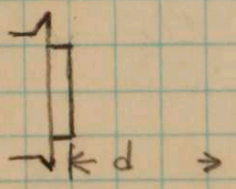
Ring at base of cathode is to prevent arc from going to seal and to give a pocket for the helium and Hg.

Mar. 24, 1932

C = 1.845

Lens calibration
for camera
Int. Paper Co.



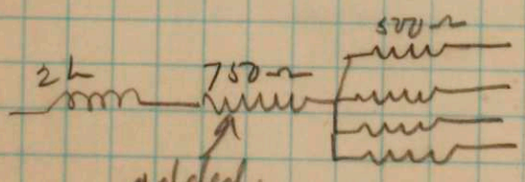


I = 32.5 A.
W = 3 K.W.

Mar. 29, 1922
Kenneth J Germeshausen

Hutchins was here the 28 + 29th. Left today. We have the power unit in shape for shipping.

We had considerable trouble with double firing at slow speeds. A check showed that it was due to oscillation of the discharge capacitors against the filter capacitor. Tried removing the 2 h. choke but then the lamps held over. Finally stopped the difficulty by increasing the charging resistor as shown below.



When operating one lamps with 1 mfd. discharge the lamps tended to hold over due to too quick a build up.

Some work should be done designing charging circuits and investigation of separate power supply for the trip circuit.

3/24/32.

Resume of tube tests:

Built the tubes as suggested on page 32 and a similar one with a cathode as shown in fig (21)

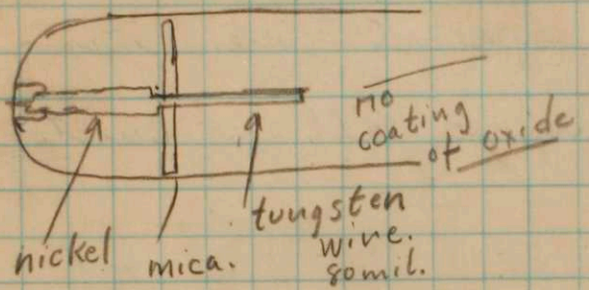


fig 21.

These tubes were pumped together and operated at high temperatures on the pumps. With a helium pressure of 5 m.m they were sealed off.

They refused to start unless hot but when upp to temperature ran very well. At low temperatures they showed a purple discharge showing the presence of gasous impurities probably nitrogen. Where this came from is not known but its presence probably accounts for the difficult starting and erotic behavior.

Iron showed less sputtering as a cathode than either copper a tungsten. All these tubes

showed a tendency for the arc to form on the seal instead of on the cathode proper, especially when cold.

The next tube is to have larger cathode area and special precautions are to be taken to remove all impurities from the tube.

4/5/32
Kenneth J Germeshausen

Edgerton suggested the use of a charging circuit as in fig (21)

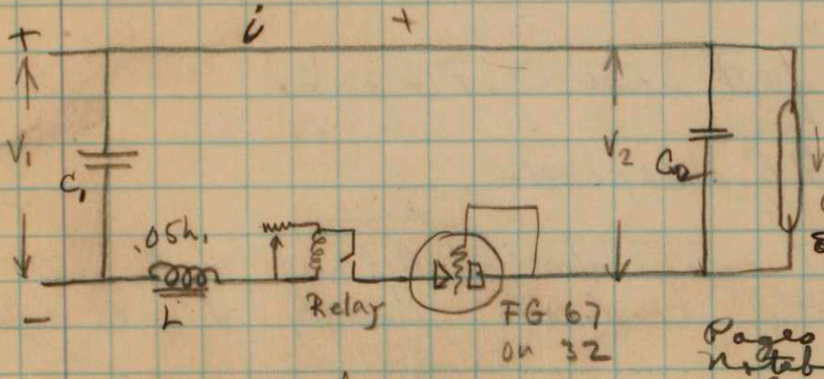


fig (21)

Circuit as used in prelim. set up.

United States Patent Office
Before the Examiner of Interferences
Edgerton vs. Miller - Int. 76,701
Edgerton Exhibit 18.
Pages 37, 38, 39 & 40 of Germeshausen notebook No. 2, April 5, 1932. (4 pages - page 37.
January 2, 1940. Clara Pelosky Notary Public

This gives double voltage on C_2 and prevents oscillation of C_2, L, C_1. It is also a much more efficient form of charging circuit. The relay is to protect the system in case of hold over.

Calculation

Assume $R = 10\ \omega$
$L = .025$ h.
$C = 4$ mfd.

$$i' = \frac{E\,\varepsilon}{L\,K}\,e^{-\frac{Rt}{2L}} \sin kt$$

$$k = \sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$$

$$k = 3160$$

$$t = \frac{\pi}{3160} = .007 \text{ secs for } i' = 0$$

for $i' = \max$

$$\cot kt = \frac{R}{2Lk} = 16$$

$$Rt = 90^\circ \text{ approx.}$$

$i_{max} = \frac{E}{LR} = 6.9$ amps approx.

for $C = 8$ mfd. $i = 10.8$ amps approx.

4/6/32.

Test data.

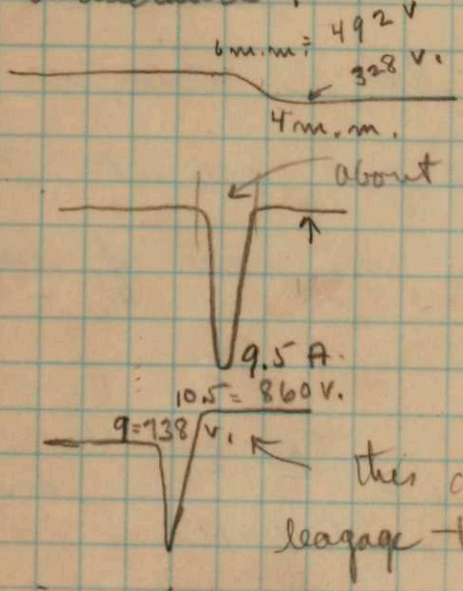
500 volts full wave - 2FG 32's.

$C_1 = 42$ m.f.d. G.E. capacitor.

$C_2 = 7$ m.f.d. G.E. capacitor. (Did not work well with 8 m.f.d. of other condensers. - Probably due to different inductance.

Lamp operated at about 20 V

Max inductance.



For minimum induct this time is about $\frac{1}{1000}$ sec.

Min inductance

$I_{max} = 13.5$ H.

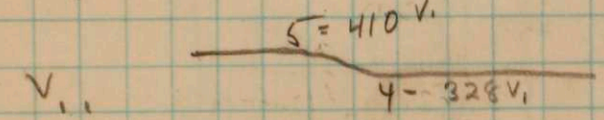
Voltages approx the same as for max inductance except that charging time much shorter.

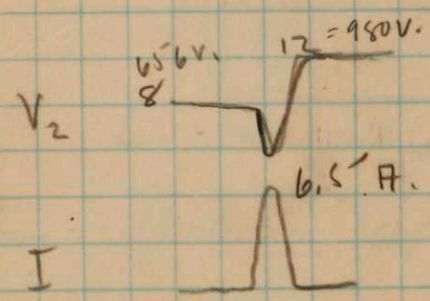
6/5 V = 7.5 m.m. deflection. 1 m.m.

Before the Examiner of Interferences
United States Patent Office
Edgerton v. Mason - Interference 76,771
Edgerton Exhibit 18
Pages 37, 38, 39 & 40 of Journal
Notebook No. 2, 35
(4 pages - Part 2)
Samuel April 5, 1932 Edgerton
2, 1940. Notary Public

Lamp shows less tendency to hold over than when using charging resisters. When they get hot they hold over readily but the circuit breaker clears without difficulty

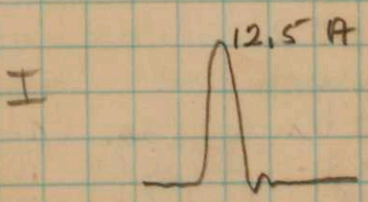
— Reduced C_2 to 3.5 mfd. for 20 ~. max inductance





— operation O.K.

Ha min Ind.



Lamp tended to hold over.

Charging time is noticably shorter but oscillograph is not fast enough to respond accurately to the charging current.

United States Patent Office
Before the Examiner of Interferences
Edgerton vs. Miller - Interference 76771
Edgerton Exhibit 18.
Pages 37, 38, 39 + 40 of Gernsheimer Notebook No. 2, April 5, 1932.
(4 pages - page 39)
January 2, 1940.

Clara Schlosky
Notary Public

4/5/32.

Since we were using a thyratron (see fig 21) it seemed plausible to employ the thyratron to introduce a time delay in voltage build up across the stroboscopic lamps and hence prevent hold over.

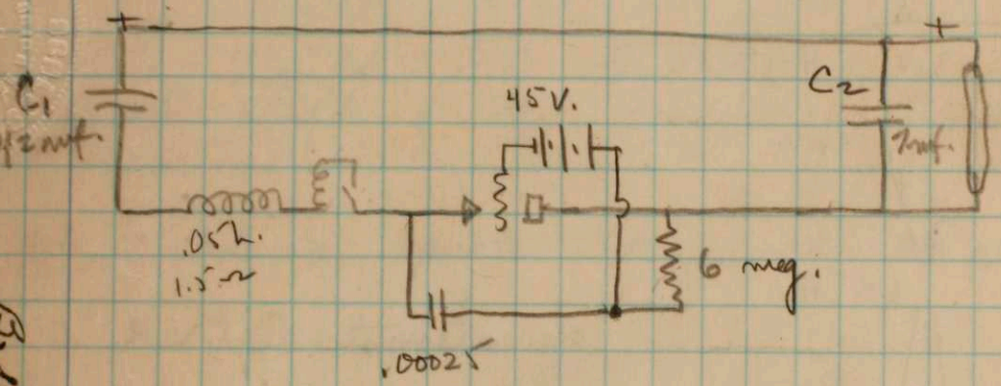
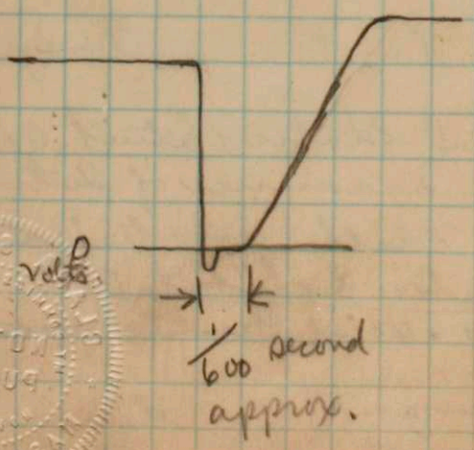


fig 22.

The circuit in fig 22 was employed. This gave an appreciable time lag as per fig 23 and prevented hold over except when the lamps were very hot.



Voltage across C_2 (2 mfd.)

fig 23

Since it is desired to operate lamps in parallel some means must be employed to separate their circuits. - Fig 24 was tried.

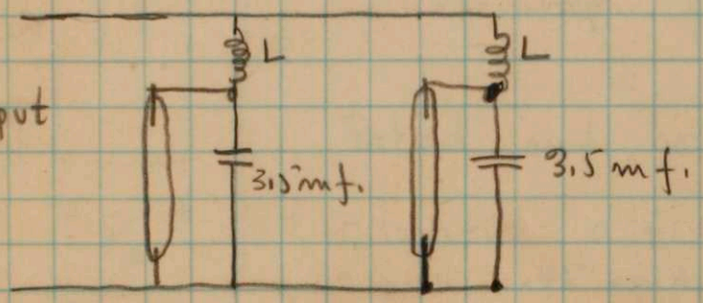


fig 24

L consisted of 20 turns of about 2½" dia. This effectively separated the lamps yet did not introduce enough impedance to produce a double flash in case one lamp failed to operate When L was removed the lamps would not operate as one lamp took all the power. Did fail occasionly especially at 30 v or more.

United States Patent Office
Before the Examiner of Interferences
Edgerton vs. Miller - Interference 76771
Edgerton Exhibit 25.
Page 41 of Germeshausen Notebook No. 2,
April 5, 1932.
January 3, 1940. Clara Schlosky
Notary Public

4/6/32

Built Thyratron #1

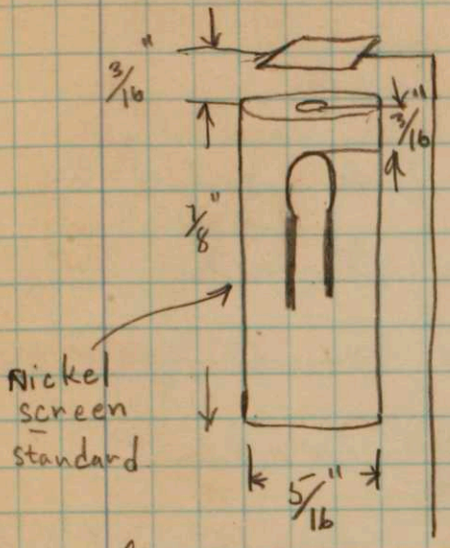


fig 25

Grid hole 1/8" diam.

filament 5/8" of thoriated tung.
.25 amp. for 20 A.

Baked and bombarded.

Filament activated
2 min. .45 amp. hr. .32 amp.

This thyratron gives trouble with filament bombardment. Filament current of .35 amps gives about 10 mils continous plate without bombardment.

4/12/32

Kenneth J. Germeshausen.

Ran some further tests on the cricuit fig 22 p 40. at 480 cycles.

It was found that on tube could be run with 4 m/d. at 480 cycles. It heated very quickly but could be run at exceedingly high temperatures and high intensity. Excellent pictures were taken with this arrangement but they showed some trailer.

An attempt was made to run four tubes in parallel but was not satisfactory. Two tubes were operated with about .1 h iron core

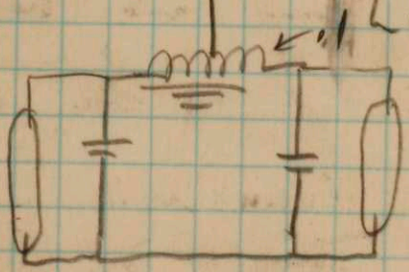


fig 26.

.25 h was two much since if one tube missed its LI^2 was sufficient to cause bad oscilations and to trip the cricuit breaker. It was also found that operation was better when the spark

coil had separate primary and secondary.

It seems that an inductance of 50 turns air core on a 2" tube should be enough

4/12/32.

Suggested tube for test

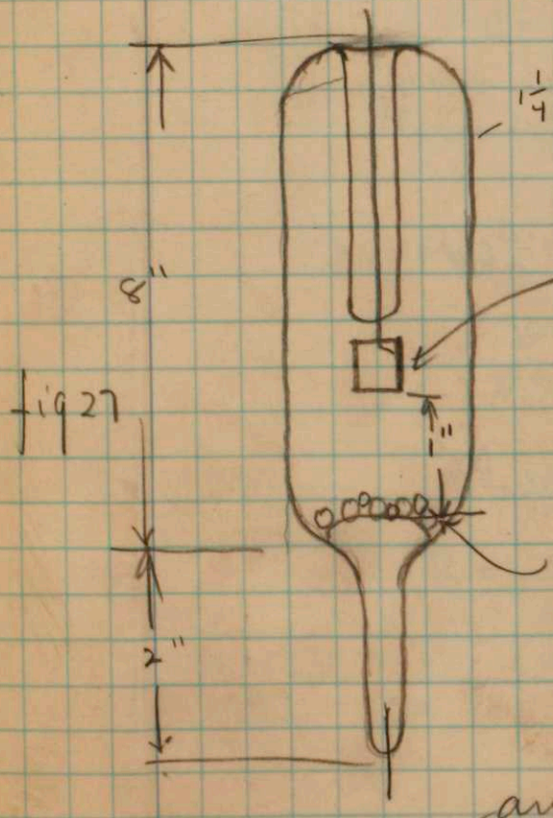


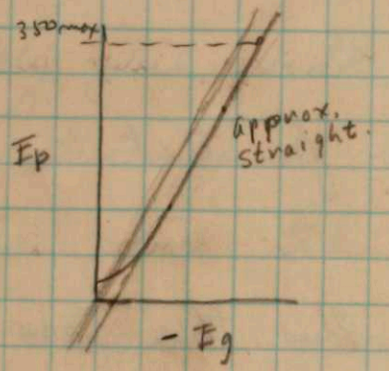
fig 27

This tube was built and tested. Due to small anode to cathode spacing it tended to hold over. The anode became very hot and though intensity was high the lamp tended to streak into an arc as the anode potential built up without the application of a spark.

A similar tube should be built but with slightly more spacing and greater anode size.

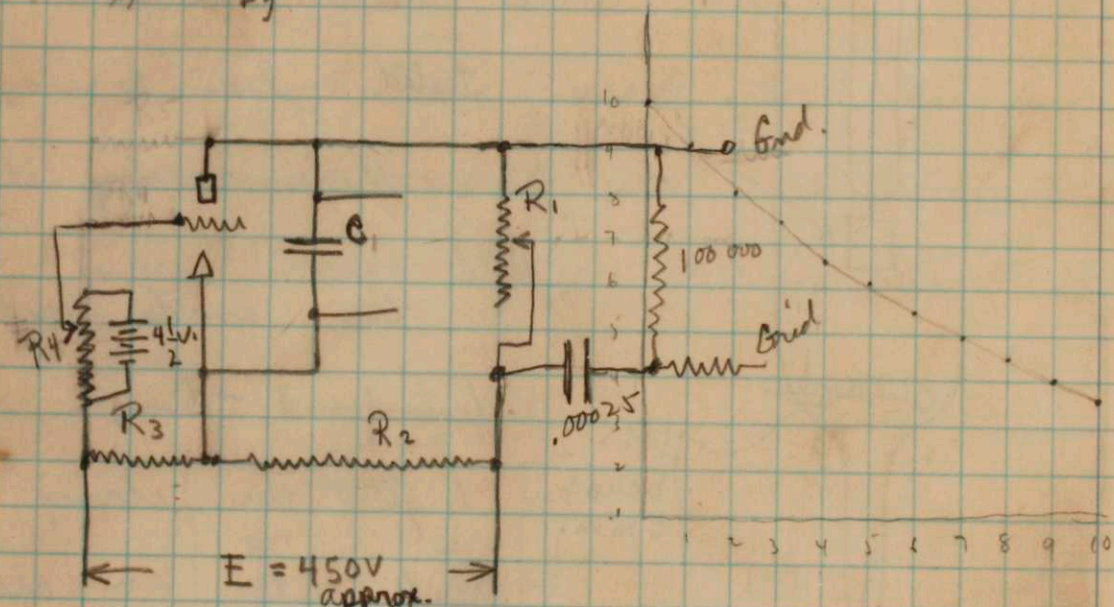
4/14/32
Kenneth J. Grueshausen.

Design of a stable oscillator for stroboscope control and sweep circuit using a 256 A. - (Argon filled. $I_f = 1.1$ $V_f = 2.3$. $I_p = 75$ m.a. $V_p = 350$ max. mu factor = 40)



characteristic of 256 A.

fig 28.



To fire when $t = .5\ RC$.
$E_c = 250V$ at time of discharge

Discarded because of necessity of using a biasing battery.

4/20/32.

Decided to finish calculations on circuit of p 46. Edgerton gave talk today on stroboscopes at National Safety council - Hotel Bradford.

Referring to fig 28 P 46.

Assume $R_2 = 50{,}000$

then $R_1 = \frac{50000}{40} = 1250$ - approx. Should be closely adjustable.

Let $R_4 = 100\,000$.

Assume $C = .04$ then for frequencies of 10 N

It is desired to fire when $e_c = 250$ V.

$$250 = e_c = 450 - 450\,\varepsilon^{-\frac{t}{RC}}$$

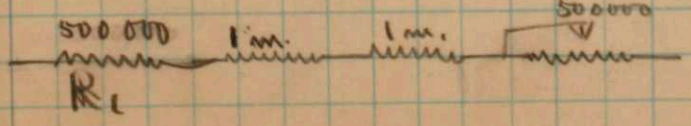
$$\frac{t}{RC} = .81$$

assume $t = \frac{1}{10}$ sec $\quad C = .04$

$$R = \frac{.1 \times 100 \times 10^6}{4 \times .81} = 3.12 \text{ megohms.}$$

Also $C = .001 \quad t = \frac{1}{50000}$

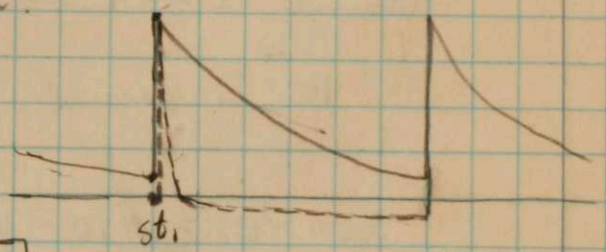
$$R = \frac{1000 \times 10^6}{50000 \times .81} = 246\,000 \text{ ohms.}$$



Operation.

For a given 25bA the ratio of R_3/R_2 must be such that the tube is critical over a range of E.

– Remove C bias 4½ v. – Set E = 220 V. and reduce R_3 until tube just fires. Reduce R_3 to just below critical point, reset and reduce E until tube fires again.



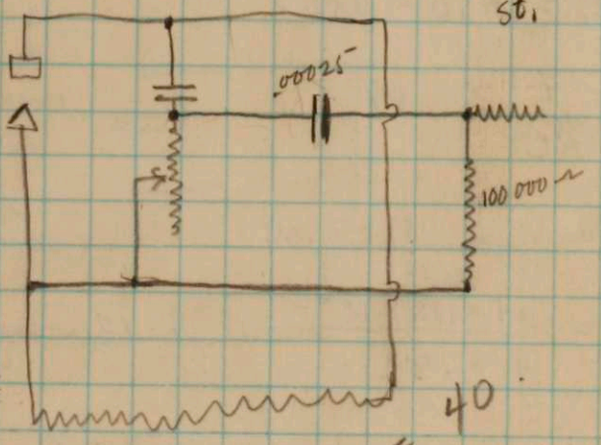


Fig 29

N.B. see fig 26

40

$\frac{50\,000}{1270} = 24$

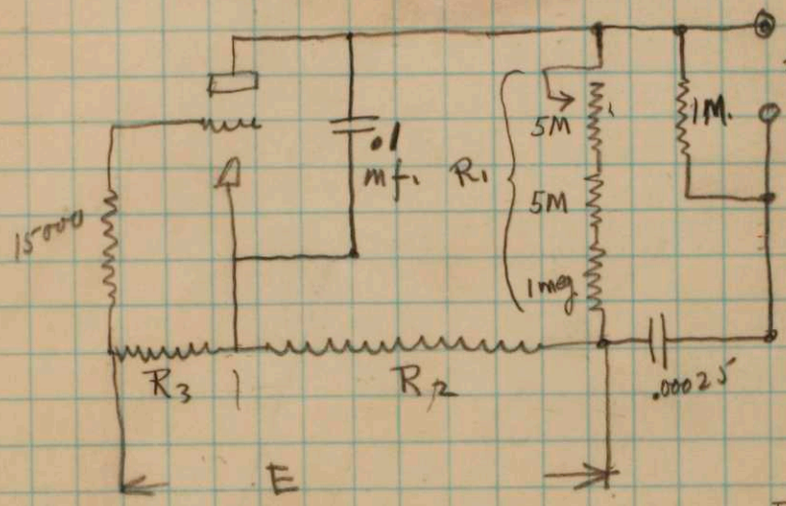
$\frac{210}{8.72}$

$\frac{R_3}{R_2 + R_3}$

$\frac{R_2}{R_3 + R_3}$

4/22/32.

Final circuit of oscillator for test.

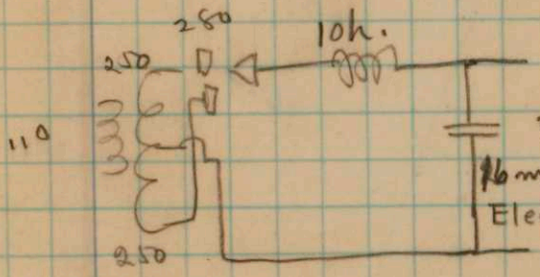


this did just the same as fig 17

fig 30

$E_g = KR_3$

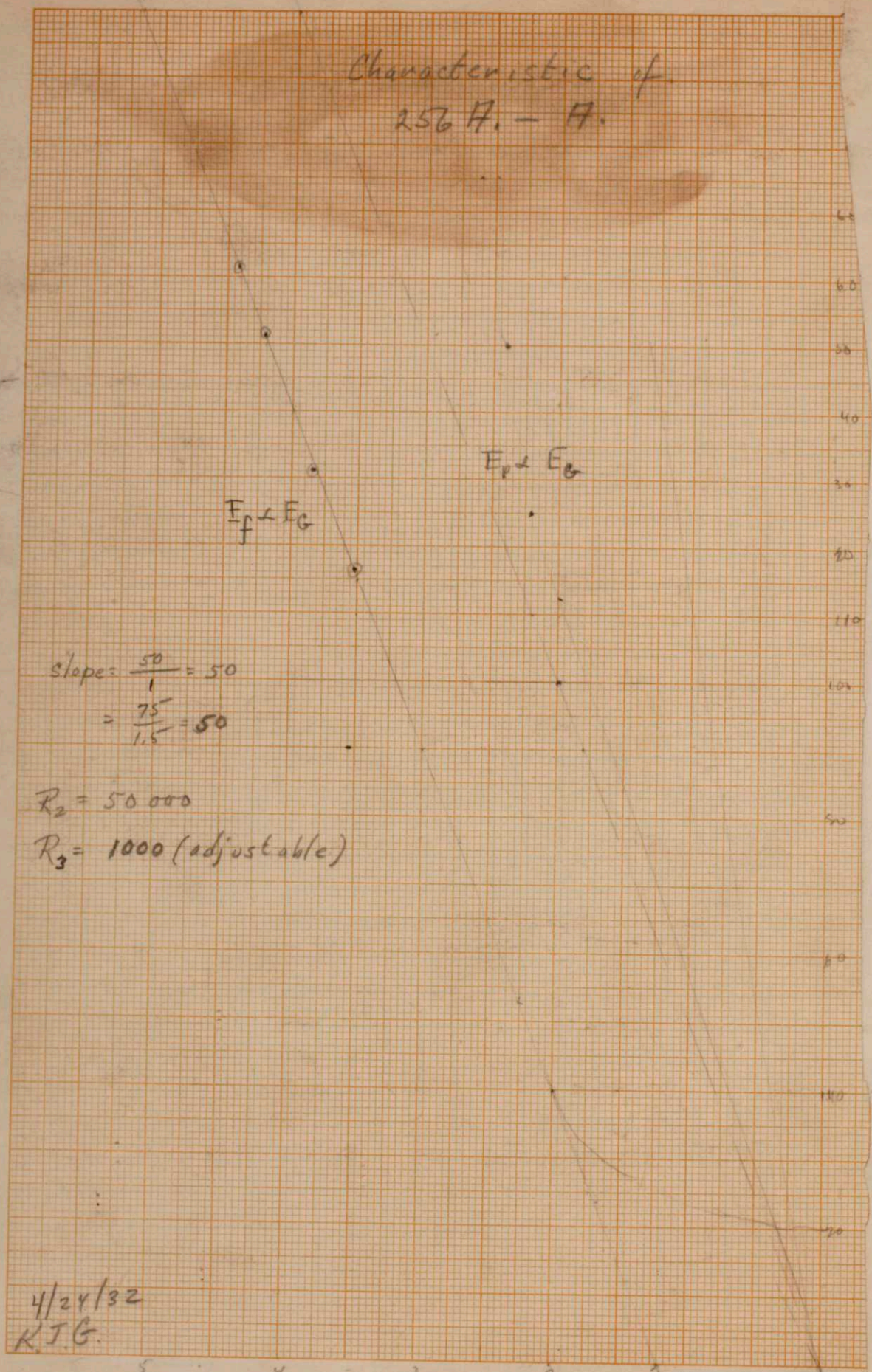
$E_p = KR_2$



Tests for critical ratio of E_p to E_g.

E	R_2	R_3	Critical. R_2+R_3	E_p	E_G	
135	50000	1460	51460	131.2	~~4.75~~	3.84
155.5	"	1390	51390	151.13	~~5.75~~	4.21
166	"	1365	51365	161.6	~~6.25~~	4.42
120	"	1510	51510	116.5	~~4.09~~	3.52
208	"	1275	51275	202.8	~~8.36~~	5.17
216	"	1270	51270	210.6	~~8.72~~	5.35 ✓

Characteristic of 256 A. – A.



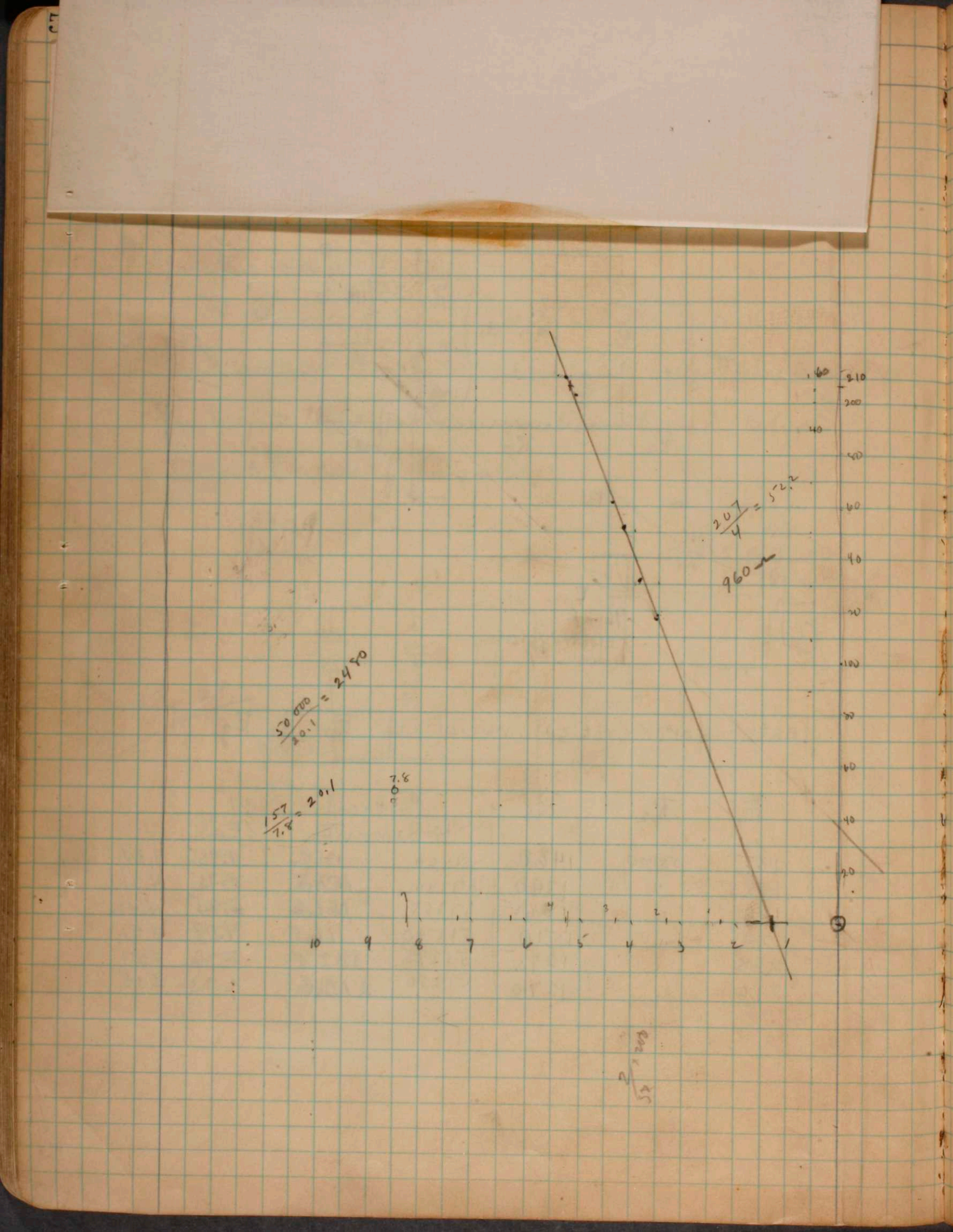
slope $= \frac{50}{1} = 50$

$= \frac{75}{1.5} = 50$

$R_2 = 50\,000$

$R_3 = 1000$ (adjustable)

4/24/32
K.J.G.


$\frac{50\,000}{20.1} = 2490$
$\frac{157}{7.8} = 20.1$
7.8
$\frac{207}{4} = 51.75$
960
10 9 8 7 6 5 4 3 2 1
160 210 200 40 50 60 40 30 100 50 60 40 20

4/25/32.

From the characteristic it is seen that for the oscillator to be independent of line potential the ratio

$$\frac{E_f}{E_p} = k \quad \text{must hold.}$$

E_f = firing voltage.

$$E_p = \frac{R_2 E}{R_2 + R_3}$$

μ = slope of characteristic

$$\mu = \frac{E_f}{E_g - E_{g_0}} \quad \mu \text{ factor.}$$

$$E_f = \mu(E_g - E_{g_0})$$

$$= \mu\left(\frac{R_3 E}{R_2 + R_3} - E_{g_0}\right)$$

E_p = potential across R_2

$$\mu\left(\frac{R_3 E}{R_2 + R_3} - E_{g_0}\right) \frac{R_2 + R_3}{R_2 E} = k$$

when $E_p = 0$

This has no solution since it is obviously impossible for $\frac{E_f}{E_p} = k$ to be true where E_f, E_G and E_p as are on the graph of page 50.

Studying the characteristic more closely we find that the line $\frac{E_p}{E_g}$ must intersect the line $\frac{E_f}{E_g}$ at some point such as where $E_f = 0$ (see fig. 31).

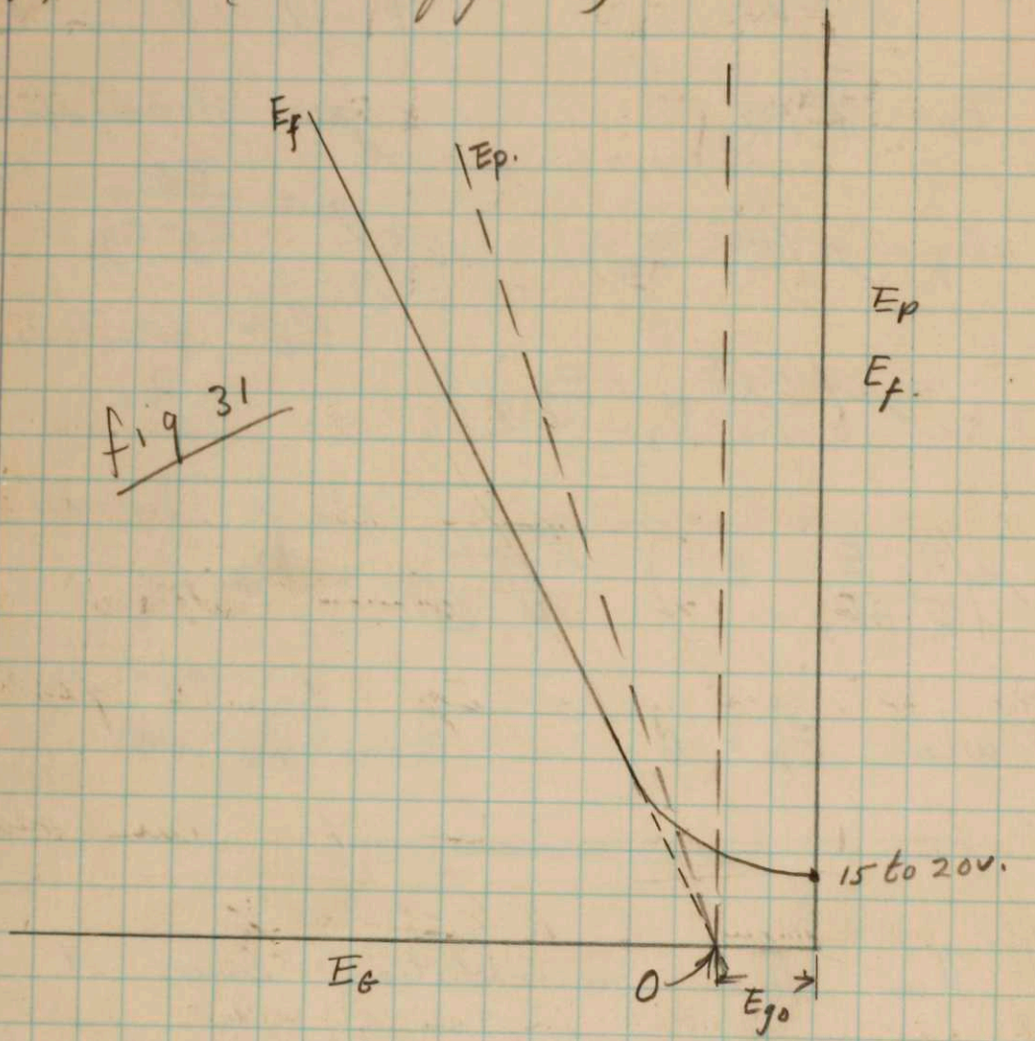


fig 31

First assume that the voltage across condenser C_1 starts from zero on each cycle. From fig 31 it is seen that if we introduce a constant negative grid bias E_{g_0} we shift $\frac{E_p}{E_G}$ so that it passes through point 0. There are now an infinite number

of values of $K = \frac{E_f}{E_p}$ ranging from one to zero that will give an oscillator independent of E.

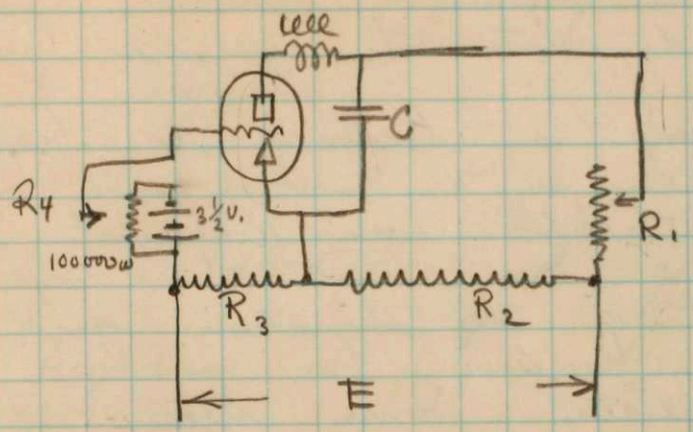


fig 32

We have now that the line $E_p \propto E_G$ must have a slope greater than the line $E_f \propto E_G$ and less than ∞. It should intersect $E_p \propto E_G$ at the extinguishing voltage of the particular oscillator.

We will assume that for this oscillator a desirable value of $K = \frac{E_f}{E_P} = \frac{1}{2}$

We also have the relationship

$$\frac{R_3}{R_2} = \frac{K}{\mu}$$

Assuming $R_2 = 50000$

$$R_3 = \frac{50000}{40 \times 2} = 625 \text{ ohms.}$$

4/25/32

Made tests with the oscillator today and found that even with batteries on filament and plate the operation was still erratic showing a tendency to beat with 60 ~. The trouble was diagnosed as due to the effect of the thyratron grid circuit on the oscillator. Some means of coupling must be found that will prevent this.

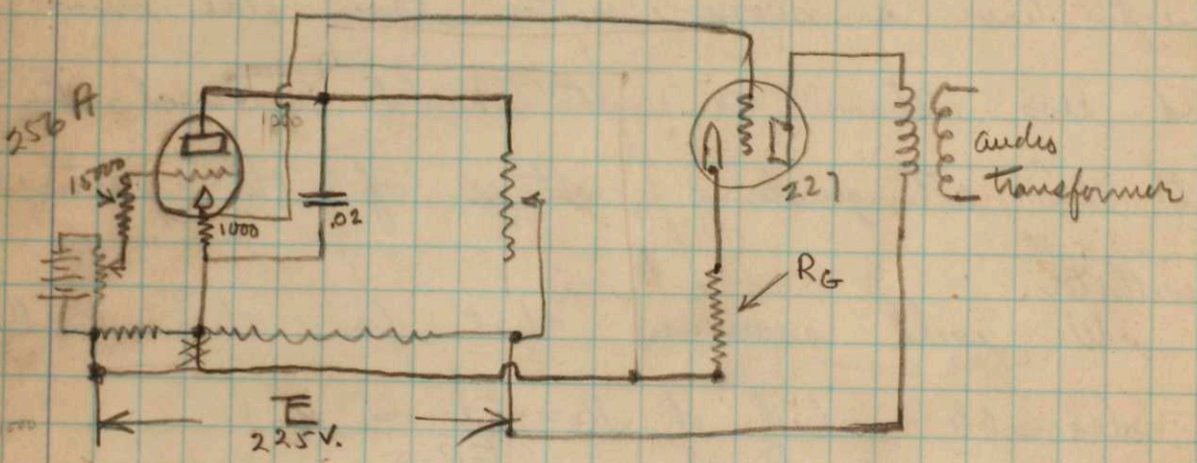


Fig 33

for $E_p = 225$ $I_p = 2$ m.a. $E_G = -23$ V. (227).

$R_G = \frac{23}{2} \times 1000 = 10\,000$ ω.

This oscillator showed marked ~~tendencies~~ to pull into 60 ~ even with a battery plate supply. It was found that the

oscillator is affected by electromagnetic and electrostatic pickup. It is a form of oscillator with no inherent frequency and hence extremely liable to suggestion.

In the present it is planned to discard this form of osallator and go to a form where frequency is determined by L and C.

4/26/32 ← Returning to tube design.

It is thought that for gas filled tubes of the iron cathode type that starting may be more readily accomplished by a method as in fig (34) (See pages 84, 85, 86 book #1.)

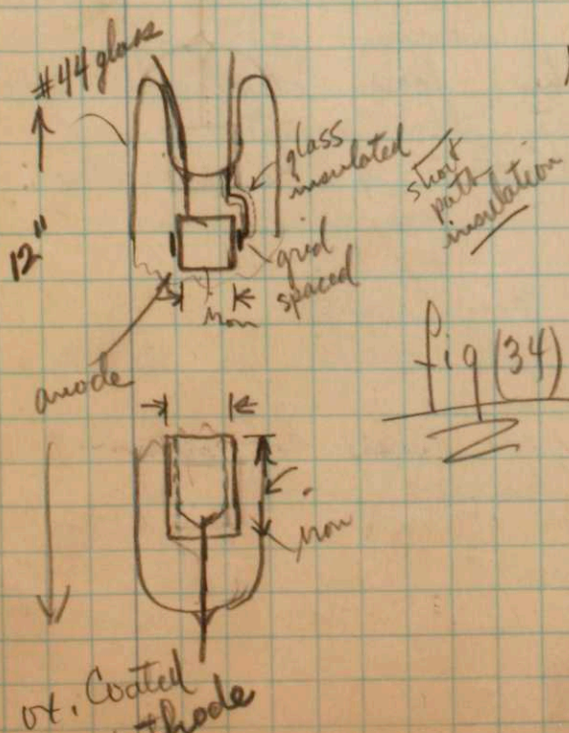


fig (34)

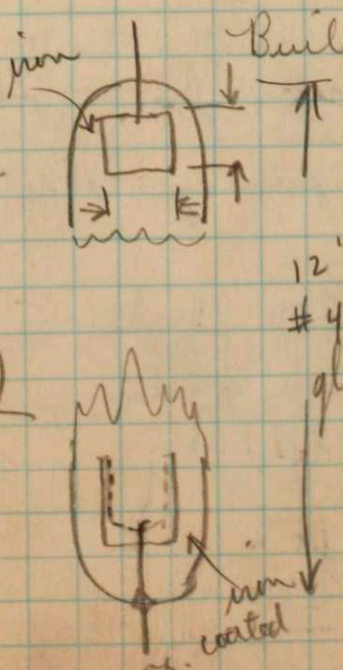


fig 35

References on oscillators. 4/27/32

(1) Neon tube oscillator
EB Lyford Radio N. Je Jl '30.

(2) Vacuum tubes as oscillation generators
J.C. Prince + FB Vogdes G.E. Review. Je; O, '27
F- Mr - Je - O - D '28 My 29.

(3) Periodic contactor operated by neon tube oscillator - H.J. Reich R Sci Instr Mr. '31.

(4) Van der Pol four electrode relaxation oscillator. RM Page + W.F. Curtis Inst + R. Eng Proc N'30.

(5) A New frequency stabilized oscillator system
Ross Gunn. Inst of R Eng. Sept 1930 (good)

S. Reid Warren Jr. - The four electrode tube as a beat frequency oscillator I. R. Eng. Proc. Mar '30.

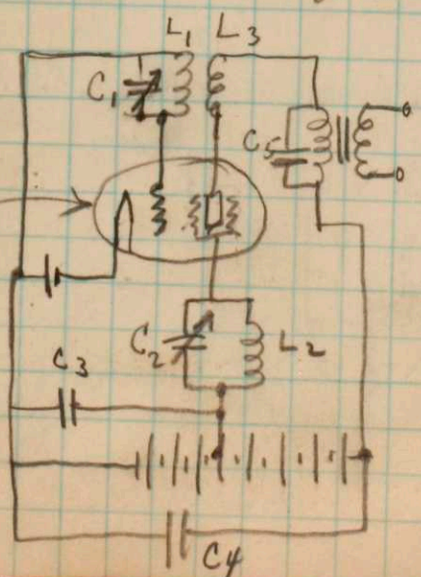


fig 36

UX 222

will oscillate at 32 KC with plate to screen capacity.

4/27/32.

A new idea for an oscillator.

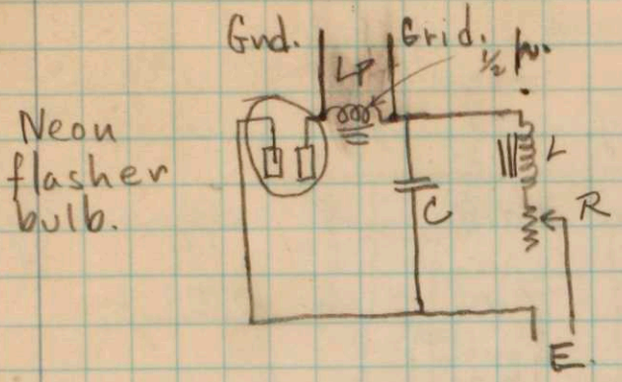


Fig. 37

$L_1 = \frac{1}{2}$ h. open core.

The idea is to use such combinations of R, L + C as to give a near vertical portion to the voltage across the condenser at 260 V. (Fig 38)

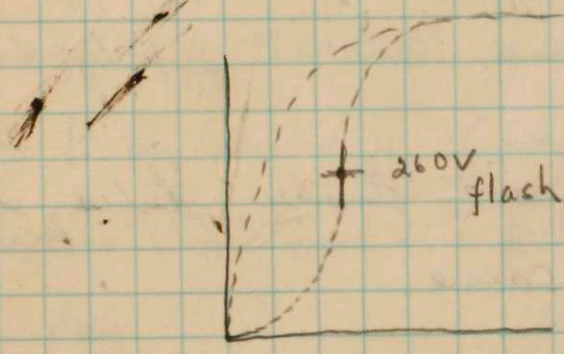


Fig 38

This means that there may be considerable variations in voltage without appreciable variations in frequency.

The best method of approach is test but it would seem that for a step curve R should be small & L should be non linear. The circuit will probably be oscillatory.

To try a small 30 h. choke with air gap removed - 20000 ~ R and .1 mf. C

Tried 2 audio transformers in series with C = .25 but inductance did not appreciably affect the charging time (400 to 600 hunries).
The circuit as per fig 37 is not promising OT works well at 60 ~ or above but at the lower frequencies is erratic. Average frequency is constant but the time per flash varies. Batteries in place of a power supply did not help.

Tried several different flasher tubes but the results were the same.

4/30/32

Started on work taking single photos of bullets.

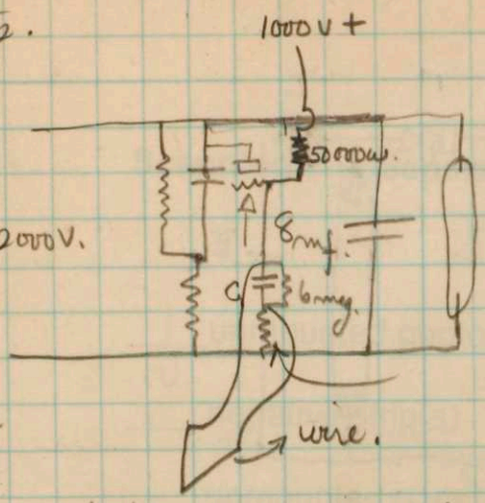


fig 39.

With C = .04 mf. the bullet traveled about 1" after breaking the wire. The wire was across the muzzle of the air pistol. Muzzle velocity about 400 ft per second. 8 mfd. discharge gave good shadow pictures. (f 4.5). More work to be done Monday

Built two tubes today as per fig 40. a, b. Plan to build the third tomorrow and evacuate the lot.

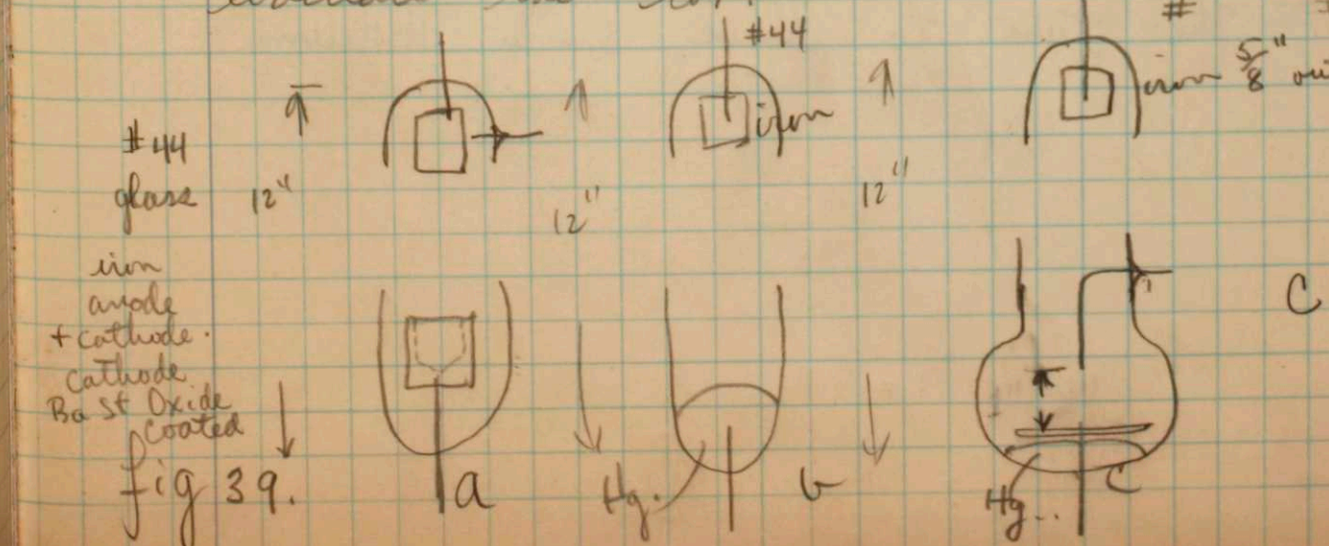


fig 39.

The circuits for these tubes are as per fig 40 a, b. c. (Book 1 – 84, 85, 86) P.

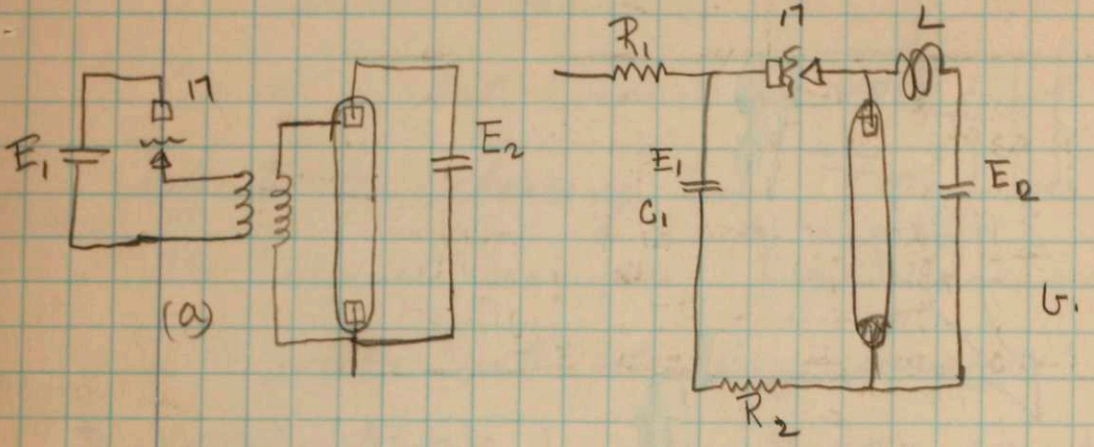


fig 40

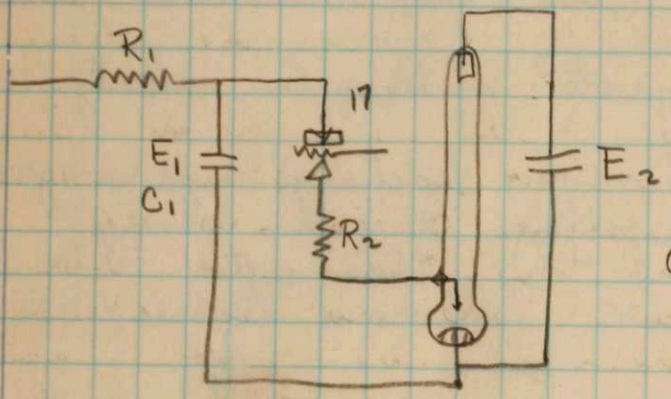


Fig 40 C is new. It is hoped that with E_2 = 400 V an E_1 of 400 V will start the arc. - The tube to have 5 m.m. Helium.

Notebook Number: Germeshausen bk 2

Scanning and Separation Record

__1__ unmounted photograph(s)

____ negative strip(s)

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

was/were scanned where originally located between page 60 and 61.

Item now housed in accompanying folder in MC 25, box 166

5/1/32.

An idea for taking high speed pictures.

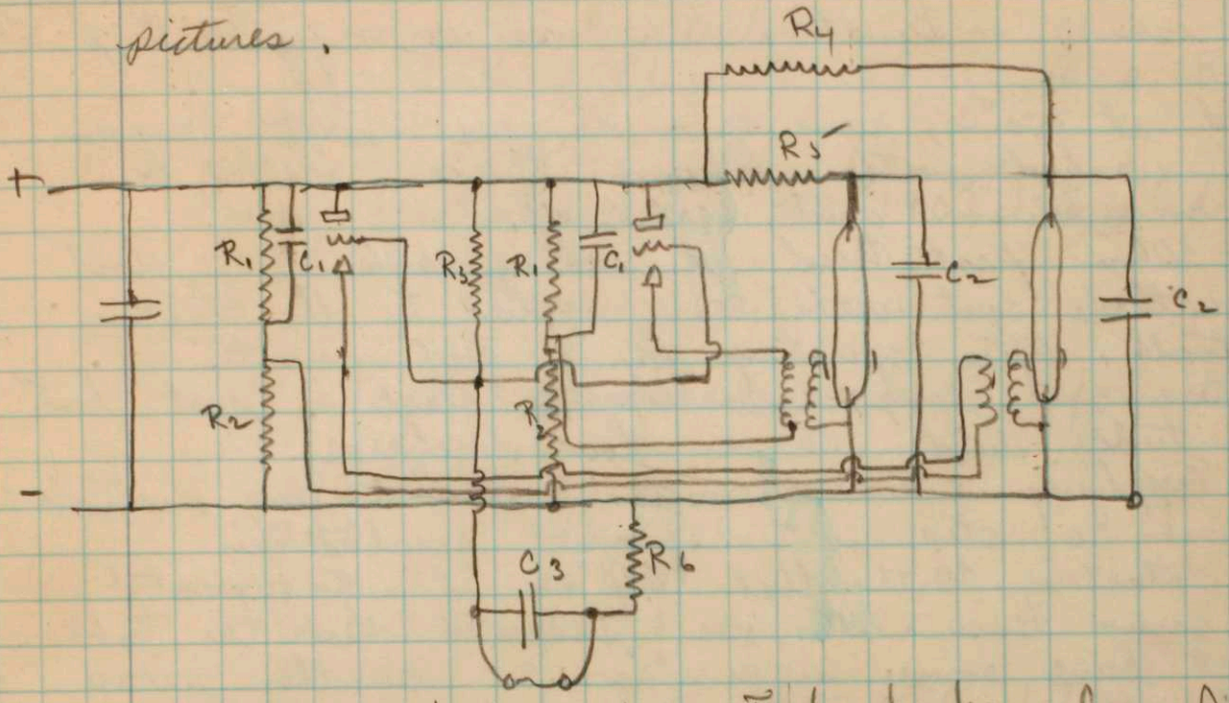


fig 41

Shorting wire. To be broken for firing.

When the shorting wire is broken the thyratrons will fire. The time lag will depend upon bias relations & the value of C_3 and R_6.

The thyratrons may be made to fire in any sequence with any time lag between their firing and the sequence may be made to start any given time after the breaking of the wire.

By this method 5 or 6 successive pictures could easily be obtained at rates of 100,000 pictures per second and up.


10

5/2/32

Kenneth J. Germeshausen

Built a tube as per fig 39 C, p 59.

Baked at 350°C, run as a d.c. arc with 3 amps and washed with helium twice. Filled to 3 m.m. helium and sealed off.

When first tried it was possible to start a cathode spot with 800 v. applied to the starting electrode. After operating for a few minutes it was no longer possible to start a spot but the tube held into a glow discharge.

Applying 3 to 4000 volts to the starting electrode through a step up transformer resulted in good starting. With that set up it was operated for some time. It was suspected that the tube might have some impurities so another was built.

This tube was baked at 400°, bombarded, run as a d.c. arc, washed with neon twice, neon purified by H.F. osc., filled to 2 m.m. and exhausted. 800 v. applied to the starting electrode would not consistently form a spot, the usual result being a high voltage glow discharge. The critical potential from anode to cathode was about 800 v. Reversing the terminals and using the iron as a cathode improved results, the spot forming more readily.

Conclusions - In gas filled tubes with Hg. a spot is not readily formed with a mercury cathode. If a spot is not formed the tube holds into a steady glow of 600 to 800 v. drop. An iron cathode seemed to lend itself to spot formation (possibly a borax coated cathode)

The voltage applied to the starting electrode must be sufficient so enough current is drawn to form a spot on the cathode.

References:—

Danow - Elect discharge in gases.
Penning - Zeits f. Physick 57, 723 1929 - Breakdown of neon.

Voege - Electrotechn Z. 28, 1907 - Breakdown pot. of various gases.

Vapor pressure vs. temp. for Hg.

270° C -	123.9 m.m.
300	246.8
350	658.0
360	784.0

- Minimum sparking potential between plane electrodes exists when

$ps = 3$ (neon) p = m.m.
$ps = 4$ (helium) s = spacing cm.
$ps = .9$ Argon ?

purify gases by high freq. discharge.

for neon at 2 m.m. $s = 1$ c.m.
" " " 5 " " $s = \frac{3}{5}$ c.m.
" " " 1 cm. $s = \frac{3}{10}$ m.

let s = 2 m.m.
then $p = \frac{3}{.2}$ = 15 m.m. neon.

~~Vapor~~ Normal boiling point of Hg = 320°

Density of vapor at 320° = .020 v.p. - 373 m.m.
Density of liquid = 13.54

for neon

5/13/32.

I have been working with Draper on the taking of high speed photos.

Pertinencies:

We have had the spark circuit operating at 4000 ~. If the gap breaks down at that frequency the air doesn't have a chance to deionize and tends to break down at low voltage.

- .1 mfd. at 1000 V. gave ample spark. improved high freq. + consistency. - at least 2000 w. in the charging circuit.

- High impedance in the main charging circuit does not necessarily prevent hold over. - ½ mfd. and 500 w + 2 hen. works well up to 3000 ~. (1,000 V).

- Recommend a charging choke - swinging, and experiment until proper charging impedance is found.

5/14/32 Eureka!!

Kenneth J. Germeshausen.

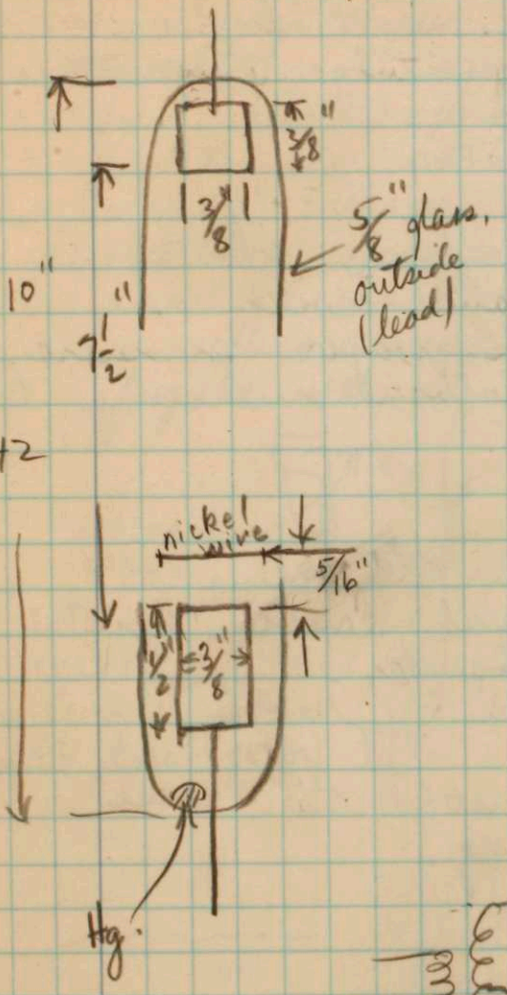
Built a tube as per figure 42

Anode and cathode of iron 1/32" thick. Cathode coated inside with fused borax.

This tube was baked for 1/2 hr at 360° C. - Both electrodes thoroughly bombarded and then the tube was washed with 1 m.m. neon.

It was then filled with 3.5 m.m. neon and the gas excited with the bombarder, care being taken not to heat the electrodes. - Tube sealed off immediately.

It was connected in a circuit as per figure 43.



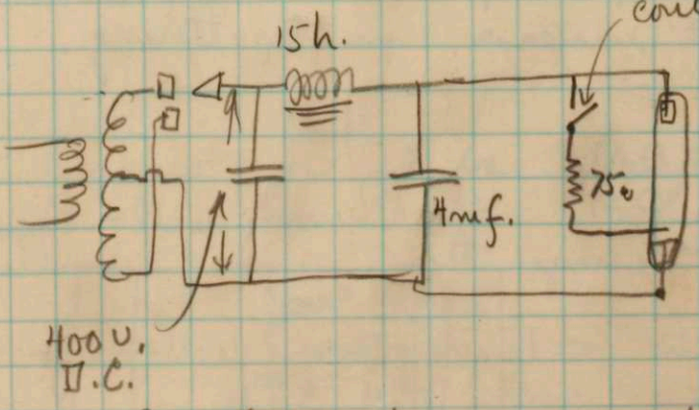


Fig 43

Time Record and comments -

Started at 11 a.m. - Ran O.K. but showed occasional tendency to break down spontaneously. Voltage probably a little to high. - Was operated at about 60 ~ but overheated. When too hot it refused to fire or held over at random.

- Speed was reduced to 30 ~ and kept about there.

- 1 p.m. Slight cathode sputtering - Operation much more consistent with less tendency to extraneous firing. It is noticed that there is

very little current in the contactors, there being no visible sparking. - This is partly because as soon as the arc starts the voltage is automatically removed from the contactors.
— Color of the light at operating temperature a reddish white.

Suggestions. -

A mercury lamp the same as #42 but without neon and with a heater to keep a reasonable vapor pressure.
— Mixtures of gases without mercury to give a good light color.

Off at 2.25 P.M. - Operation the same -. Quite steady with an occasional double fire. + Slight increase in cathode Sputter.

Sun - 15th.
9.15 A.M. to 1.15 P.M. - Operation the same with slight increase in sputtering.

Mon 16th.
9.25 A.M. on
5.00 P.M. off. Running well - slight increase in sputtering

This tube still operating well - for new design see page 74

This tube operated another 15 or 20 hours and still operated well - Sputtering objectionable but not too bad.

5/16/32

It has been noticed that successful use of internal starting electrodes depends to some extent on cathode contamination. A small mercury tube with an internal spark electrode would not operate well until the tube had first been operated with the external electrode. After the cathode had sputtered operation was much more consistent. — An internal spark electrode operates well only when the tube is warm. —

This suggests a tube of the form as in figure 44.

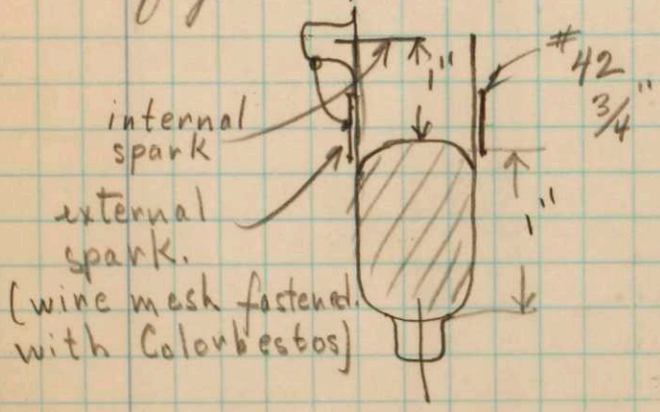


Fig 44 —

Circuit for Tube of pages 65 + 66.

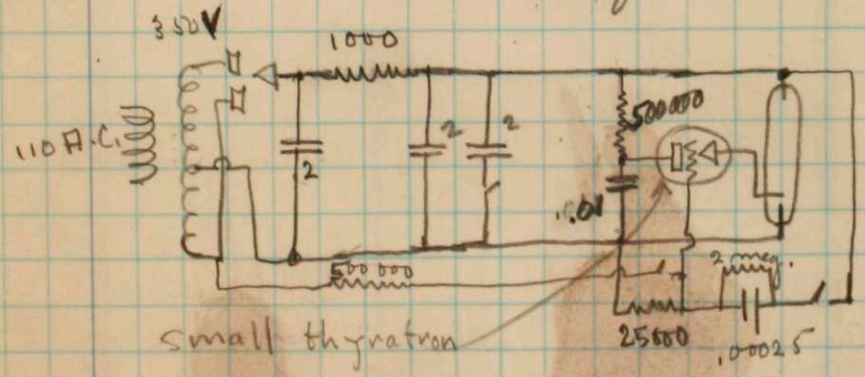


Fig 45 —

May 16 - 1932

Pictures taken. 4 lamp in parallel
2 mfd at. 1000 v. per lamp. ——

May 18, 1932.

Thoughts on high speed stroboscopy.

The use of a grid to clean up ionization and prevent conduction until the desired moment.

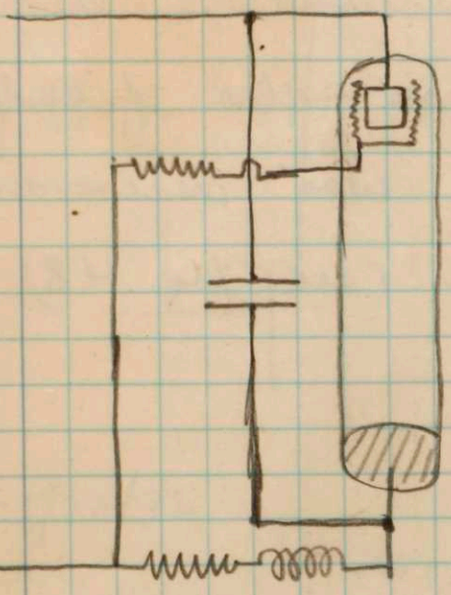
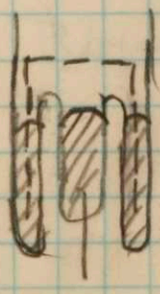


Fig 46.



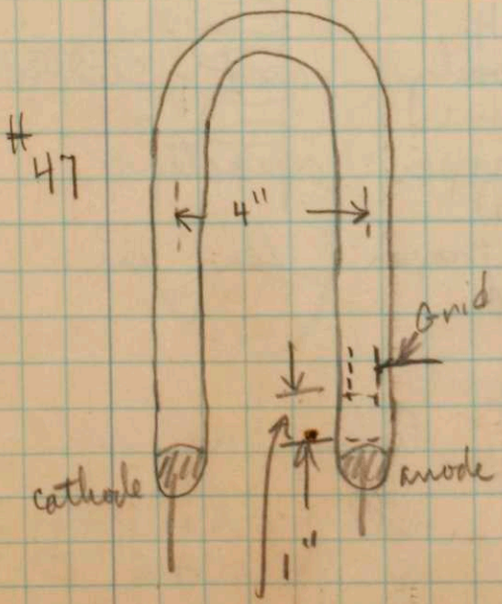
May 19, 1932

Built a tube as per figure 47.

#44 glass - length 22"

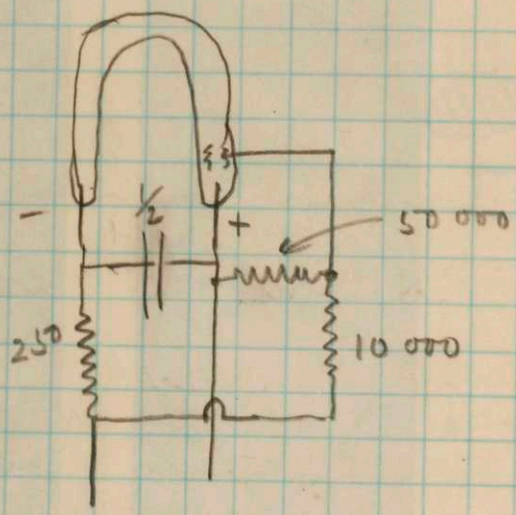
Grid of nickel screen ½" diameter 3/4" long. Pumped operating stroboscopically on the pump. It was found that operating stroboscopically at 1000 V. that 90 V minus on the grid would extinguish the tube when cold. When hot -90 V on the grid was not sufficient to control.

#47



This tube was operated at 4200 cycles with ½ mfd. and 250 Ω charging resistor. (No choke.) It was found that about 10 000 Ω was needed in the grid circuit and it was also found that some positive bias was necessary to operate at 4200 cycles. (see fig 48)

Fig 48



The grid sputtered badly and shorted to the anode preventing proper operation. Suggest iron grid with proper lead in insulation.

Built as straight tube as per figure 49. It operated well showing grid control but in a circuit as

per fegure 48 it would not run abroove 2400 cycles, but missed every other cycle.

#44 lead glass

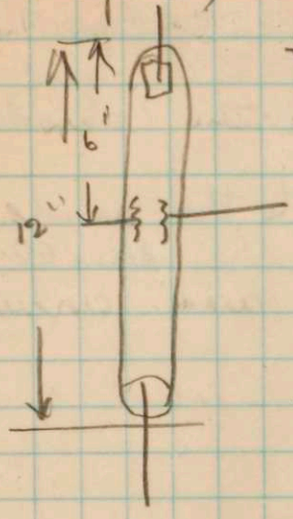
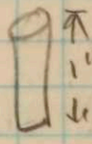


Fig 49

grid 3/8" x 1"



iron screen.

Grid control to effective, probably needed positive bias. as per fig 48.

5/22/32

Things going poorly.

Built a tube as per fig 48 with an iron grid as per fig 50.

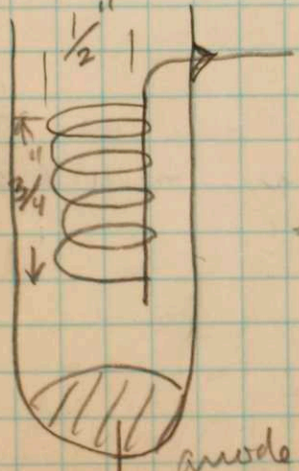


Fig 50

This tube would not work properly High grid bias with low grid impedance was needed and this tended to allow holdover. Probably caused a glow discharge due to high potential gradient. - Tried tube of fig 48 again but it would not work, appeared to be gasy.

Thoughts:

1. The grid should be made much more complete so that less grid bias and less grid power will be needed for control. This will prevent the tendency of the grid to break into glow discharge to the anode or cathode.

2. Place the grid close to the anode so the space to be cleaned will be small.

3. Suggested trial tube and circuit are shown in fig 51.

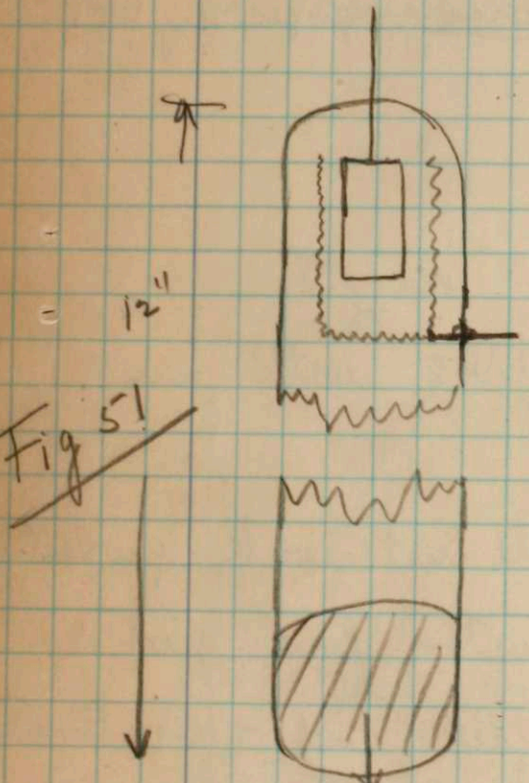
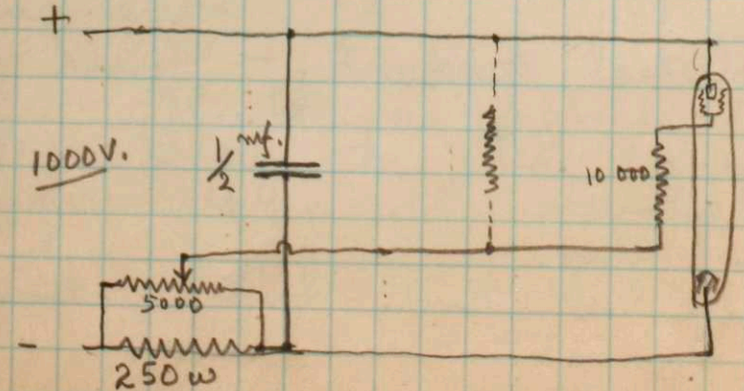


Fig 51

#44 lead.
11/16" inside dia.
Anode: Iron 3/8" x
Grid. Wire screen mesh —
1/2" x

Treatment: To be run on the pump as a d.c. arc. — Mercury bombarded.

Circuit.



The tube of page 69 is to be duplicated but the grid will be made twice as long with a crossectional piece of larger mesh. It should be used in a circuit as on page 72.

5/23/32

Kenneth J. Germeshausen

Built two tubes as per fig 5.2. Anode and cathode of 1/32" silicon steel. Cathode coated with fused borax. Tubes baked at 350° C and electrodes thoroughly bombarded. Washed with neon.

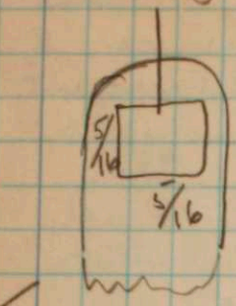
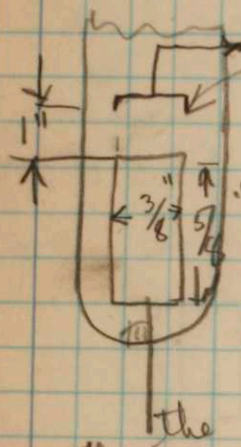


Fig 5.2



#1 was filled with 4 m.m neon and a drop of Hg.

#2 a mixture of neon and argon to give a purplish white. Total pressure 2 m.m.

Observations:

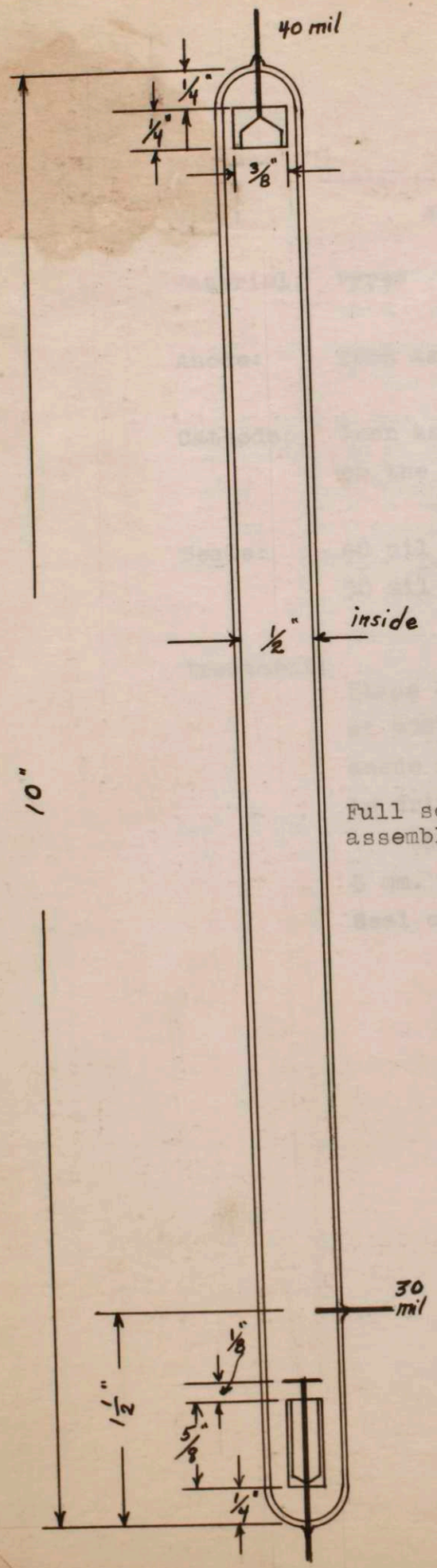
These tubes were operated in the conventional Stroboscope circuit (400 V d.c.). The both showed some difficulty in starting, #2 would not run at all with pressures of greater than 3 m.m. This was probably do to the shielding effect of the cap. Reversing the spark coil improved operation (should be so that last half of cycle makes grid plus) This difficulty is obviated in the new design (p 75)

The mixture of neon + argon gives less light and shows more tendency to hold over and erratic operation. It would seem that the neon Hg. combination is best from the stand point of light quantity, quality and consistent operation. Its objectionable feature is the color change but this occurs after 2 or 3 minutes of operation.

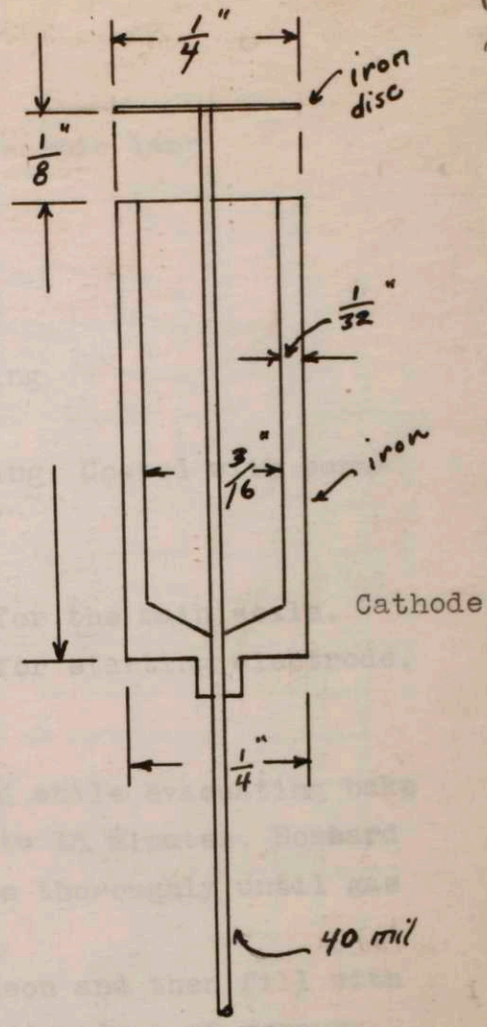
Tube #1 is to be put on test at the Russel Box Co in the conventional circuit. (400 V.).

6/3/32 #1 was given to Lamson who has operated it for 20 hours or so. Still running well but it shows some sputtering

P 75



Full scale assembly



Cathode

Design of a stroboscopic lamp

sheet no. 1

May 23, 1932

K Germeshausen

P75

Design of a stroboscopic lamp
sheet no. 2

Material: Pyrex

Anode: Iron as per drawing

Cathode: Iron as per drawing. Coated with borax. on the inside.

Seals: 40 mil tungsten for the main seals.
30 mil tungsten for starting electrode.

Treatment:
Place on pump and while evacuating bake at 400°c for 10 to 15 minutes. Bombard anode and cathode thoroughly until gas is driven out.

Wash with neon and then fill with 5 mm. neon and add a drop of mercury. Seal off.

May 23, 1932.

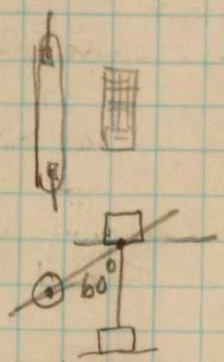
H Germeshausen

May 24 1932

Kenneth J. Hammerhausen.

Tube #2 of Page 74 was tried again. It is thought that part of the erratic behavior is due to low gas pressure and electrode shielding. Some pictures were taken. 7 mfd. at 600 V. Lamp at 3" angle about 60°.

figure 53



These were taken on positive film and the results are shown in figure 54.

Fig 54

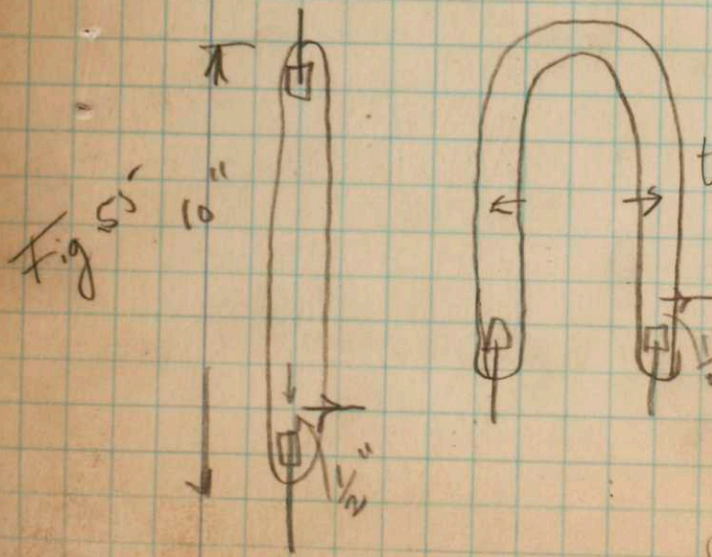
30 f.p.s. continuous film.

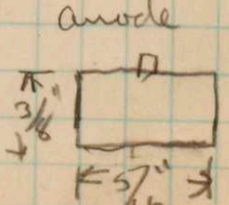
Tubes should show nearly twice the speed.

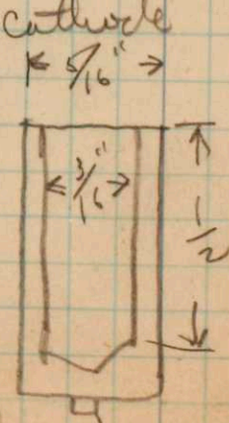
These lamps seem to have possibilities and it is decided to build two as per figs 55 & 56

glass lead ½" inside.

Fig 55







cathode borax coated.

anode & cathode of aluminum

May 31 1932
Kenneth J Germeshausen.

A tube was built as per fig 5-5 (horse shoe type) aluminum electrode. It did not work well, tended to hold over & not to start at all. Aluminum did not sputter but emissivity was low and spot forming uncertain.

Built a straight tube as per fig 5-5 12" long. Anode iron, cathode tantalum, Borax coated. 6 m.m. neon + Hg. This tube worked well + was put on life test. This tube with the tantalum electrode was operated for 15 hours @ 3 mfd at 400 V. It showed sputtering but it was not too objectionable.

June 13 1932

Current in spark circuit at 4200 f.p.s.

R = 1200 ω C = .1 mfd. E = 1000 V. (2 866's)

I = 465 M.A.

June 14 1932:

Resume.

High Speed. Took pictures of Compur shutter at 4200 f.p.s. — — — The lamp was the usual type 12" tube and 18" tube. It was noticed that all tubes of similar construction would not operate at this speed but hold over. It is thought that these tubes must be hard.

5000 cycles is a probable limit to FG 67 operation. Tubes may not need grids. Large glass area helps ~~d~~ionization.

Started to rebuild power pack in anticipation of a job for Lever Bros.

Mon June 21. 10:30 to 12 with Ben Holger. G R in aft
Tues – a hard day no sleep + liquor
Wed. G R in morning.
Thurs. G.R. – Wattl picture –

Thurs June 30 1932.

Test on Jumbo power pack.

Transformer. 3 KW. special # (Interrupter

Choke – .3 Hen. – 3 amp. special laced one #

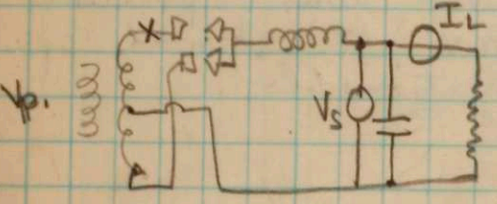
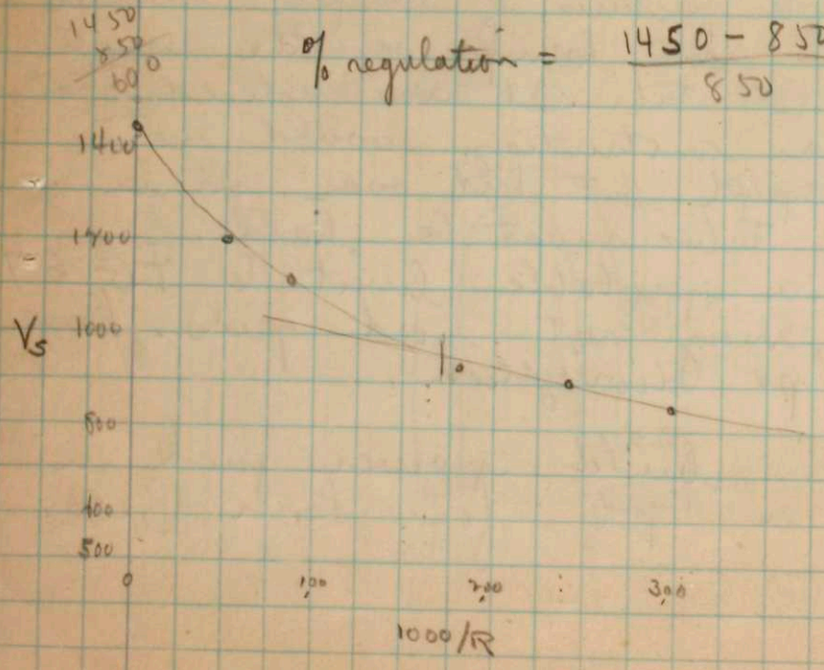


fig 56

Assume V_P = 115 V.

V_p	V_s	$I_{p_{D.C.\ AV.}}$	V_s corrected for V_p drop.	R	
					I peak current at X
114	1430	0	1450	∞	7 ← (condensers discharged)
109	1140	.60	1200	2000	2
106	1030	1.0	1120	1120	3
103	865	1.75	965	550	4.5
99	775	2.15	900	420	5.0
97.5	720	2.50	850	340	5.5

$$\% \text{ regulation} = \frac{1450 - 850}{850} \times 100 = 70\% \quad ?$$



Kenneth J. Germeshausen

Thurs June 23 1932.

Something must be done about tube life and starting.

Make two tubes — one with a bit of thorium on the Hg and the other with iron chips.

— Standard 12" —

Perhaps an internal electrode will work with granulated iron — Effect of

— Effect of shape on dionization.

June 27 1932.

Tests on Spark supply:

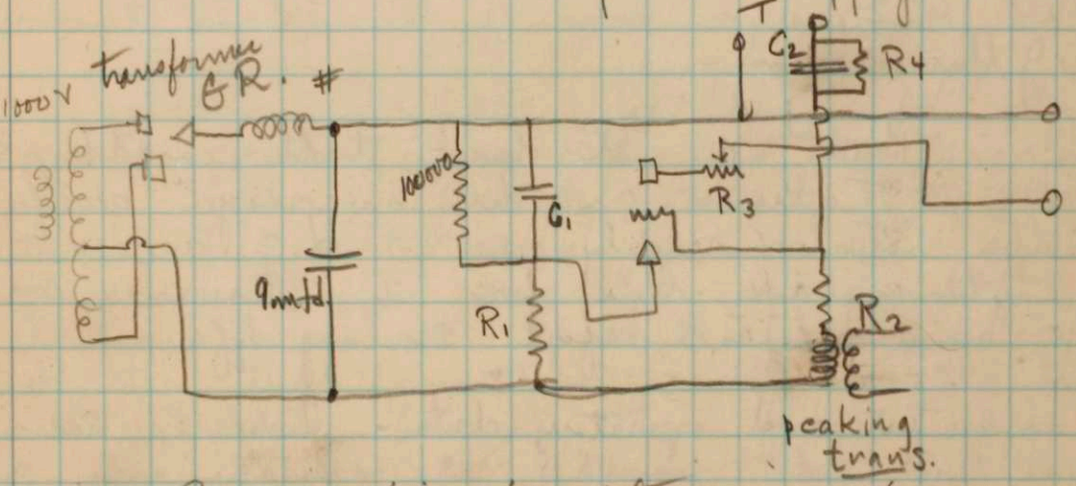


fig 5-7

Experimenting to determine best constants:

Observations.

With

$R_1 = 1000$

$C_1 = .1$

$R_2 = 10,000$

$R_4 = 10^6$

$C_2 = .00025$

Results good up to 4000 V —
Unstable on closed contacts.
Breaks at 4000 V - 60 ~ leak.
No hold over
Variation of Any of the Constants

did not seem to improve results.
Oscillograph shows that C_1 is not being fully charged though the time constant = $\frac{1}{10^4}$.
R_1 cannot be reduced below 1000 Ω.
- Probably time of discharge is appreciable and causing trouble.
- 4000 ν seems a limit.
- Past experience shows changing chokes of little value.
- Oscillograph shows ample filter.
- Try less C_1 -

June 28 1932
Kenneth J Hammerhansen -

Built a standard tube with some metallic thorium on the mercury surface.
Tube starts readily as a d.c. arc.
This tube was run for 2 hours on the pumps as a d.c. arc before sealing off.

Life test and operating data - Tube darkened so badly that it would not operate as a stroboscope - The next tube to have less thorium.

June 28, 1932.

Report on Strobograph tests.

Power Supply - See page 78. - O.K.

Spark -

$R_1 = 3500$ $C_1 = .25$

$R_2 = 5000$ $C_2 = .0025$

$R_3 = 100$

$R_4 = 1$ meg.

With the circuit as on page 79 and constants as above, the spark gave consistent stable operation up to 1500 v with sufficient intensity to operate four tubes. - This was about the limit of good operation.

With $R_1 = 2000$ $C_1 = .125$ mfd. others the same. good operation was secured to 4000 v or more with sufficient intensity to operate one tube. Difficulty was found in pushing the frequency higher and it is doubtful if it is practical at present because (1) The glass of the tube punctures readily 2. The tubes will not operate above this frequency.

The oscillograph shows that C_1 is never fully charged. This indicates long discharge time as charging time is 1/5000 second.

Tubes With 2 mfd each - 500 v charging and the primary of a filament transformer for a choke ( ) the tubes operated without holdover from 0 to 1500 v. The question of the effect of discharge circuit length not definitely settled. It appears that for the range from 0 to 5000 v one set of cond. and resistors will serve. - Operation will check this. The presence of the choke did not lengthen charging time measurably. - Tubes overheat at 60 v. - Continuous operation question.

June 30, 1932.

At slow speeds stigmation fires both on make and break. Trouble due to sparking at contactor on the break. Samson suggested remedying this by increasing R_1. This will accomplish the result if R_1 is very large but there is still sparking at the contacts and if keying is used flashes will be obtained on make and break.

My suggestion is shown in Fig 5-8.

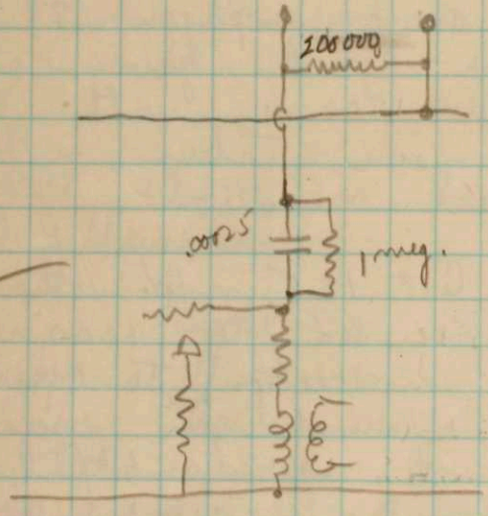


fig 5-8

This solves the difficulty O.K.

July 5th 1932
Kenneth J Germeshausen

For single pictures a light source of high intensity would be desirable. — (See figure 59)

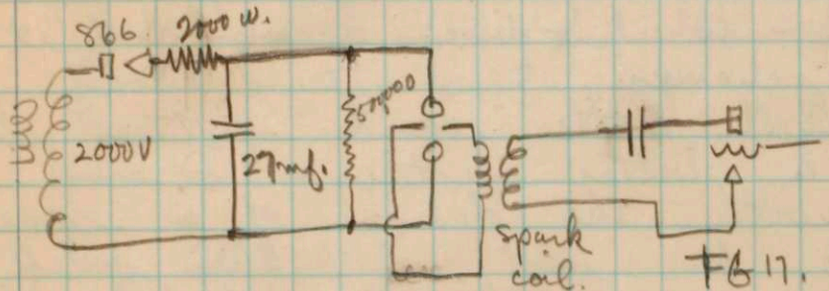


fig 59 A.

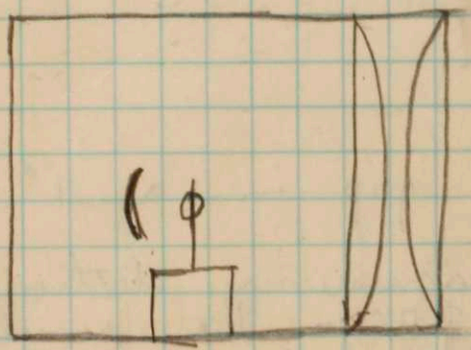


fig 59 B.

A spark gap with Mg. electrodes in a spotlight assembly will give ample light for single photographs and will be very convenient. - Start design. - Could be used at A. D. Little's

Must get equipment not so makeshift for studying such problems.

July 6 1932
Kenneth J. Gunnelhausen

Saw Lawson. - He is busy with 548-B production so I will go ahead with the design of the large unit. - Saw their small contactor - wheel + disc drive - and it needs some changes.

— A.D. Little wants pictures showing more detail - a better picture - I am going ahead with the design of a spark gap unit to be used in this work - Since it is possible to withdraw the jet from the tower I think this method will give excellent results - See design sheets.

July 11, 1932 -

built a gap in a 9" parabolic mirror reflector.

With magnesium electrodes (½" dia) - 27 m/d - 2000 v R.A.C. - The results obtained are shown in the following pictures - (The reflector had a glass front.)

July 20, 1932

built a standard 12" tube, Hg pool with iron filings added. - (third electrode) This tube operated erratically with the inside sparker but operated well in the conventional fashion. - Tube is now on test and results will be given later.

July 27 1932.

Kenneth J Germeshausen

Got some thorium wire from Percy Spencer to repeat experiment of page 80 wire is inches and two pieces of 1/4" were floated on the pool.

July 29, 1932

Made tests on the spark gap today to determine light duration.

Set up.

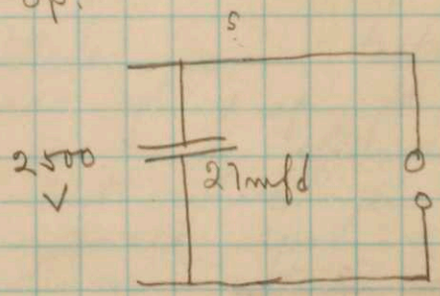


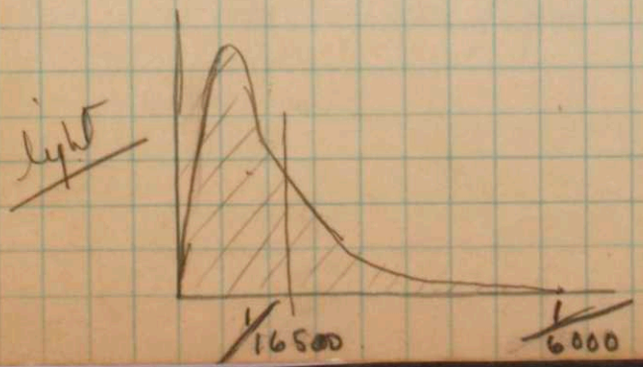
fig 60.

Leads from condenser stranded about #10 light. length 20" total. Used Stark's camera, film speed 1100 inches per second.

fig 61.

film in motion

film still.



Aug 9, 10, 11.

Performing tests on Mg. gap. - Results are shown in attached plans. These were tests on time of flash with various voltages and capicitances.

Did some work photographing falling drops.

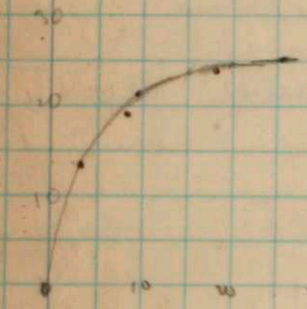


Fig 62. dist.

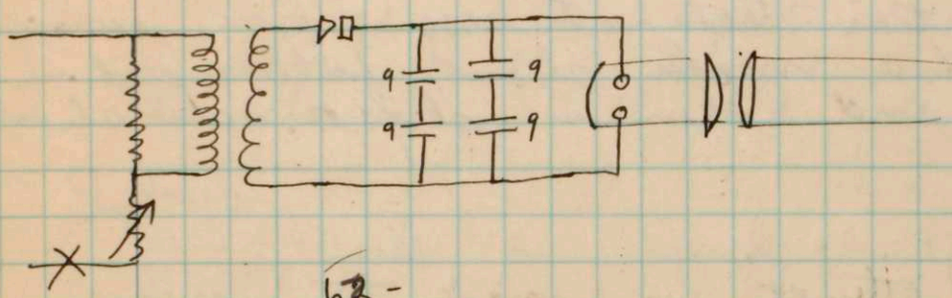
attached films and computations show data on falling milk drops.

Fig 62 is a plot of velocity versus falling distance

Aug. 22, 1932.

Kenneth J. Germeshausen.

Took pictures at Lever Bros. Apparatus as in fig. 63.



63 -

Pictures taken at f 11. — tests to be made on time of flash with this set up.

— Made some tests on optical systems. For areas of 1 sq. ft. or more the parabolic reflector is more efficient than the condenser system but where the light is concentrated into a small spot 3 or 4 in. in diameter the condenser system is decidedly better.

Aug 26 1932

Took more pictures at Lever Bros. of thin soap.

The new high speed camera has been equipped with a D.C. motor and attempts will be made to speed up the equipment to 1480 f.p.s. (full frames)

Aug 27 1932.

Some trouble is being had to secure accurate framing. Even with the commutator directly on the camera framing is bad. The answer is probably interaction of the spark & main circuits. Eventually they will have to be separated.

Acceleration tests at 2000 r.p.m. using the 1/6 h.p. d.c. motor show full speed in 20" of film and then a slight over-shoot.

Sept 2 - 1932

An attempt was made to increase camera speed by reducing the field but the 1/6 h.p. motor will not drive the camera at more than about 300 frame. -

Work on pictures for Dr Peterson.

Sept. 13, 1932

Timing gadget for Spark outfit.

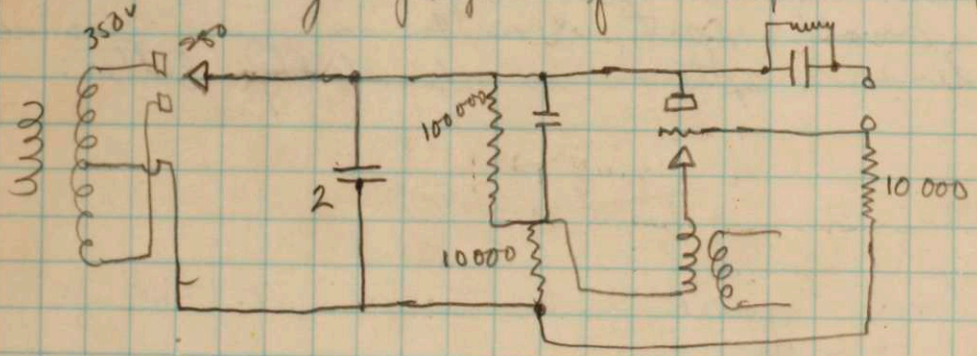


fig 64

Sept 16 - 1932.

Have been taking sparktimed photos of golf balls being struck. -
9 mfd 7000 v. Mg. electrodes. f 11.

Suggestions made that a mechanical striker would aid in securing and descriptive series, possibly movies. -
Tried motion pictures but club head moves too fast. - Suggest some tests at 1000 f.p.s. to determine ball and club speeds.

Sept 19 -
Work on Spark outfit.

Circuit.

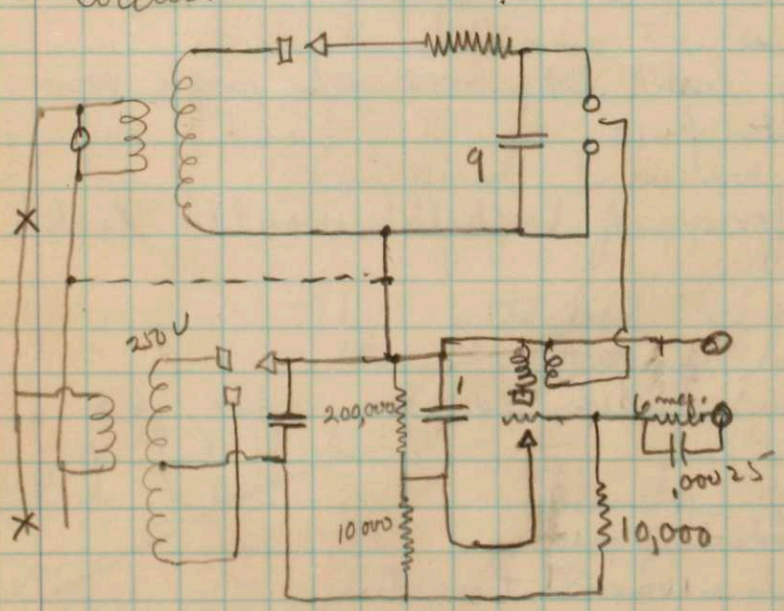


fig 15

Sept 27th 1932.

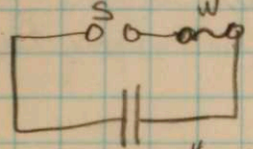
Spark outfit finished + tested at A. D. Stiles
Light direct no condenser lens. -
Special A.V. plates show less sensitivity than super pan plates or films.

Results do not compare to those with previous set up.

Sept 26 Preliminary tests indicate 4 to 5 times increase in light flux exploding wire in series with spark gap. - Try Hg lamp.

Sept 29th.

Made some tests on circuit as shown at A. D. Little



Wire = #40 phosphor bronze 3/8" long.

C = 1 4/5 mfd. S = sphere gap - 1/2" spheres 1/2" gap.

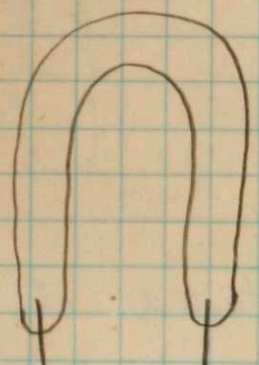
Voltage = 20000.

At 4' a very light exposure on super pan. Quartz lens at f:16

— Some form of reflector would double the light.

Oct-5- made a tube as per fig 66

Fig 66



Glass 1" pyrex
seals 100 mil tungsten
total length 12"

pumped hard - and blew it on first discharge of 9 mfd 7000 V.

.0085
.001

Oct 8 1932.
Kenneth J. Germeshausen.

Tests on the spark outfit.

Oscillation difficulties stopped by C_2 fig 67

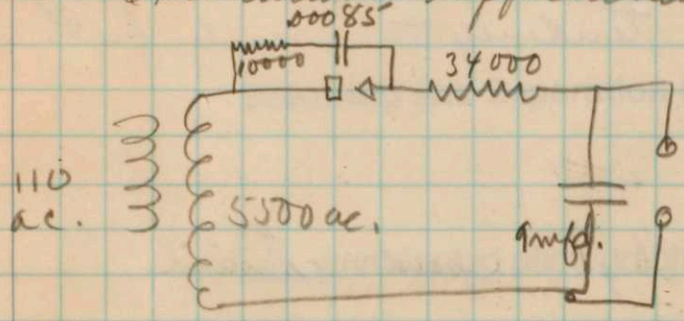


fig 67.

Tests - Compared Voigtlander Illustra plates with pleachrome film pack and found approximately the same speed.

Compared Brownie Lens with Skopar and found approx. the same speed.

The attached negatives show results obtained. Distance Lens to light 28"
" camera to subject 24"
" Lens to face of box 1" (marked)
Diameter of lighted spot 5"
Lens used Skopar Set op f:32
Brownie lens at distance to give same image size.

charging time 20 seconds

Notebook Number: Germeshausen bk 2

Scanning and Separation Record

1 unmounted photograph(s)

____negative strip(s)

____unmounted page(s)
(notes, drawings, letters ...)

was/were scanned where originally ~~located between page~~ in place on page 92 ~~and ____~~.

Item now housed in accompanying folder in MC 25, box 166

Oct 18 1932

Kenneth J Germeshausen.

Test on ¼ horse single phase 3600 r.p.m.

Motor reaches ¾ speed in about 10 ft film but shows no tendency to reach full speed.

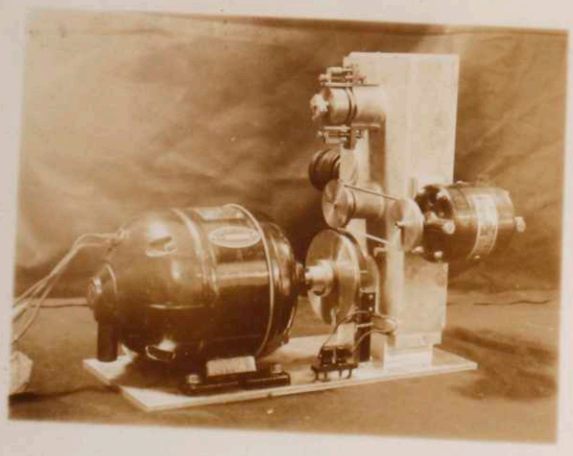
Oct. 30, 1932.

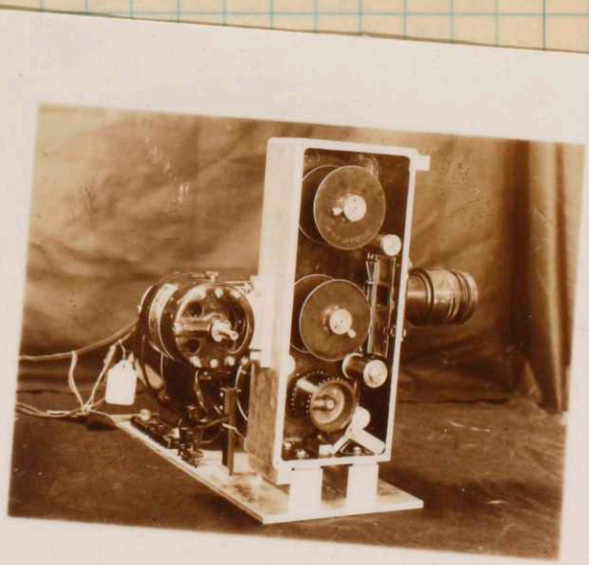
Waking with high speed camera.

Series motor placed on take up reel as per photographs.

With ½ H.P. 230 V, 1800 r.p.m. d.c. motor on main shaft at 440 V. and a 110 V, 10 000 r.p.m. series motor at 220 V. the camera operates o.k. coming up to about 570 f.p.s. in 3 feet 2 film.

Long strips were made and Ellis took some to be developed.



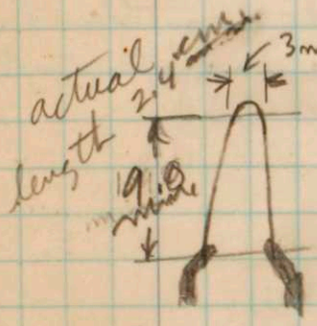


Nov. 1 1932.

Design of a Kenetron.

Filament of 8 mil tungsten 2.2 cm. long. in 250 bulb. 2.5 Volts 3.4 amps.

Nov 1. 1932 Kenetron # 1.



Filament

8 mil tungsten

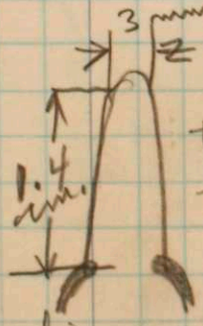
-pumped on production system. Gage read 1.65 on meter or less than .1 micron. Thoroughly bombarded baked and filament run at 4.9 amps for 5 min.

fig 68.

Tests (I_f = 4.1 rated E_p = 1.75 V.)

Forgot and corrections for current. With E_f = 2.5 V. I_f = 5.2 amp. Temperature = 2600° K R_p = 5000 ω. ~~to~~ at 40 mil.

2 + 3. same as one but filament as per 69.



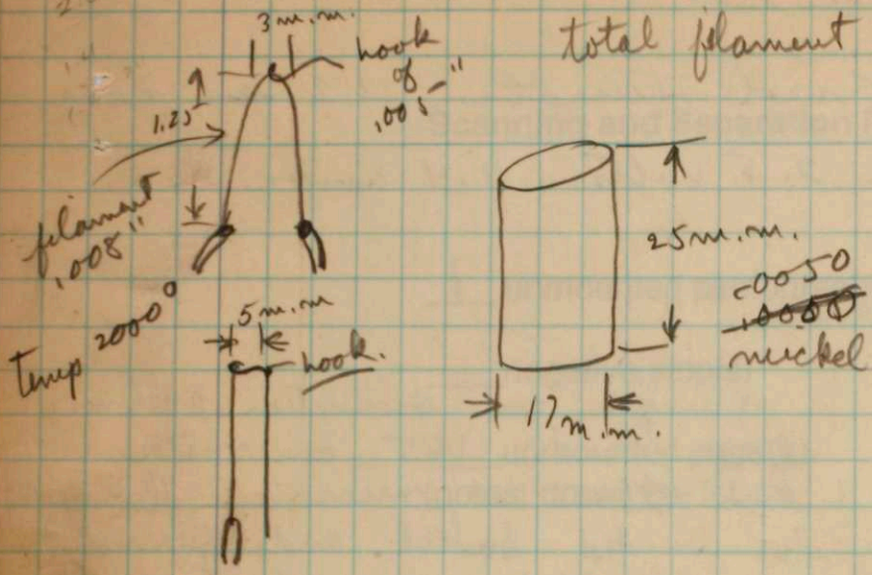
3 has a 5 mil hook for filament support.

Ruined on pump.

fig 69.

Nov 3 1932.

Kenetron # 4.



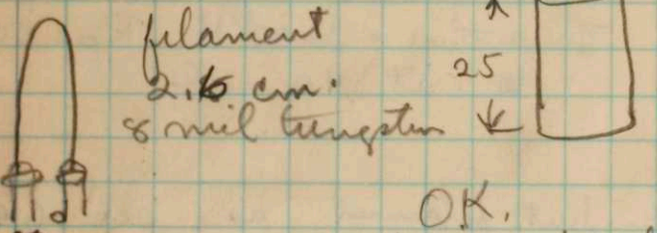
total filament length 2.8 m.m.

Butyl system failed at seal off.

Repumped on Hg (gas) system, baked & bombarded. Some of getter redistributed.

fig 70

Kenetron # 5.



Pumped on Hg system (gas).
Baked Bombarded & filament run. — Ba-Mg getter.

OK.

— this tube stands 30000 back voltage.

——— Chicago trip

Dec. 1 - Designs for rotating mirror timing device.

Intend to test spark and exploding wire & Hg tube for light efficiency and time of flash.

Voltage 8000 & 16 000

Feb 10 1933.

Illness and Book neglect have prevent many entries.

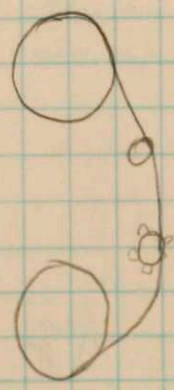
New work - design of 16 m m 3000 f p.s. camera.
New tripping device - Stepcam high impedance.

—

Feb 10-1933

Data on camera design.

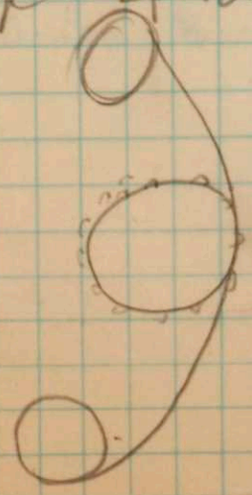
Wt of commutator - 2 3/4 oz. dia 2 1/2"



- this sprocket drives the commutator from the film.

Single motor on the take up reel drives the film.

Powers that be decided against this design and for the large sprocket type



in this type the film is driven by the sprocket the commutator being on the same shaft.

Feb. 13 1933.

Tested tube as per fig 72.

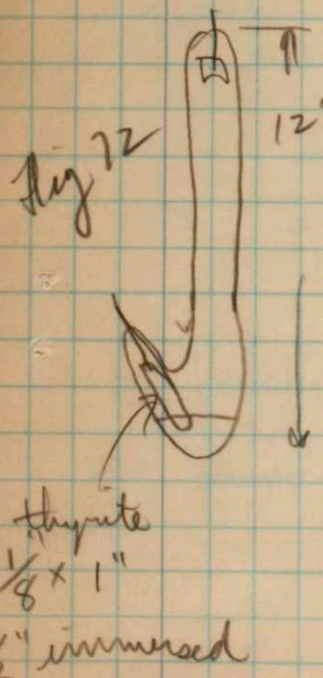


fig 72

When hand would not quite start consistently with 675 volts from thyrite to cathode but started readily with 1000 V. Tube became gassy due to leaks or gas from the thyrite - Would not operate in gassy condition.

Feb 18 1933.

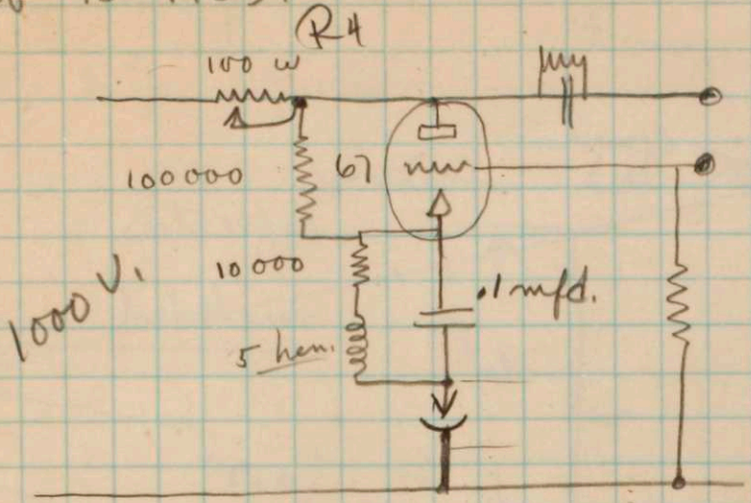


Fig 73

This Type 1 circuit is proposed for the driving circuit

As shown the circuit is self oscillatory at about 1000 ~.

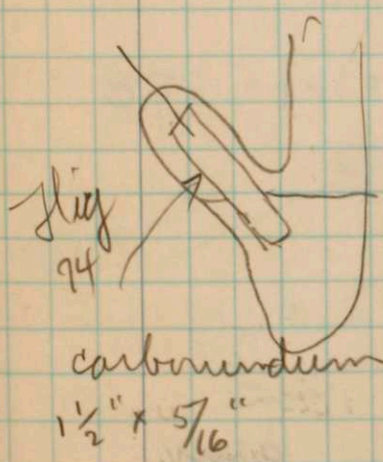


Fig 74

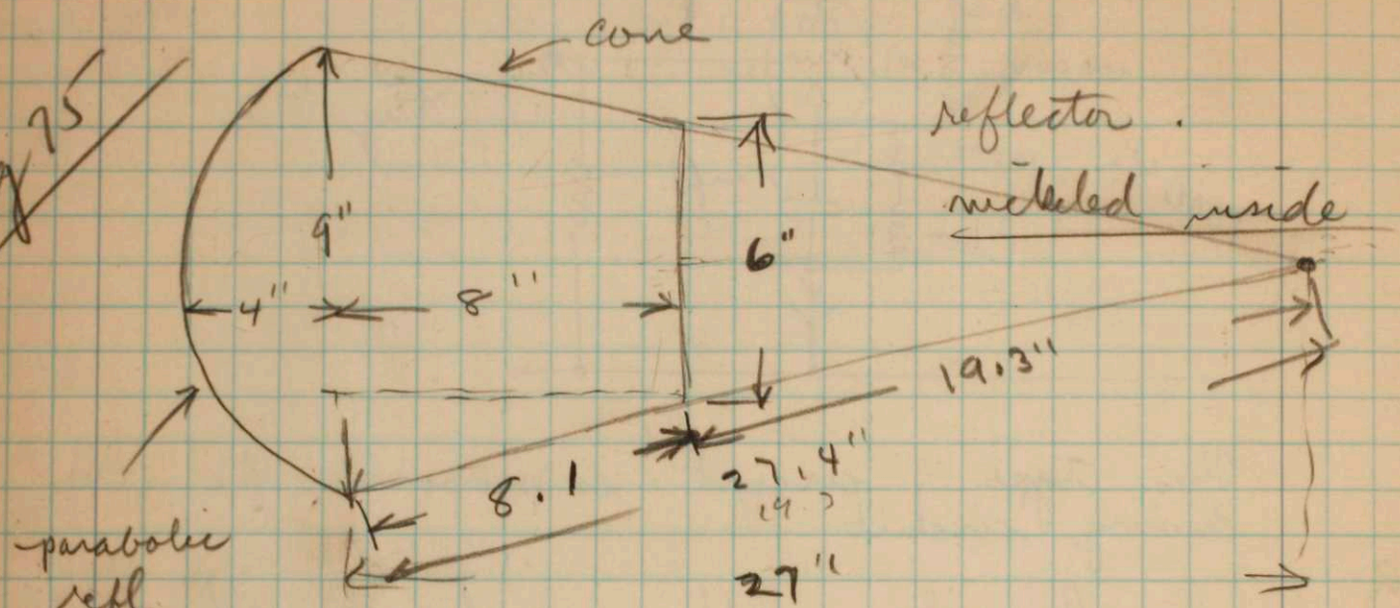
carborundum
1½" × 5/16"

used with an electrode as in fig 74 it will start a spot is the R4 is practially out of the circuit

3/2/33.

New Lamp unit.

Fig 75



$$\frac{6}{9} = \frac{x}{x+8}$$

$$6x + 48 = 9x$$

$$3x = 48$$

$$x = 19'$$

$$9 + 36 = 370$$

20.3
730
750

$$Cir = 9 \times \pi = 27.3''$$

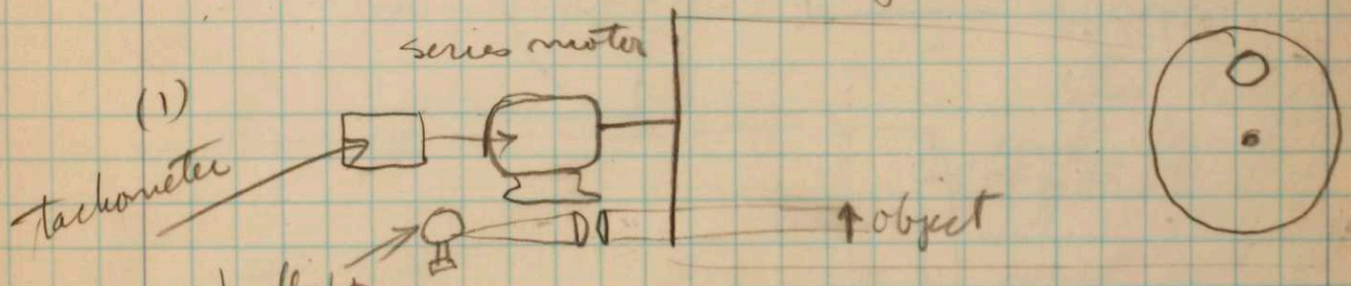
As much light from one lamp as from 4 when used without reflector

3/4/33.

Suggestion - Also an infra-red filter of 2% solution of $CuSO_4$ (blue vitriol)
2% solution did no good.

3/4/33

Small stroboscopes for speed indicators.



Could be built small + cheap with sufficient definition for speed work.

— Hg. stroboscope -

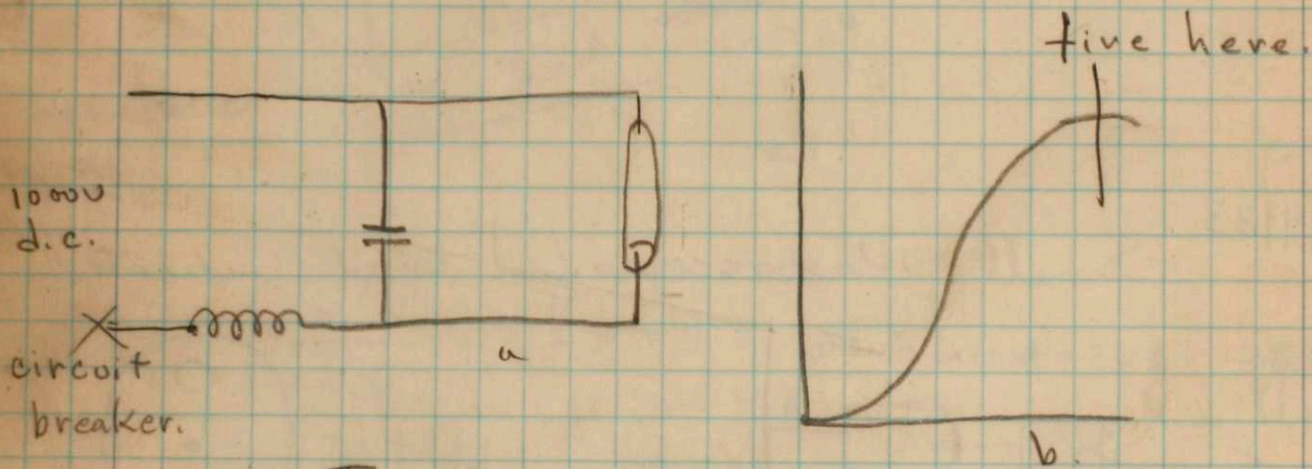
Solutions for etching -

Copper Iron perchloride to 42° Baumé.

Zinc. 2 oz Nitric acid to 80 oz H_2O.

4/24/33 -

New stroboscope ideas.



- Fig 77 -

An A.C. circuit timed to fire at the peak of the charging wave.

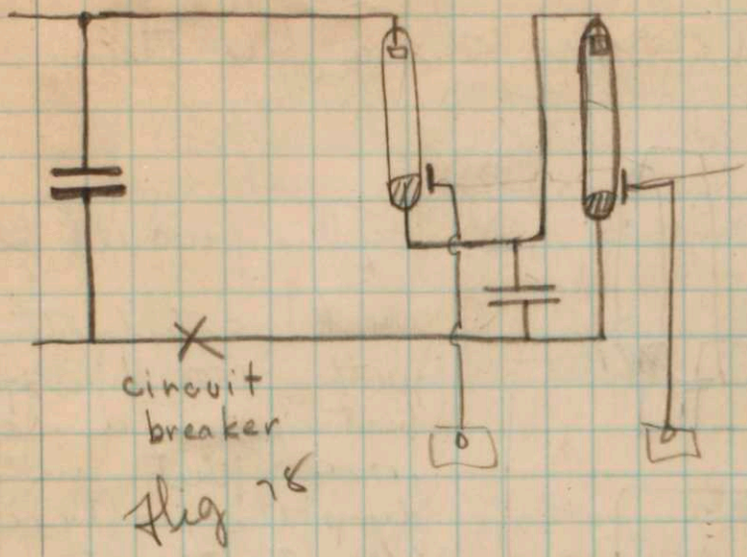


Fig 78

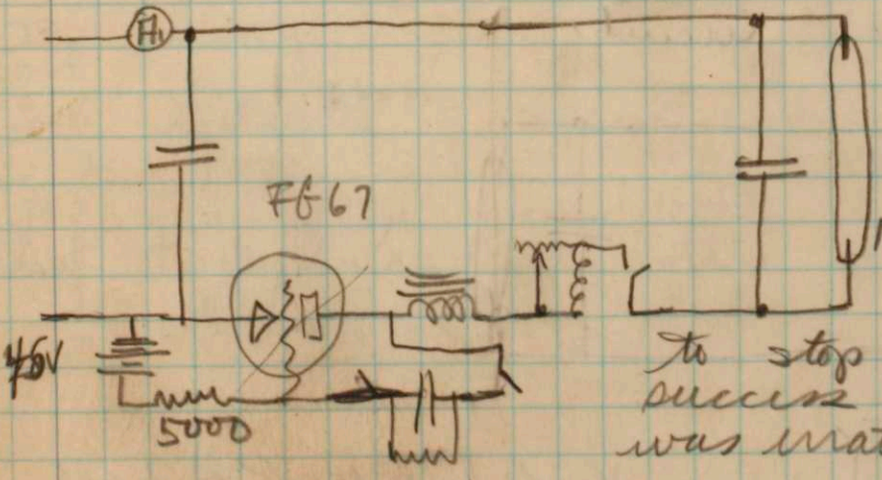
At speeds up to 1000 per second one spark coil should do for both lamps.

For higher speeds there must be separate spark circuits for each lamp.

Lamps fired in push pull fashion.

July 19-1933 Design of charging circuits

See page -40-



This circuit tried and found that the FG67 tended to fire when the spark went and also when the Hg lamp fired.

Schemes were tried to stop this with partial success but operation was erratic.

United States Patent Office
Before the Examiner of Interferences
Edgerton vs. Miller - Interference 76771
Edgerton Exhibit No.
Page 101 of Germeshausen Notebook No. 2.
July 19, 1933.

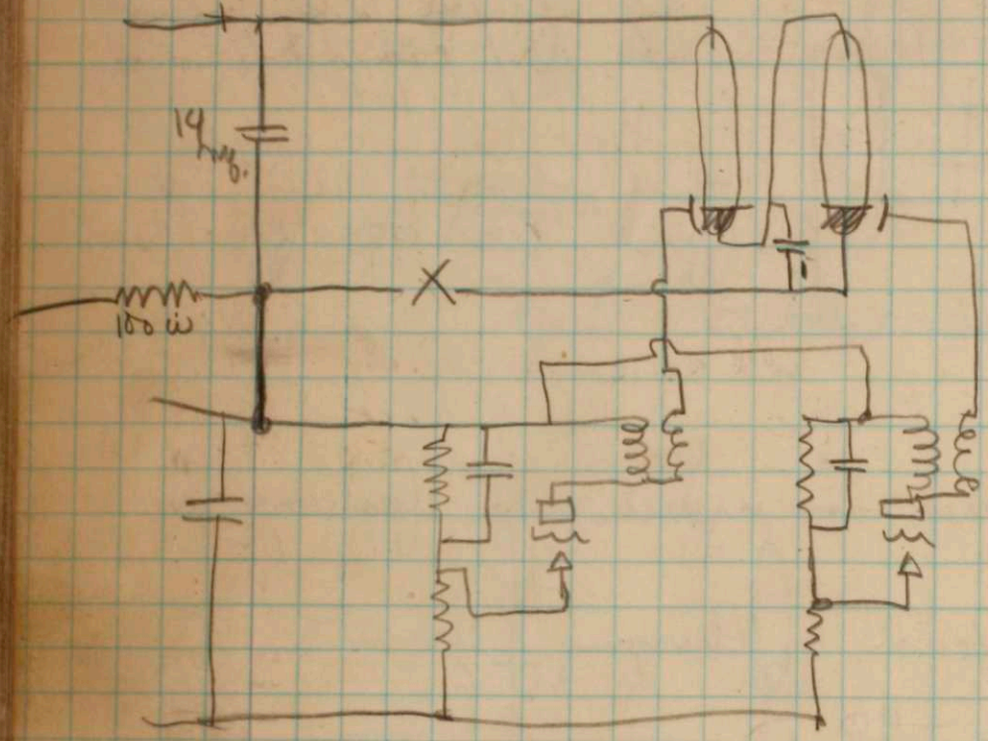
JAN 18 1940

January 2, 1940.

Clara Selbosky
Notary Public

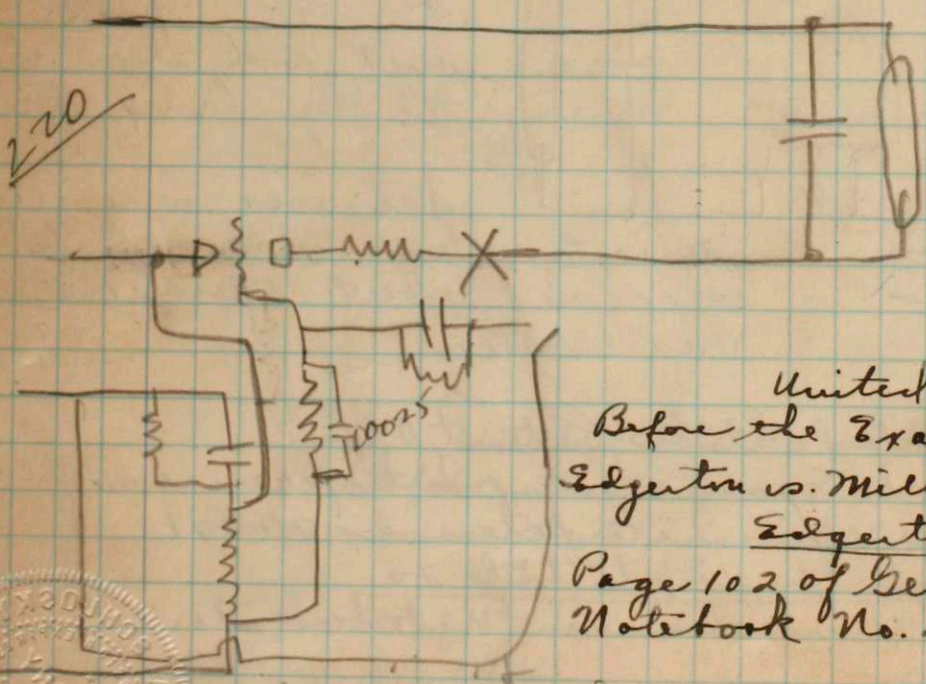
July 22 1933.

Diagram of high speed strobo first tried.



This would not work satisfactorily with 1000 ∿ applied but when a resistance was put in to drop the voltage to about 500 it work O.K. at 9500 cycles (3000 total)

July 24 1933. Circuit.



Spark circuit

Flipation circuit.

Subject to hold on.

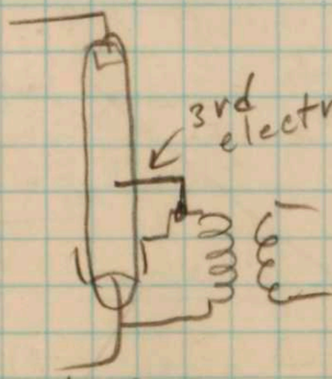
United States Patent Office
Before the Examiner of Interferences
Edgerton vs. Miller-Interference 76771.
Edgerton Exhibit 24,
Page 102 of Germeshausen
Notebook No. 2, July 22, 1933.

January 3, 1940. Elsa Schlosky
Notary Public

July 28.

Hold over difficulties are largely due to continued spark excitation the spark secondary voltage continuing to oscillate for as long as 1/1000 second.

Tried a 3rd electrode as per the figure in the push pull circuit

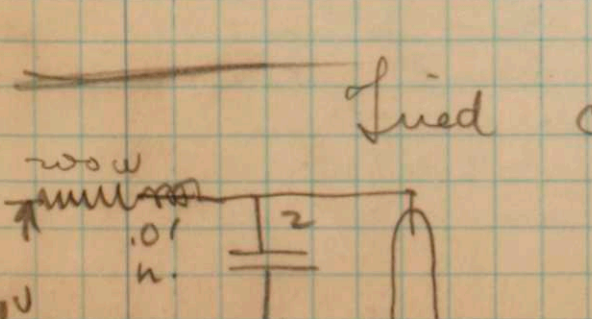


Idea was that when the tube started to conduct it would short the spark coil and remove the energy but the main discharge is so short (10 m.s.) that there is not time to dissapate much of the spark coil energy.

This device does help some but not enough.

Polarity of spark coil makes a marked difference in the conductivity, one way it takes very little energy from the spark and the other it removes 1/2 of the secondary wave.

Tried circuit as per figure



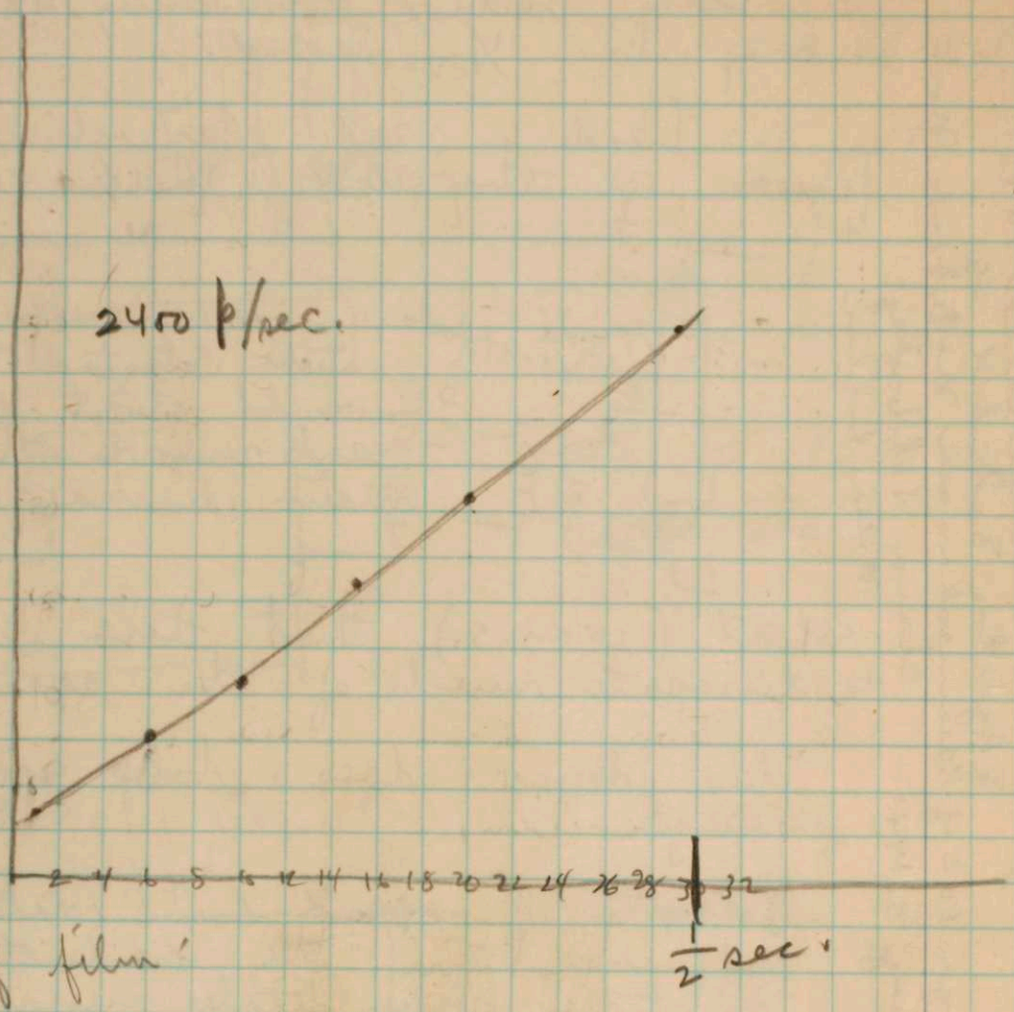
Worked beautifully at 1500 v except when hot - much better than push pull circuit. More stable with spark connection that uses most spark energy.

— 1 Tube —

Acceleration data with 3600 r.p.m. motor. 230V 3φ

Distance between in cm. between $\frac{1}{60}$ second marks.

1	3.5	20.1	14
2	4.15	21.1	20
3	5.00	22.1	21
4	6.05	23.1	22
5	6.85	24.1	23
6	7.75	25.1	24
7	8.6	26.2	25
8	9.5	27.1	26
9	10.45	28.1	27
10	11.3	29.1	28
11	12.45	30.05	29
12	13.25		
13	14.2		
14	15.2		
15	16.1		
16	17		
17	18		
18	19		

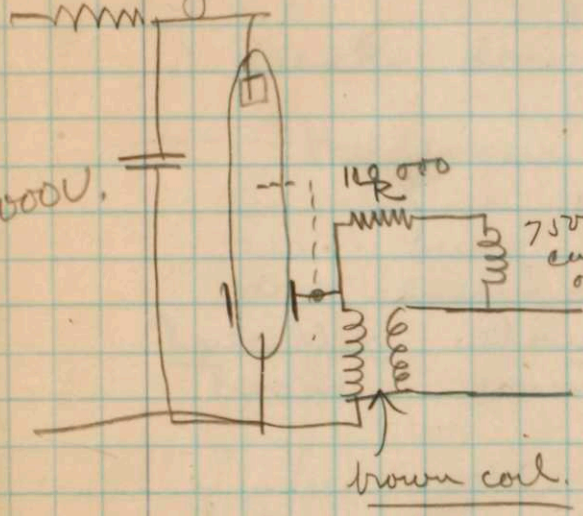


15 feet of film.

Aug 22-

Observations to date on high speed.

A spark coil operated as per the figure gave the best results.



With the spark coil arranged as in the figure it was found that some tubes would operate up to 6000 v with a capacity of .1 mfd and a charging resistance of 130 w.

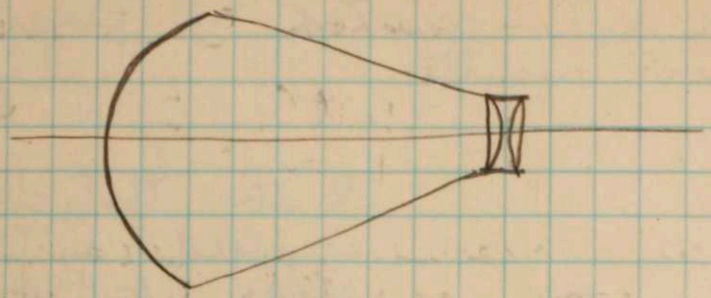
A special spark coil with a seandary of cupron wire was tried but it gave less spark energy and less consistent operation than the trick scheme shown above. (The tube showed a greater tendency to hold over)

A third electrode connected as per the dotted line made operation more consistent but was not necessary.

A test was made to determine why some tubes would operate at 6000 v and others would not — A tube pumped as hard as possible using a CO_2 trap and P_2O_5 would not operate. Another tube filled with Spectrum Hydrogen operated quite well so apparently gas content is important — experiments are under way to determine the proper quantity.

Aug. 2 1937 —

Reflectors + Lens.



Parabolic reflector with cone + condensing lens: tried with different forms of lamps to determine most efficient arrangement.

No good results.

A diffuse source does not lend itself to optical handling.

See report of Color.

Aug. 26, 1933. High speed.

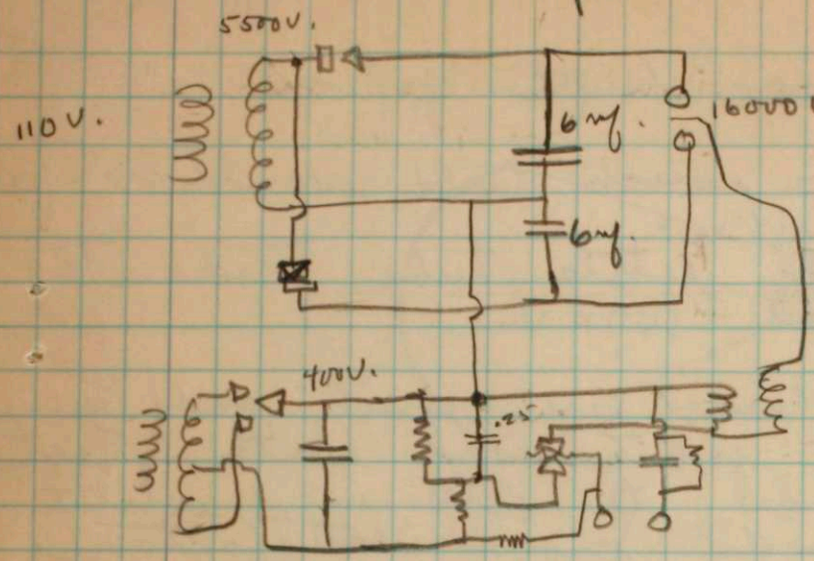
Gas filled tubes - length approx 12"

25 microns Hg too much tube would not fire
5-10 " " 0.1 ".
1.0 " " too little tube tends to break down at 1000 V.

— Hydrogen cleans up easily and hence is not a good gas to work with. Tests are being made to determine whether air residue might prove satisfactory.

Tubes with 1.5 to 2 microns of air left in them seem to be the most satisfactory for high speed work. These tubes will operate with good consistency at 6000 V.

The new spark set.



Tests – Comparing 8000 V to 16000 V.

Exploding wire ↔ series gap.

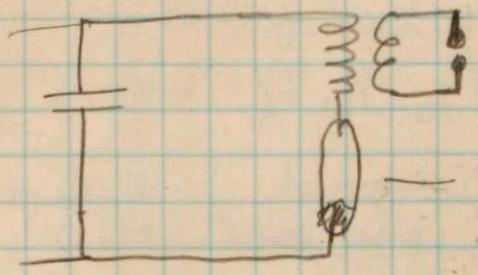
On 8000 V. wire gives more light than gap and shorter time of flash

On 16000 V. gap gives more light than wire and shorter time of flash.

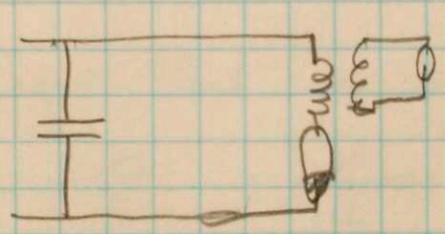
Oct - 1933.

Stroboscopes. - Point sources may be obtained by following methods.

(1)



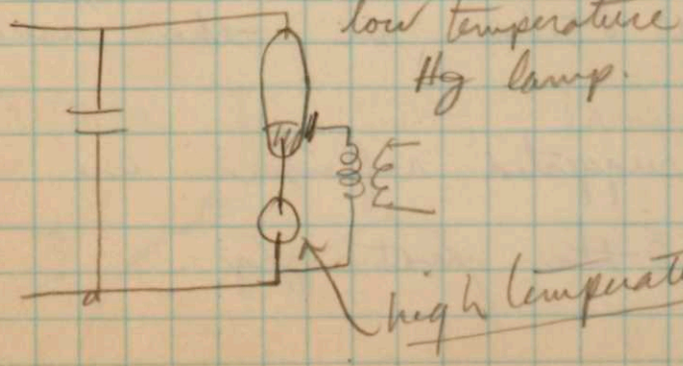
(2)



(3) Use pulse to excite high frequency discharge.

——— The control switch may be a specially designed stroboscope tube.

(4)



Etched Aluminum reflectors.

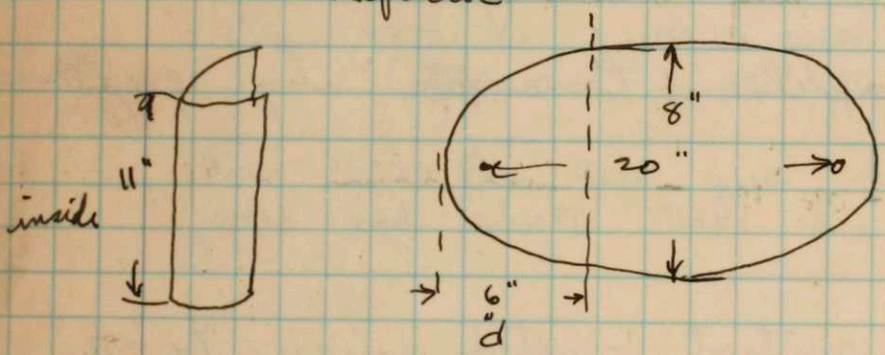
Journal of the Optical Society. 1931-33

Taylor + Edwards.

5% NaOH plus 4% NaFl (sodium fluoride) + 91% water temperature 90°C. - removed washed and dipped in HNO_3 one part H_2O 1 part then washed.

Oct. 4, 1933.

Reflector.



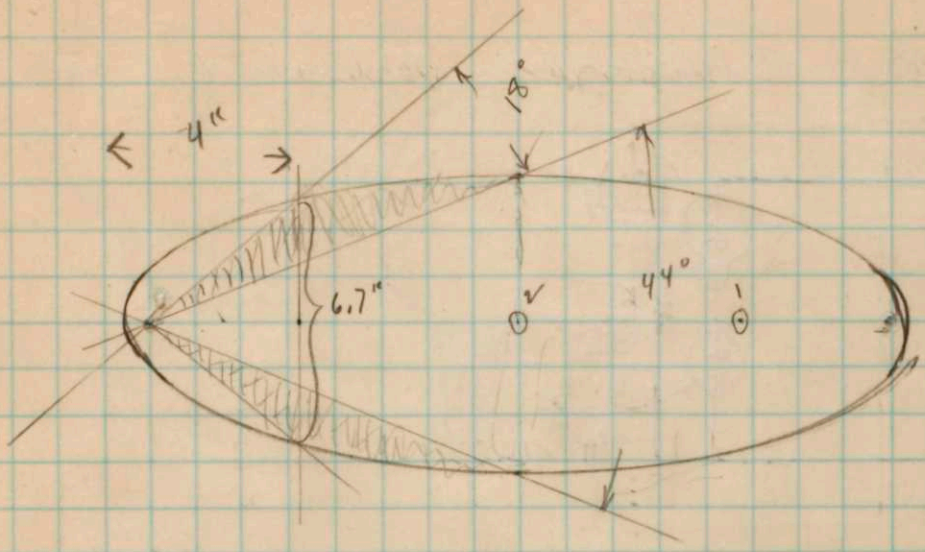
ellipse 20" x 8"

reflector of etched aluminum.

ends of etched aluminum.

In the first reflector d = 6". Using 1 12" tube this reflector gave about 4 times the light obtained from 4 12" tubes in the usual reflecta (plane).

The suggested reflectors are as shown on the next page.



360
44
316

36
44
70

% light lost in shaded angle by cutting down reflector = $\frac{36}{316} \times 100 = 11.4\%$.

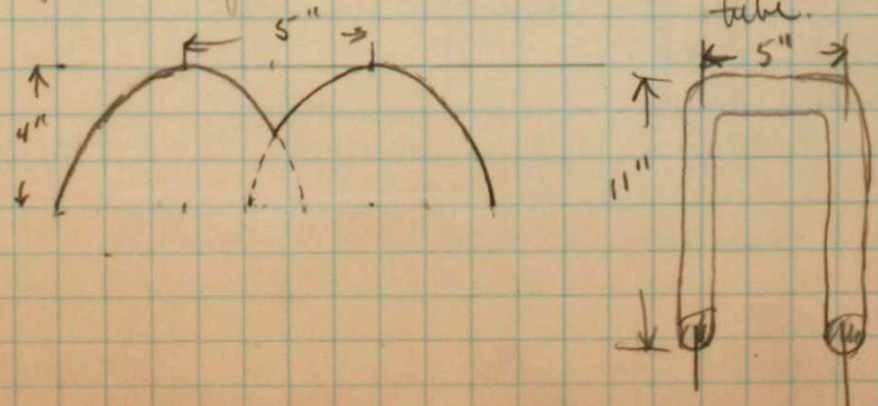
→ Assuming 6" working distance

light gained by cutting down reflector.

$\frac{252}{100} \times 100 = 256\%$ — net gain 240% approx

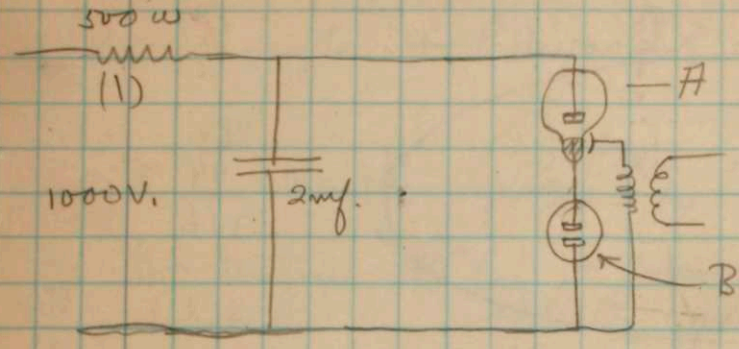
→ A cylindrical lens. focal length 2" width 3" — length 11" — angle 70° would increase the light appreciably.

Reflector for Twin lamp.



Oct 10, 1933 Kenneth J Germeshausen.

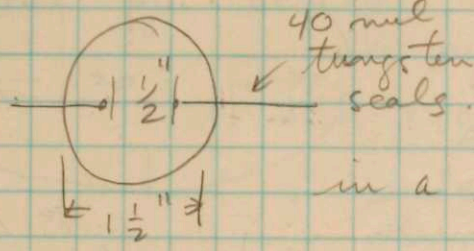
Ideas on stroboscopes, particularly high speed.



A conventional stroboscope circuit.

-A- is a lamp intended to operate at low temperature with low drop. -B- is a two electrode lamp with Hg. vapor operating at high temperature and pressure. - It should probably have a heater.

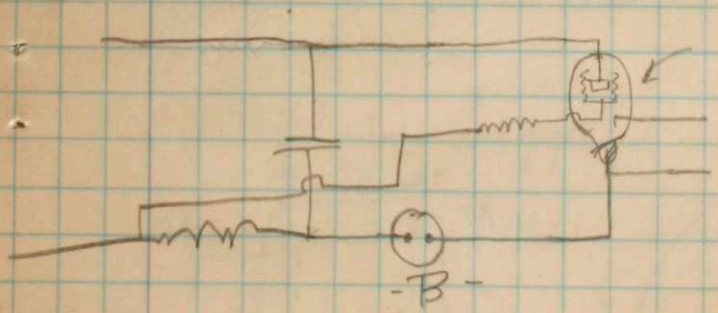
test this bulb - indicated very high efficiency - tungsten cathode probably activated



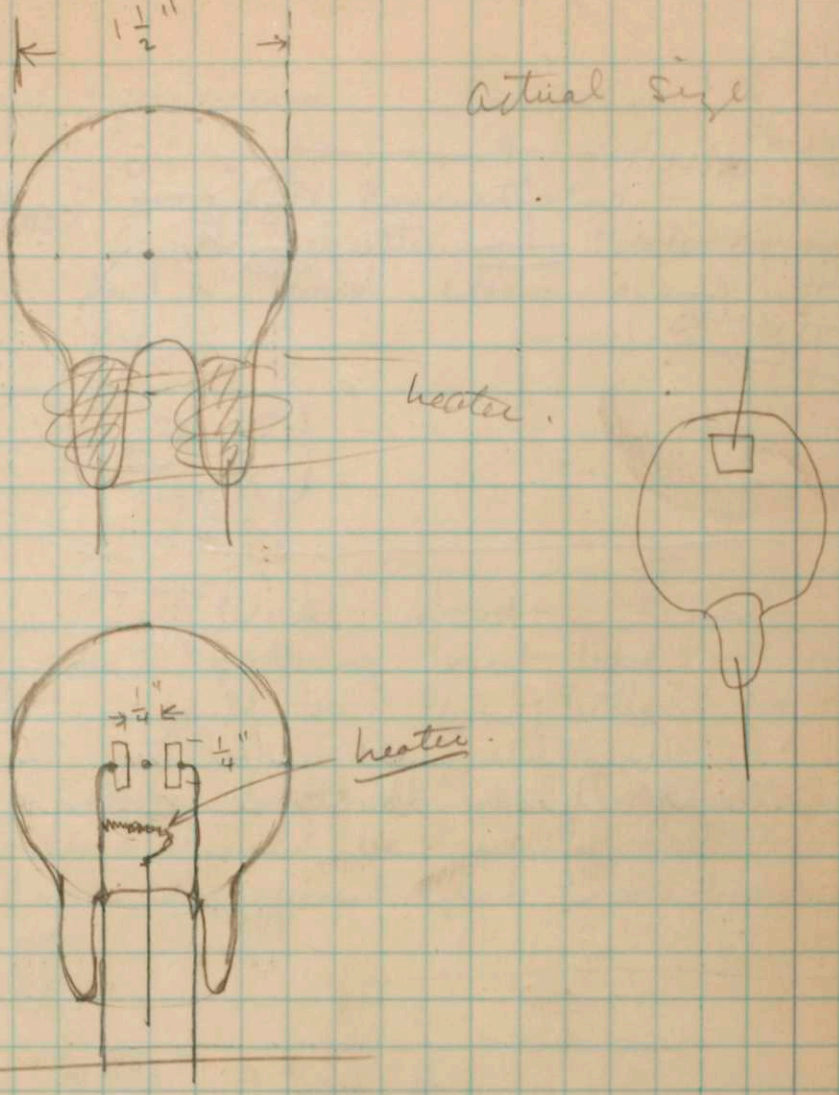
in a pyrex bulb

Must determine best temperature for -B-

Alternative circuit.



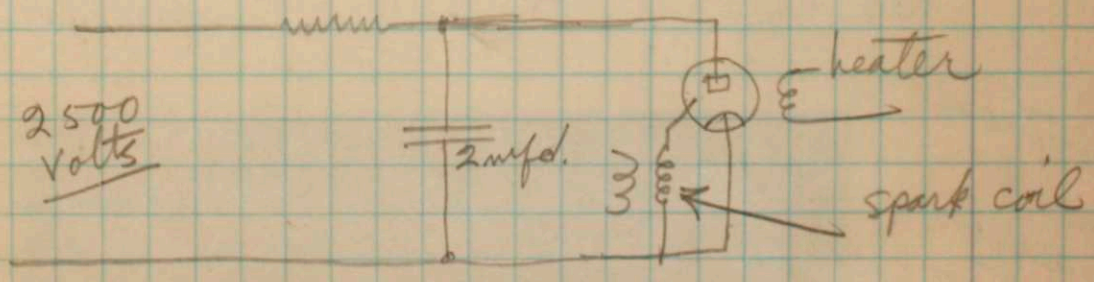
Design of bulb B



Oct 11 1933

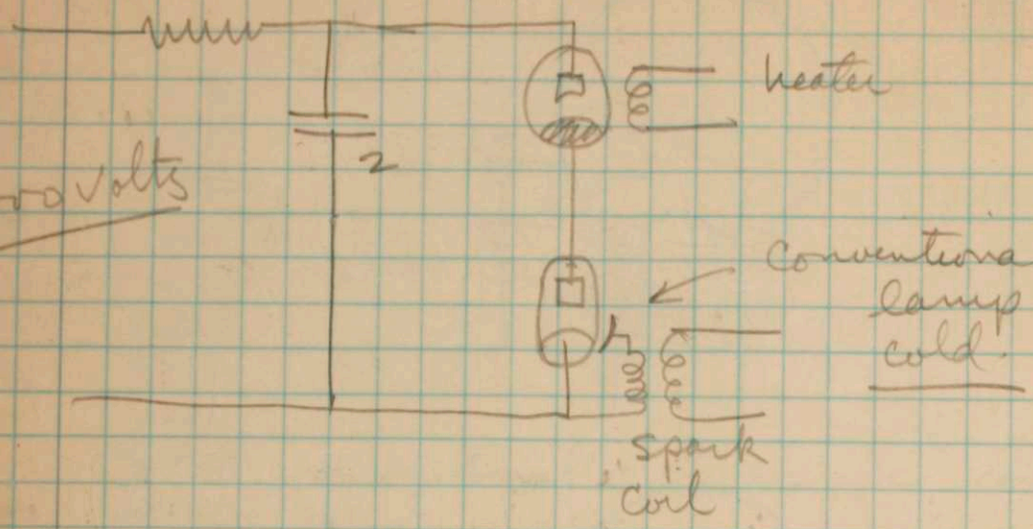
This type of lamp promises such high luminous efficiency that it may be applied to the spark circuit on medium voltages.

Circuits:

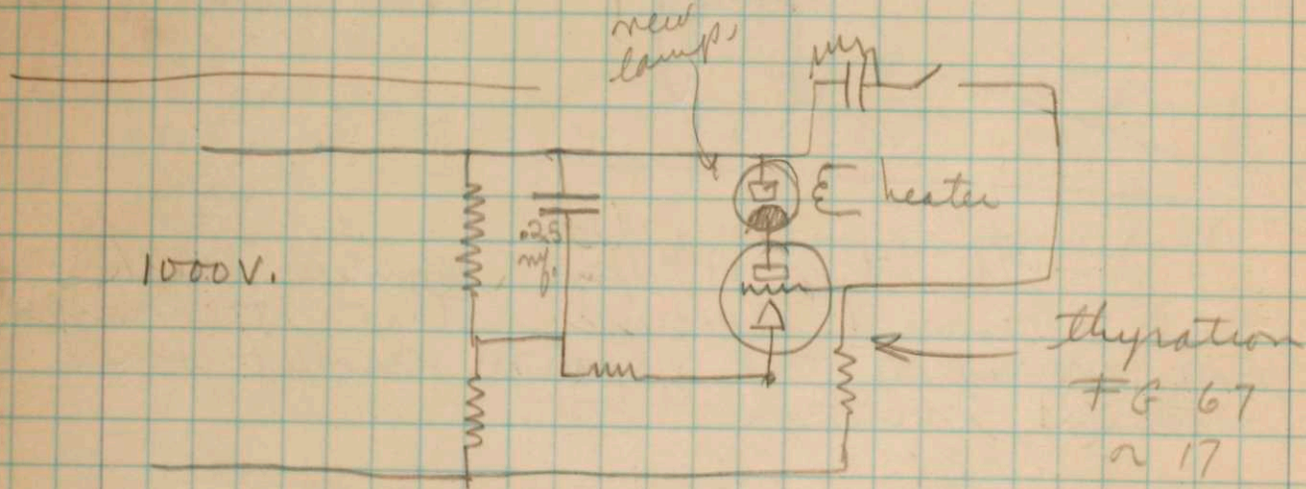


Circuit to replace present high voltage spark outfit.

(2)

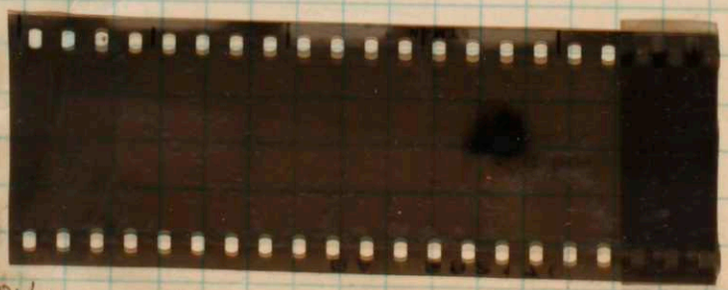


Another possibility to replace present high voltage spark set.



Stroboscope to replace present model.

Eastman sound recording film.

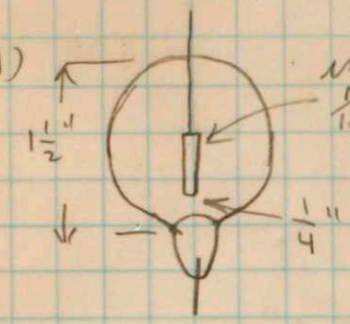


1 mfd 1000 V. with lamp similar to (1) page 116

Oct 13 – 1933.

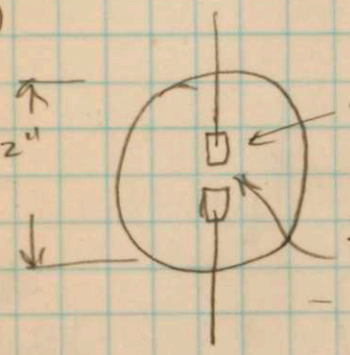
Tests on high pressure lamps.

(1)



works O.K. small anode keeps. are well concentrated – Some Anode sputtering – ~~Too close for~~ but a good clear view of the arc.

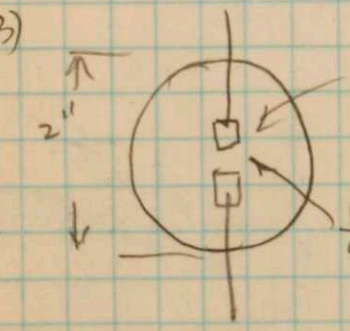
(2)



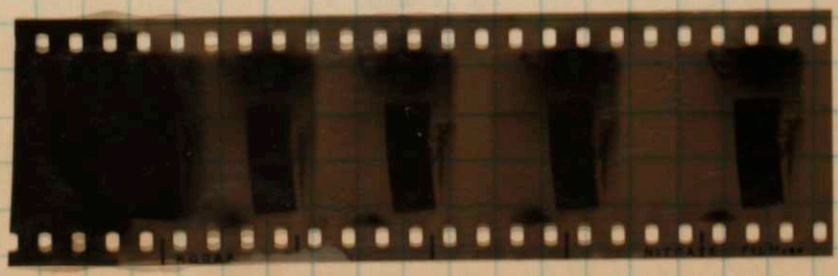
Works good – 2 mfd. 240 V sputtering not bad. – gap could be 3/16" – better. (or 1/8")

Runs best at high temperature – bulb should be much smaller (runs if sufficient spark is applied.)

(3)



Aluminum does not sputter but melts too easily – Will try electrodes of larger area.



Lamp as per #2
2 mfd. 240 V

Paper –
5" nearest from lamp.
12" farthest

Oct 13, 1933.

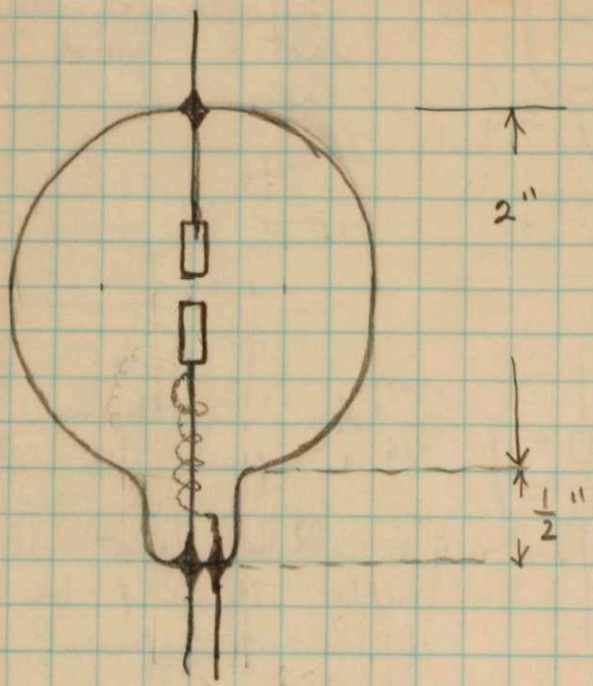
Design of a high pressure Hg. Lamp.

(1)

pyrex bulb.

40 mil tung seals.

Heater 25 watts.

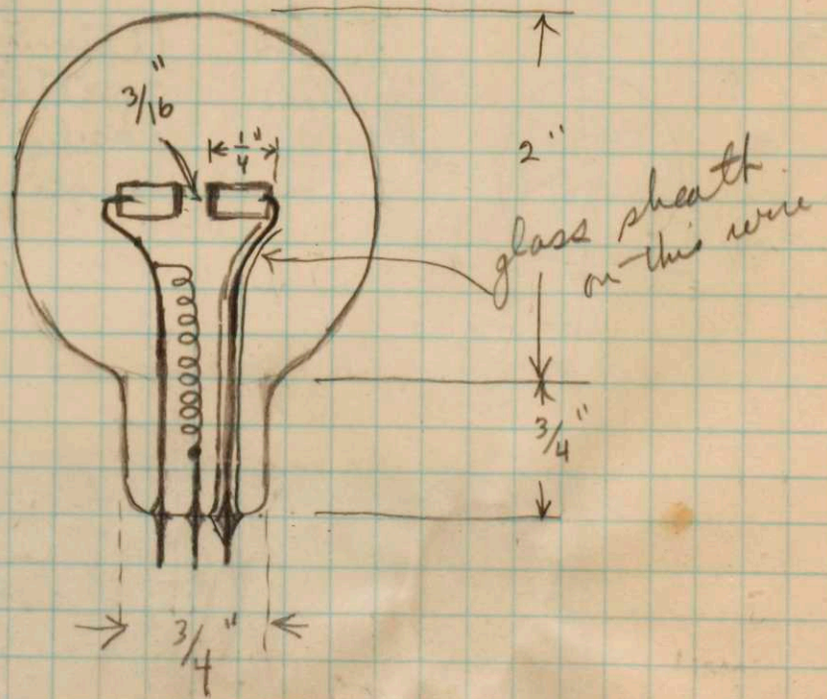


(2)

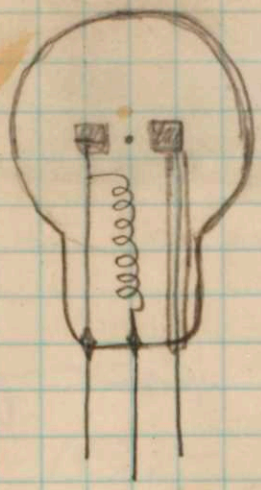
electrodes 3/16" dia.

Heater 25 watts.

40 mil seals.

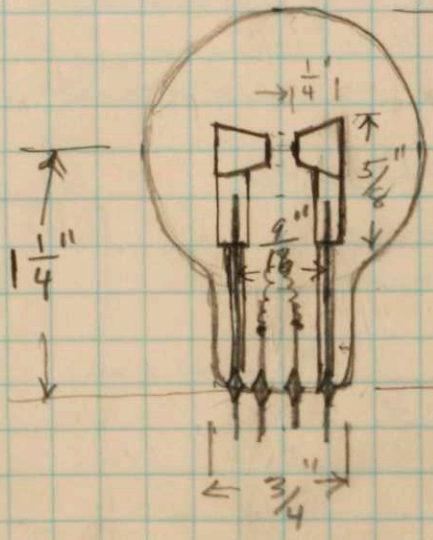


(3)



(4)

leads jacketed.



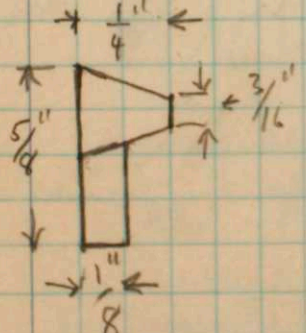
aluminum electrodes

~~30~~ watt heater

~~5 cm~~.

2" of 10 mil tungsten

electrode.



3/16" stock

This electrode melted at low temperature

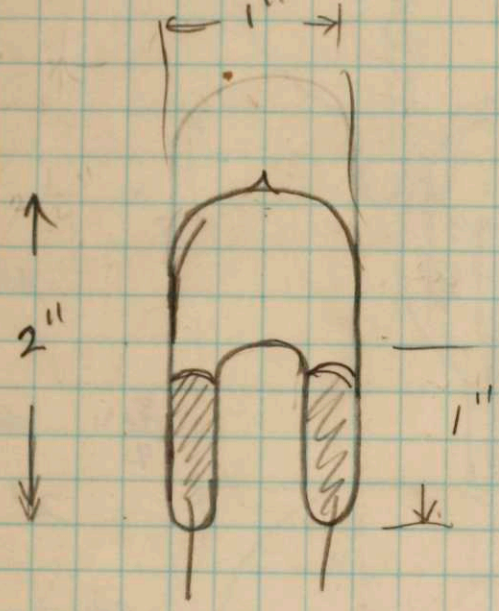
30 watt heater not nearly enough.

Oct 18, 1933 -

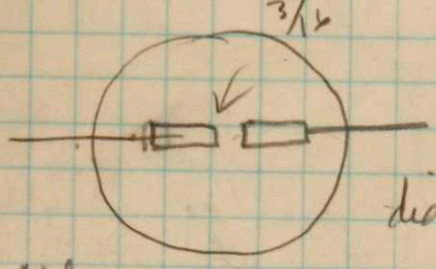
Tried tantalum electrodes - they sputtered and did not give much light.

Oct, 18, 1933

Try tube as per fig.



Oct 23 - 1933



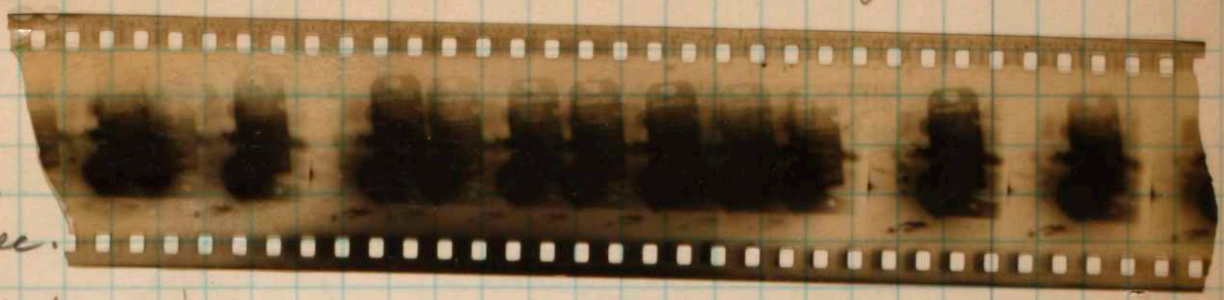
Electrodes iron 3/16" dia.
3/16" spacing.
Electrodes hydrogen cleaned - did not sputter.

When at medium operating temperature lamp shows long time of flash but with a large quantity of light.

As the temperature was increased the lamp showed a much shorter time of flash - but gives less light.

Results shown on attached film

1020 ~
1 mfd.
1000 V;
film 75'/sec.



Small lamp but so arc is constricted.

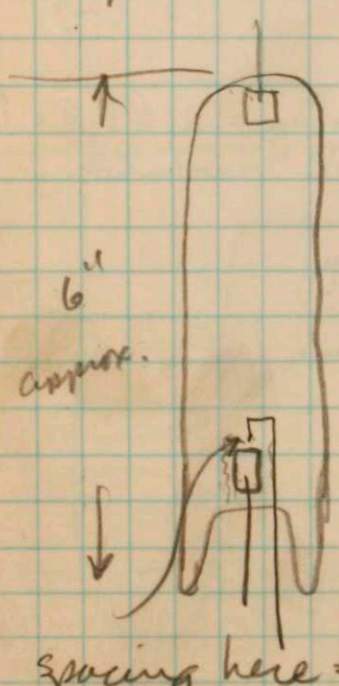
— Oct 23 1933 —

Design of a neon lamp for a simple stroboscope.

electrodes 3/16" iron rod.

Pressure breakdown curve for 2 m.m. electrode spacing.

m.m. P	V.
1.4	155
1.2	150
1.0	138
.6	160
.4	175



spacing here = 2 m.m.

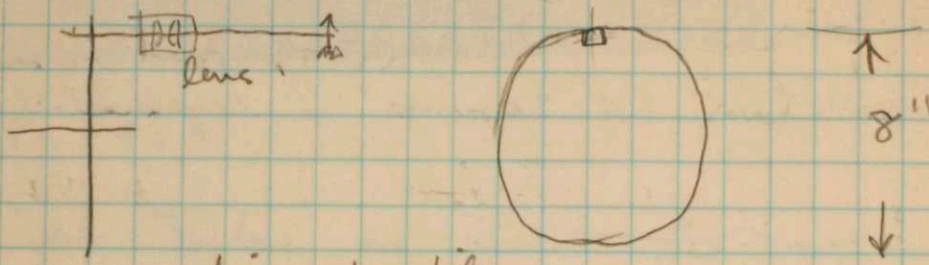
Operated about 6 hours then stopped. Arc would strike to starting electrode but not to anode.

Boron coated electrode allows spot to form more readily.

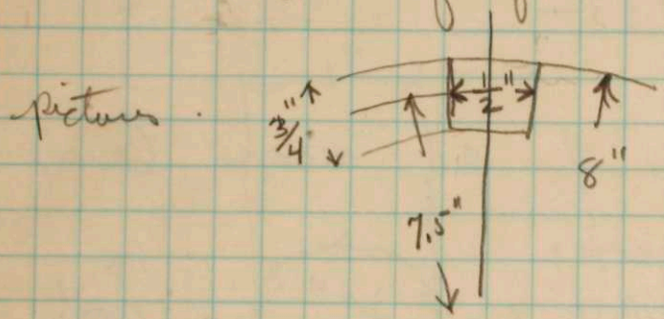
Distance to anode probably not enough

Oct 23 - 1933 Kenneth J. Germeshausen

Design of a high speed camera.



disc of film.



Circumference = $\pi \times 7.5 = 23.8$" pictures = $2 \times 23.8 = 48$ per revolution.

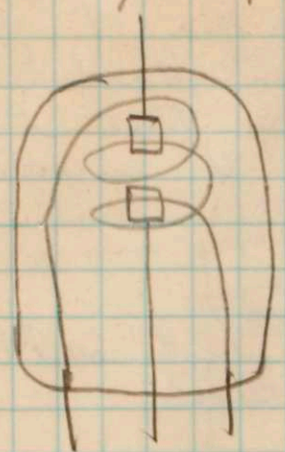
if speed is 18000 r.p.m = 300 r.p.s.

pictures = $300 \times 48 = 14{,}400$ pictures/sec.

Nov. 10, 1933.

High pressure Hg. Lamps.

(1)



Approx actual size.

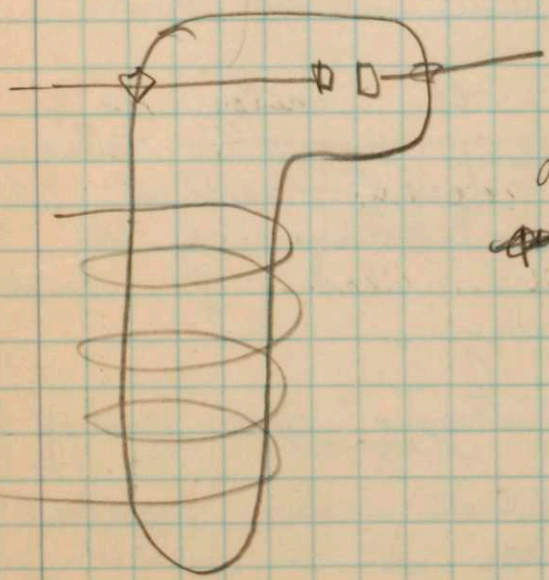
Heater 75 watts.

– 75 watts not enough to maintain pressure –

Tube blackens badly

Recombination of Hg on filament heats and bombards it.

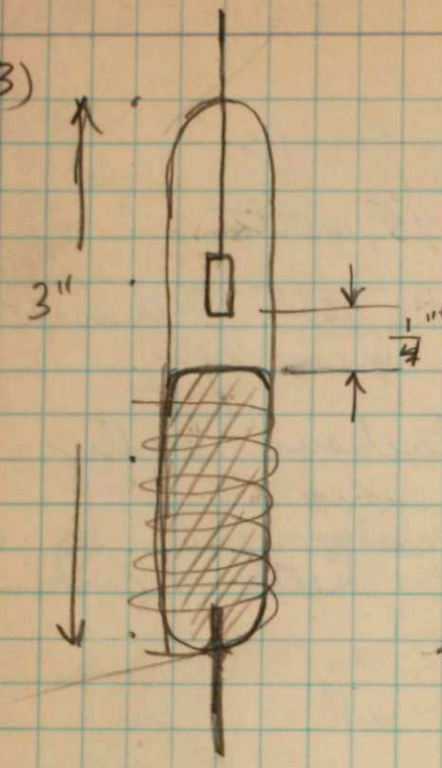
(2)



Could get high enough pressure with about 100 watt heater –

Mercury condensed on glass cutting off light.

(3)

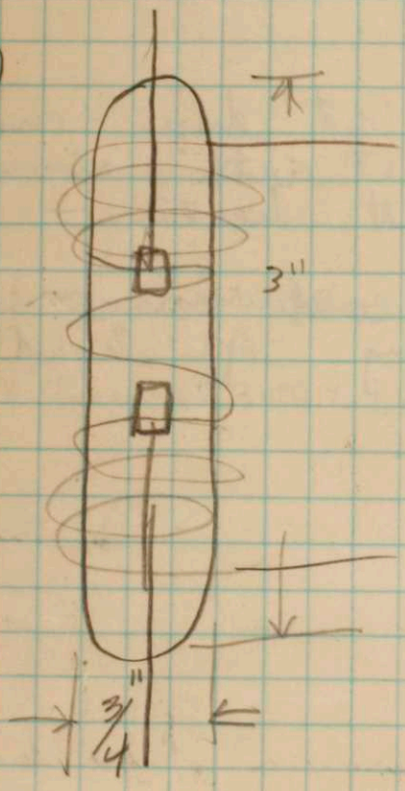


to secure sufficient pressure the Hg. must be boiled so violently that it bubbles up around the anode changing the arc path and shutting off the light.

- Works best with iron as the cathode.

~~15~~ m. m. glass.

(4)



This tube worked O. K.

With the heater as pictured operating temperature was easily reached the window portion of the tube remained clear of condensed mercury.

Sputtering was very bad -

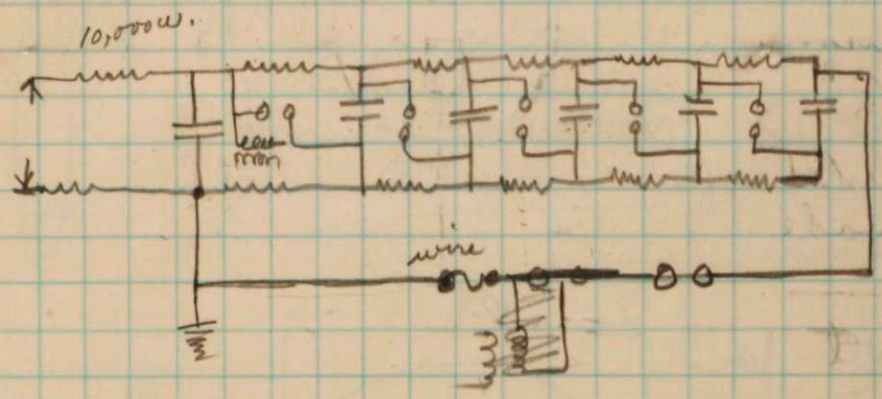
Operating life about 1 hour.

Nov. 15, 1933.

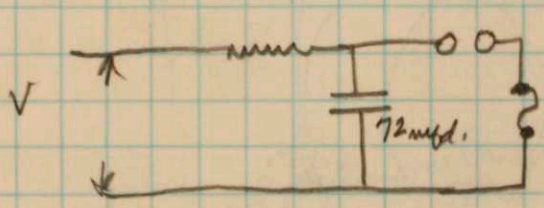
Spark circuits.

Condensers - 6, 12 mfd. G.E. Condensers.

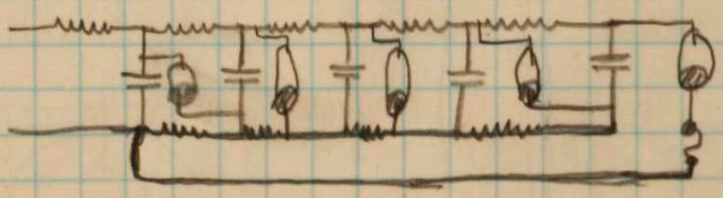
#1 -



#2



#3



using mercury lamps in place of spark gaps.

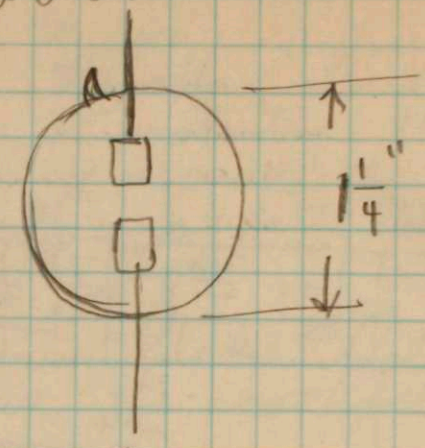
#1 To dissapate most of the energy in the desired place (the reflector) a wire is used instead of the gap.

Gives about as much light as (V = 2600) the 16000 volt 3 mf. spark gap.

Nov 19 1933.

High pressure tubes.

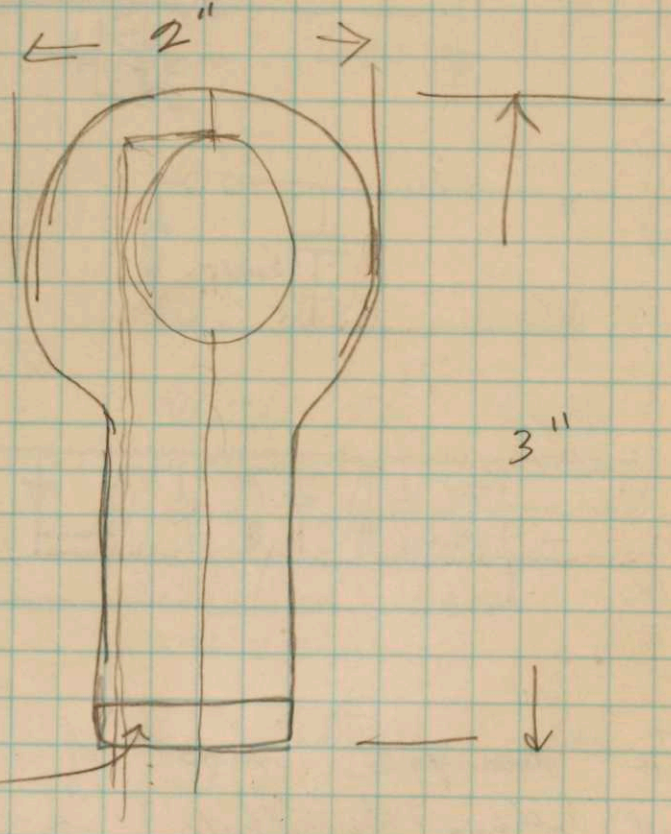
Lamp.



electrodes 3/16" dia
Swedish iron
Spacing 1/8"

Hydrogen treated after lamp is made.

bell jar.



40 m.m. pyrex tubing

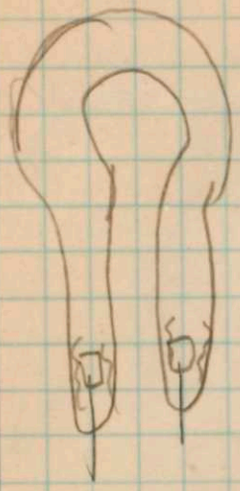
asbestos end

Bulb sputtered badly - about 100 watts heater brought bulb to temperature.

Why sputtering? try a larger bulb.

Nov 21 - 1931.

Neon tubes.

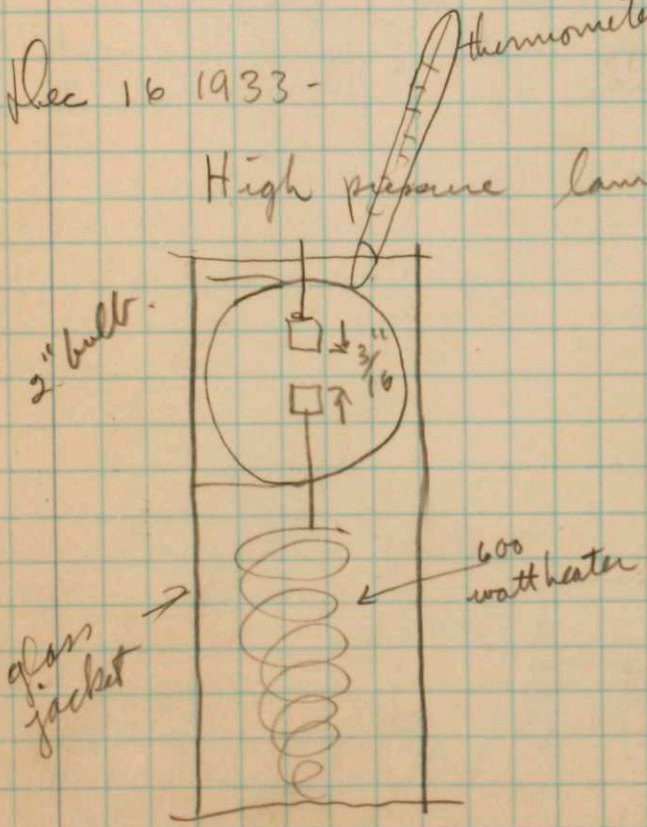


standard U tube
swedish iron electrodes
Mica jackets.
1 cm. neon.
washed twice
run on pump - 1200 v transformer
metal electrodes are hot

Nov 27th 1933.

Dec 16 1933 -

High pressure lamps.



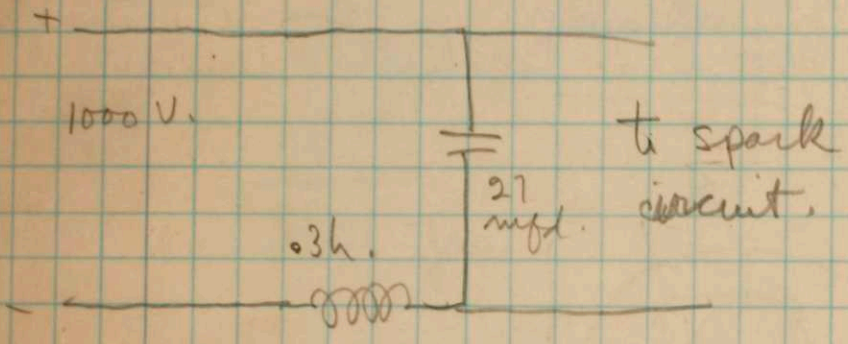
lamp misses badly at 250°C
works best in range 200° to 220°
At lower temperatures arc tends to go to seals.

$\frac{5}{254} = \frac{1}{5}$" spacing.
in G.E. sun lamp.

Dec 30 1933.

Notes on power supplies.

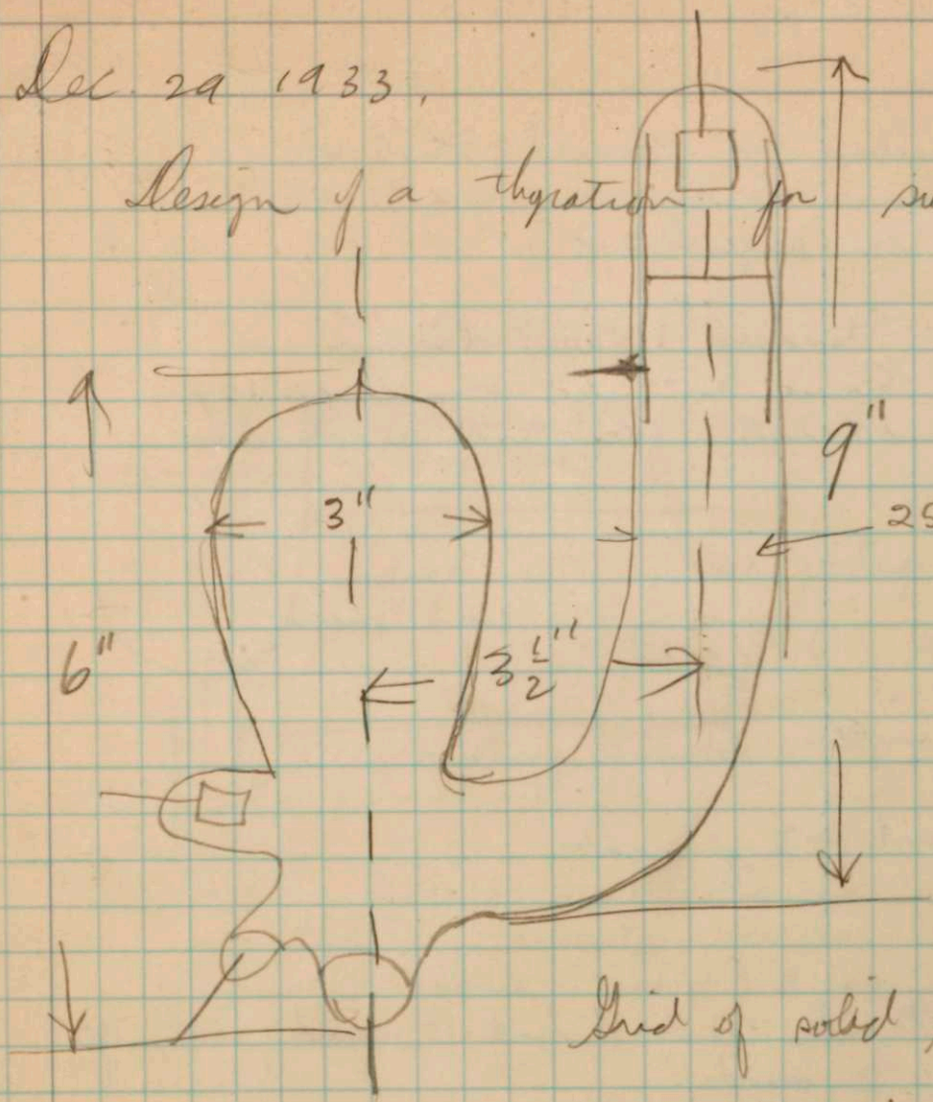
When spark and main discharge is run from same supply the surges tend to make the flopation circuit unstable. Try circuit as per the figure.



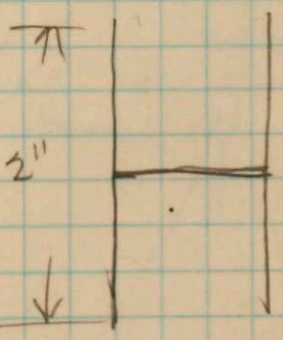
At 3000 cycles - with $\frac{1}{2}$ mfd in lamp with 200 w charging - lamp and spark draw 3.5 amps.

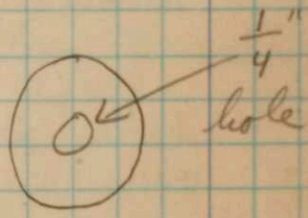
Dec. 29 1933.

Design of a thyratron for switching



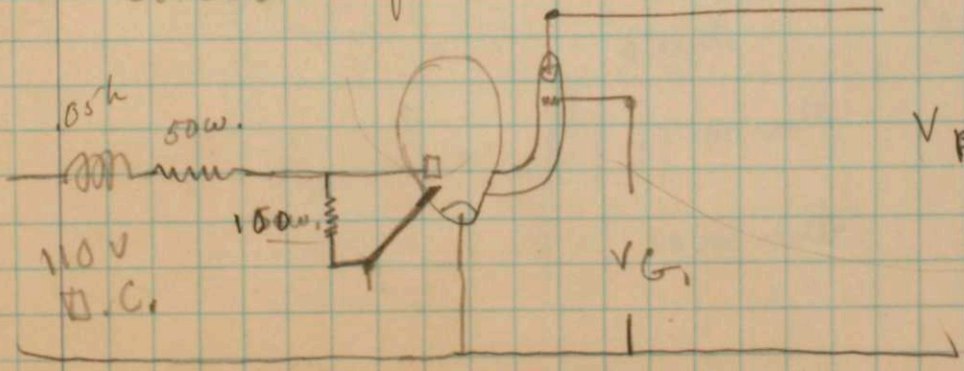
Grid of solid iron sheet.





a tight fit into 25 m.m. tubing.

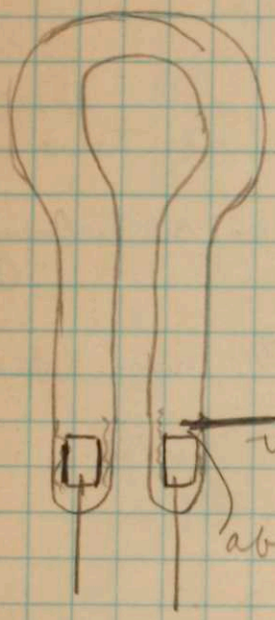
Circuit for test



Jan 6 1933.

Neon tubes for small Stroboscope

See page -19-



Standard U tube design
Same as tube on page 125
except for 3rd electrode

1 cm. neon.

Arc struck O.K. but would not go around tube to anode.

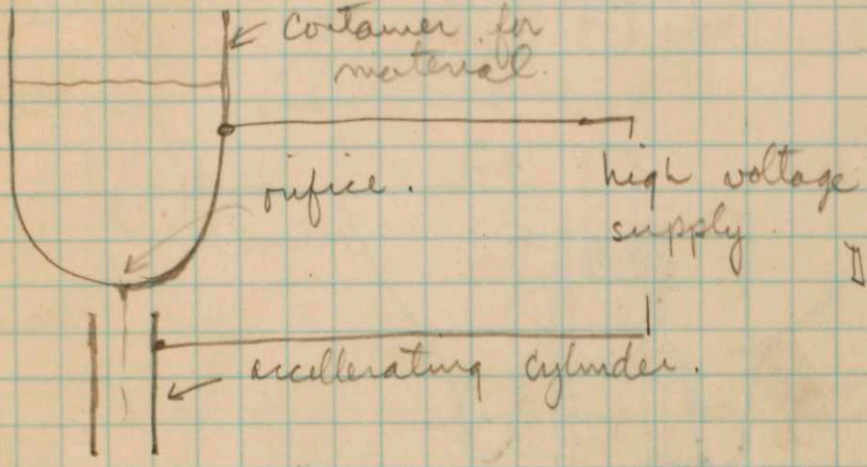
If voltage is raised sufficiently to take arc to the anode the tube tends to hold over.

$\frac{20 \times 10^3}{50 \times 10^{36}}$

Jan. 7, 1933.

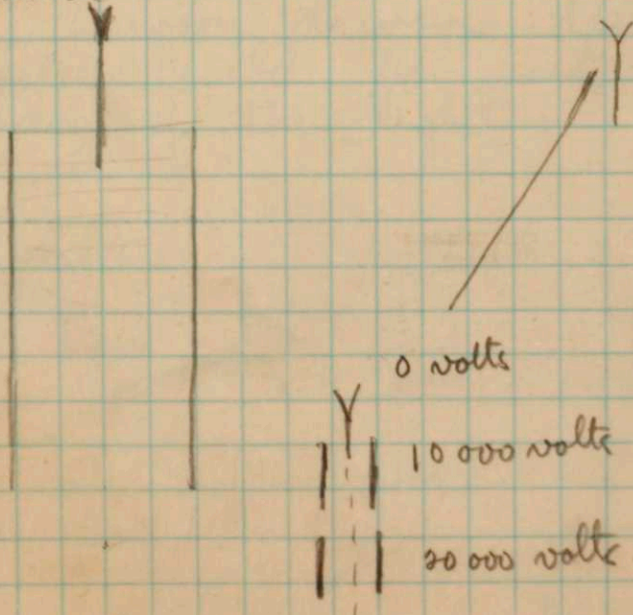
Electrostatic forces used in spray drying.

An Electrostatic gun.



Viscous materials will be drawn into thin filaments, more fluid materials will form solid drops under the action of surface tension.

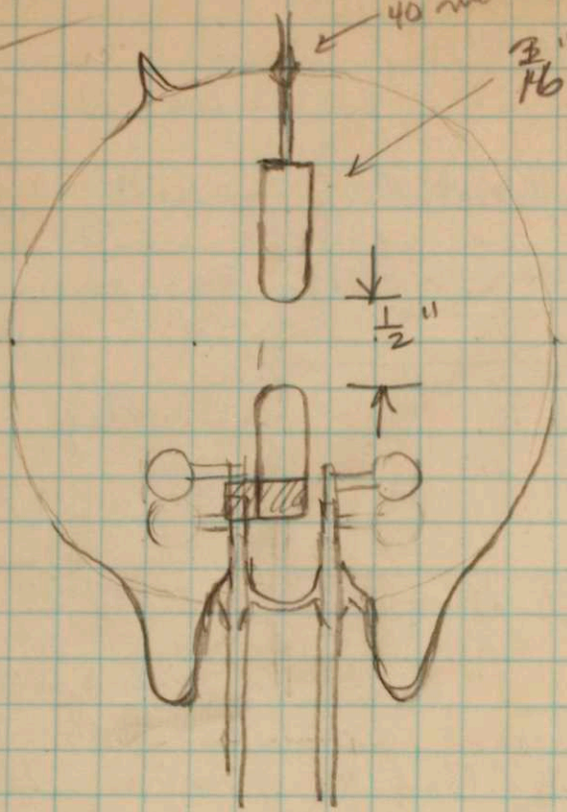
A succession of accelerating guns may be used.



accelerating electrode shaped like this to reduce field at exit and hence reduce tendency of filament to be drawn back to the electrode

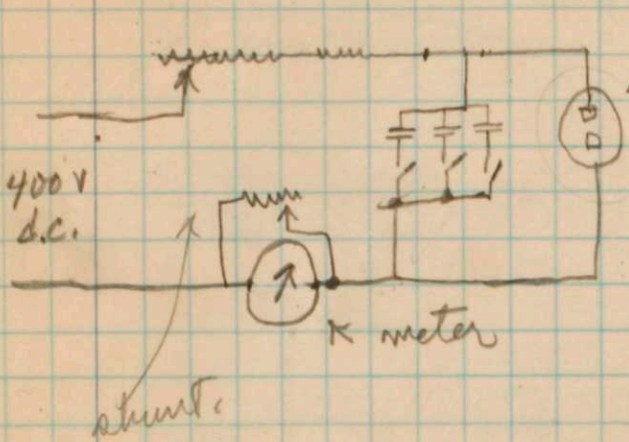
High pressure lamp.

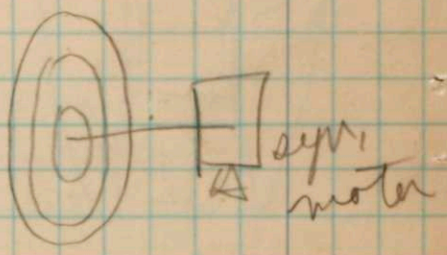
actual size.



Feb 1, 1934.

Design of a Tachometer Stroboscope





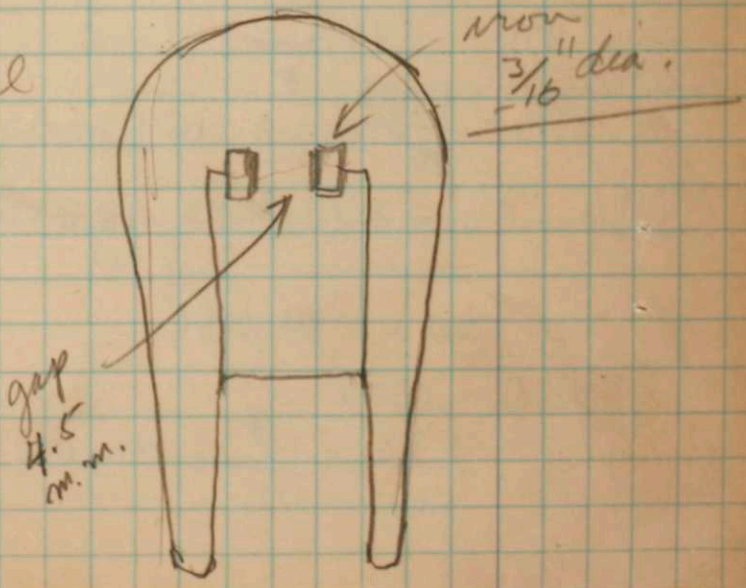
Use of a relaxation oscillator for a tachometer. The ammeter is calibrated in cycles per second or in r.p.m. To calibrate the device use a synchronous motor with speed counting disc.

Or a motor driven disc with attached tachometer could be used to measure the frequency of the light.

Test bulb.

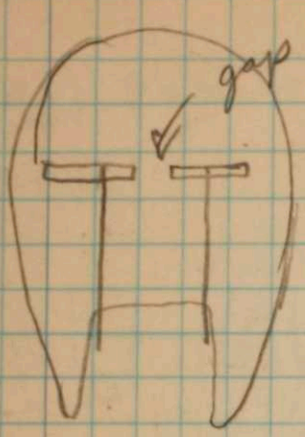
		actual size
#1	1 cm pressure	

Consists of holding over into a glow.



March 19 1934
Edgerton
Harold E.

Test bulb # 2.

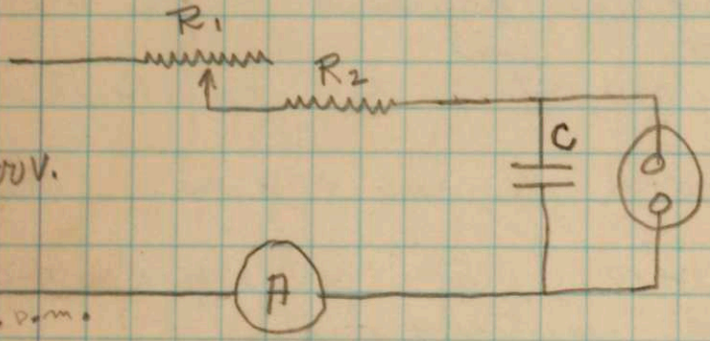


holds into glow
1 cm. pressure - 15

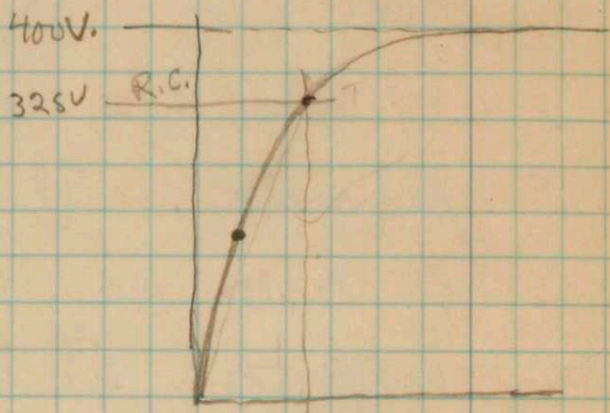
$\frac{400^2}{x^2} = \frac{1}{.66}$ $x = 325$

$x^2 = 10.5$

Circuit



400 r.p.m.



Assume lamp fires at 175 volts

Time = about $\frac{1}{2}$ the time constant.

Assume C = 1 mfd.

at 15 cycles t = .067 secs.

RC = .134 secs.

$R = \frac{13.4 \times 10^4}{1} = 134,000$ ohms.

for C = 2 mfd R = 70,000 ohms.

for 60 ~ t = .0166

RC = .0332

$R = \frac{3.32}{100} \times \frac{10^4}{2} = 30,000$ ohms.

Assume $R_1 = 100\,000$ w 15 watt ≈ I = 10 mils approx

if E = 400 v. $R_2 = \frac{400}{10} \times 1000 = 40\,000$ minimum

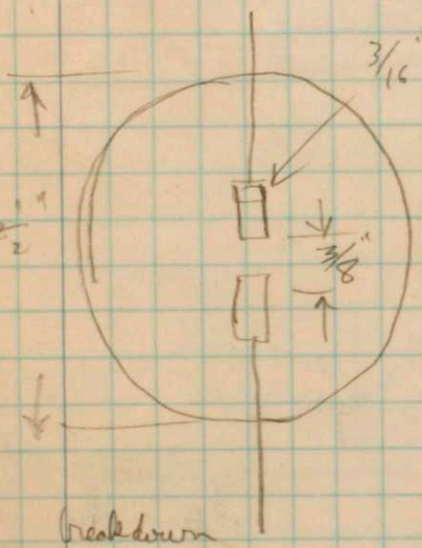
$RC = .134$

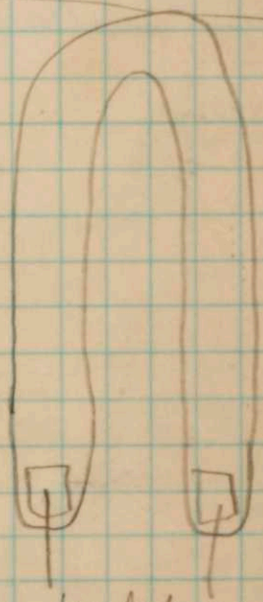
$C = \frac{.134}{1000} \times 150{,}000 = 1$ mfd approx.

for $R_1 = 100\,000$, $R_2 = 50\,000$, $f = 15$ ~

gives about 50 ~ for $R_1 = 0$, $R_2 = 50000$, $C = 1$ mfd.

2. $\frac{50\,000}{1000 \times 2} = \frac{2.5}{100} = .025$





breakdown V

P mm.	
4	225 v. glow at one electrode
6	" " " " less light
3 cm.	300 v. Tends to form spark.

Seal M at 1 cm.
- Use glow not spark discharge.

∴ not enough light with glow discharge

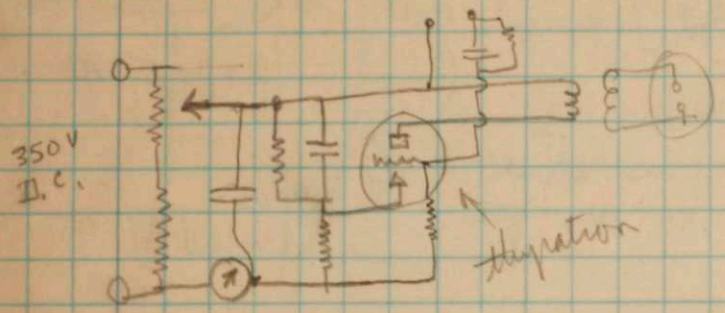
breakdown V

P	
4	— striations visible
6	— " "
8 mm.	Blue light - no striations
9 mm.	begins to constrict.

- Comment - 5 mm probably a good pressure -

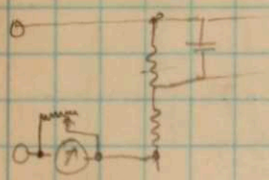
Feb. 5, 1934.

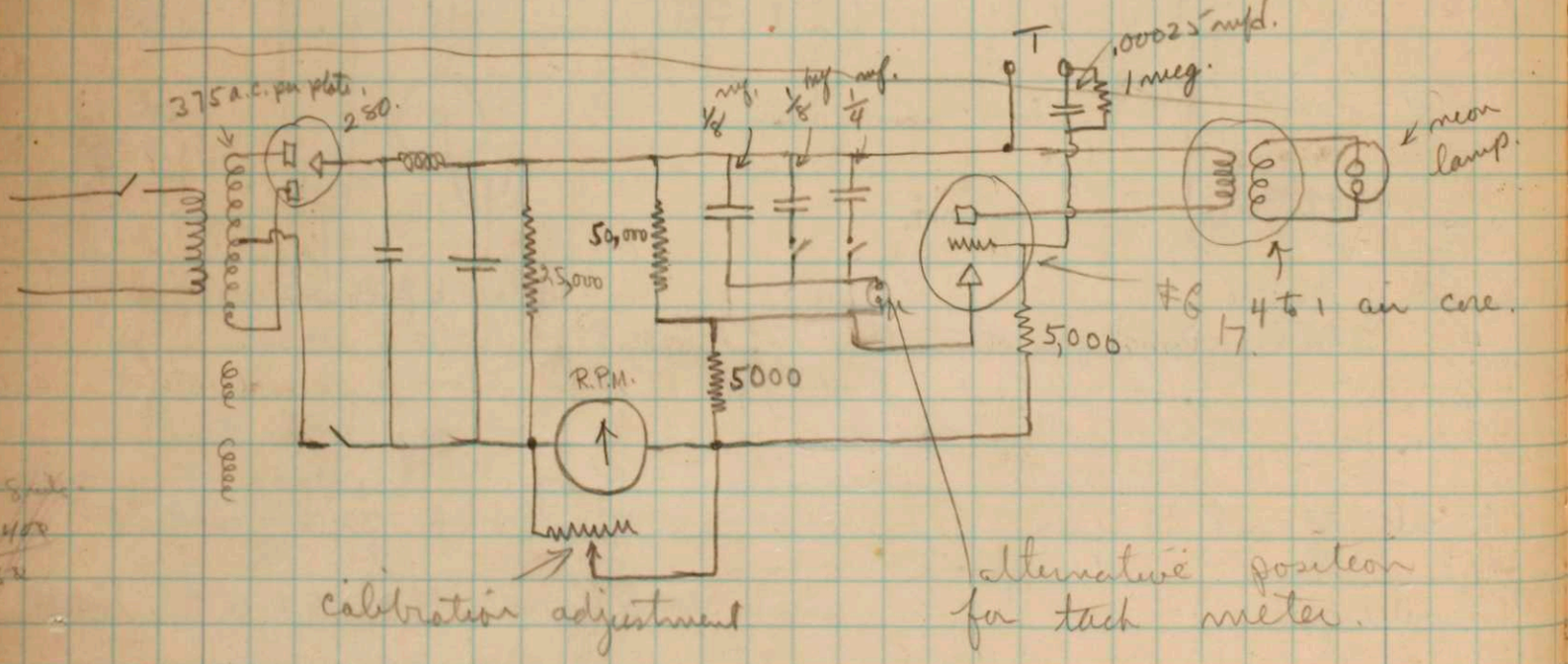
A stroboscopic tachometer.

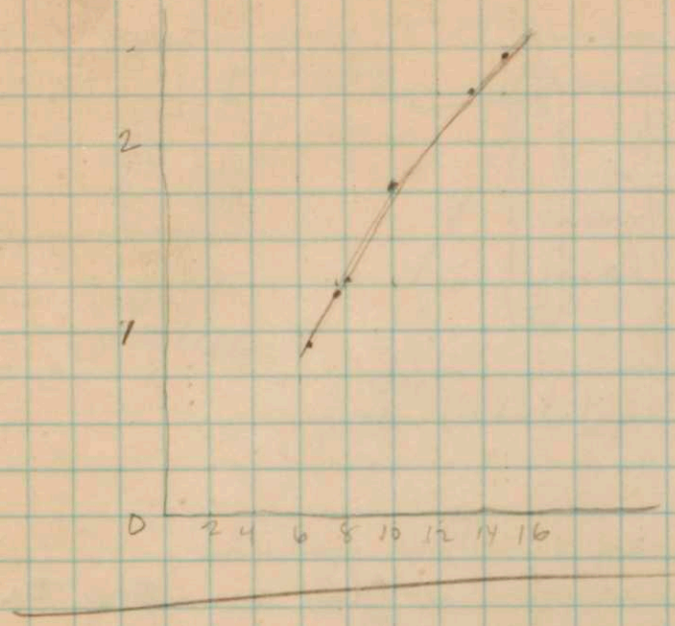


Conventional thyratron spark circuit used on all our mercury strobos.

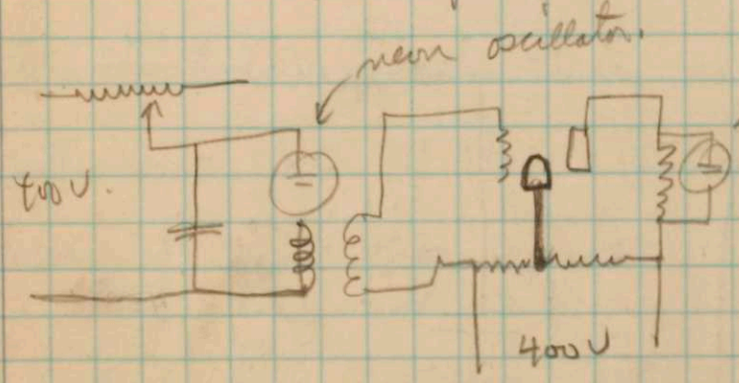
Adjust voltage to correct meter reading.







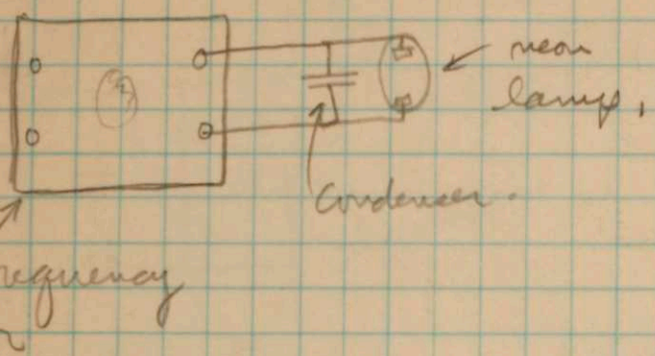
Stroboscopic Tachometer



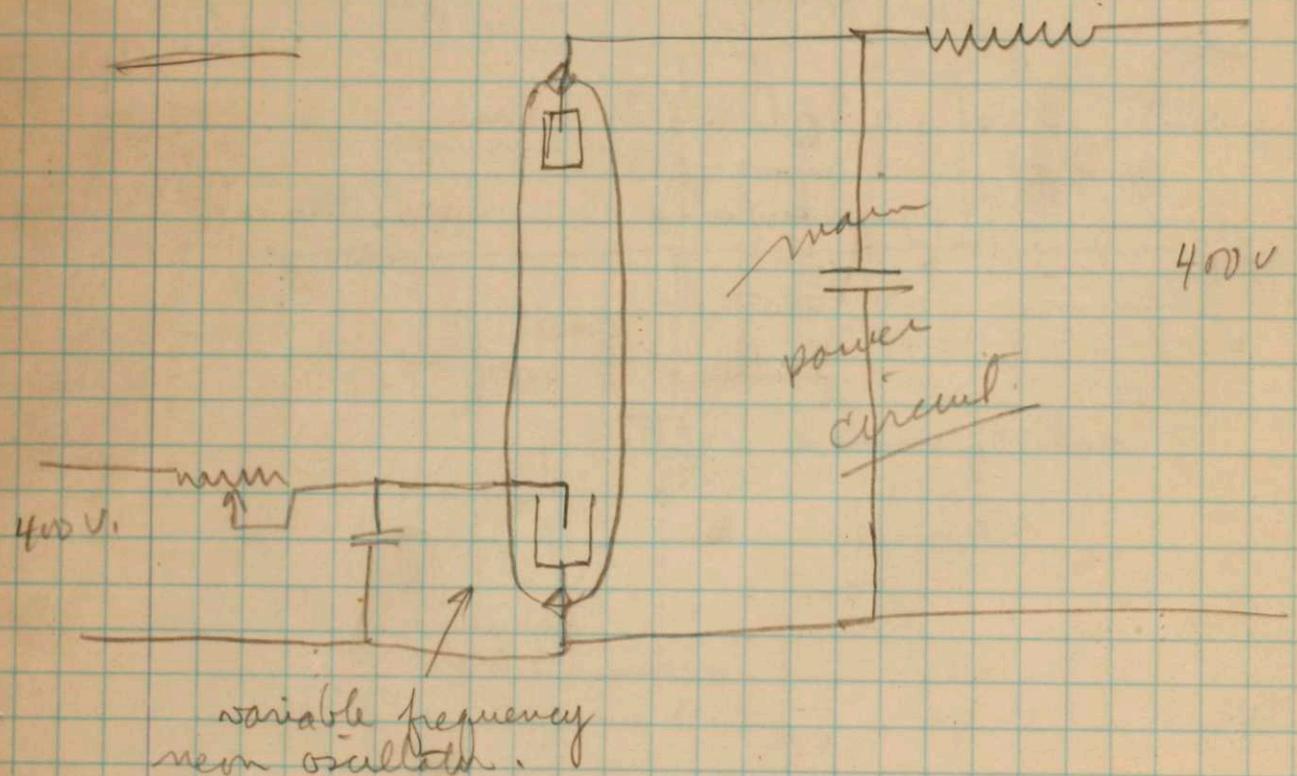
not enough light.

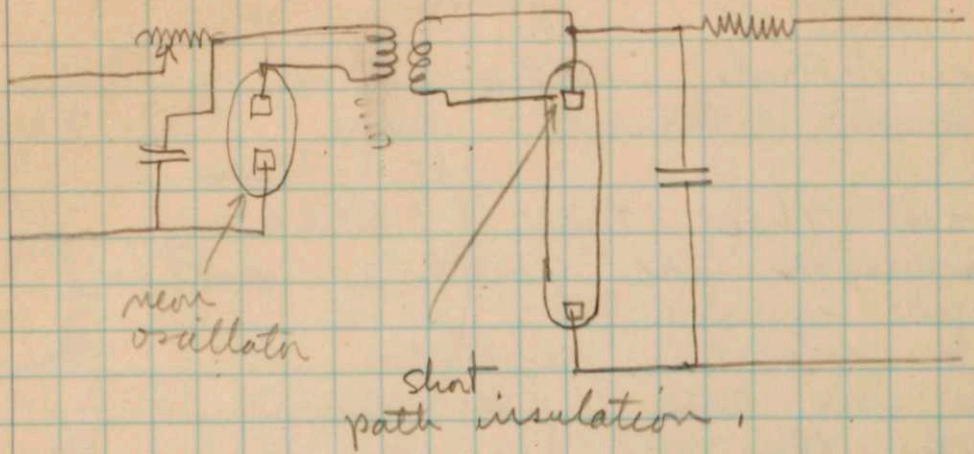
Feb. 9-1932.

Tachometer Stroboscopes.



A dynatron oscillator with a power amplifier tube would do well.





A.C. + D.C. striking voltage of neon lamps. L.E. Ryall
J. scien. Inst. 7 pp. 177-188 June 1930

Neon-tube Oscillators D. Pollack Rad. N ☐ 32 ☐ 33

Practical methods of starting Mercury arc. R. sci Ins. Apr. 33

Flyration oscillator D. Hale R. sci Inst 4 My 32

Theory of neon tube operation C.M. Sommers
Elec. Eng. N 32
Phil mag. Nov 1927 to Dec 1927 1356.

Cold electrodes

Neon flasher lamps. Feb 14 1934

Many electrode configurations, gas pressures and electrode materials have been tried.

There are three types of discharge, glow, arc and arc with a cathode spot.

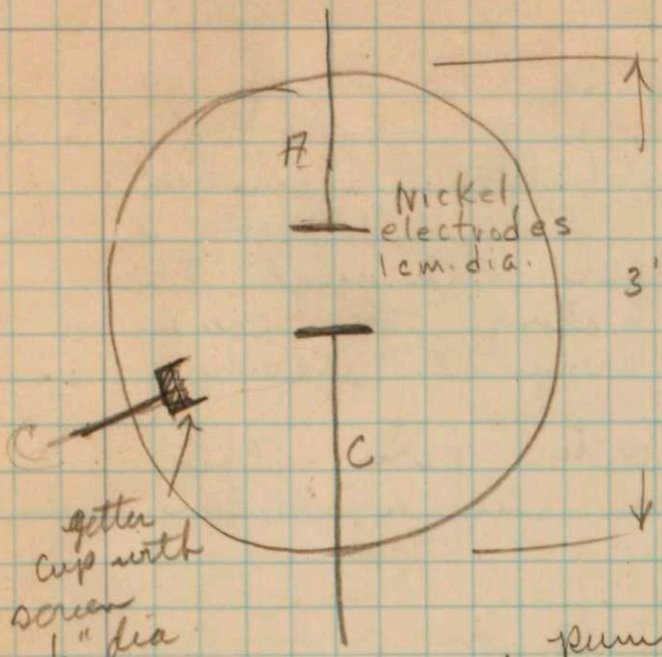
For a relaxation oscillator it is desirable that when the tube breaks down it will break into either an arc or arc with cathode spot, otherwise it will hold over in a glow discharge.

Plain electrodes of nickel and iron show a marked tendency to hold into a glow and an arc is started only with difficulty.

Various electrode coatings have been tried to improve this such as borax, barium, ~~caesium~~ and the regular filament coating of barium and strontium oxides. While these coatings aid in the formation of an arc it is uncertain. They often hold into a glow and the arc may or may not be with a cathode spot. - This makes operation erratic.

Recon

Feb 24 1934.



A tube was made as per the figure.

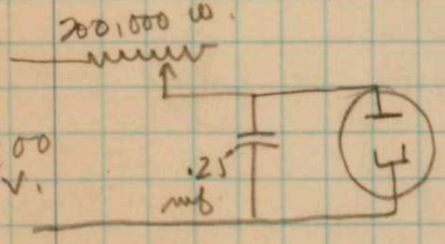
The getter cup was filled with ceasium chloride and calcium chips.

Tube run on pump between electrodes with 5 m.m. neon with electrodes hot.

pumped flat and getter partially flashed. then sealed off with 5m m. neon.

This tube would not break into an arc readily between electrodes even though they were coated with ceasium. (tended to go into glow discharge)

If the getter cup was made the cathode it was found that the tube broke into an arc very readily and that a cathode spot was always formed.



Connected as shown in the figure it made a remarkably stable oscillator showing very constant break down voltage and always going into an arc with a cathode spot.

To secure constant break down it is necessary to keep glass parts away from the arc and electrodes to remove the effect of charges on the walls

A longer arc gives more light but makes it difficult to fulfill the previous qualification

March 19 1934

A. E. Edgerton

Norbert E. Lien

Feb. 14 1933.

Neon flasher lamps.

In pumping the bulbs described on the previous page a third electrode is necessary to pass a discharge through the bulb without unduly heating the ceasium cup, since ceasium evaporates easily.

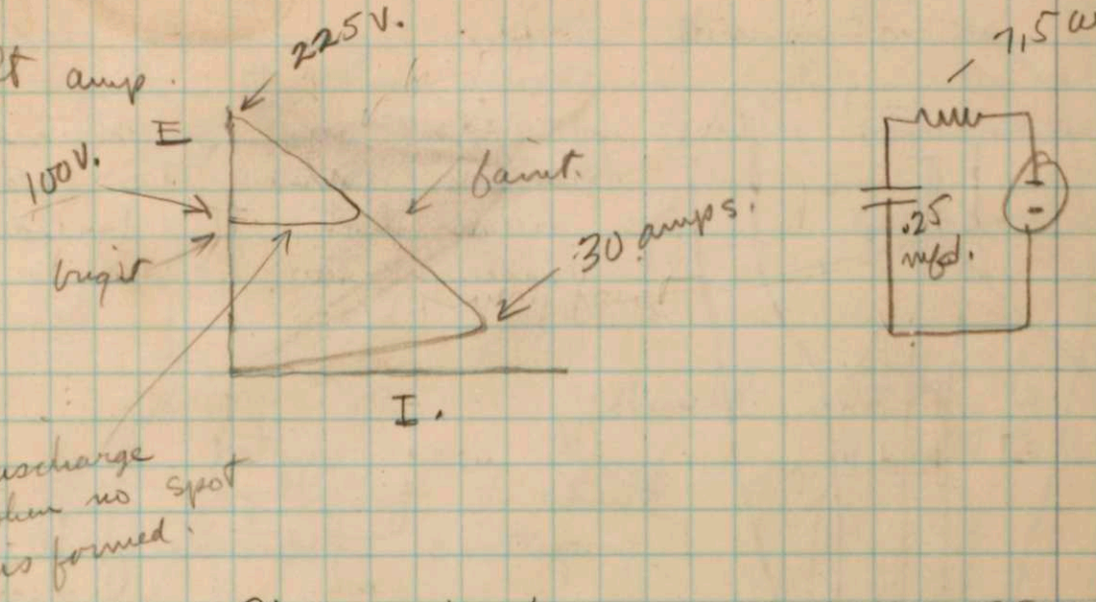
Sodium would be better from this standpoint as it has a higher boiling point.

Life test on tube on opposite page.

Feb.	14	7.5 hrs.
Feb.	15	2 hrs.
"	16	4 "
	17	5 "
	19	8 ½

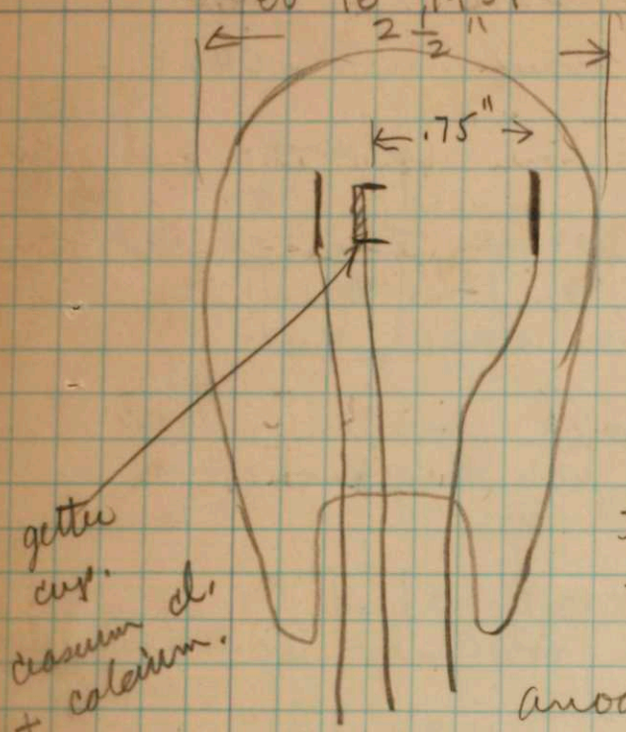
Data on tube on page 139.

Volt amp.



Static breakdown potential = 325 V.

- Feb 16, 1934 -



The two outside electrodes were used to treat the tube. Current was passed with 1 m.m. neon until the electrodes were hot. This boiled out cesium too readily.

It was noted that the arc tends to form on any points or projections. - Particularly at a welded joint

The light increases with large anode and cathode area.

The light increases with long arc path.

The difficulty is to properly treat the bulb and electrodes without boiling off all the cesium.

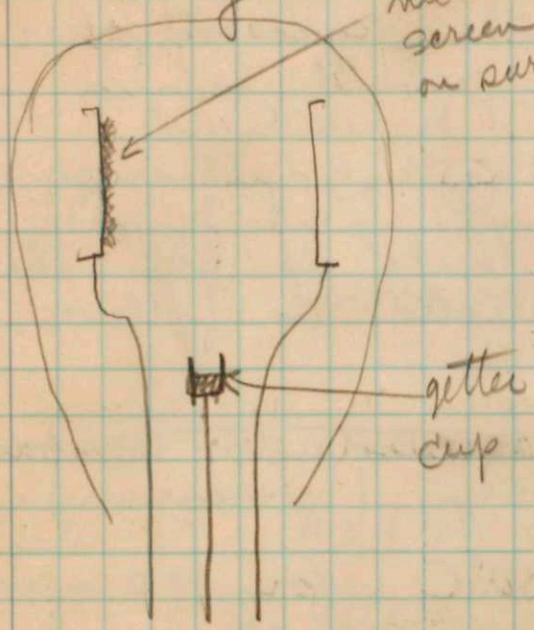
Cathode should have large area to prevent heating and boiling off cesium.

Large flat electrodes give more uniform field hence less trouble from charges on the glass and stray fields.

March 19, 1934
Harold E. Edgerton

Feb 16, 1934

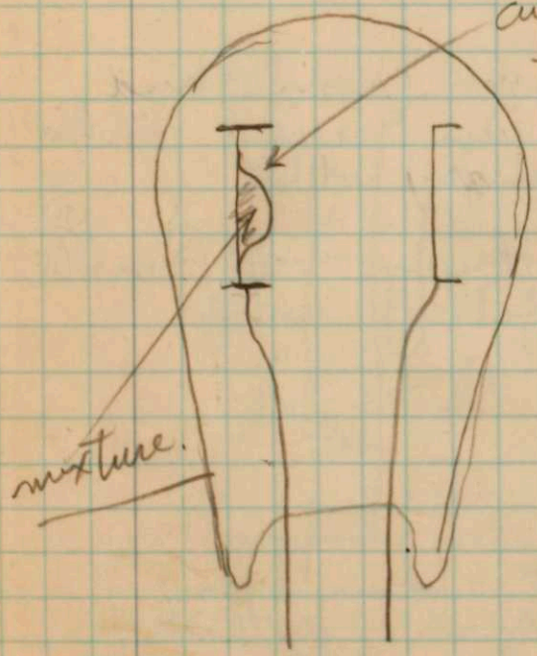
to try.



The screen surface was coated with stannic oxide but the stannic oxide was all boiled off during bombardment.

(Tube gassy)

Would work to getter cup - not otherwise.



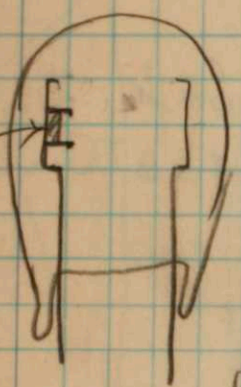
(gassy.)

Stannic oxide + ceasium gives ceasium oxide at ten.

Feb 21, 1934.

The trouble to this point has been the difficulty in properly degassing the tube so that the discharge would be in reasonably pure neon.

⊕



A tube built as per the figure was treated as follows.

(1) Electrodes degassed by bombardment before assembly. (vacuum)

(2) baked at 250°C for 30 min. (this drove off a small ammount of ceasium)

⊖

(3) 2 m.m. neon and run on a.c. for 10 min. this drove off some ceasium.

(4) pumped flat and again 2 m.m. neon. and run on a.c. until more ceasium was boiled out. — (Electrode under red temp.) not hot

(5) Pumped flat, ceasium driven off bulb with flame, ~~and cooled~~ filled with 6 m.m. neon, when cool.

(6) Sealed off. ⊖

Spot would not form on cathode (getter cup) when used in oscillator circuit. Arc was good neon color indicating that the neon was pure.

Evacuation technique is O.K.

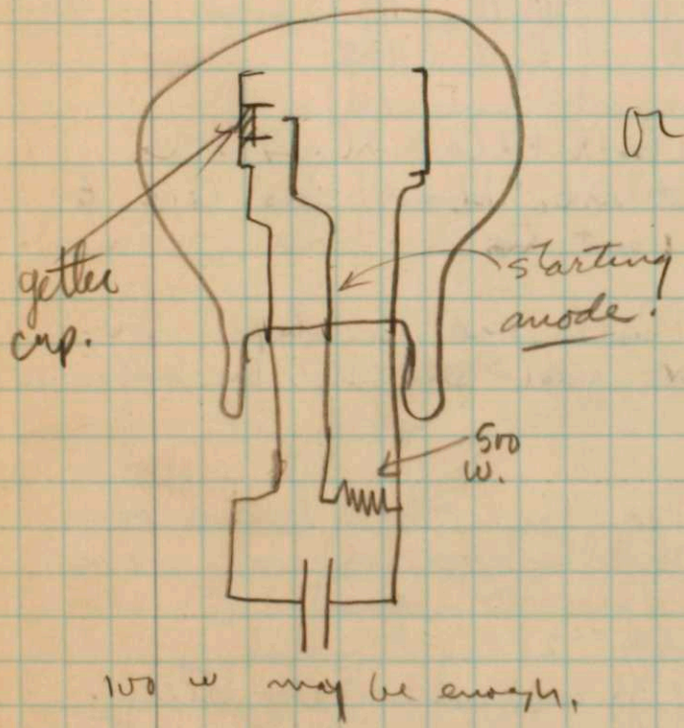
Tried driving out more ceasium with bombarder but arc would not form on cathode -

~~triple~~ Tried driving of ceasium by making getter cup anode and ~~or~~ cathode. ~~but~~ Ceasium driven off but are would not form on getter cup.

— Discharged 1 mfd at 60 ~ and apparently cathode became ~~ac~~activated. Also color of bac improved.
(— Perhaps this is the proper treatment?)

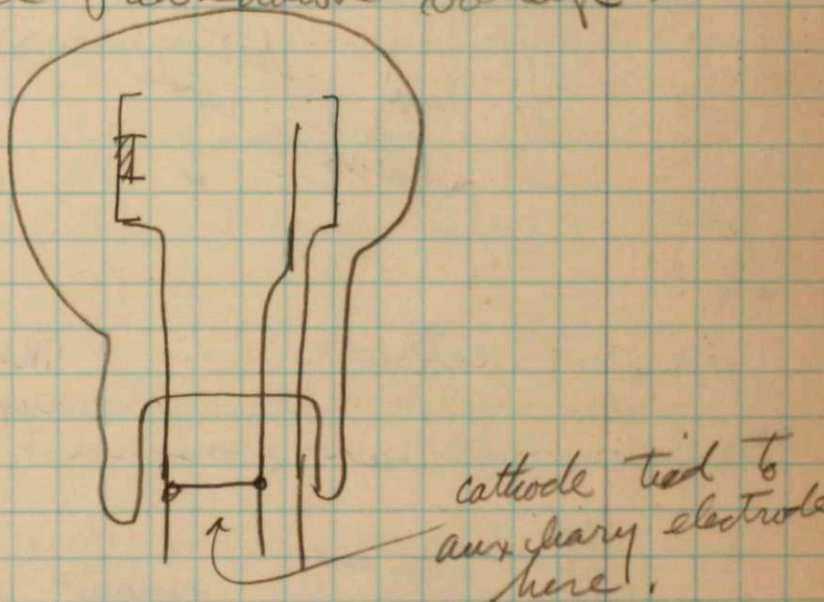
Feb 21, 1934.

Idea to make a more stable oscillator with lower breakdown voltage.



100 w may be enough.

or.

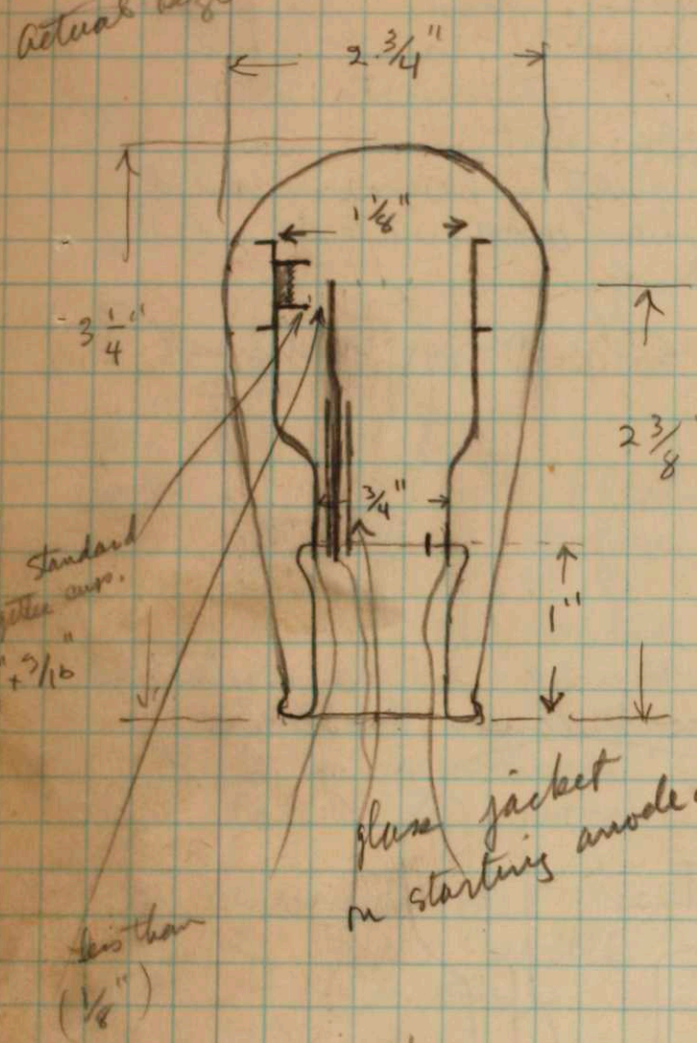


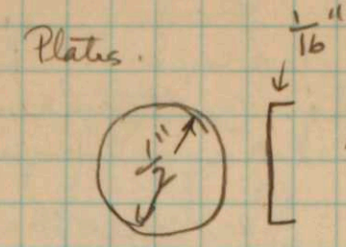
Also freedom from charges on glass.

March 19 1934
Harold E Edgerton

Feb 23 1934 – Klemenhausen.

Standard lamp.





Pressure 10 to 12 m.m.
minimum distance 2 to 3 m.m.

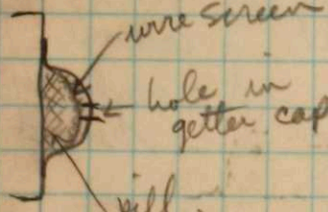
Cs	140	4, 3
Cl	35	1,
Ca	40	2
$CaCl_2$	110	
CsCl	168	

$2CsCl + 2Ca = 2Cs + 2CaCl_2$

wt ratio about 3 pts CsCl to 1 part Cs

Mix CsCl and Ca chips in approx equal portions by volume.

Alternative cathode



Twice size

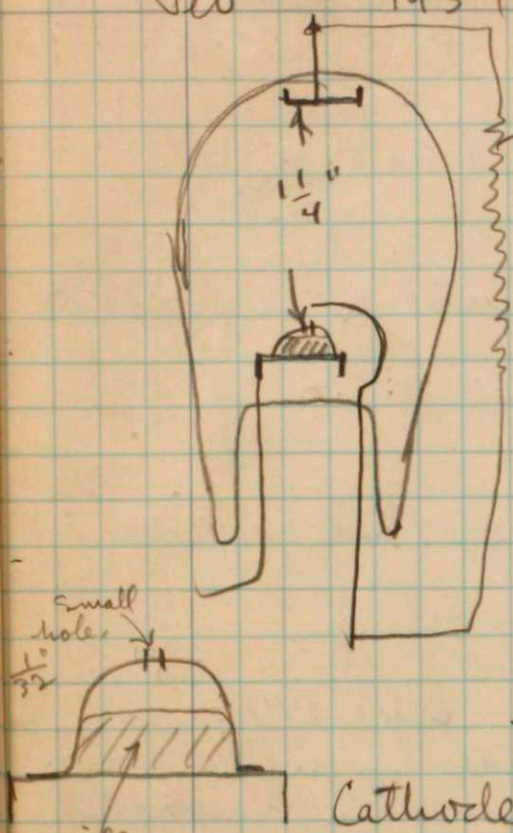
Treated as per the lamp on page 144. except 1 cm. neon.

Arc tends to go across at stem. making operation erratic and tending to produce bold over.

Evaporating caesium by passing a discharge tends to make it stick to the glass walls.

Life at 450 v mfd.

Feb 1934



Lamp built as per figure (same dimensions as on opposite page)
Electrodes degased before assembly
equal portions Calcium chips and $CsCl$ by volume.
Baked at 250°C for 20 min.
2 m.m. neon and run on pump for 5 minutes. (to starting wire for anode)
pumped flat.
2 m.m. neon and run for 5 min.
pumped flat.
Cathode bombarded to drive of a very small quantity of ~~Caesium~~
Ceasium driven off glass by flame.
Cooled and filled with 1 cm. neon and sealed off.

Comments - Runs well with values of R from 100 to 10000 ohms - (all that were tried)

Care should be taken in passing a discharge through the lamp while on the pump as it permanently darkens the bulb. (probably by sputtering)

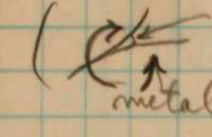
Arc forms consistently inside cathode cap.

A similar tube with a cathode as per the figure on page 146 showed some inconsistency as to the point of formation of the spot. It tended to form on the outside of the cup.

Cathode comments.

Cathode must have large area so it will stay cool.

Arc tends to form on points or in cracks.

(

)

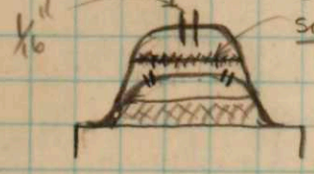
Cathode should be designed so that ceasium vapor remains inside.

A cathode of the type on page 147 was run for 2 hrs. continuously at 45 v $\frac{1}{4}$ mfd. drawing 5 mils without any appreciable evaporation of ceasium.

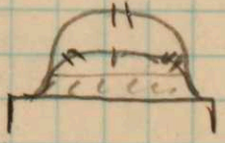
Cathodes run for a considerable period stroboscopically show practically no deteriation of the getter pill.

Cathodes heated to a dull red for 10 min. show practically complete disintegration of the getter pill.

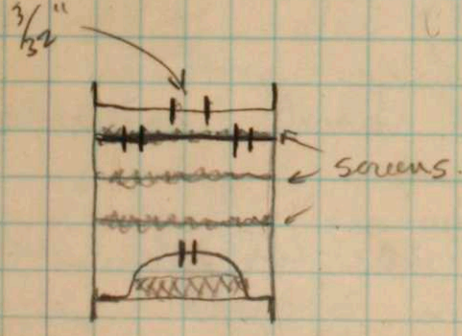
Small cathode design.



or

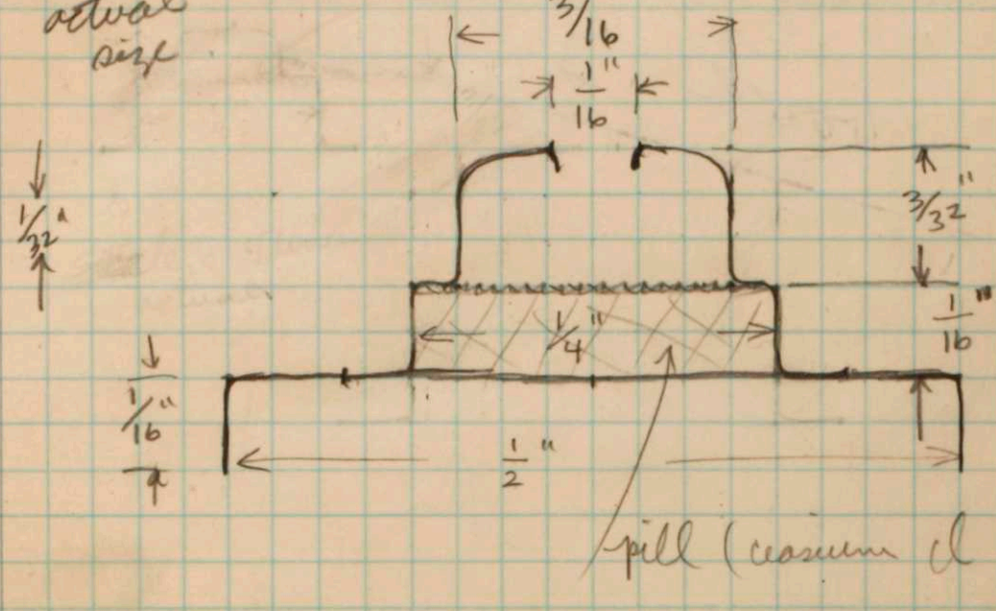


Large cathode



Design of small cathode

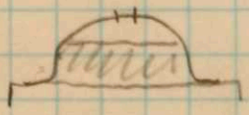
stones actual size



Cathodes – Feb 28

Standard getter as per page 147.

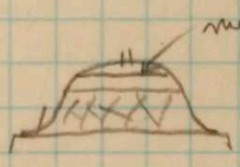
(1)



– Best tube of this type
Pill blackens and wears away with use.

– If path to anode is too long tube tends to hold over because arc drop prevents current density from rising high enough.

Test – 15 milliamps. – ½ mfd. to starting electrode



this works.
but disc prevents best operation.
Caesium deposited on the outside of cathode emits sufficiently to prevent current density rising to point to start spot.
(insulating shield could be used on cathode)

see page 30

book 3

Sept.
~~Aug~~ 2 2 hrs. on work for Sa Peterson.
884. Photo service.
Sept 15 – 3 hrs. work – $1.00 photographic work. (P)

Lever Bros. Time Account.

Total time from June 20 to Aug 9 - 3½ days. } billed
Helm $3.60
Labor + Material 2.25 } Aug 10

1432 Aug 9 - 1 hr. with Fogler
" 10 5 hr. testing time of flash
11 - visited plant - no work - breakdown 2 h.

Mon Aug - Took 1 doz pictures - 2½ hours -

Time in Lab. one day 8
Mon Aug 22 - 2 hrs. at Lever Bros. 2
Fri 26 2 hrs. " " " 2
~~Aug.~~
~~Sept~~ 2 1432 2 hrs. on Lever Bros 2
Some hours consulting - 4 hrs.
till Sept. 19.
Sept 27 - ½ day
Sept 28 - ½ day
Sept 29 - ½ day.
Oct 6 ½ day
Oct ½ day.
Oct 10 - 1½ hrs.
Oct 26 - 1 hour.
Oct 28 - 4 hours.
Oct 29. 1 hour.
~~Oct 31~~
Nov. 1 2.0 hours.
Nov. 2 4 hours.
Nov 3 2 hours - Camera construction
Nov 4 3 " Pictures.
Nov 7 3 " Pictures
" " 3 " Penetrons
Till Nov 12 10 "
Nov 14 - 8 "

+12
23.11 charges
Bill presented Sept 5
3 days at $40
1 day at $25

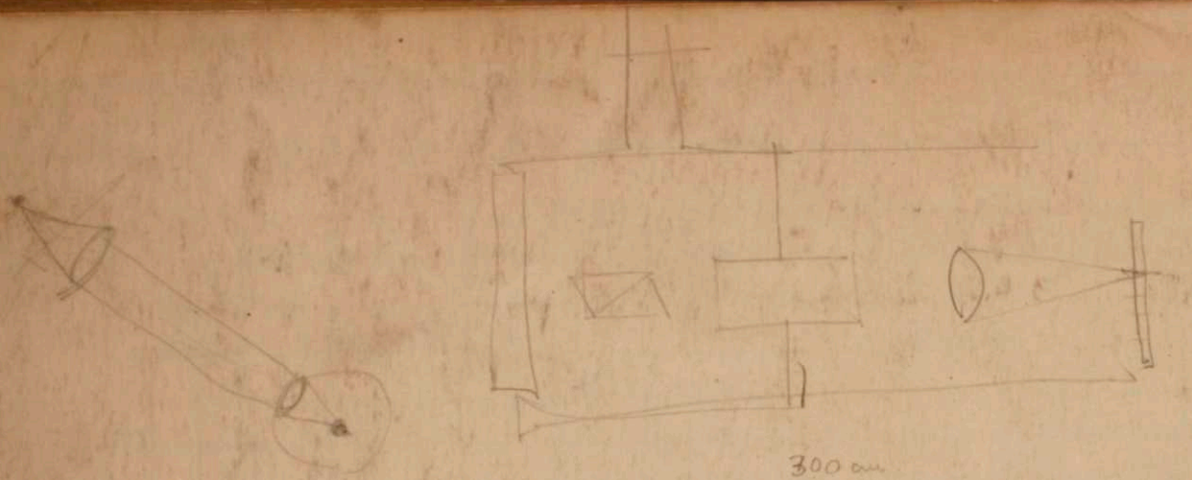
Bill presented Oct 10 1935
Total 3 days.

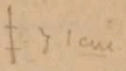
Transformer repaired

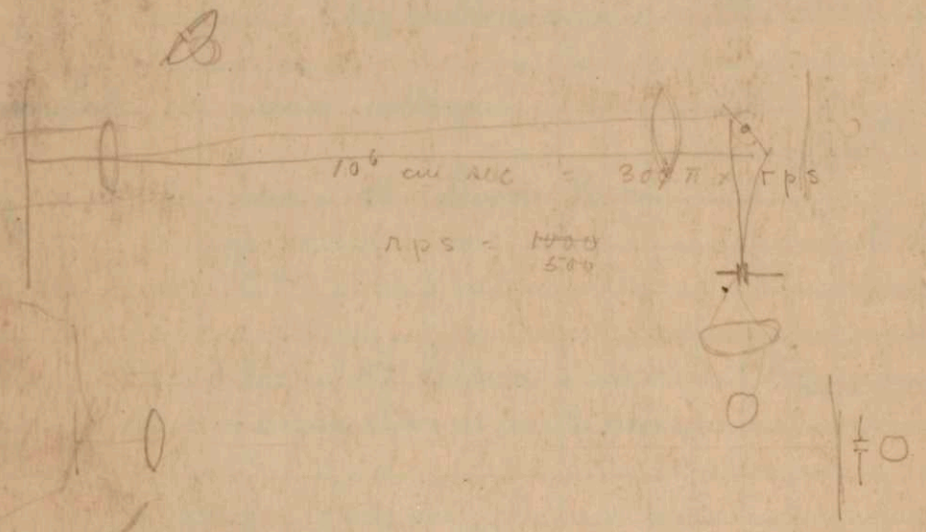
1.30
5.20

$3.30 personal
Building Penetrons charge (disbursed)
$5.20 for plates personal.
.25 for rope.
Plates + Masks.

45







$2\pi R \times 60 = v$

$360\ R = v$

$36{,}000 =$

$v = 3{,}6 \times 10^{6}$

30 meters