

**HAROLD E. EDGERTON**

**PAPERS**

MC 25

Series III

Laboratory Notebooks

Number —

Dated July 20, 1931 to Jan. 12, 1932

NOTEBOOK T-II

Myo 6680

THYRATONS II.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

COMPUTATION BOOK

NAME

HAROLD E. EDGERTON

Number

COURSE

Used from JULY 20

1931, to JAN 12

1932

JAN 18 1940



Recollections of early work p

MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
COMPUTATION BOOK

Faint, illegible text, likely bleed-through from the reverse side of the page. Some faint markings resembling a page number '9' and a fraction '1/3' are visible.

11  
12  
13

Mercury Arc tubes, thyratrons, etc.  
Stroboscopes

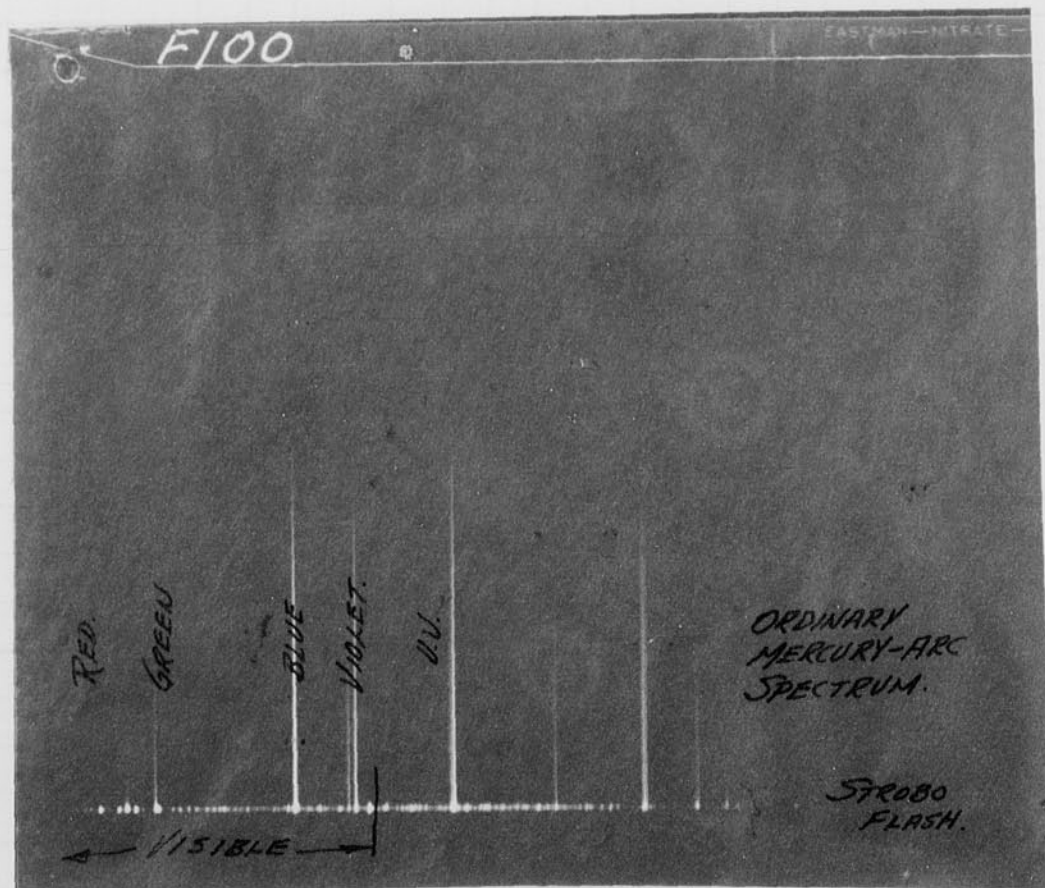
Harold E. Edgerton  
July 20, 1931.  
Cambridge, Mass.

July 20, 1931.  
H. E. Edgerton

Working with J. C. Stodolbarger in Radiation Laboratory. We are taking a time spectrogram of the 12 mm tube which was tested last sat on the pump. The tube got very hot and gave out a very intense white light when it was operated as a 60 cycle stroboscope. The tube got very hot.

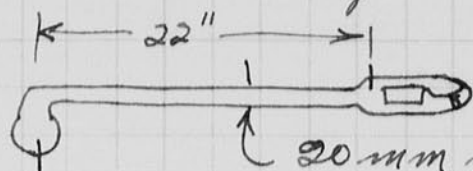
Some trouble was experienced with slicer. It was due to a spark coil that was about burnt out.

In the afternoon K. S. Gorneshanum helped me move the outfit to the Dynamo lab. and set it up in front of the 160 HP motor in the Dyn Lab. Substation. Prof. Harrison of the physics department came over to see the outfit run. Major Smith was there also and he had the power turned on so that the outfit could be operated.



July 21, 1931  
 H. S. Edgerton.  
 K. S. Germeshausen.

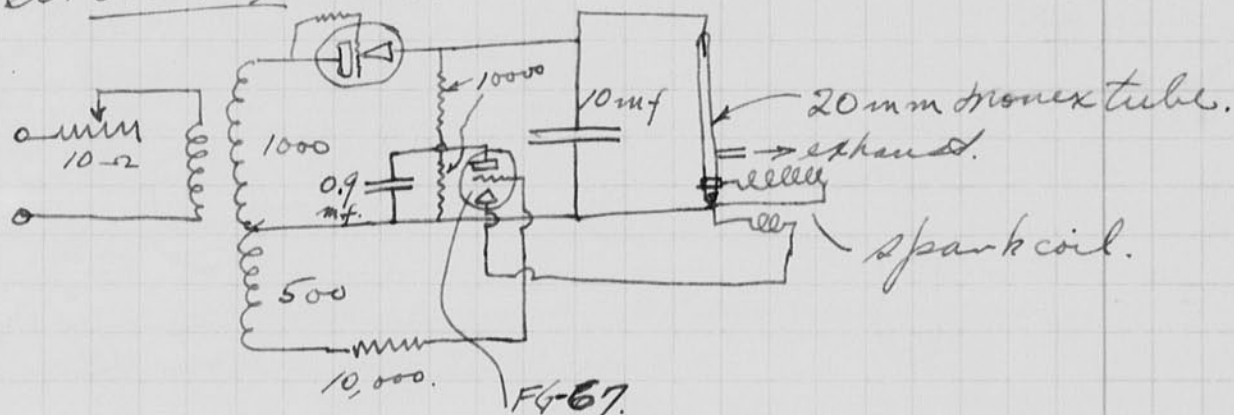
Started glassblower, Mr. Ryan, on a new stroboscope tube of the new design.



The discharge will be sufficient to heat this tube so that the light will be brilliant as shown in the recent experiments.

Exhausted a tube of 20 mm nonex that I made on July 19. In the afternoon Germeshausen and I tried it out. A capacity of about 10 mf. is about right for this tube. The light was very bright and white in quality.

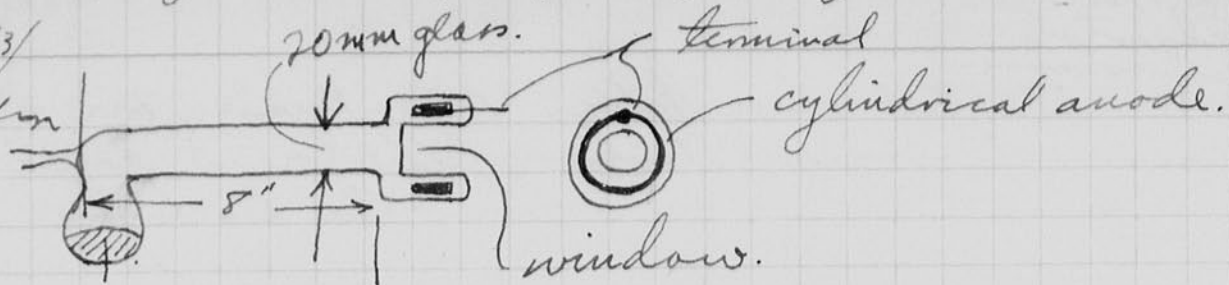
Circuit used.



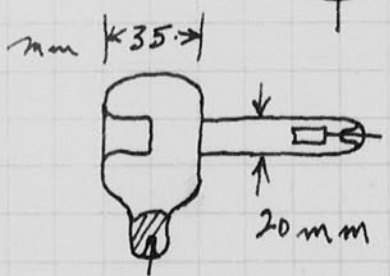
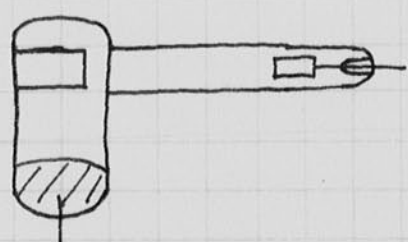
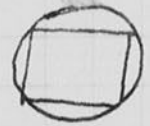
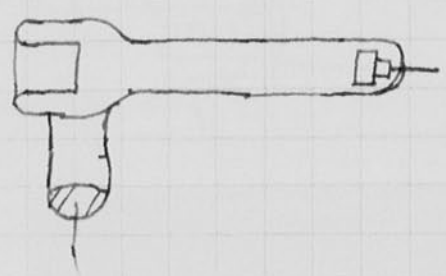
Germeshausen took some snap shots with his camera of the stroboscope tube today.

Proposed design of Projector pulse tube.

July 21/1931  
H. E. Edgerton



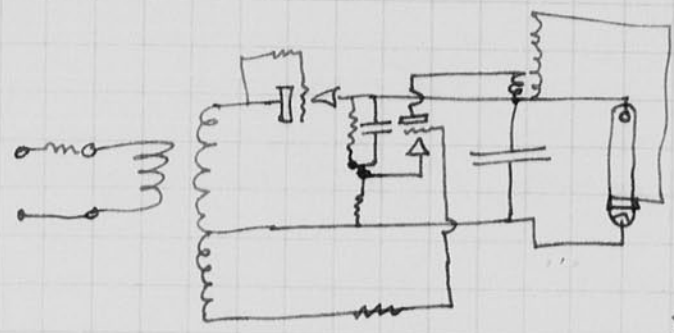
The window is put in this position so that the heat of the arc column will keep it free of condensed Hg.





July 22 1931.  
 H. Edwards  
 K. Remmerhauer

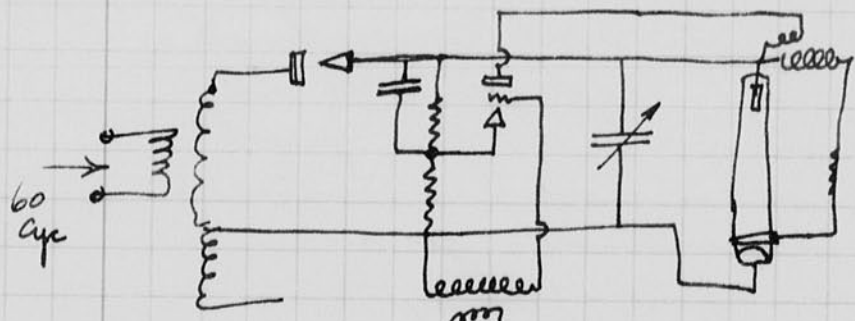
Continued experiments with the 20 mm tube which was tested yesterday. Changed circuit as follows.



This circuit works a little better when the tube is hot.

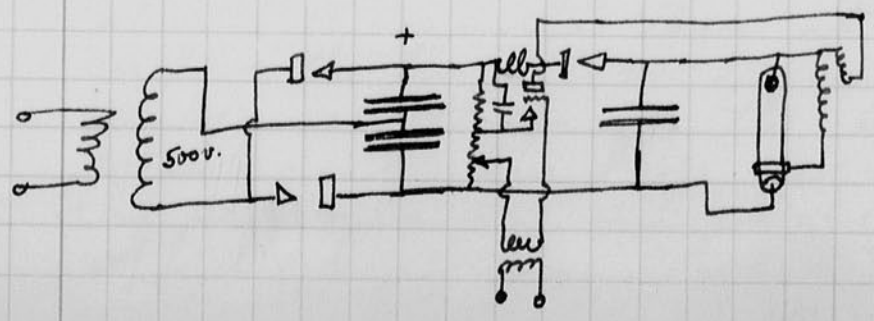
The light from the tube gradually increases in brilliancy until as the temperature rises until the pressure is such as to cause flickering. This temperature is about 200 degrees C. The highest recorded was 232 degrees. At this temperature the arc begins to become restricted in area inside of the tube. When the arc does not strike the tube is filled with a green glow which is very faint.

$4 \times 10^{-6} f \times 20,000 = 8 \times 10^{-2} = .08 \text{ sec} = \text{time const of circuit when the tube fails.}$



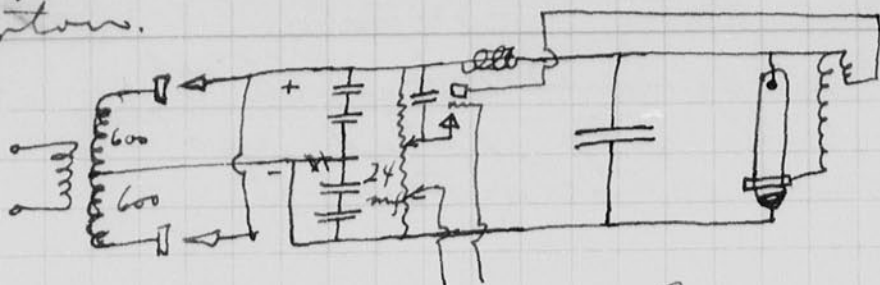
Circuit good for frequencies less than 60 cycles per second.

audio frequency oscillator.



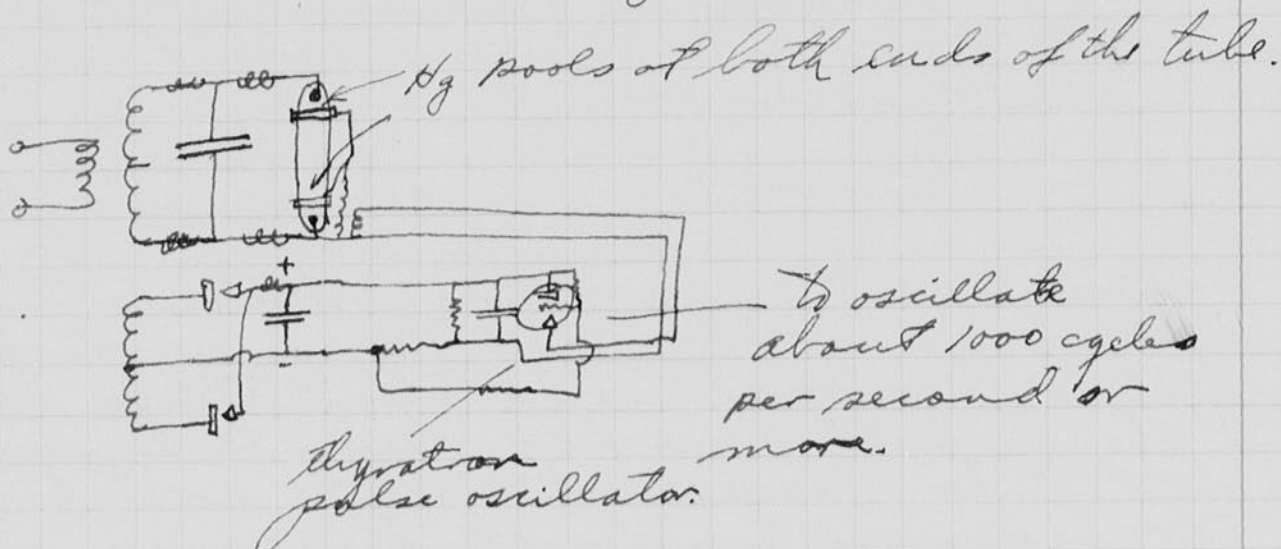
Haus Muller saw the arrangement. Perrin of the physics Dept was also over and saw it run.

July 22 1931  
H. Edgerton.



$8 \times 3 = 24 \text{ mf.}$

Light source.



The light from an ordinary mercury arc lamp shows about five main colors, namely 2 violet (dim.), 1 blue (bright), 1 blue green (dim), 1 green (bright), 1 yellow doublet. Also there are three very faint red lines. The stroboscope tests show that there are a great many lines excited by the high voltage, high current discharge, especially at high temperatures which are not desirable for the ordinary discharge. These ~~long~~ extra radiations ~~of~~ are composed mainly of many red yellow and green lines which make the light very good as a light source.

July 23 1931  
H. S. Edgerton

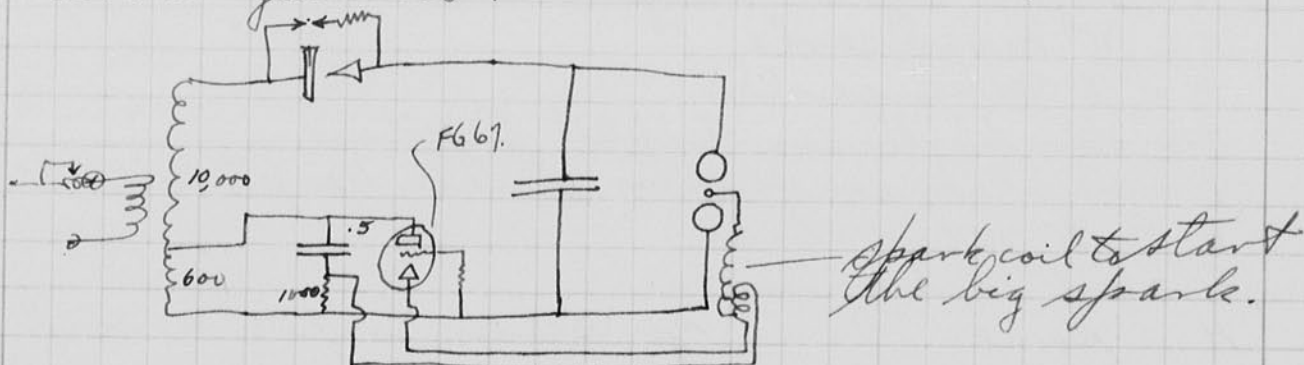
7

Spent day pumping a 20mm tube. It had a leak somewhere so the vacuum could not be reduced to less than  $\frac{1}{4}$  of a micron. At the same time Geo Hoodley had a tube made of capillary tubing on the exhaust system. This tube will be an experimental one to find out if it is possible to make the light a line or approach a line source. I cut my tube off the system about 4 P.M.



In the afternoon Prof. Harris of the ~~physics~~<sup>chem</sup> dept. came over to look at the spectrum of the stroboscope arc. He also brought over a synchronous motor that he thought was n.g. The light showed that it was running perfectly.

We discussed at some length his circuit for obtaining a high voltage condenser discharge which excites non-chromatic radiation for his experiments. I suggested the following arrangement.



The rectifier charges the big condenser to about 15,000 volts. Then at the end of the cycles the thyatron discharges the small condenser through the primary of the spark coil. The high secondary voltage of the secondary ionized the space and kicks off the heavy condenser discharge. We experimented some with the circuit of P 3 using needle points spaced about  $\frac{1}{4}$  of an inch with fair results.

July 24/1931

Continued exhaust of tube and experiment. Leaks in tube somewhere. Tested the capillary tube with the strobo discharge and got a yellow glow from the ~~the~~ discharge.

July 25 1931. Tried to fix a blow hole in tube but cracked off the pool bulb. Disconnected from the system. Exhausted another tube. Built a 40" Monex tube of 16 mm stock in a zigzag shape to see if the discharge will go around a corner.

- A = Triplet system Hauptserie
- B = II Nebenserie
- C = I Nebenserie
- D = Kombinationen Triplet System
- E = System einfacher Linien Hauptserie 25-amp.
- F = II Nebenserie
- G = I Nebenserie
- H = Kombinationen zwischen triplets und einfachen Linien.

tree"

Notebook # July 20, 1931 - Jan. 12, 1932

**Filming and Separation Record**

\_\_\_ unmounted photograph(s)

\_\_\_ negative strip(s)

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

was/were filmed where originally located between page 8 and 9.

Item(s) now housed in accompanying folder.

6100 A. Triplet system Hauptserie  
 4050 B. I Nebenserie  
 3000 C. I Nebenserie  
 D. ~~Be...~~ Kombinationen triplet System.  
 E. System einfacher Linien Hauptserie 25-m P  
 F. II Nebenserie. G. I Nebenserie

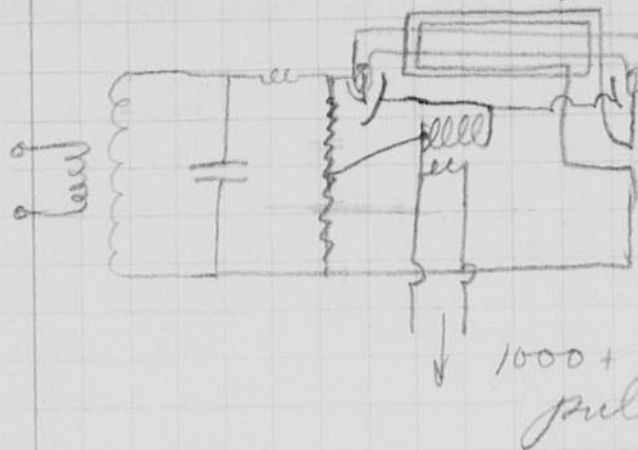
6200	6234.35E	
6000	6072.63H	
5800	5803.55E 5803.55A	5859.32A 5872.12H
5600	5675.86H	5789.69H 5790.66G. 5769.60H
5400	5460.74B 5460.74A	5549.28E
5200	5218.9E 5290.1E	5384.70A 5393.50E 5357.05A 5389.01A 5316.69 5140.10A 5102.42H 5138.09H 5128.9E 5120.65A 5165.8E 4916.06F 4991.5H 4980.82AV 4970.13H
5000	5025.56H ✓ 4822.3H ✓ 4883.1H ✓ 4827.1A ✓ 4832.2H ✓	4722.8A ✓ 4748.1A ✓ 4792.1A 4701A ✓
4800	4870.27H ✓ 4896.9A ✓ 4662.4A - 4672.7A -	
4600	4675.3A - 4653.4A	
4400		4359.34B - 4343.64H - 4313.3H - 4358.34A - 4347.60G - 4339.23H -
4200	4077.83H ✓	4140.03H -
4000	4046.56B - 4046.56A -	4108.08F -
3800	3815.84H ✓ 3801.67F 3813.89H -	3903.64H - 3906.40G - 3901.90H -
3600	3650.15C 3654.83C 3663.28H 3662.88C 3680.01D	3702.36H 3704.22G 3701.44H
3400	3447.22G 3478.98G 3477.85H.	3524.27G 3523.0H 3592.97G 3590.95H 3591.48H
3200		3305.08D 3341.48E 3144.55D 3125.66C
3000	3021.50C 3011.05D 3023.47C 3020.26D 3025.62C 3050.40D 3087.48H	3131.55C 3131.84H
2800	2804.46C 2856.94H 2805.42C (2810.51D) 2893.60B 2803.48C 2806.84	2967.28C 2925.41B 2967.52H.

H. Kombinationen zwischen Tripletts und einfacher Linien.

Reclassification of the Spectral lines of mercury  
from Paschen & Dotze. "Gesetze der Linienspektren".

λ 6234.35 E	4672.7 A	3085.26 D
6072.63 H	4662.4 A	3050.40 D
5872.12 A	4653.4 A	3027.48 H
5859.32 A	4358.34 A & B	3025.62 e
5803.55 A & E	4347.60 G	3023.47 C
5790.66 G	4343.64 H	3021.50 C
5789.69 H	4339.23 H	3011.05 D.
5769.60 H	4313.3 H	2967.52 H
5675.86 H	4140.03 H	2967.28 C
5549.28 E	4108.08 F	2925.41 B
5460.74 A & B	4077.83 H	2893.60 B
5393.50 E	4046.56 A & B	2856.94 H
5389.01 A	3906.40 G	(2810.51 D)
5384.70 A	3903.64 H	2806.84
5354.05 A	3901.90 H	2805.42 e
5316.69	3893.89 H	2804.46 e
5290.1 E	3815.84 H	2803.48 e
5218.9 E	3801.67 F	
5165.8 E	3704.22 G	
5140.10 A	3702.36 H	
5138.09 A	3701.44 H	
5128.9 E	3680.01 D	
5120.65 A	3663.28 H	
5102.42 H	3662.88 C	
5025.56 H	3654.83 C	
4991.5 A	3650.15 C	
4980.82 A	3592.97 G	
4970.13 H	3591.48 H	
4916.06 F	3590.95 H	
4896.9 A	3524.27 G	
4890.27 A	3523.0 H	
4883.1 H	3478.98 G	
4832.2 A	3477.85 H	
4827.1 A	3447.22 G	
4822.3 H	3341.48 B	
4782.1 A	3305.08 D	
4748.1 A	3144.55 D	
4722.8 A	3131.84 H	
4701. A	3131.55 C	
4685.3 A	3125.66 C	

July 26 1931 Circuit for super excited Hg arc lamp.

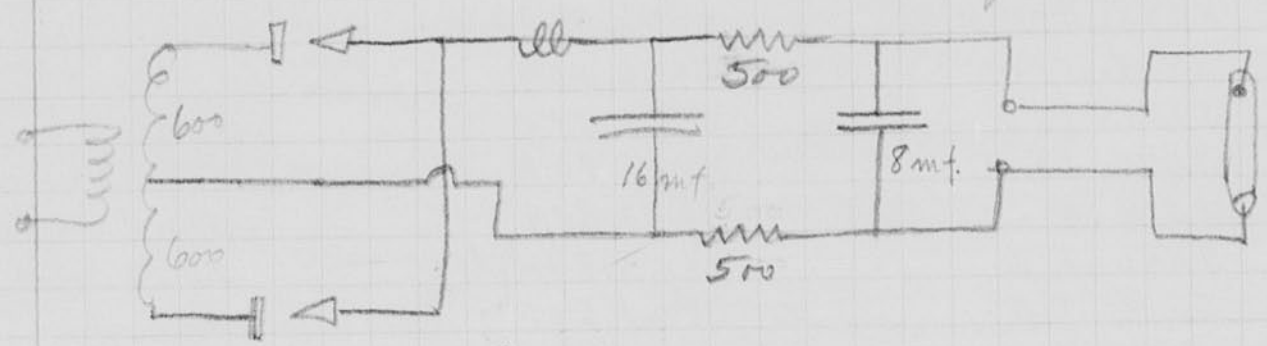


Magnetic field from the cond. discharge current.

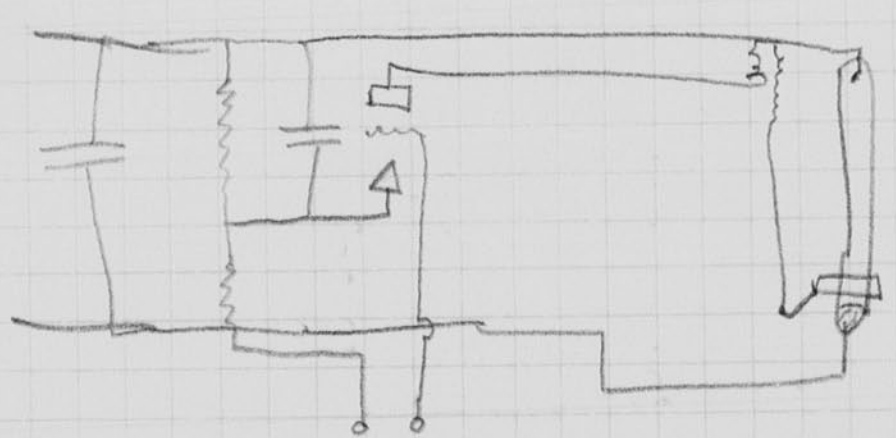
Lamp with Hg pool at both ends.

1000+ cycle thyristor pulse oscillator.

Lead down Melmore and Standard Strobog and wire as follows.

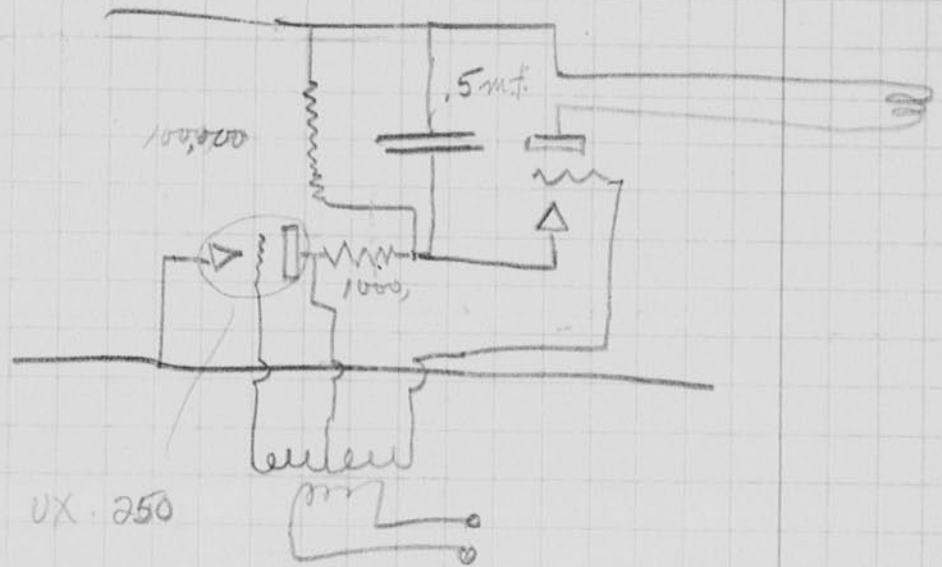
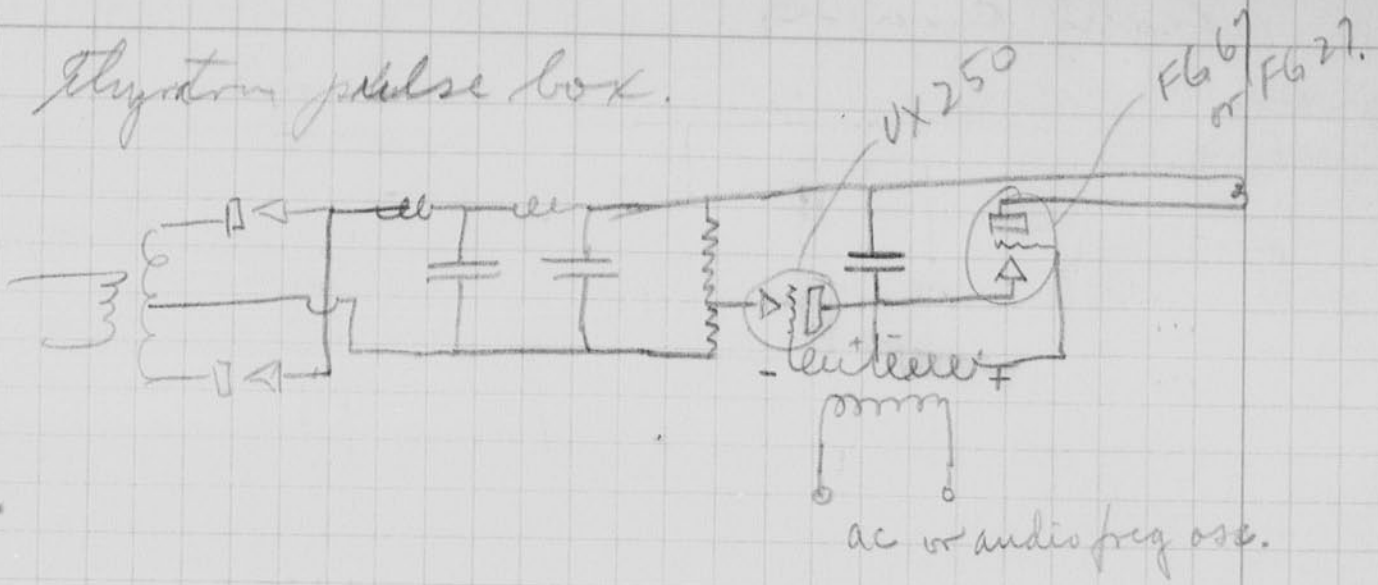


300 cyc sec  
 $\frac{1}{.300} = 3.3 \times 10^3 = 0.003 \text{ sec.}$   
 $C = 8 \text{ mf} \quad R = \frac{.003}{8 \times 10^{-6}} = \frac{3 \times 10^3}{8} = 370 \text{ ohms.}$

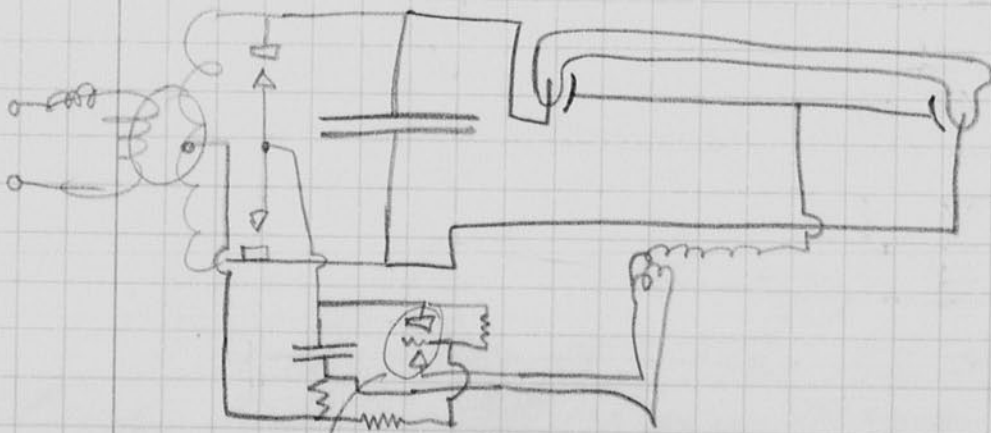




Thyatron pulse box.

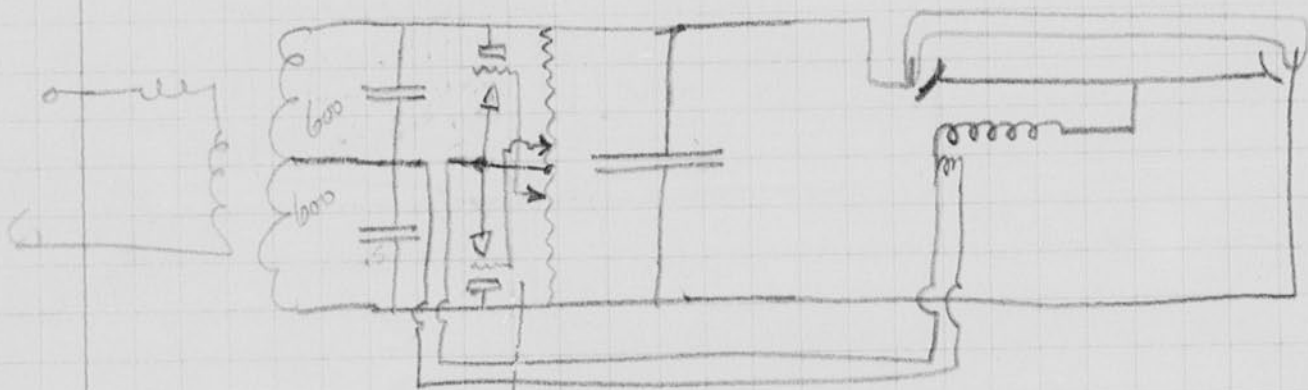
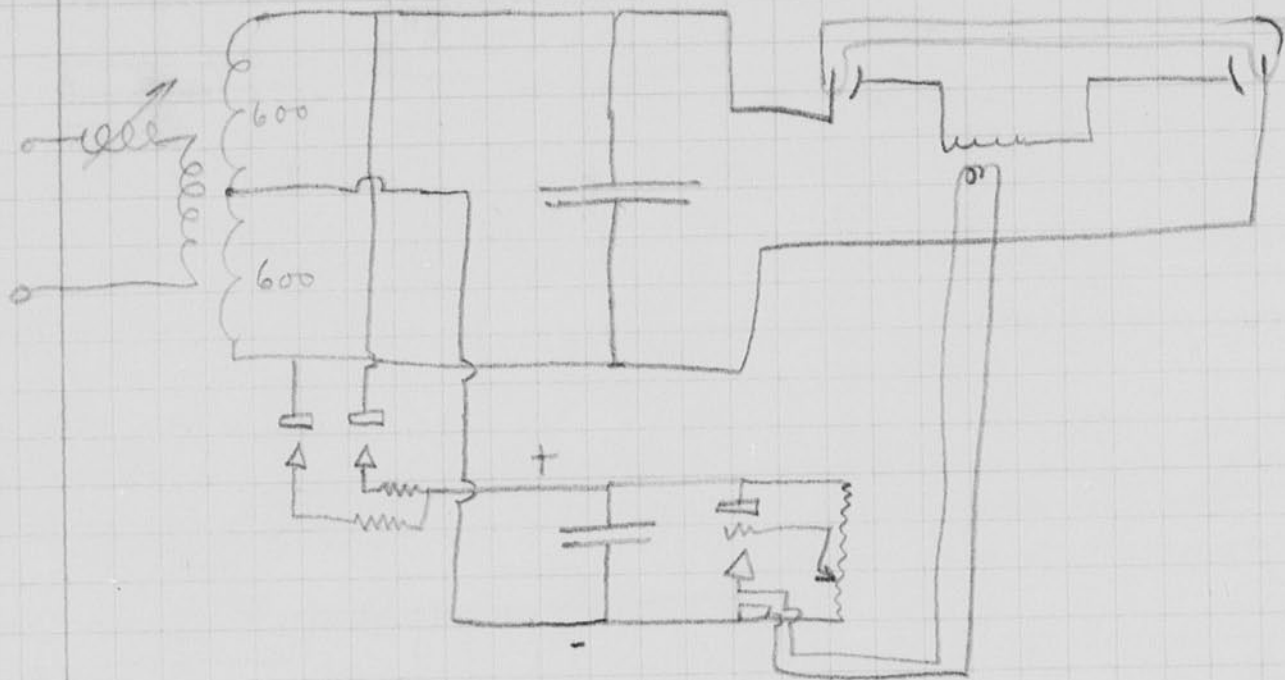


Snmp

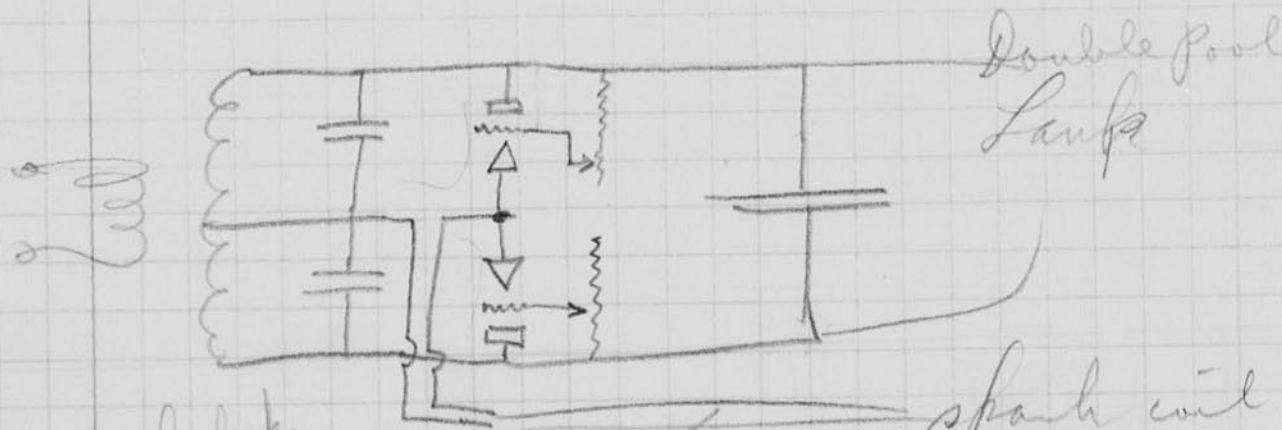


thyatron circuit to oscillate at  
3000 cycles

Light circuits.

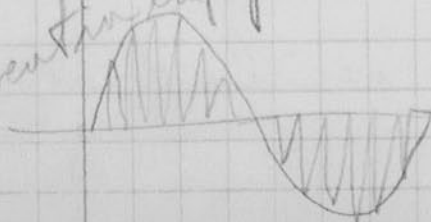


two thyristors



Double Pool  
Lamps

Current lamp.

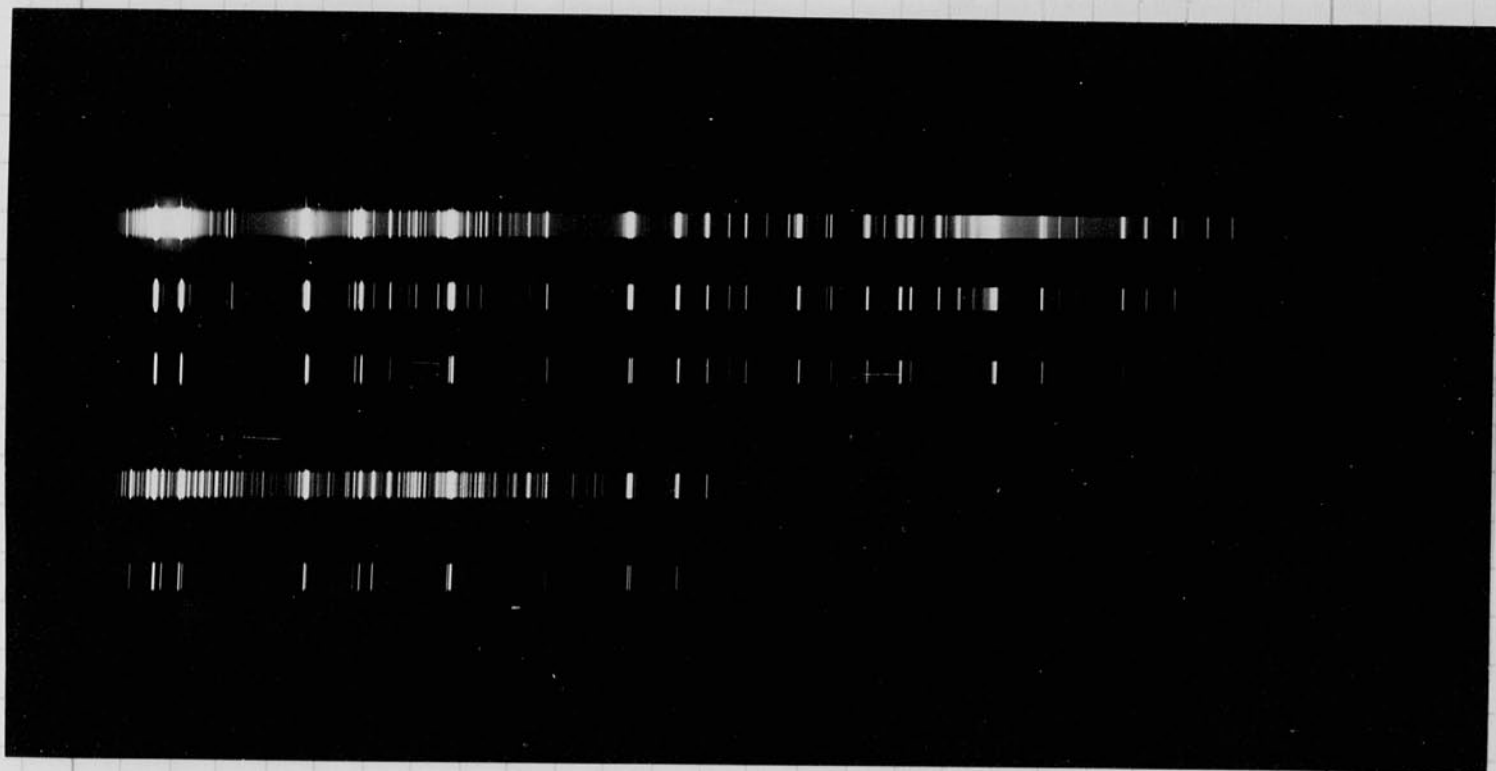


spark coil  
about 1000+ cycles.

July 27 1931

Spent most of the day taking some spectrograms in Simpson's lab in the physics dept with the help of Mr. Albertson.

last spectrogram. Quartz arc 3 sec 15 sec 2 min.  
Stroboscope 20 sec. 12 min.



Expanded a tube while taking the spectrograms. It is shaped like this,  $\frac{3}{4}$ , the tube length is 40 in and it is ~~20~~ 14 mm nonex glass. Works ok. on pressures below 2 microns.

July 28/1931

Scaled off  $\frac{1}{2}$  tube.

Mitsuhashi Fukuda

Change of Wave Lengths for  
certain lines of Zinc, Cadmium  
and mercury in a condensed  
Discharge.

Tokyo Univ Sci pgs 3 p 173.

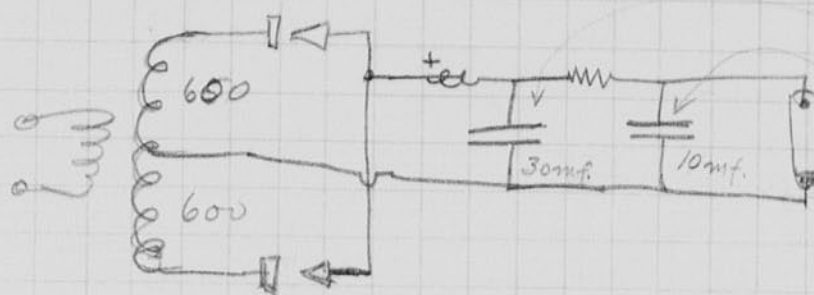
L. & E. Bloch Le Journal de Physique  
1923 no 10 p 338.

Moved from 6 Willow St Belmont to 15 Alden Rd  
Water town on July 29 and 30.

July 31 1931 - Pumped out Projector pulse tube  
similar to those shown on p 4. There  
was a leak somewhere.

Aug 1 1931 - Continued pumping on pulse  
tube with no success.  
Experimented with a joint  
and punctured  $\frac{1}{2}$  tube and  
cracked glass on the 20 mm tube.  
Built a turn reflector for the 20 mm  
tube.

Aug 2, 1931. Variable freq. Stroboscope



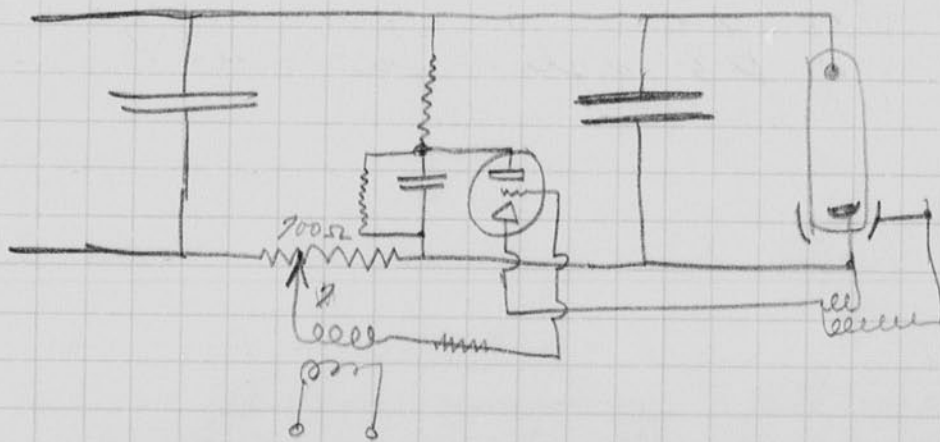
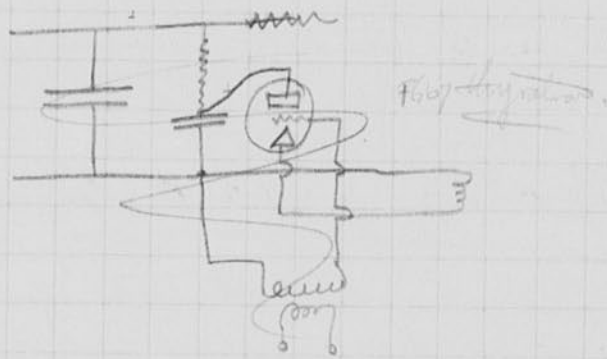
- 3 - (9CE1A5F) 14mf 440v a.c.
- 1 - (9CE1A5B) 90mf 350v a.c.
- 5 - (9CE1A5) 2.0mf 550v a.c. (10mf)

500 cyc sec.  
 $\frac{1}{500} \text{ cyc} = 2 \times 10^{-3} = 0.002 \text{ sec.}$

$RC = .002 \text{ sec} \quad C = 10 \text{ mf.}$   
 $R = \frac{.002}{10 \times 10^{-6}} = \frac{.002 \times 10^6}{10} = 200 \text{ ohms.}$   
 and if 2mf is used  
 $R = 1000 \text{ ohms.}$

$10 \times 10^6 \times 10^{-6} = 100,000.$

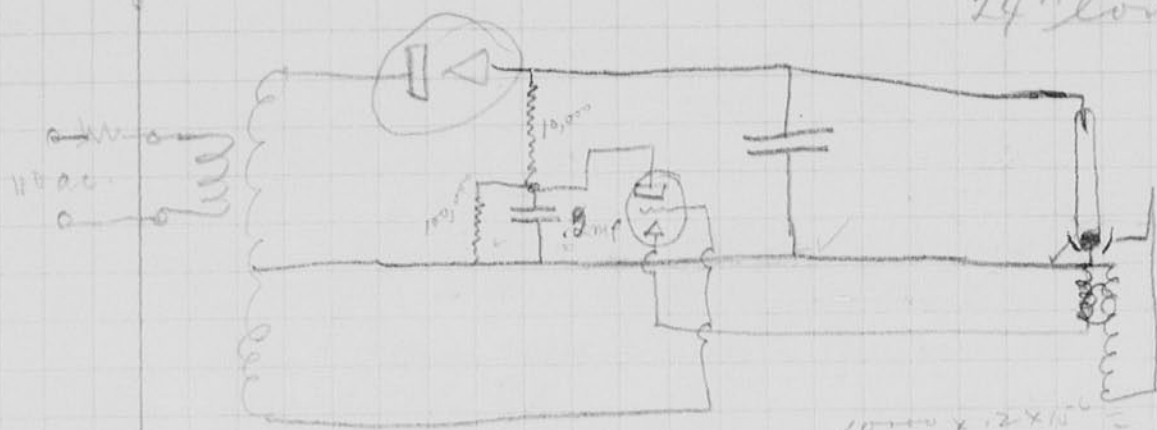
Let R = 700 ohms.



110 ac  
 or audio freq oscillati

Aug 3, 1931

H. G. G. G. G. G.

Built another tube. 16 mm diameter  
24" long.

changed circuit

Joseph V. Ubasgle Sparks Spectra of Mercury Vapor  
J.O.S.A. 17 - 1928 p 102Dejardins and Phys 2 pp 241-327 1924  
C. R. 183 p 1340 1928

Eldridge Phys Rev 29 p 213 1927

Smyth Proc. Roy Soc A 102 p 238-293 1923

Carroll Phil Tran A 225 pp 357-420 1926.

Reason for the name 2 hrs. to

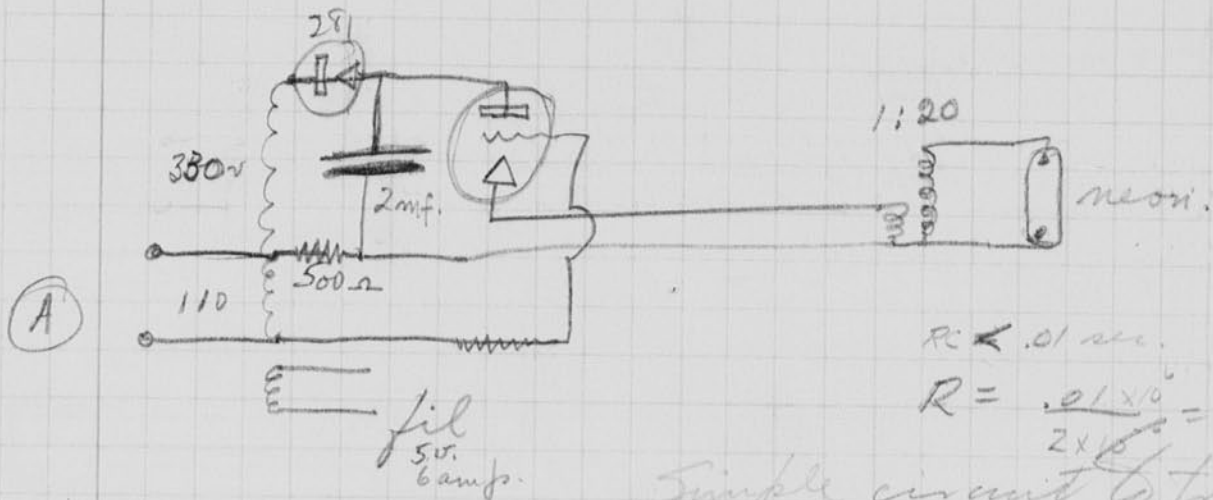
Aug 4, 1931

Exhausted tube shown at top  
of p 3, after bulb had been  
repaired.5 tubes 4 hrs  
2 tubes

Aug. 5, 1931.

Small lab. stroboscope.

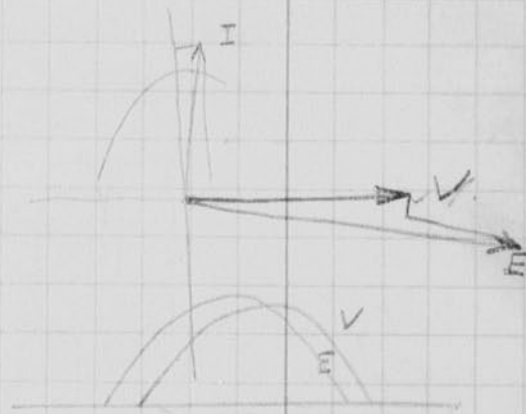
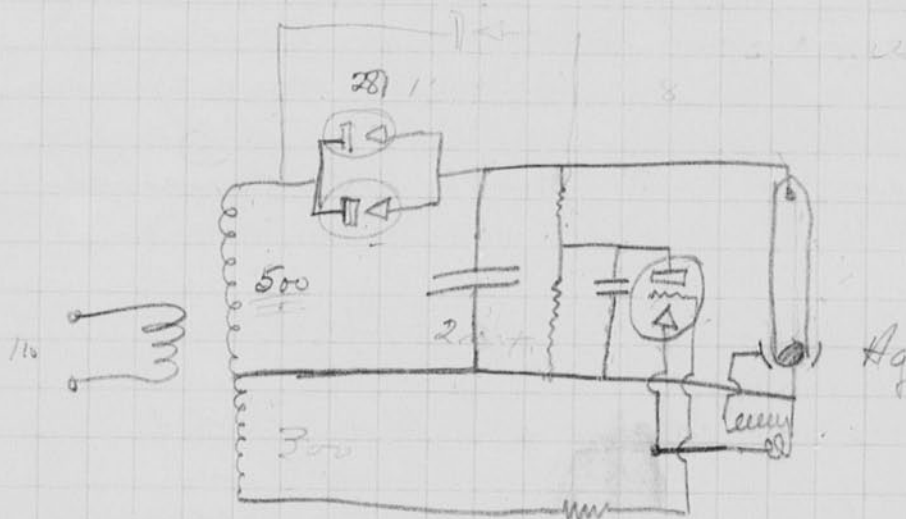
110 8mf.  
300 2mf.



$R_c < .01 \text{ sec.}$

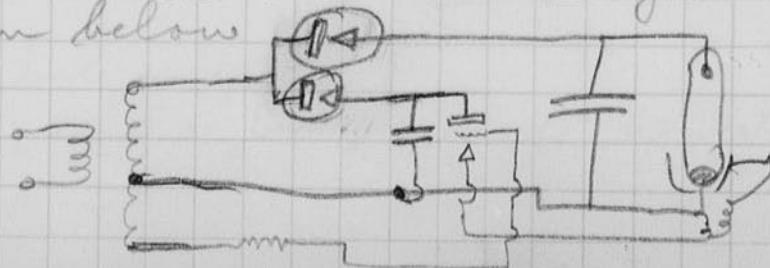
$$R = \frac{.01 \times 10^6}{2 \times 10^6} = \frac{10000}{2} = 5000 \text{ ohms.}$$

Simple circuit to try.



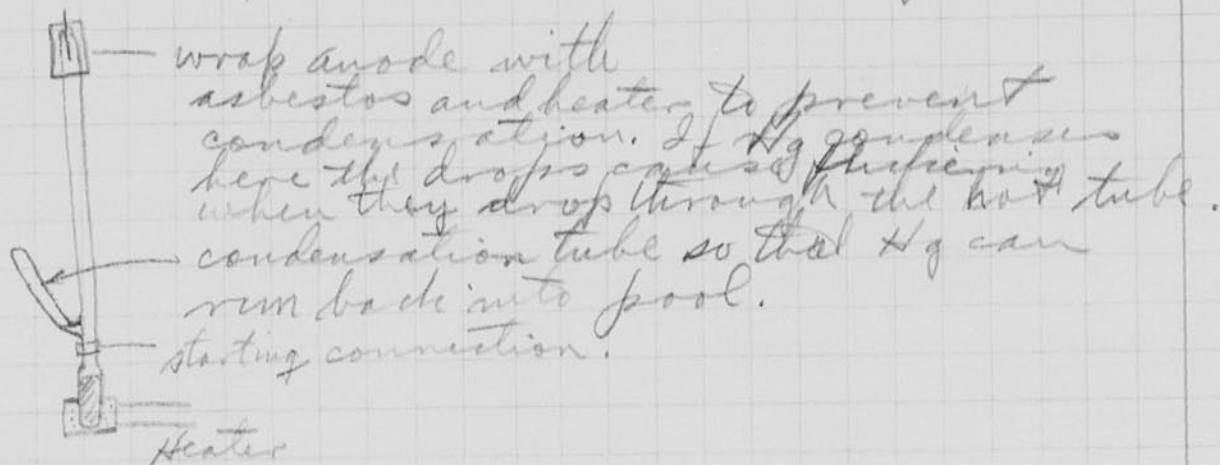
Exhausted double pool tube today. Circuit p. 12.

Experimented more with circuit shown above. Some trouble was found when the Hg tube failed to strike. If this occurs the stroboscope blocks and control is not regained for the next cycles. This can be remedied by connection shown below.

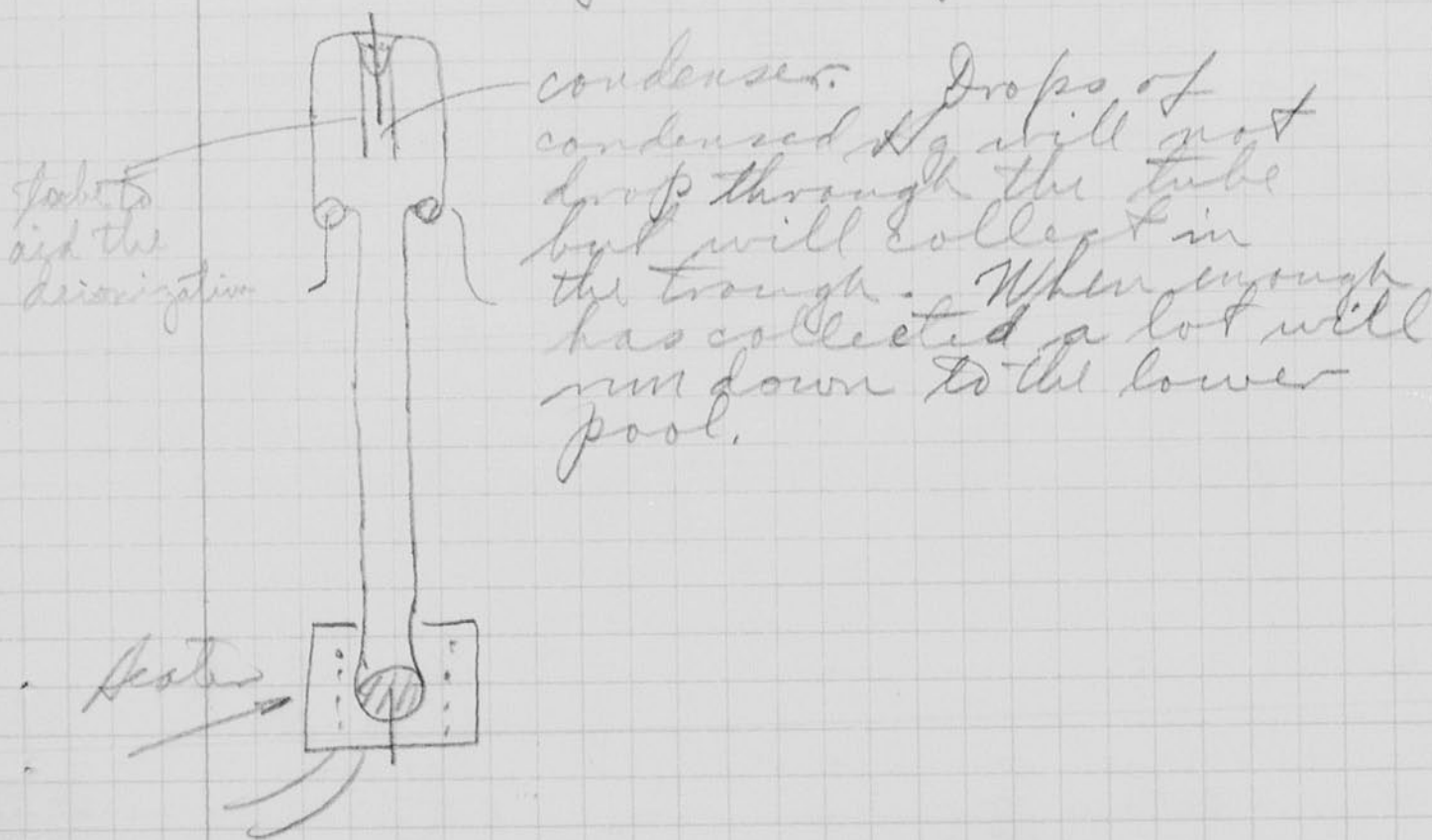


With this arrangement, the trigger circuit is not effected by the main discharge circuit.

The tubes will work better if they can be heated before starting I believe this can be easily accomplished



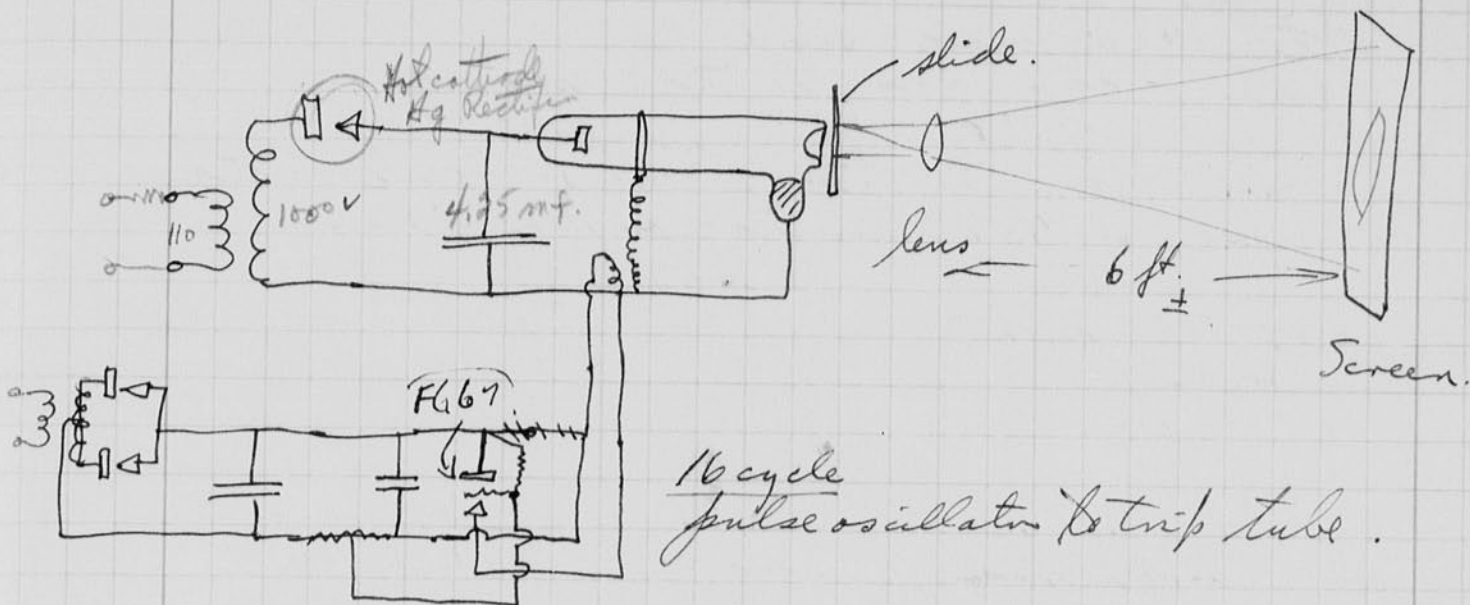
With high pressure, that is, high temperature, the tube ~~requires~~ requires more voltage to hold the arc. This means that high voltage is necessary to get the intense light at high pressures.





Aug 6 1931  
 W. E. Edgerton.

Projector pulse tube setup  
 and exhausted.



W. E. Edgerton  
 Aug 6 1931  
 2/2/31

Image was fairly good in a room with the shades partly down. The diameter magnification was about 30 times.

Aug. 7, 8. Worked for Burn with Ba and Hg distillation apparatus.

Aug 8. 600 volt transformer as supply.  
 8 mf. capacity (3/4) charged.  
 gives ok operation with a 24" 16 mm tube. at 60 cycles.  
 12 mf. is too much and causes flickering.

$$\frac{(\sqrt{2} \cdot 600)^2 \left(\frac{3}{4}\right)^2}{2} \cdot 8 \times 10^{-6} = \text{energy per cycle}$$

$$\frac{.18 \times 36 \cdot 9 \cdot 8}{16 \cdot 2} = 0.112 \text{ joules per cycle}$$

Light is not brilliant but is bright.

at 1000 volts 2.2 mf is about the limit.

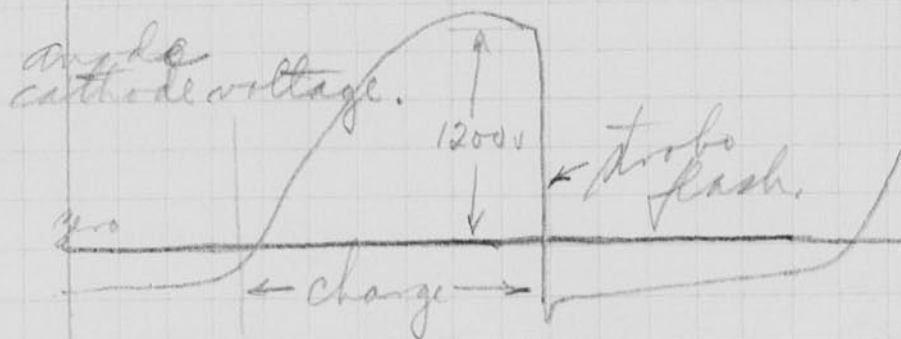
$$\frac{1,000 \times 1,000 \times 2.2 \times 10^{-6}}{2} = 0.1 \text{ joules per cycle}$$

1. joule per cycle.

1 x 60 = 60 joules per sec = 60 watts.

Aug 9. Distilled Hg and Ba in Bulb apparatus.

Experimented with circuits. The oscillograph shows that the voltage across the tube is actually negative after the discharge. This is caused by the inductance of the leads, etc. which make the discharge circuit oscillatory. The back voltage is about  $\frac{1}{5}$  of the forward voltage.



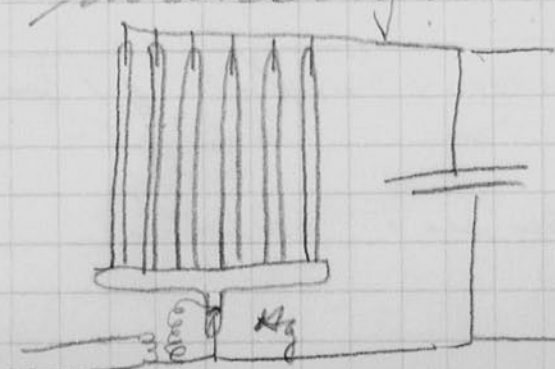
When the tube gets real hot the voltage goes to zero and does not go negative.

A 0.95 mfd condenser and a 1000 volt connection on the rectifier operates ok with 4 ohms in the primary.

Aug 10, 1931. Blew and exhausted a tube with a grid. The parts were from an old thyratron. When this tube was hot it would sputter once in a while without any excitation. The upper part was about an inch in diameter.



I plan to use a lot of small tubes on a manifold for high intensity work. It is the ratio of wall area to cross section area that is important for deionization.

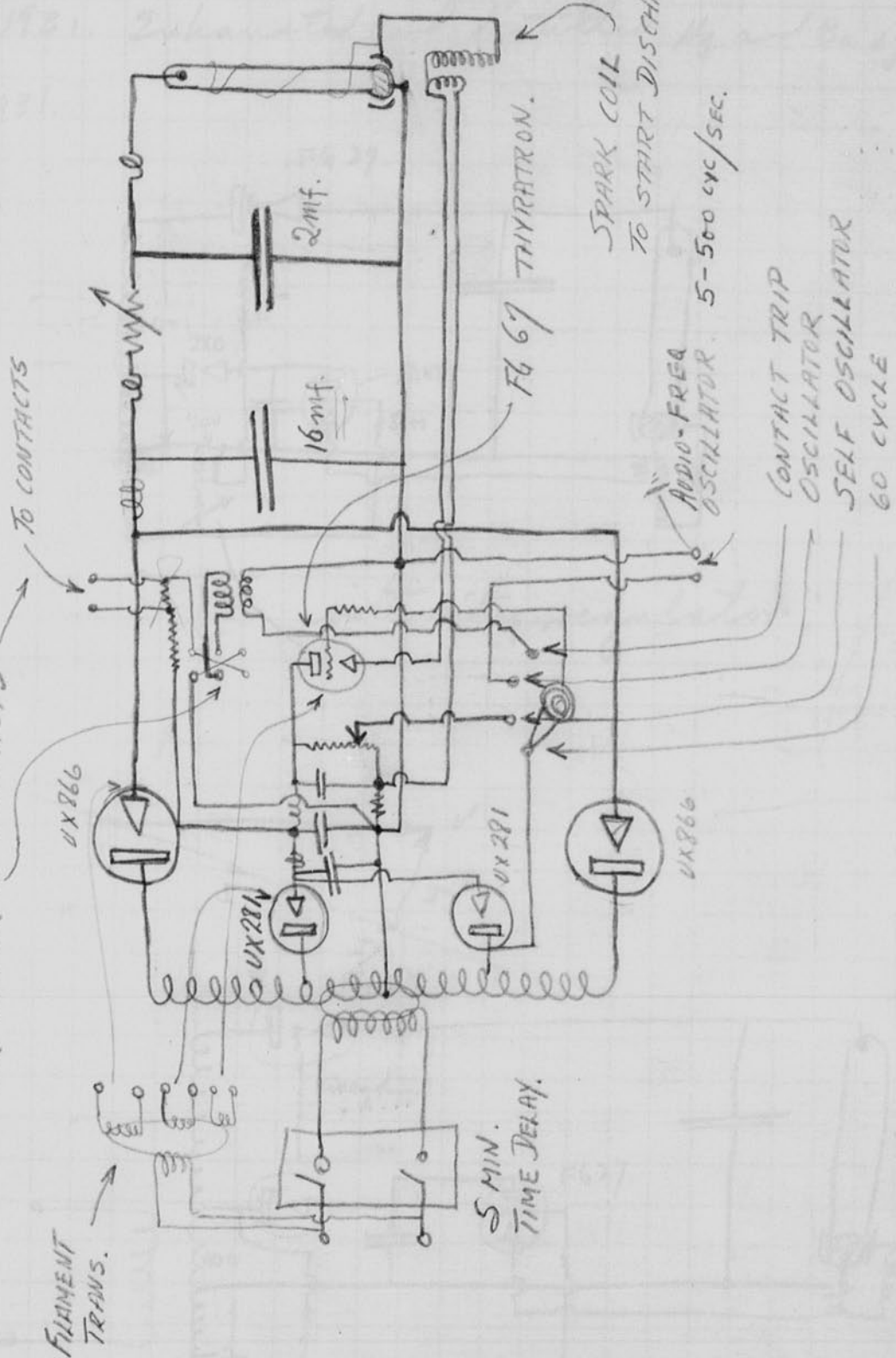


Aug N 1421

3000 } 3000

REVERSING SWITCH TO OBTAIN FLASH ON MAKE OR BREAK OF CONTACTS

FI LAMENT TRANS.



STROBOSCOPE.

AUGUST 10, 1931.  
A. E. EDGERTON.

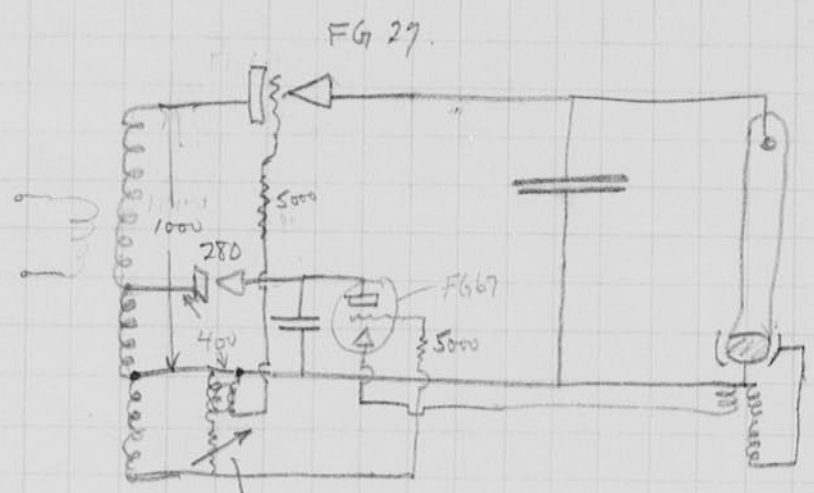
on  
ciph

Aug 11 1931.

Built tube for Ba and Hg exps for Fitch.  
Other exp a failure since chemists could find no Ba.

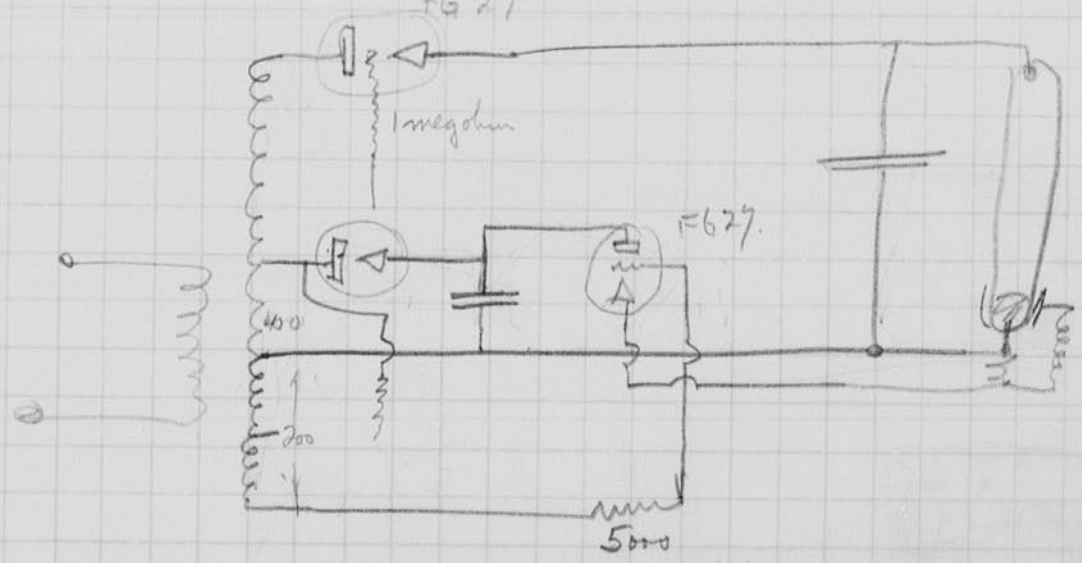
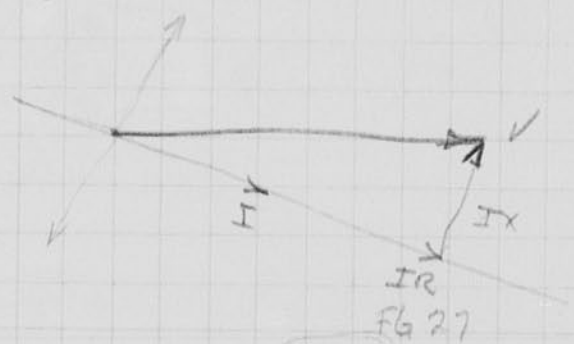
Aug 12, 1931. Exhausted and distilled Hg and Ba apparatus

Aug 13, 1931.



$$\frac{225}{2 \times 10^6} \times \frac{1500}{500} \times 60 = 130$$

intensity regulator.



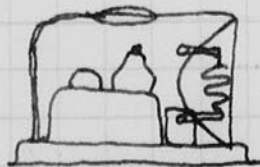
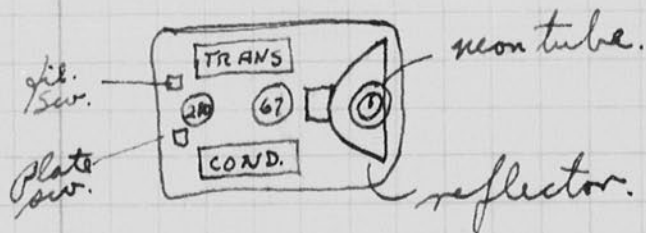
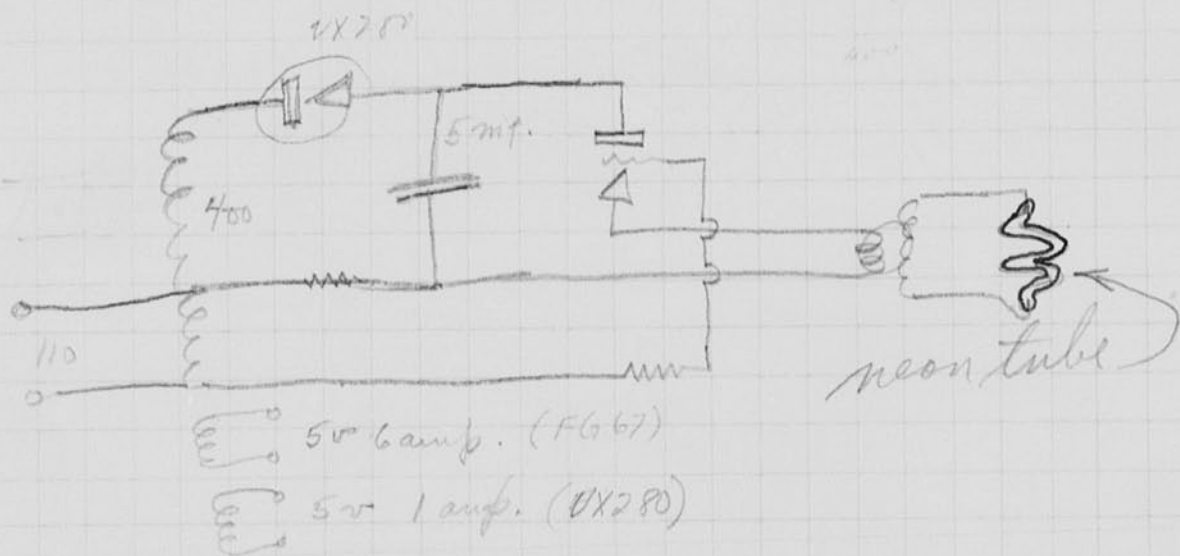
This equipment was shown us in operation on August 24, 1931, and we have understood the principle of its operation.

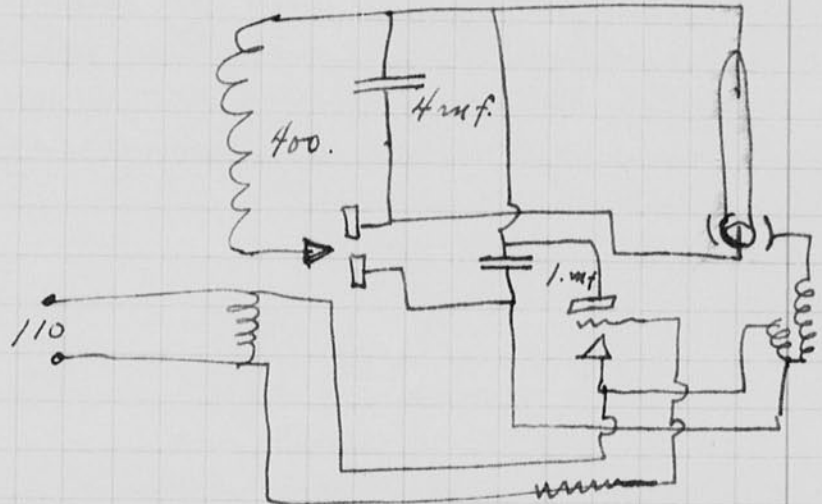
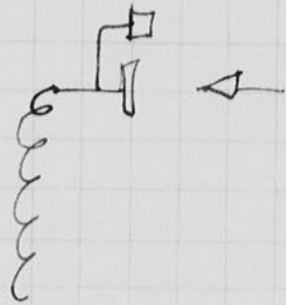
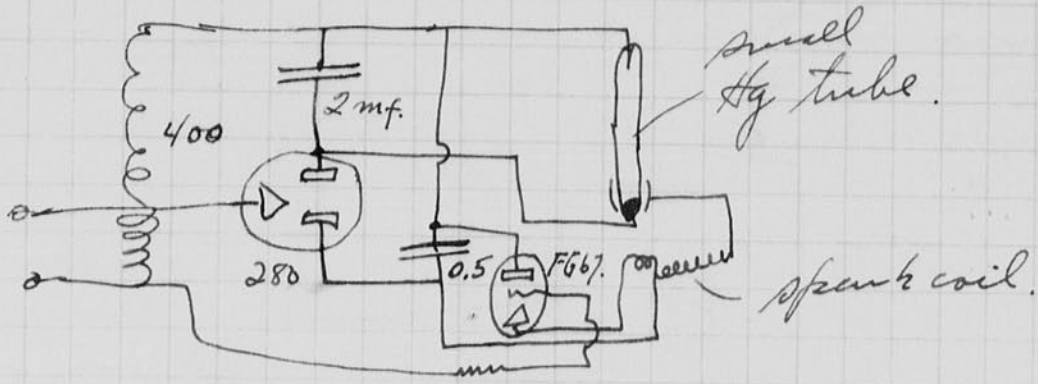
R. K. Fitch  
David S. Luck

Aug 14 1931 Experimented with Ba precipitates  
Started wiring up 60 cycle strobo. as  
shown on p 21.

Aug 15, 1931 Repeated Experiment. to Marshall  
of Raytheon Co.  
Finished wiring up 60 cycle  
strobo as shown on p 21. There was  
a lot of flicker at first which  
was eliminated by  
reversing the leads to the spark  
coil

### Small portable strobo scope

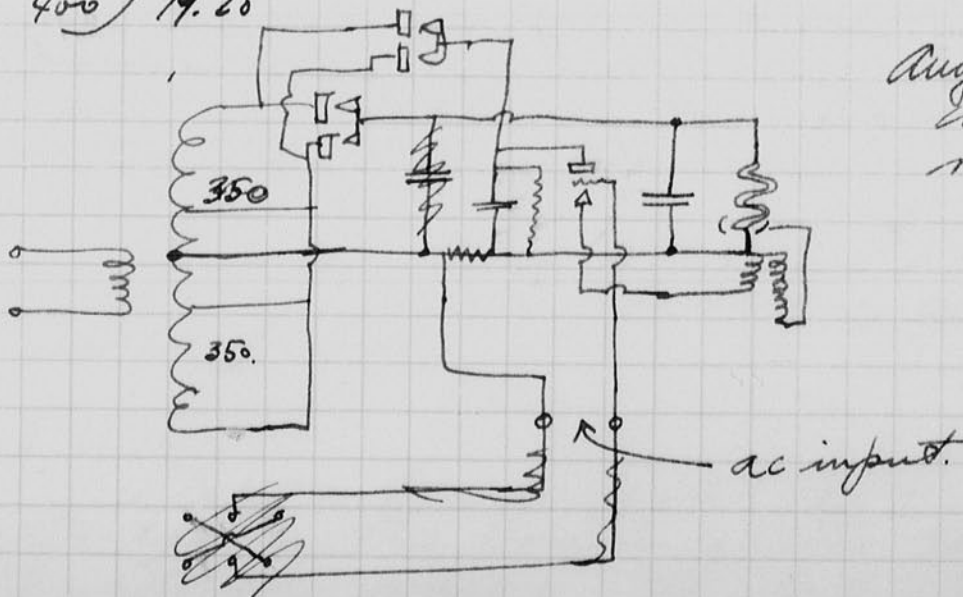




$$\frac{CE^2}{2} = \frac{4 \times 10^{-6} \times .400 \times 400}{2} \times 2 \times .16 = 0.32 \text{ joules.}$$

$$60 \times 0.32 = 19.2 \text{ watts.}$$

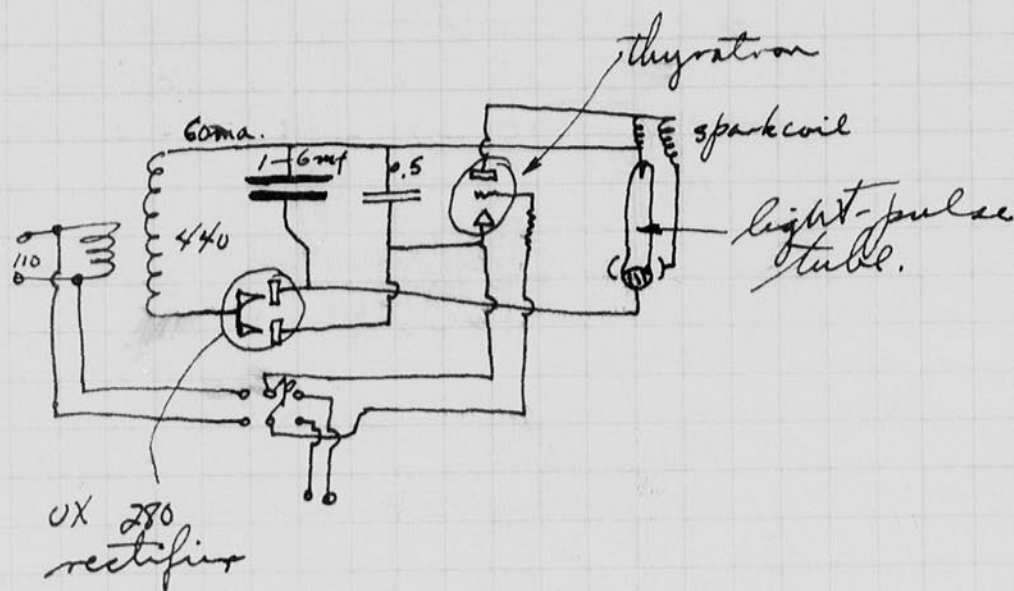
$$400 \times \frac{.04}{19.2}$$



Any ac input can be used to run this circuit.

## Stroboscope circuit

Aug. 16, 1931.  
A. E. Edgerton.



I plan to build two of these for the machine transparencies lab and may sell one of them or possibly two to Tucker for the dynamo laboratory.

Mr. Ried was shown this circuit today and may study it as a thesis problem. I explained to him how it worked.

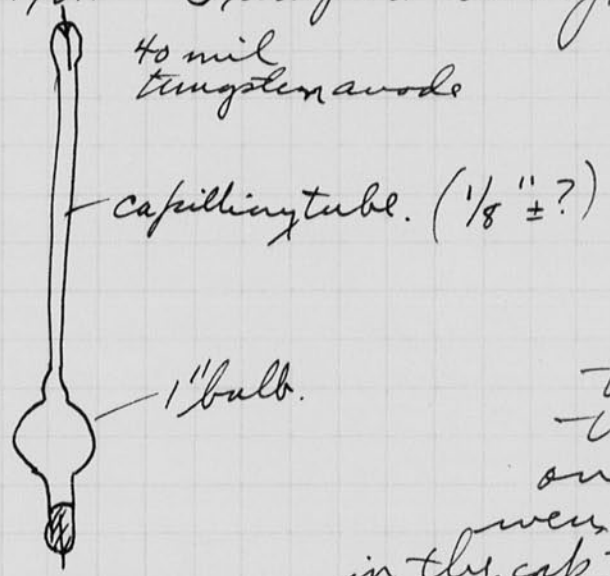
Aug. 17, 1931.

Prof Hardy was up and I showed him the pulse projector tube and the stroboscope (60 cycle). He wants me to show something to the Soc. of Motion Pict. Engineers at Swan Point in October.

The circuit shown on p 21. acts up when it gets hot. Part of the trouble is in the thyatron that triggers the main circuit. There are occasional flashes of light.

Aug 18, 1931.

Pumped two pulse tubes.



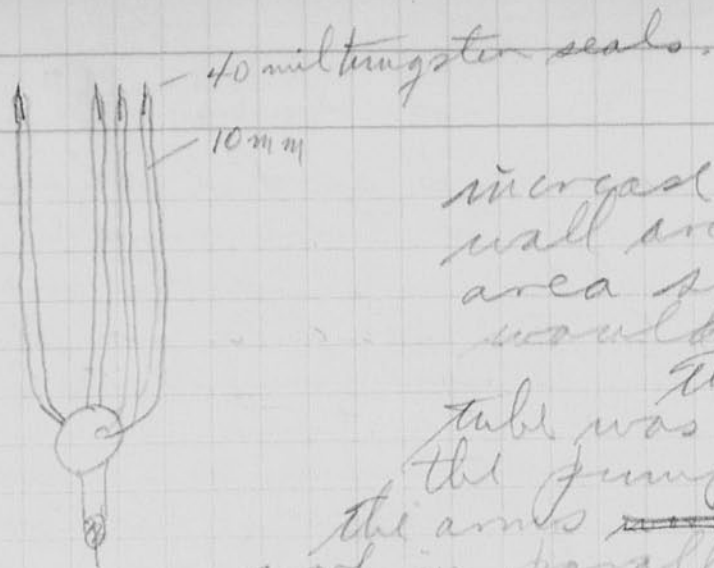
Some difficulty was experienced in getting this started. Once when started fairly cold there was an orange glow at the joint of the capillary tube and the 1" bulb. As time went on this orange discharge went up several inches in the cap tube. I observed it in the spectroscope and apparently the strong orange line is one that is in the other part of the tube but is stronger. I am not sure about this. The inside of the bulb appears to be a little red somewhat where this orange glow was.

The second tube was about 2 1/2 feet long and was of 6 mm nonex glass. It works ok.

Aug 19 1931.

Blew a 4 amp tube today in Gray's lab in the basement. Sketch on the other page. The idea was to





increased the ratio of wall area to cross-sectional area so that the tube would deionize.

The operation of this tube was very erratic on the pumps.

The arms ~~do not~~ do not work in parallel when cold but do when they become hot.

Aug 20, 1931. Built tube



Sides poked in to decrease deionization time.

This tube worked fine especially for 2 mf at 1300 volts. The pressure was probably quite low. For more input the arc through the large part of the tube was stringy and erratic.

I ran this tube with ~~the~~ the fine pump only for one test. It seems to start much easier when there is several microns of air present.

I tried to put some "indentation" in the glass wall just above the pool. The spark punctured a hole through one of these before I had a chance to observe any benefits or changes in the operation.

Aug 21, 32

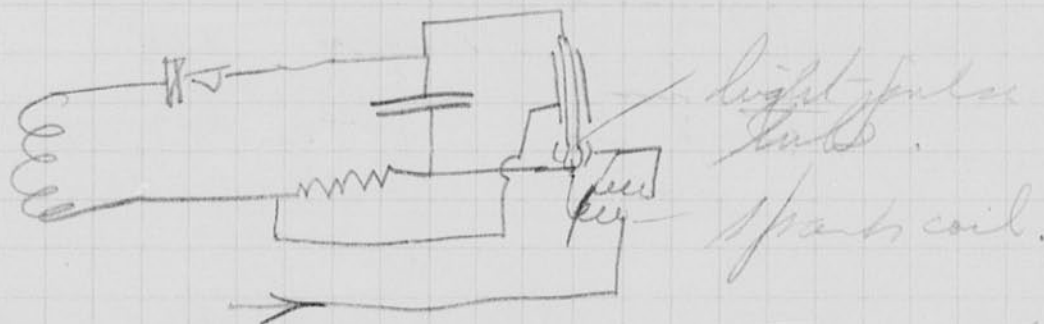
Experimented with 60 cycle strobe and completed wiring but in a box for portability.

Aug 24 1931

H. E. Elgerton. Started wiring the variable freq. stroboscope.

The external grid which I have been using on the secondary of the spark coil to help start the discharge is detrimental when the tube is hot. It apparently gives the walls a high charge which raises pressure with the positive column. If the tube has a  $\frac{1}{2}$  micron of air left in it when exhausted the starter wire is not needed.

I hope to try an experiment which puts a high negative voltage on the external grid as soon as the tube discharges. Such a circuit does this.

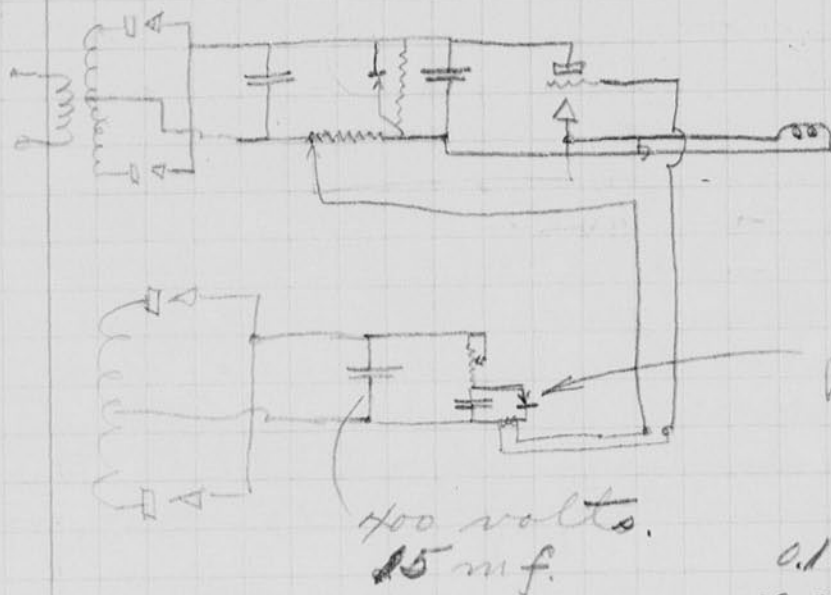


Aug 25, 1931 L. Bingham, Uni of Neb., was here today with his wife and son, Richard. He saw the 60 cycle strob in the apt.

Aug 26 1931 Answered letters. Saw Mr. Palmer of Colorado and showed him the 60 eye strob. In the afternoon Mr. Alger (M.S.C.) and Prof. Creed saw the lab and I again demonstrated the 60 eye stroboscope.

Had parabolic reflector cut out in the carpenter shop. 15" x 9" x 24".

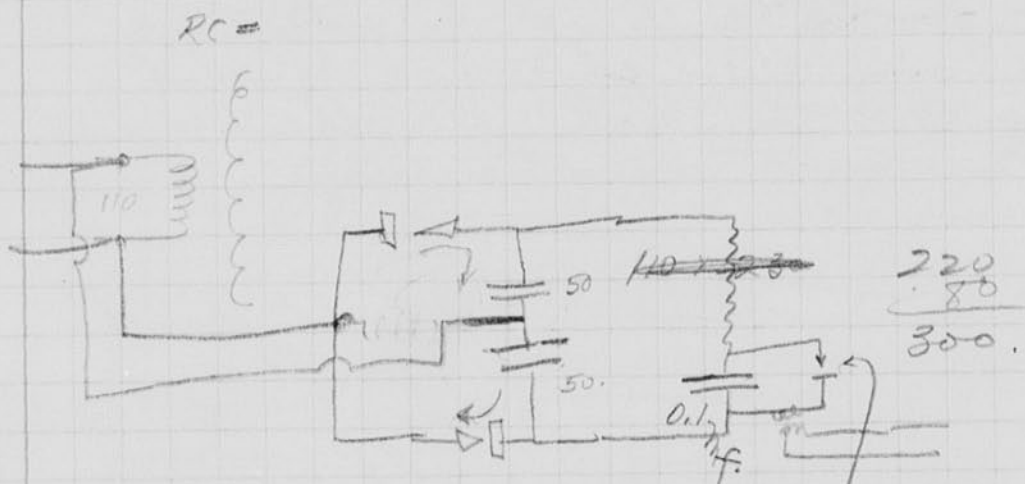
Aug 27 Oscillator for strobo.



flasher lamp.

400 volts.  
15 mf.

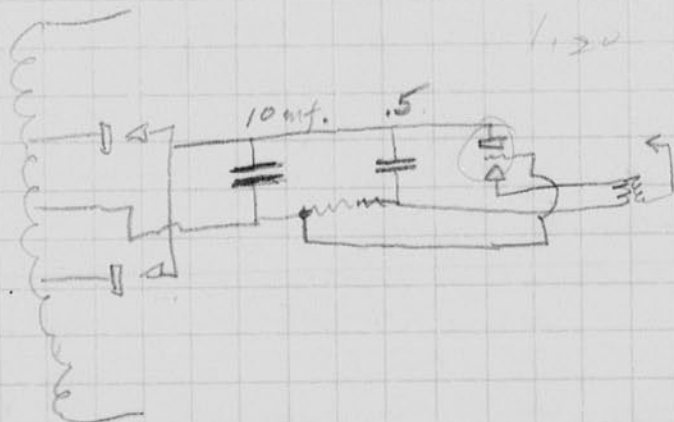
0.1 mf.  
~~0.1 mf.~~



220  
80  
300.

flasher lamp.

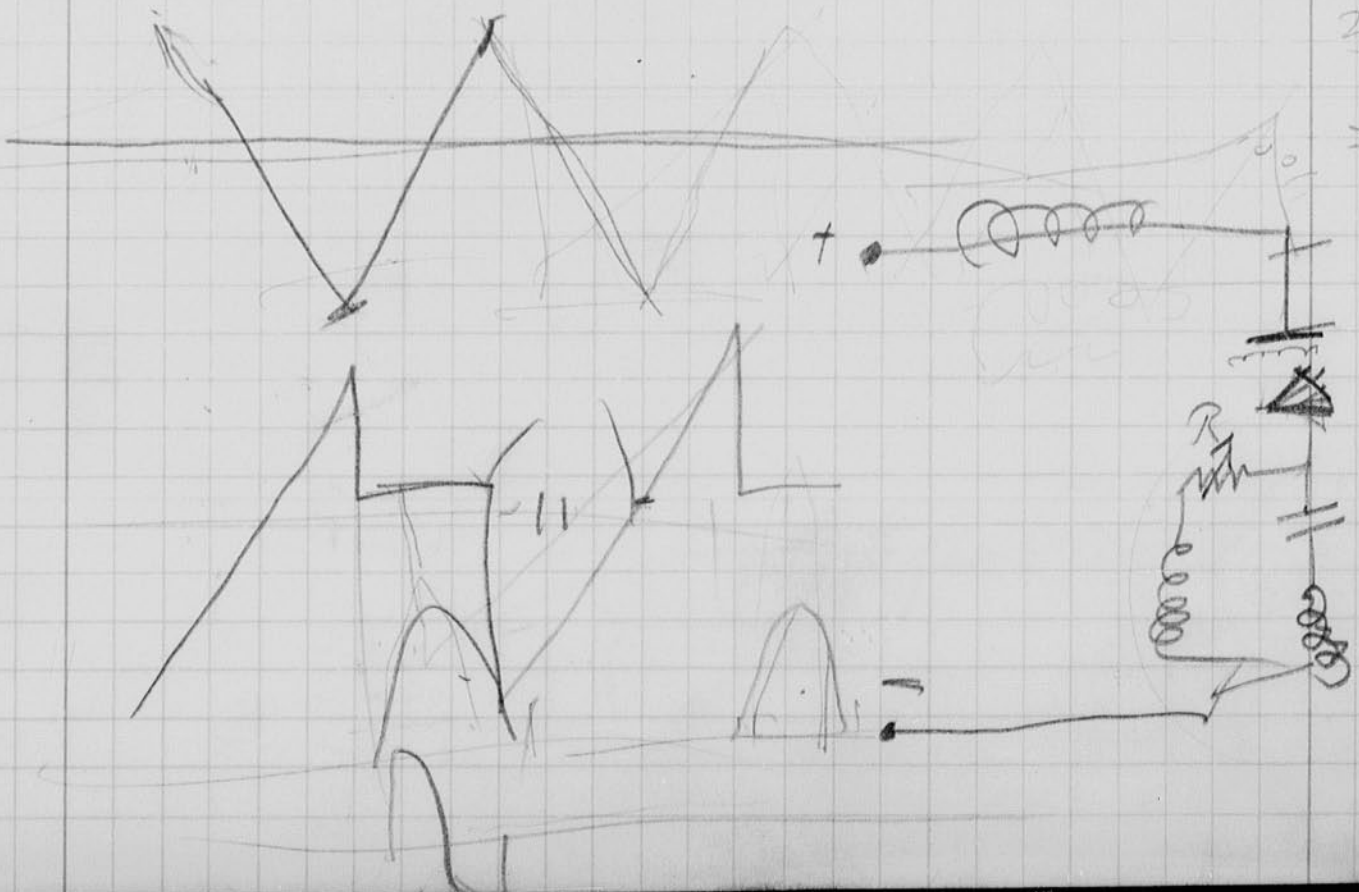
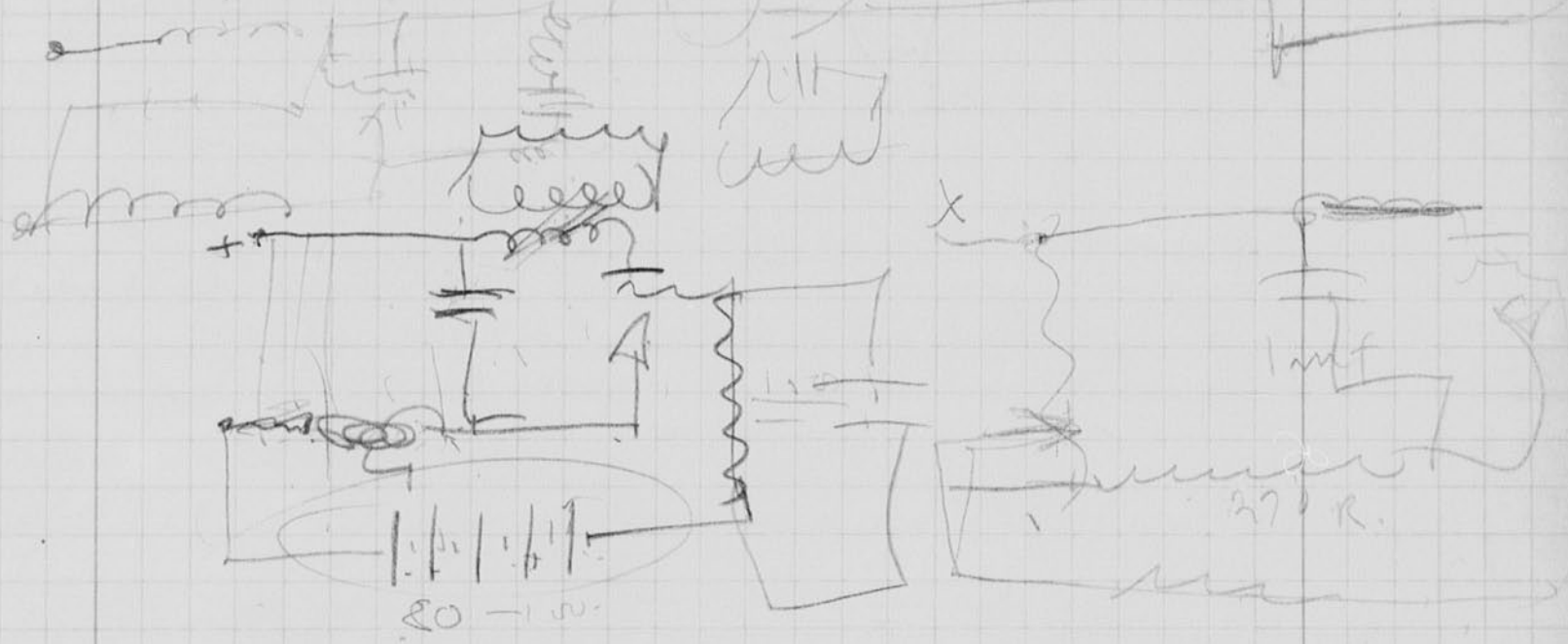
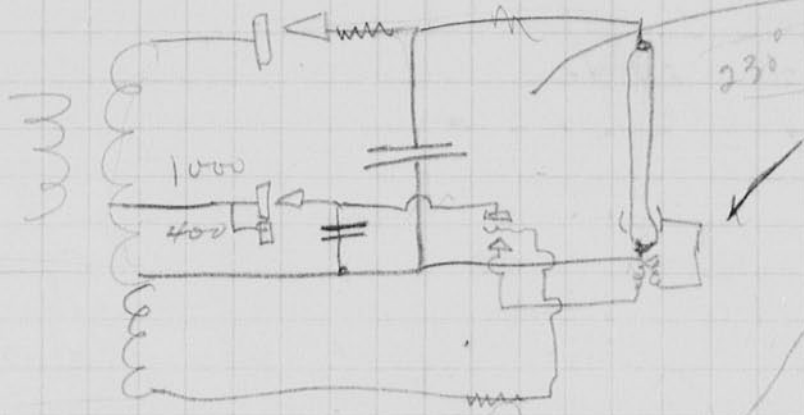
24  
574



Aug 29/1931.

Portchard was here and was discussed

circuit steps  
Sketches show.

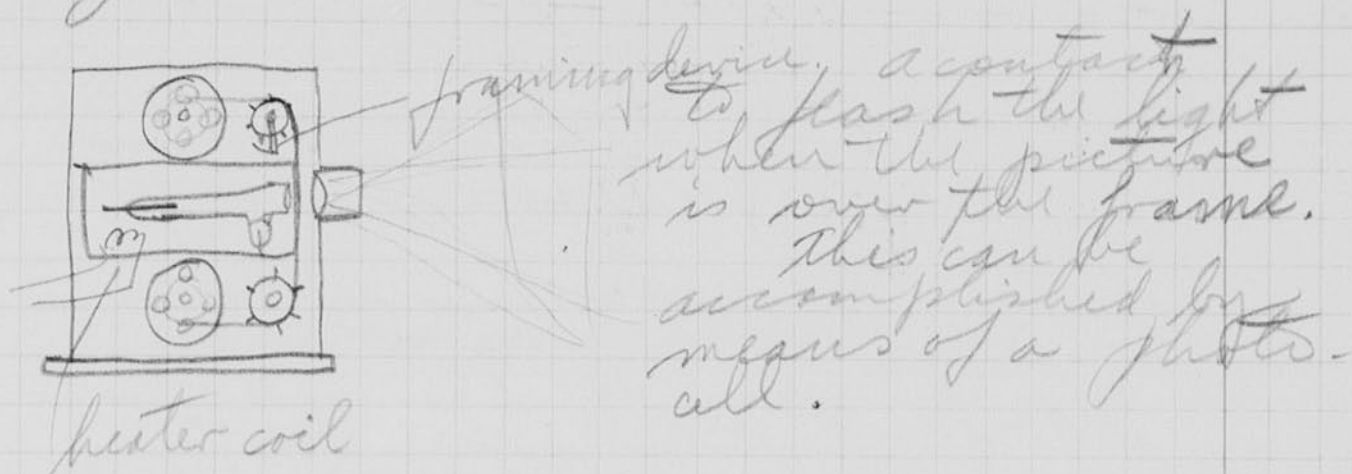


Aug 29 1931  
H. E. Edgerton

Spent time wiring up variable speed strobo. Yesterday I went over to Anne's apparatus and saw Rosefield. He showed me a photoelectric device for enlarging printing ~~on~~ on tin foil so that it could be used for blind people. Also talked to Quincy about Hayes collator that he has built. It is a dynatron which I think may be ok for variable frequency for ~~the~~ driving the ~~stroboscopic~~ ~~light~~.

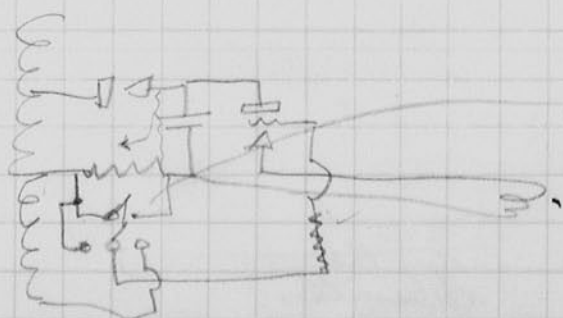
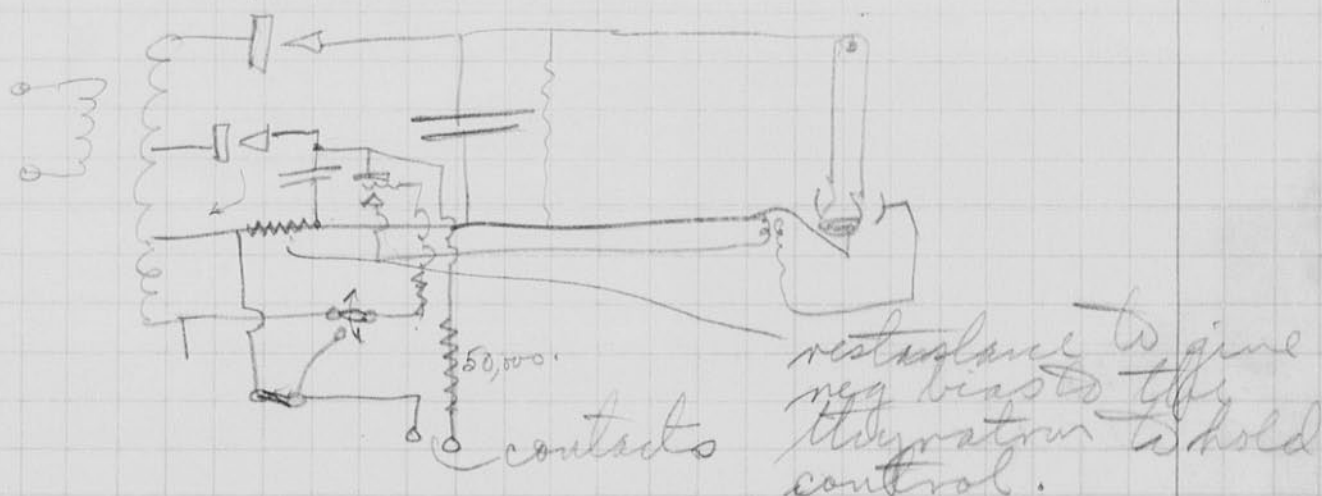
Exhausted another tube 23 inches long to fit the new parabolic reflector. Metal for a reflector is being made at Peter Gray's Co.

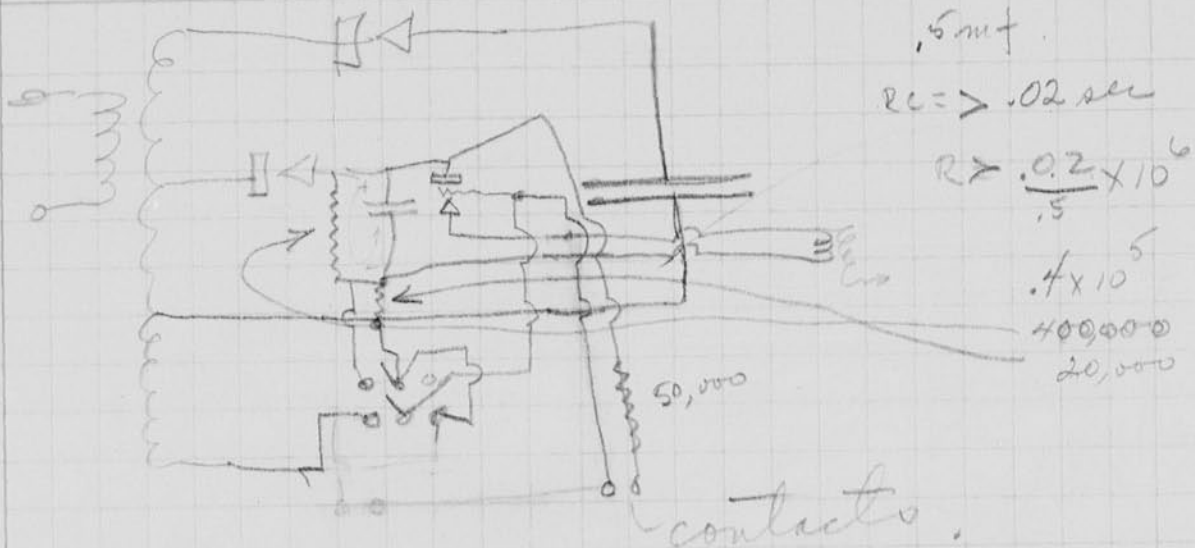
Aug 30 1931 Intermittent light.  
 H. K. Kippen. Movie Projector.  
 Experimental model.



Aug 31, 1931 Wired on Strobe for var. freq.  
 Built Parabolic reflector.  
 P. Gray & Sons Co bent the stainless  
 steel mirror

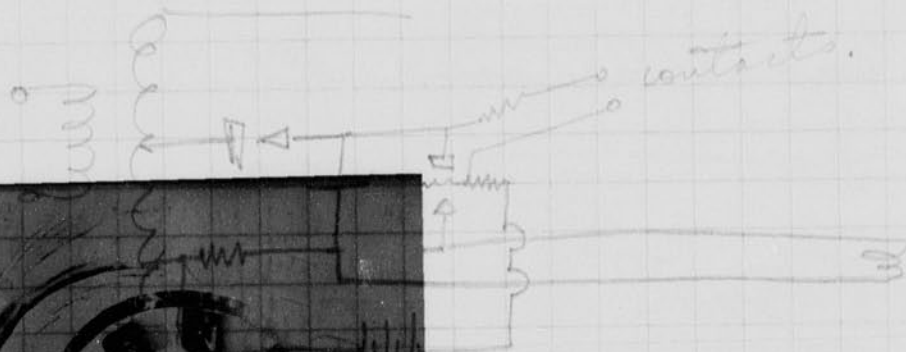
Sept. 1, 1931 Wired reflector and tried it out.



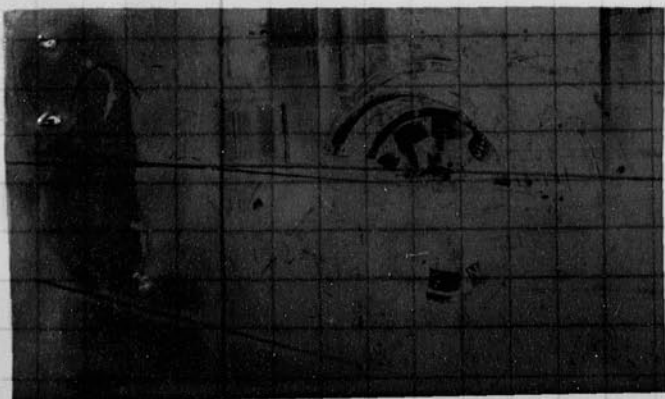


This don't work.

A battery (6 volt) was used as a bias and it worked fine. Fried ~~some~~ a contactor but the springs vibrated.



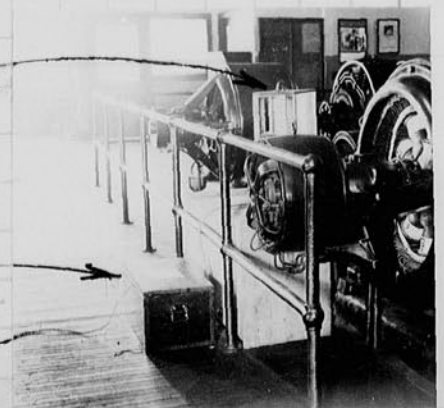
- ✓ 1 - Picture F12 1/2 second exposure, closeup.
- ✓ 1 " " F12 1 min " General view
- ✓ 1 " " F12 1 second " Closeup



Parabolic Reflector

any other apparatus.

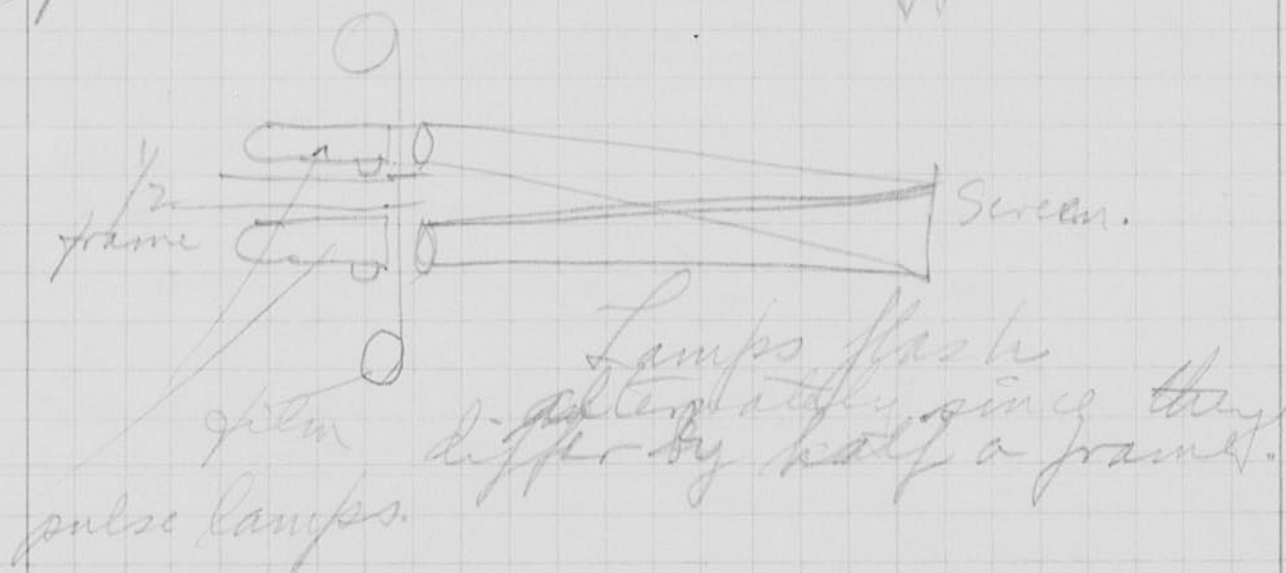
110V  
A.C.



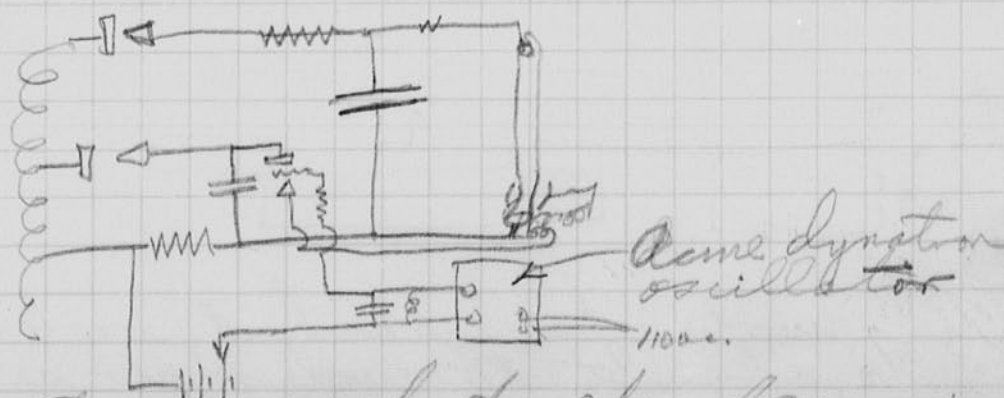
Called Church at Edison Illuminating Co about synchronous motors. I wanted to get the address of some companies which had large motor under variable load condition or difficult starting condition. He is coming over tomorrow at 3:30 or 4 to see the strobos.

### Stroboscope movies.

Flash each frame twice to get rid of the flicker. There would be two flashing intermittent pulse lamps and the images would be focused on the same place.



Sept 2, 1931. Got dynatron oscillator from Quincy at Acme.



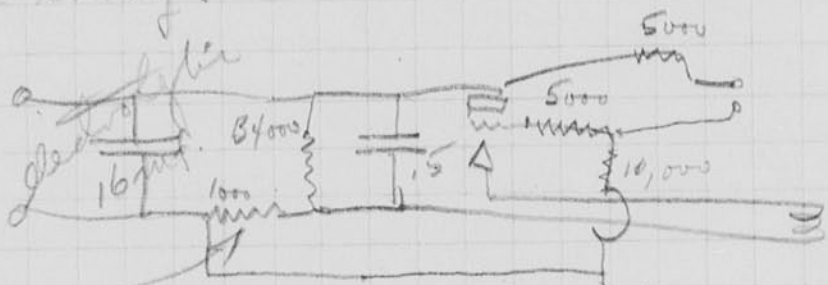
Does not work so hot. OK at 30 cyc per sec. Talked to Church and demonstrated stroboscope in dyn lab.



Sept 3 1931

Wired Variable freq strobo  
 Started up part of tube.  
 Experimented with oscillator  
~~and tubes.~~

Sept 4, 1931 Finished variable freq strobo  
 driven by contactor. Observed the  
 moving picture mechanism  
 and it was very interesting to see  
 the springs etc. oscillate! Showed  
 to Hardy and Sam Caldwell.  
 Mendell Bege and wife from Washington D.C.  
 were here today.



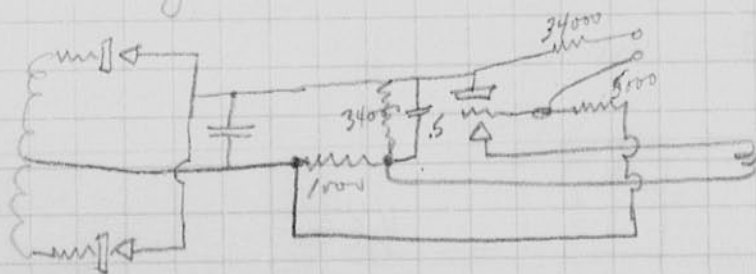
$$RC = .5 \times 10^{-6} \times 10000 = .5000 \times 10^{-3} \text{ sec}$$

should be .0016 sec. say .001.

2000 ohms instead of 1,000

When at low speed, the condenser  
 (capacitor in circuit) charges ~~up~~ before  
 the contacts part and the tube  
 buzzes, this is oscillates by  
 means of its own circuit

Changed circuit.



This works fine. I had it working from  
 5 to about 80 cycles per second.  
 For higher frequencies a multitoothed  
 contactor is needed or a higher speed motor.



$A$  = number of repeated images

(R.P.S) = the speed of rotation in rev. per. second.

$F$  = the light frequency in cycles per second.

$N$  = any integer such as 1, 2, 3, 4, ... etc.

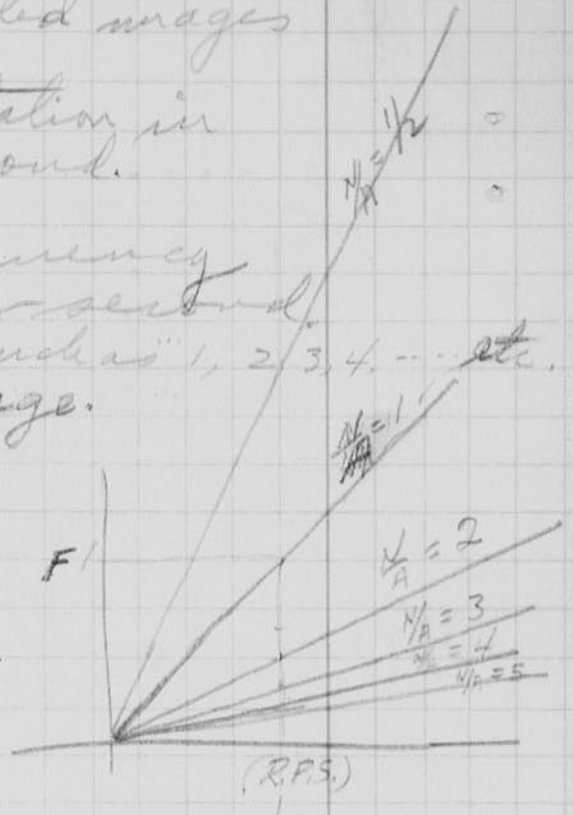
Condition for stationary image.  
(R.P.S)  $A = NF$

(R.P.S)  $A = \frac{NF}{A}$

(R.P.S) =  $\frac{NF}{A}$

$1 = \frac{1}{2} \times 2$

R.P.S =  $\frac{N}{A} F$



Example.  
60 cycles per second (light).

$N/A$	1	2	3	4	5	6	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{5}$
(R.P.S)	(1)	(2)	(3)	(4)	(5)	(6)	$1\frac{1}{2}$	$\frac{1}{3}$	$1\frac{1}{4}$	$1\frac{1}{5}$
	60	30	20	15	12	10				
R.P.S.	60	120	180	240	---	etc.	30	20	15	12

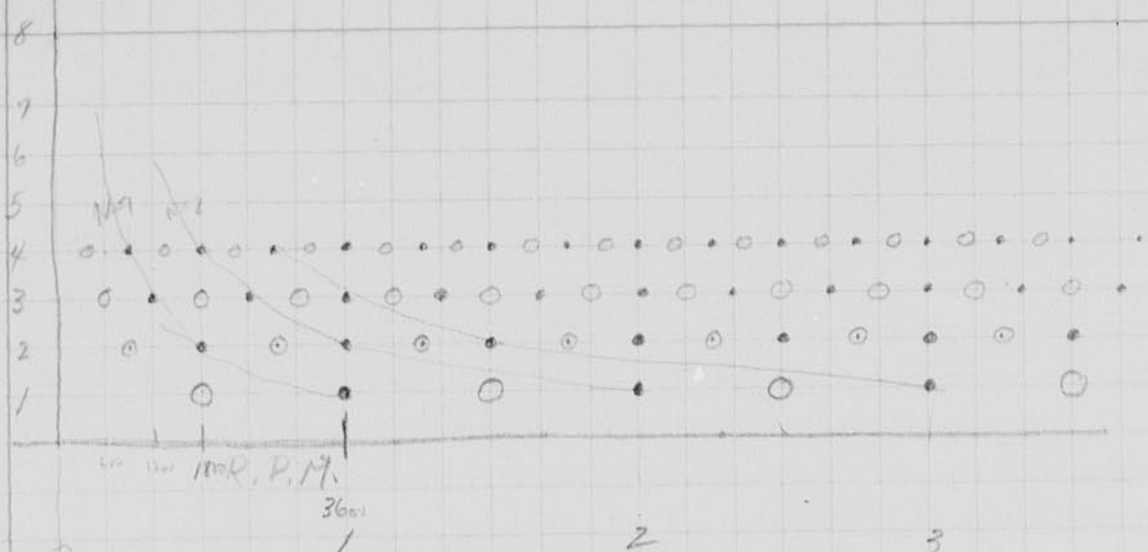
$A = 10$  divisions

	$\frac{1}{10}$	$\frac{2}{10}$	$\frac{3}{10}$	$\frac{4}{10}$	$\frac{5}{10}$	$\frac{6}{10}$	$\frac{7}{10}$	$\frac{8}{10}$	$\frac{9}{10}$	$\frac{10}{10}$
R.P.S	6	12	18	24	30	36	42	48	54	60
R.P.M.	360				1800					3600
	10	10	5		2					1

Possible speeds. spot.



A  $\frac{N}{A}$

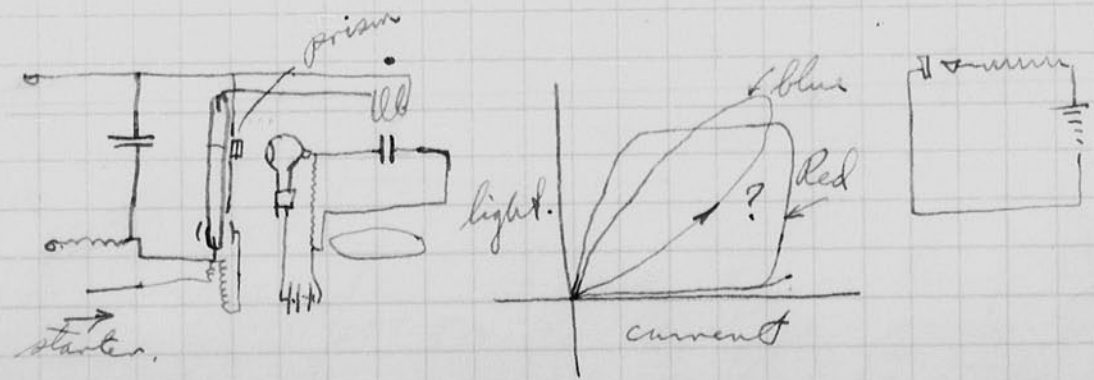


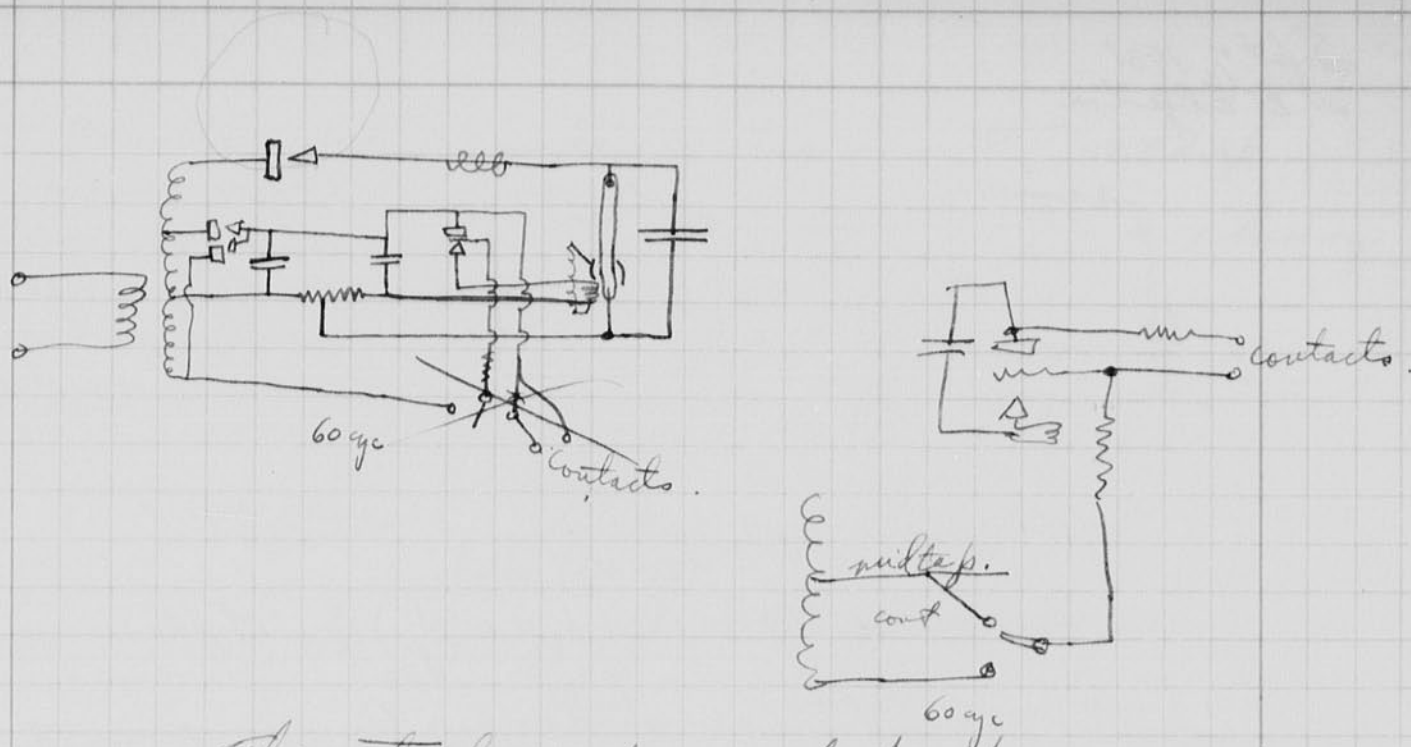
$$\frac{N}{A} = \left( \frac{R.P.M.}{60 \times F} \right) = \left( \frac{R.P.S.}{F} \right) \quad 1 \quad 1:2$$

Sept 5 1931. Inquired about a movie camera. Talked to Draper about high speed camera. Hope to have it going next week.

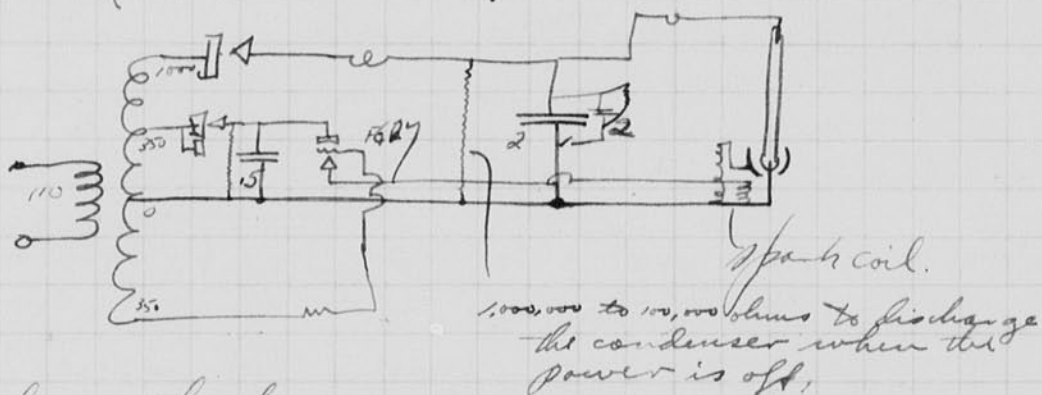
Sept 6 1931.  
A.E. Edgerton

Some question has arisen in my mind about the relationship between light and current in the stroboscope tubes. An important experiment is to find this relationship. One method occurred to me. Deflect a cathode ray oscillograph beam with current along one axis and deflect it the other axis by means of a photoelectric cell which gives a ~~light~~ response proportional to the light. The experiment could be performed with each color as there undoubtedly would be some difference.





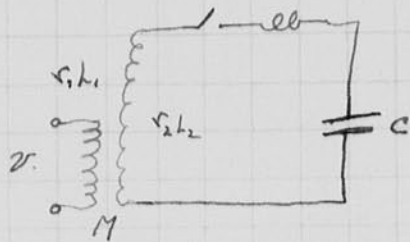
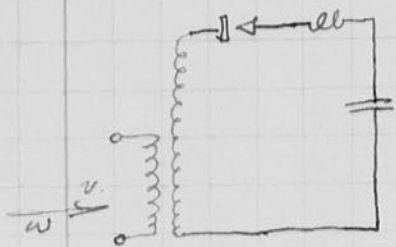
This stroboscope is ok for frequencies lower than 60 cycles per second. A full wave on the high voltage end would be desirable however.



60 cycles strobo.

Talked this scheme over with Prof. Harrison and Mr. Albertson on Sept 26, 1931.

Sept. 7, 1931.  
L. E. Edgerton



Close switch when sec voltage is zero. Open switch when current reverses.

$$v = (r_1 + L_1 p) i_1 + M p i_2$$

$$0 = \cancel{(r_1 + L_1 p) i_1} + \cancel{M p i_2} + (r_2 + L_2 p + \frac{1}{C p}) i_2 + M p i_1$$

Initial current in secondary = 0.  
 " " " primary =  $\frac{v}{(r_1 + L_1 p)} = \frac{v}{(r_1 + jX_1)} \approx \frac{v}{j\omega L_1}$   
 " charge on condenser = 0  
 $jX_1 = j\omega L_1$

Solve for characteristic mode

$$i_1 = -i_2 \left( \frac{r_2 + L_2 p + \frac{1}{C p}}{M p} \right)$$

$$(r_1 + L_1 p) \left( \frac{r_2 + L_2 p + \frac{1}{C p}}{M p} \right) + M p = 0$$

$$\frac{r_1}{C p} + L_1 L_2 p^2 + r_1 r_2 + L_1 p r_2 + L_2 p r_1 + \frac{L_1 p}{C p} + M p^2 = 0$$

$$p^2 (L_1 L_2 - M^2) + p (L_1 r_2 + L_2 r_1) + (r_1 r_2 + \frac{L_1}{C}) + \frac{r_1}{C p} = 0$$

$$(L_1 L_2 - M^2) p^3 + (L_1 r_2 + L_2 r_1) p^2 + (r_1 r_2 + \frac{L_1}{C}) p + \frac{r_1}{C} = 0$$

Assume  $r_1 = 0$  and  $r_2 = 0$ .

$$(L_1 L_2 - M^2) p^2 + \frac{L_1}{C} p = 0$$

$$p = \sqrt{\frac{-\frac{L_1}{C}}{(L_1 L_2 - M^2)}}$$

$$\omega = \sqrt{\frac{L_1}{C(L_1 L_2 - M^2)}}$$

two pure imaginary roots  $p = \pm j\omega$ .  
 The currents etc will be of the form

$$i_1 = \frac{I}{A} e^{j\omega t} + \frac{I}{B} e^{-j\omega t} + I_{ss}$$

300 watts 110v 3 amps exciting current = 0.3 amp.

$$\frac{110}{0.3} = \omega L \quad L = \frac{110}{0.3 \times 377} = \frac{110}{113} = 1 \text{ henry.}$$

10:1 ratio.

$$L_1 = 1 \text{ henry.}$$

$$L_2 = 100 \text{ henries. +}$$

$$M = \sqrt{85} = 9.22 \text{ henries.}$$

$$C = 2 \times 10^{-6}$$

$$\omega = \sqrt{\frac{1}{2 \times 10^{-6} (100 - 85)}}$$

$$= 10^3 \sqrt{\frac{1}{30}} = 10^2 \sqrt{\frac{100}{30}} = 183.5 \text{ rad. per second.}$$

$$f = \frac{\omega}{2\pi} = \frac{183.5}{6.28} = 29. \text{ cye per second.}$$

$$i_1' = \frac{I_A}{A} \varepsilon^{j\omega t} + \frac{I_B}{B} \varepsilon^{-j\omega t} + I_{ss}$$

$$i_2' = \frac{I_C}{C} \varepsilon^{j\omega t} + \frac{I_D}{D} \varepsilon^{-j\omega t} + I_{ss}$$

when  $t=0 \quad i_1' = \frac{V}{j\omega L_1}$

$$i_2' = 0$$

when  $t = \infty \quad i_1' = \frac{V}{Z_T}$

$$i_2' = \frac{V(M)}{Z_T(L_2)}$$

Substitute and solve for  $I_A \quad I_B \quad I_C \quad I_D$ .

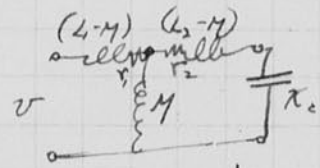
$$X_L = 15 \times 377 = 5680 \text{ ohms.}$$

$$X_C = \frac{1}{377 \times 2 \times 10^{-6}} = \frac{10^6}{377 \times 2} = 1330 \text{ ohms.}$$

$$Z_T = \frac{5680 - \text{ohms}}{1330} = 4350 \text{ ohms } X_C$$

$$I_{ss} = \frac{110 \text{ v}}{4350} = 25 \text{ amps.}$$

Sec  
Pri  
 $I_{ss} = 2.5 \times 100 = 25 \text{ amps.}$



$$2 \times 10^{-6} = 200 \text{ mF}$$

$$\frac{100}{7} = 14 \frac{1}{7} \text{ ohms.}$$

$$Z = \frac{1}{R_2 + (L_2 - M)\omega - \frac{1}{C\omega}} + \frac{1}{\omega M}$$

$$+ X_1 + (L_1 - M)\omega$$

when  $r_1 = 0 = r_2$ .

$$Z_T = \frac{1}{(L_2 - M)\omega - \frac{1}{C\omega} + \frac{1}{\omega M}} + (L_1 - M)\omega$$

$$\frac{[(L_2 - M)\omega - \frac{1}{C\omega}] \omega M}{(L_2 - M)\omega - \frac{1}{C\omega} + \omega M} + (L_1 - M)\omega$$

$$\omega = \sqrt{\frac{L_1}{C(L_1 L_2 - M^2)}}$$

$$\omega = \sqrt{\frac{1}{C(L_1 L_2 - M^2)}} = \sqrt{\frac{1}{C(L_2 - \frac{M^2}{L_1})}}$$

$$L_2 - \frac{M^2}{L_1} = 100 - \frac{85}{1} = 15$$

$$E \sin \omega t = L_1 p i_1 + M p i_2$$

$$0 = L_2 p i_2 + \frac{1}{c p} i_2 + M p i_1$$

$$E \sin \omega t = (L_1 - M) p i_1 + M p (i_1 + i_2)$$

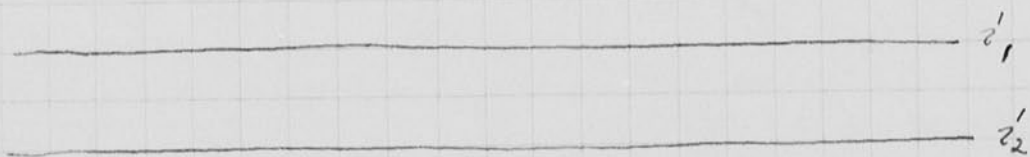
$$0 = (L_2 - M) p i_2 + \frac{i_2}{c p} + M p (i_1 + i_2)$$

$$i_1 = - \frac{\left( L_2 p + \frac{1}{c p} \right) i_2}{M p}$$

$$E \sin \omega t = (L_1 - M) p i_1 - (L_2 - M) p i_2 - \frac{i_2}{c p}$$

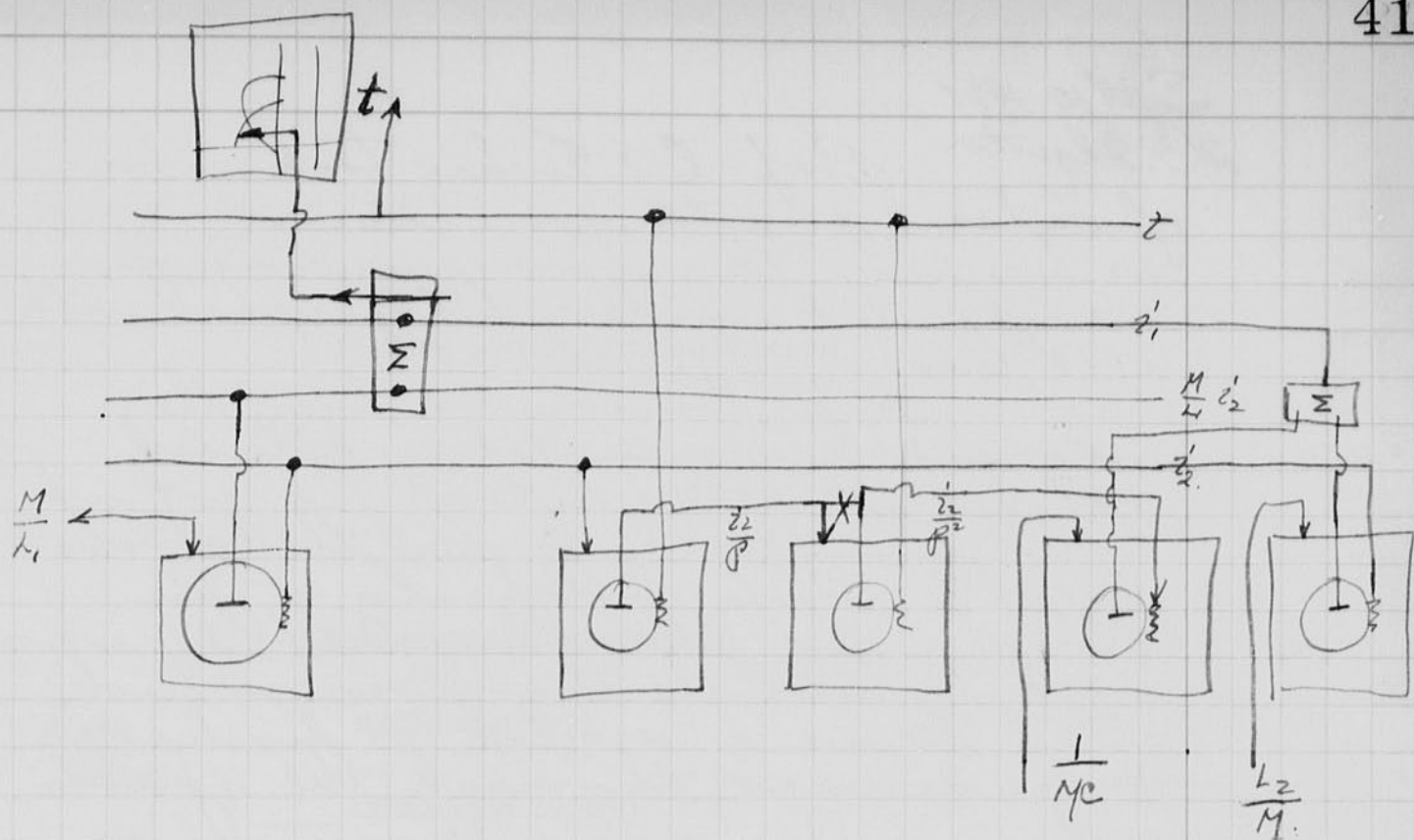
$$\frac{E \cos \omega t}{\omega} = \frac{E \sin \omega t}{p} = L_1 i_1 + M i_2$$

$$0 = L_2 i_2 + \frac{i_2}{c p} + M i_1$$



$$\frac{E \cos \omega t}{\omega L_1} = i_1 + \frac{M}{L_1} i_2$$

$$0 = i_1 + \left( \frac{L_2}{M} - \frac{1}{M c p} \right) i_2$$



Sept 8, 1931.

Observed Hudson's moving picture camera with the stroboscope. Painted moving parts white. Experimented with the circuits.

Sept 9, 1931. Took strobo over to the engine lab. Draper and Townes ran an engine for me so that I could observe the valve springs which were painted white. Traveling waves in the spring were very plain. Also the support vibrated about 1/16 inch at eye speed. Plan to take movies of this later.



Sept 10 1931  
 S. E. Edgerton. Prof. L. E. Tucker took movies of Hudson's projector movie camera mechanism. This framing mechanism was painted white. Photographed with a F1.9 lens.

Draper, Townner and I tried the valve mechanism again today but did not get it satisfactory. Lab got up to 92° during the day and the strobo failed to work properly. A fan blowing air from dry ice (CO<sub>2</sub>) was used to cool the thyatron which acted ~~to~~ as a switch to discharge the condenser through the spark coil.

Spent afternoon in the dynamo laboratory taking movies of Machine 804. The set was run at a speed slightly different than synchronous. The camera ~~was~~ has a f6.3 lens and the camera was cranked about 30+ frames per second. This 35mm camera belongs to Tech. A few frames of the movies are attached to this page. The angle can be read to about one degree.

electrical  
 In the evening I again returned to the engine lab and we took some movies of the valve springs with this 35mm camera. These did not turn out so good.

United States Patent Office  
 Before the Examiner of Interferences  
 Edgerton } Interference 76771  
 vs  
 Miller }  
 Edgerton Exhibit 7.

Pages 42, 43 and 47 of Edgerton Notebook T-11  
 (3 pages - page 42)

JAN 18 1940 January 2, 1940. Clara Schlosky  
 Notary Public

Notebook # July 20, 1931 - Jan. 12, 1932

### Filming and Separation Record

\_\_\_ unmounted photograph(s)

4 negative strip(s)

\_\_\_ unmounted page(s)  
(notes, drawings, letters, etc.)

was/were filmed where originally located between page 42 and 43.

Item(s) now housed in accompanying folder.

Mary Ruth

7911740



JAN 18 1940

43

Sept 11, 1931.

H. Edgerton. Cleaned the lens on the 35mm camera  
(f 3.5 lens.) and Draper made some new  
developer. Repeated the movies that were  
taken yesterday and got some fair  
results.

United States Patent Office  
Before the Examiner of Interferences  
Edgerton vs. Miller - Interference 76771  
Edgerton Exhibit 7.  
Pages 42, 43 and 47 of Edgerton Notebook T-11  
(3 pages - page 43) Clara Schlosky  
January 2, 1940  
Notary Public

These movies were  
taken at about 16 frames  
per second.

For this speed there was quite a  
possibility of ~~not~~ getting frames  
with no stroboscopic flash.  
The normal light from the  
room gives an exposure  
however which shows the  
spring moving and dim.

The picture at 1930 r.p.m.  
are fine.

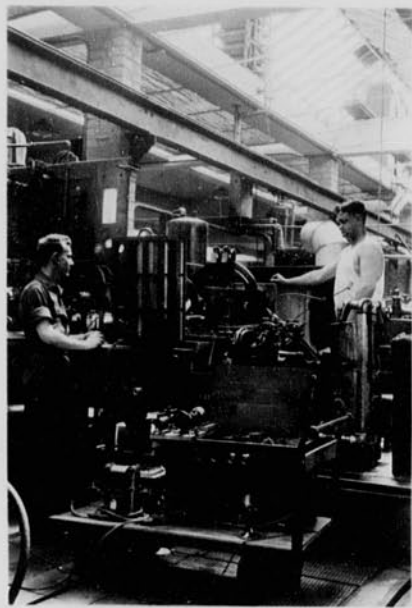
Sept 12, 1931 Sam Caldwell came down with  
me in the evening and we took some  
movies with his 3.5 Eastman  
camera

50 ft film by SA Caldwell scenes

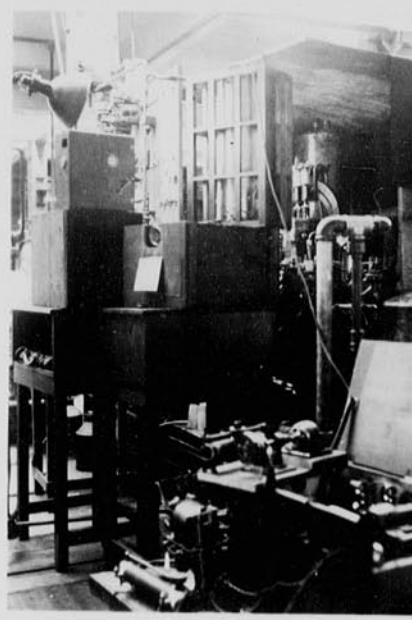
1. 1200 RPM
2. Lamp light
3. 1625
4. 1900
5. 1800
6. 1900 / change lamp
7. 1800 R.P.M.

United States Patent Office  
 Before the Examiner of Interferences  
 Edgerton vs. Miller - Interference 76771  
 Edgerton Exhibit 6.  
 Page 44 of Edgerton Notebook T-II.  
 January 2, 1940.  
 Clara Selbecky, Notary Public  
 Save space for Pictures.

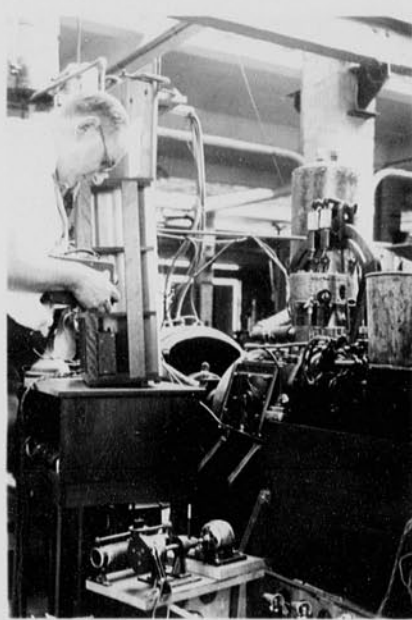
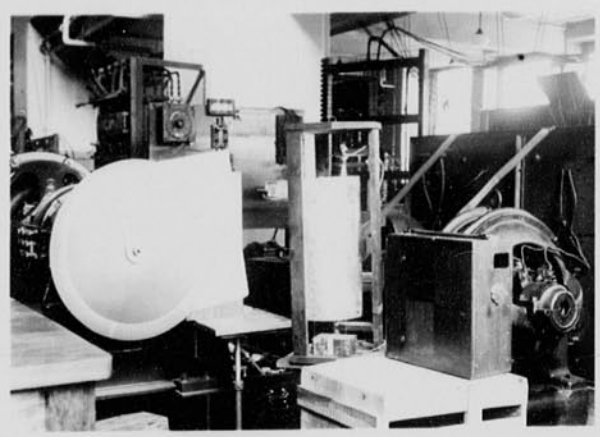
JAN 18 1940



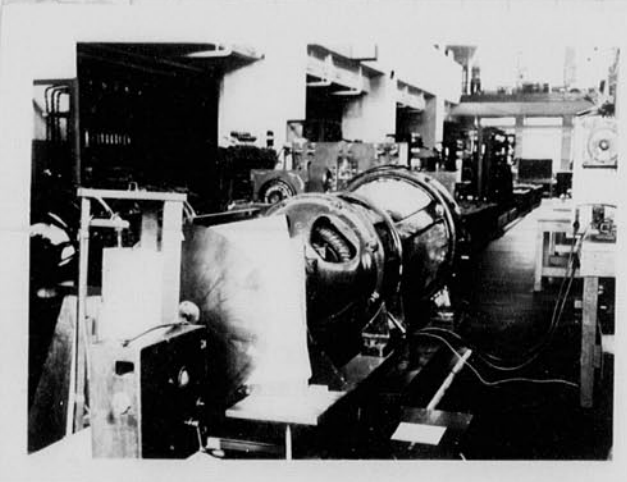
C.S. DRAPER



TOWNER ↑  
 AERO ENGINE LAB.  
 SEPT 1931.



Prof. Tucker



8 mm movies of  
 law mechanism.

STROBOSCOPE MOVIES OF VALVE SURGES. ENGINE SPEED 1930 R.P.M.  
 SEPT 11, 1931 H.E. EDGERTON M.I.T.  
 KODAK NITRATE FILM

Notebook # July 20, 1931 - Jan. 12, 1932

**Filming and Separation Record**

\_\_\_ unmounted photograph(s)

2? negative strip(s) (16 mm movie strips) in mounted envelope  
pg 44

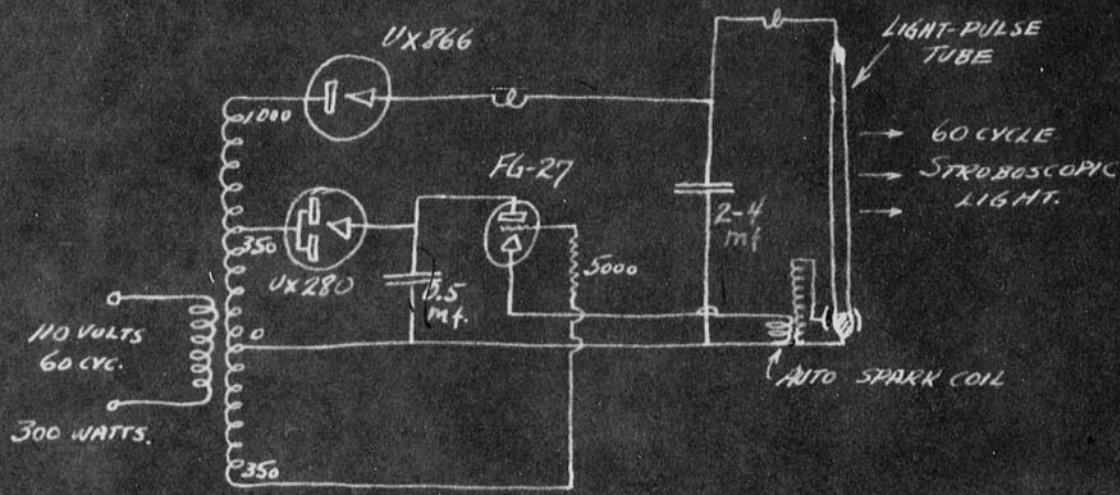
\_\_\_ unmounted page(s)  
(notes, drawings, letters, etc.)

was/were filmed where originally located between page 44 and 45.

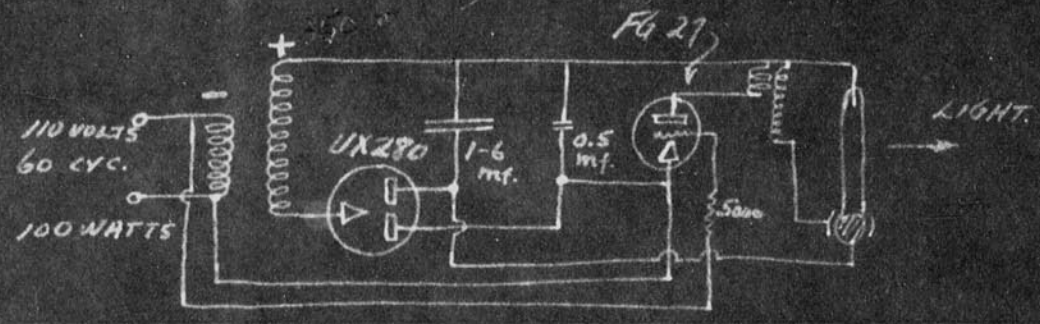
Item(s) now housed in accompanying folder.

Page 45 of Edgerton notebook I-II  
January 2, 1940. Helen Schlock, Notary Public





60 CYCLE STROBOSCOPE. 300 WATT FOR TAKING MOVING PICTURES.



60 CYCLE STROBOSCOPE 100 WATT FOR VISUAL OBSERVATION

With letter to  
E. S. Zen, S. S. Co.

H. E. EDGERTON  
SEPT. 14, 1931.

Edgerton vs. Miller - in paper  
Edgerton & Whititt  
Page 45 of Edgerton Notebook I-II  
January 2, 1940. notes, Bulletin

1940

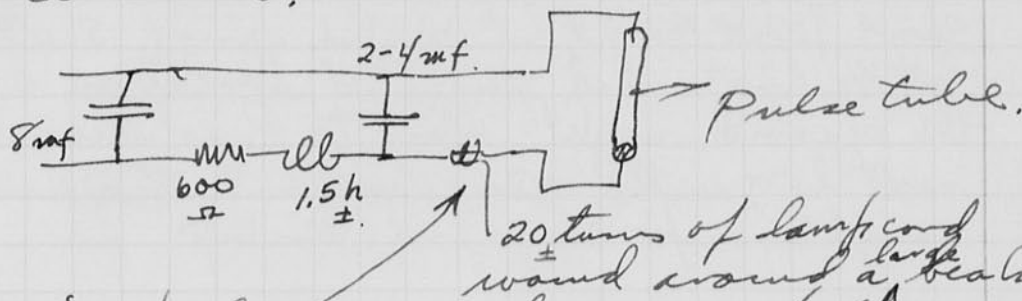
ed



Sept 14, 1931

Returned Stroboscope to the Research Lab. in the E.E. Dept. Experimented further with the circuits. Also brought over the new continuous speed camera which (S. Draper) has been building this summer. Draper left yesterday for N. Y. to spend two weeks with the Sperry Gyro-strope Co.

Sept. 15. Mounted the variable speed contactor on the lid of the box and worked further with the circuits.



With this impedance in the circuit the mercury spot appears to look like a lichtenberg figure. With the impedance shorted there still is some of the lightning appearance. I hope to take some micrographs of this phenomenon. There is plenty of light to get it in one flash.

Sept. 16. Put stroboscope tube with quartz section on the pump. This glass part was purchased from the Cooper-Hewitt Co.

Ran the frequency of the stroboscope up to  $(80 \times 8) = 480$  cycles per second. I had a one microfarad condenser in the discharge circuit. This was too much and it caused the tube to get hot but it worked fine.

Spent several hours at the General Radio Company with J. K. Clapp. (Eastman?) Tolson? They were all very interested in the stroboscopic movies of the valve mechanism. I had a print of several frames showing a compression

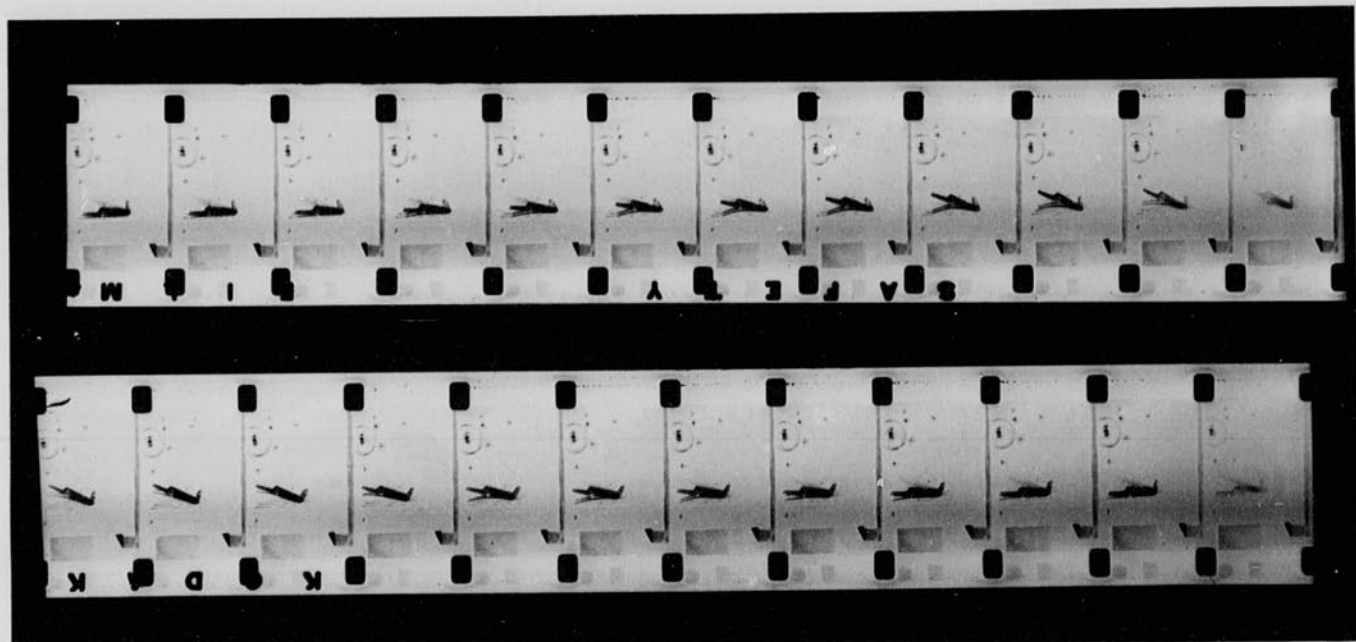
United States Patent Office  
Before the Examiner of Interferences  
Edgerton vs. Miller - Interference 76771  
Edgerton Exhibit 5  
Page 45 of Edgerton Notebook I-II  
January 2, 1940.

JAN 18 1940

wave as it travelled back and forth through the spring. They plan to come over next week, about Tuesday or Wednesday to see the apparatus.

Sept 17. Worked on circuit. Got motor to drive stroboscope discs for S.M.P.E.

Sept. 18-19-20-21 Trip with Chas Kingsley to the White mountains. Left car at the Crawford House. Spent first night at Mizpah spring shelter, climbed Mt Washington and stayed at Assolation shelter the second night. Hiked to Resolution shelter the next day in the rain. Came out at Bemis and caught train for Crawford. Fine trip!



Notebook # July 20, 1931 - Jan. 12, 1932

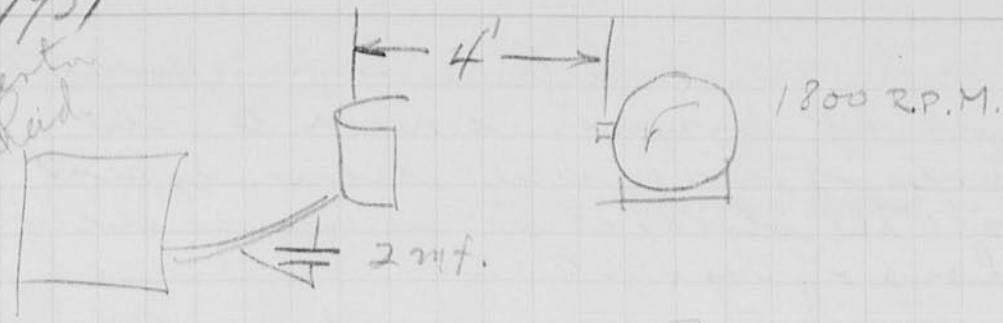
### Filming and Separation Record

3 unmounted photograph(s)  
     negative strip(s)  
     unmounted page(s)  
      (notes, drawings, letters, etc.)

was/were filmed where originally located between page 46 and 47.

Item(s) now housed in accompanying folder.

Sept 22 1931  
Edgerton  
and Reid



Variable frequency

Bromide paper  
on drum.

$$\frac{3.1 \times 1800}{60} = 93 \text{ ft/sec}$$

$$93 \times 12 = 1120 \text{ in/sec}$$

$$\frac{1}{16} \times 1120 =$$

6720	1000000
1120	1000000
17920	866000
	134000

R

JAN 18 1940

- No 1. F. 3.5      2mf      hot
- 2      F. 3.5      2mf      cold
- 3      "      4mf      warm.

No 1.

No 2

No 3

United States Patent Office  
 Before the Examiner of Interferences  
 Edgerton }  
 vs. Miller } Interference 76771

Edgerton Exhibit 7.

Pages 42, 43 and 47 of Edgerton Notebook I-II  
 (3 pages - page 47)

January 2, 1940.

Clara Schlosky  
 Notary Public

Sept 23. Mother arrived with the Meyers from Broken Bow.

Sept 24. Set up Graflex camera to take pictures of <sup>water</sup> drop oscillations. Expect to operate the strobe at 500 cycles per second. A shadow of the drop will be focused on ~~the~~ a strip of bromide paper on the continuous drum.

$$1 \text{ ft diam of drum} = \frac{12 \times 2.54 \times \pi}{.95} = 128 \text{ frames of } 16 \text{ mm film.}$$

$$1 \text{ r.p.s.} = 128 \text{ frames.}$$

$$\frac{500}{128} \times 1 = 3.9 \text{ rev per sec or } 235 \text{ r.p.m.}$$

so the frames will not blur.

$$\text{Exposure} = \frac{1}{3.9} \text{ sec} = .255 \text{ seconds.}$$

Sept 25 Took more pictures of the water drops but they were N.G.

Sept 26. Draper back from N.Y. today. He says the Ferry gyroscope company is interested in the stroboscope. Sent abstract to S.M.P.E.

1. Stroboscope tube used winter and spring 1931
2. Tube with starting electrode.
3. First successful light-pulse tube using high temperature.
- 4.-11-12. Projector tubes
5. Tube used to get movies of claw and valve springs
6. Similar to 3.
7. Parallel anode tube
8. Horizontal tube.
9. Slender tube similar to 3 and 6
10. Horizontal tube with a pool at both ends.
13. Tube with Quartz section.
17. Capillary discharge tube.

PHOTO TAKEN SEPT 23 or 24, 1931.

Notebook # July 20, 1931 - Jan 12, 1932

**Filming and Separation Record**

1 unmounted photograph(s)

       negative strip(s)

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

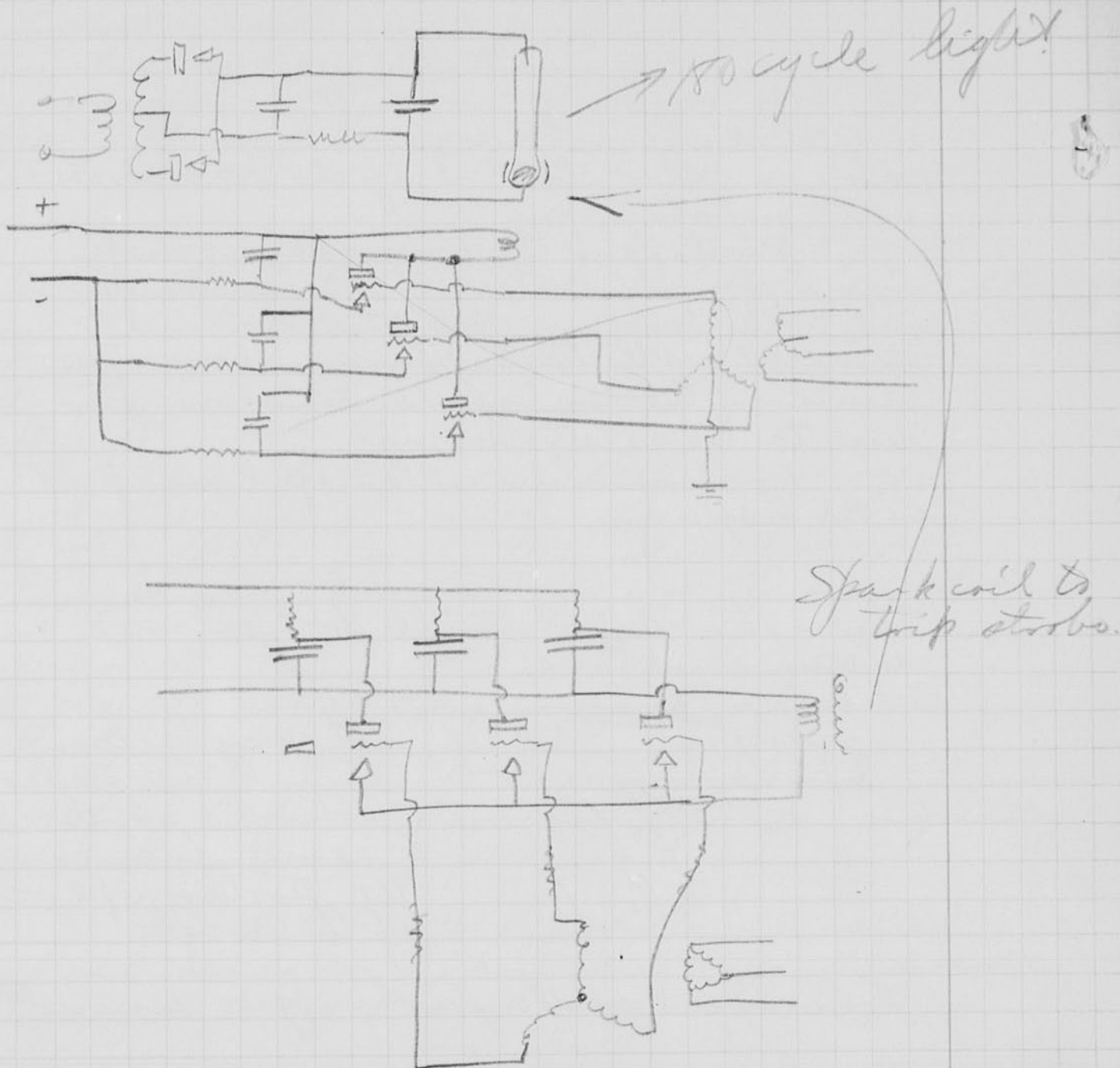
was/were filmed where originally located between page 48 and 49.

Item(s) now housed in accompanying folder.



g

Sept 27, 1931.  
H. E. Edgerton.



This circuit flashes for the zero of each phase voltage. It is useful for investigating what goes on in short circuits and unbalanced conditions as it immediately locates the voltage vectors with respect to the angular position.

This circuit was explained to me on Sept 28, 1931  
by H. E. Edgerton.

Ch Kingsley Jr.



October 6, 1931

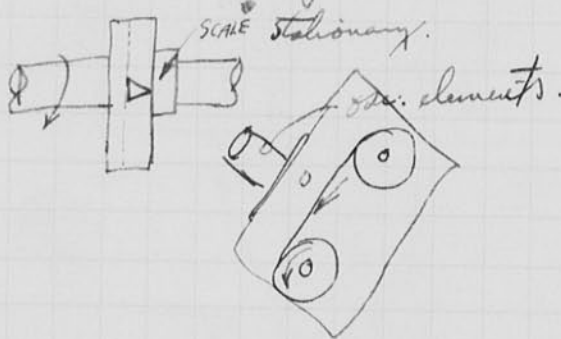
H.S. Experiment

Showed a stroboscopic display to the members of the National Research Council group. First showed the two big discs then the vibrating spring mechanism and the claw on the moving picture camera. Also started up the ~~160 HP~~ motor in the substation.

J. K. Clapp of the General Radio company was over with others of his company to see the display. Also Stewart and J. Barnett (?) of the Westinghouse were over. Spencer of the New England Power company came to see the stroboscope.

K. S. Sommerhausen helped me put on the display.

Three phase stroboscope for power system analysis.



It may be possible to put the oscillograph records on the same film as the stroboscope record of the angle.

Film speed for 180 flashes per second.

Say  $\frac{2}{3}$  cm per record.

$$\frac{2}{3} \times 180 = 120 \text{ cm per second.}$$

$$\frac{120}{2.54} = 47 \text{ inches/second or } 3.9 \text{ feet/second.}$$

try 3 ft per second. 30 feet for 10 seconds

The records could be bunched even closer than this say ~~two~~ three flashes per cm which gives  $1 \times 60 = 60 \text{ cm/second}$  or 2 ft. approx. per second.

Oct. 11, 1931

On Thursday Oct. 8 Germeshausen, Towner and I took the ~~the~~ variable freq. stroboscope and several exhibits to the Society of Motion Picture Engineers convention at Swampscott. Howard Biggs of the Hygrade Lamp Co came over and I talked with him.

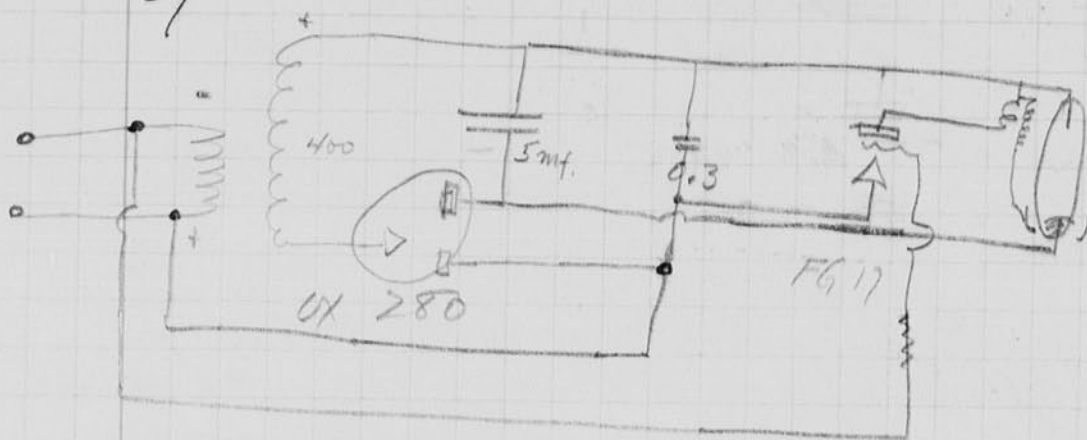
Friday Oct. 9 Germeshausen and I went over to the Hall Laboratories on Boylston St (700±) 939 and Mr. Hall showed us some of his tricks. We invited him over to see the stroboscope display.

Saturday Oct. 10 Mr. Hall came over and was very much impressed by the effects from the stroboscope especially <sup>with</sup> the two large discs which we have shown at tech for open house demonstrations for several years. I plan to wire up a small 60 cycle stroboscope for him to experiment with and possibly he can find a market for them in stage lighting and advertising schemes.

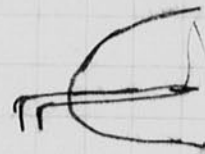
Mr. Fuller of the Hygrade Lamp Co called up and made an appointment for Wednesday to go out to the Russell Box Co to look over a job where the stroboscope light may be useful.

Oct 11, 1934.  
H. Edgerton

Circuit for small power  
stroboscope.



1- transformer	5.00	9.50
1- UX 280	0.85	
1- 5 m.f. 600 volt condenser.	3.00	1.00
1- 0.3 m.f. 600 volt ..	.50	
1- FG-17	5.00	
1- spark coil.	2.00	
1- grid resistor (110 v) 5000 $\Omega$	.75	
2- sockets.	.50	
1- pulse lamp.	3.00	
gt. cost of materials.	18.60	

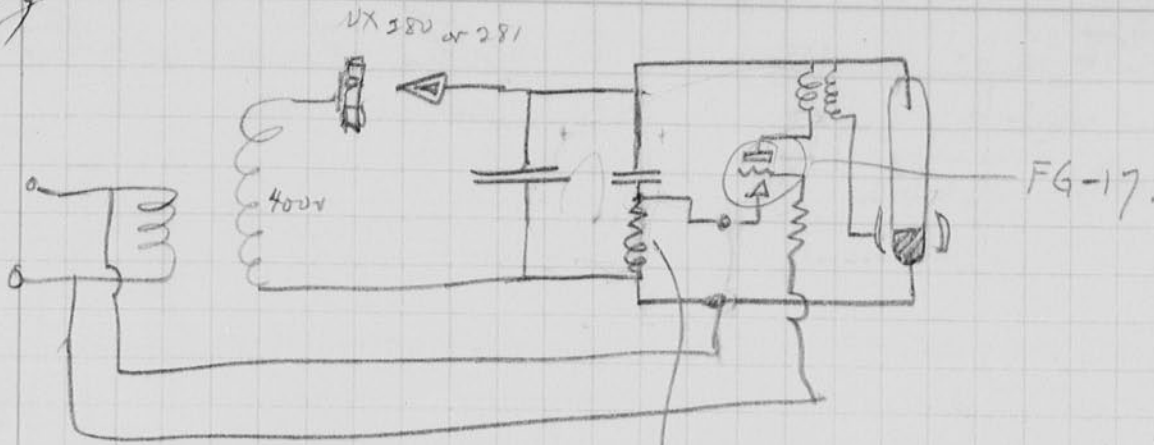


Shapes for  
the lamp.  
Glass  $\frac{1}{2}$ " in diam.  $\pm$   
and about one ft long.

Showered this circuit to  
Prof. Tucker on Oct 13  
and discussed it  
with him.



Oct. 13, 1931  
H. S. Edgerton



This resistance & inductance will stop the discharge of the large capacitor. First the small capacity will flash through the spark coil, then the large flashes through the pulse lamp.

$$400 \times 120 \text{ ma} = 48.0 \text{ watts}$$

$$\frac{30}{60} \times \frac{CE^2}{2} = 48$$

$$C = \frac{48}{30} \frac{1}{E^2} = \frac{48}{3} \frac{1}{.600^2} = \frac{48}{3 \times .36} \times 10^{-6} = \underline{\underline{4.5 \text{ mf.}}}$$

30 h

10 h 120 ma.

$$f = \frac{1}{2\pi\sqrt{LC}} = 6.28 \sqrt{10 \times 4.5} \times 10^3$$

$$6.28 \times 7 \times 10^3 =$$

$$.042 \text{ sec.}$$

$$.0167 \text{ use 1 henry.}$$

$$RC = 4L$$

$$R^2 = \frac{4L}{C} = \frac{4 \times 1}{5 \times 10^{-6}} = 1 \times 10^6$$

$$R = 1 \times 10^3 = 1000 \text{ ohms.}$$

$$RC = 1000 \times 5 \times 10^{-6} = .005 \times 10^{-3}$$

try 2000 ohms for the resistance.

Oct. 13, cont.



The tube acts  
as a switch.

.3 .6x.6

$T = 2\pi\sqrt{LC} = 2\pi \times 10^{-3} \times 0.6 \times \sqrt{L}$  must be  
less than

$$\frac{1}{60 \text{ sec.}} \times \frac{1}{10,000} =$$

$$i = \frac{2EC}{\sqrt{4LC - r^2C^2}} e^{-\frac{rt}{2L}} \sin \frac{\sqrt{4LC - r^2C^2}}{2LC} t$$

R.R.L. p. 155.

when  $R = \text{small}$

$$i_{\text{max}} = \frac{2EC}{\sqrt{4LC}} = E\sqrt{\frac{C}{L}}$$

$$C = 0.3 \times 10^{-6} \text{ farads.}$$

$$L = ?$$

$$i_{\text{max}} = 2 \text{ amps.}$$

$$L = \frac{E^2 C}{i_{\text{max}}^2}$$

$$= \frac{.600 \times .600}{2 \times 2} \times 0.3 \times 10^{-6} \text{ H} = \frac{0.36 \times 0.3}{4} = \frac{.108}{4} = .027 \text{ henr}$$

$$T = 2\pi \sqrt{.027 \times 0.3} \times 10^{-3} = 54 \times 10^{-5}$$

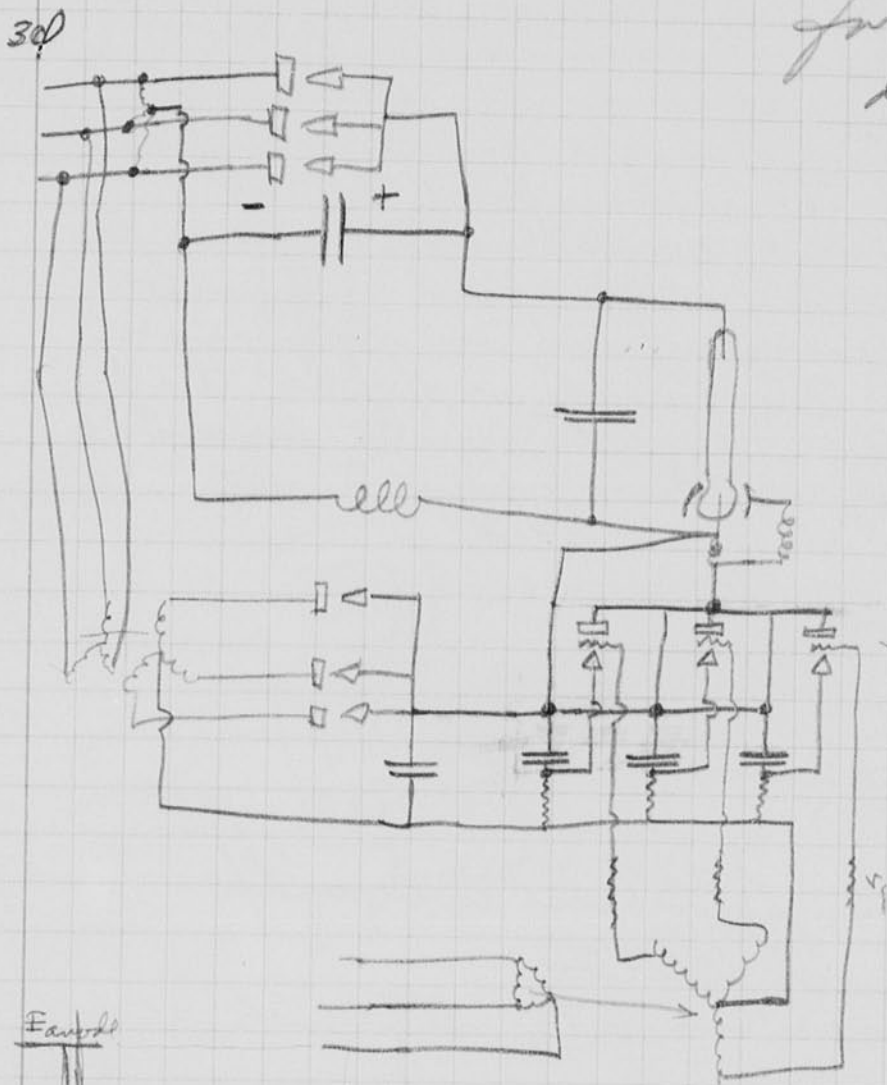
$$\frac{.0080}{9 \times 10^{-2}}$$

$$= \frac{.000054 \text{ sec. per cycle.}}{.01600 \text{ sec. per 60 cycles}}$$

If .01 henry is used I believe it will  
come out about right since the  
tube holds back the discharge to some  
extent.

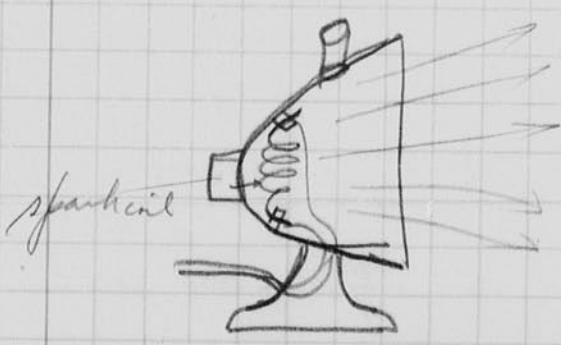
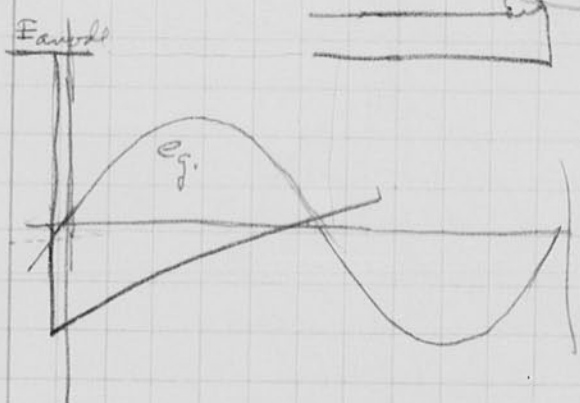
Oct. 13, 1951.

180 cycles strobo  
for power  
disturbances.



use 6G 6 for  
6Q 33 tubes  
which require  
considerable  
current to get  
them started.

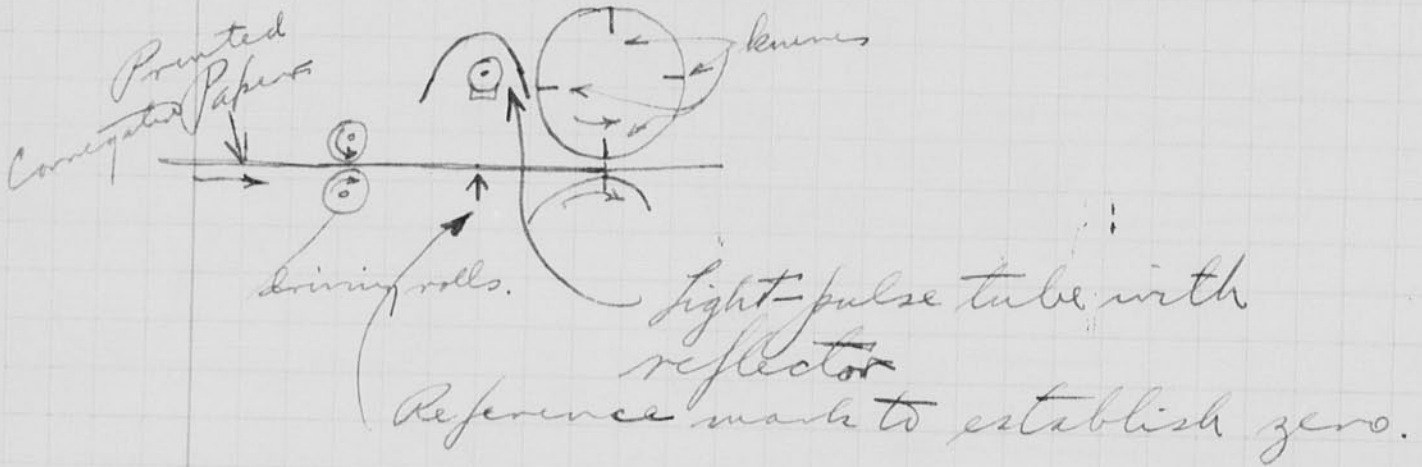
then use a  
grid resistor  
high that they  
will not start  
until the anode voltage  
has become 600 volts.



Design for a  
reflector for a strobe lamp

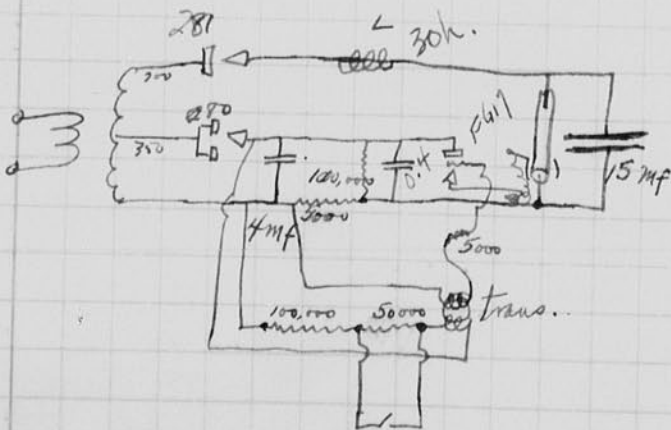
Oct. 14, 1931.  
 F. E. Edgerton.

Mr. John. Q. Fuller of the Hygrade Lamp company of Salem was in this afternoon. He took Bernshausen and I to the Russel Box company in ~~Emerson~~ <sup>Malden</sup> to see if the stroboscope could be used to speed up the manufacture of cartons to hold incandescent lamps. The mechanism's ~~with~~ speed is now limited because of an observer's eye reaction time. It is hoped that stroboscopic light will enable the machinial cutting speed to be enormously increased.



After looking this over we came to tech and gave a demonstration of the stroboscope. Mr. Pike of the Russel Box company was with us.

Proposed circuit.

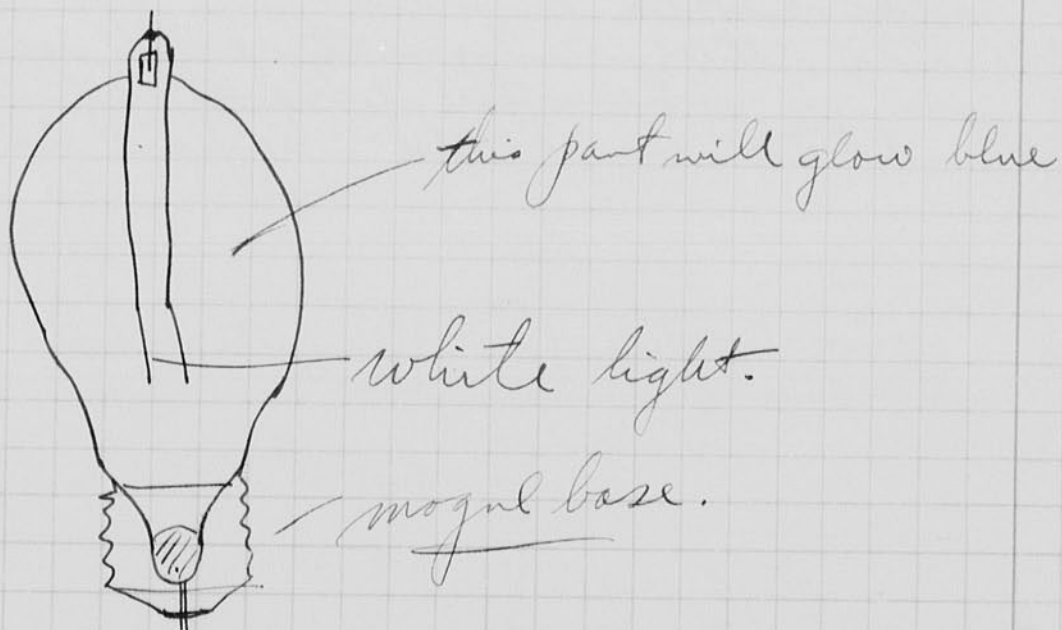
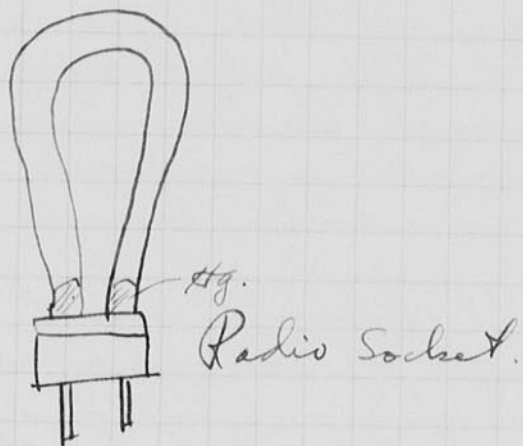
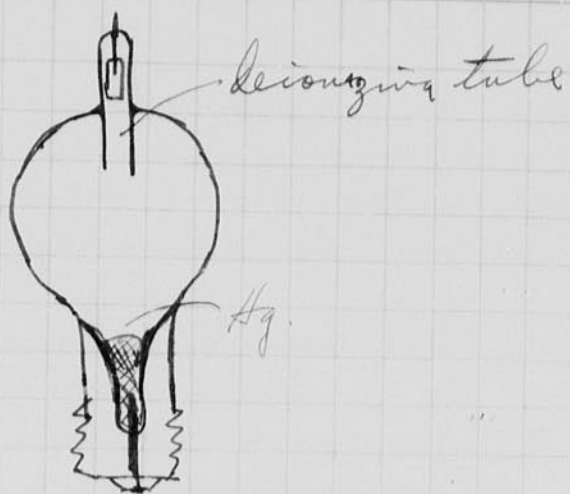


60 times a sec 5mf. 100 watts.  
 20 times a sec 15mf.

$$L = \frac{700 \times 700}{12 \times .2} \times 15 \times 10^{-6}$$

$$= \frac{.49}{.04} \times 15 = 4.75 = 200 \text{ henries.}$$

use a 30 henry choke.



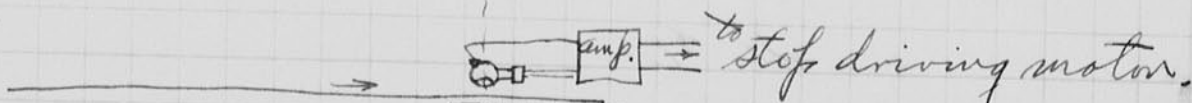
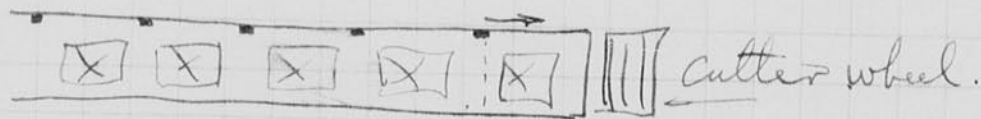



Oct 15/1931  
H.E. Edgerton

A stroboscope and a photocell can be used very effectively to stop ~~to~~ any automatic machine as soon as any trouble develops.

For instance the cutting machine of the Russel Box Co can be stopped. ~~For~~ As the cutting speed is increased by stroboscopic cutting observation, the waste if a defect in printing comes along is larger because the operator cannot adjust the phase of the paper and cutter quickly. The waste becomes greater as the speed is increased.

If a small black spot is put on the edge of the paper and a stroboscopic light source is placed on one side of ~~it~~ the paper with a photocell on the other side, there is a method of immediately noting when the phase of the cutter and the paper is out.

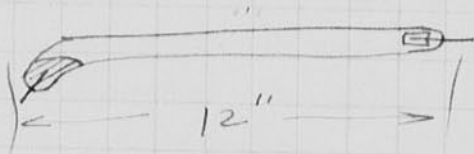


Stroboscopic light source  so arranged to give a flash of light when the black spot is opposite the stroboscopic light, when the paper is in proper phase position with the cutter.

Oct. 21, 1931. The idea on these pages (58 and 59) were explained to me by Mr. Edgerton on Oct. 15, 1931. Kenneth J. Bernshausen

Oct 16 1931  
H.E. Edgerton.

Germushausen and I worked in  
3003 blowing and exhausting some  
light-pulse-stroboscopic tubes for  
the job at Russell Boy Co. We built  
three good tubes. Two of them were  
12 inches long and  $\frac{1}{2}$ " in in diam.



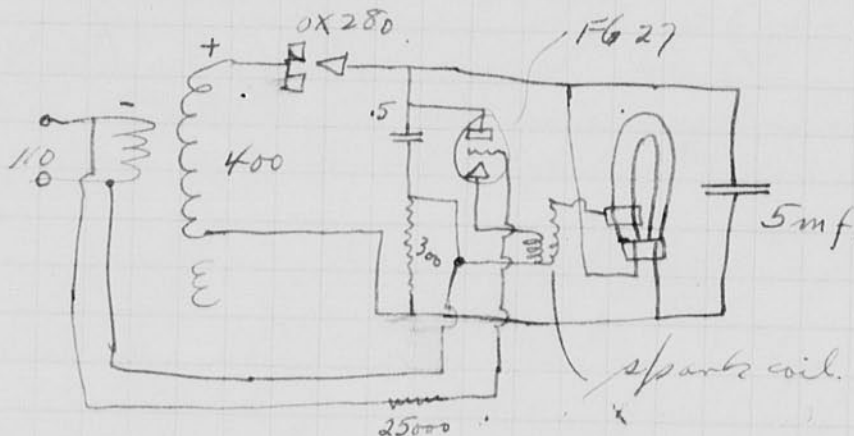
The lower  
end was  
bent down  
so that the  
Ag would  
stay there.

The other tube was V shaped so that  
the two ends could be put into a  
radio socket.

Oct. 17, 1931.  
H. Edgerton.

In the afternoon I took some characteristics on a model or replica of a Von Lieben tube which had both electrostatic and electromagnetic control, for Bowles.

Oct. 18, 1931. Worked some for Bowles and then connected up a small 60 cycle stroboscope which had the circuit shown below.



This circuit works great

Gordon Brown helped wire this outfit up and he tried to make a stroboscope tube. Circuit similar to that described in letter to E.S. See (page 45 this note book). Resistance keeps big cond from discharging through the thyatron. Inductance tried also.

Oct. 19, 1931 Showed this circuit (above) to Prof. Trencher. He is going to get one for the dyn. lab. to use in experiments.

Mr. Cain and Washburn of the Edison Co. borrowed the variable freq strobo for the U.S. Navy Exp at the Copley Plaza Hotel.

Oct 20 1931. Gave my 6.03 (alt current machinery) class a demonstration in the Dynamic lab with the stroboscopes shown above. I showed the change of angle with power.

In the afternoon I took the stroboscope over to the Hall Laboratory, 739 Boylston St Boston and showed it to Mr. Hall. Sam went along.

The ~~AMA~~ variable frequency stroboscope which was borrowed by Cain and Washburn of the Edison Company has a circuit very similar to that given with my letter to H. A. Sherman of the G.E. Co. See diagram on p 21 of this book. It is the outfit which was used to get the moires of the valve springs in the engine lab see pictures on p 44.

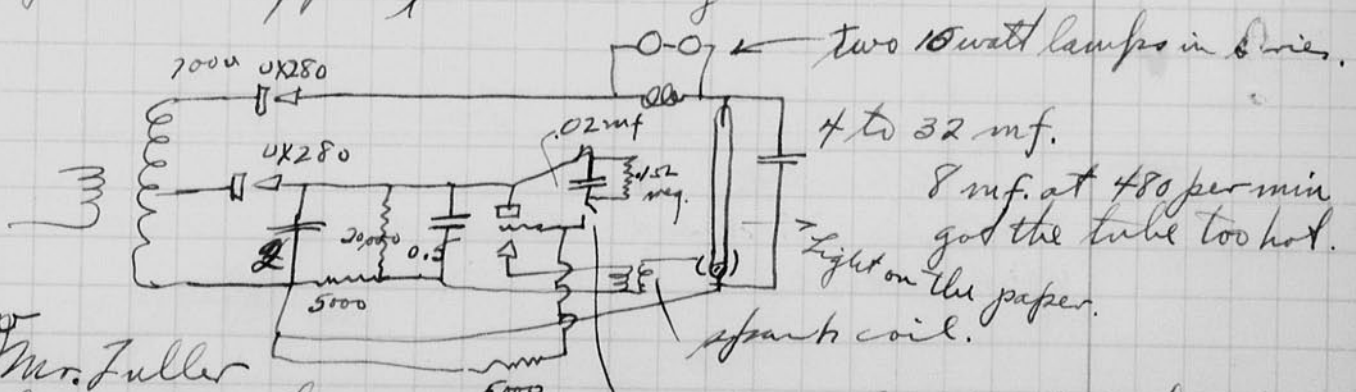
Cain and Washburn are ~~to use~~ <sup>again</sup> the outfit at the Copley Plaza Hotel and will continue until Wednesday.

Called Pike at the Russel Box Co and told him I would be out tomorrow.

Heard from Wentworth of the United Shoe Mach Co. He said to find Mr. Jamell and come any time. I wrote Jamell saying I would come Friday afternoon.

Bermeshausen has been working yesterday and today on the outfit for the Russel Box Co.

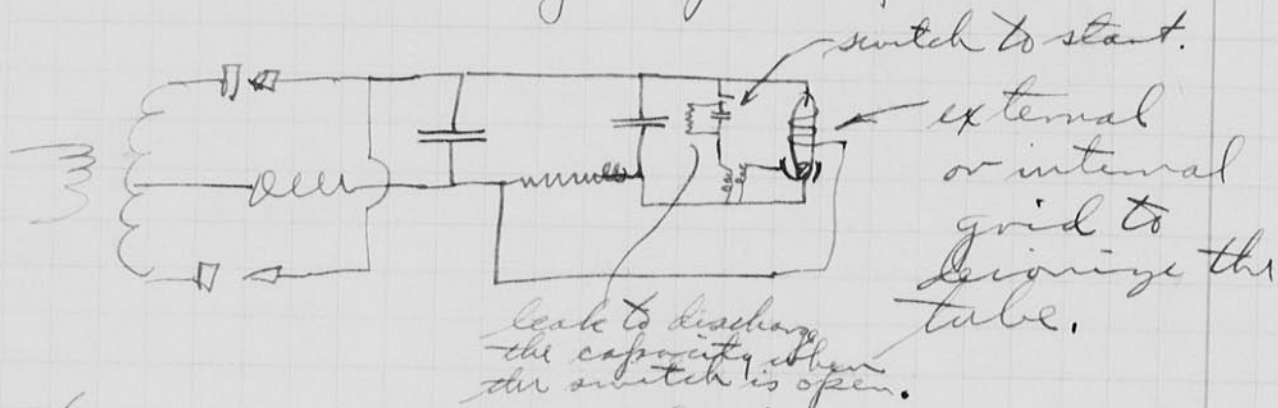
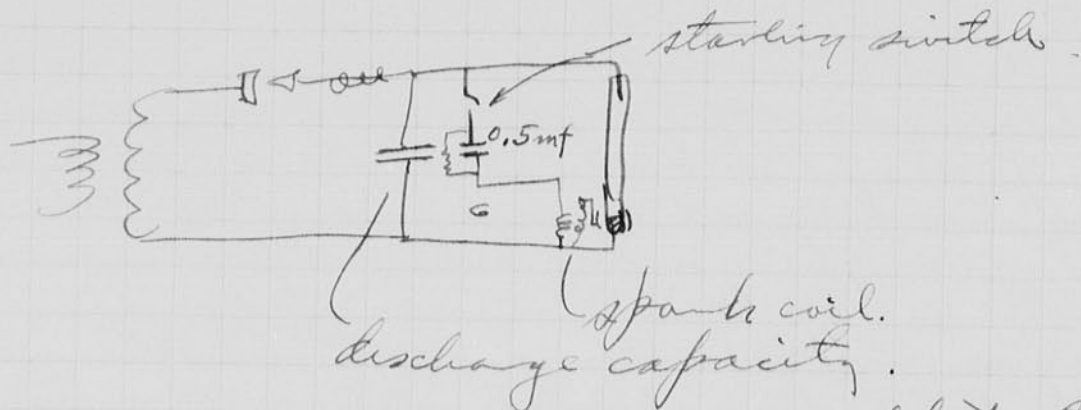
Oct. 21, 1931. I spent the entire day at the Russel Box Co. in Medford. The stroboscope enabled the machine to be speeded up. We had some trouble with the circuit, the condensers would not charge fully in the interval between flashes. This was remedied by the use of a resistor in parallel with the 30p duke in the charging circuit. The actual circuit is below. It is very similar to that on p 56 except for the tripping arrangement.



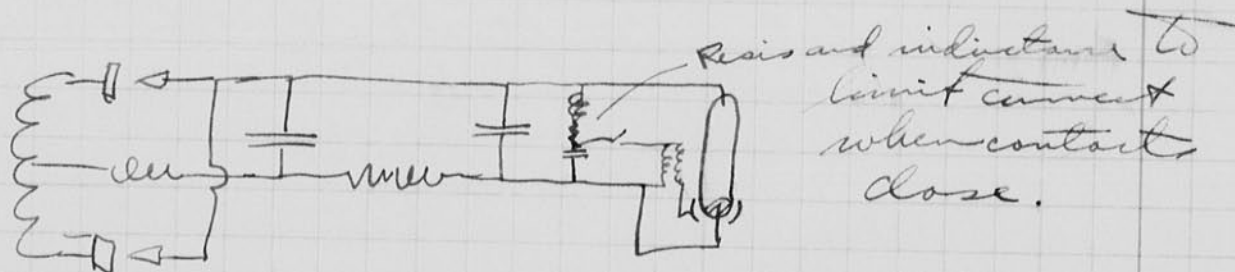
Both Russel Brothers saw this work. Mr. Fuller of the Hygrade Co. was there also in the aft. Talked to Pike in the afternoon.

Oct 21, 1931  
H. G. K. K. K.

# Stroboscope circuit without thyatrons.

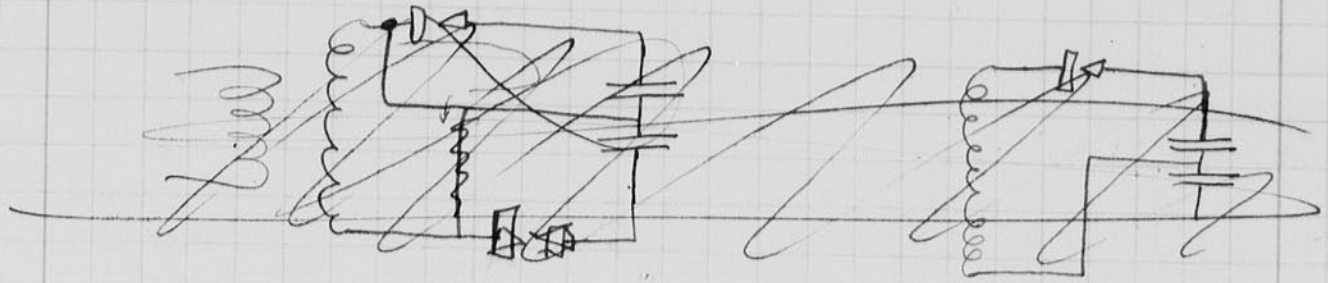


The contacts need to be driven by a variable speed motor say 0 to 5000 r.p.m. a tachometer should be attached so that speed can be read, that is the frequency of the light noted.



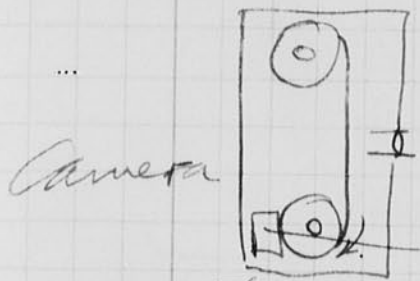
This circuit use the discharge of the small condenser through a spark coil to get the high voltage.  
These circuits are similar to those I had Beardley work on in 1929 and 30.

# Three Color Motion Pictures



Oct 21. cont A. E. Edgerton

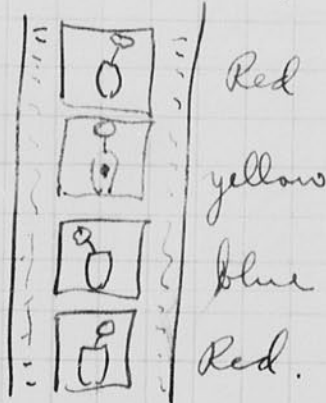
## Three color motion pictures.



Continuous moving panchromatic film.

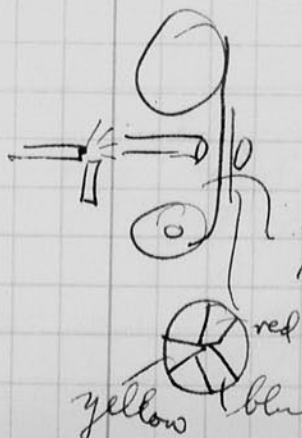


Stroboscopic light sources, arranged to flash on different frames. Light duration  $10^{-5}$  sec.



The film speed will be increased to  $24 \times 3 = 72$  frames per second.

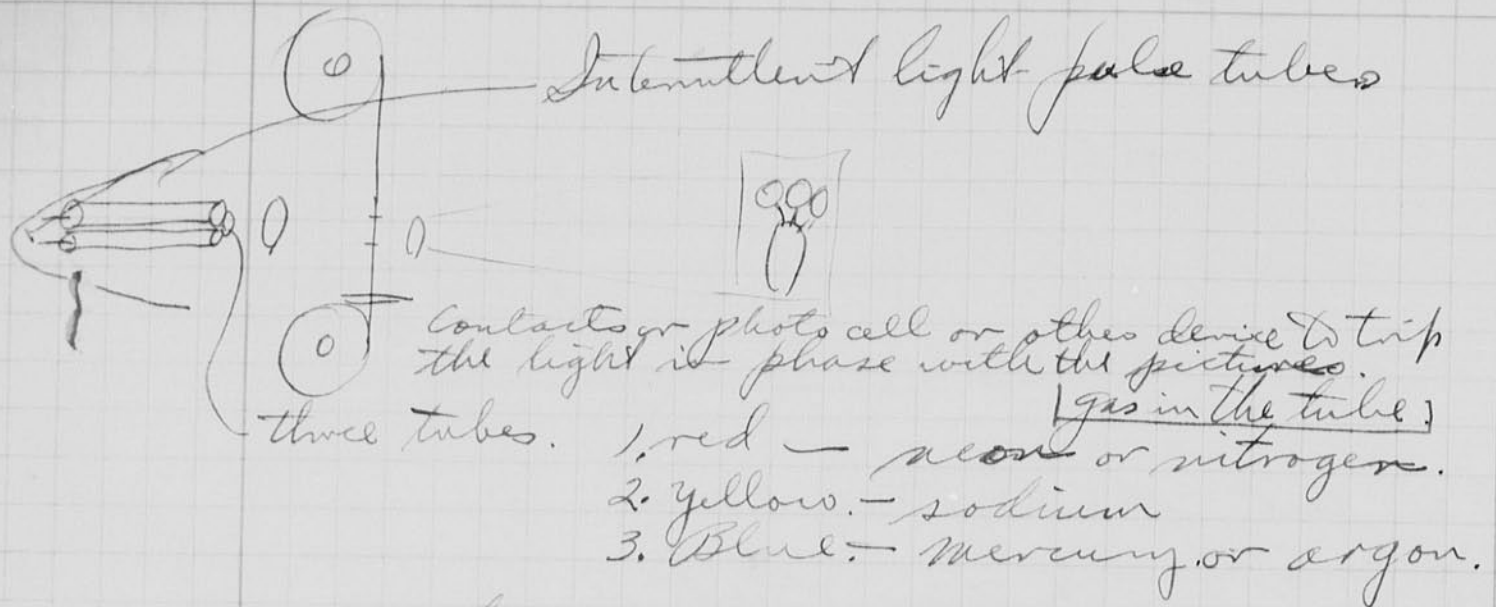
Projection can be with a <sup>moving</sup> color screen over the shutter on the projector or with intermittent light from three light sources of the same colors which were used in taking the pictures.



Are projectors with colored filters.

72 frames per sec.

The filters are phased so that they correspond to the proper frame.



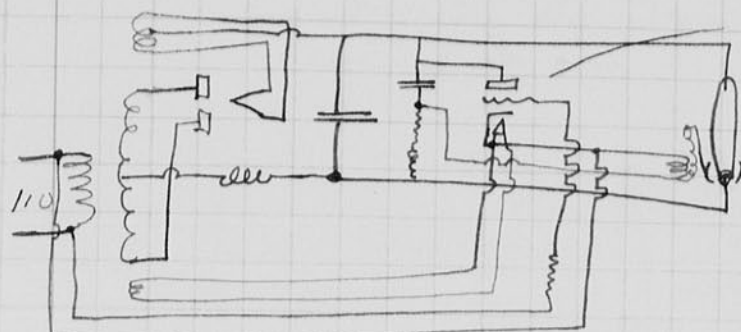
The light source is arranged to flash each frame as the film runs by at a continuous rate.

Read and understood  
Oct 22 1931  
J. Bush

Read + understood  
Oct 22 1931  
Kenneth J. Gammehausen

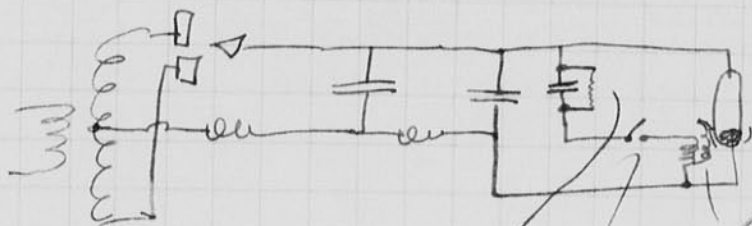
Nov. 4, 1931. I explained this method of colored motion pictures to Jim F. Van in the evening

60 cyc stroboscope. Oct. 21, 1931 H. E. Edgerton



thyatron

The thyatron may be replaced by a mechanical contactor which discharges the condenser through the spark coil and thereby snaps on the large tube.  
For frequencies higher than 60 cycles a second there will need to be a filter circuit to maintain a supply of d.c.



spark coil

starting switch

this can be a counter relay such as is used on telephones and will record the number of flashes, that is the number of cuts.

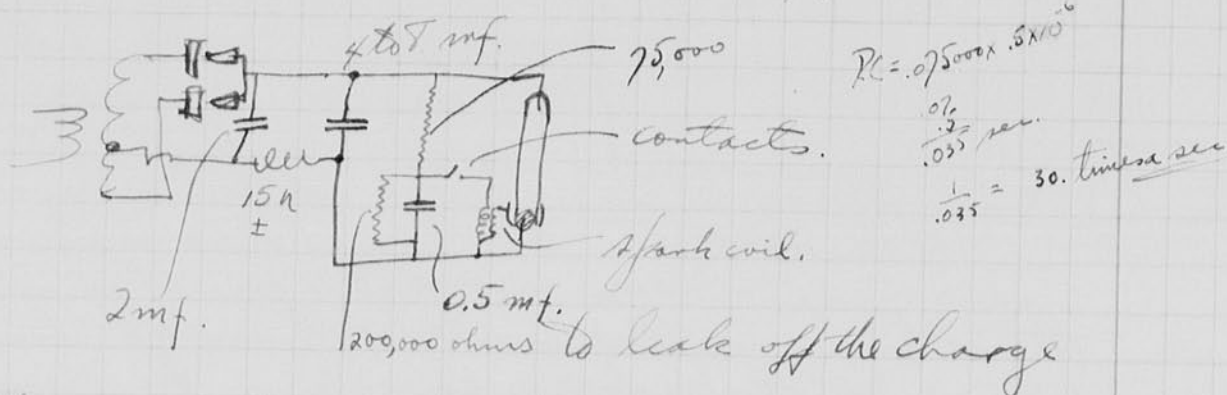
From this need to be subtracted the waste to get the total output.

Oct. 22, 1931. Worked more on the circuits for the Russell Box Co.

Oct. 23, 1931. I spent afternoon in United Shoe Mach Factory in Beverly, Mass. Few of the machines went fast enough to give a good picture.  
Stopped at the Hygrade Lamp Co in Salem on the way home and demonstrated the stroboscopes to a lot of people.  
Talked to Biggs and Bokken about the outfit. Discussed tube design and a 110v 60 cyc strob.  
Worked in evening on the Russell Box circuit. It did not work very well until we changed the discharge



condenser that starts the flash.  
The best circuit is evidently.



If the small starting condenser is connected as shown on page 5, second drawing, the voltage of the large discharge condenser is suddenly reduced <sup>when the switch is closed</sup>. This seems to effect the starting of the mercury tube.

Oct. 24, 1931  
H. E. Edgerton

In the morning I talked with Hugh Spencer about some tests we wished to make on the Power Systems of N. E. especially the 15 mill Falls plant.

Germershausen and I went down to the Herald-Triangler Bldg about noon time. Also we went to the Metropolitan and to the Loew's state to see about the application of the stroboscopic light to the stage. Got in touch with Sullivan - Met. Dirpr - Loew's

JAN 18 1940

United States Patent Office  
Before the Examiner of Interferences  
Edgerton vs. Miller } Interference 76771

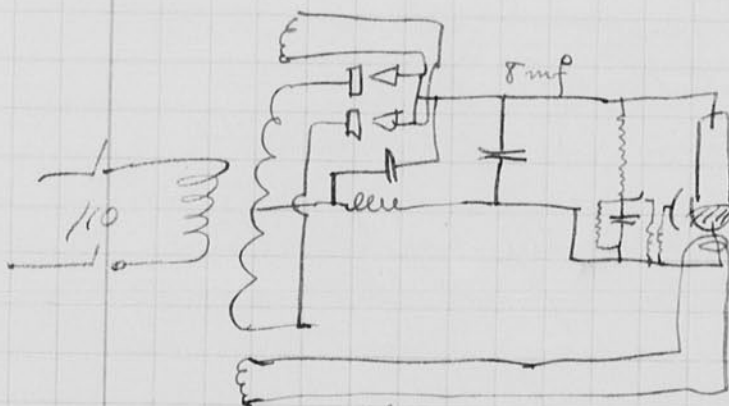
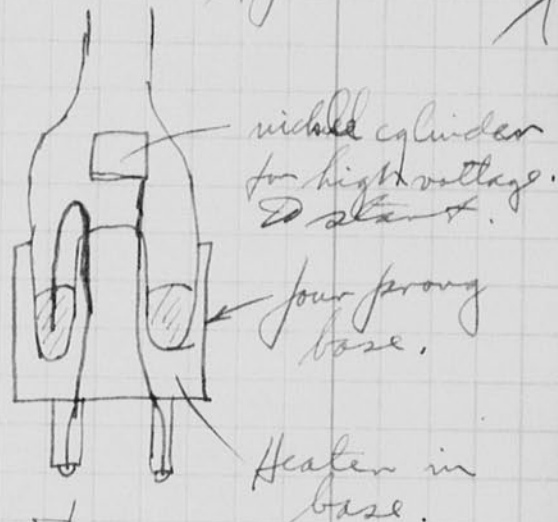
Edgerton Exhibit II  
Page 66 of Edgerton Notebook T-II.  
January 2, 1940.  
Clara Schlosky  
Notary Public

Oct 25 1931

#2 Edgerton. When these mercury arc stroboscopes tubes are too hard and too cold, they often are difficult to start. A rather easy way to cure this would be to put a filament or a heater close to the pool of mercury to warm it up



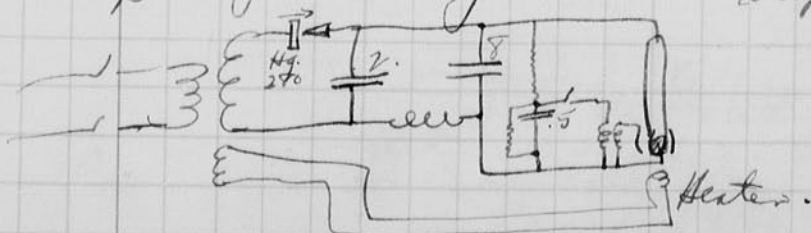
The filament will undoubtedly have some other effect of the operation which needs to be determined experimentally.



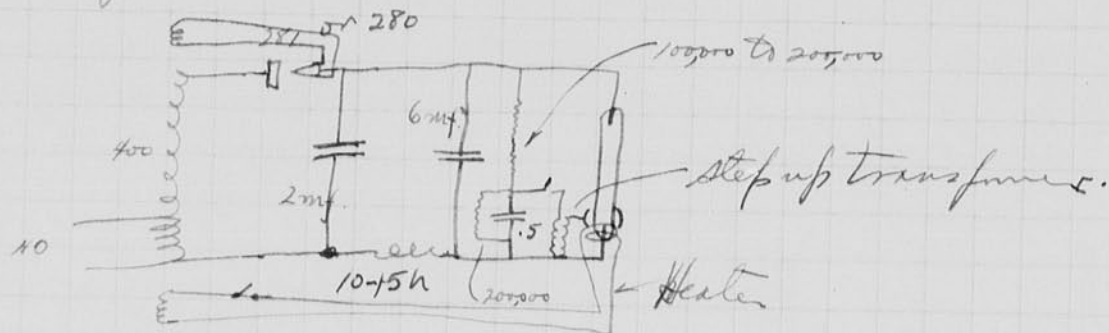
Heater to warm mercury.

2.5 volts  
3 amp.  
 $R = 0.5 \text{ ohms in the heater}$   
 $W = EI = 12.5 \text{ watts.}$   
try 0.7 ohms first.

or Half Wave for slow start



Oct 25 / 93 / cont.  
 L.S. Edgerton Use trans as auto to get  
 higher voltage.

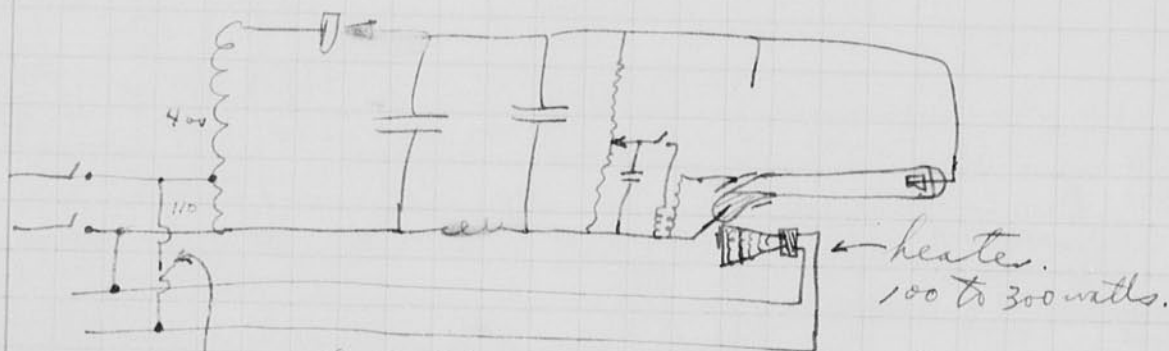


$$RC = 200,000 \times 0.5 \times 10^{-6} = .05 \text{ sec to } 6390 \text{ chg on the cond.}$$

$$\frac{1}{.05} = 20 \text{ flashes per sec} \approx \text{limit of ariet.}$$

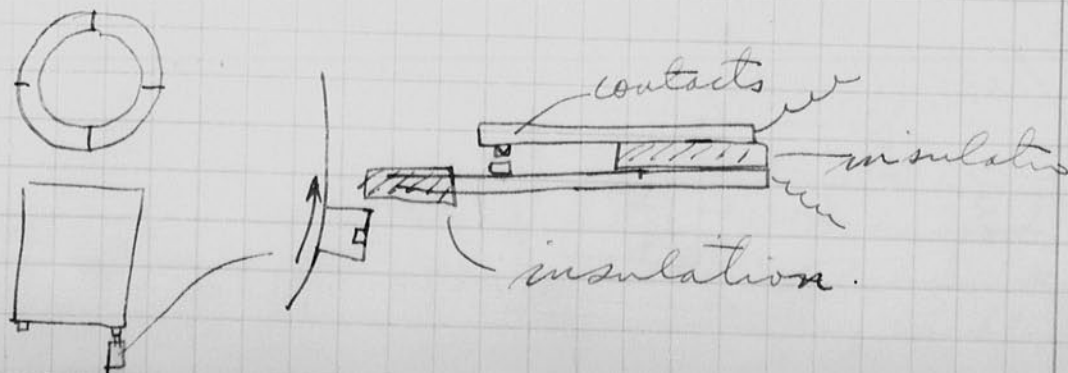
$$20 \times 60 = 1200 \text{ flashes per min.}$$

Another heater scheme.



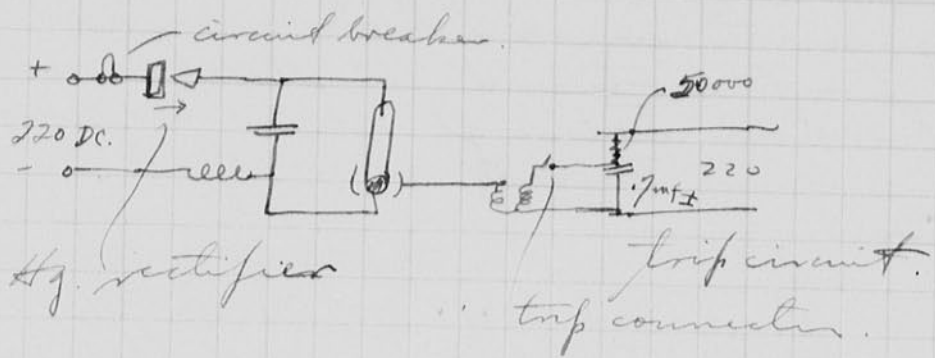
push button to put on the heater to warm up the tube if it does not start. Have spring return so the switch will not be on all the while.

Put start switch on other side so the ground will not affect the system. Use otherwise an insulated tab on the contacts.

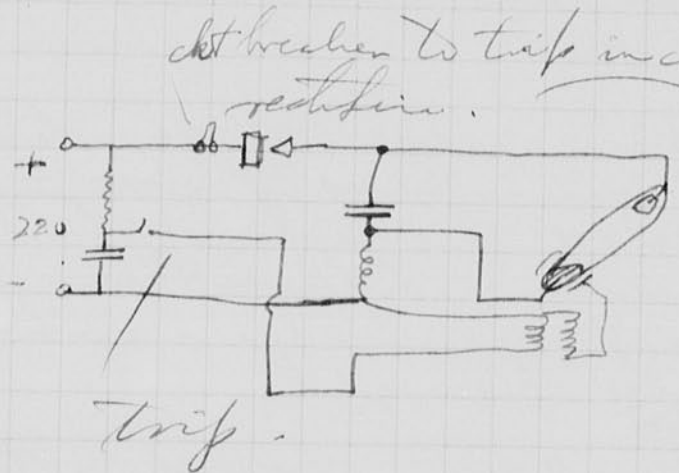


Oct. 25, 1931 cont.  
H. E. Edgerton.

D. C. Stroboscope

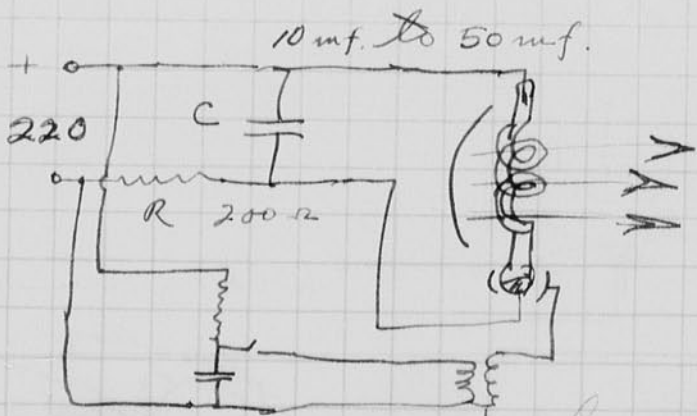


This circuit gives a voltage of nearly twice line voltage on the tube.



the rectifier can be omitted.

One of these will be wired up to try on the printing presses of the Herald Examiner and the Christian Science Monitor.



$RC = .0200 \times .50 \times 10^6$   
 $= .02 \times .5 = .01 \text{ sec}$   
 100 flashes per sec  
 R can be 400 ohms or greater.

JAN 18 1940

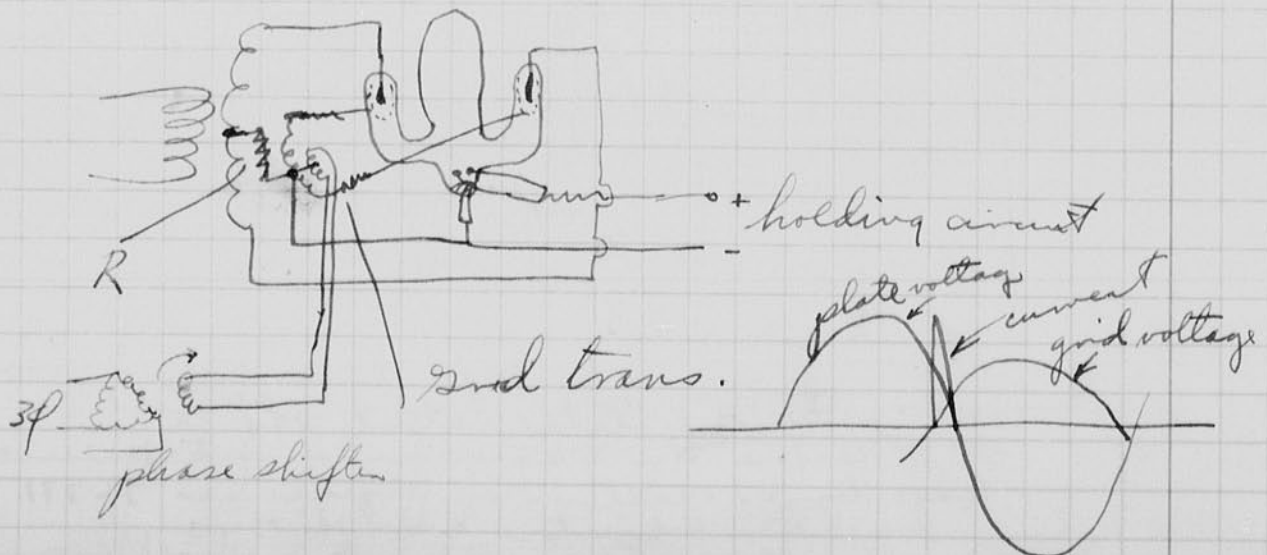
high ratio transformer  
 United States Patent Office  
 Before the Examiner of Interferences  
 Edgerton v. Miller - Interference 76771.  
 Edgerton Exhibit 10.  
 Page 69 of Edgerton notebook T-4; Oct. 25, 1931  
 January 2, 1940  
 Clara Schlosky - Notary Public

Oct. 25, 1931

H.S. Edgerton As I recall, my first stroboscope experiments were as described below. I first noticed the stroboscopic effect when taking voltage-angle curves on a twenty amp pool type thyatron. These experiments are described in my note book, "thy I" pages 4 to 26. dated 10-13-1927 to Dec 31, 1927. The light of the tube showed the blades of an electric fan which was keeping the tube cool. No mention of this was made at this time but I used the idea for a display at the "open house" demonstration in the spring of 1928.

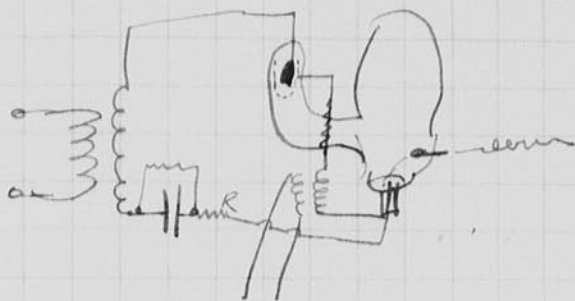
Several discs were made which had different numbers of ~~squares~~ equally divided sections. These appear to move in different directions or at different velocities when the ~~xxx~~ speed <sup>of the disc</sup> is changed.

I first used a circuit where the phase of the grid voltage was about 180 degrees out of phase with the anode voltage. A resistance load was used such that considerable current would flow.



cont.

To give a higher peak current a condenser was used. A leak was put across the condenser so that it would discharge between flashes!



R was made very small for this circuit and a very quick flash was obtained of good light intensity.

Mr. J. Gardner, Dr. V. Bush, Mr. Kershaw (mechanic), T. S. Gray, Marvin Dixon and others saw this operate and understood the circuits.

Paul Fourmarier and the writer upon the pulling-into-step transients of synchronous motors.

- Dec. 17, 1930. T-1 page 70. Double ended stroboscope for 120 cycle light from 60 cycle power.
- Dec. 21, 1930. T-1 page 71. Shutterless motion picture cameras and projectors with continuously moving film. Stroboscopic light to take motion pictures in color.
- Jan. 19, 1931. T-1 page 74. Demonstration of the thyatron stroboscope for the popular science lectures by Prof. E. L. Bowles. Carl Neitzert aided in this demonstration. Stroboscopic methods of printing telegrams by frequency and by phase.
- Jan. 28, 1931. T-1 page 78. Stroboscopic switching relay to pull salient-pole motors into step by applying the field current at the most favorable angle.
- Feb. 5, 1931. T-1 pages 81-83. Variable frequency stroboscope circuits.
- March 9, 1931. T-1 page 94. A-c. operated variable frequency stroboscope for Killian to show at the M.I.T. Alumni banquet.
- May 23, 1931. T-1 page 112. Use of small stroboscope circuit to start a large tube by means of a sudden high voltage.
- May 31, 1931 to Oct. 26, 1931.  
 Notebook T-1 page 118 to end of the book.  
 S-3 pages 83-89, 102-103, 107-109, 112-113.  
 T-2 pages 2-71  
 Development of stroboscope tubes and circuits to drive them.

SUMMARY OF RECORDS AND DATES  
OF WORK DONE ON THE MERCURY-ARC STROBOSCOPE.

Oct. 26, 1931.  
Harold E. Edgerton.

Spring 1928. "Open house" demonstration with a thyatron mercury-arc stroboscope.

May 1929. Spring vacation spent developing stroboscope circuits using mercury-arc tubes. Records in notebook T-1 pages 32 - 37.

June 3, 1929. T-1 page 56. Agreement with the General Electric Company regarding patents when entering their research laboratory for the summer. The following reserved invention was listed in this agreement.  
"Stroboscope - a device using an electrical circuit including a mercury-arc lamp, for observing moving objects."

June 6, 1929. T-1 page 57. The circuits shown on this page were given to the G. E. Patent Department at their request.

April 5, 1930. T-1 pages 30-31. Thyatron stroboscope circuit driven by a beat frequency oscillator.

April 21, 1930. T-1 page 39. An a-c. operated stroboscope with a tube having an external starting connection.

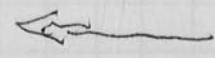
Spring 1930. T-1 page 43 and S.M. thesis by Seardsley. Circuits to operate a Cooper-Hewitt mercury-arc lamp as a stroboscope.

August-September 1930. T-1 pages 44-45. Work on the thyatron stroboscope for the New England Power Ass'n. Went to the fifteen mile falls plant with the apparatus on September 4 and arranged it to measure the angle of generator No. 2. Returned a second time on the 12th of September with Mr. W. L. Sullivan.

Sept. 30, 1930. T-1 page 48. Thyatron stroboscope for 120 cycle flashes from 60 cycle power.

Oct. 24, 1930. T-1 page 54. Photographie tests of the thyatron by Hugh Spencer and Lyman Thurston.

Dec. 6, 1930. T-1 page 65 and S-3 page 51. Stroboscopic motion pictures of the substation generator taken by Henry Lane. These were shown in New York at the A.I.E.E. Convention to illustrate a paper by





Oct 26, 1931.  
 J. S. Edgerton.

Showed Prof. D. C. Jackson my notebooks regarding the stroboscope developments.

Oct. 27, 1931. In the evening Gerneshauer and I made some tubes. We tried one with an internal starting connection. It did not work very well. The external connection is apparently best. Another tube with a filament had a hole in the glass and was U. G. A tube of this form was made of glass,



~~made~~ neon tube glass. It was pumped a while and sealed off. It does not start well. I hope to either repump it or build another.

Oct. 28, 1931. Started to rebuild the quartz section tube. Last week Wulf and Brian in the physics dept took some spectrograms of the light. Stockberger also tried to get some time strobograms but the tube went gassy before these were taken.

Oct. 29, 1931. Worked in aft with Gerneshauer on various circuits. Results discussed in his notebooks. We tried a tube with a filament in the bottom. The filament apparently has no effect except to heat the tube.



Wired up a pair of UX 281 on a 650 volt winding (each side of center tap). It makes a very good power supply.

Hope to try a tube with a filament  
and a holding anode.

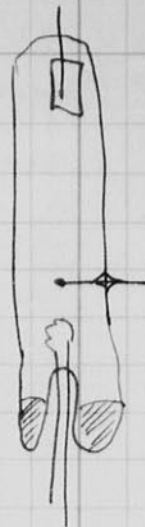
Oct 30 1931.

A new Experiment Bearing  
on Cosmic Ray Phenomena.

L. M. Mott Smith and  
G. L. Locher.

The Rice Institute

Sept. 4, 1931. Read.



P 1402 - mentions mercury flash lamp.

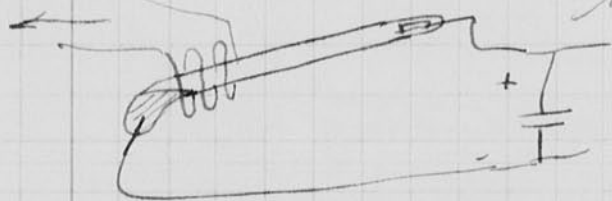
Nov. 2, 1931

Haynes called regarding a  
magazine wrapper. (Prof. Smith)

Yesterday missed Blake and... from Lucas table.

Germeshausen and I tried an experiment  
to see if a high frequency field around the tube  
would start the flash. We used the spark  
bombardier as a source of high freq. It worked  
alright except 120 cycles  
was too fast for our  
power supply on  
the discharge tube.

to bombardier



Germeshausen  
is wiring up a V4210  
as an oscillator to  
see if it will trip the  
tube.

Nov. 3, 1931. Spent aft and evening making U shaped  
stroboscope tubes. We are trying to decide on  
the proper amount of gas to put in these  
tubes.

Mr. Blake and Mr. Jones of the Saco Lowell  
shops came over in the afternoon and we demonstrated  
to them the variable freq stroboscope (top left  
picture p 44). Circuit glued in top page 21. Some  
minor changes have been made in the circuit  
since this wiring diagram was made. Germeshausen and I  
plan to go thro their Newton plant next Monday afternoon to  
demonstrate the stroboscope.

Nov. 4, 1931.

H. E. Edgerton

In the afternoon Gemushausen and I went over to the Metropolitan Theater to see Mr. Thurston. We went to invite him over to Tech to see our stroboscopic display. It is possible that he will come to Boston next Sunday with another man to see the stuff that we have to show. While there with him Mr. Hall came in regarding his U.V. light.

Mr. Thurston gave us an autographed book of his life on the stage ~~as a magician~~ "My Life of Magic".

Nov. 5, 1931. Gem worked on a circuit that ~~he~~ he is trying to get together. It is a small outfit with a 60 cycle and variable speed arrangement. The ~~mechanical~~ parts are all radio parts except the thyatron which is an F. G. - 17. Started Reid wiring up a 60 cycle stroboscope for the dynamo lab. Pumped a tube for him today.

Made a date with Draper to go over to the Boston airport next Saturday night to look at propellers with the stroboscope.

Gemushausen's ideas regarding a disc and a wheel to get a variable speed for the stroboscope is great. The disc can be driven by a synchronous motor and thus the speed can be accurately determined if the diameter of the small wheel and its distance from the center are known.

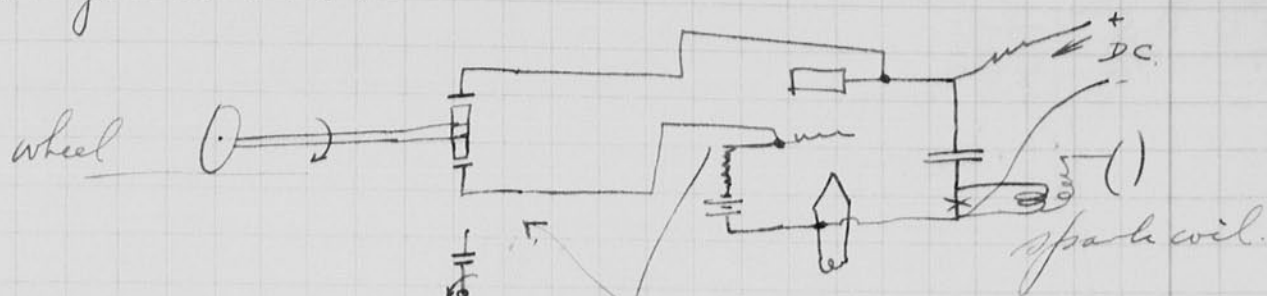


$$\text{Speed of disc} = N \text{ r.p.m.}$$

$$\text{speed of wheel} = \frac{(2\pi a)}{2\pi D} N \text{ r.p.m.}$$

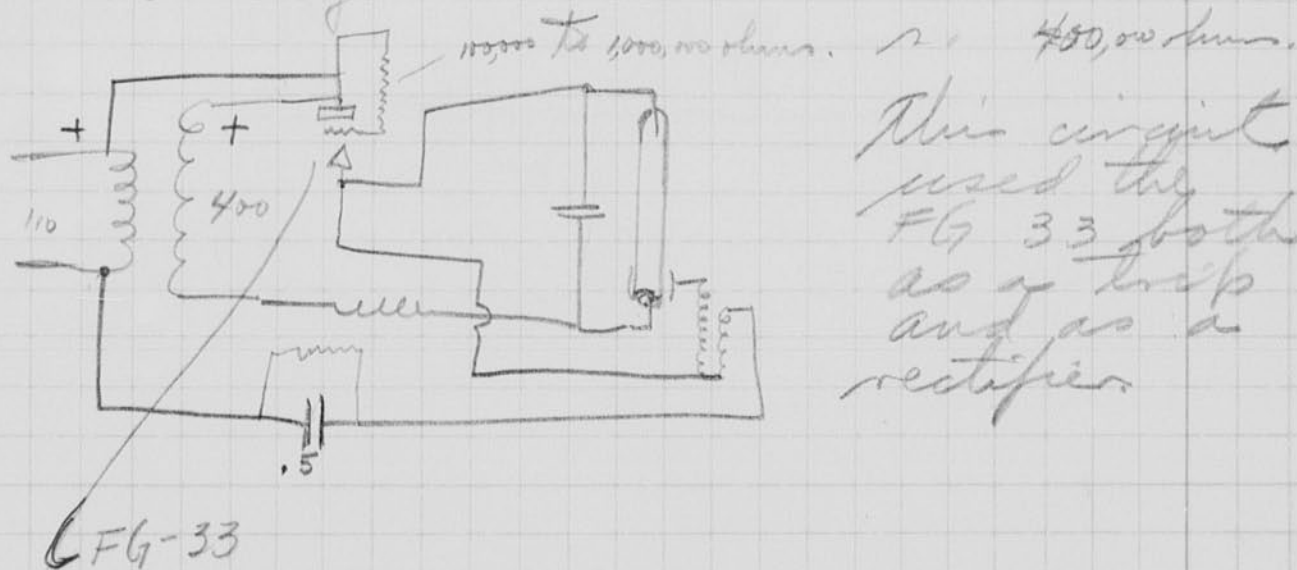
$$= \frac{a}{D} N \text{ r.p.m.}$$

We can probably get enough current out of a capacity to trip a vacuum tube or a thyatron.

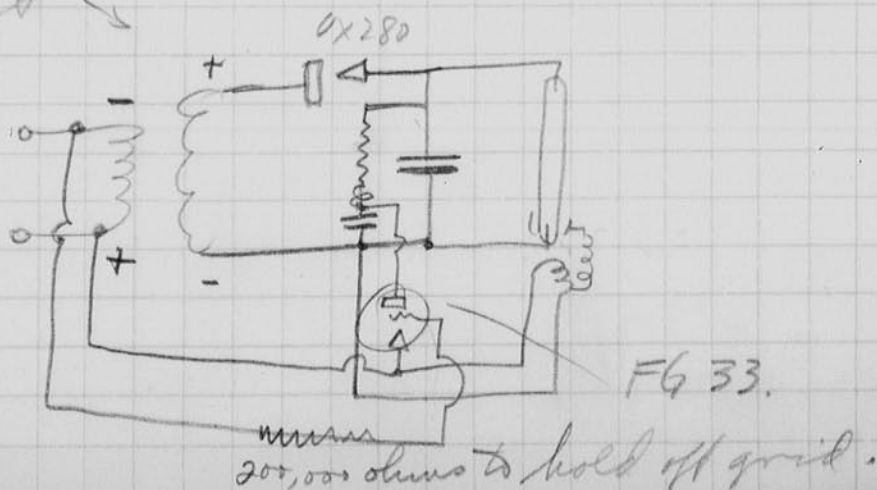


when the unsymmetrical part gets in this position it puts enough charge on the grid to raise its potential enough to start conduction. In this way no mechanical connection is needed.

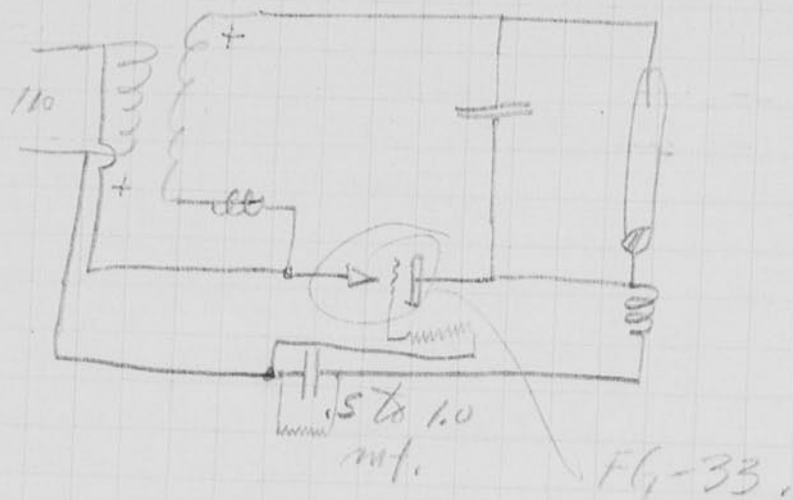
Nov. 6, 1931. Just received a letter from H.A. Sherman with data upon the operation of thyatrons. The FG 33 requires considerable grid current to start and this may be used as its own thermal relay.



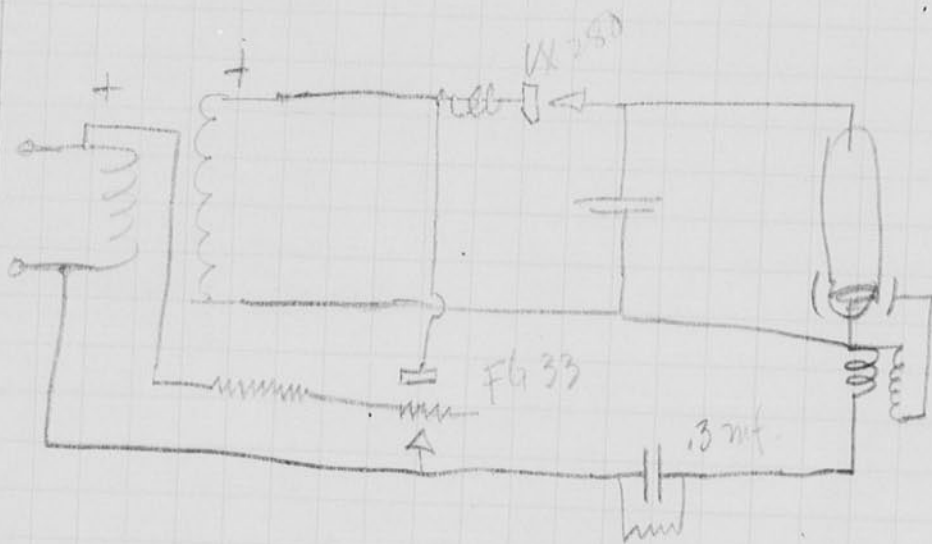
old circuit



Nov 6 1951 Cont.



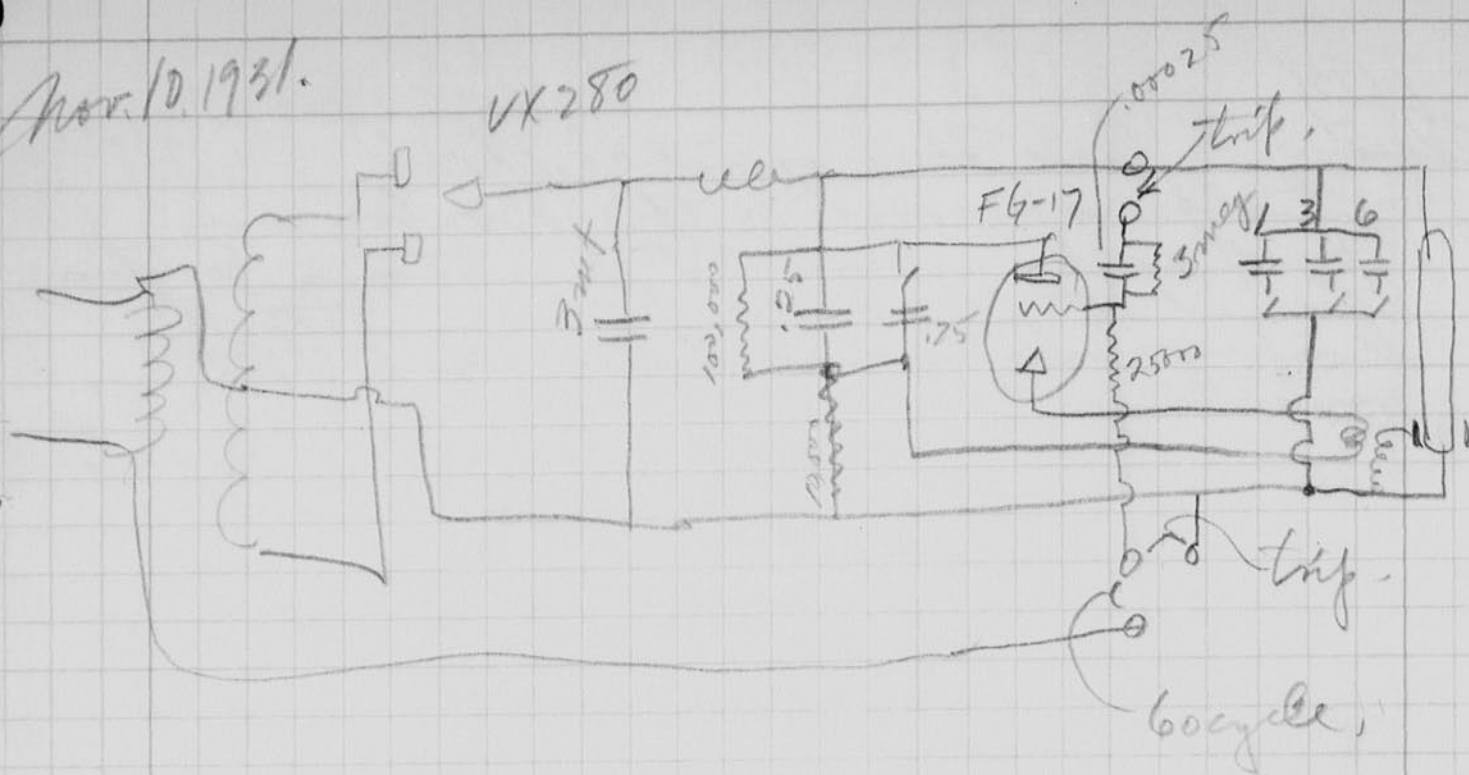
F6-33.



Nov. 7 1931

W. Edgerton. Took the variable speed  
stroboscope out to the Boston air  
port and looked at airplane propellers.  
Looked at Harris's plane. Stan K  
Drapers was there and arranged the  
meetings.

Nov. 10, 1931.



A copy of the above circuit was given to me, Dec. 10, 1931 by H. E. Edgerton for my personal use in operating an experimental apparatus for stroboscopic purposes in a particular research problem.

H. Hugh Willis

The experimental model of the stroboscope which was loaned to Willis was built by Kenneth Gerneshausen last week. We let Willis have it for two months for 200 rent. He is going to use it for research on gyroscopes.

h  
 Notebook # July 20, 1931 - Jan 12, 1932

No. 2.

### Filming and Separation Record

\_\_\_ unmounted photograph(s)

\_\_\_ negative strip(s)

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

was/were filmed where originally located between page 80 and 81.

Item(s) now housed in accompanying folder.



60 eye.

OUT 15

240

14

2571

13

2769

12

300

IN 11

3272

10

300

9

400

8

450

7

514.7

6

600

5

720

4

900

3

1200

2

1800

10

1800

2000

3000

4000

1650

1449

1601

1631

1000

REPRODUCTION OF THIS DOCUMENT IS PROHIBITED

Nov. 11, 1931.  
 H.E. Edgerton

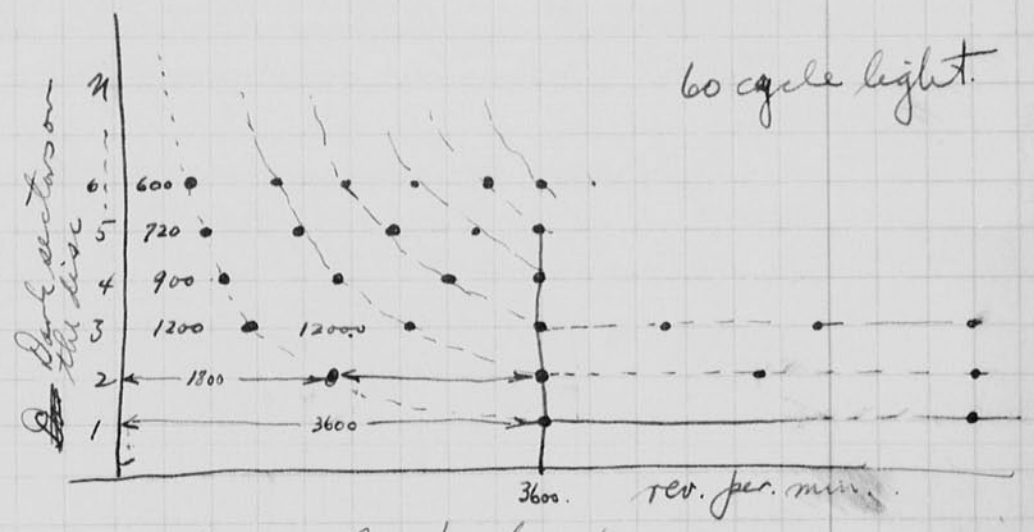
"The Rotating Sected Disc." B.W. Bartlett.  
 Bowdoin College, Brunswick, Maine.

The Review of Scientific Instruments. Vol 2. new Series No 2.  
 page 96.

(Linckh and Vieweg *Zt. v. Instrumentenkunde*,  
 46, 30; 1926, Linckh and Vieweg; *Archiv f.*  
*Elektrotechnik*, 15, 509; 1926.)

Bartlett expresses the reflecting power as a function of the angle in a Fourier series. This is multiplied by the intensity (expressed as a Fourier series in time) to get the resulting effect to the eye. A very interesting article.

For the determination of speed of a rotating disc from a 60 cycle source I believe the following method is useful. This is described on page 35 and 36 to some extent.



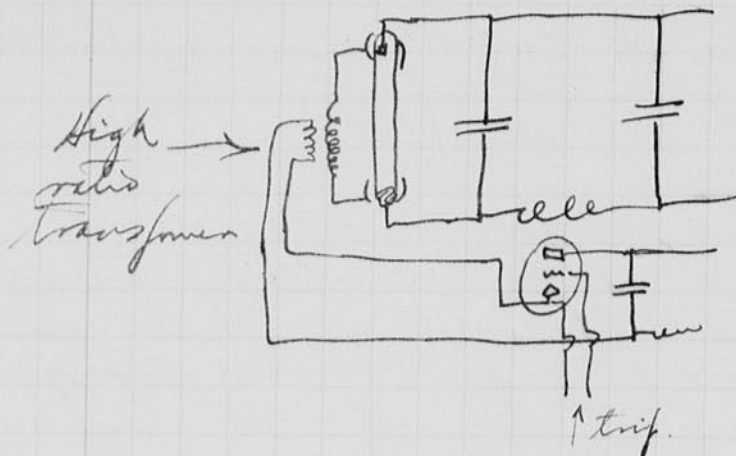
A distinguishing mark can be put upon one sector and this can be made to show if the disc is at synchronous speed or some fraction of multiple. Numbers also on the discs.

$n =$	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
of sync speed =	3600	1800	1200	900	720	600	$\frac{514.2}{600}$	450	400	360	327.2	300	276.9	257.1	240.			

Abstract in "The Review of Sci Instruments" Vol 2 new Series No 2. p 143  
 A Stroboscopic Frequency Meter. L. B. Arguimbau  
 Gen. Rad. Exper. 5, 5-7, Nov. 1930.  
 Technical Practice in Light Production in the light of modern atomic theory  
 and Atomic Physics M. Pirani, *Physik Z.* 31, 1078-1079 Dec. 1930.

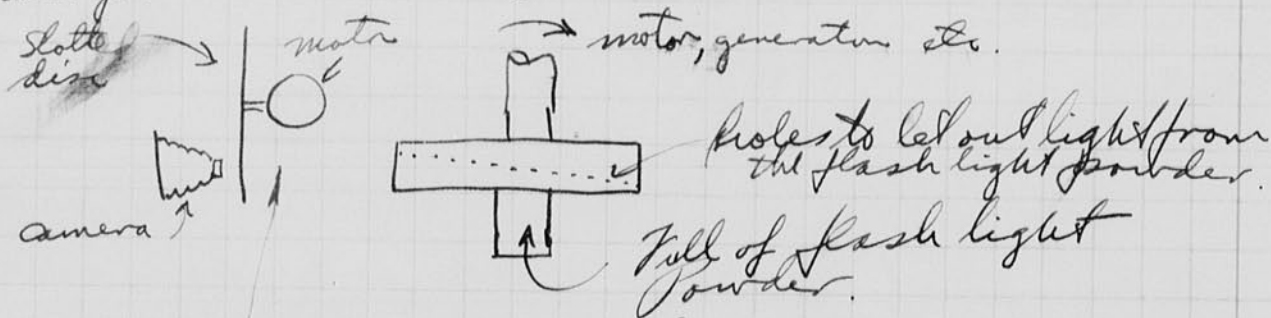
Nov. 12, 1931.

The spark which starts the mercury arc might be more effective if connected as shown below.



"Der Strobograph" eine Vorrichtung zum Aufzeichnen von Pendeldiagrammen. G. Wagner (Wagner)  
 - Regierungshausmeister in Wiesbaden. -  
 Zeitschrift des Vereines deutscher Ingenieure.  
 Vol 50 December 1906 page 1989.

Shows scheme with ~~an arc lamp~~ a method of obtaining pictures of the angular displacement.

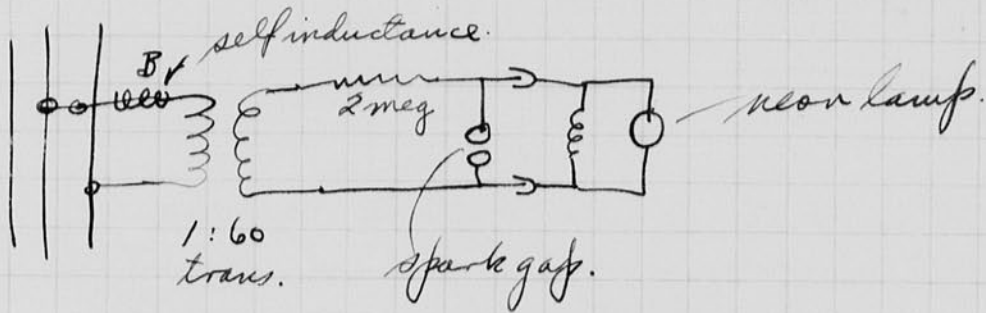


Run motor so that there is a slight difference in speed between the ~~disc~~ and the disc. Open camera and touch off the powder.

No. 13193.  
J. E. Edgerton

"Measurement of the Load angle of  
Synchronous Machinery"

J. C. Prescott and E. W. Connor Vol. 69. No 410  
February 1931 p 281.



Uses the stroboscope to get the Blondel  
reaction coefficients and to determine  
the reactance from the oscillation time.

E. E. Steinert "Neon-Electric Stroboscope"  
General Electric Review 1928 vol 31 p 136.

W. E. Bahls and D. D. Knowles. Electric Journal 28  
p 250 April 1931 (1594 also Sci).

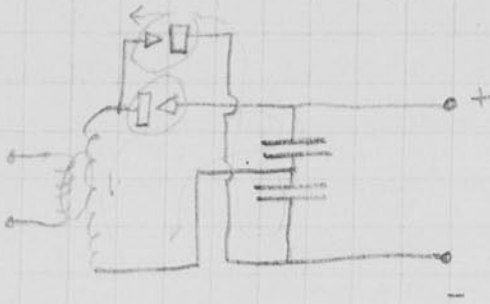
Miles Walker. The Diagnosis of troubles in  
Electrical Machines.

D. Robertson tuning fork with slots  
C. V. Drysdale tuning fork sparks coil and  
neon lamp.

Maserve and ~~Red~~ Ramadanoff - "A simple method  
of determining slip and torque angle of  
synchronous motors by means of the  
neon lamp. Sibley Journal of Engineering  
June 1927.

Standerwick. Gen. Elec Rev 33 p 566 Oct. 1930  
New form of Stroboscope -  
uses rotating prism.

Nov. 15, 1931. Parallel rectifier.



$$6600 \sqrt{2} = 9000 \text{ volts,}$$

$$2300 \sqrt{2} = 3200 \text{ volts.}$$

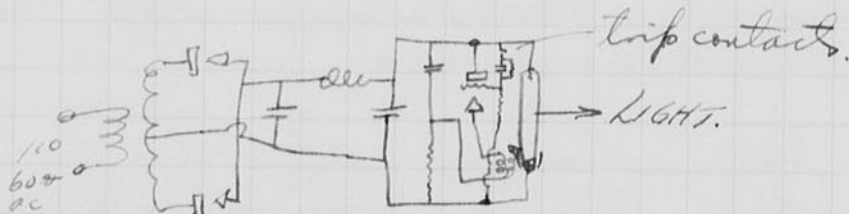
Nov-1931. Electronics  
V.K. Zworykin.

Nov. 21, 1931.

S.E. Edgerton. Pike of the Pussel Box company called on Tuesday morning and wanted the stroboscope that afternoon or the next day. He was anxious to get it since the purchasing agent of the S.E. was to be there then to see the factory.

Jameshausen built the outfit and put it in an iron box. We worked in the evening to complete it.

On Wednesday morning, Nov. 18, we took it out and installed it on one of the wrapper cutting machines. It worked very well. The circuit is below.



This ran all day. We left about 11 am.

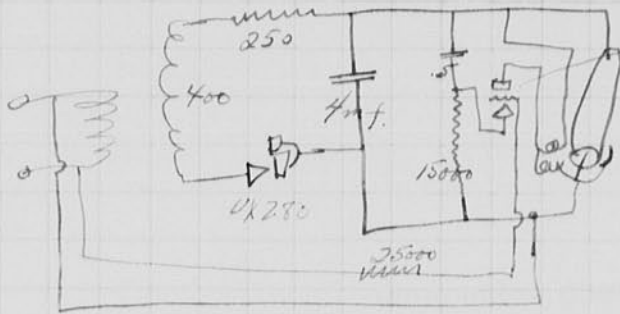
They changed wrapper stock on Thursday morning and in some way the stroboscope failed to work. Germ went out and fixed the outfit so it worked ok. The speed was considerably increased and the stroboscope worked fine.

The N. agent came in the morning and saw it work.

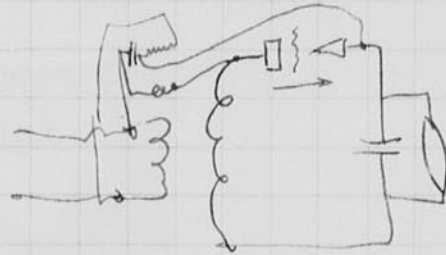
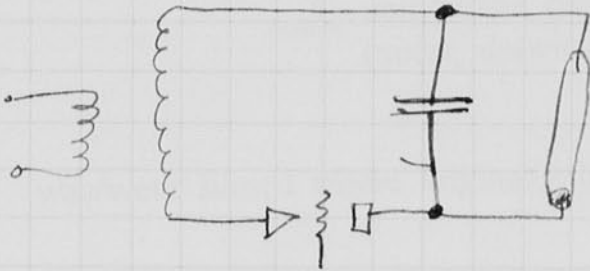
The stroboscope was used all day Friday. The girl operating the variable speed clutch did not mind the flashing light. She said it was easier to use the stroboscope than to use the old scheme.

I called Pike on Sat morning and he wants a quotation on the outfit.

Experimented with 60 cycle stroboscope  
on Sat. Used following circuit which



worked fine. Used both  
V tubes and  
straight tubes.



Spark Spectra of Hg.  
Bloch and Bloch.

Induced by high frequency fields  
external to the tube.

27  
Notebook # July 20, 1931 - Jan 12, 1932

### Filming and Separation Record

\_\_\_ unmounted photograph(s)

\_\_\_ negative strip(s)

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

was/were filmed where originally located between page 86 and 87.

Item(s) now housed in accompanying folder.



TABLEAU I.

INT.	$\lambda$	ARC			INT.	$\lambda$	ARC			
		A	ÉTINCELLE				A	ÉTINCELLE		
			E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>			E <sub>1</sub>	E <sub>2</sub>	E <sub>3</sub>
5	6 149,37		1			5		1		
2	23,48		1			1		1		
1	41°				3	1		1		
2	01°		1			2		1		
2	6 090°		1			1		1		
1	72,66	A				1		1		
1	59°		1			1		1		
2	46°			2		1		1		
1	32°		1			1		1		
2	25°			2		2		1		
2	17°		1			1		1		
1	5 994°		1			1		1		
1	82°				3	2		1		
1	71°		1			1		1		
2	62°		1			2		1		
1	56°				3	2		1		
1	49°		1			3		1		
1	44°				3	2				3
2	36°				3	2				3
1	19°		1			1		1		
1	11°		1			3		1		
4	5 888,79		1			2		1		
1	80,5				3	2		1		
4	71,30		1			3		1		
1	64,4		1			3		2		
2	54,5		1			3		1		
1	40,6		1			3		1		
2	34,0				3	1		1		
3	17,5?		1			1		1		
1	04,3				3	1		1		
2	5 799°		1			3		1		
5	90,66	A				2		1		
2	81,9				3	4		1		
5	69,60	A				1		1		
3	46,6			2		1		1		
4	28,12			2		1				3?
1	17,0				3?	1		1		3?
1	07,7°				3?	1		1		
3	5 699,0		1			2		2		
5	77,15		1			1		1		
2	66,37			2		1				3?
2	62,01			2		1				3
3	37,71			2		2		1		
4	5 595,34		1			1		1		
1	87,9				3?	4		1		
1	76,2				3?	2		1		
3	71,00			2		1		1		
1	64,6°		1			1		1?		
1	53,6		1			1		1?		
3	40,95			2		3		1		
1	13,4		1			2				3
1	01,4		1			1		1		
1	90,0		1			1		1		
1	84,6		1			1				2
1	76,3		1			1				2
5	5 460,74	A				1		1		
2	50,15			2		1				2
1	43,2		1			2		4		2
1	36,5		1			1		1		1
1						1		1		

ARC			ÉTINCELLE			ARC			ÉTINCELLE		
A			E <sub>1</sub> E <sub>2</sub> E <sub>3</sub>			A			E <sub>1</sub> E <sub>2</sub> E <sub>3</sub>		
INT.	λ		INT.	λ		INT.	λ		INT.	λ	
1	16,86		3	16,27		3	16,27		1	88,62	
1	04,09		4	09,5*		4	09,5*		1	06,70	
1	00,49		1	04*		1	04*		3	03,15	
1	3 396,31		2	2 899*		3	2 899*		3	2 599,50	
2	92,40		3	93,61		3	93,61		1	98,45	
2	86,99		1	86,90		1	86,90		3	84,74	
2	81,09		4	84*		4	84*		1	80,5*	
1	77,5		3	82,60		3	82,60		3	78,91	
1	70,12		1	75*		1	75*		1	76,31	
1	66,36		4	73,24		4	73,24		2	74,86	
3	62,85		1	66,17		1	66,17		3	71,75	
2	58,57		2	59*		2	59*		3	63,90	
1	55,1*		3	56,97		3	56,97		1	61,18	
1	51,10		4	52,41		4	52,41		1	57*	
1	44*		4	47,67		4	47,67		1	53*	
3	41,48		4	48*		4	48*		2	48,56	
1	33,1*		1	40*		1	40*		1	43*	
4	30,68		3	36,84		3	36,84		2	41,5*	
2	29,5*		3	33,53		3	33,53		4	36,52	
1	27,1*		2	27,97*		2	27,97*		1	27*	
1	26,0*		1	24,8		1	24,8		4	24,8	
1	21,8*		1	22,8		1	22,8		1	21,8	
1	20,52		1	21,15		1	21,15		1	14,2	
1	19,3*		1	18,40		1	18,40		1	14,2	
1	18,3*		1	17,71		1	17,71		1	14,2	
1	17,3*		1	16,93		1	16,93		1	07*	
1	15,7*		1	15,78		1	15,78		1	03*	
1	12,1*		1	14,93		1	14,93		1	03*	
1	07,1*		1	13,80		1	13,80		1	03*	
1	03,4*		1	12,33*		1	12,33*		1	03*	
3	298,7*		1	11,41		1	11,41		1	03*	
2	95,2*		1	10,6		1	10,6		1	86*	
2	90,1*		1	9,97		1	9,97		3	86*	
2	86,2*		1	9,78		1	9,78		3	86*	
1	81,4*		1	9,80		1	9,80		3	86*	
1	77,89		1	9,37		1	9,37		3	86*	
1	75,1*		1	9,33*		1	9,33*		3	86*	
1	71,9*		1	9,29*		1	9,29*		3	86*	
1	69,4*		1	9,24*		1	9,24*		3	86*	
1	64,06		1	9,15		1	9,15		3	86*	
2	57,5*		1	9,08		1	9,08		3	86*	
2	52,0*		1	9,05		1	9,05		3	86*	
2	50,9*		1	8,97		1	8,97		3	86*	
2	46,9*		1	8,85		1	8,85		3	86*	
3	41,2*		1	8,80		1	8,80		3	86*	
1	39,4*		1	8,73		1	8,73		3	86*	
1	38,5*		1	8,73		1	8,73		3	86*	
1	35,3*		1	8,73		1	8,73		3	86*	
1	30,7*		1	8,65		1	8,65		3	86*	
1	27,89		1	8,59		1	8,59		3	86*	
1	25,9*		1	8,54		1	8,54		3	86*	
1	24,0*		1	8,50		1	8,50		3	86*	
1	19,0*		1	8,48		1	8,48		3	86*	
1	15,1*		1	8,47		1	8,47		3	86*	
1	12,0*		1	8,47		1	8,47		3	86*	
2	08,20		1	8,42		1	8,42		3	86*	
1	03,2*		1	8,39		1	8,39		3	86*	
1	00,8*		1	8,37		1	8,37		3	86*	
1	00,8*		1	8,35		1	8,35		3	86*	
1	00,8*		1	8,33		1	8,33		3	86*	
1	00,8*		1	8,31		1	8,31		3	86*	
1	00,8*		1	8,29		1	8,29		3	86*	
1	00,8*		1	8,27		1	8,27		3	86*	
1	00,8*		1	8,25		1	8,25		3	86*	
1	00,8*		1	8,23		1	8,23		3	86*	
1	00,8*		1	8,21		1	8,21		3	86*	
1	00,8*		1	8,19		1	8,19		3	86*	
1	00,8*		1	8,17		1	8,17		3	86*	
1	00,8*		1	8,15		1	8,15		3	86*	
1	00,8*		1	8,13		1	8,13		3	86*	
1	00,8*		1	8,11		1	8,11		3	86*	
1	00,8*		1	8,09		1	8,09		3	86*	
1	00,8*		1	8,07		1	8,07		3	86*	
1	00,8*		1	8,05		1	8,05		3	86*	
1	00,8*		1	8,03		1	8,03		3	86*	
1	00,8*		1	8,01		1	8,01		3	86*	
1	00,8*		1	7,99		1	7,99		3	86*	
1	00,8*		1	7,97		1	7,97		3	86*	
1	00,8*		1	7,95		1	7,95		3	86*	
1	00,8*		1	7,93		1	7,93		3	86*	
1	00,8*		1	7,91		1	7,91		3	86*	
1	00,8*		1	7,89		1	7,89		3	86*	
1	00,8*		1	7,87		1	7,87		3	86*	
1	00,8*		1	7,85		1	7,85		3	86*	
1	00,8*		1	7,83		1	7,83		3	86*	
1	00,8*		1	7,81		1	7,81		3	86*	
1	00,8*		1	7,79		1	7,79		3	86*	
1	00,8*		1	7,77		1	7,77		3	86*	
1	00,8*		1	7,75		1	7,75		3	86*	
1	00,8*		1	7,73		1	7,73		3	86*	
1	00,8*		1	7,71		1	7,71		3	86*	
1	00,8*		1	7,69		1	7,69		3	86*	
1	00,8*		1	7,67		1	7,67		3	86*	
1	00,8*		1	7,65		1	7,65		3	86*	
1	00,8*		1	7,63		1	7,63		3	86*	
1	00,8*		1	7,61		1	7,61		3	86*	
1	00,8*		1	7,59		1	7,59		3	86*	
1	00,8*		1	7,57		1	7,57		3	86*	
1	00,8*		1	7,55		1	7,55		3	86*	
1	00,8*		1	7,53		1	7,53		3	86*	
1	00,8*		1	7,51		1	7,51		3	86*	
1	00,8*		1	7,49		1	7,49		3	86*	
1	00,8*		1	7,47		1	7,47		3	86*	
1	00,8*		1	7,45		1	7,45		3	86*	
1	00,8*		1	7,43		1	7,43		3	86*	
1	00,8*		1	7,41		1	7,41		3	86*	
1	00,8*		1	7,39		1	7,39		3	86*	
1	00,8*		1	7,37		1	7,37		3	86*	
1	00,8*		1	7,35		1	7,35		3	86*	
1	00,8*		1	7,33		1	7,33		3	86*	
1	00,8*		1	7,31		1	7,31		3	86*	
1	00,8*		1	7,29		1	7,29		3	86*	
1	00,8*		1	7,27		1	7,27		3	86*	
1	00,8*		1	7,25		1	7,25		3	86*	
1	00,8*		1	7,23		1	7,23		3	86*	
1	00,8*		1	7,21		1	7,21		3	86*	
1	00,8*		1	7,19		1	7,19		3	86*	
1	00,8*		1	7,17		1	7,17		3	86*	
1	00,8*		1	7,15		1	7,15		3	86*	
1	00,8*		1	7,13		1	7,13		3	86*	
1	00,8*		1	7,11		1	7,11		3	86*	
1	00,8*		1	7,09		1	7,09		3	86*	
1	00,8*		1	7,07		1	7,07		3	86*	
1	00,8*		1	7,05		1	7,05		3	86*	
1	00,8*		1	7,03		1	7,03		3	86*	
1	00,8*		1	7,01		1	7,01		3	86*	
1	00,8*		1	6,99		1	6,99		3	86*	
1	00,8*		1	6,97		1	6,97		3	86*	

H. E. EDGERTON  
H-210  
M.I.T.



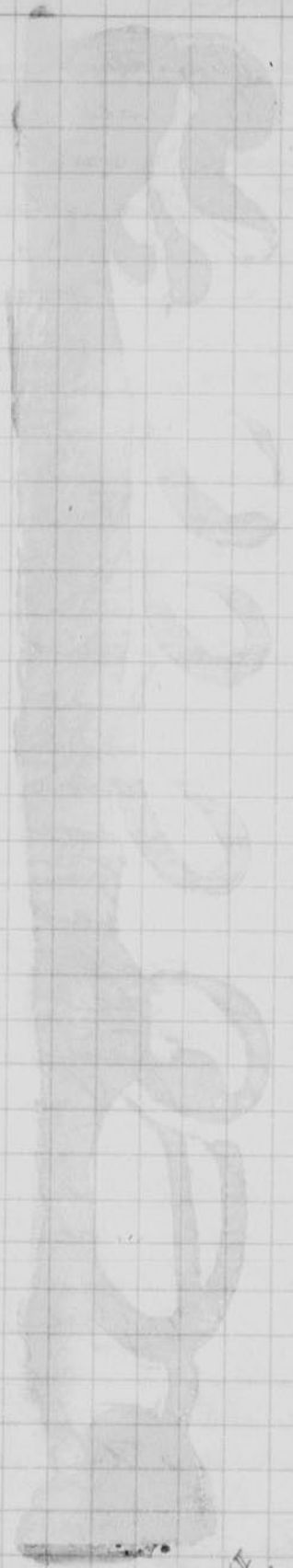
H. E. EDGERTON

M.I.T. 4-210.



H. E. EDGERTON

M.I.T. 4-210



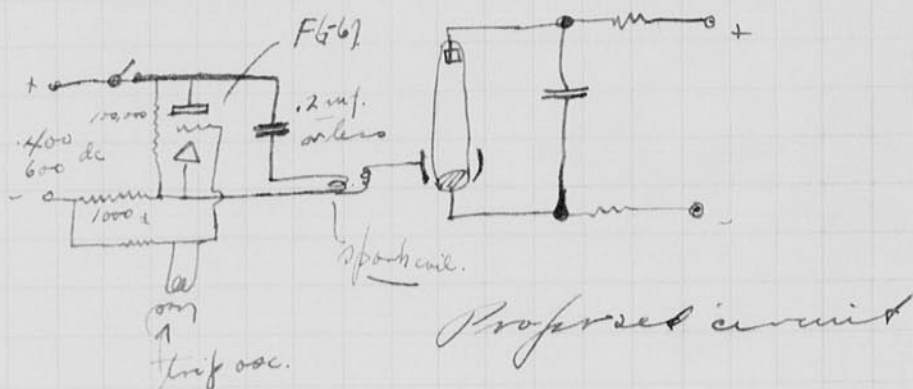
1.86	2.25	2916.1 IV
1.21	31.8	2925.4 A
1.605	42.2	2935.8 II
1.74	46.7	2940.3 II
1.79	47.0	2940.6 II
2.04	53.6	2942.2 II
2.34	61.4	2955.0 II

$\frac{23.00}{2.25} = 10.22$

$\frac{2967.28}{2853.6} = 1.04$

Nov. 24, 1931  
H.E. Edgerton.

I tried to operate the large thyatron which Dr. Hull of the S.E. loaned us for the diesel spray experiments but it has trouble with the filament. As the filament heats it expands and short circuits.



C.S. Draper of the aero Lab came over in the afternoon with his continuously moving film camera. Gemma has brought in the stroboscope that he has been building and we ran the frequency up to 600 cycles per second. Sufficient light was obtained to get a shadow photograph but not a reflected photograph.

Draper is going to fit the camera with a light valve arrangement to time the flashes so that they will occur at the proper time to be framed properly. A photo cell will get impulses from a head light bulb through small holes spaced the same as the movie frames.

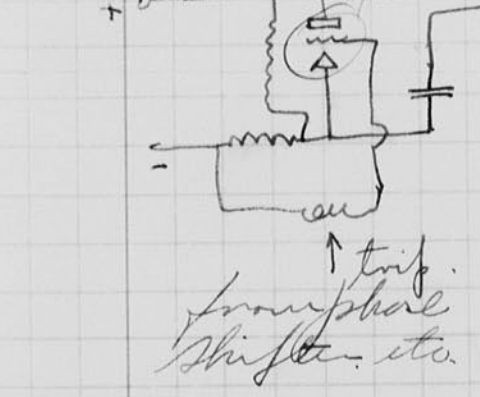
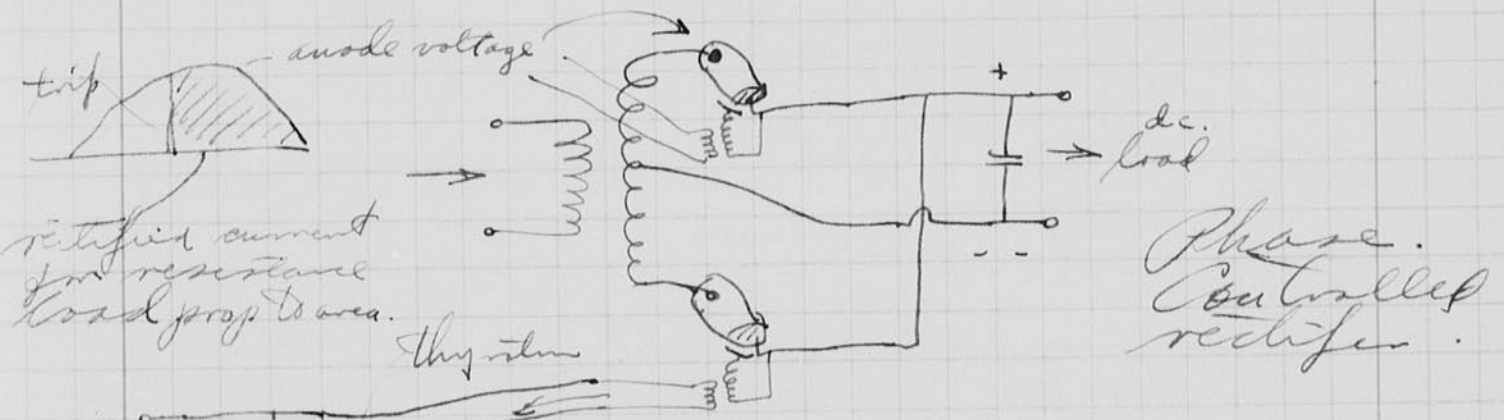
Gemma and I tried to make some tubes in the evening but they both went bad. The oven got too hot and melted them.

Nov 26/1931  
H. Skyring

# External Starting as a means of controlling an arc discharge.

Two element mercury arc tubes such as have been used for stroboscopes may also be used for controlled rectifiers or ~~or~~ inverters. The starting of the spot by means of applying a large voltage suddenly may have some advantages over other schemes using internal grids which only control the starting after the filament or mercury pool is ready to conduct.

External spot starting will undoubtedly enable a larger voltage to be used on the tubes since there is no holding arc or hot cathode.



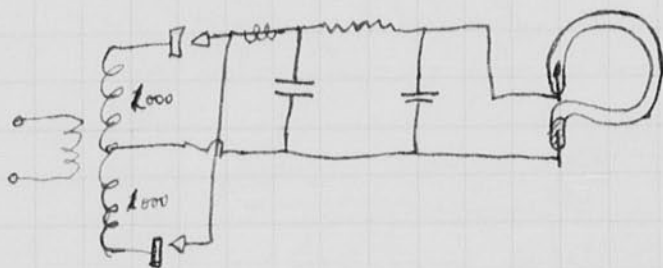
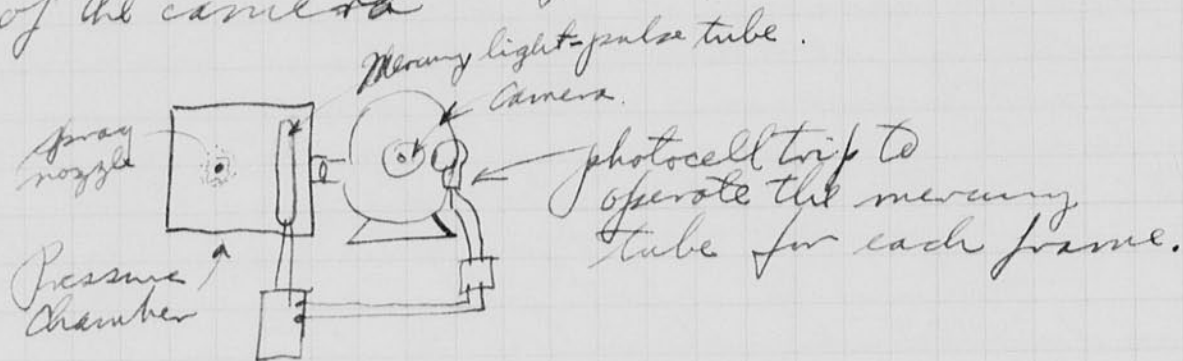
The trip causes the thyristor to discharge the small condenser through the spark coil which induces a large voltage on the external starter very quickly. This starts the spot and the anode commences to conduct. The arc will persist until the current tends to reverse and then will go out ~~and~~ It remains out until the high external starting voltage is again applied.



Nov. 29, 1931.  
H. S. Egerton

Yesterday Gemeshausen and I moved all our apparatus from the Dyn. Lab. to 10-588. This room will now be the Stroboscopic laboratory.

Talked to Taylor and Draper about the spray photographs. They want a circular tube to put around the lens of the camera.



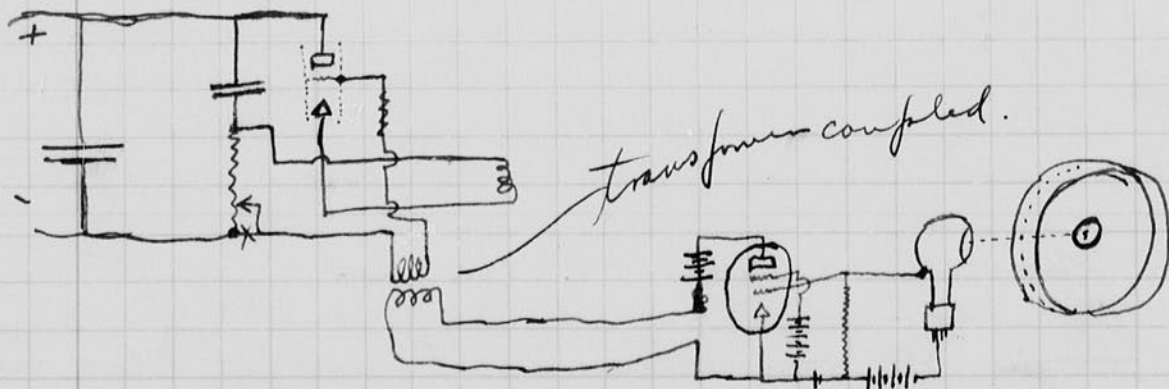
$$\frac{.200}{1.44 \times 1000} = .139$$

$$\left(\frac{CE^2}{2}\right) f = \text{power}$$

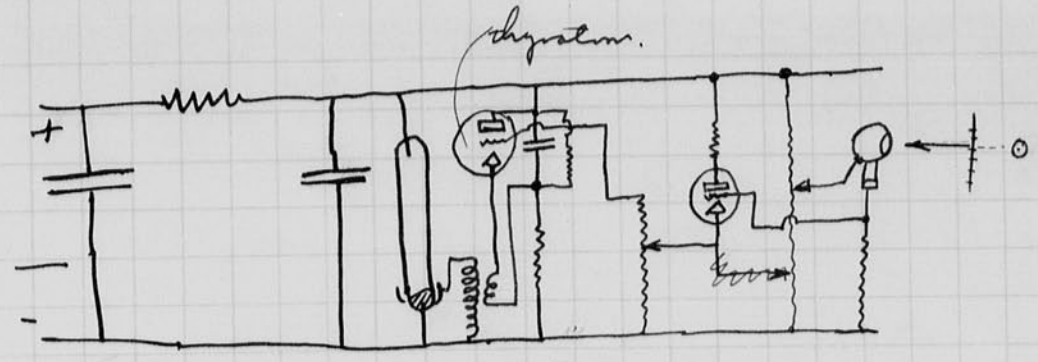
say 100 watts to the tube.

$E = 1200$	$E^2 = 1,440,000.$				
$f = 500$	$1600$	$2000$	$3000$	$4000.$	
$C = \frac{278}{100}$	$.139$	$.0693$	$.0463$	$.0347$	

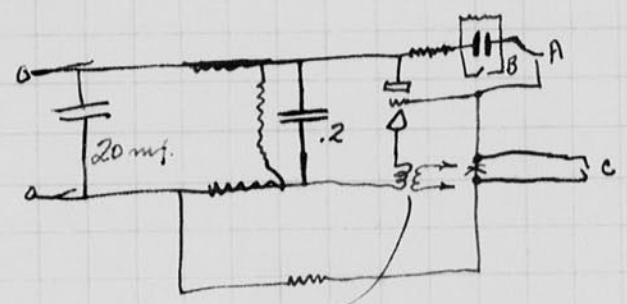
$$C = \frac{100 \times 2}{f \cdot 1.44 \times 10^6}$$



Cont.

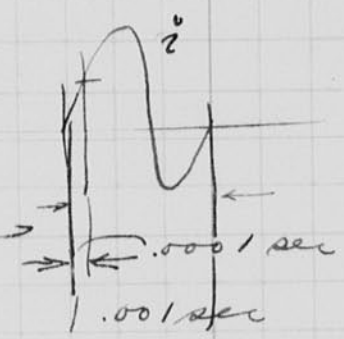


Sparkler.



Special spark coil.

.0001 sec.



.2 mf.

$$\tau = 2\pi\sqrt{LC} = <.001 \text{ sec.}$$

$$.001 = 2\pi\sqrt{.2 \times L} \times 10^{-3}$$

$$.001 = 2\pi\sqrt{.2 \times L}$$

$$\frac{1}{4\pi^2} = .2 \times L \quad L = \frac{1}{4 \times .2 \times \pi^2} = 0.14 \text{ henry.}$$

The primary inductance should be about 0.14h. or less.

$$I_{max} = E\sqrt{\frac{C}{L}} = 400\sqrt{\frac{.2}{.014}} \times 10^{-3} = \sqrt{1.4 \times .4} = .78 \text{ amperes.}$$

ratio  $\frac{5000}{400} = 10:1$

30,000 volts

Special spark coil.

Primary Inductance = .01 henry.

Let  $A = 1 \text{ cm.}$   
 $l = 6 \text{ cm}$   
 $N = ?$

$$.01 = L = \frac{N^2}{I} \times 10^{-8} = \frac{N^2 (4\pi N A)}{l} \times 10^{-8} = \frac{4\pi N^3 A}{l} \times 10^{-8} = 4\pi \frac{N^3}{6} \times 10^{-8}$$

$$N = \sqrt[3]{\frac{.01 \times 6}{4\pi}} = \sqrt[3]{\frac{.06}{4\pi}} = \sqrt[3]{\frac{.004776}{12.6}} = .069 \times 10^4 = 690 \text{ turns.}$$

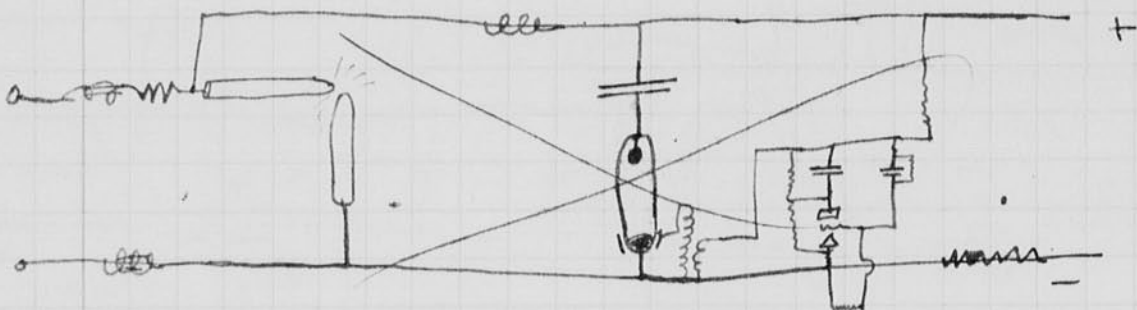
Secondary = 10,000 turns

Dec. 3/1931.  
H. E. Edgerton

Willis called from N.Y. yesterday and wanted another tube, which we sent him. The check from the Sperry Gyro Co came. Gemeshan and I made and exhausted 4 tubes on Tuesday evening. We now pump the tubes as hard as possible and bake them well during the process as well as bombard them.

Quinben is going to take a variable frequency stroboscope out to the Waltham Watch Co. over the weekend.

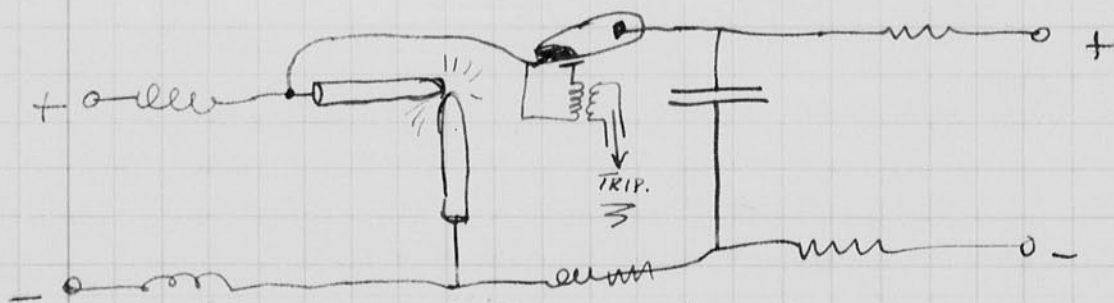
### Arc Intensifier



200 volts  
24 flashes per second.  
Energy = 400 watts

$$\frac{CE^2}{2} \times f = \text{Power} = 400 = \frac{C \cdot 200^2}{2} \times 24$$

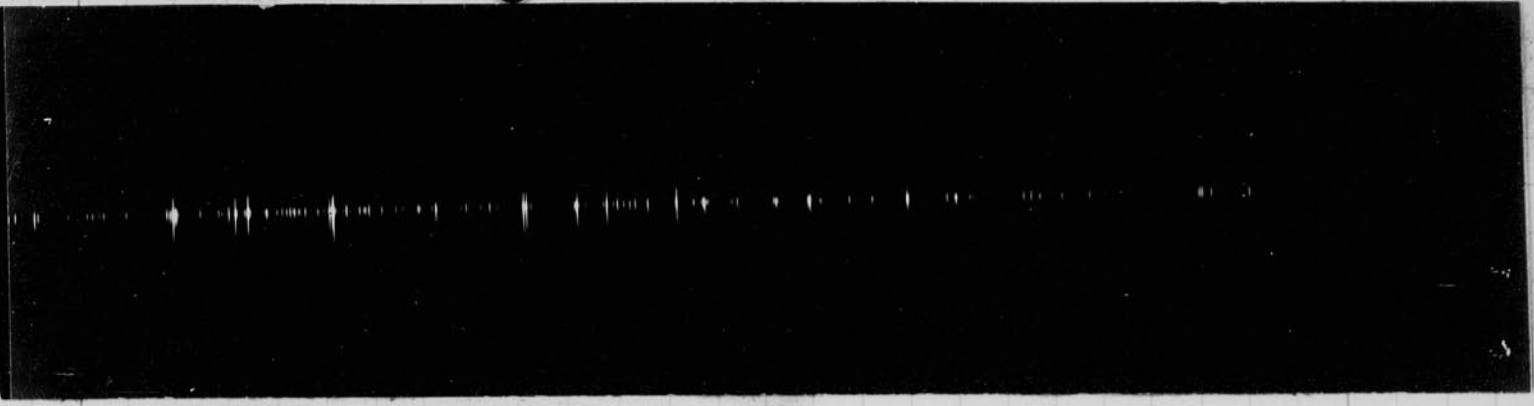
$$C = \frac{400 \times 2}{200^2 \times 24} = \frac{1}{60000} = 1.66 \text{ m.f.}$$



This could be used on motion picture projectors. The thyatron would get an impulse when the shutter was open and it would discharge the small condenser, in turn causing the large tube to conduct and put the energy through the arc.

Dec. 7 1931.

Red → visible → blue → U.V.



Spectrogram taken by Prof. Stastebarger.  
Mercury arc stroboscope.  
Quartz section

He showed us a neon strobo.

On Sat. afternoon I went over to  
Came's apartment in Brookline with  
Bernes Hansen. We tried to take some  
flash exposures with Came's cooper Hewlett  
Arc lamp. The experiment were a  
failure.

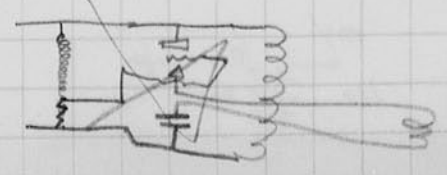
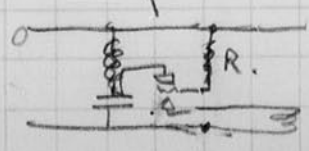
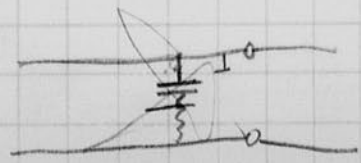
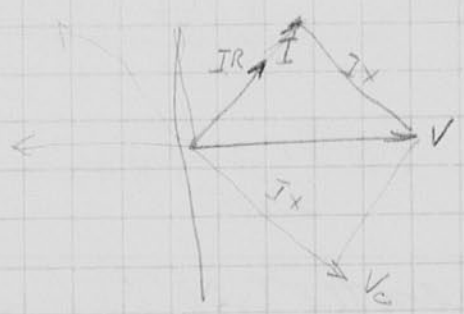
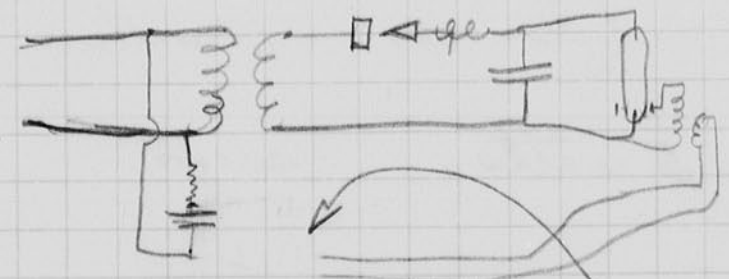
Tuesday Dec. 8 1931

Edyent & Bernes Hansen - Pumped tubes.  
Made 4 tubes.

Thursday Dec. 10 1931 Gave 7 min speech

to the EE Dept and graduate student. Demonstrated  
strobo and showed movies.

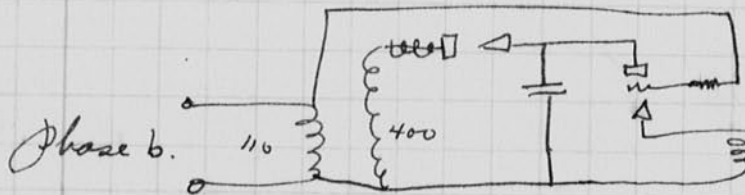
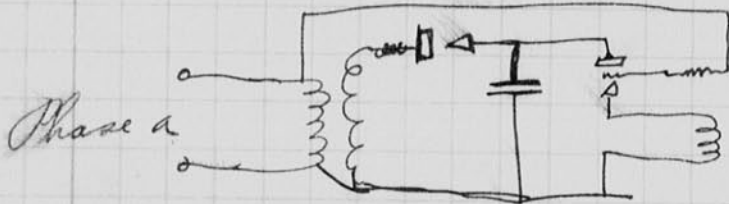
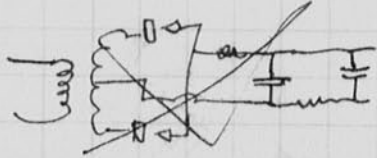
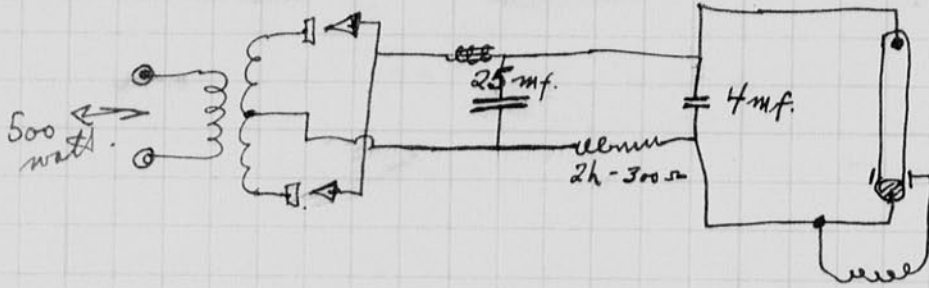
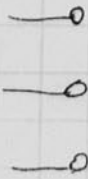
Circuit for 60 cycle strobe for the  
lab. Only one ~~resistor~~ circuit has  
rectifier.



Saw trouble at Kennell's gun  
on Wednesday aft Dec 9 1931.

Dec 11, 1931.  
A. E. Edgerton.

Three phase strobo.

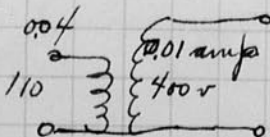


Same transformer.

$$\frac{(400)^2}{2 \times 110} \times .3 \text{ mf} \times 60 = .4 \times .4 \frac{30}{60} = .16 \times 30 = 4.8 \text{ watt.}$$

say the trip takes 5 watts,

$$.001 \times 400$$



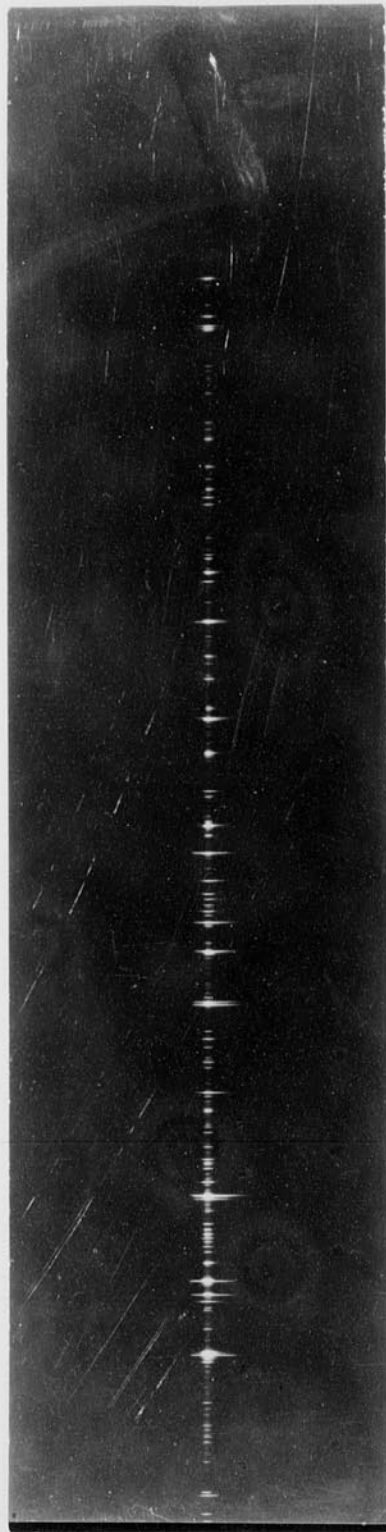
Notebook # July 20, 1931 - Jan. 12, 1932

### Filming and Separation Record

- 1 unmounted photograph(s)
- negative strip(s)
- unmounted page(s)  
(notes, drawings, letters, etc.)

was/were filmed where originally located between page 94 and 95.

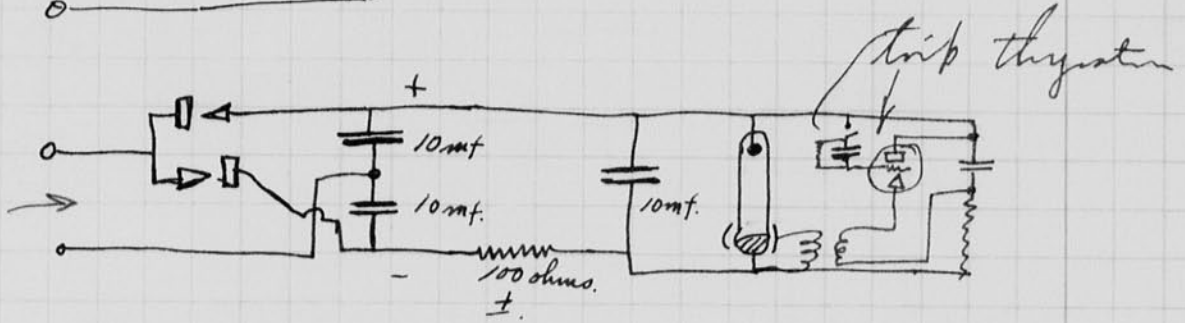
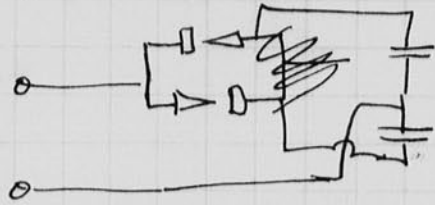
Item(s) now housed in accompanying folder.



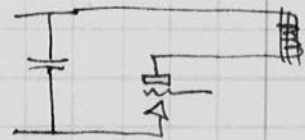
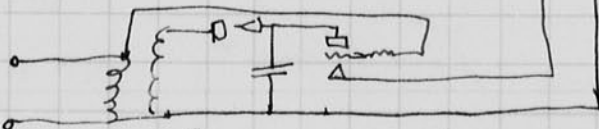
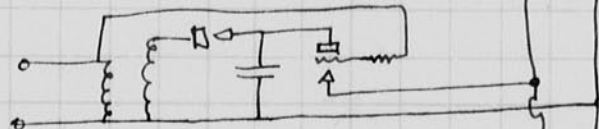
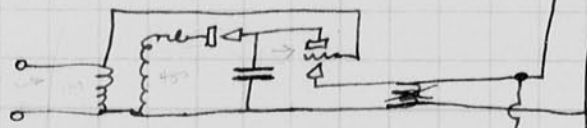
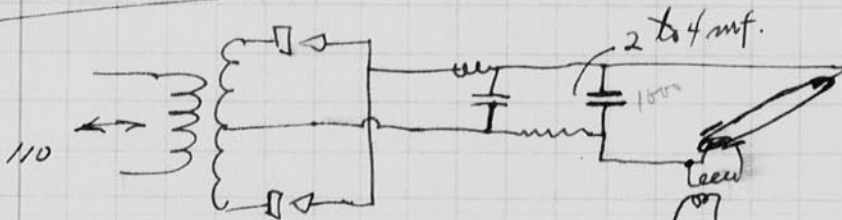
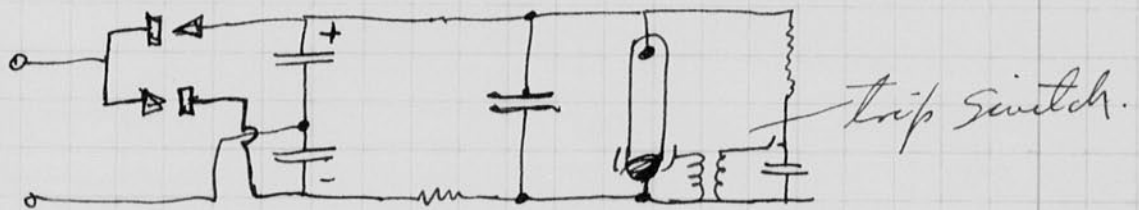
Dec 11 1931

# Cont. Low Voltage Strobo for industrial use.

Transformers only needed for filament supply.



or. switch.



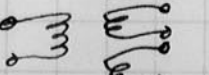
Put 3 sparken in the anode lead so the filament transformer can be common.

110V → 5 amp 2.5 volt filaments.

110V → 15 amp 2.5 volt } or 3 windings 5 amp 2.5 volt.

5 amp 2 amp midtap.

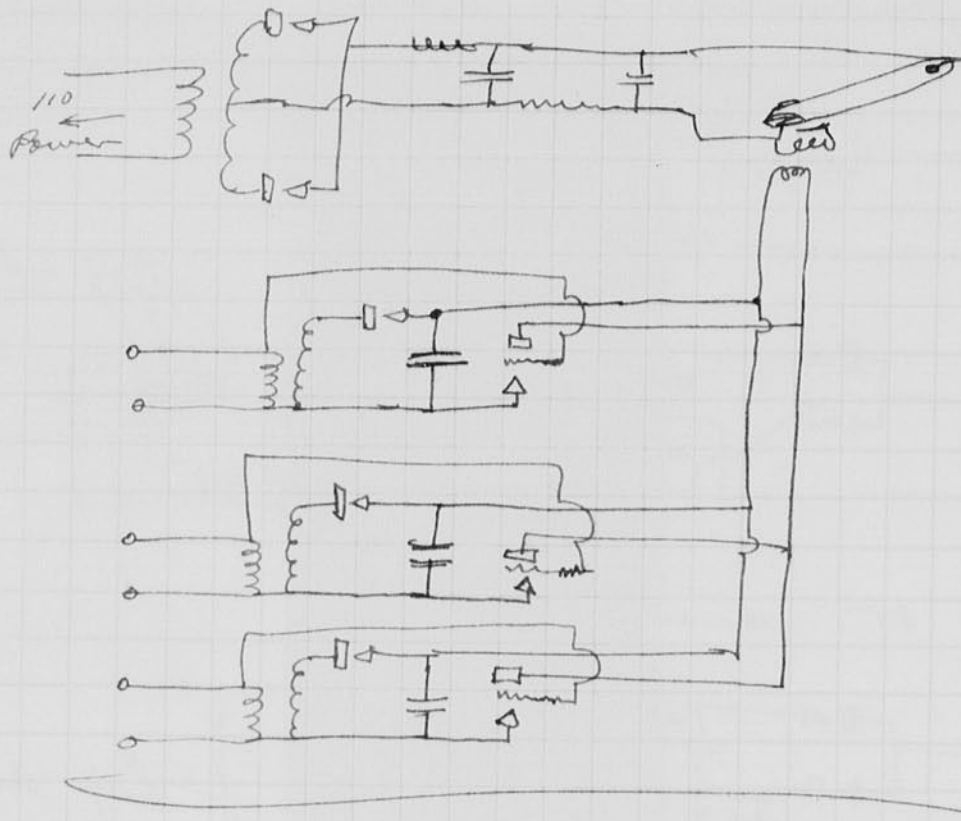
" " " "





Cont.

Three phase power-angle strobo.



Dec. 13 1931

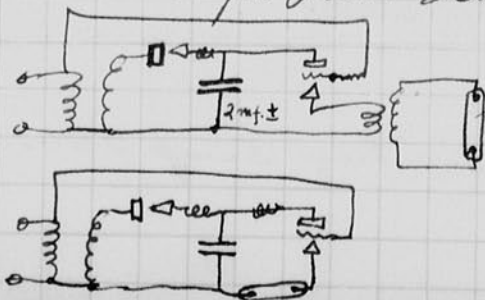
A. E. G. photo.

Some trouble is expected with this circuit since a common spark coil is used to trip the big tube. That is the primary of the transformer is connected to all three thyratrons. When one thyatron fires, ~~the~~ the voltage of the other thyratrons cathodes ~~are~~ or anodes are changed because of the common circuit.

this trouble can be overcome with three separate spark coils.

Dyn Lab. Strobo.

Low intensity.

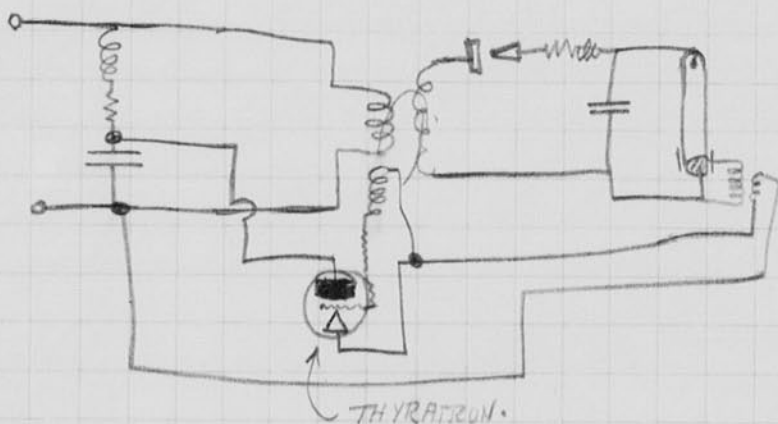
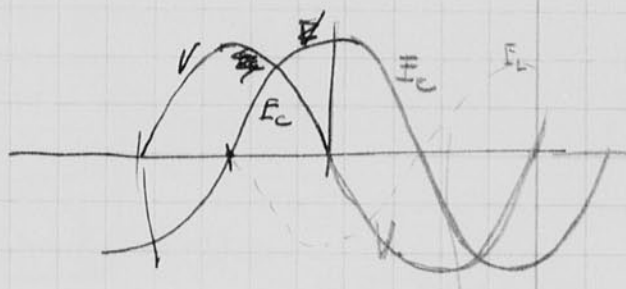
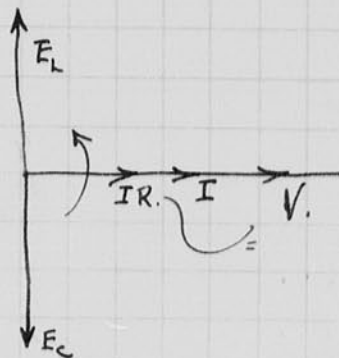
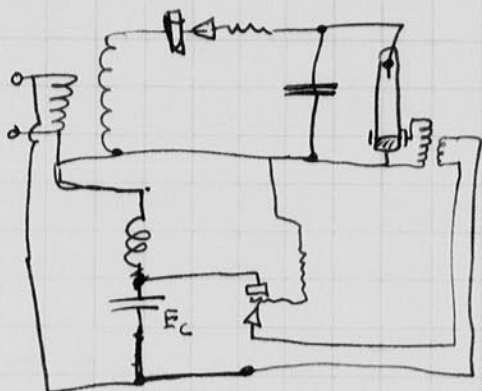


neon and arg. or neon, argon, or other gas.

try these circuits out.

Dec 13 Cont.

600 Stroboscope circuits.



$C = 0.3 \text{ mf}$

$X_C = \frac{1}{\omega C} = \frac{10^6}{377 \times .3} = 10^4 \text{ ohms.} = 10000 \text{ ohms.}$

$X_L = 10000 \text{ ohms.} = \omega L = 377L$

$L = \frac{10,000}{377} = 30 \text{ henries.}$

300 volts across the capacity, (max.)

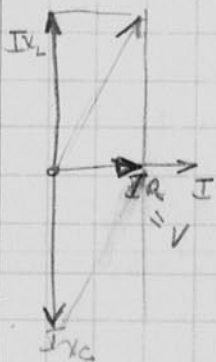
$\frac{300}{\sqrt{2}} = 212 \text{ volts. r.m.s.}$

$212 = 10,000 \times I \quad I = \frac{212}{10^4} = 212 \times 10^{-4} = .0212$

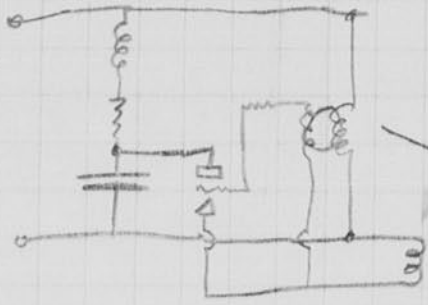
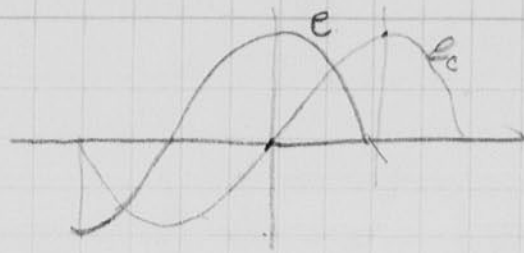
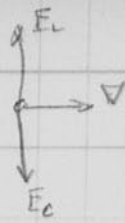
$IR = E = 110$

$R = \frac{110}{.02} = \sqrt{\frac{5500}{11000}} = 5500 \text{ ohms.}$

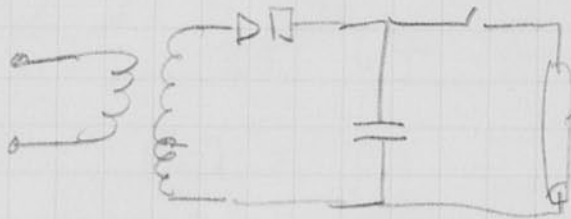
$\frac{R}{2L} = \frac{5500}{2 \times 30} = 100 \text{ sec.}^{-1}$



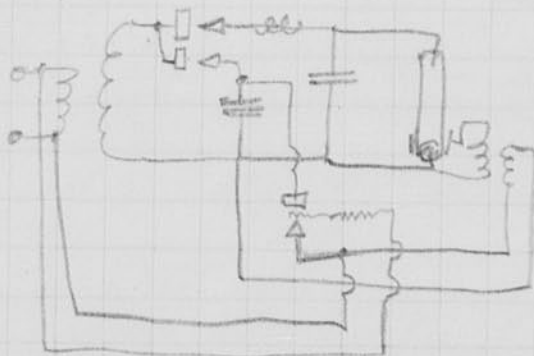
$\beta$  cont



transformer to reverse the phase of the grid voltage.  
 to trip benz tube or to gaseous lamp.



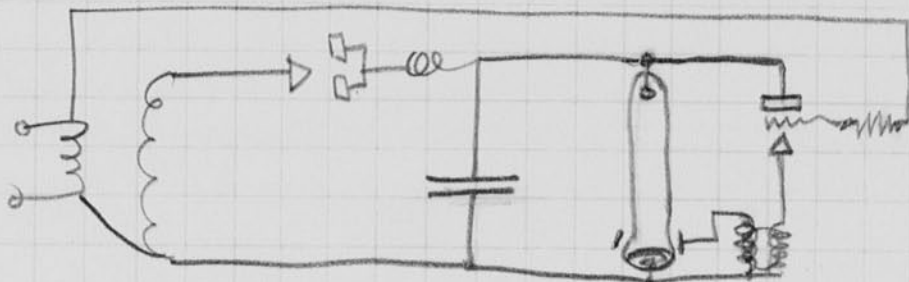
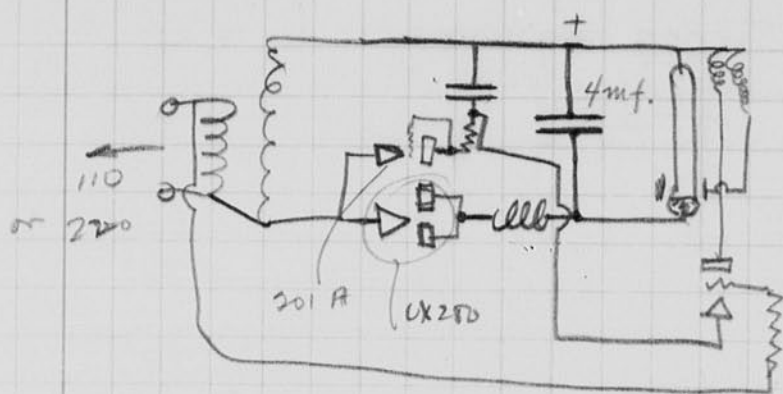
gaseous lamps such as neon etc.



See March 1931 "Electronics"  
 "Controlling cut-off knives for accurate  
 Packaging." Used by (S7) Heintz Co.  
 Variable speed control by the Jewell  
 Mfg Co of Columbus, Ohio.

cont.

## Laboratory Stroboscope.



The condenser would ~~be~~ start to discharge through the transformer. The resulting high voltage on the secondary would start a cathode spot and the tube would discharge the remaining energy in the condenser.

## Bibliography from thesis by Beardsley

- Buttolph. The Cooper Hewitt Mercury Vapor Lamp. E. E. Review Vol 23 p 741. 1930.
- Crowley. Intermittent Illuminants in Industry. Ill. Eng. Technol. Vol 16 p 189. 1923.
- Hospitalier. The Slow Registration of Rapid phenomena by Stroboscopic methods. Journal I.E.E. Vol 23 p 95. 1903.
- Judge. Kinematics. Automobile Eng. Vol 14 p 265. 1924.
- Moore. Stroboscopy and the testing of Rotating meters. Electrician Vol 10 p 117. 1928.
- Stevenson & Marsh. Observation of moving bodies by Intermittent Illumination. Journal Textile Inst. Vol 19 p T 279. 1928.
- Thomas. P. H. Theory of Mercury Vapor Apparatus. Sci. Amer. Supp. Vol 75 p 338. 1913.
- Sequin. Stroboskopa Stroboscops. American Machinist Vol 68 p 710. 1928.

Dec. 17, 1931.

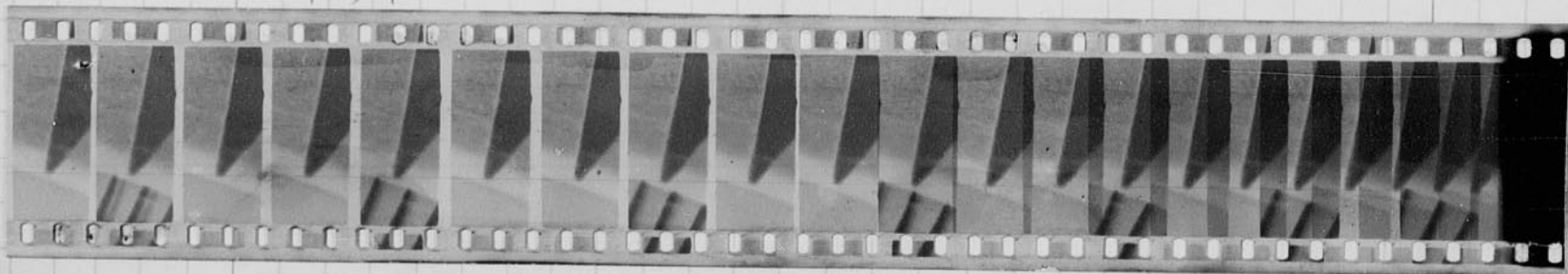
H. S. Edgerton.

Saw C. S. Grover yesterday concerning search for stroboscope patents (using gaseous discharge lamps) and told him of my circuits and uses of the tube.

I called Lamson of the General Radio Company yesterday and he plans to come over to tech today with his continuous speed film camera. We are going to try to get some photographs of the oscillations of a synchronous motor.

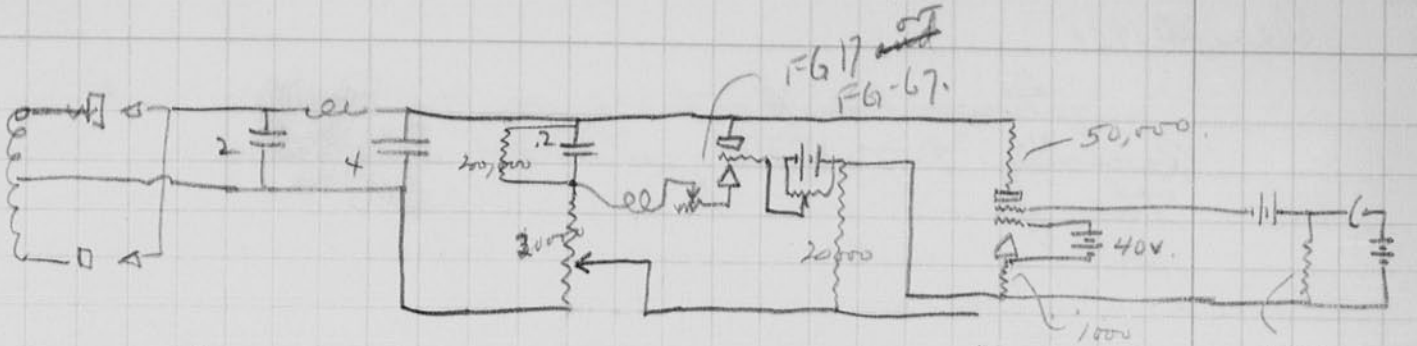
Someshausen is working on the circuit for the Engine Lab. This is the arrangement for obtaining indicator diagrams, using the thyatron.

Dec. 18, 1931. Lamson of G.R.C. came over yesterday aft and we took some movies on continuous by moving film. Some of the pictures are attached to this sheet. The lens was rated  $f2.9$  and the picture was taken right on Bronid recording paper. The field of vision was rather small. The photograph was of a 12" disc on a 1200 r.p.m. synchronous motor. The lines are 5 electrical degrees apart and on the disc. the Pointer is stationary. 6 to 8 mf were used in the discharge circuit (same as blue print pasted to page 45.) This was <sup>too</sup> much energy to put in to the tube continuously as it would get too hot. The tube was one we made last Tuesday.



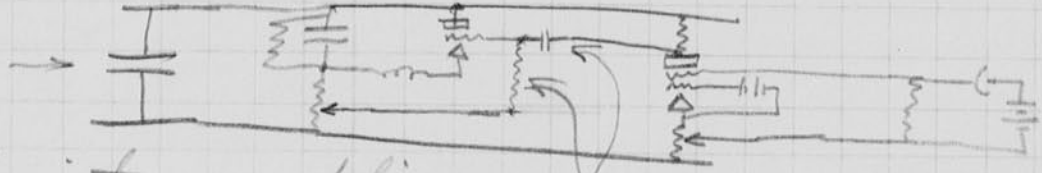
Worked Friday evening with Germ, Stark Draper, and others to get Draper's camera to work. Not enough amp. Finished Engine Lab. indicator and tested it in the aft. Looked at Spray from a diesel jet with Eddie Taylor.

Dec 19, 1931



This circuit was tried but there was not enough impulse from the photo cell to trip the thyatron. The circuit would oscillate very well with either thyatron.

Other suggested circuits



Capacity coupling.

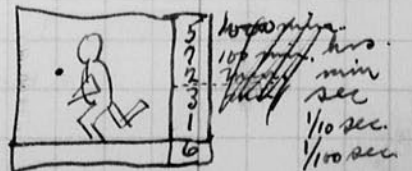
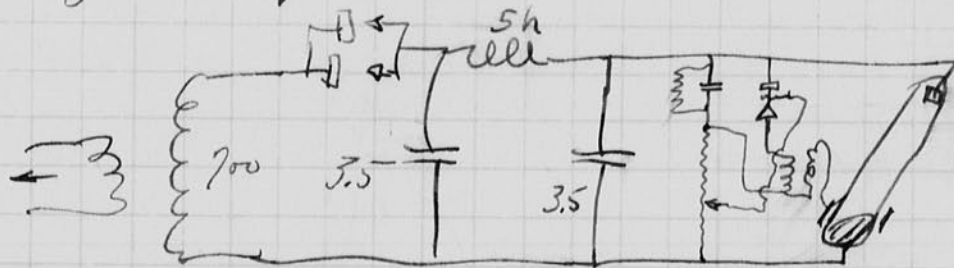
use 500,000 ohms, ±  
C = 0.01 mfd ±

or Transformer



Sat. Dec. 20, 1931.

Worked with Gernsheim on a 30 cycle stroboscope for advertising purposes for Mr. Hall. It works O.K.



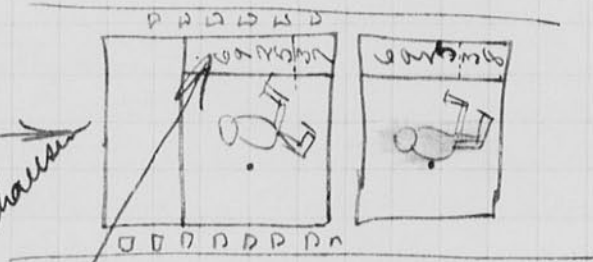
Dec. 20/1931

Letter and an article, "on the Problem of timing Races" by D. T. Kirby started me thinking about this problem. Kirby intends to use a movie with a sound track which gets an accurately known frequency.

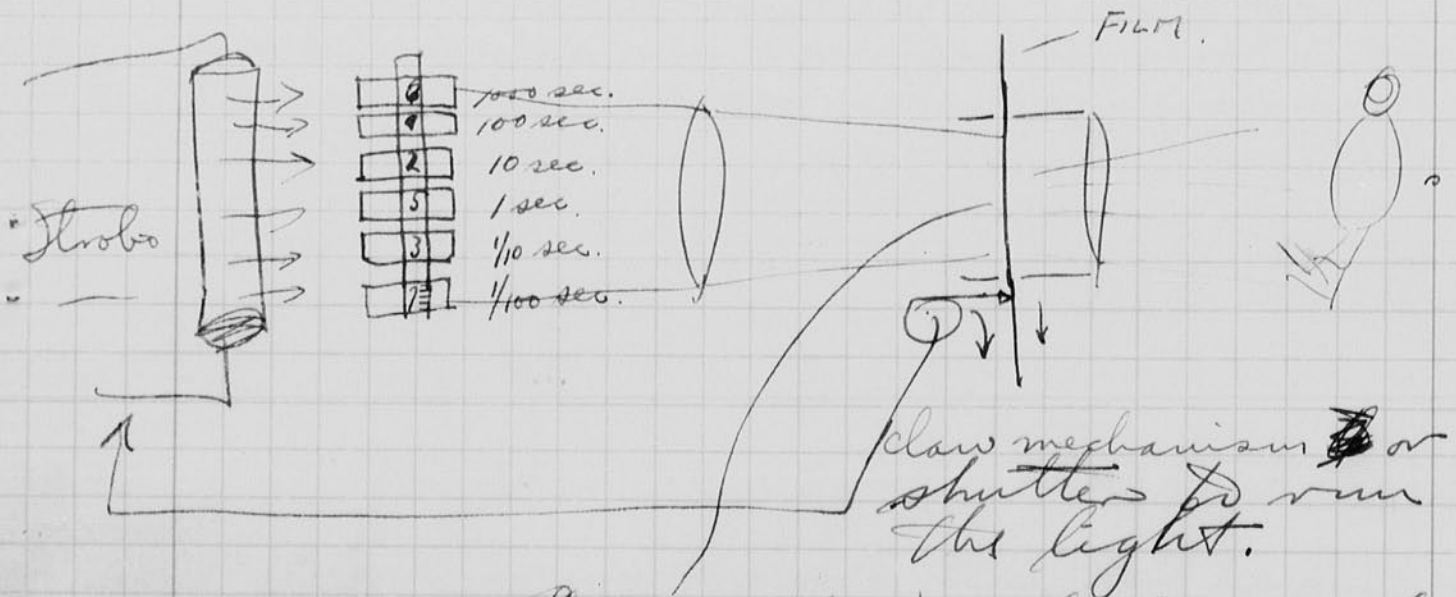
Objections to this scheme are: 1. the time signal is several inches from the corner of picture. 2. the total elapsed time is obtained by counting the cycles!

I would like to perfect a scheme showing on each frame of movies the exact time!

This was explained  
 to me by Mr. Edgerton  
 12/20/31  
 Kenneth J. Gernsbacker



These numbers are driven by a timing fork clock or a piezo-oscillator clock. A stroboscope lamp prints them on the film at the start of the exposure (or at the end of the exposure).



Photographic print of record put on the film.

The start of the race would be recorded on the film before ~~the film~~ was started. Film would not need to be run through except just for the final spurt. The starter's gun would trip the stroboscope tube and print the starting time. A lot of film would be saved this way.

Dec. ~~14~~<sup>21</sup> 1931.

Whipple of the Aviation Dept has been having trouble with a thyatron circuit. He wants to see Shames and to fix it up for him. His device is used to time the flight of a model through the air. The steel wings have paper on them at intervals which closes a contact between the wings and trips a thyatron. There is bounce or vibration or poor contacts enough to cause erroneous records. Gem. started ~~it~~ in the apt to work on this.

Dec. ~~14~~<sup>22</sup> 1931. I went over to see Max Knoble since he called me yesterday. He has been out to the Dennison Paper Co. and wants to use our stroboscope to study some of their problems and speed up their machines. Gem and I are to build a stroboscope this week and try it out next. Knoble is going to build a contactor which is run by the machine being tested.

Mr. Brummings of the Forbes Fifth Mfg Co (Chel. 0800) called regarding stroboscope fix work. I made an appointment to see him tomorrow at 1:30 at their factory.



Dec 24 1931

H.S. Edgerton. Yesterday morning I looked up a concern in south Boston to make us some metal boxes to hold the stroboscope units. Thorson Company at (223rd) at and L in So Boston is going to make us three boxes.

In the aft. yesterday I went out to the plant of the Forbes Lithograph Company in Chelsea to discuss with him the stroboscope. He and his electricians had rigged up a neon lamp with a contact which gave practically no light. They want to use the stroboscope to help them work out a new machine for printing.

Mr. Brunnings and Mr. Bruce Pollodi? came to tea with me and saw the 30 cycle stroboscope work. Also we showed them a variable speed stroboscope. They think it is just the thing for their purpose.

Mr. Brunnings wants to build the outfits in their shop. He offered to let us do the engineering and submit specifications for the material. Then after they were built, we would go out and check them over and get them into running shape.

Mr. Larsson of the General Radio Company was the one who suggested my name to Mr. Brunnings!

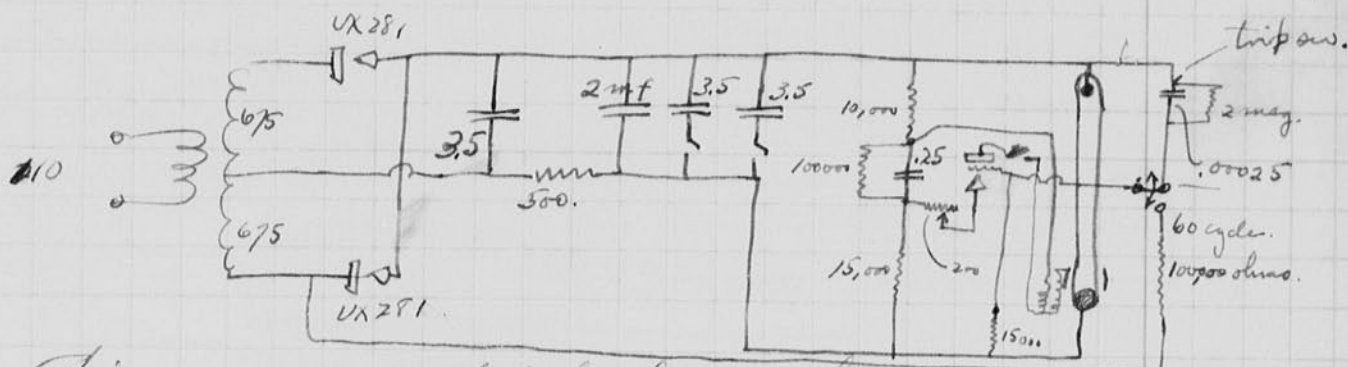
Dec 26 1931

As Edgerton. Germ and I wired up stroboscopes. Germ the one for the engine indicator and I one for Knoble.

Dec. 27, 1931

Built tubes. 2 - 18" tubes during the day. Had Germ out to supper at 15 Allen Rd. & White town

Dec. 28, 1931. Put stroboscopes in the metal loops. The circuit I worked on is shown below.



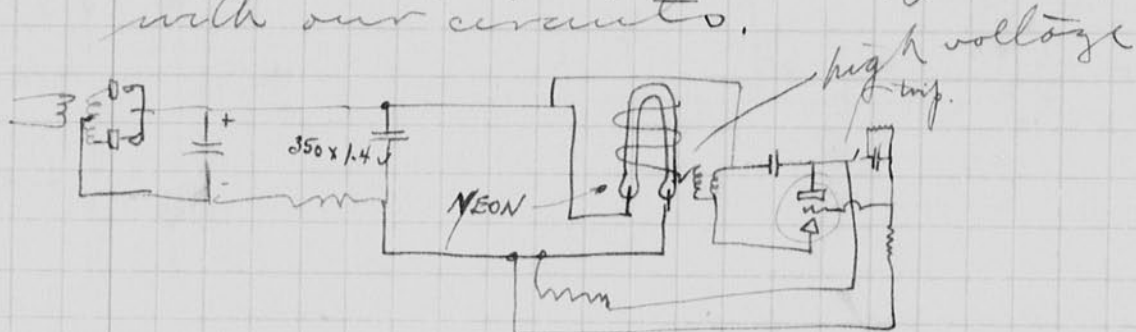
This was completed in the am.

Mr. Lamson of the G.R. Co came over in the aft. with his continuously moving film camera which was used here last week on Dec. 18. It has another lens on it which gives a larger field ~~than~~ <sup>than</sup> the other lens ~~that~~ <sup>that</sup> was previously used. We took some movies of the swinging of the rotor of the synchronous machine. I used 8 mf charged through 600 ohms and a mercury arc rectifier from a 1000 volt transformer.

We also took some pictures of a vibrating spring and a cam with the stroboscopes shown above. The condenser in the discharge was 7 ~~volts~~ microfarads. Germeshausen worked on these also. Prof. Bennett (R.D.) saw these pictures and went home with me. Made a date with Lamson for tomorrow to take some pictures of the cathode spot in the mercury arc tube.

Dec. 29, 1931  
S. S. Edgerton

Max. Knoble came over in the morning with a small rotary converter for converting dc. to ac. We ran the stroboscope with it and it apparently can stand the strain. Knoble wants a smaller out fit and wants it cheap. We talked about stroboscopes using neon tubes. After Knoble left we, Gerny and I, tried some experiments with our circuits.



This worked fairly well. The light was quite white and very bright. We also tried our 281 rectifier 675 x 1.4 volts. After the first flash the neon lamp would hold a glow discharge which once in a while would snap into an ~~arc~~<sup>arc</sup> and give a bright light.

The arrangement worked best when there was a small air gap ( $\frac{1}{8}$  to  $\frac{1}{4}$  inch) between the spark coil secondary and the external wire grid around the tube. This probably causes high frequency oscillations which trip the tube.

Stark Drape was over during these experiments. He is going to start tomorrow to wire up the amplifier to trip the strobo tubes with the photoelectric relay.

Received order no 4481 from the Forbes Lithograph Co of Chelsea to furnish them with plans for a stroboscope.

Called Bertram concerning the stroboscope especially for a transformer for the Forbes Lithograph Co. Bertram and Dellenbaugh are coming over to see the stroboscope tomorrow morning.

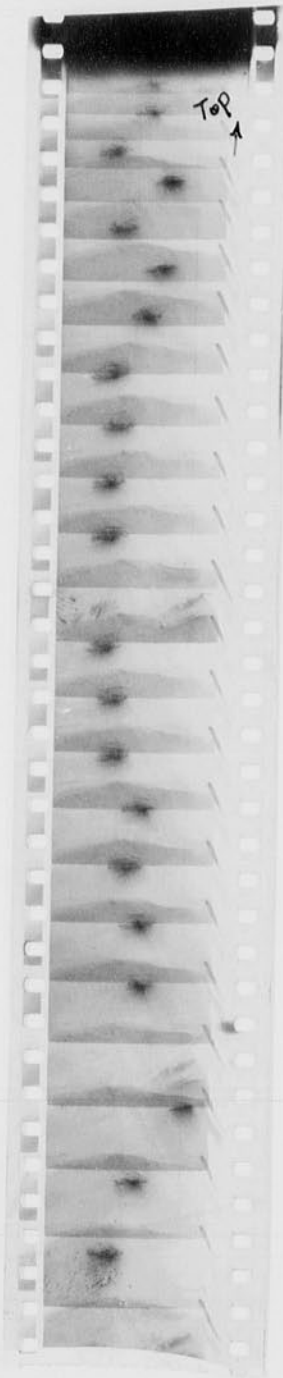
Notebook # July 20, 1931 - Jan. 12, 1932

### Filming and Separation Record

- 1   unmounted photograph(s)
- negative strip(s)
- unmounted page(s)  
(notes, drawings, letters, etc.)

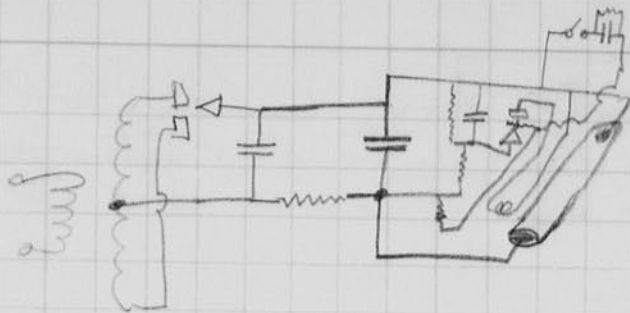
was/were filmed where originally located between page 106 and 107.

Item(s) now housed in accompanying folder.



Photographs of the castle of St.  
 taken on Bbinaid paper.  
 Dec. 1931.  
 H. S. Egerton.

known



$$\begin{aligned} .200 \\ .04 \times 500 = 20 \text{ mth.} \\ \frac{500 \times 500}{14,400} = 25 \text{ mth.} \end{aligned}$$

$$\frac{.05 \text{ amp} \times 200}{14,400}$$

$$\frac{.05}{.001} \times 200 = 10,000$$

Dec. 30, 1931

Bertram and Dellenbaugh of the Delta Mfg Co were over in the morning and Gem and I showed them the stroboscope (circuit on p105). Also the strobo that was loaned to Sperry Gyro for several months. I sent Bertram a circuit diagram so they could figure on the expense of manufacturing the stroboscopes for such jobs as the Russel Box Co.

Lamson of the General Radio Company called up by phone in the morning and asked me to come over to talk with them regarding the stroboscope. We had a long talk with Mr. Horton who believes the strobo will be a useful device now that it has enough light to take pictures.

Lamson returned with me to Tech and we took some photographs of the cathode spot.

Dec. 31, 1931. Spent morning downtown. First got new plates for the car. then stopped at the Edison Company. Saw Elwood Church first there and he introduced me to Mr. Crimmon(?) also to Mr. Dillor. I talked to them about taking stroboscopic movies of the angular swinging of synchronous generators. They are going to cooperate with me to take some pictures of their generators. Made a date for Tuesday at 2.30 o'clock with Mr. Crimmon to go to the L S station in East Boston.

Also stopped at the Herald Traveller to see Mr. Ross about the stroboscope for watching the printing presses. He said somebody tried that

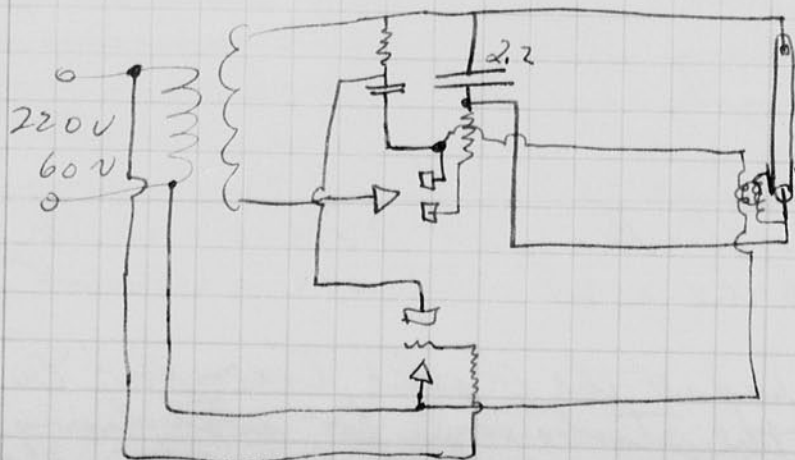
in their plant several years before but it gave them no advantages for adjusting the presses and so it was dropped.

Jan. 1, 1932. Gem and I worked on tubes in the afternoon. We made two 6" tubes of (1cm±) lead glass and exhausted them. Then we made a tube with an auxiliary anode for starting. It was close to the pool and was covered with glass except for the very end.



On Dec. 31. I stopped at the Raytheon Inc and saw Percy Spencer. He is going to build stroboscope tubes for me. The first one will be ready for next Monday. It will be tested to see if it sputters. Then if it is o.k. he will build me two more for the Forbes Lithograph company.

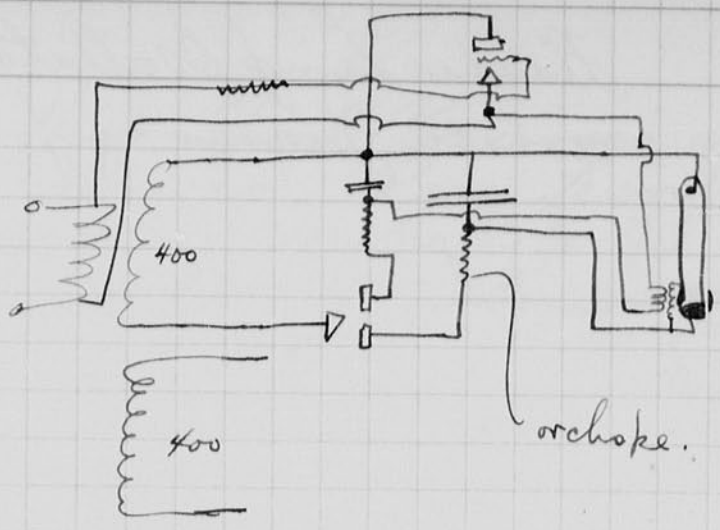
Jan 2, 1932. Gem experimented with the three electrode tube and I worked on the 60 cycle stroboscope for the Dynamo Lab. I used this circuit.



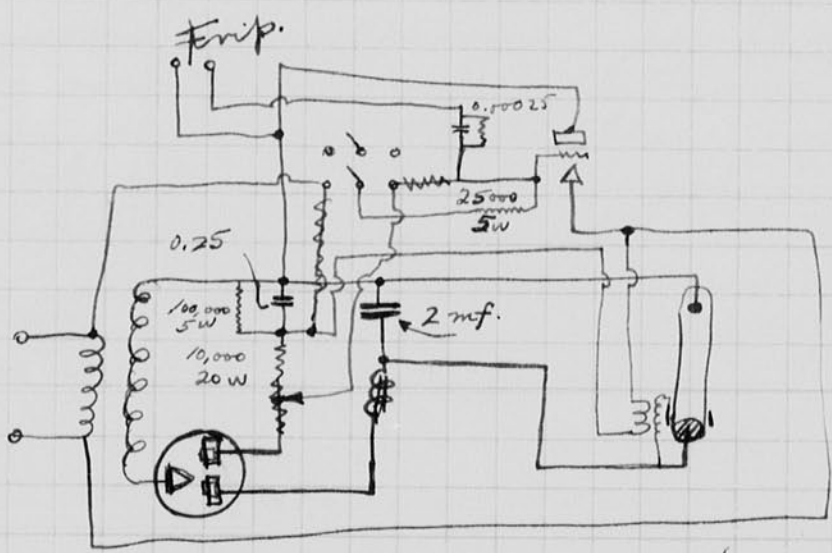
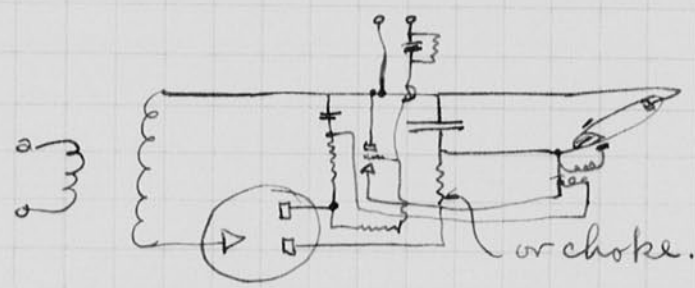


Jan 3, 1932  
H.E. Edgerton

Circuit for  
60 cycle and  
variable freq.  
strobo.



2.5V  
5 amp. F6-17  
5V  
2 amp. UX 280.



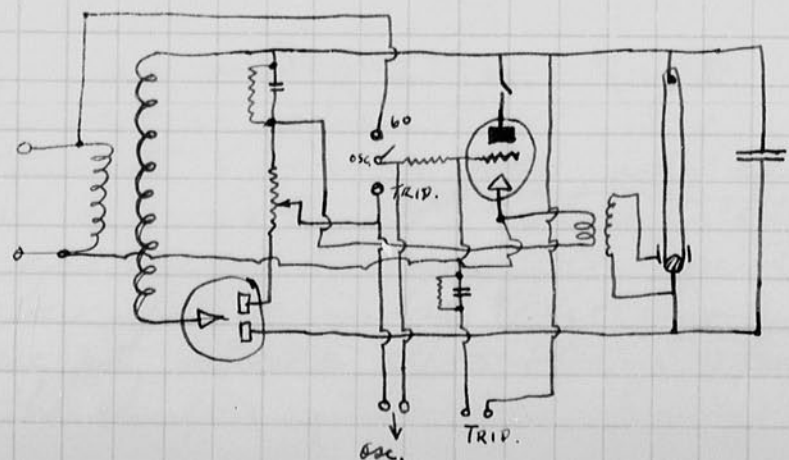
$$\frac{2.20 \times 2.70}{2.5000}$$

$$\frac{40 \times 40}{1000} = 16.$$

$$.03 \text{ sec} = 2 \times 10^{-6} \times R.$$

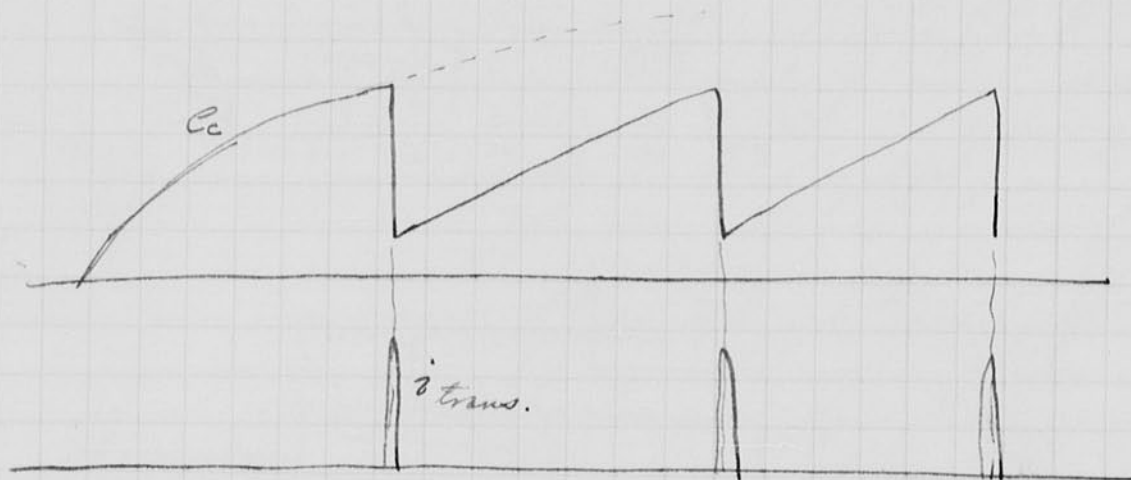
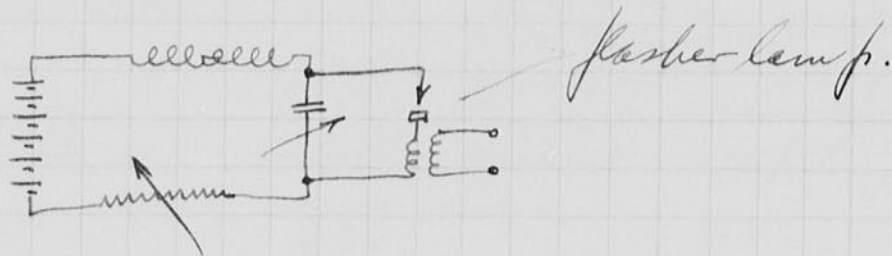
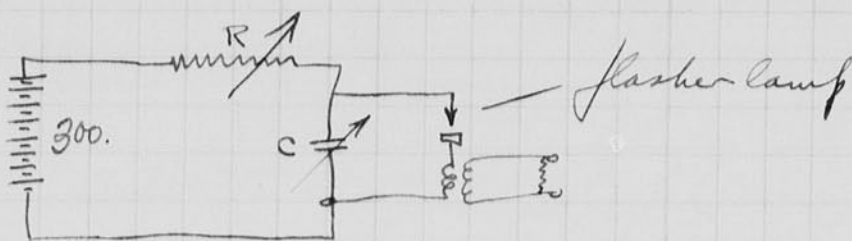
$$R = \frac{.02}{2.4 \times 10^{-6}} = .01 \times 10^6$$

$$.01000000$$



Jan. 4, 1932  
H. G. Gorton.

Flasher Lamp Oscillator for variable frequency for strobo.



let  $C = .01 \text{ mf.}$

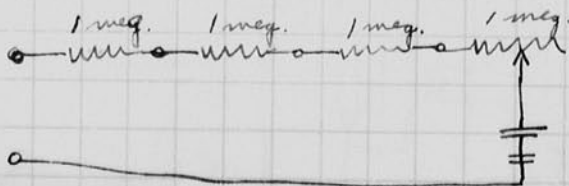
$\frac{1}{60} \text{ sec.}$

$$\frac{1}{60} = .01 \times 10^{-6} \times R.$$

$$R = \frac{1}{.60} \times \frac{10^6}{.01} = 1.67 \times 10^6 \text{ ohms.}$$

$.01 \text{ mf. } .167 \text{ meg ohms.}$

$$\frac{300}{.100} \times 10^{-6} = 3,000,000 \text{ ohms.}$$



Photographing High-Speed Processes with special film cameras. Rene Leonhardt. The Military Engineer Vol. XXIV No. 133 Jan Feb 1932 p 82.  
 Tube built by Spencer arrived and seems to work fine. It is of no 44 glass and is about 18 inches long.  
 We ran this tube until aft. Spencer called and I told him to go ahead and pump the other two for the Forbes & Co.

Howard Biggs of the Hygrade Lamp Co came in and had a talk with me regarding stroboscope tubes. His company has a request from the S.R. Co to quote them a price.

Jan. 5, 1932.  
 H.S. Egerton.

Mr. Cassie of the Sturtevant Company, Hyde Park 0340  
 Hyde Park was over looking for a stroboscope. We are going over tomorrow afternoon to see how ours works. Bertram of the Delta Co called up and said Bergstrom of the Sturtevant Co called him about the Strobe and he referred it to us.  
 Took ~~the~~ a design for a small six inch strobe tube over to Spencer at the Raytheon, Inc.

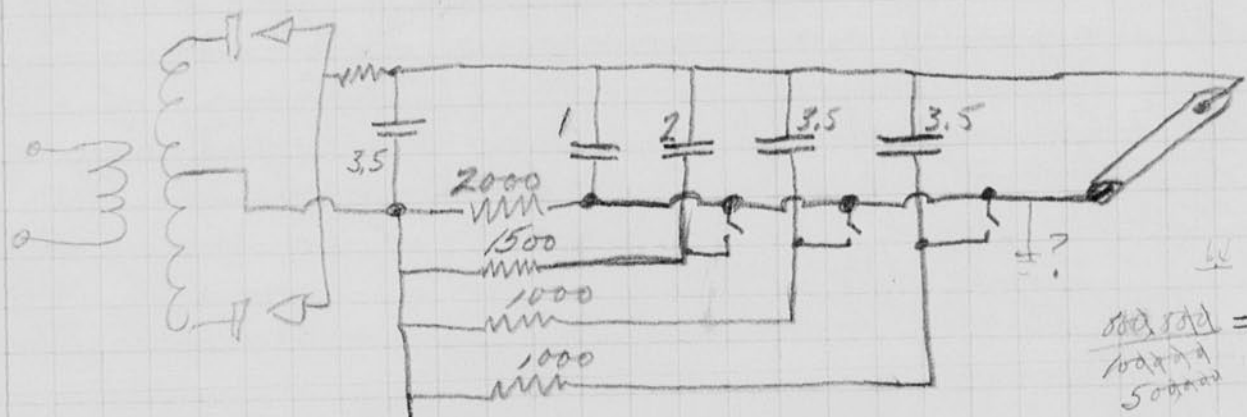
Jan. 6, 1932.  
 H.S. Egerton.

Took the strobe (circuit on page 105) out to the Sturtevant Company. Bern. went along. Set it up in front of a blower that is causing trouble from vibration. This blower is about 18" in diam and rotates about 6000 r.p.m. At about 5400 r.p.m. there is a violent vibration present which causes enough motion to cause the fan to strike the housing. We could see it vibrate at certain speeds. Mr. Hagen is the chief engineer in charge of research.

Cont.

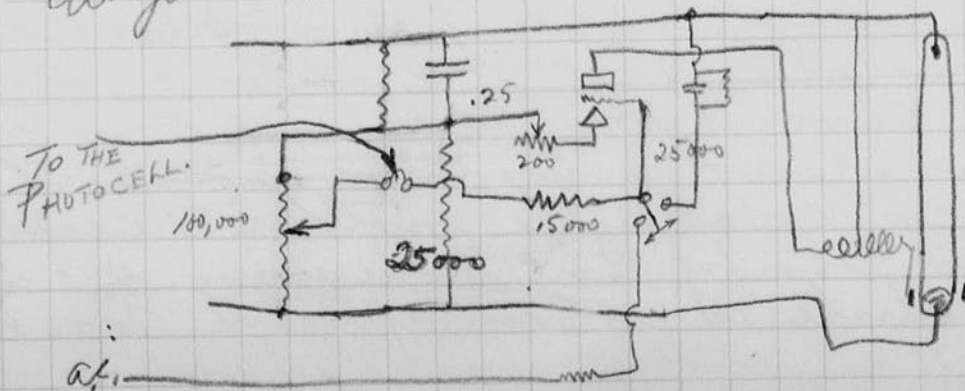
We are to get in touch with the same (Delta) company and get one of their photoelectric cells and amplifiers to ~~the~~ trip our strobo. in exact synchronism with the rotor. A disc is going to be mounted on the shaft with a hole in it for the light to shine through once each revolution.

The strobo seems to flicker somewhat, if more capacity is put on, this is overcome. I believe that it is due to the quick build up of the ~~table~~ ~~rober~~ voltage on the anode and the metal reflector which acts as an external grid. Several changes are to be made in the outfit.



$$3.5 \times 10^{-6} \times 1000 = 3.5 \times 10^{-3} = .0035 \text{ sec.}$$

Ground here to shift every thing neg. when charging, with respect to the pool.



Concl

The main strobo circuit on the preceding page, has ~~two~~ two distinct advantages over the circuit on page 105. These are:

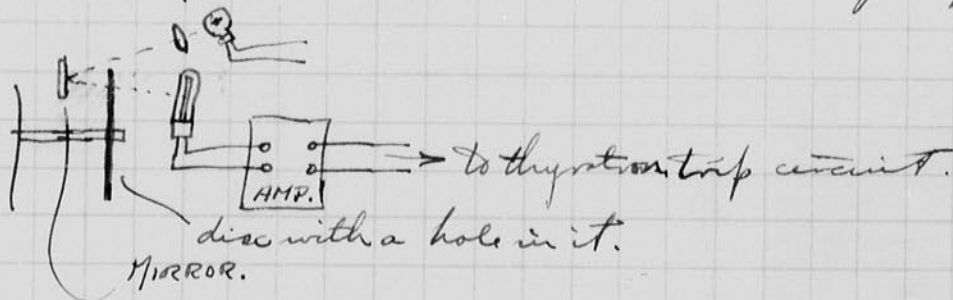
1. The extra discharge ~~resistor~~ capacitor act as a filter.
2. The charging resistance is automatically adjusted.

This charging should be done by chokes to increase the efficiency.

Jan 9, 1932.  
H. Sedgwick.

Mr. Day who is associated with Mr. Kidly in New York was here today. I showed him everything that we were doing along stroboscopic and these lines.

I have been experimenting with the photocell control of the stroboscope. There is not enough light or enough gain in the outfit we were using. The Acme Smoke amplifier has a power pentode ~~of~~ as an amplifier tube.



Jan 9, 1932. Mr. Day was over again and showed me some spectrograms of his white gaseous discharge lamp.

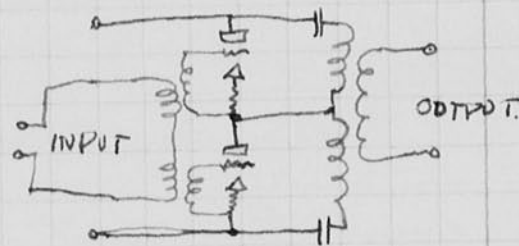
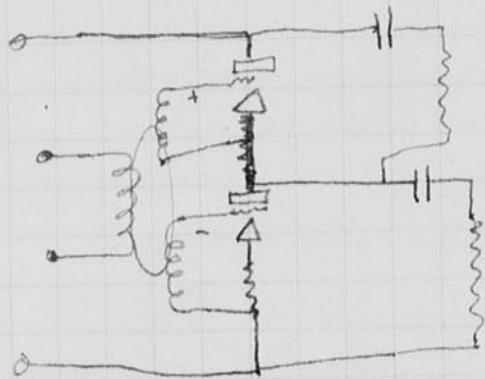
A stronger lamp and a 4:1 transformer

cont.

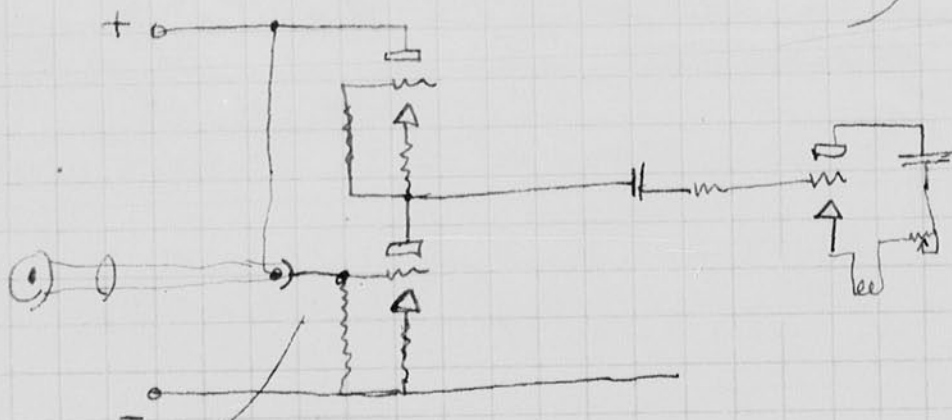
in the output of the photoelectric relay gave enough light to trip the stroboscope.

The operation was not very steady. There was a small variation from the average position of the stroboscopic image. This was due to the power supply as was noticed as the speed of the contact wheel was close to 1800 or 3600 r.p.m. so that beats were evident.

I think that we need a d.c. amplifier on the photocell to get rid of this small variation of the conditions for trip.

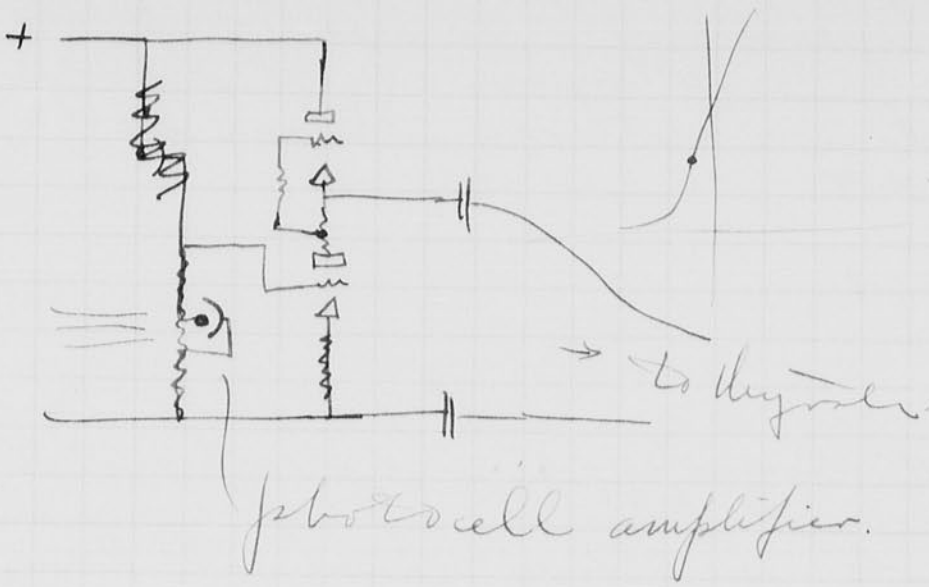


Series amplifier

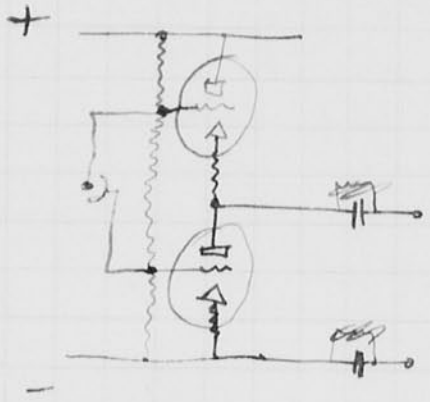


when light shines the grid swings +

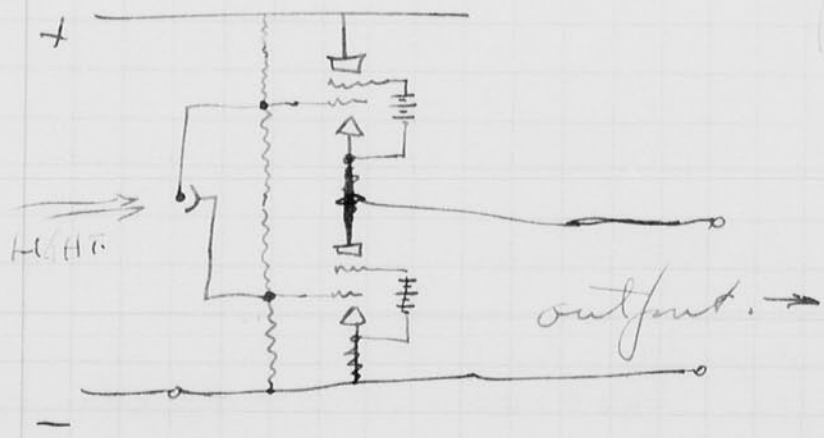
Cont



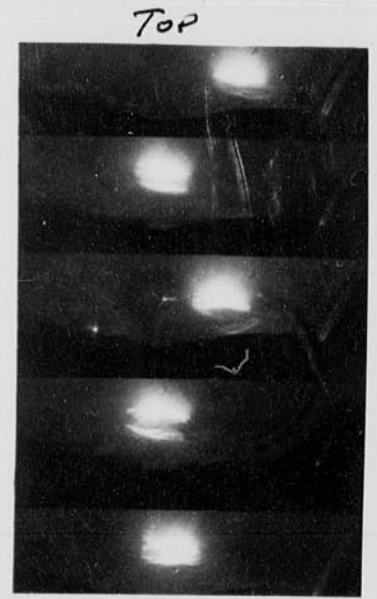
photocell amplifier.



Photocell amplifier for voltage



no imp in the disc circuit



with imp in the discharge circuit.

Enlargements of films taken on Dec 30 by Mr. Larson of the G.P. Co.

D. Robertson "Separation of the No-load losses in a <sup>slay</sup> continuous current machine by Stroboscopic Running Down Methods Journal I.E.E. 1915. Vol. 53 p 308

Jan. 12, 1932 Tuesday.  
H. Edgerton

Yesterday morning at 8 I took Gemushausen and the stroboscope (circuit p 105) out to the Sturtevant Power company in Hyde Park. He stayed there all day. In the afternoon of yesterday I went to the "L" street station of the Edison company with Charlie Reize. We looked over the generators and so that some scales can be mounted for reading the angle. About 4 o'clock drove over to the Sturtevant Plant and picked up Gemushausen.

United States Patent Office  
Before the Examiner of Interferences  
Edgerton  
vs.  
Miller } Interference 76771

Edgerton Exhibit 39.  
Page 116, the last record in Edgerton  
Notebook T-II.  
January 3, 1940. Clara Schlosky  
Notary Public

JAN 18 1940



May 10, 1933.  
H. S. Edgerton.

Blake Jacob-Lowell Shops.  
147 Milk St Boston.

(Stroboscope)  
Jan 9 1902

620.08 620.08  
N. 67

Sturboant  
1-B 3L - 1-Q, SAE...

two spark coils.	3.00
transformer	6.50
wire	\$ 4.25
screw clamps	.60
S.E. Cond.	7.00
" thyatron	14.00
" " 2nd.	6.00

