HAROLD E. EDGERTON

PAPERS

MC 25

Series III

Laboratory Notebooks

Number —

Dated July 20, 1931 to Jan. 12, 1932

NOTEBOOK T-II

THYRATRONS II.

Massachusetts Institute of Technology

COMPUTATION BOOK

NAME	Number
HAROLD E. EDGERTON	

Course .....

Used from JULY 20 1931, to JAN 12 1932

Recollections of early work p

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

COMPUTATION BOOK

GENERAL INSTRUCTIONS

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

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

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

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

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

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

* * * * * * * *"

Mercury arc tubes, thyratrons, etc.
Stroboscopes

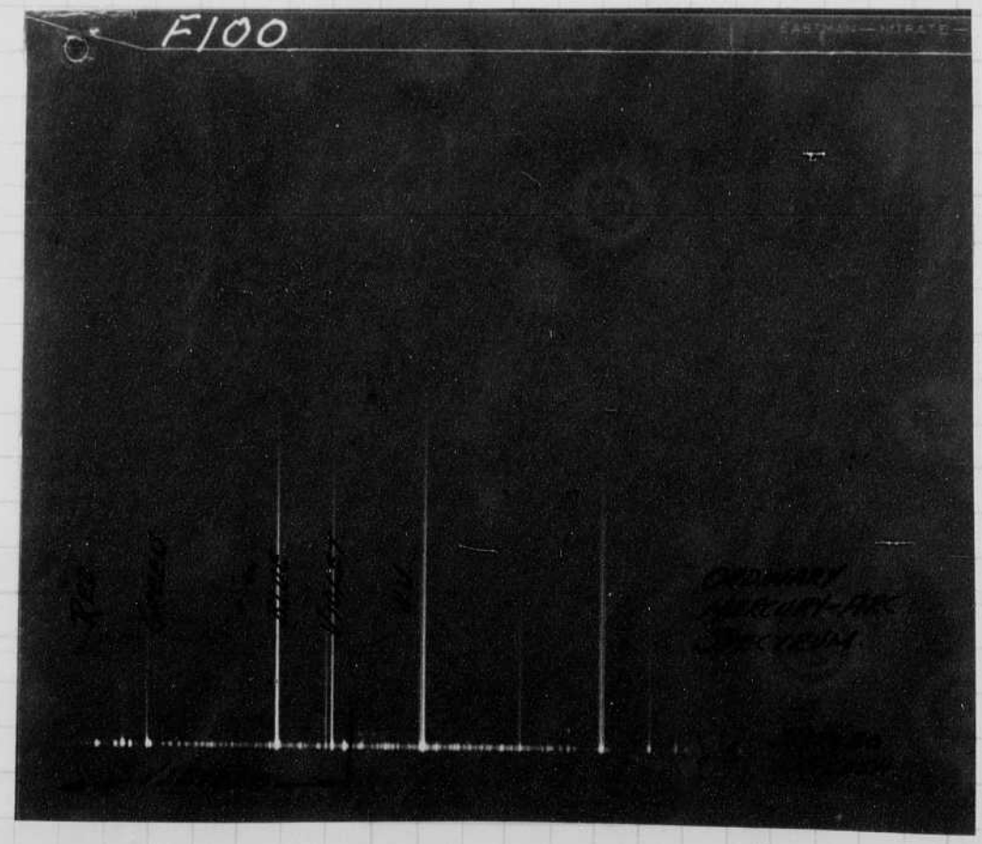
Harold E. Edgerton
July 20, 1931.
Cambridge, Mass.

July 20 1931.
H.E. Edgerton

Working with D.C. Stockbarger 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 yellow light when it was operated ag at 60 cyc stroboscope. The tube got very hot.

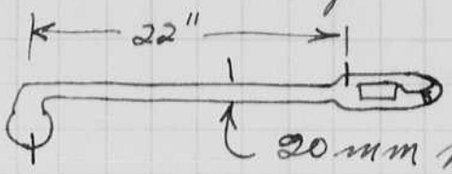
Some trouble was experienced with flicker. It was due to a spark coil that was about burnt out.

In the afternoon K.S. Germeshausen 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.



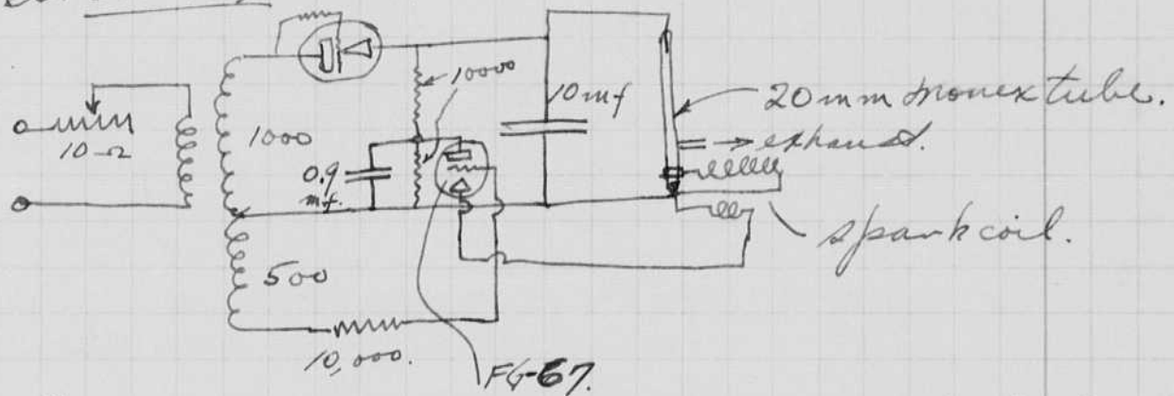
July 21, 1931
H. E. Edgerton.
K. J. Germeshausen.

Started glass blower, Mr. Ryan, on a new stroboscopic 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 m.f. 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.

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H. E. Edgerton

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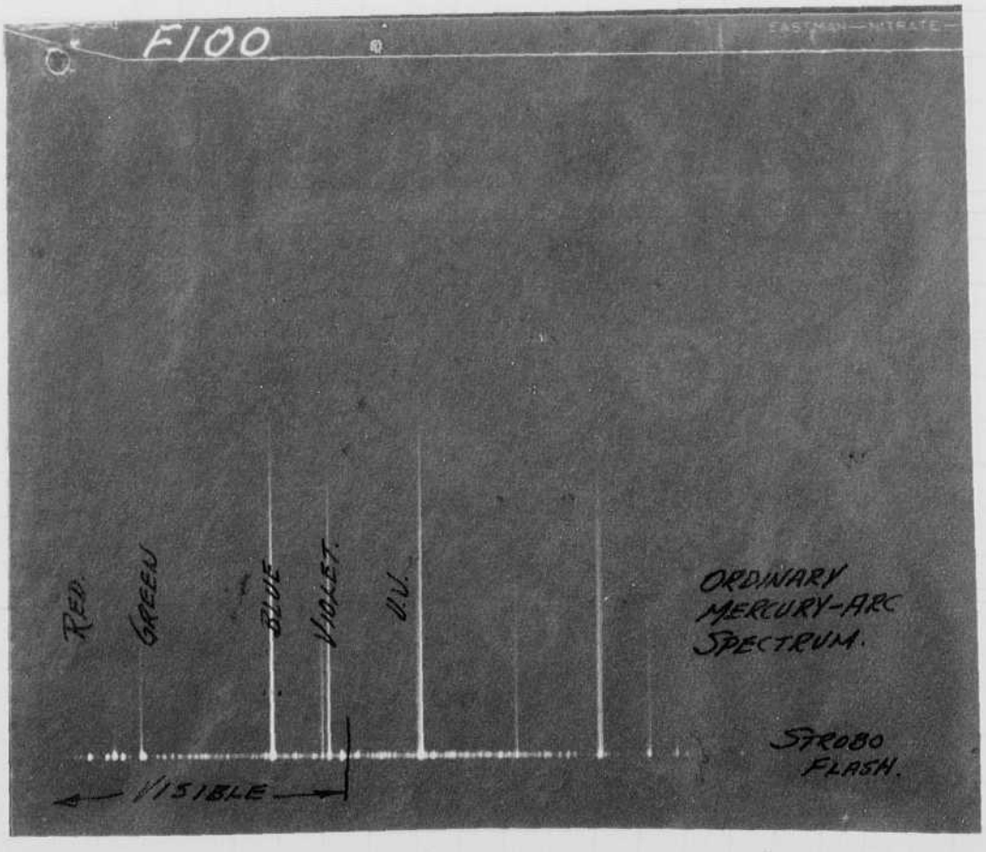

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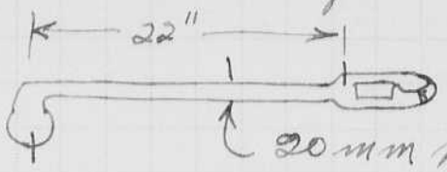

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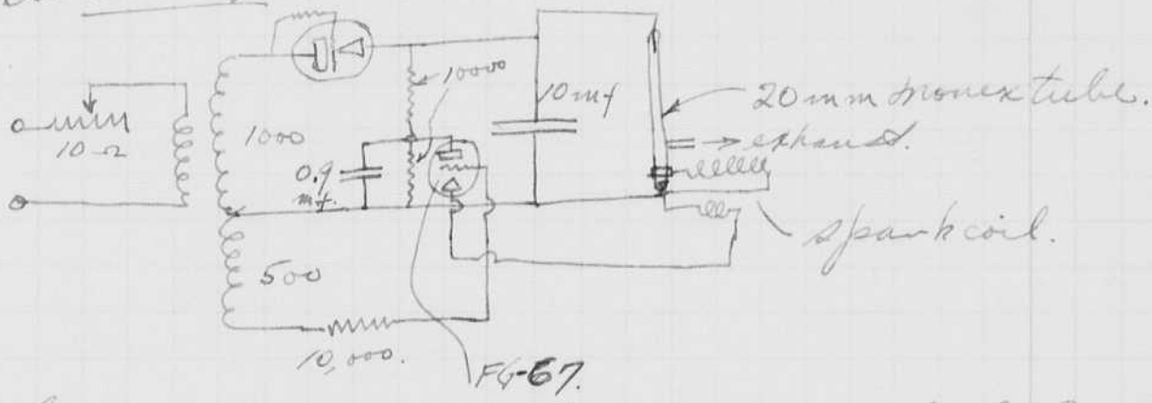
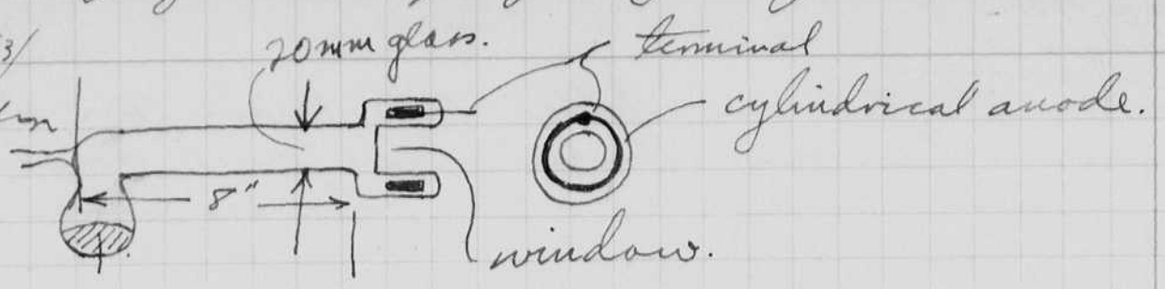


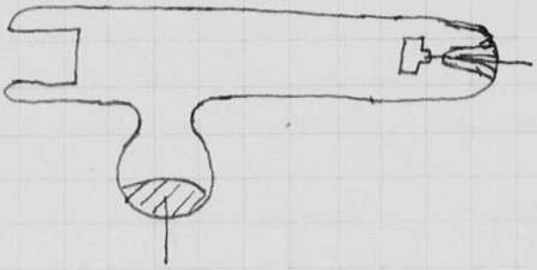
Germeshausen took some snap shots with his camera of the stroboscope tube today.

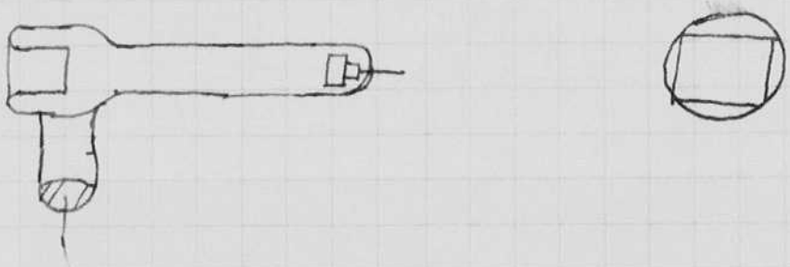
Proposed design of Projector pulse tube.

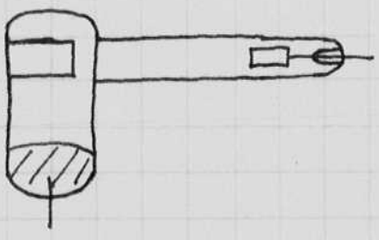
July 21 1931
H E Edgerton

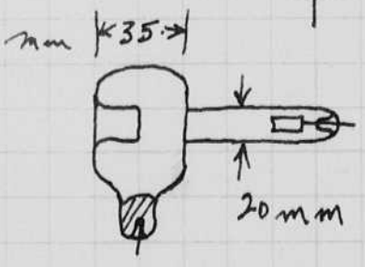


The window is put in this position so that the heat of the arc column will keep it free of condensed Hg.



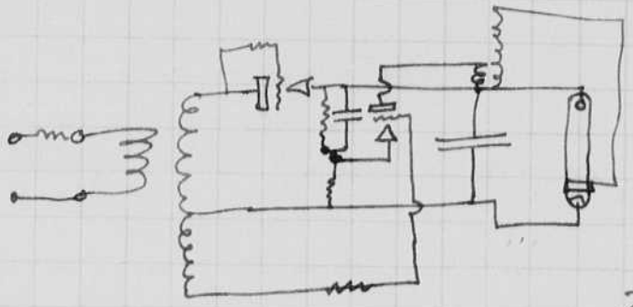






July 22 1931.
H. E. Ogata
K. Kennelly

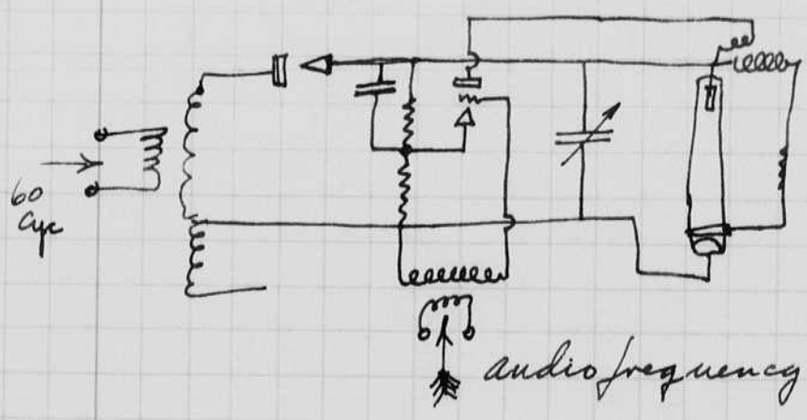
Continued experiments with the 20 mm tube which was tested yesterday. Changed circuit as follows.



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

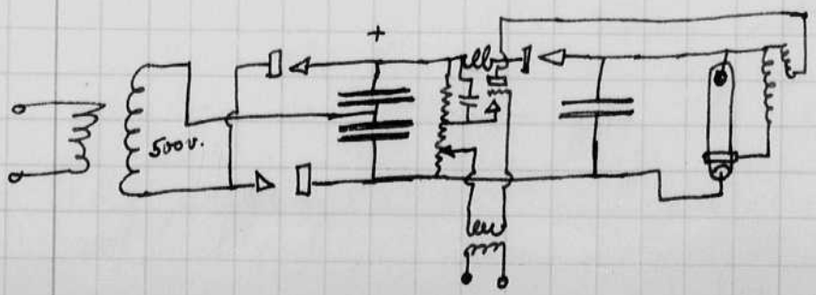
The light from the tube gradually increases in brilliancy until as the temperature rises until the pressure is such as to cause flickering. This temperature is about 200 degrees C. The highest recorded was 232 degrees. At this temperature the arc begins to become restricted in area inside of the tube.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

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



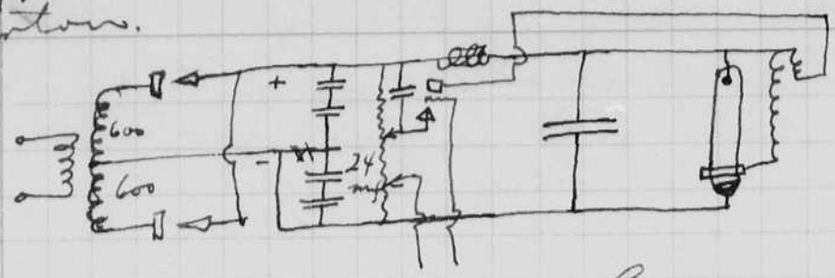
Circuit good for frequencies less than 60 cycles per second.

audio frequency oscillator.



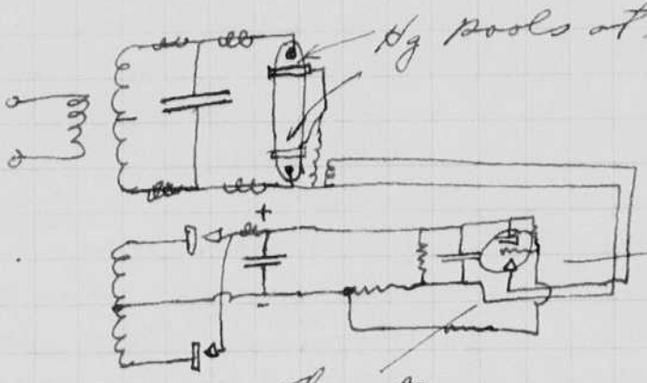
Hans Muller saw the arrangement. Perrin of the physics dept was also over and saw it run.

July 22 1931
H. Edgerton.



8 x 3 = 24 mf.

Light source.



Hg pools at both ends of the tube.

To oscillate about 1000 cycles per second or more.

Thyratron pulse oscillator.

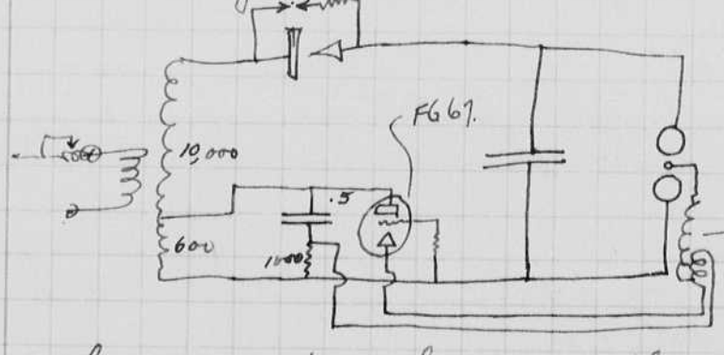
The light from an ordinary mercury arc lamp shows about ~~five~~ main colors, namely 2 violet dim., 1 blue (bright), 1 blue green (dim) 1 Green (bright) 1 yellow doublet. Also there are three very faint red lines. The stroboscope tests show that there are a great many lines excited by the high voltage high current discharge, ~~especially at high temperatures~~ which are not usable for the ordinary discharge. These ~~lines~~ 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. E. Edgerton.

Spent day pumping a 20mm tube. It had a leak some where so the vacuum could not be reduced to less than ¼ of a micron. At the same time Geo Hoadley had a tube made of capsilion 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 chem 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 this circuit for obtaining a high voltage condenser discharge which excites monochromatic radiation for this experiments. I suggested the following arrangement.



Spark coil to start the big spark.

The rectifier charges the big condenser to about 15 000 volts. Then at the end of the cycle the thyratron 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 gap unit of P 3 using needle points spaced about ¼ of an inch with fair results.

July 24 1931

Continued exhaust of tube and experiment. Leaks in tube somewhere. Tested the capilliary tube with the strobo discharge and got a yellow glow from the ~~tube~~ 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 10" Neon tube of 16 m.m. 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-m.p.
F = II Nebenserie
G = I Nebenserie
H = Kombinationen zwischen triplets und einfachen Linien.

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.

July 24 1931

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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
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6100 A. Triplet system Hauptserie

4050 B. II Nebenserie
C. I Nebenserie

3000 D. ~~Be[illegible]~~ Kombinationen triplet System.
E. System einfacher Linien Hauptserie 2S-mP
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 5354.05A 5389.01A 5316.69 5140.10A 5102.42H 5138.09H 5128.9E 5120.65A 5165.8E

5000 5025.56H 4827.3H 4883.1H 4827.1A 4832.2H

4800 4890.27A 4896.9H 4916.06F 4991.5H 4980.82A 4970.13H.

4662.4A 4672.7A 4685.3A 4653.4A 4722.8A 4748.1A ~~4748.1H~~ 4701A.

4600

4400

4358.34B 4343.64H 4313.3H
4358.34A 4347.60G 4339.23H

4200 4077.83H

4046.56E 4046.56A 4140.03H 4108.08F

4000

3815.84H
3801.67F 3893.89H 3903.64H 3906.40G 3901.90H

3800 3650.15C
3654.83C 3663.28H 3702.36H
3662.88C 3680.01D 3704.22G 3701.44H

3600 3523.0H
3524.27G 3590.95H
3592.97G 3591.48H

3400 3447.22G
3478.98G 3477.85H.

3305.08D
3341.48E

3200 3144.55D
3125.66C

3021.50C 3011.05D
3023.47C ~~3016.16D~~
3000 3025.62C 3050.40D 3087.48H 3131.55C 3131.84H
2804.46C 2856.94H
3805.42C (2810.51D)

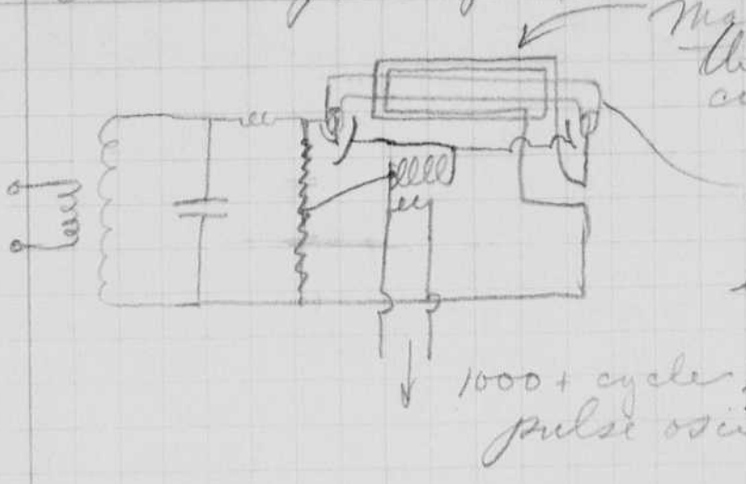
2800 2893.60B 2803.48C 2806.84 2967.28C
2925.41B 2967.52H.

H. Kombinationen zwischen Triplets und einfachen Linien.

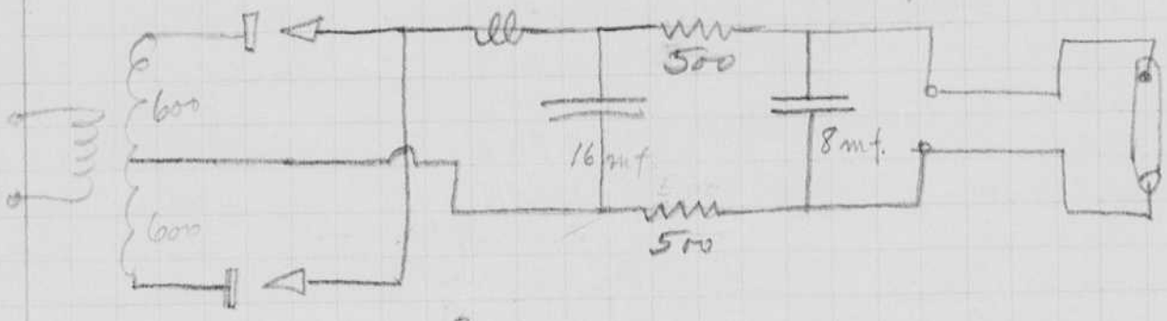
Reclassification of the Spectral lines of mercury from Paschen & Götze. "Serien gesetze der Linien spektren".

λ			
	6234.35 E	4672. 7A	3085. 26 D
	6072.63 H	4662. 4A	3050. 40 D
	5872.12 A	4653. 4A	3027. 48 H
	5859.32 A	4358. 34A & B	3025. 62 e
	5803.55 A & E	4347. 60 G	3023. 47 e
	5790. 66 G	4343. 64 H	3021. 50 e
	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 e
	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 lamps.



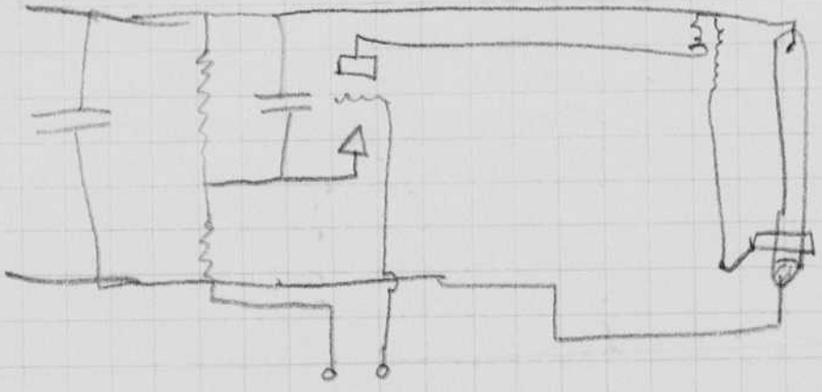
Tear down McClure and Starter Strobo and wire as follows.



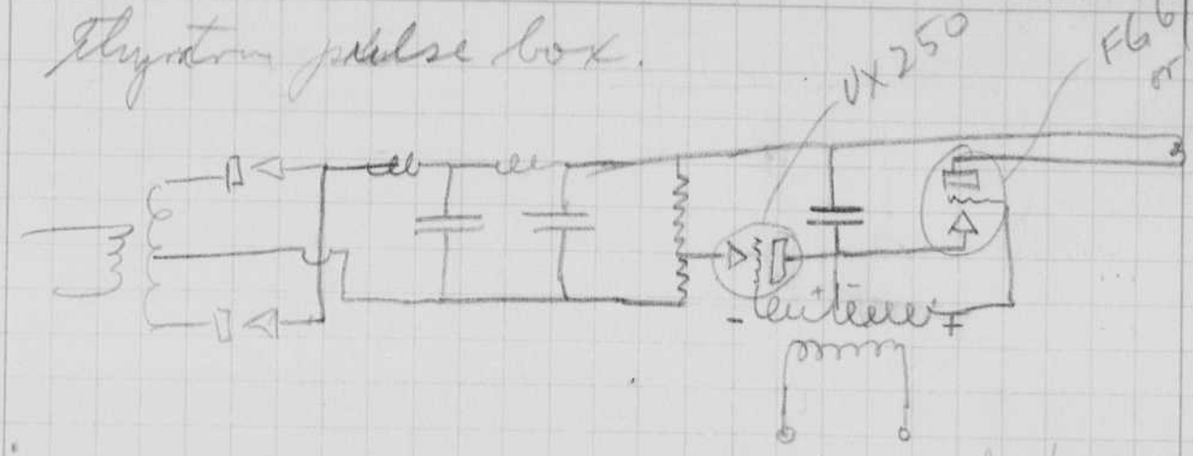
300 cyc sec

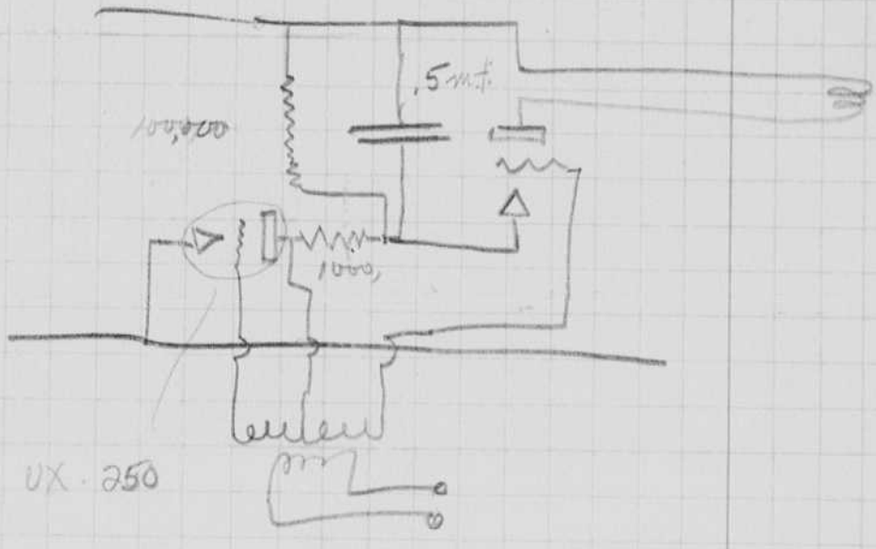
$\frac{1}{300} = 3.3 \times 10^{-3} = .003$ sec.

$C = 8$ mf $\quad R = \frac{.003}{8 \times 10^{-6}} = \frac{3 \times 10^{3}}{8} = 380.$ ohms.

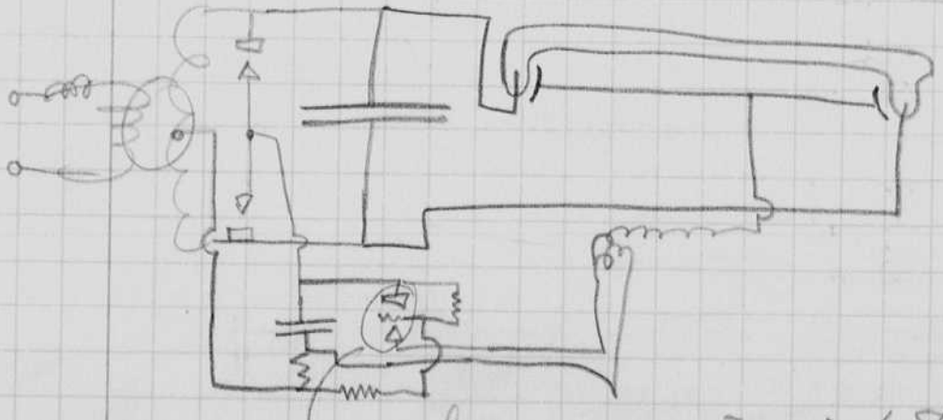


Thyratron pulse box.



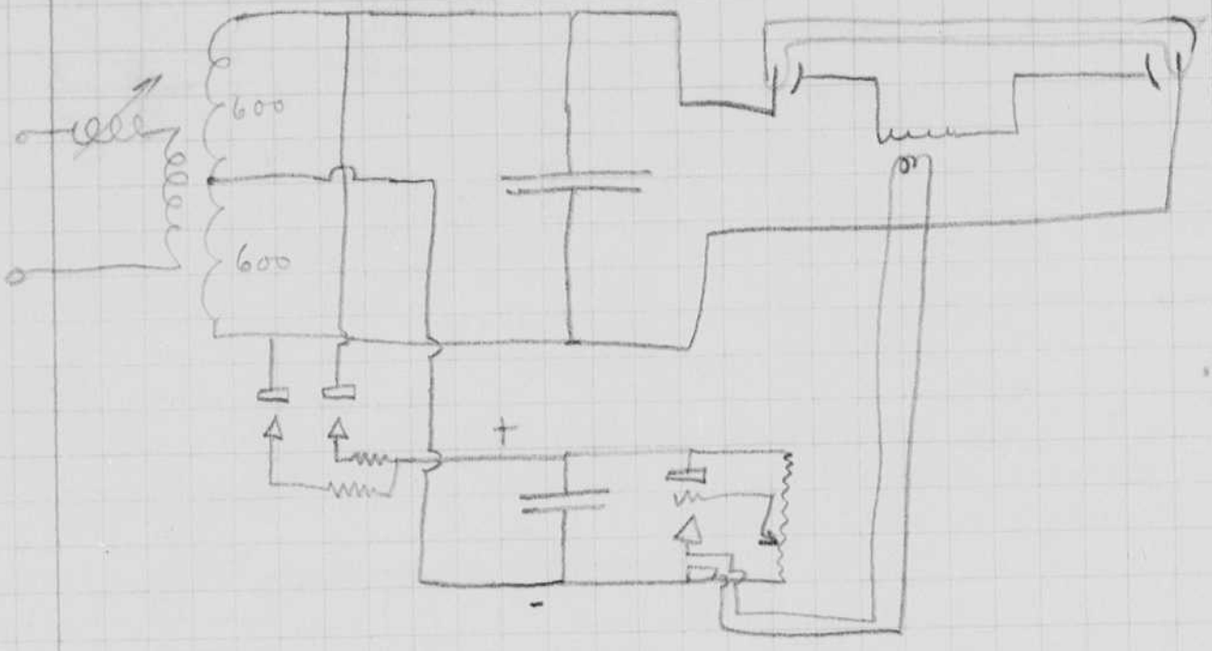


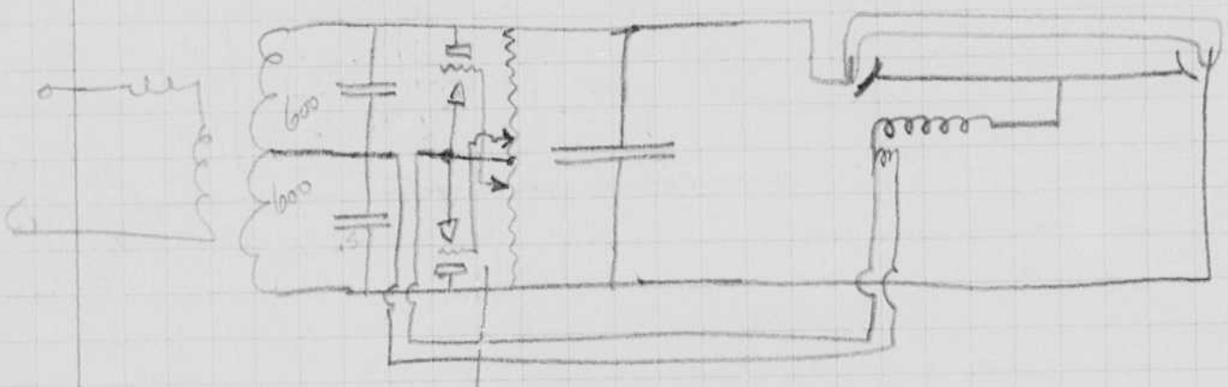
Lamp



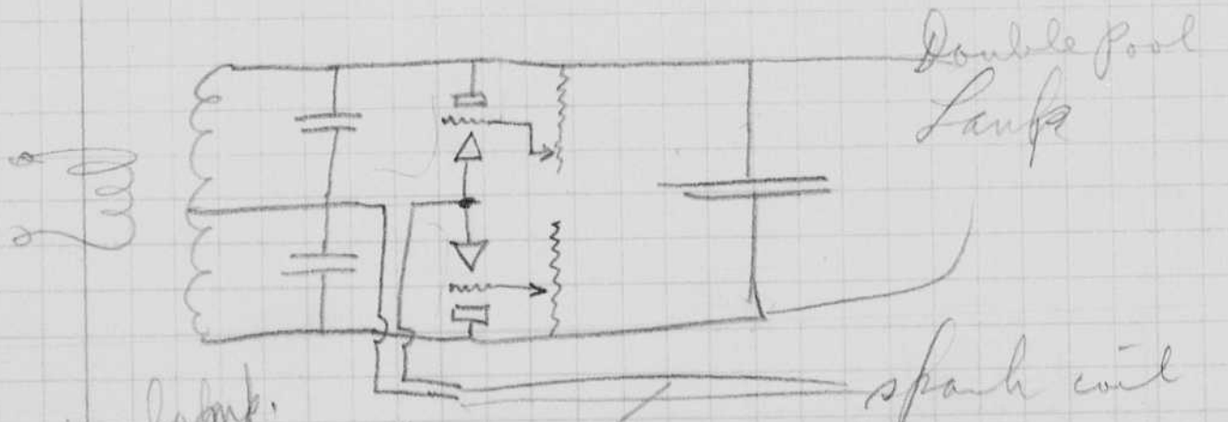
thyratron circuit to oscillate at 3000 cycles

Light circuits.

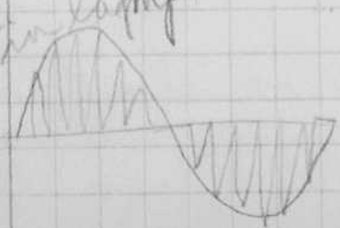




two thyratrons



Current thru lamps.

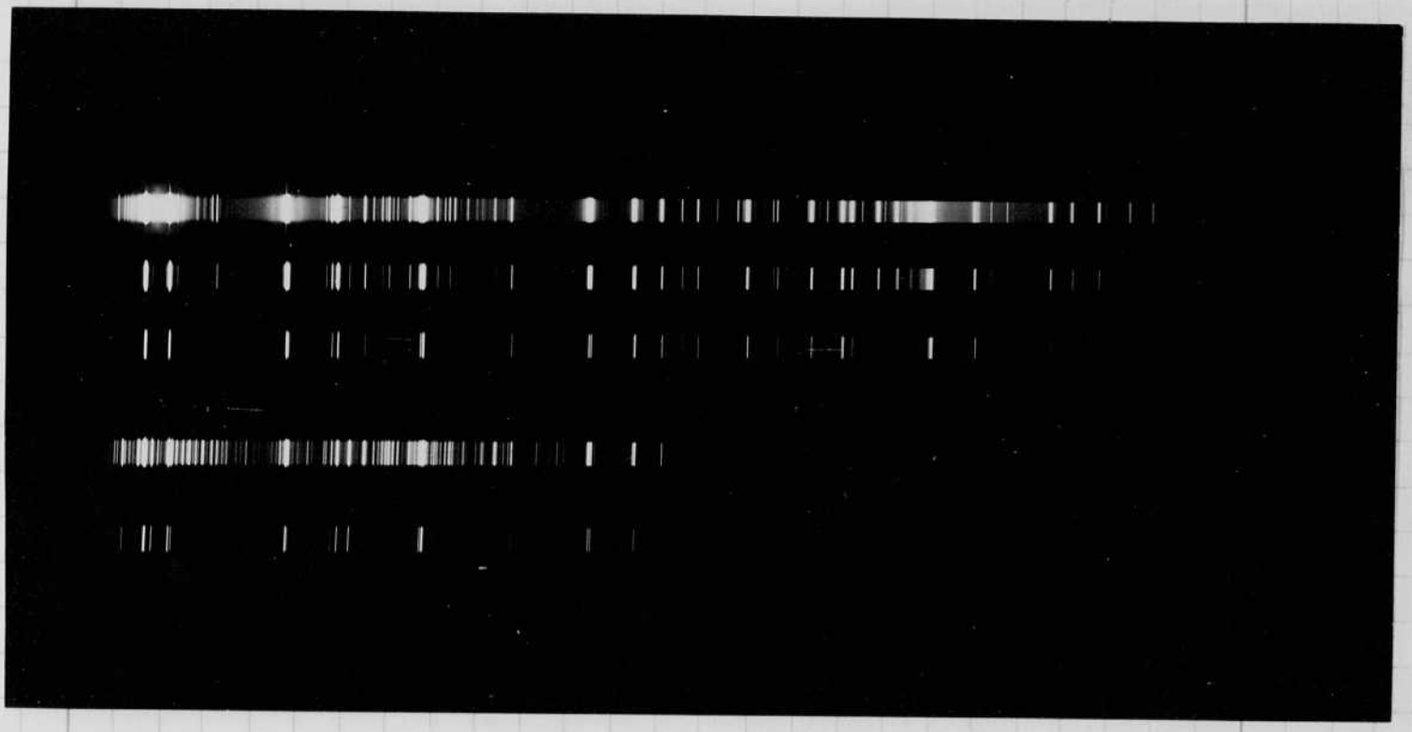


about 1000+ cycles.

July 27 1931

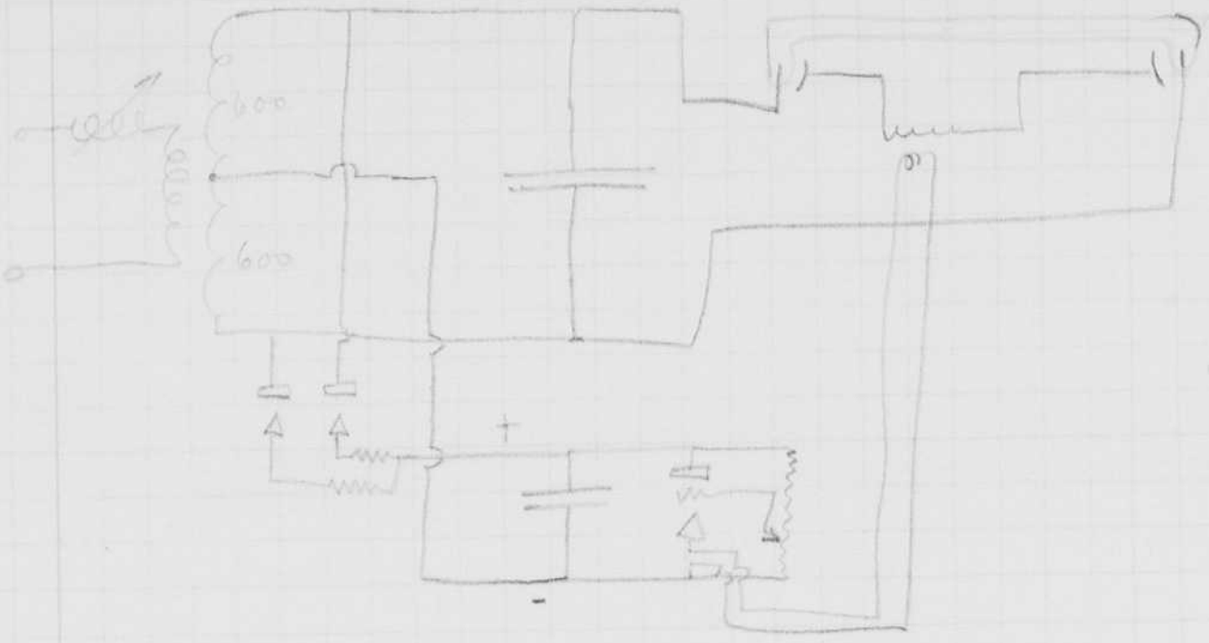
Spent most of the day taking some spectrograms in Seegraph Lab in the physics dept with the help of mr. Albertson.

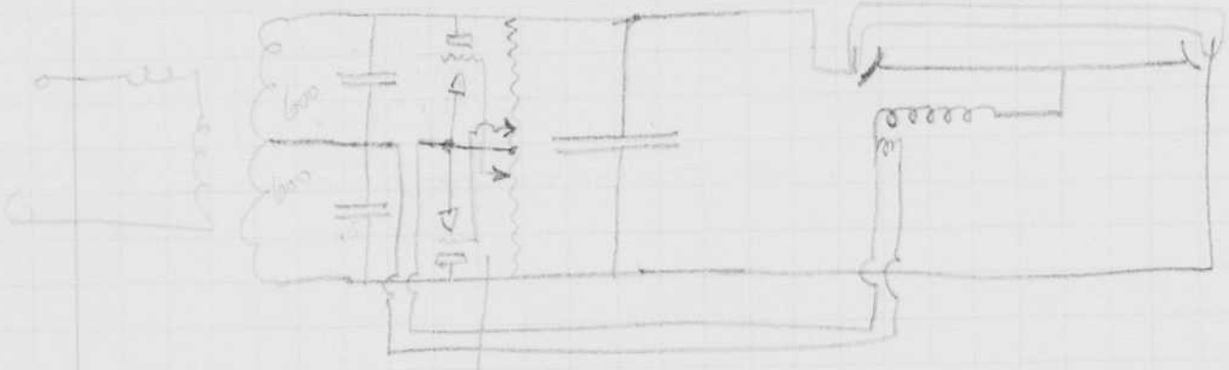
Last spectrograms. Quartz arc 3 sec 15 sec 2 min.
Stroboscope 20 sec. 12 min.



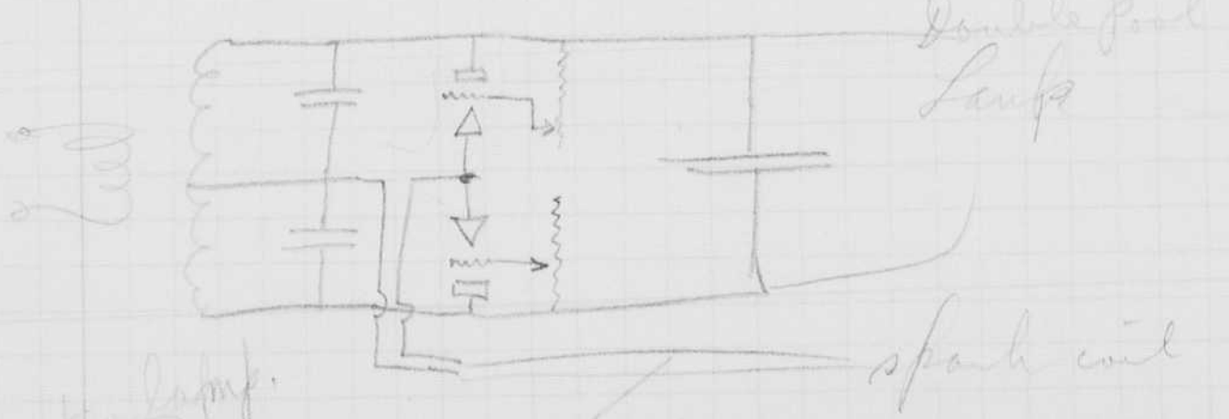
Expanded tube while taking the spectrograms. It is stepped slightly, ½, the tube length is 40 in got it up to 14 mm monex glass. Works ok. on pressures below 2 microns.

Light circuits.





two thyratrons



Double pool Lamps

spark coil

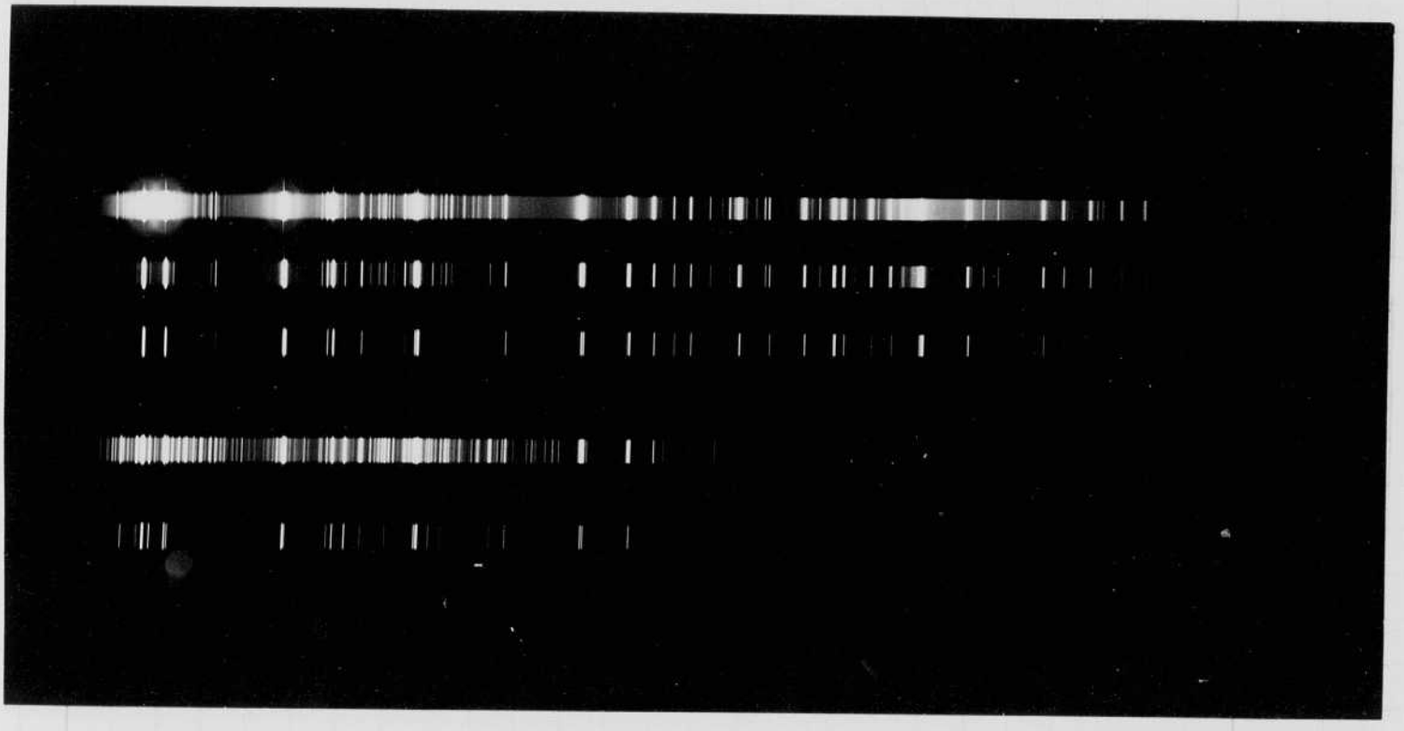
about 1000+ cycles.

Current in lamp.

July 7 1931

Spent most of the day taking some spectrograms on long lamp. Ed Bozman helped me with the plunger. Left with the help of Mr. Albertson.

1st spectrogram. Quartz arc 3 sec 15 in. 2 min.
Strobe spk 20 sec. 12 min.



Separated plate with filter along the spectrograms. Also left feed lengths. The tube length is four [illegible] 14 mm Nonex glass. Works O.K. on pressures below 2 microns.

July 28 1931

Sealed off Z tube.

Mitsuharu Fukuda

Change of Wave length for certain lines of Zinc, cadmium and mercury in a condensed Discharge

Tokyo Phys Sci Proc 3 p 185.

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

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

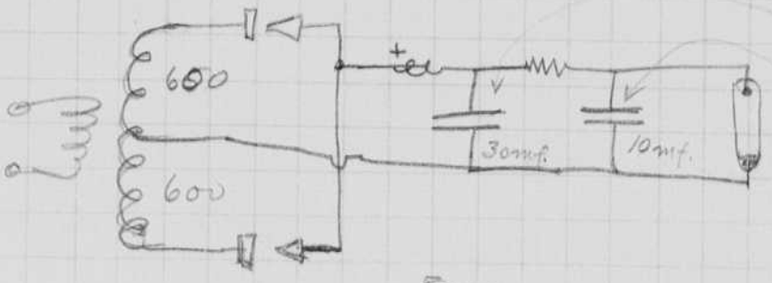
July 31 1931 Pumped out Projector pulse tube similar to those shown on p 4. There was a leak somewhere.

Aug 1 1931 Continued pumping on pulse tube with no success.

Experimented with cajant and punctured Z tube and cracked glass on the 20 mm tube.

Built a ~~tin~~ reflector for the 20 mm tube.

Aug 2, 1931. Variable freq. Stroboscope



3 – (9CE1A5F) 14 mf 440 v a.c.
1 – (9CE1A5E) 9D mf 350 v a.c.
5 – (9CE1A5) 2.0 mf 550 v a.c.

500 cyc sec.

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

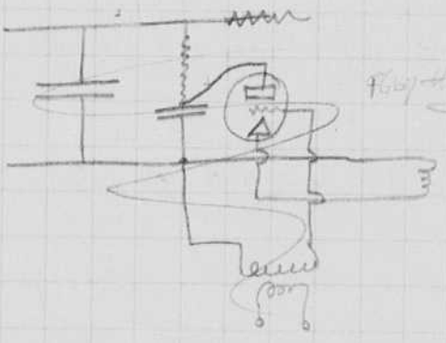
RC = .002 sec C = 10 mf.

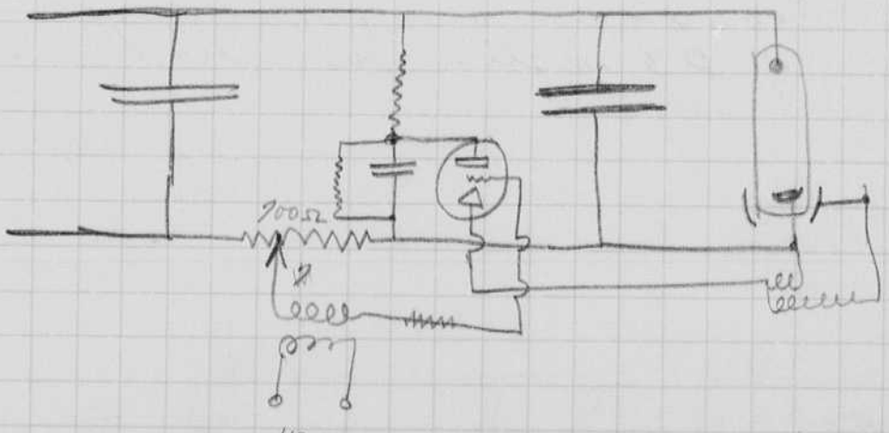
$R = \frac{.002}{10 \times 10^{-6}} = \frac{.002000}{10} = 200$ ohms.

and if 2 mf is used

R = 1000 ohms.

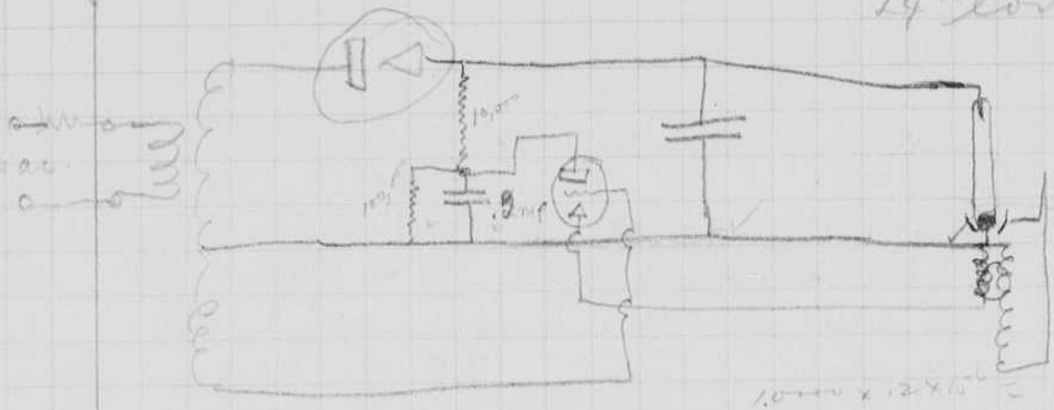
Let R = 700 ohms.





Aug 3 1931

Hg Vapor. Built another tube. 16 mm Neon 24" long.



Changed circuit

Joseph. Vabaogle Spark Spectra of Mercury Vapor
J.O.S.A. 17 - 1928 p 102

Dejardin Ann de Phys 2 pp 241-327 1924
C.R. 185 p 1340 1928

Eldridge Phy Rev 29 p 213 1927

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

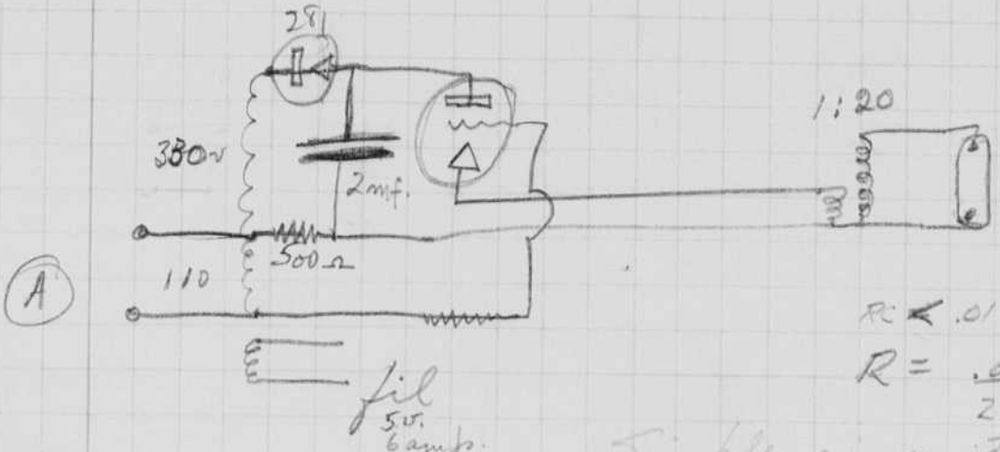
Carrol Phil Tran A 225 pp 357-420 1926.

Aug 4 31 Exhausted tube shown at top of p 3 after bulb had been recoated.

Aug. 5, 1931.

Small lab. stroboscope.

110 5 mf.
300 2 mf.

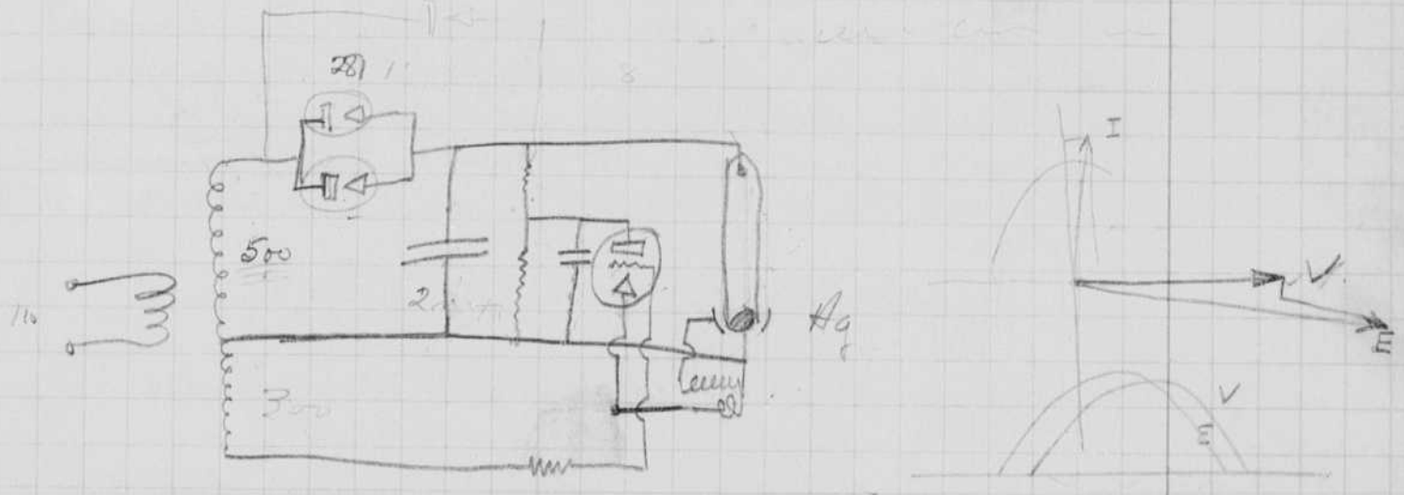


(A)

R < .01 res.

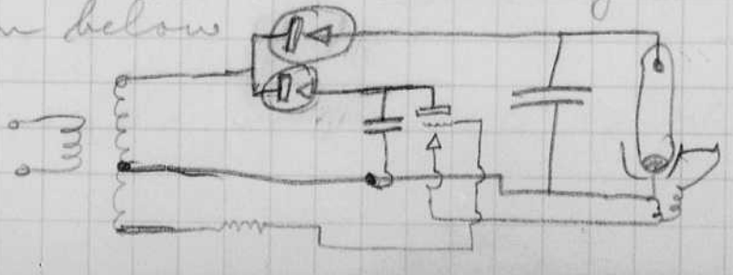
$R = \frac{.01 \times 10^6}{2 \times 10^4} = \frac{1000}{2} = 500$ ohms.

Simple circuit to try.



Exhausted double pool tube today. Circuit p. 12.

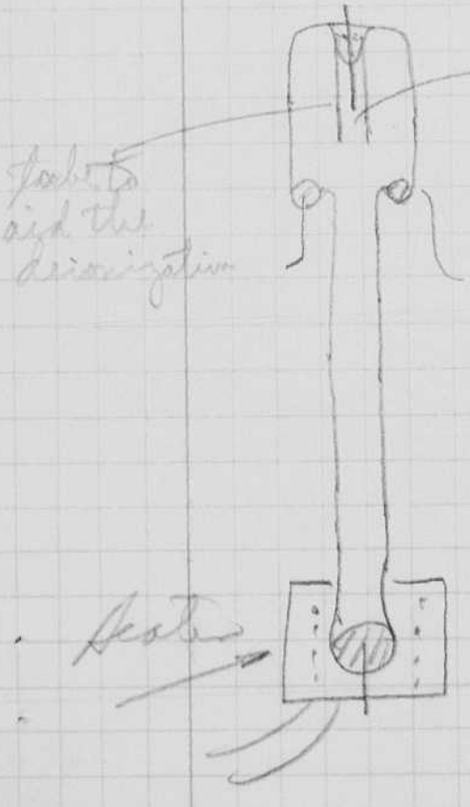
Experimented more with the circuit shown above. Some trouble was found when the Hg tube failed to strike. If this occurs the discharge blocks and control is not regained for the next cycles. This can be remedied by connection shown below.



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

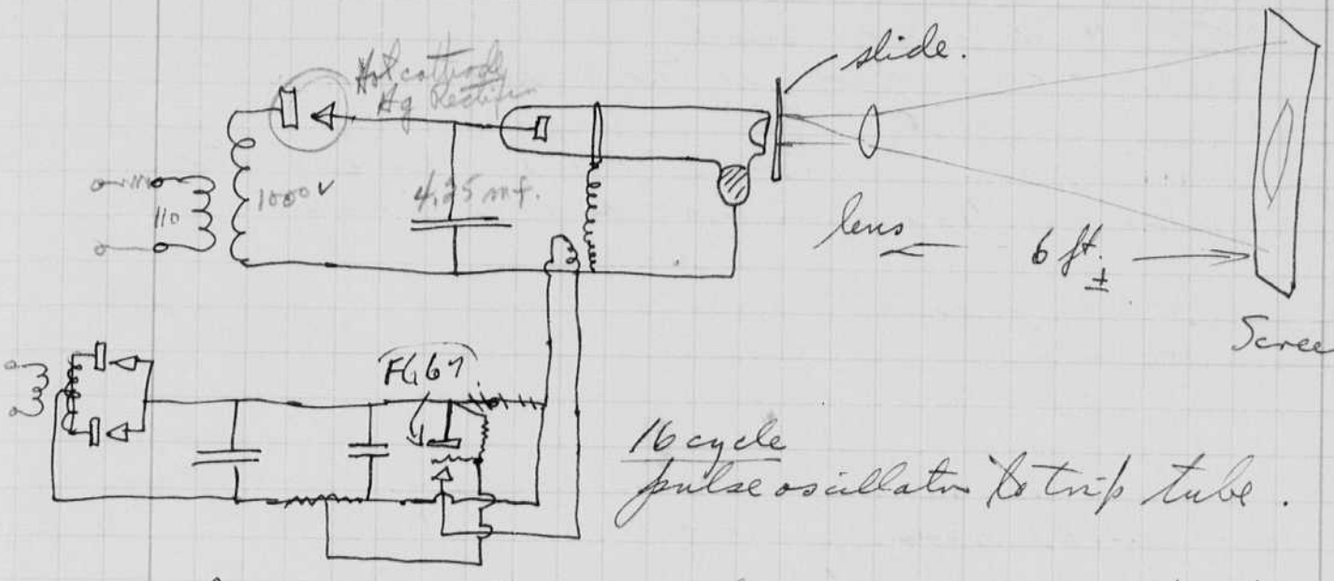
The tubes will work better if they can be heated before starting I believe this can be easily accomplished

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



Aug 6 1931
H. E. Edgerton.

Projector pulse tube set up and exhausted.



16 cycle pulse oscillator & trip tube.

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

Aug. 7, 8. Worked for Bunk 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.

$\frac{(\sqrt{2}\,600)^2 \left(\frac{3}{4}\right)^2 8\times10^{-6}}{2}$ = energy per cycle $\frac{2\times.36}{2}$ = 0.112 joules/sec

Light is not brilliant but is bright.

at 1000 volts 2.2 mf is about the limit.

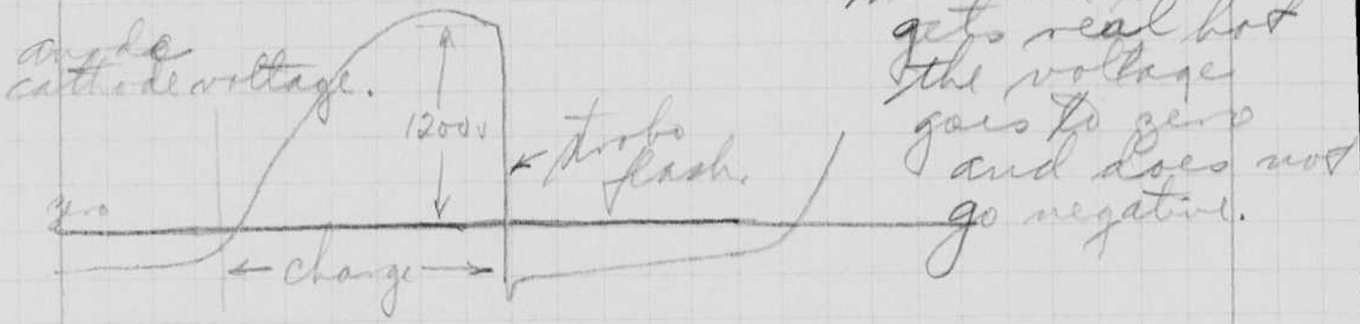
$\frac{1.000\times1.000\times2.2\times10^{-6}}{2}$ = 1.1 Joules per cycle

1. Joule per cycle.
1 × 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 1/5 of the forward voltage.

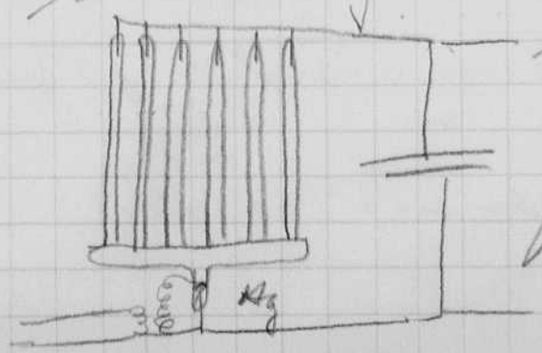
When the tube gets real hot the voltage goes to zero and does not go negative.

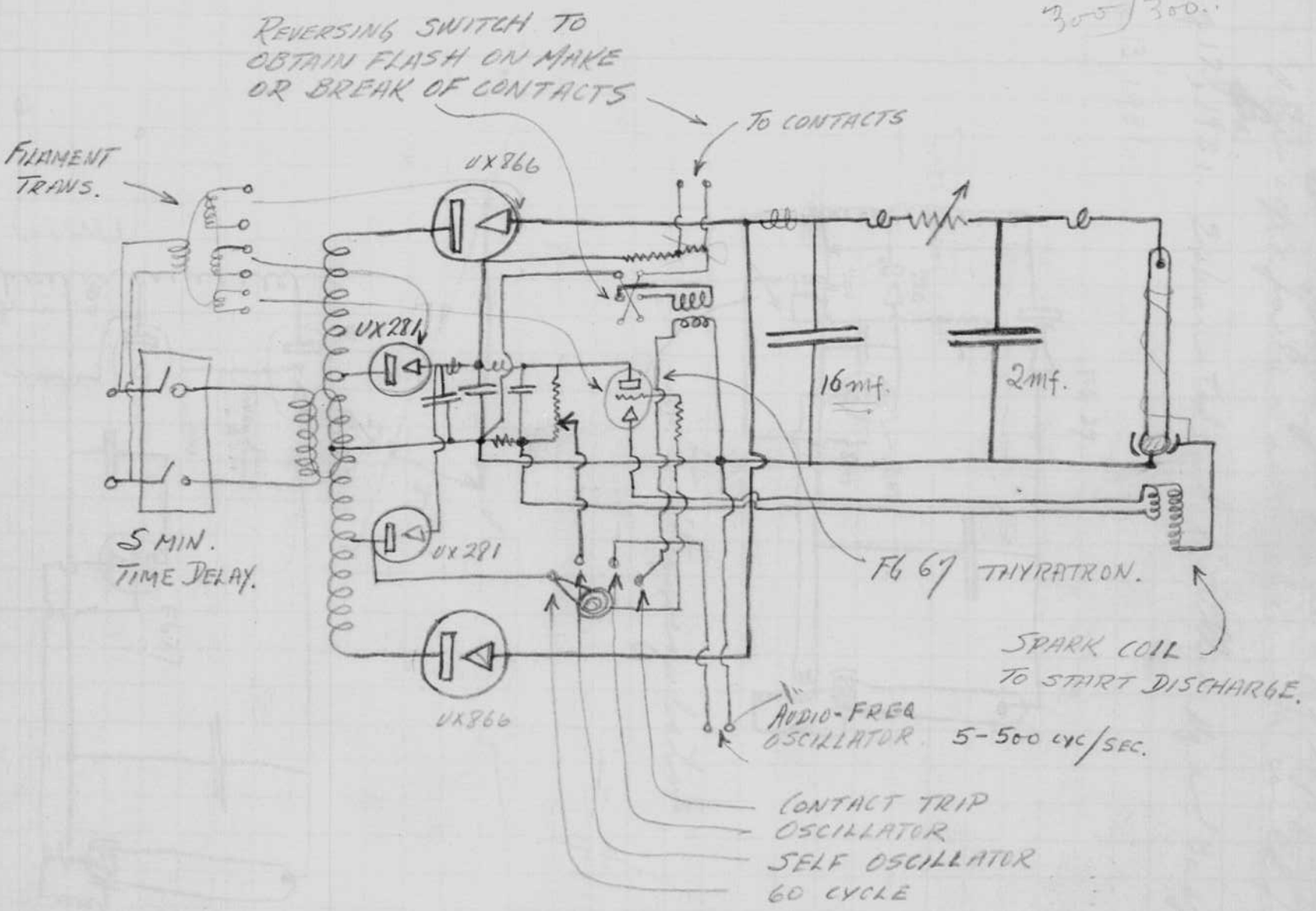


A .95 mf condenser and a 1000 volt connection on the rectifier operates ok with 4 ohms in the primary.

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 spit 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.





STROBOSCOPE.

AUGUST 10, 1931.

H. E. EDGERTON.

Aufg. 9.

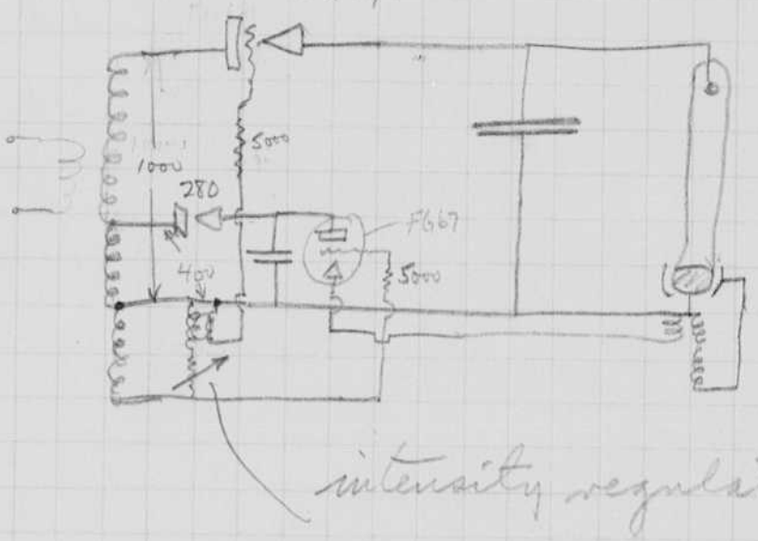
Aug 11 1931.

Built tube for Ba and Hg exp for Fowler.
other exp a failure since chemists could find no Ba.

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

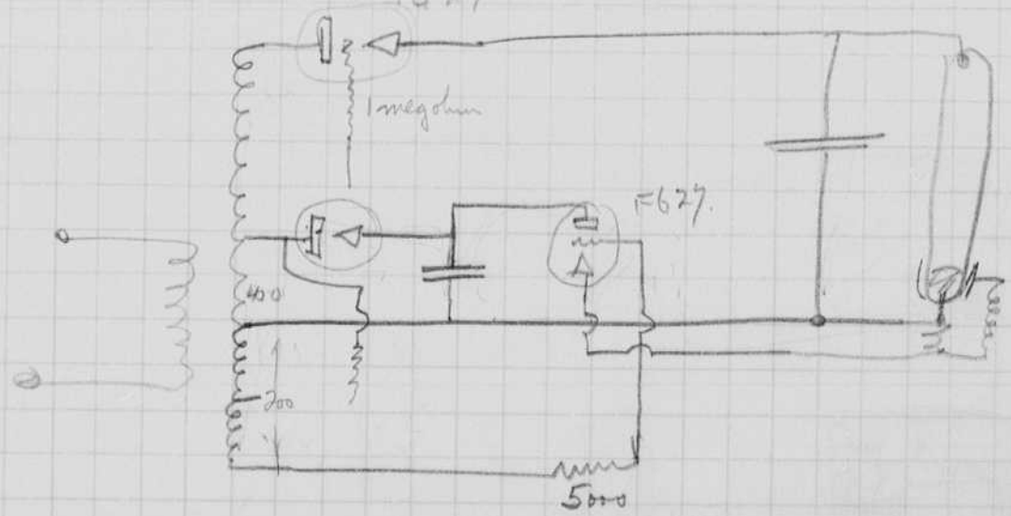
Aug. 13, 1931.

FG 27.



intensity regulator.

FG 27



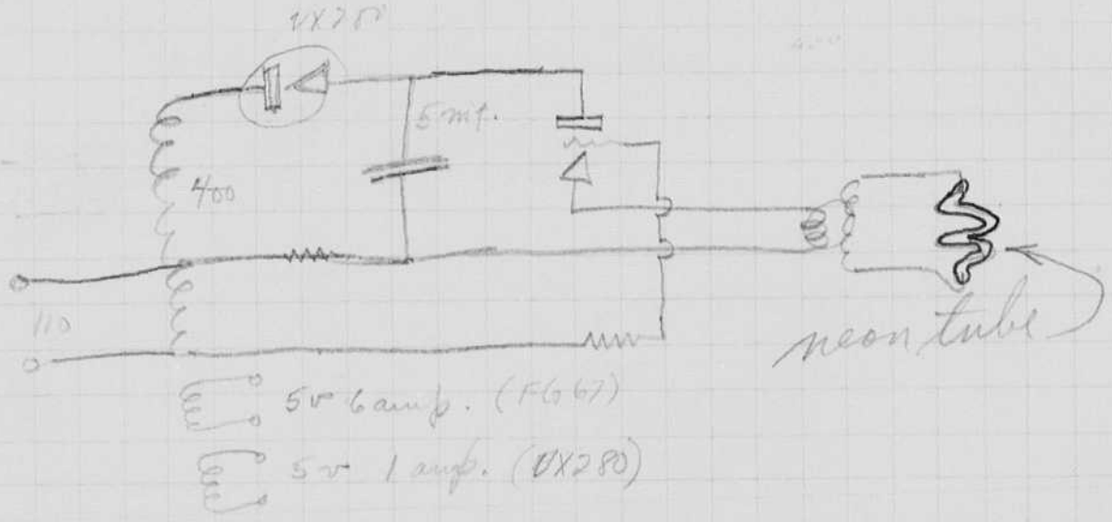
This equipment was shown us in operation on August 24, 1931, and we have understood the principles of its operation.

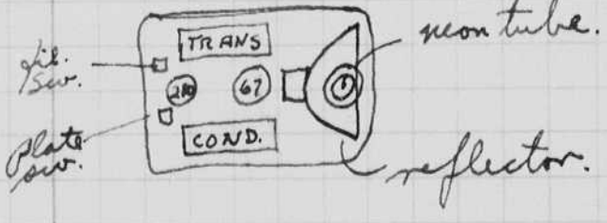
A R Fletcher
David L. C. Luck

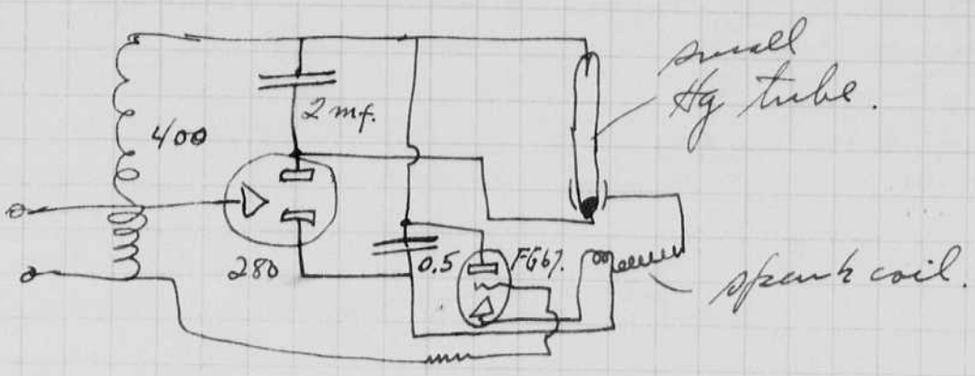
Aug 14/1931 Experimented with Ba precipitates
Started wiring up 60 cycle strobs. as shown on p 21.

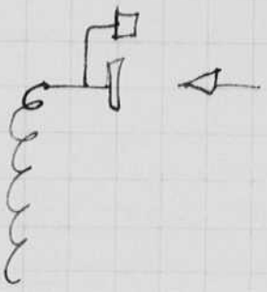
Aug 15, 1931 Reported Experiment to Marshall of Raytheon.
Finished wiring up 60 cycle strobo as shown on p 21. There was a lot of flicker at first which finally was eliminated by reversing the leads to the spark coil

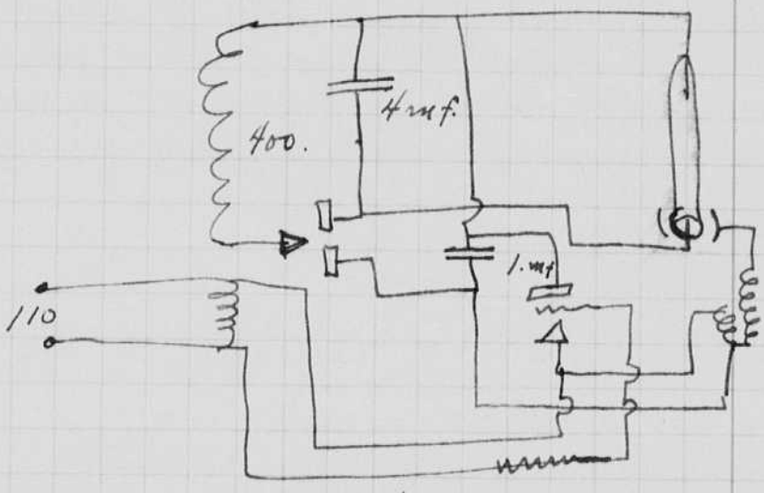
Small portable stroboscope







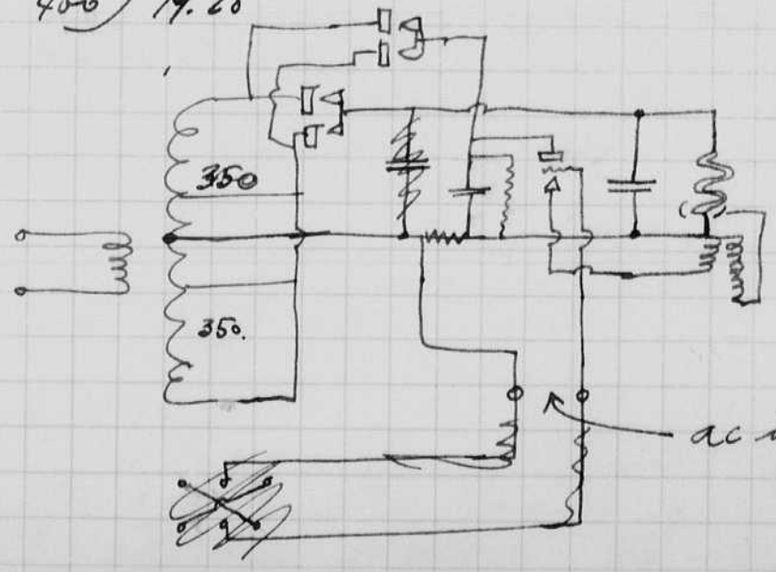




$\frac{CE^2}{2} = \frac{4 \times 10^{-6} \times 400 \times 40}{2}$ $2 \times .16 = 0.32$ Joules.

$60 \times 0.32 = 19.2$ watts.

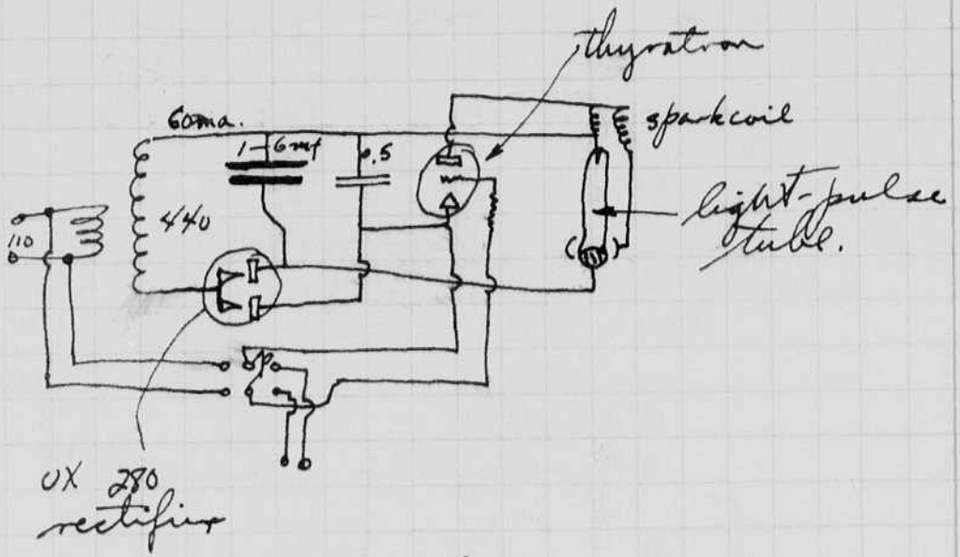
$400 \overline{)19.20}$ .04



Any ac input can be used to run this circuit.

Stroboscope circuit

Aug. 16, 1931.
H. E. Edgerton.



I plan to build two of these for the Machine transients lab and may sell one of them or possibly two to Studer 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 Swampscott in October.

The circuit shown on p 24 acts up when it gets hot. Part of the trouble is in the thyratron 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 capilliary 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 altered somewhat where this orange glow was.

The second tube was about 2½ feet long and was of 6 mm monex glass. It works OK.

Aug. 19 1931.

Blew a 4 arm tube today for 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 deconize.
The operation of this tube was very erratic on the pumps.
the arms do not work in parallel when cold but do when they become hot.

Aug 20/1931. Built tube

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

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

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

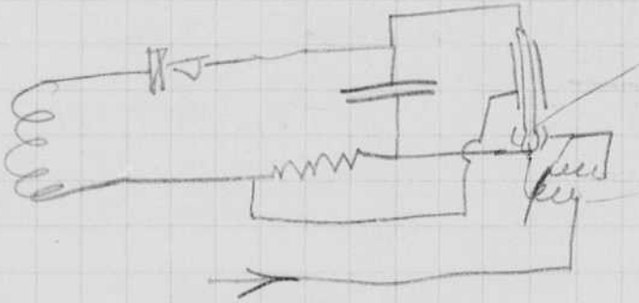
Aug 21. 32

Experimented with 60 cycle stroboscope completed and put in a box for portability.

Aug 24 1931
1 P.M. to 6. 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 hell with the positive column. If the tube has a 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.

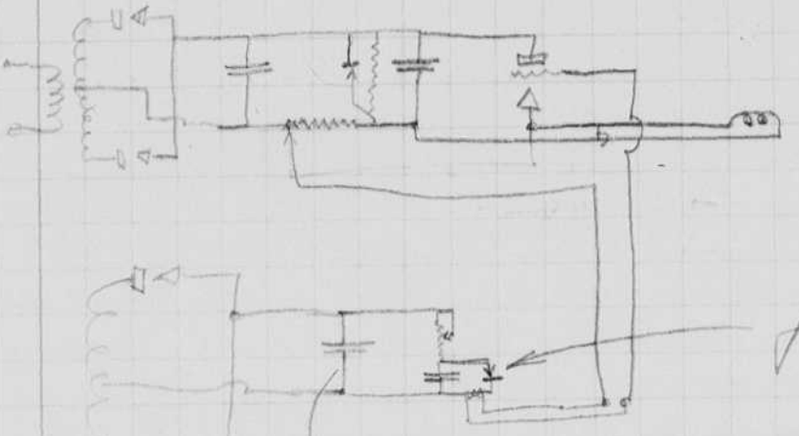


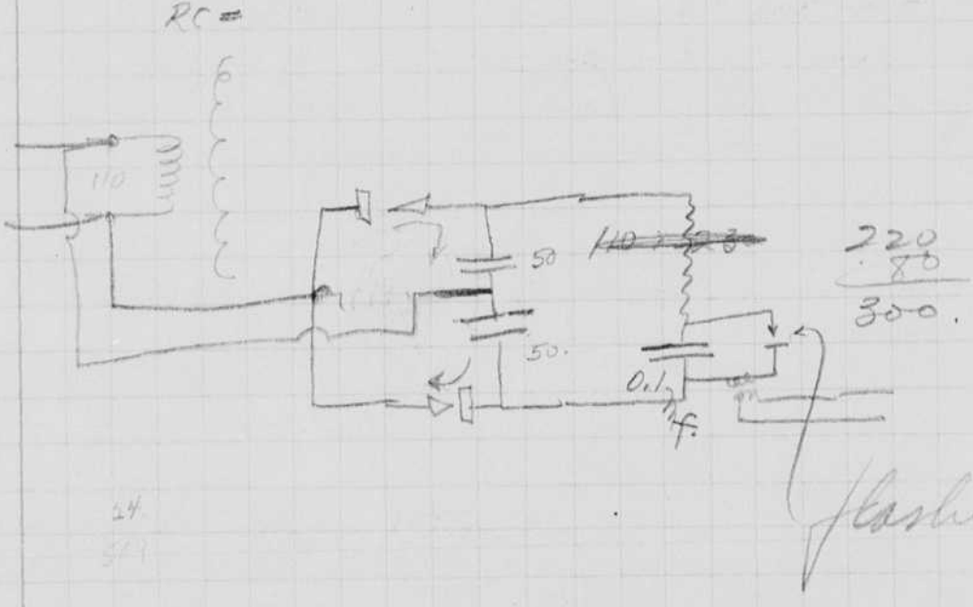
Aug 25, 1931 L. Bingham, Univ of Nebr. was here today with his wife and son Richard. He saw the 60 cycle strobo in the a.f.

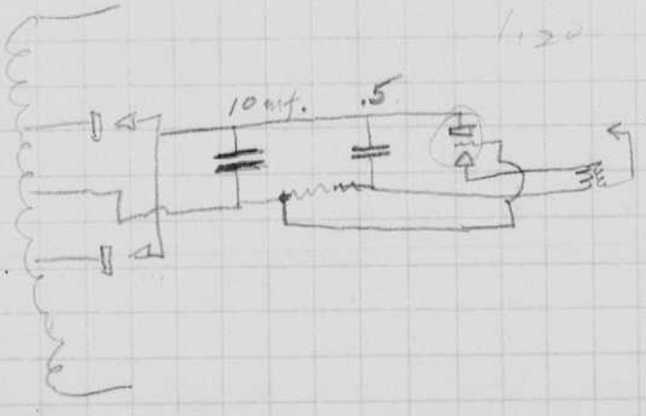
Aug 26 1931 Answered letters. Saw Mr. Palmer of Colorado and showed him the 60 cyc strobo. In the afternoon Mr. Alger (U.S.G.) and Prof. Creedy saw the lab and I again demonstrated the 60 cyc strobo scope.

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

Aug 27 Oscillator for strobe.



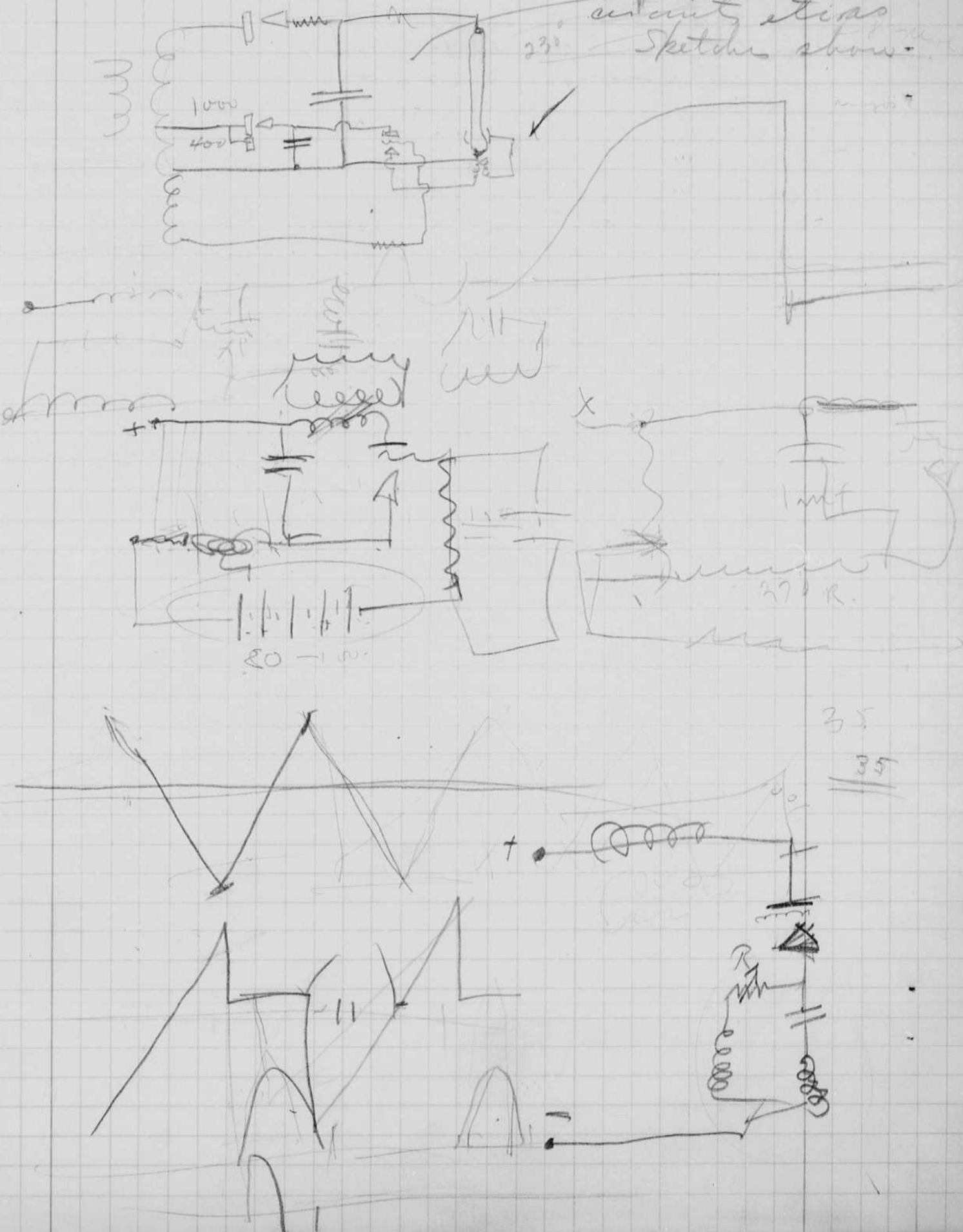




Aug 28 1931.

Protoboard was here and we discussed circuit bias

Sketches shown.

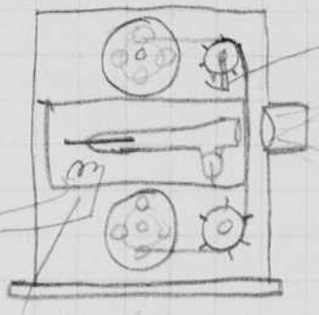


Aug 29 1931
H. E. Edgerton

Spent time wiring up variable speed strobe. Yesterday I went over to Agnew Hospitals and saw Hasefield. He showed me a photoelectric device for enlarging anything on tin foil so that it could be used for blind people. Also talked to Quimby about taps & collar that he has built. It is a dynamo which I think may be OK for variable frequency for driving the stroboscope.

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

Aug 30 1931 Intermittent light.
H. Hedgcock. Movie Projector.
Experimental model.

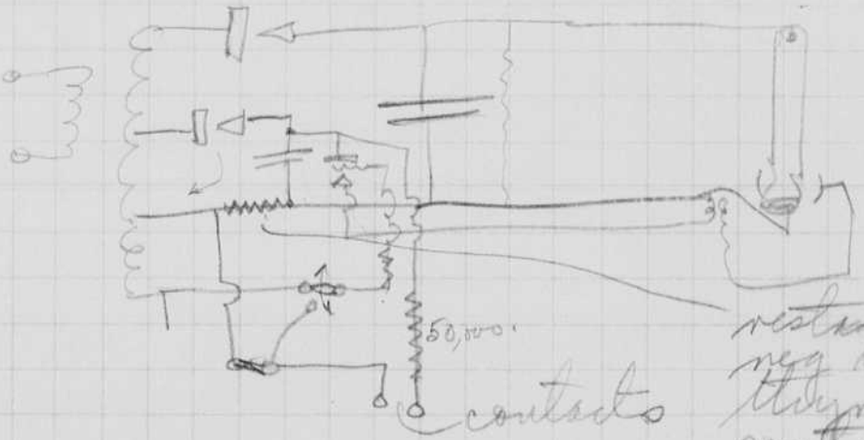


framing device, a contact to flash the light when the picture is over the frame. This can be accomplished by means of a photo-cell.

heater coil

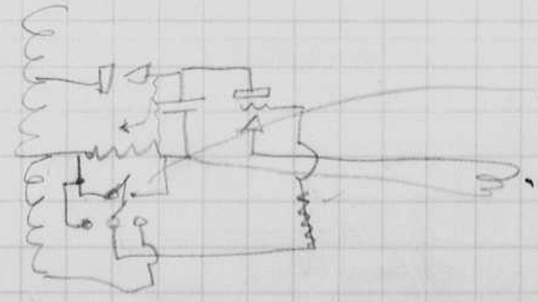
Aug 31, 1931 Wired on Strobs for 60 cy. freq. Built parabolic reflector. P. Gray & Sons to bend the stainless steel mirror

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

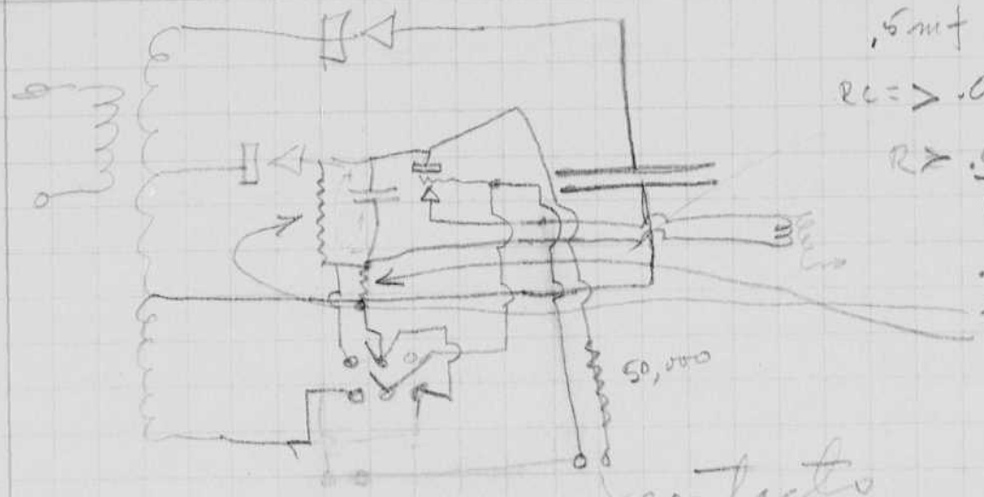


contacts

resistance to give neg. bias to the modulator shield control.

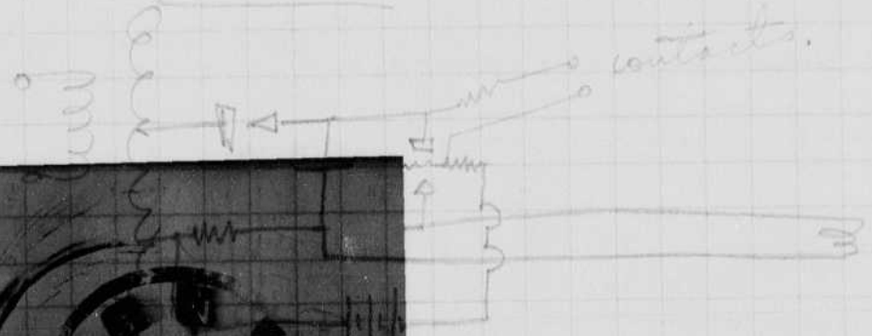


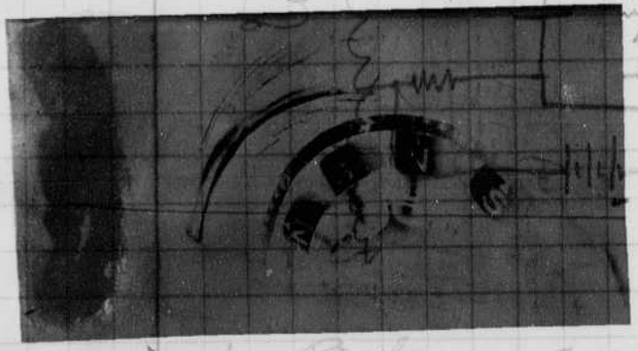
plus resistance for 60 cycle operation.



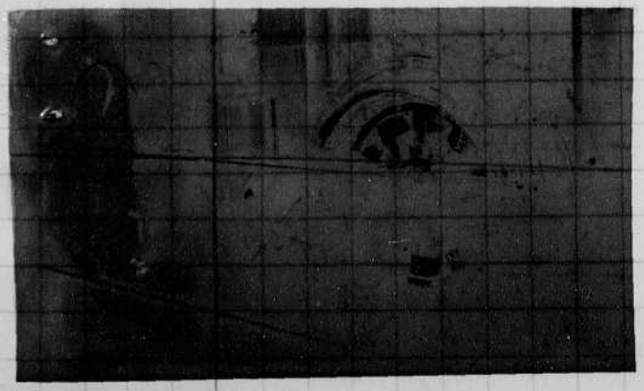
Assistant work.

A battery (6 volt) was used as a beam and bit worked by a contactor but the springs vibrated.





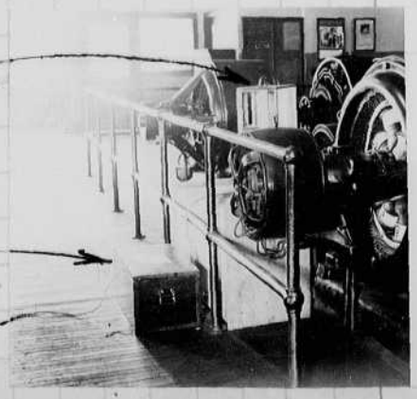
↖ 1-Picture F12 1/2 second exposure Speed.
1 " F12 1 mix
↙ 1 " F12 1 second.



Parabolic Reflector

Auxilliary apparatus.

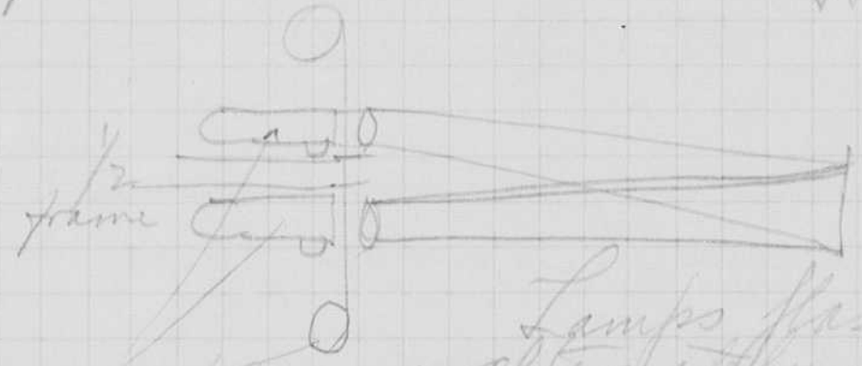
110 V a.c.



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 conditions. He is coming over tomorrow at 3:30 or 4. To see the stroboscope.

Stroboscope notes.

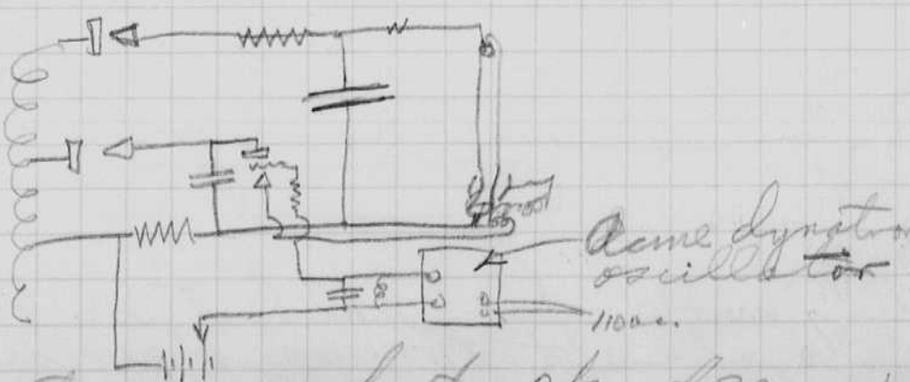
Flash each frame twice to get rid of the flicker. There would be two flashing in addition to pulse lamps but the ones would be focused on the same place.



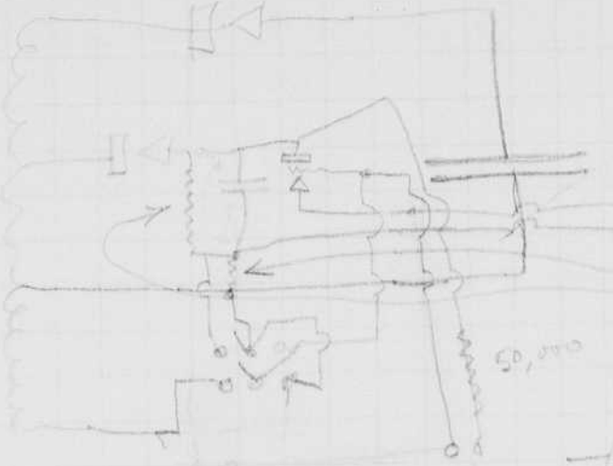
Lamps flash given distance apart thus differ by half a frame.

pulse lamps.

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

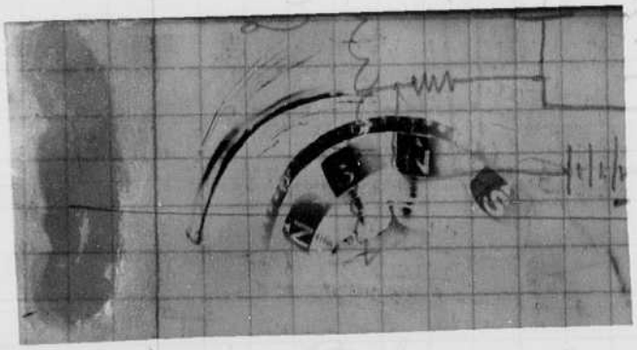


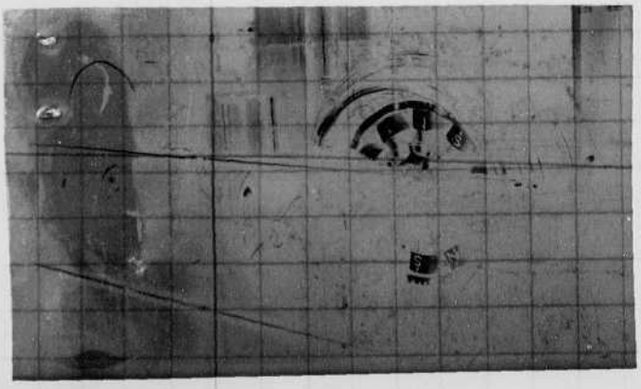
Does not work so hot. OK at 30 cycles per sec.
Talked to Church and demonstrated stroboscope in dynalab.



.5 mf
Rc => .02 meg
R> .02/.5 x 10^6
.4 x 10^5
40,000
20,000

contacts.

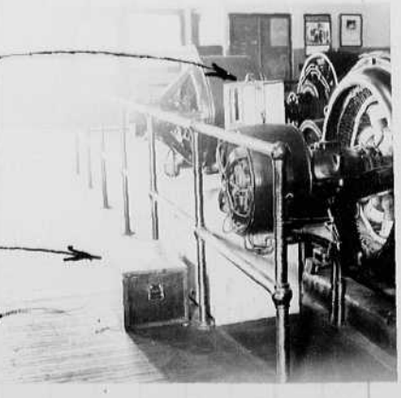




Parabolic Reflector

Auxilliary apparatus.

110 V a.c.



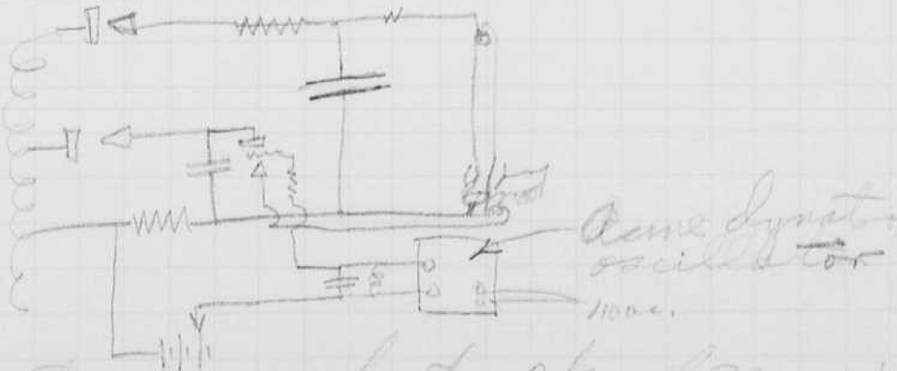
Alfred Church at Silver Illuminating Co
about approximate motors. Invited
to see the apparatus and comparison
which had large room under
variable load conditions to
difficulties starting conductors. Je
at coming over Dynamo and
3.3 or 4. To see the diagram.

Stroboscope Notes.

Flash tube frame hinged to
get rid of the flicker. Then work
the two flashing alternately for
comps and the image produced
focused on the same place.

Lamps should
not be operated
with different
pulse lamps.

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

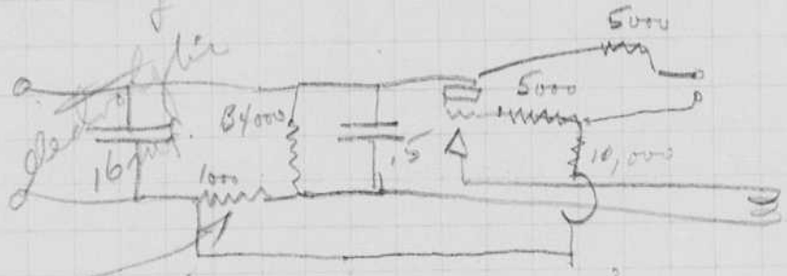


Does good work on 60 cycle. OK at 30 cycles
Talked to Church and demonstrated stroboscopic lamp.

Sept 3 1931

~~Wired~~ Wired Variable freq strobo
Started exhaust of tube.
~~Experimented with~~ Experimented with oscillator.

Sept 4, 1931 Finished variable freq strobo driven by contactor. Observed the supervising picture mechanism and it was very interesting to see the springs ~~play~~ oscillate! Showed to Hardy and Dan Caldwell.
Wendell Berge and wife from Washington D.C were here today.

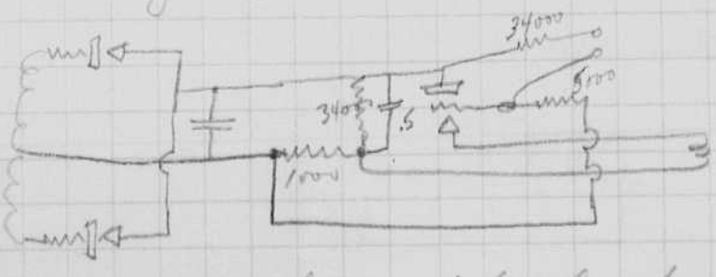


$RC = .5 \times 10^{-6} \times 1000 = .5000 \times 10^{-3}$ sec

should be .0016 sec say .001.
2000 ohms instead of 1000

When at low speed the condenser (Hyatt ignition circuit) charges ~~through~~ before the contacts part and the tube breaks, thus 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.

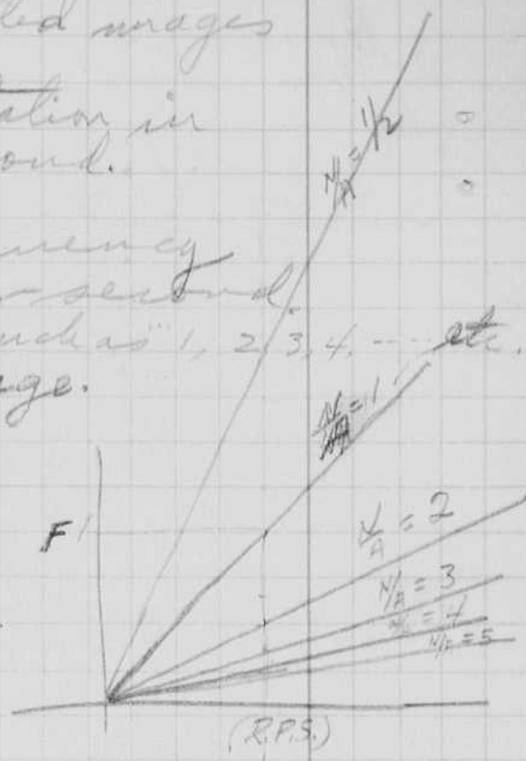
F = the light frequency in cycles per second.

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

Condition for stationary image.

(R.P.S.) $A = NF$

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



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

Example.

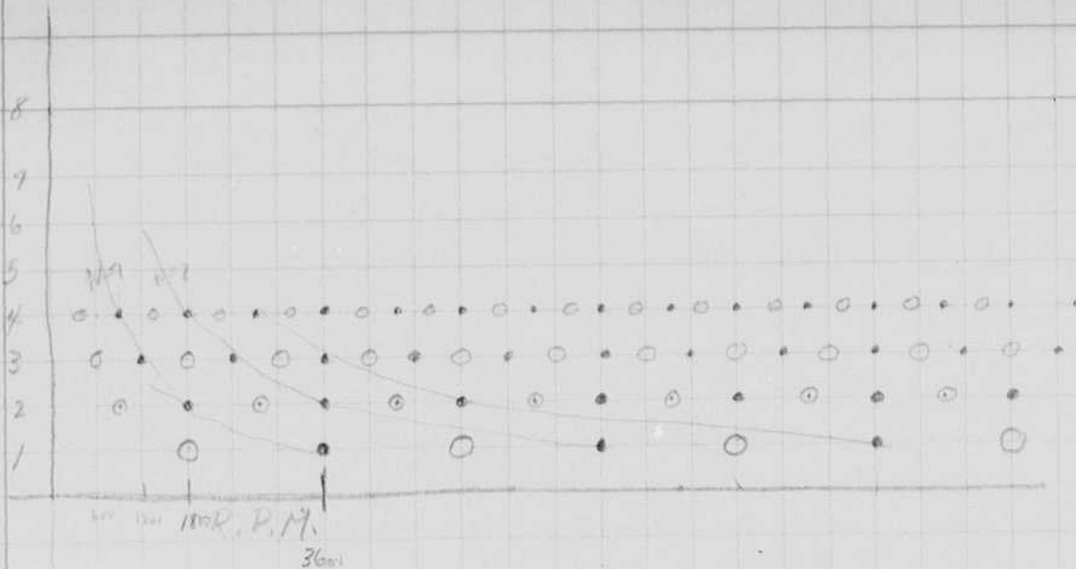
60 cycles per second (light).

N/A	1	2	3	4	5	6.		1/2	1/3	1/4	1/5
(R.P.S)	(1	2	3	4	5	6.)	×60	1/2	1/3	1/4	1/5
	~~60~~	~~30~~	~~20~~	~~15~~	~~12~~	~~10~~					
R.P.S.	60	120	180	240	---	etc.		30	20	15	12	10 ---

A = 10 divisions

	1/10	2/10	3/10	4/10	5/10	6/10	7/10	8/10	9/10	10/10
R.P.S	6	12	18	24	30	36	42	48	54	60
R.P.M.	360				1800.					3600
Possible speeds.	10	10	5		2					1

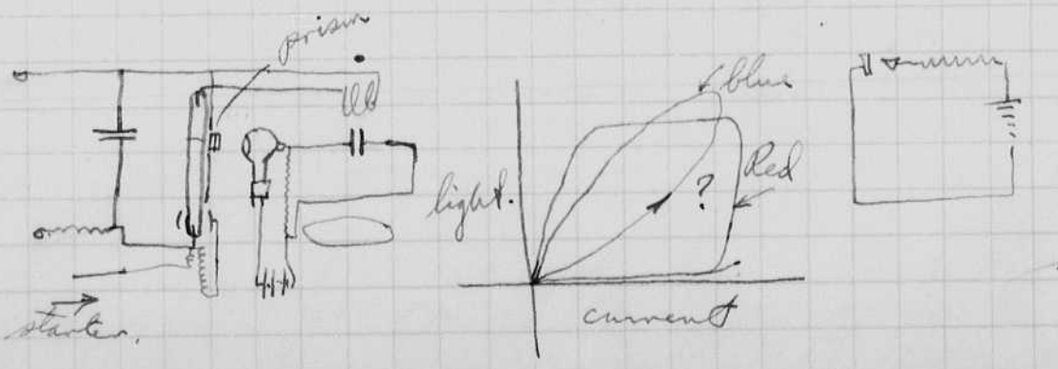
Spot.

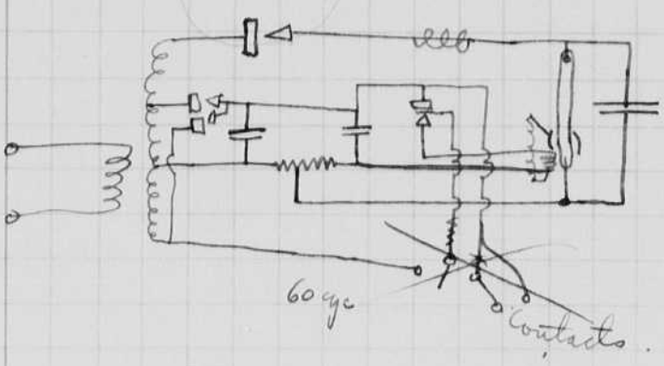


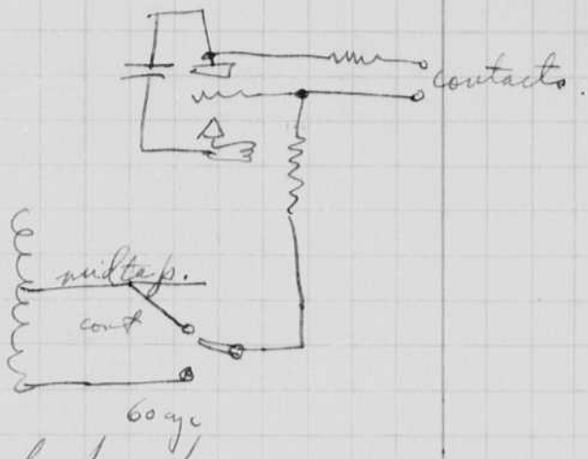
$$\frac{N}{A} = \left(\frac{R.P.M.}{60 \times F}\right) = \left(\frac{RPS}{F}\right) \quad \begin{matrix} 1 & 2 & 3 \\ & & \\ 1 & & 1:2 \end{matrix}$$

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

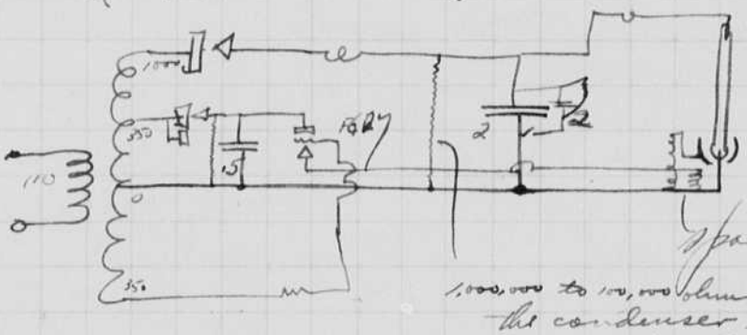
Sept 6 1931.
H. E. Edgerton Some question has arisen in my mind about the relationship between light and current in the stroboscopic tubes. An important experiment is to find this relationship. One method occured to me. Deflect a cathode ray oscillograph beam with current along one axis and deflect it 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.

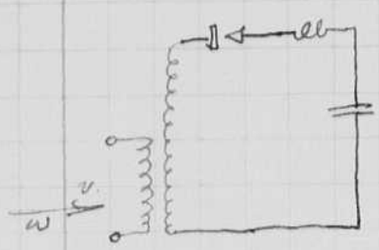


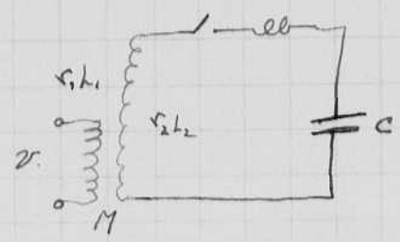
1,000,000 to 10,000 ohms to discharge the condenser when the power is off.

60 cycles strobo.

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

Sept. 7, 1931.
H. E. Edgerton





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

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

$$0 = \cancel{(r_2 + L_2 p) i_2' + M p i_1'} \quad \left(r_2 + L_2 p + \frac{1}{Cp}\right) i_2' + M p i_1'$$

Initial current in secondary $= 0$.

" " " primary $= \frac{v}{(r_1 + L_1 p)} = \frac{v}{(r_1 + j X_1)} \cong \frac{v}{j\omega L_1}$

$j X_1 = j\omega L_1$.

" charge on condenser $= 0$

Solve for characteristic mode

$$i_1' = -i_2' \left(\frac{r_2 + L_2 p + \frac{1}{Cp}}{Mp}\right)$$

$$(r_1 + L_1 p)\left(\frac{r_2 + L_2 p + \frac{1}{Cp}}{Mp}\right) - Mp^2 = 0$$

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

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

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

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

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

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

two pure imaginary roots $p = \pm j\omega$.

The currents etc will be of the form

$$i_1' = I_A \varepsilon^{j\omega} + I_B \varepsilon^{-j\omega} + I_{ss}$$

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

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

10:1 ratio. $L_1 = 1$ henry.
$L_2 = 100$ hennyes. +
$M_c = \sqrt{85.} = 9.22$ hennies.

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

$\omega = \sqrt{\frac{1}{2\times10^{-6}(100-85)}}$

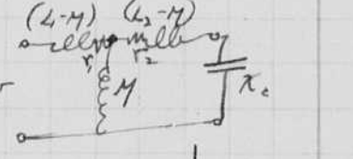
$= 10^3\sqrt{\frac{1}{30}} = 10^2\sqrt{\frac{100}{30}} = 183.5$ rad. per second.

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

$2\times10 = 20$ mf
$\frac{10^6}{200 \times 377 \times 14^6}$
$\frac{100}{7} = 14 + \frac{1}{7}$ ohms.

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

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



$Z_1 = \frac{1}{\frac{1}{r_2 + (L_2-M)\omega - \frac{1}{C\omega}} + \frac{1}{\omega M}} + r_1 + (L_1-M)\omega$

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

$i_2' = 0$

when $r_1 = 0 = r_2$.

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

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

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

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

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

$\omega_1 = \sqrt{\frac{L_1}{C(L_1L_2-M^2)}}$

$\omega_1 = \sqrt{\frac{\frac{1}{C(L_1L_2-M^2)}}{L_1}} = \sqrt{\frac{1}{C\left(L_2 - \frac{M^2}{L_1}\right)}}$

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

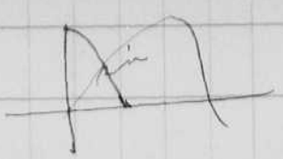
X_L 15 × 377 = 5680 ohms.

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

$X_T = \frac{5680}{1330}$ ohms = 4350 ohms X_L.

$I_{ss} = \frac{1100.0}{4350} = 25$ amps.

Sec
I_{ss} = 2.5 × 10.0 = 25 amps.
Pri



$$E\sin\omega t = L_1 p i_1 + M p i_2'$$

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

$$E\sin\omega t = (L_1 - M) p i_1' + M p (i_1' + i_2')$$

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

$$i_1' = -\left(\frac{L_2 p + \frac{1}{Cp}}{Mp}\right) i_2'$$

$$E\sin\omega t = (L_1 - M) p i_1' - (L_2 - M) p i_2' - \frac{i_2'}{Cp} -$$

$$\frac{E\cos\omega t}{\omega} = \frac{E\sin\omega t}{p} = L_1 i_1' + M i_2'$$

$$0 = L_2 i_2' + \frac{i_2'}{Cp^2} + M i_1'$$

---

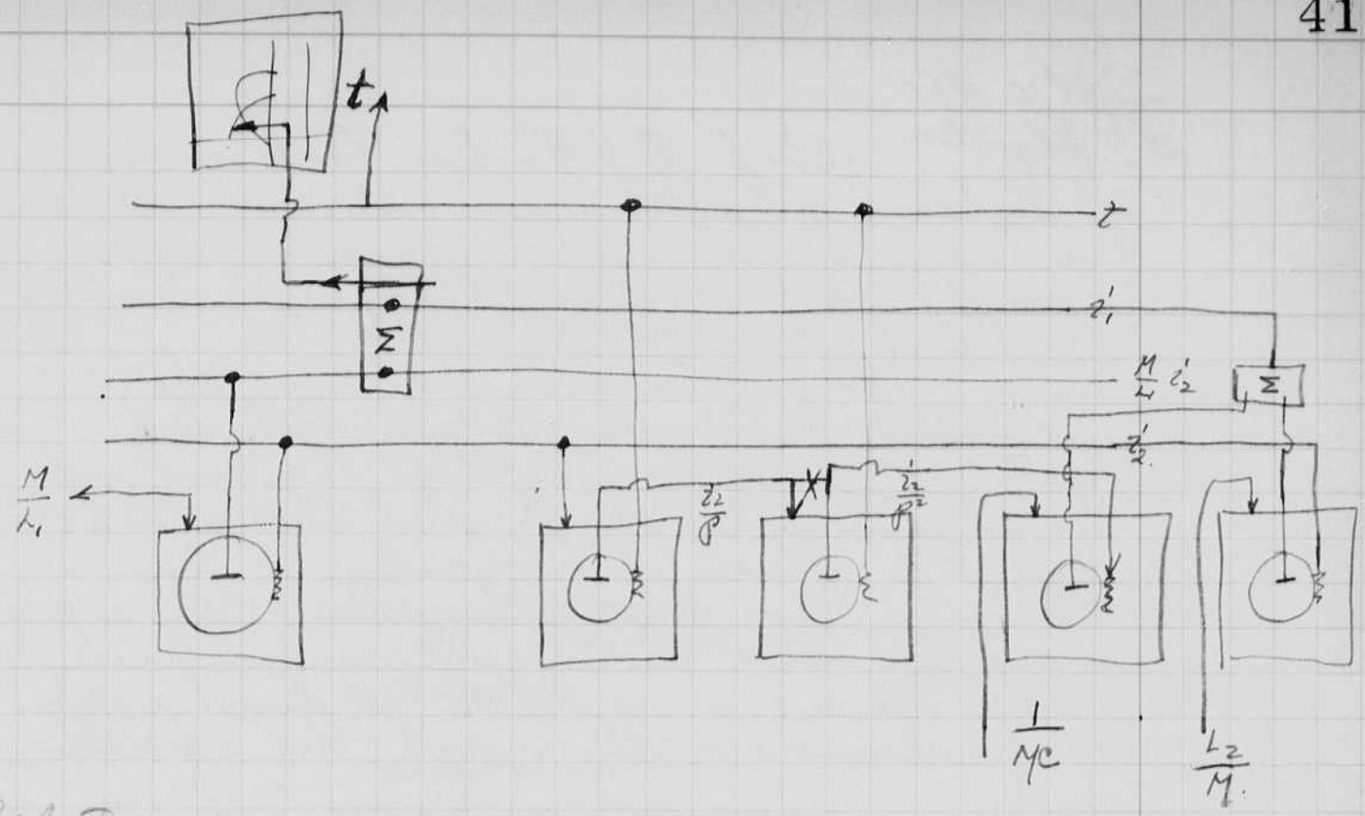
i_1'

---

i_2'

$$\frac{E\cos\omega t}{\omega L_1} = i_1' + \frac{M}{L_1} i_2'$$

$$0 = i_1' + \left(\frac{L_2}{M} - \frac{1}{MCp^2}\right) i_2'$$

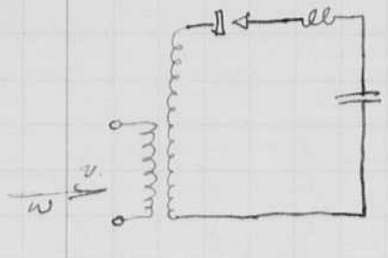


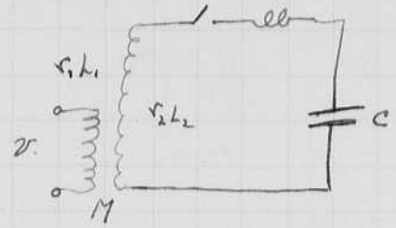
Sept. 8, 1931.

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

Sept 9. 1931. Took stroboscope to the Engine Lab: Draper and Towner ran an engine for me so that I could observe the valve springs which were painted white. Trailing wires in the spring gave very pleasing effect. Also the crankshaft vibrated about 1/8" in red at engine speed. Plan to take movies of this later.

Sept. 7, 1931
H. E. Edgerton





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

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

$$0 = (r_2 + L_2 p + \frac{1}{Cp})\, i_2' + M p\, i_1'$$

Initial current in secondary = 0.

" " " primary $= \frac{v}{(r_1 + L_1 p)} = \frac{v}{(r_1 + j x_1)} \simeq \frac{v}{j\omega L_1}$ $\quad j x_1 = j\omega L_1$

" charge on condenser = 0

Solve for characteristic mode

$$i_1' = -i_2' \left(\frac{r_2 + L_2 p + \frac{1}{Cp}}{Mp} \right)$$

$$(r_1 + L_1 p)\left(\frac{r_2 + L_2 p + \frac{1}{Cp}}{Mp} \right) - Mp = 0$$

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

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

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

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

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

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

two pure imaginary roots $p = \pm j\omega$.

The currents etc will be of the form

$$i_1' = I_A \varepsilon^{j\omega} + I_B \varepsilon^{-j\omega} + I_{ss}$$

200 watts 110 v 3 amps ~~exciting current~~ = 0.3 amp.

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

10:1 ratio. $L_1 = 1$ henry.

$L_2 = 100$ henries. +

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

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

$\omega = \sqrt{\frac{1}{2\times10^{-6}(100-85)}}$

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

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

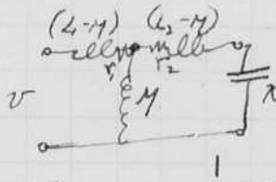
$2\times100 = 200$ mf

$\frac{\cdot10^6}{200\times377\times10^6}$

$\frac{100}{7} = 14.+$ ohms.

$i_1 = I_A \varepsilon^{j\omega t} + I_B \varepsilon^{-j\omega t} + I_{ss}.$

$i_2 = I_C \varepsilon^{j\omega t} + I_D \varepsilon^{-j\omega t} + I_{ss}$



when $t=0 \quad i_1 = \frac{V}{j\omega L_1}$,

$i_2 = 0$

when $t = \infty \quad i_1 = \frac{V}{Z_T}$

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

$Z = \frac{1}{\frac{1}{r_2 + (L_2-M)\omega - \frac{1}{C\omega}} + \frac{1}{\omega M}} + r_1 + (L_1-M)\omega$

when $r_1 = 0 = r_2$.

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

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

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

$X_L = 15 \times 377 = 5680$ ohms.

$X_C = \frac{1}{377\times2\times10^{-6}} = \frac{10^6}{377\times2} = 1330$ ohms.

$X_T = \frac{5680}{1330}$ ohms $= 4350$ ohms X_L.

$I_{ss} = \frac{110.0}{4350} = 2.5$ amps.

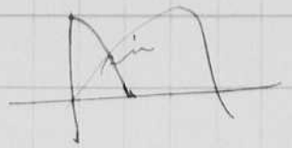
Sec

I_{ss} Prim $= 2.5 \times 10.0 = 25$ amps.

$\omega_1 = \sqrt{\frac{L_1}{C(L_1L_2 - M^2)}}$

$\omega_1 = \sqrt{\frac{1}{\frac{C(L_1L_2-M^2)}{L_1}}} = \sqrt{\frac{1}{C\left(L_2 - \frac{M^2}{L_1}\right)}}$

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



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

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

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

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

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

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

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

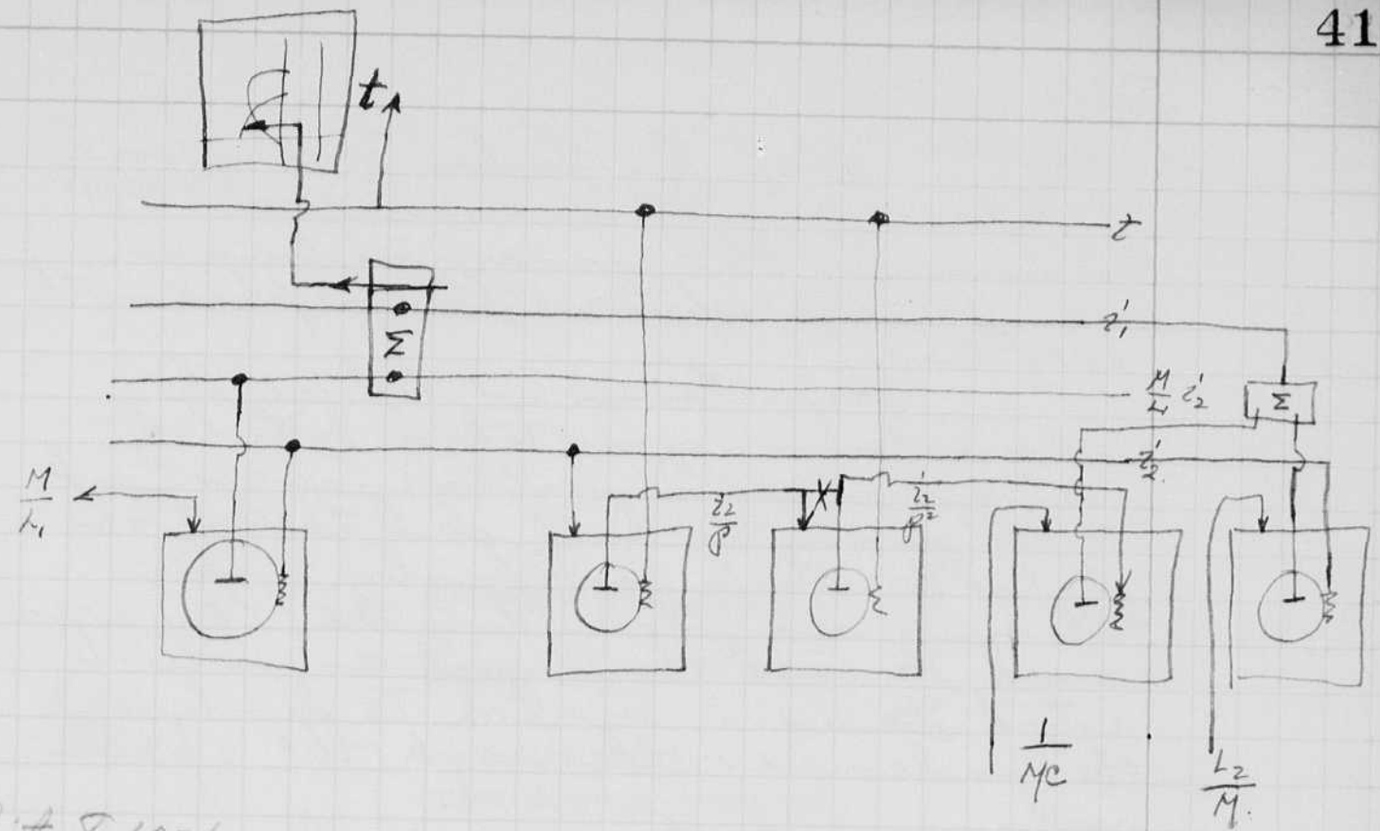
$$0 = L_2 i_2 + \frac{i_2}{Cp^2} + M i_1$$

i_1

i_2

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

$$0 = i_1 + \left(\frac{L_2}{M} - \frac{1}{MCp^2} \right) i_2$$



Sept 8, 1931.

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

Sept 9, 1931. Took stroboscope to the Engine Lab: Draper and Towner ran an engine for me so that I could observe the valve springs which were painted white. Trailing wires in the spring gave very plain blur. Also the crankshaft vibrated about $\frac{1}{16}$" in all at operating speed. Plan to take movies of this later.

Sept 10 1931
H. E. Edgerton.

Prof. C. E. Tucker took movies of Hudson's ~~projector~~ movie camera mechanism. This framing mechanism was painted white. Photographed with a f1.9 lens.

Draper, Towner 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_2) was used to cool the thyratron which acted 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 has a f6.3 lens and the camera was cranked about 30± frames per second. This 35 m m 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 35 m m camera. These did not turn out so good.

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 42)

January 2, 1940. Clara Selbosky
Notary Public

JAN 18 1940

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.

Sept 10 1931
H. E. Edgerton.

Prof. C. E. Tucker took movies of Hudson's ~~projector~~ movie camera mechanism. This ~~framing~~ mechanism was painted white. Photographed with a F1.9 lens.

Draper, towner 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_2) was used to cool the thyratron which acted 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 has a f6.3 lens and the camera was cranked about 30+ frames per second. This 35 m m 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 35 m m camera. These did not turn out so good.

United States Patent Office
Before the Examiner of Interferences

Edgerton
vs. } Interference 76771
Miller

Edgerton Exhibit 7.

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

January 2, 1940. Clara Selbakey
Notary Public

JAN 18 1940

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

Filming and Separation Record

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4 negative strip(s)

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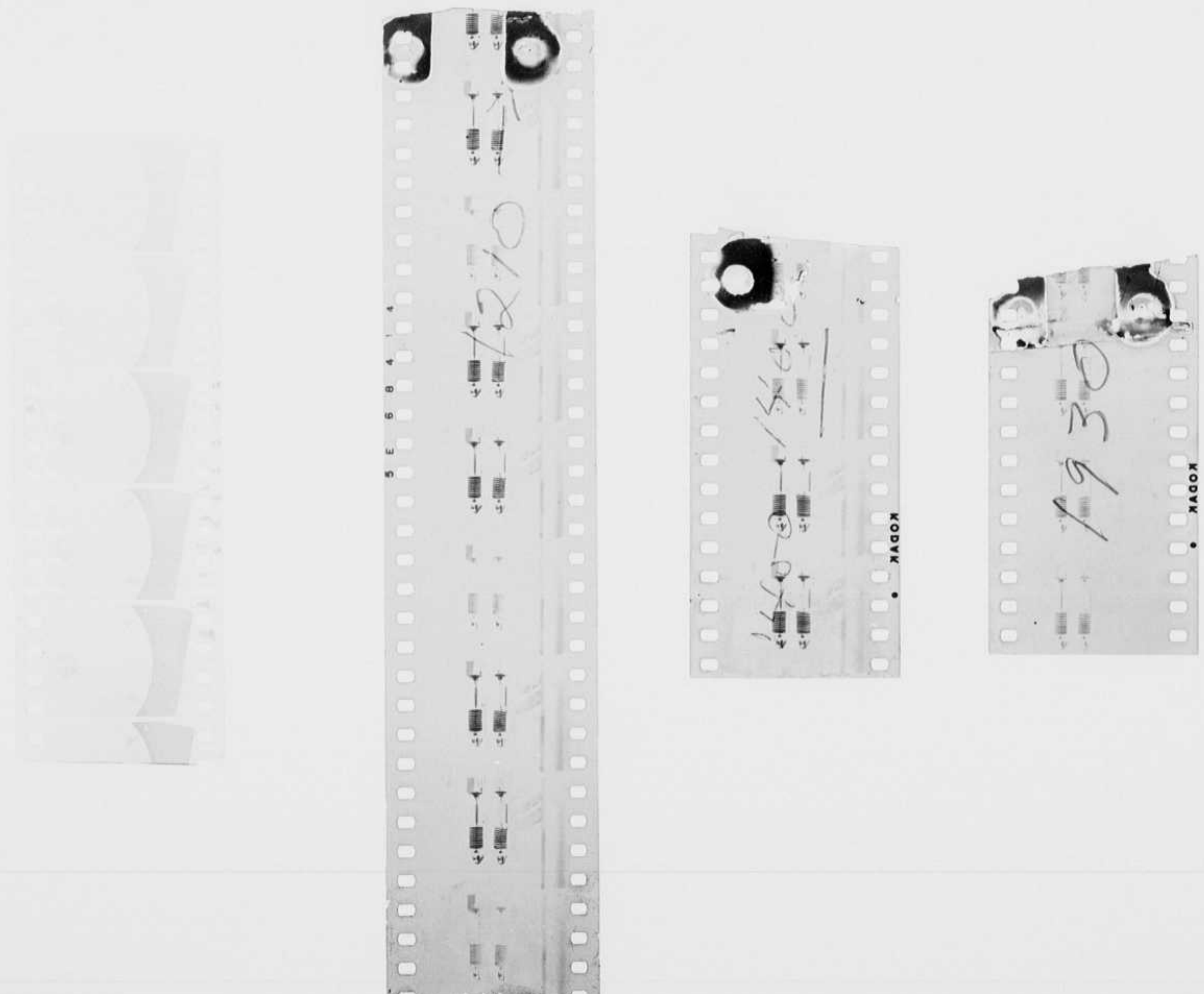
(notes, drawings, letters, etc.)

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

Item(s) now housed in accompanying folder.


KODAK

Sept 11, 1931.

H Dept. Cleaned the lens on the 35 mm camera (f3.5 lens.) and Draper made some new developer. Repeated the movies that were taken yesterday and got some fair results.

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 effect. The normal light from the room gives an ex posure however which shows the spring moving and dim.

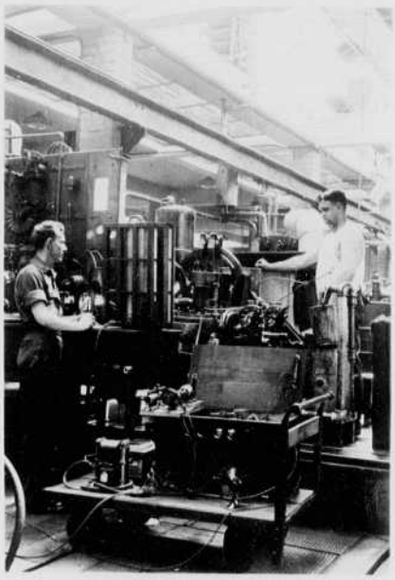
The picture at 1930 r.p.m. are fine.

Sept 12, 1930 Sam Caldwell came down with me in the evening and we took some movies with his 3.5 Eastman camera

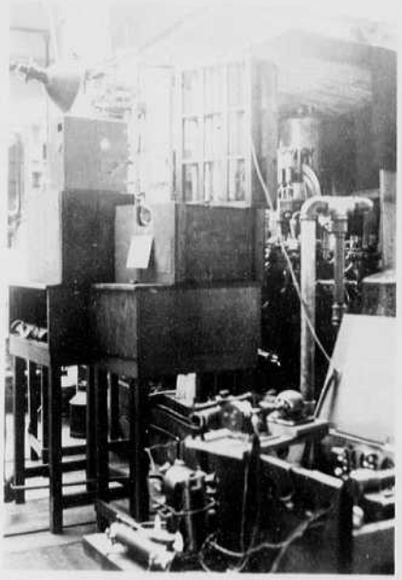
50 ft film by S & Caldwell Scenes
1. 1500 RPM 2. Sam flight 3. 1625 4. 1700 5. 1800
6. 1900 / change lamp 7. 1800 R.P.M.

United States Patent Office
Before the Examiners of Interferences
Edgerton vs. Miller - Interference 76771
~~Edgerton Exhibit 6.~~
Page 44 of Edgerton Notebook T-H.
January 2, 1940. Clara Jelinsky Notary Public

Save space for Picture.

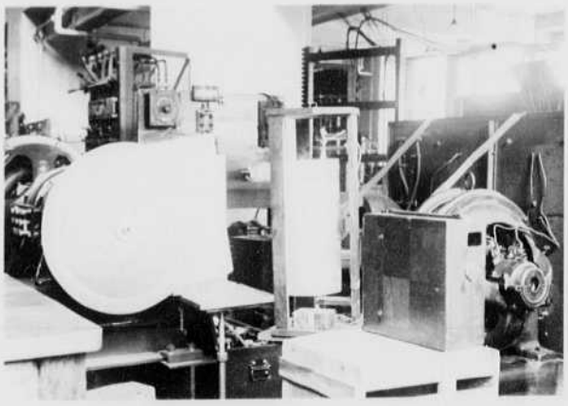


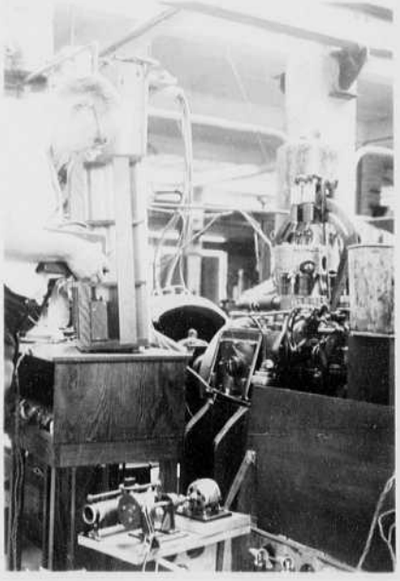
C.S. DRAPER

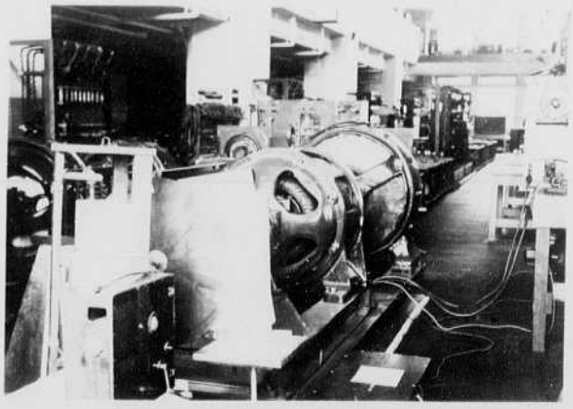


TOWNER

AERO ENGINE LAB.
SEPT 1931.







Prof. Tudsen.

16 mm movies of
cam mechanism.

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.)

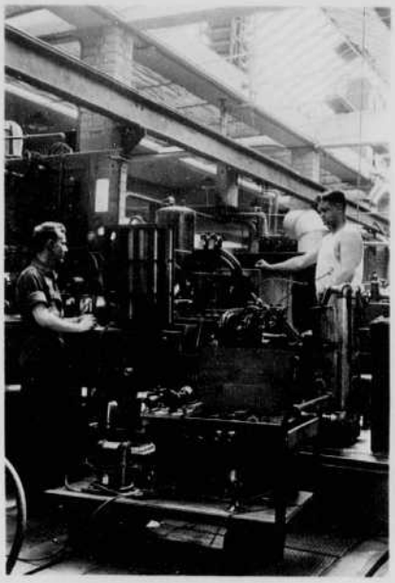
was/were filmed where originally located between page ____ and 45.

Item(s) now housed in accompanying folder.

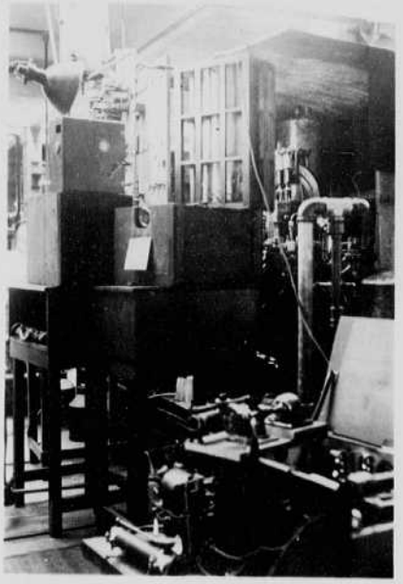
6 pages 4"s of Eisgruber notebook I-II. January 2, 1940. Clara Schlookby, notary Public

United States Patent Office
Before the Examiner of Interferences
Edgerton vs. Miller - Interference 76771
Edgerton Exhibit 6.
Page 44 of Edgerton Notebook T-11.
January 2, 1940. Clara Jelinsky, Notary Public

Save space for Picture.

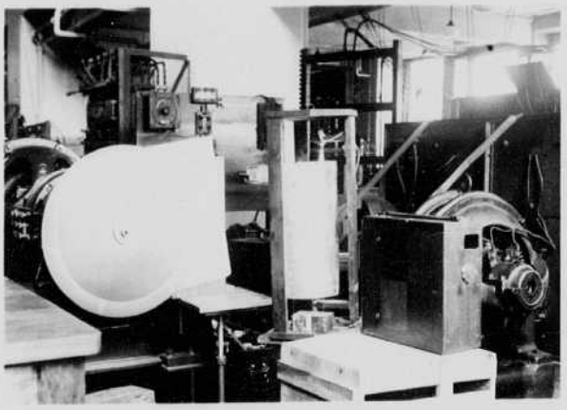


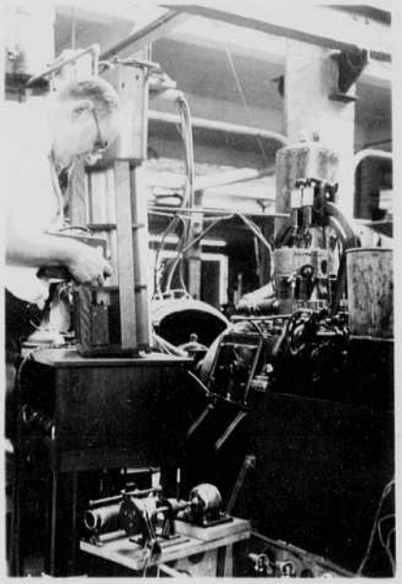
C.S. DRAPER

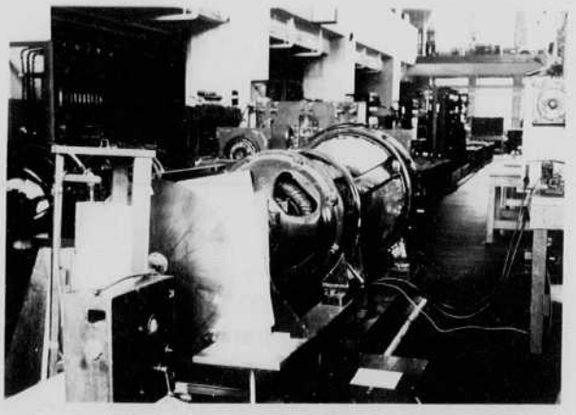


TOWNER

AERO ENGINE LAB.
SEPT 1931.







Prof. Tucker.

16 mm movies of
cam mechanism.

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

Filming and Separation Record

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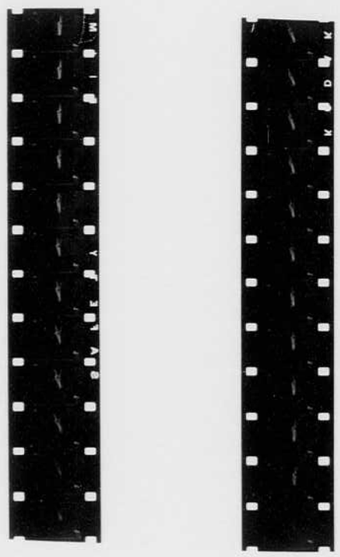
2? ~~negative strip(s)~~ (16 mm movie strips) in mounted envelope pg 44

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

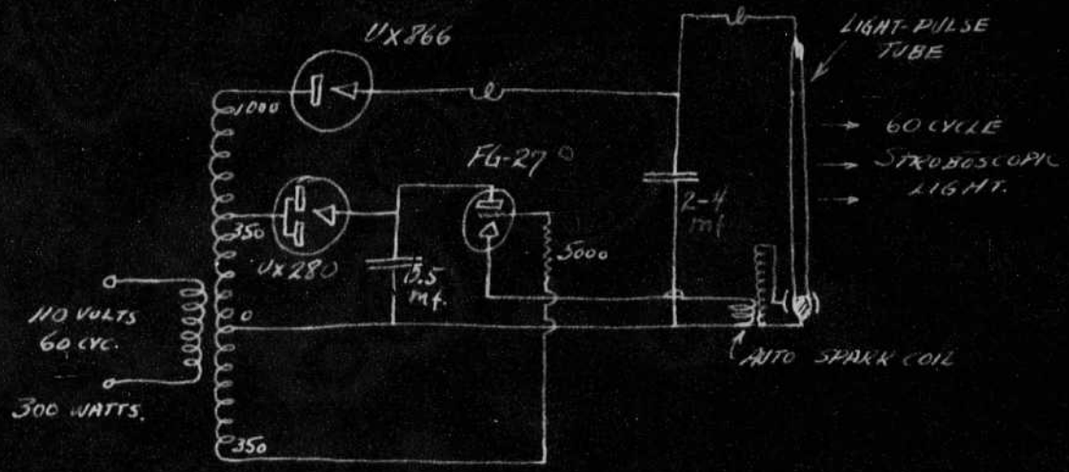
was/were filmed where originally located between page 44 and 45.

Item(s) now housed in accompanying folder.

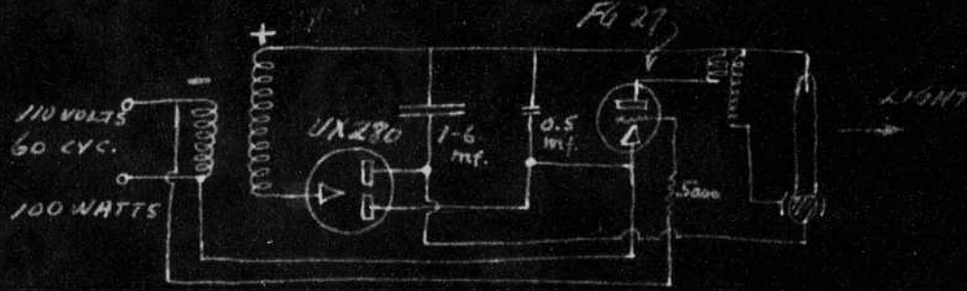
Pages 45 of Edgerton notebook I-II. January 2, 1940. Clara Schlosser, notary Public



United States Patent Office
Before the ...



60 CYCLE STROBOSCOPE. 300 WATT
FOR TAKING MOVING PICTURES

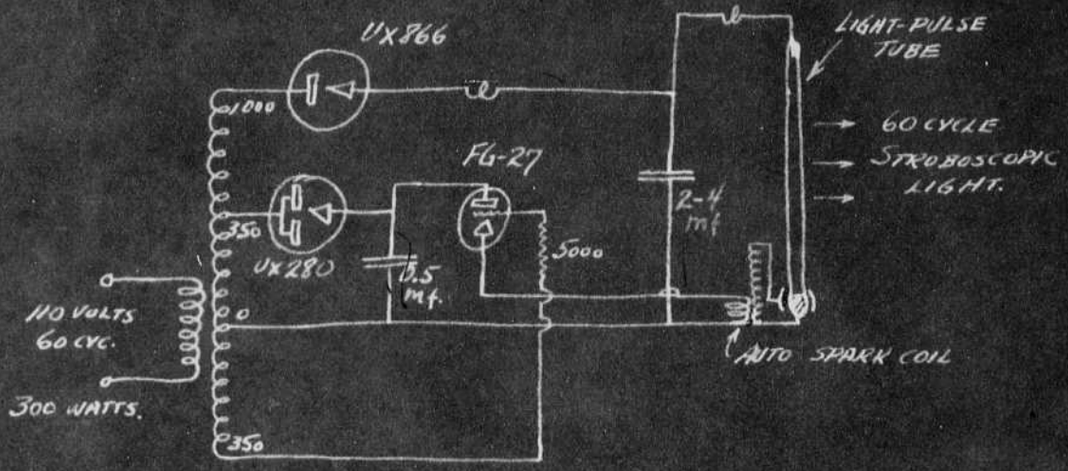


60 CYCLE STROBOSCOPE 100 WATT
FOR VISUAL OBSERVATION

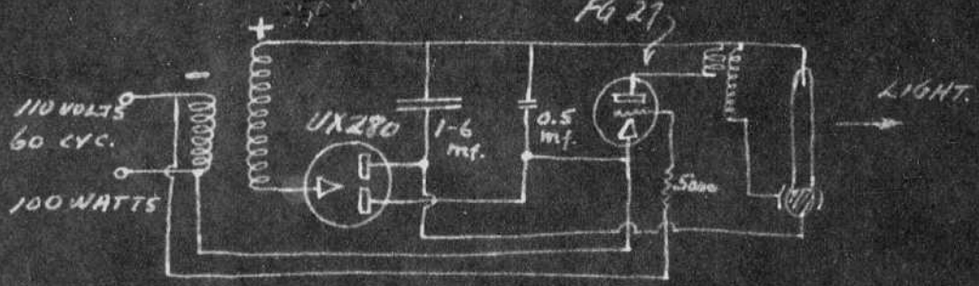
H.E. EDGERTON
SEPT. 14, 1931.

Edgerton & Milton - Adaptation of
Edgerton & Klieber
Page 45 of Edgerton Folder I-II.
January 2, 1940. Jelan Folder, Notary Public

United States Patent Office
Before th. E.



60 CYCLE STROBOSCOPE. 300 WATT
FOR TAKING MOVING PICTURES.



60 CYCLE STROBOSCOPE 100 WATT
FOR USUAL OBSERVATION

H. E. EDGERTON
SEPT. 14, 1931.

With letter to
U.S. Tea. Co.

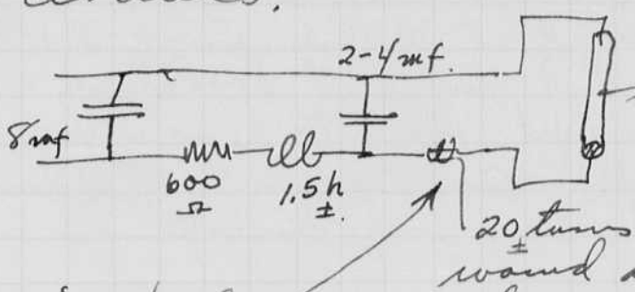
Edgerton, Germeshausen & Grier
Page 45 of Edgerton notebook, I-II.
January 2, 1940.
Clare Schlaikjer, notary public

U. to d State Patent Office

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 C.S. Draper has been building this summer. Draper left yesterday for N.Y. to spend two weeks with the Sperry Gyro-scope 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 phenomena. There is plenty of light to get it in one flash.

Sept. 16. Put stroboscope tube with Quartz section on the pump. The glass for this was purchased from the Cooper-Hewett Co.

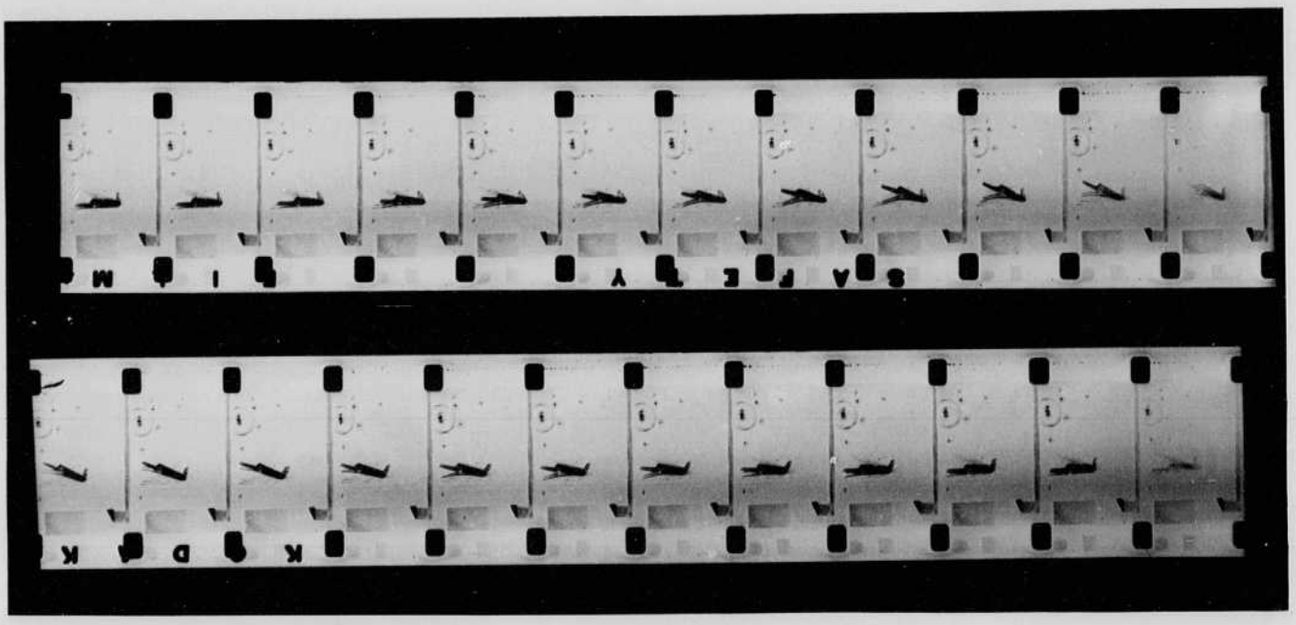
Ran the frequency of the stroboscope up to (60x8) = 480 cycles per second. I had a one microfarad condenser in the discharge circuit. This was too much and it caused the tube to get hot but it worked fine.

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

wages 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.

Septe. 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 Isolation 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.

Notary Public

~~Jasper is~~ ~~travelled~~ ~~Slade and~~
~~go th through the spring. They~~
~~plan to come over next week~~
~~about Tuesday or Wednesday~~
~~see the apparatus.~~

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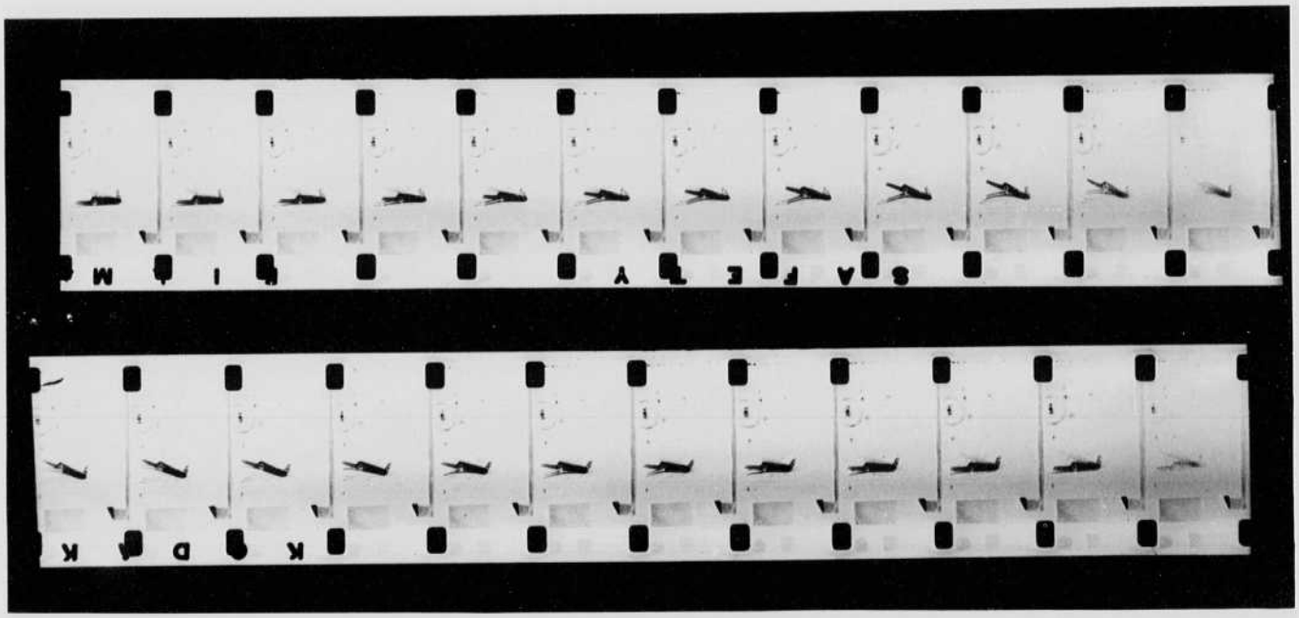

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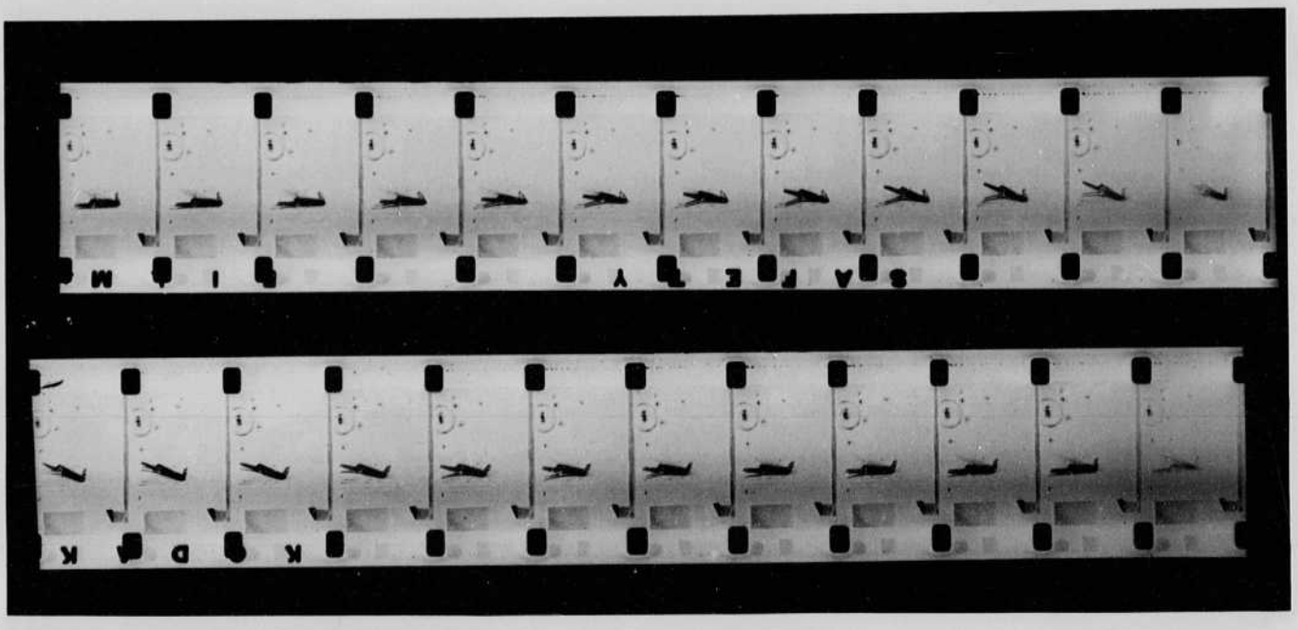

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____ negative strip(s)

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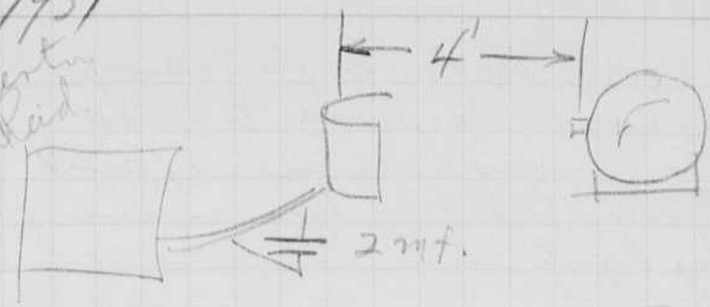
Item(s) now housed in accompanying folder.

" 8 Notary Public

Sept 22 1931

Edgerton
Reid



Variable freq stroke Bromide paper on drum

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

$93 \times 12 = 1120$ in/sec

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

16 | 1.0000000
6720 | 86600
1120 | 13400
12320 | 1080
1120 | 960
960 | 120
112 | 112
112 | 8

No 1. F. 3.5 2 mf hot

2 F. 3.5 2 mf cold

3 " 4 mf warm.

JAN 18 1940

United States Patent Office
Before the Examiner of Interferences

Edgerton
v.
Miller
} Interference 76771

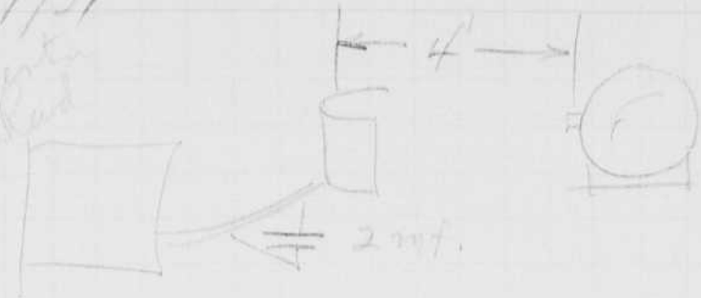
Edgerton Exhibit 7.

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

January 2, 1940.

Clara Schlosky
Notary Public

Sept 12 1931



Needle for stock Bromide paper on drum

3.1 x 120 = 13 ft/sec

13 x 12 = 1120 sq cm

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

No 1. F. 3.5 2 mf hot

2 F. 3.5 2 mf cold

3 " 4 mf warm.

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. Met the men with the Meyers from Broken Bow.
Sept 24. Set up Draper camera to take pictures of water drop oscillations. Expect to operate the strobe at 500 cycles per second. A shadow of the drop will be focused on a strip of bromide paper on the continuous drum.

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

1 rev. = 128 frames.

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

so the frames will not blur.

Exposure = $\frac{1}{3.9}$ sec = .255 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 Sperry 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 successfull light-pulse tube using high temperature.
4.-11-12. Projector tubes
5. Tube used to get movies of claw and valve spring
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.
14. 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.

Sept 23. Mother and I visited the Meyers from Broken Bow.
Sept 24. Set up Draper camera to take pictures of water drop oscillations. Expect to operate the strobe at 500 cycles per second. A shadow of the drop will be focused on a strip of bromide paper on the continuous drum.

1 ft diam of drum = $\frac{12 \times 2.54 \times \pi}{.75}$ = 128 frames of 16 mm film.

1 rps = 128 frames.

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

so the frames will not blur.

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

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(notes, drawings, letters, etc.)

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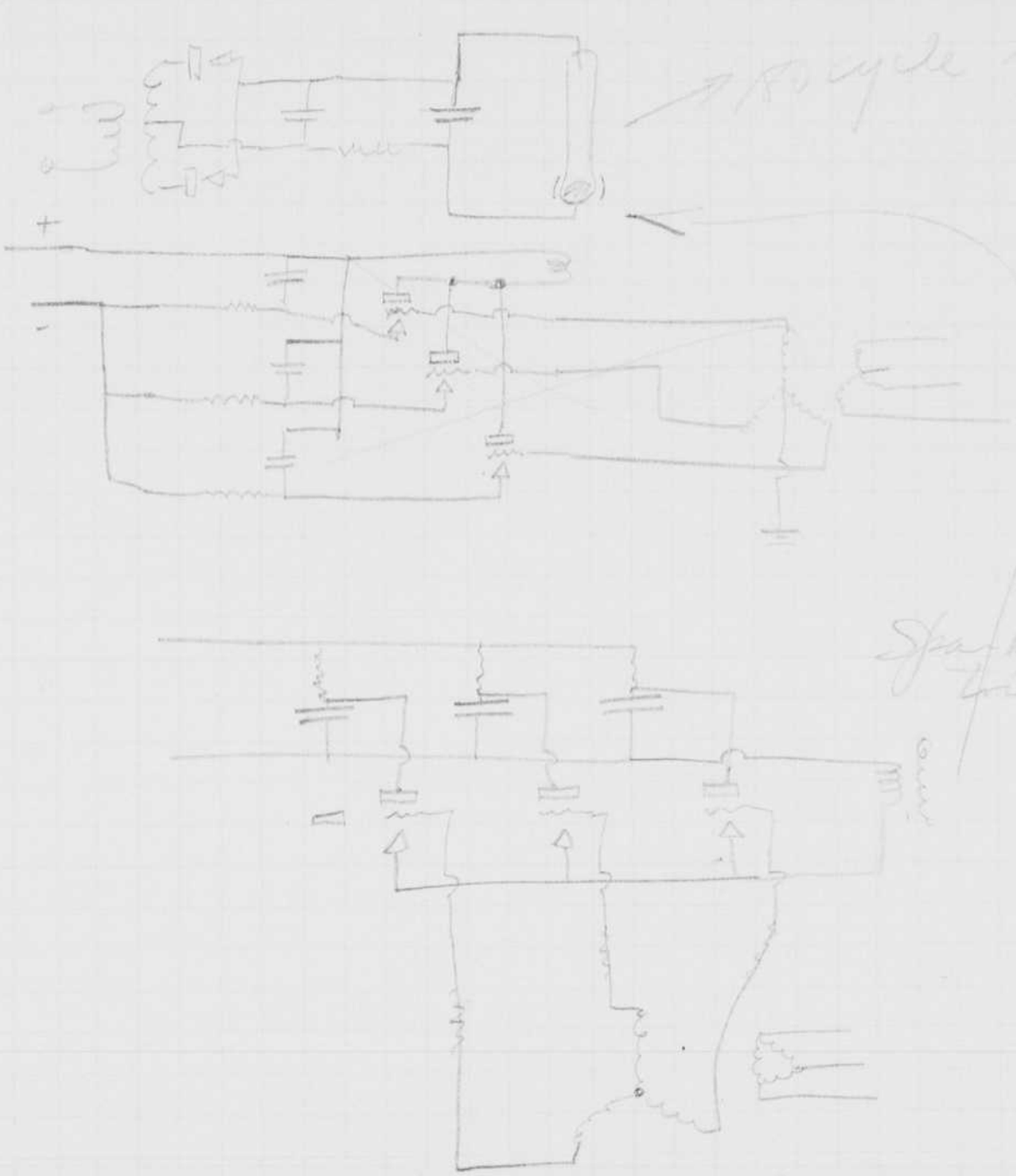
Item(s) now housed in accompanying folder.

Sept 27, 1931.
H.E. Edgerton.

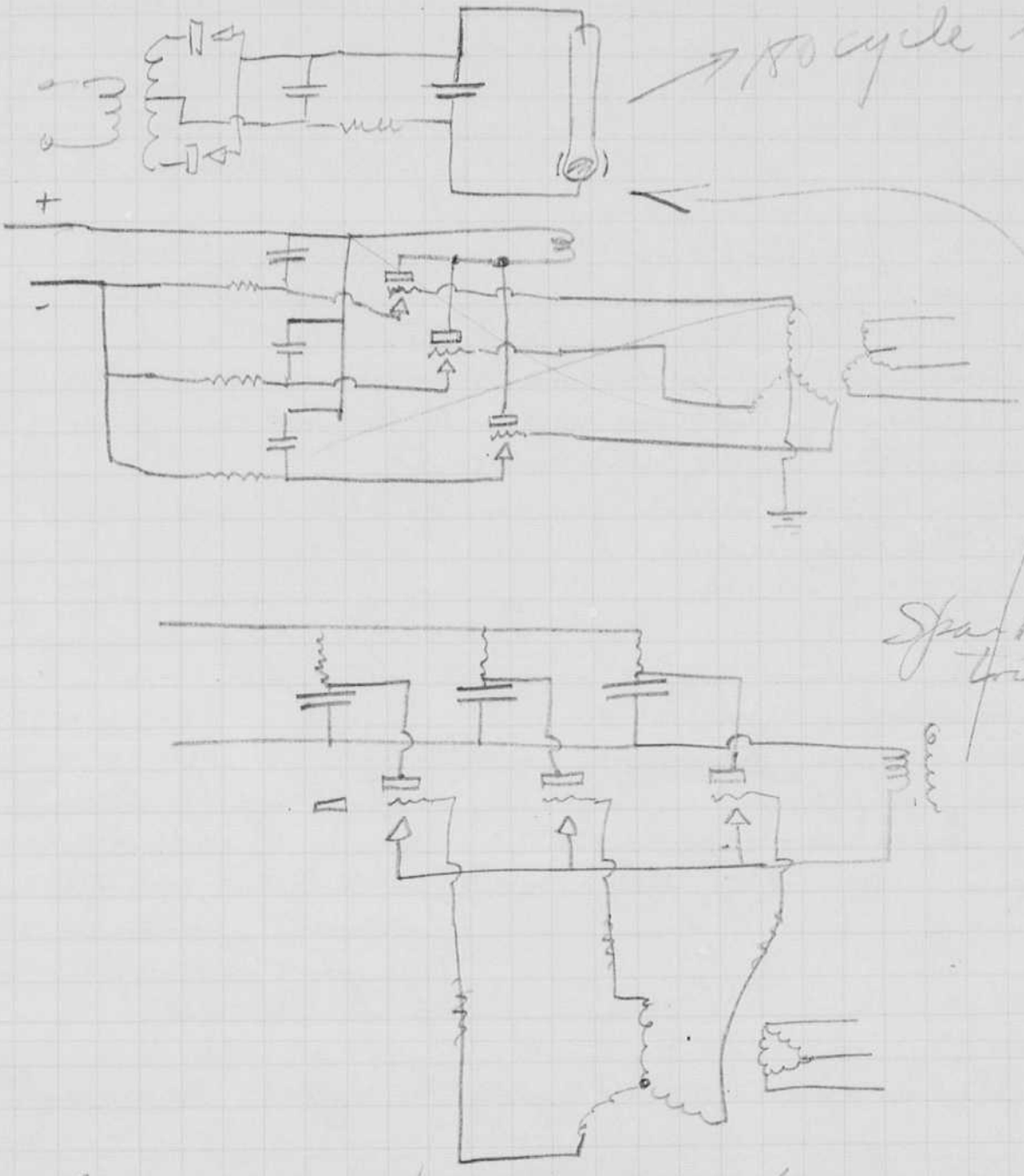


This circuit flashes for the zero of each phase voltage. It is useful for investigating what goes on in short circuits and unbalanced conditions as it immediately locates the voltage vectors for a specified angular position.

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

C Kingsley Jr.

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.

C. Kingsley Jr.

October 6. 1931

H. E. Edgerton

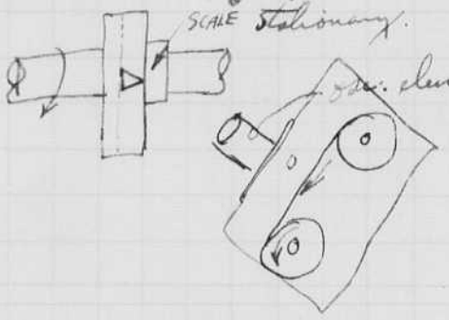
Showed a stroboscopic display to the members of the national Research Council Four. First showed the two big discs Then the vibrating spring mechanism and the claw on the moving picture camera. Also started up the 60 HP motor in the substation.

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

K. S. Zimmerhausen 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.

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

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

try 3 ft per second. 30 feet for 10 seconds

The records could be bunched even closer than this say three flashes per cm which gives $1 \times 60 = 60$ cm / second

or 2 ft. / approx. per second.

Oct. 11, 1931

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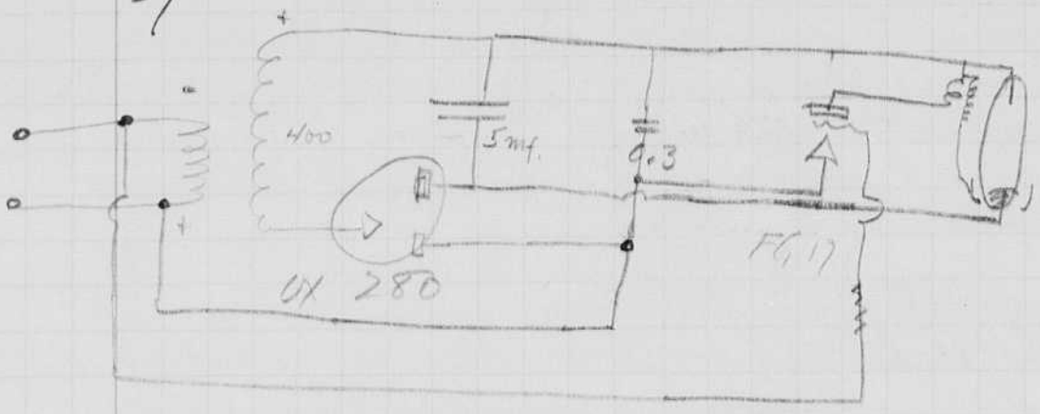
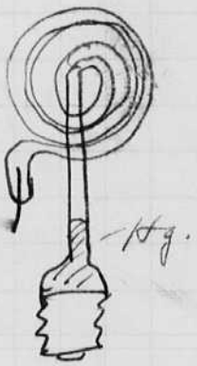
Mr. Fuller of the Hygrade Lamp Co called up and made an appointment for Wednesday to go out to the Riesel Box Co to look over job where the stroboscope light may be useful.

Oct 11, 1934.
H. E. 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 mf. 600 volt "	.50	
1 - FG-17	5.00	
1 - spark coil.	2.00	
1 - grid resistor (110 v) 5000 Ω	.75	
2 - sockets.	.50	
1 - pulse lamp.	3.00	
est. cost of materials.	18.60	

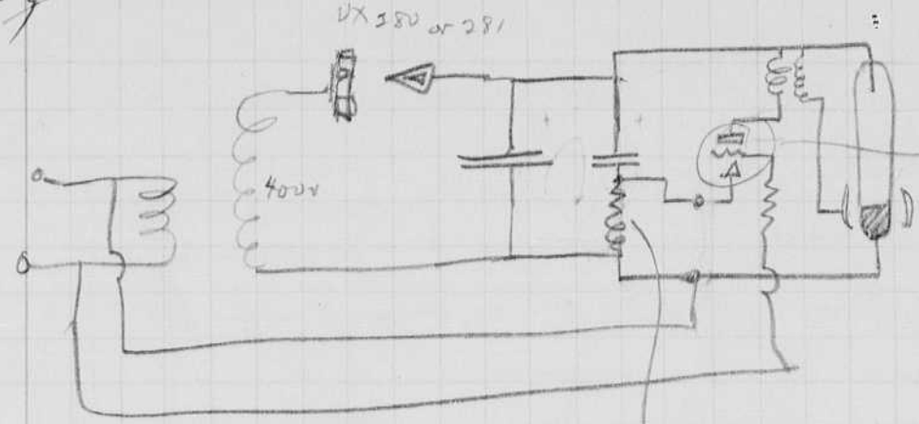


Shapes for the lamps.

Glass 1/2" in diam ±
and about one ft long.

Showed this circuit to Prof Tuttle on Oct 13 and discussed it with him.

Oct. 13. 1931
H. S. Edgerton.



This resistance & inductance will stop the discharge of the large ~~inductance~~ capacity.

First the small capacity will flash through the spark coil, then the large flashes through the pulse lamps.

~~400~~ × 120 ma = 48.0 watts

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

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

30 h
10 h 120 ma. $f = 2\pi \sqrt{LC} = 6.28 \sqrt{10 \times 4.5} \times 10^{-3}$
$6.28 \cdot 7 \times 10^{-3} =$
.042. sec.
.0167 use 1 henry.

$R^2 C = 4L.$
$R^2 = \frac{4L}{C} = \frac{4 \times 1}{5 \times 10^{-6}} = 1 \times 10^6$
$R = 1 \times 10^3 = 1000$ ohms. $RC = 1{,}000 \times 5 \times 10^{-6}$
$= .005 \times 10^{-3}$

try 2000 ohms for the resistance.

October 6. 1931

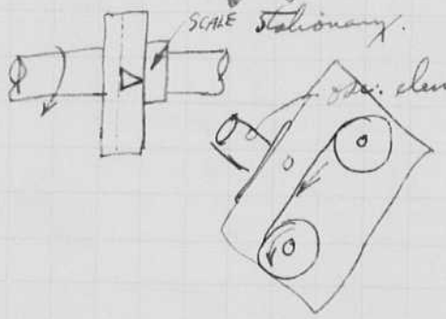
H. E. Edgerton

Showed a stroboscopic display to the members of the National Research Council Four. First showed the two big discs. Then the vibrating spring mechanism and the claw on the moving picture camera. Also started up the 60 ~ 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. Zimmerhanzen 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.

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

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

try 3 ft per second. 30 feet for 10 seconds

The records could be bunched even closer than this say three flashes per cm which gives $1 \times 60 = 60$ cm / second

or 2 ft. (approx.) per second.

Oct. 1, 1931

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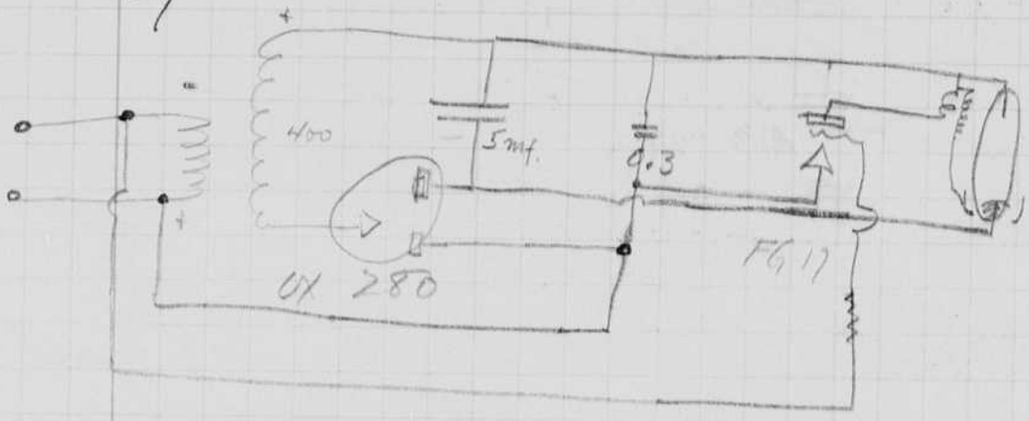
Oct 11, 1931.
H. E. Edgerton

Circuit for small power Stroboscope.



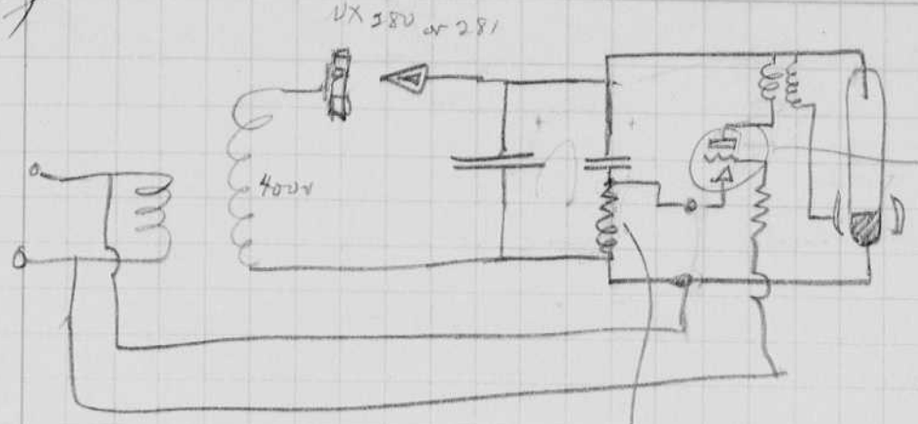
1 - transformer	5.00	9.50	
1 - UX 280	0.85		
1 - 5 m.f. 600 volt condenser.	3.00	1.80	
1 - 0.3 mf. 600 volt "	.50		
1 - FG-17	5.00		
1 - spark coil.	2.00		
1 - grid resistor (110 v) 5000 Ω	.75		
2 - sockets.	.50		
1 - pulse lamp.	3.00		
gt. cost of materials.	18.60		

Shapes for the lamp.

Glass 1/2" in diam ±
and about one ft long.

Showed this circuit to Prof Tuttle on Oct 13 and discussed it with him.

Oct. 13. 1931
H. Edgerton.



This resistance & inductance will stop the discharge of the large ~~reduced~~ capacity.

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~~400~~ × 120 ma = 48.0 watts

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

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$6.28 \times 7 \times 10^{-3} =$

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.0167 use 1 henry.

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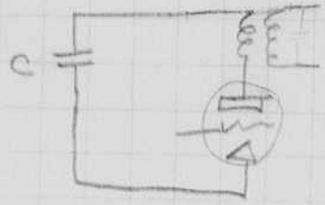
$R^2 = \frac{4L}{C} = \frac{4\times 1}{5\times 10^{-6}} = 1\times 10^6$

$R = 1\times 10^3 = 1000$ ohms. $RC = 1{,}000 \times 5\times 10^{-6}$

$= .005 \times 10^{-3}$

try 2000 ohms for the resistance.

Oct. 13, cont.



the tube acts as a switch.

.3 .6x.6

$T = 2\pi\sqrt{LC} = 2\pi \times 10^{-3} \times .6 \times \sqrt{L}$ must be less than

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

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

K.R.L. p. 155.

when R = small

$$i'_{max} = \frac{2EC}{\sqrt{4LC}} = E\sqrt{\frac{C}{L}}$$

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

$L = ?$

$i'_{max} = 2$ amps.

$$L = \frac{E^2}{i'^2_m} C$$

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

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

$.0080$

9×10^{-2}

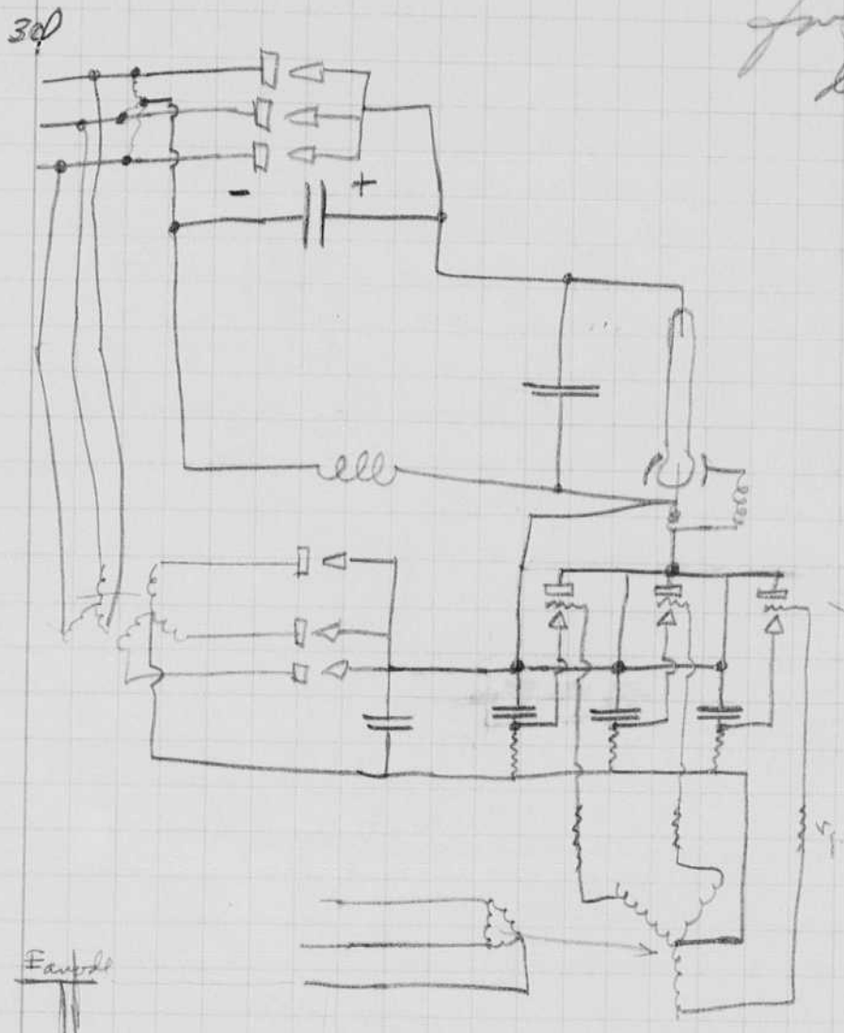
$= .000054$ sec. per cycle.

$.01620$ sec. for 60 cycles.

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

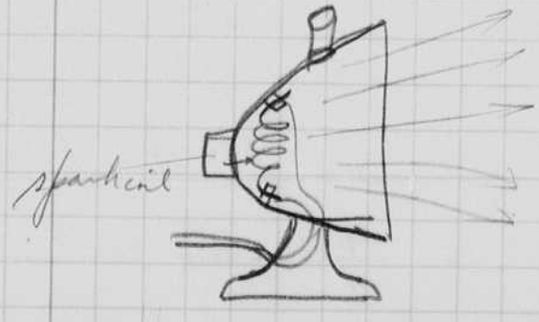
Oct. 13, 1931.

180 cycles strobe for power disturbances.



use FG 67 or FG 33 tubes which require considerable current to get them started.

Then use a grid resistance such that they will not start until the anode voltage has become 600 volts.

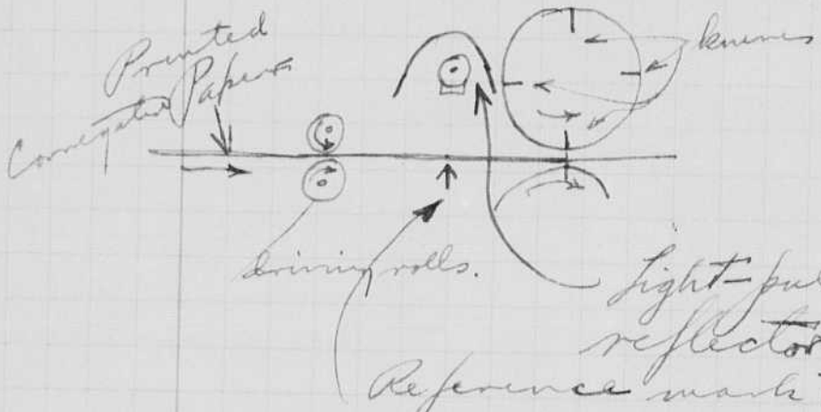


Design for a reflector for a strobo-mic

Oct. 14, 1931.

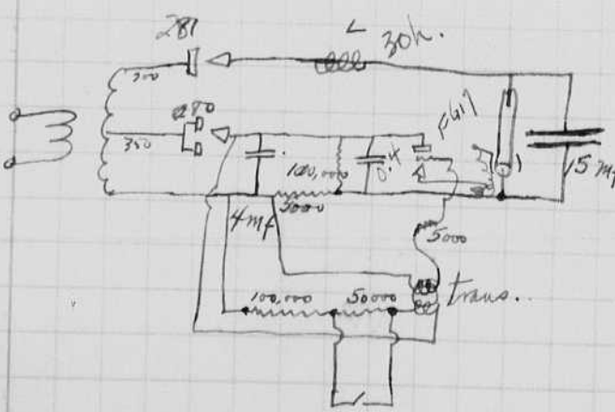
~~H. E. Edgerton.~~

Mr. John R. Fuller of the Hygrade Lamp company of Salem was in this afternoon. He took Semeshausen and I to the Kassel Box company in ~~Emerson~~ Malden to see if the stroboscope could be used ~~to~~ speed up the manufacture of cartons to hold incandescent lamps. The mechanism is ~~still~~ speed is now limited because of ~~not~~ an observer's eye reaction time. It is hoped that stroboscopic light will enable the machine 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 Kassel Box company was with us.

Proposed circuit.



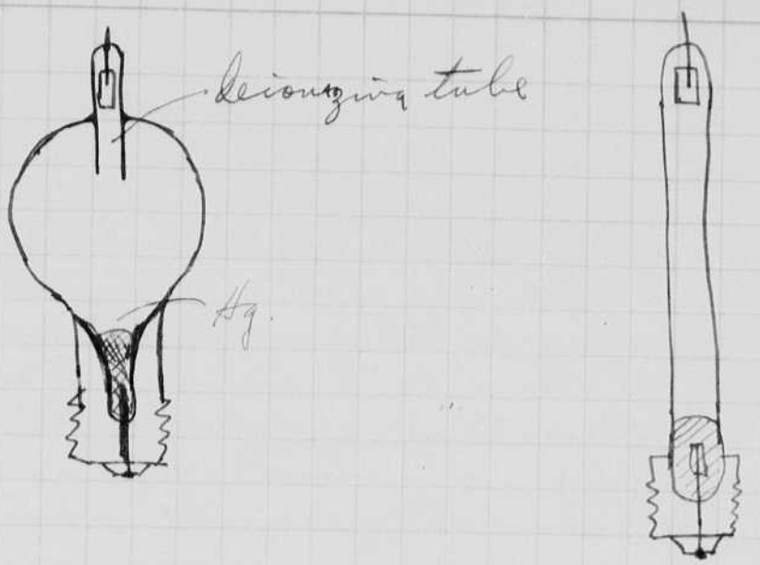
60 times a sec 5 mf. 100 watts.
~~100~~ 26 times a sec 15 mf.

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

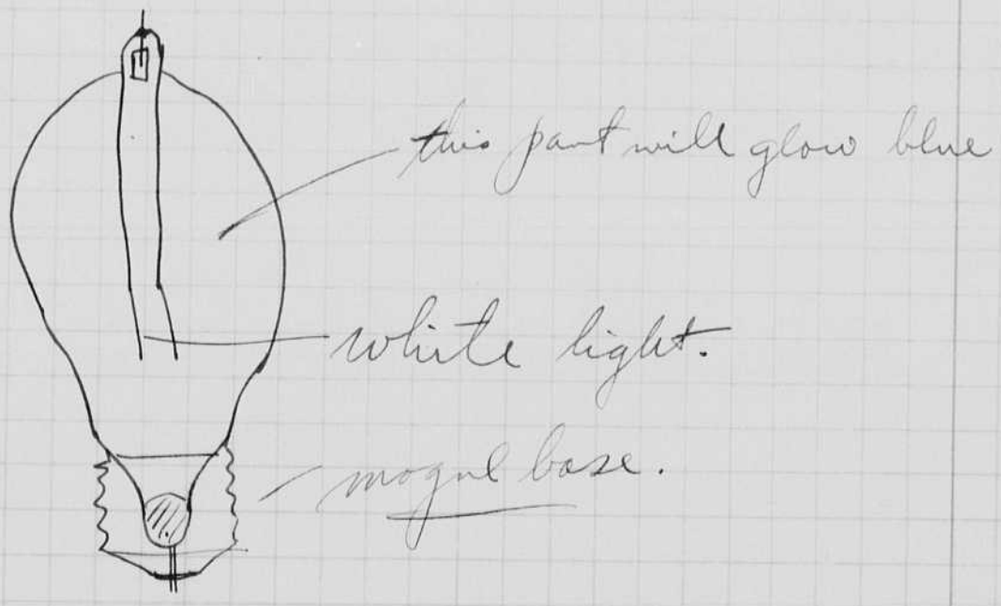
$$= \frac{.49}{.04} \times 15 = 4.75 = 200 \text{ henries.}$$

Use a 30 henry choke.

75.


deionizing tube
Hg.


Hg.
Radio Socket.

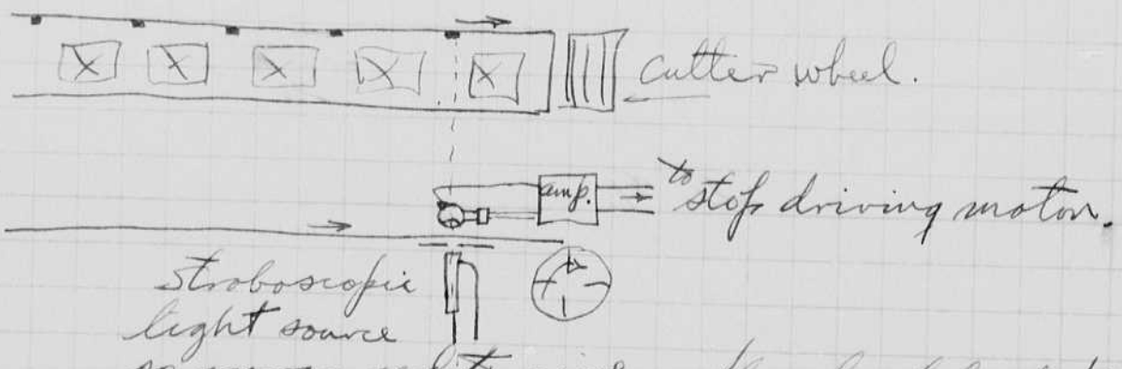

this part will glow blue
white light.
mogul base.

Oct 15 1931
H. E. Edgerton

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

For instance the cutting machine of the Russel Box Co can be stopped. As the cutting speed is increased by stroboscopic observation, the waste if a defect in printing comes along is larger because the operater 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 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.

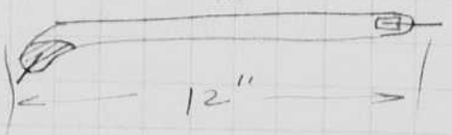


so arranged to give a flash of light when the black spot is opposite the stroboscopic light, when the paper is in proper phase position with the cutter.

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

Oct 16 1931
H. E. Edgerton.

Germeshausen and I worked in ~~3-003~~ blowing and exhausting some light-pulse. Stroboscopic tubes for ~~that~~ job at Russel Boy Co. We built ~~them~~ three good tubes. Two of them were 12 inches long and 1/2" in diam.



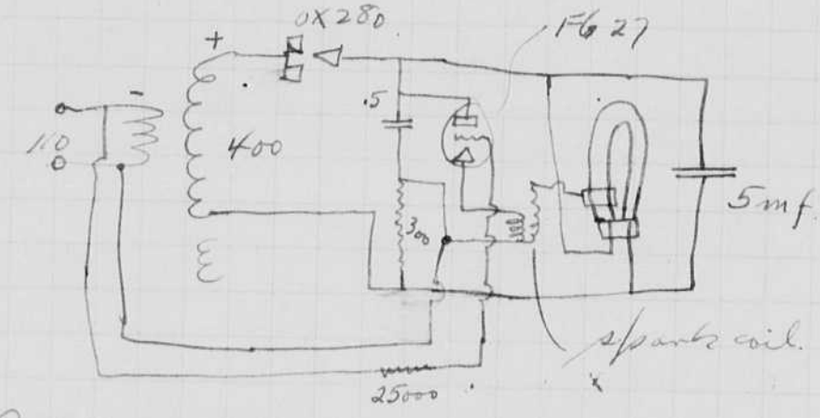
the lower end was bent down so that the fly would stay there.

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

Oct. 17, 1931.
H. E. 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 thyratron. Inductance tried also.

Oct. 19, 1931 Showed this circuit (above) to Prof. Tucker. He is going to get one for the dyn. lab. to use in experiments. Mr. Cain and Washburn of the Edison borrowed the variable freq stroboscope for the U.E. Manufg Exp at the Copley Plaza hotel.

Oct 20. 1931. Gave my 6.03 (alt current machinery) class a demonstration in the Dynamo 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 Laboratories 739 Boylston St Boston and showed it to Mr. Hall. Benn went along.

The 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 motion of the valve springs in the engine lab see pictures on p 44.

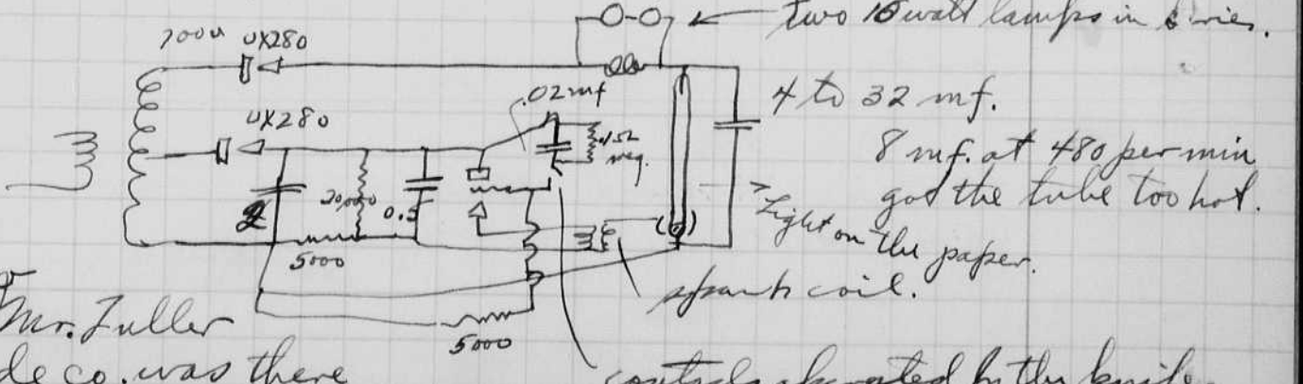
Cain and Washburn are ~~going~~ the outfit at the Copley Plaza Hotel and will outside until Wednesday.

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

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

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

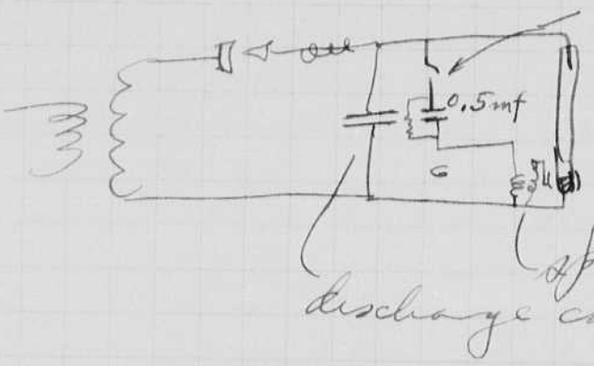
Oct. 21, 1931. Spent the entire day at the Russel Box Co. in Medford. The stroboscope enabled the machine to be speeded up. We had some trouble with the circuit, the condensers would not charge fully in the interval between flashes. This was remedied by the use of a resistance in parallel with the 30K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

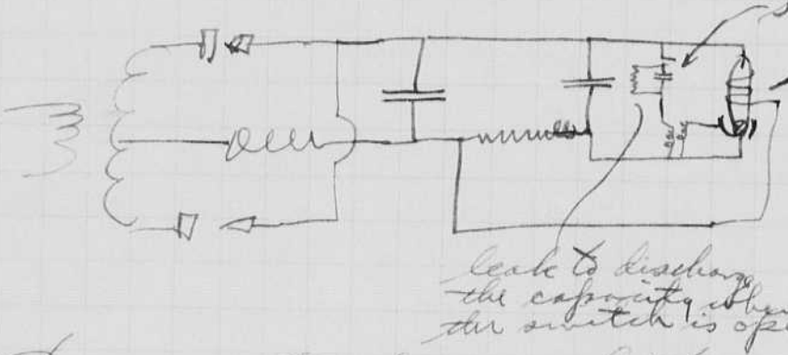


Both Russel Brothers saw this work. Mr. Fuller of the Hygrade Co. was there also in the aft. Talked to Pike in the afternoon.

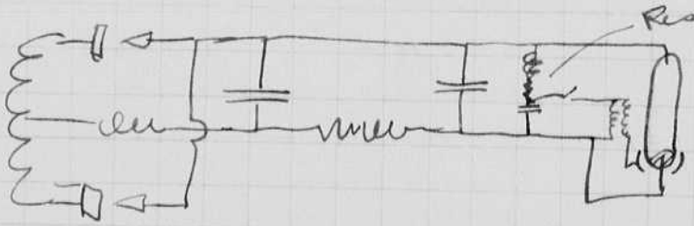
Oct 21, 1931
D. C. Ellerton

Stroboscope circuit without thyratrons.





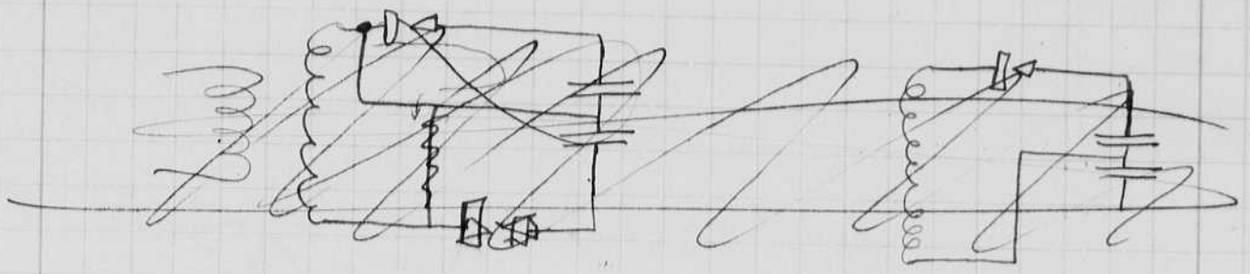
The contacts need to be driven by a variable speed motor say 0 to 5000 r.p.m. A tachometer should be attached so that speed can be read, that is the frequency of the light noted.



This circuit use the discharge of the small condenser through a spark coil to get the high voltage.

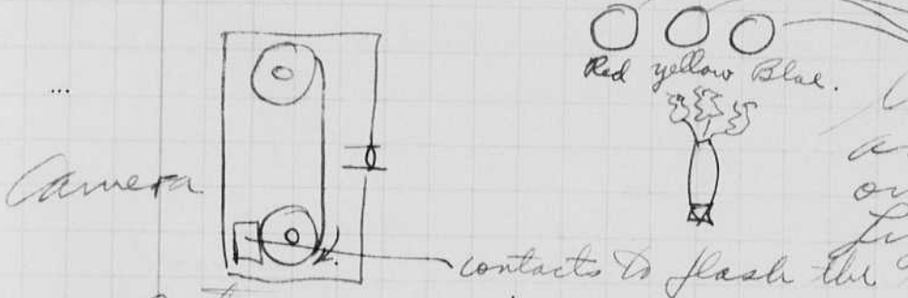
These circuits are similar to those I had Beardsley work on in 1929 and 30.

Three Color Motion Pictures



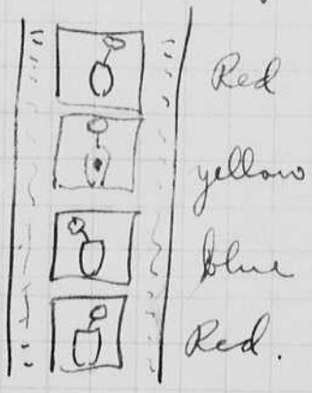
Oct 21. and A. E. Edgerton

Three color motion Pictures.

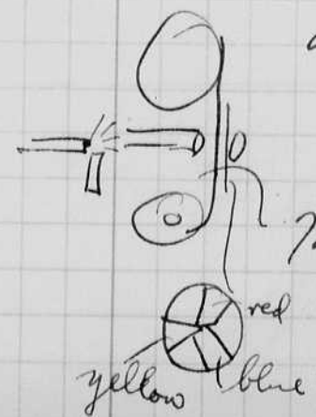


Stroboscopic light sources, arranged to flash on different frames. Light duration 10^{-5} sec.

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

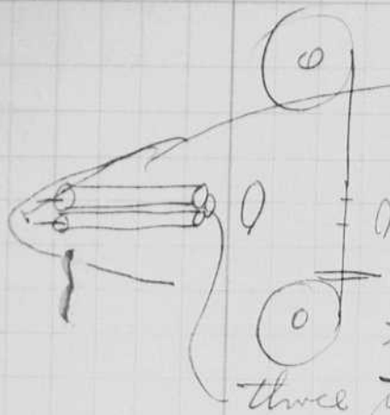


Projection can be with a moving color screen over the shutter on the projector or with intermittent light from three stroboscopic light sources of the same colors which were used in taking the pictures.



Arc projectors with colored filters.

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



Intermittent light pulse tubes

Contacts or photo cell or other device to trip the light in phase with the pictures.

three tubes. 1. red — neon or nitrogen. (gas in the tube)
2. yellow. — sodium
3. Blue — mercury or argon.

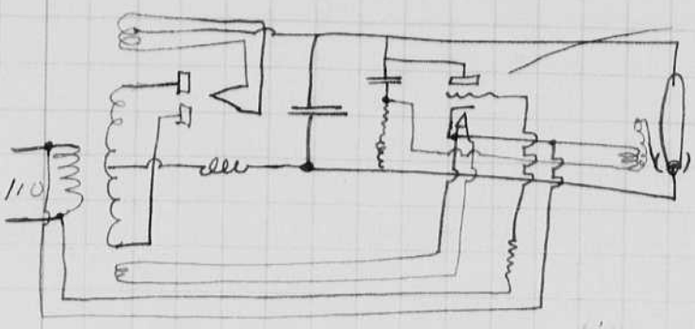
The light source is arranged to flash each frame as the film runs by at a continuous rate.

Read and understood
Oct 22 1931
C. J. Burch

Read + understood
Oct 22 1931
Kenneth J. Hemmendinger

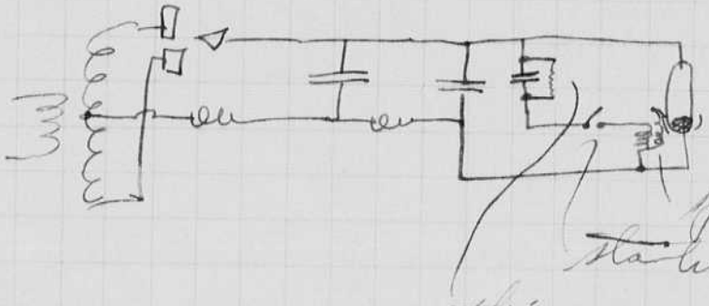
Nov. 4, 1931. I explained this method of solved motion pictures to Jim Le Van in the evening X

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



~~the~~ thyratron 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.



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.

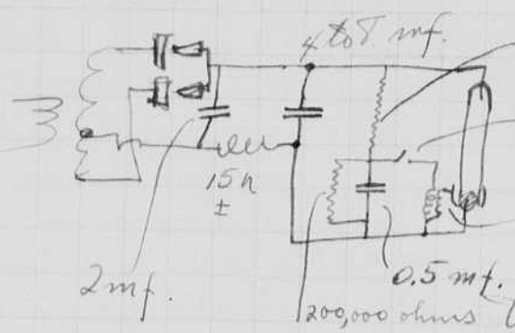
Oct. 22, 1931. Worked more on the circuits for the Russel Box Co.

Oct. 23, 1931. 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 stroboscope to a lot of people. Talked to Biggs and Bo~~x~~ked about the outfit. Discussed tube design and a 110 v 60 cyc strobe.

Worked in evening on the Russel Box circuit. It did not work very well until we changed the discharge

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



$PE = .075000 \times .5 \times 10^{-6}$

$\frac{.07}{.2} = .035$ sec.

$\frac{1}{.035} = 30.$ times a sec

to leak off the charge

If the small starting condenser is connected as shown on page 5, second drawing, the voltage of the large discharge condenser is suddenly reduced when switch is closed. 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 mile Falls plant.

Germeshausen and I went down to the Herald-Traveler Bldg about noon time. Also we went to the Metropolitan and to the Loews state to see about the application of the stroboscopic light to the stage. Get in touch with Sullivan - Met.
Dixon - Loews.

United States Patent Office
Before the Examiner of Interferences

Edgerton
vs. } Interference 76,771
Miller

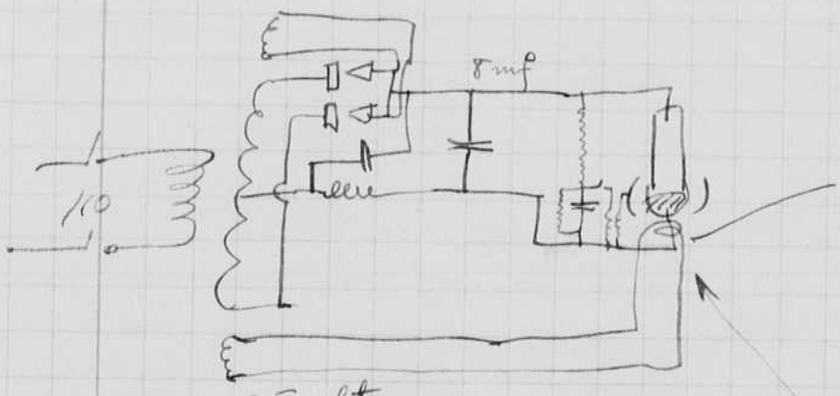
Edgerton Exhibit 11
Page 66 of Edgerton Notebook I-II.
January 2, 1940.

Clara Schlosky
Notary Public

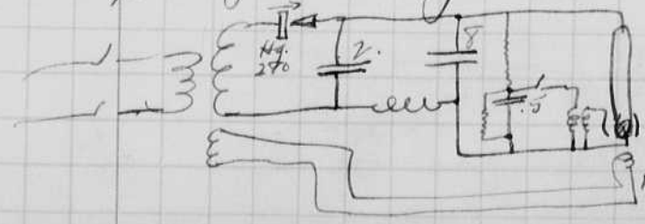
Oct 25 1931

H E Edgerton. When these mercury arc stroboscope 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.

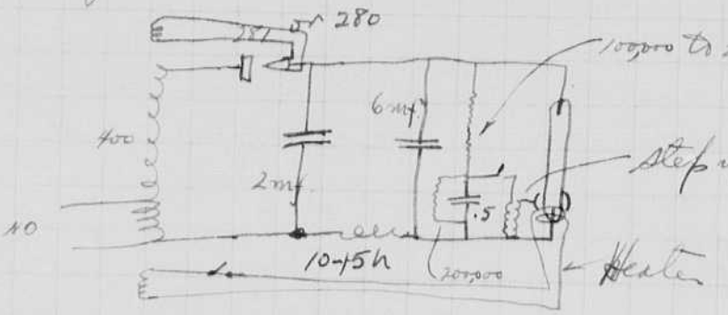


or Half Wave for slow stuff



Oct 25 1931 Cont.

H. E. Edgerton Use transformer autos to get higher voltage.

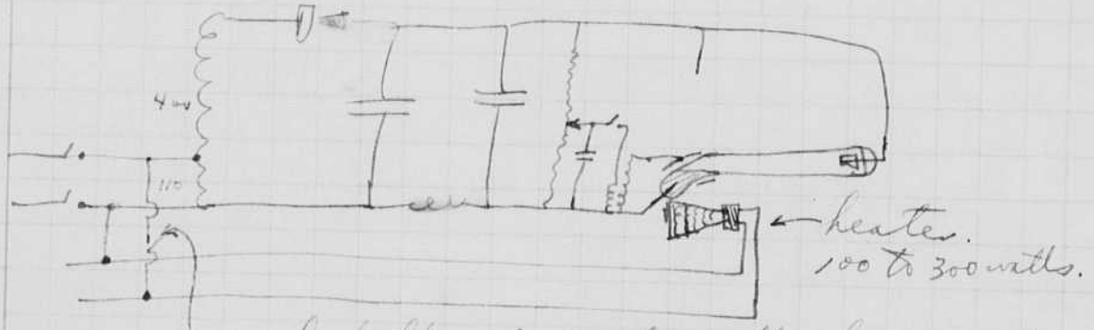


$RC = 200,000 \times 0.5 \times 10^{-6} = .05$ sec to 63% chg on the cond.

$\frac{1}{.05} = 20.$ flashes per sec $\leq$ limit of circuit.

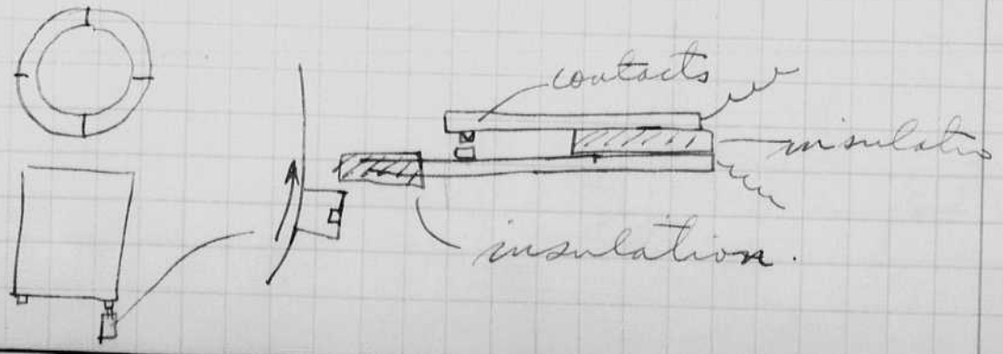
$20 \times 60 = 1200$ flashes per min.

Another heater scheme.

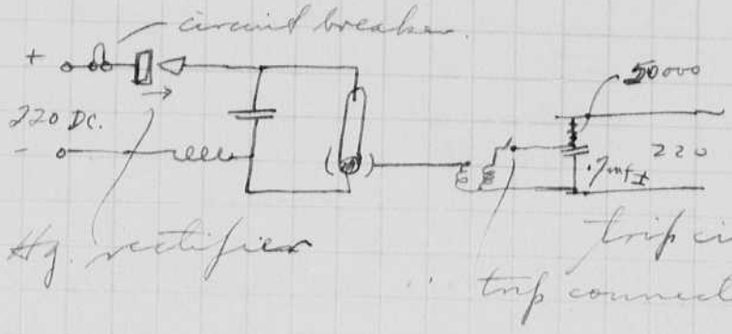


push button to put on the heater to warm up the tube if it does not start. Have spring return so the switch will not be on all the while.

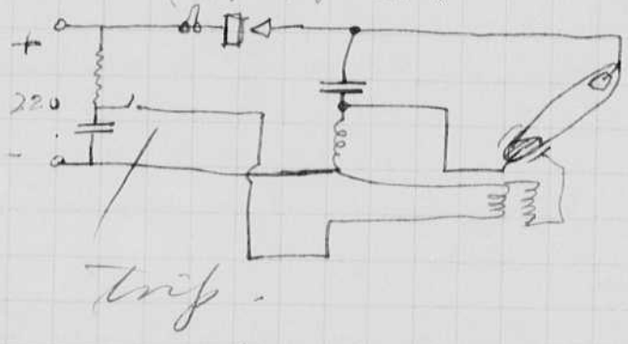
Put start switch on other side so the ground will not effect the system. Use otherwise an insulated tap on the contacts.



Oct. 25, 1931 ont. D. C. Stroboscope.
H.E. Edgerton.

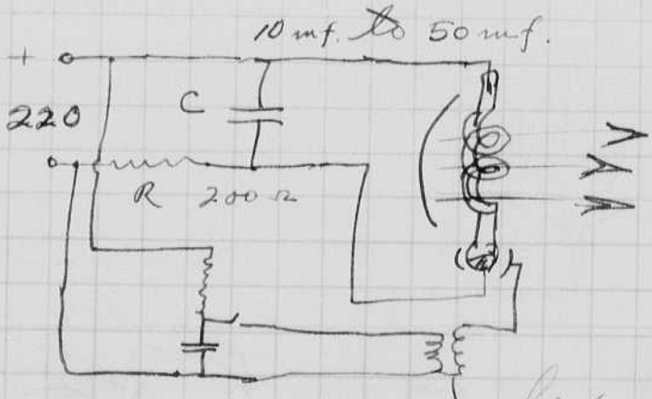


This circuit gives a voltage of nearly twice line voltage on the tube.



the rectifier can be omitted.

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



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

JAN 18 1940

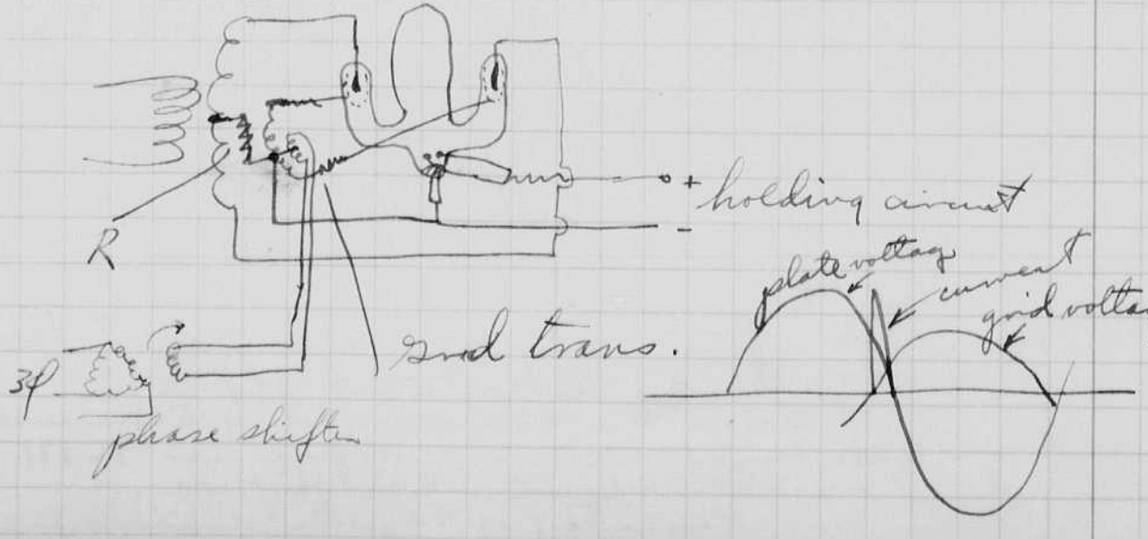
United States Patent Office
Before the Examiner of Interferences
Edgerton vs. Miller - Interference 76771.
Edgerton Exhibit 10.
Page 69 of Edgerton Notebook J-4; Oct. 25, 1931
January 2, 1940 Clara Schlosky - Notary Public

Oct 25, 1931.

H.S. Edgerton As I recall, my first stroboscopic experiments were as described below. I first noticed the stroboscopic effect when taking voltage-angle curves on a twenty amp pool type thyratron. 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.

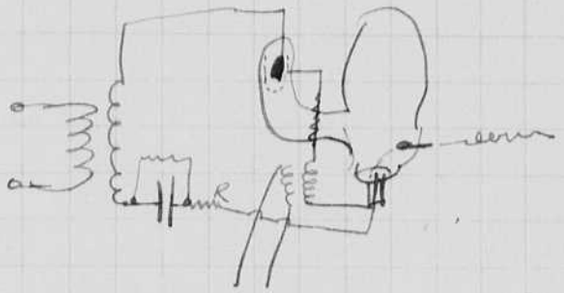
Several discs were made which had different numbers of equally divided sections. These appear to move in different directions or at different velocities when the speed V of the disc is changed.

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.



Con't.

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. F. Gardner, Dr V. Bush, Mr. Keehan (mechanic), F. S. Gray, Mamin Dixon and others saw this operate and understood the circuits.

cont → from

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 thyratron stroboscope for the popular science lectures by Prof. F. 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 2, 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 thyratron 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. Thyratron 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 Beardsley. Circuits to operate a Cooper-Hewett mercury-arc lamp as a stroboscope.

August-September 1930. T-1 pages 44-45. Work on the thyratron 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. Thyratron stroboscope for 120 cycle flashes from 60 cycle power.

Oct. 24, 1930. T-1 page 54. Photographic tests of the thyratron stroboscope 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.
H. E. Edgerton.

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

Oct. 27, 1931. In the evening Germeshausen 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 N. G. A tube of this form was made of glass, 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 O'Brian in the physics dept took some spectrograms of the light. Stockbarger also tried to get some fine stroboscopic but the tube went gassy before these were taken.

Oct. 29, 1931. Worked most of the day with Germeshausen on various circuits. Results discussed in his notebook. 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 one 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.
J. M. Mott-Smith and
G. L. Locher
The Rice Institute
Sept. 4, 1931. Read.

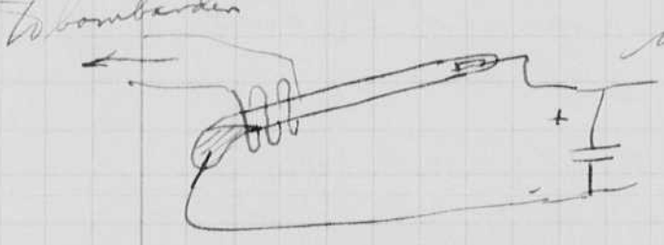
P 1402 – mention using flash lamps.

Nov. 2, 1931

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

Yesterday I missed Blake and ... from Locus Stab.

Gemmesheimer and I tried an experiment to see if a high frequency field around the tube would start the flash. We used the spark bombarder as a source of high freq. It worked alright except 120 cycles was too fast for our power supply on the discharge tube. Gemmesheimer is working up a UX210 as an oscillator. To see if it will trip the tube.



Nov. 3, 1931. Spent all day 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 Sacco Lowell shops came over in the afternoon and we demonstrated to them the variable freq stroboscope (top left picture p 44). Circuit glued in to page 21. Some minor changes have been made in the circuit since this wiring diagram was made. Gemmesheimer and I plan to go tho their Newton plant next Monday afternoon to demonstrate the stroboscope.

Nov. 4, 1931.
H. E. Edgerton In the afternoon Kennethanson 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 "My Life of Magic".

Nov. 5, 1931. Kennethanson worked on a circuit that Lee is trying to get together. It is a small outfit with a 60 cycle and variable speed arrangement. The parts are all radio parts except the thyratron which is an F. G. -17. Started Reid winding 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

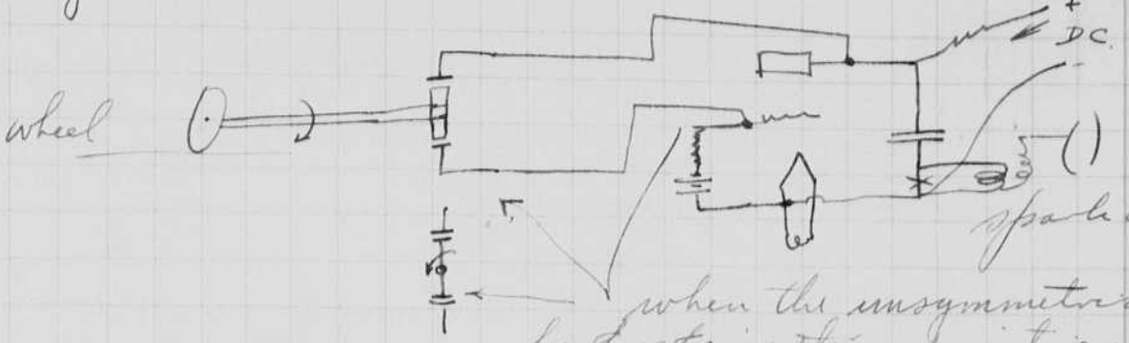
Kennethanson's idea regarding a disc and a wheel to get a variable speed for the stroboscope is great. The disc can be driven by a synchronous motor and thus the speed can be accurately determined if the diameter of the small wheel and its distance from the center are known.

Speed of disc = N r.p.m.

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

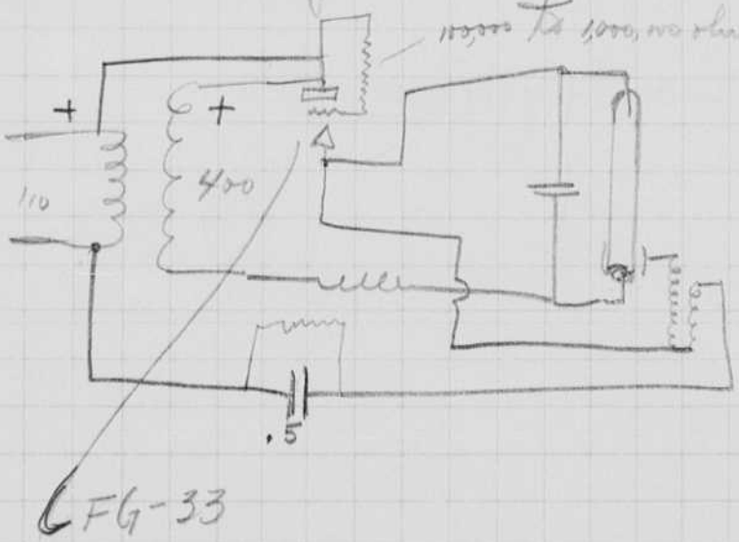
$= \frac{a}{D} N$ r.p.m

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



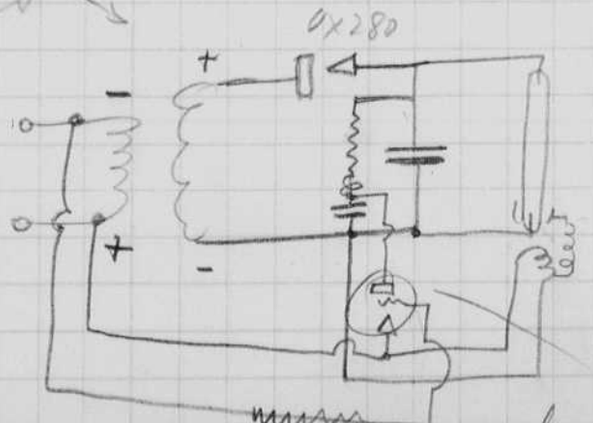
when the unsymmetrical part gets in this position it puts enough charge on the grid to raise its potential enough to start conduction. In this way no mechanical connection is needed.

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



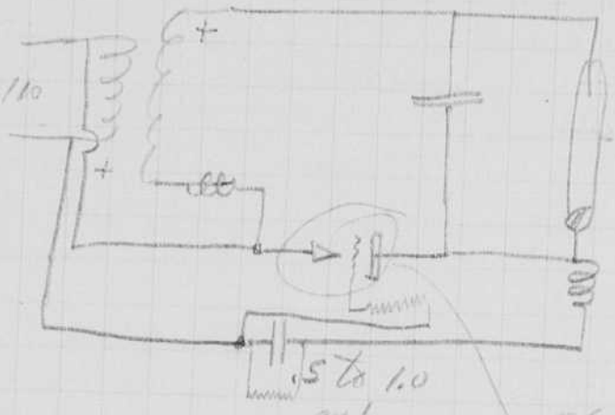
This circuit used the FG 33 both as a trip and as a rectifier.

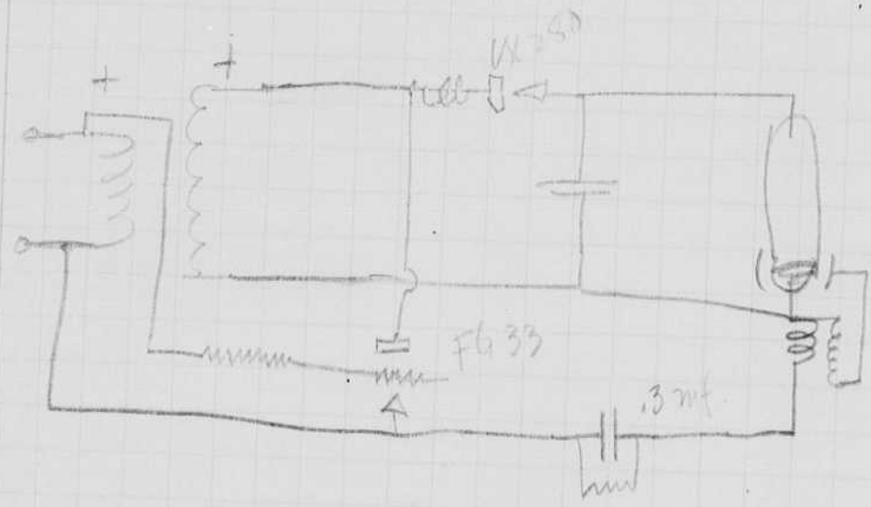
Old circuit →



7

Nov 6 1931 Cont.

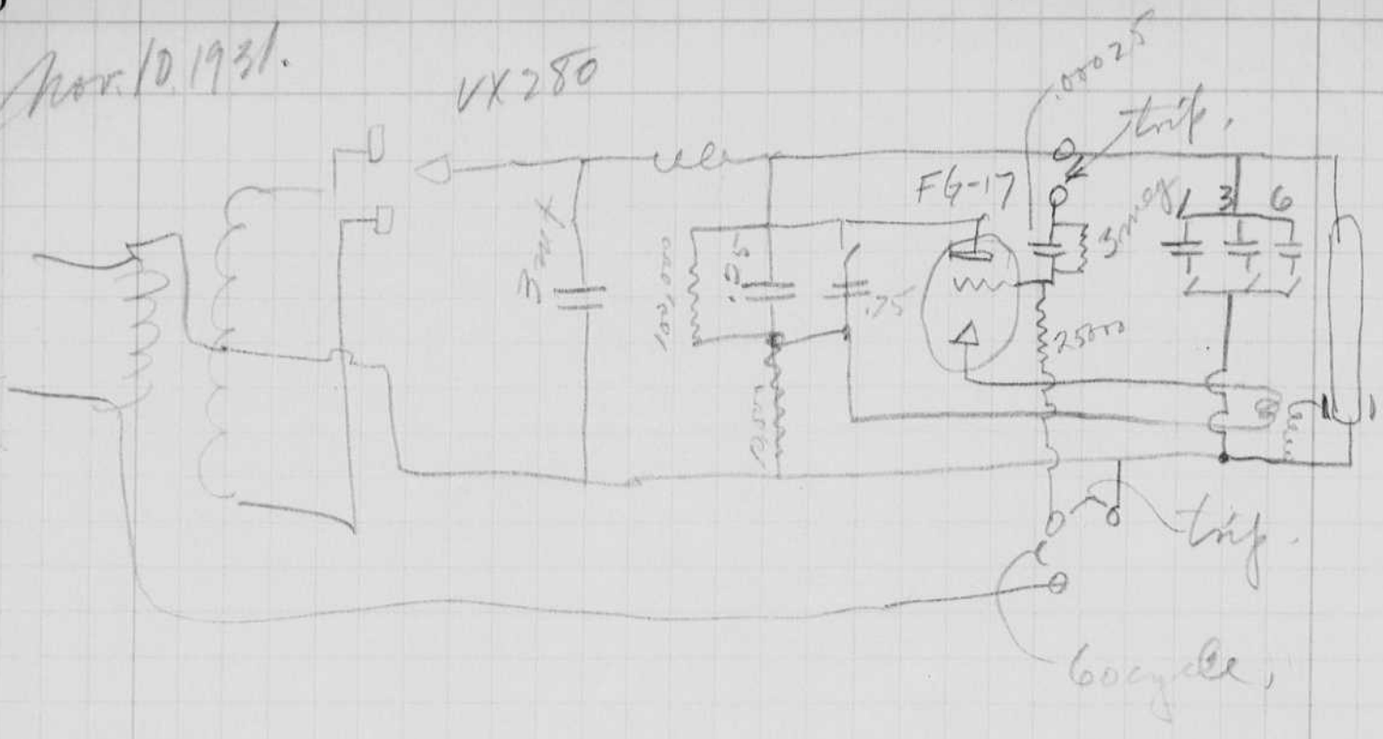




Nov. 7 1931

Wednesday. Took the variable speed stroboscope out to the Boston airport and looked at airplane propellers. Looked at Harris's plane. ~~Stark~~ ~~Draper~~ was there and arranged the meeting.

Nov. 10, 1931.



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

W. Hugh Willis.

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

Notebook # July 20, 1931 - Jan 12, 1932

Filming and Separation Record

____ unmounted photograph(s)

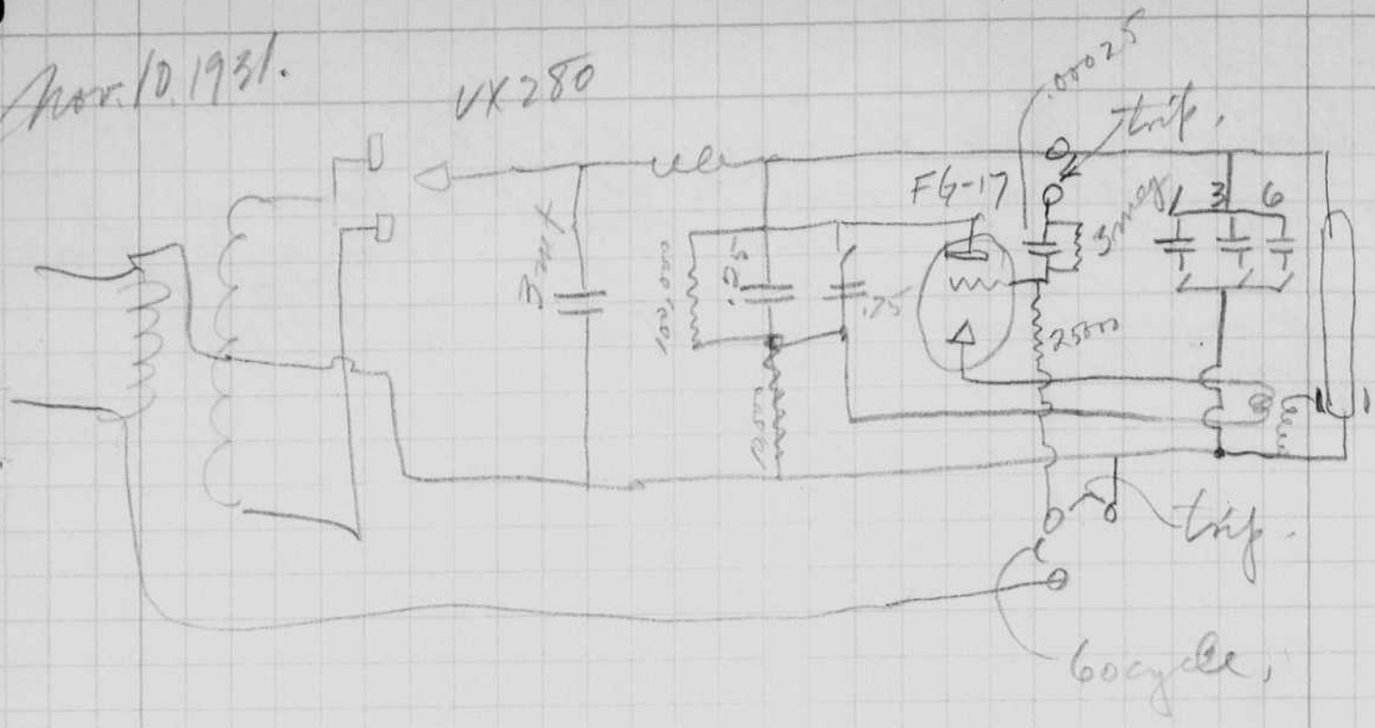
____ negative strip(s)

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

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

Item(s) now housed in accompanying folder.

Nov. 10, 1931.



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

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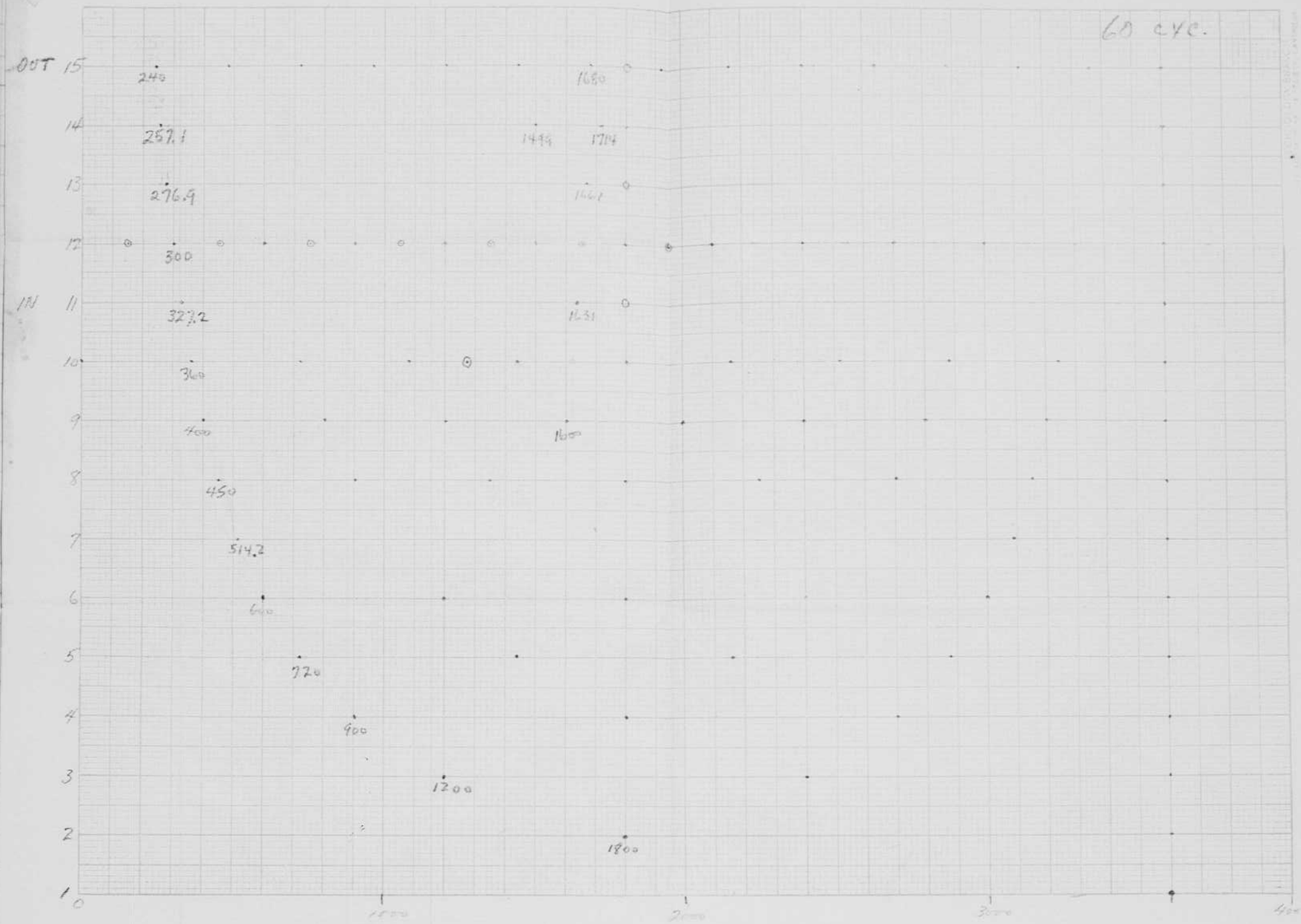

60 cyc.
OUT
IN
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
240
257.1
276.9
300
323.2
360
400
450
514.2
600
720
900
1200
1800
1680
1499
1704
1461
1631
1600
2000
3000
4000

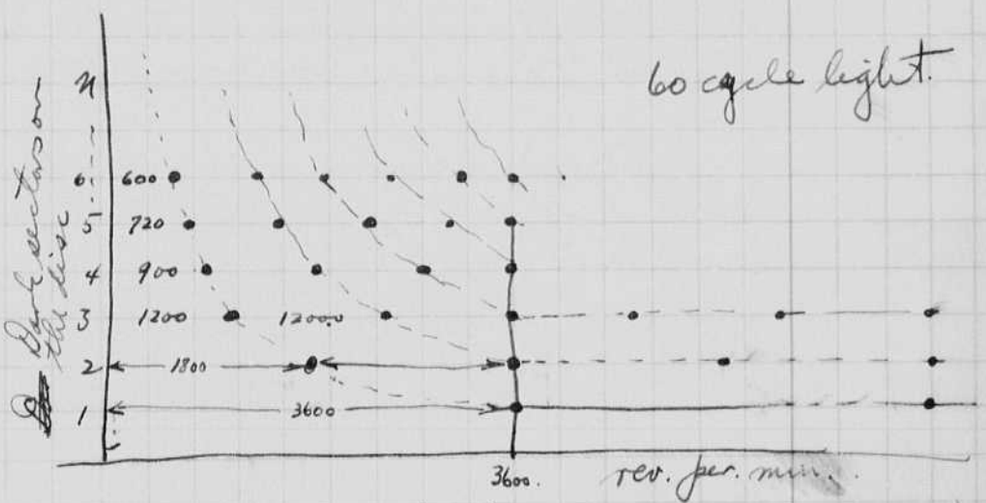
Nov. 11, 1931.

H. E. Edgerton

"The Rotating Sectored Disc" B. W. Bartlett.
Bowdoin College, Brunswick, Maine.
The Review of Scientific Instruments. Vol 2. new Series No 2.
page 96.
(Luckh and Viewg ~~Z~~ f. Instrumentenkunde, 46, 30; 1926, Luckh and Viewg; 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.

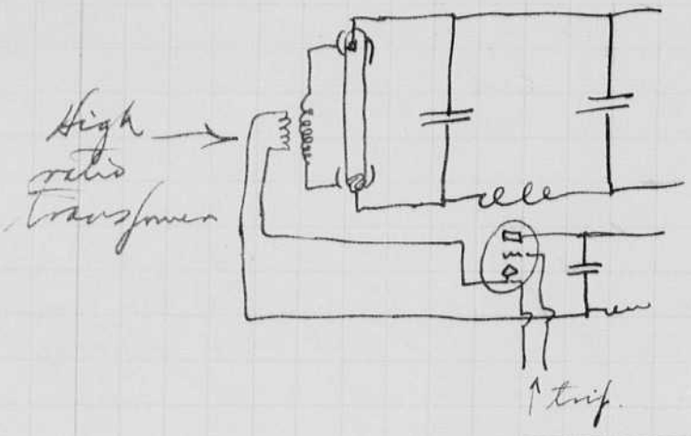
n =	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
first sync speed =	3600	1800	1200	900	720	600	~~514.2~~	450	400	360	327.2	300	276.9	257.1	240.			

Abstract in "The Review of Sci Instruments" Vol 2 new Series No 2. pp 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.

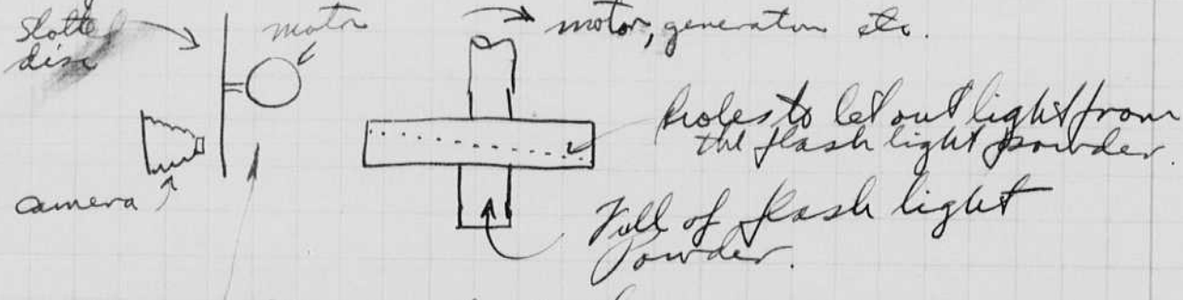
Nov. 12, 1931.

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) — Regierungsbaumeister in Wiesbaden. — Zeitschrift des Vereines deutscher Ingenieure. Vol 50 December 1906 page 1981.

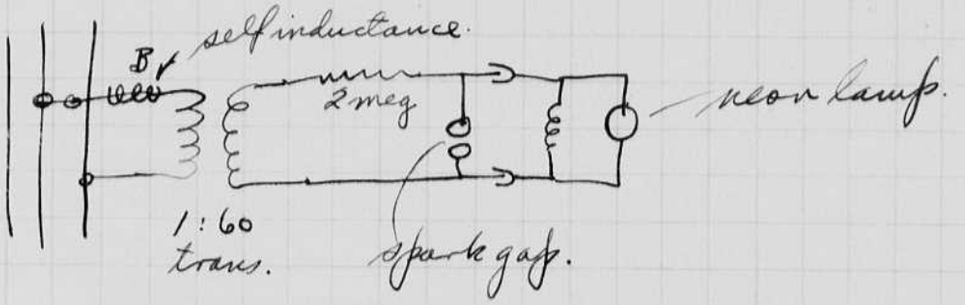
Shows scheme with ~~an arc lamp~~ a method of obtaining pictures of the angular displacement.



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

Nov. 13 1931.
H. 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).

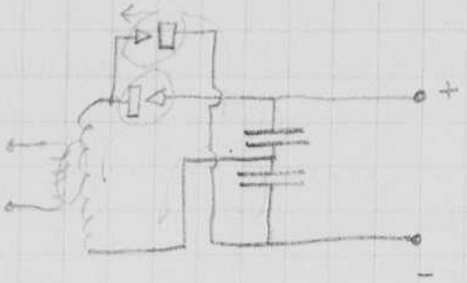
Miles Walker. The Diagnosis of trouble in Electrical machines.

D. Robertson tuning fork with slots,
C. V. Drysdale tuning fork spark coil and neon lamps.

Maserve and ~~Rad~~ 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. Elect Rev 33 p 566 Oct. 1930
New form of Stroboscope -
uses Rotating prism.

Nov. 15, 1931. Parallel rectifier.



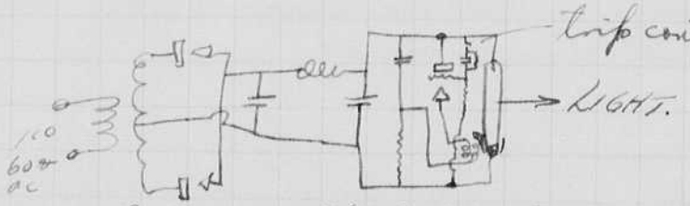
$6600\sqrt{2} = 9000$ volts.
$2300\sqrt{2} = 3300$ volts.

Nov 1931. Electronics
V.K. Zworykin.

Nov. 21. 1931.
H.E. Edgerton. Pike of the Razor 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 G.E. was to be there then to see the factory.

Jones has 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.



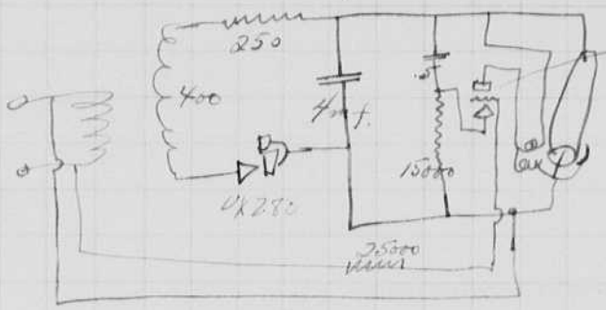
This ran all day. We left about 11 a.m.

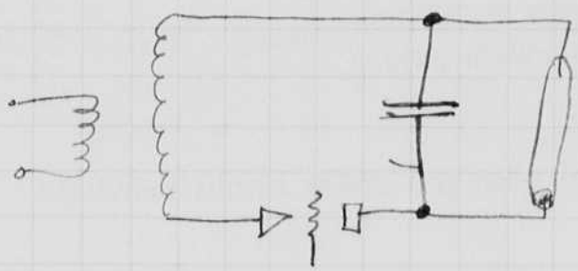
They changed wrapper stock on thursday morning and in some way the stroboscope failed to work. Germ went out and fixed the outfit so it worked ok. The speed was considerably increased and the stroboscope worked fine. The G.E. agent came in the morning and saw it work.

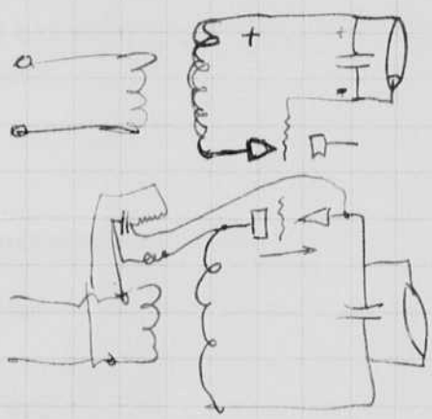
The stroboscope was used all day Friday. The girl operating the variable speed clutch did not mind the flashing light. She said it was easier to use the stroboscope than to use the old scheme.

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.

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.

Spark Spectra of Hg.
Bloch and Bloch.
Induced by high frequency fields
external to the tube.

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.	λ	ARC A	ÉTINCELLE E_1	ÉTINCELLE E_2	ÉTINCELLE E_3
5	6 149,37		1		
2	23,48		1		
1	11*				3
2	01*		1		
2	6 090*		1		
1	72,66	A			
1	59*		1		
2	46*			2	
1	32*		1		
2	25*			2	
2	17*		1		
1	5 994*		1		
1	82*				3
1	71*		1		
2	62*		1		
1	56*				3
1	49*		1		
1	44*				3
2	36*				3
1	19*		1		
1	11*		1		
4	5 888,79		1		
1	80,5				3
4	71,30		1		
1	64,4		1		
2	54,5		1		
1	40,6		1		
2	34,0				3
3	17,5?		1		
1	04,3				3
2	5 799*		1		
5	90,66	A			
2	81,9				3
5	69,60	A			
3	46,6			2	
4	28,12			2	
1	17,0				3?
1	07,7*				3?
3	5 699,0		1		
5	77,15		1		
2	66,37			2	
2	62,01			2	
3	37,71			2	
4	5 595,34		1		
1	87,9				3?
1	76,2				3?
3	71,00			2	
1	64,6*		1		
1	53,6		1		
3	40,95			2	
1	13,4		1		
1	01,4		1		
1	90,0		1		
1	84,6		1		
1	76,3		1		
5	5 460,74	A			
2	50,15			2	
1	43,2		1		
1	36,5		1		

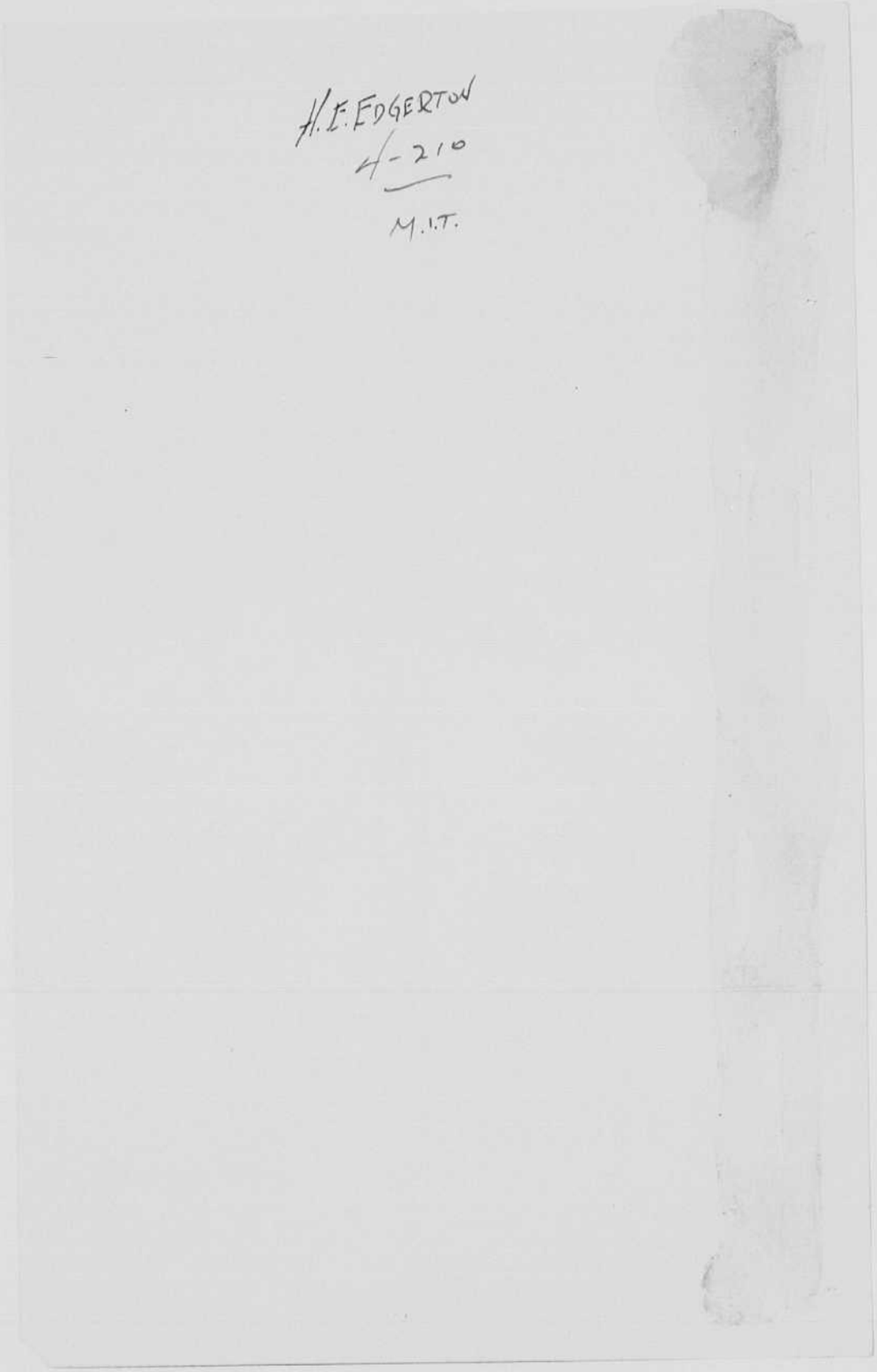
INT.	λ	ARC A	ÉTINCELLE E_1	ÉTINCELLE E_2	ÉTINCELLE E_3
5	25,25		1		
1	16,9		1		
1	07,5*		1		
2	5 398,5		1		
1	93,4		1		
1	84,9		1		
1	73,2		1		
1	65,24		1		
1	54,29		1		
2	46,3		1		
1	34,3		1		
1	17,2*		1		
2	11,7		1		
1	08,0		1		
2	5 294,7		1		
2	88,7		1		
3	81,5		1		
2	73,7				3
1	54,0				3
3	42,8		1		
2	33,8		1		
2	24,2		1		
3	16,38		1		
3	10,79			2	
3	04,78		1		
3	5 196,6		1		
1	90,7		1		
1	87,5		1		
1	72,4		1		
3	62,28		1		
3	49,2?		1		
2	35,6?		1		
4	28,41		1		
1	21,2		1		
1	18,1*				3?
1	15,1*				3?
1	13,7		1		
1	07,3			2	
2	01,5		1		
1	5 098,4				3?
1	86,3				3
2	81,26		1		
1	73,6		1		
4	66,49		1		
2	62,6		1		
1	58,4		1		
1	51,8		1?		
1	48,4		1?		
3	43,26		1		
2	38,3				3
1	36,6*		1		
1	23,9*		1		
1	20,9			2	
1	18,4			2	
1	08,6		1		
1	01,3*			2	
2	4 992,13			2	
1	88,04			2	
1	80,58			1	

INT.	λ	ARC A	ÉTINCELLE E_1	E_2	E_3
3	73,42			2	
2	60,43		1		
2	49,53			2	
1	43,4		1		
1	33,0		1		
1	21,0*		1		
3	16,05	A			
1	13,0		1		
3	02,85		1		
2	4 898,79			2?	
1	95,8		1		
1	90,0				3?
1	80,2		1		
2	69,85			2	
2	66,72			2	
2	64,76		1		
2	55,72		1		
1	49,4		1		
1	44,56		1		
2	41,46				3
4	25,62		1		
3	12,78		1		
4	4 797,01			2	
1	89,7*		1		
1	81,0				3?
1	73,7				3?
1	68,1				3?
3	66,39			2	
1	62,7		1		
1	60,2*		1		
2	51,17		1		
3	42,41		1		
1	38,0*		1		
1	31,9*				3
2	27,26				3
3	07,7		1		
1	4 697,9		1		
1	89,1				3
1	87,0		1		
1	81,6				3
1	78,3*		1		
1	76,0*				3
1	67,5				3
1	64,2				3
1	61,64				3
4	60,28		1		
2	51,17			2	
1	47,45				3
1	39,3?				3
1	35,9		1		
1	30,5				3
1	26,2		1		
1	20,5				3
1	04,11		1		
1	02,37				3
1	00,7				3
3	4 598,2			2	
1	93,5				3?
1	87,1				3?
1	85,1*				3?
1	79,6*				3?

INT.	λ	ARC A	ÉTINCELLE E_1	E_2	E_3
1	78,2		1		
1	71,5				3?
1	68,8				3?
1	62,3				3?
2	56,7		1		
2	52,89			2	
1	46,55				3
1	43,59				3
1	37,44				3
1	34,49				3
1	32,10		1		
1	28,6*				3
3	22,9		1		
2	15,79			2	
1	11,5				3
1	07,78				3
1	06,70				3
2	05,0			2	
1	4 499,8				3
1	98,0				3
1	93,2		1		
1	91,60				3
1	89,73			2	
5	87,48			2	
1	83,68				3
1	80,49				3
3	70,60			2	
1	66,7				3
2	64,2		1		
2	59,18				3
1	54,1		1		
1	51,64		1		
1	46,4				
2	35,24				
1	30,90				
3	25,9		1		
1	22,2				3
1	20,6				3
1	14,89				3
1	13,83				3
1	11,78				3
3	02,06			2	
3	4 398,2		1		
2	92,14			2	
1	85,57				3
1	82,58				3
2	78,63			2	
2	76,19			2	
1	72,6		1		
1	68,95		1		
1	65,8*		1		
5	58,34	A			
4	47,50	A			
2	39,24	A			
2	36,90			2	
1	33,22				3
1	27,02				3
1	24,62				3
2	20,53				3
2	14,00				3
1	10,3		1		

INT.	λ	ARC A	ÉTINCELLE E_1	E_2	E_3
2	05,5				3
1	01,7				3
1	4 297,27				3
2	92,21				3
1	89,72				3
1	88,2				3
3	84,71			2	
3	82,78			2	
1	77,57		1		
1	70,09				3
3	64,66			2	
3	61,87			2	
1	56,18				3
1	52,58				3
1	48,9				3
1	39,2*				3
1	37,49				3
2	33,99			2	
2	30,13			2	
2	27,87			2	
2	21,41			2	
4	16,72			2	
2	12,22			2	
1	06,10				3
1	4 196,68			2	
1	91,98		1		
2	85,51			2	
3	78,2			2	
2	75,63			2	
2	61,65			2	
1	56,68				3
1	40,38			2	
3	22,12			2	
3	15,38			2	
1	08,08	A			
3	05,86			2	
4	4 077,84	A			
5	46,56	A			
2	32,94			2	
1	25,95			2	
1	13,46			2	
3	06,27			2	
7	3 983,96		1		
2	68,03			2	
2	64,83			2	
2	62,80			2	
2	60,24			2	
1	54,45			2	
2	48,29			2	
2	45,09			2	
2	42,59			2	
1	36,62			2	
2	25,65			2	
1	22,04			2	
2	18,92		1?		
1	16,25			2	
1	14,20		1?		
1	06,48	A			
1	3 880,90			2	
2	74,98			2	
1	69,11				3

INT.	λ	ARC A	ÉTINCELLE E_1	E_2	E_3
1	60,29		1		
2	57,34				3
2	45,15			2	
1	39,26		1		
1	32,46				3
2	26,61			2	
1	20,6	A			
1	07,6		1		
1	03,51			2	
1	3 790,36	A			
1	89*				3
2	74,52			2	
2	72*			2?	
1	71,01	A			
1	57,20			2	
1	55,0			2	
1	51,74	A			
2	50,84		1		
1	42,48			2	
2	29,40			2	
1	09,51			2	
3	07,94		1		
1	3 689,82			2	
3	84,91			2	
3	80,01			2	
5	63,27	A			
5	54,83	A			
5	50,14	A			
4	38,34			2	
4	30,64			2	
3	18,6			2	
2	13,61			2	
4	07,60		1		
4	3 594,94			2	
3	78,75			2	
1	61,74	A			
1	56,28			2	
1	52,65			2	
1	49,41		1		
1	43,70	A			
1	39,4?			2	
3	32,63		1		
2	28,32				3
2	22,38				3
2	15,7			2	
2	12,83			2	
1	08,9				3
2	03,54			2	
4	3 492,77		1		
1	86,44		1		
4	73,01			2	
4	71,55			2	
2	62,94			2	
3	56,21			2	
1	51,69		1		
1	45,43			2	
1	42,87				3
2	34,73		1		
1	31,23			2	
2	28,5			2	
3	19,99			2	


H.E. EDGERTON
4-210
M.I.T.

H. E. EDGERTON
M. I. T. 4-210.

INT.	λ	ARC A	ÉTINCELLE E_1	ÉTINCELLE E_2	ÉTINCELLE E_3
1	16,86				3
1	04,0?				3
1	00,4?				3
1	3 396,31				3
2	92,40			2	
2	86,99		1		
2	81,09				3
1	77,5			2	
1	70,12			2	
1	66,36				3
3	62,85			2	
2	58,57			2	
1	55,1*				3
1	51,10				3
1	44*				3
3	41,48	A			
1	33,1*			2	
2	30,68				3
2	29,5*				3
1	27,1*			2	
1	26,0*			2	
1	21,8*				3
1	20,52				3
3	19,3*			2	
1	18,3*			2	
1	17,3*			2	
1	15,7*				3
2	12,1*			2	
1	07,1*				3
2	03,4*				3
1	3 298,7*				3
2	95,2*				3
2	90,1*			2	
1	86,2*		1		
3	81,4*			2	
1	77,89		1		
1	75,1*				3
1	71,9*				3
1	69,4*				3
3	64,06		1		
2	57,5*		1		
2	52,0*		1		
2	50,2*				3
3	46,9*				3
1	43,7*				3
1	41,2*				3
1	39,4*				3
1	38,5*				3
2	35,3*				3
2	30,7*				3
1	27,84		1		
1	25,9*				3
1	24,0*				3
2	19,0*				3
1	15,1*				3
2	12,0*				3
3	08,20		1		
1	03,2*		1		
2	00,8*				3
1	3 197,9*				3
2	91,0*		1		
1	86,9*				3
1	84,8*				3
1	81,2*				3
2	76,6*			2	
1	74,0*				3
1	69,8*			2?	
1	68,3*				3
1	66,7*				3
1	59,4*				3
1	58,52				3
1	52,4*				3
2	48,8*				3
3	44,55				3
1	42,1*				3
1	40,1*		1?		
4	31,85	A			
4	25,62	A			
1	20,3*				3
3	16,23		1		
1	13,8*				3
3	09,6*				3
1	07,66		1		
1	3 096,22				3
2	92,79				3
3	90,05			2	
1	86,5*				3
1	84,0*				1
1	81,0*				3
2	77,9*				3
1	73,4*				3
1	71,4*				3
2	68,7*		1		
1	64,8*		1		
2	61,5*				3
1	59,6*				3
1	56,5*		1		
1	53,7*				3
1	52,8*				3
2	45,0*			2?	
1	42,0*				3
1	38,19				3
2	34,9*		1		
1	31,4*			2?	
2	27,49	A			
2	23,48	A			
3	21,50	A			
2	07,16		1		
1	04*				3
1	2 992*				3
3	83*				3
1	75*		1		
1	73,05		1		
4	67,28	A			
2	62*				3
1	58*				3
1	55,74		1		
3	47,08		1		
1	40,53		1		
2	35,92		1		
1	30,5*				2?
1	25,39	A			

INT.	λ	ARC A	ÉTINCELLE E_1	ÉTINCELLE E_2	ÉTINCELLE E_3
3	16,27		1		
1	09,5*		1		
1	04*				3
1	2 899*				3
3	93,61	A			
1	86,90				3
1	84*				3
1	82,60		1		
1	75*				3
1	73,24		1		
1	66,17				3
2	59*				3
1	56,97	A			
1	52,41		1		
4	47,67		1		
1	20,01		1		
1	18*			2	
1	10*			2?	
3	06,84		1		
3	03,53	A			
2	2 797*		1		
1	91,15	A			
2	88,40		1		
1	84,71		1		
2	81,93		1		
1	78*				3
1	71,5*			2?	
1	69*			2?	
1	67,6		1		
2	61,97		1		
1	59,78	A			
2	52,80	A			
1	37*			2	
1	33*			2	
1	29*			2	
3	24,41			2	
1	10,45		1		
1	05,36		1		
3	02,47		1		
3	2 699,50	A			
1	93*			2	
1	91*		1		
1	87,20			2	
1	85*		1		
1	83*				3
1	78,5*			2	
1	74,99	A			
1	73,19			2	
1	70,9		1		
1	68,5*			2	
2	63,80		1		
1	56,67				3
3	55,14	A			
3	53,70	A			
4	52,07	A			
2	41,98	A			
1	30,5*				3
2	28,06			2	
1	25,24	A			
2	17*			2	
1	12*				3
1	08,62				3
1	06,70				3
3	03,15	A			
3	2 599,50				3
1	98,45				3
3	84,74		1		
1	80,5*				3
1	78,91				3
2	76,31	A			
2	74,86			2?	
3	71,75				3
1	63,90				3
1	61,18	A			
1	57*		1		
2	53*		1		
1	48,56	A			
1	43*			2	
3	41,5*				3
4	36,52	A			
1	27*				3
1	24,8		1?		
2	14,2		1		
1	07?		1?		
1	03*		1		
1	2 499,37		1		
3	92,09		1		
2	86*				3
3	82,07	A			
1	71,5*			2	
2	68,73		1		
2	67,85		1		
2	64,06	A			
2	58,5*			2	
1	51*				3
1	48,56				3
1	46,92	A			
2	31,5*			2	
3	14,13		1		
3	07,35		1		
2	2 399,38	A			
2	90,16		1		
2	78,39	A			
4	54,21			2	
1	52,65	A			
1	45,49	A			
1	40,60		1		
2	39,37		1		
1	23,30	A			
2	15,0		1		
1	02,16	A			
1	2 296,4		1		
2	95*			2	
2	92,1		1		
3	63,93		1		
3	62,30		1		
3	60,52		1		
3	53,00		1		
3	44,40			2	
1	35*			2	
1	30,1		1		
3	24,87		1		

H. E. EDGERTON

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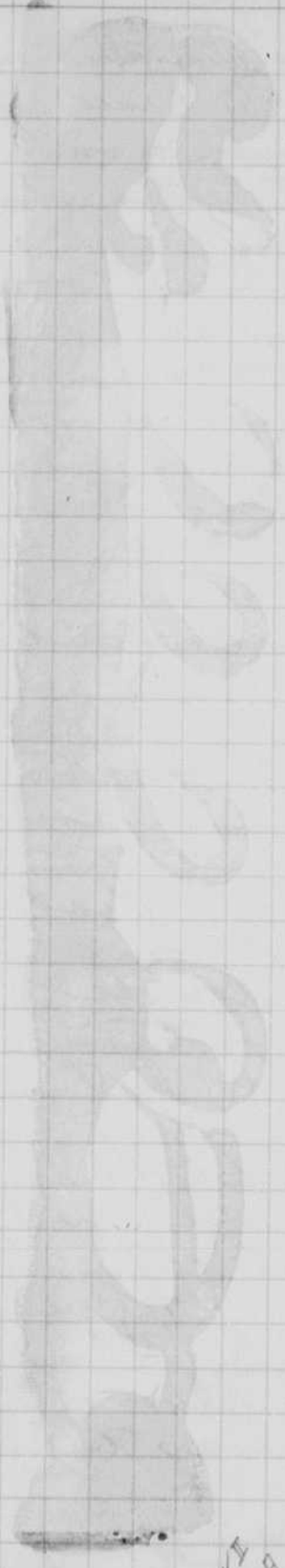

.86 23.5 2916.1 II
1.21 31.8 2925.4 A
1.605 42.2 2935.8 II
1.74 46.7 2940.3 E
1.79 47.0 2940.6 E
2.04 53.6 2947.2 E
2.34 61.4 2955.0 E

23.68 / 25 = 2925

2961.28
28.68
73.68

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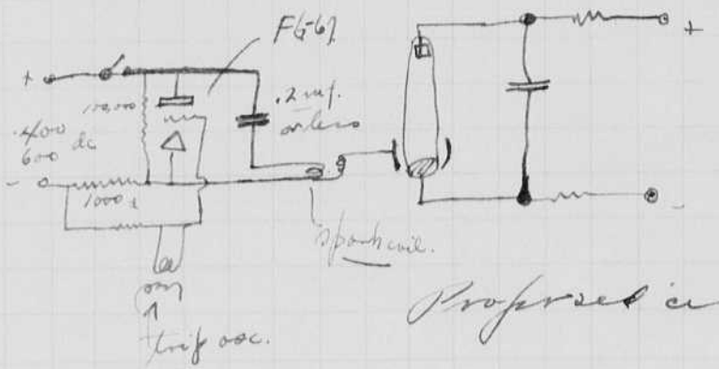
.86
1.21 22.5 2916.1 A
1.605 31.8 2925.4 A
1.74 42.2 2935.8 A
1.74 46.7 2940.3 A
1.79 47.0 2940.6 A
2.04 53.6 2947.2 A
2.34 61.4 2955.0 A

Nov. 24, 1931
H.E. Edgerton.

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



Proposed circuit

C.S. Draper of the aero Lab came over in the afternoon with his continuously moving film camera. Genn also 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 photocell will get impulses from a head light bulb through a small hole spaced the same as the movie frames.

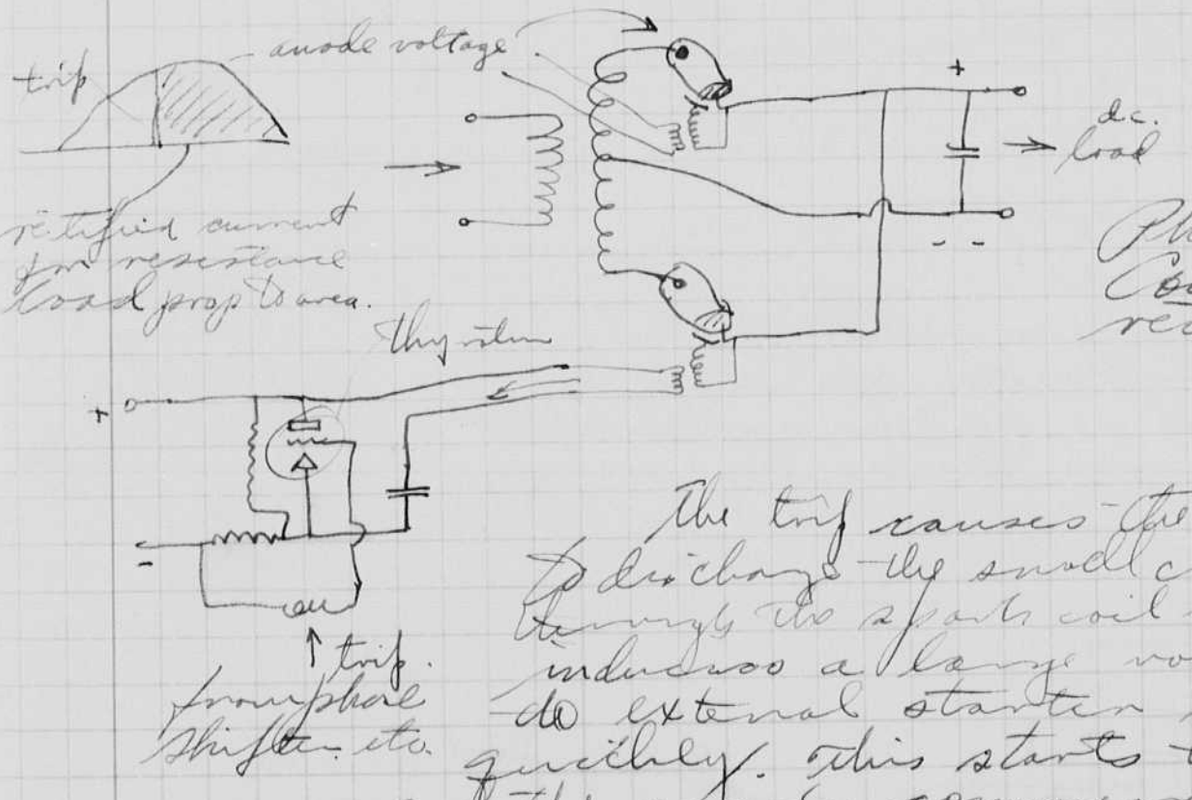
Genn and I tried to make some tubes in the evening but they both went bad. The oven got too hot and melted them.

Nov 26 1931
H. G. Edgerton

External Starting as a means of controling an arc discharge.

Two element mercury arc tubes such as have been used for stroboscopes may also be used ~~for~~ as controlled rectifiers or ~~rectifiers~~ 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.

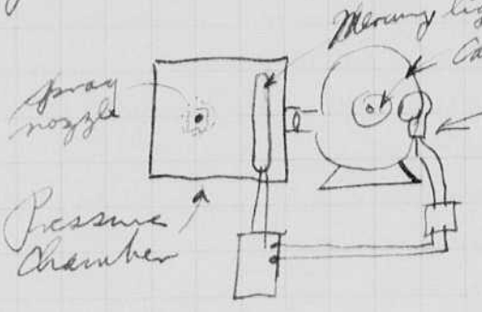


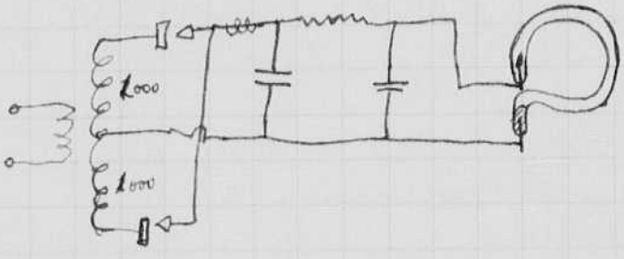
The trip causes the thyratron to discharge the small condenser through the spark coil which induces a large voltage on the external starter ring ~~ring~~ quickly. This starts the spot and the arc commences to conduct. The arc will persist until the current tends to reverse and then will go out ~~and~~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

Nov. 29, 1931.
H. E. Edgerton

Yesterday Kennedy and I moved all our apparatus from the Dyn. Lab. Q 10-088. 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





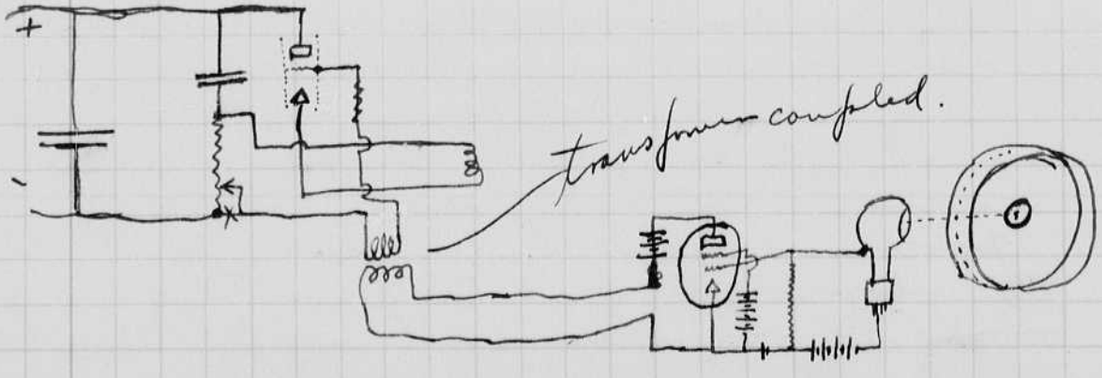
$\frac{.200}{1.44\ 1.000} = .139$

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

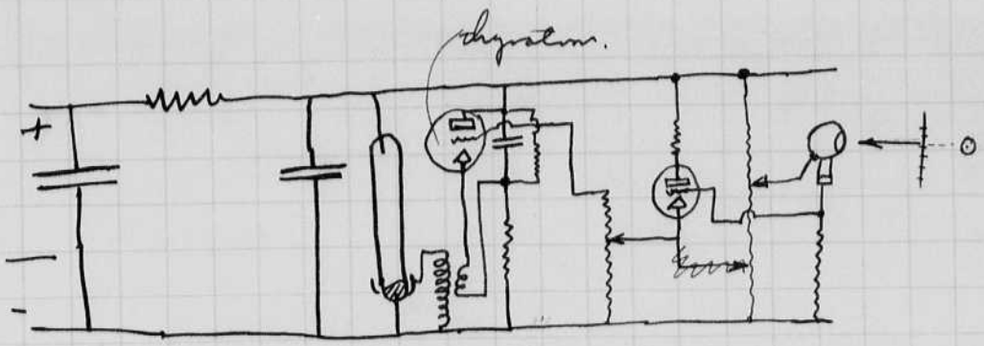
say 100 watts to the tube. $C = \frac{100 \times 2}{f\ 1.44 \times 10^6}$

E = 1200 E^2 = 1,440,000.

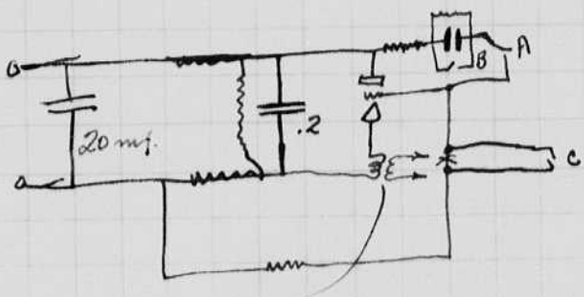
f =	500	1000	2000	3000	4000.
C =	~~.278~~ .278	.139	.0693	.0463	.0347



Cont.

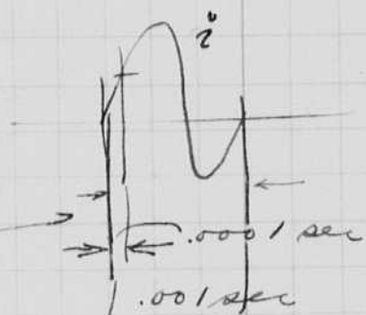


Sparker.



Special spark coil.

.0001 sec.



.2 mf. $T = 2\pi\sqrt{LC} = < .001$ sec.

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

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

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

The primary inductance should be about 0.14h.

or less.

$I_{max} = E\sqrt{\frac{C}{L}} = 400\sqrt{\frac{.2}{0.14}} \times 10^{-3} = \sqrt{1.4} \times .4 = .48$ amps.

$1.2 \times \sqrt{\quad}$

ratio $\frac{5000}{400} = 10:1$ $\qquad$ 30,000 volts

Special spark coil.

Primary Inductance = .01 henry.

Let A = 1. □ cm.
l = 6 cm
N = ?

$.01 = L = \frac{N\Phi}{I} 10^{-8} = \frac{N\left(\frac{4\pi NI}{\frac{l}{A}}\right)}{I} \times 10^{-8} = \frac{4\pi N^2 A}{l} \times 10^{-8} = 4\pi N^2 \frac{1}{6} 10^{-8}$

$N = \sqrt{\frac{.01 \times 6}{4\pi} 10^4} = \sqrt{\frac{.06}{12.6}} 10^4 = .0476 \times 10^4 = .069 \times 10^4 = 690.$ turns.

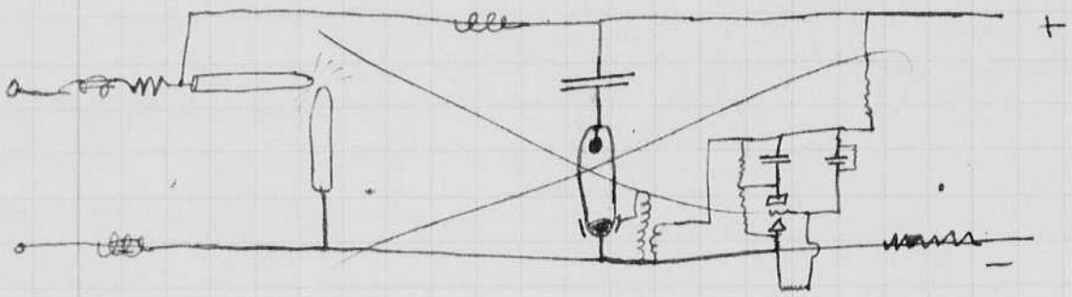
Secondary = 10,000 turns

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. Jennes Hanna 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.

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

Arc Intensifier

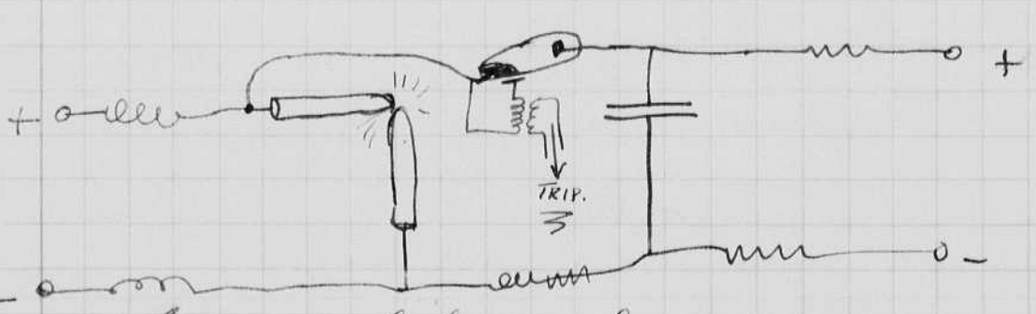


200 volts
~~10~~ 24 flashes per second.
Energy = 400 watts

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

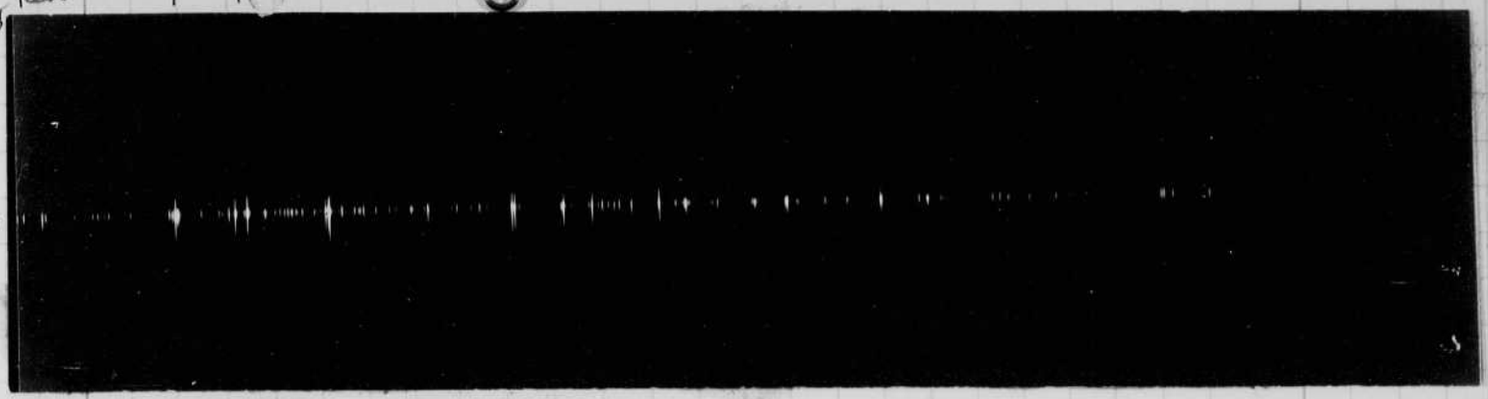
.002 / 400. / 1,000

$$C = \frac{\cancel{400}}{\cancel{200}\ \cancel{200}\ 24} = \frac{1}{.002400} = 416 \text{ m.f.}$$



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

Dec. 7 1931.



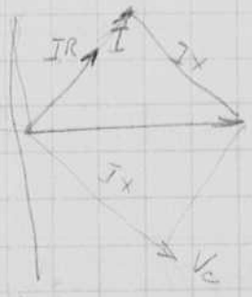
Spectrogram taken by Prof. Stoelzbarger.
Mercury arc stroboscope.
Quartz section

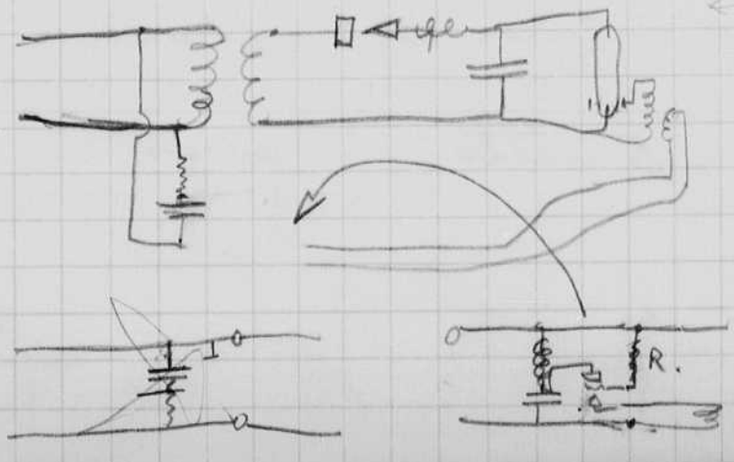
On Sat. afternoon I went over to Cannes' apartment in Brookline with Gennesbaussen. We tried to take some flash exposures with Cannes cooper Hewitt arc lamps. The experiments were a failure.

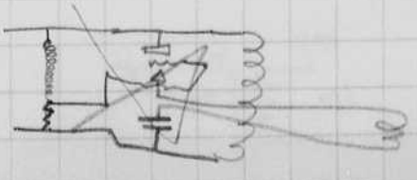
Tuesday Dec. 8 1931
Edgerton & Gennesbaussen - Pumped tubes.
Made 4 tubes.

Thursday Dec. 10. 1931 Gave 7 min. speech to the E E Dept and graduate students. Demonstrated Strobo and showed movies.

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







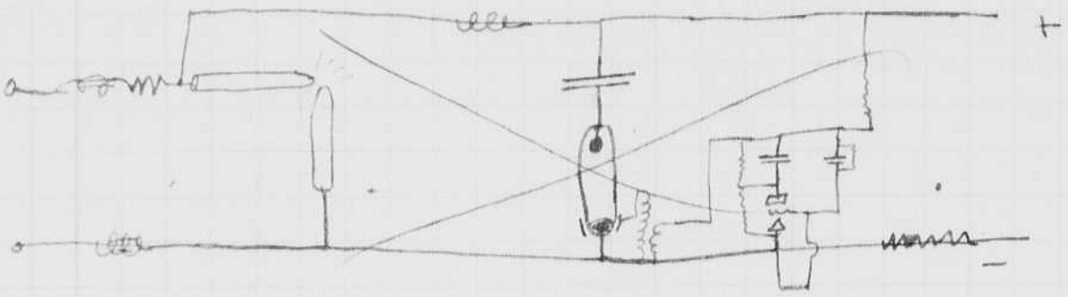
Saw Knowlton at Kendall Square
Met Wolcott Gray at MIT Dec 9 1931
He showed me Neon Strobo.

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. Semeshamm 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.

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

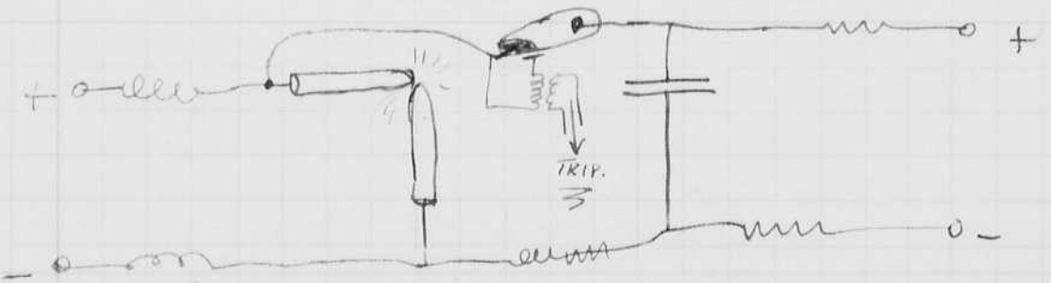
Arc Intensifier



200 volts
24 flashes per second.
Energy = 400 watts

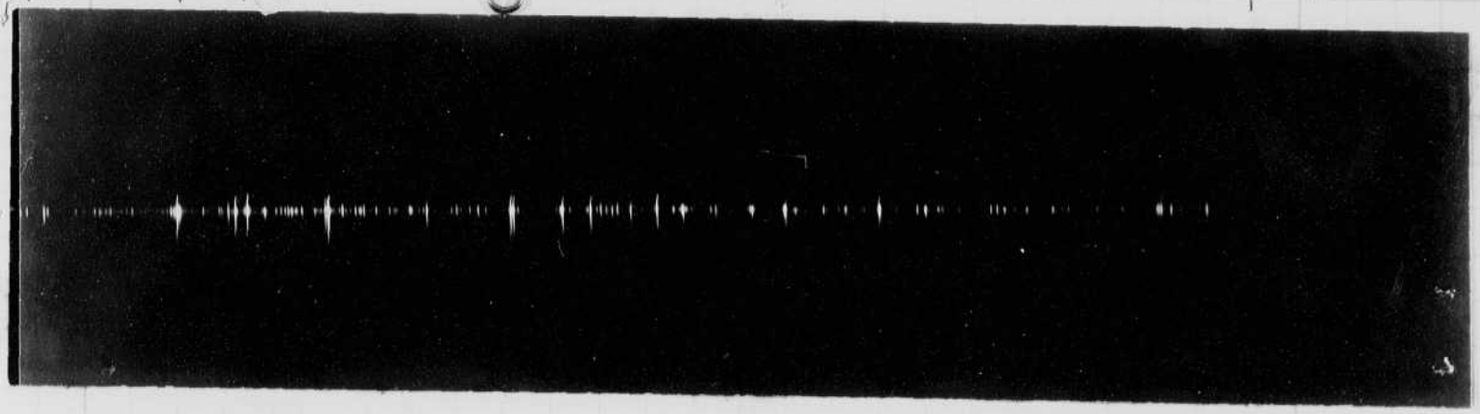
$$\frac{C E^2}{2} \times f = \text{Power} = 400 = \frac{C\ 200^2}{2} \times 24$$

$$C = \frac{400}{200 \times 200 \times 24} = \frac{1}{.002400} = 416 \text{ m.f.}$$



This could be used on motion picture projectors. The thyratron 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.



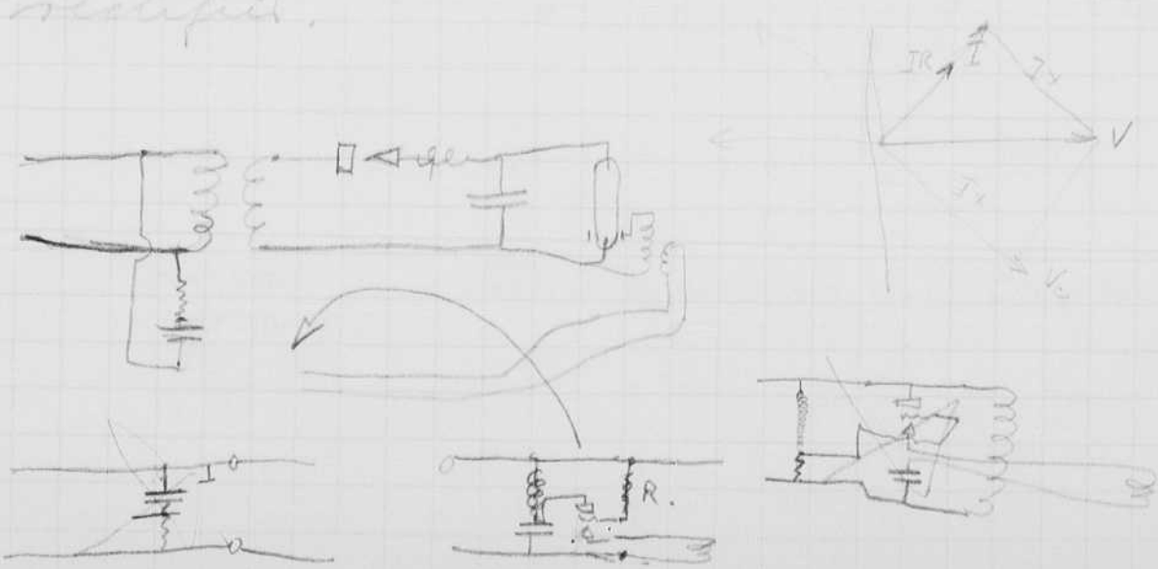
Spectrogram taken by Prof. Stetsbarger.
Mercury arc stroboscope.
Quartz section

On Sat. afternoon I went over to Cann's apartment in Brookline with Semmelbauer. We tried to take some flash exposures with Cann's cooper Hewitt Arc Lamp. The experiments were a failure.

Tuesday Dec. 8 1931
Started Semmelbauer - Pumped tubes. ...
Sealed 4 tubes.

Thursday Dec. 10. 1931 Gave 7 min. lecture to the 5 (Def) Grad. graduate students. Examined Strobe and showed movies.

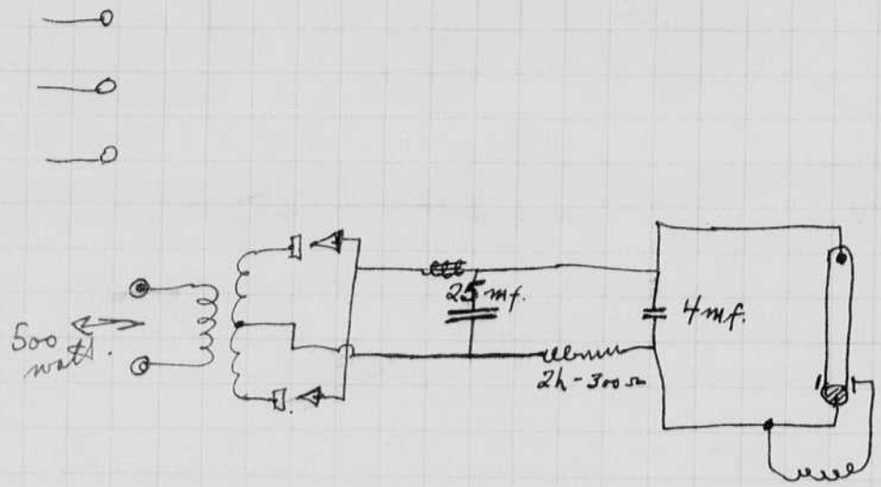
Circuit for 60 cycle strobe for the lab. Only one ~~transformer~~ Line unit thus needed.

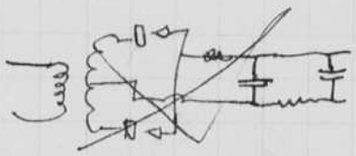


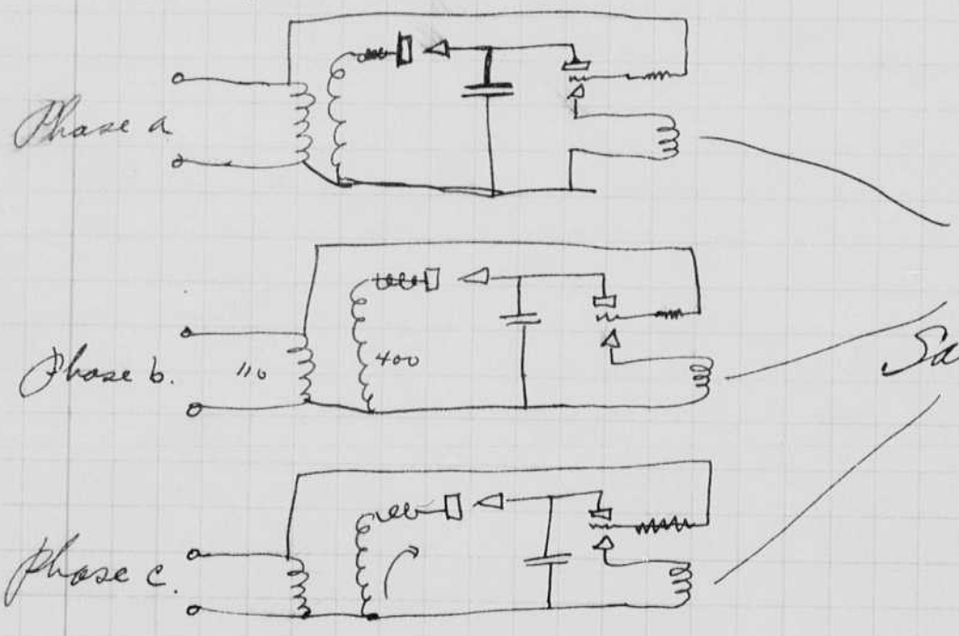
Saw Lowell at Harvard Observatory on Wednesday Dec 9 1931. He showed us a new Strobo.

Dec 11, 1931
H. E. Edgerton.

Three phase strobo.

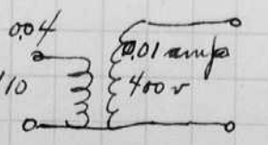






$$\frac{(400)^2 \times .3 \text{ mf} \times 60}{2 \times 10^{-6}} = .4 \; .4 \; \frac{30}{60} = .16 \times 30 = 4.8 \text{ watt}.$$

say the trip takes 5 watts, @ 0.1 × 400



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

Filming and Separation Record

1 unmounted photograph(s)

____ negative strip(s)

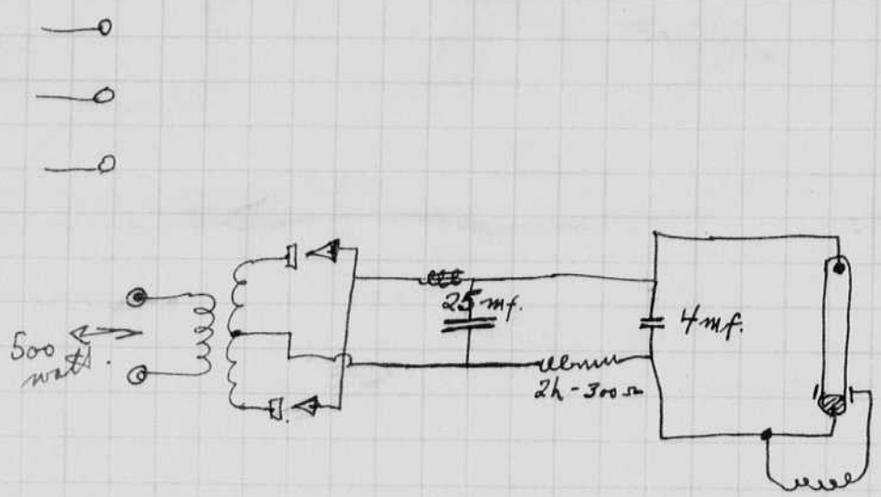
____ unmounted page(s)
(notes, drawings, letters, etc.)

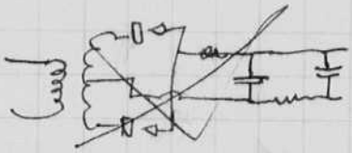
was/were filmed where originally located between page 94 and 95.

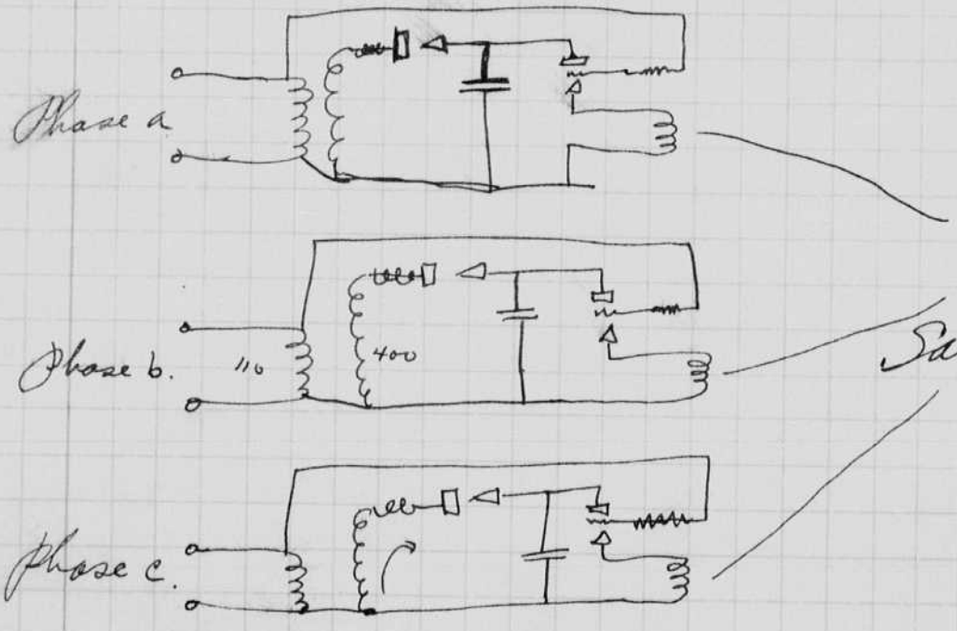
Item(s) now housed in accompanying folder.

Dec 11. 1931
H. E. Edgerton.

Three phase strobo.

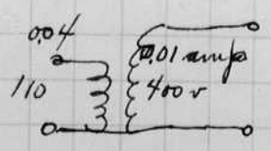






$$\frac{(400)^2 \times .3 \text{ mf} \times 60}{2 \times 10^{-6}} = .4 \quad .4 \quad \frac{30}{60} = .16 \times 30 = 4.8 \text{ watt.}$$

~~say the trip takes 5 watts.~~ .01 × 400



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Filming and Separation Record

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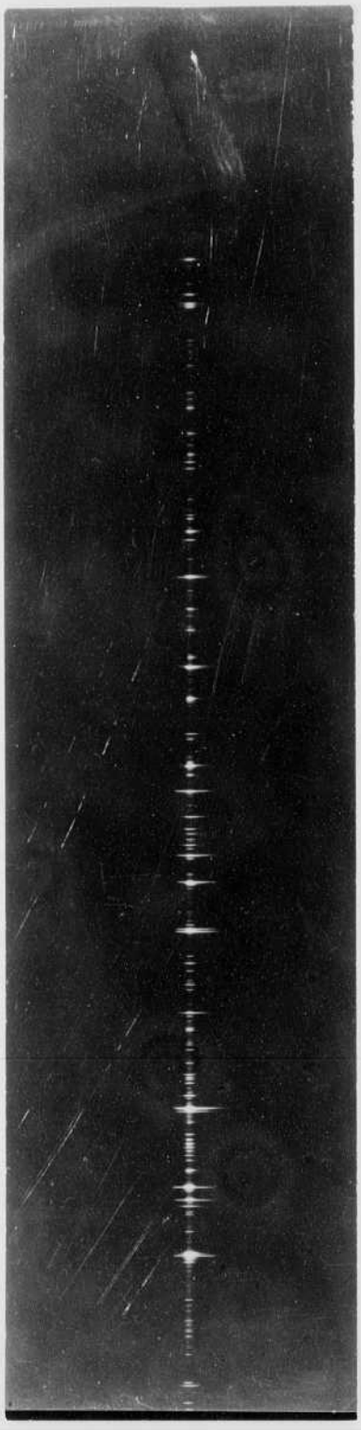
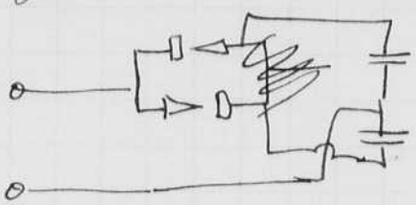
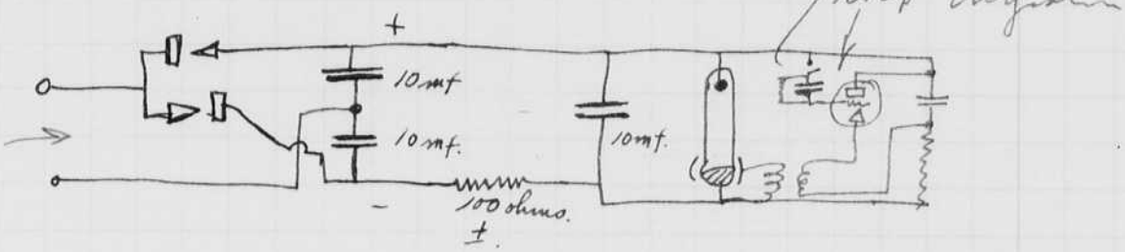


Dec 11 1931

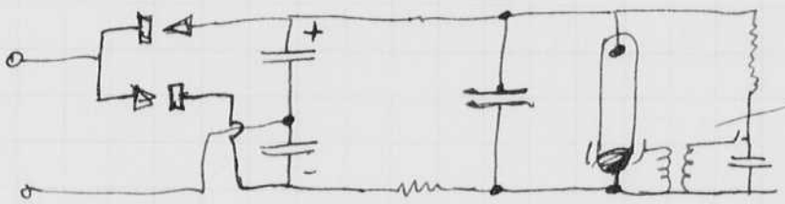
Cont'd Low Voltage Strobo for industrial use.

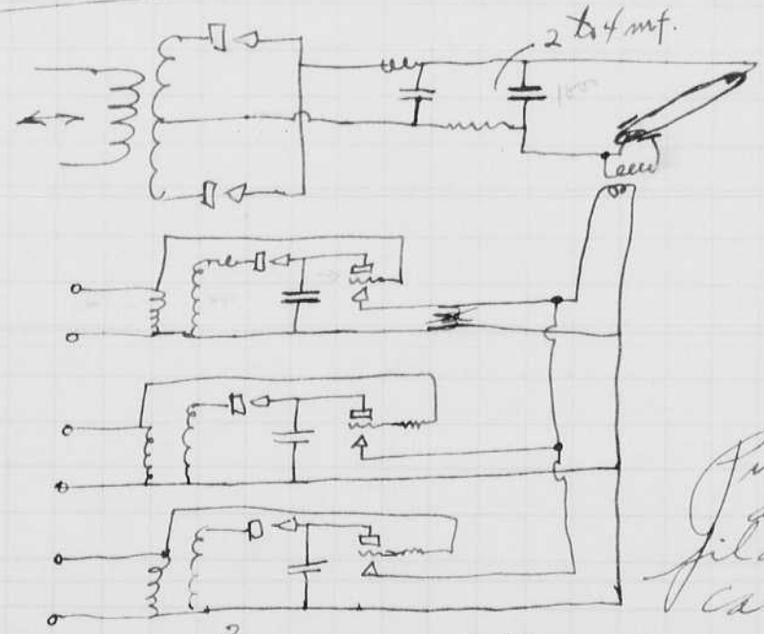
Transformers only needed for filament supply.

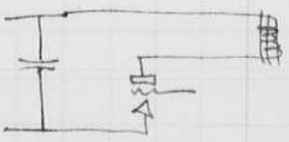




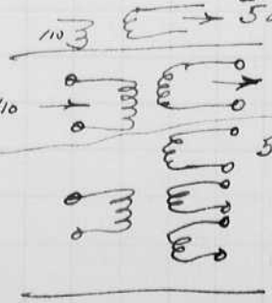
or. switch.

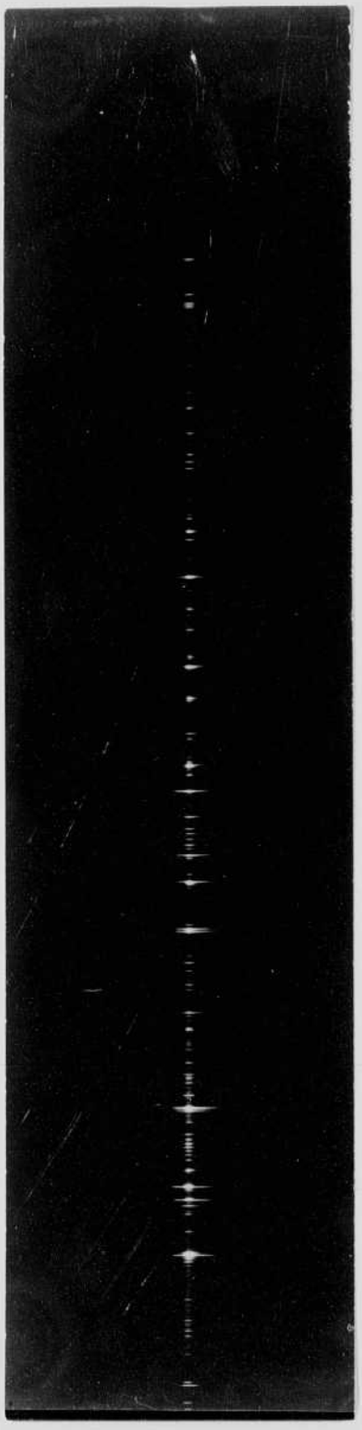






Put 3 sparken in the anode leak so the filament transformer can be common.

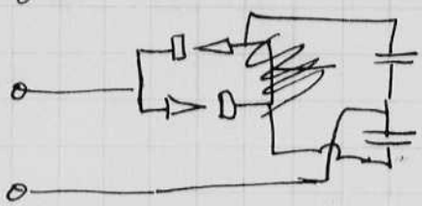


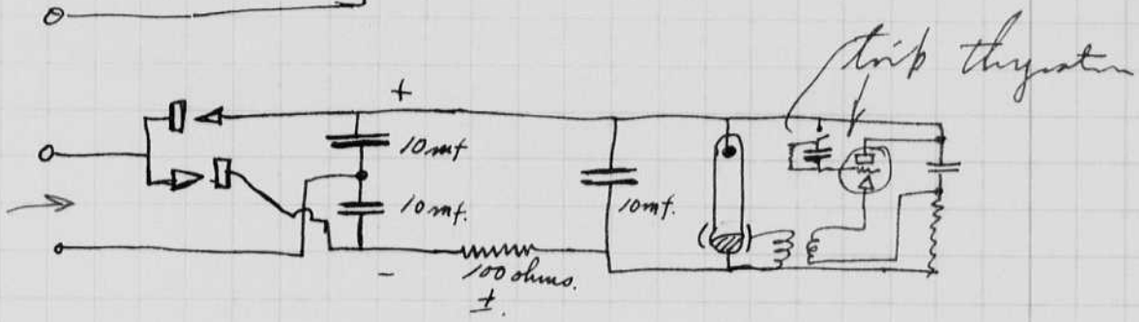


Jan 11 (31)

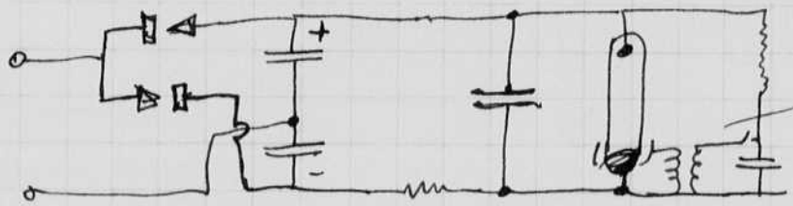
Cont. Low Voltage Strobo for industrial use.

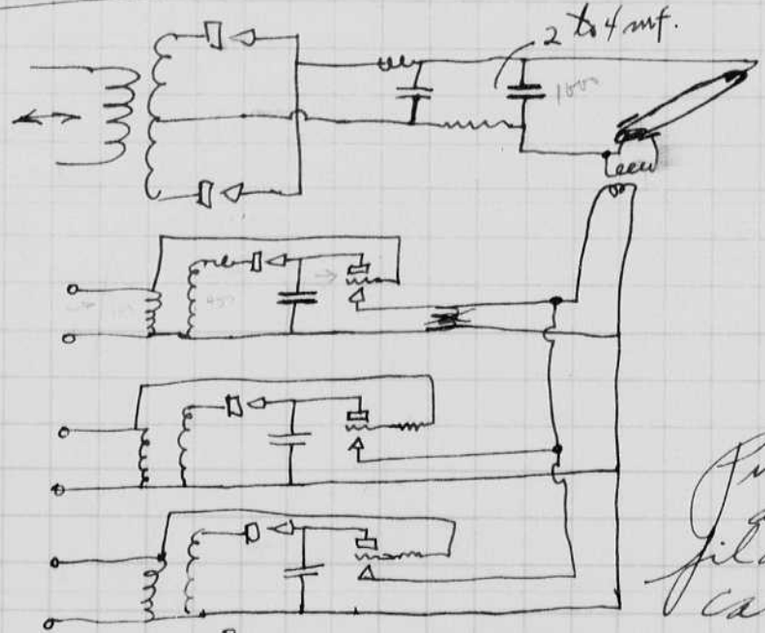
Transformers only needed for filament supply.

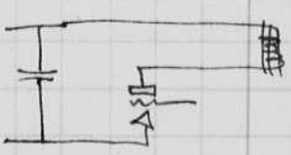




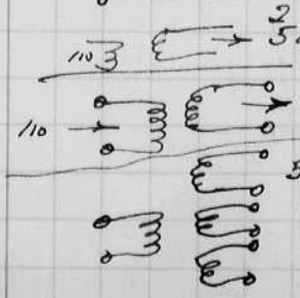
or. switch.





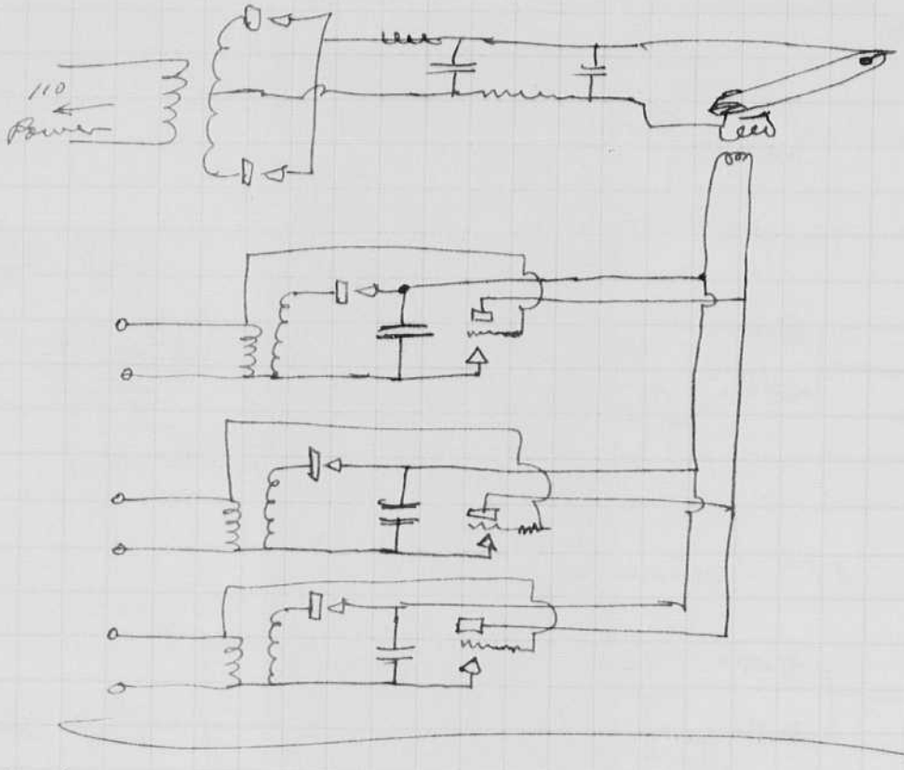


Put 3 spoken in the anode lead so the filament transformer can be common.



Cont.

Three phase power-angle ~~strobo~~.

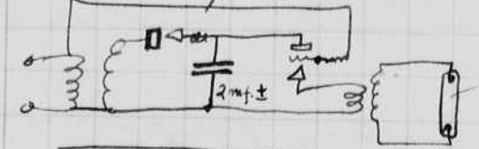


Dec. 13 1931

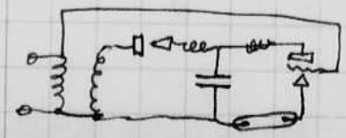
H. E. Edgerton. Some trouble is expected with this circuit since a common spark coil is used to trip the big tube. That is the primary of the transformer is connected to all three thyratrons. When one thyratron fires, ~~if~~ the voltage of the other thyratrons cathodes ~~and~~ or anodes are changed because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

This trouble can be overcome with three separate spark coils.

Gym Lab. Strobo. Low intensity.

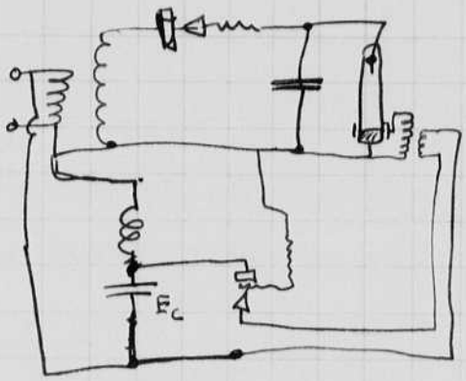


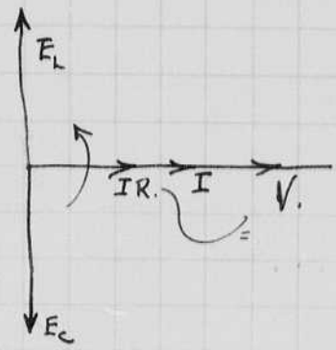
neon and Hg. or neon, argon, or other gas.

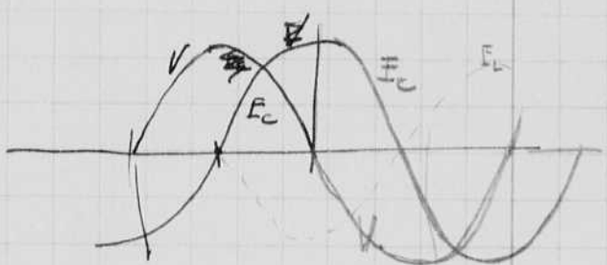


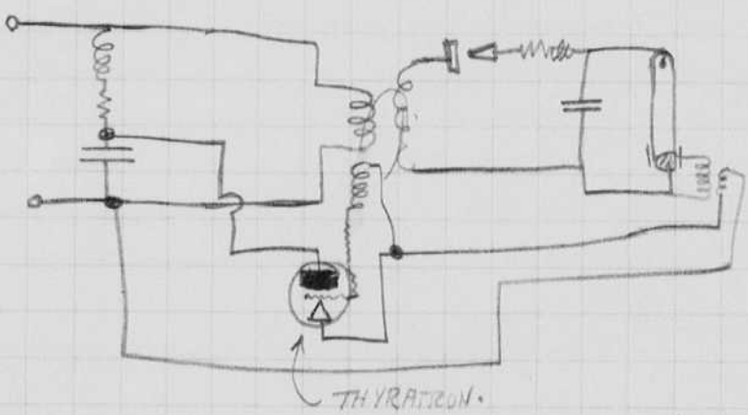
Try these circuits out.

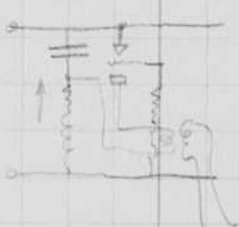
Dec 13 Cont't. 60# Thyratron circuits.







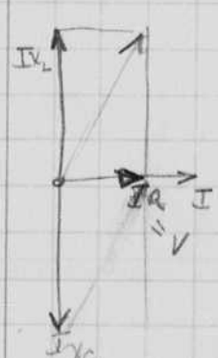




$C = 0.3$ mf $\quad X_c = \frac{1}{\omega C} = \frac{10^6}{377 \times .3} = 10^4$ ohms. $= 10000.$ ohms.

$X_L = 10000$ ohms. $= \omega L = 377L.$

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



300 volts across the capacity (max.)

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

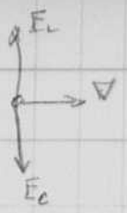
$212 = 10,000 \times I \qquad I = \frac{212}{10^4} = 212 \times 10^{-4} = .0212.$

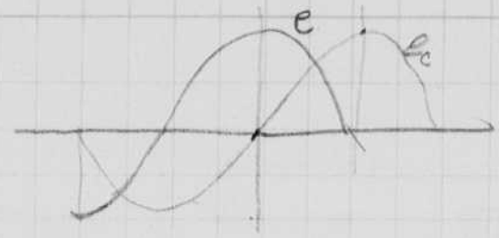
$IR = E = 110$

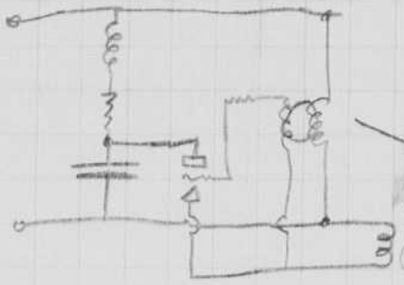
$R = \frac{110}{.02} = 2\frac{5500.}{110.00} = 5500$ ohms.

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

B cont

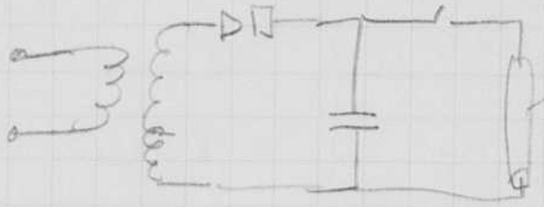




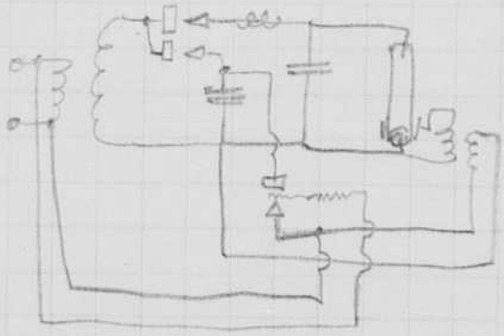


transformer to reverse the phase of the grid voltage.

→ to trip flange tube or to gaseous lamp.



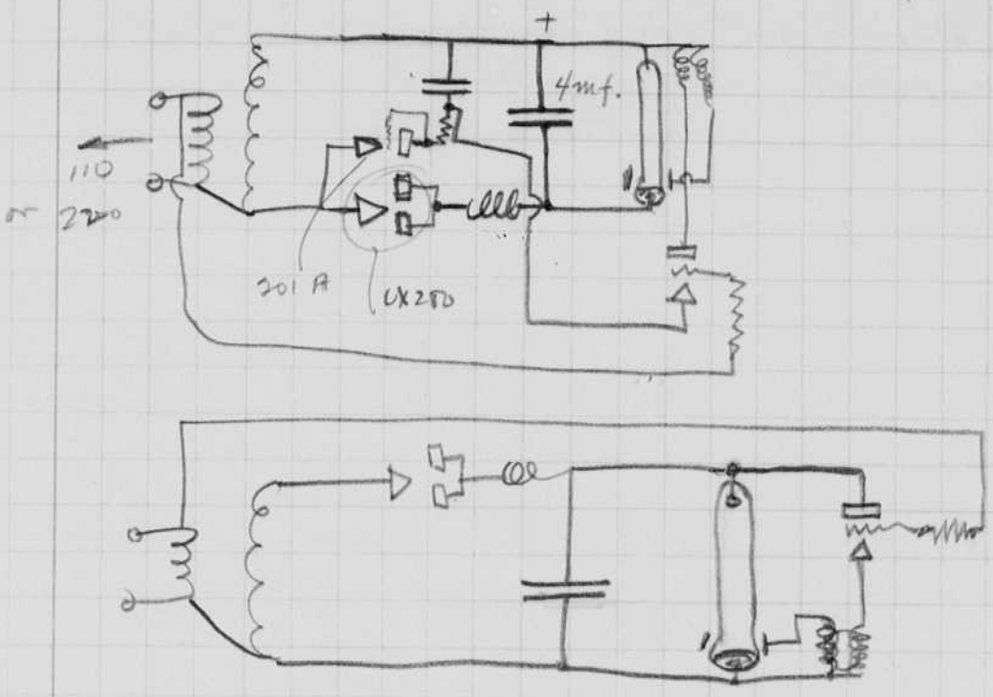
gaseous lamps such as neon etc.



See March 1931 "Electronics"
"Controlling cut-off knives for accurate Packaging." Used by (57) Heintz Co.

Variable speed control by the Lewellen Mfg Co of Columbus, Ohio.

Cont. Laboratory Stroboscope.



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

Bibliography from thesis by Beardsley

Buttolph The Cooper Hewitt Mercury Vapor Lamp G. E. Review Vol 23 p 741. 1920.
Crowley Intermittent Illumination in Industry. Ill Eng. London Vol 16 p 189 1923.
Hospitalier. The Slow Registration of Rapid Phenomena by Stroboscopic methods Journal S E Vol 33 p 75 1903.
Judge. Kinematics Automobile Eng Vol 14 p 265 1924.
Moore Stroboscopy and the testing of Rotating Meters Electrician Vol 101 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.
— Seguin. Stroborama Stroboscope American Machinist Vol 68 p 710 1928.

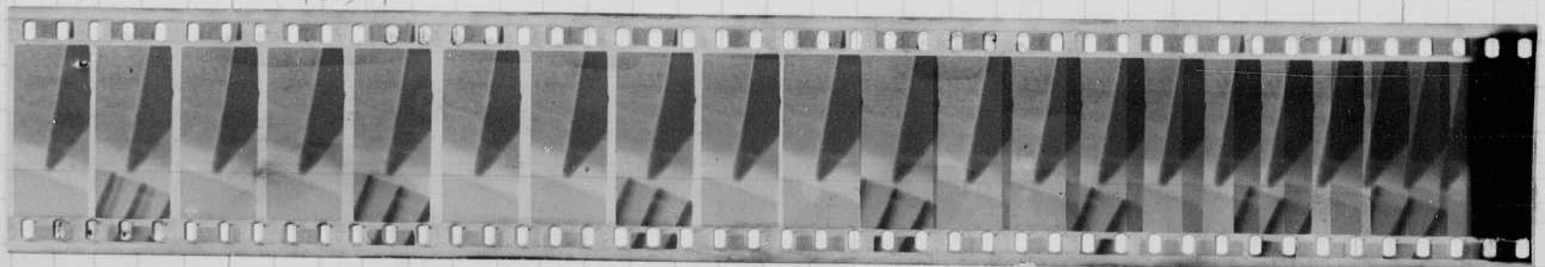
Dec. 17, 1931.
H. E. Edgerton.

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

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

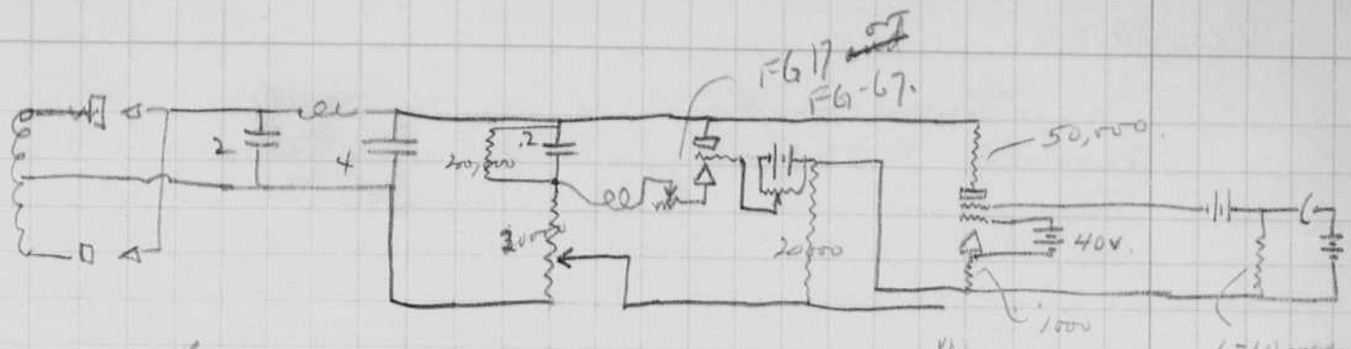
Someshausen is working on the circuit for the Engine Lab. This is the arrangement for obtaining indicator diagrams, using the thyratron.

Dec. 18, 1931. Jamison of G.R.Co 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 Bronisil 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 ~~enough~~ too much energy to put in to the tube continuously as it would get too hot. The tube was one we made last tuesday.



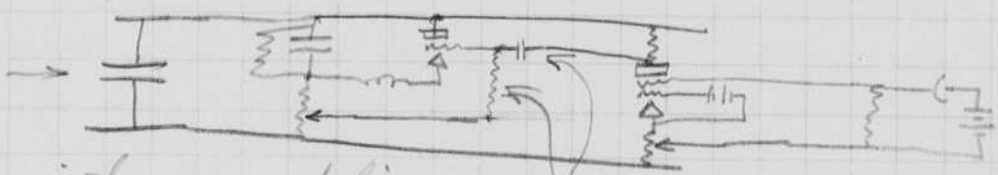
Worked Friday evening with Germ, Stark Draper and others to get Draper's camera to work. Photographs. Finished Engine Lab. indicator and tested it in the aft. Looked at ~~Spray~~ from a diesel jet with Eddie Taylor.

Dec 19, 1931



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

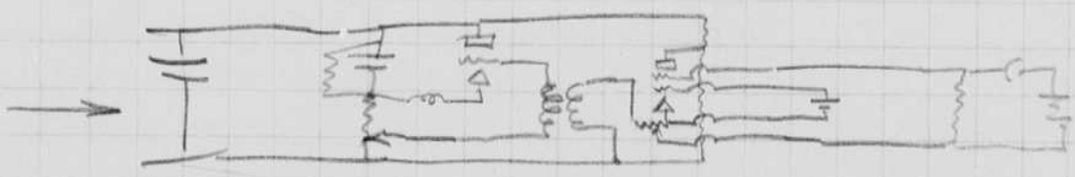
Other suggested circuits



Capacity coupling.

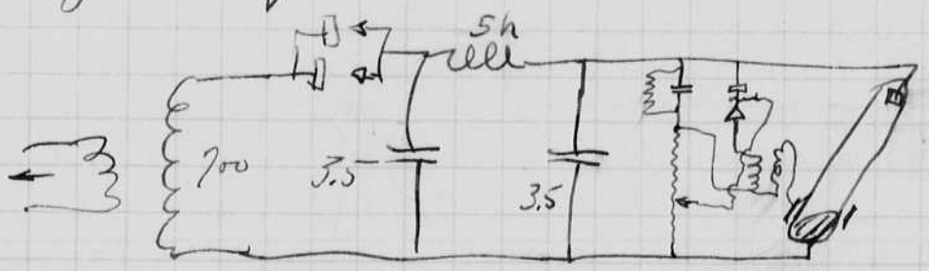
use 500,000 ohms ±
C = 0.01 mf ±

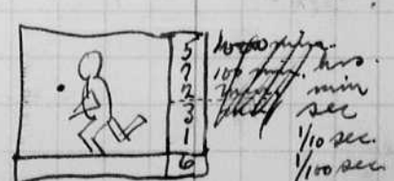
or Transformer



Sat. Dec. 19, 1931.

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





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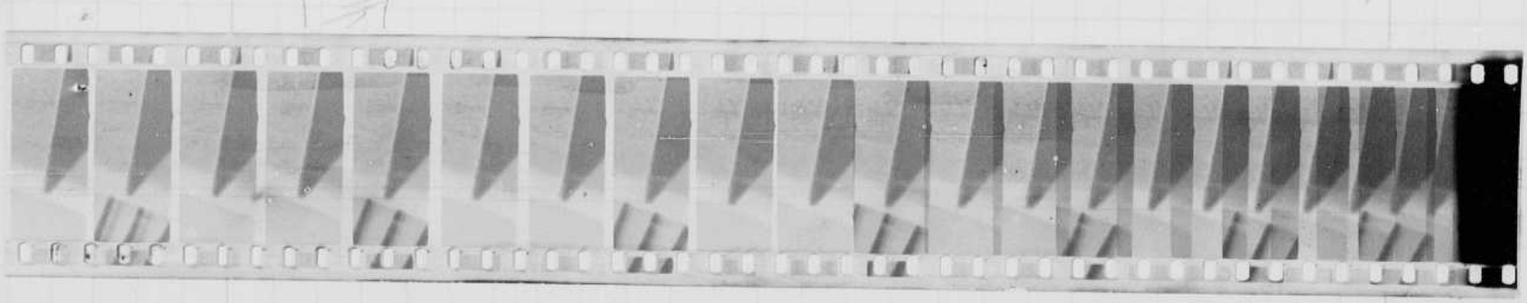

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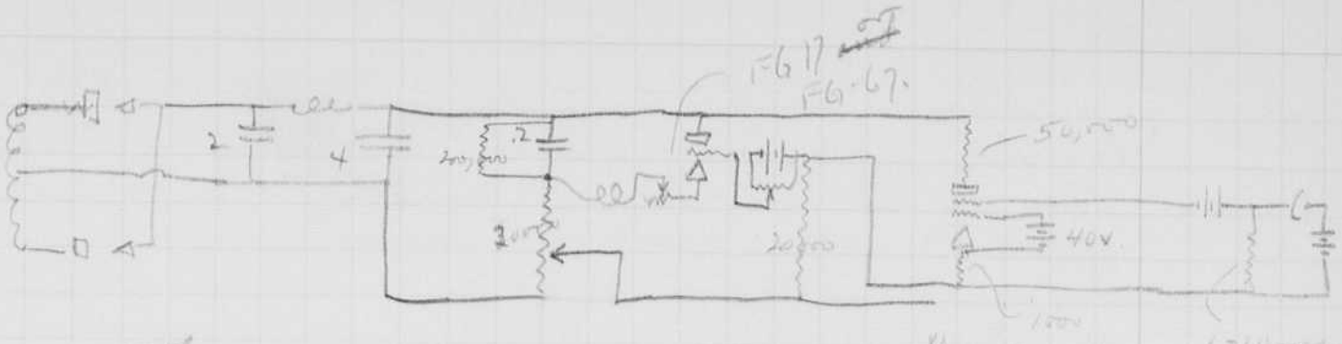
Dec. 19, 1931



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Capacity coupling.

use 500,000 ohms ±
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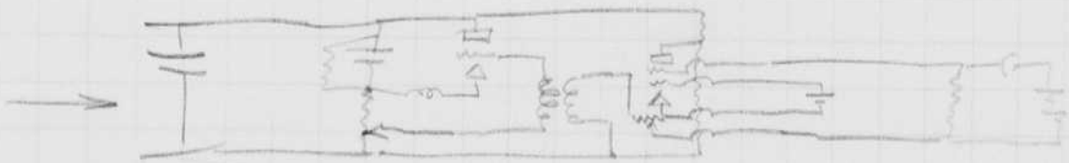
or Trans former



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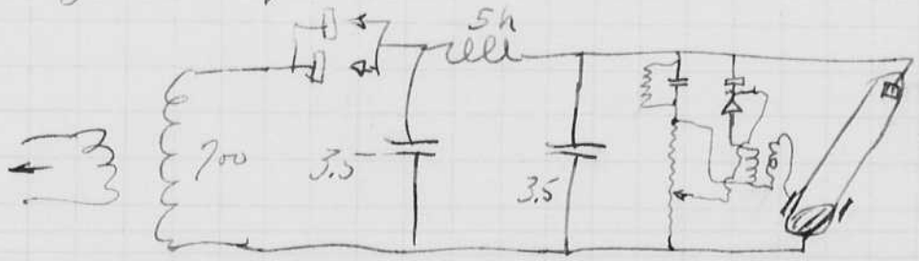
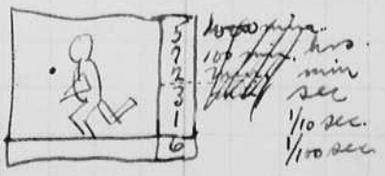


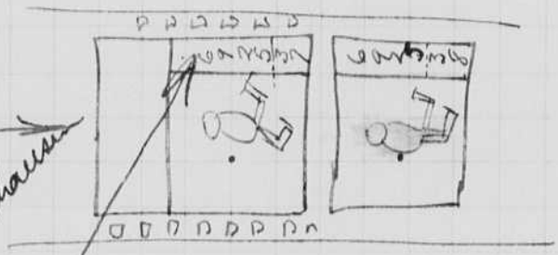


Dec. 20/1931

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.

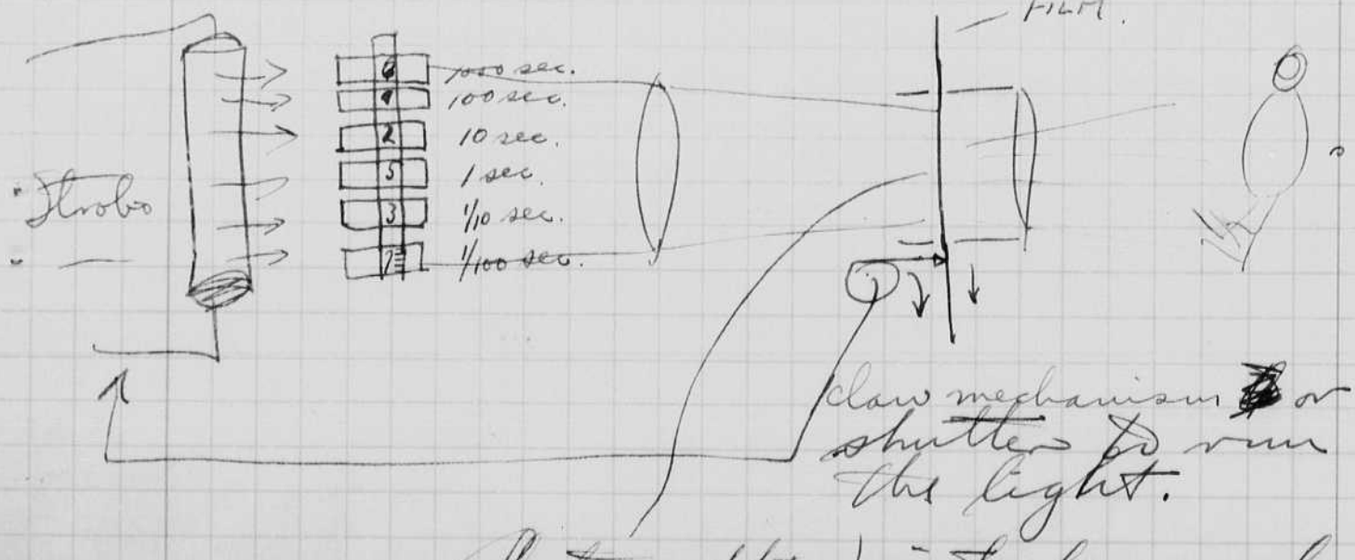
Objections to this scheme are: 1. the time signal is several inches from the corresponding picture. 2. the total elapsed time is obtained by counting the cycles!

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. Germeshausen

These numbers are driven by a tuning 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).



claw mechanism or shutter to run the light.

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. 21 1931.
Whipple of the Aviation dept has been having trouble with a thyratron circuit. He wants Bennes Hanscom and I to fix it up for him. His device is used to time the flight of a model through the air the steel wires have paper on them at intervals which closes a contact between the wire and trips a thyratron. There is bound or vibration or poor contacts enough to cause erroneous records.
Benn. started in the aft to work on this.

Dec. 22 1931. I went over to see Max Knobel 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 analyses. Benn and I are to build a stroboscope this week and try it out next. Knobel is going to build a contactor which is run by the machine being tested.

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

Dec 24 1931

H. E. Edgerton. Yesterday morning I looked up a concern in south Boston to make us some metal boxes to hold the stroboscope units. Thomson Company at 283rd st 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 electrician had rigged up a neon lamp with a contactor which gave practically no light. They want to use the stroboscope to help them work out a new machine for printing.

Mr. Brumings and Mr. Bruce Pollock? 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. Brumings 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.

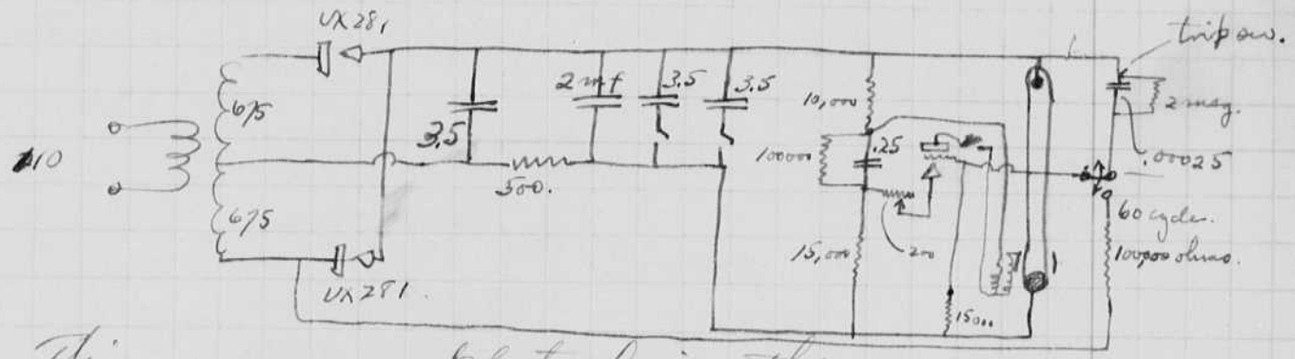
Mr. Lamson of the General Radio Company was the one who suggested my name to Mr. Brumings.

Dec 26 1931

H E 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.

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

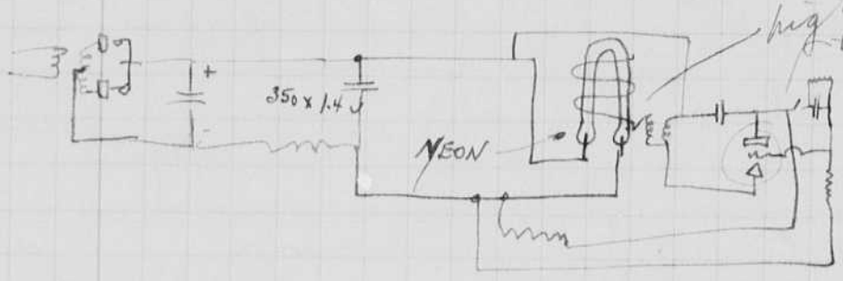


This was completed in the aftn. Mr. Lawson of the S.R. Co came over in the aft. with his continuously moving film camera which was used here last week or so Dec. 18. It has another lens on it which gives a larger field that on the other lens that was previously used. We took some movies of the swinging 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 stroboscope shown above. The condensers in the discharge was 2 microfarads. Germeshausen worked on these also. Prof. Bennett (R.D.) saw these pictures and went home with me. Made a date with Lawson for tomorrow to take some pictures of the cathode spot in the mercury arc tube.

Dec. 29, 1931
H. E. 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 outfit and wants it cheap. We talked about stroboscopes using neon tubes. After Knoble left Ivo, Germyand 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~~ arc and give a bright light.

The arrangement worked best when there was a small air gap (1/8 to 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 Draper 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 from the Forbes Lithograph Co. Bertram and Hellenbaugh 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.

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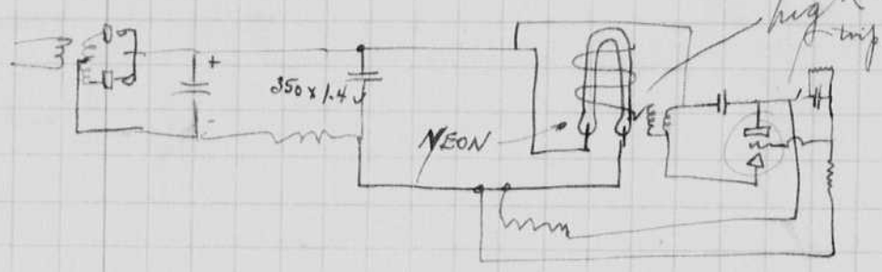

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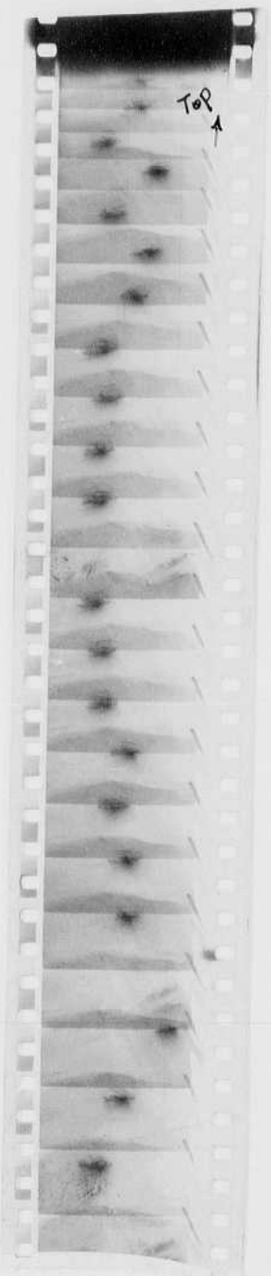
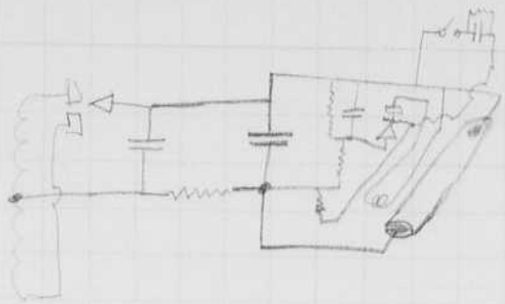

TOP



Dec. 30. 1931

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

Lawson 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.

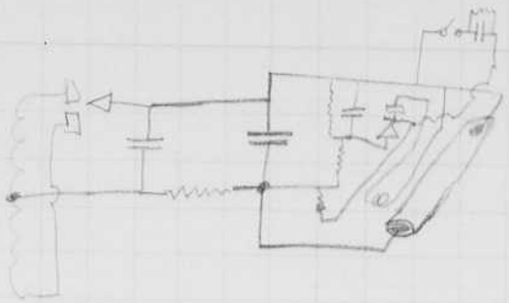
Lawson returned with me to Tech and we took some photographs of the cathode spot.

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. Dillon. 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 o'clock with Mr. Crimmon. To go to the L St station in East Boston.

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

Photographic reproduction of the cathode spot.
Nelson Bloodgood Physics.
Dec. 1931.
U. S. Olympiad

monday.



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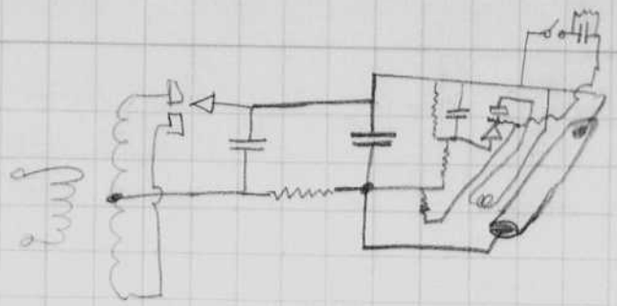
Photographs of the cathode spot.
Taken on Bromide paper.
Dec. 1931.
H. E. Edgerton



.200
.04 x 500 = 20 watts.
500 x 5 = 25 watts.
100

.05 amp x
100 V

.05
.05
.05 x 200
.5

Dec. 30. 1931

Bertram and Dellenbaugh of the Delta Mfg Co were over in the morning and I demanded showed them the stroboscope (wait 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 stroboscope for such jobs as the Russel Box Co.

Lawson 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.

Lawson 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. Dillon. 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 o'clock with Mr. Crimmon. To go to the L St station in East Boston.

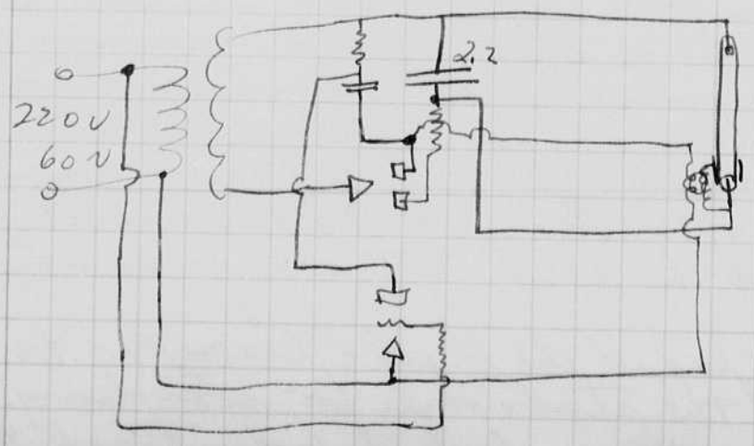
Also stopped at the Herald Traveller to see Mr. Rand about the stroboscope for watching the printing presses. He said somebody tried that

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

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

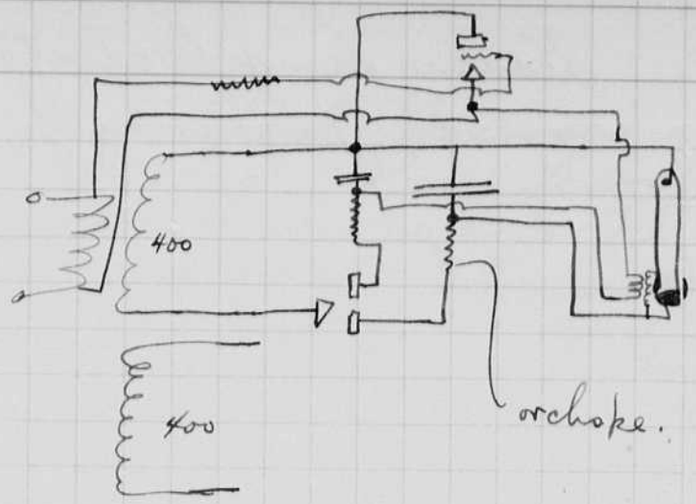
On Dec. 31 I stopped at the Raytheon Inc and saw Percy Spencer. He is going to build stroboscopic tubes for me. The first one will be ready for next monday. It will be tested to see if it sputters. Then if it is o.k. he will build me two more for the Forbes Lithograph company.

Jan 2. 1932. Germ experimented with the three electrode tube and I worked on the 60 cycle stroboscope for the dynamo lab. I used this circuit.



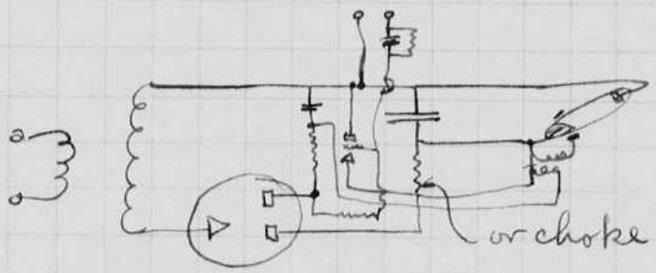
Jan. 5, 1932
H. E. Edgerton

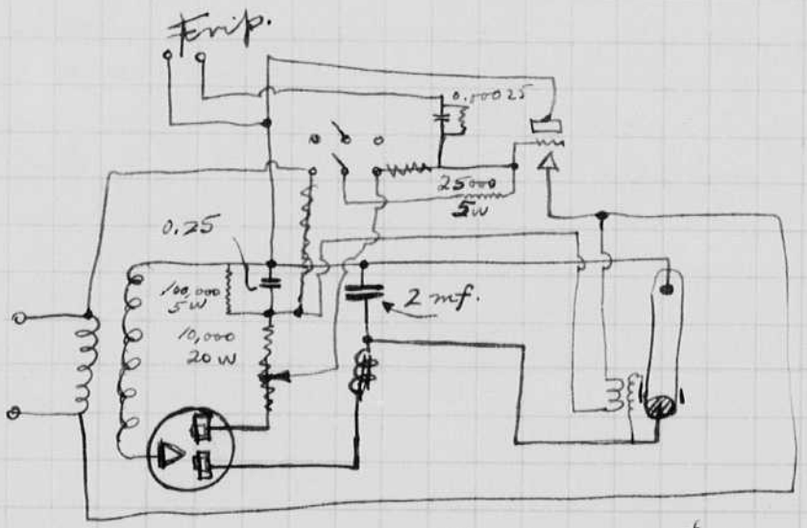
Circuit for 60 cycle and variable freq. strobo.



E_o 2.5V 5 amp. FG-17

E_o 5V 2 amp. UX 280





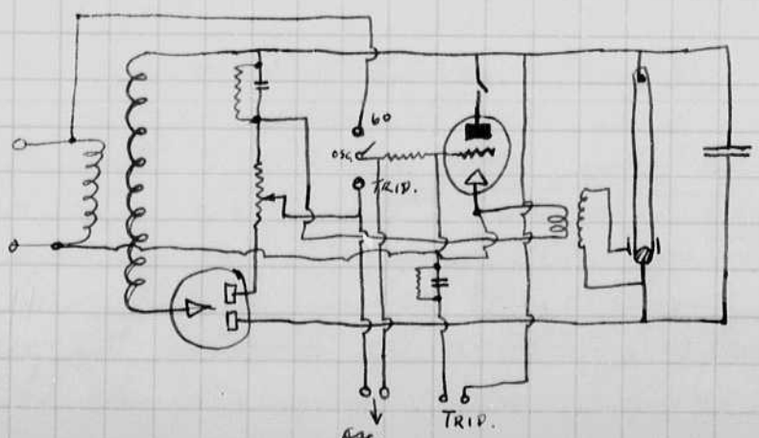
$\frac{2.20 \times 2.70}{25000}$

$\frac{\cancel{220 \times 270}}{\cancel{2500}} = 16.$

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

$R = \frac{.02}{2. \times 10^{-6}} = .01 \times 10^{6}$

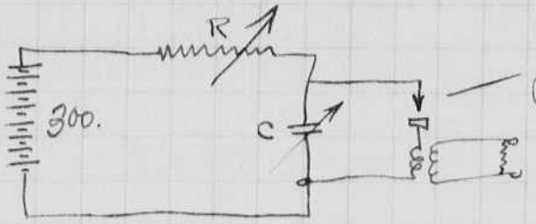
$.010,000$

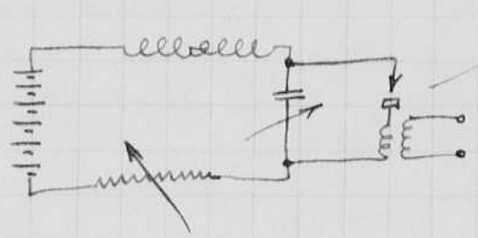


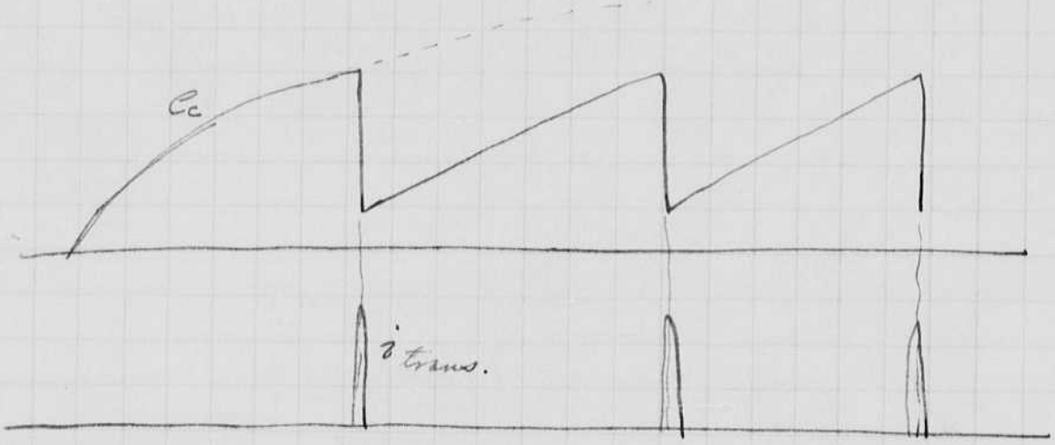
Jan. 4, 1932

H. E. Edgerton.

Flasher Lamp Oscillator for variable frequency for Strobo.







let C = .01 mf.

1/60 sec.

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

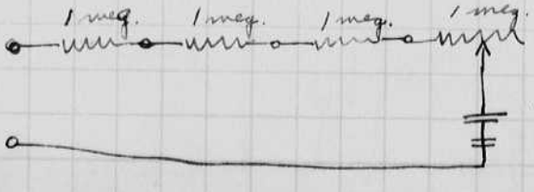
$R = \frac{1}{.60} \times \frac{10^{6}}{.01} = 1.67 \times 10^{6}$ ohms.

=

.1 mf. .167 meg ohms.

$\frac{300}{.100.} \times 10^{-6}$

.003000. mils.



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 Tilt 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 G.R. to quote them a price.

Jan. 5, 1932.
H.E. Edgerton.

Hyde Park 0340

Mr. Cassice of the Sturtevant company, 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 Strobo and he referred it to us.

Took a design for a small six inch strobo tube over to Spencer at the Raytheon Inc.

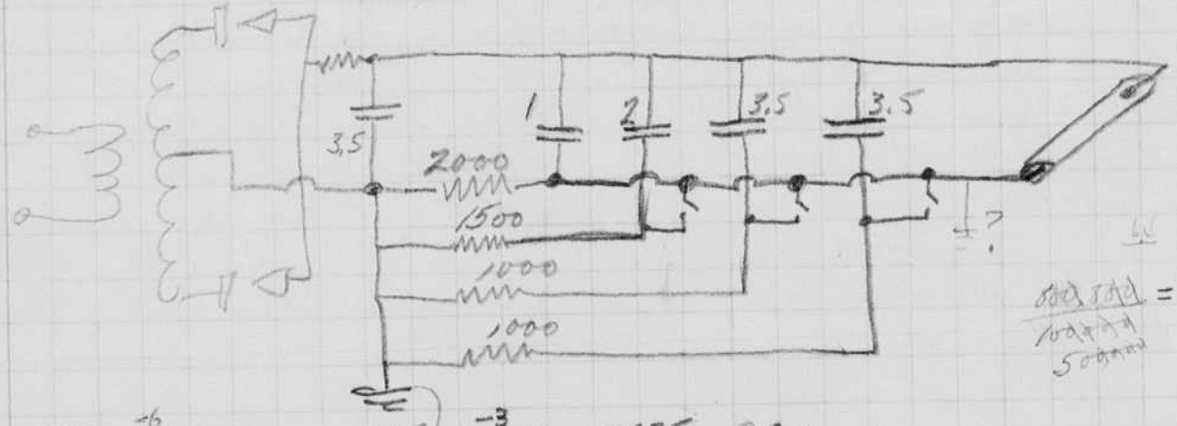
Jan. 6, 1932.
H.E. Edgerton.

Took the strobo (circuit on page 105) out to the Sturtevant company. Demonstrated 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.

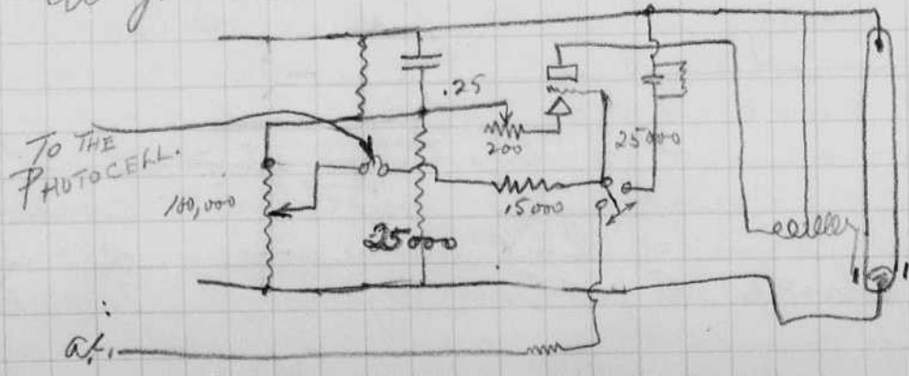
We are to get in touch with the Acme (Delta) company and get one of their photoelectric cells and amplifiers to trip our strobo. in exact synchronism with the rotor. A disc is going to be mounted on the shaft with a hole in it for the light to shine through once each revolution.

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 ~~tube voltage~~ voltage on the anode and the metal reflector which acts as an external grid. Several changes are to be made in the outfit.



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

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



Cont.

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

1. The extra discharge ~~capacity~~ capacity acts as a filter.

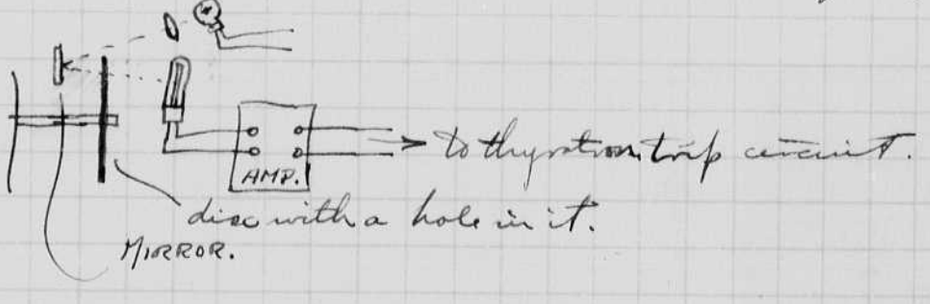
2. The charging resistance is automatically adjusted.

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

Jan. 8. 1932.
Sedgwick.

Mr. Day who is associated with Dr. Kisly in New York was here today. I showed him everything that we were doing along stroboscopic and other 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 same Smoke amplifier has a power pentode ~~in that~~ as an amplifier tube.



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

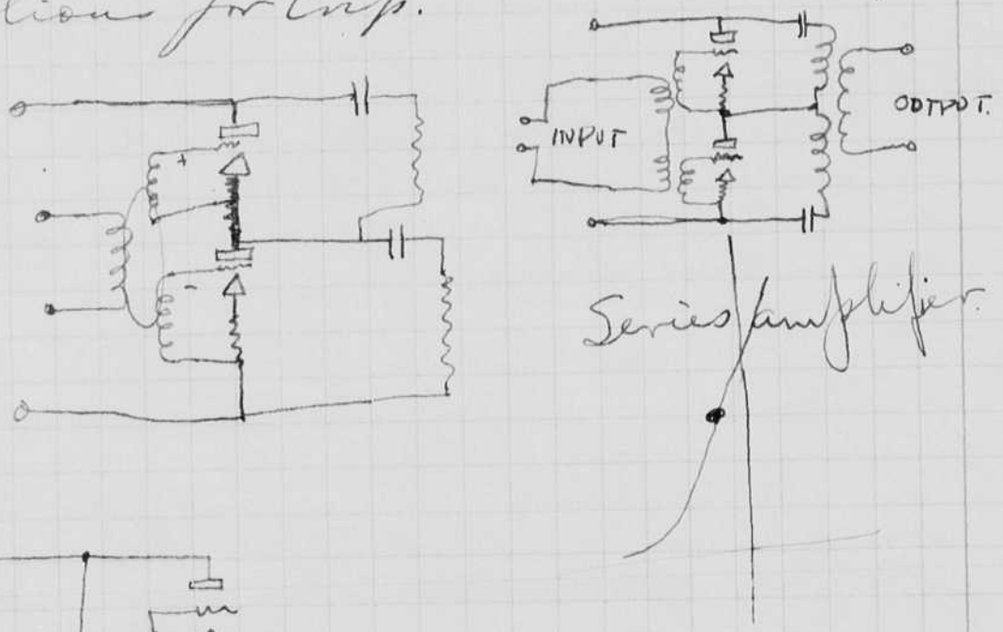
A stronger lamp and a 4:1 transform

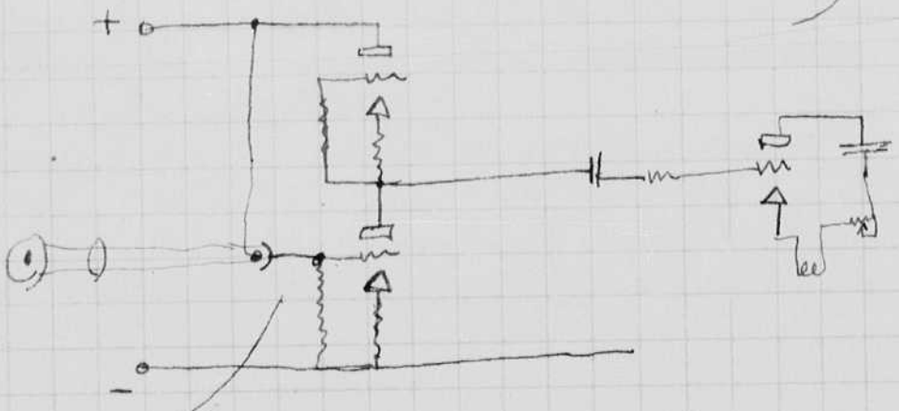
cont:

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 stroboscope image. This was due to the power supply as was noticed as the speed of the contactor wheel was close to 1800 or 3600 r.p.m. so that beats were evident.

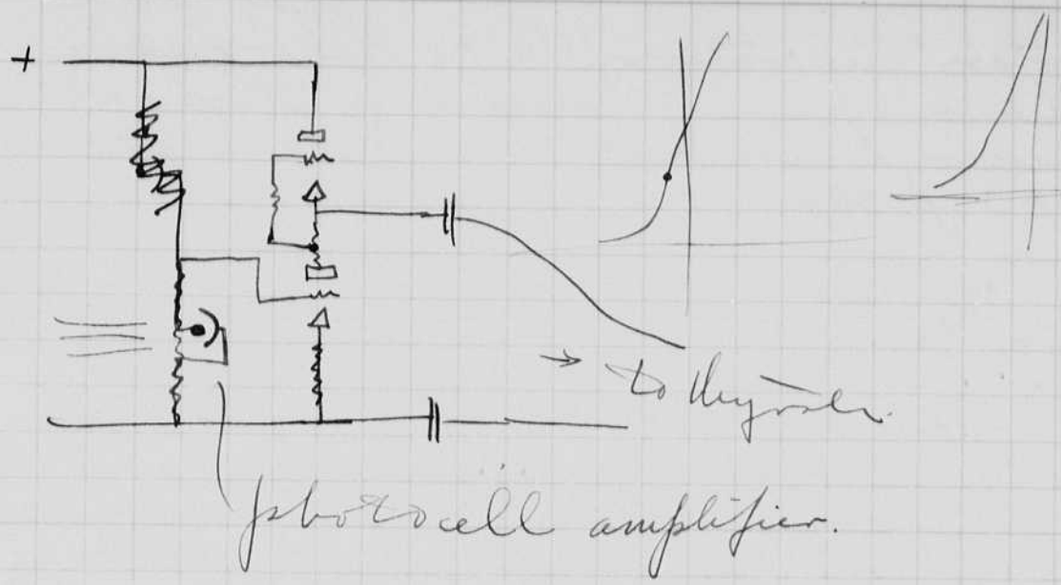
I think that we need a d-c amplifier on the photocell to get rid of this small variation of the condition for trip.

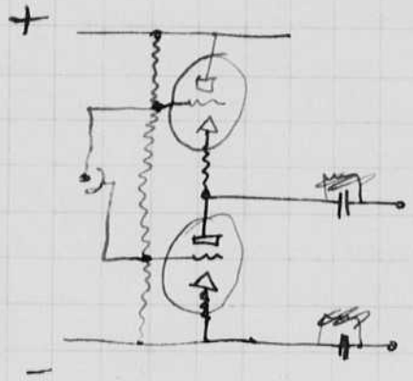




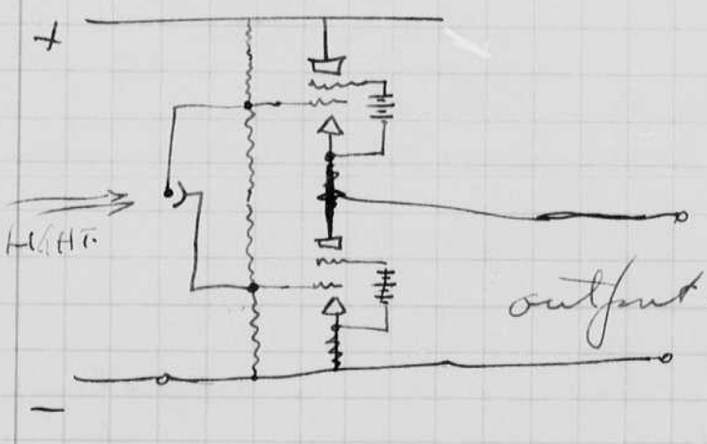
when light shines the grid swings + or

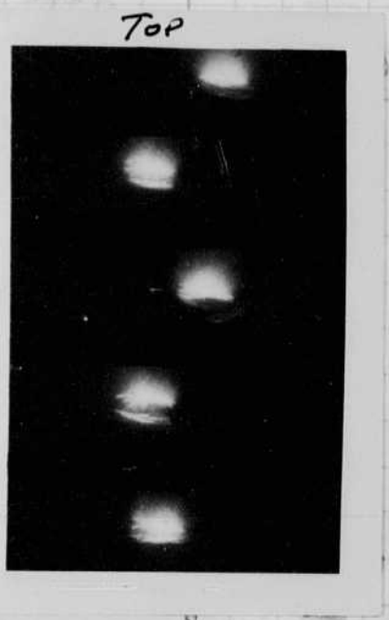
Cont'd



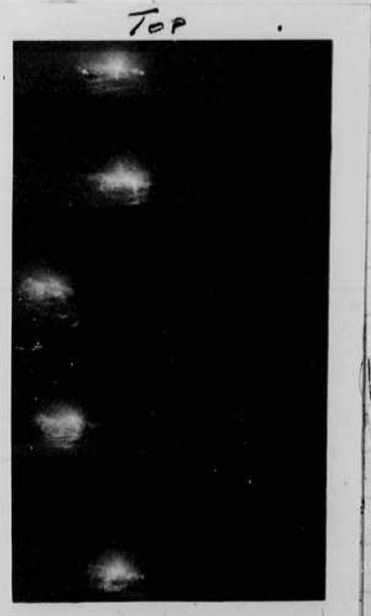


Photocell amplifier for voltage





no imp in the disc. circuit



with impulses in the discharge circuit.

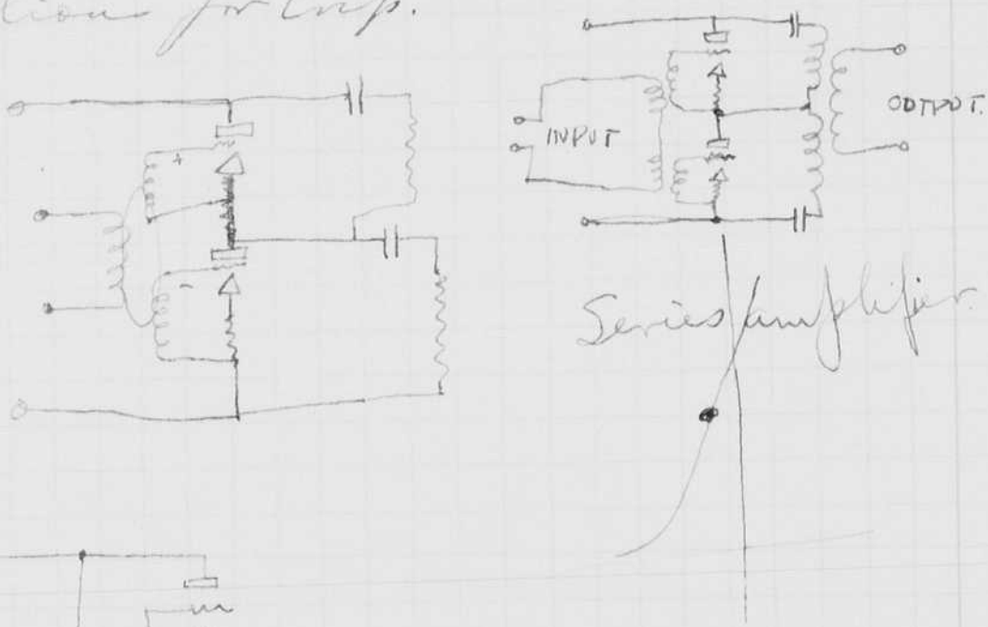
Enlargements of films taken on Dec 30 by Mr. Jansson of the G.E. Co.

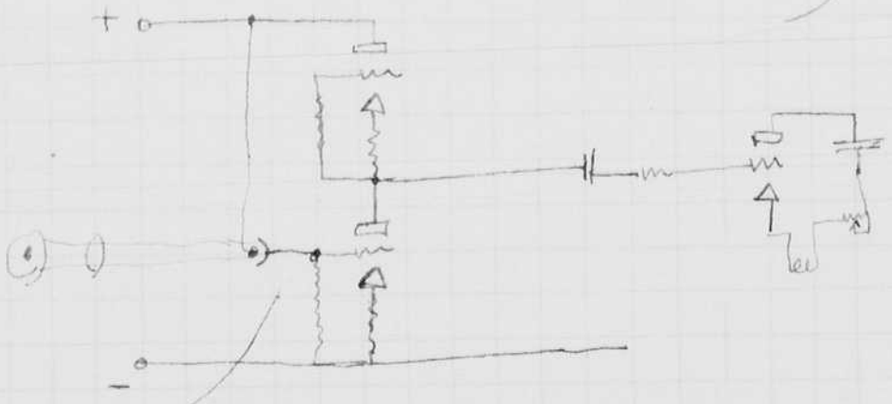
cont.

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 contactor wheel was slowed to 1800 or 3600 r.p.m. so that beats were evident.

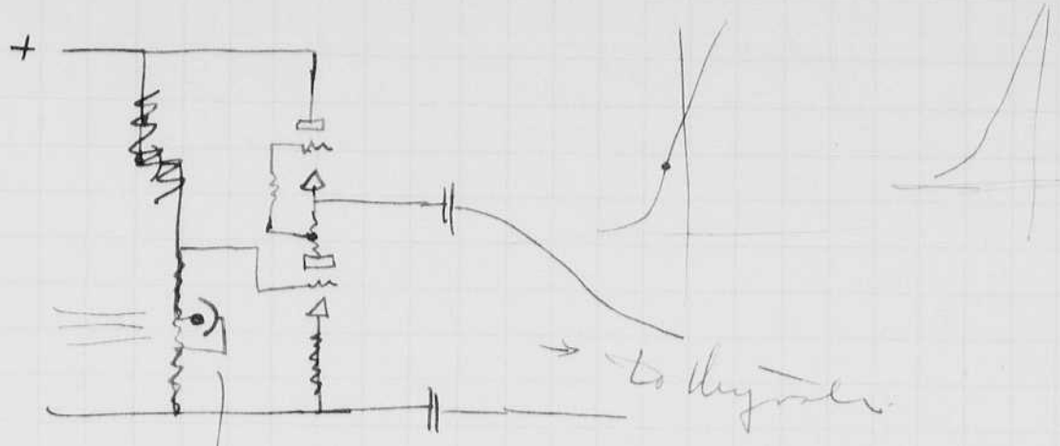
I think that we need a d-c amplifier on the photocell to get rid of this small variation of the condition for trip.

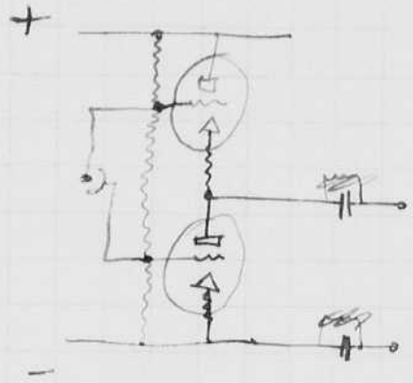




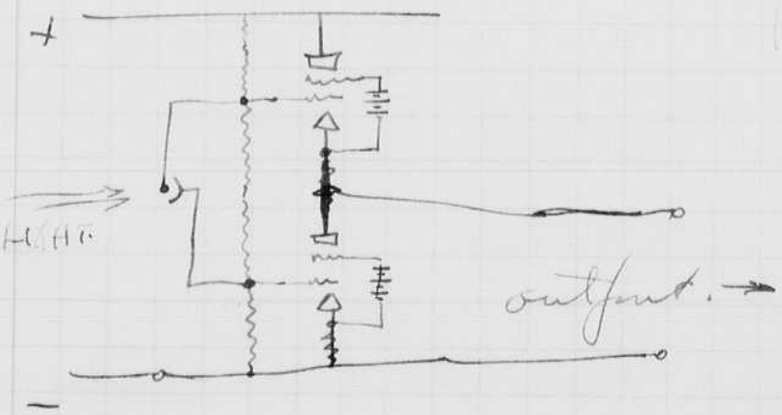
When light shines the grid swings + or

Cont

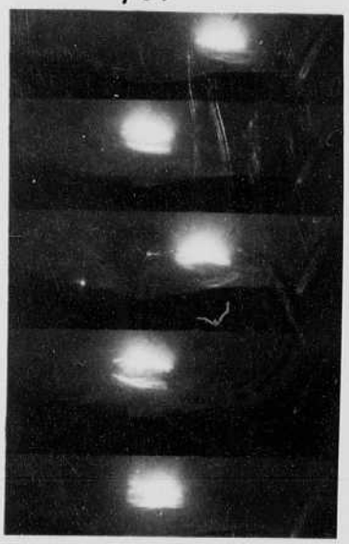




Photocell amplifier for voltage



Top



No jump in the disc circuit →

Top

With ripples in the discharge circuit.

Enlargements of films taken on Dec 30 by Mr. Lawson of the G.E.R. Co.

D. Robertson "Separation of the no-load losses in a continuous current machine by Stroboscopic Running down Methods" Journal A.I.E.E. 1915. Vol. 53 p. 308

Jan. 12, 1932 Tuesday.
H.E. Edgerton

Yesterday morning at 8 I took Gemeshausen and the stroboscope (circuit p 105) out to the Sturtevant Blower 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 Reige. We looked over the generators and so that some scales can be mounted for reading the angle.

About 4 I took drove over to the Sturtevant Plant and picked up Gemeshausen.

United States Patent Office
Before the Examiner of Interferences

Edgerton
vs. } Interference 76771
Miller

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

May 10, 1933.
H. E. Edgerton.

Blake Saco-Lowell Shops. (Stroboscope)
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Sturbovant
1-B 32 - 1-9, S&E..

CONTINUED
ON
NEXT REEL