HAROLD E. EDGERTON

PAPERS

MC 25

Series III

Laboratory Notebooks

Number 8

Dated June 1, 1937 to April 16, 1938

MASS. INST. OF TECHNOLOGY.

HARVARD UNIVERSITY

CAMBRIDGE MASS.

COMPUTATION BOOK

NAME	Number
HAROLD E EDGERTON	8

Course .....

Used from JUNE 1 1931, to April 6 1932.
1938

Harold E. Edgerton
Room 4-111 M.I.T.
Cambridge, Mass.

June 1, 1937.

note book 8.

205 School St
Belmont Mass.
Bel. 4369 M.

HARVARD UNIVERSITY

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."

* * * * * * * "

HARVARD CO-OPERATIVE SOCIETY

Cambridge, Mass.

June 3 1937
Harold E. Edgerton.

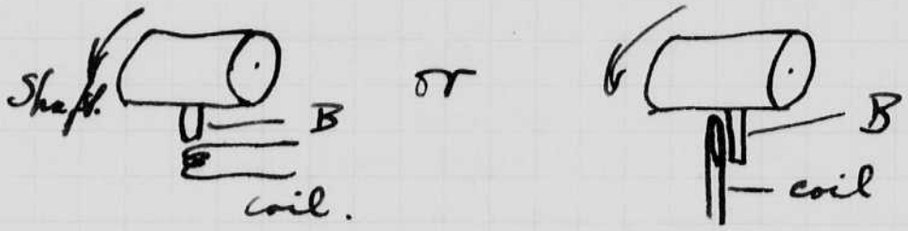
I pumped more tubes today for the Norton Grinder powersupply. About 1/2 of an atmosphere of argon was put in the tube after baking and hydrogen cleaning. This pressure is not quite enough as the tube fires by itself after running for 3 or 4 minutes at 900 r.p.m. 1 mf 2000 volts. The capillary part of these tubes was 1" long 3mm I.D.

Apparently the treatment on the pumps has not been vigorous enough since the electrodes color up in use. The coating does not come off with vac. heating but is taken off by hydrogen and heat. Probably the colored material is an oxide.

Mr. Milo A. Durand of the Film Book corp. of South Norwalk, Ct was here late this afternoon and we discussed the application of flashing lamps to photographing of books, etc, on film. This application will require a life of 100,000 flashes for the tubes. Aperature of f 8 to f 35 are used. Lighting is important so that no highlights are present and so that the subject is uniformly lighted. Durand is going to send us some lenses and other equipment for experimental work. One of us will probably go to South Norwalk next week to see what they are doing and to make other arrangements. Mr. Verneur E. Pratt is the president of the Int. Filmbook Corp.

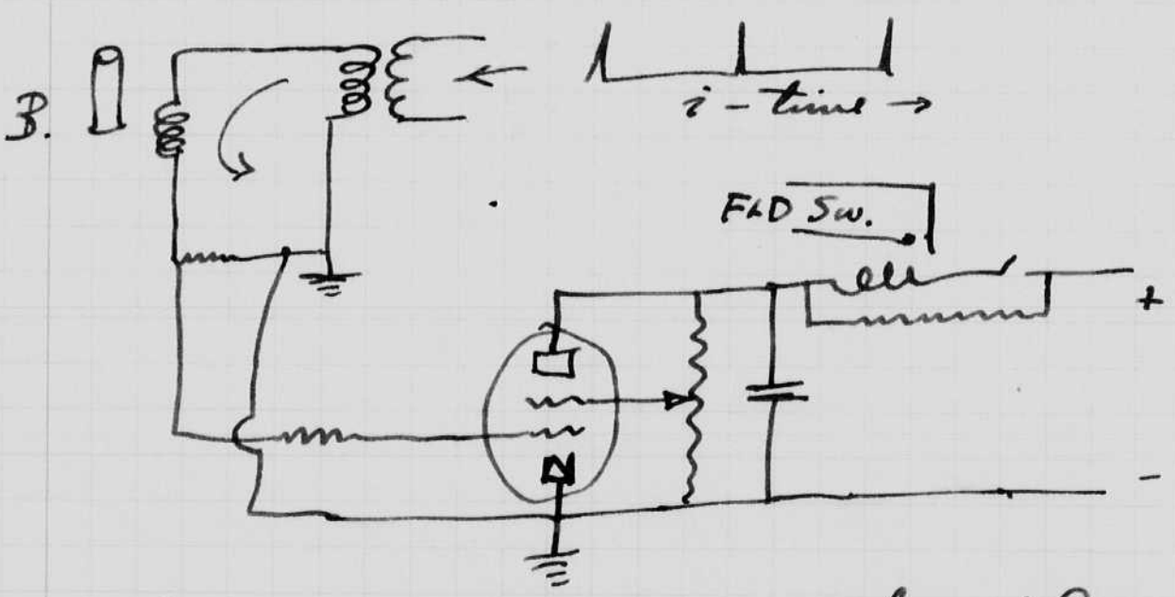
June 4 '37
H. E. Epsen. Syn. Mot. Field Switching Scheme.

Continuation of magnetic method described in note book No. 6 p 78.



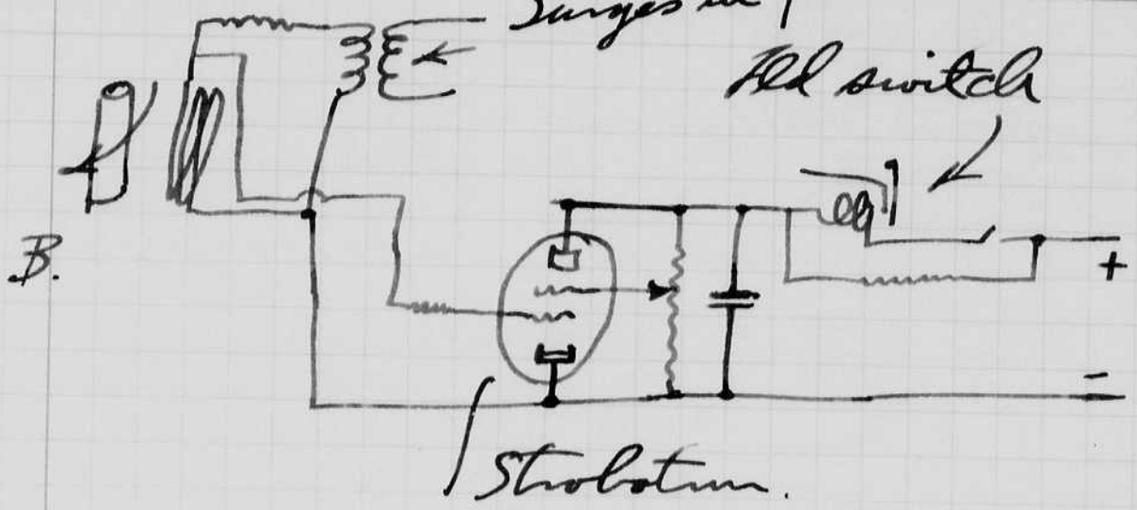
the circuit feeding the coil must be able to discriminate if the impulse B is opposite the coil at the time the coil receives a short pulse of current.

B.



If B is opposite the coil then its impedance is increased appreciably and the voltage across the resistor R is decreased. ~~grid~~ the trip coil should be across the impedance.

Surges in phase with voltage.



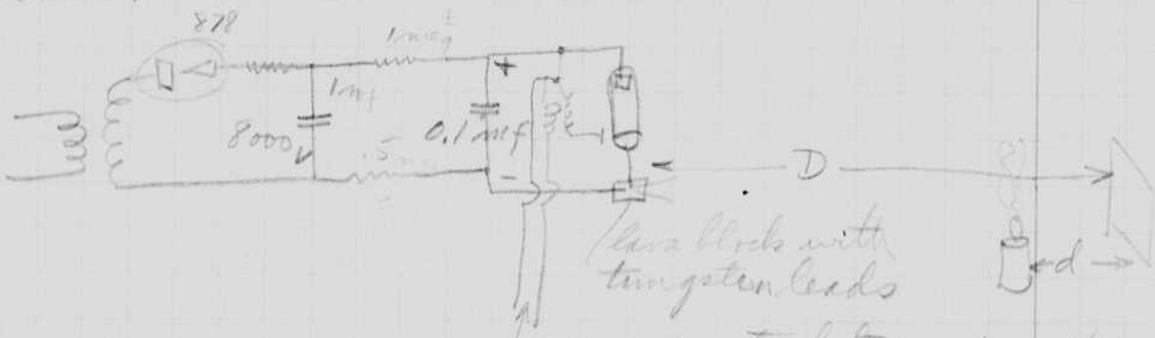
A Similar circuit can be used with a thyratron or other tube.

June 9, 1937.

Spark Shadow Apparatus for use at the Owens Ill. Glass Co.

Grier obtained an 8 × 10 Graflex shutter and fitted it with a contact that turned on the spark at the instant the curtain was in an open position.

I connected up the following apparatus this afternoon and made some experiments with a lighted candle.



Grier took the first two pictures while I was playing tennis with Simoshenko.

After supper in Hattons I took the following. Peo film 8 × 10

No. 3. D = 66" d = 12 inches. exp. ok.

No. 4 D = 50" d = 6 "
failed to fire spark first time candle light over exposed.

No. 5 D = 50" d = 7" ok. but not a good picture of the heated air.

No. 6. D = 50" d = 2" + Soldering iron hot enough to melt solder. No heat effects in air.

June 25, 1931.
[illegible] Elgin.

Returned from trip west on thursday night June 24. I left on Sunday ~~night~~ June 13 for Chicago arriving ~~at~~ there in the morning. First I went to the plant of the Chicago Pump co. and discussed work with Mr. Durdin and Mr. Morgan that we have been doing upon diffusers. I left 5x10 prints with them of photos taken just before leaving. after lunch with Mr. Durdin and — ? I left for Evanston and spent some time with Paul Moore at north western. Then I went down town and saw Dudley Young who works for the Anaconda ~~co~~ Copper co in Chicago.

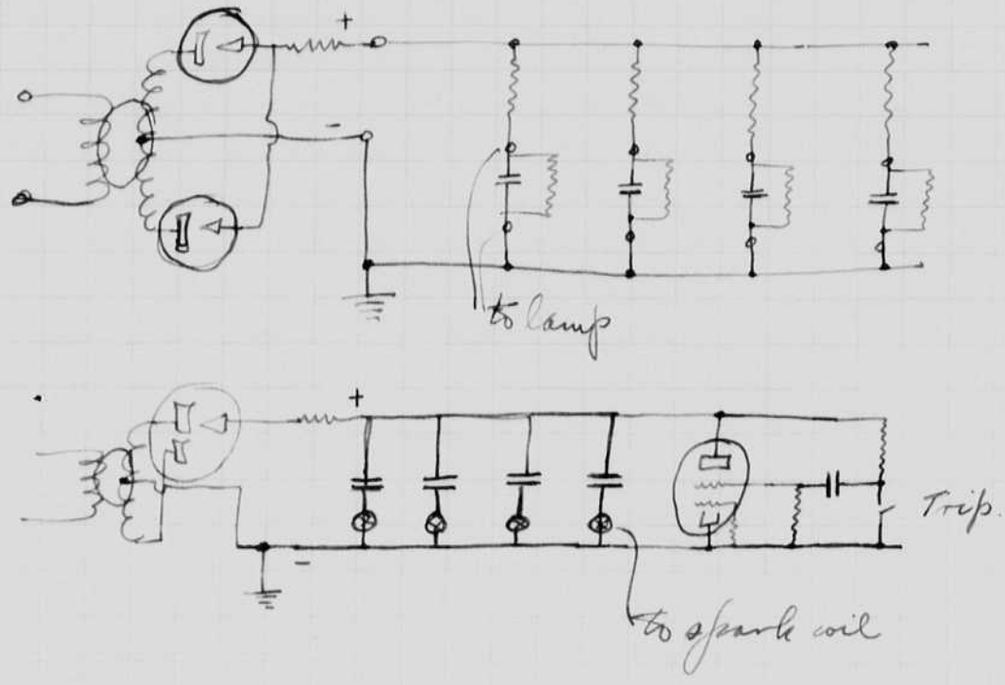
I left that night for Lincoln via the Burlington on the "Ashbarton" arriving there at 10 am or there abouts. My father met me at the train and we went up to the state capital building. We had lunch with Mr. Dunther of the Electric co. Afterwards we saw Prof. Bergmann of the Uni of Nebr.

Arrived in Aurora in afternoon of June 15. Out to Garrett's farm near Giltner on June 16. Spent June 17 at home. On June 18 I went with my father and mother to his ranch north of Taylor Nebraska (44 miles north ±). 170 miles from Aurora. Asberry Perry and wife were at the ranch. June 19 out to Garrett's. I left Aurora via car on June 20 for Lincoln where I took the Burlington for Chicago and Milwaukee to attend the ASME convention, Schroeder hotel.

I had lunch with Fritz Meyer and Carrol Flansburg of the Cutler Hammer co on June 22 and then went out to their factory and discussed welder control. The Thyrotrol seems to have some promise in this field. Flansburg is going to send me a contactor for experimental purposes.

I took a train at 5.05 from Milwaukee and arrived in Boston the next night.

June 26 1937
H. E. Edgerton. Speed-light circuit.



July 2 1937
~~A~~ E Edgerton.

This has been a busy week due to the convention of the S.P.E.E. here at MIT and at Harvard.

I discussed high-speed photography yesterday with Mr. E. A. Waldman (Hartford Empire Co) and Dr F.W. Preston Butler Pa. (consulting engineer). they have connection with the Corning Glass Co and the Owens-Illinois Glass co. The fracture of glass is the problem that they wish to study. I suggested

1. single flash photographs
2. high-speed movies 1000/sec.
3. Reflected light from crack to show up speed of growth using a moving film camera.

July 3, 1937 Sion Mili was here today from New York. We discussed large flash apparatus that we are going to make for him, especially lamps etc.

Dick Evans was in this morning discussed flash machine with him for bullet photography. Shadow and reflected light.

Dr. Hodge from Aberdeen was here on June 29 and we spent ½ day discussing flash photography. We are to send him a special circuit for an apparatus for taking photos of bullets.

Last summer 0.2 mf 10,000 volts in argon lamp gave photo at f 7.7 rev ibmore film. at 3000 volts the capacity would need to be

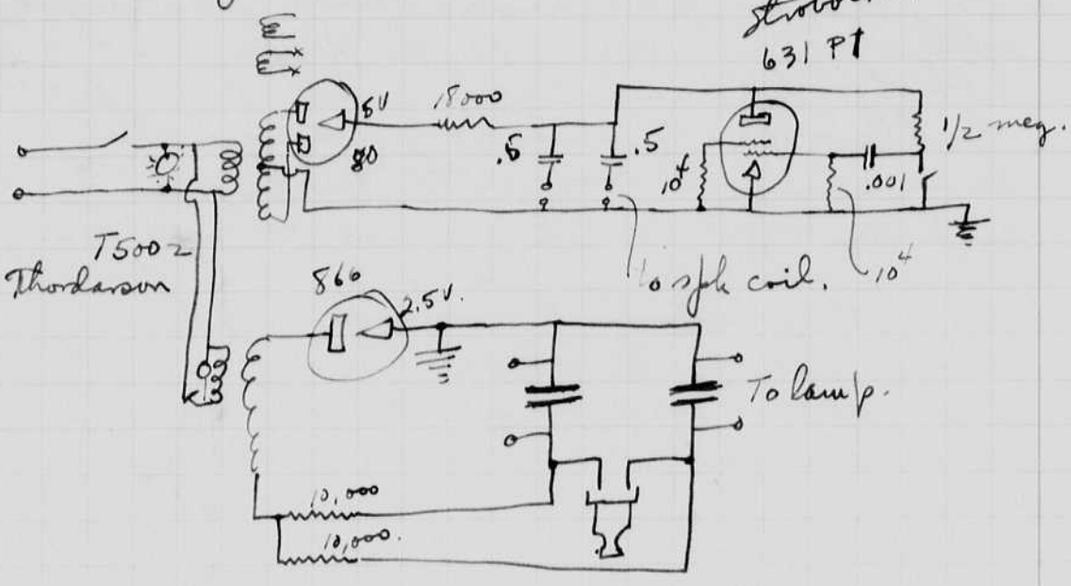
$$CE^2 = 0.2 \times 10{,}000^2 \times 10^{-6} = 20 \text{ joules}$$

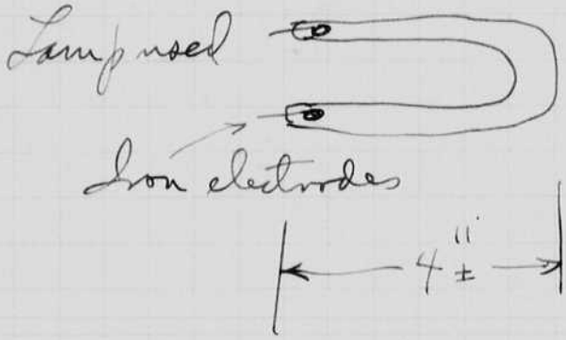
$$= C\, 3{,}000^2 \times 10^{-6} = 20.$$

$$C = \frac{20\ 10^6}{9 \times 10^6} = 2.+ \text{ mf.}$$

July 4 1937

Finished wiring 2 flash units each 48 mf. in running. Tucker came at noon and we tested them against the old outfit.





Pyrex 14 mm O.D.
Argon gas 1/2 atmosphere.

July 4 1962
Chick Kane has one of these sets. He has used it for nature photos. KFZ

On Roll

#1	48 mf,	new
#2	" "	old

On Film pack

# 8	48 mf,	old
# 9	no cap.	
# 10	48 mf	new
# 11	24 mf	"

Notebook # 8

Filming and Separation Record

____ unmounted photograph(s)

6? negative strip(s) inside envelope mounted on page 9

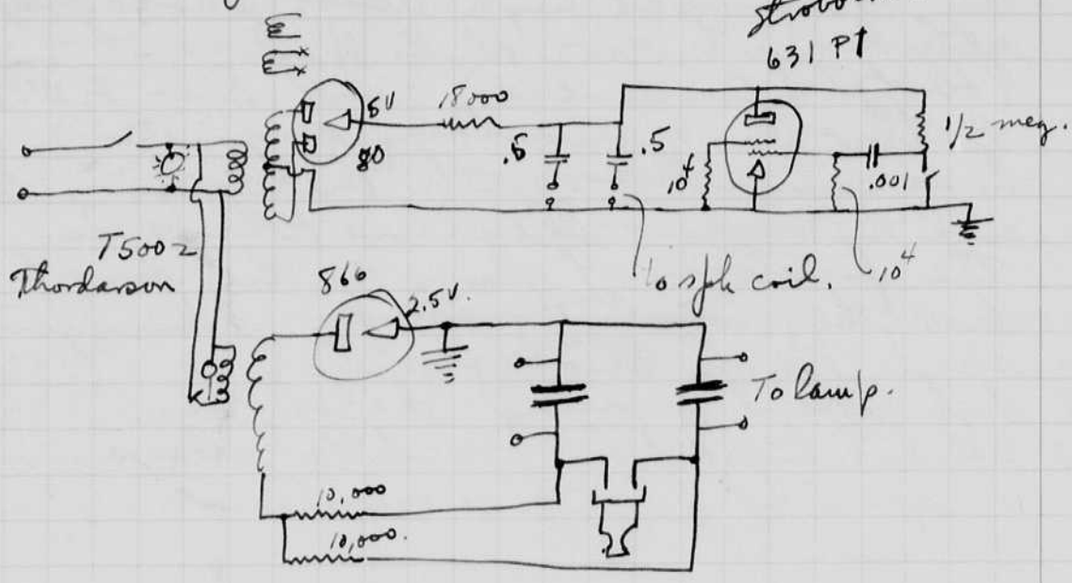
____ unmounted page(s)
(notes, drawings, letters, etc.)

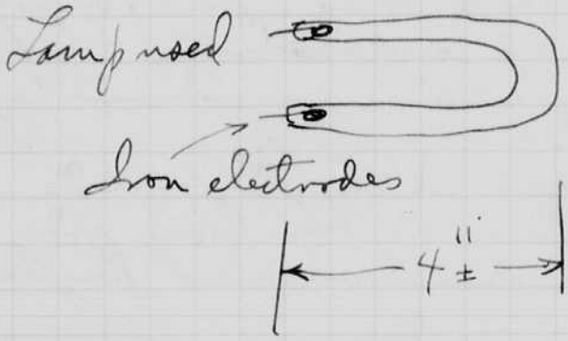
was/were filmed where originally located between page 8 and 9.

Item(s) now housed in accompanying folder.

July 4 1937

Finished wiring 2 flash units each 48 mf. in morning. Tucker came at noon and we tested them against the old outfit.





Pyrex 14 mm O.D.
Argon gas 1/2 atmosphere.

July 4/1962 Chick Kane has one of these sets. He has used it for nature photos. KFZ

On Roll

#1	48 mf,	new
#2	" "	old

On Film pack

# 8	48 mf,	old
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# 10	48 mf	new
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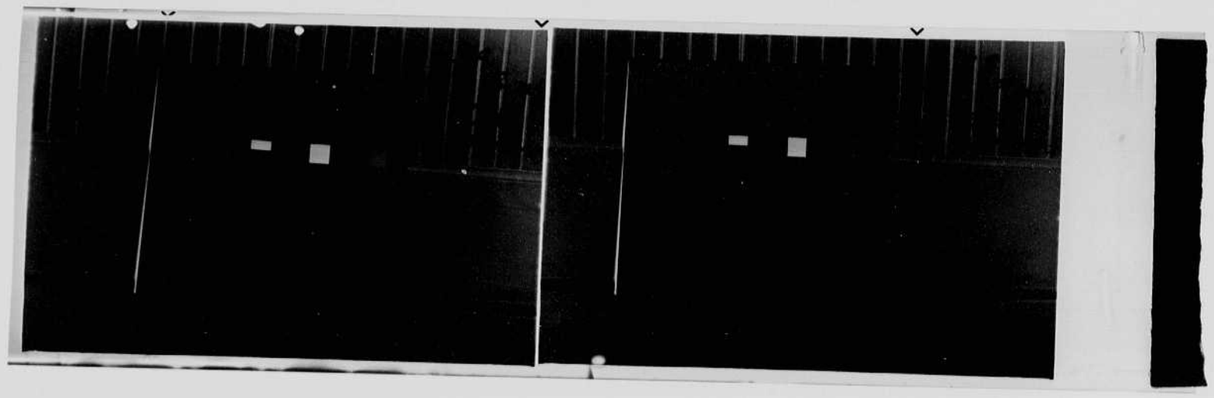
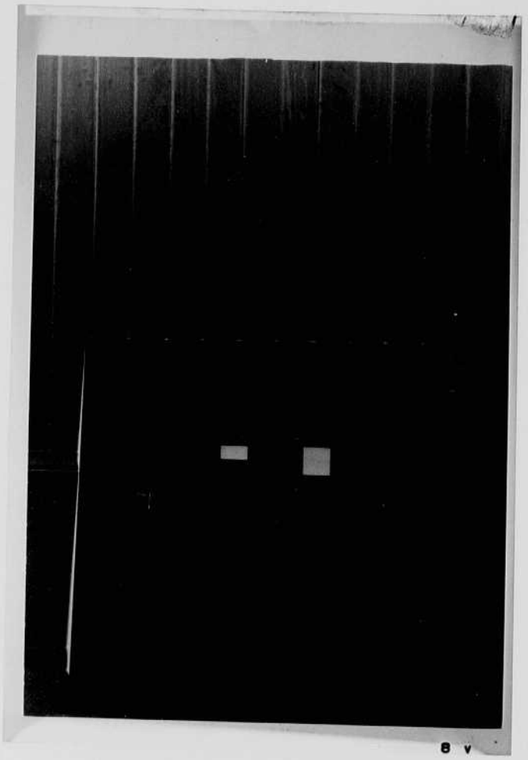
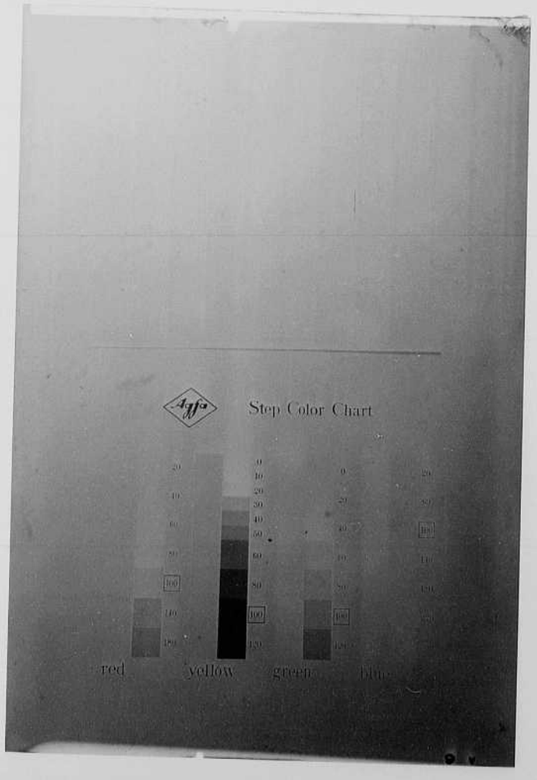



8 v


10 v


11 v


Agfa
Step Color Chart
red
yellow
green
blue
9 v

negs.
4 9x12 cm
2 120 roll

B.H.
Taken by McDonald.
with argus speed
light.

D.B.
Taken by McDonald.
with argus speed
light.

July 5 1937
H. E. Edgerton. Preliminary Design of Argon flash unit for Aberdeen.

Requirements: to photograph a bullet at f 8 in 10^{-6} seconds by reflected light using the sound wave to initiate the light flash.

From previous experience last summer a 0.2 mf condenser at 10,000 volts will give enough light. We plan to try a lower voltage say 4000 or 3000 volts which calls for a 2 or 2.5 mf condenser.

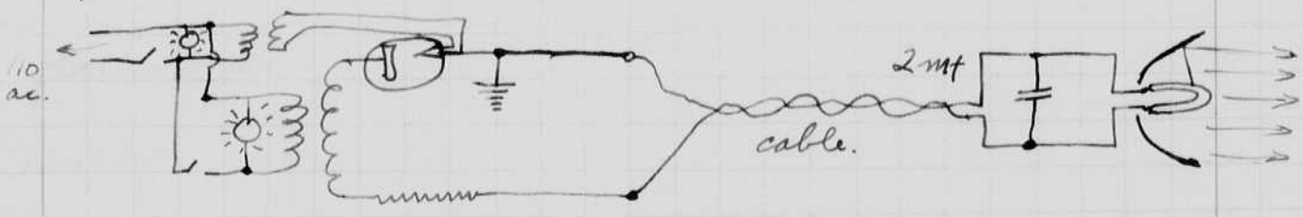
Equipment required:

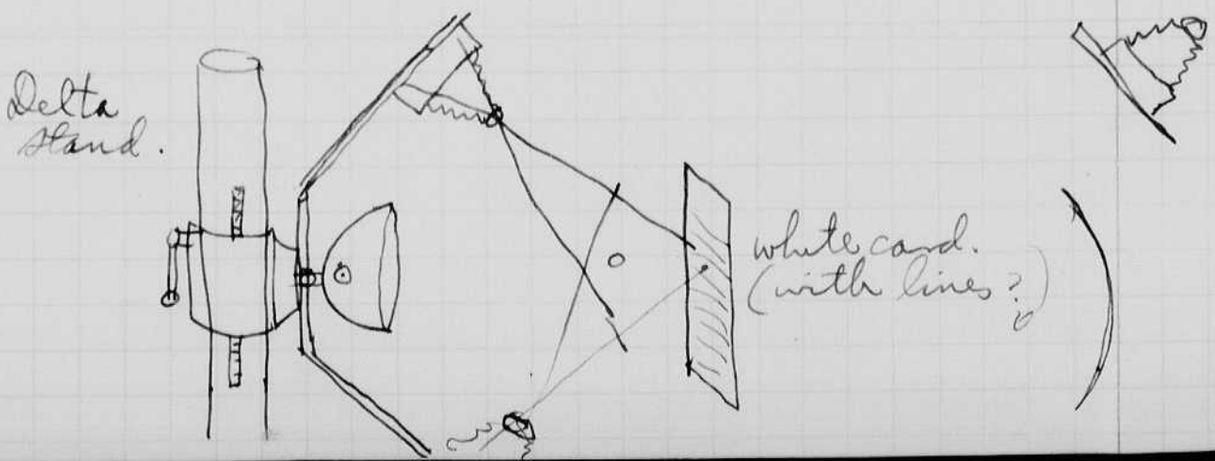
1. Argon lamp, reflector, condenser, coil, and camera stand.

2. Power supply to charge condenser.

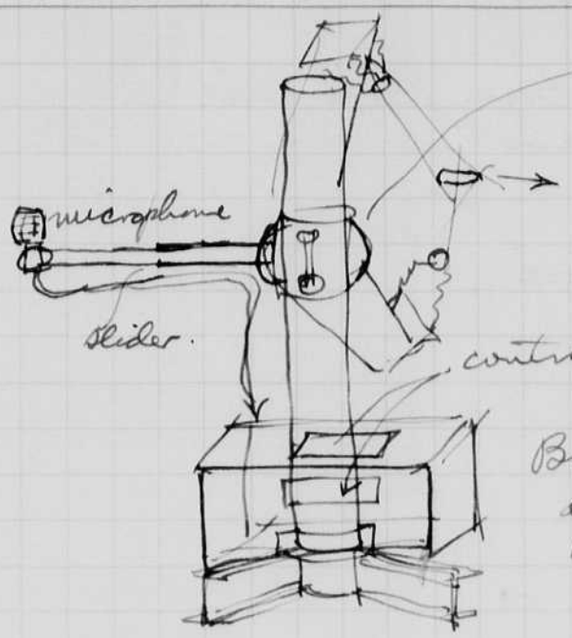
3. crystal pickup, power supply, amplifier and strobotron to flash the lamp.

#1. Circuit

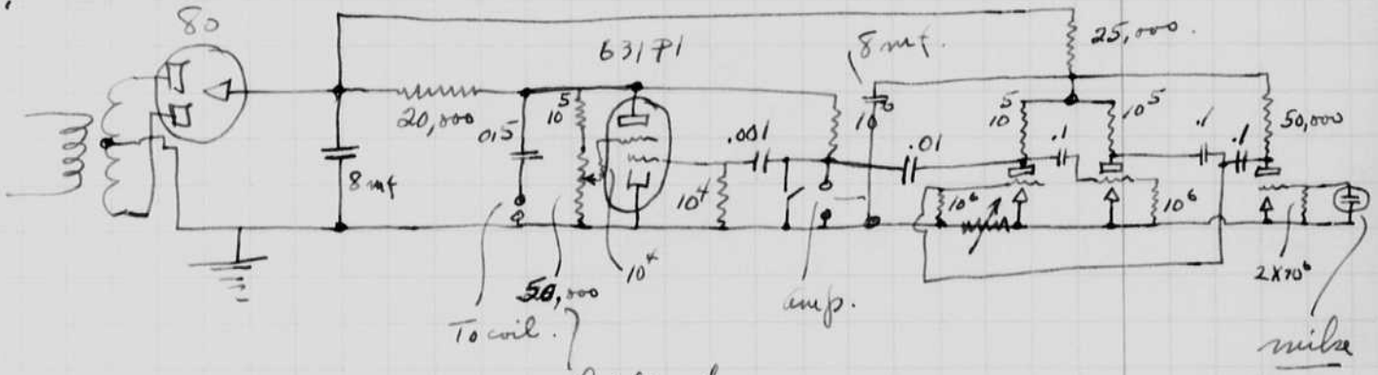




Side view of stand.

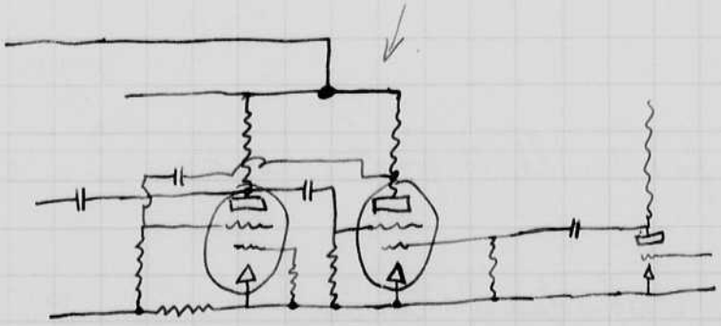


#3.



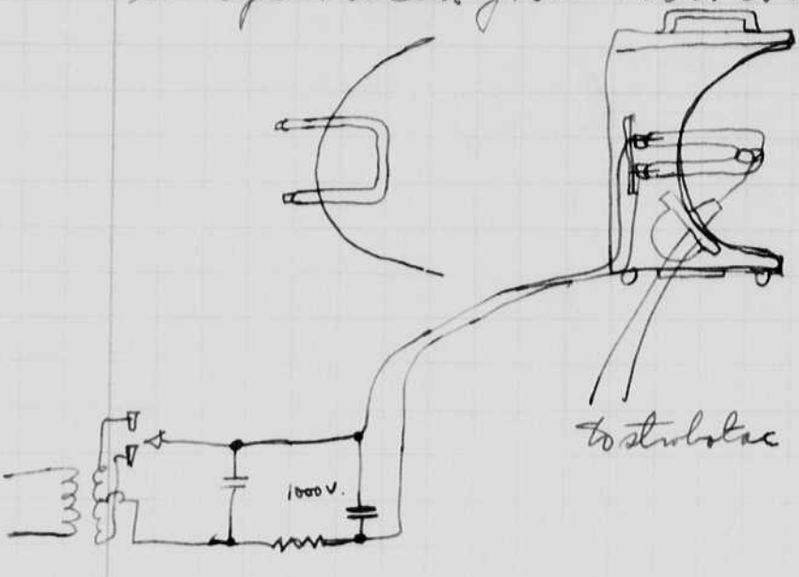
adjustment may not be needed if amp stages are large enough.

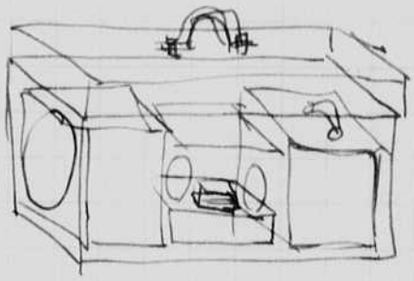
Pentodes in place of triodes



July 7, 1937
H. E. Edgerton. Stroboscope

Argon filled tube and power supply to be operated from stroboltac oscillator.





Pumped tubes.

7 for Nortron Co 1/2 atmos argon.

2. argon for Nile to fit over lamps. 15 cm.

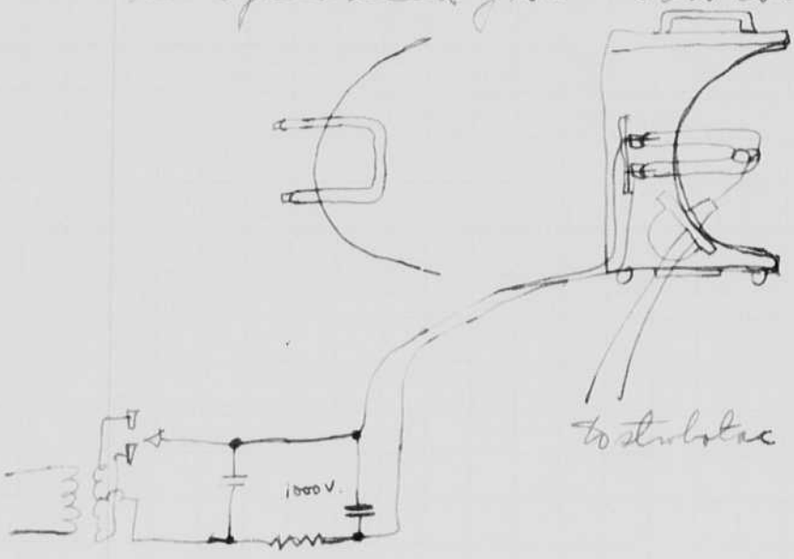
5 argon U shaped tubes 35 cm.

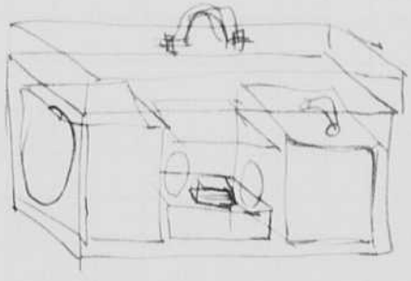
Bob Bill Mary Jane

205 School St
Belmont.

July 7, 1931
H. E. Edgerton. Stroboscope

Argon filled tube and power supply to be operated from Strobotac oscillator.





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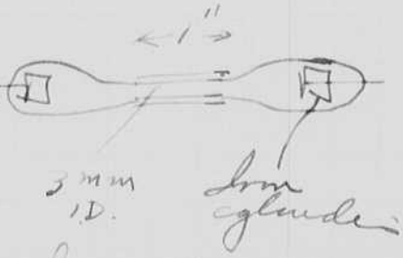


2. argon for Nile to fit over lamps. 15 cm.

5 argon U shaped tubes 35 cm.

Bob Bill Mary Jane

205 School St
Belmont.

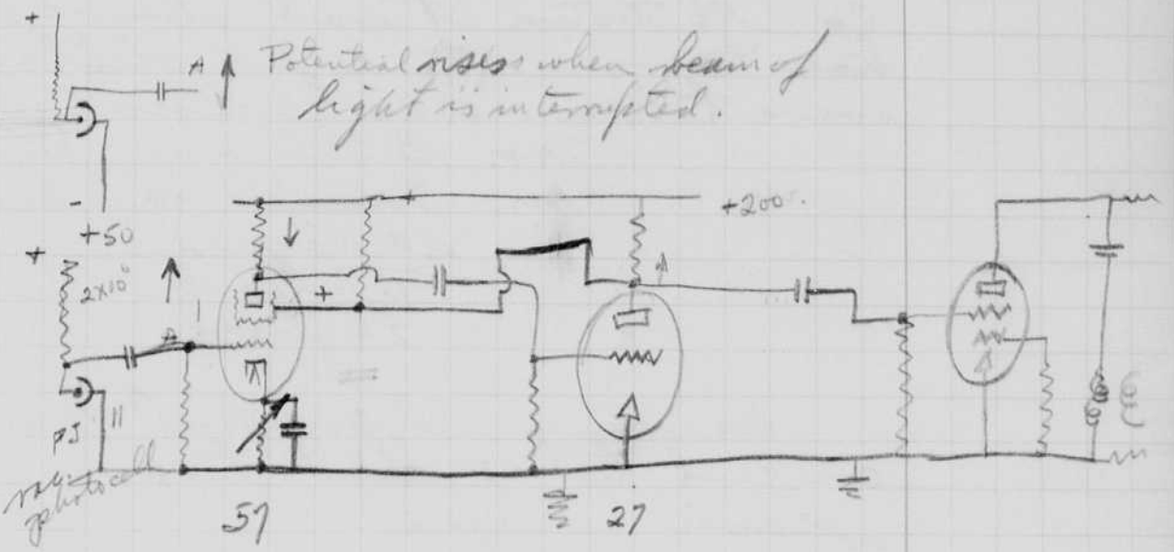
July 20 1937
Edgerton

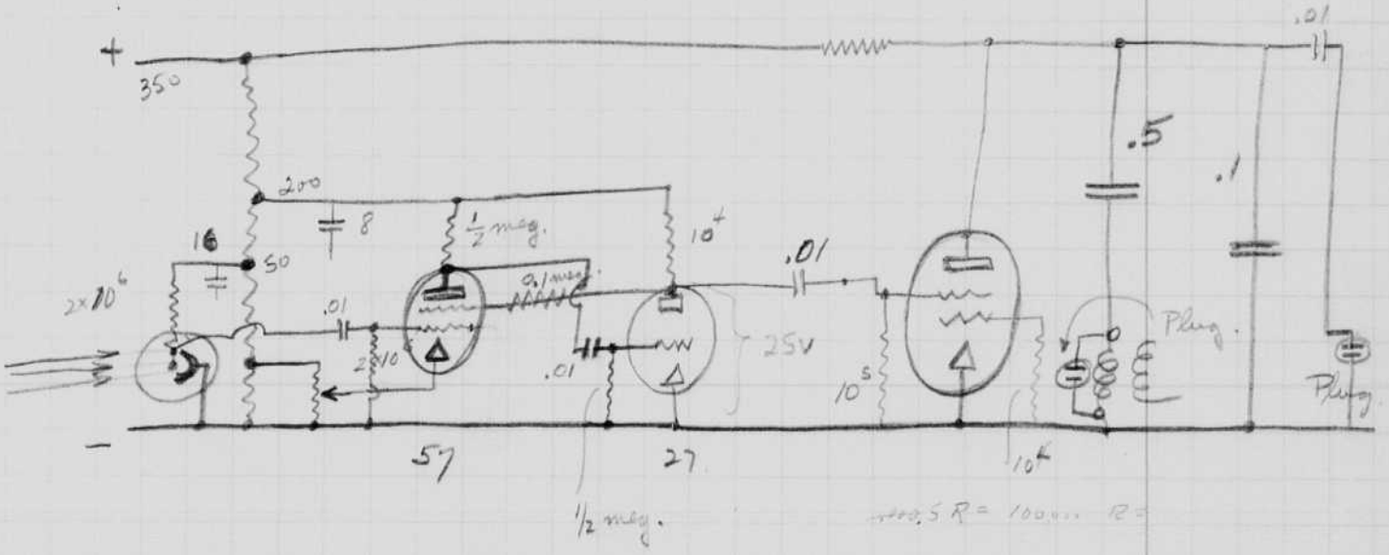
I took pictures for the Chicago Pump Co today. Also pumped some tubes. Saw Mr. Cuchendall(?) of Cornell U. who has been taking high-speed photos of photo-elastic impact specimens. He used .05 mf at 30,000 volts.

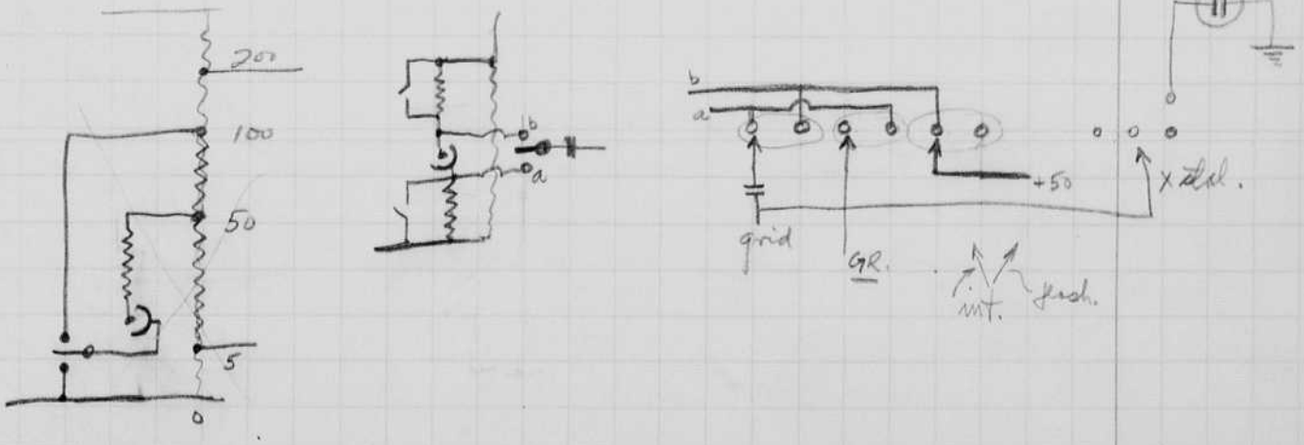
W.B. Tucker used Sorensen's Hg lamp and took some shots here of a cam and rod rotating at speeds up to 1400 r.p.m. Tucker used 4 mf 3800 volts. A filter was used to limit the active light to the desired color.

Discussed high-speed photography with Evans and Bradburn(?) of Remington. Offered them our fit. 400. like ours 4 mf 3800 V

Photocell trip.







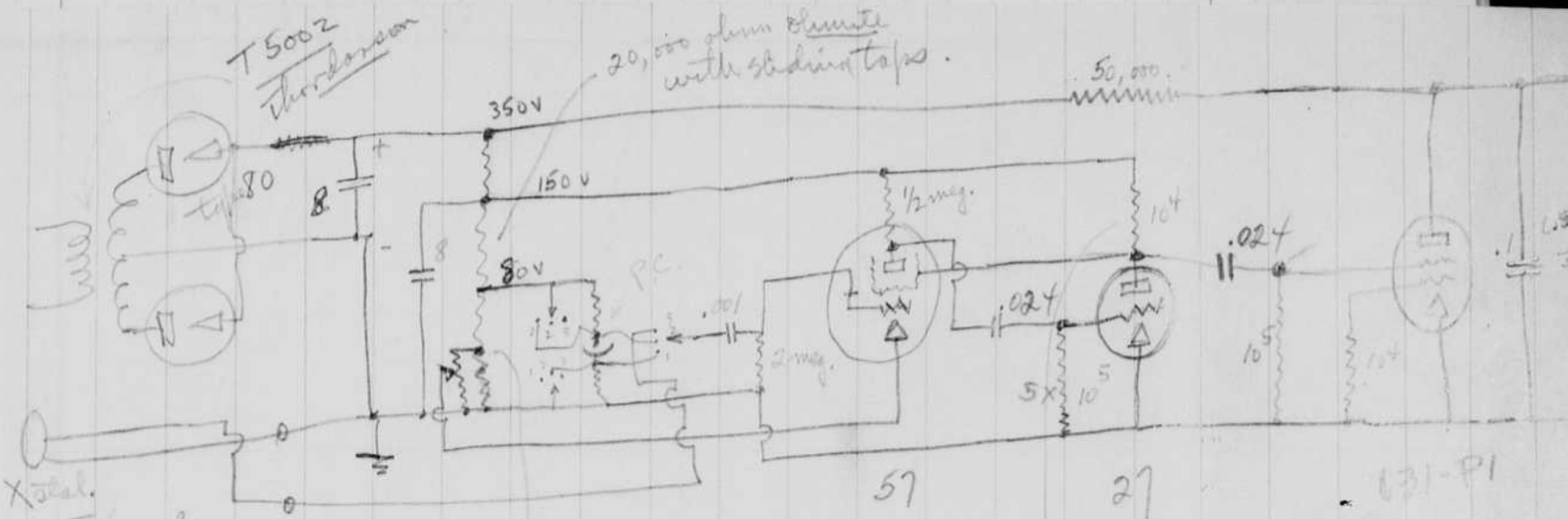
H. E. Edgerton
July 28 1937

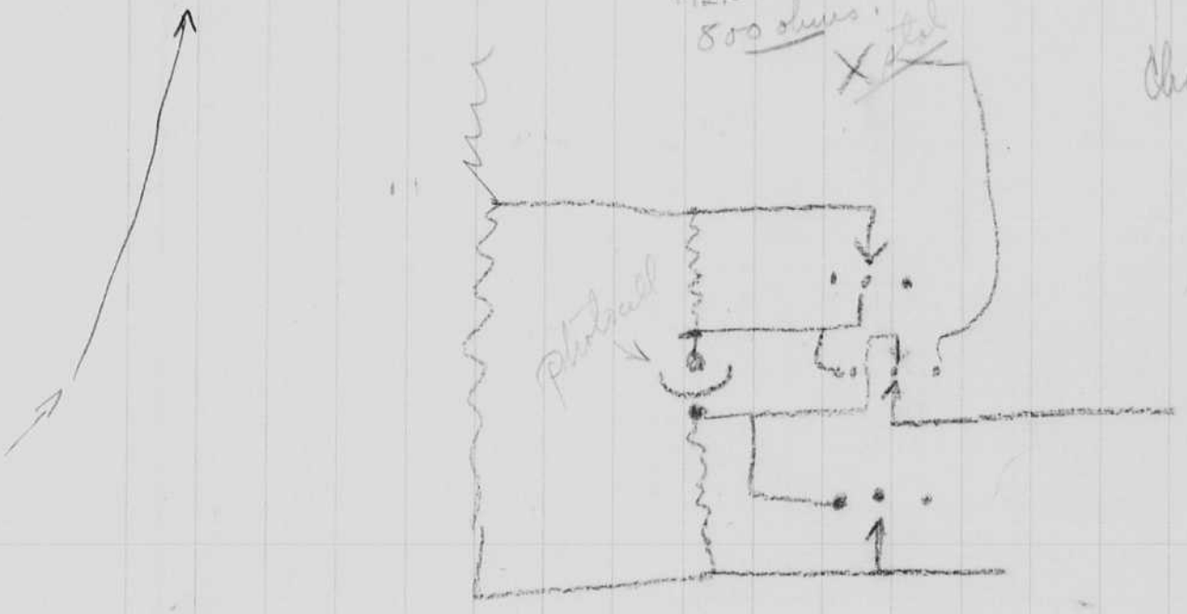
Brier and I went to Winchester yesterday and set up the stroboscopic camera on the grinder at the Norton Co. We tested it and showed them how to run it. a few photographs were taken. those present

Mr. Becher — Div. of Res.
Mr. Saunderson. — Director
Mr. K. W. Wagner
" Whitcomb
" Englund

On return I pumped two Hg control tubes and two argon flash lamps.

Dec. 10. 1937
With J. W. Horton: this circuit was actuated with 6 millivolts from a contactor one m.v. was not enough with the arrangement but could be I am sure with effective filtering.





Sat July 24. Finished wiring circuit page 15
Same as shown above, except for 631-P1
and output which was temporarily omitted.
The 57 and 27 connected as shown
work fine for both connections of the
photocell and the crystal microphone.
A hand clap 3 ft from the mike will
trip the circuit.

CATHODE RAY SCREENS

1 oz. Willimite

200 CC Acetone (ball mill pt. size)
Ball for 12 hrs.

Remove Willimite. Evaporate acetone. Place in graphite crucible. Fire at 1200°C for 15 min. to remove stresses caused by grinding.

- - - - - - - -

Putting on Screen

200 grains (nitro-cellulose)
gun cotton
Dissolve in 200 CC Acetone. Add 100 CC Ethyl Oxalate* or Amylacetate. Place 1 oz. of ground Willimite in mixture. Place in ball mill. Grind for 15 min. (to get thorough mixture). Remove and place in bottle. Bring up the whole solution to 600 CC by adding Acetone.

- - - - - - - - -

Spray screen with spray gun. Bulb should be at 180°to 200°C and rotated while spraying is in operation.

- - - - - - - - -

After bulb is cool, heat the end of the tube until it turns brown where you desire screen to stick.

- - - - - - - - -

Screen now partially carbonized is insoluble in Acetone. Place Acetone in bulb and scrub out sides with rubber sponge on the end of a rod. Cut the rim of the screen by using a pipe cleaner wound on the end of a heavy wire. Don't touch the screen portion (brown part) with sponge or pipe cleaner. Slowly pour out Acetone mixture so that "back slop" will not spot screen. Run water into bulb very slowly. Avoid "back slop". Scrub and clean sides with sponge and pipe cleaner as before. Rinse twice in water, allowing water to run slowly in and out.

- - - - - - - - - -

Place bulb in oven. Bake at 500°C. 20 min. This anneals and burns up carbon.

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* Preferred.

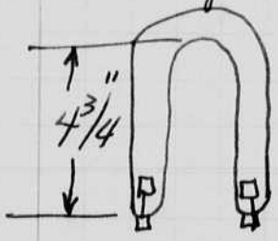
R. P. Fogwell.
July 28 1937

I pumped 11 tubes (V shaped) yesterday, made at Macallister Bulmell Co. Baked 1 hour - hydrogen treated electrodes area metal iron, . *Discharged 48 mf 4000 v 10 time on pump. 5" of argon. Pumped out and sealed off with 5" of argon.
* First 5 only. Second batch of 6 flashed only 3 times each.

Finished a few odds and ends on circuit page 17. Thacher started wiring up one also.

Aug 1 1937.

A life test on ~~a~~ an argon flash lamp has been in progress for several days. A 48 mf condenser (C-D) ~~rated~~ at about 3500 or 3800 volts is being discharged into a V shaped tube. 7/8" O.D. heavy wall pyrex tubing.



At the end of 1000 flashes at 1 per minute there was a black deposite ~~argon~~ around the cathode. At 2000 flashes the deposite extended about 1/2 way down one leg. It was thin however compared to the deposite around the cathode.

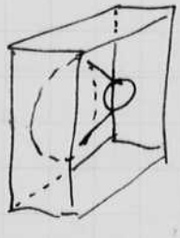
6440 counts read
9246 Aug 1 10 am.

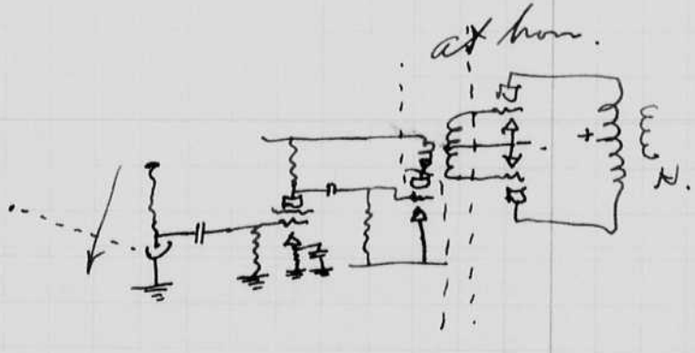
A small coil is being used which was sent to us by Mr. Hartzell of the Delco Remy co. .5 mf 350 volts used in the coil circuit tripped by a stirbotron.

The rate was increased to 2 per minute at about the 1500 flash point.

The amplifier in the above sound Projector was replaced by a 10 watt amplifier from Woodbury Radio and the quality was greatly improved.

On May 3 mrs. I. Marks came to hear the projector.





Sound thru glass. 15,000 ft/sec.

H. E. Edgerton.
Aug. 6, 1937.

We have spent most of the week trying to take photographs that show what happens to small dust particles when they impinge against a surface. Mr. Jun Eastman of the Burly co, Chicago wants to show that large particles breaks up into small particles by the impact of the particles against the object.

Some results of interest were obtained.

400 ft of pos. film used.
4 9x12 cm film.
? 3 doz. 5x7 Pan film.

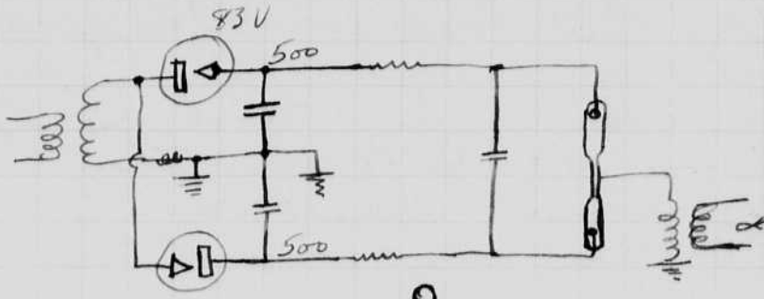
Aug 12 1937. Mr. Wadman of the Hartford Empire co was here today and authorized start of glass breaking experiment.
6" x 2" x (3/10 or larger). plate glass strips. hit with dropped object.

Several days ago Miss E. Treacy of Fortune called Mr. Rowlands about the possibility of pictures of the sampling of paper as it passes through a paper making machine. Also the slashing of the sheet and the rethreading of the rolls was another subject. I wrote her on Fri the 6 and a letter told us to go ahead. Mr. Killian made arrangements with the the Warren Paper co at Cumberland Maine for next Tues. and Wed Aug. 17 and 18.

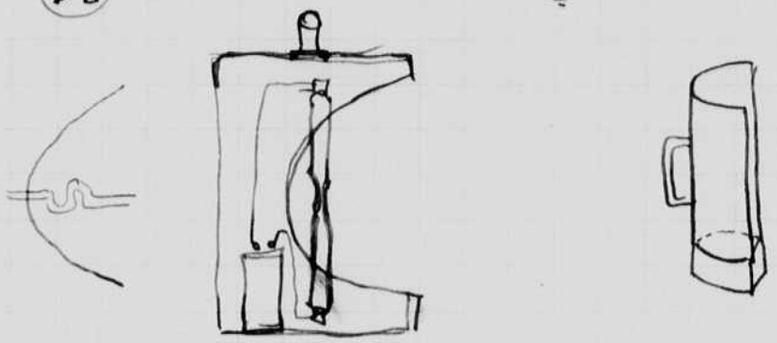
Don Griffin wired from woods hole that he could bring balls this weekend, for movies. I wired to wait a week or two.

H. E. Edgerton
Aug. 6, 1931

Stroboscope



to var. 10 - 60 cycles.



End of life test 8500 flashes.
Tube still worked ok - but was dark on the cathode lead side up about half way

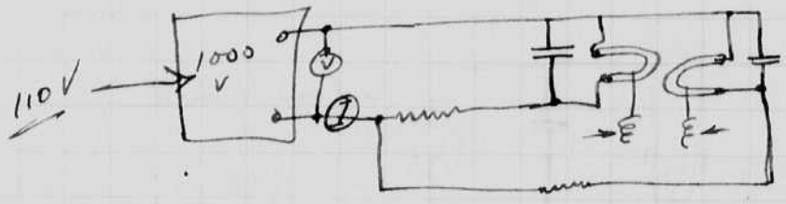
The end of the iron cathode looked melted away, or rather pounded.

The black deposit looked like small particles under the microscope. More tubes to be built with data in Germeshausen's book.

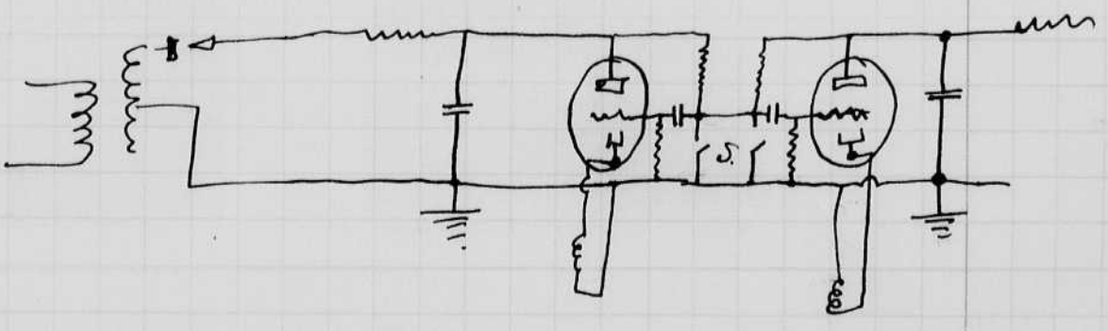
Aug 13 1937. Movie Setup for study of
H. E. Edgerton. Paper Machine.

We plan to use an ordinary movie camera, a Universal, and to illuminate with strobos or pic light in synchronism with the shutter. A contact was put on the intermittent motion yesterday by Grier and connected to the three kw 1000 volt power pack.

I am pumping some U shaped lamps to use with it as follows.



4 tubes were pumped and filled with argon at about 3 cm pressure. They were run on the pump with 24 mf, 1000 volts. 400 ohms. 0-50 cycles or flashes/sec.

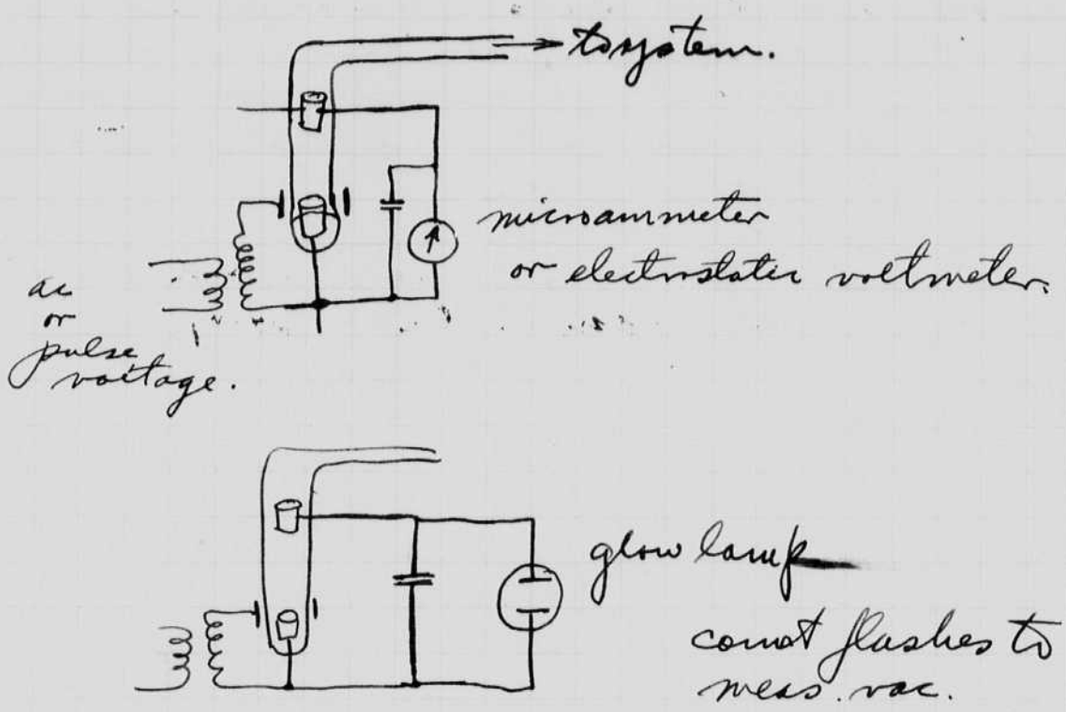


With this connection, either one or the other strobotrons fire but not together when switch is closed.

Lamp with cooled electrode has now run 4500 flashes with no appreciable blackening of the cathode.

Aug 15 1937
H. E. Edgerton

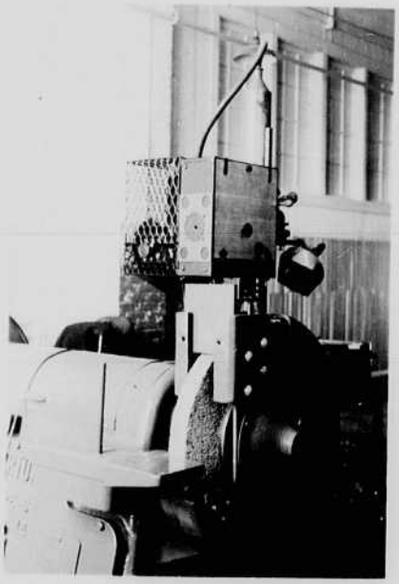
Pressure Gage for vac. system.

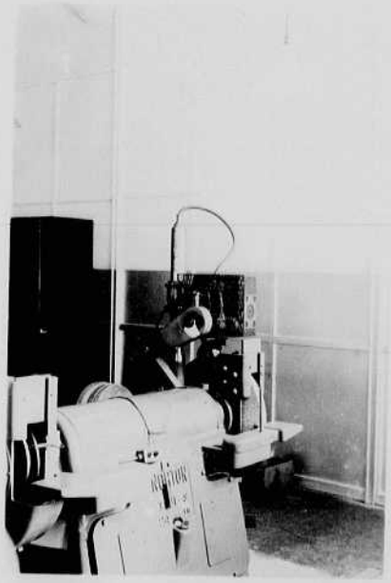


Aug 18 1937
D.F. Edgerton. Trip to S.D. Warren paper co yesterday.
Segues and I left at 630 a.m. for plant near Portland to photograph sheet sampling from paper machine for Fortune.

A contactor was mounted in the universal 35 mm movie camera to operate a 24 mf condenser discharge (1000 v). through an argon lamp. Reflector about 6 ft away from subject.

also took some single flash photos with two new flash units 24 mf 3500 v.

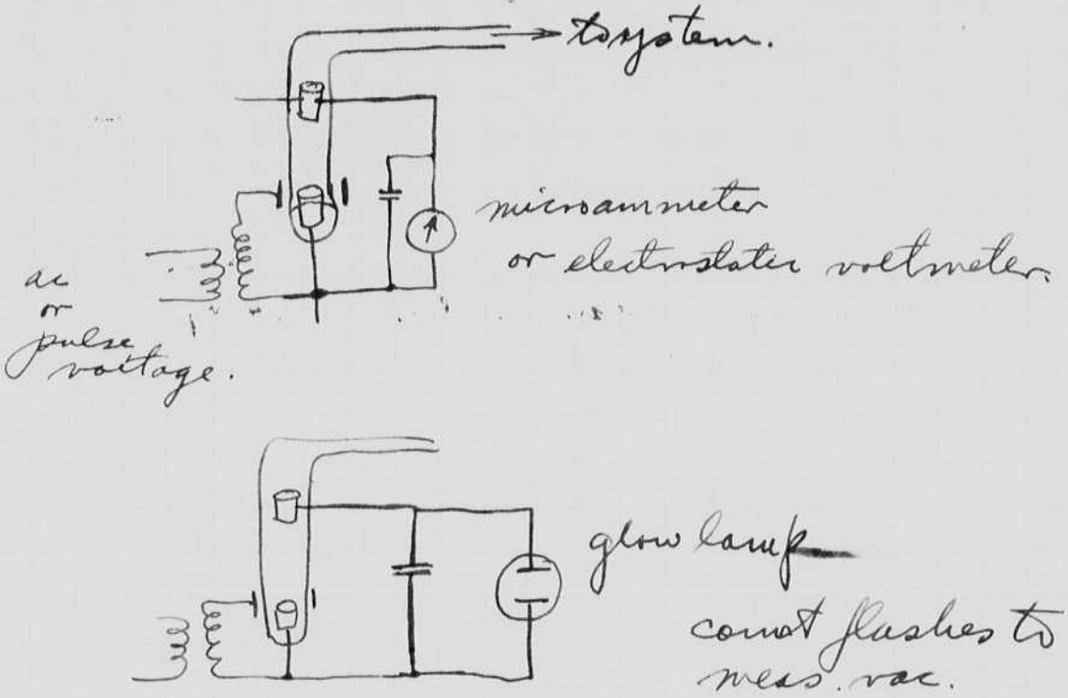




Stroboscopic-light camera installed at the Norton Co plant at Worcester.

Aug 15 1931
H. E. Edgerton

Pressure Gage for vac. system.



Aug 18 1937

E.J. Edgerton. Trip to S.D. Warren paper co yesterday.
I Segues and I left at 630 a.m. for plant near Portland to photograph sheet sampling from paper machine for Fortune.

A contactor was mounted in the universal 35 mm movie camera to operate a 24 mf condenser discharge (1000 v). through an argon lamp. Reflector about 6 ft away from subject.

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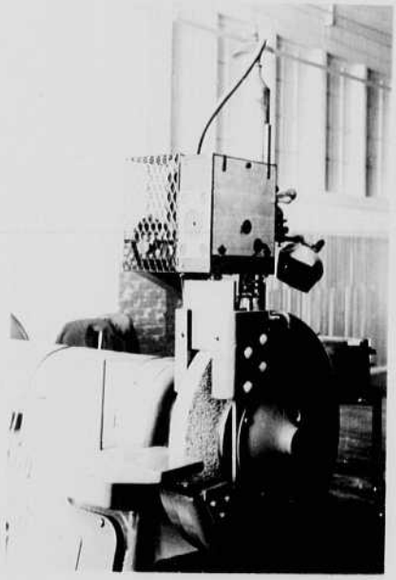
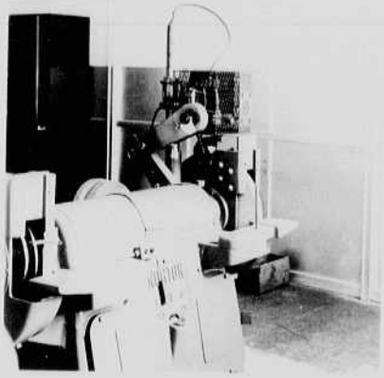
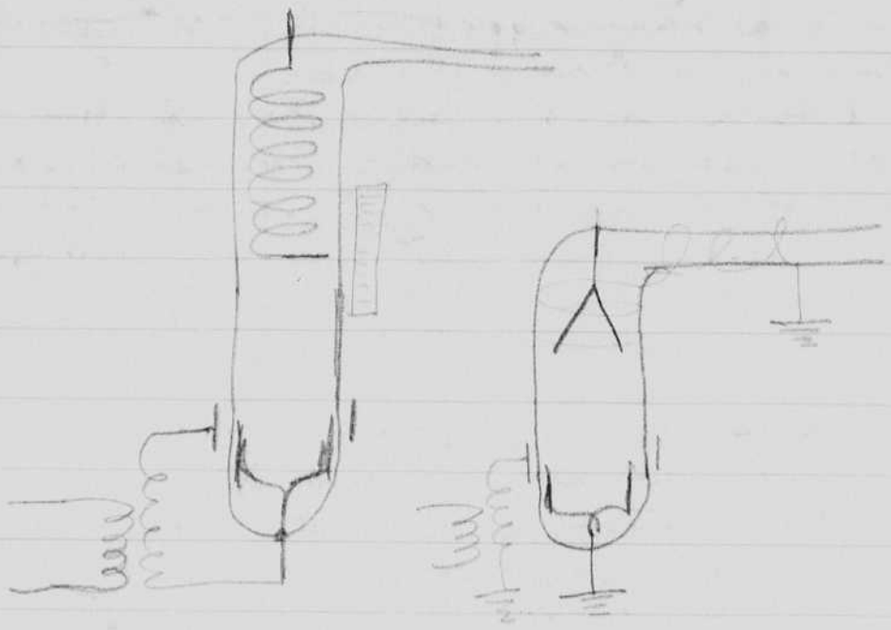




Strobos copier light camera installed at the Norton Co plant in Worcester

Aug. 18, 1937.

Pressure gage for low pressure



electrostatic ~~voltage~~ forces due to high potential at low pressure. show reading.

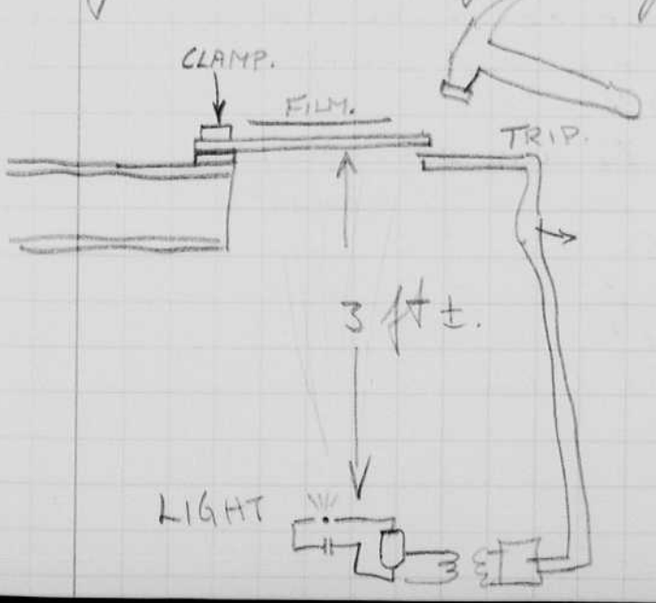
Dust counter. — Piezo crystal hit by jet of air containing dust. Each particle will produce a voltage when it hits which can be counted electrically. Different circuits to select according to size.

Aug 26 1937

On last Friday Aug 21 I went to Westbrook, Maine with Mike to the Warren Co. We arrived there about 7 o'clock and worked until 4 in the morning taking ~~and~~ or flash photos of action. We stayed all night at the Elms, after a visit at the plant we left for Holdgates N.H. and took a few photos of humming birds. We left about 5 pm and got home at 11 to Ted. Gems and Grier were helping take movies of bats with Don. Griffin. The other boys left then but Griffin and I worked until after 12, taking a few more movies. The new 2000 volt ~~pow~~ motor generator set was used. U shaped argon lamps 3/4" O.D. 8" long. 3 mf with control lamps at 600 f.p.s. 330 ohms changing resistance.

Monday Aug 23. Developed negs. Tuesday made prints also Wednesday. Final enlargement mailed Wed. night to Miss Treacy by Portune.

Today I started the experiments with glass for the Hartford Empire Co. I set up the shadow apparatus and tripped it with a hammer and a pair of contacts. The samples were 2 x 6 x 3/16 inches. The contacts were about 1/4 of an inch below for a break photograph. I took a dozen or so shots. 10 showed before the break 2 after.

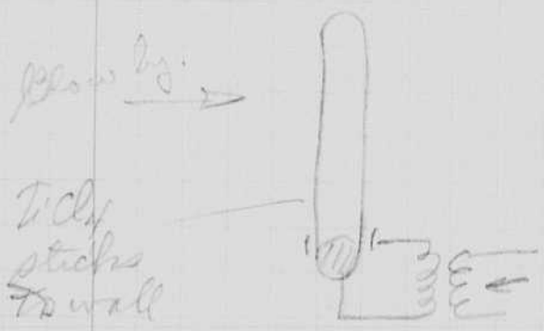


Aug. 2/1907

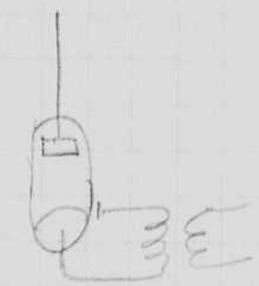
More work on the glass breaking setup today. Grig helped set up a tube and weight in place of the hammer. I took one photo putting the contacts about 1/4 inch under the end of the plate. The contact of the weight and the film made a mark — I mean an exposure on the film. The film was placed on top of the glass, emulsion down.

Air Filter.

The mercury-arc tubes collect smoke such as $TiCl_4$ on the outside when operated. Possibly this will be a useful way of precipitation of dust, smoke.



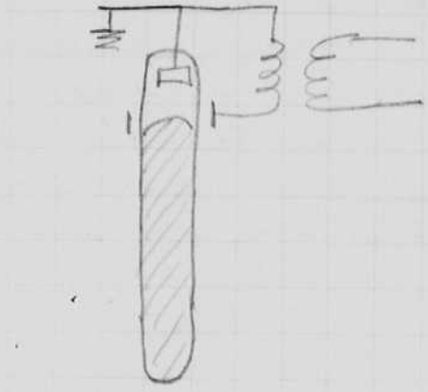
the inner walls of the tube become highly charged with negative electricity

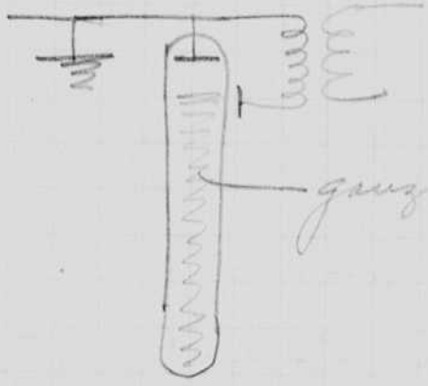


Zinc wire outside to be charged in dusty laden atmosphere. A filter condenser should be connected with anode cathode ends of the tube.

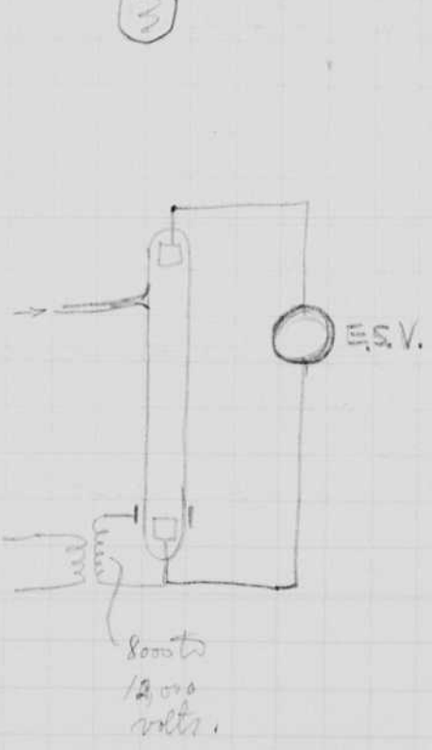
cont. dust collectors.

To get a positive charge, the anode is grounded.





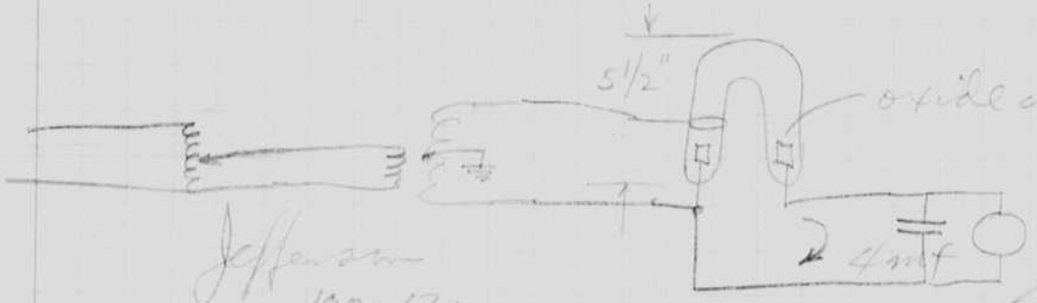
Argon 99%
pressure 0 – 500 microns range.



Aug 28 1931
Harold Slapter

Exp. with Filament Hot Rectifier

Tube used A shaped 3/4" O.D. Electrode one Sweanwelded from cylinder 3/8 diam 1/2 in long. Other has nickel screen wire coiled with Ba and Sr Oxide. before put in tube. This tube was sealed off to pump pumped down for a leak. 2 estimate that the pressure is between 10 and 100 microns of air. The oxide coated electrode was violently bombarded and by both Hydrogen and Oxygen treated in the tube.



Jefferson
100-120
15,000 volt.
neon sign trans.
Cat no 722-111
no. 50-1897
Sec 25 ma.

Current flows in direction indicated. Band 3" above plate from electrode for below exp.

	Varian reading	Milliamps.	
①	30	1.5	20 - 0.04
	40	3.1	
	50	5.5	
	60	7.9	
	70	9.9	
	80	14.3	
	90	18.1	
	100	23.0	
	80	14.4	
	60	7.6	
	40	3.0	
	30	1.4	

Var.	ma	Time.
70	10.4	10.11 am.
70	9-9.6	10.15
70	9.2-9.4	10.17

The band was a composite of about 6 strands of no 26 (?) copper wire. I took off all but one turn and ran the following. The band is 3" above the cathode as before.

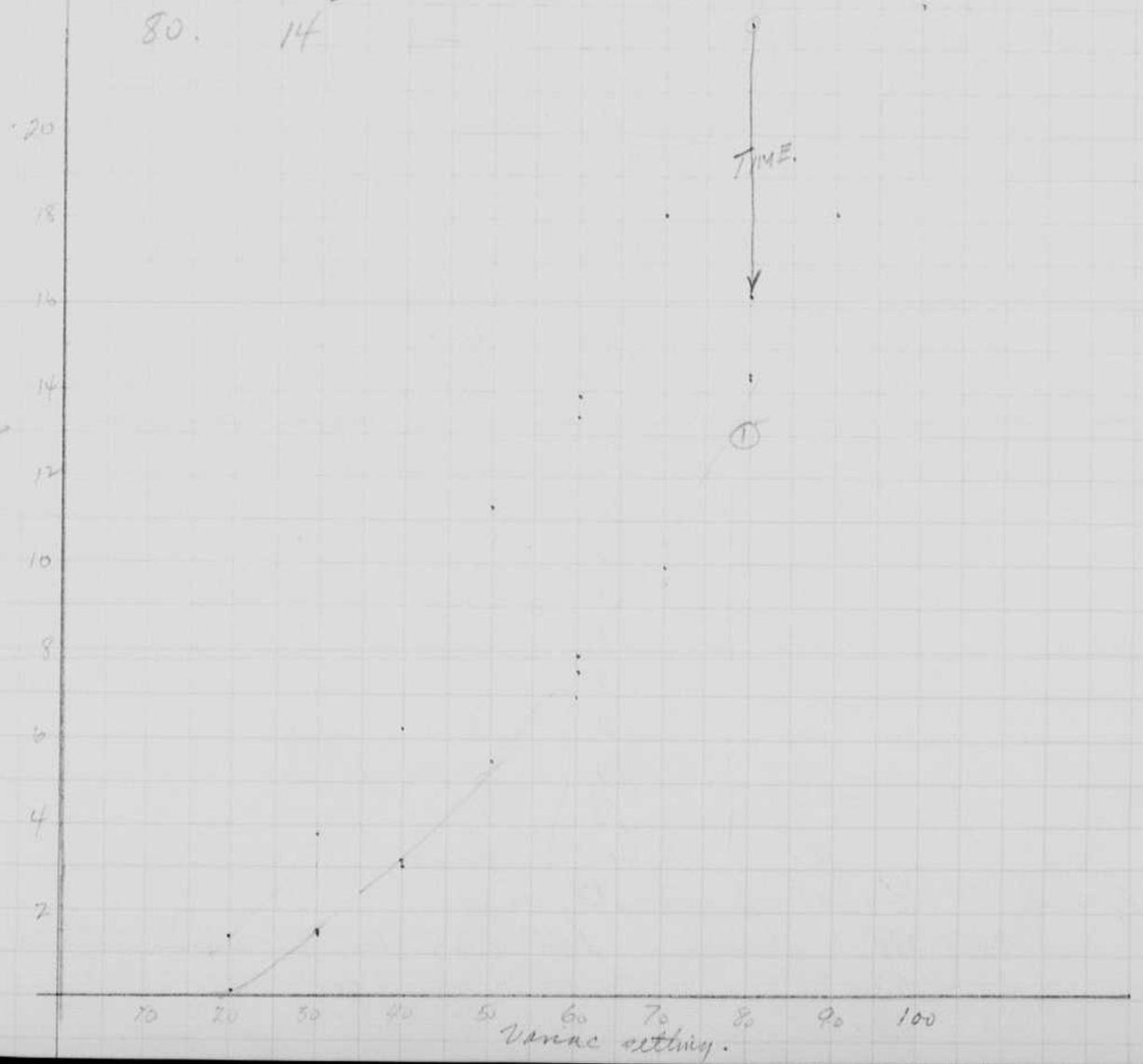
Var.	ma.
20	1.4
30	3.8
40	6.2
50	11.3
60	13.4-13.8
70	18.1
80	21. 21.5 ?
80	22.5
80	20.5
80	20. 1 min t
80	16.2 1 min t
80.	14

Band moved to 2" above cathode.

30	1.7	3" again.
40	3.6	40 5.2
50	7.3	50 7.7
60	11.	60 12.4
70	14.5.	70. 17.8

3" above electrode on other leg of V.

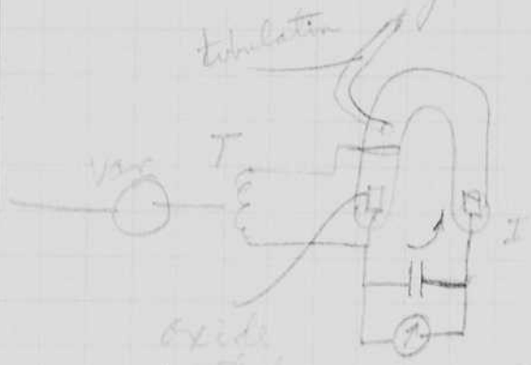
40	2.7
60	7.4
80	14.6



Cont.

Ends of U tube changed.

Current goes opposite direction!!



Here is a change of direction of current at about 25- or 30 on Variac.

Var.	ma
30	1.4
40	3.4
50	6.0
60	9.4
70	13.6
80	18.3
90	24.2
70	13.1
50	5.7

Band 3" above of

with bright fingers like current is reversed. 70 or 80 volts, ma reading reversed.

Band at 2" above.

70	1.2
80	2.2

current goes noisy!

Changed to 3" again which is above the [illegible] plates

30	1.1
50	5.0
70	11.4
90	21.

noisy. Tube filled with very faint glow.

Band at center of U.

30	2.8
40	5.2
60	8.0
60	12.5
70	17.8
80	24.5
90	30+
60	10
40	4.2

Band 3" above opposite leg.

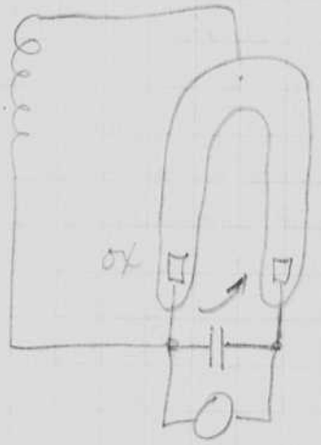
30	2.8	jumpy	60	8.5 10	glow intermittent
40	5.2 - 5.5		70	9.5 12	
50	7.8 - 8.5		80	9.5 — 14	on jumps.

Cont

A spiral of 4 turns of wire were twisted around the U part of the tube. Noisy and very little current. Puts at 50 - 60 on voltmeter. Current .5 microamp.
N.G. due to wire being off!

40.	4.5
60	11.5
80	24 - 25

Wire band taken off and point of wire against glass used.



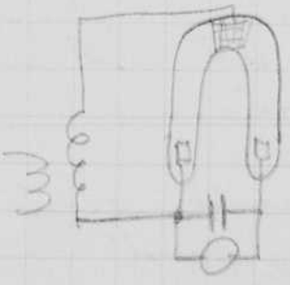
90	7.4	Very steady
70	4.6	

two points 1/2 inch apart used. more current!

90	14	
90	11.5	1/2 min. steady but noisy.

Tried a # 16 or #18 wire band. the current at 70 was 11 compared to 12 with the first wire # ( ) ?

I next put a band of nickel guage, such as used for our tube grids. 7/8" long along length of tube at U



40	4.3
60	9.9
80	18.5
100	27.5 28.5
80	16.8
60	9.2
40	3.8
70	13.
90	21

I shall get these results to Monday.

Aug 29 1937
H. E. Hazeltine.

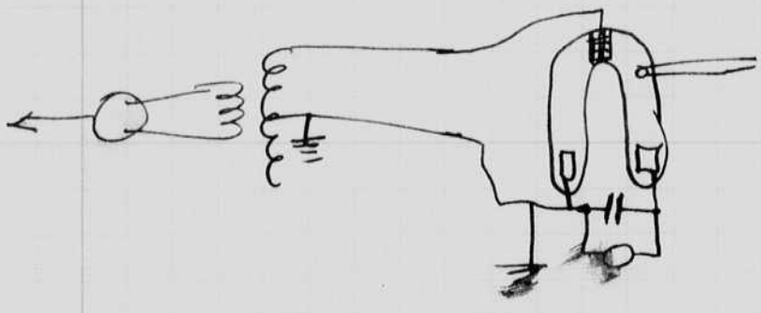
Vac gage

I took more photos of Glass breaking today for Hartford Empire Co.

Filamentless Rectifier as a vacuum gage for low pressures that is 10 to 100 microns.

Two V shaped argon-flash-lamp tubes were sealed to the system in 10-107. One had an oxide coated nickel screen in a nickel cylinder for an electrode. the other 3 electrodes were of iron strip.

Before baking or bombarding I tried the tubes with a screen external electrode at the center. I used only half of the near sight transformer since the meter was on the metal base of the pump

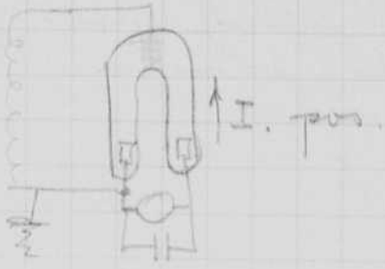


The tube with the ox electrode was erratic while the other seemed good. the later read about 95 ua at 0.5 microns pressure — 15 ua at 100 microns.

I bombarded the electrodes and put hydrogen into the tube and again heated them to get the iron oxide. Pumped out H2 and bombarded again.

Cont.

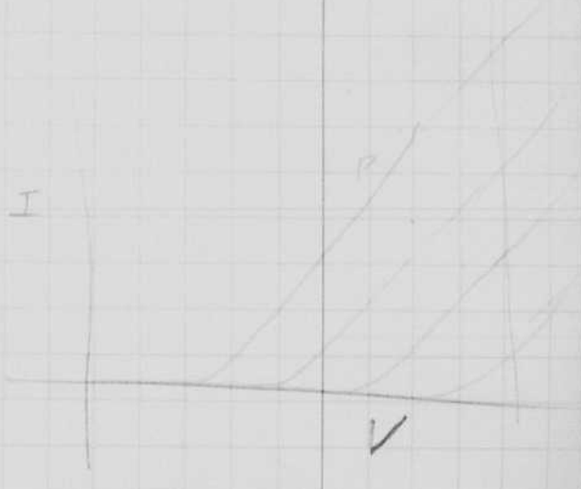
Plain Iron electrode tube.



Var.	I	Pres.
40	5-9	.35 m.m.
60	13-23	"
80	4-20	"
		.45 micron.
40	.5-.8	"
60	5.7-6	"
80	11.5-12.5	"
100	18±4	"
110	26±4	"
40	0	13
100	—	"
100	-.5	"
105	-3.5	"
110	-7.7	"
110	-0.7	I.

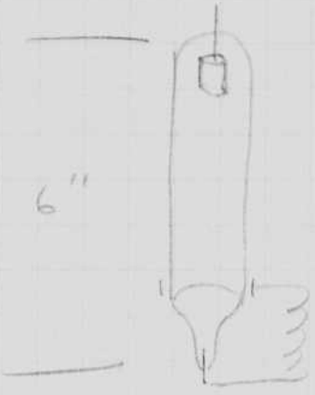
Transformer secondary voltage doubled.

40	+0.6	9.5 ?
60	15.5	
70	28	
50	5	↓
50	.7	
60	1.7	
70	13	
80	26.	?
70	1.1	4.4
80	11-13	"
90	28	"
30	2.7	23.
40	8.5	
50	18	
40	7.5	21
50	14.5	
60	22	

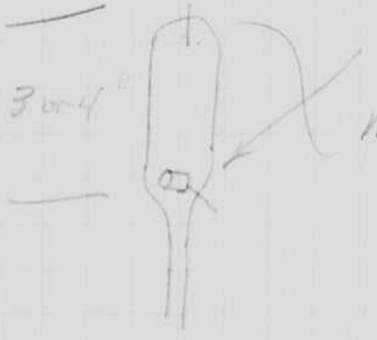


Aug 30 1937 Vac-gage & Filamentless Rectifier

I spent most of the day experimenting with the following tubes.



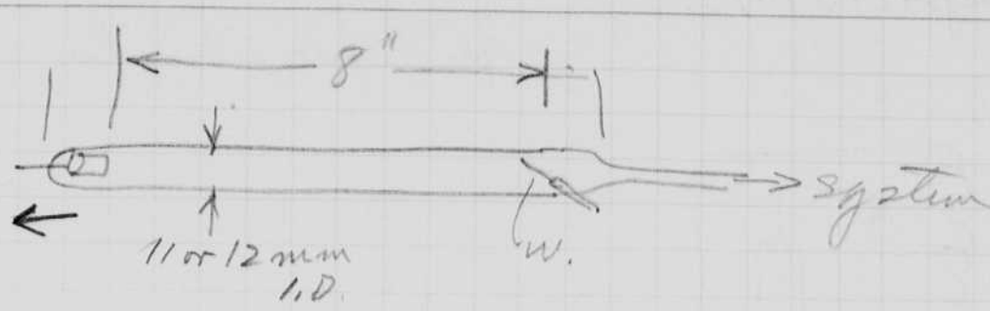
Standard Hg. control lamps.



with a band of two strands of No 28 wire 1/8 th above the bottom cylinder the following was recorded.

Pressure microns	current ma
63	22
30	11.8
20	4.5
12	.5
4	0.
.01	-.5

For these tests a transformer for lighting an oil burner was used Jefferson. No 14843 500VA 110 prim.



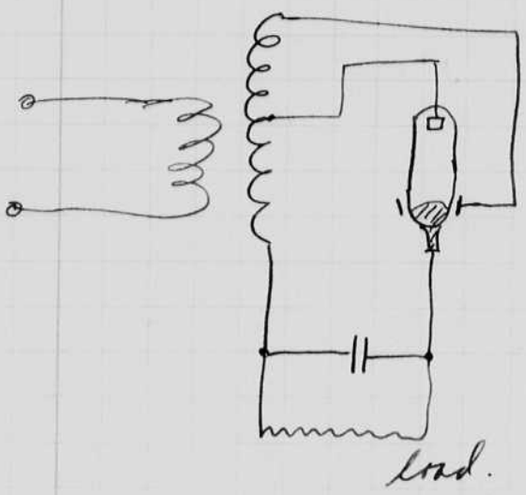
microns	ma.	deduced data
180	+15.5	
140	12.	
115	- 7	
115	+ 9.5 ?	
95	- 3	current reversed when pump pulls down pressure
.0	+ .5	

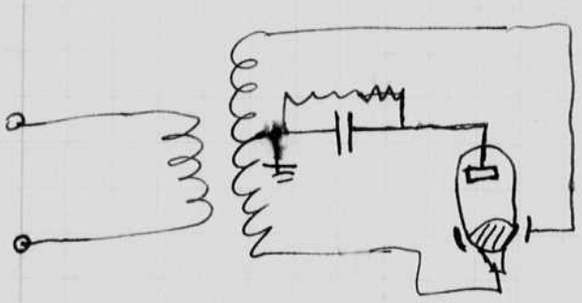
current went up then + again and finally down to .5 with open.

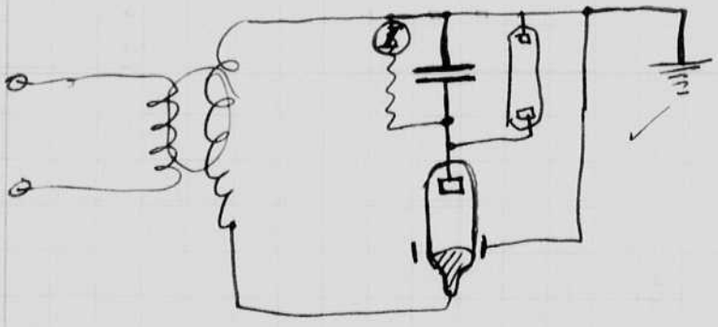
Another tube was built with an oxide coated cathode. Considerable reverse current flowed from it

H E Edgerton.
Sept. 1. 1937.

Rectifier circuits.





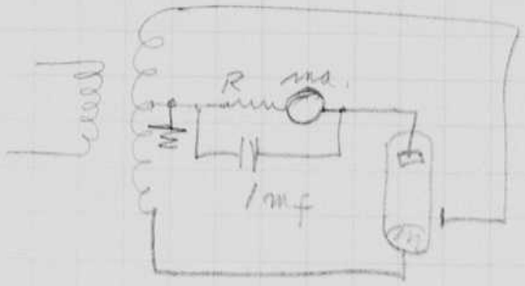


3000 volts.
$\frac{5 \text{ ma}}{3000} = .0013$ ma

.001 amp 1 ma.

Cont.

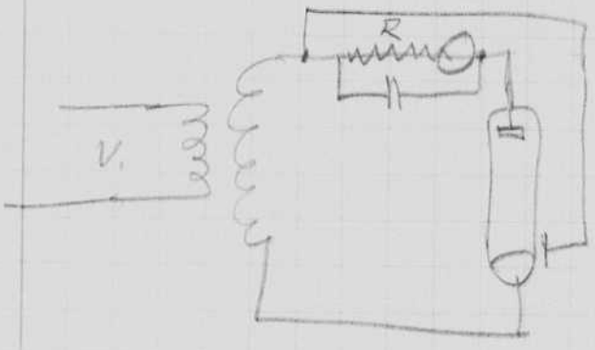
Set up and tried.



R = 5 megs.

I = 1 ma. V = 90

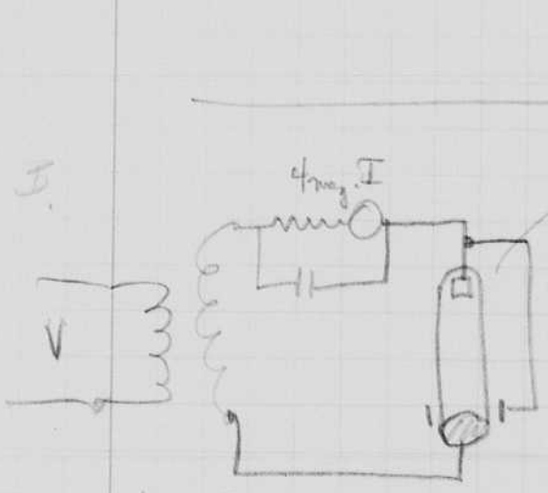
Jefferson sign transformer. 110 – 15000.



R = 4 megohms.

V = 90 I = 2 ma.

	35	0 ±		√
	37	.2 ma		800
	40	.48 x 2	.96	1240
	50	.56 x 2	1.12	2380
	60	.5 x 2	1.0	4000
	70	.62 x 2	1.24	4960
×	70	.26 x 5	1.30	5200
	80	.31 x 5	1.55	6200
	90	.19 x 10	1.9	7600
	100	.23 x 10	2.3	9200
	110	.27 x 10	2.7	10800



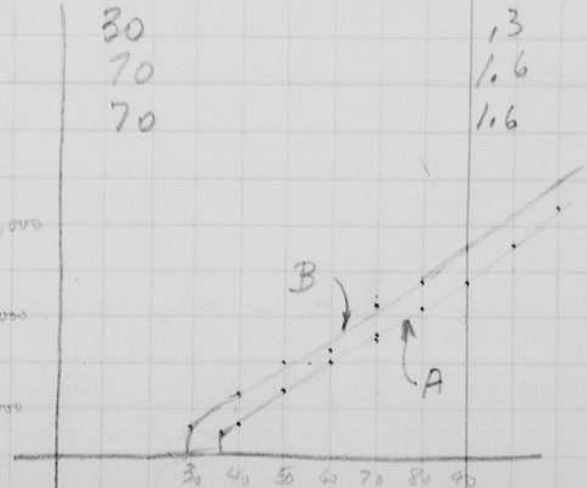
12" Standard strobe tube.

Sparkover.

Time 5.20
5.35

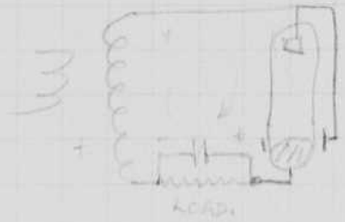
			Volts
50	.1 x 10	1.	4000
60	.13	1.3	5200
70		1.6	6400
80		1.9	7600
40		.6	2400
30		.3	1200
70		1.6	6400
70		1.6	6400

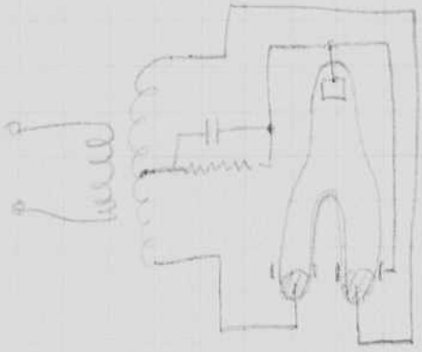
$\frac{6400 \quad 6400}{4 \times 70^2} = 10.24$ watts



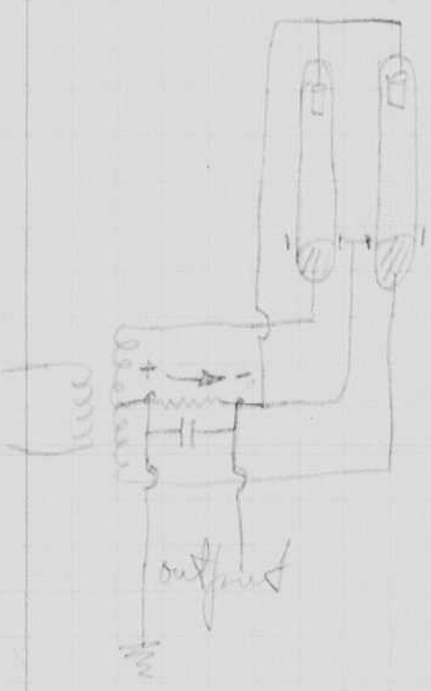
Important the D.C. output voltage plus the starting voltage is used in case B.

Cont. Hg high voltage rectifiers





Full wave.

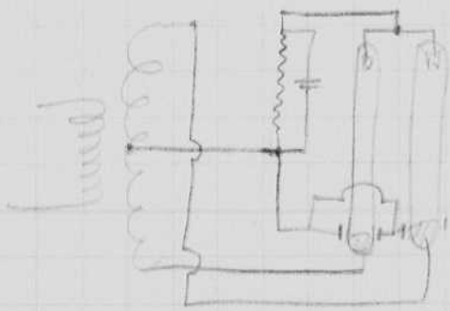


Push pull is easier to use two straight tubes.

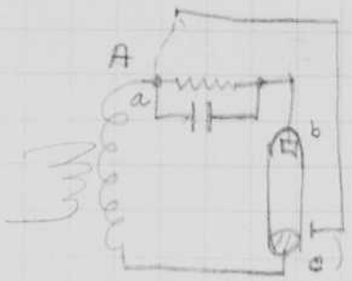
$\frac{4000}{R} \quad \frac{4000\,V}{} = 6.$

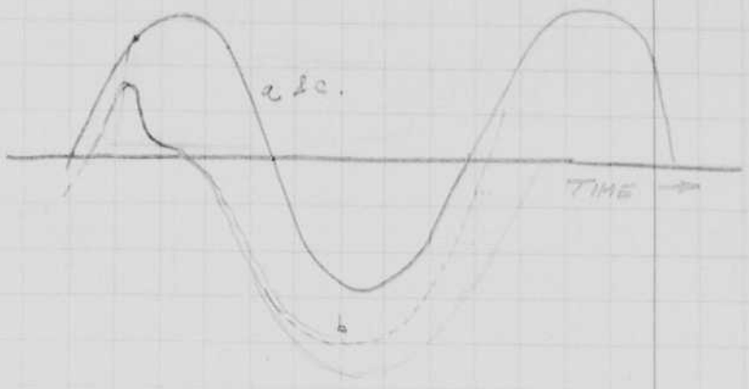
$\frac{18}{6} = R \times 10^{6} = 3$ megs.

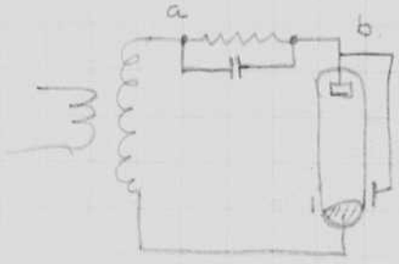
2 - 1.5 megs required.



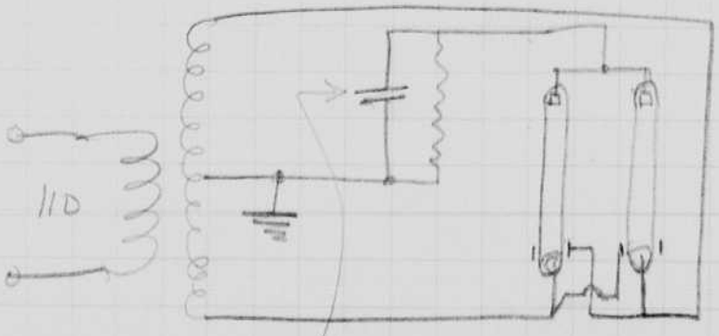
Con't.







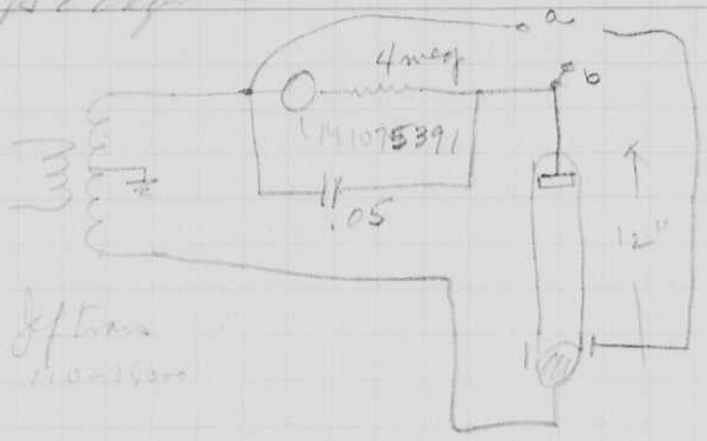
This connection sparks over before the one at the top of the page



this connection looks interesting since the starting voltage is double the anode voltage.

Condenser is not needed except for filtering.

Sept 21 1937
H.S. Lyon



connection b.

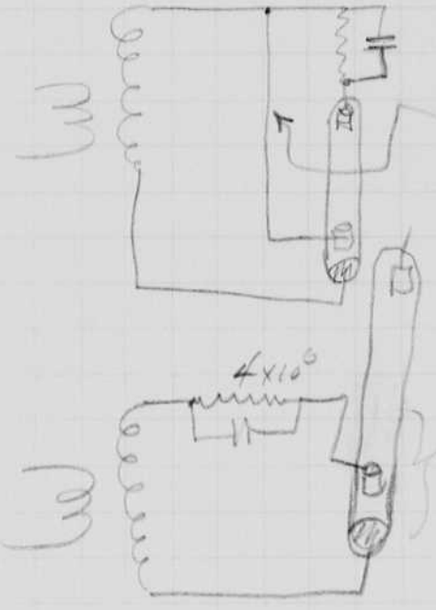
V	$I_{ma.}$	
30	.05 x5	
40	.11 x5	
50	.18 x5	
60	.24 x5	
70	.31 x5	
75	.34	5 spark over here.
60	.25	
50	.19	
40	.12	

connection a.

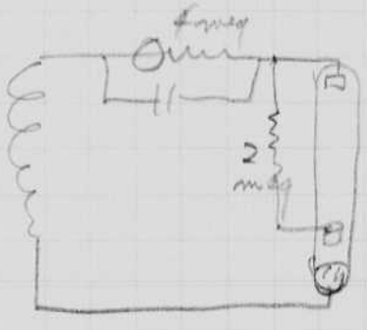
40	.14 x5	
50	.195	
60	.25	
70	.31	
80	.38	
90	.445	
100	.515	
110	.58	spark over
90	.45	
80	.38	
70	.315	
60	.265	
50	.19	
40	.12	
30	.05	
28	start.	

yesterday I tried a tube with an internal electrode but it did not work. an impedance shows to have been put in the lead to the starting electrode.)

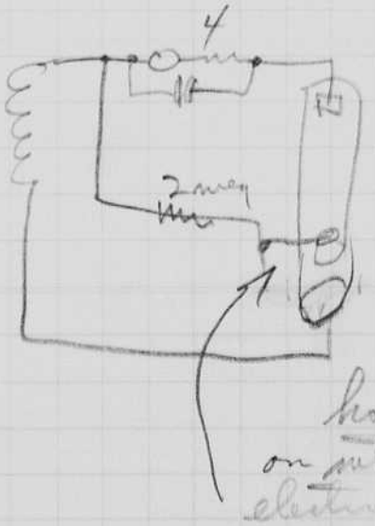
current probably shorts the transformer.



V	I ma.
80	.13 x 5
90	.32 x 5.



V	I	I
90	.22 x 5	±.05
100	.26 - .29 x 5	
110	.39 x 5	1.9 5.



80	.15 x 5
90	.28 x 5
100	.32
110	.39
120	.46

Something happened prev. tube too hot and back fire.

90	.13 x 5

hot spot on internal electrode and 2 megs got hot.

$\frac{2}{3,300}$ $\frac{14 \times 5}{5}$ $\frac{2}{14}$ = 2 watts

Cont

Connection "d" page 42. Another tube.

V.	I
50	.14 x 5
70	.27 x 5
90	.40
100	.48

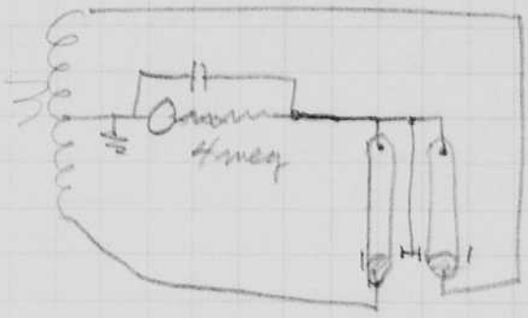
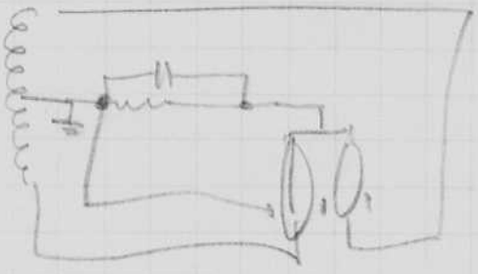
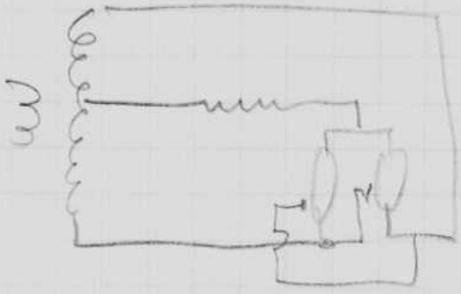
Big tube

10	.3 x 5
80	.38

3rd tube

70	.31 x 5
80	.38
100	.51

Cont.

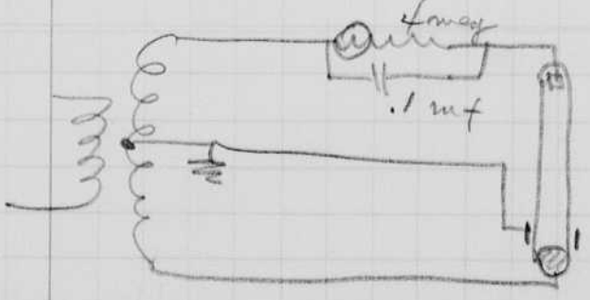
	V	I ma.
a 	100	.22 x5
	110	.26x5
	90	.18 x5
	80	.15 x5
b 	80	.155 x5
	90	.195
	100	.23
	110	.26
c. 	80	.145x5
	90	.180
	100	.22
	110	Spark over at 105V.

Reconnected to connection b.

1.7 / 5=20	Started running.	110	.26x5	8:45 am
	about 8:45 am.	110	.26 x5	9:45
	Single wire used for load.	110	.27x5	11:30

$\frac{10,000 \times 10,000}{40\,\text{in}}$ $2\frac{5}{8}$ watts = 7.

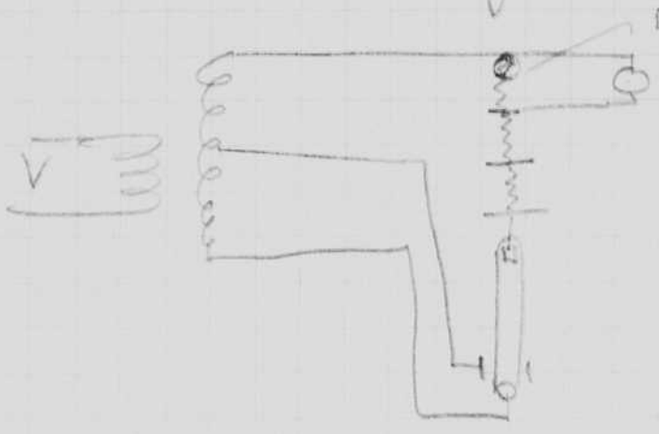
2.4 / 10.4



		110	.53x5	11:45
			2.650	10,400 v.
		90	.39 x5	1:50
	18" tube.	100 v.	.5x5	2.50

The 4 meg. resistance consists of 3 1⅓ meg resistors 1KC 3 watt Size. The resistance varies as a function of voltage and of temp.

An electrostatic voltmeter was used to check the voltage.



V range	I ma.	V esu	
72	.31x5	2500	across one resistor.
107	.5x5	off scale	3.35 pm

H. E. Edgerton
Sept 14 1937

I went to Rochester N.Y. on Sept 6 to attend the Chemical convention. On Tuesday I heard a session on photographic processes. Then that afternoon I saw Lord Tullee at Eastman Kodak and we discussed high-speed photography. I left with him three rolls of 35 m/m Kodachrome that was taken at the Webster in Holderness Sept 5. of humming birds.

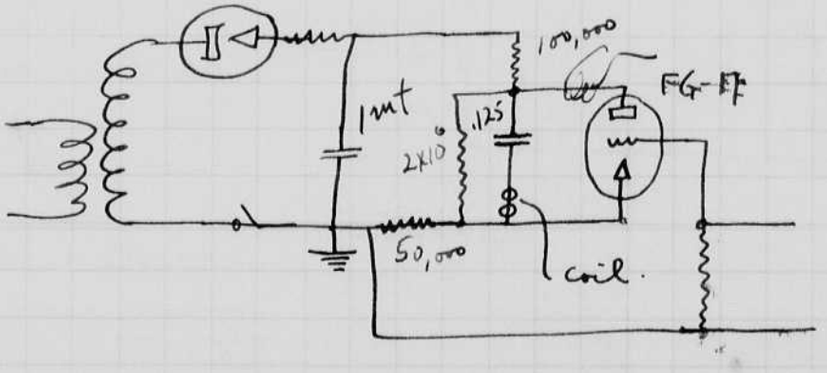
Contax fitted with compur shutter f 2.8 1/200 sec.

two argon lamps, 48 mf each 3000 volts. K1 filter gives about the right correction for color.

I showed the pictures and movies to the organic and physical chemists on sept 7 at their banquet at the Hotel Seneca. Prof. Johnson of Ohio was the presiding officer.

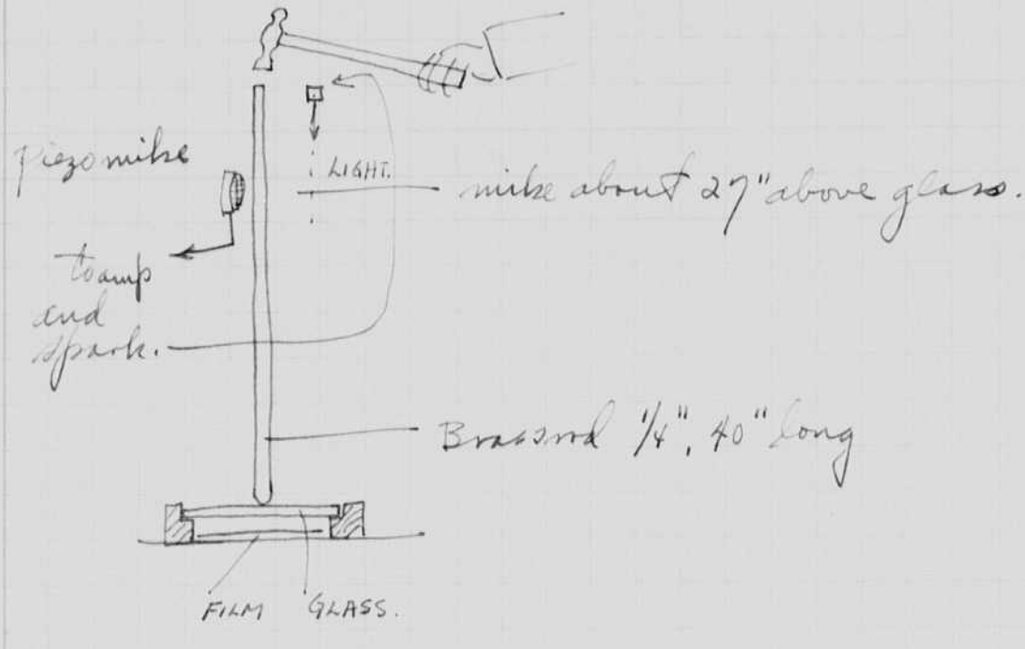
Returned to Boston on the 6.25 pm train Sept 8 after hearing a talk by Mees on color photography.

Resumed work on the fracture of glass for Hartford Empire Co.



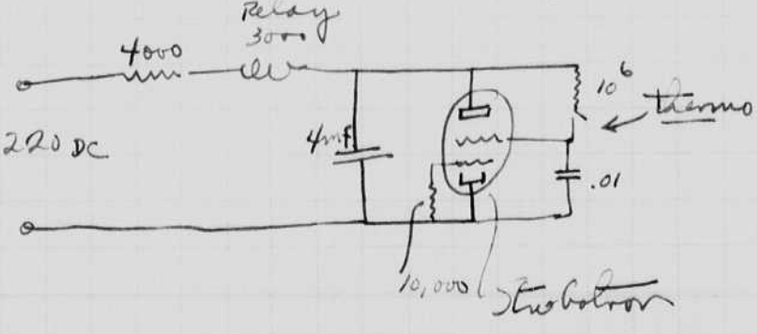
Sept 16 1937
Devol 1 Eleventh.

Yesterday and today one glass fracture. This afternoon a few successful photos were taken by the following method.



The microphone is adjusted in position and distance to the rod in order to get correct timing of the spark.

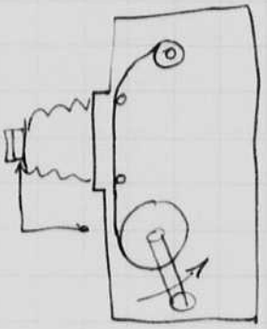
Circuit connected for Skidding -



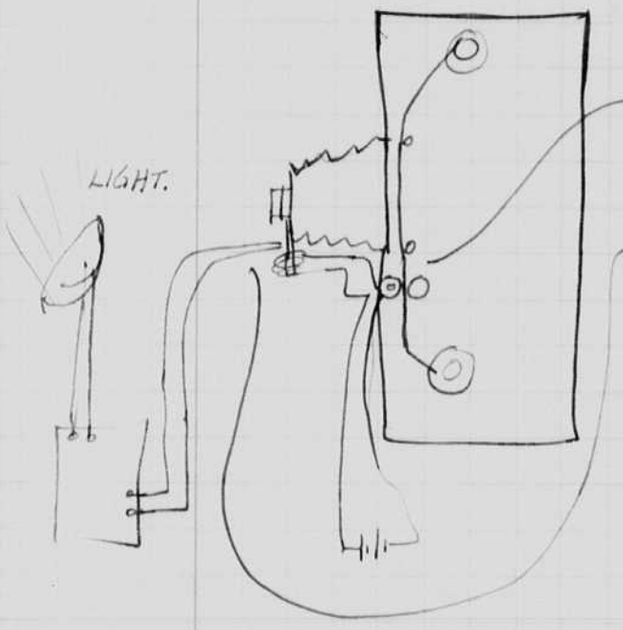
The firing of the strobotrons was not sure until the condenser (.01) was used.

Old and rejected strobotrons were used for this test.

Cont. Multiflash Speed Camera.



1. Large film size.
2. Continuous motion of film
3. ~~Commutator to flash lights.~~
4. Shutter operated in synchronism with lights.



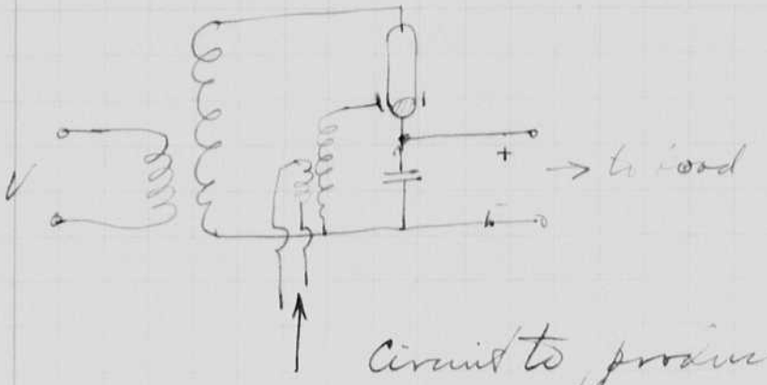
→ Commutator run by film which flashes circuit for tripping shutter. When shutter is open the ~~lights~~ flash.

This camera will take photos at a fairly slow rate but the pictures will be large, and good quality due to ample light.

115 - 1600. -

Sept 18. 1937
H. E. Edgerton

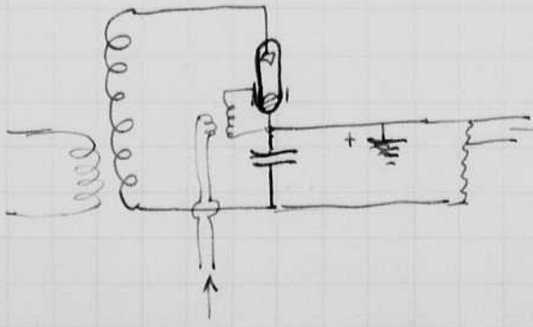
High Voltage Rectifier.



Circuit to produce one pulse of current every 10 or 100 cycles at the peak of the voltage, V, wave.

This surge will start the Hg tube and permit it to supply current into the condenser, charging it to a high voltage. The load will slowly drain the condenser to a lower voltage by the time the tube again fires. The number of flashes will depend upon the capacity, the load, the desired regulation and the rip, p.f.

The starting surges can be made automatic by regulating the flashes from the photocell.

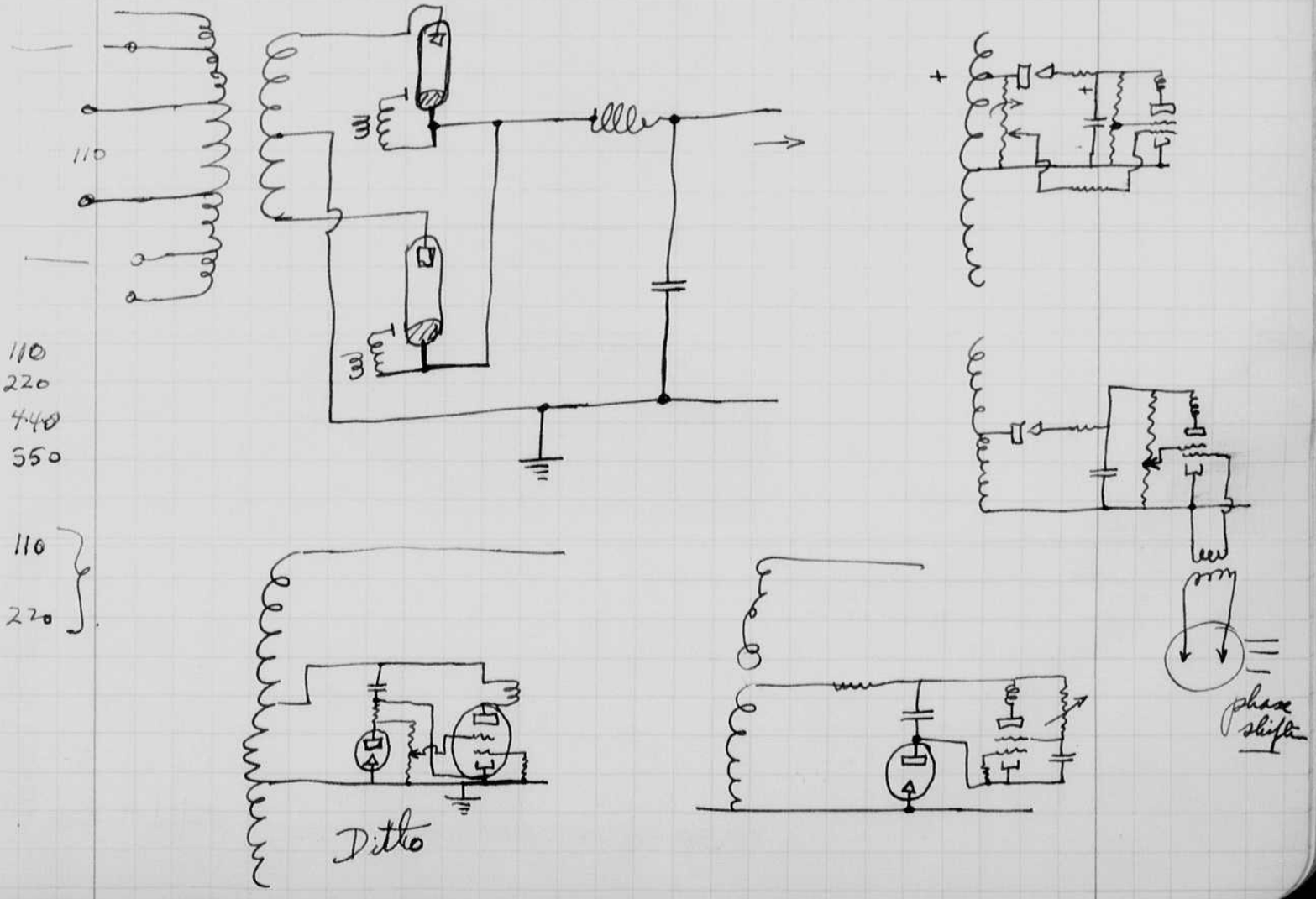


Sept. 27, 1937.
Harold E. Edgerton

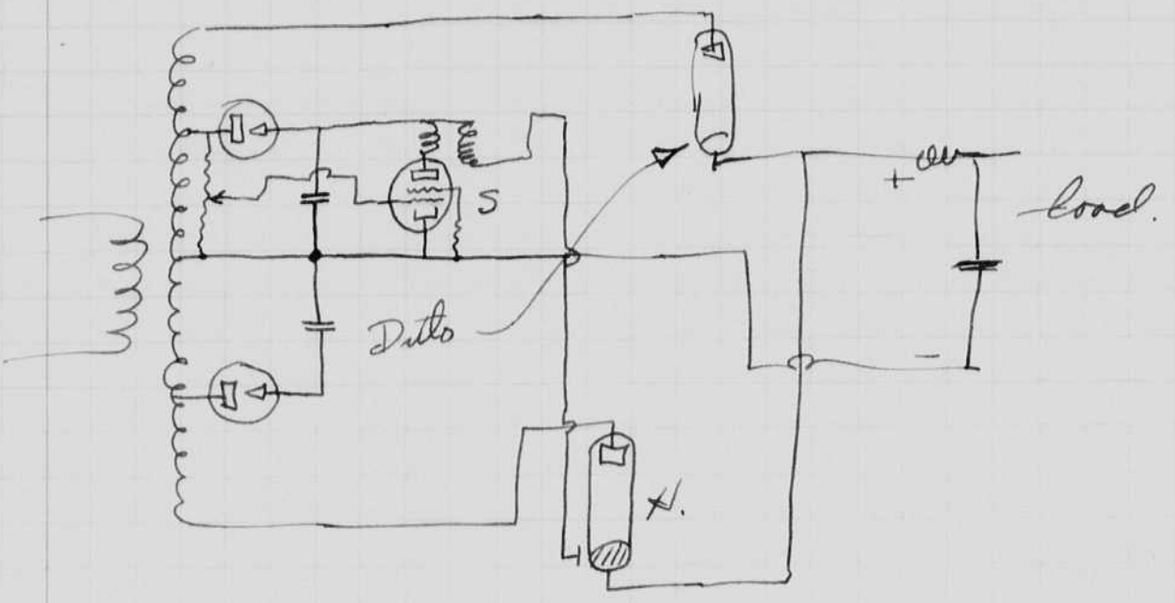
Registration today at M.I.T.

We have had considerable discussion last week regarding the start of a company for making strobo scopic equipment and for further development. Carroll Wilson of the Research Corp. and Dean Buck are interested and trying to get assistance from several companies who will be prospective users of stroboscopic equipment.

A new power supply is needed for high speed movies. It should have an output voltage of about 1500 to 2000 volts. control tube (thyratron type) might be used to advantage for this intermittent service.

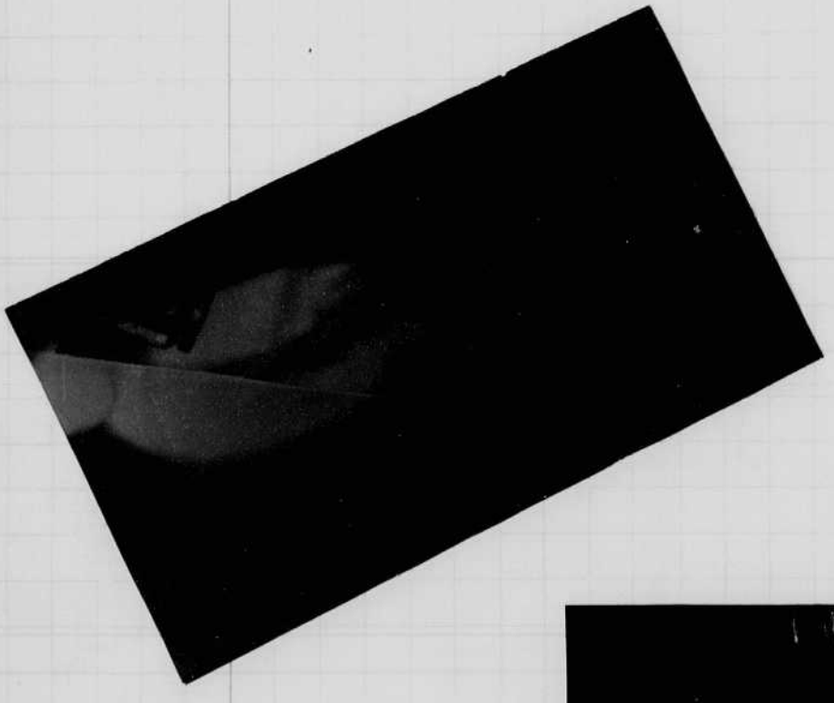


Sept 27/33
H. E. Edgerton.

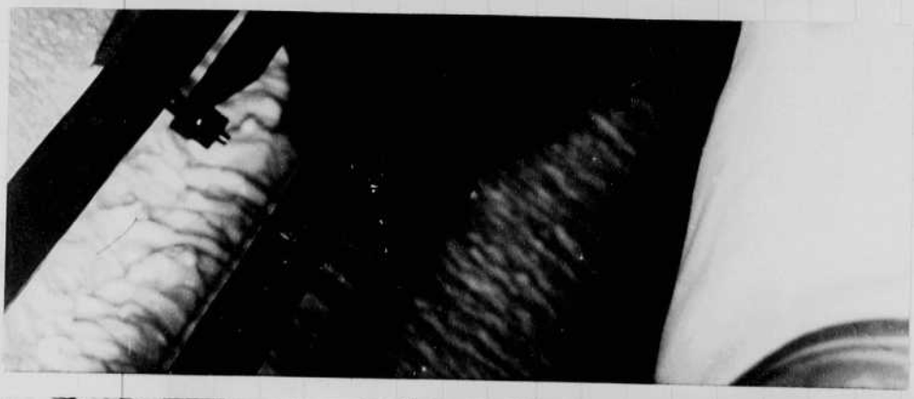


S Stroboscope.

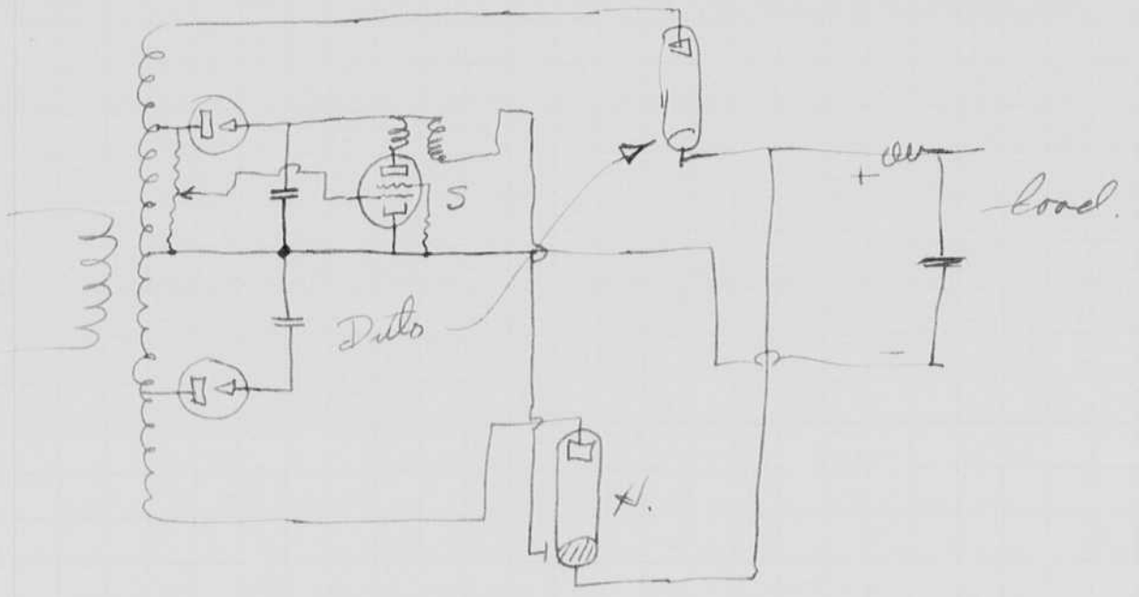
N. Hg Control tube.



Scraps from
Warden Paper
Expedition.



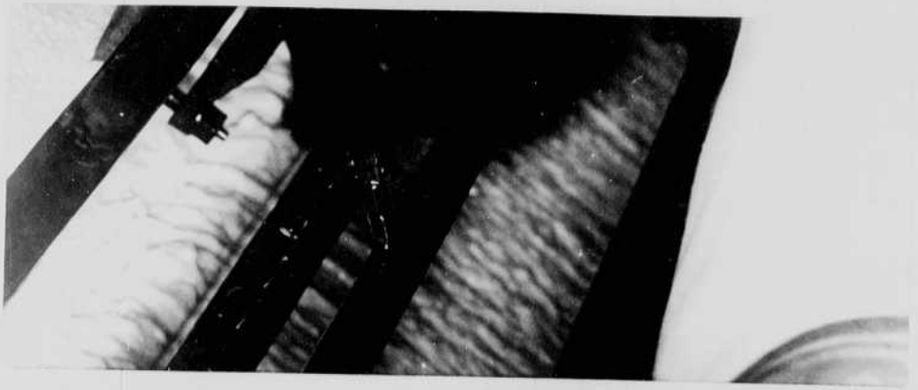
Sept 27, 1937
H. E. Edgerton.



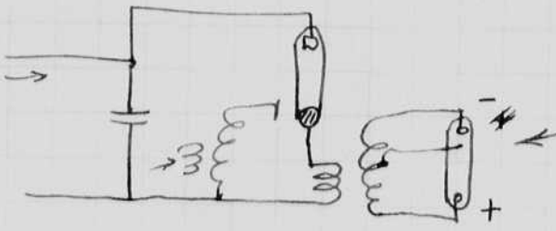
S Stroboscope.

N. Hg Control tube.

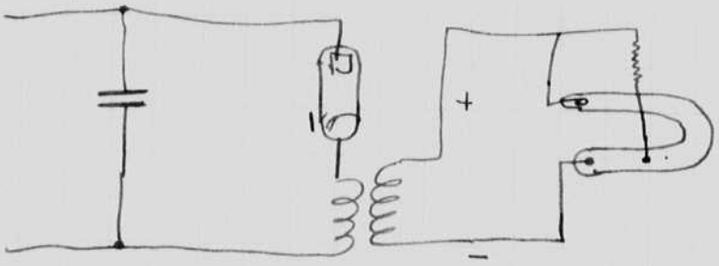
Scraps from
Warden Paper
Expedition.

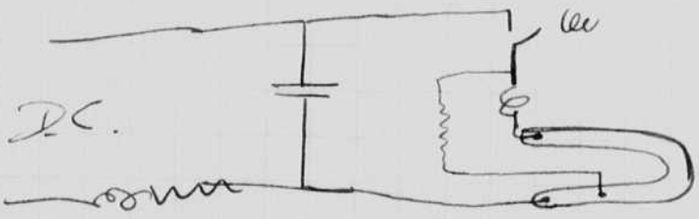


Sept 30 1937 Flash Circuits.



Small auxiliary ~~electrode~~ to start the discharge at the ~~right instant~~ instant that the condenser is flashed into the transformer.





Relay operated switch to flash the lamp.

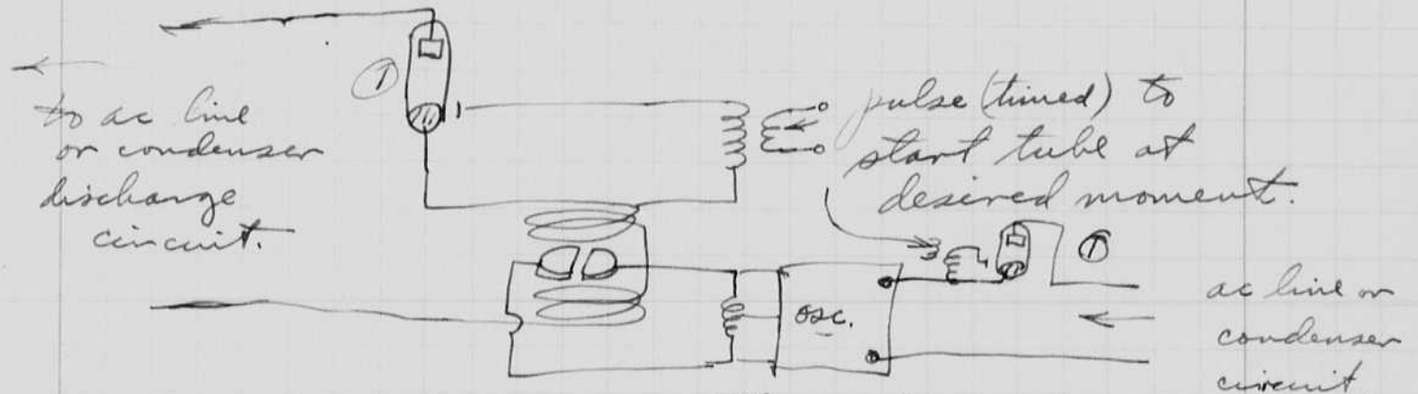
Oct 1 1937
H. E. Edgerton.

Surge Cyclotron.

Cyclotrons at present are very large due to the fact that a large magnetic field of high value is required.

Some time ago in leading 6.02 it seemed possible to be able to use surge currents for operating the magnetic field. This was discussed with Tucker some time last spring.

The oscillator driving the plates of the cyclotron could also be operated on surge and during the time the field was on.



This oscillator might be of the spark variety.

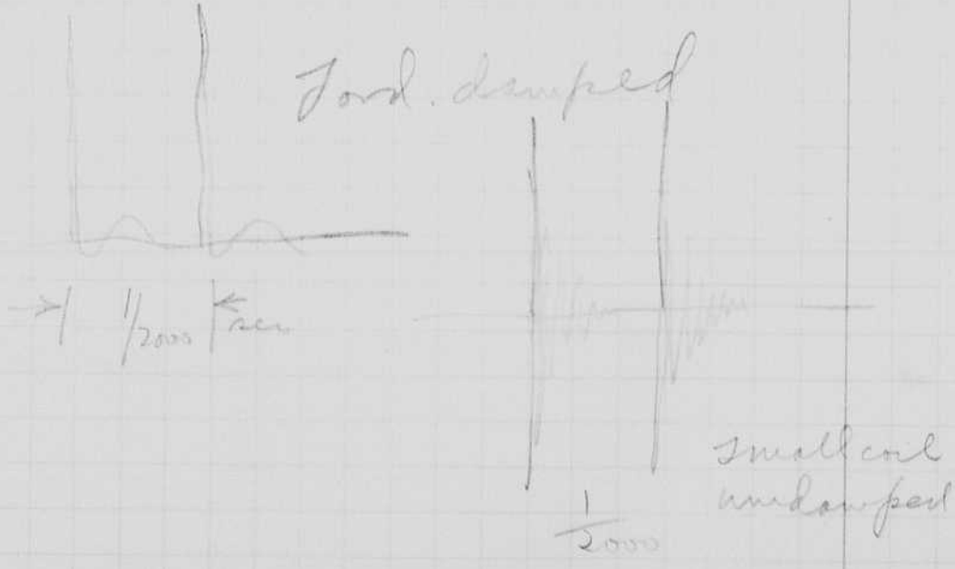
1 tube 1 may be a thyratron ignitron.
Pool type Hg tube with holding elect.
Control tube with external hand starter
or it may be a simple contactor switch.

Oct 11 1937
H.S. Edgerton

Grier and I spent most of yesterday testing the large movie outfit that Gen. Radio Co had made for the U.S. Army. Difficulty has been experienced with the 2000 ~~cycle~~ connection due to holdover of the lamps. Several types of tube have been used with this outfit, some of quartz.

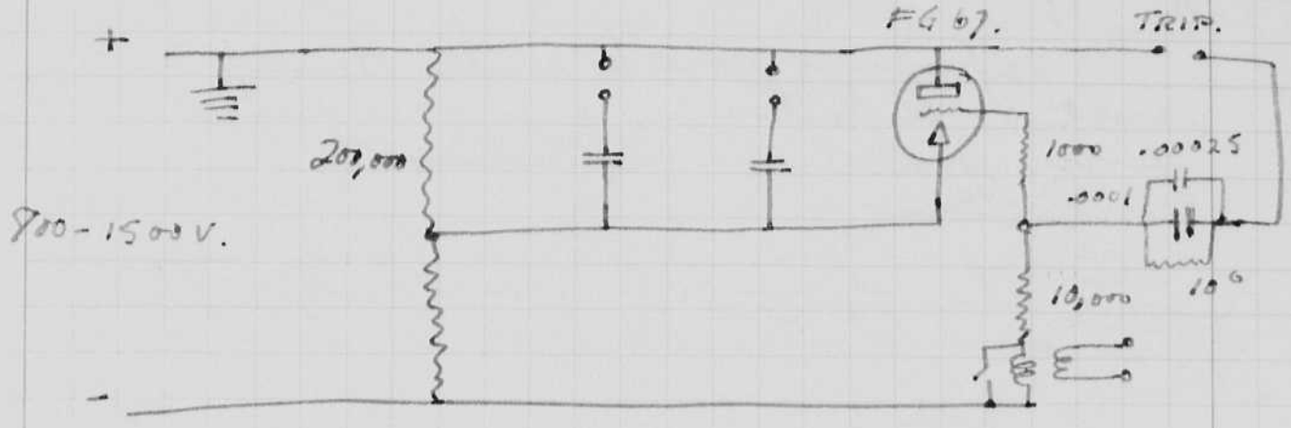
Yesterday we found that the coil for starting the tube was in backwards due to the different connections used also the cathode ray oscillograph indicated that a damping resistance across the secondary of the coil. I used a 3 watt 10 c 1.3 meg yesterday. A 1 meg of the same variety would probably be better.

An open spark gap about 1/4" wires fine at 2000 flashes a second in this circuit with 1.5 mf and a 200 ohm charging resistor.



cont.

Circuit



Open circuit voltage of generator

Fld res.

Max	960 volts.	meter	D2338. + multiplier
1/2	1390 "		
min.	2000 "		

Max	1.6 amps	700 volts.	400 ohms.
1/2	2.4 "	1030 "	
min.	3.75 "	1540 "	

cont.

Trial exposure with 1/4" air gap in 5/8" glass tube.

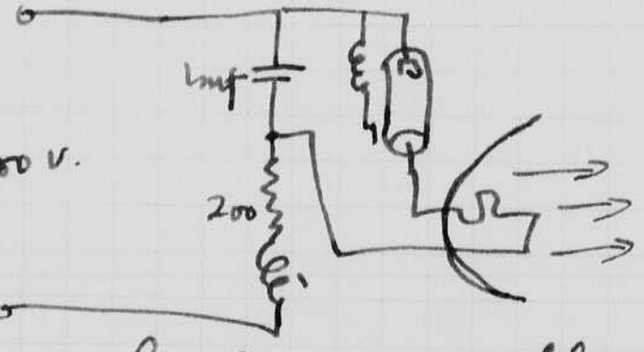
Exposure weak with 1/2 mf 2000 volts. Reflector in fair focus and .12" from front of reflector to the contactor.

The glass tube was dirty after two runs of about 2 sec or less each.

Yesterday I made an argon tube with two electrodes and a 3/8 or 1/2 inch gap. This ran fairly well yesterday but N.G. today due to holdover. It gives more light than the air gap.

Trial exp with above & 2 Sound recording jars. .5 mf (2000 V ?) 400 ohms. 1020 flashes/sec. Better than air gap but not very good.

I next put in a pyrex 5 tube and took some pictures same as above. Exposure better. Also runs ok 1 mf full voltage 1020 cyc. 400 ohms. Holds over with 200 ohms. 1020 cycles.



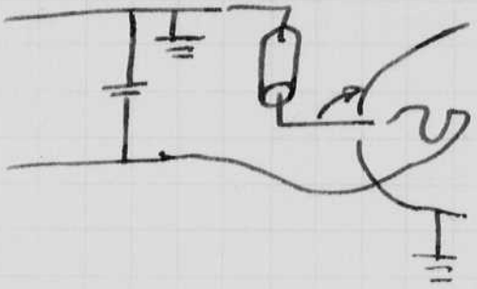
also holds over with choke coil in series.

1 mf 200 ohms 1020 cycles.

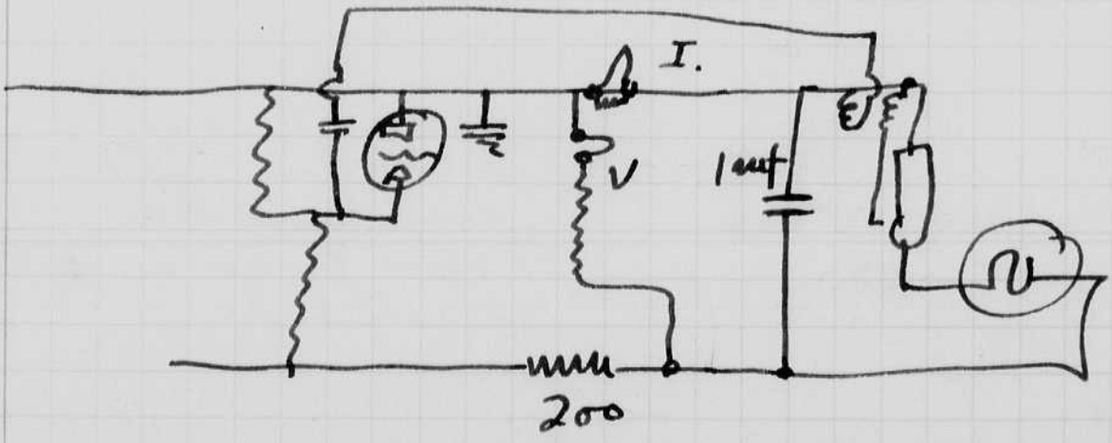
cont.

Reversed anode and cathode leads still HO 1 mf ≠ 200 ohms no choke at full voltage. Runs ok at 3/4 voltage or there abouts.

With 400 ohms there is some double fire. Starting is much harder with cathode end in open. this is due to the loss of current in the argon lamp from the anode to the case by capacity and leakage paths.



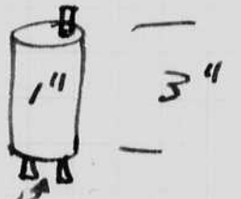
I set up the 3 element S E Oscillograph and took oscillograms of the current and the voltage across the condenser. the current was in the grounded lead which included the spark coil current.



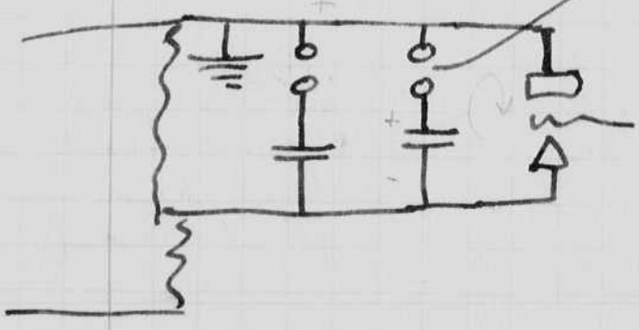
Three oscillograms show that the HO starts on the buildup of voltage. See next page.

Drop across tube is not much but it takes a long time to get down ; about .005 seconds.

Put the small spark coil in the circuit.
Damping resistance to stop osc. in secondary 250,000 ohms.

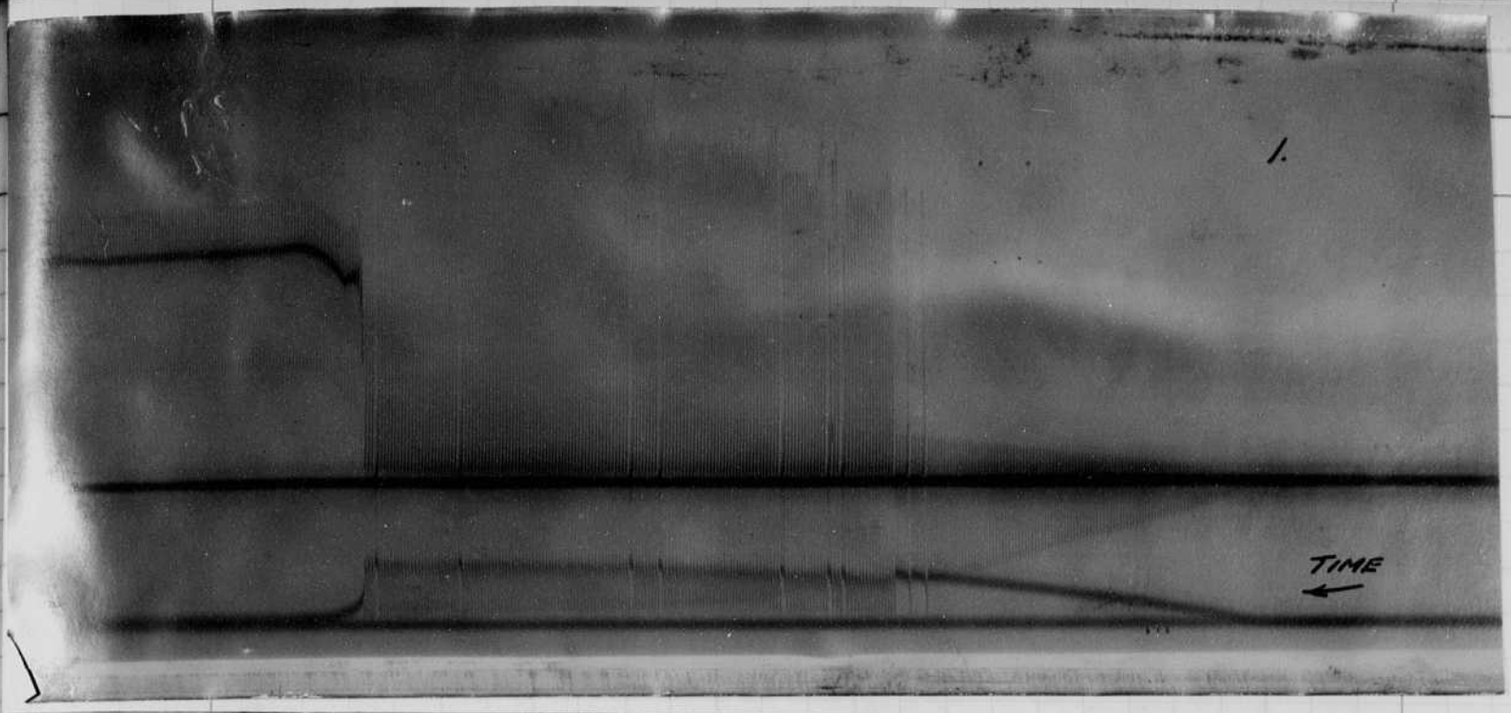


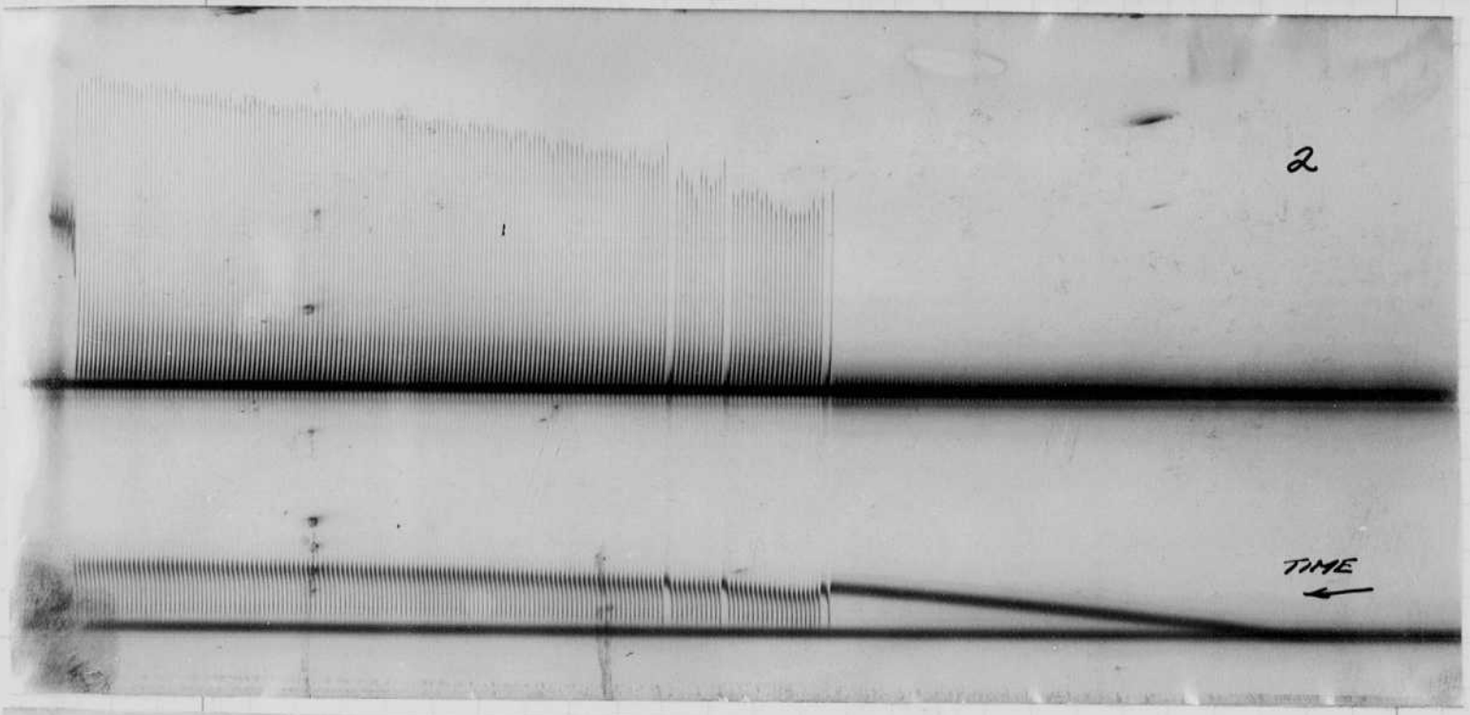
ground. to give + surge to secondary.

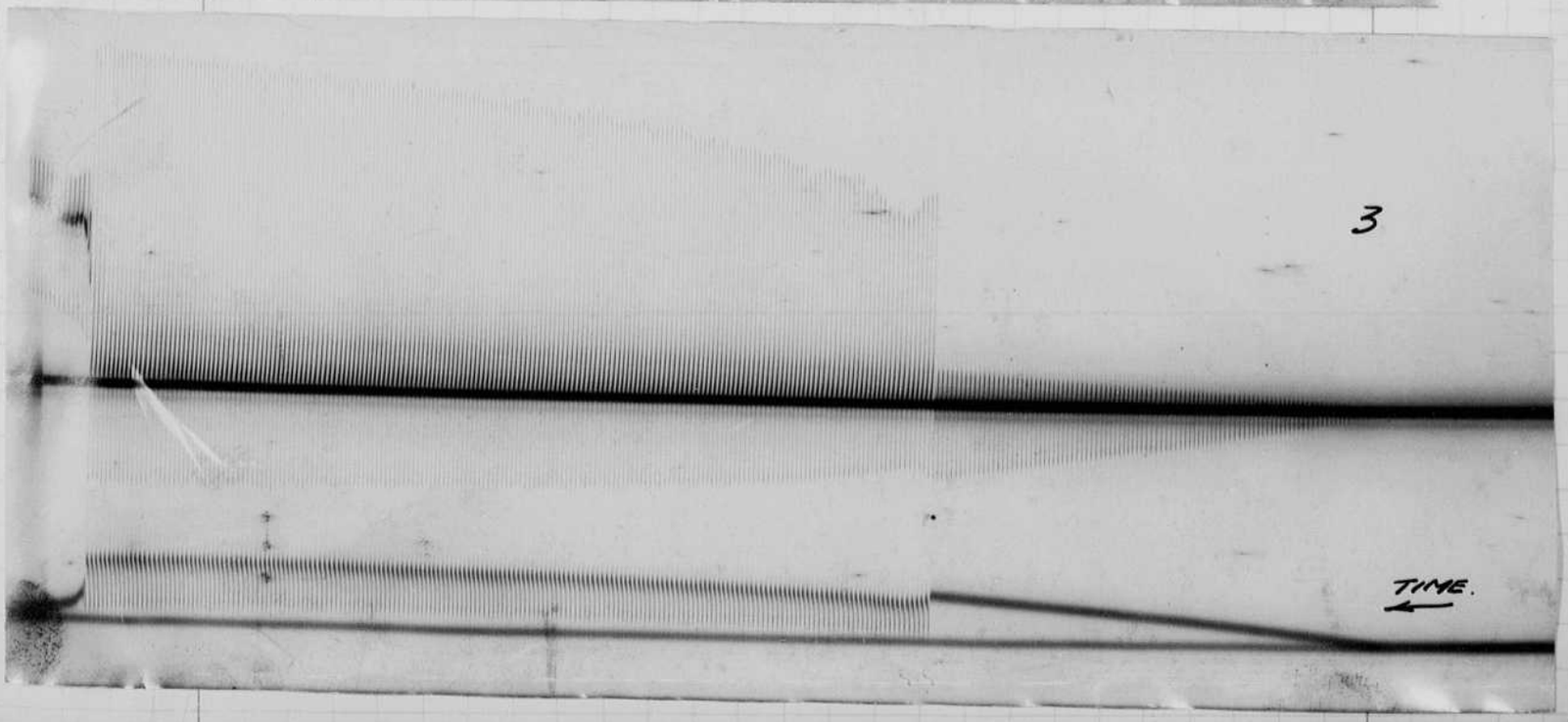


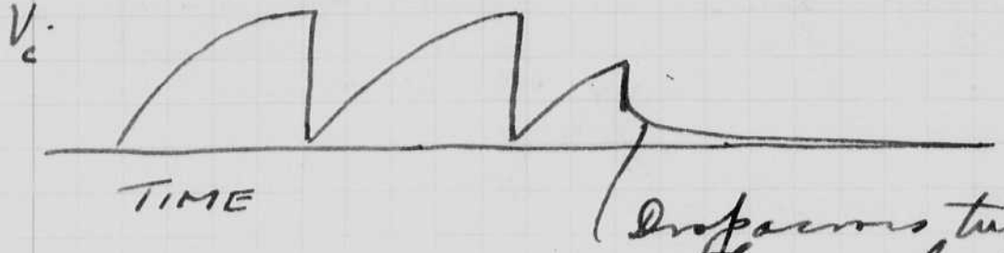
Osc. No 4.
200 ohms.
1 mf.

4.


1.
TIME

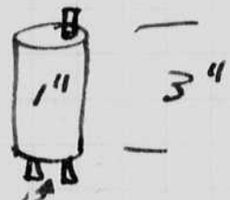

2
TIME


3
TIME.

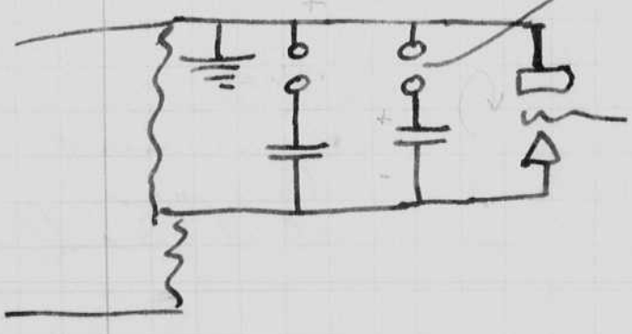


Drop across tube is not much but it takes a long time to get down i.e. about .005 seconds.

Put the small spark coil in the circuit.
Damping resistance to stop osc. in secondary 250,000 ohms.

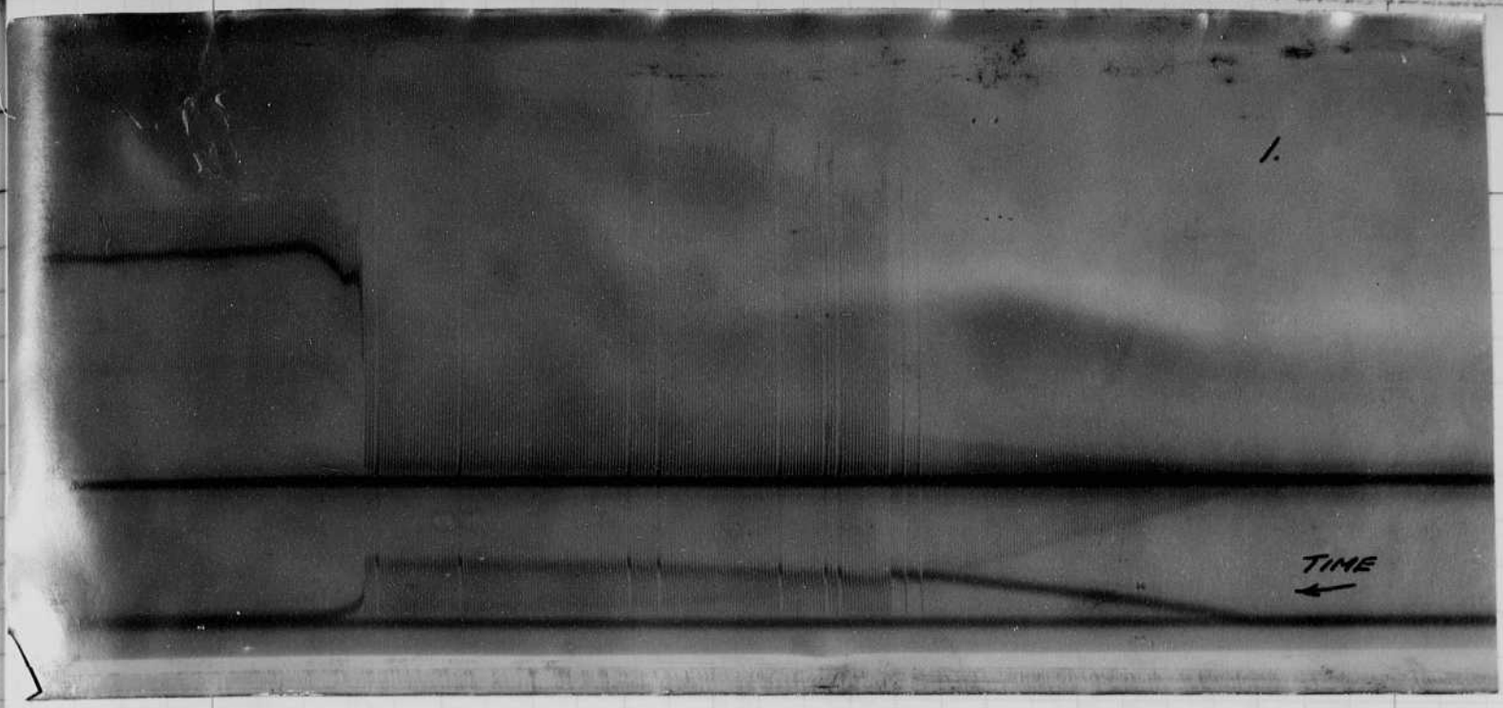


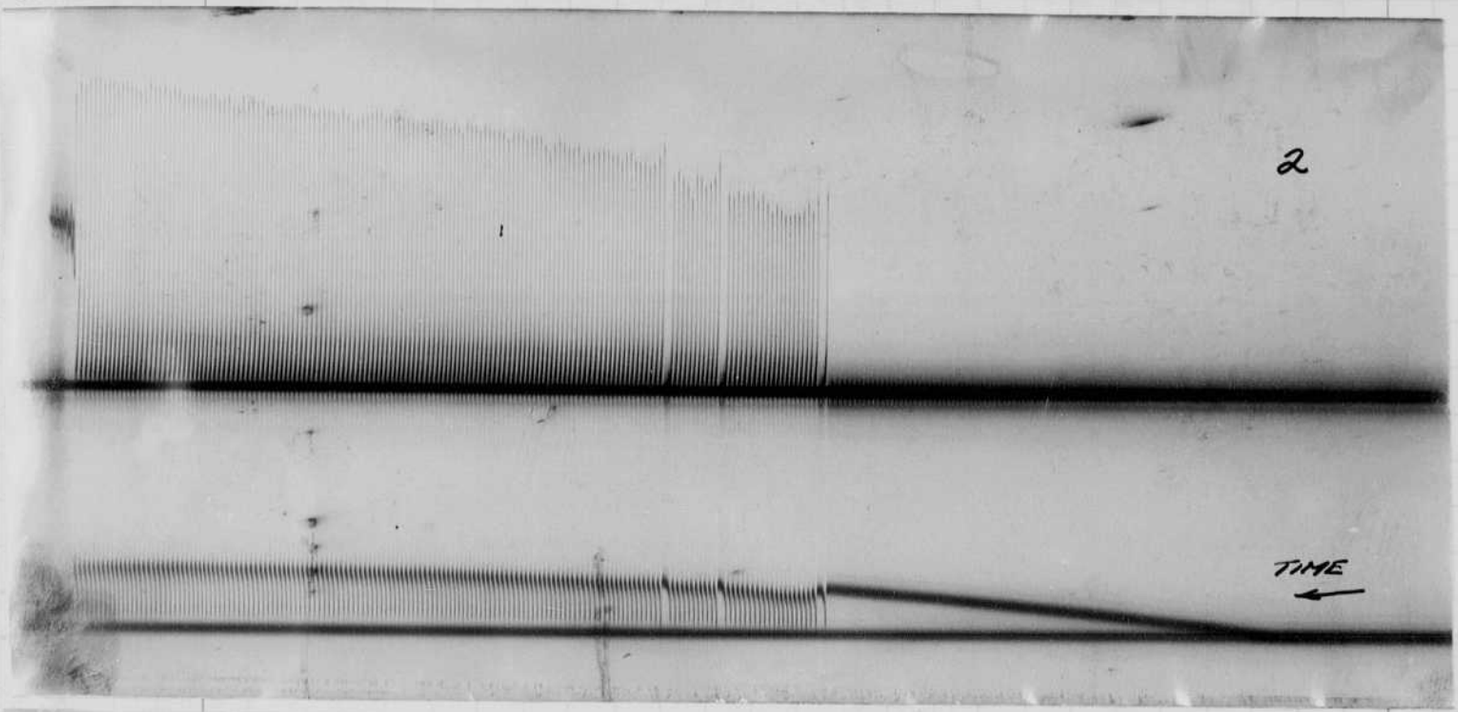
ground. to give + surge to secondary.

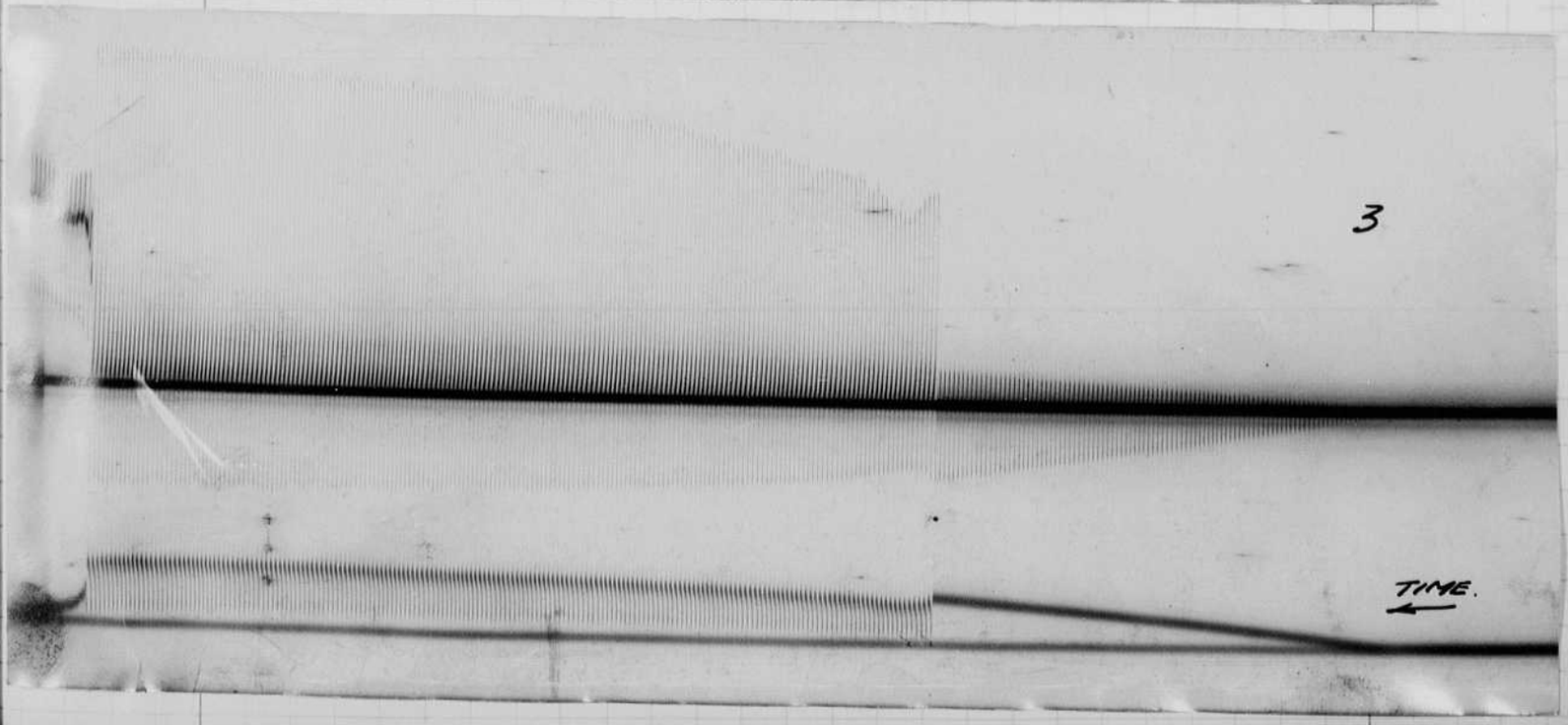


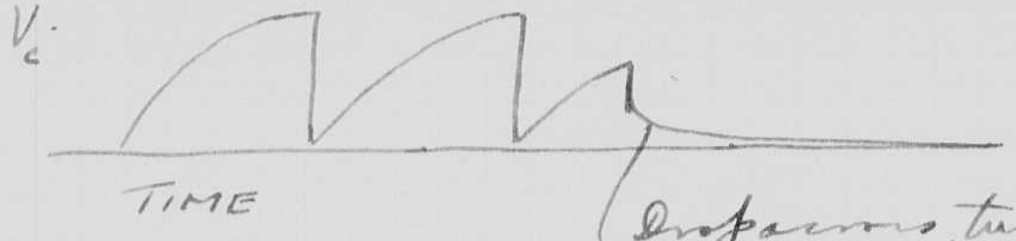
Osc. No 4.
200 ohms.
1 mf.
Small coil 25000 ohms.
1020 cycles.
The current element fuse blew out and therefore did not record. The thyrator peak curve runs the much longer with the small coil.

No 4
Oct 10 1937
KBH


1.
TIME


2
TIME

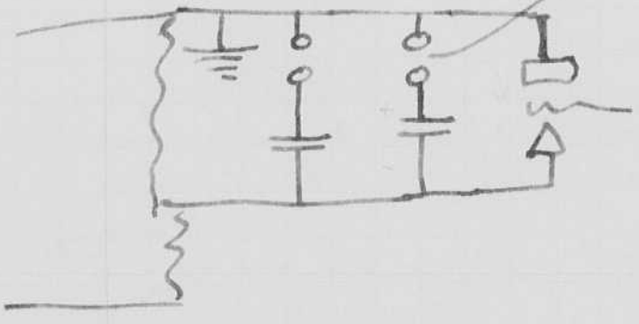

3
TIME.



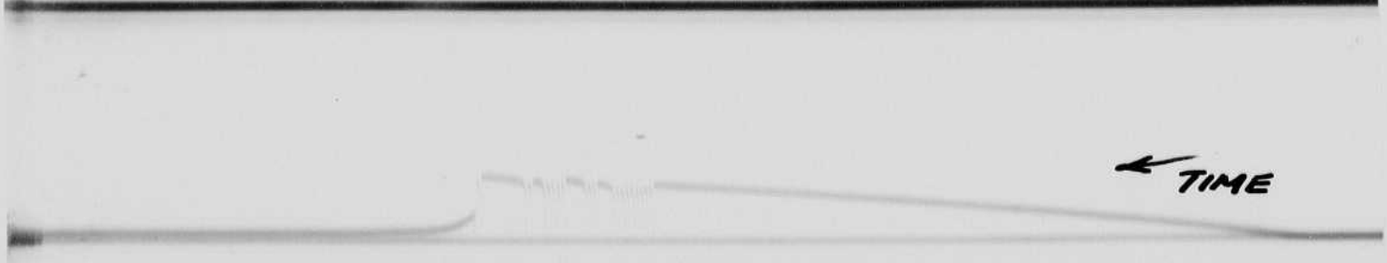
Drop across tube is not much but it takes a long time to get down ; about .005 seconds.

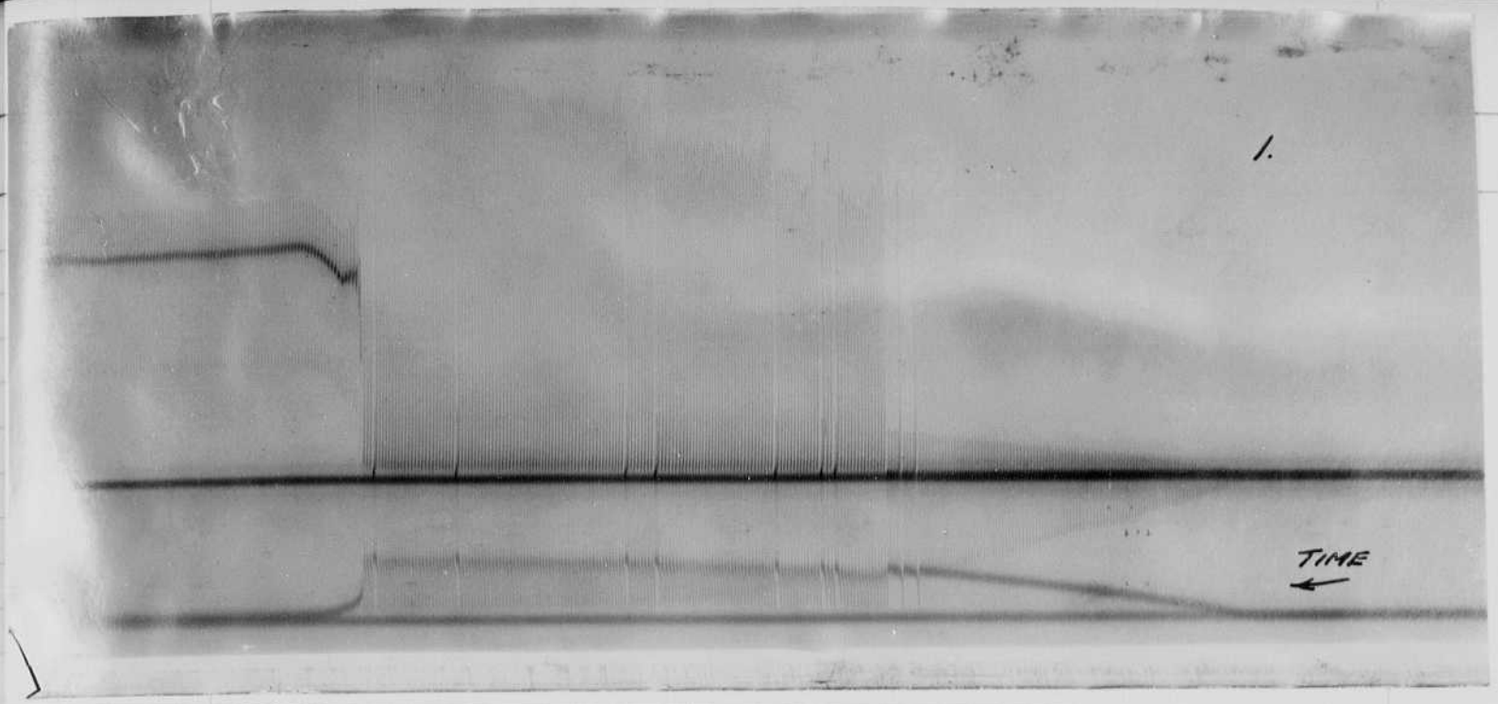
Put the small spark coil in the circuit.
Damping resistance to stop osc. in secondary 250,000 ohms.

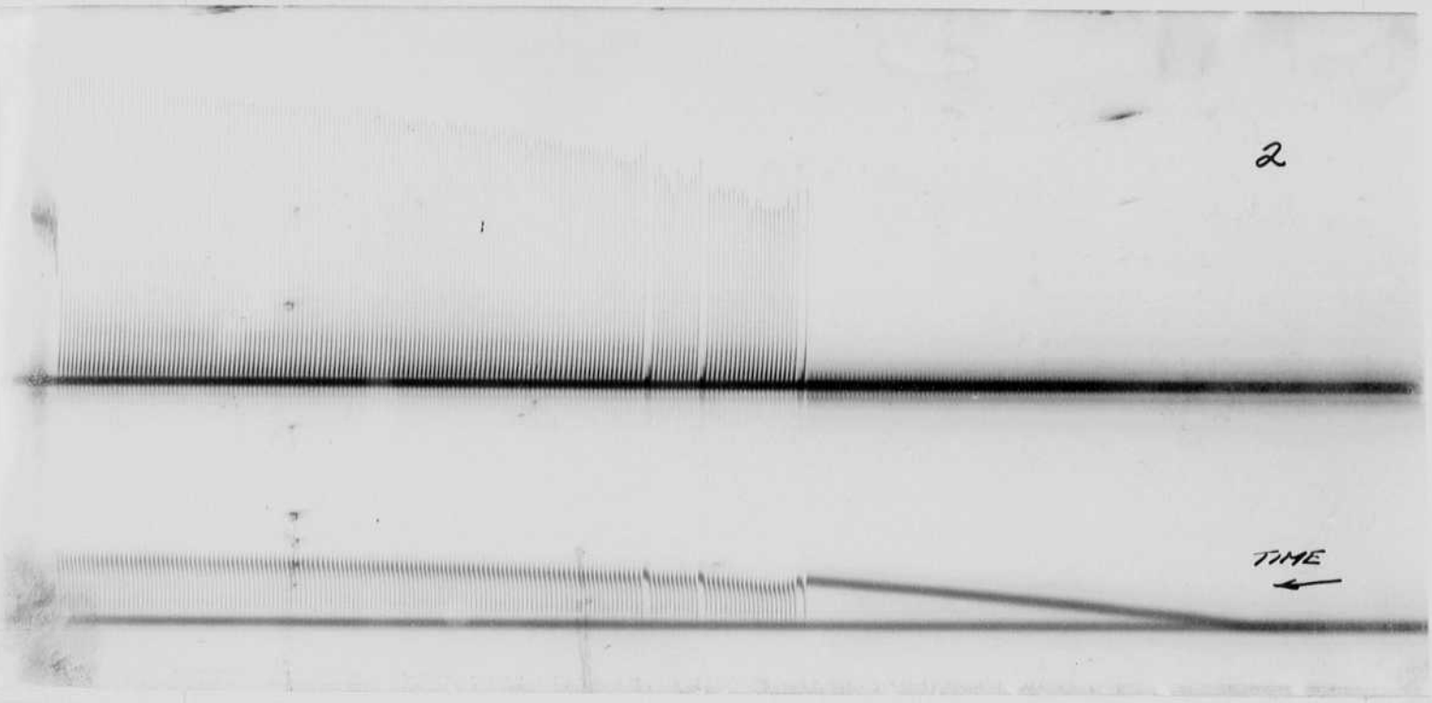
ground. to give + surge to secondary.

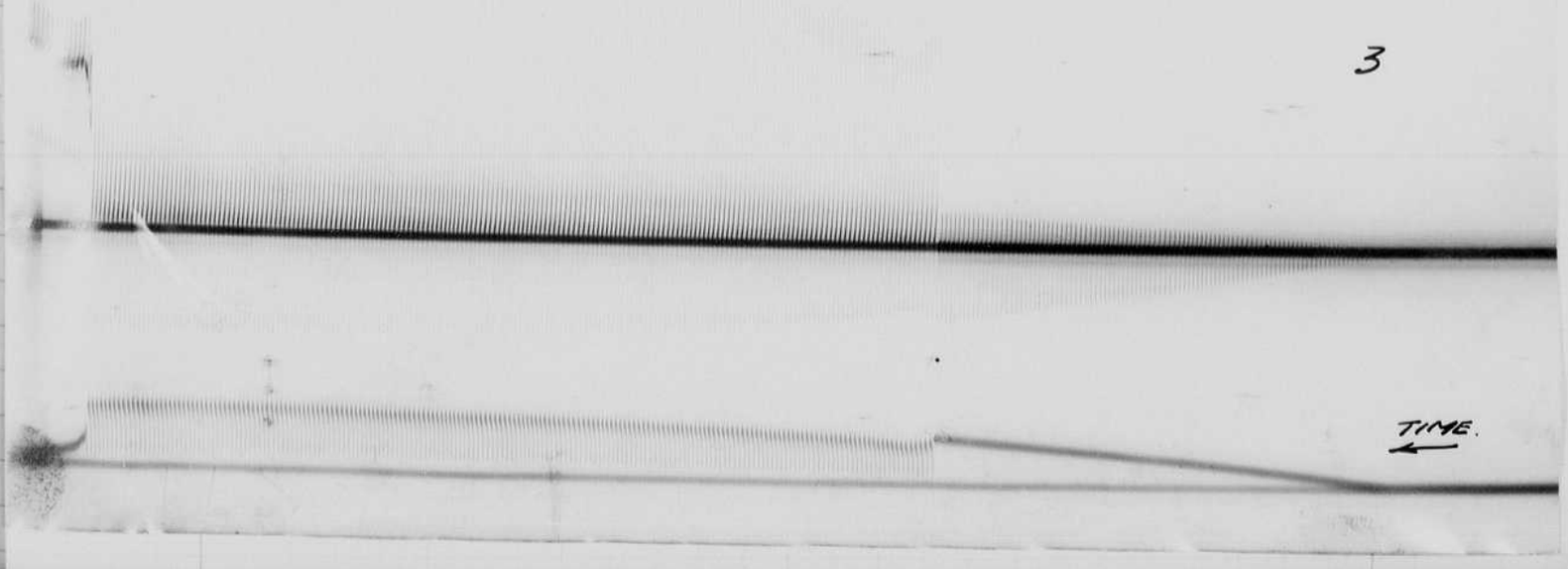


4.

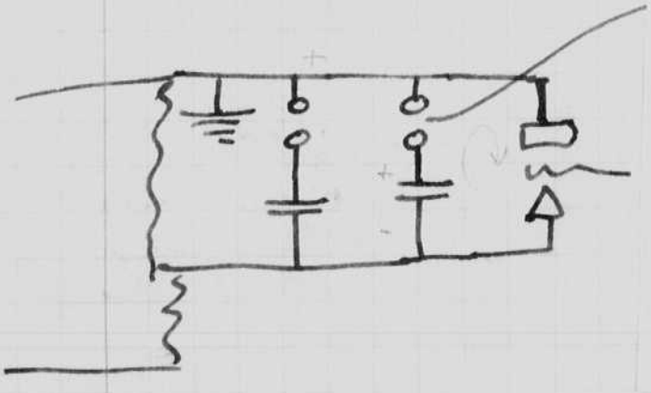


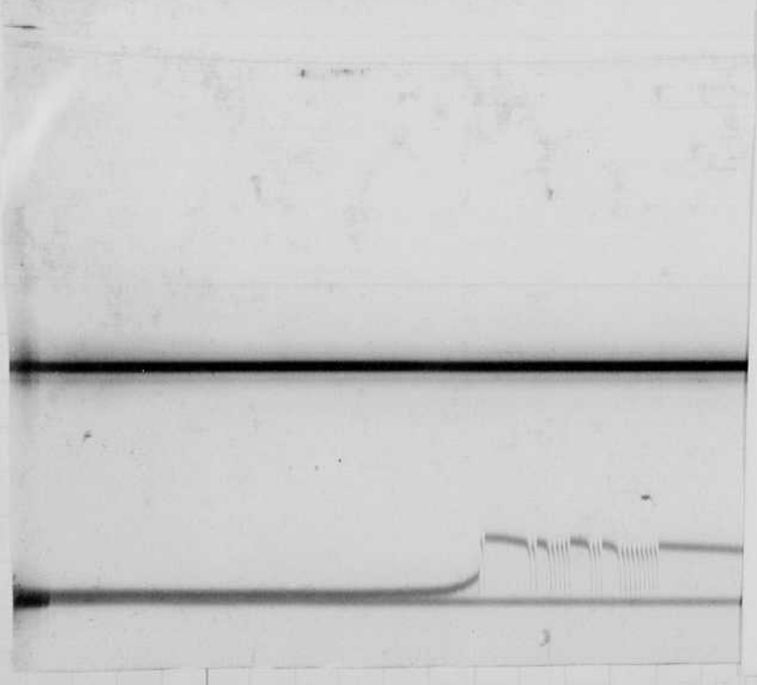

1.
TIME


2
TIME


3
TIME.

Put the small ca
in the circuit.
damping resistan
step osc. in series
250,000 ohms.





no 1
Oct 10 '37
H.S.E.

no 2
Oct. 10. 19
H.S.E

no 3.
Oct 10 '37
H.S.E

Oct 12 1937
K. H. Kingdon.

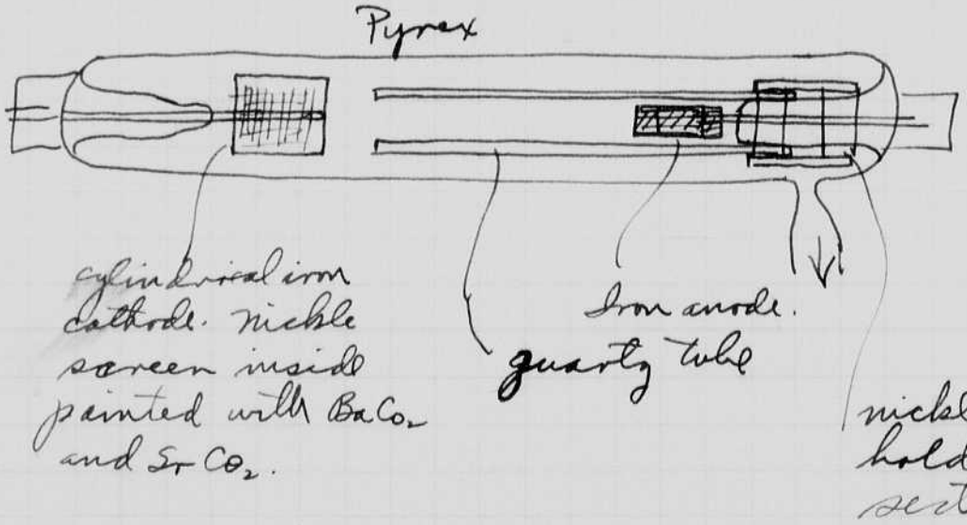
Have worn today on movie camera two lamps 1 mf each 400 ohms 1020 flashes/sec. Oh. better at .5 mf.

Took picture of white card to show synchronism of two lamps. Lights run with contactor. Camera at 1200 pict/sec. f 2 1 ft from subject a white card. Lamps at 45 degrees and 2 ft from subject.

Positive film D 76 Developer.
One lamp fires late and also misses some.

Oct. 18, 1937

Yesterday I worked some more on the 2000 per second apparatus for the army. Sat also was spent working with the apparatus and the lamps. I pumped some tubes that Germershausen made on Sat - morning. They were built as sketched below.



First this tube was pumped, filled with H_2 and bombarded to clean the oxide from

Notebook # 8

Filming and Separation Record

____ unmounted photograph(s)

__1__ negative strip(s)

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

was/were filmed where originally located between page 62 and 63.

Item(s) now housed in accompanying folder.

3600 rpm.

Oct 12 1937

L'Hospitalet.

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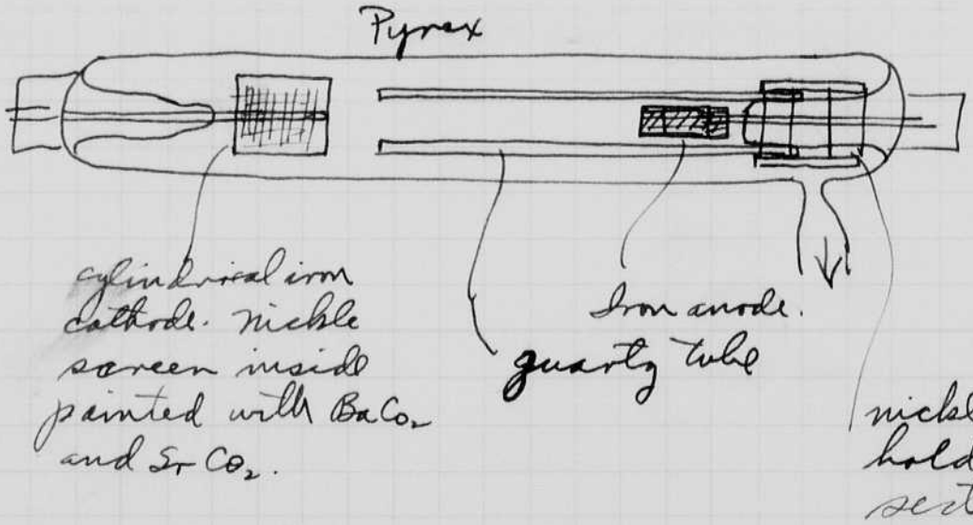

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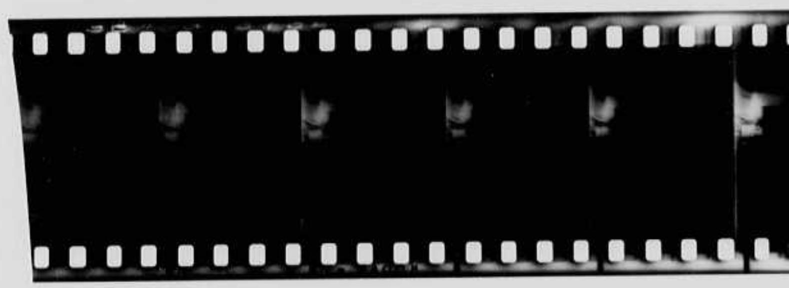
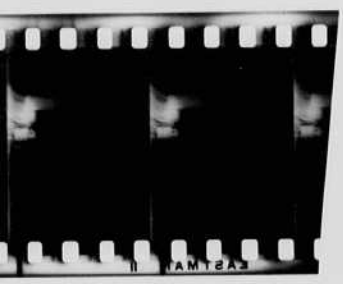




the electrodes. then it was run several times at 4 mf 800 volts 600 cycles with argon gas in it. The tube was sealed-off with almost an atmosphere of argon.

When put on the apparatus it held over badly and could not hardly run 1000 ~~flashes~~ with .5 mf 400 ohms.

The above tube was put back on the vac. system and retreated. H_2 at one cm. was put in the tube then an atmosphere of argon. It operated ok. on the pump with our 3 kw power supply .5 mf 600 cycles nearly. (a few skips.) at 300 cycles it was excellent. I also tried the same tube with 6 cm of H_2 and 1 atmosphere of argon. However the tube did not run very well because the break down voltage was too high.

The tube was sealed off the system with 1½ cm H_2 and 1 atm argon. It was tried on the 2000 flash unit in 4-111 and it ran ok although it required as high a voltage as could be obtained with the unit. For this test a bosch coil, un mounted, with 250,000 ohms damping was used. The Ford coils have been breaking down electrically and will have to be discarded.

A second tube was sealed off at 1 cm H_2 and 1 atm argon.

Germeshausen was with me in the afternoon when the above tests were made. He plans to make several tubes like these today.

Late in the afternoon I set up the camera and took a trial exposure of the light on an area 5 x 8" at f 2. the camera reached 1500 frames a second using about 40 ft of positive film and dc 220 volts on the take up motor.

I also set up the drum camera and took a few pictures of the time duration. Drum speed 3600 rpm.

Oct. 23, 1937
H. E. Edgerton.

Busy week with classes etc.

G.R. camera returned to us yesterday after being modified as per our instructions.

I hooked it up last night and took two strips of film each about 50 ft long, camera set for 2000 frames / second.

The first was of a fan running ( ) r.p.m. camera at f 1.5 full voltage of power unit. 400 ohms and 0.5 mf. The record showed that the film reached a speed of 1600 to 1700 ± frames per second. The plow under the sprocket ~~ganged~~ into the sprocket and ~~pulled out~~ broke off a screw holding it. Exposure dark 3 min D72

The film was torn on the second piece near the end. f 4. 6 min D72.

The above experiments were ~~repeated today~~ and a high speed movie of the new camera was taken with the old camera at 1000 pictures per second. This movie showed that the take up reel did not pull up the slack film as it came from the top reel.

Jan movies 3R camera Positive film.
#1 Speed of fan 1400 rpm f 1.5 .5 mf 150± V.
#2. " " " 1350 " f4 " "

Nov.
~~Oct.~~ 5, 1937.

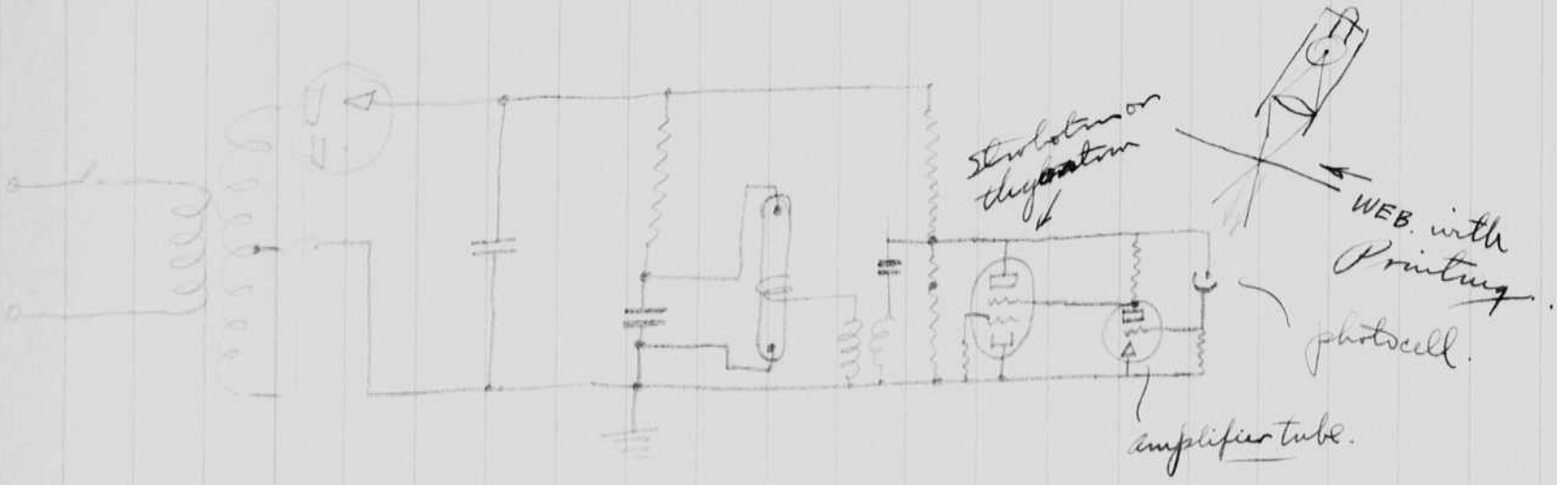
Yesterday afternoon at 4:30 I gave a talk to the EE. seminar staff group on stroboscopic light developments.

On tues. aft. Nov. 2. I went out to the Forbes lithograph plant in Chelsea and looked over a stroboscopic arrangement. I arranged with Mr Brunnings to return later in the week with a more powerful stroboscope for observing the printing coming from the rotary presses. Cellophane wrappers.

Mr. Carrol Wilson of the Research corp. has been trying to get an agreement started between Gebelhanum, Frier, and myself and them in order to organize the company to start the stroboscope developments.

On Sat. Oct 30 Mr. Milo Durand and wife were here and stayed overnite at my home. He was in Boston to get an inverter ~~of the~~ from the Raythem Co for one of his film flow machines. On Sat night we went to Patton's for dinner and then to the Symphony concert at Mass & Huntington ave.

Wilkins of 2R. got the camera on monday Nov 1 and has been building it up for shipment to Wright field.



Nov. 4, 1937. Proposed circuit for use at the Forbes Lithograph Co.

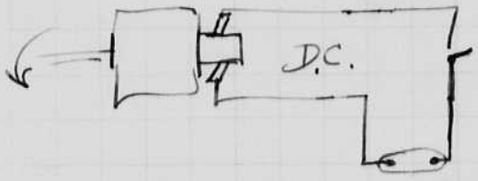
Photo cell control of the flashes.

This type of arrangement was discussed with Mr. Bruning, and Mr Connell on tuesday of this week.

Dr. Durand called by phone today and asked me to come to South Norwalk to see the continuous film camera with the stroboscopic light for flashing the photographs. We plan to go on the early morning train which arrives there about 10:30 or 11: a.m. Sat Nov. 6.

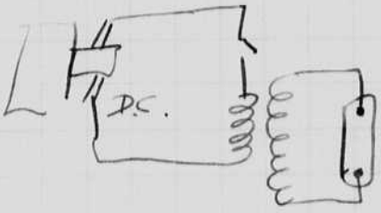
Nov. 4, 1937
H. E. Edgerton.

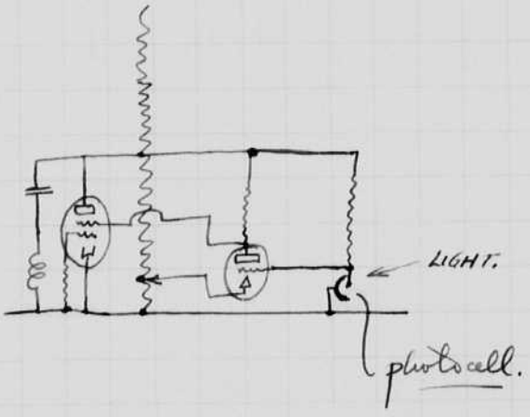
Flash photographing from a rotating machine.

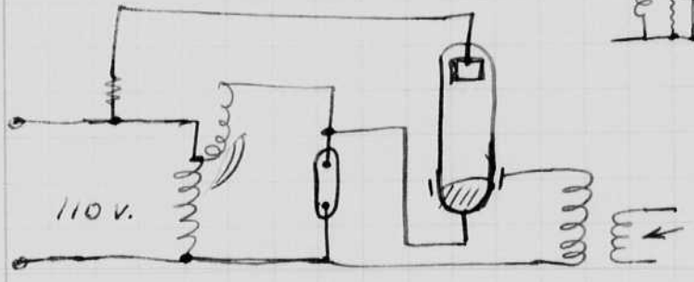


For max. power output
$R_L = R_0$.

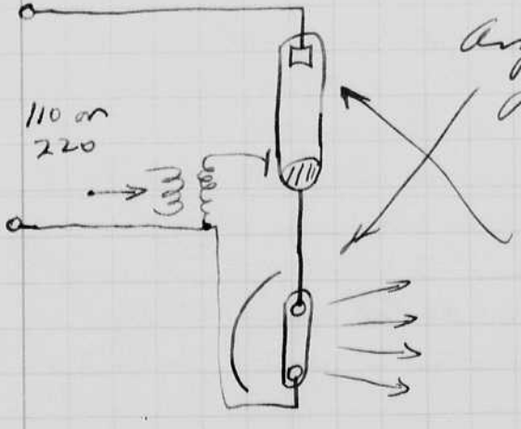
Difficulty to start the tube on a low voltage. Low impedance once the tube starts.





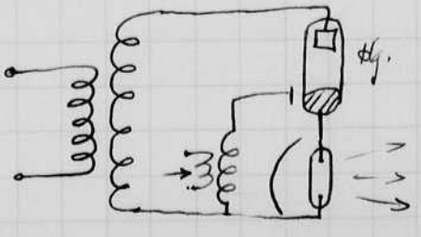


Triode pentode 6F7



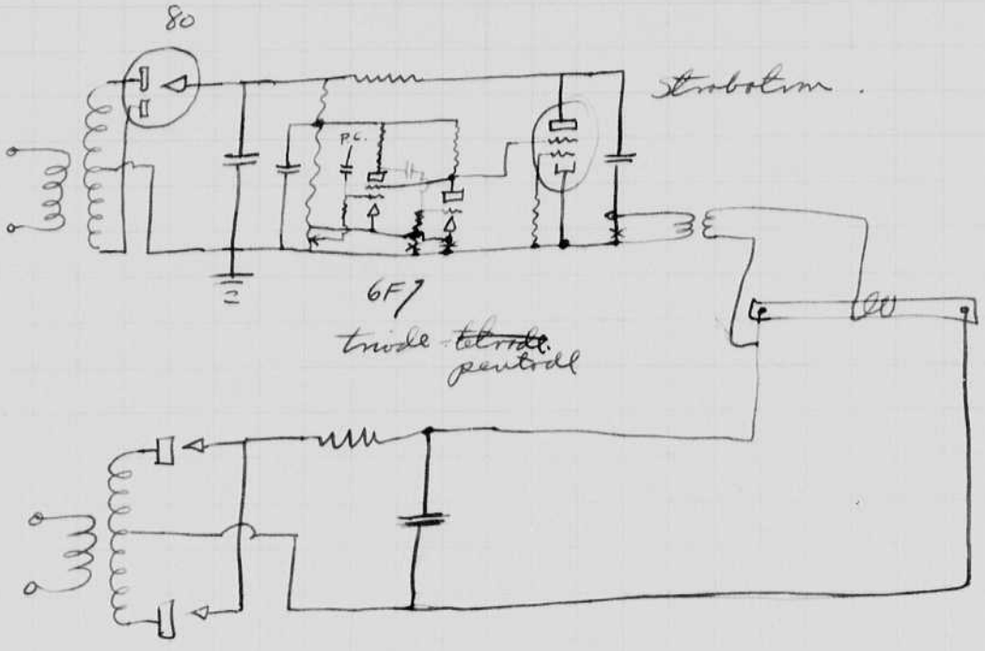
Argon Neon & Krypton Xenon filled tube.

mercury flash tube.



argon or other gas.

Nov 5 1937
H E Edgerton Flasher circuit



Cotton C- 10 meg resistor

76 triode.

3 c.p. lamp.

Feb 10 1938
At Schdy L. Towbs showed me a cut off tube - Hg are through a small tube. the pressure would change and are drop moved cut off curve cut.

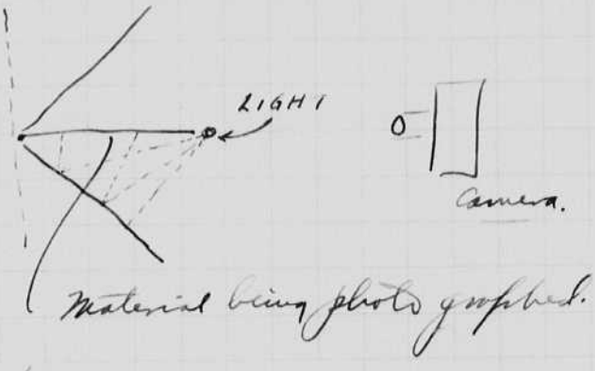
I also heard a discussion by who ~~took~~ made x rays with a condenser discharge through a cold tube (Hg).

Nov 7, 1931.

Yesterday, Fennebaum, Zinn and I went to South Norwalk on the 7.30 am train. We were met at the station by Dr. Durand and went to the Filmbook factory. There we met Mr. Patterson and later at the laboratory. Mr Pratt. after looking over the fast camera that uses our lights we had lunch at the Silvermine.

We discussed changes in the lighting circuit to produce even illumination on the sample.

An oval tube design was suggested to reduce the dimension of the lamp in the field of the camera.



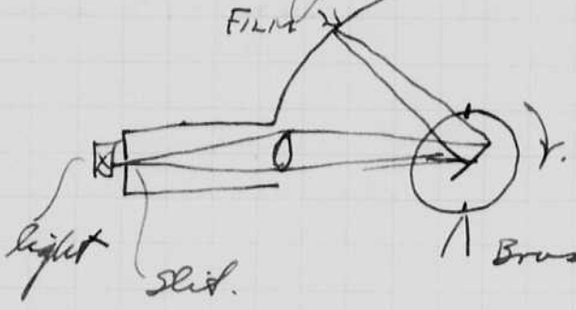
Nov. 14, 1931.

I went to Schenectady on new 10 with Nottingham an Gray. We had dinner that night with Dr. Hull, Seitz and Blewett at the Mohawk club. The next day we toured the research lab at the G.E. Co. I had dinner with Boucher in Scotia - also saw Schindler there. Retired to Boston on the night train.

On the 12 th Mr. Pratt of the Int. Filmbook co was here and we had a meeting in Pine office at 11 am. Wilson was there also. Adjourned to see Bush about prosecution of the Filmbook co who want a 3 year exclusive license for a copying camera. Resumed the discussion at 4 pm. Filmbook through us. Pratt will send in suggested modifications of the plan suggested by the Research Corp.

Nov 19, 1931
H. E. Edgerton.

Discussed design of rotating mirror camera with a Senior named Winn as a possible thesis subject.



Start transient.

1 ft radius · 10,000 r.p.m. Series motor
Governor cont.

Equiv to 20,000 r.p.m.

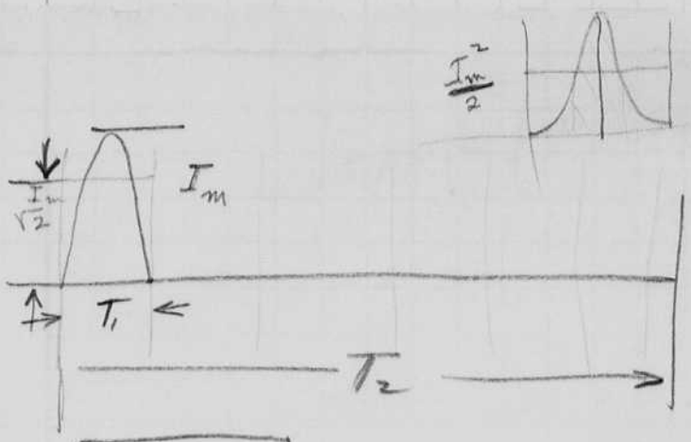
$3\text{ft} \times 12'' \times \frac{20,000}{60}$ inches/sec.

$\cong$ 10,000 inches/sec.

or 1 inch = 10^{-4} sec.

More discussions regarding Strobo Co.

1. Letter received from Prattsburg.
2. " " " completion on Monday.
3. " " " Pouillon ∴ Thurs to Geneva.



method of measuring discharge time compared to total between flashes.

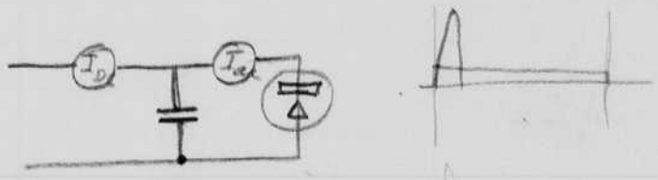
$$\sqrt{\frac{1}{T}\int i^2\,dt}$$

$$\frac{I_{ac}}{I_{dc}}$$

$$= \sqrt{\frac{1}{T_2}\left(\frac{I_m^2}{2} \times T_1\right)} = \frac{I_m}{\sqrt{2}}\sqrt{\frac{T_1}{T_2}} = I_{ac}$$

$$I_{dc} = \frac{1}{T_2}\int i\,dt = \frac{2I_m}{\pi}\left(\frac{T_1}{T_2}\right) = I_{dc}$$

$\frac{\pi}{\sqrt{2}} = 1.11$



$$\frac{I_{ac}}{I_{dc}} = \frac{\frac{I_m}{\sqrt{2}}\sqrt{T_1/T_2}}{\frac{2I_m}{\pi}\,T_1/T_2} = \frac{\pi}{2\sqrt{2}}\sqrt{\frac{T_2}{T_1}}$$

amp.

		× 1.11	I_{ac}/I_{dc}.
		1.11	1.11 ✓
		3.6×7	3.67.
		11.1	
1000	33.3	36.7	
10,000	100	111.0	
100,000	333	367.	
10^6	10^3	1110.	

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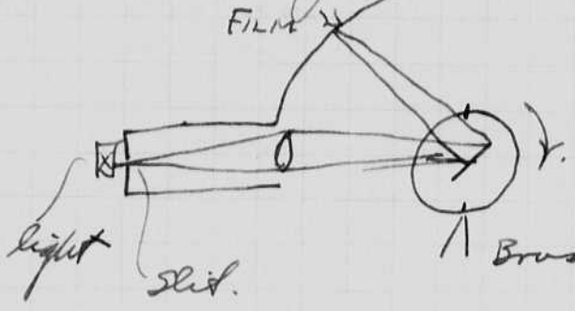
Discussed design of rotating mirror camera with a Senior named Winn as a possible thesis subject.



1 ft radius · 10,000 r.p.m. Series motor Governor cont.

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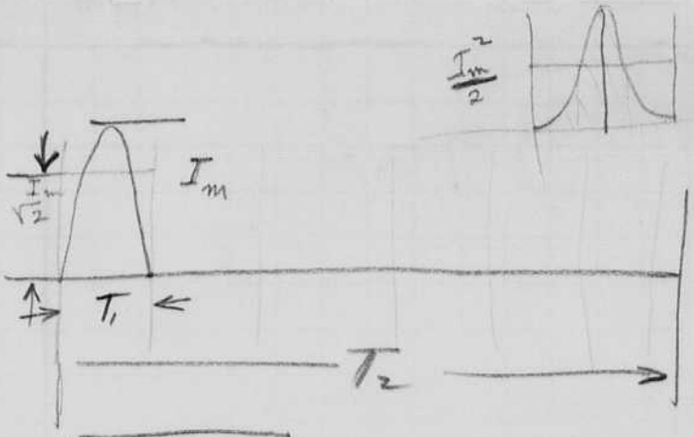

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$$\frac{I_{dc}}{I_{dc}}$$

$$= \sqrt{\frac{1}{T_2}\left(\frac{I_m^2}{2} \times T_1\right)} = \frac{I_m}{\sqrt{2}}\sqrt{\frac{T_1}{T_2}} = I_{ac}$$

$$I_{dc} = \frac{1}{T_2}\int i\,dt = \frac{2I_m}{\pi}\left(\frac{T_1}{T_2}\right) = I_{dc}$$

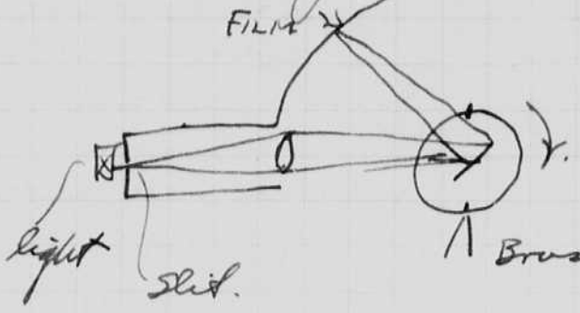
$\frac{\pi}{\sqrt{2}} = 1.11$

$$\frac{I_{ac}}{I_{dc}} = \frac{\frac{I_m}{\sqrt{2}}\sqrt{T_1/T_2}}{\frac{2I_m}{\pi}\,T_1/T_2} = \frac{\pi}{2\sqrt{2}}\sqrt{\frac{T_2}{T_1}}$$

		$\times 1.11$	I_{ac}/I_{dc}
		1.11	1.11 ✓
		3.6×7	3.67.
		11.1	
1000	33.3	36.7	
10,000	100	111.0	
100,000	333	367.	
10^6	10^3	1110.	

Nov 19, 1931
H E Edgerton.

Discussed design of rotating mirror camera with a Senior named Winn as a possible thesis subject.



To start transient.

1 ft radius · 10,000 r.p.m. Series motor Governor cont.

Equiv to 20,000 r.p.m.

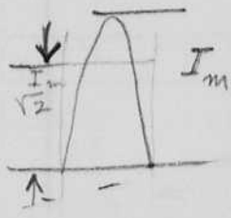
$3\text{ft} \times 12'' \times \frac{20,000}{60}$ inches/sec.

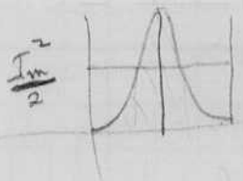
$\cong$ 10,000 inches/sec.

or 1 inch = 10^{-4} sec.

More discussions regarding Strobo Co.

1. Letter received from Pratt or two.
2. " " " Compton on Monday.
3. " " " Pouillon " Thurs to Geneva.





method of measuring discharge time compared to total between flashes.

$$\frac{\pi}{2\sqrt{2}}\sqrt{\frac{1000}{1}} = 33 \qquad \frac{\pi}{2\sqrt{2}} = 1.11$$
$$= 36.7$$

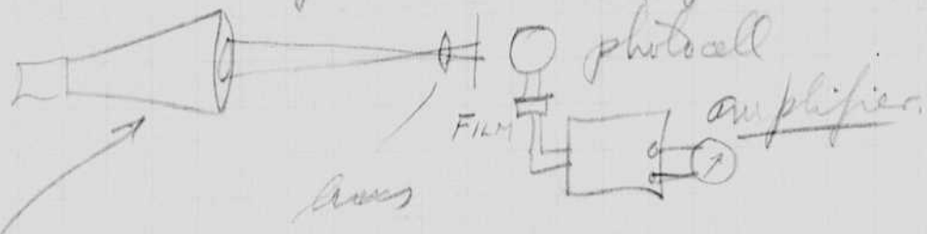
1 amp. 40 amp.

T_2/T_1	$\sqrt{T_2/T_1}$	$\sqrt{}$ x 1.11	I_{ac}/I_{dc}.
1	1	1.11	1.11 ✓
10	3.33	3.6x7	3.67.
100	10	11.1	
1000	33.3	36.7	
10,000	100	111.0	
100,000	333	367.	
10^6	10^3	1110.	

Rochester.
Nov. 24 1937

I went to Toronto on Friday night and talked to the Royal Canadian Institute on Saturday evening, 1800 people
Prof. Ellis theory dir. prob. Kerr
Prof Barton Physics dept.
Prof Price Elect. dept.
Bruce Murray. secretary of CRD.

Method of measuring grain in film.



called ray tube — the spot is propelled around in a circular path.

a lens casts the image of the spot on the film.

light is picked up by a photo cell and amplified to give an output or ripple due to the grain of the film.

3/4"
1"

x 1/4 inch circle on film. 1/16" = .0625
Spot size with 10/1 red
= .00625.

H E Edgerton
Nov 25 1937

Yesterday I pumped 4 tubes for use with single flash photographs, 2000 volts, for the single flash unit we are making to load to mili.

Two of these had cathodes with nickel screen inside of an "oxed" metal iron cylinder. The screen was painted with $BaCO_3$ and $SrCO_3$ solution such as used for coating radio tube cathodes.

The other two had cathodes that were made by heating an iron electrode and putting it into powdered $BaCO_3$ and $SrCO_3$. The carbonates apparently melt into the surface when heated again forming some kind of compound with the iron. The surface appears to have blisters on it but these are solid, not containing air. The surface is black or dark colored. In treating the tube cathode it becomes silvery or metallic when heated to a red heat in an atmosphere of H_2.

The screen type also were heated to a red or yellow heat in H_2 and also appear metallic.

A pressure of 16 cm of argon gas was put in the tubes. They were run once on the pump and then flashed.

H. Bagert
Nov 25 1937

Oxide-coated cathode

Proposed method of making a coated electrode of Ba or Sr or both on an iron base, suggested by experiments on coated cathodes (unheated) for stroboscope lamps.

The method will be to heat an iron wire or ribbon electrically and run it through powdered BaO_2 and $SrCO_3$. Then put it in a tube and heat it in H_2 to break down the carbonate, and to combine the H_2 with the oxide to form the pure metal. It might be easier to heat the filament wire in H_2 in a continuous furnace. However, the active metal surface might be damaged by contact with the air.

Another method is to use a binder with the carbonates as is done in tube practice, painting it on the iron. The reduction of the oxide is accomplished by H_2 and heat. This experiment should also be accomplished with nickle and tungsten filaments.

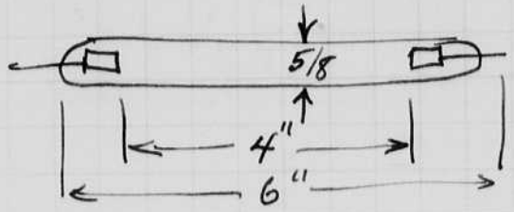
I also plan to try some $CsCl$ with the same procedure, or $CsCl$ with the carbonates.

Nov 27 1937
Friday.

argon lamps.

Sent to Swift & U.S. Env.

(1)

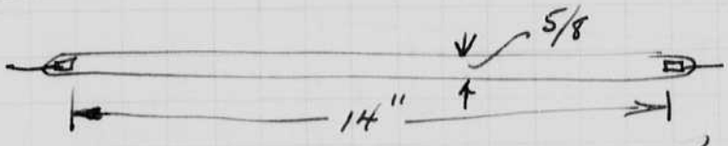


Iron electrodes $BaCO_3$ melted into iron in Bunsen flame. Heated in H_2 air pump.

Filled with argon at 16 cm

---

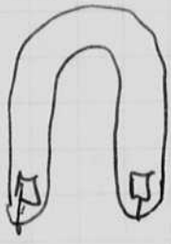
(2)



Electrodes ditto.
Pyrex tube.
Pressure ~~16~~ 6. cm argon.

---

(3)



argon lamp for flash photomicrography

16 cm. argon.

Nov. 29. 1937.

Test of tube no 2 above.

2 mf 1600 volts. 15 a second.

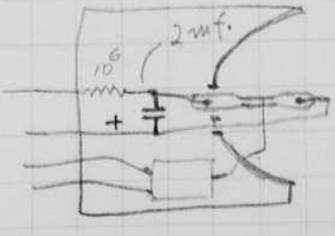
$$\frac{CE^2}{2} = \frac{2\times10^{-6}\times1.6^2\times10^6}{2} = 2.56 \text{ joules per flash.}$$

$$\frac{15}{2.56} = 37 \text{ watts.}$$ seems ok.

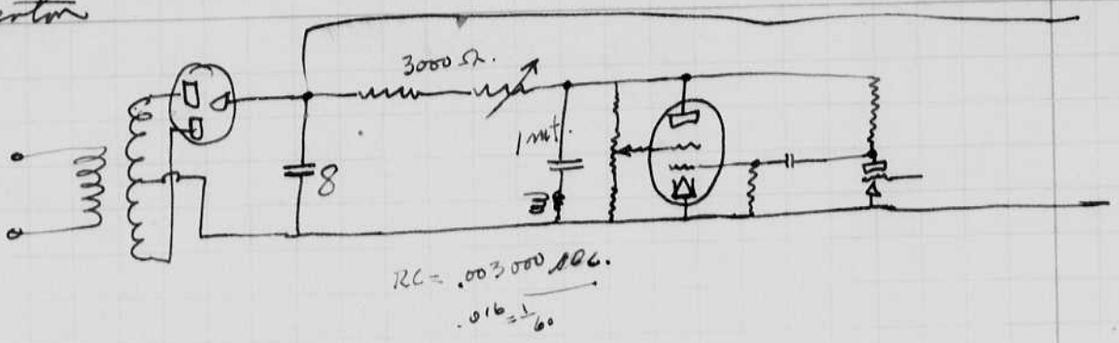
Run continuously.

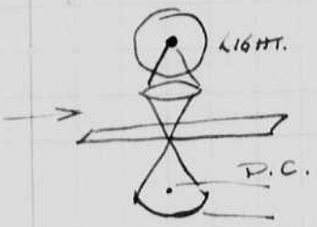
0.5 mf 2000 volts 4000 ohms (no filter)
60 cycles. (30% flicker estimated).

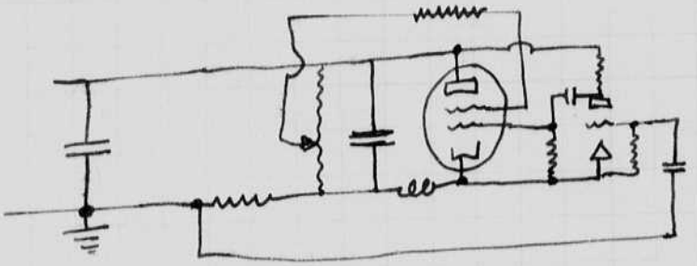
Ultra high Speed lamp.

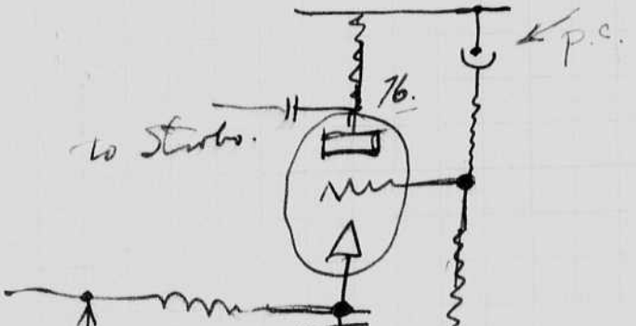


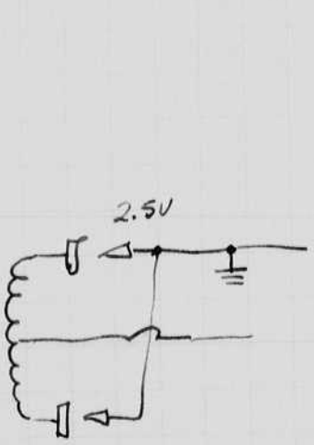
Nov. 29 1937.
H. E. Edgerton

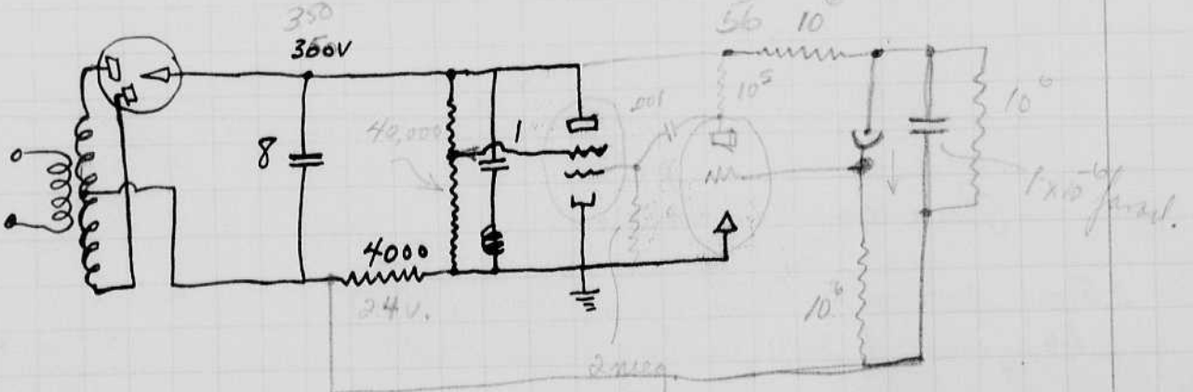












Dec. 7, 1937.
Summit Herald

1c. Paid.
Summit, N. J.
Permit No. 3

$3.50 PER YEAR

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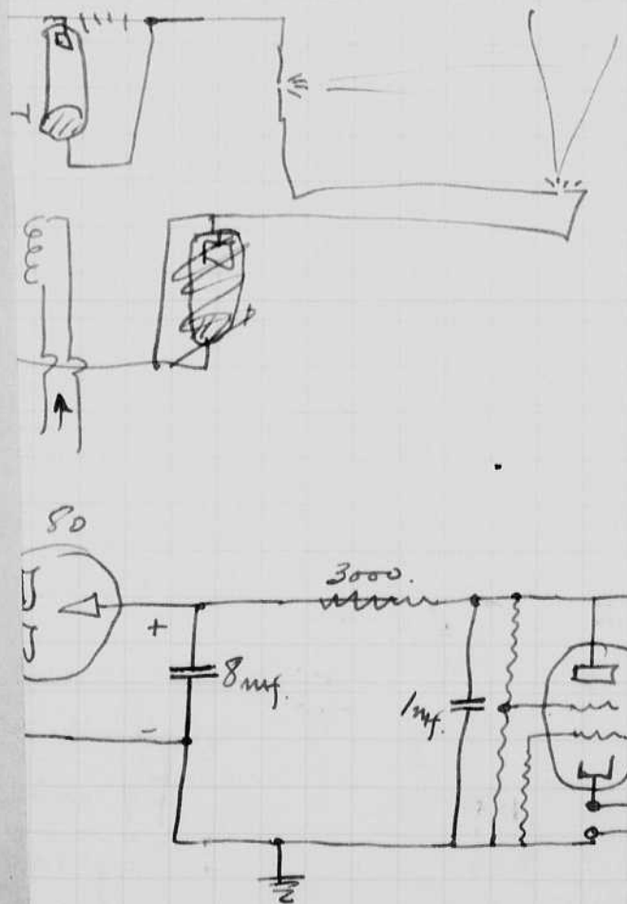
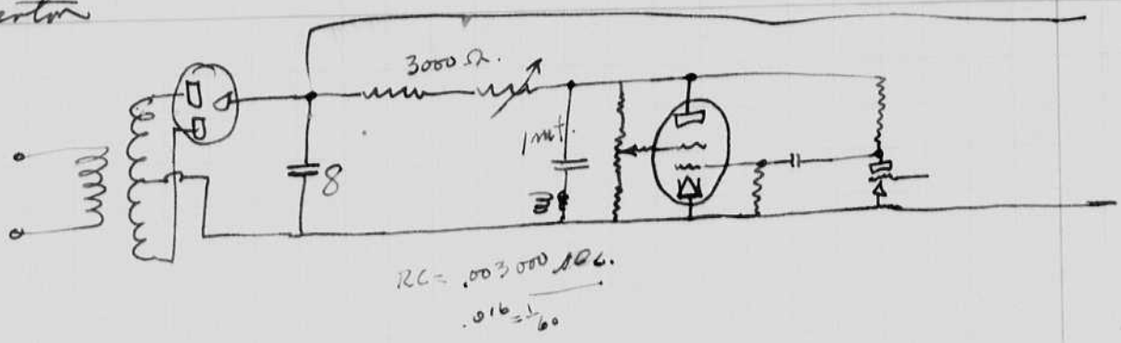
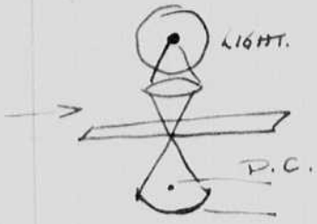
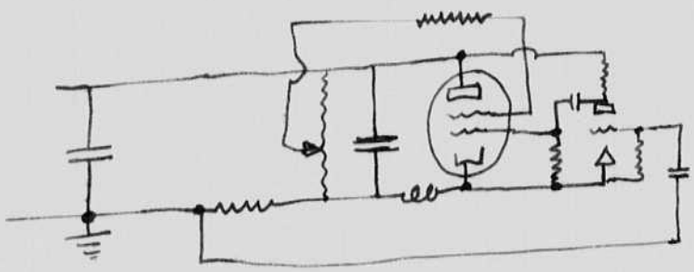
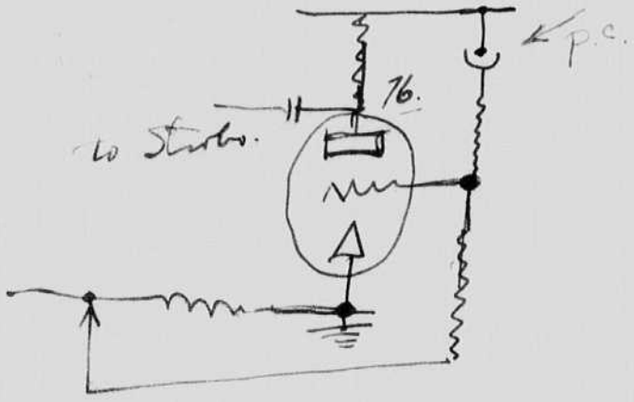


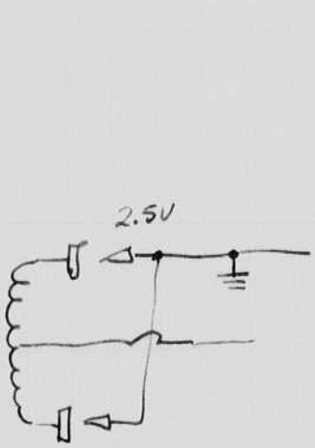
Nov. 29 1937.
H. E. Edgerton

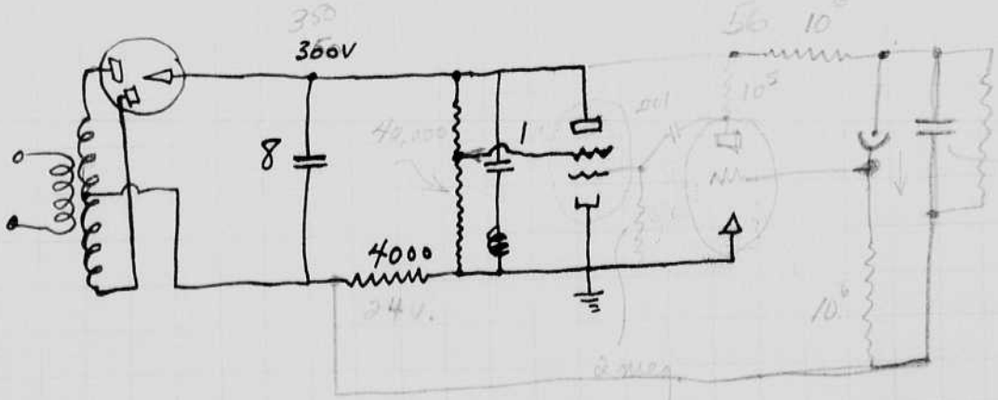












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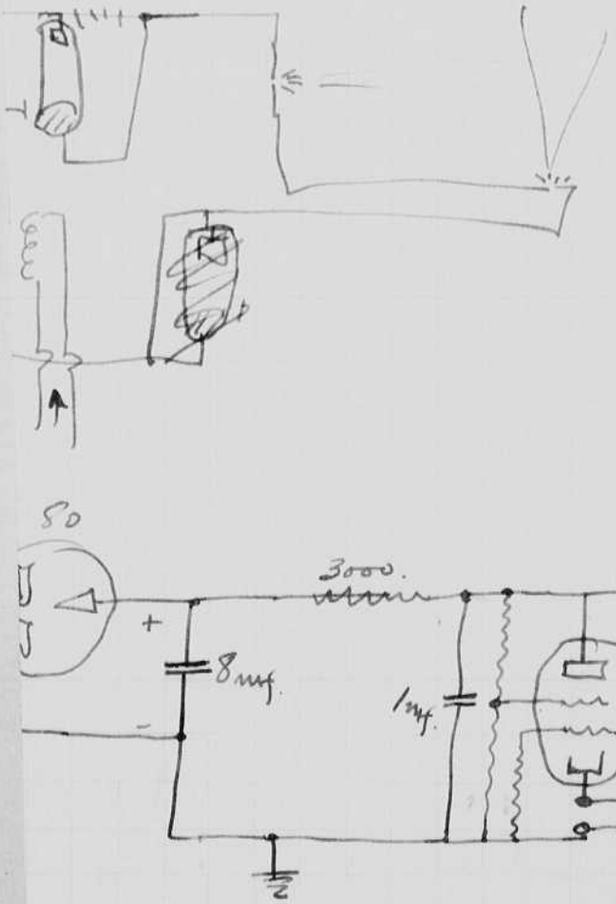
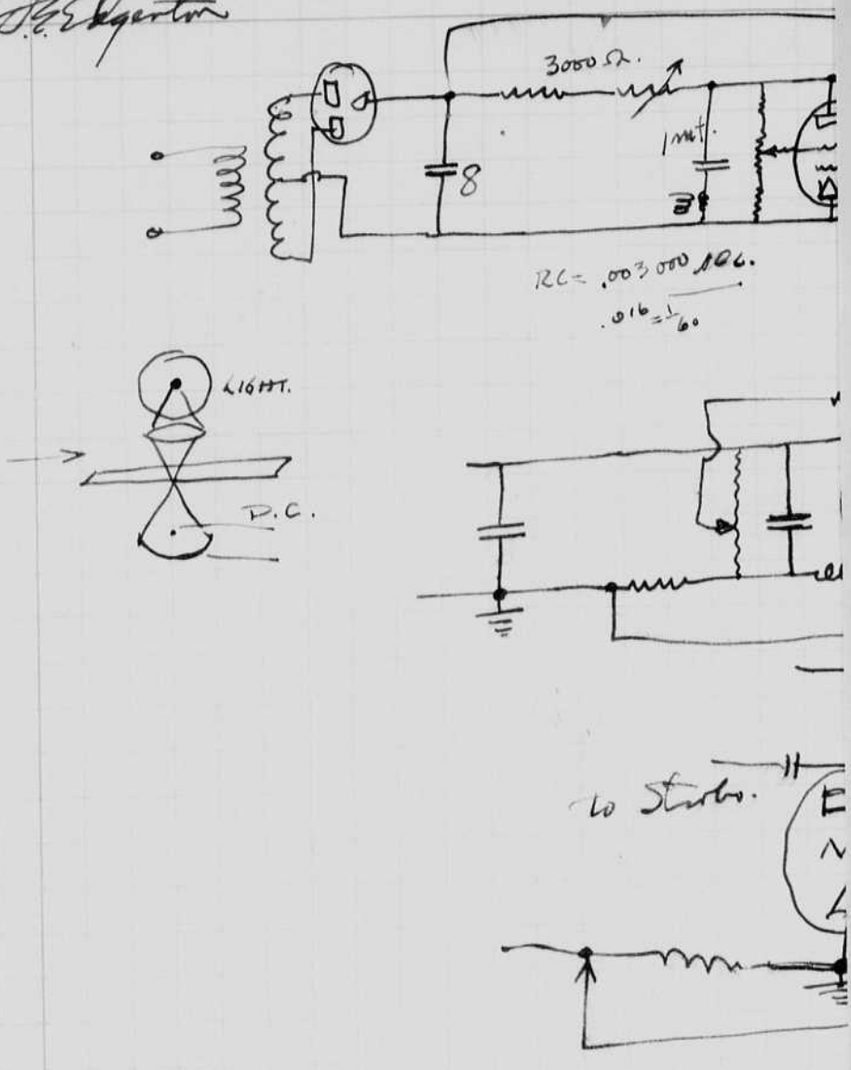


Nov. 29 1937.
H. E. Edgerton



PERS

Miss Virginia Mandeville of H
bart avenue will entertain at a bu
fet supper on Saturday evening.

Inducted recently into the Sca
let Rifles drill team at Rutge
University was James Sinclair
Summit.

Mrs. W. C. I. Stiles will ente
tain at tea at "The Moorings," h
home in Rowan road tomorrow a
ternoon.

This afternoon from 3-5, the Mi
dle School at Kent Place is holdi
its annual Christmas fair in t
Phraner Gymnasium on the Ke
Place campus.

Miss Eleanor Price of Summ
spoke on period furniture befo
the home department of the co
temporary Club of Newark yeste
day afternoon.

Miss Marion L. Turner of Su
mit is a member of the Connectic
College Speaking Choir which to
part in the Thanksgiving chapel e
ercises at the college.

Mrs. G. Danforth Williamson
Woodland avenue will give a lar
dinner at the Beechwood Hotel
December 23rd, before the secon
Junior Assembly in Hobby Hall,
honor of her daughter, Miss Loui
Williamson.

Junius Allen, A. N. A., of Fer
wood road, is represented in th
annual exhibit of small canvases
the Upper Gallery at the Montcla
Art Museum. The exhibition, whic
opened Sunday, will be on vie
through December 23rd.

Miss Cynthia Drake of Sho
Hills, who returns from Swe
Briar College in Virginia on D
cember 17th, will entertain at t
at her home in Fairfield drive
the afternoon of December 19t
Miss Drake's guests will be h
classmates at Kent Place Scho
from which she was graduated la
June.

Miss Virginia Prout of Summ
and New York is a member of th
second octet of the New Yor
Junior League Glee Club, chose
recently from new members, to sin
in New York City hospitals. Th
schedule is planned as follows
December 15, Ruptured and Cri
pled Hospital; December 16th, Cit
Hospital; December 20, Seton; D
cember 21, Bellevue; December 2
Psychopathic; December 28, Me
ropolitan.

Dec. 7, 1937.

Dec 6 1937
H. E. Edgerton.

On Dec. 3 ~~2nd~~ Friday I gave a talk on speed photography to the Fortnightly club of Summit N. J. Mrs. Beck, president Mrs. Morse. committee. after the talks we had a group affair at my sisters home Mrs. Nelda Pogue, 216 Summit Ave, Summit. My wife and two oldest children went on the trip. Returned on the 12 o'clock train Sunday for home. Operator. Mr. Sargent.

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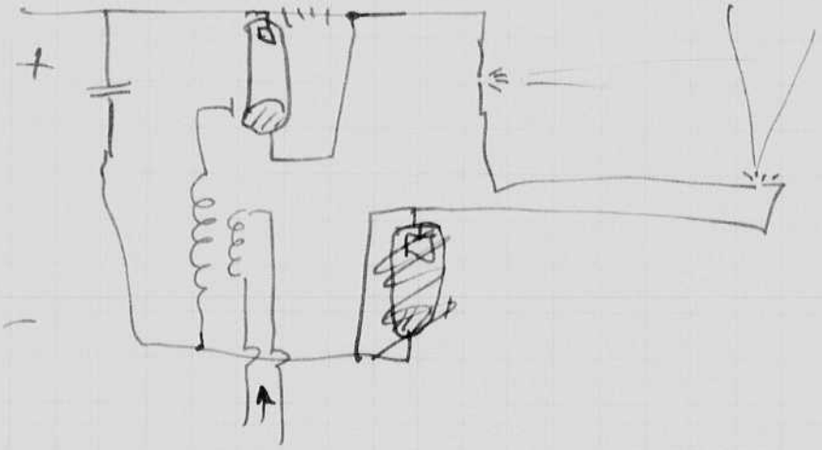
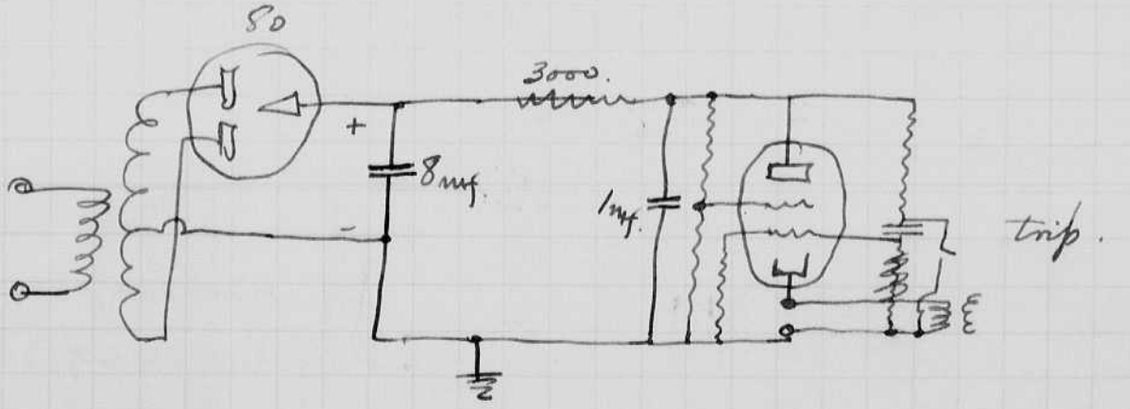
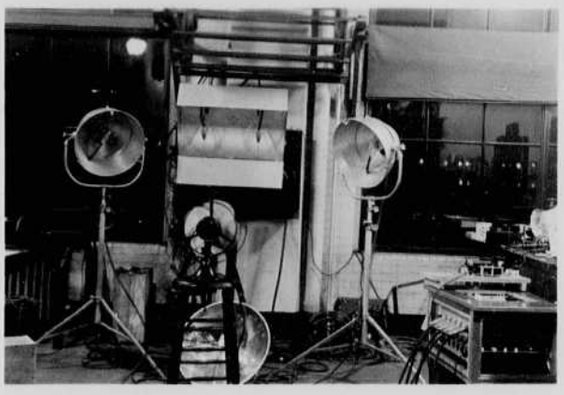




Dec 10 1937
H.E. Edgerton.

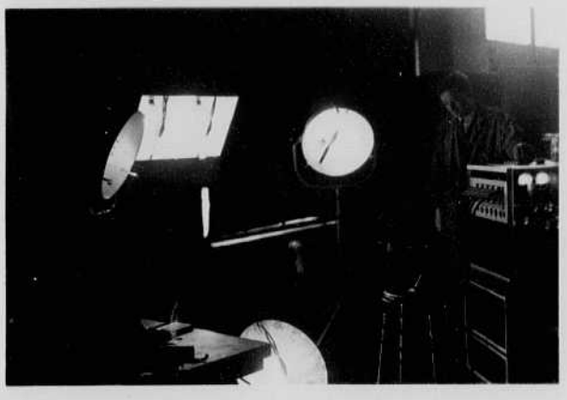
Audience at Harvard.
Nov 26?
Mrs. Bodwell and family 48 mf 3000 v f 4.5
Verichrome film

Large flash machine finished recently



H.E. Grier flashing unit

Fan running!



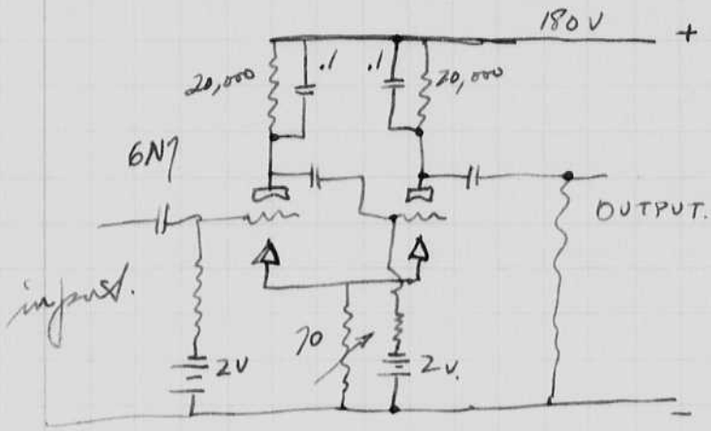
Detto

Grier flashing Lawrence.

my three children
f 9 verichrome film
2 lights 24 mf 3000 v.

Dec 10 1931

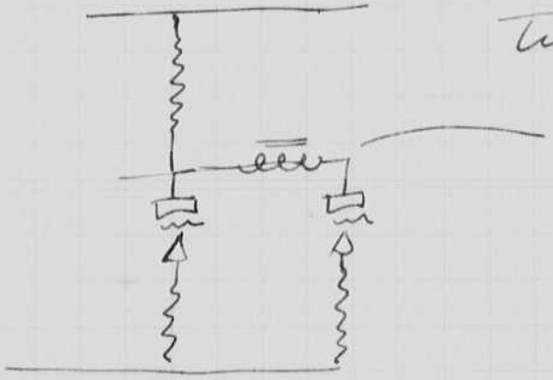
Amplifier circuit shown in operation by J. W. Horton yesterday and today.



Regenerates through the common cathode resistor.

1 m.v. from moto contactor or from body when heart beats.

4 volts out.



Two thyratrons.

Relay to discharge condenser into tank circuit

Dec 10 1931
M E Epstein.

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~~Jan~~
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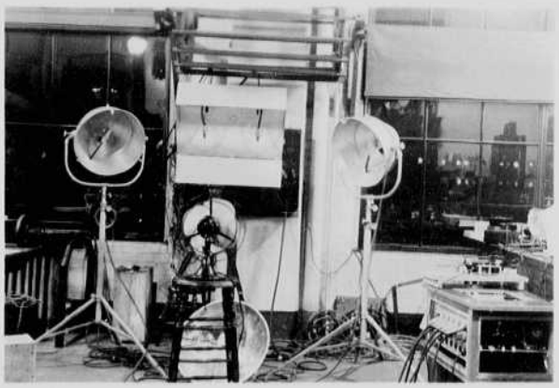


D.F. Brier flashing unit

For running

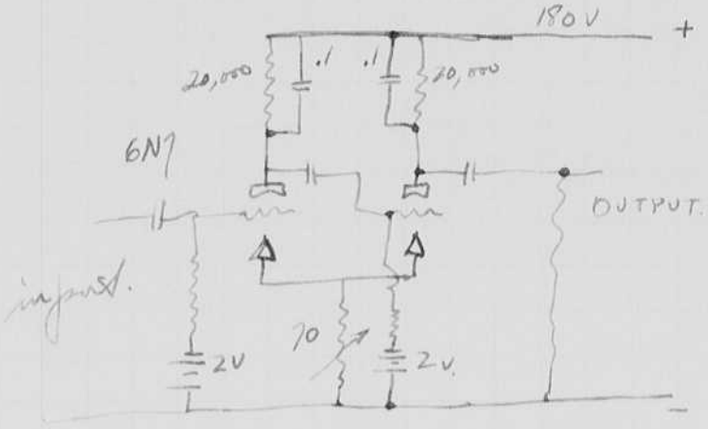
Delts

Brier flashing Lawrence.

my three children
f 9 verichrome film
2 lights 24 mf 3000 V.

Dec 10 1931
HEK

Amplifier circuit shown in operation by J.W. Hunter yesterday and today.



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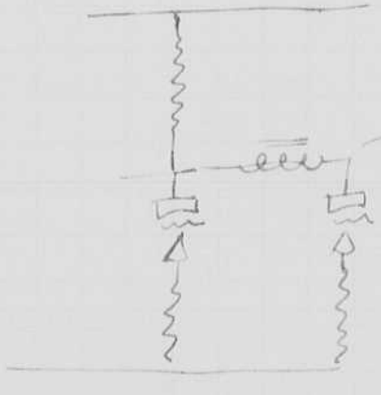

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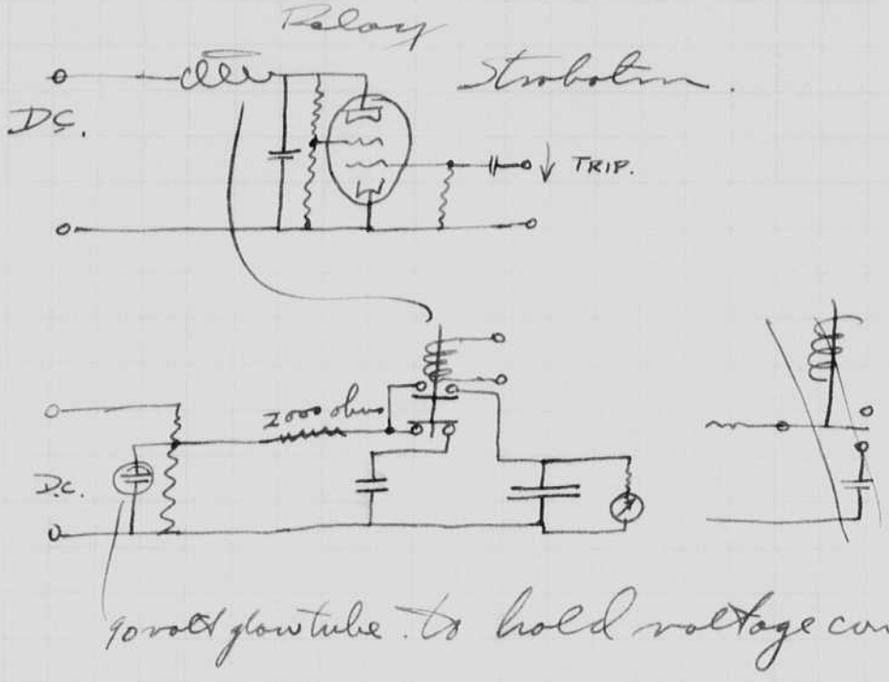
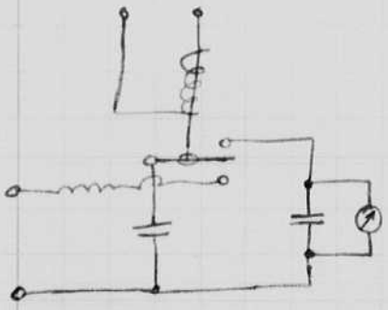
Dec. 10. 1937.
H. E. Edgerton.

I discussed the use of a
stroboscope in the circuit for counting
heart beats on the previous page.
circuit follows.



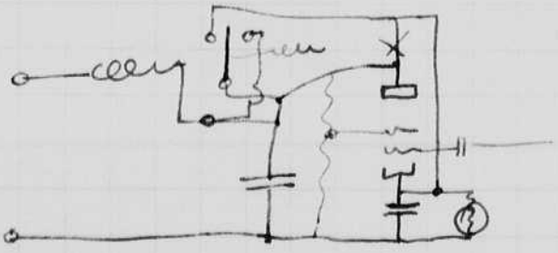
90 volt glow tube. to hold voltage constant.

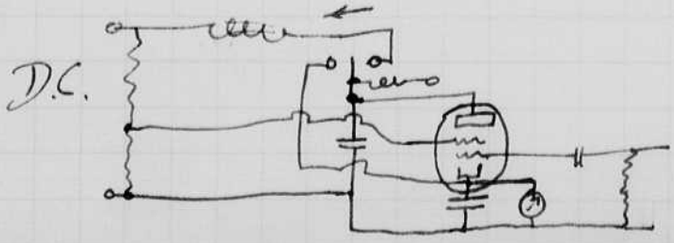


2 mf. 100 ma 90 volts.
900 ohms.

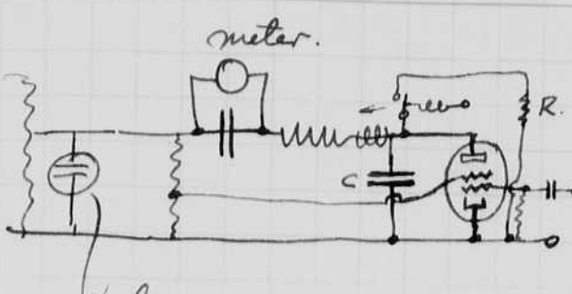
$RC = 2 \times 900 \times 10^{-6} = .001800$ sec.

3.5 sec.
60 / 200
11
20



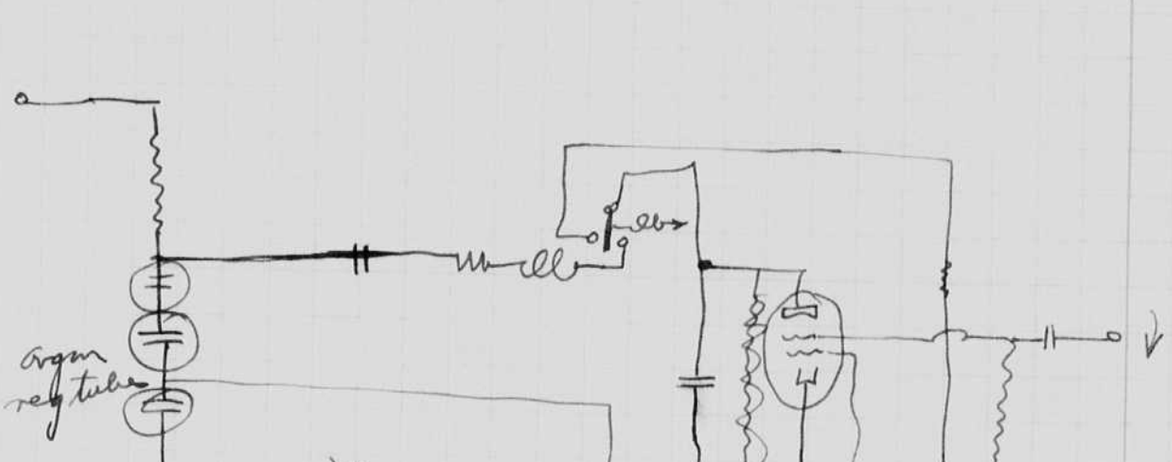


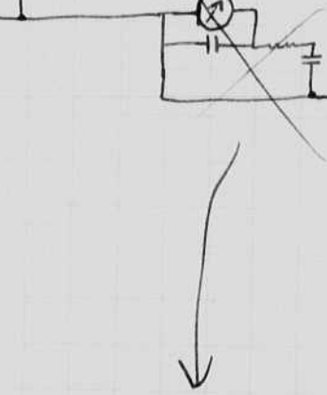
Cont.



tube.
Regulator. 180 volts.

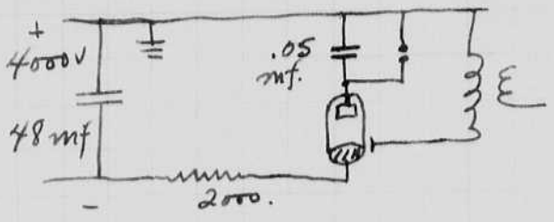
Relay must also open condenser C circuit first so that it will not hold shut.

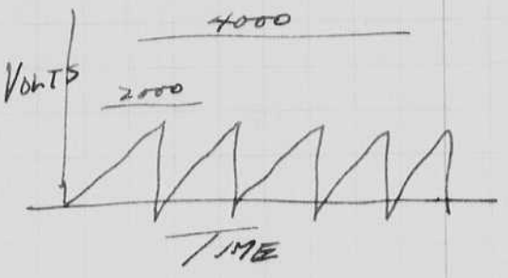


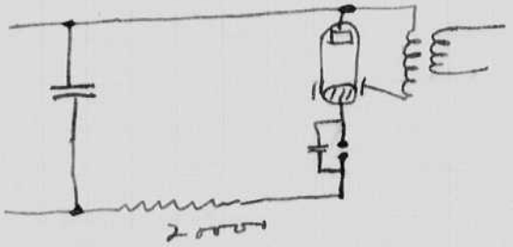


meter to read average current.

Dec 12 1937
O. B. Shepherd.



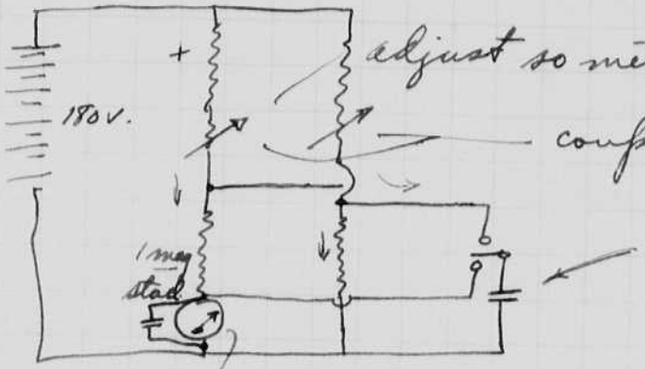




Oscillating spark for high speed movies.
control tube to start the sequence
at the correct time.

Dec 13 1937
H. E. Ely.

Rate indicator.

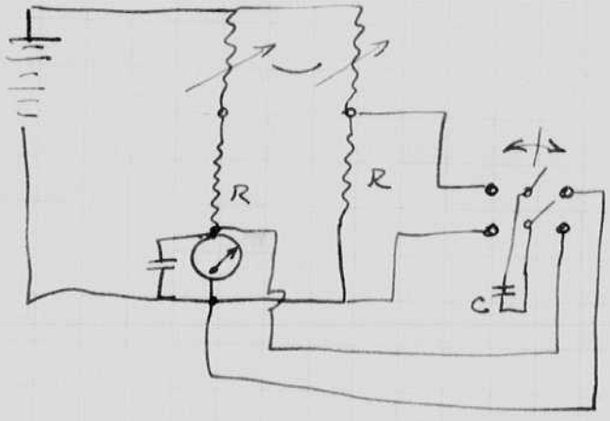


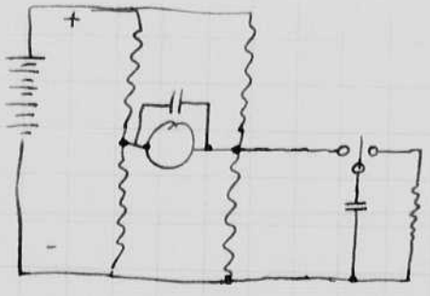
adjust so meter reads full scale.

coupled resistors.

meter set for full scale.

$\frac{180.00}{10^6}$ = 180 micro amps.



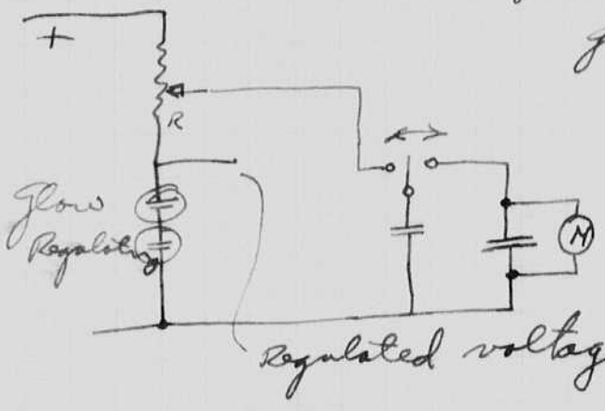


Cont.

Error due to IR drop in meter effects readings and condenser does not completely discharge

this can be over come by adding IR drop to charging circuit of the proper value.

The circuit here does not give the effect desired.



Dec. 14 Horton said this drop across the metering circuit was negligible.

12000 = S.

6000	2
4000	3
3000	4
2400	5
2000	6
1700?	7
	8

$\frac{S}{n} = A$

$\frac{S}{m} = B.$

$m - n = 1$

$m = n - 1$

$S = nA = (n-1)A. = nA - A.$

$S = mB. = nB.$

~~25~~ $B(S+A) = mAB$

$AS = nAB$

$BS + AB - AS. = 0$

$S(B-A) = -AB.$

$S = \frac{AB}{(A-B.)} = \frac{4 \times 3 \times 10^6}{10^3} = 12000$ ✓

Equations for measurement of speed of a rotating object by a stroboscope which cannot read the 2nd freq.

the speed is given by the product of two adjacent speed readings by the difference.

Dec 22 1937
H E Edgerton.

On Fri. Dec 18 I went to [illegible] gave a talk on high-speed [illegible] to an audience at the Bushnell Hall. I visited the Hartford Engineering Society in the afternoon and saw Mr. Walker Worrest (nebraska '26) and also Green had a dinner at the club that evening before the which were present.

Mr & Mrs Green
" " Widman
" " Nate ?
" Murat Geo
" Carl
" ? Worked

I returned to cambridge Sat. morning and worked also on Dec 20 with Jim Mikel large flash unit that we loan him for speed photo series of experimental pictures in the theater, Bldg 2 first floor.

this unit is equiped for 5 lights, 4 with 48 mf and one with 16. the voltage is 2000 and we are going to put on a tap that will give 2500.

Hartford Courant Dec 19 '37

Speed Camera's Wonders Shown By Prof. Edgerton

About 2000 persons sat for about two hours in Bushnell Memorial last night and saw things happen that happened a long time before they reached the hall, but which really happened at the time they saw them happen. S'elp us, that's what happened!

In other words they saw what a booby a high-speed camera and a little stroboscopic light will make out of time. The longest exposure of the pictures cast on the screen was about one-fifty-thousands of a second, and the shortest, about one-one-hundredth-millionth of a second.

As the second event of the Bushnell Motion Pictures and Lecture Course, the performance by Professor Harold E. Edgerton of the Massachusetts Institute of Technology was anything but dull. Bullets fired from rifles were shown pushing sound waves ahead of them, wakes of turbulent atmosphere sharply silhouetted behind them. Also, the audience saw in slow motion a cock fight, a cat landing on its feet after being droped upside down inches from the floor, the graceful wing technique of pigeons and humming birds and the creepy action of a snake's tongue.

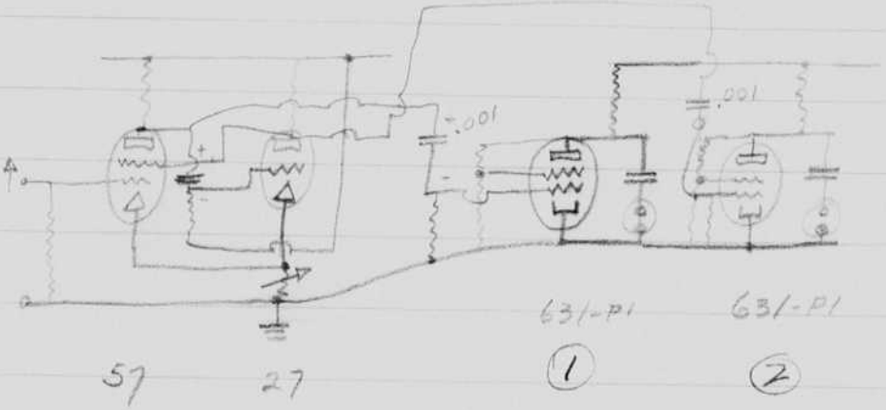
Preceding the showing of the films and slides, Professor Edgerton first demonstrated the action of an electric fan and of whirring, figured cardboard disks in the glare of a stroboscope, an instrument of light whose frequency is adjustable and which engineers use for measuring speed. All kinds of various designs with countless movement formations, both clock and counter-clockwise and phantasmagoria-like, were produced. With the aid of a second stroboscope the lecturer made the fan appear as two fans, each revolving in the opposite direction.

Police Range Targets

Dec 22 1937
H. E. Edgerton.

I discussed yesterday with a student the method of measuring velocities by taking two photographs on the same film with two flashing lights. This method is also mentioned in one of my earlier note books.

ST-1



Tripping the (57-27) relaxer first fires the strobotron ① which in turn fires the lamp which is not shown in the usual way with an external grid high potential

the second strobotron ② fires either when the tube 27 begins to carry plate current after the relaxation.

Dec 22 1937
H E Edgerton.

On Fri. Dec 18 I went to [illegible] gave a talk on high-speed to an audience at the Horace Hall. I visited the Hartford Em the afternoon and saw Mr. Wak Wrest (Nebraska '26) and at Green had a dinner at club that evening before the which were present.

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" " Nate ?
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" ? Worked

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this unit is equiped for 5 lights, 4 with 48 mf and one with 16. the voltage is 2000 and we are going to put on a tap that will give 2800.

Dec 19. '37

Speed Camera's Wonders Shown By Prof. Edgerton

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Police Range Targets

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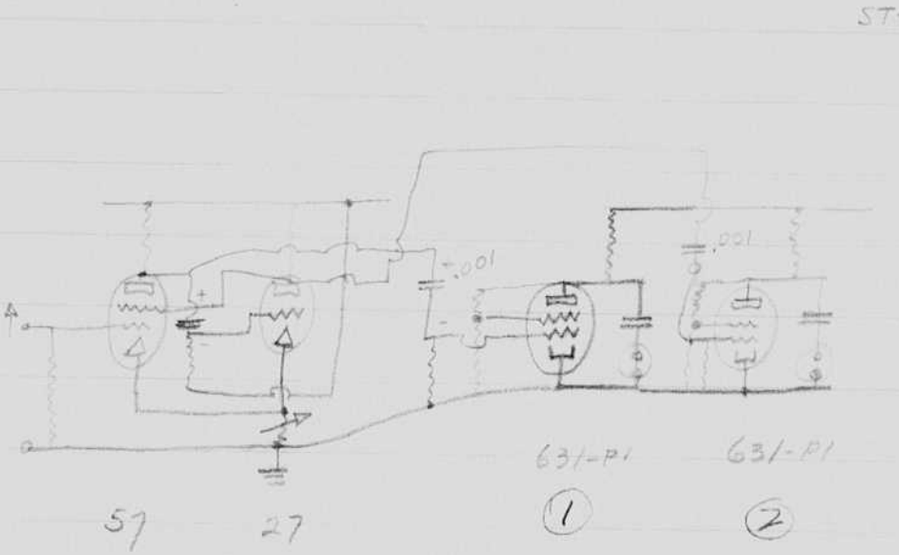

Tripping the (57-27) relaxer first fires the strobotron ① which in turn fires the lamps which is not shown in the usual way with an external grid high potential

the second strobotron ② fires when the tube 27 begins to carry plate current after the relaxation.

Dec 22 1937
J. E. Edgerton.

On Fri. Dec 18 I went to Hartford and gave a talk on high-speed photography to an audience at the Horace Bushnell Hall. I visited the Hartford Empire Co. in the afternoon and saw Mr. Wadman Mr Green Worrest (nebraska '26) and others.

Green had a dinner at the country club that evening before the talk at which were present.

Mr & Mrs Green
" " Wadman
" " Wate? (M.I.T. club pres.)
" Murat Geophysical lab Washington
Carnage Inst.
" ? Worked on coming mirror 100".

I returned to Cambridge on Sat. morning and worked that aft and also on Dec 20 with Jim Mili with the large flash unit that we are going to loan him for speed photography. A series of experimental photos were taken in the theater, Bldg 2 first floor.

this unit is equiped for 5 lights, 4 with 78 mf and one with 16. the voltage is 2000 and we are going to put on a tap that will give 2800.

Dec 22 1937
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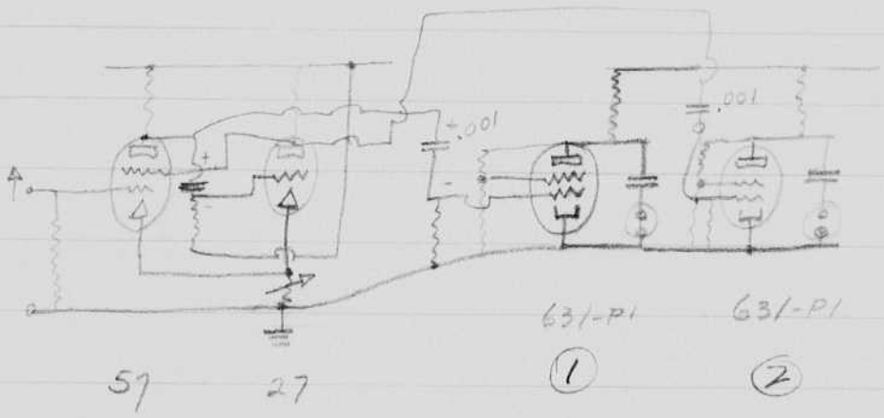
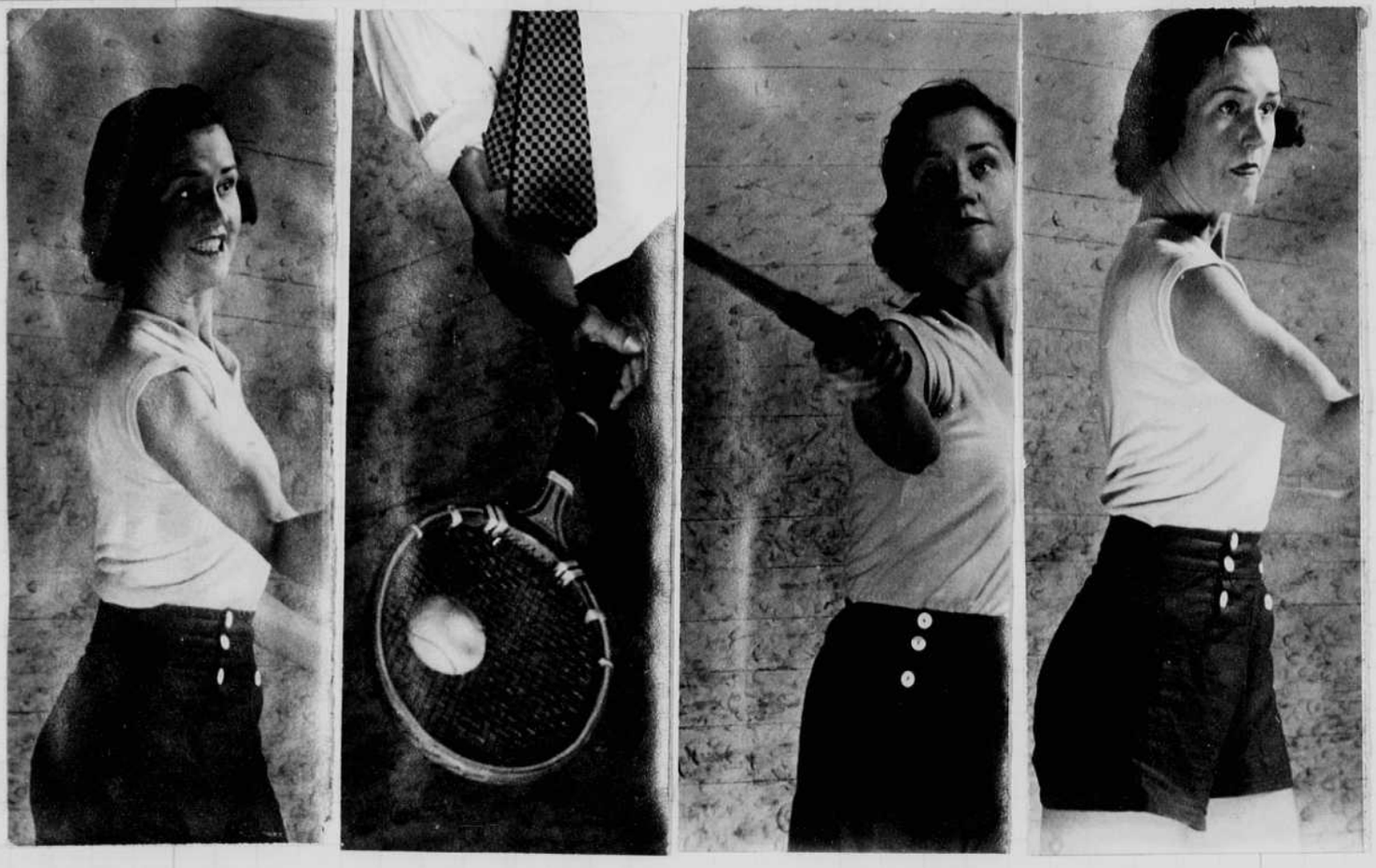
ST-1



Tripping the (57-27) relaxer first fires the strobotron (1) which in turn fires the lamps which is not shown in the usual way with an external grid-high potential

the second strobotron (2) fires either when the tube 27 begins to carry plate current after the relaxation.



Photos taken Dec 24 1937 in Gym of M.I.T. Sylvia Berger
Squash courts. Dick Bush helped.

Dec. 27, 1937. Movies of Rattle Snake Mr. Folk.
Mrs. E. Shorrock (Col 2631). (Salisbury college)

4 mf 2000 volts. 300/sec.
f 3.2 Sunwar Lens.

Movies of pigeons f 5.6 [20 mf 2000 volts
large U argon lamp 5 ft away at camera)
4 mf small argon lamp at 90° in bright
reflector.).

Notebook # 8

Filming and Separation Record

____ unmounted photograph(s)

5? negative strip(s) inside envelope mounted on page 89

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

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

Item(s) now housed in accompanying folder.

Photos taken Dec 24 1937 in Gym at M.I.T. Sylvia Berger
Squash courts. Dick Bush helped.

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large U argon lamps 5 ft away at camera)
4 mf small argon lamp at 90° in bright
reflector.).

Notebook # 8

Filming and Separation Record

____ unmounted photograph(s)

53 negative strip(s) inside envelope mounted on page 84

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

was/were filmed where originally located between page 88 and 91.

Item(s) now housed in accompanying folder.

Photos taken Dec 24 1937 in Gym at N.Y.U. Sylvia Bergen
Squash courts. Dick Bush helped.

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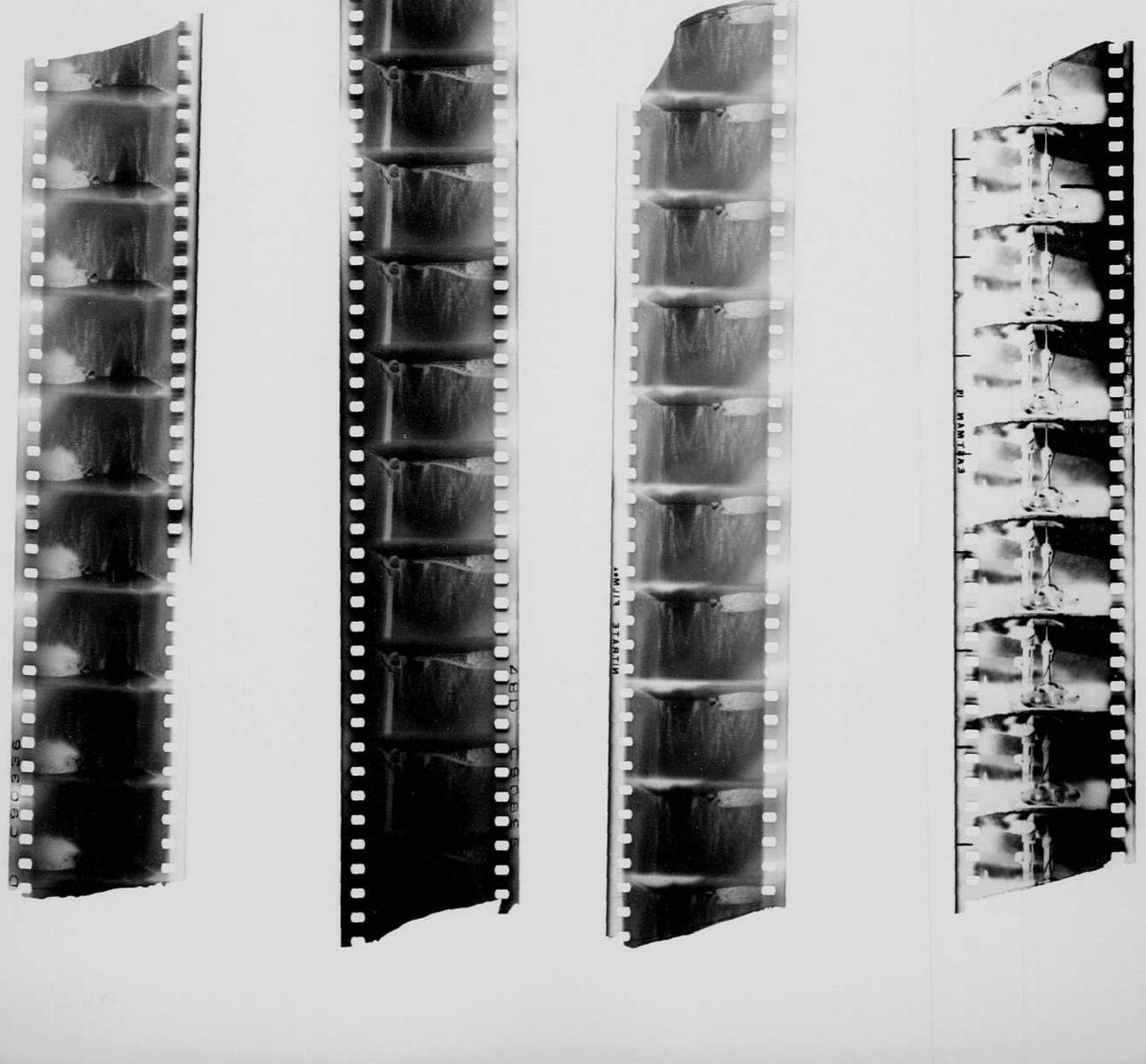
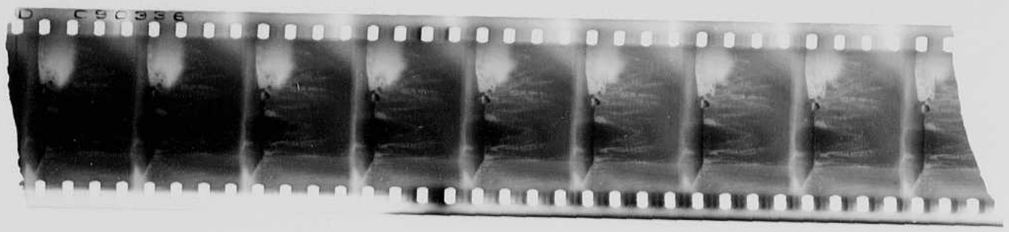
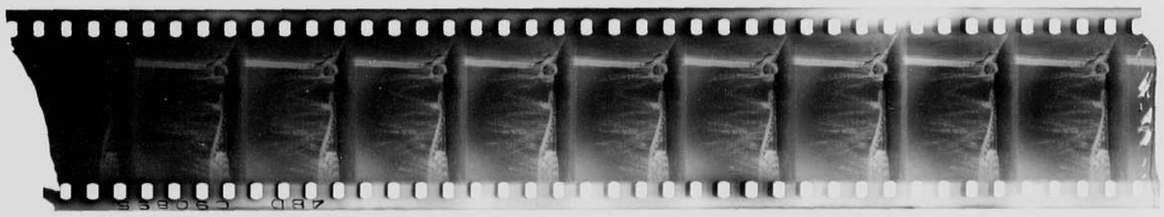
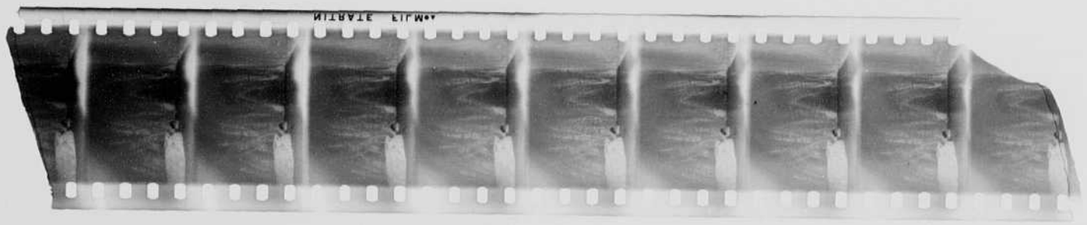
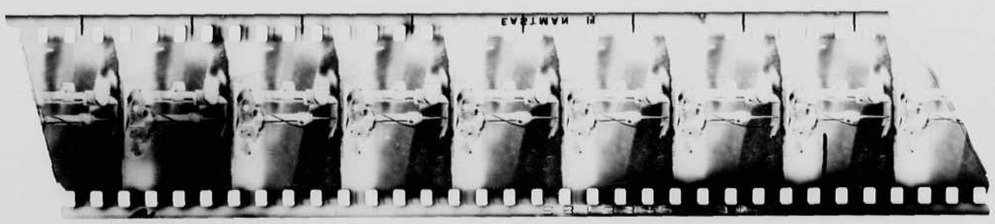
EASTMAN
KODAK
NITRATE FILM











EASTMAN TL

KODAK

High Speed Nikkor
.05 mf. 4000 v. Dec 1937
1/60 Timing way

f 3.2

4 mf 2000 volts.
Par. neg. D76
Kodak Super X
Mouse.

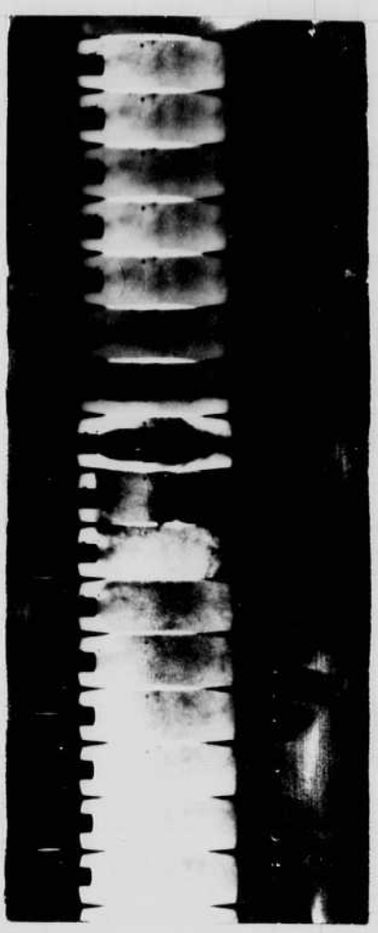
Sewing Machine
½ mf 2000 V
2000 a sec.

Also
Silhouette
high speed
15000 - 20,000 feet/sec.

3000 per second of
a shot gun. Winchester
worth of lead gone.

↑ 3.2

4 mf 2000 volts.
Par. neg. D76
Rattlesnake's
Mouse.



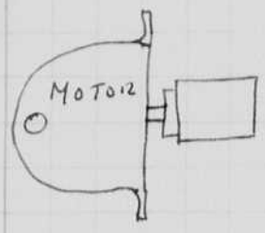
Sewing Machine
½ mf 2000 V
2000 a sec.

Also
Silhouette
high speed
15000 - 20,000 feet/sec.

300 [illegible] of
a [illegible]
work of [illegible]

H. E. Edgerton.
Jan 2, 1938.

On Friday I polished the mirror of stainless steel that Buell gave me. This was made from a rod to fit a series motor of the type we use on the takeup reel of the camera.

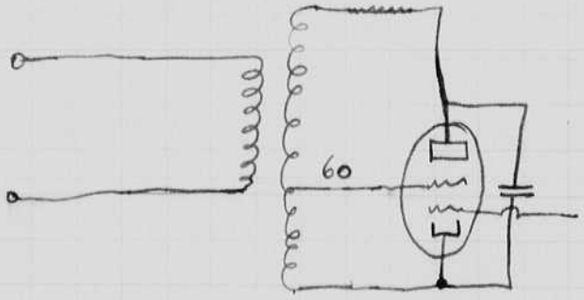


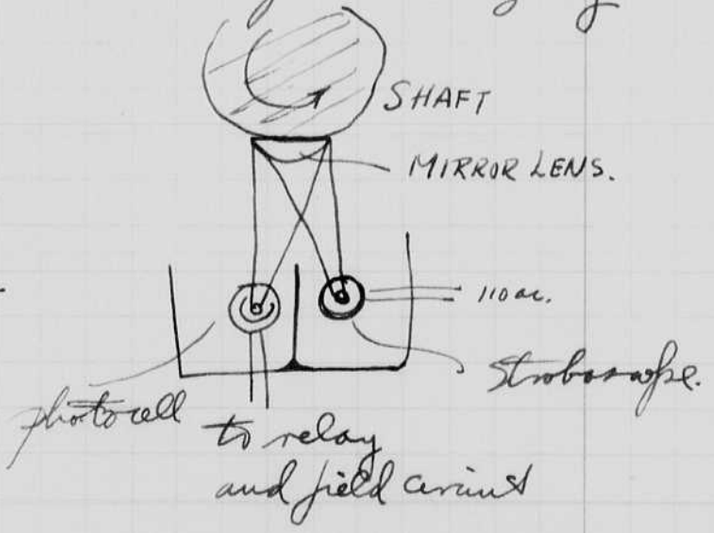
Flat surfaces to be polished into mirrors.

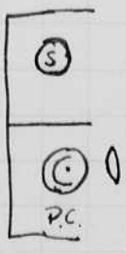
One side was finished to a fairly good surface on Friday afternoon I tried it out with a beam of light into the photocell trip circuit which is shown on p 17.

I aimed the "strobtac" at this same photocell amplifier unit and found it very sensitive.

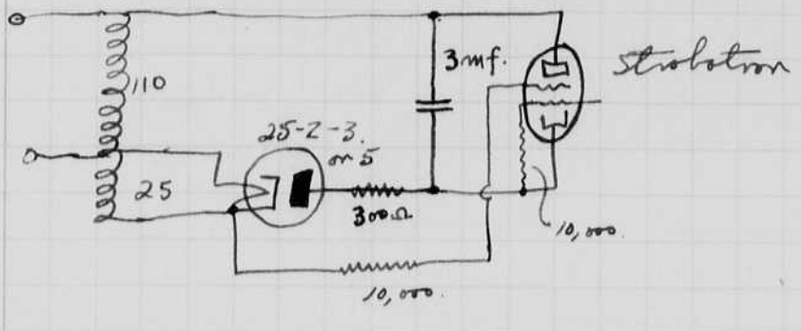
Synchronous motor synchronizing method.

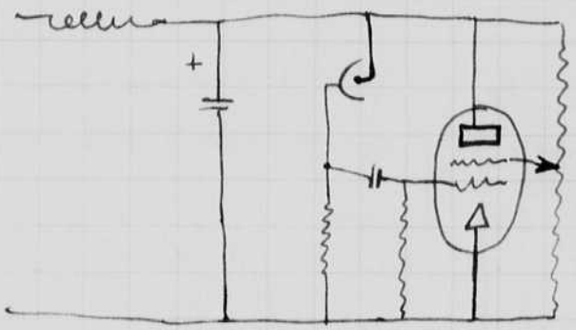


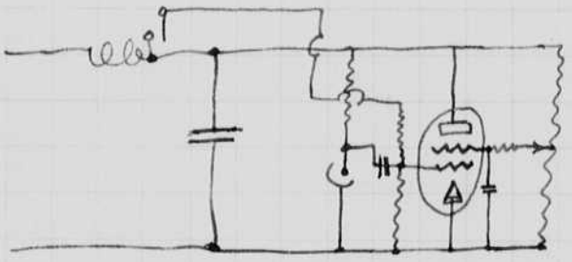


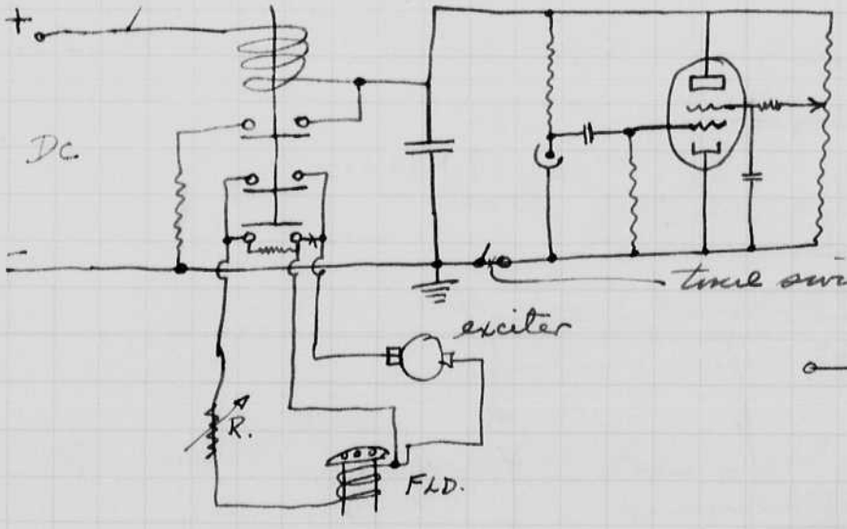


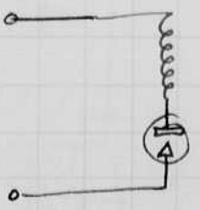
Adjustment
1. Move entire unit
2. Move mirror to new position.
3. Move strobo or P.C. to new position.
4. Adjust phase of stroboscope tube.


110
25
25-Z-3.
or 5
300Ω
3mf.
Strobotron
10,000
10,000

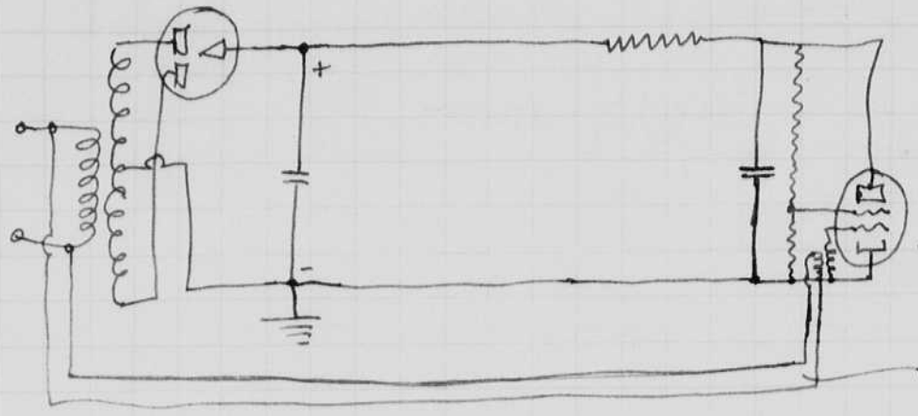

+




+
DC.
-
time switch or other control.
exciter
R.
FLD.



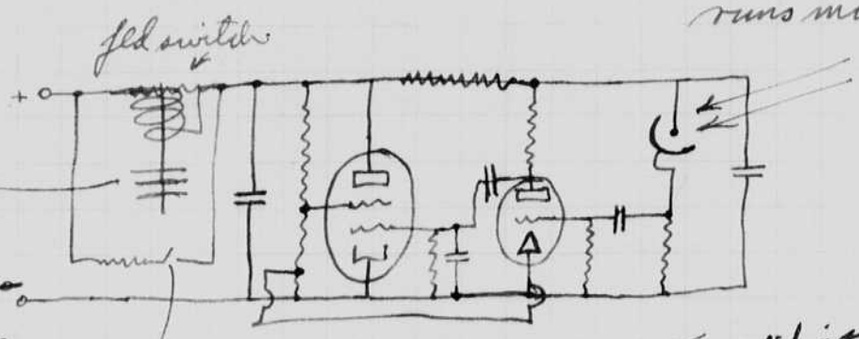
cont.



Strobo light.
one per cycle.

or from other source that runs motor.

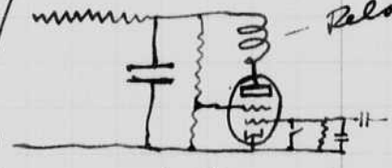
MIRROR



See prev. page for approx connections. this relay connects the field circuit as soon as the mirror reflects the light from the strobo scope tube.

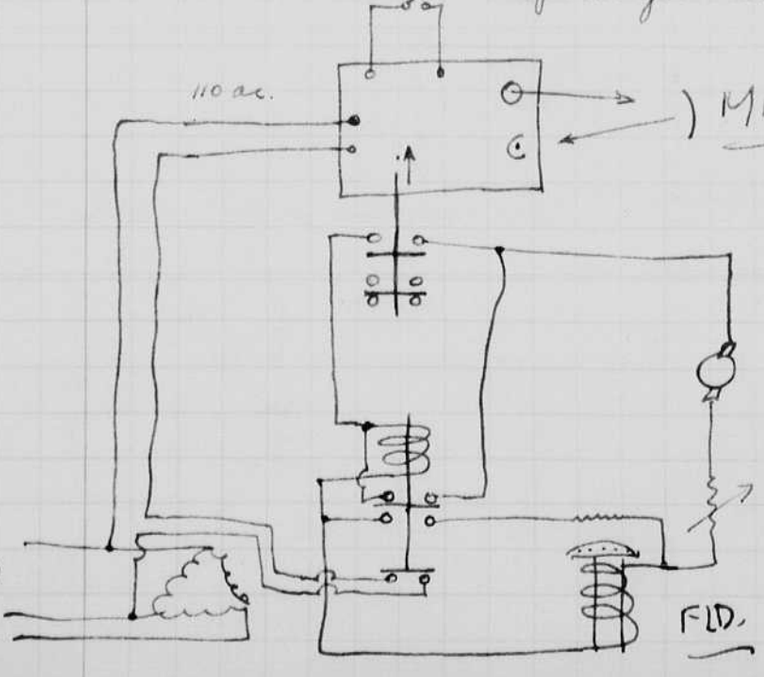
open when p.c. is to get control.

modification of above.



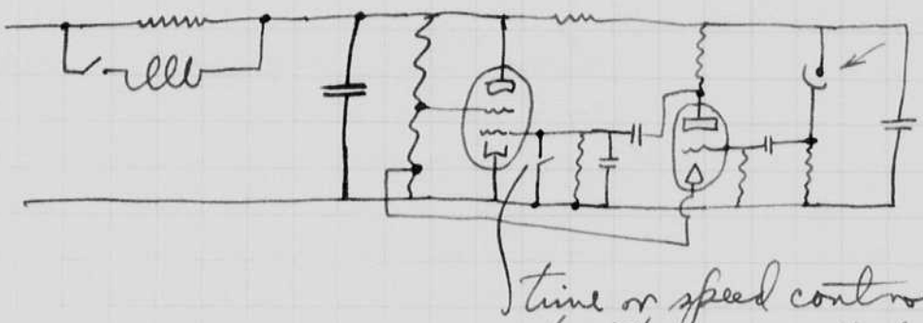
Extended on p. 95.

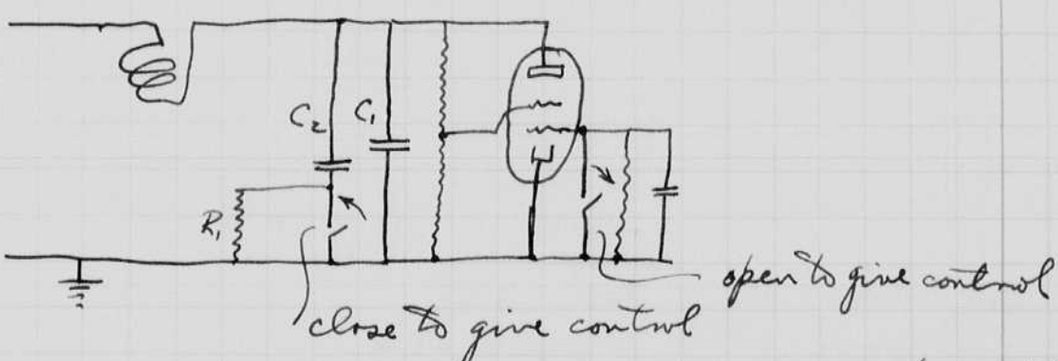
open to give control. time or speed control.



cont.

A better place to put the control switch would be across the ac grid bias or the 60 cycle strobotron or across the inner grid of the strobotron that trips the field circuit. This would prevent continuous operation during the starting period.





Both switches should be operated simultaneously when the speed or time switch indicates angle control time.

C_1 small condenser. - does not have enough current to trip relay field sw.

C_2 larger condenser - to trip field relay.

R_1 resistor to charge up C_2 slowly.

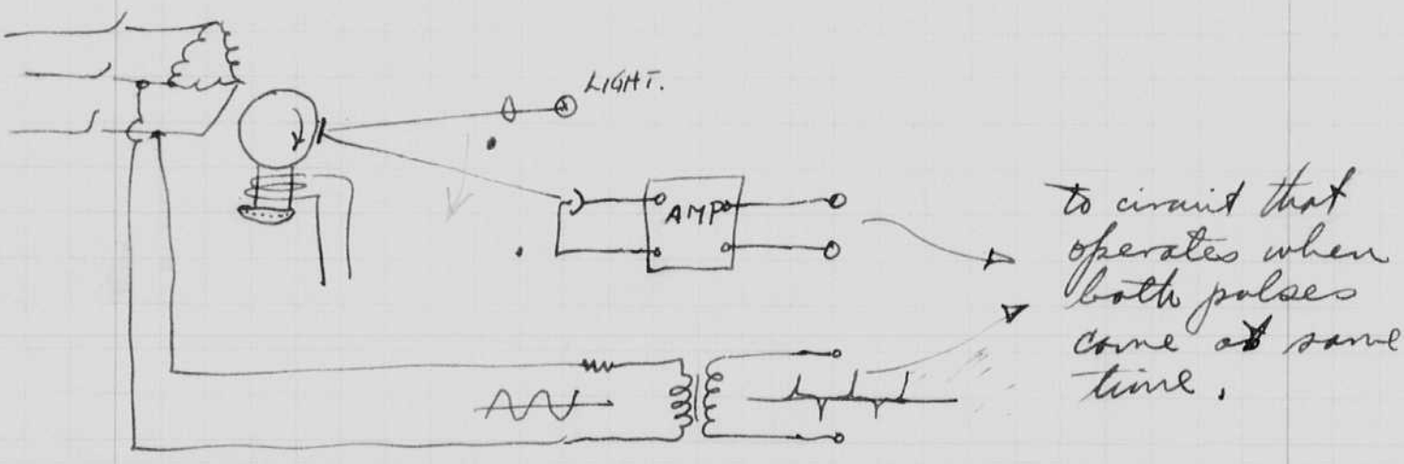
Jan. 3, 1938.

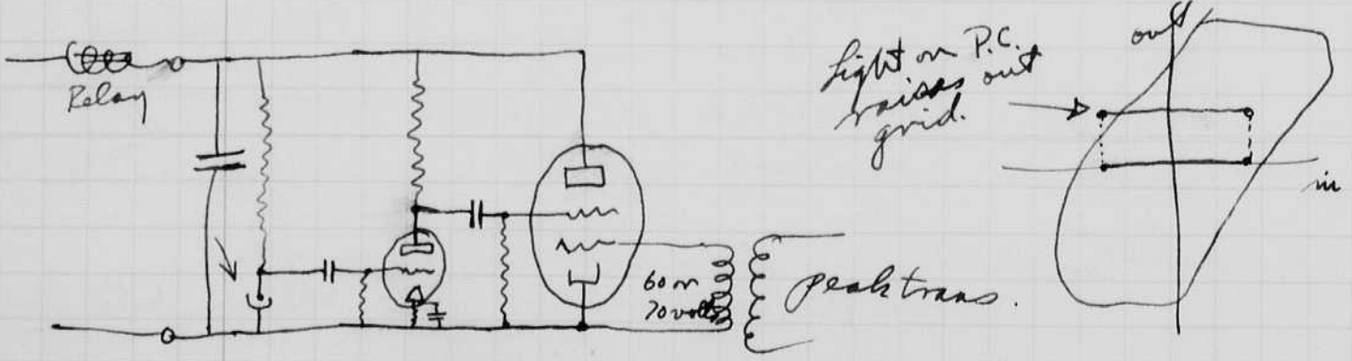
Angle-Switching System for a synchronous Motor.

Control - from rotor. Light reflected from a continuous light into a photo electric cell.

from stator - a voltage from a peaking transformer will be in phase with applied potential.

these two signals will be put into a thyratron on the two grids (or a double grid thyratron) to trip the field relay.

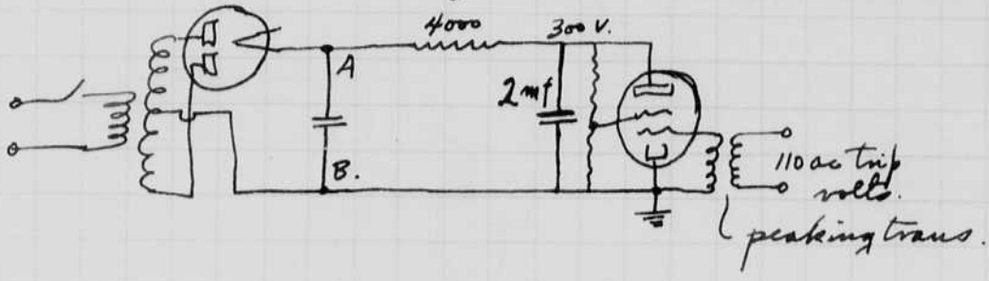


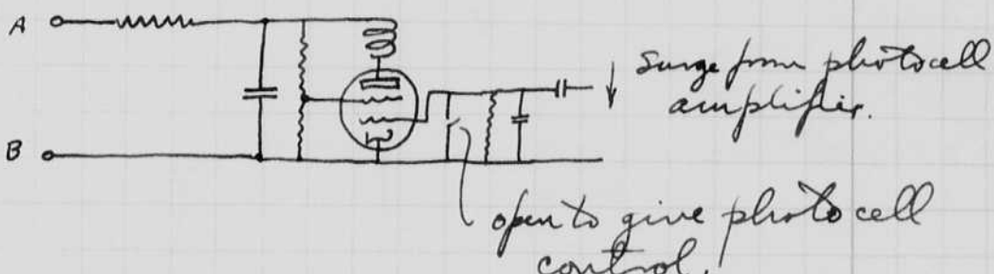


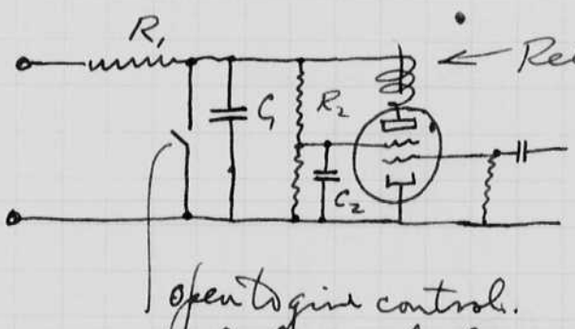
Jan. 6. 1938
H. E. Edgerton

Ford Tuttle and mr. Hopkins from Eastman were here today and we talked Speed photographing with them.

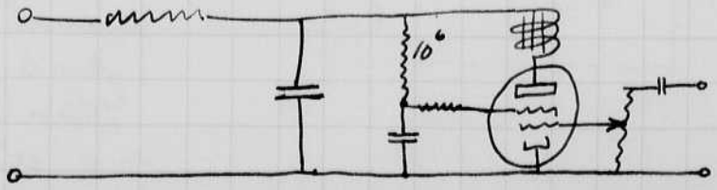
Field-Synchronizing methods.



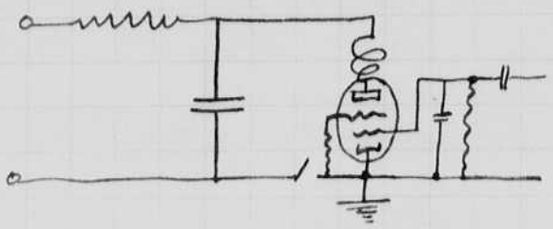


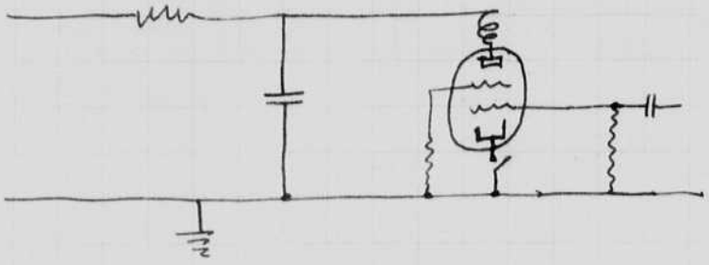


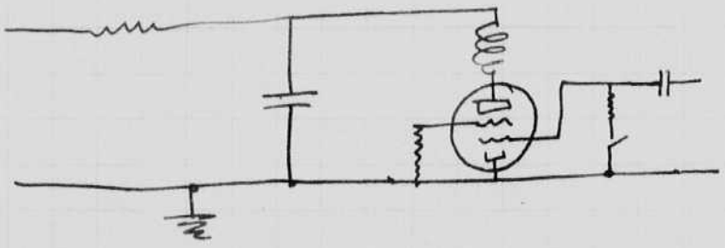
This can be accomplished by having $R_1 C_1 = 1/10$ sec.
and $R_2 C_2 = 1/5$ sec.
The surges on g, must be lower than 90 volts — say about 30 volts.

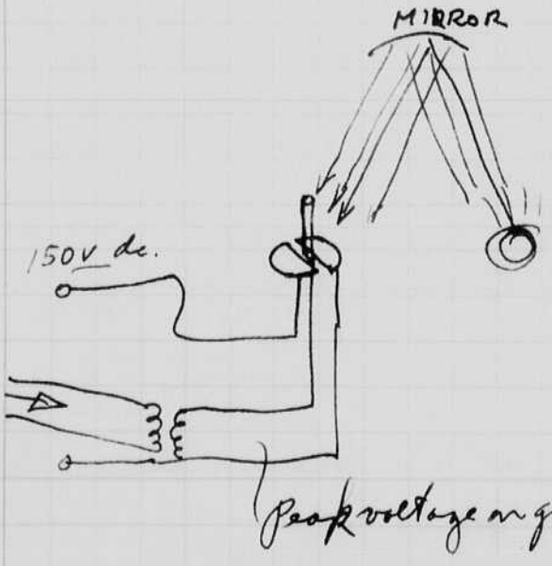


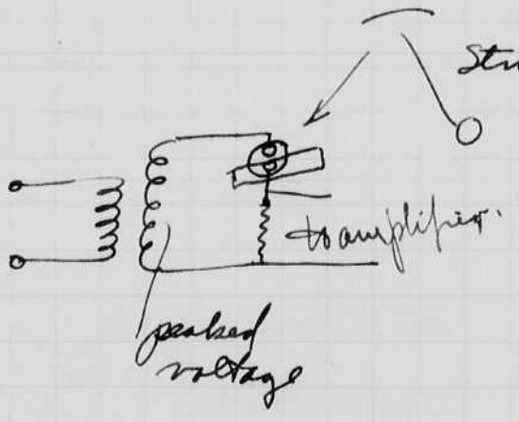
Cont.





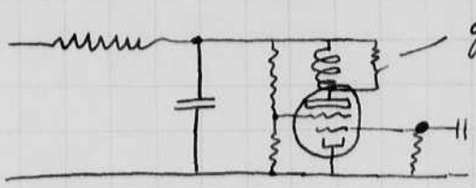


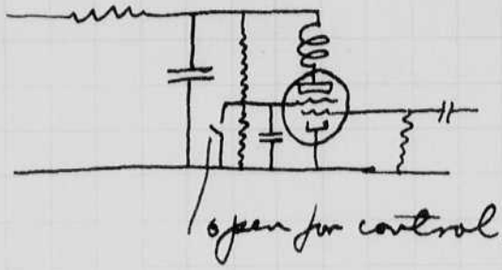


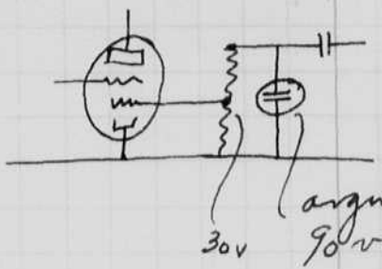


Light strikes sensitive surface and starts glow if peak voltage is greater than 100 volts. Only one electrode is exposed.

Cont.

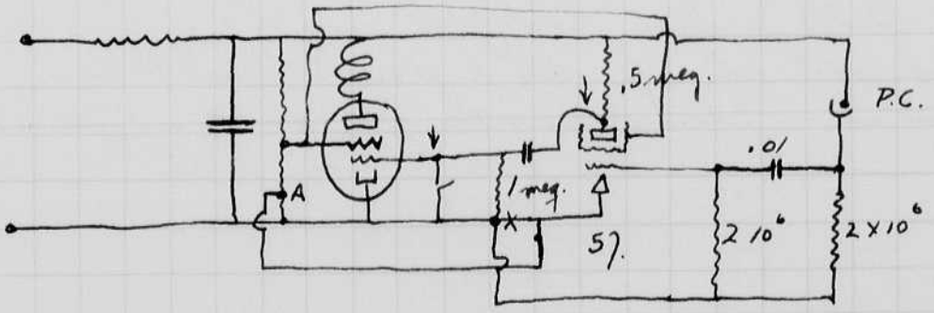






this might be used to prevent breakdown when outer grid was zero.

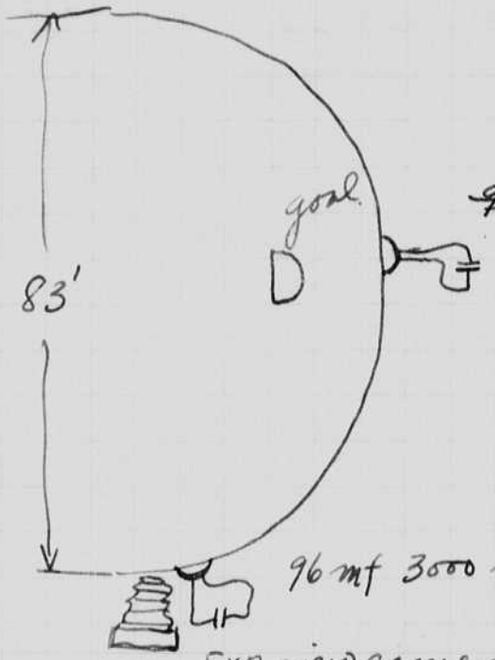
Still another method of control of time for starting would be to prevent the stroboscope from operating or obstructing the light.



Jan. 8. 1938.
H. E. Edgerton.

Mrs Mae Webster died yesterday. She was responsible for the humming bird photos. that were taken last summer and the summer before.

Today I tried out the flash units and made arrangements for photographing the Mc Gill Harvard hockey game. The set up is shown below.



~~96 mf 3000 volts.~~
48
24
72 mf 4000 v.

$\frac{CE^2}{2} = \frac{1150}{2}$ j

96 mf 3000 volts. $\frac{865}{2}$ joules.

5x7 view camera. f 8 Superpan Press.
3 at f 11

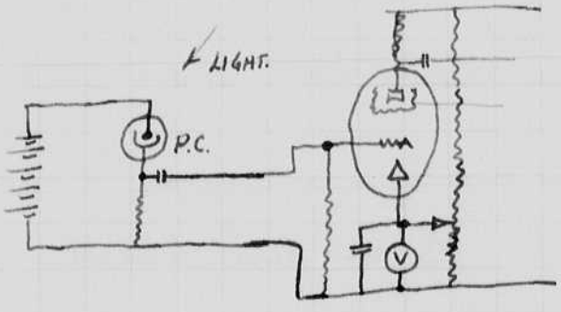
Verichrome at f 9. ~~6x7~~ 120 size.
under exposed.

Bill Tucker helped lug the apparatus over and set it up at 6 pm. Mr. Dear, electrician, ran in special lines for our apparatus.

Col. Deeds 20 Exchange place New York. Jan. 4. 1937 tues.

Jan 11. 1937. Method of measuring peak illumination from a flash lamp.

A photocell output will be connected to a regenerative amplifier with slide back control. the voltage to prevent operation will be measured.



as per page 17.

Jan. 8. 1938.
H. E. Edgerton.

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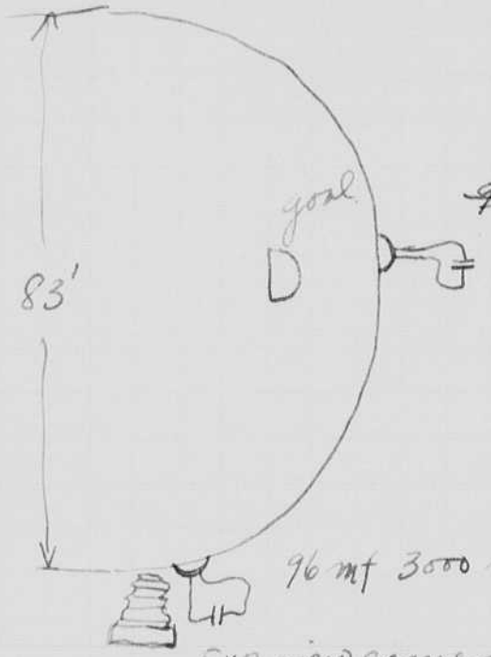

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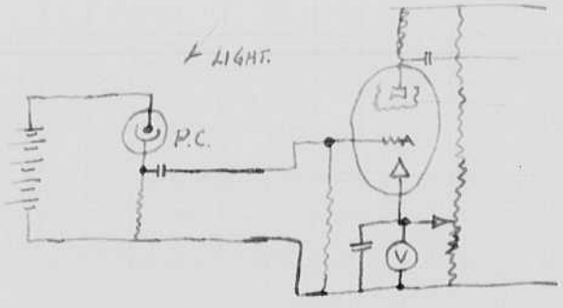

as per page 17.

Jan. 11, 1938.
H. E. Edgerton.

Photographic tests with argon flash lamps.

Lamp - V shaped argon lamp. 5/8" tube 8 or 10" long.

Set up - Kiethley's box 4" on a side. White inside. Lamp at center. ~~Photocell~~ ~~side~~.

Diaphragm in front of ground glass. 1/2" X 1/2"

Energy 48 mf 2600 volts. (2 meg x 1.6 ma.)

~~8~~-4-2-1-1 flashes.
Exp. ratio 8-4-2-1.

Dev. D72 X 4 H_2O Temp. 65 start - 66? 70°

No 1. 1/2 developed 3 min.
No 2. other 1/2 6 " .

Film Super speed Eastman Portrait.

No 3. Soft Agfa Bovira 1 1/2 min development. 70°
4 Medium "
5 ~~Hard~~ "
6 X hard. "
7 DOP normal
8 Chloride Eastman Press extra slow. (Harvey)
9 " Ditto with Double exp. on all strips

Notebook # 8

Filming and Separation Record

5? unmounted photograph(s) inside envelope mounted on page 101

____ negative strip(s)

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

was/were filmed where originally located between page 100 and 101.

Item(s) now housed in accompanying folder.

Jan. 11, 1938.
#2 Explorer.

Photographic tests with argon flash lamps.

Lamp - V shaped argon lamp. 5/8" tube 8 or 10" long.

Setup. — Kreibig's box 4" on a side. White inside. Lamp at center. ~~Photo at side~~.

Diaphram in front of ground glass. 1/2" X 1/2"

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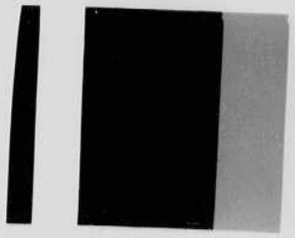
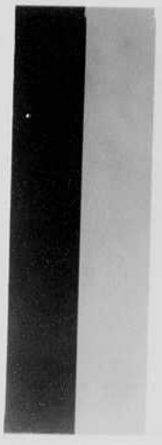
4

med

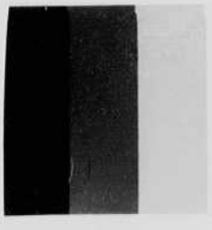


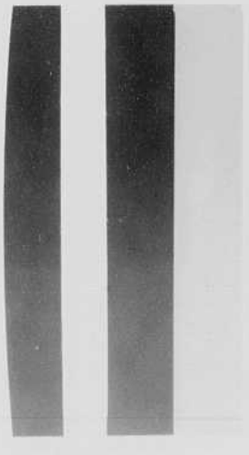


Ch

x 2

Hard



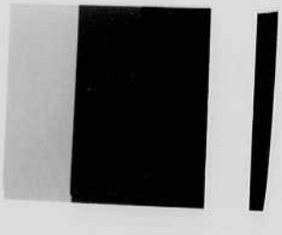


3

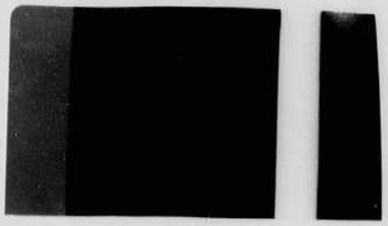
Soft

agta

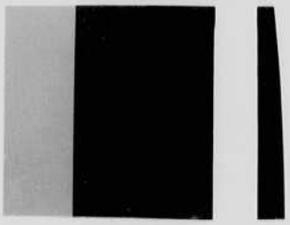
Ch



X Hard

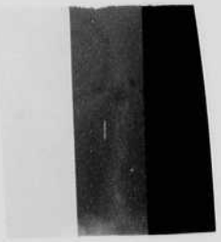


3
SOFT



4
med.

Chloride 8x exposure to Bovina medium.



5
Hard.

6
X Hard

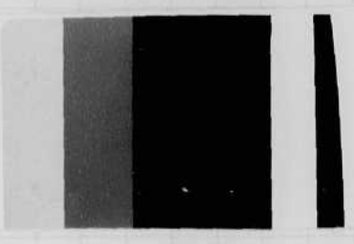
8
Chloride

9
Chloride
X 2.


med

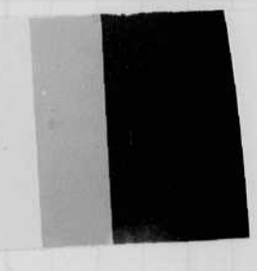

Hard

3
SOFT

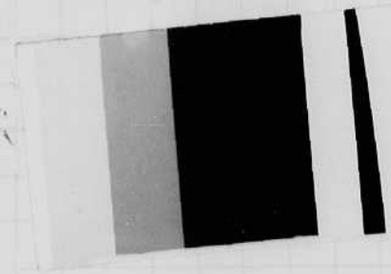


4
med.

Ch. neg. 8x exposure to
Bovira medium.

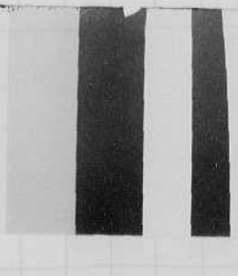


5
Hard.

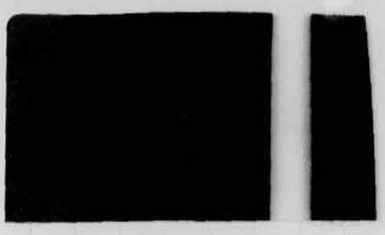


6
X Hard

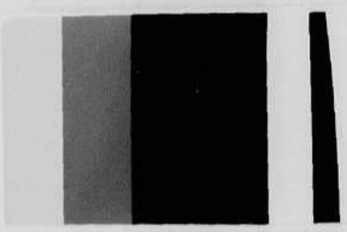
8
Chloride



9
Chloride
X 2.

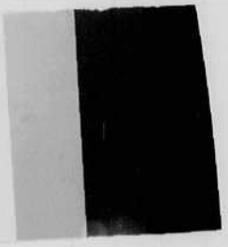


3
SOFT

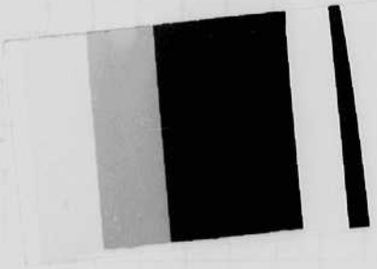


4
med.

Ch. neg. 8x exposure on
Bovira medium.

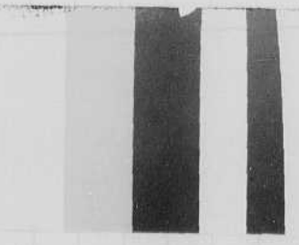


5
Hard.



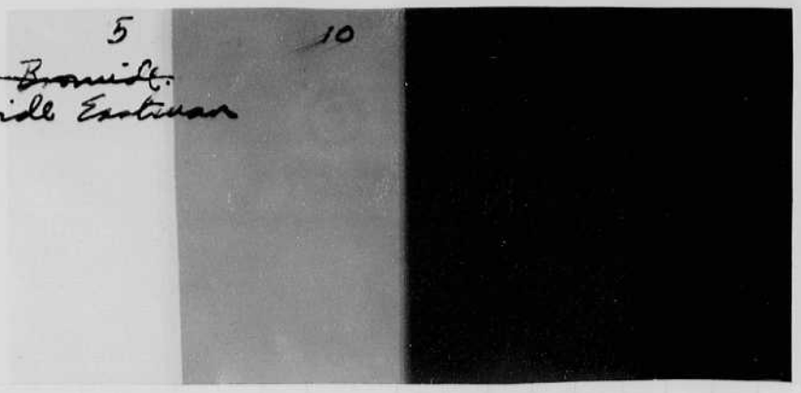
6
X Hard

8
Chloride

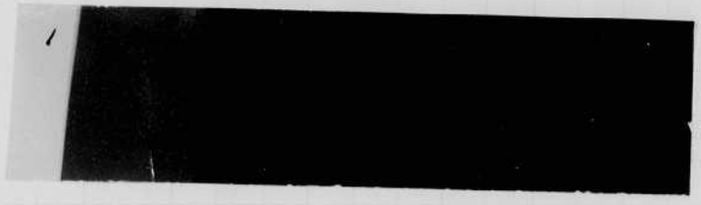


9
Chloride
X 2.

Jan. 12, 1938



~~Med. Bromide~~
Chloride Eastman



Med.
Brown.

50 watt lamp about 6" from surface
Ground Glass in front of lamp.

Jan 13 1938.

Exposure tests with
different size lamps.

Zeiss Orthopress Eastman (Dated 1933)
Developed 6 min. D76. 70°

48 mf. 1. 2600 volts 10" U lamp.
8 4 21 flashes. 1/4" hole

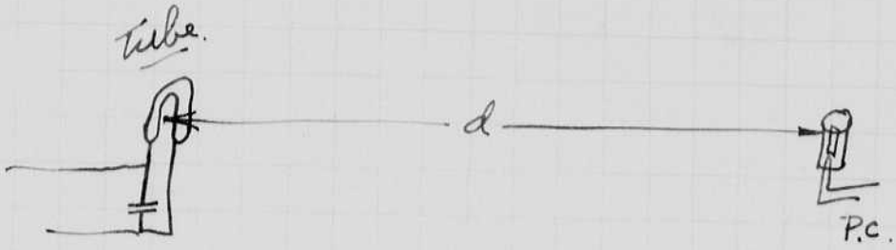
2. 2600 " 2" st lamp.
8 4 21 flashes "
this was covered during development.

3. 2000 volts 10" U lamp. U 8, 4, 2, 1. 6 in.

4 " 2" " " 6 in

Jan 13 1938

Meas of Instant. candle power with photo cell and regenerative amplifier.



Illumination in foot candles = $\frac{C.P.}{d^2}$ = ft. candles.

= lumens / sq. foot.

Lumens on P.C = area of cathode x lumens/sq ft.

= $A \frac{C.P.}{d^2}$ A in square ft.

Example. calculate current in P.C. with 10^6 C.P. source at 10'

Illumination = $\frac{10^6}{10^2} = 10^4$ lumens/sq ft.

area = 1 sq in = $1/144$ sq. ft.

Lumens on cathode = $\frac{10^4}{144} = 69.4$ lumens.

Assume cell sensitivity = 10 ma/lumen = S

cell current = 10×69.4 ma = 694 ma

= 0.694 ma.

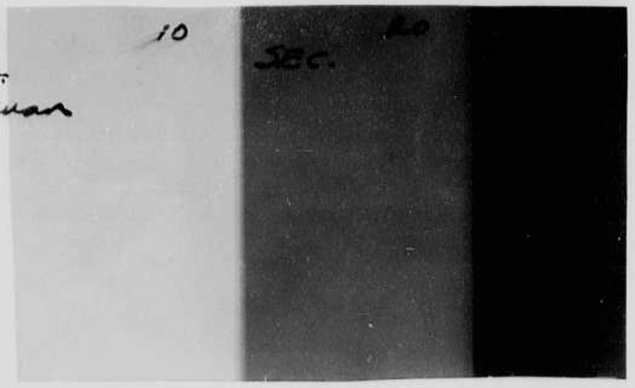
Drop in 10^4 resistor (R) = 6.94 volts.

$E = R \left(\frac{A\ C.P.}{d^2}\right) S \times 10^{-6}$

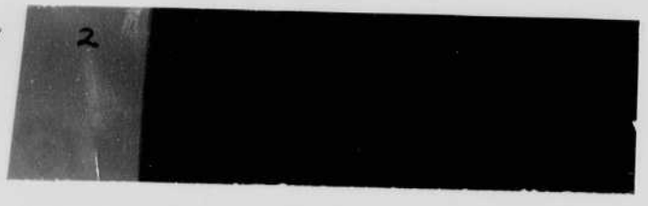
$C.P = \frac{d^2 E}{RAS.} \times 10^6$

d in feet.
E = volts
R = resistance ohms
A = area of P.C. cathode in sq. ft.
S = Sensitivity of P.C. ma/lumen.

jan. 12. 1938



~~Med. Bromide~~
Chloride Eastman



Med.
Brom.

50 watt lamp about 6" from surface
Ground Glass in front of lamps.

Jan 13 1938.

Exposure tests with
different size lamps.

Peter orthopress Eastman (Dated 1933)
developed 6 min. D76. 70°

48 mf. 1. 2600 volts 10" U lamp.
8 4 21 flashes. 1/4" hole

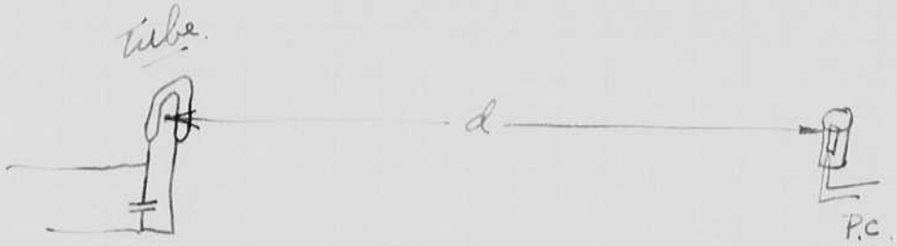
2. 2600 " 2" st lamp.
8 4 21 flashes "
this was covered during development.

3. 2000 volts 10" U lamp. U 8,4,2,1. 6 mm.

4 " 2" " " 6 mm

Jan 13 1938

Meas of instant. candle power with photo cell and regenerative amplifier.



Illumination in foot candles = $\frac{C.P.}{d^2}$ = ft. candles.

= lumens / sq. foot.

Lumens on P.C = area of cathode x lumens / sq ft.

= $A \frac{C.P.}{d^2}$ A in square ft.

Example. calculate current in P.C. with 10^6 C.P. source at 10^4

Illumination = $\frac{10^6}{10^2} = 10^4$ lumens / sq ft.

area = 1 sq in = $1/144$ sq. ft.

Lumens on cathode = $\frac{10^4}{144} = 69.4$ lumens.

Assume cell sensitivity = 10 ua / lumen = S

cell current = 10 x 69.4 ua = 694 ua

= 0.694 ma.

Drop in 10^4 (R) resistor = 6.94 volts.

$$E = R\left(\frac{A\ C.P.}{d^2}\right) S \times 10^{-6}$$

$$C.P = \frac{d^2 E}{RAS.} \times 10^6$$

d in feet.
E = volts
R = resistance ohms
A = area of P.C. cathode in sq. ft.
S = Sensitivity of P.C. ua/lumen.

Jan. 12, 1938

50 watt lamp about 6" from surface
Ground glass in front of lamp.

Jan 13 1938.

Exposure tests with
different size lamps.

Film Ortho press Eastman (Dated 1933)
developed 6 min. D76. 70°

48 mf. 1. 2600 volts 10" U lamp.
8 4 21 flashes. 1/4" hole

2. 2600 " 2" st lamp.
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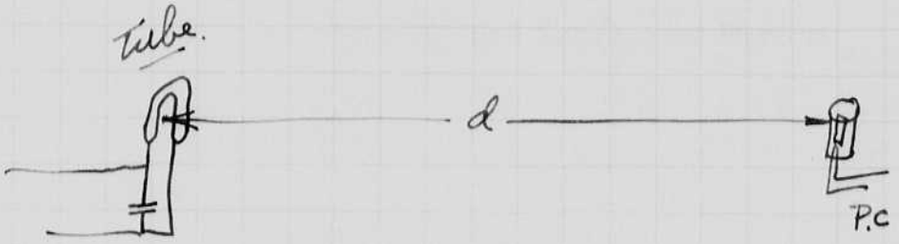
this was covered during development.

3. 2000 volts 10" U lamp. U 8, 4, 2, 1. 6 mm.

4 " 2" " " 6 mm

Jan 13 1938

Meas of Instant. candle power with photo cell and regenerative amplifier.



Illumination in foot candles = $\frac{C.P.}{d^2}$ = ft. candles.

= lumens / sq. foot.

Lumens on P.C = area of cathode x lumens/sq ft.

= $A \frac{C.P.}{d^2}$ A in square ft.

Example. calculate current in p.c. with 10^6 C.P. source at 10'

Illumination = $\frac{10^6}{10^2}$ = 10^4 lumens/sq ft.

area = 1 sq in = 1/144 sq. ft.

Lumens on cathode = $\frac{10^4}{144}$ = 69.4 lumens.

Assume cell sensitivity = 10 ma/lumen = S

cell current = 10 x 69.4 ma = 694 ma

= 0.694 ma.

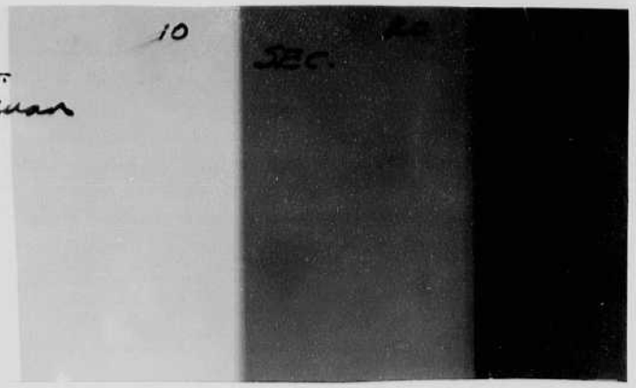
Drop in 10^4 resistor (R) = 6.94 volts.

$E = R \left(\frac{A\ C.P.}{d^2}\right) S \times 10^{-6}$

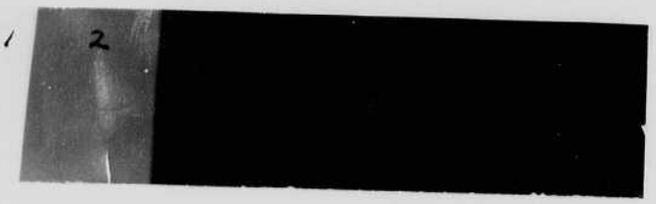
$C.P = \frac{d^2 E}{RAS.} \times 10^6$

d in feet.
E = volts
R = resistance ohms
A = area of P.C. cathode in sq. ft.
S = Sensitivity of P.C. ma/lumen.

Jan. 12. 1938



~~Med. Brownish~~
Chloride Eastman



Med. Brown.

50 watt lamp about 6" from surface Ground Glass in front of lamps.

Jan 13 1938.

Exposure tests with different size lamps.

Film Orthos pres Eastman (Dated 1933)
developed 6 min. D76. 70°

48 mf. 1. 2600 volts 10" V lamp.
8 4 21 flashes. 1/4" hole

2. 2600 " 2" st lamp.
8 4 21 flashes "
this was covered during development.

3. 2000 volts 10" V lamp. V 8,4,2,1. 6 mm.

4 " 2" " " " 6 mm

Jan 13, 1938

Meas of instant. candle power with photo cell and regenerative amplifier.

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= lumens / sq. foot.

Lumens on P.C = area of cathode x lumens/sq ft.

= $A \frac{C.P.}{d^2}$ A in square ft.

Example. calculate current in P.C. with 10^6 C.P. source at 10'

Illumination = $\frac{10^6}{10^2} = 10^4$ lumens/sq ft.

area = 1 sq in = 1/144 sq. ft.

Lumens on cathode = $\frac{10^4}{144}$ = 69.4 lumens.

assume cell sensitivity = 10 ma / lumen = S

cell current = 10 x 69.4 ma = 694 ma

= 0.694 ma.

Drop in 10^4 resistor (R) = 6.94 volts.

$E = R \left(\frac{A\ C.P.}{d^2}\right) S \times 10^{-6}$

$C.P = \frac{d^2 E}{RAS.} \times 10^6$

d in feet.
E = volts
R = resistance ohms
A = area of P.C. cathode in sq. ft.
S = Sensitivity of P.C. ma/lumen.

		0	1	2	4	8	
1-11-38	No 2.	18.8	4.5	3.1	2.2	1.6	
		71.2	85.5	86.9	87.8	88.4	
		.95	2.21	2.53	2.83	3.11	D.
			8	4	2	1	
"	No 1	24.9	3.0	4.1	6.3	9.4	
		65.1	87.0	85.9	83.7	80.6	
		.31	2.56	2.79	1.91	1.56	
1-13-38	1	30.8	10.8	13.0	15.6	18.2	
		69.2 61.7	84.8	84	81.9	80.7	
		.54	2.08	1.96	1.69	1.57	
	2	NG.					
	3	58.6	77.9	75.7	73.8	71.3	72.4
		.43	1.34	1.19	1.07	.94	
	4	58.6	75.2	72.2	69.8	65.9	
		.43	1.16	.99	.87	.70	

Photostrongs changed.

Notebook # 8

Filming and Separation Record

____ unmounted photograph(s)

6? negative strip(s) inside envelope mounted on page 104

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

was/were filmed where originally located between page 104 and 105.

Item(s) now housed in accompanying folder.

			0	1	2	4	8	
1-11-38	No 2.		18.8	4.5	3.1	2.2	1.6	
			71.2	85.5	86.9	87.8	88.4	
			.95	2.21	2.53	2.83	3.11	D.
				8	4	2	1	
"	No 1		24.9	3.0	4.1	6.3	9.4	
			65.1	87.0	85.9	83.7	80.6	
			.31	2.56	2.79	1.91	1.56	
1-13-38		1	30.8	10.8	13.0	15.6	18.2	
			69.2 61.7		84	81.4	80.7	
			.54	2.08	1.96	1.69	1.57	
		2	NG.					
		3	58.6	77.9	75.7	73.8	71.3	72.4
			.43	1.34	1.19	1.07	.94	
		4	58.6	75.2	72.2	69.8	65.9	
			.43	1.16	.99	.87	.70	

Plate to be changed.

Notebook # 8

Filming and Separation Record

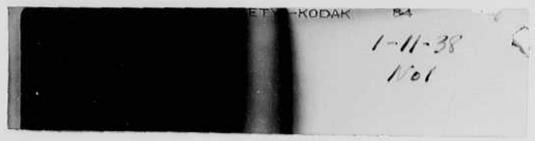
____ unmounted photograph(s)

6? negative strip(s) inside envelope mounted on page 104

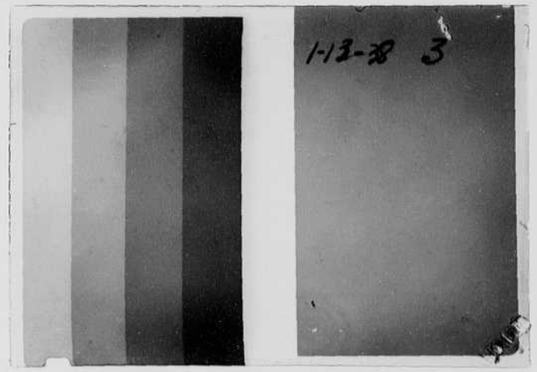
____ unmounted page(s)
(notes, drawings, letters, etc.)

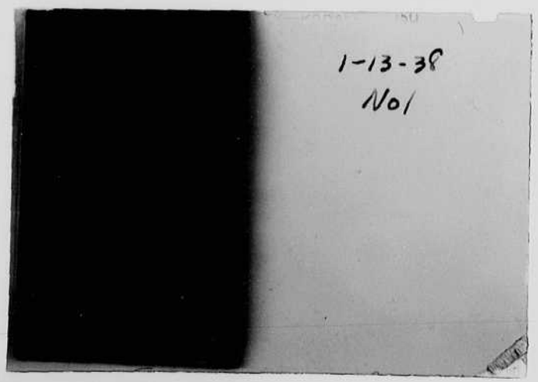
was/were filmed where originally located between page 104 and 105.

Item(s) now housed in accompanying folder.

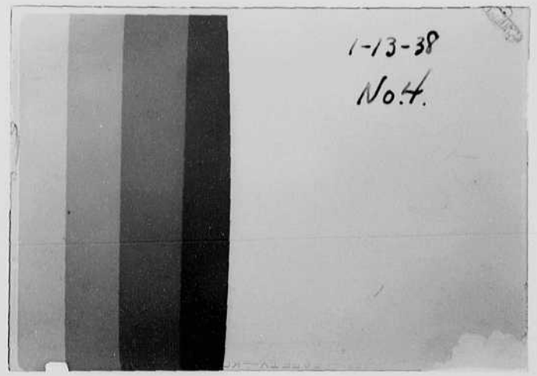

1-11-38
No1

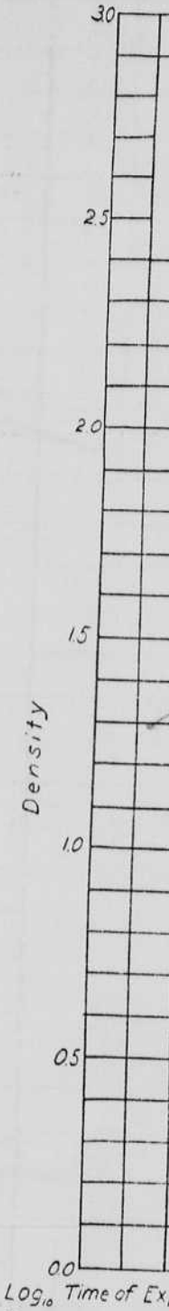

1-11-38
No2

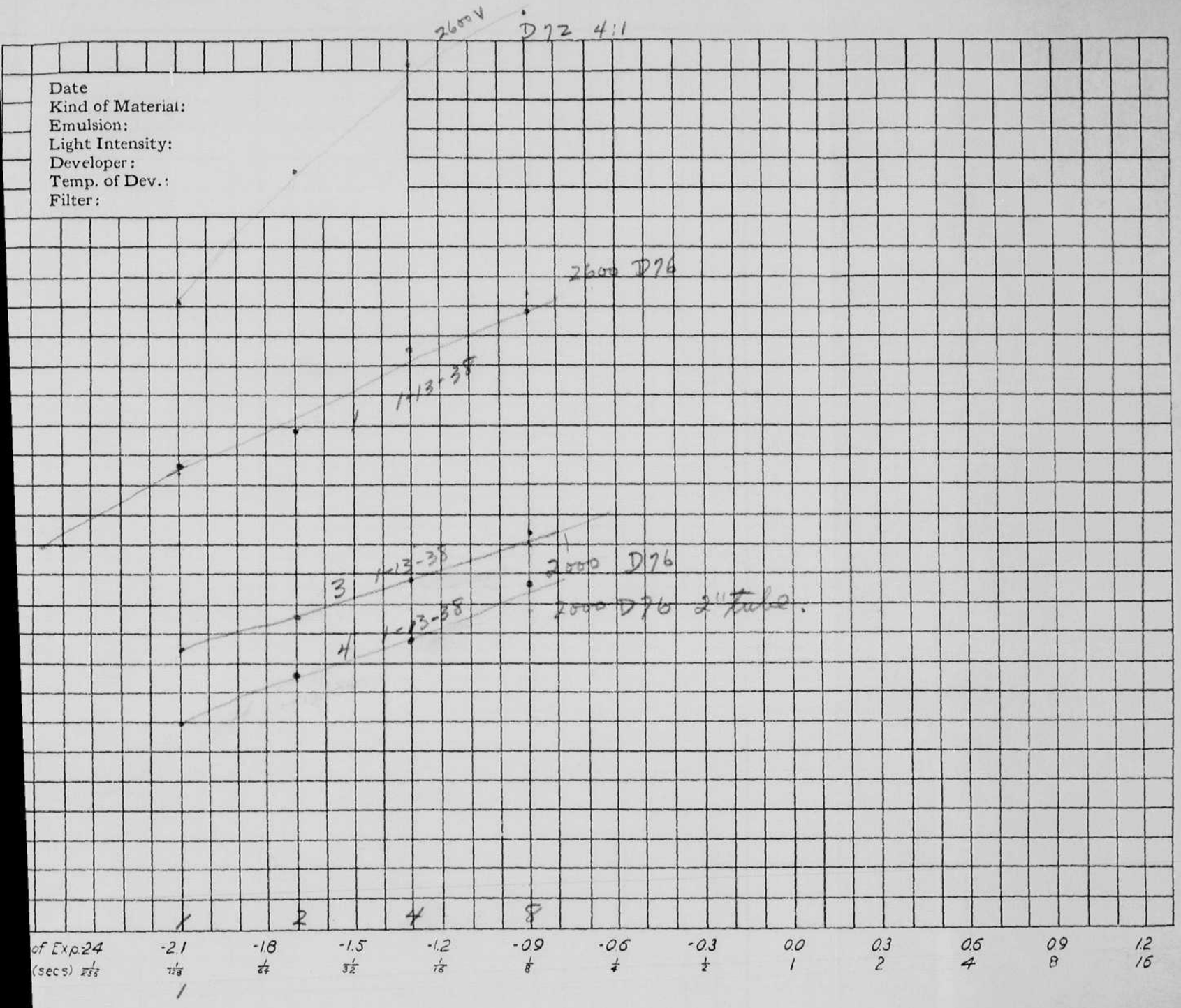

1-13-38 3


1-13-38
No1


1-13-38
#2


1-13-38
No.4.


3.0
2.5
2.0
1.5
Density
1.0
0.5
0.0
Log10 Time of Ex
Exposure (secs


2600 D72 4:1
Date
Kind of Material:
Emulsion:
Light Intensity:
Developer:
Temp. of Dev.:
Filter:
2600 D76
1+13-38
3
1+13-38
2000 D76
4
1+13-38
2000 D76 2" tube.
1
2
4
8
of Exp. 24
(secs) 1/256
-2.1
1/128
-1.8
1/64
-1.5
1/32
-1.2
1/16
-0.9
1/8
-0.6
1/4
-0.3
1/2
0.0
1
0.3
2
0.6
4
0.9
8
1.2
16
1

1-14, 1938
H. E. Edgerton.

Cont. of tests.

Film ortho Press Eastman 533.
U lamp 48 mf.

No 1	16 8 4 2 1	flashes.	~~1.8ma~~ $\times 2\times10^{6}$ 2600 volts.
No 2.	16 8 4 2 1	"	$1.2\times2\times10^{6}\times10^{-3}$ 2400 v.

note two of the flashes in the 16 were low about 2200± volts or less.

for exposure the 2nd slightly.

No 3 16 8 4 2 1 " $10^{-3}\ 1\times2\times10^{6} = 2000$ v.

No ~~4~~ " " $10^{-3}\ 1.9\times2\times10^{6} = 2800$ v.

this should have no effect on the result.

above strips cut in two parts and developed in fresh D76. 10 and 20 min.

Notebook # 8

Filming and Separation Record

____ unmounted photograph(s)

7? negative strip(s) inside envelope mounted on Page 106

____ 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.

Density

Log
Expo

1-14, 1938
H. E. Edgerton.

Cont. of tests.

Film ortho Press Eastman 533.
U lamp 48 mf.

No 1 16 8 4 2 1 flashes. ~~1.8~~ ma x 2×10^6 2600 volts.

No 2. 16 8 4 2 1 " $1.2 \times 2 \times 10^6 \times 10^{-3}$ 2400 v.
note two of the flashes in the 16 were low about 2200± volts or less.

for print slightly changed slightly.

No 3 16 8 4 2 1 " 10^{-3} $1 \times 2 \times 10^6 = 2000$ v.

No 4 " " 10^{-3} $1.9 \times 2 \times 10^6 = 2800$ v.

this should have no effect on the results.

above strips cut in two parts and developed in fresh D76. 10 and 20 min.

Notebook # 8

Filming and Separation Record

___ unmounted photograph(s)

7? negative strip(s) inside envelope mounted on page 106

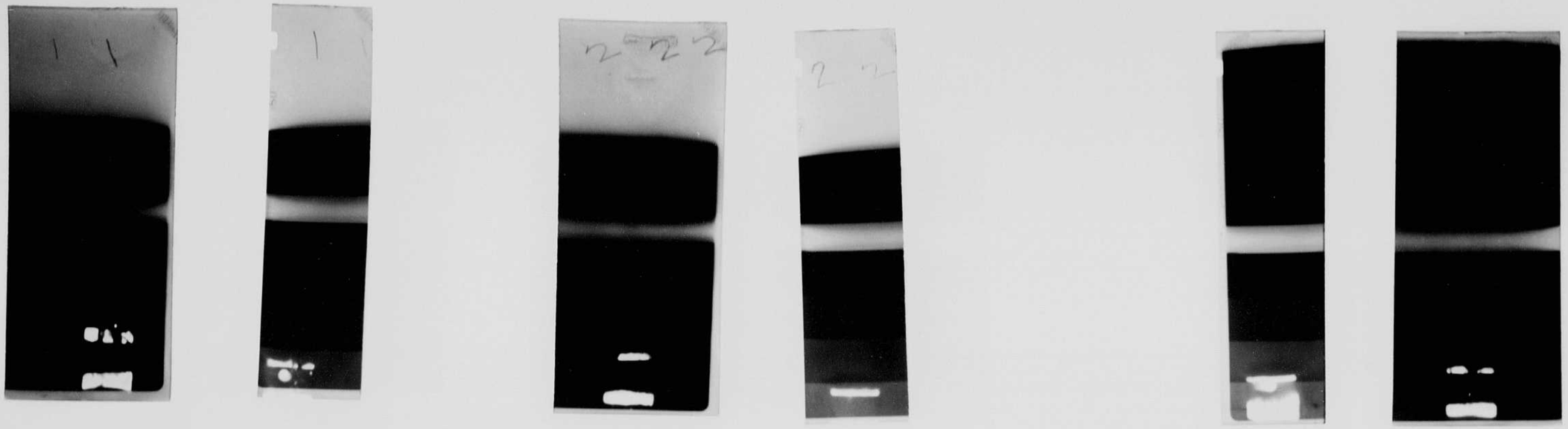
___ unmounted page(s)
(notes, drawings, letters, etc.)

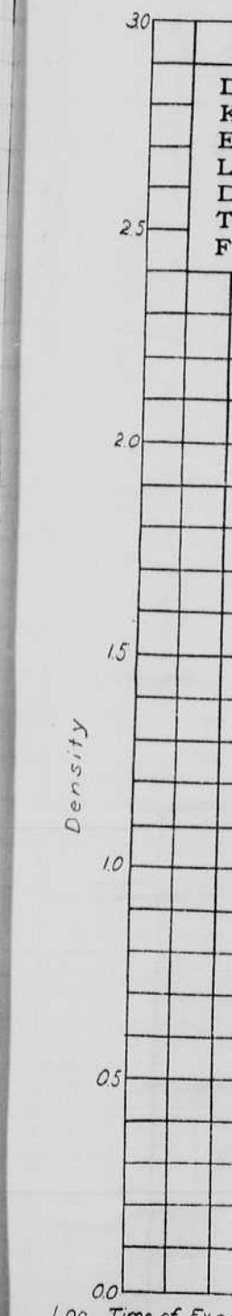
was/were filmed where originally located between page 106 and 107.

Item(s) now housed in accompanying folder.

Density

Log
Expo

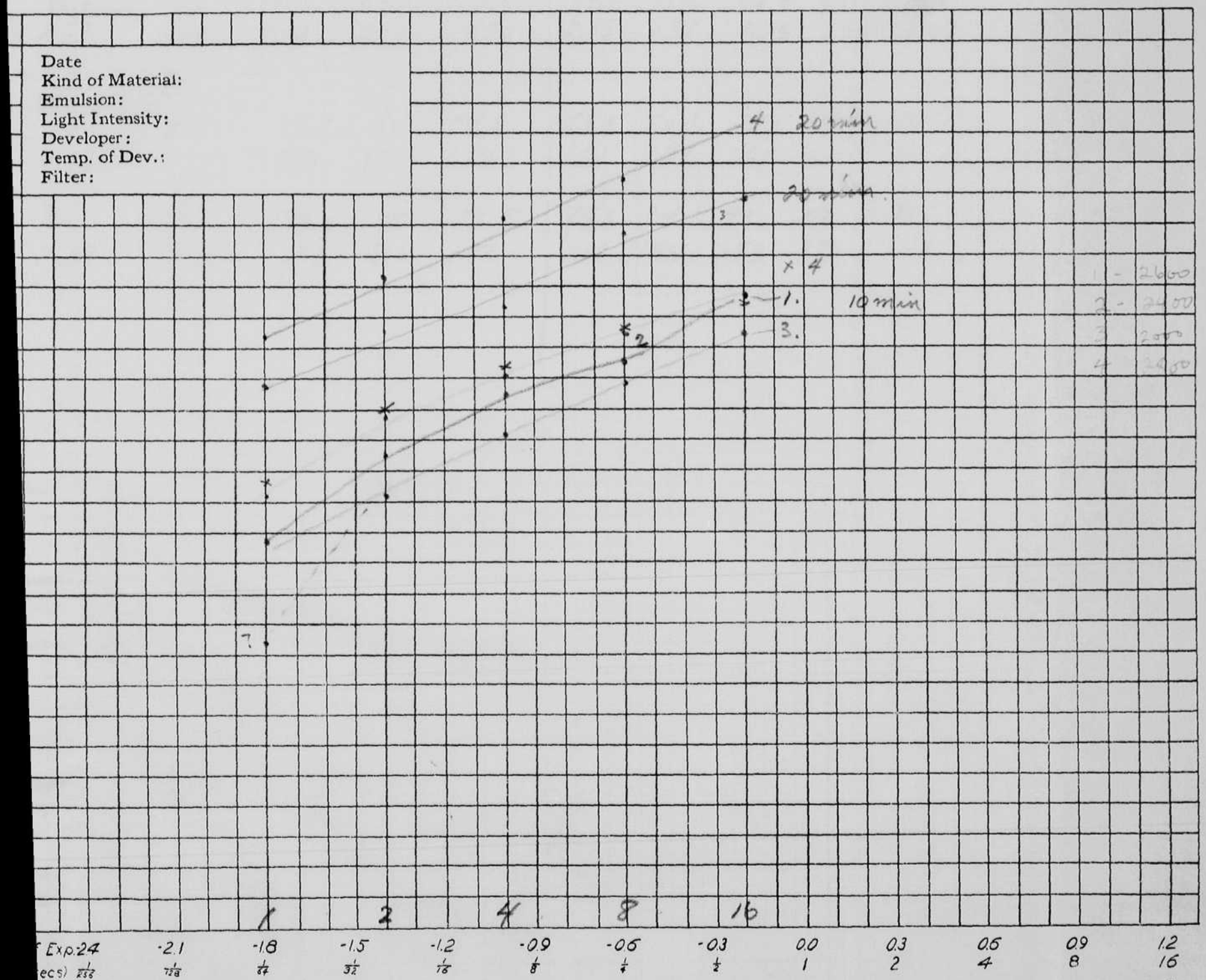



30
25
2.0
1.5
1.0
0.5
0.0
Density
Log10 Time of Exp
Exposure (secs)

20 min

					10 min				
87°	86.8	86	84.8	84.	84.7	83.9	82.8	81.8	78.8
2.56	2.51	2.31	2.06	1.96	2.07	1.94	1.80	1.68	1.41

Date
Kind of Material:
Emulsion:
Light Intensity:
Developer:
Temp. of Dev.:
Filter:



Exp.	-2.1	-1.8	-1.5	-1.2	-0.9	-0.6	-0.3	0.0	0.3	0.6	0.9	1.2
(secs)	1/256	1/128	1/64	1/32	1/16	1/8	1/4	1/2	1	2	4	8	16

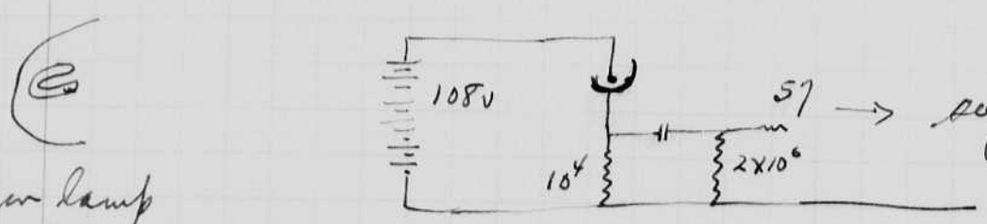
20 min

87°	86.8	86	84.8	84.	84.7	83.9	82.8	81.8	78.8
2.56	2.51	2.31	2.06	1.96	2.07	1.94	1.80	1.68	1.41
9	86.5	85.9	84.9	83.6	84.6	83.2	82.4	80.5	76.9
3	2.43	2.29	2.10	1.90	2.05	1.86	1.75	1.55	1.27
2	85.8	85.1	84.	82.6	83.9	82.7	81.1	78.9	71?
8	2.27	2.13	1.96	1.77	1.94	1.78	1.61	1.41	.93
3	86.6	86.0	85	83.8	84.6	84	83.1	82	79.5
8	2.45	2.31	2.12	1.93	2.05	1.96	1.83	1.70	1.46

10 min

Jan 12 1938
H. E. Edgerton

Worked Sat and today trying scheme for measuring intensity (peak) of flash units. See page 99.



argon lamp
2 mf. 3000 v±.

At a distance of 15± feet the peak light was enough to ~~start~~ the 57 with bias of 7 to 10 volts greater than the critical.

C.P. from equation page 103.

$$= \frac{d^2 E 10}{RAS.} = \frac{15 \times 15 \times 10}{10^4 \quad \frac{1}{144} \quad 10} = \frac{144\ 256\ 10^6}{10^4} =$$

256
144
1024
1024
256
36864

$$= 3,686,400 \text{ c.p.}$$

Instantaneous C.P. = > 3.6×10^6
since the 10 volts bias was not enough to keep the 57 from firing.

The 57 amp did not fire when the light was covered - showing that the electrical transients did not reach the amplifier.

Jan. 25, 1938
Harold E. Edgerton.

Moore and Bradett left on the Federal 9 P.M. for Washington D.C. We spent yesterday and today taking pictures of vocal cords.

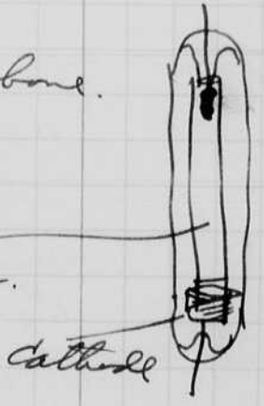
Stroboscopic movies - with Victor 16 mm camera. Argon lamp with greatly restricted 4 pi area. 12 mf. 2500 volts. 24 per. SS pan film negative. This was developed at Harvard Film service. The stroboscope was fired by the shutter of the camera. A 16 c.p. lamp was put in front - light went through the Victor focusing mount and then into a photocell amplifier of the type that triggers the thyratron.

f 4.5 6" lens

High-speed movies - considerable difficulty was encountered in lining up the optical part of the experiment. The same 6" lens was used but it was pushed out farther to produce a larger image on the film. Most of the films were out of line.

f 4.5 6" lens. 23" to subject?

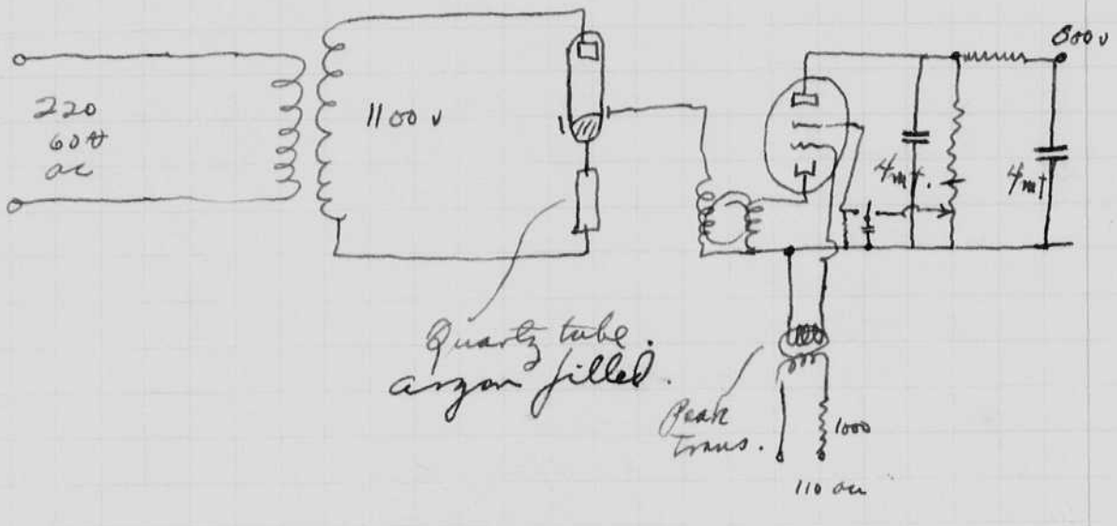
2500 - 3000 volts from M.G. set
1 mf 400 ohms. Argon lamp as above.

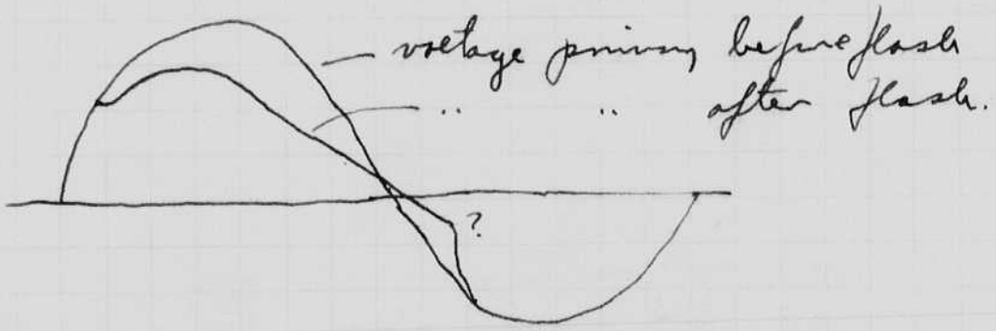


Last week I worked two afternoons with Gilfillin(?) and Rubenstein of A. D. Little Co. We exposed some oil (think) in thin layers on a glass slide with U.V. light from condenser discharges. Data was recorded in their note book.

Jan. 27, 1938.
Howard S. Ogden.

Last night I connected up the following circuit for producing flashes of U.V. light for Gil Gillin (S.D. Little).

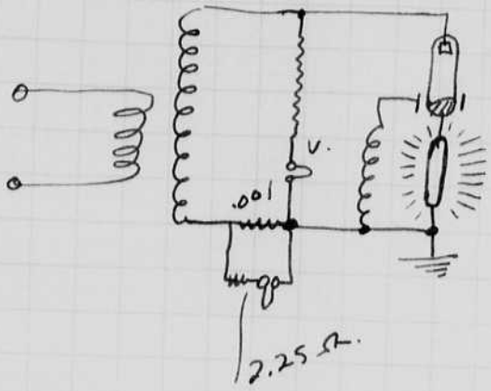




11 am. Gilfillan, Rubenstine, andrews? and ( )? were here to test effect of light. 10 flashes 1/2 cycle gave desired result.

Problem now to measure energy per half cycle.

Guess 4 amp. x 150 volts x 1/120 sec. = 300. watt/sec.



1000 volts.

50 amps .050 volts.

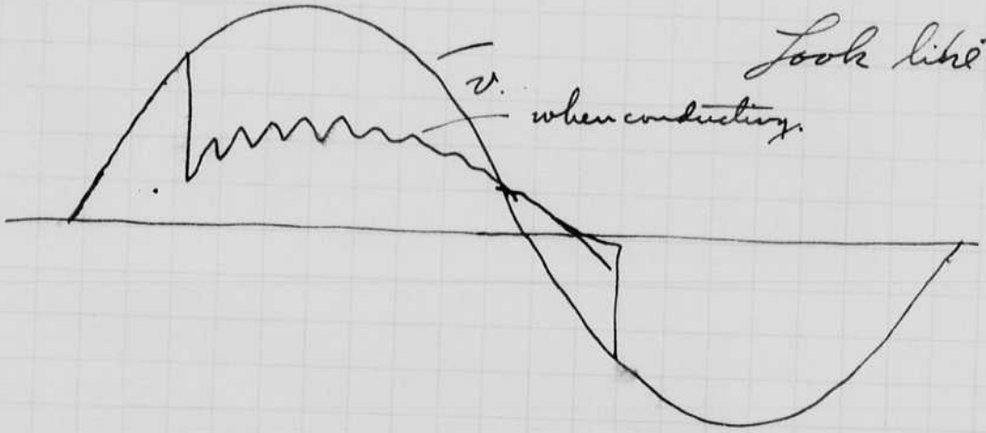
$R = \frac{V}{I} = \frac{.05}{50} = .001$ ohms

50 mv. shunt.

1100 10,000 ohms.

Oscillograms taken with above connections.

Look like this.



Resistance of oscillograph unit = 2.25 ohms

This same element with 8000 ohms and 1100 volts r.m.s. gives about 6.7 cm peak to peak.

$$\frac{6.7 \text{ cm}}{I} = \frac{6.7}{\frac{1100 \times 2 \times \sqrt{2}}{8000}} = \frac{6.7 \times 8000}{1.41 \times 2 \times 1100} = 19. \text{ cm/ampere.}$$

current deflection = 1.7 cm. from oscillogram

current in element = $\frac{1.7}{19.} = .09$ amperes. peak

$I_T = \frac{.09 \times 2.25}{.001} = \frac{.20}{.001} = 200$ amperes. peak.

cont.

voltage from ore $\begin{matrix} 3.7 \\ 0,6 \end{matrix}$

voltage (peak) $= \frac{1100\sqrt{2}}{3.7} \times \frac{0.6}{3.7} = 250$ volts.

Power rate $= \frac{250 \times 200}{2} = 25{,}000$ watts.

or 25 KW.

watt seconds $= 25{,}000 \times \frac{1}{120} = 208.$ watt sec.

3900 volts. 48+24 = 72 mf.

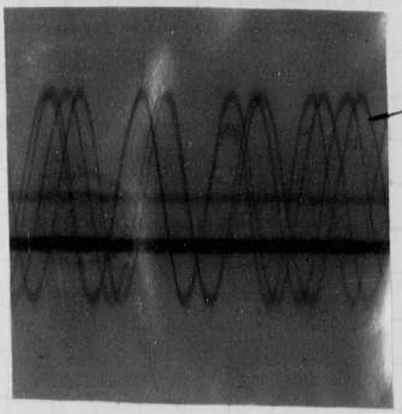
energy $= \frac{3900^2 \times 72}{2} = 550$ watt seconds.

Panatomic film f 6.3 Leica
f 12.5

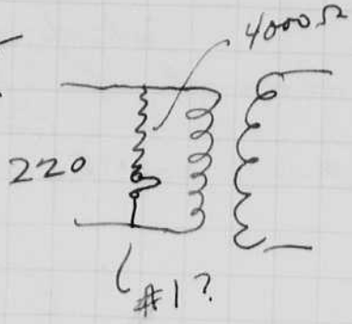
Mr. Breyer 4 ft from lamp. 1/2 cycle

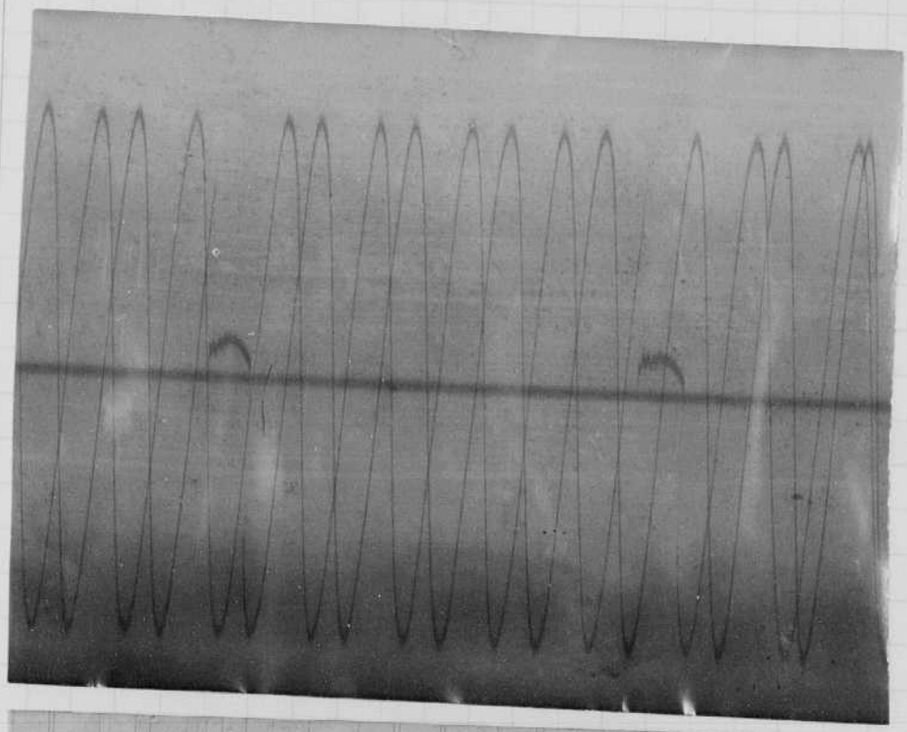
$\frac{220^{v}}{170^{v}} = \frac{F_2}{F_1}$ Condenser discharge 4000 V 48 mf

same subject but with glasses or + { f 12.5, 6.3, 18.

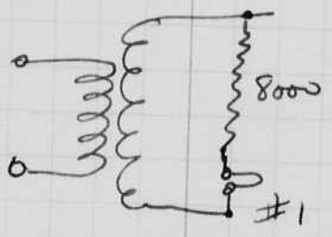


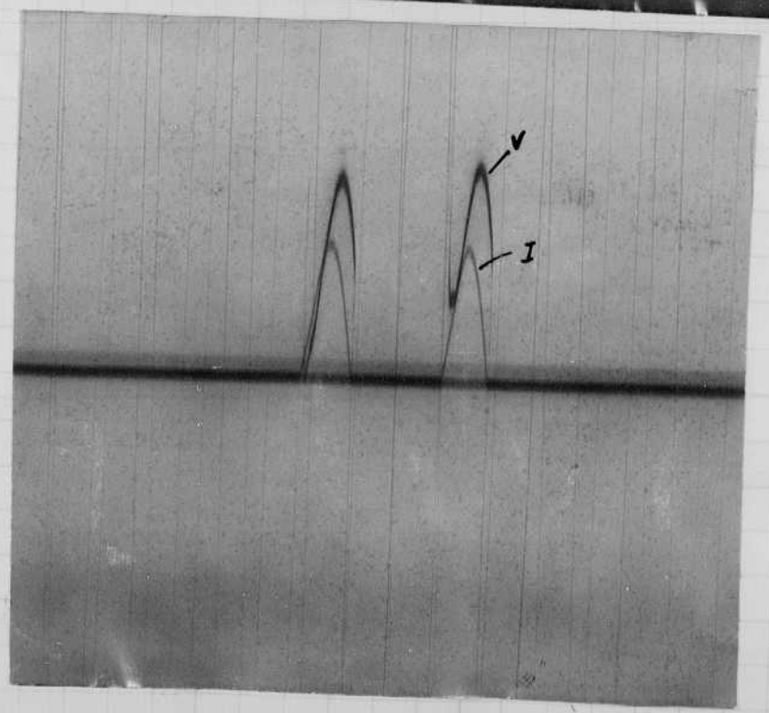
Primary voltage.





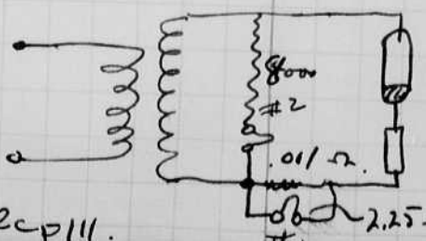
Secondary voltage.





Secondary voltage.

Secondary current.



See calc p111.

cont.

voltage from osc $\begin{matrix} 3.7 \\ 0,6 \end{matrix}$

voltage (peak) $= \frac{1100\sqrt{2}}{3.7} \times \frac{0.6}{3.7} = 250$ volts.

Power rate $= \frac{250 \times 200}{2} = 25{,}000$ watts.

or 25 KW.

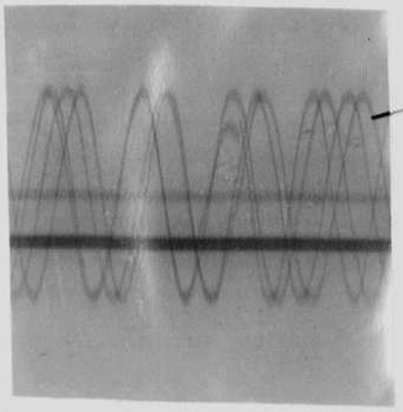
watt seconds $= 25{,}000 \times \frac{1}{120} = 208.$ watt sec.

3900 volts. $48 + 24 = 72$ mf.

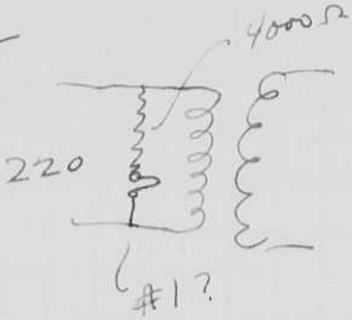
energy $= \frac{3900^2 \times 72}{2} = 550$ watt seconds.

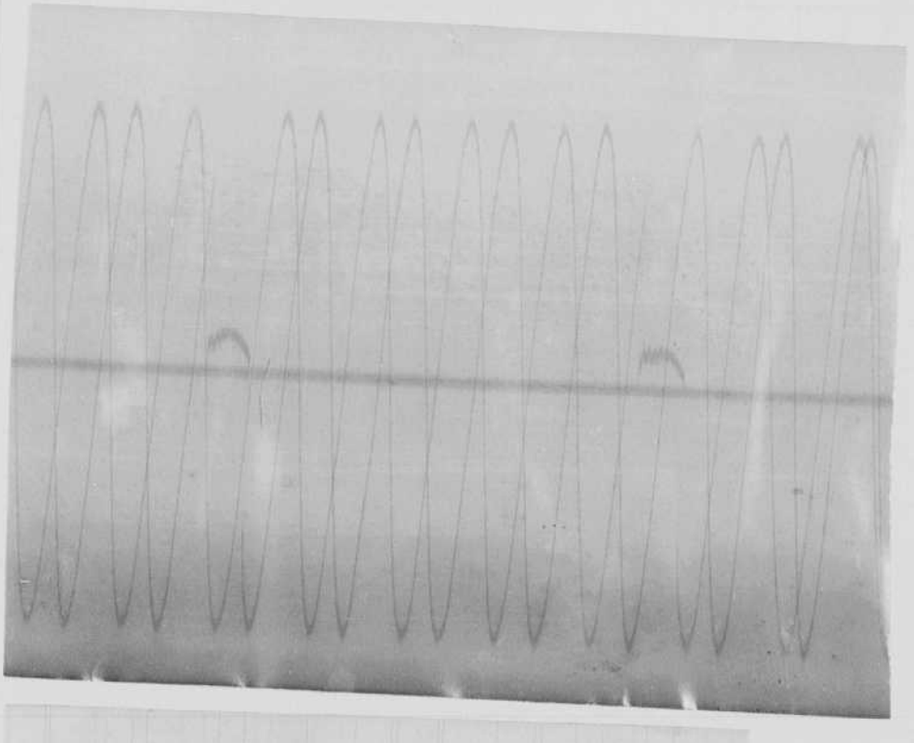
Condenser discharge 4000 V 48 mf

Same output 5 ft 12.5
but watts 6.3
Glass or. 1.8.

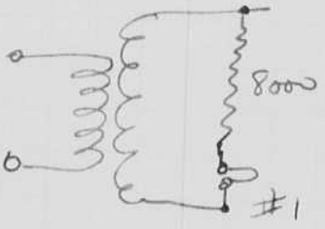


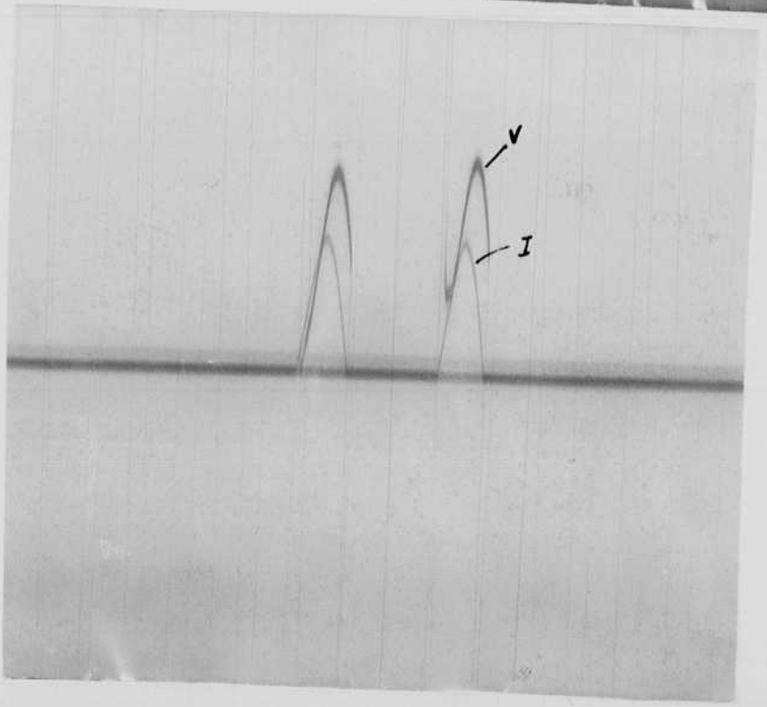
Primary voltage.





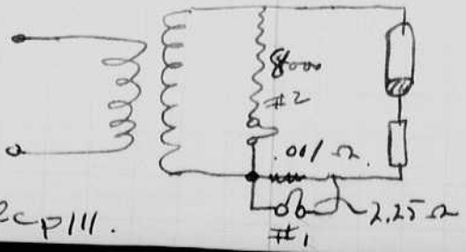
Secondary voltage.





Secondary voltage.

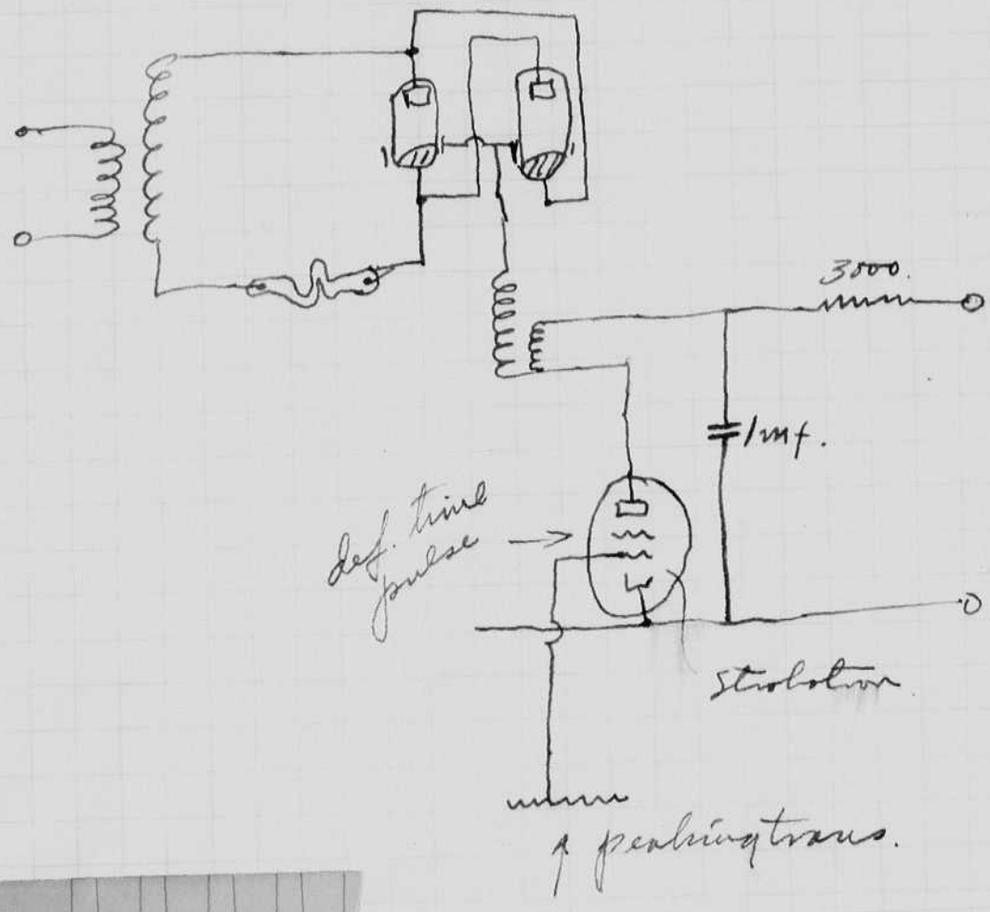
Secondary current.

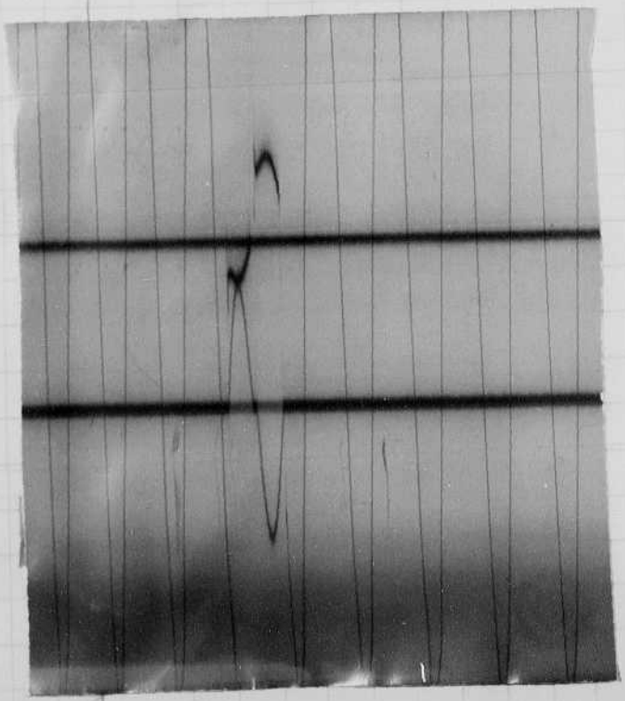


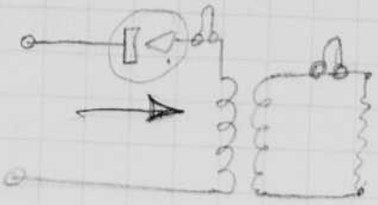
See calc p111.

Jan 28, 1935.
H. E. Edgerton.

Set up multiflash unit for discharging several half cycles with Breyer last night in T.E.M. Lab. Circuit was then brought in to ~~G~~-111 and tried on argon lamps.







Feb 1, 1938

More work was done Saturday Jan 29 with Breyer on full wave multicycle flasher. Data regarding experiments and oscillograms is recorded in his note book.

Resistance of #2 element = 3.15 ohms.
(Spring tension was increased on this element for these tests as compared to previous experiments).

#2 element 6.5 cm = $\frac{1100}{4000}$ volts.

1 cm = $\frac{1100}{6.5}$ = 169. volts.

or current calib.

6.5 cm = $\frac{1100}{4000}$ = .275 amps.

1 cm = $\frac{.275}{6.5}$ = .0423 amps./cm.

Primary current was measured with a 50 m v shunt 100 amp rating.

$R = \frac{.05}{100}$ = 0.0005 ohms.

$\frac{.005}{.05} = .001$

$\frac{50}{5.}$

From Film No 2. I_m = 1.8 cm. #1 element 19 cm/amper. shunt 50 mv 50 amps. Res. of element = 2.25 Ω.

$I_{element} = 1.8 \times \frac{1}{19} = .0947$ amperes

$I = \frac{IR}{R_s} = \frac{.0947 \times 2.25}{.001} = .213$ amp peak.

E = 6.5 cm = 1100 √2 volts. $\frac{1.2 + .6}{2} = .9$ cm max.

cond per = $\frac{3.5}{4.5} = .777$

$E_{max} = 1100\sqrt{2} \frac{.9}{6.6} = 152$ volts eff. $P = \frac{213}{\sqrt{2}} \times 152 \times .77 = 17,700$ watts.

$= 22,800$ watts.

Jan 8, 1938.
M. I. T.

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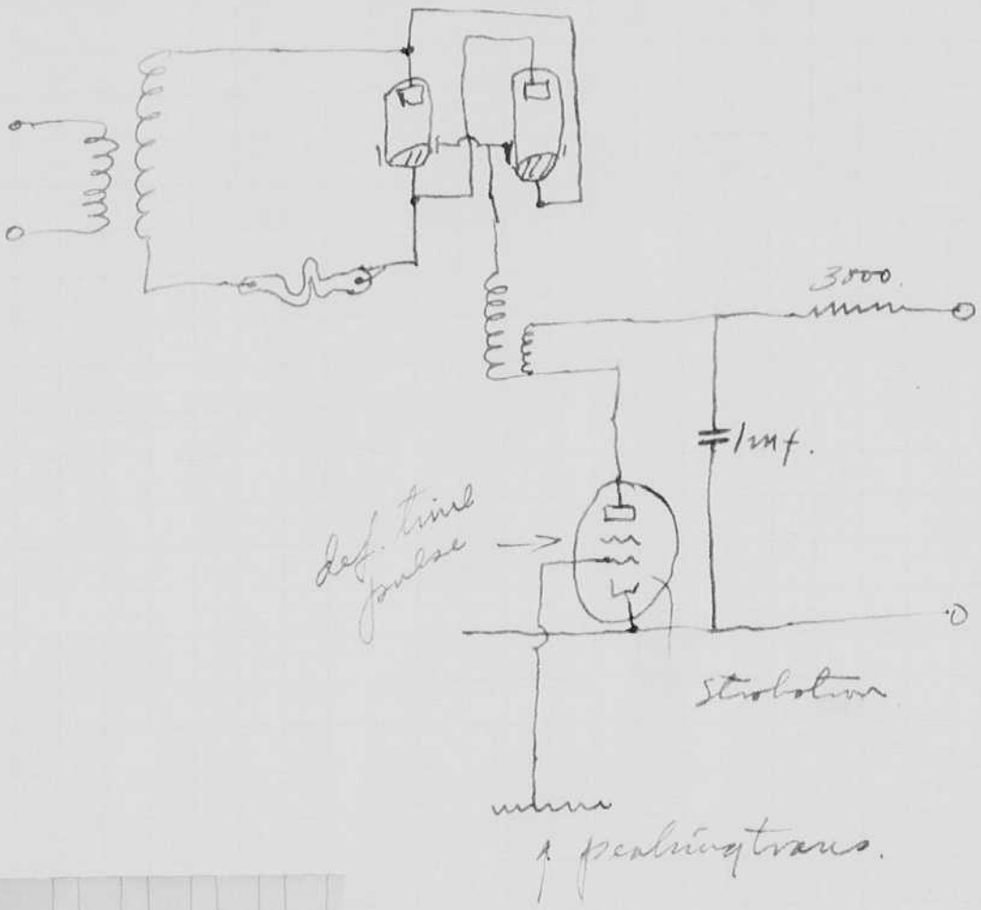

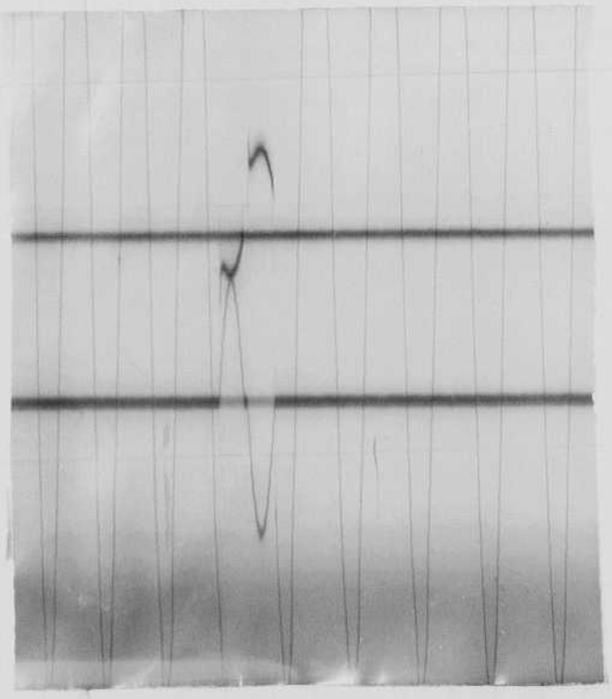

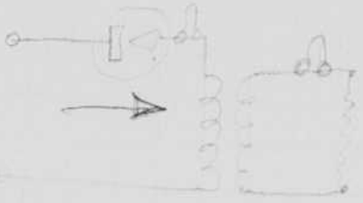

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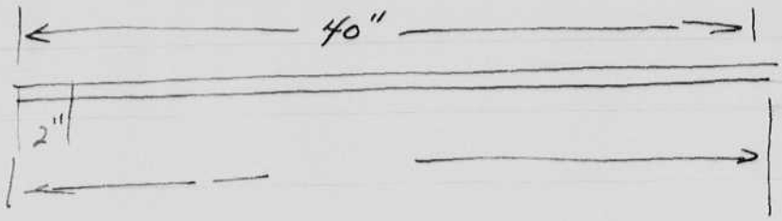
x.77 17,700 "



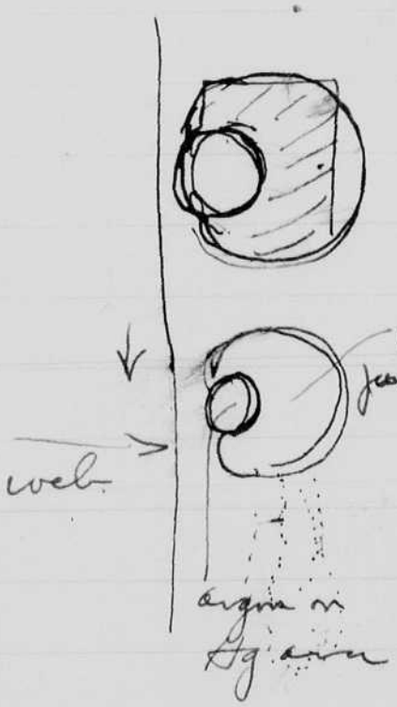
200 watts.

100 watts

X 20 X 25 =
20
500. kw.

500 watts/inch.
12,000 watts./sq inch.
24 tubes.

Feb. 31, 1938 monday
got p. with full wave
10 and 20 half cycles



Feb. 2. 38 notes made when discussing U.V. lamps with Rubenstine of A.D. Little. Co. Jan 31. 38
Power calc. 500 kw for 40" web?
Our power data is rather inaccurate but it appears that 25 kw for 1/6 sec. gives sufficient exposure.

A.D. Little.

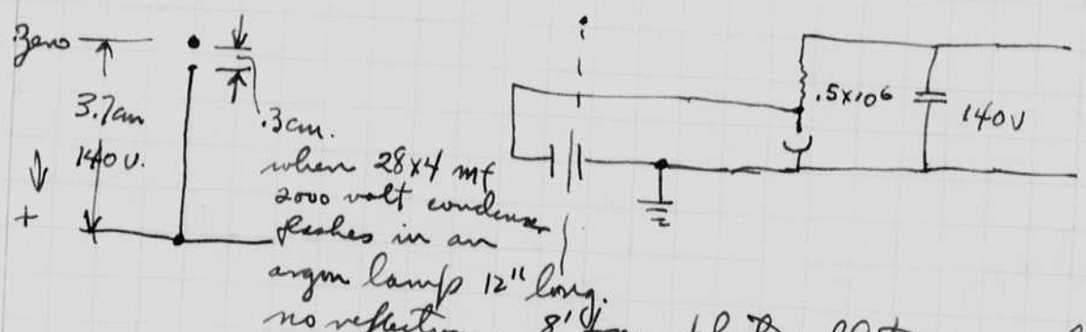
Jan 20.	2 hrs.	
Jan 21	3 hrs.	
" 26.	6 "	
" 27.	6 "	test and meas of power
" 28	6 " + Full wave	1 Hg tube broken.
" 29	5 " " "	osc. paper. 1½ doz.
" 31	7 "	tests with Rubenstein. 1 argon lamp "

Feb 3, 1938.

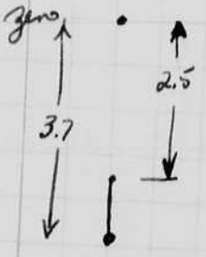
Hall at Harvard to the N.E. Engineering societies. Mr. Bliss president.

I gave a lecture last night at the new Lect.

Measure of photocell output from stroboscope light etc.



when 28x4 mf 2000 volt condenser flashes in an argon lamp 12" long. no reflector. 8' from photocell to argon lamp.



current in cell = $140 \times \frac{3.4}{3.7} \div .5\times10^{6} \cong 140\times2\times10^{-6} = 280\times10^{-6}$

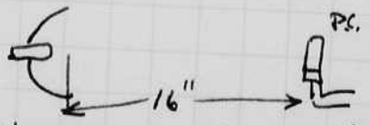
Stroboscope without reflector 60 cycles 6 mf 130 V ± ?

2½" ℄ tube to photocell ℄.

$\frac{3.7-2.5}{3.7}\ 140\times2\times10^{-6} = \frac{1.2}{3.7}\ .324\times140\times2\times10^{-6} = 90.5\times10^{-6}$ amp.

Stroboscope low scale 10/sec 16" from photocell

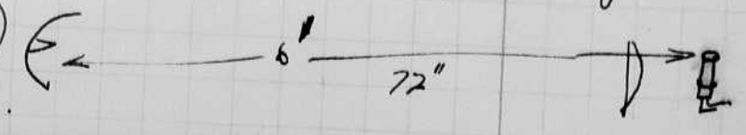
current = $\frac{(3.7-2)}{3.7}\times140\times2\times10^{-6}$ amps $\cong 70\times10^{-6}$ amp ±



Ditto but stroboscope 6' away and 5" lens 8" focal length put in front of PS.

current = $\left(\frac{3.7-2.7}{3.7}\times140\times2\times10^{-6}\right)$

75.6×10^{-6} amps.

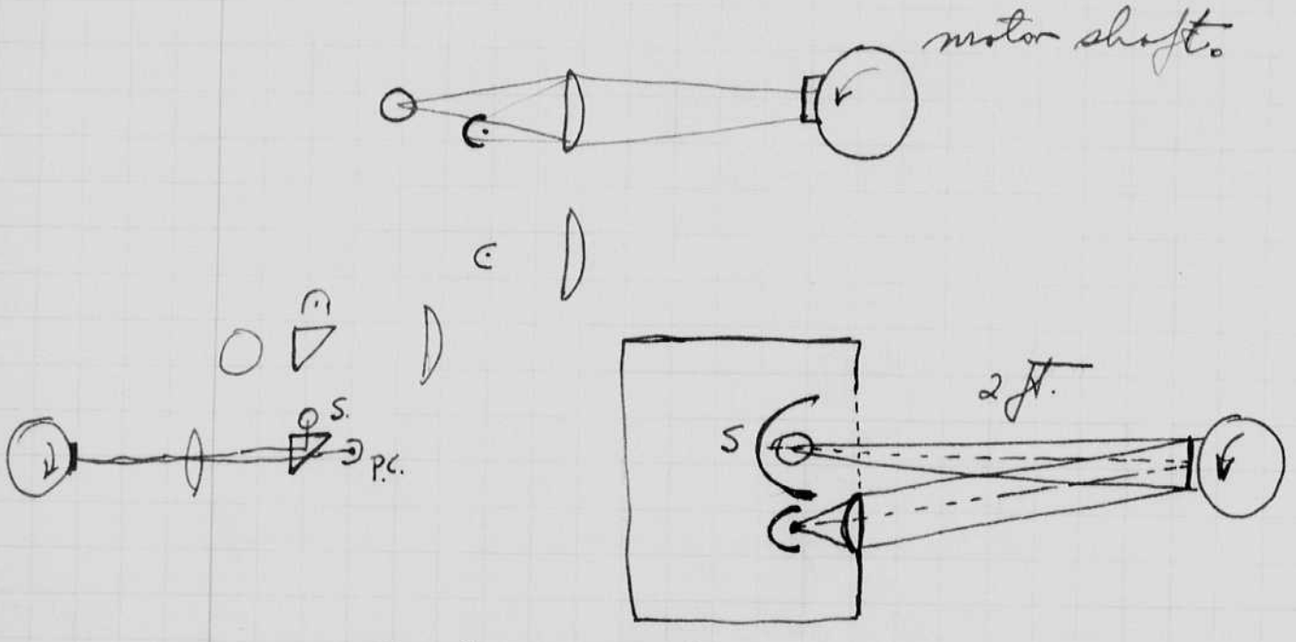


Cont.

a #2 photoflood 12" away from the P.C. & causes a current of $\frac{3.7-2.7}{3.7} \times 140 \times 2 \times 10^{-6}$ amps.
No condenser used on the optical system.

Argon flash lamp. 1×10^5 ohms in place of $.5 \times 10^6$

$\frac{3.7-2.7}{3.7} \times 140 \times 10^{-5}$ amps. $= 37.8 \times 10^{-5} = 378 \times 10^{-6}$ amps.



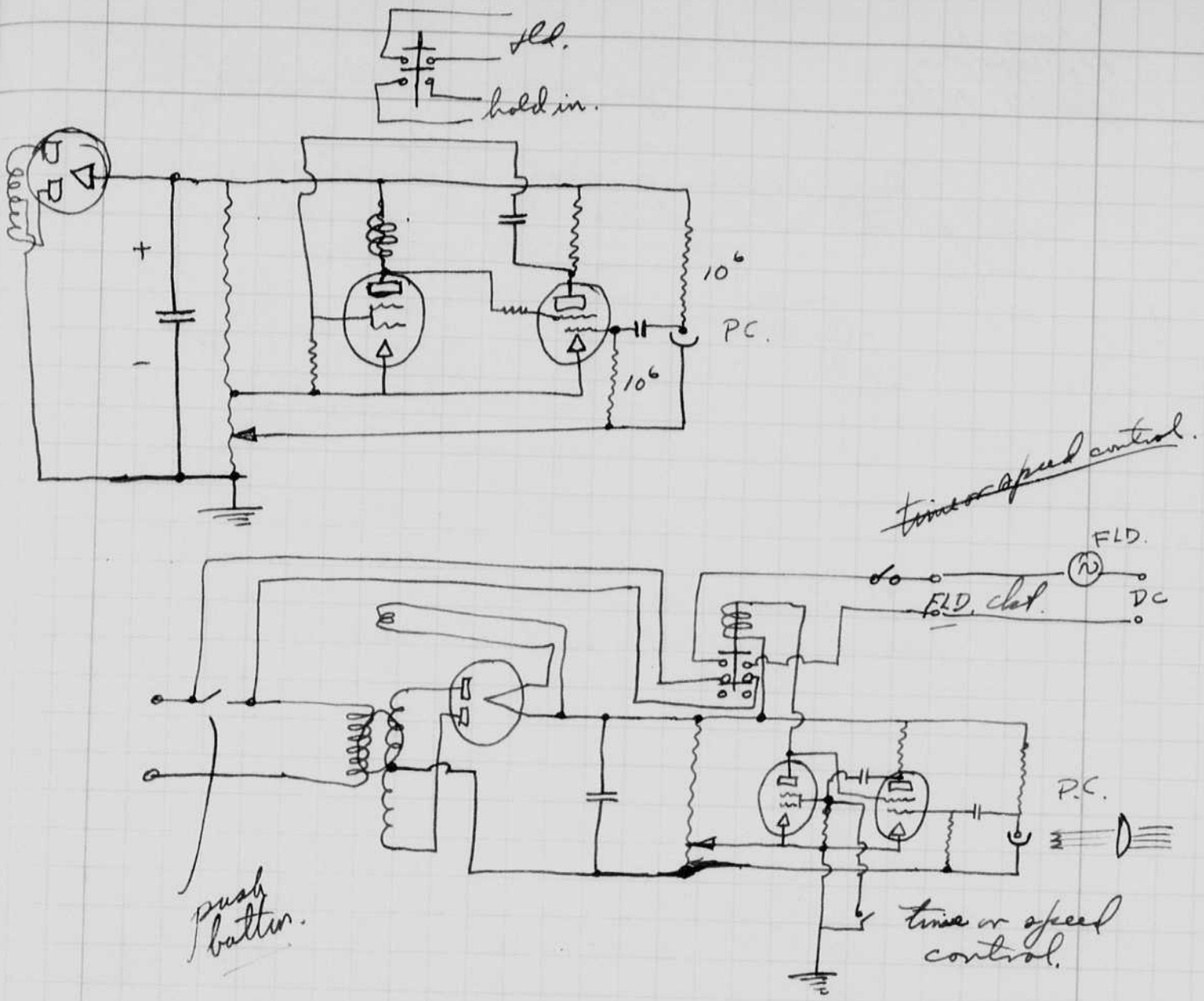
Prob. current in p.c.

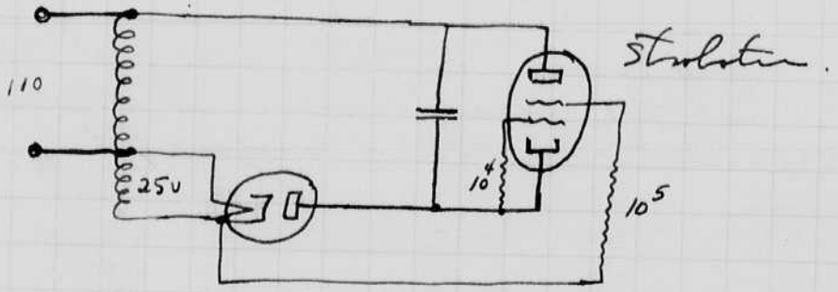
$90 \times 10^{-6} \times \left(\frac{2.5}{48}\right)^2 \times 4 = .90 \times 108 \times 10^{-7 \times 10^{-6}} = 1. \times 10^{-6}$ amps.

$\left(\frac{2.5}{48}\right)^2 = (.052)^2 = 27. \times 10^{-4}$

lens. square law.

with 10^{+5} ohms this gives 0.1 volt
or 10^{+6} " " " 1.0 volt.
250,000 " .25 volt.

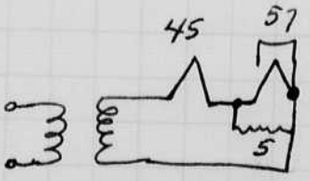




45. power tube.
2.5 V 1.5 amps.

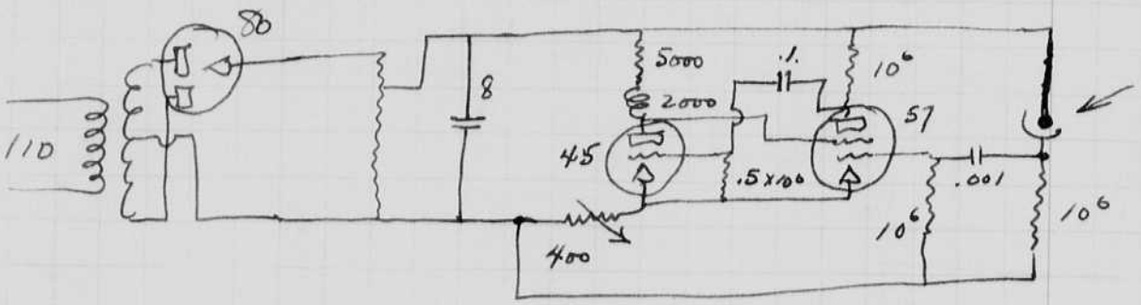
57 2.5 V 1 amp.

$R = \frac{2.5}{.5} = 5$ ohms

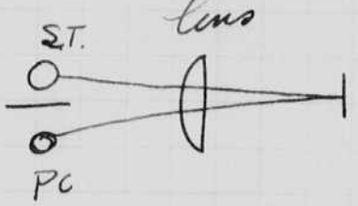


Feb. 5, 1938. Syn-motor Pullin Relay

Today I experimented with stroboscope and photo cell field-closing relay.



with lenses, a stroboscope at 6 ft or more could trip the circuit

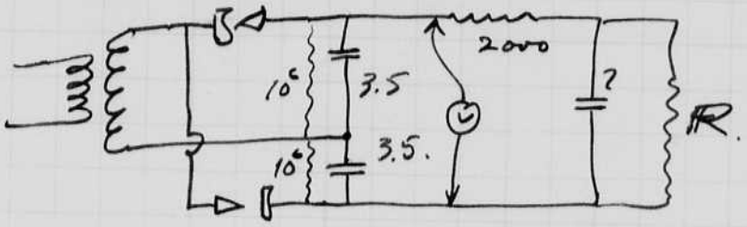


a small motor with a prism was used to show that the tripping was fast. The relay closed about 1/2 second with this circuit after the impulse is received.

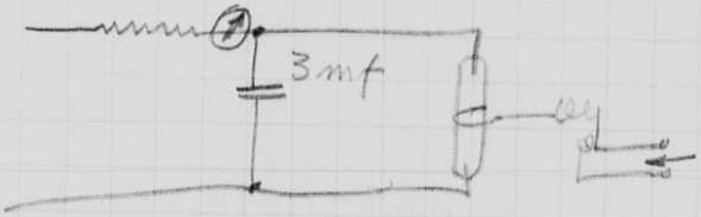
This 1/2 sec. is not delay, it is the time that the relay remained closed before the oscillator circuit relaxed.

Feb. 8, 1939
K. E. Edgerton.

Regulation test of a power supply.



V.	R+2000	watts. E^2/R	ma. $I = \frac{E}{R}$
1200	∞		
730	6000	58.5	080
680	4500	103.	151
550	3000	102	183
450	2000	102	225.



1
4
8

argon.
12 cm. 6" tube
5/8"

R.P.M.	ma. dc
900.	55
1800.	94
2500	115
3000	125.
1400	77.

3 mf

RPM	ma
1000	20
2000	40
3000	58.
4000	73.
6000	95.
10,000	125

1 mf. ~~Leiden~~ jar flashover.

same as 3 mf.

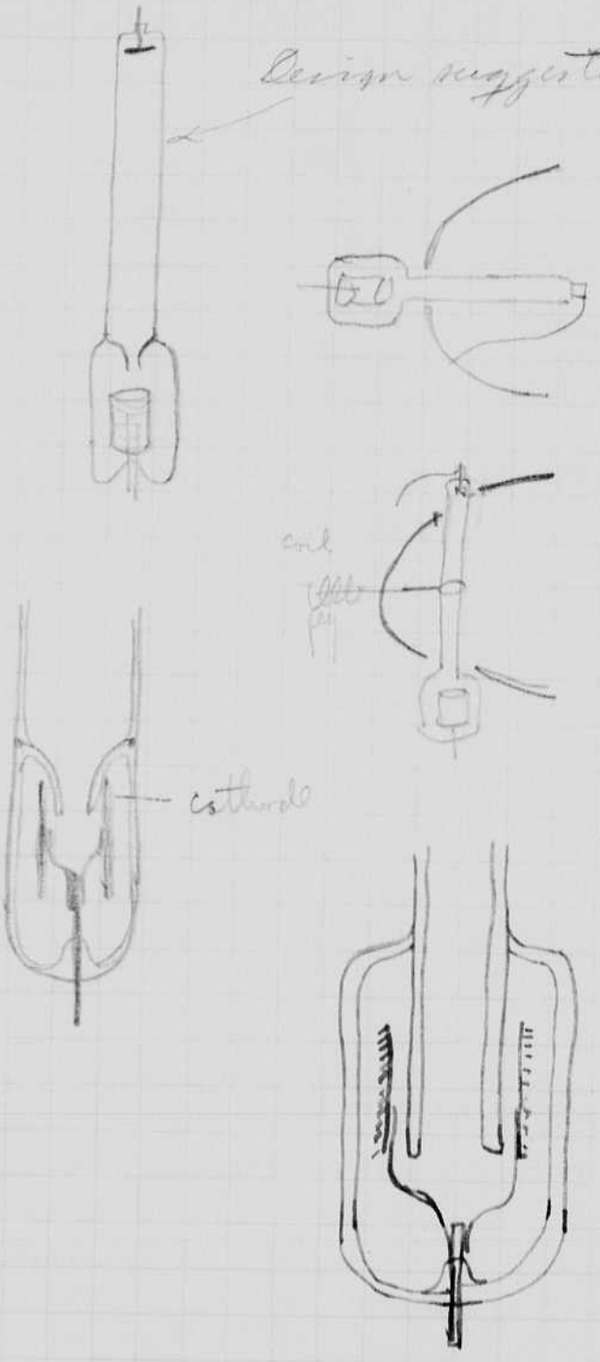
900	112.
1200	133.
1800	155.

8 mf.

Feb. 9, 1938.
H. E. Edgerton

Flash lamps for Strobosnite

Design suggested by Germeshausen.

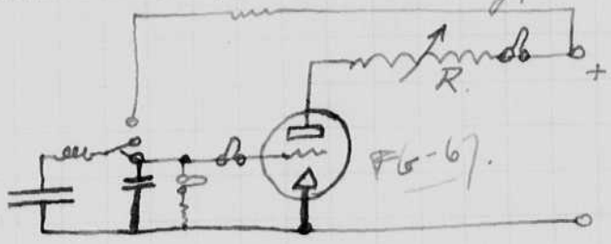


Feb 10 1938
H. E. Elgerton.

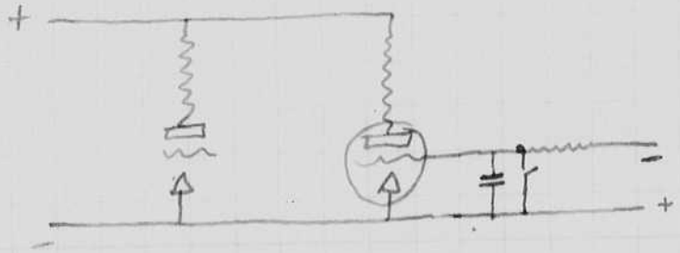
Cut off Grid.

Rough calculations show that a FG-67 thyratron with 1/2 amp plate current can probably be extinguished with a grid voltage of 100 volts. negative. This seems to check an experiment I made some time ago in trying to use the grid v. amp char. as a constant current device for charging a condenser in a sweep circuit.

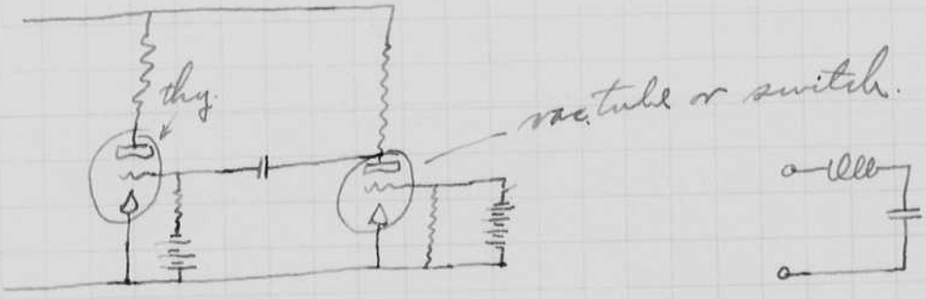
Experiment to show cut off

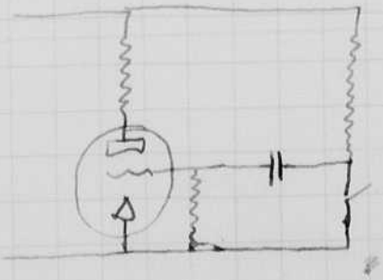


The grid voltage will swing negative when the one condenser discharges through the inductance and the other.



Open switch to start or tube.





close switch to stop thyrat. a bias is also needed to keep tube from starting.

Feb. 12. 1938
B Egerton

Feb. 9. 1938

I had a conference on Wednesday afternoon at 2 p.m. with Mr. Kines in his office at the Federal St. Subject matter the synchronous motor pulling relay using a stroboscope and a photo cell. I first called say. Kines on Saturday Feb. 5 about ~~the~~ an appointment but he was unable to see me until Monday. Later on saturday I called and told him that I could not come ~~as previously arranged~~ Monday morning. This call was made to his office about 5 o'clock or later. I told him I would call him Monday about arranging a later date, which I did and arranged for Wed., Feb 9, afternoon. Mr. Kines said he could not see me Tues. afternoon due to a previously arranged appointment.

Notebook # 8

Filming and Separation Record

____ unmounted photograph(s)

____ negative strip(s)

__1__ unmounted page(s) inside envelope mounted on page 124
(notes, drawings, letters, etc.)

was/were filmed where originally located between page __124__ and __125__.

Item(s) now housed in accompanying folder.

Feb. 12. 1938
H B Egerton

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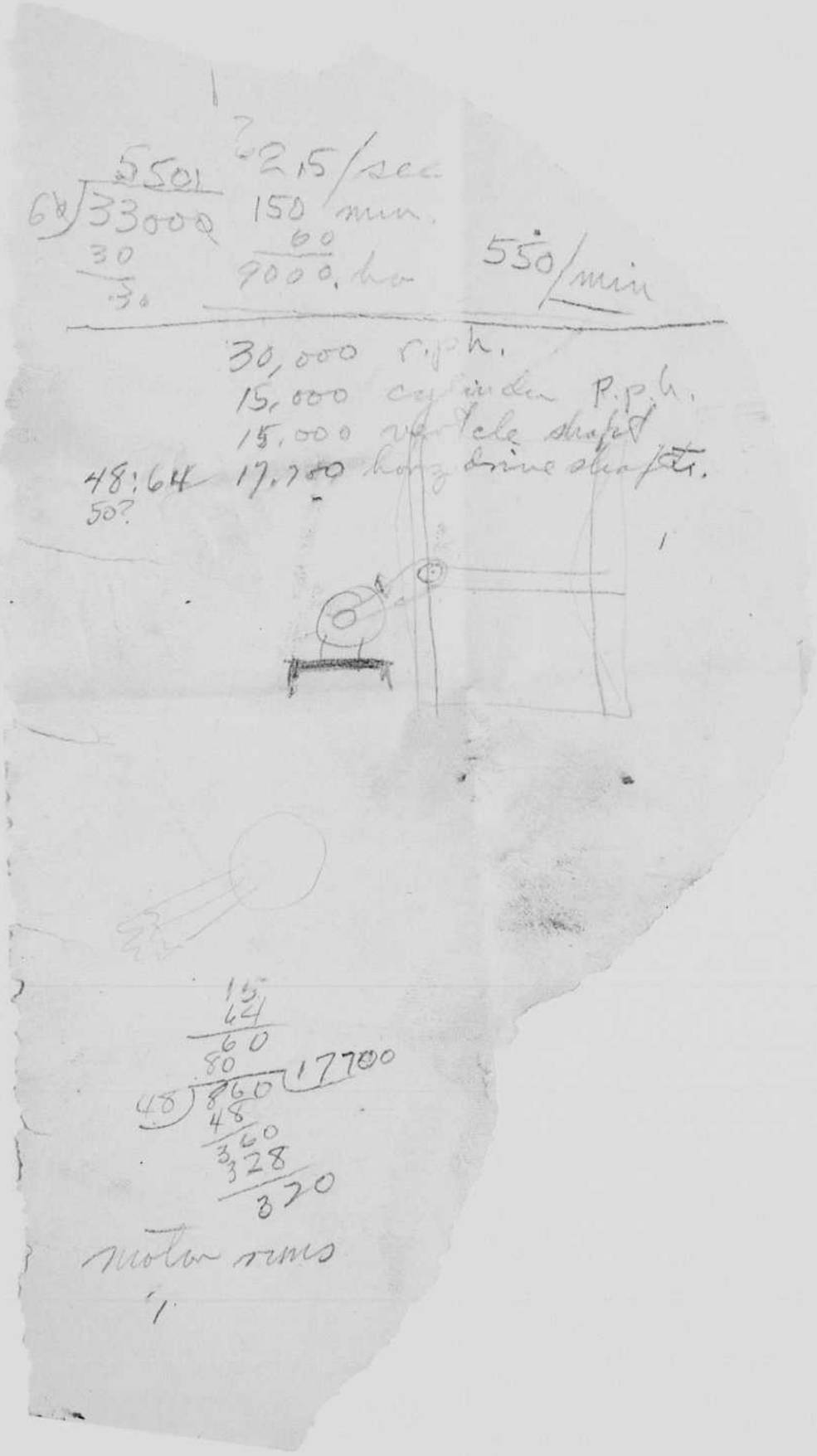

550
64 33000
30
30
2.15/sec
150 min.
60
9000. hr
550/min
30,000 r.p.h.
15,000 cylinder R.P.h.
15,000 vertical shaft
48:64 17,700 horz drive shaft.
50?
15
44
60
80
48 860 17700
48
360
328
320
motor runs
1

2 pedometer count.
37000 = 34,400.
580 per min.
580, 290.

34,000 P.P.h.
17,000 r.p.m.
300. rpm

29500 ——

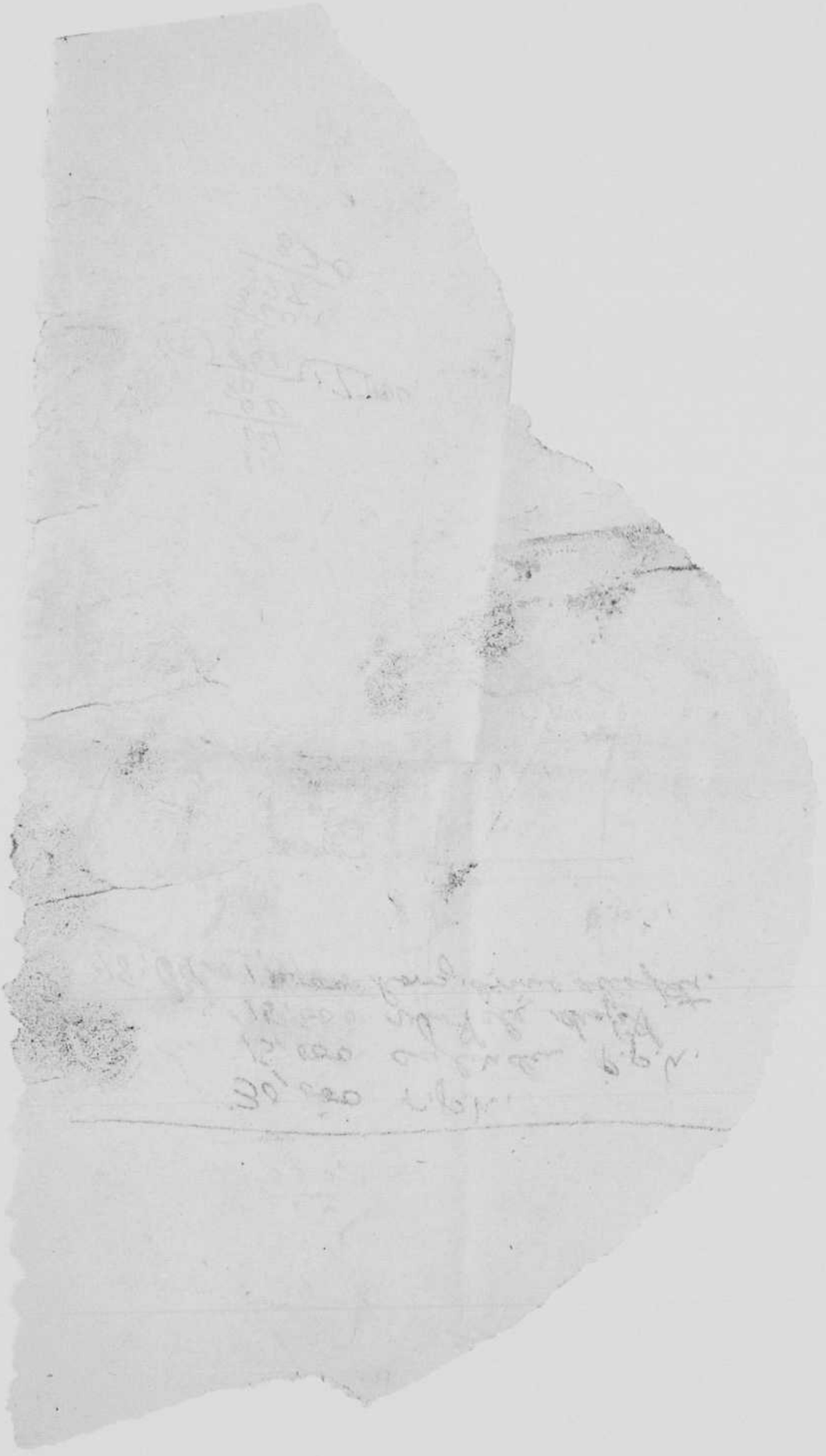
Vibrations per min
29,500 P.P.M.

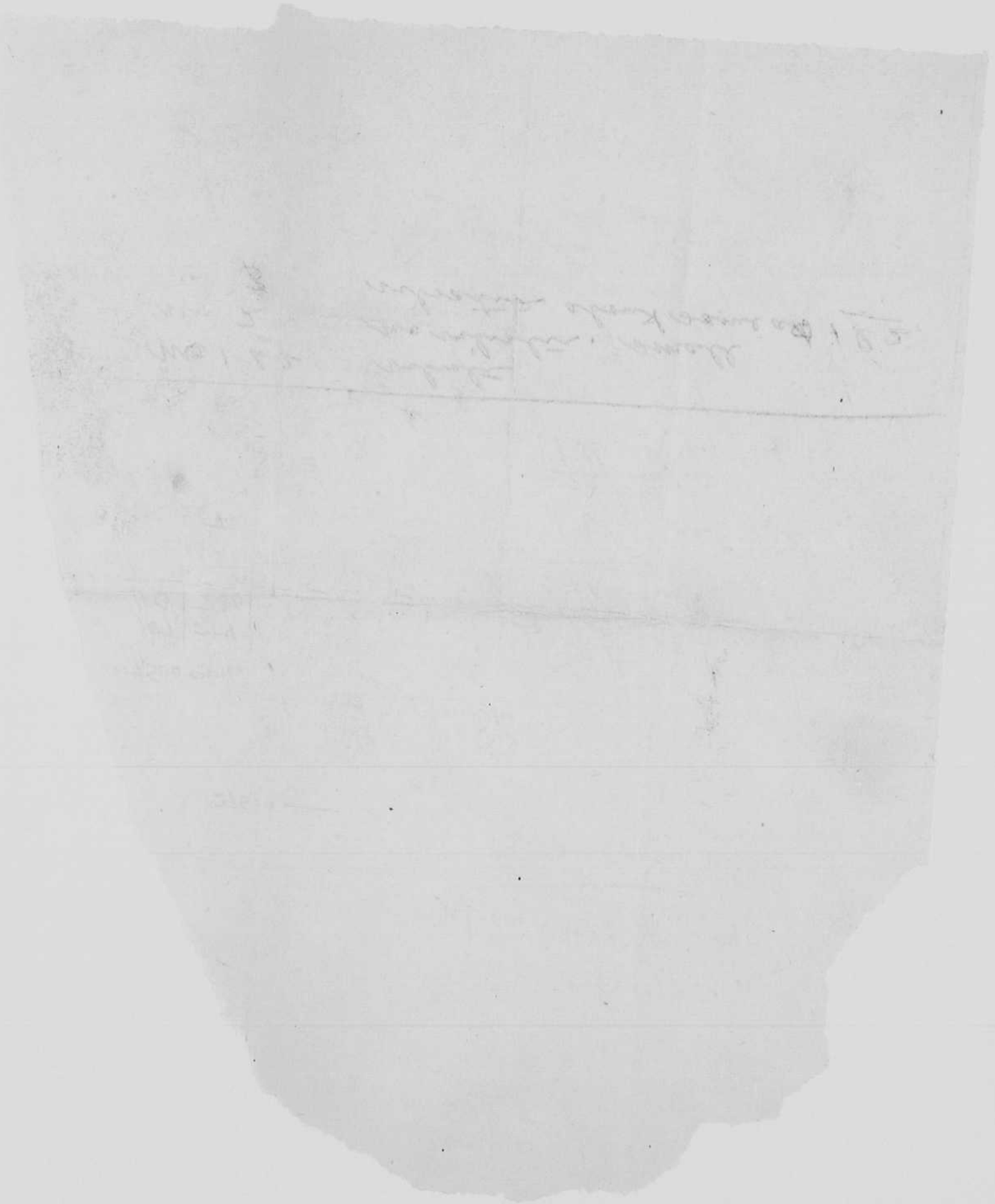
107 | 214 | 2 min 98 — Red
110 | 220 | 2 min 105 — Grey → 95 ✓ ½ min
1. | 60 | ½ min
13200 | 2
26400

× 2
190. per min.
60
11400.

no 1 & 2 — vibrate
no 2 — no vibration small
" 1 — vibration about same as 1 & 2.
but not as no 1 unit.
Rest of machine vibrates from center to far end.

B. Brewer.





Feb 12, 1938.

Mr. B. Brewer.
Standard Times
New Bedford, Mass.
Max Kramer.

Christian Sci. Monitor
H.T. Stanger & Mr Read?
138 taunton
140 New Bed.

Pressman Arthur Robinson
Tom Peck.

Arrived in New Bedford at 12:15 am. from Cambridge. The press "duplex" vibrated at a speed of 34,000 - 36,000 papers per hour. This corresponds to a cylinder speed of 17000 - 18,000 rev. per hour or about 300 per minute. Above this speed the vibration ceases or becomes much smaller.

Drive. The press is driven by an induction motor thru a metal chain belt. A solid cement foundation is under the motor and the motor. it does not vibrate. The driving shaft on the press is mounted half way from the foundation to the top. as the frame vibrates it causes the chain belt to flop as it changes the distance between the motor pulley and the center line of the shaft. A Rough check of the stator and rotor currents in the induction motor show satisfactory performance of the motor.

Experiments to locate source of vibration.

The following experiments seem to show that there is an unbalanced force in the cylinders or other moving parts of the no 1 unit.

test	LOAD.	Vibration. remarks.
1.	Units no 1 & 2 & folder.	Vibration about 1/16" at center of pres. side to side motion.
2.	Units no 1 & 2 (Folder disconnected).	Vibration about the same.
3.	Drive shaft only.	Practically no vibration. the speed could not be held at critical value since there was no load.
4.	Unit no 2.	no vibration.
5.	Unit no 1.	Vibration about same as test no 1. There was no appreciable motion at unit no 1

Notebook # 8

Filming and Separation Record

____ unmounted photograph(s)

__1__ negative strip(s)

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

was/were filmed where originally located between page 126 and 127.

Item(s) now housed in accompanying folder.

Experiments to locate source of vibration.

The following experiments seem to show that there is an unbalanced force in the cylinders or other moving parts of the no 1 unit.

test	LOAD.	Vibration. & remarks.
1.	Units no. 1 & 2 & feder.	Vibration about 1/16" at center of pres. side to side motion.
2.	Units no. 1 & 2 (Feder disconnected).	Vibration about the same.
3.	Drive shaft only.	Practically no vibration. the speed could not be held at critical value since there was no load.
4.	Unit no 2.	no vibration.
5.	Unit no. 1.	Vibration about same as test no 1. There was no appreciable motion at unit no. 1

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____ unmounted photograph(s)

__1__ negative strip(s)

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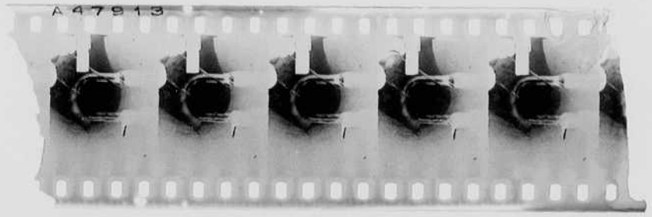
Item(s) now housed in accompanying folder.


A47913

Feb. 14, 1938

On Friday night I hooked up a shielded Hg. lamp in the circuit shown on page 114. The light was very bright. Dotson and a friend were in the lab and saw it work. We concluded that the light was more to the eye than the argon tube.

Today I am working with it again. RC time constant. R = 10^6 ohms.

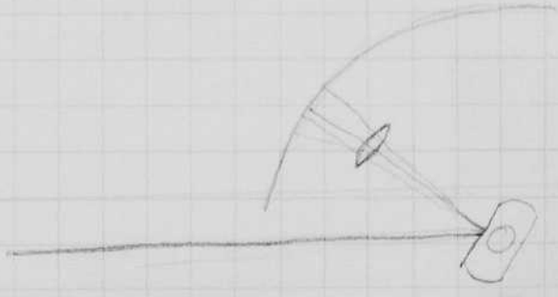
$$RC \times .65 = 0.1$$

$$C = \frac{0.1}{.65\ 10^6} = .147 \times 10^{-6}$$

Gilfillin and Rubenstine were here today and made further tests with Hg and argon lamps. The data was recorded in their note book. One flash, 1/10 second, turned the oil. A flash 1/20 second also turned the oil but we noted a time lag. A movie camera was set up and operated at 16 frames per second (hand cranked). It showed the time lag of the formation of the film.

Feb 17 1938

Rubenstine was here again yesterday and we repeated the experiment of Feb. 14. The motion picture film showed an instantaneous result this time. Also a slow change later.

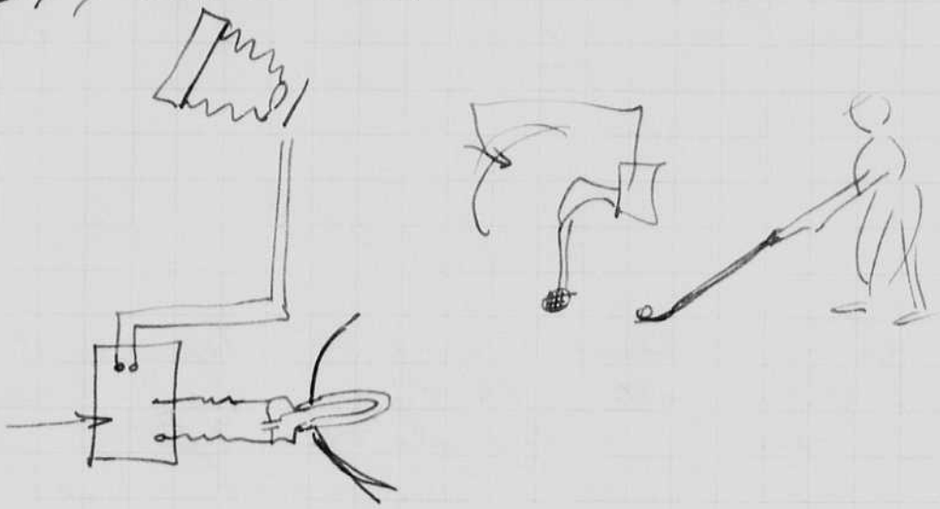


Mar 1
~~Feb 29~~ Bill to A.D. Little
4 days @ 30
1 lamp 50.

H. E. Edgerton.
Feb 17, 1938.

Photos of ~~Golf~~ club.
for American Fork & Hoe Co.

Frequency 100 frames per second. Exposure time set by hand and shutter on 5×7 camera.



Also a sound pickup and a single flash will be used to photograph the ball at the exact instant of impact.

2 mf. — 1000 ~~per sec~~.
20 — — 100 per sec.

H E Edgerton.
Feb 19 1938

Photographic Study of Johnson Automatic Rifle.

Mr. Howard and Mr. Johnson brought the gun in the morning. 30 caliber. The recoil of the barrel turns the lock and releases the bolt. A series of both still and movie pictures were taken to show what goes on in the mechanism of this gun.

Single photographs were taken with a 5×7 camera of the entire gun from the muzzel to the bolt. Firing of the flash was controlled by the bullet. Exposure due to ordinary light shows stationary position of the gun bolt.

a thyratron FG-17 800 volts on plate was used to fire an argon flash lamp.

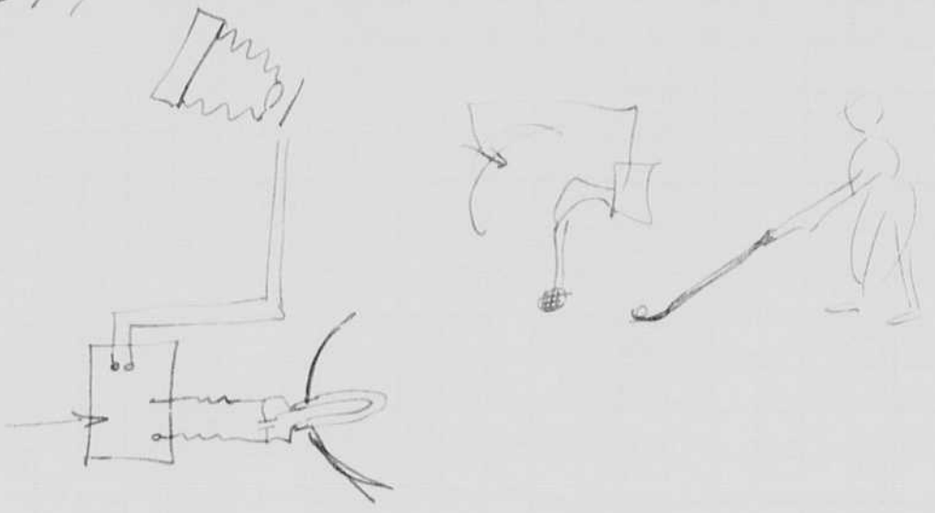
Movies at 1200/sec. were taken by reflected light f 2. 1 mf 1000 volts (new power supply).

1. Single shot.
2. two shots.
3. Extraction of single shot. This shows shell cartridge goes out due to gas pressure in gun.

Oz Engstrom.
Dec 17 1938.

Photos of Golf club.
for American Fork & Hoe Co.

Frequency 100 frames per second. Exposure time set by hand and shutter on 5 x 7 camera.



Also a sound pickup and a single flash will be used to photograph the ball at the exact instant of impact.

2 mf. — 1000 per sec.
20 — — 100 per sec.

H E Edgerton.
Feb 19 1938

Photographic Study of Johnson Automatic Rifle.

Mr. Hayward and Mr. Johnson brought the gun in the morning. .30 caliber. The recoil of the barrel turns the lock and releases the bolt. A series of both still and movie pictures were taken to show what goes on in the mechanism of this gun.

Single photographs were taken with a 5 x 7 camera of the entire gun from the muzzle to the bolt. Timing of the flash was calculated with the bullet. By ~~p~~ means due to ending light shows stationary position of the gun bolt.

A thyratron FG-17 800 volts on plate was used to fire an argon flash lamp.

Movies at 1200/sec. were taken by reflected light f 2. 1 mf 1000 volts (new power supply).

1. Single shot.

2. two shots.

3. Extraction of single shot. This show shell cartridge goes out due to gas pressure in gun.

⊙ = 5.3 cm.
Bolt handle.

Feb 22 1938
UBExpt.

Johnson Rifle.
Analysis shot no. 1.

frame.	5.5/60 sec. = entire cycle. D.
0	2 cm
1+?	Forged .5.
2	5.5
3	7
4	9.4
5	11.5
10	21.5
15	30.6
20	39.3
25	46.0
25	21 + 17.1 = 46.1
30	33.1 = 50.2
35	Shell in way.
40	31.5 ? 52.2
45	28.7 45.8
50	42.4 42.4
50	25.5 + 17.0 = 42.5
55	38.5
60	34.1
65	29.5
70	24.5
75	19.1
80	13.1
85	9.1
90	2.2 ?
95	2.3 Handle turned

15½ p = 1/60 ← 0 frame
15 3/4 p = 1/60 sec.
16 1/4 p = 1/60 sec 95 fps
avg 1/6 = 16×60 = 960 feet/sec.

check of first 9 of cam.

frame.	D. cm.
-2.	2.1
-1	2.1
0	2.5
1.	5.3 Fes. & Bullet. 1½ frames later.
2.	5.7
3.	7.0

No 3. 5 3/4 of 1/60 sec feeding for first 3 without ext.
.015 sec. for Extraction.
Shell does not come out!!

Feb 23 1938
D.E.E.

Mr. Howard, Johnson, and Brower were here at noon and I showed them the photographic results of the Johnson rifle.

Feb 24 1938. I went to Washington on Feb 24 on the Federal at 9 o'clock to talk to the National Geographic Society at Constitution Hall. 4000 people were there. I talked an hour.

While in Washington I stayed with Margaret Robinson, sister, at 4822 Reservoir road. She had a small party after the talk inviting in
Bob Fields & wife
Wendell Berge "
Henderson "
Russel Wright
Frank Kerr and M. Cottrell.

"See the Unseen in High-Speed Motion Pictures" — Friday, February 25, at 8:15 p. m.

BY H. E. EDGERTON—who with his Massachusetts Institute of Technology associates has developed a camera which takes photographs of actions too fast for the eye to see. He will bring to The Society's screen, motion pictures and still photographs showing what happens when a golf ball is struck, a bubble bursts, or a cup is dropped in the kitchen sink.

Unbelievably fast, this camera can make 6,000 exposures a second and "catch" even the firing of a shotgun—showing successively a sound wave dancing out of the barrel, a whiff of gas, the charge of lead, the bright flash, and a final cloud of smoke. Included will be shots of water gurgling from a [illegible] snake darting its tongue in and out, corn [illegible]g over a fire, and human muscles contracting [illegible]panding.

GRADUATE HOUSE DINNER

Speaker: H. E. Edgerton, Assistant Professor of Electrical Measurements, M.I.T.
Subject: "High Speed Motion Pictures"
Wednesday, Mar. 2, 1938. Reception, Faculty Lounge 5:45 P.M.
Dinner, North Hall, Walker 6:00 P.M.

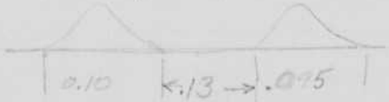
Professor Edgerton and his associates have developed the technique of high speed photography further than has ever been done elsewhere. He will demonstrate a stroboscope and show his latest slides and films.

Please sign this card and put it in the box labeled "Graduate House" in the Dormitory Office by 1 P.M. Wednesday, if you plan to come.

I will come with_____guests.

Signed_____

No 2. { time fasher = time required. = $\frac{5}{60} = \frac{1}{10}$ sec. record short.
$\frac{3}{4}$ fasher from end of first to start of second shot.
$5\frac{3}{4}$ " for first shot. } two shots.



No 3. { $5\frac{3}{4}$ of $\frac{1}{60}$ sec. fashes for first 3 without ex.
.095 sec. for Exhaustion.
Shell does not come out !! }

Feb 23 1938
B.H.E.

Mr. Howard, Johnson, and Brower were here at noon and I showed them the photographic results of the Johnson rifle.

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⊙ = 5.3 cm.
Bolt handle. Johnson Rifle.
Feb 22 1938
NE Expedition.
Auriga's shot no. 1.

frame	D.
0	2 cm.
1+?	Bolt ? 5.
2	5.5
3	?
4	9.4
5	11.5
10	21.5
15	30.6
20	39.3
25	40.0
25	21 + 17.1 = 40.1
30	33.1 = 50.2
35	Shoulder ?
40	31.5 ? 52.2
45	28.7 45.3
50	42.4 42.4
50	25.5 + 17.0 = 42.5
55	38.5
60	34.1
65	29.5
70	24.5
75	19.1
80	13.1
85	7.1
90	2.2 ?
95	2.3 Handle turned

15 1/2 p = 1/60 ← 0 frame
15 3/4 p = 1/60 sec =.
16 1/4 p = 1/60 sec 95 fr
avg 1/60 = 16x60 = 960 pict/sec.

Check of first 7 frames.

frame.	D. cm.
-2.	2.1
-1	2.1
0	2.5
1.	5.3 Bullet. 1/60 sec.
2.	5.7
3.	7.0

No 3. 5 3/4 ± 1/60 sec frames for part of 3 without ex.
.095 sec. for 3 station.
Shell does not come out!!

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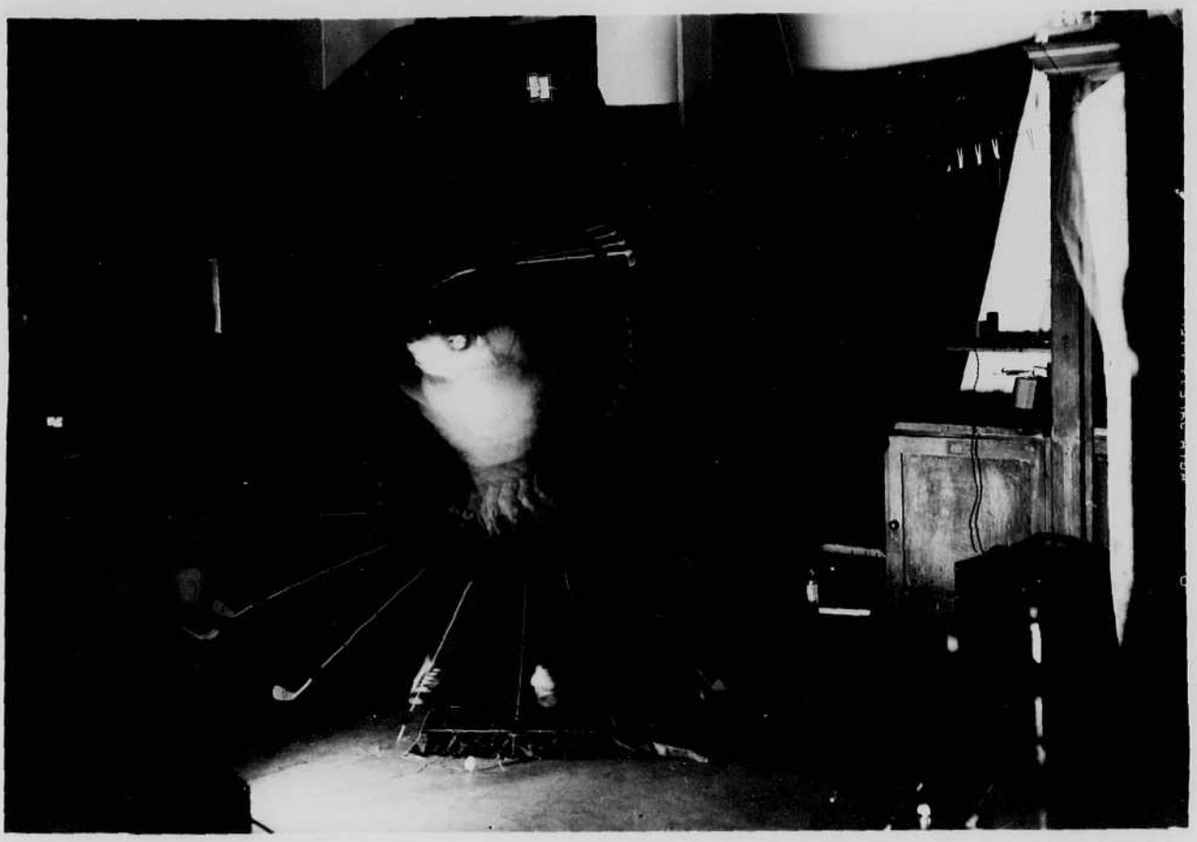


Elmer. Reed American Tool & Die Company.

agfa commercial Pan film. } also Presto. at f 6.3.

f 4.5
1/5 + exposure.
6000 flashes / minute or 100 / sec.

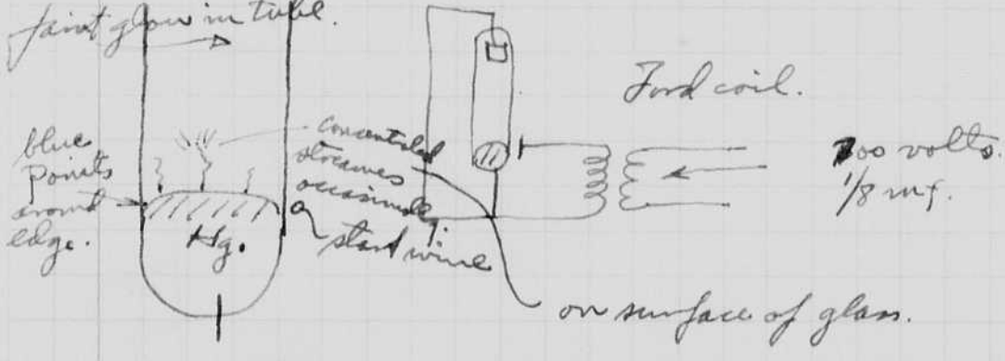
10 mf. (or 9).
3 Kw outfit - 200 ohms.
Hg lamps in series with argon lamps 6" long.

Photos taken March. 3. 1938. in evening.

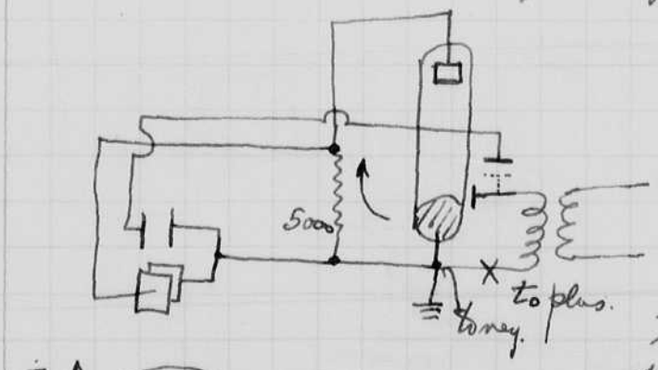
March 5, 1938.
H. E. Edgerton.

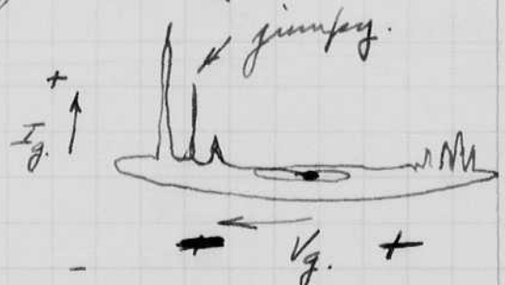
I worked this morning with Lichtenberg figures using a spark coil voltage to form the patterns. I tried to get the pattern on the side of a Hg bulb. A pattern is made only at the surface and slightly above it. A faint glow could be seen in the entire tube but it was not strong enough to expose the film. For this test the film was held in close contact with the glass and the starting wire was put on the outside.

Mark Townsend was here in the afternoon and we did some experiments in the dark room on the starting of the Hg pool tubes. First we examined the tubes when carrying current from anode to cathode.

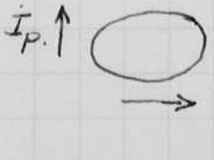


The cathode ray oscillograph was then brought in and connected up as follows.



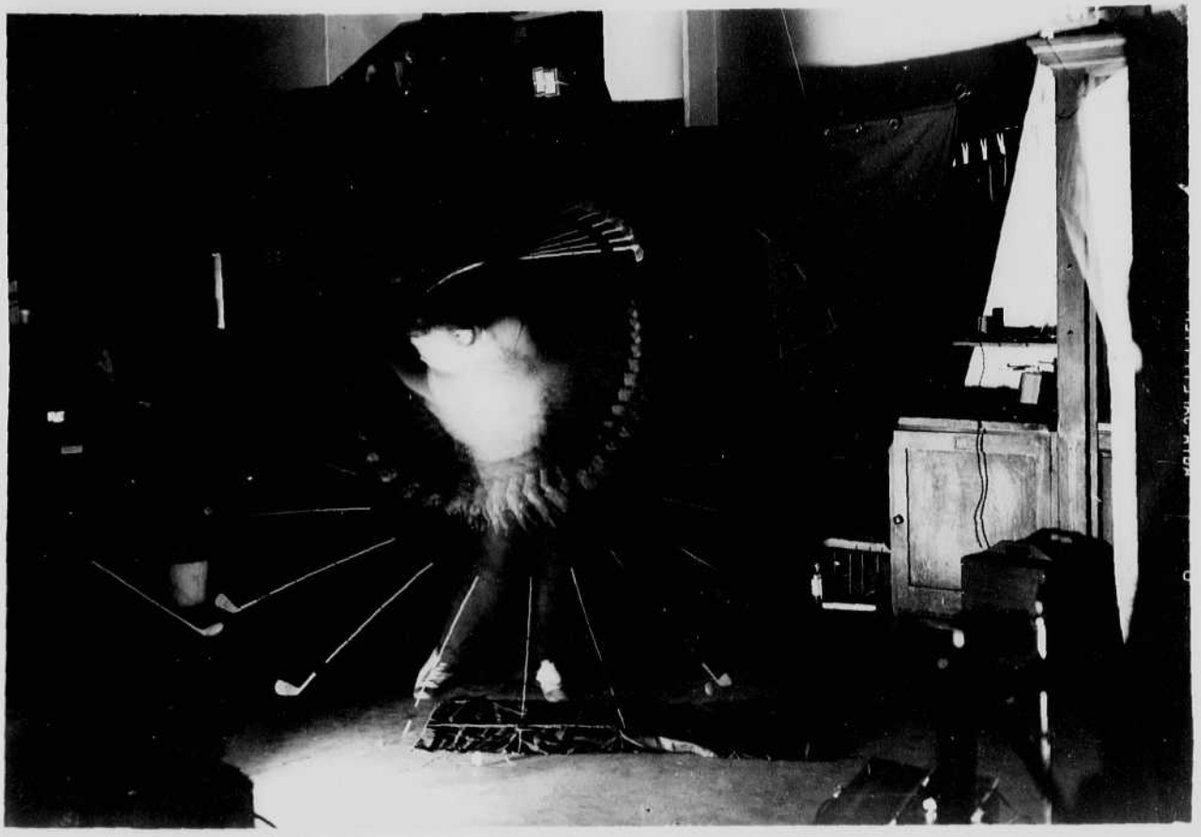


direction of current as shown in diagram



The oscillograph gave a ~~constant~~ voltage reading of about 300 volts on plate (erratic). 5000 ohms resistance

$$I = \frac{300}{5000} = .06 \text{ amps.} = \underline{60 \text{ ma.}}$$



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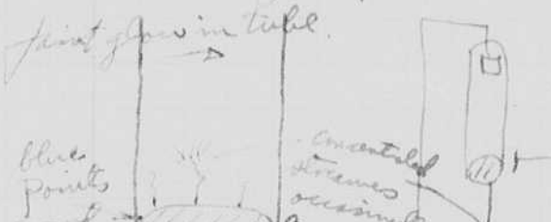

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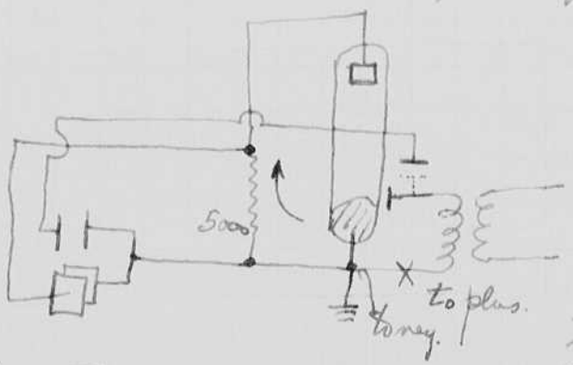
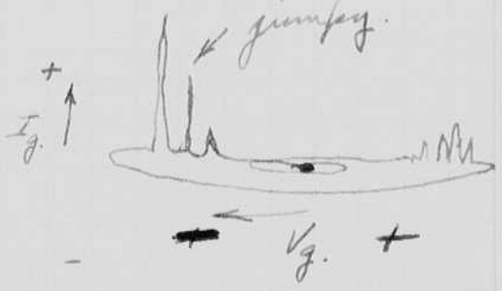
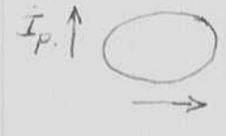




direction of current as shown in diagram



The oscillograph gave a ~~constant~~ voltage reading of about 300 volts on peak (erratic). 5000 ohms resistance

$$I = \frac{300}{5000} = .06 \text{ amps.} = \underline{60 \text{ ma.}}$$

Const

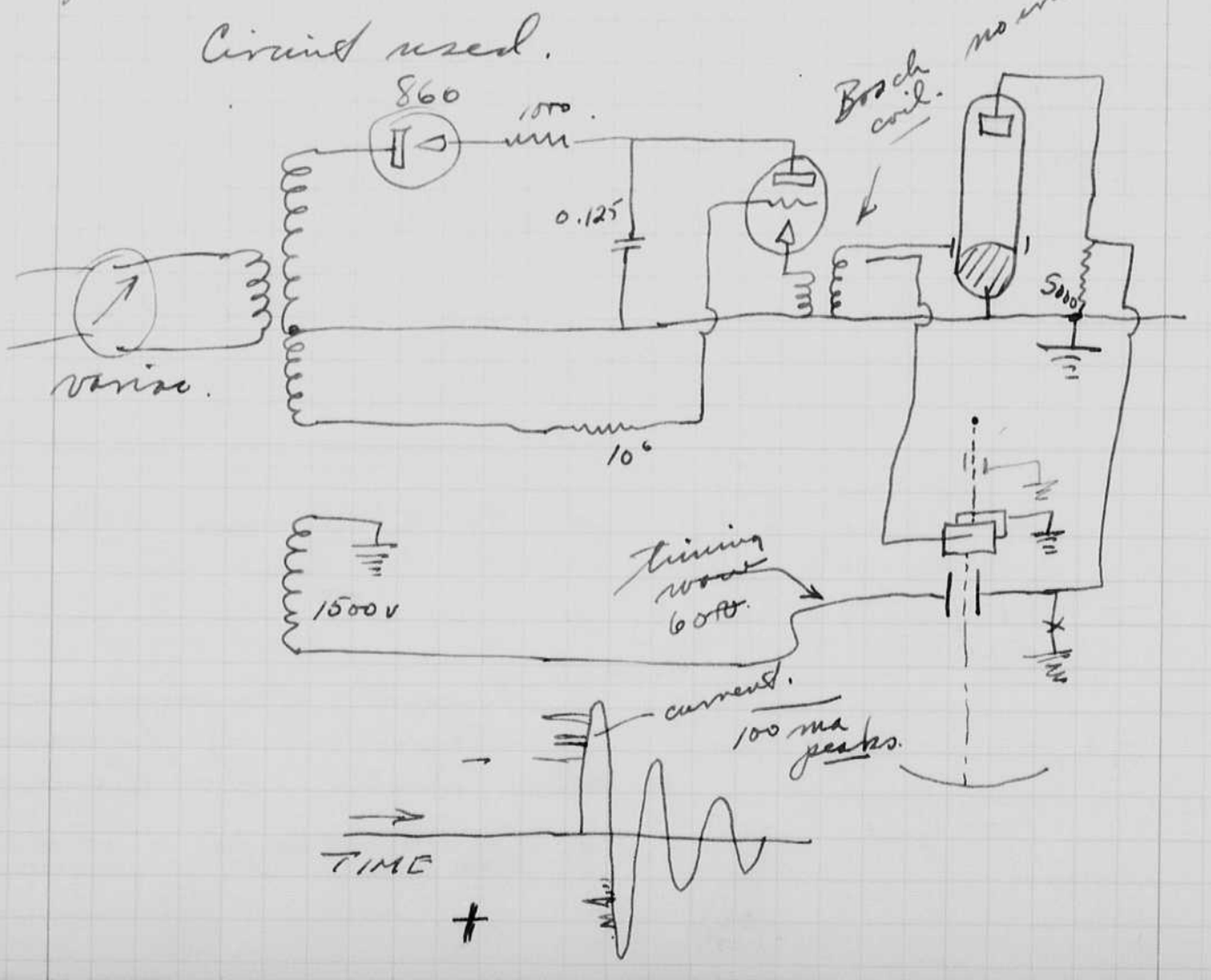
A second tube which was gassy was tried and it gave a current in the opposite direction, (when the grid was positive).

The current was about the same each time. A glow was seen in the tube especially over the cathode.

Mar. 2/1935.

The above experiments were repeated and extended by Townsend and myself on Sunday afternoon. Joe Caldwell also was with us and supplied some of the apparatus that was used.

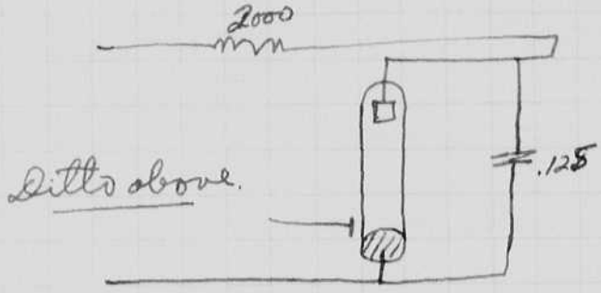
Circuit used.



cont.

Conclusions.

1. Current flows from anode to cathode.
2. Current flows on both + and - half cycles.
   direction ~~same~~ as ~~above~~ on ~~both~~ examples.
3. Tube starts only on + half cycle or (going +)
4. Currents are larger when grid is negative but tube does not start with + plate voltage.



Ditto above.

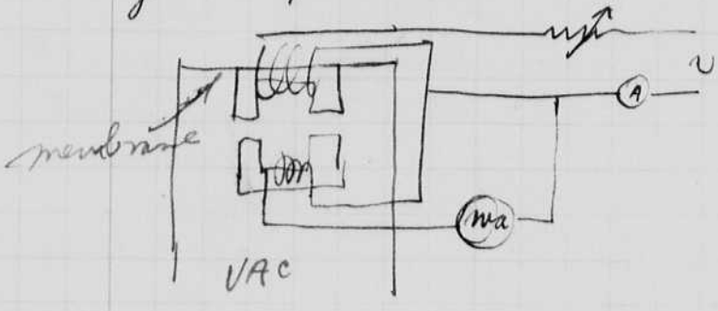
Exp. to show start of tube.

I need to check the sparks voltage with a resistance divider or other method to find if there was a phase shift in the oscillogram.

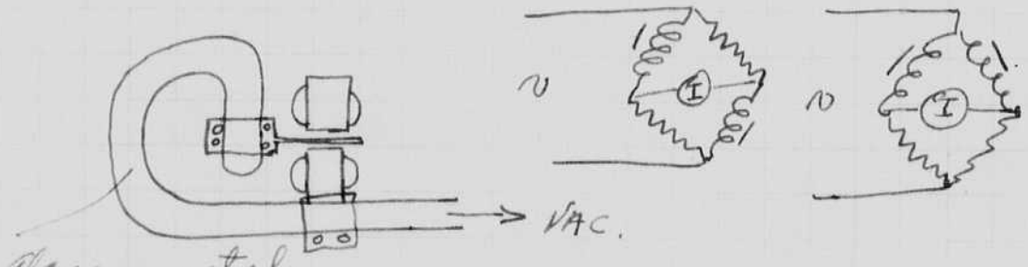
P. B. Edgerton.
Nov 9 1935

Vac. Gage - Arch fur Elektrotech.
17 Jan 1938
C. Brunlemann. p 59:

Magnetic measuring coils in a vacuum. Flexable membrane for giving motion to moving system



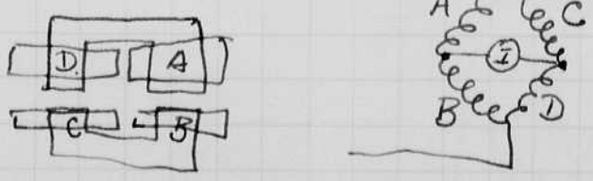
the modification below should be useful.



Spring to vary spacing of magnetic membrane when pressure is changed.

An amplifier might be needed to raise the sensitivity.

Several trials might be used to average the sensitivity of the method.



March 1938.
[illegible]

Measured freq of spark discharge last night with Fred Boston.

10^{-6} sec. on film = 0.017 inches.

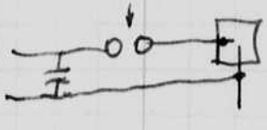
enlarged 10 to 1 in enlarger.

10^{-6} sec = 0.17 inches.

1 cycles of osc = 3/8" on film.

1 cycle = 2.2×10^{-6} seconds.

f = 450,000 cycles. $C = .05 \times 10^{-6}$

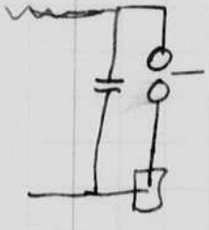


$$\frac{1}{LC} = \left(\frac{2R}{L}\right)^2$$

$$\frac{1}{C} = \frac{4R^2}{L} \qquad f = \frac{1}{2\pi\sqrt{LC}} \qquad T = 2\pi\sqrt{LC}.$$

$$T^2 = 4\pi^2 LC.$$

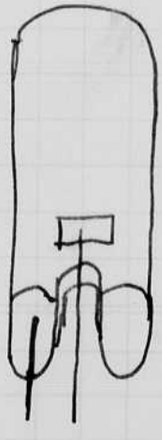
$$L = T^2/4\pi^2 C.$$



$$\frac{1}{\alpha} = \frac{4R^2 4\pi^2 C^2}{T^2}$$

$$1 = \frac{4RC\pi}{T}$$

$$R = \frac{T}{4\pi C} = \frac{2.2 \times 10^{-6}}{4\pi .05 \times 10^{-6}} = 3.5 \text{ ohms.}$$



Phila.
Mar 26 1938

Took spark pictures, silhouette, with Fred Barstow in afternoon.

22 cal. long rifle.
0.1 mf 7500 volts. } Two condensers.
.05 " "

Light about 2 1/2 ft from gun.
Process film. Eg&a. D72+4H$_2$O 4 min dev.

Sound Pickup. mike - crystal.

Mar 24

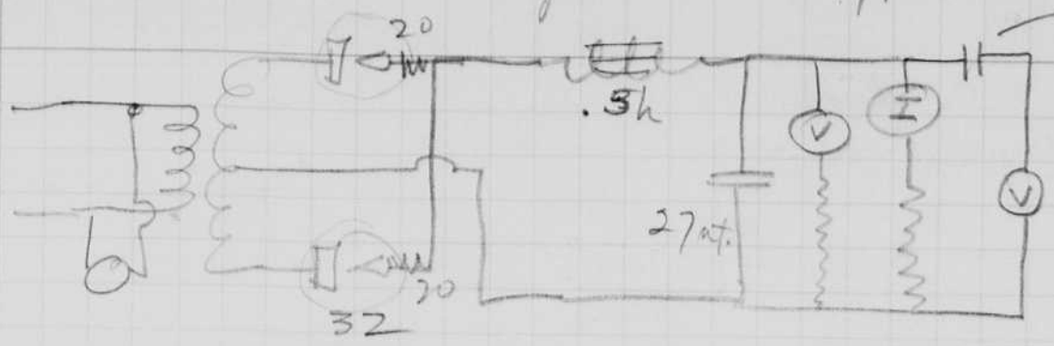
Jno Caldwell went in the lab last night & to Providence to talk to the Engineering Society there.

Explained Photocell - Strobe motor sync. demonstration to Caldwell and Nelson who are going to experiment with it.

Strobe 68 1/2 Delta .1h 60 cycles.

1 amp	50		1/8 gap ±
2 amp	2.25 x 50	115	
2.37	2.65 x 50	132.5	
1.5	132.5		1/2 of air gap out.
1	1.75 x 50	87.5	
.1 ±	132.5.		no gap.
.45	132.5		

June 24 1935 Regulator rectifier.



3 K.w. unit.

Sec	Vdc	ΔV.		Prim. Vac
0	1430	.7 X 2	1.4	110
1.4	1050	1.4 X 50	70.	105
4.20	920	1.05 X 100	105.	101.5

20 ohms in cathode lead shorted.

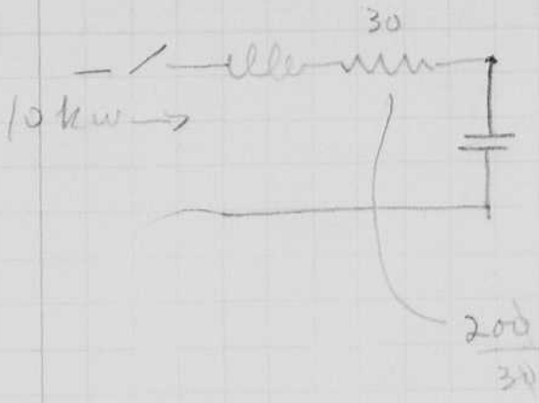
3.35	990	.62 X 200	124.	107.5	Xline $x = \frac{R}{m} = .5h.$	$\frac{100}{.4} = 400$ ohm. $\frac{100}{400}$.
1.3	1100	1.4 X 50	70	105.		
.3	980	1.3 X 50	65	101	+20 mf.	
		.9 X 50	45	101	+40 "	105.2± 4 volts drop in cable.
3.2	890	.64 X 100	60		+ " blow fuse.	

0	1260	—	—	225	10 KW 30 ohms in load,
1.4	1170	.5 X 2	1.0	224	shorted
4.2	1180.		2.5		"
3.85	1060				30 ohms in series.
5.5	1150				" " shorted.
5.5	1180		20	—	with 12 mf in place of 4 X 14 mf.

two new tubes put in.

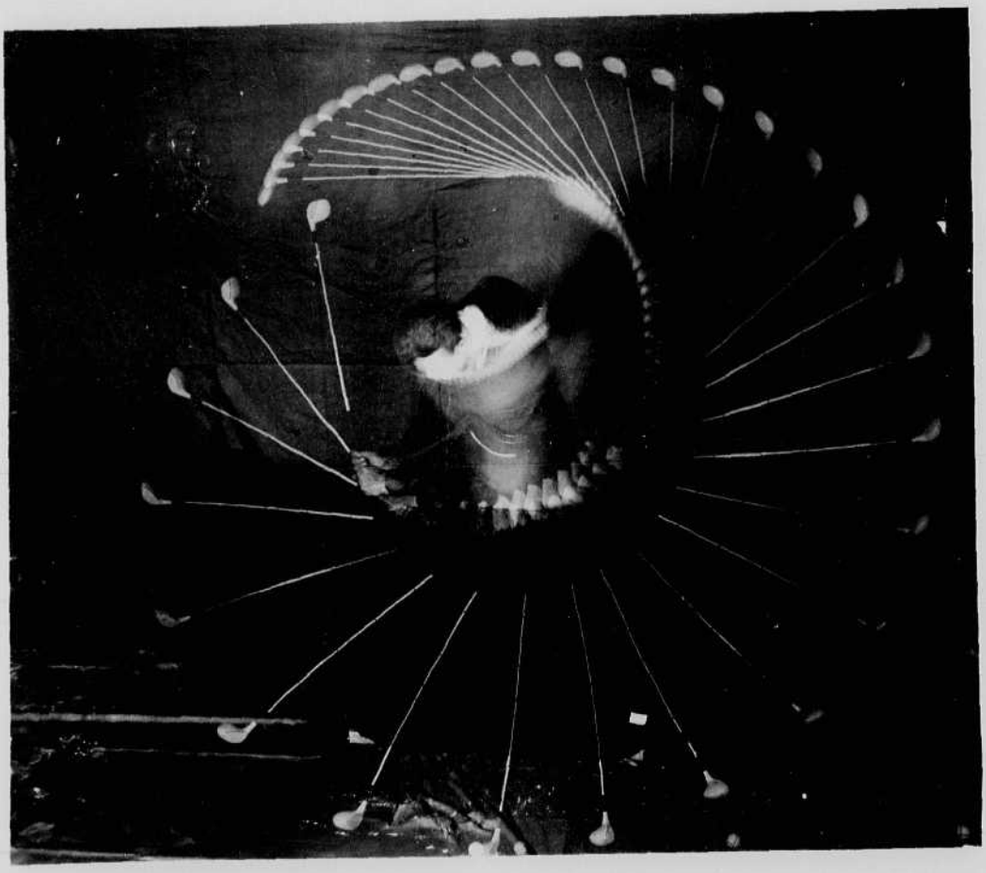
30 KW 6 phase outfit.

6.8	1140		45



On March 29/38 Mili was here and we discussed additional capacity for his speed light unit.

Suggested value 2 condensers 440 ac 28 mf.
2 additional outlets & plugs.
Unit to fit under cabinet.



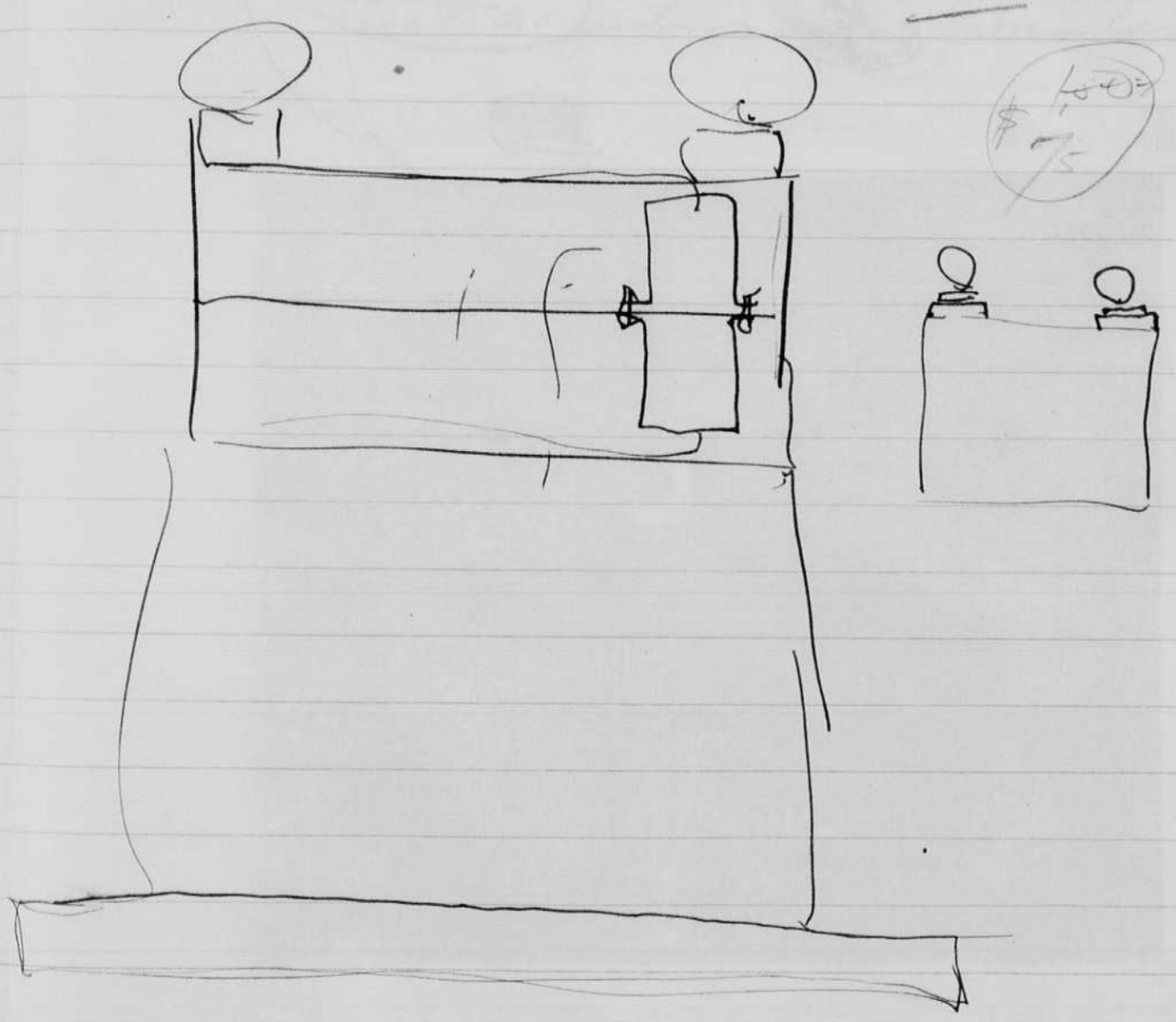
H. E. Edgerton

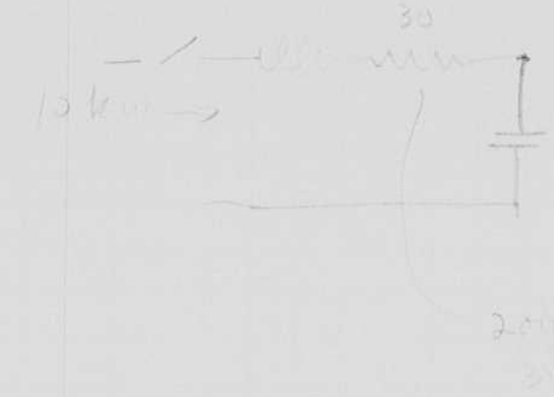
Mar. 29. 1938
Conf. with Nili.

24 condensers. 440 v. 28 mf.

2 additional outlets.
plugs.

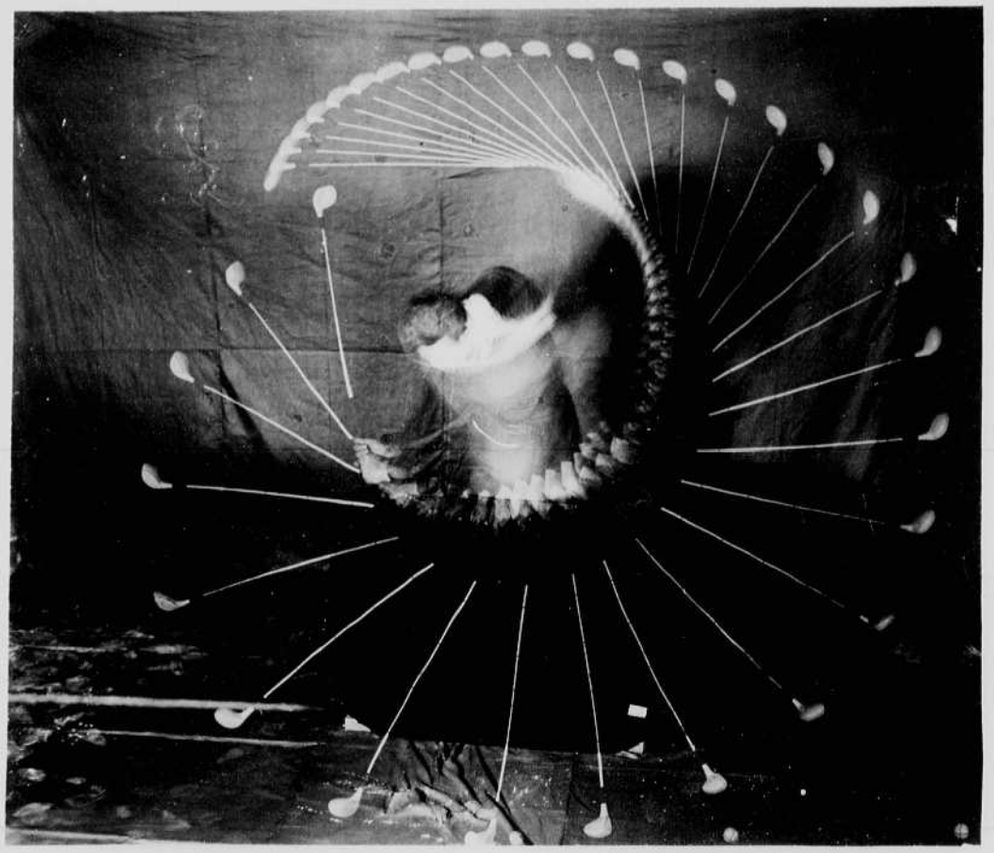
Vice





On March 29, 1938 Mike was here and we discussed additional capacity for his speed light unit.

Suggested value 24 condensers 440 ac 28 mf.
2 additional outlets & plugs.
Unit to fit under cabinet.

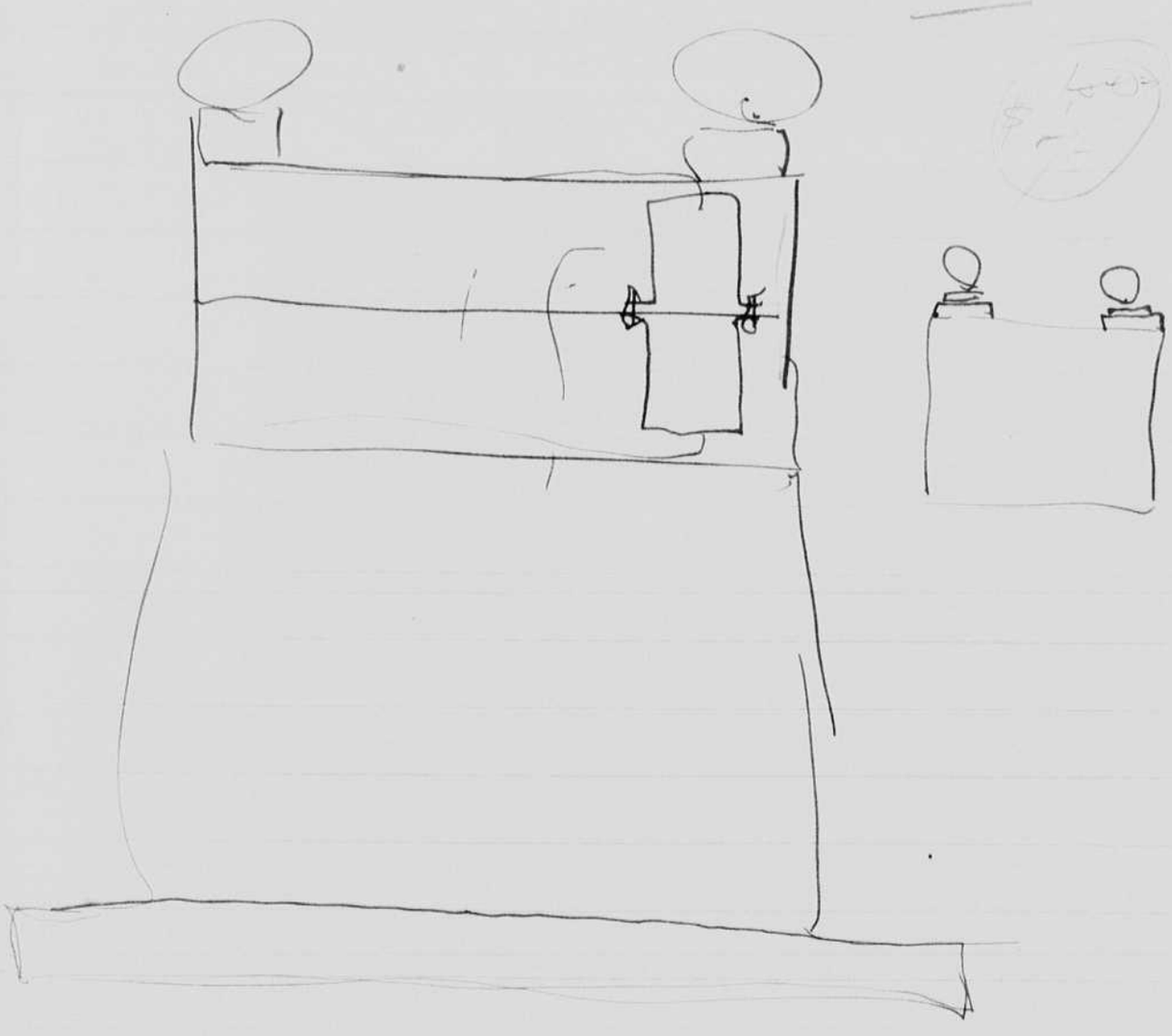


H. E. Edgerton

Mar. 29. 1938
Conf. with Nile.

24 condensers. 440 v. 25 mf.

2 additional outlets.
plugs.



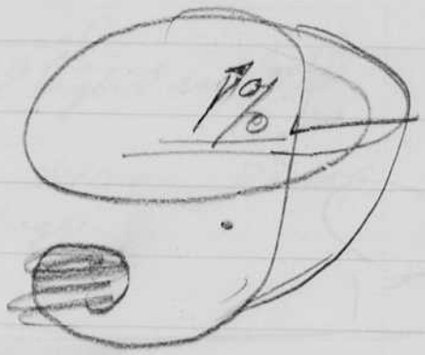
10 km

On March

as

Sug

Un



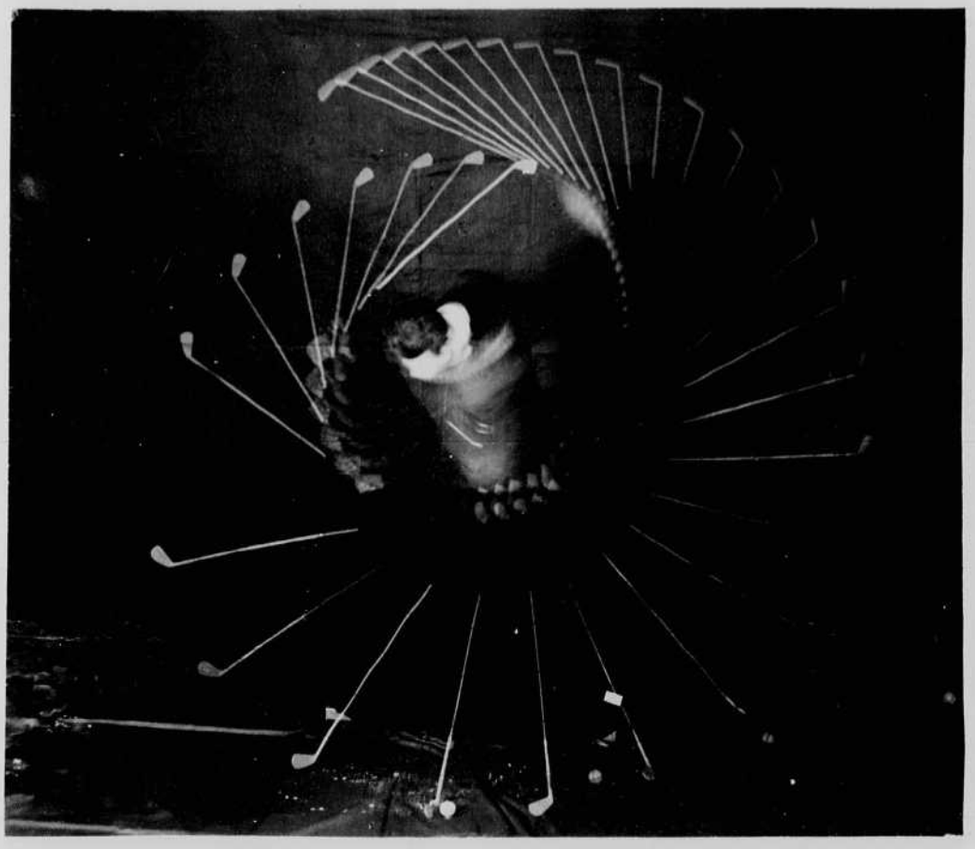
H. E. Edgerton
March 29, 1938.

Pictures taken last night with Brotzman of A. F. & Hoe Co. Elmer Reed hit the ball for us.
5 x 7 camera f 6.3 Agfa Pan Ortho.
5 min dev. in std. devel recommended.
two lights were used.
4 mf 2200 volts large U tube 12" long total.
800 ohms. 5/8" diam.

800 cycles. a second.

lights about 6 to 8 ft. from subject.

about 20 pictures were taken last night.



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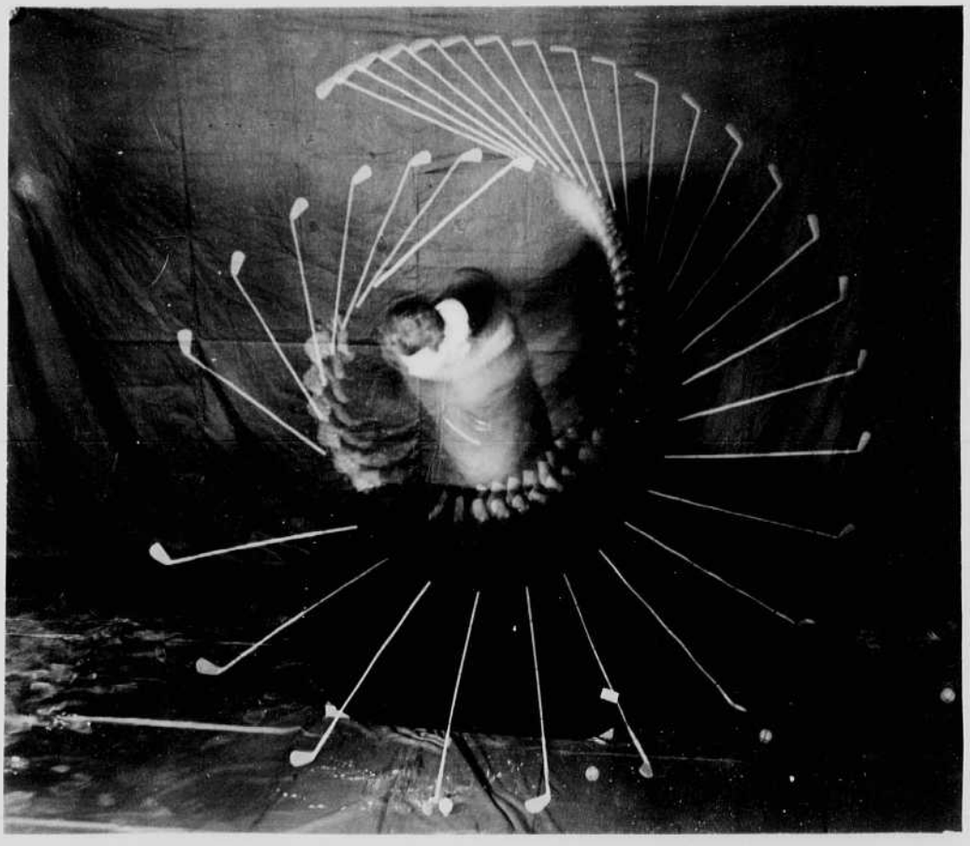
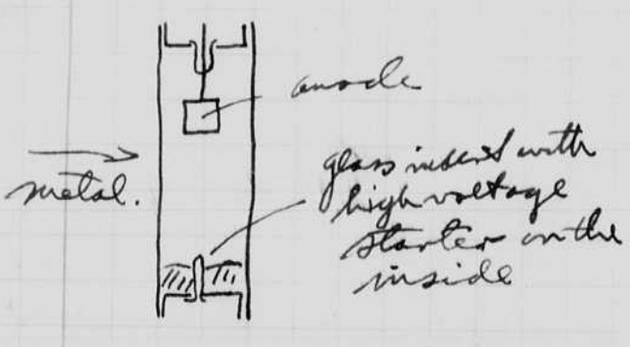


April 7 1938
H E Edgerton.

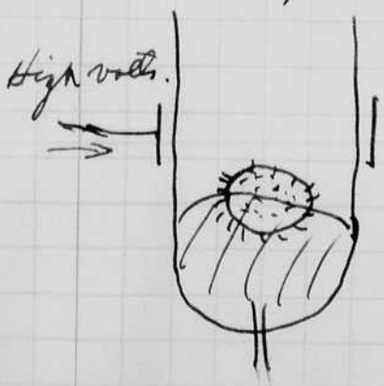
I talked last night to the Harvard Club arranged by Mr. Spike (Ed). At dinner before a group, Mr. Wilson, Mr. Healy, Burton (former student M.I.T., thesis with Taplin) and others. Mr. Charles Stuart told me of an invention of his father Mr. Robt Stuart that printed microfilm at a fast rate.

Last weekend I went to Schenectady ny to Alland an electronics conference arranged by Nottingham who is at the G.E. plant this term. While in Sch I saw Mr. Dunham and Mr. White about the flash lamp project with Eastman. etc.

I had a discussion on Sat. with Kingdon about the starting of Hg tubes with an external band. He said his experiments showed cracks at the junction of the Hg and the mercury. It may be that the tubes he used were of Nopex glass. He discussed a metal type.



Suggested type of starter.



Glass balls in mercury with carborundum or other material melted into the surface.

The high voltage might be put on an internal electrode for starting.

Cont.

Gennesaussen showed me this morning a starter rod covered with Al oxide. The Al oxide was heated to a red heat in a gas flame and appeared as a film of material over the nickle rod.

In air into a cup of Hg, it showed bright points of fire at the surface of the Hg. when excited with a "sparker" giving about 1/2 inch of sparks.

He is going to mount it in a tube today for evacuation.

Evening

√HERB GRIER Trial exposure. 2 films agfa Pan Press 5×7.
" Plena " "

f-16.
12 ft from subject Herb jumping.
1 light at camera 48 mf 3000.
1 " at r angles. " "
6 or 8 ft. from subject.
and high.

D 72 4 H2O to 1 of D72 Stock.
5 min dev.

Exposure about right

Herbert Grier

April 7 1938
H. E. Edgerton.

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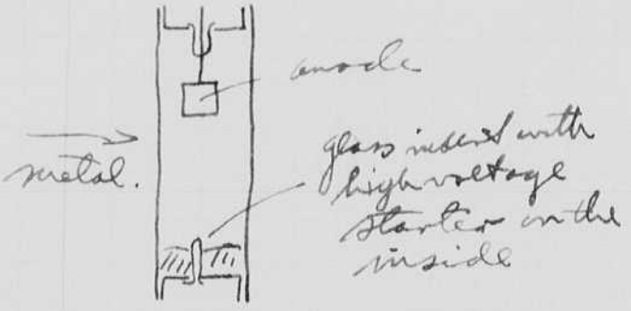
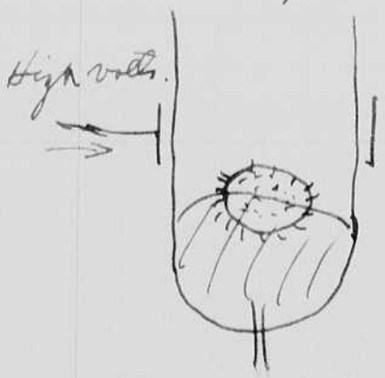


Suggested type of starter.



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f-16.
12 ft from subject Herb jumping.
1 light at camera 48 mf 300.
1 " at r angles. " "
6 or 8 ft. from subject.
and high.

D72 4 H2O to 1 of D72 Stock.
5 min dev.

Exposure about right

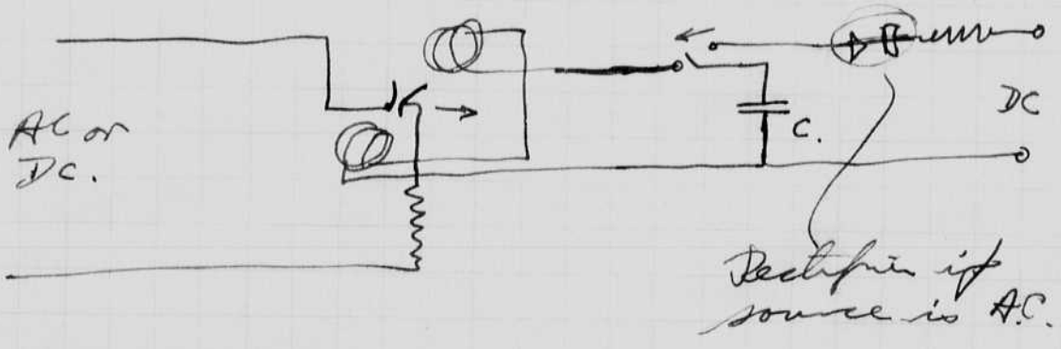
Herbert Grier

April 8 1938
Jerrold E. Edgerton

Hg arc starter.

Glass or quartz tubing on a metal rod in the Hg.

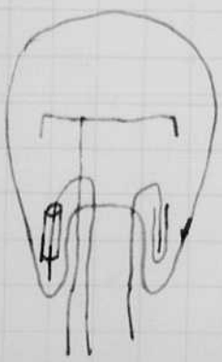
Method of blowing out an arc.
Use a condenser discharge through a coil around the arc path to set up a very high field.



April. 13, 1938.

Demo made one starter with Quartz as per above sketch. The spacing was not enough to try.

I made ~~two~~ three in glass bulbs, small lead ~~glass~~ but did not get a chance to pump them.



April 14, 1938.

Discussed Strobroscopes this morning with Wilkins.

1. New Strobotac circuit. 631
   Features to consider in design.
   3 Ranges 100 - 600 ?
   600 - 3600
   2400 - 14000
   Fine control 60° 30° phase shift.
   Contact control for high upper limit.
   Parallel operation.
   External a.c. control (volts needed) Ports.
   External lamps connection.
   Insert into condenser discharge circuit for high intensity lamps.

2. Special stroboscope for Gen. Elect. Lynn
   to be sold with Watt hour meters.
   Upper speed desired about 400 cycles.
   500 teeth in watt hour meter discs now.

Question about relative velocity of disc with half frequency light

$$\text{actual velocity} = \frac{(S+\Delta S)}{\Delta t} =$$

(S = distance between teeth.) $\text{visual velocity} = \left(\frac{S+\Delta S}{\Delta t}\right) - \left(\frac{S}{\Delta t}\right) = \frac{\Delta S}{\Delta t}$.

with 1/2 frequency. $\text{actual velocity} = \left(\frac{S+2\Delta S}{2\Delta t}\right)$

$$\text{visual velocity} = \frac{S+2\Delta S}{2\Delta t} - \frac{S}{2\Delta t} = \frac{\Delta S}{\Delta t}.$$

visual velocity (drift) is the same.

cont.

At 10 am I went down to one federal and had a conference with Mr. Rines.

Discussed with Schlater and Sennesbausen method of electrical prospecting. Prof. Schuster showed us some calculations regarding velocity and attenuation of electrical waves in the earth.

The returned signal would be about 10^{-8} as large as the sent signal.

Method of measuring or comparing the returned reflection with an attenuated wave from the original signal was discussed.

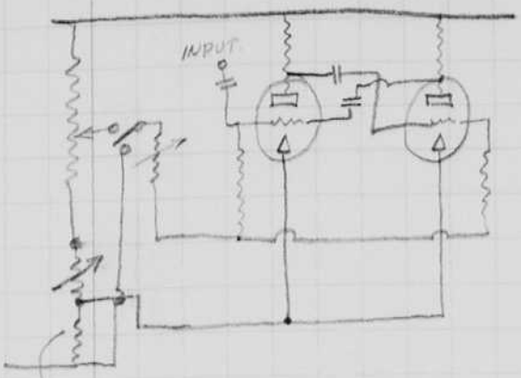
Heard lecture today by Evans and Goodman on the age of the Earth, as determined by radium content and by helium content.

Yesterday I pumped a tube with a tight ~~seal~~ to be used as a point source for single flash photography. The tube leaked so was not finished.

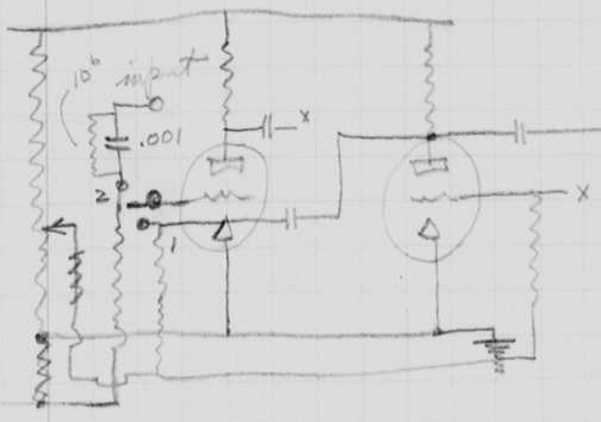
Our supply of Krypton 20% Xenon 10% came this week and some tubes were filled today by Sennesbausen. They give about twice as much light as krypton filled tubes.

Kathly showed today that a small photo flash bulb is about equivalent to 2000 volts 100 mf.

Strobotac Switching scheme.



maybe O?



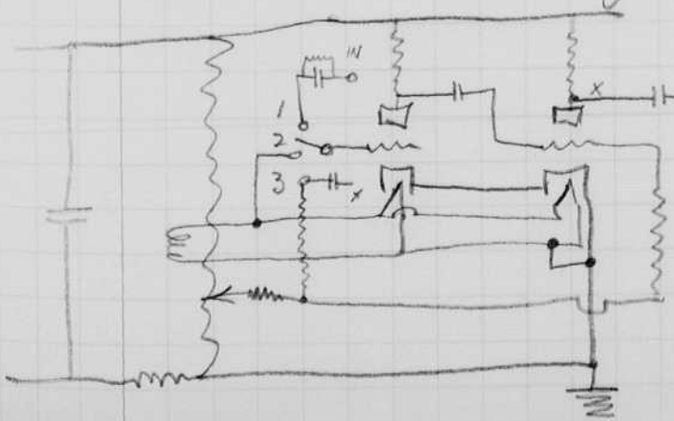
to Strobotac,

$\times 10^{-6}$ $10^{6} \times .001 = RC = .001$ sec enough?
if not try .01 mf.

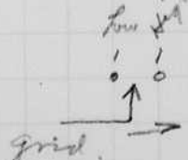
type 53, $\mu = 35$. ?
$r_p = 11{,}000$.

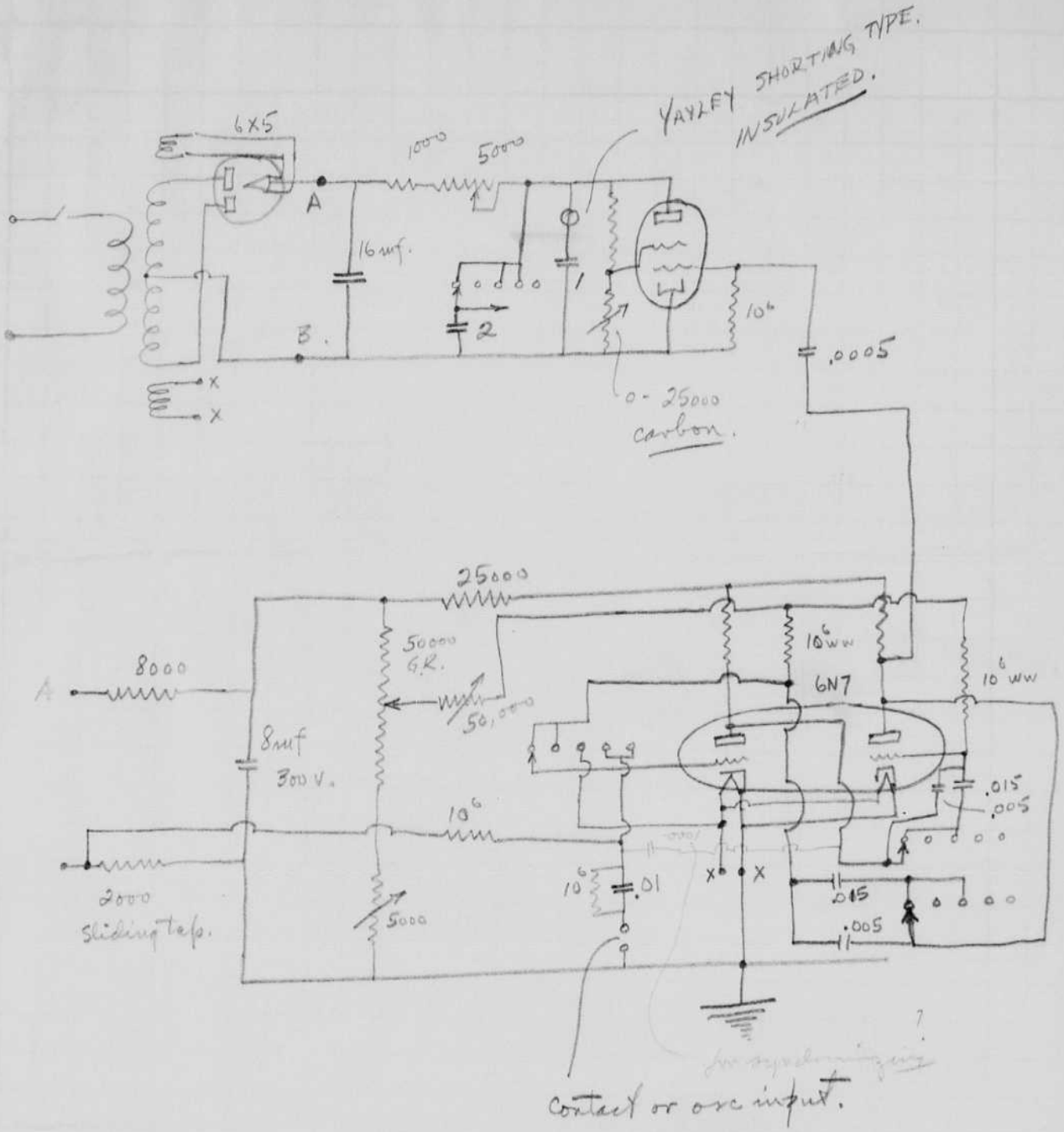
$\mu' = \frac{35}{1 + \frac{11{,}000}{50{,}000}} = \frac{30}{\frac{3}{4}}$ tro. gain

Also investigate 60 cycle circuit, connect ~~6~~ 6 volt heater ac power to grid



no phase shift with this ckt.





this circuit was given to Wilkins afm. 15, and he is going to mount it on a board for test.

APRIL 14 1938

H. E. EDGERTON

Notebook # 8

Filming and Separation Record

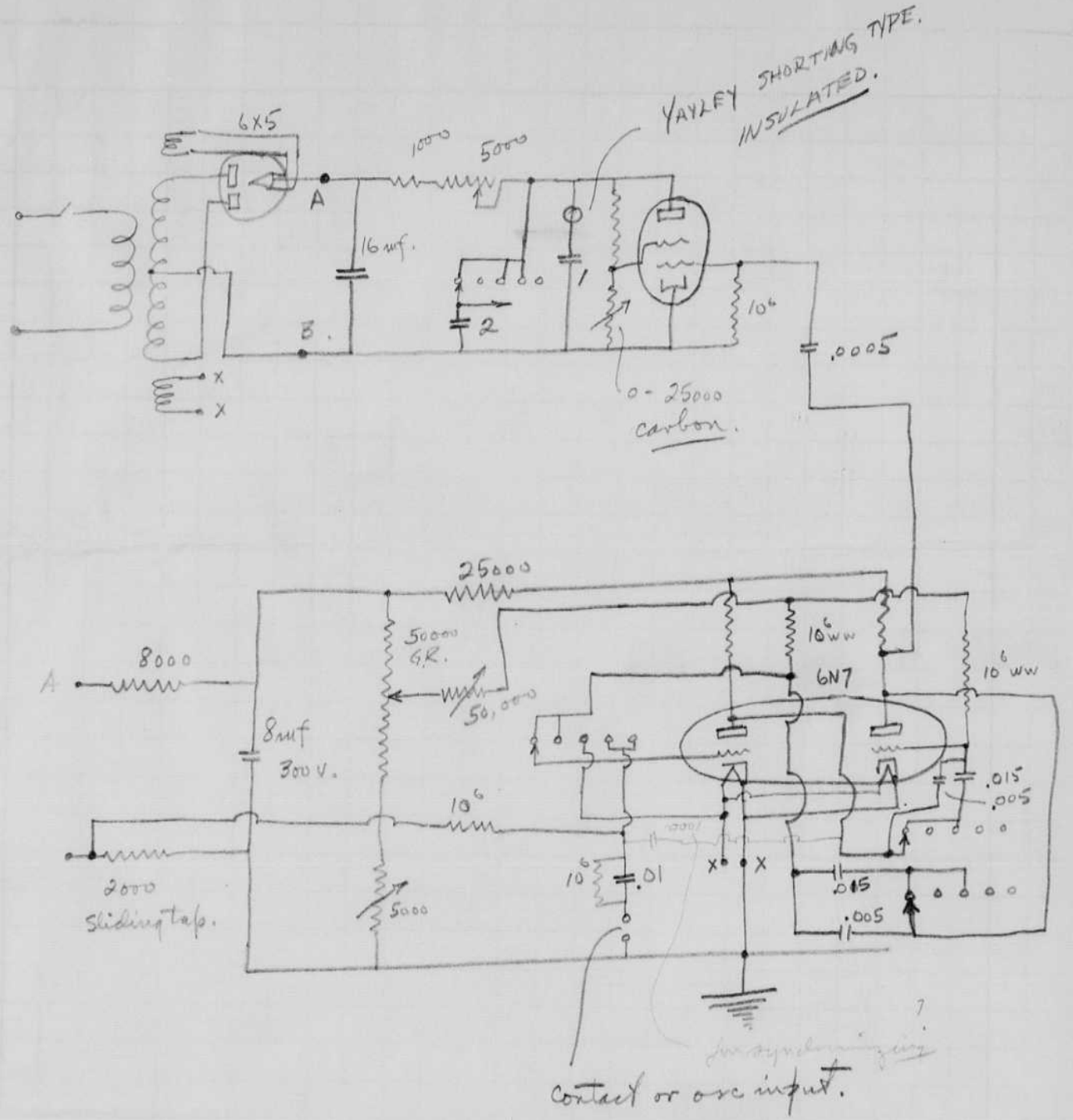
____ unmounted photograph(s)

____ negative strip(s)

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

was/were filmed where originally located between page 148 and 149.

Item(s) now housed in accompanying folder.



this circuit was given to Wilkins 4pm. 15, and he is going to mount it on a board for test.

APRIL 14 1938

HE EDGERTON

Notebook # 8

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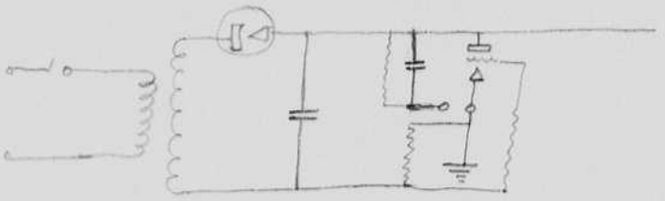


10,000 = V
.5 amt.
15,000 V.
2 mmf.

April 16 1938.
Re-exposures.

Pumped tube and tried 22 cab. bullet

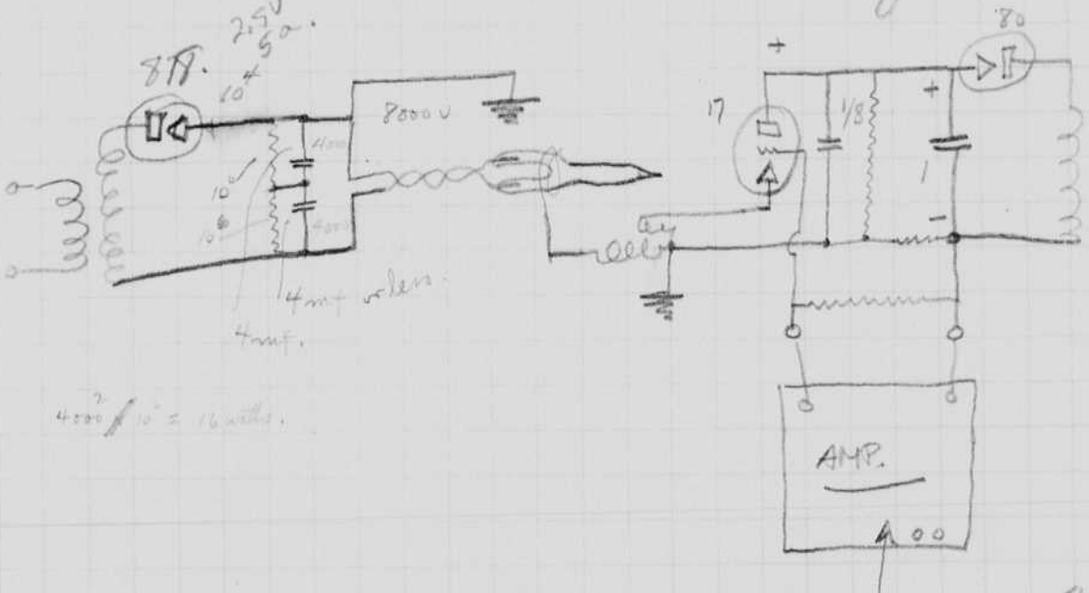
1/4" Tubing - tungsten electrodes.
filled at 1 atmosphere argon.

2 mf 3000 volts.
f 8 camera vericham film.

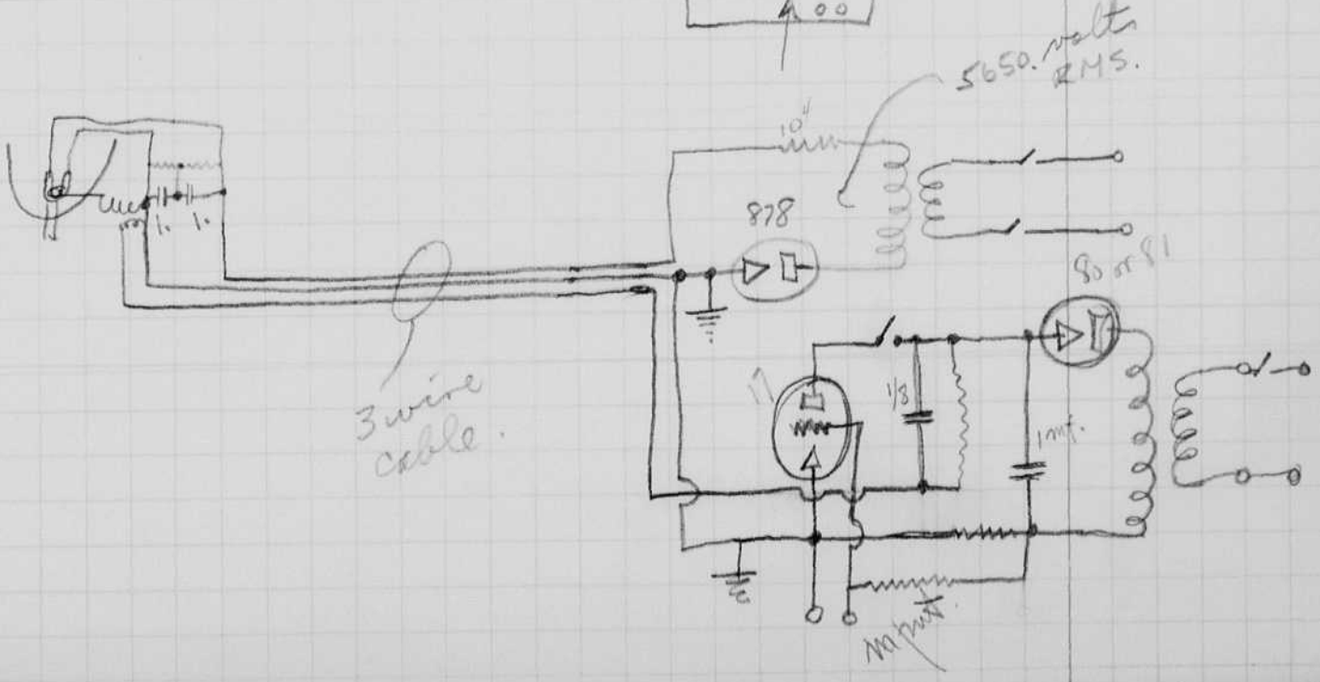
Exposure light.

Trailer on light light of bullet.

The tube was repumped this morning 1 cm H_2 + 1 atmos argon.



4000² / 10" = 16 watts.



Cathode Ray screens p 18.
Photo cell trip circuit. p 17

CONTINUED
ON
NEXT REEL