HAROLD E. EDGERTON

PAPERS

MC 25

Series III

Laboratory Notebooks

Number 9

Dated April 18, 1938 to June 12, 1939

M.I.T.

~~HARVARD~~ UNIVERSITY

COMPUTATION BOOK

NAME	Number
HAROLD E. EDGERTON	9.

Course .....

Used from APRIL 18 1938, to JUNE 12 1939

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

BANTAM 12372 LENS
5382833 SHUTTER

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

April 18, 1938.

April 18 1938
H. E. Edgerton.

In Washington D.C. on duty as a naval reserve officer. At 930 in the morning I met Commander Homer Graf in his office. After an hour or so we were taken by auto to the Belview Research Laboratory. There I met the following

Capt. H.M. Cooley Director
Cmd. Swenson asst.
Dr. Ross Gunn Tech. advisor and head of mechanical section.
Dr. Harvey Hayes Sound
Dr. E.L. Hulburt Optics
T. Borgstrom Chem
R.H. Canfield Metal

Geo. Irwin working on spark photography.

Dr. Gunn took me around the laboratory and spent the entire day with me.

April 21 1938.

On Apr 19 I went to Annapolis with Mr. and Mrs. Homer Graf in their car. We left the Navy Dept at 9.30 in the morning. While at Annapolis we spent several hours at the experimental station. I met there

Capt Cox.
Cmd Marcus Hutchinson
Lt Sims - doing experimental work on the measurement of sound of fans.
Jochim? Diesel engine man.
and several others.

There is a mercury arc stroboscope (G.R. type) at this station and they asked some questions concerning its operation. Apparently it is used quite a bit. I advised them to get an argon filled lamp for their work which is all at low speeds.

The diesel engine man wishes to take pictures of piston rings through a glass port in the cylinder wall of an experimental engine. I advised him to try to use the stroboscope with extra condensers.

On Wednesday April 20 I went with Mr & Mrs. Graf in their car to Dalgren, Va, 100 miles from Washington. Here the guns and ammunition are tested for approval.

I met Comd. J.H. Carson, a class mate of Graf.

Dr. L.T. Thompson - in charge of the physical testing section. Thompson was a student of Webster of Clark Univ at Worchester Mass. He is from Michigan.

Dr. N. Riffolt. Physics M.I. - working with resistance pressure gage which works without an amplifier. the gage is put in the end of the gauge guns.

Dr.? Stover Physics M.I. from Gettysburg Pa. trained at Michigan.

I spent a very interesting day inspecting the various work that they were doing at this proving ground.

Dr. Thompson has a program in mind for the study of the impact of projectiles on armor plate using 3" projectiles instead of the large ones.

I suggested the use of single flash photography and Thompson asked me to send him details on how to obtain equipment for their use. I mentioned the possibility of measuring the distortion in the large guns due to the pressure in them.

Thompson wishes to try the method on small tubes, to measure the distortion

Apr 21 1938
H.E. Edgerton.

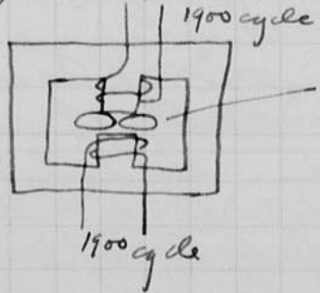
On tuesday evening Apr. 19. I called on Mrs. Jenkins and she let me see her late husband's high speed camera. Mrs. Clarke, Jenkins former secretary was there with her husband to show the camera and also ~~the~~ some of the films. Mrs. Price, Mrs. Jenkins companion and son were there also.

One reel of pictures were shown including Bobby Jones swinging a golf club, some divers, pigeons in flight. the camera took the pictures at 200 times normal speed. they were very good.

Apr. 22, 1938.

Yesterday I spent most of my time at the Washington Navy yard. I left Commander Bragg's office at 10 am or shortly thereafter in a navy car. Lt Conrad met me and also Commander Sexton. First we looked Capt. Eggert for permission to inspect the work at the navy yard.

Lt R.D. Conrad is in the structural section and showed me the testing department. Mr. S.E. Dawson was engaged in making a vibration recorder of the "Dayhart" type, illustrated below.

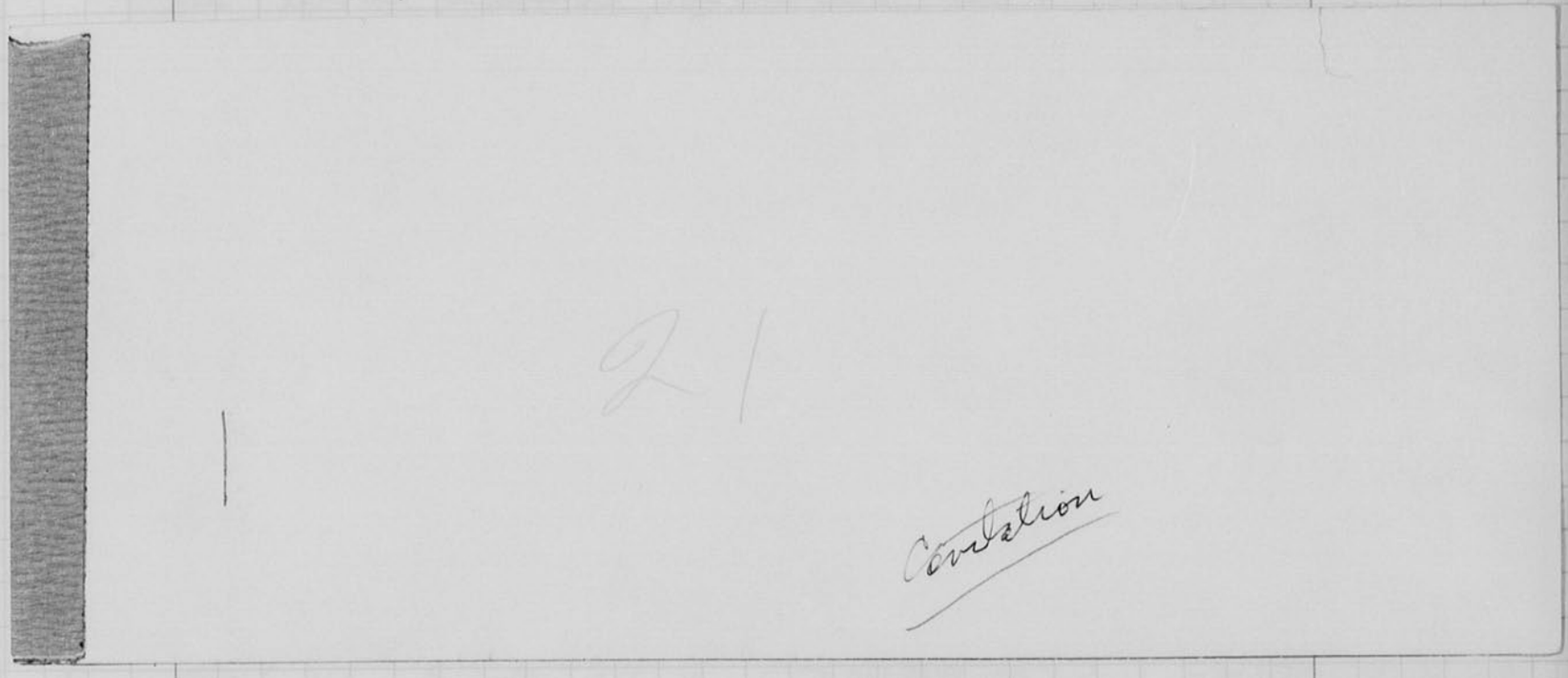


two coils in air gap with opposing emf at the center position. a voltage will be induced when coil is off center, thus recording displacement.

this equipment with a photographic recording method is to be used in Boston in about a month by Commander

Sexton. (Ship - Ralph Talbot - radder).

Comd. Sexton showed me a high speed (960)/sec. camera for photographing a propeller model in a pressure tank. A stroboscope was used for observation. Mr. Bowers ran the apparatus. A section showing H_2O going around a corner was shown to me. This is the same as Lewis plans to use in the tunnel here.



Mr. K.E. Schoenherr (M.I.T Graduate) was operating the carriage on the towing tank and I met him.

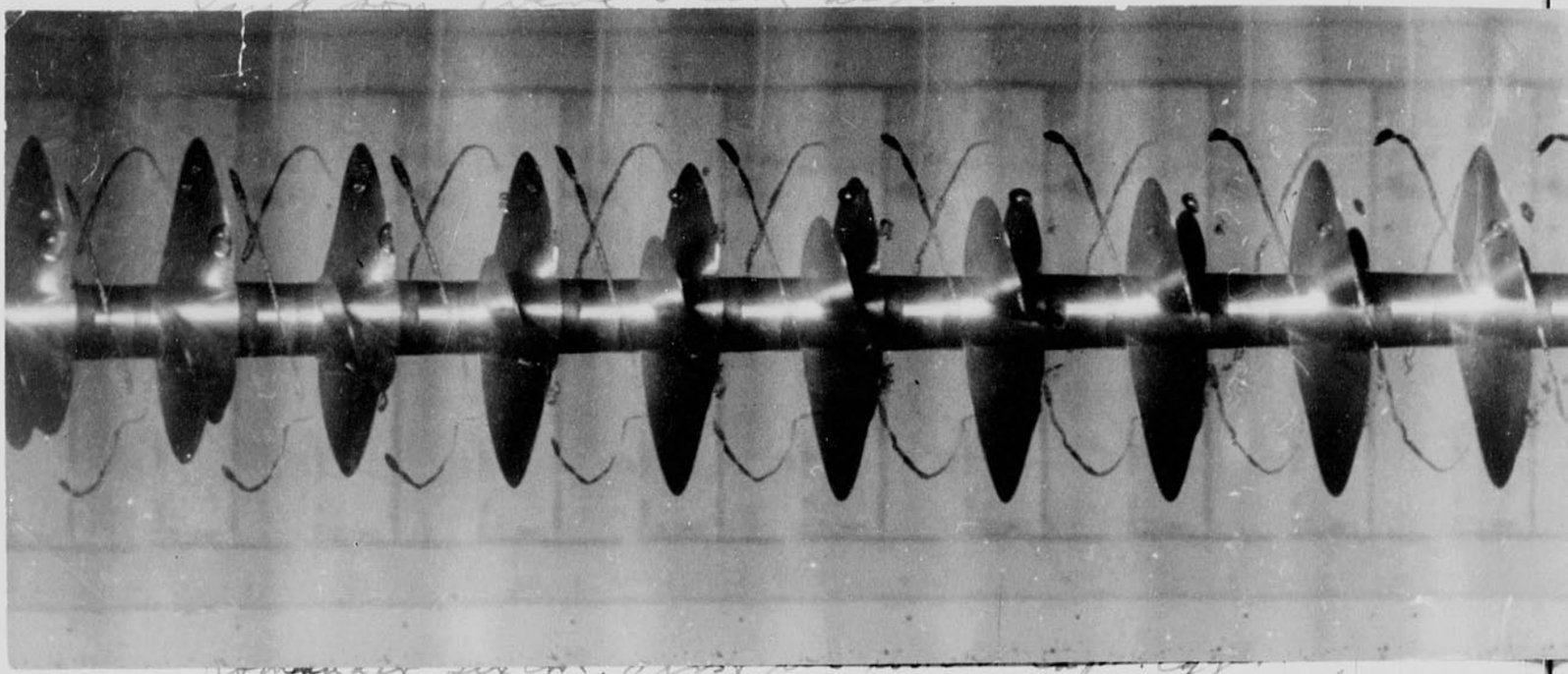
Mr. Kaye - Photographic dept - Vacuum paper holder.

{Lt. Kell - now in Boston Navy Yard.
{Comd Gayhart " " Philippine islands on duty

McGoldrick Physicists interested in stereoplitography.

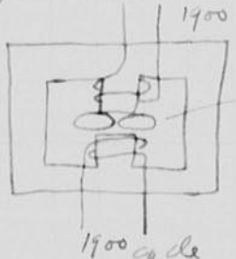
Apr 21 1938
Washington

On tuesday evening Apr 19. I called on Mrs. Jenkins and she let me see her late husband's high speed camera. Mrs. Clarke Jenkins former secretary was there with her husband to show this camera and also some of the films. Mrs. Price, Mrs. Jenkin's companion and son were there also.



for permission to inspect the work at the navy yard.

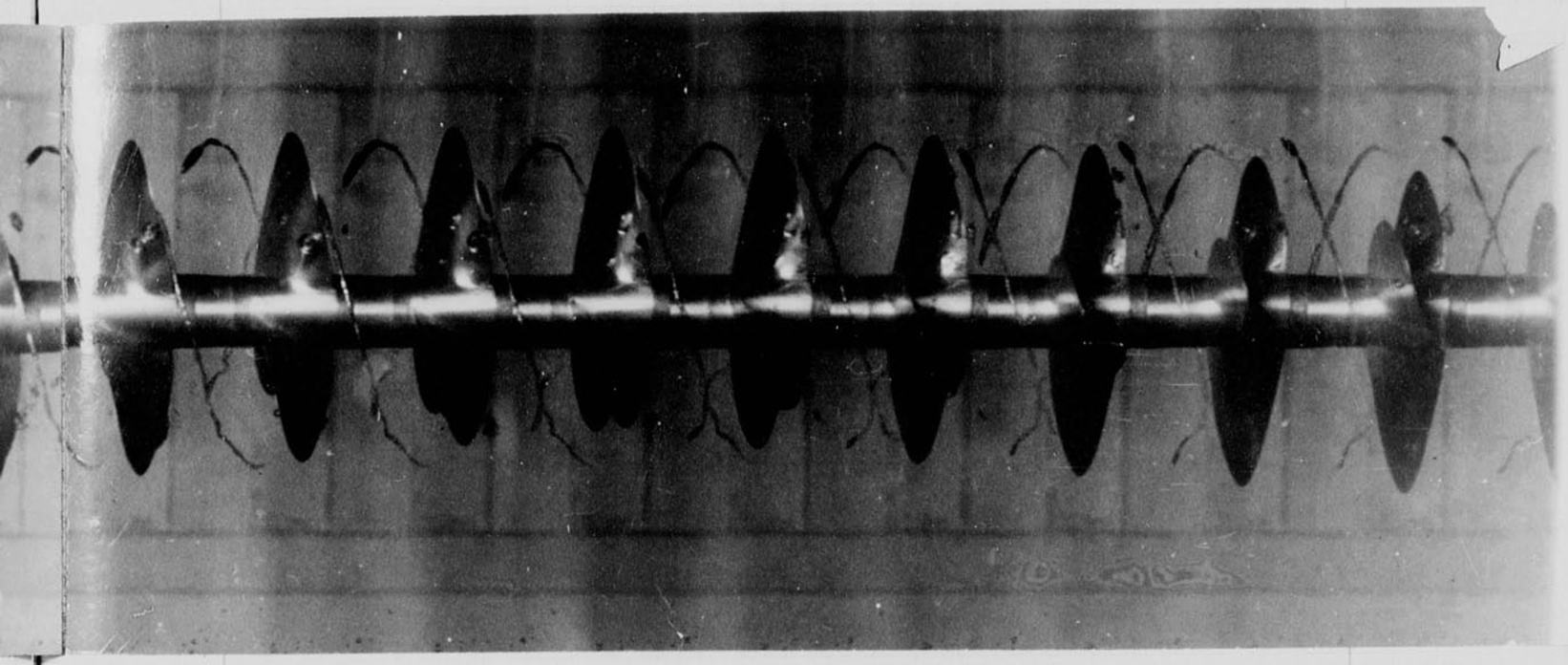
Lt R.D. Conrad is in the structural section and showed me the testing department. Mr. S.E. Dawson was engaged in making a vibration recorder of the "Dayhart" type, illustrated below.



- two coils in air gap with opposing emf at the center position. A voltage will be induced when coil is off center, thus recording displacement.

This equipment with photographic recording method is to be used in Boston in about a month by Commander

Sexton. (Ship - Ralph Talbot - rudder).
Cmd. Sexton showed me a high speed (1/60)/sec. camera for photographing a propeller model in a pressure tank. A stroboscope was used for observation. Mr. Bowers ran the apparatus. A section showing H_2O going around a corner was shown to me. This is the same as Lewis plans to use in the tunnel here.



Mr. K.E. Schoenherr (M.I.T Graduate) was operating the carriage on the towing tank and I met him.

Mr. Kaye - Photographic dept - Vacuum paper holder.

{Lt. Kell - now in Boston Navy Yard.
{Cmd Gayhart " " Philippine Islands, on duty

McGoldrick Physicists interested in stereoplatography.

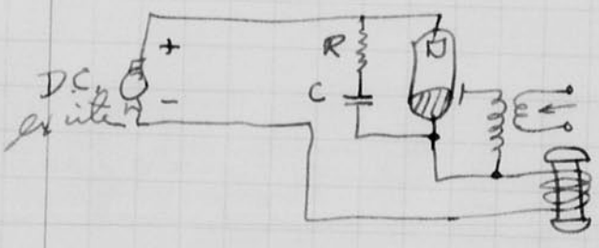
April 24 1938
Harold E. Edgerton

Yesterday morning I went to the navy yard and had a medical exam.

On Friday several students tried out the single flash unit, microphone control, for open house.

Nelson and Caldwell have been working for several weeks with the motor synchronizer that I wired up some time ago. They installed it on a synchronous motor in the laboratory.

The above could not use an ignitron or hard ignitron tube for a field relay since the current built up too slowly. The following circuit should overcome this difficulty as the condenser current would keep the spot in operation.



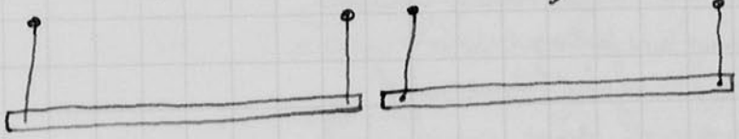
R needs to be large enough to prevent a back surge of current which might put the tube out.

April 26, 1938.
L. E. Elgerton

Meas of Dynamics Stress.

This morning I discussed with Strasser and Prof. Refrest the meas of stress by the resistance strip method. Several methods of obtaining a violent stress were discussed.

1. A method now used is to impact two long bars of the same length.



At impact the wave goes through both parts and is reflected back to the ~~other~~ hit end.

2. Dynamite cap on end of bar or between bars as they hit.

3. Bullet fired into rod shaped specimen.

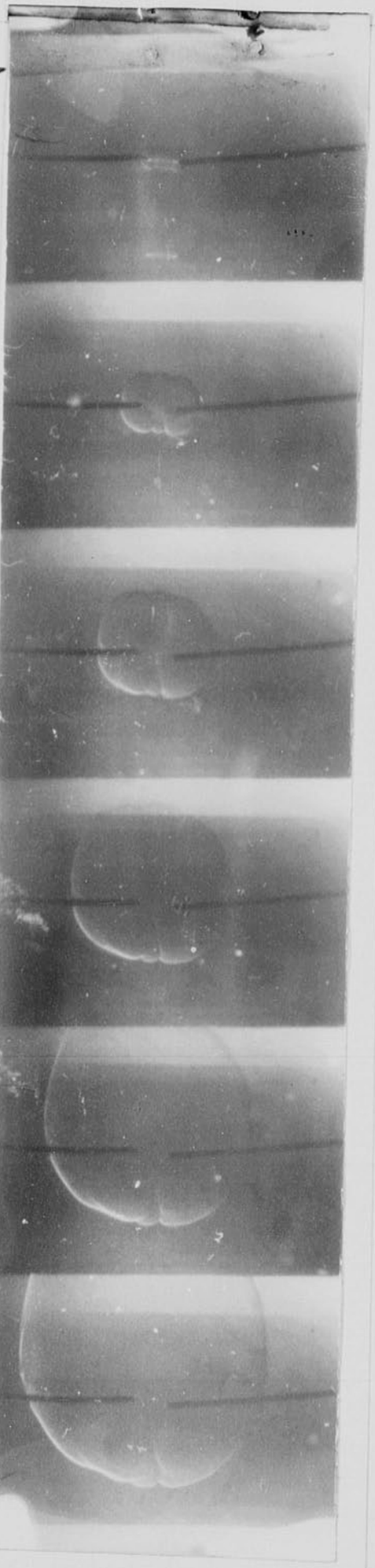
4. Reduce cross section of bars above in / so that stress is increased.

I suggested the photographic method of measuring the elongation, recording the time of photo on the film.

1. Single flash photo timed with sound pick up

2. moving film record with continuous light from a small ball bearing set in surface or from a turned knife edge.

initialing spark here →



960/sec.

Silhouette movies of an explosion in a mixture of gas and air.

May. 2, 1938.

M.I.T. open house last Saturday Apr. 30. there was the usual large crowd here.

High speed movies were shown in 10-250 by Mr. Trancel (?) and Mr. Bursey (?) seven times to a full house.

In room 4-111 we had a water jet driven by a vane pump. 1000 pulses a minute. The stroboscope built by Grier recently was being used for light. X-Kr lamps 500 volts 2 mf. Driven by the strobotac.

I also set up the following for observing the splash of a drop on a surface.

Norman Li

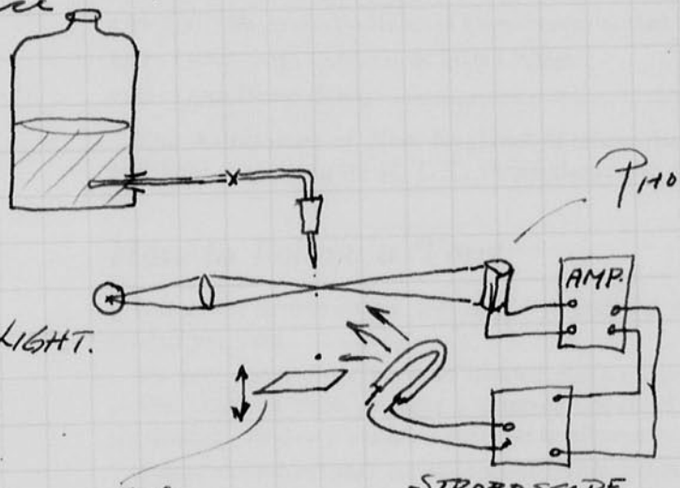


plate.
Raise or lower to see drop splash with crown formation.

Kenneth Germeshausen.
Fred Barstow
Joe Kiethley.
Herb Grier
Sheridan
Algor.

My mother, Mrs. F. E. Edgerton left this morning after a week visit, via the "Colonial" at 9 a.m. on the N.Y. N.H. & Hartford. She will stay a week with my sister Mrs. Welch Poyne 216 Summit Ave Summit N.J. before returning to Aurora, Nebraska.

Mr. Robt Swan Hingham BYMC Camera Club came in today and gave me two pictures that he took Sat at open house with our high speed lights.

10

Copyrighted materials are not being displayed.

MIT will only display materials for which MIT is the copyright holder or for which there are permissions for public distribution.

If you would like access to the full page image for educational or research purposes, please contact the MIT Libraries' Institute Archives and Special Collections.

http://libraries.mit.edu/archives/

9.00 Open House closes.

The Association of New England Mathematics Teachers will hold a meeting at M. I. T. throughout the day.

How to Follow a Tour

Follow the arrows—they will help you find the exhibits that interest you most.

For your convenience we have divided our displays into eleven groups. Each of these presents a different branch of science and engineering. And each one has a sign that is different.

Choose the subject that appeals to you. Then follow the colored arrow. You will find your visit much more worth while!

Groups are marked with these signs:

Engineering	Red Arrow
Science	Yellow Arrow
Biology	Green Arrow
Chemical Engineering	Blue Arrow
Electrical Engineering	Orange Arrow
Metallurgy	Brown Arrow
Architecture	Purple Arrow
Business Administration	Red Circle
Naval Construction	Blue Circle
Mathematics	Purple Circle
Geology	Yellow Circle

THE GUIDES ARE FOR YOUR CONVENIENCE

The Murray Printing Company
Kendall Square, Cambridge

ght to work
knew house-
People who
n institution
coziest little
dreamed of."
s are to move
were many
nd many more
John Carroll, a
achusetts hous-
a prominent la-
elegation of 75
efly representa-
ng trades, to the
a tour of inspec-

last night sent
jection of applic
batch of hopef
apartments in
nment project b
to have incomes too
therwise disqualified.

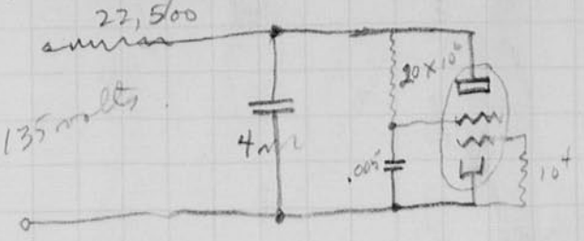
01

SS OF WAR
ANCER TOLD

Official Talks to
Osteopaths

who advise patients to
ll it bothers you" were

May 4 1938
H B Edgerton



traffic beacon.

Photocell control.

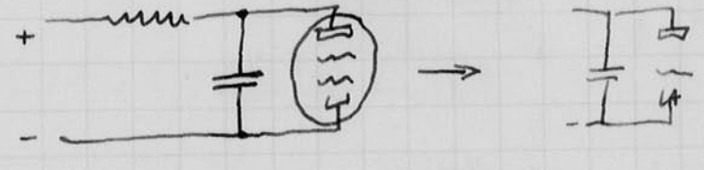
If light shines on the cathode there is photoelectric current which puts the lamp out.

In day light the beacon does not operate.

May 5. 1938.

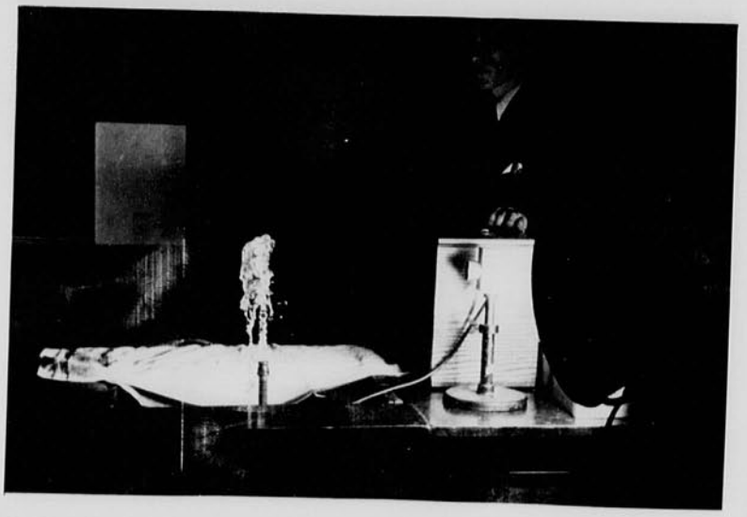
Progressive sign using tubes

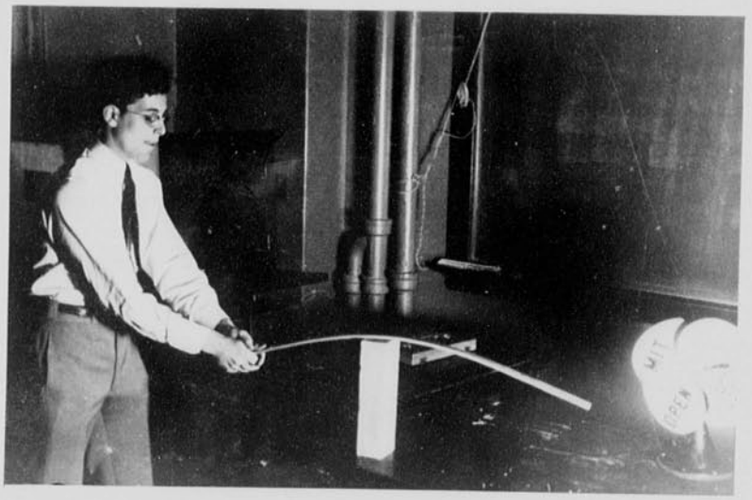
The idea is to connect up a series of tubes so that they go on progressively from one end.



Each lamp stays on after starting.

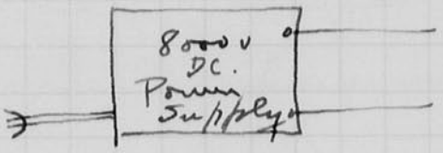
The same method can be used with A.C.

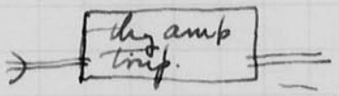




Harold E. Edgerton.
May 7 1938

Photographic equipment for Dalgren Va.



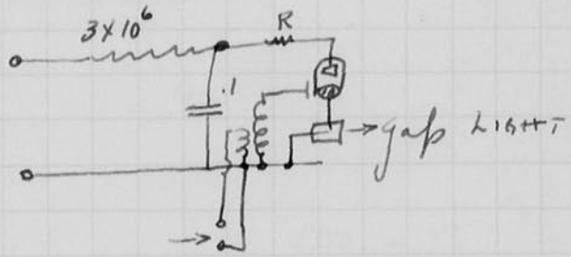


to coil.

polarized plug.

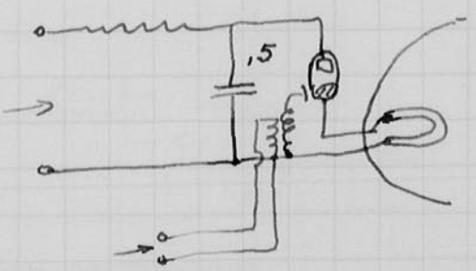
Above two in one unit.

1. Silhouette set.



.4 mf.

2. Reflected light. 10^{-6} exposure. small area.



3. Reflected light - large area.

T.
nd M. I. T.
Memorial.
Offices.

cs Teachers
day.

exhibits that

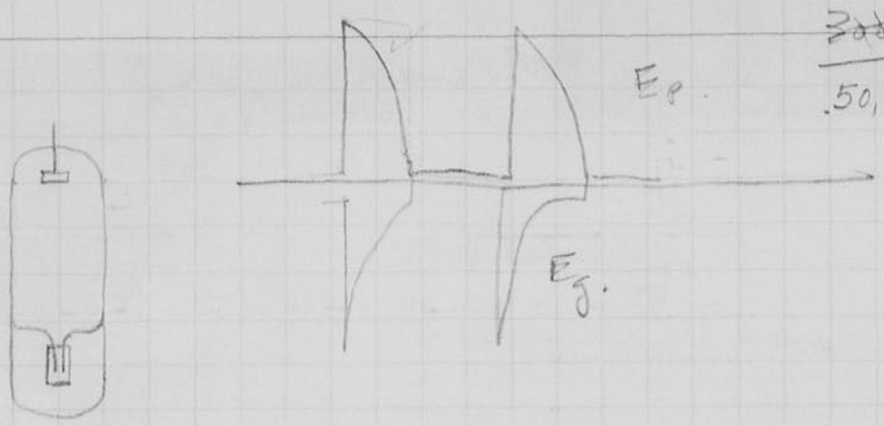
s into eleven
science and

w the colored
e!

Arrow
v Arrow
Arrow
Arrow
e Arrow
n Arrow
e Arrow
Circle
Circle
e Circle
v Circle

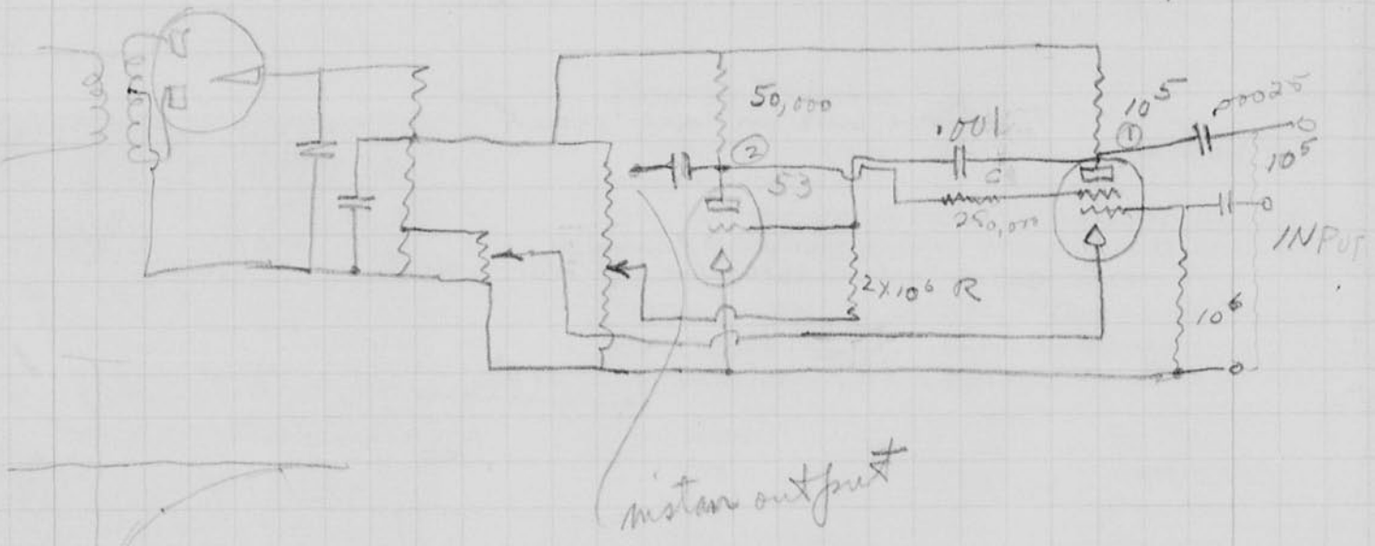
ENIENCE

Murray Printing Company
Brattle Square, Cambridge



$\frac{300\ V}{.50,000} = 6\text{ ma}$

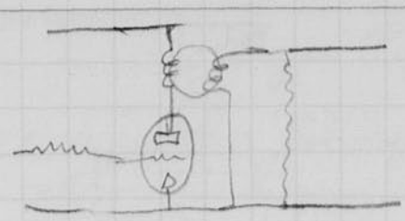
Time delay circuit for spark photos of air waves in conjunction with Prof Day.

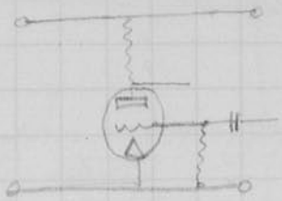


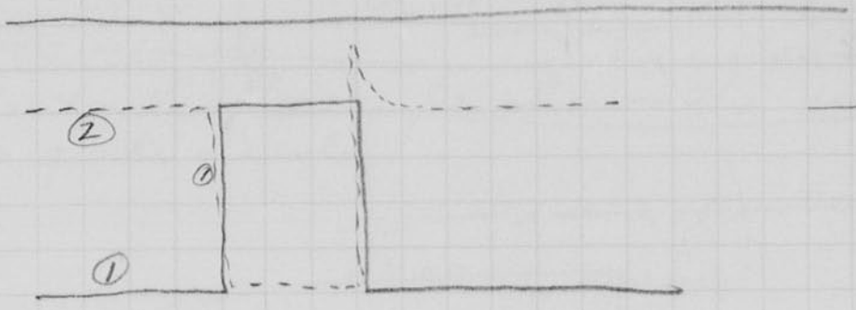
$RC = .003$

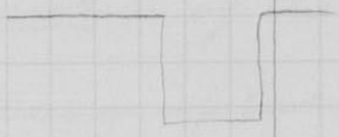
$R = 2 \times 10^6$

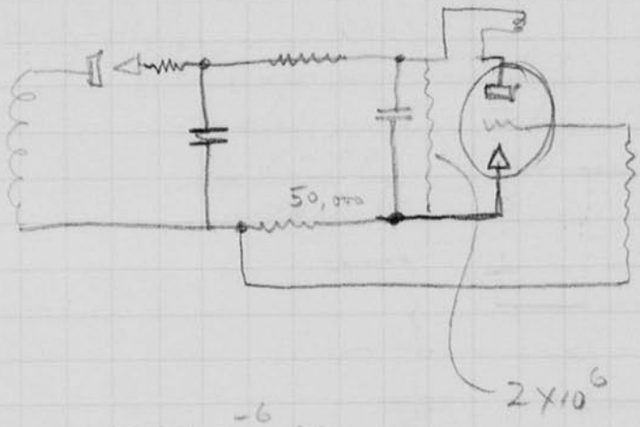
$C = \frac{.003}{2 \times 10^6} = 1.5 \times 10^{-9}$ farad or .0015 mf.









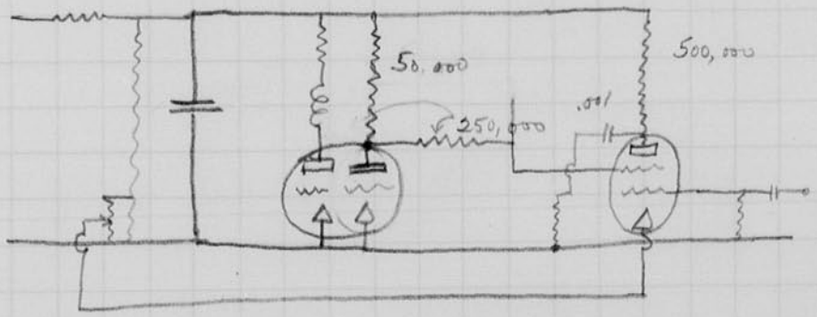


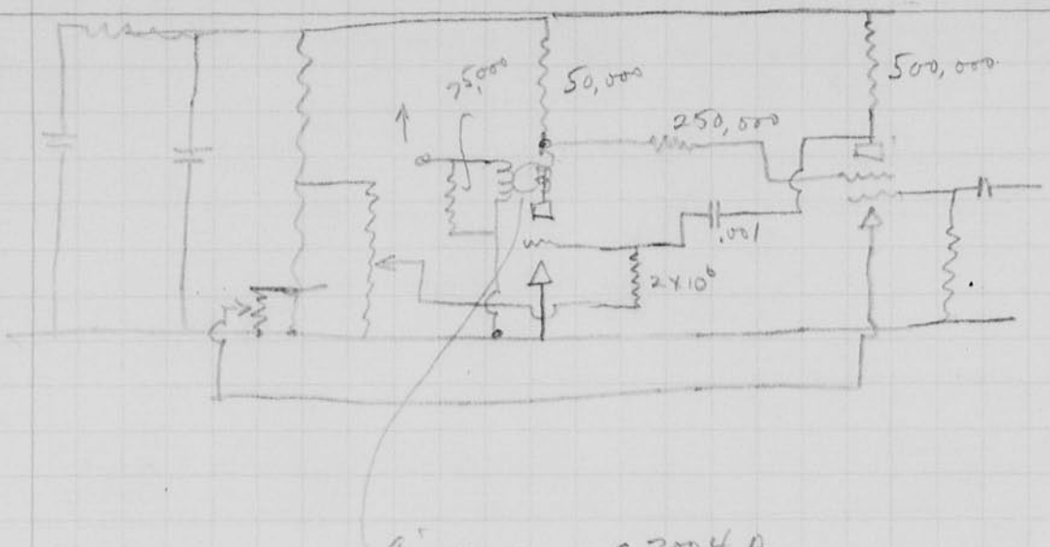
800 watts.
10 watts. 1/80
50,000/80
625

$50,000 \times .125 \times 10^{-6}$ sec

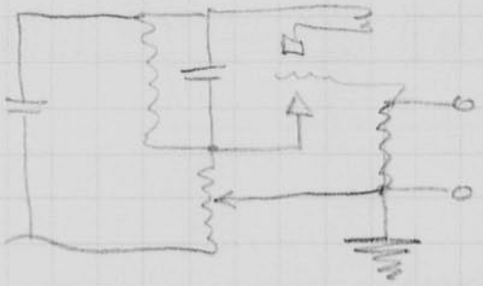
$.6 \times 10^{-2}$ sec $= .006$

$1 \times 10^{-9} \times 2 \times 10^{6} = 2 \times 10^{-3} = .002$ sec.





air core S7004A
P5700 - inplate lead.
2340 - output



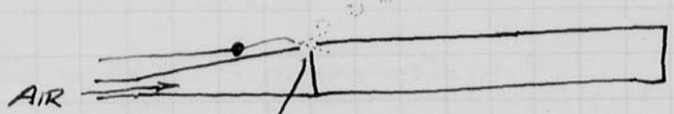
May 21, 1938.
H. E. Edgerton

Organ Pipe.

A study of the flow of air in an organ pipe with a ~~stroboscope~~ and TiCl4 smoke.
Mr. E. M. Skinner furnished the pipe 528 cycles/sec.

Smoke TiCl4 on a wire with a cloth end on the outside of the pipe shows the motion of the air quite clearly.

⋮⋮ — a series of vortices go up here.



The air stream dips into the hole once each vibration. Then it goes up rapidly and rolls into a vortex.

May 27. 1938.
F. B. Egerton.

Strasser's test of Dreyfus's amplifier in thesis 1938. Course IX. flat 10 - 40,000. 20,000 10,000
$10^\circ - 40^\circ$ 10°

Speed of sound in steel

Rayleigh Theory of Sound Vol I.
Max Mueller.

$v = \sqrt{\frac{E}{\rho}}$ E = modulus of elasticity $= 30 \times 10^6$

ρ = density = 486.9 lbs/cu ft.

$v = \sqrt{\frac{30 \times 10^6 \times 144 \times 32}{486.9}} = 16,800$ ft/sec.

Murray

May. 27, 1938.

1 atom or 2 at.

Bell Telsher's photos. Spring 1937.

48 mf 3000 volts. Hg lamp 1" 340°
control tube.

Filter # 76. Hg. green.
15 2" square.
Eastman.

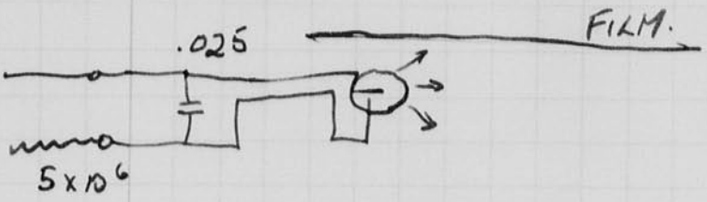
10" Polaroid discs.

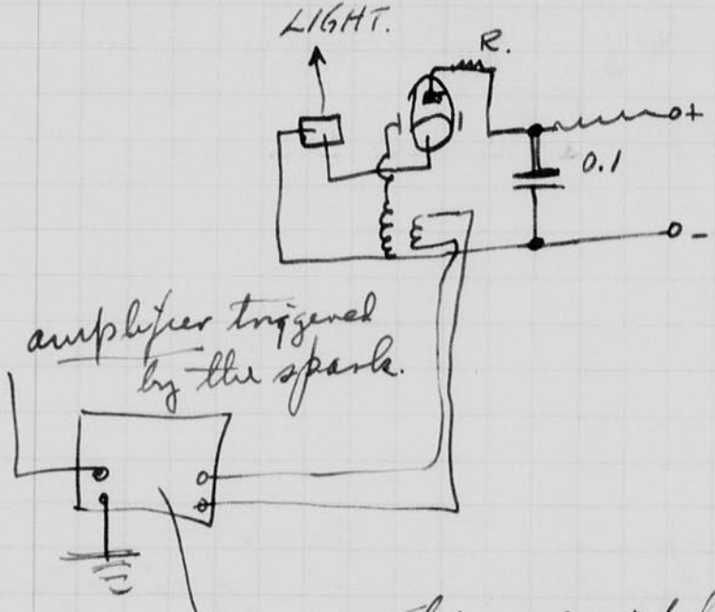
May 28 1938.

Discussed program with Murray for construction and test of apparatus for stroboscopic observation and high-speed photographing of photoelastic specimens. We suggested an expenditure of $500 for the summer, $300 for a man and 200 for supplies. A memo is to be given to Prof. Le Salles(?) summing up our oral discussion of the same.

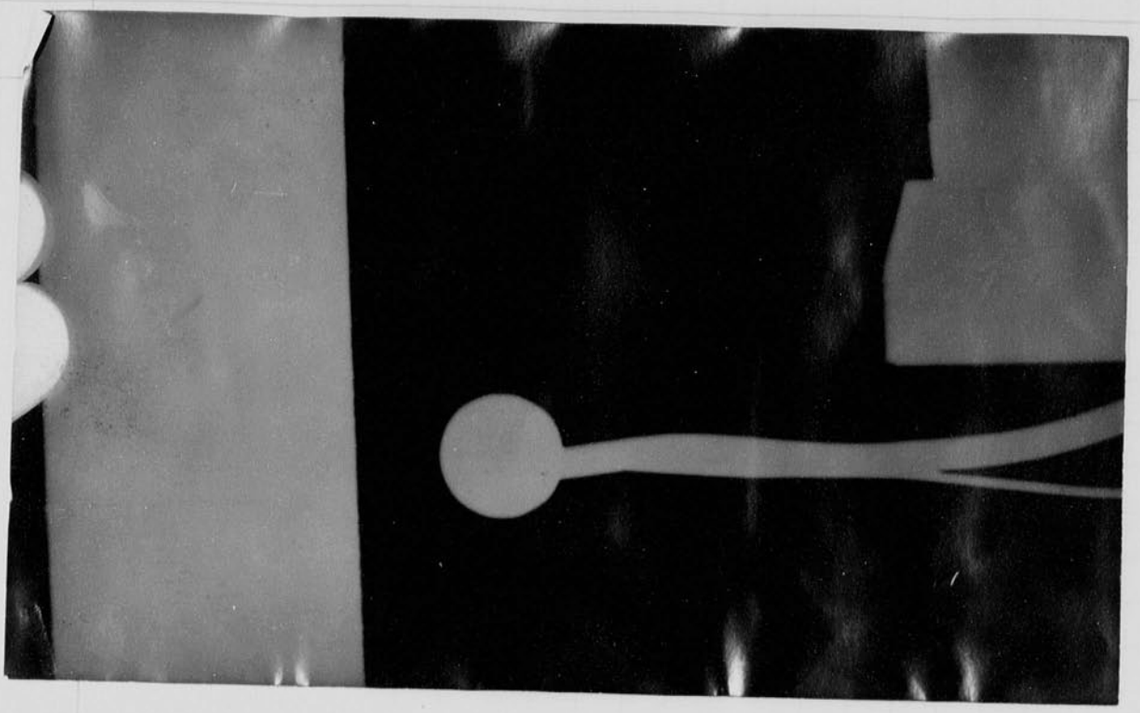
May 29, 1938.
H. E. Edgerton.

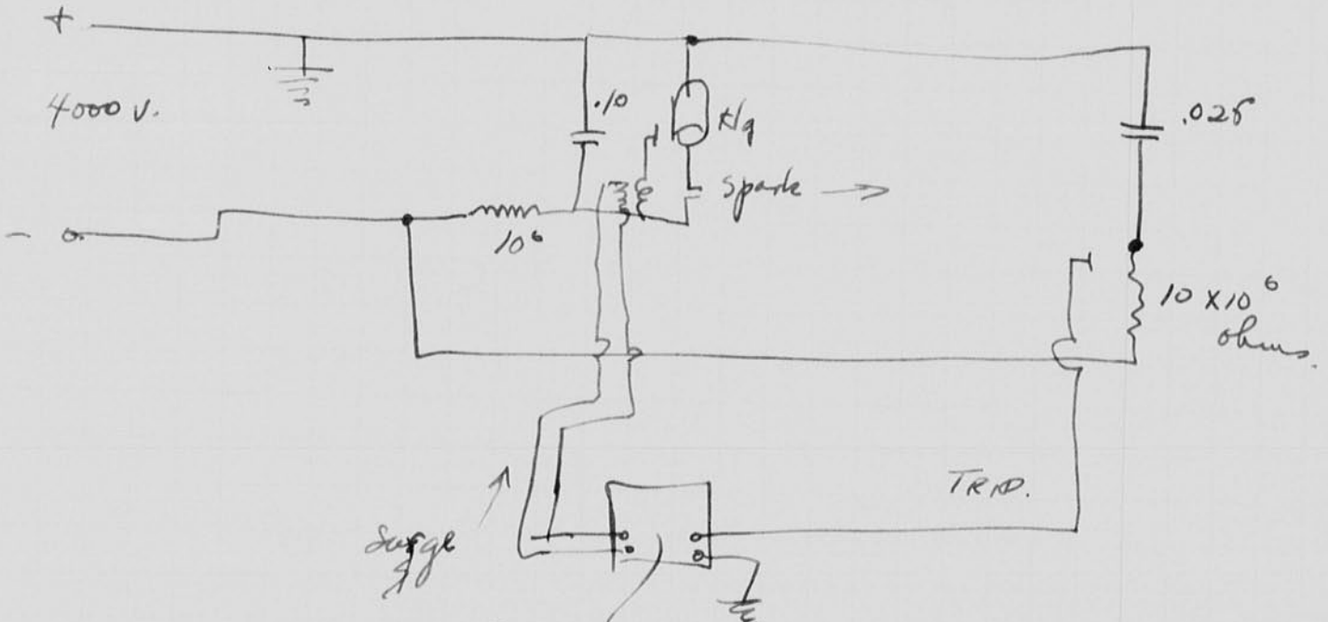
Sound Photos for R. D. Fay.



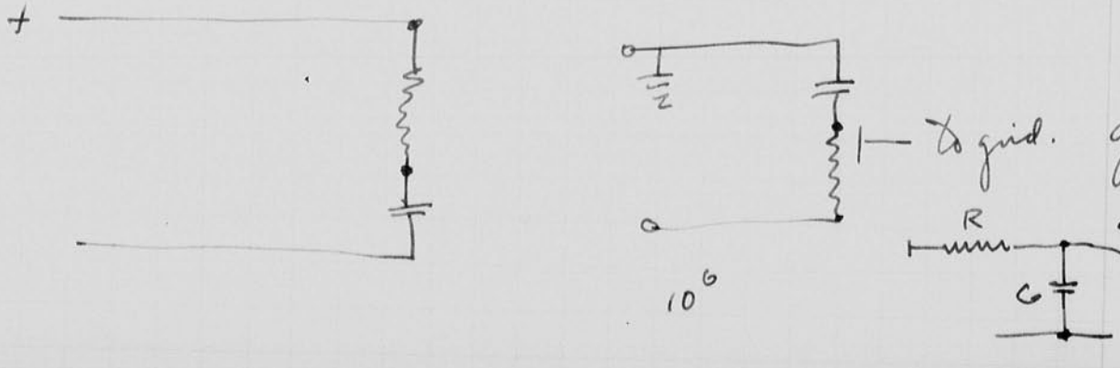


This circuit has also a time delay feature to slow up the light source.





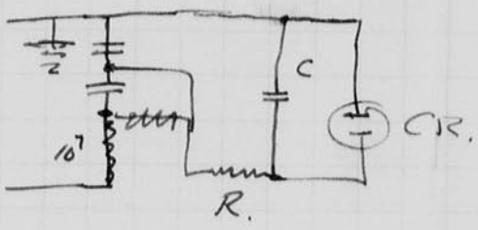
time delay and trip mechanism amps.

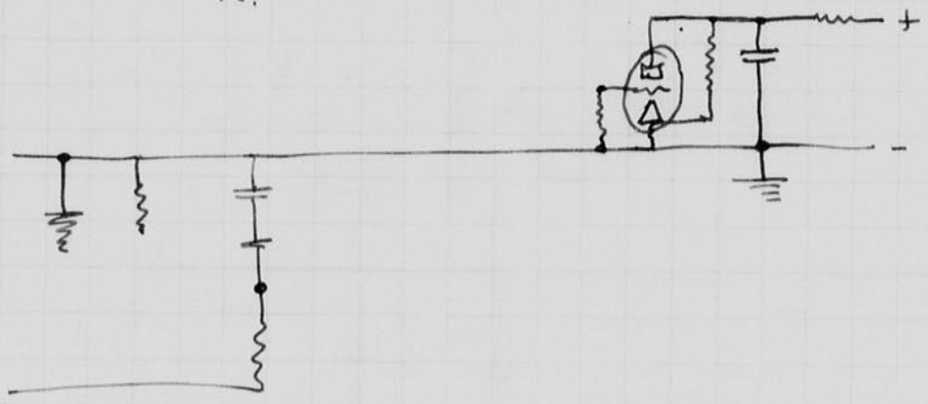


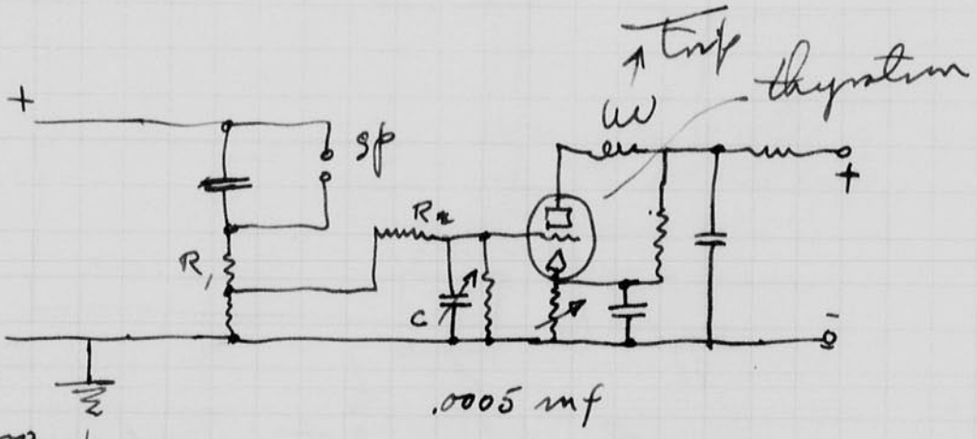
May 30 1938
Edgerton.

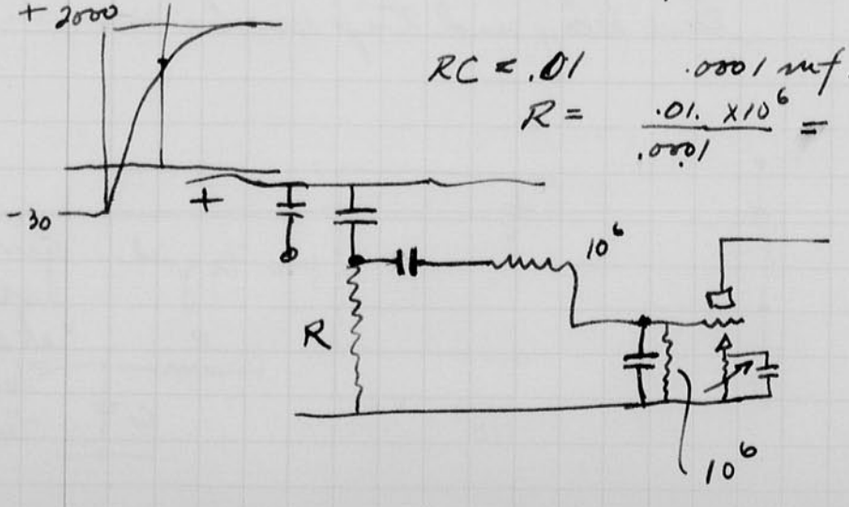
Dinner last night with Nomura Li and brother at 8 Tyler St Boston. Hong Kong.

Cont. experiments.



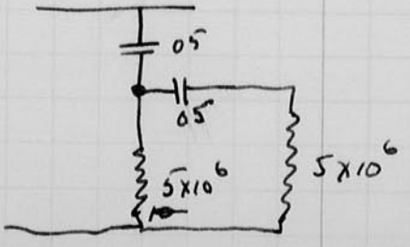


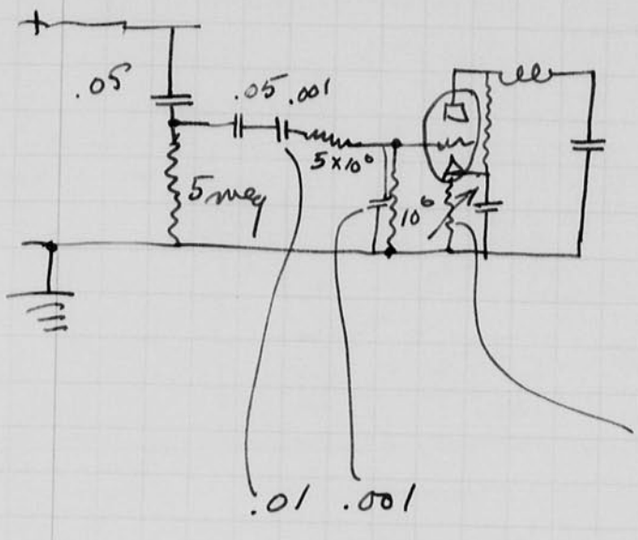




$RC < .01$ .0001 mf.

$R = \frac{.01 \times 10^6}{.0001} = 10^8$ ohms.





.0001 time delay.

.0001 mf x 10^6 ohms =

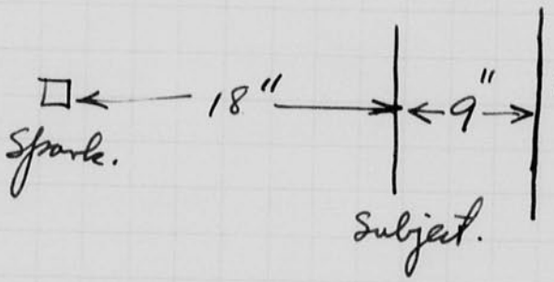
Works OK.

4 photos taken.

Different settings of this resistor.

.002
.005

3 or 4" motion of the sound wave with max. bias on the FG. 17



Agfa process film.

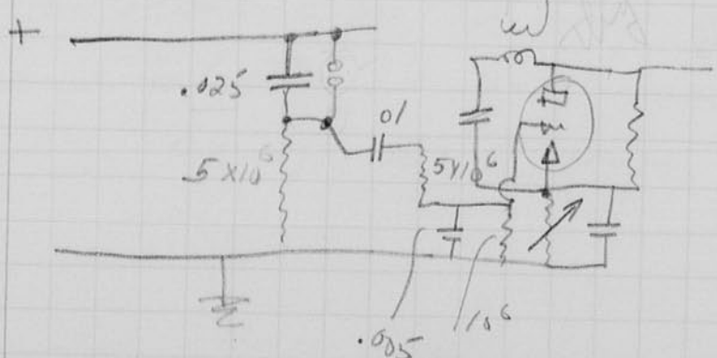
End No 200.

More photos taken.

May 31 1935.

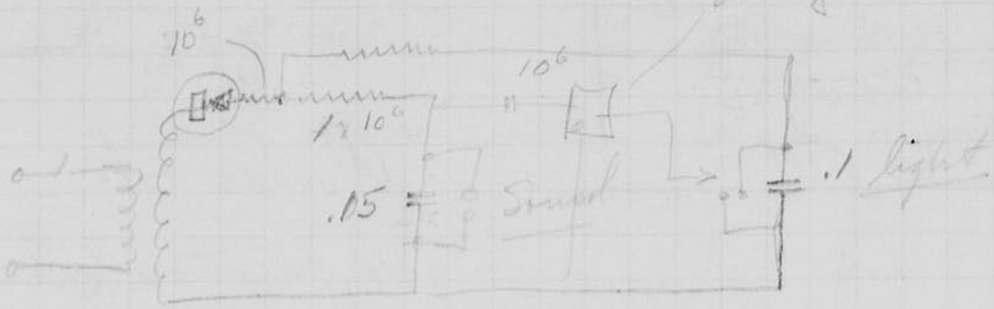
Driver Cast night with Chas.

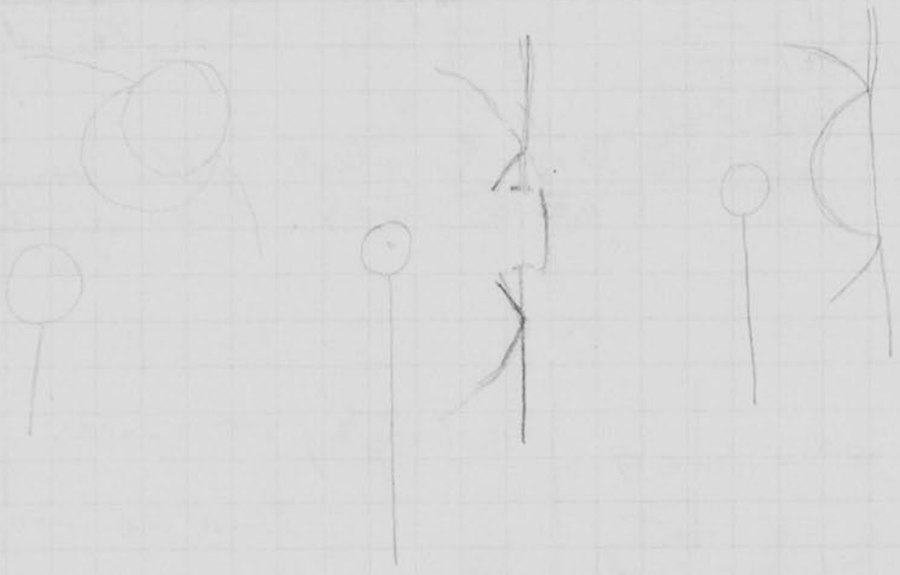
3" delay in spark on travel of wave

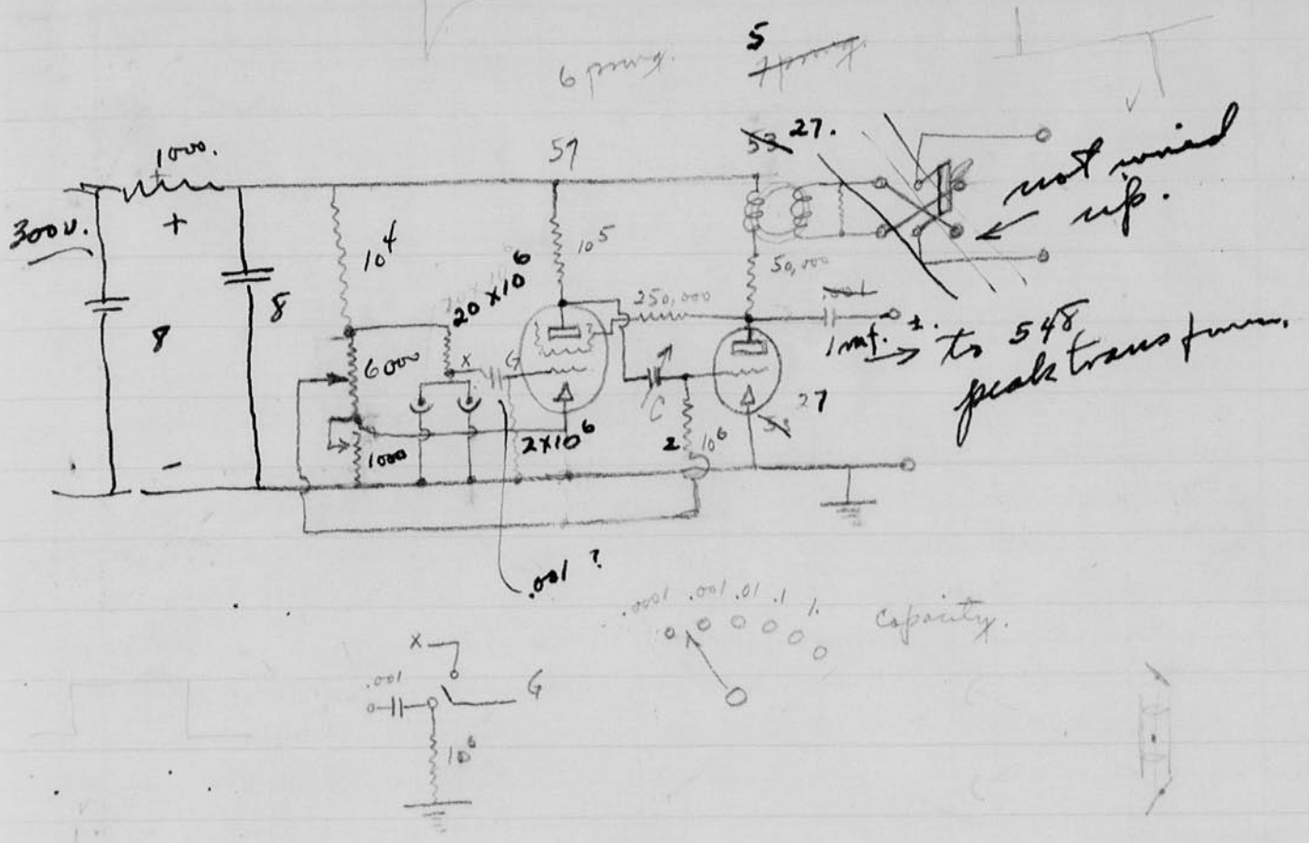


5 pictures taken with a reduced scale model.

May 24, 1935 Strobe exhibit of spark and sound waves.







See page 46

1 DPDT Switch. outlet. ⑪

$ insulated B.P.

Circuit above used on Alumni Day June 6, 1928 to observe milk drop splash. Only one photocell was used.

C = 0.1 mf R = 2 megs.

June 7. 1938.
Harold E. Edgerton.

Prof Eames and Mr. Cheney arranged a small pelton wheel, diam 12" ±, for visual observation last week. This wheel is the property of the North Eastern Univ.

A stroboscope Kr-Ne type, driven by a synchronous was used to observe it.

The wheel was driven by a d.c. motor at constant speed, about 300 r.p.m. The head was about 6 or 8 ft.

Photos were taken with the 5 x 7 camera and also with the 9 x 12 cm camera. The 48 mf 3000 volt argon spot light was used for this work, also a Kr-Xe lamp, for side lighting of some of the pictures.

Watertown arsenal stroboscope
Super
f 3.5 Pan. film Dupont
11 mf 1200 v.
lamp. Spiral 7" reflector
2 ft from 15" Aperture
$1,200^2 \times 11 = 1,44 = 15.$ joules

~~300 volts~~ 700 volts same exp.

$\frac{48}{144}$ $\left(\frac{1200}{700}\right)^2$ volts $11 = 32.3$ mf.

June 11 1938
Harold E. Edgerton

Yesterday I went to visit the Crompton-Knowles plant at Worchester with John Caldwell and Ben Thompson. We met Mr. Palmer (Harv.) Mr. Gordon (M.I.T.) Mr. Peterson (Wor. Tech.) and others. Photos were taken of a loom in action. I used two lights, one a flood and the other a spot. 3000 V 48 mf on each. Exposure 1/50 m ± Aperature f 11 to f 22.

After this we went to the alden Hydraulic laboratory at Holden and met Prof. Allen, Mr. Hopkins, and others.

Then we stopped to see Mr. Beecher at the Norton Co on the way home.

Arrived ~~home~~ MIT at 7 pm and developed films before going home.

Wayne Nottingham and family from Schenectady were with us last night. He mentioned a project planned by Epson Arens which might need an intense flashing light.

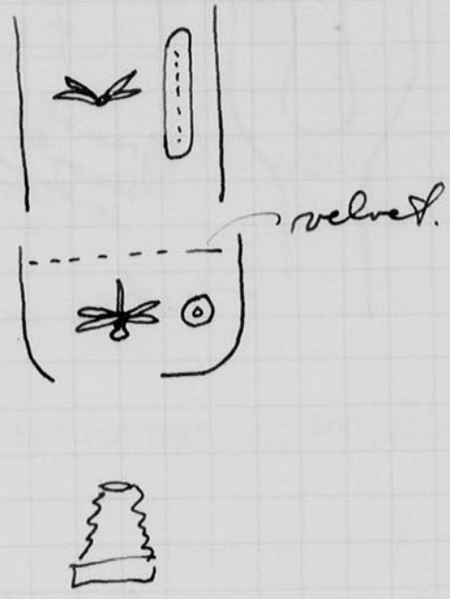
6.632 class 1938 spring.

Usen Irvin Hansel Rosen Nelson Thompson Nie Steiner Caldwell
Sto
Gemmil Kilgore McNeil Abbe

June 15, 1938.
H. E. Edgerton
Chadwick

Dragon fly. 9×12 camera. 600 flashes/second. 1/25 sec. shutter.
4 mf R400&800 in parallel 3KW.
Argon lamp quartz section.
Velvet background.

f 4.5
Verichrome film.



Exposure ok.

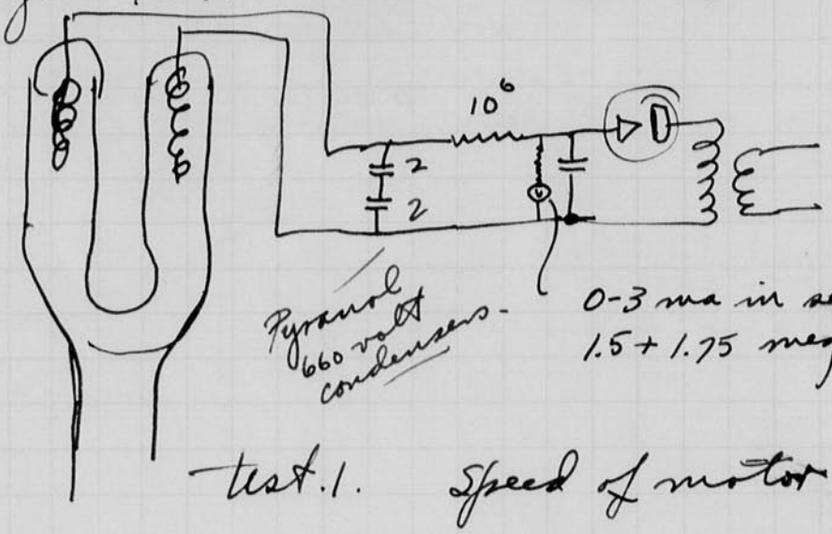
Butterfly
Black Swallow tail.

Movie at 90 per second.
4 mf 1000 volts.
Argon lamp 3KW outfit.
Pan film D-11 6 min ok.
f 3.2

The specimen did not fly very well.

June 16 1938
Harold E. Edgerton

Test of high-speed light source
argon 40 ~~or~~ 50 cm 1 cm Hg



test 1. Speed of motor 7000 ± 5% or less

f - 6.3 positive film. old agfa.
Volts 2 ma x 3.25×10^3
Slightly out of focus.

Film No. 2. Voltage (2.2 ma) other same.

1' radius of film
$12 \times \pi$ inches of film in 1 revolution.
$2 \times 12 \times \pi$" due to reflection angle. double.
in 1/120 second.

$$1'' = \frac{1}{120 \times 24\pi} = .110 \times 10^{-3} \text{ seconds.}$$

$$= 110. \times 10^{-6} \text{ seconds.}$$

300 20/
9000

Notebook # 9

Filming and Separation Record

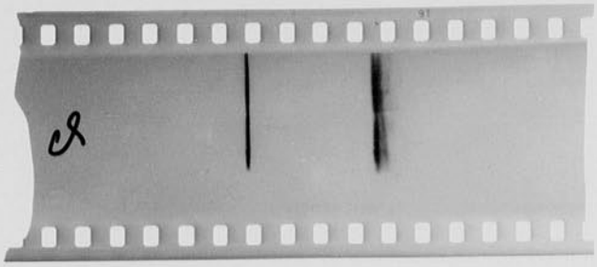
____ unmounted photograph(s)

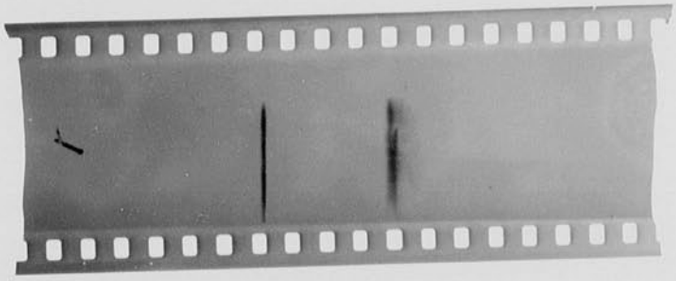
4? ____ negative strip(s) inside mounted envelope on page 31

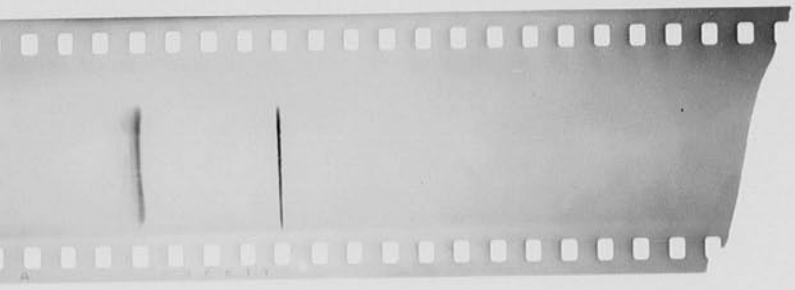
____ unmounted page(s)
(notes, drawings, letters, etc.)

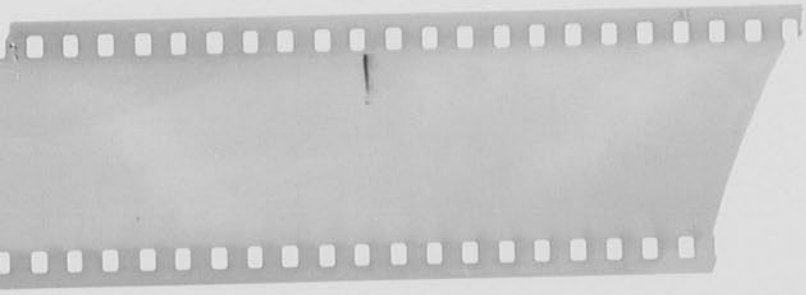
was/were filmed where originally located between page 30 and 31.

Item(s) now housed in accompanying folder.





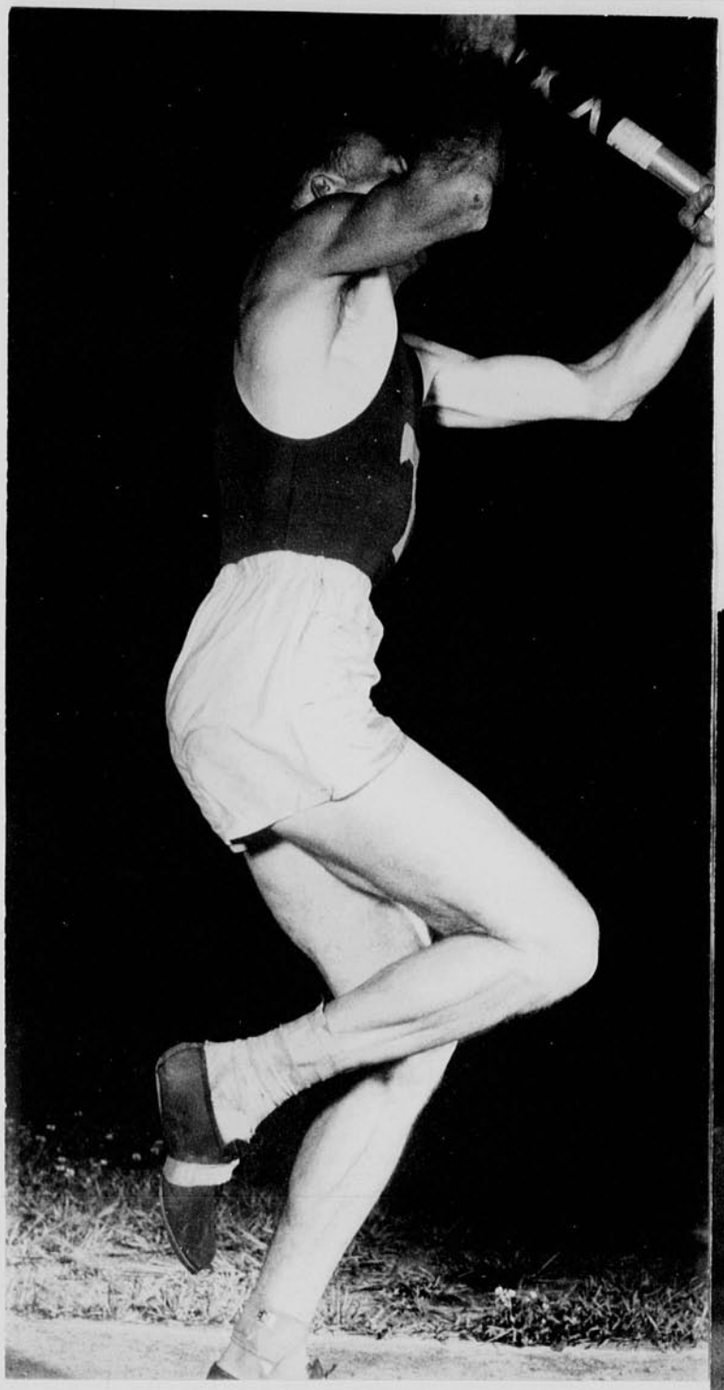


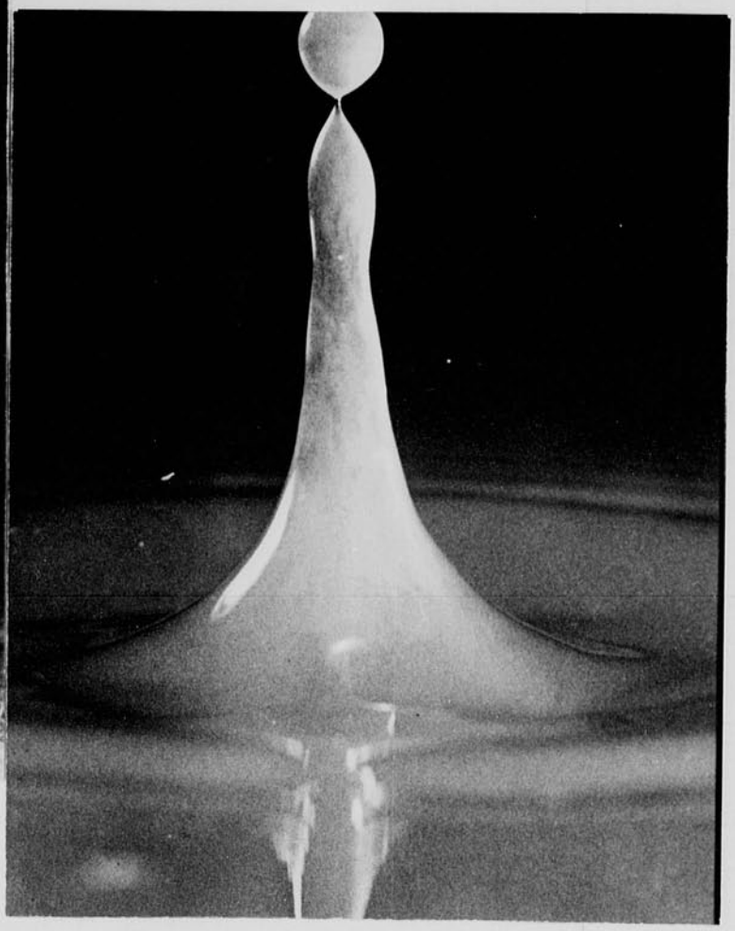


June 17 1938.

Pumped another tube same as one tested yesterday. Filled ½ 6 cm then argon to 50 cm.

Trip to Marion Mass. Date?
talked at Brotherhood Club at Tabor Acad.
for Mr. Countway of Lever Bros.
Stayed all night at home of Robt Houghton.
On the way stopped at Plymouth
Cordage Co to inspect plant.

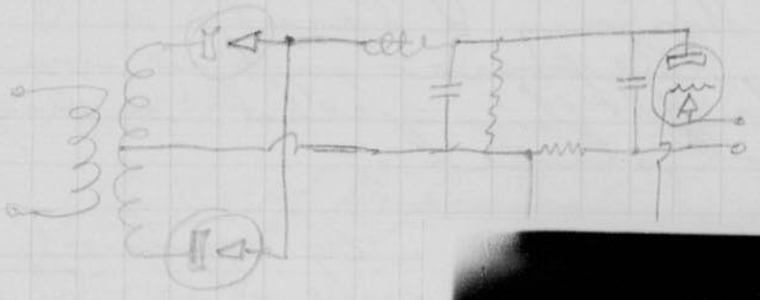


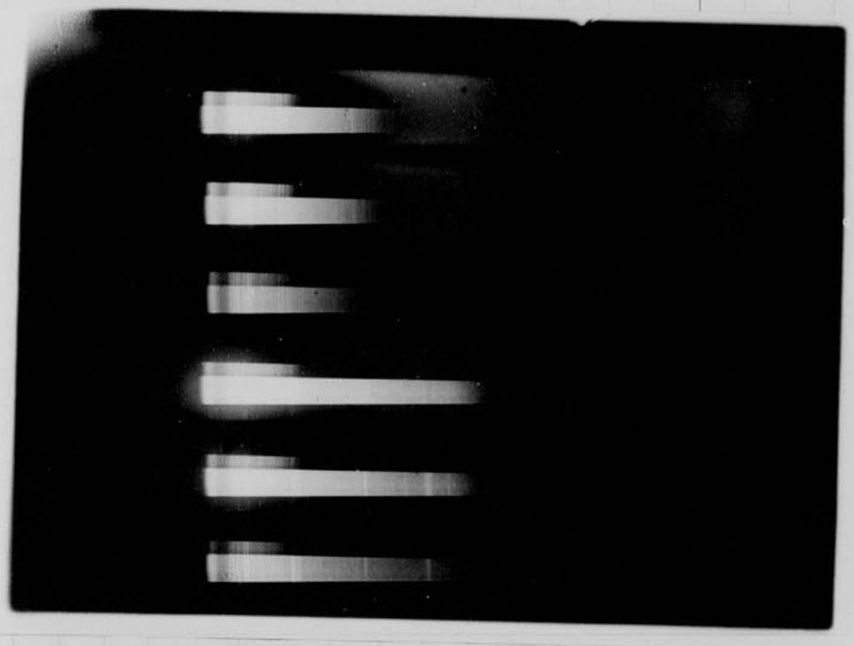


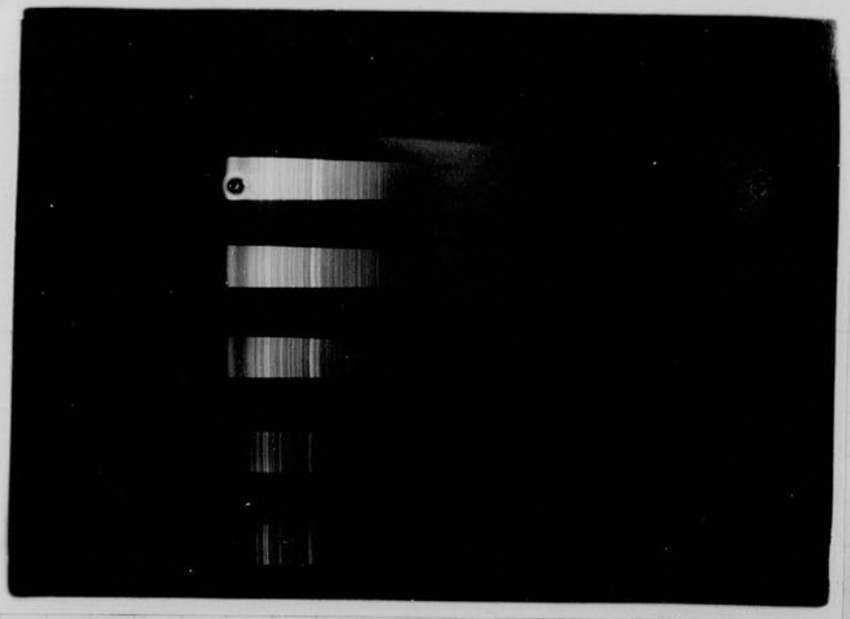
$CE^2 = .2 \times 800^2 \times 10^{-4} = 128 \times 10^{-2} = .128$ watt/flash

$n = 1000$ cycles $\times .128 = 128$ watts.

$\frac{128}{800} = .160 = 160$ ma. 8/10





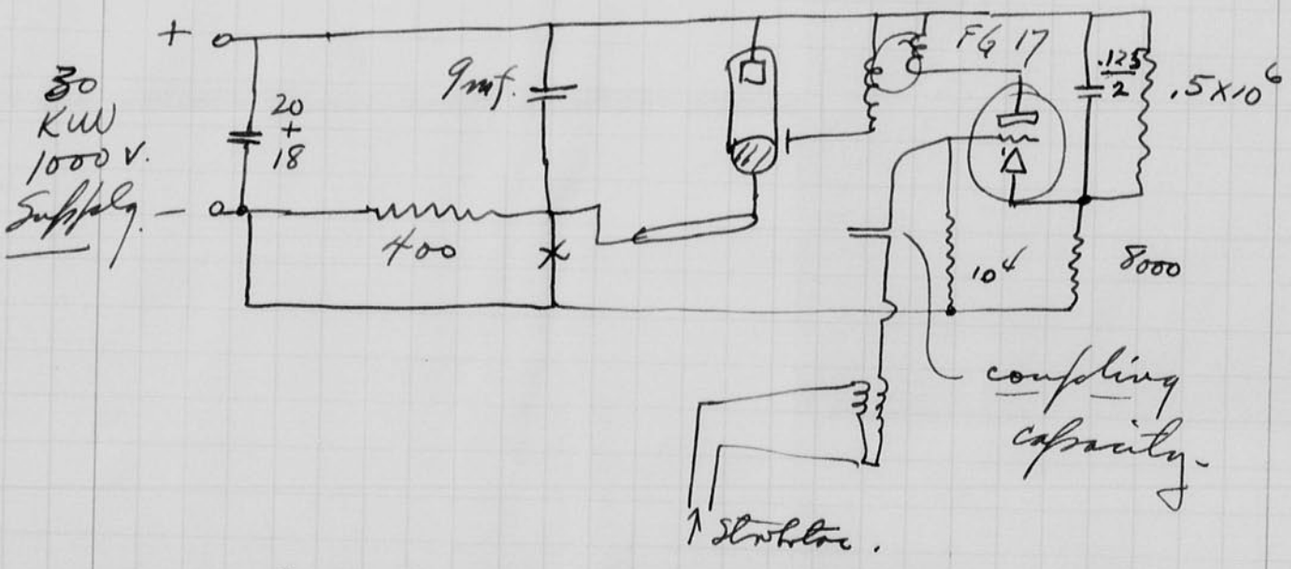


June 27, 1938
Harold E. Edgerton.

Bill Tucker left for Calif. today. He and John Andreas are going to work for technicolor in Hollywood.

I spent today wiring up a unit for sequence photography. First tried driving a lamp a 100 cycles. The power input was too much for this speed, using an external starter.

Then I put in a Hy control tube and tried to drive it with the Strobotac into a ~~Tesla~~ coil (small Delco Remy) with no success for more than 30 cycles. Next a large Hy lamp was used for control and a spark coil using a 17 was wired up to run from the 1000 volt supply. It worked ok. when driven by the Strobotac.



I took a picture on Super Pan Press. f 4.5 100 frames/sec. 15 ft to Ed Gladding. waving yard stick. Developed in D-X at 75° for 10 min. ok but thin.

June 28, 1938.
H. E. Edgerton.

Some difficulty was experienced with holdover with circuit shown on preceding page.

I plan to change the .5 x 10⁶ to 100,000 ohms this morning. this will put more bias on the FG-17 the grid.

June 30 1938

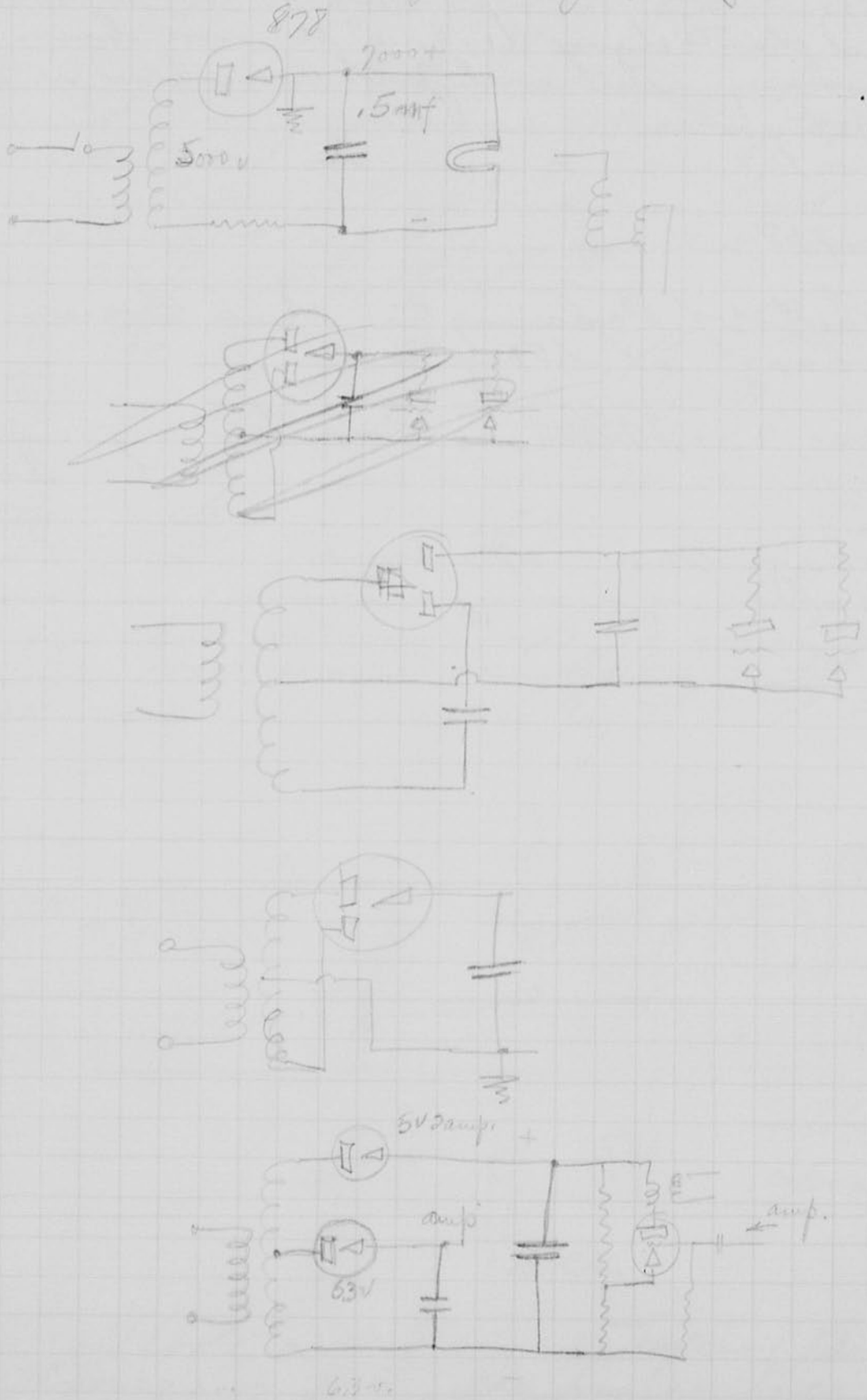
Photos of Badminton, Jack Brown yesterday at 150/sec.

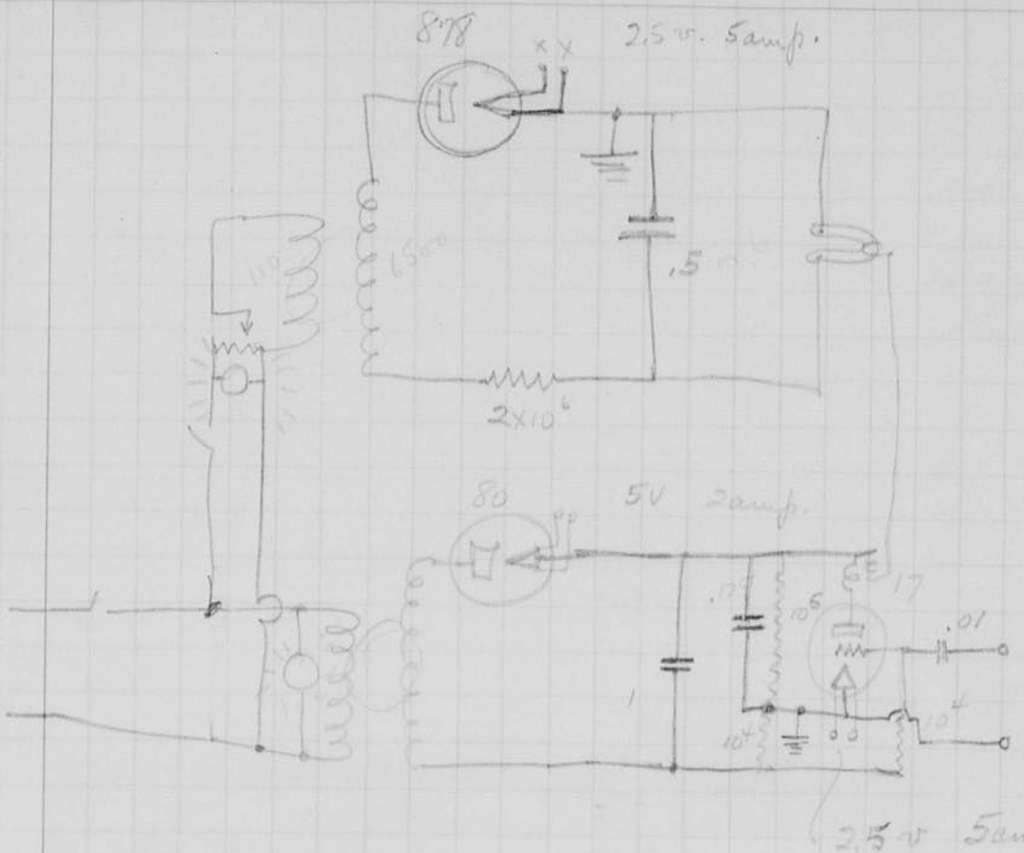
also 22 bullets going through glass Lamp bulbs etc.

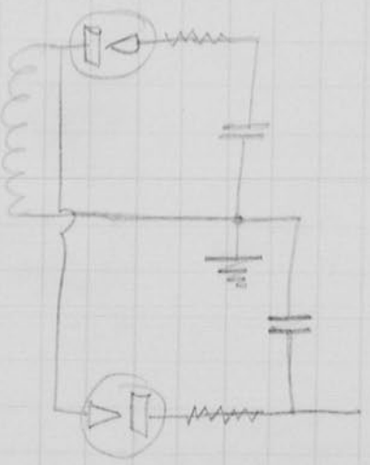
Today more of same. also of 22 bullet coming from gun

July 1, 1938

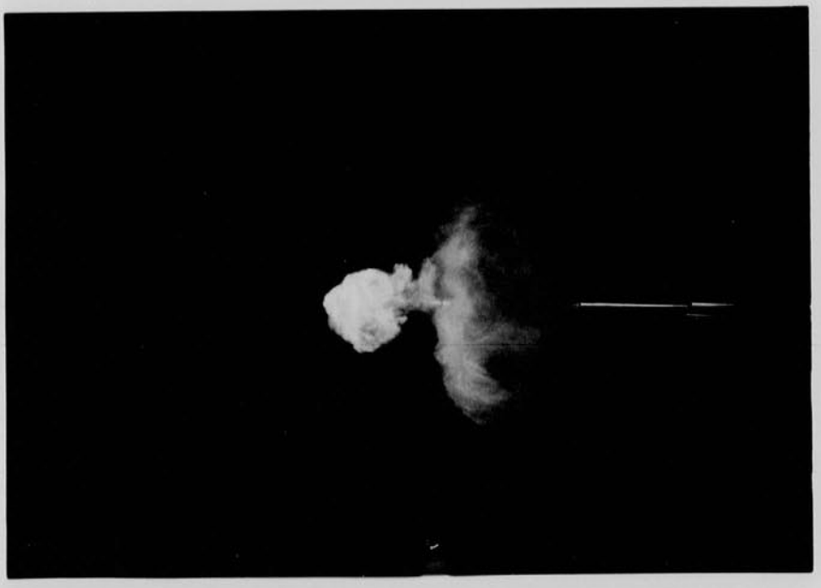
Design of High Speed Photographic unit for Bullet photographing.







.85
7000
6800 volts.
used on tests
yesterday.



30°

5°a
45°

July 7 1938
Mr Edgerton.

Set up velvet curtains and white curtain in hangar last week end. Single photography also multiple shots arranged.

Benny Shultz, wife, and Eleanor Reed came over July 5 and we took photos of them in evening.

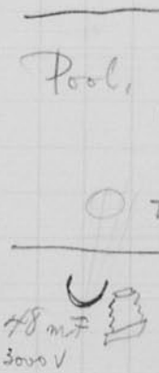
Ralph Guldahl came over July 6 in morning for a series of pictures.

Went out to Wonderland track Sat. July 9 to arrange for greyhound photos.

Revolver .38 with Hadding on July 5.
f 11 ad 1 or 2 x 10^{-6} sec. SS pan press.

Discussed Spaulding studies with Stevens of AD Little on Friday aft July 8.
We are to work for 6 months at 400 per or studies of golf etc.

Took photos at Harvard swimming pool SS pan Press film Agfa. f 16.
lighting below.



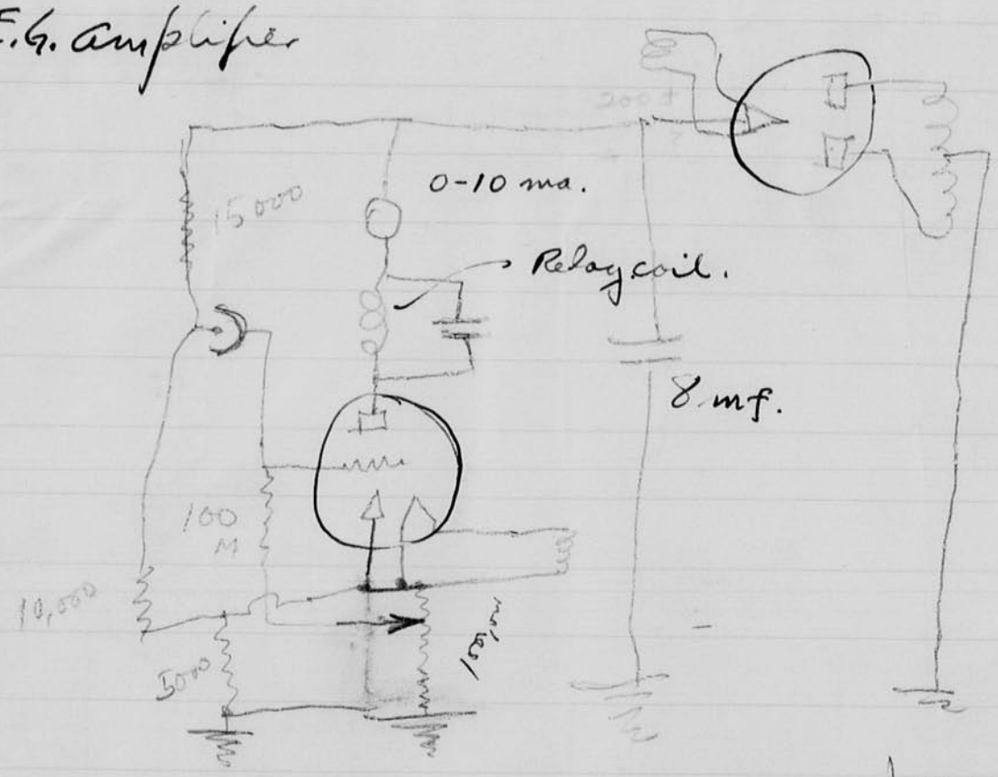
July 19 1938
Harold E. Edgerton.

I helped the Necco Co with photocell amplifiers on 3 wrapping machines from Germany. The call came through the General Radio Co on Friday morning.
Mr. Moulton - manager
Mr. Achorn factory manager.
Mr. Schoenhen

One unit was working ok, another needed the light adjusted, a third had a defective photocell.

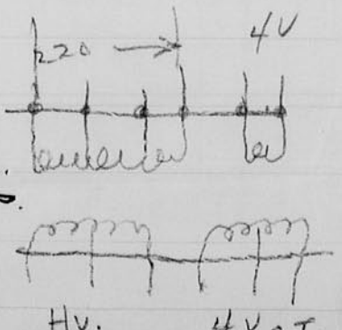
Since no extra tubes were sent from Germany, we proposed rebuilding the amplifiers with U.S. types. Mr. Moulton asked to do this.

A.E.G. amplifier



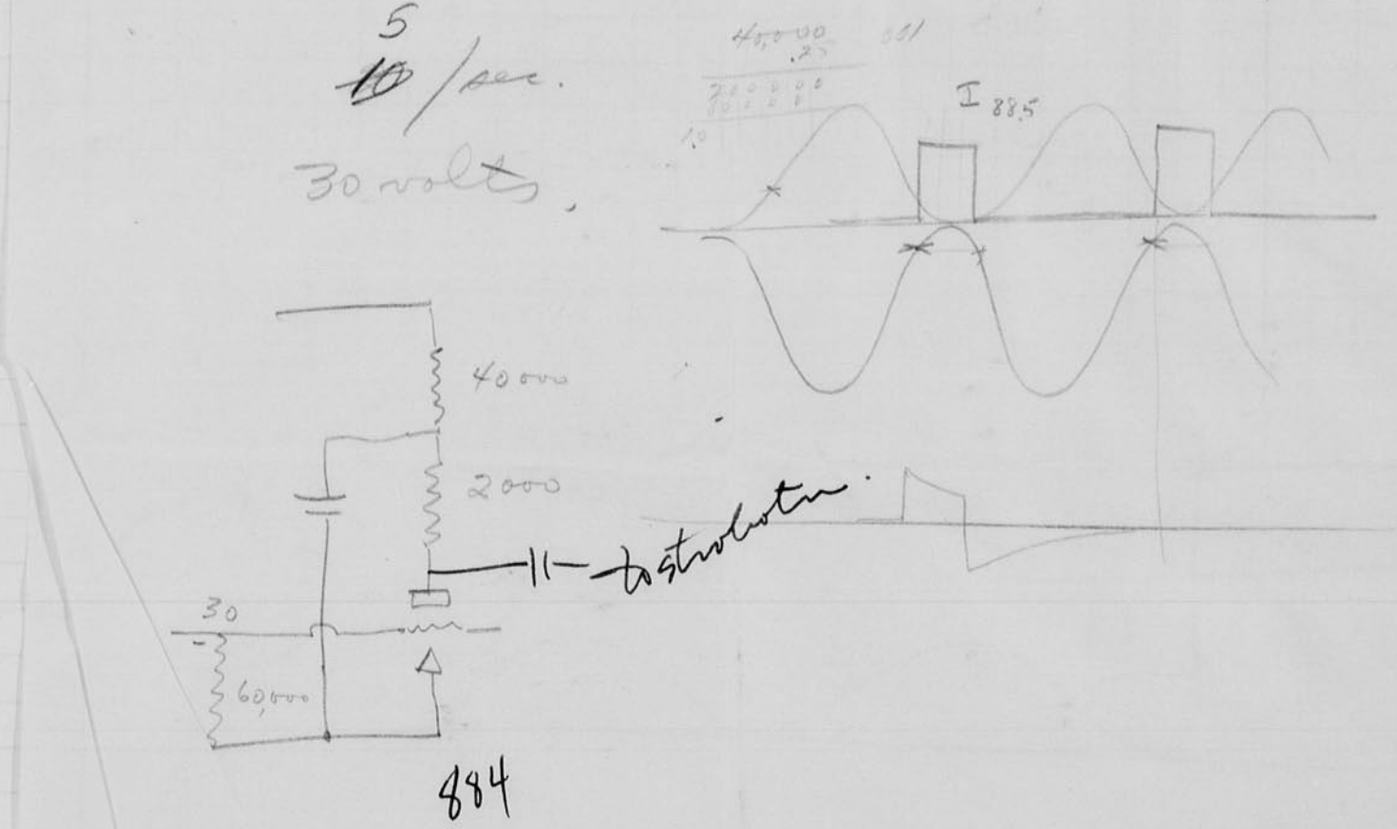
Circuit of amplifier.

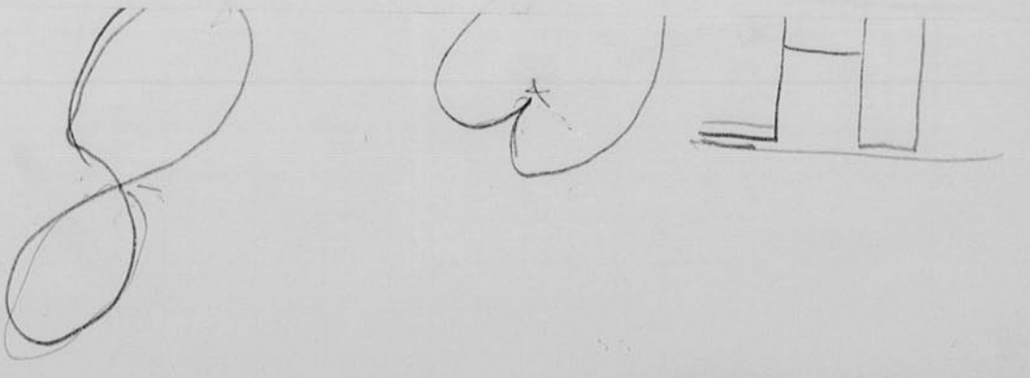
Transformer connections.



cont.

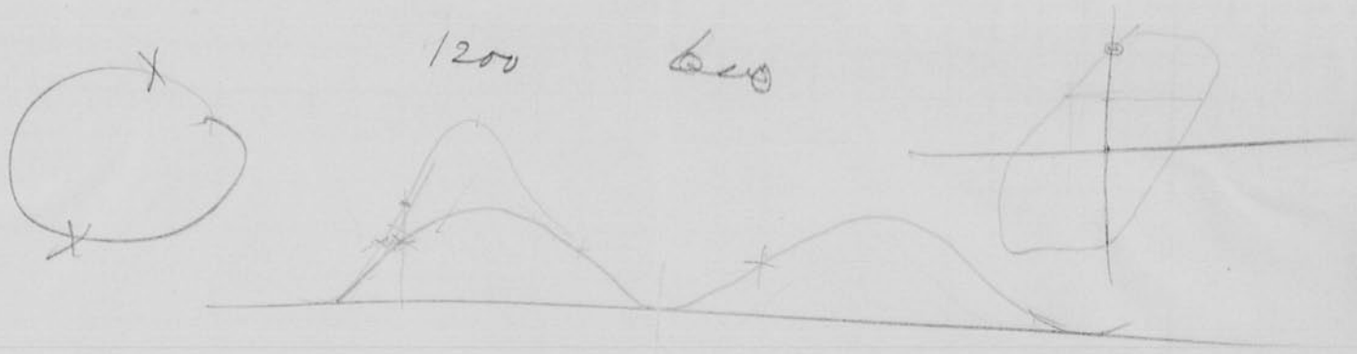
Yesterday afternoon I went over to the General communications laboratory at the invitation of Mr. Dane to inspect his device for direction finding for aircraft. The unit was in operation and used a strobotron for flashing the position. He discussed the operation of the unit and improvements he wished to incorporate. Below are circuits and diagrams of the unit which were made when I was there.

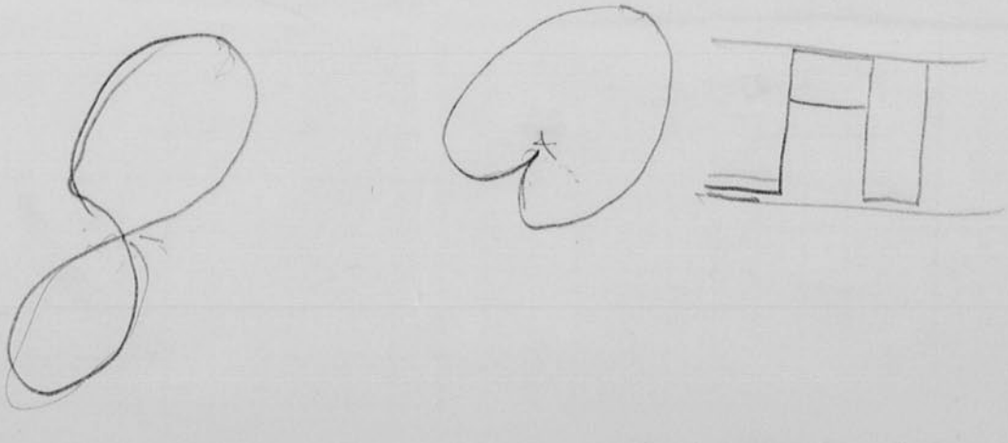


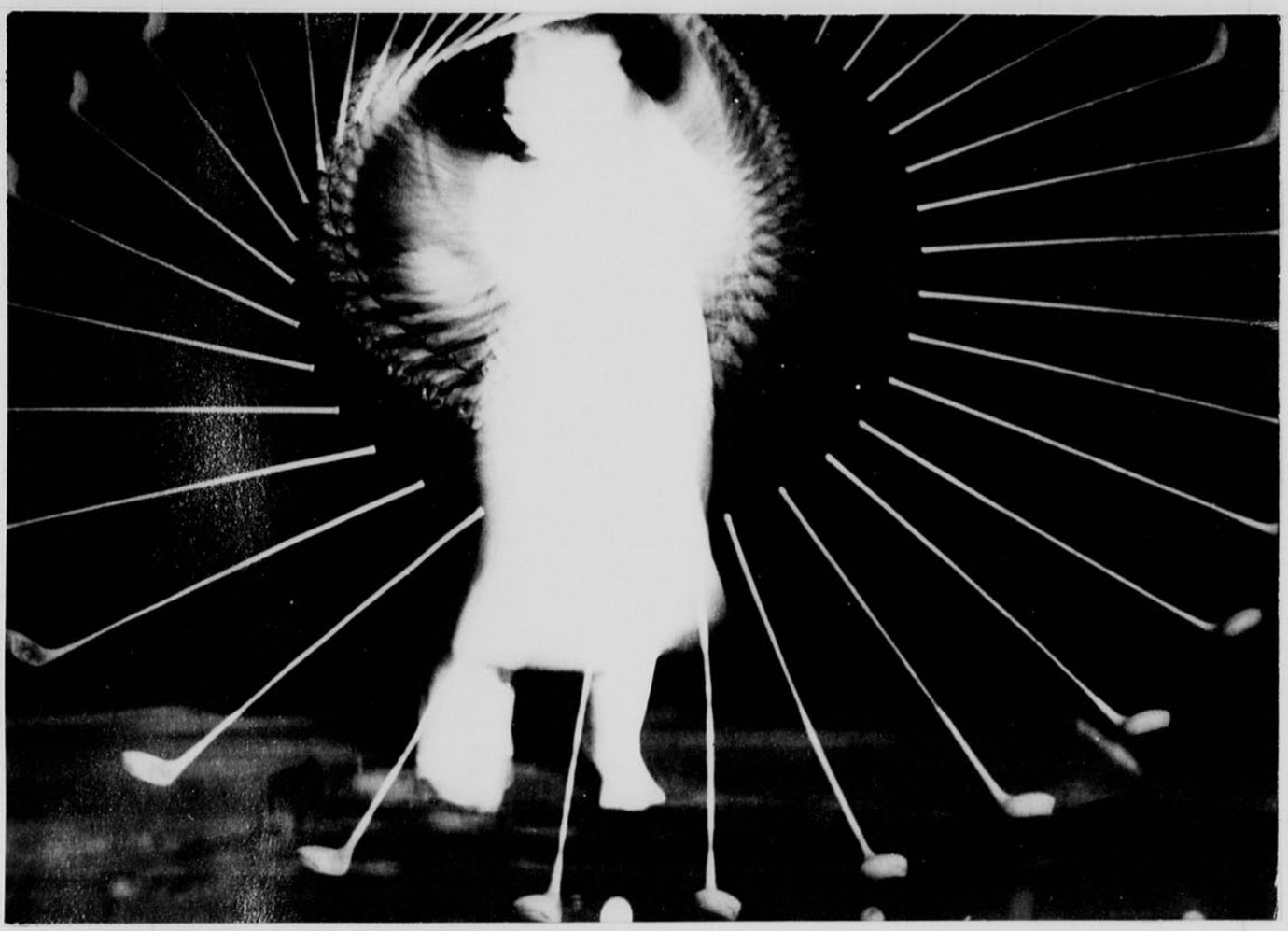


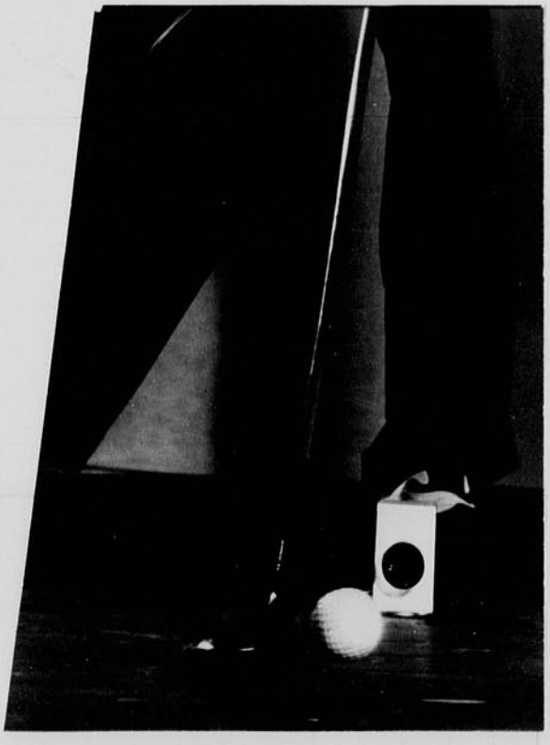
cont.

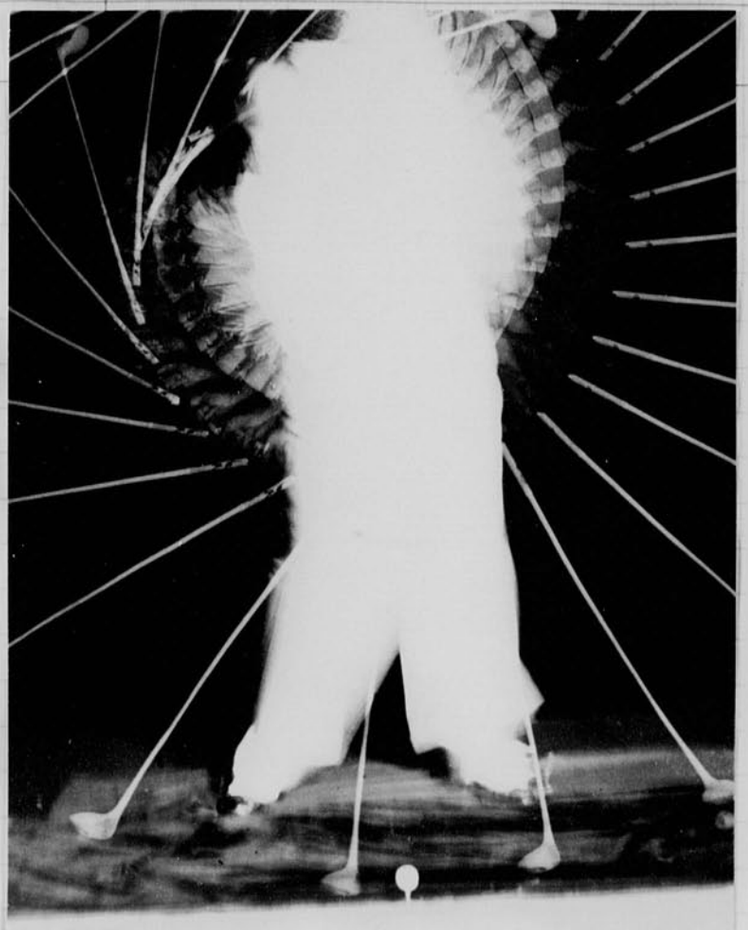
Yesterday afternoon I went over to the General Communications Laboratory at the [illegible]. Dame to inspect his



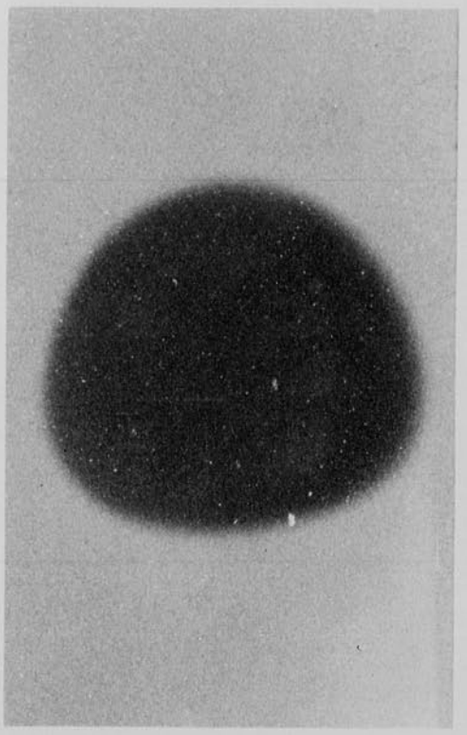






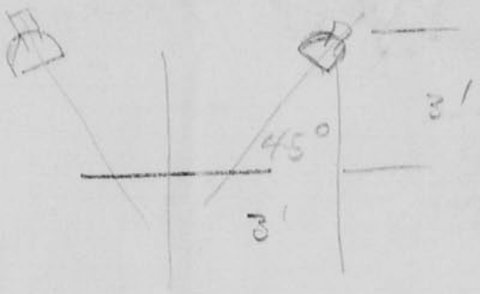


Guldahl



4 #2 Phila floods.
100 volts.
1000 each. 4000 watts

320 F.C.



Same density. ±
8 flashes of 5p light.
distance 25% more
Two lights 24 mf 3000.v

---

microfile 4/min der 70°

← 4 flashes about 1/2 enough.

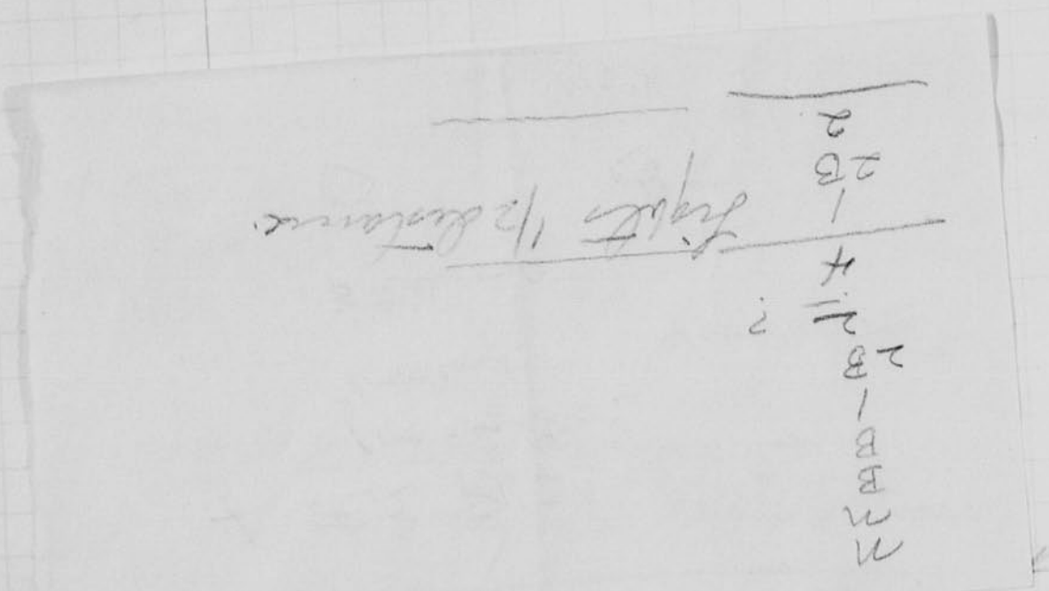
---

f 15 newspage.

Graphic Survey. July 19 1938

Data sheet made July 19 1938 at Graphic Service Corp.
Mr. Foote
Bob Pace from Edenton.
Beal
Akins.
Wheelright

An approximate Dupont film was o.k. with one flash. Data on back of sheet.



4 plates about 1/2 enough.

f15 newspage.

July 19 1938

Graphic Survey.

Data sheet made July 19 1938 at Graphic Service Corp.

Mr. Foote
Bob Place from Plainbank.
Beal
Abaus.
Wheelright

An approximate Dupont film was O.K. with one flash. Data back of sheet.

July 27, 1938.
M. Elgarten.

Mr. C.Z. Case of the Eastman Co was here today, this morning, and during his visit we discussed the E.K. Co's possible interest in flash photography. I introduced him to Harry Moore Cand. also I took two negatives of Mr. Case hitting a golf ball. 1000/second f 5.6 55 pan Press film.

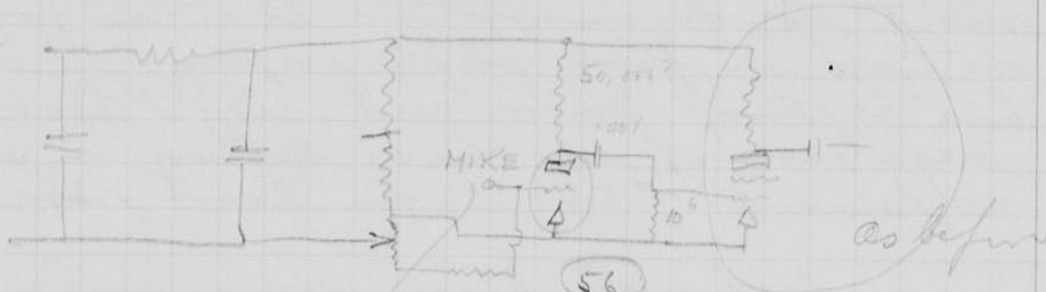
Last week I took some photos of tennis players. In two or three weeks I plan to take more.

Mr. Hooper of the Allen Hydraulic Lab. was here today to discuss speed photo-graphy.

Al Lopez and Mc Jayden of Boston Bees were here July 29 for photographs.

Aug 1 1938

Added tube to circuit shown on page 25.



$\mu = 13.6$.

and plate cells as before.

works ok.

Boston transformer No 2113
115 - 6000 volt 60 ~

Open circuit 110 volts .8 x 50 = 40 ma.

Short circuit 2.3 volts. .96 x 100 = 096. ma.

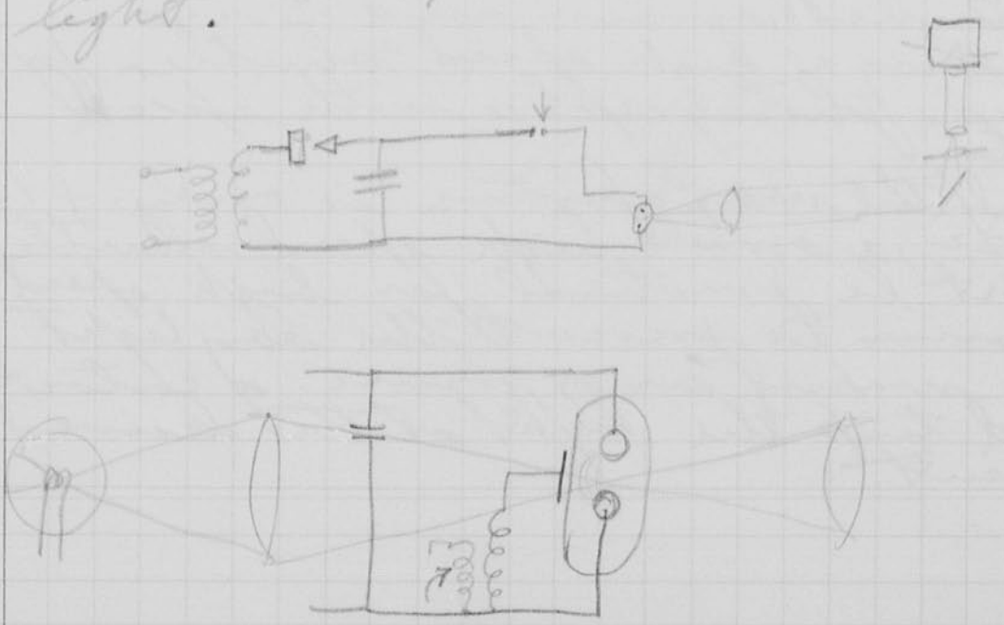
.1 x 50 = 5 amps. ss.

Aug. 7. 1938.

Mr. Brown Mr. Roach, and Mr. Dixon of the Spaulding co were here on Aug 2 and discussed golf clubs etc.

I plan to set up apparatus for taking about 20 pictures during impact at 500 a second of a golf swing.

Microscope illuminator high-speed light.



Aug. 4, 1938 cont.

Mr. Gilman of the Jackson & Moreland co was in this afternoon and discussed stroboscopic tests of propeller vibration apparatus.

Since I was going through Hartford tomorrow he called, regarding a possible visit at the Hamilton Standard Propeller co.

Edwin D. Eaton. Asst Engineer.
Frank W. Caldwell Eng. Manager.
Erle Martin Chief Engineer.

Bob Love is arranging propeller photos. Bathianna at Inter cities.

Amer. Air Lines. Mr. Waver.

Clarke Belimm tune up motors.
Local air line.

Yesterday I had a long discussion with Kennedhausen and Grier regarding a high speed shutter for outside photographies with speed lights.

If the max aperture is only f 16 or f 22, a small high speed shutter might be practical for high speed exposure to prevent the day light from making an exposure. A contact would trip the lights at the desired moment.

Notebook # 9

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 48 and 49.

Item(s) now housed in accompanying folder.

Aug. 6, 1938.
H. E. Edgerton.

Trip yesterday by car 350 miles. Left home 5:45 am. Arrived Submarine base New London about 9.0'clock. Went abord Semmes there and met Mr. Patterson. Prince, Draper and Capt McCool. C&R Drawing No A-1140 shows dimensions of the port holes of which there are two.

Left Sub. base about 10 and drove to New Haven, Winchester plant to see Mr. Pugsley. Discussed their problems and possibilities of consulting work or of setting up a laboratory for ballistic problems.

Saw R. Evans at Bridgeport Remington Co. and inspected his laboratory for ballistic studies. Bradford & ... were there.

Stopped at Hamilton Prof. Co to see vibration apparatus. Edwin D. Eaton ass't Eng. Bob. Mueller & ... Mueller and I had dinner together in Hartford.

Aug. 11, 1938

Took high-speed photos of Bobby Jones on Sunday Aug. 7. Mr. East and Mr. Keach of Spalding brought him over by car from Springfield.

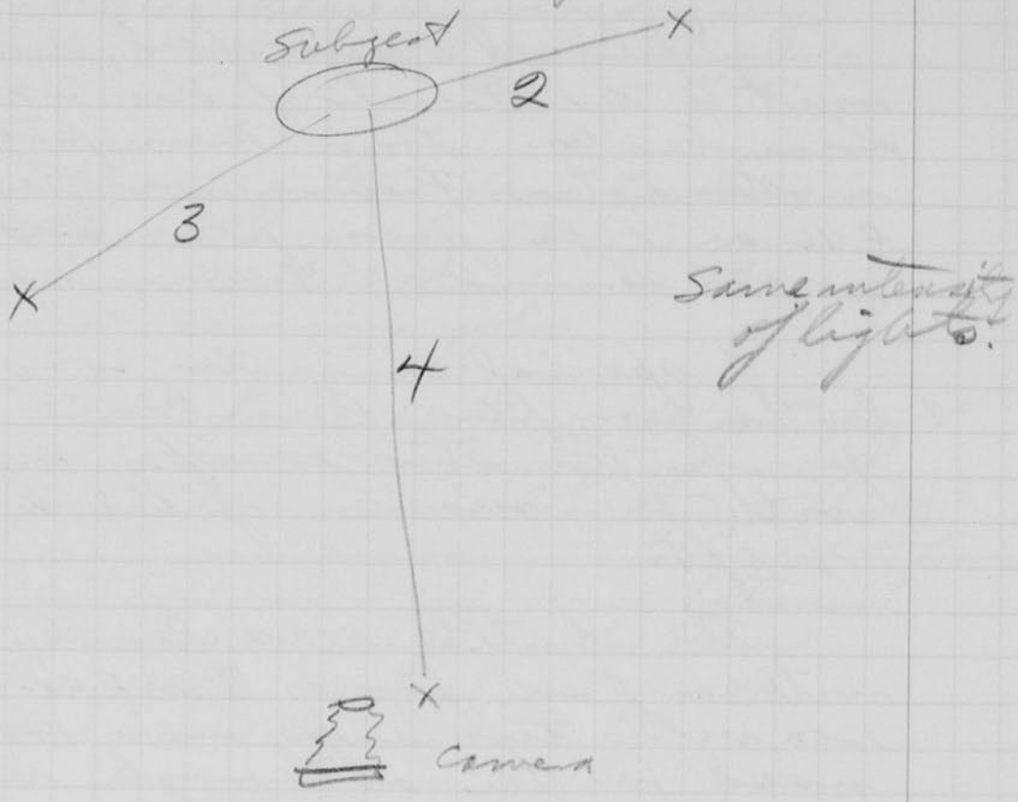
Worked last night with Fred Barstow taking photos of cracks in tempered glass. A more powerful spring was required than he used before in the plate glass. Also more time lag was needed in the electrical circuit to photograph the cracks.

Sept. 9, 1938.
Harold Edgerton

I went to the Sub base at New London on Sept 7 with Ed Kadding to try to get propeller photos of the USS Skimmer. The results were nil due to several reasons. I wrote Dr Hayes at Anacosta suggesting new windows and other changes that would help.

Yesterday in the a/f. Mr. Wadman and Dr. Preston were here for a conference regarding spark photography of cracks in glass. Wadman gave me a translation of an article by Schardin and Struth in the Glastechnische Berichte Vol 16, page 219, 1938. Movies at 200,000 a second were taken to measure the velocity of the cracks. Conclusion - cracks go at 1500 meters a second.

Lighting method. 3 lights



Harold Edgerton
Sept. 26, 1938.

I delivered a high-speed photographic unit to Mr. Palmer of the Crompton-Knowles Co. Loom Manufacturers in Worcester. Pictures were taken at f 16 on agfa press film and at 100 per second at f 4.5 on same.

A special contactor was built by the Crompton Knowles Co. to flash the stroboscope in phase with the motion of the driving shaft.

The shuttle was clearly visible with a flash from a 8 mf condenser 1200 volts. Two lamps were sometimes used for this although only one was enough.

I gave Victor Ser — a pencil drawing of the circuit. He is going to redraw it and send me a copy for checking.

New lamps and spares are to be sent to the company.

A straight lamp was used for the 100/second movies.

Harry Lamm and I took photos of my car with 6 white spots on one of the rear wheels. One shot with a graflex showed distortion & another with a compur showed a different kind of distortion. These photos are to be used in my book on speed photography to illustrate the action of the shutters.

Last week on Wednesday we had a very violent hurricane which did considerable damage.

I am trying to get the glass breaking research to continue. Barstow is now finishing his masters thesis in the physics dept. Remaining jobs.

1. Double flash pictures 20 μs apart to measure velocity of crack formation. Simultaneous cathode ray oscillograms are to be taken to measure the time between flashes as well as the time from the initial impact.

2. A photo from the side showing the progress of the fracture from the very start.

3. Experiments with Polaroid to show strains before or after the cracks form.

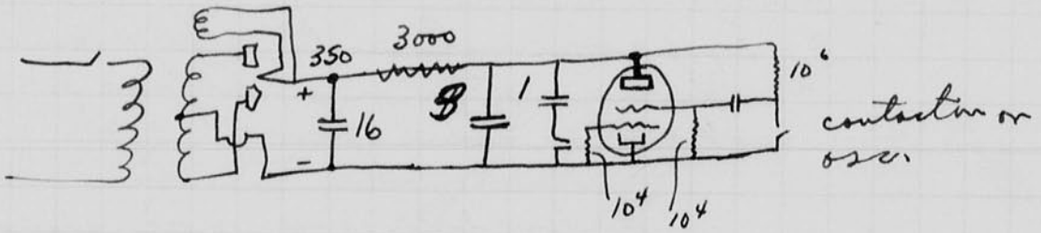
   A preliminary experiment with this material showed a negative result last week. No indication of a strain was present although the polaroid was weak and the exposure dim. (thin).

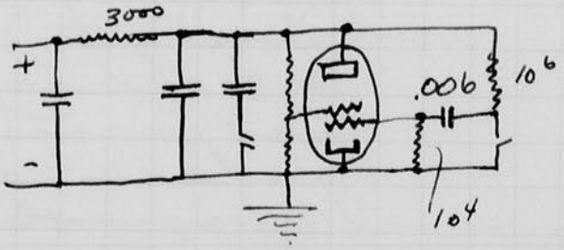
Sept. 27. 1938
Harold E. Edgerton.

Discussion with mr. Wilkins and mr. Burke this morning regarding "Strobolux" Various changes were suggested and Wilkins is going to complete the no. 1 model for final experimentation. Wilkins offered to make a batch of 10 in the experimental shop in 6 weeks time.

The new model of the Strobotac is about through drafting. They will not be ready to sell until Jan. about 38 or 40 were sold (old model in August). Today there were 21 in stock and 50 in the factory. There may be a gap between the new and the old.

A contactor strobotac was discussed for use with the new Strobolux. It will also be useful by itself as a stroboscope. Ernie is to build one and try it out.

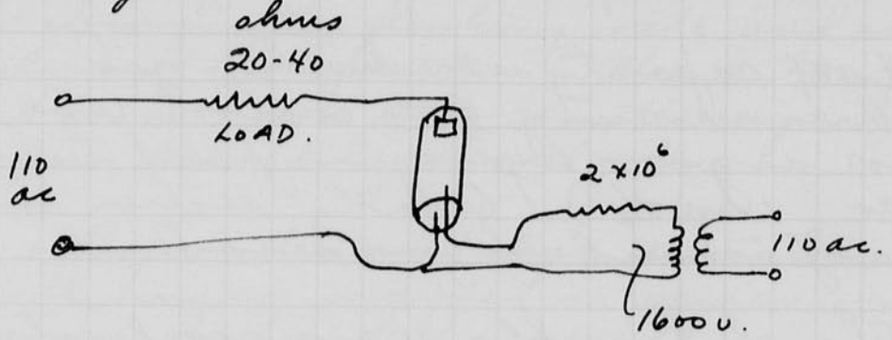




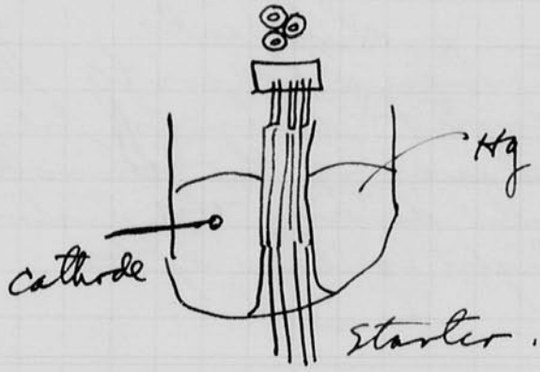
I am to try a double jack out box for the driving of two Stroboluxes in parallel.

H. E. Edgerton
Sept. 29, 1938.

Gemeshausen has an internal glass-covered arc starter that has been running day & night now for about 700 hours +. The arrangement is as shown below.



The starter consists of a group of W 3 wires (10 mils?) in a triangular formation each covered with a thin glass layer. The wires are spot welded together at the top with a plate.



about 1000 volts starts the arc.

Letter received from Orthemin and sent to Mr. Rines

Oct, 4. 1938
Harold E Edgerton.

Photographs were taken Friday of Joe Stein hitting a golf ball and of Chambers hitting a tennis ball.

4 mf capacity was discharged through a mercury ~~tube~~ control tube and an argon - hydrogen filled tube. (40 cm ar 1 cm H_2.). Orlaty section movie camp. Speeds of 600 and 300 per second were used.

The photographs show acceleration or deceleration at the moment of impact plus a reduction of speed to about 75% in the first 1/100 of a second. The hands of the heads then speed up and eventually decrease to zero towards the end of the swing.

Loading of the handle at the hands with lead to increase the weight should be beneficial in reducing the shock received by the hands during the disturbance at impact and slightly there after.

Explained to Mr. Stein 10:11:38

Read + Understood Oct 4, 1938 Lemuel J. Hemmelmann

Dr. Dickson and Mr. East were here on Friday for the above mentioned tests.

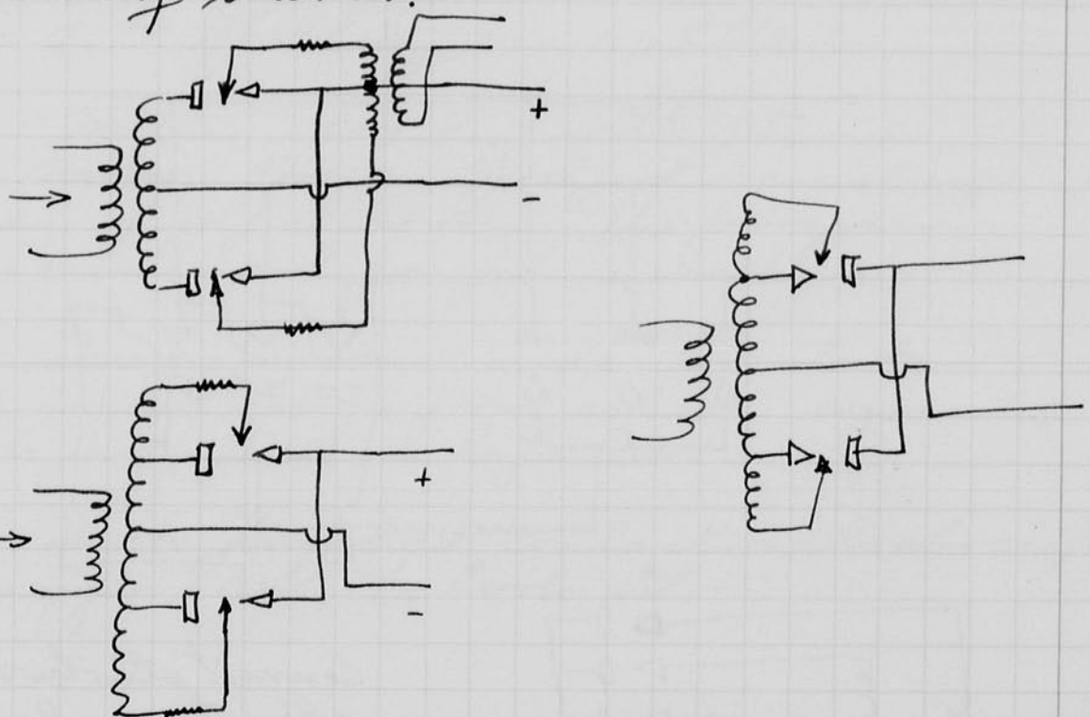
Mr. Bert Fuller of the Eastman Kodak Co was here today and I showed him various devices in the Institute for calculating. Of particular interest were the torque amplifier and the new following mechanism for the new integraph.

Harold E. Edgerton.
Oct. 10. 1938

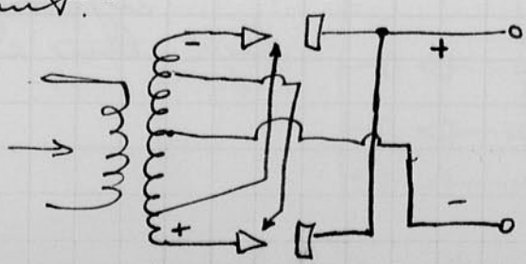
Herb Grier recently sent to Mr. Turner of the Eagle Signal Co a battery operated stroboturn flasher. Provision was made for changing the flashing rate and also photocell control of the operation. The battery was put in an oak box below the signal, and consisted of four heavy duty 45 volt cells.

Before the unit was sent Grier tried a bell ringer magnet in series with the charging circuit for operating a bell or gong. There is ample power to ring a bell from the charging surge.

I discussed with Grier and Germeshausen yesterday circuits for using the low voltage capacity starter.

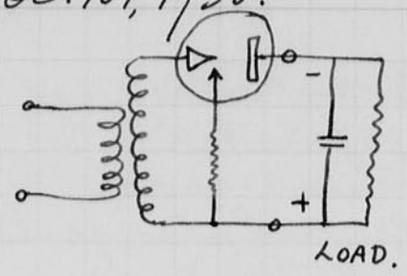


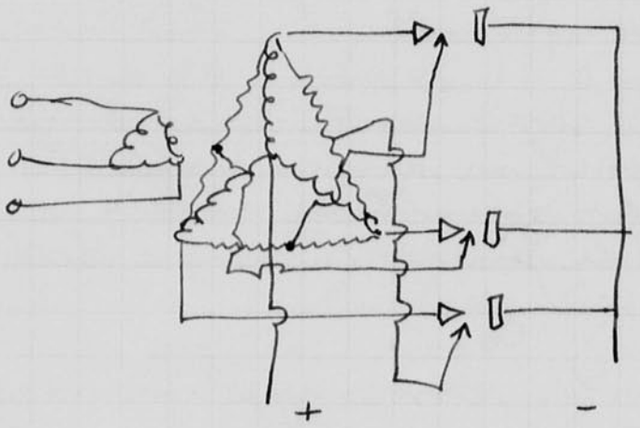
Today Germeshausen showed me the following circuit.

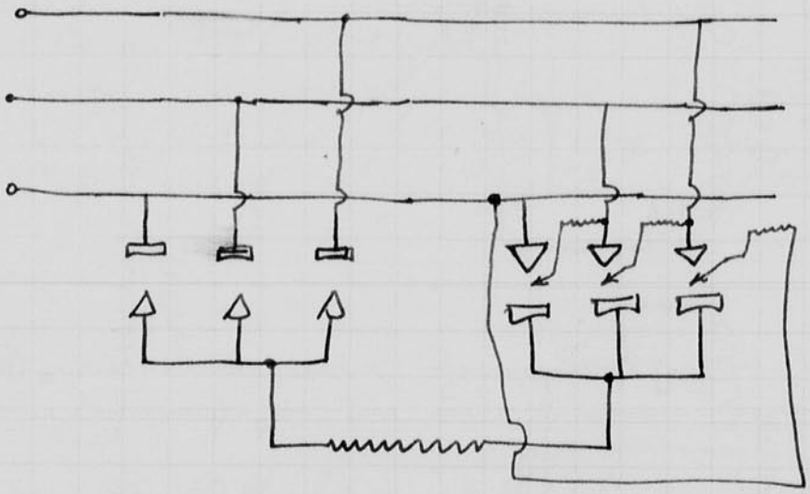


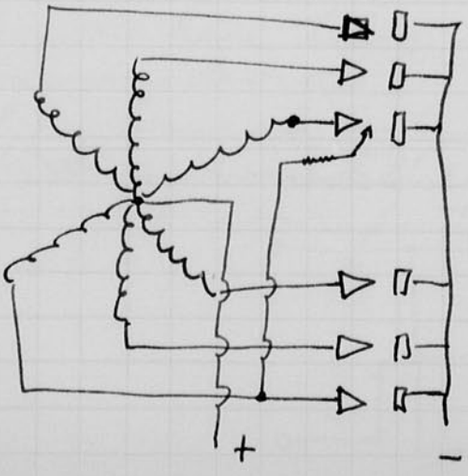
Oct 10, 1938.

Rectifier circuits.

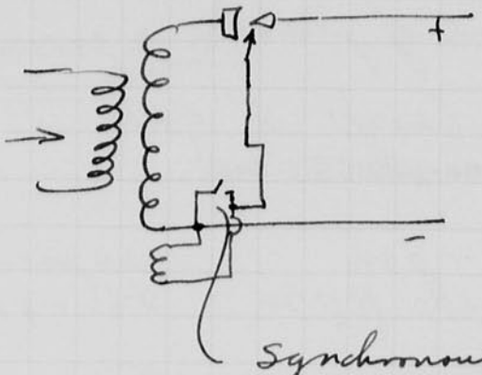








connect starters to opposite ends of phases or to center tap if output voltage is high ~~too~~ enough.



Vibrator type contactor.

Synchronously driven contact point arranged to give a break at the peak of the wave or wherever desired for regulation.

This system can be made to operate multiphase.

Oct. 13, 1938

6 - Golf clubs painted white received from A. D. ~~Goldsby~~ via A. D. Little Co.

Meeting yesterday with Stevens, Voss, Norton, Brown, Radford regarding study of golf clubs etc. The program was discussed for future work.

Jenes-Kanen made arc-starter tube today, sphere form which seems to work fine. Put on life test.

~~Herb.~~ Finished contactor strobo-scope today for GR. to look at.

Oct, 15. 1935

W. Elgert H. Brier

Measurement of time of flash,

4 mf 2000 volts argon lamps 2" gap 5/8 glass
condenser & lamps. pressure 50 cm².

mirror speed 7200 rpm 120/sec.
effective speed 14400 rpm. 240 rps.

" (11¼)

Distance per rev. = 3.14 × 2 × 12 = 75.4 inches

240 × 75.4 = 18,100 inches/sec.
= 46,000

3600 r.p.m.
1 cm = 43.5 μs.

7200 r.p.m.
1 cm = 21.75 μs

1 cm = 21.75 × 10⁻⁶ = 1/46000 sec.
1 in = 55.3 × 10⁻⁶ = 1/18000 sec.

Blur on film = 1.5 mm

∴ flash = 21.75 × 1.5 = 3.26 μs.

(with 11½ mf 2000 volt [illegible])

[illegible] sec
[illegible]

Oct, 15. 1935

JB Edgerton HE Grier

Measurement of time of flash.

4 mf 2000 volts Argon lamp 2" gap 5/8 glass
condenser at lamp. pressure 50 cm.

Mirror speed 7200 rpm 120/sec.
effective speed 14400 rpm 240 rps.

Distance per rev. = $3.14 \times 2 \times 12 = 75.4$ inches

3600 r min
1 cm = 43.5 ms.

$240 \times 75.4 = 18100$ inches/sec.
$= 46{,}000$

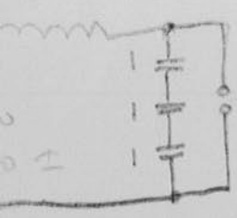
7200 r p m
1 cm = 21.75 ms

1 cm = $21.75 \times 10^{-6} = \frac{1}{46000}$ sec.
1 cm = $55.3 \times 10^{-6} = \frac{1}{18000}$ sec.

Blur on film = 1.5 mm

∴ Flash = $21.75 \times 1.5 = \underline{\underline{3.26}}$ m s.

Spark d... with 1/2 mf long leads (10 ft ±)
the flash duration was $\frac{1}{20{,}000}$ sec
= 50 microseconds



Notebook # 9

Filming and Separation Record

____ unmounted photograph(s)

3? negative strip(s) inside envelope mounted on page 60

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

was/were filmed where originally located ~~between~~ on page 60 and —.

Item(s) now housed in accompanying folder.

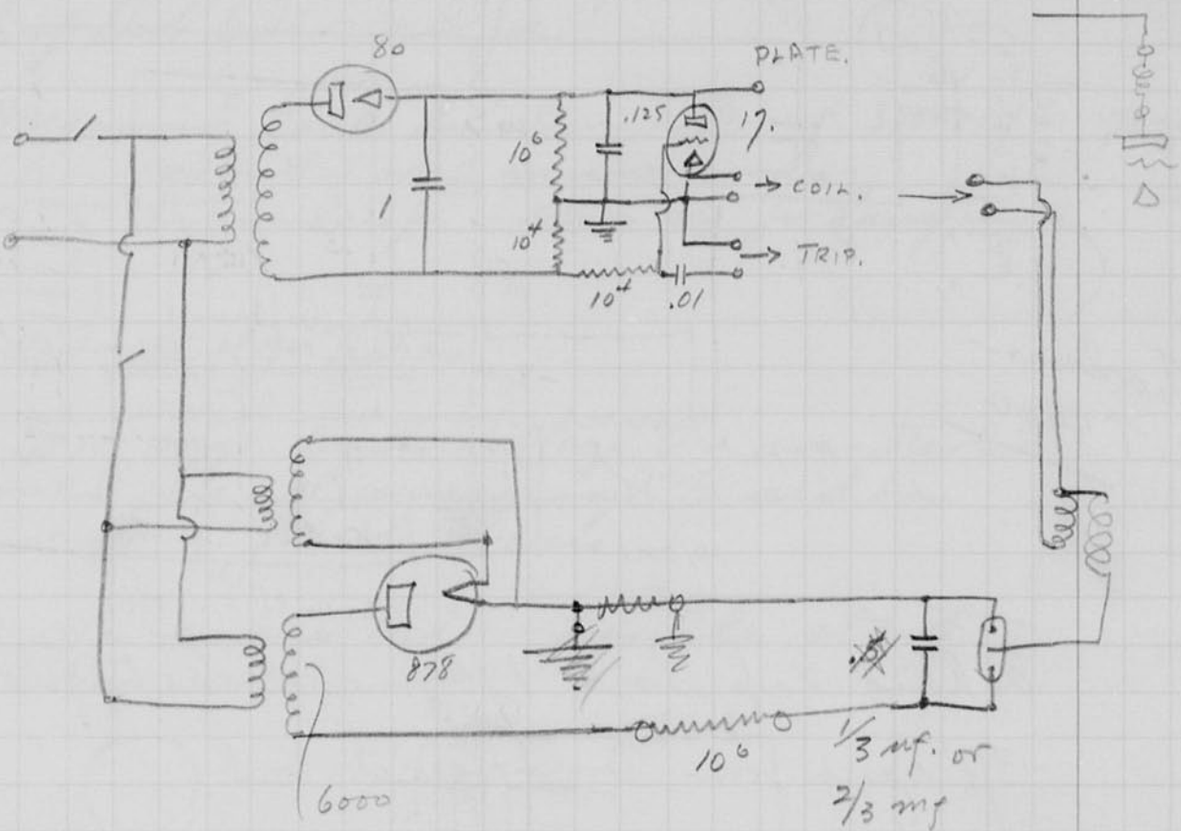
1 CM = 22 M.S.

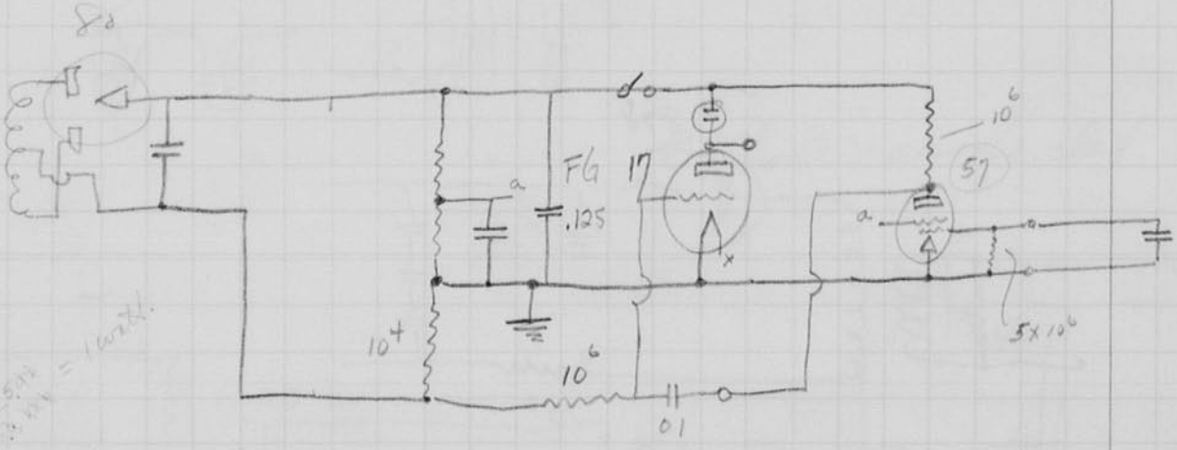
3" AR. LAMP.
4 MT 3.50 U.

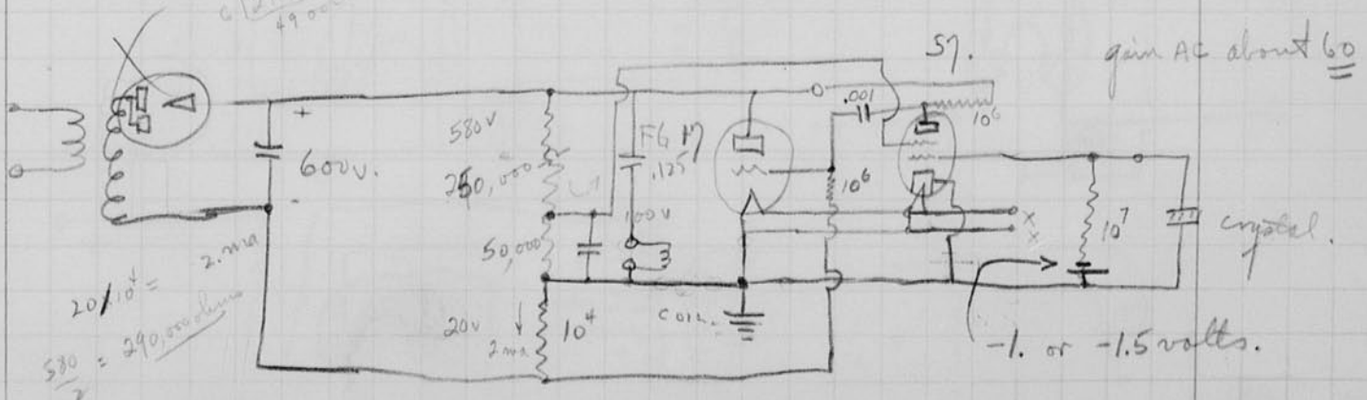
Oct 15, 38

10^{-6} Flash unit circuit

See page 36 37.



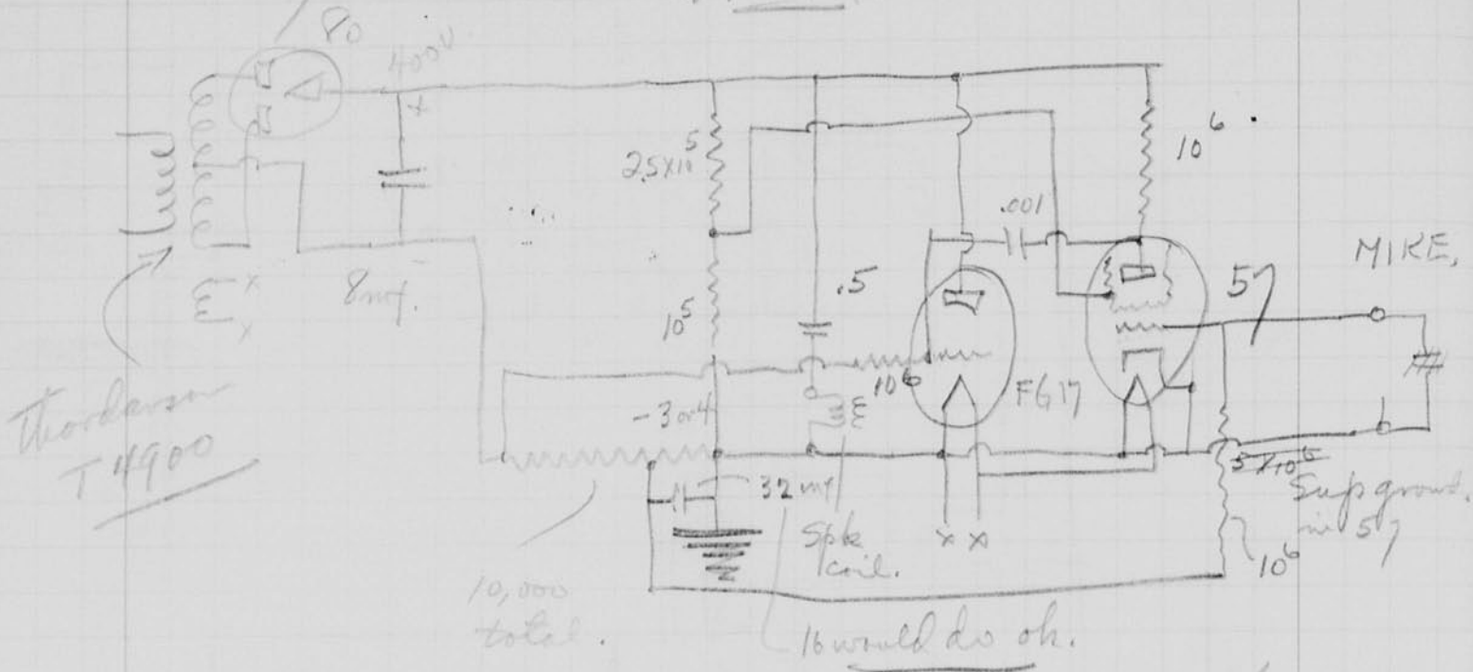




See next page for detail

Oct. 16, 1938.

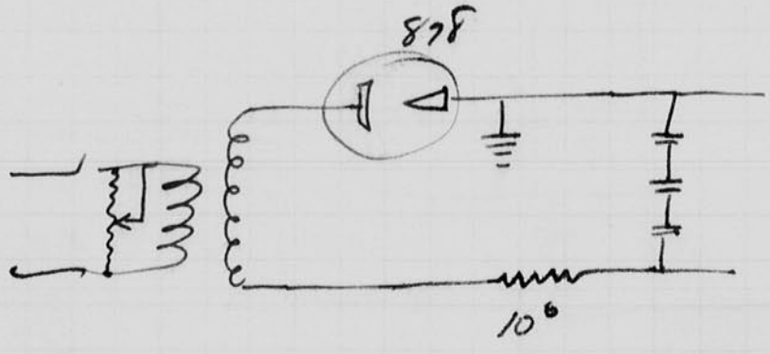
Not Used.



16 would do oh.

a hand clap about 1 ft from mike trips thyratron.

3/8" spark from Brown Beach Coil.



Oct. 17, 1938.

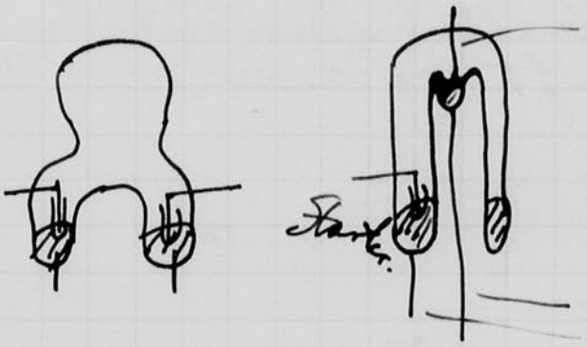
Finished lamphouse for 10" flash unit with help of Herb Brier and Joe.

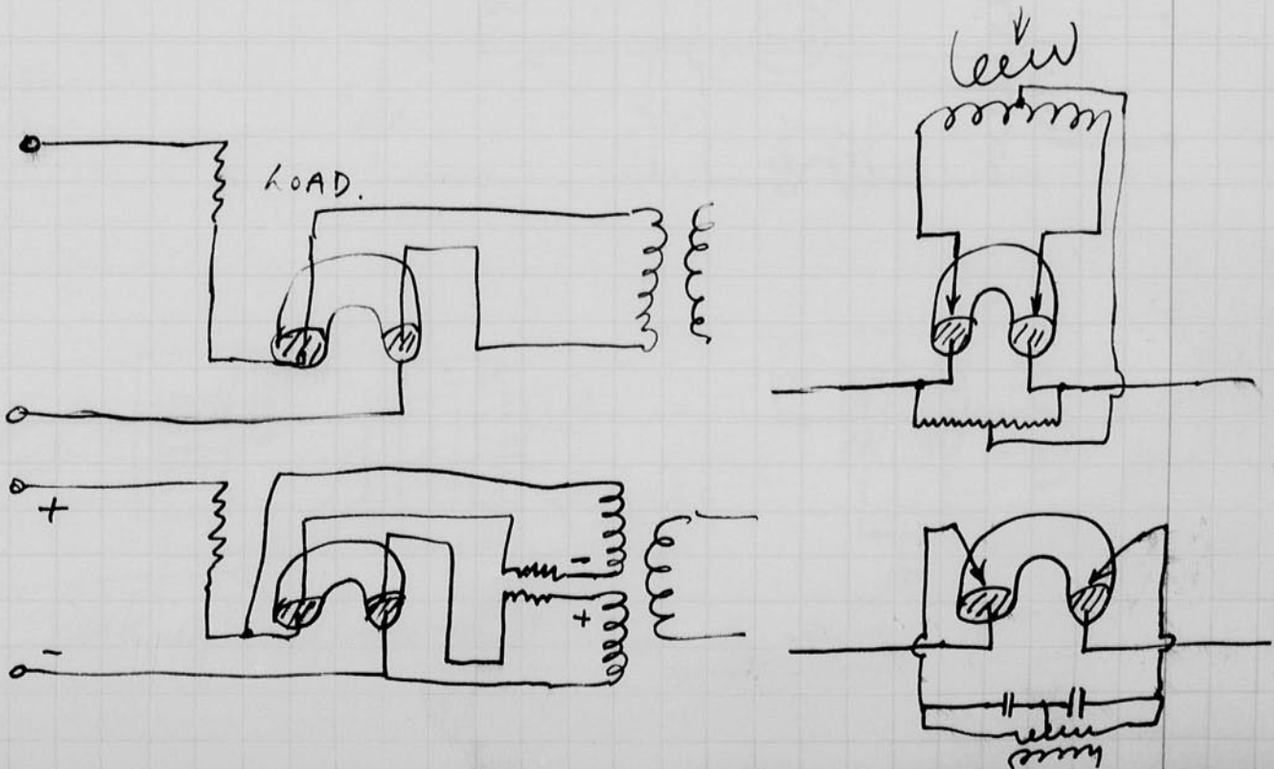
Measured flash duration . 1/3 mf 5500 × 1.4 = 7000 ± volts.
about 1 or 2 microseconds.
Argon lamp. 2 cm H_2 for damping.

arc-starter tubes.

For high back voltage the arc-starter should be glass covered to aid in preventing flash back.

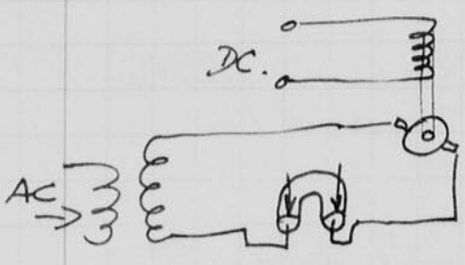
Hg anode tube - double start.





Oct. 18, 1938
H. E. Edgerton.

The double ended tube shown on the preceding page can be used either for ac (current going both directions) and as a rectifier for current going in either direction. This might be useful for elevators and other applications where the direction change of rotation is needed

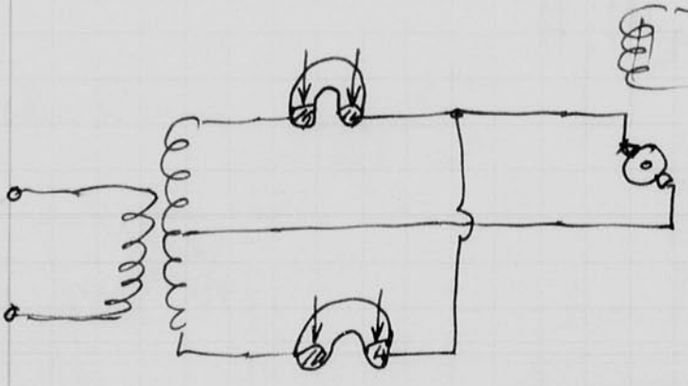


DC FIELD.

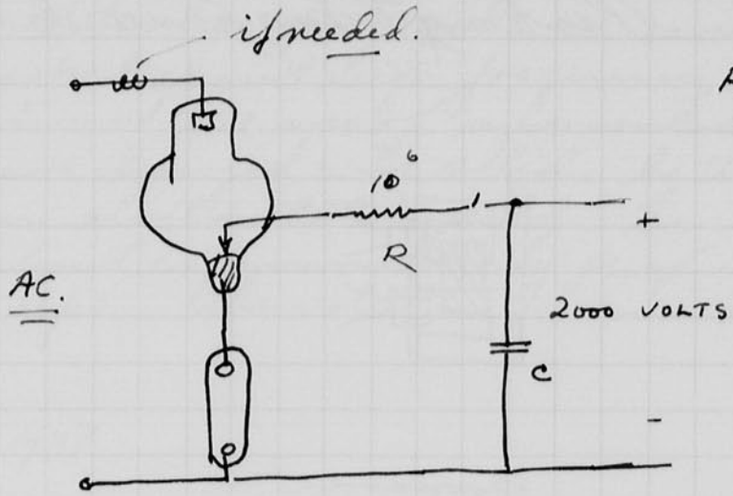
MOTOR.

control arranged to run motor either direction at a controlled amount by phase shift methods.

Full wave.

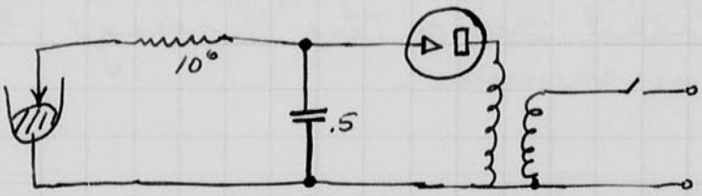


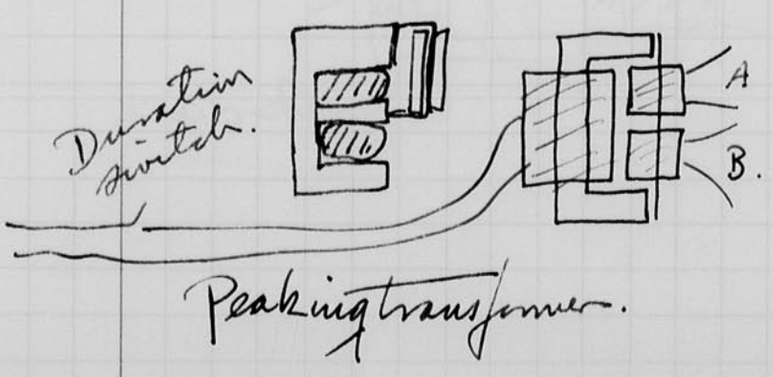
Oct 18 1938
H. E. Edgerton. Photo Flash Lamps.

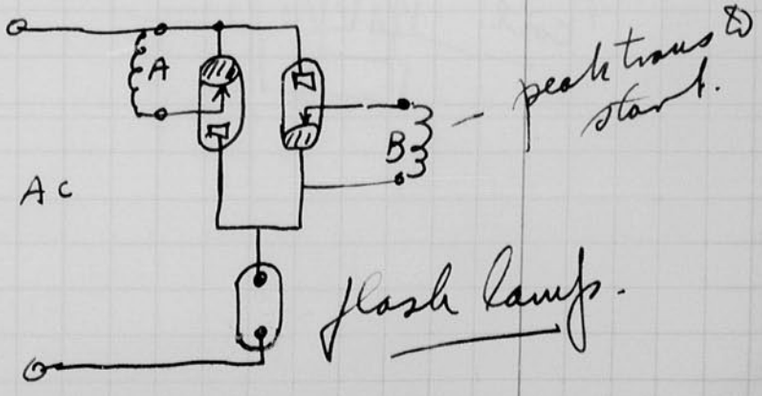


RC determines roughly the flash time.

The use of other 60 cycle stroboscopic circuits with phase control could be used here to flash the light at the desired time in the ~~deg~~ cycle and for the desired duration.

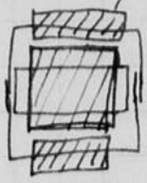


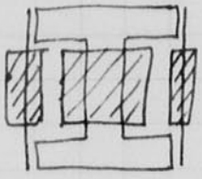


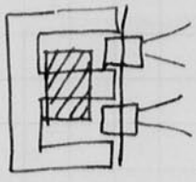


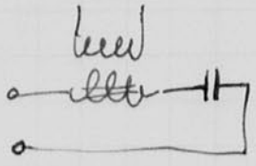
Oct 1938
Harold Edgerton.

Peaking transformer design.

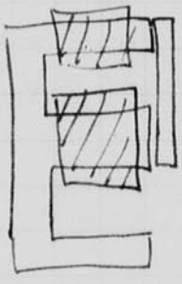




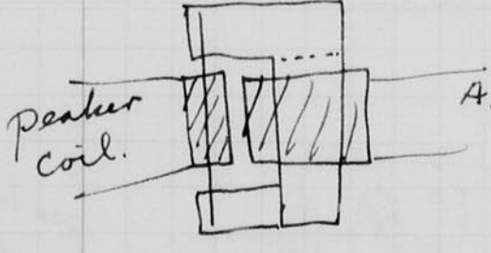




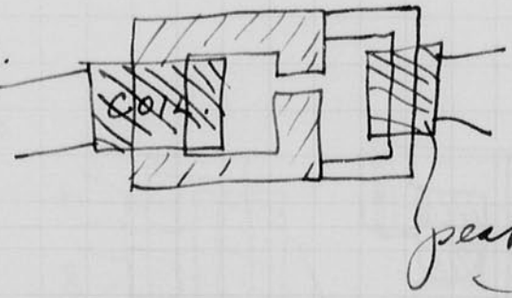
Resonance. —



A wire core for the saturated section might be an advantage as before stated since the leakage flux would be a minimum.



A.C. COIL.



Oct. 22, 1938.
K. E. Egerton.

Rubenstein of A.D. Little Co. came in yesterday and asked about high frequency heating. I mentioned the use of ~~impregnated~~ liquids that are changed into solids by the application of an electrostatic field. Mr. Gladding told me about experiments by Prof Morton of the chem dept. the solutions were sugars?

~~Oct~~ nov 3. 1938

Carrol Stansbury was here yesterday and ~~We~~ we discussed the new improvement to the capacity starter tube that Gemmer has been working on for the last few months. Stansbury is with the Cutler Hammer co of Milwaukee. He left here to see B.R. Co about variacs etc.

I have been taking photos for the projected book of high-speed photography. Jack Summers posed for aquaslo photos, Mary Ellen Goodman for action photos. Rowland Wingate - Golf. also golf ball through a phone directory.

Nov. 7 1938
Harold E. Edgerton

Golf Improvement.

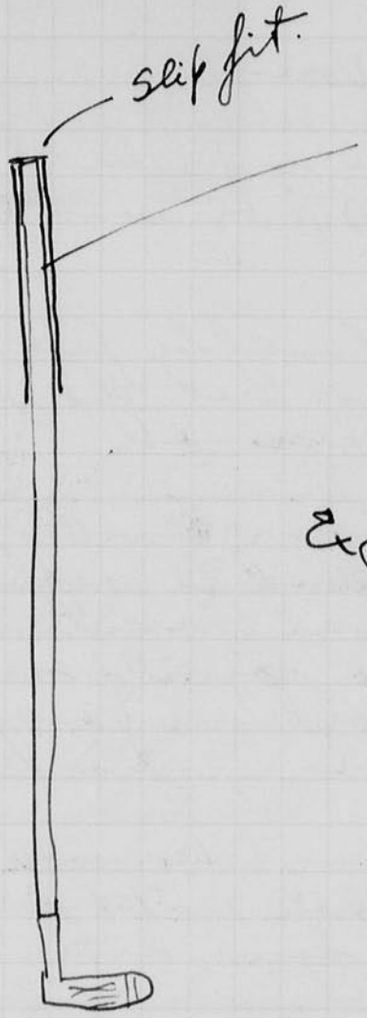
A violent twist is given to the hands of a golfer at the moment of impact if the ball is not hit exactly square.

I suggest the use of a slipping handle that will be tight as long as the torque or acceleration does not exceed that encountered in the initial swing of the club. The violent twist at impact will slip the club shaft in the handle and remove the sting from the hands.

The above slipping handle will be something like a vibration damper such as used on rotating machinery. The object is to use up the energy of the angular motion of the club without a violent strain on the hands of the golfer.

A somewhat similar effect would result from the use of a free tube on the shaft at any point with a friction connection to the shaft.

Probably some method of adjusting the tension would be needed. It is quite possible that a method of damping the tension with the centrifugal force or impact force might be useful.



The shaft might be split and spring so that there would be a slight tension or friction on the handle to prevent slip before the blow.

Explained 11-7-38
Herbert E. Grier

Kenneth J. Gernshausen

Nov 12, 1938.
Harold E. Edgerton

Discussed with Vose the design of a club to illustrate the scheme on pages 68-69. He has done this and sent specs to Ray Stevens (A.G. Little Co) to be sent to the Spalding Co.

A rough scale should be put on the handle or the shaft so that the percent motion could be measured.

A notch with some sort of an index should be used to replace the handle to the initial condition. This could be done with a counter sunk ball bearing ball held in by a spring from the back.

Some 30 photos were taken on Wednesday Nov. 9 of Joe Stein. photo 72-104 inc. Gardener Norton took down data. Herb Grier helped with the outfit.

I spoke before the Zonta Club cambridge Nov. 9. My wife ran the projector. This club consists of business women. Miss McKenzie Burdakin, miss Green. etc.

Nov. 12, 1938.
Harold E. Edgerton

Discussed with Vose the design of a club to illustrate the scheme on pages 68-69. He has done this and sent specs to Ray Stevens (A.D. Little Co) to be sent to the Spalding Co.

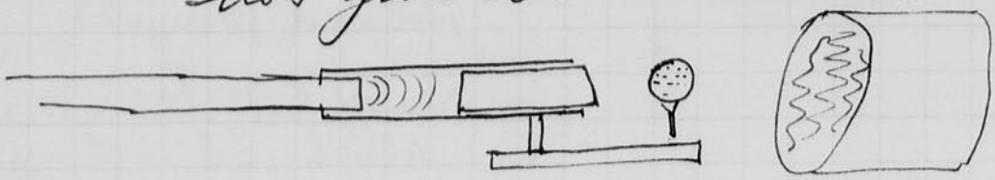
A rough scale should be put on the handle or the shaft so that the percent motion could be measured.

A notch with some sort of an index should be used to replace the handle to the initial condition. This could be done with a counter sunk ball bearing ball held in by a spring from the back.

Some 30 photos were taken on Wednesday Nov. 9 of Joe Stein. photo 72-104 inc. Gardener newton took down data. Herb Grier helped with the outfit.

I spoke before the Ponta Club cambridge Nov. 9. My wife ran the projector. This club consists of business women. Miss McKenzie Burdakin, miss Green. etc.

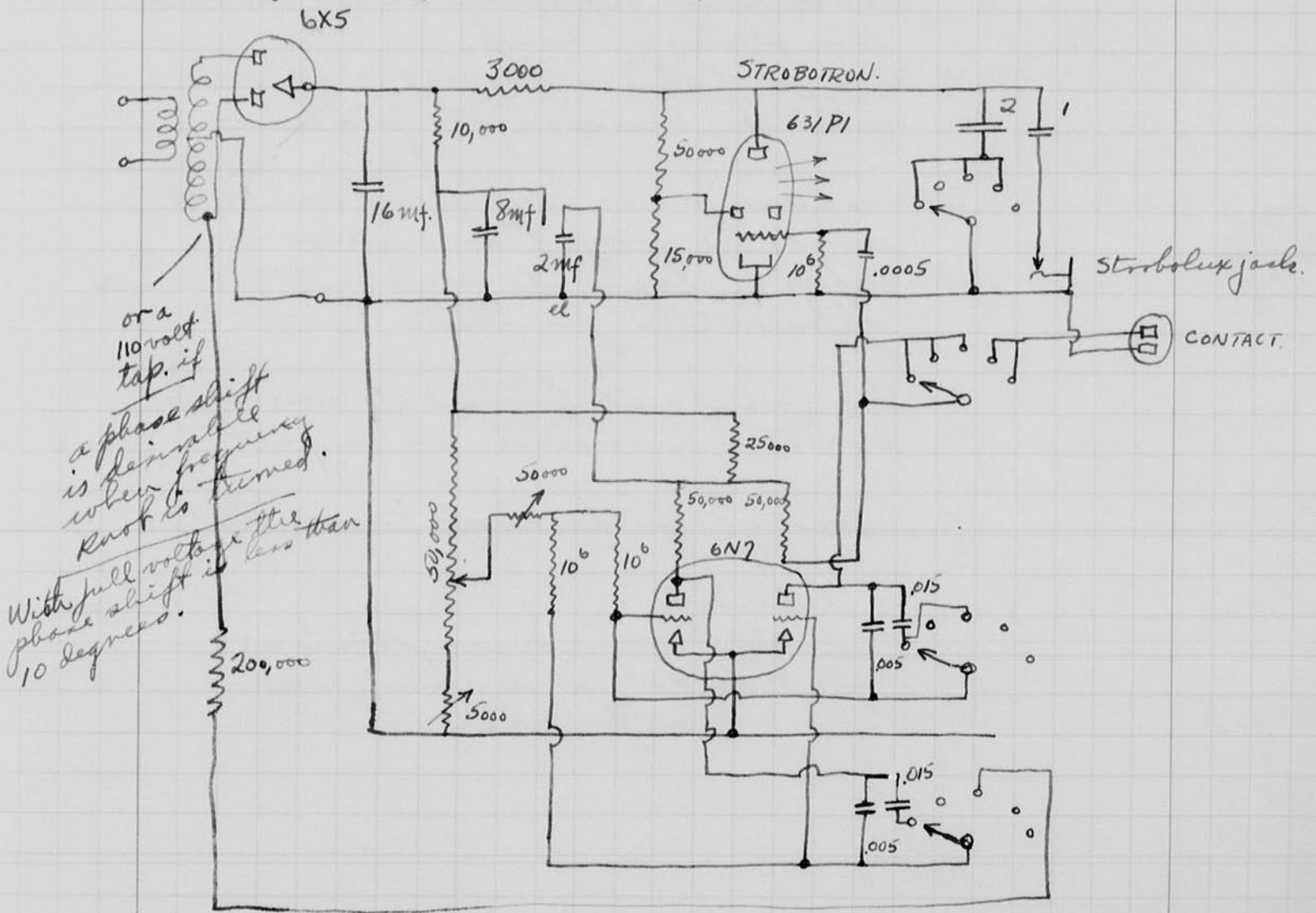
Shot gun to drive club head.



Barrel of waste
to stop club and
ball.

Harold E. Edgerton.
Nov 24 1938

Yesterday afternoon I obtained a blue print of the circuit of the new model 631 Strobotac from Mr. Wilkins of the General Radio Co. I experimented with the circuit until about 1130 p m and made several changes. The most important gives a 60 cycle operation over the entire range of adjustment of the frequency knob. Previously there was only a portion of the range at the low frequency end which would pull in. - the rest giving several flashes per cycle - not equally spaced in time.



Cont.

I had lunch yesterday noon with Ray Stevens (A.D. Little Co) Jim. Killian and Jim. Loiselands. Purpose to discuss copyright of photos taken for Spalding Co. and also the proposed showing of the photos on Dec. 7 in New York.

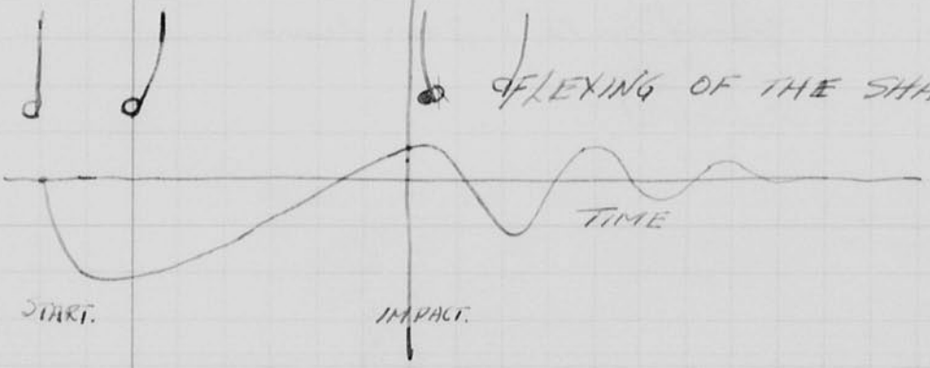
Discussion after with Mr. Stevens in my office at M.I.T. Points discussed -

1. Letter to ~~Spalding~~ check on captions on any news photos that the Spalding Co may release.
2. Program of research to date.
   a. Draw conclusions from photos as to what happens at the hands. from photos on hand.
   b. Take photos to emphasize what goes on to the hands. 200 pict./sec.
   c. Arrange for closeup of ball and club devices to project as a movie.
   d. Trip to Chicopee to see about apparatus for item c.
   e See Vose about fatigue of muscles due to acceleration or impact.
   f. Arrange for New York Demonstration.
      1. Slides
      2. Stroboscope demonstration
      3. Prints for display. (also for release.) J.

Analysis of golf club photos.

1. Prepare slides.
2. Read data on ball and club to plot position - time
   velocity - time.

BEFORE → | ← AFTER.

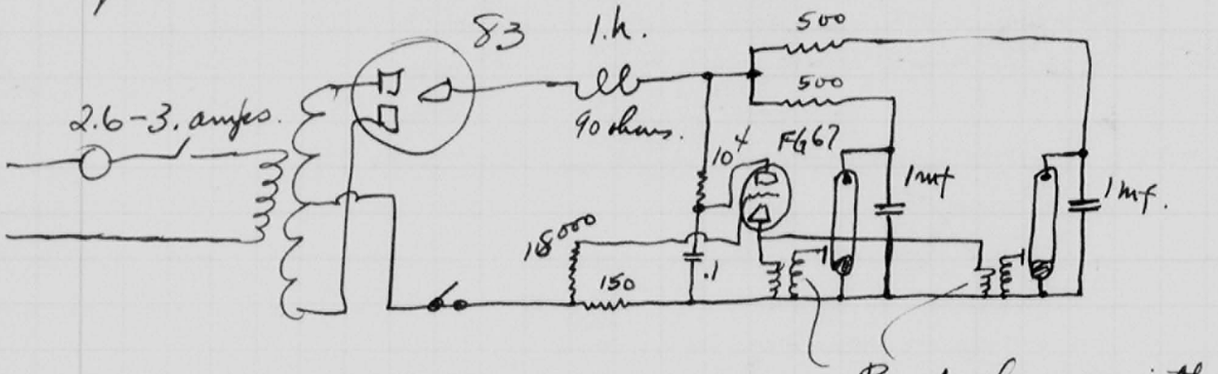


Dec. 12 1938
H. E. Edgerton

Showed multiple-flash photography at New York. Spalding Co. 518 Fifth ave, New York ~~operation~~ last Wednesday.

Inspected Worlds fair grounds in N. Y. on Thursday Dec. 8 with Mr. White of Lansdenne & Hatch work for N.C.R. Co.

Herb and I rehuilt 1/120 cycle strobo for math exhibit. Now is



Bosch brown with out core.
Lamps 12" 2cm diam.
Hg.

Dec 7 1938

Harold Edgerton.

Left M.I.T. about 2 pm for New London on Dec 14 for New London - Sub base for another try at propeller photographing on U.S.S. Semmes. Stayed in Quarters D ~~and went~~ that night and went aboard the morning of Dec 15 at 8 a.m.

A new hatch had been cut in the floor of the steering engine room which gave an unimpeded approach to the two glass port holes.

I used a 2" gap in argon gas (2 cm tube diam) at 3/4 of atmospheric pressure for a light source. A reflector was clamped over the 5" port hole on the starboard side, forward. 48 mf 3000 volts was used to discharge into this lamp. As the ac was obtained from a rotary, the exact voltage was not known.

Capt McCool
Lieut. Patterson.
Prince
Frazier
Douglas ?

Naval Office Geyer Radio.

Dr. Stephenson. } Sound experiments.
" Arnold

Turner. Sub. Signal Co.

Gardner Horton Reserve officer.
Helped me with data etc.

Starboard Prop

In Reply Refer
File No.

U. S. Submarine Force

U. S. S. SEMMES
EXPERIMENTAL DIVISION ONE

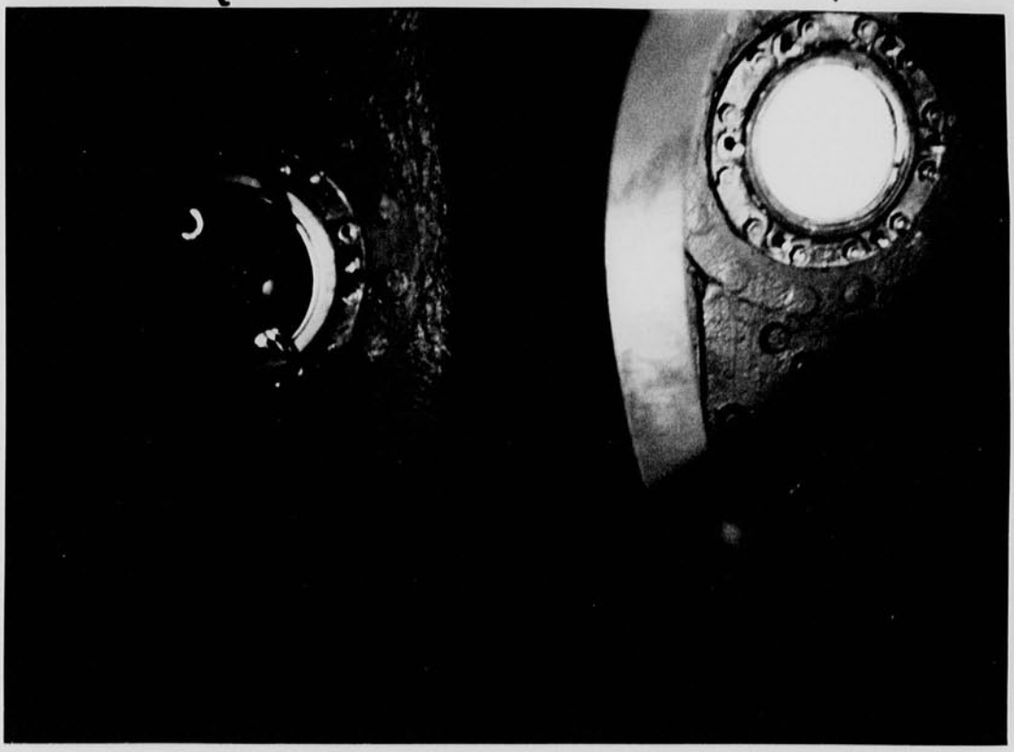
Film No	Time	Course	Speed	Sea	Prop Rev	f	Exposure	Trans
4	11.30	90°	6k	Following sea		2.0	.01 sec.	3½ ft
							Daylight Illum	
5	11.32						1/25	
6							1/5 sec	
7								
8		Surface				2	.01	
9						2	.01	With Strobe type controlled by H.E.L.
10						2	.01	
11								
12								
13								
14				All fourth pane astern				
15	12.45	260°	15k	Against sea		2	.01	2½
16		Blank				No Strob		3.0
17 - 23 inclusive								
24 - 26 incl						2	.01	
						4	.01	Strobo scope
						8	.01	
27		070° True with sea	20 Kn	Against sea	Time 1.10	2	.01	4.0
28								
29								
30								
31						4		
32								
33						8		
34								
35								
36		Picture of	portholes		1:124			

SPECIAL LAMP IN REFLECTOR

TOP

CAMERA HERE

FORWARD



Argon lamp 48 mf 3000 volts.

2" gap - atmospheric pressure ±.

Camera f 2 lens Dollina. 35 mm film.

Estman XX

(2)

In Reply Refer
File No.

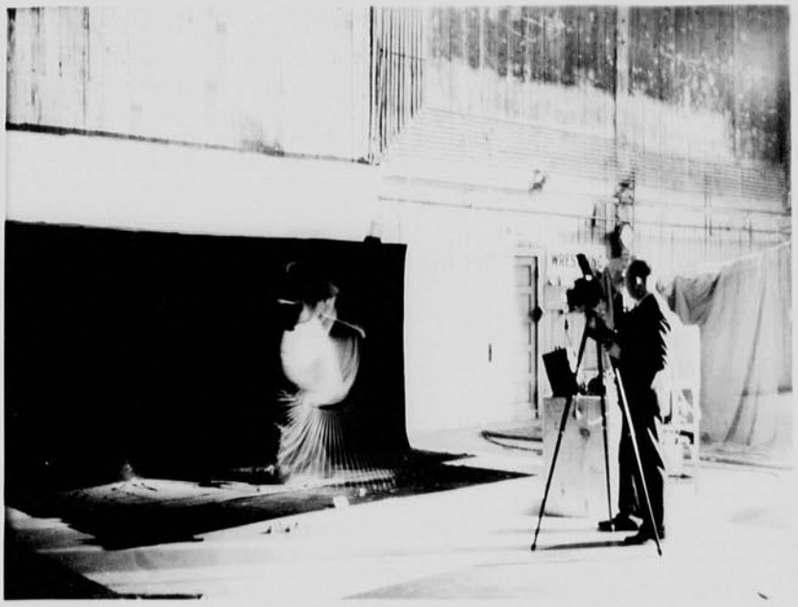
U. S. Submarine Force

PM Thurs

U. S. S. SEMMES
EXPERIMENTAL DIVISION ONE

Eastman Film

	Course	Speed	Time	Shot	Exposure	f	Ftgs
1-2	Pictures	Port hole		Portble	.01	2	4ft
3-8		10	13:37	Prop		2	
9-11		11	13:37	Prop.		8	Sun on port low
		14	13:50				
No pictures at 14k							
12-14 incl		17k	14:00	Prop.		2	3
15-17						4	3
18-20			1404			8	3



In Reply Refer
File No.

U. S. Submarine Force

U. S. S. SEMMES
EXPERIMENTAL DIVISION ONE

Time 15:25 Attack start running bubbles.

No.		F	Exp	
21	Starting Shaft	2	.0 sec	4 feet
22	Propellers Starting			
23	1 min after			
24	Strid			
25	Stbd Wheel only (full)			
26	after 15 secs.			
27	Sthd Wh. only. 1 sec	4		
28	after 15	✓		
29	after 19	✓		
30	after add 25			

Films printed Eastman

#1 View of portholes & lamps.

8 11 knots speed. f2 

Prop blade.

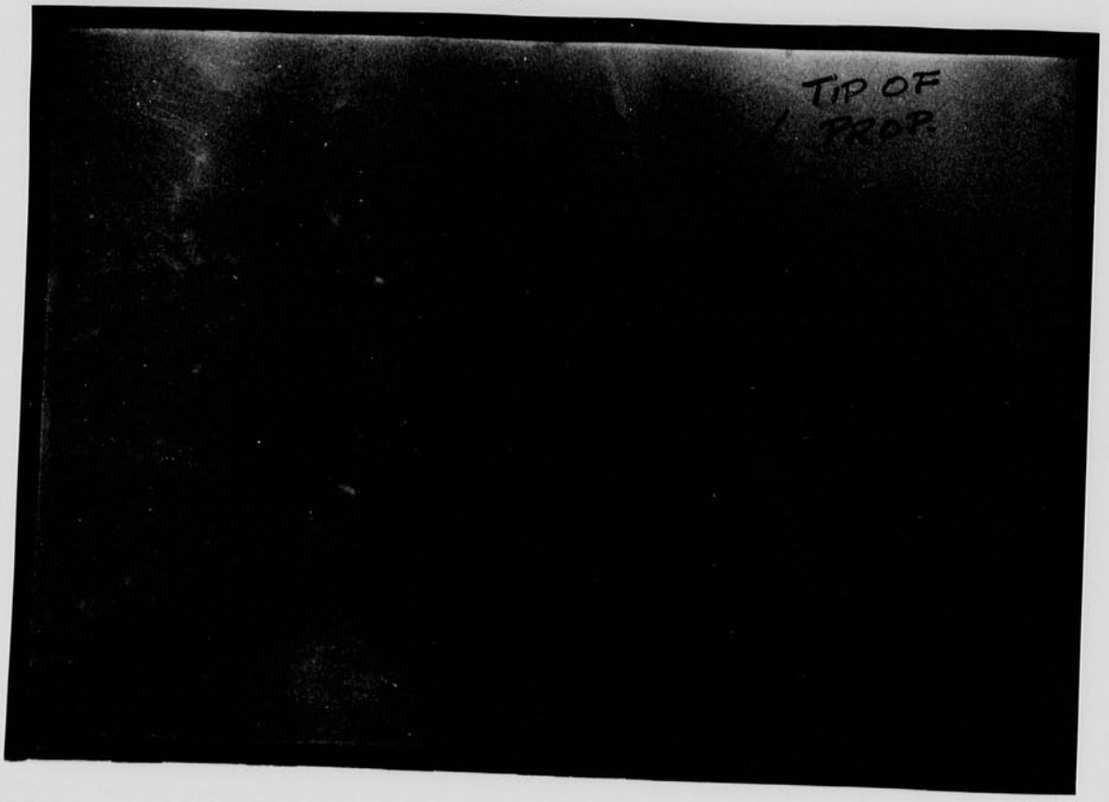
26
~~27~~ Start. f4  after 15 sec.

27
~~28~~ " 4  after 7 sec.

30 " 4 

after 25 sec.

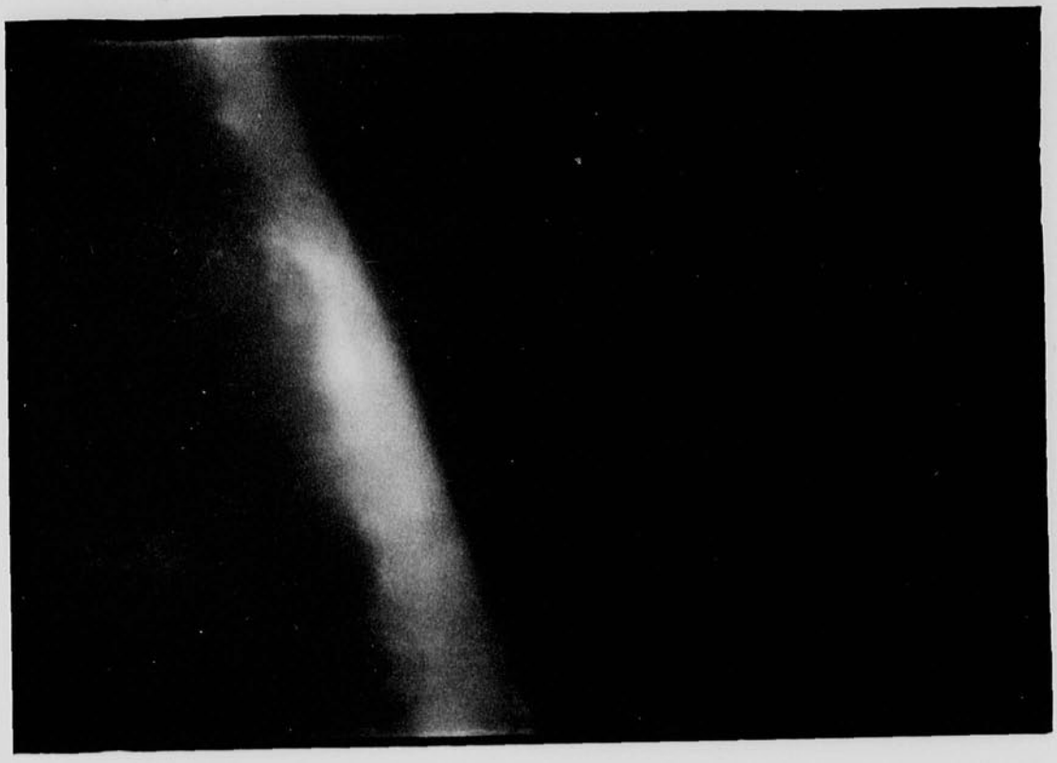
No 8 TOP. 11 KNOTS.



FORWARD.

No 26.

CAVITATION ON TIP.



~~Dec.~~ 26, 1938.

Took photos at 600/sec on Dec. 23. of golf strokes by Joe Stein. # 105 - to 153 inc.
S. Norton and ~~Herb~~ Brier assisted.

Jan 4 1938.

My parents Mr & Mrs. J. E. Edgerton of Aurora Nebraska were here for the ~~past~~ week after a visit at ~~Kent~~ Washington D.C. with my two sisters there.

A life test has been run on a Spiral Ar-Xe lamps. Mode data in Kennebrunens note book.

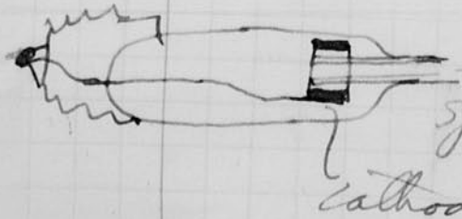
Conditions

30 flashes/second.
1000 volts +?
+ mf capacity. 5000 ohms.

18+ hrs until lamp started to hold over nite glow more starting load added and ran 24 hrs more flickered some at end - not misses but different brightness on each flash.

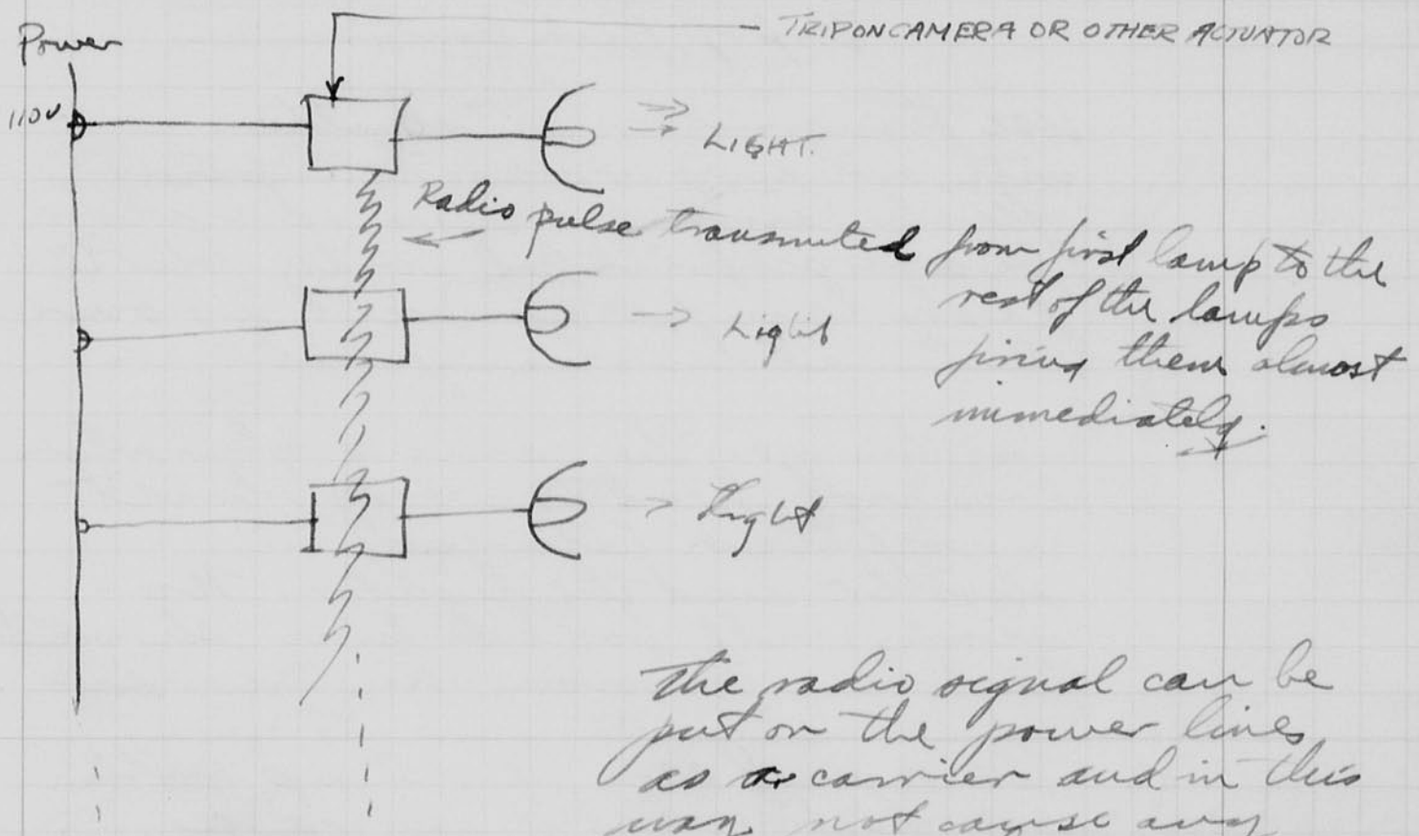
The light was about 50% decreased at the end of the life ~~test~~ due to a brown deposit on the inside of the glass Spiral.

The chamber surrounding the cathode was very blacky dee to sputtering of the cathode.

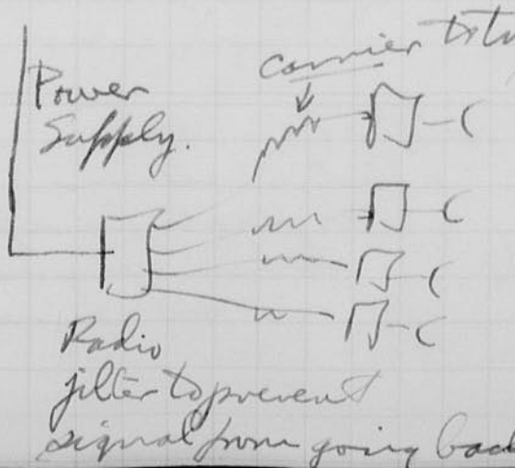


Jan. 7 1939.
Harold E. Edgerton.

On several occasions I have considered the firing of several flash units by some radio signal in order to synchronize them. Each lamp is connected to its own power supply and trip circuit and to a separate line from the power source. The radio ~~link~~ link may go either via air or on the power lines as a carrier signal.



the radio signal can be put on the power lines as carrier and in this way not cause any static to other radio apparatus.



Explained + understood
1-9-39
2/24/39

Jan 8 1939
Harold E. Edgerton.

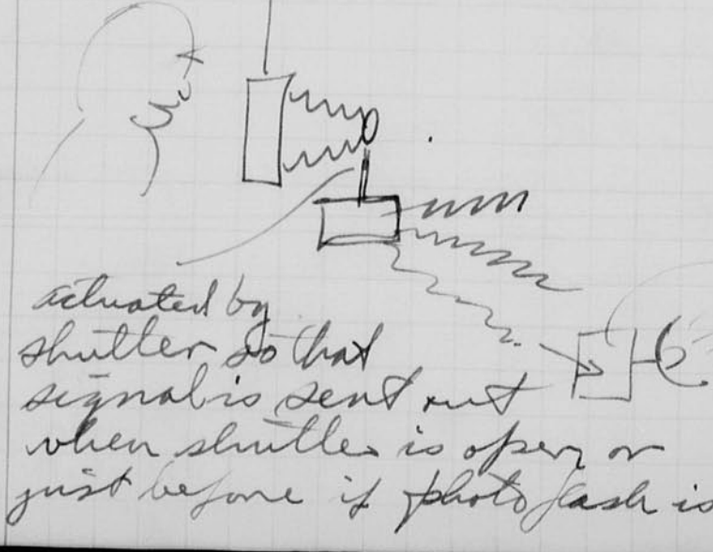
Dinner last night at the Boston Camera Club celebrating the 100 years of photography.
There. A.C. Hardy. Phys Dept
Lightcap Health Dept.
Prof. Palash Harvard. crystals.?
Mr. Trapnell Publishing Co.
Esther Ahern Weston College.

Trip of flash units.

Use transmitter at shutter with out any wires to trip the flash lamps. This can also be accomplished with flash lamps as well as our electrical discharge tubes.

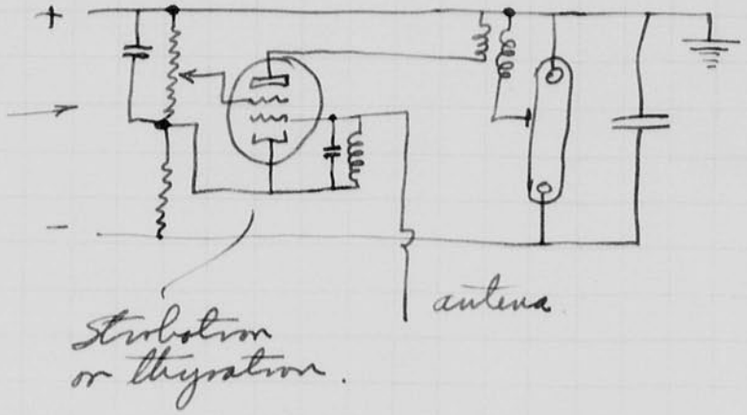
In this way the camera operator does not need to worry about connection between his shutter and the lights. No wires will bother him should he desire to move his camera.

The signal can be set up with energy from a battery or a magneto etc.

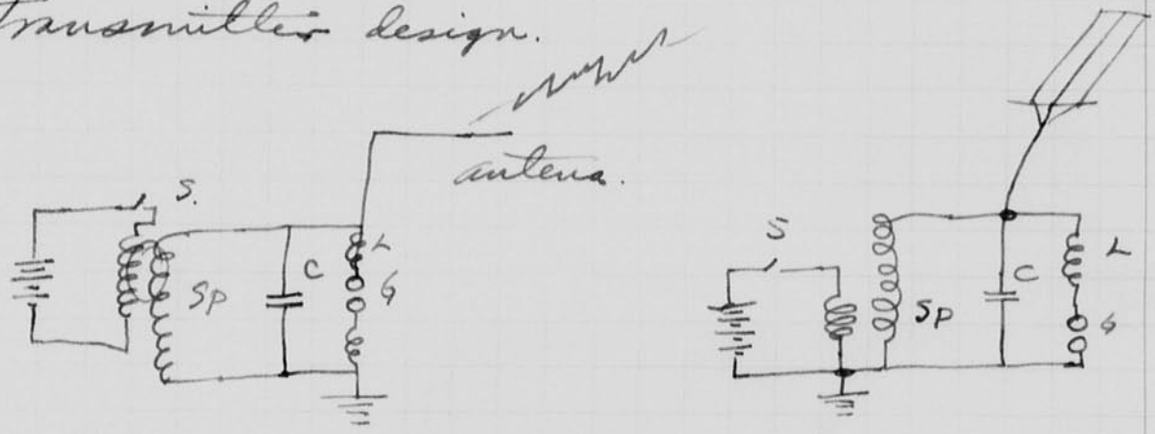


Cont.

possible circuits to receive signals to flash lamp.



transmitter design.



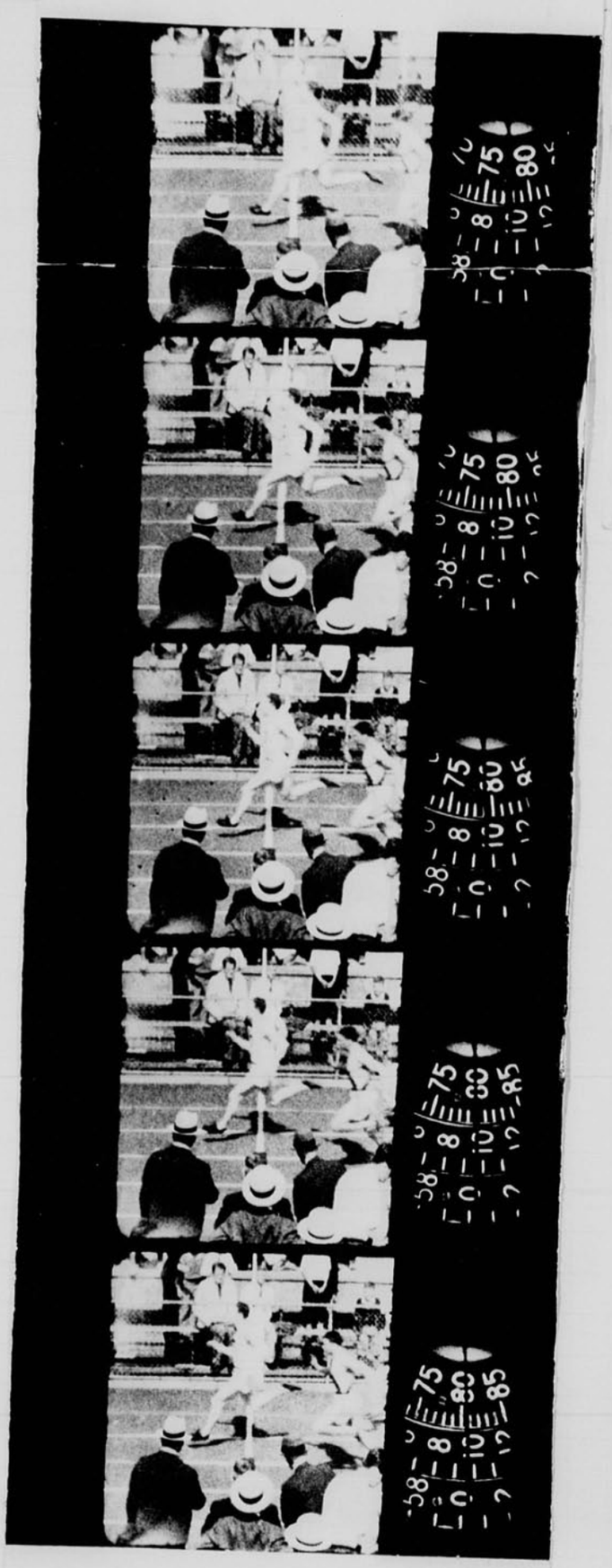
The switch S would close as the shutter started to move to establish current in the primary of the spark coil Sp. The switch S would open when the shutter blades were open, interrupting the current and producing a high voltage on the secondary of Sp. this would charge the condenser until the gap G broke down causing a radio frequency surge in C and L.

Pages 88 & 89 Explained & Understood W. E. Grie
1-9-39

Bobby. Inez. M.I.T. Taken summer 1938. 100 Bobbies/second.

The laboratory was cleaned up on Saturday Jan. 14. I salvaged the prints on the following pages from the outcasts and pasted them in here for record purposes.

Race track timing record made by E.K.P.I. camera.



Sam Caldwell with Strobotac.

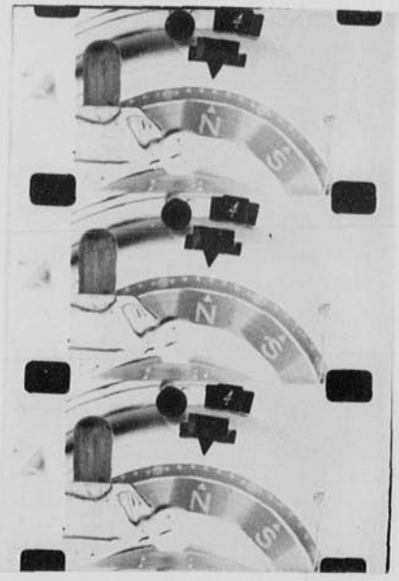
Bramhall

Photo by Skadding with a Argus

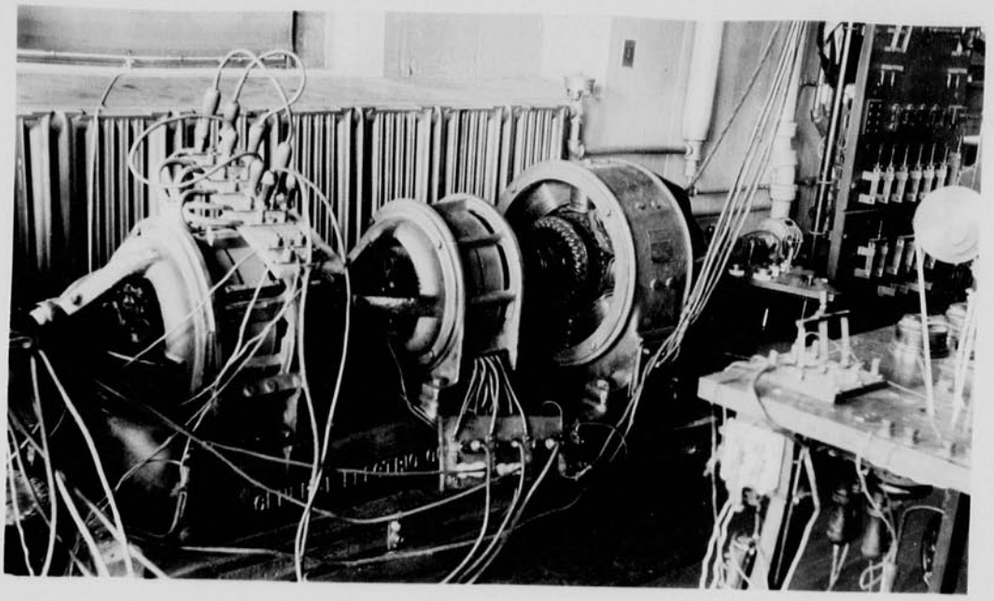
Research Lab in 1927 or 28

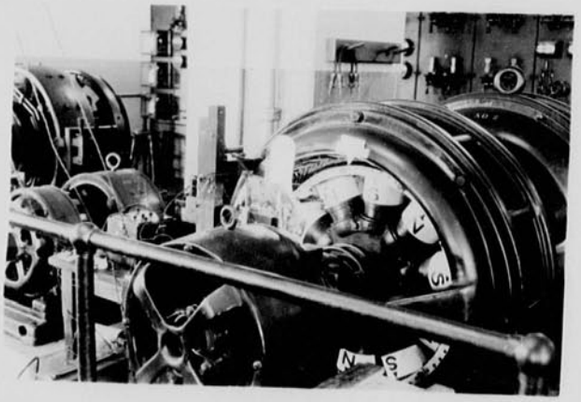
Kelly · Dr. Von Bardeen · Kershaw · Young · Moon · Buck · Broderick · Griffith · Kear

60 cycle stroboscope and camera.

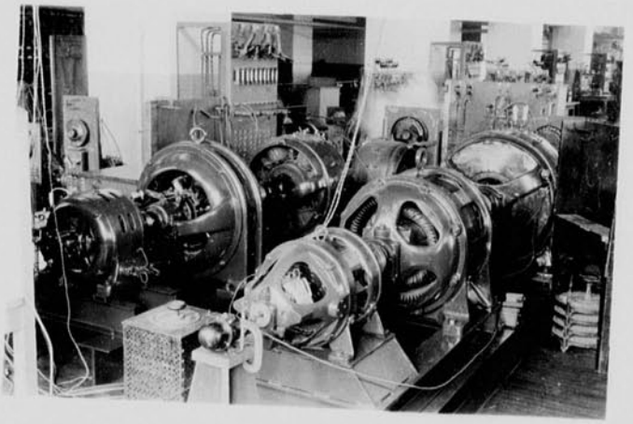


First photos of synchronous motor.

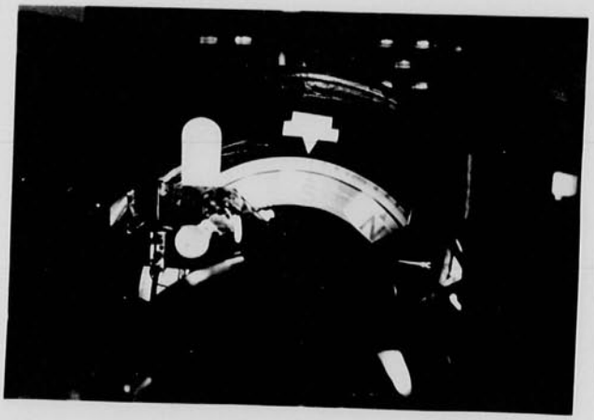




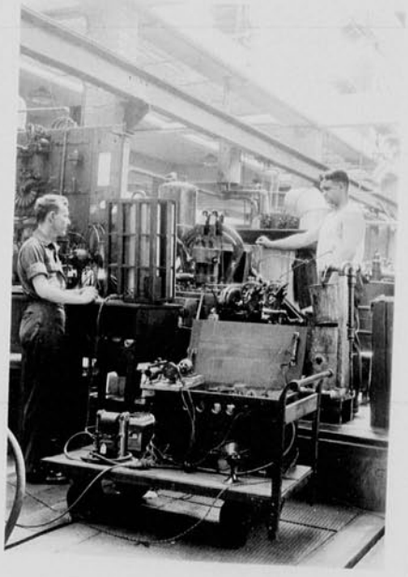
thyratron and motor.



AC & DC Machines at M.I.T.

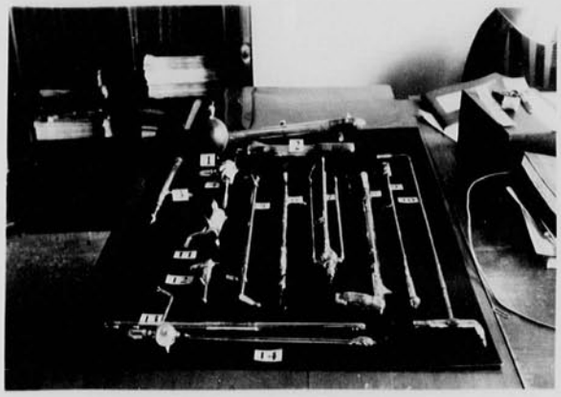


Stroboscope and
synchronous motor.
first setup.

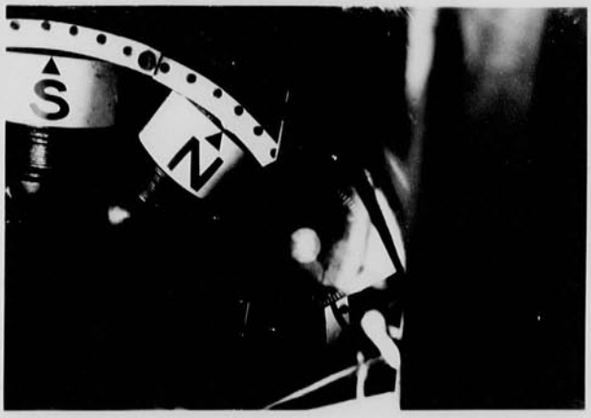


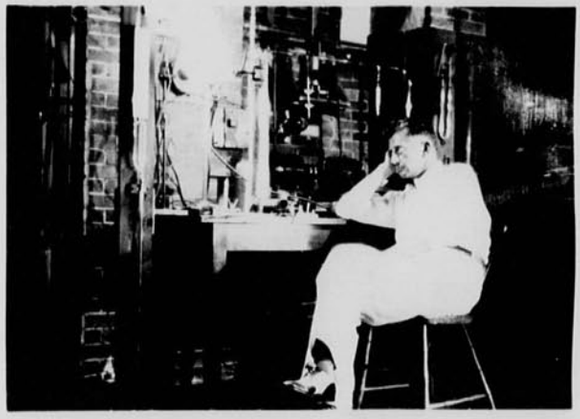
Draper.
Stroboscope

Early experimental tubes

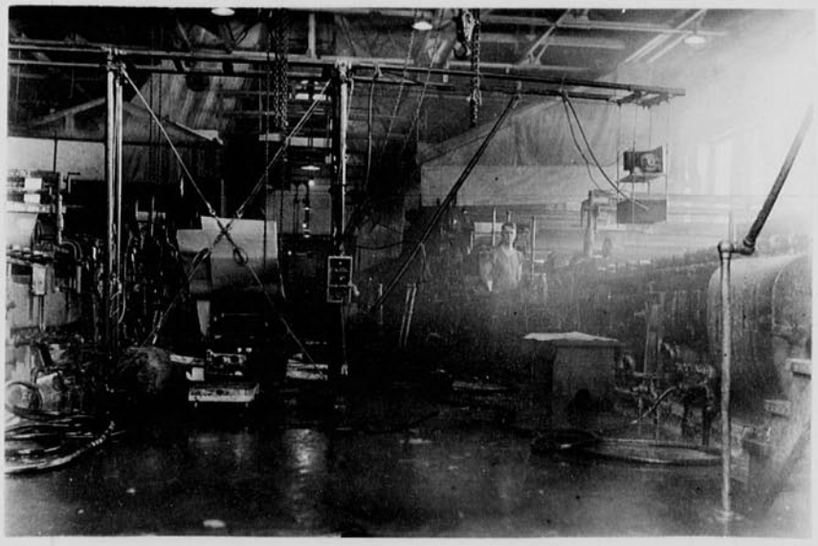


W. V. Lyon

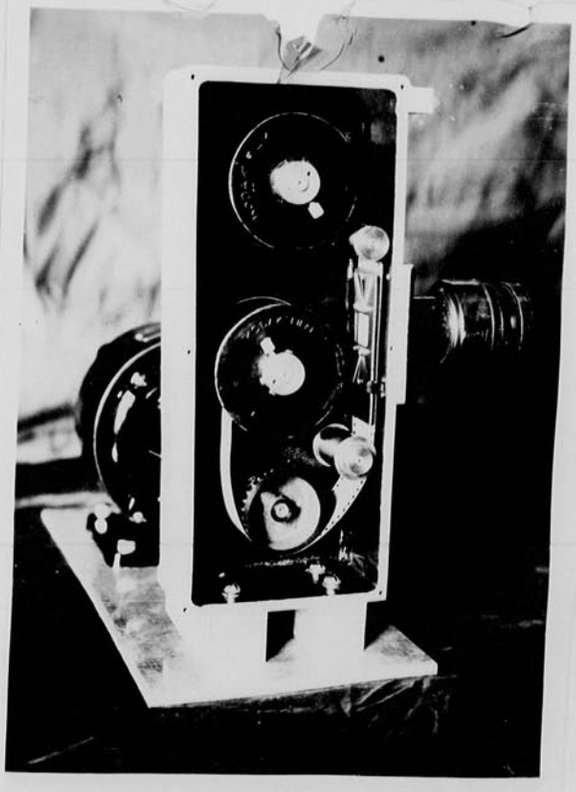




Lorenz - Harvard -

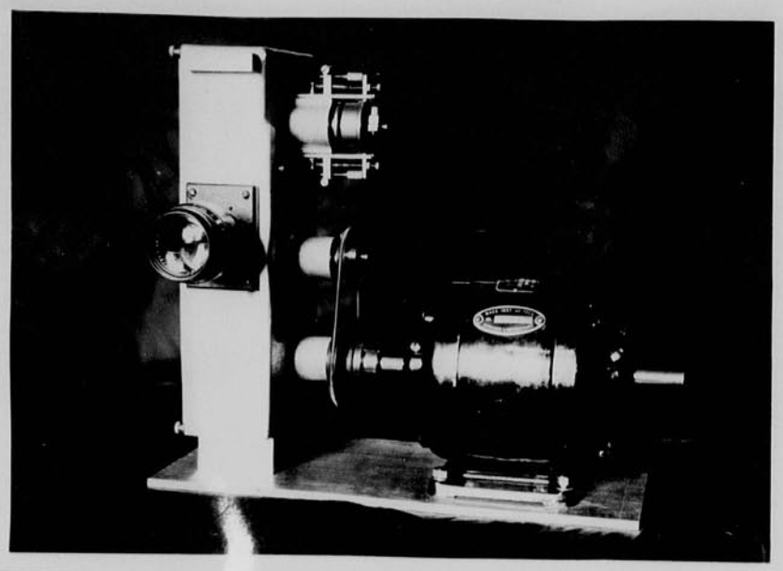


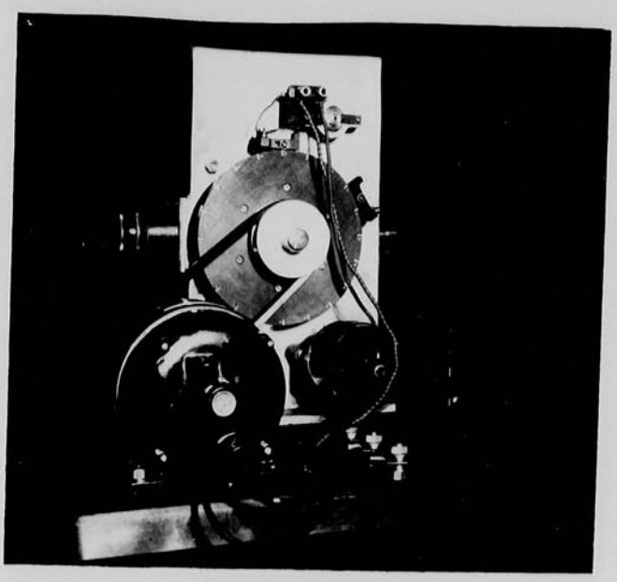
Camera in a paper mill



Early high-speed movie camera.
600 frames/sec.

B.S. Camera.

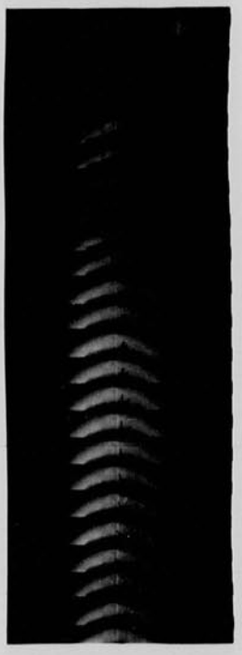


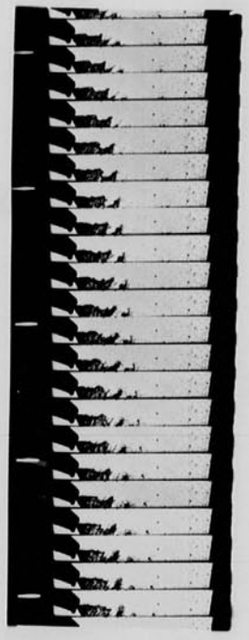


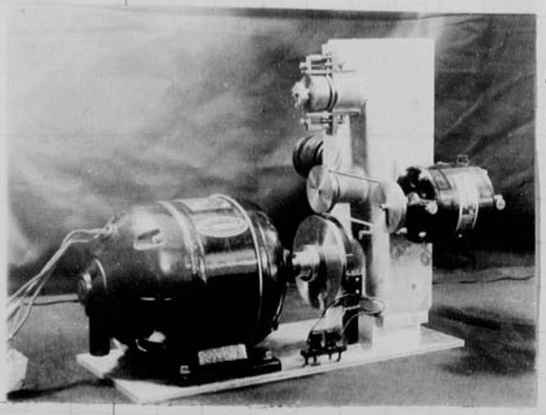
Another view of early camera

House fly. 6000 frames sec.

Soap 6000 frames/sec.



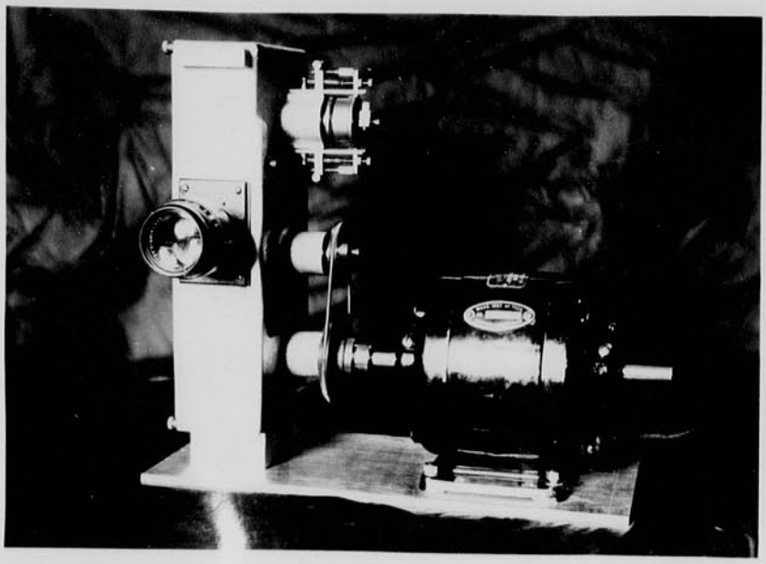


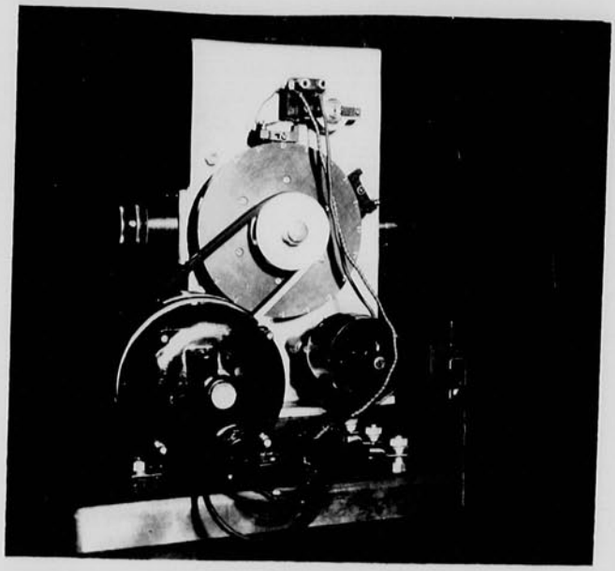


Camera with Commutator.

Elmer. Reed.

R.S. Camera.

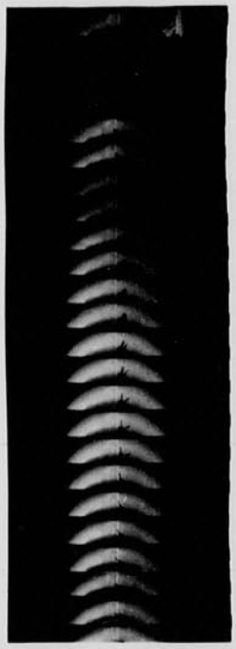


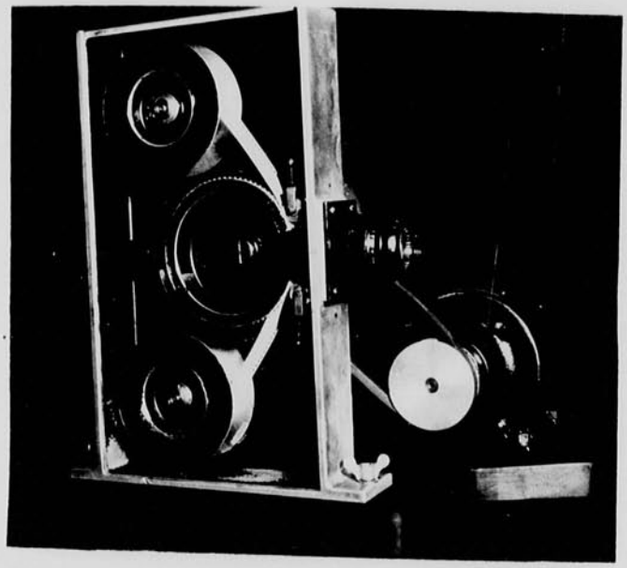


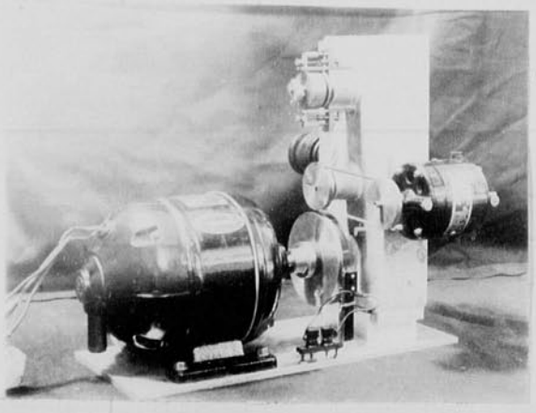
Another view of early camera

House fly. 6000 frames sec.

Soap 6000 frames/sec.

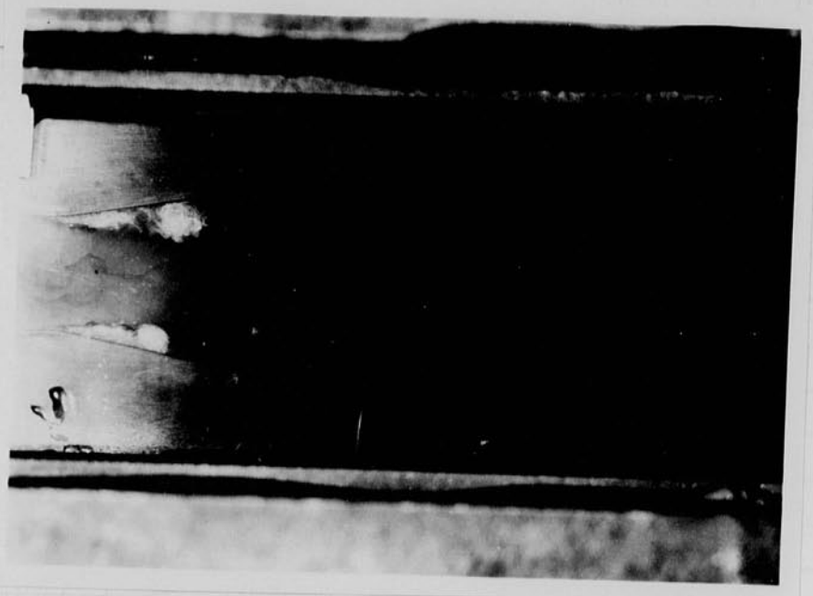






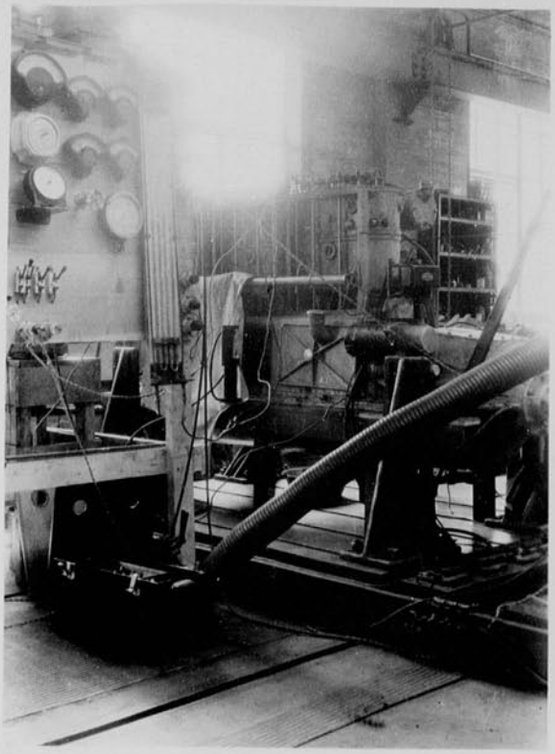
Camera with Commutator

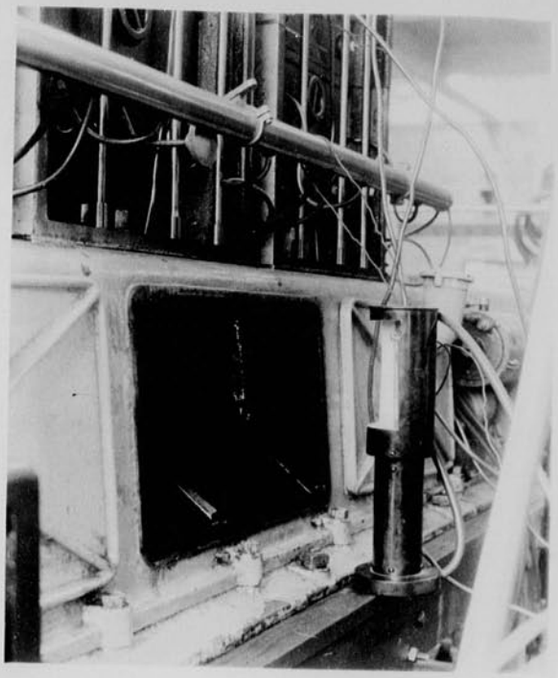
Elmer. Reed.

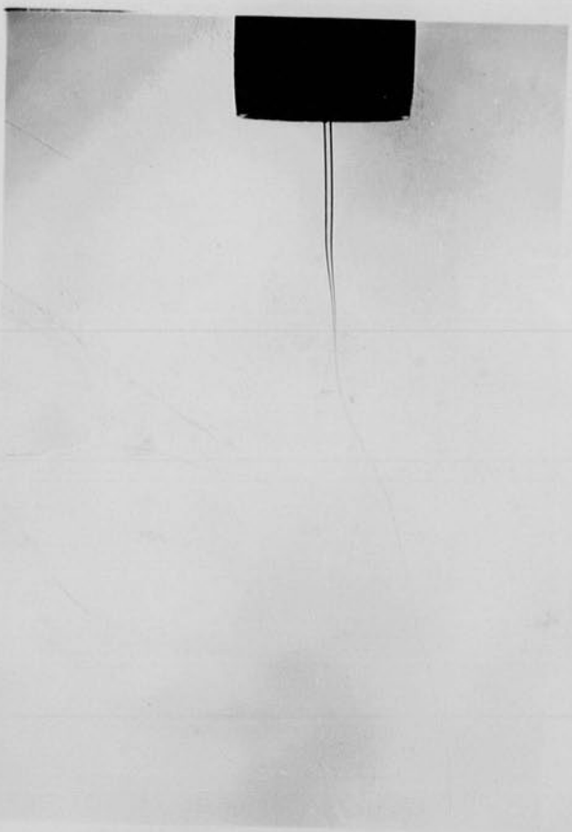


Cavitation

→







Stroboscope in use.

Glass blown into a fiber

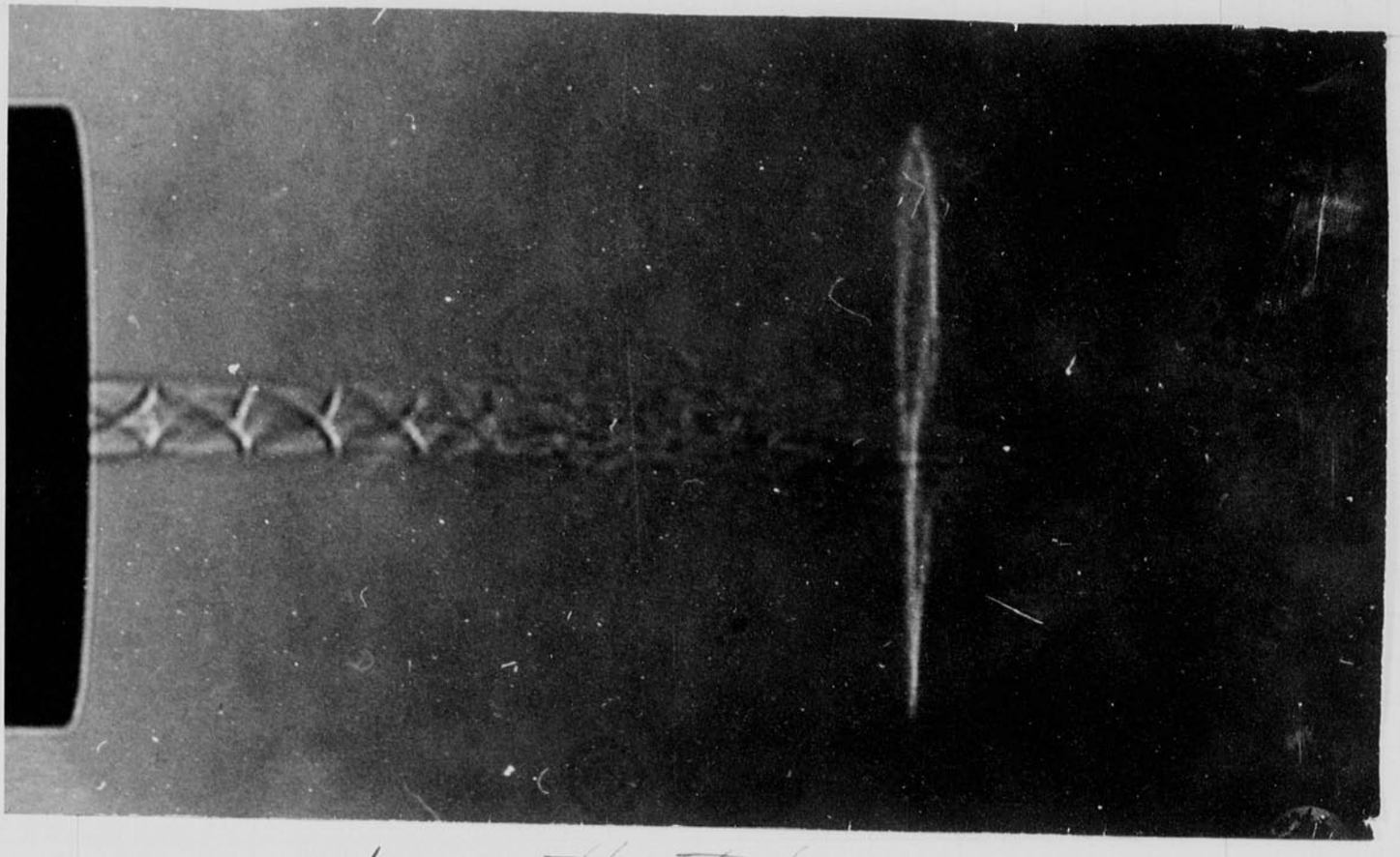
Squam Lake.

Holderness N. H.

Home of L. H. Webster

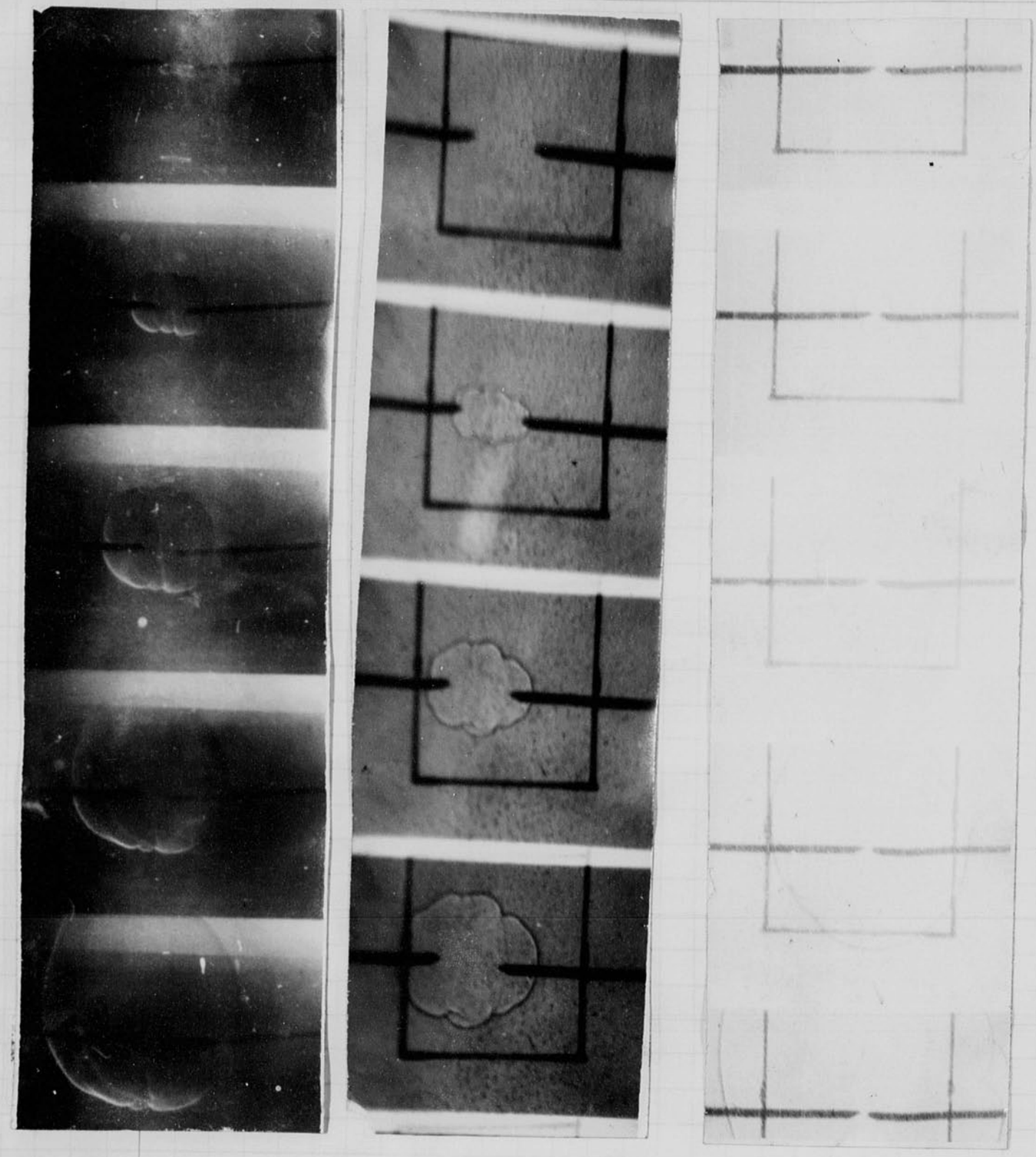
Humming Birds

Open house 1938.

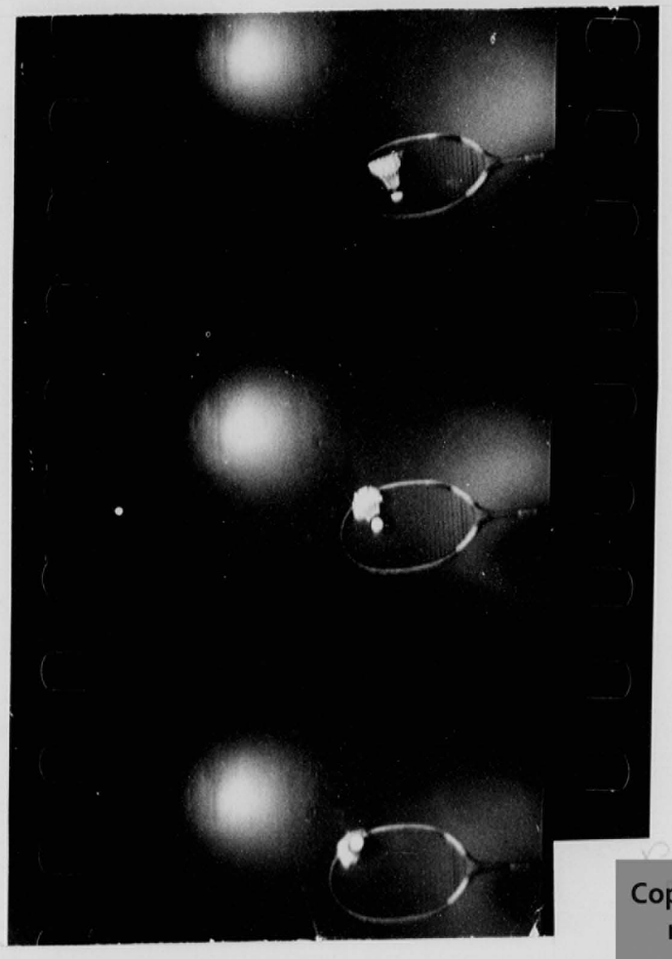


TIP #55 45# C_2

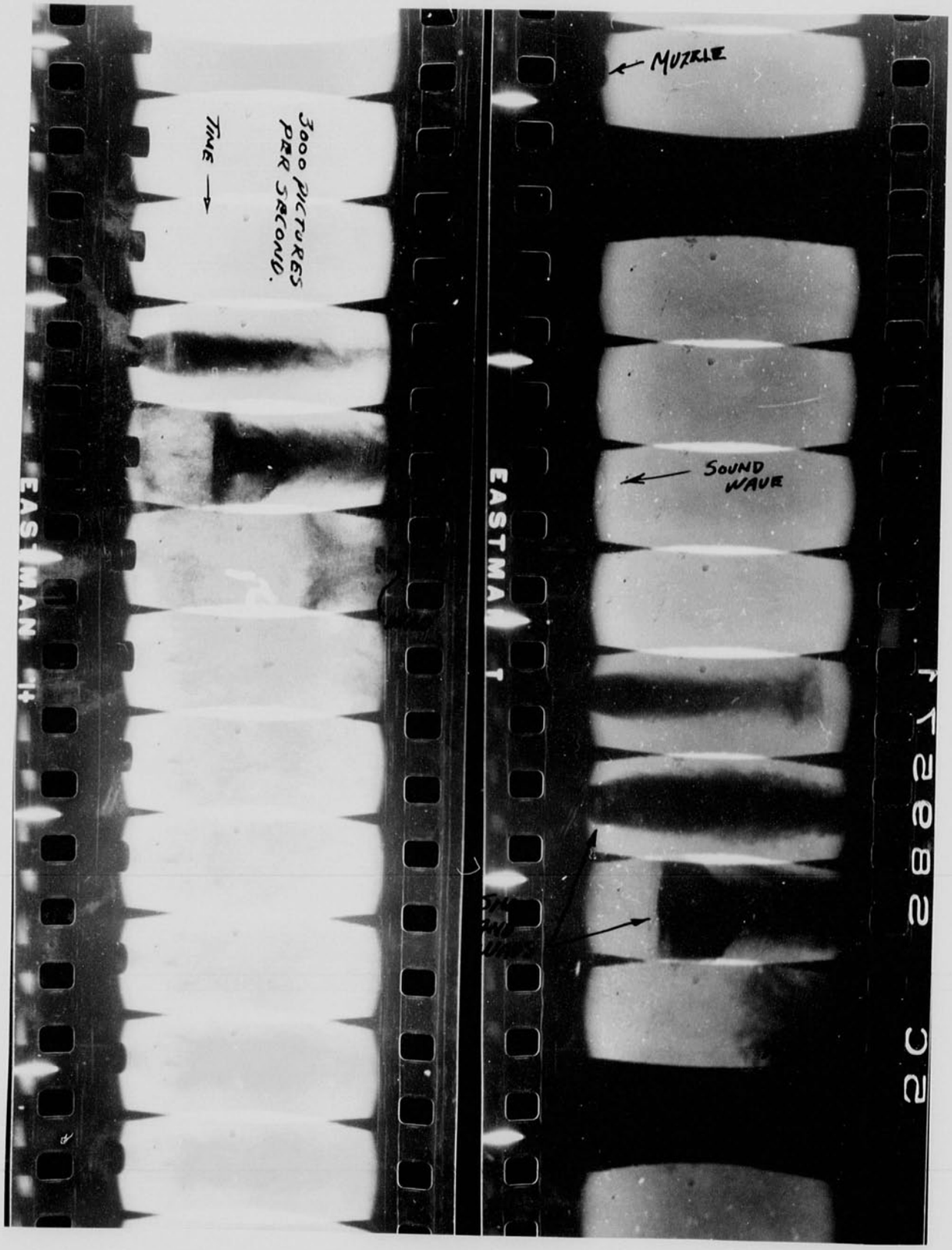
Oxygen from a cutting torch.



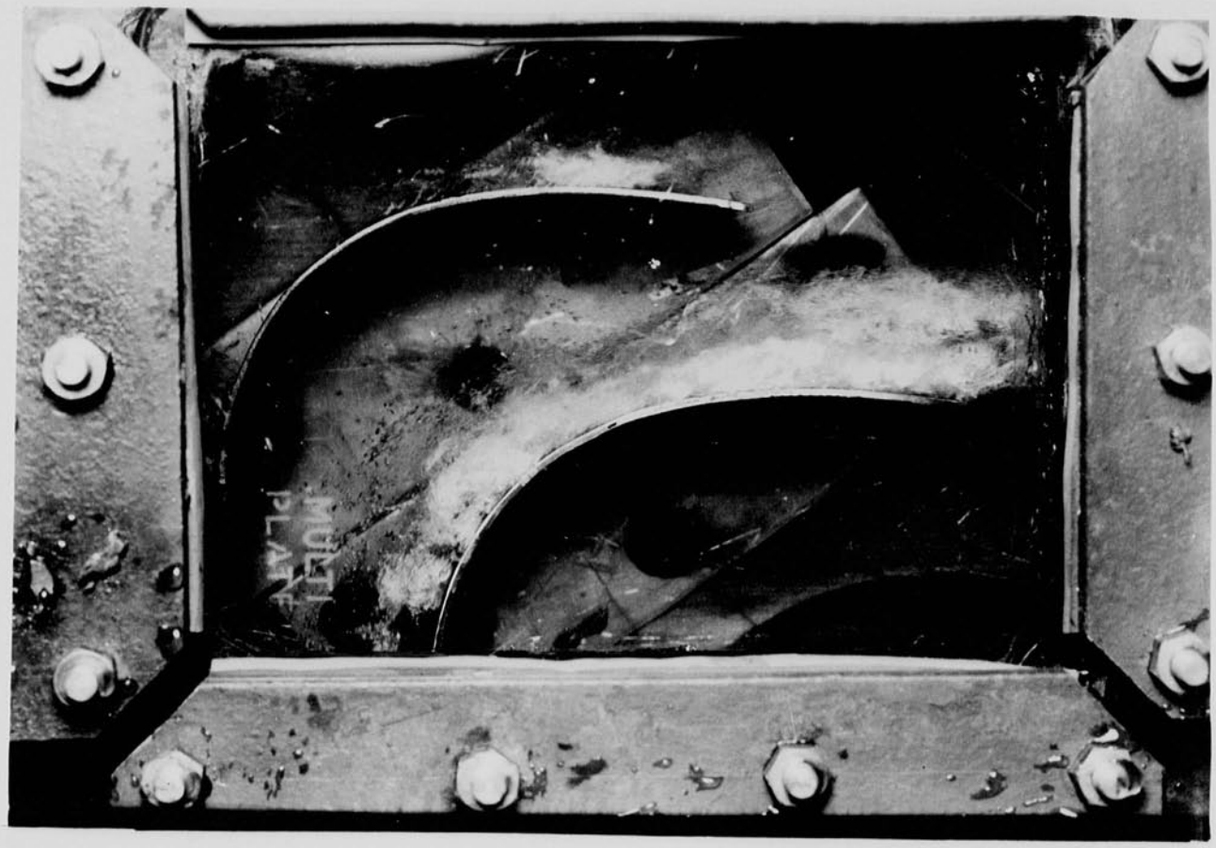
Burning of gas in a cylinder.



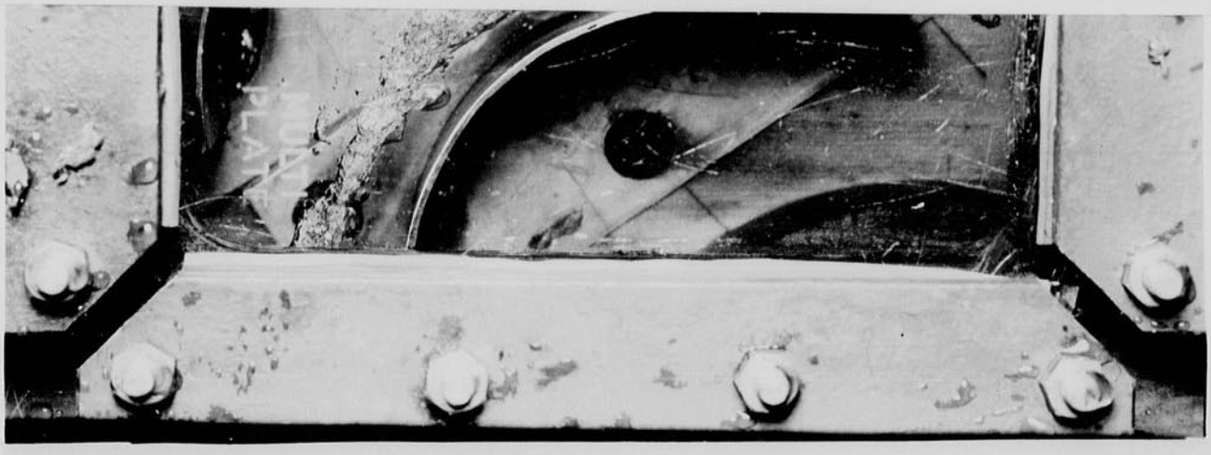
Bruning ton



Shot gun movies 3000/sec.



PLATE

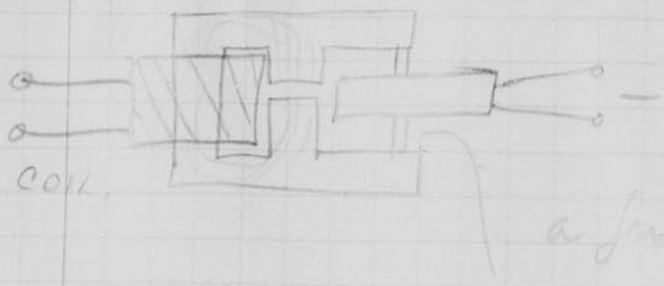


PLATE

Jan 16 1939
H. E. Edgerton

Peaking transformer.

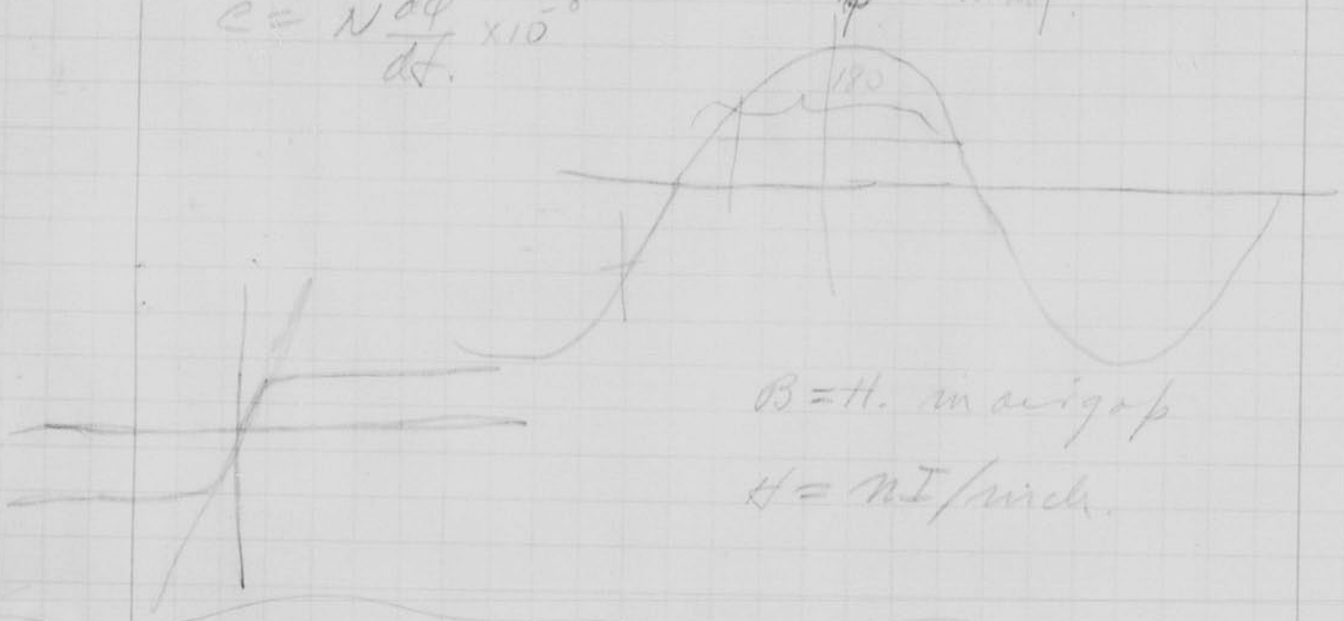
On last Friday I collected core material from B.R. for a peaker.



a few laminations.

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

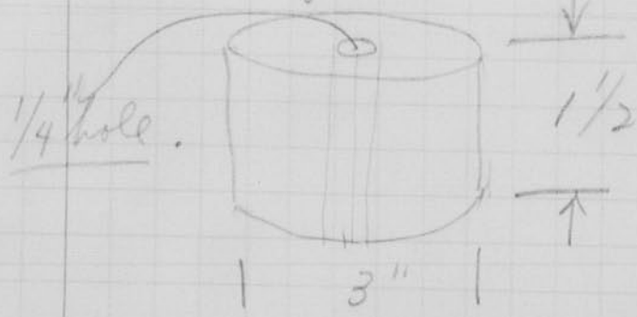
ϕ = mmf.



B = H. in air gap

H = nI/inch.

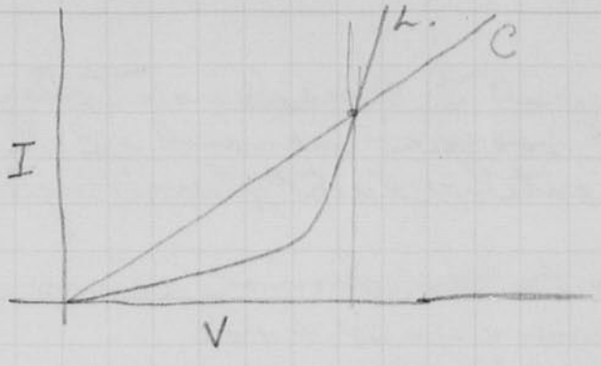
Coil Specs. 100,000 turns.

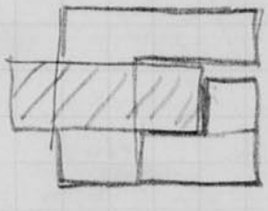


#40 wire
0.0103.14 inches diam

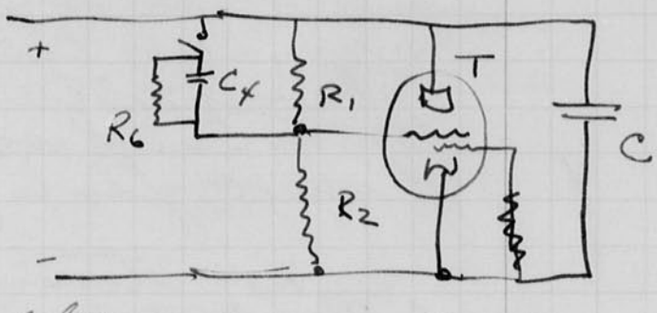
1/2 inch
1 1/2 - 1/4 = 1 1/4 inches $\frac{1.25}{-.0.314} = 400$ layers.

ordered by phone from Bob Quinn by Raytheon Jan. 17, 1939.





Circuit sent in letter to Paramount Studio



T - Strobotron.

C_4 = .005 mf.
R_6 = 500,000.
R_1 500,000
R_2 50,000
R

Jan 19 1939.
H. E. Edgerton.

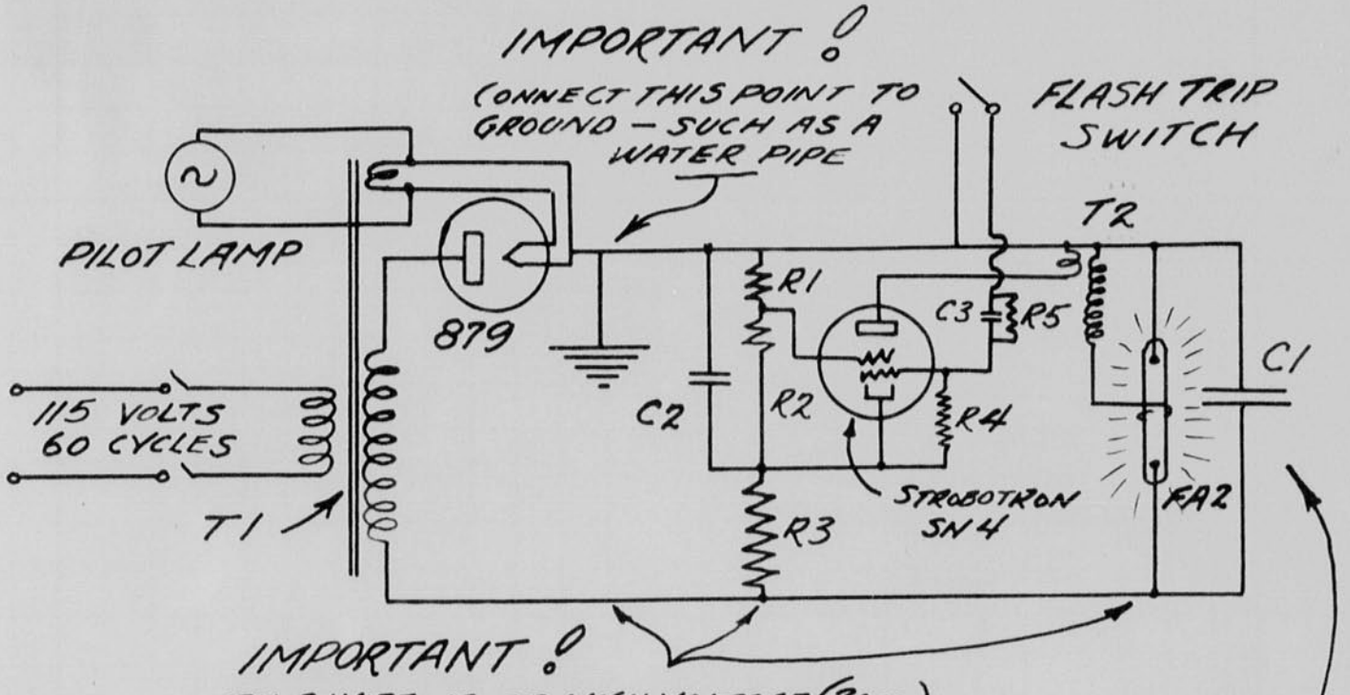
Germs. & Herb. went to New Haven today to take movies at 1000 per second of guns at the Winchester plant (Mr. Pugsley.)

Jan. 16 I talked to Mr. Driot's class at the Harvard Business school.

Bobby Jones, Mr. Reach, Mr. Rodford (Spalding Bros Co.) were here on Jan 12 from 9 to about 2 p.m. Photos were taken. I gave a talk at 11 at the Cambridge Morning Club Continental Hotel. Mr. Stuber of Eastman Co was here in the afternoon and we discussed ~~ass~~ exhibit of single-flash photography.

Mr. Stevens has been discussing speed photography with the Westinghouse Co. We may cooperate with them in the application of the method of flash photography.

STROBLITE FLASH UNIT.



IMPORTANT

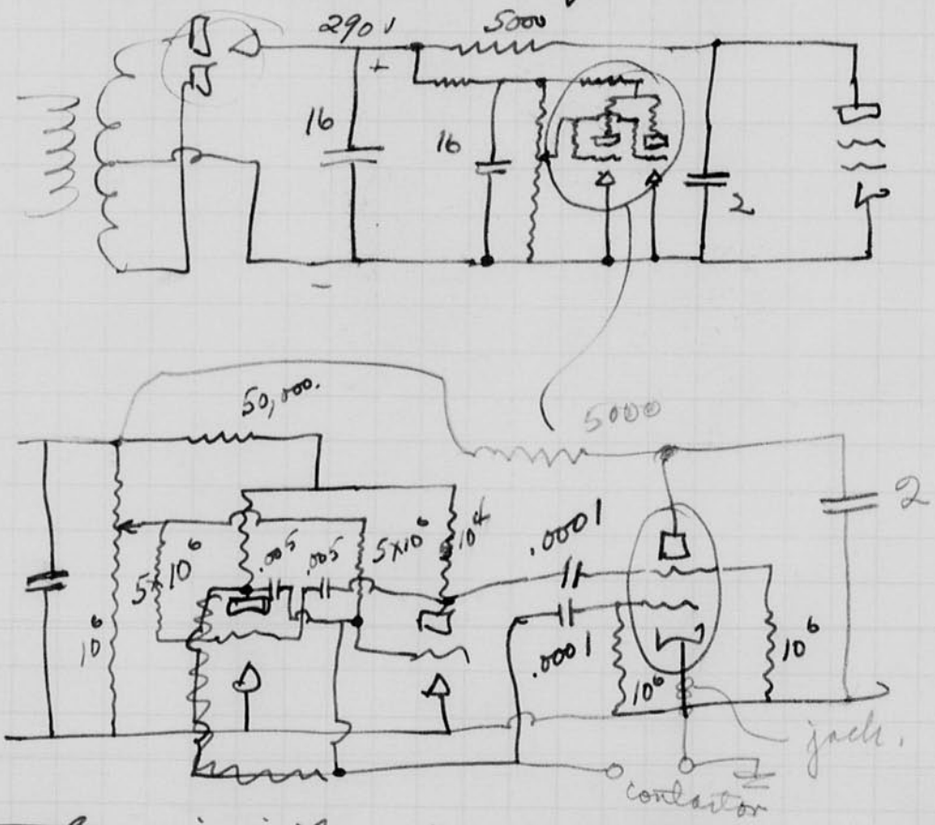
SHORT CIRCUIT CONDENSER C1 BEFORE TOUCHING LAMP OR CIRCUIT EVEN IF MAIN SWITCH IS OFF.

JAN 2, 1939.
H.E.E.

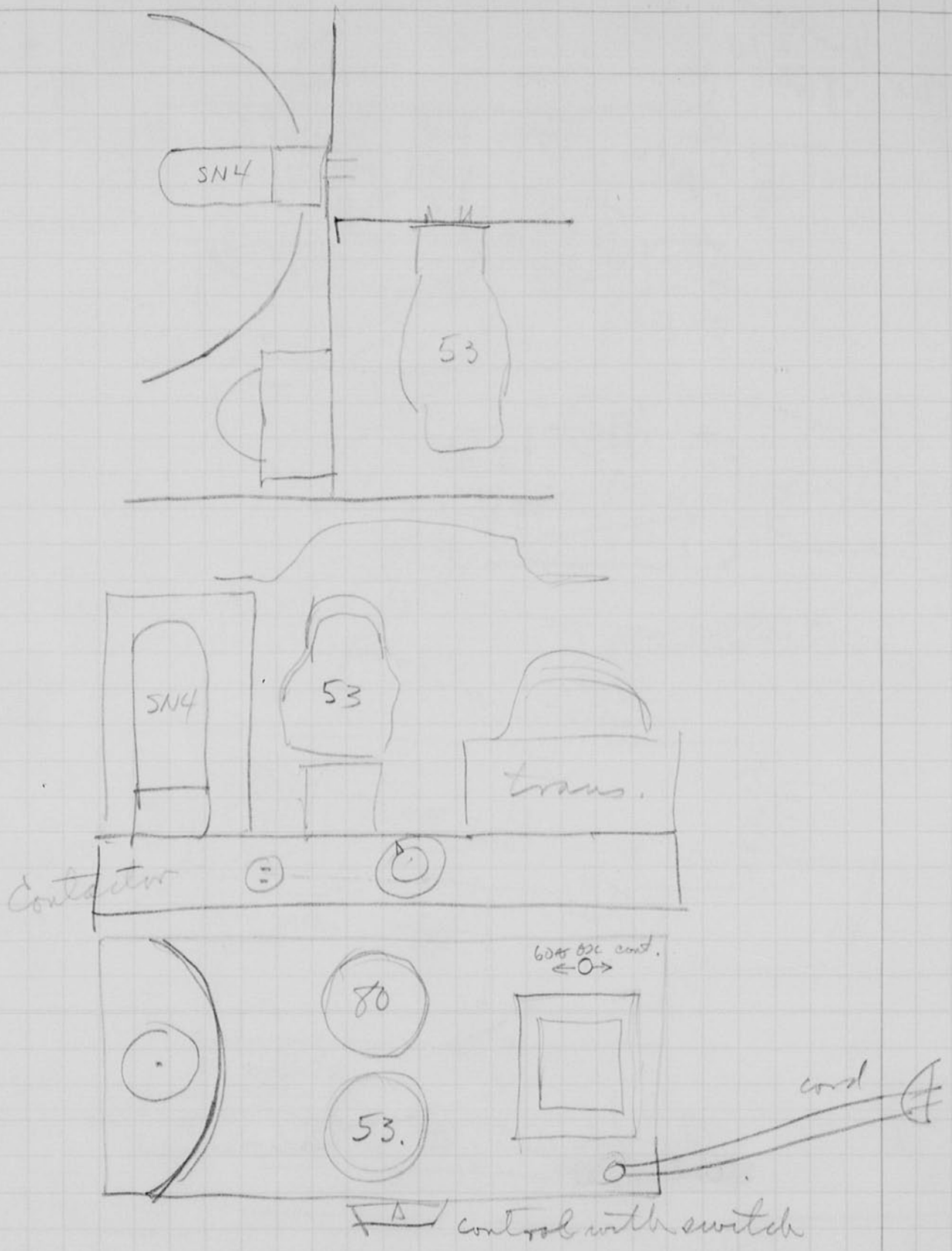
Jan 22, 1939
Harold E. Edgerton

Mr. Reed and Mr. Michels (?) of the Boston Herald came over Saturday Jan 21 morning and we took a few photos of different subjects with both photo flash lamps and with a argon flash lamp. The unit used the one that Grier is to send monday to the Washington navy yard. Circuit on previous page. 112 microfarads capacity - 2000 volts.

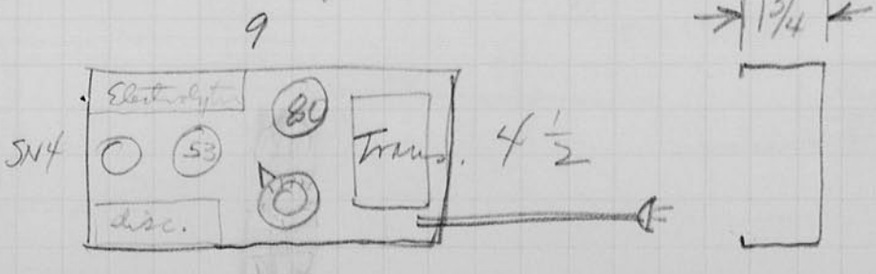
Stroboscope



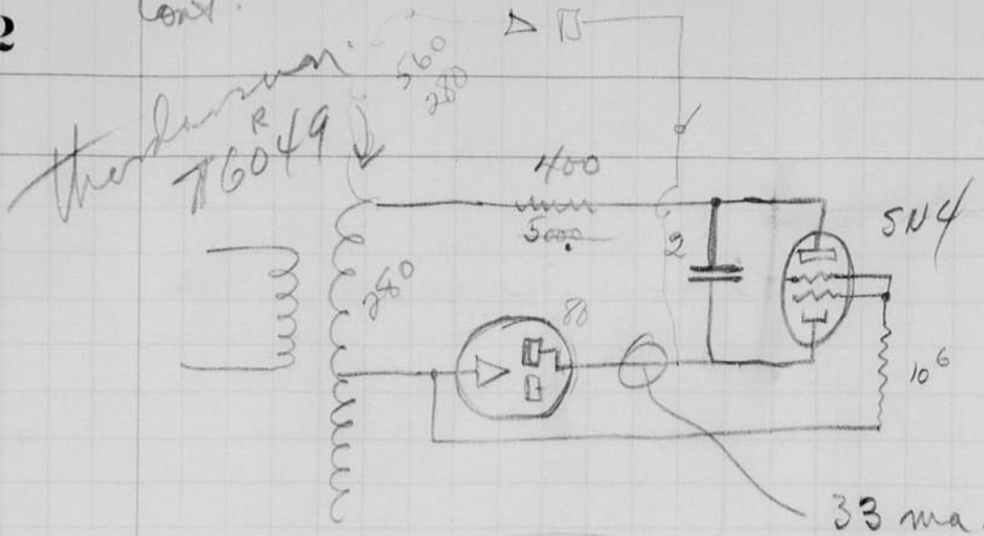
this circuit gives a + surge on one grid and a - surge on the other at the moment of relaxation.

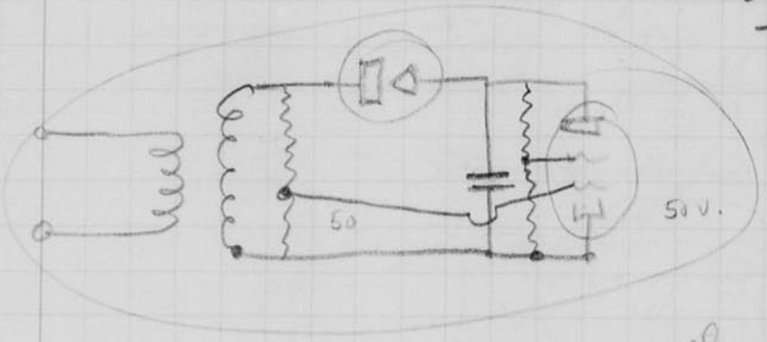


for contactor operation — Remove 53 tube!



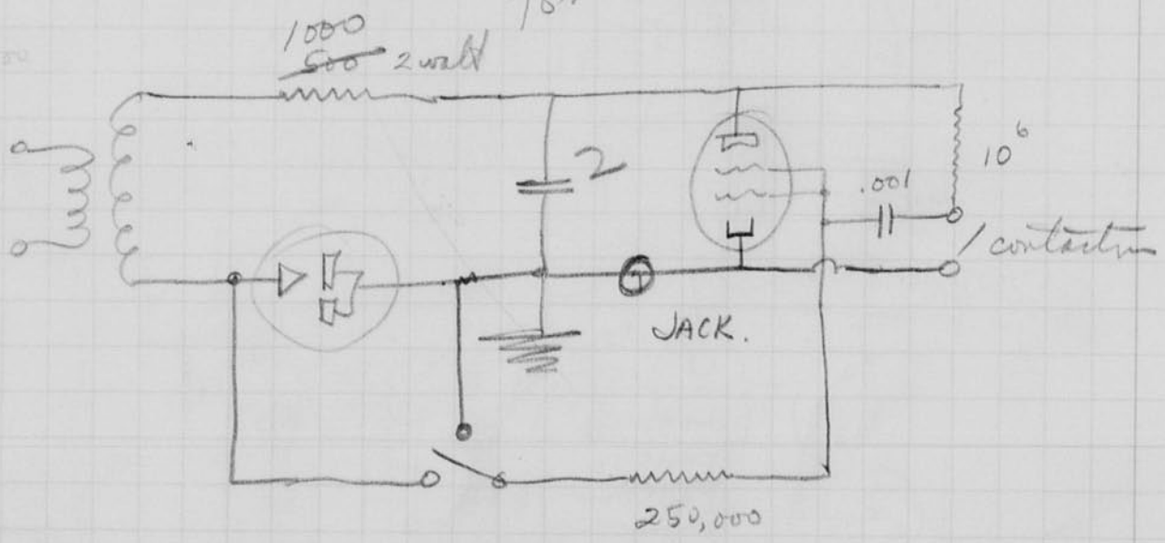
Cont.





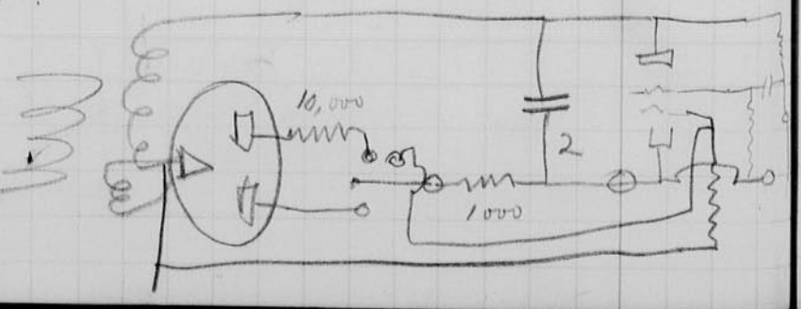
works fine

.03
.03
.001 x 500

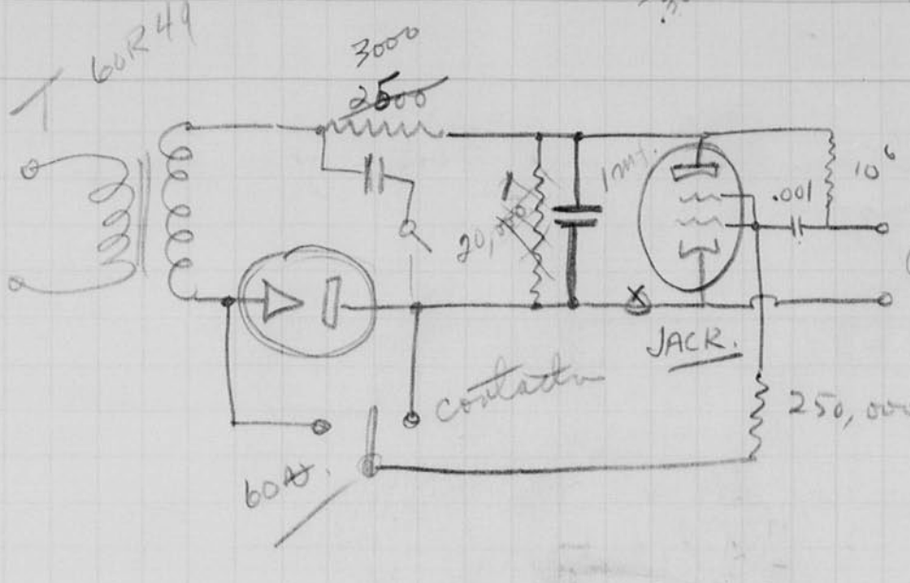


ok for single flash

$\frac{E^2}{R} = \frac{490}{1000} = .5$ watts.

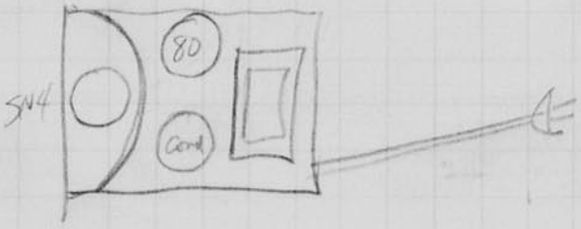


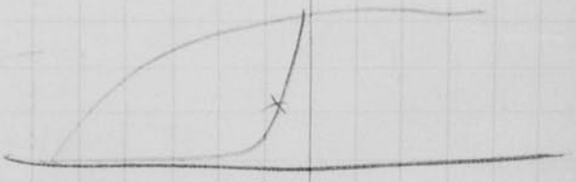
100² / 3000 - 3 watts.

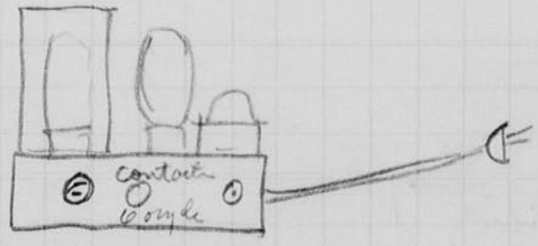


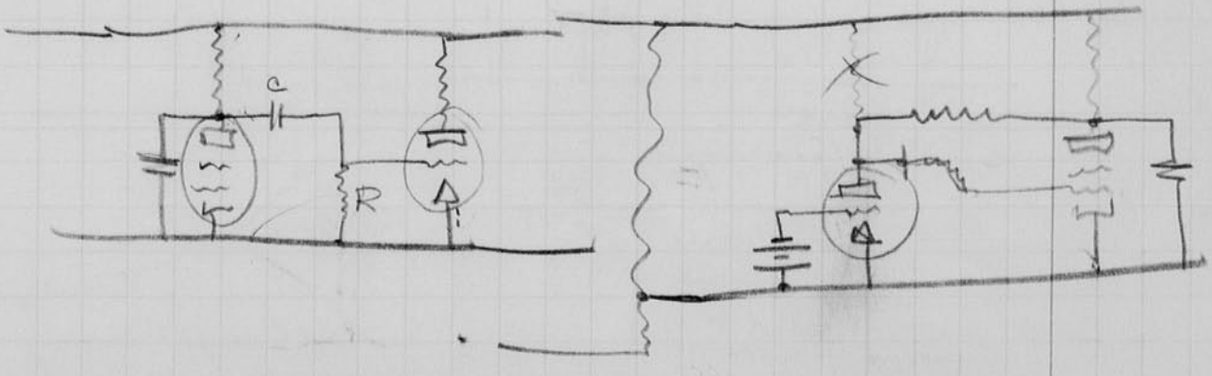
60 cycle cond as above max volts at discharge = 2.5 x 100
250 volts.

Leak on 1 mf condenser removed.
works ok and better.
Action slightly jumpy due to poor contactor.





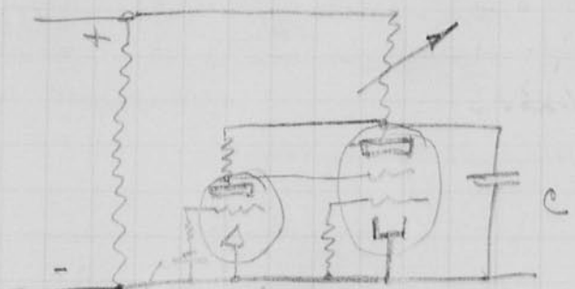




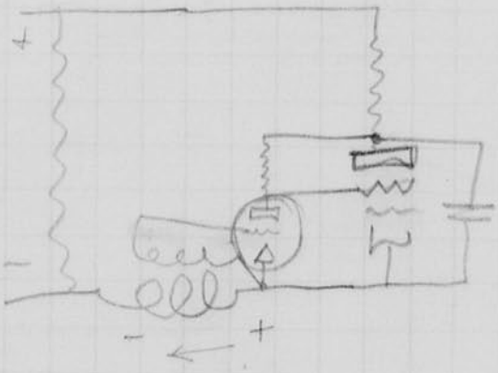
39

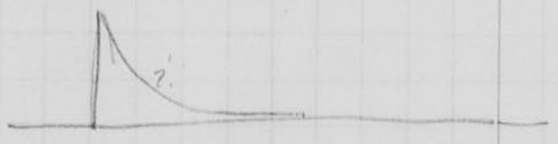
Jan 23, 1932.
H. E. Edgerton

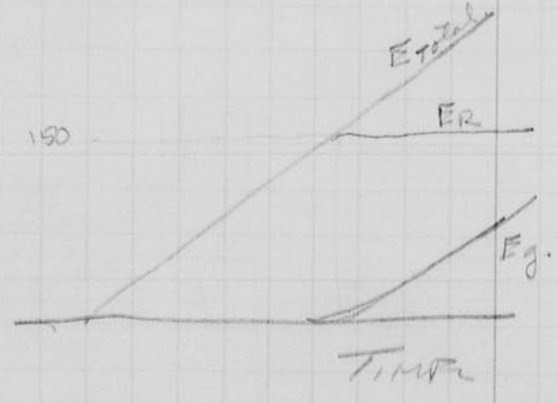
Discussion with Brier regarding stroboscope circuits.

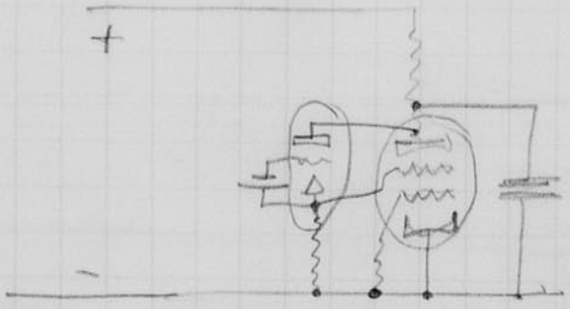


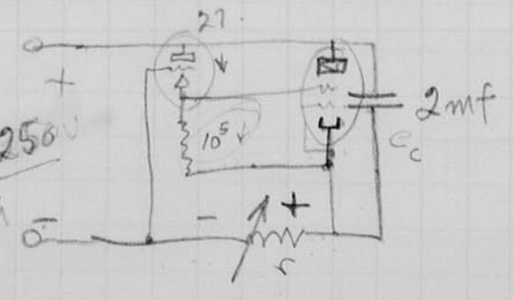
-18 cutoff at 150 volts on plate.



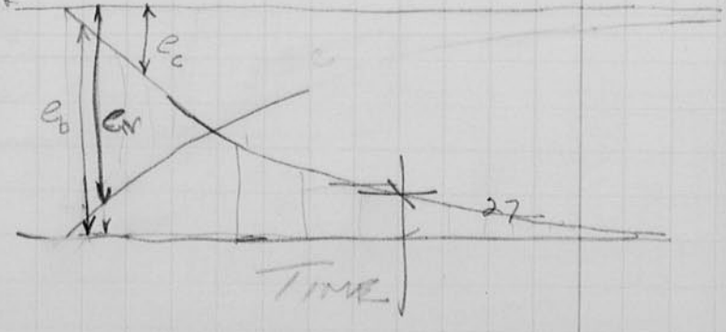


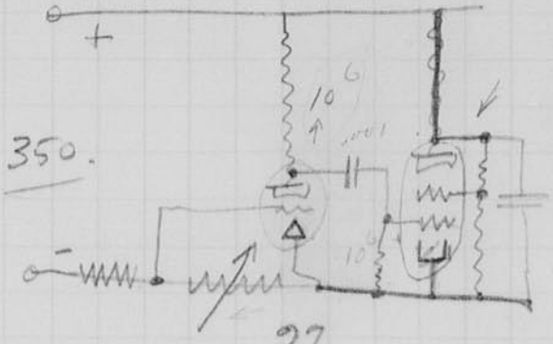


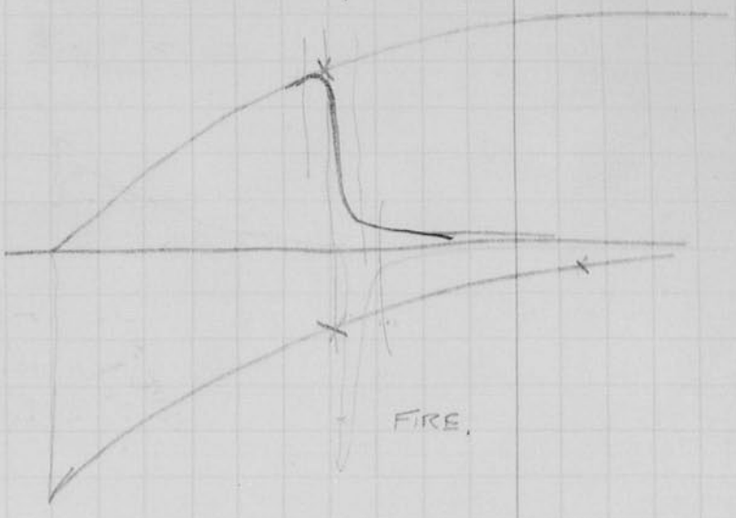


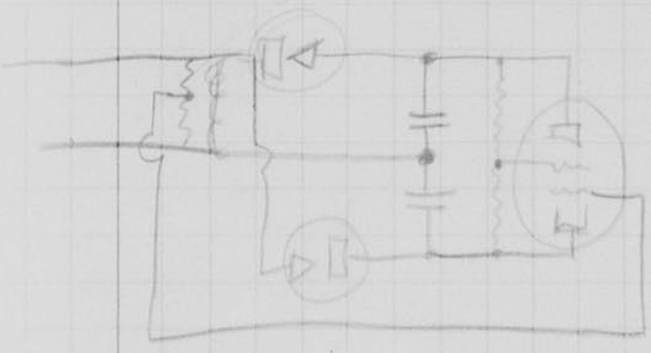


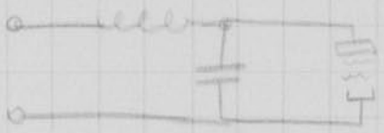
Make high

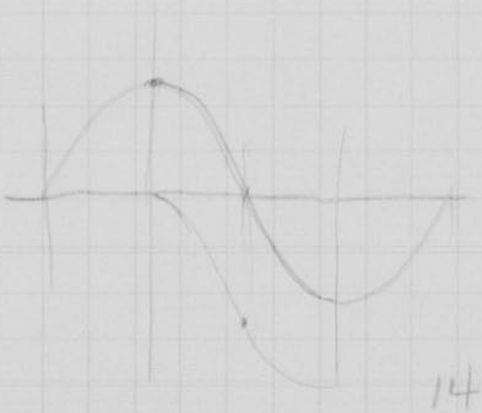












×1.h =

$T = 1/60 = 2\pi\sqrt{LC}$

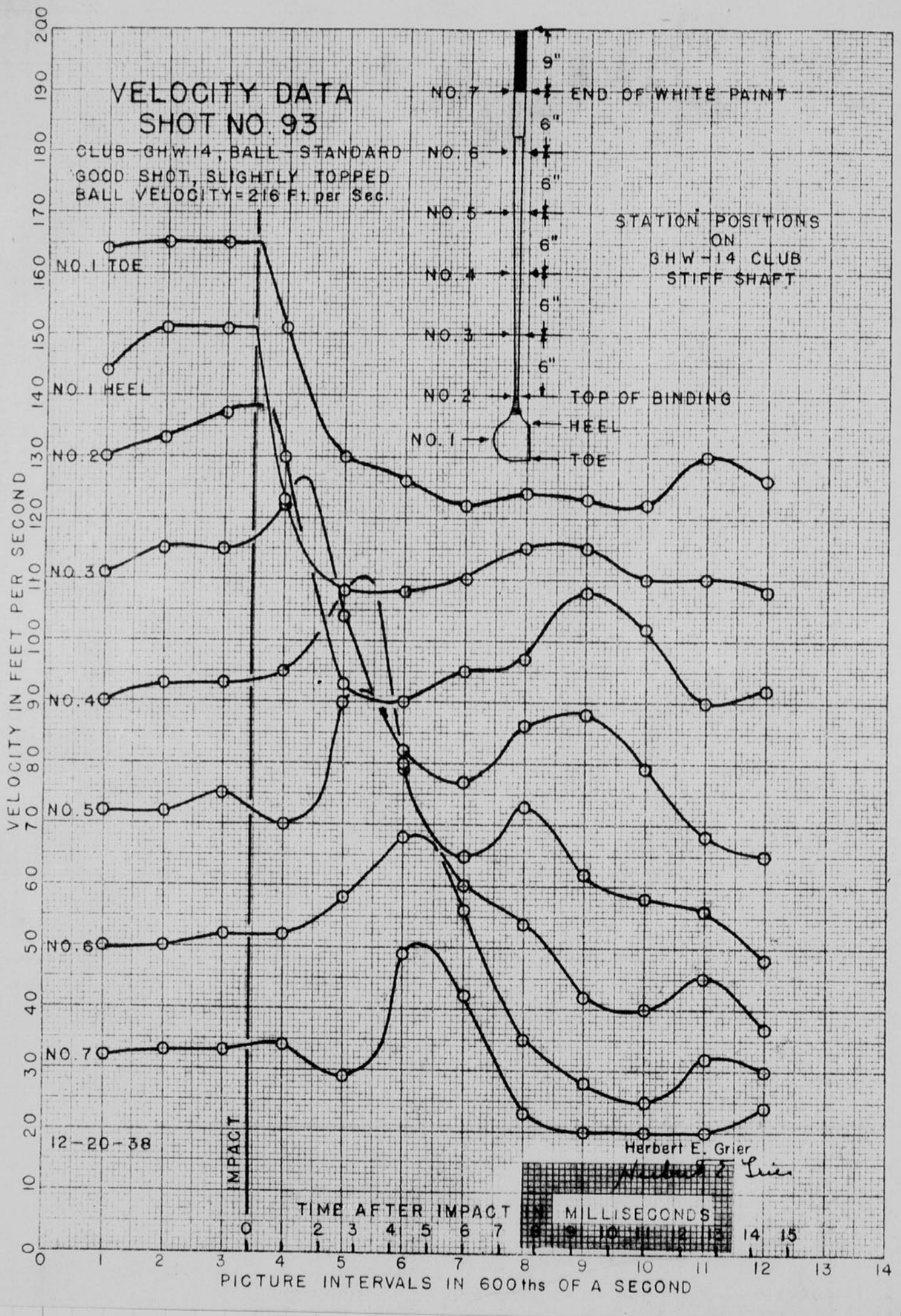
$\frac{1}{6.2 \times 3600} = \cancel{6.66}\ LC$

144,000 $\frac{30}{10^9}$ $\frac{10}{10^6}$ = mf. 7. mf.

10 h — ~~1 mf.~~

60 ~~+~~ C = .7 mf.

.5. h = 1.4 mf.


VELOCITY DATA
SHOT NO. 93
CLUB-GHW 14, BALL-STANDARD
GOOD SHOT, SLIGHTLY TOPPED
BALL VELOCITY = 216 Ft. per Sec.
NO. 1 TOE
NO. 1 HEEL
NO. 2
NO. 3
NO. 4
NO. 5
NO. 6
NO. 7
STATION POSITIONS ON GHW-14 CLUB STIFF SHAFT
NO. 7 → END OF WHITE PAINT
9"
NO. 6 →
6"
NO. 5 →
6"
NO. 4 →
6"
NO. 3 →
6"
NO. 2 → TOP OF BINDING
NO. 1 → HEEL
TOE
VELOCITY IN FEET PER SECOND
PICTURE INTERVALS IN 600ths OF A SECOND
IMPACT
TIME AFTER IMPACT IN MILLISECONDS
12-20-38
Herbert E. Grier

Joe Louis.

made with open shade by Bernstein and Brier

Feb. 1. 1939
Headquarters.

Yesterday afternoon took 4:10 pm train on Boston & Springfield with Ray Stevens, Ben. Fogler, Bob Rose, Herb. Grier. At Kimball Hotel met Mr. Brown, Radford (Geo), Victor East, John Dickson, John Boogmiller, W. F. Reach and several others. After dinner had discussion until about 12 on golf report etc.

This morning we assembled at the A. G. Spalding Bro. plant and resumed the discussions until noon. Stevens and I then took the train to Boston leaving the others. Program -

Construction and design of club heads.
Design of shot gun for ~~tablets~~ balls.

Consider ultra-high speed analysis of the impact of club and ball.

On Jan 4 (or 30) Sexton, Dotson and Gold from Navy were visitors at M.I.T.

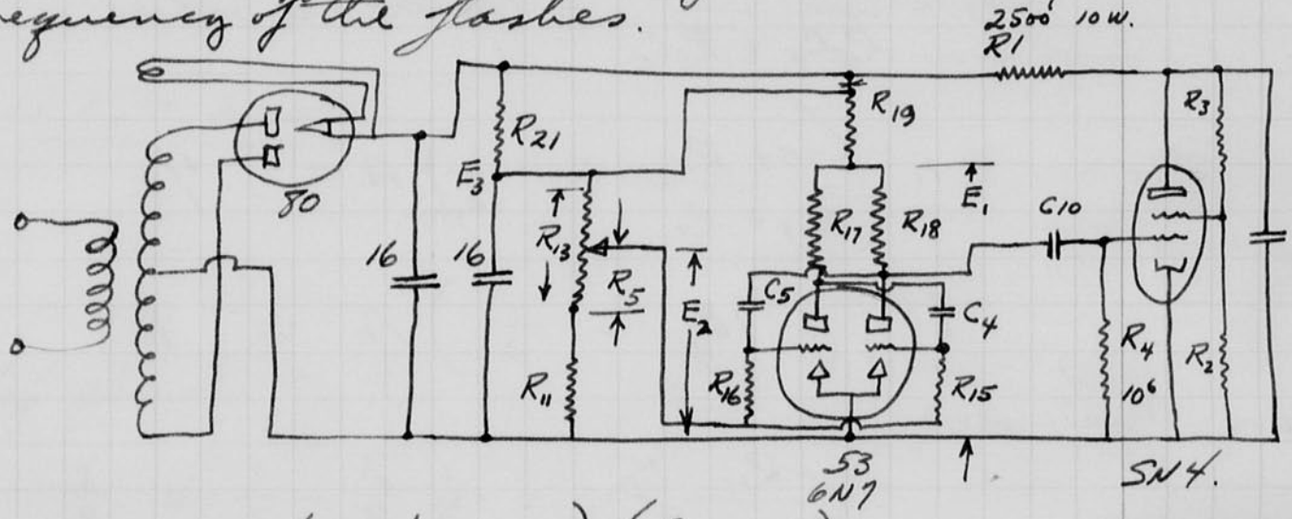
Last weekend I was at Pinkham Notch Camp of the A.M.C. with the Nottinghams. Skiing. Met Bennet and Bartlett. Boston Gas. Wire.
Mac Beth Illuminator Co. —
Daylight reflectors.

Joe Dodge - camp manager.

Feb. 6 1939.
Keleyotor.

At General Radio in afternoon working with Lewis & Shier on strobotac. The mirage was jumpy and the cause - faulty condenser. Apparently the connections in the condenser were faulty and caused a poor contact which prevented the tube from going into an arc the same each flash.

Wilsons of B.R. wants design of strobotac for limited range of speeds for special purposes. Below shows approx method of calculating the frequency of the flashes.



$$FREQ = \left(\frac{1}{R_{16}C_5 + R_{15}C_4}\right)\left(\frac{E_2}{E_1} + \frac{1}{2}\right) \quad \text{approx.}$$

$$\text{But } E_1 = \left(\frac{R_{18}}{R_{18}+R_{19}}\right)E_3 \quad \text{approx.}$$

$$\text{and. } E_2 = \left(\frac{R_5+R_{11}}{R_{18}+R_{11}}\right)E_3$$

$$\therefore FREQ = \left(\frac{1}{R_{16}C_5 + R_{15}C_4}\right)\left[\left(\frac{R_5+R_{11}}{R_{18}+R_{11}}\right)\left(\frac{R_{18}+R_{19}}{R_{18}}\right) + \frac{1}{2}\right]$$

Trop for 10,000 – 5000 cycles. 166 – 83.3

Let $R_{19} = 0$

$R_5 = R_{13}$

in brackets is then $1\frac{1}{2}$.

$C_5 = C_4$ if $R_{16} = R_{15} = 10^6$.

$\frac{166 \text{ cycles/sec}}{1.5} = \frac{1}{2R_{16}C_5}$

$C_5 = \frac{10^{-6}}{2}\frac{1.5}{166} = .00452$ use $C_5 = C_4 = .005$

then R_{15} and R_{16} will be $10^6 \times \frac{452}{500} = .903 \times 10^6$ ohms.

or since the oscillator will run fast due to the drop in the tube (triode). the one meg value may be o.k.

Now to set R_{11} – R_{13} can be 50,000 ohms.

$f = \frac{186}{2} = 93.3$ cycles.

(A) $= \frac{1}{R_{15}C_4 + R_{16}C_5}$ = same as before.

$\therefore \left(\frac{0 + R_{11}}{R_{13} + R_{11}} + \frac{1}{2}\right) A = 1/2$

$\left(\frac{3}{2}\right) \left(1\frac{1}{4} + \frac{1}{2}\right) A = 1$

$A = 2/3.$

$\frac{0 + R_{11}}{R_{13} + R_{11}} + \frac{1}{2} = \frac{1}{2}\frac{3}{2} - \frac{1}{2} = \frac{3}{6} - \frac{3}{6}.$

$= 3/4 - 1/2 = 1/4$

R_{11},

$4 R_{11} = R_{13} + R_{11}$

$R_{11} = R_{13}/3. = 3\overline{)50,000} = 16,666.$

Use 10,000 fixed.
+ 10,000 variable

check –

With $R_5 = 0$

R_{11} varies from 10,000 to 20,000.

at $R_{11} = 10{,}000$

$$f = \frac{1}{2(.005 \times 10^{-6} \times 10^{6})} \left[\frac{10{,}000}{60{,}000} + \frac{1}{2} \right] \qquad \frac{1}{6} + \frac{1}{2} = \frac{4}{6}$$

$$= 100 \times \frac{2}{3} = \frac{200}{3} = 66{,}6 \text{ cycles.}$$

4000 r.p.m.

at $R_{11} = 20{,}000$

$$f = 100 \left[\frac{2}{6} + \frac{1}{2} \right] = \frac{5}{6} \times 100 = 83{,}3 \text{ cycles.}$$

5000 r.p.m.

top speed.

$$f = 100 \left[1 + \frac{1}{2} \right] = 150 \text{ cycles or } 9000 \text{ r.p.m.}$$

Stevens Brown Joyler Grier Dickson Voss Boyniller

East Head

Photo taken at Kimball Hotel Springfield Feb. 1, 1939.

Pres. Radford.

1 sec. f 2

1 sec. f 4.5

Bantam Camera. panatomic film.

Feb. 9, 1939. Second term started yesterday steadi me section of 6.00 and also course 6.632

6.00 junior electrical engineering

6.632 advanced eng. electronics.

Feb. 10, 1939.
Harold E. Edgerton

Mr. Cook of the Soil Cons. Department was here today to discuss high-speed photography of drops landing on soil. He and Irien arranged a possible program.

Father O'Hara of Notre Dame was here this afternoon. He is looking for a dean of Engineering. Suggested D.C. Jackson Jr. who saw him at 5 at Hotel Statler.

Saw Stevens at noon about Westinghouse deal.

Feb. 11, 1939.

Jim Nili here from 9:30 to 3 discussing speed photography. Some lamps spark in base due to poor spot welded connections a studio will be in operation by march 1 on 23rd street.

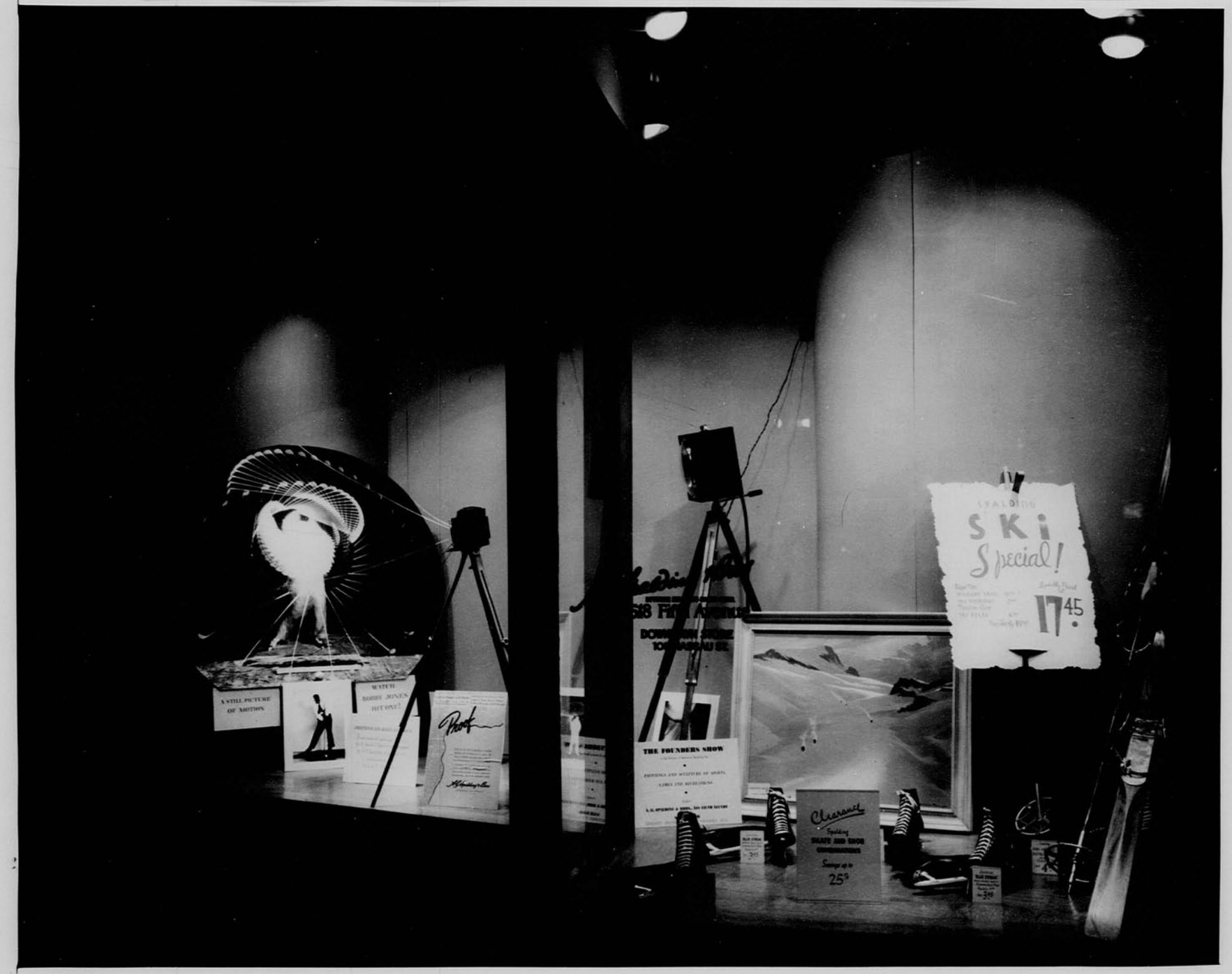
Worked on book with Jim Killian.

Set up flash unit to take photos for Eastman Exhibit.
24 mf 3000 volts large argon lamps. Reflector 20 inch aluminum. 3 ft from two jars.
1. 1mm window large aperature
2. Strobo flash " "
3. Blank. do.
7. 8 Strobo small "
Panatomic film 10 min D76 72° C.

Varichrome: 1. 1/2 sec control large ap.
2. " small " + jump jar Row
3. Strobo as above large aperture
4. " " " small "
5, 6, 7, 8. Large snaps in snow.

South window of A. G. Spalding & Bros. Fifth Avenue Store, designed and executed under the direction of Miss Eleanor Treacy and Mr. W. B. Okie, using the Spalding Research De-

designed and executed under the direction of Miss Eleanor Treacy and Mr. W. B. Okie, using the Spalding Research Department as the theme, placed January 5, 1939.



North window of A. G. Spalding & Bros. Fifth Avenue Store, designed and executed under the direction of Miss Eleanor Treacy and Mr. W. B. Okie, using the Spalding Research De-

Color Photo. - by Pancake.

f 4.5 outside Kodachrome.
Kr lamp 2 tube 11" reflector
18" from subject. 45° + reflector
Photog slightly dark.
Lighting needs ~~tub~~ two lamps
Red glass with milk flash.

Feb. 16, 1939.

Mr. Grant and Mr. Dorfman of Westinghouse were at A.D.L. Inc last Tuesday and we showed them our apparatus and circuits.

ordered a new reflector for enlarger today to be fitted with flash lamp.

LIFE TEST.

ARGON LAMP KR-XE SPIRAL (GR TYPE) 4mf.

ON TWO LIGHT POWER SUPPLY. 1000 VOLT TAPS.

TIME	FREQ.	CAPAC.	VOLTS.	RES.	REMARKS.	TOTAL.
4.00pm	30.	4mf.	1000?	5000	Tube 1 has had about 2 hours.	
					7.5 very slight coloration	9.5
7.00	"	"	"	"	5.5 hrs. clear spiral.	18.0
					8	26.0
					9 Tube still looks o.k.	35
5, 1938	30	4mfd.	1000	5000	Tube still operating - is now some what brown but has at least 50% light output (held over once)	

tendency to run = more sparkband added

March 6, 1939.
H. E. Edgerton.

Busy with 6.00 and 6.632 courses this term.

Dadakis was in last thursday about an oscillator to operate a clock motor for timing races. The idea was to get a gong at regular intervals that would help racers to set their paces.

I suggested the use of a relaxation oscillator to do the job without the motor. Also a shirlotron to ring the bell.

This was set set up in the comm. lab. On saturday I went up to see why it did not work as it should. The reason - filaments of 30 tubes were not hot enough. Raising the filament voltage to normal made the operation satisfactory.

Dadakis is going to redesign the circuit to use "heater" type tube such as the 53 and make the outfit all ac.

Mar 7, 1939.
H. E. Edgerton.

Note on life of capacity or capacitor type starters.

External band starters have proven to have a short life due to a dirty condition on the glass after a length of time. This time is variable ~~during the~~ depending upon certain conditions.

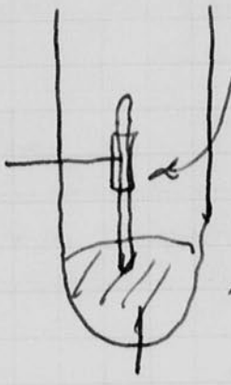
The new type of internal starter using a seal as tried by Gumeshamm seems to have a very long life as they have been running several thousand hours now.

The small internal igniters apparently do not get dirty as does the glass on the outer ones.

The reason may be that amount of charge that suddenly flows down the side of the wall of the tube at the instant of start. In the band type tube there is a large amount of charge while in the other the amount is very small due to the small area.

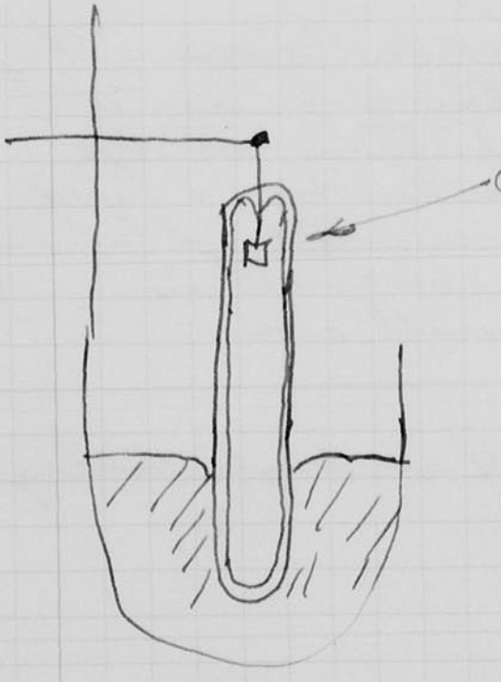
March 8, 1934.
Edgerton.

Last night I thought of the following abc. - starter for a Hg tube. The scheme is to use a hollow glass tube filled with gas at a pressure so that a discharge would occur with a sudden change.



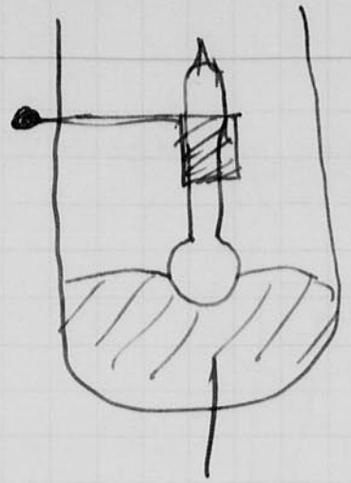
Hollow glass tube filled with gas say argon at several cm of pressure.

a desiharge would occur from the upper part to the mercury through the glass as a condenser when a certain voltage would be reached.



Another piece of metal inside at the bottom could be used.

these should be put in at an angle to get more surface.



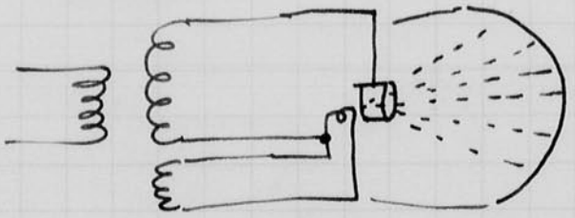
Glass bubble on the end
gas inside to give
conduction.

March 15, 1939.

Chadwick L. E. was here this afternoon and we discussed the work done last summer with insects - using high-speed photography.

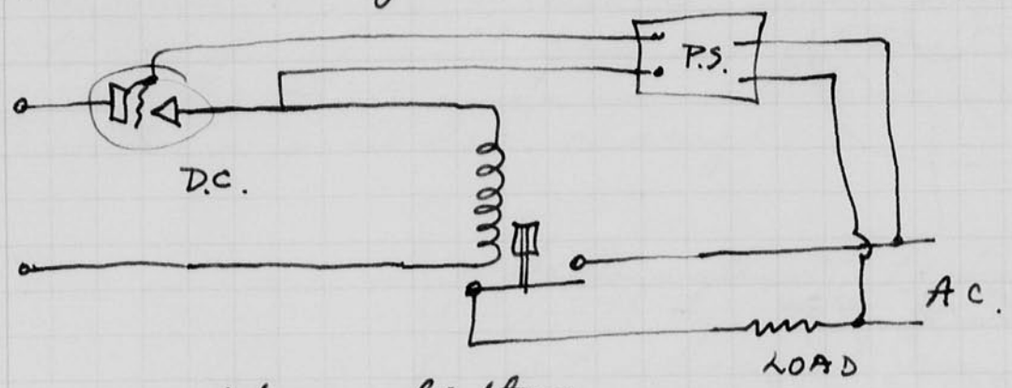
He is going to show the pictures at M.I.T. on Monday March 20th 4 p.m. in Room 4-231. I invited the commercial people.

Several days ago I suggested to Gennes the use of a cathode-ray tube as an enlarger light source. Today he finished an experimental unit. Cathode - anode and screen in bulb. This was run on a.c. from a transformer.



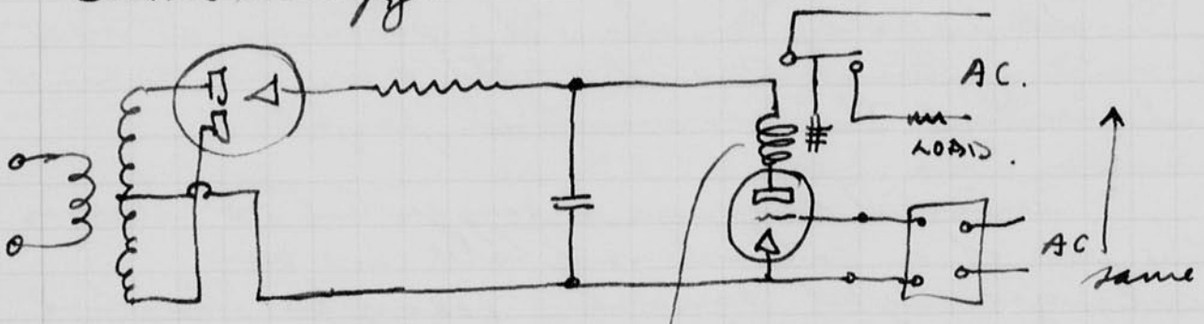
H. E. Edgerton
Mar. 15, 1939
cont.

Circuit to close contactor at desired point in cycle (when V = 0).



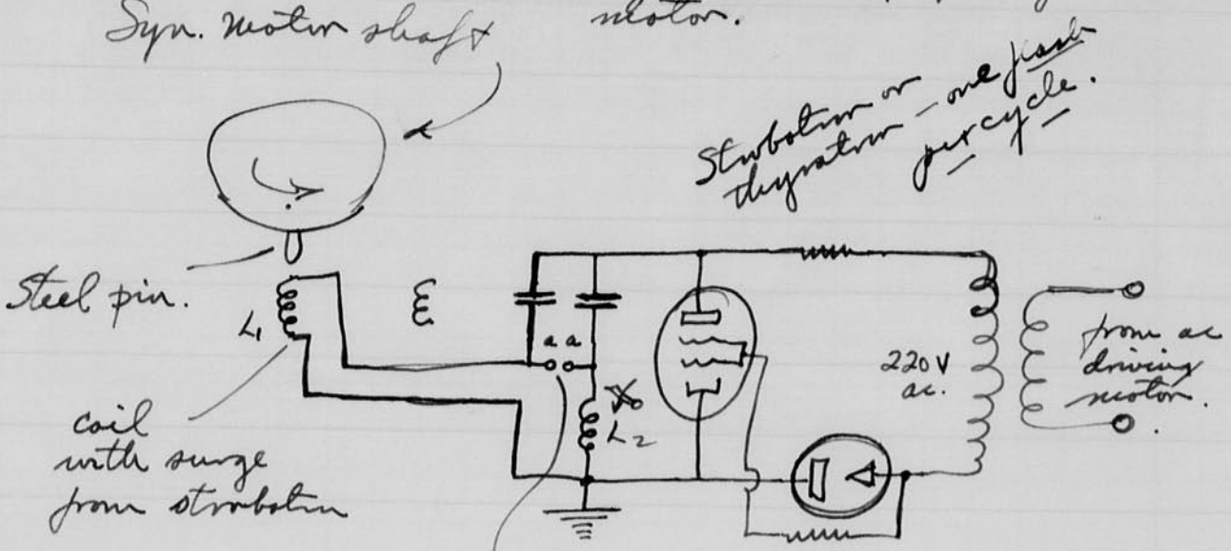
P.S. = phase shifter.

Store energy.



switch.

Transient Bridge for use with angle switching of a synchronous motor.

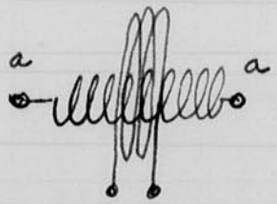


Strobotron or thyratron - one flash per cycle.

voltage will appear here when steel is in position shown. This can trip thyratron to close switch.

on rotating shaft of synchronous motor going at slip frequency.

Balance bridge with an adjustable core in L_2 so that no signal is received



to measuring device - for peak voltages. Such as peak voltmeter (vac. tube) or cathode Ray osc.

March 18, 1939.
Harold Edgerton

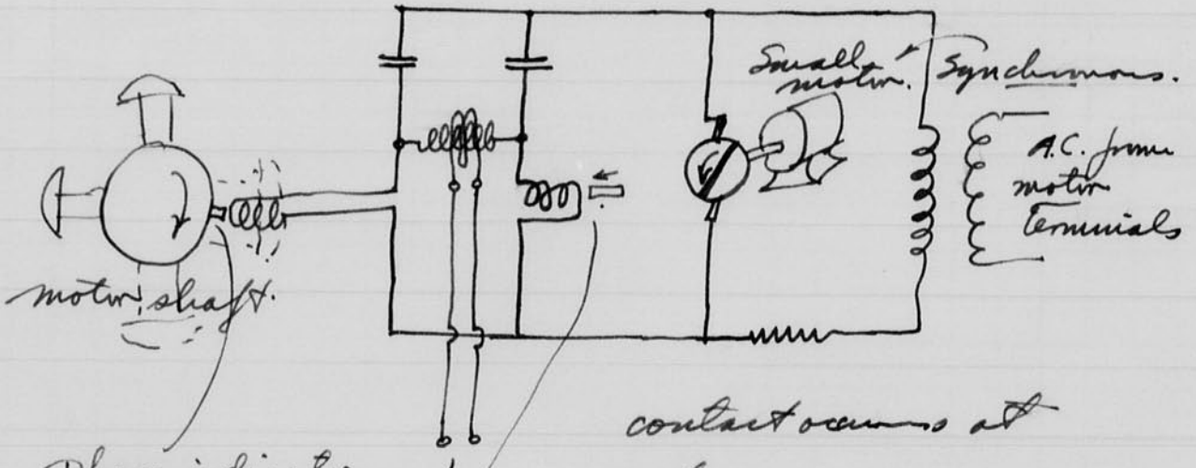
Read and Understood
Mar. 21, 1939
Kenneth J. Germeshausen

March 20, 1939.
Daniel E. Edgerton

The circuit ~~on~~ on the page before this (Transient Bridge) will also be useful for detecting metalic bodies underground or magnetic materials. It should be especially useful in portable outfits where the apparatus needs to be transported about.

The sudden and intense field should increase the sensitivity.

Transient Bridge Angle switching method



contact occurs at peak of ac wave or close to it.

Adjustment of zero setting of bridge so that no output results.

output when indicator or shaft is at certain angle when the surge comes.

Read + Understood
Mar 21, 1939
Kenneth J. Germeshausen

Mar 21, 1939.

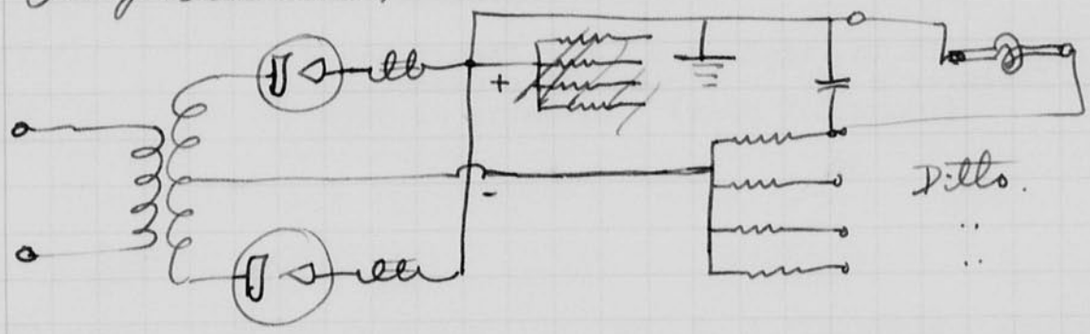
Harold Edgerton.

Mr. Brisson and Mr. Alexander are going to try the circuit of page 133 in the laboratory using the Tube-a Strobotron. they will test Sensivity and also methods of detection of the impulse from the unbalanced bridge.

Ener suggested that the circuit would be useful for operating signals (road) where the autos would act as a metal or magnetic body.

March 29, 1939.

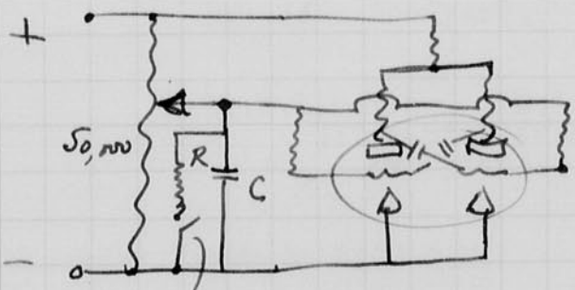
Power stroboscope for Worlds fair. 4 light unit. to be rebuilt from one designed for Prof. Eames.



$CE^2 = 4 \times 10^{-6}$ $10^6 = 4$ joules
$20 \times 4 = 80$ watts.
each lamp.

frequency desired = 20 flashes / sec.

Automatic speed changer or oscillator.



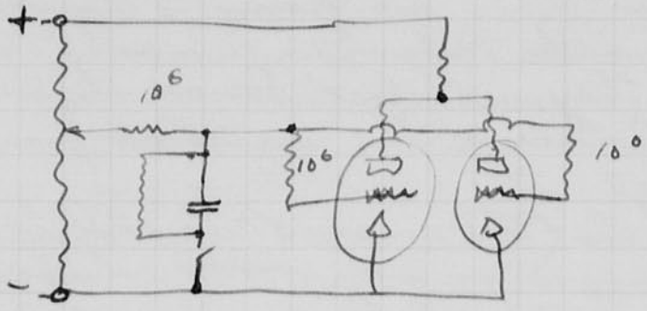
50,000 ohms.

$RC = 20$ sec.

$C = \frac{20}{R} = \frac{20}{25,000} = \frac{10}{10^4} = 10^{-3}$ farads.
$= 1000 \times 10^{-6}$ farads

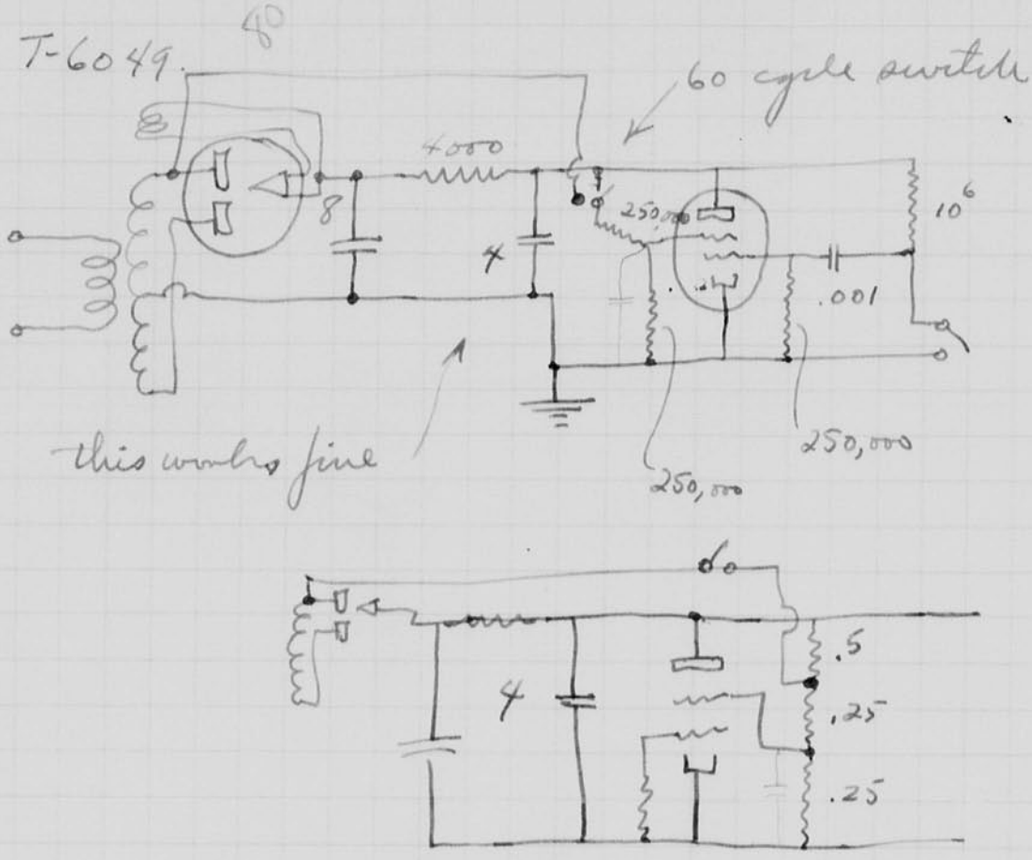
5 sec interval
switch momentary
(2 sec)

10 sec strobo. speed varying slightly.
5 sec ordinary light (put on with ordinary light.)

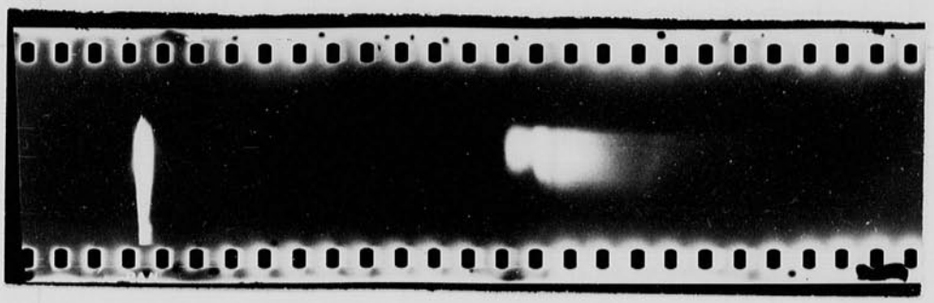


$\frac{20}{10^6} = C = 20$ microfarads.

April 17 1939.
Harold Edgerton



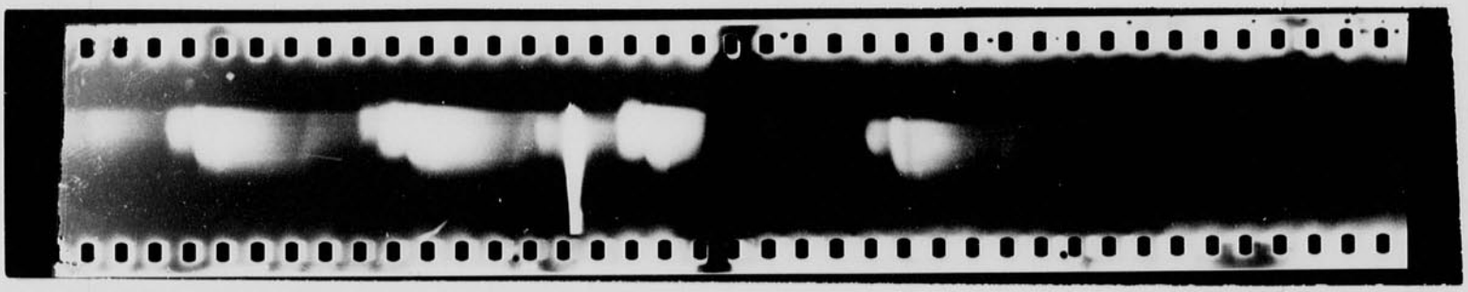
May 29 39 HEdg & HS Brien. above put in metal frame to be sent to Central Sci co Chicago. Works ok with good tubes 110-130 volts input. Transformer 1319 used instead of T6049.



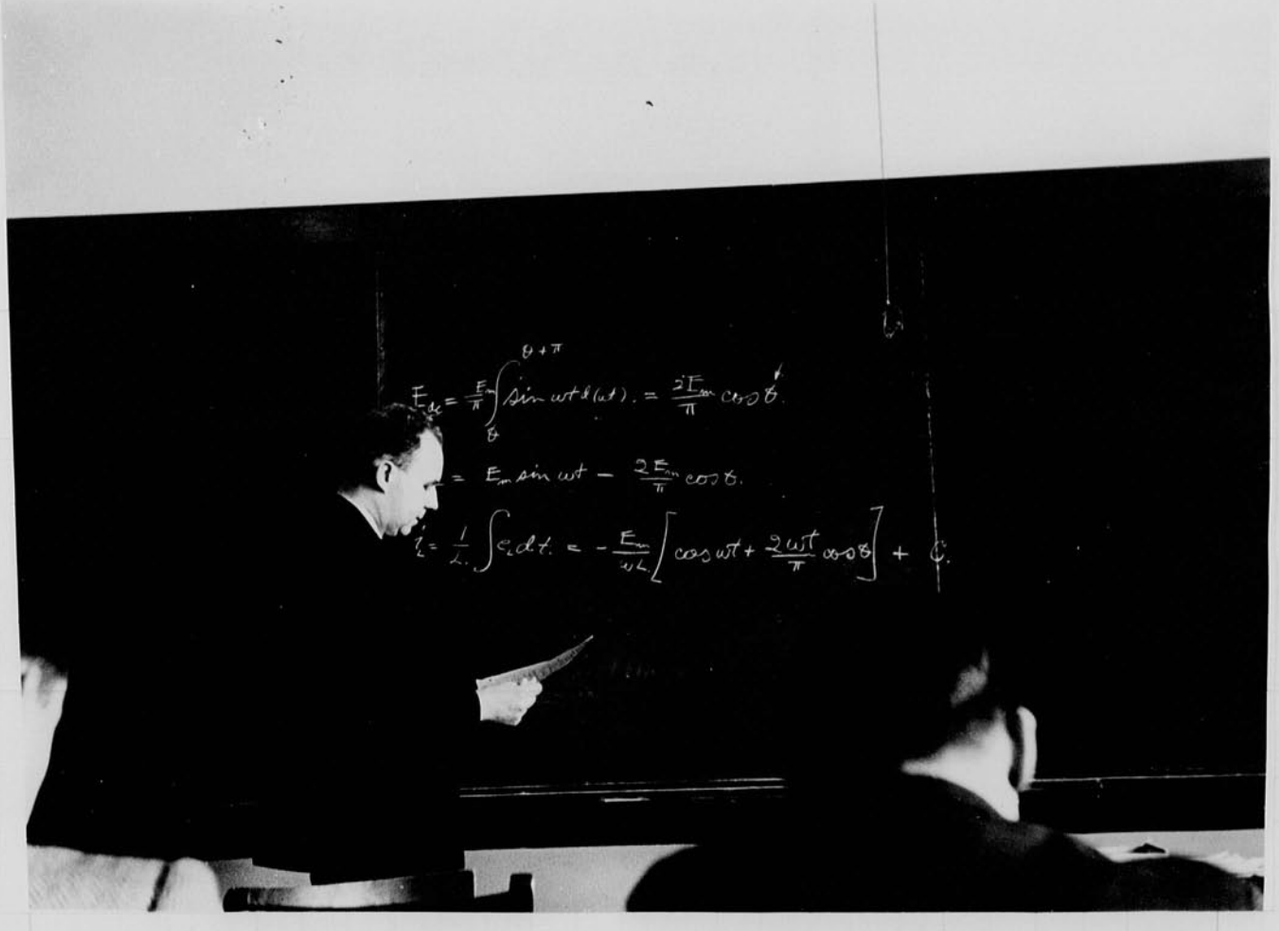
1" = .368 x 10⁻⁴ sec.

Note delay in lapse !!

Strobotron operated with contactor in Strobolac.



Hoffgrot

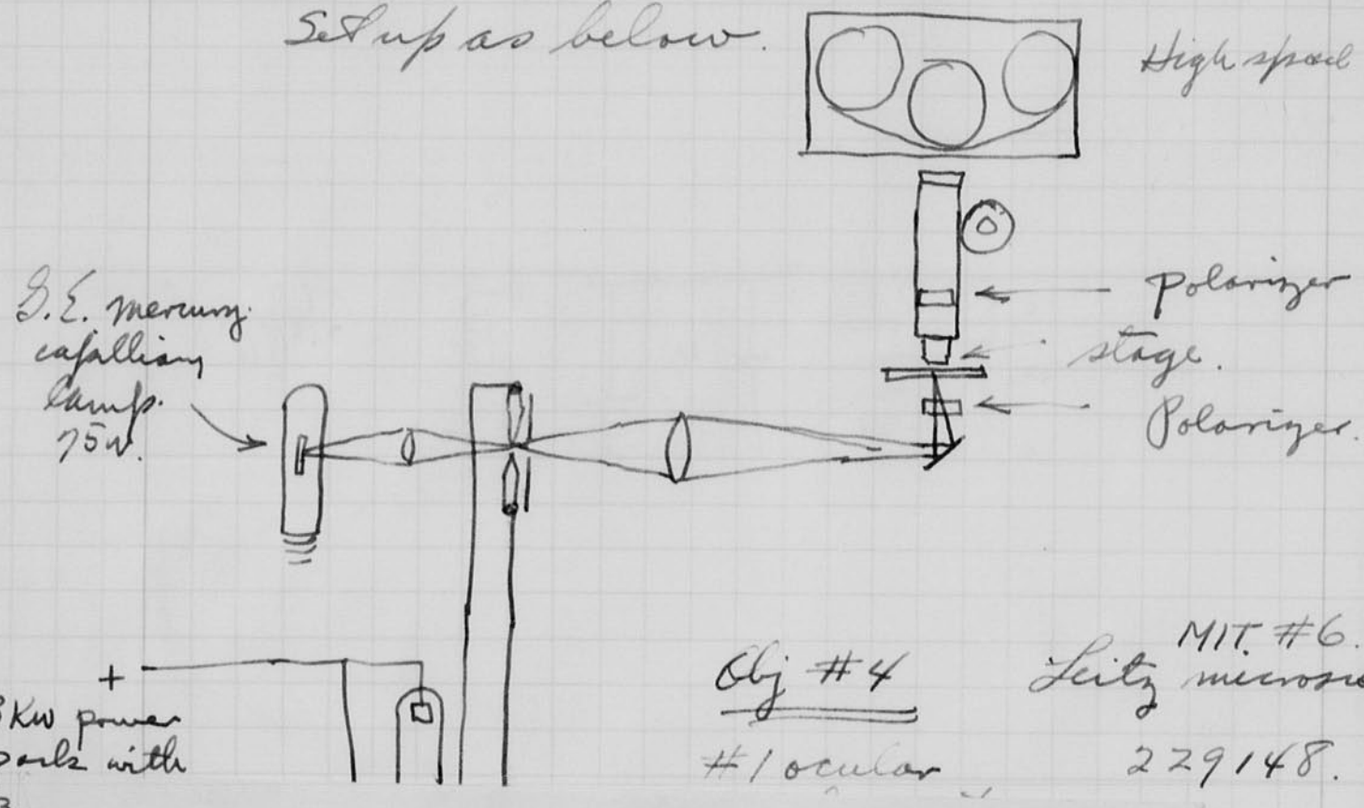


April 22 1939
Harold E Edgerton

Frog. Muscle photography.

I worked 19 and 20th with Jerome Gross, biology student, taking polarized light photographs of frog muscle fibers. Some 500 ft of film was used. Eastman background x.

Set up as below.



00/second.

Notebook # 9

Filming and Separation Record

____ unmounted photograph(s)

2 ? negative strip(s) inside envelope mounted on page 140

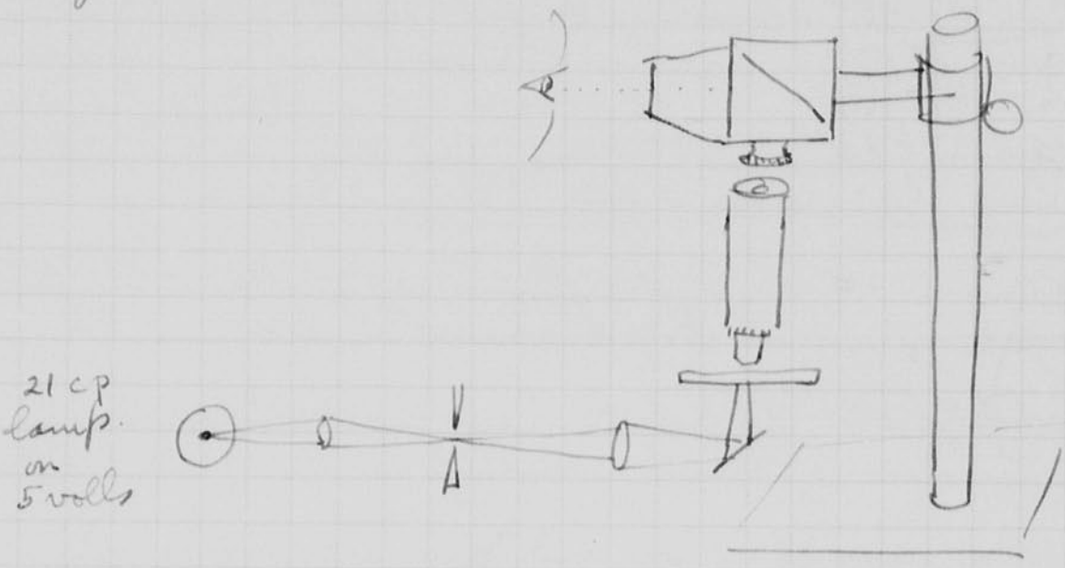
____ unmounted page(s)
(notes, drawings, letters, etc.)

was/were filmed where originally located ~~between~~ on page 140 and —.

Item(s) now housed in accompanying folder.


EASTMAN

Yesterday I set up a microscope and Pilot camera for photographing water bugs.



Sample film 120 size in Pilot Verichrome.

8x2

No	EXP	AP	LAMP	OBJ.	SP.	
1	1/20	4.5	21 cp.	16		nothing on film.
2	1/20	"	21	16		"
3	1/150	"	21	16		oh.
4	1/150	↓	↓	? {40		
5	1/20	↓	↓	40		
6	1/20			40	10 mf.	
7	1/20			40	?	
8	1/20			↓	10 mf.	
9	1/150				10 mf.	
10	↓				↓	
11						
12.				↓		
13				16		
14				16		
15				16		
16.	↓			16	↓	

April 28 1939

Wed Day -

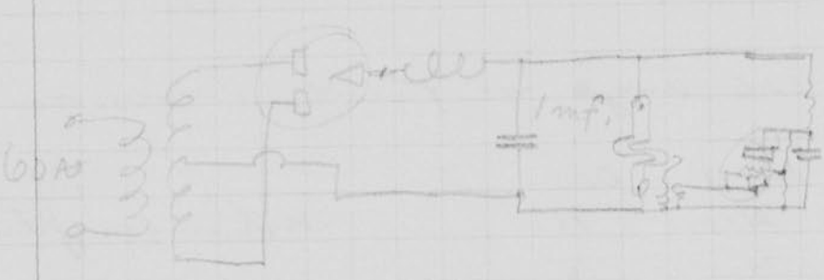
Apr 24 left at 7 for new York with 4 Light Strobroscope for M.I.T. exhibit in N.C.R. Bldg. 3.5 mf 5000 ohms in each lamp.

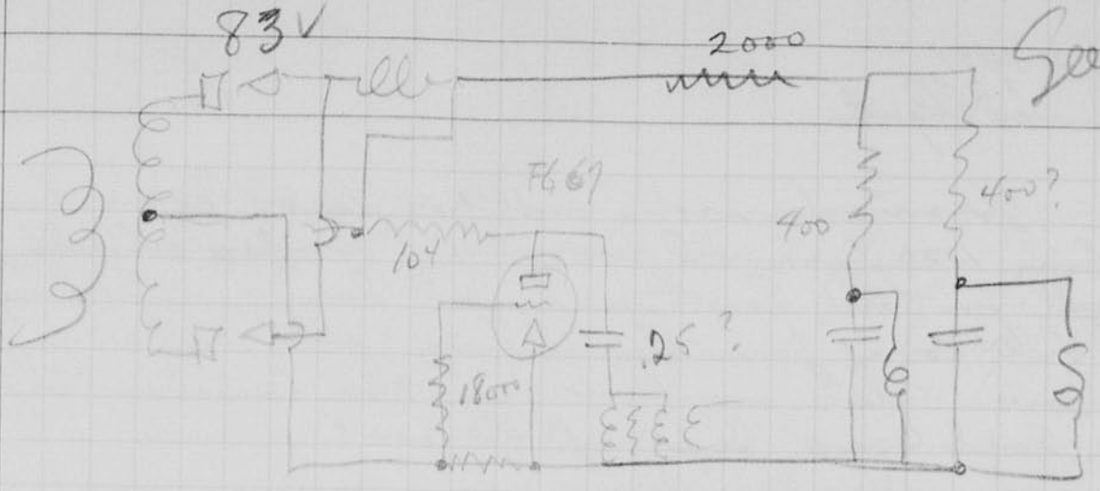
April 25 Installed unit in N.C.R. Bldg. at N.Y. fair grounds. Ralph & Caen -

April 26 left for home at 10 am - Saw Pingsley and Cook about 2 p.m.

April 29 Herb Price left for N.Y. with Eastman spark machine.

120 cycle Strobo.

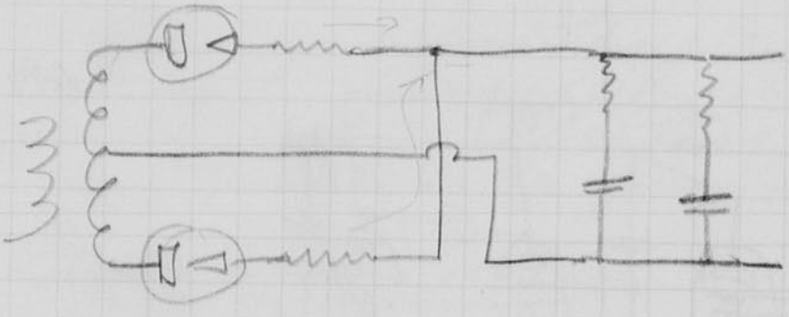




Spiral lamps.
1.5 cm Xe Kr gas.

The above circuit draws 175 ma from the 83 V. Replacing the 2000 ohm with a 800 ohm increases current to 200 ma.

It would be advisable to use 2 rectifier tubes with resistance in each plate

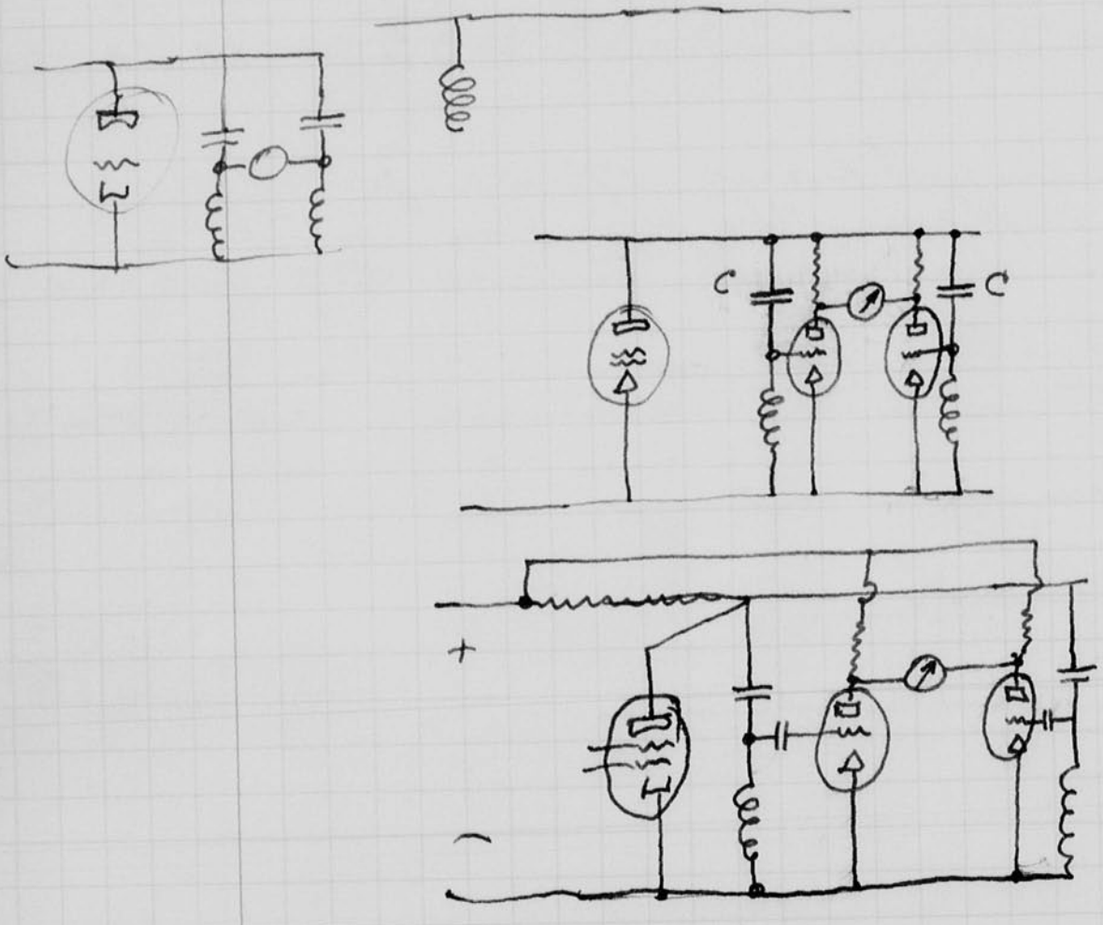


May. 3. 1939.
Howard Elgarten.

Semmelhausen and Mr. Laws have been taking 1000 / second movies of drops striking soil for the last several days. The drops of H_2O come from the ceiling and hit samples below. This work is for Mr. Bennet of the Soil Cons. Dept of the Govt.

Parson Laws Bros. back here on Friday last week

Transient Bridge circuit with amp.



May 7 1939
Experiment

Set up multiple flash unit in 5-210?
Single light argon with diffuser in 7" reflector. This light was put behind the player and focused on the hands. Object - to show the edge only - one side - to prevent confusion due to multiple images.

1 mf 1200 volts from 35 KW power supply
300 and 600 ~~from~~ pilts/sec.

May 9 1939 Inventory:

19 Irons.	19 total
16 Drivers here + 2 in lab.	18 total.

Spent most of day setting up multiple flash apparatus 100 sec and 600/sec.

Grier and Geo. Temple Jr. left for UK last night. They expressed the multiple flash unit to Spalding Store on fifth Ave. Temple is to operate it there.

Unit here for 100/sec.

Two light-argon filled 8" 14 cm pressure.
Hg control tubes.

Spark 1 mf 350± volts from
strobotron for each lamp.

100/sec from oscillator strobotron type.

12 mf on flash lamps 350 ohms charging
35 KW power pack.

600/sec unit 3 mf 200 ohms Hg control tube + argon
cap lamps quartz section.

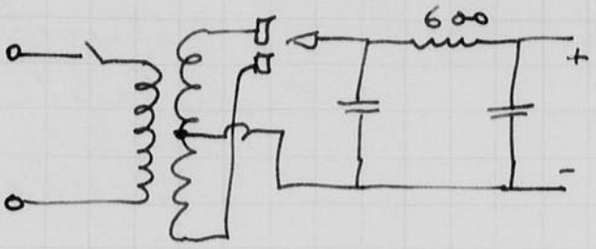
Cont.

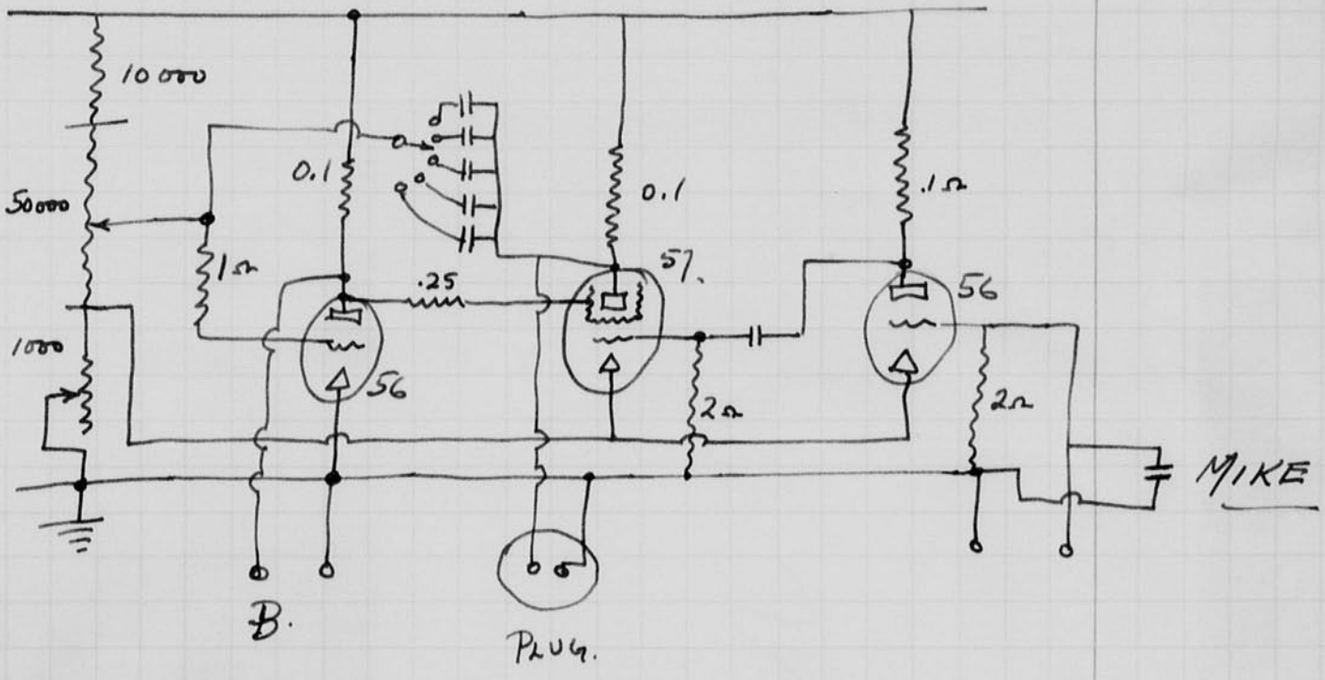
Experimented this evening with Gennesaw
100 and 600 /sec.
Tried Burnt cork on hands } 600/sec.
also side lighting.

Test of Eastman Outfit
with Regulator.

2 on 100 / 25,000 / 1,000,000	1.775	110	AC supply.
	1.87	115	
	1.975	120	
	1.8	110	
1 unit 14 mf	1.57	100	Reg.
	1.57	110	
	1.57	120	
	1.58	125	
	1.62	110	2 units
	1.65	120	
	1.65.	125	"
	1.7	126	Changed tap on Reg.
	1.65	110	
	1.65 (113 Reg).	125	
2040 v.	1.67	1135 125.	Changed tap. 2 units 42 mf. + 28. mf.

Time delay circuit — as of May 22 1939.
Tested by K.J. Germeshausen.

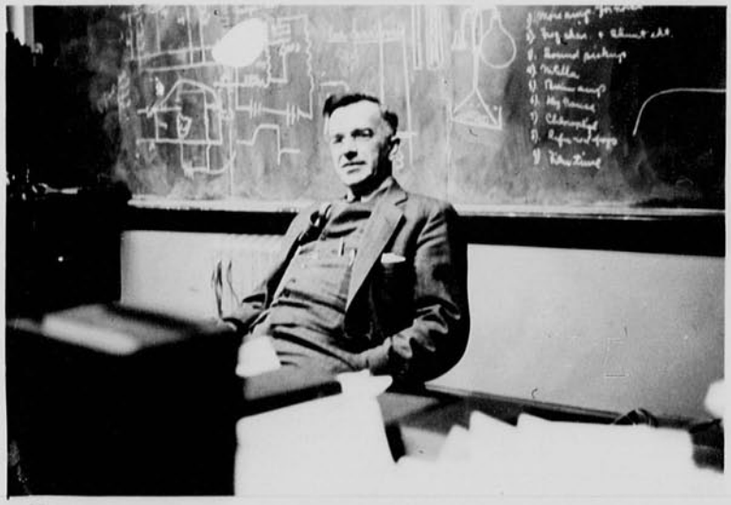




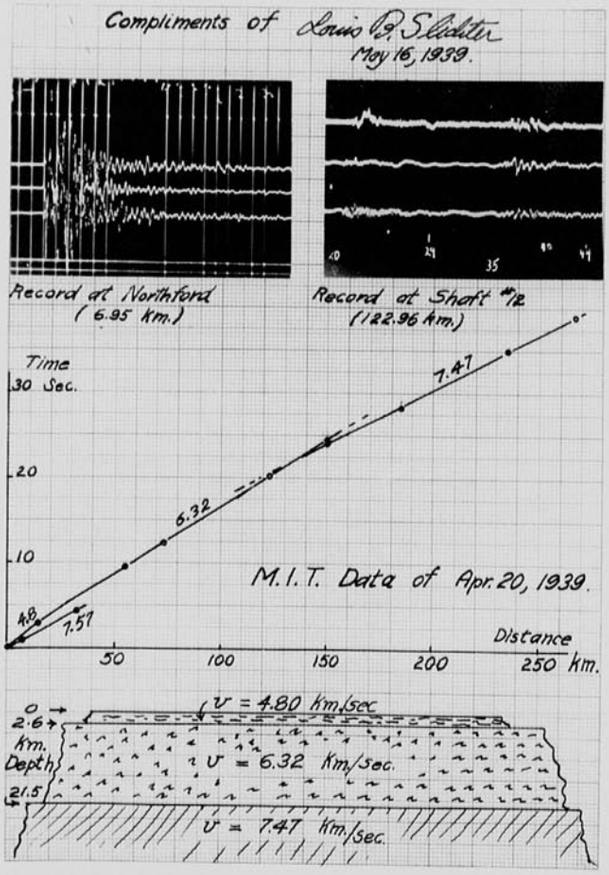
Mueller-Fuller

M.I.T. Exhibit
in National
Cash Register Bldg.
N.Y. World's Fair

Mr. Pugsley.
Winchester
Repeating
Arms. Co.

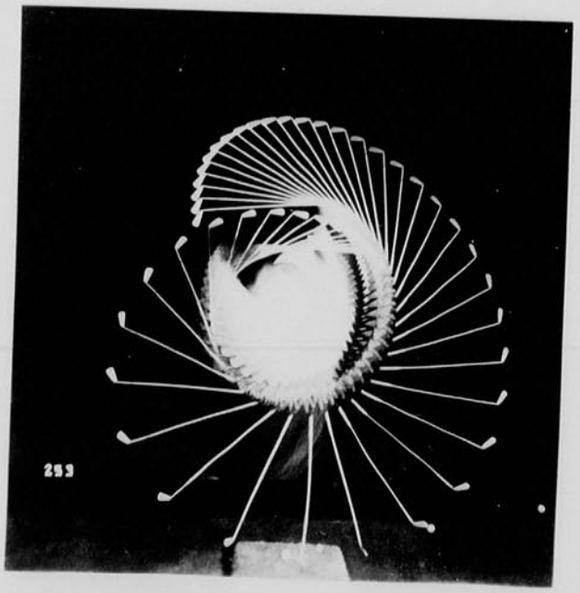


J. M. Bunker

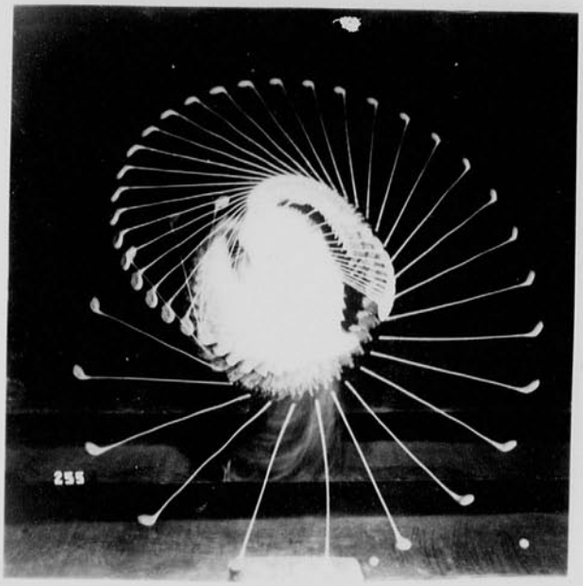


Lyon
Lorrie
Pete and Steve.
N. Y.

James Laws
Soil Cons. Dept.



Jimmy Thomson
May 10 1939
100/sec.



Jimmy Thomson
100/sec

Taken May 10 '39.

May 25? 1939

Mr. Undersee of G.E. Co (textile dept) was here today and took a new tube for the flash lamps. He is going to use it today at Taunton in a textile plant to study the warps of ~~a thread~~ the threads.

EDGERTON.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	
9-10					6.00 4-132		Subj. No. Room
10-11	6.00 4-132		6.00 4-132		↓		Subj. No. Room
11-12		6.632 4-232		6.632 2-235			Subj. No. Room
12-1							Subj. No. Room
1-2							Subj. No. Room
2-3							Subj. No. Room
3-4	Hopgood.						Subj. No. Room
4-5							Subj. No. Room

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
SCHEDULE CARD—FOR STUDENT'S USE

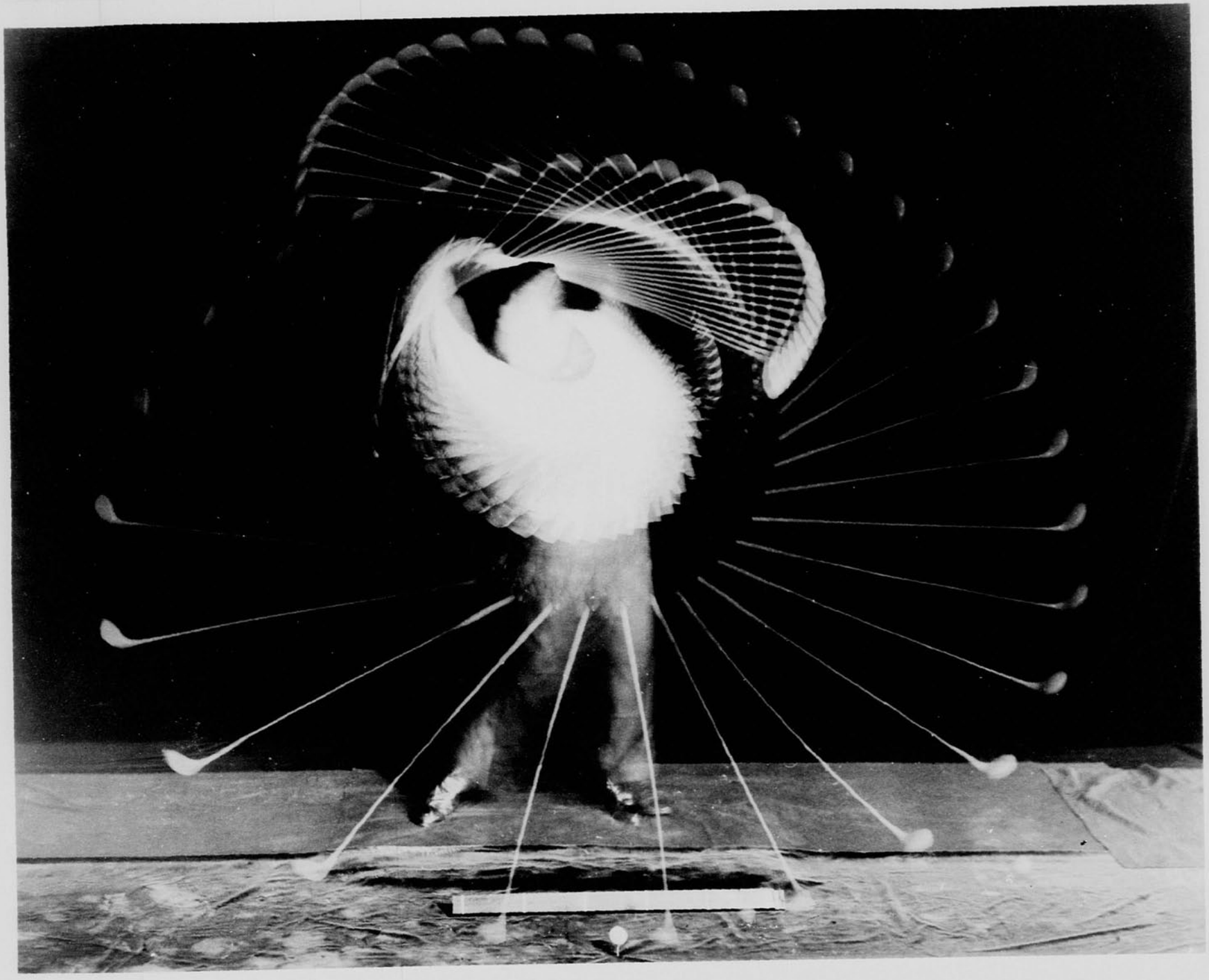
4-37 55M A8

STUDENT KEEPS THIS CARD

May 27. 1939.

Arrangement with Eastman Kodak complete today.

Grier spent yesterday in New York with lamps for Eastman in Worlds Fair exhibit. A pane of glass is broken for visitors two lights flash.



3. A multiple-flash photograph of Bobby Jones with a driver. The interval of time between pictures is 1/100 second. The exposure of each picture is 1/100,000 second. Measured from this photograph:
   The ball velocity is 225 feet per second
   The club velocity before

2B7-8-9. Timbie 100/sec.

Lacrosse Thomas J Cremer
530 Beacon St Boston

May 31 1939.
multiflash
photos.

280, 1, 2 100/sec.
283, 4, 5, 6 50/sec.

McCarty Indian Clubs.
50/sec.
25/sec.

Norman. E. F. Western Cartridge Co.
Worked with us June 1, 2, 3, 4 taking 3000/sec movies and single flash photographs of shot guns.

Grier was in New York June 5 at Eastman Co Worlds Fair Exhibit.

Grier & I went to New York June 8 for opening of Spalding Co. multiflash unit at 5th avenue store.

I spent June 9 (Friday) at Eastman exhibit W. E.
Returned to Boston on midnight train.

Sat June 10 Ralph Booth called about Edison Co Gen in L St station.

Sun June 11 Spent morning with William Mitchell Folberth Jr. Com 8048. 22 Fenway Boston Phi Sam. Home in Cleveland. Father makes molded Bows.

June 12 '39 Saw Ralph Booth at 10 and discussed vibration with Mr. Julian. J and I spent two hours or so at L St station looking over the generator.

The ball velocity is 225 feet per second
The club velocity before impact is 166 feet per second
The club velocity after impact is 114 feet per second

1201 strobo p 142 76

10^{-6} flash lamp. p 61-2 37

Time delay p 25 46.