

HAROLD E. EDGERTON

PAPERS

MC 25

Series III

Laboratory Notebooks

Number 22

Dated Jan. 9, 1954 to April 19, 1955

Massachusetts Institute of Technology

COMPUTATION BOOK

| NAME | Number |
|--------------------|--------|
| HAROLD E. EDGERTON | 22 |

M.I.T. 20D 102
CAMBRIDGE MASS.

Course.....

Used from JAN 9 1954, to APRIL 19 1955.

Book No. 22
Jan. 9, 1954

#22

Harold E. Edgerton

Jan. 9, 1954.

M.I.T. 20D102

Cambridge, Mass.

Sparker 21.

Souder-Pinger p 19
43
45

Battery cable lamps p 8. Nov 24 1953.

Battery cable Hunt & Wilson p 27 Mar 1954

Battery cable cameras. p 94

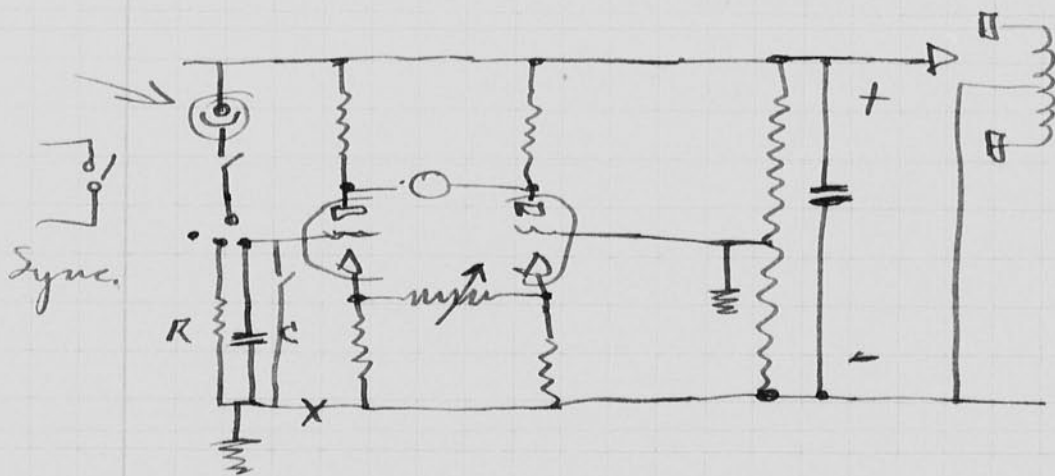
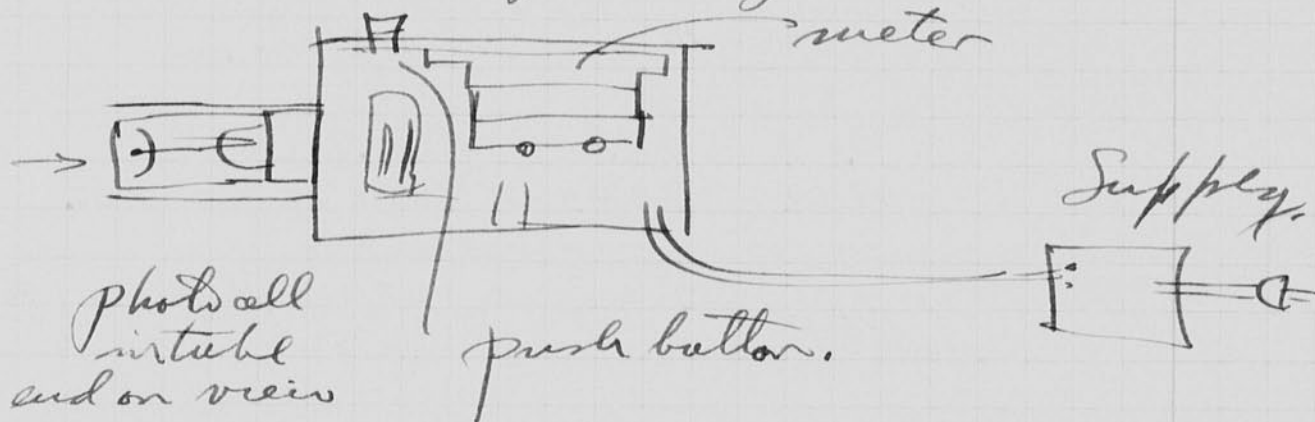
Jan 9 1954
 Harold E. Edgerton
 M.I.T. 20D102 Camb. Mass.

Light meter

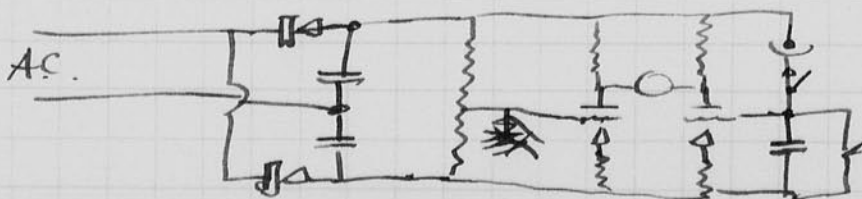
It seems that now is the time to consider the design of an ac operated integrating exposure meter for electronic flash.

The vacuum tube circuit will probably be a twin triode circuit of conventional design.

I propose that the photocell amplifier (or vacuum tube voltmeter) and meter and push button be placed in a probe which can be used if desired on the ground glass.



no trans needed



2 Jan 16 1954

Harold Edgerton.

Eilenberger was here from the 13th. He was formerly chief engineer of Heiland. Now is a consulting engineer at Denver.

S.P. Duntley was here today to talk about a P.M. pickup and flash tube for scattering of light in the air. He is now at the Scripps Inst. San Diego, Calif.

All set for multiflash of pole vaulting tonight at Boston Garden.

25 mf at 4KV or ^{each of} two lamps.

reflector factor of 15 or 20?

$$CE^2/2 = \frac{25 \times 16}{2} = 200 \text{ watt sec.}$$

$$n = 30 = \text{c.p.s.} = 600 \text{ c.p.}$$

$$M.C.P. = B.C.P.S. = 600 \times 15 = 9000.$$

$$DA = \sqrt{\frac{5}{c} \text{ BCPS}} = \sqrt{\frac{100}{15} 9000} = \sqrt{\frac{900000}{15}} = \sqrt{60000}$$

$$= \frac{250}{1}$$

Guide number 250
Lamps at 40 feet.

$$f = \frac{250}{40} = 6.$$

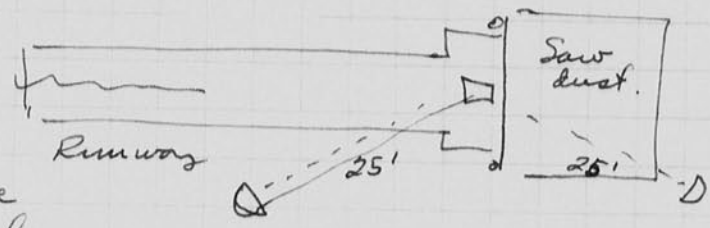
Clyde Jan 11 letter from Dugan

Jan 18 1953

Howard Edgerton

Pole vault photos of Boston Garden Jan 16
with son of Richard and Lay.
14'6" 14'9"

Two lamps were used each with 25 m+ at 4KV.
Lighting was from the side



Lamps were held by hand and pivoted that is swung into line to aim at the pole vaulter as he went through his poles.

Plus Ortho X Eastman film was used at f 22. No appreciable exposure resulted from the room light with 4 exposures at 1/200 sec exposure each. Exposure was very good on the pole vaulters.

The camera was in the stands on the north side in the best row in the front section just forward of the main walkway.

FX-1 efficiency at 2000 volts 100 w/d.

- 4.8 C.P./watt
- 4.9 C.P./watt
- 4.9 "
- 5.18 "
- 4.95 "

Jan 23 1954
Harold Edgerton.

I was in Rochester Jan 21 morning with Joe Boone, Roger Leavitt. Discussed a copy unit. Suggested 12 inch FX-1 tubes with cylindrical reflectors.

Afternoon - Julian Webb took us per. Made sensitometry experiments with electronic flash on Plus X and Ektachrome films. (Freshman)

Dinner with Bob at Todd Union at Rochester Uni. Night train to New York. ASA committee meeting at 9:30 in Grand Central terminal Bldg. Lunch with Harry Parker.

Then saw Roy Davis at Commercial Studios. His comments are

- (1). Our 10,000 W.S. unit requires further division of parts.
- (2). He would have preferred to buy our equipment but buys Salthman since Salthman has units in stock. Last 2 units this was true. 20,000 W.S. Commercial now has 92,000 W.S. in two studios beside the small flash units!
- (3). A focus or modeling lamp system is badly needed. Would be willing to pay \$1000 for 1000 watt continuous operation of FT-623. Not 2000.

Then saw Dr. Broder at the N.Y. Museum about fish photography. Bill was there also. He is now a junior at Columbia.

Next we went to the Broadway theater and watched Mili, nodler, and Bob finish up a photo job set up of a show Ballet de Paris.

Afterwards we went to Mili's studio. Then dinner with Bill and the plane to Boston.

On the train to Rochester on Wednesday night I met Mr. Condon of National Fireworks. Discussed Joe Miraldi's experiment of exploding a wire in oxygen vapor.

Bob's room mate.
Harley.

this method of exploding a wire may be useful for obtaining large quantities of light for aerial photography. I thought of the system on the train to Cleveland in Oct last year. About a month or two later Mirachi came in to discuss the problem. I offered to loan him my shutter exploder as used in a capping shutter for the high speed camera after making some preliminary experiments. He promised to get a purchase order from the company to defray costs.

I did some experiments as recorded in notebook 21 on page 143. A more powerful unit is required for Mirachi's requirements. The O.K. to go ahead on the job came in last week from the Nat. Fireworks.

Mirachi reported that a brilliant flash of light results when metal powder is used in an explosive in a bullet. He believes that the burning may be fast like a detonation. The experiments with electrically dispersed metal may show what is going on.

Feb 5 1954
 Harold E. Egerton

Made test of La cathode - in carbon cylinder. Arc strikes to carbon an sputters badly. with 1 mf at 2000 volts.

also tested hollow cathode of the Phillips co. metal sputters at 3 mf 2000 volts.

Both the above tubes were 10 mm ^(?) ID. with 1/2" gaps. 2 at pressures of xenon gas was used for firing.

Wednes Feb 3, Mirarchi acid, ^{Dr.} Row and Bischock came in to discuss exploding wires. I showed them the shutter firing unit. Two tests were made - one on a .017 brass wire 6" long - which melted at 45 mf 3000 volts. another on 1 1/2" length which vaporized.

A large tube as above in diameter has been tested by Herb. Budge. the electrodes have stood up fine.

See page 151
 N.B. 21

tube dimensions 3/8 1/2" cor O.D.
 54" long.

Tube resistance = 9 ohms (calculated)

C = 600 mfd

V = 6000 volts.

Peak current $I = 6000/9 = 670$ ampro.

It stands to reason that the short tube should have the current limited to this peak and duration to give the same cathode performance.

~~neglect the tube resistance.~~

tube resistance of 3/8 tube 1/2 inch long
calculated.

6" tube has 1 ohm

1/2" tube has 1/12 ohm = 0.083 ohms.

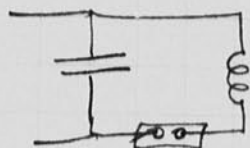
Say about 0.1 ohms.

Feb. 9, 1954

Harold E. Edgerton

Cont all morning with Al Clark E. Klein and
Gomeshausen - discussed action at Albuquerque
and future business.

Cont calc. page 6 with 0.1 ohm flash tube.
Let peak current be 500 amperes.



Minimum starting voltage = 1000

C = ?

$$I_{max} = E \sqrt{\frac{C}{L}} \text{ amperes} = 500$$

Let C = 500 mfd.

$$500 = \frac{1000}{\sqrt{L}} \sqrt{500 \times 10^{-6}}$$

Solve for L.

$$\begin{aligned} L &= 4 \times 500 \times 10^{-6} \\ &= 2000 \times 10^{-6} \text{ henries} \\ &= .002 \text{ henries.} \end{aligned}$$

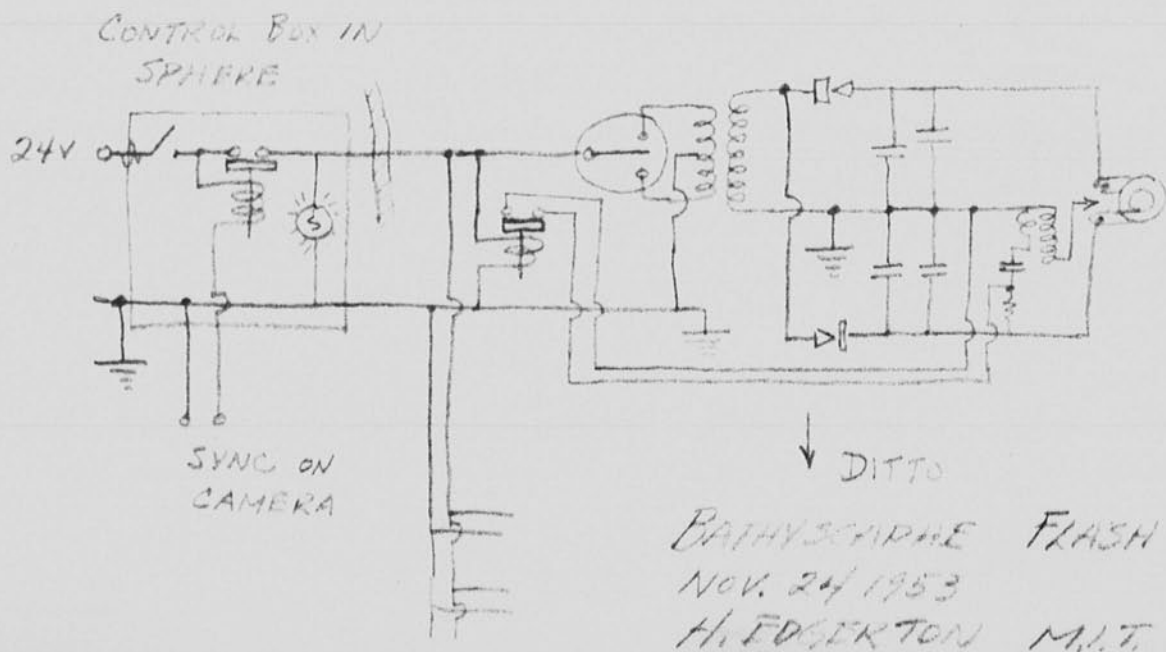
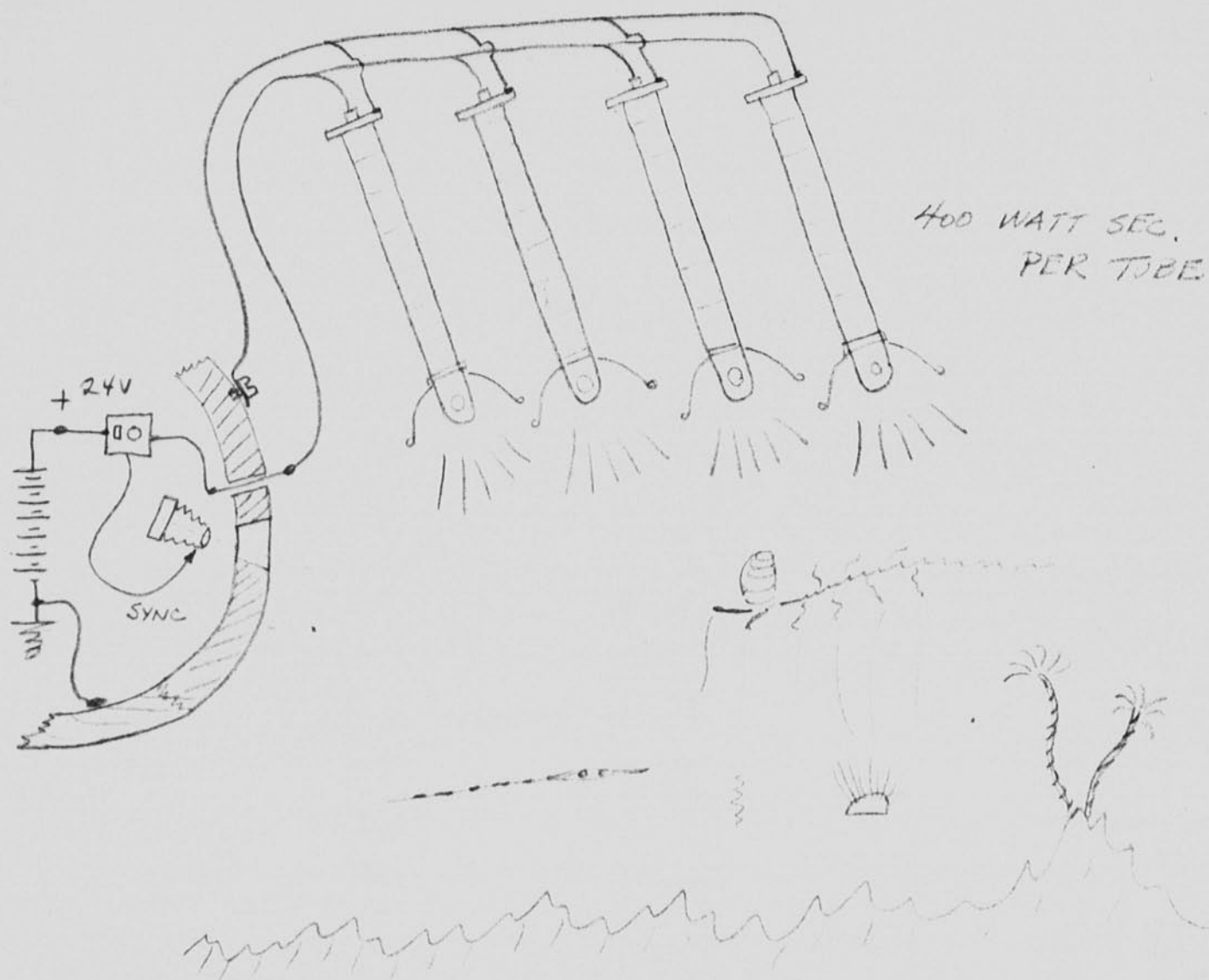
Oscillatory criteria

$$\begin{aligned} T &= 2\pi \sqrt{LC} = 2\pi \sqrt{.002 \times 500 \times 10^{-6}} \\ T &= 2\pi \cdot 10^{-3} = .00628 \text{ sec.} \end{aligned}$$

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

$$\begin{aligned} R^2 &= \frac{4L^2}{LC} = \frac{4L}{C} = \frac{4 \cdot .002}{500 \times 10^{-6}} = \frac{8}{.5 \cdot 10^{-6}} = 16 \times 10^3 \\ &= \frac{.008}{.500 \cdot 10^{-6}} = 16^2 \text{ ohms. seems high.} \end{aligned}$$

Shows that circuit will oscillate violently,
since tube has but 0.1 ohm.



March 4, 1954.

Lancel Edgerton

Very busy with lamps for Balyscaphes.
Crushed one container at Woodhole with 2200
#/sq inch. Extra heavy 3" pipe. 2.9" I.D.

Shipped one unit to Hout at Dakar
today by P.A.A. air.

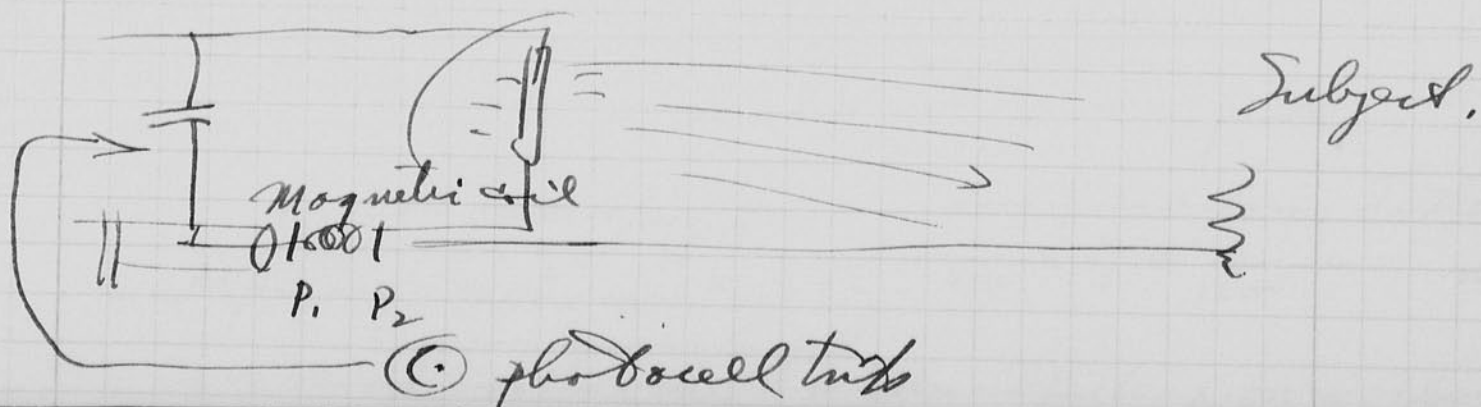
March 6 1954

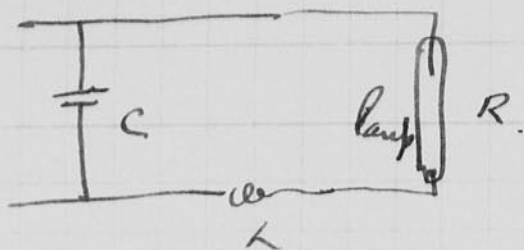
Duttonoff Aberdeen gave talk Mon 4 evening
on speed photography. McPherson - machine co.
Beatty from U.F. was here also that day.
I left on Federal that night for Wash DC.
Meeting on the 5th at Wash DC with Cousteau
Smith, Ryan, etc Research Committee.
Cousteau described the bathyscaphic dive off
Coulon. This was described in the french
paper *Figarea Figero* in a series of
articles in December.

Plans were made for a July meeting
at Dakar with the bathyscaphic for photography.
I have a big list of things to design and
build.

Last week I discussed with Babbitt
the magneto optic method of
cutting down light. It works on
arc illumination when a fuse lets go

The next day I thought of the
use of a synchronized flash to
illuminate the subject when the
shutter is closed. I plan to use the
capacitor circuit to excite the
coil





circuit.

neglect coil inductance in the first loop
of the circuit

$$I_{\text{max}} = \frac{E}{R} =$$

$$\text{Duration of flash} = \frac{CR}{2} = .01 \text{ sec.}$$

Required by subject -

$$\text{Lamp } R = 5 \text{ ohms.}$$

$$C = \frac{.02}{5} = .004 \text{ farads.}$$

$$= 4000 \text{ microfarads.}$$

Peak current at 900 volts.

$$I = \frac{900}{5} = 180 \text{ amperes}$$

Further calc. SMPTE ofr 1951 p 398. By Wyckoff.

$\theta = ALH.$ $AL = \frac{\theta}{A}.$ $A = .0647 \text{ min/arcsec.}$
 Chem Handbook.

$W = \frac{1}{2} LI^2$ $L = N^2 d F$
 $N = \text{turns}$
 $d = \text{diam of coil in inches}$
 $F = .0071 \text{ for } l/\text{diam} = 3.$

$W = \frac{F}{2} d (NI)^2 \times 10^{-6} \text{ watt seconds,}$

$W = \frac{1}{2} CE^2 \text{ watt sec.}$

$AL = \frac{\theta}{A} = \frac{4\pi}{10} NI \text{ gilberts.}$

$I = \frac{\theta}{AN} \frac{10}{4\pi} \text{ amperes.}$

Now let $I = 200 \text{ amperes.}$
 $\theta = 90^\circ \text{ degrees} = 90 \times 60 \text{ minutes.}$
 $= 5400$

Solve for N.

$N = \frac{I}{\frac{\theta}{AN} \frac{10}{4\pi}} = \frac{200 \cdot .0071 \cdot (10)}{5400 \cdot (4\pi)}$
 $= \frac{\theta}{A} \frac{1}{I} \frac{10}{4\pi} = \frac{5400}{.0071 \cdot 200} \times 1 = \frac{N}{54}$
 $= 380 \text{ turns.}$

more current needed $I = 1000 \text{ amperes.}$

$N = 70 \text{ turns.}$

if $I = 2000 \text{ amp} = 35 \text{ turns.}$

try FT-17A flash tube 573 mfd, 4 KV.
 Current peak = 1600 amperes.
 Light peak = $275 \times 10^6 \text{ lumens peak.}$

$\frac{275 \times 10^6}{52} = 10 \times 10^6 \text{ lumens/sq foot.}$

4000 frames/sec. Tostax.
 $\frac{1}{4000} \times \frac{1}{3} = \frac{1}{12000} \text{ sec} = 100 \mu\text{s.}$

exposure = $10 \times 10^6 \times 100 \times 10^{-6}$
 $= 1000 \text{ lumen sec/sq foot}$

B&W needs less than this. \rightarrow Polaroid filter $\times 1000 = 1 \text{ lumen sec/sq ft.}$

ASA.
238261948.

$$I = \frac{CA^2}{TS}$$

$$\text{or } IT = \frac{CA^2}{S}$$

foot candle sec.

$$= \frac{15 \text{ to } 30 (3.5)^2}{100} = \frac{150}{100} = 1.5$$

S = 100 for Super XX

Proposed set up for test.

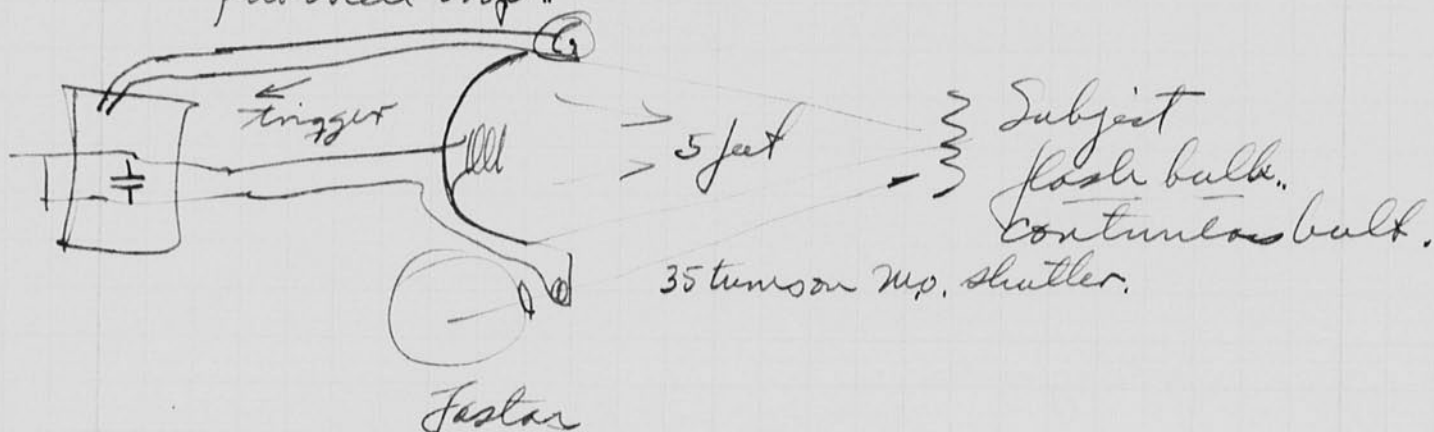
Coil turns = 35

C = 500 +

Lamp FT-17A.

V = 4000

photocell trip.

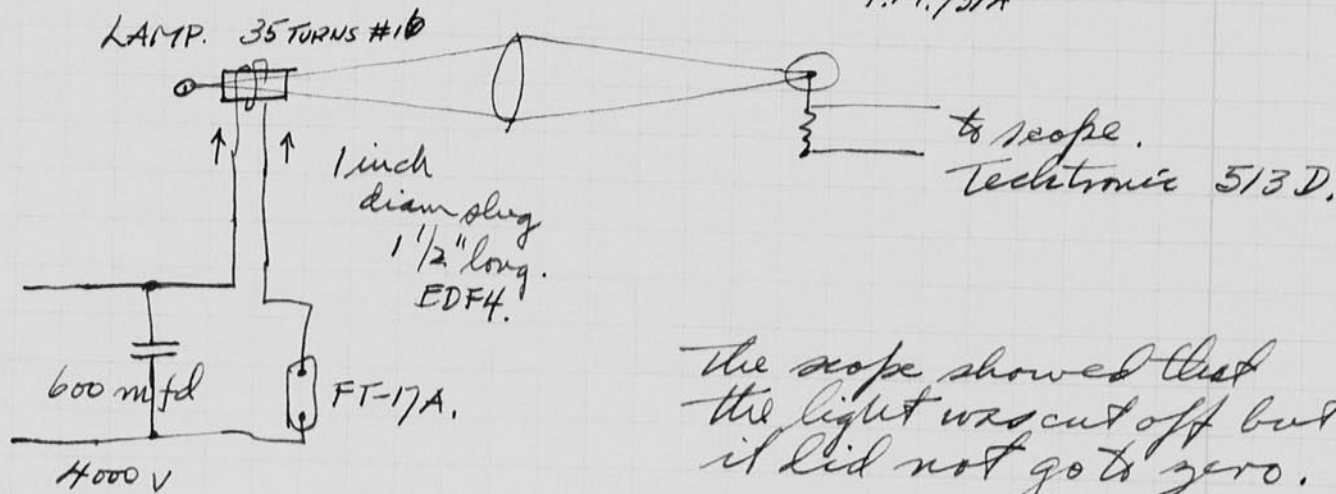


March 8, 1954.

Harold S. Edgerton

On Sat I set up the experiment below.

P.M. 9:31 A



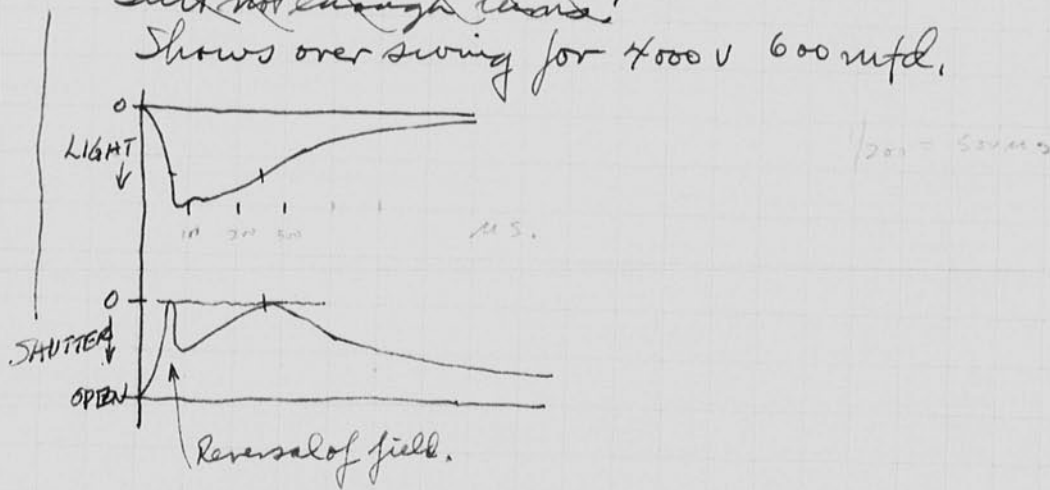
The scope showed that the light was cut off but it did not go to zero.

The amp will need a filter of about 3 to cut it down.

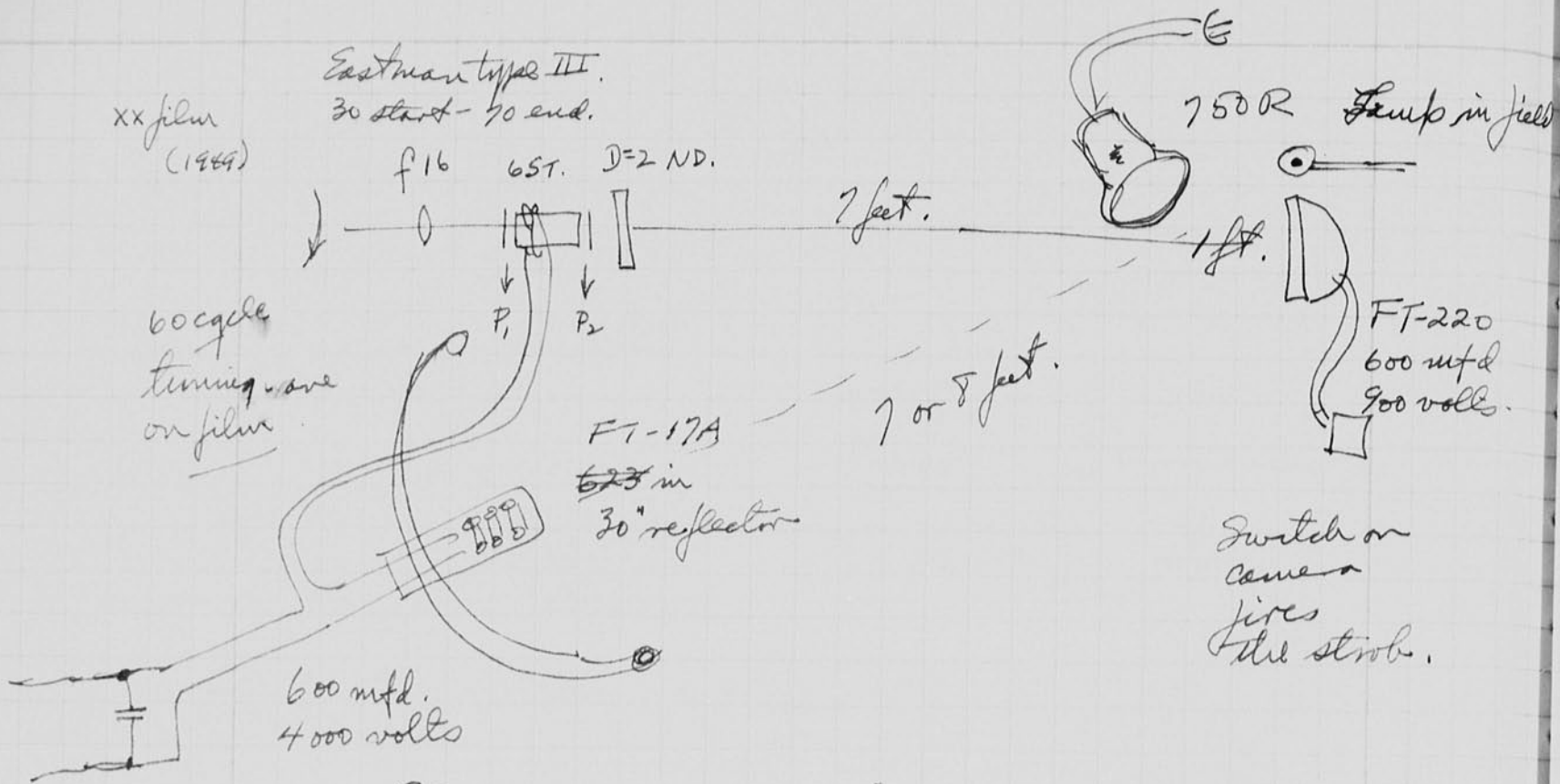
Today a new coil of #18 solid wire was wound the turns are about ~~50~~ 60 to 65.

Still not enough turns!

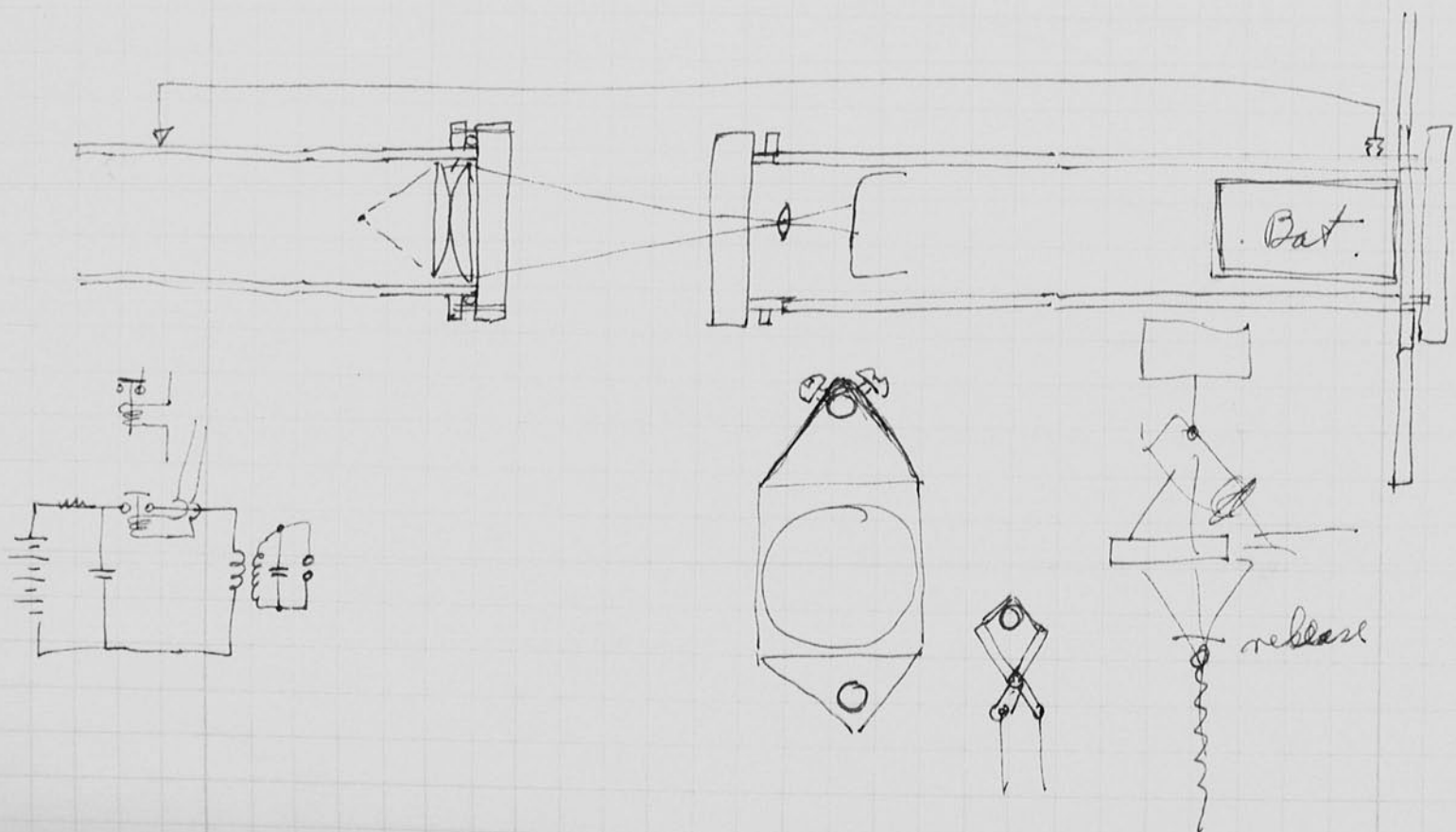
Shows over swing for 4000 V 600 mfd.



See next page for movie setups.



Film mailed to Rochester for development.



Mar 8 1954

Data from Lloyd Headley.

Harold E. Edgerton.

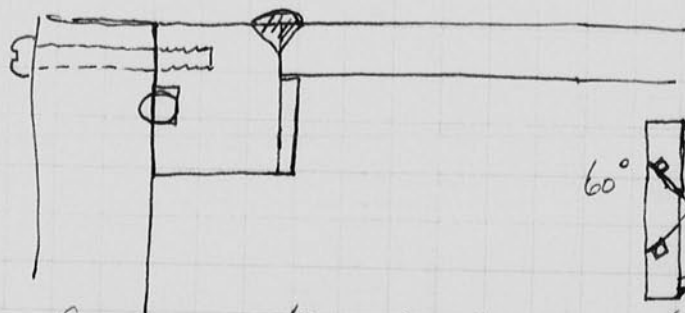
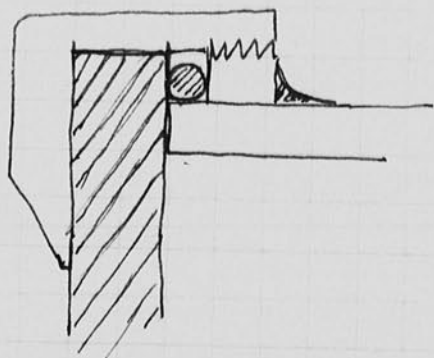
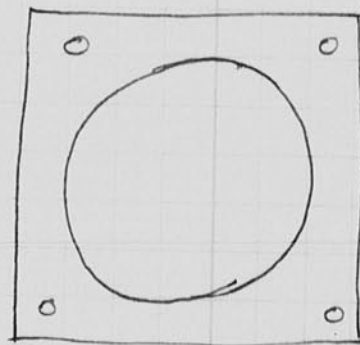
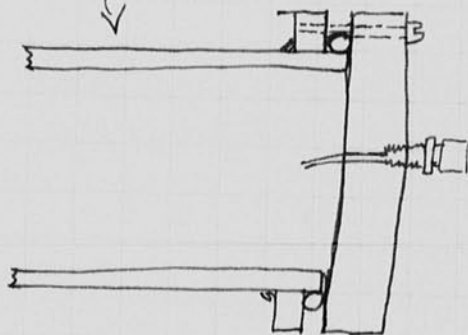
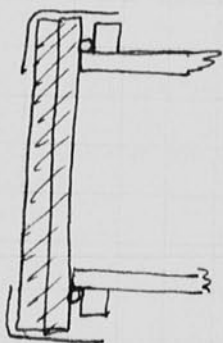
calc with 17-4 stainless 200,000#/sq inch

| Depth ft. | P.S.I. 1000 | 1" diam | 4" diam |
|--------------|----------------|---------|---------|
| 4000 | 2. | .0595 | .238 |
| 10,000 | 5 | .0773 | .3102 |
| 15,000 | 7.5 | .0908 | .3632 |
| 20,000 | 10 | .1014 | .4056 |
| 30,000 | 15 | .1198 | .4792 |
| 40,000 | 20 | .1350 | .5400 |

The 1500 meter camera cases, 4500 feet, 1 mile,
with 4" hole will require a 1/4 inch wall.

Endcaps .378 5000

Glass
thickness
= 1"

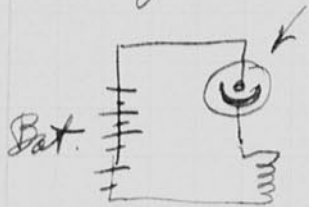


60°

The 1/2" thick wall tube will be good to the bottom of the deepest sea.

Amex Dept
March 10, 1954. Ballistic light meter for strobe.

I have been considering the ballistic meter method of measuring the light for electronic flash. The Weston meter people say that 10 ma sec is required for the input to a 301 type meter. I told Brodhead on the phone that this was too much. A figure of 1 ma second was given as an upper limit.



Incident light for $f 3.5$

20 to 60 lumens sec / sq foot.
(40)

meter area = 0.6 sq inch
= $0.6 \times \frac{1}{144}$ sq foot.

Lumen sec = $40 \times .6 \times \frac{1}{144} = 0.167$

lumen sec
on the cathode.

Assume 100×10^{-6} exposure time.

$$L \times t = .167$$

$$L = \frac{.167}{100 \times 10^{-6}} = .167 \times 10^4 = \underline{\underline{1670 \text{ lumens.}}}$$

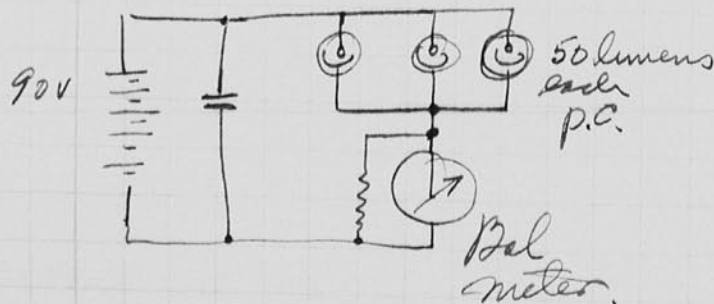
$$\text{with } t = 1000 \times 10^{-6} \\ = 10,000 \times 10^{-6}$$

$$L = 167 \text{ lumens}$$

$$L = 16.7 \text{ lumens.}$$

Data on 929. 145 lumens - 150 volts.

36 lumens - 75 volts.



150 lumens total.

1000×10^{-6} seconds.

$150,000 \times 10^{-6}$ lumen sec.

0.15 lumen sec. on the cathode

Should be set for f/16. $40 \times \left(\frac{16}{35}\right)^2$

$$\left(\frac{16}{35}\right)^2 = \frac{256}{1225} \approx \frac{28}{1500}$$

$$40 \times \left(\frac{16}{35}\right)^2 = 20.9 \times 40 = 835 \text{ lumen sec / sq foot.}$$

the 929 with a 0.6 sq inch cathode.

Limit the time to $1000 \times 10^{-6} \text{ sec} = .001 \text{ sec.}$

$$\text{then } \frac{835}{.001} = 0.835 \text{ lumen sec / sq foot} = 835000 \text{ lumen sec / sq foot.}$$

$$\frac{835,000}{150 \text{ lumen max}} = 557$$

foot photo cell (150V)

$$150 \text{ lumen (929)} \times 0.6 \times \frac{1}{144}$$

$$150 \times \frac{1}{.6} \times 144 = 36,000 \text{ lumen / sq foot on P.C.}$$

allowable with 150V.

$$\frac{835,000}{36,000} = 23.2 \text{ photocells.}$$

I need a more sensitive meter!

Limit photo cells to 3. then $\frac{1}{3}$ as much sensitivity say 0.14 ma sec.

See letter to Brodhead $3 \times 6 \text{ ma} \times 1000 \times 10^{-6} = .018$
ma. sec. sens.

Lamp Photocells
require filter of $D=1$
with 400 lumen sec / sq ft. (f/11).

allowable circuit Res ≈ 2000 ohms
with 180 or 200 volts on circuit.

Harold E. Egerton
Mar 12 1954

Yesterday Dr. Donaldson Dr.

T

and Miss Barry brought in two rabbits for flash experiments on the eye.

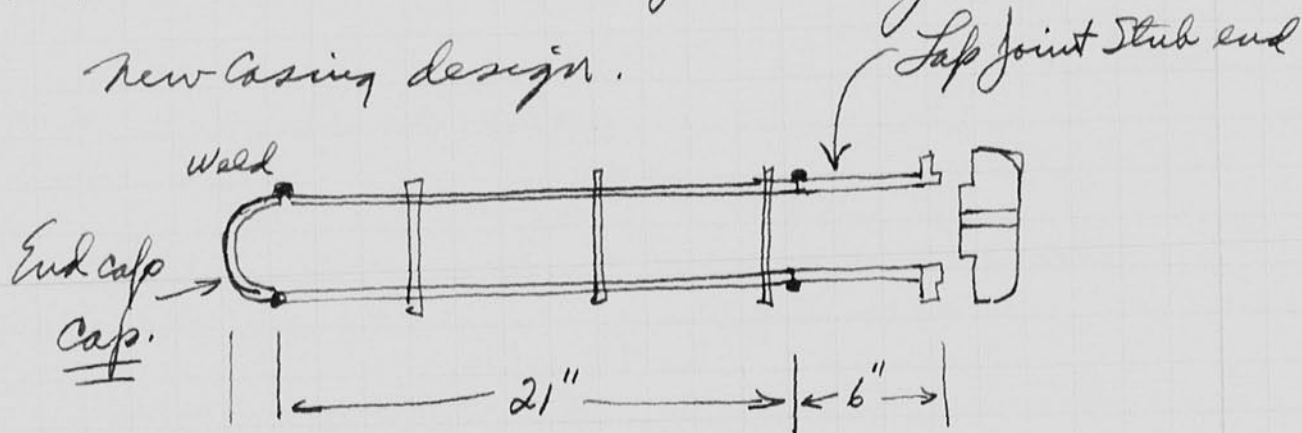
We set up 20,000 watt sec in an FT-618 and a 30 inch reflector. Light at 5 or 6 feet was 188,000 lumen sec./sq foot.

One flash was given on right eye. a cloud of smoke arose when the flash occurred, off the rabbit's face. no visual effect on the eye was noted, eyes were closed afterwards

Farmer and I from Photo switch were here today to make measurements. Used ordinary photo cell with I.R. filter, 934, and lead sulfide. Curves of output, peak, are different with voltage and watt seconds.

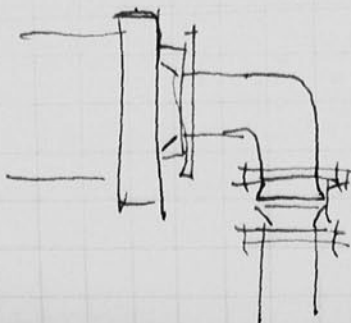
Finished 2 more 200 watt second lamps for Houdt. These were sent to Dakar French West Africa by Pau, Amer.

New casing design.



Industrial steels.

Camb. Mass. Mr. Ed Malcom



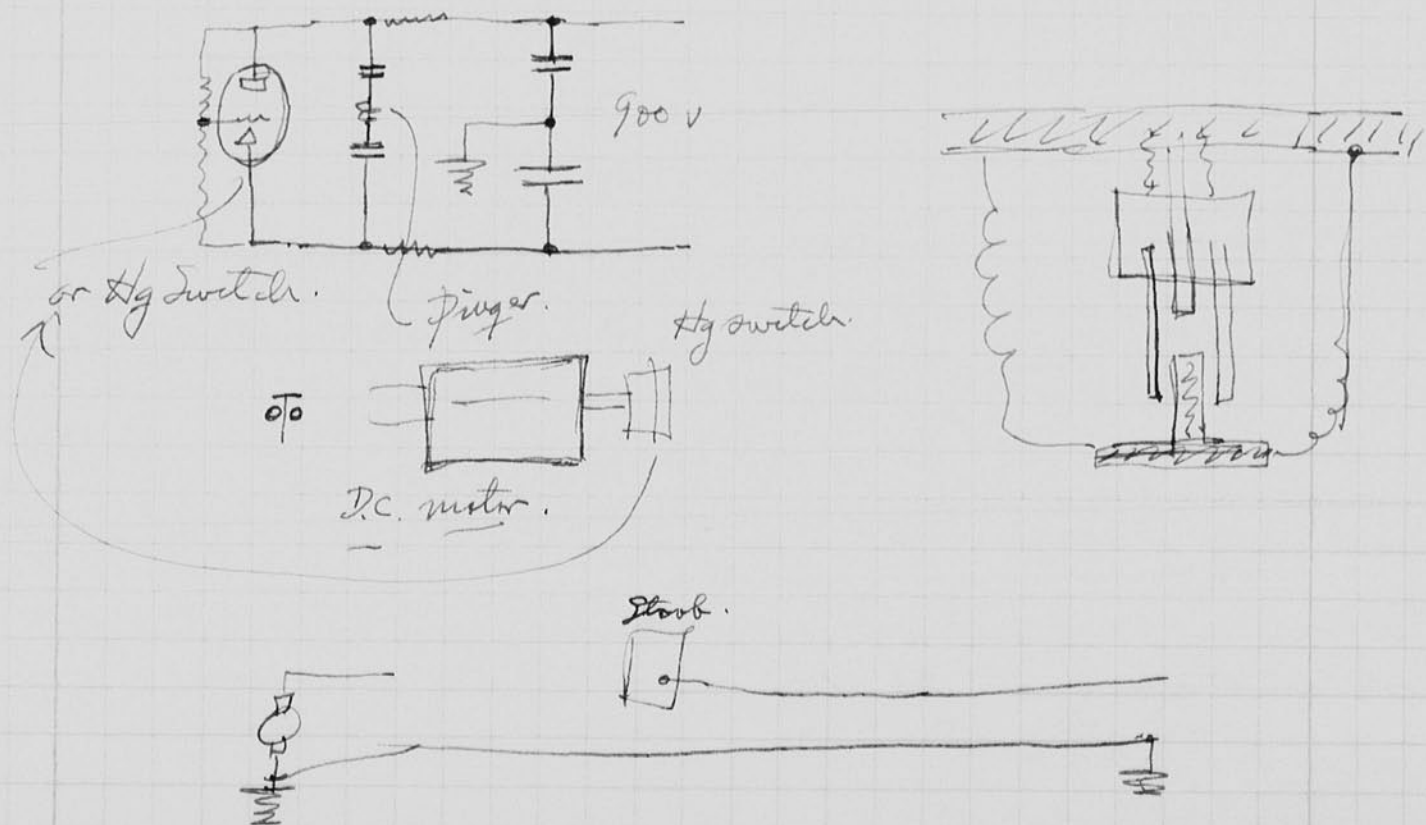
Sonar signal for Bottom indicator

- methods.
1. Pinger works continuously until camera is on bottom.
 2. Camera makes one big ping when it hits bottom.
 3. Camera makes series of pings on bottom.

Method no. 1. would be best with a signal keyed into the regular sonar signals to reinforce the echo. There might be some confusion due to angles.

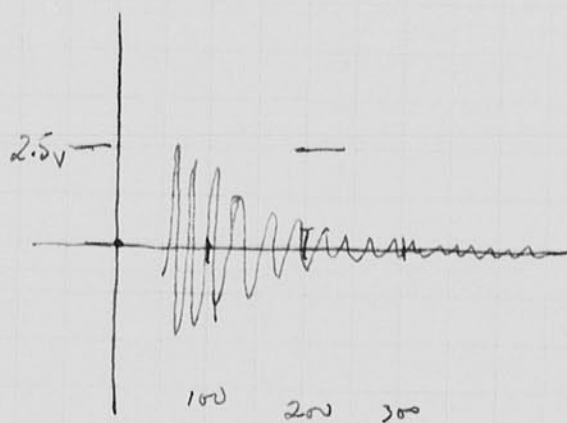
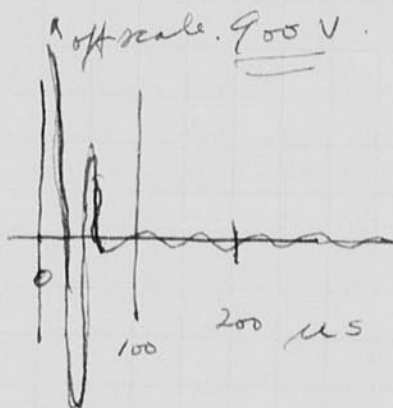
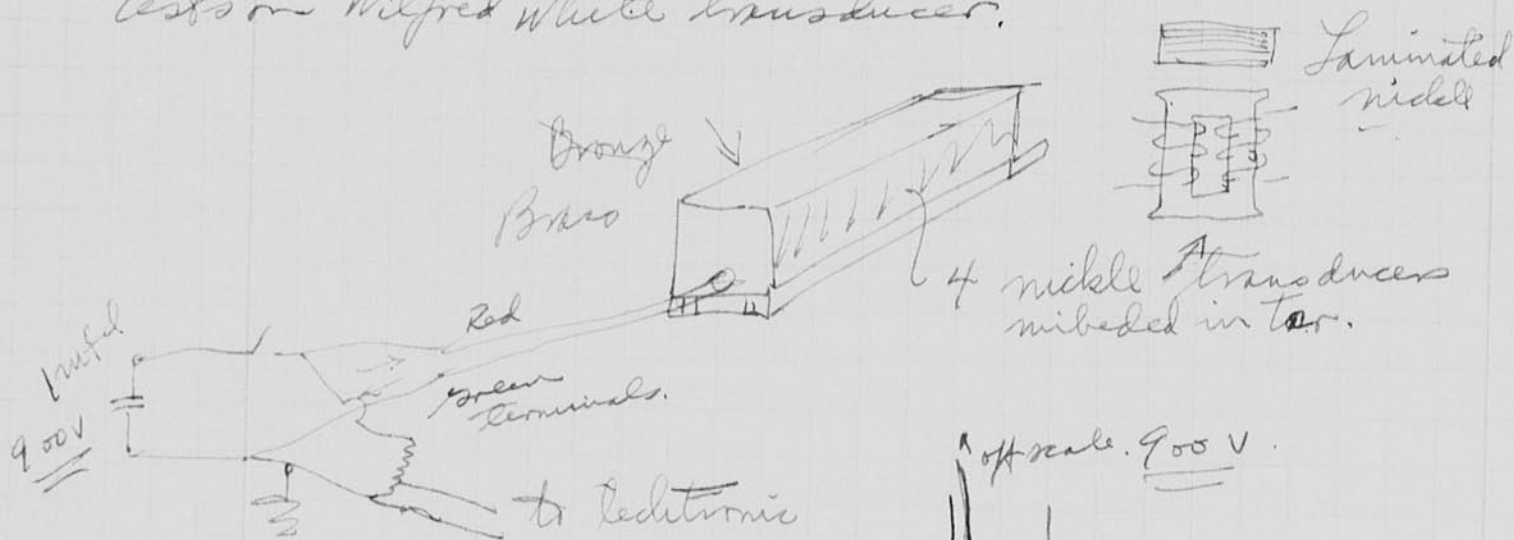
Method no. 2. could also have regular pings at long time intervals - depending upon change to not have two ping signals at once.

A fourth method would involve a method of resolving the direct and reflected ping from the bottom. The time between would be the height above the bottom.



Still a 5th method would be to change the ping rate when the camera was on the bottom. This could be accomplished by a resistance in the motor circuit so that the motor would run at a different rate when on the bottom.

Tests on Wilfred White transducer.

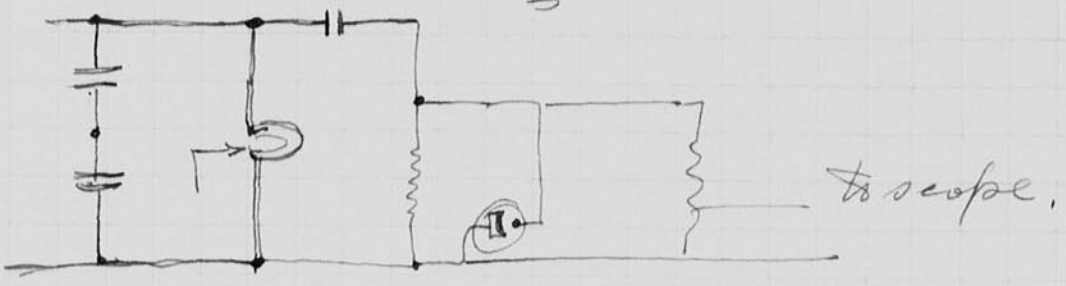
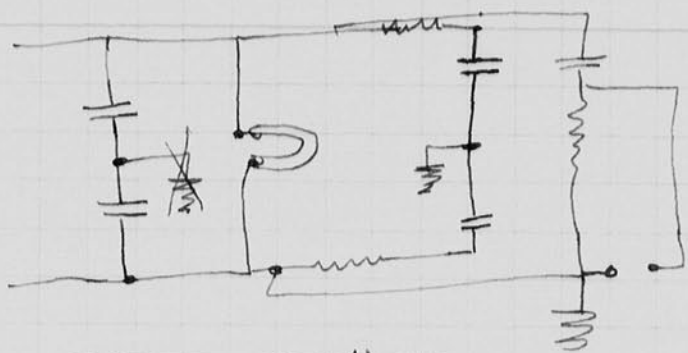


adjust almost
same with
.5 or 1 mfd.
1.5 - no more
2.5 - almost gone?
5. small.

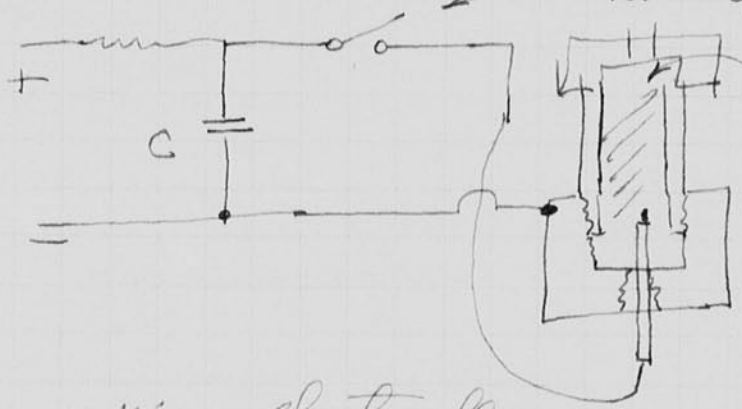
frequency about 30 KC.
Main bang is larger than this.

There was very little noise or motion in the transducer?
Inaudible at 30 KC.

Spark method.



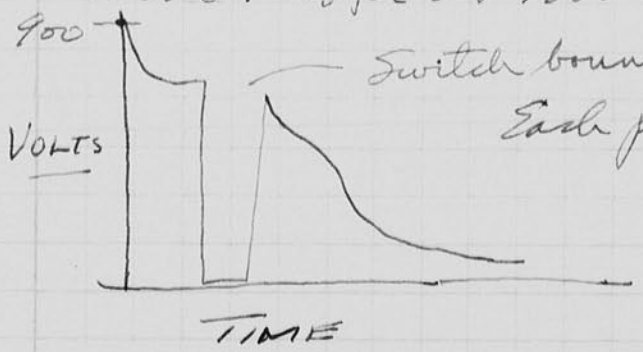
Performance is jittery due to switch(?)
Hand operated switch



Water squirted out of the top when several mfd at 900 volts was used.

Wire electrode in water was copper wire with insulation, plastic, over all but 1/8" at the end. #14 wire (or 16?).

Noise was audible.
With 1 mfd at 1000 volts the voltage

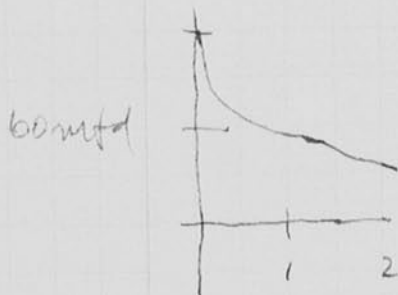
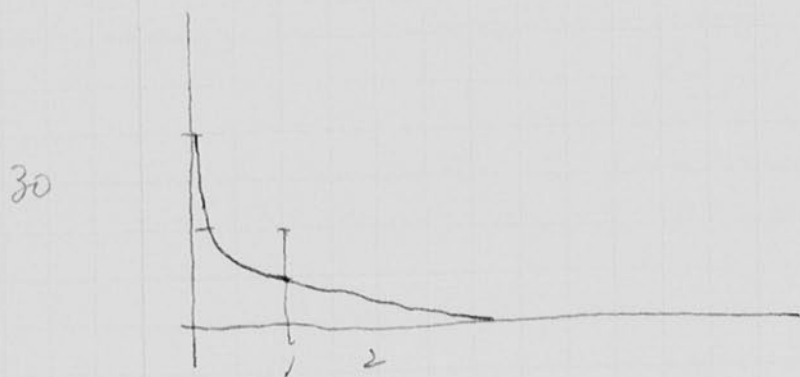
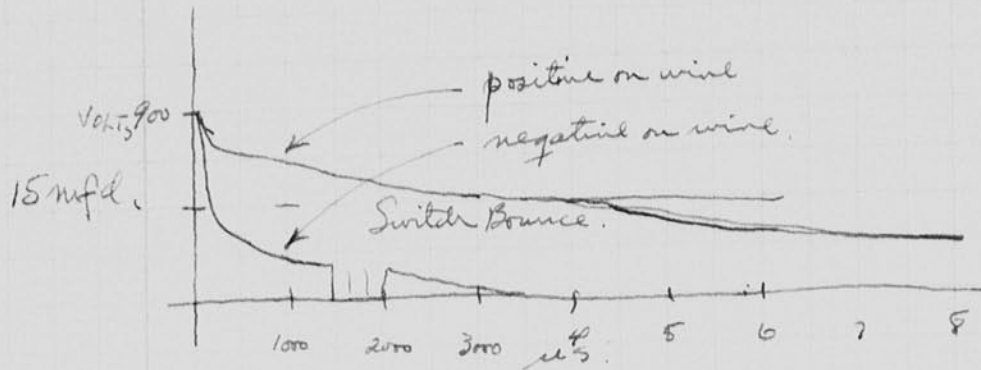


Each picture different due to inconsistent operation.
There is no arc at this level of sparking - and no sparking.

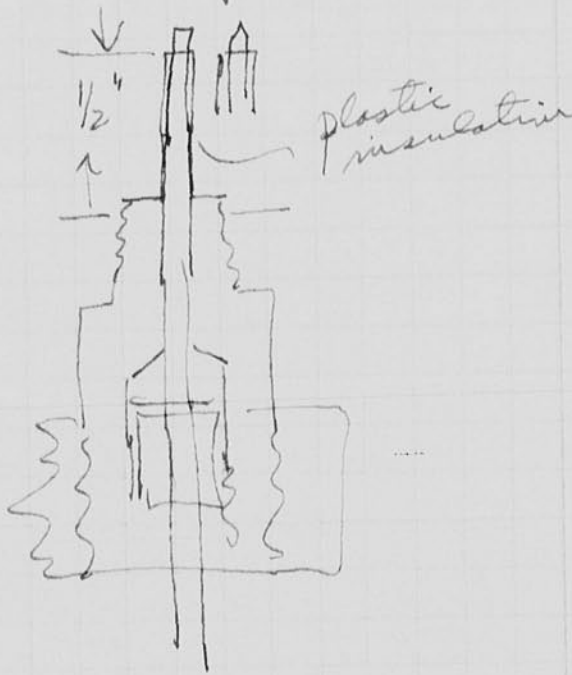
Polarity reversed.

The small electrode is now negative

Discharge rate seems faster and noise is greater.



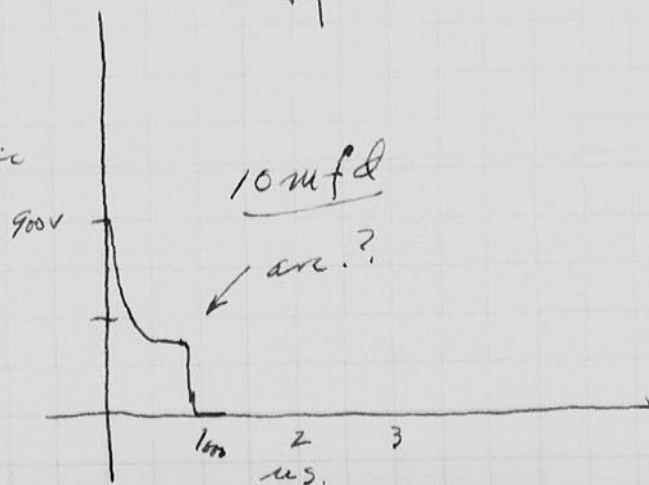
End of copper wire shows some melting on the tip.

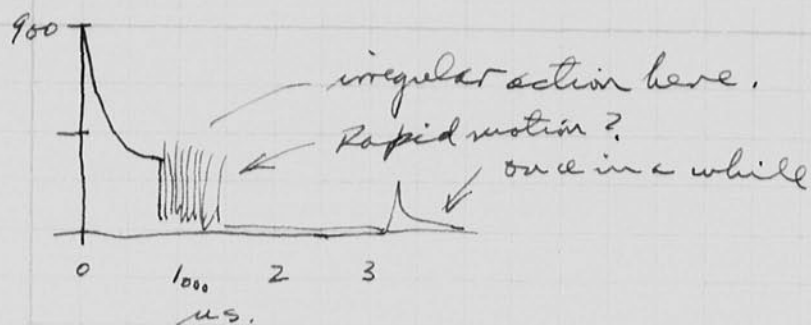


Removed this copper wire and inserted a nickel wire 0.6 inches with a very short gap to the plate

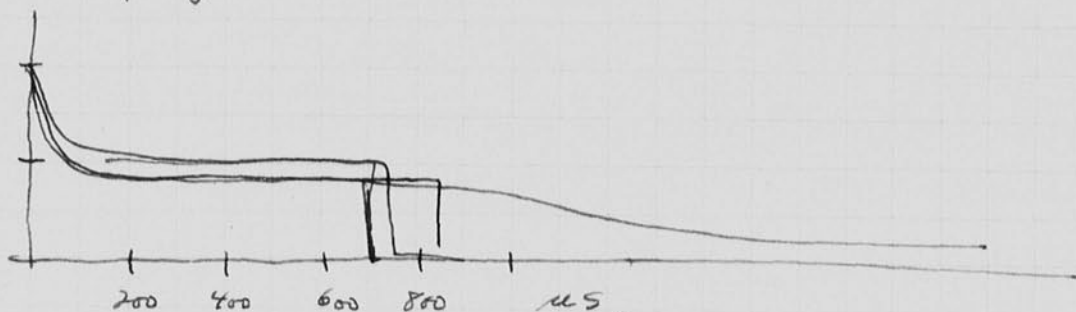


more noise than before.





Sweep speed increased 15 mfd 900 volts,

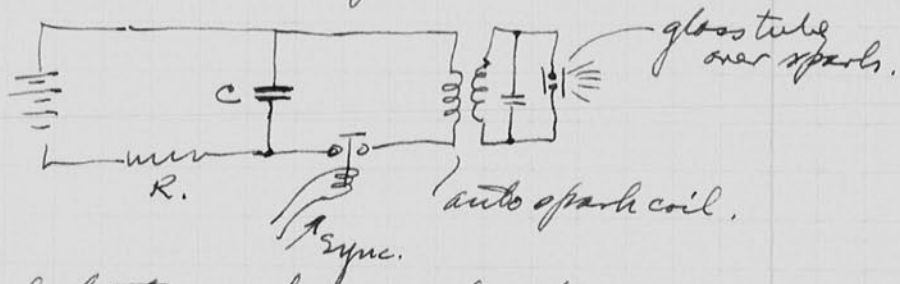


UUUU

March 18 1954
 B. G. S.

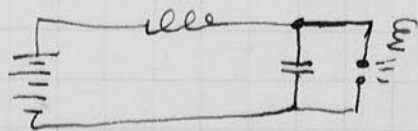
Spark source for silhouette photography
 under water.

Last summer I used a system as below

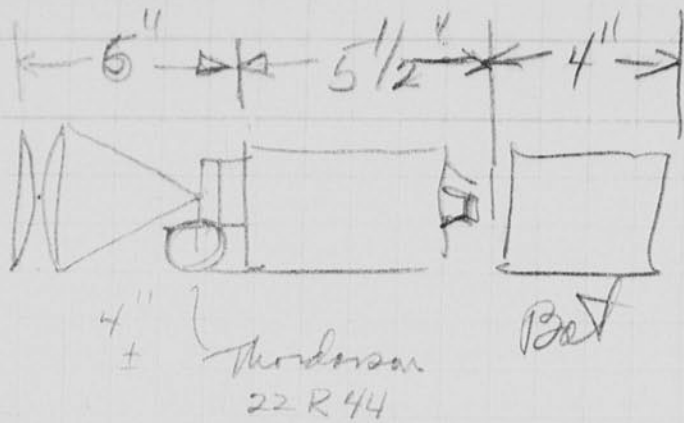


This worked ok but was fussy due to
 the spark irregularities. There were some
 misses and some double firing.

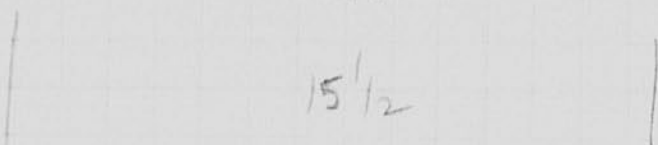
I tried a 6 volt battery yesterday into a
 model electric coil. This system takes a lot of
 energy out of the battery. There was a good
 spark at the contacts in the 6 volt circuit.
 Possibly this could be used as the light.



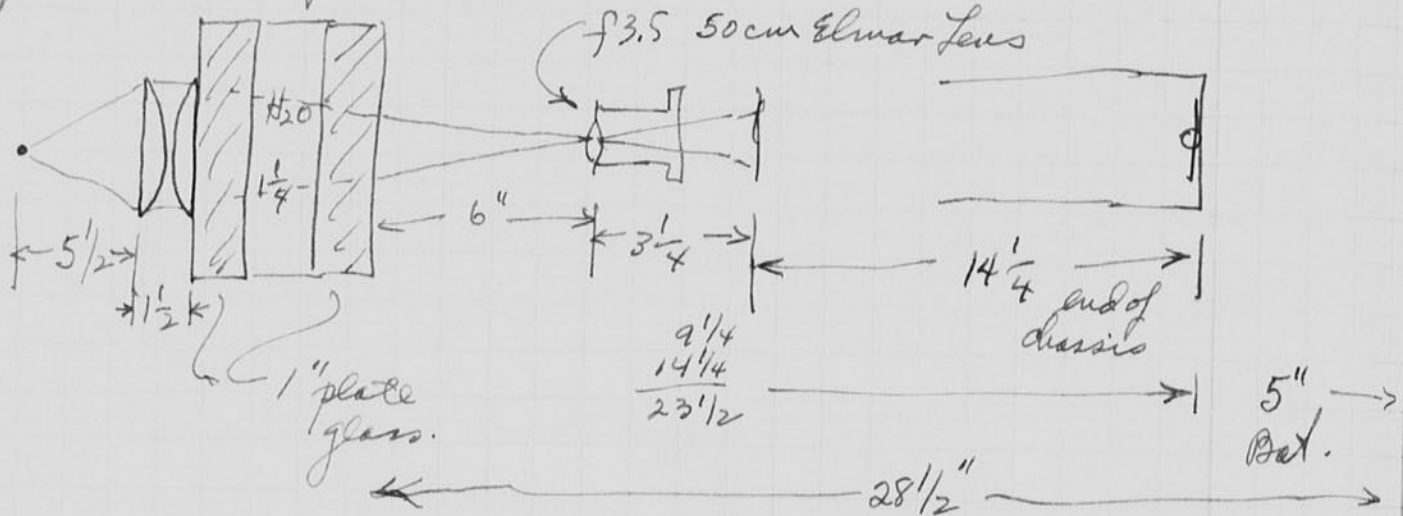
magnet to open the
 circuit at the spark.



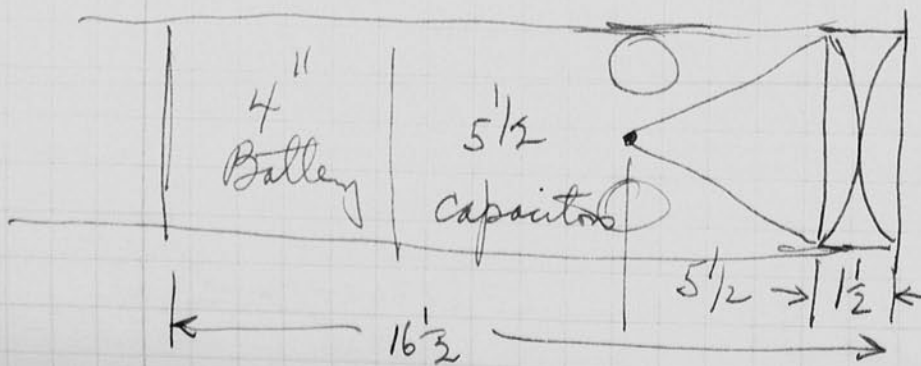
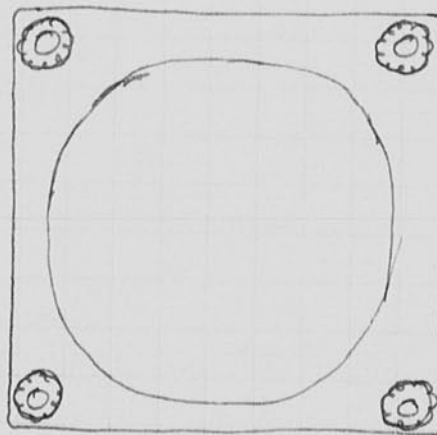
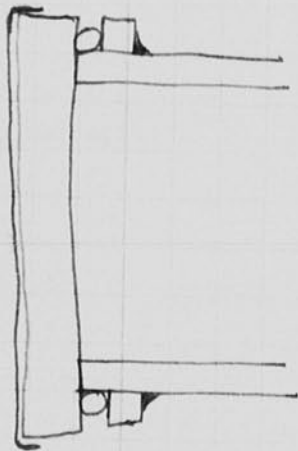
Silhouette camera design.



Continued optical setup for Silhouette camera.



total required.
 Casing come about 30" long.
 for cameras.



Light

Mar 21 1959
 Daniels & Estlin
 Edgerton.

Further tests as per p 25.

Roll

#1 XX film (out of date but in Refrigerator).

- f 22. (a) FT-220 600 mfd 900 volts and photo flood, 25 ft.
 the M.O. was "off" also the strobe "off".
 open
- " (b) Ditto but with 10,000 wet sec. in FT 617A 30
 M.O. shutter closes with FT-617 current.
- " (c) Ditto except the strobe light was 35
 not directed at the subject!

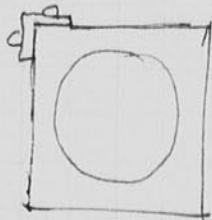
#2 Kodachrome film Daylight type.

f 5.6. Blue Background FT-220 600 mfd 900 volts,
 & #1 Photo flood,
 FT-617 was about 6 feet away.
 30 ft to trigger off

#3 Kodachrome Daylight.

f 2.7 Tilt # 2

note - Strobe for above was
 1200 mfd at 4000 volts.
 with a FT-623 in a
 30 inch reflector.



March 27 1954

Harold E. Edgerly

27

Log of etc.

- Feb 17. Washington ASWAP adm Sylvester,
.. 26 N.Y. Yacht Club, 37 West 44th St.
Jacques Cousteau Jim Dugan.
McLean.
- Mar 5 Cousteau in Washington at Nat. Geo. Soc.
Lecture in Constitution Hall.
- Mar. 9 Holgar - R.C.A. Lecture at MIT for I.R.E.
17 Geo Harrison lecture to 620 class 20E121.
17 HEE lecture to Grad House students
Bensley, 154, every
22. I went to Washington to see Houot and
Willm at N.G. Soc.
25. Houot and Willm were in Boston to visit M.I.T.
27. Talk at Nottingham conference, 9:15 am
Samuel's chairman. Toules.

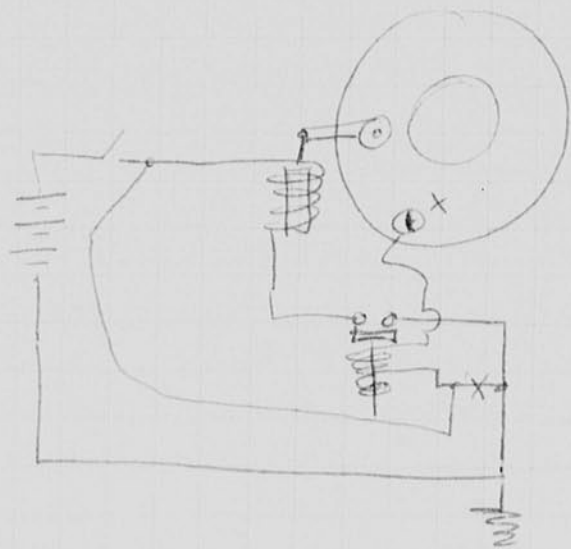
I was asked by the Nat. Geo Society
on the 5th of March to go to Dakar Africa
to help Cousteau with photo graphy on
the Bathyscaphe.

It now appears that Houot will take the
Bathyscaphe back to France - Toulon in April.

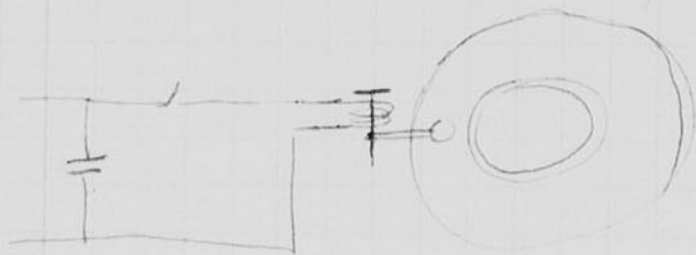
March 30, 1954

Hassel Elgerton

Camera with Shutter operated by a magnet.



Magnet opens
shutter. X contacts
causes main
circuit to open and
opens shutter.



Pulse method of operation

Alan Stenning & Bob Kriebel Engine Lab. M.I.T.

Discussed Schlieren of a pulse of gas in a gas turbine. These men plan to set up an experiment in about two months.

March 31, 1954

Harold E. Edgerton

16 mm XX film came in today that was taken on March 21 page 26. 3 shots on one film.

#1. FT-220 was greatly over-exposed due to no filters or magneto optic shutter closing. This was a check on the light without the strobe or m.o.

2. The m.o. put out the tungsten photo flood. The strobe gave normal exposure for about a second. The FT-220 was still over exposed but not too much - no halation.

3. Shows FT-220 with magneto optic only. Tungsten lamp goes out.

These photos show wobble on the screen since the camera operated differently each time. Some image wandering.

I would say that the experiment was tremendously interesting as a preliminary attempt. I hope the color shots come in tomorrow.

I called Babbitt last week. He had not performed any experiments as yet on the arcs for density as we had discussed.

This method is a most powerful one for photographing the circuit breaker arcs etc.

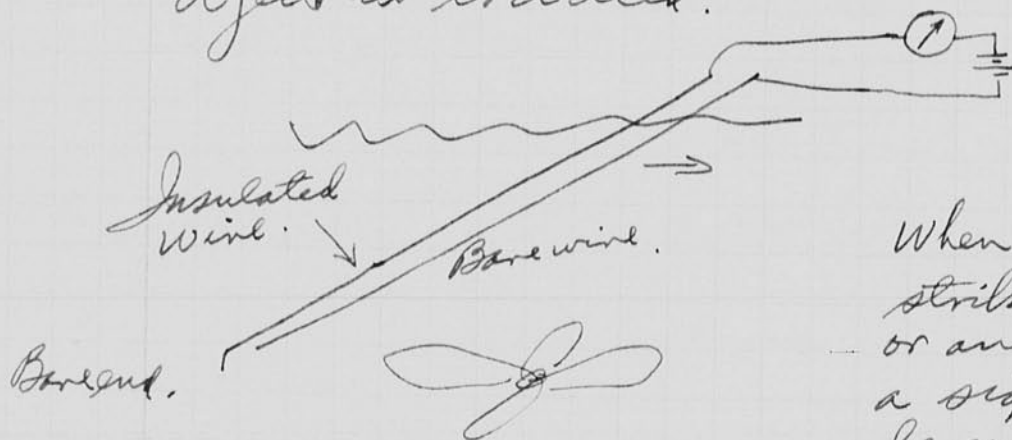
April 2 1954

Harold E. Edgerton.

Crowley of Diamond Power Co. (television and power plants) went with me to visit Geo. Perry at the Boston Harbor. Irene Mae is the name of his ship - for diving. We plan a television demonstration on his ship after the demonstration at Woods Hole on May 15, 1954.

Perry wants very much to find a propeller, 14 ft Bronze, that was lost from a tanker in 19? when run out of fore river. The prop. was not on the ship when she ~~stopped~~ started after leaving the pilot near Groves light.

I plan to interest Perry in using a search method of small negative contacts which will give a large change of current when a metallic object is touched.



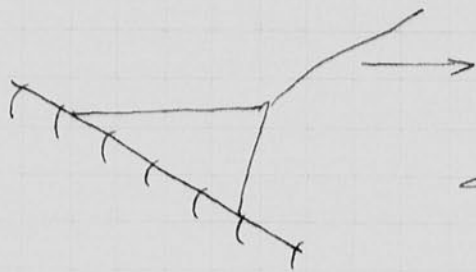
When the small end strikes the propeller or any metal object, a signal change will be noted above on the ship.

A small negative electrode quickly builds up a layer of gas which increases the resistance. When a large metal object is struck, the resistance will greatly decrease.

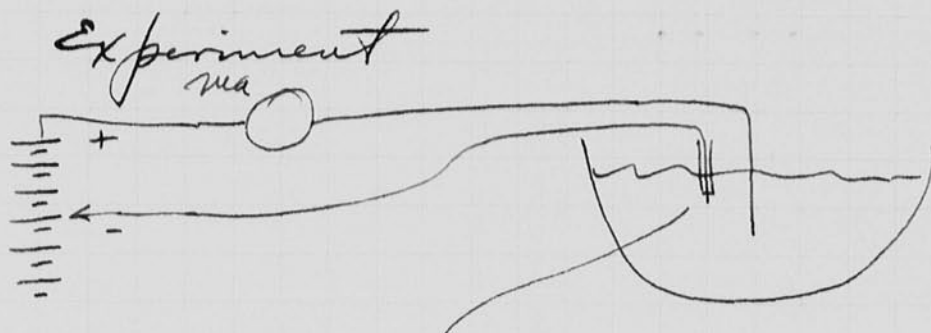
A relay could be put in the circuit to ring a gong when the prob hits metal.

a large rake could be built with a large collection of points all of which would give a signal when metal was hit.

Searding
rake for metal.



Insulated wire
with small
sharp points
protruding from the
insulation.



Bucket of
sea water,
enameled.

negative end insulated except for
1/4" of #16 copper strand.

Gas bubbles form on negative end.

| | ✓ | amp. |
|------|-----------------|----------------|
| 1.3 | -1.4 | 1.1 ma. |
| 2.9 | -2.8 | 64 |
| 4.4 | -4.6 | 162 |
| 6.05 | -6.3 | 268 |

many bubbles on small negative end.

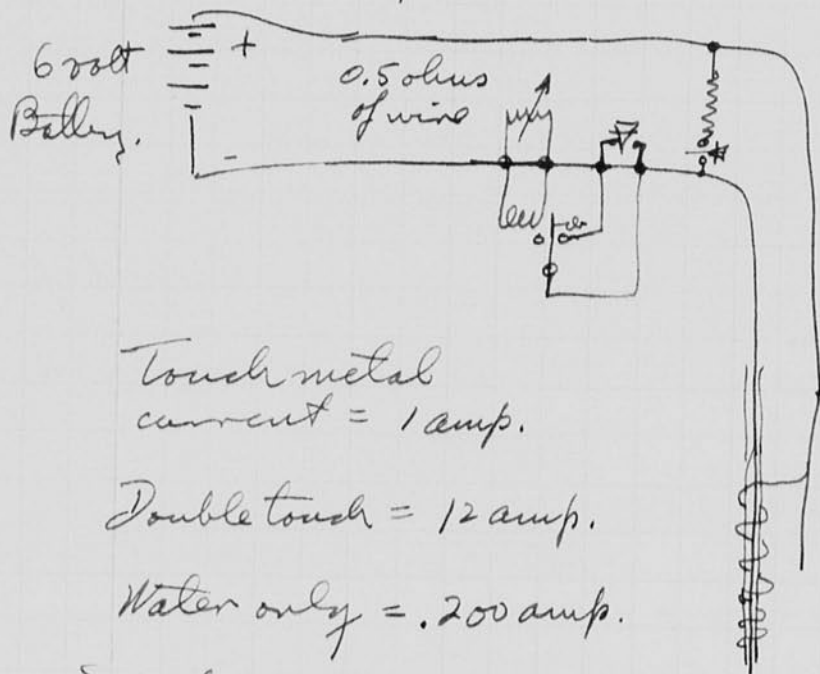
| | | | |
|------|------|--------------------------------------|---|
| 6.05 | -6.3 | 144 | Smaller end of metal on negative end, |
| | -1.4 | .080 ^{ma.} amps. | 80 ma. |
| | -1.4 | 2.8 ma | 60 ma on 2" x 15" x .040 stainless steel |
| | -2.8 | 50 ma | 200 ma - becomes more 400 ma when touched closer to the steel with anode. |
| | -4.6 | 100 ma. | 500+ on steel. |

Try 100 feet of cable #14 twin conductor

Resistance = 200 ft. #10 is 0.5 ohms
 #14 = 2.5 ohms/1000 feet.
 200 ft res = 0.5 ohms.

6 volts gives $\frac{6}{.5} = 12$ amp short current.

Relay resistance for 6 volt relay =



Touch metal
 current = 1 amp.

Double touch = 12 amp.

Water only = .200 amp.

Select sigma relay Series 4.

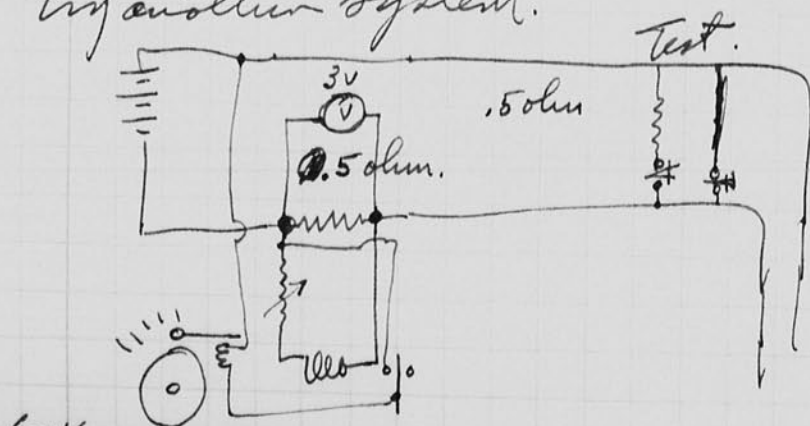
10.5 45 ma operate 20 ma release
 10 ohms.

Set shunt R on relay so that current is
 5 ma in ~~shunt~~ relay.

200 ma \rightarrow 5 ma. 40 to 1 ratio.

$\frac{10}{40} = 0.25$ ohm.

Try another system.



GONG.

Single touch.

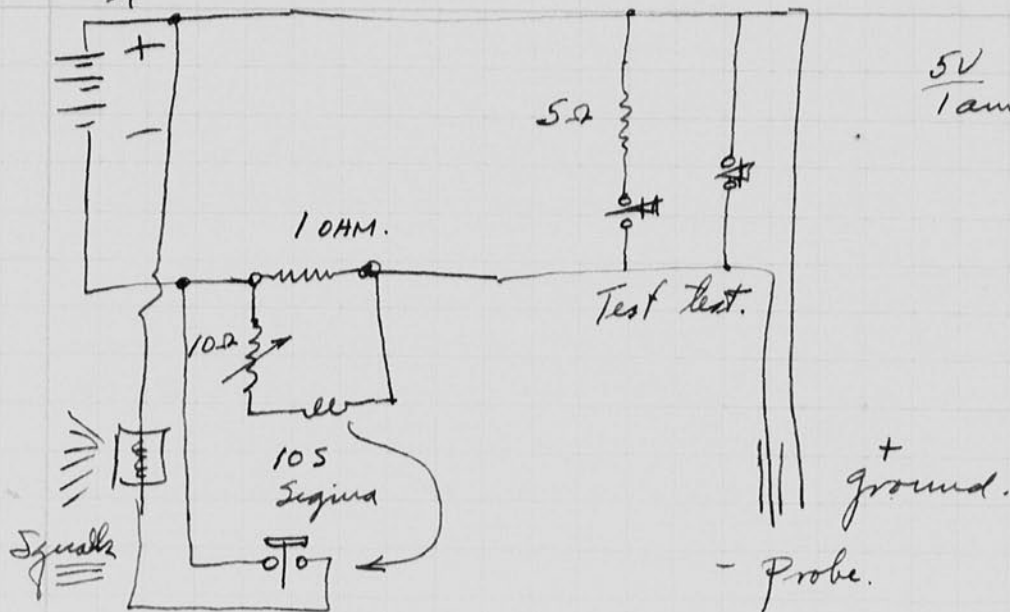
current = 1 amp.

45 ma reqd. to operate
 relay.

$V = I \times R = .5$ volt.

$\frac{.5}{.045} = 10$ ohms.

2nd try:



$$\frac{5V}{1amp} =$$

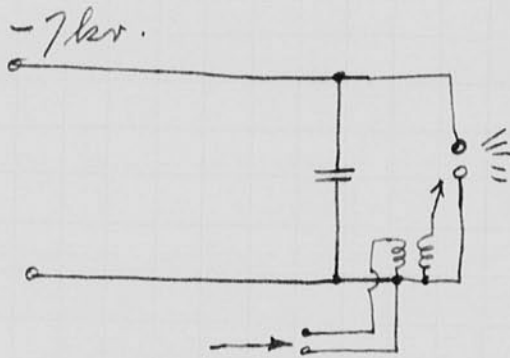
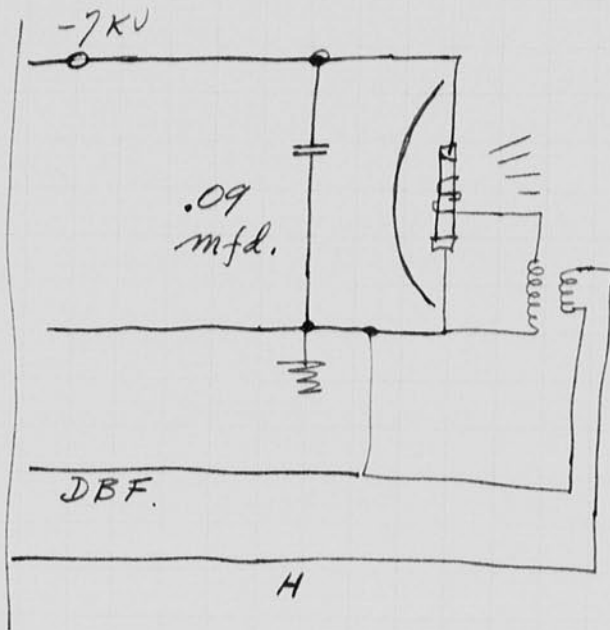
Spark set for use with Rafatron power supply.

Apr 2 1954

Herschel Edgerton

2208 C4 Drawing E.G. 26.

To
2208
Power
Supply.

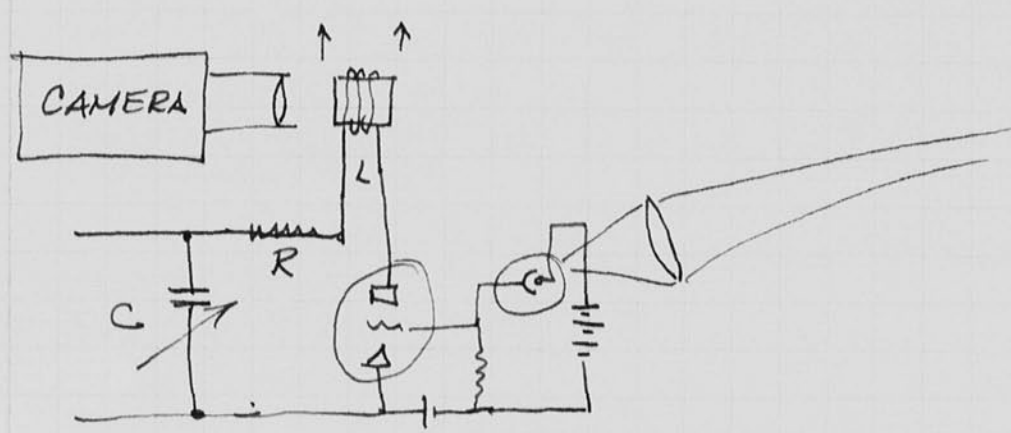


April 5, 1954.

Speed Electron. Jaraday Filter.

Photography of explosions such as the atomic ones could use a filter that varies with time so that over and under exposure would not be serious.

I propose that a triggered transient could be put into an open Jaraday shutter to close quickly - and then open at a preset rate to match the desired density to a first degree.



Phototube trigger.

$$FT-623.$$

$$\frac{4000V}{R} = 1000$$

$$R = 4 \text{ ohms.}$$

The time constant should be adjustable from 0.01 to 0.1 second.

From page 25 - 65 turns on 1" slug EDF4 gives cutoff at about 1000 amperes.

Increase Set $E = 450 \text{ volts.}$
 $I = 1000 \text{ amperes.}$
 $R = 0.45 \text{ ohms.}$

Increase turns to 200. then current = 333 amps.
 $R = 1.35 \text{ ohms.}$

$$RC = 0.1$$

$$C = \frac{0.1}{1.35} = 0.74 \text{ farads.}$$

$$\frac{740,000 \text{ mfd.}}{500} = 1500 \text{ capacitors!!}$$

$\frac{1500}{50 \text{ w.s.}}$
 $\frac{75000 \text{ watt sec.}}{}$ The coil would get Hot.

The optical path for the calc on page 36 is about 1 inch. This could be increased to about 6 inches. Then the amp turns could be decreased for the same effect.

$$\frac{65 \times 1000}{6} = 10,833 \text{ instead of } 60,000 \text{ amp turns.}$$

The turns could be increased to $200 \times 6 = 1200$.

$$\frac{10,833}{1200} = 9.0275 \text{ amperes.}$$

$$\text{Then } R = \frac{450}{10} = 45 \text{ ohms.}$$

$$RC = 0.1 \quad C = \frac{0.1}{45} = .0022 \text{ farads}$$

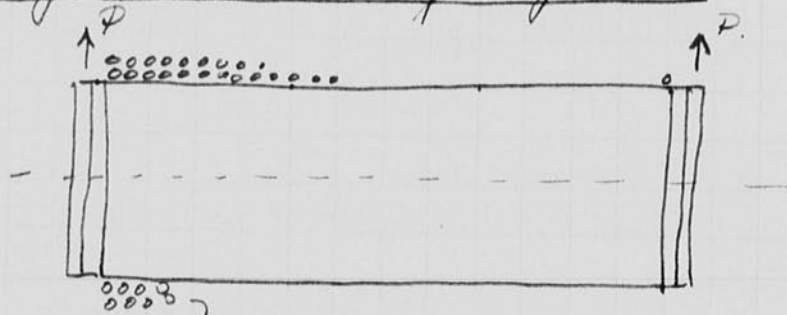
$$= 2,200 \text{ mfd.}$$

$$= 4 \text{ capacitors.}$$

This looks more reasonable!

Probably can promise with a shorter length than 6."

→ Try a 3 inch length of EDF4



Coil on glass cylinder.

$$200 \times 3 = 600 \text{ turns of wire}$$

$$\frac{330 \text{ amperes.}}{3} = 110 \text{ amperes.}$$

$$R = \frac{450}{100} = 4.5 \text{ ohms.}$$

$$C = \frac{0.1}{4.5} = .022 \text{ farads}$$

$$\frac{20,000 \text{ mfd.}}{500} = 40 \text{ capacitors.}$$

$$\frac{50 \text{ watt sec each.}}{2000 \text{ watt sec total.}}$$

April 8 1954
Harold Edgerton

FX-3. test.

37

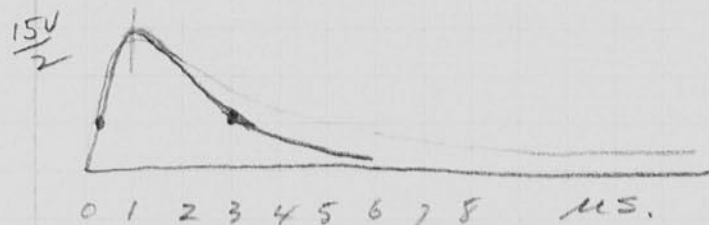
1/4 mfd 4KV. 38" to Technomic

old lamps.

5908-1 2.8×10^6 peak c.p.

.48 volts = peak.

with x100 filter in P.S.



$$\text{Peak cp} = \frac{2.8 \times 10^6}{100} \times \frac{15}{.48} = 0.88 \times 10^6 \text{ p.c.p.}$$

$$3 \times 10^{-6} \quad 0.88 \times 10^6 = - 2.64 \text{ h.c.p.s.}$$

$$\text{input} = \frac{1}{24} \times \frac{4000^2}{2} \times 10^{-6} = \frac{16}{8} = 2 \text{ watt sec.}$$

$$\frac{2.64}{2} = 1.32 \text{ c.p./watt.}$$

Normansen
10 sq ft. 3x3 ft at.

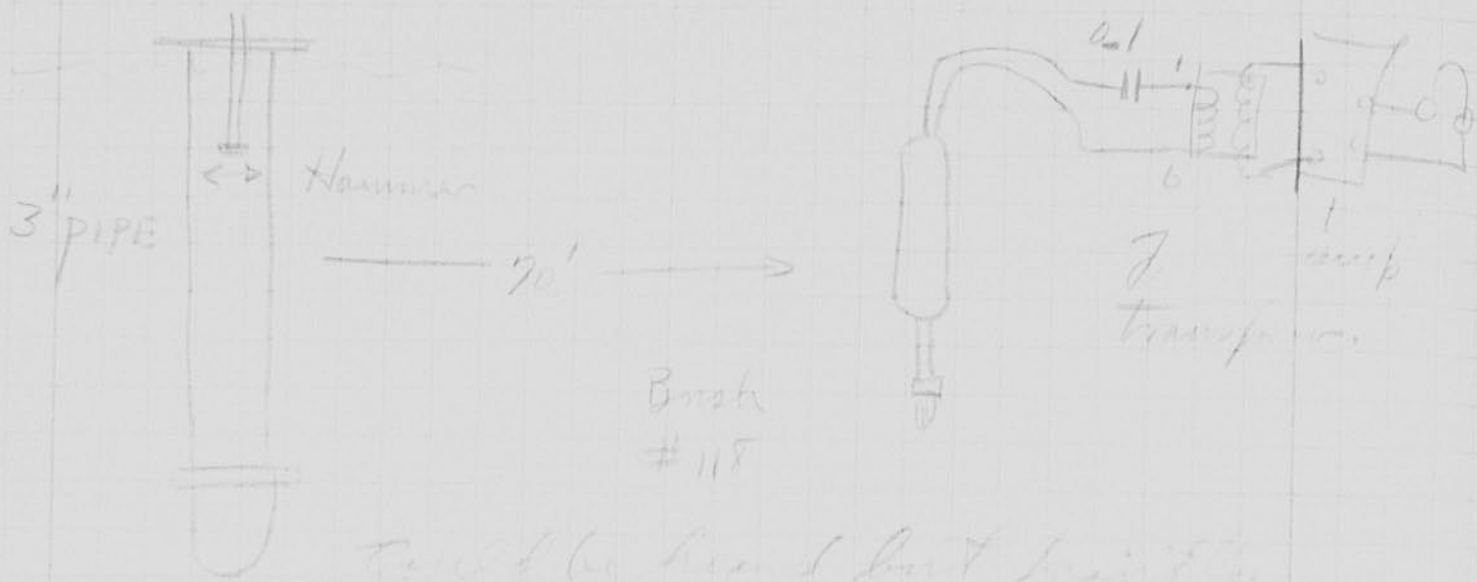
Same light as micro flash.
8KV - .2 mfd. desired.

10 watt sec.

April 11 1954

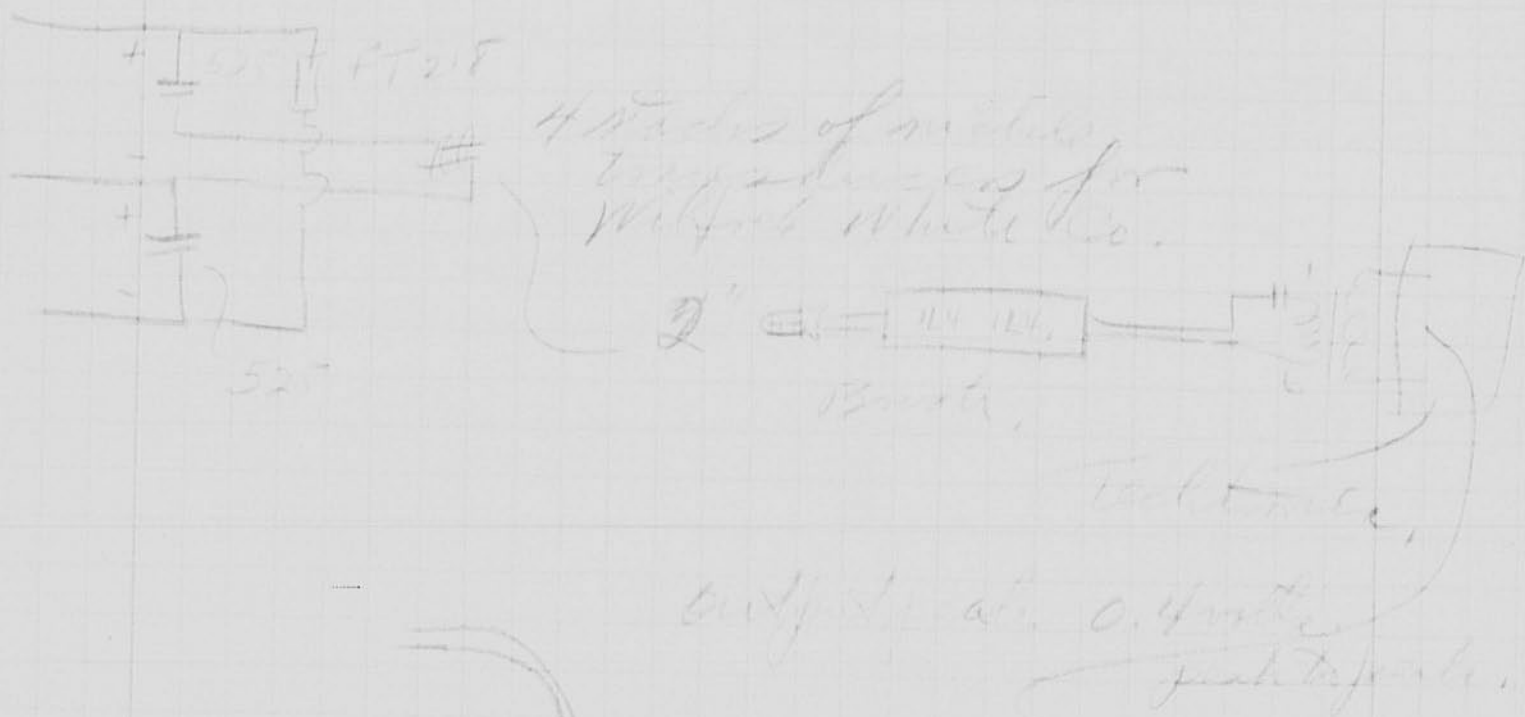
Harold Edgerton

Tests in M.I.T. Pool.



could be heard but faintly

Returned to 200V

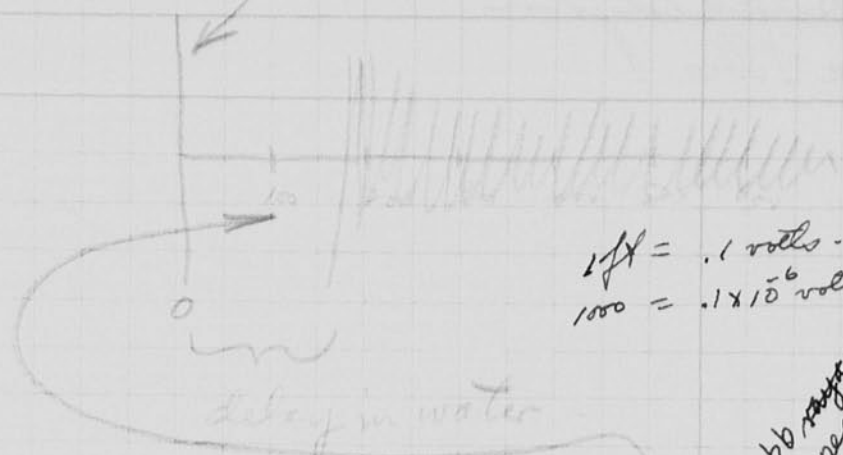
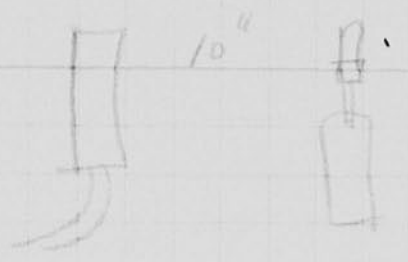


White transducer

4 stacks mica laminated,



← Scope triggered by light



$1 \mu\text{s} = .1 \text{ volts}$
 $1000 = .1 \times 10^{-6} \text{ volts}$
 -96 db response
 per dyne/cm²

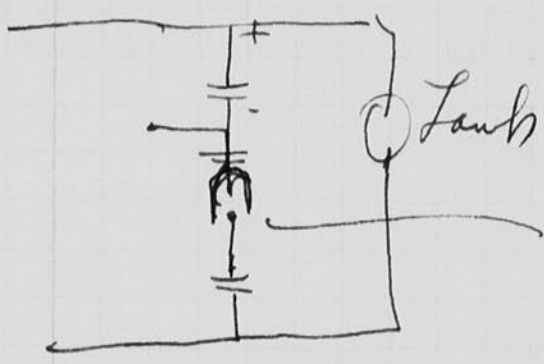
$v = 5000 \text{ ft/sec}$ $\frac{1}{5000} \text{ sec} = 200 \mu\text{s}$ ✓

.08 volts per dyne/cm² initial

Signal has lot of hash. not single frequency.

-96 db re 10¹⁰

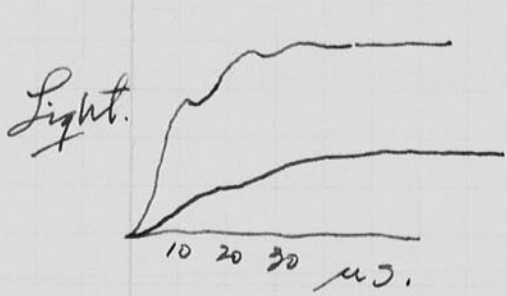
Apr 12 1954 ~~to~~ cont. exp.



Copper wire in pressure tube
 See page 22, 23.

Stopped after 10 or 20 flashes,
 makes larger noise than
 the white transducer.

Light output, without any series impedance.



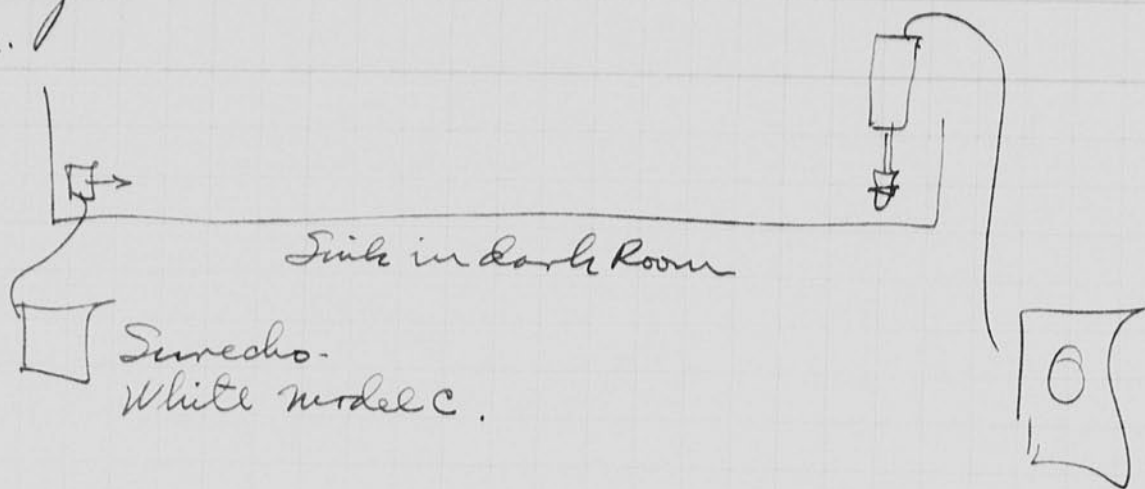
without
 with white transducer.

4 studs middle
 with wire on each,

40 April 12 1954

Harold Edgerton
Joe Vitka.

Sound test,



Model C. Surrecho. 0.7 volts peak to peak.

Stub in series with 250 mfd 900 volt and FT 2:1
voltage about 1/3 of the above

Information from Joe Vitka. Van Loung ^{Students.} Bill Paar. Geo Schwentz.

25 db loss at bottom surface

20 db loss per kiloyard. 1000 yards = 3000 feet.



(A) At 1 mile the signal is down
by $60 + 25$ db. = 85 db.

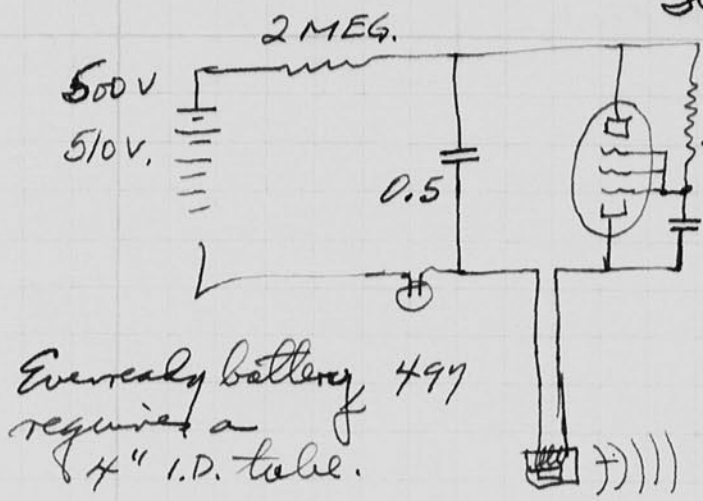
(B) With transducer at bottom
30 db in water only loss.
should be 35 db greater than
at surface.

Surrecho can read bottom at 2500 feet.

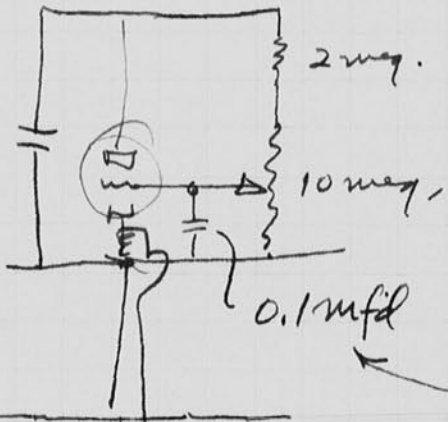
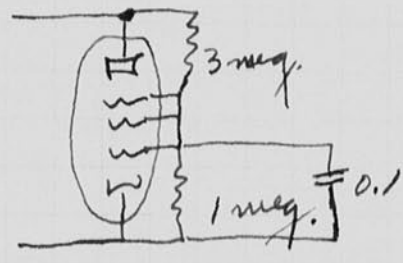
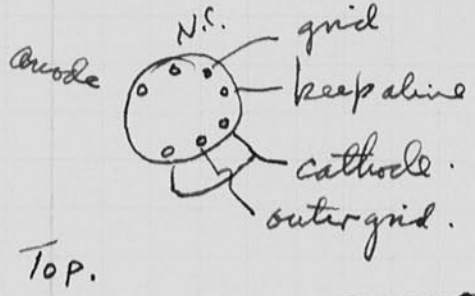
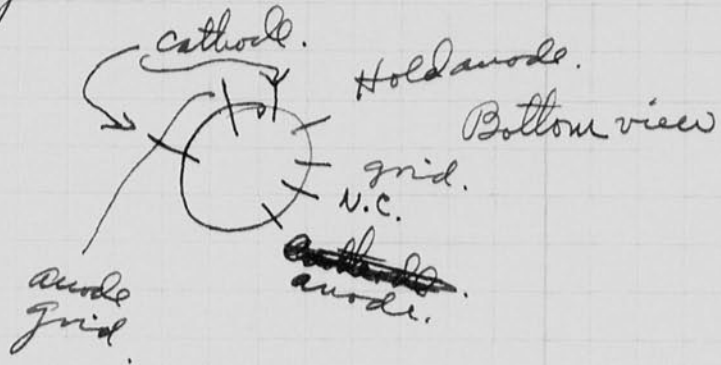
$20 + 25 = 45$ db.

Driver

Stroboscopy



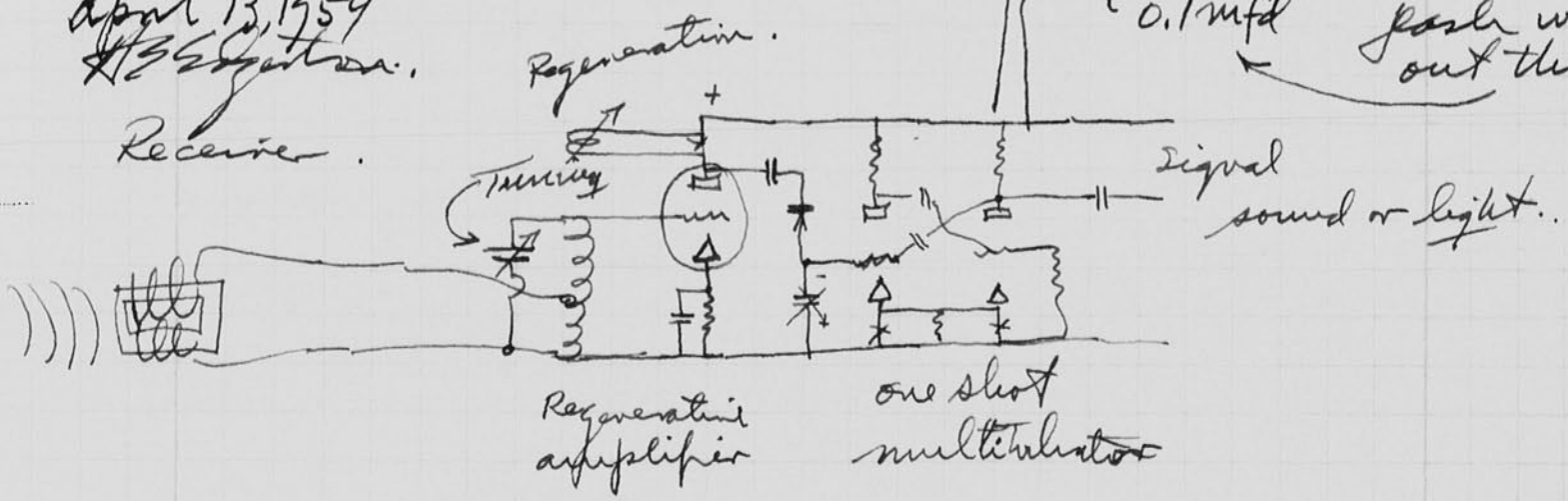
Evenly battery 497 requires a 4" I.D. tube.



does not flash with out this!

April 13, 1954
H.S. Egerton.

Receiver



Regenerative amplifier

one shot multivibrator

42 April 16 1954

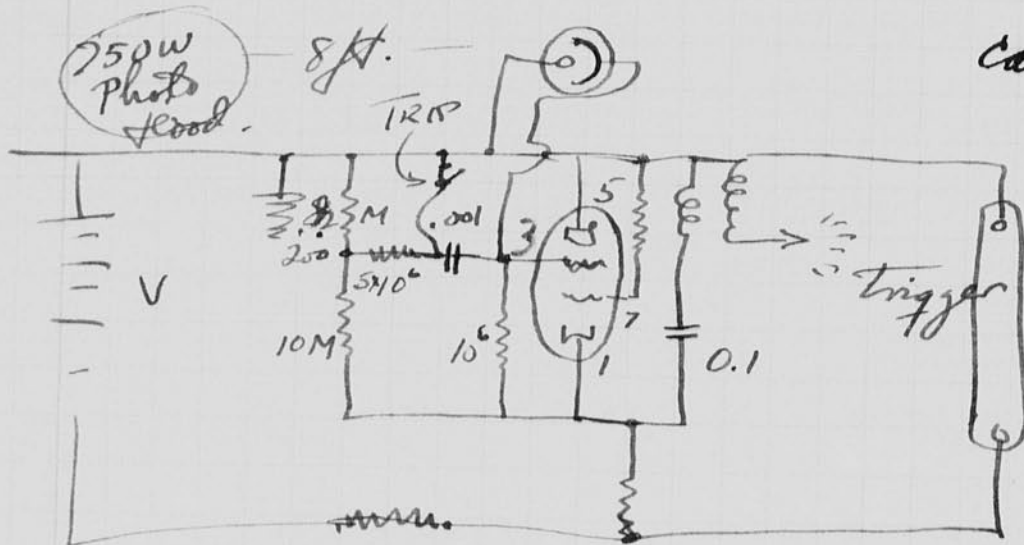
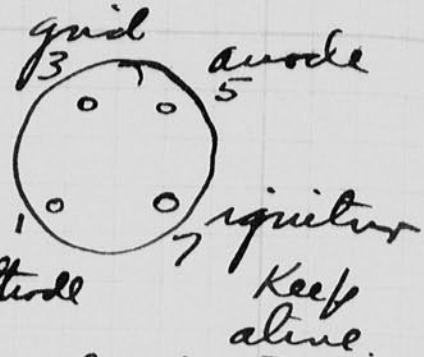
Lavel Edgeston Sylvania 6483

Subminiature structure.

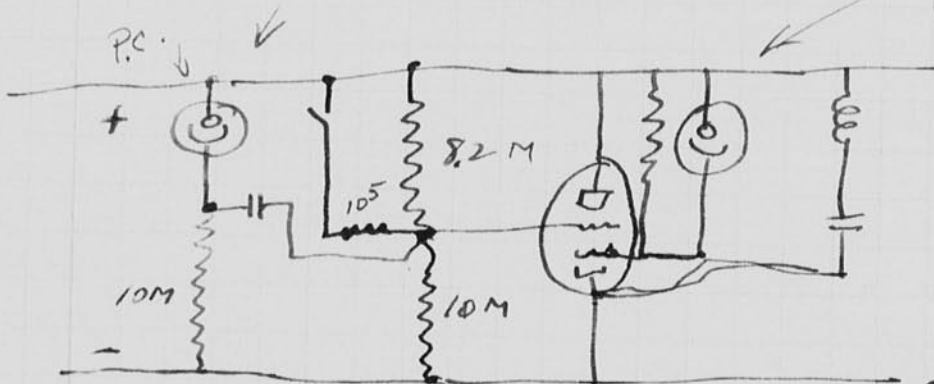
brought in by Don Cozzinis on April 15.



Circuit tested by Bill MacRoberts.



6k 350 to 650 volts.



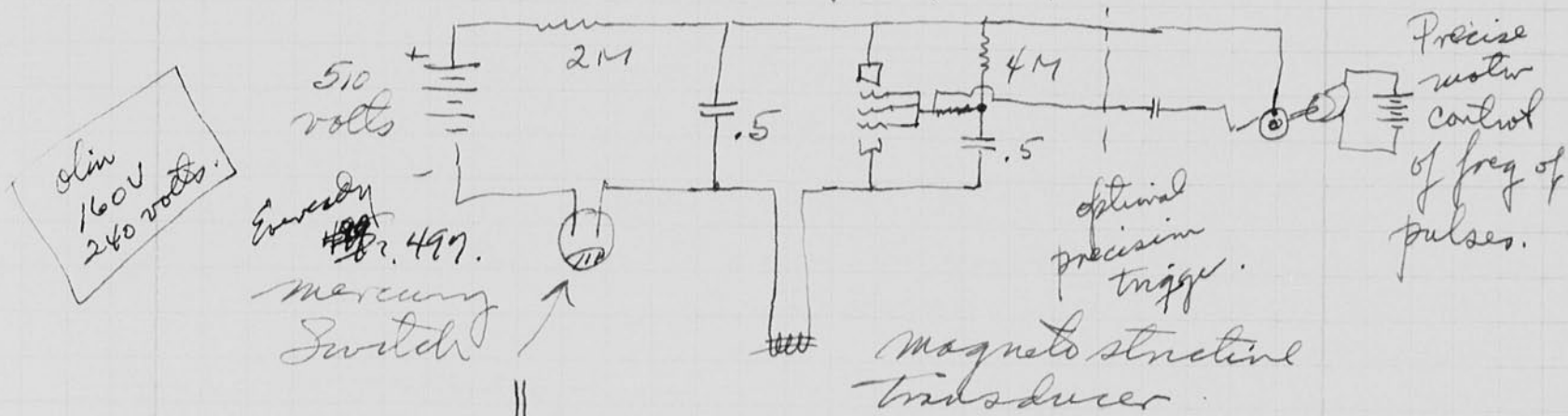
This works but requires more light. Transalone.

April 18 1954
Belmont Mass
205 School St

Bottom indicator.

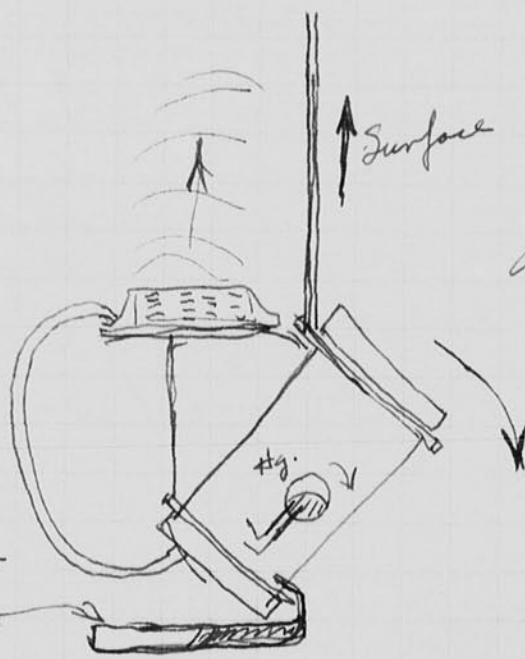
A pinger circuit will be put in a cylinder for timing a transducer at about 1 or 2 pings per second. This will be listened for from the surface with a tuned amplifier and a loud speaker.

When the bottom is hit, the angle of the device will change and a mercury switch will turn the pinger off.

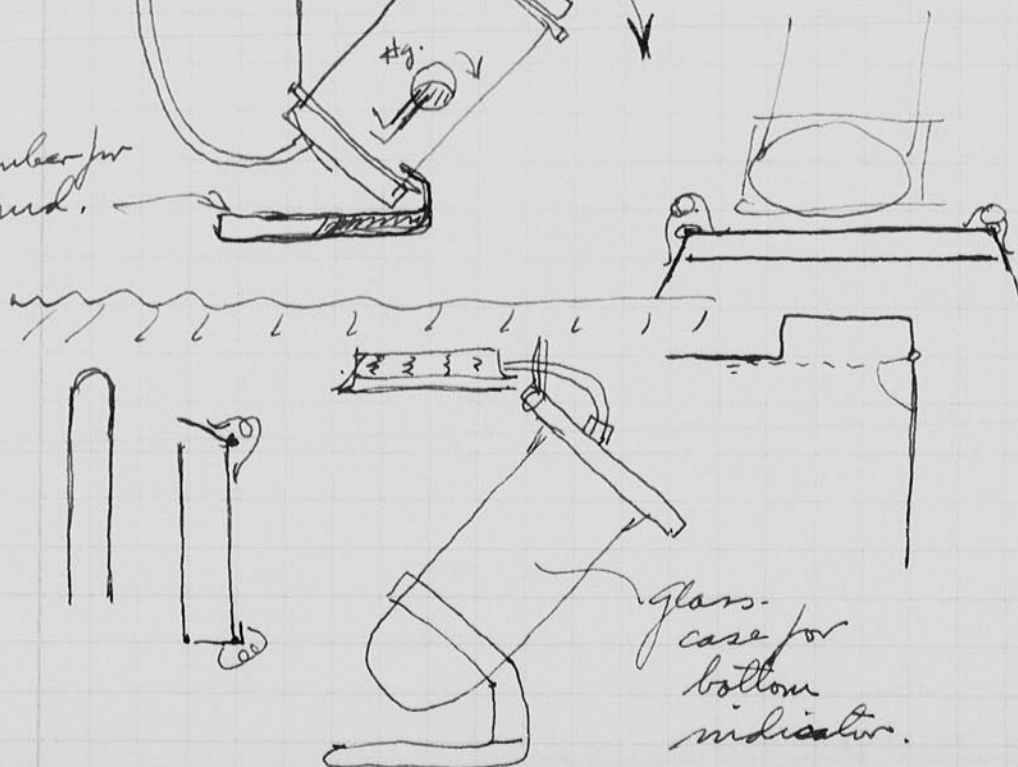


clin
160V
240 volts.

Emerald
#497.
mercury
switch



Assembly will tip on bottom and turn off the circuit.



Spring doors to allow mud to enter and then close with a spring.

Designed & constructed
by me June 11, 1954
T. H. Holmes

44 April 18 1954 Belmont.

Harold E. Edgerton.

Automatic filter for movies
of atomic explosions.

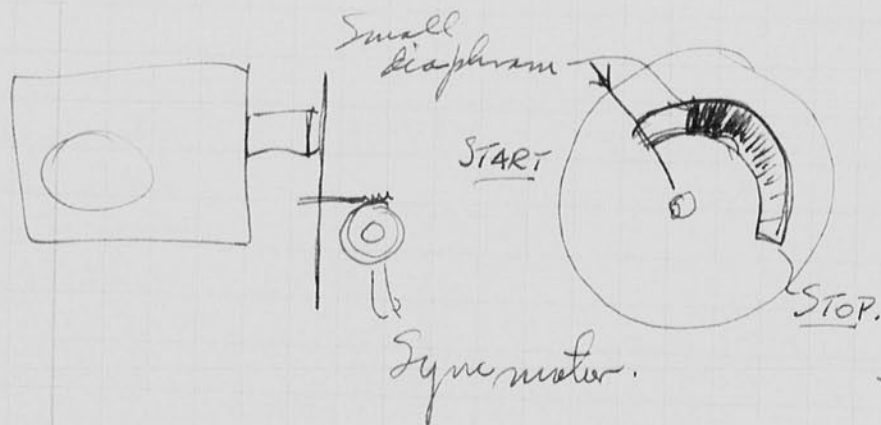
Suppose movies at 1000 frames per second are being taken, at the instant of start, a bright light entirely fogs the film. This gets dimmer as the fire ball expands, there is actually more light but the area of radiation is greater - therefore colder.

I propose an iris that closes almost completely at the instant of firing, say 0.1 second before hand. Then the iris opens at a rate - preset, as determined by a phototube starter.

Crossed polaroids could be used with a motor drive or one to give density time curves of the desired properties.

Another method would be to use a graded strip over the aperture.

See also Apr 5. *Friday shutter* page 35. for giving a density-time curve.



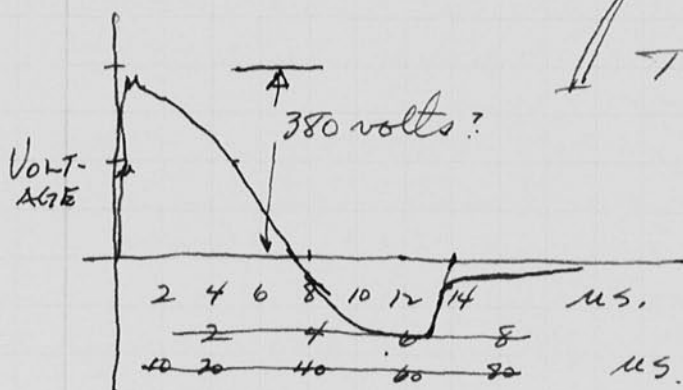
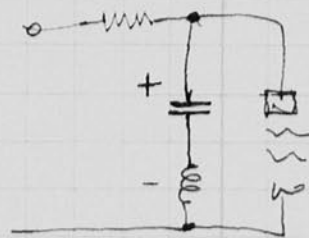
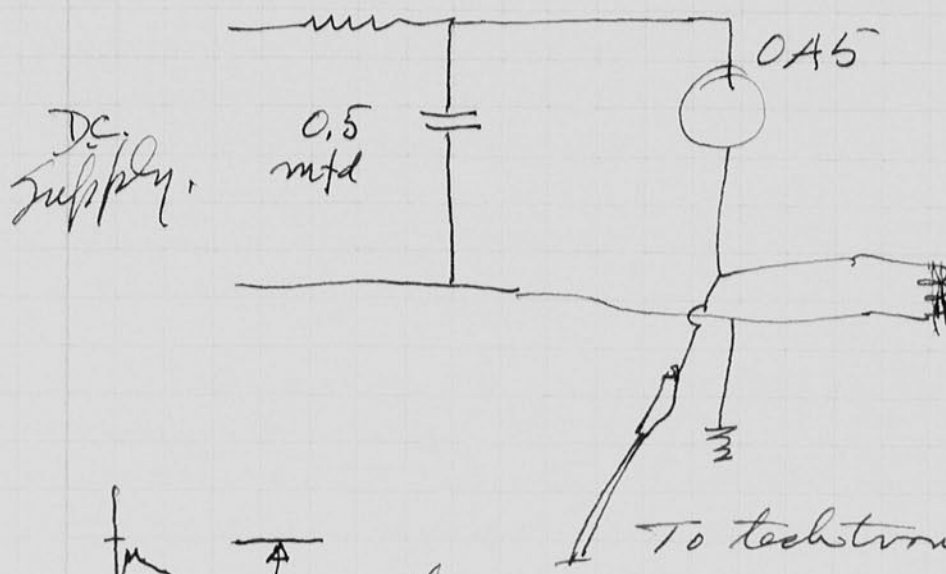
A program of density-time is set up in advance on the disc.

Use 1 sec signal to start motor.

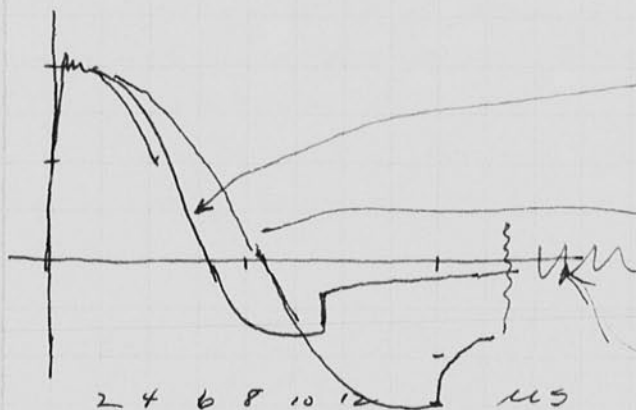
Bill left 2 pm for N.Y. on
American Airlines.
Now a junior at Columbia Univ
Bob will be home until Thursday. Now a

Apr. 19, 1954
 Harold Edgerton
 Bldg 20 M.I.T.

Bottom Indicator Circuit,
 Tests with scope.



this is with 30 foot cable
 and sealed magnet structure
 unit. Rubber cement over the
 nickel laminations.



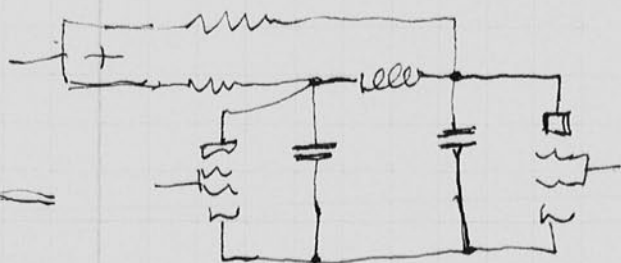
with 6 ft cable and open
 laminations. 0.5 mfd.

with ditto except 1.5 mfd.

frequency of output = 4 cycles = $20 \times 5 = 100 \mu s$.

1 cycle = $\frac{100}{4} = 25 \mu s$

$f = \frac{1}{T} = \frac{1}{25 \times 10^{-6}} = 40,000$
 sec cycles.



This circuit gives
 alternate current
 pulses to the coil.

Assembled with
 510 volt battery was
 put in a 4" I.D.
 steel tube for
 water tests

Elevators and drill hole into the earth
 air conditioned rooms at max elevator levels. 2000 feet. +



46 April 20 1954
Harold Edgerton

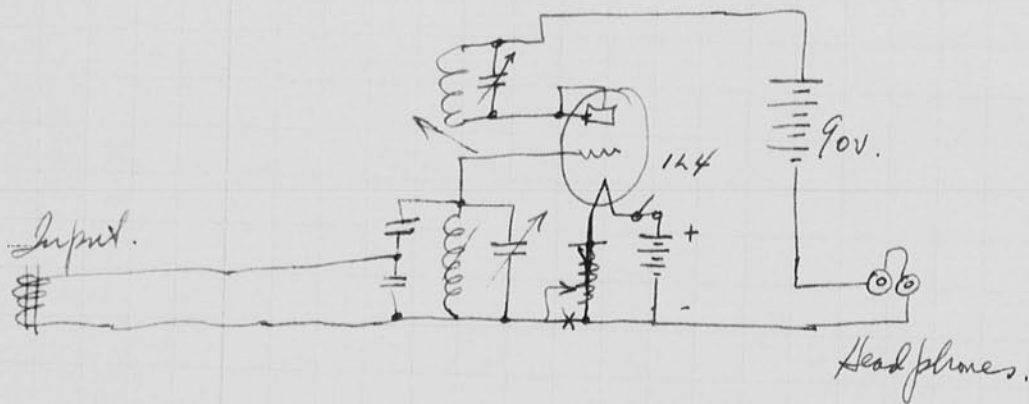
Depth indicator

I invited Joe Vitka to help me this afternoon at the sailing pavillion on the Charles River. He brought a standard Earecho unit for a detector while I brought the pulser of page 43 which I had put into a 4 inch R. camera case yesterday.

We could not get signals further than about 40 feet.

Tonight at supper time Joe called to tell me that the transducers were of different types and therefore the tuned circuits for the input amplifier would not receive the signal. We are going to try again tomorrow for results.

May 6. - a second test the next day (Apr. 21 ±) showed a $\frac{1}{2}$ mile \pm operation of the pickup and driver combination. Van Luong helped on this test.



June 11 '54
HSE

Harold Edgerton.
May 4, 1954.

47

Amplifier for Bottom Indicator was finished this week. There is lots of noise in it. We tried several locations of the tuned circuits before we got a combination to work.

Busy today with open-house preparations for Saturday. Tom Lamb is to be in charge of the exhibits this year.

Tomorrow I go to Washington to the S.M.P.T.E. convention at the Statler Hotel. Virginia paper with Lamb and Baragoli on May 6 at 3 pm. on Flash Duration.

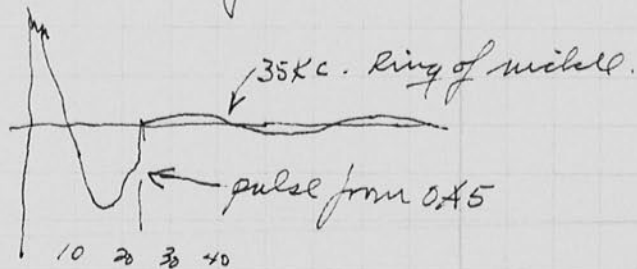
May 7, 1954. 5th and 6th of May in Washington at S.M.P.T.E. convention. Tom Lamb gave paper on flash tubes with me.

Setting up open house today. Showed my 620 class some demonstration of strobe. Bursting balloons, etc. Tomorrow is open house.

Worked part of day on flash-bulb camera for the T.V. tests of May 18 at Wood Hole. Using M.G. camera #1 and 4 inch pyrex pipe of last summer as a lamp. Wollensak shutter is being used with a magnet on the shutter blade.

2:45 pm Cont tests with Depth indicator. Sender driven by 0.5 mfd at 570 - volts through 0A5 tube. Receiver located parallel and 2 inches away.

Calib max. sens = .025 volts/cm.
Input .002 volts 35 KC at 2" from driver in air.



Receiver now moved 2 ft away in air.

Gain full on.

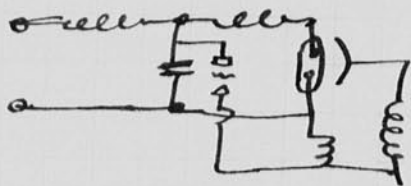
Output of second stage of amp - plate.

Peak = $.6 \times .025 = .0150$ volts. $\times 100 = 1.5V$ gain at max.

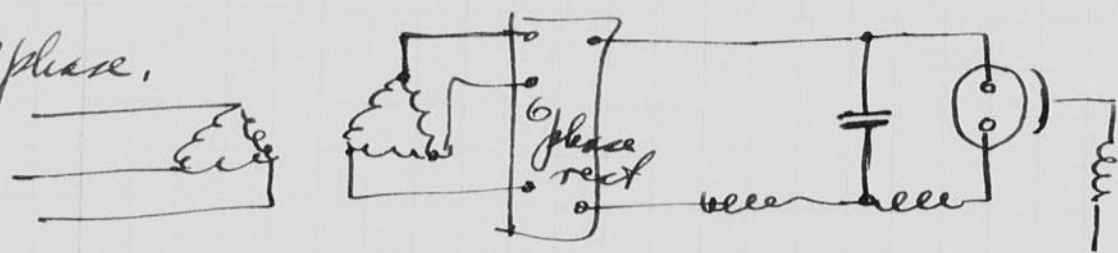
6 feet trans to Receiver in air
 Max gain - just barely audible. - Hum noise in set.
 good signal at 6 feet.

May 8 1954. M.I.T. Harold Edgerton. Sat - Open House M.I.T.

Reflector starter with
 High volt pulse.



3 phase.



Harold E. Edgerton
May 13, 1954.

Automatic Rewind camera.

49

Finished casing and camera wiring yesterday with Bill. Shutter and relay are triggered with pulse from a battery. Tests are scheduled for next week.

Film tests. 35 mm movie films

| | D=1 | T=5min. | Density of filter for Density 1 at Taine = 5min | Depth 4:1 |
|----------|---------|---------|---|-----------|
| EK. 5305 | .95 + 1 | 1.95 | Blue High-Speed Positive | |
| 5372 | 1.8 | 1.8 | | |
| 5203 | .65 | .65 | Pan. Fine Grain Pan Dup. neg film. | |
| 5302. | .92 | .92 | Blue Eastman Fine grain Release Positive. | |

The above films were tested by Chris Wyleoff at 160 Brookline ave. Boston.

| Fog level | ASA. | 125 (10 min) | 65 (5 min) | 47 (2 min) | 22 (1 min) |
|-----------|------|--------------|------------|------------|------------|
| 5305 | .06 | | | | |
| 5372 | .22 | | | | |
| 5203 | .23 | | | | |
| 5302 | .05 | | | | |

May 16, 1954. The depth sender and receiver (David White Co 35Kc) magnetron structure type was tested in the afternoon of May 13 Thursday. Jack Wood, Jerry, and a student helped. Jerry and the student took the transmitter to various spots across the bay. The receiver was mounted on a stick about 6 feet below the surface by the carpenter at the sailing pavilion. Reception was good across the entire basin, except getting weak at the far side.

We then changed the angle towards the east end of the basin. The signal dropped to less than noise at 3000 or 4000 feet.

A transmitter of more power is required to

gain further distance since the noise is evident in the receiver. the power is now 0.5 mfd at 500 volts. (-). more energy in the capacitor does not give greater signal strength, probably due to some limitation of the magnetostrictive effect. a test needs to be made with pressure to find if the frequency changes or if other effects come about.

Push button camera -

A test in the swimming pool was made yesterday of a camera - light combination with a 150 foot cable to the push button on the surface. The camera casing was the #1 model that I used on the Bear and at Hawaii. This was also used by Owen at U.H.O.I.

A dry battery light was used with 25 watt sec into a FT-215. A reflector gave a spotty lighting.

The shutter was a Wollensak alpha 0 with an arm on the shutter blade ring.

A capacitor pulse gives a slight operation of the shutter. It also closes a relay circuit that moves the film to a new position.

I used Background X film at f8 in the pool focussed for 5 feet in air.

The ambient light on a cloudy day at 3pm was enough to give a photo of the entire length of the R.I.T. pool.

Bill Westell and a friend were in the pool testing Bill's new model lung. Several photos were taken of Bill in the deep end of the pool.

May 16 - 1954 Harrod is working, Eicher is helping
 General Radio High Speed Camera - 35 mm
 Governor adjusted for 1200 frames per sec. (3600 r.p.m.)

| time in seconds. 120 volts | frames per sec. | frames per sec. | time in sec. | frames per sec. |
|-------------------------------|-----------------|-----------------|--------------|------------------|
| 0.0 | 0.0 | 0.0 | 0 | 0 |
| .2 | 24 in | | .2 | 27.1 * → 3.25 in |
| .3 | 17 in | | .3 | 37.5 4.5 |
| .4 | * 2 1/4 in | | .4 | 47.7 5.72 |
| .5 | 22.5 2.7 | | .5 | 61.2 6.86 |
| .6 | 3.0 | | .6 | 66.0 7.94 |
| .7 | 28.7 3.4 | | .7 | 74.2 8.92 |
| .8 | 3.8 | | .8 | 77. 9.25 |
| .9 | 34.2 4.8 | | .9 | 77.8 9.33 |
| 1.0 | 4 3/4 | | 1.0 | 77.9 9.35 |
| 1.1 | 38.5 4 5/8 | | 1.1 | 77.9 9.35 |
| 1.2 | 41.7 5. | | 1.2 | 77.9 9.35 |
| 1.3 | 43.9 5 5/16 | | 1.3 | 77.5 9.3 |
| 1.4 | 46.7 5 9/16 | | 1.4 | 77.3 9.28 |
| 1.5 | 47.5 5 13/16 | | 1.5 | |
| 1.6 | 50.5 6 1/16 | | | |
| 1.69 | 53. 6 3/8 | | | |

| 220 volts A-C: no governor 32 in. of film has gone through → | time in sec. | frames per sec. | 220 volts D-C: no governor 6 feet film has gone through → | time in sec. | frames per sec. |
|---|--------------|-----------------|--|--------------|-----------------|
| 0.2 | 26.6 * | 3.2 in | 0 | 0 | 0 |
| .3 | 38.4 | 4.62 | .2 | 57.7 * → | 6.93 in |
| .4 | 49.0 | 5.89 | .3 | 76.6 | 9.2 |
| .5 | 59.0 | 7.08 | .4 | 92.5 | 11.1 |
| .6 | 68.3 | 8.20 | .5 | 106 | 12.75 |
| .7 | 76.5 | 9.18 | .6 | 117 | 14.1 |
| .8 | 84.4 | 10.12 | .7 | 128 | 15.35 |
| .9 | 91.2 | 10.96 | .8 | 137 | 16.4 |
| 1.0 | 97.7 | 11.73 | .9 | 146 1/2 | 17.5 |
| 1.1 | 103.5 | 12.42 | | | |
| 1.2 | 109 | 13.05 | | | |
| 1.3 | 114 | 13.68 | | | |
| 1.4 | | | | | |
| 1.5 | | | | | |

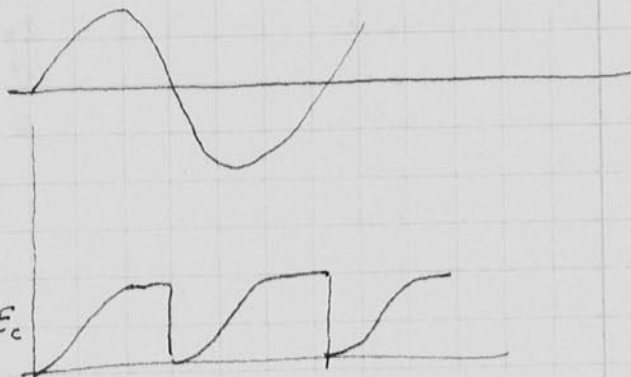
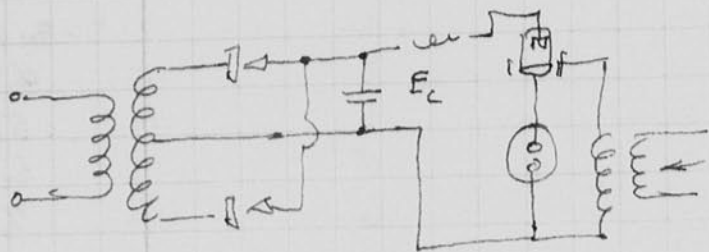
* These numbers are the number of inches traveled in .01 sec
 The speed in feet per second is the distance in inches $\times \frac{100}{12}$

May 16 1954
David Egerton

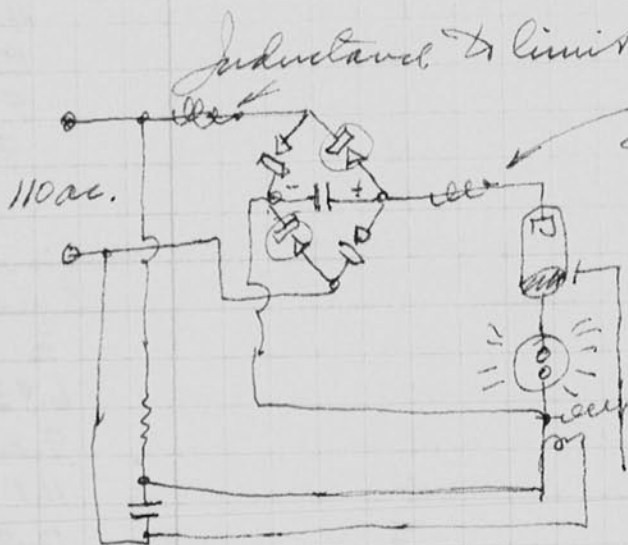
60 cycle and 120 cycle lamps.
mercury tube for starting and control.



control and start tube.



change -
flash at zero voltage to
prevent hold over.



Inductance to limit charge surge current.

Inductance to limit peak
current in lamps.

efficient lamp.
Xenon - high pressure.

Phase shift. peaked output
here to start tubes
at zero or in phase wave form.

Jan 11 '54
W. H. Rines

A more precise trigger could be provided which would give 120 cycle pulses at the zero points of the wave and with the same polarity at each pulse.

The mercury arc tube always starts the ^{light} tube between the main electrodes. A very low voltage can be used on the capacitor and starting will still result. Ionization is excellent.

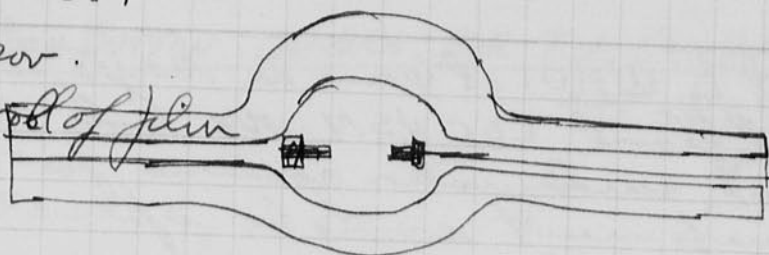
230 volts D.C.

no Gov.

Full roll of film

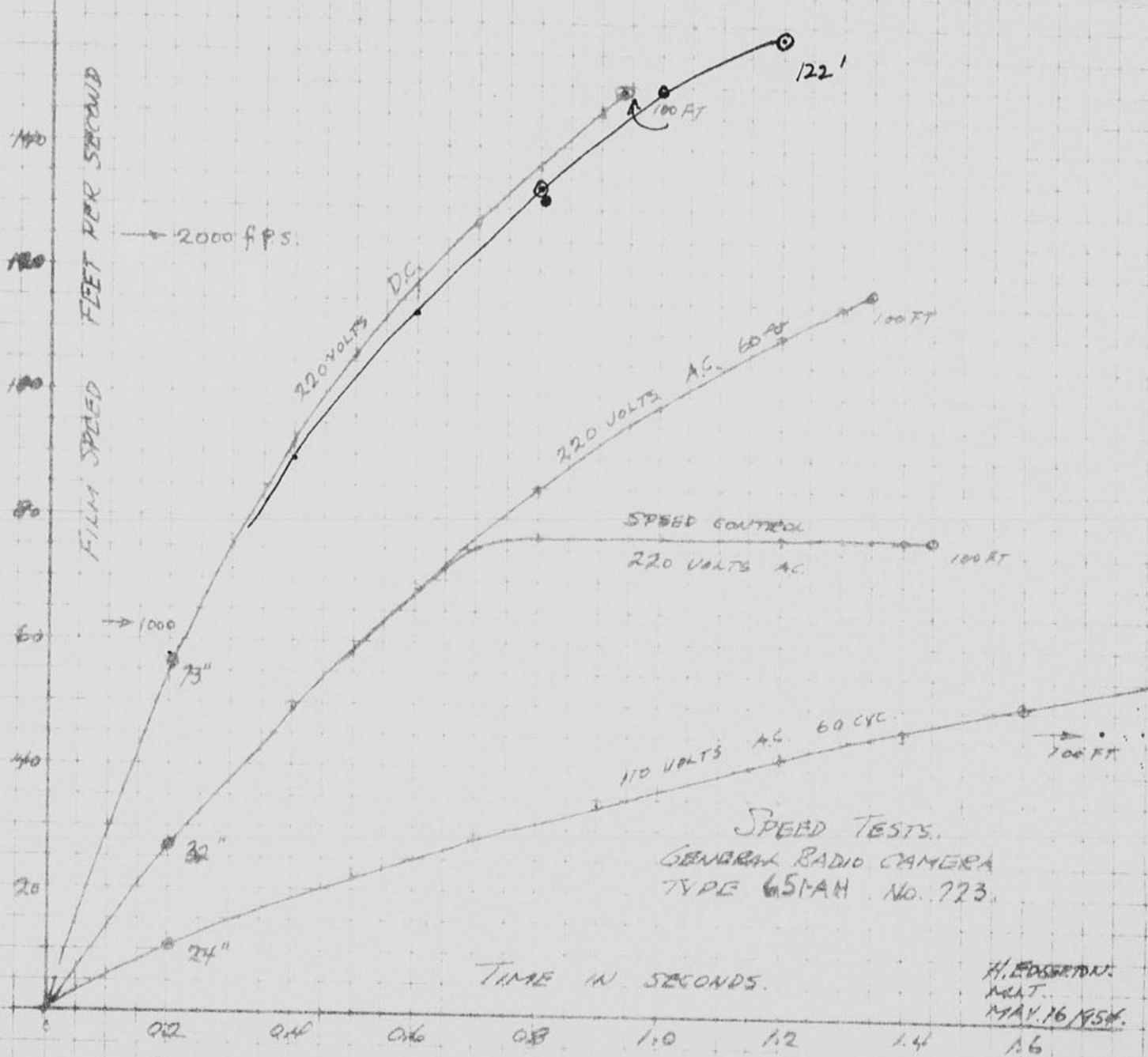
Therby

330.



| Time sec. | inches / 0.1 sec. | |
|-----------|-------------------|-------|
| 0 | 6 ft 11 inches | |
| .2 | 7" | 58.3 |
| .3 | 8.8 | 73.2 |
| .4 | 10.7 | 89.2 |
| .5 | 12.25 | 102.1 |
| .6 | 13.6 | 113 |

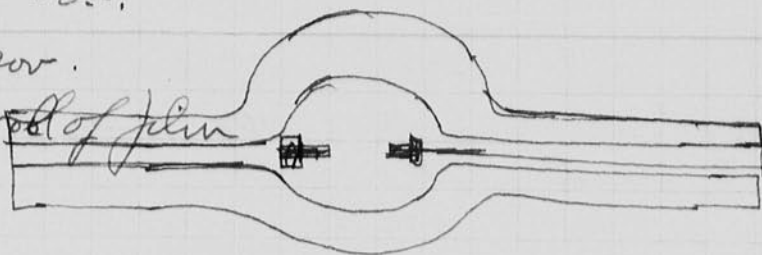
Speed trial of G.R.
35 mm camera.
Brake on top reel
loosened.



230 volts D.C.

no 20v.

Full roll of film



Theater

330.

| Time sec. | inches in .01 sec. | |
|-----------|--------------------|-------|
| 0 | 0 | |
| .2 | 7" | 58.3 |
| .3 | 8.8 | 73.2 |
| .4 | 10.7 | 89.2 |
| .5 | 12.25 | 102.1 |
| .6 | 13.6 | 113 |
| .7 | 14.9 | 124 |
| .8 | 16.0 | 133 |
| .9 | 17.1 | 143 |
| 1.0 | 17.9 | 149 |
| 1.1 | 18.6 | 150 |
| 1.2 | 19. | 158 |

Speed trial of B.R.
35 mm camera.
Brake on top reel
loosened.



SPEED TESTS.
GENERAL RADIO CAMERA
TYPE 651AM NO. 723.

H. EDGEMAN
M.A.T.
MAY 16 1954.

May 22, 1954.

Harold Egerter

I went to W.H.O.I at 6am on May 18, taking Capt J. N. Lofland, CEC, U.S.N. We took the push button under water camera for test with a T.V. equipment as to be operated by the Diamond Power Co. The 18 and 19th were both spent off Wood's Hole looking at various spots on the bottom.

First I had trouble with the shutter. The wire connection between the magnet and the shutter arm was not solid. As a result the shutter sometimes stuck in the open position. This was fixed by taping the two parts together. Then the rubber tappet joint failed electrically. After that was fixed the camera did not recycle. So I was unable to get a single good photo of the entire effort.

Todo: 1. Rebuild shutter connection to magnet.

2. Obtain new relay for the motor start device

3. Study the connector problem at the lamp end. Go back to 6 volt relay to operate the lamp. In this way only low voltage circuits are used. Check the synchronization with the shutter and see if the shutter closing time is ample for operating the relay.

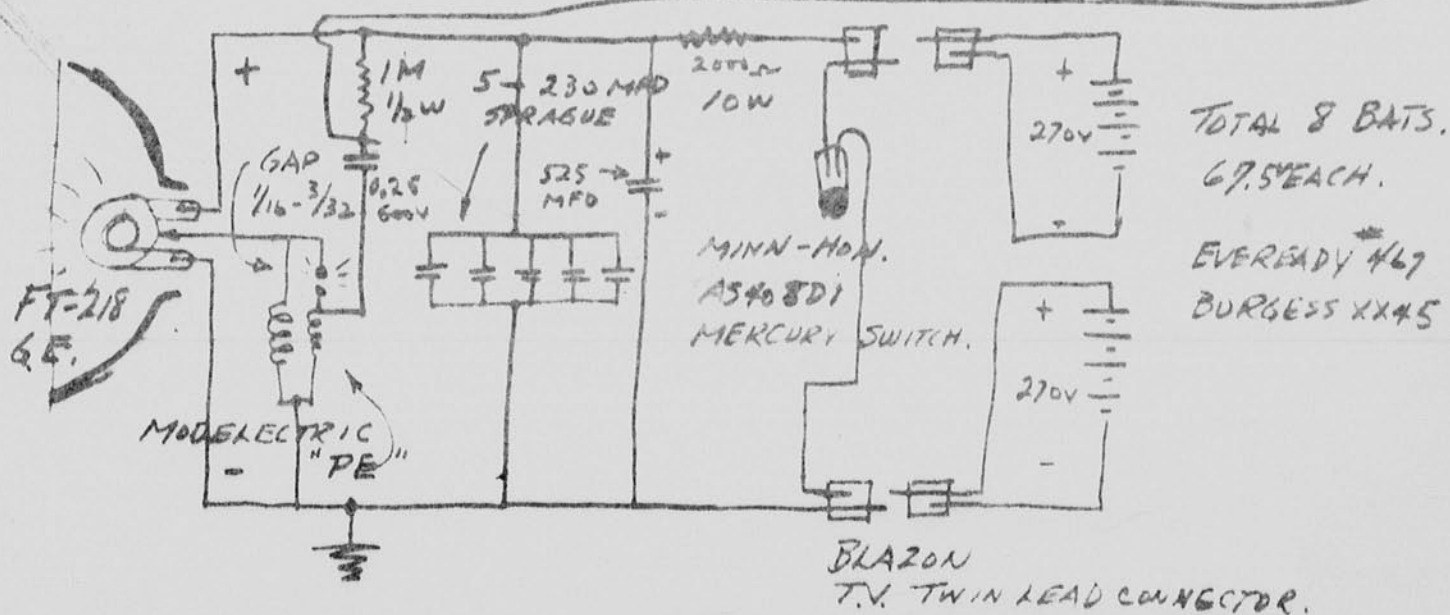
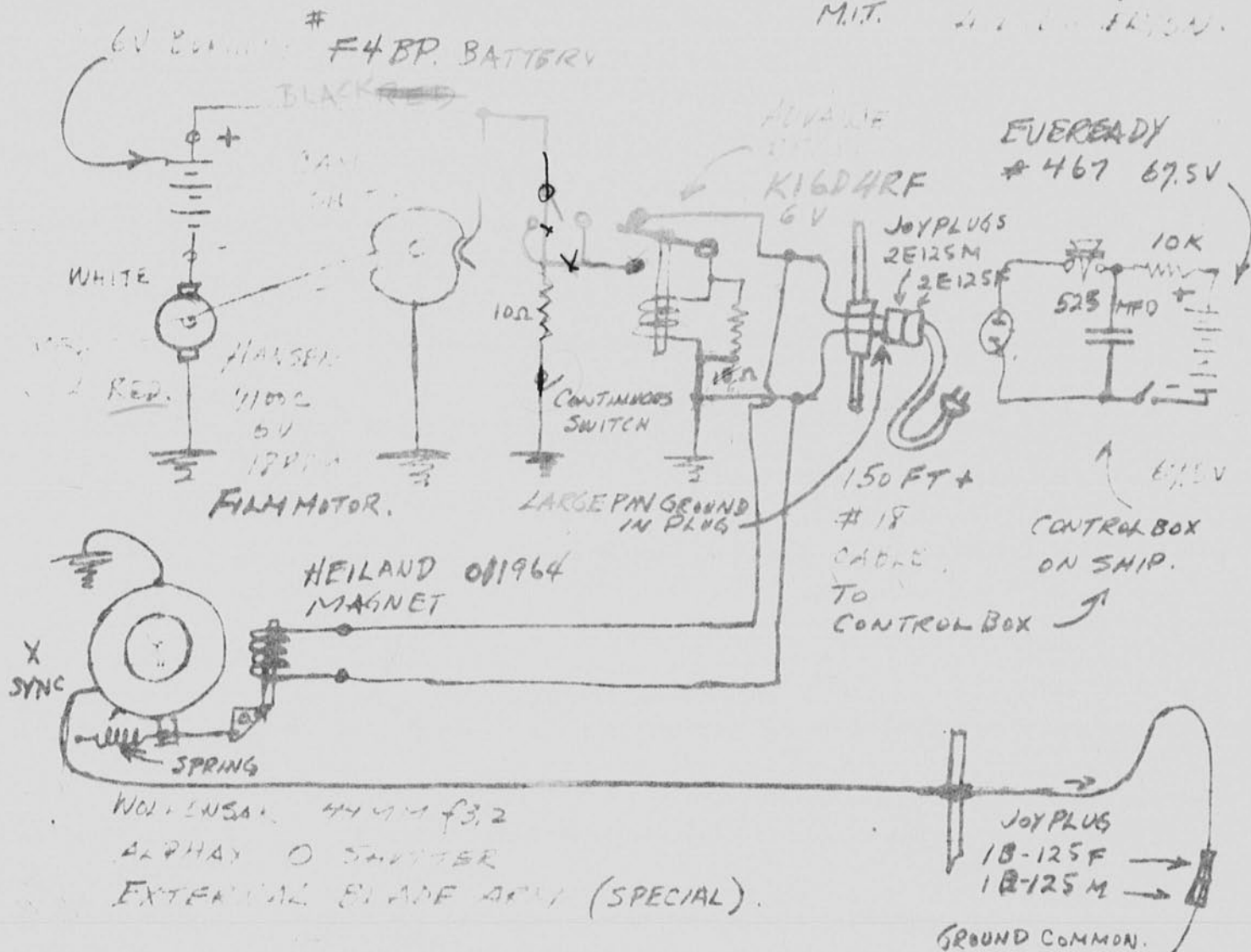
Called Signa Relay Co (Geo Border) to get a special relay
Type [4IF 1000 MS - SIL] for use in circuit.

This relay has a 1 ohm coil and operates from 200 ma. Should give the motor enough power to operate in the series position.

PUSH BUTTON CAMERA. FOR T.V. (UNDERWATER)

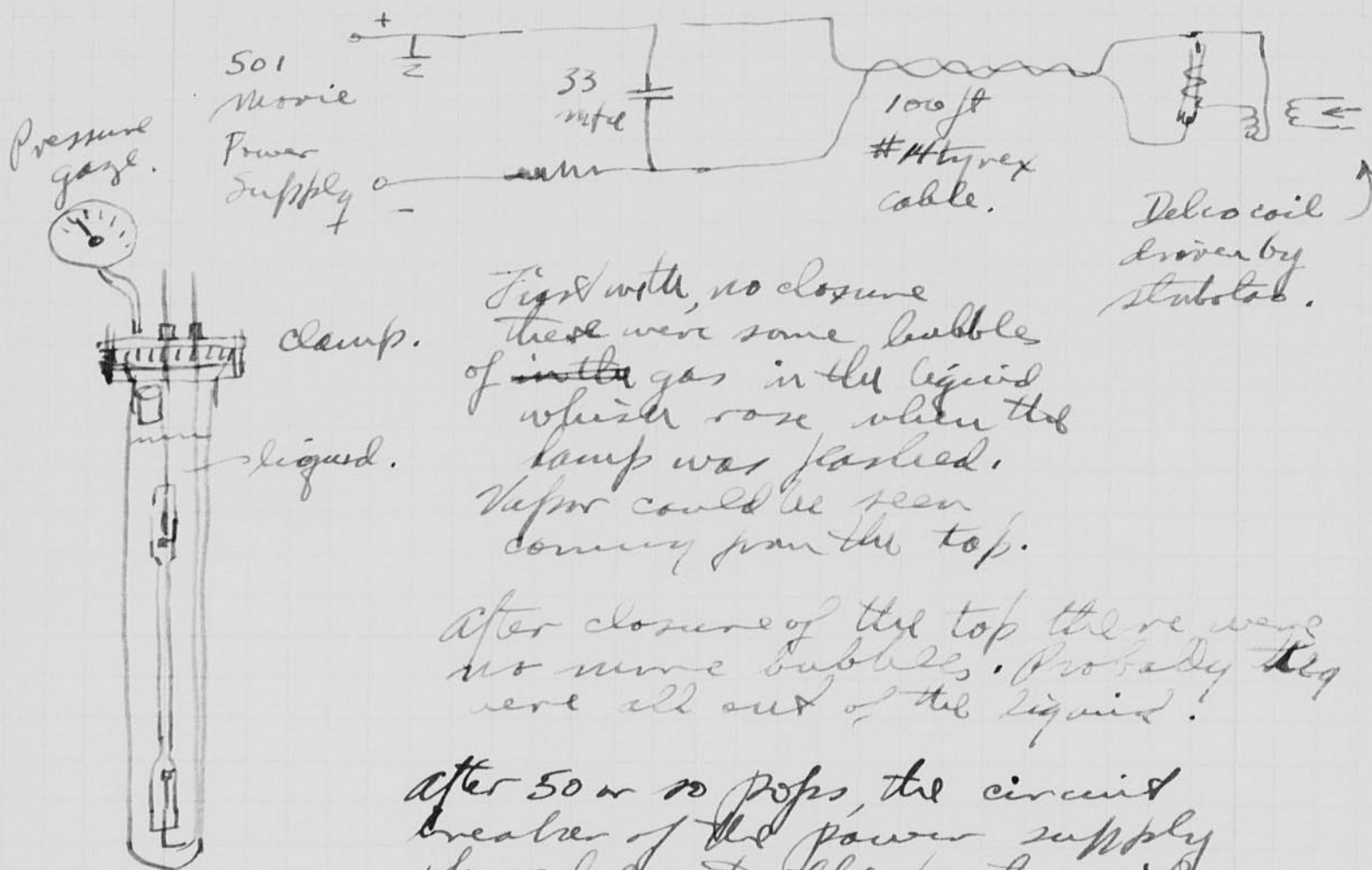
NAT. GEO. CAMPAIGN #1

W. H. ... 45
M.I.T. ...



June 11-54
M. Hines

Yesterday Bill and I set up the new T.V. neon lamp (FT-427) in a 3 inch I.D. glass tube for test in Ethylene Glycol. The circuit was



First with, no closure there were some bubbles of ~~in~~ gas in the liquid which rose when the lamp was flashed. Vapor could be seen coming from the top.

After closure of the top there were no more bubbles. Probably they were all out of the liquid.

After 50 or so pops, the circuit breaker of the power supply opened due to the heater coil.

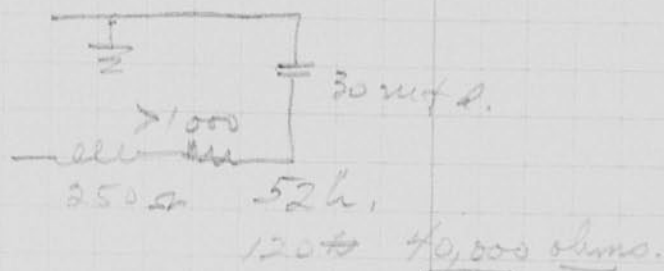
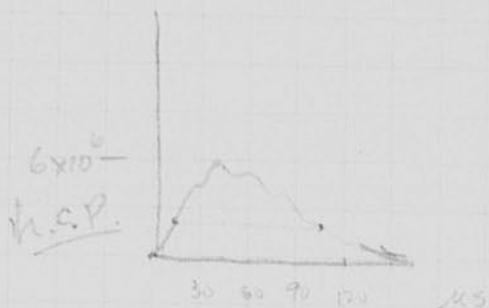
The temperature of the glass tube was barely warm to the hand opposite the tube - this test was run in the horizontal position. The pressure was beginning to come up when the supply went off.

| | | | |
|------------------|---------------|-------------|-----|
| Ethylene Glycol. | Specific heat | 0.544 | ° |
| Chem Hand book. | Heat of evap. | 191 cal/gr. | |
| | water. | 540 | " " |

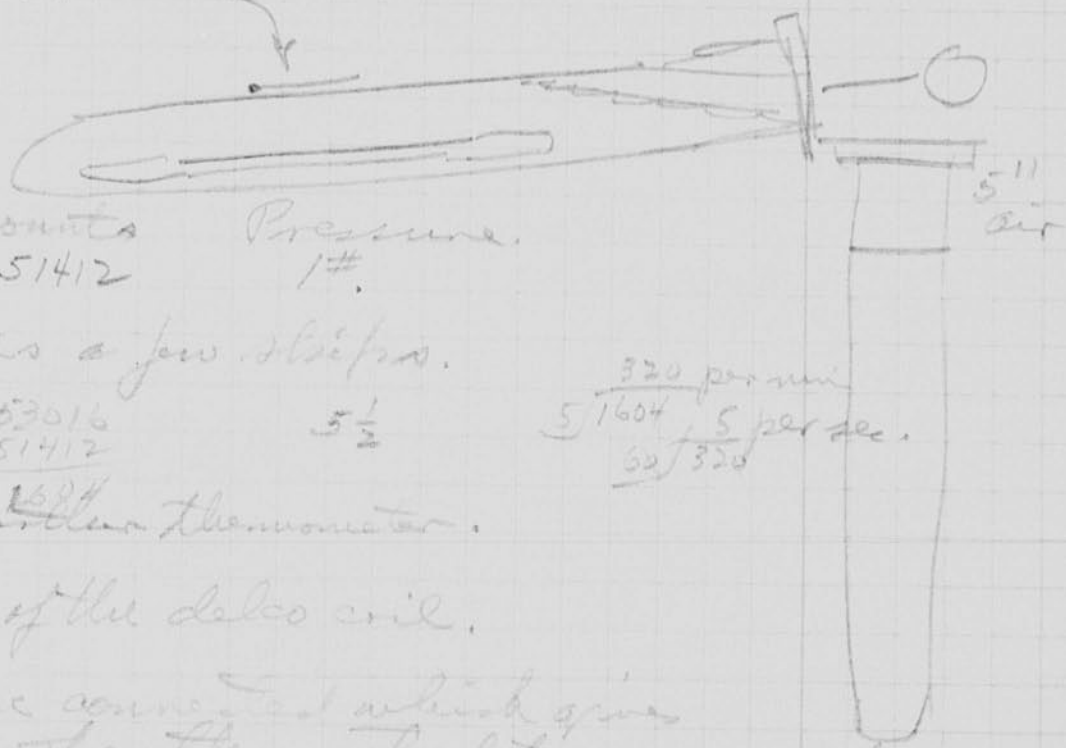
Calib 10 mfd 2000 volts FX1 Plate 3×10^6 c.p.

| Def. | Volts | |
|----------|----------|------------------------|
| Std. 3cm | 10 volts | 10 mfd |
| 2cm x 3 | 21 (2cm) | 30 mfd 4000 V ± FT-427 |

6×10^6 h.c.p.
 100×10^6 us
 400 h.c.p.s.



Temperature run
 the monitor on top



| TIME | °F | counts | Pressure |
|--------|-----|--------|----------|
| 10, 15 | 80° | 51412 | 1# |

4 minutes a few strips.

| | | | | |
|--------|----------------|--------------------------|-------|---|
| 10, 20 | broke 140°+ | 53016 51412 | 5 1/2 | $\frac{320 \text{ per min}}{60} = 5 \text{ per sec.}$ $\frac{51604}{60} = 860$ |
| | 125° | for another thermometer. | | |

Wax is coming out of the delco coil.

another slotted ac connected which gives more space. the other slotted ac was weak.

| | | | | |
|------------|---|-------|----|---------------------------------------|
| 10, 51 | - | 53018 | 4# | 22 amperes from line 208 volt line |
| 10, 55 3/4 | | 54600 | 6# | |

Smells come from choke in power unit.

Light meter 1501 3 ft 89 89 on floor.

18 $\frac{4200}{32 \text{ mfd}}$ } = 260 w.s. $\frac{781}{260} = \text{h.c.p.s.} = 3 \frac{\text{c.p.}}{\text{w.}}$

cont. tests with Propeller Strob under water, type.

aluminum reflector on outside

output of strob
per flash.

with Reflector 69 x 2 at 3 ft.

$\frac{69}{55.2}$
69

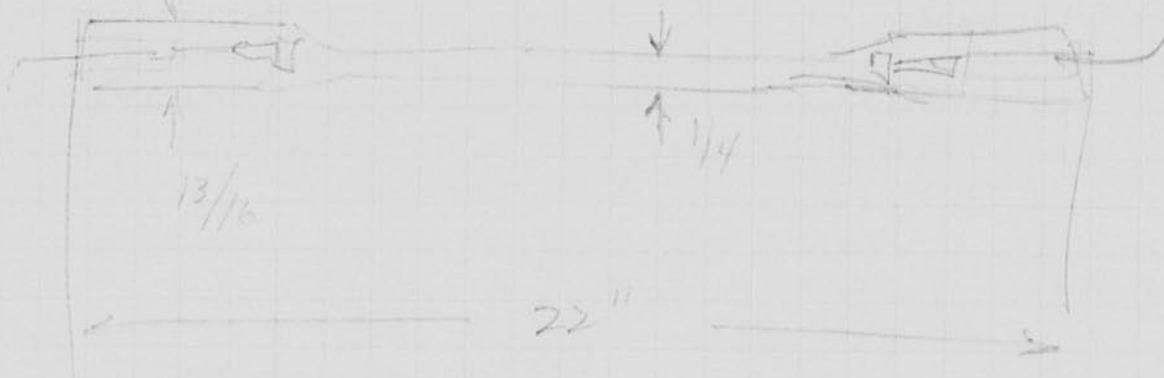
1242 HCPS (BCPS)

without 36 x 2 at 3 ft

$\frac{729}{648}$

648 HCPS

FT-427



Bill is designing a tube holder to fit in the Davis Case.

The above tests look wonderful, there is no trouble with a 1KW input for 10 min. probably can be run indefinitely in the sea where the outside is water cooled.

May 22, 1954 cont.
Harold Ogden.

200 Watt sec under Water flash

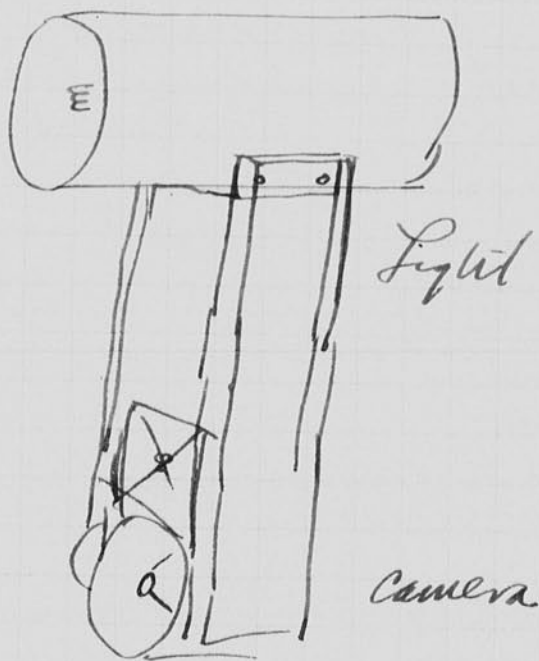
59

Some trouble with firing was observed several weeks ago in the pool. Bill looked into it and reports that thyristor 5896 was the source of the trouble if the voltage (6V) was low. He tested many of our stock of tubes, finding but few that were satisfactory.

A good tube was installed, now works with 7 sec recycling time.

Leica 576503 - X sync - no rangefinder
Lens. f 2 784/01.
Summitar. 5 cm.

The strob is a 200 watt sec. one charged from 6 ER6 Batteries in Ser Par for 6 volt. 900 volt out put with a FT-218 GE. I get 10,000 B.C.P.S. from this unit with a standard reflector type.



| Focus lines. | f |
|--------------|------|
| 1 meters. | |
| 1.1 | 2 |
| 1.2 | 2.5 |
| 1.3 | 4 |
| 1.4 | 5, 6 |
| 1.5 | 8. |
| 1.7 | 11. |
| 2. | 16. |
| 2.2 | |
| 2.5 | |
| 3 | |
| 4 | |
| 5 | |
| 7 | |
| 10 | |
| 20 | |
| ∞ | |

Homer Edgerton

Temperature calculations.

Heat flow through 3 inch I.D. $\frac{1}{4}$ " wall glass pipe.

$$\frac{Q}{t} = \frac{CKAT}{d}$$

$$K = .0015 \text{ (Hudson p 244)}$$

glass.

$$A = \text{sq feet}$$

$$d = \text{inches}$$

$$T = \text{differential Fahrenheit}$$

$$t = \text{hours.}$$

$$Q = \text{kw hours.}$$

$$C = 0.851 \text{ Hudson}$$

$$\text{Let } \frac{Q}{t} = 1 \text{ kilowatt}$$

$$A = 2 \text{ sq feet}$$

$$d = 0.25 \text{ inches}$$

$$T = \frac{Q}{t} \frac{d}{CKA} = 1 \frac{.25}{0.851 \cdot .0015 \cdot 2}$$

$$= 100 \text{ degrees rise (this is ok.)}$$

now calculate the quartz tube.

$$K = .0036 \text{ (Hudson)}$$

$$Q = \text{kw hour.}$$

$$d = \text{cm}$$

$$A = \text{sq meters}$$

$$T = \text{Temp deg. cent.}$$

$$t = \text{hours.}$$

$$C = 41.8.$$

Example Let $Q/t = 1$ kilowatt.

$$d = 0.2 \text{ cm}$$

$$T = 700^\circ \text{C}$$

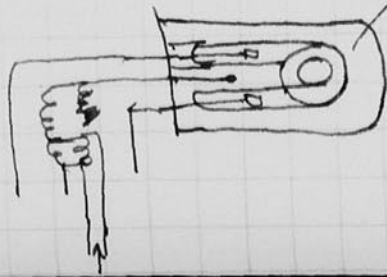
Solve for area

$$A = \left(\frac{Q}{t} \right) \frac{d}{CKT} = 1 \frac{.2}{41.8 \cdot .0036 \cdot 700} = .002 \text{ sq meters}$$

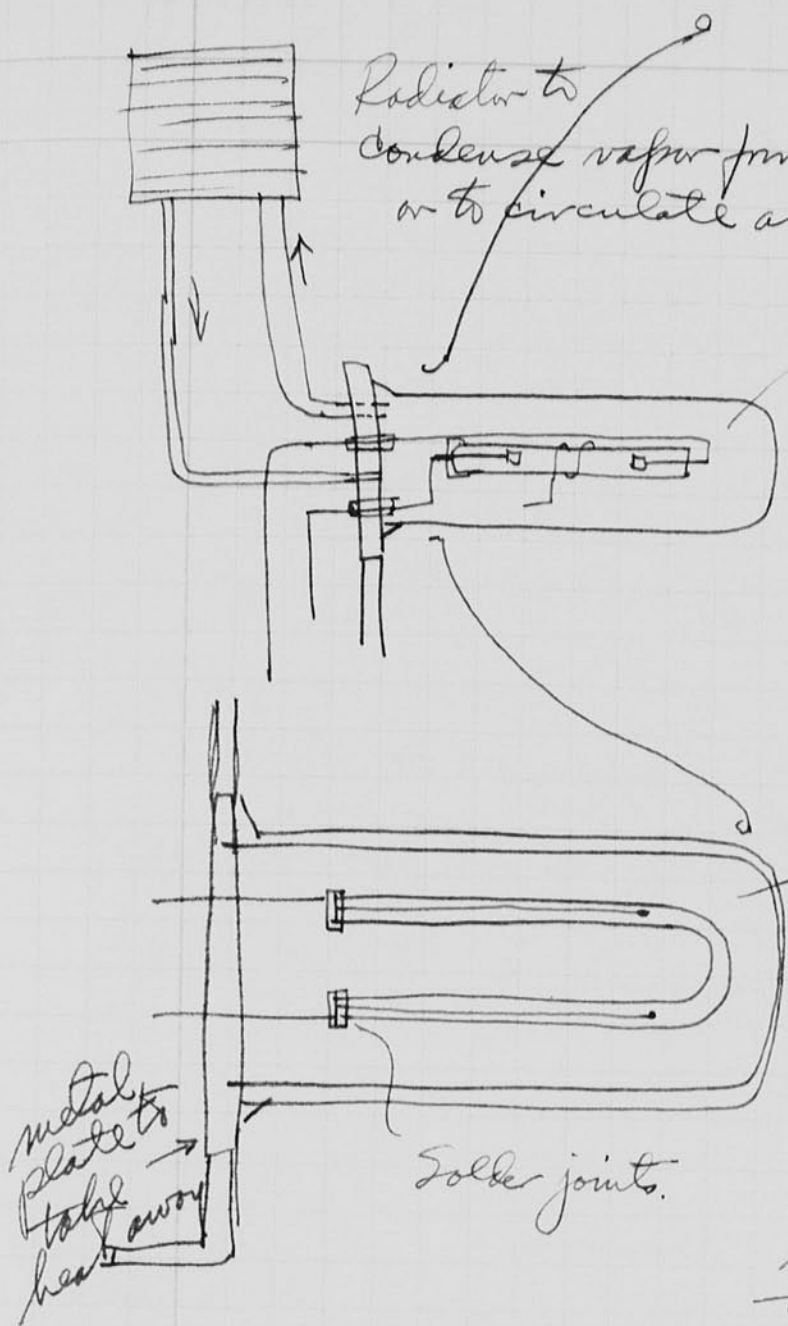
$$= 20 \text{ sq cm.}$$

This is about the dimensions of the FT-427.

I now propose a thin walled quartz tube with a cooling liquid to carry the heat away and also to act as a starting band for the sparks.



liquid filled. Liquid is connected to the spark coil. main terminals may be insulated, although this may not be necessary.



Radiator to
condense vapor from lamp
or to circulate and cool.

Liquid filled lamp.

spark connector.



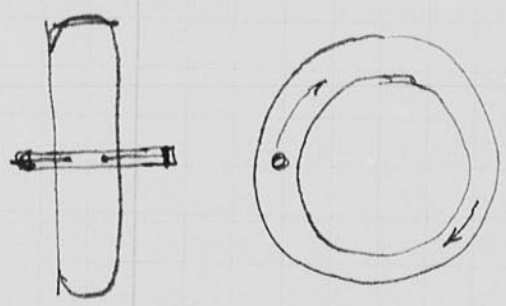
liquid coolant.
also spark connector.

Liquid

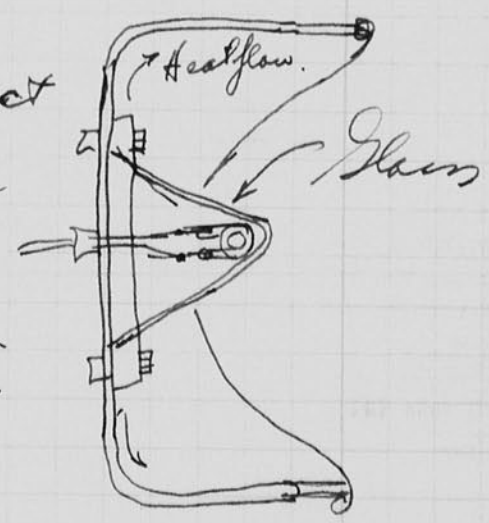
Solder joints.

Air cooled high pressure lamps are not strong due to the weakness of the quartz at high temperatures. Liquid in contact will keep the temperature low on the outside shell of the flash tubes.

Heat flow around the donut of glass or metal.
cools on far side



Wide contact to conduct heat away from tube. There will be a thermal flow in the liquid due to convection.



62 May 24, 1954

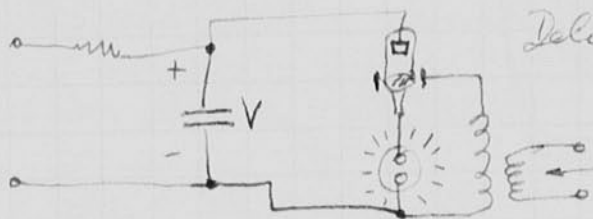
Harold E. Edgerton.

6:20 quiz at 10 am. Integrating and differentiating circuit.

I called Forman at Photo switch to come over tomorrow to check the Infra Red output of the FT-427 in Ethylene Glycol liquid. Experiments on Saturday for the underwater navy submarine T.V. illumination lamp look most inviting.

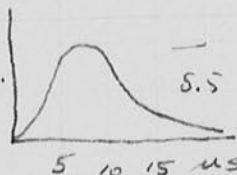
May 26 1954. H.E. Visit from group at RLE today. Bill and I showed flash tubes, micro flash of bullets, 20,000 watt seconds on carbon paper and magneto optic shutter.

Set up Hg tube into a high pressure X-ray tube. I find that the tube can be started with 40 volts on the capacitor! This tube requires a 1/2 inch spark in air to make it go.

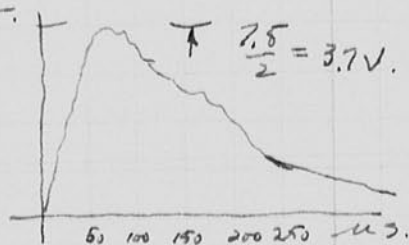


Delco coil with 1/2+ inch spark.

| V. | C | D | Remarks. |
|-----|------------|---|---|
| 90 | 6 mfd. | | Lower starting limit. (some misms) |
| 100 | " | | " reliable |
| 250 | 6 mfd. 24" | | Very reliable start |
| | | | no filter in P.C. $\frac{11}{2} = 5.5$ volts. |



100 ~~v~~ 525 electrolytic + 6 mfd. 24" no filter.
50 volts at end of flash.



Read and understood page... to page... inclusive

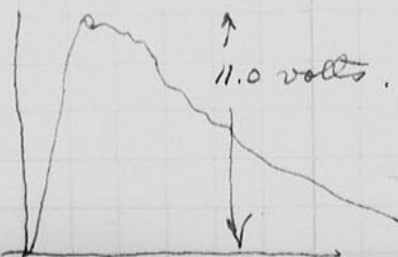
D. E. Edgerton
JUN - 1 1954 DEC

Date

150V

525.

24" no filter

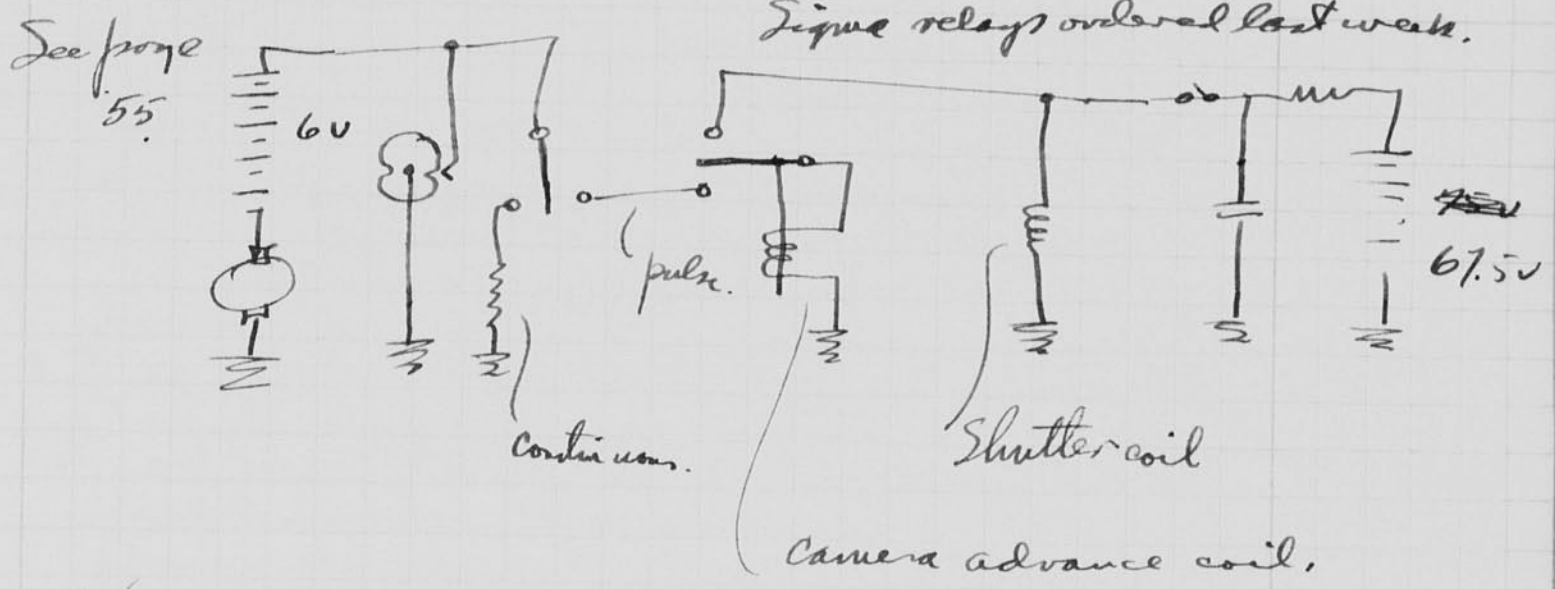


May 29 1954 M.I.T.
 Harold Edgerton

Yesterday at West Point Hotel thayer - Photo Eng Soc.
 Paper on tube characteristics FX-1 in particular.
 Saw Lipton, Lester, Costle, Zultaroff, Jarber, Parker
 Clark, etc. Esther went along.

Picked up Bill and Allyn Moore at ⁶²⁵ west 114
 at 4:30 pm and brought them to Boston with all of
 Bill's books etc.

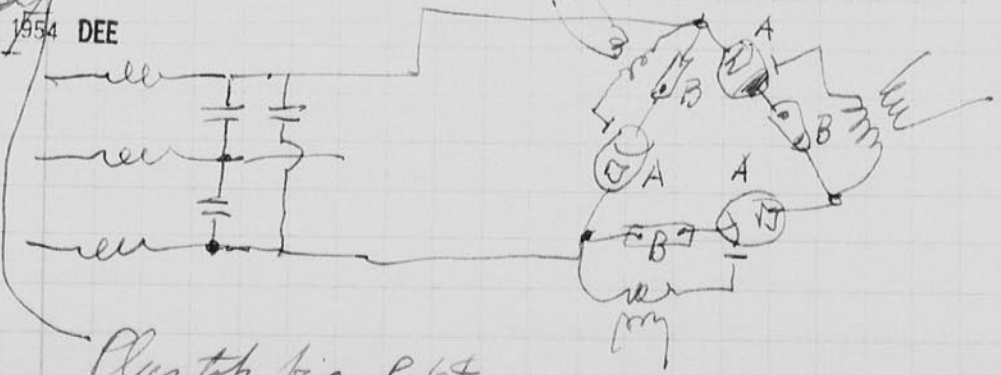
Working today on 620 tube papers and grade.
 Relay system for camera.



June 1 1954
 Commence Pa. on train to Cleveland.
 Harold G. Edgerton.

3 phase Power-light

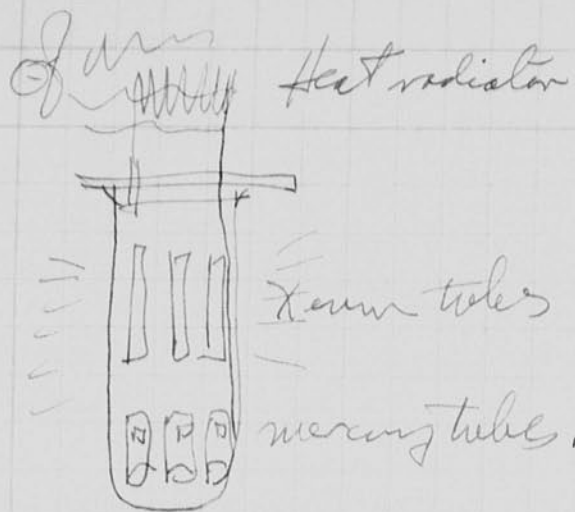
The series mercury tube will enable one to
 start a high pressure efficient xenon tube
 without a step up transformer. Since two lamps
 will always be lit at one time the flicker from
 all bank of three should not be objectionable for
 continuous light purposes.



A = Mercury tubes
 B = Xenon
 high effy tubes

Plus top fig. P. 64.

Read and understood
 page... to
 page... in-
 clusive
 D. E. Edgerton
 JUN - 1 1954 DEE
 Date



Harold E. Edgerton
 June 2, 1954,
 Park Manor Hotel Cleveland Ohio.

I discussed at great length the series mercury arc tube with Elmerendorf, Noel, Barnes, etc while at G.A. Ueda Park yesterday afternoon.

Elmerendorf requested ~~of me~~ ^{of me} to make a 1 atmosphere xenon flash tube of quartz with tungsten rod electrodes. I suggested a bit of $1/16$ " ^{width} length and $1/8$ " length to act as a heated cathode. a $1/2$ " quartz tube was to house the assembly with special seals on the end to carry the heavy currents. This will be tested with the series mercury starting lamp.

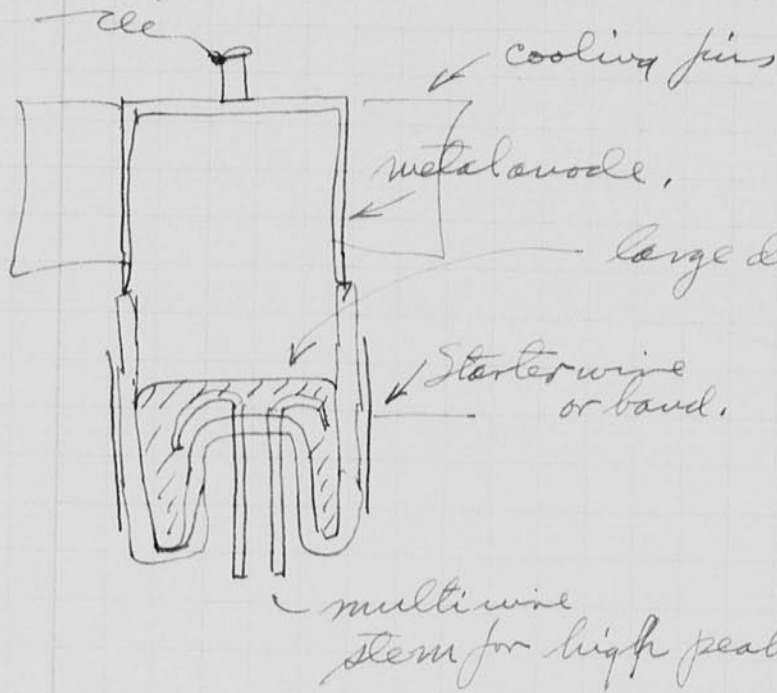
A discussion of special mercury tubes was also had with Noel and Elmerendorf. I suggested a tube with short anode - pool spacing and a large anode for low drop operation at high current pulse operation.



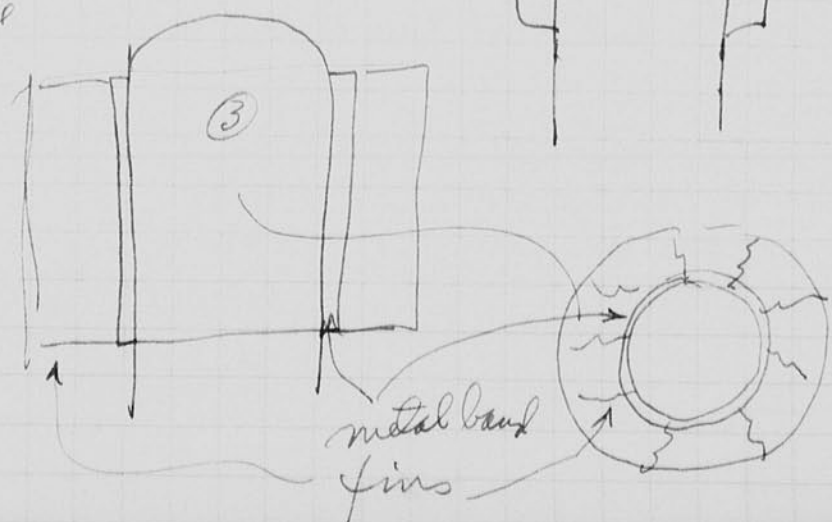
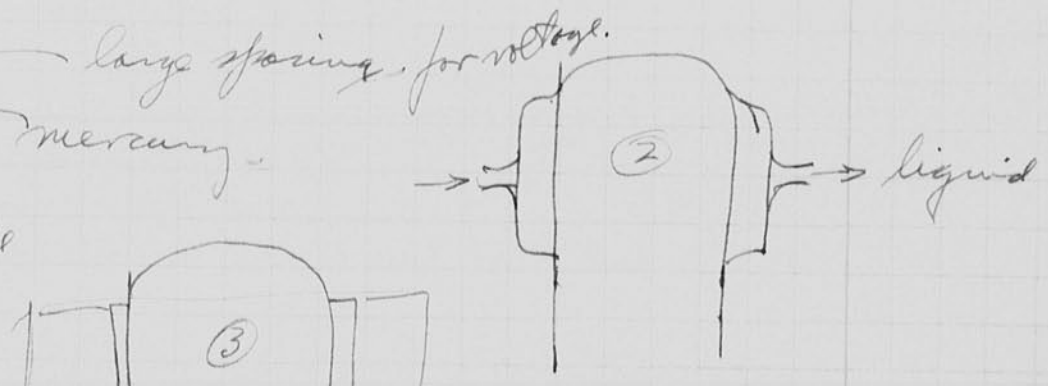
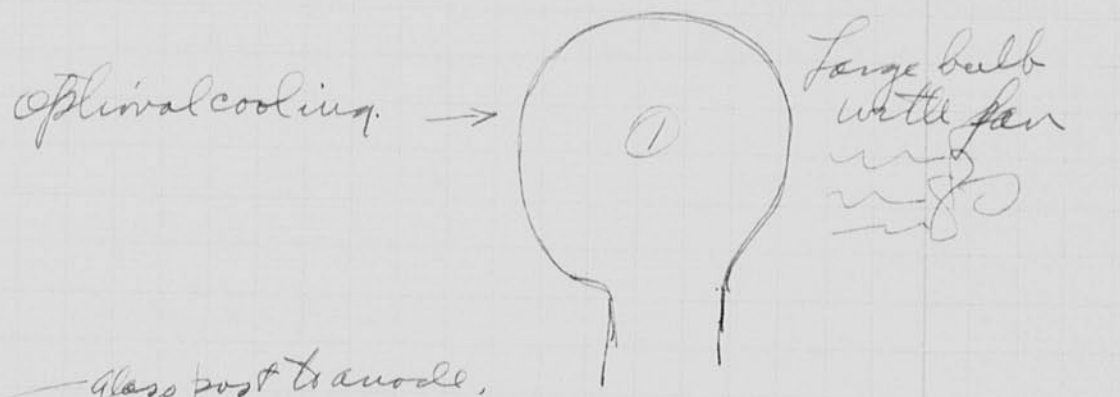
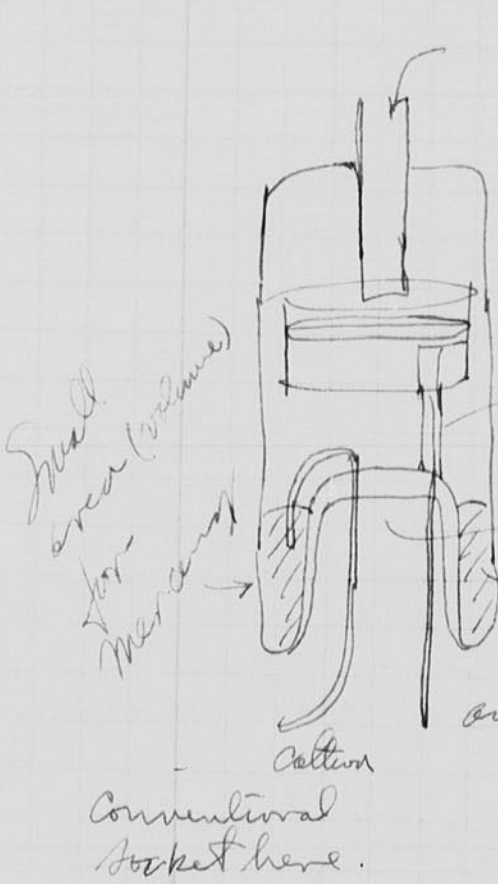
A screen or band of large area in contact with the glass outside the mercury is very important, since this glass and metal serves as a series capacitor to transmit the spark to the xenon tube in the cathode circuit.

For continuous use a radiator should be used on the top part of the

tube to take away the heat of condensation from the mercury vapor. The top could be made of metal so good heat conductivity would result.

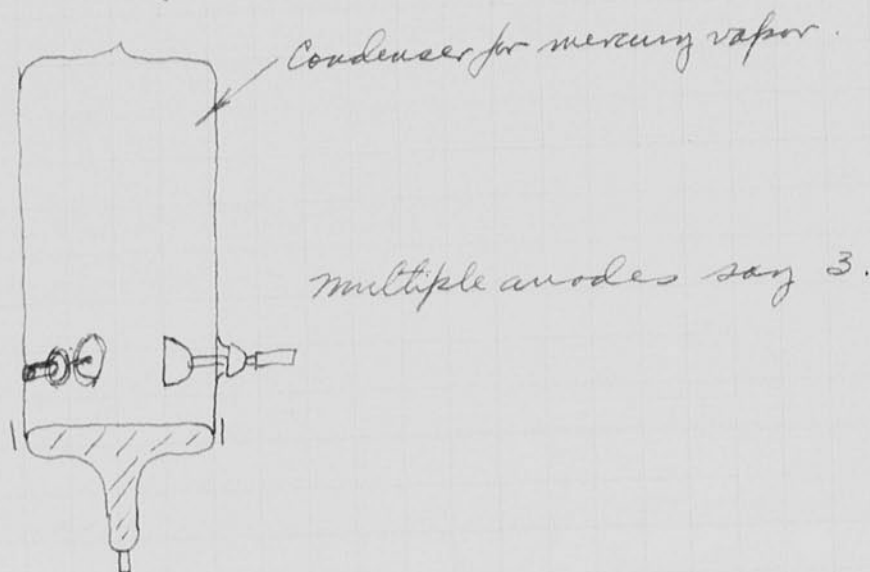


large diameter mercury surface to give large interface of mercury-glass. this line becomes dark after life due to the action of the cathode spots.



66 Cont. June 2 1954
 Nela Park, Cleveland Ohio
 Harold E. Edgerton

mercury-tube designs



1 kw into a 120 cycle neon lamp.

200 volts to 50 $f \frac{CE^2}{2} = 1KW = 1000 \text{ watts.}$

400
 400
 16000
 40000

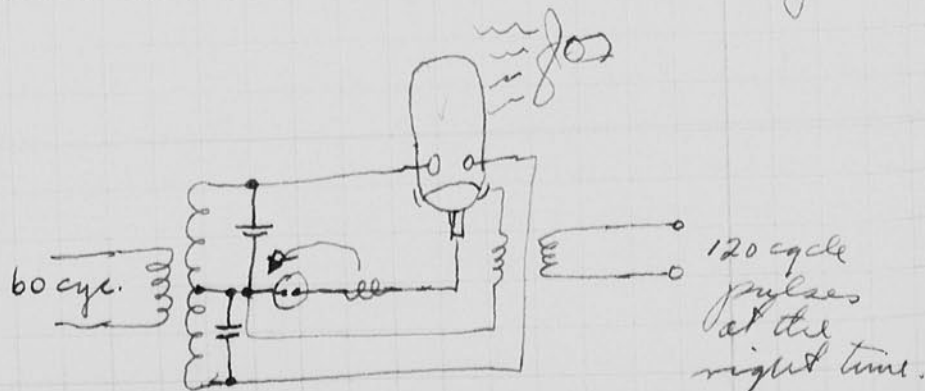
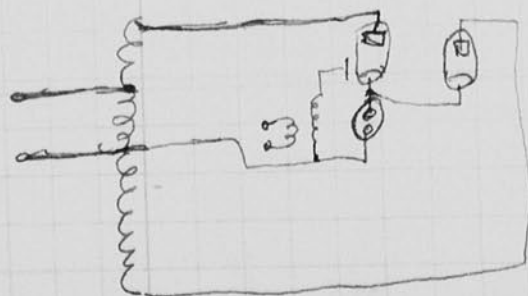
4 - .25.

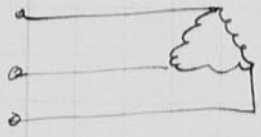
$$C = \frac{1000 \times 2}{f (200^2 - 50^2)} \cong \frac{2000}{120 \times 37500} = \frac{2000}{4500000} = \frac{1}{2} \times 10^{-6} \text{ farads.}$$

$$= 500 \times 10^{-6} \text{ farads}$$

$$= 500 \text{ mfd.}$$

An electrolytic would get very hot and become inoperative due to the leakage current. the electrolytic should be made in a thin strip so that the heat can be conducted away.

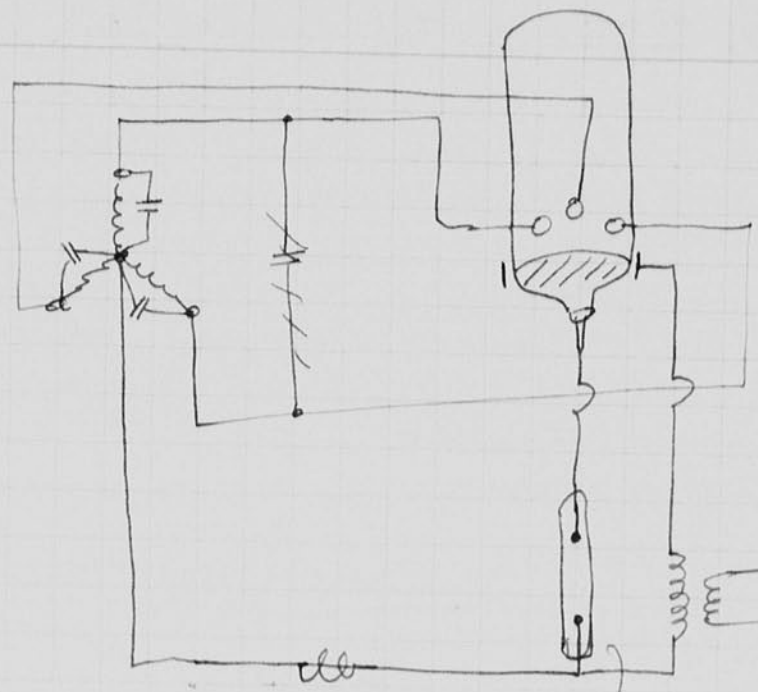




3 phase power
220 volts.

High leakage
transformer.

Capacitors on
secondary for
supplying surge
power to flash lamp.



vacuum high pressure
lamp to produce
light efficiently and
at the right color.

Designed & understood
by me June 11 '54
R. H. Jones

Read and
understood
page 64 to
page 67 in-
clusive

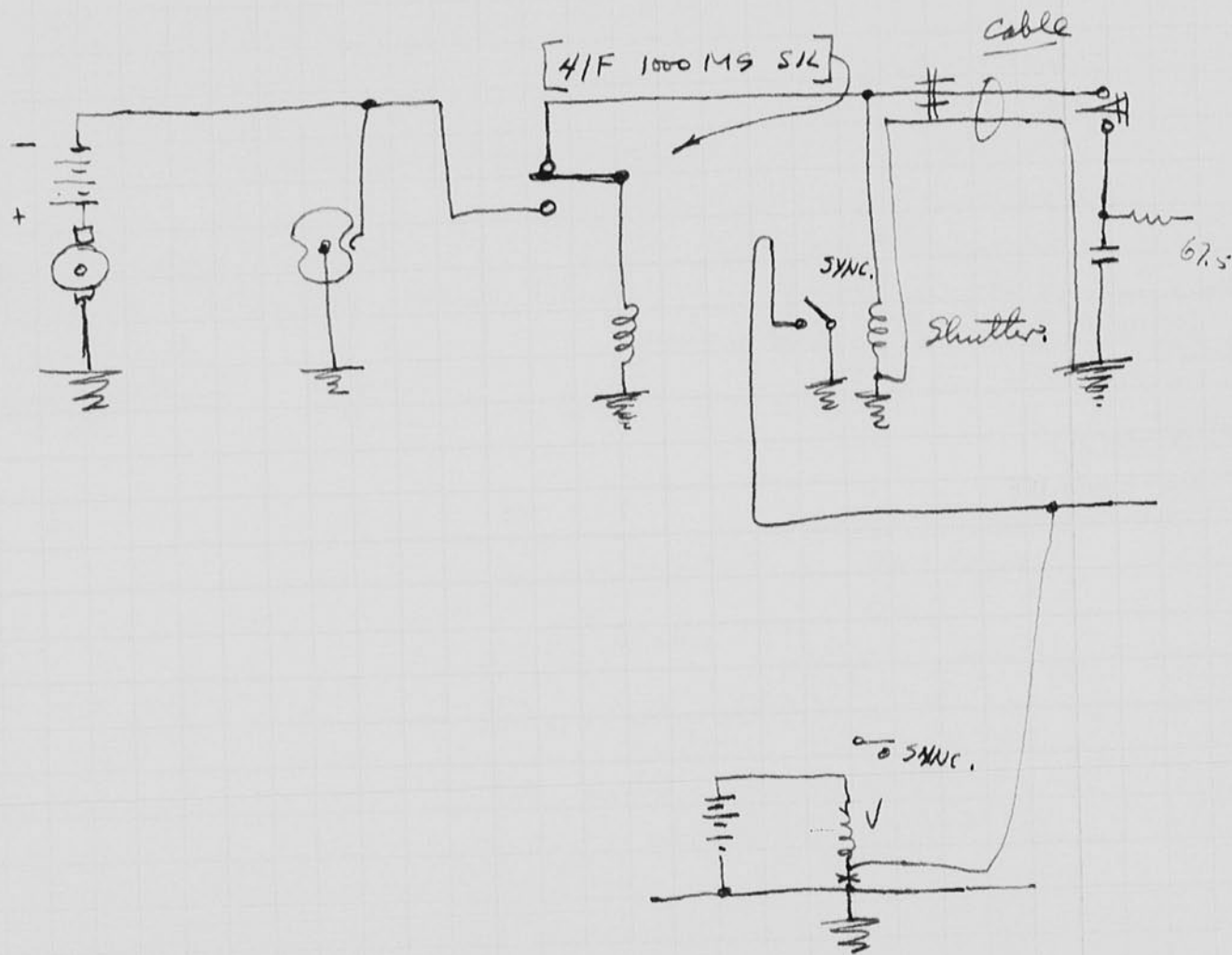
R. E. Emendorf

JUN - 2 1954 DEE
Date

June 4, 1954.
Harold Edgerton.

Bill Edgerton started working with me yesterday on the camera for under water pressure button operation. This is the camera that did badly on the last trip to Woods Hole.

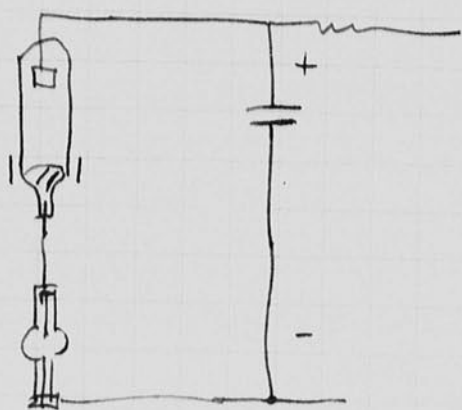
A new relay. Sigma 41F Code 1000 MS coil 512 was used. The first sample did not work very well, a second one did after adjusting the inner contact.



June 5 1954 M.I.T. 20D102.

Harold Edgerton

Henovia Lamp. 10 atmospheres xenon?
3/16" gap tungsten electrodes.



at 400 volts with
a 605 mfd capacitor
the seals melted on
the inside opening
the circuit. However
the sparkler would
make it go - but hard start.

$$\frac{CE^2}{2} = \frac{400^2 \cdot 605}{2} = 48.4 \text{ watt sec.}$$

$$\text{Light h.c.p.s.} = 27 \times 1^2 \times 1 = 27 \text{ h.c.p.s.}$$

$$\frac{\text{h.c.p.s.}}{\text{watt sec}} = \frac{27}{48.4} = 0.558 \text{ h.c.p./watt.}$$

CP/watt
0.558

Size of area = sphere 3/16" diam.

$$\frac{3}{16} = .1875 \text{ cm.}$$

$$\text{area} = \frac{4}{3} \pi R^3 = \frac{4}{3} \pi \left(\frac{D}{2}\right)^3 = \frac{4}{24} \pi D^3$$

$$R = .238 \text{ cm.}$$

$$= 4 \pi R^2 = 4 \pi \cdot .012 = .075 \text{ sq cm} \quad 06.25$$

$$= 7.5 \text{ sq mm.}$$

$$\frac{27 \text{ h.c.p.s.}}{.075} = 360 \text{ h.c.p.s./sq cm.}$$

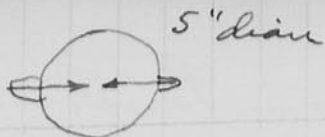
$$\text{FX-1 H.C.P.S.} = 100 \times 3^2 = 900.$$

$$\text{area} = 6" \times \pi D = (2.54 \times 6) \times \pi \cdot 4 = 19.2 \text{ sq cm}$$

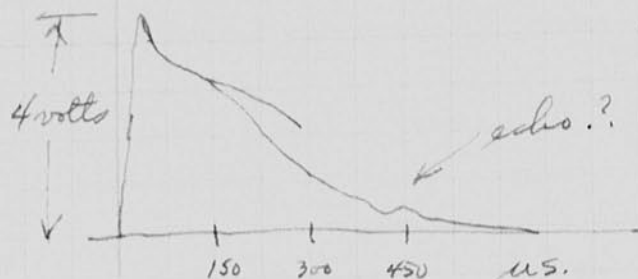
$$\frac{900}{19.2} = 46.8 \text{ h.c.p.s./sq cm}$$



5" diam Krypton lat.
1 cm gap.



605 mfd 300 volts.



eds.?? at 450 μ s. for 5 inch travel of wave.

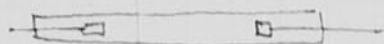
$$v = \frac{d}{t} = \frac{5 \text{ inches} / 12}{0.45 \times 10^{-3} \text{ sec}}$$

$$= 1000 \text{ ft/sec.}$$

about right for velocity of sound.

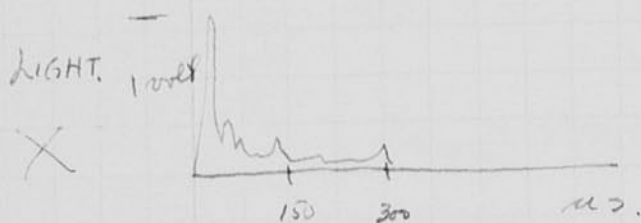
frequency for standing waves = $\frac{1}{1.50 \times 10^{-3}} \approx 2000 \text{ cycles.}$

P.C. at 1 meter no filter.

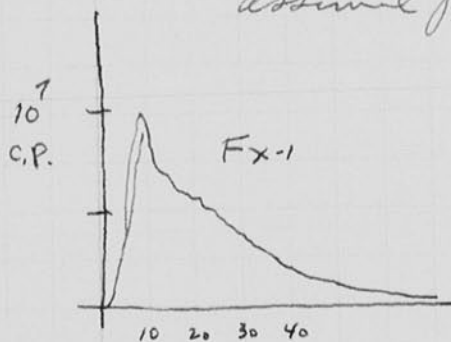


1 inch gap in 0.4 cm diam 10 tube
2 atmospheres of xenon.

?? Less peak - shorter duration
rough light time curve ??

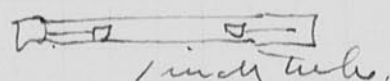


Fx-1 2000 volts 10.5 mfd. 1 meter $D=1.3$ 3-1
assume peak is 10×10^6 h.c.p.

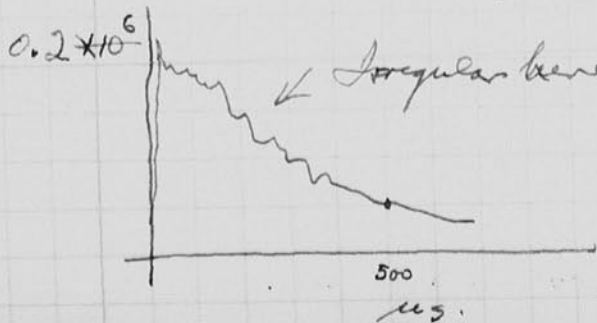


Scale

now test with



450 volts 605 mfd 1 meter $D=1.3$

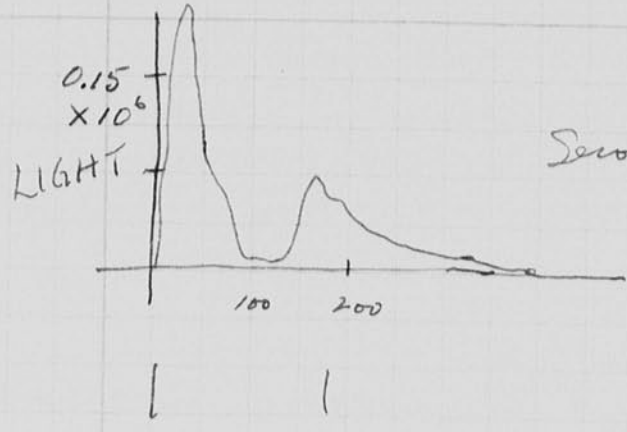


Irregular here? why.

about same curve with
1200 \times mfd.

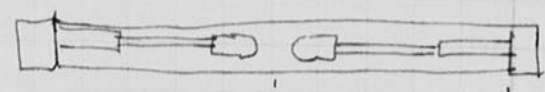
Peak slightly higher.
say $.3 \times 10^6$.

1/8" Xenum gap 2 admas.
 1200 mfd. 470v. Hg tube.



Second peak at 180 us.

Due to return surge of gas from ends of the flash tube.



$$\frac{2 \text{ inches} \times \frac{1}{12}}{.200 \text{ us} \times 10^{-3}} = 1000 \text{ ft/sec} \checkmark$$

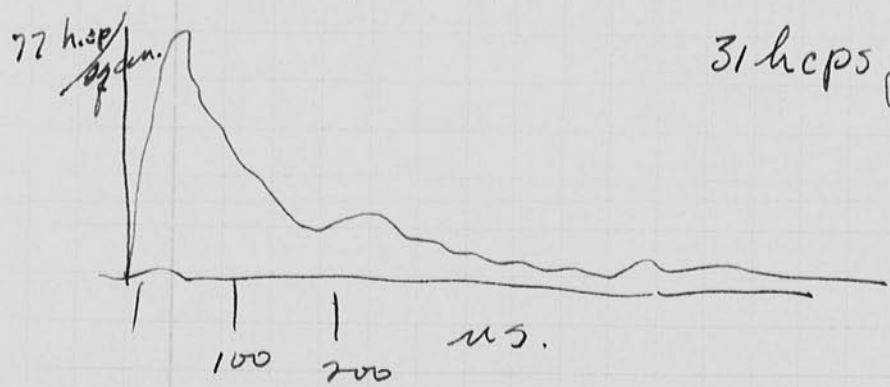
From tests with
 Light meter.

| Area. (sq cm) | CP/μsec | Tube | H.c.p.s from | Capacitor | Voltage | Watt sec. | CP/watt. |
|---------------|---------|-----------|--------------|-----------|---------|-----------|----------|
| 3.2 | 181. | 1" tube | 580 | 1210 mfd | 470v | 134 | 4.32 |
| .4 | 160. | 1/8" tube | 64 | " | " | 134 | .478 |

There was some erosion on the 1" tube electrodes.

The 1/8" tube electrodes showed.
 anode - melting - spots of tungsten dropps.
 cathode - cracks forming in tungsten.
 The ~~anode~~ anode heating is much more than the cathode.

Tried 4 750 mfd at 180 volts. into 1/8" tube.



31 h.c.p.s from 3000 mfd 180v $\frac{31}{48.7} = .64$ C.P./watt

Bob returned for his first year at Uni of Rochester June 5.

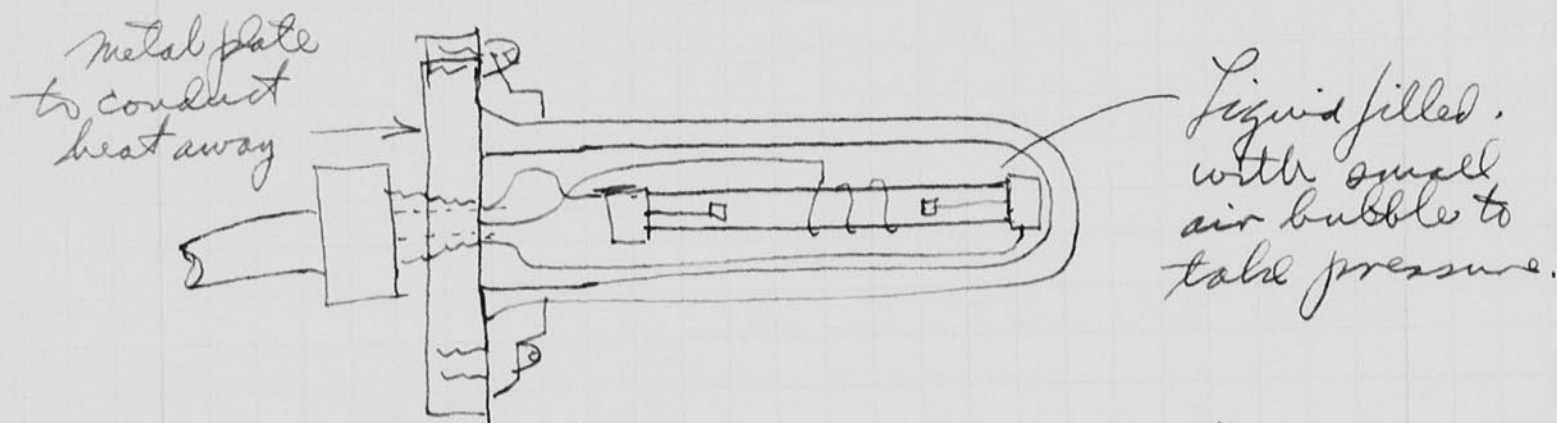
June 6, 1954

Harold Edgerton

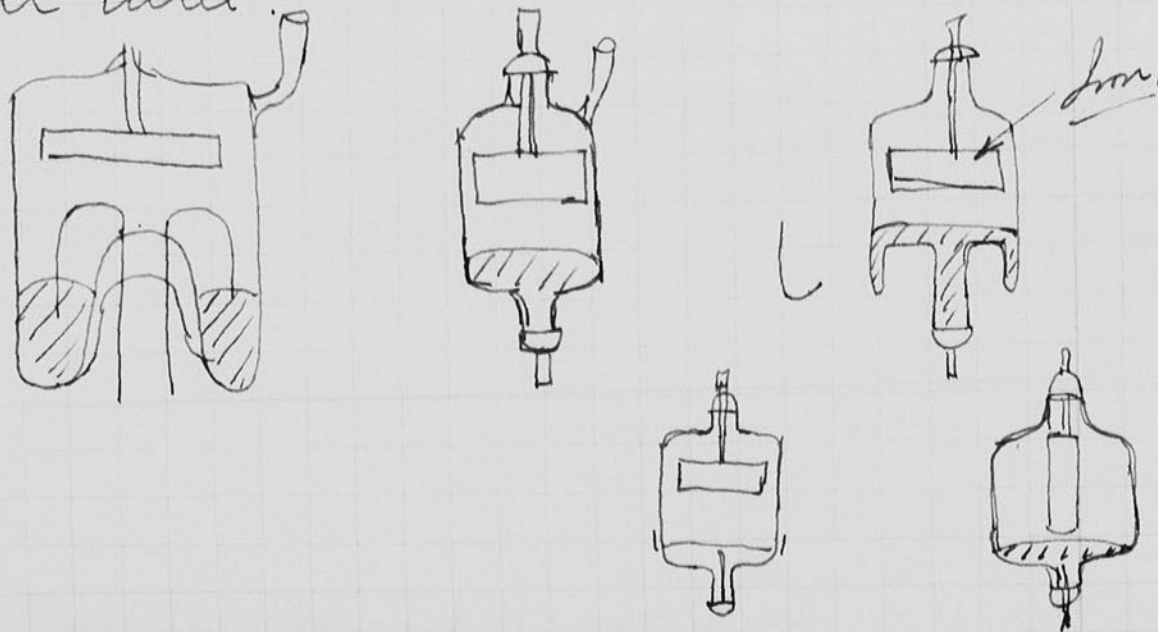
Liquid-Cooled Stroboscope.

The big problem with continuously operated stroboscopic lamps is ~~the~~ the heat flow. Especially in the quartz lamps with soldered ends, the temperature is most important.

Immersion of the lamp in a liquid will do wonders for heat transfer. Circulation from thermal flow will go a long way in reducing high local temperatures. I propose that the lamps be sealed into high-pressure glass enclosures with liquid cooling somewhat as shown in the sketch below.



For very high frequencies, the mercury arc tube can be used to drive the flash tube.



Power out put = 20 watts estimated.

100 cycles/sec.

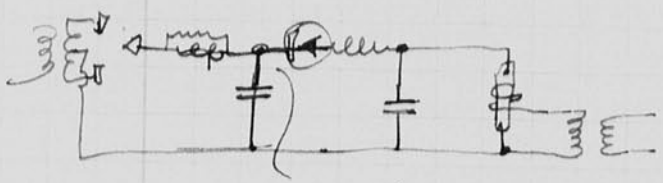
$$\frac{CE^2}{2} f = 20.$$

$$\frac{CE^2}{2} = \frac{20}{100} = \frac{1}{5} \text{ watt sec.}$$

$$f = 240 \text{ A.}$$

$$P = 20$$

$$\frac{CE^2}{2} = \frac{20}{240} = \frac{1}{12} \text{ watt sec.}$$



400 volts.

max. Efficient tube. FX-1 200 mfd 2000 volts $\frac{CE^2}{2} = 200 \text{ watt sec.}$
 $l = 6'' \quad d = 0.4 \text{ cm.}$

What is most efficient size for 1000 volt tube, 1 watt sec.?

$$l = 3''$$

$$d = \sqrt{\frac{1}{200} \cdot 4} = \frac{.4}{14.1} = .04 \text{ if volume is criteria.}$$

then tube resistance will be

$$2 \text{ ohms} \times \left(\frac{3}{6}\right) \times 200 = 200 \text{ ohms. !!}$$

$$C = 1 \times \frac{2}{E^2} = 2 \text{ mfd.}$$

$$\frac{RC}{2} = \frac{200 \times 2}{2} = 200 \text{ microsec.}$$

Discharge should be less than 20 us.

Try new design with $l = \frac{1}{2} \text{ inch}$
 $d = .1 \text{ cm.}$

Pressure increase.
 $6 \times 20 = 120 \text{ atm}$
 $= 2 \text{ atmospheres.}$

$$R = 2 \times \frac{1}{12} \times \left(\frac{4}{1}\right)^2 = \frac{1}{6} \times 16 = 2.6 \text{ ohms.}$$

$$\text{Peak current} = \frac{1000}{2.6} = 380 \text{ amp.}$$

$$RC = 2 \times 2.6 = 2.6 \text{ us.}$$

$$T = 700^\circ \text{C.} \quad K = .0036$$

$$\frac{Q}{T} = .10 \text{ kw.} \quad C = 41.8$$

Temp calc. See page 60.

$$A = \left(\frac{Q}{T}\right) \frac{d}{CKT} = 0.1 \frac{0.1 \times 10^4}{41.8 \cdot 0.0036 \cdot 700} = 1.07 \text{ cm.}$$

$$\frac{420}{200}$$



I.D. 1 mm
 O.D. 2 mm

$$\text{area} = \pi \cdot 2 \times \frac{2.54}{2} = .8 \text{ sq cm.}$$

Should do it.



Neon 2 atmospheres.
 1 mm I.D.
 Length 1/2 inch.

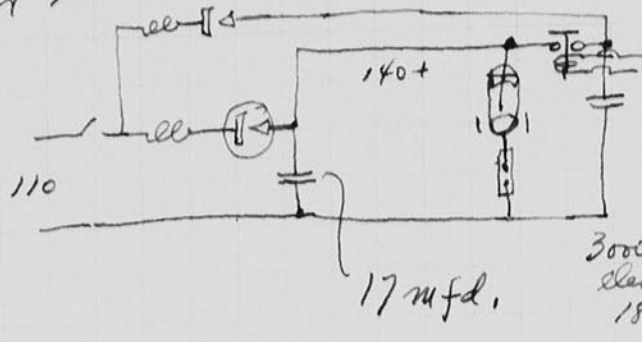
74 June 6 1954
 Harold Edgerton
 205 School St
 Belmont Mass.

Microscope Strob.

$$\frac{1}{.06} = 16.$$

$$\frac{.14}{.02} = 7.$$

$$.06$$



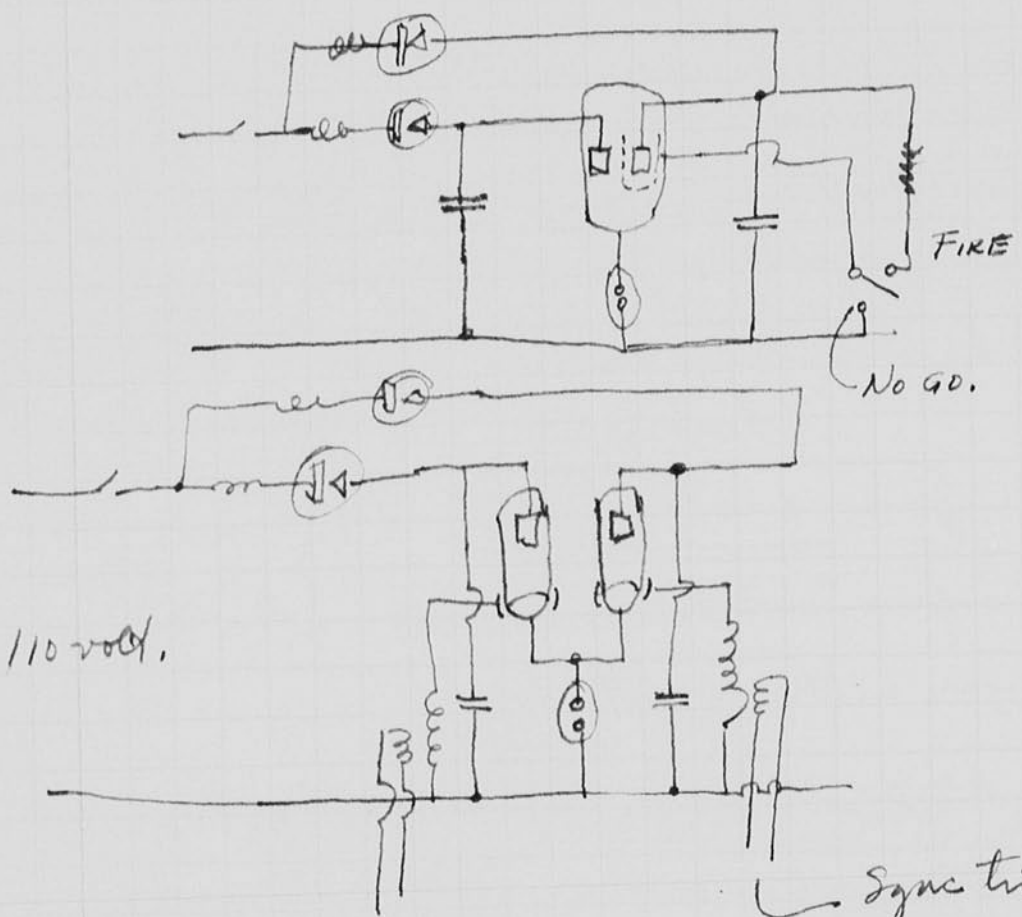
10 watts = $\frac{CE^2}{2} 60$

$\frac{CE^2}{2} = \frac{1}{6}$ watt sec per flash.

$C = \frac{2}{6} \frac{1}{E^2} = \frac{1}{3} \frac{1}{(140)^2} = 17 \times 10^{-6}$

3000 mfd
 electrolytic.
 180 volts.

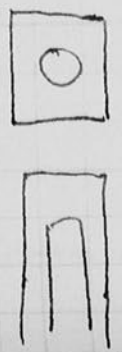
50R



110 volt.

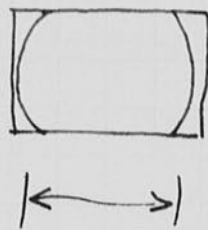
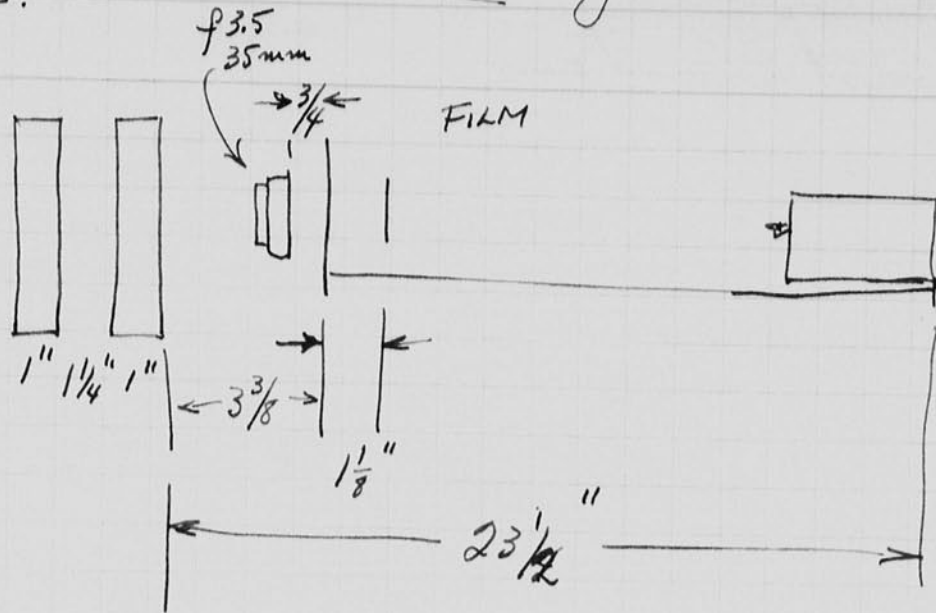
60 cycle
 pulses for
 steady focus light

Sync trip from
 camera shutter.



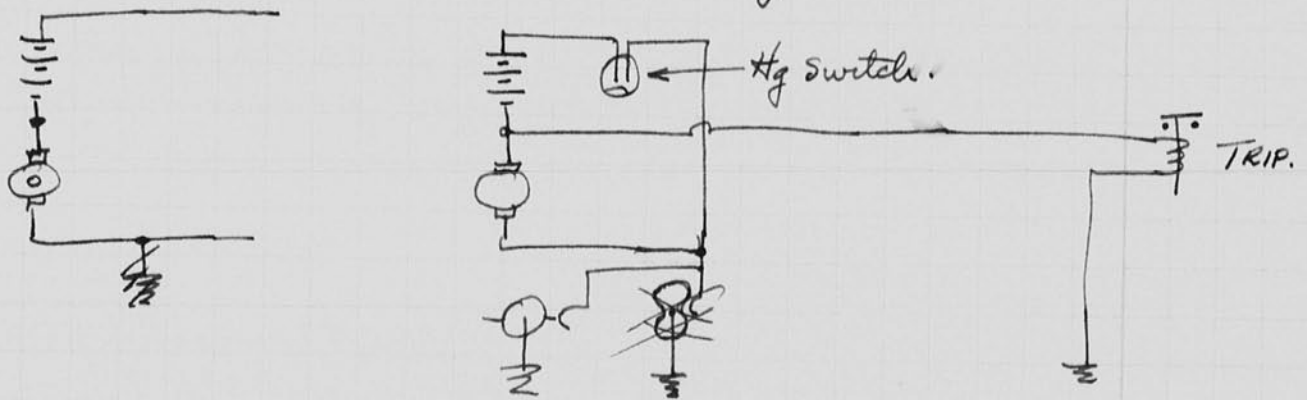
June 7 1954
Harold G. Edgerton.

Silhouette camera for summer.



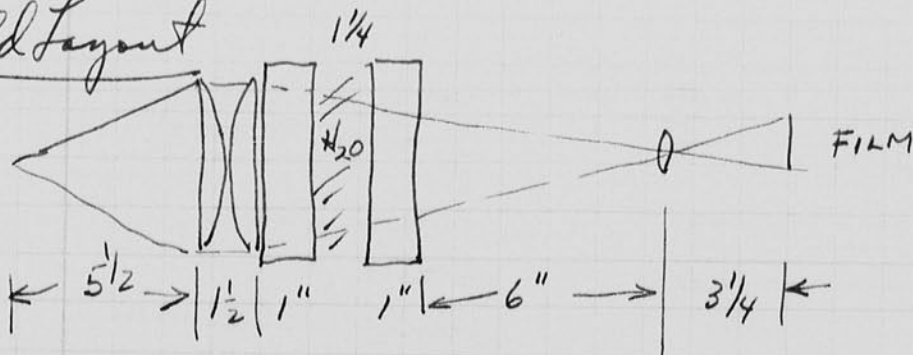
frame on 35 mm film
3" diam approx field at subject.

Camera case is 30" long inside
Light case is 20" long inside.



Camera wiring diagram.

Old Layout



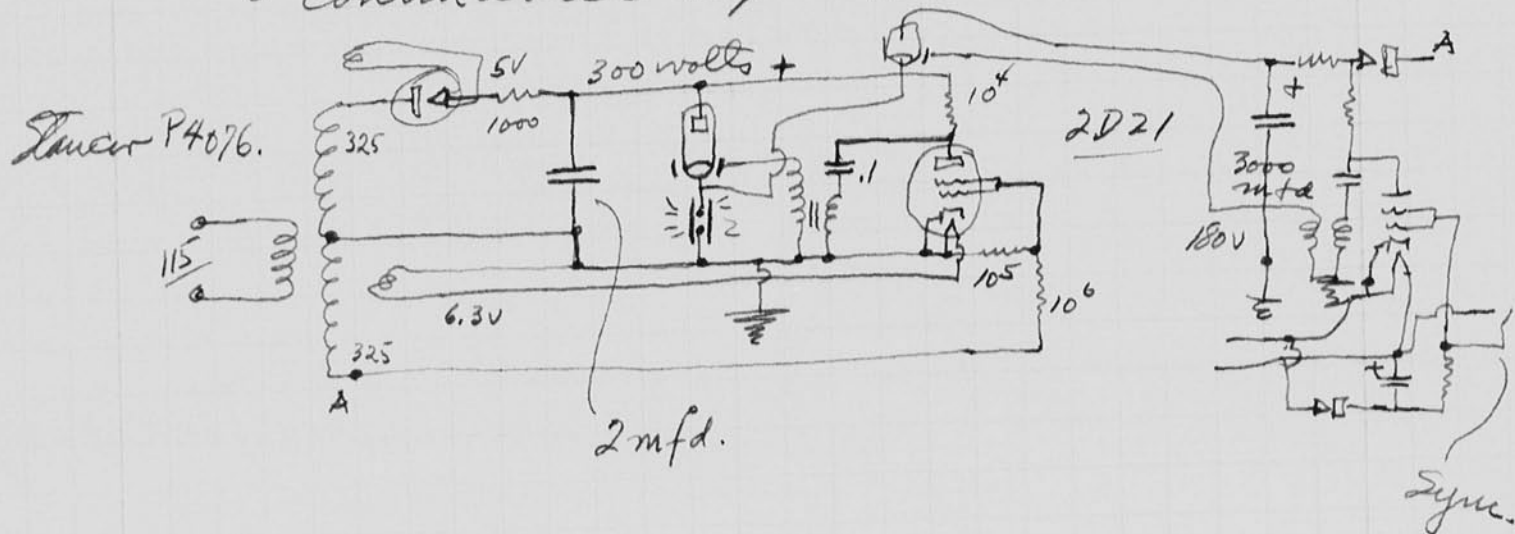
June 8 1954
 Harold S. Edgerton

205 School St Belmont Mass.

Just home from busy day making equipment for trip to France, leaving June 30. Bill is helping and will make the trip with me.

Grade conference this morning in 10-203 Jackson room.

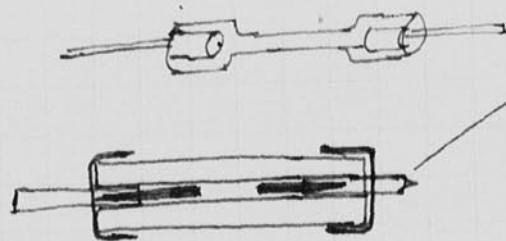
Continuous light circuit.



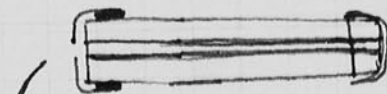
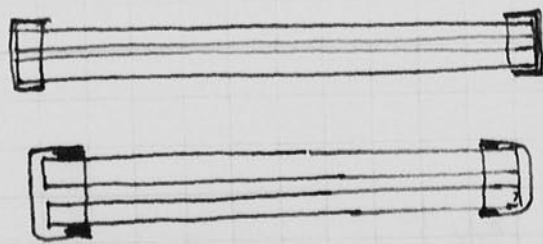
Tube design



Blow full of argon gas at atmospheric pressure.
 Cement ends with tungsten seals.
 Capillary tubing for pressure.

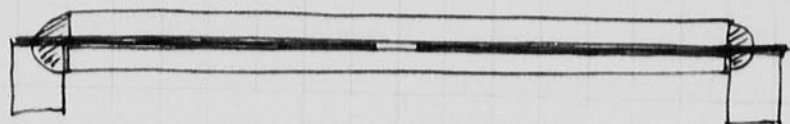


Exhaust connection here.
 also seal off tip.



evacuate.
 Bake.
 Distill in Caesium
 X-ray / at mos.
 (or argon) Seal off.

Longer ends to take away heat. Argon 1 atmosphere



$\frac{1}{4}$ " gap.

Tungsten seals,
40 mils

$\frac{2.54}{.04}$

.1016 cm or 1.016 mm



Short arc tube.

Cathode on end plate.
under end of capillary glass or
quartz tubing.

After making these -

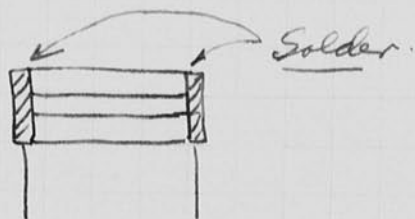
Drill one end
flush with argon at 1 atmosphere.
Solder shut on end.

100 watt focus lamp for underwater 30 volt 100 watt
1" diam
3 $\frac{1}{8}$ " overall

Other lamps.

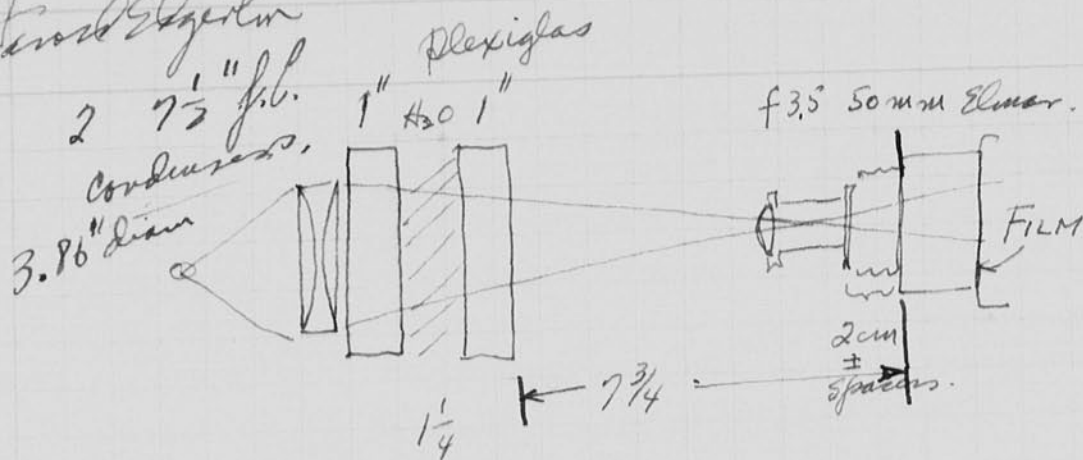
200w G 30/1 12 volt 3 $\frac{3}{8}$ diam Round bulb.

Bostow requested power supply (28 volt) and other
night photo equipment for summer tests of
operation for the Fairchild contract.



June 9 1954

Hand Experiment



Elmar focused on mid section of water between plexiglas 1" discs.

Sparkler has $67.5 \times 4 = 280$ volts.

4 mfd.

Model electric PE coil.

4 - cap. on sec. 500 uuf.

Spark gap $\frac{1}{16}$ " in glass.

Enlargements of range of field

$\left. \begin{array}{l} 9.1 \text{ mm} \\ 8.25 \text{ mm} \\ 7.95 \text{ mm} \end{array} \right\}$ actual size = 2.8 mm
 hole in
 side of
 35 mm film.

$$7.68" = \frac{3}{4} \pm$$

$$\text{enlargement} = \frac{7.68}{7.5} = \underline{\underline{10.2}}$$

on film

$$\frac{8.25}{10.2} = \underline{\underline{.81 \text{ mm}}} \text{ of subject } 2.8$$

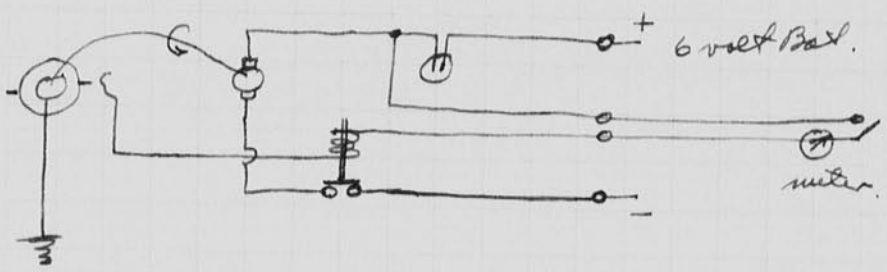
$$\text{Demagn on film} = \frac{2.8}{.81} = \underline{\underline{3.46}}$$

June 17, 1954

Harold Edgerton

Conference with Risser and Langley & Joan Needelman.
10.30 am Rounds and Mac? of the David Taylor model Basins,
were here to discuss propeller (slip) photography problems.
Spent every free moment on cameras for summer
effort.

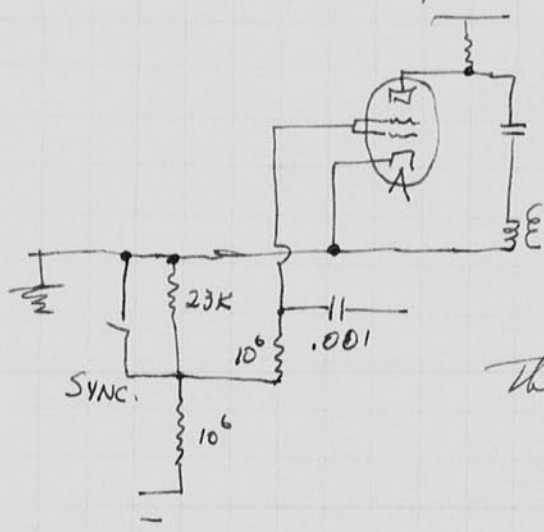
Dave Owen called. 30 ohms in his line to the surface,
camera diagram.



June 18, 1954

The Swinable flash unit has a delay when
used with the Leica at 1/50 sec.

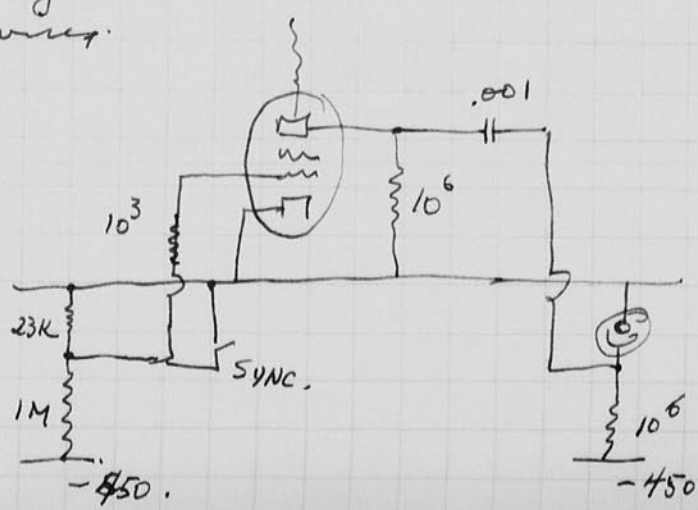
Orig circuit N.G. dated Apr 15 1954.



There is a delay with this
circuit. 5696 tubes
vary also in ability to
carry the peak current.

Bill Mac Roberts changed
the circuit to be following.

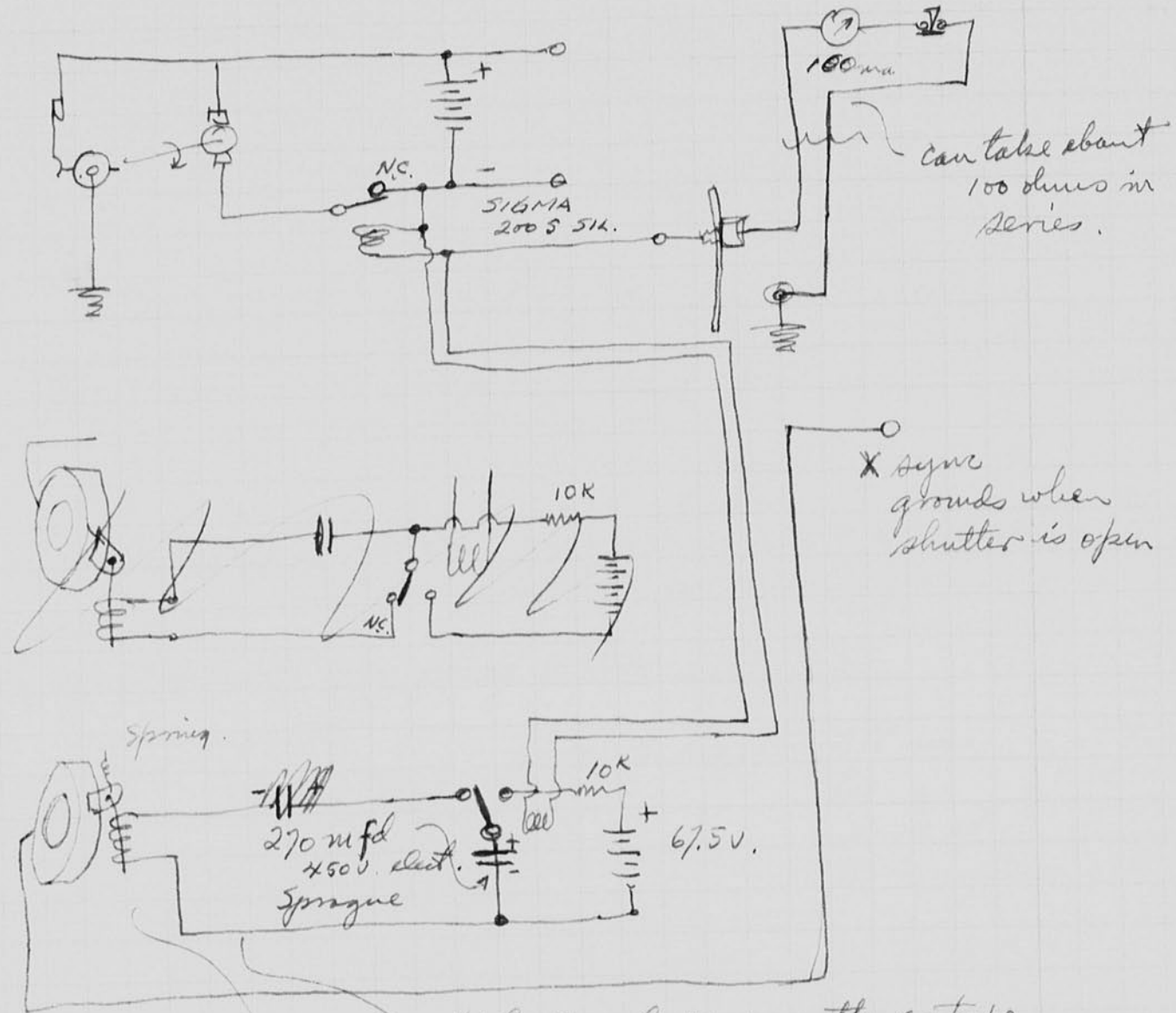
Works fine without
delay. However the
photo cell
part is not over
sensitive.



June 20 1954
 Harold E. Edgerton.
 Camera wiring with

Shutter control.

X sync to lamp. (Lamp has own power)
 monitor indicator.



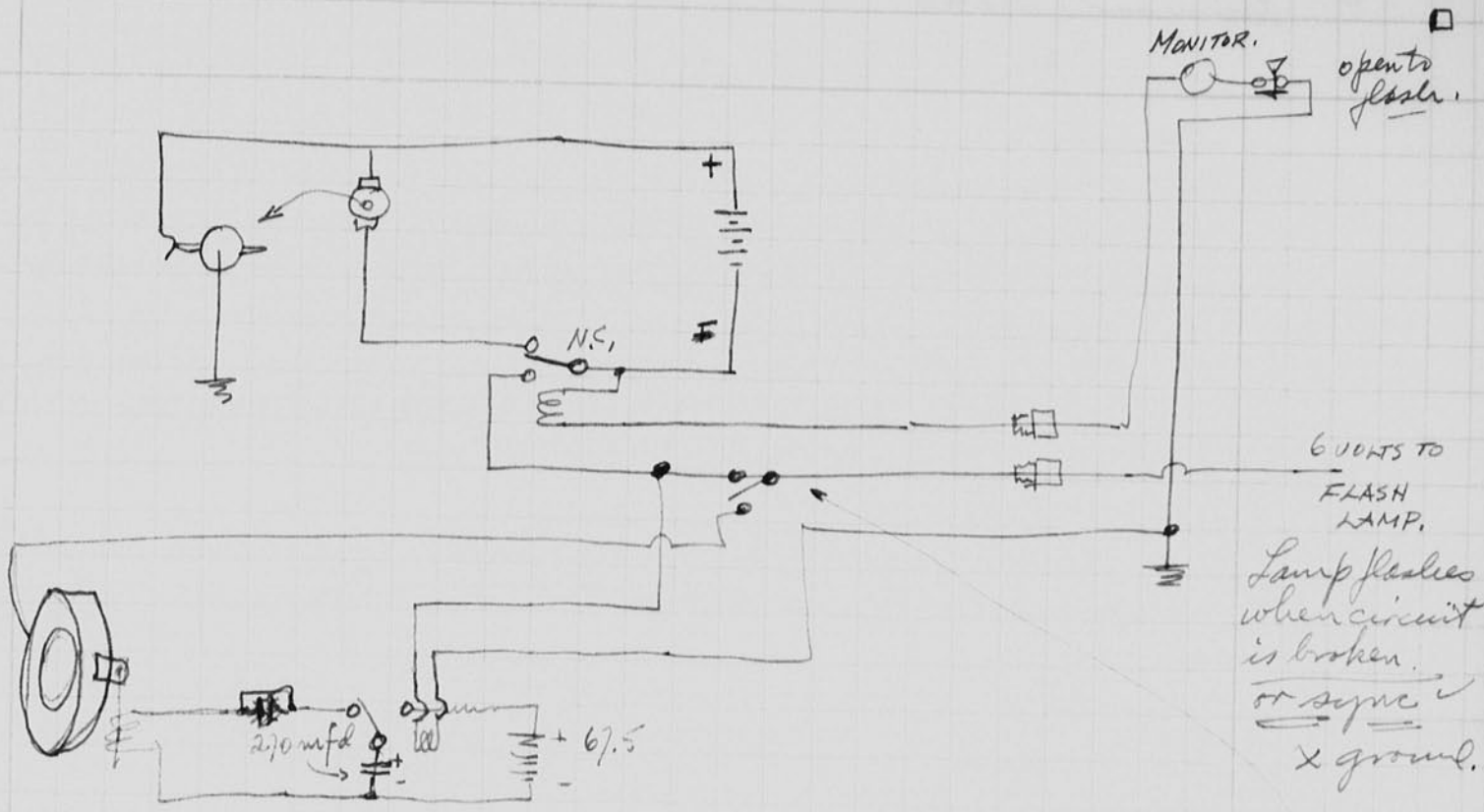
can take about 100 diodes in series.

X sync grounds when shutter is open

Mollensahn.
 X sync.
 Heiland cork 52-1 with a type plug on other end.
 Heiland Type 35 A
 #2 foot.
 #29 wire? \$13.75

It would be better to have the shutter time arranged so that it would also work in our army operation.

Use.

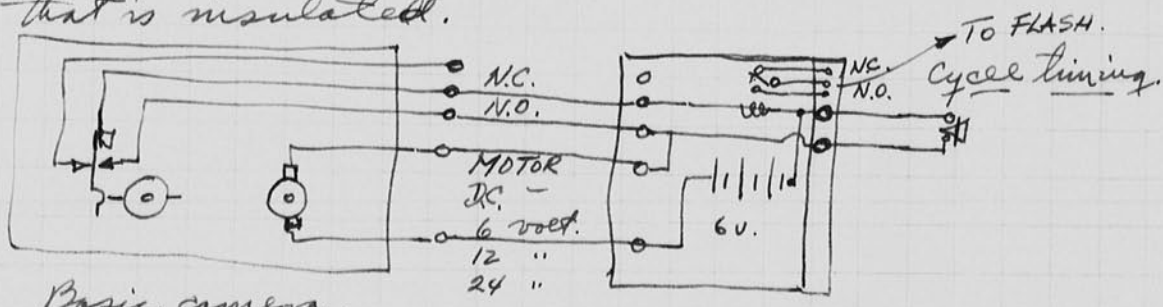


Synchronization depends upon the shutter being open when the flash occurs. There will be a delay in the triggering relay in the flash unit which must be made to correspond to the open time of the shutter.

Modification - bring sync wire out to the flash lamp. This will be a grounded "connection". Therefore the flash lamp must be powered separately.

Above requires extra time for charging after the camera has cycled the film.

Suggestion - Use insulated contact or cycle switch - such as a micro switch with an arm that is insulated.



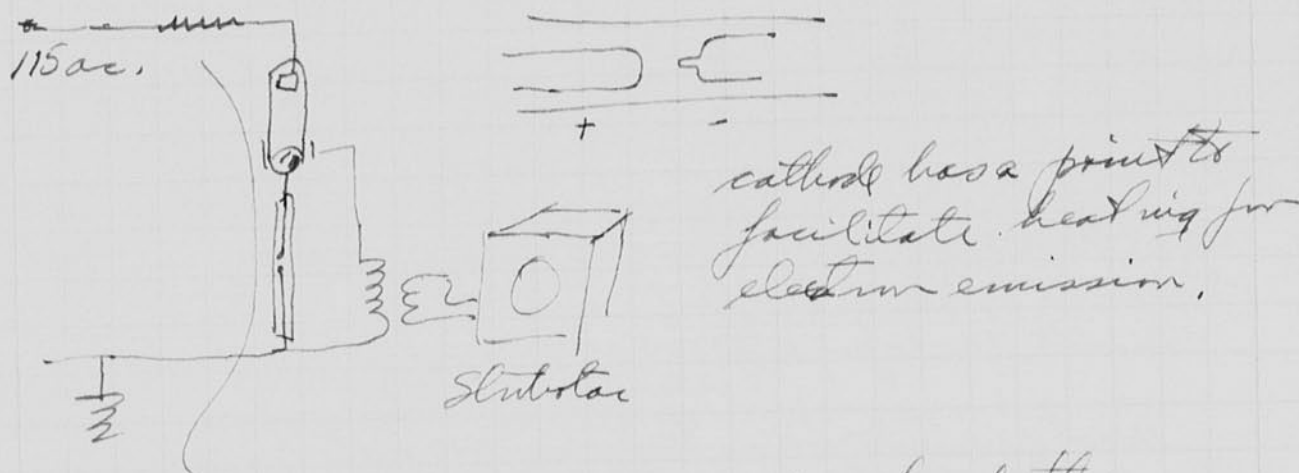
Basic camera circuit.

June 26 1954 Sunday
205 School St
Belmont, Mass

On Friday the 25th, 14 suitcases and boxes of camera equipment totaling 973 pounds was expressed to New York to meet the Constitution for Cannes France where my son, Bill, and I will work with Cousteau on the photography of the sea with the help of the Bathy-scaphe.

Swim and picnic at Lake Walden this noon with Esther, Bob and Bill.

Tests on X-ray lamp from G.E. 1 atmosphere pressure in a short volume.



try 5 ohms and endeavor to spark the circuit at the peak of the ac wave.

Sept. 25, 1954
Harold E. Edgerton

Returned Sept. 11 ~~1954~~ by air plane (air France) from Paris with Bill. The story of our summer adventures with under water photography of the bottom of the sea was written in a series of 20 letters which were sent to the Nat. Geo. society.

Three methods were used to take photos of the bottom.

- (1) The Bathygraph, where an observer "shoots" the photo at the right time.
- (2) The Sled where the camera is towed along on the bottom.
- (3) The vertical camera with a sonar indicator to tell when the camera is near the bottom.

All these methods were used during the summer.

Bill and I lived in the toulon navy yard for the month of July on the Calypso, while working on the Bathygraph. Then we went to Marseille and Indisid and return with a group of biologists.

Aug 29 1954
on Calypso.
taken by Nelson
Couslean.

Ray Joanas started to work for me while I was away this summer.



Bill Edgerton

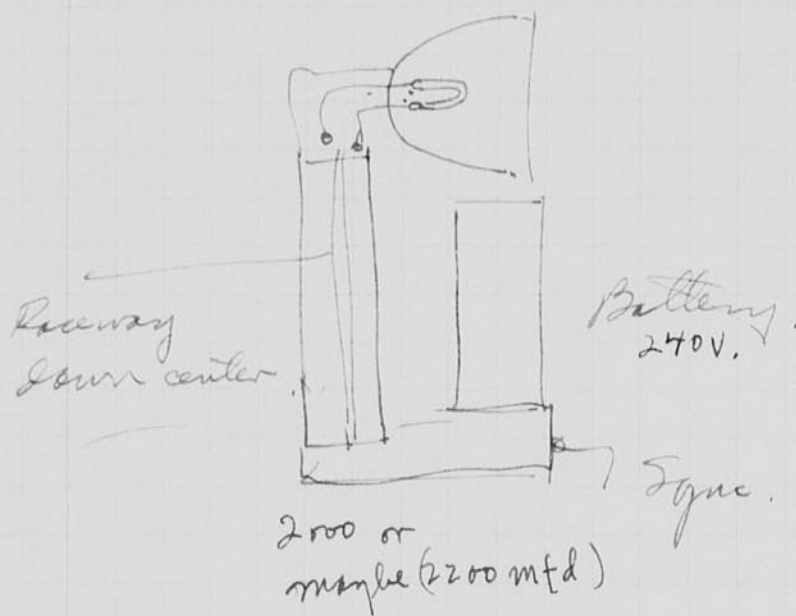
Bill

The April 1955
had an article
about the camera
works.

Oct 10 1954
Harvard University

M.I.T. started classes Sept 20. I have a section of 620 - Paul Stoft has the other, also I have 5 students in 6.631 a lab course in gaseous conduction.

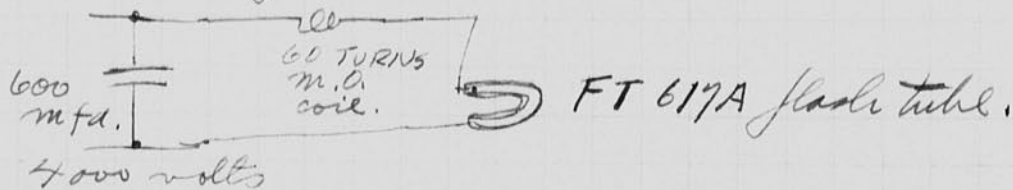
I was in Rochester Oct 8 to attend a conference at Eastman on Eilenberger's model of a portable. The design was a single unit with a 240 volt battery, a 2000 mfd capacitor and a V shaped flash tube. Output was rated measured at 2200 v.c.p.s. in first tests at Nela Park, 160 reading at 4 feet. (140?).



Eilenberger model had a detachable lamp. This probably is not needed.

Babbitt called from Pittsfield about ^{the} Magneto-optic shutter for circuit breaker high-speed motion picture photography. See page 13 and p 25.

Final tests on page 25 show



Photograph tests of photo cells.

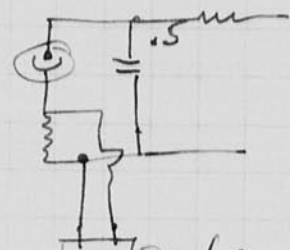
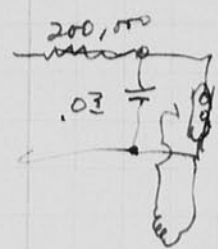
Oct. 13, 1954

Harold Dyer

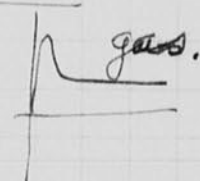
Source .03 at 2KV.

high freq trigger.

Gas tube 1/8" gap Xenon 2 atmospheres.



| Osc No. | Sweep $\mu s/cm$ | E | R. | Voltage Calib. | Scope | cell |
|---------|------------------|----------------|------|----------------------|---------------|---------------------|
| Osc. 1. | 0.5 $\mu s/cm$ | 90 | 1000 | | | 929, Voc <u>all</u> |
| 2.5 | .5 μs . | 400 | 1000 | 26V/2. per μm . | 3.25 μ/cm | " |
| | | 200 | " | | | |
| | | 100 | " | | | |
| Osc 3. | .5 μs . | Light reduced. | | Distance = 3' 7" | | |
| | | 400 V | " | 3.4V/2 = 3.0cm | .566 | |
| | | 200 | " | | | |
| | | 100 | " | | | |
| | | 50 | " | | | |
| 4 | 1.5 | 80V | 1000 | " | .566 | 929 |
| | | 80 | 1000 | } | } | 930 |
| | | 80 | | | | |
| | | 80. | | | | |



light increased by factor of about 5.

High speed positive is marginal with 10 $\mu s/cm$ and full intensity f2.5 on lens.

Oct. 16, 1954.
H. J. Gintan
Ray Swanson

Response of photocells
with short pulses of light.

Source $1/8$ inch gap in X-ray with 2 at-mospheres.
Capacitor .01 mfd. Spark gap 10^7 ohms chg from 2KV.

| Sec. | Subject | $\mu\text{s/cm}$ | volts/cm. | |
|------|-----------------------|------------------|-----------|------------------|
| 1. | 929 90V $10^4 \Omega$ | 1 | .5 | |
| 2 | 930 90 $10^4 \Omega$ | 1 | .19 | |
| 3 | 929 2000V 10^3 | 1 | 2.1 | Spark triggered. |
| 4 | 929 2000V 10^3 | 1 | 2.1 | |
| 5. | 929 2000 10^3 | 0.1 | 2.1 | |

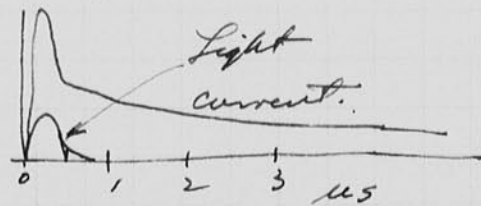
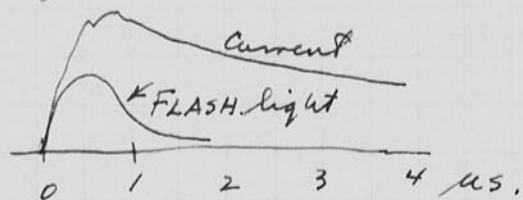
Photon Lamp. .01 mfd. Self flasher at 2KV.

Oscillograms made with teletronic 13D scope.
f 3.5 lens xx film
trace ok at $0.1 \mu\text{s/cm}$.
Light $1/2$ on lines with 1 sec exposure.

Oct. 19, 1954 #44.

The above experiment shows that pulse length plays an important role in the ~~photo~~ current in a gas-filled photo electric cell.

For example with a $1 \mu\text{s}$ flash, the photocell current holds up the peak. With a $1/3 \mu\text{s}$ flash the peak is greater than the after current.



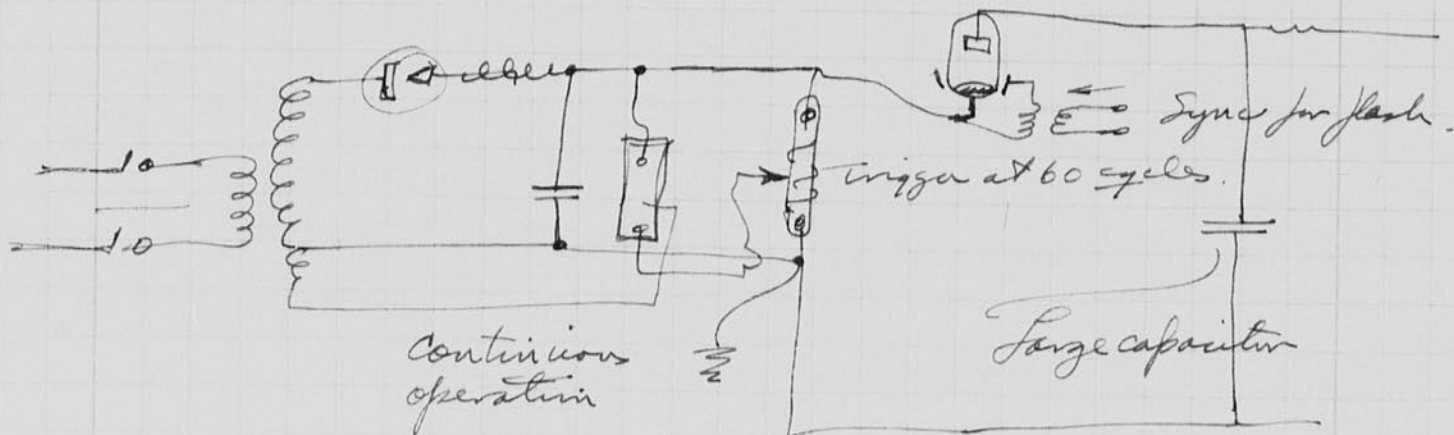
Ray S ~~made~~ made a series of measurements today on some capacitors in the laboratory to find the natural frequencies. We then hope to make a series of experiments on gas-filled cells. A special zinc electrode photocell is being made by Larry Ryan in the glass shop.

Oct 19 1954
Harold Edgerton

Liquid Cooled Flash lamps.

87

The liquid cooled flash lamp offers a good solution to those who wish a pilot lamp for focusing their electronic flash equipment, now the lamp can be run continuously as a strob, with the flash superimposed.

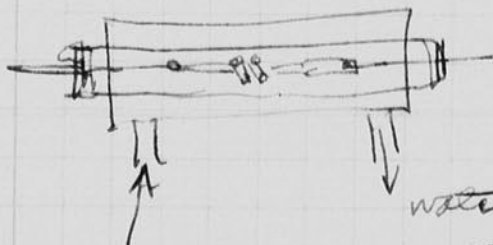


Suggest quartz or glass tube like the FT-218 for first studio model - then follow with unit using FT-623.

Ray ran a 100 watts into the FT-218 several weeks ago while I was getting ready to go to Rochester. It worked fine at 100 watts. The tube was in mineral oil in a 1 1/2" end caps as made by Corning.

Oct 20 1954 Egon FT-2 without jacket
0.02 mfd at 150 cycles at 8 KV. heavy mineral oil. 1 1/2" tube I.D.
this was then put in a jar of water to give additional cooling.

Bill suggests thin walled glass tube over lamp to give heat transfer to external moving water.

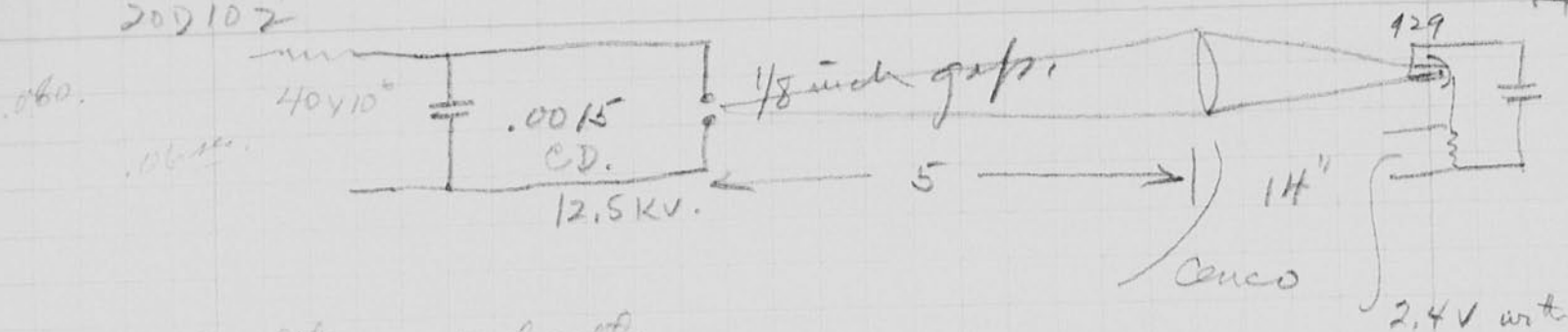


Read and understood
V.E. Mac Roberts
10/20/54

with .02 at 1500 cycles ~~anode~~ gets red hot.
" .02 500 cycles could be run continuously.

H. Edgerton
Ray Swanson
Oct 23 1954.
20D102

Short flash test

Image covers
cathode

c Condition. peak volts.

.0015 Spark gap. 24 90V input

.0015 Xenon 1/8 inch. 2.5V 60V input

.0005 Xenon gap. 10V 105 Sangamo.

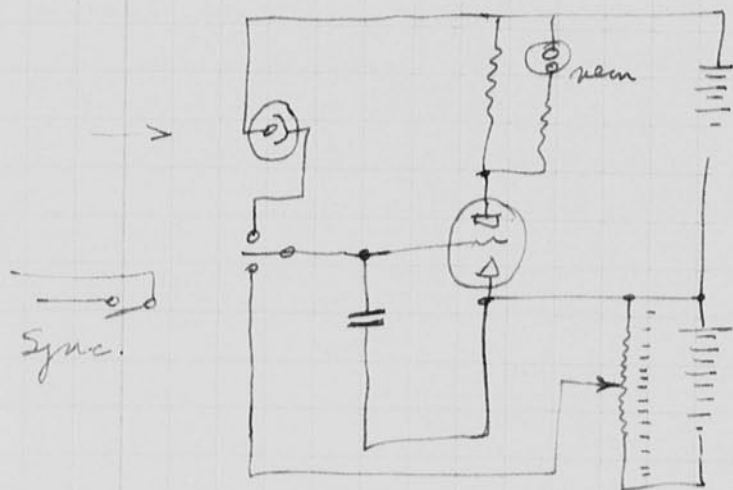
I begin to suspect the amplifier in the Techtronic scope type (513D). An effort was made to observe the light directly with a photo cell at the cathode ray plates. Difficulty with Sync.

Great effort was made for a powerful short flash without too much success. Perhaps we need to go to a higher voltage and smaller capacity.

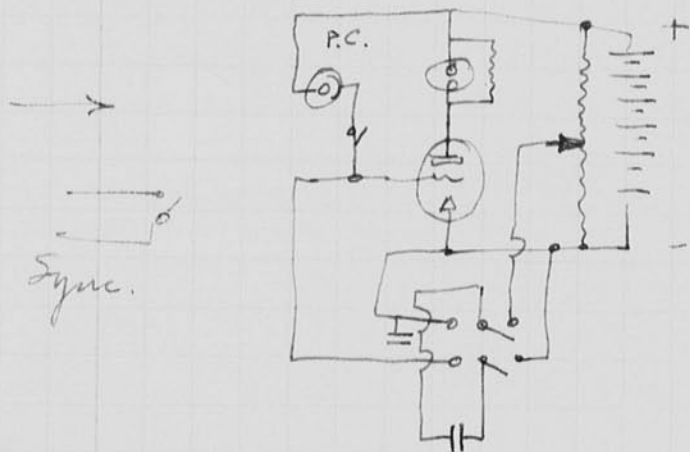
Oct. 30, 1954
Harold Egerton.

Bob and Dave Rivers were in yesterday. Discussed liquid cooling and sonar "tick tick" method of finding the ocean bottom.

Light meter - "go or no go type."

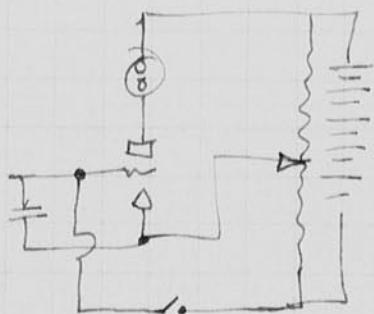


There is no meter on this equipment, a neon indicator tells if the integral of flash has reached a preset value.



Sequence.

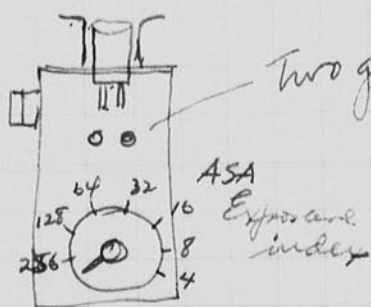
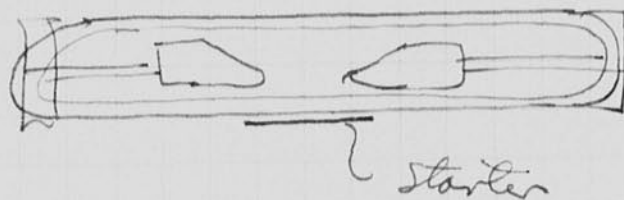
1. Charge capacitor.
2. Connect onto grid.
3. Connect photo tube.
4. Flash lamp.
5. Reset.



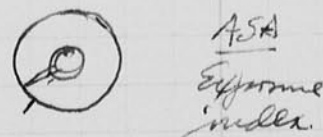
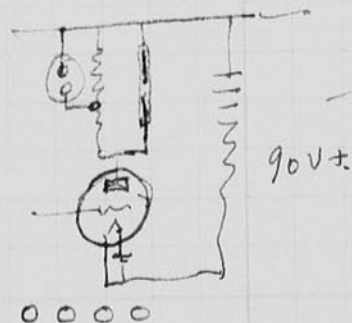
90 Oct 30 1954
 #32 System cont.

The arc in a flash tube always follows the surface of the inner glass when starting, therefore for the gap tube, I propose to use the spark band on one side only to help this effect. Two reasons, (1). The arc will form the same place every time and second the starter may act as a reflector. A third reason - The arc will be a long way from the part of the tube that puts out the light.

||||| gap with tungsten electrodes.



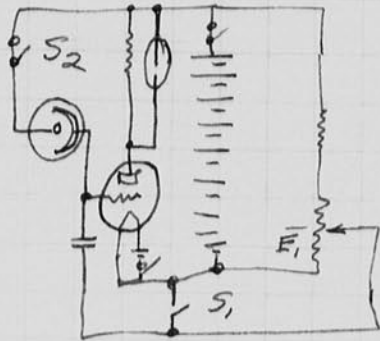
Two glow tubes.



Oct. 31, 1954

Nov
Howard Edgerton

Exposure Indicator



S₁ switch throws the capacitor negative by an amount, E₁,

S₂ opens after flash to stop further photo cell current.

-10 volts. bias to -1 10 volts swing.

$$i = C \frac{dE}{dt}$$

$$i = 10^{-12} \text{ amperes.}$$

$$C = ?$$

$$\Delta E = 10 \text{ volts.}$$

$$\Delta t = 100 \text{ seconds.}$$

$$C = i \frac{\Delta T}{\Delta E} = 10^{-12} \frac{100}{10} = 10^{-11} \text{ farads} = 10 \times 10^{-12} \text{ farads.} = 10 \text{ muf.}$$

Limiting value. This about the capacity of the grid and the circuit.

Now calculate the phototube performance.

929 phototube 40 ~~lumens/area~~ microamp/lumen = $40 \times 10^{-6} \text{ amp/lumen}$

$$i = k l$$

$$k = i/l.$$

$$e_c = \frac{1}{C} \int i dt = \frac{k}{C} \int l dt = \frac{k}{C} \cdot l \cdot \text{area.} \quad \int l dt = 1 \text{ lumen sec/ft}^2.$$

$$10 = \frac{40 \times 10^{-6} \times \text{area}}{C} \quad C = 4 \times 10^{-6} \times \text{area}$$

$$\text{area} = 0.5 \text{ sq inch} = \frac{0.5}{144} = .00347 \text{ sq ft.}$$

$$i = k l$$

$$= k \frac{L}{\text{area}} \times (\text{area sq ft.})$$

$$C = 0.1 \times 10^{-6} \text{ farads.}$$

$$\int l dt = 1 \text{ lumen sec/ft}^2 \times \frac{.03}{.12}$$

$$l = L \times \text{area.}$$

$$\int l dt = \int L \times \text{area} dt. = 1$$

$$e_c = \frac{k \text{ area}}{C} \int l dt$$

Several glow tubes could be used to indicate a range of values that are of interest.

$$C = \frac{k \text{ area} \int l dt}{e_c} = \frac{40 \times 10^{-6} \cdot .035}{10} = 0.1 \text{ mfd.}$$

A magic eye tube could be used where the opening or closing of the eye would indicate the exposure.

Nov. 10 1954
Harold Edgerton.

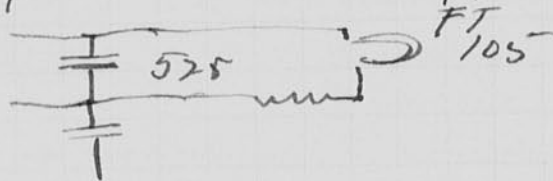
6.631 experiments are being made on the characteristics of Strobolium tubes mainly the 631 P1.

Streak photographs were taken by Watson and LeCompt last week. Yesterday by Miller and Tandy. Escillograms were taken the week before by the same group also by me assisted by Roy Swanson.

Rockwell a 6.20 student may investigate the go-go light meter as a thesis subject.

Nov 18 1954. Washington Nov 12 to see Constantine, Jimmie Dugan. Also saw them in N.Y. at 10 pm at St. Trinity on Nov. 11.

Wychroff wants long flash tubes.



$$RC = .01 \text{ sec.}$$

$$C = 525 \times 10^{-6}$$

$$R = \frac{.01}{.000525 \times 10^{-6}} = 20 \text{ ohms}$$

No Bounce Relay. WE 275F as used in experiments.

Motor Hansen 7100 C 6 volt DC 18 RPM

Rate at start = 24 / minute,
 " " 1/2 = 120 / min. $(16 \frac{1}{2})^{3/4} =$
 " " end

Current in motor = 175 ma at start - 150 at mid.

Nov 20 1954 Darwin tests.

FT-110 Starts at 200 - 250 volts.



2.5 ft

93% → 1000 ohms.

10 mfd 500 rolls.

D Light volts

| | | | |
|-----------|--------|-----------|--------------------------------|
| 1000 volt | 10 mfd | FT-110 | 50 rolls peak on scale |
| 500 | 10 " | FT-110 | 20 us. 15 " " " " |
| 500 | 10 | FT-110 | 60 us 1. volt Series 10 Ω ± ? |
| 125,000 | 450 | 525 (600) | " 500. 25 v. no R. ? |
| 100,000 | 450 | 525 | " 3500 2 Res #1 7 |
| 80,000 | 450 | 525 | 6000 .4 v " #2 19 |
| 70,000 | 450 | 525 | 9000 .2 " #3 29 |
| 60,000 | 450 | 525 | 10,000 .2 " #3 10 ⁸ |

Nov 21. A.S. called Chas W. about the above today.

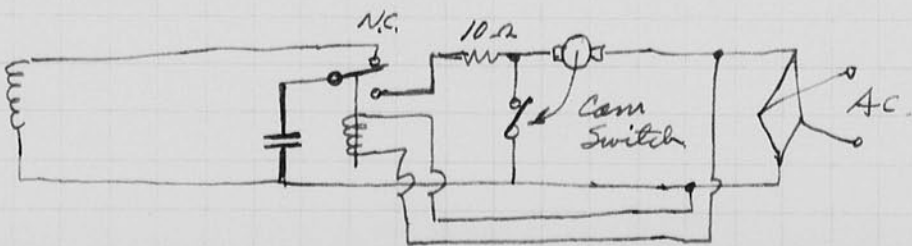
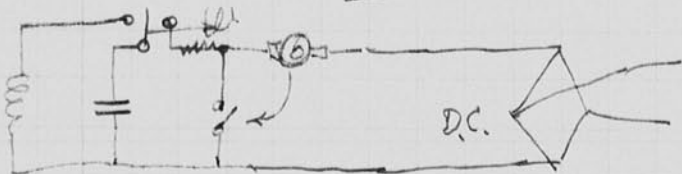
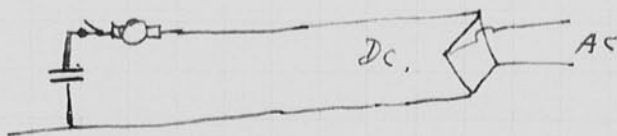
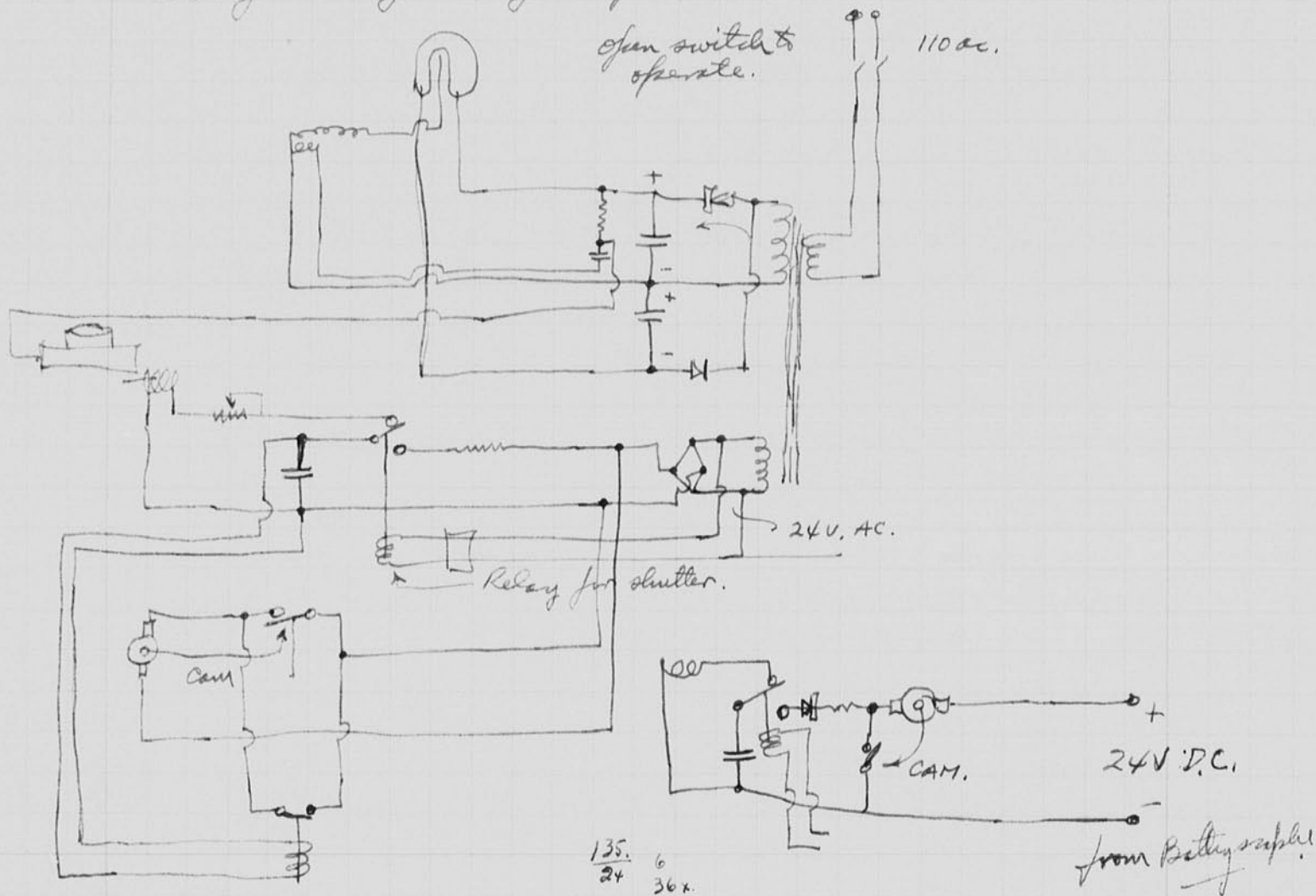
This system increases the exposure time to 10,000 us or 0.01 seconds. The peak light is down by a factor of 100 from the resistance less case. However the duration is greater by a factor of 20.

The .01 second flash source will be useful for the sensitometer which E.S. & D. are trying to make.

Harold S. Edgerton

I worked with Bill MacRobertson Saturday on the underwater cameras for the navy and for the Battyscope. The Battyscope cameras will be operated from 24 volts and the navy from 110 ac.

Navy unit for 300 foot operation.



$$e = \frac{1}{c} \int i dt$$

$$e = \frac{.100}{200 \times 10^{-6}} t$$

$$e = \frac{.01}{.000250} = 40 \text{ volts/sec.}$$

8×10^6 peak

Efficient flash tube at low loading.

The FX-1 flash tube has a maximum efficiency at 2000 volts with 100 mfd (200 watt seconds). This tube is 6" long with a 4 mm I.D. $\text{Effy} = 50 \text{ cp/watt}$.

Suppose we desire a 500 volt flash tube of 1 watt sec rating, with 5. cp/watt.

Let length be prop to voltage and watt sec to volume. then length = $\frac{600}{4} = 1.5$ inches.

$$d_1^2 l_1 = d_2^2 l_2 \times 200$$

$$d_2^2 l_2 = \frac{d_1^2 l_1}{200} = \frac{4 \times 6}{200} = \frac{24}{200} = \frac{1}{8.33} \approx \frac{1}{8}$$

then $l_2 = 1.5$ "

$$d^2 = \frac{1}{2} \cdot \frac{1}{1.5} = 0.335 \text{ mm}^2$$

$$d = 0.58 \text{ mm.}$$

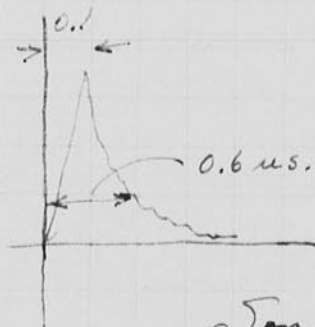
6"
2.5"
1.5"
 $\frac{8 \times 10^6}{15} = 5 \times 10^5 \text{ cp/cm.}$
circumference = $4\pi = 12.57 \text{ cm.}$
there $5 \times 10^5 \text{ cp/cm.}$

try a gap length of $\frac{1}{2}$ inch.

$$d^2 = \frac{1}{2} \cdot \frac{1}{\frac{1}{2}} = 1 \text{ and } d = 1. \text{ mm.}$$

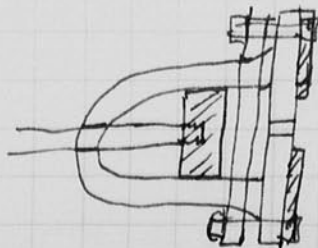
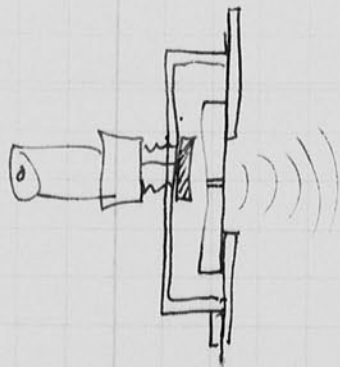
max brilliance $\frac{1}{2}$ joule .01 mfd
peak intensity = $1.3 \times 10^6 \text{ cp./sq.cm.}$

Data from Cornell Lab
Buffalo.
John Lawton



Light from spark source. Described today by Fr from Hamburg Germany.

Sonar device for underwater. Hole in insulator acts as the source. Several holes can be used parallel.



96 Nov 25 1954

Thanksgiving!
Harold Edgerton.

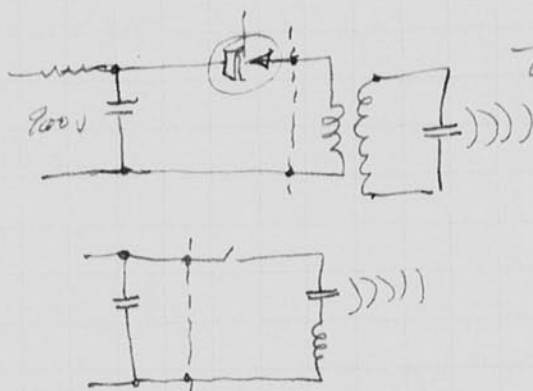
200 people. { Geo Rank. Eng. Dept
Sol Levine Chief Eng.
Larry Albert Elect.
Bill Ryan
NB McLean

Met Couslan at 7 am yesterday morning at Grand Central Station. Then went to St. Moritz Hotel. Conference with Bowie - then to Edo Company for an all day discussion of the problems of a sonar signal from the bottom to measure the camera - ~~from~~ distance.

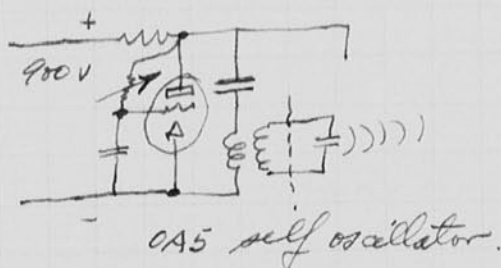
I looked at both Barium titanate cylinders and at ADP crystals. Finally decided to use ADP crystals in banks of 10 each.

$$30 \text{ uf each} \times 30 = 900 \text{ uf.} \\ = .0909 \text{ uf.}$$

A set of these will be sent in 2 weeks from Edo for test. Possible drivers.



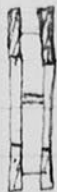
Transducer.



0A5 self oscillator.

The idea is to use two transducers on the camera - one on top and one below. The up signal trips the scope on the surface and then the delay until the second signal is measured. Thus the camera to bottom distance is measured since the delay is due to the bottom echo.

Bottom loss 12 db. to 24 db. ±. Reflection on mud or sand or hard rock. 18 sand 2 soft mud from Bill Ryan.



Bronson deep 4270 fathoms AN/UQU1
 19° 35' N 67° 30' W

97
 Grommets. -
 Neo-Fail Prod. Div
 Rubber Associates
 850 Metropolitan Ave
 Barium titanate crystals. Brooklyn N.Y.

Glenco corp Dr. Dutton
 Abe Dranelz MIT 46.
 Metuchen N.J.

Schedule for Calypso

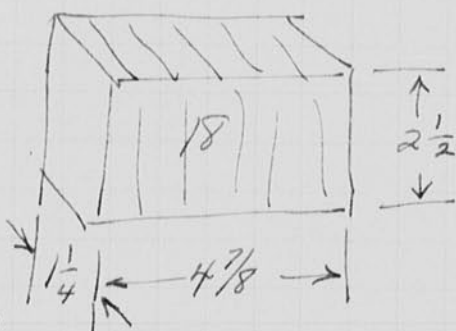
Jan 20 Leave for Adelsra
 May 20 arrive at Marseille

June 1
 to October.

Egypt
 Syria
 Lebanon
 Cyprus Crete Manapiran
 Turkish coast, Black sea.

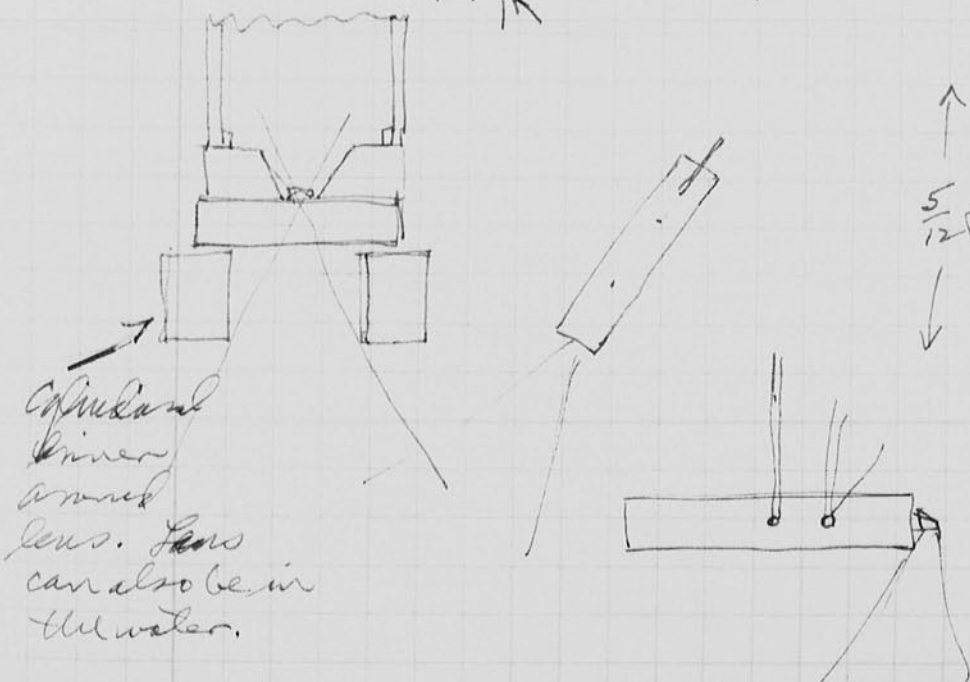
During this last trip we plan to take bottom photos at the 4000 meter deep near the Greek islands. This will be a trial effort for the real test at the Bronson deep in 1956. The best time for the Porto Rico effort is out, now.

Standard stack of ADP crystals



Film Viewer

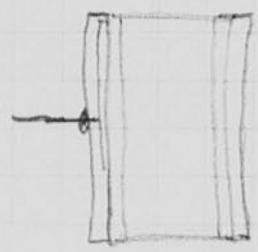
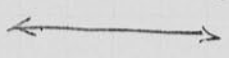
Flo Film
 Diebold Co.
 Centon Ohio.



12 kc. resonant in H₂O.
 $v = 5000 \text{ ft/sec.}$
 $d = vt.$
 $= 5000 \cdot \frac{1}{12,000}$
 $= \frac{5}{12} \text{ foot.} = 5''$

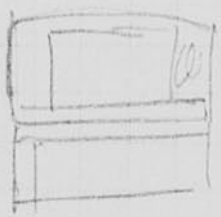
Todo for this summer with Austean.

1. Get 3000 feet of nylon braided cord
2. Design 4000 meter camera with sonar driver.
3. Scope for time meas from Edo. This might be in the standard Edo sonar or it might be a fish scope.



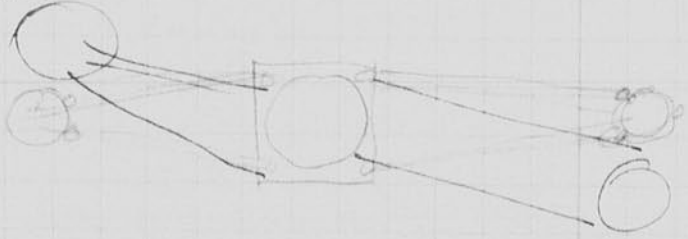
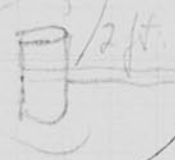
Rubber.

Sound pulser.

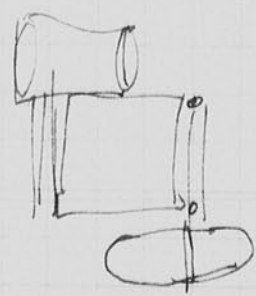


SOUND

LIGHT



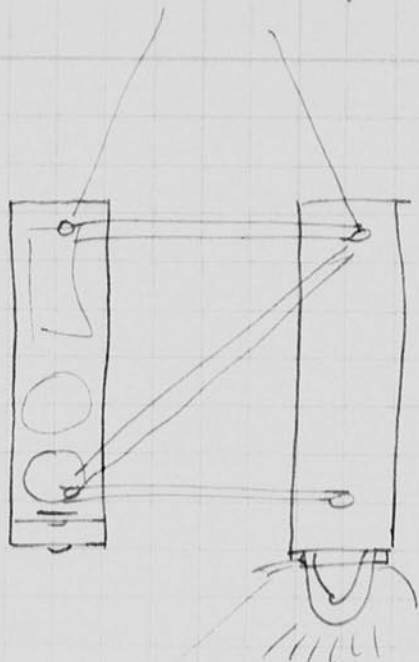
Hinge here
 Springs that
 break with
 trouble allowing
 lamp and sonar
 to swing down.



Nov 27 1954

Harold E. Edgerton

Deep camera with photocell triggered camera from flash lamp.



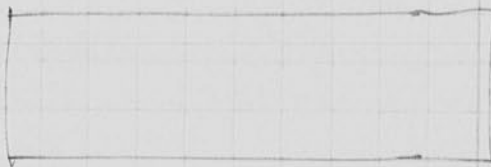
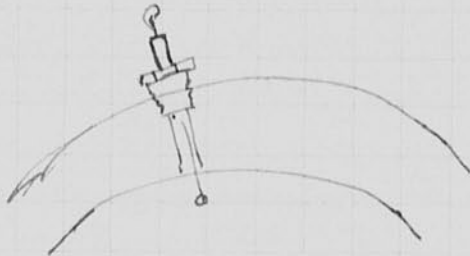
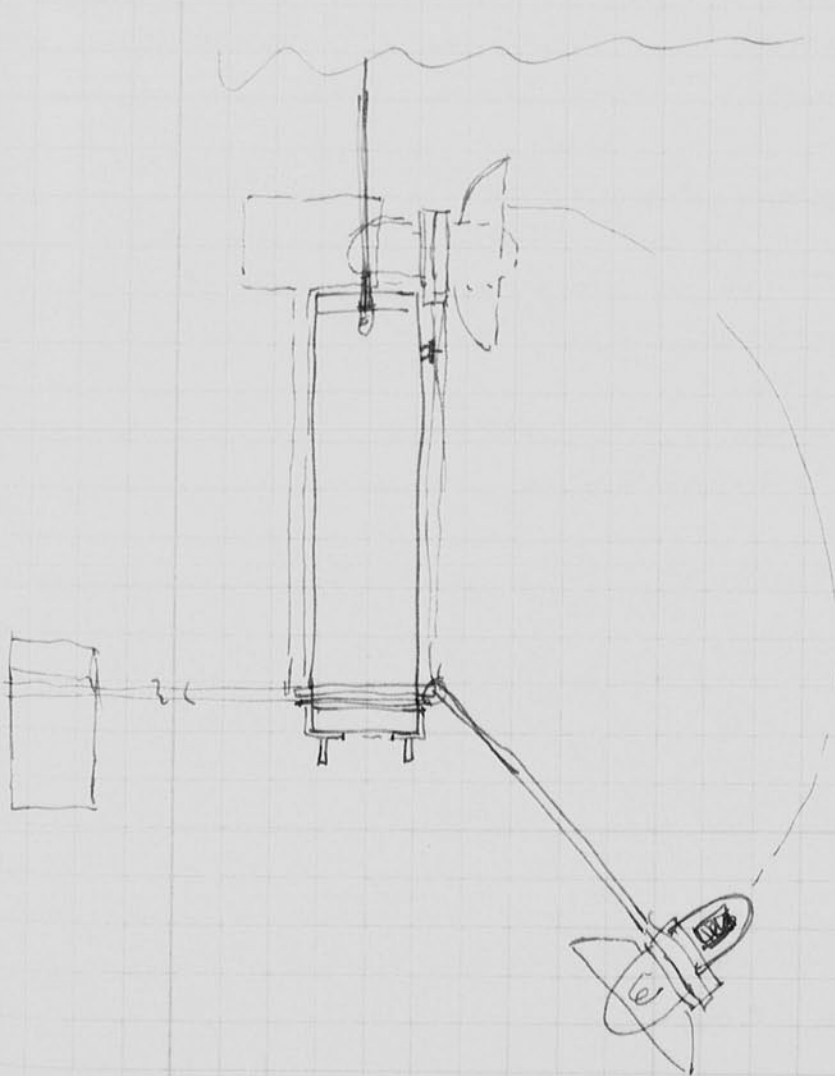
No wires from camera to light.

Light flashes at regular intervals.

Photo cell in camera causes film to cycle.

CAMERA with photocell to cycle the film.

LIGHT.



Camera test.

W. J. Robertson
 Mr. Roberts

motor 40 R.P.M. Motor Hansen 7100 C 24V,

Initial rate = 60 photos / min.

Time

1:16

24 volts Rectified AC in bridge.

1:18

60 per min

13 min.

1:21

56 per min.

60/800 sec
20

1:30

48 "

120 ma

1:33

16 min for a 100 \$ roll.

24 volt 640 RPM

1/16 sec. per frame

160 "

1/4 sec. "

40 "

1 pic/sec. "

10 "

4 sec "

2.5 "

16. "

.625 "

92 sec. "

< order 4 of these motors

Dec. 4, 1954, Sat. Off.

Harold Edgerton

Just showed slides to the U.S. Science teachers
 Assoc at Wentworth Institute. McCray of Sonics
 was there for a talk also.

Greenwald called yesterday about the use
 of the FT-110 on 2700 volts at 14 m.f.d. He wants
 portable equipment, so I suggested spark
 flash battery operated lamps.

$$LTC = 525 \text{ mfd and } T = 50 \mu\text{s.}$$

$$\frac{ARC}{2} = 50 \mu\text{s}$$

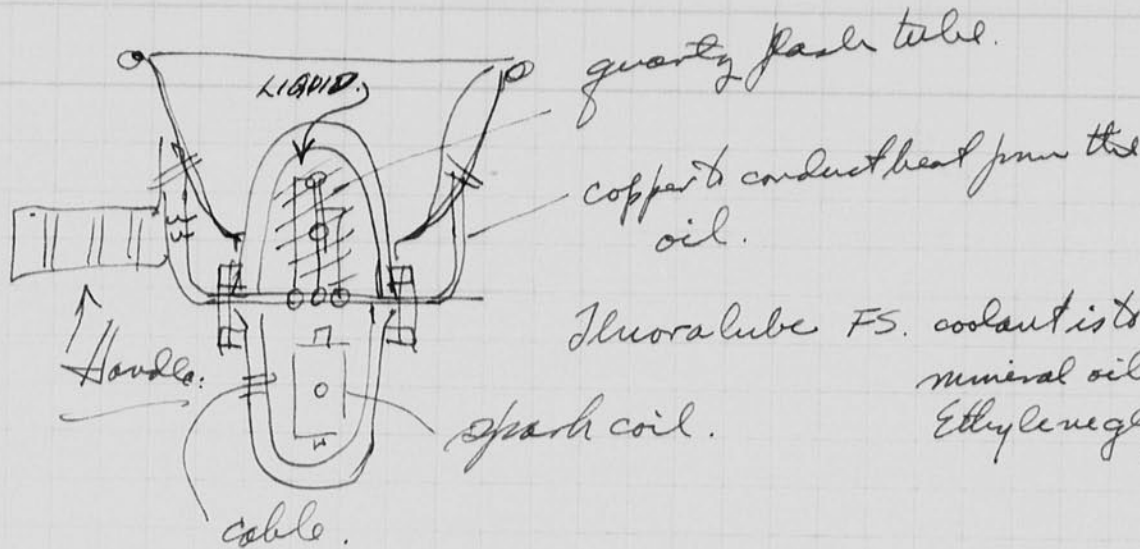
$$RC = 100 \mu\text{s. } R = \frac{100 \mu\text{s}}{500 \text{ Mf}} = \frac{1}{5} \text{ ohms}$$

an FX-1 lamp of large diameter and
 1 inch long would be just right.

$$\text{Watt seconds} = \frac{CE^2}{2} = \frac{450^2 \cdot 525}{2} \approx 50 \text{ W.S.}$$

Suppose that 900 volts were used with two
 capacitors in series. Then the flash tube
 could be about 2 inches long.

Liquid Cooled Strobe lamp.



fluoralube FS. coolant is to be tried.
 mineral oil and
 Ethylene glycol turn yellow.

Ray Swansen has been testing some flash tubes of quartz.
 This tube was made by Fred Conley for I.B.M.
 (Woodland.) Quartz capillary 1 mm x 1/4" with
 FX-1 ~~long~~ ends.

More calc on Greenwalt flash unit.

For 50 us unit on FX-1 $C = 35 \text{ mfd}$ at 2000 or 3000 volts.
 1000 1500 amp.

now take tube 1 inch long (FX-1 is 6" long).
 then C can be 6 times longer. larger.

$$C = 35 \times 6 = 210 \text{ mfd.}$$

$$V = \frac{3000}{6} = 500 \text{ use 450 on electrolytic.}$$

$$\frac{CV^2}{2} = \frac{210 \times 450^2}{2} = 21.3 \text{ watt seconds.}$$

$$\text{Peak current} = \frac{450}{\frac{1}{30} \mu\text{sec}} = 1350 \text{ amperes.}$$

use more units in parallel for more light.

now calculate full load condition for 1 inch tube using
 base calculation of 100 mfd 3000 volts. $\frac{CV^2}{2} = 450 \text{ watt sec.}$

$$V = \frac{3000}{6} = 500 \text{ volts.}$$

$$C = 100 \times 6 = 600 \text{ mfd.}$$

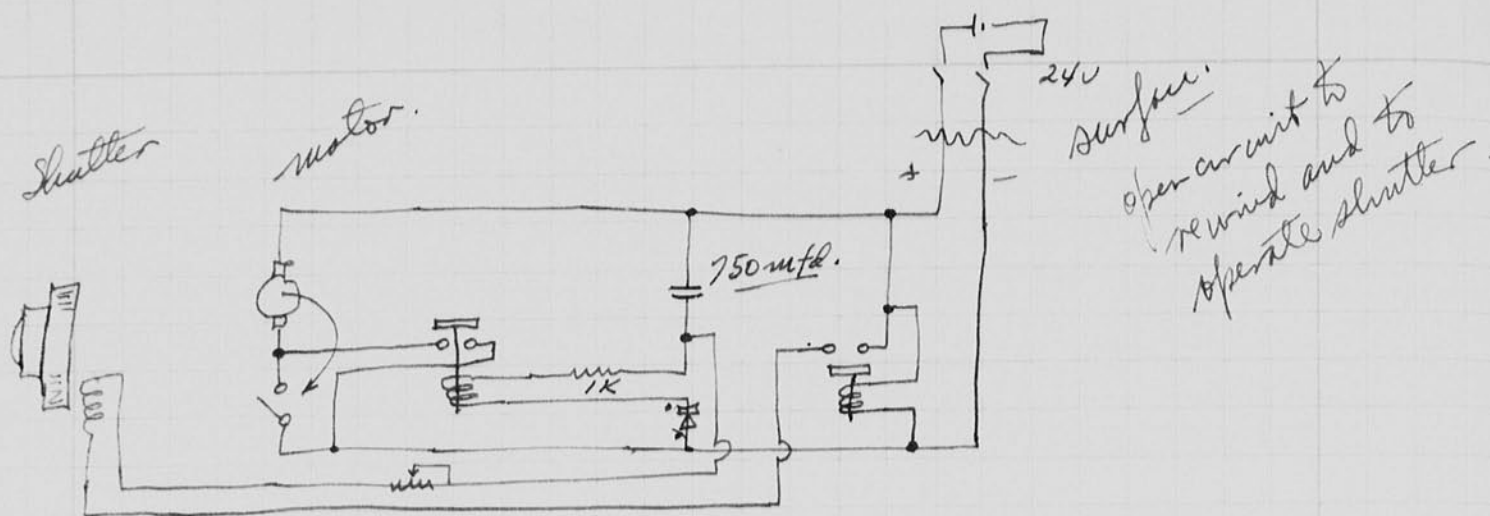
$$I_{\text{max}} = \frac{3000}{6} \times \frac{1}{3} = 1500 \text{ amperes.}$$

$$\frac{CV^2}{2} = \frac{500^2 \times 600}{2} = 25 \cdot 10^4 \times 300 \times 10^{-6}$$

$$= 75 \text{ watt seconds.}$$

$$\text{Duration} = 140 \text{ us.}$$

24 volt Battery scope camera



$$\frac{24}{1000} = 24 \text{ ma peak surge for charging.}$$

Design dropout at 12 ma.

$$RC = 1000 \times 750 \times 10^{-6} = 0.75 \text{ seconds.}$$

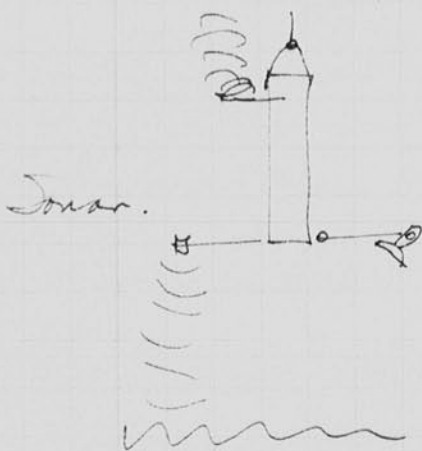
Short on points will be for about .3 seconds.

Dec. 9, 1954 Harold E. Ogerton.

made a tape recording with Father Daniel Leuchan 2.3.
and Dana Orcutt at WGBM station today for use on
Frid. Sunday. Subject Archeology and science.

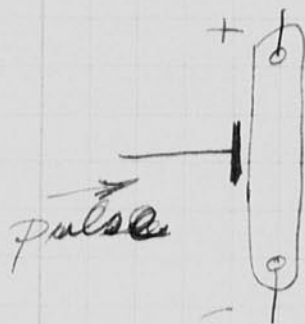
Sonar bottom signal to trigger camera.

Echo if in right time bracket will
trigger the lamp and camera to
advance film. then a signal
will be sent up to the top so
the operator will know
that the device is in the
correct range.

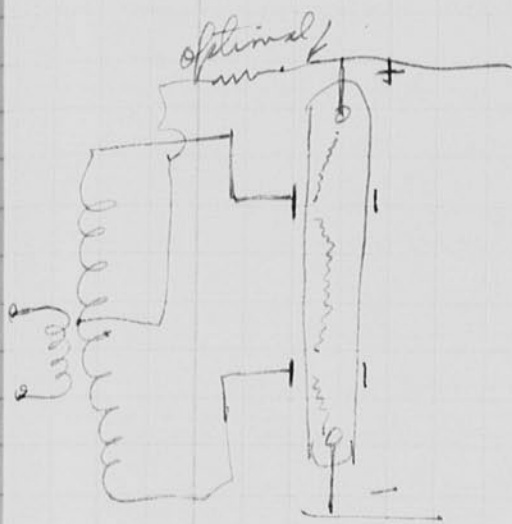


Starting of flash tubes.H. Edgerton
Dec 9, 1954.

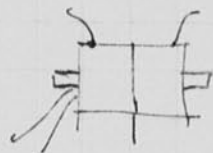
Usually an external high-voltage or a trigger electrode causes a flash tube to start. The polarity seems to effect the result a little. It is my memory that a + initial pulse is more effective than a negative one.



I now propose that starting might be facilitated if two starting bands were used with different polarities.



For example, see the double ended transformer and the two starter bands on the sketch to the left. Note that a glow spark leader will go to both electrodes and between the two starting electrodes.



I believe that this system will assist in starting the low voltage tubes, but with high pressure gas so that they will be efficient for the production of light.

Dec 11, 1954 H. Edgerton

Breene walt wants a 50 us flash lamp with 100 watt second output, color guide factor of say 30 to 40 range.

I suggest a 1" FX-1 type of lamp.

Loading = 450 volts 250 mfd. (or 500 mfd.)

$$\frac{450^2}{2} \times 250 = 25 \text{ watt sec.} \quad \frac{450^2}{2} \times 500 = 50 \text{ watt seconds.}$$

Suppose $n = 4 \text{ C.P./watt.}$

$$= 100 \text{ C.P.S.}$$

or 200 C.P.S.

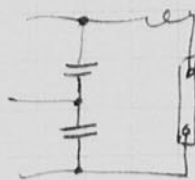
Reflector with factor of 15

$$1300 \text{ P.C.P.S.} = 1500$$

$$3000 \text{ P.C.P.S.}$$

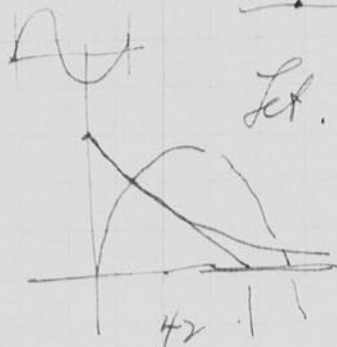
$$RC = \frac{1}{6} \times 250 = 83.2 \text{ us.}$$

also try two 250 mfd capacitors in series on 900 volts. An inductance is necessary to prevent damage to the flash tube.



$$\frac{CE^2}{2} = \frac{900^2}{2} \left(\frac{250}{2}\right) = 50$$

$$RC = 125 \times \frac{1}{3} = 42, \mu s.$$



Let. $T = \frac{1}{f} = 40 \times 10^{-6}$ seconds. $= \sqrt{LC}$

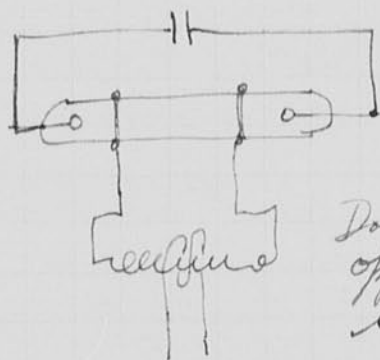
$$1600 \times 10^{-12} = LC$$

$$\text{or } L = \frac{1600 \times 10^{-12}}{C} = \frac{1600 \times 10^{-12}}{125 \times 10^{-6}} = 12.8 \times 10^{-6} \text{ henries.}$$

Actual flash duration is closer to $RC/2$ since light varies as the square of the voltage.

Dec. 12, 1954.

Double starting band for low voltage tube.



Short fat tube of low resistance with short leads leads to the flash capacitor.

Double-ended spark coil with opposite polarity to the bands.

Primary at center

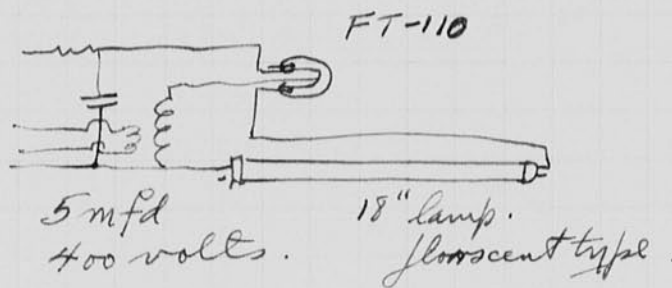
Harold Egerton
Ray Swanson
Geo. LaCompte
Dec. 17, 1954.

Lunch with visiting committee. I sat by Richmond
and Dean Soderberg. Hauser (Scars Reebuch), Olmenschky (Lynn DC)
Richmond (G.R.) Tear (Carnegie Tech) Woodridge (R-W. Co) Forbes (con. Edison)
Potras (Gen wall) Chesterman (telephone) Monticelli (Westinghouse).

Sam Cohen of Precision Eng. was here today. He said Fred
Barstow this morning then came to M.I.T. this afternoon. We
discussed his problem at great length.

I suggested battery operated flash unit
on the ground to be triggered from a flash unit on the
air plane. He now uses 200 watt seconds in
4 lamps arglow type.

An experiment was made in the lab.



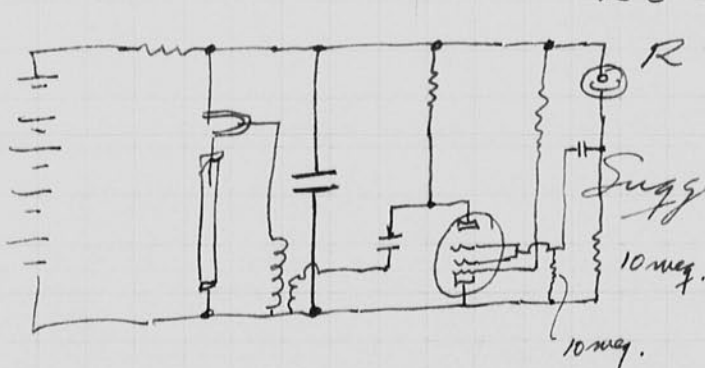
Camera test.

Panatomic film
Two exposures
f 5.6 and f 11.

$$\frac{CE^2}{2} = \frac{5 \times 10^{-6} \cdot 500^2}{2} = .6 \text{ watt sec.}$$

The FT-110 is overexposed
in both.
The 18" tube is readable in both,
the f 5.6 is best.

RC = 0.5 sec.



$$R = \frac{0.5}{5 \times 10^{-6}} = 0.1 \times 10^6 = 100,000 \text{ ohms.}$$

Suggest 25,000 ohms 2 watts.

$$\frac{500}{10 \times 10^6} = 50 \mu\text{a.}$$

$i = k l$. $k = 40 \mu\text{a/lumen}$.

Let $iR = 100$ or $i = \frac{100}{R} = \frac{10^2}{10^5} = \frac{1}{10^3}$

$i = k l$ $l = \frac{i}{k} = \frac{1}{10^3 \cdot 40 \times 10^6}$

$= \frac{1}{4} \text{ lumen on cathode.}$

$\frac{1}{4} \times 144 = 36 \text{ lumens/sq. foot.}$

Lam $\frac{QP}{D^2} = 36$

C.P. = $2000^2 \times 36 = 162 \times 10^6 \text{ candle power.}$

Try a 929 phototube.

40 $\mu\text{a/lumen}$.
0.5 sq inches area.

$$\frac{40 \mu\text{a} \times 144}{0.5 \times 144} = 288 \mu\text{a/lumen/sq. ft.}$$

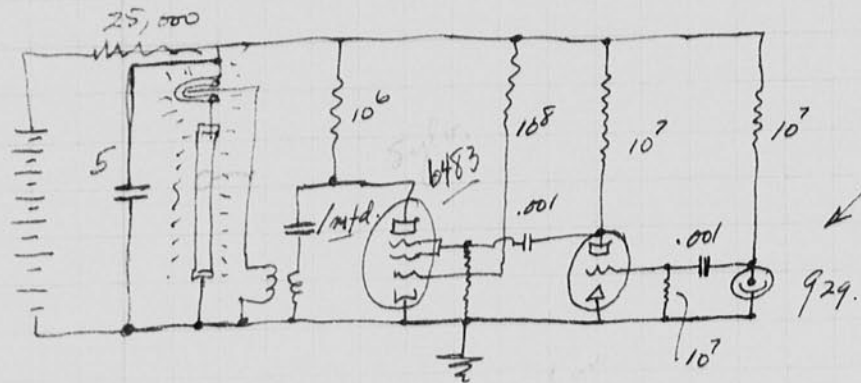
$$\left(\frac{1 \text{ lumen}}{0.5 \times \frac{1}{144}}\right) = 288 \text{ lumens/sq. ft.}$$

$e = 5 \times 10^6 \times 288 \times 40 \times 10^{-6}$

$\frac{10^6}{500^2} = 4 \text{ lumens/sq. ft.}$

Cont.

Calc on previous page shows that the sensitivity is lacking. Suggest a simple amplifier tube into the trigger tube.

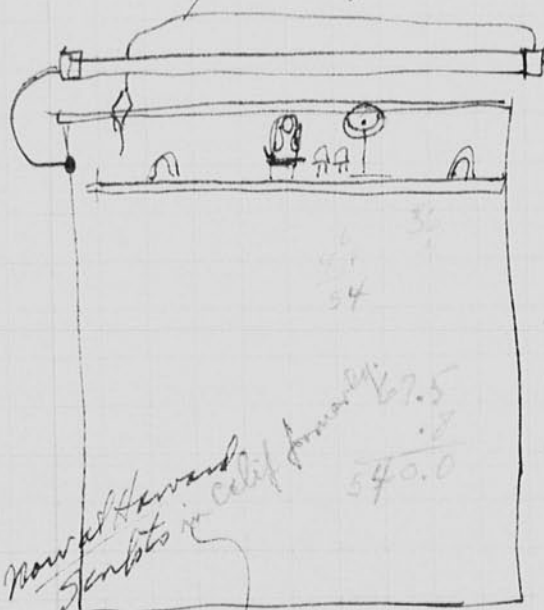


Light from plane.

174
174 + be 2
1000 957. →
u = 13
Fp = 20,000
g = 600.

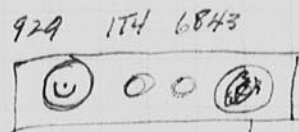
1.25V .05 amp.
2ma plate.

use a plexiglas top or glass.



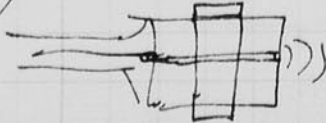
Battery #6
(A-1300) air cell 350
47.5
405.0 bulbs
472.5 7 cells.
540. 3 cells.
467 67.5V 245
8
19.60

Newell Howard
Sensit in cell if forward
27.5
540.0

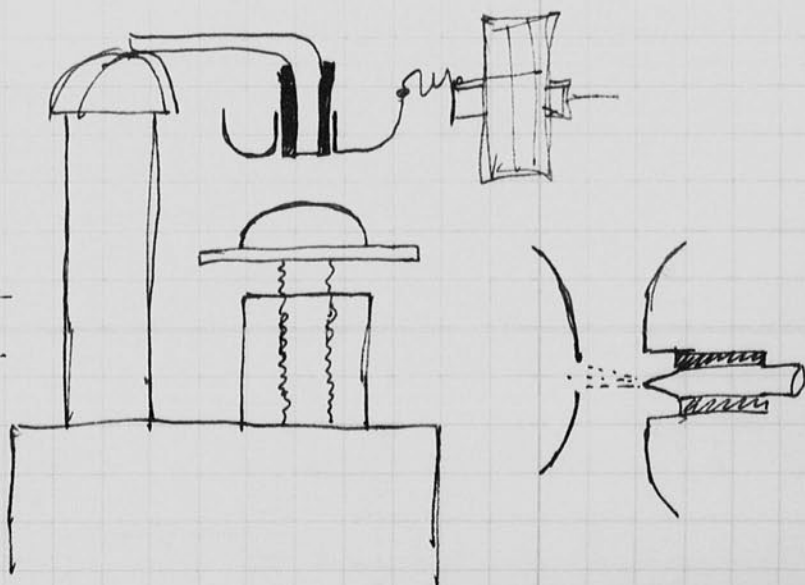
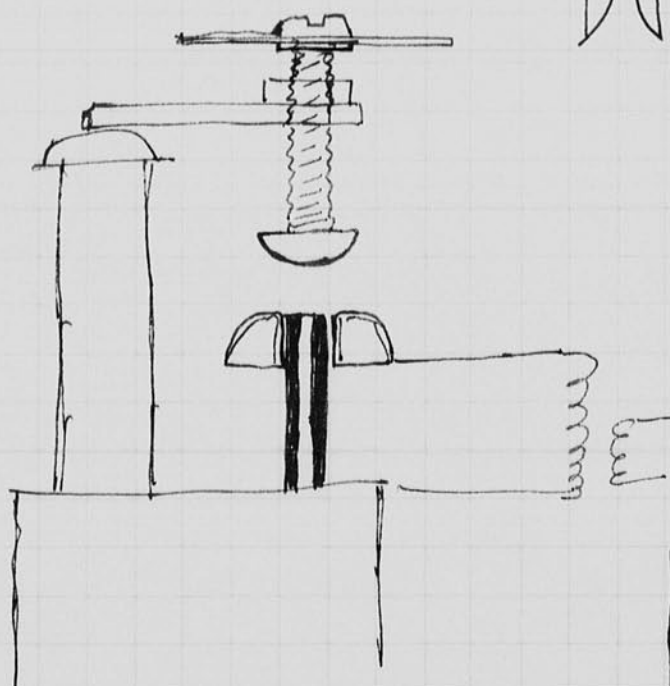
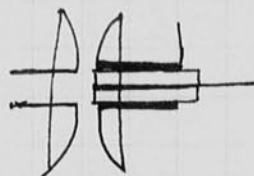
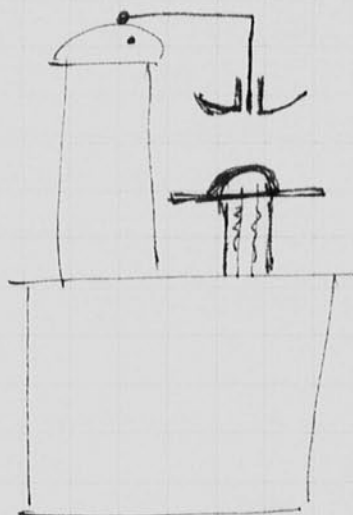
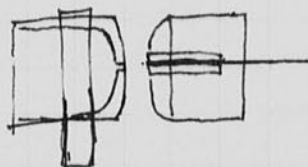
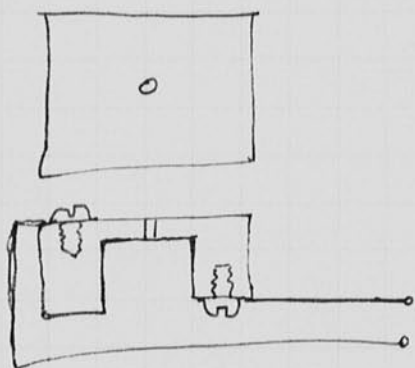
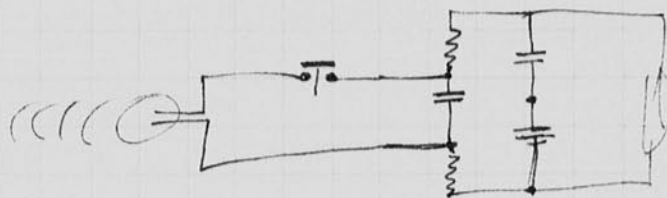
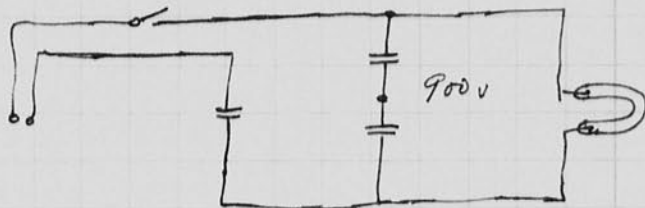
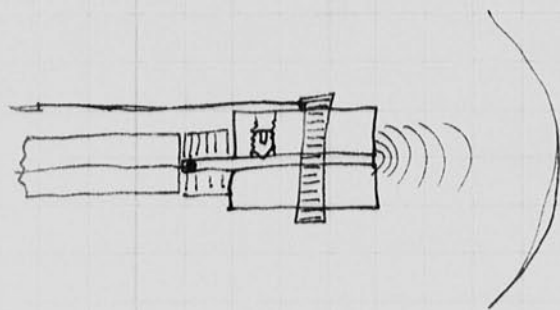


flash
FT-118
FT-105

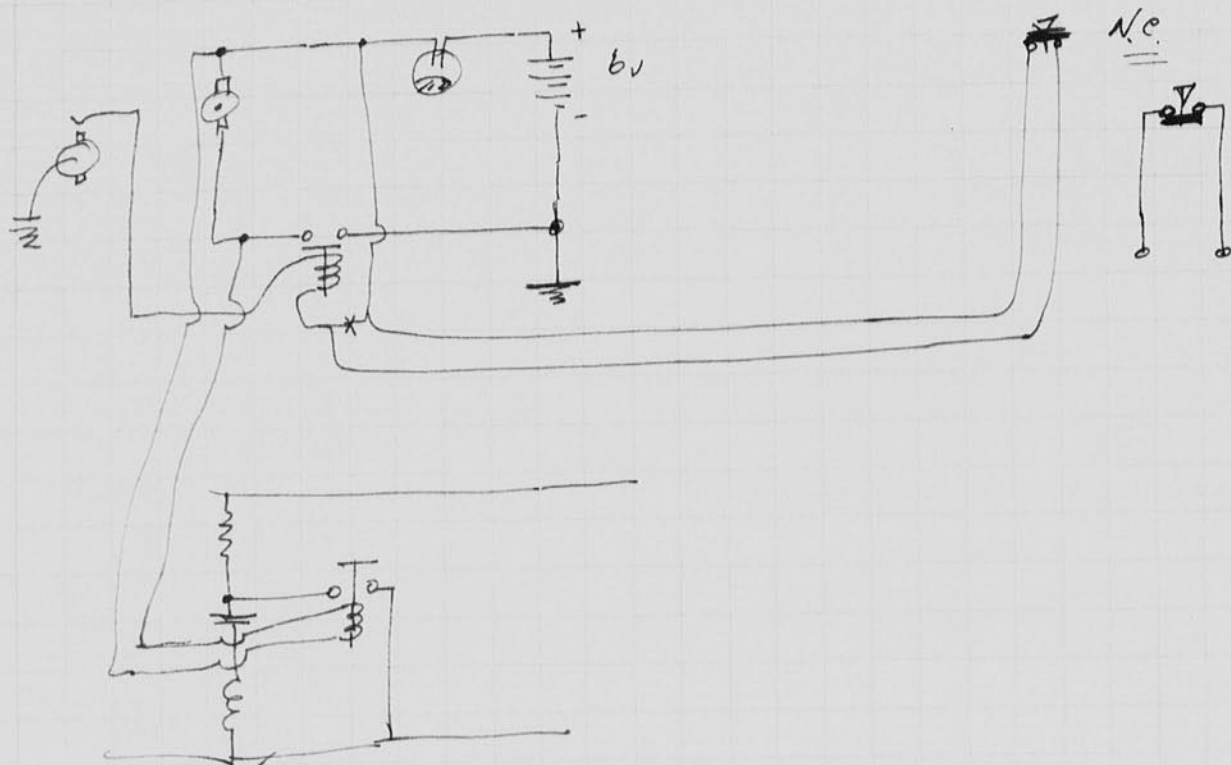
Victor Anderson came in on Wednesday to tell me of his work with sparks under water. He used 20KV from the surface 0.5 (?) mfd. into a spark on the end of a cable. He said his best results were from a small wire that was flash against a bakelite rod. A bubble is formed on the end which pulsates only once. Two bangs are sent out, one by the discharge,



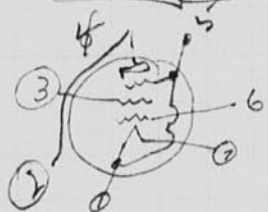
the other when the bubble collapses, this bubble does not reform
 as does an explosive since there is no residual gas left!
 I hope to also study the bubble formation in
 an insulator where a hole has been formed.



Hershey and Basus from W.H.O. came to borrow a camera last Thursday. I gave them camera #1 with out a lens but with a dry battery flash unit.



124



5696 thyntom 150 ma.
filament current.

molded plexiglass cover for metal can.



Battery

Eveready ~~85~~
482

Duracell

M30

10,000 hours life 100 ma.

45
12
90
45
540 volts.

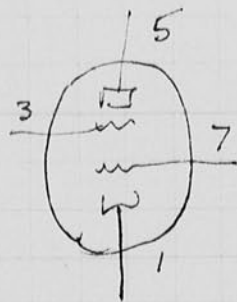
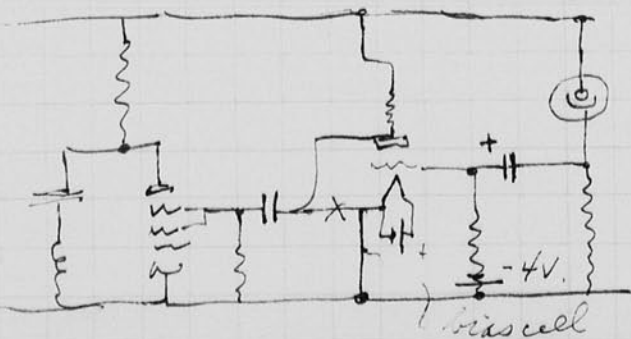
1.75 (6 pence)

10.50

\$20.00

Eveready no. 6. 1.5 volt bat. for filament 50 ma. \$.45

25
21
25
50
\$ 525.



Sylvania
6483

$$\frac{540}{10m} = 54 \mu a.$$

Dec 18, 1954.
H. S. Gaster

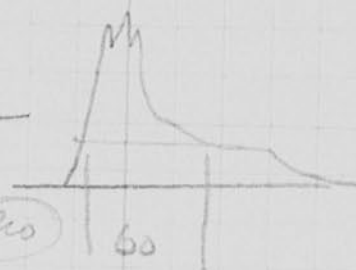
Xenon

XENON 1" TUBES
4mm I.D. 1" LONG.
2 ATMOS.

| V | C | Peak light | Duration | Comment |
|-----|-----------|------------------|---------------------------|---------|
| 450 | 10 paper. | $.8 \times 10^6$ | 15 μ s. | |
| 450 | 20 " | 1.5 | 20 | |
| 450 | 40 " | 2.2 | 25 \pm | |
| 450 | 100 | 4.0 \pm | 40. | |
| 450 | 250 elect | 5 or 6 | 50 μ s. | |
| " | " | " | 70 | |
| " | " | " | $30 \times 4 = 120 \mu$ s | |

Duration too long for
Greenwalt.

900 250/2 10×10^6 cp. 60 μ s 12 μ h in series
 Output = $10^7 \times 60 \times 10^{-6} = 600$ cps



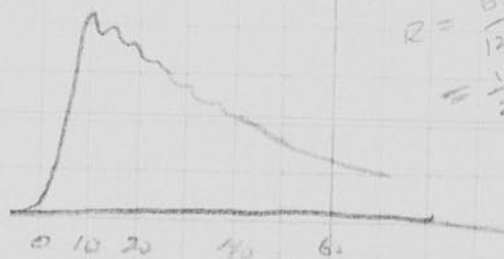
FT110 900 250/2 8×10^6 150 μ s. 12 μ h in series 60 μ s.

1" Xenon
4mm I.D.
2 atm.

A smaller inductance was tried with
light about the same in duration but a
faster rise time.
Leads only used for inductance or - seems ok.
This looks ok for the
bird unit.

$$\frac{2}{6} = \frac{1}{3}$$

$$R = \frac{60 \times 10^{-6}}{125 \times 10^{-6}} = \frac{1}{2} \text{ ohms}$$



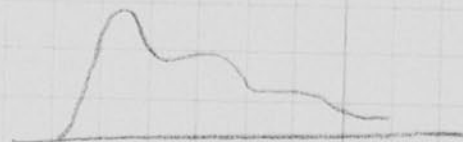
1/2" gap

6mm I.D.

900 V 250/2

7.5×10^6

30 or 40 μ s.



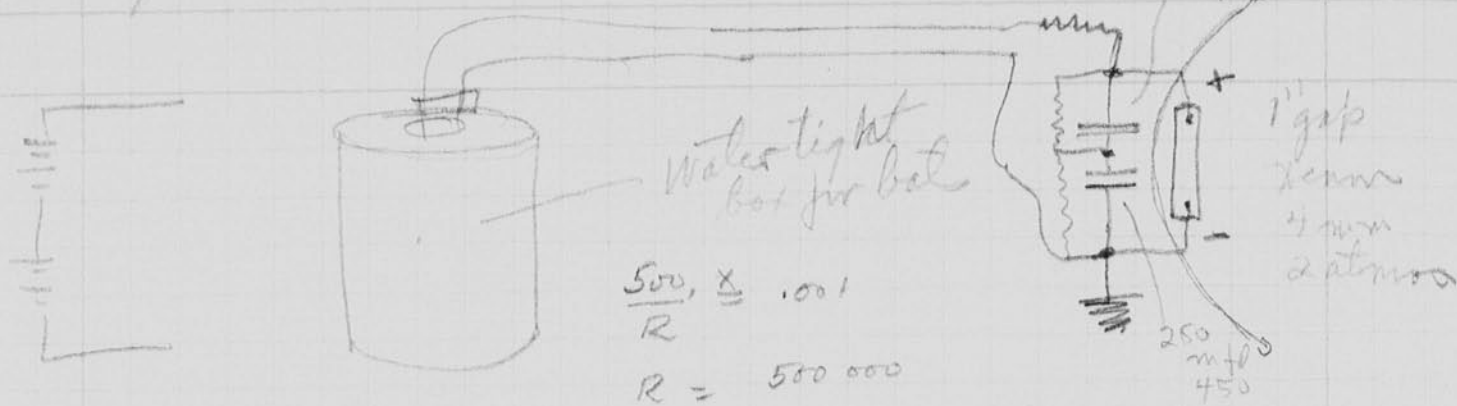
$2 \text{ ft.}^2 \cdot 23 = 92 \text{ HCPS}$ Input = 50 watt sec. $\frac{92}{50} = 1.8 \text{ CP/watt.}$

Reflector Drift
Prism type.

$$300 \times 3^2 = 2700 \text{ h.c.p.s.}$$

(old units were)
2200 B.C.P.S.
Bird unit for
Greenwalt.
100 μ s.

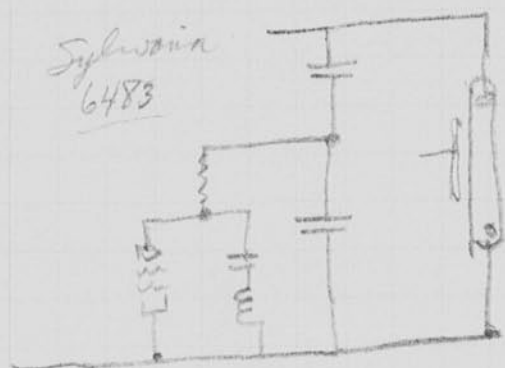
Greenwald Field unit:



$$\frac{500, \times}{R} = .001$$

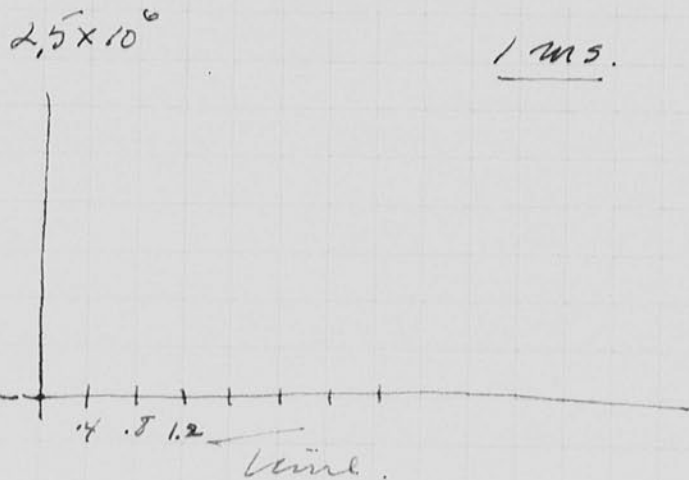
$$R = 500,000$$

$$RC = 250 \text{ mfd} \times 500,000 = 125 \text{ sec.}$$



See page 35.
Conf fourth Russell

Sun brightness = 10^6 watt/sq meter. (0.5 - 0.7)
5800 degrees K. yellow filter.
 6.4×10^7 watts/sq meter.
4990 below .7.



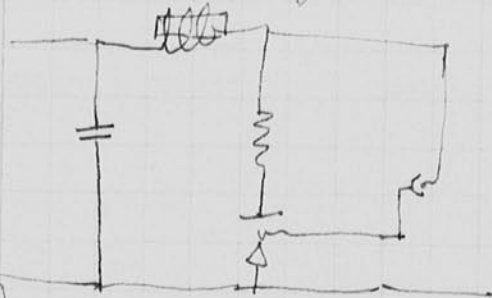
Film
f.
Camera exposure
 $10,000 \rightarrow 10$
{ function of time }
1000, - 10

$\frac{1}{25}$ ms/frame
80 us exposure time.

| | | |
|--------|-----|-----------------------|
| 1/2 f. | .04 | 10^8 watts/sq meter |
| | .08 | 2×10^7 |
| | .12 | 1×10^7 |
| | .16 | 1.6×10^7 |

| | | |
|--------|--------|--------------------------------|
| 30K T. | .4 ms. | 1.5×10^7 watts/sq cm. |
| | 3. | 7×10^5 |
| | 6. | 5×10^5 |
| | 12. | 3×10^5 mm. |
| | 2 | |
| | 1 | 2.5×10^6 |

↑ camera filter magnet opti-closes when triggered.
Russell says



Eastman camera
24" f6. lens.
eff
yellow filter.
microfilm
2500 f.p.s. 1/5
80 us.

can and understood
Dec 22 1954

R. Russell, Jr

discussed by
letter in March 1953
which in Pacific

112 Dec 23 1954

Spark coil tests.

cycles.
600 usH. Edgerton
Ray Swanson.

| Coil # | S. | V | C. | f. | Spark distance Turns · 20/inch | f |
|---------------------------------------|------------|---|------------|--|-----------------------------------|---|
| S. | 500 | | 0.1 | $\frac{7.9 \text{ us.}}{600 \text{ us}}$ | 3.5/20 70 | 11,600 |
| PE. | 500 | | 0.1 | $\frac{6.5}{400}$ | 4/20 | 16,200 |
| Poult | 500 | | 0.1 | $\frac{3}{450}$ | 1/20 | 6,650 |
| Thord. 22R44 | 500 | | 0.1 | $\frac{6}{400}$ | 1/4/20 | 15,000 |
| Delta, | 500 | | 0.1 | $\frac{6.5}{400}$ | 1/20 | |
| Thord 22R44 | 300V | | 1 | $\frac{5}{300}$ | 5/20 | 16,600 |
| S.S. 86641 | 500 | | 0.1 | $\frac{1}{40}$ | 3/20 | freq higher than 10^5 cycles/sec. two frequencies evident. |
| " | 300 | | 0.1 | | 1/20 .05" | |
| TRIAD Small coil from Silenburger. | 300 500 | | 0.1 1. | ? ? | very small! .. | no. output? -?? |
| SE 86631 | 400 300 | | 0.1 0.1 | $\frac{4}{5.5 \times 4 \text{ us.}}$ | 3/20 | |

Dec 26 1954

94
56

Harold Edgerton. Magneto-optic shutter for use with high speed cameras (movies).

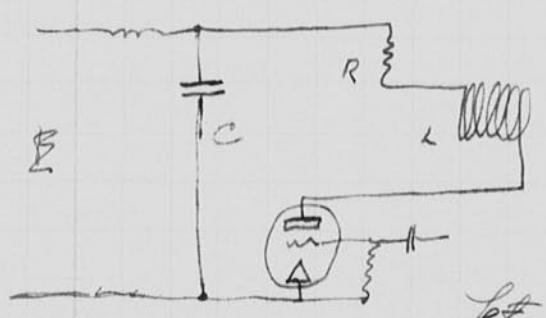
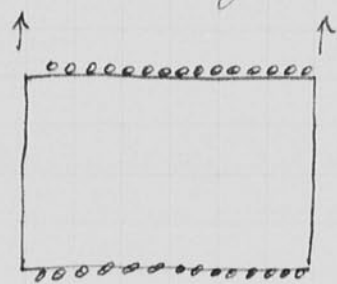
See other code.
or pages 35 & 36
0.1 to 0.1 sec.
summed up
pages 0.02 sec
for
fast cutoff.
KE Jan 29/1955.

Studies of the fire ball require motion pictures taken at 2500 f.p.s. on a Fostax or an Eastman type III. The first few frames are always overexposed according to Lewis Fussell. See page III. Design of a shutter for photo cell triggering from the teller light or early fire ball - see below.

Normal camera settings = 24" lens at f 8
yellow filter microfilm
2500 f.p.s. 1/5 exp = 80 μ s.

Now use a double ~~photo~~ polaroid filter with EDF glass

65 turns \times 1000 amp = 65,000 amp turns.

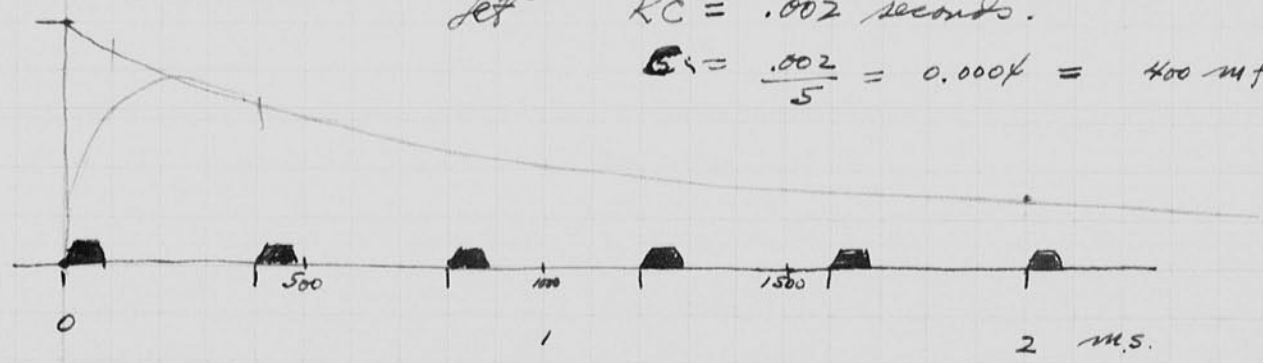


Let $E = 4000$ volts.
 $R = 5$ ohms.
 $L =$

~~3045 theatron~~. overload.
Spark gap.

Let $RC = .002$ seconds.

$$C = \frac{.002}{5} = 0.0004 = 400 \text{ mfd.}$$



Secondary = Sures - Turns increased

$R = 100$ ohms.
 $C = 20$ mfd
2000 volts.
 $I_{max} = 20$ amperes.

$NI = 65,000$
 $N = \frac{65,000}{20} = 3250$ turns.

too many?!

Jan. 1, 1955.
205 School St
Belmont Mass.

Bob returned this afternoon via ~~Moscow~~ Air Lines to Rochester N.Y. where he is a soph at Uni of Roch. Bill left last Wed for U.Y. where he is a senior at Columbia. Mary Lou Dixon and 5 month old daughter Jan came Dec 27 at 4pm via American.

Jan 5, 1955. Eddie Bielinski, a pilot of the 155 Resco Squadron was in with wife and two children a few days ago.

Flash bulb (chemical) tests.

Special bulbs with no foil were received from Elmendorf of G.C.

14 inches from P.C.

Jan 6, 55. ^{Dan} Bob LeDoux and ^{Stacey} from Springfield Arsenal came yesterday with a T44 automatic rifle. We shot photos in the cage of the operation, 20 photos with 20 shots.

Movies 6000 feet on 35 mm film.

f1.5 - Background X film negative.

White background 15" from FX-3 lamp in reflector.

Exposure was dim.

6" to bullet from FX-3 in reflector.

Fast
Positive
film.

Test with 501.

Exposure ok.

Scotch light 1" strip at .4 ft from lens.
f2. Fast Positive film.

Capacity .04 1000 cycles.

FX-3 directly over the lens.

Background X Strob. 501

Exposure ok, !!

Scotch light 1" strip at 4 ft from lens.

f2 Back X Eastman.

Capacity .01 10,000 cycles

FX-3 directly over lens.

Jan 7 55

10" Double lens with point source is not so good.
The light comes through in Rings.

.01 mfd into lens gives over exposure on Fast. Pos. film
at f2. cannot stop down due to dead areas in light.

Background X. Lamp with .01 mfd in Fx-3. - white card at 13"
Exposure fine at f 1.5. missed shot.

H.E. Eng & John Swensen "Genco"

Ceramic cylinder. 6 megacycle.

.01 mfd 0.6 μ s = 1 cycle 1.6 mc.

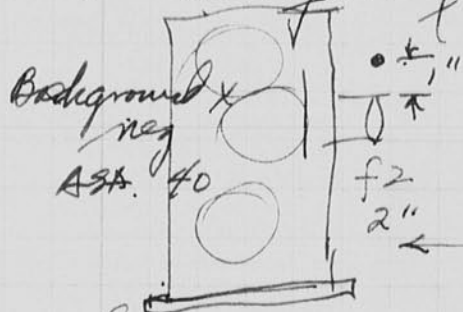


Genco. Body 103 Genco. .01 mfd. 0.1 μ s flash
Diss about 3" diam.

12 Kc. ~~led~~ long duration
on oscillation.

more movies at 10 Kc of 22 cal bullet.

Jan 8 1955 H.E. Eng & Ray Swensen



General Radio Camera

→ 6" ← GUN.

⊙ 2" Scotchlight
Screen.
Silver

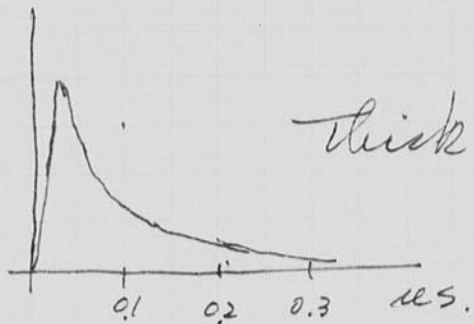
4 feet

Shadow of gun
falls in center
of the scotchlight

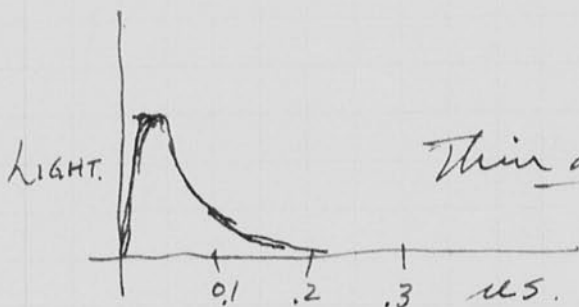
Results - Exposure weak!

no shock waves on scotch light!

Glenco Discs from Johnson Jan 5 '55.

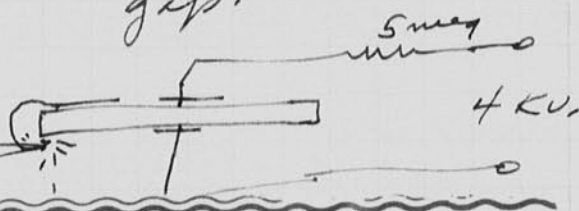


thick sample.



Thin disc.

Discharge time is about 0.1 us. with wide gap.



2000V 929
to scope
technic 5

EDO WELCOMES UNDERWATER EXPERTS



Jacques Cousteau, author of "THE SILENT WORLD", and Dr. Harold Edgerton, Professor of Electrical Engineering at M.I.T. paid a visit to Edo to discuss problems in connection with underwater acoustics. Mr. Cousteau, together with Dr. Edgerton, is conducting a series of research experiments aboard the CALYPSO, a French vessel, involving underwater acoustics. The CALYPSO has been assigned to Mr. Cousteau by the French Government for oceanographic research. Edo UQN-1B equipment is being used for the experiments and exhaustive studies are under way concerning underwater marine life. Standing, left to right, are Mr. Cousteau, Gerry Albert, George Rand, Sol Levine and Dr. Edgerton. W. R. Ryan is seated.

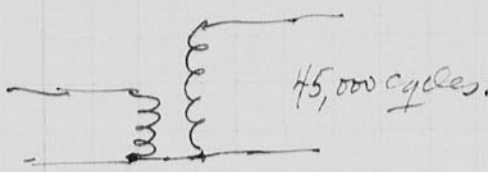
Edoite Finds Adventure in Mexico

Transformer test.

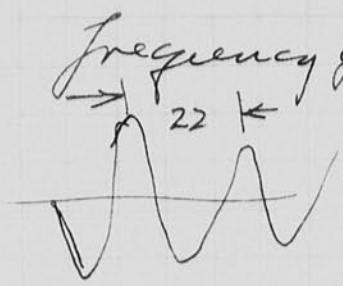
Edo. -

Delco Coil

$$22 \overline{) 1.00} \begin{array}{r} 045 \\ 85 \\ \hline 120 \end{array}$$

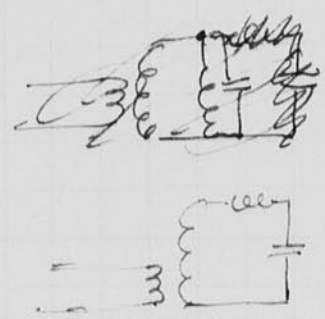


Spark coil.



1 cycle = 22 μ s,
 $f = \frac{1}{22 \times 10^{-6}} = \frac{10^6}{22} \times$
 $= 0.45,000$
 $= 45,000 \text{ cycles.}$

Condition (2) coil loaded with Edo. 30 ADP crystal and coil

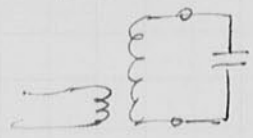


$$f = \frac{1}{150 \times 10^{-6}}$$

Jagged voltage wave here →



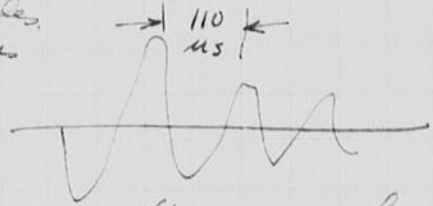
Condition (3)



$$f = \frac{10^6}{110} = 9,090 \text{ cycles}$$

$$f = \frac{10^6}{110} = 9,090 \text{ cycles}$$

$$110 \overline{) 1,000,000} \begin{array}{r} 9090 \\ 990 \\ \hline 1000 \end{array}$$



wave is smooth now when the inductance is shunted out.

Thunderstorm spark coil. 3x11 μ s per 1/2 cycle

$$f = \frac{10^6}{3 \times 11} = 30,000 \text{ open cir}$$

22T44.

.. .. with Edo. (no ind)

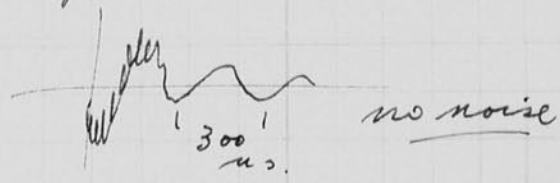
$$f = \frac{10^6}{200} = 5,000 \text{ cycles.}$$

Modelair type 5. 20 μ s
shows situation?

$$f = \frac{10^6}{20} = 50,000 \text{ cycles open cir}$$

with Edo.

$$f = \frac{10^6}{300} = 3,300$$



14499 Auto coil without cone
8000 40
220 21

$$f = \frac{10^6}{20} = 50,000 \text{ cycles.}$$

with Edo.

$$f = \frac{10^6}{100} = 10,000 \text{ cycles}$$

Newton coil

$$f = \frac{10^6}{8 \mu\text{s}} = 120,000 \text{ cycles open cir.}$$

wave jerky? →

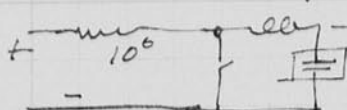
$$f = \frac{10^6}{25} = 40,000 \text{ cycles with Edo.}$$

f =

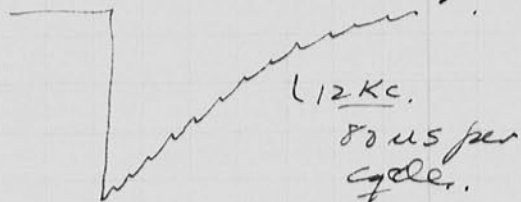
Edo transducer
Aug 1955.

20D102
M.I.T.

3800 volts - sparks over on edge



to scope - shows 12 KC oscillation. 20 V



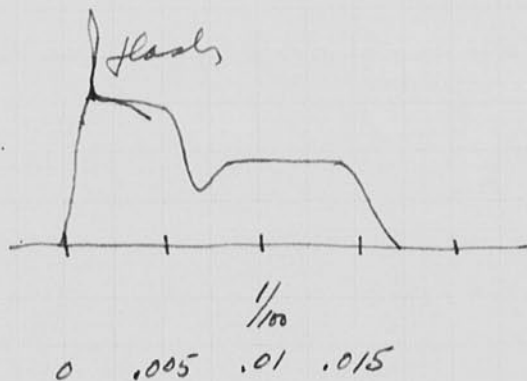
Edo output measured with a mike. (Shure Red mike).

Input 1000 volts as per above
mike at 15" above the transducer
output \approx 0.1 volts.
(Small on scale!).

Shutter data from Mac Roberts.

Underwater camera.

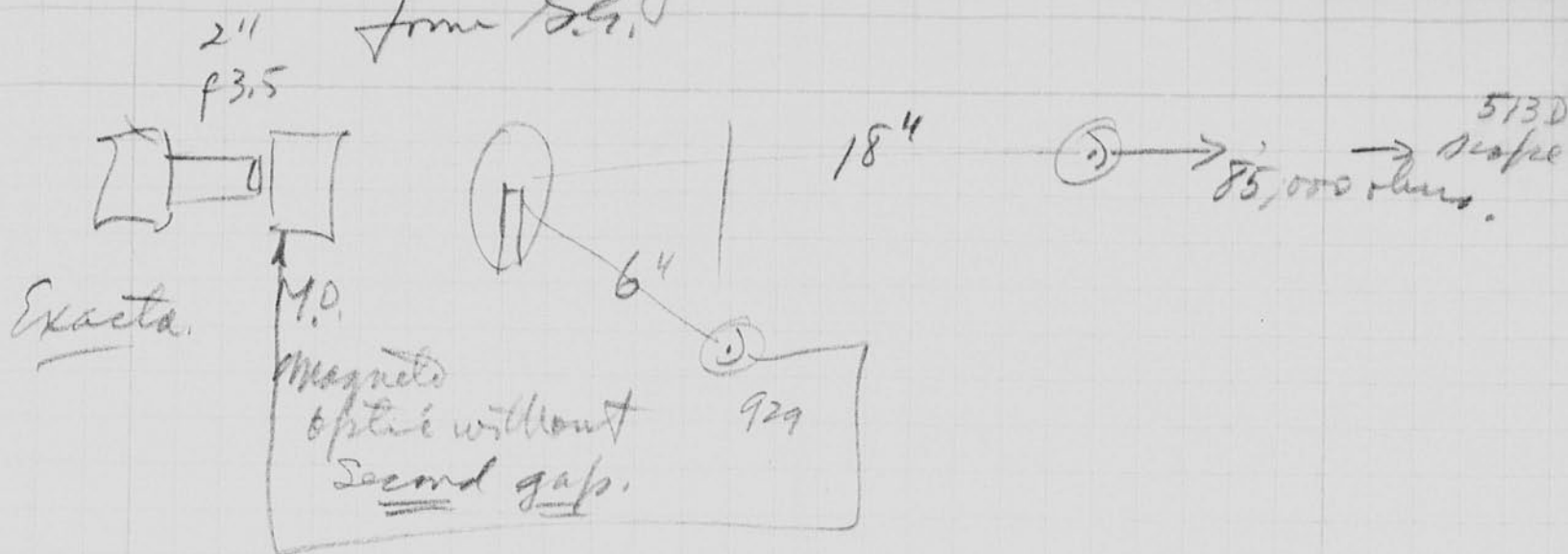
28 volts into
magnet.



with 16 ohm in series the flash does not go.

with 10 " " " Duration = 40 ms at f5.6.

M-2 Photo flash bulbs without wire
from S.S.



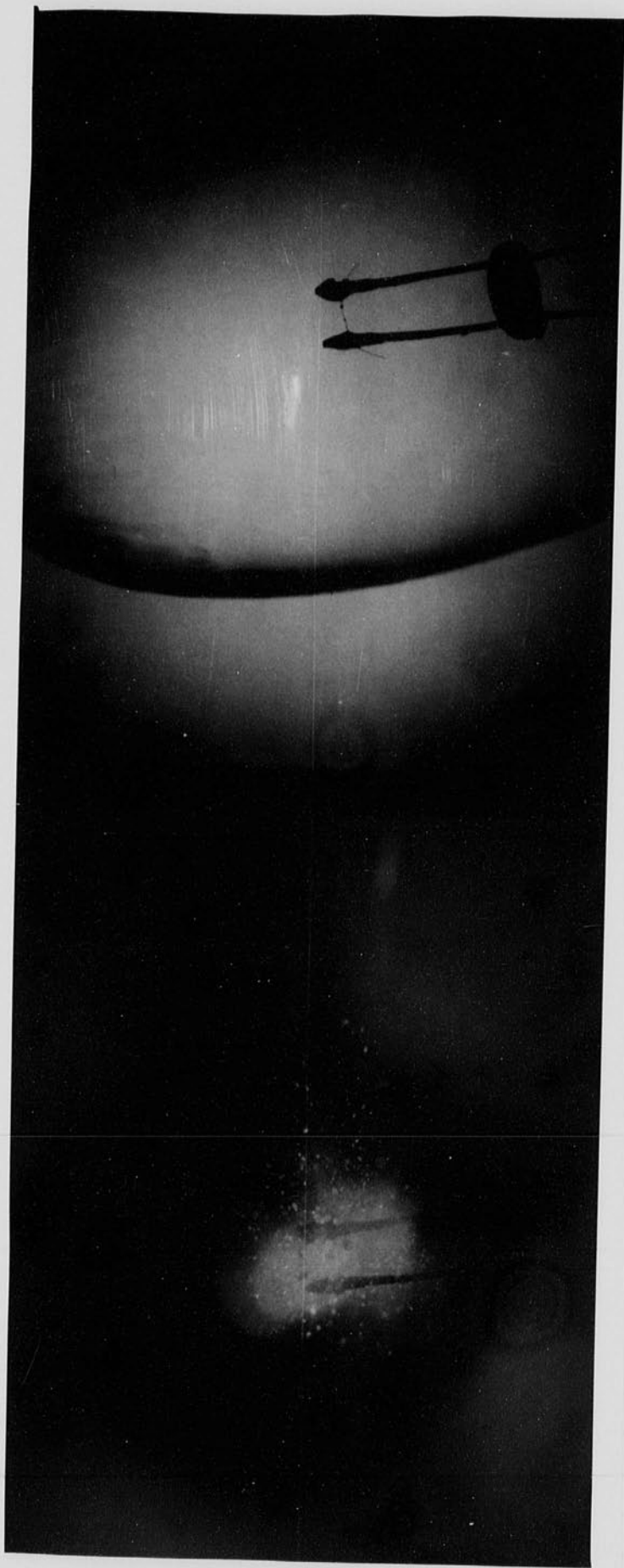
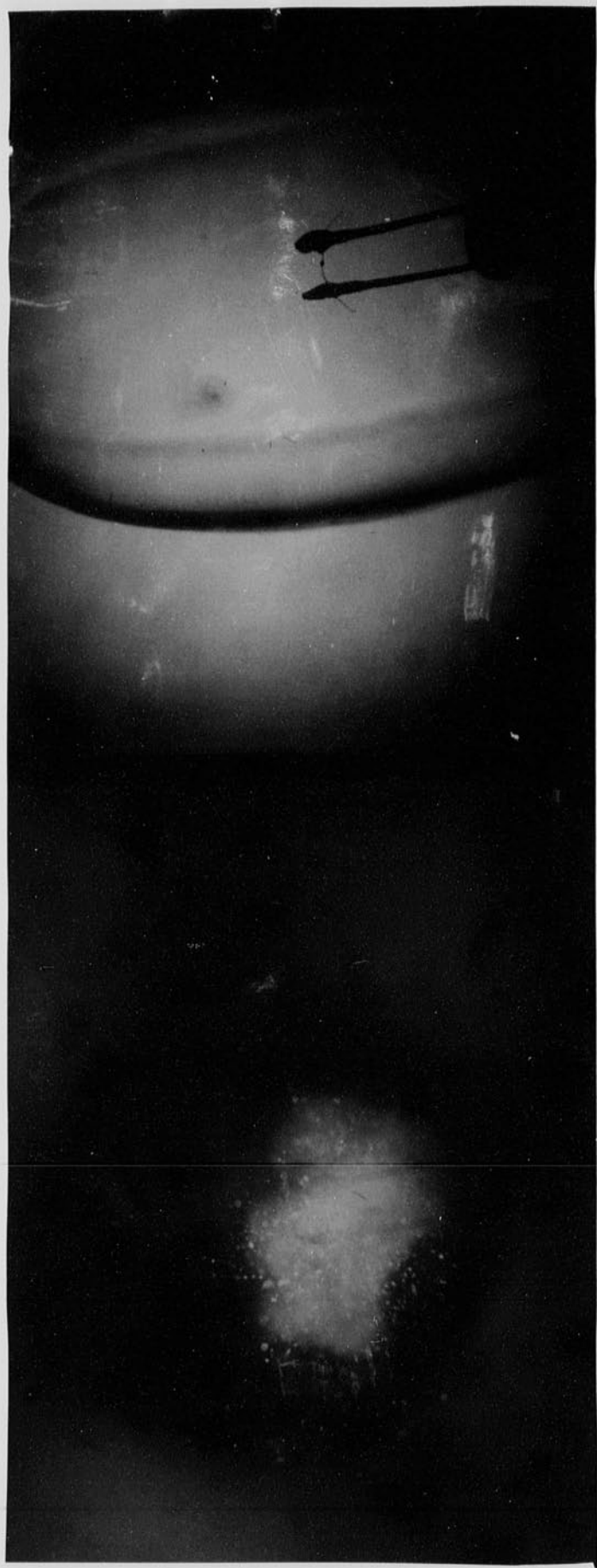
| Photo. | Delay | Trigger P.C. |
|--------|-------------|--------------|
| 1. | 100 μ s | 6" |
| 2. | 100 μ s | 12" |

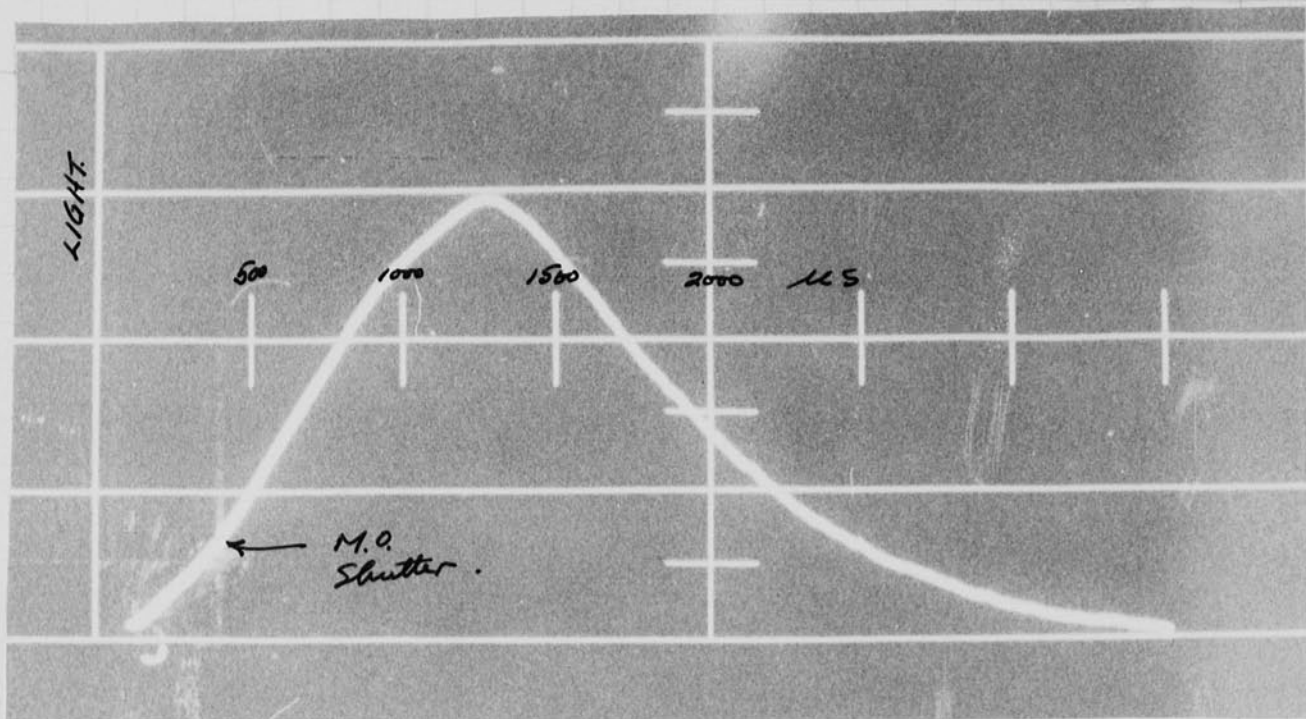
Developed - Exposure seconds, etc.

| | | |
|----|-----|----|
| 1. | 0 | 6" |
| 2. | 25 | 6" |
| 3. | 50 | |
| 4. | 75 | |
| 5. | 100 | |

oscillogram also made,
26.5V = 2cm.
85,000 ohms 18"

15V/cm 500 MS/cm





Magneto optic photographs of M-2 igniter
 The damping spark was removed by pulling V105 out
 of its socket.

Jan 14, 1955. ABG.

I was in Rochester yesterday visiting the Graflex company,
 Doc Whitaker, Schuyler C Wells Jr. Engineer in
 Oscar Steiner, Roy Hickey, Warren White, Otto Sahmel, Ed Farber,
 V. E. Whitman, Gillespie, H. F. Hopper, C. H. Harper,
 Sarah Kuhnert (Chas Faidlaw Water town 55 Belmont St.)
 Local Rep.

Jan 1958 motor

Fred Barstow

Tests with Double Flash.

| | | | | | |
|--------|------|-----|-----------------|-------------------|-----------------------|
| Resist | .005 | 8KV | 1/2" Xenon Cap. | 100 ohms, 3.5 ft. | 5 volts, Graph & Ref. |
| | 1/3 | 7KV | microflash | 100 ohms, 3.5 ft. | 1.3V Dan 2. B.R. 130 |
| Resist | .005 | 7KV | 1/2 Xenon | 100 ohm 3.5 | 15 volts Graph |
| Resist | .1 | 8KV | 1/2 x 2 | " " | 1.3 Dan 2. Graph |

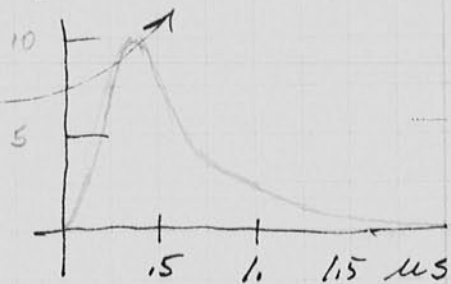
The tube shows some quartz blowing.

July 15 1955 Continued experiments with short flashes.

1" Xenon tubes self flash at 8KV - therefore cannot use conventional circuits.

Series gap circuits.

| | | | P.C. | Scope. | Filter |
|-----|-----|----------------|-----------|-------------|-----------------|
| .03 | 8KV | 3/4" 4mm Xenon | 100R 4ft. | 1/3 uS 2.5V | none |
| .03 | 8KV | 1/2" 1mm Xenon | 100 4ft. | 1/3+ 2.5V | " |
| .10 | 8KV | 1/2 1mm Xenon | 100 4ft. | 1/2 uS 8V | " |
| .1 | 8KV | 3/4 4mm Xenon | 100 4ft. | 1/2 6V | " |
| .1 | 8KV | 1/2" 1mm Xenon | 100 4ft. | 1/2+ 12V | " Shorter leads |



Above voltage readings are no good due to low voltage of the power supply due to a leak.

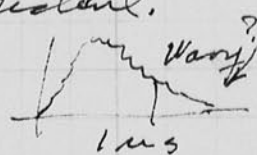
0.1 8KV 1/2" 1mm Xenon 100 4ft. 1/2+ 17V.
a plain glass filter 1/8" thick changes the picture.

0.1 8KV 1/2 1mm Xenon 100 4ft. 1/2+ 7V

The high initial peak is gone.

Duration is longer.

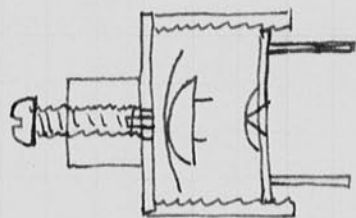
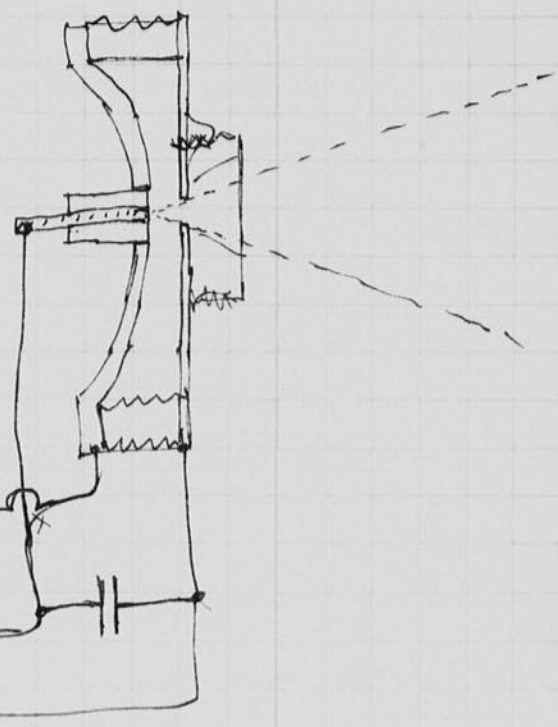
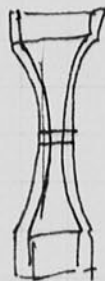
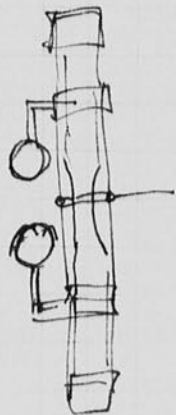
0.1 8KV 3/4" 4mm " 100 4ft. 1/2+ 7V.



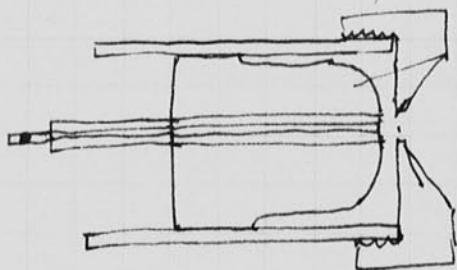
air gap

.01 8KV. air gap. 100- Ω 4ft. $\frac{1}{4}$ μ s. 3V.

Should design a gap with a xenon tube in series, both in the focus of the reflector.



Screw gap adjustment,



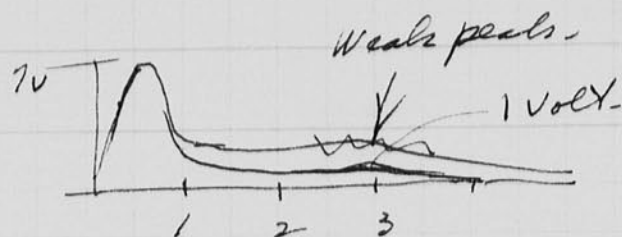
10 μ fd 2KV. FX-1 100- Ω 4ft glass. 20 μ s. 12.5 volts.
 \downarrow
 2.5×10^6 c.p.

Then $7V = \frac{7}{12.5} 2.5 \times 10^6 = 1.4 \times 10^6$ c.p. Xenon.

$3V = \frac{.6 \times 10^6}{.25}$ c.p. air gap

H.C.P. 5 = $1.4 \times 10^6 \times 0.7 \times 10^{-6} = 0.98$ H.C.P. 5. Xenon.
 = $.6 \times 10^6 \times 0.25 \times 10^{-6} = 0.15$ ~~Xenon~~ air gap.

FT-110



0.1 8KV. Series gaps.

0.1 8KV. $\frac{1}{2}$ 1mm X 1mm.

8v.

cheds.

0.1 8KV. $\frac{1}{2}$ " $\frac{1}{2}$ " Xenon large gap. Blew up on second pop.
no sealing was made.

0.1 8KV FX-2 - one would not start.

0.1 8KV. FX-3

$$\text{Input} = \frac{64 \times 10^6}{2} \times 0.1 = \frac{1 \mu\text{s} \cdot 5 \text{V}}{3.2 \text{ watt sec.}}$$

$$1 \times 10^6 \times 1 \times 10^{-6} = 1. \text{ HCPs. HCP.}$$

Efficiency is low. ✓

The 1mm $\frac{1}{2}$ " "so called" tube is actually a $\frac{1}{4}$ " gap +.

Note that the capillary is very clean while the end zones became quite dark. This is good. The arc sours and the sputtered material into all ends where the position of the arc is not important.

Get effy curves for this tube.

$$\text{energy (1 mfd at } \frac{1000}{200} \text{ volts)} = \frac{C V^2}{2} = \frac{1}{2} \text{ watt sec}$$

$$\text{try 2 mfd at } 1000 \text{ v.} = 1 \text{ watt sec.}$$

Power allowable = ? Say 10 watts.

f = 100 cycles. Then n.s. must be 0.1 n.s.

C = $\frac{1}{5}$ mfd at 1000 volts.Light 0.1 1KV $\frac{1}{4}$ " 1mm X 1mm. 2 ft 100 Ω . 2 μs ($\frac{.578 \text{ volts}}{3}$),1 mfd 1KV. " " " " 5 μs . 1.6v.In vac with Reflector. 3 mfd 950V Strontium 2 ft 100 Ω 30 μs . .03 volts.

with Ref. } Strobotal peak light = $.06 \times 10^6$ cp. beam } 18×10^4 C.P.S.
 Duration = 30 μ s.

since at 24V

Proc 1.0 ~~at 100V.~~
 $\lambda_{\text{sum}} = 3.2 \times 10^6$ cp. } $15.2 \times 10^4 = 15.2$ MC.P.S.
 5 μ s. = 5×10^6

0.1 2 volts x 2 = 0.4×10^6 cp.
 Duration 2×10^{-6} 0.8 C.P.S.

use 25 reflector factor = $.8 \times 25 = 20.0$ C.P.S.

actually may only use $1/3$ of this gives 7 B.C.P.S.
 which is then about 3x the strobotalc.

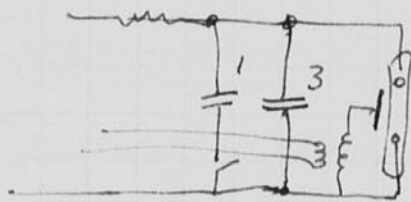
Power energy = 0.1 watt sec.

Strobotalc = $3 \text{ mfd } \frac{350^2}{2} = .15$ watt sec.

} about same?

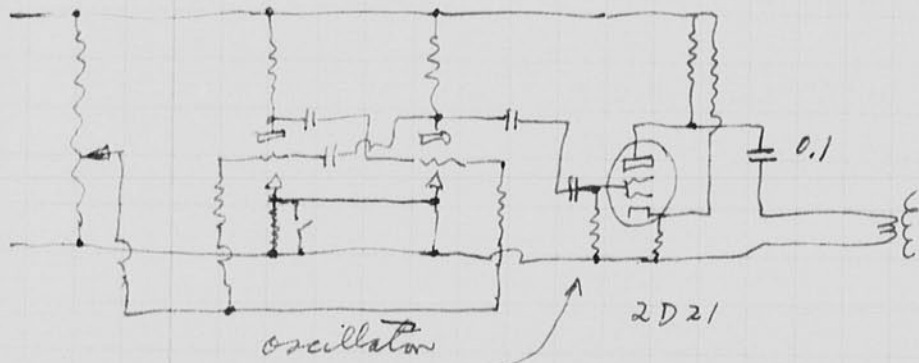
$\frac{60}{9.00}$ watts. actually less since the voltage drops at the higher speeds.

new Strobotalc design. white light tube.

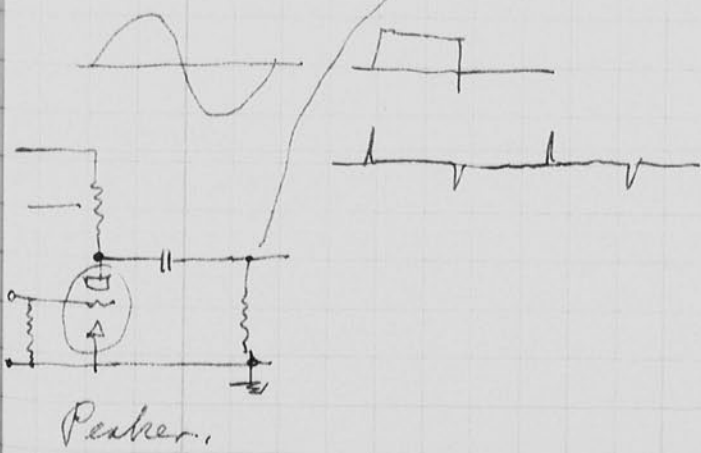


$$\frac{CE^2}{2} = \frac{1 \times 10^{-6} \cdot 350^2}{2} = .05 \text{ watt sec per flash.}$$

$$.05 \times 240 = 12.00 \text{ watts.}$$



Low.
 High.
 ac external.
 60 cycle.
 contactor low
 contactor High.



C V P.C. R. V.
 .01 600. 2ft. 100 5

calibrator FX-1 10 mfd 2KV.

10 2000 3ft. 100 24 volts = 2.7×10^6 c.p.

1/4 1mm. .01 3000 3ft. = .25 to .4 $\times 10^6$ c.p. .25 to .4
 .01 2000 " = ~~.1 to .2~~ $\times 10^6$ c.p. .01 to 0.2
 .01 1000 " = ~~.01~~ $\times 10^6$ c.p. .01

Strobosc with reflector

" 4. 350 3ft.

= .002 $\times 10^6$ c.p.

.01 1000 3ft.

= ~~.02~~ $\times 10^6$ c.p.

} Visual effects 30 us
 do not check.
 Distances different 91 us

Roughly the strobosc color of above give 0
 4 ft vs 2 ft.

Strobosc Xenon.

.06 c.p.s.

.02

$\times 25$

0.5 c.p.s. which is 10x stronger
 than strobosc.

} Visual is 4 to 1. approx.

Sylvania

.01 1000

3ft

.005 $\times 10^6$ 2 us.

.01

"

.01 2000

3ft

Holdover.

.01 to .02 $\times 10^6$ 3 us. \pm

.03

FT 218

.01 2000

0.1 $\times 10^6$ 1/2 us.

.05

Photo []

.01 2000

Jan 27 1955

Harold E. Edgerton

Scope off calibr. 1 cm = 115 μ s. (instead of 100),

Delco driving crystal 30 EDP Edo 126.5 μ s.

TD2R44 " " " 460 μ s.

Large Delco coil " " " 138 μ s load click

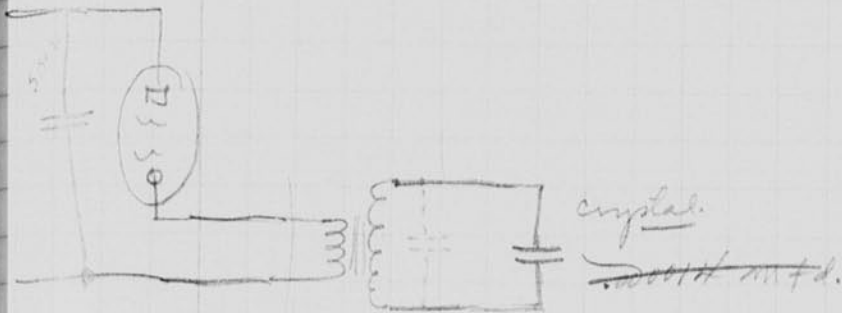
" " " as is 34.5 μ s.

" " " crystal and Edo Ind. 20.7 μ s ?

$$\frac{115}{115} = 1$$

$$\frac{920}{115} = 8$$

$$\frac{115}{2070} = 0.055$$



0.0014 μ f. = 1400 μ mf.

Large Delco # 14499 0.52 henries. $(2\pi)^2 = 39.$

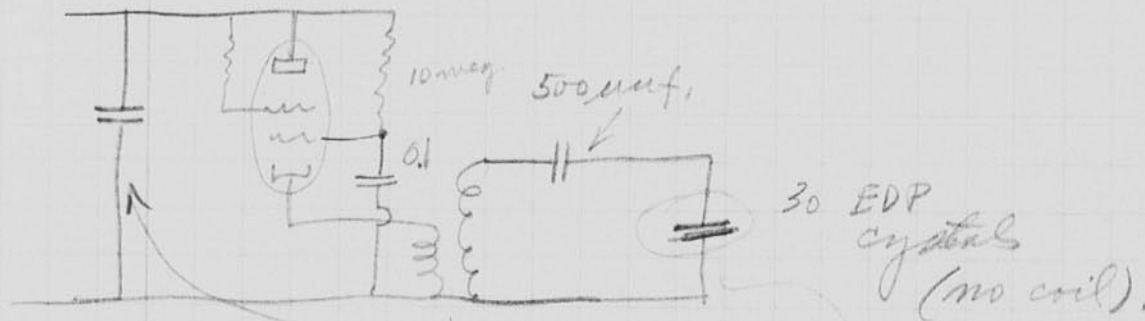
$$34.5 = T = 2\pi \sqrt{LC}, \quad C_1 = \frac{T^2}{(2\pi)^2 L} = \frac{34.5^2 \times 10^{-12}}{(2\pi)^2 \cdot 0.52} \rightarrow \frac{570 \times 10^{-12}}{1990} \quad \frac{119}{205}$$

$$T = 2\pi \sqrt{0.52 \times ((1400 + 570) \times 10^{-12})}$$

$$= 2\pi \sqrt{1000 \times 10^{-12}} = \sqrt{10 \times 10^{10}} = 3.3 \times 10^{-5} = 330 \mu s.$$

$$T = 2\pi \sqrt{3.0 \times 10^{-12}} = 2\pi \cdot 1.73 \times 10^{-6} = 6.75 \times 10^{-6} = 109. \mu s \quad \text{Does not check.}$$

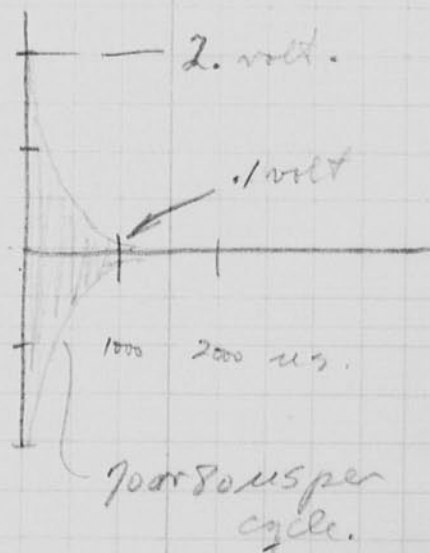
1 cm = 1



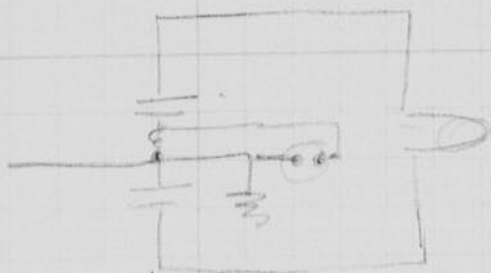
seems best at 0.2 mfd

Delco old large # 14499

see and other capacity turned for approx 12 KC.



Tried spark in water Jan 27 with Roy Swansen
 100 ws at 900 v in series with FT-21P, gave
 a small Bang. - Light reduced about
 30%. Signal small on microphone
 with lots of after noise.

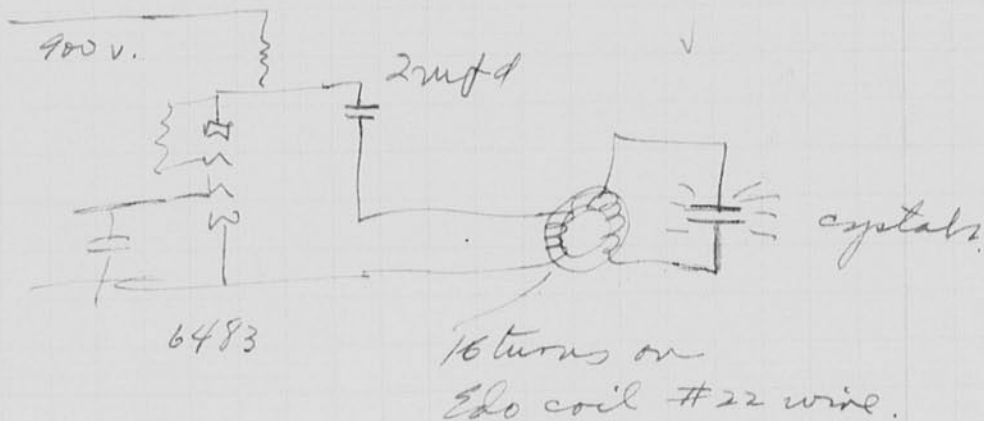


Jan 29 1955.
 March Edgerton

more experiments with
 Edo 30 EDP crystal transducer.

now using

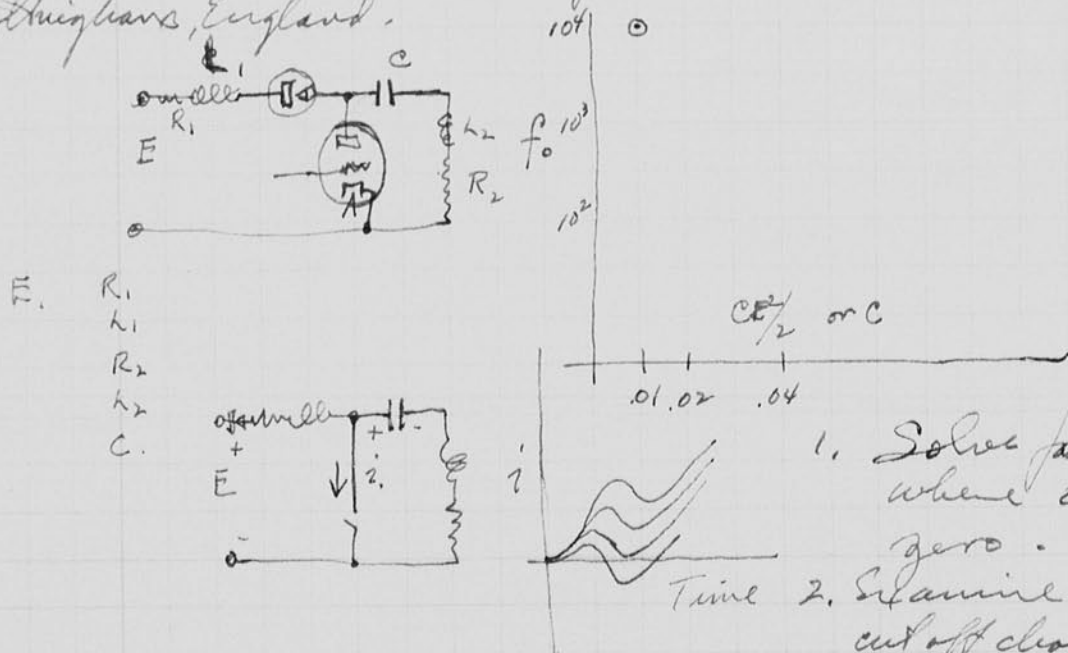
This looks good



Castor oil over crystal.
 mist at 1 foot above gives 0.1 volt.
 frequency is about 10 or 11 KC.

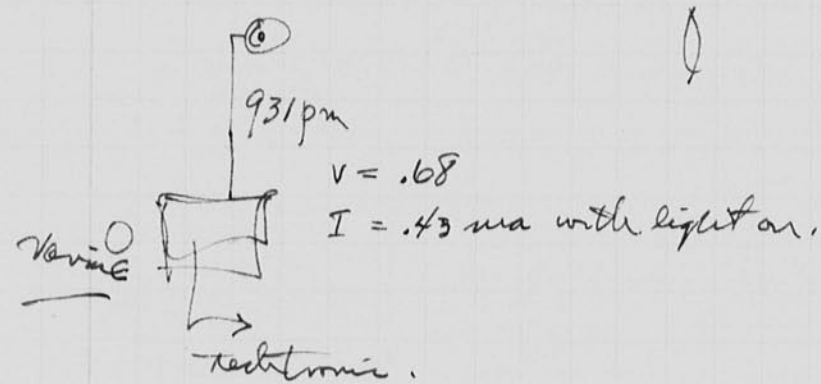
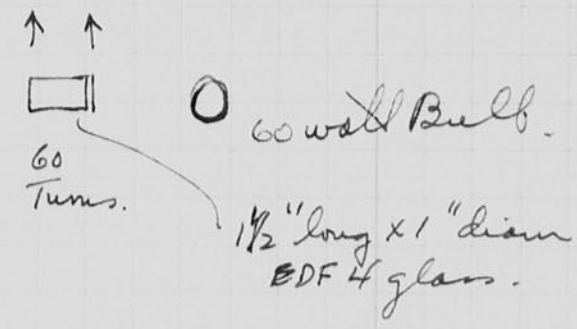
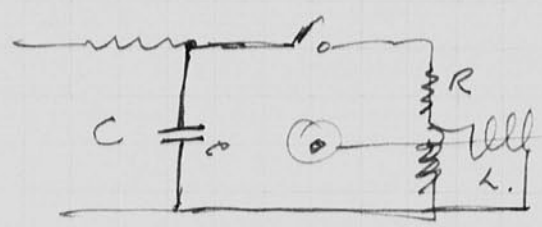
Voltage on crystal is about 1500 volts peak.

Joe Watson - thesis on High-speed motion pictures.
 Nottingham, England.

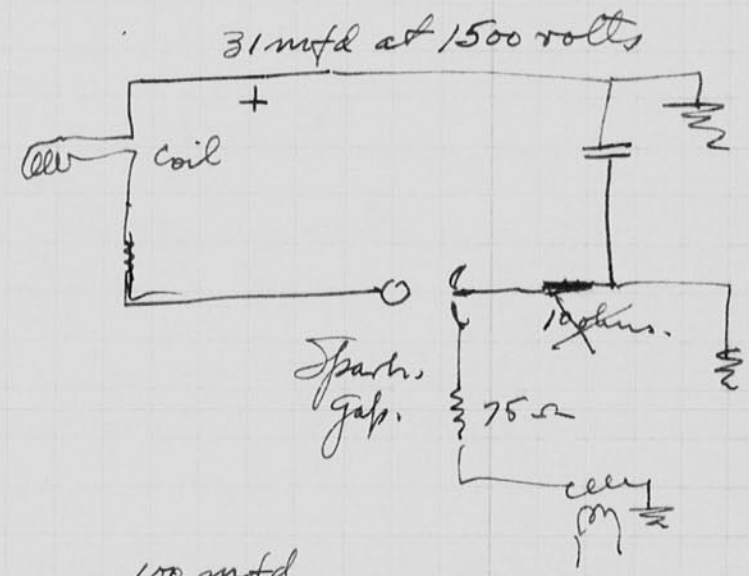
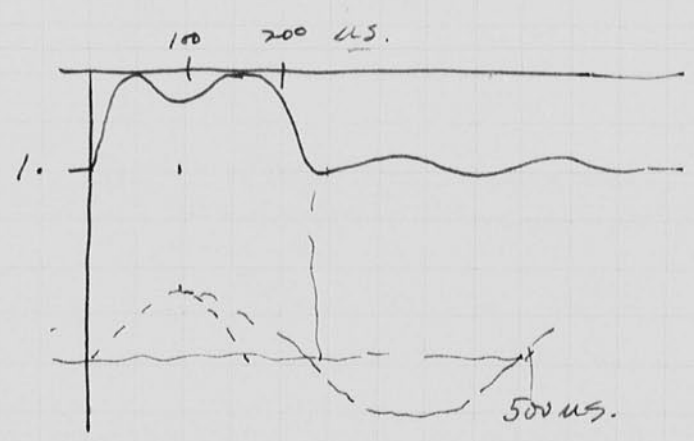
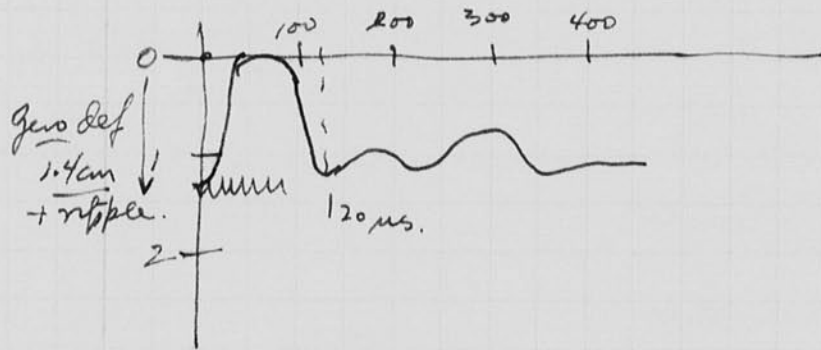


1. Solve for transient where current reaches zero.
2. Examine Hydrogen thyristor cut off characteristics. Grid no current cutoff.

Magneto optic stroboscope
 H. G. Egerton
 Jan 30, 1955. 20D102 M.I.T.



Ripple in a.c. output of P.M. Filter needed?



Coil used above + 15
 #18 leads
 $R = 0.33 \text{ ohms.}$
 $L = 65 \mu\text{h.}$
 $DQ = 1.2.$

$$T = 2\pi \sqrt{LC} = 6.28 \sqrt{65 \times 10^{-6} \times 100 \times 10^{-6}}$$

$$= 6.28 \sqrt{65 \times 10^{-12}} = 8 \times 10^{-5}$$

$$T = 80 \times 10^{-6} \text{ sec.}$$

$$= 500 \mu\text{s.}$$

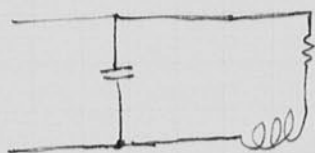
Exp shows about this per cycle.

From page 25 fog on film for $\frac{1}{200}$ sec. G.E. Co. data via Babbitt.

$$\frac{1 \text{ sec}}{200} = 5,000 \mu\text{s.}$$

$$\frac{1}{100} \text{ sec} = 10,000 \mu\text{s.}$$

$$\frac{1}{200} \text{ sec} = 5,000 \mu\text{s}$$



$$\text{current for closure} = E \sqrt{\frac{C}{L}} = 1500 \sqrt{\frac{30 \times 10^{-6}}{65 \times 10^{-6}}} = 1500 \sqrt{\frac{1}{2}} = \frac{1500}{1.7} = 100 \text{ amps.}$$

actually, less due to damping.

try 3200 with sec unit.
400 mfd at 4 KV. =

Let $R = ?$ to limit current to 100

$$100 = 4000/R \text{ or } R = 40 \text{ ohms.}$$

$$RC = 40 \times 400 \times 10^{-6} = 16000 \times 10^{-6} = .016 \text{ mfd sec} \\ = \underline{16,000 \mu\text{s.}}$$

now increase the time by some factor n .

$$100 \times 65 = I \times (65n)$$

$$I = 100/n \text{ amperes.}$$

$$\text{and } I = \frac{E}{R} = \frac{E}{R_0 n}$$

$$R_0 = 40 \\ R = 40n.$$

$$\text{and } T = RC$$

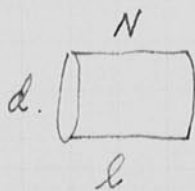
$$T = 40nC = \underline{40}$$

$$\text{Let } T = 5000 \mu\text{s.}$$

$$\text{then } n = \frac{5000 \times 10^{-6}}{40 \times 40 \times 10^{-6}} = \frac{5}{16} \checkmark$$

time is shorter
by ratio.

Design calc.



90° for $N \times 100$ ampturns.

$$R = \left(\frac{0.3}{60}\right) \text{ ohms} \times N$$

$$I_{\text{max}} = E/R.$$

$$T = RC$$

$$6000 = NI$$

$$I = \frac{E}{R} = E \frac{60}{.3 N}$$

$$T = RC$$

$$6000 = E \left(\frac{60}{.3}\right)$$

$$E = \frac{100}{.3} = \underline{\underline{333 \text{ volts.}}}$$

AC
camera

Design for 1000 volts
 $T = .002$

$$100 = \frac{1000}{R} \quad R = 10$$

$$T = RC$$

$$C = \frac{T}{R} = \frac{.002}{10} = .0002 \text{ farads}$$

$$= 200 \mu\text{f.}$$

$$10 = \frac{.3}{60} N \quad N = \frac{600}{.3} = 1800 \text{ turns.}$$

2nd calc try 2000 volts,

$$R = \frac{E}{I} = \frac{2000}{100} = 20 \text{ ohms}$$

$$T = .002 = RC$$

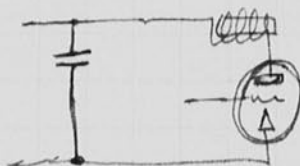
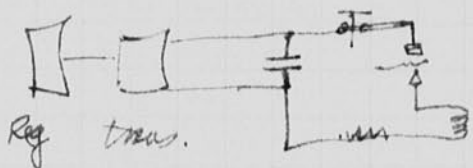
$$C = \frac{.002}{20} = .0001 \text{ farads} = 100 \text{ mf.}$$

$$N = \frac{R \times 60}{.3} = \frac{1200}{.3} = 3600+ \text{ turns,}$$

3rd. try. 450 volts, $R = \frac{450}{100} = 4.5 \text{ ohms,}$

$$RC = .002 \quad C = \frac{.002}{4.5} = .0004 \text{ farads} = 400 \text{ mfd.}$$

Wind coil with any resistance and add series R to get 4.5 ohms, 60 turns



100 amp peaks in this tube!

now try a coil with $N = 120$ turns,

$$NI = 6000$$

$$I = 50 \text{ amps.}$$

$$R = ? = \frac{E}{I} = \frac{450}{50} = 9 \text{ ohms.}$$

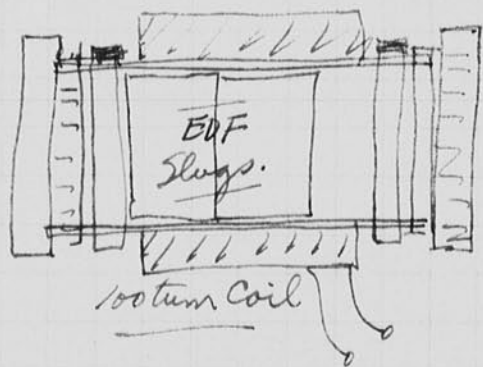
for AEC. fastax camera 2500 f.p.s.

$$RC = .002$$

$$C = \frac{.002}{9} = .0002 = 200 \text{ mfd.}$$

Suggest newtonian camera into a fastax with a shutter as above set for .002 seconds.

Series 6 Polarizers



3/4 unit with 1/200 sec. exp. Now for ballist $T = .005$ sec

$$\text{Let } N = 120$$

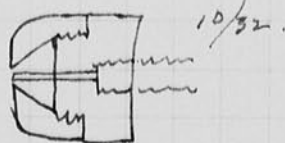
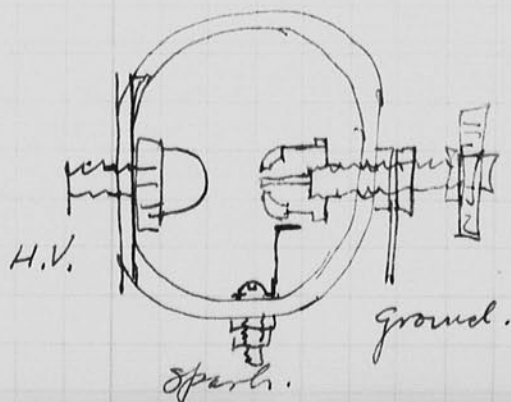
$$I = 50 \text{ ampro.}$$

$$R = 20 \text{ ohms.}$$

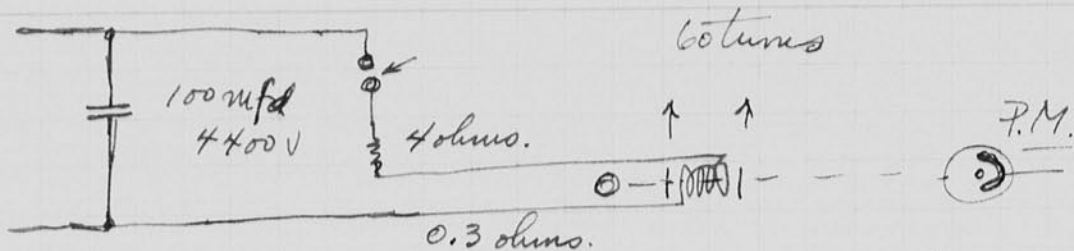
$$E = 1000 \text{ volts.}$$

$$RC = .05$$

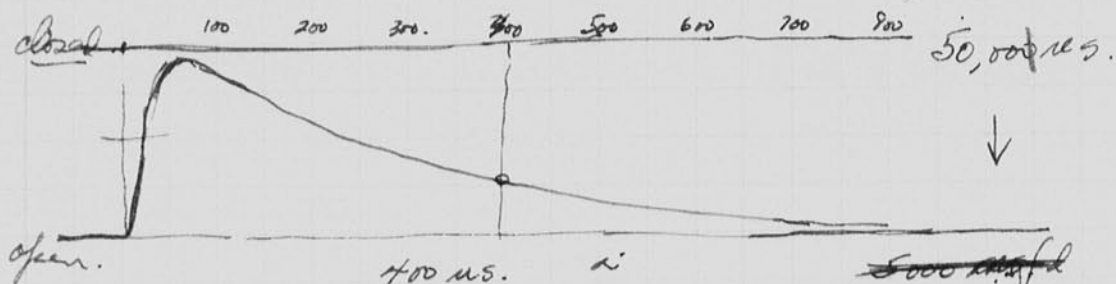
$$C = \frac{.05}{R} = \frac{.05}{20} = .0025 = 2500 \text{ mfd.}$$



Jan 31 1955 20D102 M.I.T.
Harold Engstrom



$1 = 10^0$
 $1 = 10^1$
 $1 = 10^2$
 $1 = 10^3$



50,000 μ s. 2000 μ s.

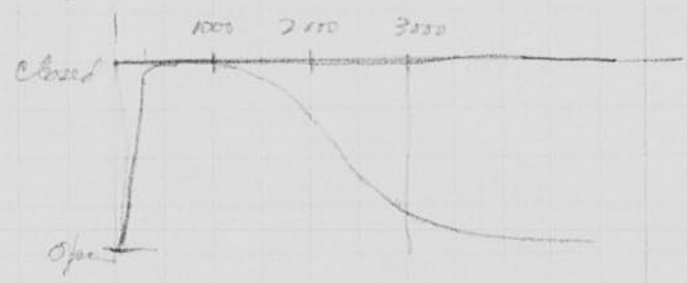
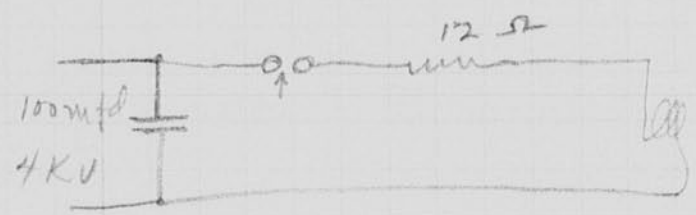
↓ mtd
500 ~~ms~~
will do it.

400 μ s. \approx
for 100 mfd.
~~10,000~~
5000 mfd
10,000 mfd
regd.
Sacrificial rise
time.
and redesign.

New Coil

Tests of new coil of #22 wire on p131 spool
2 1" diam EDF 1/2" long each, 1" total.

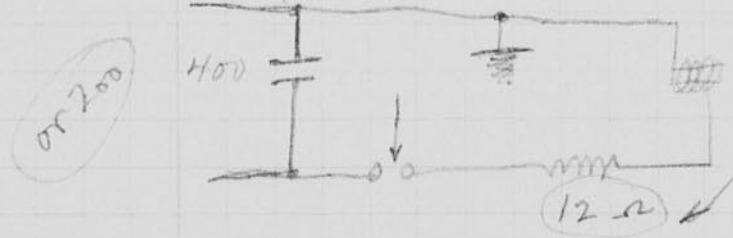
$R = 4.12$ ohms,
 $L = .008$ henries.



$$T = 2\pi\sqrt{LC} = 6.28\sqrt{.008 \times 100 \times 10^{-6}}$$

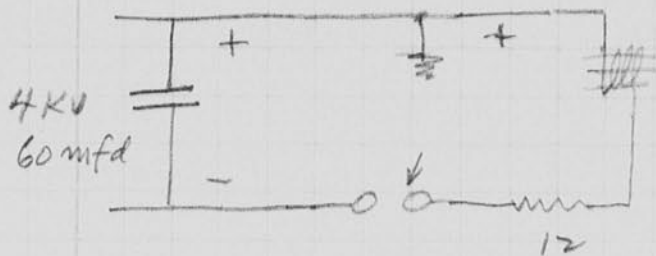
$$= 6.28\sqrt{.8 \times 10^{-6}} = .9 \times 10^{-3} \times 6.28 = .006 \mu s = \text{cycle.}$$

circuit for use at G.M. Pittsfield or June Feb 18,



this way consist of
a FT-503 or
maybe 2 FT-505 tubes
in series.

Circuit for ABC unit



Phone call from Elmendorf. - Cleveland Ohio. -
 Plans to come east Feb 17. to see R.H.E. Lab.
 mentioned intense light when
 magnet field is used near
 a point source as tube.
 Gain of 100 in light? or light intensity?

$$\Delta = \frac{4L}{R^2C}$$

$$\Delta = \frac{.008 \times 4}{16.2 \times 10^{-4}}$$

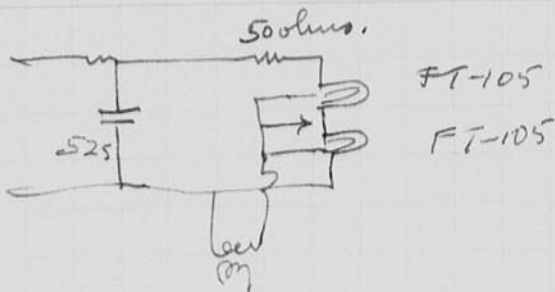
$$\Delta = \frac{320}{256} \approx 1.5$$

$$\frac{65}{4} = .4$$

H. E. Sargent
Ray Swensen.

Sensitometer flash.

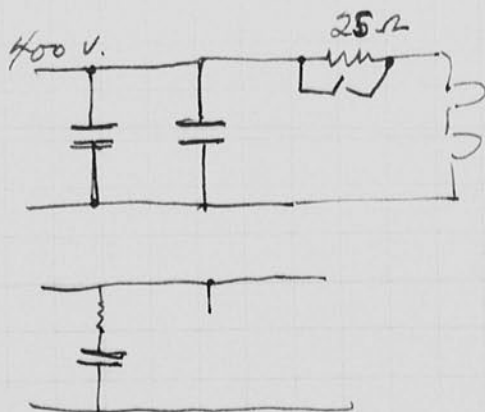
actual.



Lamps. (645)

Def at 18"

| | | | | | | |
|----|------|----------|---------------------------|---------------------|-----|---------------|
| 2 | 525 | 25 ohms. | Duratin = 5000 μ s. | 1.2 x .32 V | | |
| 2 | 1050 | 25 " | " = 12,000 μ s. | | | |
| 2 | 525. | 25. | Duratin = 5000 | 1.5 x .32. | | |
| 2 | 525 | 0 | 1400 | 4.7 x .32 x 100 | | |
| 2 | 525 | 25 | 9000 ← | 1.4 x .32. | } 3 | |
| 2 | 525 | 50 | 10000 + | 0.7 x .032. | | |
| 1 | 525 | 0 | 500 | (36") 2.2 x .32. | | |
| 3. | 525 | 0 | 2000 | 18" 2.5 x 3.3 x .32 | | |
| 3 | 525. | 25. | 7000 | 1.5 x .32 | | |
| 1 | 525 | 25. | 5000. | 1. x .32. | | |
| 3. | 1050 | 25 | 9000 | 1. x .32 | | |
| 2 | 1050 | 25 | 9000 | 1.6 x .32. | .32 | T x L. 3.2 |
| 2 | 1050 | 0 | 1000. | 1.1 x .32. | 32. | 32. |



1000 mfd - 25 Ω - 9000 μ s.

1000 mfd - 0 Ω - 1000

Lamps: C R D Light

2. 20 mfd. 0 100 μs. 2 x 3.2 (18°)

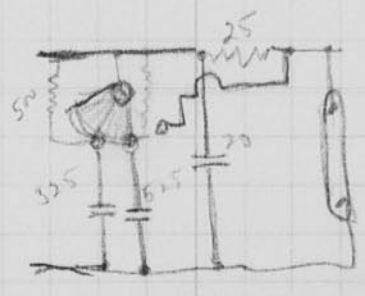
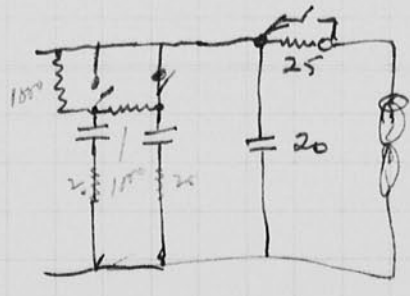
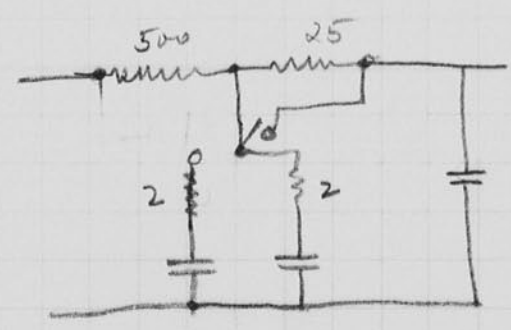
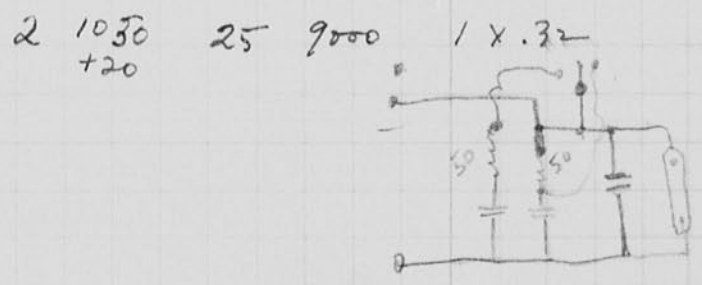
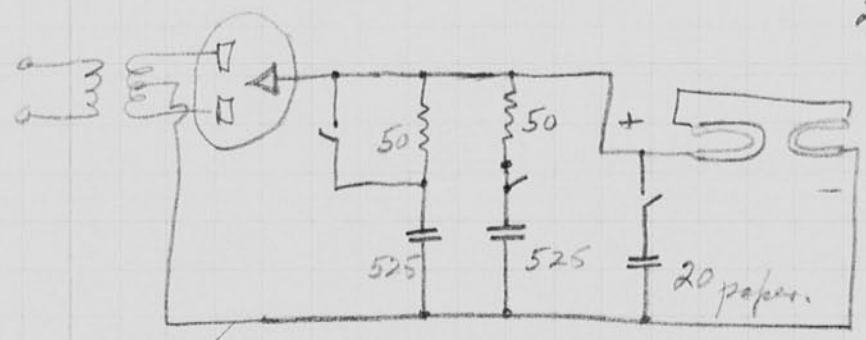
Now Ray connected 2 other electrolytic capacitors of 525 mfd each in parallel into the circuit for a check final.

| | | | | | | | | |
|---------------|-----------------|--------------|----------------|-----------------|----------------------|--------------|--------|--------|
| 2. | 1050 | 0 | 25. | 1500 | 1.2 x 32. | V | M.C.P. | C.P.S. |
| 2. | 1050 | | 25. | 8500, | 1.1 x .32 | 0.352 | .00915 | 77.8 |
| 2 | 20 paper. | 0 | 100 μs. | 2 x 3.2. | 6.4 | | .166 | 166 |
| 2 | 525 | 0 | 1000 | 1 x 32. | 32. | | .835 | 835. |

FX-1 20 mfd 1000 V 50 μs. 1.8 x 32. (36°) 0.6 M.C.P.

$$C.P. = \frac{.6 / 18^2}{36} \frac{V.}{1.8 \times 32.} = \frac{.6}{4} \frac{32}{1.8 \times 32} = .026 \times 32 = .835$$

2. 525 0 1300. 1.5 x 32.
+ 20 paper
2 525. 0 1300 - 1.5 x 32

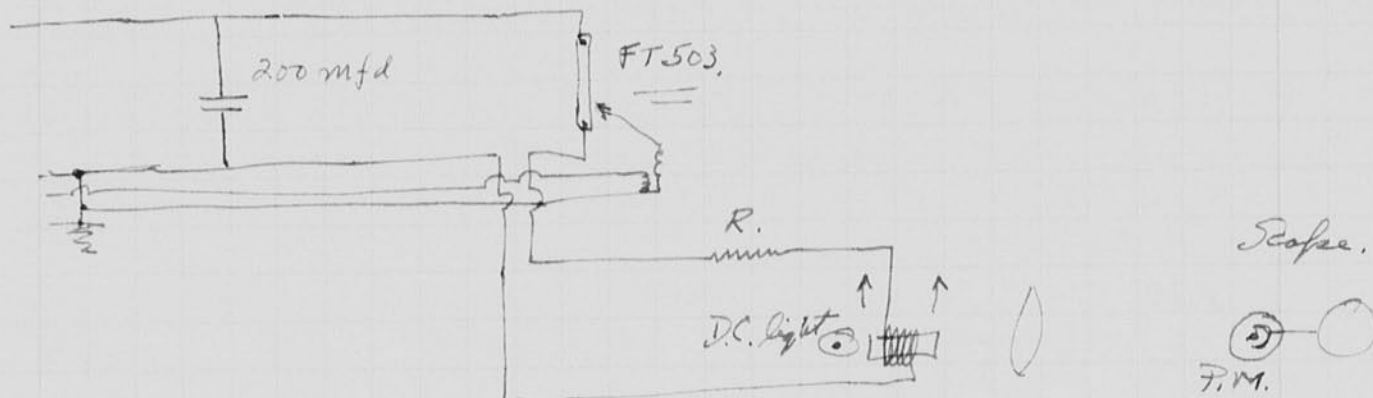


136 Feb. 5, 1955. (Sat.)

David E. Egerton
Ray Swensen.

Pete Franklin was in to test the Robot under water camera. This will then be taken by Marden to the Red Sea on the Calypso.

I tested the magnetooptic shutter using the 3200 watt second flash unit, 4KV.



EDF 4 Glass 1" diam 1 1/2" long with 300 turns? of #22 wire. Oscillograms were made of the dimming of the light

| Osc. no. | Res | c | |
|----------|---------|------|------------------------------|
| 4 | 4 ohms. | 200 | Rotation exceeds 90 degrees. |
| 5 | 9 | 200 | Rotation still exceeds 90°. |
| 6 | 14 | 200. | Looks ok. |
| 11 | 9 | 200 | Shows overshoot. |

Inoperative

Output of FT-503 = $36 \times 94 \times 4 = 13,800$ B.C.P.S.
(14 ohms & coil)

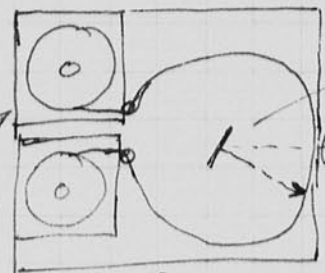
Output of FT-503 = $36 \times 120 \times 8 = 34,600$ B.C.P.S.
(coil.)

Rotating mirror camera design

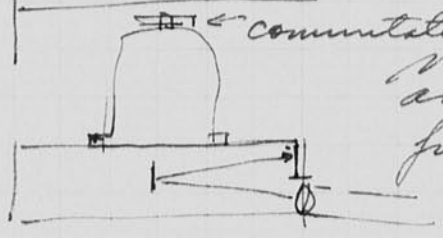
Feb 5/1955

A. S. Elger

Light tight
film
chamber



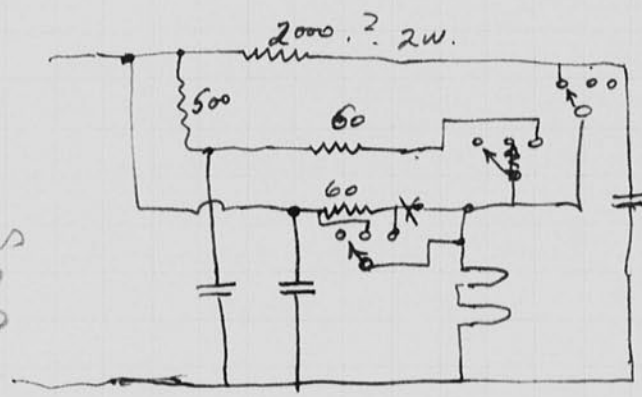
Rotating mirror



commutator
note that lens and film
are at angle so that
film is always active.

Feb.

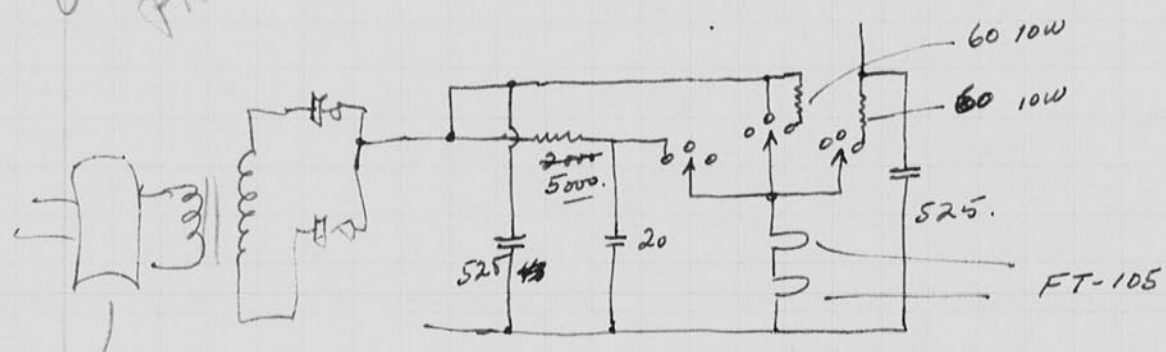
Chicago Trans
PHR 55



100 10³ 10⁴
0 2 0

$$20 \times 10^{-6} \times 1000 = .02 \text{ sec.}$$

$$5000 = .1 \text{ sec.}$$

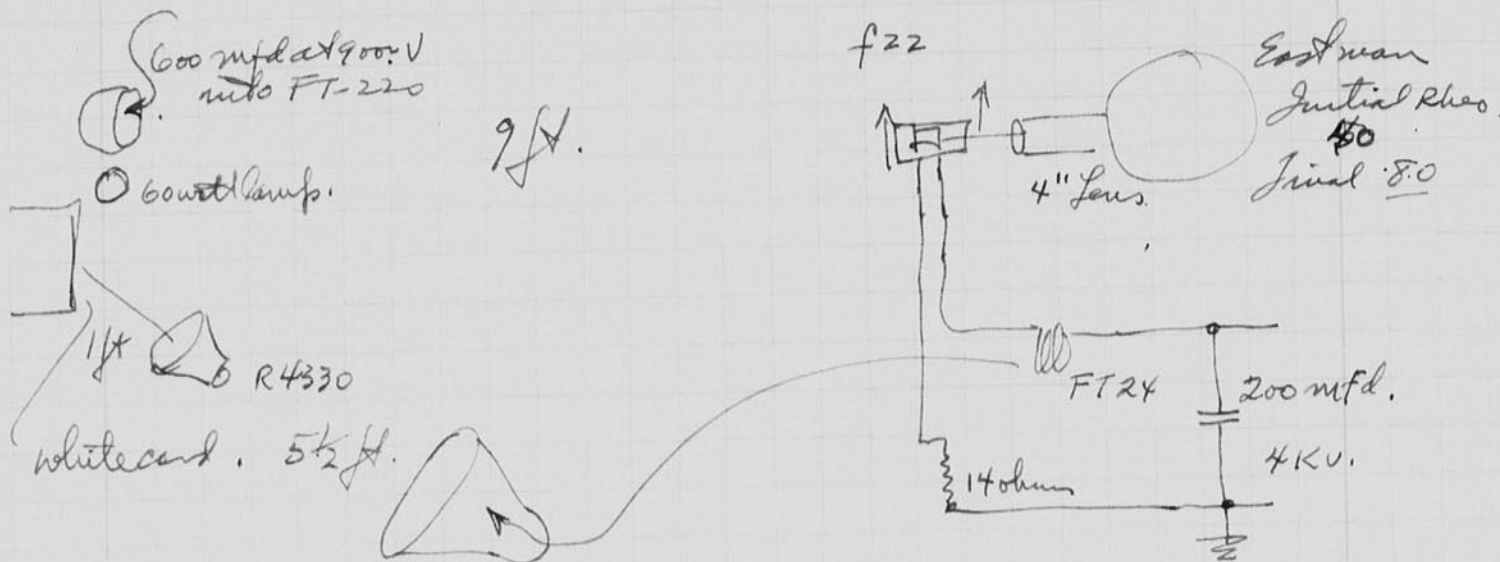


Roylton
VR 6111
30 watt

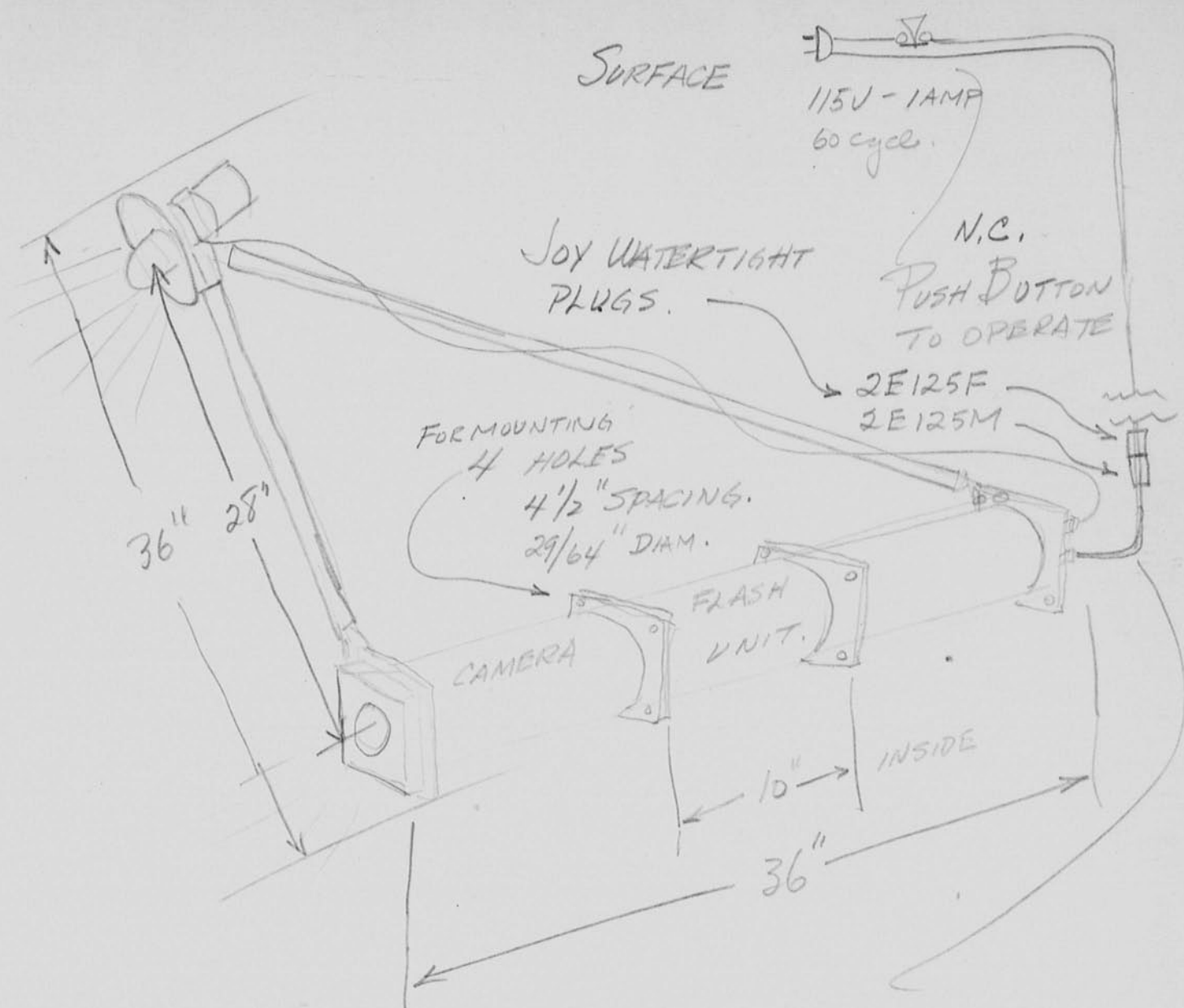
100 1000 10,000.

Feb 7 1956
H. S. Edgerton
Ray Swensen.

Test of Mag-opt shutter
for use in Pittsfield on Feb 17 at Circuit Breaker.



| Film No. | f | Film | Subject | Comments. |
|----------|------|------|---|--|
| 1. | f22. | XX | as per above. | no exposure on 60 watt bulb. FT-220 about right for exposure. No exposure from R4330. No exposure from Strob. |
| 2. | f22 | XX | #2 photo flood in place of 60W. no R4330. FT-220 covered 1/2 by white paper. FT 24 at 2 ft in Reflector. | This was <u>under developed</u> so no conclusions could be made. |
| 3. | | | Film jammed in camera when 50 on scale for start. try 40 next time! | |
| 4. | | | " " Same way! | |
| 5. | | | OK. 40-75 on Rheostat. | |
| | f22 | XX | #2 photo flood. FT-220 as before with paper over lamp. FT-24 at 1 foot away from the photo flood. | |
| 6. | | | Same as 5 <u>except</u> coil on M.O. was shorted out. | |



RECYCLE TIME - 6 SEC (INTERMITTENT) 30 FT
 FILM - 100 FT 35mm. # 16 TIREX
 SHUTTER TIME - 1/100 SEC. TYPE 50 600VOLT
 CABLE.
 FLASH - 100 WS - 2200 BCPS.
 DEPTH - 1000 FT.

UNDERWATER

PUSH BUTTON CAMERA

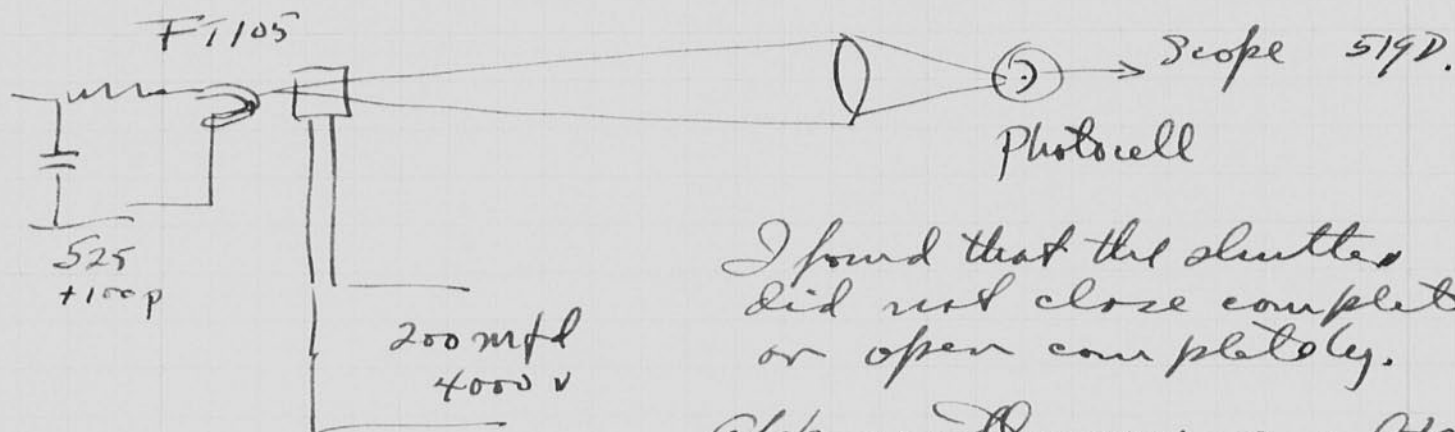
E616 TYPE 2227.

FEB. 8, 1955,
H. EDGERTON

Feb. 9, 1955.
Harold E. Edgerton.

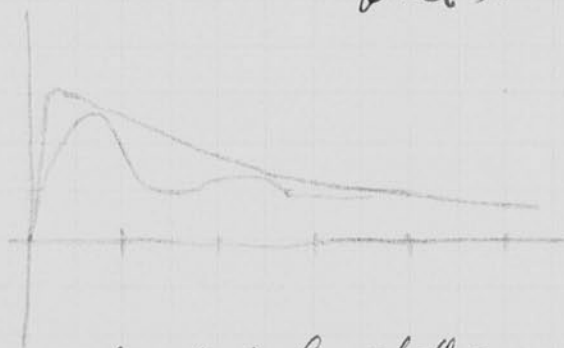
Tests of my M.O. shutter with the moving picture camera were not good. There was some reduction of light but not much.

Today I connected up the following.



I found that the shutter did not close completely or open completely.

Apparently my results with the P.M. tube were influenced by the magnetic field from the shutter itself.



Feb 10 1955

I am very disturbed about the inability of the circuit to close the shutter!

Idea. (1) maybe the ~~band pass~~ band pass is too broad. try a filter.

(2) maybe the amplifier and scope are lying

yellow filter gives no help! experiment.

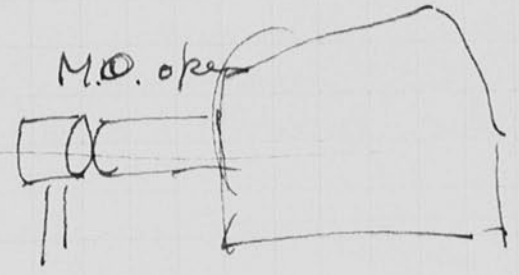
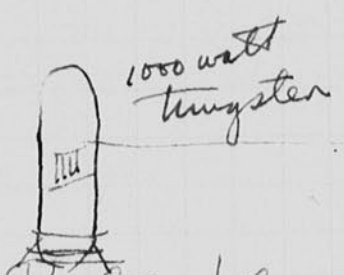
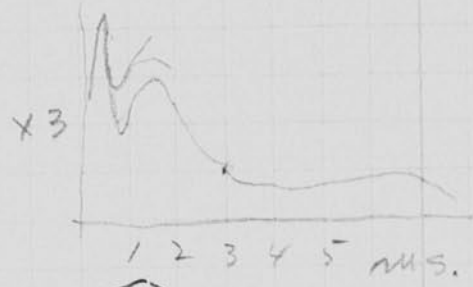
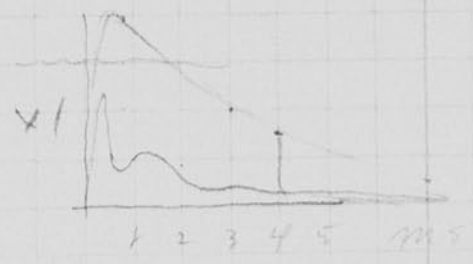
Amplifier looks ok on D.C. pulse of 3 volts.

Blue Filter did not help much either.
Baffle installed - no help.

Feb 12 1955
Harold Dyer
20D102 M.I.T.

Magneto-optic shutter

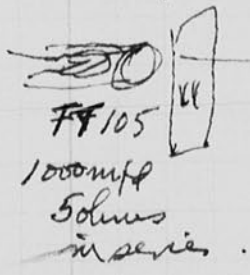
open-close ratio about 600 with mechanical rotation,
next covered flash lamps to exclude stray light.



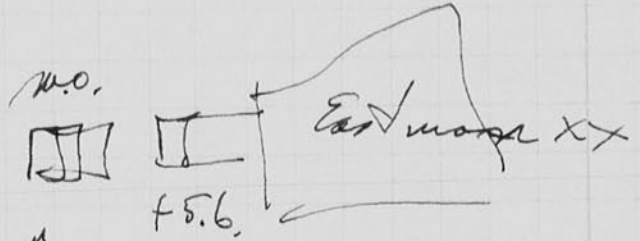
Eastman
30-70.

Positive films - fine grain
Film when developed show peculiar intermittent spots??
This may have been exposed on a slot that was missing?

XX film next f5.6



Photocell



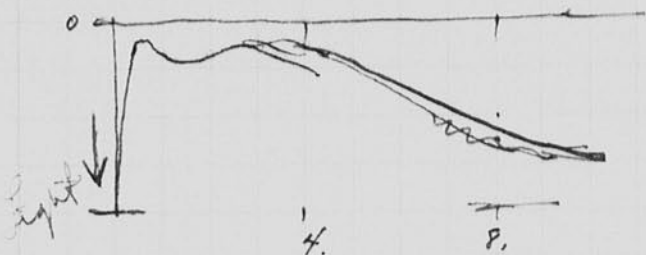
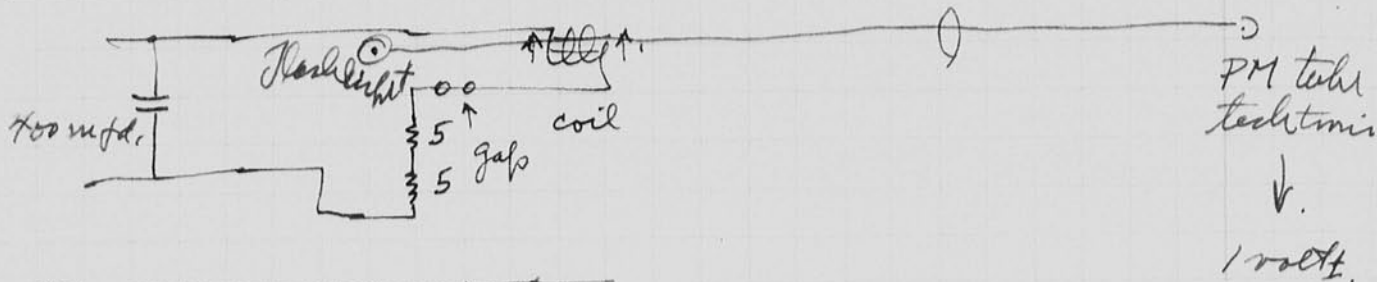
Both sources were overexposed badly on XX film at f5.6!
m.o. helped but not enough!

Feb 14 1955 Ray finished Sensitometer

.280 ms } three conditions
1.0 ms }
8. ms }

M.C. Shuttles.

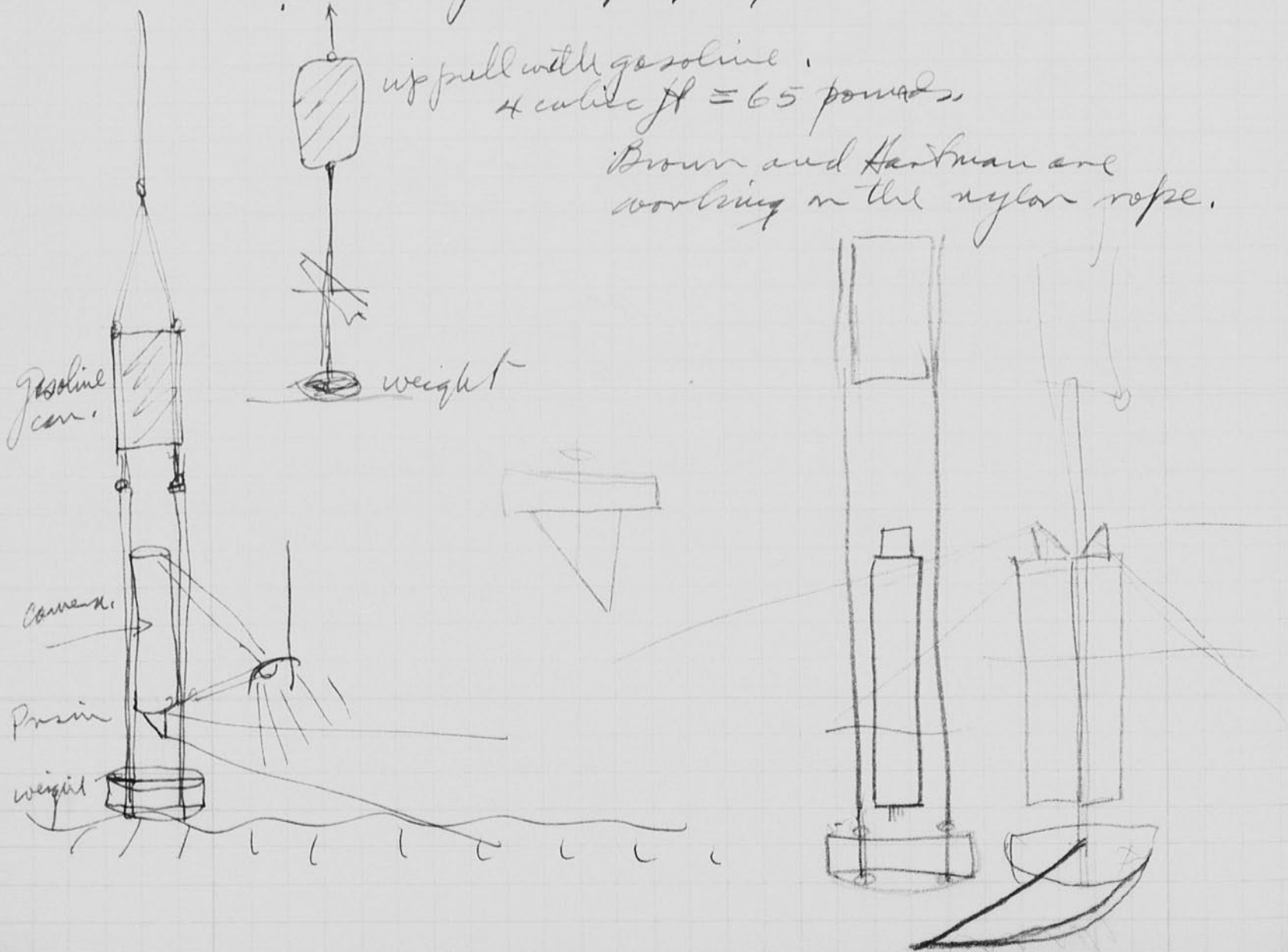
Flash unit with 400 mfd at 4KV.



This is final setting
not to go to Pitt's field.
P.C. for tests.

#3

Under-water camera, Bill Westall suggested
a gasoline suspended camera for the
bottom photography.



36 pounds, case plus cables + lamp house and bracket
ac operated by push button on surface.

$7\frac{1}{2}$ pounds power unit

$3\frac{1}{2}$ " camera with 100 ft of film.

47 " in air.

Results from Tandy experiment. on short flash lamps.

| Gap length inches | Gas. | Energy W5 | Diameter in. | Peak BCP. | Output BCPS. | Effy cp/watt |
|----------------------|-------|--------------|-----------------|-------------------|-----------------|-----------------|
| * $1/8$ | Xenon | .06 | .46 | 4.5×10^4 | .0177 | 0.295 |
| * $1/2$ | " | .06 | .74 | 4.9×10^4 | .0324 | 0.54 |
| * 1 | " | .06 | 1.1 | 3×10^4 | .0306 | 0.51 |
| .02 | air | .06 | .35 | $.62 \times 10^4$ | .00175 | .029 |
| .083 | air | .135 | .43 | 2×10^4 | .0072 | .053 |
| .083 | air | .24 | .44 | 3.6×10^4 | .0152 | .063. |

Efficiencies up to 5 cp/watt have been obtained
with the FX1 tube. 6" long and 4 mm I.D. 20 cm Xenon.
with 2000 volts and 100 mfd.

* 0.03 mtd 11.1 mc 2KV.

I was in Pittsfield Feb 17 with Don Severence to show movies and
slides of the Ballysapher and calypso -

Feb 18 I worked with Babbitt on the M.O. study of
the fuse breaker. Bill Rudge.

Feb 22 1955
 Harold Enger
 Roy Swanson.

Strobolux, new model.

Tube 1/4" gap 1mm Xenon 1atmosphere.

Cap 1 mfd. 60 cycle 750 volts. 1000 ohms.

$$\frac{CE^2}{2} = \frac{10^{-6} \cdot 750^2}{2} = .25 \text{ watt sec.}$$

$\frac{60}{15.00}$ watts in glass tube with
 mineral oil cooling.

This is too much heat for a 1 cm diam.
 glass tube 7 cm of oil + Lamp slips when over heated.

Geo LeCompte and I experimented with
 the starting of flash tubes to observe the
 branching of the initial arc.

He observed that a 1" 4mm i.d. 1atmos Xenon
 tube with 500 volts had single branch
 " 800 " several.

We tried a 4" FX-1 with 0.1 mfd at
 voltages from 500 to 4000. Above 1000 volts
 the arc showed several paths.

We noted a different type of discharge
 at marginal starting conditions. The dim
 stage did not have a many spectra
 lines as the stronger discharge. The strong
 discharge showed a narrow bright path
 in the tube.

A 1" tube showed interesting
 branching when tested with 0.1 mfd at
 4KV. The light from the area near the
 spark coil was very dim compared to the
 light from near the ends.

Roy helped me set up the 20,000 watt second
 equipment for a talk I am to give to the
~~dept~~ dept on Wednesday Feb 23.

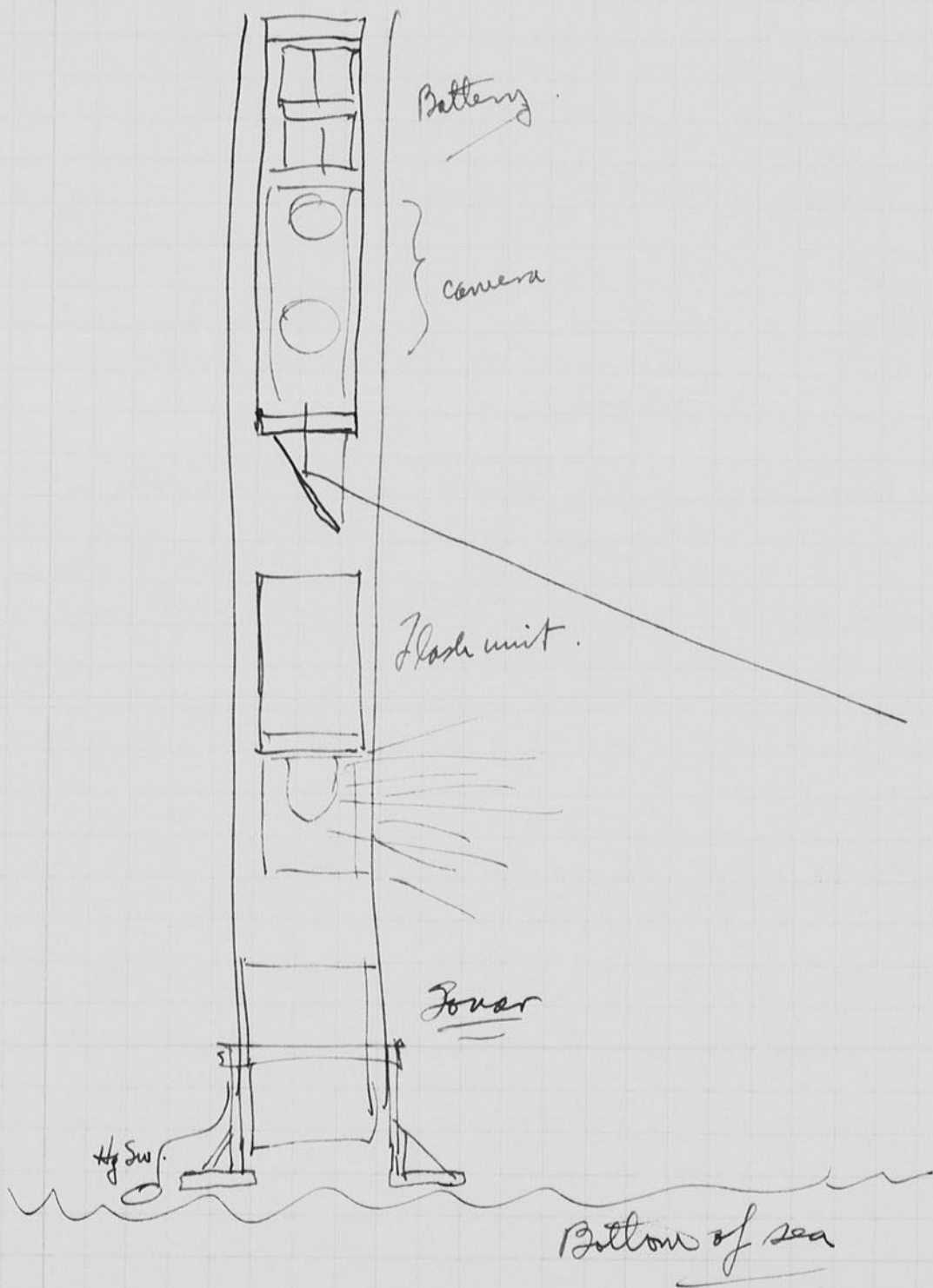
March, 16, 1955.
H. E. Edgerton.

Tested camera casing - $1\frac{1}{4}$ " window over $1\frac{1}{4}$ " hole
broke at 13,000 p.s.i. new windows of $1\frac{1}{2}$ " are
being ordered from Hargool.

$\frac{1}{4}$ " gap.
1 mm I.D.
1 at rear.

Took probe to Bidsmell at Blowdown tunnel.
0.75 mfd at 1800 volts. It up on Solcheimer. Tests
are to be made on photo effectiveness.

Underwater camera design.



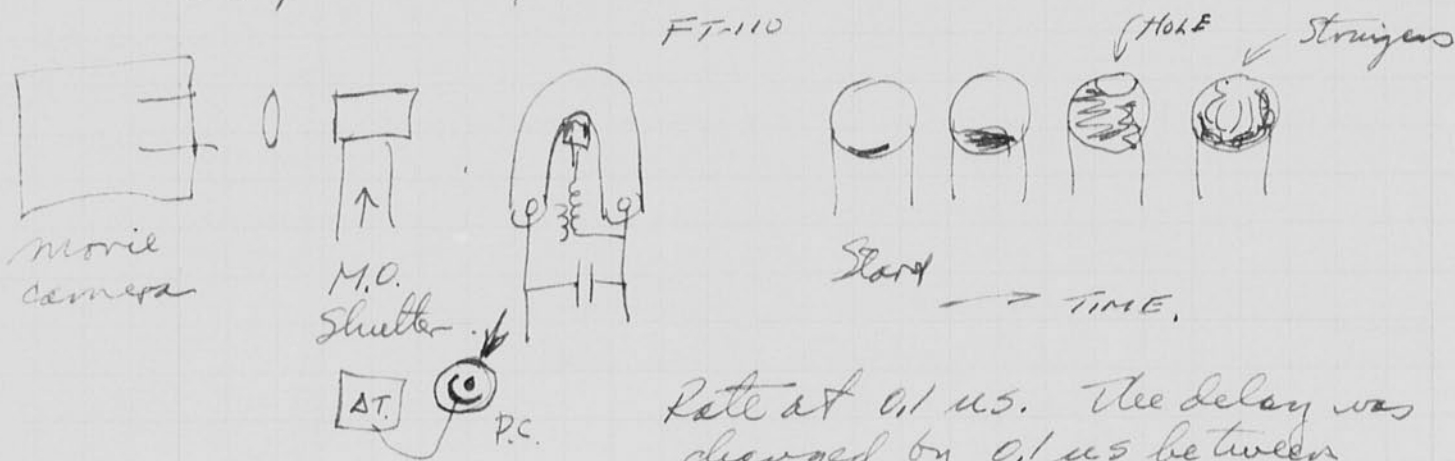
Yes can tip
prevent tip of
camera.

March 27, 1955.

Harold Edgerton

Nottingham's electronics conference was held last week. I gave a short paper showing the stroboscopic light output. Two things were emphasized (1) the light output just after the current ceased and (2) the bumps caused by the increased pressure when the compression wave reflected from the wall.

Geo LeCompte showed some motion pictures of the growth of an arc in a FT-110 tube.



Rate at 0.1 μ s. The delay was changed by 0.1 μ s between shots.

March 29, 1955
H2

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

Bill Hoy 2279 phone wind tunnel called
BH Lamp 4500 23 mfd. 231 W.S.
2885. 2000 0.75 mfd. 225 W.S.

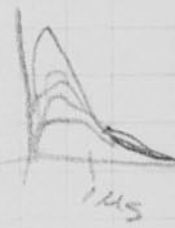
He used a 6" circle for his photography in his schlieren set up.

With a 35 mm camera he could use less light say $1/10$ or $1/2$.

Suppose 1 W.S. is acceptable then at 20 per sec power = 20 watts.

$$\text{Let } RC = .01 \text{ sec. } R = \frac{.01}{C} = \frac{.01}{.5 \times 10^{-6}} = \frac{10^4}{.5} = 20,000 \text{ ohms}$$

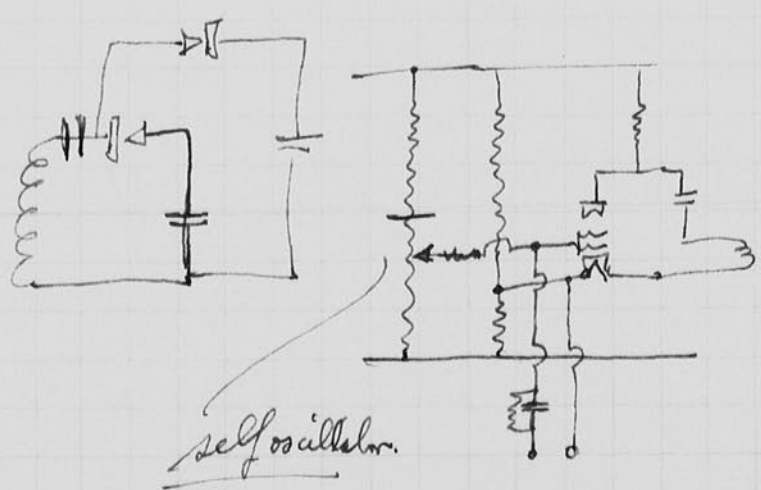
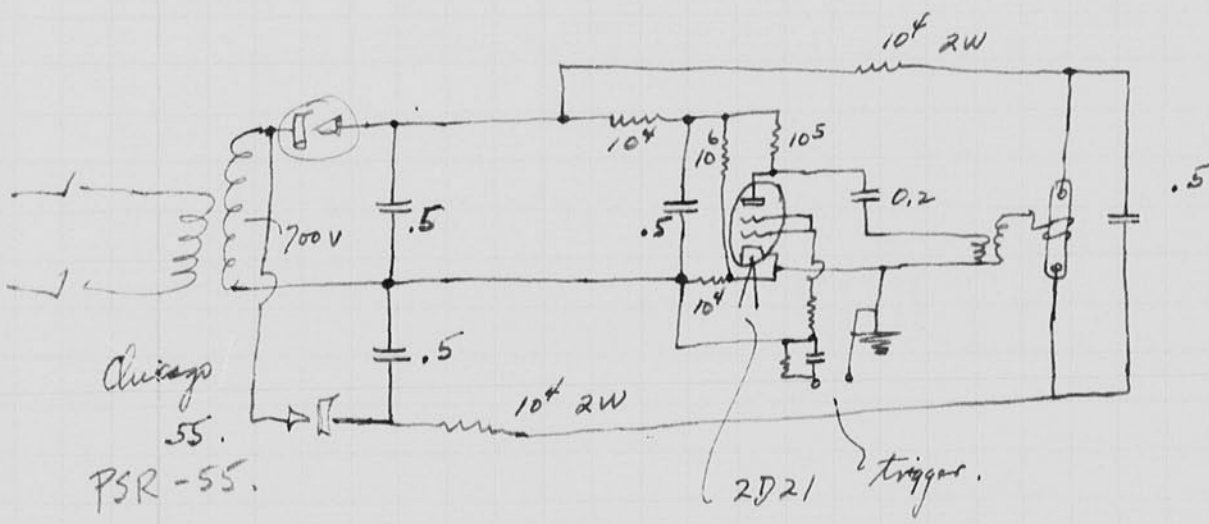
| f | V | C | $C\sqrt{f}$ | Power $C\sqrt{f}$ wall | R. | Comments. |
|-----|---|-----|-------------|------------------------------|-----------------|--|
| 30 | 2 | 0.1 | 0.2 | 6. | 10^4 | Runs ok continuously. |
| 60 | 2 | .1 | .2 | 12. | 10^4 | Self flashes when hot. Does not run at 60 continuously. |
| 24 | 2 | 0.5 | 1. | 24 | 10^4 | Double flashes after 20 or 30 sec. |
| 24 | 2 | 0.5 | 1 | 24 | 5×10^5 | Better than above, ok 20 sec ±. |
| 60 | 2 | .05 | 0.1 | 6 | 5×10^5 | ok But light is <u>variable</u> |
| 240 | 2 | .01 | .002 | 4.9 | 5×10^5 | ok but jittery light intensity |

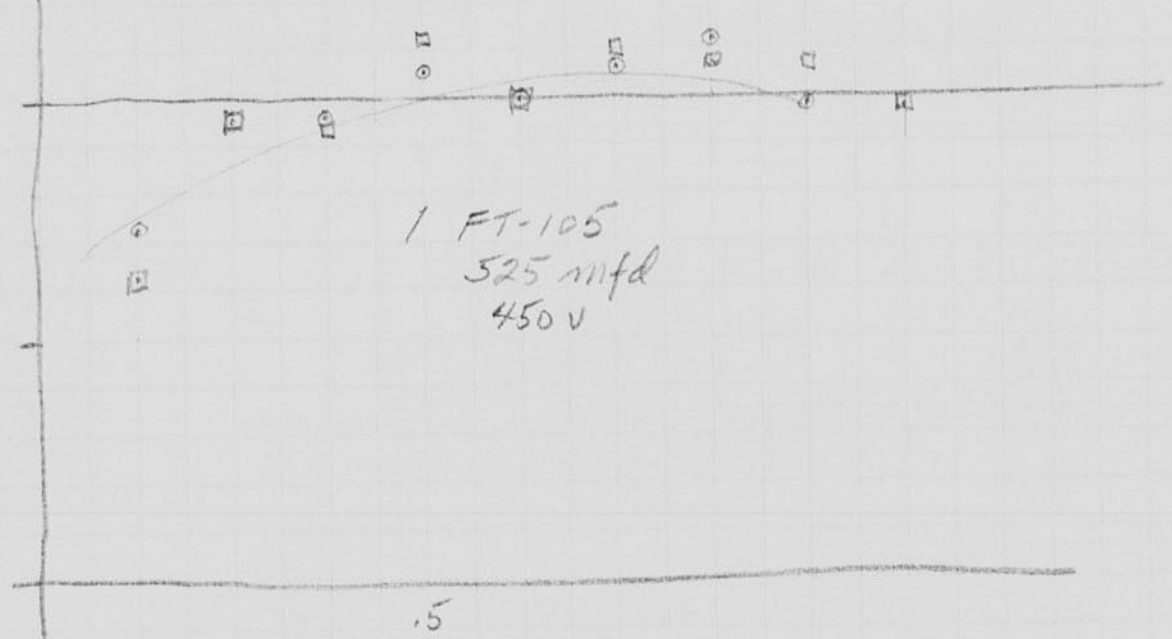
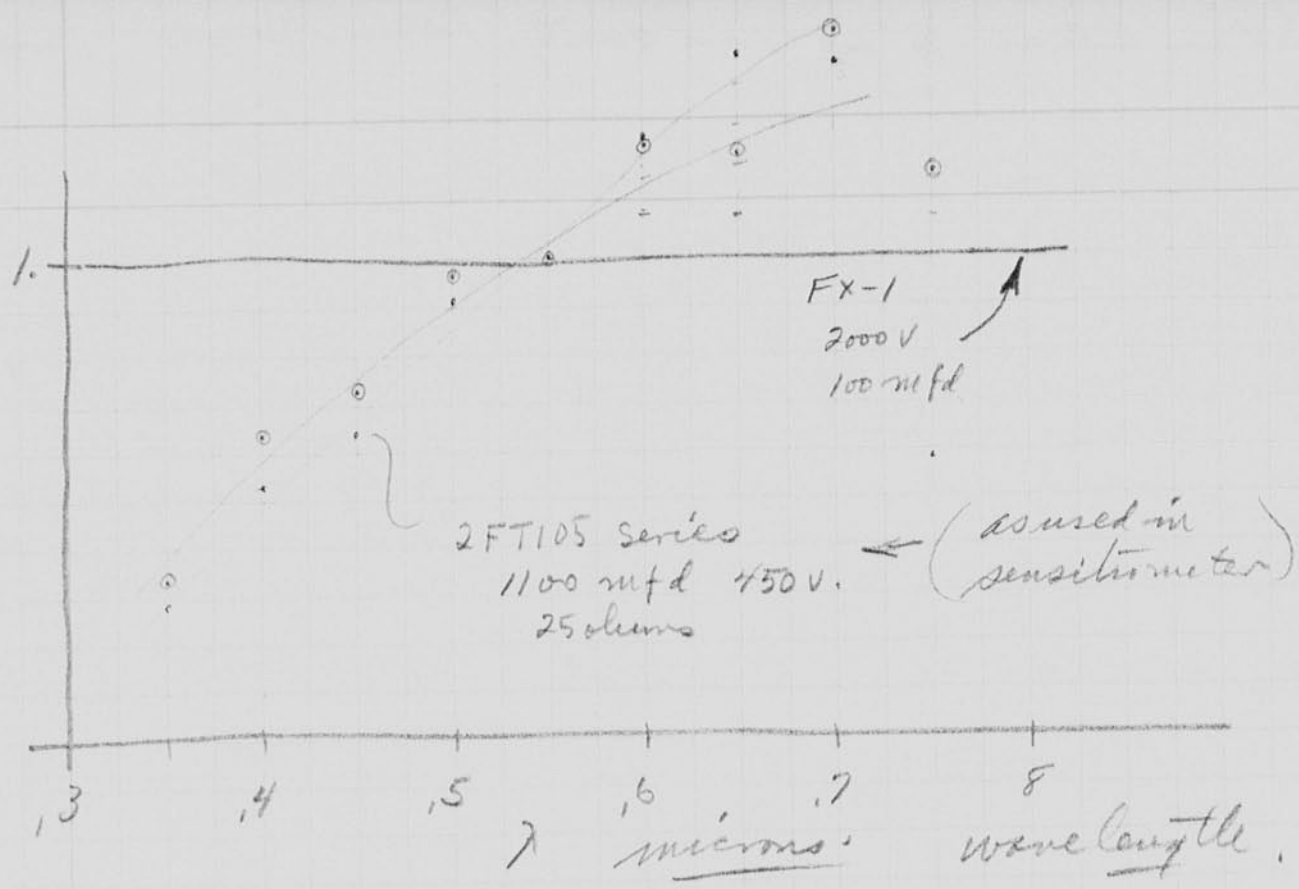


Light in capillary looks uniform
the light in the end zones is jumpy.

Ends shielded with clips - seems better.

60 2 .04 ok continuously.





Liquid Cooled tube.

Quantity lamps. 1/4" gaps 1mm diam xenon.

WS/flash V

C

f.

1. 2000 volts, 0.5 mtd at 10/sec. ok continuous.

1. " " " 30/sec. ok. 30 sec at ~~30~~ 30 flashes/sec.

Old work machine

C

I

25 FX-2 flash tube. .04 .445 diam.

120 volts.

25

.01 .445

85 volts.

25

.02 .445

100 "

 $\frac{100}{.445} = 200 \text{ amp}$

3000

25 1/4 gap 1mm. 25Ω .01 .445

55 v.

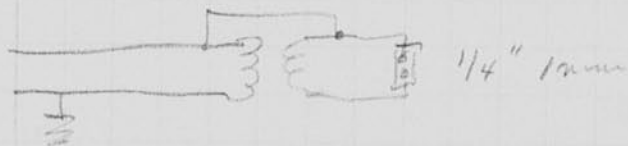
25 1/4 gap.

12.5Ω .01 .445

95

1/4"

5Ω .01 kicks out circuit breaker.



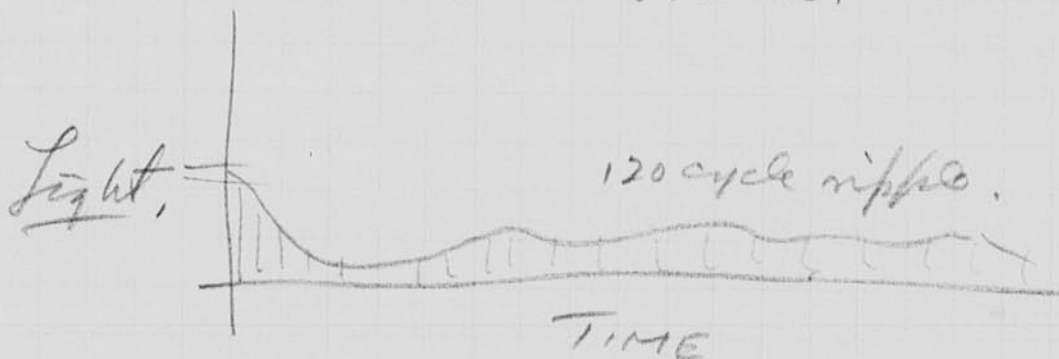
FX-2 .01

22.5 volts. at 2 ft. (2000)

35.

Transformer is best.

Ran with .01 to 12 Kc.



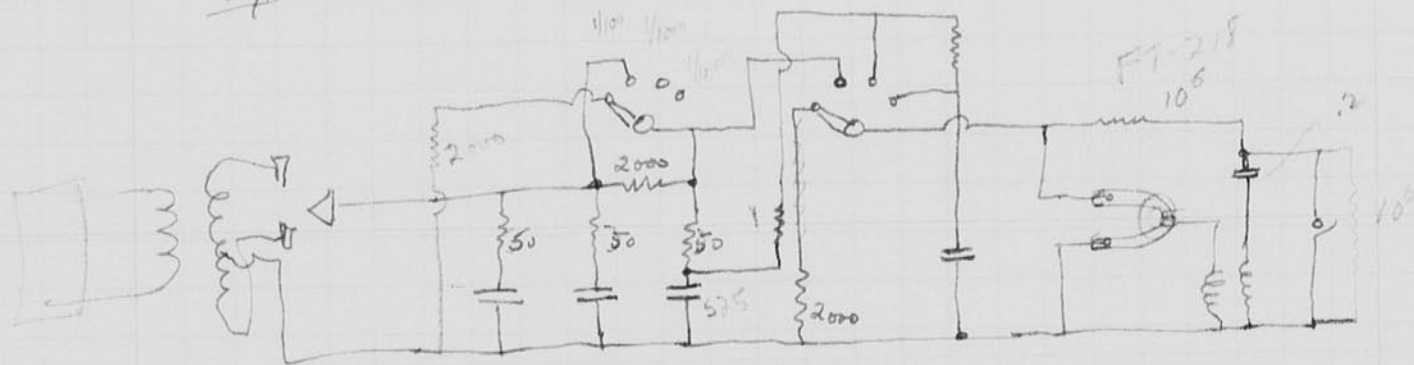
*Deetz
Kinsman
Watson
Woolsey
Caldwell
Smith
Smyth
Mullin
Baker
Esther*



*March 1955
Party 620 class
and guests student*

*Hartman
Ward
Ward
Brower
Ridman
Pitt
Vance
Ward
Sue
Parkwell
Esther
Caly*

April 9 1955. Fred Barstow does not like the two series flash tubes in the sensitometer as now being made. He suggests one tube with an increase in capacitor size. For example the use of three 575 mfd capacitors. new type circuit



OFF 1/100 1/1000 1/10,000

Test made today with Roy Jaraman show
 1/100 sec. FT-118 1800 mfd 90 or 10 ohms. 450V
 1/1000 sec. FT-118 600 mfd 1 ohm. 450V
 150 μ sec FT-118 40 mfd 0 ohms.
 $40 \times \frac{2}{3} = \frac{80}{3} = 26.6 \text{ mfd}$
 75 μ s FT-118 38 mfd paper.

April 15 1955
Harold Edgerton

Sensitometer tests.

tube changed to ~~FT-23~~ FT-118.

G.R. light meter.

| | | | |
|----------|-------------|-----------------|-----------------------------------|
| 1050 mfd | 25 Ω | 12,000 μ s. | 1600 640 45 |
| 525 | 0 | 900 μ s. | 640 |
| 40 | 0 | 120 μ s. | 20. |

935 photo cell at film position. 1200 ohms. w/television scope

(40 mfd. 20 volts \times 3 = ⁶⁰ peak light. 60V
40 \times 30 = 120 microseconds.)

525 mfd. .33 \times 3 = .99V
25 Ω 9 \times 30 = 15,000 micro sec

1000 mfd. 37 \times 6 = 222 volts. peak.
2.3 \times 30 = 690 μ s.

WM. Circuit changed.
1ohm added to 525 mfd
25 changed to 12.5 or 1050.

525 1ohm. 4.1 \times 300 = 1200 μ s.
150 volts.

1050 12.5 Ω . 3 \times 3000 = 9000 μ s.

Oscillograms taken of 3 conditions above.

Light Readings

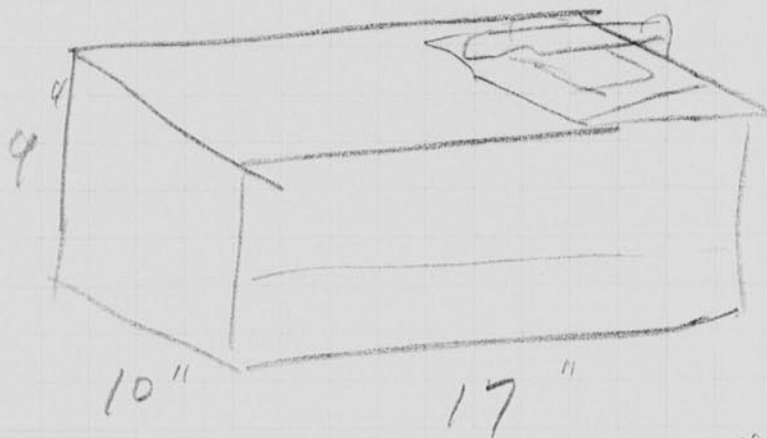
| | | | |
|-----------------|--------------|------|---------------|
| 110 \times 4 | one diffuser | 1050 | 1 Ω |
| | same with 2. | | |
| 120 \times 1. | | 525 | 12.5 Ω |

Final conditions

| | | f.c.s. | D. μ s. | Peak V. | peak light |
|----------|---------------|-----------------|-------------|---------|------------|
| 1050 mfd | 12.5 Ω | 120 Light meter | 9000 | | |
| 525 | 1 | 440 | 1200 | 150V | 0.1 |
| 40 | 0 | 20 | 120 | | |

Overall size.

1/100 112 120 120
 1/1000 105x4
 1/10000 15 16 15



Regulation.
 Input Light.

| | | |
|-----|-------|-------------|
| 100 | 103x4 | .01 setting |
| 105 | 103 | 30 sec |
| 125 | 112 | red dye |
| 130 | 114 | |

Model IV

Sally Lunt.

Miss Rockwell
 Jack Brown

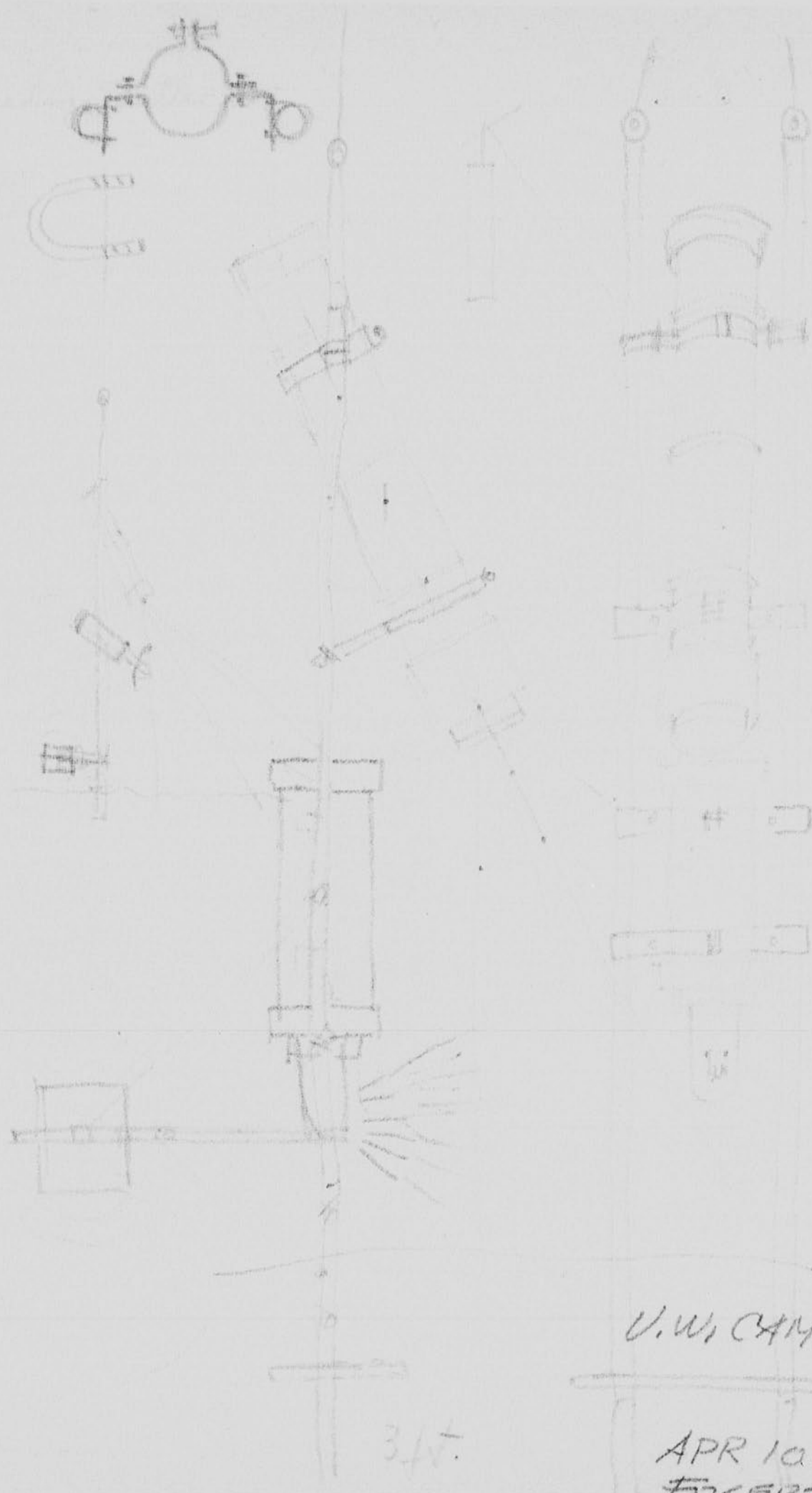
Van Bergen.

Joe Vaccaro



52 Birthday party April 6 1955.

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U.W. CAMERAS

3/4

APR 10 1955
EDGERTON

Page 13 tests.
Page 26 tests.
Page 35. Calc.
Page 113 calc for AEC tests.