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.

#22

Harold E. Edgerton

Jan. 9, 1954.

M.I.T. 20D102

Cambridge, Mass.

Sparker. 21.

Sonar-Pinger p19
43
45

Bathyscaphe Camera p 8. Nov 2 1953.
Bathyscaphe Hunt & Wilson p 27 Nov 1954
Bathyscaphe camera. p 94

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

COMPUTATION BOOK

GENERAL INSTRUCTIONS

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

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

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

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

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

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

* * * * * * * *"

TECHNOLOGY STORE
HARVARD COOPERATIVE SOCIETY, Inc.
40 Massachusetts Ave., Cambridge 39, Massachusetts

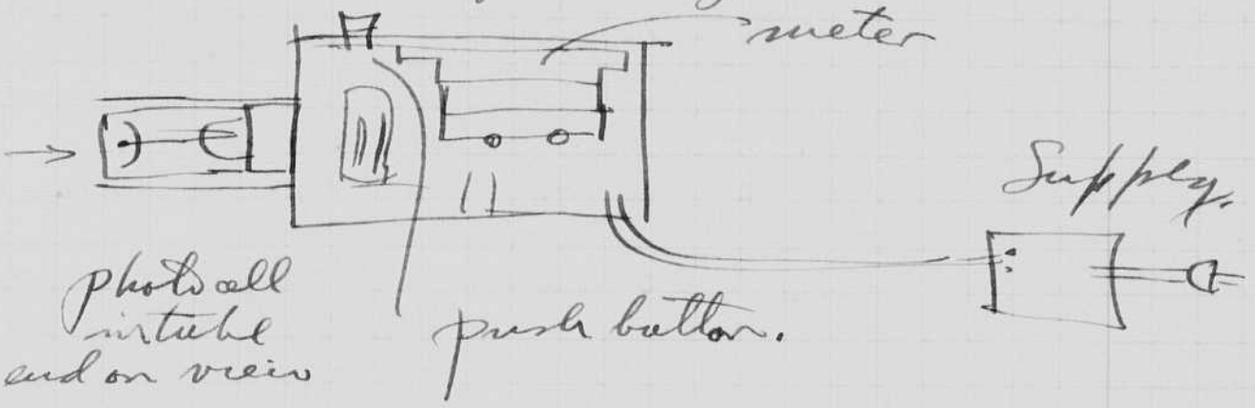
Jan 9 1954
Harold E. Edgerton
M.I.T. 20D102 camb. Mass.

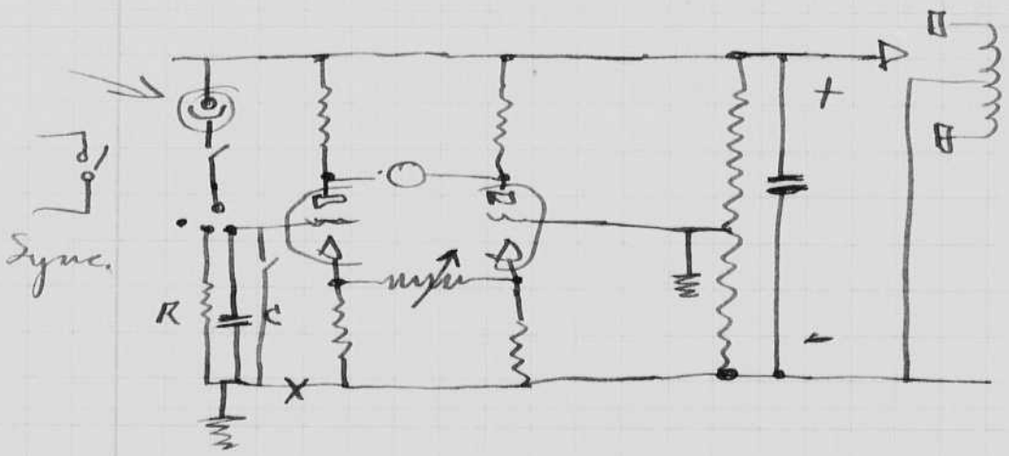
Light meter

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

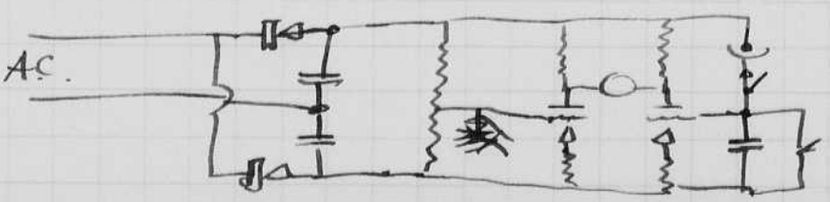
The vacuum tube circuit will probably be a twin triode circuit of conventional design.

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 on each of two lamps.

reflector factor of 15 or 20?

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

$n = 3.0 =$ C.P.S $= 600$ c.p.

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

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

$= \sim\!\!80$ 250.

Guide number 250
Lamps at 40 feet.

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

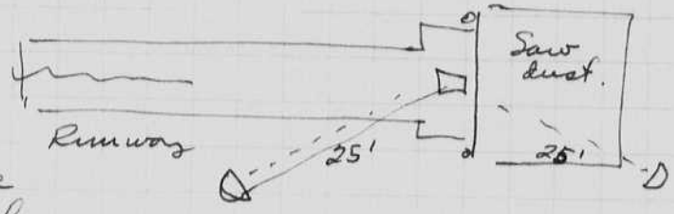
Calypso Jan 11 letter from Dugan

Jan 8 1953

Harold E Edgerton.

Pole vault photos of the Boston Garden Jan 6
with cameras of Richardson Lab.
14'6" 14'9"

Two lamps were used each with 25 mfd at 4 KV.
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 paces.

~~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 last row in the front section just forward of the main walkway.

FX-1 efficiency at 2000 volts 100 mfd.

4.2 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, Rodger Leavitt. Discussed a copy unit. Suggested 12 inch FX-1 tubes with cylindrical reflectors.

afternoon - Julian Webb Jack Tupper. Made sensitometric experiments with electronic flash on Plus x and Ektachrome films. (Freshmen).

Bob's roommate. Harley

Dinner with Bob at Todd Union at Rochester Univ. 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 Saltzman since Saltzman 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 focusing modeling lamp system is badly needed. Would be willing to pay $100 for 1000 watt continuous operation of FT-623. Not 2000.

I then saw Dr. Brader of the N.Y. Museum about fish photographing. Bill was there also. He is now a junior at Columbia!

Next we went to the Broadway theater and watched Mili, Nadler, and Bob finish up a photo job ~~at~~ 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.

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 Miraldi came in to discuss the problem. I offered to loan him my shutter exploder as used a 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 miraldi's requirements.

The O.K. to go ahead on the job came in last week from the Nat. Fireworks.

Miraldi 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 Edgerton

made test of La cathode - in carbon cylinder. Arc strikes to carbon and 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 atmospheres of xenon gas was used for firing.

Wednes Feb 3, Mirarchi and Dr. Rowe and Bischoh 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 1/2" length which vaporized.

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

tube dimensions 3/8 Vycor O.D.
57" long.

See page 151
N.B. 21

Tube resistance = 9 ohms (calculated)
C = 600 mfd
V = 6000 volts.
peak current = 6000/9 = 670 amps.

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

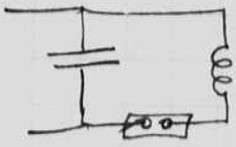
~~Neglect the tube resistance.~~
Tube resistance of 3/8 tube 1/2 inch long
calculated.
6" tube has 1 ohm
1/2" tube has 1/12 ohm = 0.083 ohms.
Say about 0.1 ohms.

Feb. 9, 1954

Harold E. Edgerton

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

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



Minimum starting voltage = 1000

$C = ?$

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

Let $C = 500$ mfd.

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

Solve for L. $L = 4 \times 500 \times 10^{-6}$

$= 2000 \times 10^{-6}$ henries

$= .002$ henries.

Oscillatory criteria $T = 2\pi\sqrt{LC} = 2\pi\sqrt{.002 \times 500 \times 10^{-6}}$

$T = 2\pi\ 10^{-3} = .006,28$ sec.

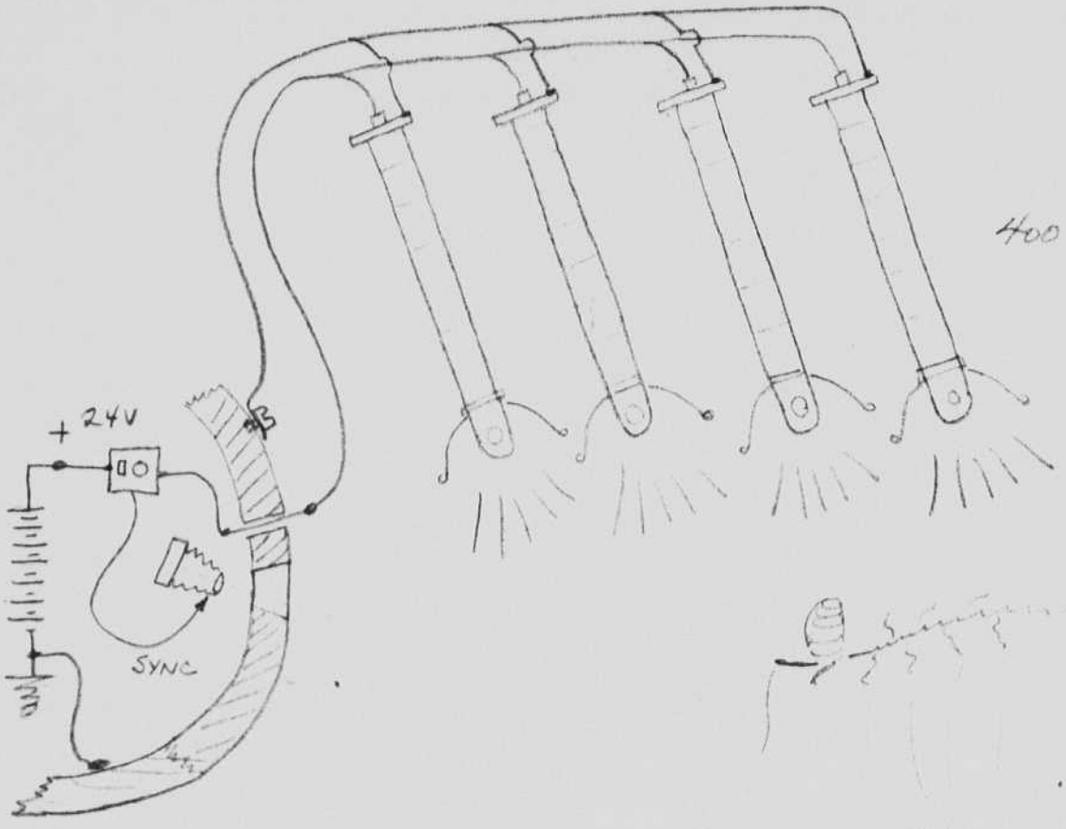
$\frac{R^2}{4L^2} = \frac{1}{LC}$

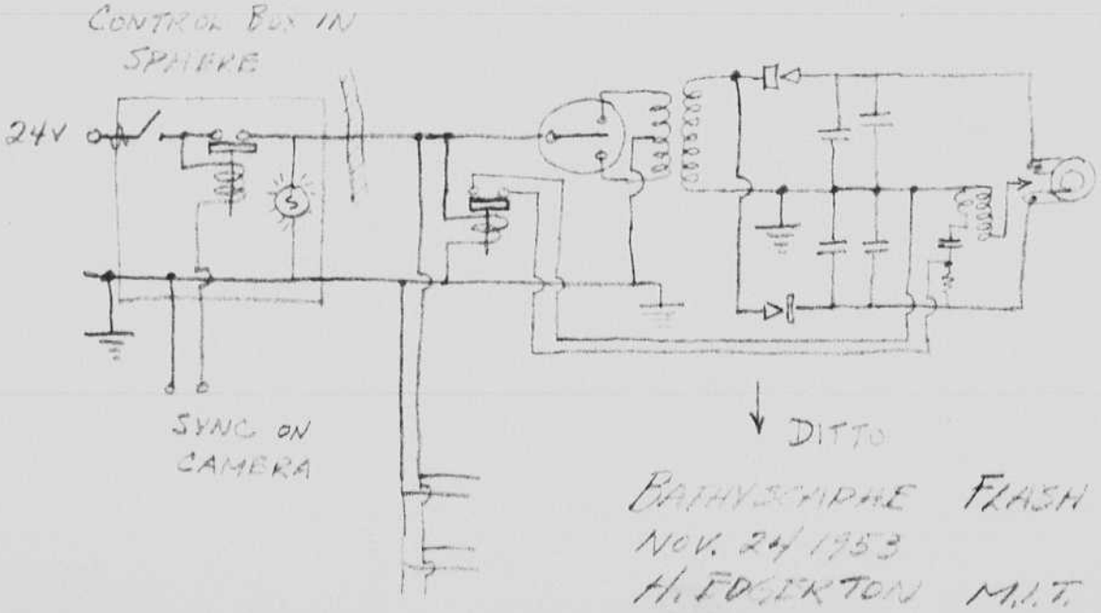
$R^2 = \frac{4L^2}{LC} = \frac{4L}{C} = \frac{4 .002}{\sqrt{500 \times 10^{-6}}} = \frac{8}{.5\ 10^{-6}} = 16 \times 10^3$

$\frac{.008.}{.500. \times 10^{-6}} = 16^2$ ohms. seems high.

$R = 4$ ohms.

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





BATHYSCHPHE FLASH
NOV. 24 1953
H. EDGERTON M.I.T.

March 4, 1954.
Harold Edgerton

Very busy with lamps for Bathyscaphe. Crushed one container at Woods Hole with 8200 #/sq inch. Extra heavy 3" pipe. 2.9" I.D.

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

March 6 1954

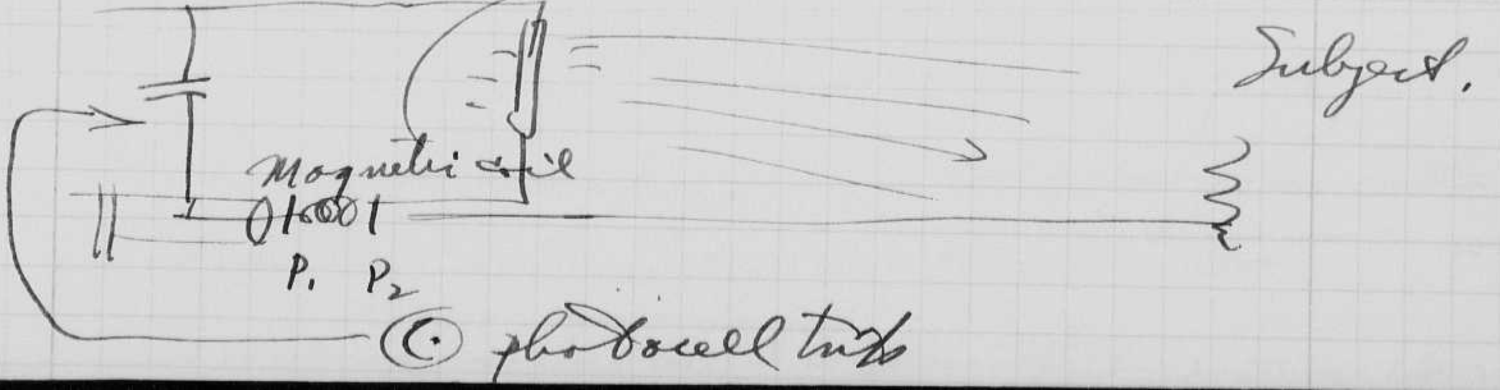
Sultanoff Aberdeen gave a talk Mar 4 evening on speed photography. McPherson – machine co. Beatty from W.F. was here also that day.

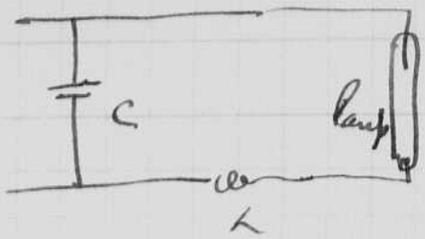
I left on Federal that night for Washington. Meeting on the 5th at Washington with Cousteau, Smith, Dugan, etc Research Committee. Cousteau described the bathyscaphe dive off Toulon. This was described in the French paper ~~Figarea~~ Figaro in a series of articles in December.

Plans were made for a July meeting at Dakar with the bathyscaphe 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. He wants an arc alternator 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

$I_{max} = E/R =$

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

Required by subject.

Lamp R = 5 ohms.

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

= 4000 microfarads.

Peak current at 900 volts.

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

Rudberale. SMPTE of pr 1951 p 398. Dy & Wyckoff.

$\theta = Al\mathcal{H}$. $\quad \mathcal{H}l = \frac{\theta}{A}$. $\quad A = .0647$ min/oersted. Chem Handbook.

$W = \frac{1}{2} L I^2$ $\quad L = N^2 d F$

N = turns

d diam of coil in inches

$F = .0071$ for $l/\text{diam} = 3$.

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

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

$\mathcal{H}l = \theta/A. = \frac{4\pi}{10} NI$ gilberts.

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

Now let $I = 200$ amperes.

$\theta = 90°$ degrees $= 90 \times 60$ minutes.

$= 5400$

Solve for N.

$N = \frac{I}{\theta} \frac{4\pi}{10} A = \frac{200}{5400} .007 \left(\frac{10}{4\pi}\right)$.

$= \frac{\theta}{A} \frac{1}{I} \frac{10}{4\pi} = \frac{5400}{.007\ 200} \times 1 =$ 38.

$= 380$ turns.

More current needed $I = 1000$ amps.

$N = 70$ turns.

if I 2000 amp = 35 turns.

Try FT-17A flash tube 573 mfd. 4 KV.

Current peak = 1600 amperes.

Light peak. = 275×10^6 lumens peak.

$\frac{275 \times 10^6}{5^2} = 10 \times 10^6$ lumens/sq foot.

Exposure $= 10 \times 10^6 \times 100 \times 10^{-6}$

$= 1000$ lumen sec/sq foot.

4000 frames/sec. Tastax.

$\frac{1}{4000} \times \frac{1}{3} = \frac{1}{12000}$ sec $= 100$ μs.

B2W needs less than this! + Polaroid filter $\times 1000 = 1$ lumen sec/sq ft.

A.S.A.
Z 38 2 6 1948.

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

foot candles sec.

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

S = 100 for Super XX

Proposed setup for test.

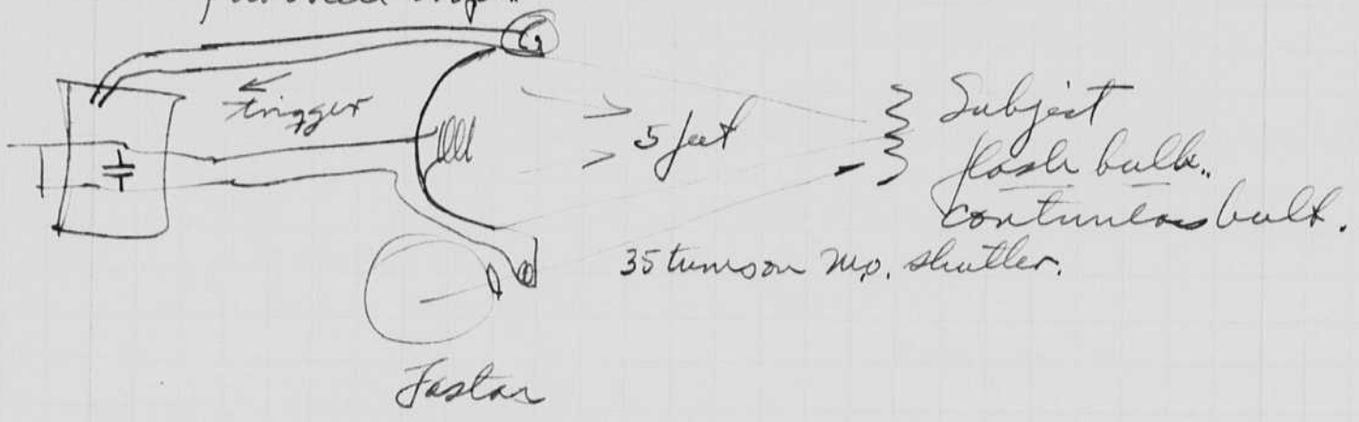
Coil turns = 35

C = 500 +

Lamp FT-17A.

V = 4000

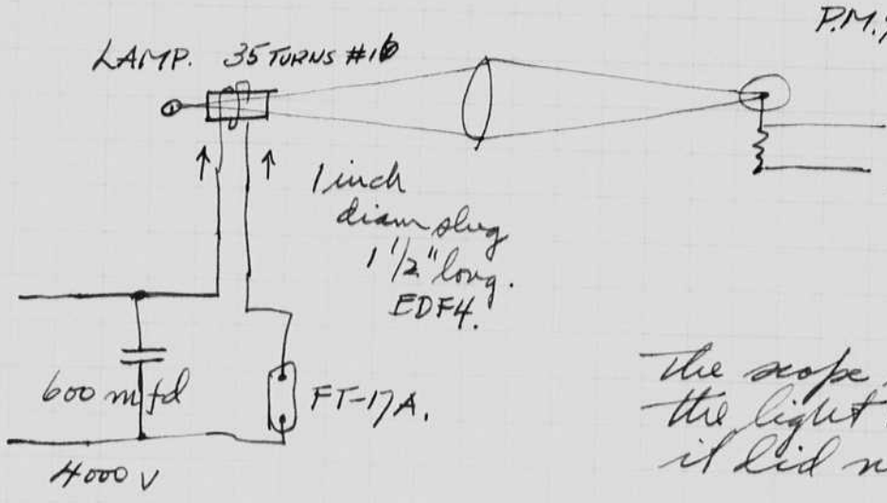
photocell trip.



March 8, 1954.

Harold E. Edgerton

On Sat I set up the experiment below.

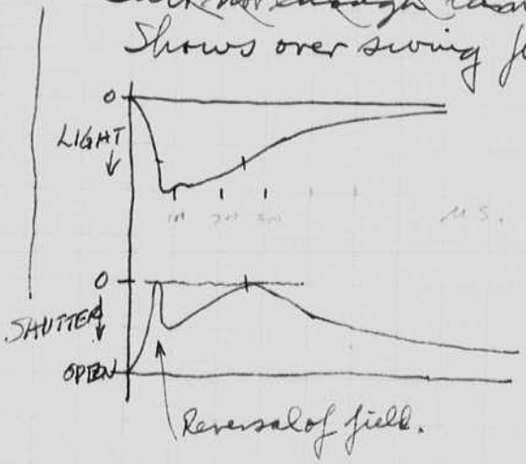


the scope showed that the light was cut off but it did not go to zero.

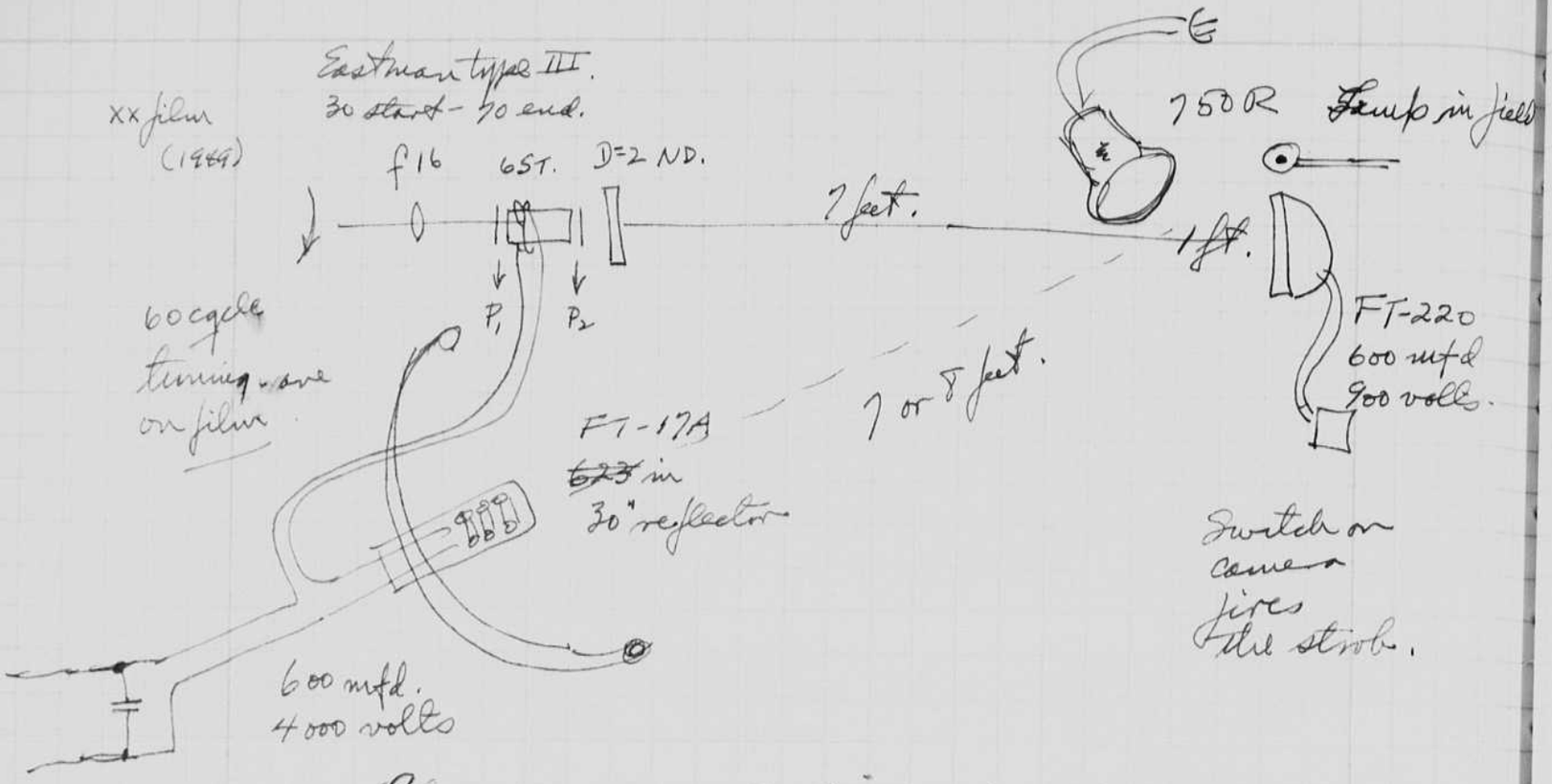
The arc will need a filter of about 3 to cut it down.

Today a new coil of # 18 solid wire was wound the turns are about ~~300~~. 60 to 65.

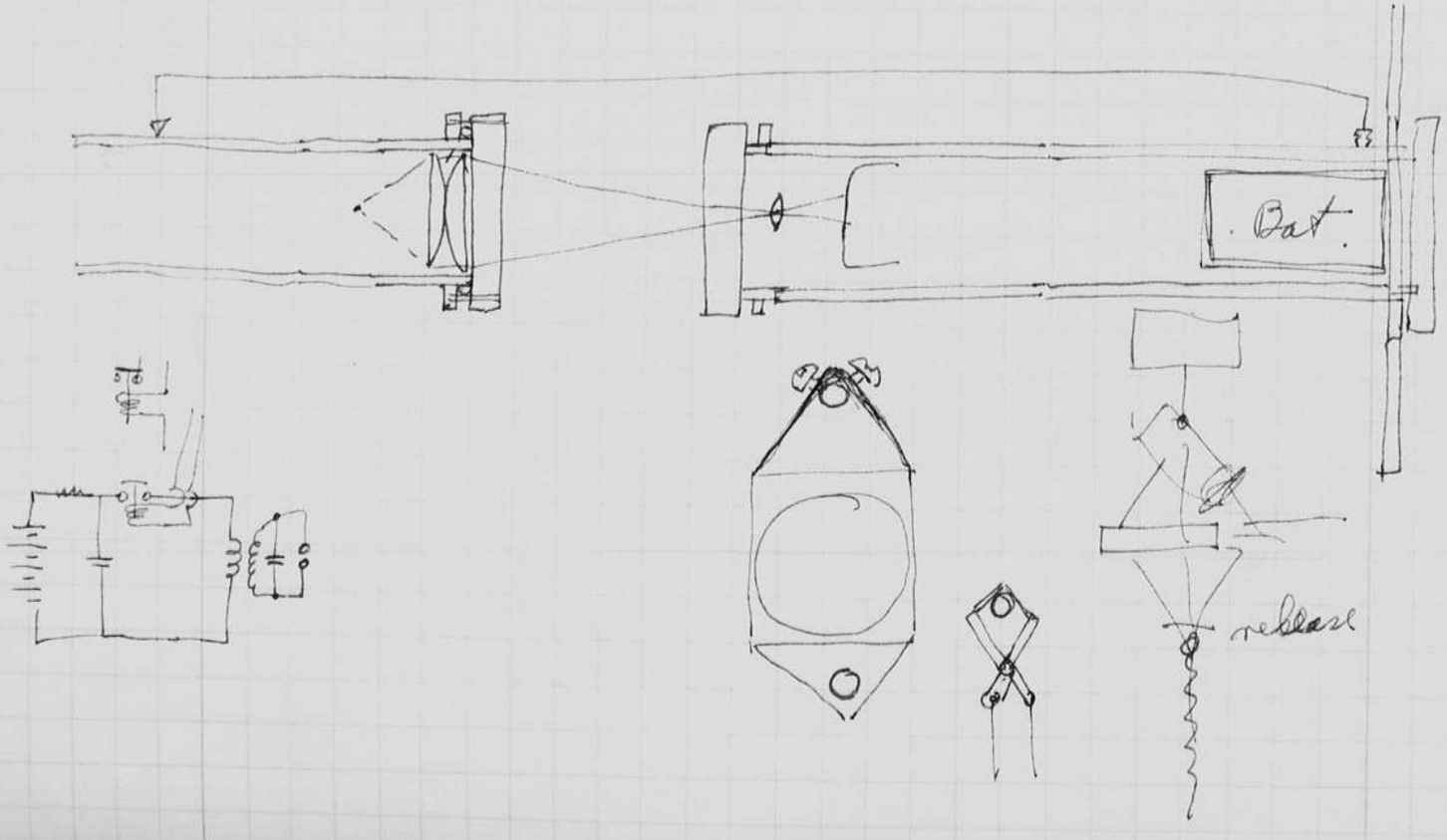
~~Still not enough turns!~~
Shows over swing for 4000 v 600 mfd.



See next page for movie setups.



Film mailed to Rochester for development.



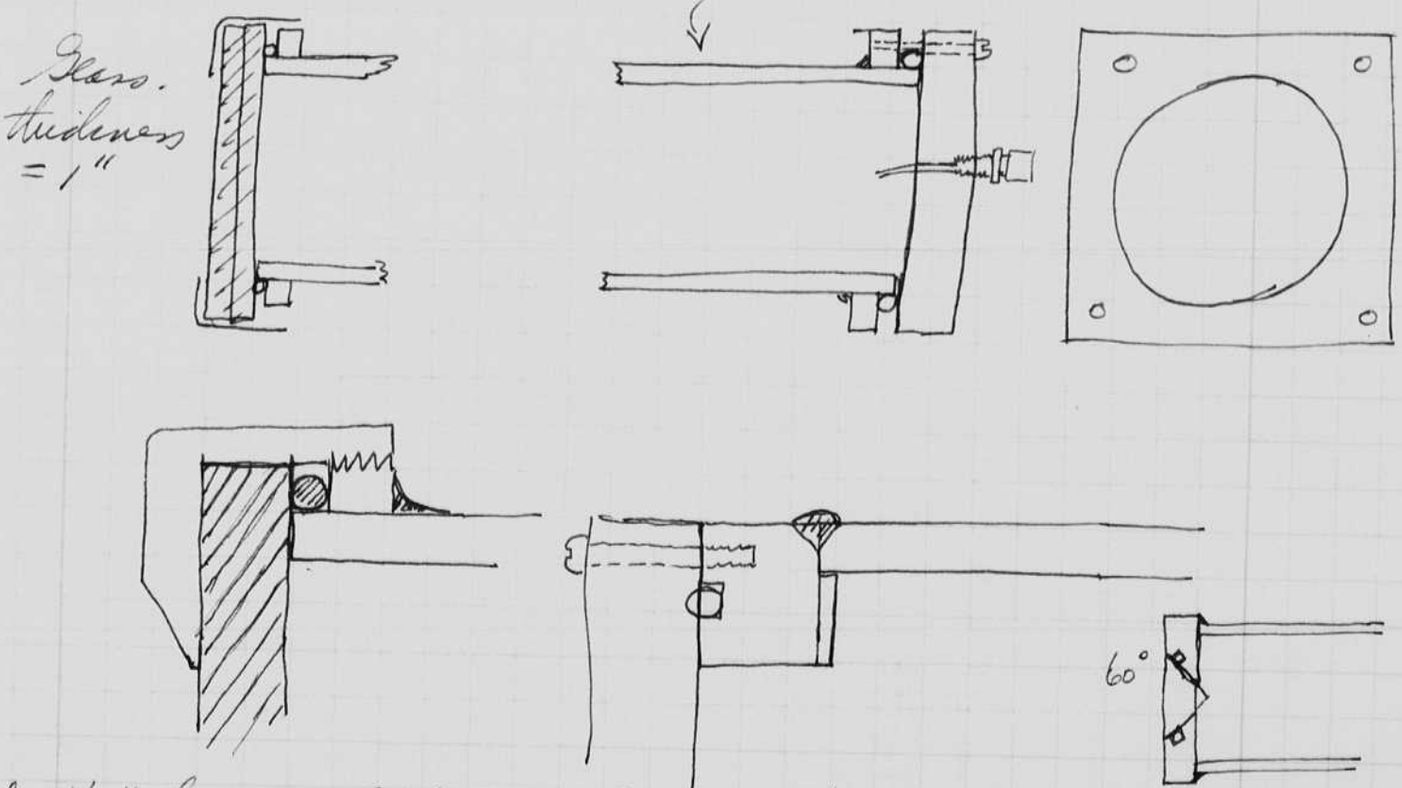
Mar 8 1954
Data from Lloyd Hoadley.
Harold E Edgerton.

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

Depth ft.	P.S.I. 1000	1" diam	4" diam
4000	2.	.0595	.238
12,000	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.

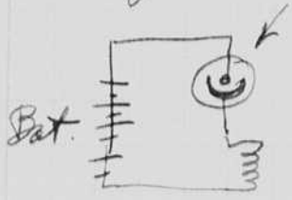
Endcaps .375 5000



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

Harold Edgerton
March 10, 1954. Ballistic light meter for strob.

I have been considering the ballistic meter method of measuring the light for electronic flash. The Weston meter people say that 10 mu 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 mu 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.

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

lumens sec on the cathode.

Assume 100×10^{-6} exposure time.

$L \times t = .167$

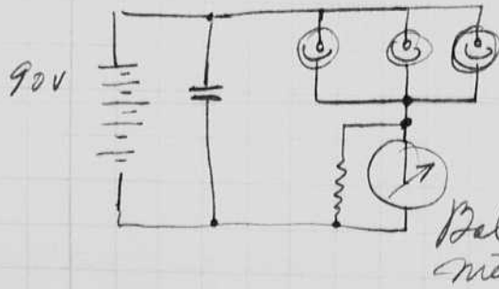
$L = \frac{.167}{100 \times 10^{-6}} = .167 \times 10^{4} = 1670$ lumens.

with $t = 1000 \times 10^{-6}$ $L = 167$ lumens

$= 10{,}000 \times 10^{-6}$ $L = 16.7$ 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 cathodes

Should be set for f16. $40 \times \left(\frac{11}{3.5}\right)^2$

$\left(\frac{16}{3.5}\right)^2 = 15^2 = 225$ $\quad 40 \times \left(\frac{16}{3.5}\right)^2 = 209 \times 40 = 835$. lumen sec / sq foot.

the 929 with a 0.6 sq inch cathode.

Limit the time to 1000×10^{-6} sec = .001 sec.

then $\frac{835}{.001} = 0.835 \times 10^6$ lumens / sq foot = 835000 lumens / sq foot.

~~835.000~~ / ~~150~~ lumens max = ~~557~~
first photocell (150V)

150 lumens (929 / 150V) / 0.6 × $\frac{1}{144}$

$150 \times \frac{1}{.6} \times 144 = 36{,}000$ lumens / sq foot on P.C.
allowable with 150V.

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

Need a more sensitive meter!

Limit photocells to 3. then 1/7 as much sensitivity say 0.14 ma sec.

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

~~Lamps~~ Photocells
requiring filter of D = 1
with 400 lumen sec / sq ft. (f11).

Allowable circuit Res $\doteq$ 2000 ohms
with 180 or 200 volts on circuit.

Harold E Edgerton
Mar 12 1954

Yesterday Dr. Donaldson Dr. T
and his Barry brought in
two rabbits for flash experiments on the
eye.

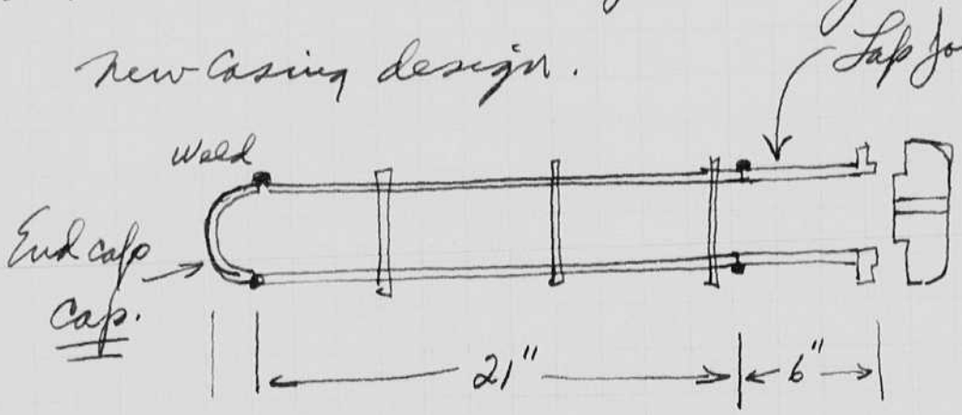
We set up 20,000 watt sec in an FT-618
and a 30 inch reflector. Eye lit at 5 or 6 feet
was 188,000 lumen sec./sq foot.

One flash was given on right eye.
a cloud of smoke arose when the
flash occurred, off the rabbits fur. No
visual effect on the eye was noted, eyes was closed
afterward

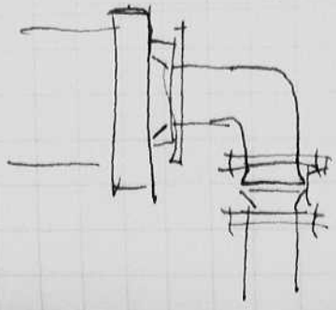
Farmer and ? from Photo world were
here today to make measurements.
Used ordinary plate with I.R. filter,
934, and lead sulfide. Curves of
output, peak, are different with
voltage and watt seconds.

Finished 2 more 200 watt second
lamps for Houot. these were sent to
Dakar French West africa by Pan. 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.

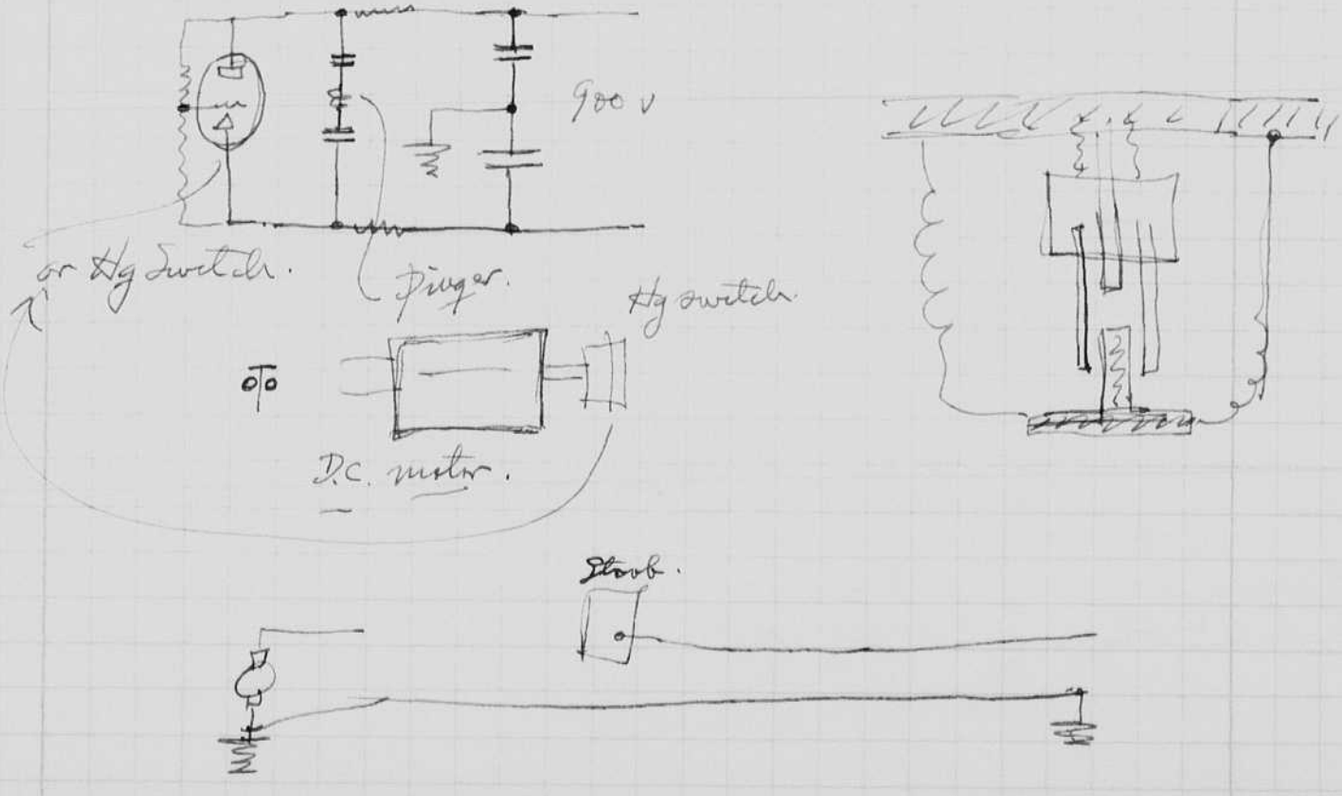
2. Camera makes one big ping when it hits bottom.

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.

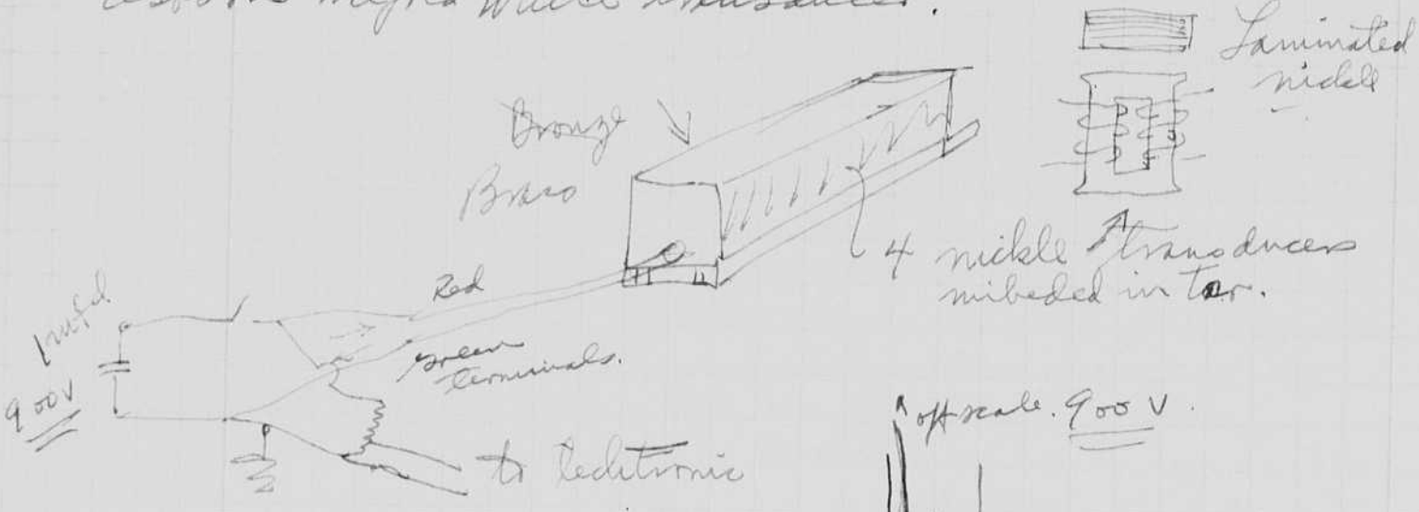
Method no. 2. could also have regular pings at long time intervals - depending upon change to not have two ping signals at once.

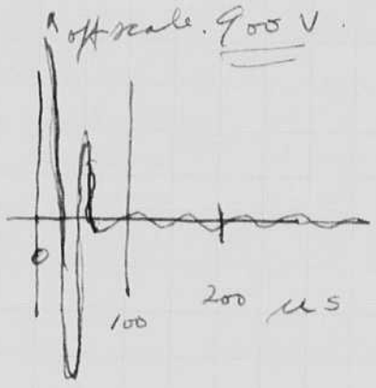
A fourth method would involve a method of resolving the direct and reflected ping from the bottom. The time between would be the height above the bottom.

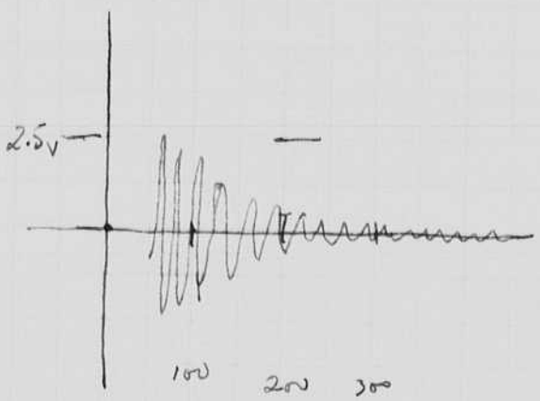


Still a 5th method would be to change the ping rate when the camera was on the bottom. This could be accomplished by a resistance in the motor circuit so that the motor would run at a different rate when on the bottom.

Tests on Wilfred White transducer.





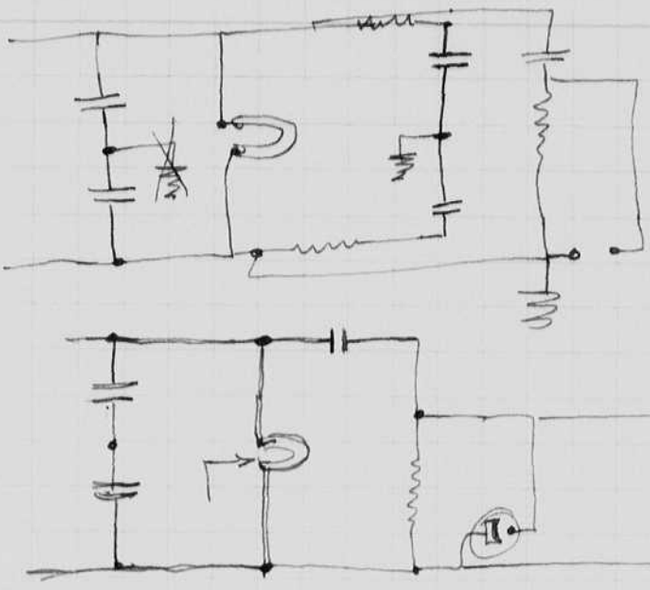


output almost same with .5 or 1 mfd.
1.5 - no sound
2.5 - almost zero?
5. small.

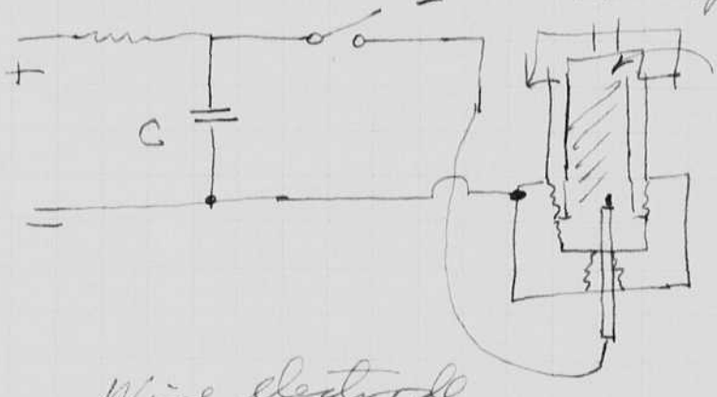
frequency about 30 KC.
Main bang is larger than this.

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

Spark method.



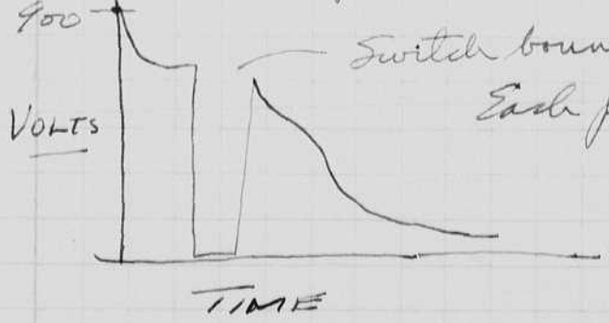
Performance is jittery due to switch(?)



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

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

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

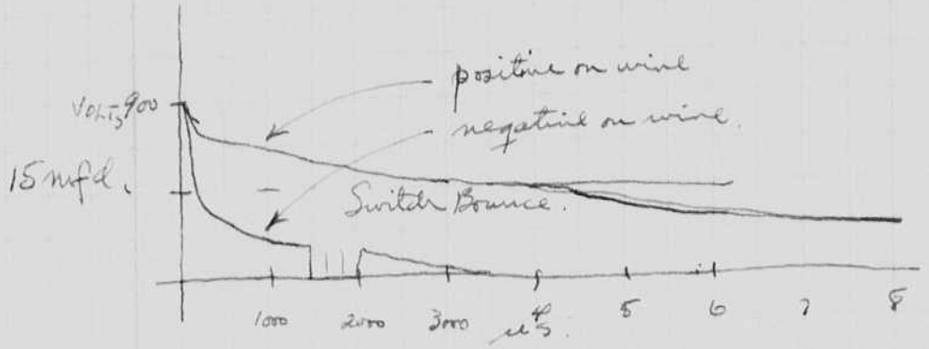


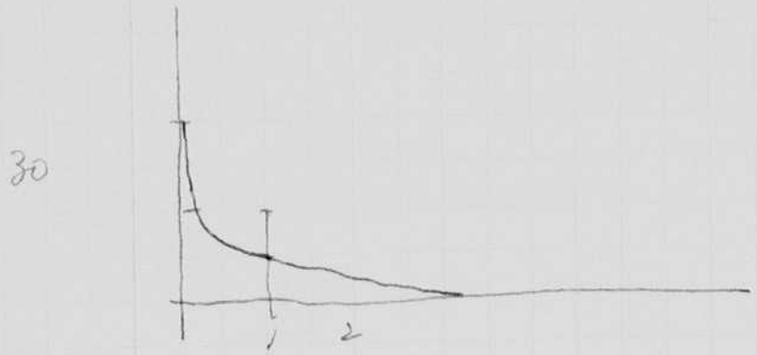
Switch bounce?

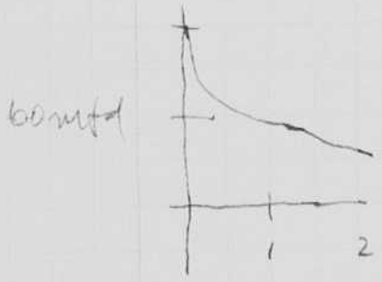
Each picture different due to inconsistent operation.

There is no arc at this level of sparking — and no sparking.

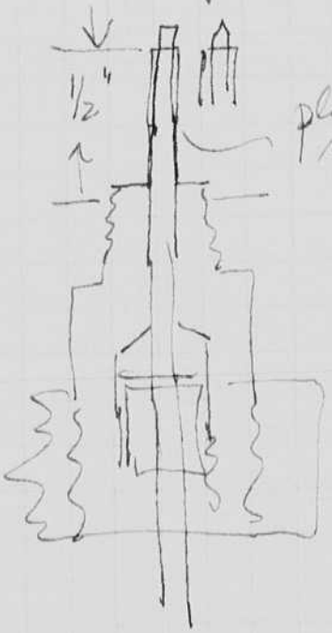
Polarity reversed.
The small electrode is now negative
Discharge rate seems faster and noise is greater.





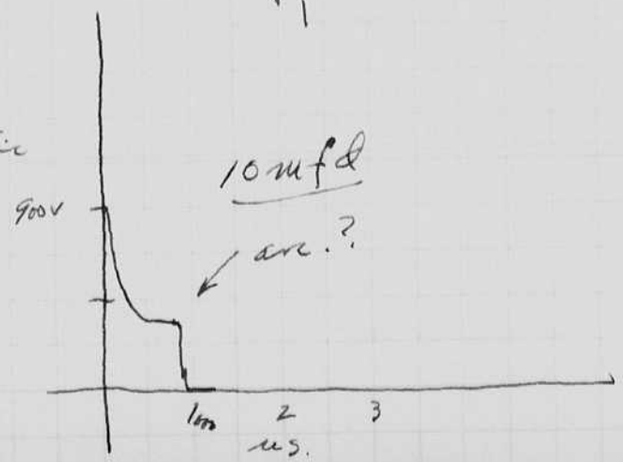


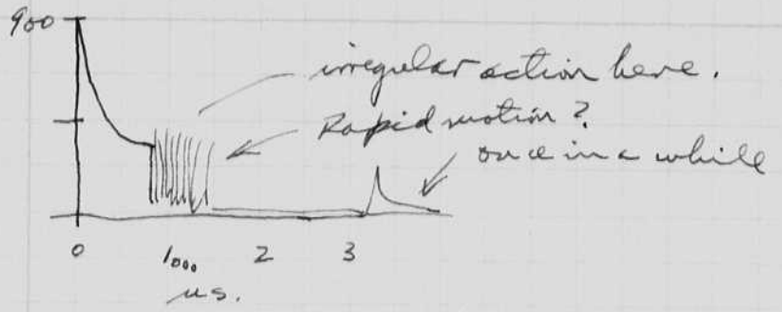
End of copper wire showed some melting on the tip.



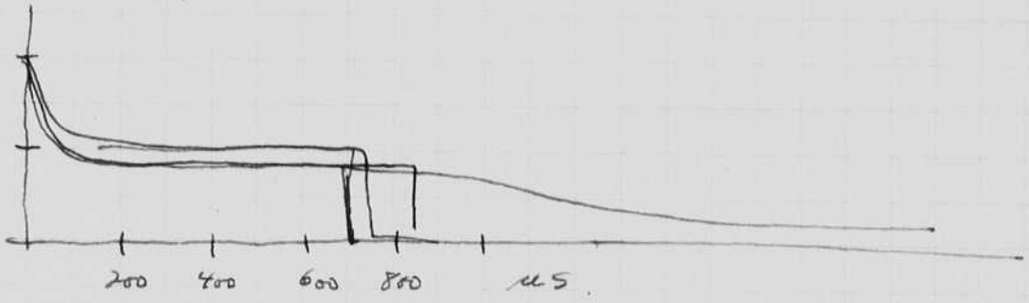
Removed this copper wire and inserted a nickel wire .060 inches with a very short gap to the plate

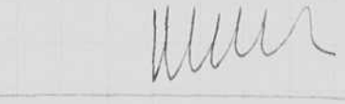
more noise than before.





Sweep speed increased 15 mfd 900 volts.

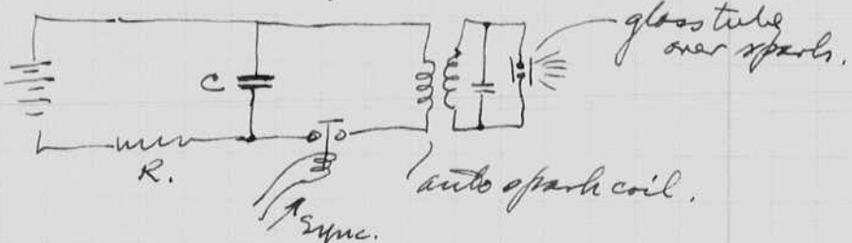




March 18 1954

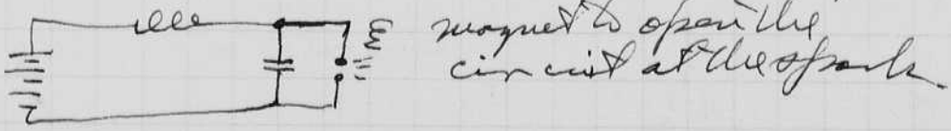
Spark source for silhouette photography under water.

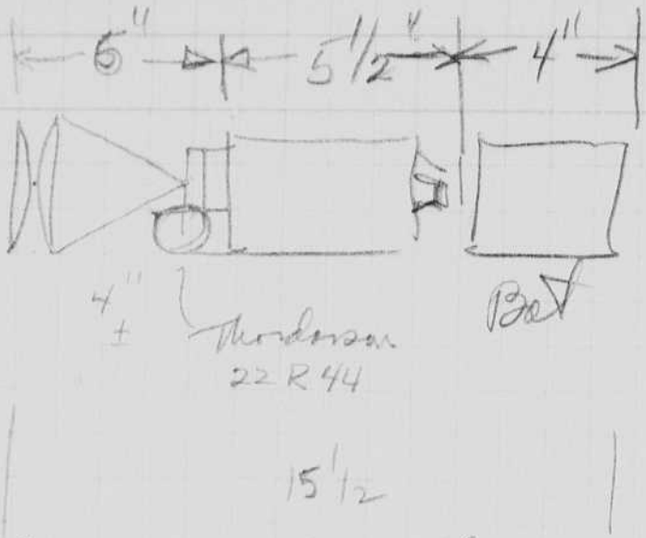
Last summer I used a system as below



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

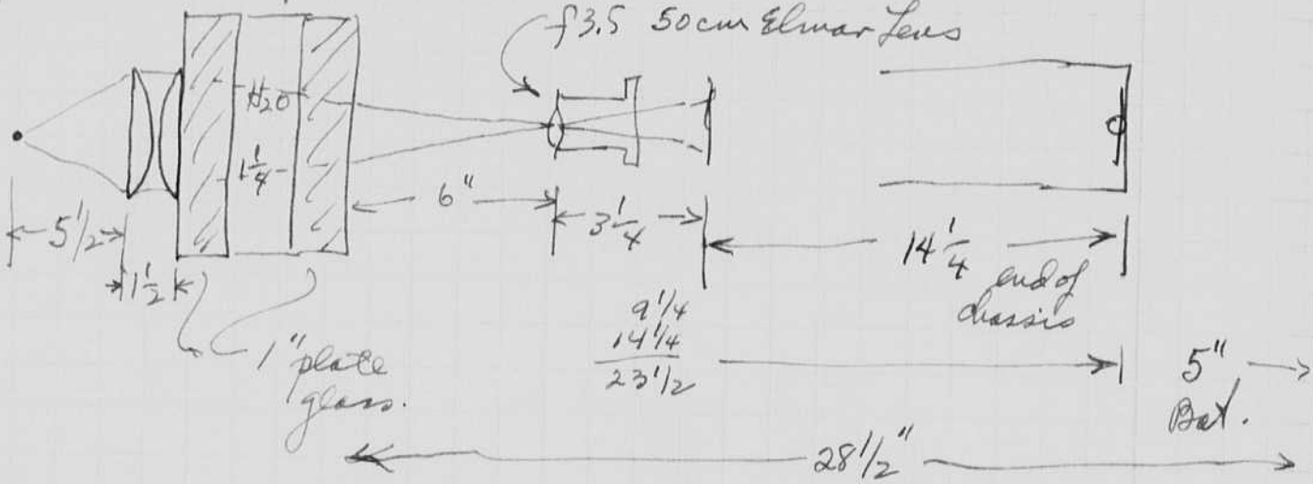
I tried a 6 volt battery yesterday into a model electric coil. This system takes a lot of energy out of the battery. There was a good spark at the contacts in the 6 volt circuit. Possibly this could be used as the light.



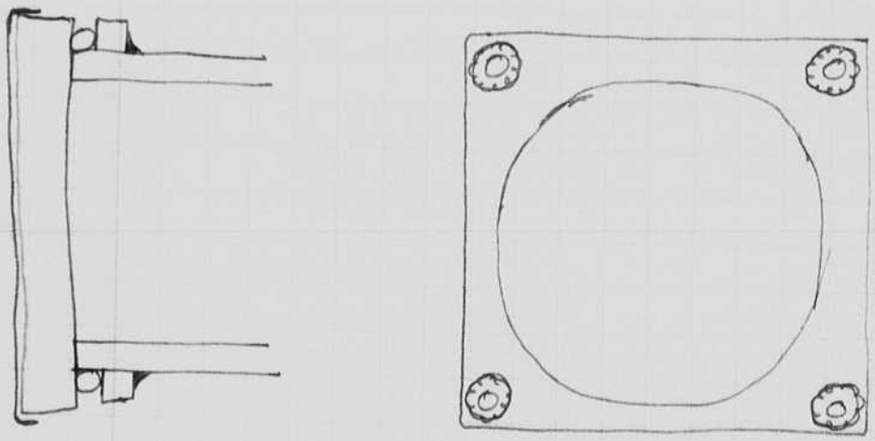


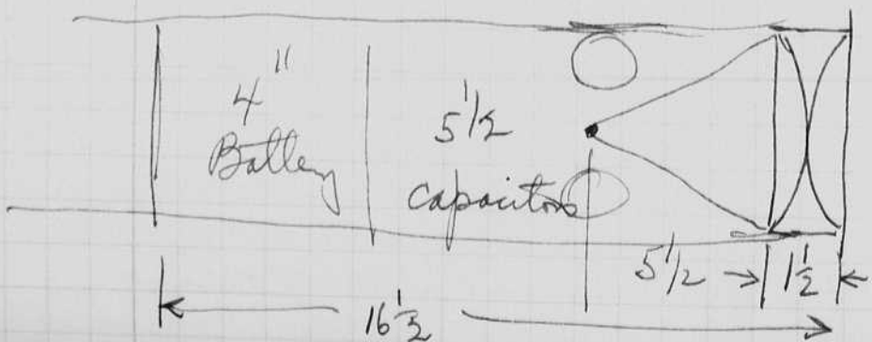
Silhouette camera design.

Continued optical setup for Silhouette camera.



Casing could about 30" long. for cameras.





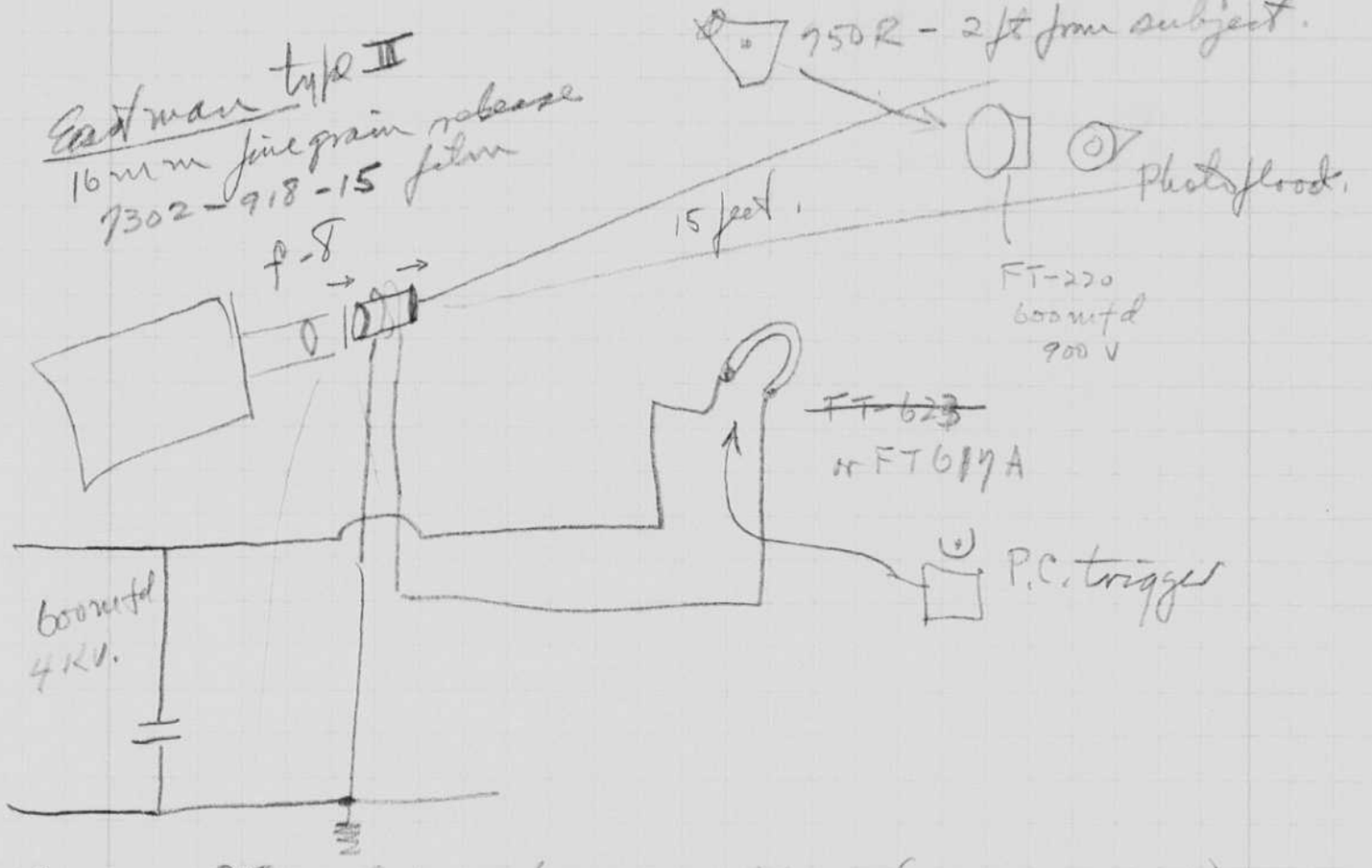
Light

Magneto optic Shutter (Refer to page 13)

Mar. 20, 1954
Harold Edgerton.

Data from Howard S. Babbitt. G.E. Co Pittsfield Mass.
Fog length on film 14 frames at 3000 fps.

$\frac{14}{3000} = \frac{1}{200}$ second. approx.



No 1 - f8. Release fine grain film. (M.O. 600 mfd.)
2 - f8 " " " " no M-O Shutter

3 f22 XX Super Blue back. MO 1200 mfd
no exposure from #750R Direct photoflood. Balbar
Strob. not over exposed?

4 f22 XX Super Blue Back MO 1200 mfd 4 KV.
Lamp FT 617A in 30 inch reflector
at 6 feet from subject.
Exposure ok from Big reflector.

26 Mar 21 1958
Harold & Esther Edgerton.

Further Tests as per ¶ 25.

Roll

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

f 22. (a) FT-220 600 mfd 900 volts and photoflood. The MO was "~~off~~ open" also the strobe "off". 26¼.

" (b) Ditto but with 10,000 with one in FT 617A M.O. shutter closes with FT-617 current. 30

" (c) Ditto except the strobe light was not directed at the subject. 35

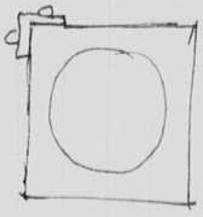
#2 ¶ Kodachrome film Daylight type.

f 5.6. Blue Background FT-220 600 mfd 900 volts, & #1 Photoflood, FT 617 was about 6 feet away. 32½ & trigger off

#3 Kodachrome Daylight.

f 2.7 Ditto #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. Edgerton

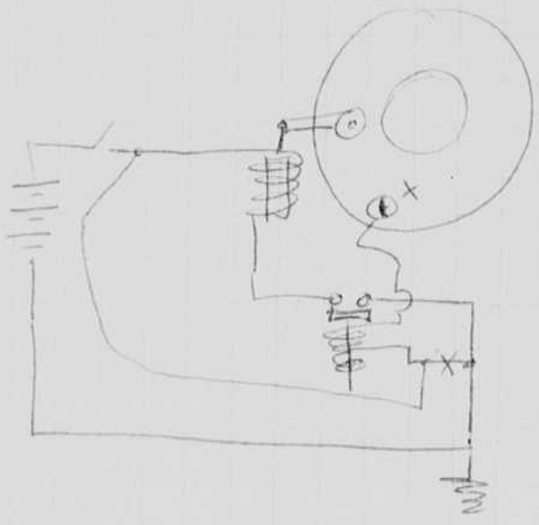
Log of etc.

Feb 17. Washington ASWAP adm Slyvester,
" 26 N.Y. Yacht Club. 37 West 44th st.
Jacques Cousteau Jim Dugan.
MC Lean.
Mar 5 Cousteau in Washington at Nat. Geo. Soc.
Lecture in Constitution Hall.
Mar. 9 Holger - R.C.A. Lecture at MIT for I.R.E.
17 Leo Harrison lecture to 620 class 20E 121.
17 HEE lecture to Grad House students
Bensley 154, avery
22. I went to Washington to see Honot and
Willm at N.G. Soc.
25. Honot and Willm were in Boston to visit M.I.T.
27. Talk at Nottingham conference. 9 15 am
Samuels chairman. Tonks.

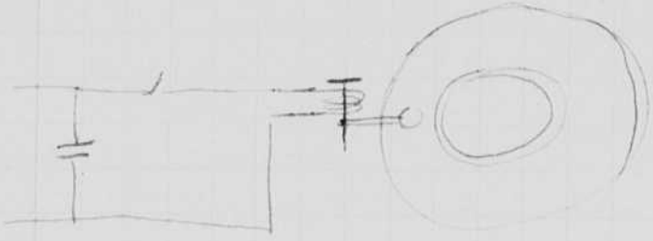
I was asked by the Nat. Geo Society on the 5th of march to go to Dakar Africa to help Cousteau with photography on the Bathyscaphe.

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

March 30 1954
Harold Edgerton.
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. (a) 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.

(b). 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.

(c) Shows FT-220 with magneto-optic only. Tungsten lamp goes out.

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

I would say that the experiment was tremendously interesting as a pedagogical 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.

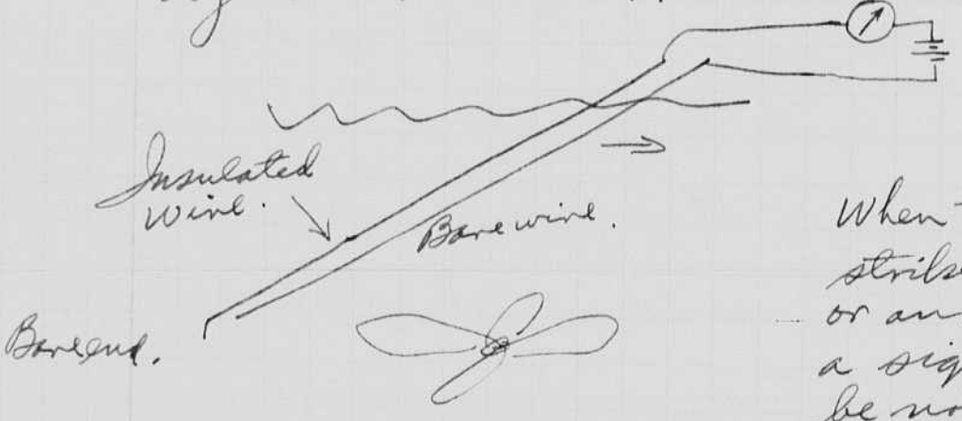
April 2 1954

Harold E. Edgerton.

Crowley of Diamond Power Co. (television and Power plants) went with me to visit Geo. Perry at the Boston Harbor. Ireme 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 new out of Fore river. The prop. was not on the ship when she ~~stopped~~ started after leaving the pilot near Graves 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 metalic object is touched.

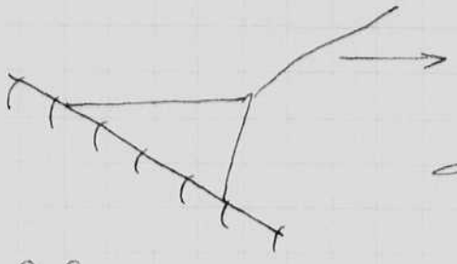


When the small end strikes the propeller or any metal object, a signal change will be noted above on the ship.

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.

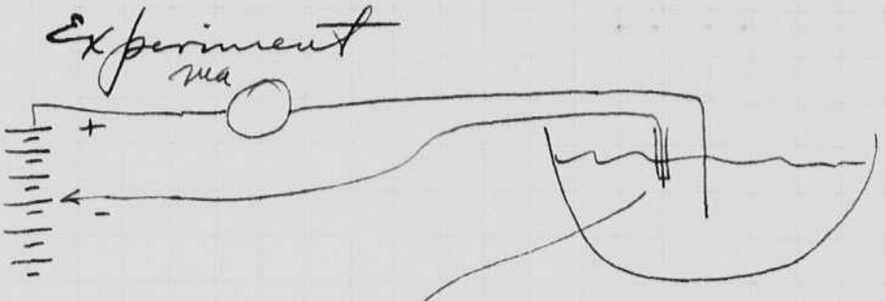
a large rake could be built with a large collection of points all of which would give a signal when metal was hit.



Insulated wire with small sharp points protruding from the insulation.

Searching rake for metal.

Experiment



Bucket of sea water, enameled.

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

Gas bubbles form on negative end.

V		amp.	
1.3	~~-1.4~~	1.1 ma.	
~~2.8~~	~~-2.8~~	64	
~~4.4~~	~~-4.6~~	~~3~~ 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 ~~amp.~~ ma. 80 ma.

-1.4 2.8 ma 60 ma on 2" x 15" x .040 Stainless steel
-2.8 50 ma 200 ma — Becomes some 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

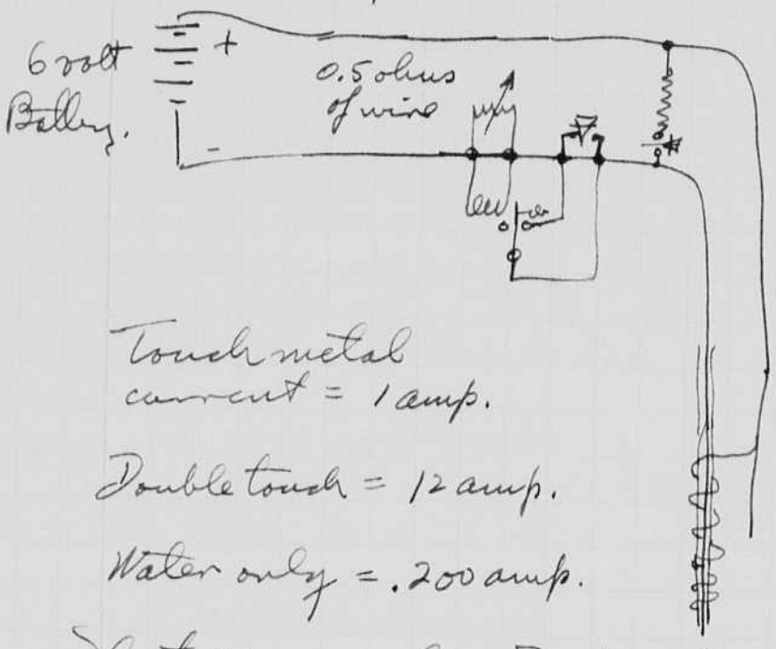
Resistance = 200 ft. #10 is 0.5 ohms

#14 = 2.5 ohms/1000 feet.

200 ft res = 0.5 ohms.

6 volts gives $\frac{6}{.5}$ = 12. amps 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.

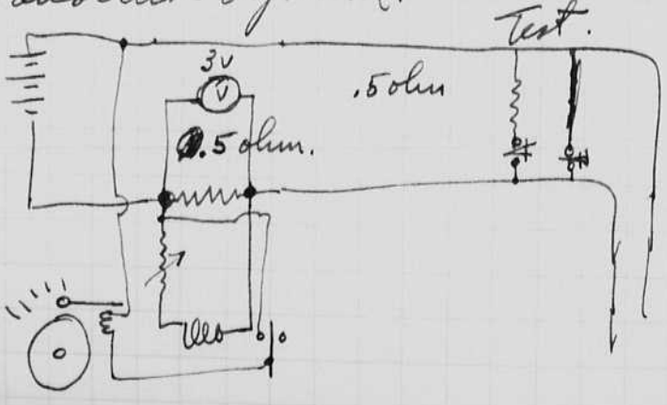
10.5 45 ma operate 20 ma release
10 ohms.

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

200 ma → 5 ma. 40 to 1 ratio.

10/40 = 0.25 ohm.

Try a volt system.



Single touch.

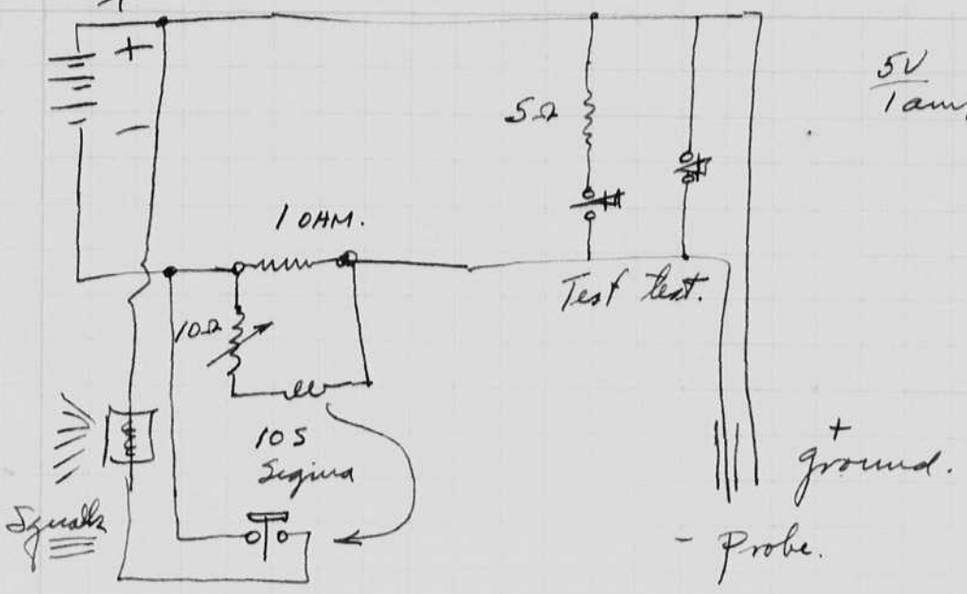
current = 1 amp.

45 ma reqd. to operate relay

V = 1 x .5 = .5 volt.

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

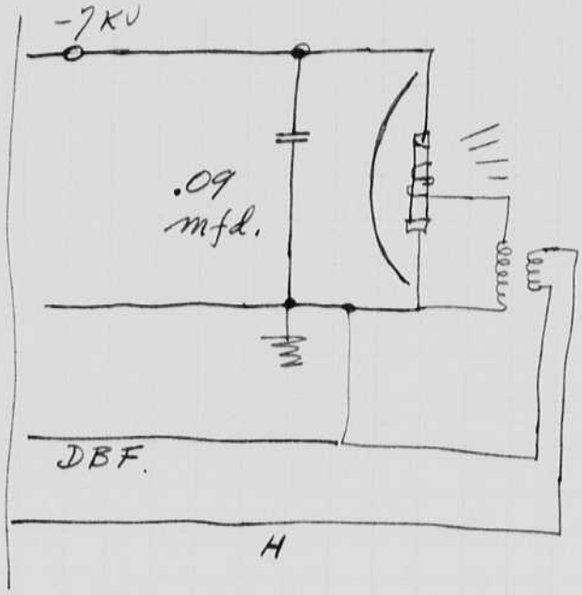
2nd try:



5V
1 amp =

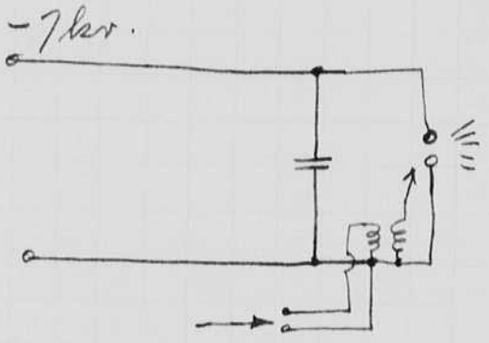
Spark set for use with Rapatronic Power supply.

Apr 2 1954
Harold Edgerton 2208 C4 Drawing E.E.26.



To
2208
Power
Supply.

1 inch x 4 inch gap
2 atmospheres.



April 5, 1954.

Harold Edgerton. Faraday 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 on an open Faraday shutter to close quickly - and then open at a preset rate to match the desired density to a first degree.

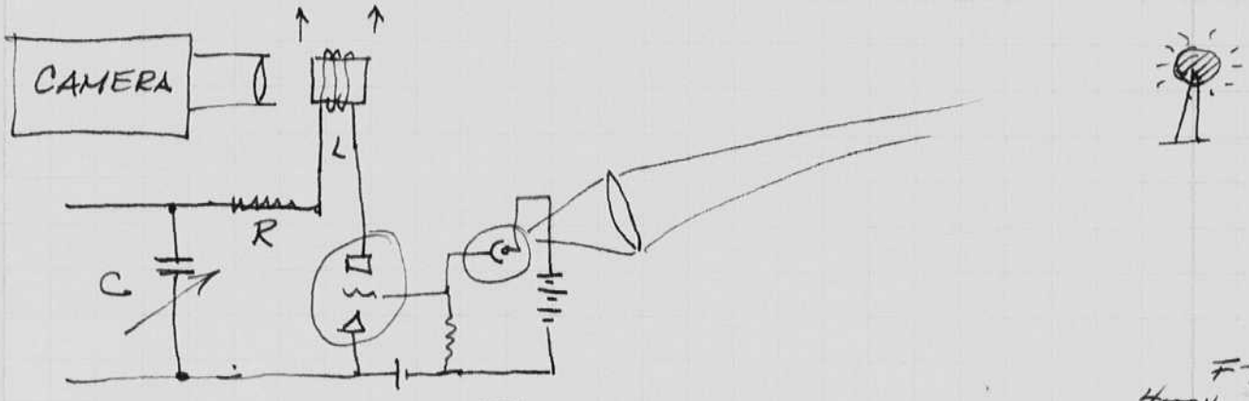


Photo tube trigger.

FT-623.

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

$R = 4$ 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 $E = 450$ volts,

$I = 1000$ amperes.

$R = 0.45$ ohms.

Increase turns to 200. Then current = 333 amps.

$R = 1.35$ ohms.

$RC = 0.1$

$C = \frac{0.1}{1.35} = 0.74$ farads. $\frac{740{,}000 \text{ mfd.}}{500} = 1500$ capacitors!!

1500 50 ws. 75,000 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.

$\frac{05 \times 1000}{6} = \frac{10,000}{}$ instead of 60,000 - amp turns.

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

$\frac{10,000}{1200} = 10.$ amperes.

Seems wrong.

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

$RC = 0.1 \qquad C = \frac{0.1}{45} = .002$ farads

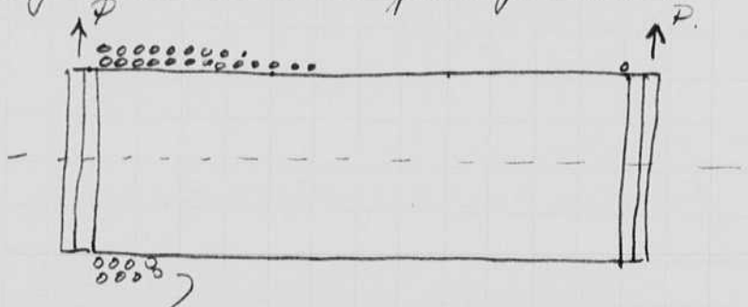
$= \underline{2,000}$ mfd.

$= 4$ capacitors.

This looks more reasonable!

Probably can compromise with a shorter length than 6".

→ Try a 3 inch length of EDF4



coil on glass cylinder.

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

$\frac{330}{3}$ amperes. $= 100$ amperes.

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

$C = \frac{0.1}{4.5} = .02$ farads $\qquad \frac{20,000 \text{ mfd.}}{500} = 40$ capacitors.

50 watters each.

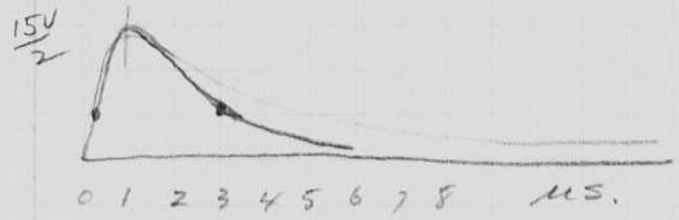
2000 watt sec total.

April 8 1954

~~Harold Edgerton~~ FX-3. test.

1/4 mfd 4KV. 38" to Electronic

Std lamps.
5908-1 2.8×10^6 peak c.p.
.48 volts = peak.
with x100 filter in P.C.



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

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

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

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

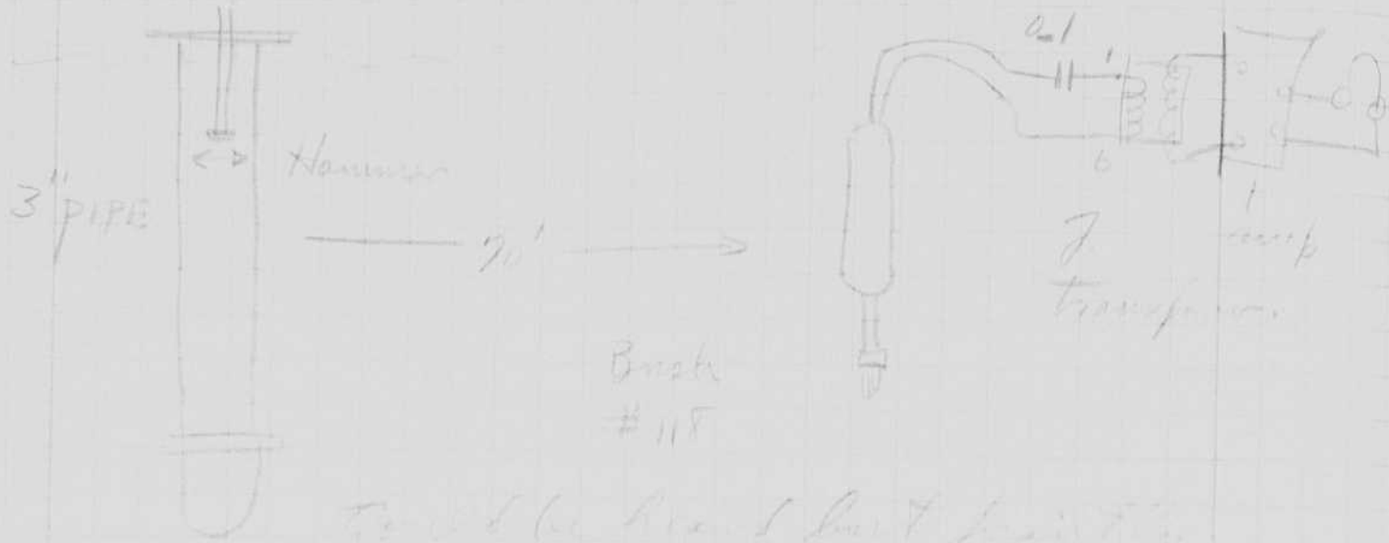
~~Domestic~~ Lessen
10 sq ft. 3x3 ft at.

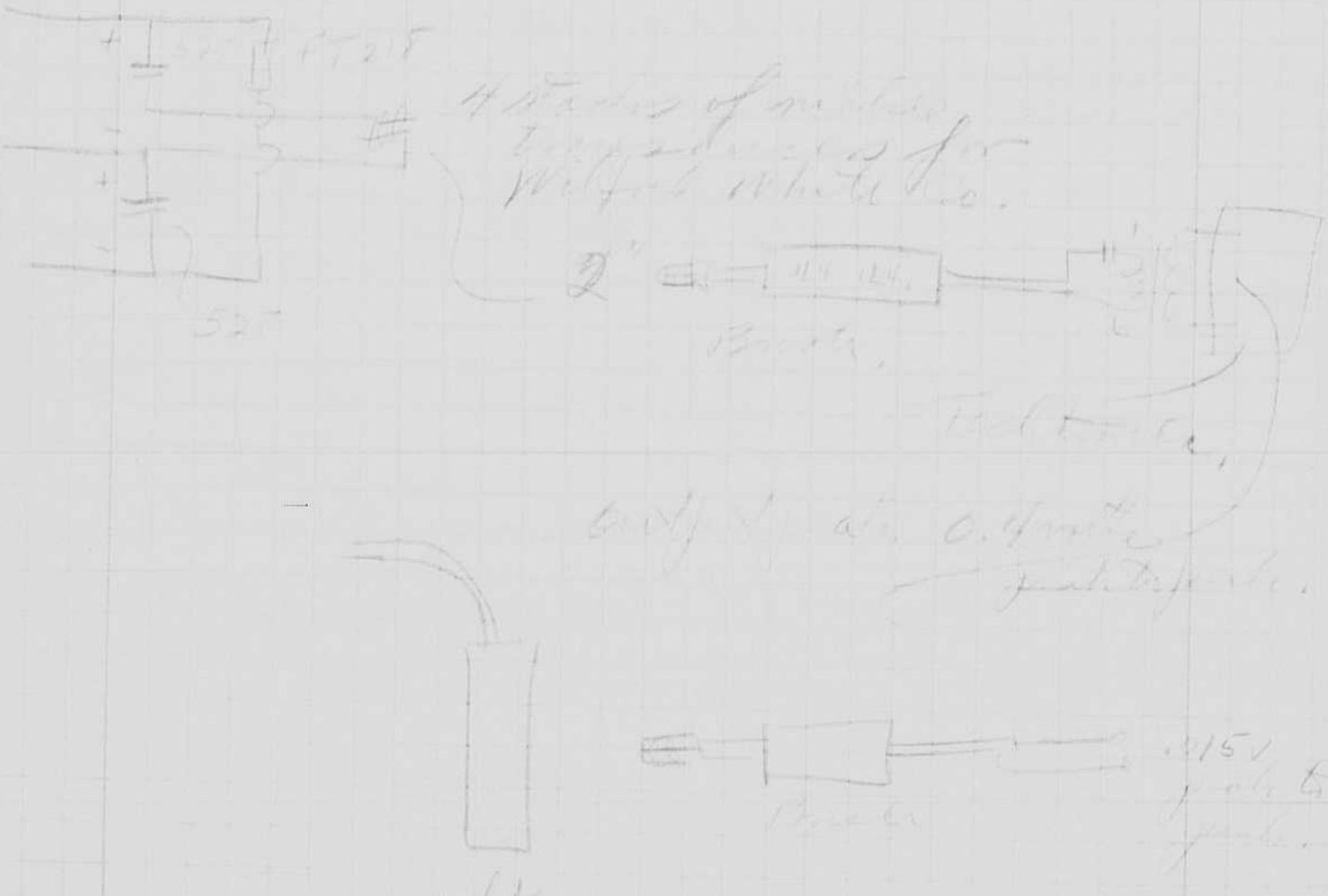
Same light as microflash. 10 watt sec.
8 KV – .2 mfd. desired.

April 11 1957

Harold Edgerton.

Tests in M.I.T. Pool.





Scope triggered by light

1 ft = .1 volts.
1000 = $.1 \times 10^{-6}$ volts.

-96 db ~~re~~ re volt per dyne/sq cm.

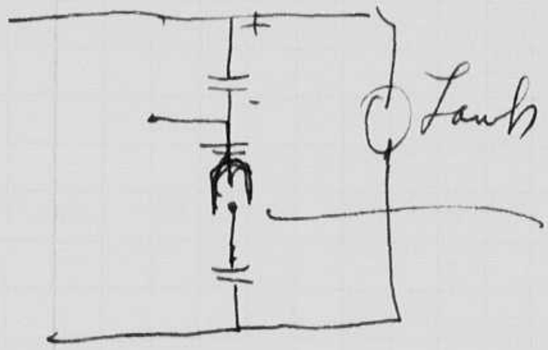
$v = 5000$ ft/sec. $\frac{1}{5000}$ sec = 200 µs.

-96 db re 1V/dyne

.08 volts peak to peak. Initial

Signal has lots of flash. not single frequency.

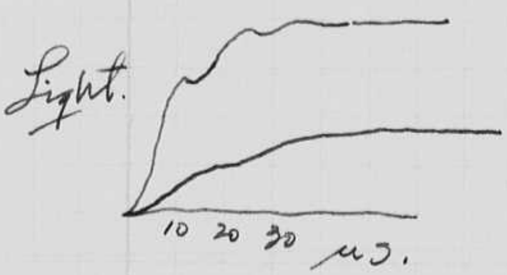
Apr 12 1954 ~~tt~~ cont. exp.



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.

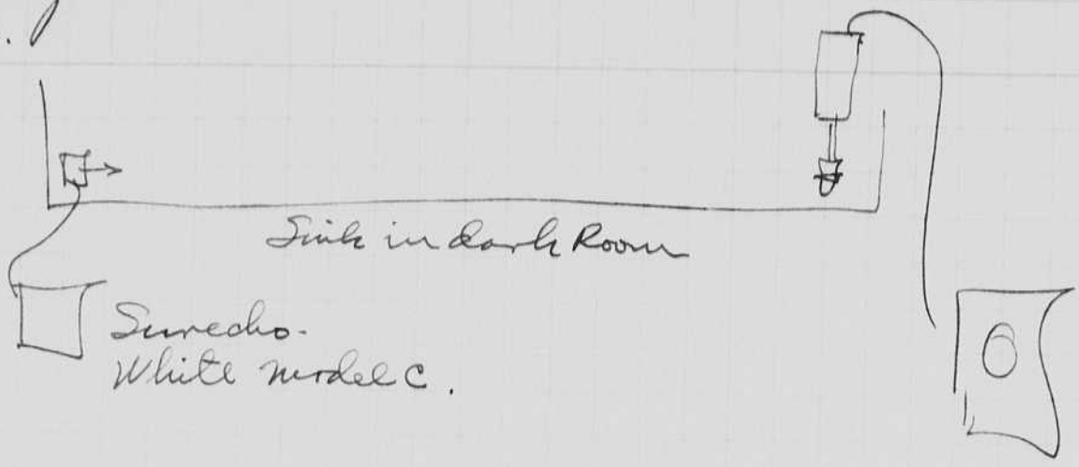


4 strands nickel
with wire on each.

40 April 12 1954

Sound test.

Harold Edgerton
Joe Vitka.



Model C. Surecho. 0.7 volts peak to peak.

Stub in series with 250 mfd 900 volt and FT 2.8 voltage about 1/3 of the above

Information from Joe Vitka. Van Young Students. Bill Baar. Geo Schwenk.

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.

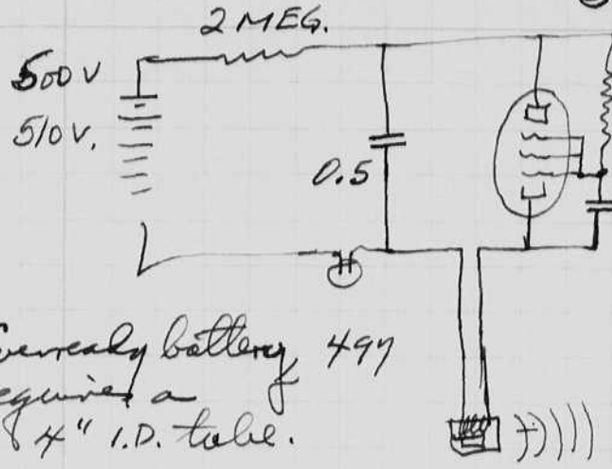
(B) With transduced at bottom 30 db in water only loss. should be 35 db greater than at surface.

Surecho can read bottom at 2500 feet.

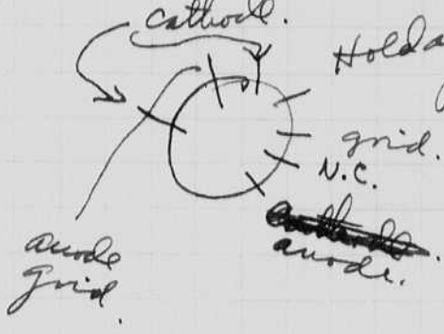
20 + 25 = 45 db.

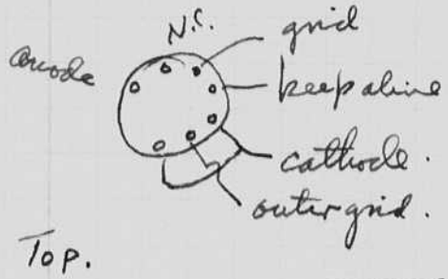
Driver

Strobotron.

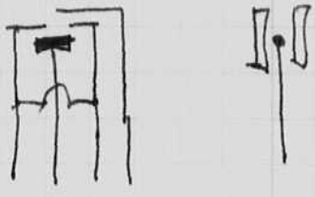


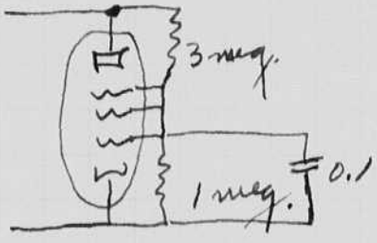
Eveready battery 497 requires a 4" I.D. tube.

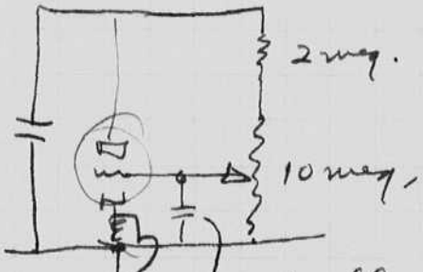




Top.



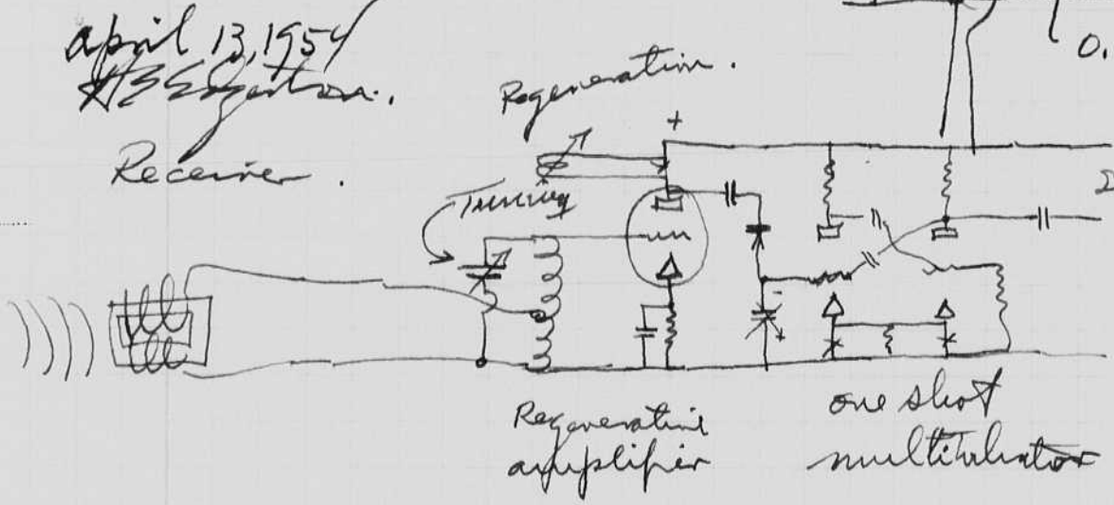




does not flash with out this!

April 13, 1954

Receiver.



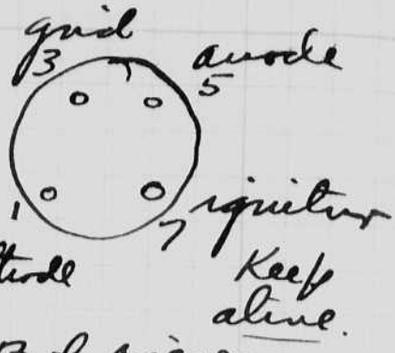
42 April 16 1954

Harold Edgerton

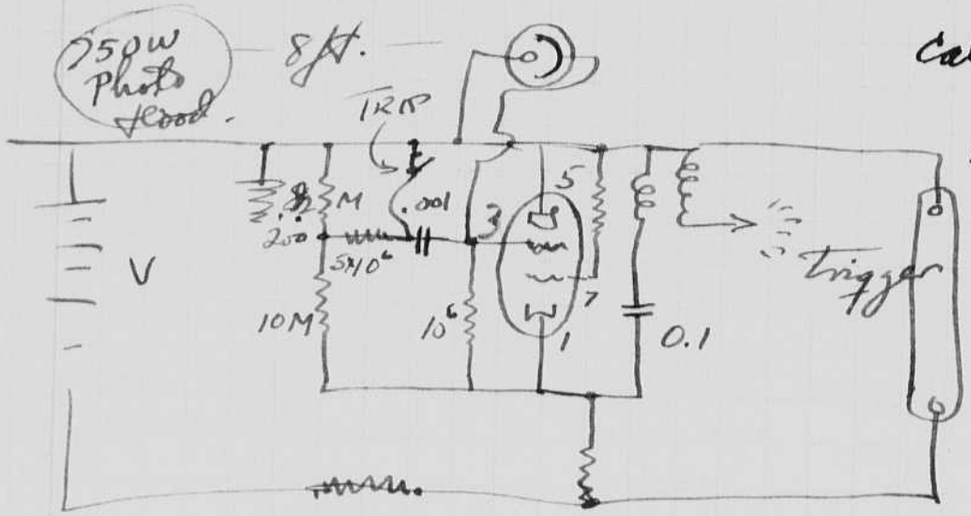
Sylvania 6483

Subminiature stimulator.

brought in by Don Coggins on April 15.

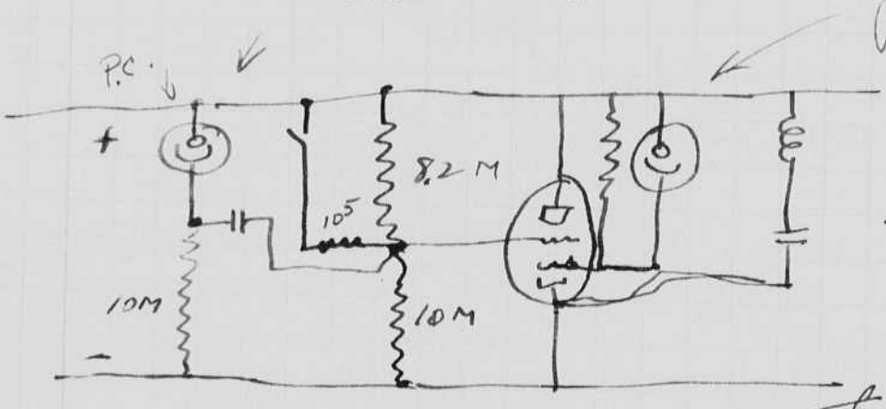


Circuit tested by Bill MacRobert.



Bat wire.

ok 350 to 650 volts.



Photocell to give additional current to igniter for triggering.

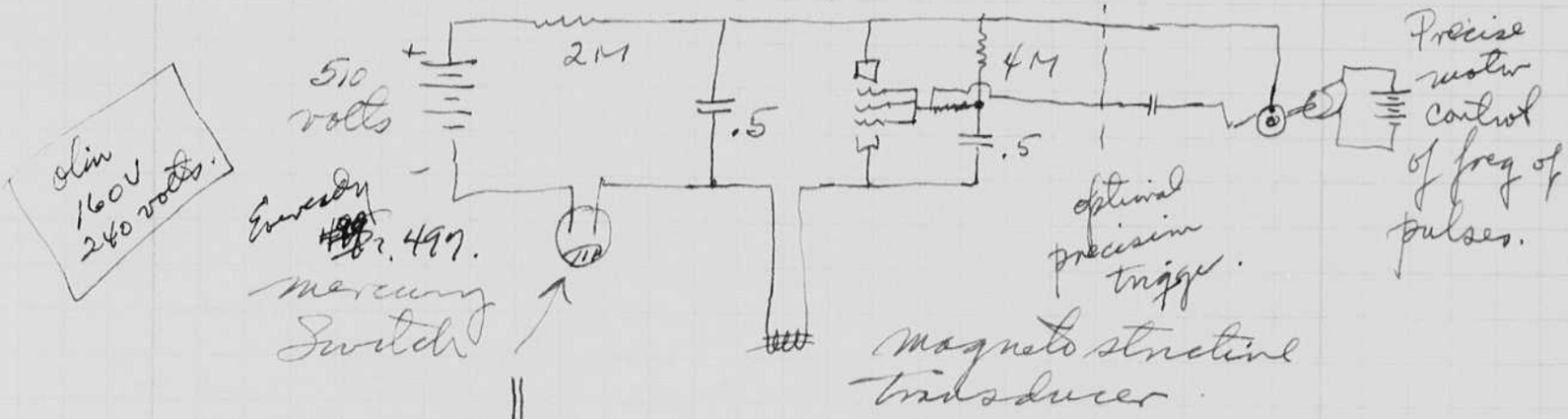
This works but requires more light. than alone.

April 18 1954
Belmont Mass
205 School St

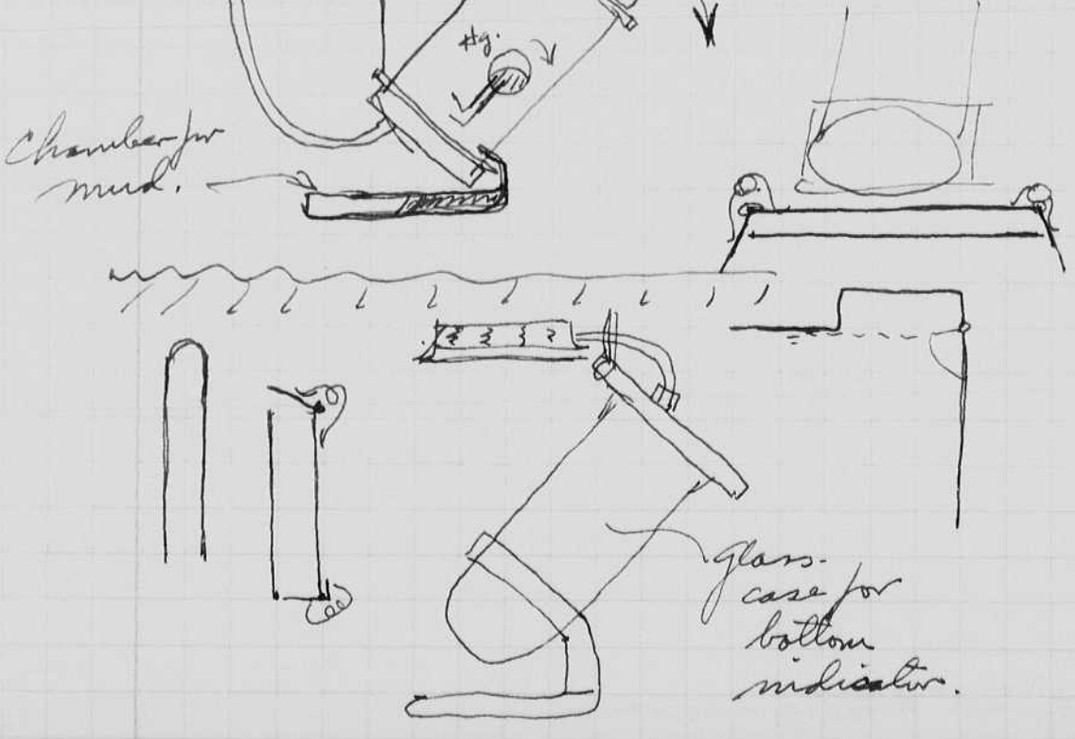
Bottom indicator.

A pinger circuit will be put in a cylinder for driving 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.



assembly will tip on bottom and turn off the circuit.



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

Drawn & understood by me June 11, 1954
Albert Kinney

 April 18 1954 Belmont.

Harold E. Edgerton.

Automatic filter for movies of atomic explosions.

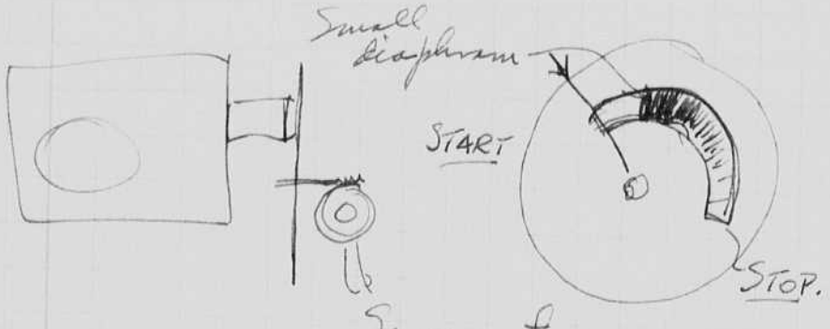
Suppose movies at 1000 frames per second are being taken. At the instant of start, a bright light entirely fogs the film. This gets dimmer as the fire ball expands. There is actually more light but the area of radiation is greater - therefore colder.

I propose an iris that closed almost completely at the instant of firing, say 0.1 second beforehand. Then the iris opens at a rate preset, as determined by a photocell starter.

Crossed polaroids could be used with a motor drive on 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. Jordan shutter page 35. for giving a density-time curve.



Sync motor.

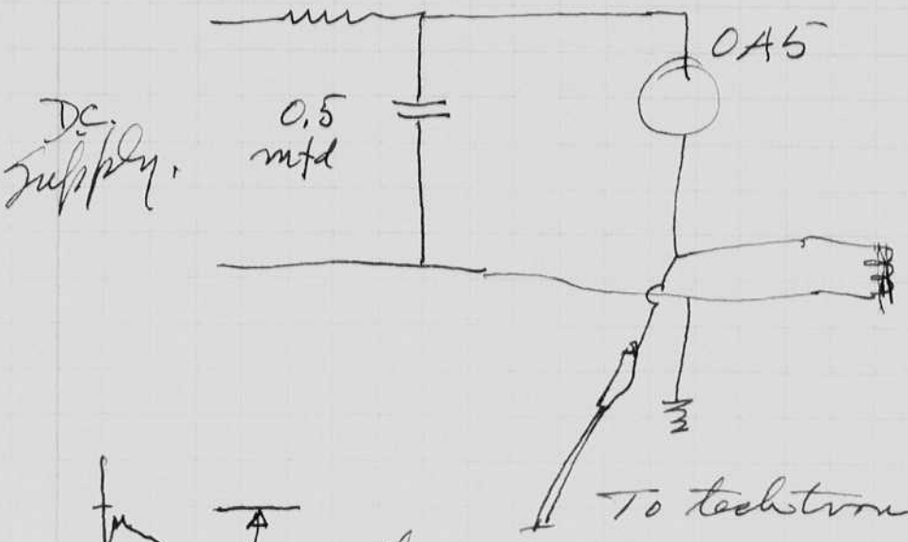
A program of density-time is set up in advance on the disc.

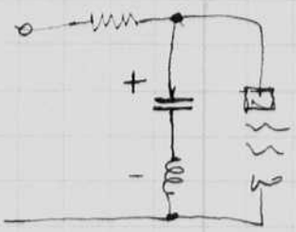
Use 1 sec signal to start motor.

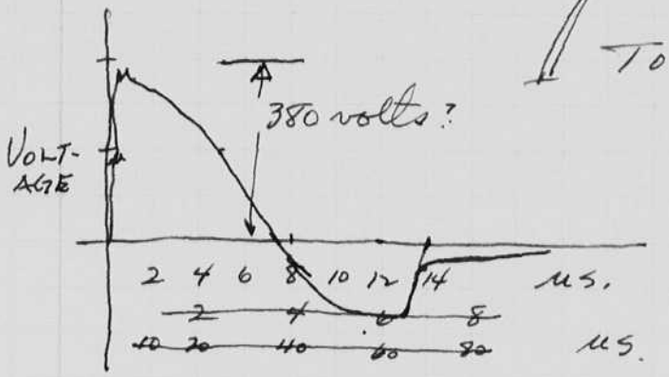
Bill left 2 pm for N.Y. on American Airlines. Now a junior at Columbia Coll. Bob will be home until Thursday - Now a

Nov. 19, 1954
Harold Edgerton
Bldg 20 MIT.

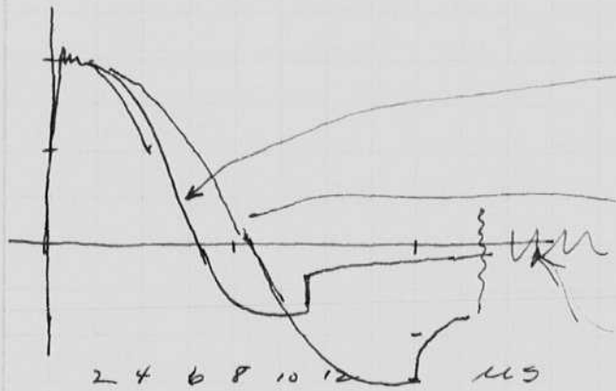
Bottom Indicator Circuit, Tests with scope.







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



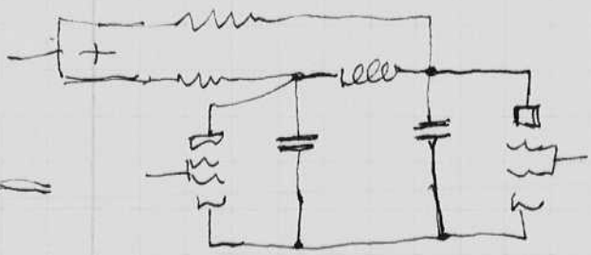
with 6 ft cable and open laminations. 0.5 mfd.

with Litro ex capt 1.5 mfd.

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

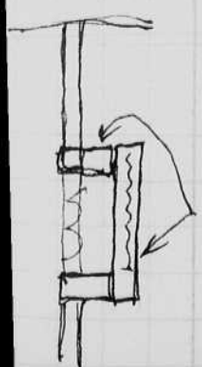
1 cycle = $\frac{100}{4} = 25$ MS

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



This circuit gives alternate current pulses to the coil.

Assembly with 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. +

 April 20 1954
Harold Edgerton

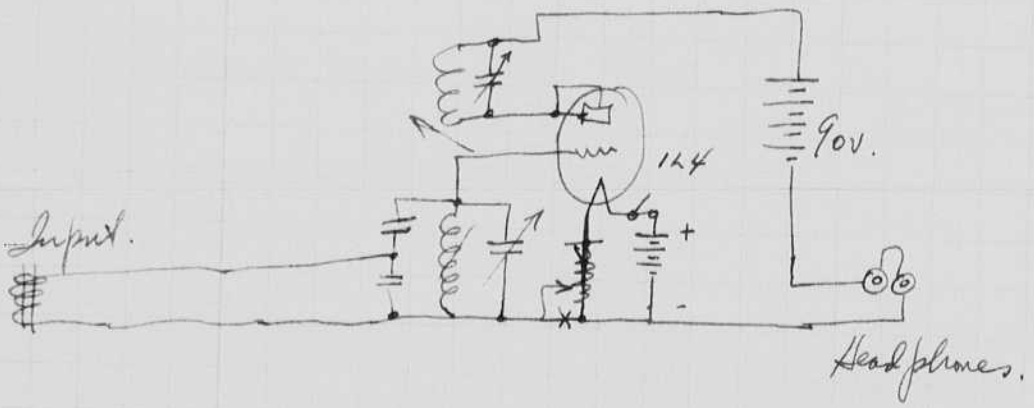
Depth indicator

I invited Joe Vitka to help me this afternoon at the Sailing pavillion on the Charles River. He brought a standard Surecho unit for a detector while I brought the pulser of page 43 which I had put into a 4 inch U. 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 1/2 mile ± operation of the pickup and driver combination. Van Luong helped on this test.



June 11 '54
[illegible]

Harold Edgerton.
May. 4, 1954.

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.

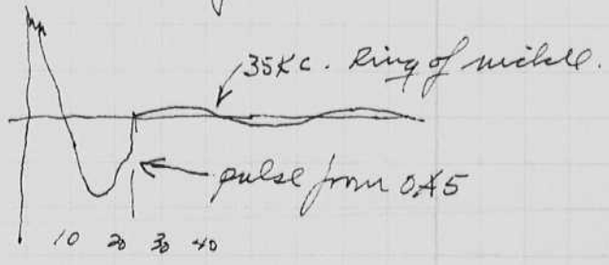
Tomorrow I go to Washington to the S.M.P.T.E. convention at the Statler Hotel. To give a paper with Lamb and Baraghi on May 6 at 3 pm. on Flash Duration.

May. 7. 1954. 5th and 6th of may in Washington at SMPTE convention. Tom Lamb gave paper on flash tubes with me.

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

Worked part of day on push-button camera for the T.U. tests of May 18 at Woods Hole. Using N.G. camera #1 and 7 inch pyrex pipe of last summer as a lamp. Wollensak shutter is being used with a magnet on the shutter blade.

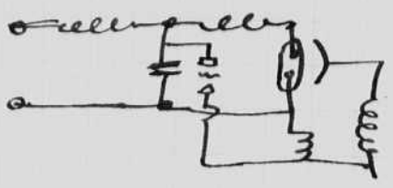
2.45 pm Cont tests with Depth indicator. Sonder driver by 0.5 mfd at 570 - volts through 045 tube.
Receiver located parallel and 2 inches away.
Calib max. sens = .025 volts/cm.
Input .002 volts 35KC at 2" from driver in air.



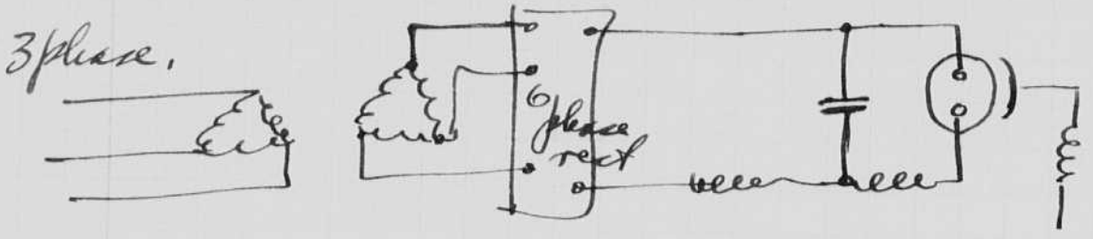
Receiver now moved 2 ft away in air.
Gain full on.
Output of second stage of amp - plate.
Peak = .6 x .025 = .0150 volts. x 100 = 1.5 V gain at max.

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.



Harold E. Edgerton
May 13, 1954. Automatic Rewind camera.

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=5 min.	Density of filter for Density 1 at Time = 5 min	Developed 4:1
EK.	5305	.95 + 1	1.95	Base High-Speed Positive
	5372	1.8	1.8	
	5203	.65	.65	Pan. Fine Grain Pan Dup. Neg film.
	5302.	.92	.92	Base Eastman Fine Grain Release Positive.

The above films were tested by chas Mayhaft at 160 Brookline ave. Boston.

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

May 16, 1954. The depth sender and receiver (David White Co 35Kc) magnetostrictive 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 pavillion. Reception was good across the entire basin, except getting weak at the far side.

We then changed the angle toward 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 magnetostriction 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 swiming 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 W.H.O.I.

A dry battery light was used with 25 watt sea nite a FT-218. a reflector gave a spotty lighting.

The shutter was a Wollensak alphax o with an arm on the shutter blade ring.

a capacitor pulse gives a short operation of the shutter. it also closes a relay circuit that moves the film to a new position.

I used Background x film at f 8 in the pool focussed for 5 feet in air.

The ambient light on a cloudy day at 3 pm was enough to give a photo of the entire length of the M.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 Harold is working, Esther is helping

General Radio High Speed Camera - 35 mm

Governor adjusted for 1200 frames per sec. (36000 rpm)

~~time in seconds.~~ ~~frames per sec.~~

120 volts

time in seconds.	frames per sec.
0.0	0.0
.2	24 in
.3	17 in
.4	* 2¼ in
.5	22.5 2.7
.6	3.0
.7	28.7 3.4
.8	3.8
.9	34.2 4 1/8
1.0	4 3/4
1.1	38.5 4 5/8
1.2	41.7 5.
1.3	43.9 5 5/16
1.4	46.2 5 9/16
1.5	47.5 5 13/16
1.6	50.5 6 1/16
1.69	53. 6 3/4

220 volts; governor setting 1200; 3600 r.p.m.

time in sec.	frames per sec
0	0
.2	27.1 * = 3.25 in
.3	37.5 4.5
.4	47.7 5.72
.5	67.2 6.86
.6	66.0 7.94
.7	74.2 8.92
.8	77. 9.25
.9	77.8 9.33
1.0	77.9 9.35
1.1	77.9 9.35
1.2	77.9 9.35
1.3	77.5 9.3
1.4	77.3 9.28
1.5	

220 volts A-C; no governor

32 in. of film have gone through →

time in sec	frames per sec
0	0
.2	26.6 * 3.2 in
.3	38.4 4.62
.4	49.0 5.89
.5	59.0 7.08
.6	68.3 8.20
.7	76.5 9.18
.8	84.4 10.12
.9	91.2 10.96
1.0	97.7 11.73
1.1	103.5 12.42
1.2	109 13.05
1.3	114 13.68
~~1.4~~	
~~1.5~~	

220 volts D-C; no governor

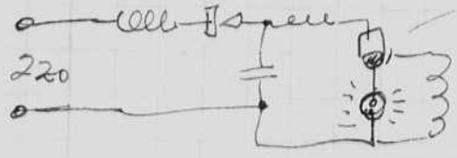
time in sec.	frames per sec
0	0
→ .2	57.7 * = 6.93 in
.3	76.6 9.2
.4	92.5 11.1
.5	106 12.75
.6	117 14.1
.7	128 15.35
.8	137 16.4
.9	146/sec. 17.5

1 foot/sec.

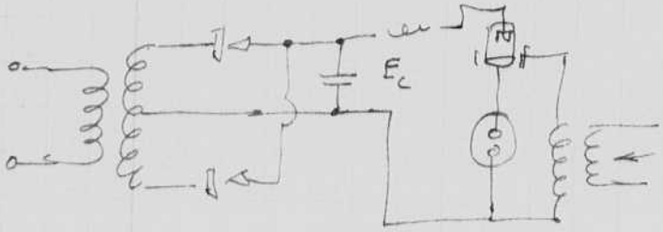
* These numbers are the number of inches traveled in .01 sec
The speed in feet per second is the distance in inches × 100/12

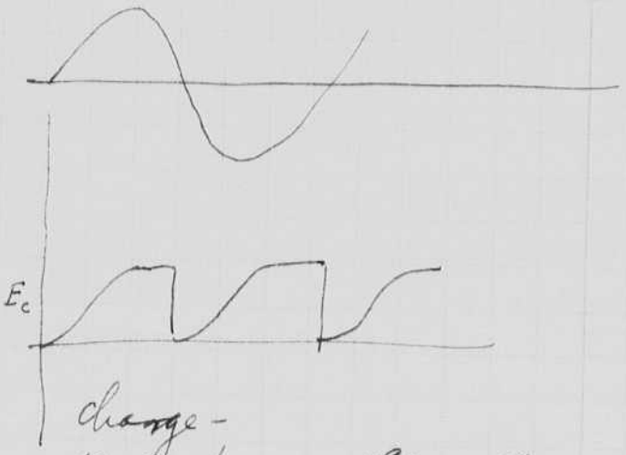
May 16 1954

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



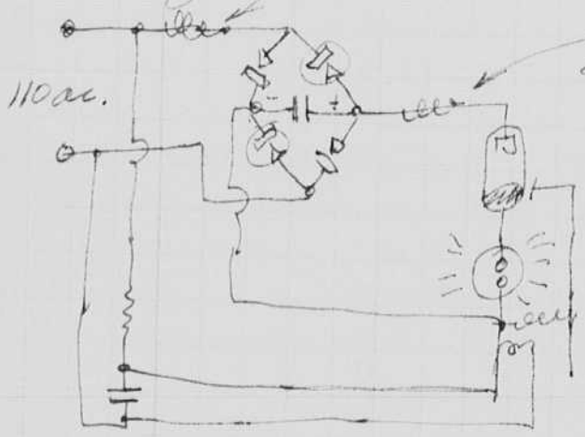
control and start tube.





charge -
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 tube at zero or input wave form.

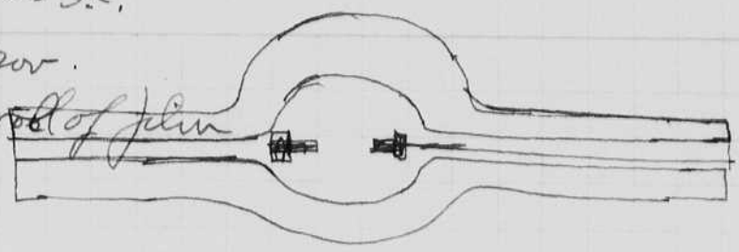
June 11 '54
Bob Rines

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 between the main electrodes. A very low voltage can be used on the capacitor and starting will still result. Deionization is excellent.

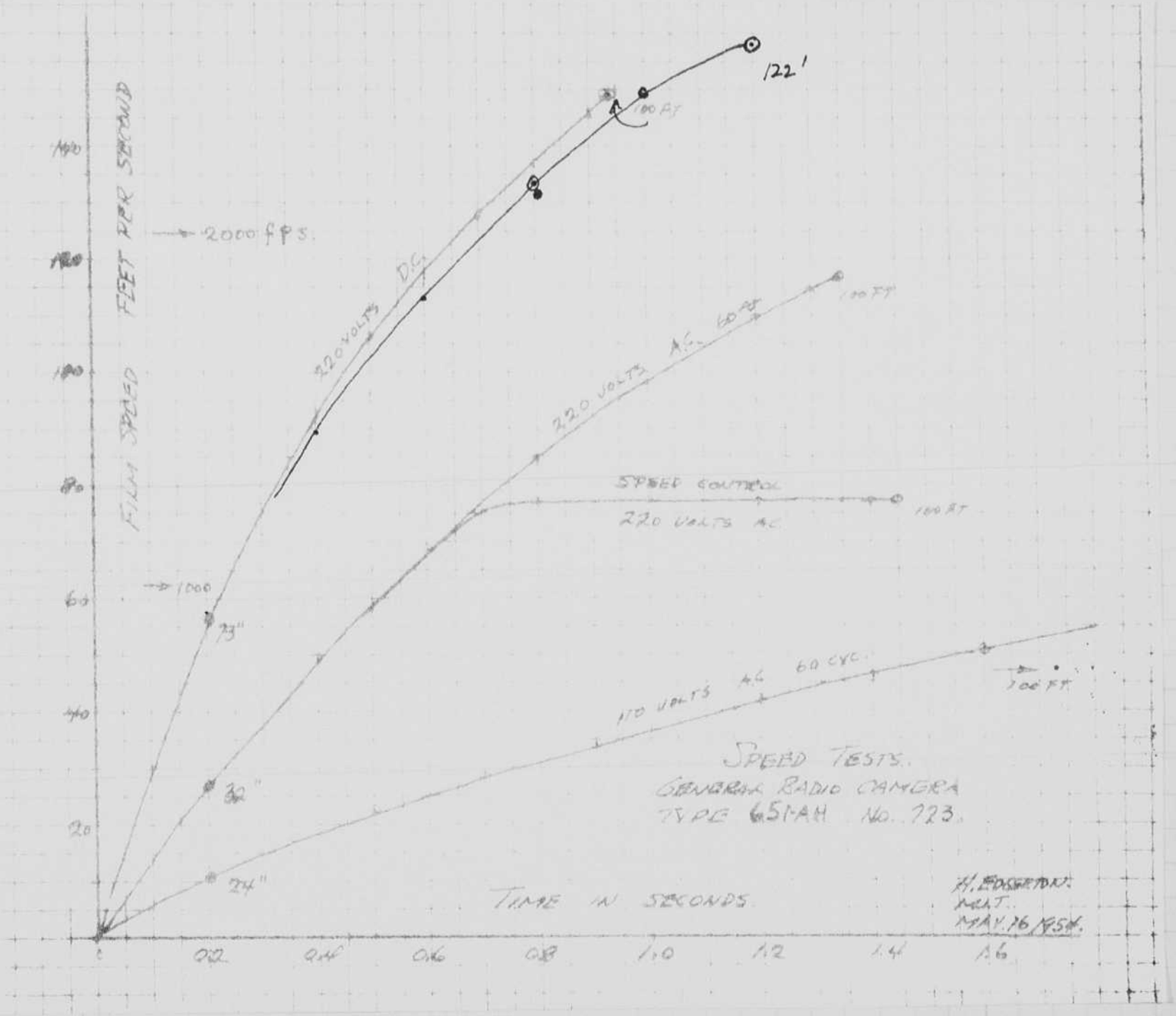
Thursday
7.30.

220 volts D.C.
no Gov.
Full roll of film



Time sec.	inches in /.01 sec. @ ft 11 inches	
0		
.2	7"	58.3
.3	8.8	73.2
.4	10.7	89.2
.5	12.25	102.
.6	13.6	113

Speed test of G.R.
35 m m camera.
Broke on top reel
loosened.



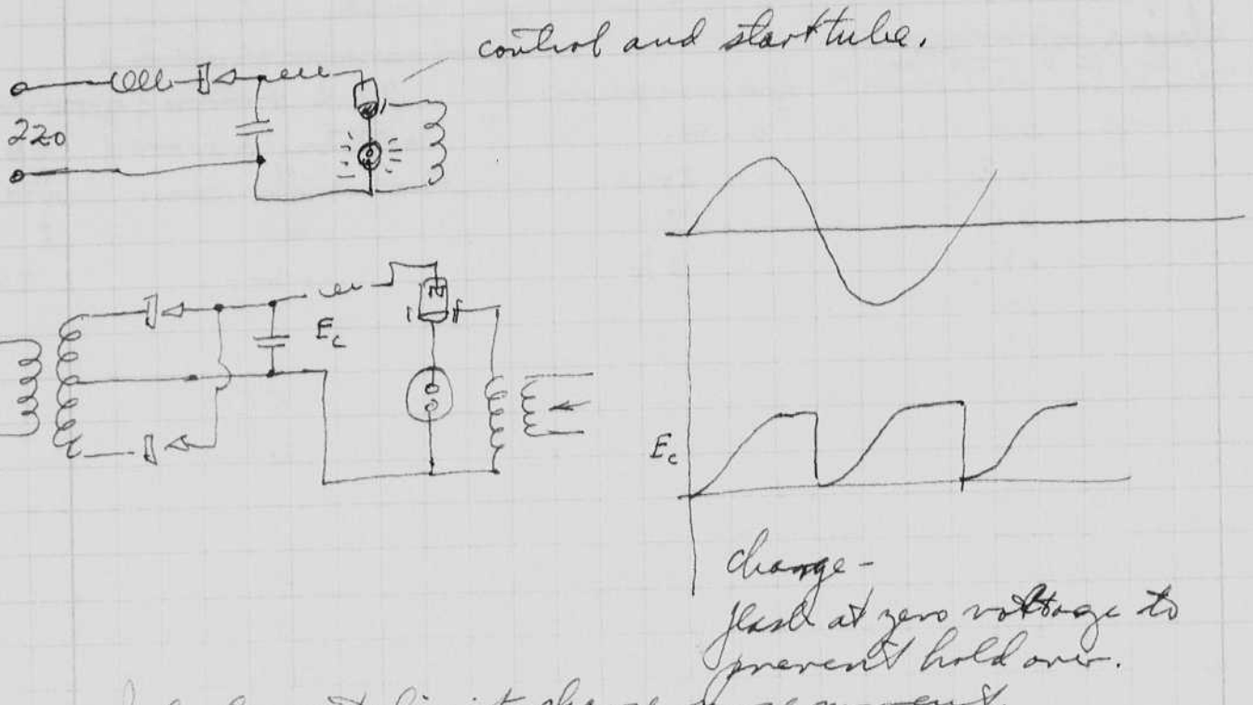
SPEED TESTS.
GENERAL RADIO CAMERA
TYPE 651-AH NO. 723.

H. EDGERTON.
M.I.T.
MAY 16 1925.

May 16 1954

Harold Edgerton

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



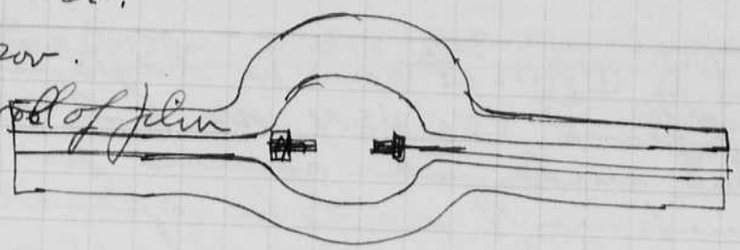
June 11 '54
Pat Rines

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. Deionization is excellent.

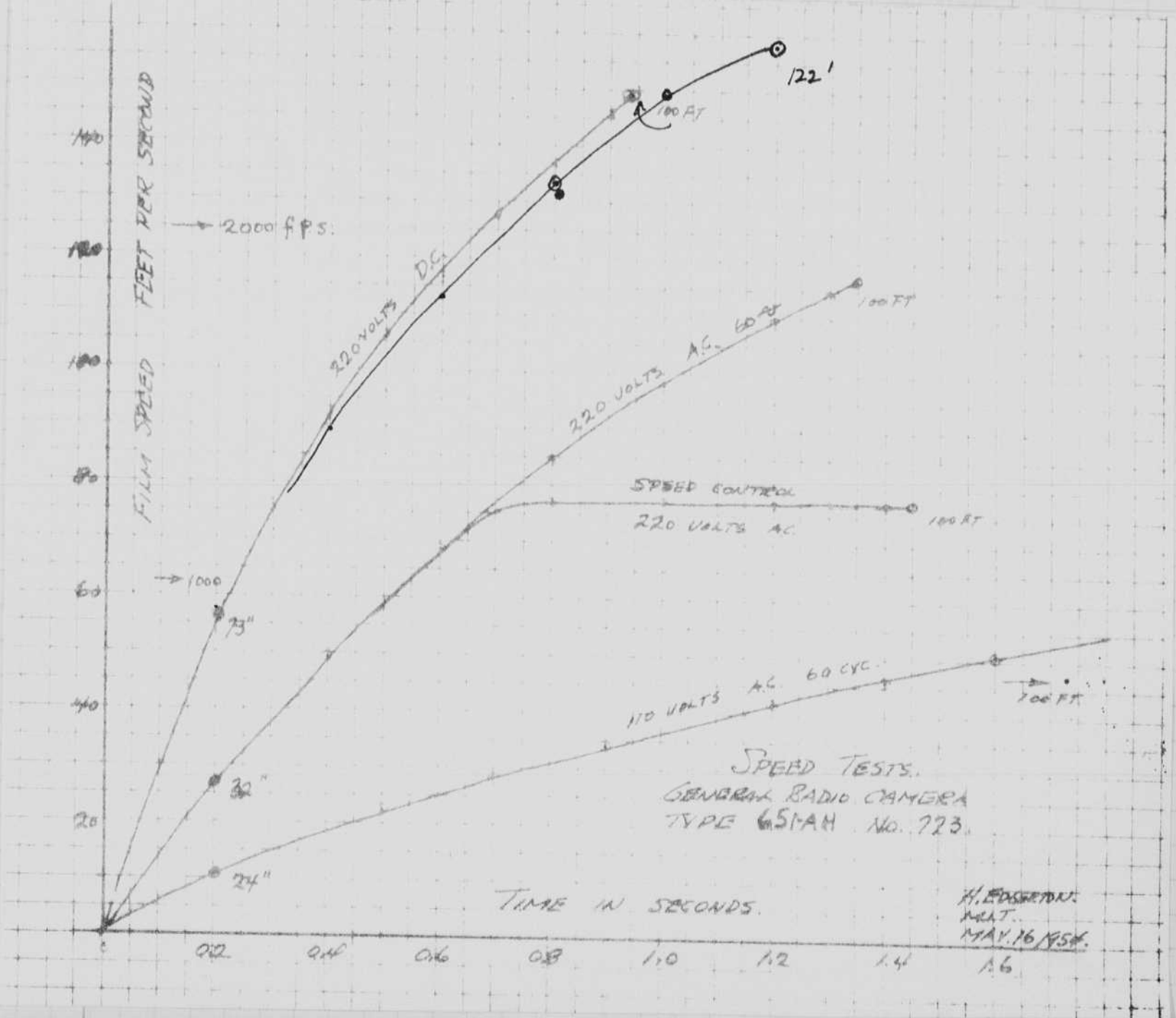
Thursday
3.30.

220 volts D.C.
no Gov.
Full roll of film



Time sec	inches in .01 sec.	
0	@ ft 11 inches	
.2	7"	58.3
.3	8.8	73.2
.4	10.7	89.2
.5	12.25	102.
.6	13.6	113

Speed limit of D.R.
35 m m camera.
Broke at top reel
loosened.

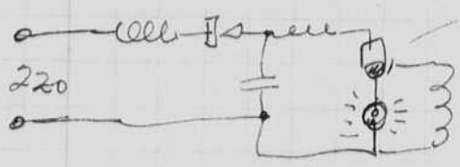


SPEED TESTS.
GENERAL RADIO CAMERA
TYPE 65-AH No. 723.

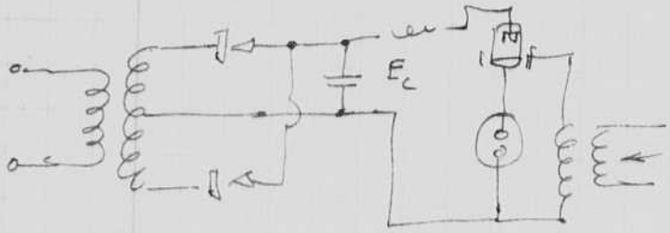
H. EDGERTON.
MAY. 16 1924.

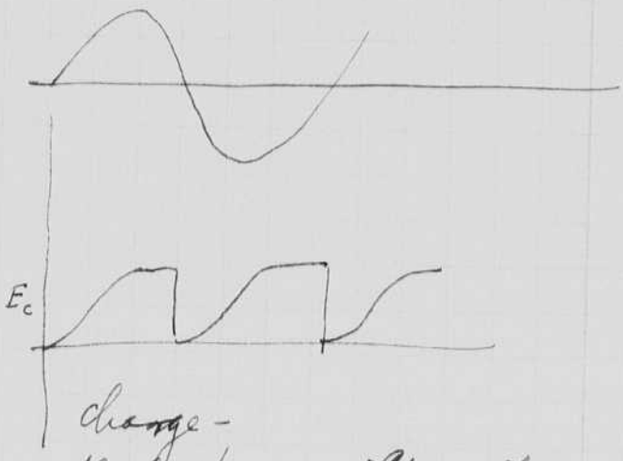
May 16 1954

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



control and start tube.

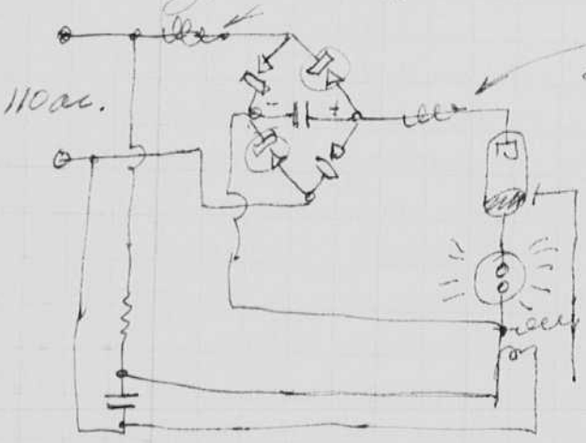




charge -
flash at zero voltage to prevent hold over.

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 tube at zero on input wave form.

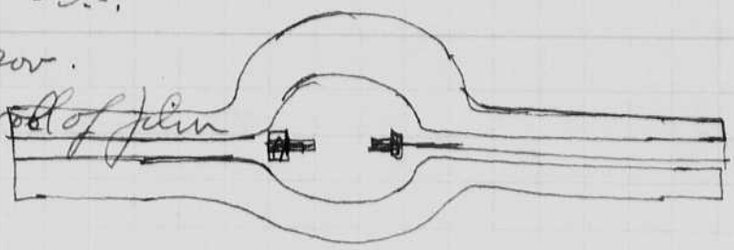
June 11 '54
Art Rines

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 between the main electrodes. A very low voltage can be used on the capacitor and starting will still result. Deionization is excellent.

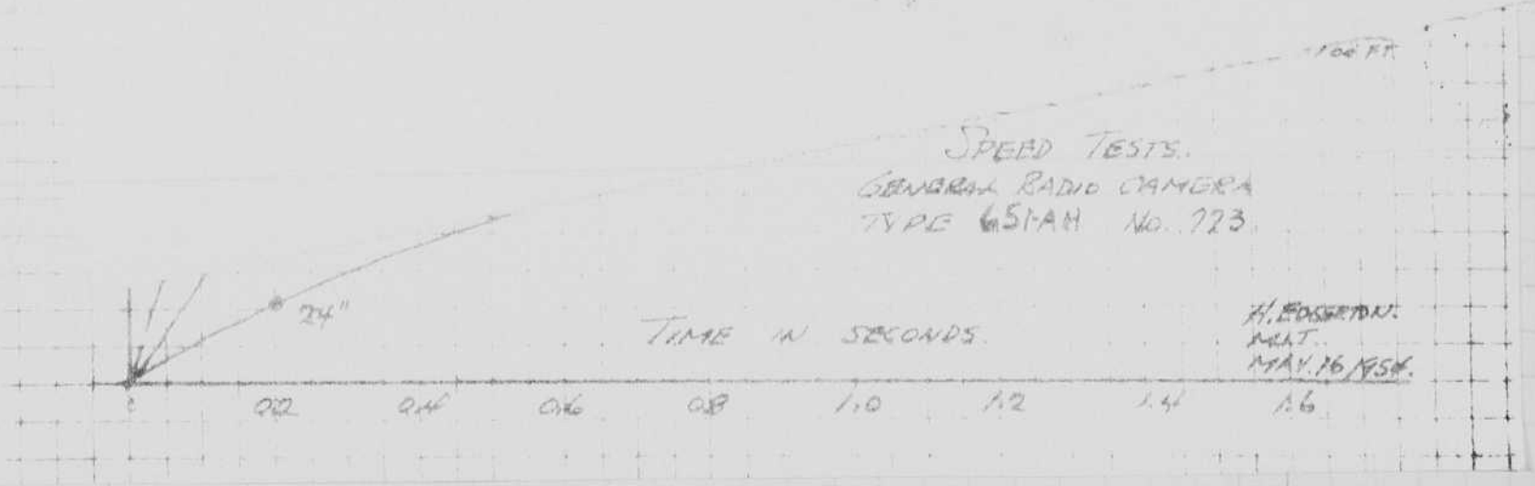
Thursday
330.

220 volts D.C.
no Gov.
Full roll of film



Time sec.	inches in /.01 sec. @ 11 inches	
0		
.2	7"	58.3
.3	8.8	73.2
.4	10.7	89.2
.5	12.25	102.
.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 test of B.R.
35 mm camera.
Broke on top reel
loosened.



May 22, 1954.
Harold Edgerton

I went to W.H.O.I at 6 am on May 18, taking Capt J. N. Tolland C.E.C. U.S.N. We took the push button underwater 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 Woods 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 tapped 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

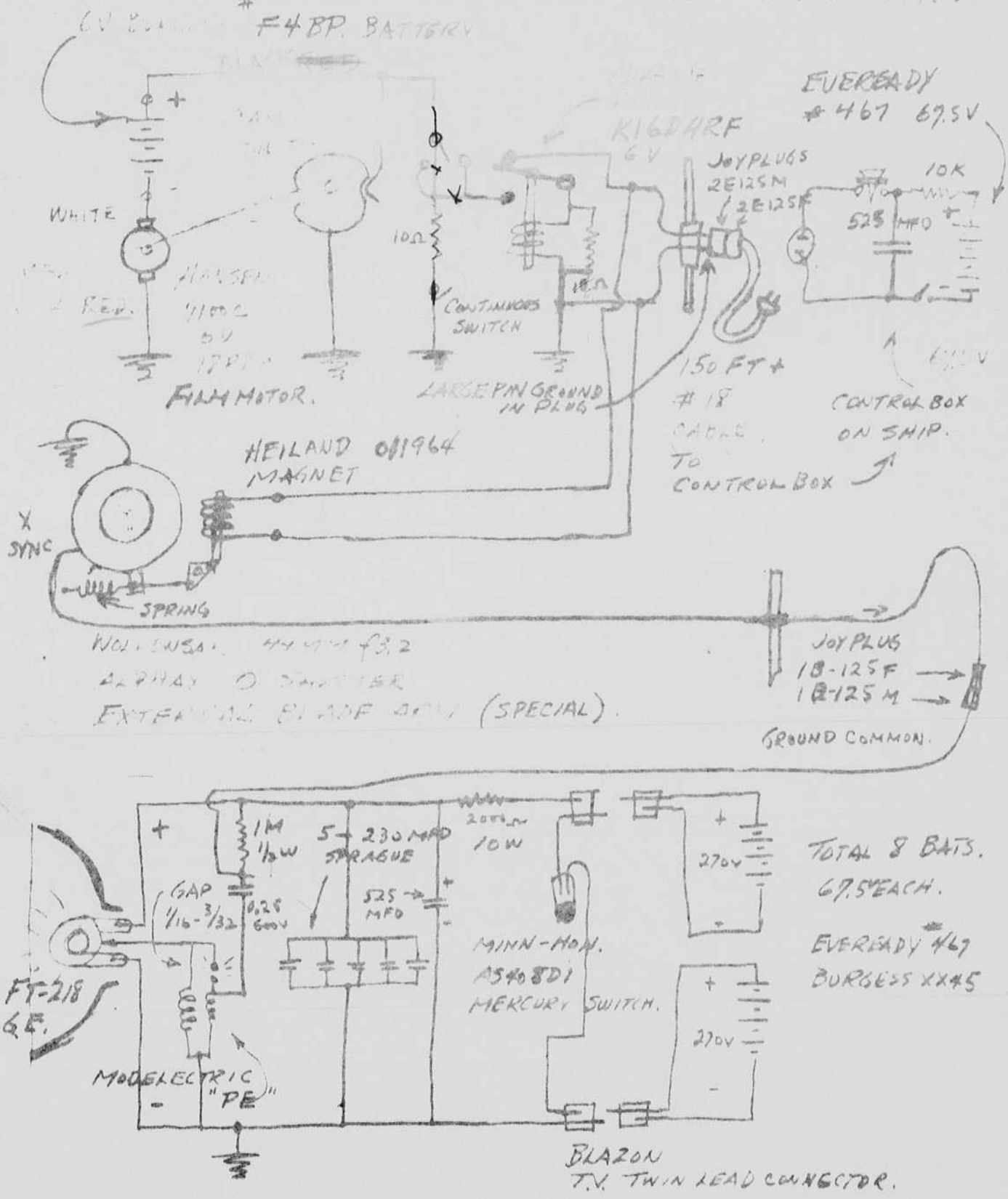
3. Study the connector problem at the lamp end, Go back to 6 volt relay to operate the lamp. In this way only low voltage circuits are used, Check the synchronism with the shutter and see if the shutter closure time is ample for operating the synch relay.

Called Signal Relay Co (Geo Border)
to get a special relay
Type [HF 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 on the series position.

PUSH BUTTON CAMERA FOR T.V. (UNDERWATER)

NAT. GEO. [illegible]

M.I.T. [illegible]



TOTAL 8 BATS. 67.5 EACH.

EVEREADY #467 BURGESS XX45

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Harold Edgerton

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

NAT. GEO. CAMERA

M.I.T.

6V BATTERY # F4BP. BATTERY

BLACK

WHITE

RED.

HALSEY 1/100 C 6V 12 VOLTS

FILM MOTOR.

10Ω

CONTINUOUS SWITCH

LARGE PIN GROUND IN PLUG

K16DHRF 6V

JOYPLUGS 2E12SM 2E12SF

EVEREADY # 467 67.5V

10K

525 MFD

1.50 FT + # 18 CABLE. TO CONTROL BOX

CONTROL BOX ON SHIP.

HEILAND 081964 MAGNET

X SYNC

SPRING

WOLLENSAK 44 MM f3.2 ALPHAX 0 SHUTTER EXTERNAL BLADE ASSY (SPECIAL).

JOY PLUG 1B-12SF 1B-12SM

GROUND COMMON.

1M 1/2W

5 230 MFD SPRAGUE

200Ω 10W

GAP 1/16-3/32

0.25 600V

525 MFD

270V

TOTAL 8 BATS. 67.5 EACH.

EVEREADY #467 BURGESS XX45

MINN-HON. AS408D1 MERCURY SWITCH.

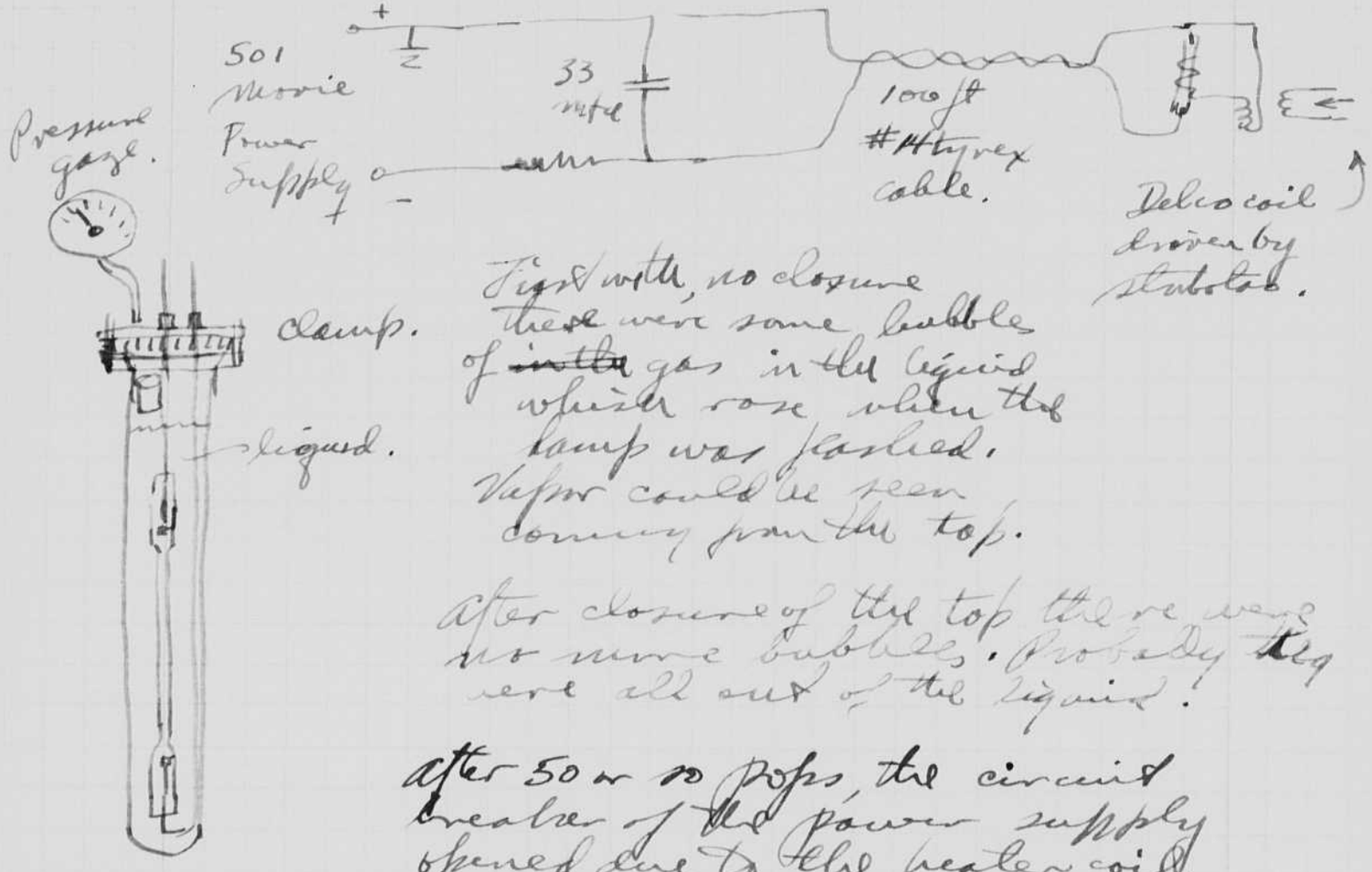
FT-218 G.E.

MODELECTRIC "PE"

BLAZON T.V. TWIN LEAD CONNECTOR.

Yesterday Bill and I set up the navy U.V. xenon lamp (FT-427) in a 3 inch I.D. Pyrex tube for test in Ethylene Glycol. the circuit was

Jun 115-4 Hollies



Tight with, no closure there were some bubbles of ~~inthe~~ 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.

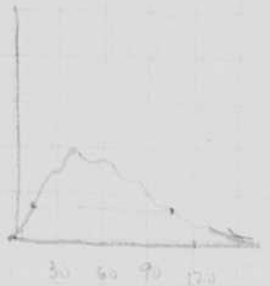
Ethylene Glycol. Specific heat 0.544 0°
Chem Handbook. Heat of evap. 191 cal/gr.
water. 540 " "

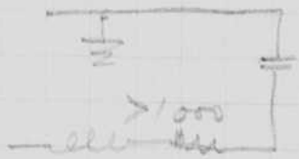
Light meas. –

Calib 10 mfd 2000 volts FX1 Peak 3×10^6 cp.

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

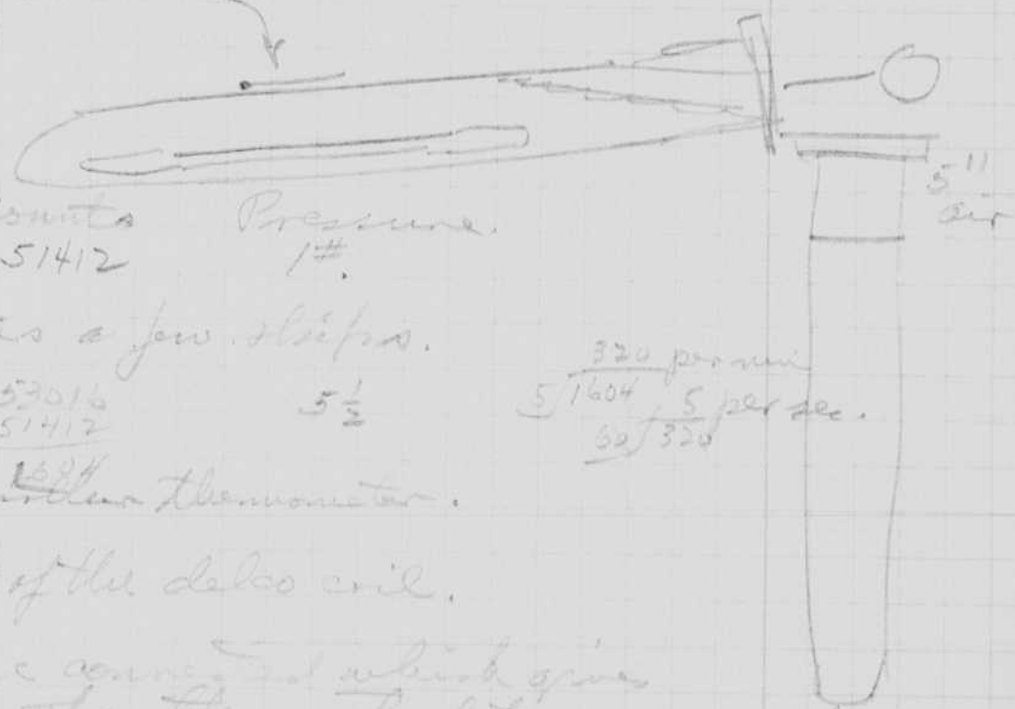
6×10^6 h.c.p.
100×10^6 μs
4000 h.c.p.s.





120 to 40,000 ohms.

Temperature run
thermometer on top



TIME	°F	Counts	Pressure.
+ 10.15	80°	51412	1#

4 minutes a few slips.

10 20	broke 140°+	53016 51412	5½	320 per min 5/1604 5 per sec. 60 of 320

125° for another thermometer.

Wax is coming out of the delco oil.

another slug that came out which gives more spark. the other slug was weak.

10,51	—	53018	4#	22 amps from line 208 volt line
10.55 ¼		54600	6#	

Smells comes from choke in power unit.

Light meter 1501 3 ft 89 89 on floor.

18 $\left.\begin{matrix} 4200 \\ 32 \end{matrix}\right\}$ mfd, = 260 v s

$\frac{9}{781} = \frac{}{260}$ 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 Reflect 69 x 2 at 3 ft.	69 / 55 2 / 69	1242 HCBS (BCPS)
without 36 x 2 at 3 ft		648 HCPS

72/9 648

FT-427

Billie designing a [illegible] holder to fit in the Glass 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 with the outside water cooled.

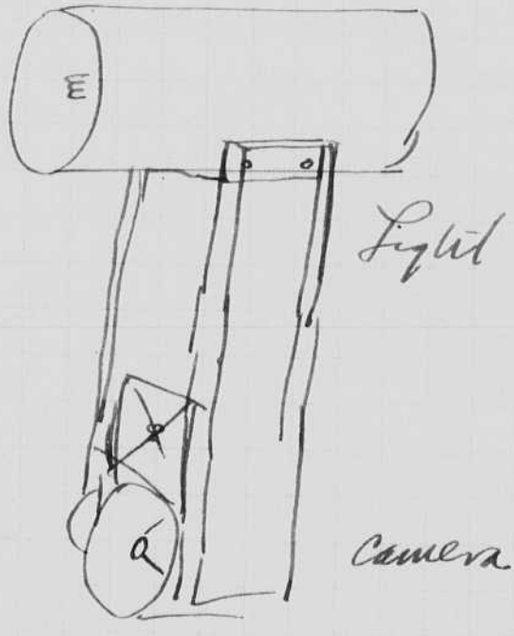
May 22, 1954 Con't.
Harold Edgerton.

200 Watt sec under Water flash

Some trouble with firing was observed several weeks ago in the pool. Bill looked into it and reports that thyratron 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 784401.
Summitar. 5 cm.

The strobe is a 200 watt sec. one charged from 6 ER6 Batts in Ser Par for 6 volts. 900 volt output unit 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		
∞		

May 23 1954 Sunday — High power Strob Lamps

Herbert Edgerton

Temperature calculations.

Heat flow through 3 inch I.D. 1/4" wall glass pipe.

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

K = .0015 (Hudson p 244) glass.
A = sq feet
d = inches
T = differential Fahrenheit
t = hours.
Q = kw hours.
C = 0.851 Hudson

Let $\frac{Q}{t}$ = 1 kilowatt
A = 2 sq feet
d = 0.25 inches

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

= 100 degrees rise (This is ok!)

now calculate the quartz tube.

K = .0036 (Hudson)

Q = kw hour.
d = cm
A = sq meters
T = Temp deg. cent.
t = hours.
C = 41.8.

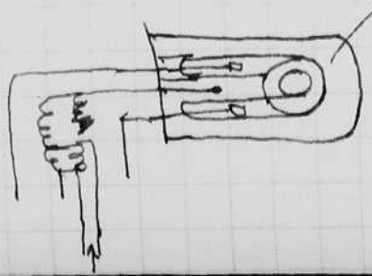
Example Let Q/t = 1 kilowatt.
d = 0.2 cm
T = 700 °C
Solve for area

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

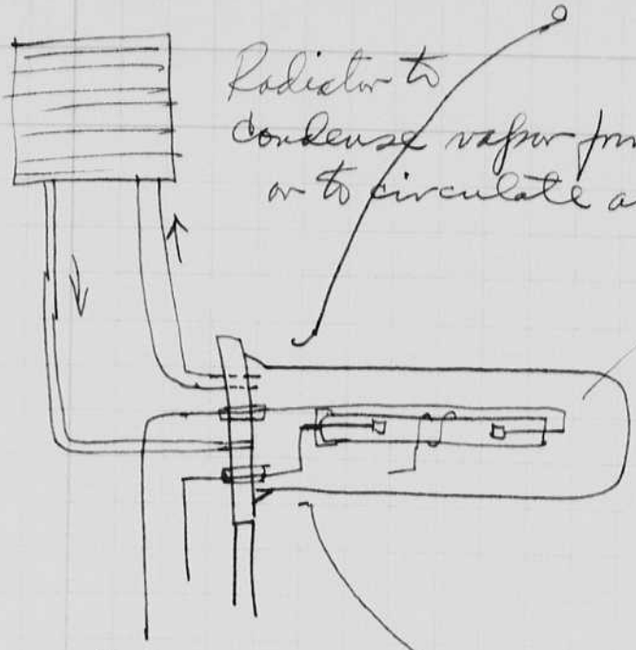
= 20 sq cm.

This is about the dimensions of the FT-427.

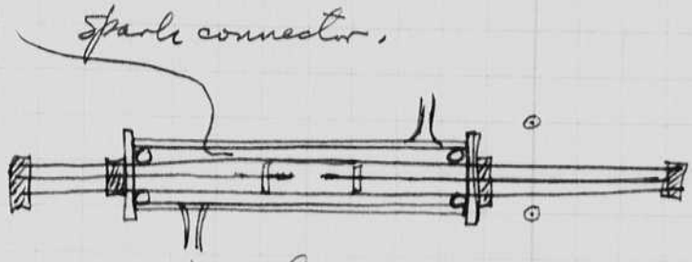
I now propose a thin walled quartz tube with a cooling liquid to carry the heat away and also to act as a starting band for the sparks.

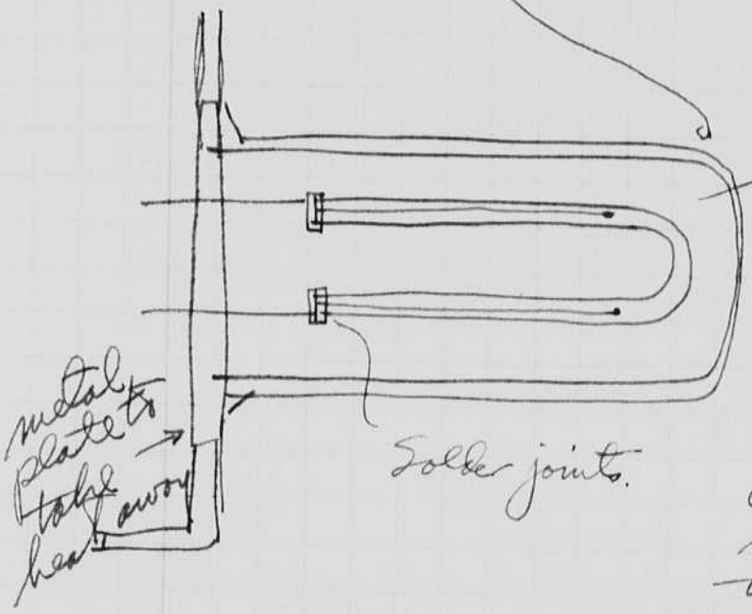


Liquid filled. Liquid is connected to the spark coil. Main terminals may be insulated, although this may not be necessary.

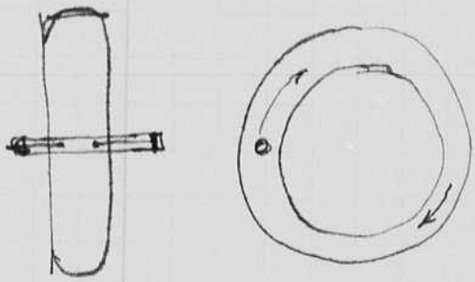


Liquid filled lamp.

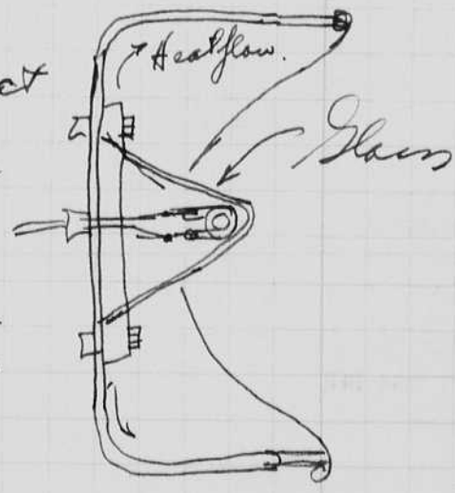




Air cooled high pressure lamps are not strong due to the weakness of the quartz at high temperatures. Liquid in contact will keep the temperature low on the outside skin of the flash tubes.



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.

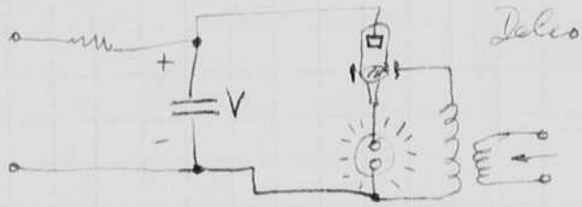
 May 24, 1954

Harold E. Edgerton.

6.20 quiz at 10 am. Integrating and differentiating circuit.
I called Forrest 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 lamps look most inviting.

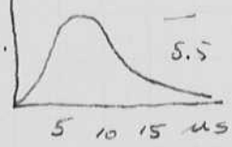
May 26 1954. Visit from groups at RLE today. Bill and I showed flashtube, microflash of bullets, 20,000 watt seconds on carbon paper and magneto optic shutter.

Set up Hg tube into a high pressure xenon tube. I find that the tube can be started with 4 0 volts on the capacitor! This tube requires a 1/2 inch spark in air to make it go.

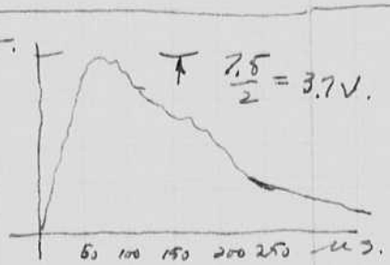


Delco coil with 1/2+ inch spark.

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



100 ~~150~~ V 525 electrolytic + 6 mfd. 24" no filter.
50 volts at end of flash.



150 V 525. 24" no filter

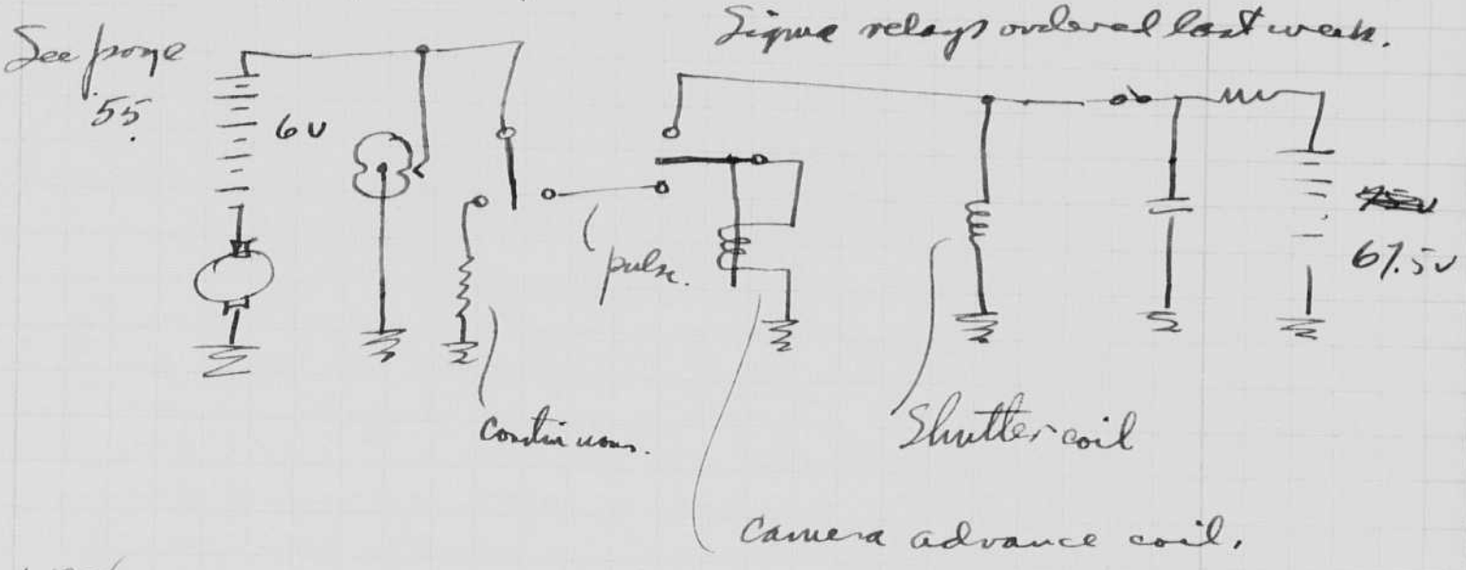
Read and understood page ... to page ... inclusive
D. E. Eisendorf
JUN - 1 1954 DEE
Date

May 29 1954 M.I.T.
Harold Edgerton

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

Picked up Bill and Allyson Moore at 625 West 114 at 4.30 pm and brought them to Boston with all of Bills books etc.

Working today on 620 term papers and grades. Relay system for camera.

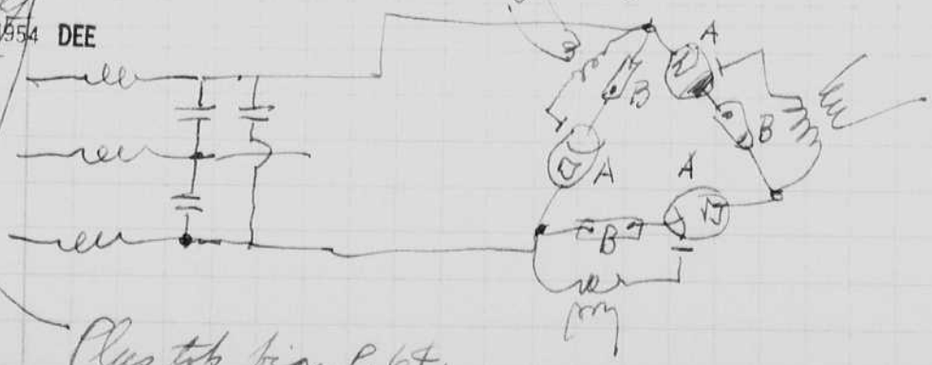


Signal relays ordered last week.

June 1 1954
Compressor ordered to Cleveland.
Harold E. Edgerton.

3 phase Power light

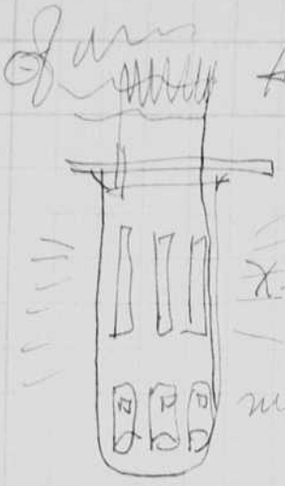
The series mercury tube will enable one to start a high pressure efficient xenon tube without a step up transformer. Since two lamps will always be lit at one time the flicker from the bank of three should not be objectionable for continuous light purposes.



A = Mercury tubes
B = Xenon high efficiency tubes

Plus trip fig. P. 64.

over

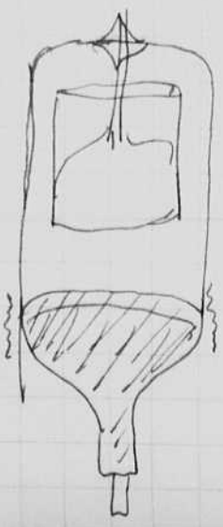


Harold E Edgerton
June 2 1954,
Xenon Room Hotel Cleveland Ohio.

I discussed at great length the series mercury arc tube with Elmendorf, Noel, Barnes, etc while at N.A. Nela Park yesterday afternoon.

Elmendorf requested Beiter to make a 1 atmosphere xenon flash tube of quartz with tungsten rod electrode. I suggested a tit of 1/16" width 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 current this will be tested with the series mercury starting lamps.

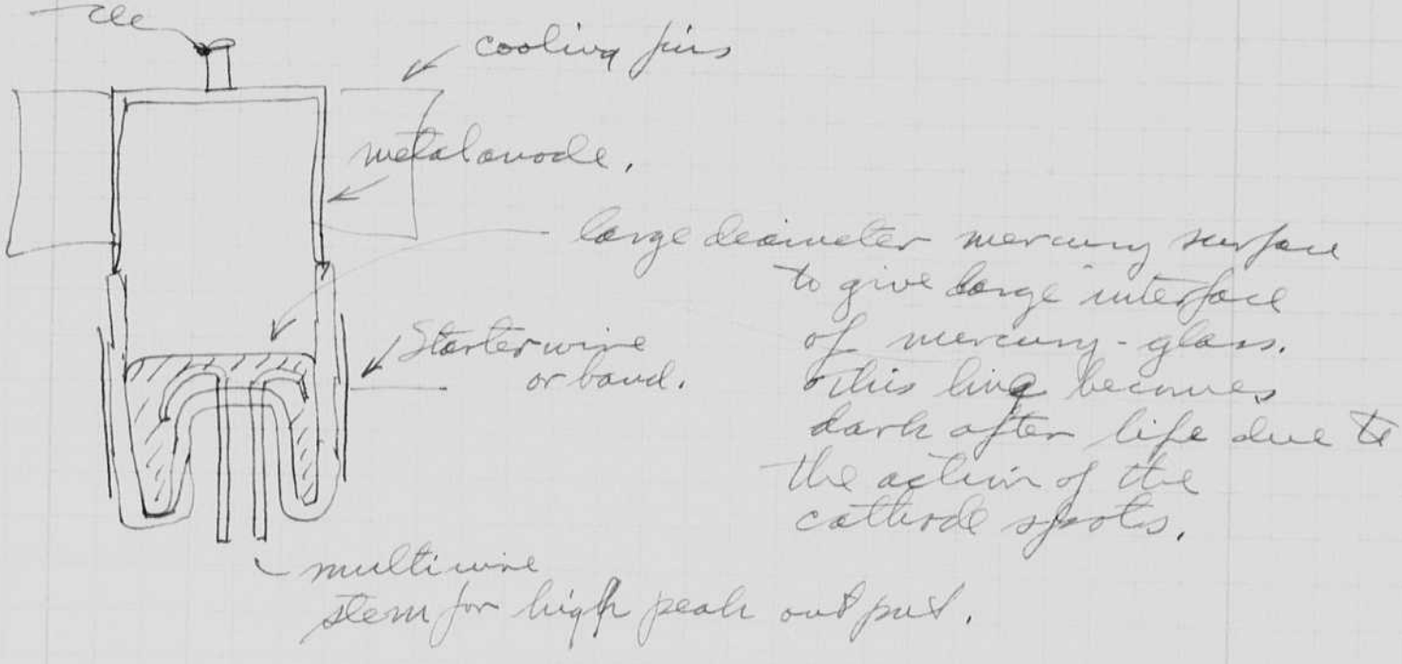
A discussion of special mercury tubes was also had with Noel and Elmendorf. I suggested a tube with short anode - pool spacing and a large anode for low drop operation at high current pulse operation.

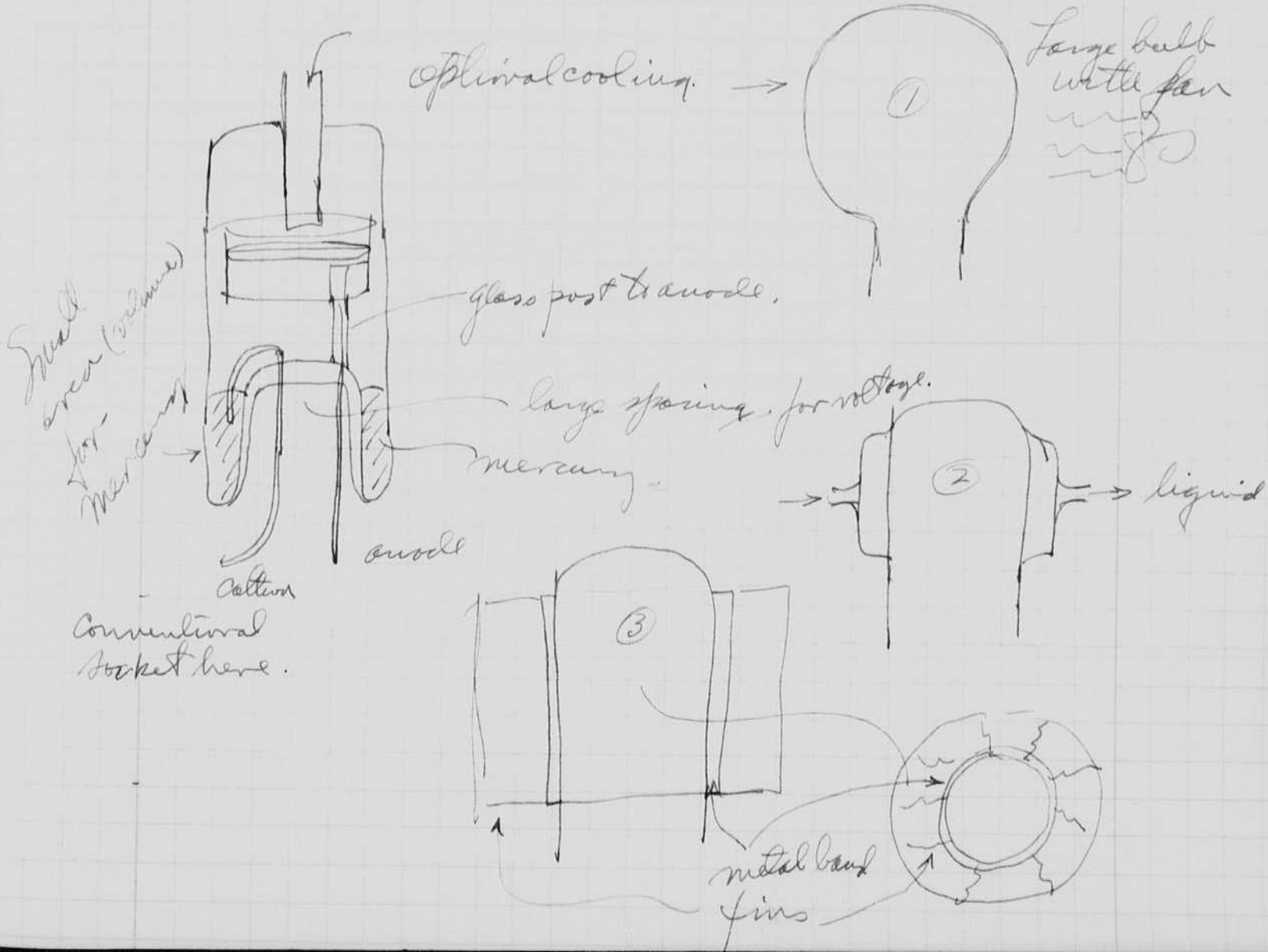


A screen or band of large area in contact with the glass outside the mercury is very important, since this gland and metal serves as a series capacitor to transmit the spark to the xenon tube in the cathode circuit.

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

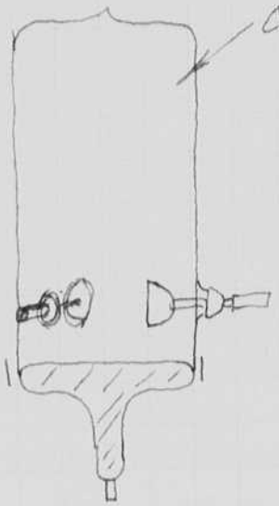
tube to take away the heat of condensation from the mercury vapor. The top could be made of metal so good heat conductivity would result.





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

Mercury-tube designs



1 kw into a 120 cycle xenon lamp.

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

4 - .25.

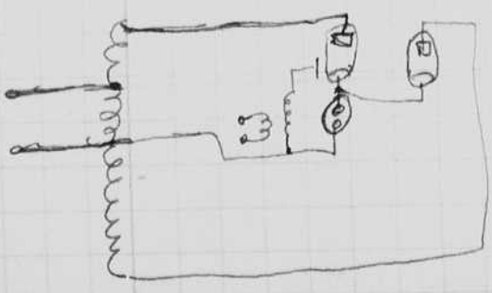
$$C = \frac{1000 \times 2}{f(200^2 - 50^2)} \cong \frac{2000}{120 \quad 37500} \quad 4000.$$

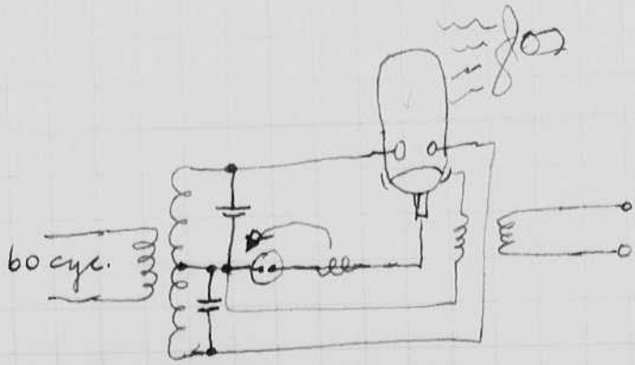
$$= \frac{1}{2} \times 10^{-3} \text{ farads.}$$

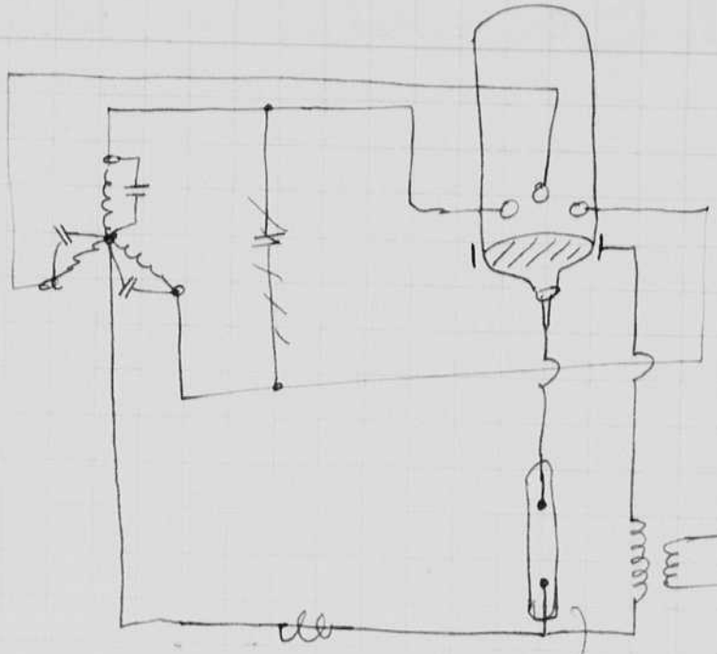
$$= 500 \times 10^{-6} \text{ farads}$$

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

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.

180 cycle pulse.

Capacitors on
secondary for
supplying surge
power to flash lamp.

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

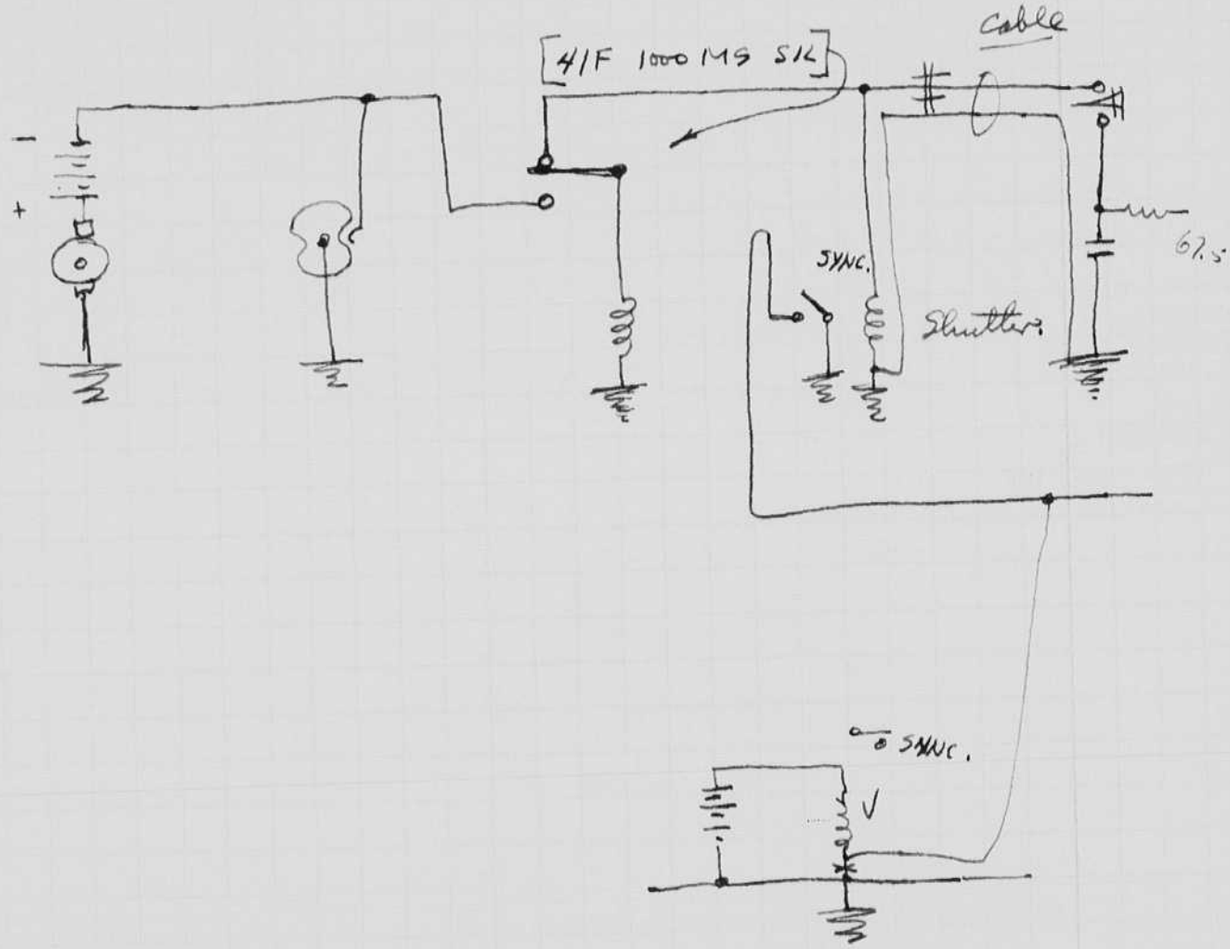
Read and understood page 57 to page 62 inclusive
D. E. Eimendorf
JUN - 2 1954 DEE
Date

Content read & understood by me June 11, '54
Robert Rines

June 4, 1954.
Harold Edgerton.

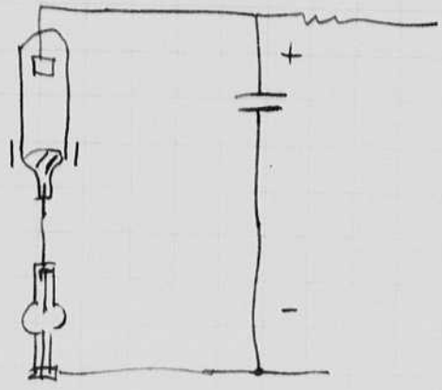
Bill Edgerton started working with me yesterday on the camera for under water push button operation. This is the camera that did badly on the last trip to Woods Hole.

A new relay. Sigma 41F Code 1000 1MS coil 51L 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 Hanovia Lamp. 10 atmospheres xenon?
3/16" gap tungsten electrodes.



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

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

Light hcps = $27 \times 1^2 \times 1 = 27$ h.c.p.s.

$$\frac{\text{h.c.p.s.}}{\text{watt sec}} = \frac{27.}{48.4} = 0.558 \text{ h.c.p./watt.}$$ 0.555

Size of area = sphere 3/16" diam. 3/16 = .477 cm. R = .238 cm.

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

$$= 4\pi R^2 = 4\pi \cdot .012 = .075 \text{ sq cm} \quad 0.25$$

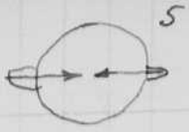
$$= 7.5 \text{ sq mm.}$$

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

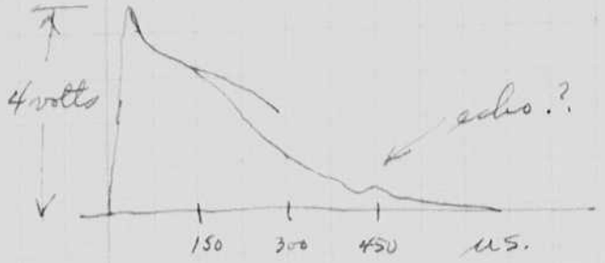
FX-1 H.C.P.S. = $100 \times 3^2 = 900$.

area = $6'' \times \pi D = (2.54 \times 6) \times \pi .4 = 19.2$ sq cm

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

70 5" diam Krypton lat. 1 cm gap.  5" diam

605 mfd 300 volts.



at 450 μs. 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.

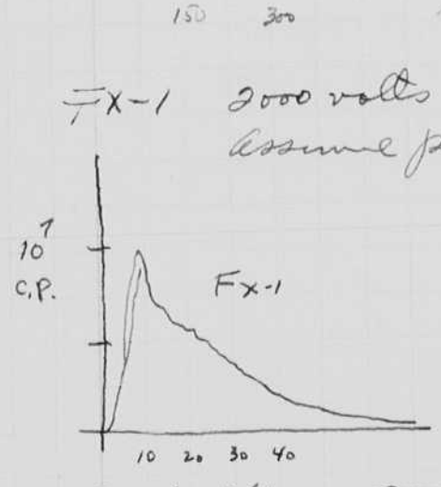
frequency for standing waves $= \frac{1}{.450 \times 10^{-3}} \cong 2000$ cycles.

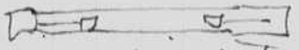
P.C. at 1 meter no filter.

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

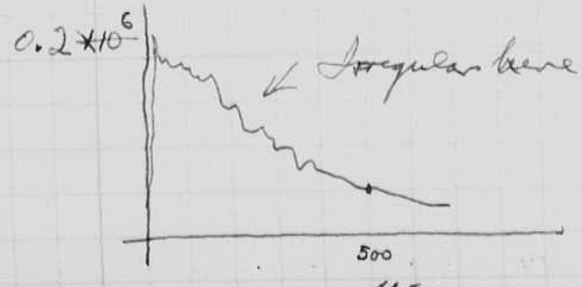
?? Less peak - shorter duration
rough light time curve ??

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



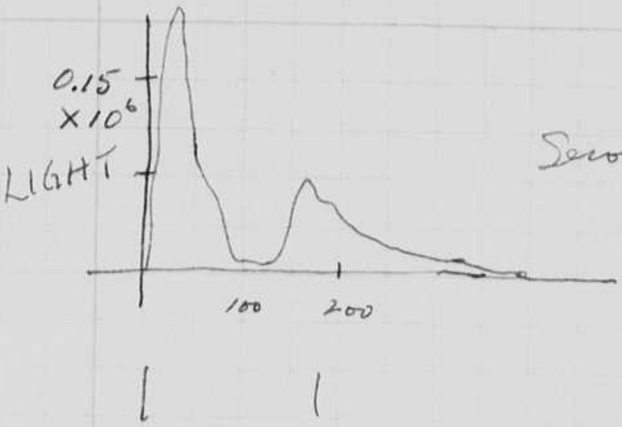
now test with  1 inch tube.

450 volts 605 mfd 1 meter D = 1.3



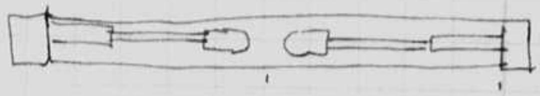
about same curve with 1200 × mfd.
Peak slightly higher.
say $.3 \times 10^6$.

1/8" Xenon gap 2 at mos.
1200 mfd. 470 v. Hg tube.



Second peak at 180 us.

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



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

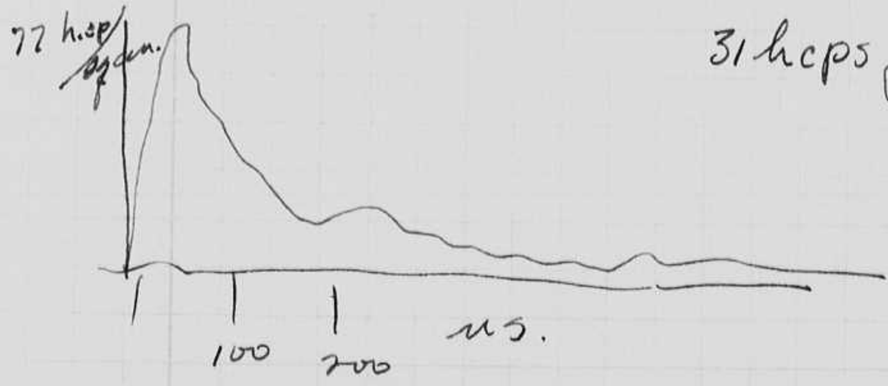
From tests with
Light meter.

area sq in	cp/sq in						cp/watt
3.2	181.	1" tube	580 Hcps from	1210 mfd 470 v		134 watt sec.	4.32
.4	160.	1/8" tube	64 " from	"	"	134 watt sec.	.478

There was some erosion on the 1" tube electrodes.

The 1/8" tube electrodes showed.
anode – melting – Spots of tungsten drops.
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 hcps from 3000 mfd 180 v $\frac{31}{48.7} = .64$ C.P./watt

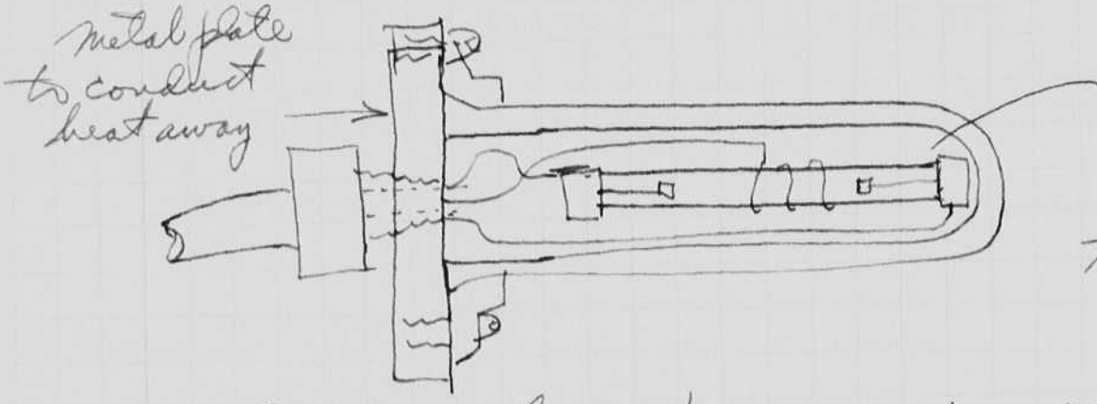
Bob returned from his first year at Uni of Rochester June 5.

 June 6, 1954

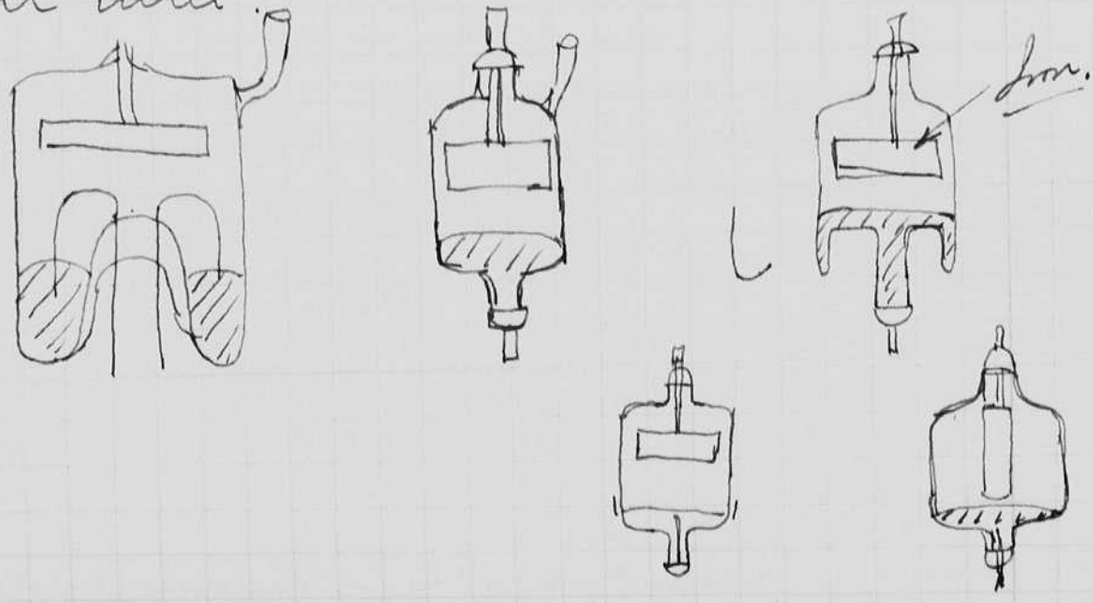
Harold Edgerton — Liquid-Cooled Stroboscope.

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

Emersion 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 output = 20 watts estimated.

100 cycles/sec.

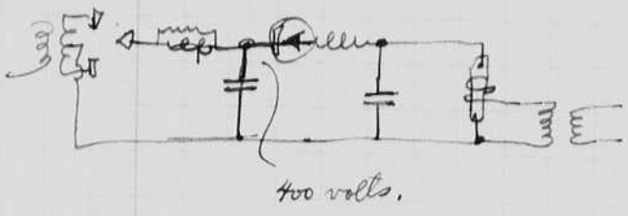
$\frac{CE^2}{2} f = 20.$

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

$f = 240$ ~.

$P = 20$

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



400 volts.

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

What is most efficient size for 2000 volt tube, 1 watt sec.?

$\ell = 3''$

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

then tube resistance will be

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

$C = 1 \times \frac{2}{E^2} = 2$ mfd. $\frac{RC}{2} = \frac{200 \times 2}{2} = 200$ microsec.

Discharge should be less than 20 ms.

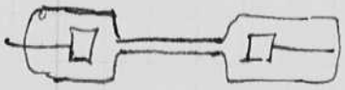
Try new design with $\ell = 1/2$ inch
$d = .1$ cm.

Pressure increase.
$6 \times 20 = 120$ cm
= 2 atmospheres.

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

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

$RC = 2 \times \frac{2.6}{2} = 2.6$ ms.



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

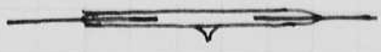
Temp calc. See page 60.

$T = 700°C$. $K = .0036$
$\frac{Q}{t} = .10$ kw. $C = 41.8$

$A = \left(\frac{Q}{t}\right) \frac{d}{CKT} = 0.1 \frac{0.1 \times 10^4}{41.8 .0036\ 700} \doteq 1$ sq cm.

area $= \pi .2 \times 2.54 = .8$ sq cm.

Should do it.



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

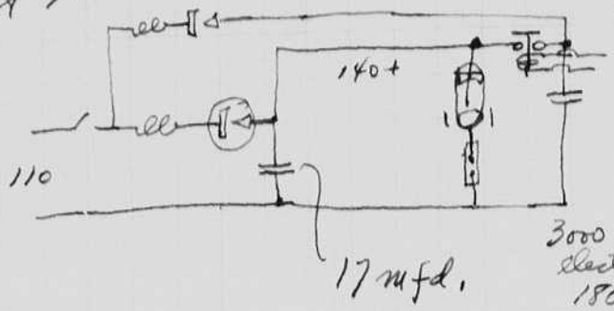
74 June 6 1954

Microscope Strob.

Harold Edgerton
205 School St
Belmont Mass.

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

.14
.14
.02
.06



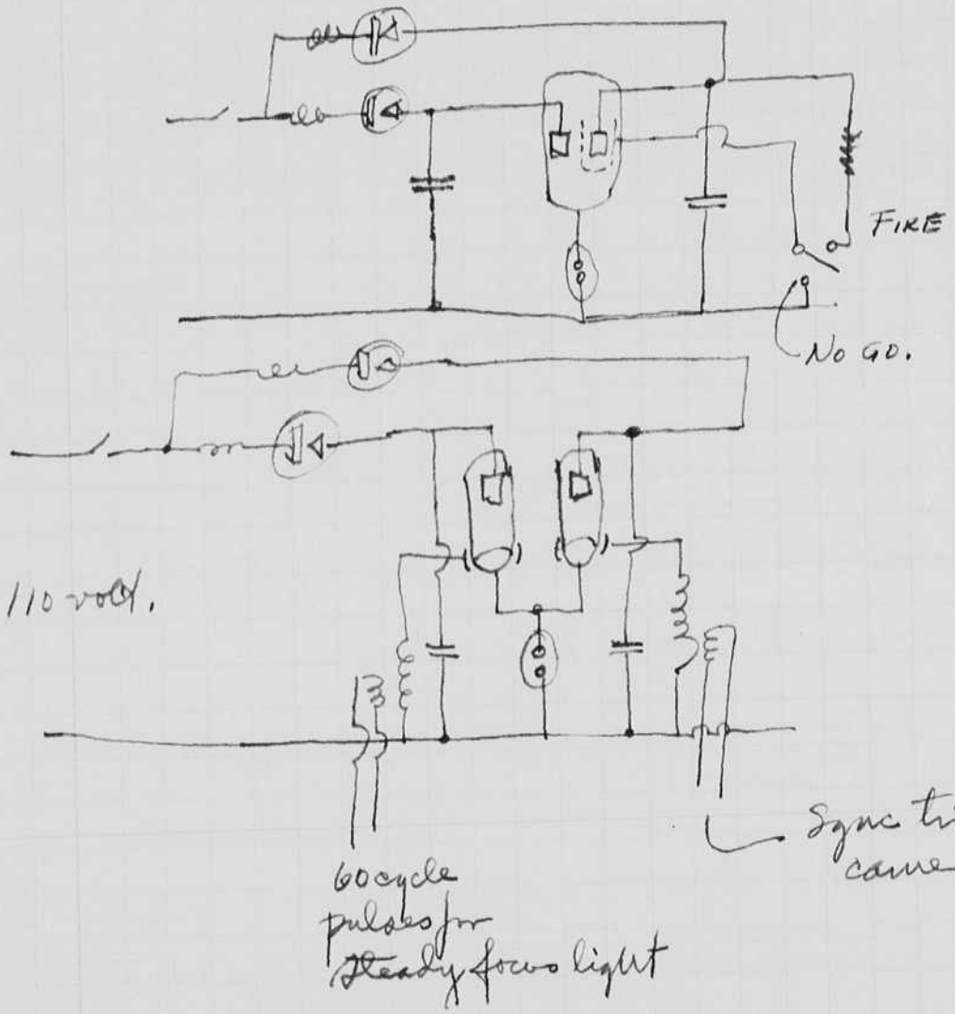
17 mfd.

3000 mfd electrolytic. 180 volts.

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

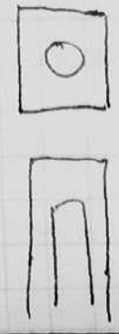
$\frac{CE^2}{2} = \frac{1}{6}$ watt sec per flash.

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



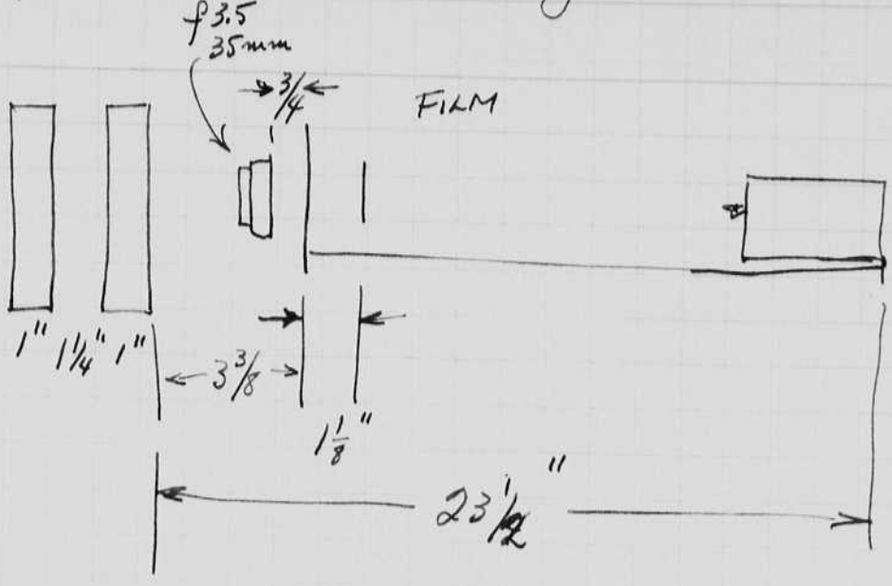
Sync trip from camera shutter.

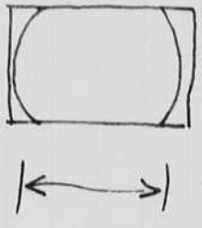
60 cycle pulses for steady focus light



June 7 1954
Harold E. Edgerton.

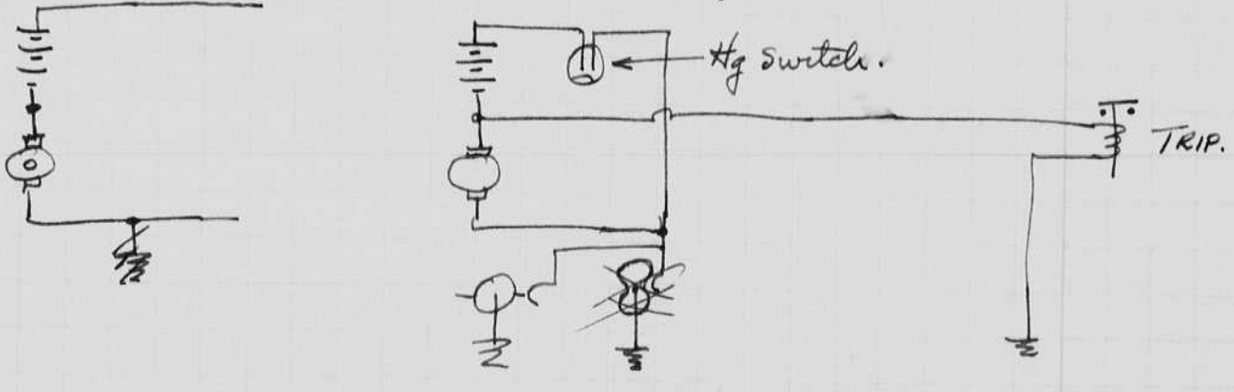
Silhouette camera for summer.





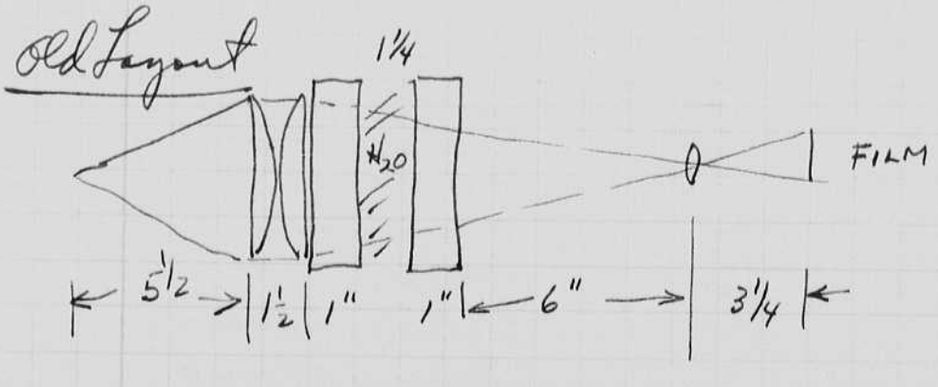
Frame on 35 mm film
3" diam approx field at subject.

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



Camera wiring diagram.

Old Layout



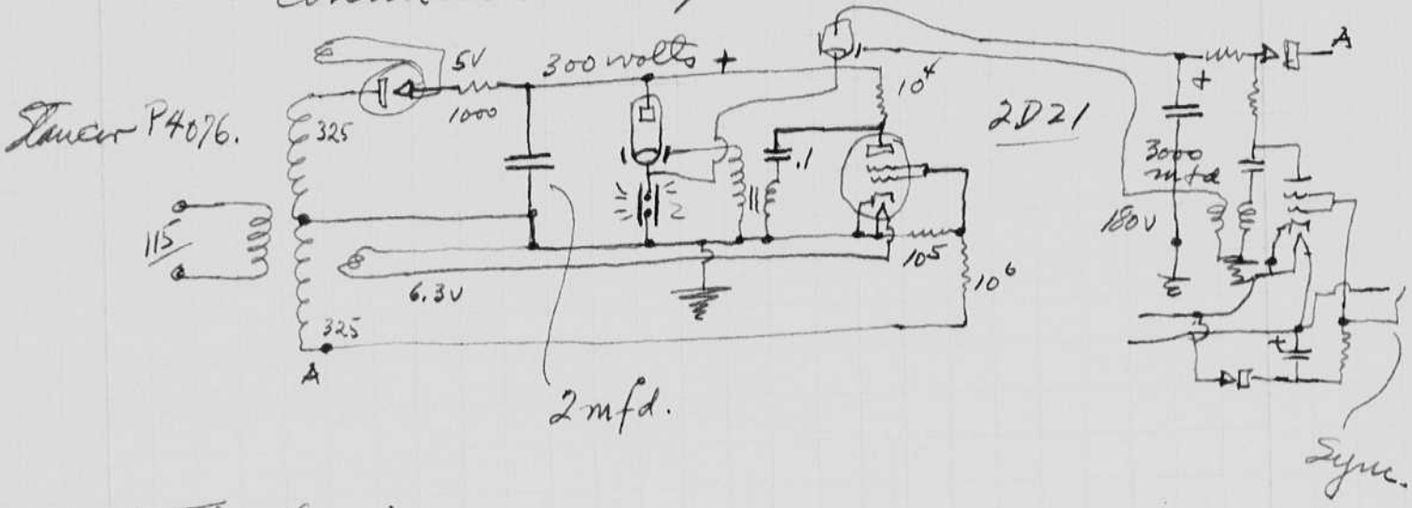
June 8 1954

Harold E. Edgerton
205 School St Belmont Mass.

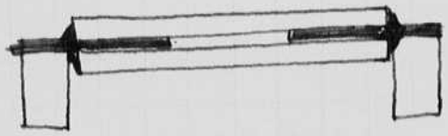
Just home from busy day making equipment for trip to France, leaving June 30. Bill is helping and will make the trip with me.

Grade conference this morning in 10-209 Jackson room.

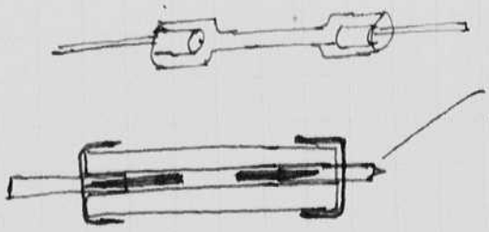
Continuous light circuit.

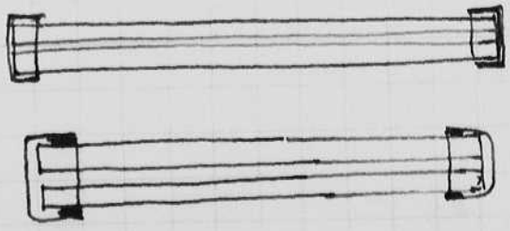


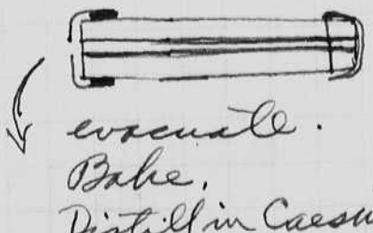
Tube design



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

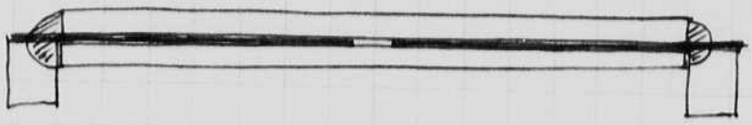






evacuate.
Bake.
Distill in Caesium
Xenon 1 atmos.
(or argon) Seal off.

Longer ends to take away heat. Argon 1 atmosphere



1/4" gap.
Tungsten seals.
40 mils
2.54
.04
.10 1 6 cm or 1.016 mm

Short are tabs.
Cathode or end plate.
under end of capillary Glass or
Quartz tubing.

after making these—
Drill one end
flash with argon at 1 atmosphere.
Solder slant on end.

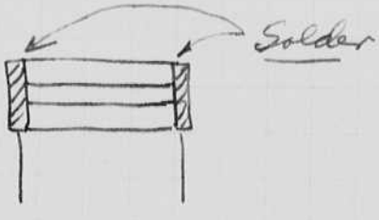
100 watt Jones lamps for underwater

30 volt 100 watt
1" diam
3 1/8" overall

other lamps.

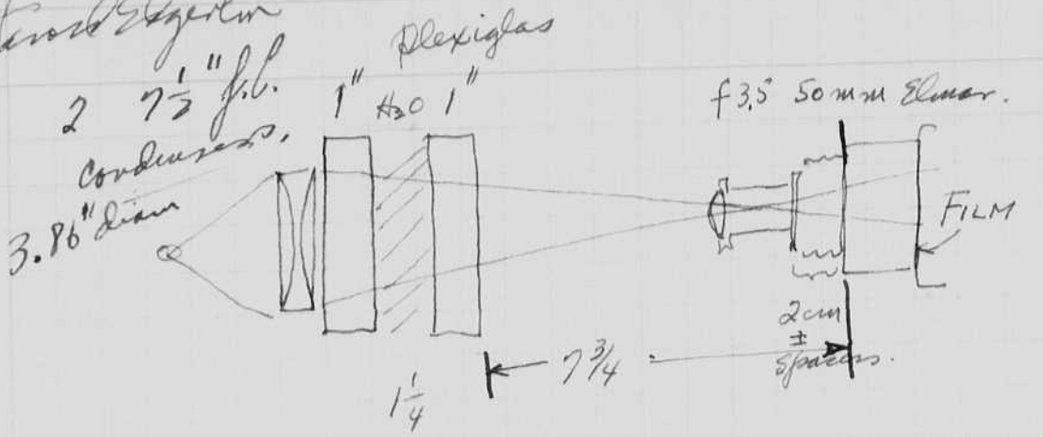
200w G 30/1 12 volt 3 3/8 diam Round bulb.

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



June 9 1954

Harold Edgerton



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

Sparker has 67.5 x 4 = 280 volts.
4 mfd.
Model electric PE coil.
4 - cap. in sec. 500 mmf.
Spark gap 1/16" in glass.

Enlargements of range of field

{ 9.1 mm
8.25 mm
7.95 mm } actual size = 2.8 mm hole in side of 35 mm film.

7.68" = 3/4" ±

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

on film

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

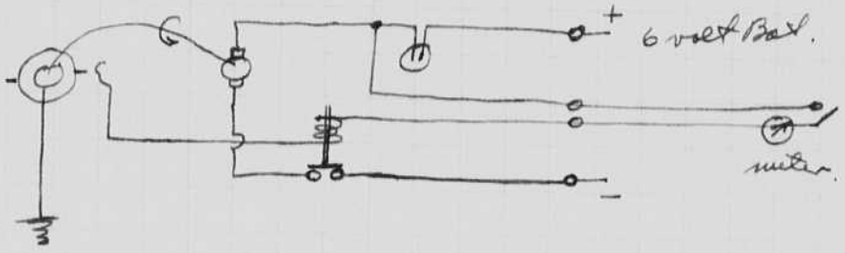
Demag on film = $\frac{2.8}{.81} = 3.46$

June. 17, 1954.

Harold Edgerton.

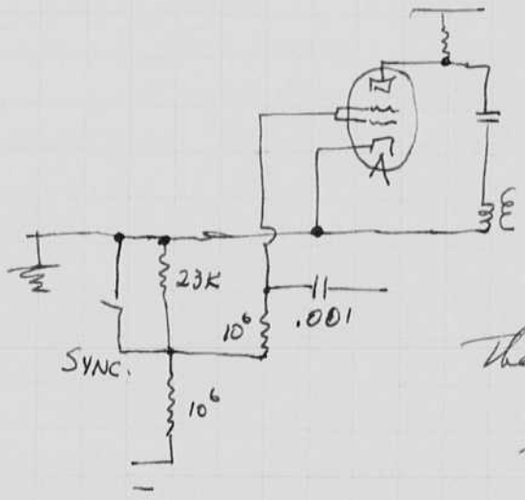
Conference with Rines and daughter Joan Needleman.
10.30 am Rounds and Mac? of the David Taylor model Basin,
were here to discuss propeller (slide) photography problems.
Spent every free moment on cameras for submarine
effort.

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



June 18, 1954. The Swimable flash unit has a delay when used with the Leica at 1/50 sec!

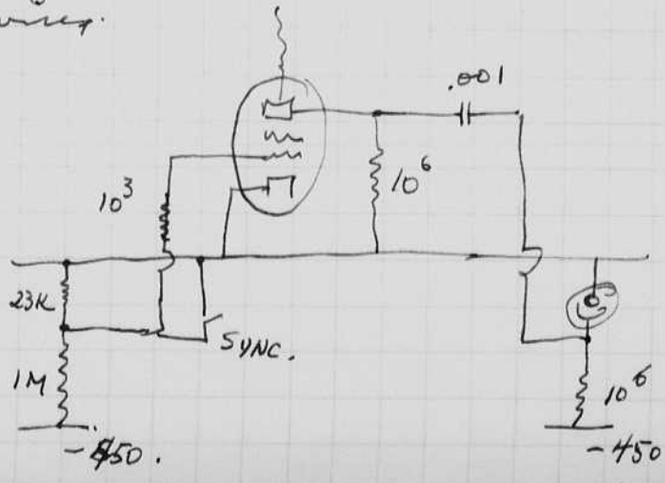
Orig circuit N.G. dated Apr 15 1954.



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 the following.

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



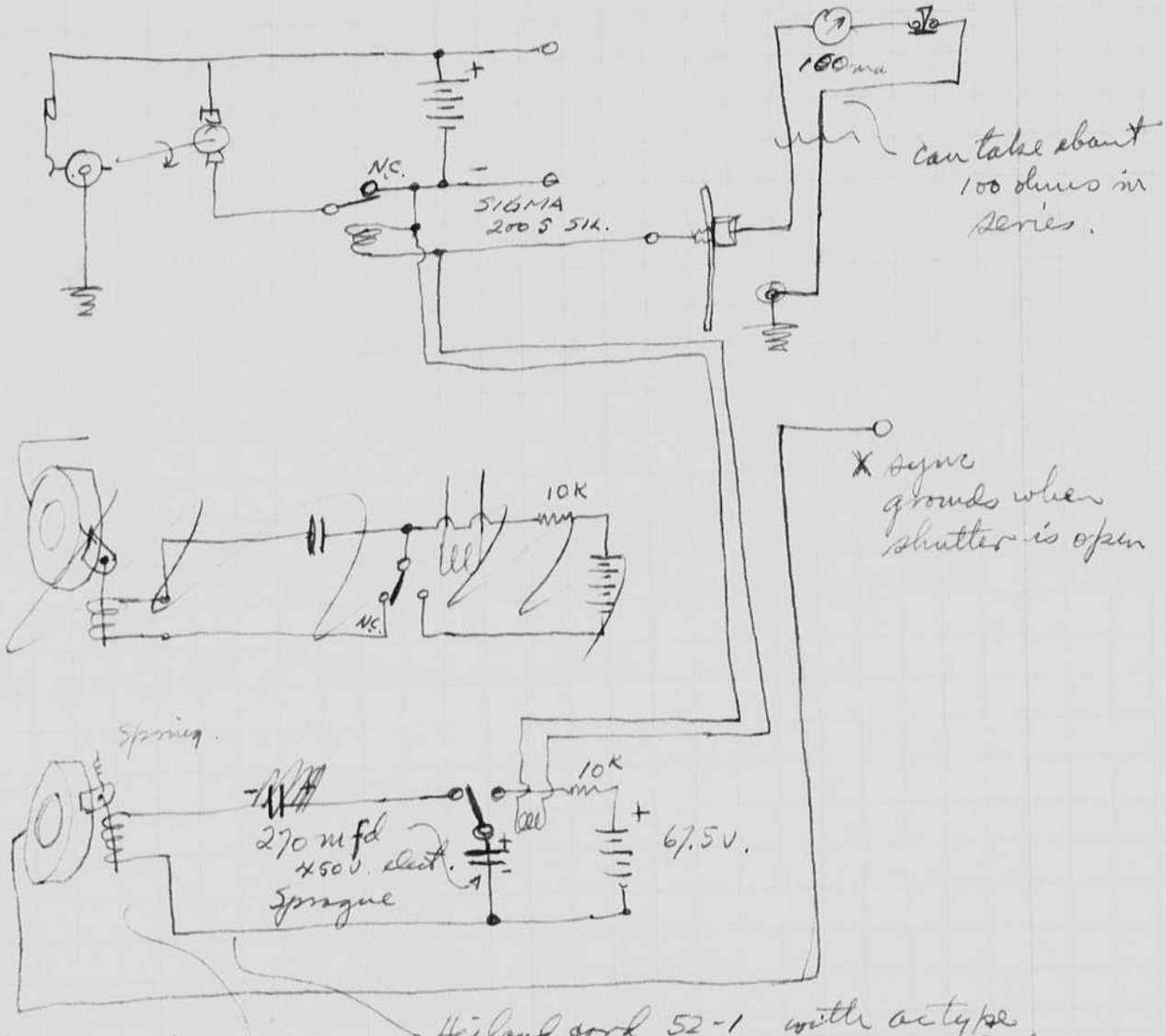
June 20 1954

Harold E Edgerton.

Camera Wiring with. Shutter control.

X sync to lamp. (Lamp has own power)

Monitor indicator.

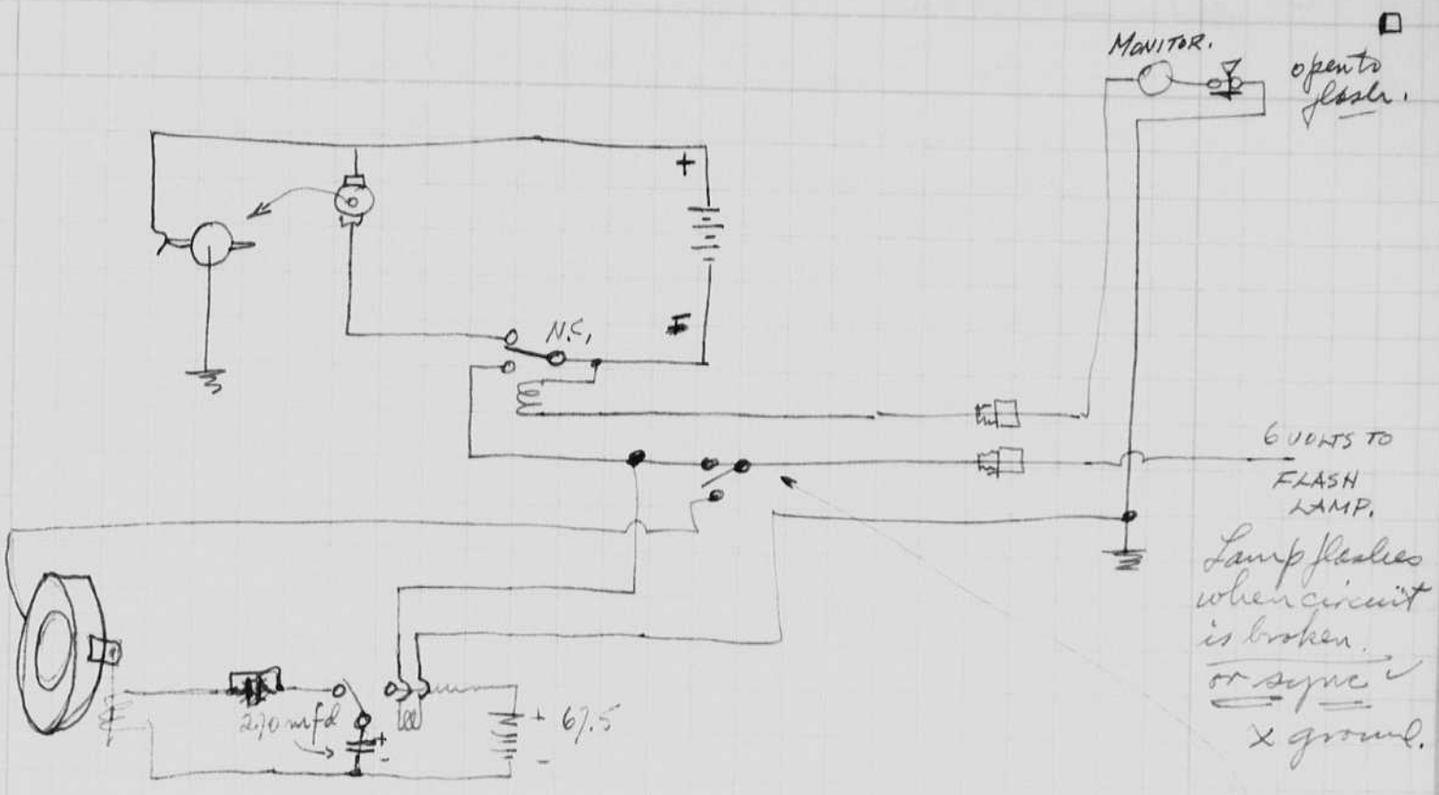


Hollensak.
X sync.

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 on runaway operation.

Use.

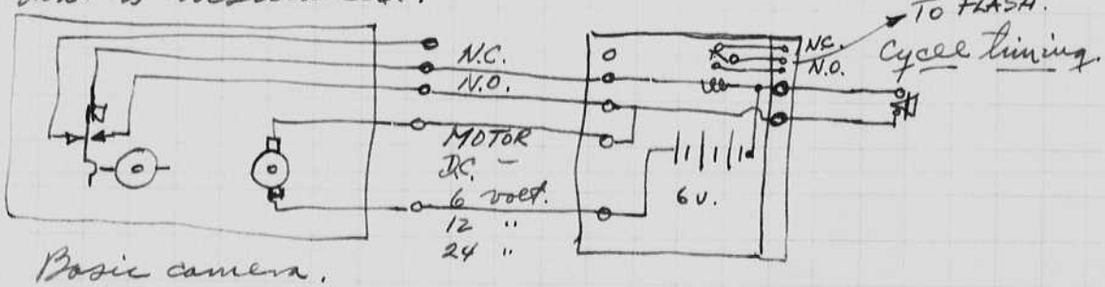


Synchronism depends upon the shutter being open when the flash occurs. There will be a delay in the triggering relay in the flash unit which must be made to correspond to the open time of the shutter.

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.



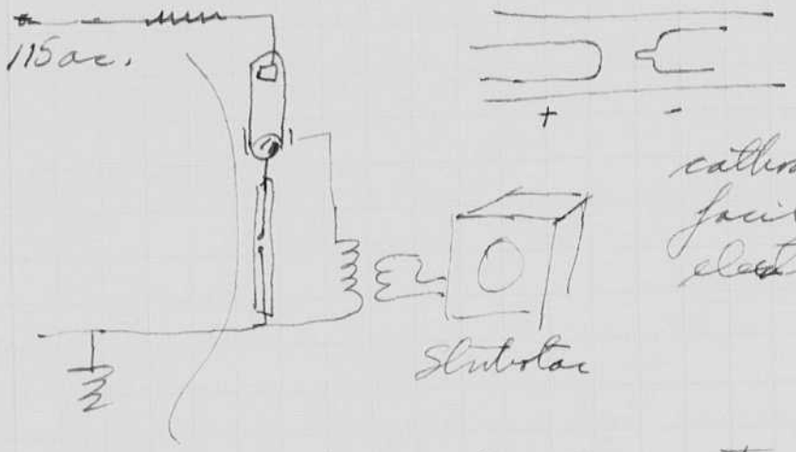
Basic camera circuit.

82 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 NewYork 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 Bathyscaphe.

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

Tests on xenon lamps from D.C. 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 by air plane (air France) from Paris with Bill. The story of our summer adventures with underwater 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 Bathysaphe, 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 three 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 Bathysaphe. Then we went to Marseille and Tunisia, and return with a group of biologists.

Aug 29 1954
on Calypso.
taken by Madame Cousteau.

Bill Edgerton

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

Feb 1955 issue Geo. Magazine had an article about the camera work.

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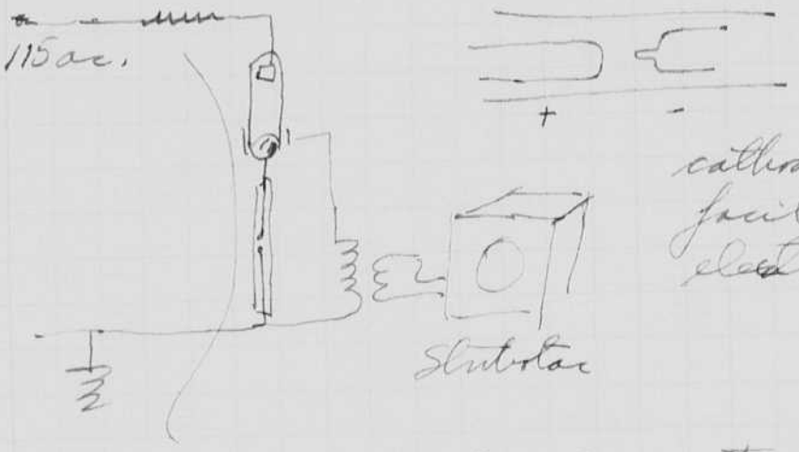

cathode has a point to facilitate heating for electron emission.

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

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Taken April 1955 Nat. Geo. Magazine had an article about the camera work.

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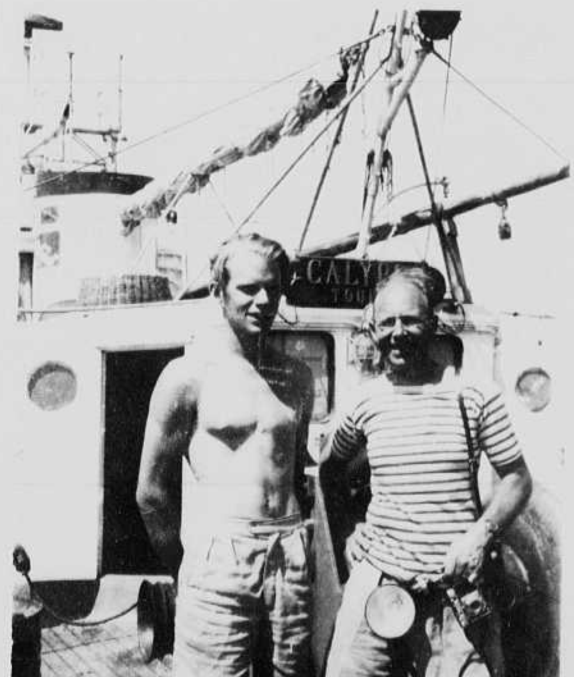
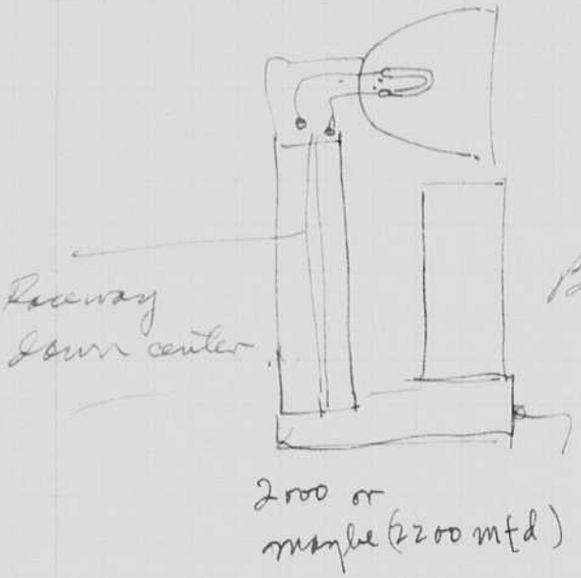


Bill Edgerton H.E.Edg.

 Oct 10 1954
Harold Edgerton.

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.

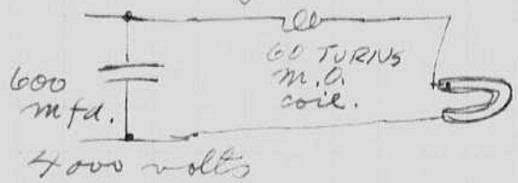
I was in Rochester Oct 8 to attend a conference at Eastman on Eilenberger's model of a portable. The design was a single unit with a 240 volt battery, a 2000 mfd capacitor and a U shaped flash tube. Out put was measured at 2200 B.C.P.S. in first tests at Mela Park, 160 reading at 4 feet. (140?).



Eilenbergers model had a detachable lamps. This probably has not reached.

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

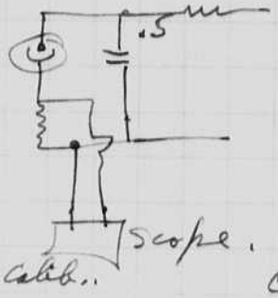


FT 617A flash tube.

Oct. 13, 1954
Harold Edgerton

Oscillograph tests of plate cells.

Source .03 at 2 KV.
high freq trigger.
Gas tube 1/8" gap Xenon 2 atmospheres.



	Sweep us/cm.	E	R.	Voltage Calib.	cell
Osc No. 1					
Osc. 1.	0.5 us/~~inch~~ cm.	90	1000		929. Vac cell
2.	.5 us.	400	1000	26 V/2. per cm.	"
		200	"	3.25 V/cm	"
		100	"		"
	Light reduced.			distance = 3' 7"	
Osc 3.	.5 us.	400 V	"	3.4 V/2 = 3 cm	.566
		200	"		
		100	"		
		50	"		
		25	"		
4	.5	80 V	1000	"	.566 929
	.5	80	1000		930
	1.0	80		"	
	5.0	80.			

light increased by factor of about 5.

High speed positive is marginal with 10 us/cm and full intensity f 2.5 or less.

Oct. 16, 1954
H. Edgerton
Ray Swanson

Response of photocells with short pulses of light.

Source 1/8 inch gap in xenon with 2 at. molybdenum.
Capacitor .01 mfd. Sprague 10^9 ohms charged from 2 KV.

Osc.	Subject	μs/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 200V 10^3	0.1	2.1	

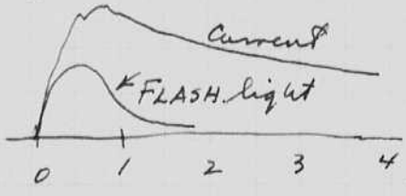
Photoflash Lamps. .01 mfd. Self flashed at 2 KV.

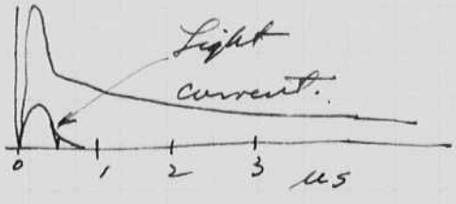
Oscillograms made with tektronic 137 scope.
f 3.5 lens XX film
trace obs at 0.1 μs/cm.
Light 1/2 on lines. with 1 sec exposure.

Oct. 19, 1954 H.E.

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

For example with a 1 μs flash, the photocell current holds up the peak. With a 1/3 μs flash the peak is greater than the after current.



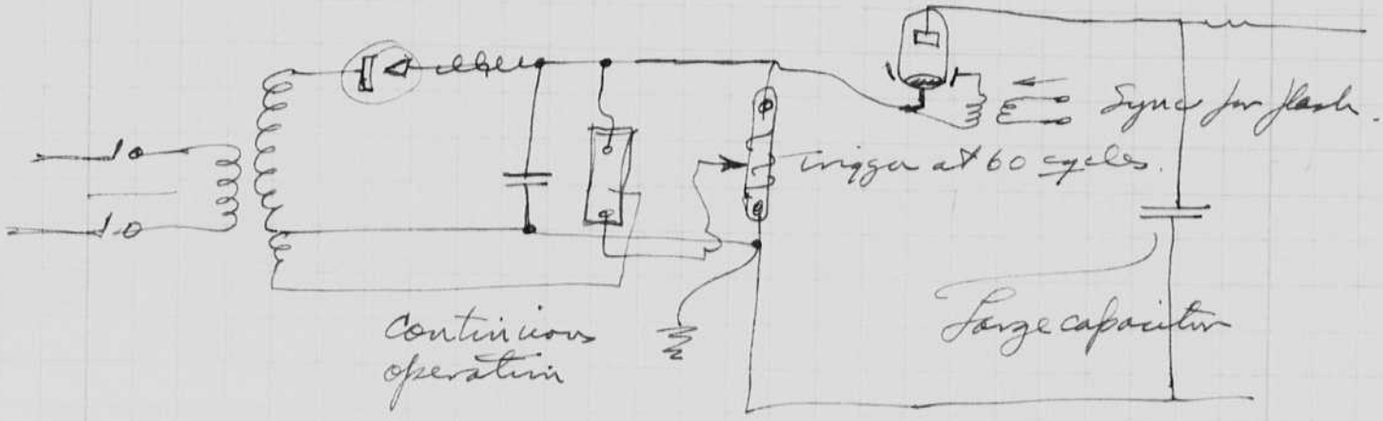


Ray S made a series of measurements today on some capacitors in the laboratory to find the natural frequencies. We then hope to make a series of experiments on gas-filled cells. A special zinc electrode photocell is being made by Larry Ryan in the glass shop.

Oct 19 1954
Harold Edgerton.

Liquid Cooled Flash lamps.

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.

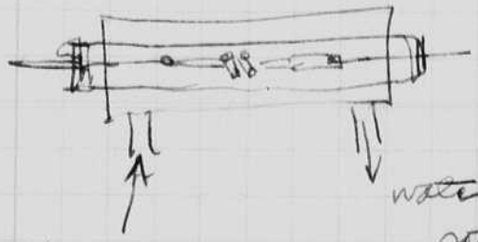


Suggest quartz or glass tube like the FT-218 for first studio model - then follow with unit using FT-623.

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 1½" end caps as made by Corning.

Oct 20 1954 Exp on FT-2 without jacket
0.02 mfd at 150 cycles at 8 kv. heavy mineral oil. 1½" 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.

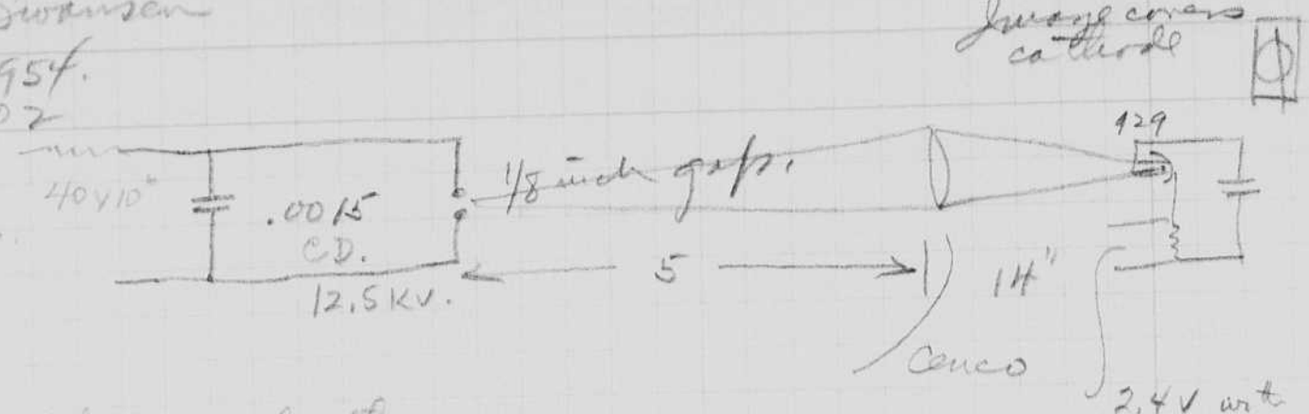


Read and understood
V. E. MacRoberts
10/20/54.

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

88 H. Edgerton
Ray Swanson
Oct 3, 1954.
20,102

Short flash test



c Condition. peak volts.

.0015 Spark gap 24 90 V input

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

.0005 Xenon gap. 10 V 105 Tungano.

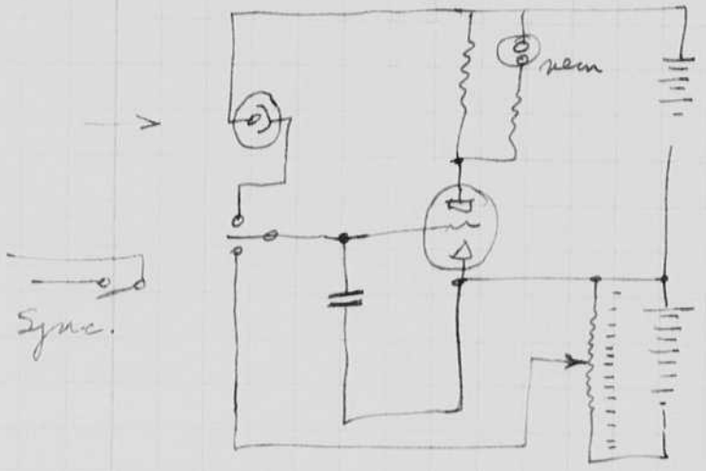
I begin to suspect the amplifier in the Tektronic scope type (513 D). An effort was made to observe the light directly with a photocell at the cathode ray plates. Difficulty with Sync.

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.

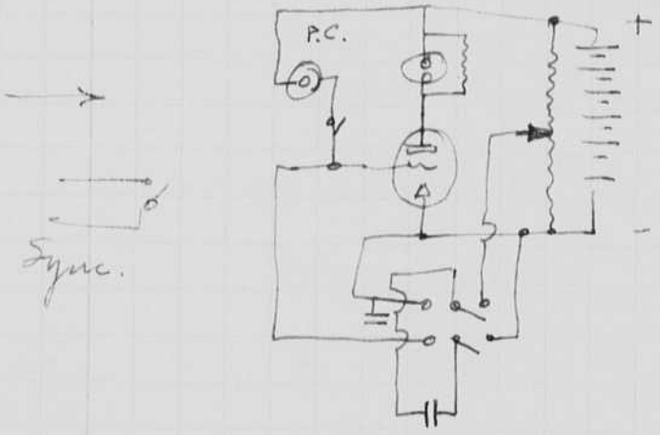
Oct. 30. 1954
Harold Edgerton.

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

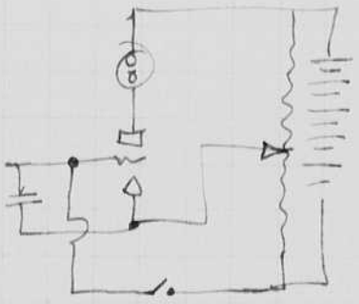
Light meter – "go or no go type."



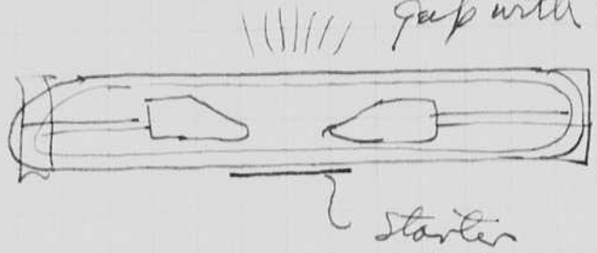
There is no meter on this equipment. A neon indicator tells if the integral of flash has reached a preset value.

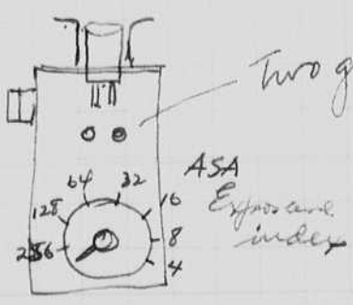


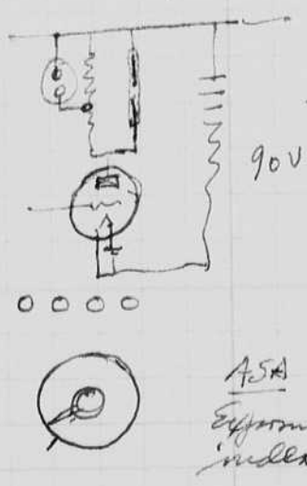
Sequence.
1. Charge capacitor.
2. Connect anode to grid.
3. Connect photocell.
4. Flash lamp.
5. Reset.



The arc in a flash tube always follows the surface of the inner glass when starting. Therefore in 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.

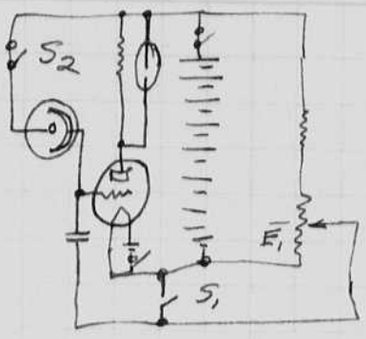






Oct. 31, 1954
Nov
Harold Edgerton

Exposure Indicator



S_1 switch throws the capacitor negative by an amount, E_1,

S_2 opens after flash to stop further photo cell current.

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

$i = C\frac{de}{dt}$ $\quad i = 10^{-12}$ amperes.

$C = ?$

$\Delta e = 10$ volts.

$\Delta t = 100$ seconds.

$C = i\frac{\Delta T}{\Delta e} = 10^{-12}\frac{100}{10} = 10^{-11}$ farads $= 10\times10^{-12}$ farads.

$= 10$ mmf.

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

Now calculate the photo tube performance.

929 photo tube 40 ~~lumens/watt~~ microamp/lumen. $= 40\times10^{-6}$ amp/lumen

$i = kl$

$k = i/l.$

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

$10 = \frac{40\times10^{-6}}{C}\times\text{area}$ $\quad C = 4.\times10^{-6}\times\text{area}$ farads.

area $= 0.5$ sq inch

$= \frac{0.5}{144} = .0347$ sq ft.

$C = = 0.1\times10^{-6}$ farads.

$i = kl.$

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

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

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

$\int L\,dt = 1$ lumen $\frac{.03}{\text{sec.}}$ / sq foot

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

$C = \frac{k\,\text{area}\int L\,dt.}{e_c} = \frac{40\times10^{-6}\ .035}{10}$

$= 0.1$ mfd.

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

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

Nov. 10 1954
Harold Edgerton.

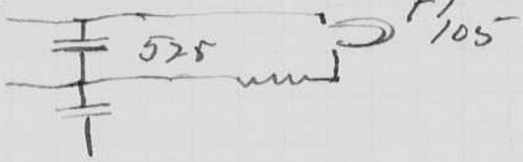
6.631 experiments are being made on the characteristics of Strobotron tubes mainly the 631P1.

Streak photographs were taken by Watson and Le Compt last week. Yesterday by Millen and Tandy. Oscillograms 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-gogo light meter as a thesis subject.

Nov 18 1954. Washington Nov 12 to see Constant, Simone Dugan. Also saw them in N.Y. at 10 pm at St Moritz on Nov. 11.

Wychoff uses long flash tubes.



$RC = .01$ sec.

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

$R = \frac{.01}{.00525 \times 10^{-6}} = 20$ ohms

=

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

Camera test new model for Bathy camera.

Motor Hansen 7100 C 6 volt DC 18 RPM

Rate at start = 24/minute,
" " ~~1/2~~ end = 120/min. (16½) 3/4 =
" " end

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

Nov 20 1954 Danish Tech.

FT-110 Starts at 200 - 250 volts,

10 mfd 500 volts.

D Light volts

	1000 volts	10 mfd	FT-110		50 volts peak on scale			
2.5 std. 25,000	500	10 "	FT-110	20 ms.	15 " " " "			
	500	10	FT-110	60 ms	1. volts	Series 10 Ω ± ?		
125,000	450	525 (600)	"	500.	25 1.	mo R.		.6x10⁸
100,000	450	525	"	3500	2.	Ran #1	7	
21,000	450	525		6000	.4 v	" #2	19	
10,000	450	525		9000	.2	" #3	29	
10,000	450	525		or 10,000.	.2	" #3		10⁸

Nov 21. H.E.Edg. called Closs Wyckoff about the above today.
This system increases the exposure time to 10,000 ms 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.

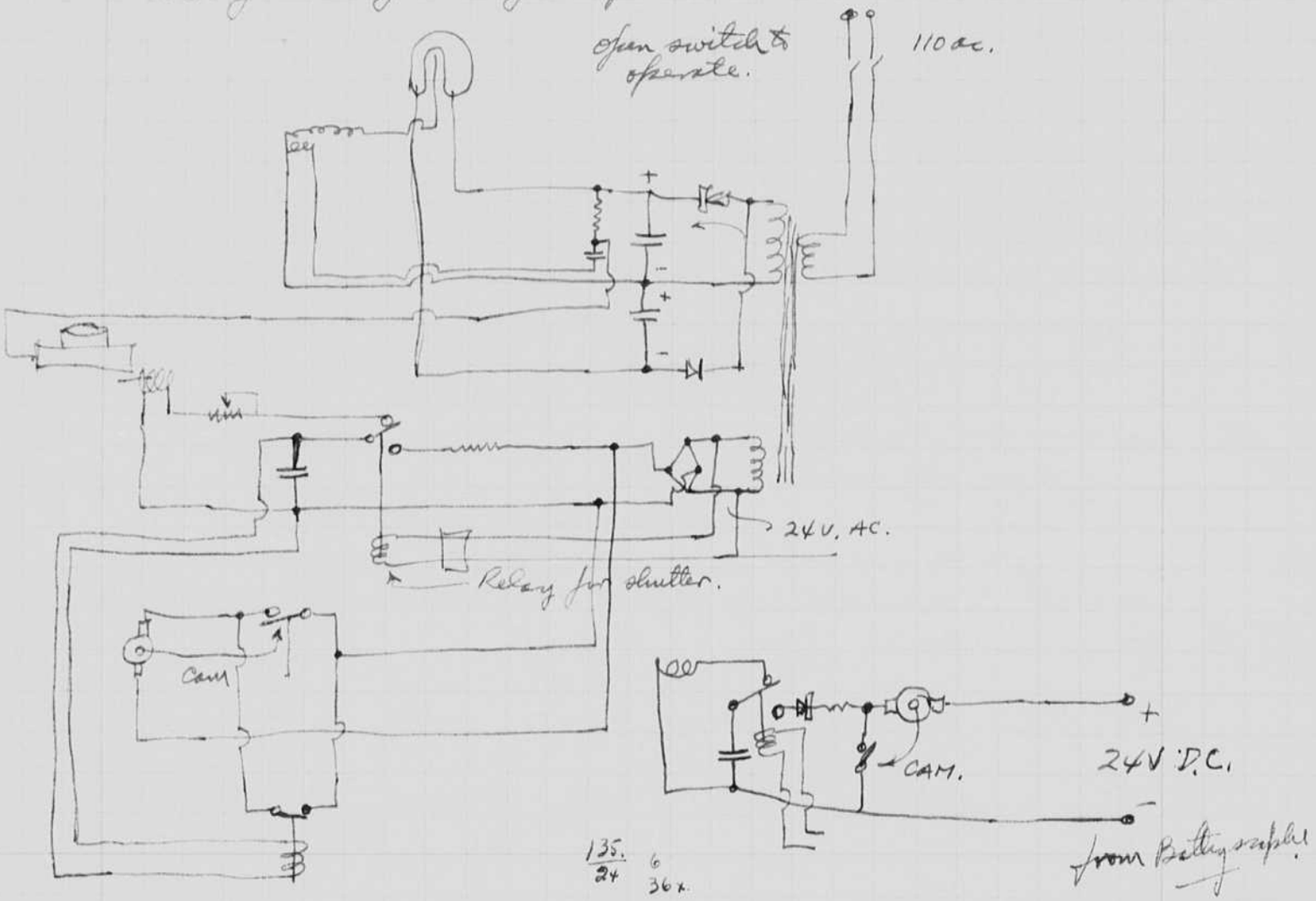
The .01 second flash source will be useful for the sensitometer which E & G are trying to make.

Nov. 22. 1954.

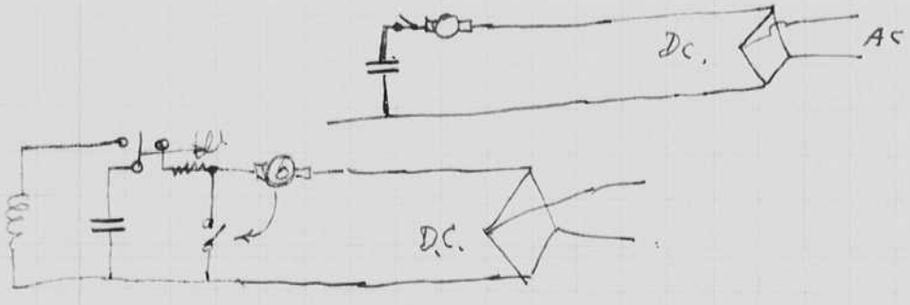
Harold E. Edgerton

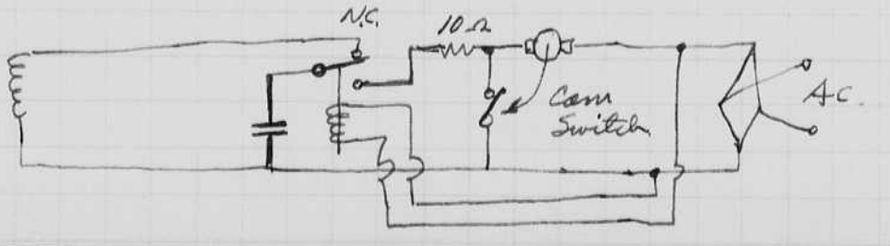
I worked with Bill MacRobertson saturday on the underwater cameras for the Navy and for the Battelle people. The Battelle people cameras will be operated from 24 volts and the Navy from 110 ac.

Navy unit for 300 foot operation.



$\frac{135.}{24}$ 6 36x.





$e = \frac{1}{C}\int i\,dt$

$e = \frac{.100}{250 \times 10^{-6}}\,t$

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

cont.

8×10⁶ 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. Effy = 5.0 cp/watt.

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

Let length be prop to voltage and watt sec to volume.
then length = $\frac{6.00}{4}$ = 1.5 inches.

$d_1^2 l_1 = d_2^2 l_2 \times 200$ $\qquad d_2^2 l_2 = \frac{d_1^2 l_1}{200} = \frac{4^2 \times 6}{200} = \frac{96}{200} = \frac{1}{2}$ $\qquad \frac{16}{6}$ $\frac{6}{96}$

then $l_2 = 1.5"$

$d^2 = \frac{1}{2}\frac{1}{1.5} = 0.335$ $\qquad d = 0.58$ mm.

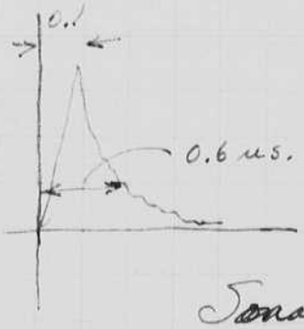
$\frac{8\times10^6}{15} = 5\times10^5$ cp per cm. $\qquad \frac{1.5\times10^6}{\text{cp per cm}} = 1$ cm.

try a gap length of 1/2 inch.

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

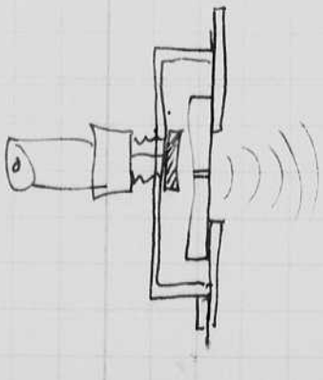
Max brilliance 1/2 joule .01 mfd
peak intensity = 1.3×10^6 c.p./sq.cm.

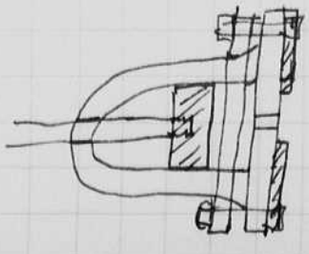
Data from Cornell Lab Buffalo. John Lawton



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 Day!

Harold Edgerton.

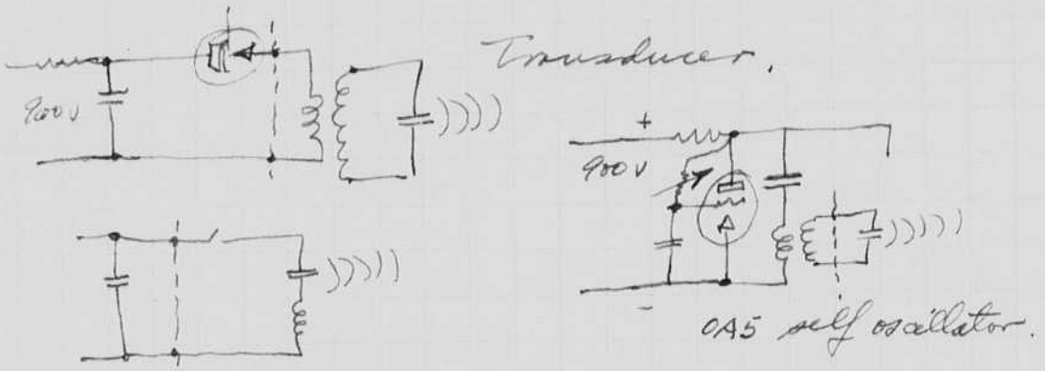
Edo people.
- Geo Rand. Eng. dept
- Sol Levine chief Eng.
- Gerry Albert Ellert.
- Bill Ryan
- NB McLean

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

I looked at both Barium titanite cylinders and at ADP crystals. Finally decided to use ADP crystals in 3 banks of 10 each.

30 mmf each x 30 = 900 mmfd.
= .0009 mf.

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



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

Grommets. -
Neo-Sil Prod. Div
Rubber Associates
950 metropolitan ave
Brooklyn N.Y.

Glenco corp Dr. Dalton
Abe Dranetz MIT '46.
Metuchen N.J.

Barium titanate crystals.

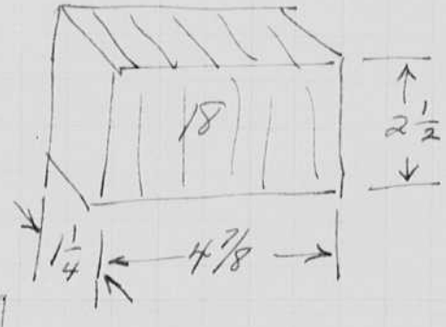
Schedule for Calypso
Jan 20 Leave for Algiers
May 20 arrive at Marseille

June 1
to October.

Egypt
Syria
Lebanon
Cyprus Crete Marmara
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 Oct. Nov.

Standard stack of ADP crystals



Film Viewer

Flo Film
Diebold Co.
Canton Ohio.

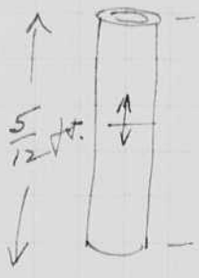
12 kc resonant in H2O.

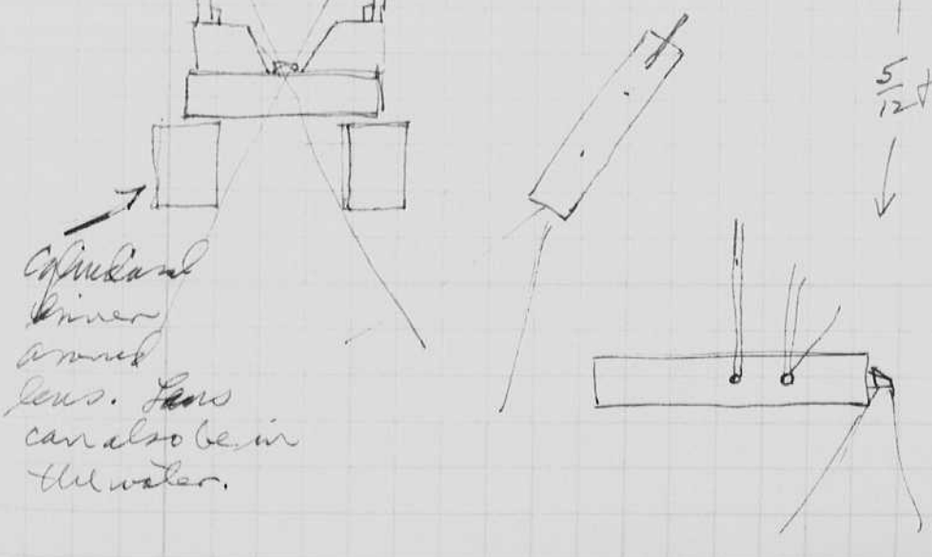
$v = 5000$ ft/sec.

$d = vt.$

$= 5000 \cdot \frac{1}{12,000}$

$= \frac{5}{12}$ foot. $= 5''$

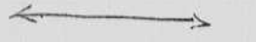


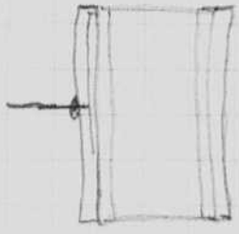


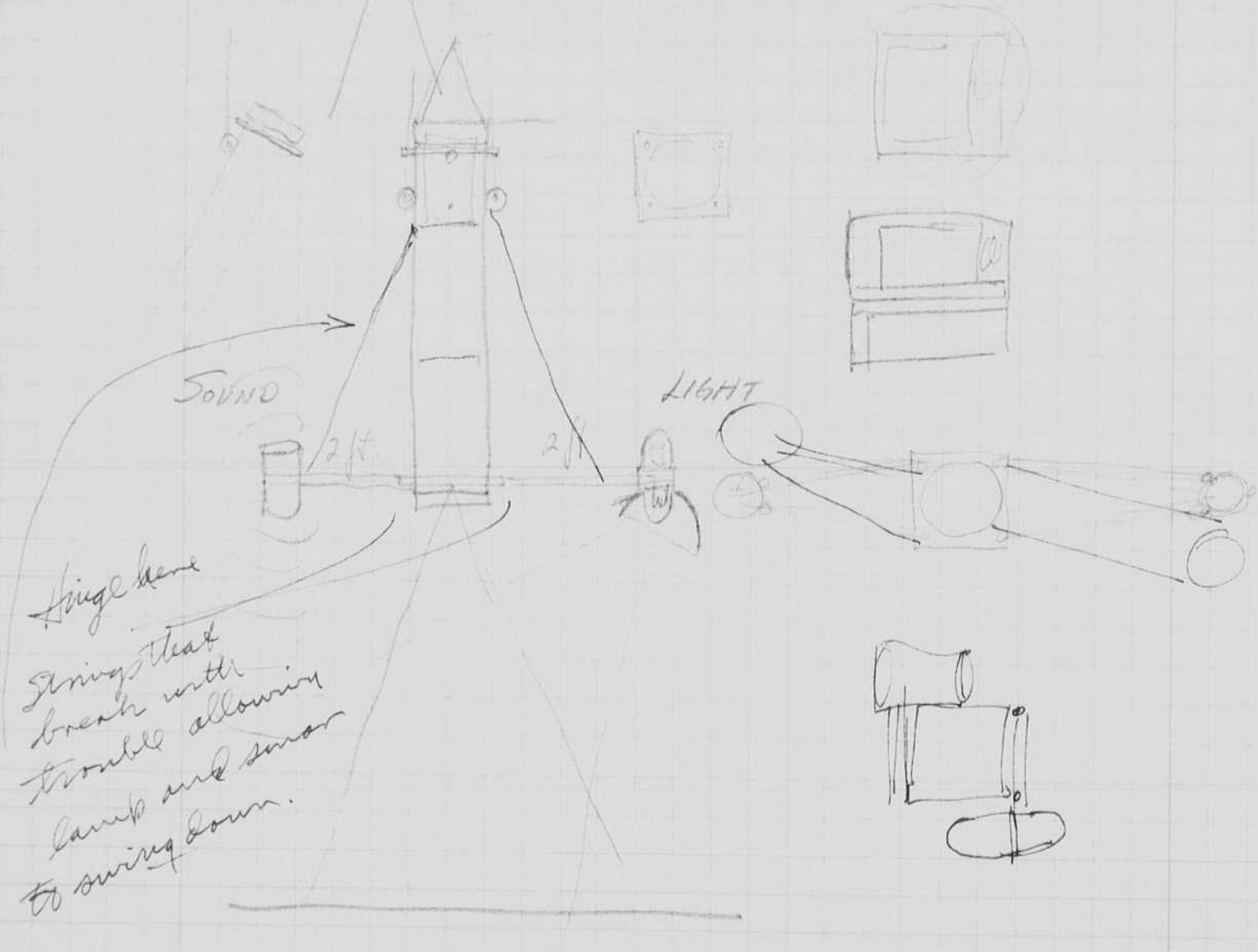
Cylindrical mirror and lens. Lens can also be in the water.

To do for this summer with Austeau.

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



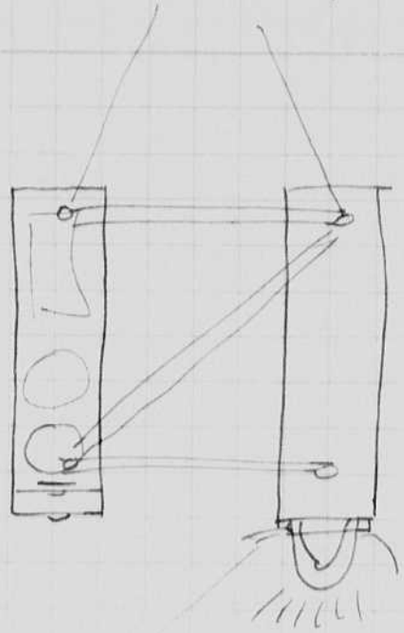




Hinge here
Spring steel
break with
trouble allowing
lamp and sonar
to swing down.

Nov 27 1954
Harold E. Edgerton

Deep camera with Photocell triggered camera from flash lamps.



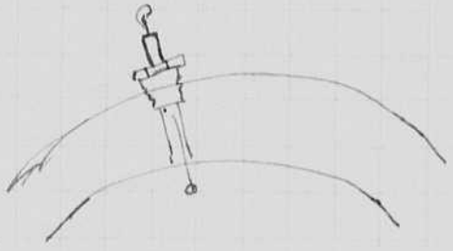
CAMERA with photocell to cycle the film.

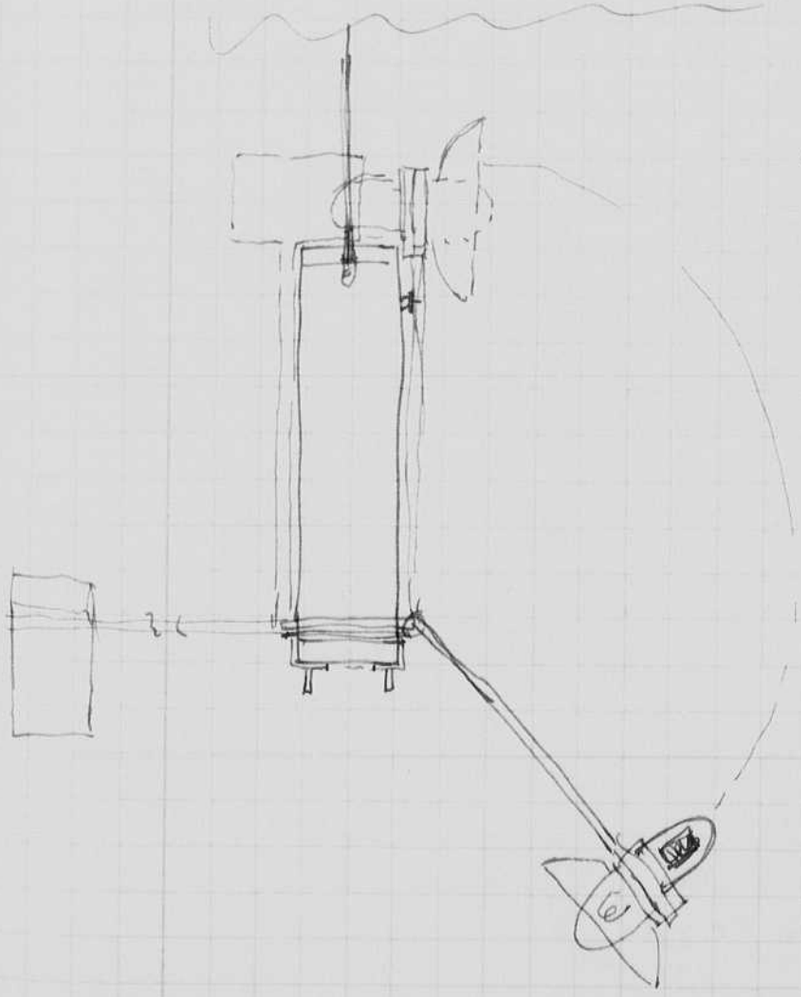
LIGHT.

No wires from camera to light.

Light flashes at regular intervals.

Photocell in camera causes film to cycle.





Camera test.

Hycon to MacRobertson.

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
1:30 48 " "
1:33. 120 sec

16 min for a 100 ft roll

24 volt 640 RPM 1/16 sec. per frame
160 " 1/4 sec, "
40 " 1 pict/sec. "
10 " 4 sec " 2 ordered 4 of these motors
2.5 " 16, " "
.625. " 92 sec. "

Dec. 4, 1954, Sat. Aft.
Hycon Elgeyton.

Just showed slides to the U.S. Science teachers assn at Mountworth Institute. McCrary of Sonics was there for a talk also.

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

Let C = 525 mfd and T = 50 ms.

$\frac{RC}{2} = 50$ ms

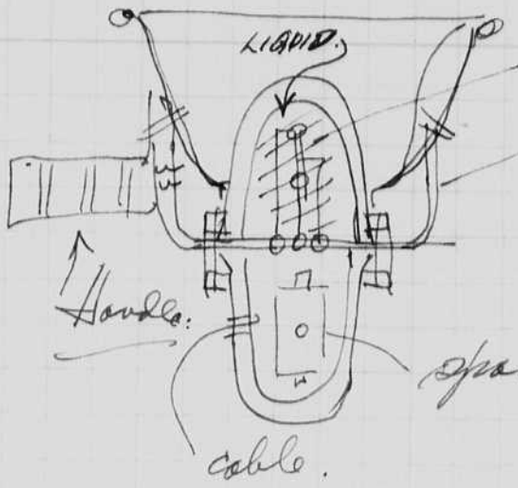
$RC = 100$ ms. $R = \frac{100 \text{ ms}}{500 \text{ mf}} = \frac{1}{5}$ ohm

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

Watt seconds $= \frac{CE^2}{2} = \frac{450^2 \cdot 525}{2} = 50$ 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 Strob lamp.



quartz flash tube.

copper to conduct heat from the oil.

Fluoralube FS. coolant is to be tried. mineral oil and Ethyleneglycol turn yellow.

spark coil.

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 Brenewalt flash unit.

For 50 us unit on FX-1 C = 35 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.

$C = 35 \times 6 = 210$ mfd.

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

$\frac{CE^2}{2} = \frac{210\ 450^2}{2} = 21.3$ watt seconds.

Peak current $= \frac{\frac{450}{3000}}{1/3 \text{ ohm}} =$ 1350 amperes.

Use more units in parallel for more light.

Now calculate full load condition for 1 inch tube using basic calculation of 100 mfd 3000 volts. $\frac{CE^2}{2} = 450$ watt sec.

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

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

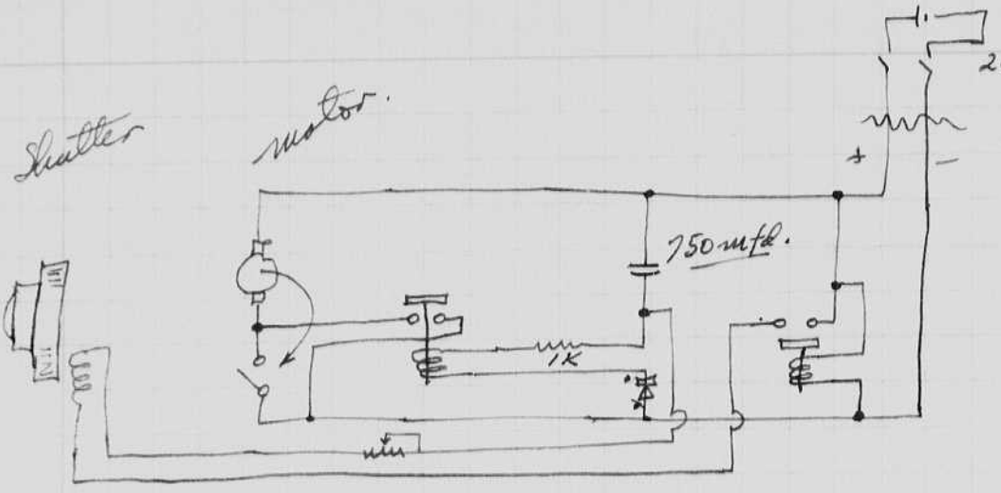
$I_{max} = \frac{3000}{6} \times \frac{1}{3} = 1500$ amperes.

$\frac{CV^2}{2} = \frac{500^2\ 600}{2} = 25.10^4\ 300 \times 10^{-6}$

$= 75$ watt seconds.

Duration = 140 us.

24 volt Battyscaphe camera



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

Design dropout at 12 ma.

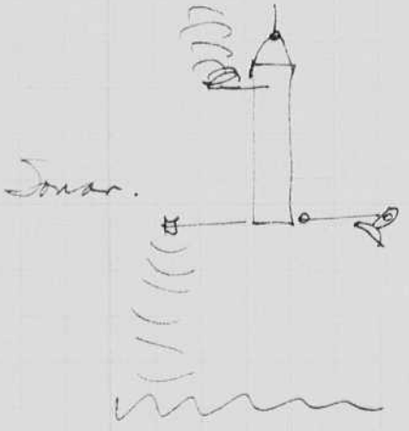
$RC = 1000 \times 750 \times 10^{-6} = 0.75$ seconds.

Short on points will be for about .3 seconds.

Dec. 9, 1954 Harold E. Edgerton.

made a tape recording with Father Daniel Lenihan S.J. and Dana Orcutt at WGBH station today for use on ~~2nd~~ Sunday. Subject Oceanology and science.

Sonar bottom signal to trigger camera.

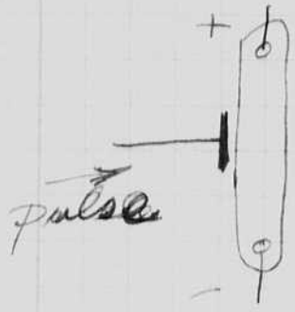


Echo if in right time bracket will trigger the lamp and camera to advance film. Then a signal will be sent up to the top so that operator will know that the device is in the correct range.

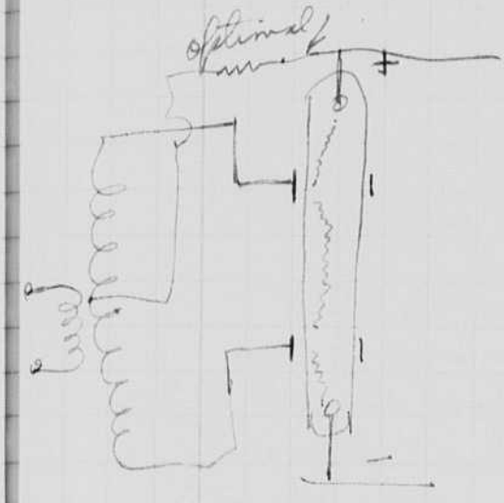
Starting of flash tubes.

H. E. Edgerton
Dec 9, 1954.

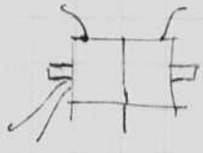
Usually an external high-voltage or a trigger electrode causes a flash tube to start. The polarity seems to effect the result a little. It is my memory that a + initial pulse is more effective than a negative one.



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 electrods and between the two starting electrods.



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 Harold Edgerton

Irene walt wants a 50 u.s flash lamp with 100 watt/second output, color guidle factor of say 30 to 40 range.
I suggest a 1" FX-1 type of lamp.
Loading = 450 volts 250 m fd. (or 500 m fd.).

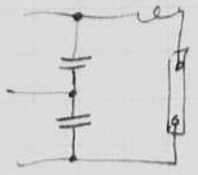
$\frac{450^2}{2} 250 = 25$ watt sec. $\frac{450^2}{2} 500 = 50$ watt seconds.

Suppose η = 4 C.P./watt.
= 100 C.P.S. or 200 C.P.S.
Reflector with factor of 15

BCPS = 1500 3000 B.C.P.S.

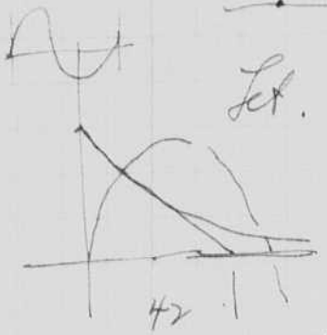
$RC = \frac{1}{6} \times 250 = 83.2$ u.s.

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



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

$RC = 125 \times \frac{1}{3} = 42$ ms.



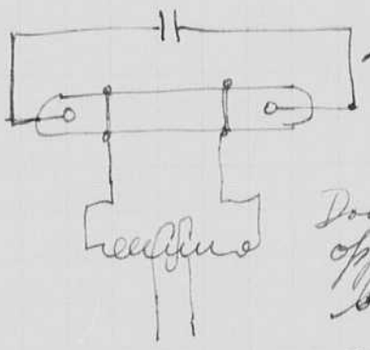
Let. $T = 1/f = 40 \times 10^{-6}$ seconds. $= \sqrt{LC}$

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

or $L = \frac{1600 \times 10^{-12}}{C} = \frac{1600 \times 10^{-12}}{125 \times 10^{-6}} = 12. \times 10^{-6}$ 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 jet tube of low resistance with short leads to the flash capacitor.

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

Primary at center

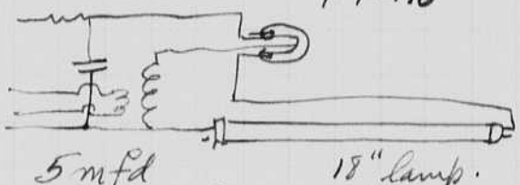
Harold Edgerton
Ray Swanson
Geo. LaCompte
Dec. 17, 1954.

Luncheon with visiting committee. I sat by Richmond and Dean Soderberg. Hauser (Sears Roebuck). Chrisansky (Lynn Mc) Richmond (G.R.) Tear (Carnegie Tech) Woolridge (R-W. Co) Forbes (Con. Edison) Poitras (Jen-wall) Chesterman (telephone) Montieth (Westinghouse).

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

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

An experiment was made in the lab.



5 mfd
400 volts.

18" lamp.
flourscent type.

Camera test.

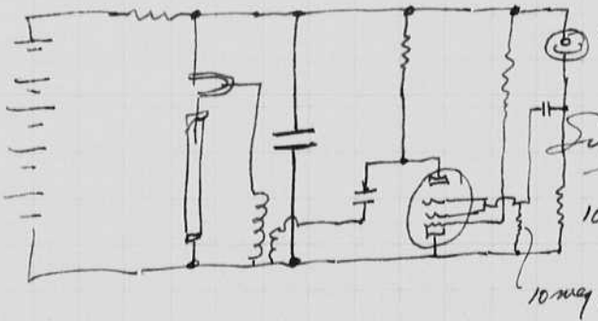
Panatomic film
Two exposures
f 5.6 and f 11.

The FT-110 is ~~over~~ exposed in both.
The 18" tube is readable in both.
The f 5.6 is best.

$\frac{CE^2}{2} = \frac{5\times10^{-6}}{2}\frac{500^2}{2} = .6$ watt sec.

$RC = 0.5$ sec.

$R = \frac{0.5}{5\times10^{-6}} = 0.1\times10^6 = 100{,}000$ ohms.



Suggest 25,000 ohms 2 watts.

Try a 929 phototube.
40 ma/lumen.
0.5 sq inches area.

$\frac{40\text{ ma}\times144}{0.5} = 288\times40$ ma/sq ft.

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

lumen/sq ft.

$\frac{500}{10\times10^6} = 50\,\mu a.$

$i = kl$ $k = 40$ ma/lumen.

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

$i = kl$ $l = \frac{i}{k} = \frac{1}{10^3}\frac{1}{40\times10^6}$

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

$e = 5\times10^6 \times 288\times40\times10^{-6}$

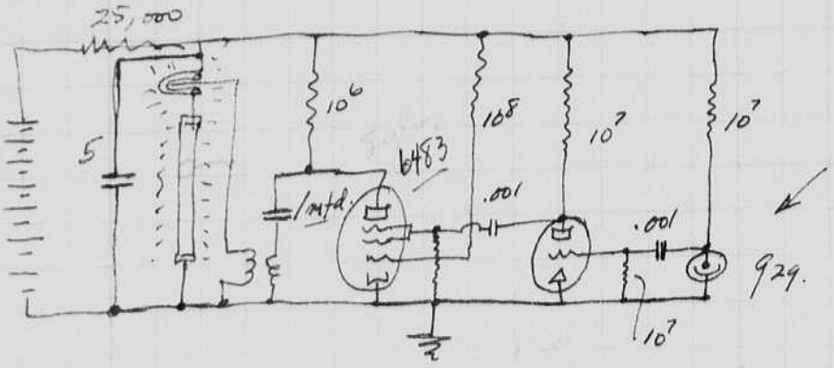
$\frac{10^6}{500^2} = 4$ lumens/sq ft.

$1/4\times144 = 38$ lumens/sq. foot.

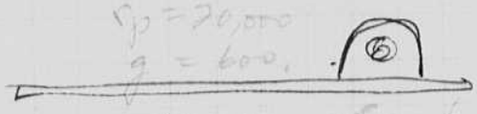
Lam, $\frac{C.P.}{D^2} = 38$ $C.P. = 2000^2\times38 = 162.\times10^6$ candle power.

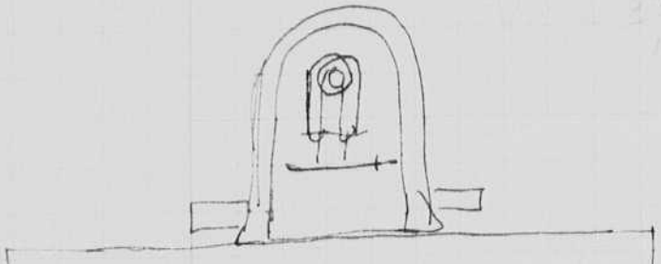
Cont.

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

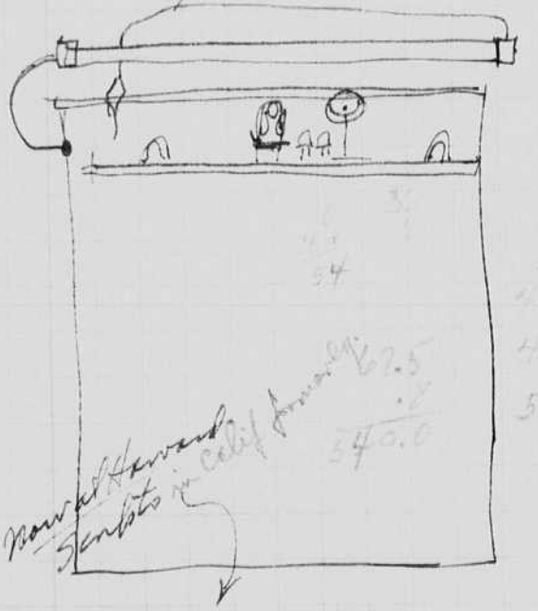


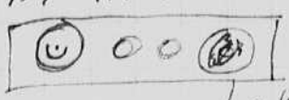
Light from plane.





Use a plexiglass top or glass.

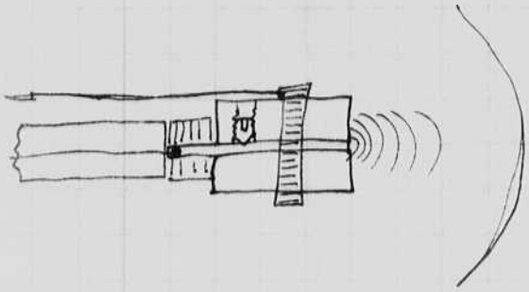


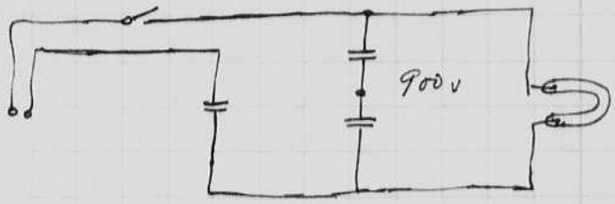


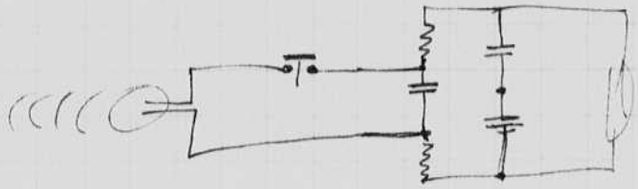
flash FT-118 FT 105

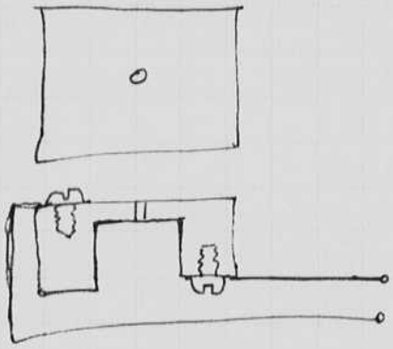
Victor Anderson came in on Wednesday to tell me of his work with sparks under water. He used 20KV from the surface 0.5 (?) mfd. onto a spark on the end of a cable. He said his best results were from a small wire that was flash against a bakelite rod. A bubble is formed on the end which pulsates only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

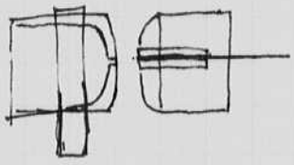
-the other when the bubble collapses. This bubble does not reform as does an explosive since there is no residual gas left! I hope to also study the bubble formation in an insulator where a hole has been formed.

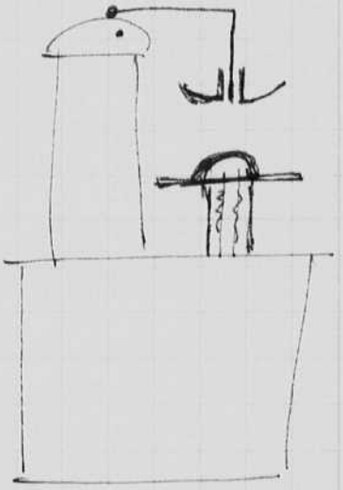


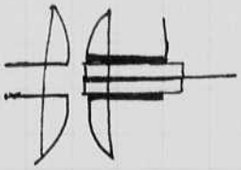


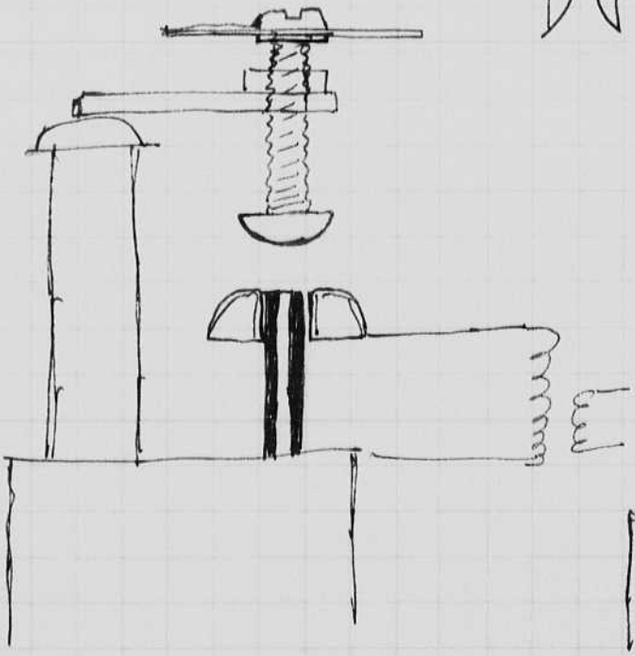


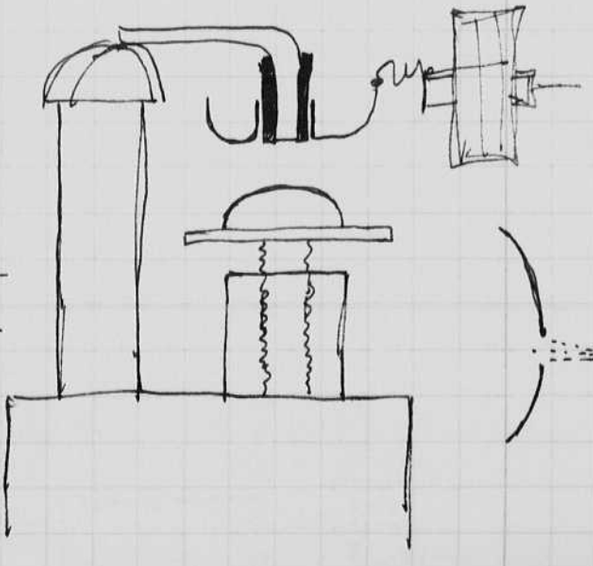




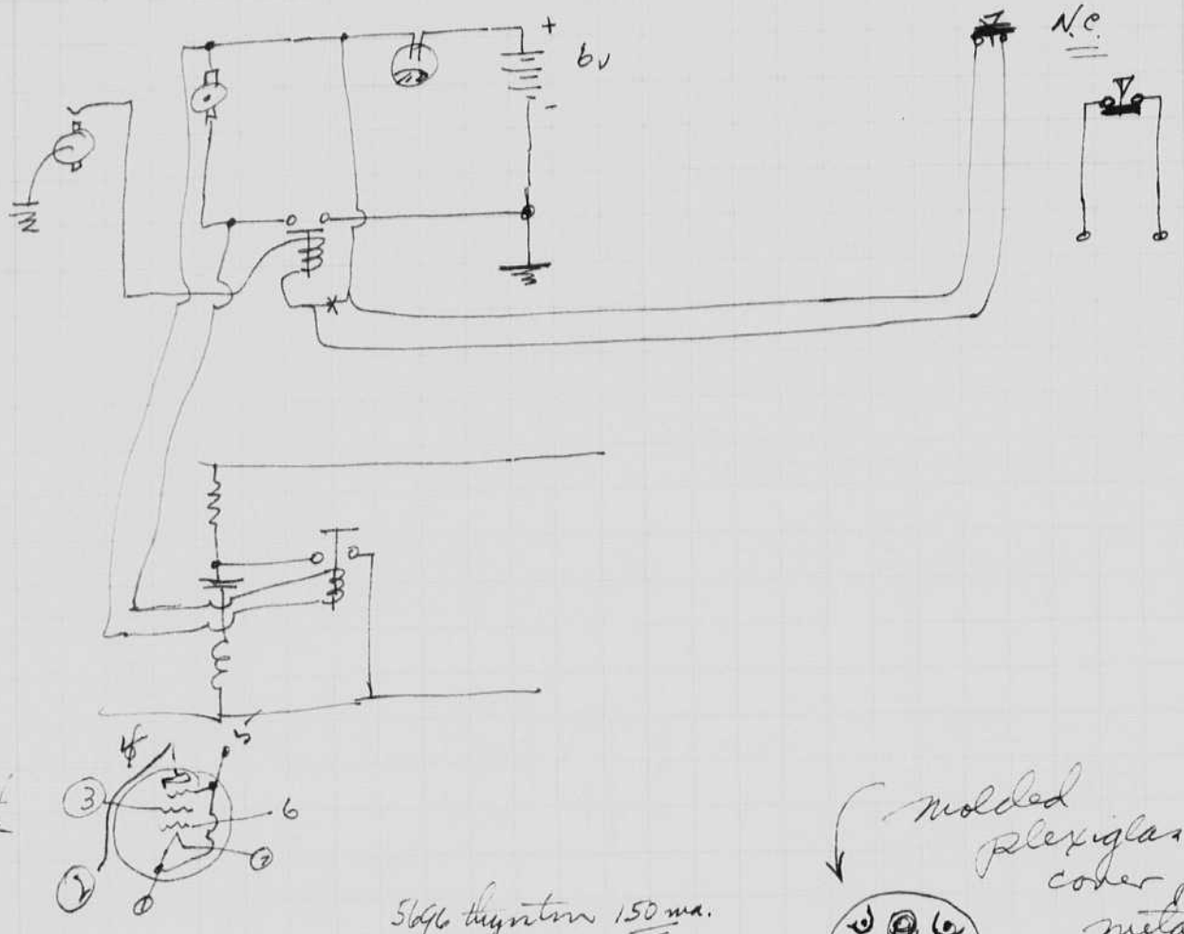








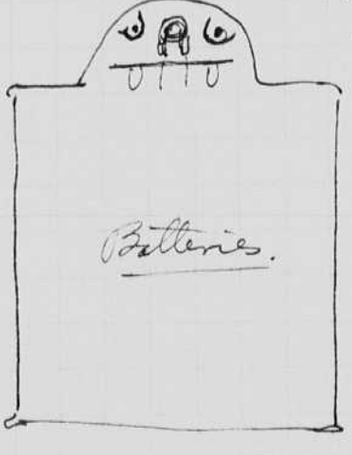
Hershey and Bacus from WHOI came to borrow a camera last Thursday. I gave them camera #1 with out a lens but with a dry battery flash unit.



124

5696 tungsten 150 ma. filament. current.

molded plexiglass cover for metal can.



Battery

Eveready ~~950~~ 482 Burgess M30

10,000 hour life 100 ma.

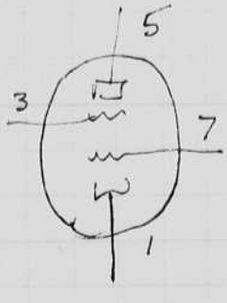
45
12
90
45
540 volts.

#1.75 (6 package).
6
10.50
#21.00

#.45

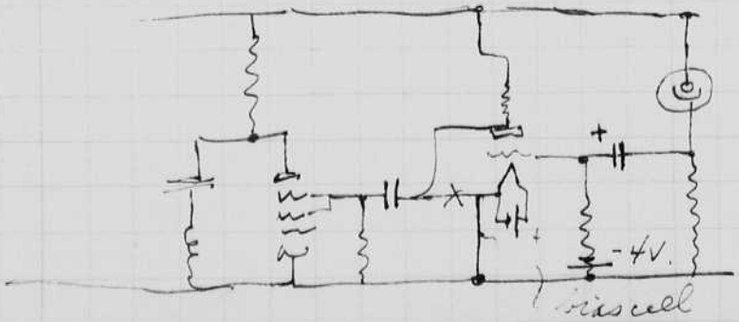
Eveready No 6. 1.5 volt bat. for filament 50 m a.

Sylvania. 6 #83



$\frac{540}{10m} = 54$ ma.

25
2
25
50
525.



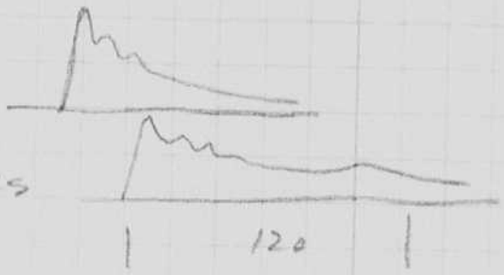
miscell

Dec 18, 1954.
H. Edgerton

Xenon in

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

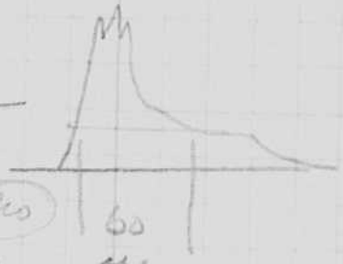
V	C	Peak light	Duration	Comment.
450	10 paper.	$.8 \times 10^6$	15 μs.	
450	20 "	1.5	20	
450	40 "	2.2	25 ±	
450	100	4.0 ±	40.	
450	250 elect	5 or 6	~~50~~ 70 μs.	
	"	"	30 × 4 = 120 μs	



~~Duration~~ too long for Greenewalt.

900	250/2	10×10^6 cp.	60 μs	12 uh in series

Output = $10 \times 10^6 \times 60 \times 10^{-6} = 600$ c.p.s



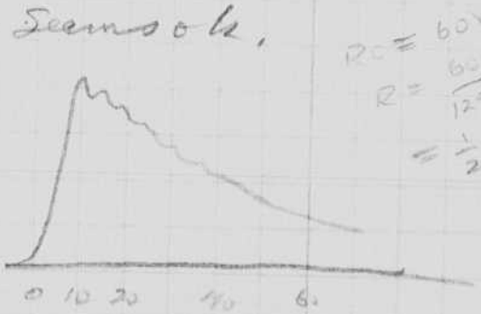
ETI 10	900	250/2	8×10^6	150 μs.	12 uh in series

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

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

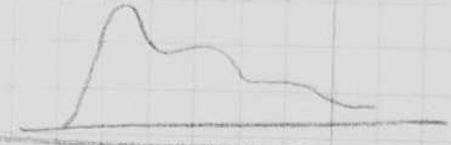
1" xenon

This looks ok for the bird unit.



1/2" gap in 6mm I.D. xenon.

900 V	250/2	7.5×10^6	30 or 40 μs.	

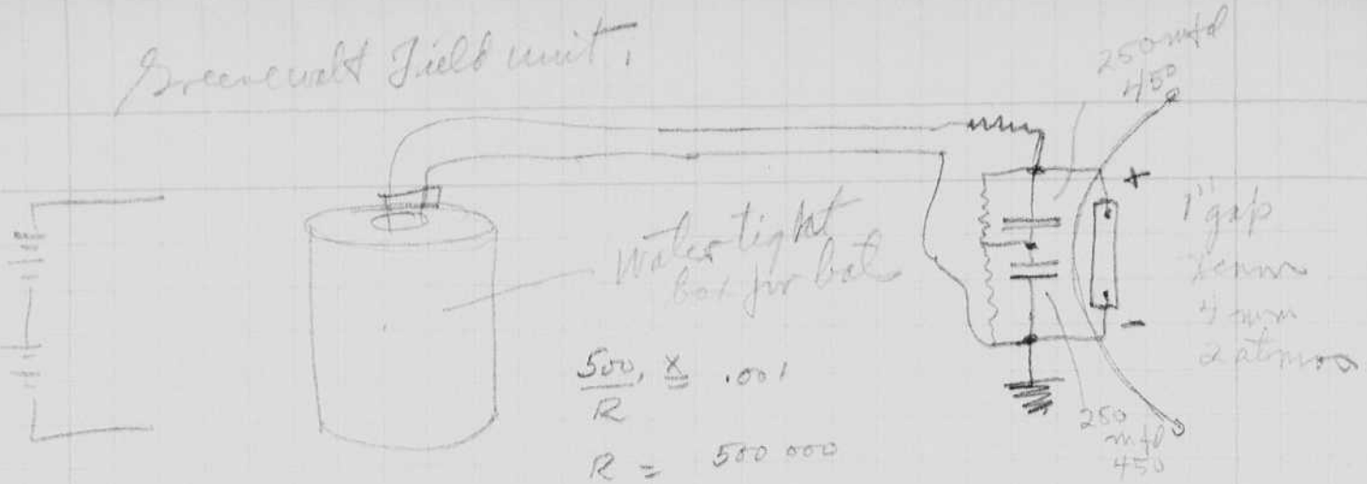


$2\pi \cdot 2\frac{3}{4}^2 =$ 92 KCPS Input = 50 watts. $\frac{92}{50} = 1.8$ CP/watt.

Reflector Bradley Prism type. $300 \times 3^2 = 2700$ K.C.P.S.

(Old units were 2200 K.C.P.S. Bird unit for Greenewalt. 100 μs.)

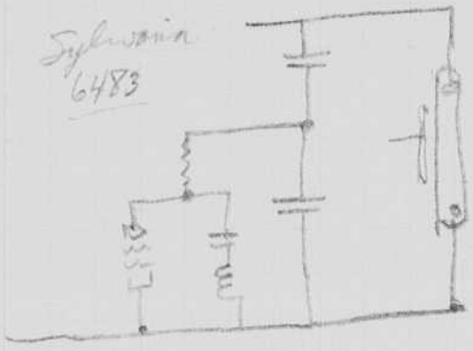
Greenwalt field unit.



$\frac{500,}{R} \leq .001$

$R = 500\,000$

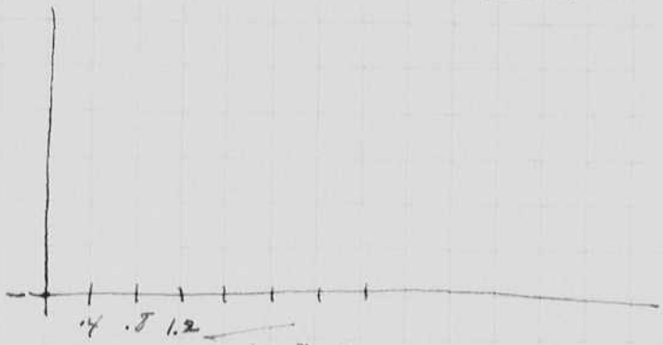
$RC = 250\,mf \times 500,00 = 125\,sec.$



See page 35.
Conf with Russell

Sun brightness = 10^6 watt/sq meter. (0.5 - 0.7)
5800 degrees K. yellow filter.
6.4×10^7 watts/sq meter.
49% below .7.

2.5×10^6 1 ms.



Film
f.
Camera exposure
10,000 → 10
{ function of time }
1000, — 10

$\frac{1}{2.5}$ ms/frame
80 ms exposure time.

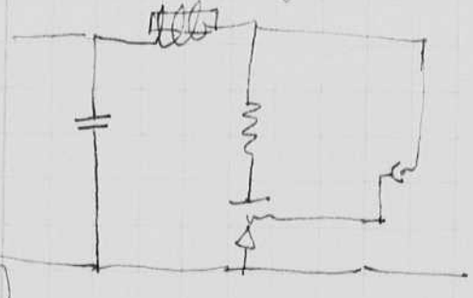
1 kT. .4 10^8 watts/sq meter
.08 2×10^7
.1x2 1×10^7
.1x6 1.6×10^7

---

30 kT. .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 ↑ magneto optic - closes when triggered.

Russell says
Eastman camera
24" f6. lens.
at f8
yellow filter.
Micro fill
2500 f.p.s. 1/5
80 ms.



Russell and Understorff
Dec 22 1954

L. Russell, Jr

discussed by letter in March 1953 while in Pacific

112 Dec 23 1954 Spark coil tests.

H. Eggerton

Roy Swanson.

Cycles. 600 μs

coil #	S.	V	C.	f.	Spark Distance Turns · 20/inch		f
	S.	500	0.1	7 gauge Coils	3.5/20	70	11,600
	RE.	500	0.1	6.5/400	1/20		16,200
	Pearl	500	0.1	3./450	1./20		6,650
	Thord. 72R44	500	0.1	6/400	1/4/20		15,000
	Delta.	500	0.1	6.5/400	1/20		
	Thord 72R44	300 V	1	5/300	5/20		16,600
	G.E. 86G41	500	0.1	11/40	3/20		freq higher than 10^5 cycles/sec.
	"	300	0.1		1/20	.05"	two frequencies evident.
	TRIAD Small	300	0.1	?	very small!		No. output? -??
	coil from Eilenberger.	500	1.	?			
	GE 86G31	400	0.1				
		300	0.1	4/5.5x4 μs.	3/20		

Dec 26 1954
Harold Edgerton.

Magnetooptic shutter for use with high speed cameras (movies).

9/2/56

See other calc. on pages 35 & 36
0.1 to .01 sec

Turned on to pages .002 sec
ok for fast cutoff.
HE Jan 29 1955.

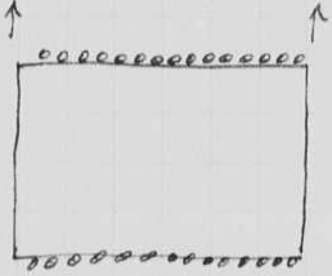
Studies of the fire ball require motion pictures taken at 2500 f.p.s. on a Fastax or an Eastman type III. The first few frames are always over exposed according to Lewis Fussell. See page 111.

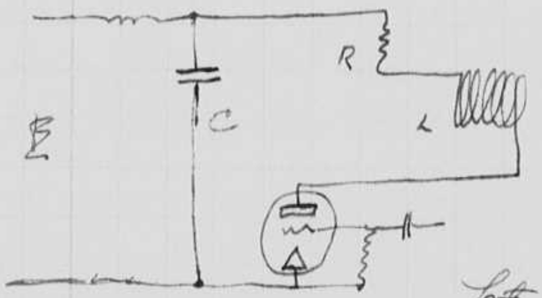
Design of a shutter for photocell triggering from the teller light or early fire ball – see below.

Normal camera setting = 24" lens at f 8
Yellow filter microfilm
2500 f.p.s. 1/5 exp = 80 μs.

Now use a double ~~photo~~ pollaroid filter with EDF4 glass

65 turns × 1000 amp = 65,000 amp turns.

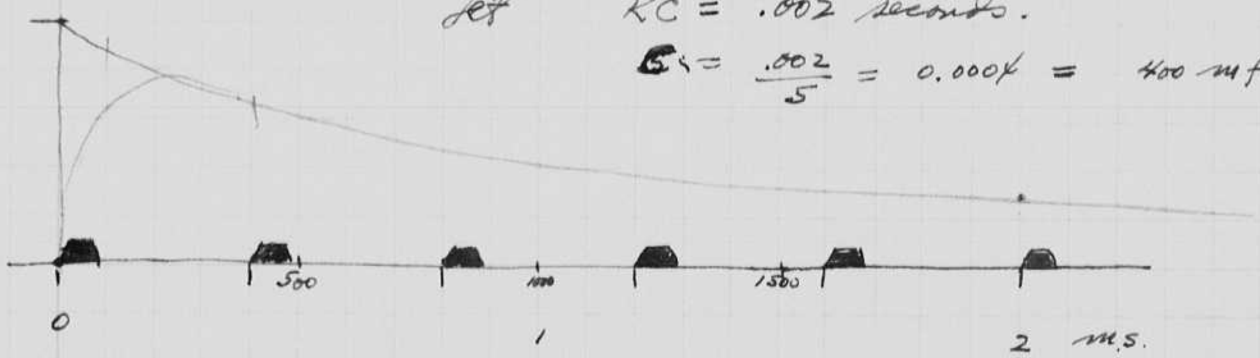




Let E = 4000 volts.
R = 5 ohms.
L =
~~3C45 thyratron~~. overload.
Spark gap.

Let RC = .002 seconds.
C = $\frac{.002}{5}$ = 0.0004 = 400 mfd.

.000,02



Secondary = Guess – Turns increased

R = 100 ohms.
C = 20 mfd
2000 volts.
I_{max} = 20 amperes.
NI = 65,000
N = $\frac{65000}{20}$ = 3250 turns.
too many!?

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

Bob returned this afternoon via Mohawk Air Lines to Rochester N.Y. where he is a soph at Univ of Roch. Bill left last Wed for N.Y where he is a senior at Columbia. Mary Jane 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 Sinendorf of D.C.

14 inches from P.C.

Jan 6, 55. Bob LeDoux and Dan Hafley 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 fps on 35 mm film.
f 1.5 – Background x film negative.
White background 15" from FX-3 lamps 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.
f 2. 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.
f 2 Back x Eastman.
capacity .01 10,000 cycles
FX-3 directly over lens.

movies.

Walker of Life.
Jan 7 55

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

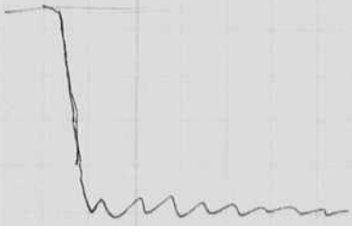
.01 mfd into lens gives over exposure on Fast Pos. film
at f2. cannot stop down due to dead areas in ~~light~~.

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

H E Edg & Johnson "Glenco"

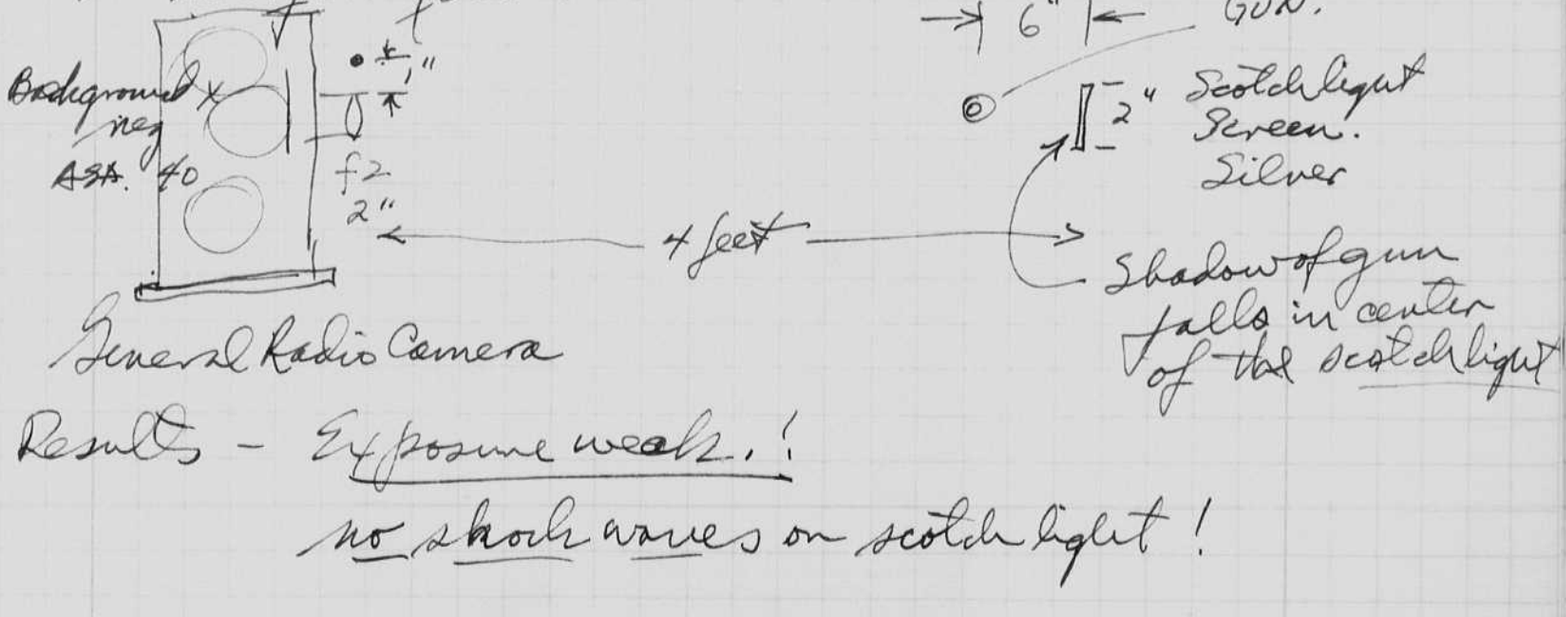
Ceramic cylinder. 6 megacycle.

.01 mfd 0.6 MS = 1 cycle 1.6 mc.



Glenco. Body 103 Glenco .01 mfd. 0.1 MS flash 12 Kc. ~~dead~~ long duration
Disc about 3" diam. on oscillation.

more movies at 10 KC of 22 cal bullet.
Jan 8 1955 H E Edg & Ray Swansen

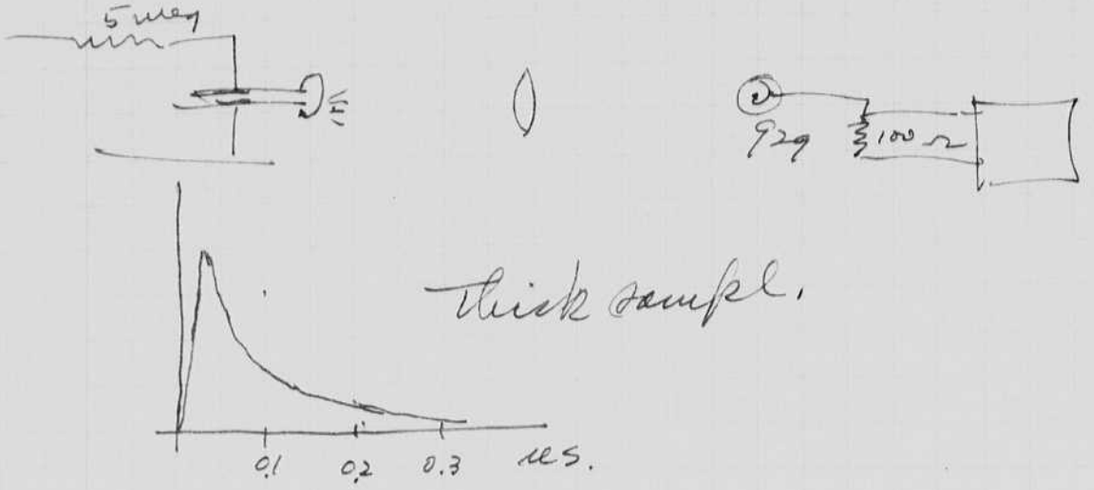


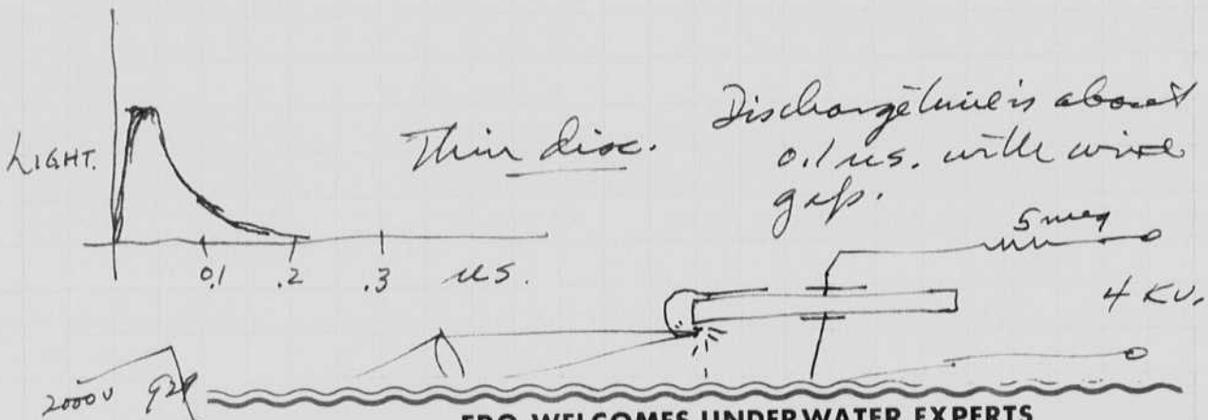
General Radio Camera

Results - Exposure weak!

no shock waves on scotchlight!

Blenco Discs from Johnson Jan 5 '55.





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.

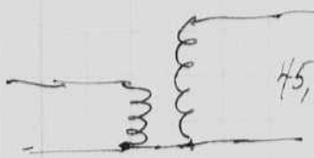
Edoite Finds Adventure in Mexico

Transducer test.

Edo. —

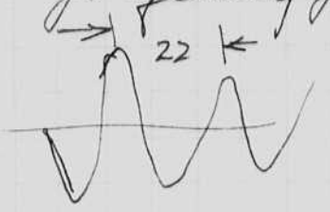
Delco Coil

$$22 \overline{)1.00} \quad .045$$
$$\underline{88}$$
$$120$$



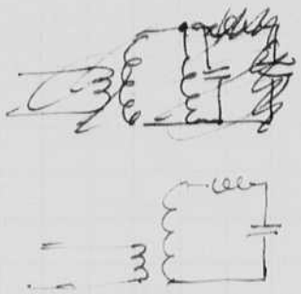
Spark coil.

Frequency of coil 1 cycle = 22 μs,



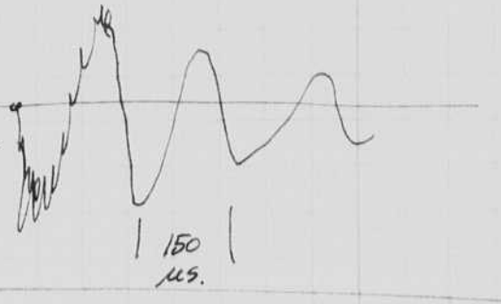
$$f = \frac{1}{22 \times 10^{-6}} = \frac{10^6}{\quad} \times$$
$$= .045{,}000$$
$$= 45{,}000 \text{ cycles.}$$

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



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

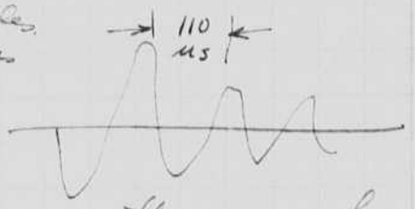
Jagged wattage wave here →



Condition (3)

$$f = \frac{10^6}{110.} = 9{,}090 \text{ cycles.} \quad 9{,}000 \text{ cycles}$$

$$110 \overline{)1.000} \quad .009$$
$$\underline{990}$$
$$1000$$



wave is smooth now when the Inductance is shorted out.

Thordarson Spark coil. 3 × 11 μs per 1/2 cycle $f = \frac{10^6}{3 \times 11} = 30{,}000$ cycles per sec

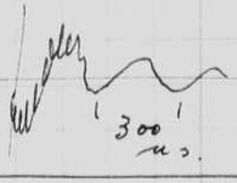
22 T44.

" " with Edo. (no ind) $f = \frac{10^6}{200} = 5{,}000$ cycles.

Model electric type S. 20 μs $f = \frac{10^6}{20} = 50{,}000$ cycles per sec

shows situation?

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



no noise

14499
8000 40
220 21

Auto coil without cone $f = \frac{10^6}{20} = 50{,}000$ cycles.

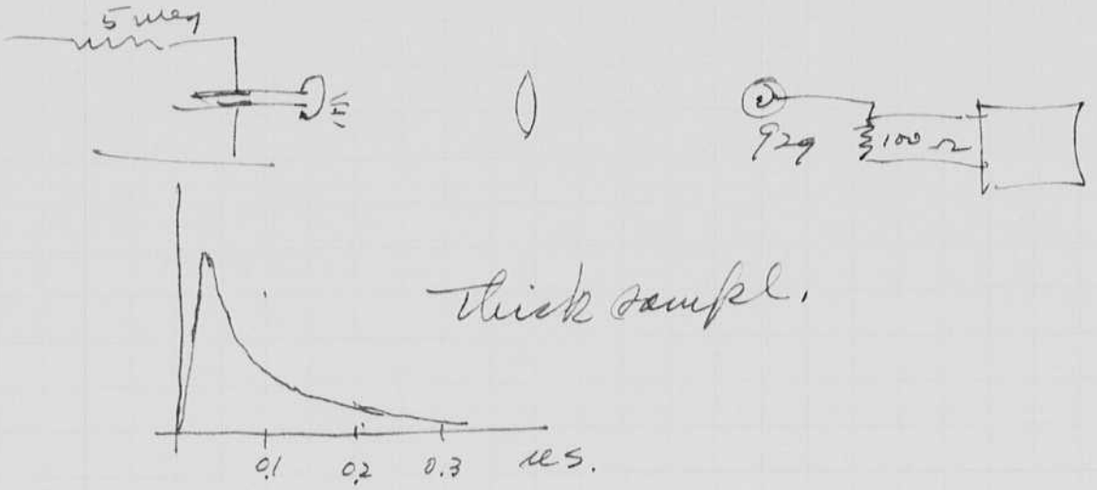
with Edo. $f = \frac{10^6}{100} = 10{,}000$ cycles

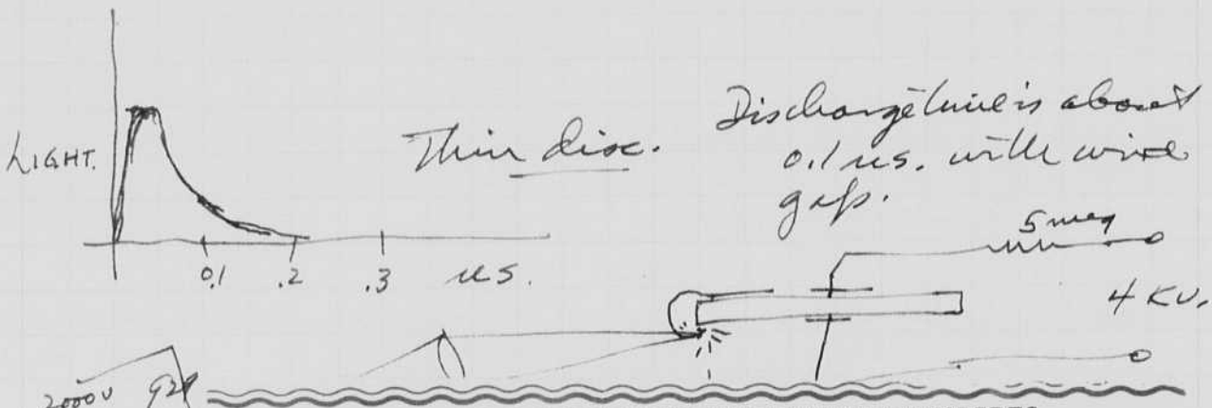
Newton coil $f = 10^6/8\text{ μs} = 120{,}000$ cycles per sec.

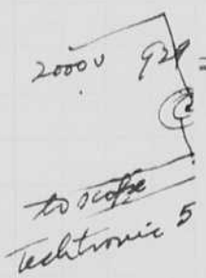
wave jerky? → $f = 10^6/25 = 40{,}000$ cycles with Edo.

$f =$

Glenco Discs from Johnson Jan 5 '55.







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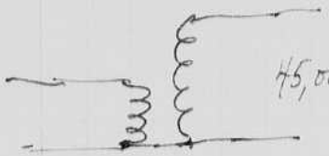
Edoite Finds Adventure in Mexico

Transducer test.

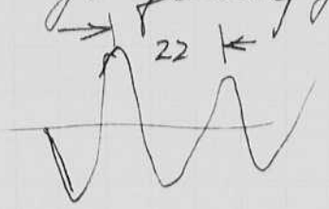
Edo. — **Delco Coil**

.045
22 ∫ 1.00
88
120



Spark coil.

Frequency of coil 1 cycle = 22 μs,

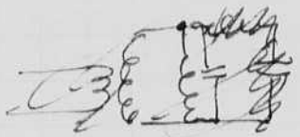


$f = \frac{1}{22 \times 10^{-6}} = \frac{10^6}{\quad} \times$

$= .045{,}000$

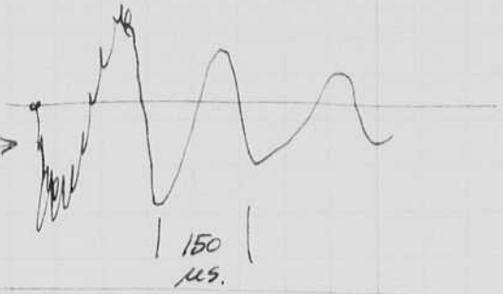
$= 45{,}000$ cycles.

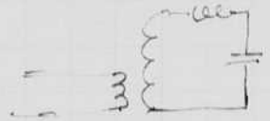
Condition (2) coil loaded with Edo .30 ADP crystal and coil



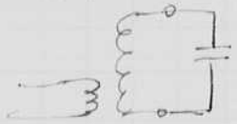
$f = \frac{1}{150 \times 10^{-6}}$

Jagged wattage wave here →



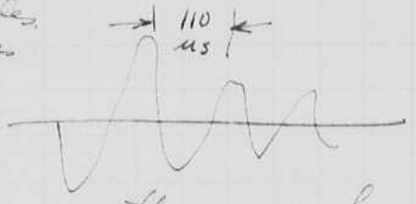


Condition (3)



$f = \frac{10^6}{110} = 9{,}090$ cycles. 9,000 cycles

110 ∫ 1.000 990 1000



wave is smooth now when the inductance is shorted out.

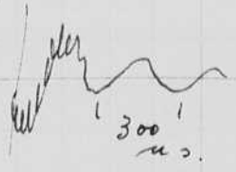
Thordarson Spark coil. 3 × 11 μs per ½ cycle $f = \frac{10^6}{3 \times 11} = 30{,}000$ open cir

22 T44. " " with Edo. (no ind) $f = \frac{10^6}{200} = 5{,}000$ cycles.

Modeleidnic type S. 20 μs $f = \frac{10^6}{20} = 50{,}000$ cycles open cir

shows saturation?

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



no noise

14499
8000 40
220 21

Auto coil without cone $f = \frac{10^6}{20} = 50{,}000$ cycles.

with Edo. $f = \frac{10^6}{100} = 10{,}000$ cycles

Newton coil $f = 10^6/8\,\mu s = 120{,}000$ cycle open cir.

wave jerky? → $f = 10^6/25 = 40{,}000$ cycles with Edo.

$f =$

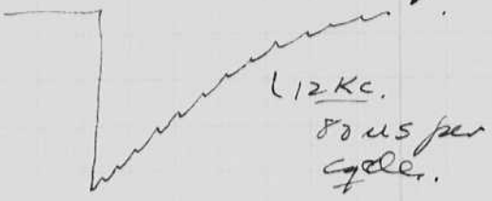
Aug 1955.

Edo transducer

20 D 102
M.I.T.

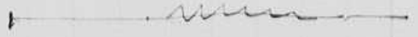
3800 volts - sparks over on edge

to scope - shows 12 Kc oscillation. so ↓.



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

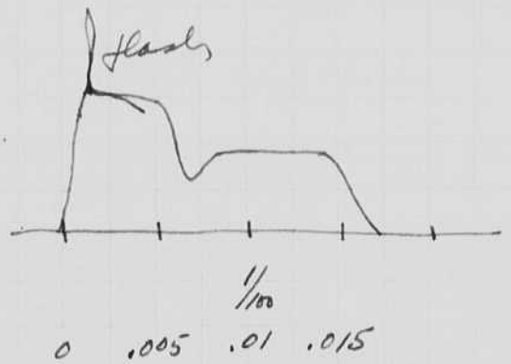
Input 1000 volts as per above
mike at 15" above the transducer
output ≅ 0.1 volts.
(Small on scale!).



Shutter data from Mac Roberts.

Underwater camera.

28 volts into magnet.



with 16 ohms in series the flash does not go.

with 10 " " " Duration = 40 ms at f 5.6.

M-2 Photoflash bulb without wire from S.G.

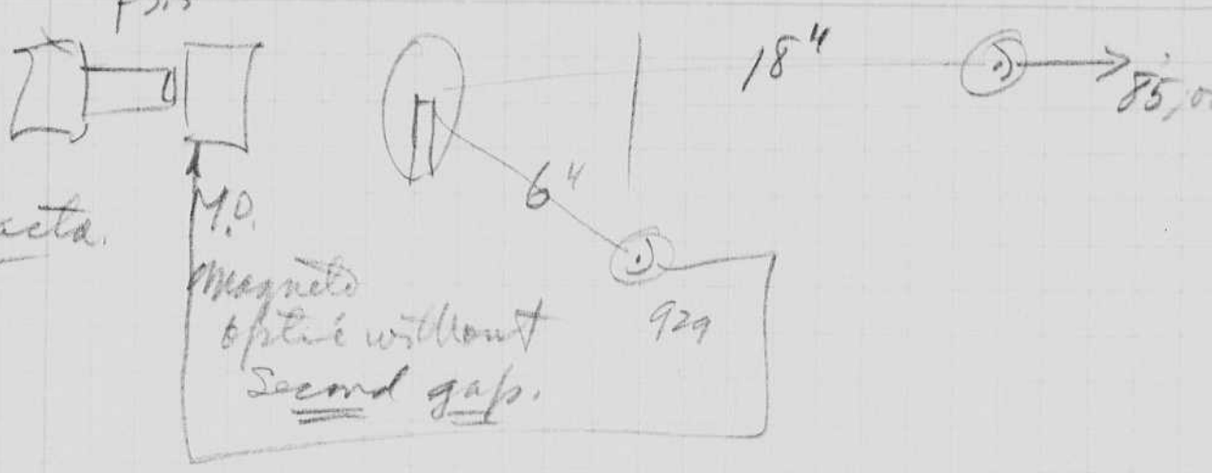


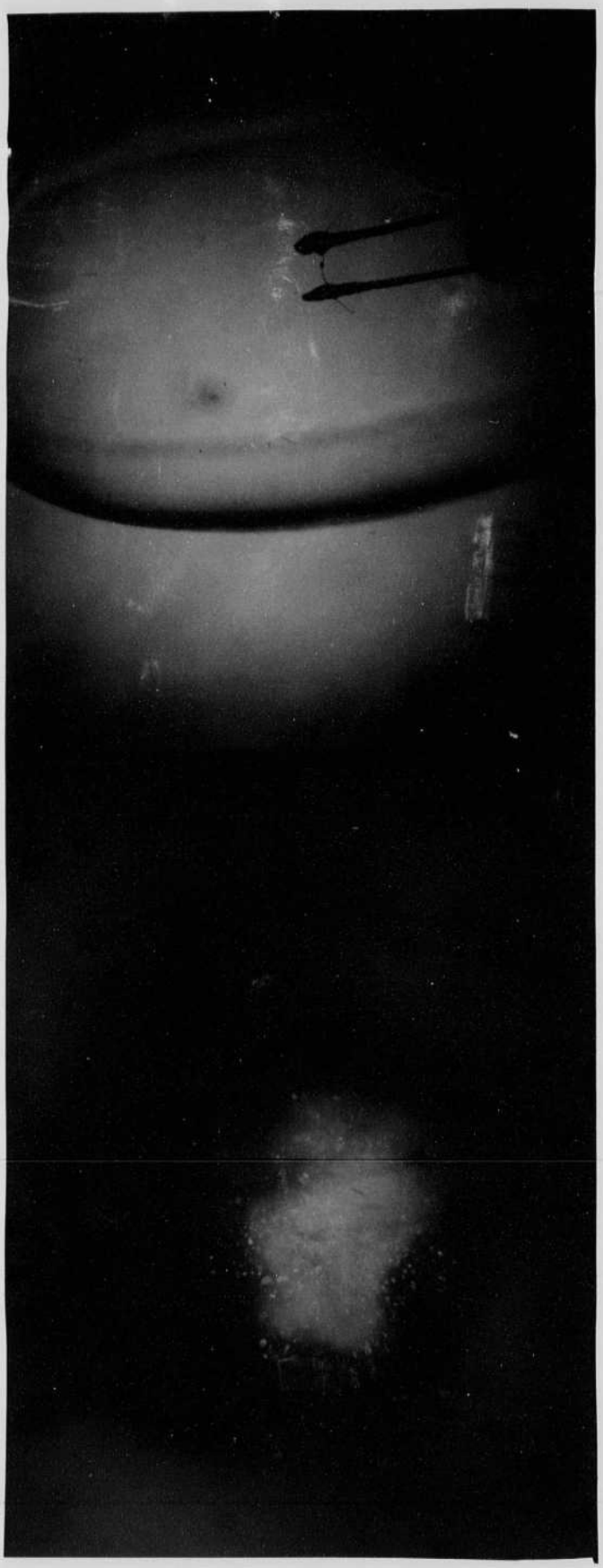
Photo.	Delay	Trigger P.C.
1.	100 ms	6"
2.	100 ms	12"

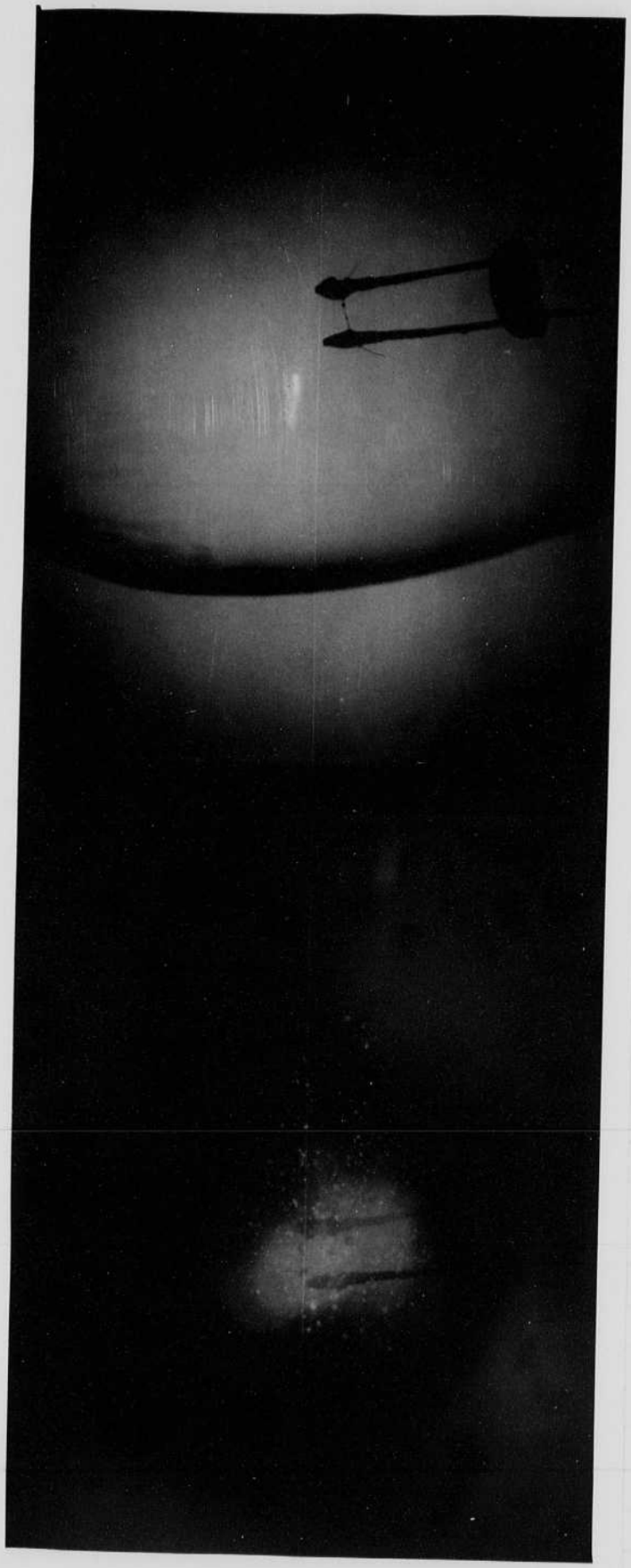
Developed – Exposure seconds, o.k.

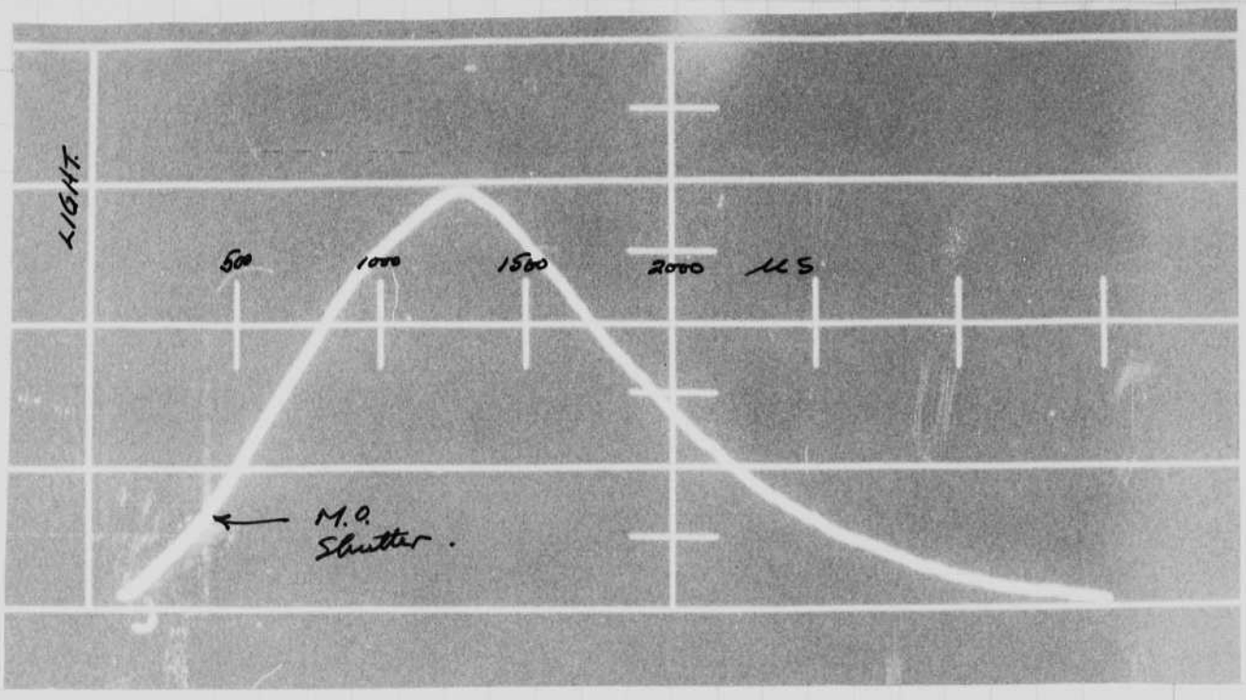
1.	0	6"
2	25	6"
~~3~~	50	
4	75	
5	100	

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

15V/cm 500 MS/cm



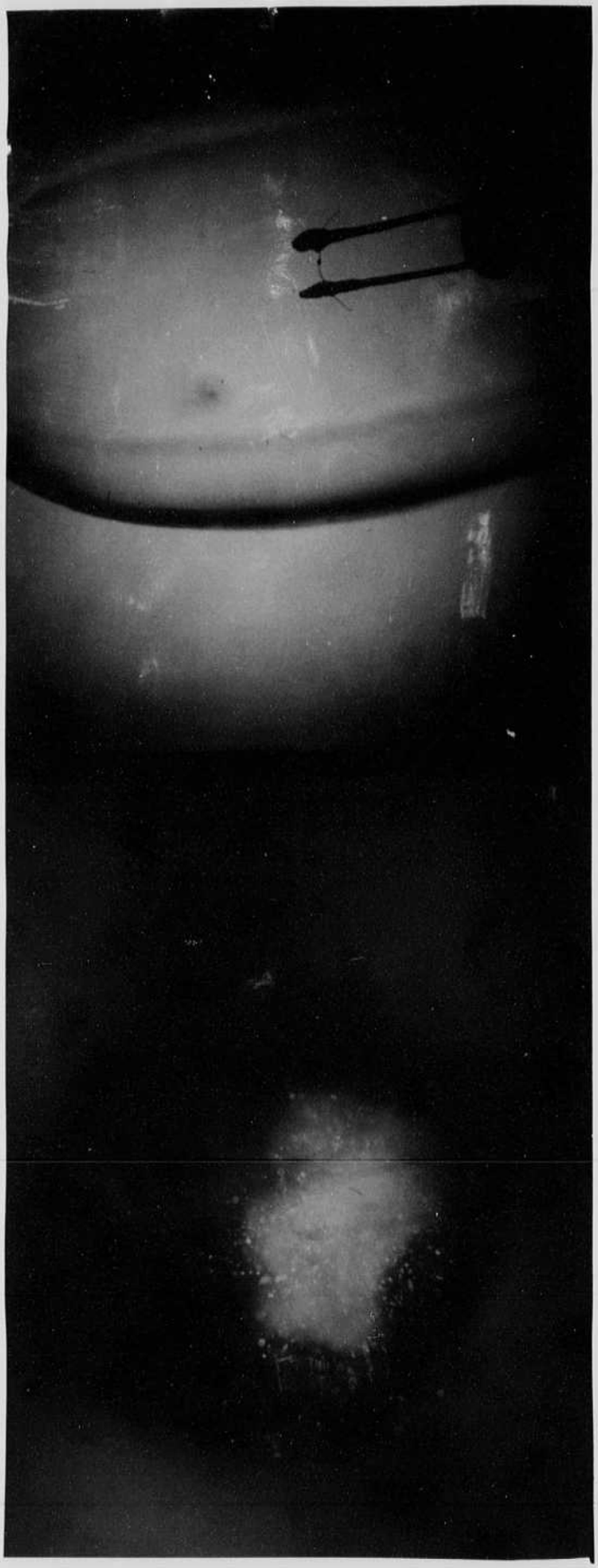


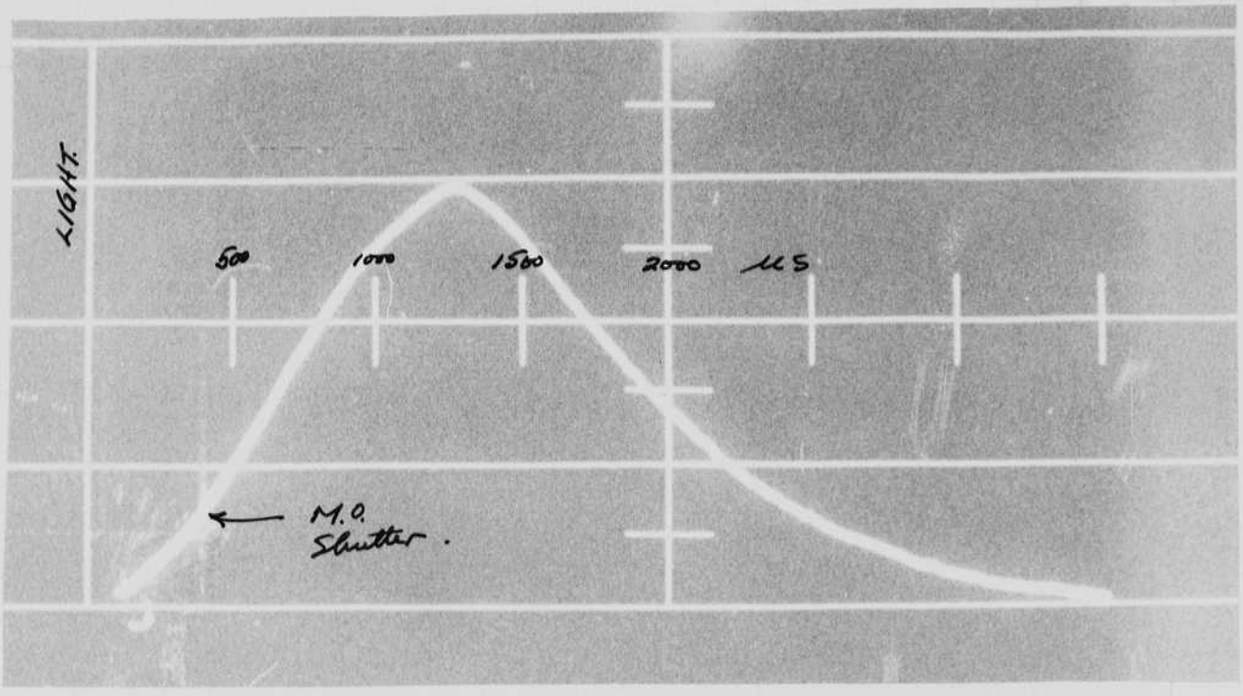


Magneto optic photographs of M-2 igniter
The damping spark was removed by pulling V105 out
of its socket.

Jan. 14, 1955. A. B. Edy.

I was in Rochester yesterday visiting the Graflex company
See Whitaker. Schuyler C Wells Jr. Engineering
Oscar Steiner. Roy Hickey, Warren White Otto Sahmal Ed Farber
V. E. Whitman Gillespie H. F. Hopper C. H. Harper
Sarah Kuhnert (Chas Faidlaw Waterlown 55 Belmont St.).
Focal Rep.





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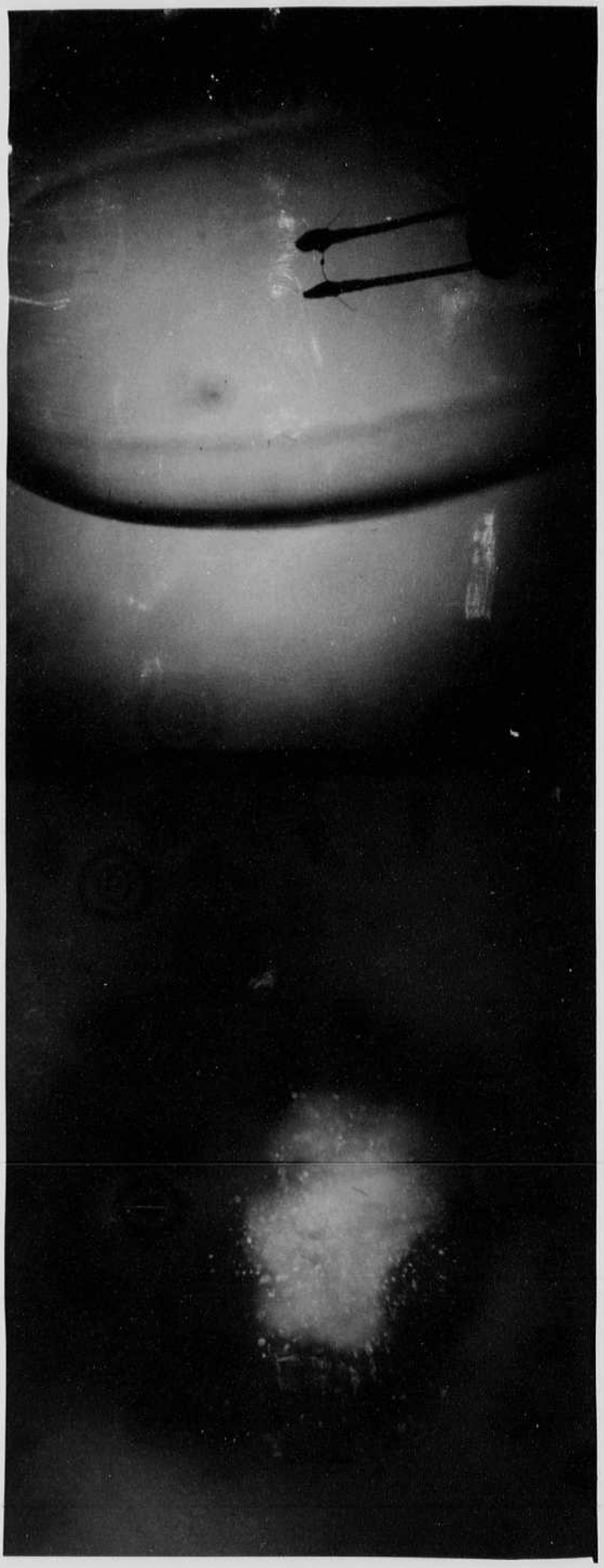

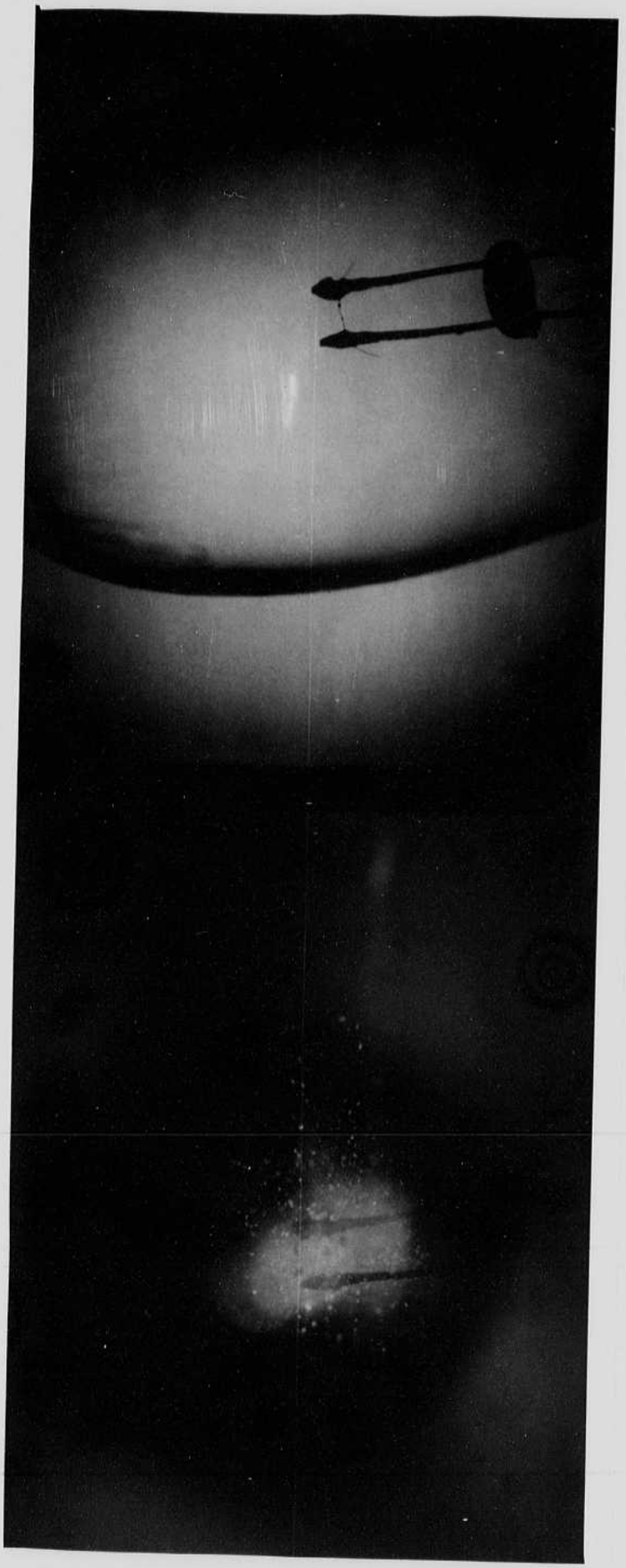

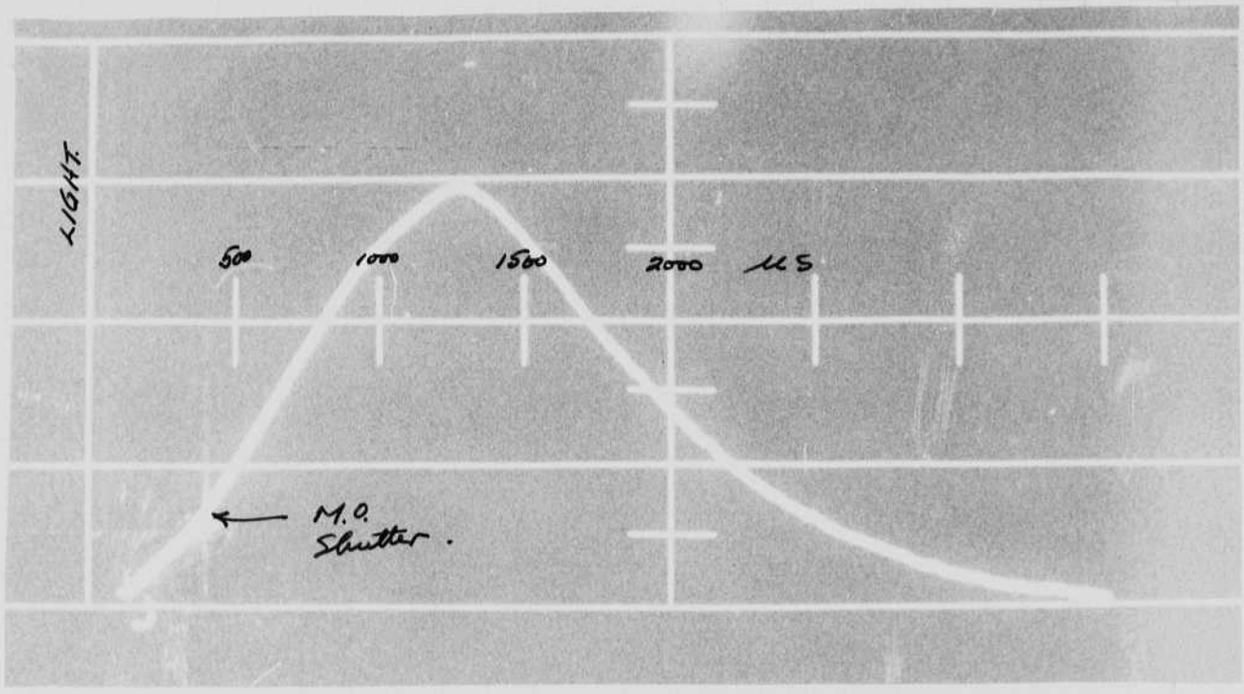

Magneto optic photographs of M-2 igniter
the damping spark was removed by pulling V105 out
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Jan 14, 1955. NBEdg.

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Oscar Steiner. Roy Hickey, Warren White Otto Sahmal Ed Farber
V. E. Whitman Gillespie H. F. Hopper C. H. Harper
Sarah Kuhnert (Chas Faidlow Watertown 55 Belmont St).
Focal Rep.

 Jan ~~Jul~~ 1 1955
H. E. Edgerton
Fred Barstow

Tests with Double Flash.

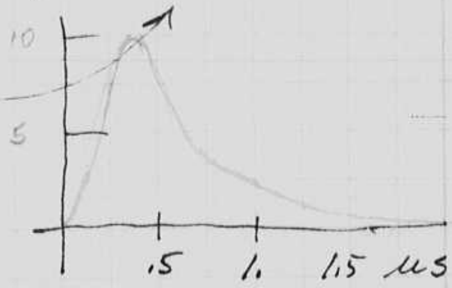
Res in	.005	8 KV	1/2" Xenon Cap.	100 ohms.	3.5 ft.	5 volts.	Graflex Ref.
	1/3	7 KV	microflash	100 ohms.	3.5 ft.	(1.3 V Dan 2.)	G.R. 130
Res out.	.005	8 KV	1/2 xenon	100 ohm	3.5	15 volts	Graflex
Res out	.1	8 KV	1/2 Xe	"	"	1.3 Den 2.	Graflex

The tube shows some greatly blowing.

July 15 1955 Continued experiments with short flashes.

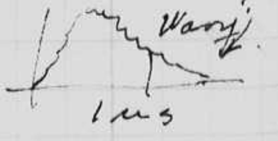
1" xenon tubes self flash at. 8 KV — therefore cannot use conventional circuits.
Series gap circuits.

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



above voltage reading are No good due to Low voltage of the power supply due to a leak !.

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



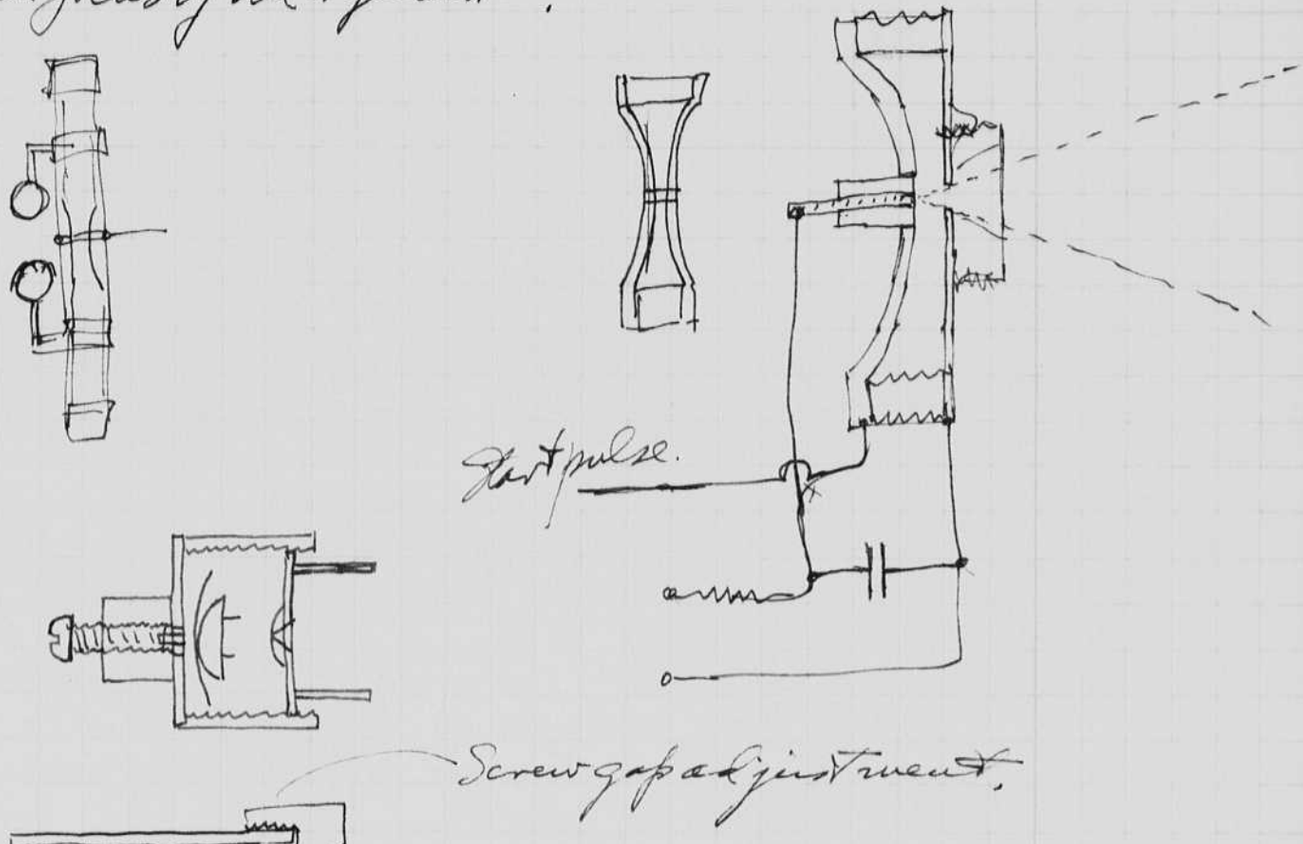
0.1 8 KV 1/2 1 mm xenon 100 4 ft 1/2+ 7 V
The high initial peak is gone.
Duration is longer..

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

~~airgap~~

.01 8KV. airgap. 100Ω 4ft. 1/4μs. 3v.

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



10 mfd 2KV. FX-1 100Ω 4ft glass. 20μs. 12.5 volts.

↓
2.5×10^6 c.p.

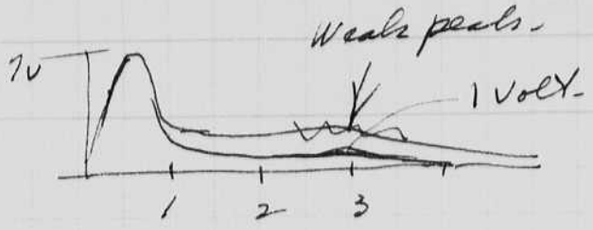
then $7v = \frac{7}{12.5} 2.5 \times 10^6 = 1.4 \times 10^6$ cp. Xenon.

$3v = .6 \times 10^6$ c.p. air gap

H.C.P.S. $= 1.4 \times 10^6 \times 0.7 \times 10^{-6} = 0.98$ H.C.P.S. Xenon.

$= .6$ " $\times 0.25$ " $= 0.15$ " ~~Xenon~~ air gap.

FX-110.



0.1 8KV. Series gaps.

0.1 8KV. 1/2 1mm Xenon. 8v. checks.

0.1 8KV. 1/2" 1/2" Xenon large gaps. Blew up on second pop. no reading was made.

0.1 8KV FX-2 – one would not start.

0.1 8KV. FX-3 1 μs. 5V. 1×10^{6} H.C.P. $\times 1\times10^{-6} = 1$. HCPS.

Input = $\frac{64\times10^{6}}{2}\,0.1 = 3.2$ watts.

Efficiency is low.

the 1 mm 1/2" "so called" tube is actually a 1/4" gap +.

Note that the capilliary is very clean while the end zones became quite dark. This is good. The arc scours out the sputtered material with all ends where the position of the arc is not important.

Get eff curves for this tube.

energy (1 mfd at 1000 volts) = $\frac{CE^2}{2}$ = 1/2 watt sec

try 2 mfd 1000 v. = 1 watt sec.

Power allowable = ? Say 10 watts.
f = 100 cycles. Then μs must be 0.1 μs.
C = 1/5 mfd at 1000 volts.

Light 0.1 1KV 1/4" 1mm Xenon. 2 ft. 100 Ω. 2 μs (.578 volts.) / 3,

1 mfd 1KV. " " " " 5 μs. 1.6 v.

Stroboscope with Reflector. 3 mfd 350V Strobotron 2 ft 100 Ω 30 μs. .03 volts.

with Ref. { Strobotac peak light = .06 × 10^6 c.p. beam ; Duration = 30 µs. } 18× B.C.P.S. /4

Bare: ~~1.0~~ 1.0 mfd at 1 kv.
Xenon = 3.2×10^6 c.p.
5 µs. = 5×10^{-6} } 15.2×10^0 = 15.2 HC.P.S. /4

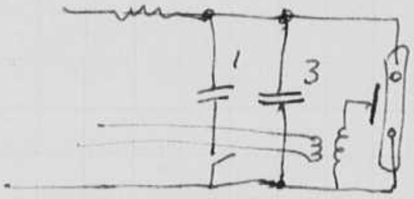
0.1 .2 volts × 2 = 0.4×10^6 c.p.
Duration 2×10^{-6} 0.8 c.p.s.

---

use 25 reflector factor = .8 × 25 = 20.0 B.C.P.S.
actually may only use 1/3 of this gives 7 B.C.P.S.
which is then about 3× the strobotac.

~~Power~~ energy = 0.1 watt sec.
strobotac = 3 mfd $\frac{350^2}{2}$ = .15 watt sec. } about same?
×60
9.00 watts. actually less since the voltage drops at the higher speeds.

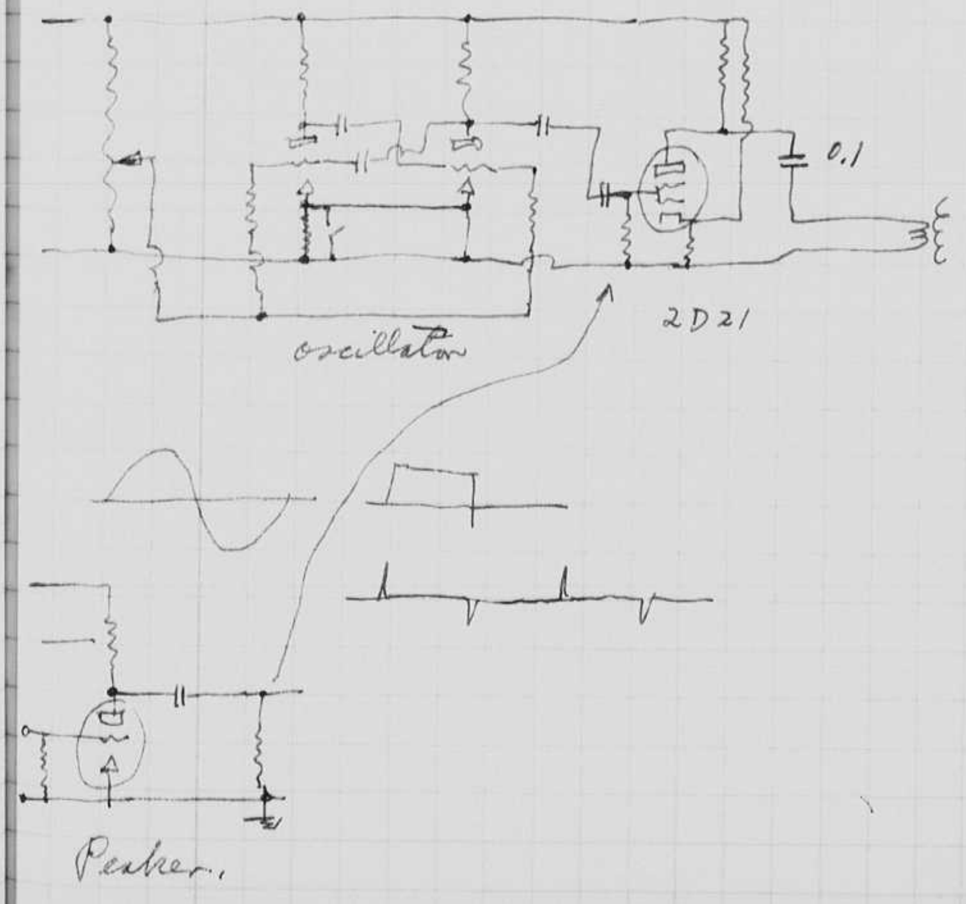
new Strobotac design. white light tube.



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

.05 × 240 = 12.00 watts.

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



1/4" 1mm Xenon.

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

calibration FX-1 10 mfd 2KV.

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

1/4 1mm.	.01	3000	3 ft.	= .25 to .4 $\times 10^6$ c.p.	.25 to .4
	.01	2000	"	= ~~.8 to 1.2 $\times 10^6$ c.p.~~	0.1 to 0.2
	.01	1000	"	= ~~.1 10^6 c.p.~~	.01

Strobotac with reflector

" 4. 350 3 ft. = .002. $\times 10^6$ c.p.

.01 1000 3 ft. = ~~.02~~ ± $\times 10^6$ c.p.

} Visual effects 30 us do not check. Duration different also.

Roughly the strobotac color of above gives 0 4 ft vs 2 ft.

Strobotac	Xenon.	
.06 c.p.s.	.02	} Visual is 4 to 1. approx.
	x 25	
	0.5 c.p.s.	which is 10 x stronger than strobotac.

Synchronic	.01	1000	3 ft	.005 $\times 10^6$	2 us. .01
"	.01	2000	3 ft Holdover.		
FT 218	.01	2000		.01 to .02 $\times 10^6$	3 us. ± .03
Photon ⊓	.01	200		0.1 $\times 10^6$	1/2 us. .05

Jan 27 1955
Harold E. Edgerton

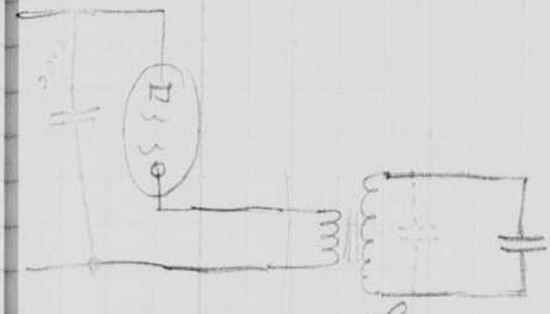
Scope off calib. 1 cm = 115 μs. (instead of 100).

Delco driving crystal 30 EDP Edo 126.5 μs.

TD2R44 " " " 460 μs.

Large Delcocoil " " " 138 μs. loud click
" " " as is 34.5 μs.
" " " crystal and Edo Ind. 20.7 μs ?

115
1
920
115
2070



0.00142 mf. = 1400 mmf.

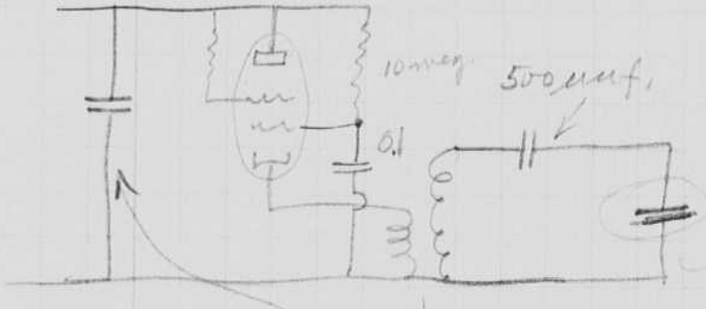
Large Delco # 14499 0.52 henries. $(2\pi)^2 = 39.$

$34.5 = T = 2\pi\sqrt{LC}, = .$ $C_1 = \frac{T^2}{(2\pi)^2 L} = \frac{34.5^2 \times 10^{-12}}{(2\pi)^2 .52} = \rightarrow \frac{570 \times 10^{-12}}{1400}$ 1970

$T = 2\pi\sqrt{.52 \times ((1400 + 570) \times 10^{-12})}$

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

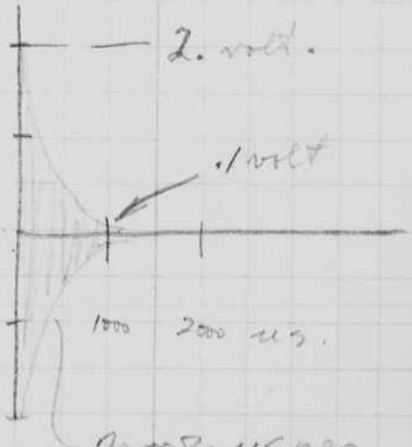
$T = 2\pi\sqrt{310 \times 10^{-12}} = 2\pi\ 1.73 \times 10^{-6} = 6.28 \times = 109. \mu s$ Does not check.



seems best at 0.2 mfd

Delco old large # 14499

Second extra capacity tuned for approx 12 KC.



700 or 800 μs per cycle.

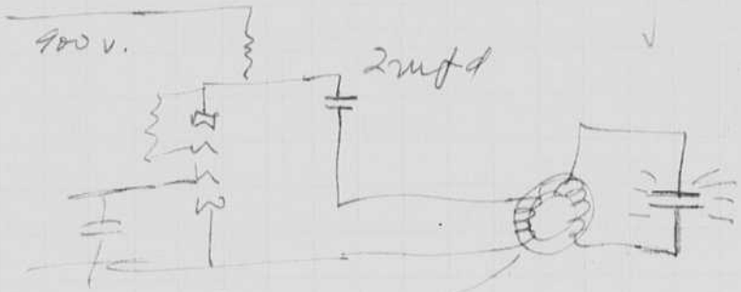
Tried spark in water Jan 27 with Ray Swanson
100 ws at 900 v in series with FT-21. gave
a small Bang. - Light reduced about
30%. Signal small on microphone
with lots of after noise.

Jan 29 1955.
Howard Stanton

more experiments with
Edo 30 EDP crystal transducer.

Now using

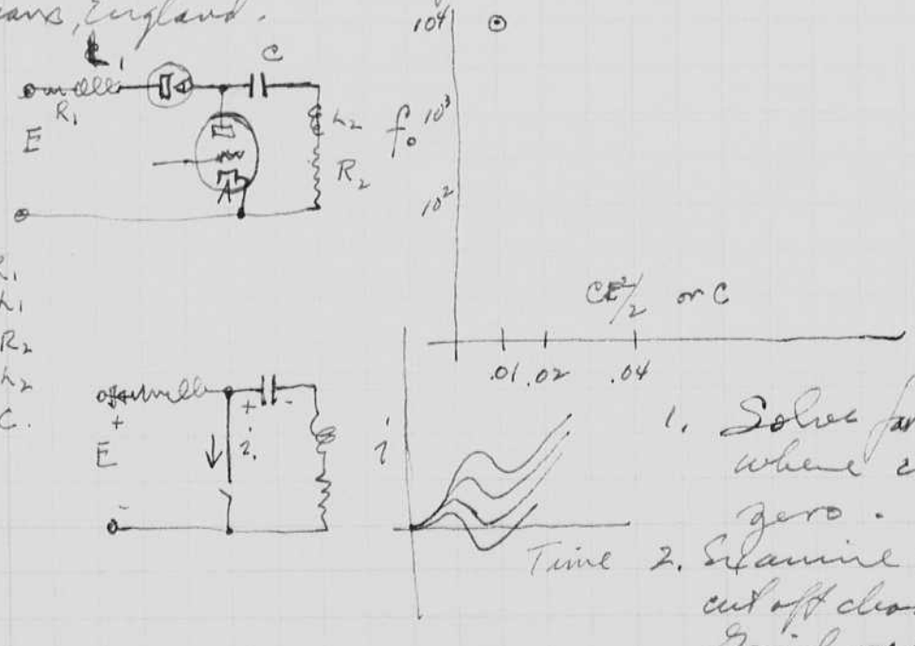
This looks good



Castor oil over crystal.
Pitch at 1 foot above gives 0.1 volt.
Frequency is about 10 or 11 K.C.

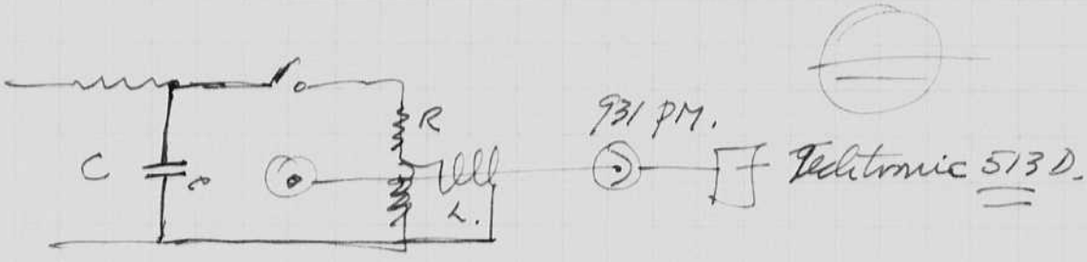
Voltage on crystal is about 1500 volts peak.

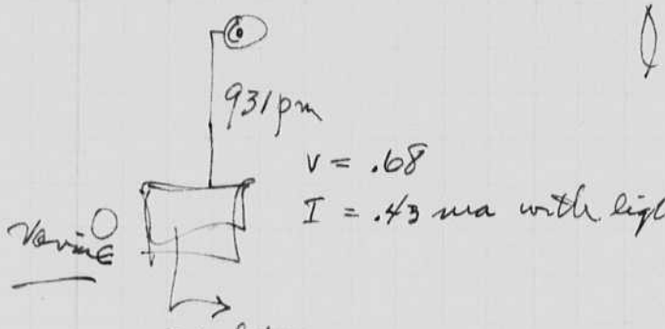
Joe Watson - thesis on High-speed motion Pictures.
Nottinghams, England.

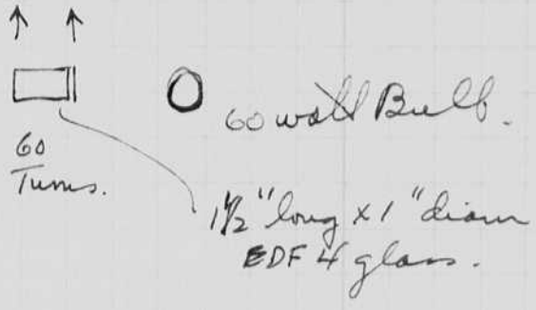


1. Solve for transient when current reaches zero.
2. Examine Hydrogen thyratron cut off characteristics.
Grid vs current cut off.

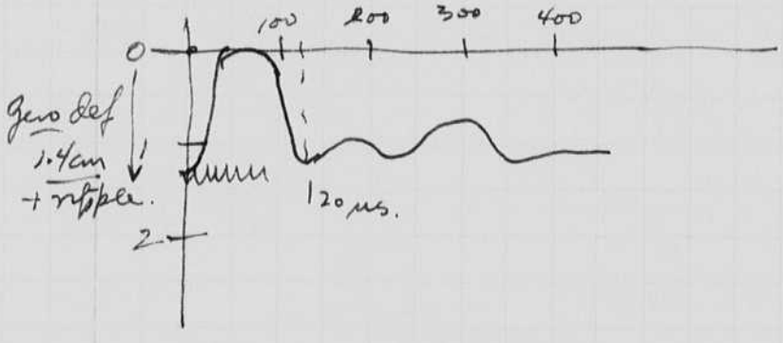
Magneto optic shutter tests
H. E. Edgerton
Jan. 30, 1955. 20D102 M.I.T.

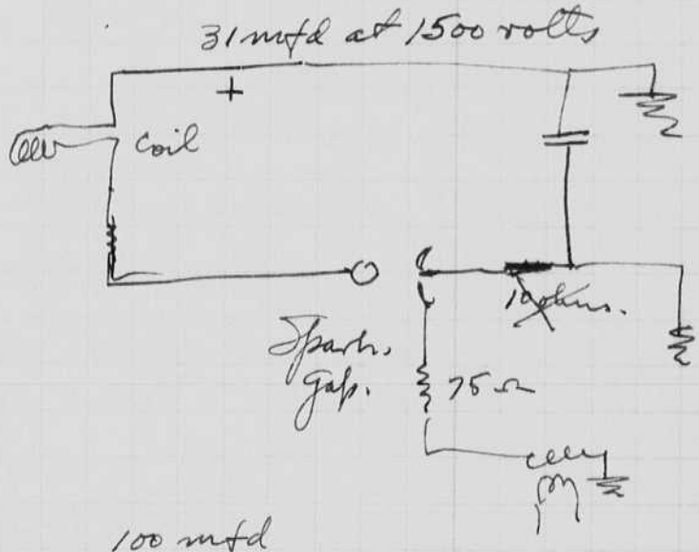


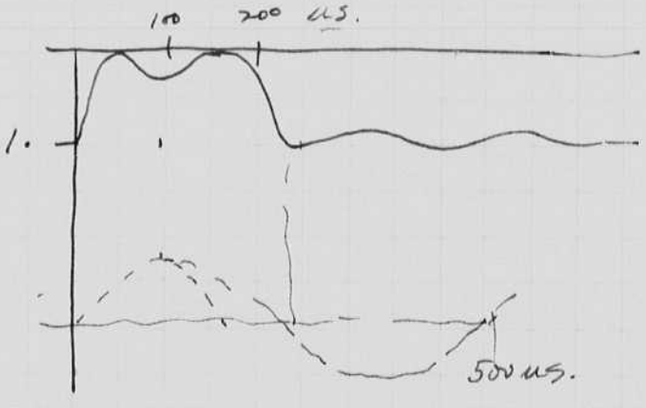




Ripple in a.c. output of P.M. Filter needed?







100 mfd
1500 volts.

Coil used above + 13 ft of #18 leads
R = 0.33 ohms.
L = 65 mh.
DQ = 1,2.

$T = 2\pi\sqrt{LC} = 6.28\sqrt{65\times10^{-3}\times100\times10^{-6}}$

$\sqrt{6500\times10^{-12}}$

$6.28\ \sqrt{65\times10^{-5}} = 8\times10^{-5}$

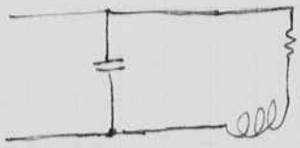
$T = 50\times10^{-5}$ sec.

= 500 ms. Exp shows about this per cycle.

From page 25 Jog on film for 1/200 sec. G.E. Co. data via Babbitt.

$\frac{1 \text{ sec}}{200} = 5{,}000\ \mu s.$ $\quad \frac{1}{100}\text{ sec} = 10{,}000\ \mu s.$

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



current for closure $= E\sqrt{\frac{C}{L}} = 1500\sqrt{\frac{30\times10^{-6}}{65\times10^{-6}}} = 1500\sqrt{\frac{1}{2}} = \frac{1500}{1.7} = 100$ amps.

actually less due to damping.

~~try 3200 with sec unit.~~

~~400~~ mfd at 4 KV. =

Let R = ? to limit current to 100

$100 = 4000/R$ ~~or~~ $R = 40$ ohms.

$RC = 40 \times 400 \times 10^{-6} = 16000 \times 10^{-6} = .016$ ~~mfd~~ sec

$= 16{,}000\ \mu s.$

now increase the turns by some factor n.

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

$I = 100/n$ amperes.

and $I = \frac{E}{R} = \frac{E}{R_0 n}$ $\quad R_1 = 40$, $R = 40n$.

and $T = RC$

$T = 40nC =$ ~~40~~

Let $T = 5000\ \mu s.$

then $n = \frac{5000 \times 10^{-6}}{40 \times 400 \times 10^{-6}} = \frac{5}{16}$ ✓

time is shorter by ratio $\frac{1}{T}$.

Design calc.

90° for $\frac{N}{60 \times 100}$ amp-turns.

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

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

$T = RC$

$6000 = NI$

$I = \frac{E}{R} = E\frac{60}{.3}\frac{1}{N}$

$T = RC$

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

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

R =

ABC Current.

Design for 1000 volts

$T = .002$

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

$T = RC$

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

$= 200\ \mu f.$

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

2nd calc Try 2000 volts,

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

$T = .002 = RC$

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

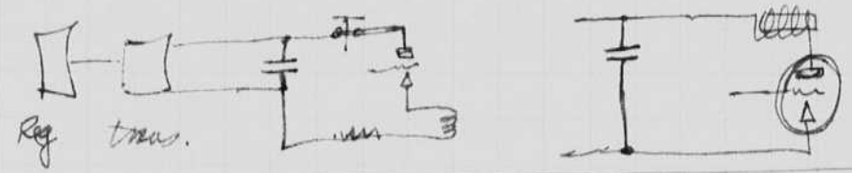
$N = \frac{R \times 60}{.3} = \frac{1200}{.3} = 3600+$ turns,

---

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

$RC = .002$ $C = .002/4.5 = .0004$ farads $= 400$ mfd.

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



100 amp peak in this tube!

---

now try a coil with $N = 120$ turns,

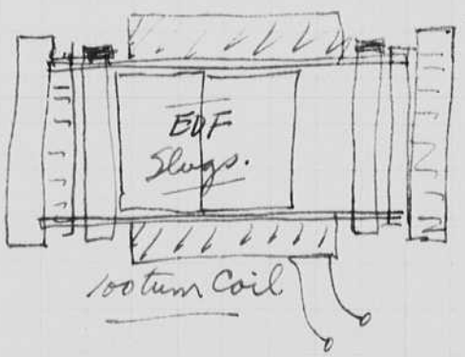
$NI = 6000$

$I = 50$ amps,

for A.C. fastax camera 2500 f.p.s. $R = ? = \frac{E}{I} = \frac{450}{50} = 9$ ohms.

$RC = .002$ $C = \frac{.002}{9} = .0002 = 200$ mfd.

Suggest newtonian camera into a fastax with a shutter as above set for .002 seconds.



Series 6 Polarizers

Try unit with 1/200 sec. exp.

Now for ballistic $T = .05$ sec

Let $N = 120$

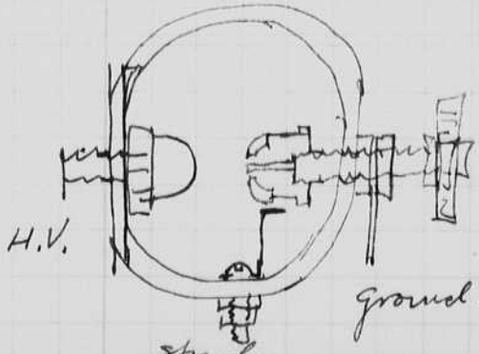
$I = 50$ amps.

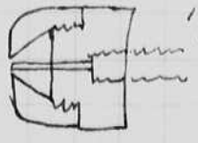
$R = 20$ ohms.

$E = 1000$ volts.

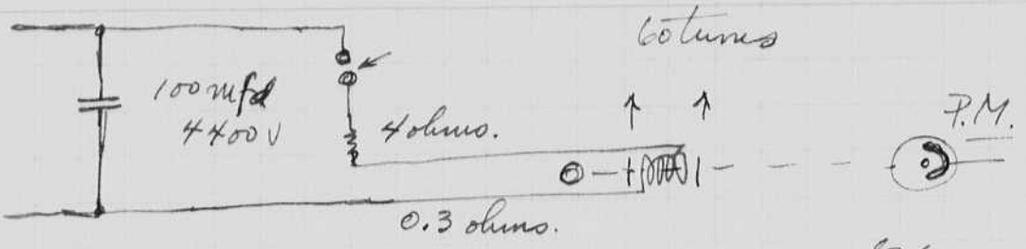
$RC = .05$

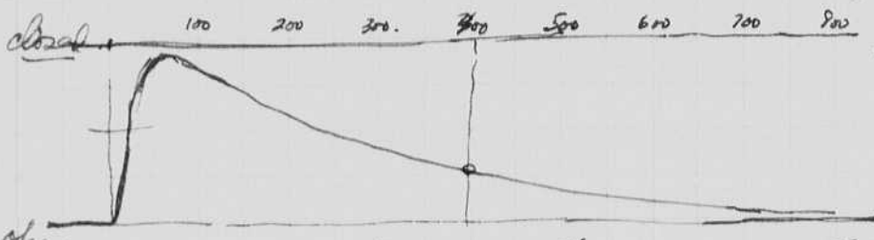
$C = \frac{.05}{R} = \frac{.05}{20} = .0025 = 2500$ mfd.





Jan 31 1956 20D102 M.I.T.
Harold Edgerton





400 μs. for 100 mfd.
~~10,000~~

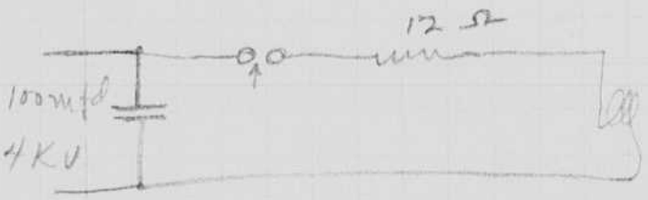
50,000 μs. 10,000 mfd reqd.
Sacrifice rise time, and redesign.

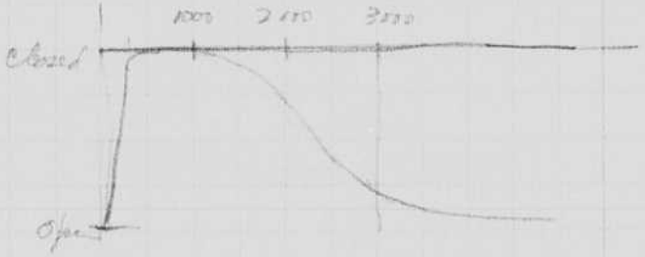
E.H.S. 2000 μs. 500 mfd will do it.

New Coil

Tests of new coil of #22 wire on p131 spool
2 1" diams EDF 1/2" long each. 1" total.

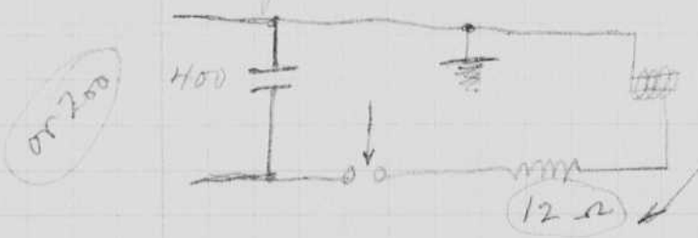
R = 4.12 ohms,
L = .008 henries.





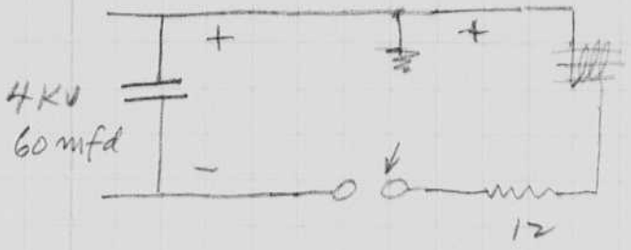
$T = 2\pi\sqrt{LC} = 6.28\sqrt{.008 \times 100 \times 10^{-6}}$
$= 6.28\sqrt{.8 \times 10^{-6}} = .9 \times 10^{-3} \times 6.28 = .006$ sec = 6 cycles.

Circuit for use at G.E. Pittsfield or June Feb 18.



This will consist of a FT-503 or maybe 2 FT-503 tubes in series.

Circuit for AEC unit



Phone call from Elmendorf. - Cleveland Ohio. -
Plans to come east Feb 17. to see R.L.E. Lab.
mentioned intense light when
magnet field is used near
a point source arc field.
Gain of 100 in light? or light intensity?

$$\Delta = \frac{4L}{R^2 C}$$

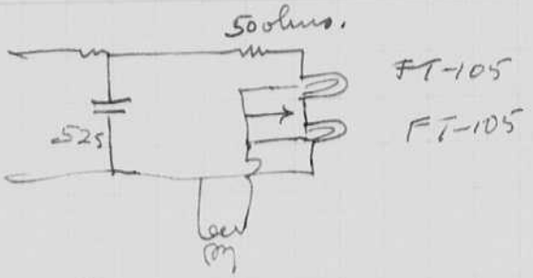
$$\Delta = \frac{.008 \times L}{16 \cdot 10^{-4}}$$

$$\Delta = \frac{320}{256} \doteq 1.5$$

$$\Delta = .4$$

 H.E. Edgerton
Kay Bowersen.

Sensitometer flash.



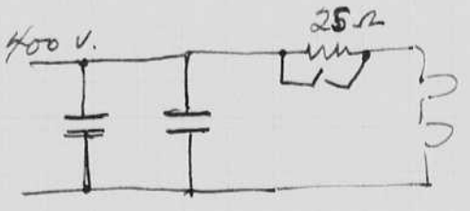
actual.

Lamps 6V3

Def at 18"

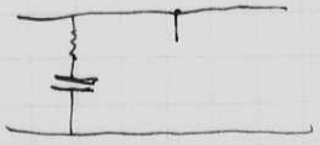
2.	525	25 ohms.	Duration = 5000 μs.		1.2 x .32 V
2	1050	25 "	" = 12,000 μs.		
2	525.	25.	Duration = ~~5000~~		1.5 x .32.
2	525	0	1400		4.7 x .32 x 100
2	525	25	7000		1.4 x .32.
2	525	50	10,000 +		0.7 x .032.
1	525	0	500	(36")	2.2 x 32.
3.	525	0	2000	18"	2.5 x 3.3 x 3.2
3	525.	25.	7000		1.4 x .32
1	525	25.	5000.		1. x .32.
3.	1050	25	9000		1. x .32
2	1050	25	9000		1.6 x .32.
2	1050	0	1000.		1.1 x 32.

		Tx L.
	.32	3.2
	32.	32.



1000 mfd — 25 Ω — 9000 μs.

1000 mfd — 0 Ω. 1000



Lamps.	C	R	D	Light
2.	20 mfd.	0	.100 ms.	2 x 3.2 (18").

Now Ray connected 2 other electrolytic capacitors of 525 mfd each Sprague into the circuit for a check trial.

						M.C.P.	C.P.S.
~~2.~~	~~1050~~	~~0 25.~~	~~1500~~	~~1.2 x 32.~~	V		
2.	1050	25.	8500,	1.1 x .32	0.352	.00915	77.8
2	20 paper.	0	100 ms.	2 x 3.2.	6.4	.166	16.6
2	~~525~~	0	1000	1 x 32,	32.	.835	835.

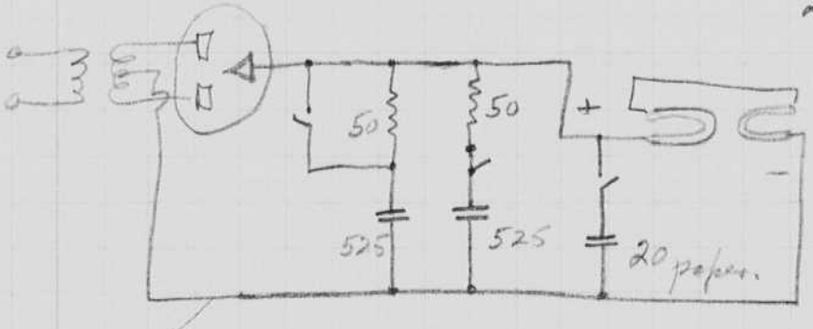
FX1 20 mfd 1000 V 50 ms. 1.8 x 32. (36") 0.6 M.C.P.

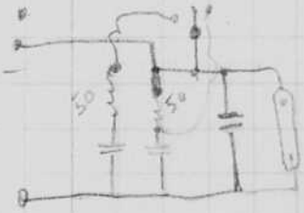
$$C.P. = \frac{.6}{36}\left(\frac{18}{1.8}\right)^2 \frac{V.}{1.8 \times 32.} = \frac{.6}{4}\,\frac{32}{1.8 \times 32} = .026 \times 32 = .835$$

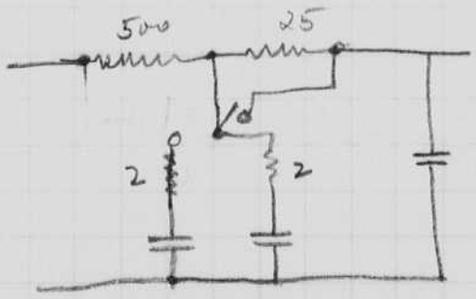
2. 525 0 1300. 1.5 x 32.
+20 paper

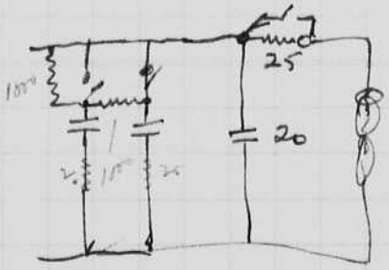
2 525. 0 1300 - 1.5 x 32

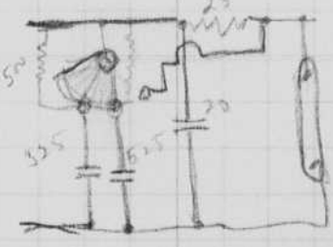
2 1050 25 9000 1 x .32
+20









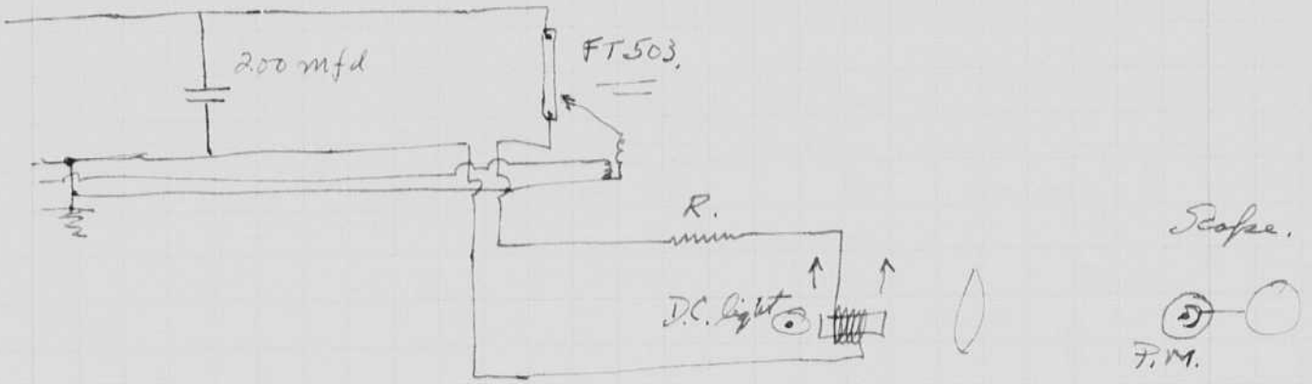


136 Feb. 5. 1955. (Sat.)

Harold E. Edgerton
Ray Swanson.

Pete Franklin (Sofer) was in to test the Robot under water camera. This will then be taken by Marsden to the Red Sea on the Calypso.

I tested the magneliöptic shutter using the 3200 watt second flash unit, 4KV.

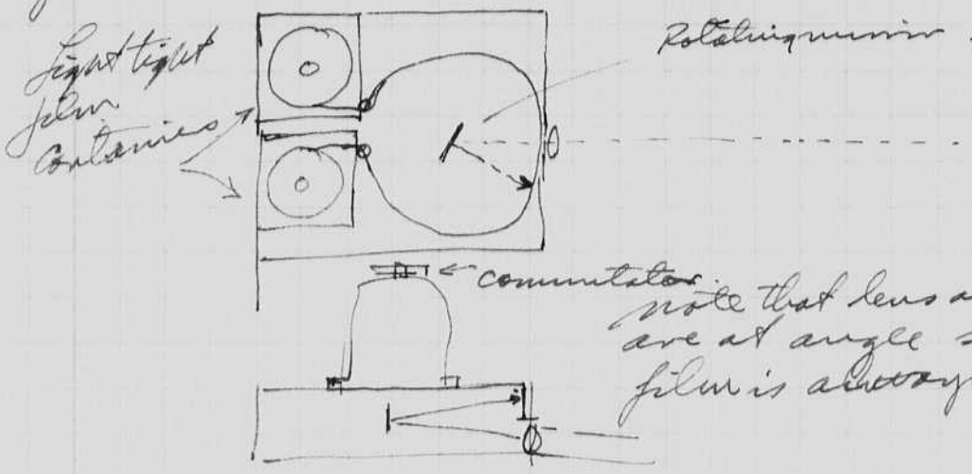


FDF 4 Glass 1"diam 1½" long with 300 turns? of #22 wire. Oscillograms were made of the dimming of the light

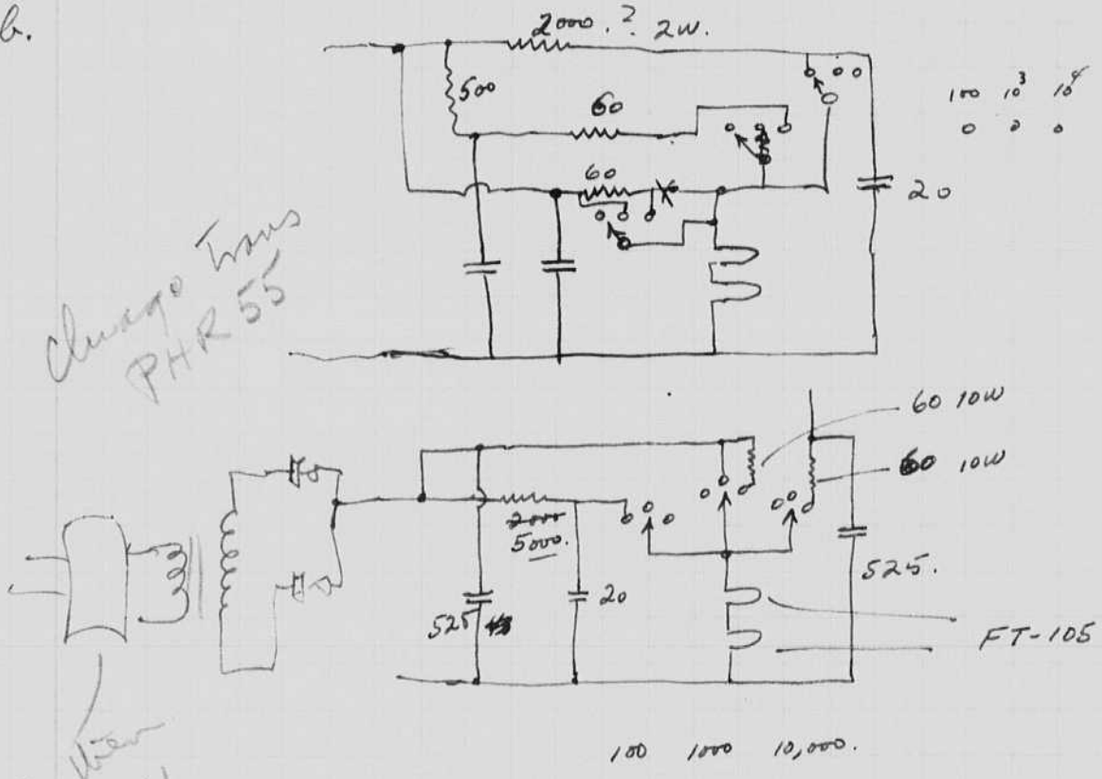
Osc No.	Res	C	
4	4 ohms.	200	Rotation excedes 90 degrees.
5	9	200	Rotation still excedes 90°.
6	14	200.	Looks o.k.
11	9	200	Shows overshoot.
Ineffective	Output of FT-503 = (14 ohms & coil)	36 x 94 x 4 =	13,800 B.C.P.S.
"	Output of FT-503 (coil.)	36 x 120 x 8 =	34,600 B.C.P.S.

Rotating Mirror Camera design

Feb 5/1955
A E Edgerton.

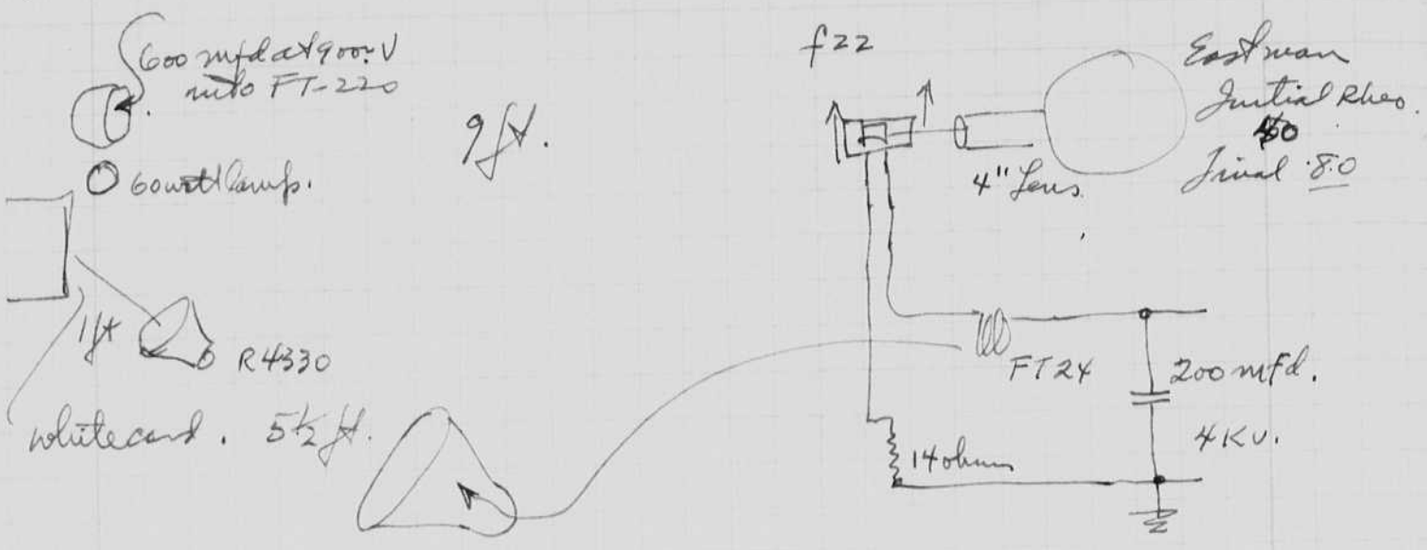


Feb.

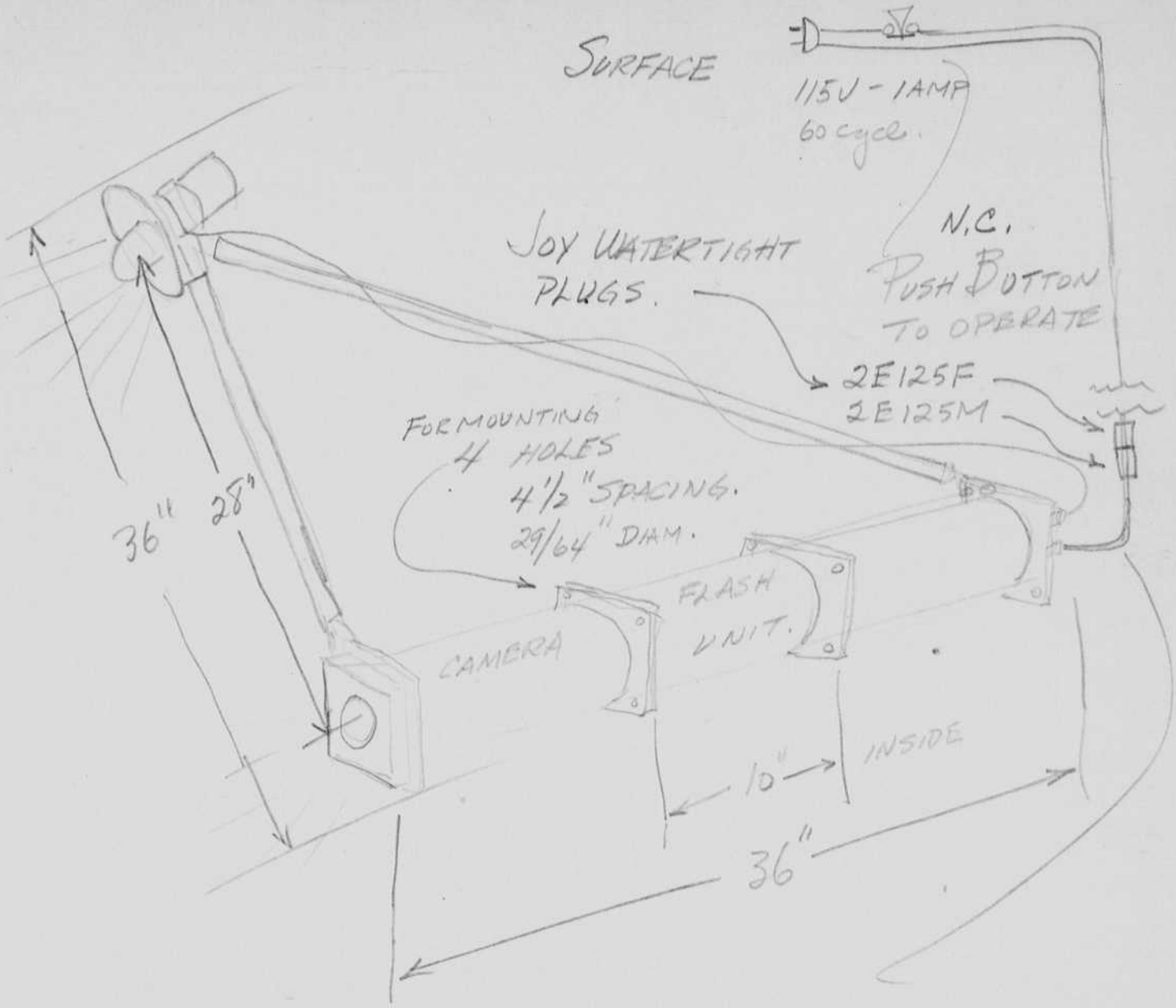


Feb 7 1956
H. Edgerton
Ray Swansen.

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 ½ by white paper. FT 24 at 2 ft in Reflector.	this was under developed 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 lamps. FT-24 at 1 foot away from the photo flood.	
6.	Same as 5 except coil on M.O was shorted out.			



RECYCLE TIME - 6 SEC (INTERMITTENT)
FILM - 100 FT 35mm.
SHUTTER TIME - 1/100 SEC.
FLASH - 100 WS - 2200 B.C.P.S.
DEPTH - 1000 FT.

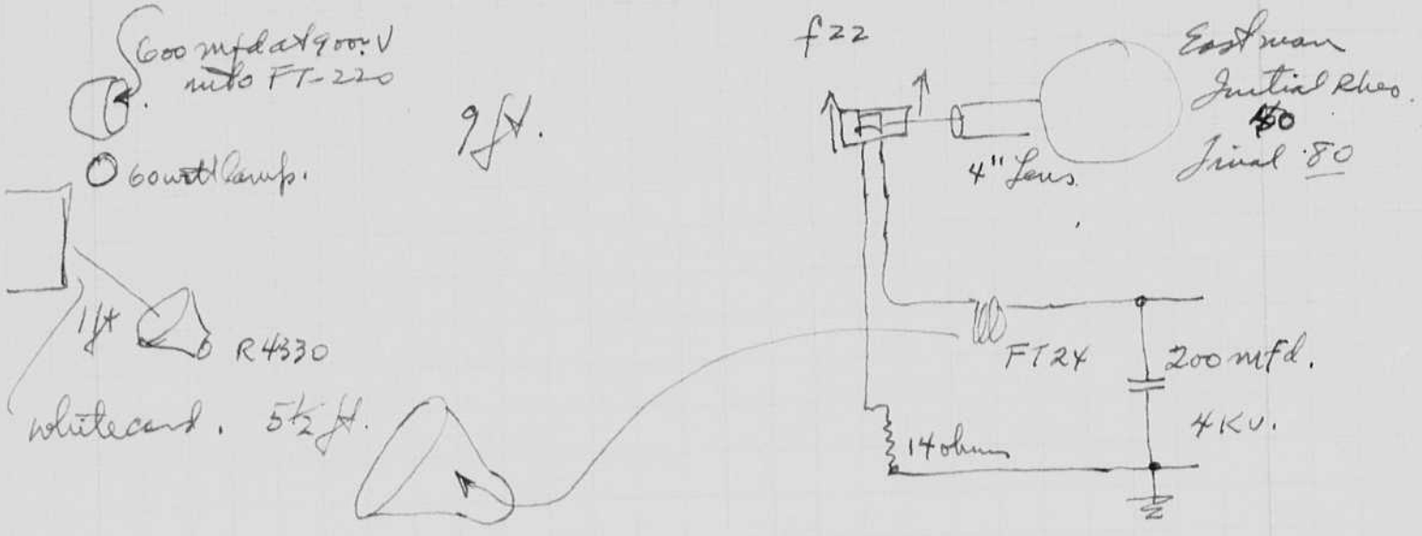
30 FT
#16 TIREX
TYPE SO 600 VOLT
CABLE.

UNDERWATER
PUSH BUTTON CAMERA
EG&G TYPE 2227.

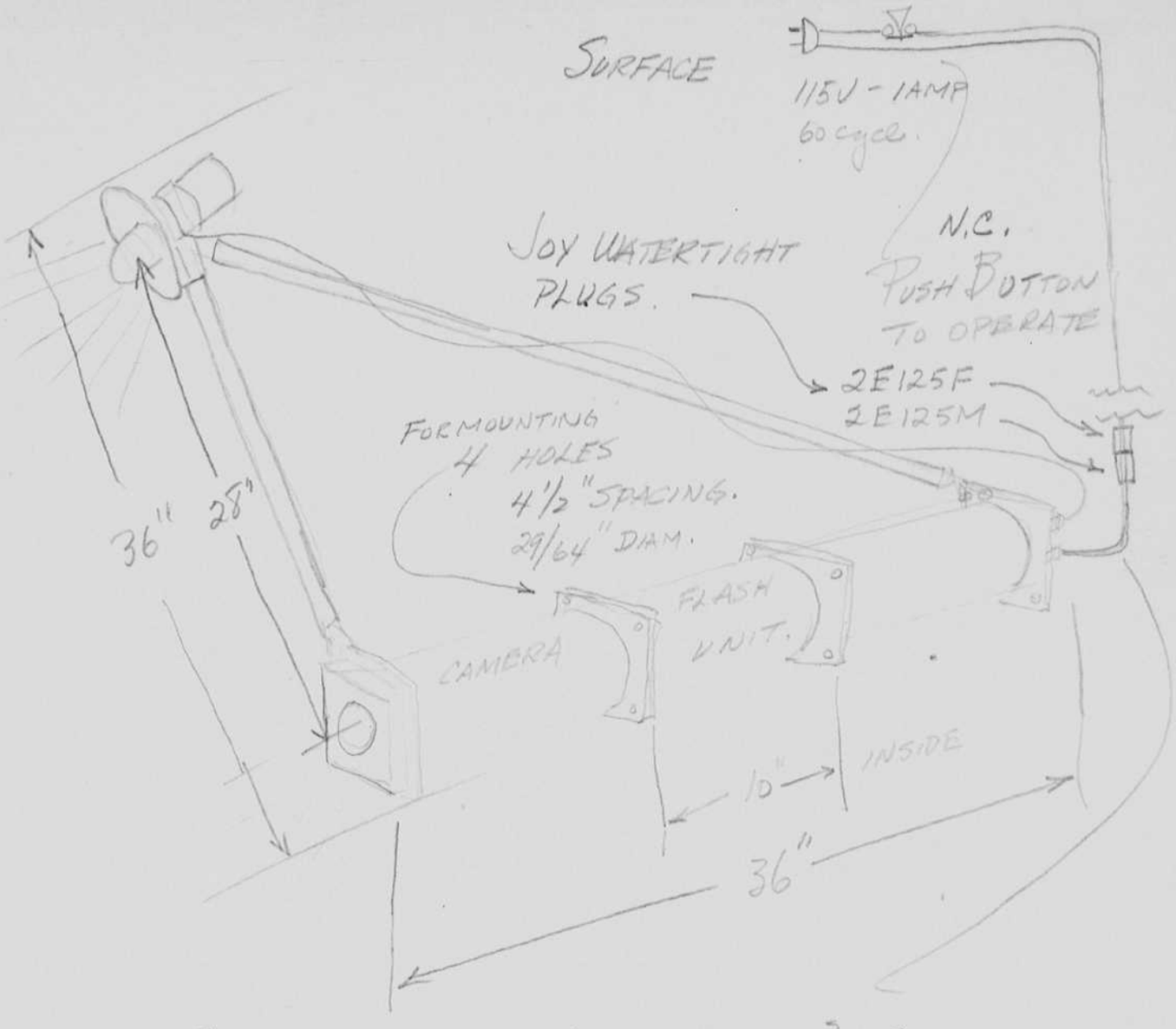
FEB. 8, 1955.
H. EDGERTON

July 7 1956
H. Edgerton
Ray Swanson.

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 photoflood in place of 60W. no R4330. FT-220 covered ½ by white paper. FT 24 at 2 ft in Reflector.	This was underdeveloped 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 photoflood.	
6.	Same as 5 except coil on M.O was shorted out.			



RECYCLE TIME - 6 SEC (INTERMITTENT)
FILM - 100 FT 35mm.
SHUTTER TIME - 1/100 SEC.
FLASH - 100 ws - 2200 B.C.P.S.
DEPTH - 1000 FT.

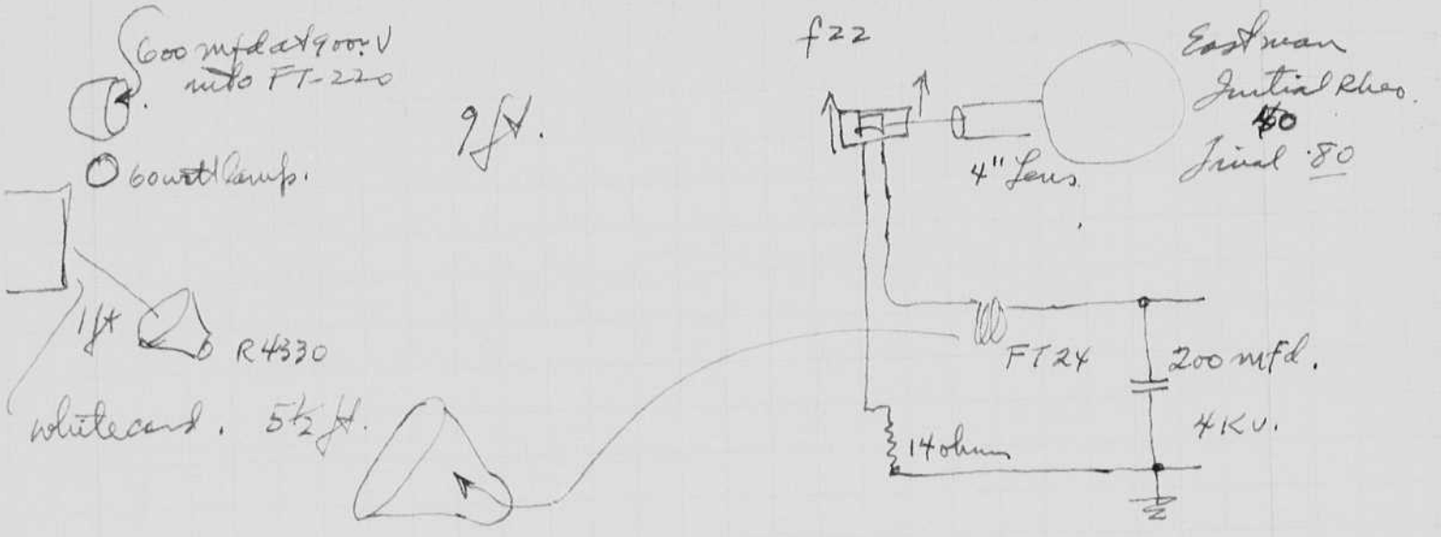
30 FT
#16 TIREX
TYPE SO 600 VOLT
CABLE.

UNDERWATER
PUSH BUTTON CAMERA
E616 TYPE 2227.

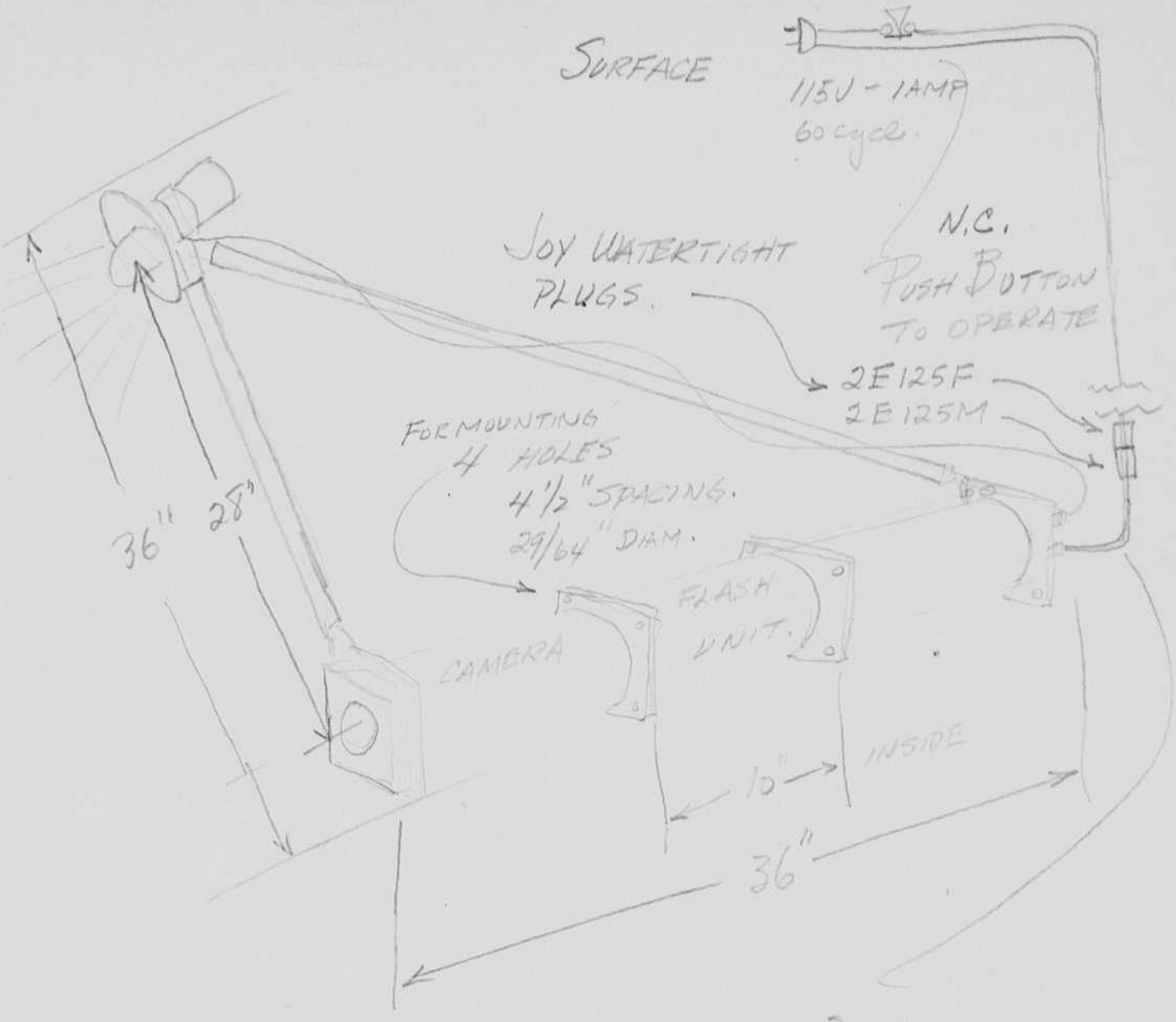
FEB. 8, 1955.
H. EDGERTON

138 July 7 1956
H. Edgerton
Ray Swanson.

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 ½ by white paper. FT 24 at 2 ft in Reflector.	This was under developed 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 photoflood.	
6.	Same as 5 except coil on MO was shorted out.			



RECYCLE TIME - 6 SEC (INTERMITTENT)
FILM - 100 FT 35mm.
SHUTTER TIME - 1/100 SEC.
FLASH - 100 WS - 2700 B.C.P.S.
DEPTH - 1000 FT.

30 FT
#16 TIREX
TYPE SO 600 VOLT
CABLE.

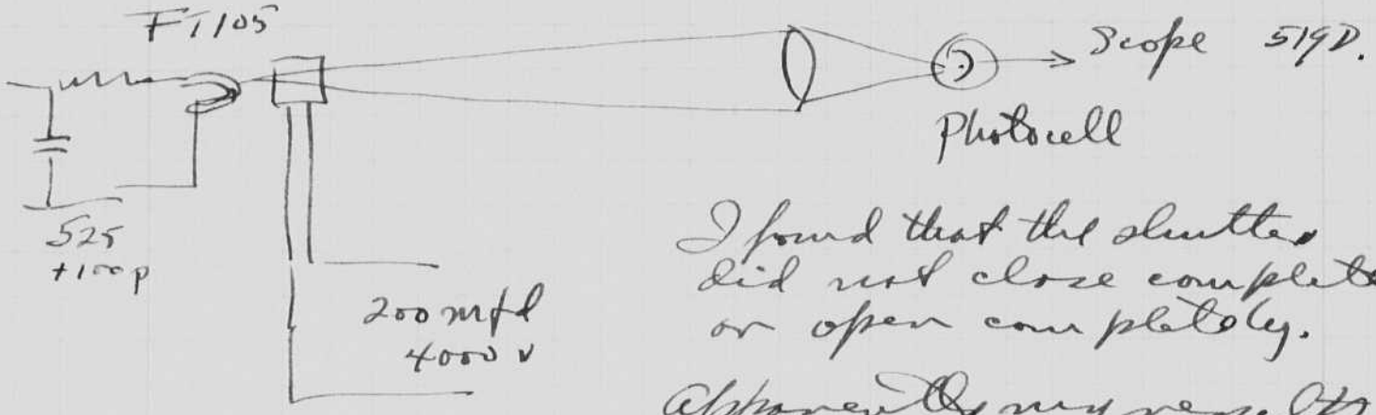
UNDERWATER
PUSH BUTTON CAMERA
EG&G TYPE 2227.

FEB. 8, 1955.
H. EDGERTON

Feb. 9, 1955.
Harold E. Edgerton.

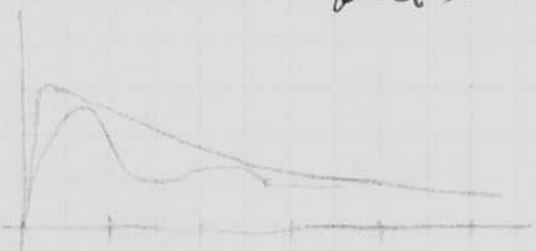
Tests of my M.O. shutter with the moving picture camera were not good. There was some reduction of light but not much.

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!

Ideas. (1) maybe the ~~band~~ band pass is too broad. Try a filter.

(2) maybe the amplifier and scope are lying

yellow filter gives us helter! experiment.

Amplifier looks ok on D.C. pulse of 3 volts.

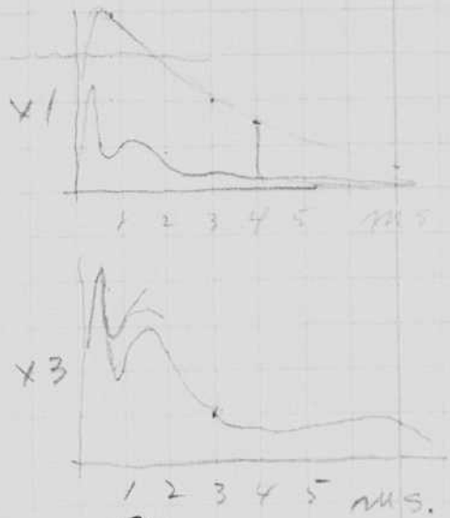
Blue Filter did not help much either.
Baffle installed – no help.

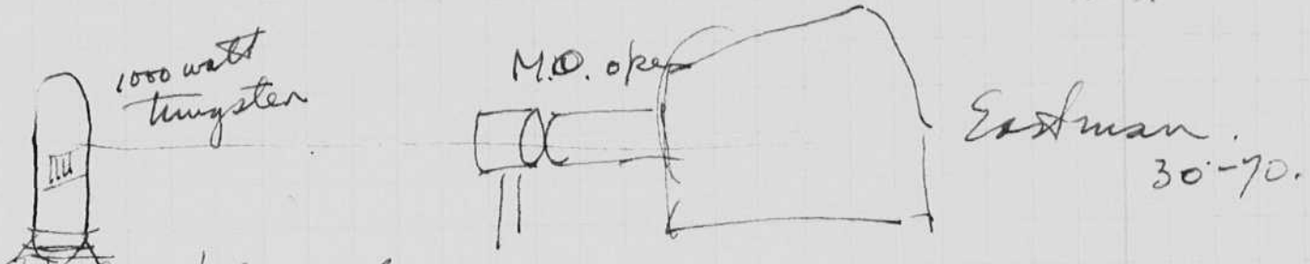
Feb 12 1955

Harold Edgerton
20D102 M.I.T.

Magneto" optic Shutter

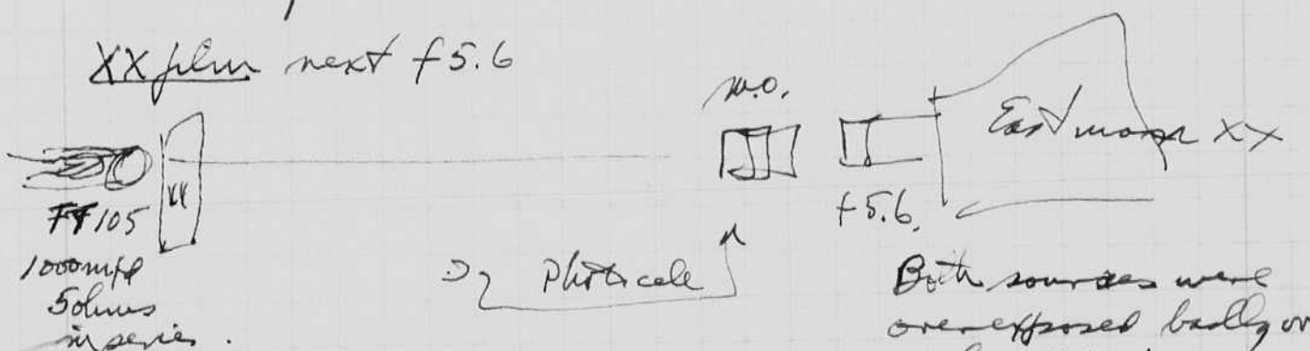
Open-close ratio about 600 with mechanical rotation.
next Covered flash lamps to exclude stray light.





Positive film. Fine grain
Film when developed show peculiar interrupted spots??
This may have been exposed on a shutter that was missing?

XX film next f 5.6

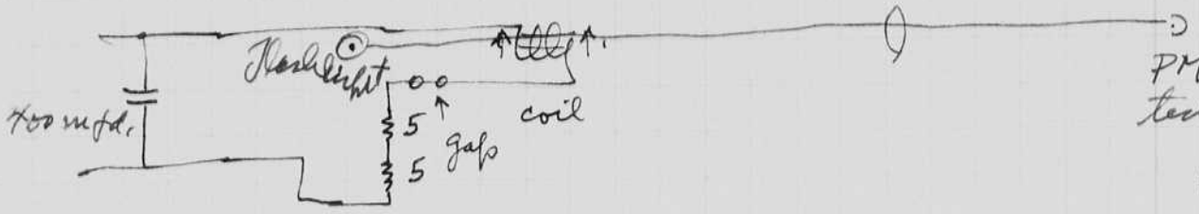


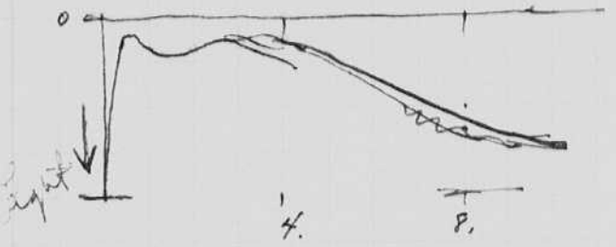
Both sources were
overexposed badly on XX film
at f 5.6 !
M.O. helped but not enough.!

Feb 14 1955 Ray finished Sensitometer
.280 ms
1.0 ms
8. ms.
} three conditions.

W. O. Shutter.

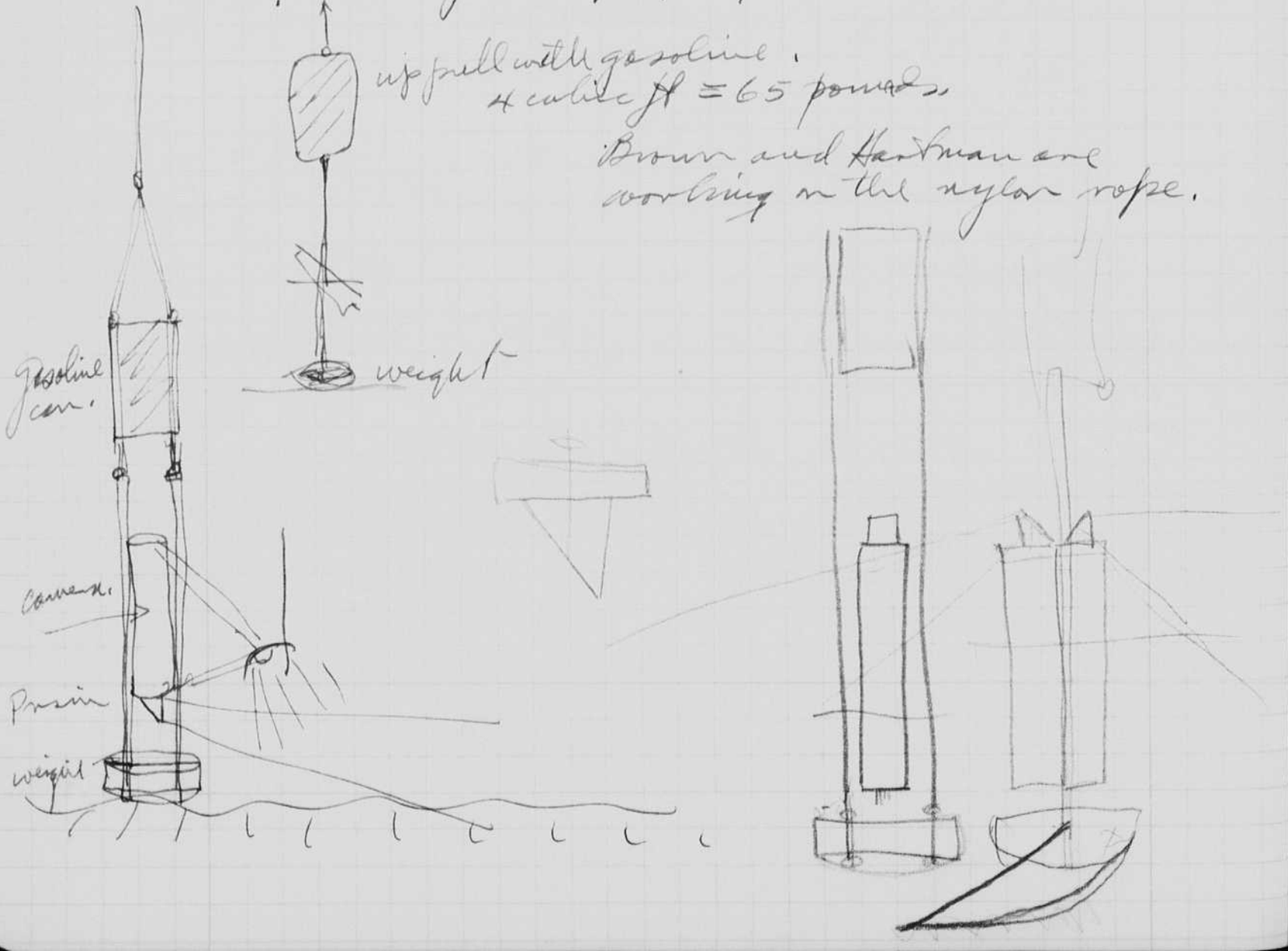
Flash unit under 400 mfd at 4 KV.





This is a final setting to go to Pitt Field. B.E. for tests.

#2. Underwater camera, Bill Westall suggested a gasoline suspended camera for the Bottom photography.



2227 Underwater Camera — Weights

36 pounds, case plus cables + lamphouse and bracket ac operated by push button on surface.

7½ pounds power unit

3½ " camera with 100 ft of film.

47 " in air.

Results from Tuddy experiment on short flash lamps.

	Gap length inches	Gas.	Energy W.S	Duration μs.	Peak. BCP.	Output BCPS.	Effy cp/watt
*	1/8	Xenon	.06	.46	4.5×10⁴	.0177	0.295
*	1/2	"	.06	.74	4.9×10⁴	.0324	0.54
*	1	"	.06	1.1	3×10⁴	.0306	0.51
	.02	air	.06	.35	.62×10⁴	.00175	.029
	.083	air	.135	.43	2×10⁴	.0072	.053
	.083	air	.24	.44	3.6×10⁴	.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 mfd 11.1 mc 2KV.

Down in Pittsfield Feb 17 with Don Severence to show movies and slides of the Bally rapid and calypso—

Feb 18 I worked with Babbitt on the M.O. study of the fuse breaker. Bill Rudge.

Feb 22 1955 Edgerton Germeshausen & Grier
Harold Edgerton
Roy Swanson.

Strobolux. new model.

Tube 1/4" gap 1 mm Xenon 1 atmosphere.

Cap 1 mfd. 60 cycle 750 volts.. 1000 ohms.

$\frac{CE^2}{2} = \frac{10^{-6} \cdot 750^2}{2} = .25$ 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 ships when overheated.

Geo LeCompte and I experimented with the starting of flash tubes & observe the branching of the initial arc.

He observed that a 1" 4 mm I.D. 1 atmos xenon tube with 500 volts had single branch
" 800 " several.

We tried a 4" FX-1 with 0.1 mf 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 4 KV. 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 Ed dept on Wednesday Feb 23.

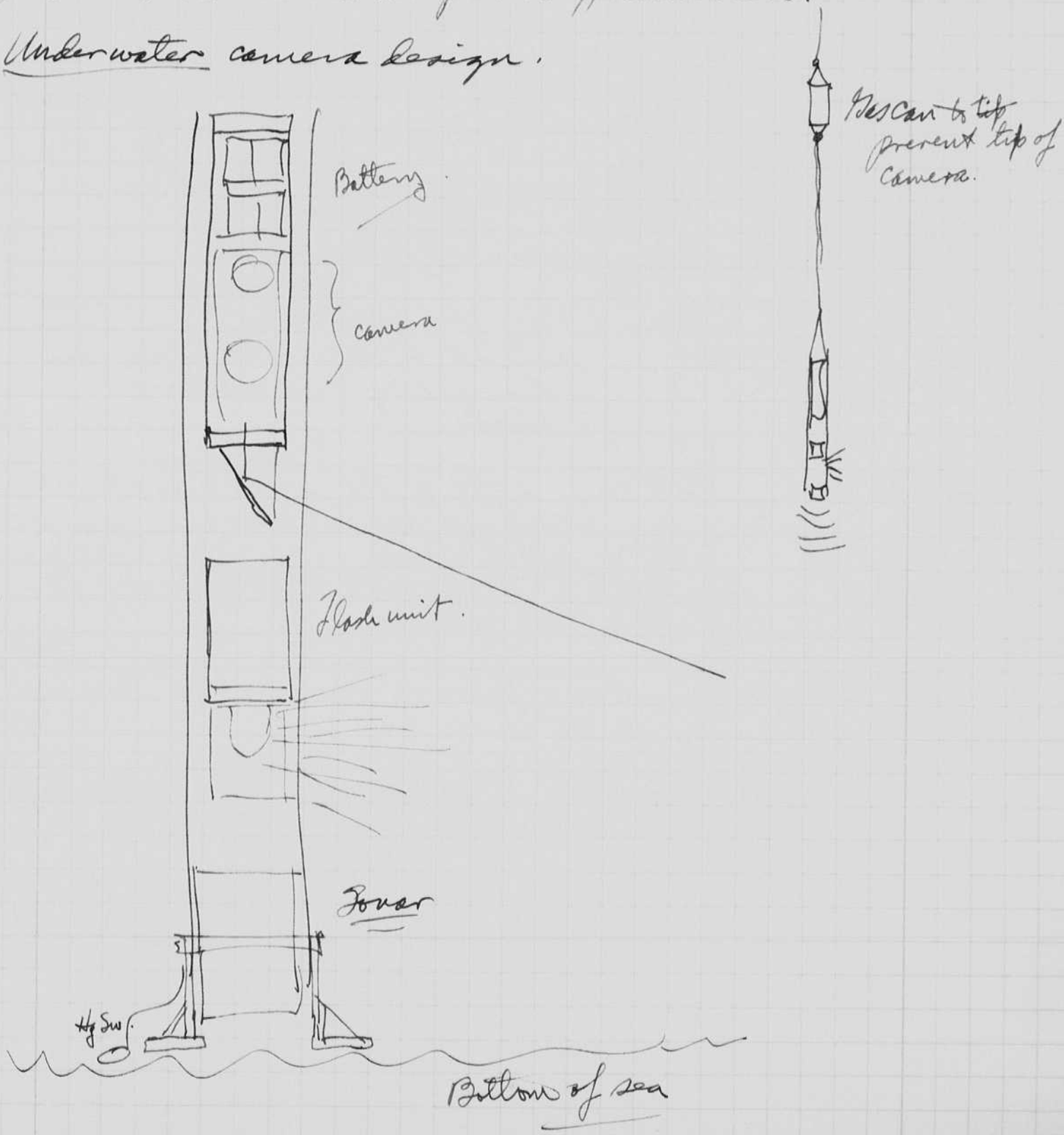
March, 16, 1955.
& E Edgerton.

Tested camera casing - 1¼" window over 1¼" hole broke at 13,000 P.S.I. new windows of 1½" are being ordered from Hartbol.

¼" gap. 1 mm I.D. 1 at sea.

Took strobe to Bidwell at Blowdown tunnell. 0.75 mfd at 1800 volts. 2 at 1/5 on Schlieren. Tests are to be made on photo effectiveness.

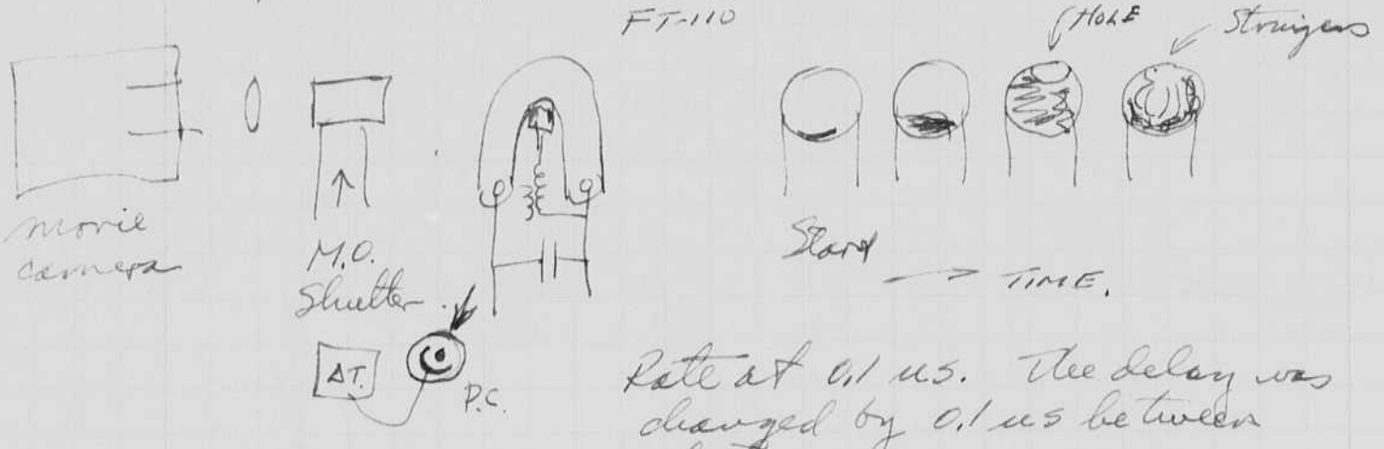
Underwater camera design.



March 27, 1955.
Harold Edgerton

Nottingham's electronics conference was held last week. I gave a short paper showing the shock wave light output. Two things were emphasized (1.) the light output after the current ceased and
(2) the bumps caused by the increased pressure when the compression wave reflected from the wall.

Jess Le Compte showed some motion pictures of the growth of an arc in a FT-110 tube.



Rate at 0.1 μs. The delay was changed by 0.1 μs between shots.

March 29, 1955 Bill Hay 2279 plane wind tunnel called
#2
B-H Lamps 4500 23 mfd. 231 W.S.
2 BD. 2000 0.75 mfd. 225 W.S.

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

He used a 6" circle for this photography in his schlieren set up.

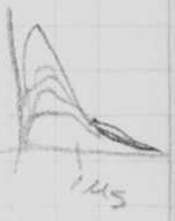
With a 35 mm camera he could use less light say 1/10 or 1/2.

Suppose 1 W.S. is acceptable then at 20 per sec power = 20 watts.

Let RC = .01 sec. $R = \frac{.01}{C} = \frac{.01}{.5 \times 10^{-6}} = \frac{10^4}{.5} = 20{,}000$ ohms.

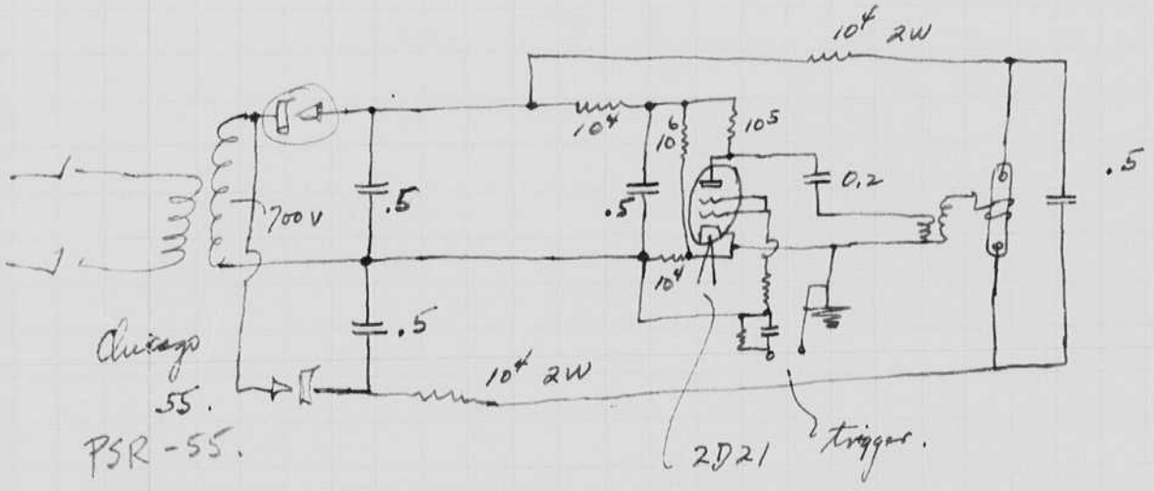
Heat run data on 1/4" gap 1mm Quartz. 1 atmos Xenon.

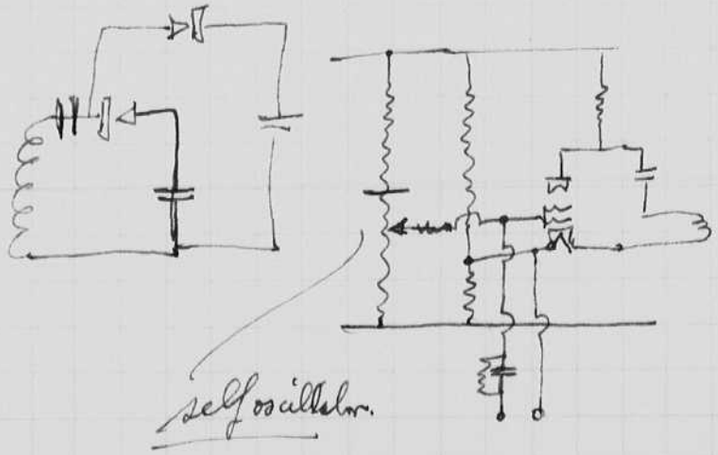
f	V	C	$CV^2/2$	Power $CV^2/2f$ watt	R.	Comments.
30	2	0.1	0.2	6.	10^4	Runs ok continuously.
60	2	.1	.2	12.	10^4	Self flashes when hot. Does not run at 600 continuously.
24	2	0.5	1.	24	10^4	Double flashes after 20 or 30 sec.
24	2	0.5	1	24	5×10^5	Better than above. ok 20 sec ±.
60	2	.05	0.1	6	5×10^5	ok But light is variable
240	2	.01	.002	4.8	5×10^5	ok but jittery light intensity

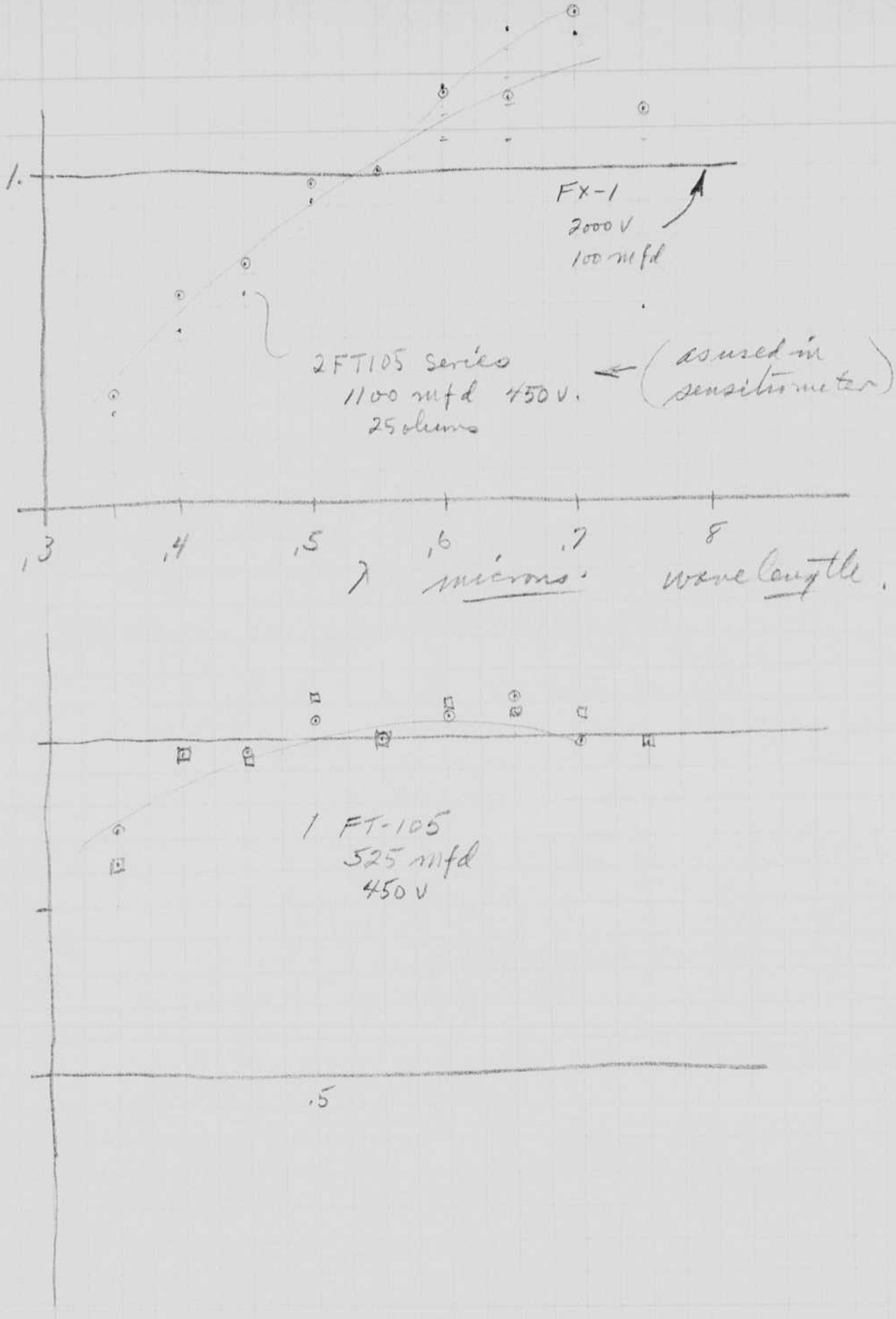


Light in capillaries looks uniform
the light in thread zones is grumpy.

Ends shielded with clips + seems better.
60 2 .04 ok continuously.






1.
FX-1
2000 V
100 mfd
2FT105 series
1100 mfd 450 V.
25 ohms
(as used in sensitometer)
.3
.4
.5
.6
.7
.8
λ microns.
wave length.
1 FT-105
525 mfd
450 V
.5

Liquid cooled tube.
Quartz lamps. 1/4" gap / mm diam xenon.

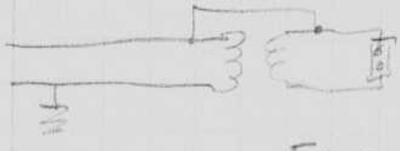
WS/pk	V	C	f.	
1	2000 volts.	0.5 mfd	at 10/sec.	ok continuous.
1.	"	"	30/sec.	ok. 30 sec at ~~30~~ 30 flashes/sec.

Old work machine

		C		I
25	FX-2 flashtubes.	.04	.445 lms.	120 volts.
25		.01	.445	85 volts.
25.		.02	.445	100 "

$\frac{100}{.02} = 200$ amps
8000

25	1/4 gap	1 mm. 25Ω	.01	.445.	55 V.
25	1/4 gap.	12.5Ω	.01	.445	85
	1/4.	5Ω.	.01	kicks out circuit Breaker.	

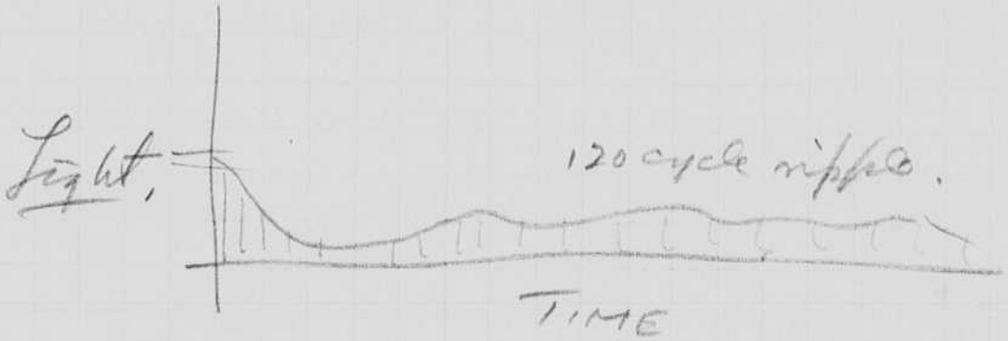


22.5 volts. at 2 ft. (200)

FX-2 .01 35.

Transformer is bad.

Ran with .01 & 12 Kc.

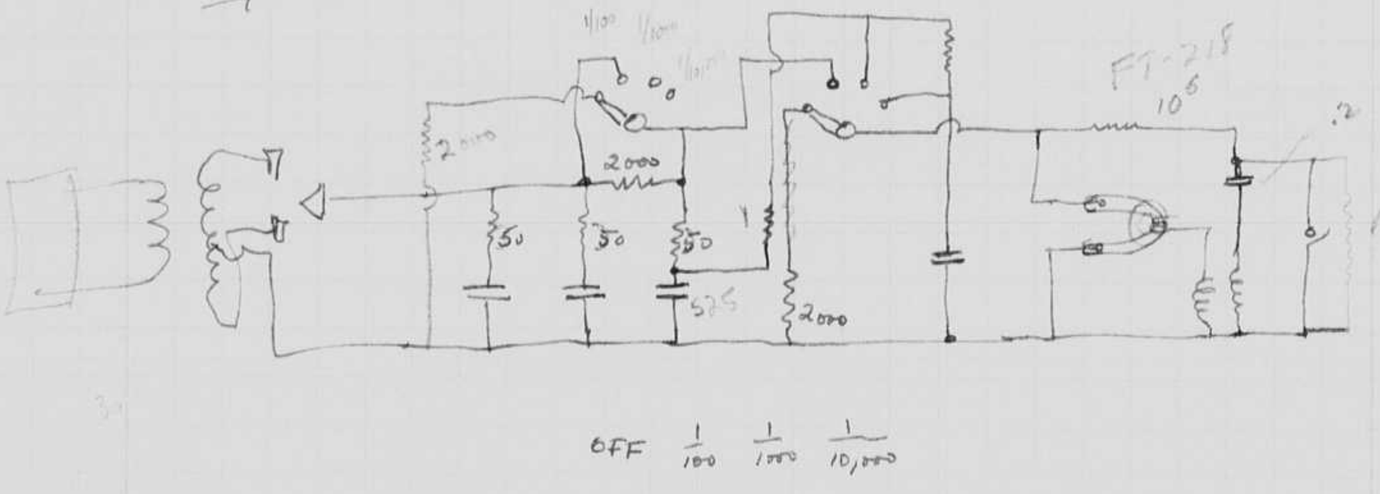


Dett Brundrick Watson Woolsey Cockerill Schwere Smythe Muller Baker Esther

March 1955
Party 620 class
and thesis students

Heilbronner mrs Dett mrs Woolsey Browner Pat Vacca Word Rockwell Sue Esther

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 525 mfd capacitors.
new type circuit



Test made today with Roy Swansen show

1/100 sec. FT-118 1800 mfd 9 or 10 ohms. 450V

1/1000 sec. FT-118 600 mfd 1 ohm. 450V

150 μ sec FT-118 40 mfd 0 ohms.
$40 \times 2/3 = \frac{80}{3} = 26.6$ mfd.

75 μs FT-118 38 mfd paper.

April 15 1955
Harold Edgerton

Sensitometer tests.

Tube changed to ~~FT-27~~ FT-118.

G.R. light meter.

1050 mfd	25 Ω	12,000 μs.	~~1600~~ ~~640~~ 45
~~525~~	0	900 μs.	640
40	0	120 μs.	20.

935 photocell at film position. 1200 ohms into tektronix scope

(40 mfd. 20 volts × 3 = 60 peak light. 60 V
40 × 30 = 120 microseconds.)

525 mfd. .33 × 3 = .99 V
25 Ω ~~5~~ .4 × 30 = 15,000 micro sec

1050 mfd. 37 × 6 = 222 volts. peak.
2.3 × ~~30~~ 60 = 690 μs.

~~WW~~ Circuit changed.
1 ohm added ~~to~~ 525 mfd
25 changed to 12.5 or 1050.

525 1 ohm. 4.1 × 300 = 1200 μs. } 150 volts.

1050 12.5 Ω. 3 × 3000 = 9000 μs.

Oscillograms taken of 3 conditions above.

Light Readings (110 × 1 one diffuser
Done with 2.
120 × 1.

1050 1 Ω
525 12.5 Ω

Final conditions

		f.c.s.	D μs.	peak V	peak light
1050 mfd	12.5 Ω	120 light meter	9000		
525	1	440	1200	150 V	0.1
40	0	20	120		

March 1955
Party 620 class and friends students

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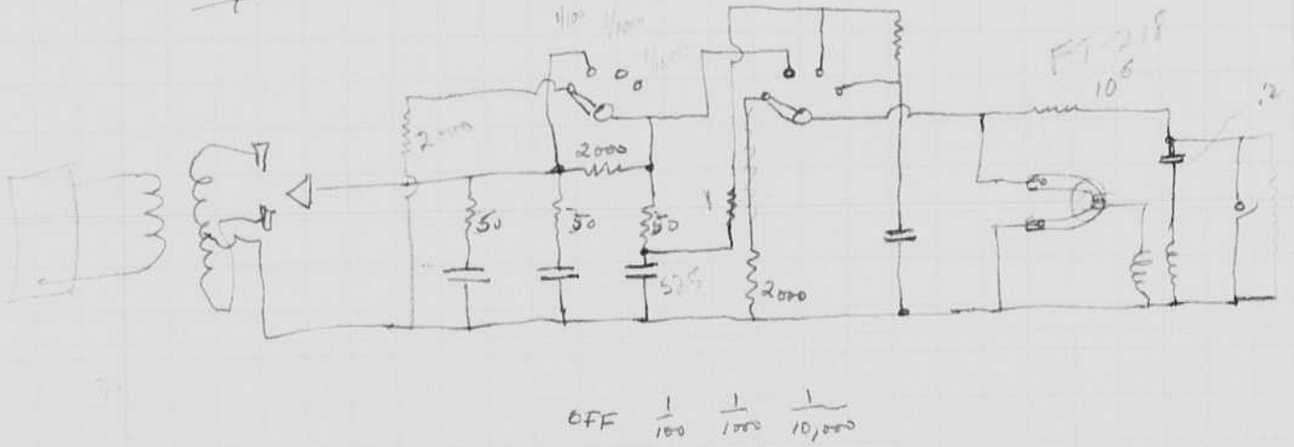
new type circuit



Test made today with Fred Barstow shown
1/100 sec. FT-118 1800 mfd 90 or 100 ohms. 450V
1/1000 sec. FT-118 600 mfd 1 ohm. 450V
150 m sec FT-118 40 mfd 0 ohms.
40 x 2/3 = 80/3 = 26.6 mfd.
75 MS FT-118 38 mfd paper.

April 15 1955
Harold Edgerton

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Light Readings 110 × 1 one diffuser
one with 2.
120 × 1.

1050 1 Ω
525 12.5 Ω

Final conditions

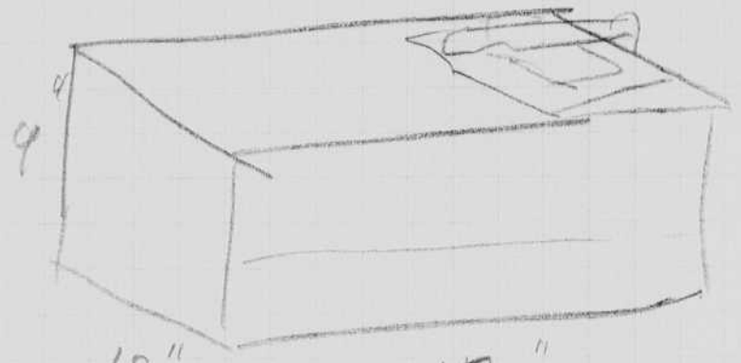
		f.s.	D μs.	peak V	peak light
1050 mfd	12.5 Ω	120 light meter	9000		
525	1	440	1200	150 V	0.1
40	0	20	120		

Overall size.

1/100	112	120	120
1/1000	105	x4	
1/10000	15	16	15

Regulation.

Dupont	Ilford	
100	103x4	.01 setting
105	103	30 sec
125	112	reading
130	114	



Marilyn

Sally Lunt.

Chas Rockwell
Jack Brown

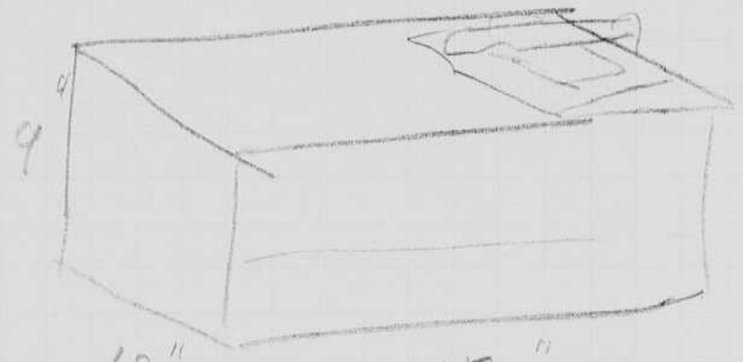
Van Borgen.

Joe Vacca

52 Birthday party April 6 1955.

Overall size.

1/100 112 120 120
1/1000 105 x 4
1/100 15 16 15



Regulation.

Dupont	Eastman	
100	103 x 4	.01 setting
105	103	30 sec
125	112	reading
130	114	

Mark IV

Sally Lunt.

Chas Rockwell
Jack Brown

Van Borgen.

Joe Vocco

52 Birthday party April 6 1955.

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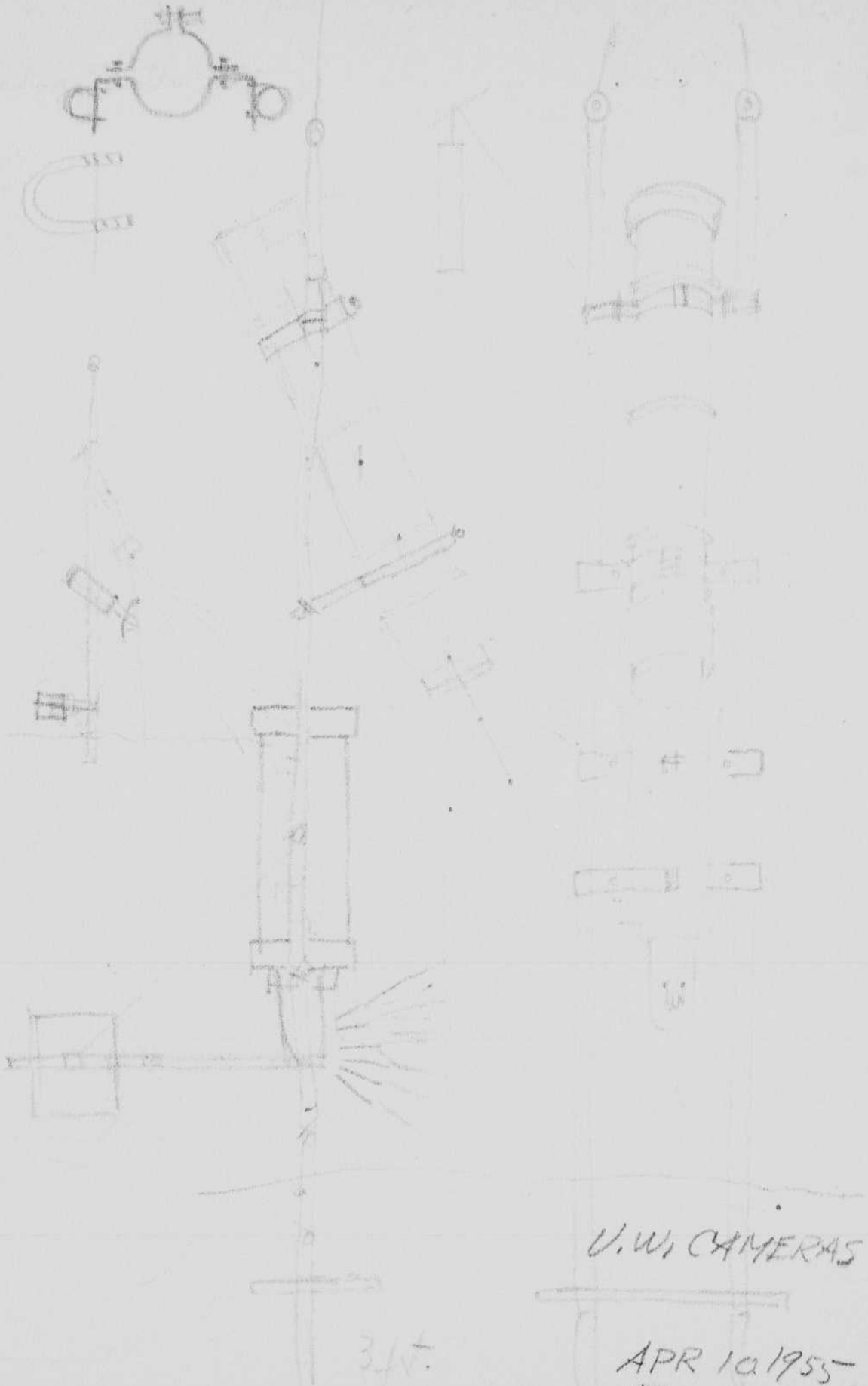
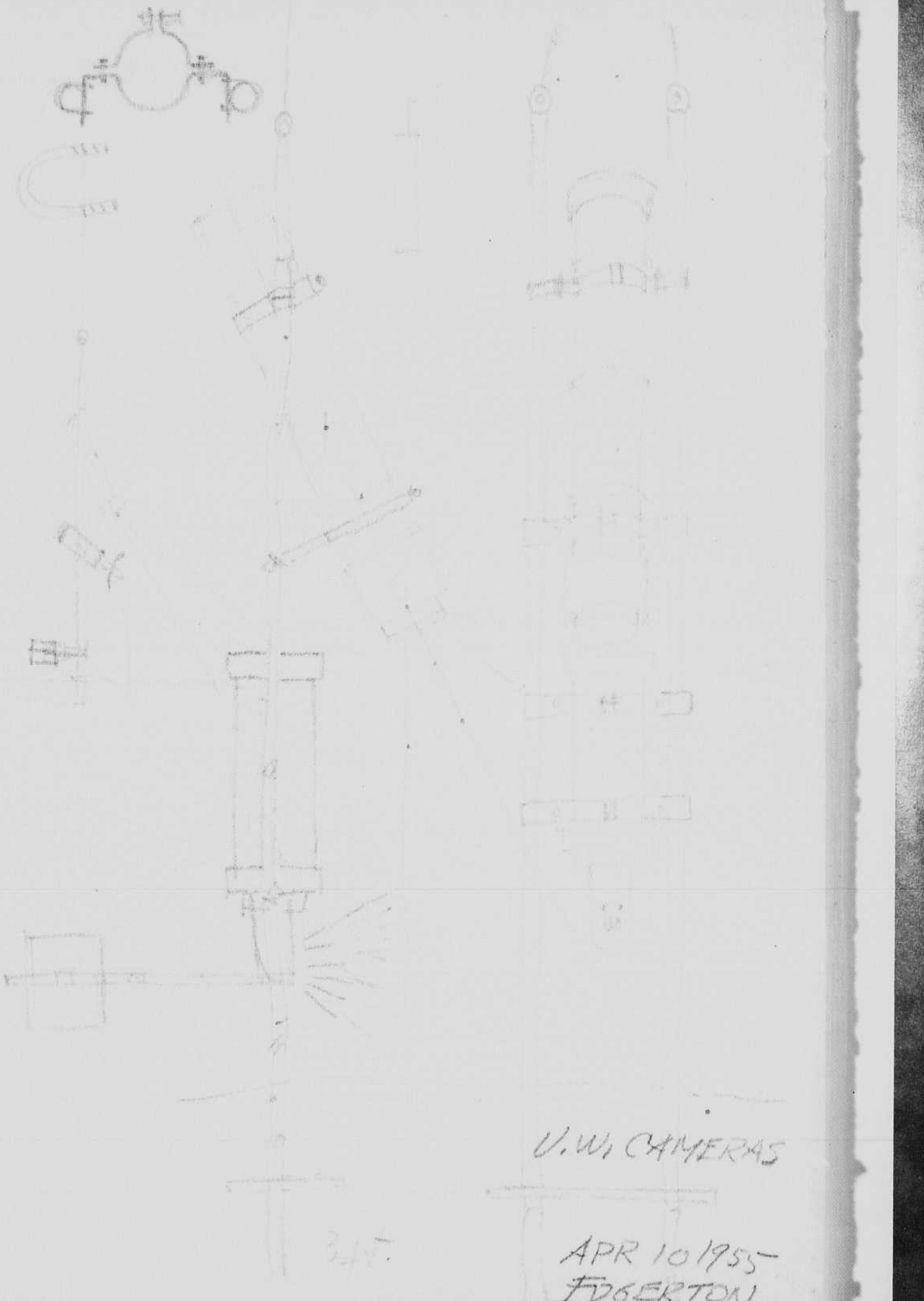


U. W. CAMERAS

APR 10 1955
EDGERTON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