

HAROLD E. EDGERTON

PAPERS

MC 25

Series III

Laboratory Notebooks

Number 20

Dated Feb. 7, 1950 to Dec. 27, 1951

# COMPUTATION BOOK

| NAME                | Number |
|---------------------|--------|
| HAROLD E. EDGERTON. | 20     |

MIT 20 D 102

Course.....

Used from FEB 7 1950, to Dec 27 1951.

HARVARD COOPERATIVE SOCIETY  
1400 Mass. Ave., Cambridge, Mass.  
40 Mass. Ave., Cambridge, Mass.



Notebook # 20

### Filming and Separation Record

\_\_\_ unmounted photograph(s)

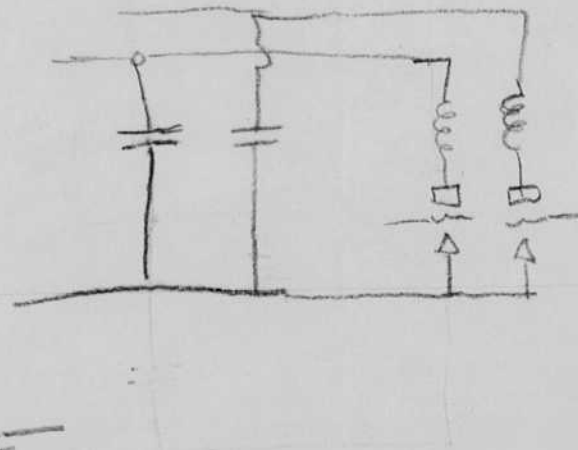
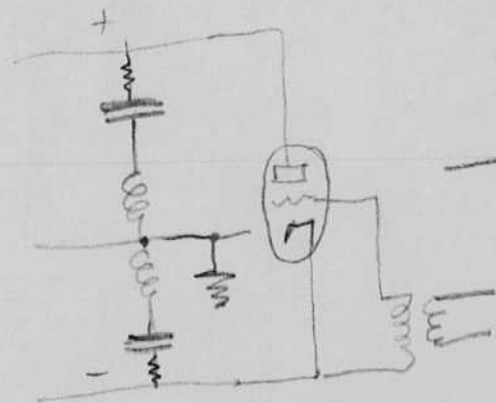
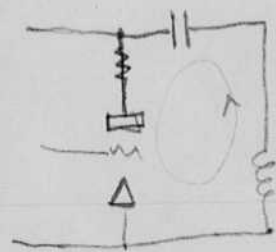
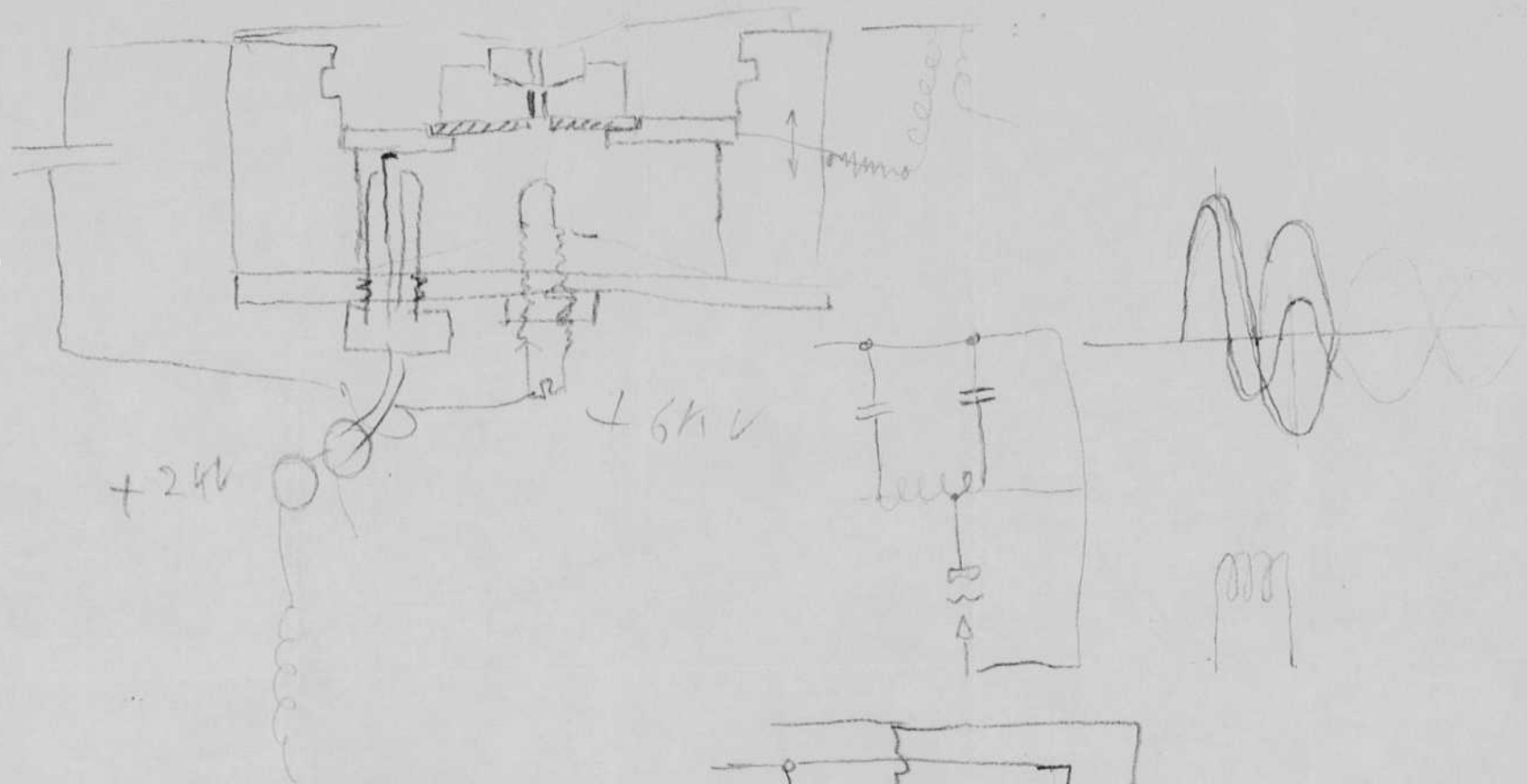
\_\_\_ negative strip(s)

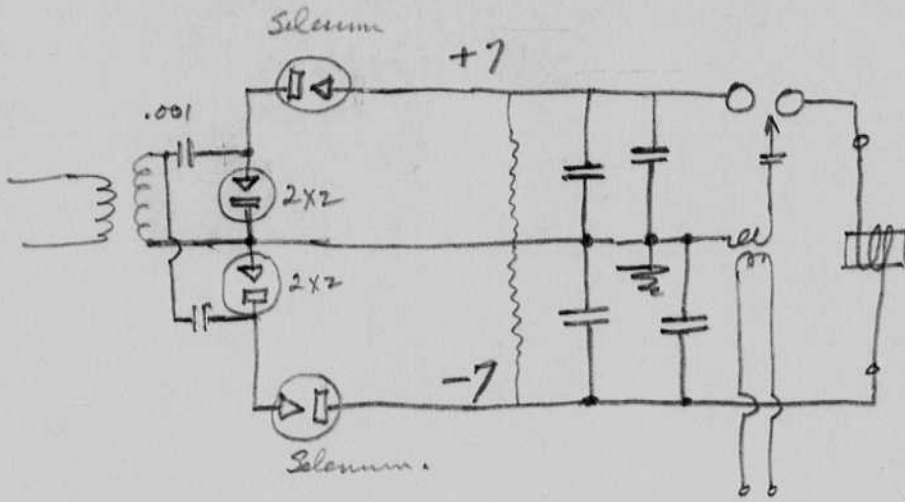
2 unmounted page(s)  
(notes, drawings, letters, etc.)

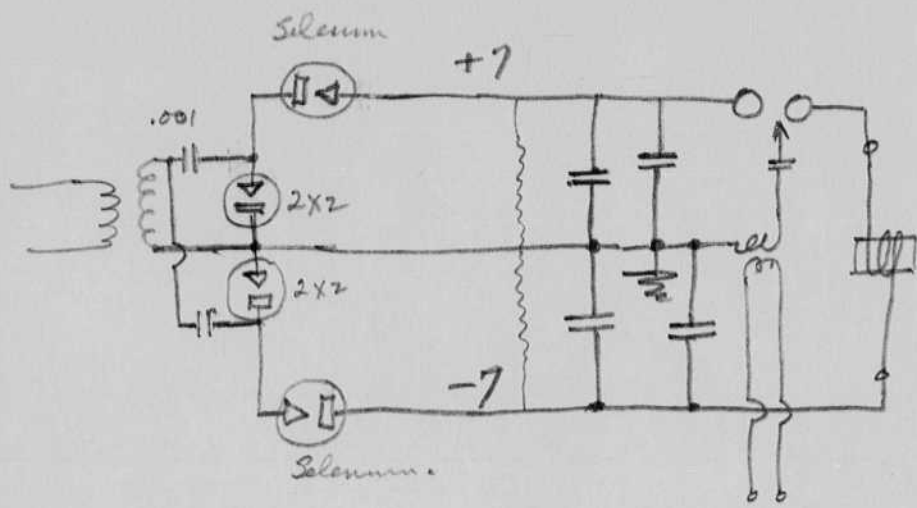
was/were filmed where originally located between page \_\_\_ and \_\_\_.  
*inside front cover*

Item(s) now housed in accompanying folder.









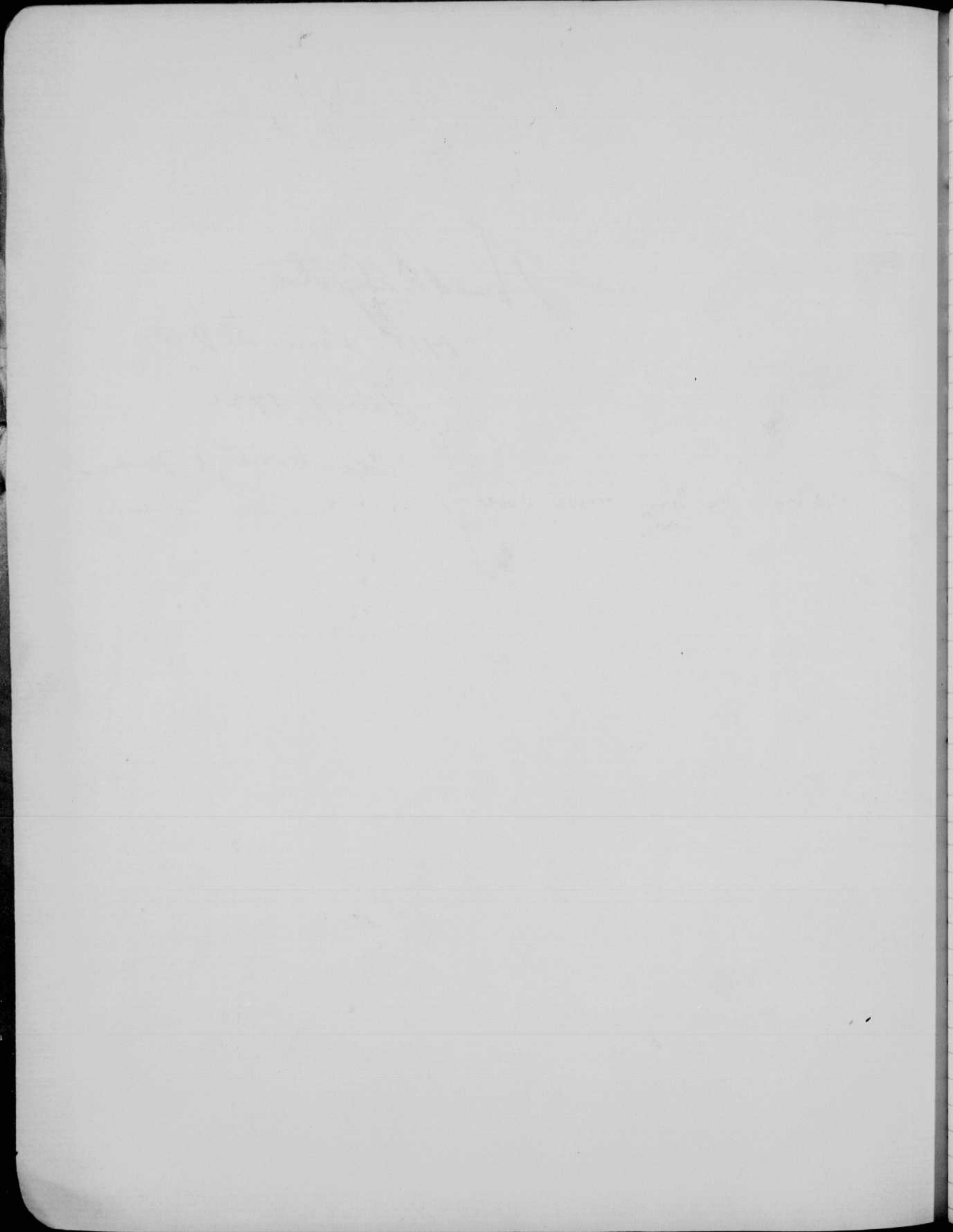


Harold E. Edgerton

M.I.T. Room 20D120

Feb. 7, 1950

Cambridge, Mass.

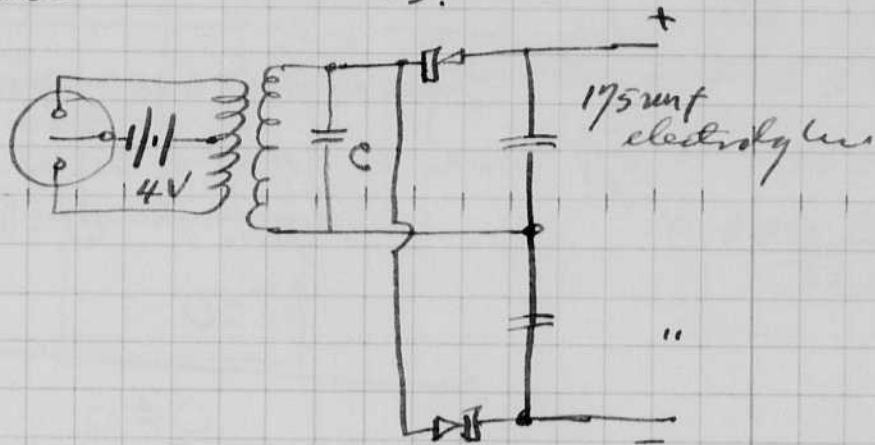




# Tests of Vibrator Power Supply

Transformer 3/4" tongue

36 turns # 16 C.T.  
2250 " # 33.



Vibrator Mallory W1000 4 volt. 125A  
870 volt.  $C = .104 \text{ mf.}$   $I_{dc} = 1.65 \text{ amperes.}$

|     |     |      |
|-----|-----|------|
| 910 | .01 | 2.18 |
|     | .02 | 1.95 |
|     | .03 | 1.73 |
|     | .04 | 1.55 |
| 860 | .05 | 1.55 |
|     | .06 | 1.68 |
| 860 | .08 | 1.95 |

Vibrator Mallory W94.

118 cycles.  
A

| C   | $I_{dc}$ | $E_{dc}$ |
|-----|----------|----------|
| .03 | 2.70     | 940      |
| .05 | 2.22     |          |
| .07 | 1.76     | 890+?    |
| .09 | 1.62     | 880      |
| .11 | 1.75     | 870      |
| .15 | 2.3      | 880      |

Delco Vilm

504000 95A

|     |      |     |
|-----|------|-----|
| .25 | 1.5  | 840 |
| .23 | 1.6  |     |
| .27 | 1.4  |     |
| .29 | 1.45 |     |
| .31 | 1.55 |     |

approx 250  $\mu$  6 volt vibrator. in circuit p 1.

$$C=0 \quad I_{dc} = .95 \text{ amp} \quad 880 \text{ V}$$

Smaller transformer

5/8 core 4V - 550  
100 T CT #22  
6850 #40

approx 250  $\mu$ .  $C=0$   $I_{cc} = .5 \text{ amp}$  950 V  
chg time about 10 seconds ok. but  
possibly too high sec voltage

Output capacity increased to 6  
Sprague 175  $\mu$  f.

$$C=0 \quad I = 1.75 \text{ amp.} \quad 790$$

$$I_{max} = \underline{5.5 \text{ amp.}} \text{ at start of charge.}$$

Mallory  
W-1000 vibrator. 4 volt.  $C=0$   $I = 1.30$  770

$$E = N \frac{d\phi}{dt} \quad 8 = 100 \cdot 2\pi \cdot 125 \phi$$

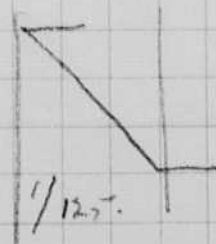
Output C reduced to 2 175 capacitors

$$I = .75 \quad 920 \text{ volt}$$

$$E = N \frac{d\phi}{dt} = 2\pi f N \phi$$

$$8 = 2\pi \cdot 125 \cdot 100 \phi$$

$$\phi = \frac{4}{2\pi}$$

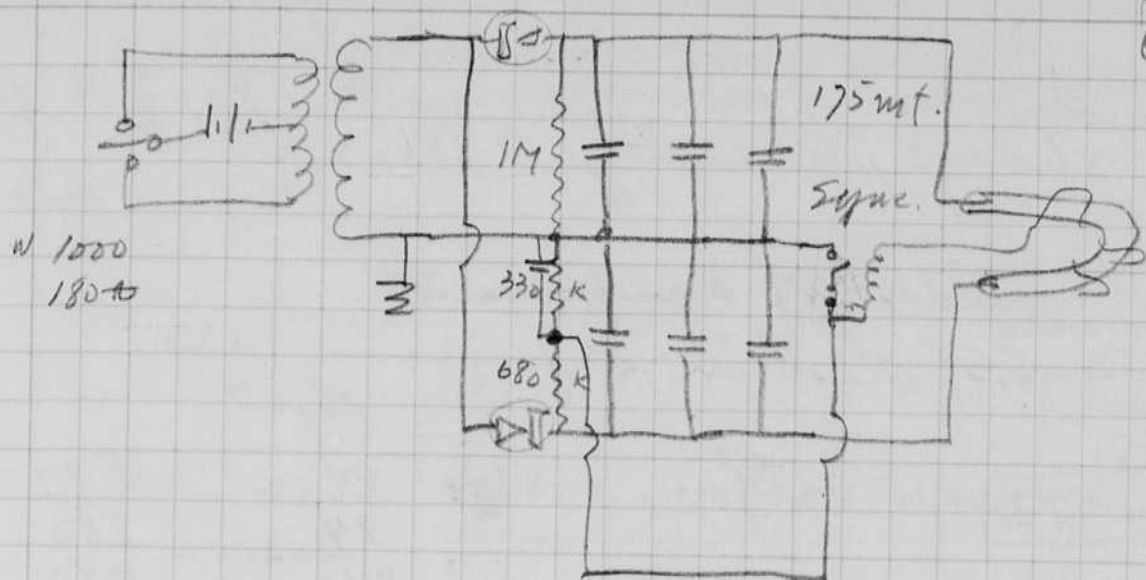


with 6 capacitors.

$$1.05$$

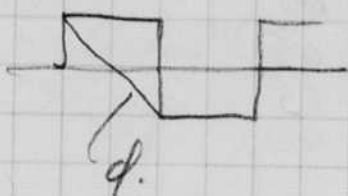
$$820$$

5 amp  
meter  
840-900



Output  
 720 volts,  
 55 cps  
 at 3 ft.  
 or 495 hcp5,  
 or 4950 lumens  
 /sec.

This transformer has a  $5/8$ " square core  
 flux calc at 180 cycles.



$\frac{1}{2}$  cycle 4 volts on primary  
 $t = \frac{1}{360}$  sec. 50 turns.

$$e = N \frac{d\phi}{dt} \times 10^{-8} = 4$$

$$\Delta T = \frac{1}{360} \quad N = 50$$

$$d\phi = \frac{e}{N} dt \times 10^8 = \frac{4}{50} \frac{1}{360} \times 10^8 = 22,200 \text{ lines}$$

this flux change. therefore  
 the max flux is half this value.

11,100 lines

$$\text{area} = \left(\frac{5}{8}\right)^2 \times .9^2 = .316 \text{ sq inch}$$

$$B = \frac{11,100}{.316} = 35,200 \text{ lines/sq inch.}$$

5,600 gauss.

Since winding is tight, increase this to 6000+

Reduce primary winding from 100 to 90  $B = 6,220$   
 " " " " 6850 to 6150

$5/8$  core.

6 volt design.

(6150) → Keep size and secondary the same

Increase primary turns to  $90 \times \frac{6}{4} = 120$   
change wire size #23 (or 24)

Feb. 14, 1950  
R. E. Egan  
+

Cold test of equipment

8.55 start in refrigerator. AM.

Light

✓

8.55

4 new battery, approx 2H±

84 x 2

870

9.10

"

84 "

880

9.40

84

880

9.55

82

870

11.40

77

880

12.50

875

2.15

64

860

3.00

65

870

4.15

63

850

shows no need  
↓  
more on frame

9.00 pm

280



Feb 14 1950

The transformer page 3. with increased flux density  
draws about the same current and gives the  
same output voltage and charging time.

$I_{dc} = .7$  amp from 4 volt circuit.

$E_{dc} = 870$  volts.

|                  |          |      |
|------------------|----------|------|
| Transformer data |          |      |
|                  | 5/8 core |      |
| #22              | 90 T     | C.T. |
| #40              | 6150 T   |      |

Should be more  
sec. turns by 6500.  
 $920 \frac{950}{870} \times 6150 = \underline{\underline{6700}}$

$\Phi$  prim 82.5

29 turns per layer of #22.

### Bird Photo.

6 volt batt 3 Wilbard ER6-2E.

Vib 1100 malling.

tube.

Reflector.



$$\frac{5.6}{6.08} = .922$$

$\frac{5.6}{5.9} = .950$  reduce ratio of  
6 volt transformer.

$$175 \times \frac{1000}{2} = 87500 \text{ volt sec}$$



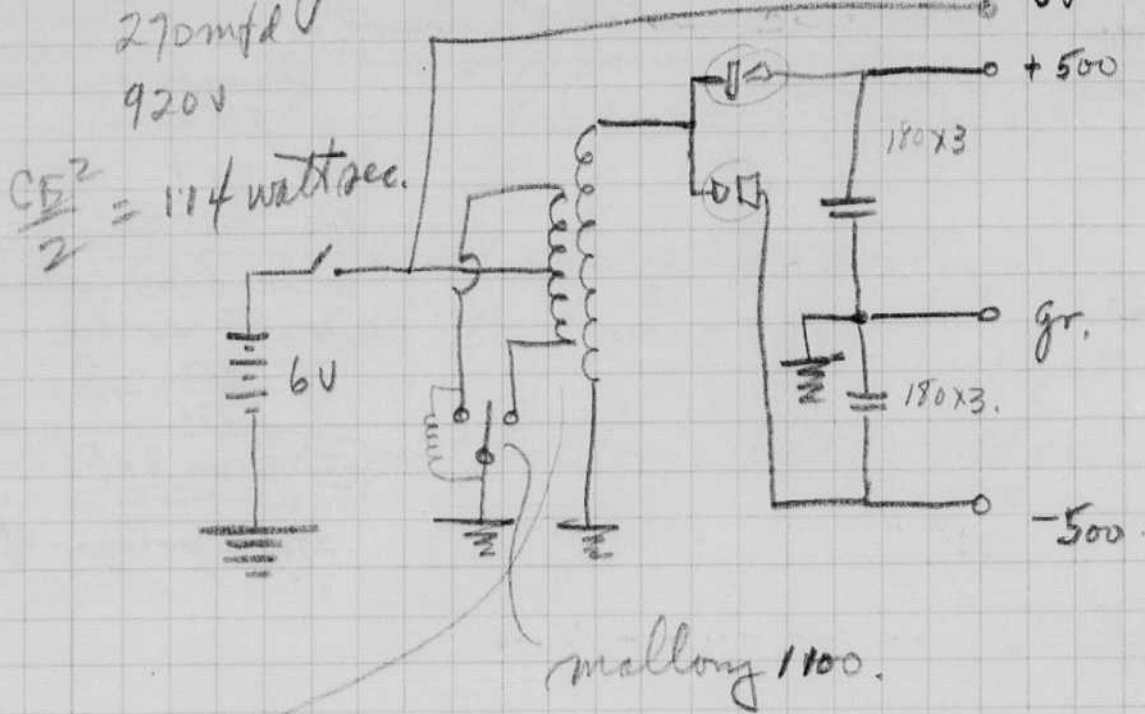
6 Sproyue capacitors. Draws 12 amp dc.  
 $E_{output} = 950$

By reducing dc input to 5.6 volts  
the output reduced to 900 volts.  
and the dc drain to 0.7 amps. This  
is worth while for stand by

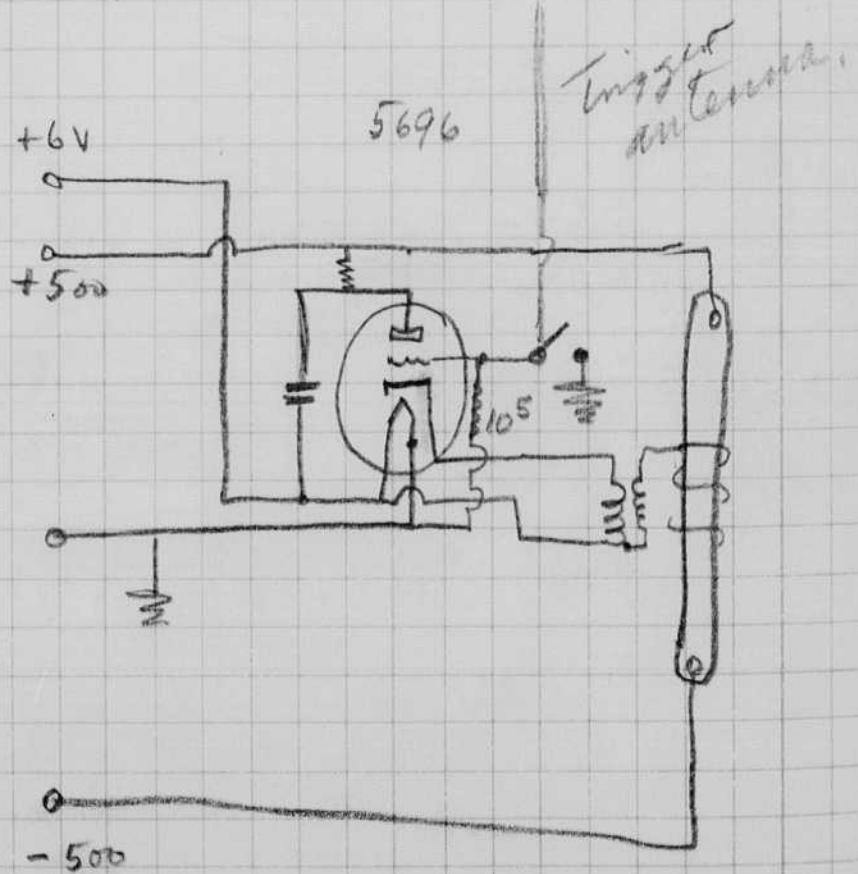
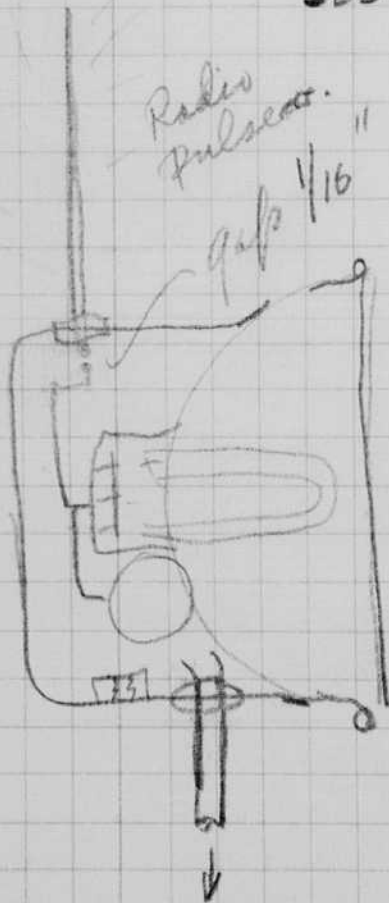
new transformer prim 120 turns #23  
 6V to 900 Sec 6150 x .95 = 5850 turns #40

Feb 18 1950  
Harold Engstrom.

270  
540

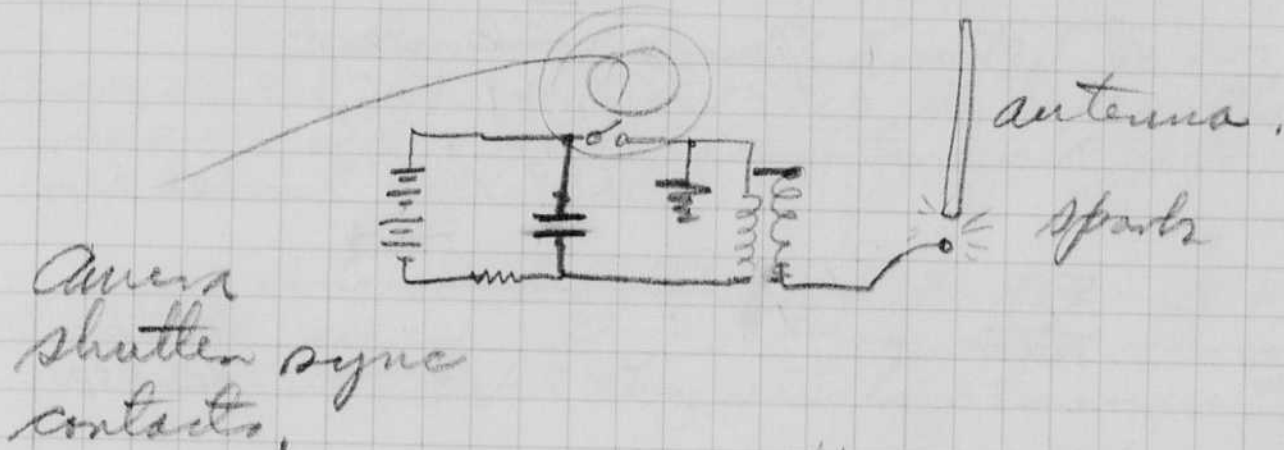


$\frac{3}{8}$  core  
120 turns #23 CT  
5850 " #40.



Triggered with one foot antenna on each trigger circuit.

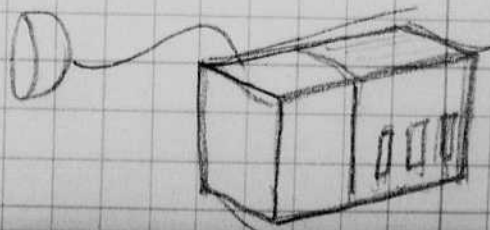
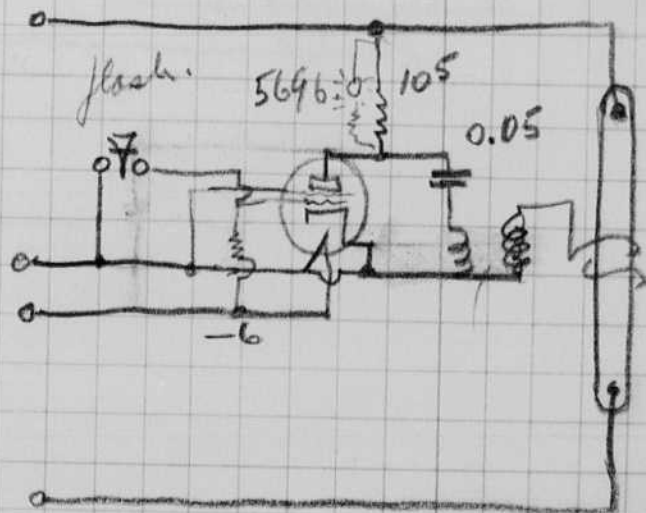
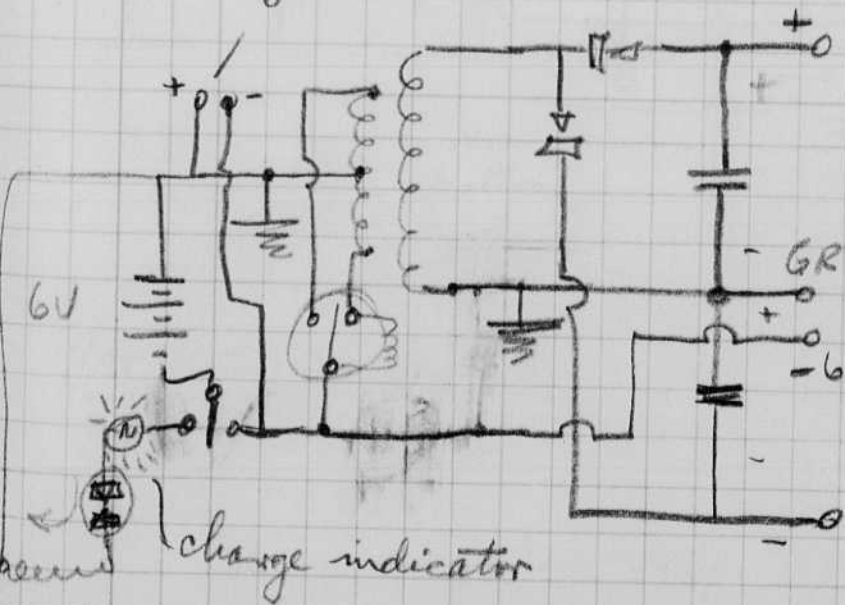
Camera shutter also has coil and spark transmitter



with  $E_{g2} = 0$       5696 char.

| $E_p$ | $E_{g1}$ |
|-------|----------|
| 500   | -3.3     |
| 400   | 2.9      |
| 300   | 2.5      |
| 200   | 2.1      |

$\frac{1.5}{6} = .25$   
6V input.



## Fish Photo Unit Under Water.

Feb. 25, 1950

4 volt battery, ER6-2B

magnetic 5/8 core trans

90T 22 CT.

6500 no 40

25. Selenium

5 amp peak  
current6 Sprague condensers  
(180mf 975.)

900V 0.8 amp.

67x9 h.c.p.s.

602 h.c.p.s.

4 Sprague condensers.

970V 0.7 amp.

45x9 h.c.p.s.

405 h.c.p.s.



March 1, 1950.

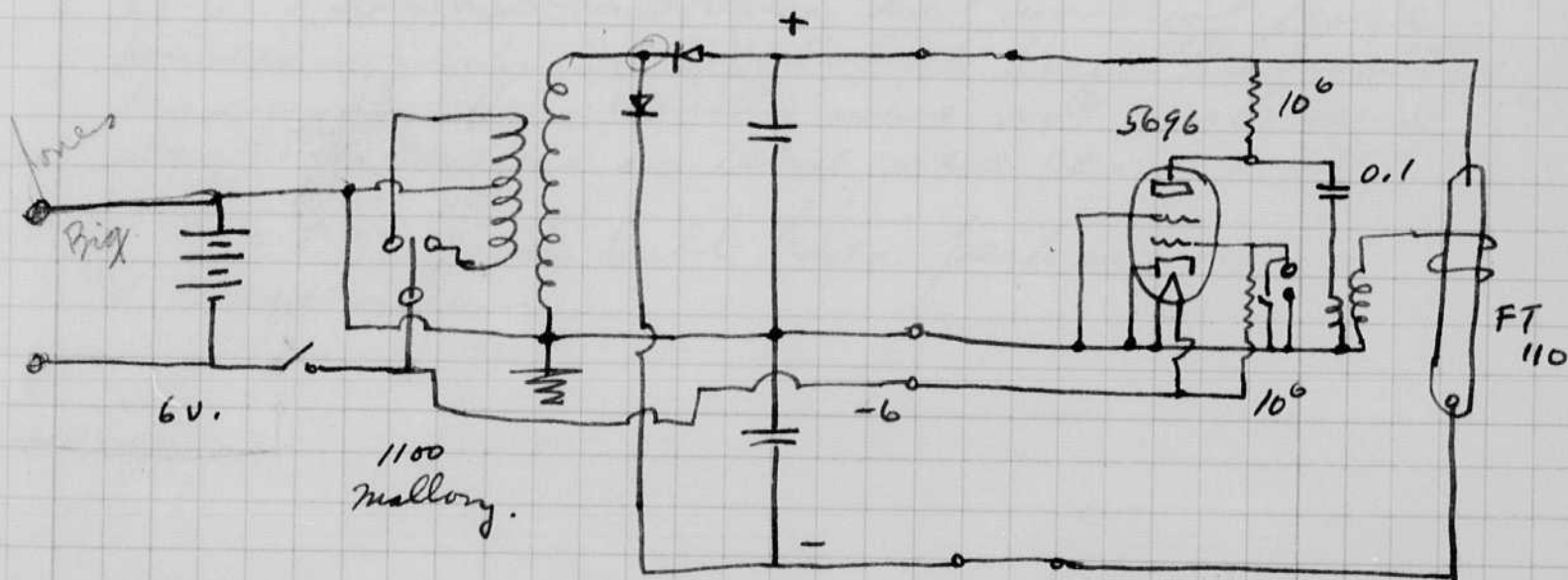
# Bird Photo unit.

Harold E. Egerton.

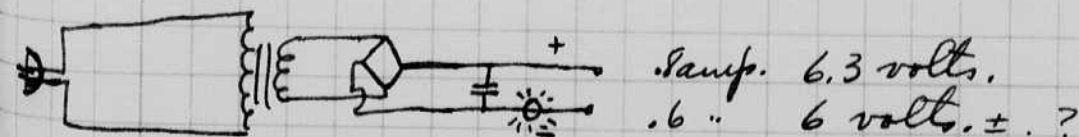
Conf. with Barstow McRoberts, and  
Germeshausen during past week or so  
on this unit which is to go to  
Tucson (Huachuca mts) on a humming bird  
photo trip with Walker Van Piper and  
Bob Reidbach (Both of Colo Mus Nat. Hist  
Denver Colorado).

Fundamental unit. Limited to 100 watt  
seconds into the FT-110 lamp. Plan to  
use 4 Sprague capacitors at 950 volts  
in series parallel.

A 6 volt battery of 3 ER-6-2E Williards  
will be used. Gives long ~~run~~ running time  
and 6 volts for thyatron filament.



## For A.C. conversion



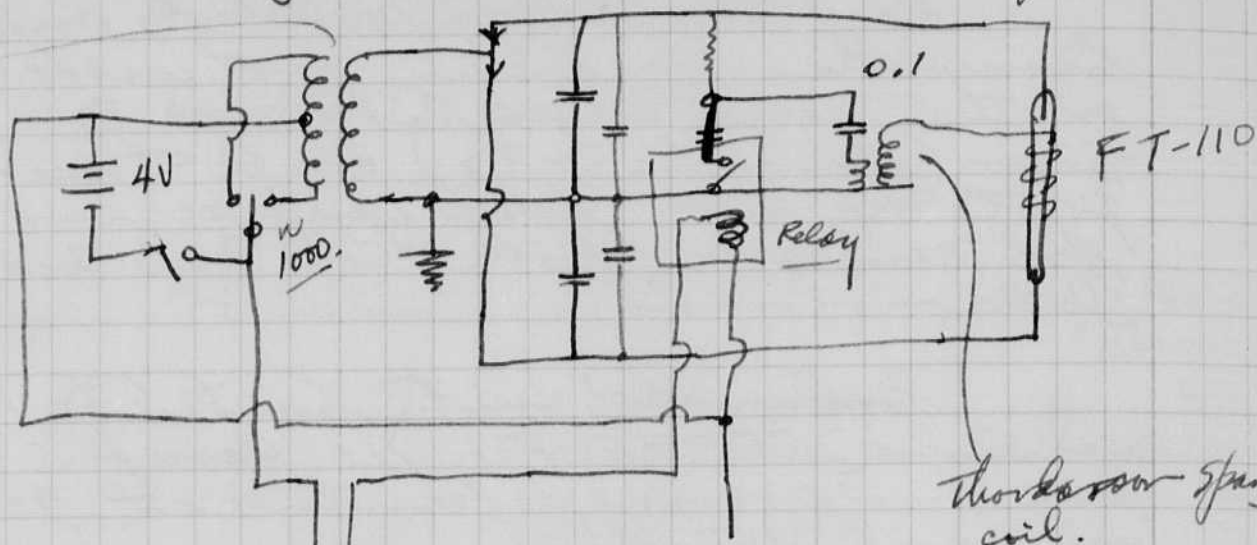
# Underwater Photo Equipment

## Low Impedance trip.

made 6/19/56  
David E. [unclear]

mystic

90 T  
#22 CT  
6500 #40



thorson spark  
coil.

cable to camera

This is a low impedance  
line which can stand  
leakage without tripping  
sync or camera.

March 9 1950

Jewell E. Edgerton

Mr. Walt Newcomb of the Eastman Kodak Co Rochester N.Y. was at our 160 Brookline Boston place on March 7 and 8. He had with him a  $3\frac{1}{4} \times 4\frac{1}{4}$  camera of the grid type. The purpose of his trip was to get some photographs of examples to illustrate its uses.

The active time of this camera is about .005 seconds, and during that time about 30 pictures are exposed.

We first tried to photograph the bursting of a balloon when it was put in contact with a #22 flash bulb. From the pictures, the balloon apparently broke on the opposite side from the flash bulb!!

Another subject was the fuse shutter that we have been developing. This consists of a  $1\frac{1}{4}$ " hole with a net work of fuse wires which is exploded by a capacitor discharge. The results were not conclusive about this as far as time was concerned.

a #22 flash bulb has a peak output of 4 megalumens.

12 Transformers  $5/8$ " square core

Primary 120 turns #23 wire center tap.  
Secondary 5800 turns #40 wire

Please supply with insulated leads brought out as shown in enclosed sketch.

Transformer specifications as used in the six-volt portable designed for the Huachuca Mountain trip.



On 10.00 AM.

10.10 - 985 ton Weston

(11.50 Noise +  
partial Discharge 3 times  
950 volts.  
Green ball 2/3 down)

11.55 self flash (1)

12.00 MD " " "

12.30 - noise

2.00 P.M.

White Ball Down

945 V (Simpson)

3.45 930V (Red Ball Down)

flashes &  
would not  
recharge

Test of Bird Machine

$\frac{375}{2}$  mf. at 1000 volts.

by Mac Roberts.

12 Transformers  $5/8$ " square core

Primary 120 turns #23 wire center tap.  
Secondary 5800 turns #40 wire

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On 10.00 AM.

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(11.50 Noise +  
partial Discharge 3 times  
950 volts.  
Green ball  $\frac{2}{3}$  down)

11.55 def flash (1)

12.00 MD " " "

12.30 - noise

2.00 P.M.

White Ball Down -

945 V (Timpson)

3.45 930V (Red Ball Down)

flashes &  
would not  
recharge

Test of Bird machine

$\frac{375}{2}$  mf. at 1000 volts.

by Mac Roberts.

mile taken during Dr O'Brien's visit  
to Boston.

160 Brookline Ave.  
March 18, 1950.

O'Brien Camera,

Rotor. —  
14516  
Pressing

1. Mech. Cap Shutter 5 ms.
2. Wire Shutter 25 ms.  
delay element 200 ms - supplied?  
50 mf 2000V ?
3. Zero time marker - a gap will  
be supplied for 5 KV to diode,  
5 KV gaps.
4. Timing marks  $10^{-7}$  sec - coded.
5. 48 or 72 elements.
6. Focal length:  $\frac{1}{4}$  should be  $\frac{1}{80}$  at  
2 miles.
7. Control boxes at 10 to 20 ft from  
cameras.
8. D.C. motor 10 amp start 115 volts.
9. Daylight loading bag.
10. 110 ac supply for Cap shutters and timing.



15-1-1.  
min.

|                | M  | M' | S. |                                               |
|----------------|----|----|----|-----------------------------------------------|
| O'Brien        | 1  | -  | 1  | $10^{-7}$                                     |
| Grid           | 1  | 1  | 2  | 0-300 $\mu$ s<br>0-3 ms                       |
| Papatrianic    | 15 | 15 | -  | 149 feet.<br>stereo pairs.                    |
| Eastman        | 3  | -  | 3  | $10^2$ filter diff.<br>centered. 16mm         |
| Eastman offset | 3  |    | 3  |                                               |
| Festax         | 3  | -  | 3  |                                               |
| M 200          | 3  |    | 3  | 8mm.<br>$10^2$ filter diff.<br>Bell & Howell. |
| Kpre           |    | 2  | 2  | Plate. -1 sec.                                |
| Kpost          |    | 2  | 2  | '                                             |
| K cloud        |    | 2  | 2  |                                               |

April 18, 1950.  
David S. Edgerton

Much effort has been expended the last few weeks on the Papatronic camera - magneto optic shutter - with the double slip. This has been used successfully by Bill Ward to photograph the light from an SM Flash bulb and a #22.

A group from the 160 Brookline ave outfit just returned from Zandia and Los Alamos.

Tests were made yesterday with my bird portable keylight Kodakome.

9.6 ft lamp to subject

camera 100" on stand to show resolution 2" lens.

Photo of cartoon with  $6\frac{3}{8}$ " lens.

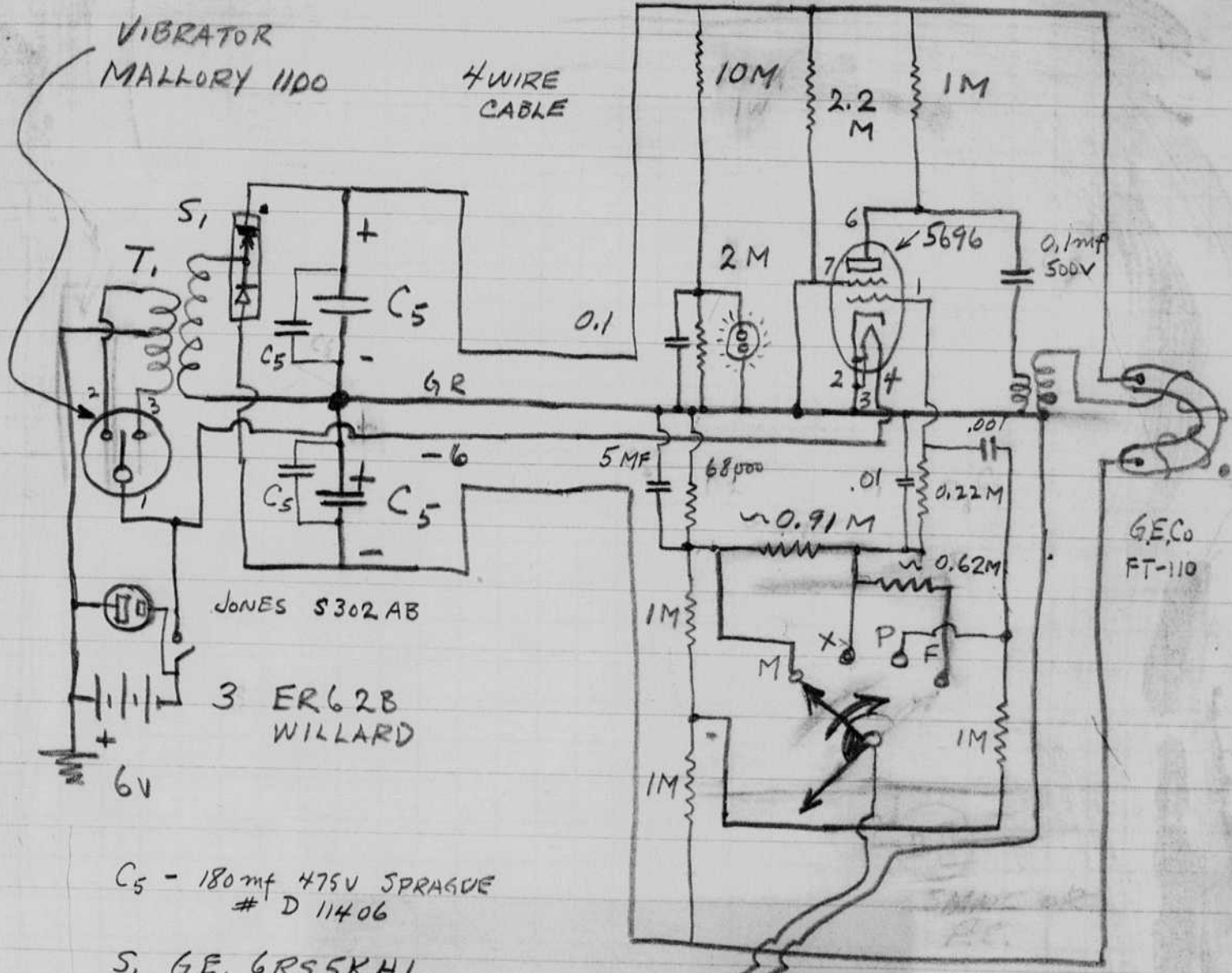


H. Parker

W. Land

W. Edgerton

LAMP HOUSE



C<sub>5</sub> - 180mf 475V SPRAGUE # D 11406

S<sub>1</sub> G.E. 6R55KH1

T<sub>1</sub> MYSTIC 6V C.T.

T<sub>2</sub> MODEL P COIL

JONES S302 CCT

M X P F

|   |                |
|---|----------------|
| M | 20 MS DELAY    |
| X | INSTANTANOUS   |
| P | PHOTOCELL TRIP |
| F | 5 MS DELAY     |

SYNG. OR P.C.

JONES P302 CCT

RCA 934

3 biogel units of above type were sent by air freight to Van Riper Denver, Colo on may 10 at 6:30 pm.

Edum had used the above portable at the Buckingham Fair with success. Selling on 3 at 10ft gave a good photo.

April 18, 1950.  
David S. Edgerton

Much effort has been expended the last few weeks on the Papatronic camera - magneto optic shutter - with the double slug. This has been used successfully by Bill Ward to photograph the light from an SM Flash bulb and a #22.

A group from the 160 Brookline ave outfit just returned from India and Los Alamos.

Tests were made yesterday with my bird portable keylight Kodakone.

9.6 ft lamp to subject

camera 100" on stand to show resolution 2" lens.

Photo of cartoon with  $6\frac{3}{8}$ " lens.



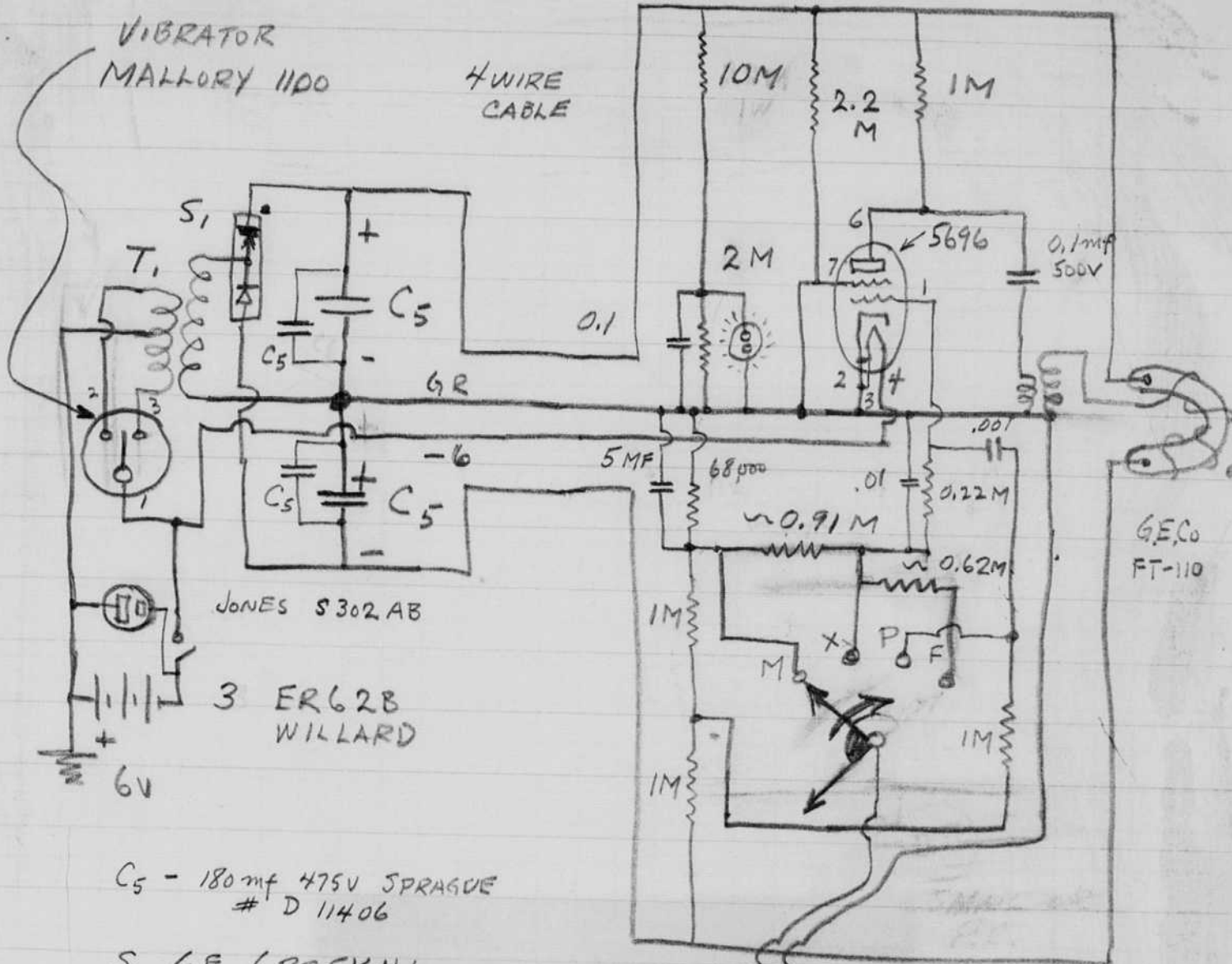
H. Parker

D. Land

H. Edgerton



LAMP HOUSE



C<sub>5</sub> - 180 mf 475V SPRAGUE # D 11406

S<sub>1</sub> G.E. GR55KH1

T<sub>1</sub> MYSTIC 6V C.T.

T<sub>2</sub> MODEL P COIL

JONES S302 CCT

M X P F

|   |                |
|---|----------------|
| M | 20 MS DELAY    |
| X | INSTANTANOUS   |
| P | PHOTOCELL TRIP |
| F | 5 MS DELAY     |

SYNG. OR P.C.

JONES P302 CCT

RCA 934

3 biopl units of above type were sent by air freight to Van Riper Denver, Colo on may 10 at 630 pm.

Edum found used the above portable at the Buckingham Fair with success. Selling on #3 at 10ft gave a good photo.

April 18, 1950.  
David E. Edgerton

Much effort has been expended the last few weeks on the Papatronic camera - magneto optic shutter - with the double slit. This has been used successfully by Bill Ward to photograph the light from an SM Flash bulb and a #22.

A group from the 160 Brookline ave outfit just returned from India and Los Alamos.

Tests were made yesterday with my bird portable keylight Kodakone.

9.6 ft lamp to subject

camera 100" on stand to show resolution 2" lens.

Photo of cartoon with 6 3/8" lens.

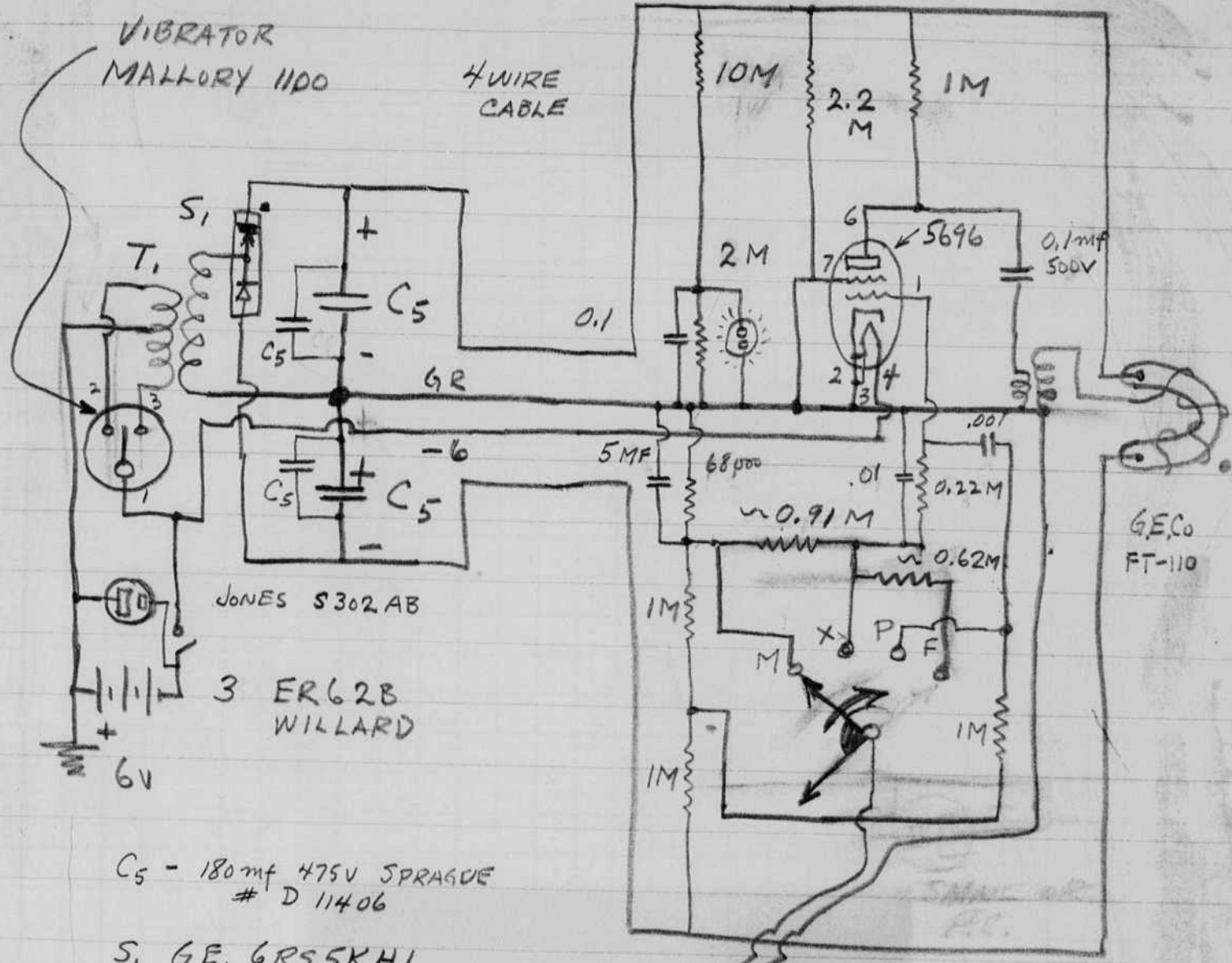


H. Barber

D. Land

K. Edgerton

LAMP HOUSE



C<sub>5</sub> - 180mf 475V SPRAGUE # D 11406

S<sub>1</sub> G.E. 6RS5KH1

T<sub>1</sub> MYSTIC 6V C.T.

T<sub>2</sub> MODEL P COIL

JONES S302 CCT

JONES P302 CCT

SYNC. OR P.C.

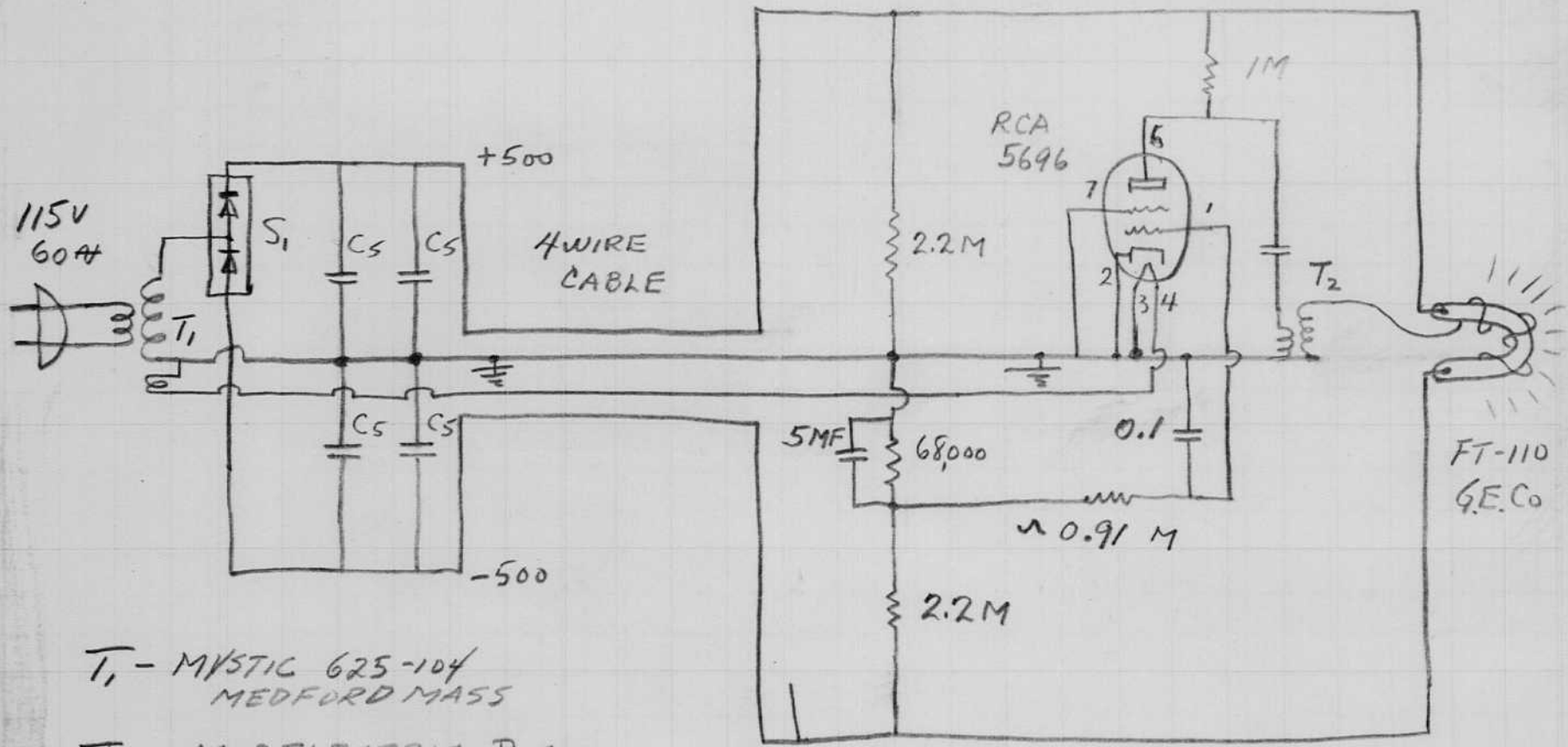
RCA 934

|   |                |
|---|----------------|
| M | 20 MS DELAY    |
| X | INSTANTANOUS   |
| P | PHOTOCELL TRIP |
| F | 5 MS DELAY     |

3 binol units of above type were sent by air freight to Van Riper Denver, Colo on may 10 at 6:30 pm.

Edum had used the above portable at the Buckingham Fair with success. Selling #3 at 10ft gave a good photo.





T<sub>1</sub> - MYSTIC 625-104  
MEDFORD MASS

T<sub>2</sub> - MOELECTRIC P COIL

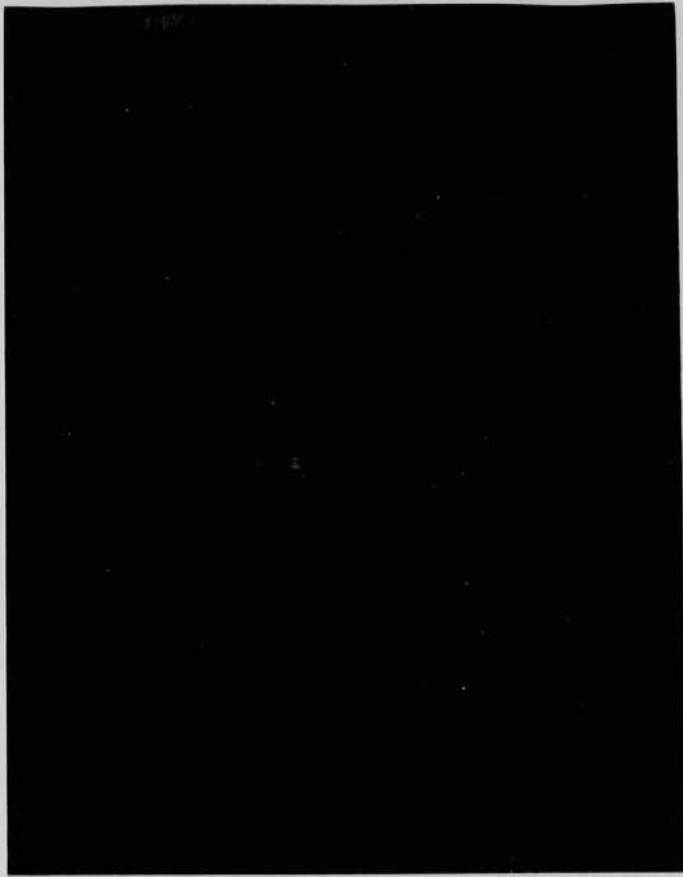
C<sub>5</sub> - 180 MF 475V SPRAGUE D11406

S<sub>1</sub> - G.E. Co 6R55KH1

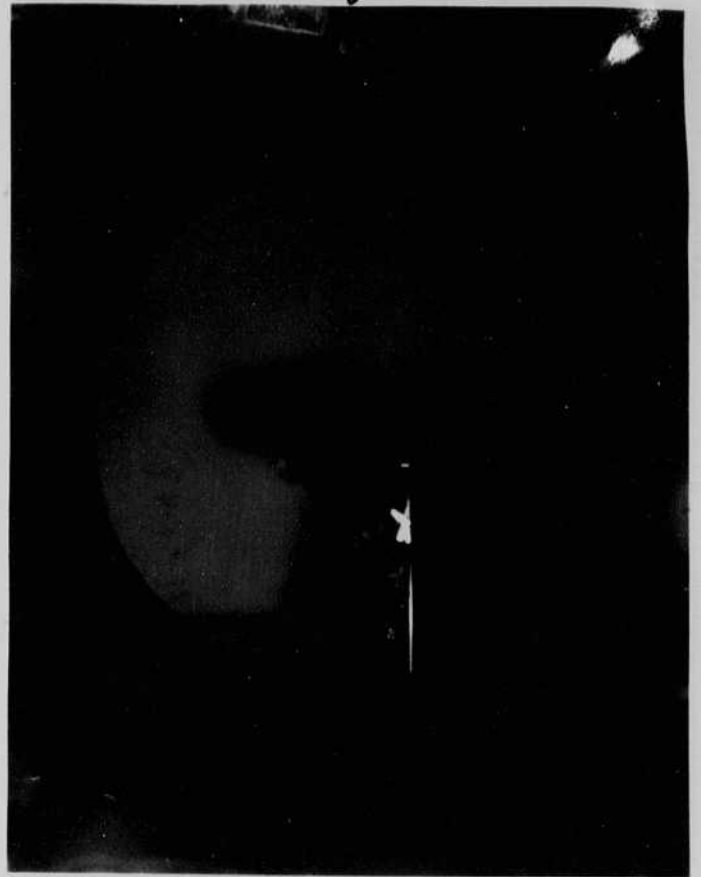
Sounded with a 100 ohm  
 in line with a 100 ohm



5



8



Mr. Grant of Bur of Mines  
was here may  
working with Beneshauer  
on exploding. Movies  
were taken at 7000  
per second on 16 mm movie  
film in a W.E. Fastax  
without a prism.  
5 grams tetrolyl.

Above taken by Bill Wood  
and St Griffith with  
the megneto optic  
shutter

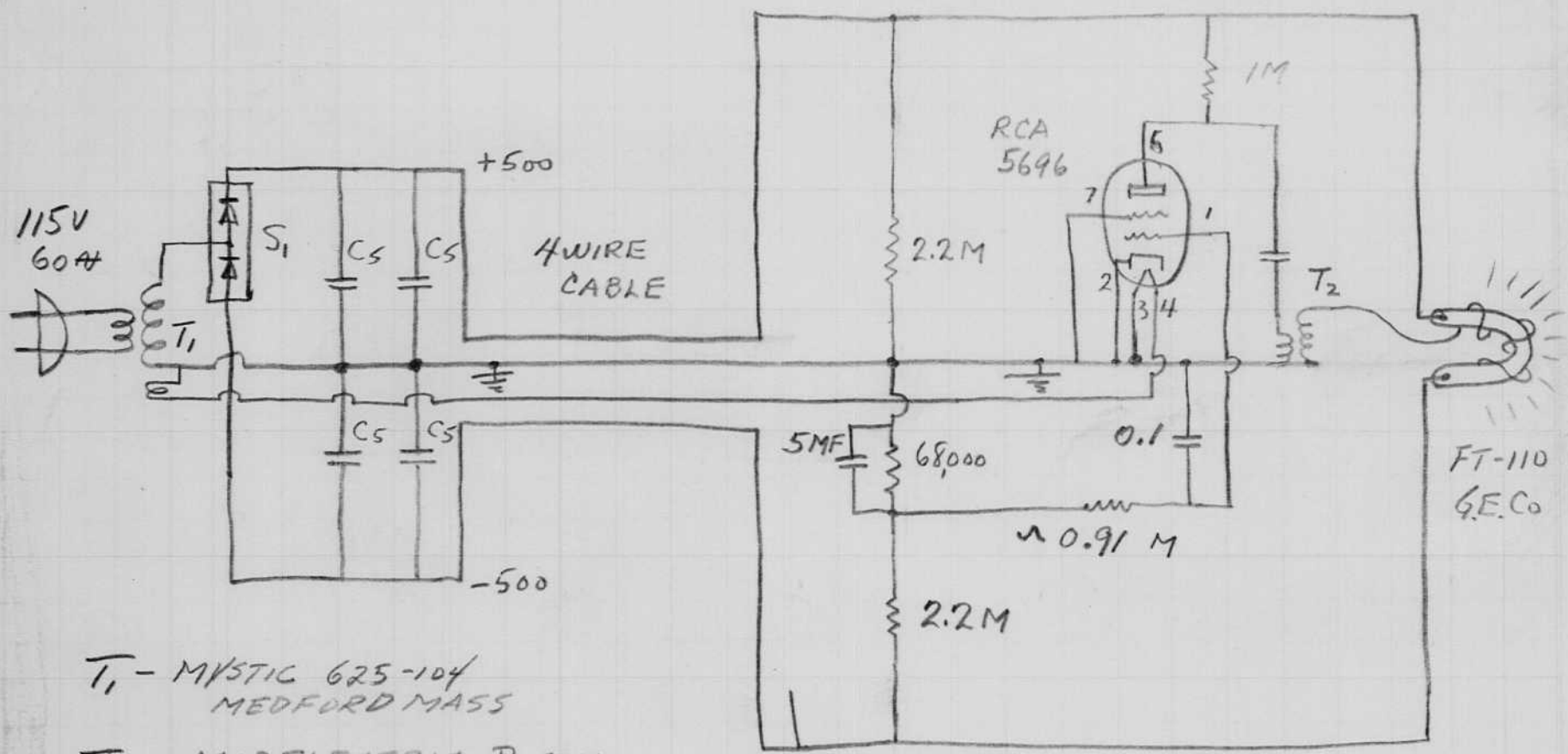
#5 Light from explosion 5ms

#8 " " " 5ms  
plus 2 1/2 turn quartz  
flash tube 4 KV 40mf.

9



#9. Ditto 8 but with out  
capacitor "shorter". 3 exposures are visible



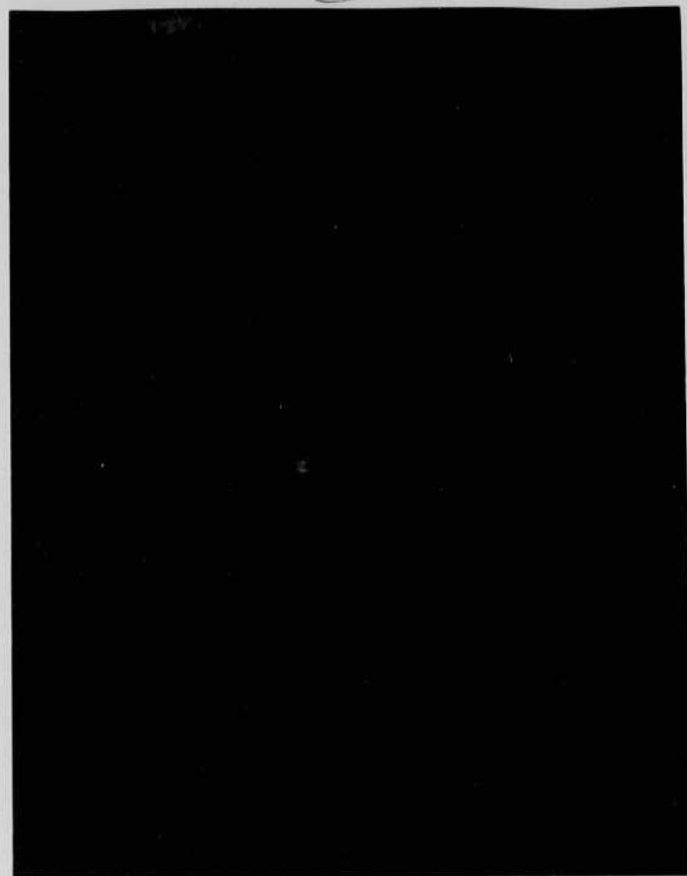
T<sub>1</sub> - MYSTIC 625-104  
MEDFORD MASS

T<sub>2</sub> - MOELECTRIC P COIL

C<sub>S</sub> - 180 MF 475V SPRAGUE D11406

S<sub>1</sub> - G.E. Co 6RS5KH1

Tuning up with a 100 ohm  
 in line with a 100 ohm



No. 5. Gust of Bro of Mines  
was here may  
working with Beneshauer  
on exploding. Movies  
were taken at 7000  
per second on 16 mm movie  
filming W.E. Fastax  
without a prism.  
5 grams tetrolyl.

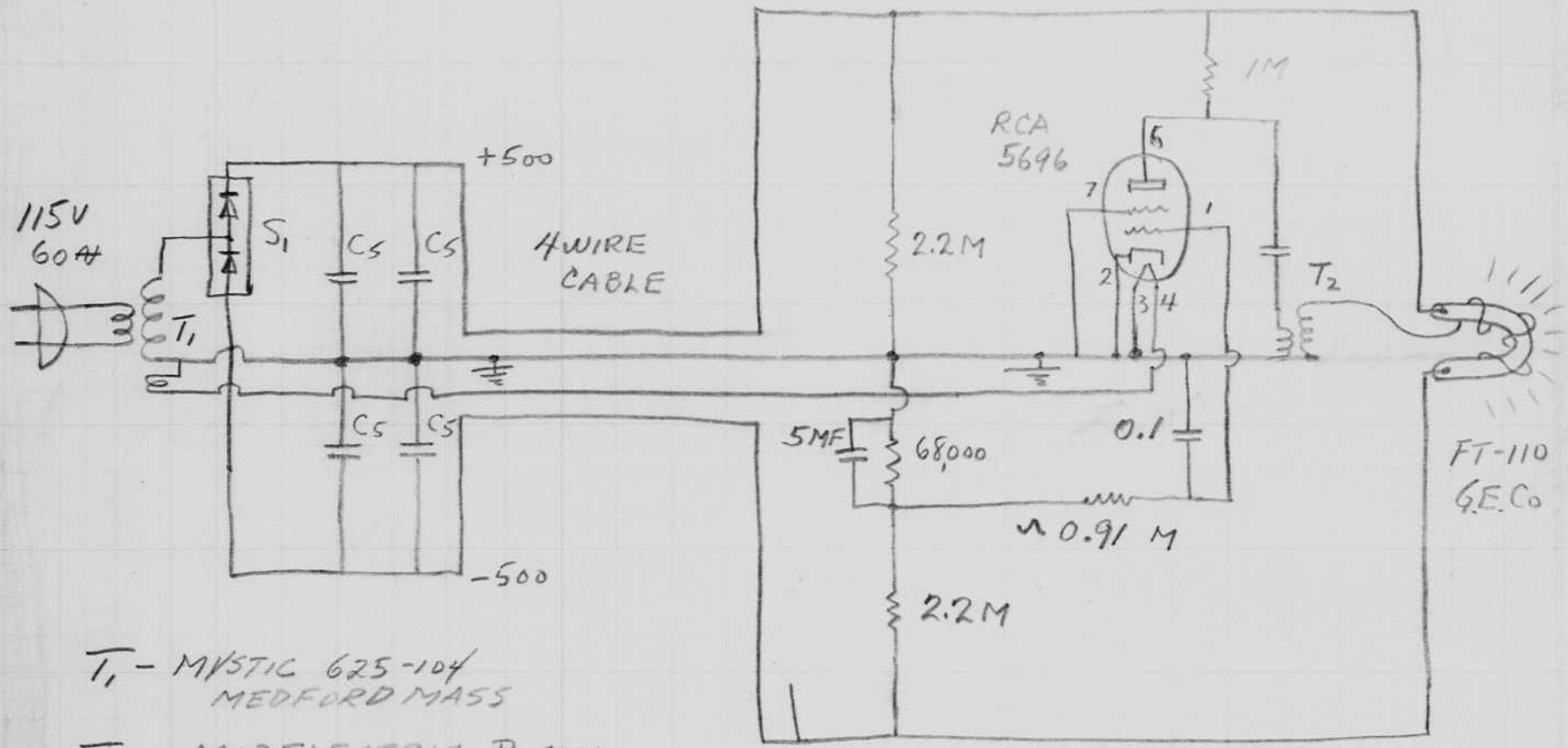
Above taken by Bill Ward  
and St Griffith with  
the megneto optic  
shutter.

#5 Light from explosion 5ms

#8 " " " 5ms  
plus 2 1/2 turn quartz  
flash tube 4 KV 40mf.

#9. Ditto 8 but with out  
capacitor "shutter". 3 exposures are visible





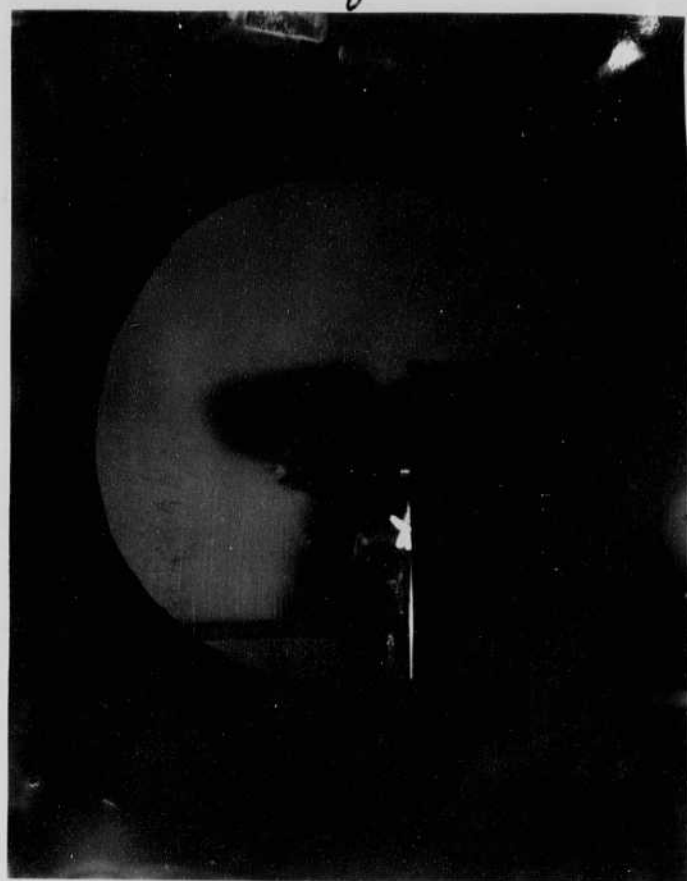
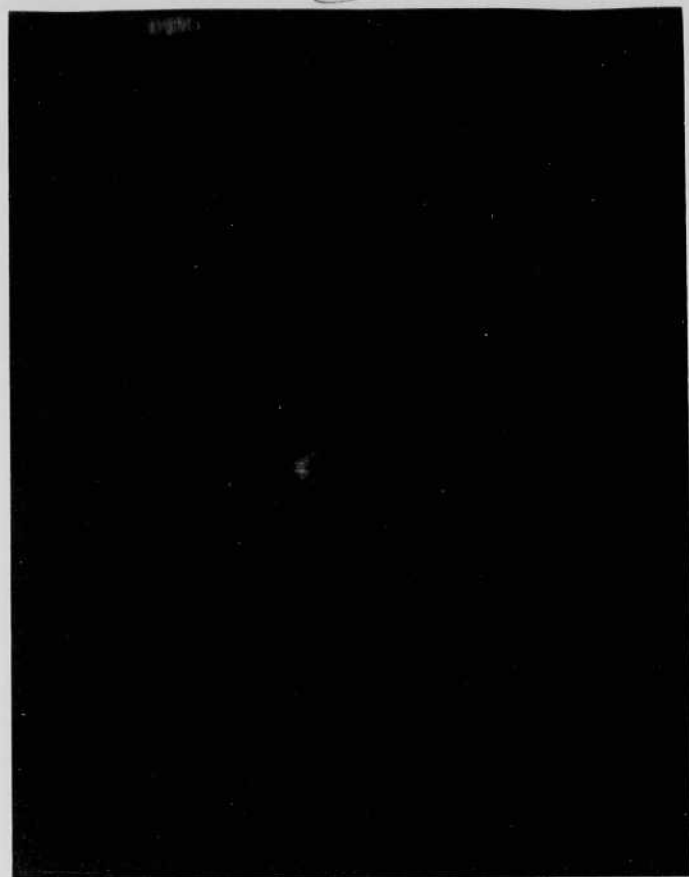
T<sub>1</sub> - MYSTIC 625-104  
MEDFORD MASS

T<sub>2</sub> - MOELECTRIC P COIL

C<sub>5</sub> - 180 MF 475V SPRAGUE D11406

S<sub>1</sub> - G.E. Co 6RS5KH1

Speaker coil with 2 pins  
 in line with a 6 pin plug



Mr. Grant of Bur of Mines  
was here may  
working with Beneshauer  
on exploding. Movies  
were taken at 7000  
per second on 16 mm movie  
film in a W.E. Fastax  
without a prism.  
5 grams tetrdyl.

Above taken by Bill Ward  
and St Griffith with  
the megneto optic  
shutter.

#5 Light from explosion 5ms

#8 " " " 5ms  
plus 2 1/2 turn quartz  
flash tube 4 KV 40mf.

#9 Ditto 8 but with out  
capacitor "shutter". 3 exposures are visible





FX-1 Duvostein and Light

Aug 24 1950

RE Edgeton  
Mac. Pollock

Oscilloscope 100,000 cycles turning usage

100 mf 2000 V

50 2000

25 2000

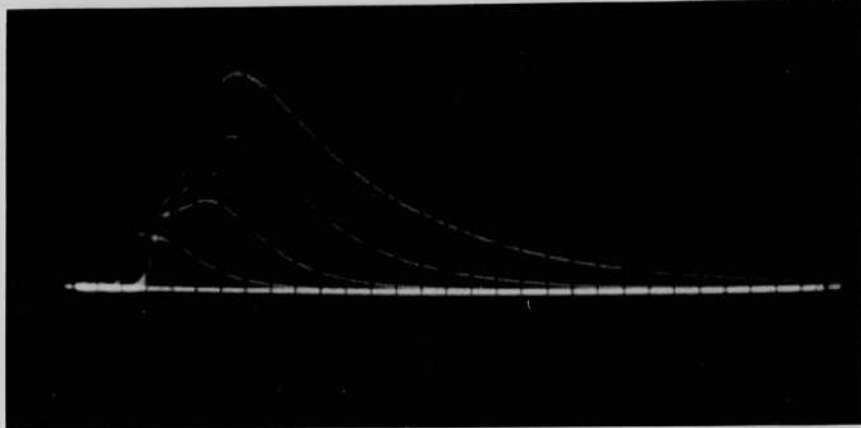
12 2000

 $\frac{0.5^2}{2} = .5$  $c = \frac{1}{2}$  $\frac{1}{2}$  unit

1.150

Vert calibration =  $1.05 \times 10^6$  c.p.x  $\left(\frac{30}{12}\right)^2 \times 2$   
per inch. 17.5

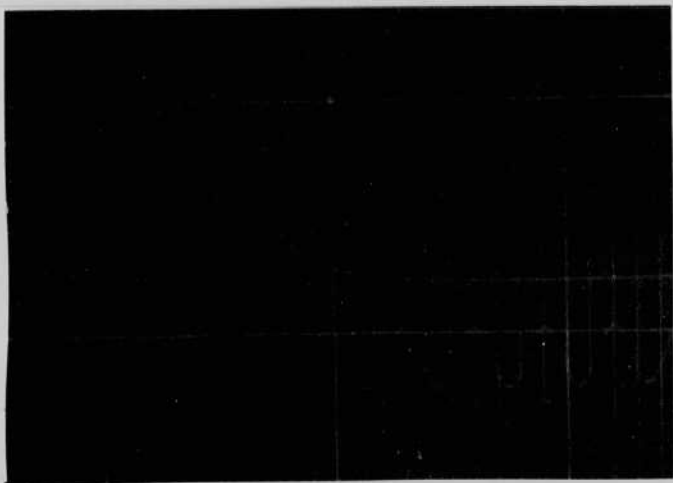
P20



FX1 2000V 100 50 25 12 mf.

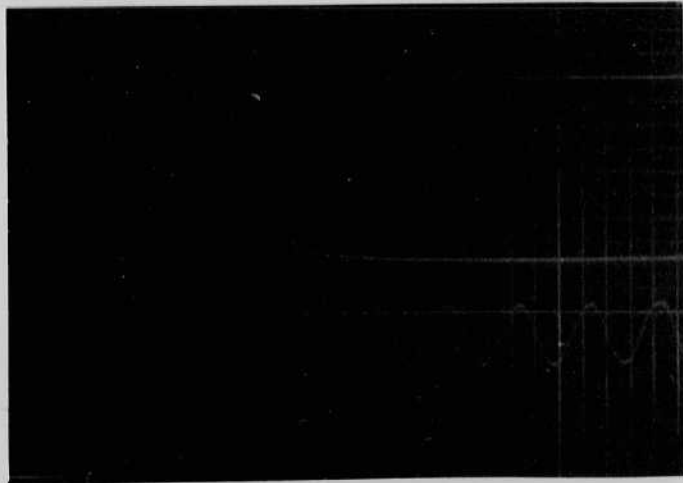
Strobostun Cathode

P28



Coppertube cathode

P24



Sylvania tubes.

1/4 mf. 2000 V.

# Sylvania Lamps

May 25, 1950

631 P1 cathode in argon lamp.

$$2 \times .125 \text{ mf} = .25 \text{ mf}$$

2000 volts.

$$\frac{CE^2}{2} = \frac{.25 \times 2000^2}{2} = .5 \text{ watt sec.}$$

Ditto argon lamp with copper-tube electrode.  
2000 V 0.25 mf.

Distance 1 1/2 ft with no diffuser  
or no polaroid.

May 26 1950.

John Mills and Tony Hyde  
took photos of bullets hitting balloons  
yesterday night.

Took photos of a Helium fountain yesterday.

Osc tests of a bird unit

P.C. 30" four lamps in reflectors.

Top. two units, P.C. synch x4 atten.

Middle Single V tube ~~125~~ 220mf 920V FT-110.

Bottom Double FT-110 220 mf 920V. 104 cycles.

Osc tests. Trans portable

top 1/2 lamps on entire unit. 30" x 8

Bot 2 lamp on unit 30" x 8

Light from one lamp.  
104 cycles.

FX-1 Duration and Light

Aug 24 1950

R.E. Edgerton  
MacRobert

Oscilloscope 100,000 cycles turning usage

100 mf 2000 V

50 2170

25 2000

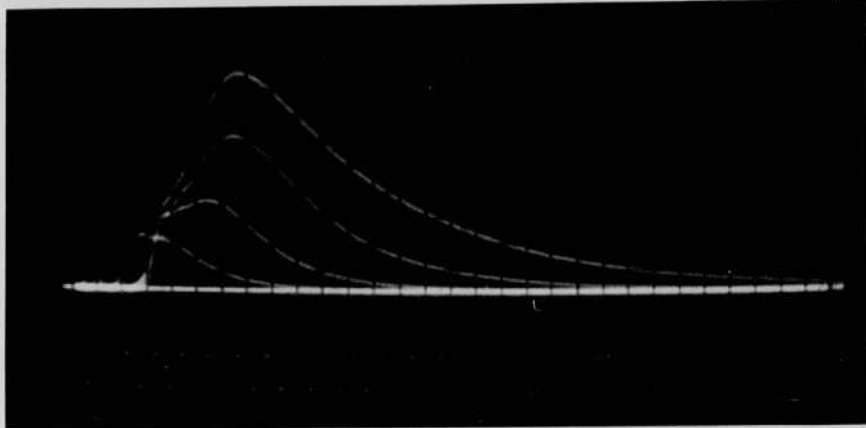
12 2000

 $\frac{0.5}{1} = .5$  $\frac{1}{2}$  unit $a = \frac{1}{12}$ 

1.100

Vert calibration =  $1.05 \times 10^6$  c.p.x  $\left(\frac{30}{12}\right)^2 \times 2$   
per inch. 12.5

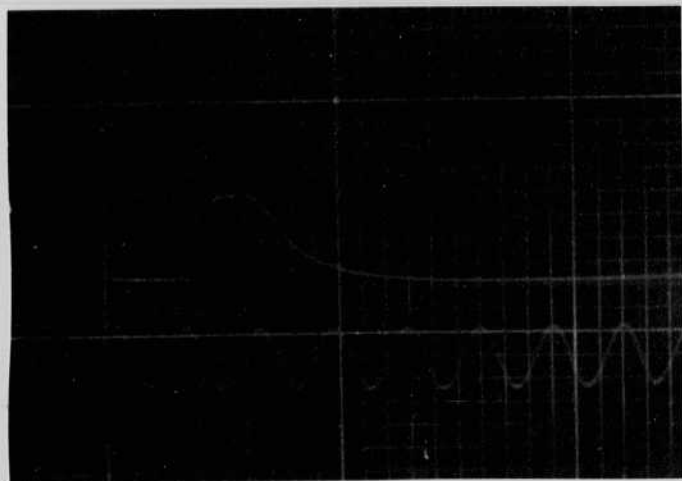
P20



FX1 2000V 100 50 25 12 mf.

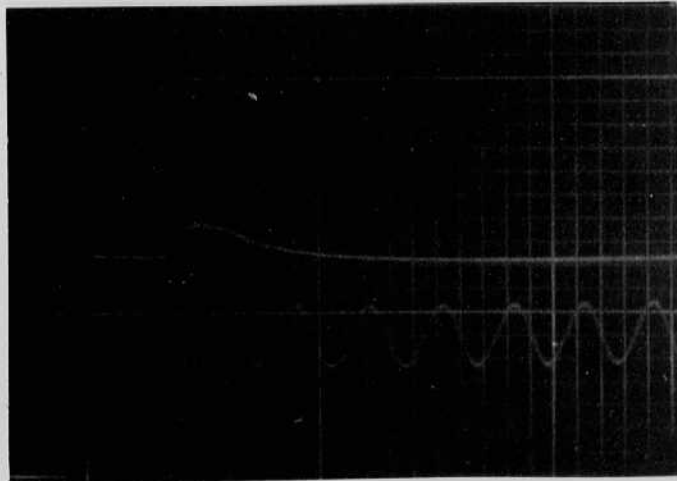
Stroboscope Cathode

P28



Coppertube cathode

P24



Sylvania tubes.

1/4 sec. 2000 V.

## Sylvania Lamps

✱

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Bottom Double FT-110 220mf 920V. 104 cycles.

Osc tests. Two portable

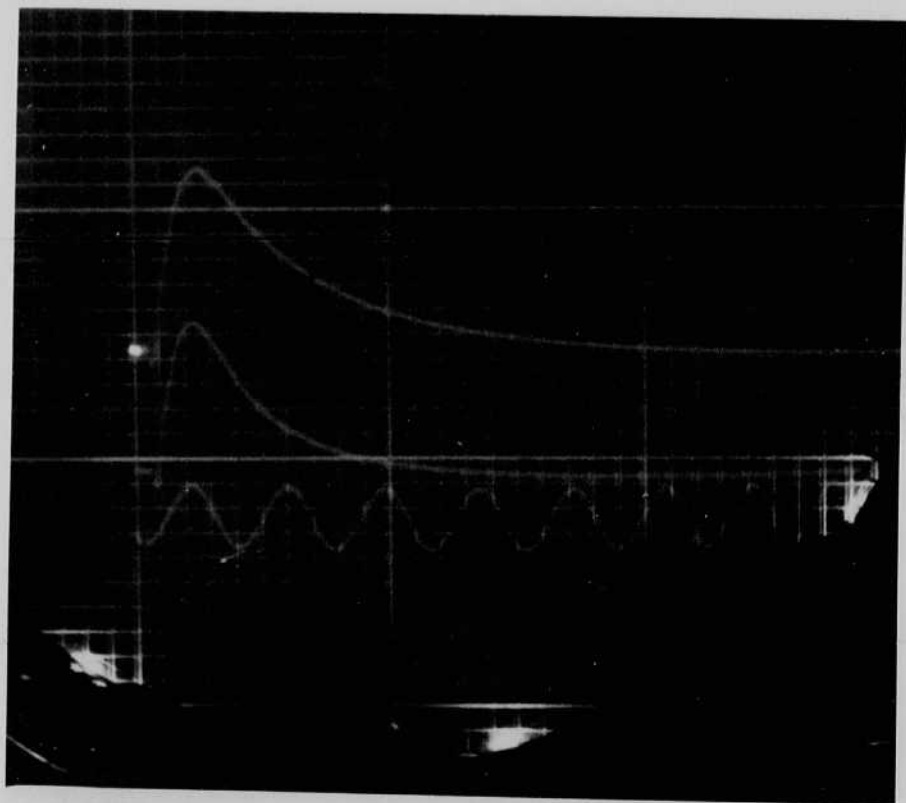
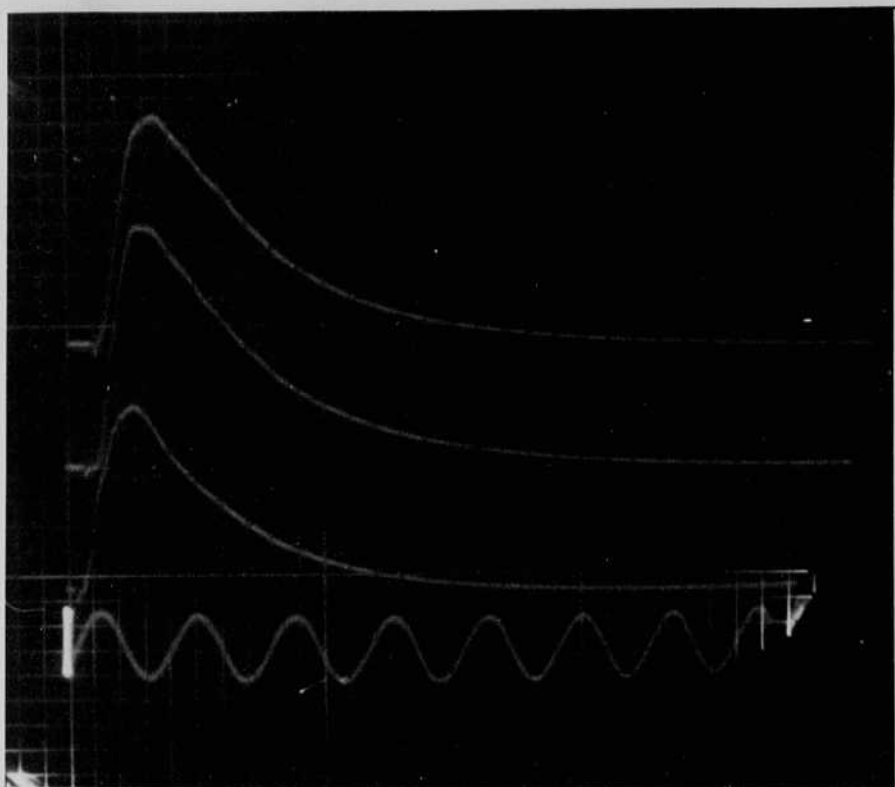
top 1/2 lamps on entire unit. 30" x 8

Bot 2 lamp on unit 30" x 8

Light from one lamp.  
104 cycles.

#Bird unit with half capacity.

Osc test. 30" x 2 on osc.





Aug. 11, 1950

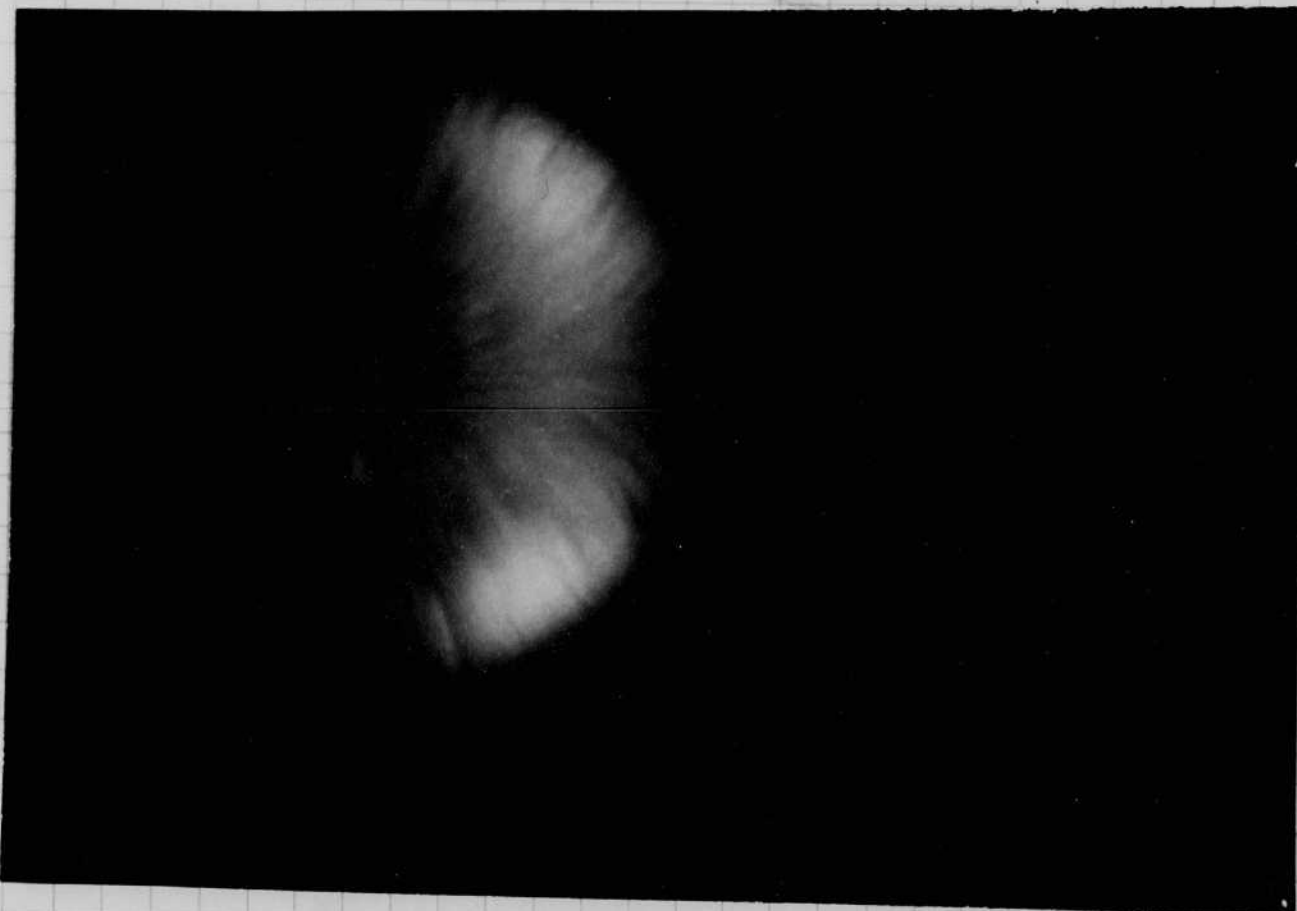
Harold E. Edgerton

23

note / ~~the~~  
See E. G. G. book for information on activities during June, July, Aug. on Raptornic camera flash units etc.

Left June 5 for Tucson Ariz to work with Van Riper, Neidrach and Knorr on photography of Humming birds. Stayed at Huachuca with Carr Canyon Ranch Major John Healy owner. Ariz Blue-throated, Rivoli, and Broadbilled. Also looked for Costas but did not find.

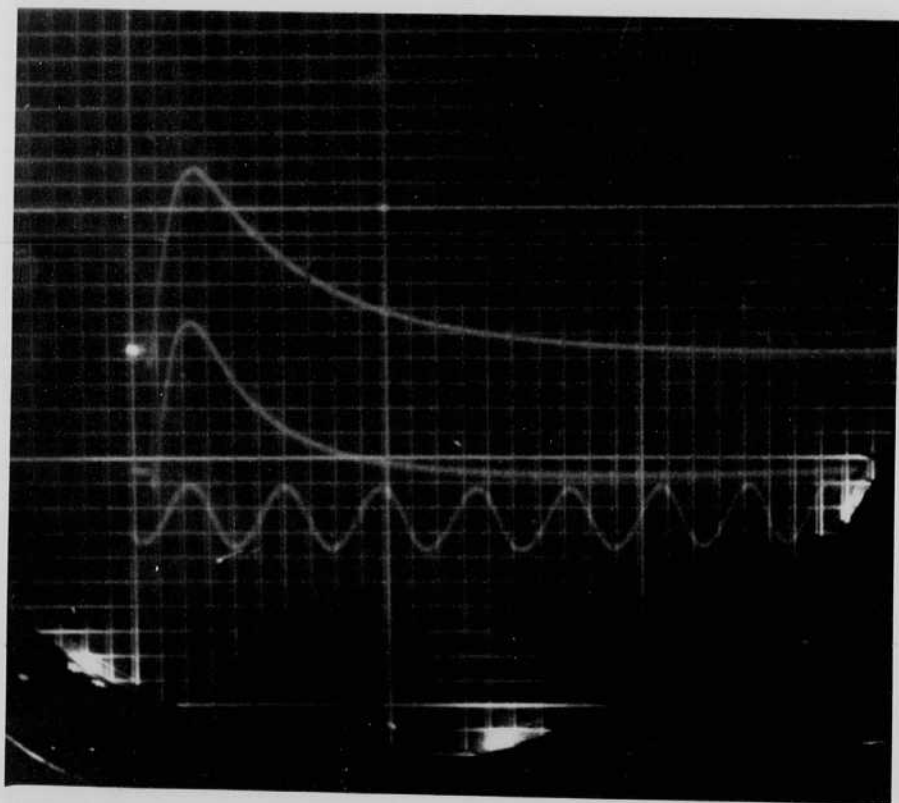
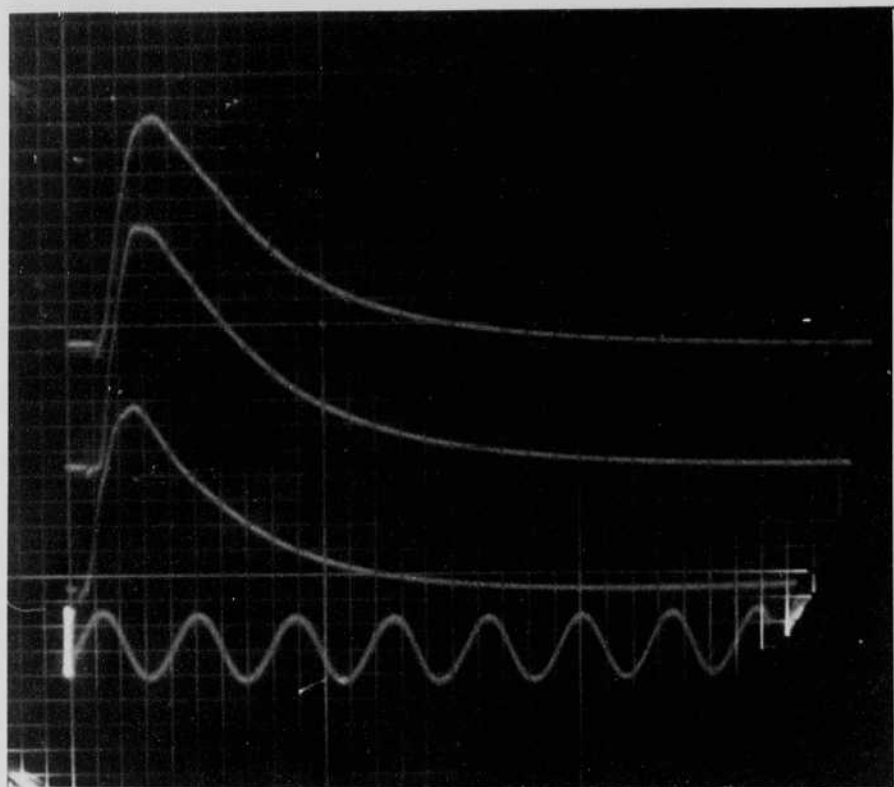
I was in Aberdeen July ~~24~~<sup>26</sup> for a few days to tune up a G.R. movie unit. Took photos of Costa H bird in Bronx Zoo on July 29. at 8 am. Photos were taken with Raptornic camera of explosions of Pentolite



Exp. 5 u.s. Exposure of 6" stick of pentolite.  
note joint second exposure of explosion

# Bird unit with half capacity.

Osc test. 30" x 2 on osc.



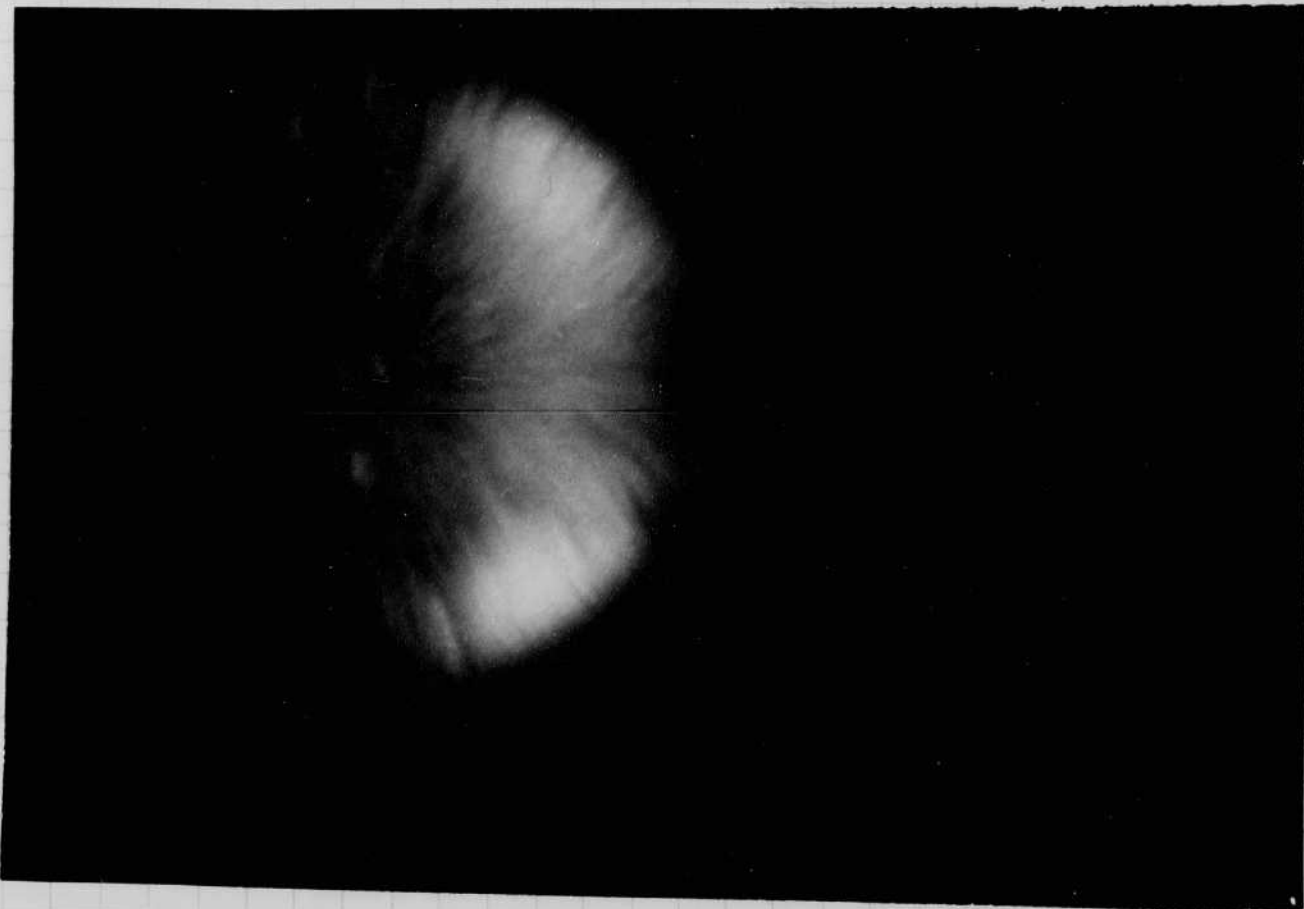
Aug. 11, 1950

Donald E. Edgerton

note / He  
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Exp. 5. U.S. Exposure of 6" stick of pentolite.  
note faint second exposure of explosion

M.I.T.  
Oct. 7, 1950.

Harold E. Edgerton.

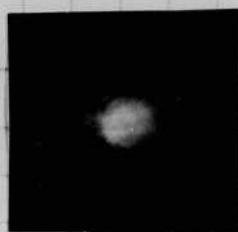
M.I.T. started Sept 18. I have a section in 6.20 this term. Others are by Gray, Van Rennes, Cotter, Dick Taylor. About 100 students!

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Dick Kriebel of Polaroid is leading a course with Blackburn on engineering management, etc. The class plan to study flash equipment. A market survey is under way at present.





FIRECRACKER

100 us delay



Taken with Greenflash H bird  
unit 100 wall sec.  
#5 setting at 10 ft.

Dampster

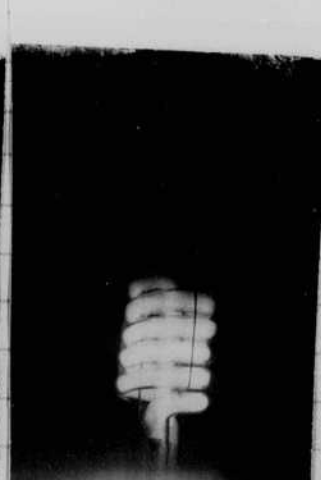
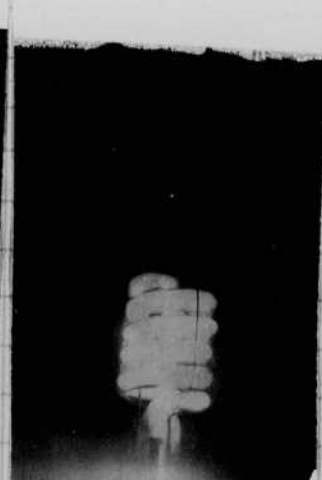
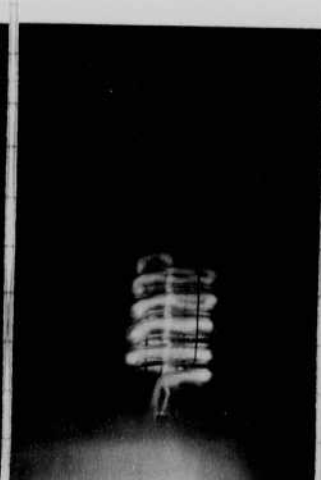
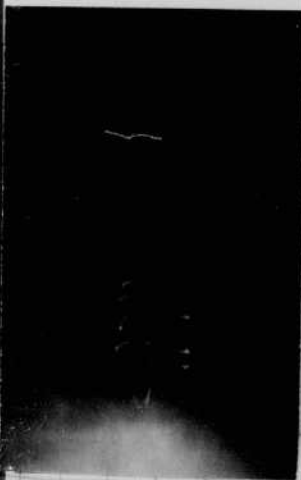
240 0 us

f4 50 us

f4 100 us

f4 200 us

11. f4 500 us delay.



FT-623 with 600 mf at 4000 volts.

Taken with Bill Ward and Joe Savriel. Oct 3 1950 at 160 Brookline Ave.



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Oct. 7, 1950.

Harold E. Edgerton.

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FIRECRACKER

100  $\mu$ s delay



Taken with Greenflash H bird unit 100 wall sec. #5 setting at 10 ft.

Dumpester

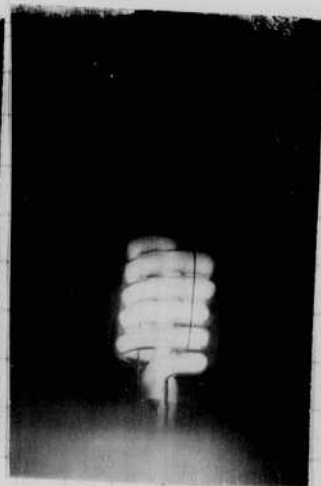
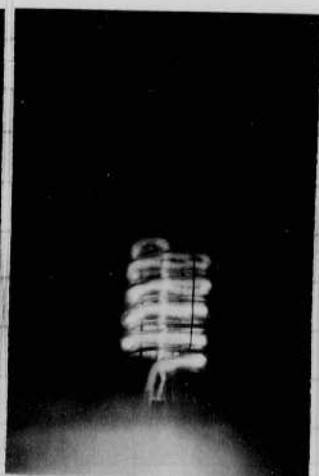
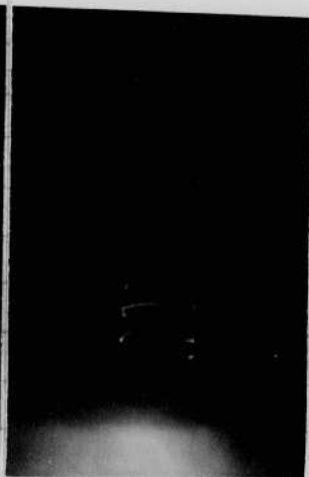
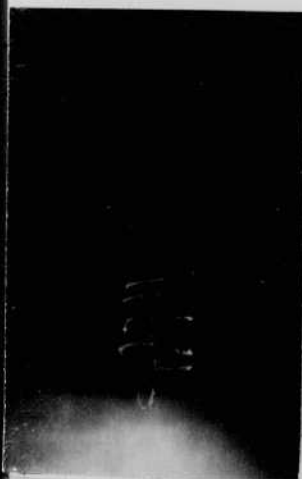
240  $\mu$ s

f4 50  $\mu$ s

f4 100  $\mu$ s

f4 200  $\mu$ s

24 600  $\mu$ s delay



FT-623 with 600 mf at 4000 volts.

Taken with Bill Ward and Joe Savriel. Oct 3 1950 at 160 Brookline Ave.

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Oct. 7, 1950.

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FT-130  
Backlight



FIRECRACKER

100  $\mu$ s delay



Taken with Green flash H. bird  
unit 100 wall sec.  
#5 setting at 10 ft.

Dumpester

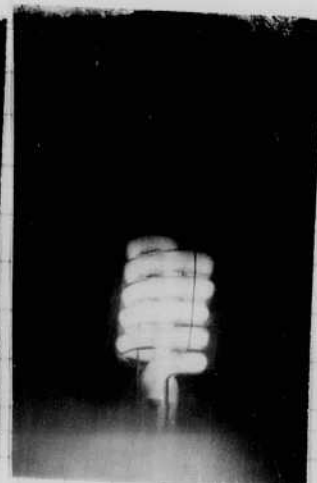
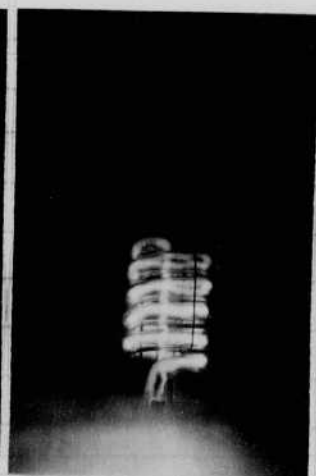
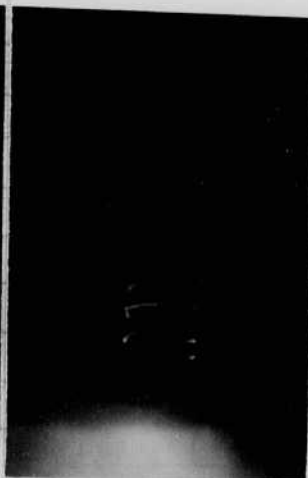
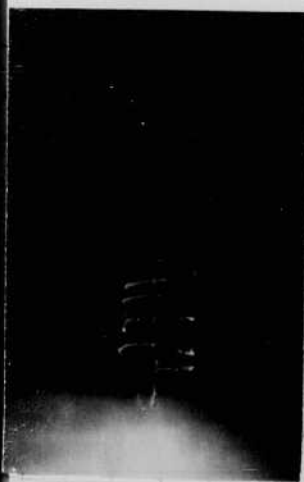
f4 0  $\mu$ s

f4 50  $\mu$ s

f4 100  $\mu$ s

f4 200  $\mu$ s

f4 500  $\mu$ s delay

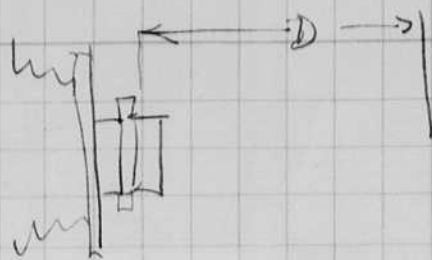


FT-623 with 600 mf at 4000 volts.

Taken with Bill Ward and Joe Savriol. Oct 3 1950 at 160 Brookline Ave.

Focus data 2" f 2 lens on Polaroid Land camera

| Scale set | Dist to Ring |
|-----------|--------------|
| ∞         | 36"          |
| 15        | 18"          |
| 8         | 13.5         |
| 5         | 9.5          |
| 3.5       | 7.5"         |



Focus data 3" f 4.5 lens put in Oct. 7, 1950.

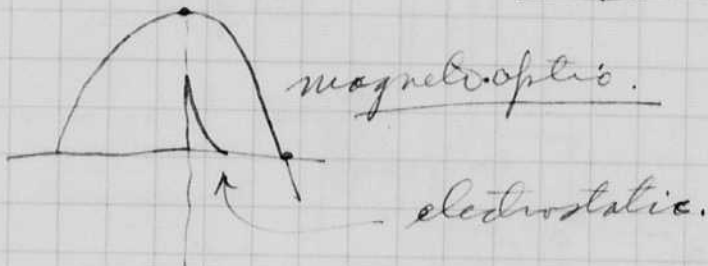
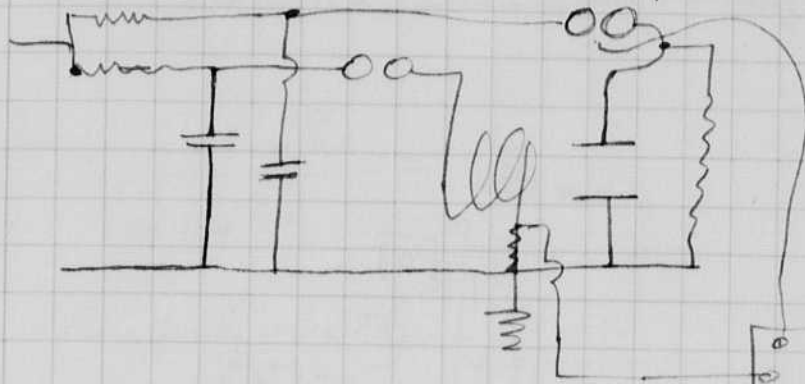
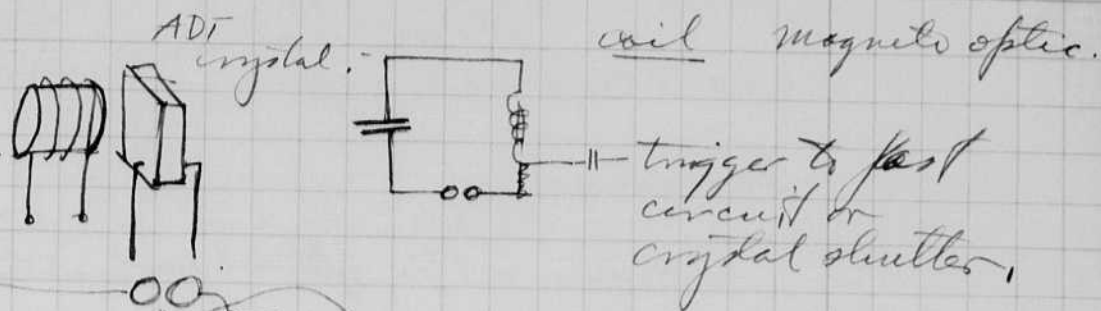
| Scale            | dist |
|------------------|------|
| <del>∞</del> ∞   | 36"  |
| <del>15</del> 15 | 27"  |
| 8                | 19.5 |
| 5                | 15.5 |
| 3.5              | 12.5 |



Oct. 7 1950

Hewlett-Packard,

Fast shutter,



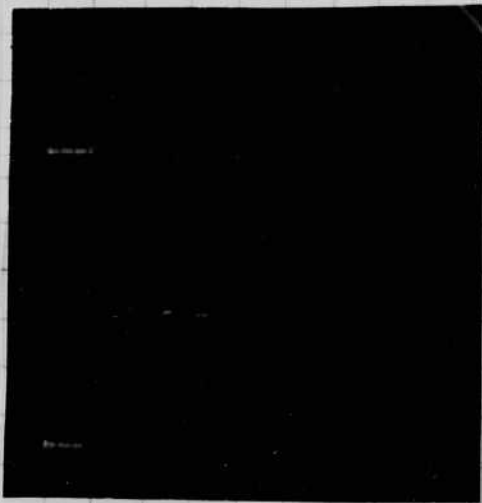
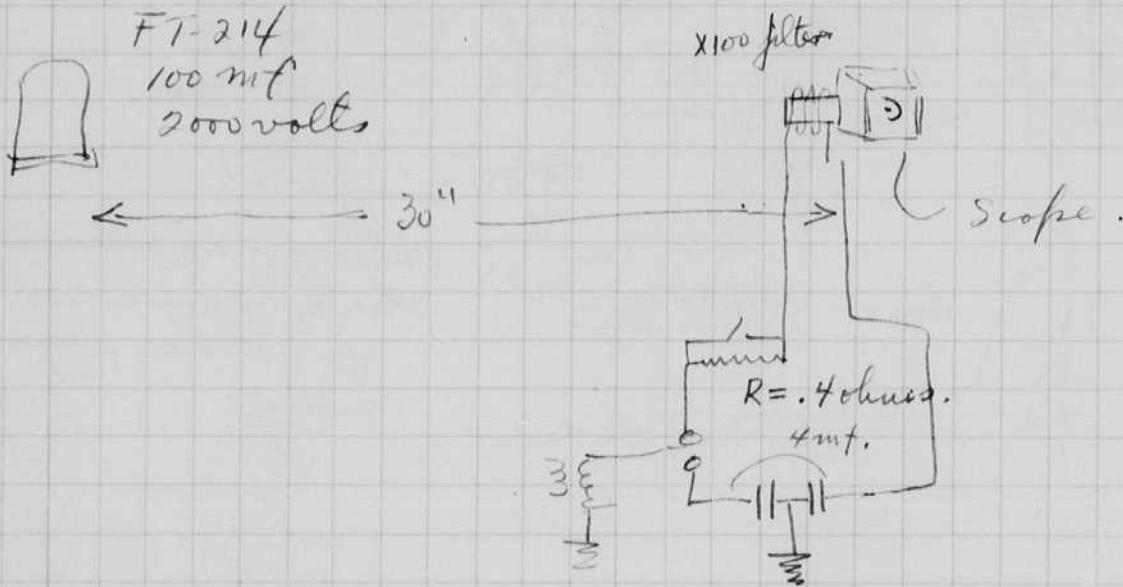
trigger when  
electromagnetic  
shutter current  
reverses, sign  
change

Repatronic Shutter

4mf 8KV. Single gap.

20 turn coil.

1" diam x 1 1/2" optical part.



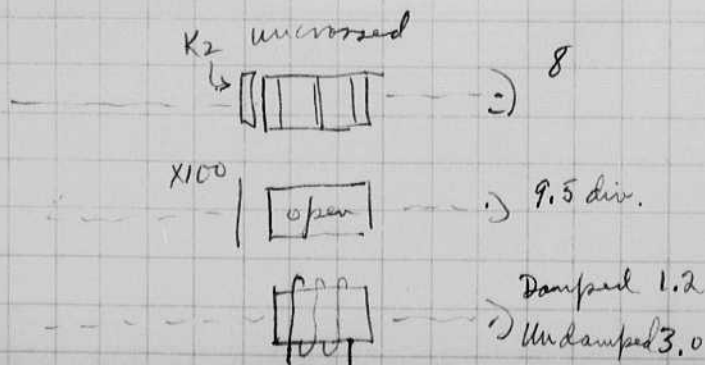
Top light x 1/100

Damped shutter

10 KC

Light x 1/100

Undamped shutter.



Undamped Shutter peak, uncrossed with K<sub>2</sub> filter. =  $\frac{4}{11} \times \frac{3.5}{8} = 0.159$

Damped Shutter peak, uncrossed with K<sub>2</sub> filter. =  $\frac{2}{9} \times \frac{3.5}{8} = 0.0974$

Damped shutter, 1/100 light =  $\frac{2}{9} =$

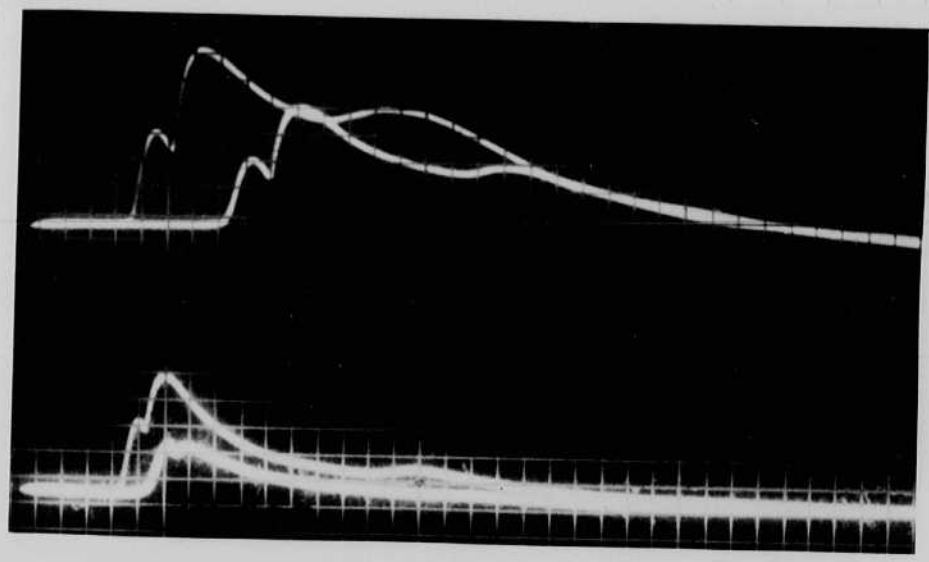
Undamped shutter, 1/100 light =  $\frac{4}{11} =$

1/100 light ~~3.5~~  $\frac{3.5}{8} =$   
K<sub>2</sub> uncrossed  $\frac{3.5}{8} =$

10,000 cp. per 10 divisions

See more accurate photos on page 34.

445± resolution for the PC. pm. amb 10 divisions 926 CF or 10 20,000 obs.



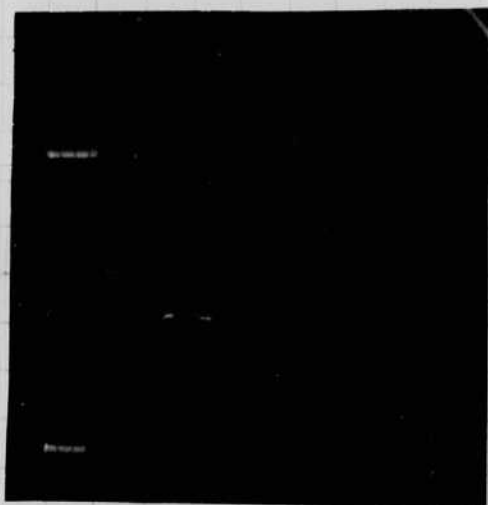
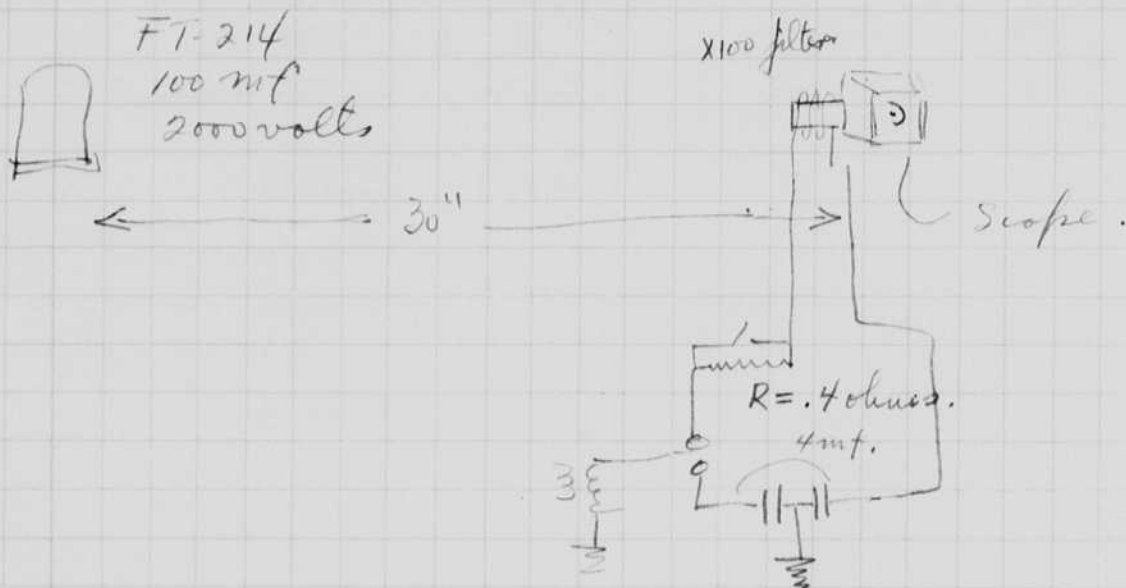
926 phototube with vis filter as supplied by corning glasses.  
Strobosc output,  
John Mills.  
Calibrated against FT-14 St. Muhl.

# Repatroni Shutter

4 mf 8KV. Single gap.

20 turn coil.

1" diams x 1 1/2 optical front.



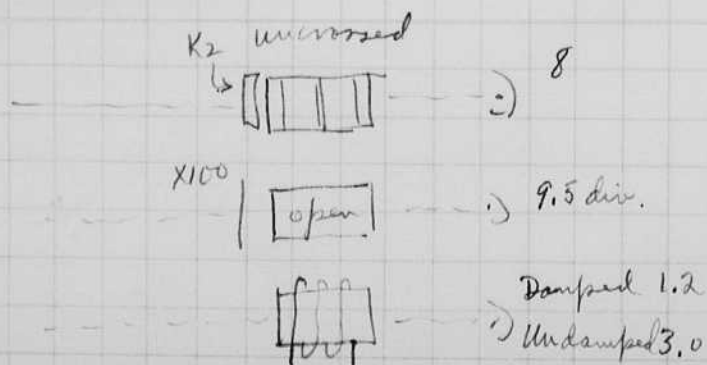
Top light x 1/100

Damped shutter

10 KC

Light x 1/100

Undamped shutter.



Undamped shutter peak, uncrossed with K<sub>2</sub> filter. =  $\frac{4}{11} \times \frac{3.5}{8} = 0.159$

Damped shutter peak, uncrossed with K<sub>2</sub> filter. =  $\frac{2}{9} \times \frac{3.5}{8} = 0.0974$

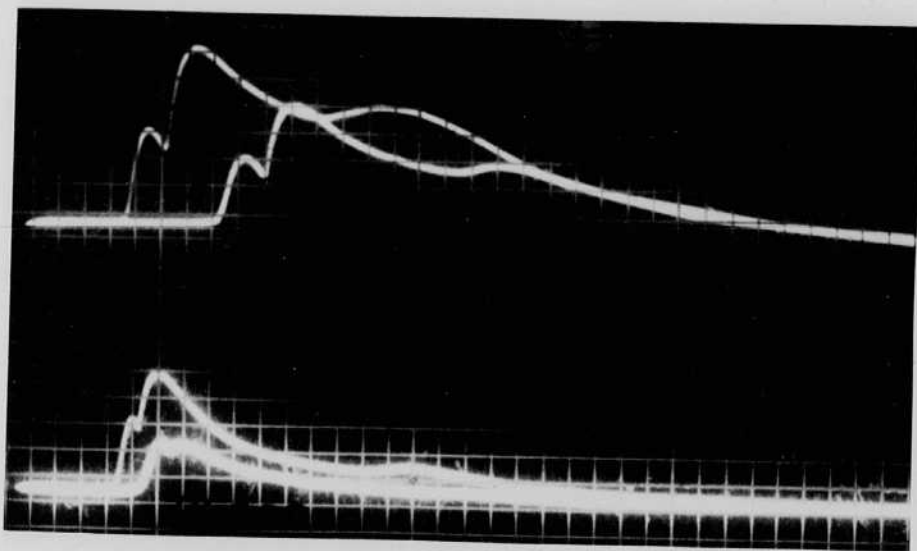
Damped shutter / 1/100 light =  $\frac{2}{9} =$

Undamped shutter / 1/100 light =  $\frac{4}{11} =$

1/100 light ~~3.5~~  $\frac{3.5}{8} =$   
K<sub>2</sub> uncrossed  $\frac{3.5}{8} =$

10,000 c.p.p. per 10 divisions

See more accurate photos on page 34.



926 phototube with vis filter as supplied by Corning glasses.

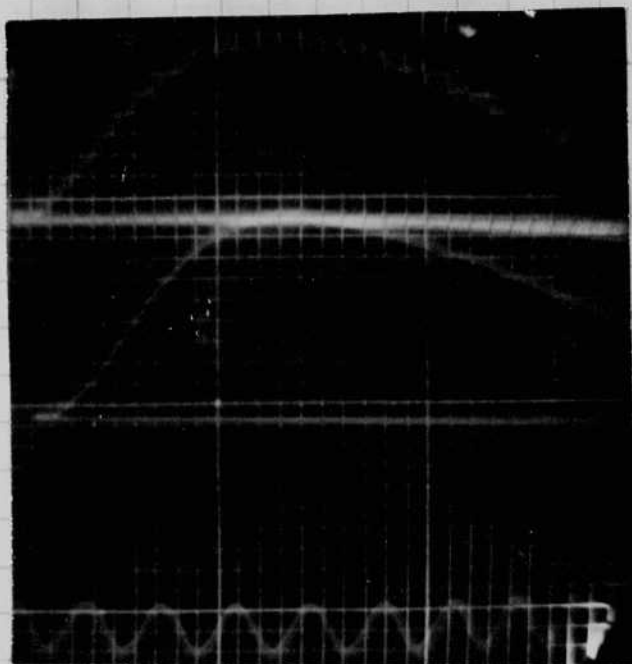
Strobotac output,

John Mills.

Calibrated against FT-14 standard.

445± resolution for this PC. per inch 1/5 divisions 926 CF with 20,000 ohms.

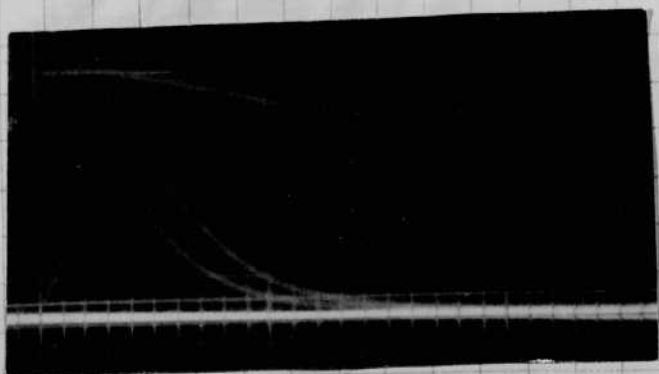
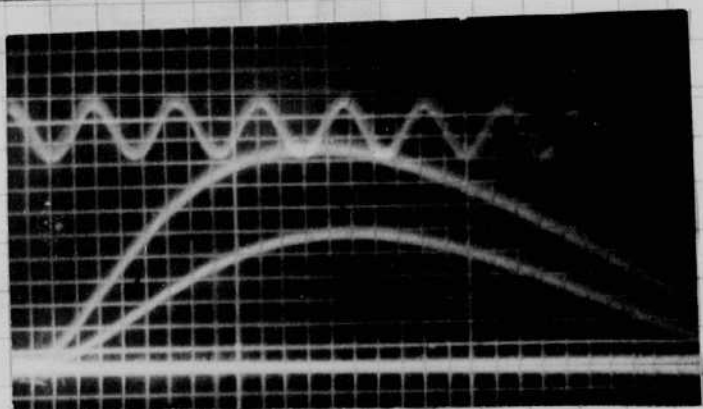
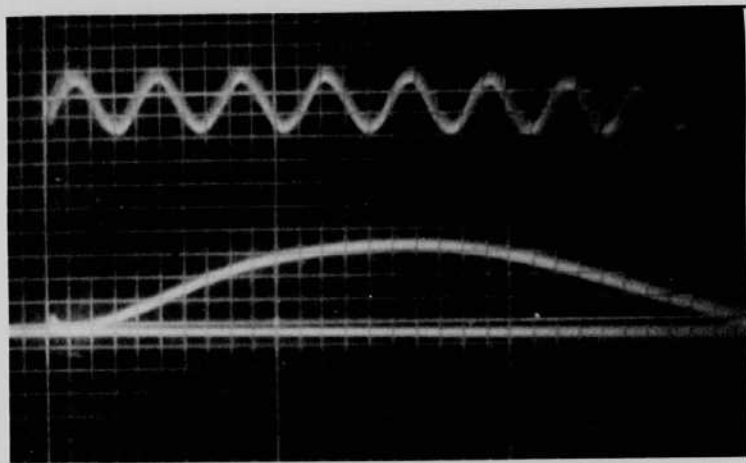


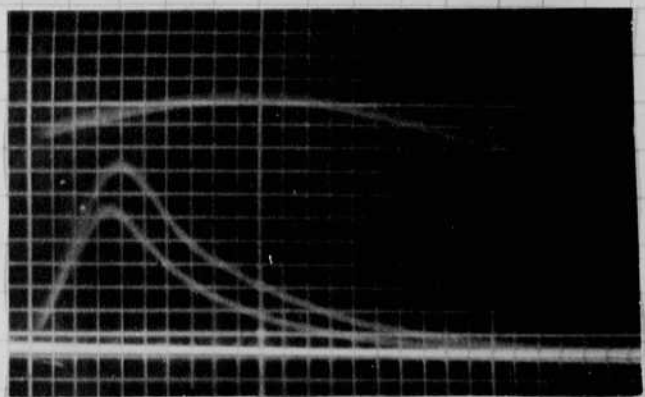
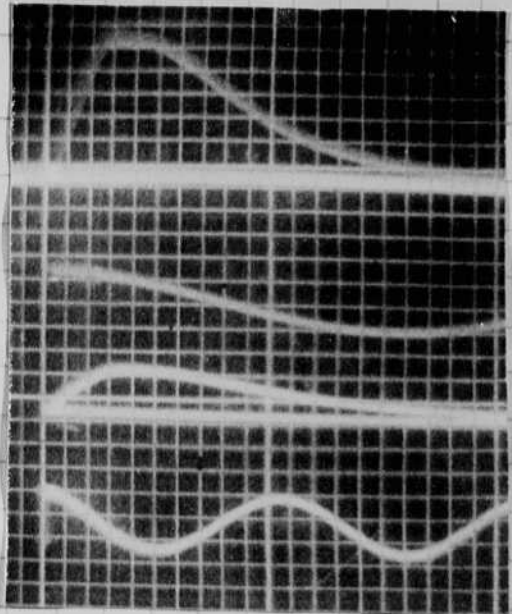


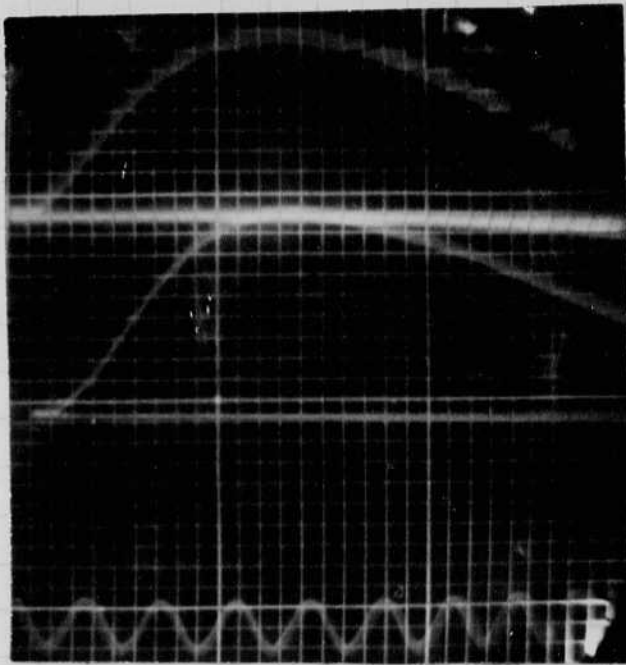
Top  $4\frac{1}{2}$  turn FT-224

Bot Sun flash FT-17

$5 \times 10^7$  c.p./div sin  
 $10^4$  cps lening



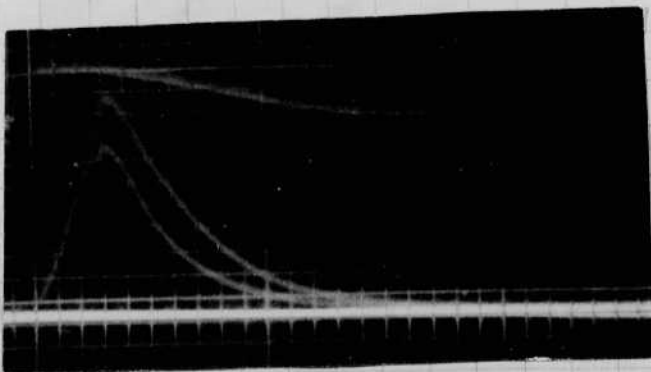
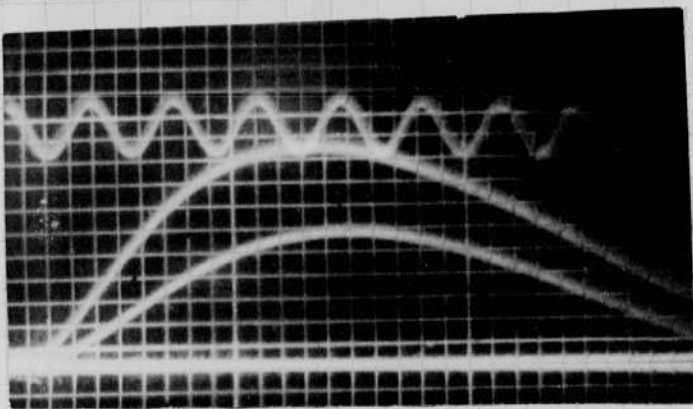
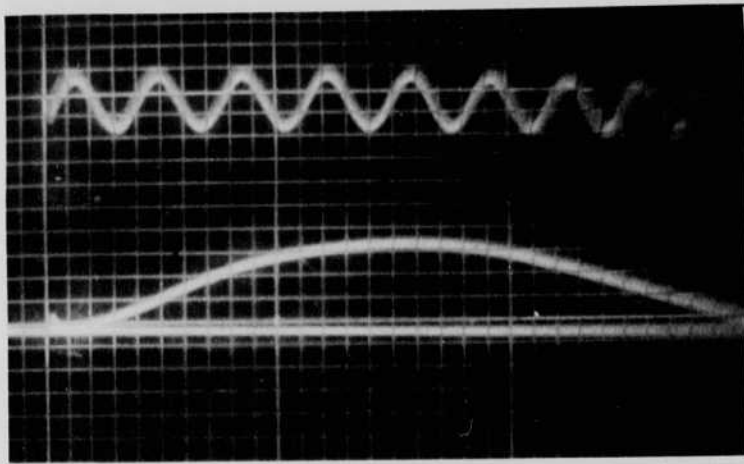


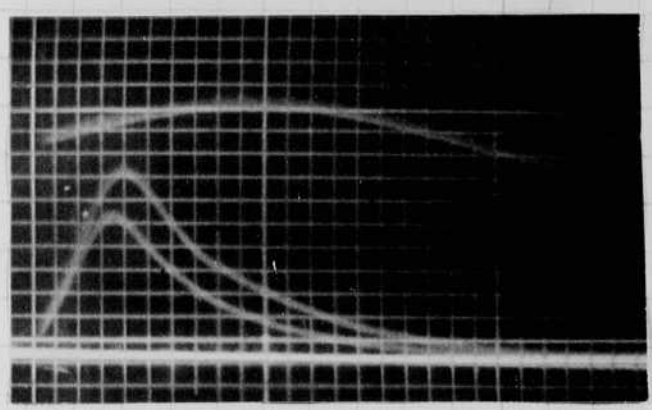
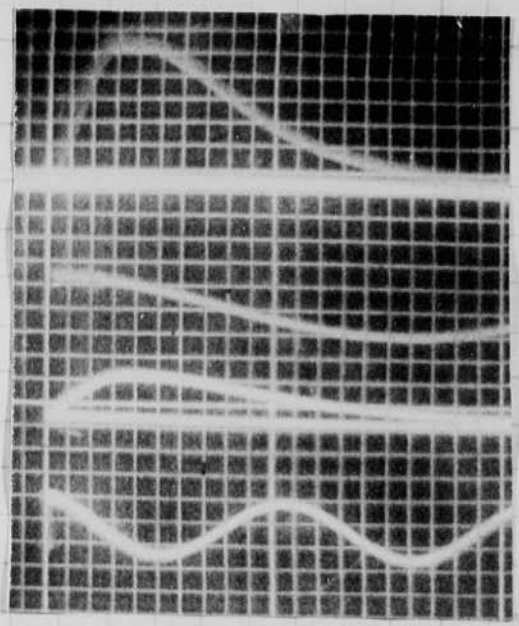


Top  $4\frac{1}{2}$  turn FT-24

Bot Sun flash FT-17

$5 \times 10^7$  cps/division  
 $10^4$  cps/turn





Notebook # 20

### Filming and Separation Record

9 unmounted photograph(s)

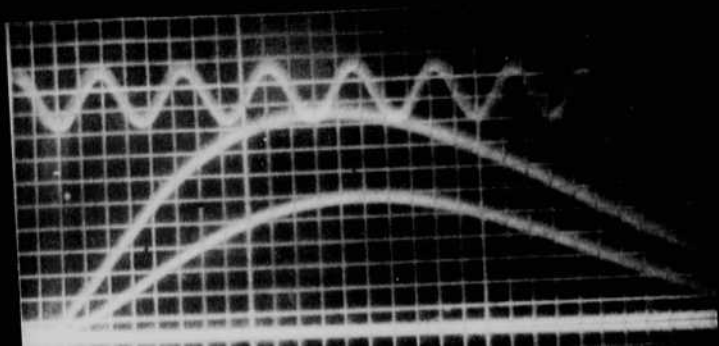
\_\_\_ negative strip(s)

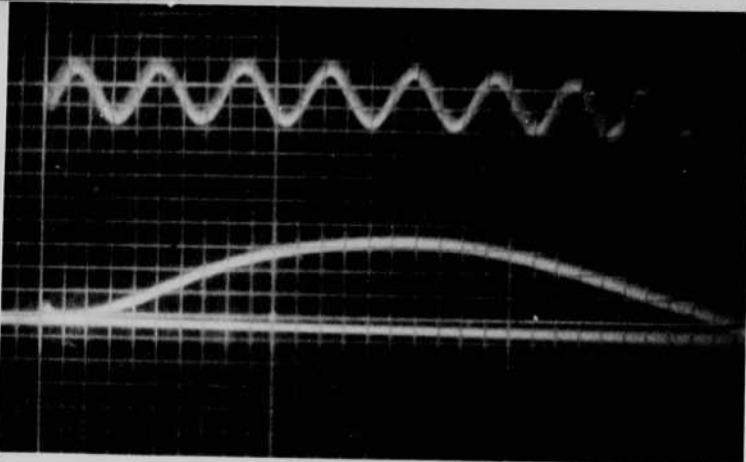
\_\_\_ unmounted page(s)  
(notes, drawings, letters, etc.)

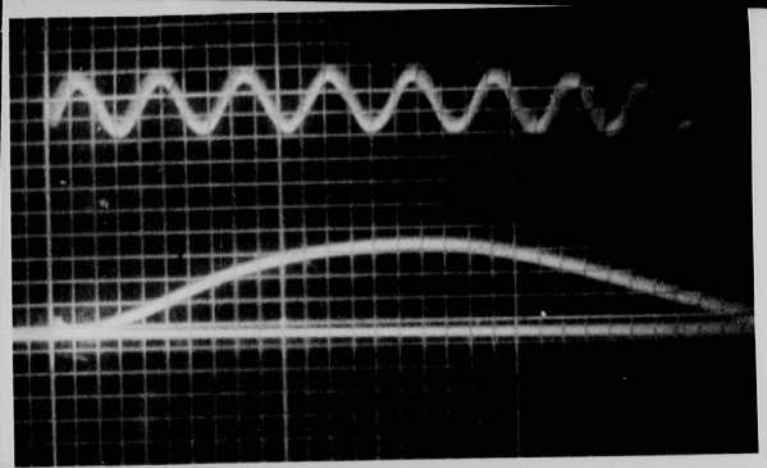
was/were filmed where originally located between page 30 and 31.

Item(s) now housed in accompanying folder.









Spray Photography

Nov. 2, 1950

Harold Edgerton

Wm. Walsh, Sykes, at A.D. Little Co  
Suffolk Bldg. asked me to look at a  
spray nozzle problem on Tuesday.

Dr. Kevill

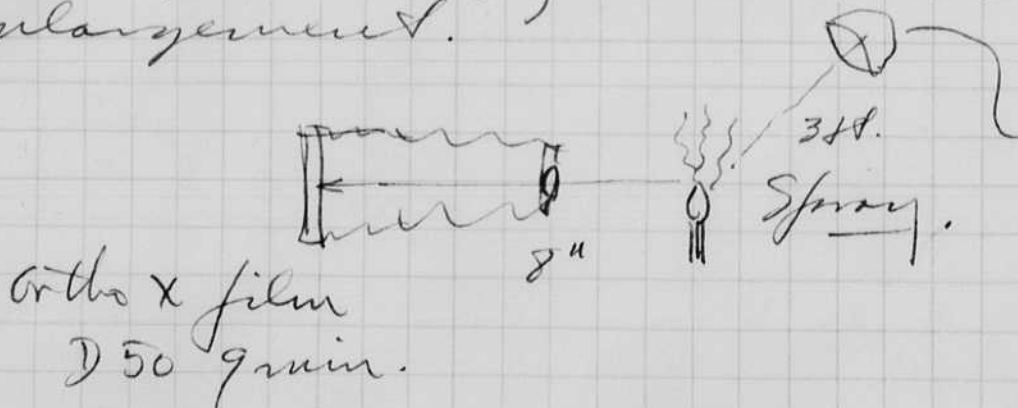
I set up a 4x5 camera  
yesterday with an 8" (205 mm) lens  
and a mini flash unit. A water  
spray was studied, atomizer type.

ortho x film - lamp 2 ft  
mini flash SP-type f 7.7 gave  
photo when 1 to 1, but the drops  
did not show well.

f 7.7 gave exposure but  
photos were not good with front  
lighting.

Back lighting with ~~white~~ white  
card and trays jerecing were  
not too good.

I then used plain back lighting  
with the lamp out of the field, as shown.  
The results were ok at f 32  
with 1 to 1 and f 22 with a 2:1  
enlargement.

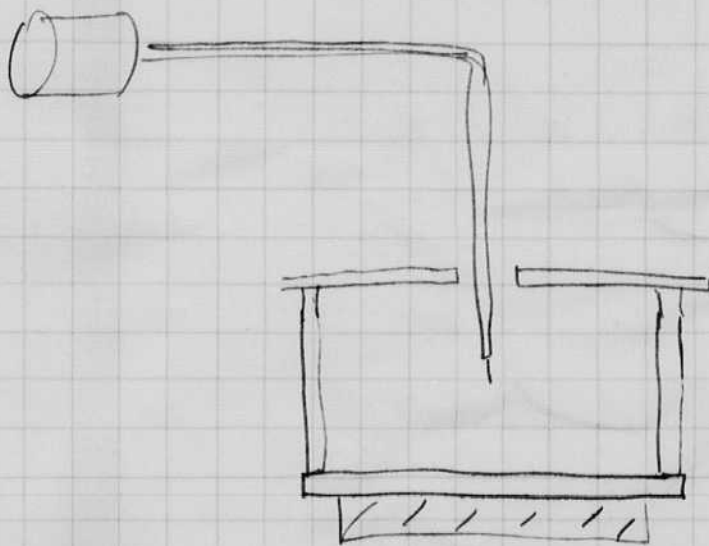
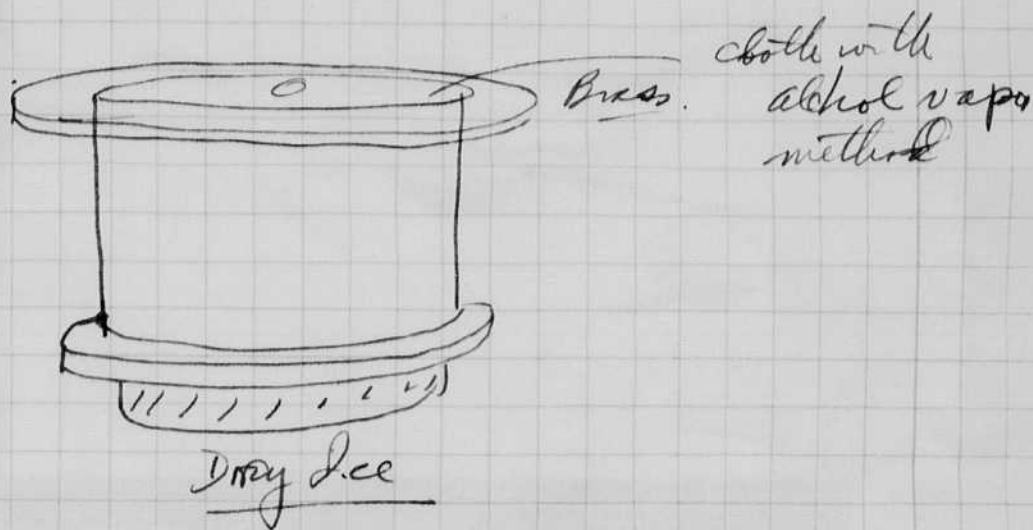


Nov. 3, 1950

33

David E. Edgerton

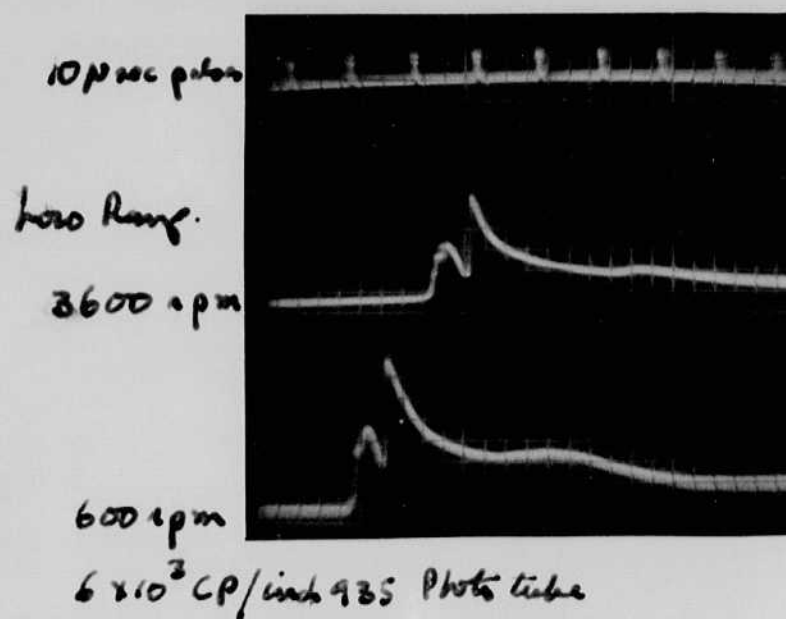
For several days I have been working with Safford on the continuous cloud chamber. Today I took up a spark unit to set up an electric static field in the chamber.



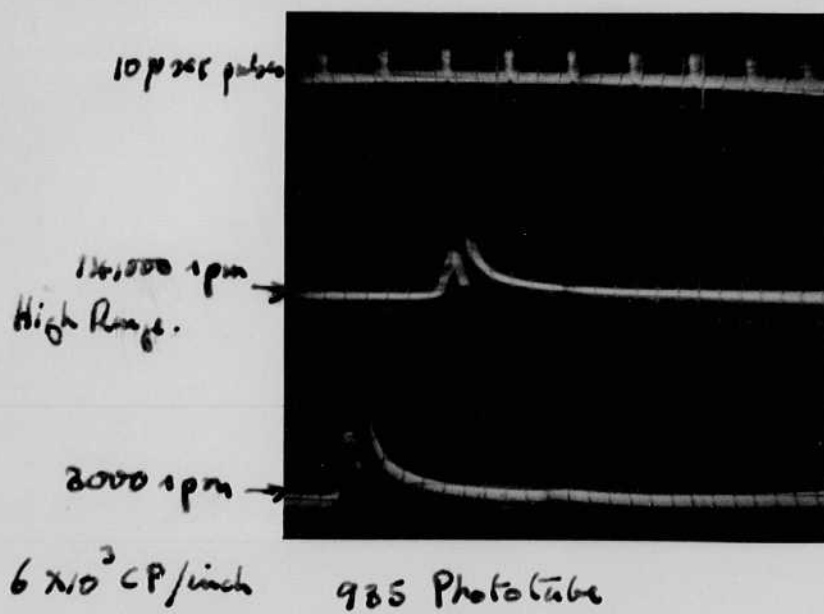
A very dense cloud was formed when the coil was pulsed. This then slowly sank to the base plate. A second spark showed a series of open spots on the cloud that was on the surface. At a still later stage the spark coil set up streamers in the air around the point. Apparently the result depends upon the saturation of the vapor in the chamber.



G.R. Strobilac # 10202



G.R. Strobilac # 10202



Cutting  
Smulovitch  
Pulman

Adrian

John  
Mills

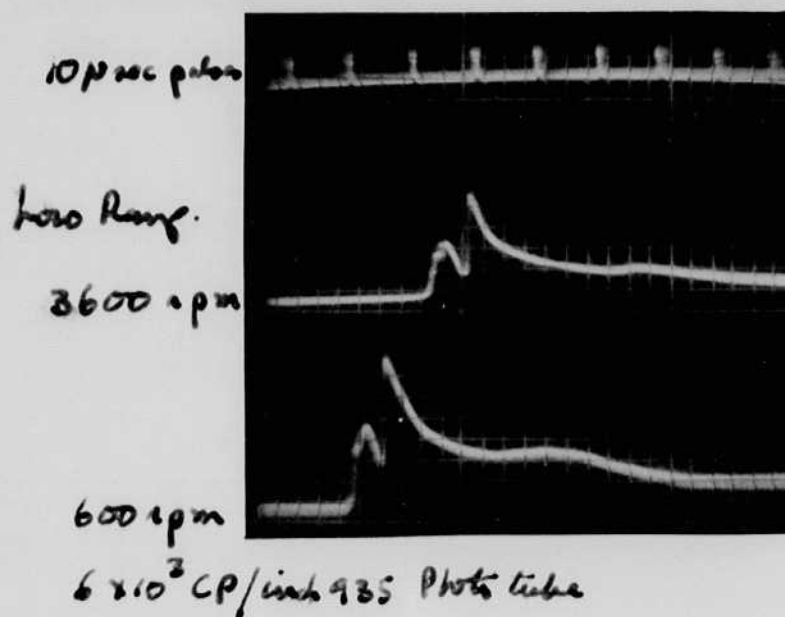


Weil

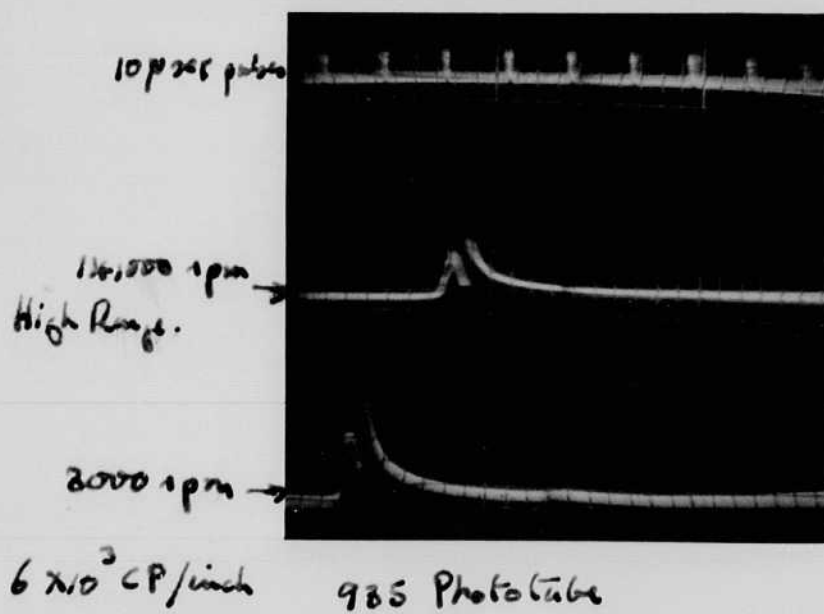


Widovitz  
Valpey  
Woods  
Arthur

G.R. Strobilac # 10202



G.R. Strobilac # 10202



Cathery  
Smulinter  
Pulman

Aldrich

John  
Mills

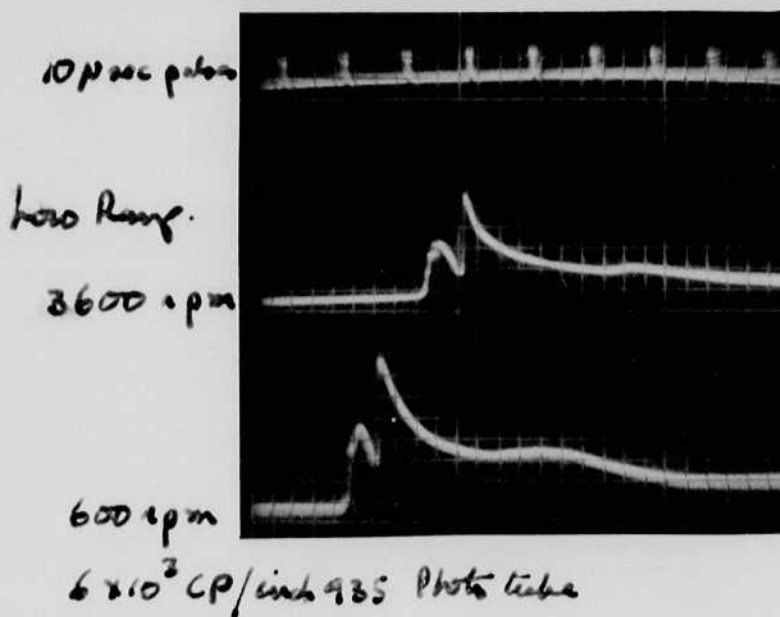


Weil

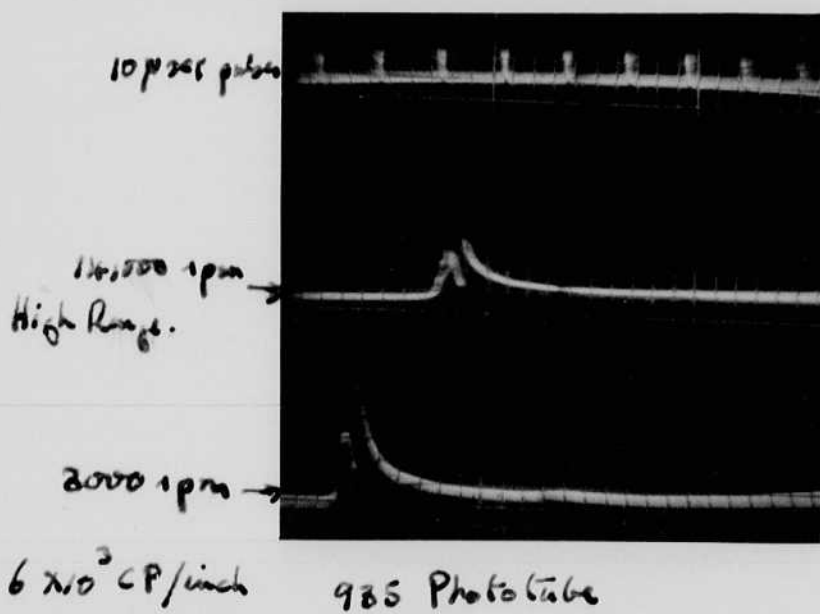


Widowity  
Valpey  
Woods  
Arthur

G.R. Stroboscopic # 10202



G.R. Stroboscopic # 10202





Cutlery  
Smulinton  
Rullman

Aldrich

John  
Mills



Weil



Widovitz  
Valpey  
Woods  
Archers

Thurs  
Nov 16, 1950  
Algeron

The photos of the spray at A.D.L. Co were not very good. The lens was f 7 8" in a 4x5 Kodora camera. Aperture f 16 with the microflash for back light at  $45^\circ \pm$

I shot more negatives from  $45^\circ$  light on the 14. Exp at f 16 and f 11.

Set up multiple flash lights at the



Taken by Jap  
visitor

1950

#3

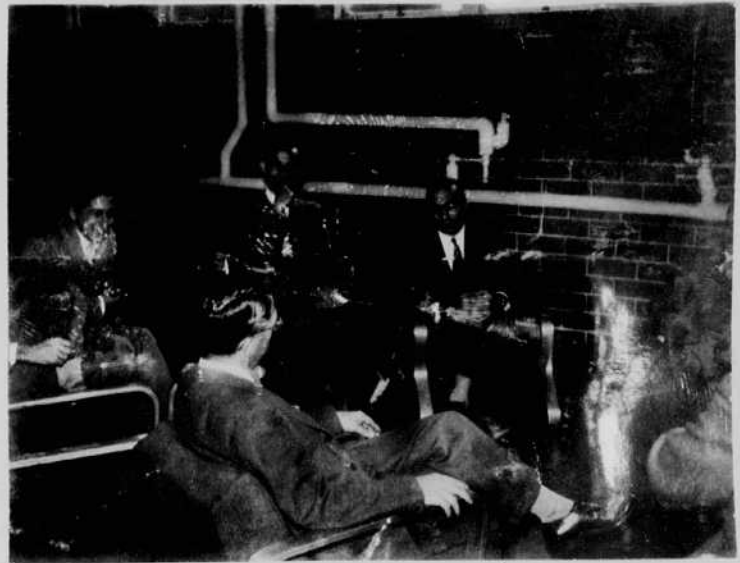
~~Green flash~~  
on Leica

taken with  
Polaroid camera  
and  
2 green  
slides.

Grossman



Conf. on condenser  
design.



Burnham → Kriebel

Grossman



Chestole

Bladebum

Stems  
Nov 16, 1950  
Edgerton

The photos of the spray at A.D.L. Co were not very good. The lens was f 7 8" in a 4x5 Kodak camera. Aperture f 16 with the microflash for back light at  $45^\circ \pm$

I shot more negatives from  $45^\circ$  light on the 14. Ap at f 16 and f 11.

Set up multiflash lights at the



Taken by Jap  
visitor

1950

#3

~~Green Flash~~  
on Leica

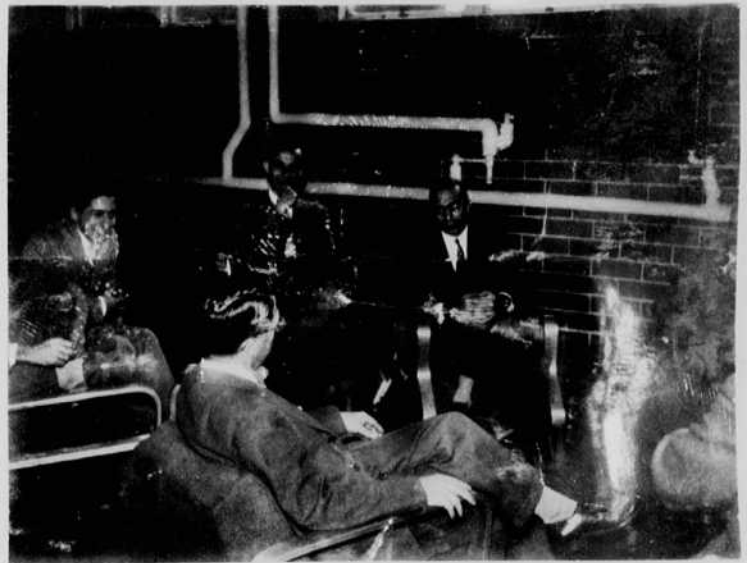


taken with  
Kolorid camera  
and  
2 green  
slides.

Grossman



Conf. on condenser  
design.



Burnham → Kriebel

Grossman



Chestole

Blackburn



Stamps  
Nov 16, 1950

Edgerton

The photos of the spray at A.D.L. Co were not very good. The lens was f 7 8" in a 4x5 Kodak camera. Aperture f 16 into the microflash for back light at  $45^\circ \pm$

I shot more negatives from  $45^\circ$  light on the 14. Ap at f 16 and f 11.

Set up multiple flash lights at the



Taken by Jap  
visitor

1950

#3

~~from flash~~  
on Leica

taken with  
Kolorica camera  
and  
2 Green  
plates.

Grossman



Conf. on condenser  
design.



Burham → Kriebel

Grossman



Chestole

Blackburn



Continuous  
cloud chamber  
excited by a  
high voltage  
spark



Cosmic rays.



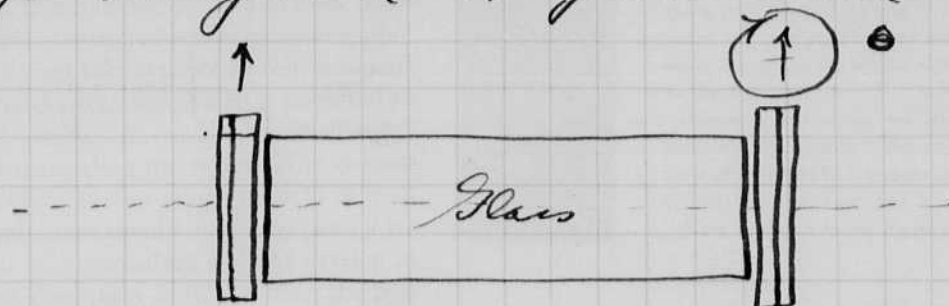
spark

Dec. 16 1950

39

Harold Edgerton

a design of a magneto optic shutter was given to Dan Roma in the PLE shop last week. This will enable me to measure the constants of ~~three~~ kinds of special heavy glass as made by E.K. Co. The samples are  $2\frac{1}{2}$ " long and  $\frac{3}{4}$  of an inch in diameter



Polaroid in an angle measuring device.

I plan to use a photo multiplier tube to record the output of the flash tube. angle can be adjusted so that the peak angle can be measured.

An Eastman Shutter with a  $\frac{1}{800}$  sec exposure time is



Continuous  
cloud chamber  
excited by a  
high voltage  
spark



Cosmic rays.



spark

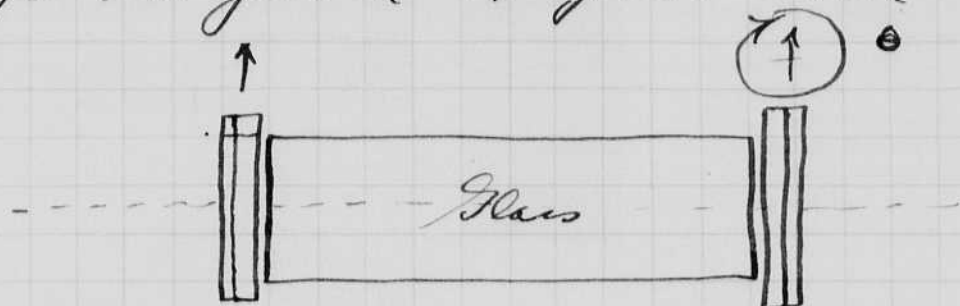


Dec. 16 1950

39

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angle measuring  
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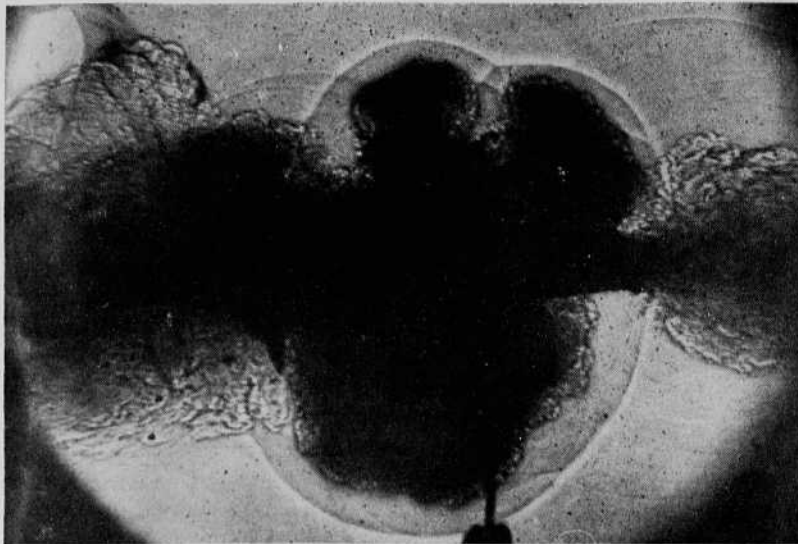
## Freezing a Firecracker

*Exposures as short as four microseconds are made possible by a magneto-optic shutter having no mechanical parts.*

A CAMERA shutter capable of making still photographs with an exposure time of from four to 10 millionths of a second has been developed by a research group which included Professor Harold E. Edgerton, Kenneth J. Germeshausen, and Herbert E. Grier, all of whom are members of the Institute's Department of Electrical Engineering. The camera has interesting potentialities for industrial research and already has been applied to a study of ordnance problems. Its advantage is that photographs of good definition, throughout a viewing angle of 30 degrees or more, are possible. Thus, the interesting transient phenomena, occurring in luminous bodies and about which we should like to know more, can be recorded.

---

*Not for Publication*



NO LIGHT OF ITS OWN was used in making this silhouette photograph of an exploding firecracker, since the shutter speed of five microseconds was sufficiently short to exclude recording the direct flash. A spark, generated by the discharge of a 0.3 microfarad capacitor charged at 12,000 volts, provided the light by which the shock waves were recorded. A field lens, eight inches in diameter, was used to concentrate the light into the camera lens.

Gases from both ends of the firecracker may be seen issuing horizontally from it. Note the wisp of smoke from the burning fuse in the upper left-hand corner, not yet disturbed by the expanding shock wave. The pin at the bottom was used as a support for the firecracker.

Instead of eliminating the direct light from the explosion, photographs in the normal manner can be made of the direct flash by opening the shutter for the desired length of time, and by removing the back lighting produced by the spark discharge.

Key element in the new camera design is the magneto-optic shutter which, because it has no moving mechanical parts, makes possible satisfactory exposures as short as a few microseconds. The shutter makes use of an effect, discovered by Michael Faraday in 1845, by which transparent bodies in a magnetic field rotate the plane of polarization of light passing through them.

Essentially, the shutter consists of three sheets of polarizing material, the plane of polarization of the center being at right angles to the planes of the end elements. These polarizing plates are cemented between thick discs of strain-free, extra-dense, flint glass. Filters at the ends of the shutter restrict light passing through the shutter to a narrow band in the visible spectrum. Surrounding the shutter, which is made up as a cylindrical sandwich, is a coil of wire into which a pulse of current may be discharged from a condenser which has been previously charged to several thousand volts.

Under ordinary circumstances, the shutter is extremely opaque, passing something like one one-billionth of the light incident on its optical axis. Such high optical density is essential when recording photographically the action taking place in self-luminous bodies. When a condenser, charged to a potential of several thousand volts, is suddenly discharged through the coil surrounding the shutter, the current through the coils establishes a magnetic field of high intensity. The resultant magnetic field produces a rotation of the plane of polarization of light passing in the strain-free flint glass discs so that, during the passage of the current, the shutter becomes relatively transparent and passes about 4 per cent of the incident light, or about 30 million times the amount transmitted with the shutter closed.

As is well known, when a charged condenser discharges through an inductance in a low-resistance circuit, the discharge current is not a single pulse, as would be most useful for the present application. In-

stead, an oscillatory current occurs which tends to "open" the shutter on successive alterations of the current flow. Although less light is passed through each successive opening, several exposures may be encountered unless precautions are taken to eliminate such multiple exposure effects. Single pulse operation may be attained by increasing the circuit resistance or by providing a spark gap to damp the discharge.

The condenser for storing energy and the coil surrounding the magneto-optic shutter are designed so as to provide the optimum time for shutter opening, usually between four and 10 microseconds. With an optimum exposure time chosen, it is possible to vary the net exposure by changing the voltage to which the condenser is charged. This alters the intensity of the magnetic field through the coil which, in turn, controls the degree of rotation of the polarized light through the shutter to determine the final amount of light recorded on the film. Voltages of the order of 8,000 volts are used to charge the condenser for existing shutters. Shorter exposure times are possible with higher voltages.

In ordnance use, the camera is set up with a phototube timing circuit so arranged that light from the explosion triggers the electronic control equipment, producing an accurately timed pulse which actuates the shutter. Photographs are usually made of the luminous discharge of the exploding material, although supplementary flash illumination may be used during the short interval for which the shutter is open. An advantage of the shutter is that light from the explosion may be excluded and the shock waves recorded by silhouette techniques. In either case, electrical circuits can be arranged so that small time delays may be introduced into the shutter circuit, making it possible to have the shutter open for any desired portion of the flash. The possibility of making either normal or silhouette photographs of intensely bright flashes greatly expands the capabilities of the photographic technique for industry.

✓ Nov. 1950 issue

## Freezing a Firecracker

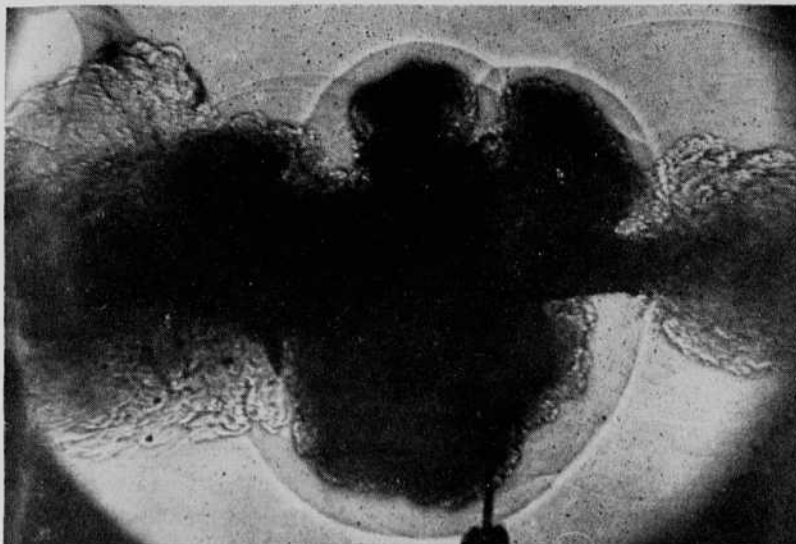
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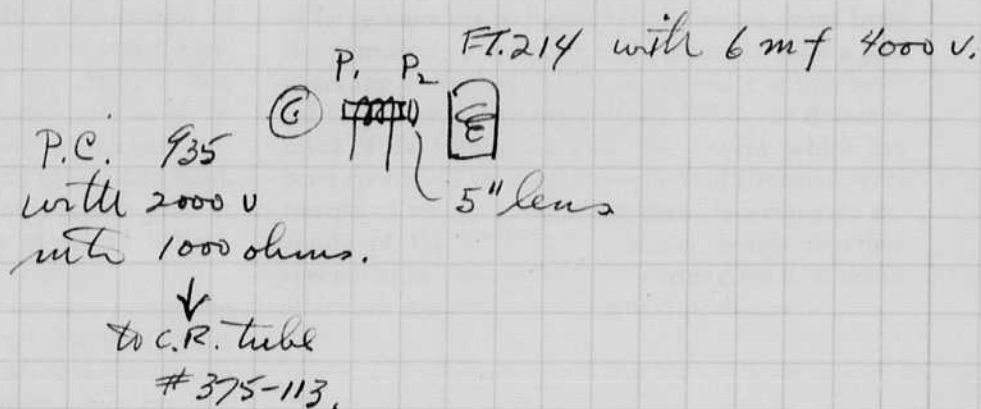


Jan 6. 1951  
 Howard E. Edgerton.

My parents were here Dec 29 to Jan 2 inc  
 on a visit to East.

Took second set of colored movies  
 yesterday using Jastax with out the  
 prism or gate.

Set up equipment to measure  
 Verdet constant in glass samples from  
 East man. 4" length  $3/4$ " diam.



I used my suitcase box 12KV  $5/4$  mf cond  
 to drive the coil,

- oscillogram of sparks in series with the coil of  
 a. 21 turns and 1 ft of cable.  
 b. 1 megacycle timing wave.  
 c. osc. of sparks without the coil in series

The above shows the frequency of the  
 condenser and coil circuit.

2nd film I # a zero  
 b 6 mf 3000 v FT-214 light  
 c ditto but with mosquito optic coil activated.

# 2-a zero  
 b 6 mf 3000 v FT-214 light  
 c ditto but with coil and extra cap on the coil.  
 13 mf.

43

note the 25K was not used on these oscillograms, Sweep 8

The polarizer was now set for the  $90^\circ$  light condition and the following oscillograms were taken

Film 2  
III - a zero.  
III - b Light from FT-214 6 mf 3000 V.  
III - c " " " " " " with coil (21 turns) operated from a box as per II. Extra 0.3 mf +  $\frac{1}{4}$  mf at 12 KV.

III - d the beam was moved up and a repeat of III - c was taken.

III - e 1 mc tuning wave.

The polarizer was now set for  $135^\circ$  ( $45^\circ$ )

Film 2  
IV - a zero  
IV - b Light from FT-214 6 mf 3000 V.  
IV - c same as b but with coil activated by the subcase 12 KV job as in III.

Film 3 auto ortho x.?  
Lamp cap 5.5k mf voltage increased to 4000

3 - I - a Polarizer angle = 0

10

20

30

40

50

60

70

90

To show transmission with angle.

no flash. zero line.

3 - II - a zero (b) Light with  $45^\circ$  on Polar (c) coil as above (d) coil terminals reversed.

3 - III - a ... Dillo above.

EK 48

Karo EK 45

|  |                  |       |
|--|------------------|-------|
|  | N <sub>D</sub> . | ✓     |
|  | 1.8186           | 40.63 |

Film 4

4-1-a.

Pat 0 Pat 90

Pat 45 with coil and EK 45.

4-II

Pat 0, 10, 20, 30, 40, 50, 60, 70, ~~80~~ 90  
and no light zero.

4-III

Pat 45

Film 5. Ditto but with EK-11

Film 6.

Ditto but with EK 33

Repeat of last sequence.





Notebook # 20

### Filming and Separation Record

\_\_\_ unmounted photograph(s)

1 ~~negative strip(s)~~ *piece of safety film*

\_\_\_ unmounted page(s)  
(notes, drawings, letters, etc.)

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

Item(s) now housed in accompanying folder.





Notebook # 20

### Filming and Separation Record

\_\_\_ unmounted photograph(s)

2 ~~negative strip(s)~~ *pieces of safety film*

\_\_\_ unmounted page(s)  
(notes, drawings, letters, etc.)

was/were filmed where originally located between page 46 and 47.

Item(s) now housed in accompanying folder.





Jan ~~12~~ 1951Harold Edgerton  
Wm Skeltoncheck of CR. and osc equipment180 ohms was put in parallel with the  
1000 ohms in the Photocell 935 circuit.Spark from .03 at 6KV was used as a  
light source. The light was increased  
with a lens for the 180 ohm example.  
5mc timing wave.

① trace near notch in film - secondary current 12" cord in parallel primary

next

primary

top

timing 5 mc (#4 position sweep)

②

two secondary current

40" coil of cord parallel primary

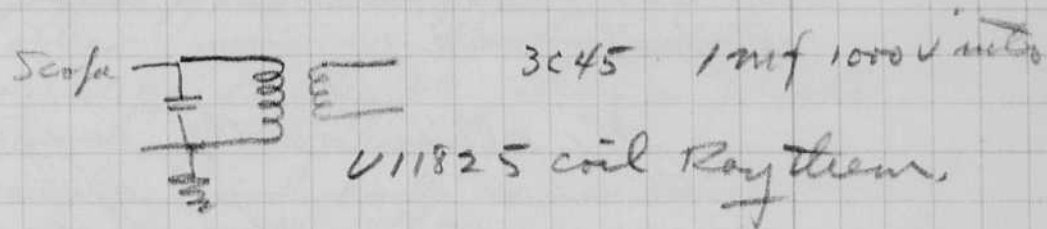
one primary

5 mc timing wave (#3 position sweep)



Jan 20 1951 with Anderson & Hedrick } of Baird Associates #7  
 H. G. Garton.

Idem #1  
 A One of spark coil output  
 1 mc reference  
 coil output with 100 mmf  
 Gold Grid Standard  
 crystal ~~4~~ 0.1 inch.

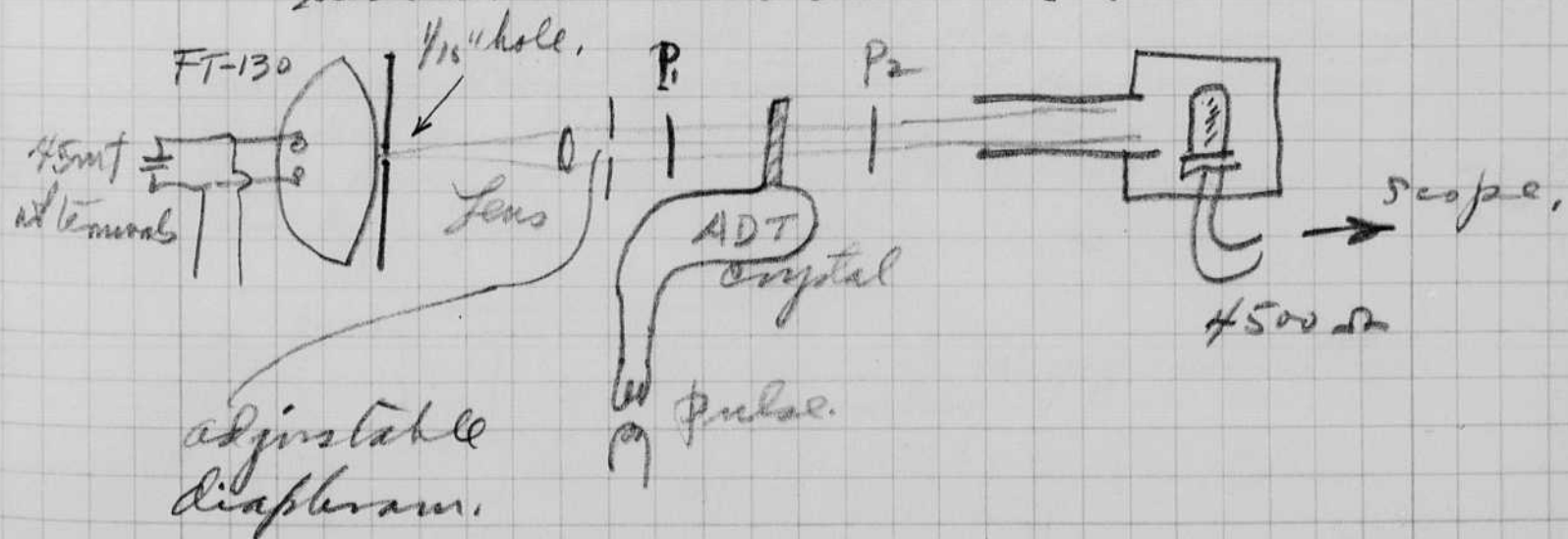


B. Crystal removed  
 1 mc  
 Voltage

The above did not work with a  
 935 pickup due to the lack of light.

a PM tube 931A with 1100 volts was  
 substituted and the gain is now  
 ample.

Jan 24 1951 Continued work with #DT crystals.  
 a small diaphragm was put in front of  
 an FT-130 so that the angle of the  
 beam would be small.



Jan 24 1950 cont.

Ward has been working with a 20 KV setup at 160 Brookline Ave in Boston, a .125 m $\mu$  cathode is used which has a 0.8 mc resonant freq.

I located some heavy flint glass at B. U. when there with Mc Donald and O'Brien. This glass seems to have about 30% more rotation than the EDF4 that we are using on the Rafatronics.

We plan a  $1\frac{1}{2}$ " length of 1" diameter with a 6 turn coil operated from the above with a spark gap and a damping resistor. Two polarizers will be used. One is cemented to the glass while the other is free to turn in a filter mount in the front of the camera.

Bill Mc Roberts is modifying the camera for the job. The ~~Eastman~~ Eastman 35 mm body forms the main part of the camera.

Two Wollensat's shutters are used. One opens just before the shot. The second closes quickly after the light triggers the event.

Jan 30 1951  
Harold Dyer

49

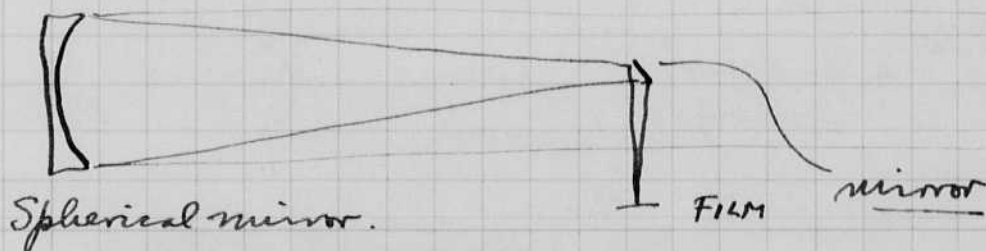
Checked <sup>four</sup> three mirrors at Boston Uni yesterday there were 10ft focal length 8" diam for photo use. made by Jones & Lawson of Vermont. three of the mirrors showed a bad section at the center.

Ben Boudreau (?) is going to make me a pyrex 8" disc of this focal length.

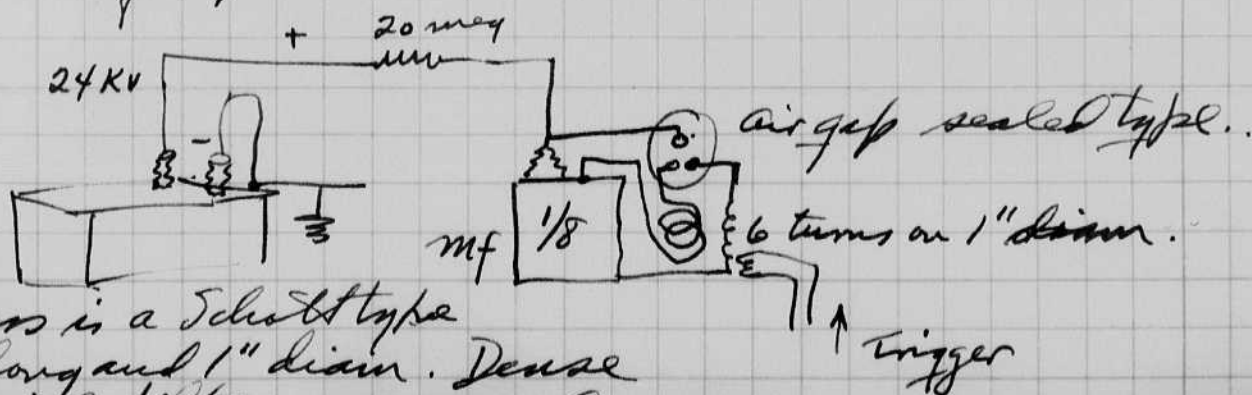
I tested the other mirror last night on the serv pent house on Bldg 20. taking a photo of the John Hancock Bldg Light.

The glass window caused considerable distortion of the beam. Also the image seemed to be intermittently blurred, either due to motion of the mirror or thermal air currents.

Took several photos on background x film at  $1/200$  sec. Several arrangements were tried for the camera position. No apparent difference resulted in the displacement of the image from the axis by as much as a foot or so. I probably will use a mirror of the front surface type.



For the past week Ward has been working with the Magneto-optic shutter at 160 Brookline. We decided on ~~Wednesday~~ Saturday to use a damping resistor instead of a second gap. the equipment is now

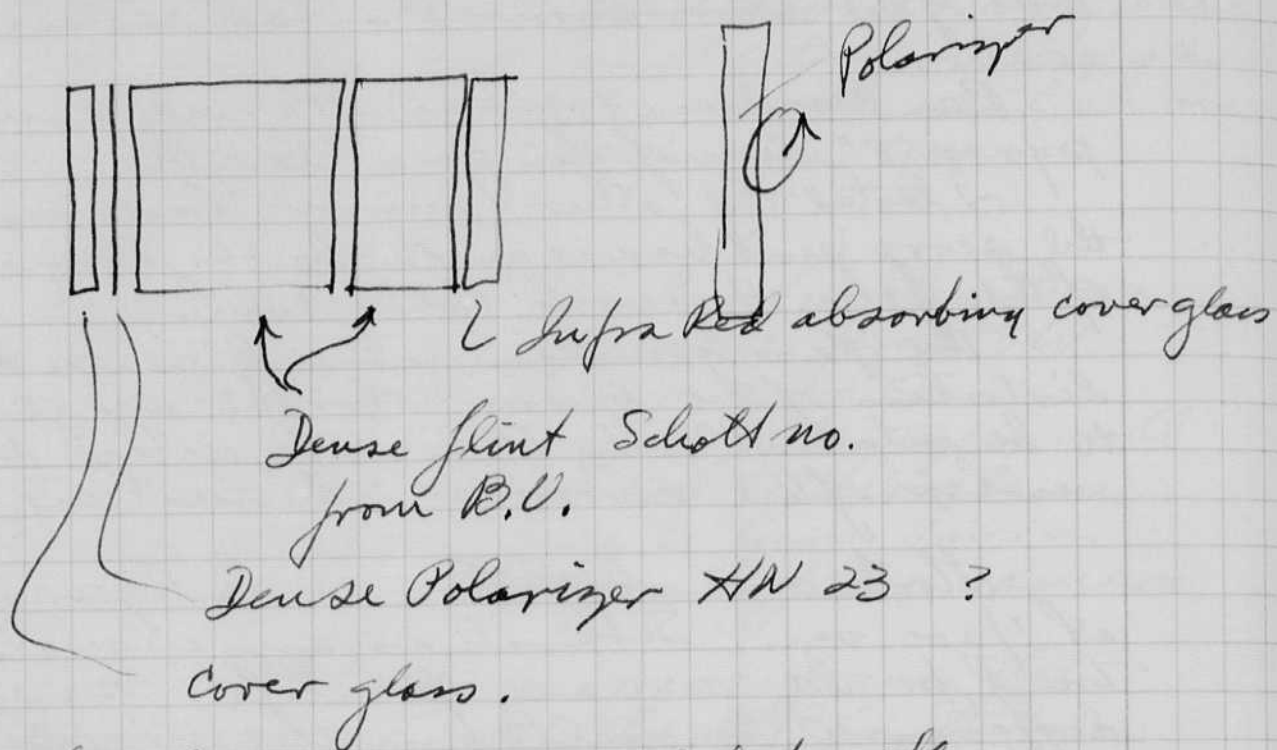


the glass is a Schott type  $1\frac{1}{2}$ " long and 1" diam. Dense Polaroid filters are used.



Polaroid Co.  
 Fault  
 Mulhall.

The assembly of the shutter parts  
 are shown.



all the above are cemented together.

Image size with 10 ft focal length mirror  
 and 1 mill distance.

$$\frac{5280}{10} \times \frac{\text{subject}}{\text{Image}} \quad \text{Image} = \text{subject} \frac{10}{5280}$$

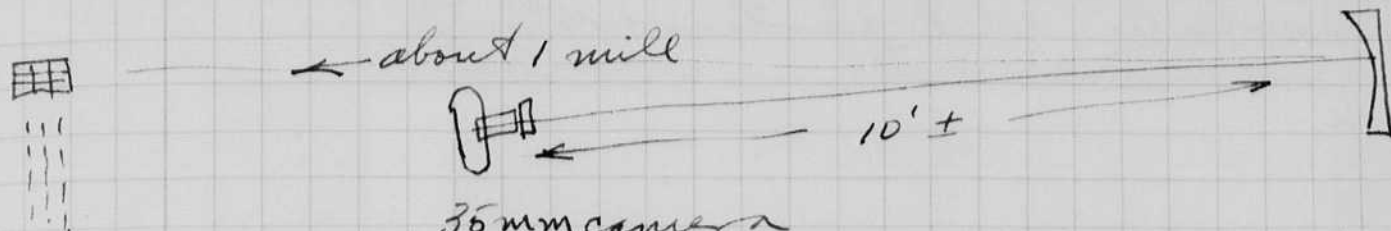
$$\text{Let image} = \frac{1}{4} \text{ then } \frac{1}{4} = S \frac{10}{5280}$$

$$S = \frac{5280}{40} = 132 \text{ inches} \\ = 11 \text{ feet.}$$

Feb 5 1951

David S. Egerton.

Tested 10' mirror camera on the John  
Hancock Building mercury light tonight.



35mm camera

Polaroid HN 23

1 1/2" slug of SF5-1 Schott glass.

Polaroid HN 23 at 0°

1/10 second shutter

XX Super film

8 min in D11 developer.

Flint glass 4.7

Water 6.9

CCl<sub>4</sub> 7.6

Ethyl Cinnamate 13.8

Clear strained glass 22.8

EDF #4 32.2

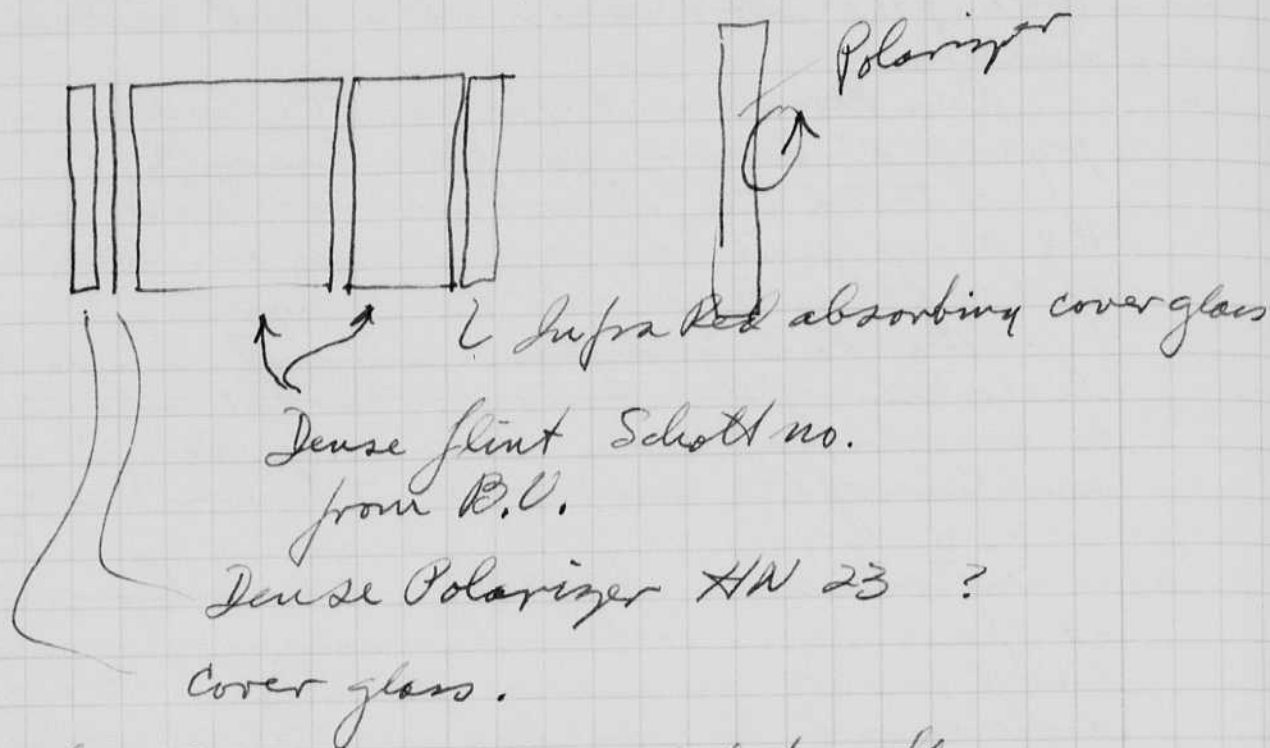
yellow strained g 47.2

Data from Bill Ward.



Polaroid Co.  
 Fault  
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$$\text{Let image} = \frac{1}{4}'' \text{ then } \frac{1}{4} = S \frac{10}{5280}$$

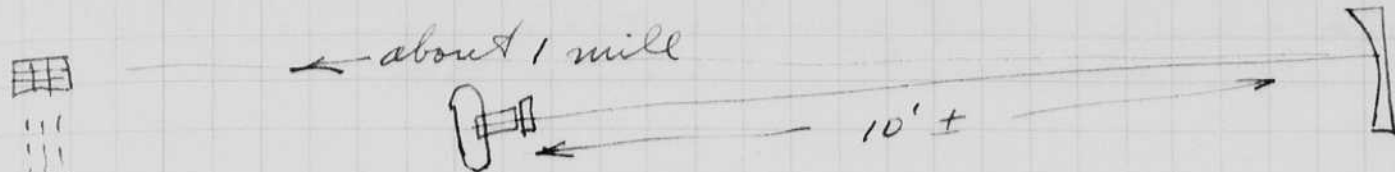
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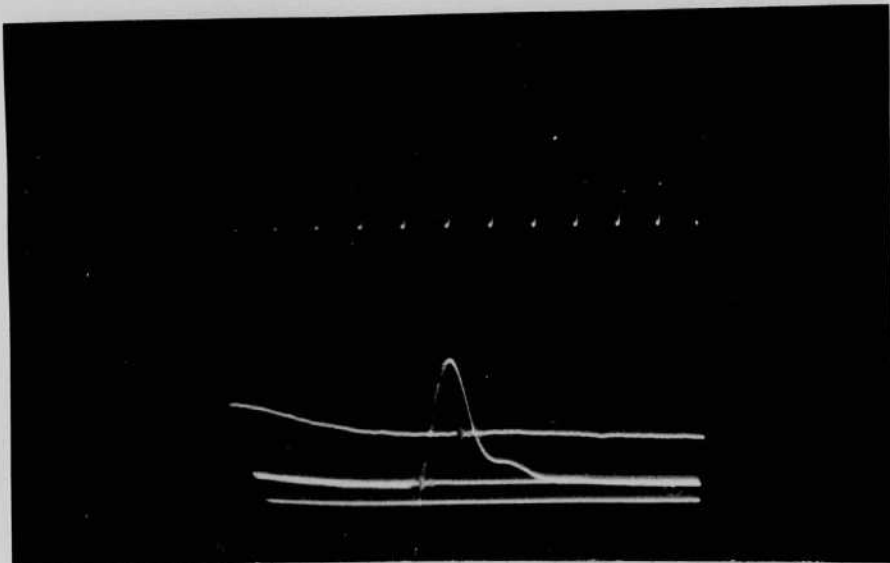
EDF #4 32.2

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Data from Bill Ward,

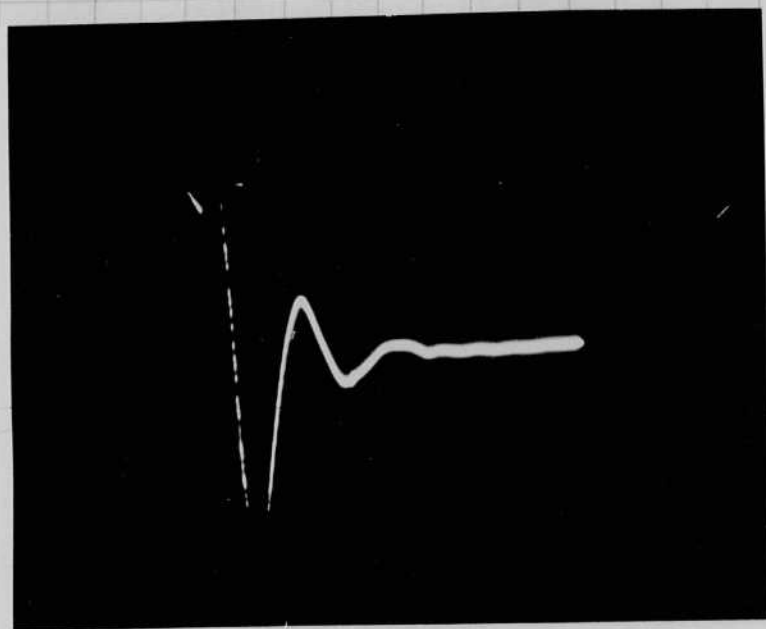
Harold E Edgerton -  
Feb 14 1951

The 1  $\mu$ s shutter is packed for the expedition to Eriwetoh. I am due to leave on the 26 of this month for Honolulu and parts west.



1  $\mu$ s.

open of  
shutter



Capacitor  
voltage

Feb 21 1951  
James Edgerton.

53

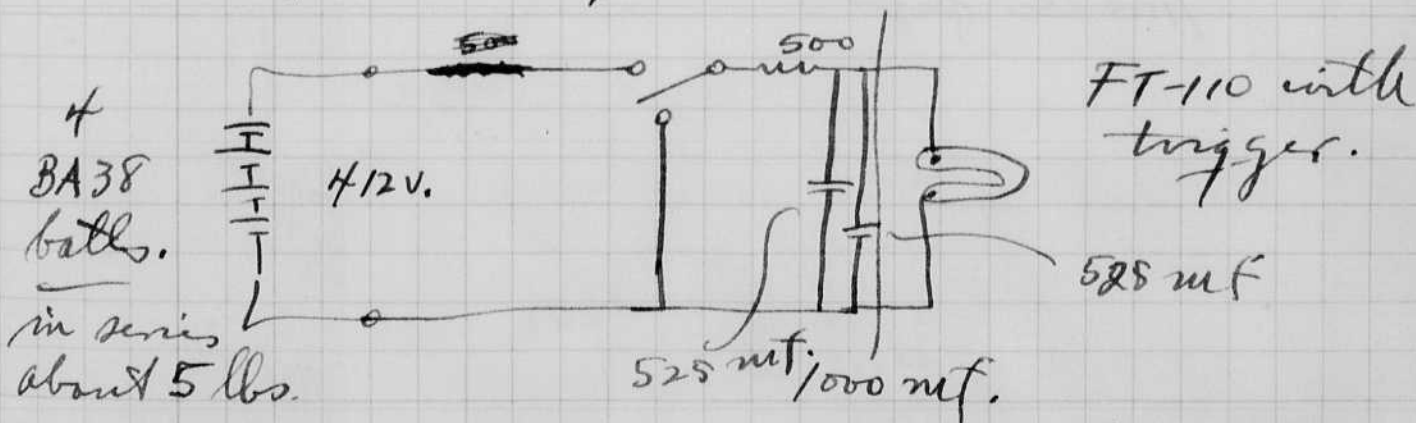
Conf. yesterday at M.I.T.

Bill Fritz. N.Y. Nat Carbon  
Bonin " " "  
Potter Cleveland,  
Chertok Sprague North Adams,  
Bernshausen  
Coggins Syracuse  
Barlow  
mills.

Battery operated flash units were discussed at length. Two designs were shown by N.C. Co. one had 450 V of 67.5 volt bats in series in a cedar box with 1000 + mf of electrolytic capacitors.

The other had 275 volts of 13 bats with a 6 volt Cal vibrator operated from 3 hearing aid bats. in a double circuit.

the output was 2400 beam a. p. s. The design for the combination compared to a 2800 for the Green part of our design with 1000 volts and a different capacitor combination.

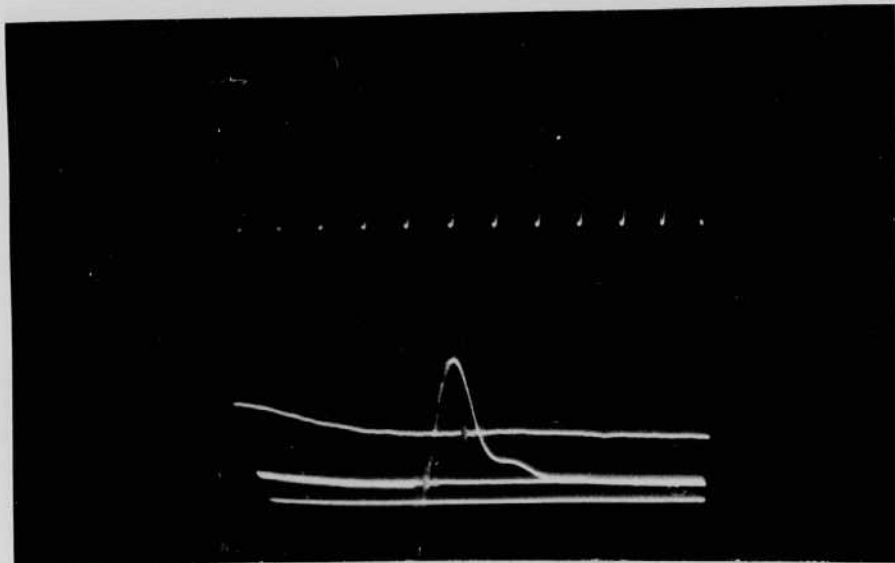
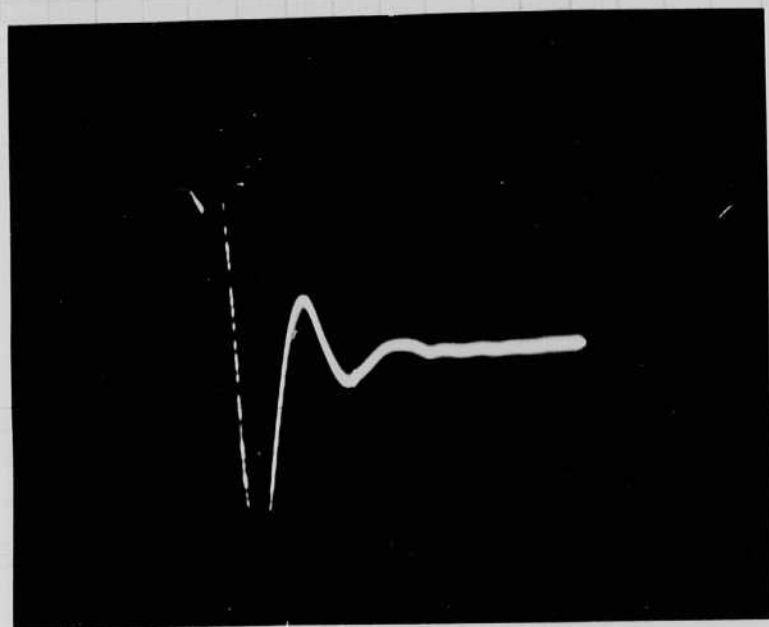


Draw about 0.2 ma per capacitor after over night with 400 volts.

Harold E Edgerton

Feb 14 1951

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shutterCapacitor  
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Feb 21 1951  
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53

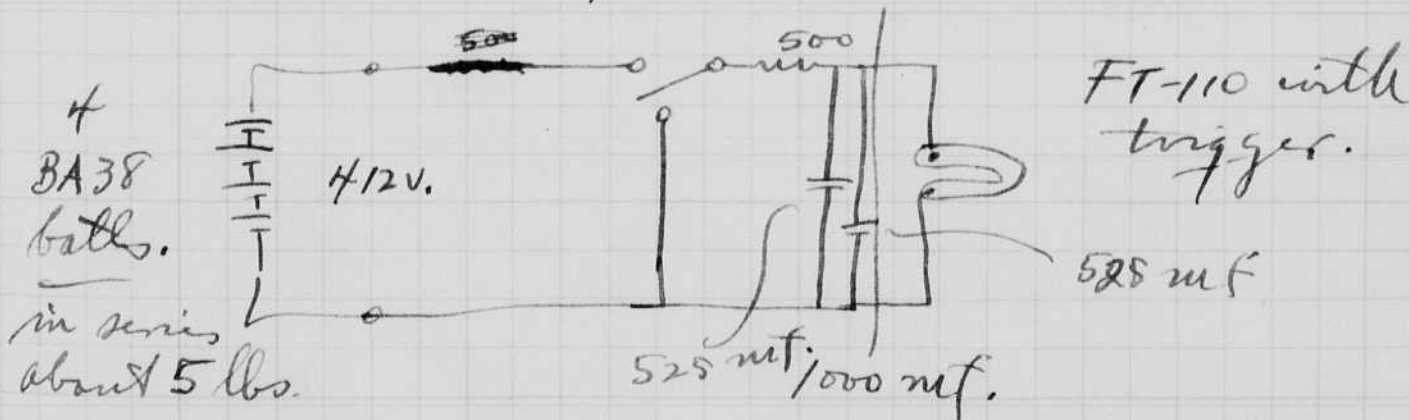
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From Univ. Conn.

| Verdet Constant       | Eastman special glasses. |        |        |        |
|-----------------------|--------------------------|--------|--------|--------|
| $\lambda$             | EK 11                    | 33     | 48     | 45     |
| $\lambda$ 436 m $\mu$ | .03441                   | .03158 | .02836 | .02606 |

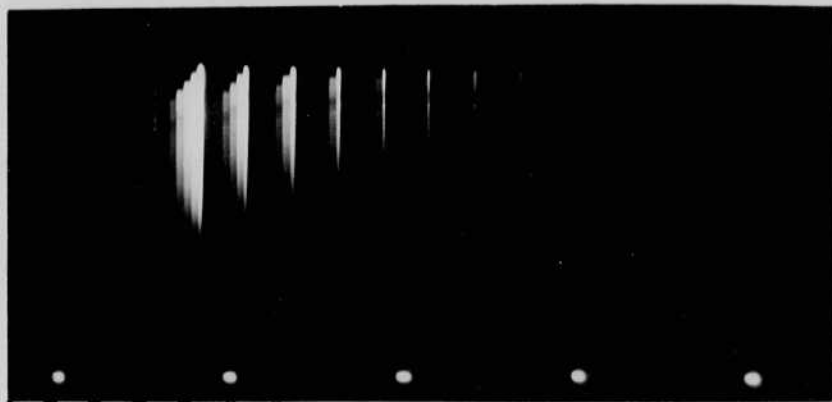
From  
Wakeley  
Dec 1 1949  
E.R. Co.  
Wakeley.

| melt no. | M-37945 | 33-2734 | X1710  | 45-15 HR |
|----------|---------|---------|--------|----------|
| $N_D$    | 1.6960  | 1.7555  | 1.8831 | 1.8186   |
| $v$      | 55.9    | 47.2    | 41.2   | 40.63.   |

Spectrum of FT110 taken at Eniwetok Green Flash

185 mf  
950 volts.

Red  
↓  
Blue



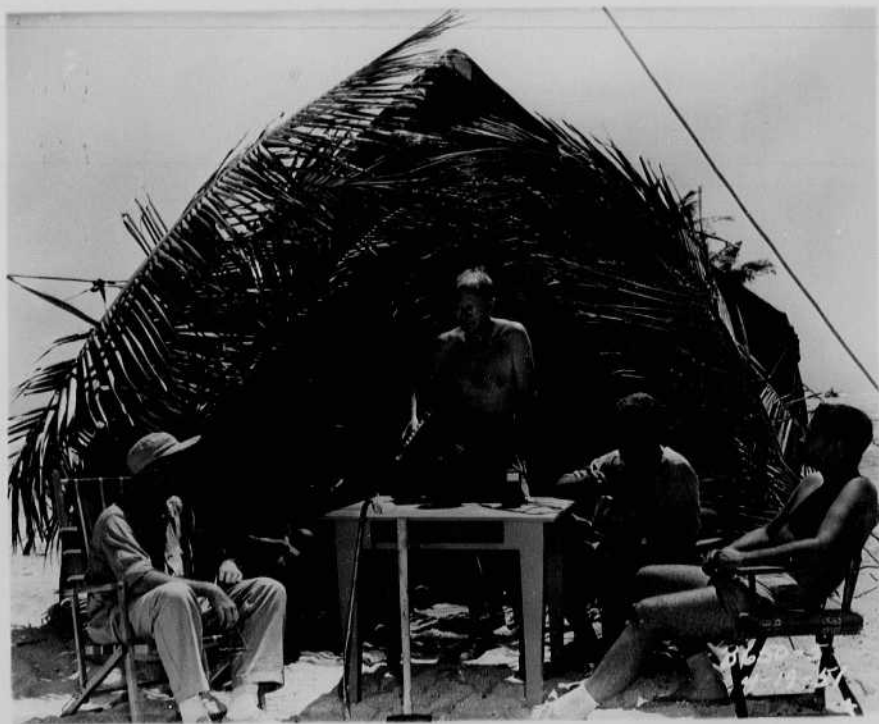
Note  
Spectrum  
at start  
is line.  
Then  
Continuum

Bokon Island  
Eniwetok.

Donald Tucker

Calwalker

Drake.



Edgerton

Morris

Carr.

June 5, 1951  
Harold E. Edgerton

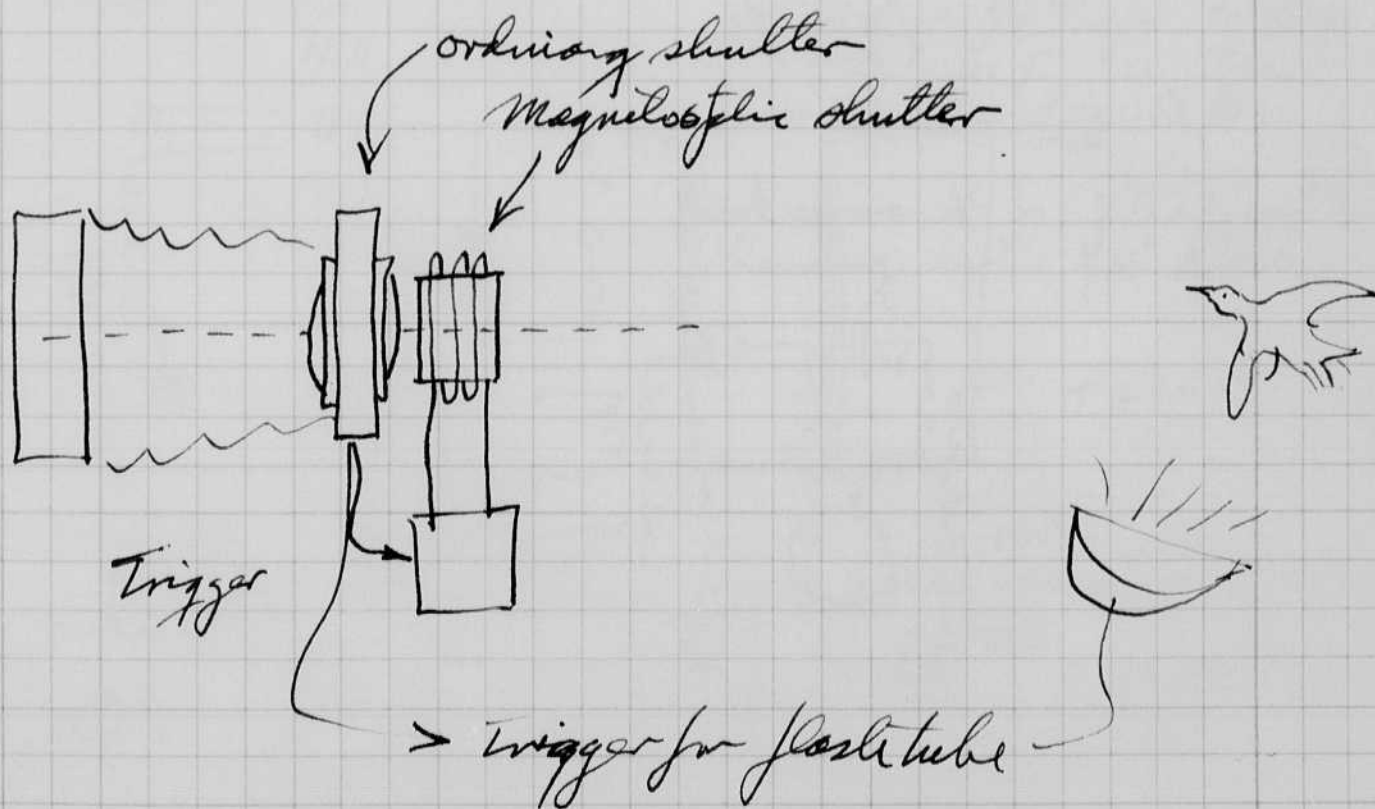
55

arrived in Boston at 2.25 P.M. on May 30 from Eniwetok atoll (Marshall Islands) including a 2 day stay in the Hawaiian Islands.

I was with a group from ESB. at Eniwetok at the request of the A.E.C. to do experiments. We were at that place about 3 months.

June 10, 1951, Herb Grier came in yesterday with his family from Honolulu. Left June 8. 19am Arrived June 9 at 2.25pm.

Shutter design. - The magneto optic shutter in combination with an ordinary between the lens shutter should be a rather useful device especially if there is synchronization. Sketch below shows a conventional shutter with X contacts (or delay tube) to fire a flash tube or an event. The contacts also will fire a circuit to start the magneto optic shutter.



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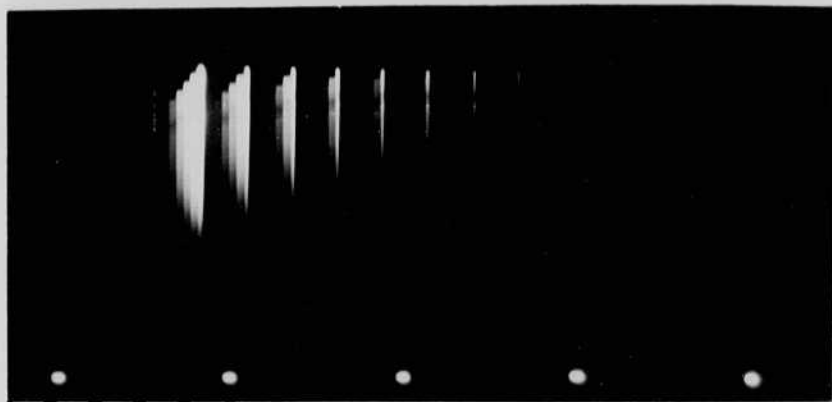
From  
W. Kealey  
Dec 1 1947  
E.R. Co.  
W. Kealey.

| melt no. | M-37945 | 33-2734 | X1710  | 45-15 HR |
|----------|---------|---------|--------|----------|
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June 5, 1951.

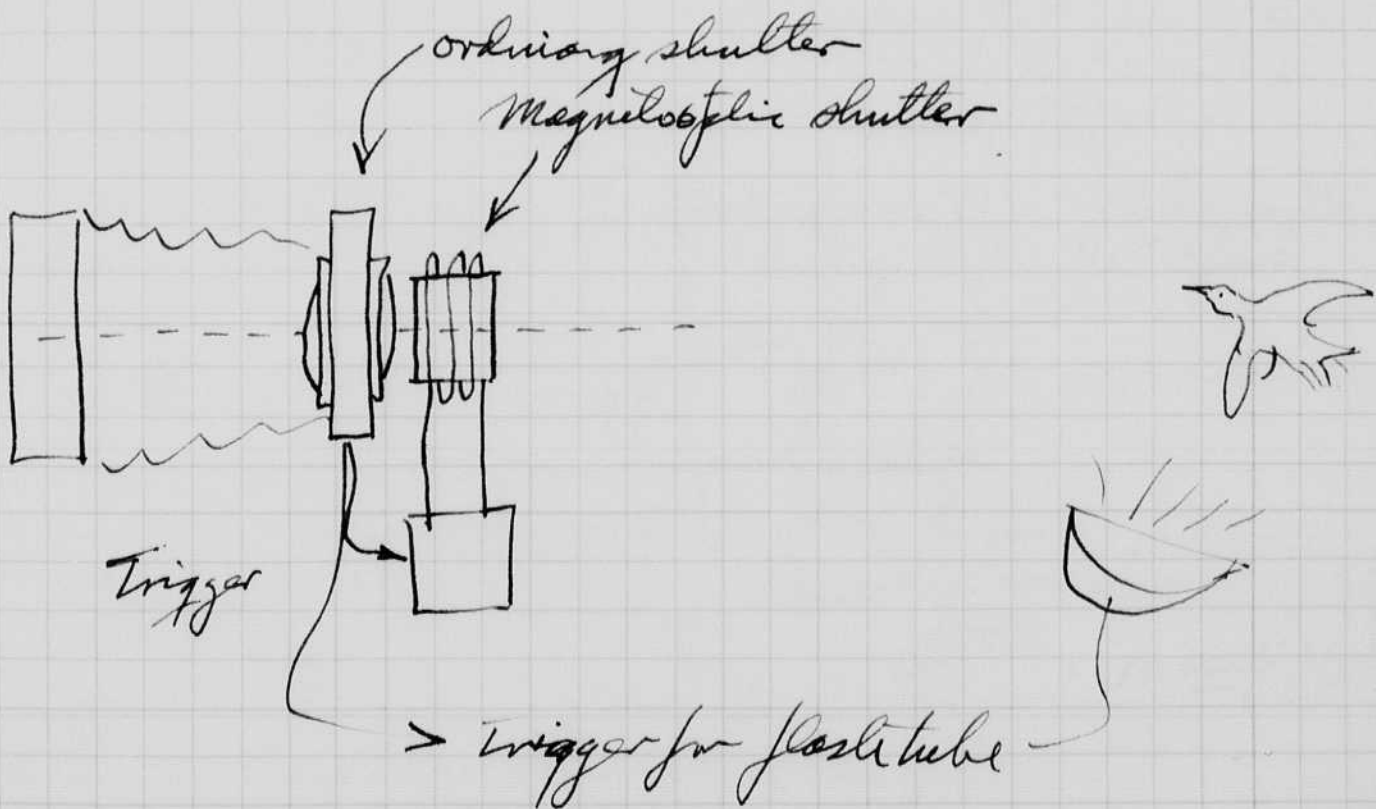
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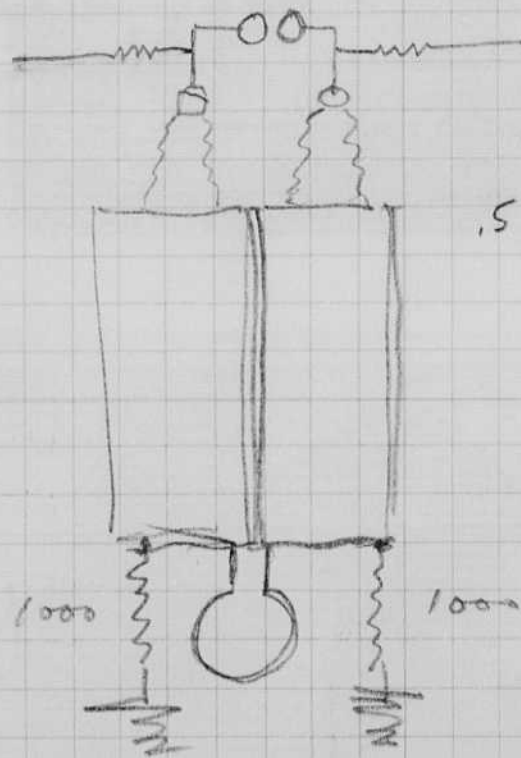
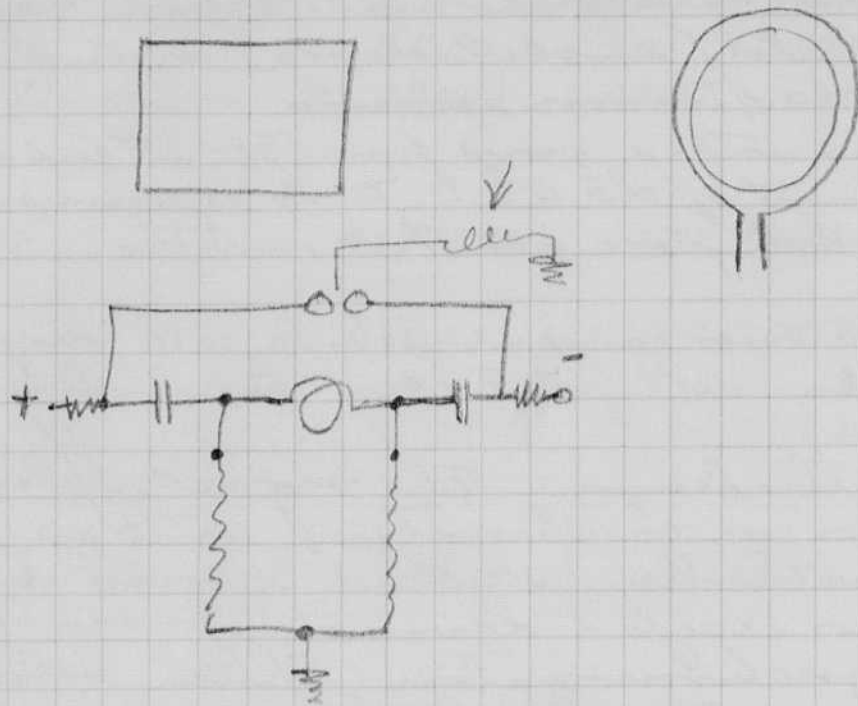
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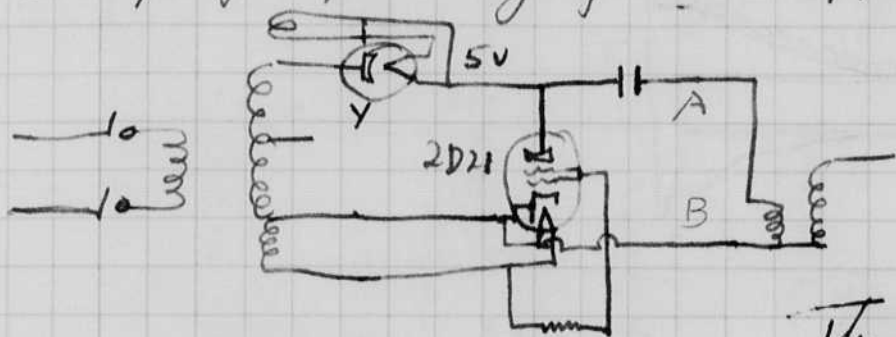
July 10, 1951.  
Harold E. Edgerton

Returned July 6 from trip to south.  
June 29 left Boston for Aberdeen with  
my son Bob and 4 Rafatroni cameras.

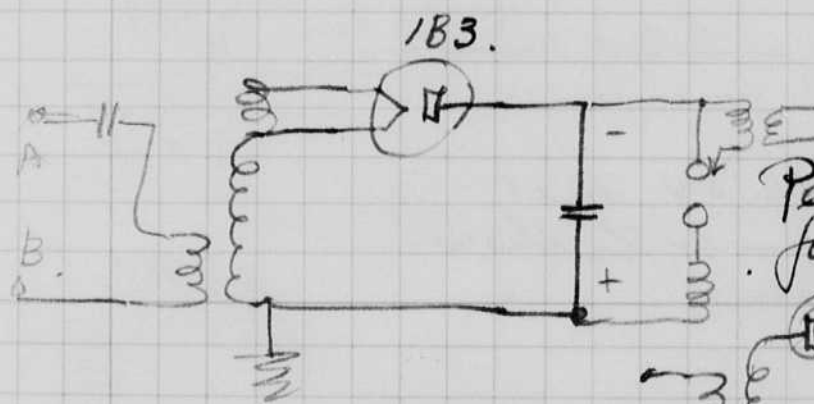
June 30 to Washington to visit Mary Ellen Pogue.

- July
- 1
  - 2 Aberdeen with Dr. Dewey & Sultanaff.
  - 3 " " " "
  - 4 Wilmington
  - 5 " " Visited Dupont and Hercules.
  - 6 New York - Parker and Photo Cow.

Design of high voltage power supply.

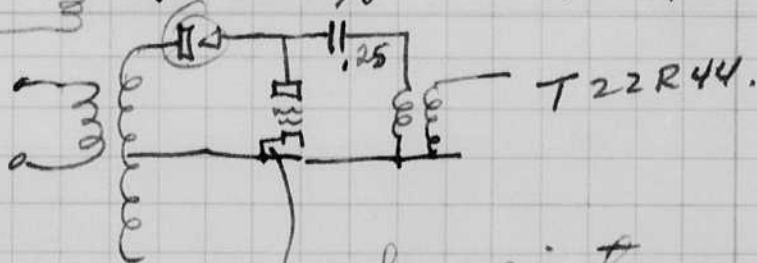


RCA 211T1 transformer  
makes noise when  
0.5 mF used.  
1/16" ~~gap~~ sparks ±.



Thordarson T22R44  
gave 1/2" spark with  
0.1 mF. with  
trans on 325v tap.

Peak current in 2021 with  
following det. 1/4" sparks.

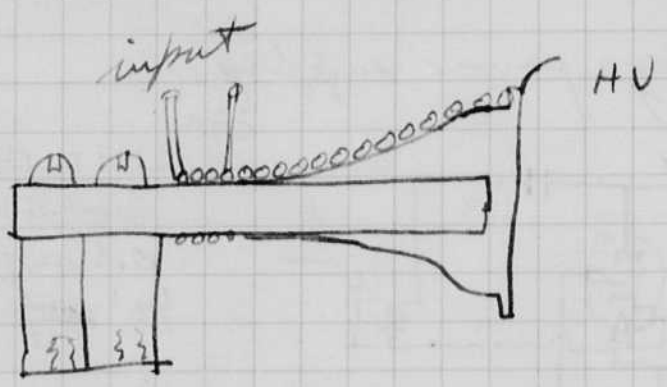
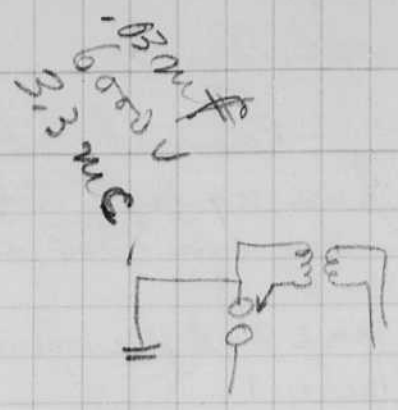
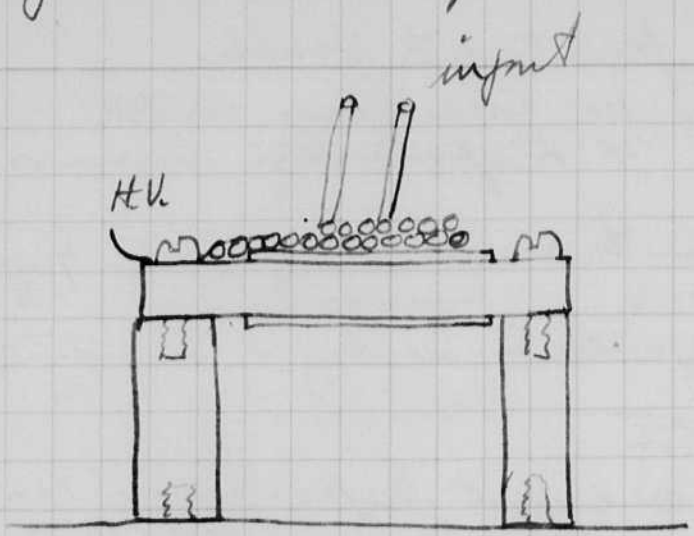


2 ohm resistor  
 $\frac{27 \text{ volts}}{2} = 13 \text{ amp peak.}$

JK -  
O +

58 MIT  
 July 10 1951  
 H. E. Elger

Spark Coil design



July 11, 1951.

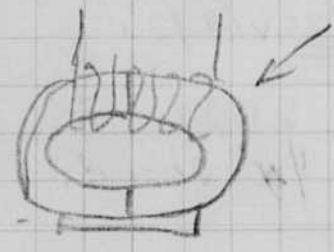
122 Rectifier

1B3

2-7 fil.

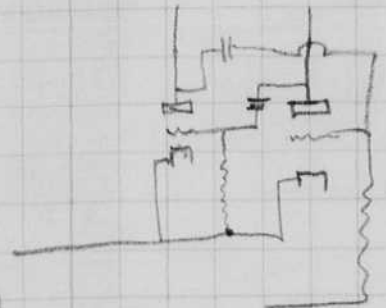
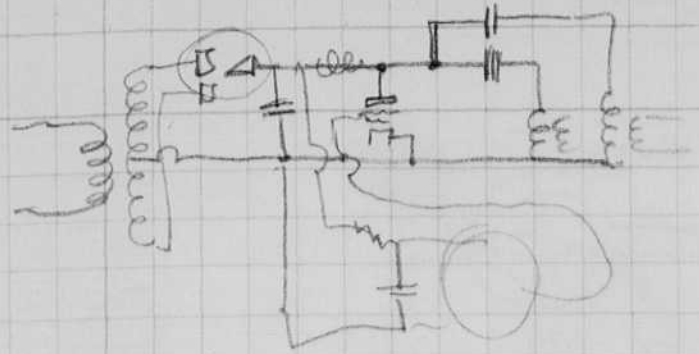
core test 10 turns #18 insulated wire on  
 5026 J coil core form

1.25V  
 0.2 amp



0.25 mf at 350 ± V. 2D21  
 present comments show  
 situation.

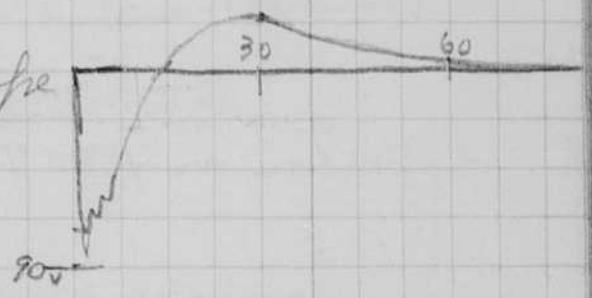
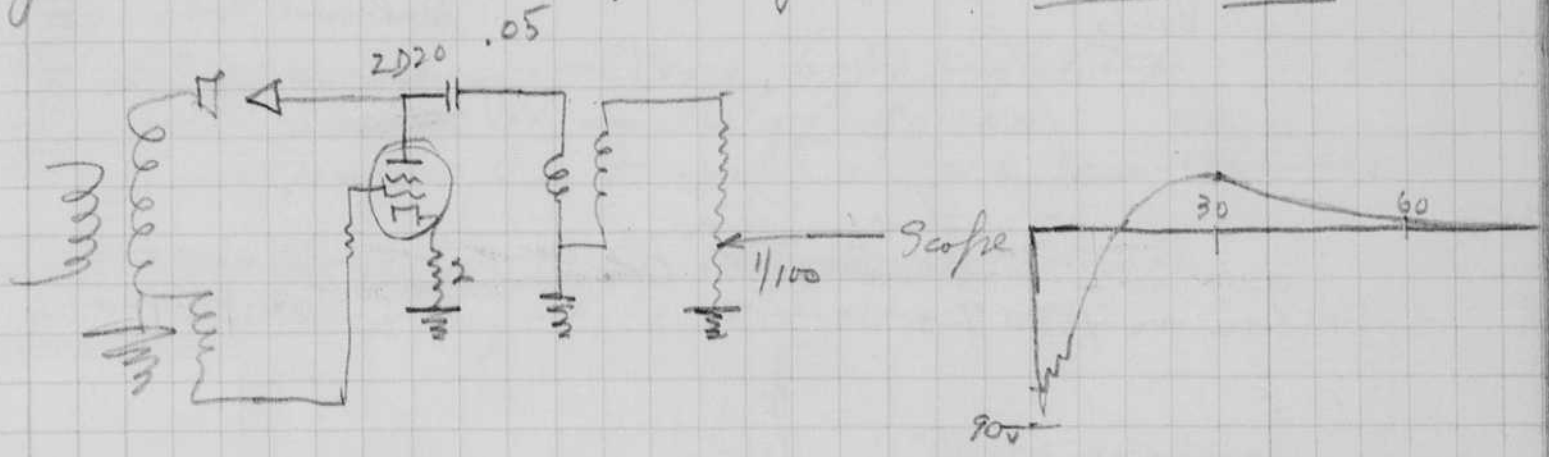
12AU7.  
u p.



July 12 1951

Driver for crystal,

10 uS driver





80  
July 13 1951

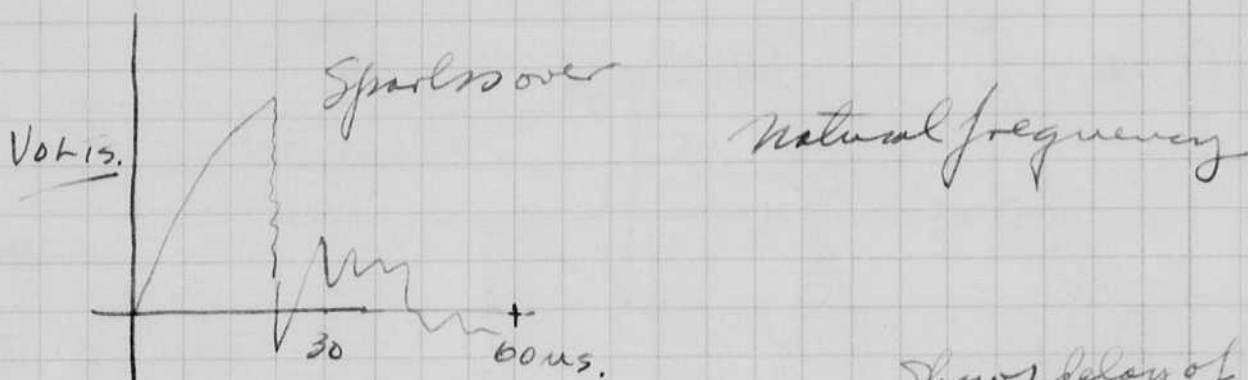
# Microflash General Radio.

test of Spark circuit

615 volts on FG-17 thyatron.

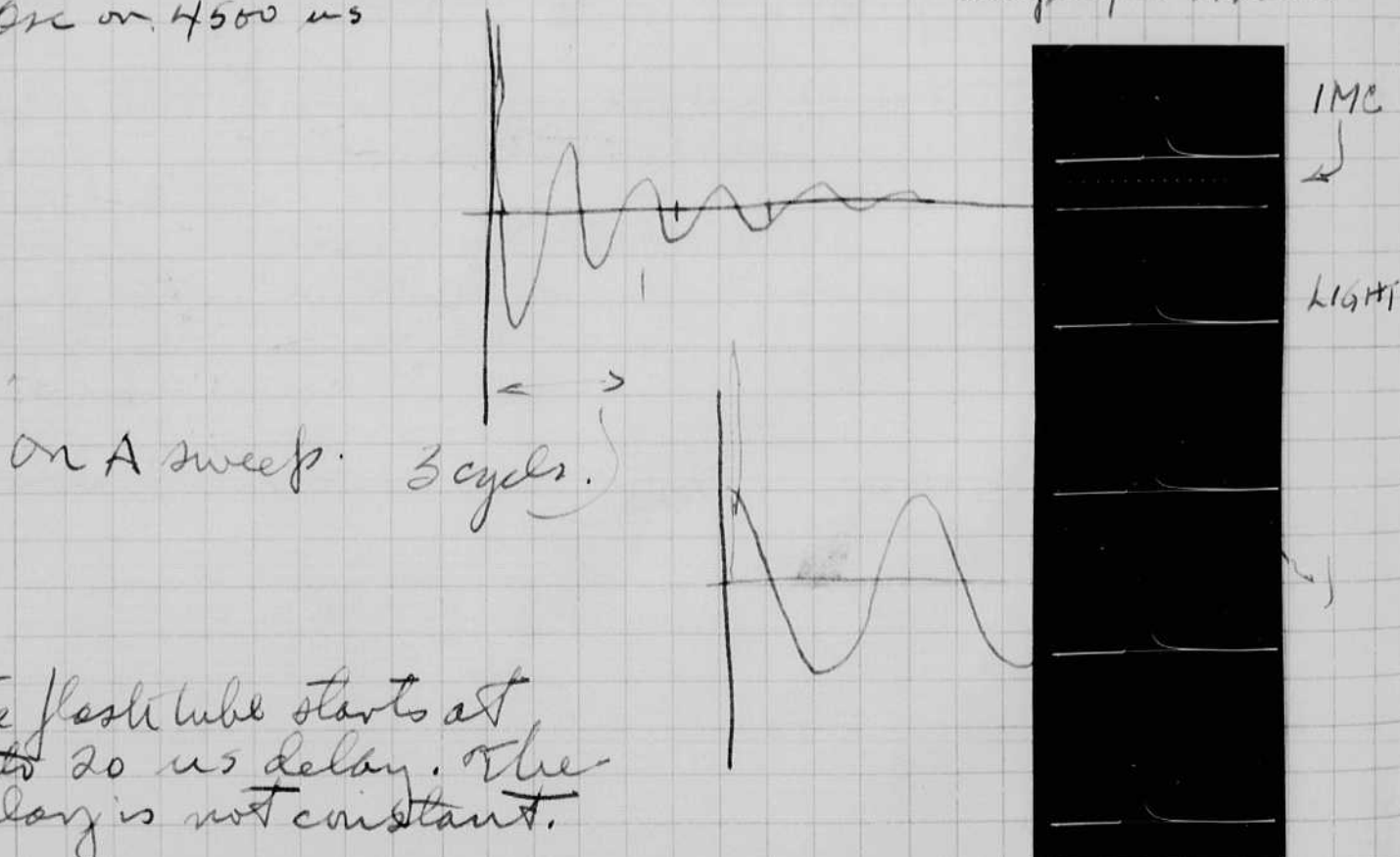
.15 mF into auto coil.

I first found the polarity of the surge to be negative on the high voltage side. This was reversed.



One on 4500  $\mu$ s

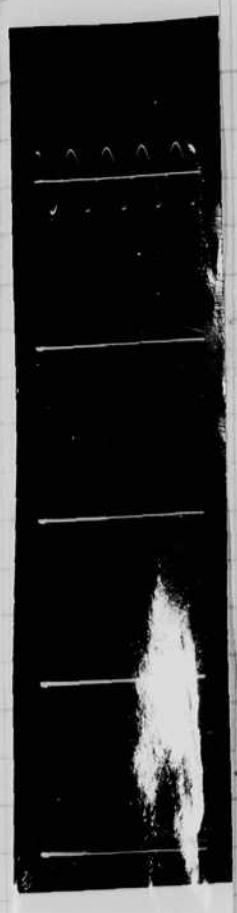
Shows delay of amplifier circuit



The flash tube starts at 5 to 20  $\mu$ s delay. The delay is not constant.

microflash





IMC.

Light

Grounded



LV



HV,

LV.

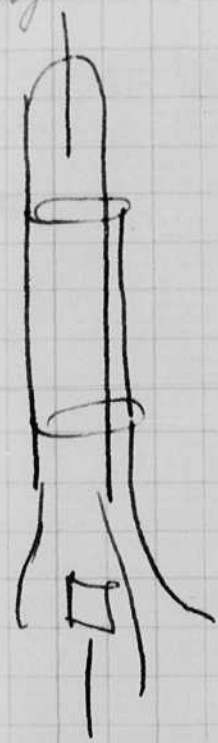
inside connection HV.

to spark  
pin or plug

the secondary voltage hops right up  
and has a 1/2 cycle of 30 us.  
First pulse is 4 with above connection.

Transformer designed  
by J. Strabala.  
R 3131 B13 Drawing  
Hypersil core 75-177-65  
40 turns #30 Jomivar  
600 " #38 Jomivar.  
Good for 30 KV.

microflash. Microflash tube starts in 10 or 2 us  
and light lasts 10 or 2 us.



Sparks.

Oscilloscopes were taken of the light  
output on the 25 KV Scope.

July 14.

Some misses  
were experienced  
the capacitor C-2  
was increased  
by 0.125 mfd.  
operation then ok.

July 23. This extra  
cap was removed  
when a 2D 21  
thyristor was used in place of the FG17

July 13 1951

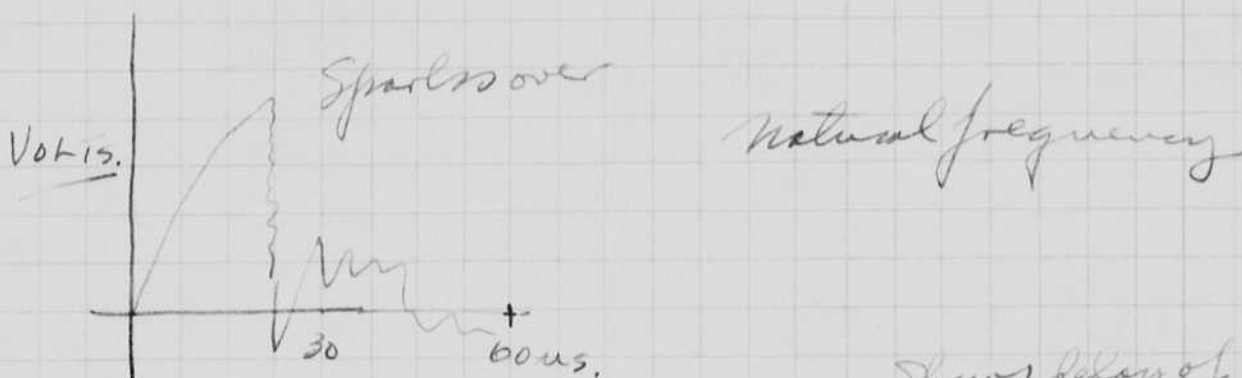
Microflash General Radio.

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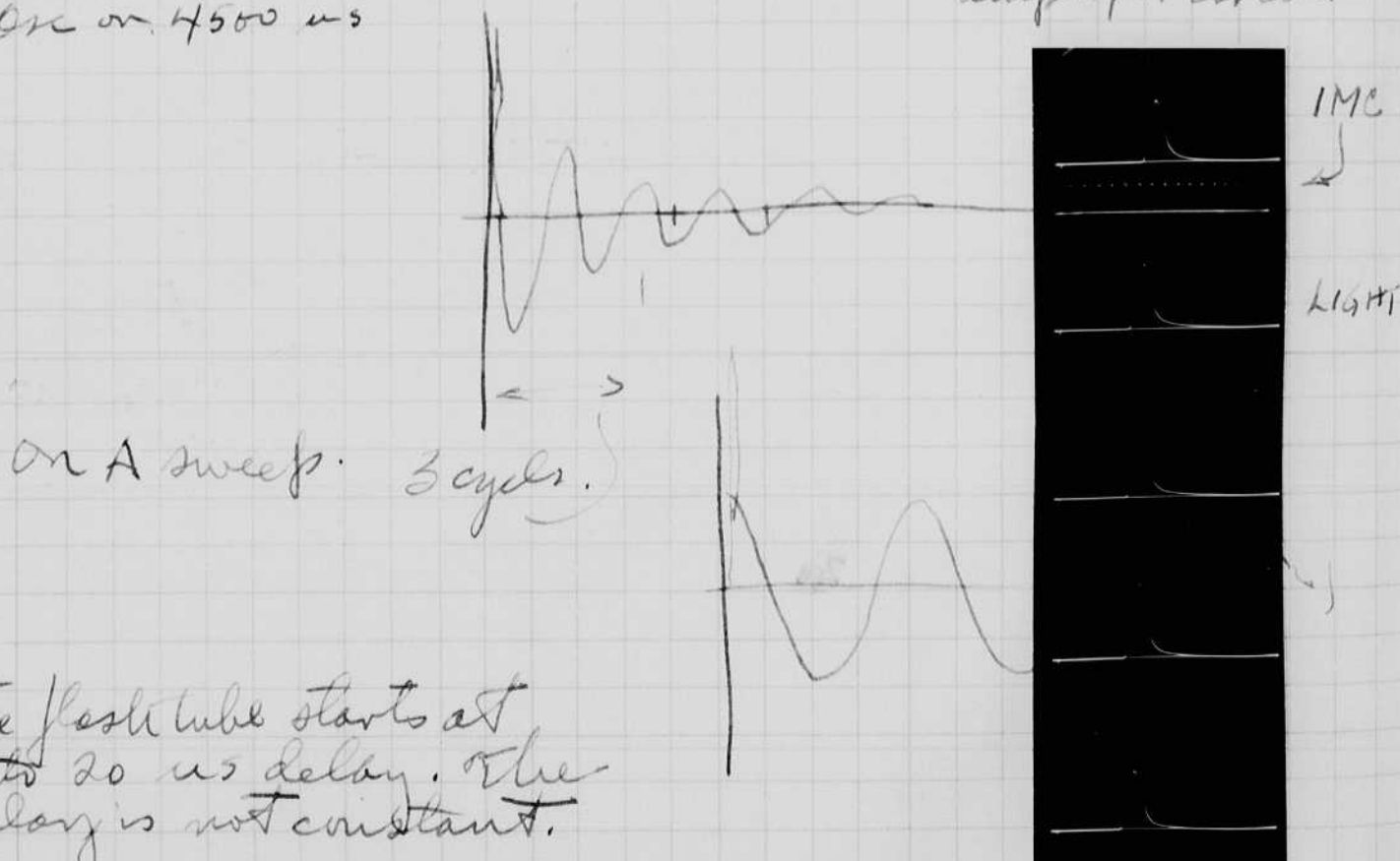
15 mH into auto coil.

I first found the polarity of the surge to be negative on the high voltage side. This was reversed.



osc on 4500 us

Shows delay of amplifier circuit



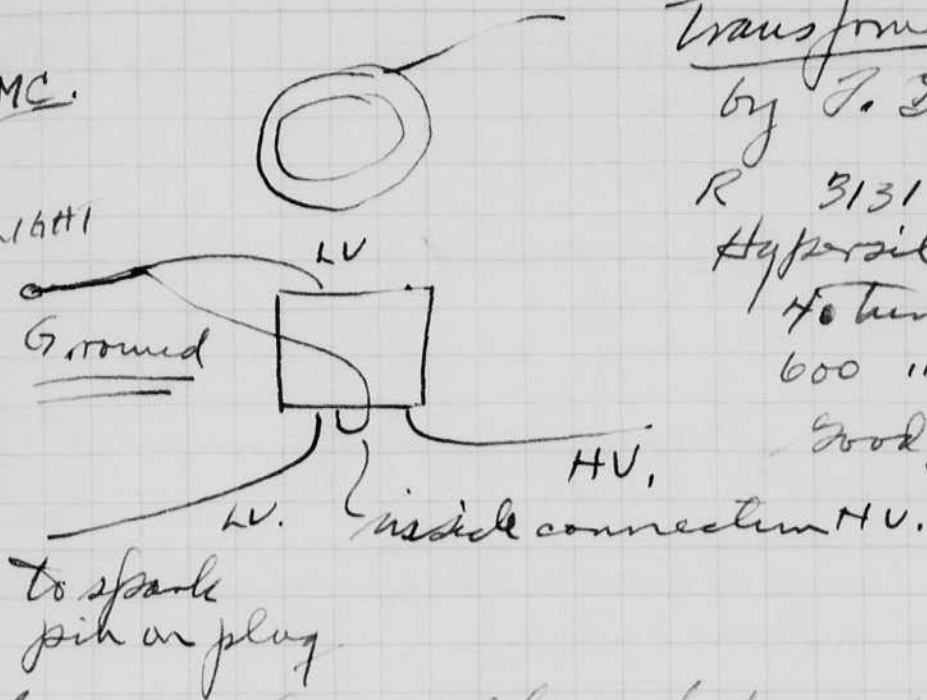
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delay is not constant.

microflash

IMC.

LIGHT

Grounded



Transformer designed  
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R 3131 B13 Drawing  
Hypersil core 75-177-65  
40 turns #30 Formvar  
600 " #38 Formvar.  
Good for 30 KV.

the secondary voltage hops right up  
and has a  $1/2$  cycle of 30  $\mu$ s.  
First pulse is  $\dagger$  with above connection.

microflash. Microflash tube starts in 10 or 2  $\mu$ s  
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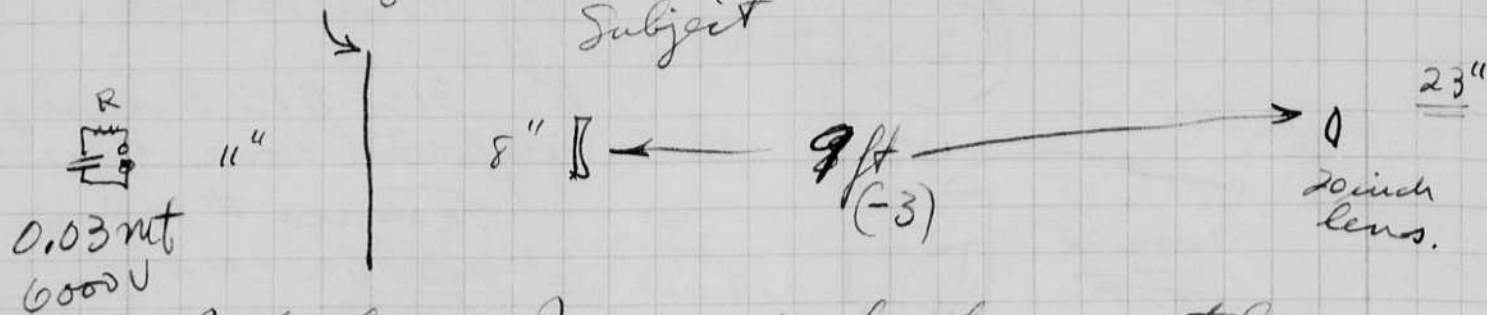
July 23. This extra  
cap was removed  
when a 2D 21  
thyristor was used in place of the FB17

Silhouette tests.

Al Egerton  
Bob Egerton  
John Mills.

8" Square Ektalite Inconel lens.

Subject



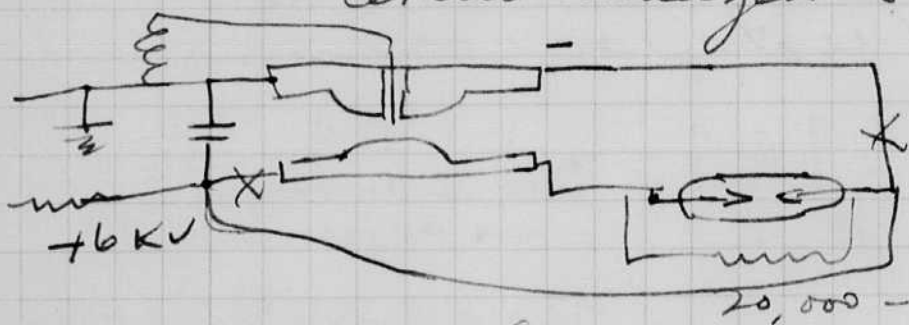
3.9 mc. Important. Image of spark must lay across input to lens.

at f32 Image covers entire lens adequately on Panthro Press Film.

actual 7500 as used on test.

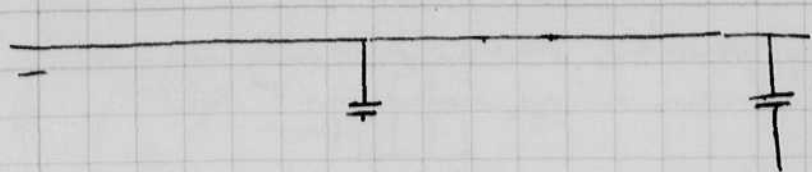
Difficulty in reducing time delay in an air gap.

Circuit changed to series gaps.

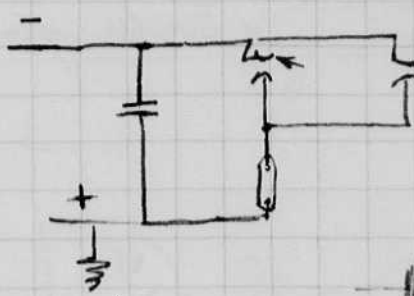
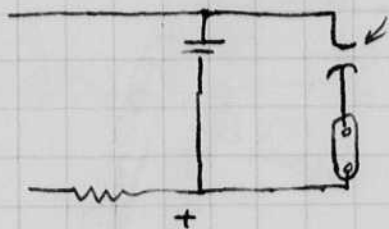


osc. taken of.  
one mc. timing  
voltage.  
light. 3 curves.



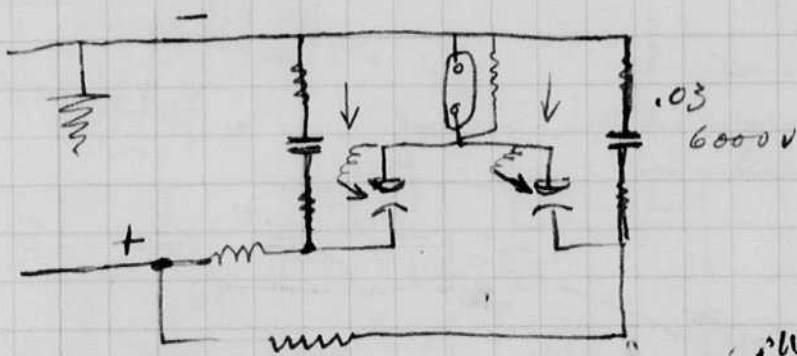


mode 1  
1000 ft/sec  
1 ft  $\frac{1}{1000}$  sec. 1000  $\mu$ s



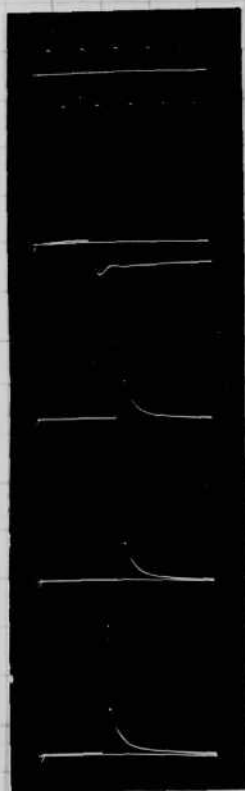
$\frac{1}{10}$  ft. 100  $\mu$ s  
mode 5  
 $\frac{5}{10}$  ft. 100  $\mu$ s  
6 inches.

or 2" in 30  $\mu$ s.



1  $\mu$ s!

#6 Dynamite caps.  
8" square Ekkalite lens.



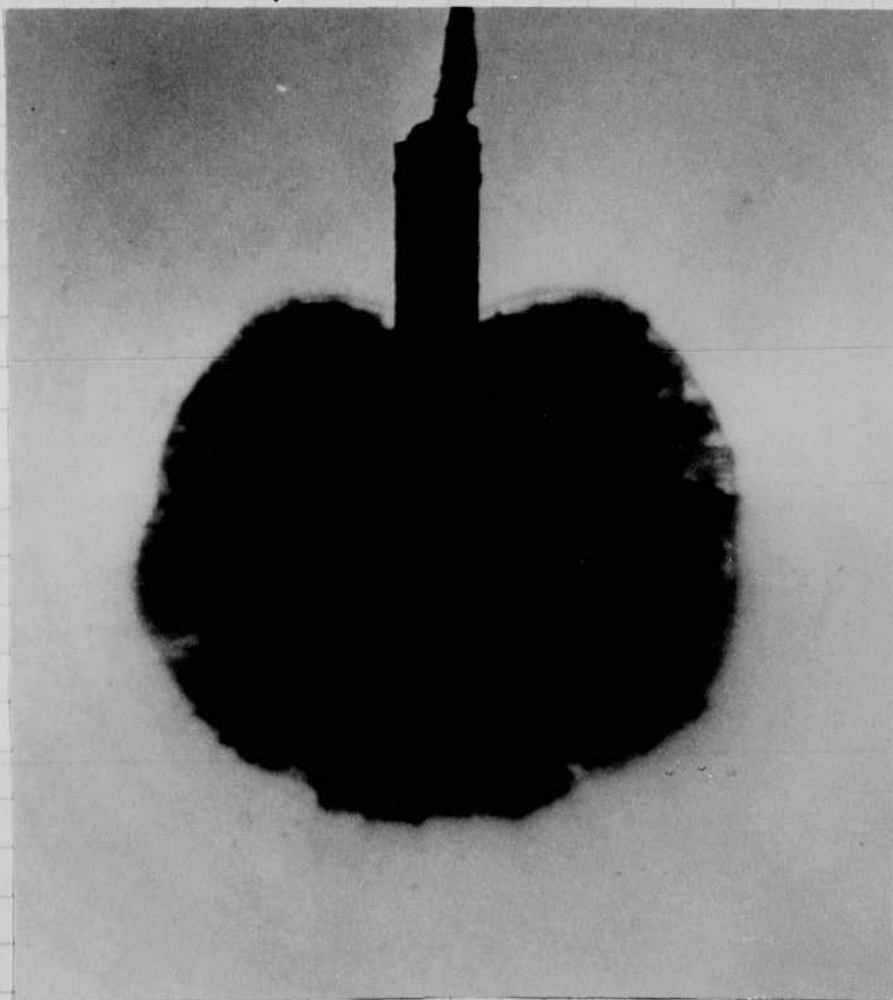
1 MC.

VOLTAGE

LIGHT

"

"



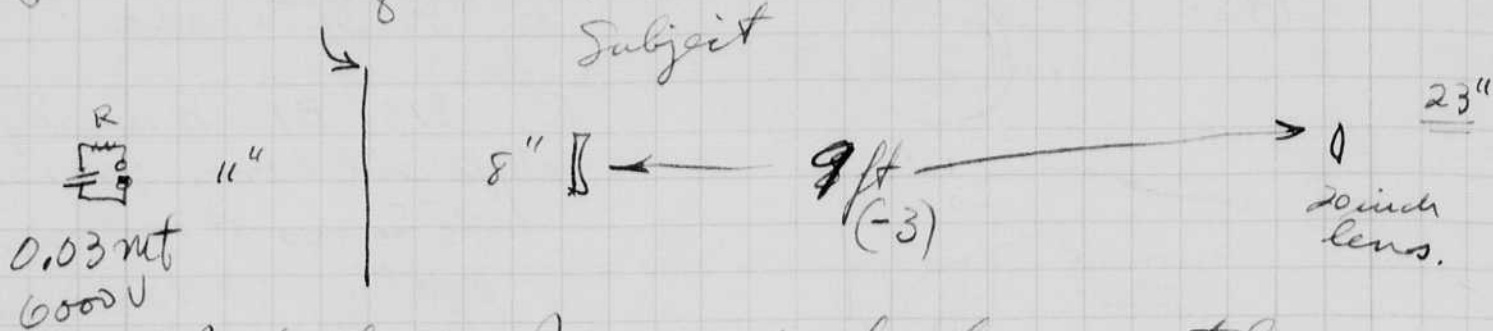
argon gap FT 130  
.03 at 7000 volts.  
f45 20 inch lens.



Silhouette tests.

Bob Edgerton  
John Mills.

8" Square Ektalite Inconel lens.



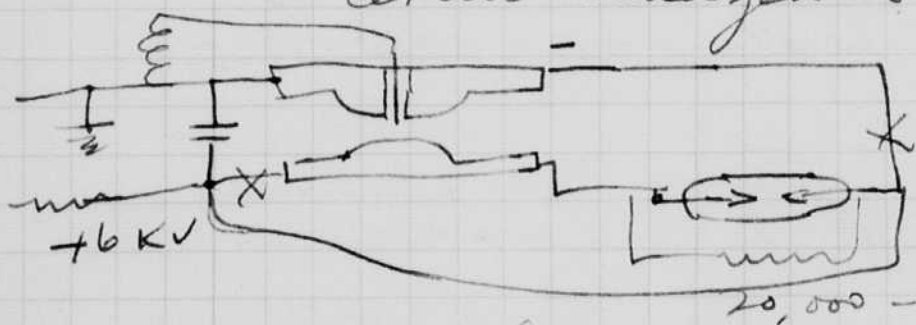
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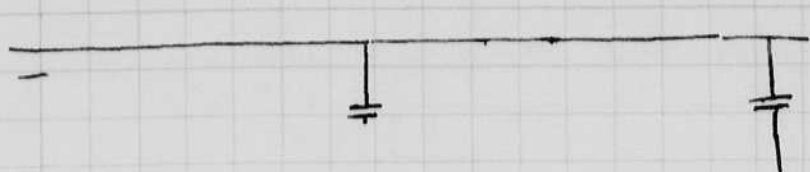
actual 7500 as used on test

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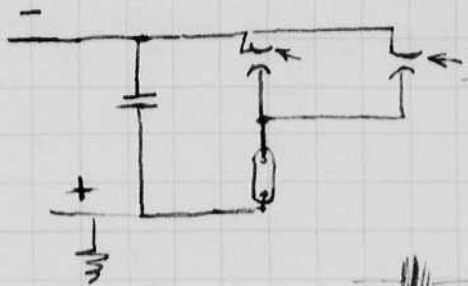
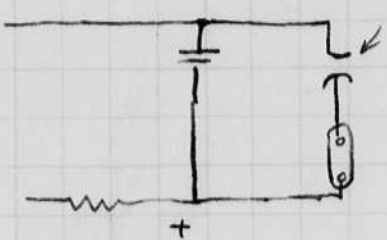
Circuit changed to series gap.



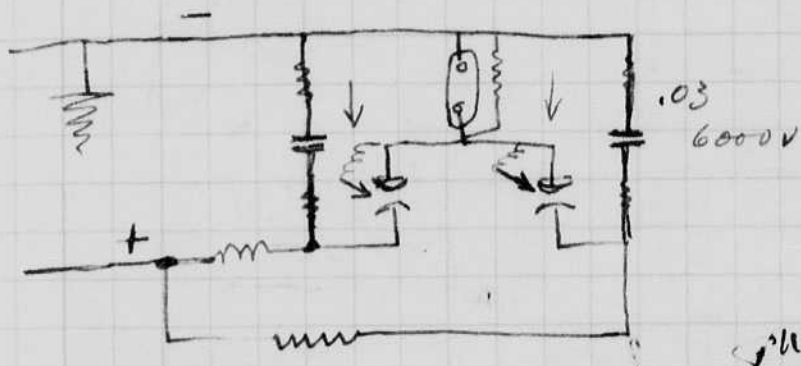
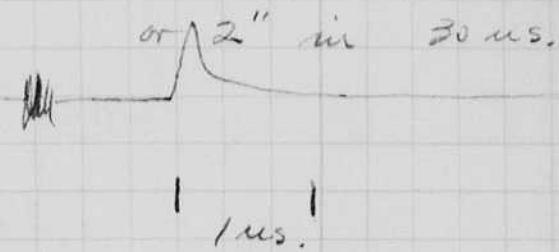
osc. taken of.  
one mc. timing  
voltage.  
light. 3 curves.



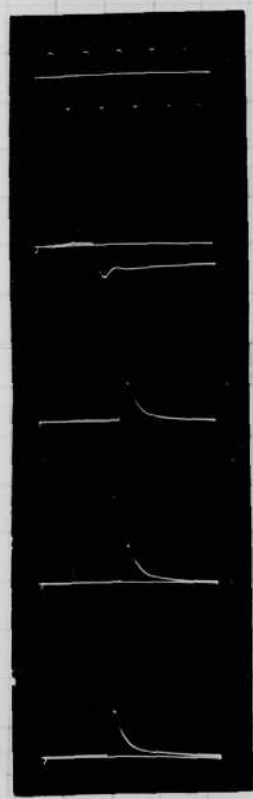
made 1  
1000 ft/sec  
1 ft  $\frac{1}{1000}$  sec. 1000  $\mu$ s



$\frac{1}{10}$  ft. 100  $\mu$ s  
made 5  
 $\frac{5}{10}$  ft. 100  $\mu$ s  
6 inches.



#6 Dynamite caps.  
8" Square Eklatis lens.



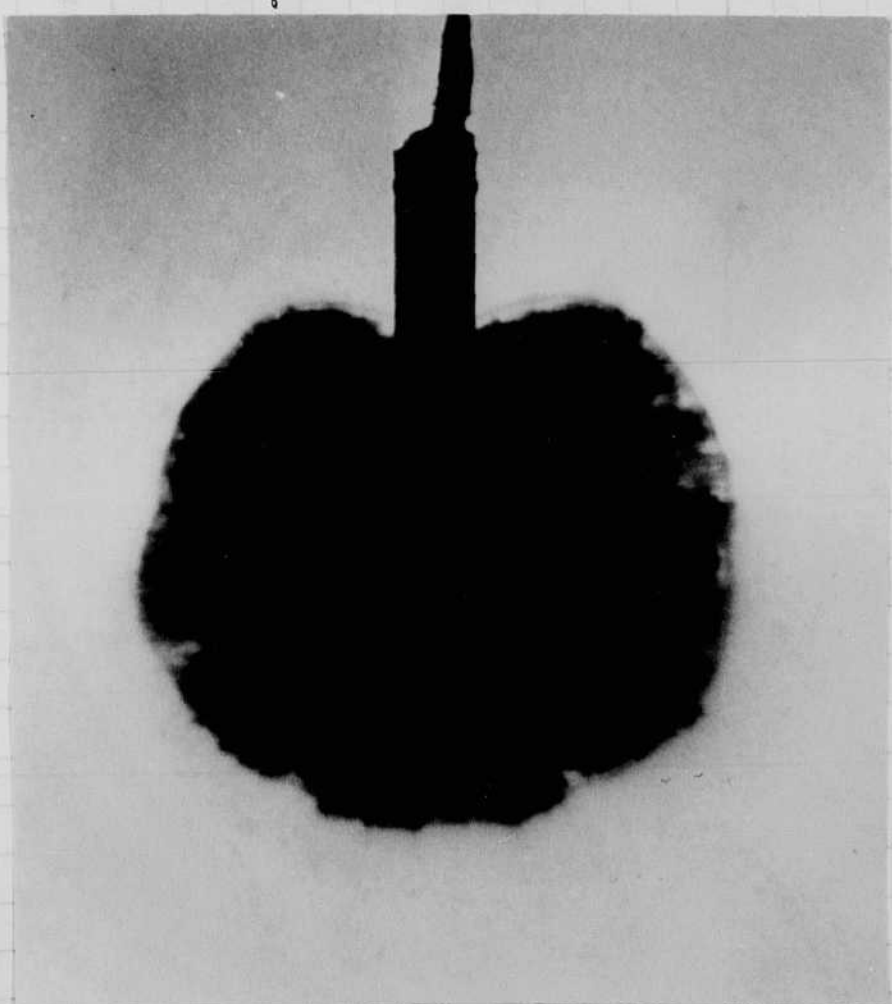
1 Mc.

VOLTAGE

LIGHT

"

"

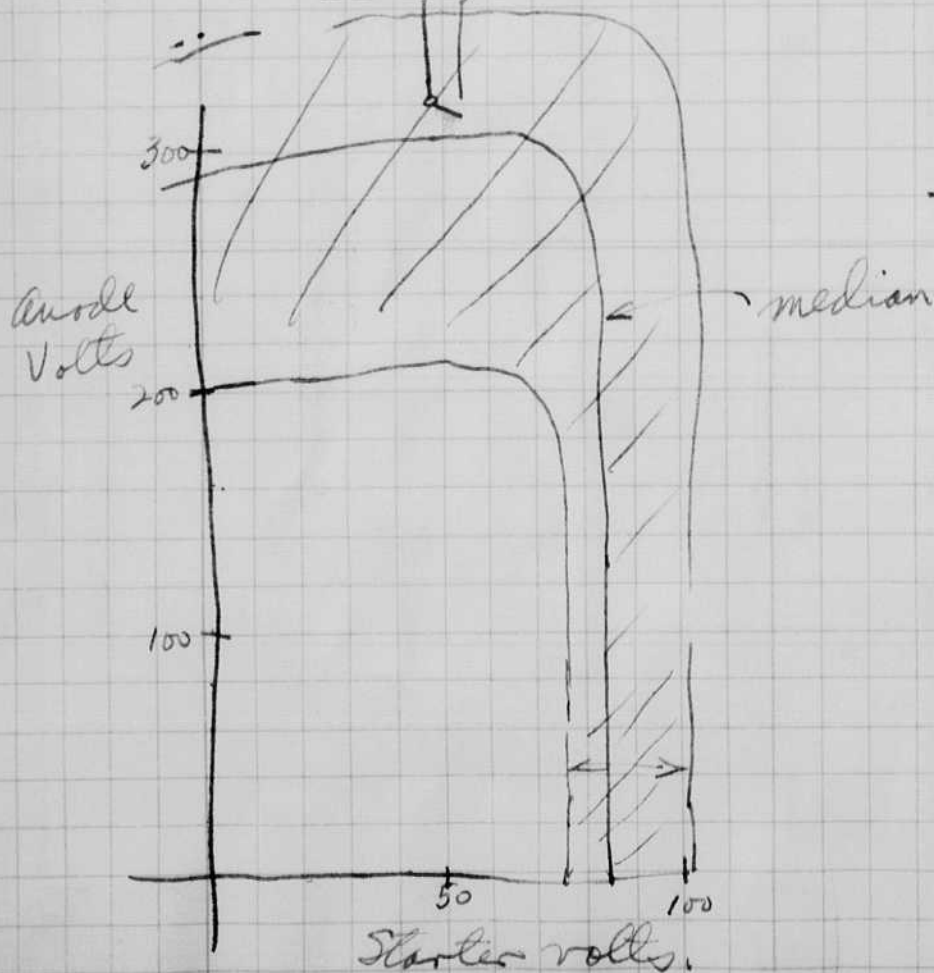
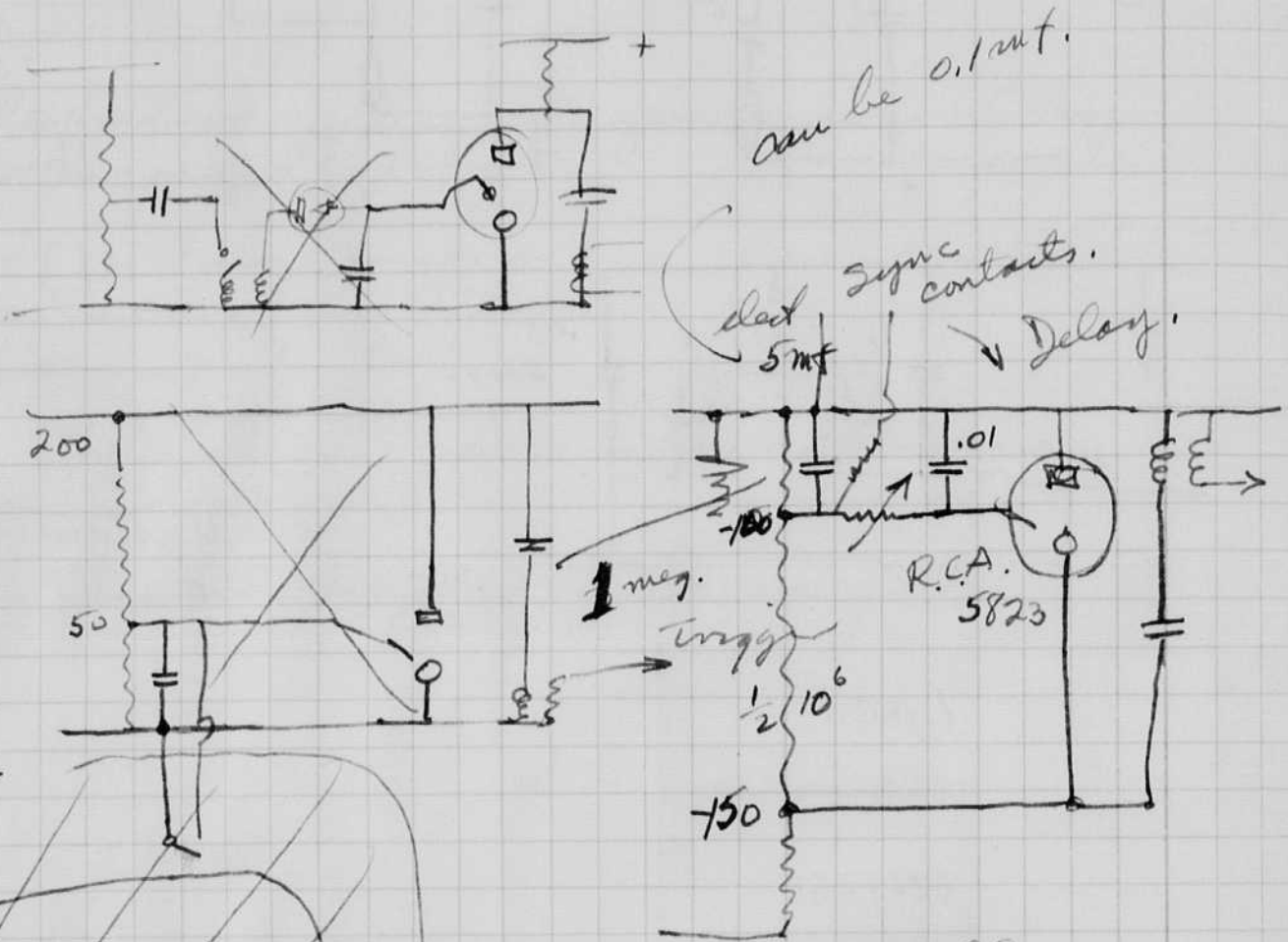


Argon gas FI 130  
.03 at 7000 volts.  
f45 20 inch lens.

July 18 1950  
Harold S. Edgerton.

Since Monday Mills, Mac Roberts and my son, Bob, have been clearing out the laboratory.

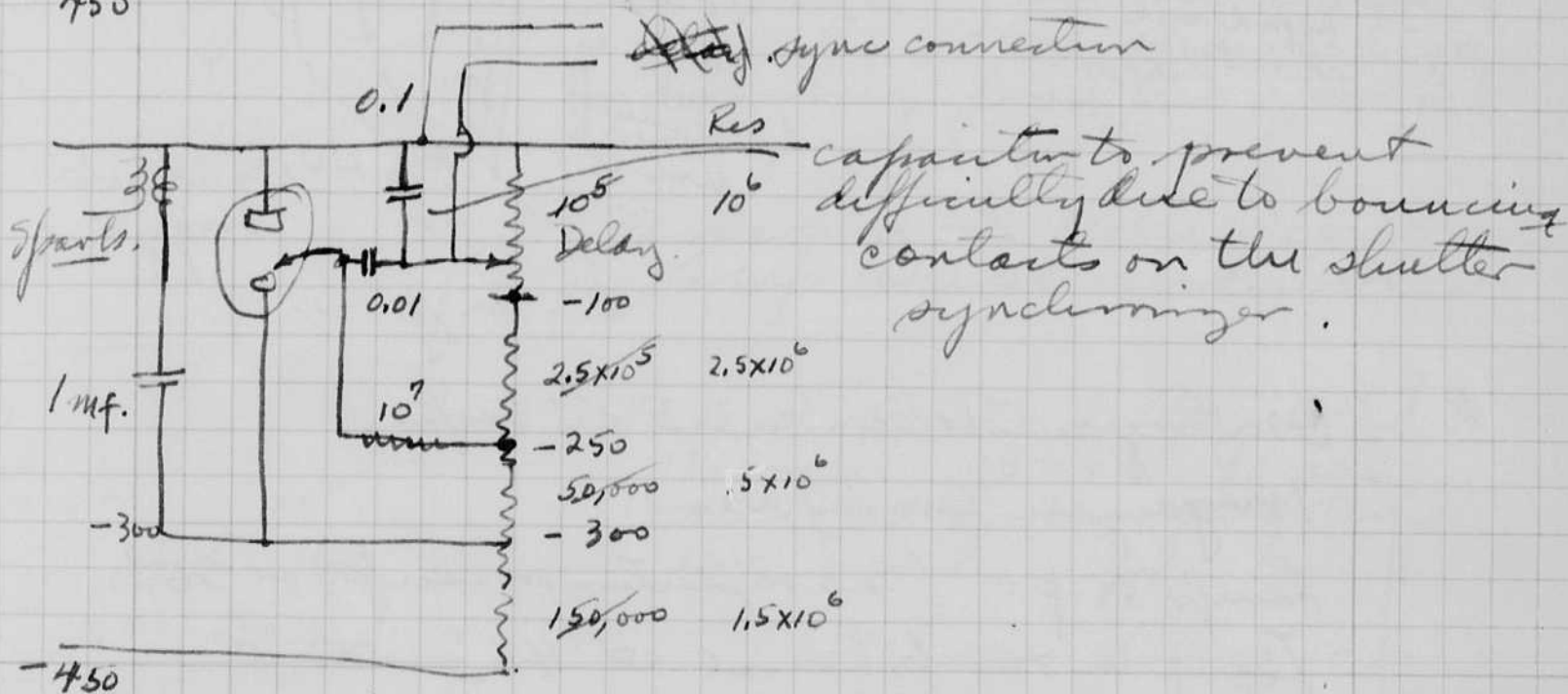
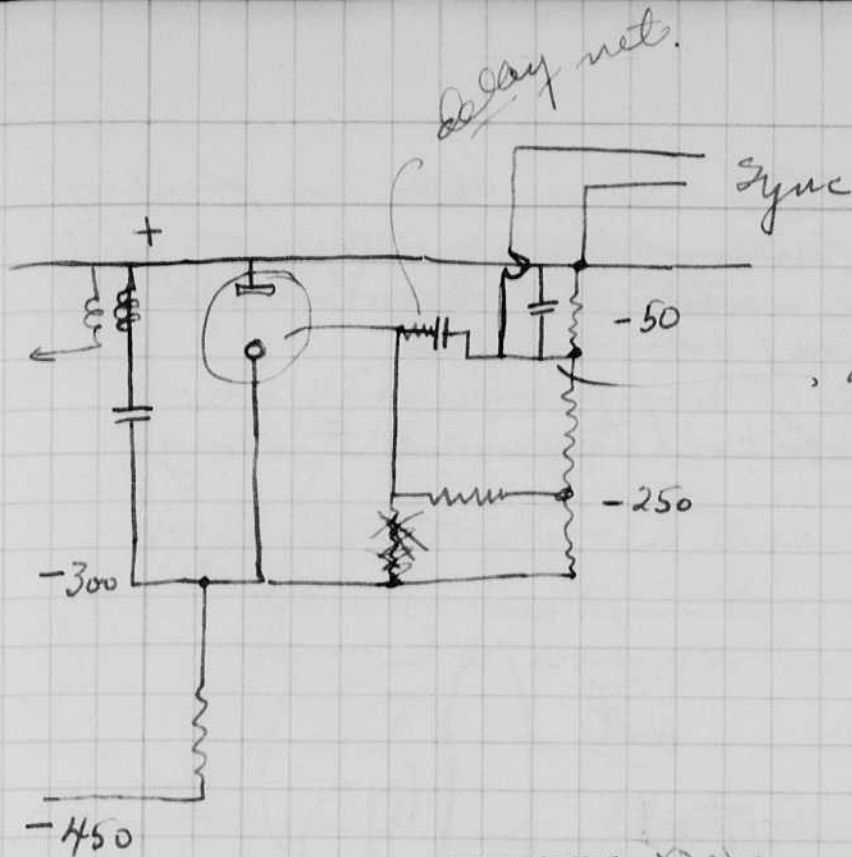
Delay circuit with glow trigger tube.



$$RC \cong \text{delay}$$

$$= .020 \text{ sec}$$

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



This tube does not go into an arc easily since the cathode area is so large. I plan to try the reverse operation where the spot will form on the small electrode.

Tried later. still goes into a glow.

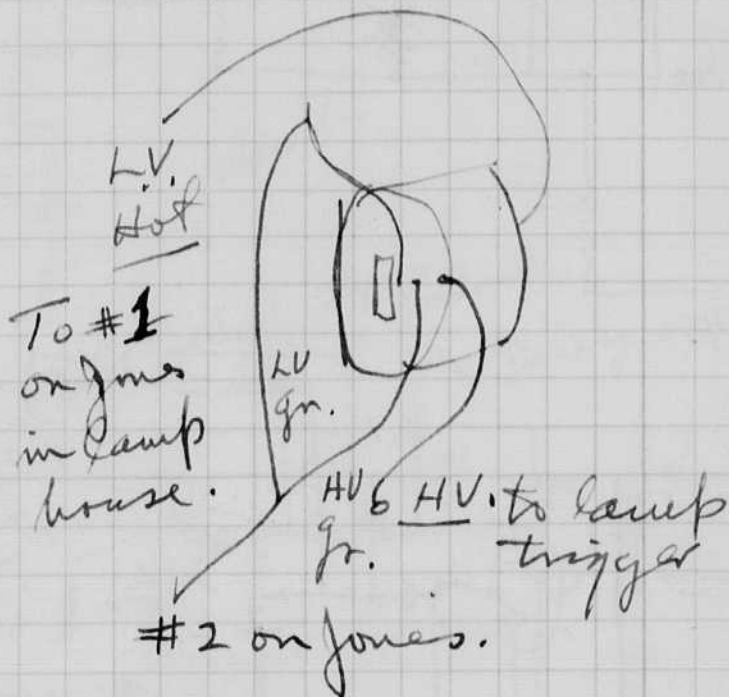
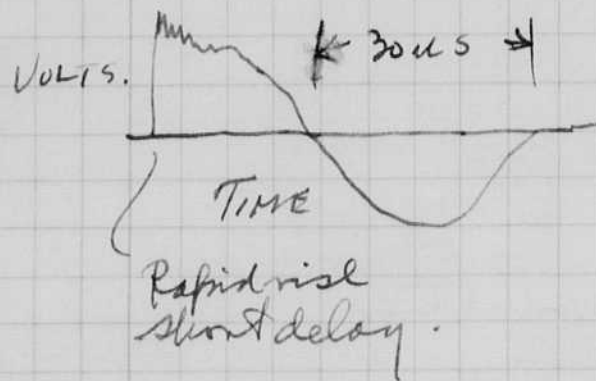


July 21 1951

A. S. Edgerton

Mac Roberts installed a 2D21 in place of the FG-17 in the microsecond unit. Operation was ok with the newton spark coil using a .5 m $\mu$ f condenser.

Reconnected spark coil to give a + surge



#1 Oscillogram taken on 25 KV scope.

1 megacycle timing wave.

Lamp to p.c. (no reflector or lamp) = 26"

Lamp in Lamp house at 45 1/2 inch p.c.



#2 Oscillogram also taken of spark voltage.

|        |         |               |
|--------|---------|---------------|
| Lamp 1 | + flash | Reflector off |
| 2      | "       | (one miss)    |
| 3      | "       |               |

all to show delay



The microflash apparatus was now assembled with the reflector. Firing now is more consistent?

Lamp house removed to 5 ft from P.C.  
X10 filter used over P.C.

Reflector factor is then about  $\left(\frac{5}{2}\right)^2 \times 10 = 62.5$   
actually less than this since the  
lens lamp was partially turned.

2.5-  
2.5-  
125-  
50

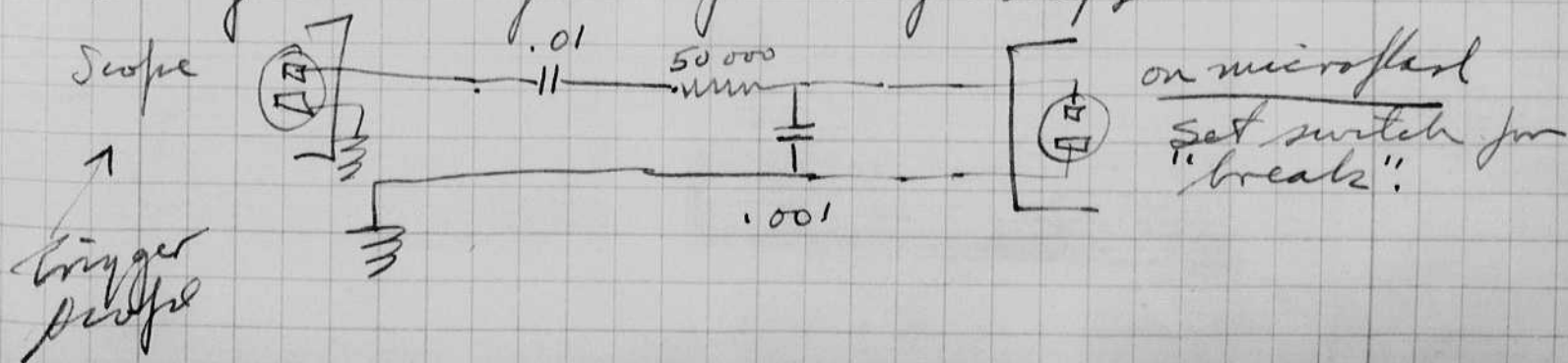
- #3 Oscilloscope.
1. ~~Part~~ Drop in anode wire to ground. (also shows high frequency from the spark coil.)
  2. Variation in delay with lamp house assembled.

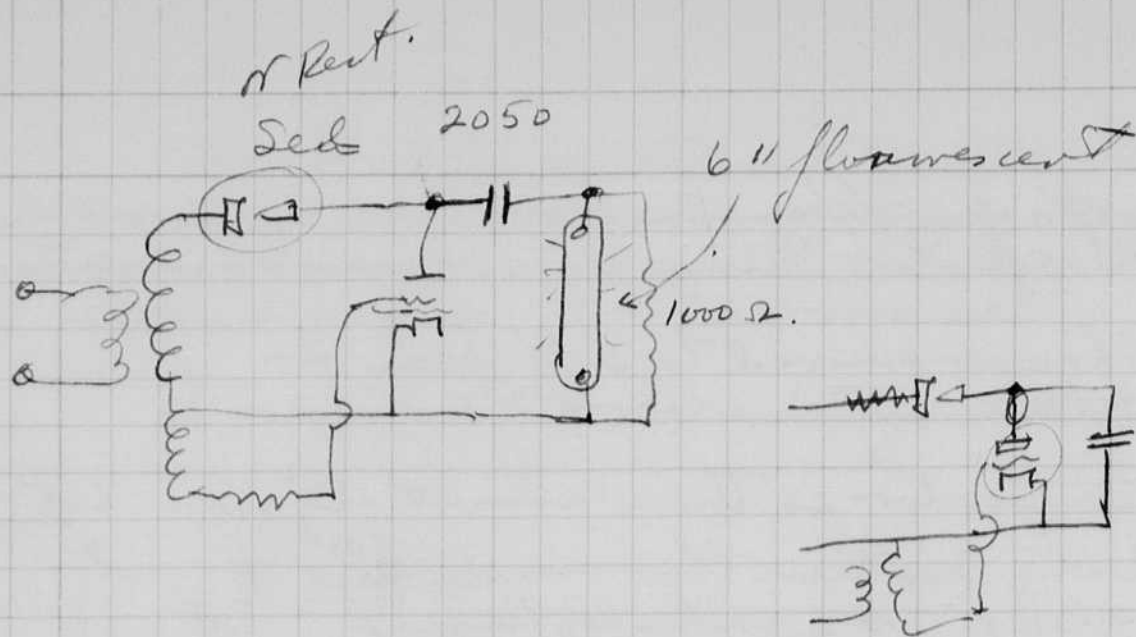
3. Variation in delay when  $\frac{1}{2}$  mm 15 sec 10 sec and 5 sec. charging time are used.

(note one shows 10 sec missing, 5 sec has delay but high peak probably due to arc shifting.)

#3  
calib.  
FT-220  
554mf  
2000 V.  
2 mfd 3500  
1 mfd 3500  
" 3000  
" 2500  
2 records.  
4 ft p.c. to  
Lamp.

Delay into microflash from scope trigger





Calibration

#3  
 FI-220 with 5 mt at 2500 volts  
 has peak out put of about  $10^7$  C.P.  
 with p.c. 4 ft from the FI-220.

For other distances.

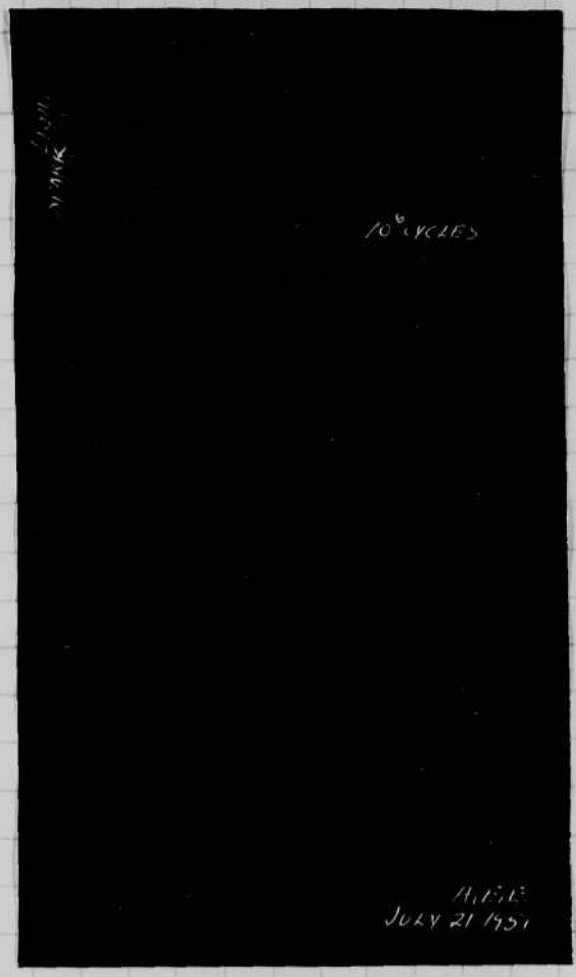
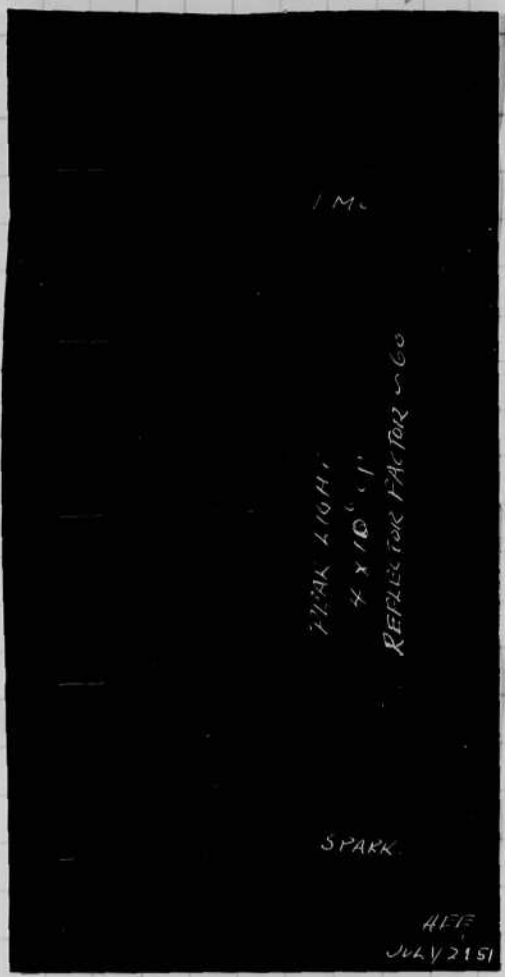
$$C.P. = \frac{10^7}{6.1 \text{ mm}} \times (\text{def in mm}) \left(\frac{D}{4}\right)^2$$

D = P.C. - to lamp  
 distance in  
 feet.

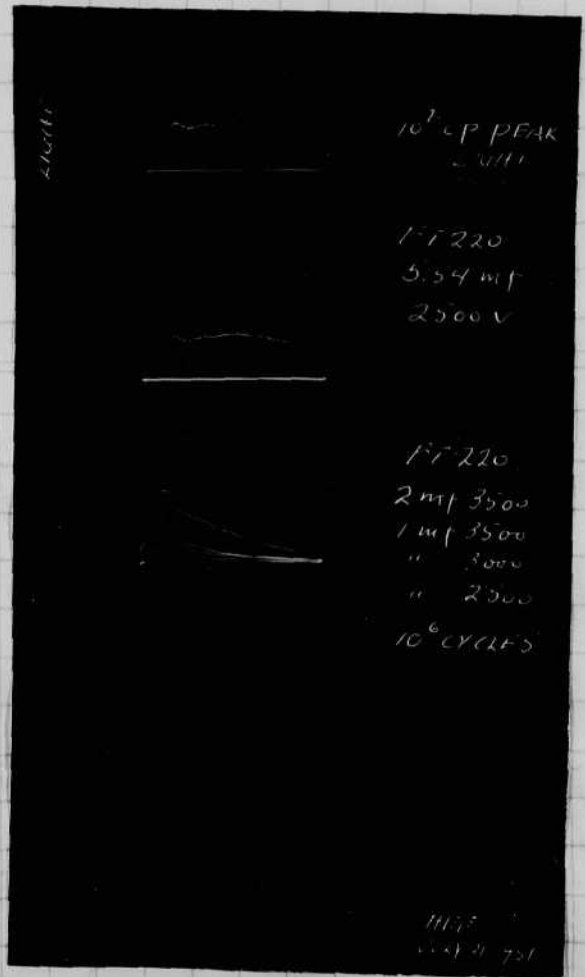
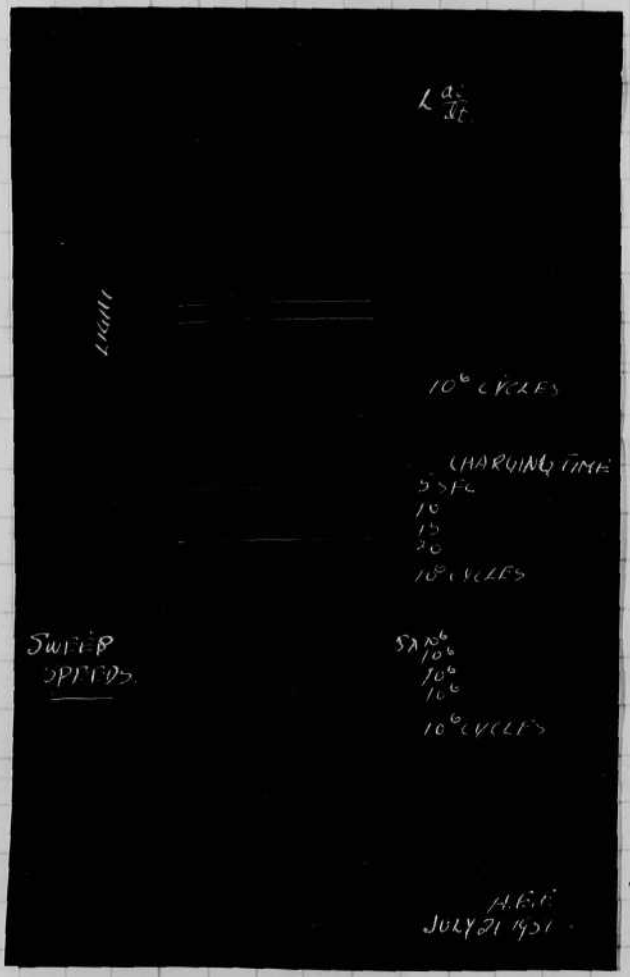
Jososc #1 p66, D = 26" say 2 ft.

$$C.P. \text{ peak} = \frac{10^7}{6} \times 10 \times \left(\frac{2}{4}\right)^2 = \frac{10^8}{24} = \underline{4 \times 10^6} \text{ cp.}$$

no number

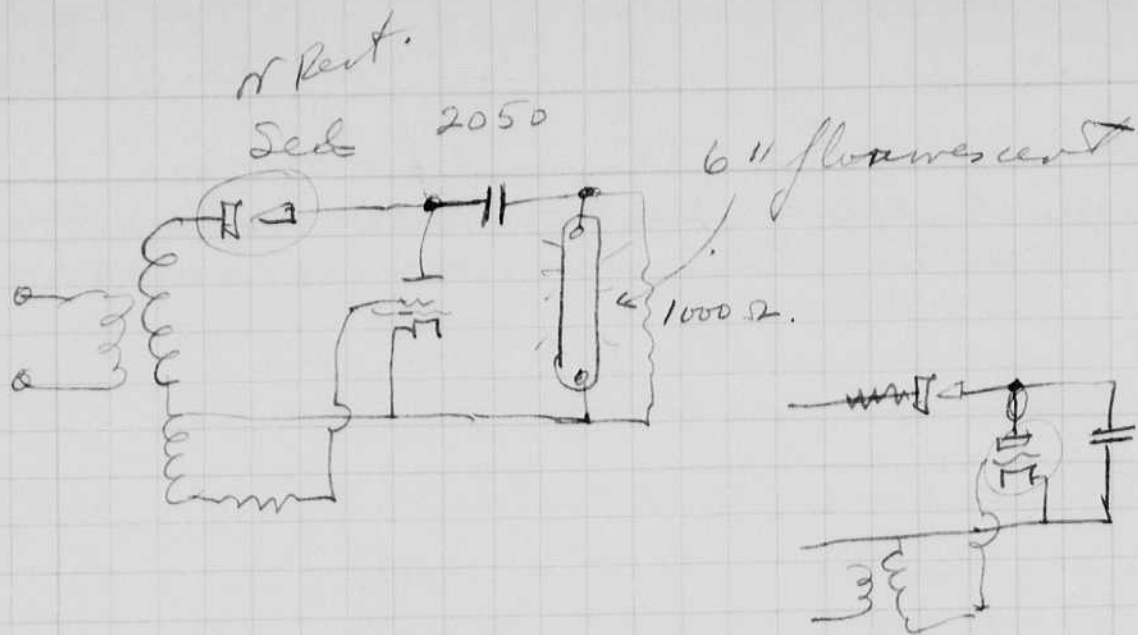


#1 P66



#2

#3



Calibration

#3  
F1-220 with 5 mt at 2500 volts  
has peak out put of about  $10^7$  c.p.  
with p.c. 4 ft from the F1-220.

For other distances.

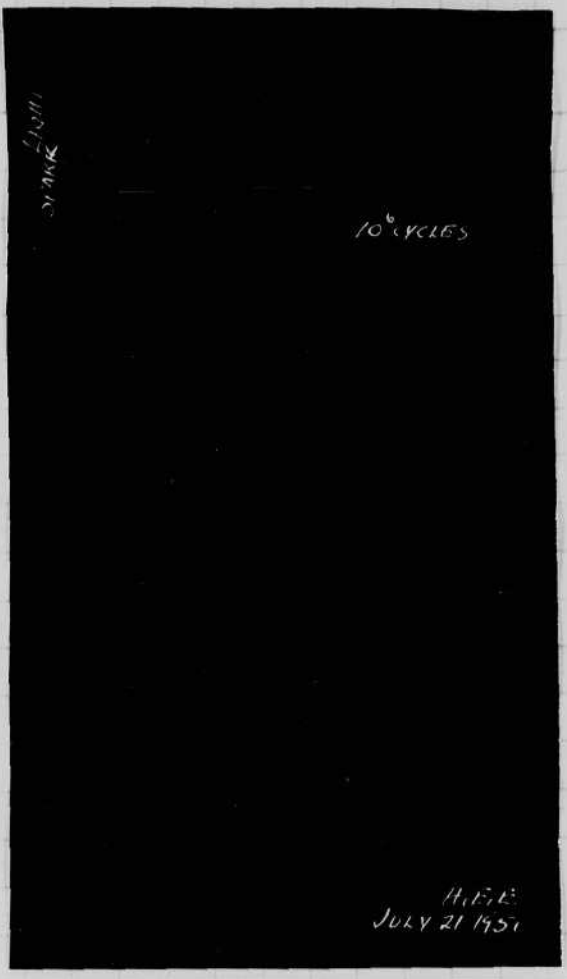
$$c.p. = \frac{10^7}{6 \text{ mm}} \times (\text{def in mm}) \left(\frac{D}{A}\right)^2$$

D = P.C. - to lamp  
distance in  
feet.

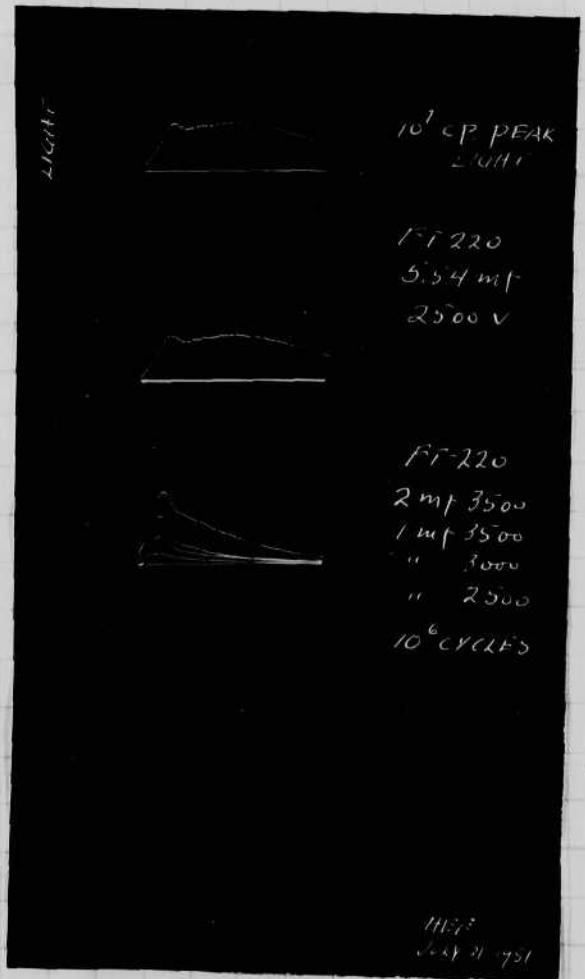
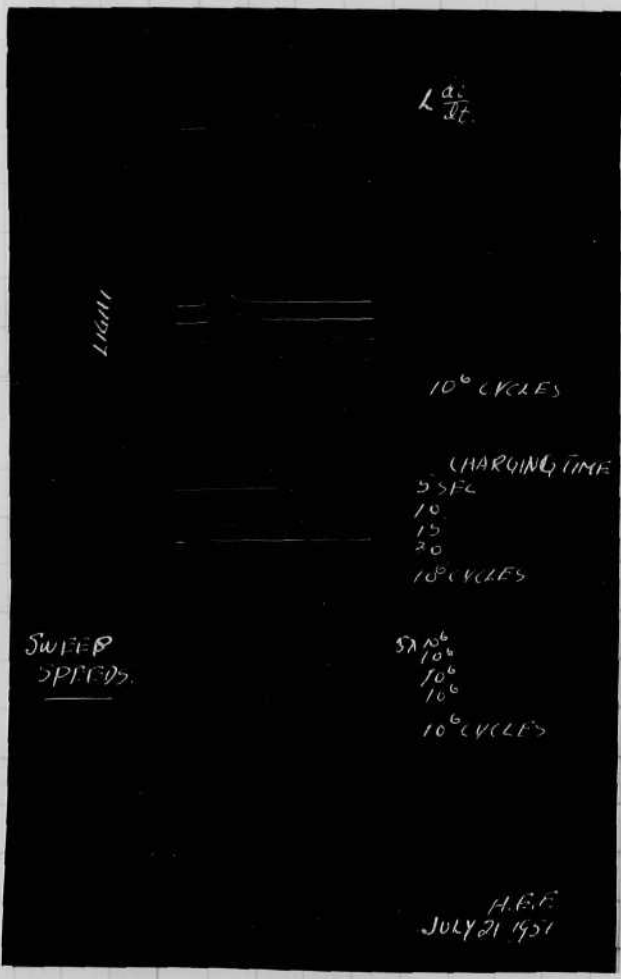
Jososc #1 p66, D = 26" say 2 ft.

$$c.p. \text{ peak} = \frac{10^7}{6} \times 10 \times \left(\frac{2}{4}\right)^2 = \frac{10^8}{24} = \underline{4 \times 10^6} \text{ cp.}$$

no number



#1 P66



#2

#3



70 Tues July 24 1951

Harold E. Edgerton Osc of. Light

PC  
H.

tube  
FT-214

cap.  
10 mf

voltage  
2000

214

"

"

110

"

"

Blue changed photocells to see if  
is direct cell.

110

"

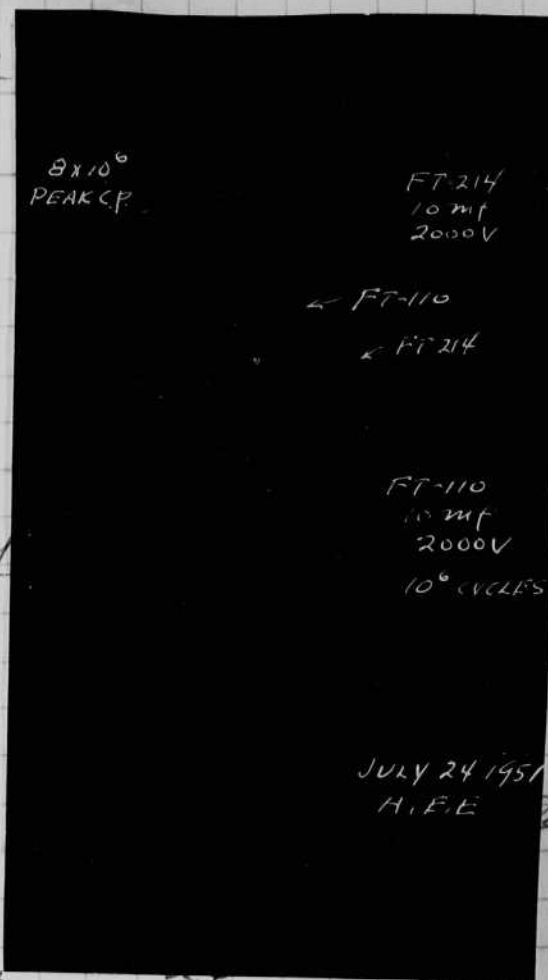
"

Last shot

110

"

"



8x10<sup>6</sup>  
PEAK CP.

FT-214  
10 mf  
2000V

← FT-110

← FT-214

FT-110  
10 mf  
2000V  
10<sup>6</sup> CYCLES

JULY 24 1951  
H.E.E.

PC.  
Tape

FT-230

changed Phototube.

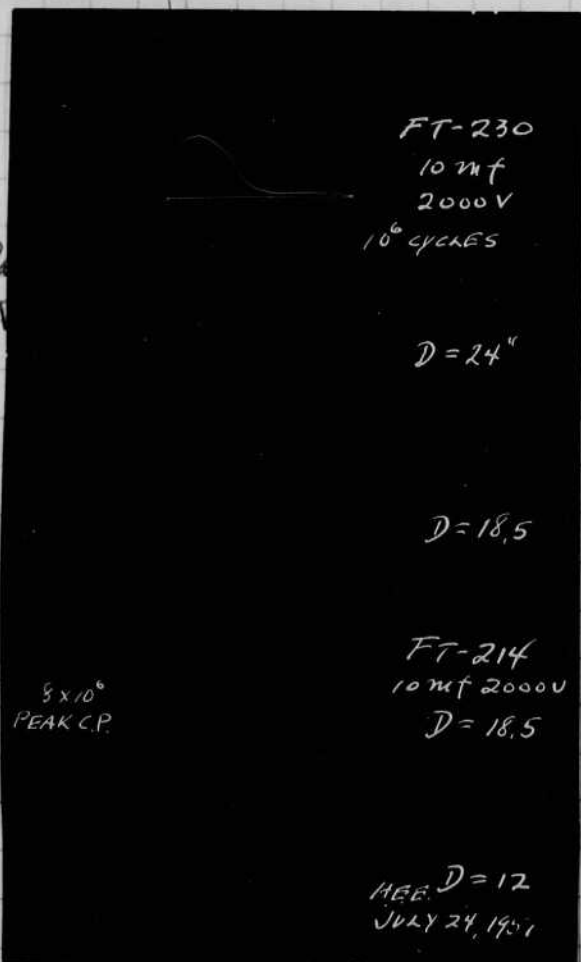
FT-230

"

"

"

18.5"



FT-230

10 mf  
2000V  
10<sup>6</sup> CYCLES

D=24"

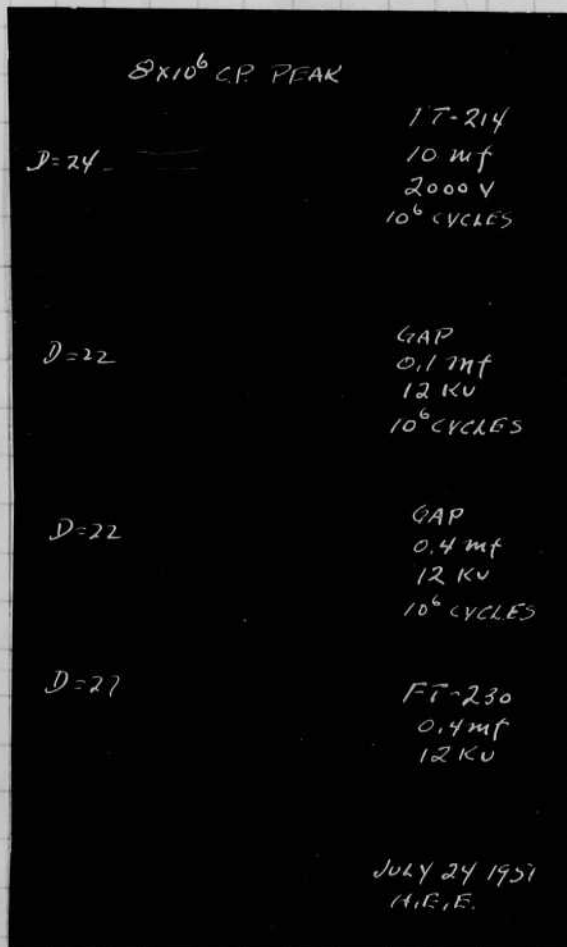
D=18.5

FT-214

10 mf 2000V

D=18.5

H.E.E. D=12  
JULY 24, 1951



8x10<sup>6</sup> CP PEAK

D=24

D=22

D=22

D=27

FT-214

10 mf  
2000V  
10<sup>6</sup> CYCLES

GAP  
0.1 mf  
12 KV  
10<sup>6</sup> CYCLES

GAP  
0.4 mf  
12 KV  
10<sup>6</sup> CYCLES

FT-230  
0.4 mf  
12 KV

JULY 24 1951  
H.E.E.

8.5

12"

24"

22"

"

27

10<sup>6</sup>

10<sup>6</sup>

10<sup>6</sup>

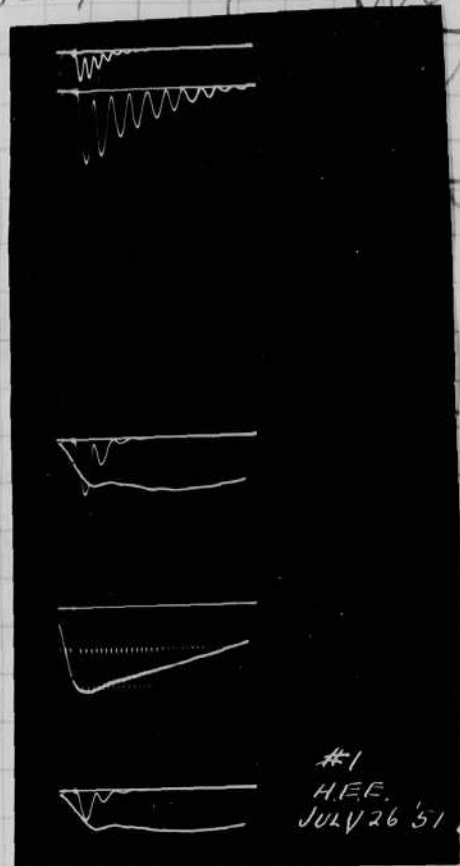
"

"

Thursday  
July 26 1951

#1 Edge-on Magneto optic shutter test.

4x5  
80c #1



#1  
H.E.E.  
JULY 26 '51

0.1 12KV on coil.

0.4 12KV on coil.

0.4 12KV

Resistance 1 ohm ±  
to lamp etc.

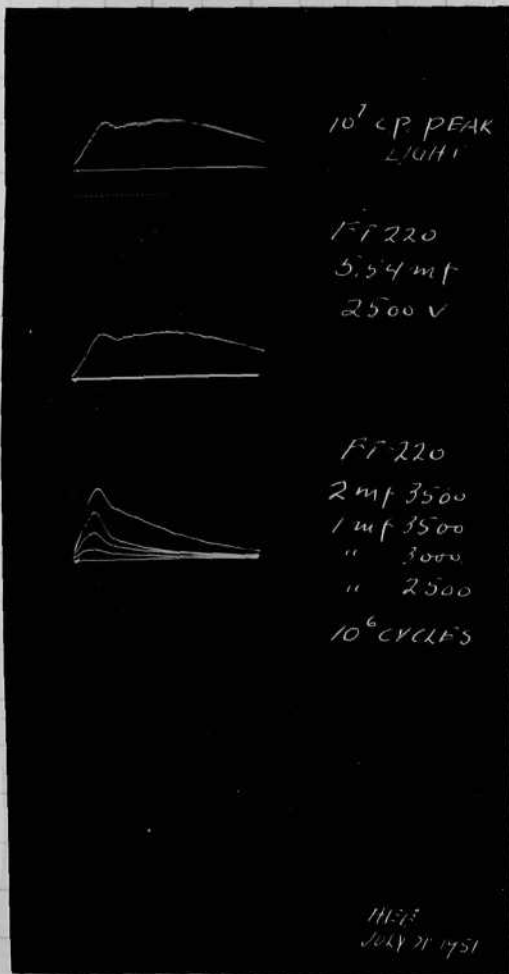
Light 15° ±

Light 90° ±

10<sup>6</sup> cycles.

pulse.

Light 15° ± 2



10<sup>3</sup> CP PEAK  
LIGHT

FT 220  
5.54 mf  
2500 V

FT 220  
2 mf 3500  
1 mf 3500  
" 3000  
" 2500  
10<sup>6</sup> CYCLES

H.E.E.  
JULY 27 1951

70 Tues July 24 1951

Harold E. Edgerton Osc of Flight

PC # FT-214 caps. 10mf volts 2000

214 " "
110 " "

Blue changed photocells to see if is direct cell.

110 " "
Last shot
110 " "

PC Tape FT-230 changed phototube.
FT-230 " "
" " " 18.5"

8x10^6 PEAK CP
FT 214 10 mf 2000V
FT-110
FT 214
FT-110 10 mf 2000V 10^6 CYCLES
JULY 24 1951 H.E.E.

FT-230 10 mf 2000V 10^6 CYCLES
D=24"
D=18.5
FT-214 10 mf 2000V D=18.5
8x10^6 PEAK C.P.
H.E.E. D=12 JULY 24, 1951

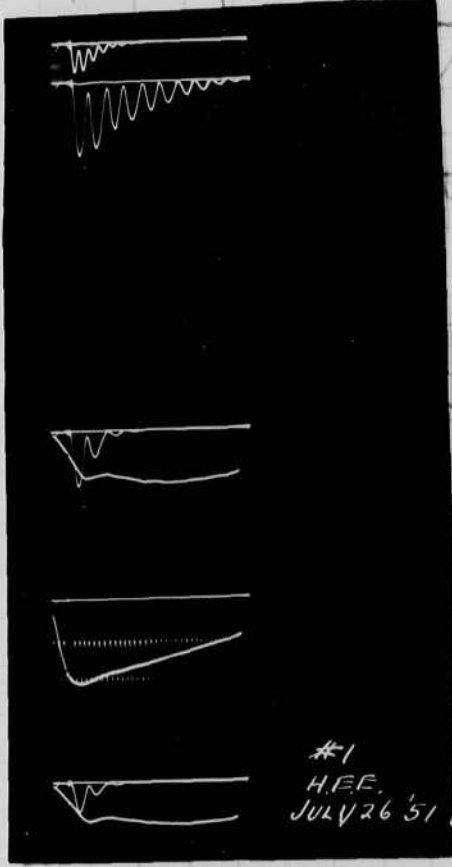
8x10^6 CP PEAK
D=24
D=22
D=22
D=27
FT-214 10 mf 2000V 10^6 CYCLES
GAP 0.1 mf 12 KV 10^6 CYCLES
GAP 0.4 mf 12 KV 10^6 CYCLES
FT-230 0.4 mf 12 KV
JULY 24 1951 H.E.E.

8.5
12" 10^6
24" 10^6
22" 10^6
" "
27 "

Thursday  
July 26 1951

# Magneto optic shutter test.

4x5  
BSC #1



#1  
H.F.E.  
JULY 26 '51

0.1 12KV on coil.

0.4 12KV on coil.

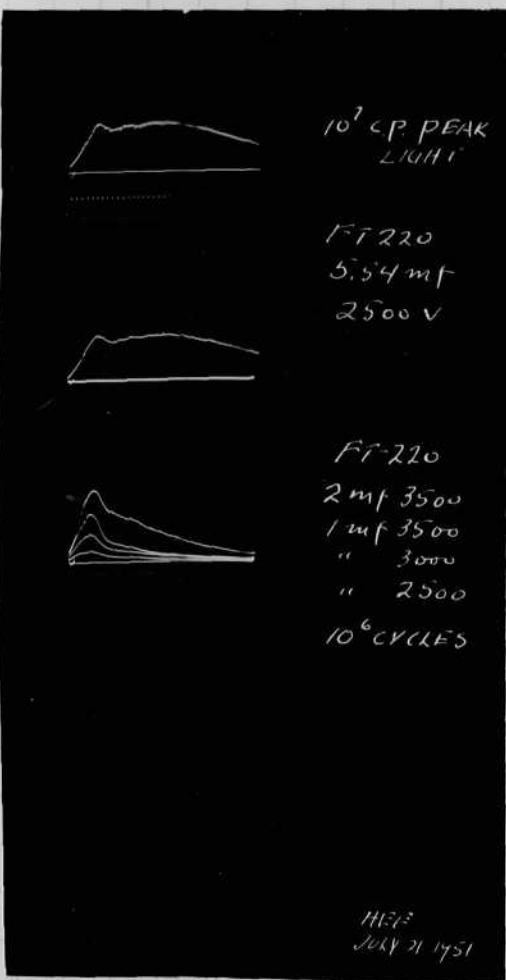
0.4 12KV

Resistance 1 ohm ±  
to lamp etc.

Light 15° ±

Light 90° ±

10<sup>6</sup> cycles.



10<sup>7</sup> CP. PEAK  
LIGHT

FT 220  
5.54 mf  
2500 V

FT-220  
2 mf 3500  
1 mf 3500  
" 3000  
" 2500  
10<sup>6</sup> CYCLES

H.F.E.  
JULY 21 1951

pulse.

Light 15° ± 2

70 Tues July 24 (1951)

Harold E. Edgerton Osc of .. flight

PC  
H.

tape  
FT-214

cap.  
10mf

voltage  
2000

214

"

"

24"

110

"

"

24"

Blue

changed phototubes to see if ripple on record is direct cell.

110

"

"

44"

last shot

110

"

"

36"

10<sup>6</sup> cycles

PC  
Tape

FT-230

"

"

24"

10<sup>6</sup> cycles

changed phototube.

FT-230

"

"

"

"

"

"

18.5"

FT-220 214

"

"

18.5"

FT-220 214

"

"

12"

10<sup>6</sup>

Calib.  
P.C. tape

FT 214

"

"

24"

10<sup>6</sup>

Spark gaps (Brown Wood box)

0.1 ?

12 12KV

22"

10<sup>6</sup>

" "

0.1 + 0.3

12"

"

"

FT-230

"

12"

27"

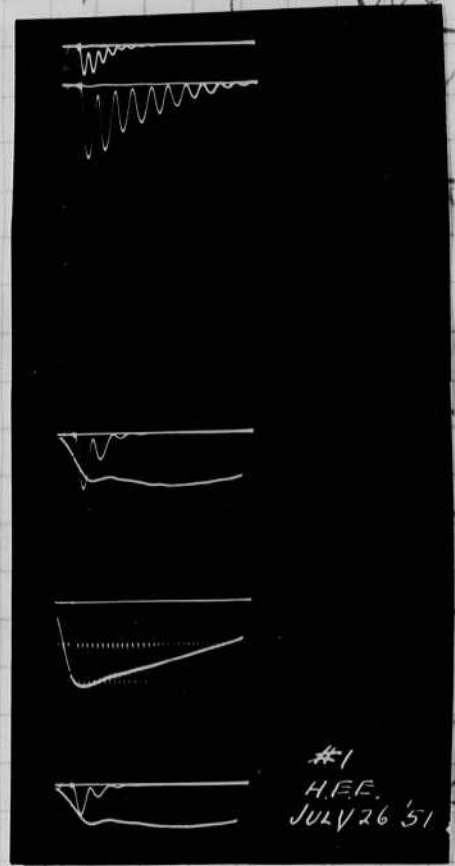
"



Thursday  
July 26 1951

# Magneto optic shutter test.

4x5  
80c #1



0.1 12KV on coil.

0.4 12KV on coil.

0.4 12KV  
Resistance to shut ±  
to lamp osc.

Light 15° ±

Light 90° ±

10<sup>6</sup> cycles.

pulse.  
Light 15° ± 2



July 26 1951  
H. E. Edgerton

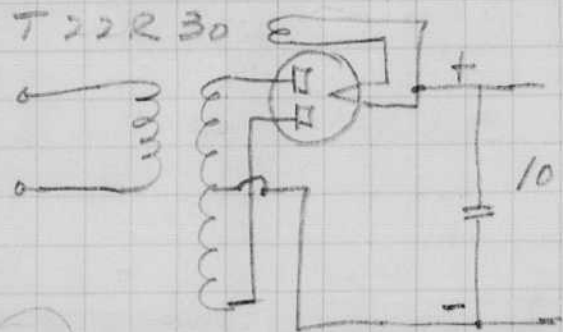
### Two-flasher

Silhouette flashing unit for sound wave velocity measurement.

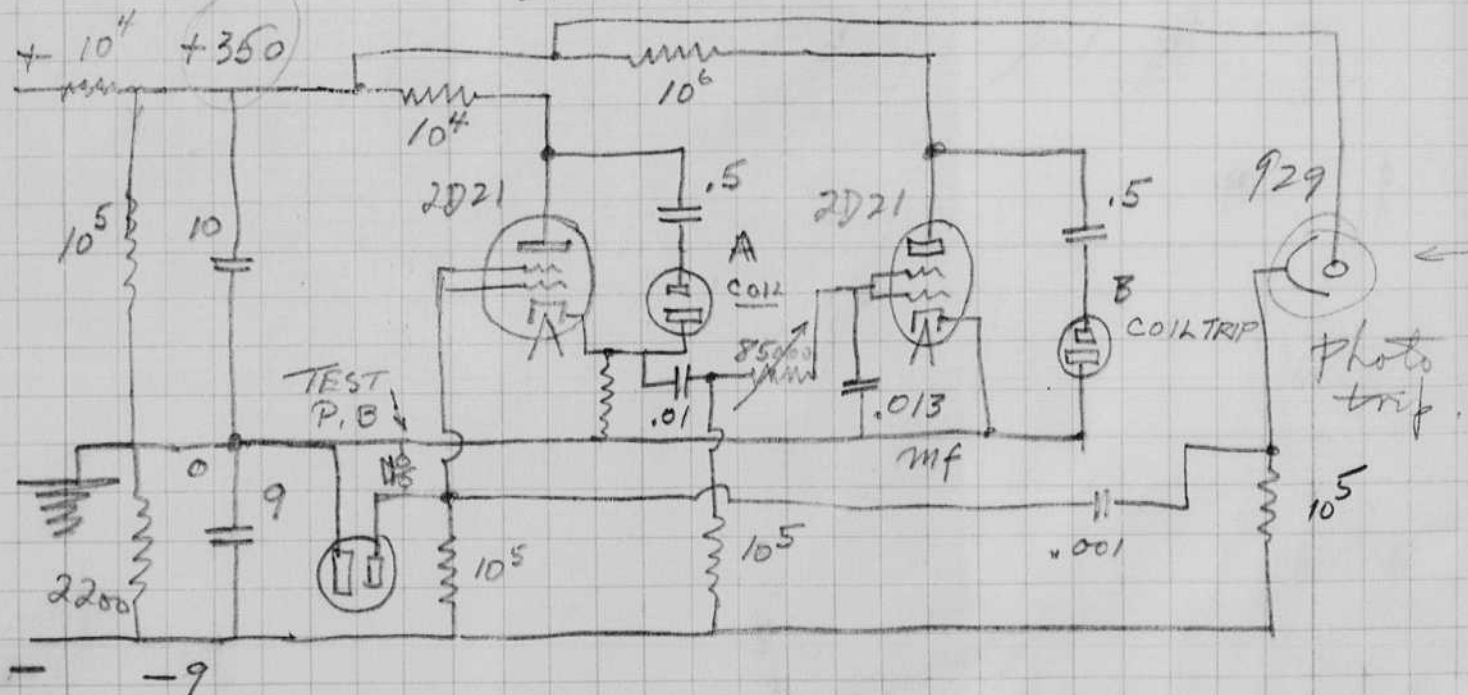
Bill Mac Roberts finished wiring the circuit below today. We had trouble with the gaps, apparently the bakelite leaks electrically causing the voltage to drop. Ward is obtaining some glass insulators.

The delay network gives about 75 microseconds which is ample for sound velocity work in an 8 inch distance.

\* Thorson 5Y3



Now 400?  
was 275.



\* Replaced Aug 8 by Sancer # P6011. to get higher volt on 2D21 Plate. This reduction in jitter some, should have more





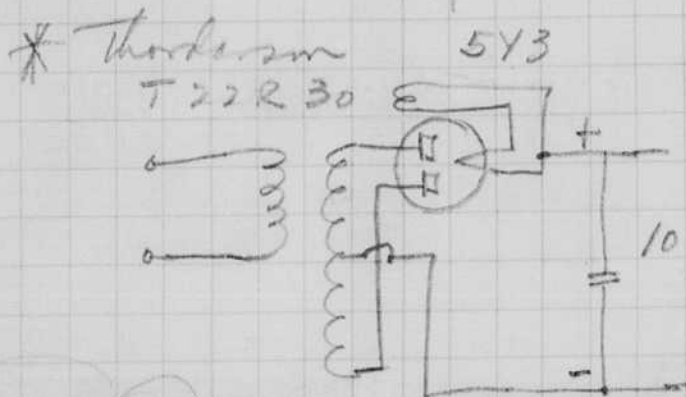
July 26 1951  
H. E. Edgerton

Two-flasher

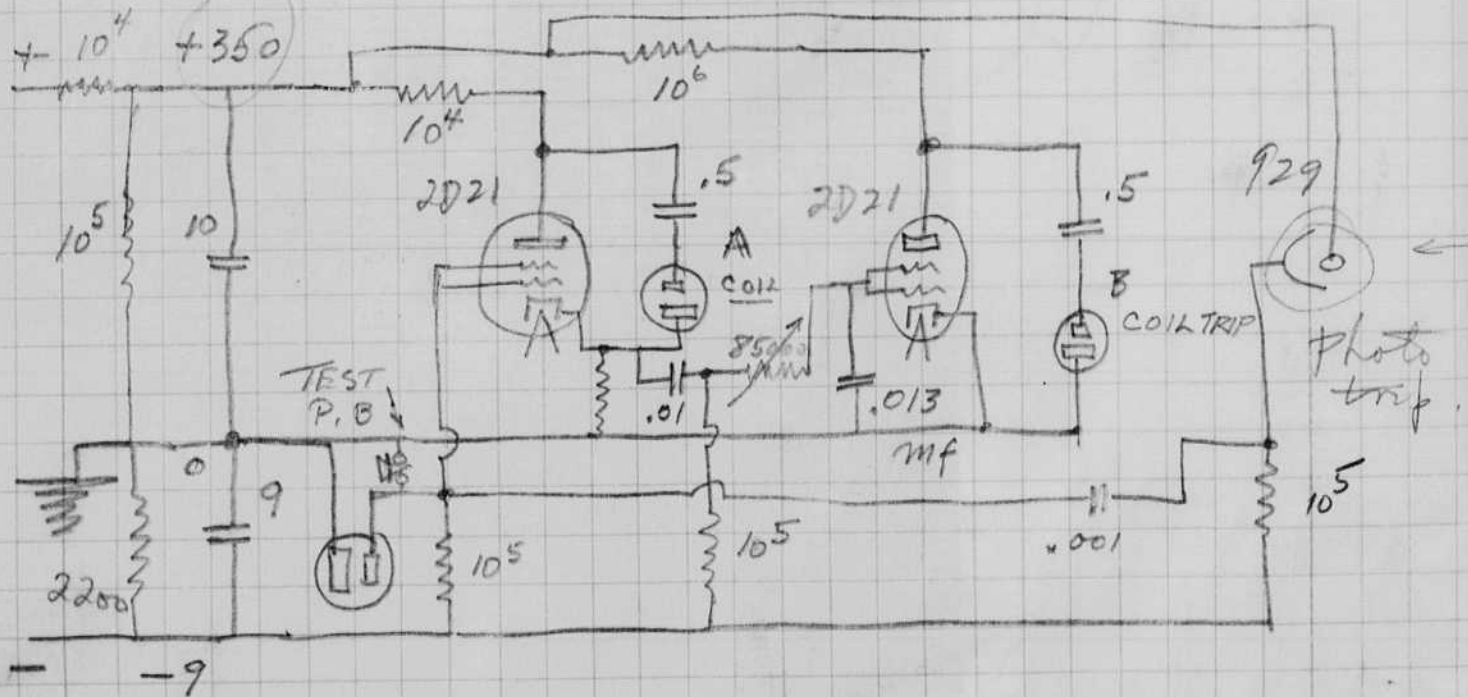
Silhouette flashing unit for sound wave velocity measurements.

Bill Mac Roberts finished wiring the circuit below today. We had trouble with the gaps. Apparently the bakelite leaks electrically causing the voltage to drop. Ward is obtaining some glass insulators.

The delay network gives about 75 microseconds which is ample for sound velocity work in an 8 inch distance.



Now 400?  
was 275.



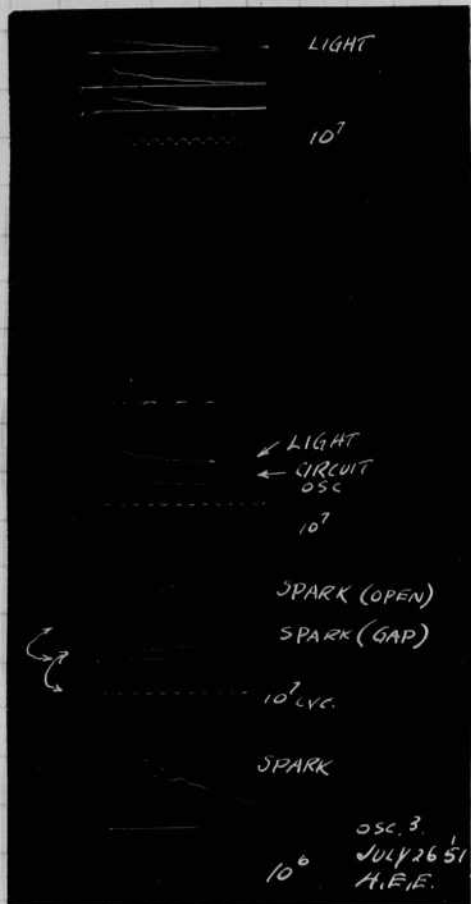
\* Replaced Aug 8 by Sancer # P6611. to get higher rolls on 2D21 Plate. This reduction in jitter some. Should have more











circuit oscillation 1,005 8KV into gap and wiring  
 SW 4  
 10 x 10<sup>6</sup> cycles time

trigger voltage 15 mV 350 into 2D21 and newton coil  
 1. Break down  
 2. Opencir  
 3. 10<sup>7</sup> cycles  
 Sweep 4

spark voltage opencir Sweep 8.

10<sup>6</sup> cycles

$\sqrt[3]{\frac{17}{5}} = \frac{3}{20}$

osc 4  
 July 26 1951

nat freq of circuit =  $\frac{5}{3} = 1.66$  megacycles.

1. Spark Sweep 8 10<sup>6</sup> cycles.  
 " Sweep 6 10<sup>6</sup> cycles.  
 " " 4 10<sup>7</sup> "  
 A. opencir secondary  
 B. Intogap trigger

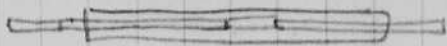
SPARK  
 10<sup>6</sup>  
 SPARK  
 10<sup>6</sup>  
 SPARK  
 (GAP)  
 10<sup>7</sup>  
 0 Ω  
 1.2 Ω OSC. 4  
 JULY 26  
 HEE  
 LIGHT

cond voltage, 605 8KV main gap, without damping res.

cond voltage with 1.2 ohms damping 5 x 10<sup>6</sup> cycles

Light - time with 1.2 ohms.

5 x 10<sup>6</sup>



# 5

1 1/2 mm quartz tube air gap  
tungsten gaps 3/16" gap ??

Sweep 5

10 x 10<sup>6</sup> cycles tuning curve

Several on  
were taken of  
the double  
system varying  
the delay between  
the flashes.

the second flash  
is weaker than  
the first.

Monday  
July 30 1951

OSC 1.

Delay set 7 15 sec. gap

Quantity of tube with air  
1/8" gap

3.5 15 sec

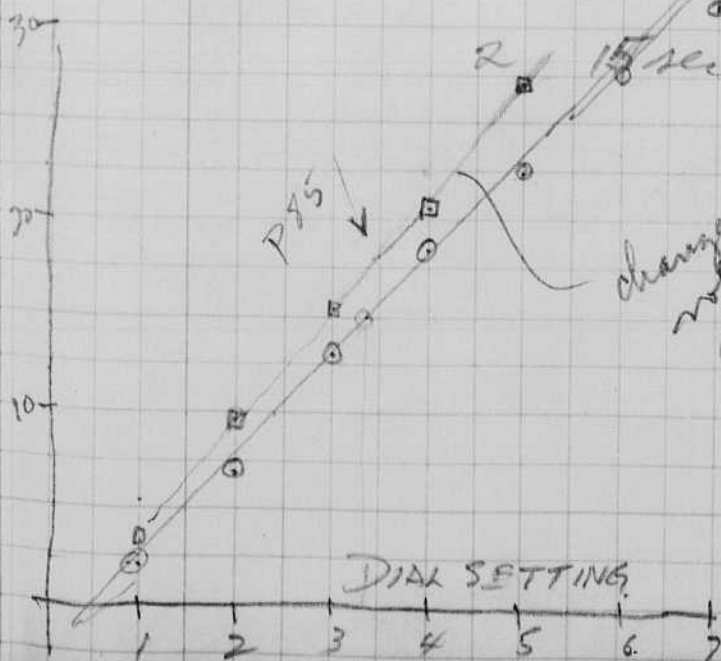
3.5 5 sec.

50 ? \*

OSC 2

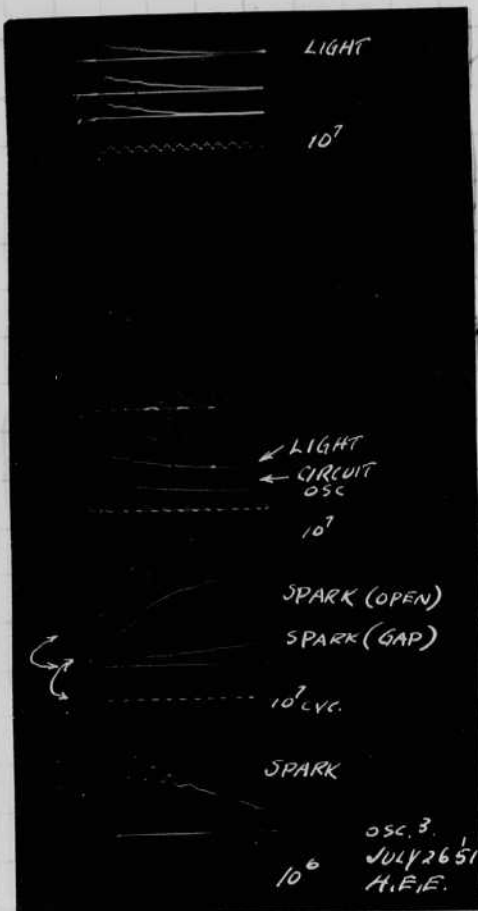
1 15 sec

2 15 sec



changed due to higher  
voltage on secondary of  
power trans.





circuit oscillation  
 10 x 10<sup>6</sup> cycles/min

.005 8KV into gap and wiring  
 SW 4

trigger voltage

15mf 350 volts  
 2D21 and  
 newton coil

1. Break down
2. Open cir
3. 10<sup>7</sup> cycles

Sweep 4

spark voltage  
 open cir

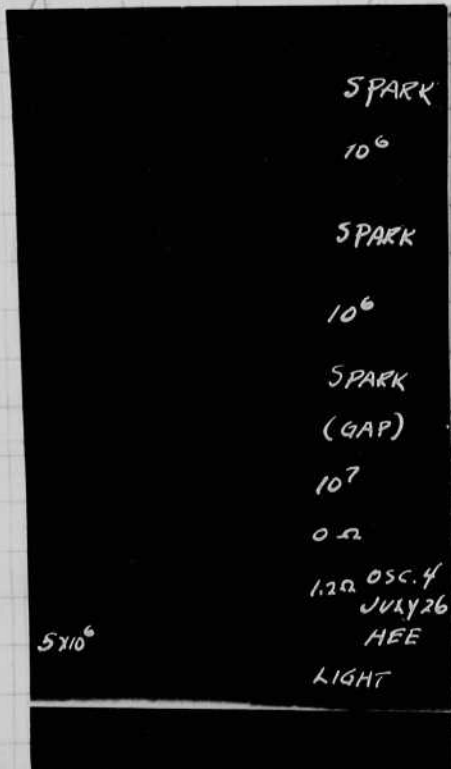
Sweep 8.

10<sup>6</sup> cycles.

$$\sqrt[3]{\frac{17}{5}} = \frac{2}{20}$$

osc 4  
 July 26 51

nat freq of circuit =  $\frac{5}{3} = 1.66$  megacycles.



1 Spark Sweep 8 10<sup>6</sup> cycles.

" Sweep 6 10<sup>6</sup> cycles.

" " 4 10<sup>7</sup> "

A. open circuit

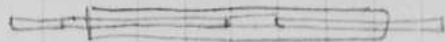
B. Intogap trigger

Cond voltage, .005 8KV main gap,  
 with out damping res.

Cond voltage with 1.2 ohms damping  
 5 x 10<sup>6</sup> cycles

Light - time with 1.2 ohms.





# 5

1 1/2 mm quartz tube air gap  
tungsten gaps 3/16" gaps ??

Sweep 5

10 x 10<sup>5</sup> cycles tuning curve

Several osc  
were taken of  
the double  
system varying  
the delay between  
the flashes.

the second flash  
is weaker than  
the first.

Monday  
Jan 30 1951

OSC 1.

Delay set 7 15 sec. gap

Quantity tube with air

1/8"

3.5 15 sec

3.5 5 sec.

50? \*

OSC 2

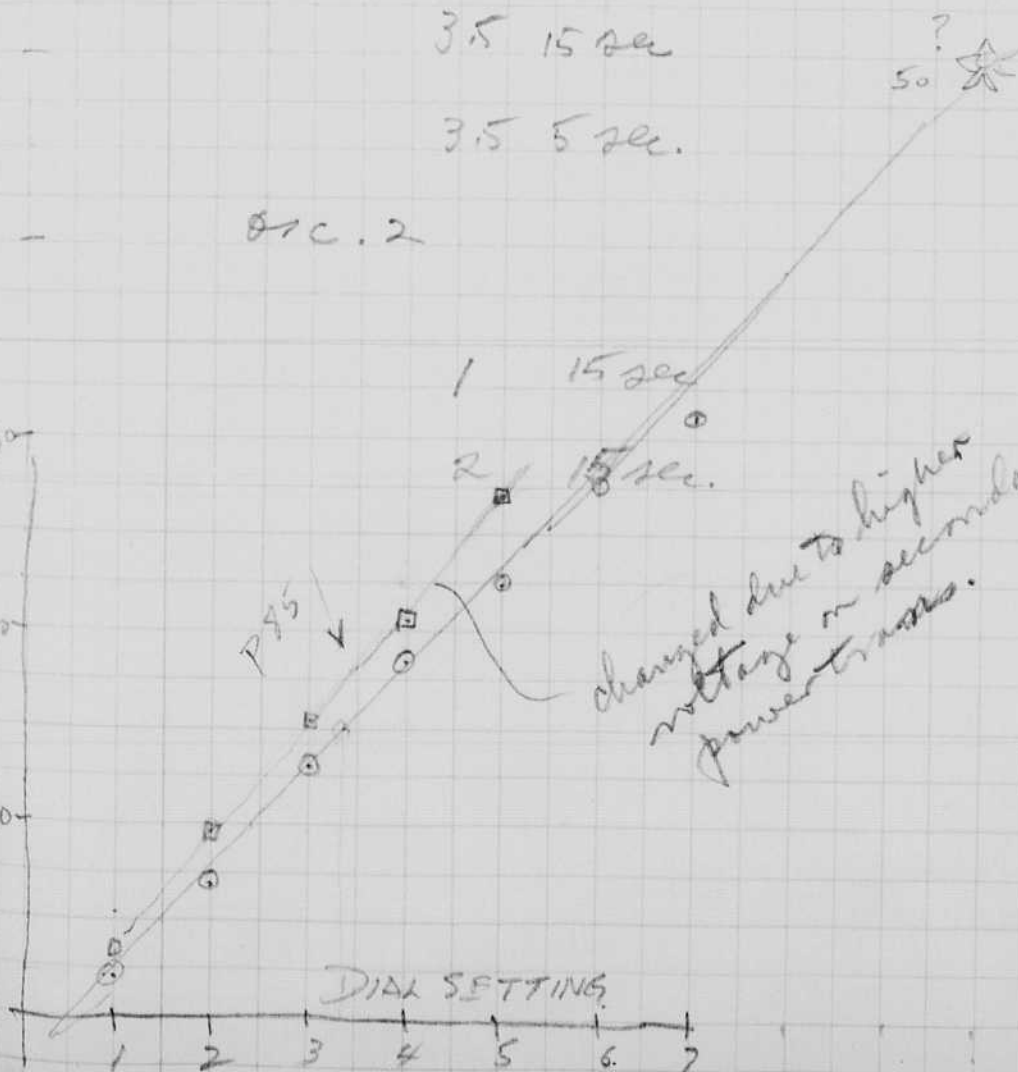
1 15 sec

2 15 sec.

changed due to higher  
voltage on secondary of  
power transformer.

DIAL SETTINGS

1 2 3 4 5 6 7

30  
20  
10

OK 3.

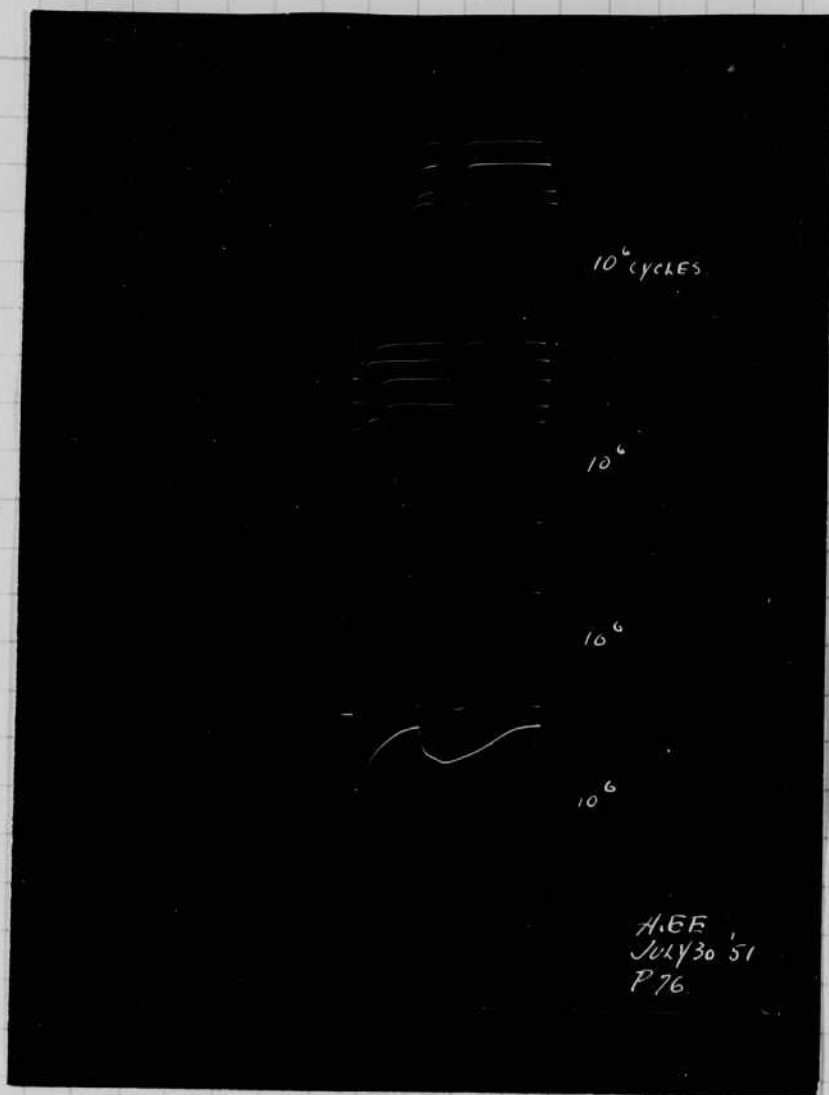
Air gaps  $\frac{1}{8}$ "  
inside in  
quartz tube.

(Top air  
Bot argon)

Top argon.

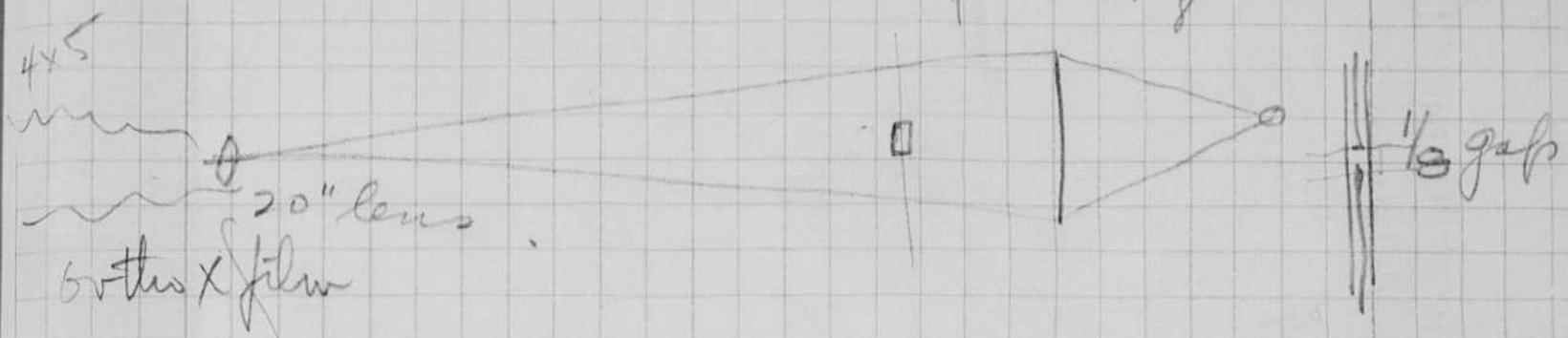
Bot FT-108.

(note Sylo-309  
is about the  
same). →



Photography of bullets with 2 flasher.

22 caliber in Stevens rifle. Plastic. 8" square lens.



f 32 dia.

.005 8KV

f 22 missed.

f 22 mungy.

ortho X f 22 Copper dynamite cap. Delay at 50  $\mu$ s.

ortho X f 22 " " " Delay at 15  $\mu$ s

ortho X f 22 Alum Squirrel " Delay at 15  $\mu$ s.

Copper #6 10  $\mu$ s (2.4)

copper #6 2  $\mu$ s.

copper #6. 5 ~~ms~~

OK 3.

Air gaps  $\frac{1}{8}$ "  
inside in  
quartz tube.

(Top air  
Bot argon)

Top argon.

Part 77-108,

(note Sylo-309  
is about the  
same). →

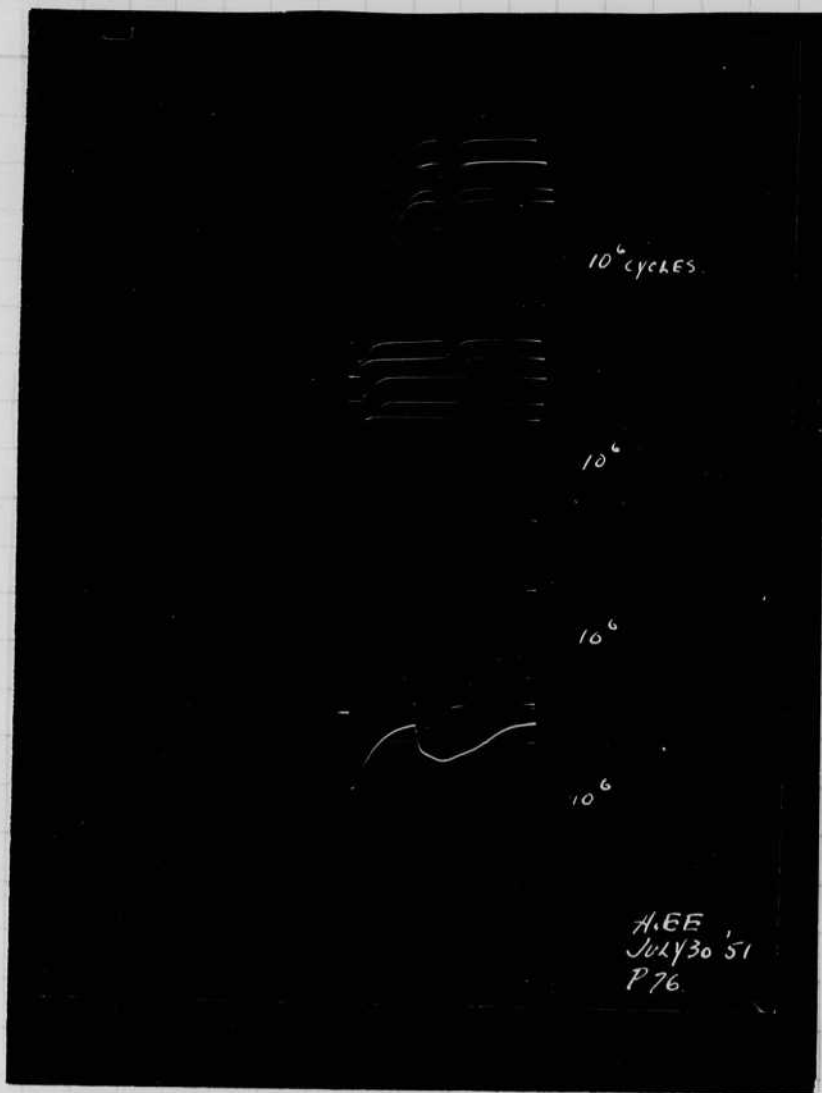
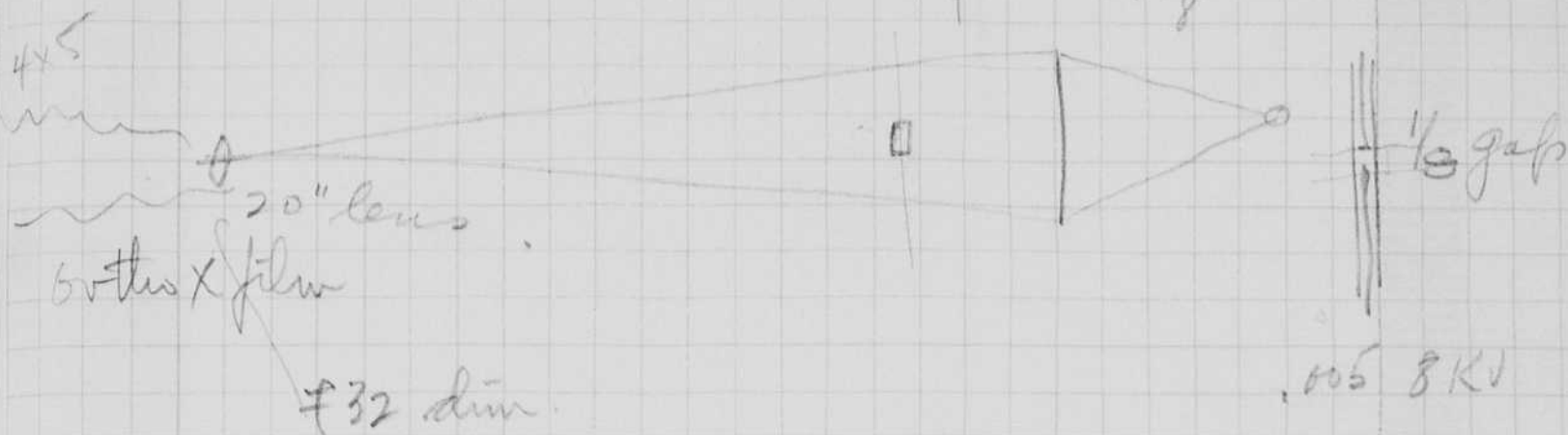


Photo gun, 4 of bullets with 2 flasher.

77

22 caliber in Stevens rifle. Plastic.  
8" square lens.



#32 dim.

f 22 missed.

f 22 muzzle.

ortho x f 22 Copper dynamite cap. Delay at 50  $\mu$ s.

ortho x f 22 " " " Delay at 15  $\mu$ s

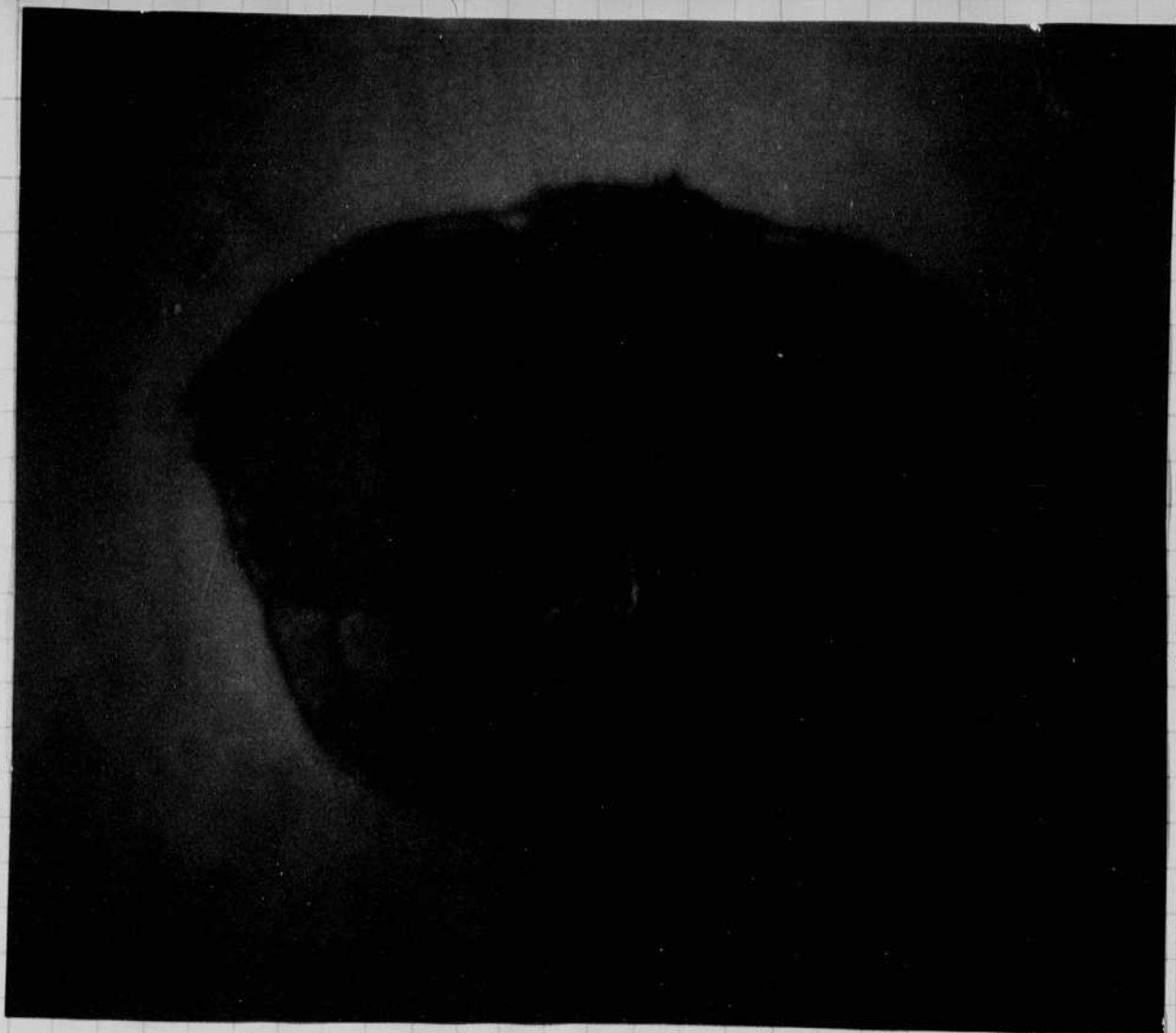
ortho x f 22 Alum Squid " Delay at 15  $\mu$ s.

Copper #6 10  $\mu$ s (2.4)

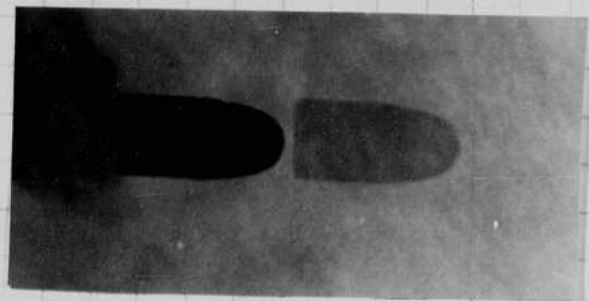
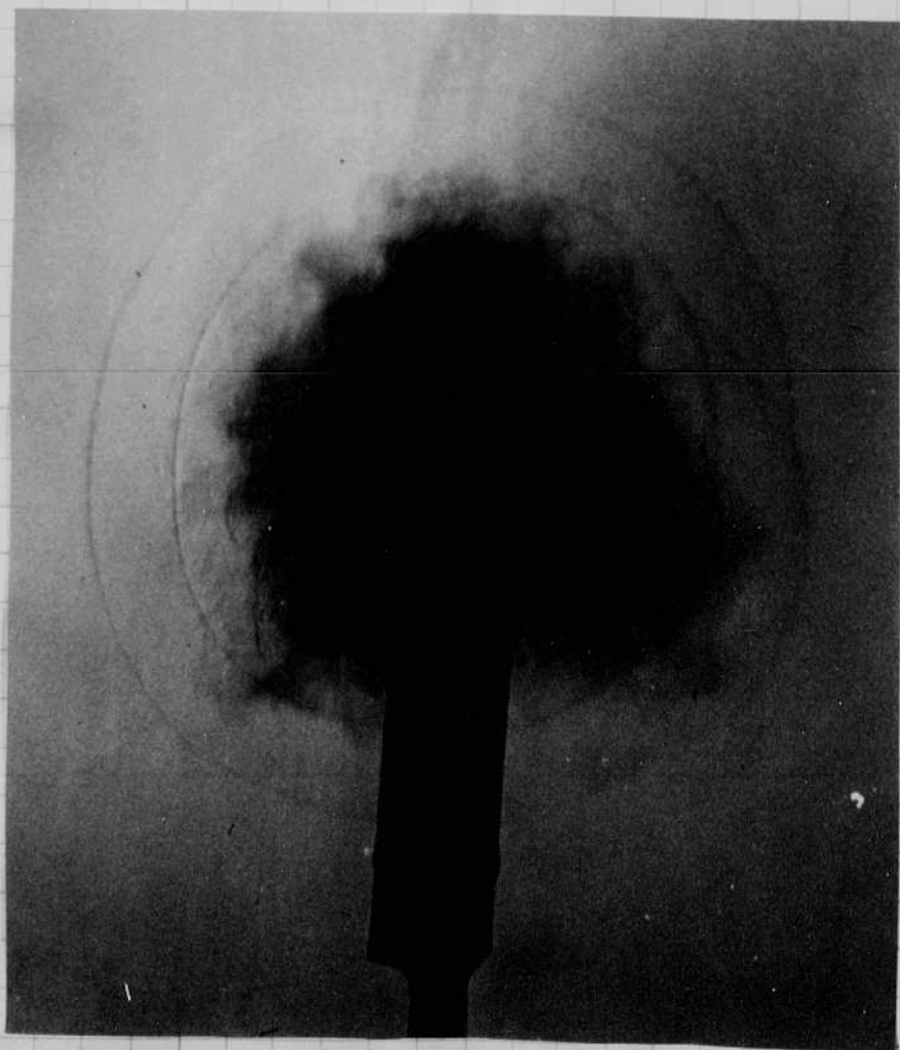
copper #6 2  $\mu$ s.

copper #6. 5  ~~$\mu$ s~~





#6  
Dyn  
caps  
10  $\mu$ s

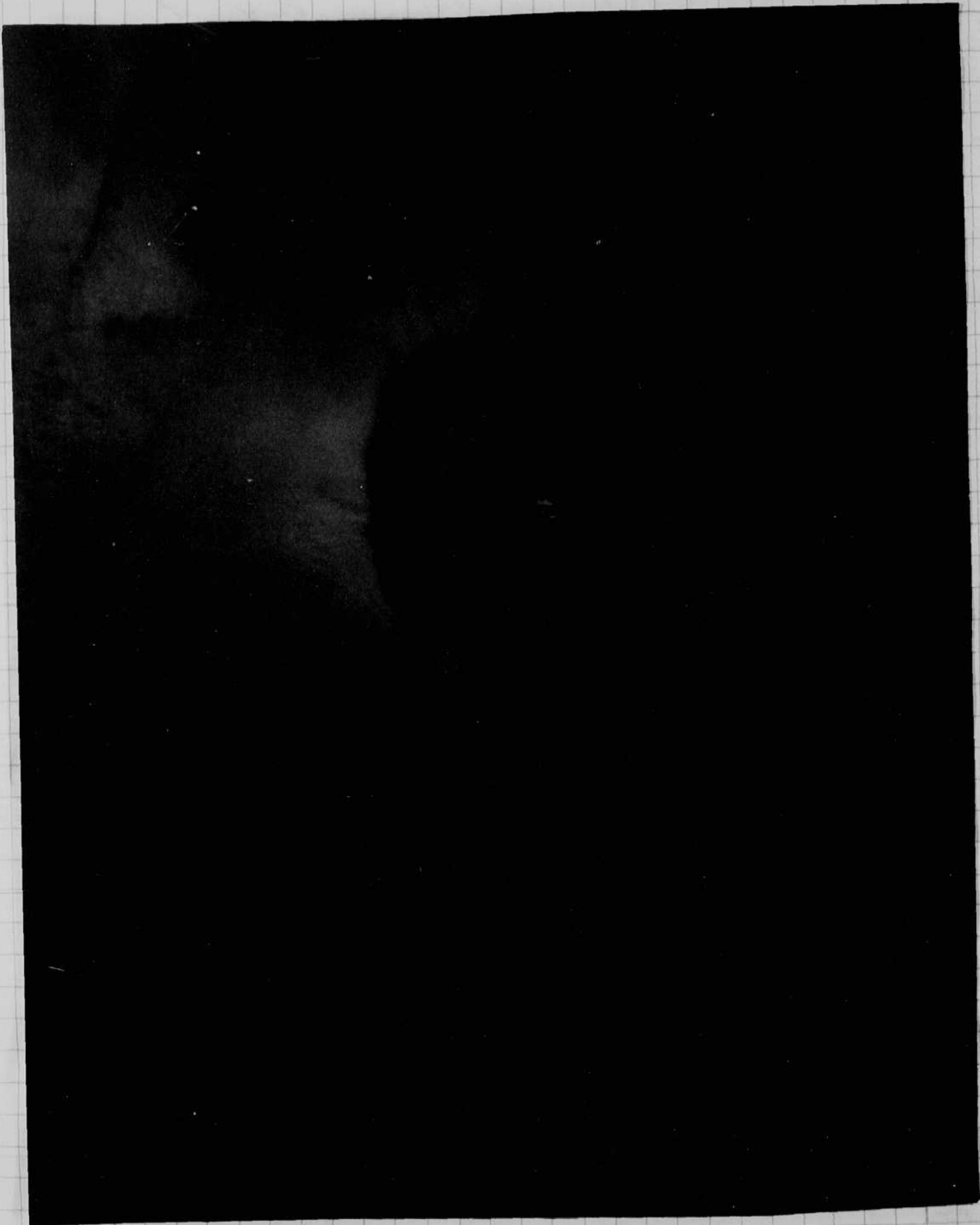


50(?)  $\mu$ s.

22 long rifle in  
Stevens automatic.  
velocity about 1000 f/sec.

Black Powder  
Squid (?)

15  $\mu$ s

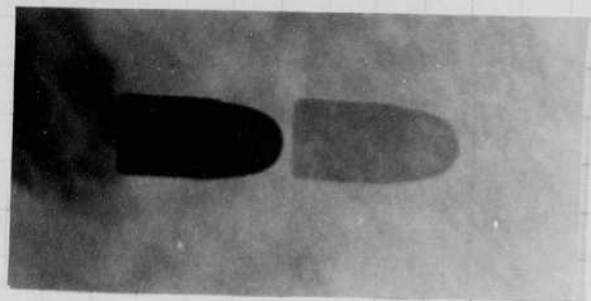
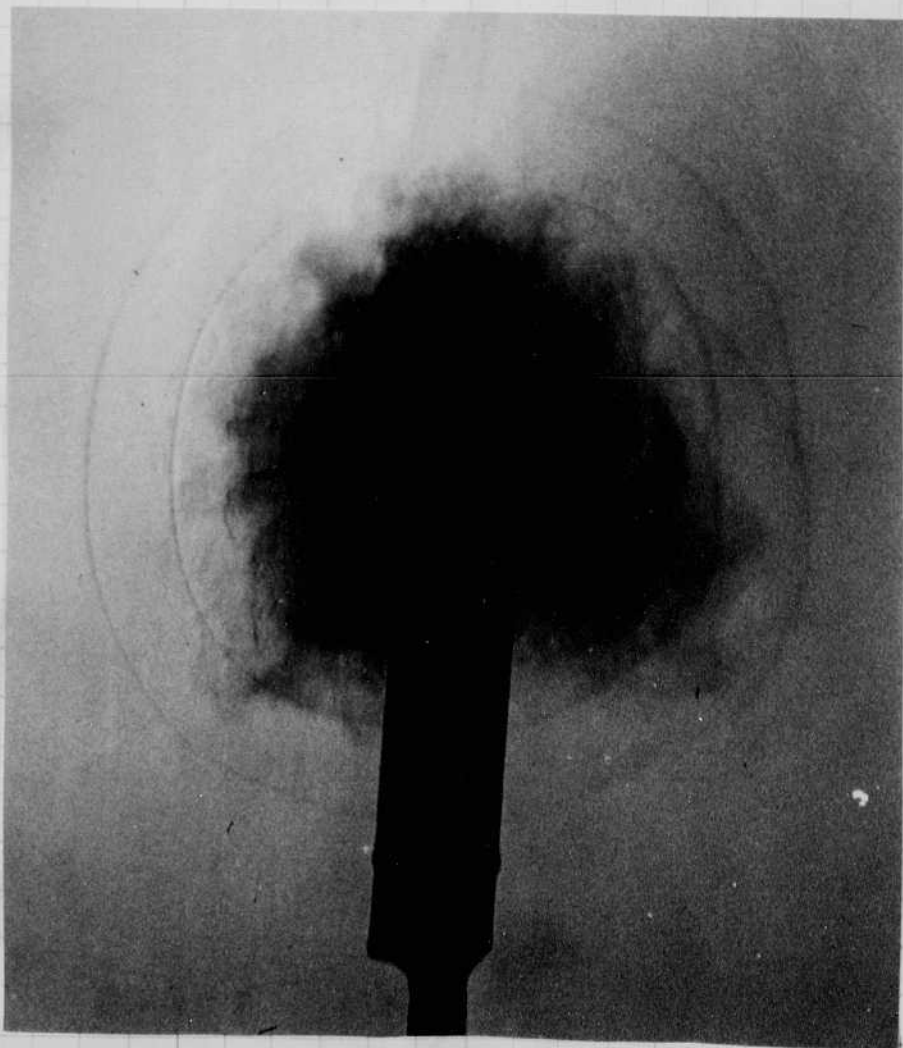


50ms?

#6 Dyn Caps.



#6  
Dyn  
cap  
10 us

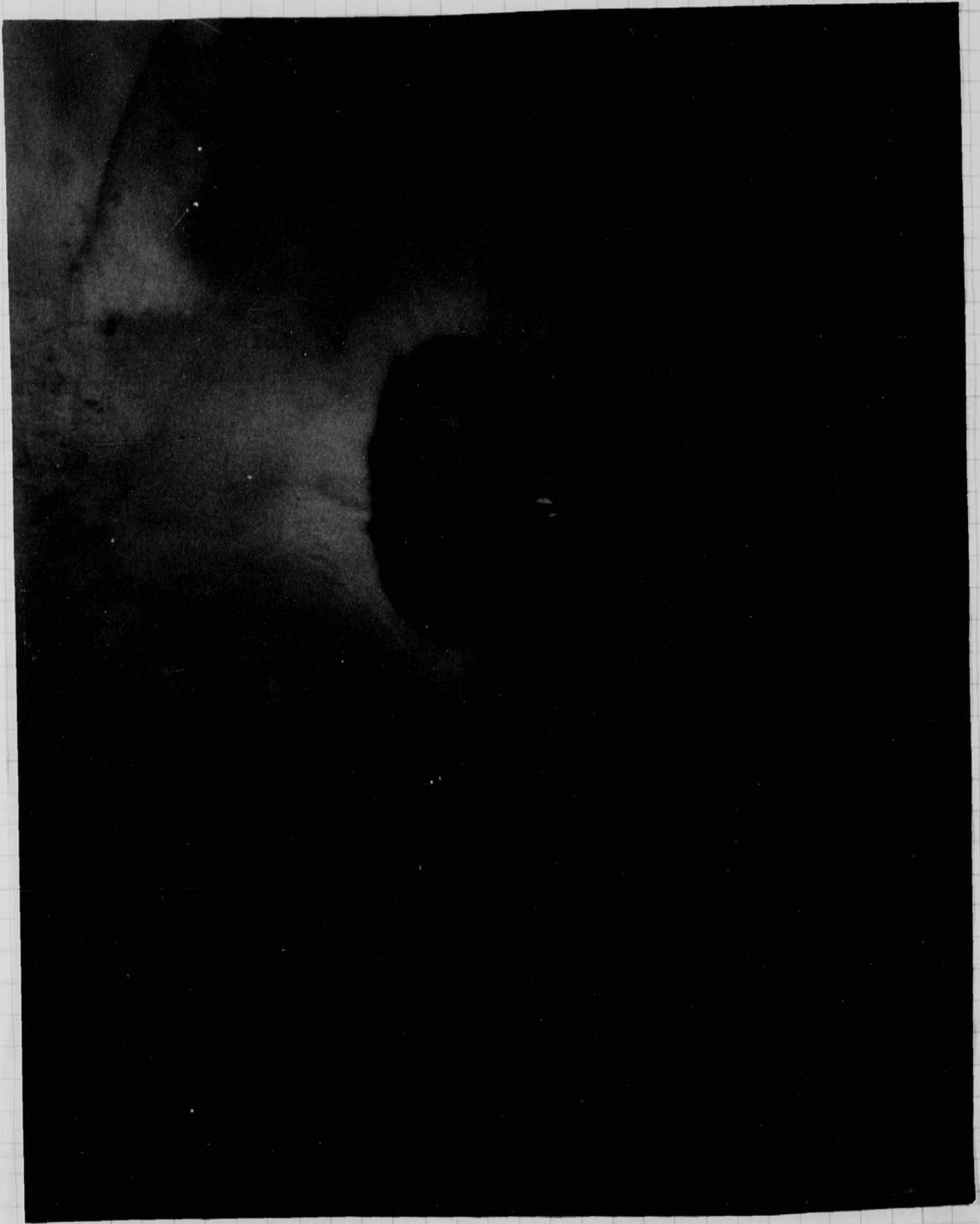


50(?) us.

22 long rifle in  
Stevens automatic.  
velocity about 1000 f/sec.

Black Powder  
Squid (?)

15 us



50ms?

#6 Dyn Cap.



30 August 6, 1951.

Herbert E. Edgerton

Took photographs of Humming Birds at  
Holderness N.H. Yesterday and Saturday.  
Used 3 units with 80 watt sec each - B.C.P.S. output  
about 2000 - 2400.

Lamps at 30° and 2 ft.

Flash and camera at 3 ft

Back light at 3 ft from subject

f16 Daylight Kodachrome - no filter.

Light meter calibration tests.

Kodachromes taken several weeks ago returned  
this morning.

I compared several light sources (all flash)  
for performance. These were

- |                                      |      |
|--------------------------------------|------|
| ① FT-220 with 101 mf at 2000 volts.  | 56   |
| ② FT-220 with 24.5 mf at 2000 volts. | 28   |
| ③ FT-220 with 600 mf at 900 volts.   | 56   |
| ④ FT-110 with 180 mf 900 volts.      | 33.6 |

The reflector for each test was arranged  
so that the light meter read 50 f.c.s.  
Then a series of 24 exposures were made  
until the to cover the expected range.

From each group the aperture of f 5.6  
was selected as the most satisfactory.  
Slight color changes could be detected  
between sources 1 and 3. Source #1 was  
bluer than source #3.

|                               |                 |
|-------------------------------|-----------------|
| Distances used were Source #1 | Distance 10 ft. |
| 2                             | 5 ft.           |
| 3                             | 10              |
| 4                             | 6 ft.           |

Guide factors #1 56 #2 28 #3 56 #4 33.6

I usually use 40 ↗



Aug 8, 1951.  
Harold E. Edgerton

For the last few days I have been working on a photoelectric pickup device to measure the light output through magneto-optic shutters.

I find that a 1000 ohm output resistor is required to give suitable frequency response with existing capacity in the leads and the scope. i.e. a 935 phototube with 1000 ohms as a load resistor and 2000 volt supply is not very sensitive.

$\frac{8 \times 10^{-6}}{1.58} = 3.2 \times 10^{-6}$

I find that a FT 214 with 10 mf at 2000 volts with a peak output of about  $8 \times 10^6$  candle power gives a  $\frac{1}{2}$ " deflection. Distance = 19" between phototube and flash lamp.

1000 ohm load R

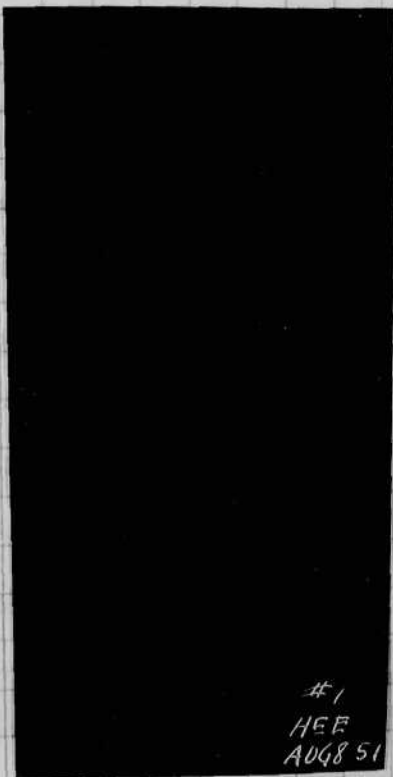
Osc 1-1

A photo multiplier with 1100 volts total and with a 5000 ohm load as used by E 9287

Osc 1-2

Wm Ward has been used some. This combination has tremendous sensitivity but lacks ability to follow fast transients?

An osc of the output from the PM tube using the same lamp conditions as above. a 1000x filter was used over the end of the tube before the P.M. tube. 3 ft of parallel leads were used between the PM device and the scope. Distance = 21"



1-5 <sup>dim</sup> or <sup>neg</sup>  
1-4

Osc 1-3 Distance = 15"

1-3

Osc 1-3 Special PM cell. Dist 15" 23" connected as shown on next page. Increased volts/stage. with extra volts (500) on 7th dynode. Filter X10,000.

1-2

more sensitive than regular PM but cannot give large output currents. This unit has a 1000 ohm load resistor. apparently the output can only give about  $\frac{1}{2}$  inch before saturated.

1-1

See later osc. for more com. phenomena.

#1  
HEE  
AUG 8 51

30 August 6, 1951.

Herbert E. Egerton

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The reflector for each test was arranged  
so that the light meter read 50 f.c.s.  
Then a series of exposures were made  
until the to cover the expected range.

From each group the aperture of f 5.6  
was selected as the most satisfactory.  
Slight color changes could be detected  
between sources 1 and 3. Source #1 was  
bluer than source #3.

Distances used were Source #1 Distance 10 ft.  
2 5 ft.  
3 18  
4 6 ft.

Guide factors #1 56 #2 28 #3 56 #4 33.6

I usually use (40) ↑

Aug 8, 1951.  
Harold E. Edgerton

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1000 ohm load R

$8 \times 10^6$   
1.58

$3.2 \times 10^6$

Osc 1-1

A photo multiplier with 1100 volts total and with a 5000 ohm load as used by E. H. P.

Osc 1-2

Wm Ward has been used some. This combination has tremendous sensitivity but lacks ability to follow fast transients?

An osc of the output from the PM tube using the same lamp conditions as above, a 1000x filter

was used over the end of the tube before the P.M. tube. 3 ft of parallel leads were used between the PM device and the scope. Distance = 21"

1-5 <sup>Dim</sup> or <sup>neg.</sup>

1-4

Osc 1-3 Distance = 15"

1-3

Osc 1-3 Special PM cell. Dist 15" 23"

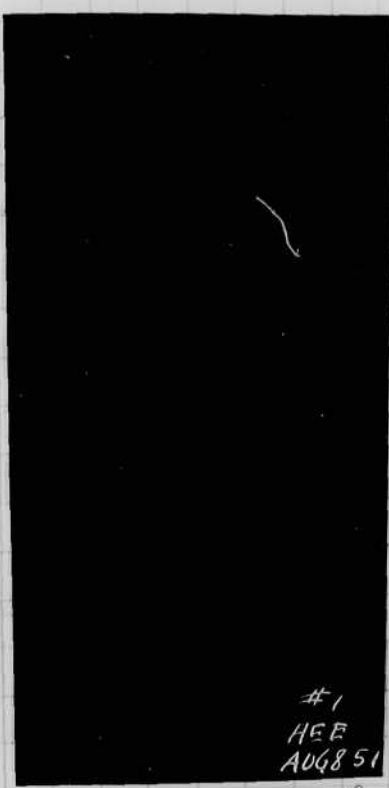
connected as shown on next page. Increased volts/stage. with extra volts (500) on 7th dynode. Filter  $\times 10,000$ .

1-2

more sensitive than regular PM but cannot give large output currents.

1-1

This unit has a 1000 ohm load resistor. apparently the output can only give about  $1/2$  inch before saturate

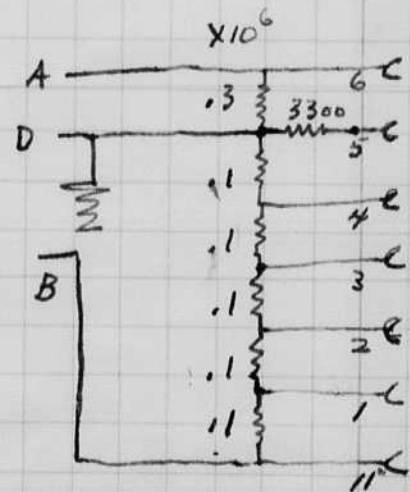
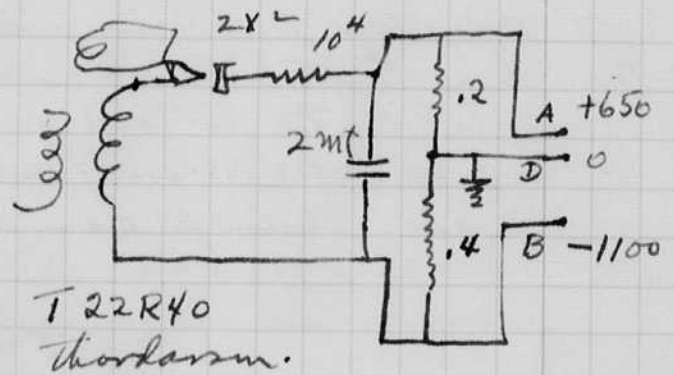
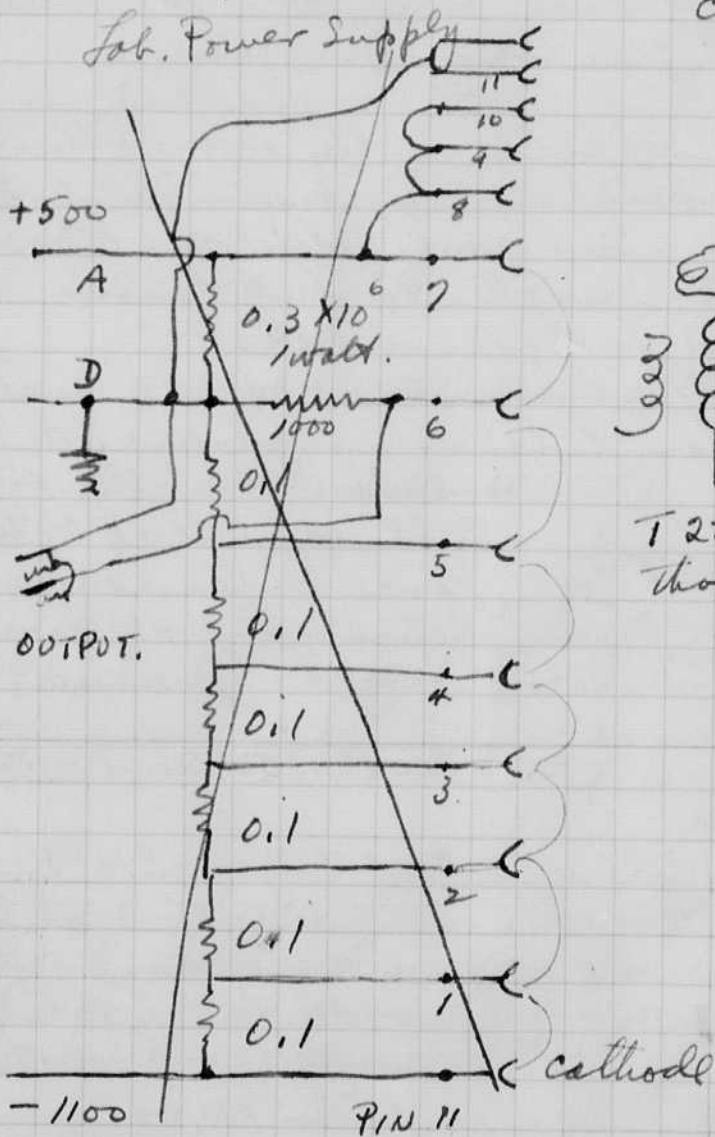
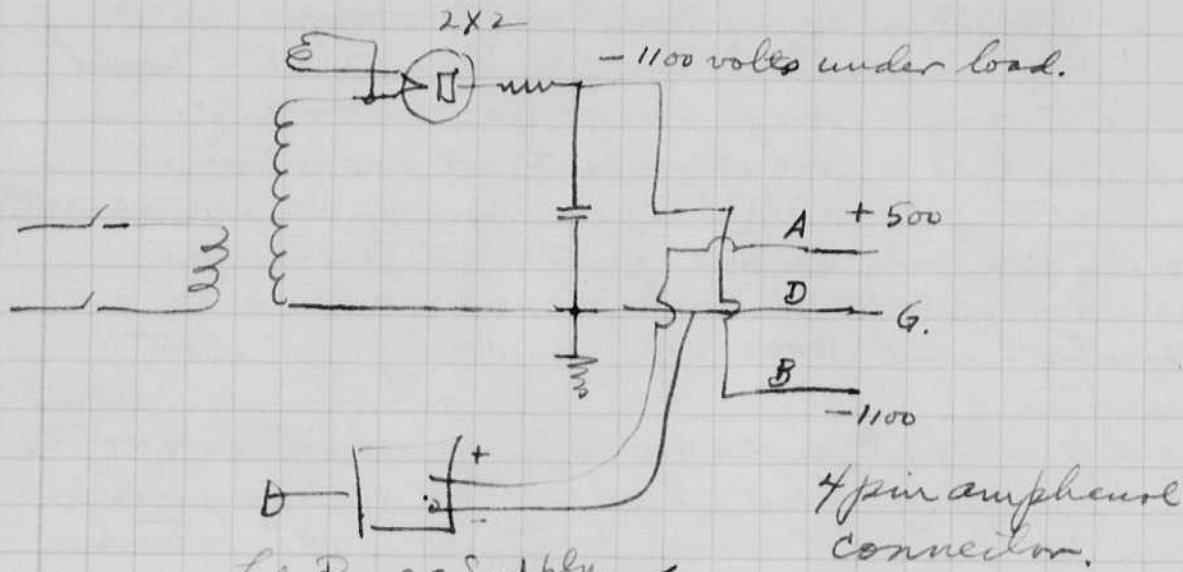


#1  
HEE  
AUG 8 51

See later osc. for more com. photos.



Special P.M. Pickups.



Note Since the output was so small - the 1000 ohm load resistor was replaced by a 3300 also a 0.1 mf was put on the 5-6 stage and a .01 on the 4-5, and a .0015 on the 3-4. The output pulse can now be about 3/4 inch before over loading occurs.

OSC 1-4 Special PM 3,300 load  
Filter x 10,000 optical.

D = 24  
= 18  
= 12

Filter x 1000 D = 24.

500 volts. last stage.

1100 volts first 5 stages.

also 935 cell <sup>no filter</sup> same circuit.

~~OSC 1-4~~ Also 935 cell 1000  $\Omega$   
12" no filter.

##

OSC 2-1 Microflash with  
Reflector

Sweep 7. 935 1000 in  
hot spot  
x 100 filter.

D = 18 miles to lamp.

On same photo spec 931.

x 10,000 also x 100 filters.

10<sup>6</sup> cycles.

OSC 2-2 10<sup>6</sup> cycles Sweep 6.

2-3. Oscillograms of output  
of P M 1 special unit  
now reconnected  
as shown on next

← page. 82.

x 10,000 filter 3 ft.

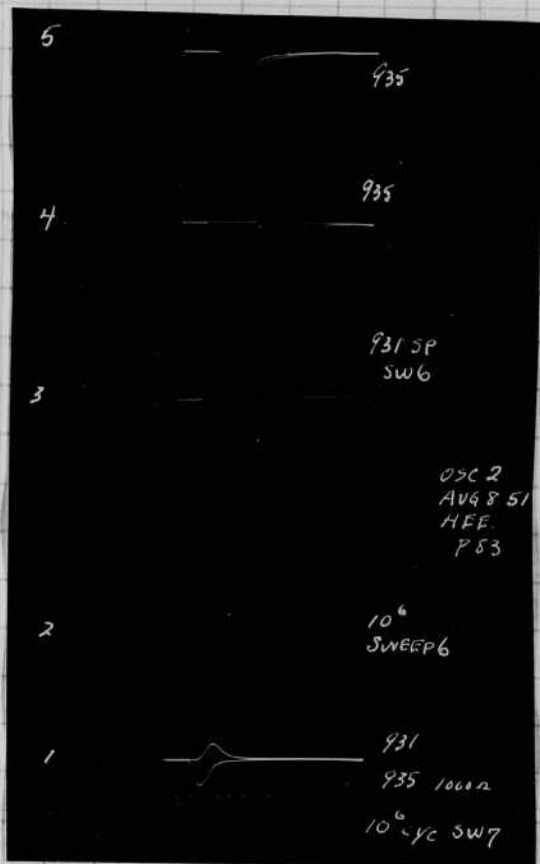
(1/2 filter and no filter)

2-4 Ditto 2-3.

with 935?

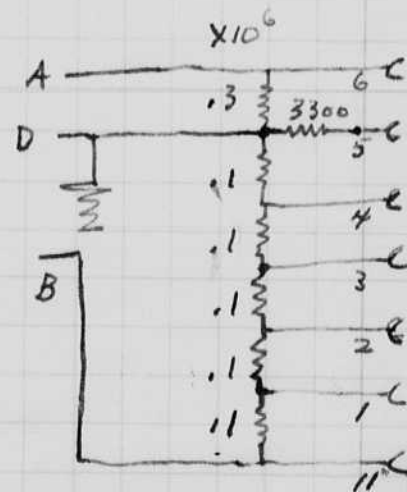
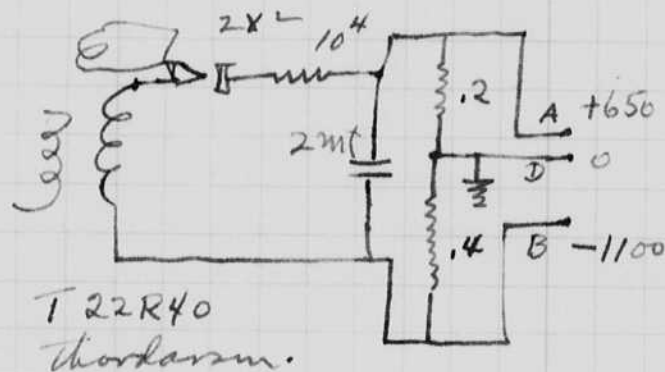
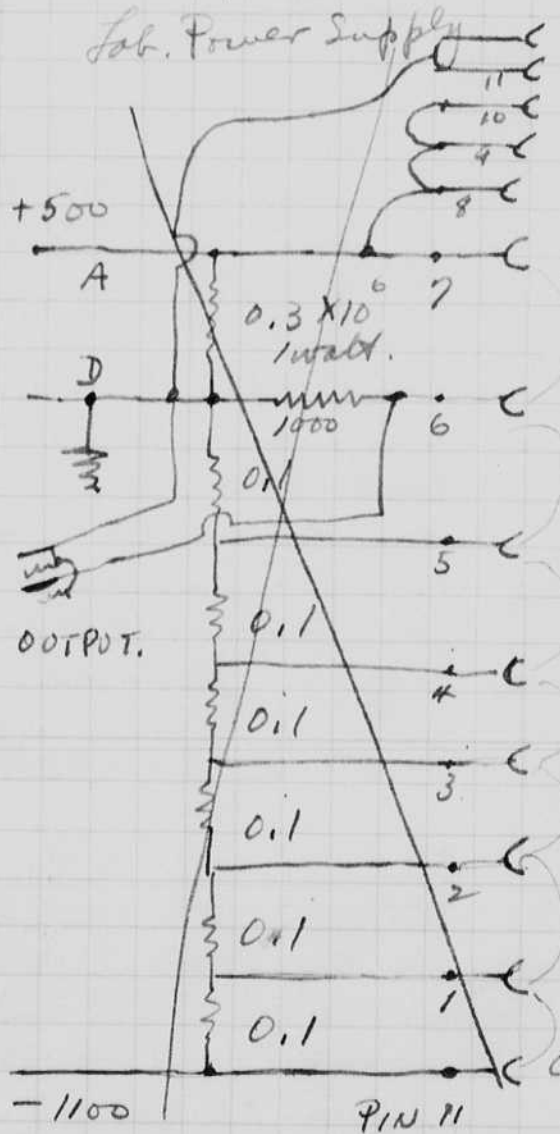
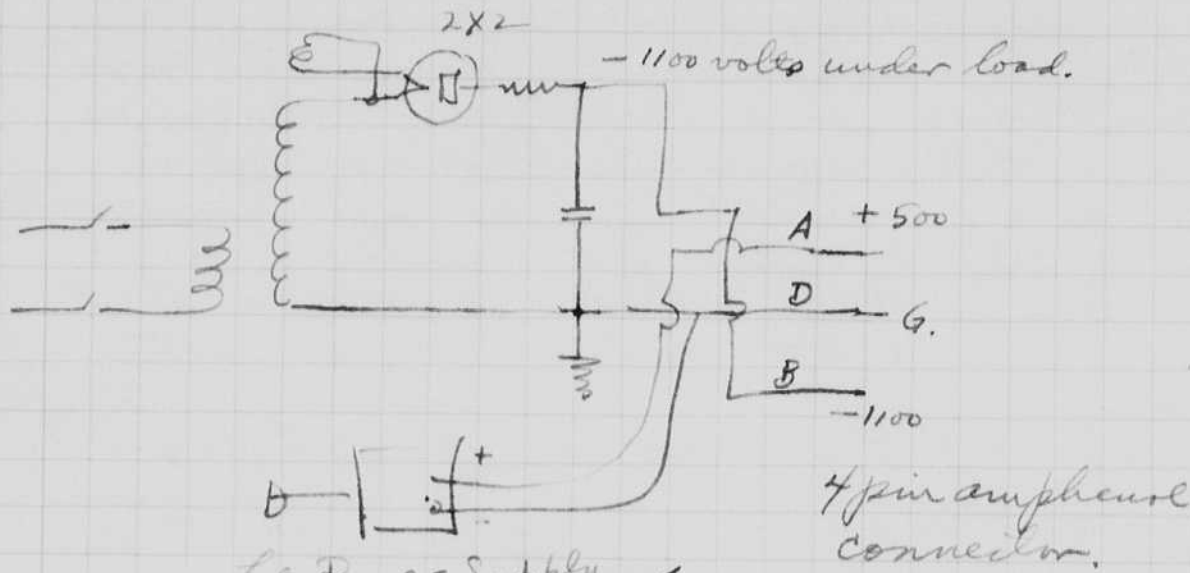
2-5

" 2-4





Special P.M. Pickup.



note Since the output was so small - the 1000 ohm load resistor was replaced by a 33000 also a 0.1 mF was put on the 5-6 stage and a .01 on the 4-5, and a .0015 on the 3-4. The output pulse can now be about 3/4 inch before over loading occurs.

OSC 1-4 Special PM 3,300 load  
Filter x 10,000 optical.

D = 24  
= 18  
= 12

Filter x 1000 D = 24.  
500 volts, last stage.  
1100 volts first 3 stages.

also 935 cell <sup>no filter</sup> same width.

OSC 2-1 Also 935 cell 1000  $\Omega$   
12" no filter.

##

OSC 2-1 Microflash with Reflector  
Sweep 2. 935 1000 in hot spot  
x 100 filter,  
D = 18 mils, 6 lamps.

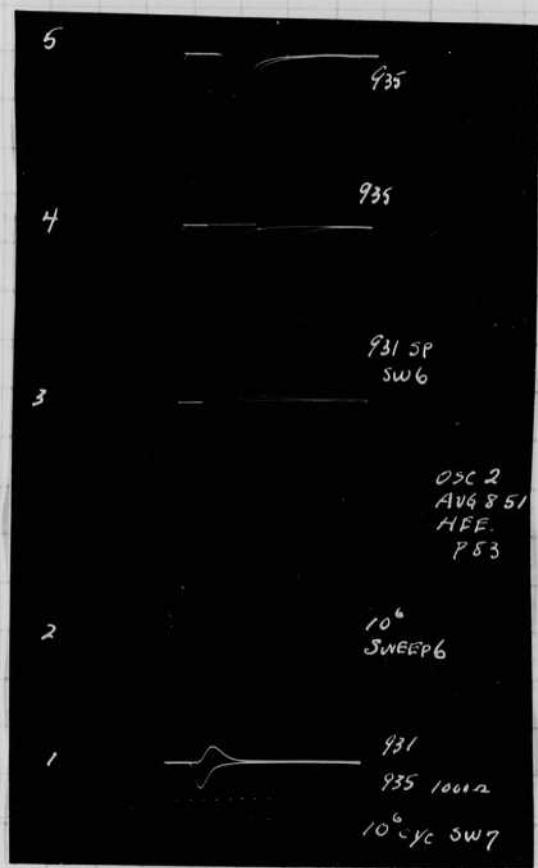
On same photo spec 931.  
x 10,000 also x 100 filters.  
10<sup>6</sup> cycles.

OSC 2-2 10<sup>6</sup> cycles Sweep 6.

2-3. Oscillograms of output of P 471 special unit now reconnected as shown on next page. 82.  
( $\frac{1}{2}$  filter and no filter)

2-4 Ditto 2-3. with 935?

2-5 " 2-4



note filler in starting new transformer to increase voltage then put in.

22R30

Replaced by Stancor P6011

Osc 3-1

FT-230 on microflash unit with series spark gaps to control starting.

3-1 S6

D = 18" ± to Std PM. cell.

10<sup>4</sup> Filter. then three photos taken 1/4 1/2 and 1 exposure.

3-2 S6

D = 18" ± to Spec PM cell equip 10<sup>4</sup> filter. then three photos taken as 3-1.

3-3 S6.

D = 5 1/2 feet S6.

to 935 with 1000 ohms.

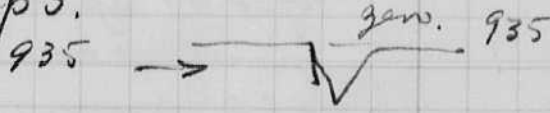
X10 filter then three shots with double attenuation as per above.

Osc 3-4. Sweep 5

New Light Source

.01 mf at 8 KV. Spark gap 1/8 inch in 2 inch. monev tubing with control gap. 935 at 3.5 inches with no filter. 1000 ohms.

Sweep 5.



Spec 931 x 100 filter

D = 9.5 inches.

Reg 931 X100 filt

D = 9.5 inches.



Osc 3-5

Double spark delay 1 on dial

Second spark 0.01 mf 8000v

first spark .005" "

Several osc to show jitter to be expected.

10<sup>6</sup> cycles.

Osc 2-1 P83 shows 10<sup>4</sup> Sens Ratio

|   |                                                              |
|---|--------------------------------------------------------------|
| 5 | " " 1 ON DELAY DIAL. SW 6.                                   |
|   | 10 <sup>6</sup> cyc.                                         |
| 4 | 935 .01 mf<br>931 SP 8 KV.<br>931 SP LIGHT<br>931 SW 5       |
|   | 10 <sup>6</sup> cyc.                                         |
| 3 | 935 1000 Ω<br>FT-230                                         |
| 2 | SPEC 931<br>FT-230<br>1, 2, 4.                               |
|   | Osc 3<br>AV4851<br>HEE<br>P84.                               |
| 1 | STD 931<br>FT-230<br>1, 2, 4.<br>SW 6<br>10 <sup>6</sup> cyc |

note that 935 with 1000 ohms shows ripples better than 931 tubes

Comments on Photo Pickups.

1. 935 seems best but 3.2 x 10<sup>6</sup> f.c. is required for 1/2 inch def.

2. Above osc says that 931 is about 80x more sensitive than 935. This seems low?

3. From exp (3-4) the 931 is 740x 935 sens. Probably above in error due to misalignment of light spot.

Aug 9 1951  
H. E. Edgerton

$8 \times 10^6 \times \left(\frac{3}{5}\right)^2 = 3.2 \times 10^6$   
 $\frac{3}{25} \times 10^6 = 0.12 \times 10^6$   
 sparks - 500  
 500 sparks

Sept 75  
for about

Osc 1-1 Delay dial set at 1. on two flashes.  
 Second gap has 0.01 mf at 8KV.  
 Plate voltage on 2D21 increased to 400+  
 7 photos to show delay plus  $10^6$  cyc.  
 935 photocell at 3 inches  
 no filter. 1000 ohms. Sw 6.

Osc 1-2 Delay set at 2. Sweep 7.  $10^6$  cyc.

Osc 1-3 " " " 3 " 8  $10^6$  cyc

1-4 " " " 4 " 8  $10^6$

1-5 " " " 5 " 8 -

7.5 = 10<sup>6</sup>

Calibration of delay with  
 new transformer in power  
 supply.

$CE^2 = \frac{1.24^2}{8 \times 2} = 36 \text{ watt sec.}$

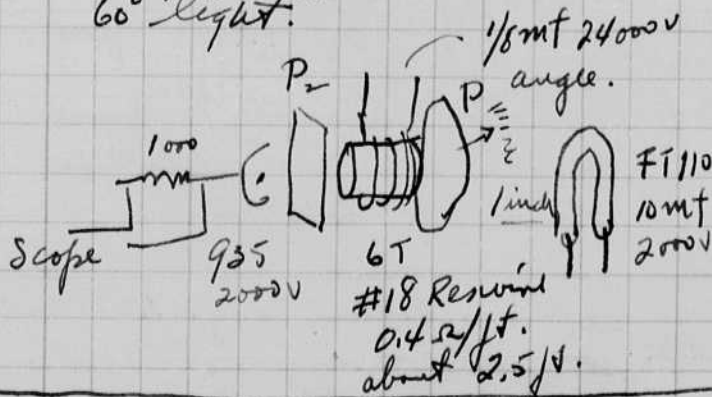
Osc 2-1 Voltage for 24KV Magneto optic Sw 7.  
 shutter  $10^6$  cycles.  
 6 Turns  $1\frac{1}{4}$ " diam  $10\frac{1}{2}$ " twisted leads.

2-2 Voltage with cond. shorted  $10^6$   
 Sweep 7.

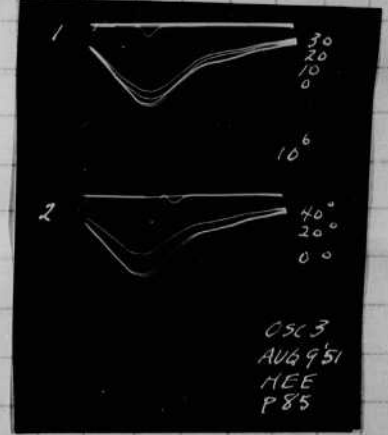
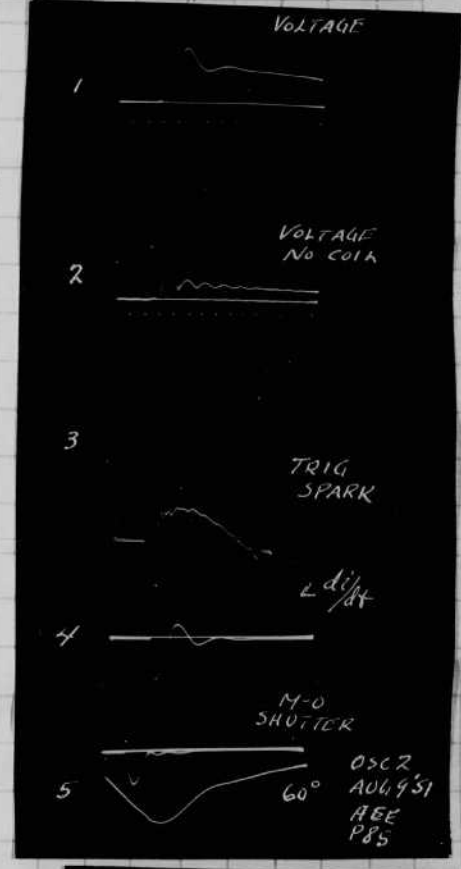
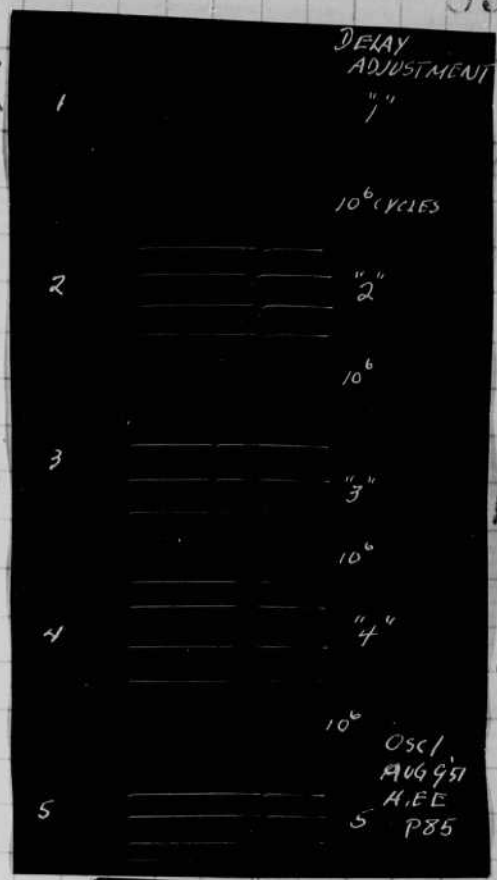
2-3 Spark voltage into gap.

2-4  $L \frac{di}{dt}$  in main circuit as (2-1)

2-5 zero.  
 Magneto effect. EDF 4.  
 60° light.



Repetitive  
 $\frac{1}{8} \text{ mf} \times 8 = 128 \text{ watt sec.}$



Osc 3-1 0, 10, 20, 30, 40 and zero  
 then zero with current pulse.

3-2 0 20 40 0 & M.O. " "  $10^6$  cyc



note filler in starting  
new transformer to increase voltage  
then put in.

22 R 30  
Replaced by  
Stancov P6011

Osc 3-1

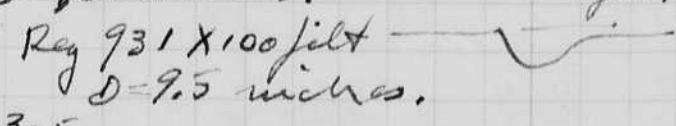
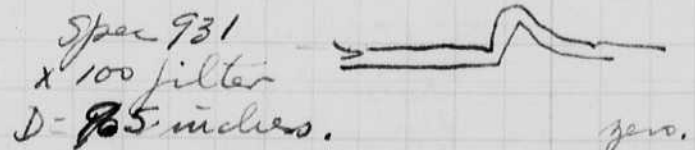
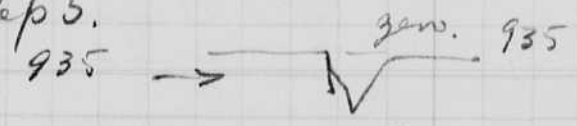
FT-230 on microflash unit with series spark gaps to control starting.

3-1 S6  
D = 18" ± to Std PM. cell.  
10<sup>4</sup> filter. then three photos taken  
1/4 1/2 and 1 exposure.

3-2 S6  
D = 18" ± to Spec PM cell equip  
10<sup>4</sup> filter. then three photos taken as 3-1.

3-3 S6.  
D = 5 1/2 feet S6.  
to 935 with 1000 ohms.  
x10 filter then three shots with double attenuation as per above.

Osc 3-4. Sweep 5  
New Light Source  
.01 mfd at 8 KV. Spark gap 1/8 inch in 2 inch. nonex tubing with control gap.  
935 at 3.5 inches with no filter. 1000 ohms.  
Sweep 5.



Osc 3-5  
Double spark delay 1 on dial  
Second spark .01 mfd 8000V  
first spark .005 " "  
Several osc to show jitter to be expected.  
10<sup>6</sup> cycles.

Osc 2-1 P83 shows 10<sup>12</sup> Ratio

|   |                                                                  |
|---|------------------------------------------------------------------|
| 5 | " " 1 ON DELAY DIAL. SW 6.                                       |
|   | 10 <sup>6</sup> cyc.                                             |
| 4 | 935 .01 mfd<br>931 SP 8KV.<br>931 SP LIGHT<br>931 SW 5           |
|   | 10 <sup>6</sup> cyc.                                             |
| 3 | 935 1000 Ω<br>FT-230                                             |
| 2 | SPEC 931<br>FT-230<br>1, 2, 4.<br>Osc 3<br>AV4851<br>HEE<br>P84. |
| 1 | STD 931<br>FT-230<br>1, 2, 4.<br>SW 6<br>10 <sup>6</sup> cyc     |

note that 935 with 1000 ohms shows ripples better than 931 tubes

Comments on Photo Pickups.  
1. 935 seems best but 3.2 x 10<sup>6</sup> f.s. is required for 1/2 inch def.

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Aug 9 1951  
 H. E. Egerton

$8 \times 10^6 \times \frac{3}{25} =$   
 $\frac{3}{2} \times 10^6 = 3 \times 10^6$   
 peak.  
 Spikes. SWB

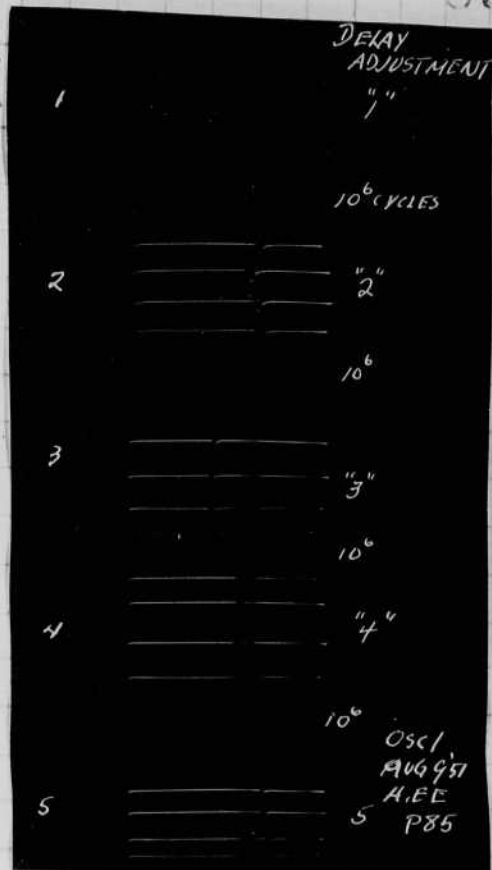
Sept 75  
 for about

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 Second gap has 0.01 mf at 8KV.  
 Plate voltage on 2D21 increased to 400+  
 7 photos to show delay plus  $10^6$  eye.  
 935 photocell at 3 inches  
 no filter. 1000 ohms. SWB.

osc 1-2 Delay set at 2. Sweep 7.  $10^6$  eye.  
 osc 1-3 " " " 3 " 8  $10^6$  eye  
 1-4 " " " 4 " 8  $10^6$   
 1-5 " " " 5 " 8

$7.5 \times 10^{15}$

Calibration of delay with  
 new transformer in power  
 supply.



1.15  
 15.3  
 20.7  
 1.55  
 20.7  
 1.75  
 24.7

$CE^2 = \frac{1.24^2}{8 \times 2} = 36 \text{ volt}^2 \text{ sec.}$

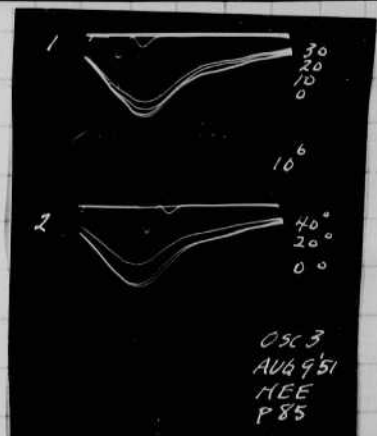
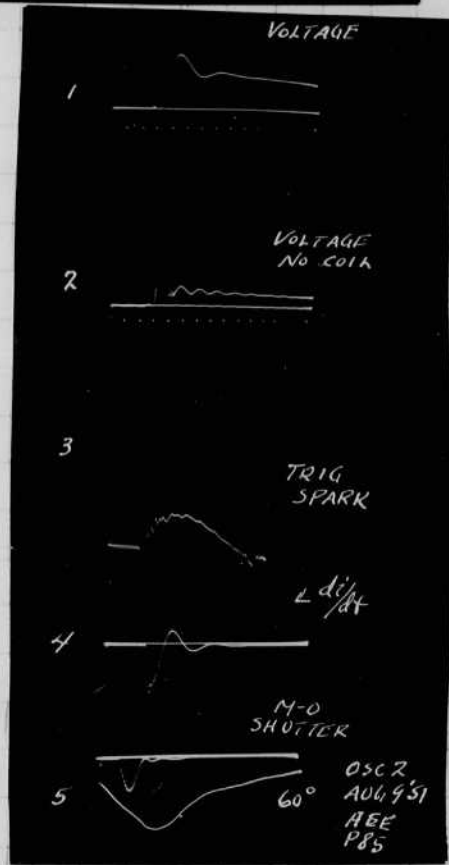
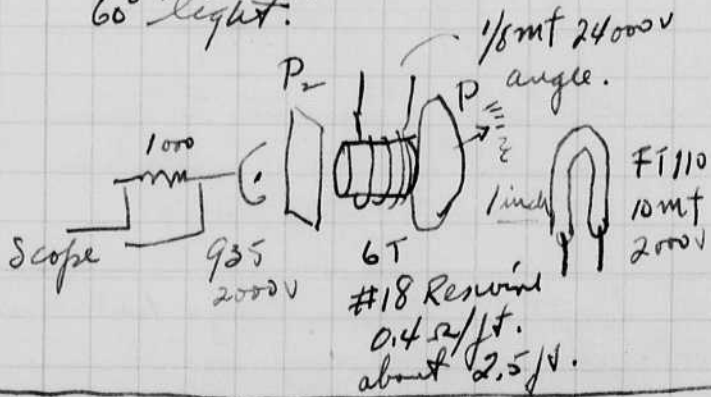
osc 2-1 Voltage for 24KV magnetoptic SW 7.  
 shutter  $10^6$  cycles.  
 6 turns  $1\frac{1}{4}$ " diam  $10\frac{1}{2}$ " twisted leads.

2-2 Voltage with cond. shorted  $10^6$   
 Sweep 7.

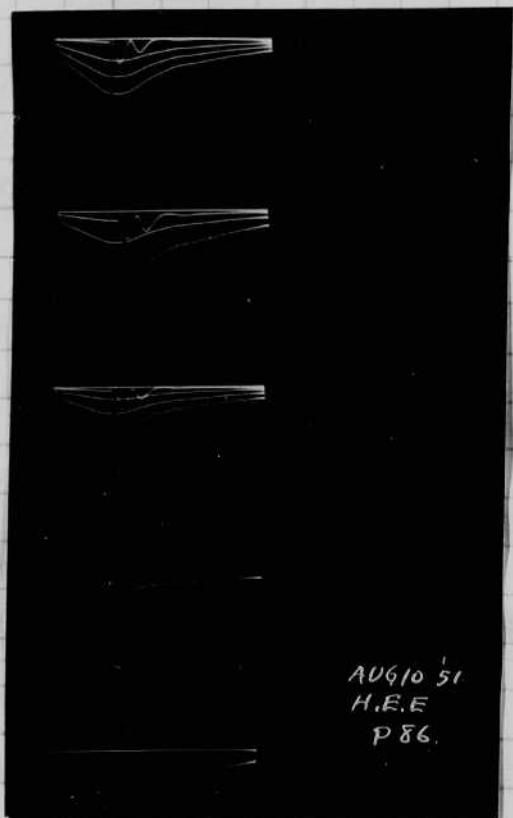
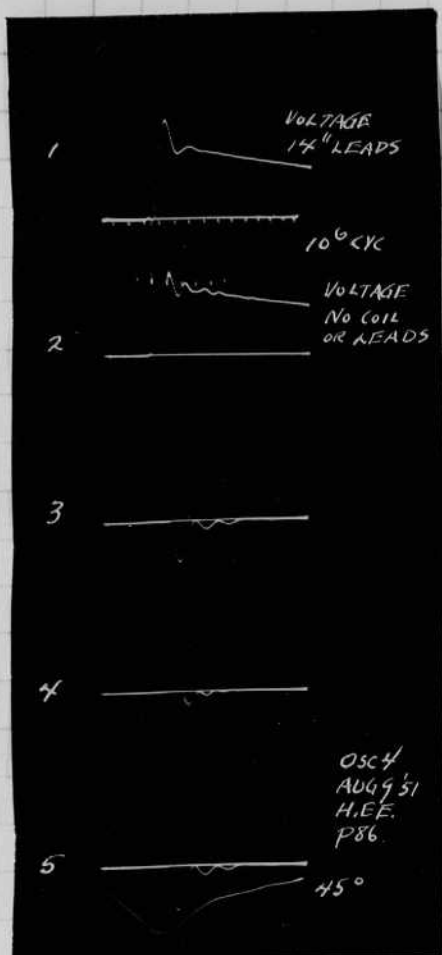
2-3 Spark voltage into gap.  
 2 di/dt in main circuit as (2-1)

2-5 zero.  
 Magneto effect. EDF 4.  
 60° light.

Repatronic  
 $8 \times 2 = 128 \text{ us} / \text{sec.}$



osc 3-1 0, 10, 20, 30, 40 and zero  
 then zero with current pulse.  
 3-2 0 20 40 0 & M.O. ... ..  $10^6$  eye



Osc 4-1  $\frac{1}{8}$  mt condenser with  
twisted leads of .4 ohms/ft  
14" ~~double length~~ length each.  
24 KV. Shorted through  
gap. 10° cyc SW 7.

Osc 4-2 no leads. Condenser freq.

4-3. adjustable front with  
polarizer glued on.  
B.U. colored yellow glass.

4-4. Ditto except leads sparked!

4-5. Ditto zero and 45°.

this coil has an 8 turn  
winding.

Aug 10 1951 H.E.E. Dyerton.

meas. of Magneto optic const.

Lamp FI-110 with 10 mt 2000 volts.

P.C. 935 with 1000 ohms.

$\frac{1}{8}$  mt at 28 KV for surge current  
into a 5 turn coil.  $L = 1$  ohm t.

1-1

EDF 4 Bl. Lamb Glass 0 20° 30° 40° 010.  
Length 3.1 cm.

1-2

Flint glass from Jones optical clear length 3.8  
gap fine by self. ~~increased~~  
decreased input volts from 98 to 81  
on main scale.

1-3

EDF 4 Length 4.1 cm 0 10° 20° 30°  
entire length not covered by coil

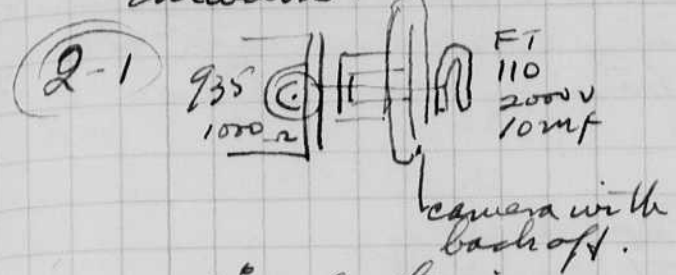
1-4

Rutile. 1" length  $\frac{1}{2}$ " diam.  
cannot see any rotation.  
45° angle with surge.

Sapphire 3.7 cm long. 1.25 cm diam  
cannot see any rotation.  
45° angle with surge.

OK 2.

35 mm camera as used at Eniwetok.

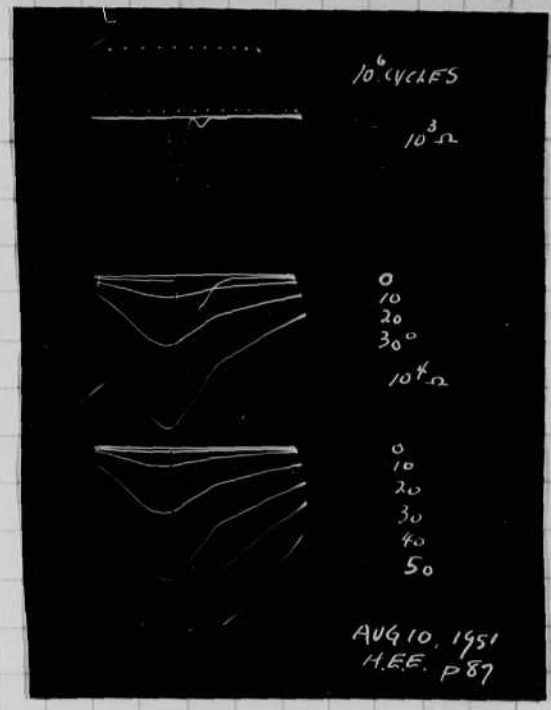


10° cycle timing wave.

2-2 Same slug but with angle analyzer.

also 10,000 ohm in 935

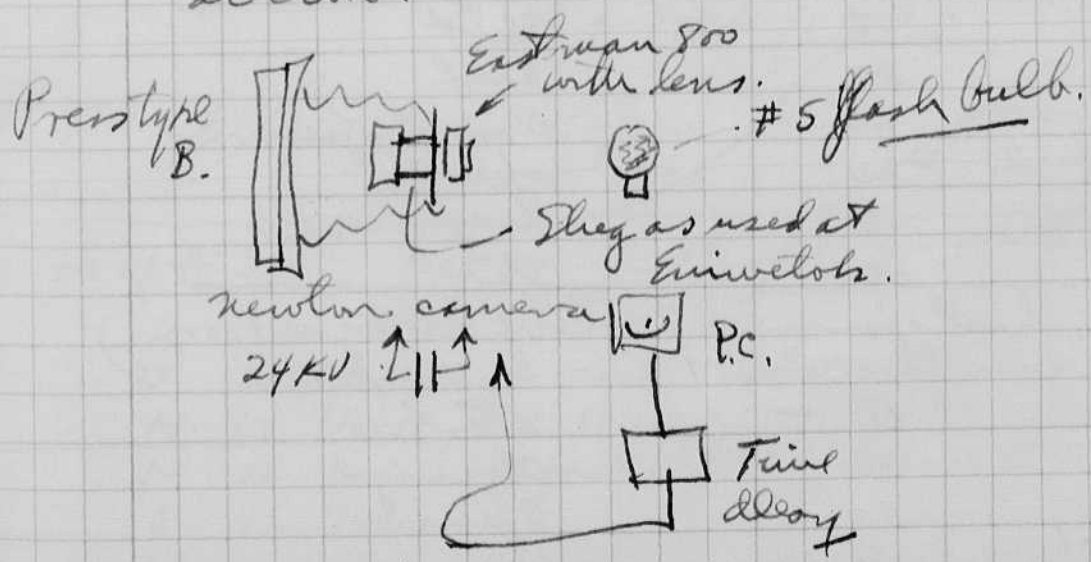
2-3 0 10 20 30° A.M.O.



1 1/2" length of EDF4 ?

The magneto optic shutter was now assembled in a shutter and several photos were taken of #5 flash bulbs.

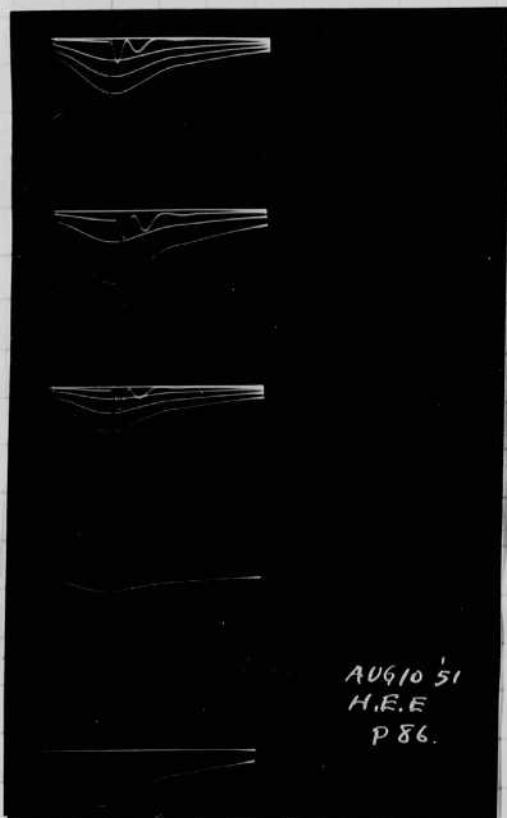
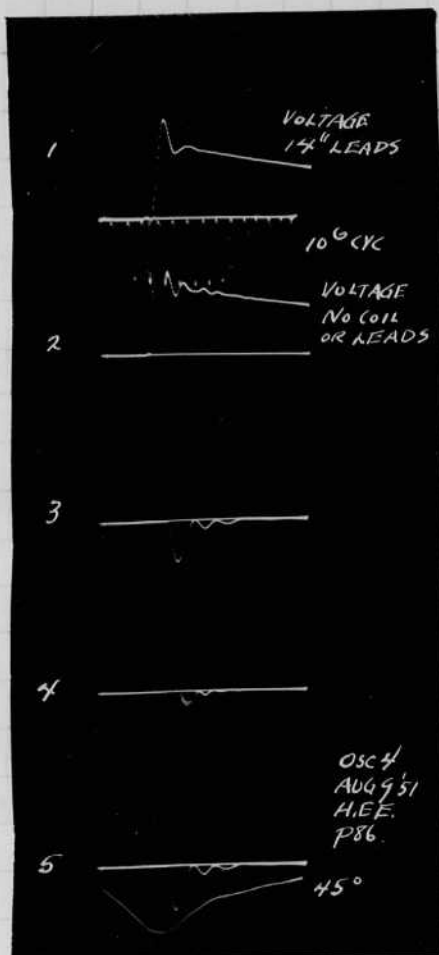
1. MO Shutter closed  
mechanical shutter open  
#5 about 1 to 1 or film.  
Photo taken to show light leakage at full aperture. Density on film at center of action.



2 Photo of bulb 1/100 sec x cont on shutter delay 5 m.s. - Shows burning of wire.

3. Ditto 2.5 m.s.

4. Ditto 20 This showed no photo, since mechanical shutter had closed.



osc 4-1  $\frac{1}{8}$  mf condenser with  
twisted leads of .4 ohms/ft  
14" ~~double length~~ length each.  
24 KV. Shunted through  
gap.  $10^\circ$  cyc SW 2.

osc 4-2 no leads. condenser freq.

4-3. adjustable front with  
polarizer glued on.  
B.V. colored yellow glass.

4-4. Ditto except leads sparked!

4-5. Ditto zero and  $45^\circ$ .

this coil has an 8 turn  
winding.

Aug 10 1951 H.E.E. Edgerton.  
meas. of magnetooptic const.

Lamp FI-110 with 10 mf 2000 volt.

P.C. 935 with 1000 ohms.

$\frac{1}{8}$  mf at 28 KV for surge current  
into a 5 turn coil.  $R = 1.0$  ohm t.

1-1

EDF 4 Blount Glass 0  $20^\circ 30^\circ 40^\circ$  Mo.  
Length 3.1 cm.

1-2

Flint glass from Jones optical clear length 3.8  
gap pins by self. ~~increased~~  
decreased input volts from 98 to 81  
on various scale.

1-3

EDF 4 Length 4.1 cm 0  $10^\circ 20^\circ 30^\circ$   
entire length not covered by coil

1-4

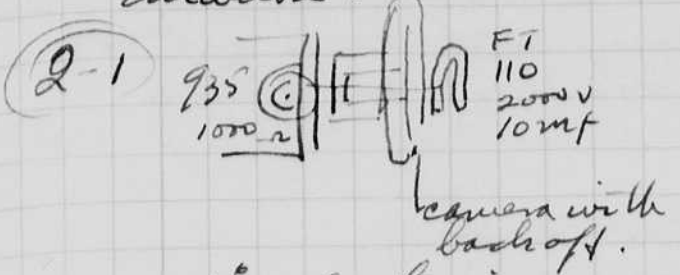
Rutile. 1" length  $\frac{1}{2}$ " diam.  
cannot see any rotation.  
 $45^\circ$  angle with surge.

Sapphire 3.7 cm long. 1.25 cm diam  
cannot see any rotation.  
 $45^\circ$  angle with surge.



OK 2.

35 mm camera as used at Eniwetok.

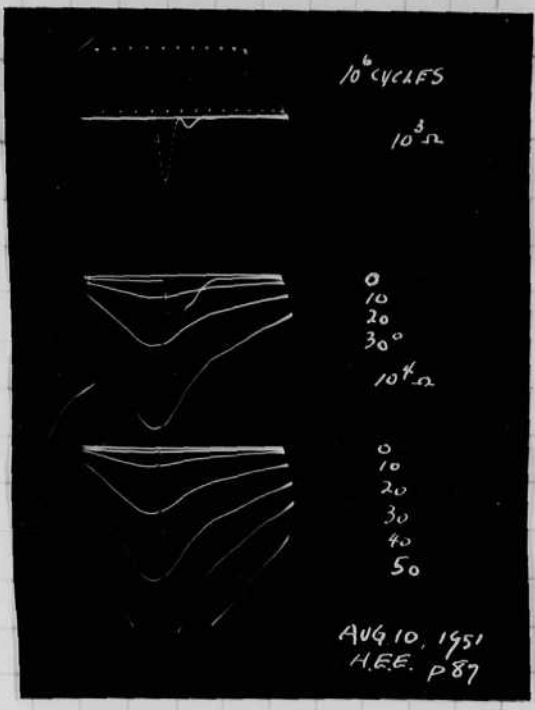


10° cycle timing wave.

2-2 Same slug but with angle analyzer.

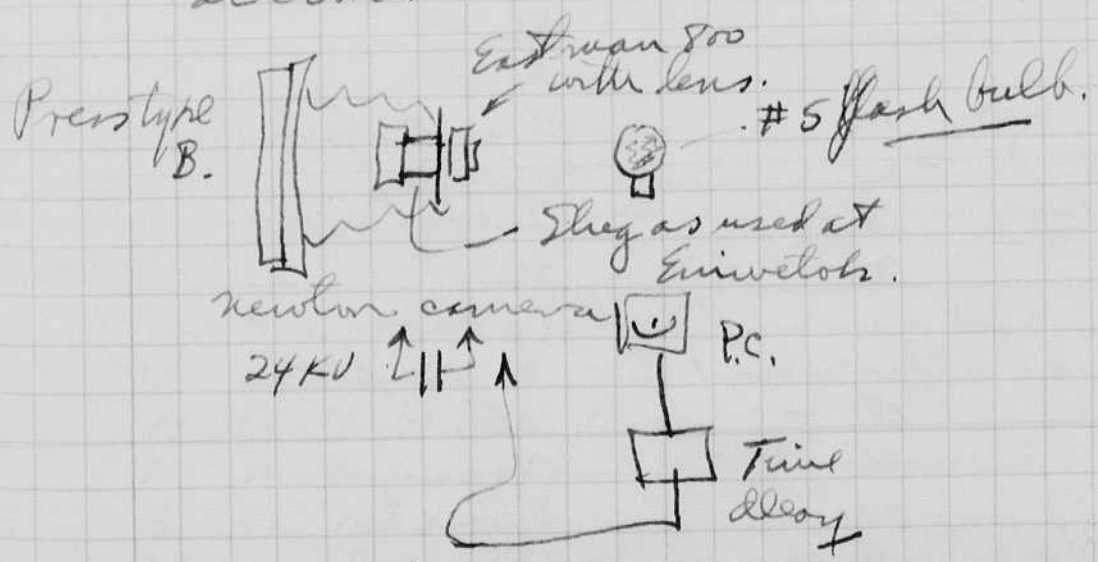
also 10,000 ohm in 935

2-3 0 10 20 30° Δ. M.O.



The magnets of the shutter was now assembled in a shutter and several photos were taken of #5 flash bulbs. 1 1/2" length of EDF4 ?

1. MO Shutter closed  
mechanical shutter open  
#5 about 1 to 1 or film.  
Photo taken to show light leakage at full aperture. Density = on film at center of action.



2. Photo of bulb 1/100 sec X cont on shutter delay 5 m.s. - Shows burning of wire.

3. Ditto 2.5 m.s.

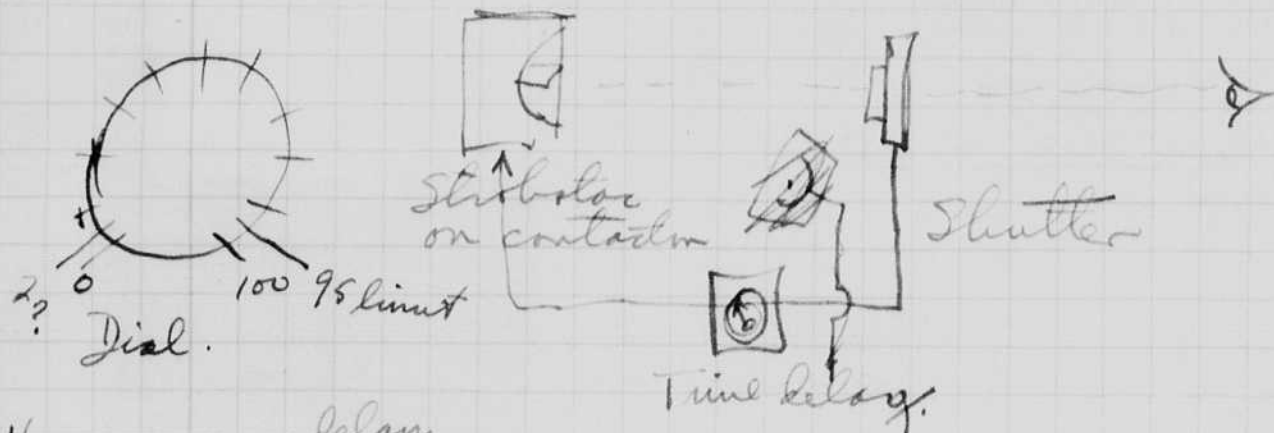
4. Ditto 10 This showed no photo, since mechanical shutter had closed.



Aug 14 1951  
H. E. Edgerton

A new gap was put in the 24KV circuit since the other kept arcing over through the insulated disk, the spacing was also increased by  $\frac{1}{16}$  inch.

Calibration of shutter delay.  
RY 3386.



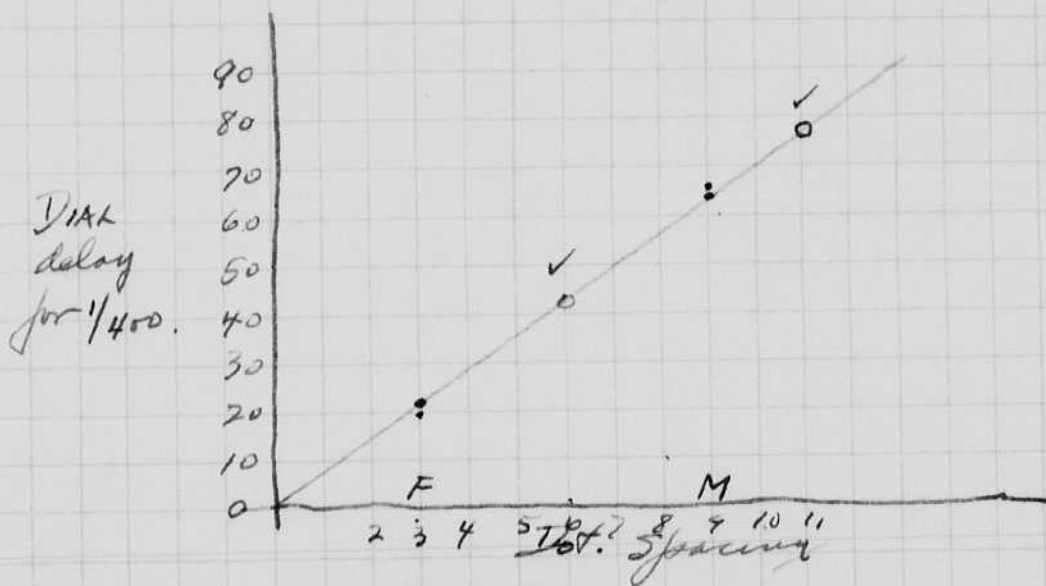
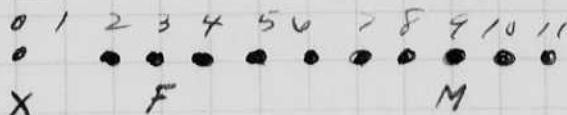
| $\frac{1}{800}$ sec. Shutter | Delay setting | Time delay dial. | T.D. Sec. | Remarks.              |
|------------------------------|---------------|------------------|-----------|-----------------------|
| X                            |               | 4 x 20           |           | Small star            |
| X                            |               | 3 x 20           |           | $\frac{1}{2}$ closed. |
| X                            |               | 2. x 20          |           | almost full open      |
| F                            |               | 15 x 20          |           | half opening.         |
| F                            | (18)          | 18               |           | open                  |
| F                            |               | 20               |           | start close.          |
| F                            |               | 21               |           | half closing          |
| F                            |               | 18               |           | start                 |
| F                            |               | 20               |           | half.                 |
|                              |               | 22               |           | almost open           |
|                              |               | 24               |           | open                  |
|                              |               | 28               |           | half closed           |
| F                            |               | 30               |           | star.                 |
| <hr/>                        |               |                  |           |                       |
|                              |               | 25               |           | open                  |
|                              |               | 24               |           | open                  |
|                              |               | 28               |           | half closed           |
|                              |               | 30               |           | star.                 |
| <hr/>                        |               |                  |           |                       |
| check                        | F             | 18               | -         | start                 |
|                              |               | 26               |           | closing?              |
| $\frac{1}{400}$              | (21)          | 20               |           | open                  |
|                              |               | 19               |           | opening               |
|                              |               | 22               |           | open                  |
|                              |               | 24               |           | closing.              |

(note, just observed that the delay set on the shutter was 1 div beyond F.)

| Shutter speed. | Shutter delay | Delay dial | T.D | Remarks. |
|----------------|---------------|------------|-----|----------|
| 1/400          | 1             |            |     |          |
| 1/400          | M             | 65.        |     | open     |
|                |               | 70         |     | half.    |
|                |               | 60 1/2     |     | half.    |
|                |               | 63 ✓       |     | open     |
|                |               | 67         |     | half.    |
|                |               | 65 ✓       |     | open.    |
|                |               | 64         |     | "        |

64

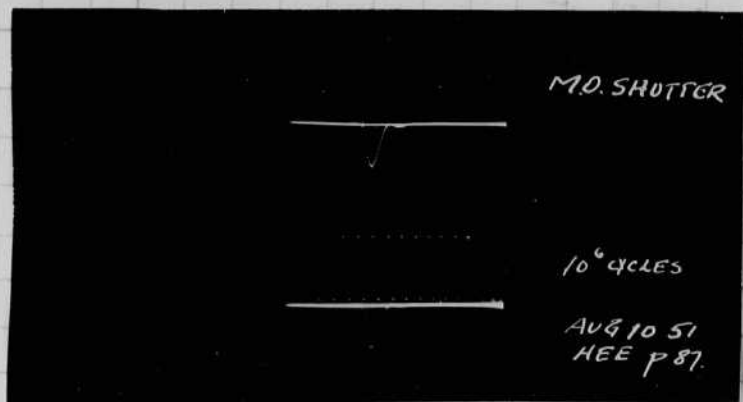
This dial has ten settings and X as per sketch →



Spacing delay at 42. ✓ open  
 " " 78 ✓ open

Photos of # 5. 1/50 sec 1 1/2 ft Spot 150 with Lucalux tent & show multi bulb.

- #1 3F 22 1/400 sec. 20" ±
- M 64 1/400 P.C closer 5"
- M 22 1/400 Repeat with P.C closer. 5" (5 sparks?)!!
- 6 42 1/400 Spark again
- M 1/400 M-O off to see if photo is taken.
- X 0 1/400 early shot.
- 7 4 28 1/400
- 8 SM 3F 22 1/400
- 8 " 0 0 1/400



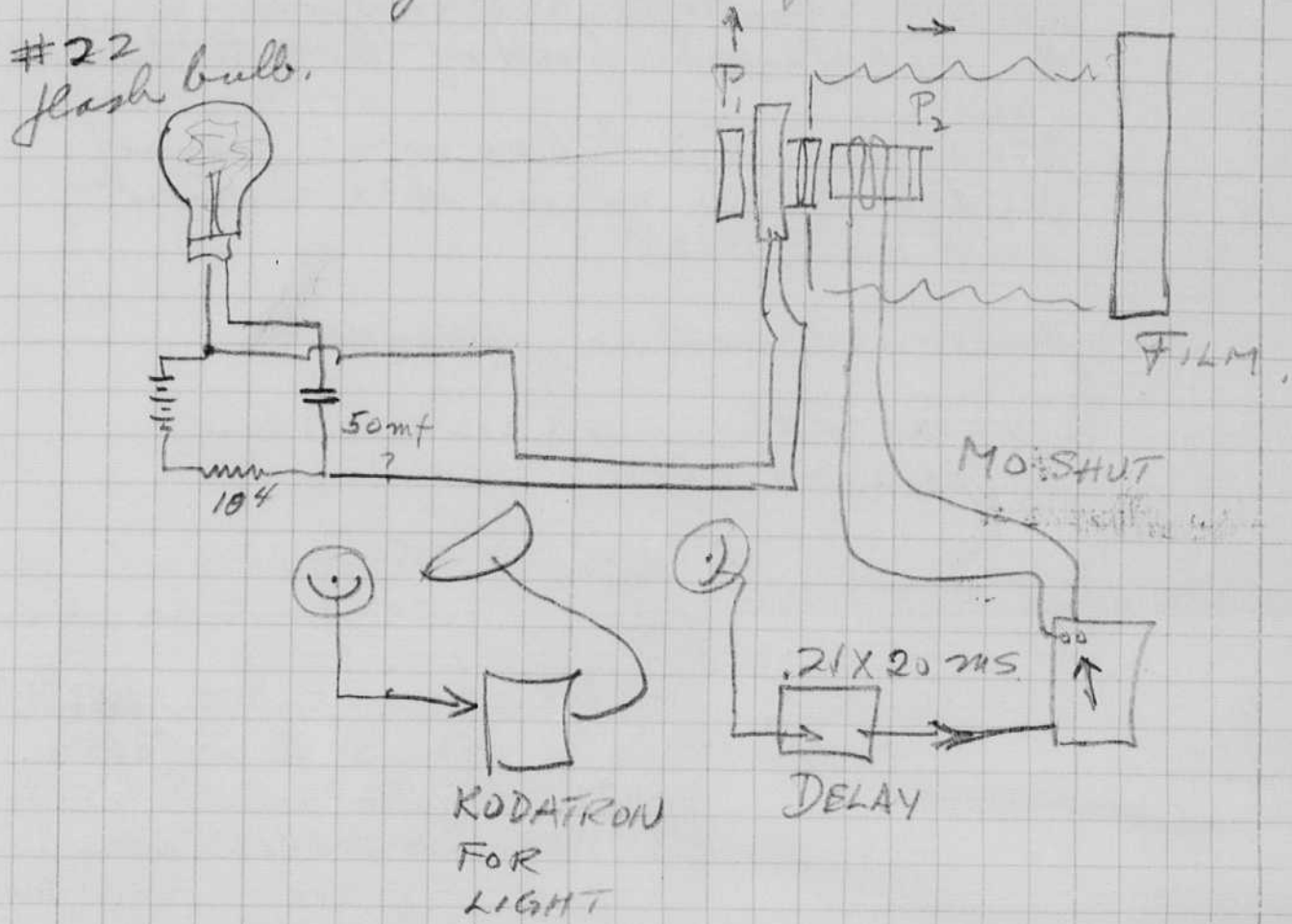
Aug 13 1951  
HEE

Tandem shutter.  
Eirevelok slug with  
Eastman 800 shutter and  
6" (?) doublet lens.  
Polarizer on outside.  
set at zero.  
coil - 7 turns of 0.63 ohms/ft.  
1/8 mf 24000 vltts. 100 on var.  
osc 1-1 M.O. shutter opening.  
osc 1-2 Ditto but with  
coil polarity reversed.  
10° cycles.

Tue  
 Aug 14 1951  
 #22  
 #22

Assembled second M.O shutter in  
 Eastman 800 shutter and Eastman  
 View camera.

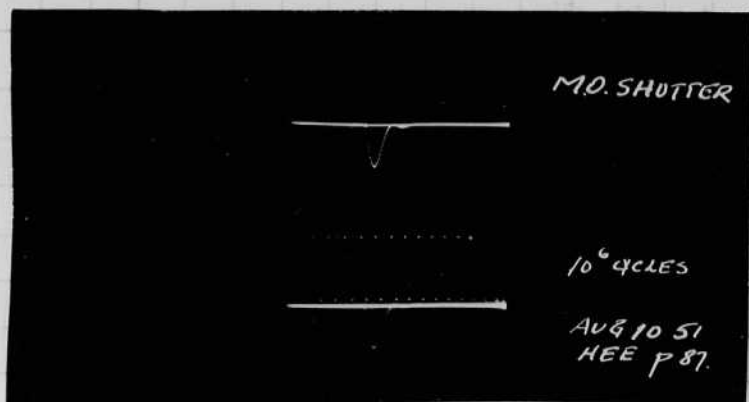
Polarizer is outside of lens.



this leaves light due to stripes in the lens.  
 note that the lens is between the polarizers!  
 at 1/400 sec the exposure of the #22 was about  
 right without the M.O. shutter.

Lens moved to outside. Polarizer now crosses  
 better but exposure on bulb #22 at M setting  
 1/400 is about the same. I then changed the  
 aperture setting to f11. the bulb image  
 is now dim.





Aug 13 1951  
HEE

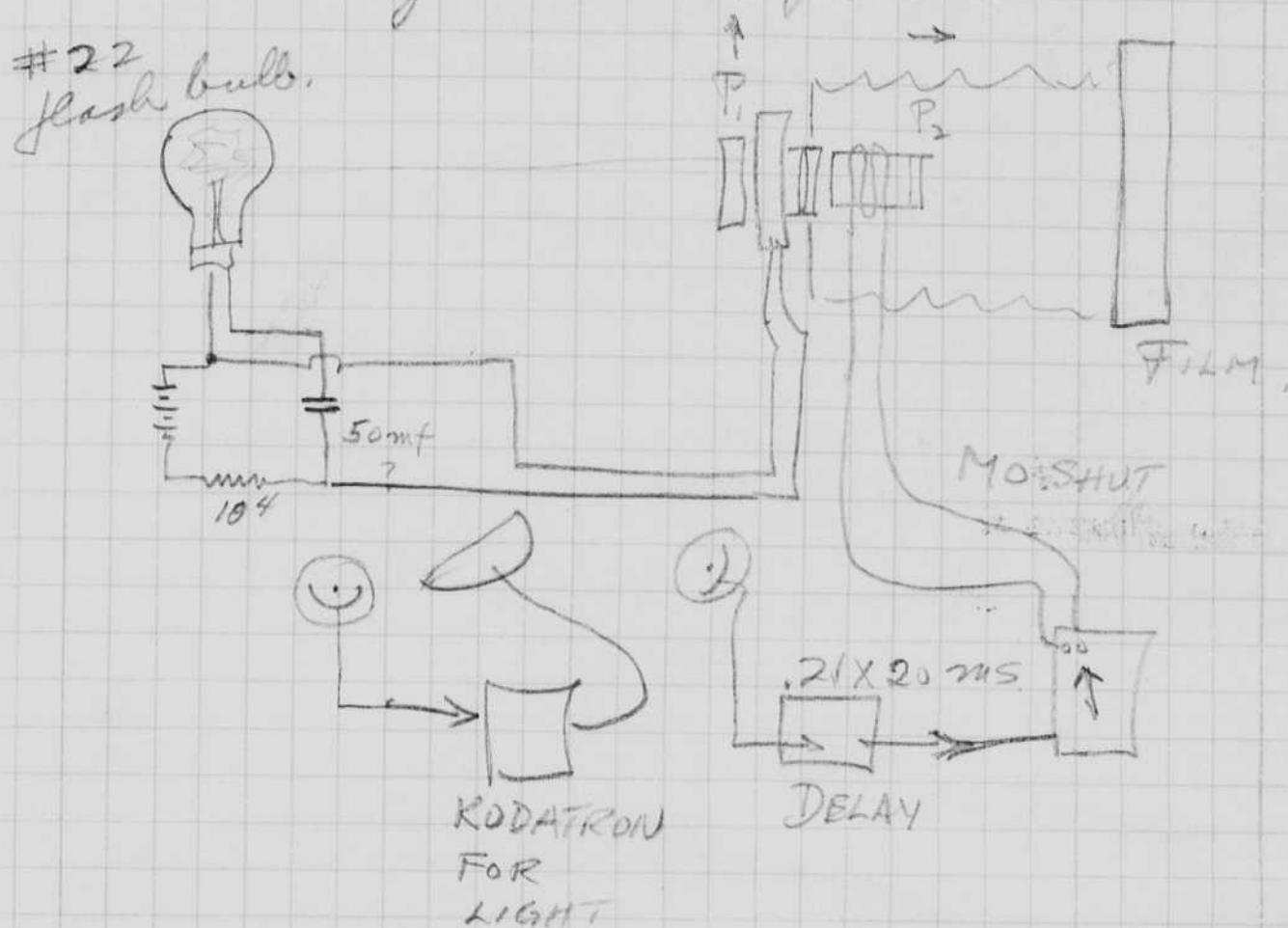
Friday shutter.  
Einvokob slug with  
Eckman 800 shutter and  
6" (?) doublet lens.  
Polarizer on outside.  
set at zero.  
coil - 7 turns of 0.63 ohms/ft.  
48 mf 24,000 volts. 100 on var.  
excl-1 M.O. shutter opening.  
excl-2 Ditto but with  
coil polarity reversed.  
10° cycles.

Two  
Aug 14 1951  
H. G. S. Jr.

91

Assembled second M.O. shutter in  
Eastman 800 shutter and Eastman  
View camera.

Polarizers outside of lens.



This leaks light due to stresses in the lens.  
note that the lens is between the polarizers!  
at  $1/400$  sec. the exposure of the #22 was about  
right without the M.O. shutter.

Lens moved to outside. Polarizer now crosses  
better but exposure on bulb #22 at M setting  
 $1/400$  is about the same. I then changed the  
aperture setting to f11. The bulb image  
is now dim.

92 Aug 15 1951  
H. E. E. H. E. E.

Special P.M. pickup as per p82 but with 3 tubes in parallel.

D = 18 inches Load R = 1000 [X 1000 filter]

FT-214 10 mf 2000 V peak:  $8 \times 10^6$  cp.

Deflection about 3/4 inch on screen.

Bronzed glass in front of three P.M. tubes.

By experiment, 3 tubes were found which balanced in sensitivity and output.

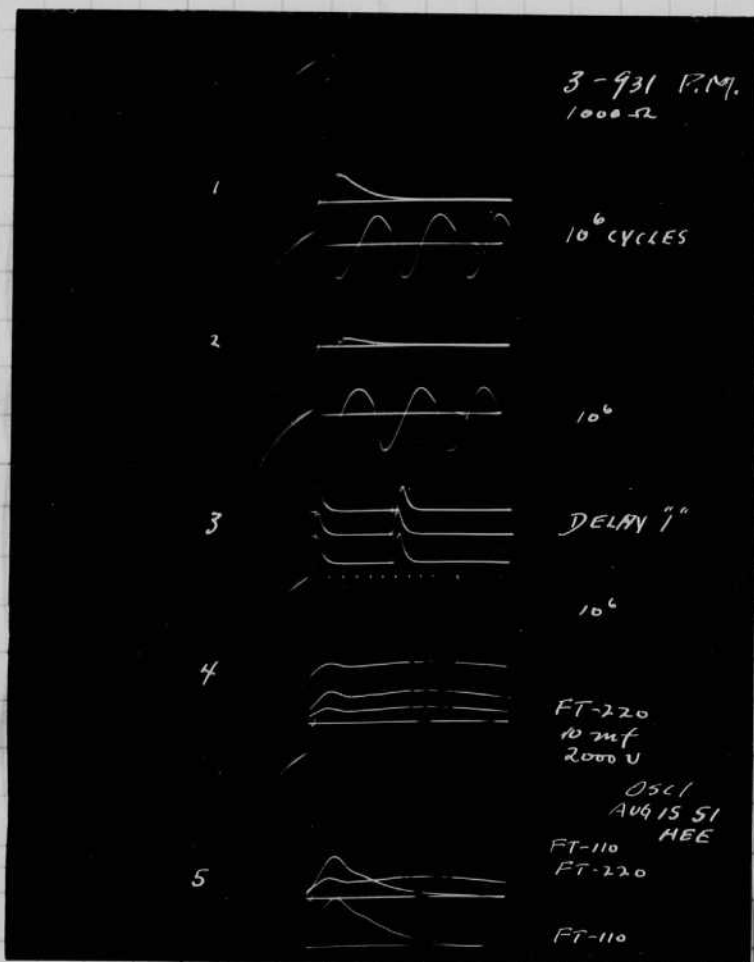
Two flasher next used as a source.

D = 12" Filter X 10 X 2 X 2 1000  $\Omega$  load.  
Spark 0.05 KV.

Osc 1-1 0.005 mf 8KV into glass arc  
3-931 pm tubes 1000  $\Omega$   
1 ft = D  
X 2 X 10 = 20 filter.  
Sweep 5  $10^6$  cycles.

Osc 1-2 Ditto except X 2 X 2 X 10 = 40  
1-3 Sw 7 F = X 20 Delay at "1".  
1-4 FT-214 SW 8  
Filter = X 1000  
D = 3 ft, 2 ft, 1 ft.

1-5 FT-214 SW 8 D = 1  
F = 1000 Y 2 X 2 = 4000  
also FT-110 with F =  $1000 \times 10^{10}$   
Trace lowered  
FT-110 with F = X 10,000  
(Single filter)

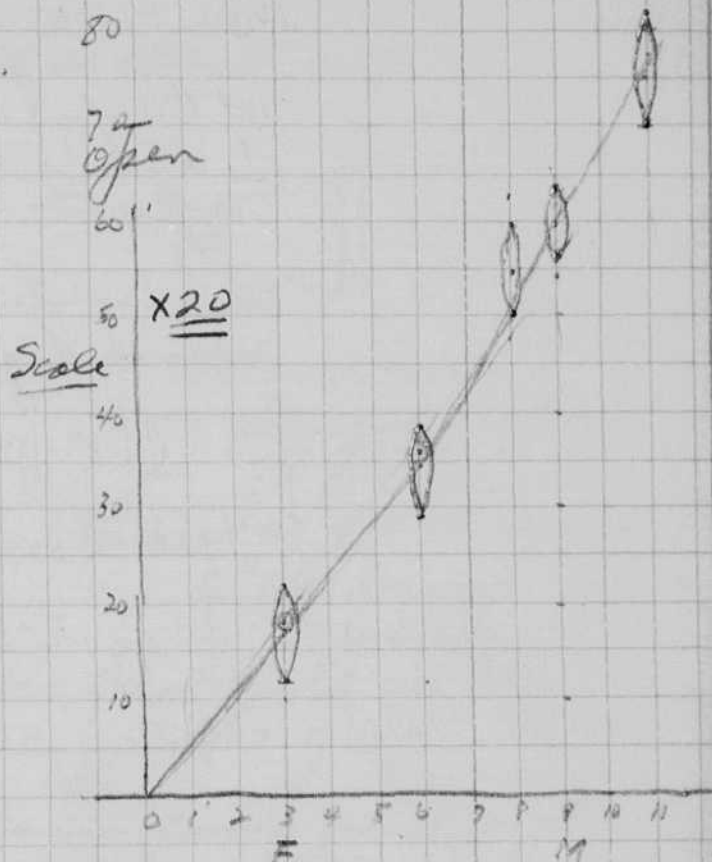


See p 89 for multiplier 23  
results on other

# Calibration of EK 800 type shutter (one with arm)

Scale setting Delay at Shut Set.

|    |        |            |
|----|--------|------------|
| OX | 0      | 1/400 sec. |
| F  | 18 X20 | 1/400      |
| M  | 56 X20 | 1/400      |



Photos with 1ms shutter  
#5 flash bulb. f full open  
Set at #6 delay (about 10 ms).  
Also two shots with M setting.

Fire cracker. Delay at 30 X 1. No photo from light  
from fire cracker.

Aug 17 1951.

Trigger circuit changed to sync 12KV 0.4 mF <sup>FT</sup> 230  
with shutter.

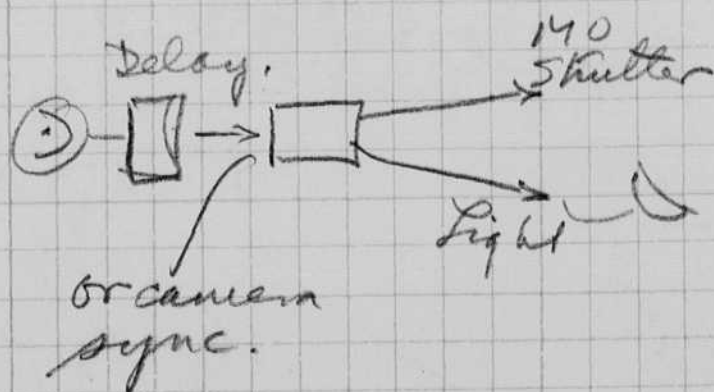


Photo delay  $.2 \times 20 = 4$  ms  
Too slow - Exp all over.

Photo delay  $-.25$  ms.  
Explosion earlier but  
still too undeveloped

Photo delay  $- 0$ .  
Early - Jet from one end



92 Aug 15 1951  
 #2 Experiment

Special P.M. pickup as per p82 but with 3 tubes in parallel.

D = 18 inches. Load R = 1000 [X 1000 filter]

FT-214 10mf 2000 V peak =  $8 \times 10^6$  c.p.

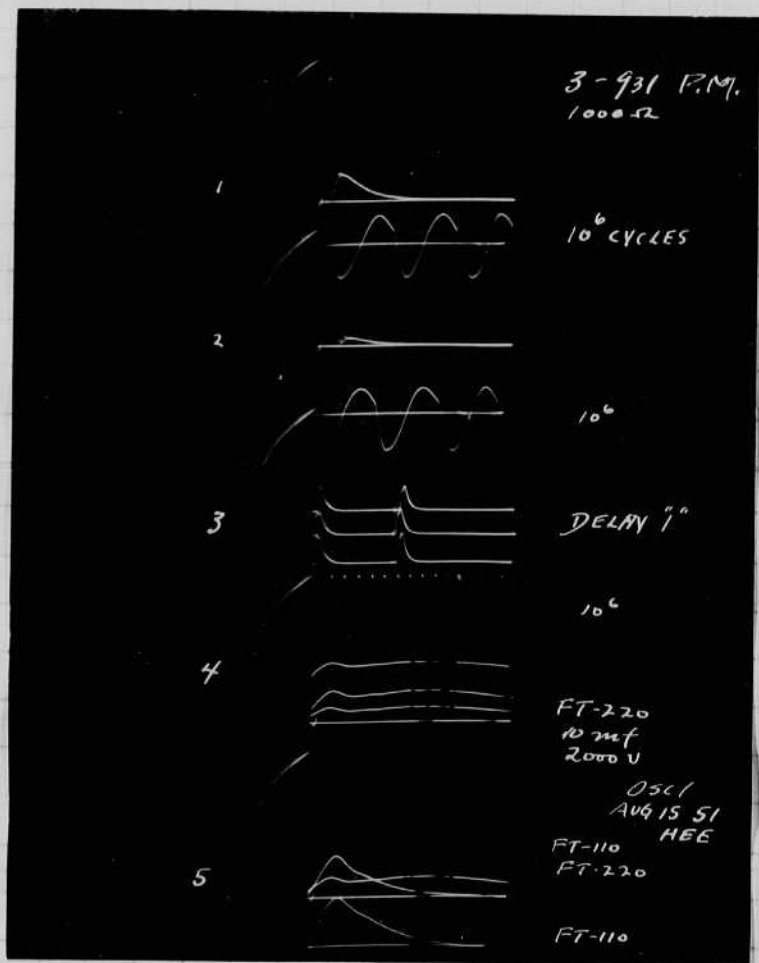
Defective about 3/4 inch on screen.

Ground glass in front of three P.M. tubes.

By experiment, 3 tubes were found which balanced in sensitivity and output.

Two flasher next used as a source.

D = 12" Filter X 10 X 2 X 2 1000  $\Omega$  load.  
 Spark 0.05 8KV.



Osc 1-1 0.005 mf 8KV into glass arc  
 3-931 pm tube 1000  $\Omega$   
 1 ft = D  
 X 2 X 10 = 20 filter.  
 Sweep 5  $10^6$  cycles.

Osc 1-2 Dillo except X 2 X 2 X 10 = 40  
 1-3 SW 7 F = X 20 Delay at "1".  
 1-4 FT-214 SW 5  
 Filter = X 1000  
 D = 3 ft, 2 ft, 1 ft.

1-5 FT-214 SW 5 D = 1  
 F = 1000 X 2 X 2 = 4000  
 also FT-110 with F =  $1000 \times 10^{10}$   
 Trace lowered  
 FT-110 with F = X 10,000  
 (Single filter)

FT-220  
 10 mf  
 2000 V

Osc 1  
 AUG 15 51  
 HEE

FT-110  
 FT-220

FT-110

See p 89 for similar results on other

# Calibration of EK 800 type shutter (one with arm)

Scale setting Delay at Shutter Set. 80

|    |        |            |      |
|----|--------|------------|------|
| OX | 0      | 1/400 sec. | 74   |
| F  | 18 X20 | 1/400      | Open |
| M  | 56 X20 | 1/400      | 60'  |

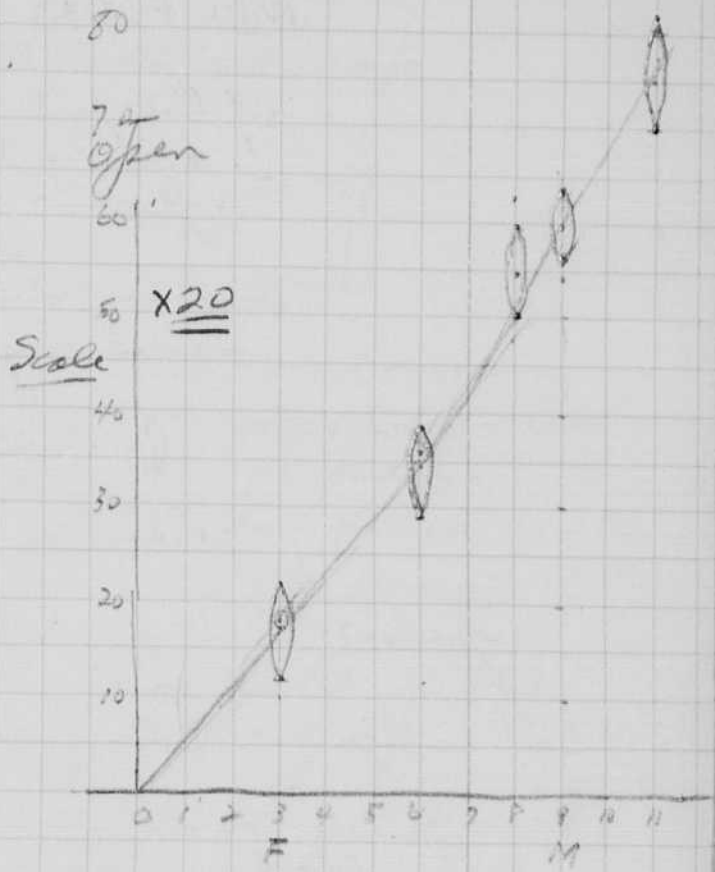


Photo with 1 ms shutter  
 #5 flash bulb. f full open  
 Set at #6 delay (about 10 ms).  
 Also two dots with M setting.

Fire cracker. Delay at 30 X 1. No photo from light from fire cracker.

Aug 17 1951.

Trigger circuit changed to sync 12KV 0.4 mF 230 FT with shutter.

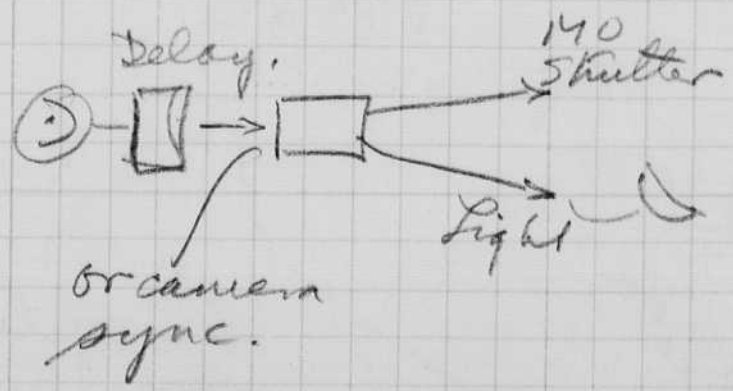
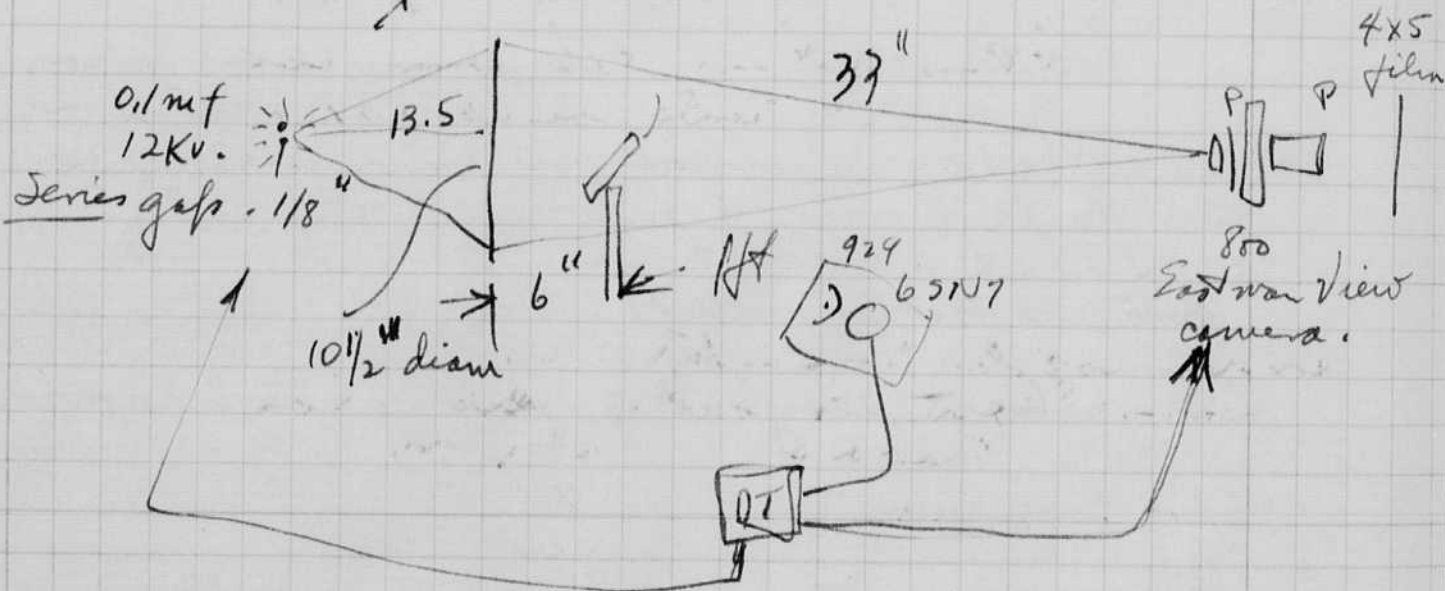
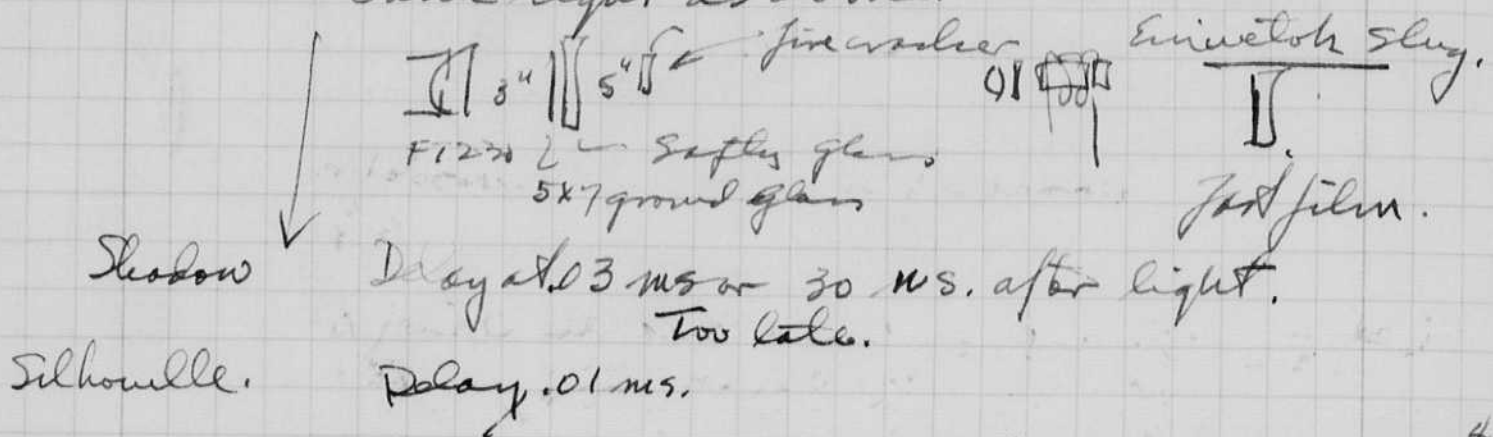


Photo delay  $.2 \times 20 = 4$  ms  
 Too slow - Exp all over.  
 Photo delay  $-.25$  ms.  
 Explosion earlier but still too undeveloped  
 Photo delay  $- 0$ .  
 Early - Jet from one end

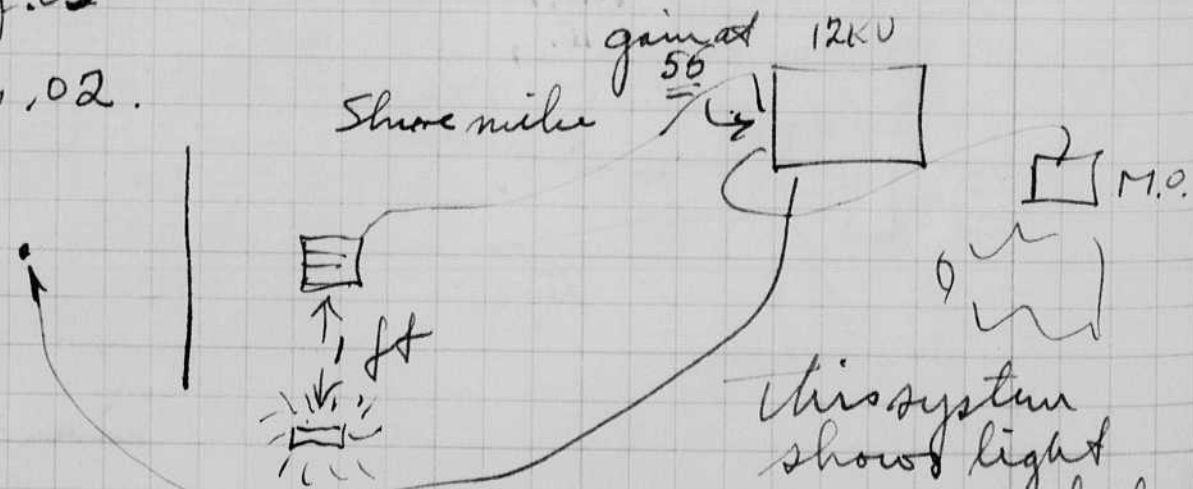
With FT230 12KV 0.4 mf there is not enough light for front lighting of the fire cracker. A white card background is dimly lit by the hot spot when the reflector is 1 ft away.

Back lighting now tried with ground glass. Same light as above.



Delay .03

Delay .02.



Photographs show sound wave and mike.

This system shows light on ground glass.

Aug 18 1951  
Harold Edgerton.  
20D102 MIT

95

# Silhouette photos of Amer. Cyn. #6 caps. Double flasher.

Photo 1. orthox film before shot to show caps.

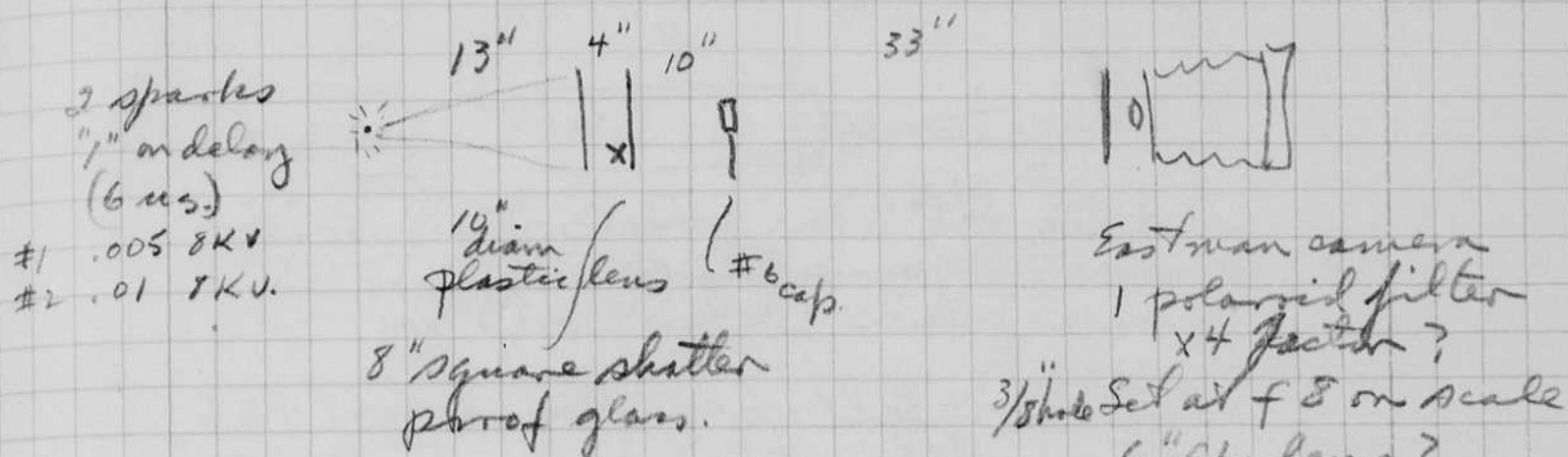


Photo 2 The cap was fired but the phototube in the chassis did not trigger the gaps.  
I then got an extension cable and put the phototube about 1 ft away and behind the ~~plexiglass~~ safety glass at x.

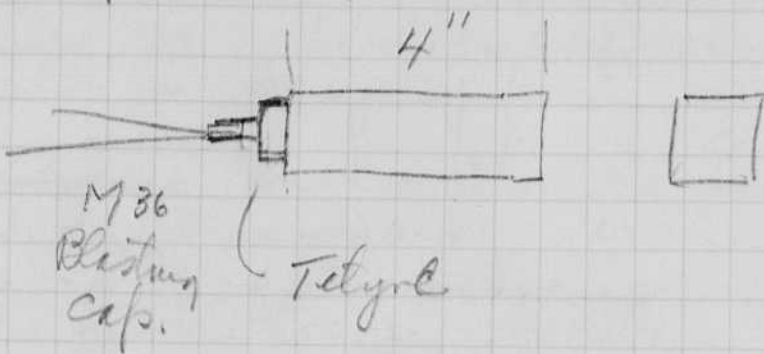
## Calibration of dial on 2 flasher.

- osc 1-1 4 traces set on delay knob mark "1"  
Sweep 6  $10^6$  cycles.
- 1-2 4 traces set on "2"  
Sweep 7  $10^6$  cycles.
- 1-3 4 Traces on "3"  
Sweep 7  $10^6$  cycles.
- 1-4 4 Traces on "3"  
Sweep 8  $10^6$  cycles.
- 1-5



Aug 21 1951  
 Harold G. Edgerton  
 Aberdeen med. TB2

Photos of  $\frac{3}{4}$ " square Pentolite sticks



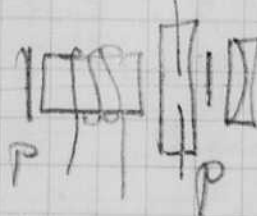
Aperture full open (marked f5.6),  
 Shined over exposure.

Aperture reduced to f 11. (on scale).  
 This shows shock wave to be  
 about 1cm wide. The shock does  
 not come into contact with the  
 unexploded stick?

Royal SS  
 on dial

For the above I am using the  
 Eastman view camera with  
 the 6 slug 7 turns of a 6 ohm wire  
 24KV and  $\frac{1}{8}$  mf. The lens is  
 a 6 or 7 inch doublet as below  
 Eastman 800 shutter

Defender  
 7  
 film



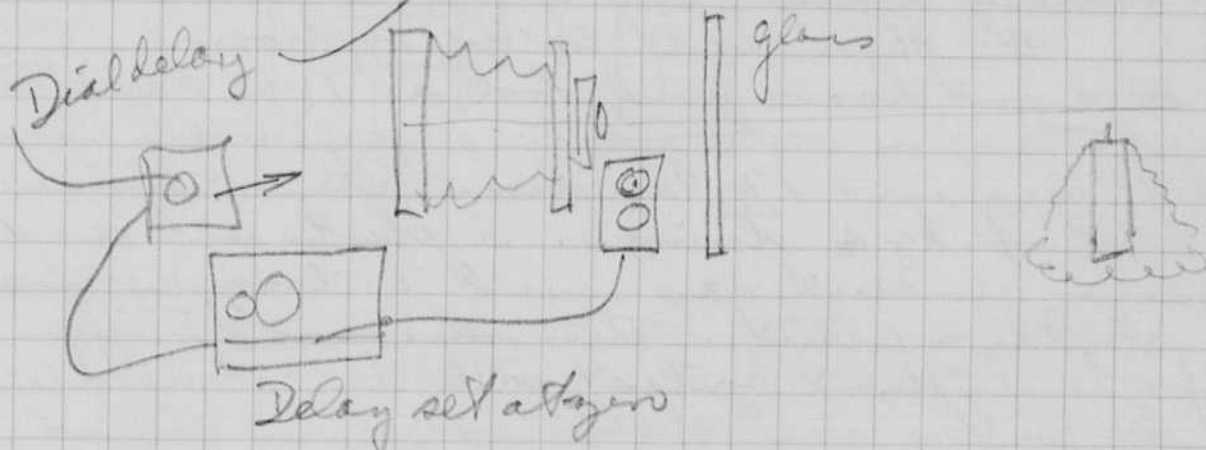
The delay was set at  $\frac{1}{3}$  of full (gross) 5ms

# Shaped Charge.

97



First shot - Delay at 11.7 on dial  
this photo shows jet about 1 cm  
in front of the charge end.



2 Shot, Delay set at "14" on dial,  
aper set at "11".

Still ~~too~~ early

3 Shot, Delay set at "17" on dial  
Same aper at "11"

Sat Aug 25 1951

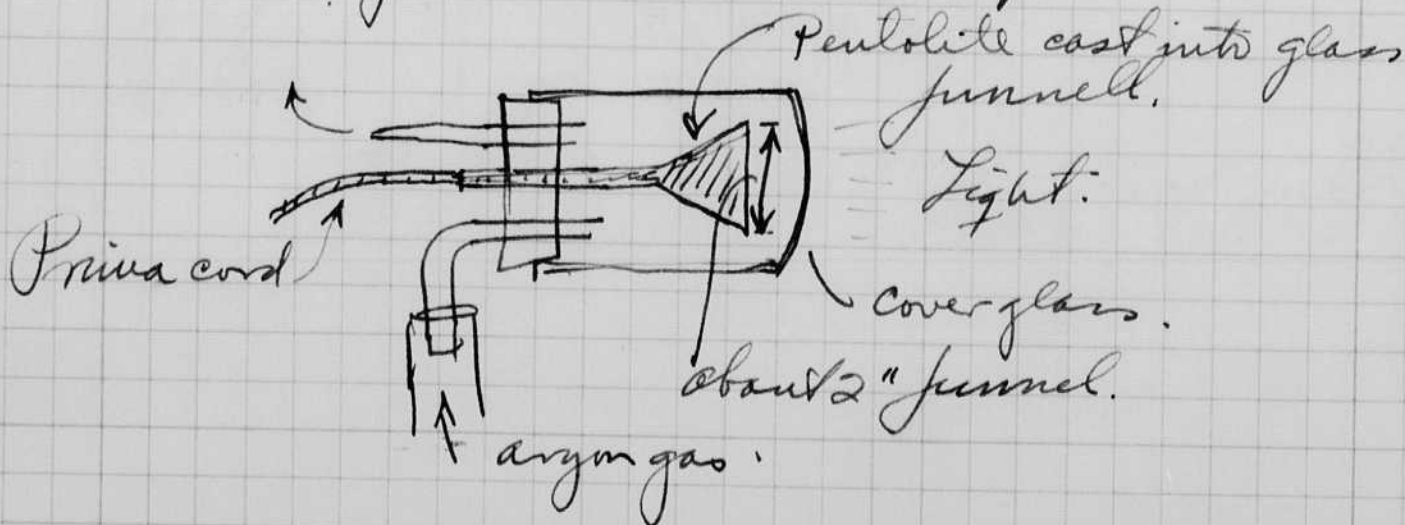
H.S. Edgerton

I was in Wilmington on Aug 22 and visited the Dupont Plant at Silboston N.J. to demonstrate high speed photography devices. I met Dr. C.H. Winning about 9 am. We first set up the silhouette apparatus for the photography of dynamite caps. Three photos were taken of # 8 (?) (Red) caps. Delays used were 5, 9, and 50 (?) us. The photos were developed and printed over the noon hour by Joe Donner the plant photographer. A fast jet was visible from the end of the cap.

We then went to the explosive area out doors and took a 1 us Repatronie photo of a nitrogelatine cylinder some 8" long and 1 1/4" in diameter; this was held up by strings. A photo cell and delay circuit was used to trigger the shutter unit. This unit was triggered by the shutter X contact with the shutter time set for 1/100 sec. The charge was in direct sun light. Exposure was heavy even with normal processing.

Winning then set up a rather complicated affair with an argon flash for back lighting. No record was obtained. I think we missed on the timing. My photo trigger probably saw the primacord light before the main Bang.

### Argon Flash bomb design

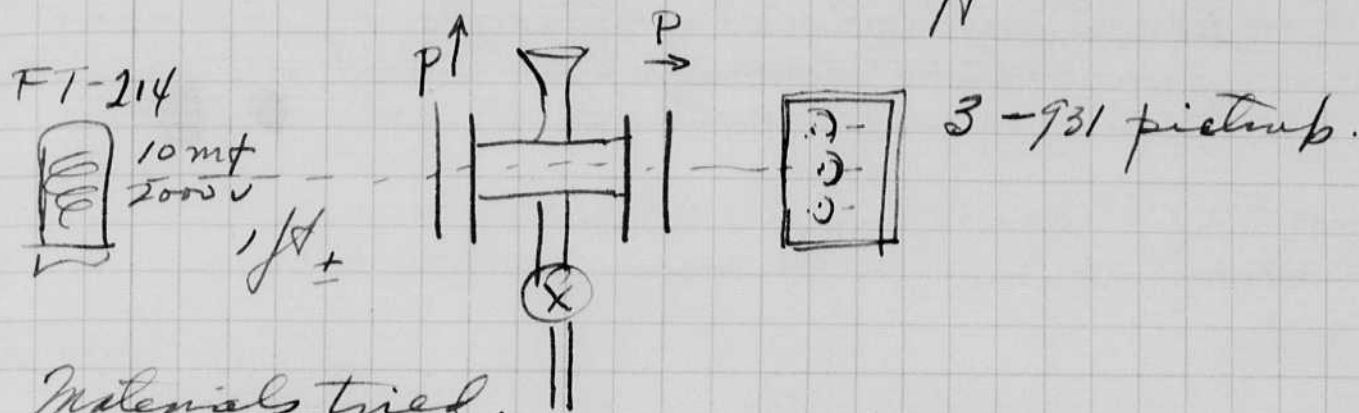




Today I spent the morning on fine-cracker photography with the 1 us magneto-optic shutter. With a 6" lens and a  $\frac{5}{8}$  hole I was not able to get a good exposure from the hot gases in 10 us delay after trigger.

I then used the 4" lens on one shot which was better. The 12KV, 4 mf. FT-230 did not give enough light for reflected operation.

Then I set up the liquid cell exp. equip to measure the m.o. Verdet effect.



### Materials tried.

Water - small

H<sub>2</sub>O<sub>2</sub> - small

Alcohol - ? none or small

Zinc chloride - 3x that of water.  $\pm$

Materials to try Zinc Sulfate in alcohol

Ferric Chloride.

(-220)?

John Mills leaves Monday for N.J. and N.Y. where he will sail to England for 6 weeks or so. He and Bill MacRobert have been working on the soldering of leads into quartz flash tubes. Tin dioxide is used to flux the solder.

Monday Aug 27, 1951. Discussed materials with Prof. Dick Lord. Lead tetrachloride yellow liquid. This was not available at the chem supply at M.I.T. We could not find it at supply houses. Lead nitrate - not much m.o. effect. Tin chloride - small effect. Liquid turbid did not pass light. Cools water when dissolved. The Zinc chloride was again tried. Gives about  $\frac{1}{3}$  rotation of lead glass. This heats when dissolved in water. Nickel chloride. Green. Small effect.

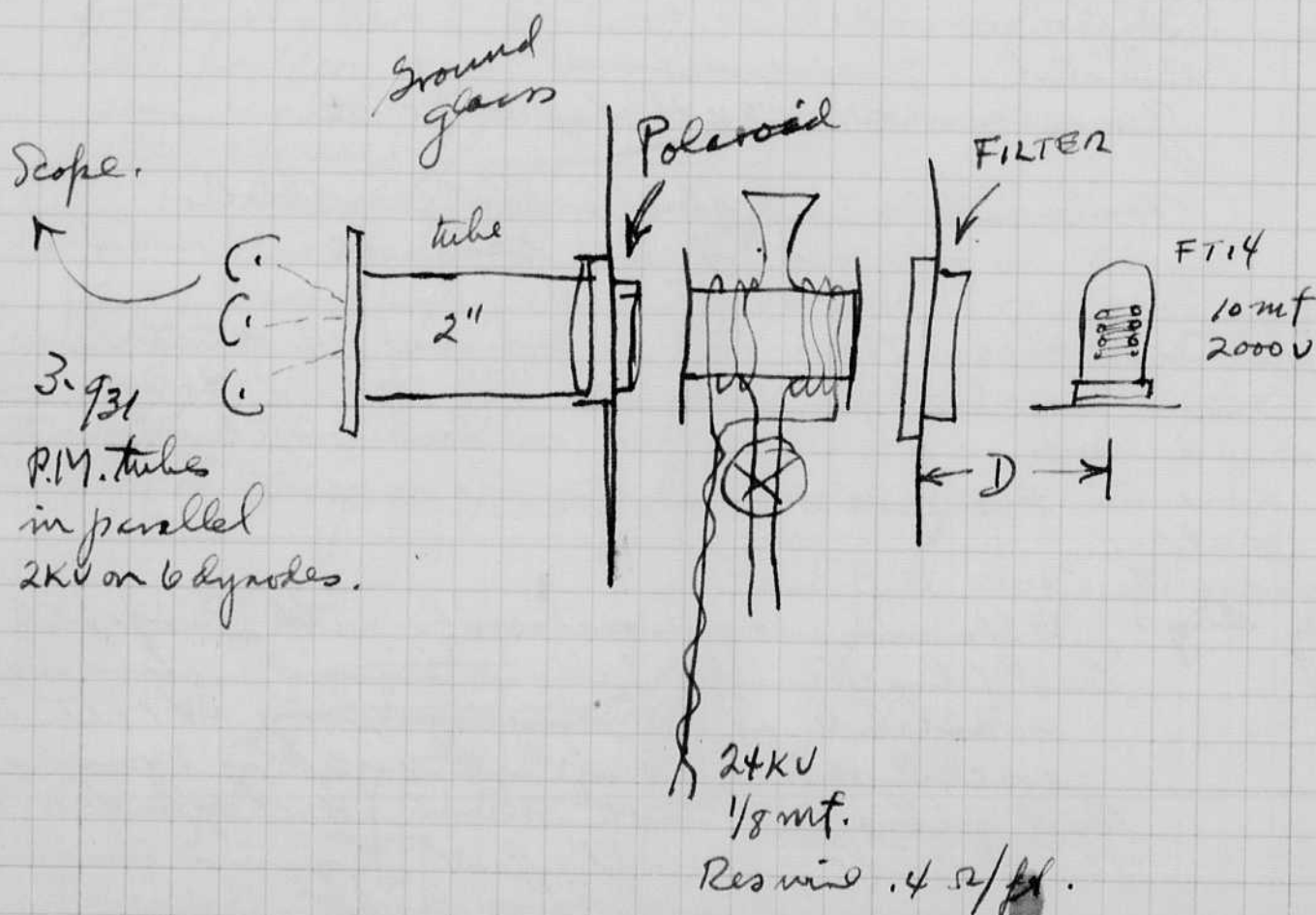


Continued

Jeric chloride - Water - Brown solution  
Small effect.

Same in acetone - Small  
M-O. effect.

Visitors in morning - Taylor, K  
and Morgan of Allied Chemical. N.Y.  
Discussed the short flash equipment  
for taking closeup photos of  
printing cylinders.



July Aug 27 1951

David E. Edgerton. Continued study of liquid materials for M-O effect.

Optical system tuned up with black paint and better polarizers. The water cell is cemented with de Kolvinsky cement. Black Paint Eastman optical flat black is used on outside of cell.

Water used as material for standard.

Lamp distance changed so that min light with crossed polarizers was small say  $1/8$ ".

Setup.

Pulse from 24KV  $1/8$ mf 6 or 7(?) turns of 0.4 ohm wire with 1ft of leads to cap.

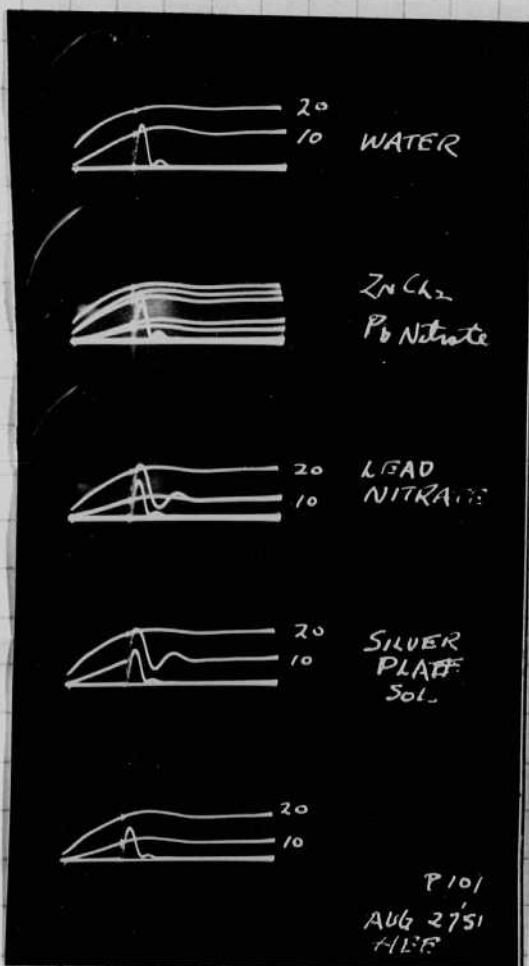
+ Water osc. zero line  
1-1 } zero light  
Water.  
0° 10° 20°  
 $6\frac{3}{4}$ " light to P.

+ Zinc Chloride }  
1-2.  $14\frac{1}{8}$ "  
0 10° 20° 30°

Lead nitrate  $10\frac{3}{4}$ " }  
1-2.

+ Lead nitrate  $10\frac{3}{4}$ "  
1-3. zero.  
m.o. effect.  
0 10°(m.o.) 20°

+ Silver plate solution  $9\frac{1}{4}$ "  
1-4 zero  
m.o.  
0 10°(m.o.) 20°

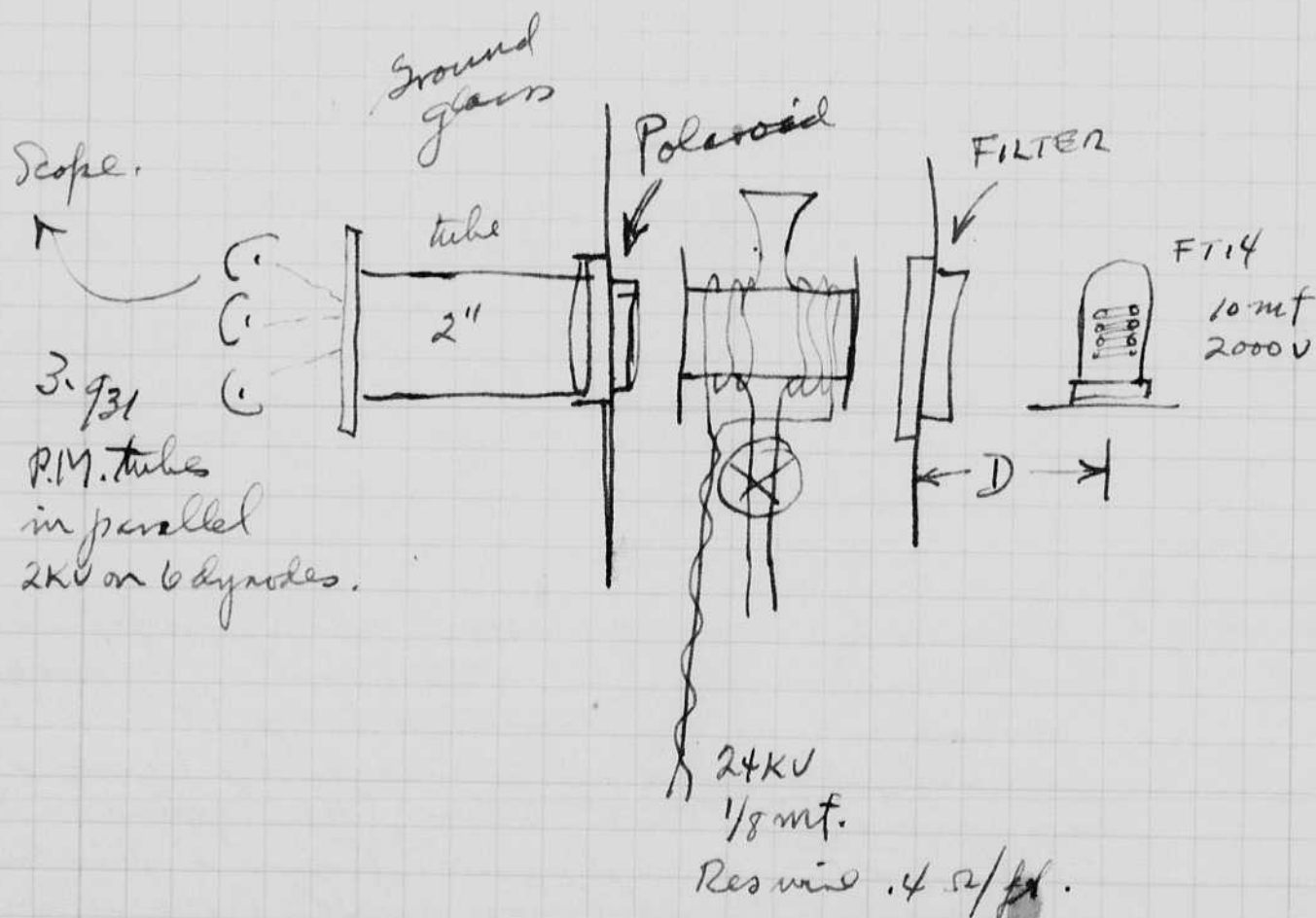


Continued

Ferric chloride - Water - Brown solution  
Small effect.

Same in acetone - Small  
M-O. effect.

Visitors in morning - Taylor, K  
and Morgan of Allied Chemical. N.Y.  
Discussed the short flash equipment  
for taking closeup photos of  
printing cylinders.



Wed Aug 27 1951

David E. Edgerton. Continued study of liquid materials for M-O effect.

Optical system tuned up with black paint and better polarizers. The water cell is cemented with de Kolvinsky cement. Black Paint Eastman optical flat back is used on outside of cell.

Water used as material for standard.

Lamp distance changed so that min light with crossed polarizers was small say  $1/8''$ .

Setup.

Pulse from 24KV  $1/8$  mf 6 or 7(?) turns of 0.4 ohm wire with 1 ft of leads to cap.

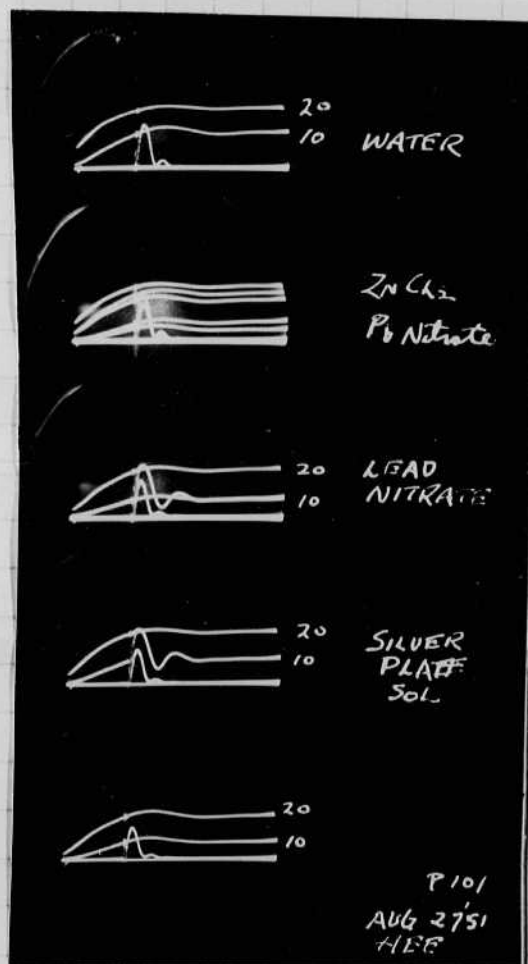
+ Water osc. gasoline  
1-1 } zero light  
Water.  
0° 10° 20°  
 $6\frac{3}{4}''$  Light to P.

+ Zinc Chloride  
1-2.  $14\frac{1}{8}''$   
0 10° 20° 30°

Lead nitrate  $10\frac{3}{4}''$   
1-2.

+ Lead nitrate  $10\frac{3}{4}''$   
1-3. zero.  
m.o. effect.  
0 10° (m.o.) 20°

+ Silver plate solution  $9\frac{1}{4}''$   
1-4 zero  
m.o.  
0 10° (m.o.) 20°





osc 2-1

+ Tin chloride, 5"  
0 10 20 30

+ 2-2 Thorium Chloride 9 1/2"  
0, 10, 20,

+ 2-3 Uranium acetate, 4 1/2" Yellow  
Filter ~~X~~ removed  
0-10-20.  
Effect small (if any)

2-4 Ni Chloride Green 4 1/2"  
no filter.

+ 2-5 Ferric chloride, Brown, 3 1/4" no filter  
Dilute. 0 + mo (???)

freq. slower. ( 10 + mo  
due to 20 + mo.  
resonance? no light? on rotation why?

osc 3-1 Zinc chloride, solution concentrated  
more than that used in 2-2.

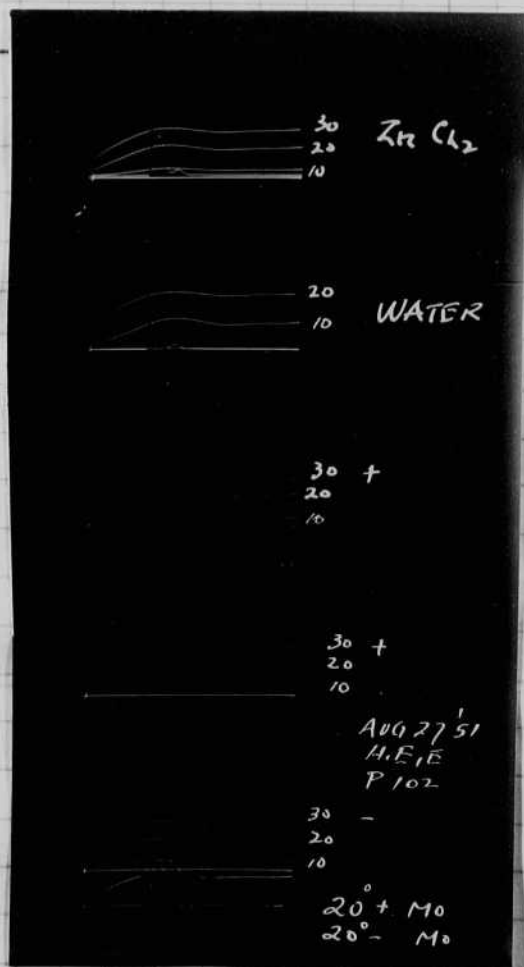
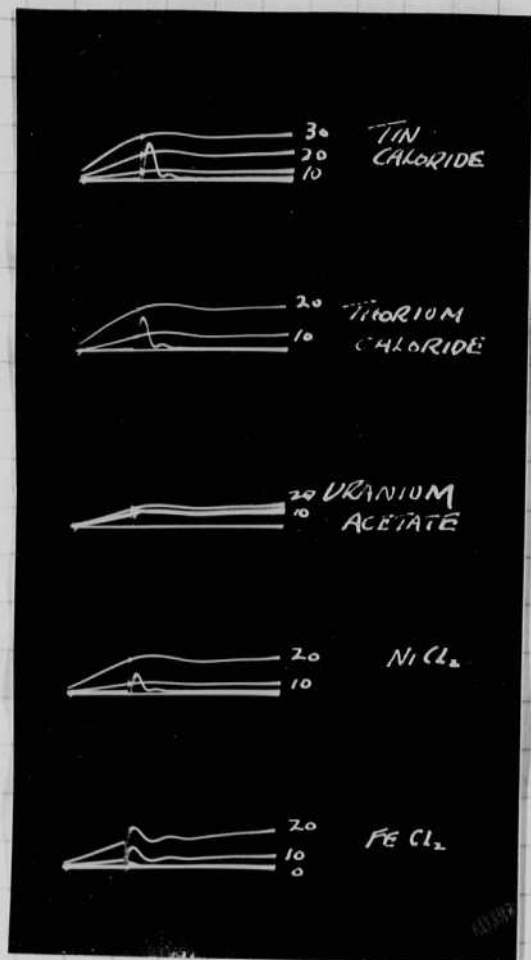
3-2 Water D = 8 3/4" F = X2  
0, 10, 20, M.O.

3-3 0 10 20 30 +

3-4 0 10 20 30 +

3-5 0 10 20 30 -

0 + mo. ZnCl<sub>2</sub>.  
+ 20 + mo "  
- 20 + mo. "



Aug 30 1951

H.E. Egelston I spent yesterday at Holderness N.H. taking high speed movies (16mm Instar 50 volt, f8 X X film) and flash f16 /40 on Leica with 6" and 12" lens. The males left three days ago. Aug 26. Keep this date in mind for next year.

Further work on M.O. effect.

Case 1-1

- ZnCl<sub>2</sub> D=14.25" Fx10 0 10 20 30 ✓
- 2 Water " " 0 10 20
- 3 H<sub>2</sub>SO<sub>4</sub> " " "
- Bad Sol 1.38
- 4 Alcohol " " "
- 5 Antimony Pentachloride " x 10 0 20 40.  
Shows large angle of rotation

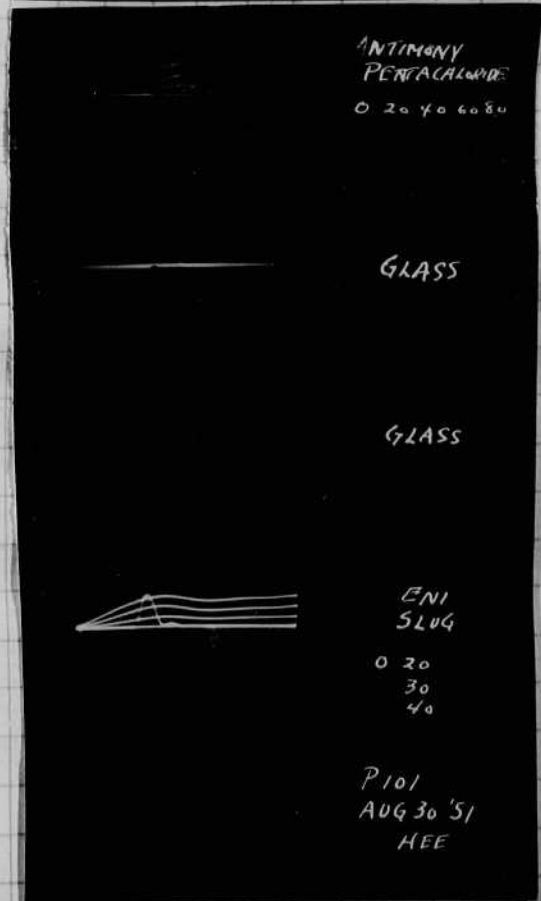
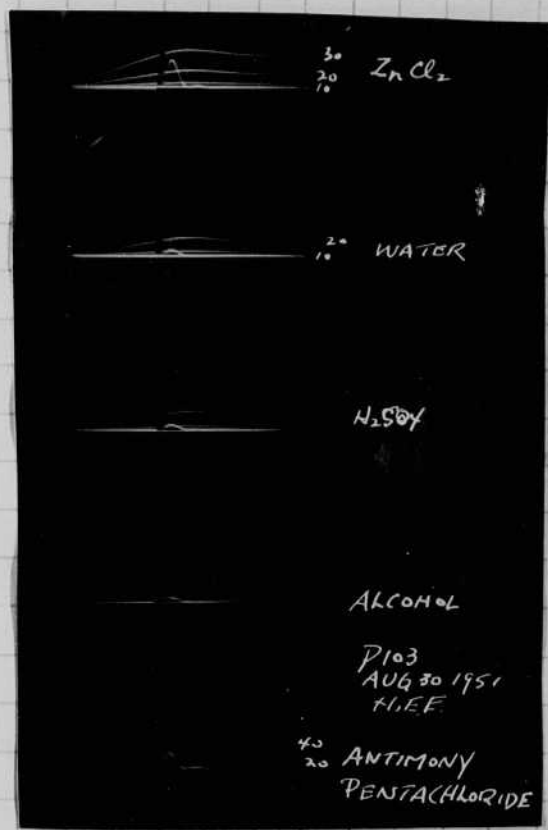
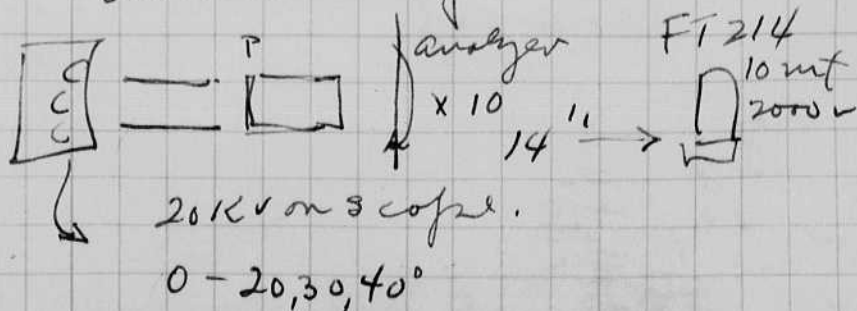
$\frac{1.5 \tau^2}{2} = 37.5 \text{ with } 200.$

2-1 Anti Parcl D=10 F=10 1  
0 20 40 60 80°

2-2 Glass. D=10 F=2  
this glass had Polaris

2-3 Glass & Polarizers only.

2-4 Euciwatoh Slug.



osc 2-1

+ Tin chloride, 5"  
0 10 20 30

+ 2-2 Thorium Chloride 9 1/2"  
0, 10, 20,

+ 2-3 Uranium acetate, 4 1/2" Yellow  
Filter ~~X~~ removed  
0-10-20.  
Effect small (if any)

2-4 Ni Chloride Green 4 1/2"  
no filter.

+ 2-5 Ferric chloride. Brown. 3 1/4" no filter  
Dilute. 0 + mo (???)

freq. slower. ( 10 + mo  
due to im? 20 + mo.  
no light? on rotation why?

osc 3-1 Zinc chloride. Solution concentrated  
more than that used in 2-2.

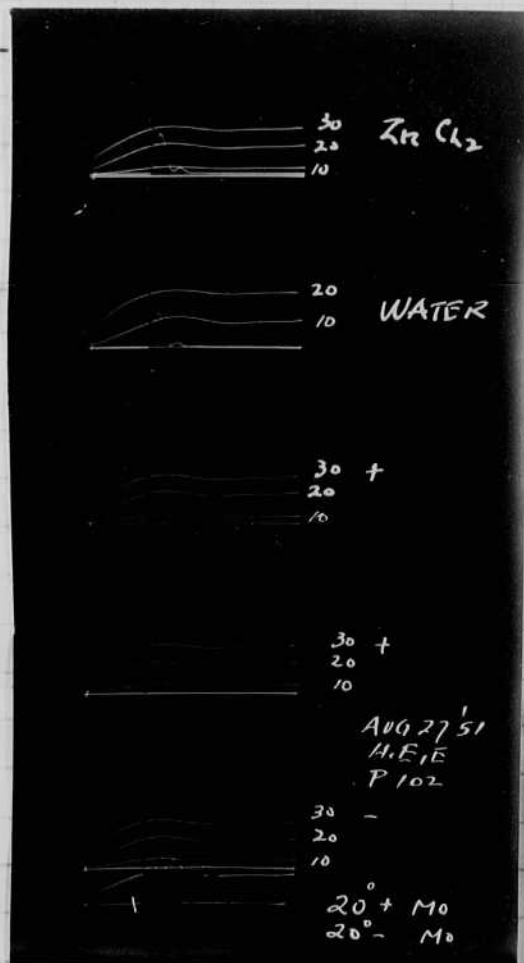
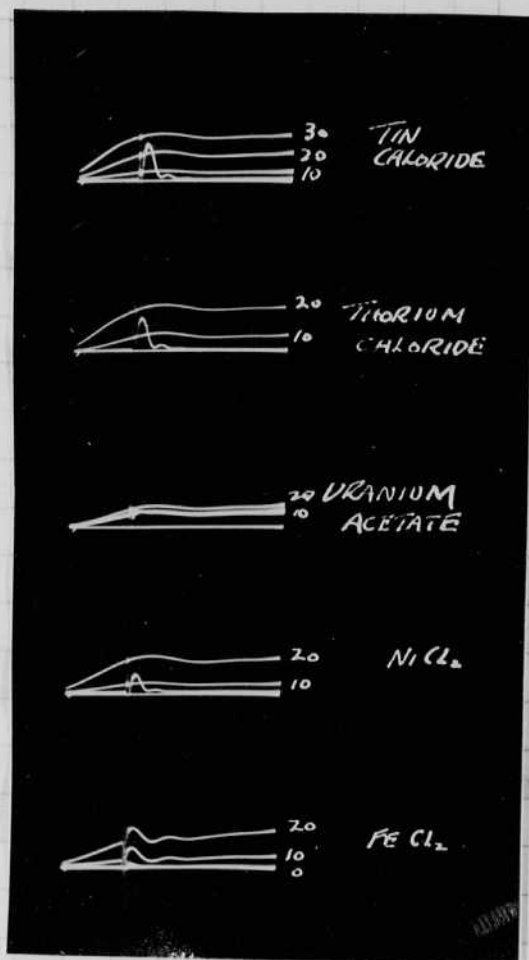
3-2 Water D = 8 3/4" F = X2  
0, 10, 20, M.O.

3-3 0 10 20 30 +

3-4 0 10 20 30 +

3-5 0 10 20 30 →

0 + mo. ZnCl<sub>2</sub>.  
+ 20° + mo. "  
- 20° + mo. "



Aug 30 1951

H.E. Elgeton I spent yesterday at Holderness N.H. taking high speed movies (16mm Jesta 50 volt, f8 X X film) and flash f16 /40 on Leica with 6" and 12" lens. the males left three days ago. aug 26. Keep this date in mind for next year.

Further work on M.O. effect.

Case 1-1

ZnCl<sub>2</sub> D=14.25" Fx10 0 10° 20° 30° ✓

2 Water " " 0 10 20

3 H<sub>2</sub>SO<sub>4</sub> " " " " " "  
Bad Sol 1.38

4 Alcohol " " " " " "

5. Antimony

Pentachloride " x 10 0 20 40.

Shows large angle of rotation

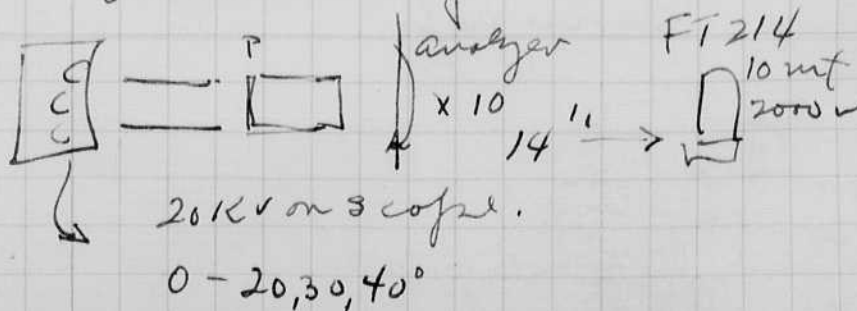
$$\frac{1.5 \tau^2}{2} = 37.5 \text{ with } 200.$$

2-1 Calc Par Cl D=10 F=10 1  
0 20 40 60 80°

2-2 Glass. D=10 F=2 this glass had Polaris

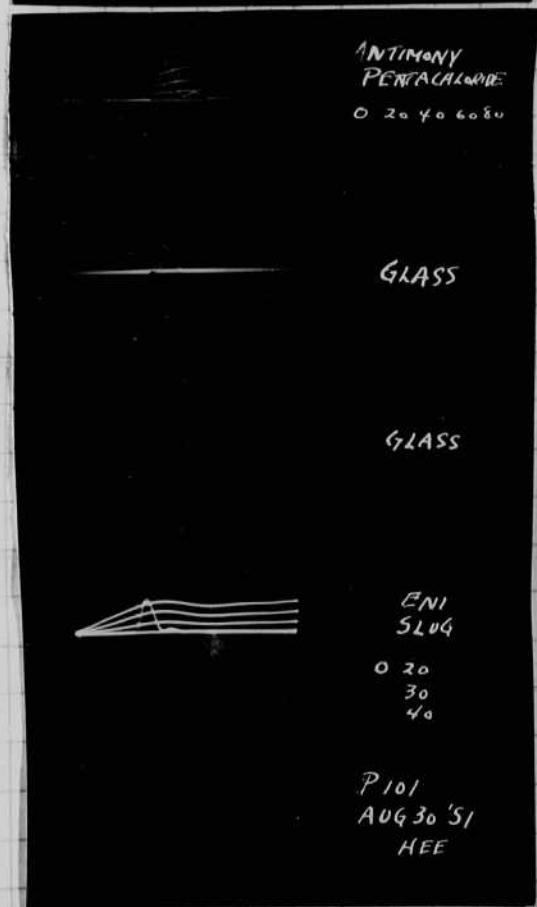
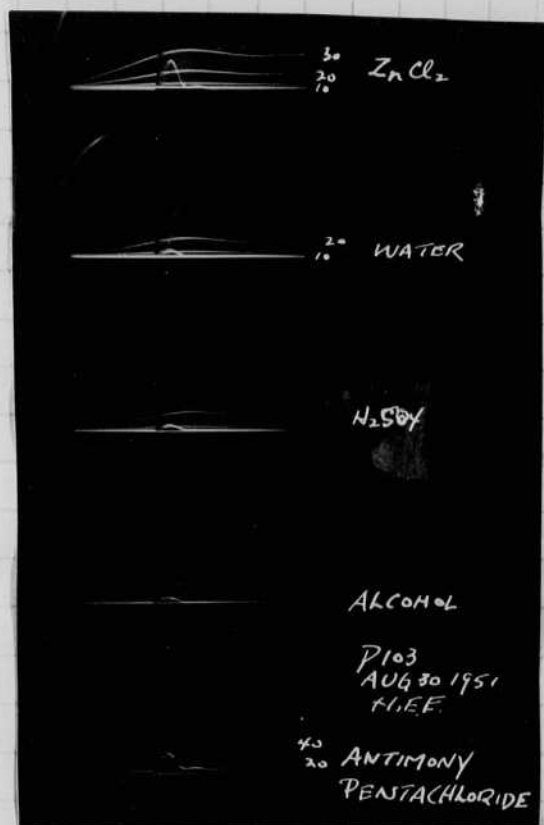
2-3 Glass & Polarizers only.

2-4 Einvilok Slug.



20KV on scope.

0 - 20, 30, 40°

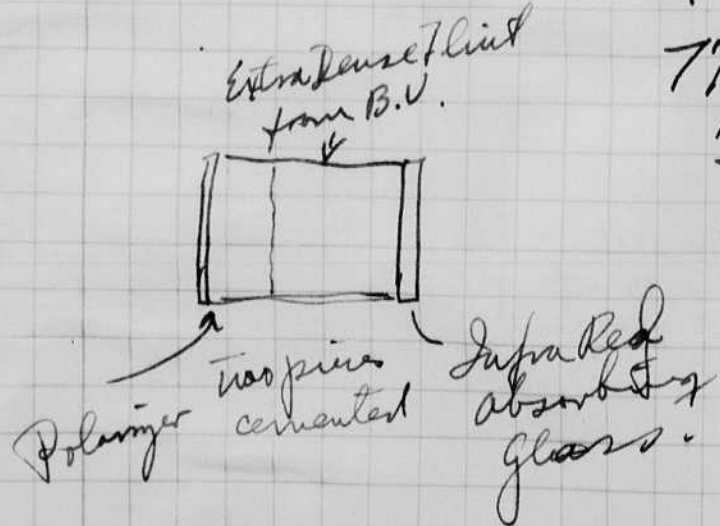
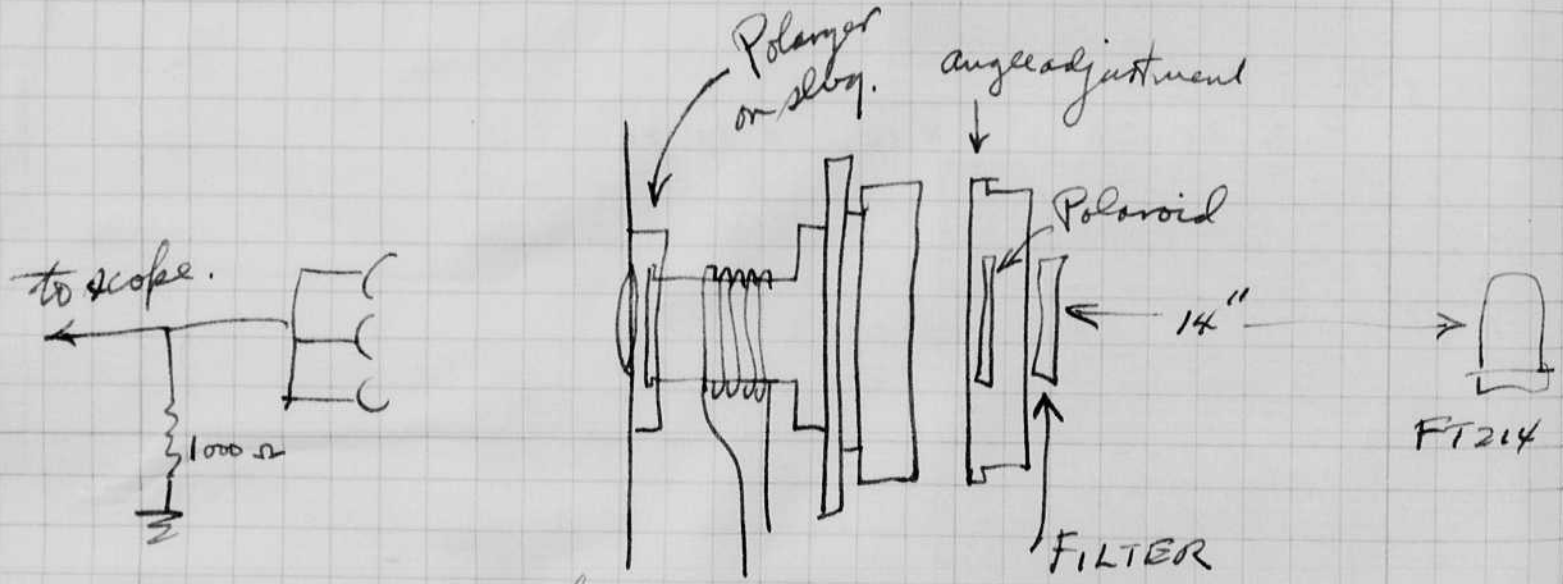
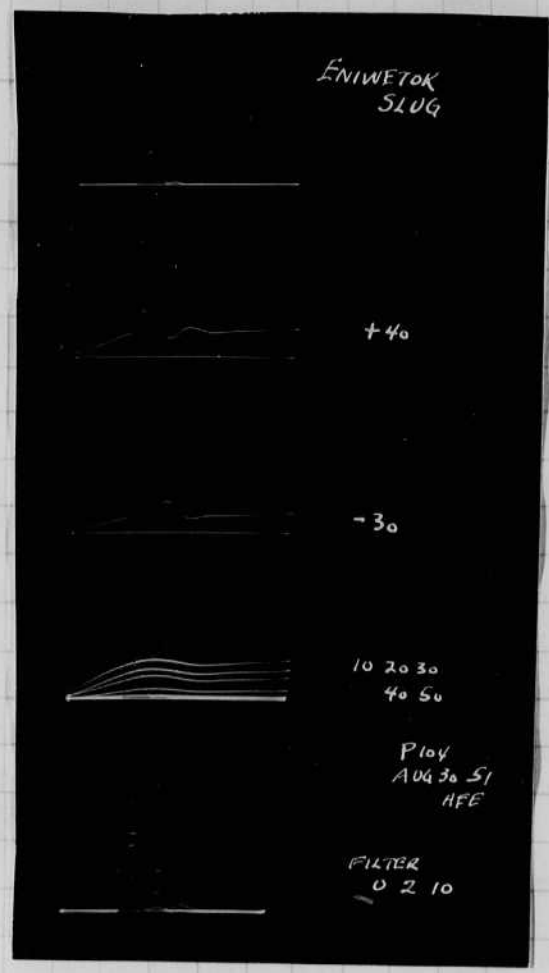




104 Sept 1 1951  
ASG

Eniwetok Slugs

- 1-1 0 + m.o. ~~2.0~~ X10
- 1-2 +40° + m.o. X10
- 1-3 -30 + m.o. X10
- 1-4 Eniwetok Slugs X10  
0 10 20 30 40 50  
0 + m.o.
- 1-5 0 + m.o. X 0 Filter  
" X2  
" X10



7 TURNS.  
1.5 ohm res wire  
to 24KV 1/8 mfd and  
series gap.

Gin with slug

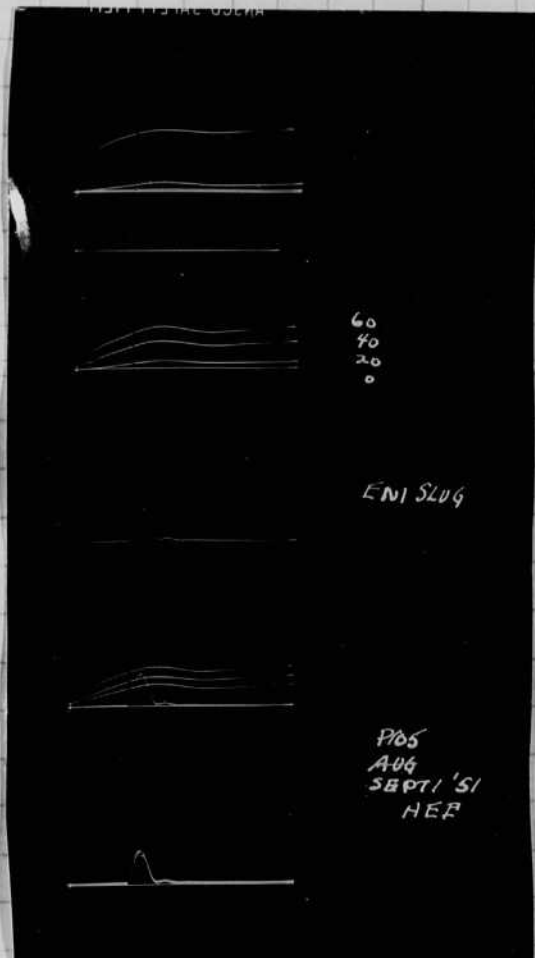
1-1 zero.  
Light  $\theta = 0^\circ$  x 0 Filter  
"  $\theta = 20$  x 10 Filter.

2-2 zero  
 $\theta = 20$  F = x 10  
 $\theta = 40$  F = x 10  
 $\theta = 60$  F = x 10  
no x 10

2-4 0 x 10  
30 x 10  
40  
50  
no.

2-5. Voltgen or discharge Cap  $1/8$   
changed, Before we  
have held 105 on Variac

$\theta = 0$  V = 105 x 10  
111  
116  
101



104 Sept 1 1951  
ASG

Eniwetok Slugs

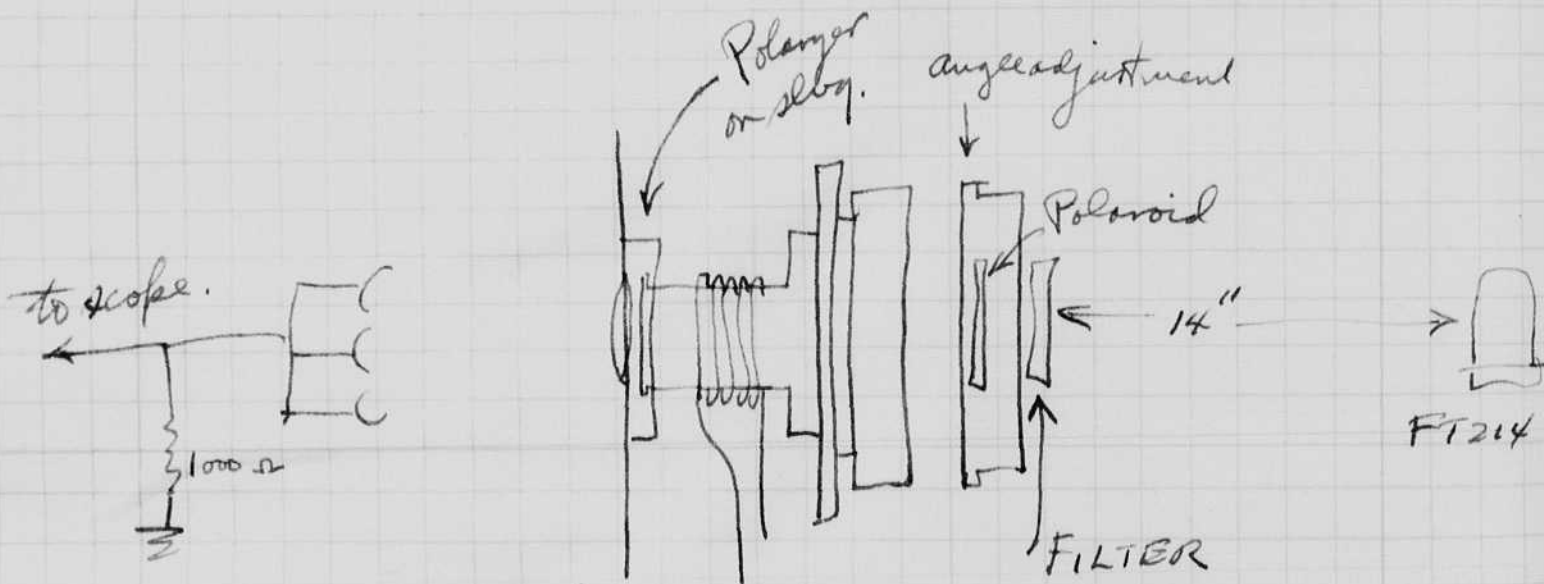
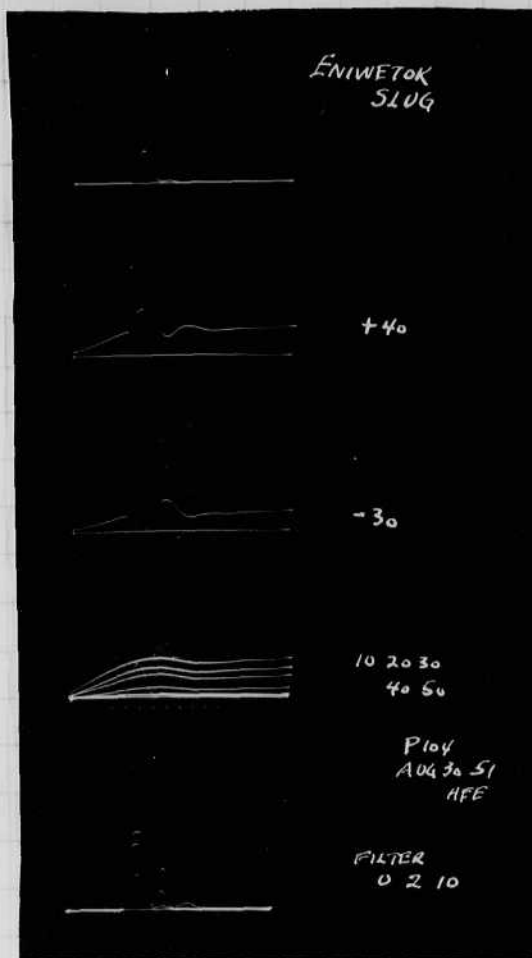
1-1 0 + m.o. ~~2~~ X10

1-2 +40° + m.o. X10

1-3 -30 + m.o. X10

1-4 Eniwetok Slugs X10  
0 10 20 30 40 50  
0 + m.o.

1-5 0 + m.o. X 0 Filter  
" X2  
" X10



7 TURNS.  
1.5 Ω res wire  
to 24KV 1/8 mt and  
series gap.

Extra dense flint  
from B.V.

Polaroid was piece  
cemented

Supplied  
absorbing  
glass.

Gun with slug

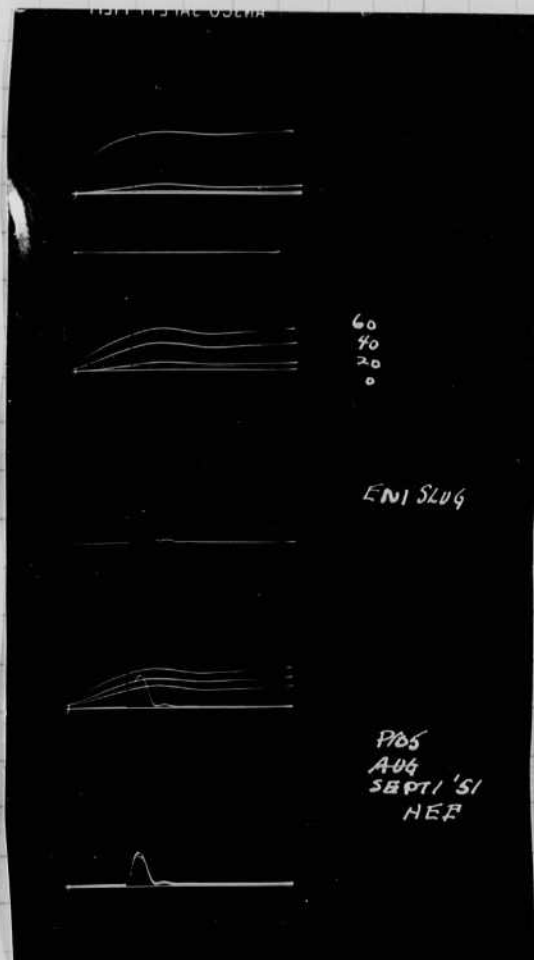
1-1 Zero.  
Light  $\theta = 0^\circ$  X0 Filter  
"  $\theta = 20$  X10 Filter.

2-2 Zero  
 $\theta = 20$  F = X10  
 $\theta = 40$  F = X10  
 $\theta = 60$  F = X10  
MO X10

2-4 0 X10  
30 X10  
40  
50  
MO.

2-5. Nitrogen discharge Cap  $1/8$   
changed, Before we  
have held 105 on various

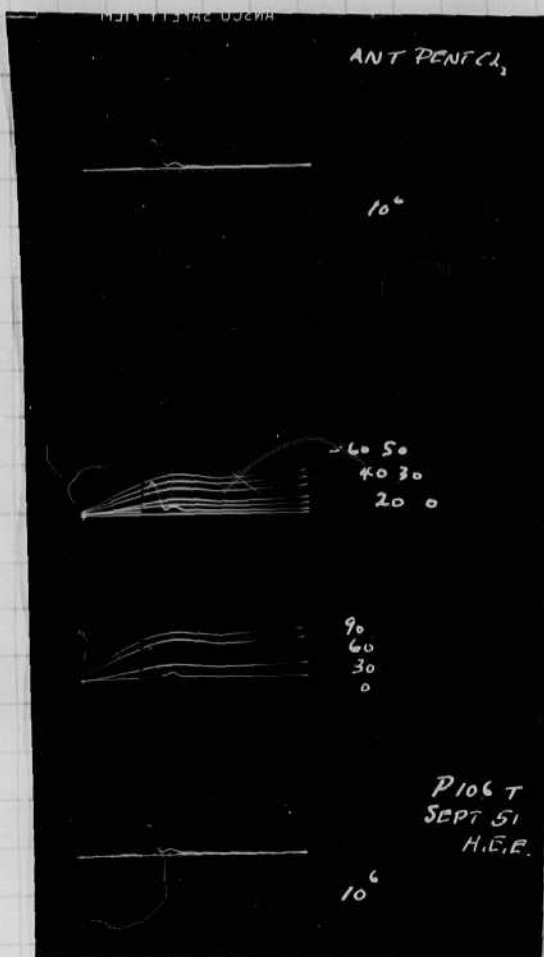
$\theta = 0$  V = 105 X10  
111  
116  
101





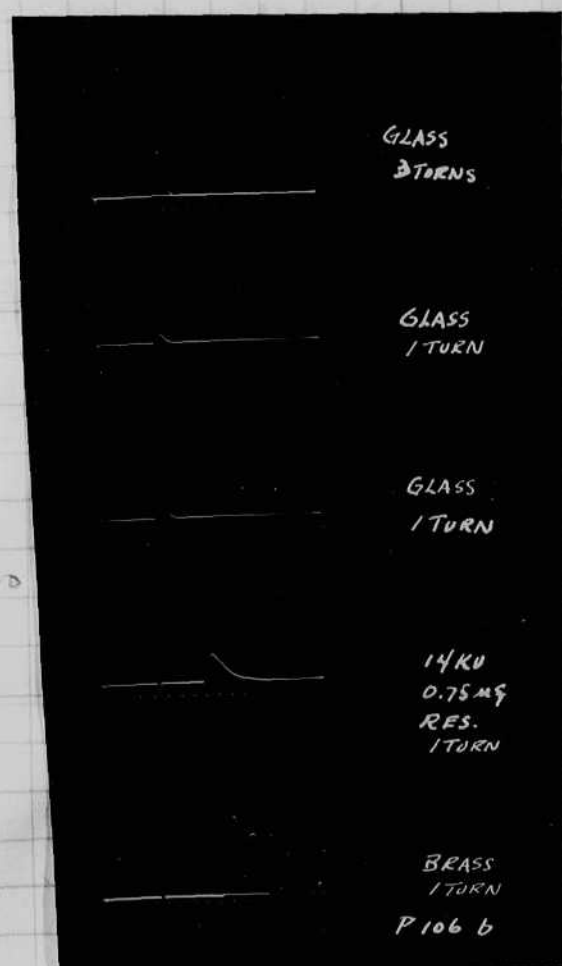
## Antimony Pentachloride.

- 3-1 0 + mo.  $10^6$  cycles
- 3-2
- 3-3. 0 + mo  $D=14''$   $F=X8$   
20 30 40 50 60°
- 3-4 0 + mo.  $D=14$   $F=X8$   
30°, 60°, 90°
- 3-5 0 + mo " "  
 $10^6$  cycles



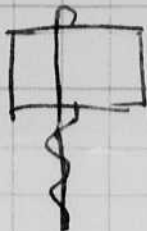
B.V. Yellow Glass.  
Slag with cemented  
Polarizers on end.

- 4-1\* 3 turns of wire on glass  $D=24.5''$   $F=0$   
 $10^6$  cycles.
- 4-2\* 1 turn  $D=24.5$   $F=0$
- 4-3\* 1 turn  $D=14''$   $F=0$   
 $10^6$  cycles.
- 4-4\* 1 turn 14KV new capacitors  $D=10''$   $F=0$   
4 0.75 in Ser per.  $10^6$  cycles.
- 4-5 Dilto but with Brass wire 1 Turn  
16 KV.



\* 3.5 ohms in lead to coil  
Brass wire has small resistance.

B.V. Green Glass  
1.25" long #.



5-1 16.3KV. .75 20"  
10° cycles.

5-2 16.6 .75mf 30"  
10° cycles.

5-3. 16.6 .75 30"  
0.9 ohm coil 2 turns  
10° cycles.

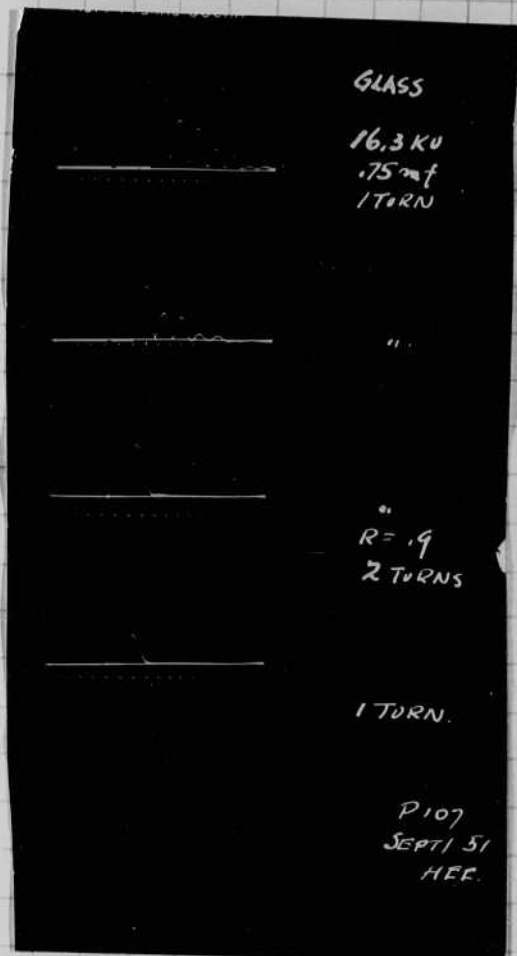
5-4. 16.6KV .75 30"  
0.9 ohm coil 1 turn.  
10° cycles.

Sept. 5, 1951. H.F.K.

oscillogram of output of  
Spark coil as a possible  
driver for Baird Shutter.  
Hedrick called this morning  
for information.

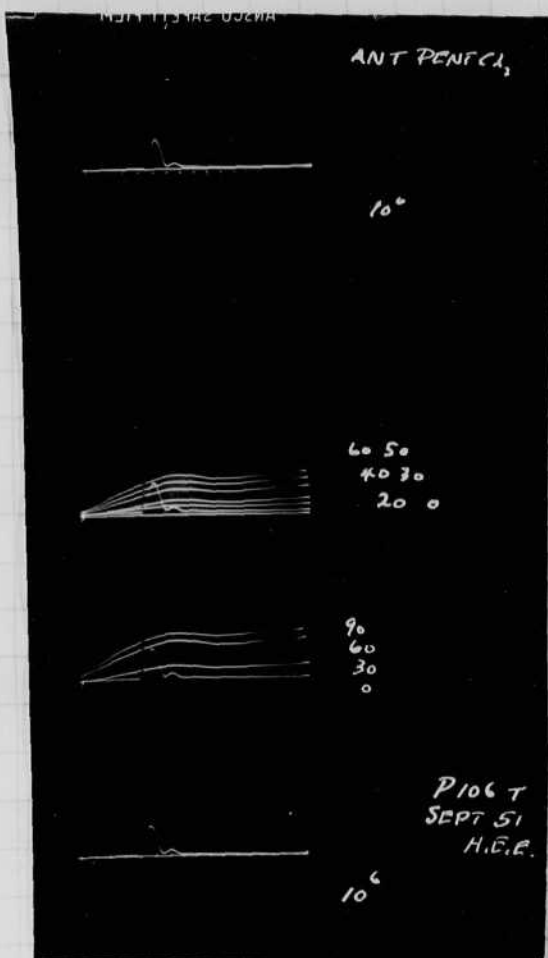
2KV. 3C45 thyratron 0.1 mf?  
011825 pulse transformer. 5 to 1(?)

10,000 ohms was put across secondary  
without appreciable change in  
osc 1-2



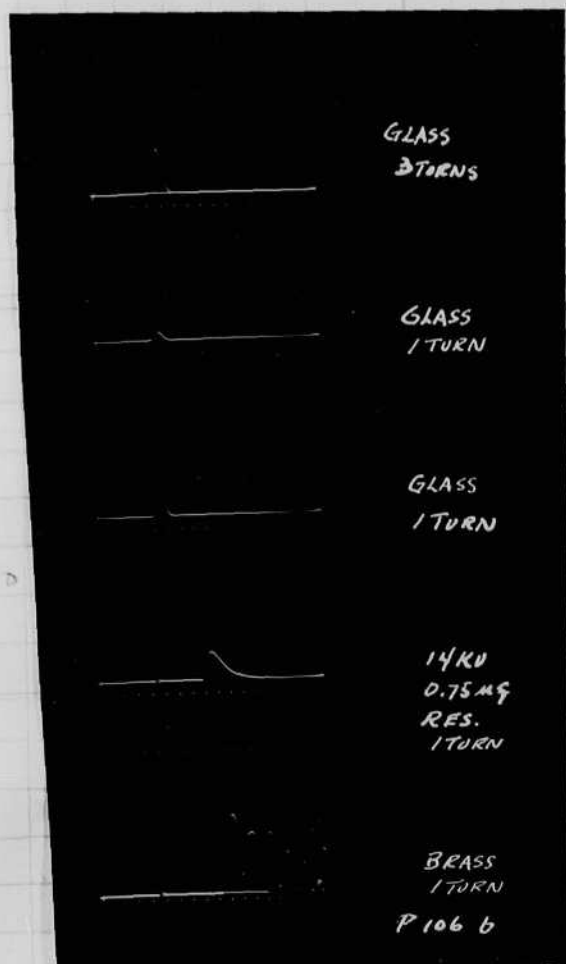
## Antimony Pentachloride.

- 3-1 0 + mo.  $10^6$  cycles
- 3-2
- 3-3. 0 + mo.  $D=14''$   $F=X8$   
20 30 40 50 60°
- 3-4 0 + mo.  $D=14''$   $F=X8$   
30°, 60°, 90°
- 3-5 0 + mo. "  
 $10^6$  cycles



B.V. Yellow Glass.  
Slug with cemented  
Polarizers on end.

- 4-1\* 3 turns of wire on glass  $D=24.5''$   
 $10^6$  cycles.  $F=0$
- 4-2\* 1 turn  $D=24.5$   $F=0$
- 4-3\* 1 turn  $D=14''$   $F=0$   
 $10^6$  cycles.
- 4-4\* 1 turn 14KV new capacitors  $D=10''$   $F=0$   
4 0.75 in Ser. par.  $10^6$  cycles.
- 4-5 Delta but with Brass wire 1 Turn  
16 KV.



\* 3.5 ohms in lead to coil  
Brass wire has small resistance.

B.V. Green Glass  
1.25" long #.



5-1 16.3KV. .75 20"  
10<sup>6</sup> cycles.

5-2 16.6 .75mf 30"  
10<sup>6</sup> cycles.

5-3. 16.6 .75 30"  
0.9 ohm coil 2 turns  
10<sup>6</sup> cycles.

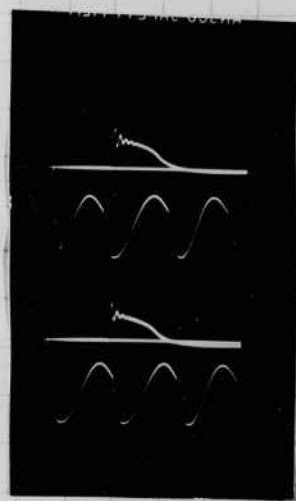
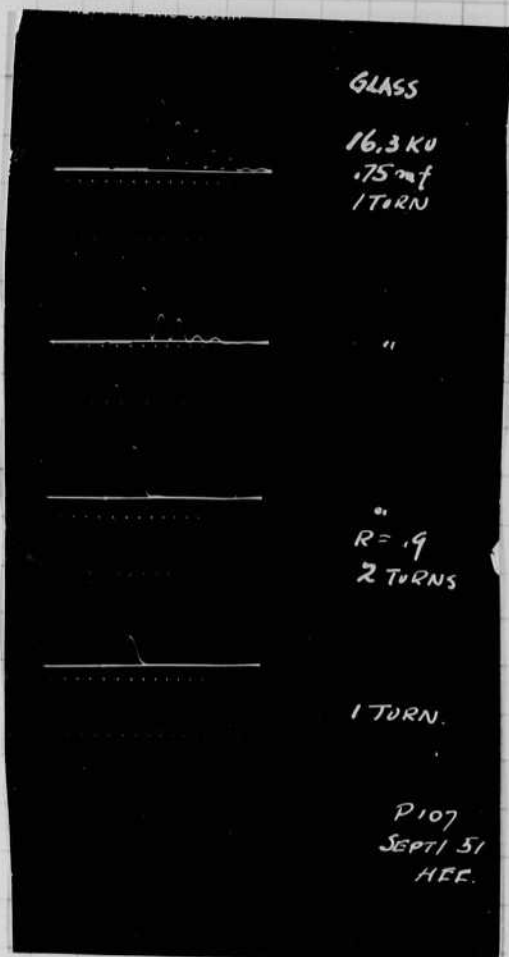
5-4. 16.6KV .75 30"  
0.9 ohm coil 1 turn.  
10<sup>6</sup> cycles.

Sept. 5, 1951. H.F.F.

oscillogram of output of  
spark coil as a possible  
driver for Baird Shutter.  
Hedrick called this morning  
for information.

2KV. 3C45 thyratron 0.1 mf?  
011825 pulse transformer. 5 to 1(?)

10,000 ohms was put across secondary  
without appreciable change in  
osc 1-2





Stanley Sage  
H. E. Sargent

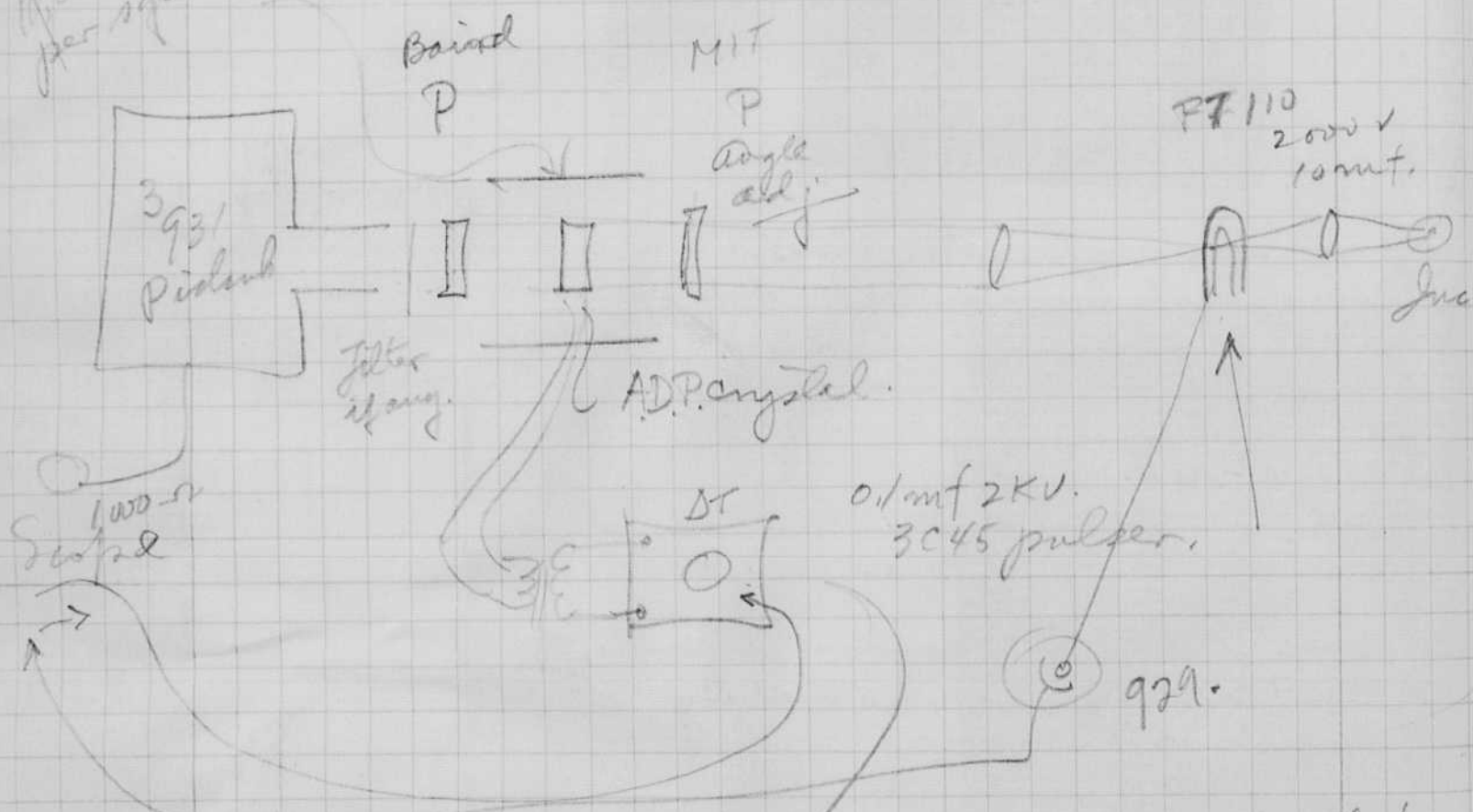
2-1 voltage on crystal.  
10°

2-1 Light transmission

3-1 20°  
Light

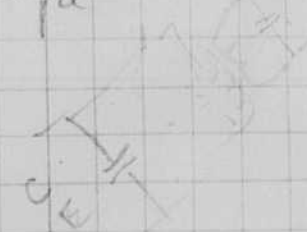


1000 ohms per square



scope  
1000-ohm

scope



40 ohms per square

gives 20° shift for  
1 μs. exposure.  
Should give 80° which  
means X4 on volts.

W.S. Gardner  
Sept 16 1951

A.D.P.  
Crystal shutter

- 0-1-1 Voltage output of 10 to 1 Trans #292 1387 Raytheon trans. 10,000 ohms in parallel.
- 1-2 Ditto except no 10,000 ohms.
- 1-3. Light transmission. X2 filter
- 1-4. Ditto and with  $\theta = 45^\circ$ . X2 filter
- 1-5. " " " X2  
Fast Light trigger.

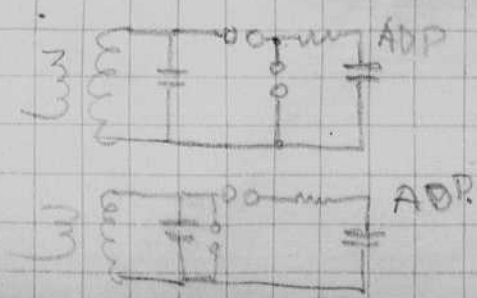
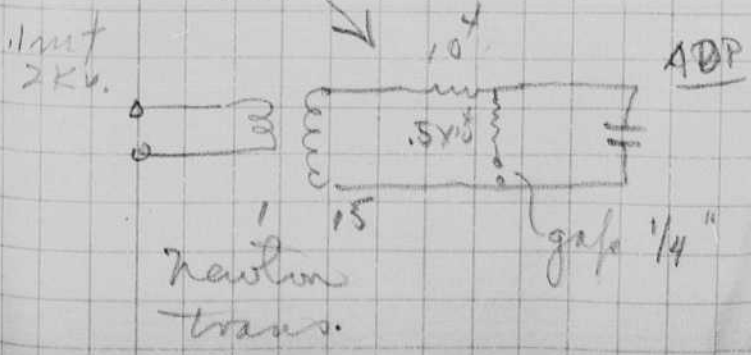
2-1 a  $10^4$  resistor was put in series with the crystal to reduce the sudden rise.

2-2 Ditto  $10^6$  cycles  $10^6$  cycles.

2-3 Newton transformer 15 to 1,  $10^4$  ohms in series Spark voltage. Sweep 5

2-4 output volts on X stat side.  $10^4$  ohms.  $10^6$  cycles. Sweep 5.

2-5 Ditto with parallel sparks and 5K



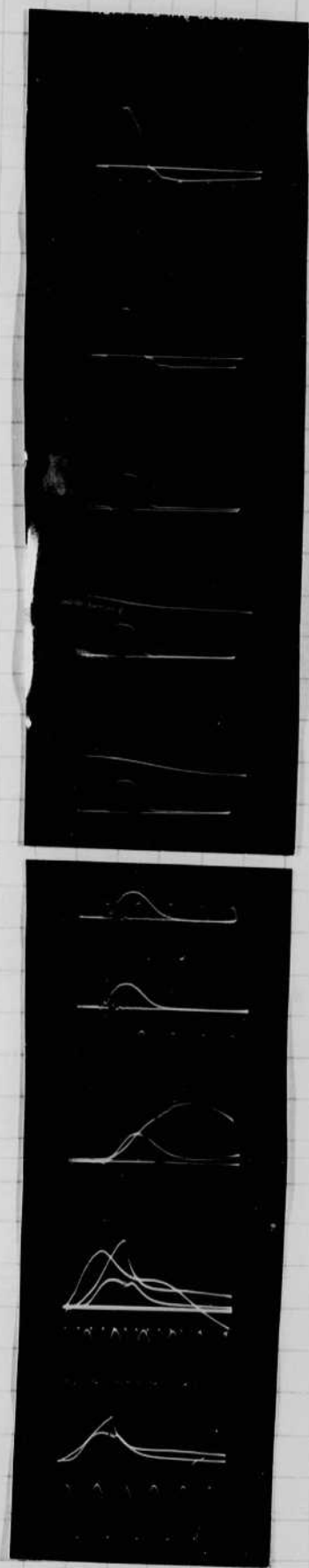
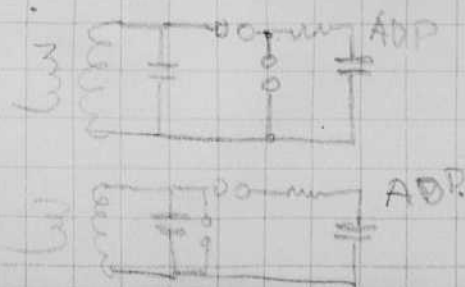
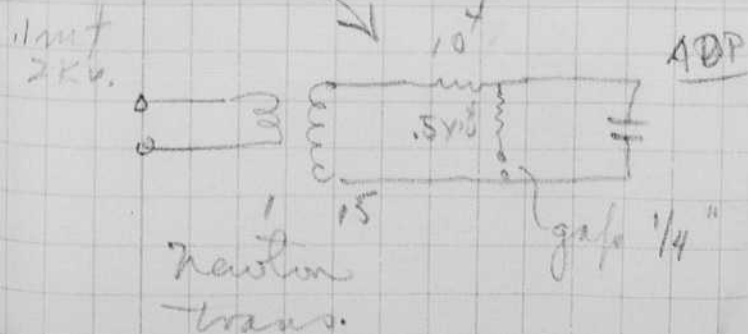


H. S. G. G. G.  
Sept 6 1951

A.D.P.  
Crystal Shutter

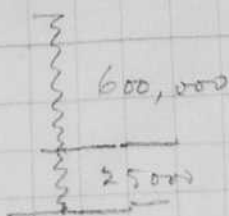
- 0-1-1 Voltage output of 10th Trans #292 1387 Raytheon trans. 10,000 ohms in parallel.
- 1-2 Cutts except no 10,000 ohms.
- 1-3. Light transmission. X2 filter
- 1-4. Ditto and with  $\theta = 45^\circ$ . X2 filter
- 1-5. " " " X2  
Faster Light trigger.

- 2-1 a  $10^4$  resistor was put in series with the crystal to reduce the sudden rise.
- 2-2 Ditto  $\rightarrow$   $10^6$  cycles.
- 2-3 Newton transformer 15 to 1.  $10^4$  ohms in series. Spark voltage. Sweep 5
- 2-4 output volts on Xstal slide.  $10^4$  ohms.  $10^6$  cycles. Sweep 5.
- 2-5 Ditto with parallel spark and 5K



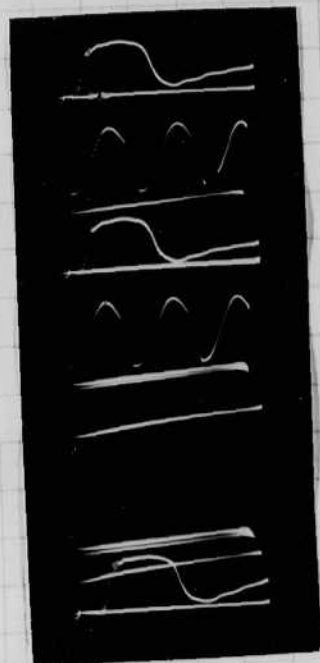


Sept 7 1951

Sage  
Register

X2 Filter.

1. ADP crystal mesa glass.  
10° cycles #55 dark
2. Ditto with optical zero  
and 45° rotation of  
First Polarizer.
3. 0 15 45 60 90°  
First Polarizer.
4. Light through crystal.  
0 22.5 45 67.5 90°



#2.

Stan Sage  
↓

Photo taken by  
Stanford with  
Kodakmox Portable  
and 4X5 camera.  
He is to use this  
for 3 or 4 weeks  
to study  
rolling mills for  
the A. E. C.

FT-110  
10mf  
2000V

Photo of moon taken  
Sept. 9 1951 about  
8 or 9 pm.

10 ft Cassigrain telescope  
"teletronic" camera  
(?)  $\frac{1}{200}$  sec on tri X plate,  
 $\frac{1}{25}$ .

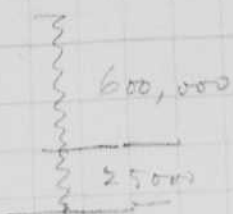
The entire moon is not  
covered by the camera  
angle.

Wm Ward.

Geo Haraden.

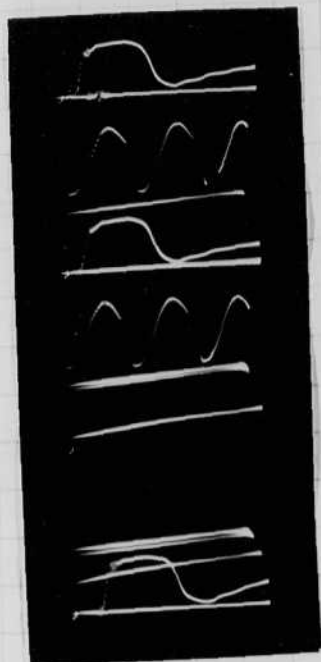
Vernon MacRobert.

Sept 7 1951

Sage  
Sage

X2 Filter.

1. ADP crystal nesa glass.  
10° cycles #55 bars
2. Ditto with optical zero  
and 45° rotation of  
First Polar
3. 0 15 45 60 90°  
First Polarizer.
4. Light through crystal.  
0 22.5 45 67.5 90°



#2.

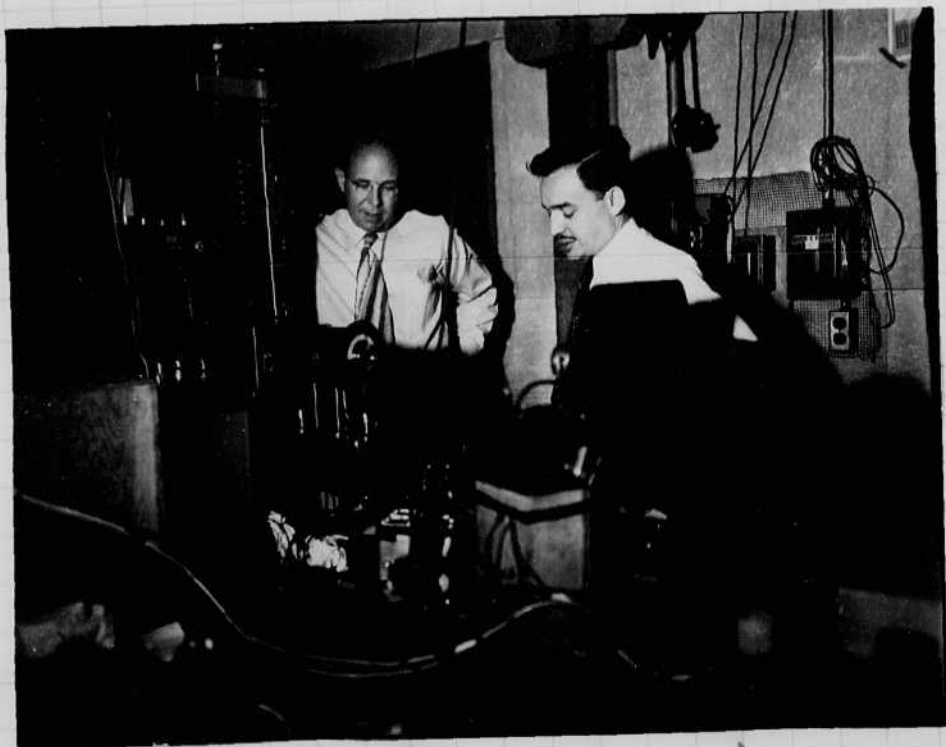
Sage Sage  
↓

Photo taken by  
Stanford with  
Kodakon Portable  
and 4X5 camera.  
He is to use this  
for 3 or 4 weeks  
to study  
milling mills for  
the A. E. C.



FT-110  
10mf  
2000 v

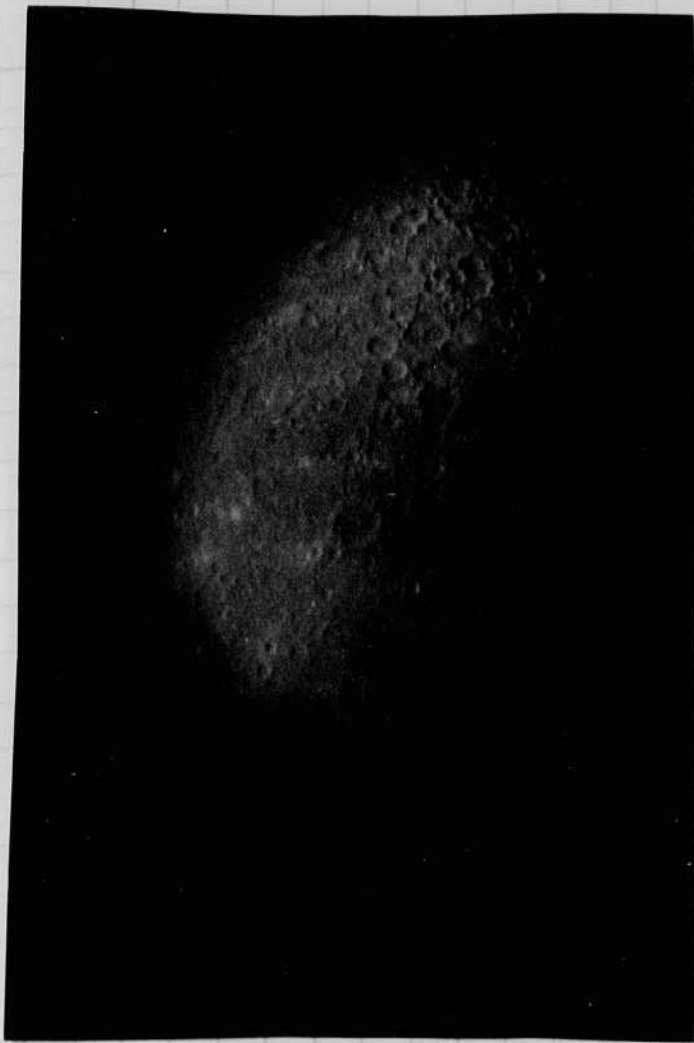


Photo of moon taken  
Sept. 9 1951 about  
8 or 9 pm.

10 ft Cassimir telescope  
"teletronic" camera  
(?)  $\frac{1}{200}$  sec on tri X plate,  
 $\frac{1}{25}$ .

The entire moon is not  
covered by the camera  
angle.

Wm Ward.

Geo Haraden.

Vernon MacRoberts.

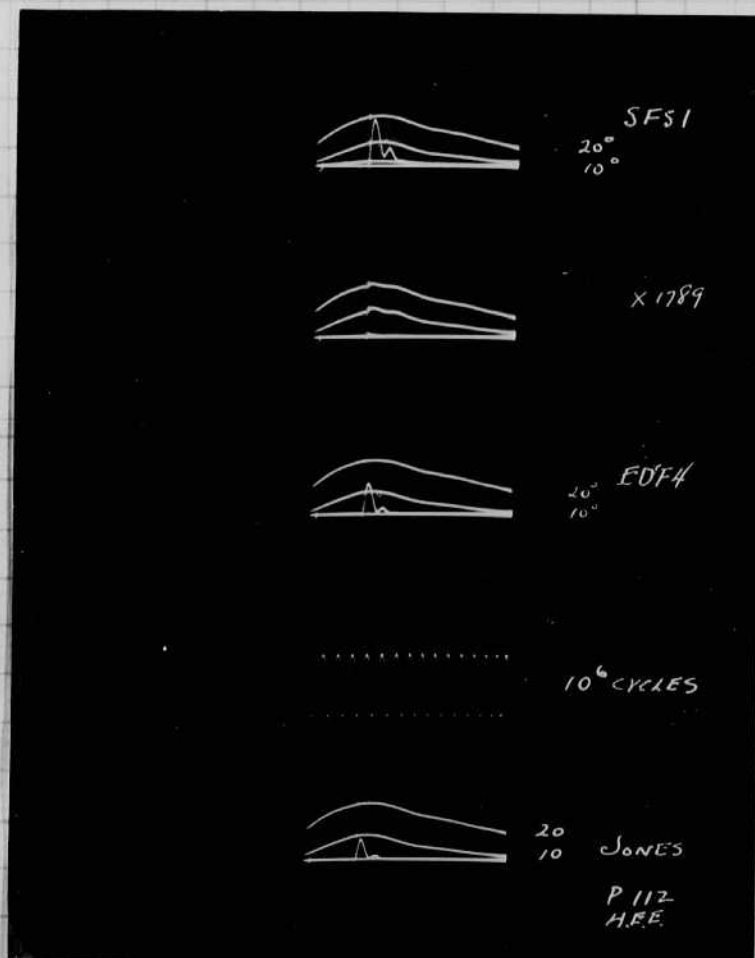


James Edgerton.  
Sept 15 1951

## Resumption of Magneto optic measurements.

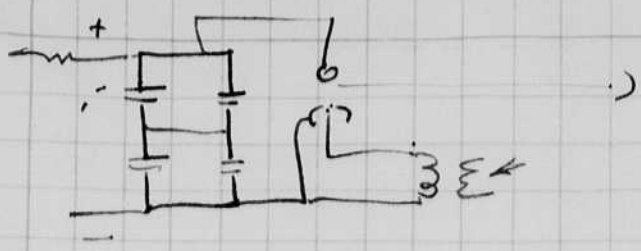
Shott Glass arrived yesterday  
from GermanyOct 1-1 Zero scope SFS 1 632 Sweep 7.  
Zero light  $\times 90^\circ$  same leads.  
105V volts on Varian No.  
10° 20°.1 TURN 1" diam. Res wire  
from 1/8 int 24KV.  
D = 36" to first Polarizer  $F=0$ 1-2 Eastman glass  $\times 1789$ .  
No appreciable  
rotation! 0 10 20  
with pulse fieldT-3 Sapphirine  
Ruby and Rutile checked  
no appreciable Rotation  
 $Al_2O_3$  TiO.  
no photo1-3 EDF4 105V on Var.  
0, 10, 20  
1/8 24KV  
1 turn.

1-4 10° cycles.

1-5 Glass from A.D. Jones.  
Clear.  $\delta$  10° 20°Clear Plastic tried  
no effect visible  
on scope.

Test of 8 Sprague capacitors.

0.75 mF 7KV DC Peak.  
18.3 watt sec.  
 $\frac{7}{73.2}$  watt sec.



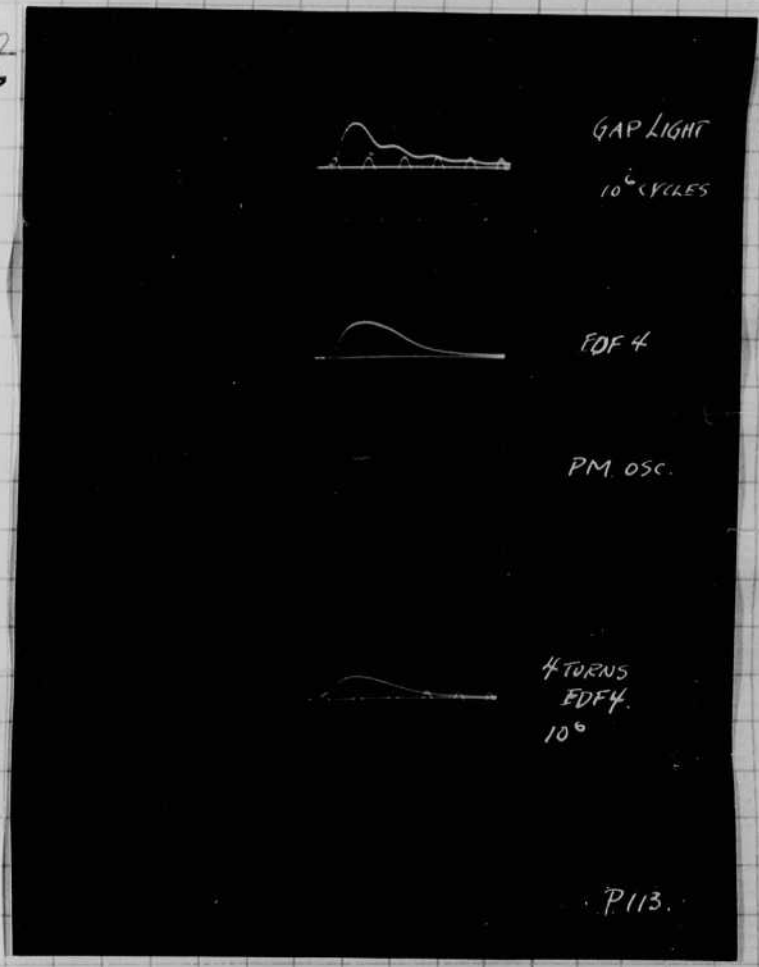
6-2-1 45V on Variac.  
Light from gaps. Sweep 6.

10<sup>6</sup> cycles. timing wave  
10° ± on polarizer as an attenuator

2-2 1" diam 4 turn coil via (EDF4)  $\frac{1}{2}$ "  
series with gap (glass) thick.  
40° ± on polarizer.  
2.4 ohms in coil of wire.

2-3. Coil arched over Bang  
~~at~~ This over loaded the  
P.M. tube. Note  
oscillation!

2-4. Worked ok with 55 volts  
on variac.  
10<sup>6</sup> cycles.



David Edgerton.  
Sept 15 1951

Resumption of Magneto optic measurements.

Shott glass arrived yesterday  
from Germany

Oct 1-1 Zero slope SFS 1 632 Sweep 7.  
Zero light  $\times 90^\circ$  same beats.  
105V volts on Varian M.O.  
10° 20°.

1 TURN 1" diam. Res wire  
from 1/8 int 24KV.  
D = 36" to first Polarizer  $F=0$

1-2 Eastman glass X 1789.  
No appreciable  
rotation! 0 10 20  
with pulse field

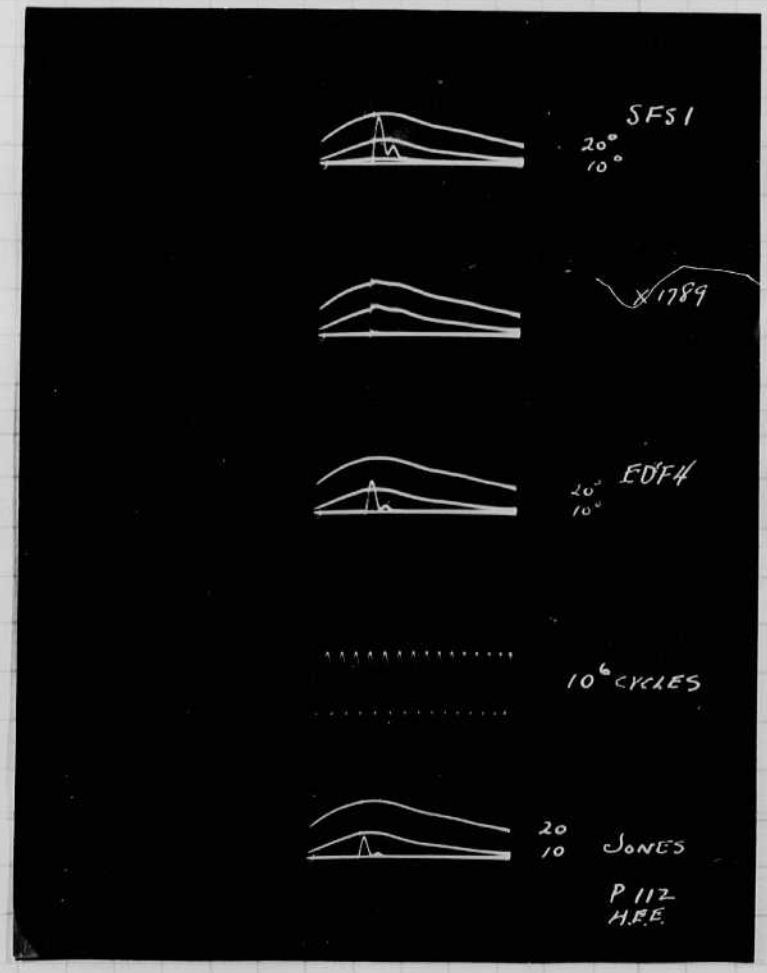
~~T-3~~ Sapphirine  
Ruby and Rutile checked  
no appreciable Rotation  
Al<sub>2</sub>O<sub>3</sub> TiO.  
no photo

1-3 EDF4 105V on Var.  
0, 10, 20  
1/8 24KV  
1 turn.

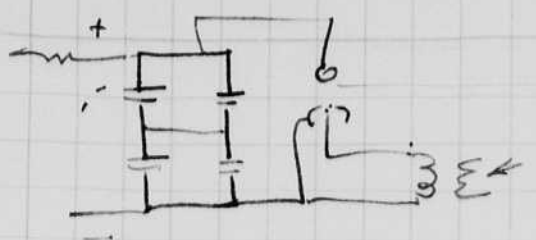
1-4 10° cycles.

1-5 Glass from A.D. Jones.  
Clear.  $\theta$  10° 20°

Clear Plastic tried  
no effect visible  
on slope.



Test of 8 Sprague capacitors. 0.75 uf 7KV DC Peak.  
18.3 watt sec.



$$\frac{7}{73.2} \text{ watt sec.}$$

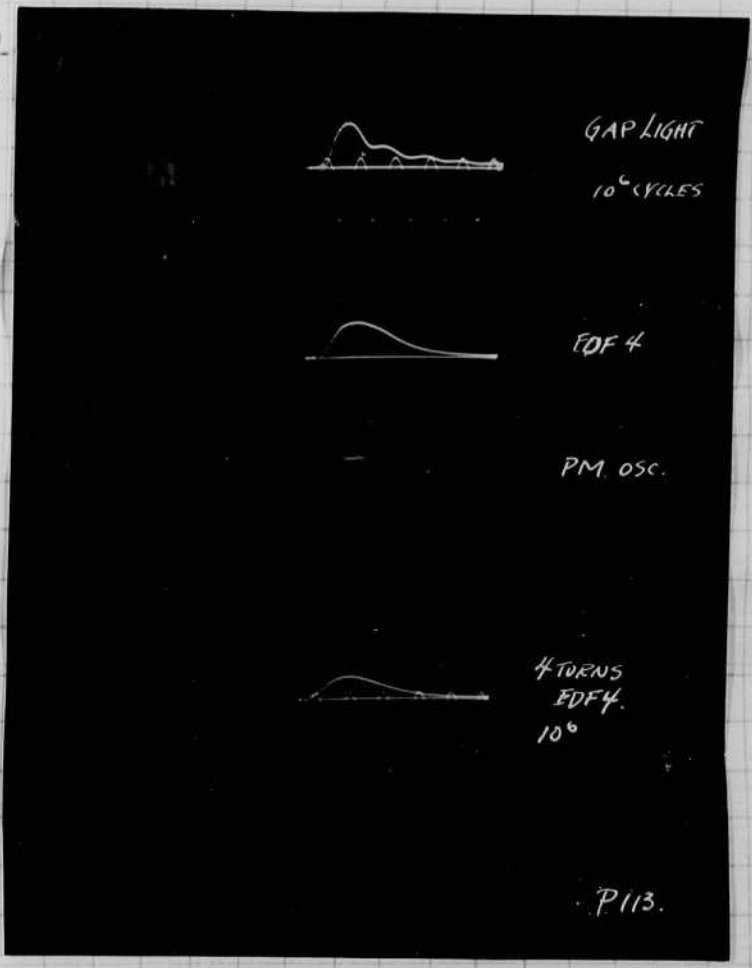
8-2-1 45V on Variac.  
Light from gap. Sweep 6.

10° cycles. timing wave  
10° ± unpolarized as an attenuator

2-2 1" diam 4 turn coil in (EDF4) 1/4" glass tube  
series with gap  
40° ± on polarizer.  
2.4 ohms in coil of wire.

2-3. Coil arched over Bang  
~~at~~ this over loaded the P.M. tube. Note oscillation!

2-4. Worked ok with 55 volts on variac.  
10° cycles.





114

Sept 17 1951  
H. E. Egerlin

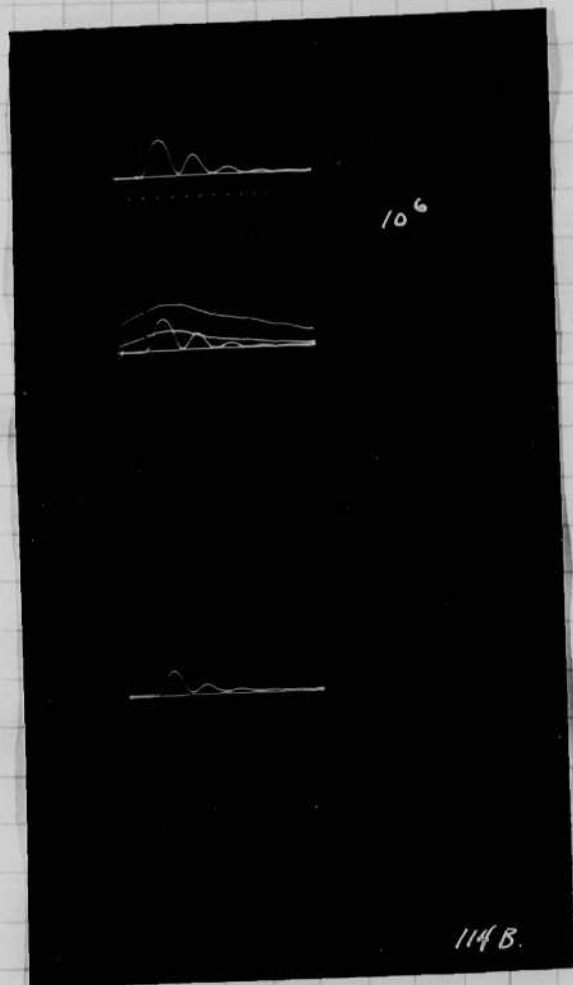
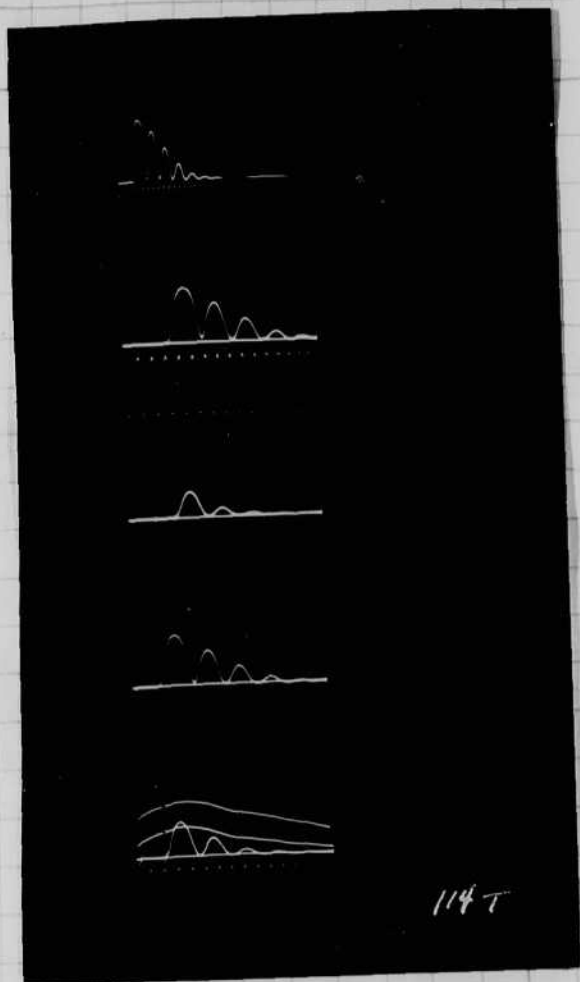
Brass wire

1-1 4 turns EDF4 1" by 3/4" long  
 Lamp FT-110 at  
 36 a.  
 57 with in vac.  
 4 Sprague caps.

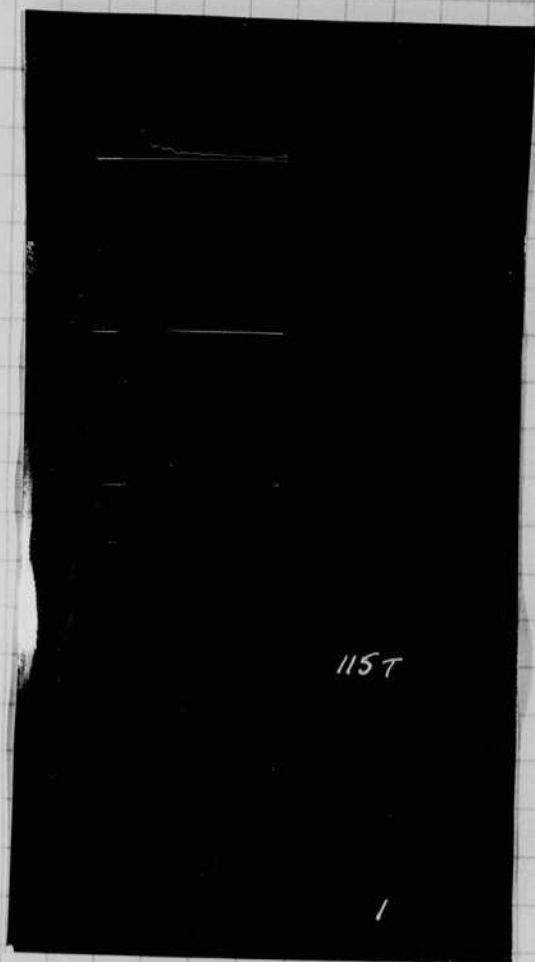
1-5. Mo. 4 turns as per 1.  
 20° 40°  
 10<sup>6</sup> cycles.

2-1 Capacitors reconnected  
 so that ground terminals  
 are together 10<sup>6</sup>

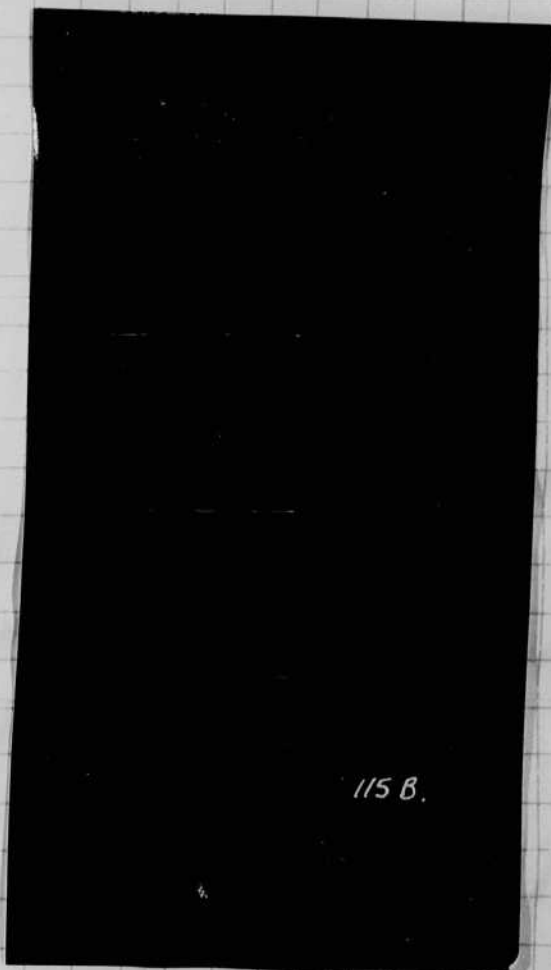
2-2 Ditto 0 20° 40°



- 3-1 Light from gaps  
4 Sproyee caps  
.75 7KV in SW 7  
Ser. Par.
- 3-2. Caps changed from  
4 to 2. Winia SW 7  
Inductan coil made  
small as possible.
- 3-3 Jello Sweep 6.  
10° cycles.  
+



- 4-1 4 Sproyee capacitors  
reconnected with  
lower inductan coil straps  
Light from gaps. SW 6 10° cyc.
- 4-2 4 turns Brass wire 1" EDFH
- 1 turn. Light increased to  
get record of time.
- 4-3
- 4-4



114

Sept 17 1951  
AG Edgerton

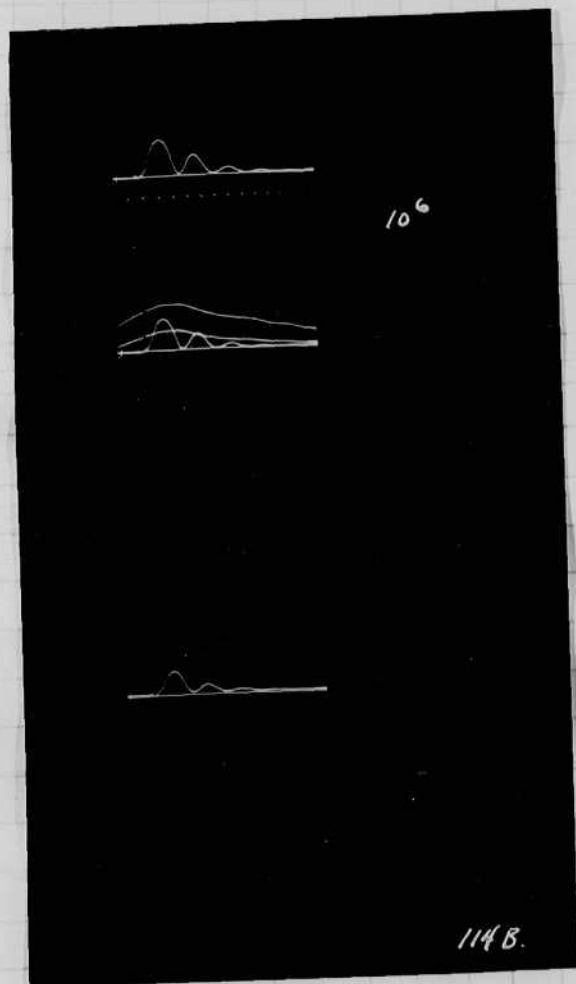
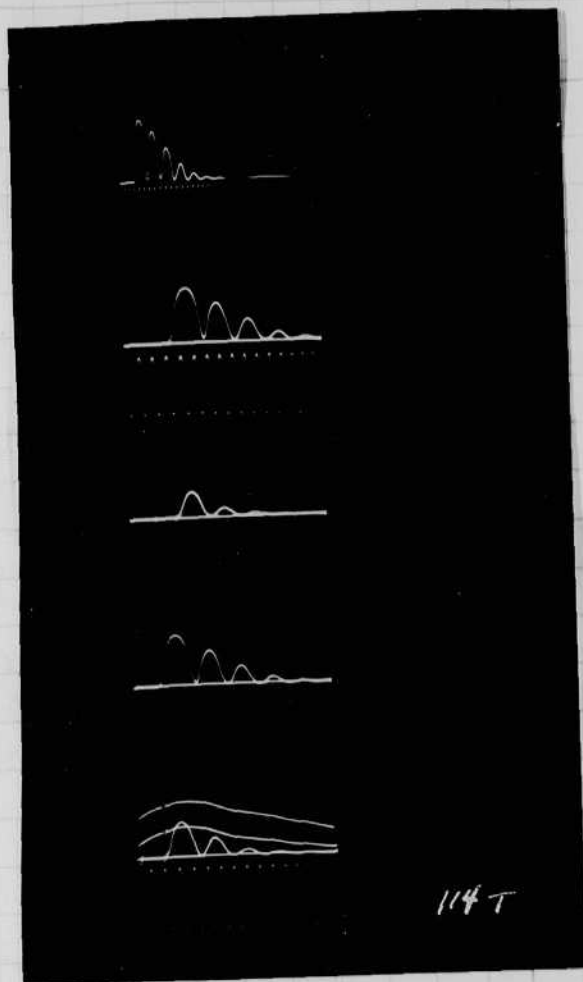
Bresswine

- 1-1 4 turns EDF4 1" by 3/4" long  
 Lamp FT-110 at  
 36°.  
 57 volts on vac.  
 4 Sprague caps.

1-5. Mo. 4 turns aspect.  
 20° 40°  
 10<sup>6</sup> cycles.

2-1 Capacitors reconnected  
 so that ground terminals  
 are together 10<sup>6</sup>

2-2 Ditto 0 20° 40°



3-1 Light from gaps  
4 Sproyue caps  
.75 KV in SW 7  
Sec. Par.

3-2 Caps changed from  
4 to 2. Wiring SW 7  
Inductance & make  
small as possible.

3-3 Jello Sweep 6.  
10° cycles.



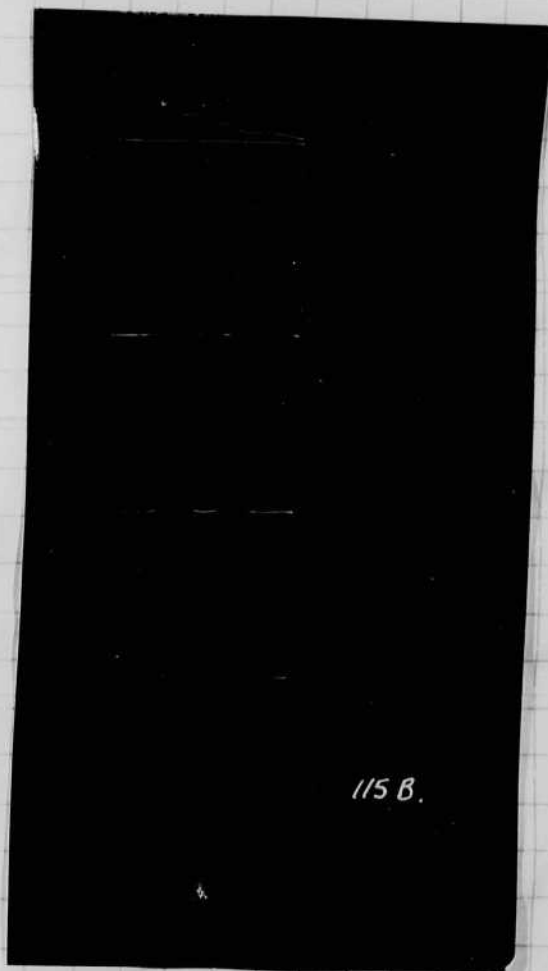
4-1 4 Sproyue capacitors  
reconnected with  
lower inductance & straps  
Light from gaps. SW 6 10° cyc.

4-2 4 turns Brass wire 1" EDFH

1 turn. Light increased to  
get record of time.

4-3

4-4



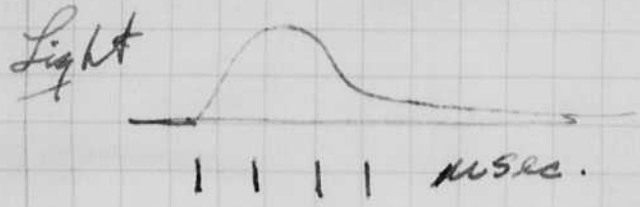


116 Sept. 18, 1951  
H. E. Edgerton

A D.R. microflash tube  
was connected across a  
0.75 m $\mu$  7000 volt  
Syringue capacitor  
to study the discharge  
light.

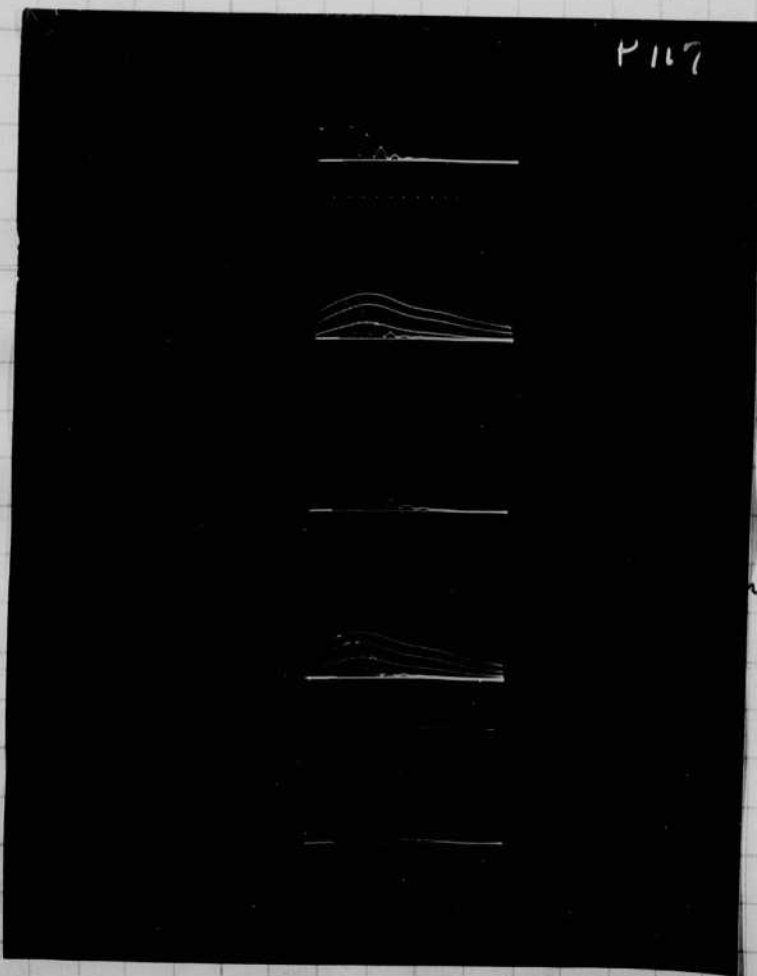


The flash lasts several  
microseconds.



Sept. 21, 1951 6.70 class in 20 E 121. MWF 11-12.

Other solutions to try.



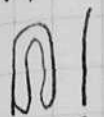
- Mn Cl<sub>2</sub> + H<sub>2</sub>O
- Mn I<sub>2</sub>
- Hg (C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>)<sub>2</sub>
- Ag NO<sub>3</sub>
- Sr (ClO<sub>3</sub>)<sub>2</sub>
- Sr I<sub>2</sub> · 6H<sub>2</sub>O 64 gr
- Tl OH
- Sr Cl<sub>2</sub> · 2H<sub>2</sub>O 70 gr.
- VO<sub>2</sub> (NO<sub>3</sub>)<sub>2</sub> · 6H<sub>2</sub>O.

Sept 27 1951  
H. E. Garton  
MIT 20D102

117

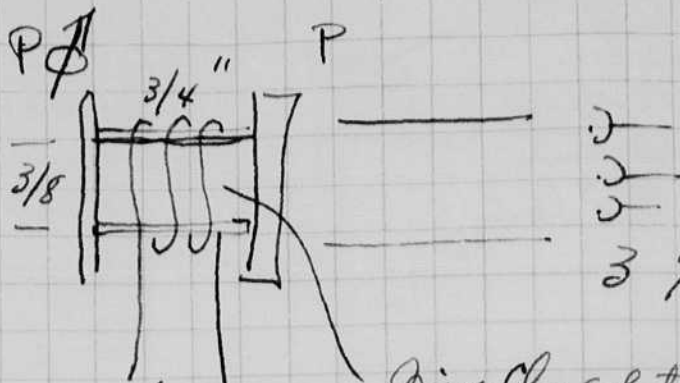
# Jarvis effect tests.

FI-110



F-X2  
10mf  
2000V

36"



3 931 tubes to scope

6 TURNS TO Zinc Cl<sub>2</sub> solution  
1/8 mf 24KV.  
(105 on vacuum).

#1 Sweep 7 10° tuning wave

#2 " " (0+mo) 20° 30° 40°

3. Coil increased to 8 turns (from 6).  
10° cycles.

4. (0+mo) 20° 30° 40°.

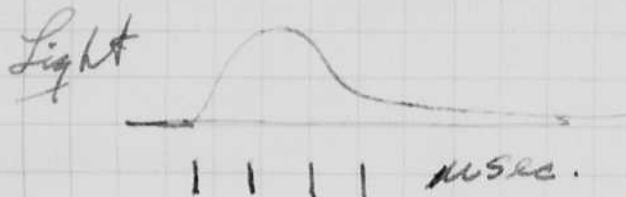
5. 8" of 1.25  $\Omega$ /ft wire put in series  
with discharge. two flashes one  
undamped.

6. Dillo but arc over ends of R wire.

116 Sept. 18, 1951  
H. E. Edgerton

A D.R. microflash tube  
was connected across a  
0.75 m $\mu$  7000 volt  
Syringal capacitor  
to study the discharge  
light.

The flash lasts several  
microseconds.



Sept. 21, 1951 6.70 class in 20 E 121. MWF 11-12.

Other solutions to try.

P 117

Mn Cl<sub>2</sub> 4 H<sub>2</sub>O

Mn I<sub>2</sub>

Hg (C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>)<sub>2</sub>

Ag NO<sub>3</sub>

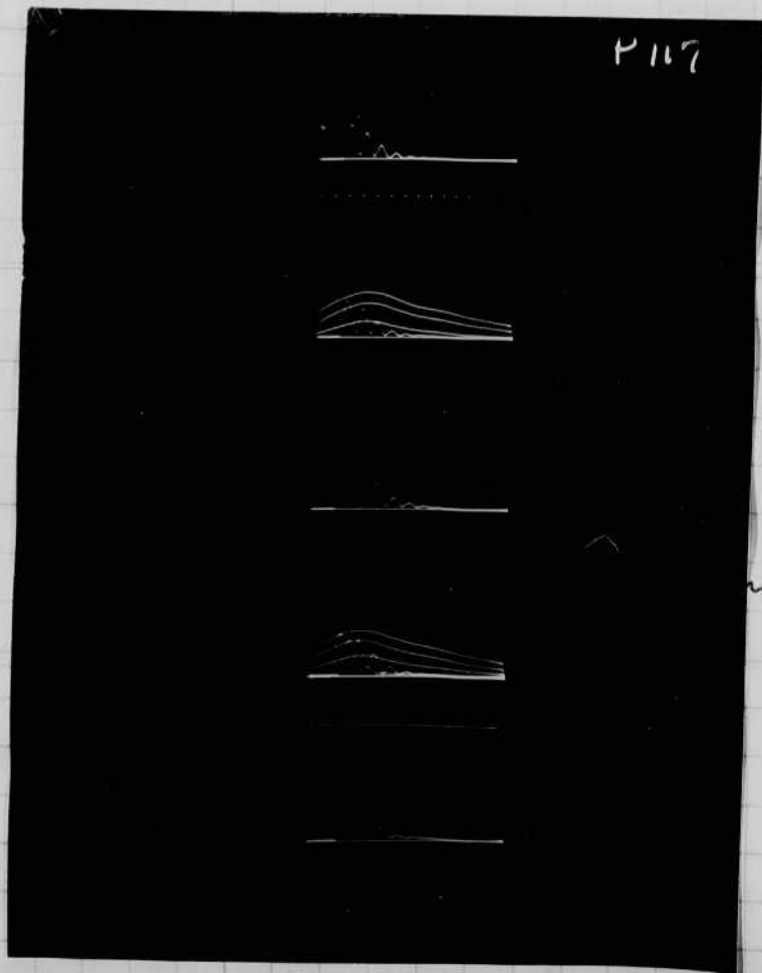
Sr (ClO<sub>3</sub>)<sub>2</sub>

Sr I<sub>2</sub> · 6 H<sub>2</sub>O 64 gr

in Tl OH

Sr Cl<sub>2</sub> 2 H<sub>2</sub>O 70 gr.

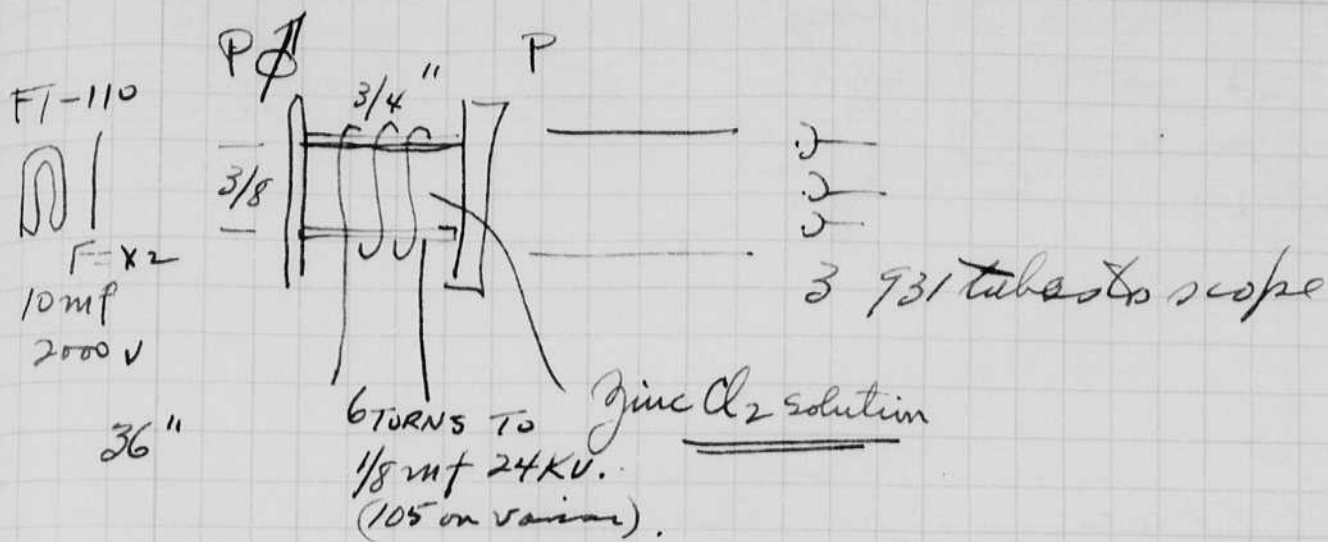
UO<sub>2</sub> (NO<sub>3</sub>)<sub>2</sub> 6 H<sub>2</sub>O.



5/22/51  
R. E. Edgerton  
MIT 20D102

117

# Jarvis effect tests.



#1 Sweep 7 10° timing wave

#2 " " (0+mo) 20° 30° 40°

3. Coil increased to 8 turns (from 6).  
10° cycles.

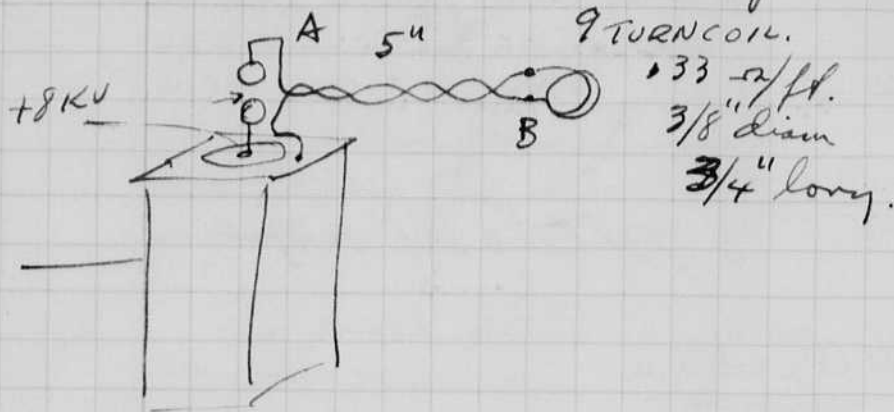
4. (0+mo) 20° 30° 40°.

5. 8" of 1.25  $\Omega$ /ft wire put in series  
with discharge. two flashes one  
undamped.

6. Filts but arc over ends of R wire.

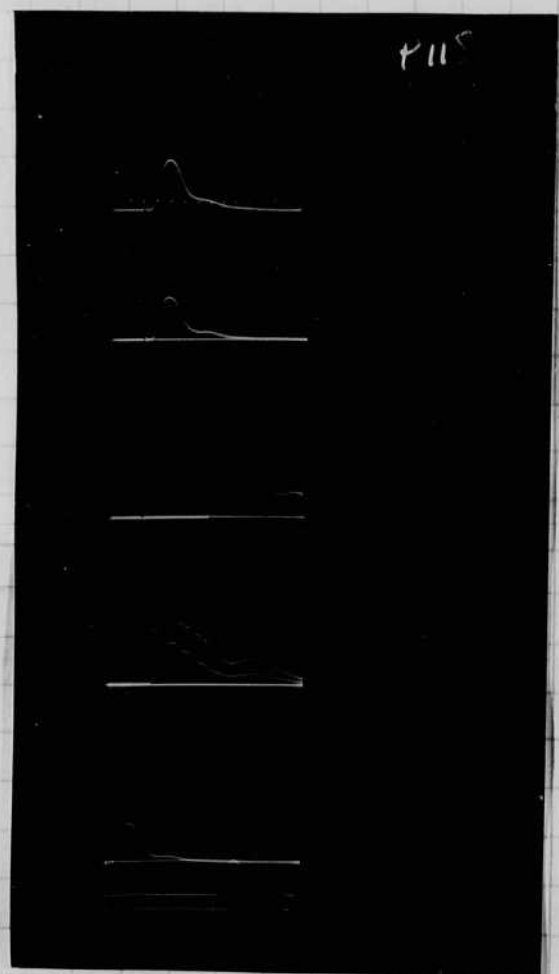


Another experiment. Difficulty is being experienced in obtaining a short trill surge.



.05 10,000  
 $\frac{CE^2}{2} = \frac{.05 \times 100}{2} = 2.5 \text{ watt sec.}$

1. Light measured from the air gap with coil in place 9 TURNS.
2. terminals at line. A shorted.
- 3.
4. Terminal at coil shorted B shorted.
5. Repeat #1.

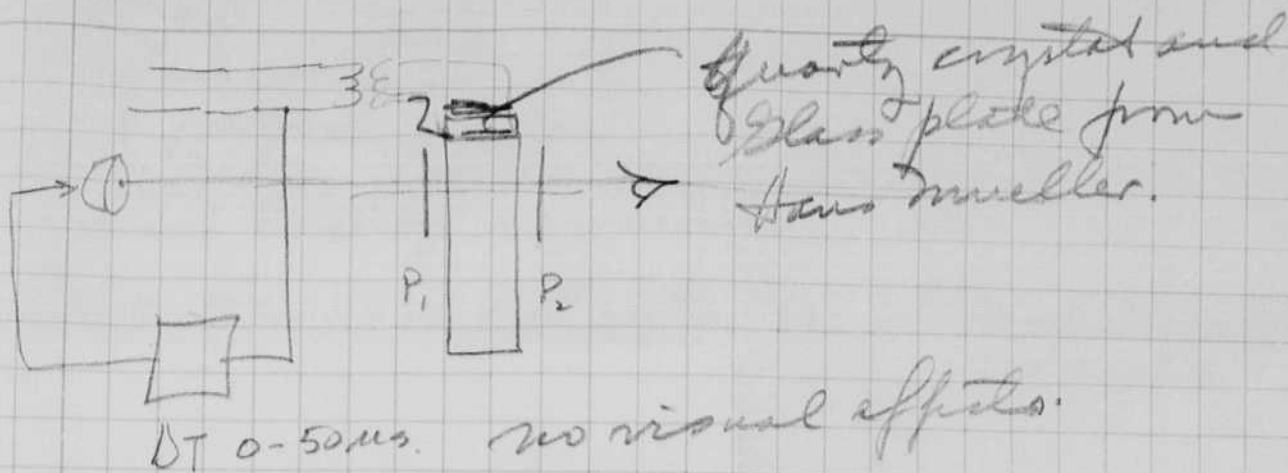


$$L = \frac{10}{C^2 \pi^2}$$

$$L = \frac{10 \times .05 \times 10^4}{.05^2 \times 4 \pi^2} = \frac{10 \times .05 \times 10^4}{.0025 \times 4 \pi^2} = \frac{10 \times .05 \times 10^4}{.01 \times 4 \pi^2} = \frac{10 \times .05 \times 10^4}{.04 \pi^2} = \frac{10 \times .05 \times 10^4}{.04 \times 9.87} = \frac{10 \times .05 \times 10^4}{.3948} = \frac{5000}{.3948} = 12688$$

$$I = \frac{E}{\sqrt{L}}$$

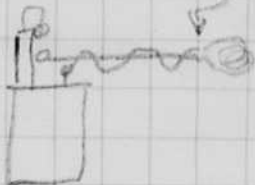
$$I_{max} = \frac{10000}{\sqrt{12688}} = \frac{10000}{112.6} = 88.8$$



.05 20,000 Volt Sprague.

# Sweep 6.  $10^6$  cycles.

The same leads and 10 turn coil were used. There was an arc at the coil.



# 2 coil & leads in

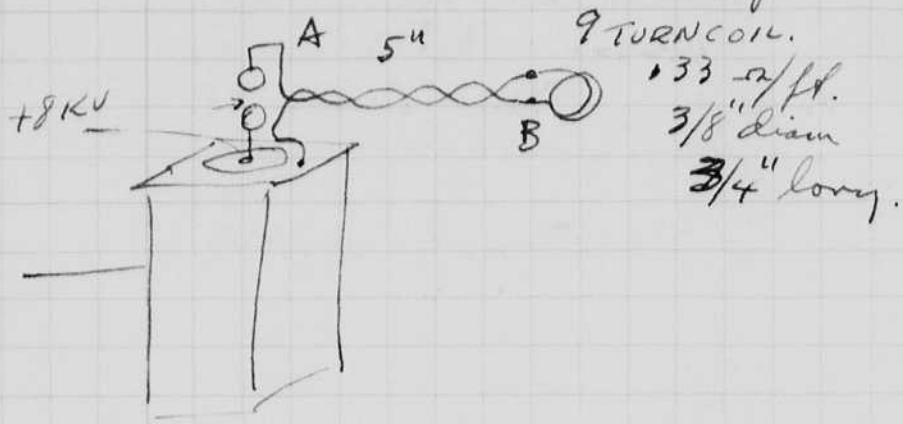
3 coil & leads in

4 no coil or leads on condenser.

5 Short pickups. coil and leads in circuit  
 $10^6$  cycles

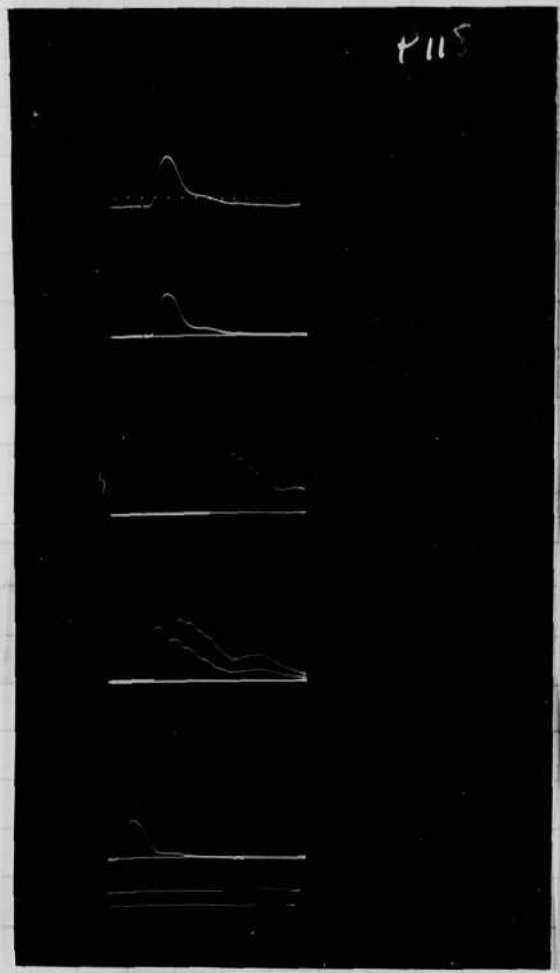


Further experiments. Difficulty is being experienced in obtaining a short trial surge.



.05 10,000  
 $\frac{CE^2}{2} = \frac{.05 \times 100}{2} = 2.5 \text{ watt sec.}$

1. Light measured from the air gap with coil in place 9 TURNS.
2. terminals at line A shorted.
- 3
4. Terminal at coil shorted B shorted.
- 5 Repeat #1.



$$L = \frac{\mu_0 N^2 A}{4\pi r}$$

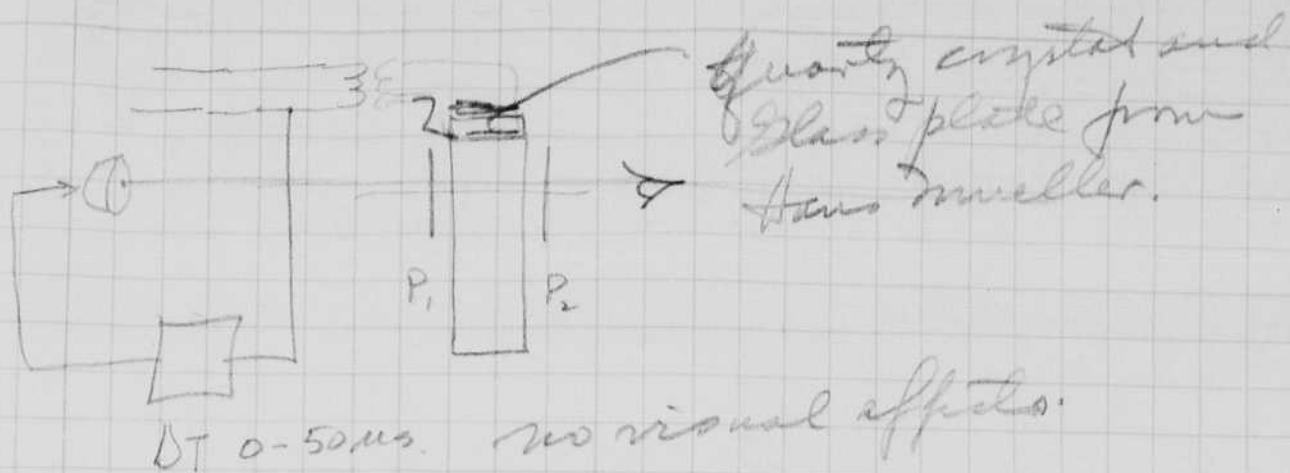
$$L = \frac{1.2566 \times 10^{-6} \times 9^2 \times \pi \times (0.0375)^2}{4\pi \times 0.75}$$

$$L = 1.04 \times 10^{-8} \text{ H}$$

$$I_{max} = \frac{E}{\sqrt{L}}$$

$$I_{max} = \frac{10000}{\sqrt{1.04 \times 10^{-8}}}$$

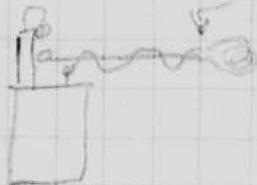
$$I_{max} = 2.0 \times 10^6 \text{ A}$$



.05 20,000 Volt Spargue.

# Sweep 6.  $10^6$  cycles.

The same leads and 10 turn coil were used. There was an arc at the coil.

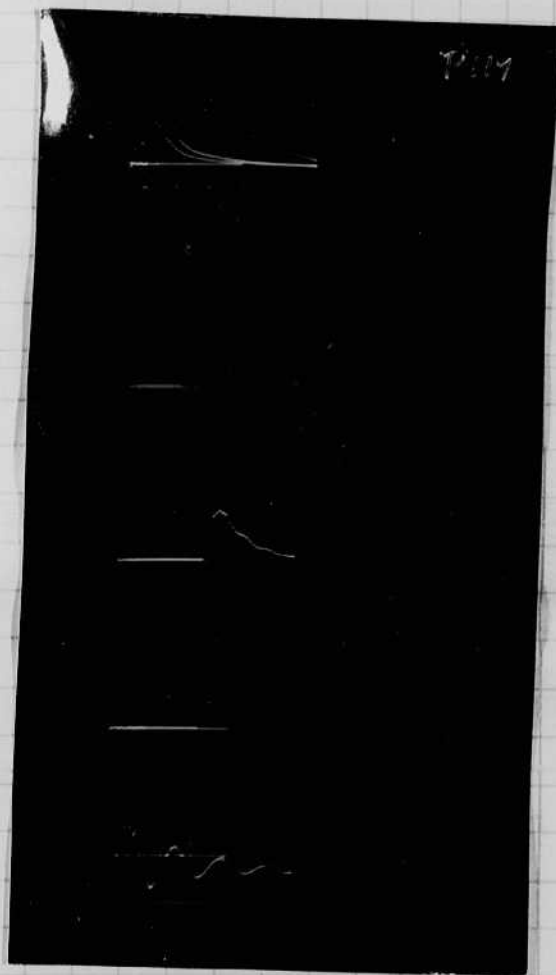


# 2 coil & leads in

3 coil & leads in

4 no coil or leads on condenser.

5 Elect pickup. coil and leads in circuit  
 $10^6$  cycles



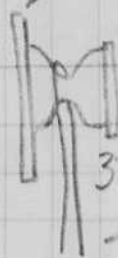


Again, .05mf 20KV Sprague  
 this time a 3 turn coil  
 was used with 2" leads  
 Res wire .9 w/H.

1/4" hole

2" 5/8"

246  
 60  
 12,400



ZnCl<sub>2</sub>

3 turn coil

twisted leads

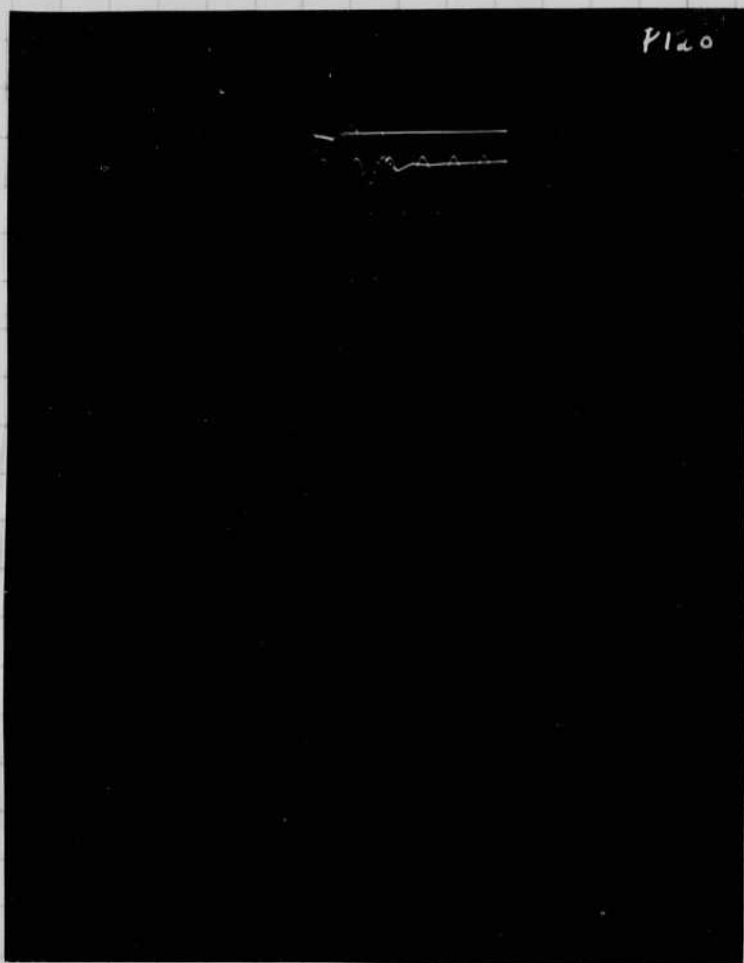
#1 Elect Pickups.  
 10° cycles.

2 Pickup.

3 Pickup, 10°

4 10° + No. 5w 7

5 0 + no 10 20  
 Sw 6



More tests M.O. Shutter. Sept. 1951  
Wed. SoCl<sub>5</sub>  
Pb tet nyl EtHgl. 121

24KV 0.125 mf again

old glass container with waxed on 2x2 slide  
and petcock drain.

Same filling of antimony pentachloride as before.  
7 turn coil of res wire. 105V


Lamp FT-110 at 4 ft with x2 filter on lamp.

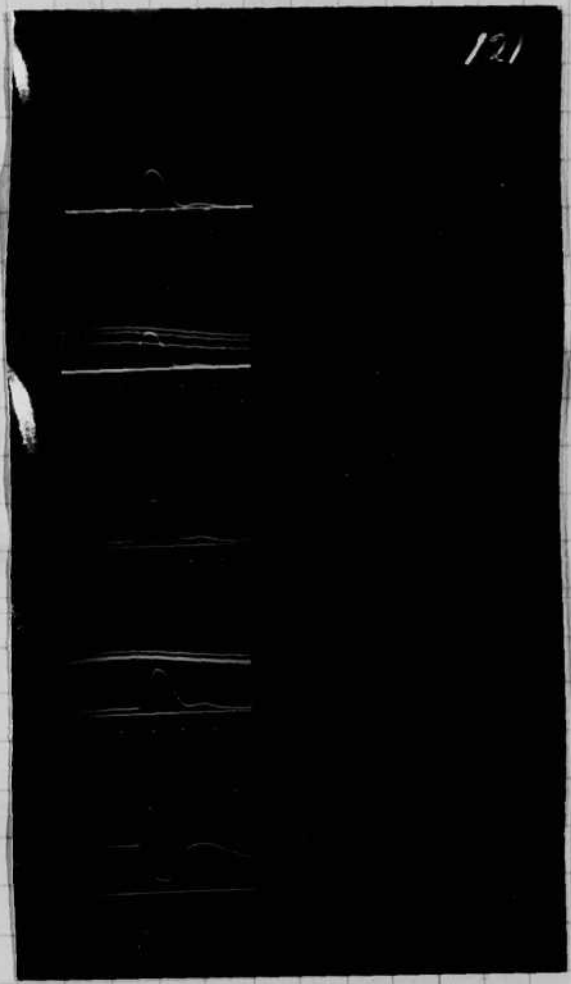
1. 0° + mo 10<sup>6</sup> cycles SoCl<sub>5</sub>

2. 0° + mo  
40° 50° 60° 10<sup>6</sup> cycles. SoCl<sub>5</sub>

Pb 3. 0 + mo no filter Lead  
tet nyl  
EtHgl.

Pb 4. 0 + mo  
40 50 60 no filter

Pb 5 + 30 + mo.  
  
no filter



Again, .05mf 20KV Sprague  
 this time a 3 turn coil  
 was used with 2" leads  
 Res wire .9 w/H.

1/4" hole

2" 5/16"

246  
 60  
 12,400



3 turn coil

twisted leads

ZnCl<sub>2</sub>

#1 Elect Pickups.  
 10° cycles.

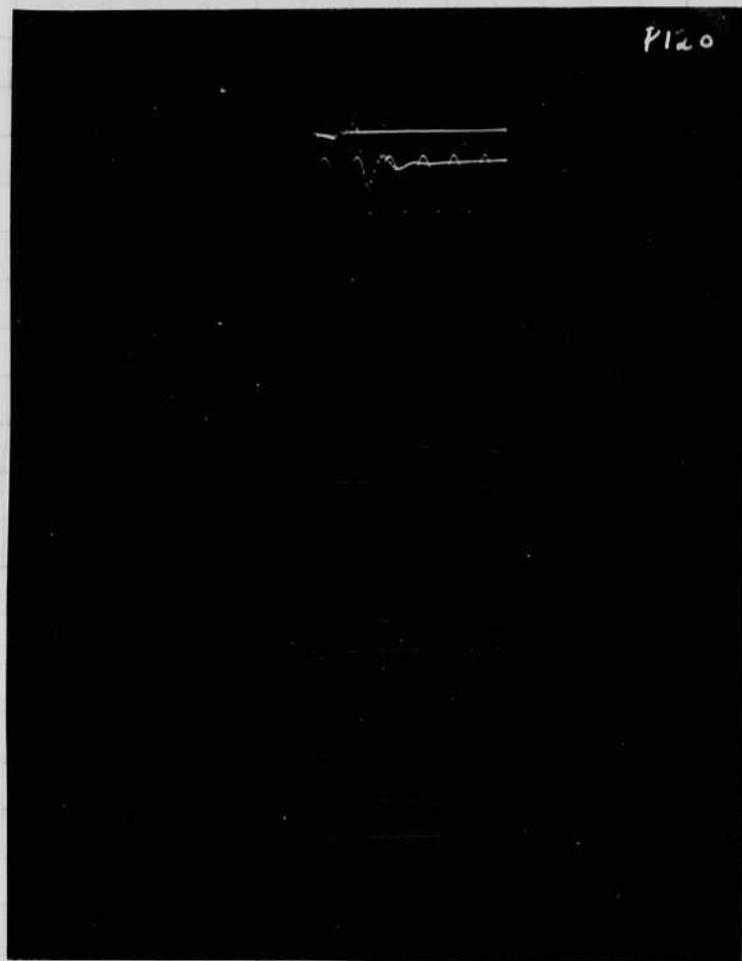
2 Pickups.

3 Pickups 10°

4 10° + No. Sw 7

5 04 no 10 20  
 Sw 6

P120



More tests M.O. Shutter, Sept. 1951  
Wed. SbCl<sub>5</sub>  
Pb tet methyl ethyl. 121

24KV 0.125 mf again

old glass container with waxes on 2x2 slide  
and petcoke drain.

Same filling of antimony pentachloride as before.  
7 turn coil of res wire. 105V

Lamp F7-110 at 4 ft with x2 filter on lamp.

Oscl. 0° + mo 10<sup>6</sup> cycles SbCl<sub>5</sub>

2: 0° + mo  
40° 50° 60° 10<sup>6</sup> cycles. SbCl<sub>5</sub>

Pb 3. 0 + mo no filter Lead  
tetraethyl

Pb 4. 0 + mo  
40 50 60 no filter

Pb 5 + 30 + mo.  
no filter





122 Sept. 28 1951 XW

Tuesday. Ethyl Cinnamate

1. 4 ft X2 filter  
mo.  $10^6$  cgu

2. Dils.  $30^{\circ}$   $40^{\circ}$

3.  $40^{\circ}$  + mo.

4. Carbon Disulfide 0 + mo  
X2 filter  $10^6$

5. none filter  $CS_2$   
0  
 $30^{\circ}$   $40^{\circ}$   $50^{\circ}$

---

tried a thin film of Irv and nickel  
on glass.

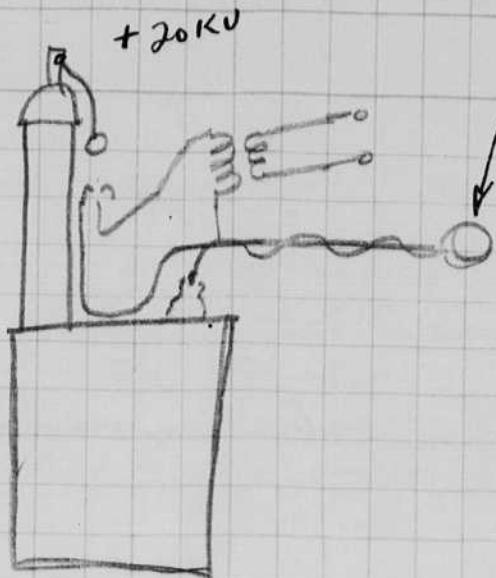
Quetum on 24KV unit. I could  
just detect a rotation with  
lamp at 4 ft and no filter.

EDFH  
1cm diam  
1cm long ±.

20KV .05mf.

EDFH glass.  
1cm diam  
1.5cm long.

6 turns of  
res wire  
about 2 ohms.



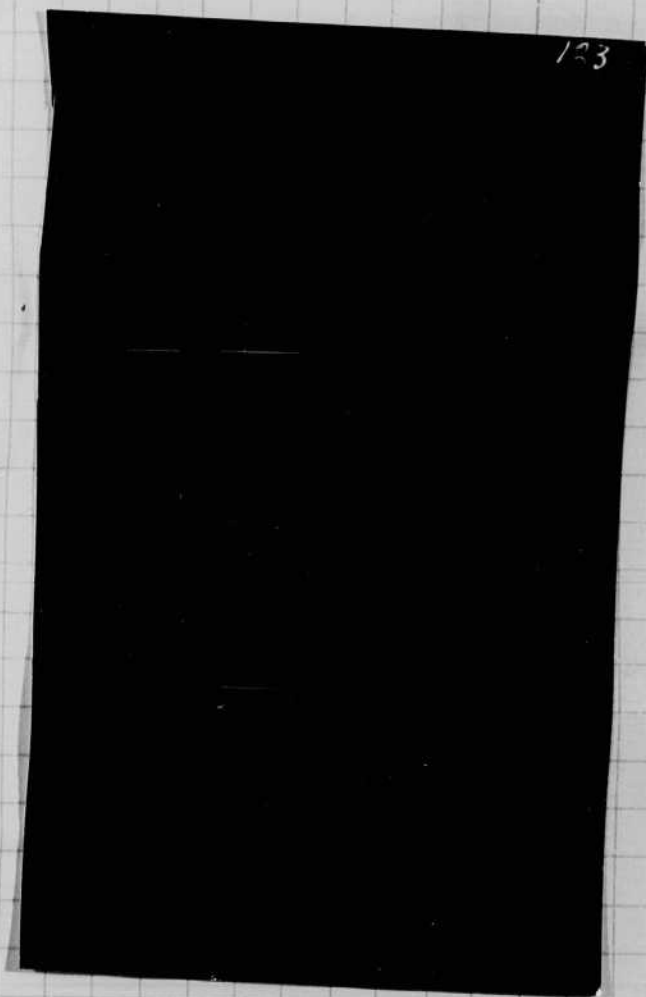
0101 Mo + 0°  
30° 40° 50°  
10° cycles.

2 Mo + 0 10° cycles.  
Inductance of leads  
decreased some.

20KV 3. Mo + 0 10° cycles.  
8 TURNS

20KV 4 Mo + 0  
30 40 50°  
8 TURNS

5 Sweep 5 0 + Mo.  
10° cycles



122 Sept. 28 1951 NW

Subst. Ethyl Cinnamate

1. 4 ft X2 filter  
mo.  $10^6$  cgu

2. Filts.  $30^\circ 40^\circ$

3.  $40^\circ$  + mo.

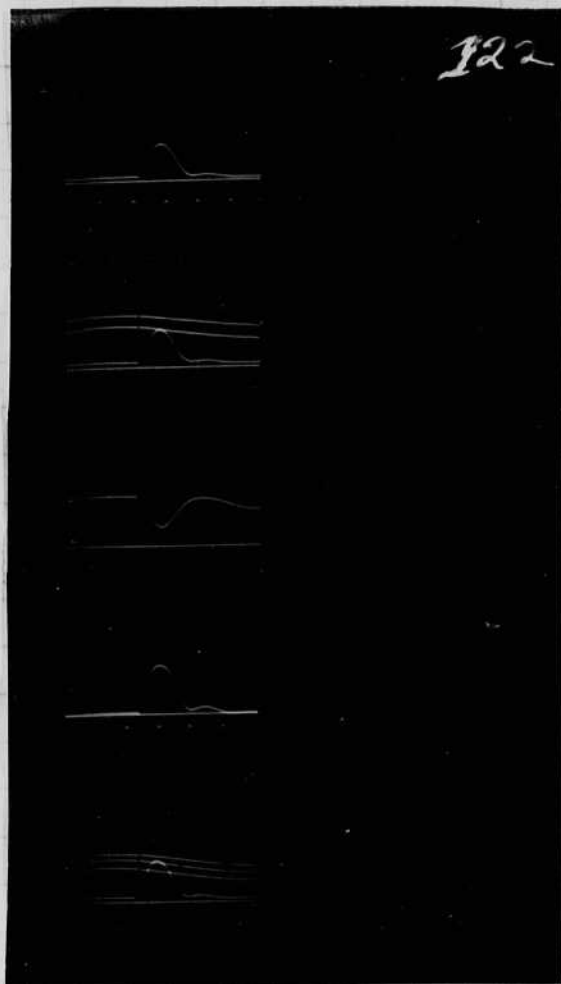
4. Carbon Disulfide 0 + mo  
X2 filter  $10^6$

5. None filter  $CS_2$   
0  
 $30^\circ 40^\circ 50^\circ$

---

tried a thin film of Irv and Michel  
on glass.

Quetum on 24KV unit. I could  
just detect a rotation with  
lamp at 4 ft and no filter.

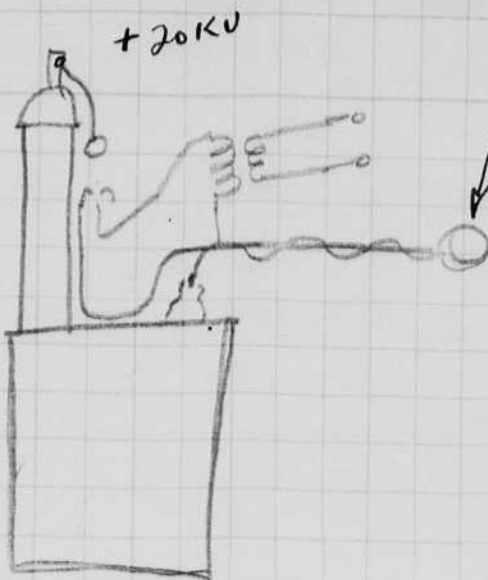


EDFH  
1cm diam  
1cm long ±.

20KV .05mf.

EDFH glass.  
1cm diam  
1.5cm long.

6 turns of  
res wire  
about 2 ohms.



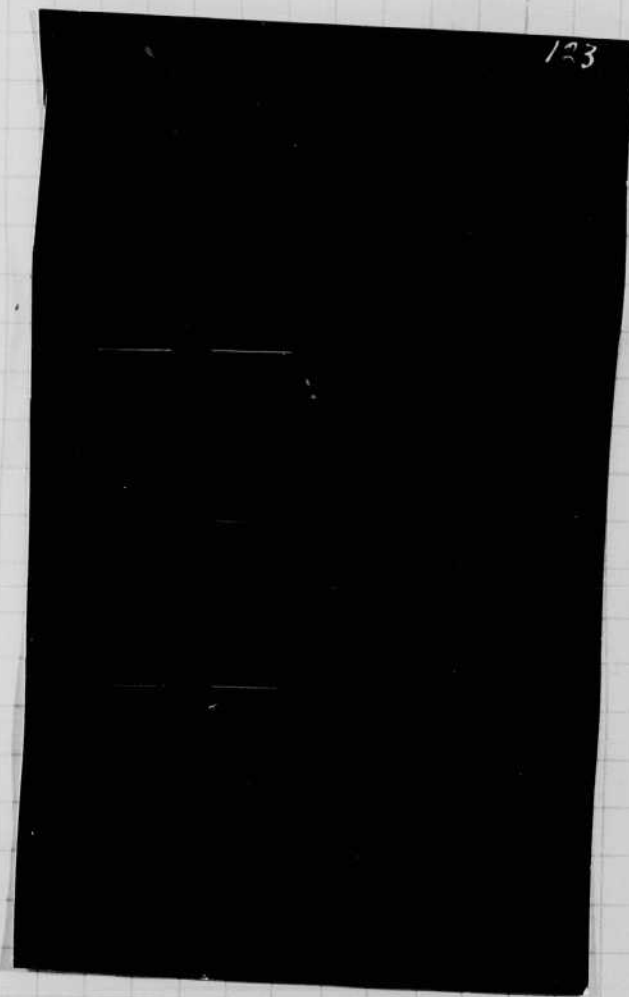
0101 M0 + 0°  
30° 40° 50°  
10° cycles.

2 M0 + 0 10° cycles.  
Inductance of leads  
decreased some.

20KV 3. M0 + 0 10° cycles.  
8 TURNS

20KV 4 M0 + 0  
30 40 50°  
8 TURNS

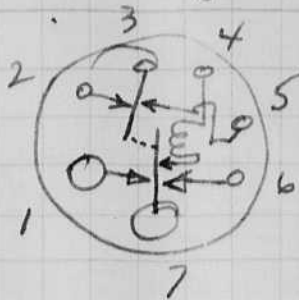
5 Sweep 5 0 + M0.  
10° cycles



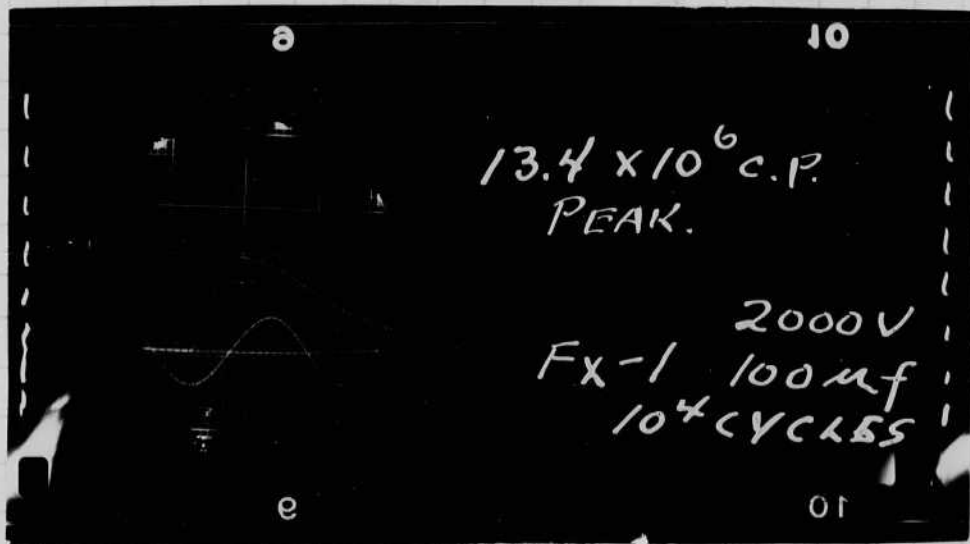
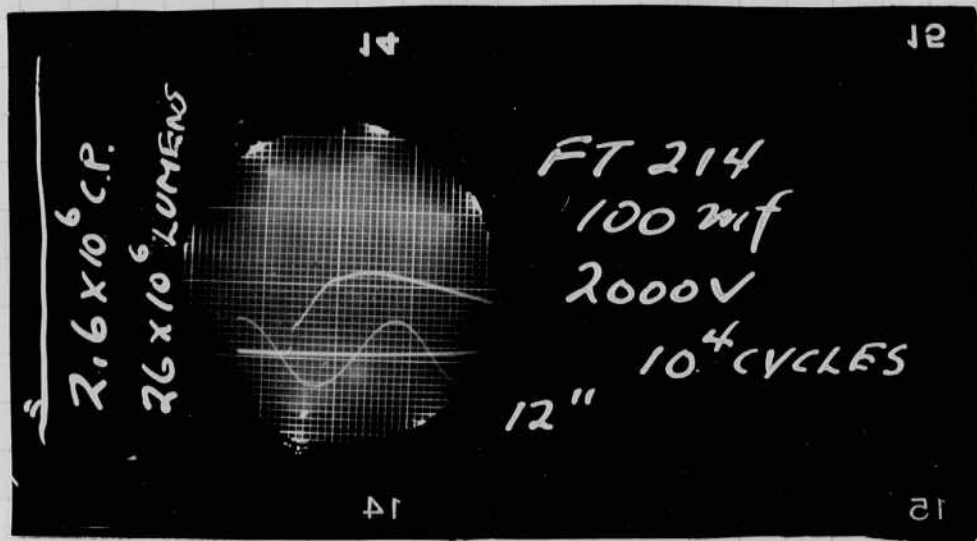


Oak vibrator 6V U6428

100 c.p.s.



note insulated vibrator needs. on pins 3 & 7.



Oct 11 1951  
H. E. Elgerton.

125

Oscillograph Calib.  
for trip to Goldstone. Dumont plant.  
Dr. C. F. Whinnery

Lamp FT-214 10.5 mf at 2000 volts in Blue Box unit  
tube # 111

Phototube pickup - Mills type  
with 1000 ohm.

929 trigger with 2D21 thyratron

Distance flash tube - side view no reflector  
to front of P.C. device = 1.5 ft.

A ground glass was used over the  
P.C.

The oscillograph (Dumont type 256D no 244)  
has an auxiliary capacitor switch on  
range 100  $\mu$ s. A dial 0, 1, 2, 3, 4,  
give the new sweep rates -

On dial setting 0

$$2'' = \frac{1}{\frac{15,000}{15,000}} \text{ sec} = 66.6 \mu\text{s}$$

$$1'' = 33.3 \mu\text{s}$$

$$1. \quad 1.32'' = \frac{1}{15,000} = 66.6.$$

$$50.5 \mu\text{s}$$

$$2. \quad 2.03'' = \frac{1}{7500} = 133.2 \mu\text{s}.$$

$$65.8 \mu\text{s}$$

$$3. \quad 1.65'' = \frac{1}{7500} = 133.2$$

$$80.8 \mu\text{s}$$

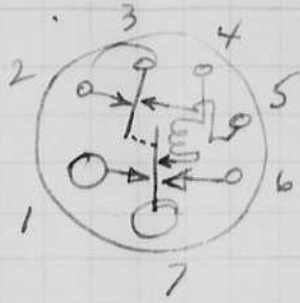
$$4. \quad 1.43'' \quad 133.2$$

$$93.2 \mu\text{s}.$$

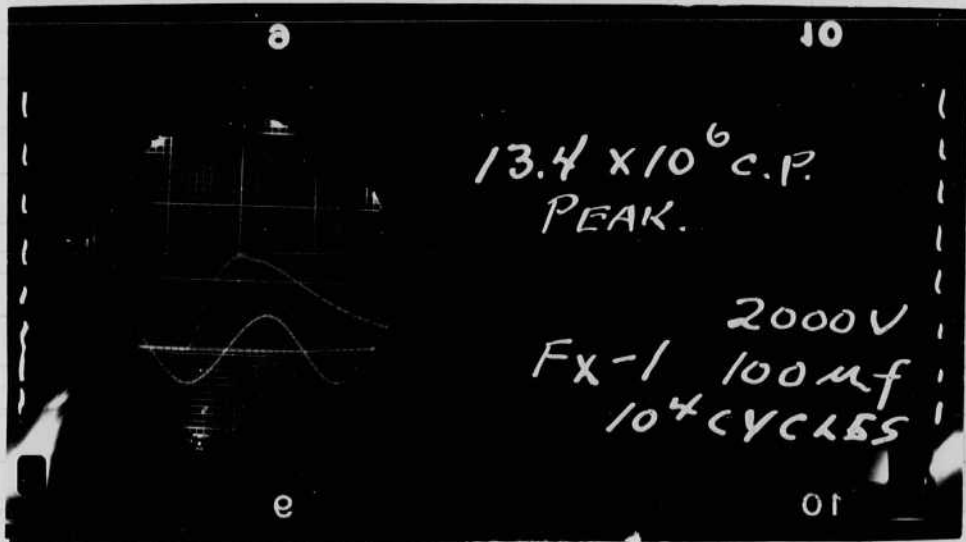
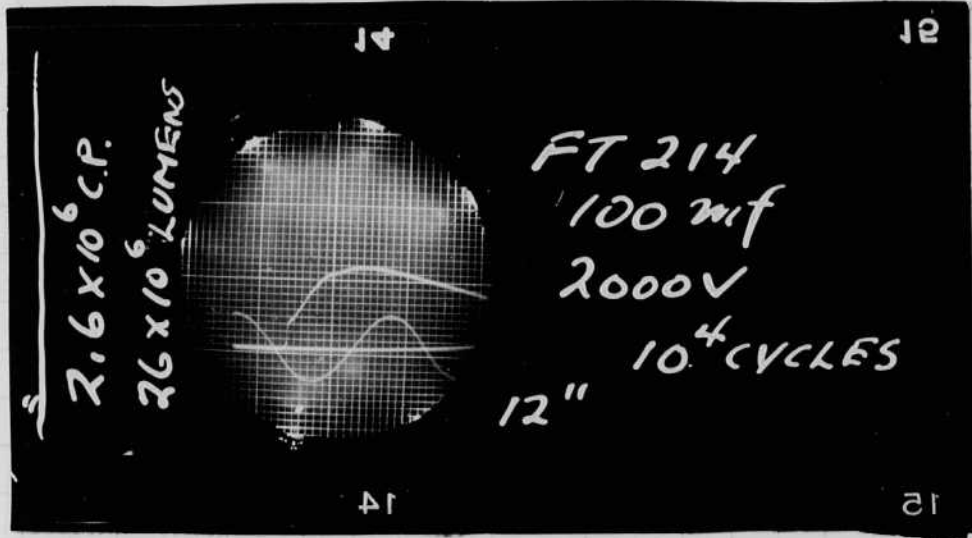
The peak light output of an average FT-214 excited  
from 10 mf at 2000 volts is about  $0.8 \times 10^6$  c.p.

at 1.5 ft distance and with a ground glass diffuser the  
scope # 244 (type 256D) gave a deflection of 0.55''.

Oak vibrator 6V U6428  
100 c.p.s.



note insulated vibrator needs. on pins 3 & 7.



Oct 11 1951  
H. E. Elgerton.

125

Oscillograph Calib.  
for trip to Gibbston. Dapunt plant.  
Dr. C. F. Winning

Lamp FT-214 10.5 mf at 2000 volts in Blue Box unit  
tube # 111

Photo tube pickup - Mills type  
with 1000 ohm.

979 trigger with 2D21 thyratron

Distance flash tube - side view no reflector  
to front of P.C. device = 1.5 ft.

A ground glass was used over the  
P.C.

The oscillograph (Dumont type 256D No 244)  
has an auxiliary capacitor switch on  
range of 100 us. A dial 0, 1, 2, 3, 4,  
give the new sweep rates -

On dial setting 0

$$2'' = \frac{1}{15000} \text{ sec} = 66.6 \mu\text{s}$$

$$1'' = 33.3 \mu\text{s}$$

$$1. \quad 1.32'' = \frac{1}{15000} = 66.6.$$

$$50.5 \mu\text{s}$$

$$2. \quad 2.03'' = \frac{1}{7500} = 133.2 \mu\text{s}.$$

$$65.8 \mu\text{s}$$

$$3. \quad 1.65'' = \frac{1}{7500} = 133.2$$

$$80.8 \mu\text{s}$$

$$4. \quad 1.43'' \quad 133.2$$

$$93.2 \mu\text{s}.$$

The peak light output of an average FT-214 excited  
from 10 mf at 2000 volts is about  $0.8 \times 10^6$  c.p.

At 1.5 ft distance and with a ground glass diffuser the  
scope # 244 (type 256D) gave a deflection of 2.55''.



## Formulae for peak calibration

$$\text{C.P.} = \left( \frac{\text{deflection in inches}}{1} \right) \times \frac{0.8 \times 10^6}{0.55} \times F \times \frac{D^2}{(1.5)^2}$$

$$= d D^2 F 0.645 \times 10^6 \text{ candle power.}$$

$d$  = oscillograph deflection in inches.

$D$  = Distance P.C. to ~~oscillo~~ light source in feet

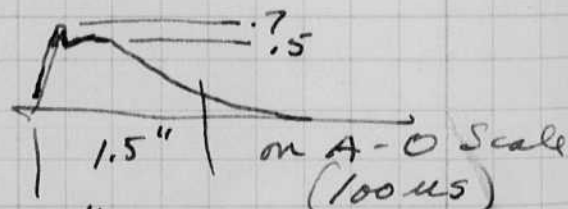
$F$  = filter factor of filter used in front of P.C.

The above applies to the 1000 ohm load resistor of the Mill's gray unit which uses a 935 tube with 2000 volts.

Strobolume No 408 high scale type 1632B.

$$D = 4.5 \text{ ft}$$

$$d = 0.75'' \text{ as observed}$$



$$1.5'' = 1.5 \times 33 = 40 \mu\text{s.}$$

$$\begin{aligned} \text{Peak C.P.} &= 0.75(4.5)^2 \times 1 \times 0.645 \times 10^6 \text{ cp} \\ &= 982 \times 10^6 \cong 10 \times 10^6 \text{ b.c.p. beam c.p.} \end{aligned}$$

Oscillogram taken on A-100-0 scale. 33  $\mu\text{s}$ /inch.  
 $D = 4.5$ .  $d = 0.7$   $F = 0$  High scale.

Oscillogram A-100-0 scale 33  $\mu\text{s}$ /inch  
 $D = 1 \text{ ft}$   $d = 0.22''$   $F = 0$  Low scale.

$$\text{Peak C.P.} = 0.22^2 \times 1 \times 0.645 \times 10^6 \text{ c.p.} = .14 \times 10^6 \text{ b.c.p.}$$

From p 126.

Beam candle power peak output of  
G.R. Strobolume # 408

High scale  $10 \times 10^6$  b.c.p.

Low scale  $0.14 \times 10^6$  b.c.p.



4 Dual .1 cap in series. 3/4 cable.

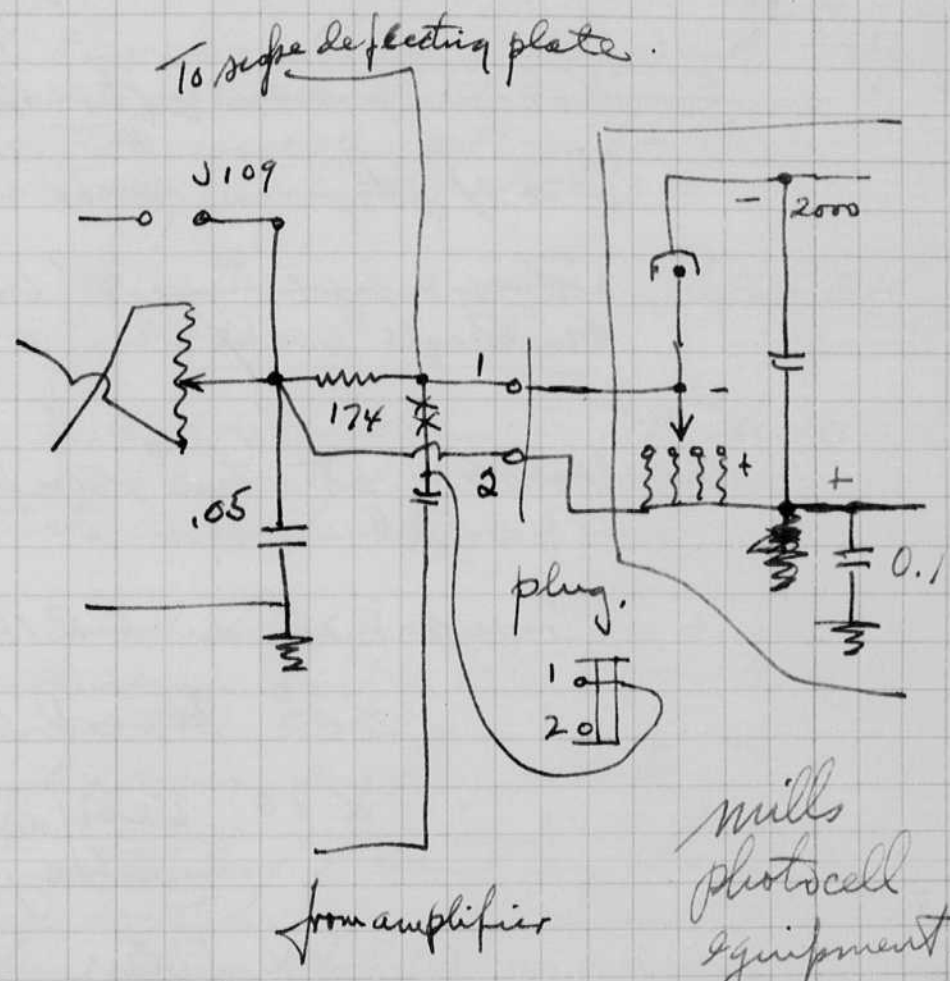
$4 ft. = D \quad F = 0$

FT-130.

sweep R-25.

2 osc, one with sales.

$RC = .05 \times 10^{-6} \times 10^{+6} = .05 \text{ sec} = 50,000 \mu\text{s}$



Dumont Scope # 244  
 modified as per above.  
 Oct 13 1951 H.E. Edg



Oct 12 1951

Calibration Oscilloscope

tube # 111

FT-214 in Blue Box flasher no Reflector  
10.5 m $\mu$  at 2000 volts.D = 1.5 feet from Mills Pickoff  
with 1000 ohms.

Diffuser but no filter.

Avg deflection  
= 0.65 inches

$$F = \frac{0.8 \times 10^6 \text{ cp}}{1.5^2} = 0.356 \times 10^6 \text{ lumens/oz ft}$$

$$F = \frac{0.356 \times 10^6 \text{ lumens/oz ft}}{0.65} = .55 \times 10^6 \text{ lumens/oz ft/inch def.}$$

10  $\mu$ s timing pipe on scale or c.

Stroboscope next after Blank picture

D = 4 ft. from lens in standard Reflector

Shows deflection of 1.1 to 1.2 inches  
on "High" scale.

As took osc at "Low" scale on Stroboscope.

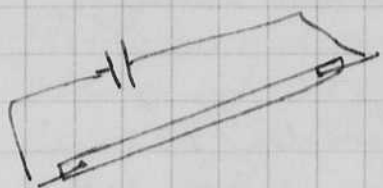
D = 12"

Sweep R25 and R10 also tried

R25 Record ok to use

R10 very weak but  
usefulXX film f 1.5 lens.  
Wollensack.d = Peak deflection = 0.4 inches.  
D = 1 ft.

Flash tube Photo with Magnet Optec (M.O.)  
Shutter.



Test of new soldered-  
end. View tube.  
6" length of arc  
100 mf at 2000 volts.

6" lens with single slug  
open ~~lens~~ shutter.

With Panchro Press film and  
crossed polaroids the exposure  
was too much at full  
aperture (about f/11 or 16).

then tried "Commercial" film E.K.  
also showed image.

then stopped down to 1/8" hole.  
this gave negligible exposure  
with commercial film.

P.C. and delay and M.O. at  
minimum with P.C. about 6"  
from the tube.  
Exposure very weak.

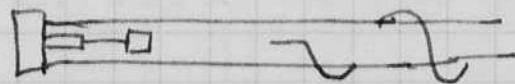
at setting of 1 unit on dial  
the exposure was about right  
this should be a delay of  
10 us.

7 photos taken on ortho film  
0 - 10 - 20 and 100 us.

1 ms = 1000 us.  
.10 " = 100  
.001 = 10 us

## Mc. photos of FX-1

Closeup of cathode end end tube.

Aperture  $\frac{1}{4}$ "

Panchro Press Film.

5 min 1:1 Dektol.

Leak.

0

10

(30 100 and 300  $\mu$ s delay. approx.Anode end.0 5 10 30 100 and 300  $\mu$ s

delay.

1.5  $\mu$ s exposure with

Eri Slug at 24 KV.

 $\frac{1}{8}$  mt. with damping resistance.

Above negatives show the positive column is first a narrow streak down the edge of the tube, usually adjacent to the tube wall. In 5  $\mu$ s this rapidly opens up into a pair of spiral discharges that again hug the tube walls. The two spirals twist the same direction and are evenly spaced. In 10  $\mu$ s the two spirals open out along the tube wall. Also a luminous wave goes down the tube over the anode and cathode. There is a periodic ripple in the illumination from an inch or so from the anode. These puffs of light are spaced about  $\frac{1}{8}$ " apart.

By 30  $\mu$ s (peak light) the entire tube is almost lighted, at 100  $\mu$ s the glow is uniform. Also at 300  $\mu$ s the intensity is considerably below the peak.



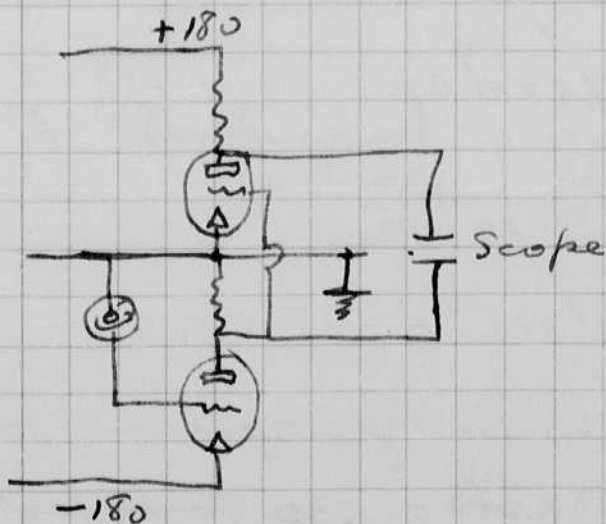
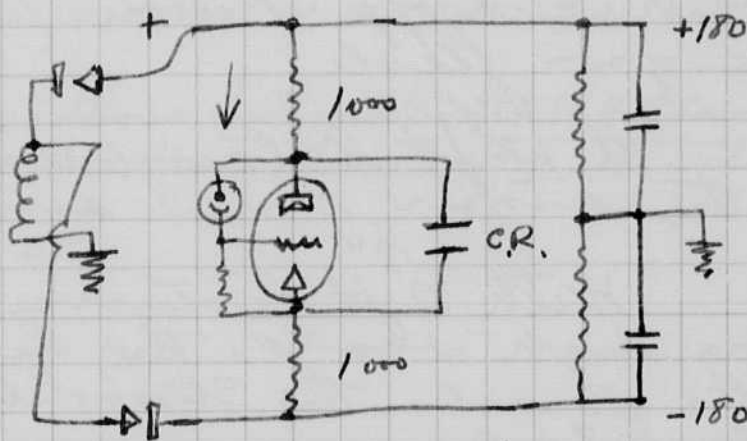
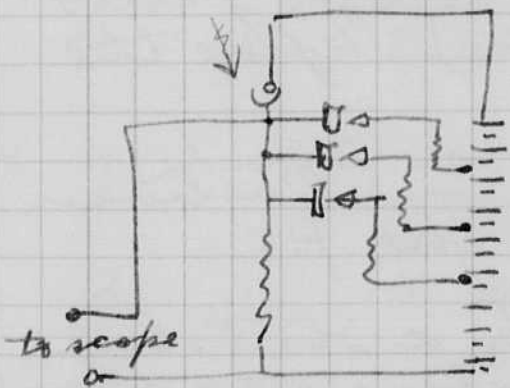
Oct 16 1951

Harold S. Edgerton.

Last night I was in New York to talk to the Photo Engineers Society at the Engineers Club Bldg on 39th st. Lester, Pabell, St Thomas, Carroll, Dorothy Delot, Daly, Adams, Shefter. were at a small dinner before the meeting at the Commodore Hotel. I returned to Boston on the night train.

Spent most of day working on a display for Land to consider for use at Chicago. A Speed Graphic with a Land camera back was supplied with a magneto optic shutter to photo graph an FT-110 bulb when flashed from 600 mf (or 1000) from a 450 volt source. A time delay was used to fire the m.o. shutter.

Non linear Filament circuits.





134 Oct. 19, 1951.

Harold G. Edgerton.

On the 17 I drove to Wilmington Del in the afternoon. Estlin and Mrs. Anderson went along. After 6:20 class quiz.

I spent the 18 and 19 at Substation with Dr. C. F. Winning at the Dupont Explosive Station. Our major interest was to measure the light output of an argon flash bomb.

A Dumont ranging scope was used with a 935 phototube into 1000 ohms at 2 KV.

Some difficulty was experienced in synchronizing the flash to the R-25 sweep.

We finally did it by using a ground cord  $\gamma$  into a tetragl pellet that went off 1 inch (4 us) before the argon flash.

A  $12\frac{1}{8}$  ft distance was used between the argon bomb and the P.C.

With  $2\frac{1}{8}$  ft distance to a Strobolime on High scale, the deflection was about the same. The Strobolime peak output is  $10^7$  c.p.

$$10^7 \times \left(\frac{12.75}{2.75}\right)^2 = 21.5 \times 10^7 \text{ c.p.}$$

Suppose the duration is  $10^{-6}$  sec.

$$\text{then output} = 21.5 \times 10^7 \times 10^{-6} = \underline{215} \text{ c.p.s.}$$

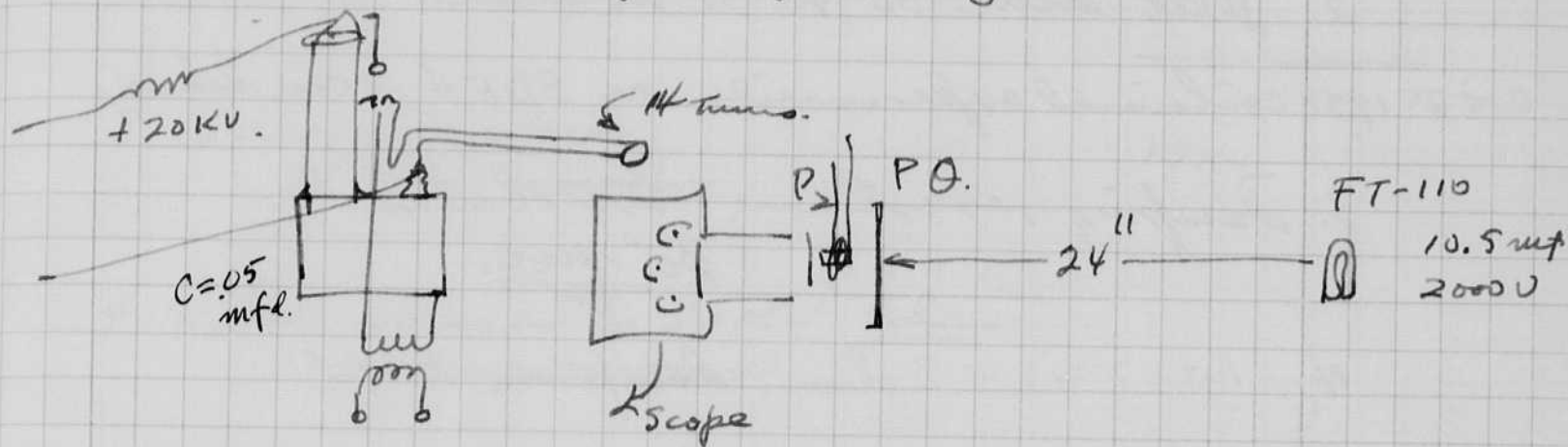
(The Green flash is 1500 c.p.s.) B&W guide factor = 200.

$$\text{eff} = \frac{200}{1500} = \frac{200 \times .115}{1500} = \underline{.153} \text{ guide factor.}$$
$$\sqrt{.13} = .115$$

Oct 24 1951  
 Harold E. Edgerton.

Test of Lead glass as supplied by  
 Pittsburgh plate glass co.

A 14 turn coil was wrapped around  
 a 1/4" diam (1/2") long slug of the glass.



M1 #1 Sweep 5 20KV  $\theta = 0$  10° cycles. Pittsburgh glass

#2 " " no MO.  $\theta = 0$  30° 40°

#3. " " Resistance inserted in series. 3ohms ±

M2 1 Sweep 5 20KV as above but with EDF 4 glass  
 10 turns 1 cm diam 1 cm long. ±. with damping  
 resistance

2. " " 0. 30° 40°

3

4 undamped + zero

5. undamped + zero.  
 Shows sparking??

Plan 3 - 1 EDF4 glass. 17KV .05 mt  
 16 turns on 1 cm size.  
 X3 filter on lamp from before

2. Ditto with 30° 40° 50° rotation.

Oct 25 1951 continued experiments. on EDF4 1 cm diam.

3. Damping resistance 2.2 ohms.  
 30° m.o.

4.  $(118 + 212) = 3$  ohms damping used

5. Ditto also 10° cycles and 30° line.

I then tried a carbon resistor instead of the wire, thinking that the wire adds inductance.

3 ohms was not enough damping  
 5 " was too much.

Oct 24 1951

1. EDF4 glass 14 turns 1 cm diam 17KV  
 4 ohms resistance for  
 damping. Note absence of  
 pickup from previous run.  
 10° cycles
2. Ditto but with 30° transmission also. 17KV
3. 5 ohms. Damping. 17KV.  
 30° transmission.
4. Voltage increased to 20KV 5 ohms  
 30° transmission
5. 21.5KV. 30°



at Aberdeen md at P.G. on the 29 and 30 of Oct to sit in on the advisory committee. I took the 1 us shutter that is in the Eastman view camera so that Sultanoff and his group could do some photography. At this and Dr. Dewey's request the device was left at Aberdeen.

I met Winn Johnson on Oct 31 at his house in Concordville and then proceeded to Philadelphia to the Gory Ferry plant of Dupont. We set up the single flash ~~to~~ 0.2 us unit at the Marshall lab with Mr. Crissy. Some 50. 4x5" photos were made of a spray nozzle with various points and pressures.

Have started the layout and design of a single flash 0.2 us unit for S.R. to consider. Basis will be .005 in f at 8KV into spark as a source.

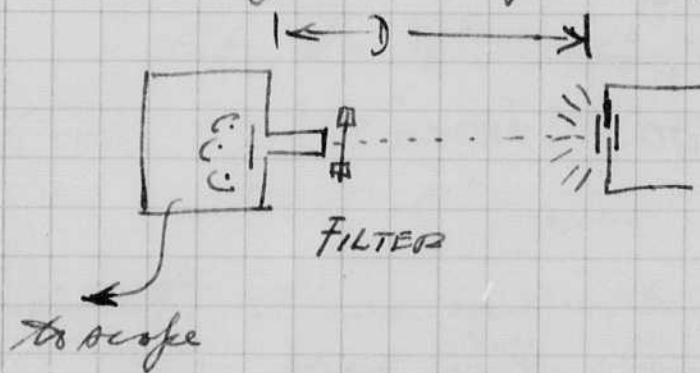
Nov 10 1951

Harold E. Edgerton.

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In Rochester Nov 6 Tues. Saw several people at Bausch and Lomb about the microscope illuminator and job about the eye camera. Test exposures of lamp carbon arc at  $1/10$  sec. has source brilliancy of several times that of 1" Xeund arc 20 cur. press 4 mm quartz tube.  
300 mf at 400 volts (300??)  
(Barstow's experimental flash unit).

Calibration of P.M. pickup 3 tubes 2000 volts.



2 sparkers

8KV .005 1st.

8KV .01 2nd.

R = about 4 ohms in each circuit.

Visual signal peak =  $1/4$ " def.  $\pm$  when  $D = 1'$  and  $F = \times 100$ .

$1/8$ " gap in 2 mm quartz - open air model.

SW 5? 1. Output of gap with 0 resistance in delay net.

SW 5? 2. ... (2 flashes) as per 1 but with zero and timing  $10^6$  cycles.

SW 8. 3. Calib on light FT-110 on 2000V/0.5mf.

FILTER =  $\times 1000$

Distance =  $\underline{\underline{3 FT}}$

4. Open trigger gap as light source. (5 ohms damping)

.005 mf capacitance Rated 4KV

Operated at 7KV.

Sweep 6.

$D = 1 ft$   $F = \times 100$  and  $\times 10$ . The osc  $\times 10$  has a  $1/2$ " amplitude.  
 $10^6$  cycles.



ex 5.

Same circuit as 4 except  
5 ohms damping.

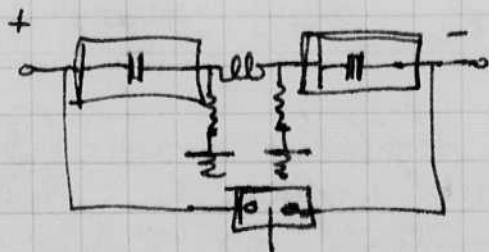
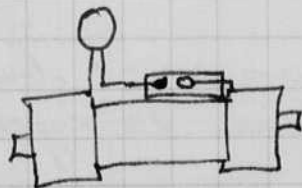
$\frac{1}{8}$ " gap in quartz tube  
→ for light

$$D = 1 \text{ ft.}$$

$$F = \times 10.$$

$$V = 7000.$$

$$C = .005 \text{ mica.}$$





Nov. 17 1951

Harold E. Edgerton

Sprogue capacitor 33203

0.1 15KV dc

141

A control spark gap was placed along the side of this capacitor so as to make the inductance a minimum.

An oscillogram showed the frequency =  $1.51 \times 10^6$  cyc/sec. assuming the  $C = 0.1$  mf. then  $L_0 = 0.115 \times 10^{-6}$  henries.

Let  $f = 0.5$  cycles/sec with a series coil  $L$

$$2 \times 10^{-6} \text{ sec} = 2\pi \sqrt{L_T C}$$

$$L_T = L_0 + L$$

$$4 \times 10^{-12} = 6.28^2 L_T 0.1 \times 10^{-6}$$

$$L_T = \frac{4 \times 10^{-12}}{39.4 \times 1 \times 10^{-6}} \approx \underline{1 \times 10^{-6} \text{ henries.}}$$

$$L = N^2 d F \text{ microhenries} \quad d = \text{diam in inches} \quad F = .0071 \frac{l}{d} = 3. \\ N = \text{turns.}$$

$$\text{Let } d = \frac{3}{8}'' = .375''$$

$$L = 1 \times 10^{-6} = N^2 .375 \times .0071 \text{ u.h.}$$

$$N^2 = \frac{1}{.00266} = 375, \quad N = \sqrt{375} = 19.3 \text{ turns.}$$

Experiment. A 1cm coil with 10 turns (1cm length) was tried with about 8" of twisted leads. The frequency was about  $2 \times 10^6$  cycles.

$$I_{\text{max}} = E \sqrt{\frac{C}{L}} = 15,000 \sqrt{\frac{0.1 \times 10^{-6}}{10^{-6}}} = 15,000 \times .333 = 5,000 \text{ amp}$$

$$10 \times 5,000 = \underline{50,000 \text{ amp turns.}}$$

Also tried again Sprogue .05 mf 20,000V P15606, 10 turn coil 1cm as per above. Put in then with 5.1 ohm lamp in.



0.1 mF 15KV Sprague capacitor  
into 18 turns on 1 cm Double layer, 6" leads.

Osc.  $\frac{.52 \text{ cm}}{3 \text{ cycles}} = 1.73 \text{ mm/cycle timing wave}$

$5.2 \text{ mm} = 1 \text{ cycle of C and L.}$

$\therefore f = \frac{10^6}{3} = 0.33 \times 10^6 \text{ cycles.}$

$\frac{1}{2f} = 1.5 \text{ microseconds.}$

(A) 0.1 into 10 turn coil with 8" leads.

Sprague Capacitor .05 mF 20KV P15606.

(B) Coil 1 cm diam 1.5 cm long.  
9 turn coil and 18" of twisted leads

$f = \frac{7}{3} \times 10^6 \text{ cycles.} = 2.3 \times 10^6 \text{ cycles.}$

of shortcircuited capacitor.  
I used an insulated wire and  
a gap on the terminal in order  
to reduce the inductance to  
a minimum.

f with coil above =

$\frac{5}{7} \times 10^6 = 0.714 \times 10^6 \text{ cycles.}$

Solve for L and R<sub>0</sub>. then  
calculate R<sub>external</sub> to  
critically damp the circuit.

Usually allow the circuit to  
oscillate about 0.1 on the  
second swing.

$T = .425 \times 10^{-6} \text{ seconds}$

$f = \frac{1}{.425 \times 10^{-6}} = 2.35 \times 10^6$   
 $= .0934 \times 10^6 \text{ ohms}$

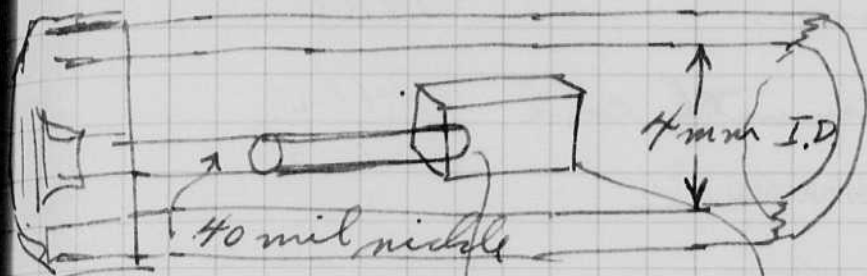
$\frac{2}{2}$

Nov 24 1951

Llewellyn E. Edgerton

143

I spent the morning working with Bill Mac Roberts on tube manufacture and test. We found that the electrodes on the FX-1 tubes were evaporating when the energy was too high. The present electrodes are: 2 mil x 1 mil by



Soldered seal

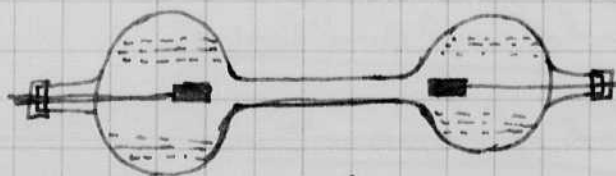
Spot weld.

This surface shows melting of edges etc.

The limit of energy of these electrodes appears to be 100 mf at 3000 volts.

Most of the darkening is in the tube space back of the electrode. However a small amount of metal vapor apparently does flow back and deposit on the quartz walls between the electrode. After several flashes the tube became slightly colored (yellow?) and the efficiency drops by 10 or 20 percent.

I propose to build a tube as follows which will deposit more of the metal vapor in the tube ends.



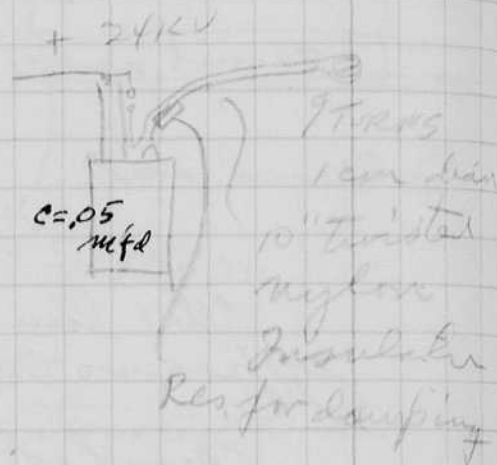
The gas in the capillary or tube will expand thus blowing the vaporized metal vapor from the electrode. The back chambers will have auxiliary surfaces upon which the vapors will condense.

SE  
Nov 28 1951

- Film 1 1 0- 30° and 60° 1 cm diam slug of EDF4.  
 10° cycles. → Turns of Dupont wire
- 2 No damping of osc. 24KV
3. 10 ohms in series with coil 24KV.

2. (a) DMS light  
 0 degrees  
 30 60 90

- b 0- 10 ohms and 5 cycles.
- c 0 5 ohms and 10° cycles.
- d 0 5 ohms 10° cycles, 30° 60°



Resistor in P.M. pickups changed from 1000 to 2000 ohms

From film 1-2

$$.57 \text{ mm} = 1 \text{ cycle} = \frac{.57}{.82} 10^{-6} = .695 \times 10^{-6} \text{ sec}$$

$$.82 = 10^{-6} \text{ sec}$$

$$T = \frac{1}{f} = \frac{1}{109} = 9.17 \times 10^{-6} \text{ seconds}$$

$$T = 2\pi\sqrt{LC}$$

$$\frac{1}{C} \frac{1}{(2\pi)^2} = L = \frac{1}{.05 \times 10^{-6}} \frac{.483 \times 10^{-12}}{39.4} = .246 \times 10^{-6} \text{ henries}$$

$$= .985 \times 10^{-6} \text{ h.}$$

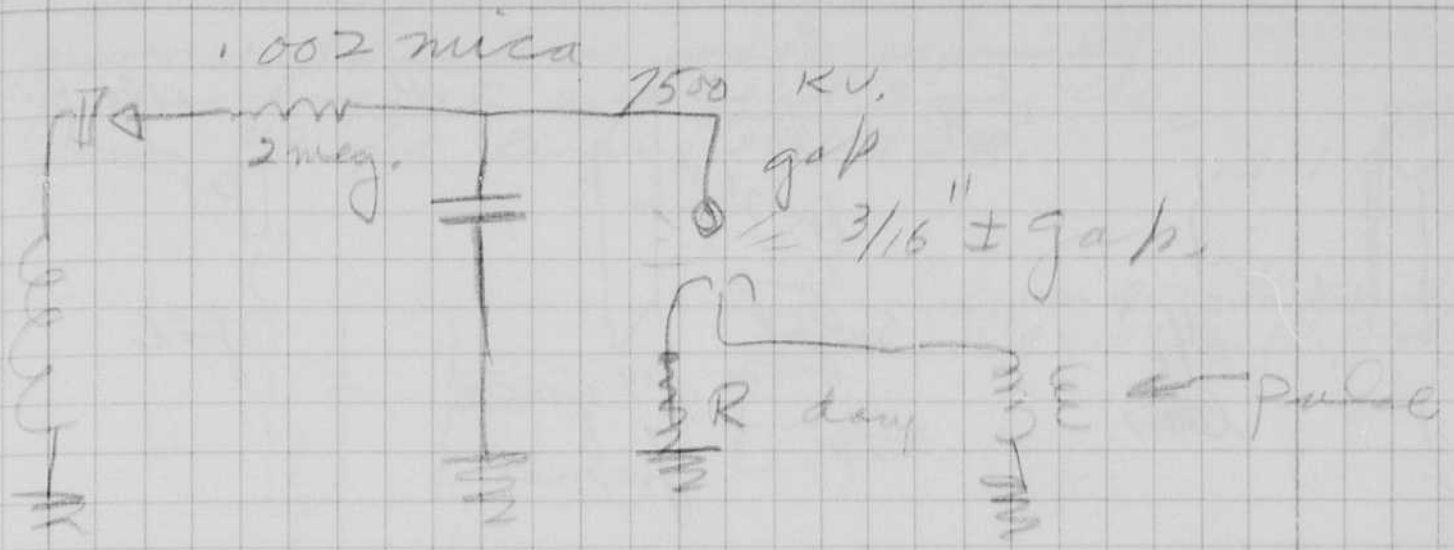
Ind. of coil and leads =  $0.985 \times 10^{-6} \text{ h.}$

Ind. of capacitor =  $0.0934 \times 10^{-6} \text{ h.}$

R = 10 ohms.



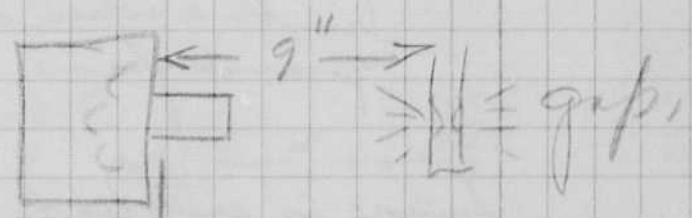
# Spark Source.



osc d: 10 divisions = R Sweep 5 10<sup>6</sup> cps,  
 b 5 " = R " "  
 c 0 " = R. " "

d. Voltage pickup from circuit with R = 0

e calib



.42" from  
 Strobolum  
 0.14 x 10<sup>6</sup> c.p.  
 peak,  
 X100 filter as  
 above.

FILTER  
 X100  
 R<sub>eq</sub> = 2000 ohms  
 15 muf cable.  
 to scope.

Sweep 7.

if def. the same

$$\left(\frac{9}{.42}\right)^2 \times 0.14 \times 10^6 \text{ p.c.p.} = .003 \times 10^6 = 3000 \text{ c.p.}$$

.0456

$$3000 \times \frac{1}{5} \times 10^{-6} = 600 \times 10^{-6} \text{ c.p.s.} = 0.0006 \text{ c.p.s.}$$

this seems to be a very small amount of light!



0.1 mf 15KV Sprague capacitor  
into 18 turns on 1 cm Double layer, 6" leads.

Osc.  $\frac{.52 \text{ cm}}{3 \text{ cycles}} = 1.73 \text{ mm/cycle timing wave}$

$5.2 \text{ mm} = 1 \text{ cycle of C and L.}$

$\therefore f = \frac{10^6}{3} = 0.33 \times 10^6 \text{ cycles.}$

$\frac{1}{2f} = 1.5 \text{ microseconds.}$

(A) 0.1 into 10 turn coil with 8" leads.

Sprague Capacitor .05 mf 20KV P15606.

(B) Coil 1 cm diam 1.5 cm long.  
9 turn coil and 18" of twisted leads

$f = \frac{7}{3} \times 10^6 \text{ cycles.} = 2.3 \times 10^6 \text{ cycles.}$   
of shortcircuited capacitor.

I used an insulated wire and a gap on the terminal in order to reduce the inductance to a minimum.

f with coil above =

$\frac{5}{7} \times 10^6 = 0.714 \times 10^6 \text{ cycles.}$

Solve for L and R<sub>o</sub>. then calculate R<sub>external</sub> to critically damp the circuit.

Usually allow the circuit to oscillate about 0.1 on the second swing.

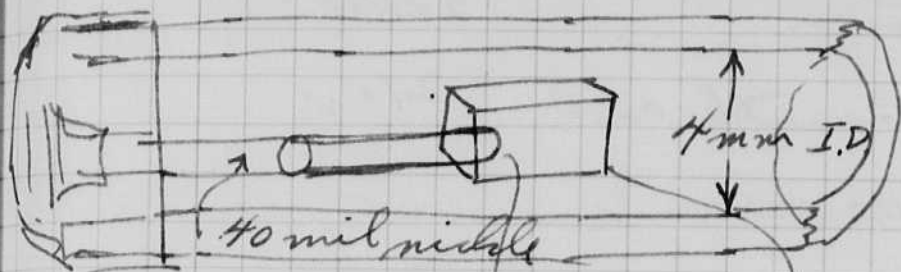
$T = .425 \times 10^{-6} \text{ seconds}$   
 $f = \frac{1}{T} = \frac{1}{.425 \times 10^{-6}} = 2.35 \times 10^6$   
 $f = .0934 \times 10^6 \text{ ohms}$

Nov 24 1951

Lewis E. Edgerton.

143

I spent the morning working with Bill Mac Roberts on tube manufacture and test. We found that the electrodes on the FX-1 tubes were evaporating when the energy was too high. The present electrodes are: 2 mil x 1 mil by



Soldered seal

spot weld.

This surface shows melting of edges etc.

The limit of energy of these electrodes appears to be 100 mf at 3000 volts.

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The gas in the capillary or tube will expand thus blowing the vaporized metal vapor from the electrode. The back chambers will have auxiliary surfaces upon which the vapors will condense.

122  
Nov 28 1951

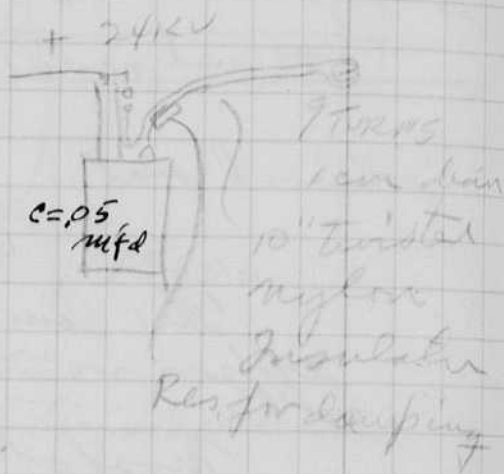
- Film 1 1 0- 30° and 60° 1 cm diam slug  
 10<sup>6</sup> cycles. of EDF4.  
 7 turns of Dupont wire  
 2 No damping of osc. 24KV  
 3. 10 ohms in series with coil 24KV.

2. (a) 0 no light  
 0 layers  
 30 60 90

b 0- 10 ohms and 5 ohms.

c 0 5 ohms and 10<sup>6</sup> cycles.

d 0 5 ohms 10<sup>6</sup> cycles, 30° 60°



Resistor in PM pickup changed  
 from 1000 to 2000 ohms

From film 1-2

$$.57 \text{ mm} = 1 \text{ cycle} = \frac{.57}{.82} 10^{-6} = .695 \times 10^{-6} \text{ sec.}$$

$$\frac{.82}{109} = 10^{-6} \text{ sec}$$

$$T = \frac{11.5}{.82} = 1.4 \times 10^{-6} \text{ seconds.}$$

$$T = 2\pi\sqrt{LC}$$

$$\frac{1}{C} \frac{1}{(2\pi)^2} = L = \frac{1}{.05 \times 10^{-6}} \frac{.483 \times 10^{-12}}{39.4} = .246 \times 10^{-6} \text{ henries}$$

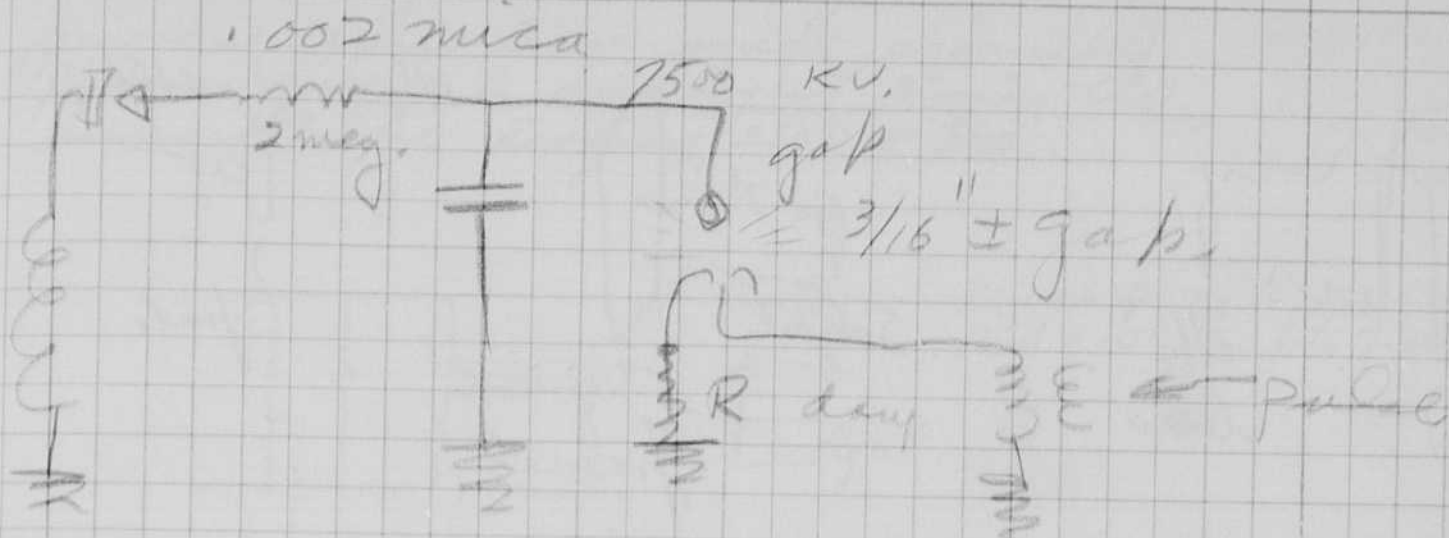
$$= .985 \times 10^{-6} \text{ h.}$$

Ind. of coil and leads =  $0.985 \times 10^{-6} \text{ h.}$

Ind. of capacitor =  $0.0934 \times 10^{-6} \text{ h.}$

$R = 10 \text{ ohms.}$



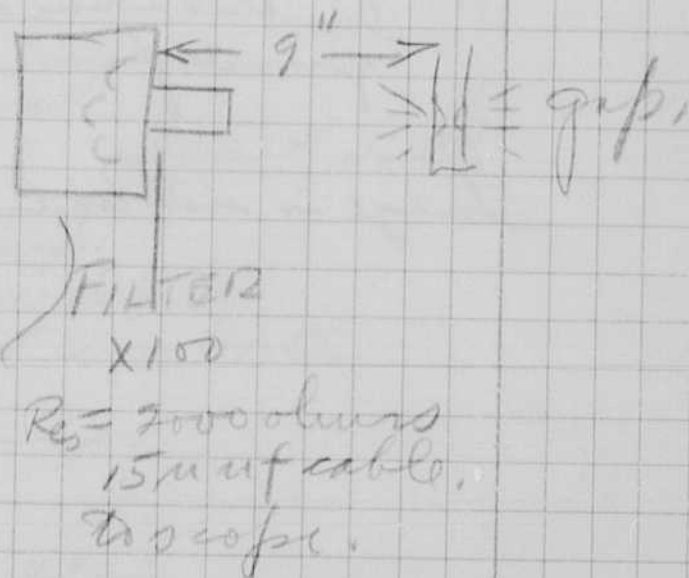


osc d 10 ohms = R Sweep 5 10<sup>6</sup> cps  
 b 5 " = R " "  
 c 0 " = R. " "

d. Voltage pickup from circuit with R = 0

e calib

.42" from  
 Strahlmann  
 0.14 x 10<sup>6</sup> p.c.p.  
 peaks,  
 X100 filter as  
 above.



Sweep 7.

if def. the same

$$\left(\frac{9}{42}\right)^2 \times 0.14 \times 10^6 \text{ p.c.p.} = .003 \times 10^6 = 3000 \text{ c.p.}$$

.0456

$$3000 \times \frac{1}{5} \times 10^{-6} = 600 \times 10^{-6} \text{ c.p.s.} = 0.0006 \text{ cps.}$$

This seems to be a very small amount of light!



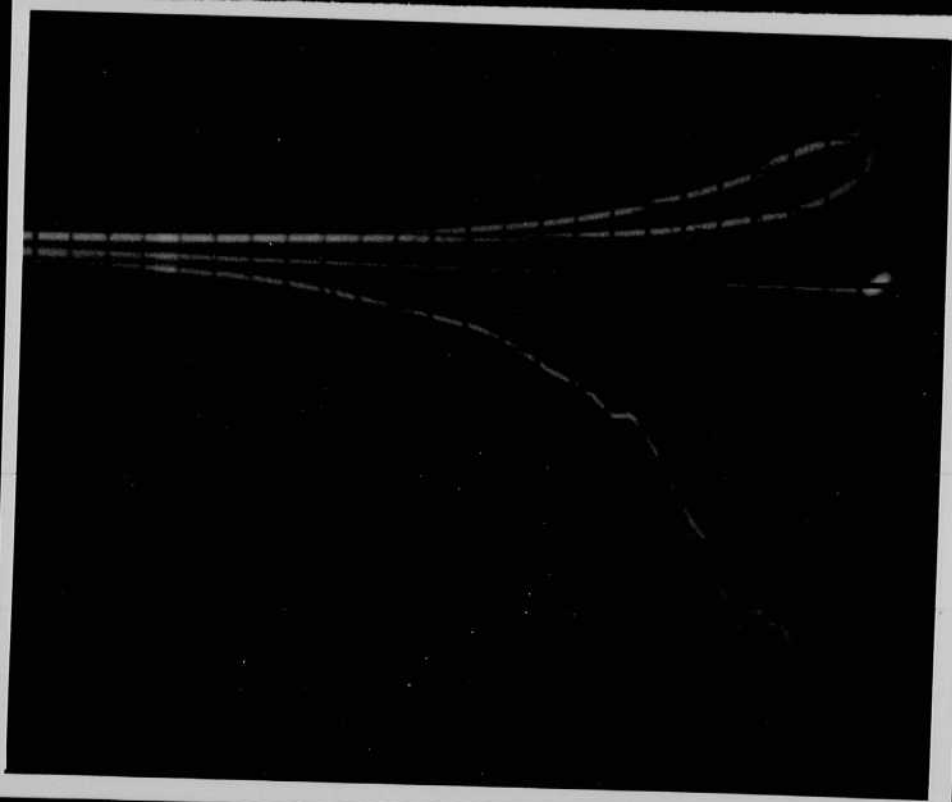
Notebook # 20

### Filming and Separation Record

3 unmounted photograph(s)  
     negative strip(s)  
     unmounted page(s)  
      (notes, drawings, letters, etc.)

was/were filmed where originally located between page 144 and 145.

Item(s) now housed in accompanying folder.



Notebook # 20

### Filming and Separation Record

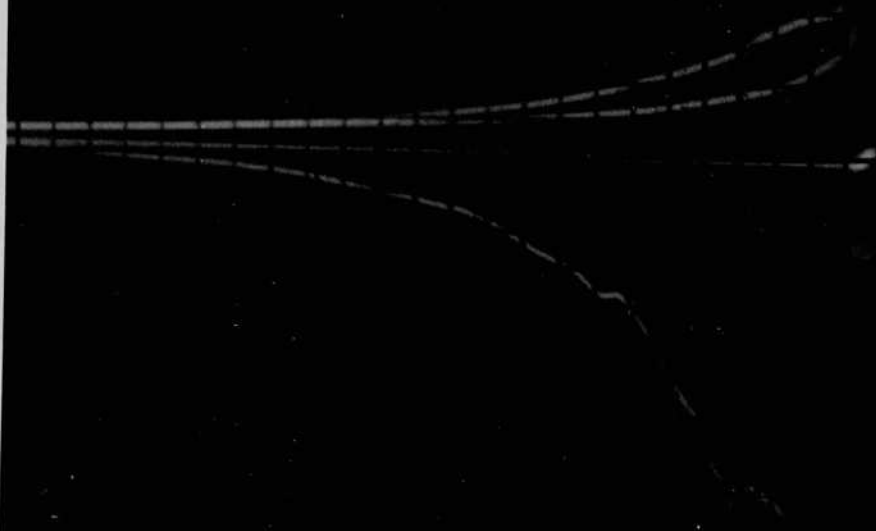
3 unmounted photograph(s)

\_\_\_ negative strip(s)

\_\_\_ unmounted page(s)  
(notes, drawings, letters, etc.)

was/were filmed where originally located between page 144 and 145.

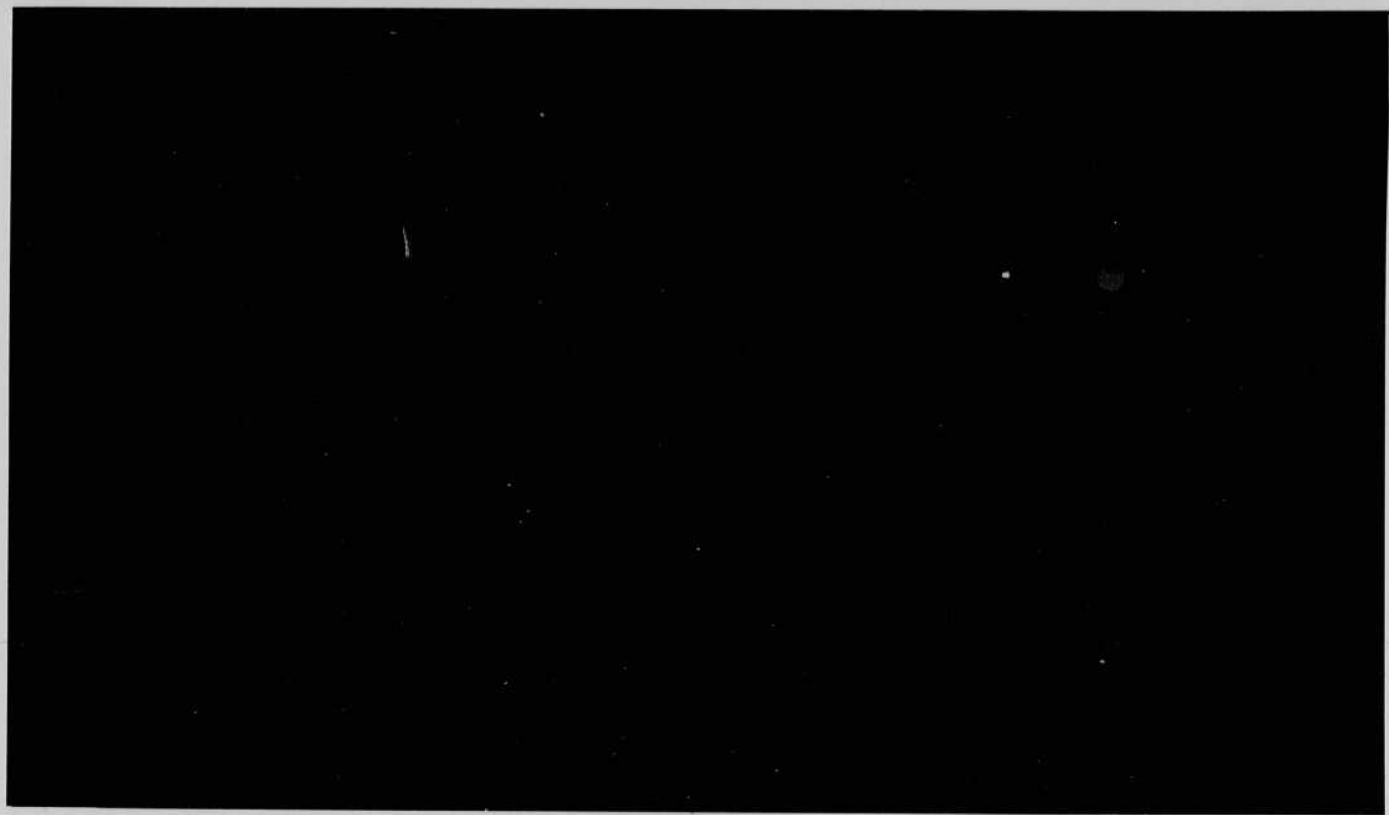
Item(s) now housed in accompanying folder.





Dec 51

Xenon  
gas

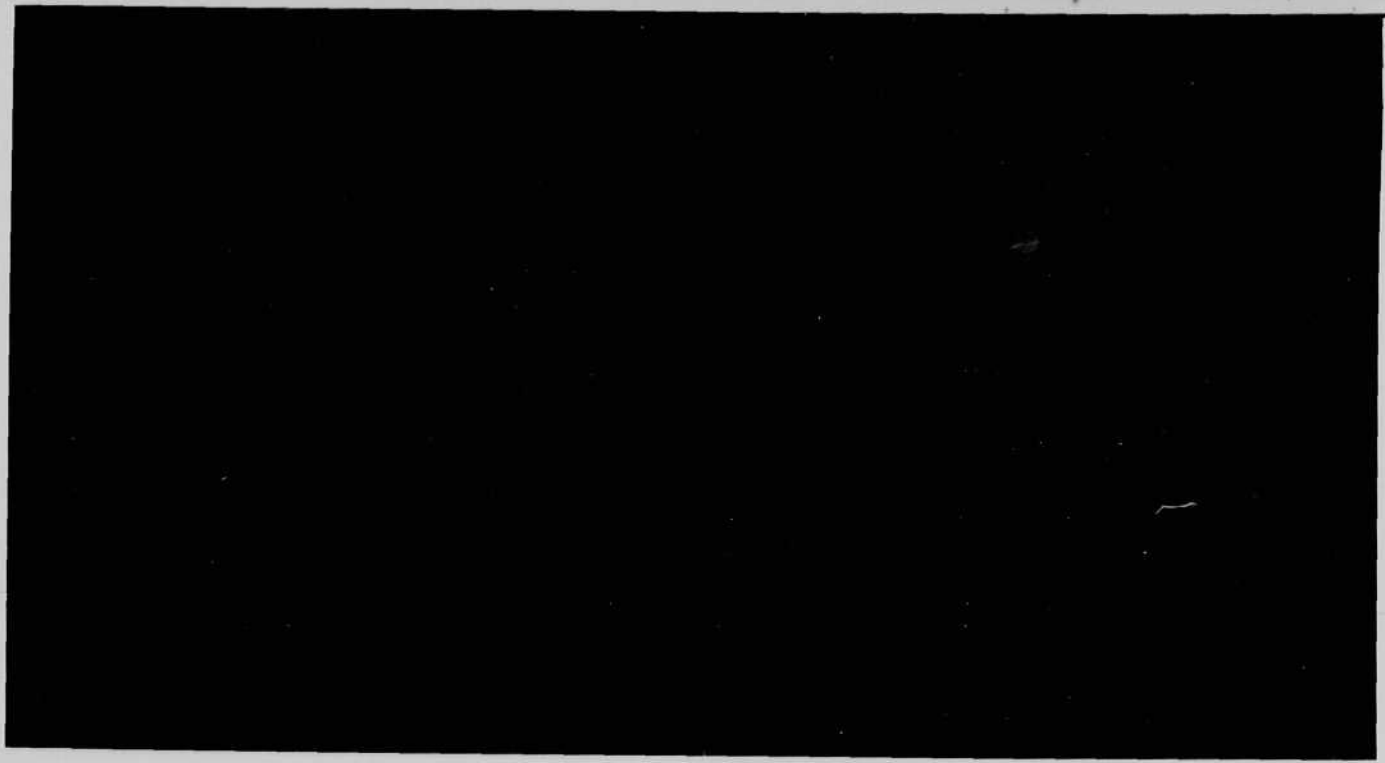


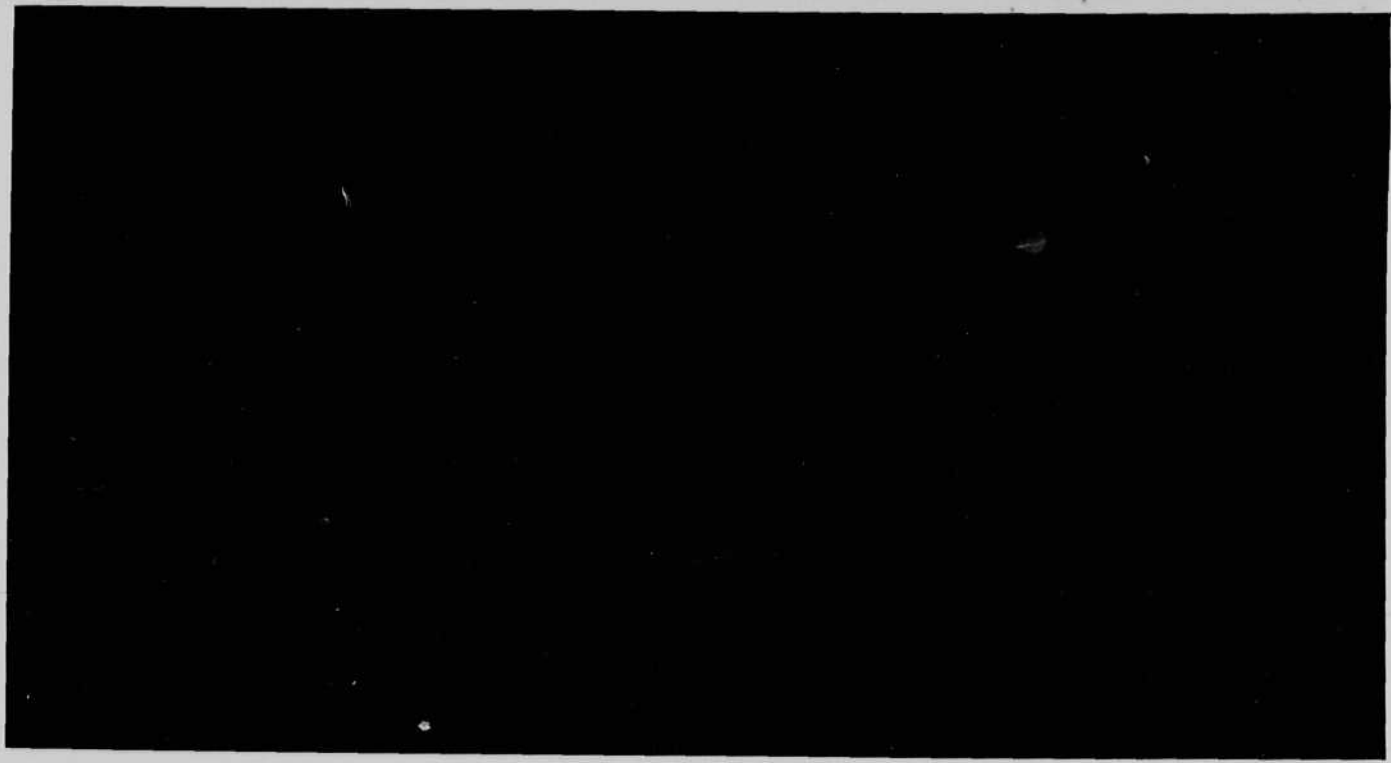


Dec '51

Henry Galt

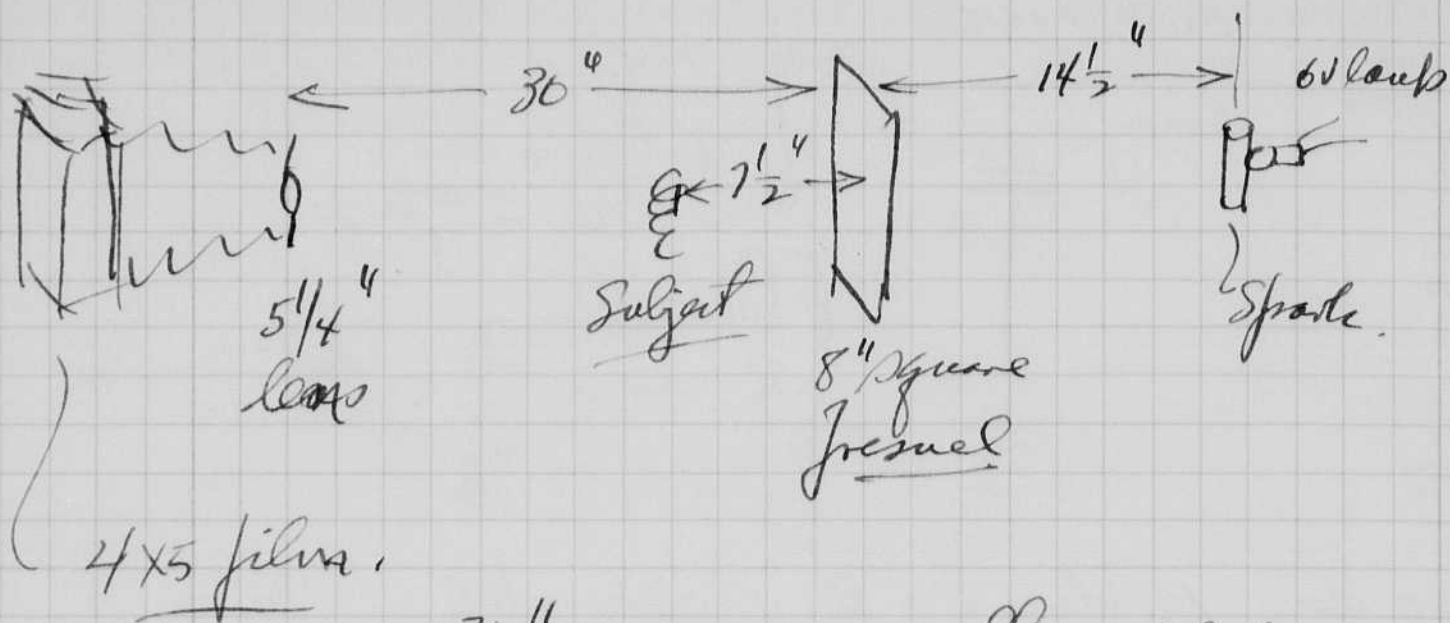






Dec 51

Kenm Dap

Optical setup for Sparks 0.12  $\mu$ S source.

1 3/4" square area illuminated on ground glass.

Test Pouch Press f4.7 1/50 sec 1 flash.  
Din blue when observed visually on ground glass.

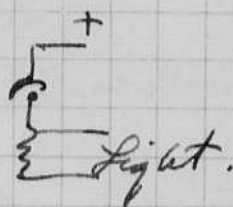
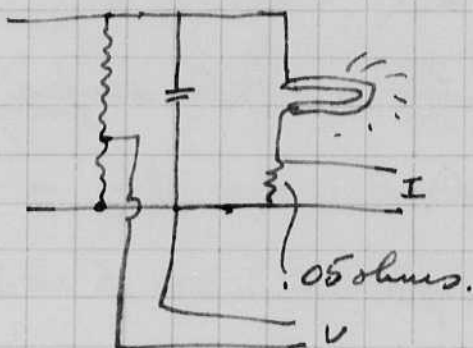
Image is not too dark but is useable.



# FT-105 Performance Oscillogram

Dec 8 1951 47  
 H. E. Edgerton  
 M.I.T.  
 20D102.

A new adjustable voltage-capacity power unit has been made, especially for recording V, I, and light using the Dumont Scope Rangier 256D # 284.



$R = 1000 \Omega$  in p.c. circuit.  
 Dist = 10" Lamp to Ground glass.

- |        |               |        |                      | Sweep   |
|--------|---------------|--------|----------------------|---------|
| osc 1. | 575 mf 450 V  | FT 105 | Light                | $\mu s$ |
| 2.     | "             | "      | Light current volts  | Sw 1000 |
| 3.     | 1150 mf 450 V | FT 105 | Light                | "       |
| 4.     | "             | "      | Light current volts. | "       |

- |      |                      |                     |                     |       |
|------|----------------------|---------------------|---------------------|-------|
| ✓ 1. | 1150 mf 450          | FT 105              | Light.              | 1000  |
| ✓ 2. | "                    | "                   | " current volts     | 1000  |
| ✓ 3. | "                    | "                   | " " "               | 100   |
| ✓ 4. | 10 $\mu s$ p.p.s. on | 100 $\mu s$ sweep.  |                     |       |
| ✓ 5. | 50 $\mu s$ p.p.s. on | 1000 $\mu s$ sweep. |                     |       |
| — 6. | 1150 mf 450 V        | Kamlite             | Light current volts | 1000. |
| 7.   |                      | Ditto               |                     | 100   |
| 8.   | 1150 mf 450 V        | FT-110              | Light current v.    | 1000  |
| 9.   |                      | Ditto.              |                     | 100.  |

- |    |              |                 |                                      |     |
|----|--------------|-----------------|--------------------------------------|-----|
| 10 | 575 mf 450 V | 4mm quartz tube | 3/4" gap.                            | 100 |
| 11 | "            | "               | " " L.I.V. and zero with weak flash? |     |

- |    |              |                      |          |                |
|----|--------------|----------------------|----------|----------------|
| 1. | 575 mf 450 V | "                    | L I V 20 | 1000 $\mu s$ . |
| 2. | "            | Constructed gap tube | "        | 1000 $\mu s$ . |



Show white deposit after 4 flashes. Probably quartz reposit.

- |    |          |                      |          |       |
|----|----------|----------------------|----------|-------|
| 3. | 575e 450 | FX-1 with 10cm Xenon | L I V 20 | 1000. |
|----|----------|----------------------|----------|-------|
- Photo cell distance changed from 10" to 6"

Scope 79 volts/inch.

Current Shunt = .05 ohms.

$$I \cdot .05 = \text{volts.} \quad \frac{\text{volts.}}{79} = \text{inches def.}$$

$$\frac{I \cdot .05}{79} = \text{inches of deflection.}$$

$$I = \text{inches def} \times \frac{79}{.05} = 1780. \text{ amperes/inch}$$

$$\frac{450}{79} = 5.7 \text{ inches but shunt} = \times \frac{1}{10}$$

$$= .57 \text{ inches. (Scope shows .5 inches.)}$$

Osc. 1 Repeat of 575 mf 450v 4mm 3/4" gap X even 1000  
Light-current-volts.

- |    |              |      |                     |      |
|----|--------------|------|---------------------|------|
| 2, | 100 mf Paper | 450v | 4mm 3/4" gap X even | 100. |
| 3  | 200 mf paper | 450  | "                   | 100. |

55  
50  
27 5.0 us/inch. for 1000 us scale.  
33 us/inch for 100 us scale.

# Apparent Resistance of Flash tubes.

Use apparent calibration of oscillogram.

$$5 \text{ divisions} = 450 \text{ volts.}$$

$$1 \text{ " } = 90 \text{ volts.}$$

$$\frac{1}{10} \times \frac{90}{.05} = 180 \text{ amp per division.}$$

$$I_{\max} = 4 \times 180 = 720 \text{ amperes}$$

$$V(I_{\max}) = 4 \times 90 = 360 \text{ volts.}$$

$$\frac{V}{I} = \frac{360}{720} = \frac{1}{2} \text{ ohms.}$$

$$R = 0.50$$

at  $t = 10 \mu s? \pm$  (heavy line).

$$V = 2 \times 90 = 180 \text{ V}$$

$$I = 3 \times 180 = 540 \text{ amp.}$$

$$R = \frac{180}{540} = .334$$

2 mm gap in 3/4" spacing tube.

$$\text{at } I_{\max} \quad V = 4 \times 90 = 360$$

$$R = \frac{360}{540} = 0.665$$

$$I = 3 \times 180 = 540$$

Kanalite V tube.

$$V = 5 \times 90 = 450$$

$$I = 2 \times 180 = 360 \text{ amps}$$

$$R = \frac{450}{360} = 1.25 \text{ ohms.}$$

$$\text{FT-105. } V = 4.5 \times 90 = \frac{405}{1} =$$

$$I = 1.7 \times 180 = 307$$

$$R = 1.32 \text{ ohms}$$

$$\text{FT-110. } V = 4.7 \times 90 = \frac{422}{1} =$$

$$I = 1.2 \times 90 = 108.$$

$$R = 3.9 \text{ ohms.}$$



Reflector test.

Dec. 19, 1951.

B3 Reflector

20" diam 7" focal length  
mirror.

Silver back glass.

Tungsten lamp 6.5 with V filament.

 $\frac{1}{3}$  ft 30 ft candles.

$$c.p. = 30 \times \left(\frac{1}{3}\right)^2 = 3.33 \text{ c.p.}$$

Beam measured at 15 feet

100 ft candles.

$$c.p. = 100 \times 15^2 = 22,500 \text{ c.p.}$$

The reflector factor is then

$$\frac{22,500}{3.33} = \underline{\underline{6800}}$$

Now compare performance with present  
green flash. Assume  $M = 10$  in Green flash.

$$\text{Since } DF = \sqrt{KQM}$$

$$\text{then D.F. with mirror will be } \sqrt{\frac{6800}{10}} = 26.1$$

In other words the distance can be  
increased from 2 feet to  $26.1 \times 2 \approx 50$  feet  
for f16!

It probably will be best to broaden  
the beam to get a bigger spot.

Let beam diam double then the factor will be

$$\frac{26.1}{2} = 13.$$

ok at f16 at  $13 \times 2 = 26$  feet. Looks interesting.



Party for 6.20  
Nov 30 1951  
at 205 School Street  
Belmont



Charles  
Richard Cann Olson Bryant Reynolds  
Noel Wilson Johnson Adams  
Charles  
Mrs. Roberts Bob E. Wedell Searle  
Donald Wong Chien H.E. Booth Mrs. E.  
Ruth McLaughlin

Reflector test.

Dec. 19, 1951.

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for f16!

It probably will be best to broaden  
the beam to get a bigger spot.

Let beam diam double then the filter will be

$$\frac{26.1}{2} = 13.$$

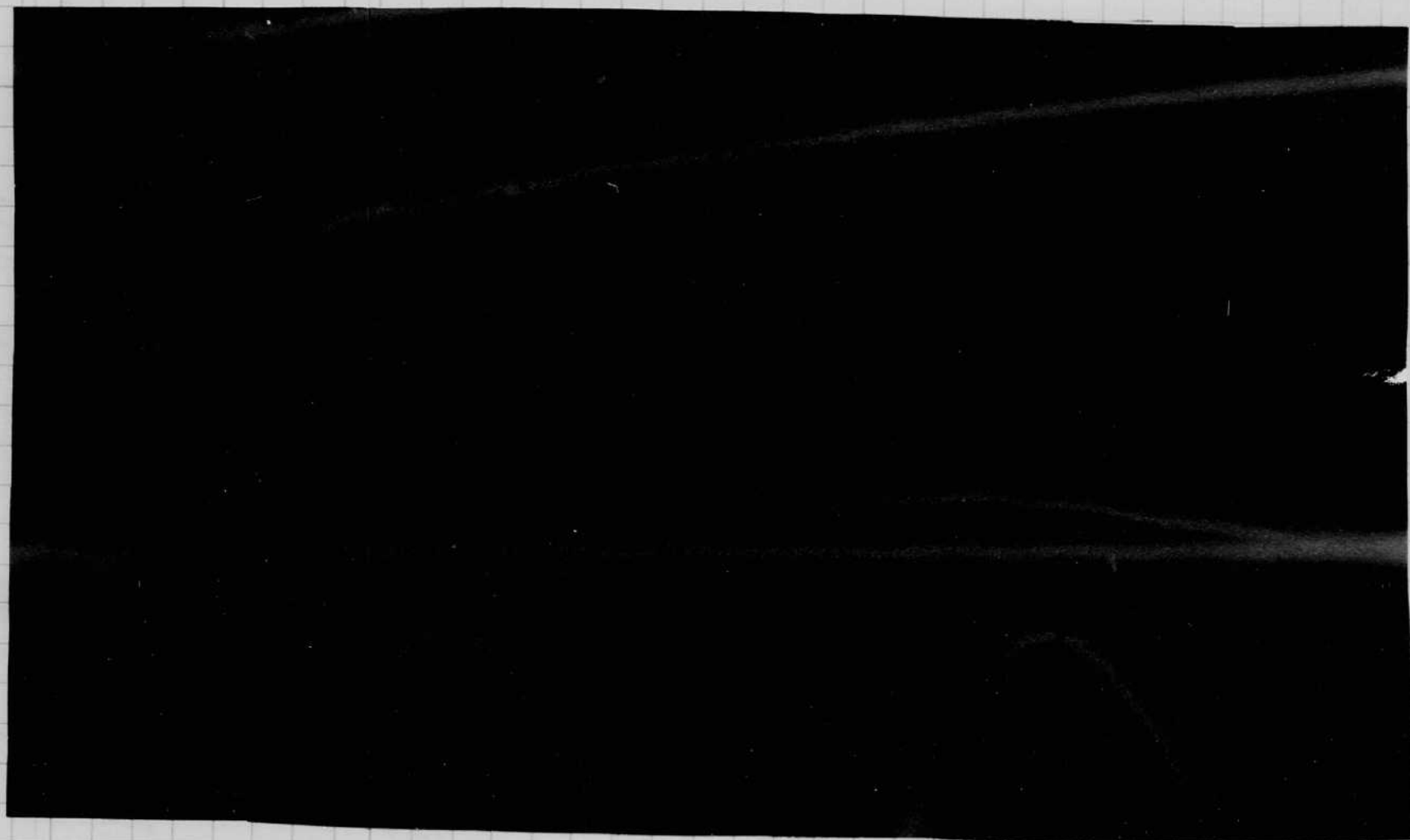
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Party for G. 20  
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 Richard Cann Olson Bryant Reynolds.  
 Zoode Wilson Johnson Adams.  
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 Donald Wong Chien H.E. Booth Mrs E.

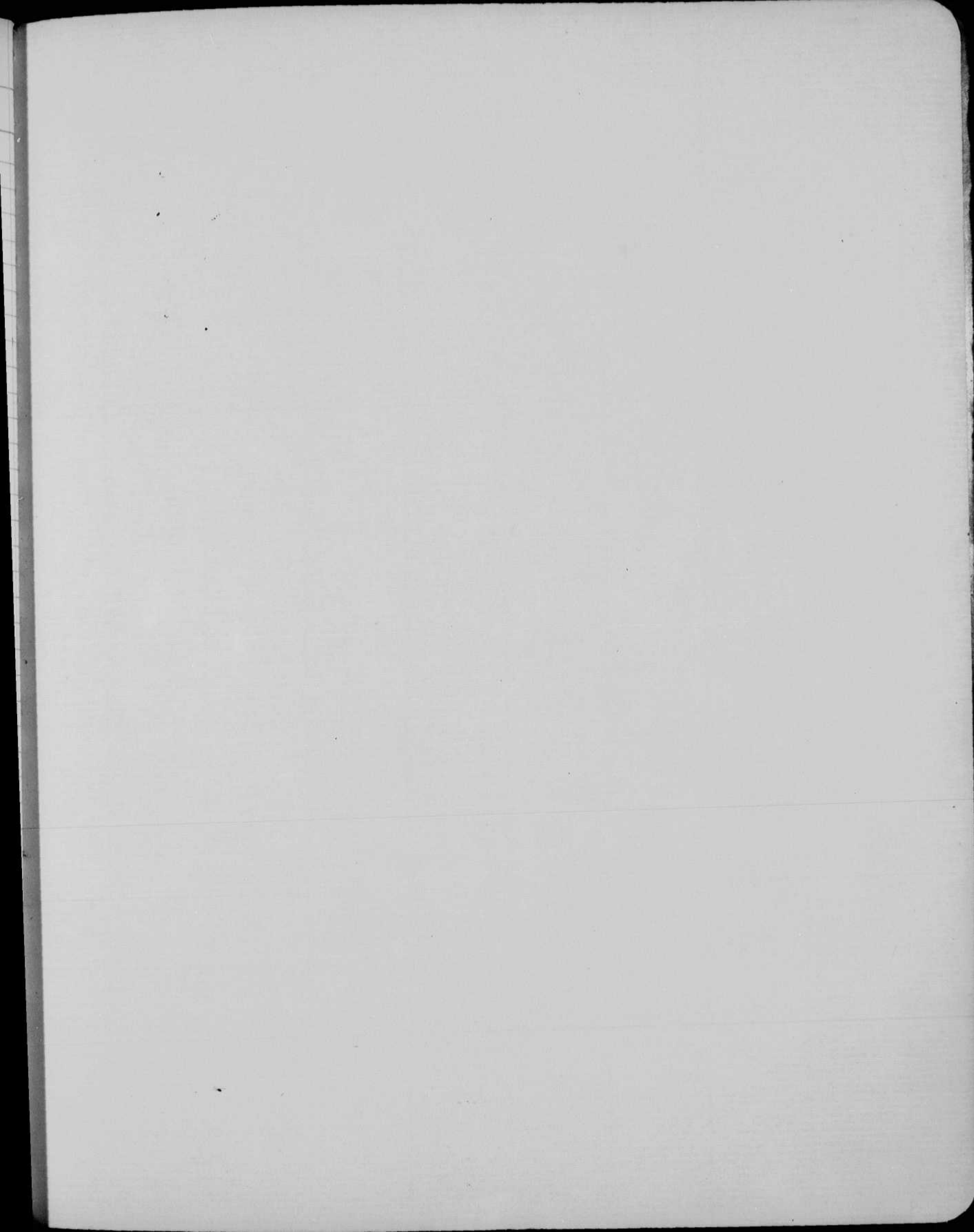
Some  
pickup?



Durston of Jaraday shutter opening is about  $10^{-6}$  sec.

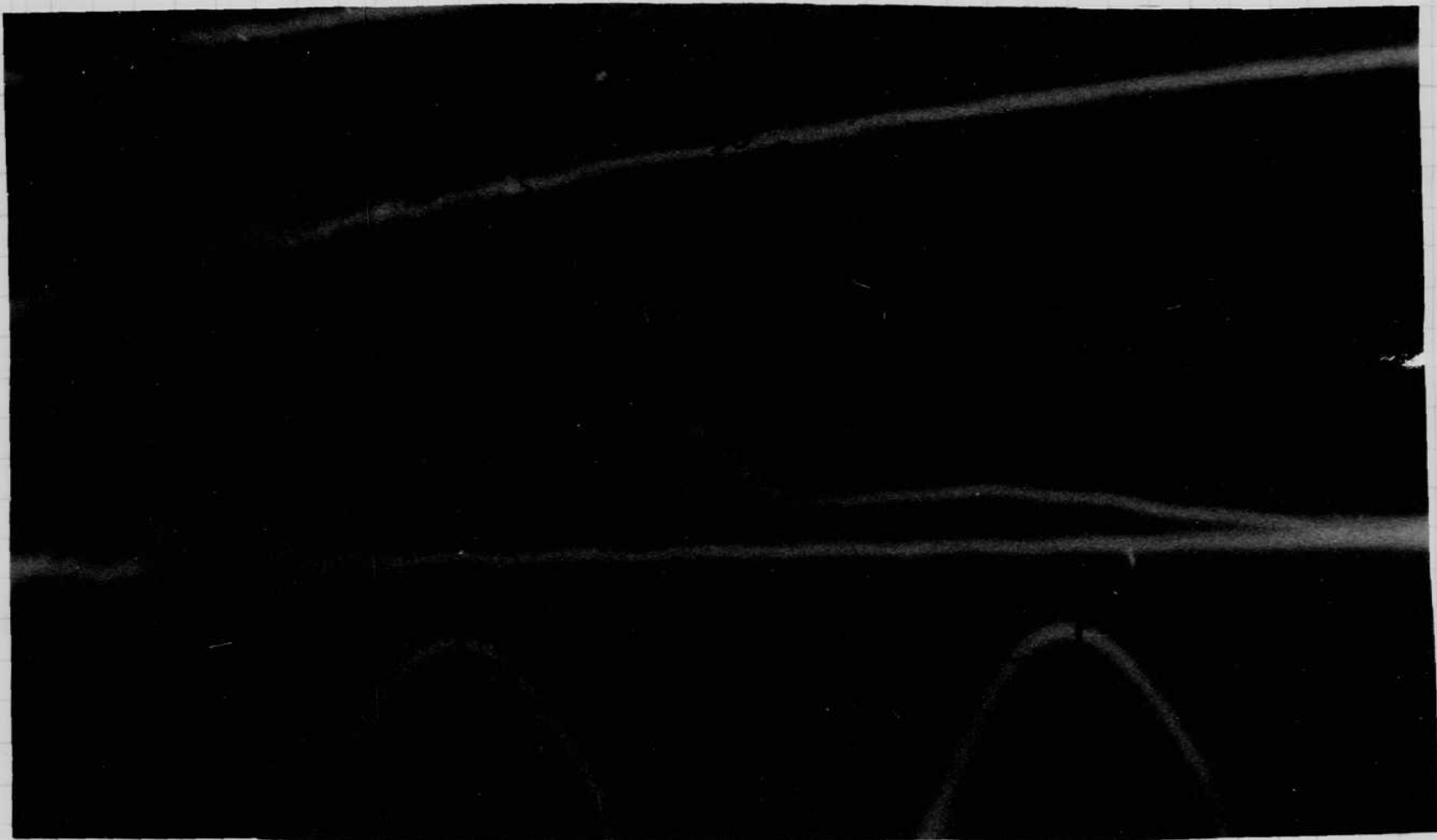
Jan. 27, 1951

Harold S. Dyer





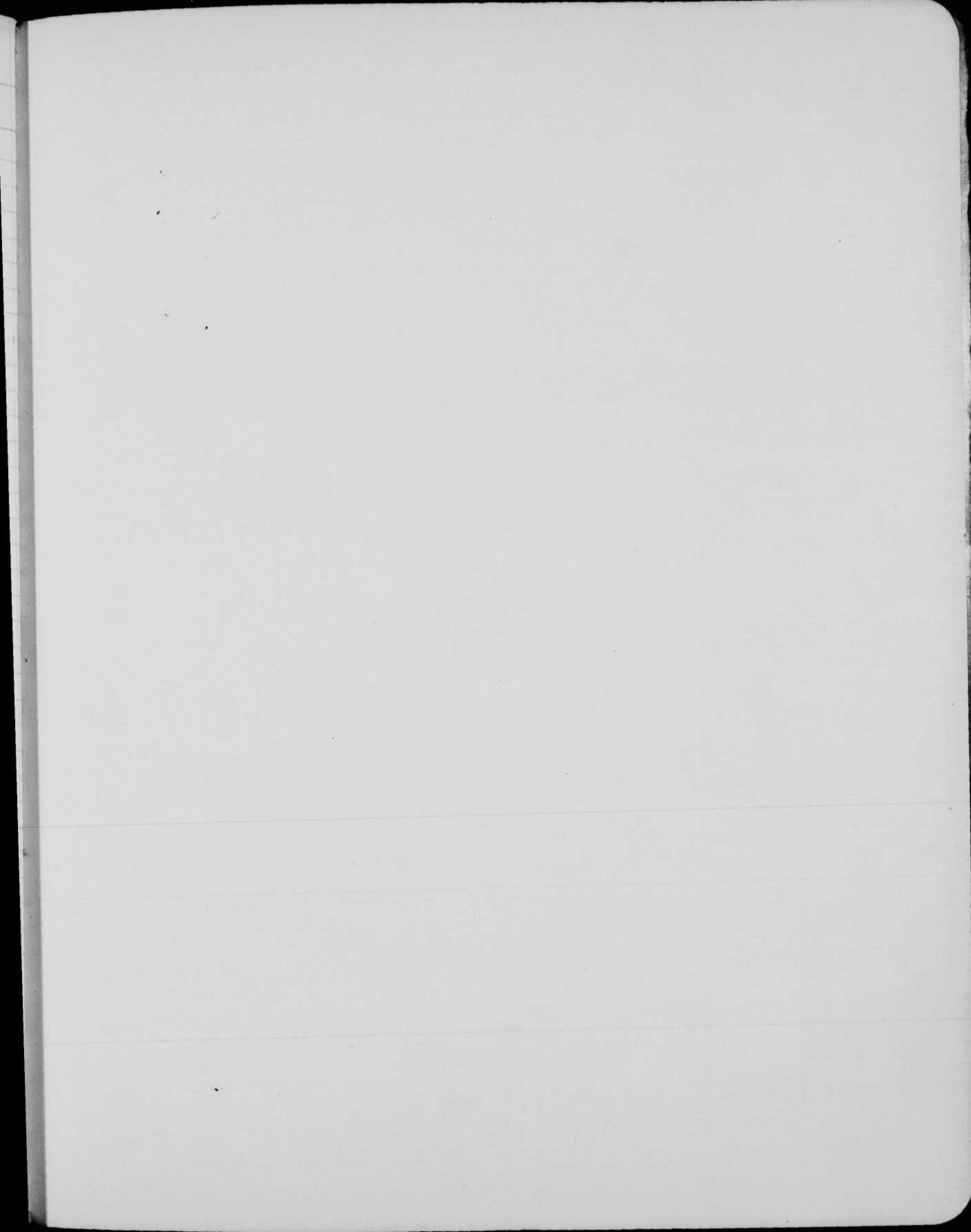
Some  
pickup?



Diameter of Jaraday shutter opening is about  $10^{-6}$  sec.

Dec. 27, 1951

Harold S. Dyer



Two flashes p. 72.

