HAROLD E. EDGERTON

PAPERS

MC 25

Series III

Laboratory Notebooks

Number 14

Dated April 1, 1943 to Jan. 30, 1944

Massachusetts Institute of Technology

COMPUTATION BOOK

NAME	Number
HAROLD E EDGERTON	14.

ROOM 4-117 8-101, 103, 105 LAB.

Course .....

Used from APRIL 1 1943, to Jan 30 1944.

Notebook # 14

Filming and Separation Record

1 unmounted photograph(s)

____ negative strip(s)

____ 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 4-117
Cambridge, Mass.
April 1943

Harold E. Edgerton

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

COMPUTATION BOOK

GENERAL INSTRUCTIONS

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

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

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

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

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

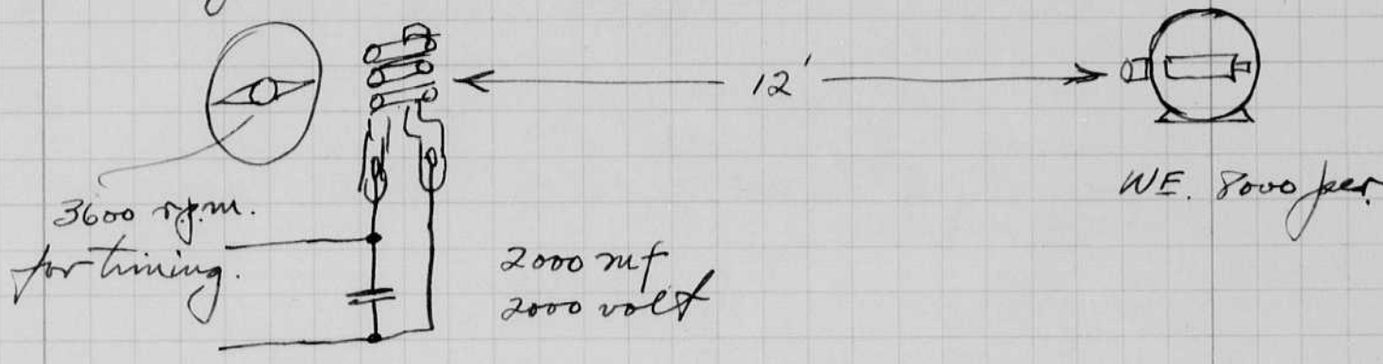
"Computations should be indexed, in the back of the book, by the person using the book."

* * * * * * * "

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

April 6 1943.
Harold E. Edgerton

Mr. Gunn of Spencer thermostat brought in an 8000 per second W.E. camera so we could shoot some of our big lamps in operation.



#1. Moly electrode as cathode. The dark end was sputtered from previous use.
f11 2000 mf 4000 volt.
24 cans rated 65 mf.

#2. Nela Park tube with sintered tungsten Ba, nickel end on an Iron tube. f11

#3 Spot welded sintered batter on iron. Solid iron backing. f11

#4 Ditto of 3 but with closer view of anode and cathode. f16

After Gunn left (3:30) I red and I started a life test on the tube used in tests 3 & 4. After 5 flops at 4000 volts one of the condensers blew up splashing castor oil all over the floor.

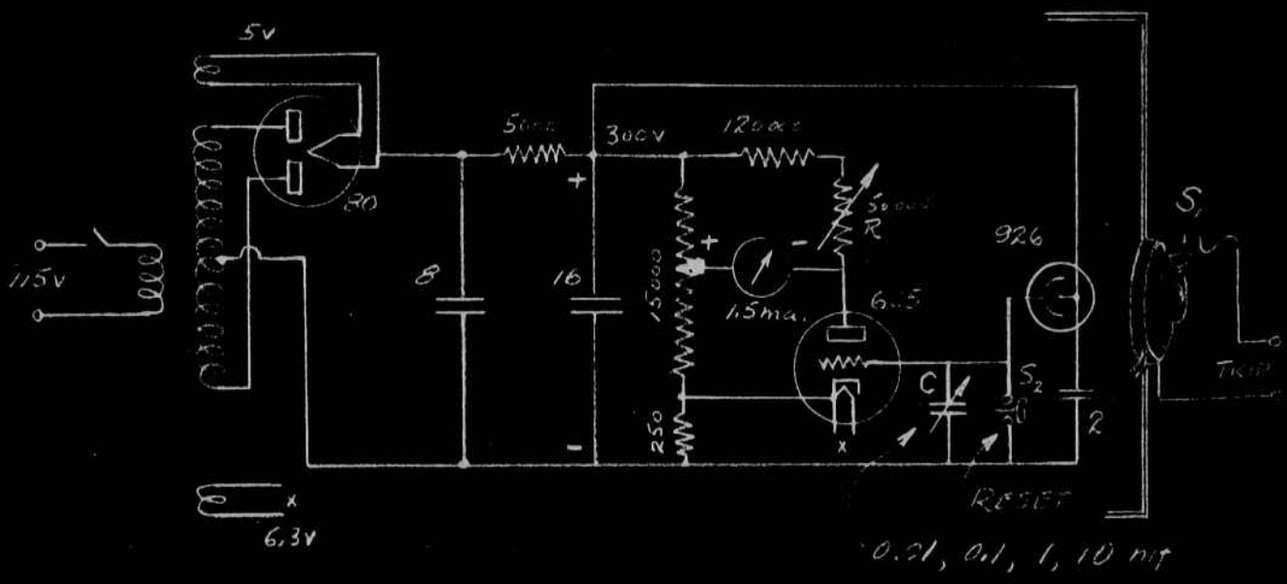
These condensers weigh 55 pounds.

April 7 1943
H. E. Edgerton

I went to N.Y. on the night train spending most of the day with Mendelsohn on a ~~Synchronizer~~. A delayed action contactor is mounted on the back of case of his magnetic shutter trippers.

A new model was made and tested to be ok. I showed it to Mili before taking the 5 o'clock train to Boston.

LIGHT INTEGRATING METER



S_1 Shutter and light-tight box for excluding the light from the photoelectric cell and triode except when measurements are made. Provision for synchronizing is provided. The lens is replaced by a ground glass diffusing element.

S_2 Reset switch for discharging the integrating condenser C before each operation.

R Zero adjustment for setting meter to read zero current with S_2 shorted.

Type 6C5 triode - selected for small grid current.

Type 926 Photoelectric cell - selected for small dark current. If another photoelectric cell is substituted, it must be of the vacuum type. The operating voltage is too high for a gas filled photoelectric cell.

Example: No. 2 Kenatron Flashlamp, Side view without reflector, 11½ mf, 2000 volts, distance 24 cm lamp center to meter, C = 0.1 mf, full meter reading 1 ___.

March 30, 1943
H. E. Edgerton

April 7 1943
H. E. Edgerton

I went to NY. on the night train spending most of the day with Mendelsohn on a synchronizer. A delayed action contactor is mounted on the back of one of his magnetic shutter trippers.

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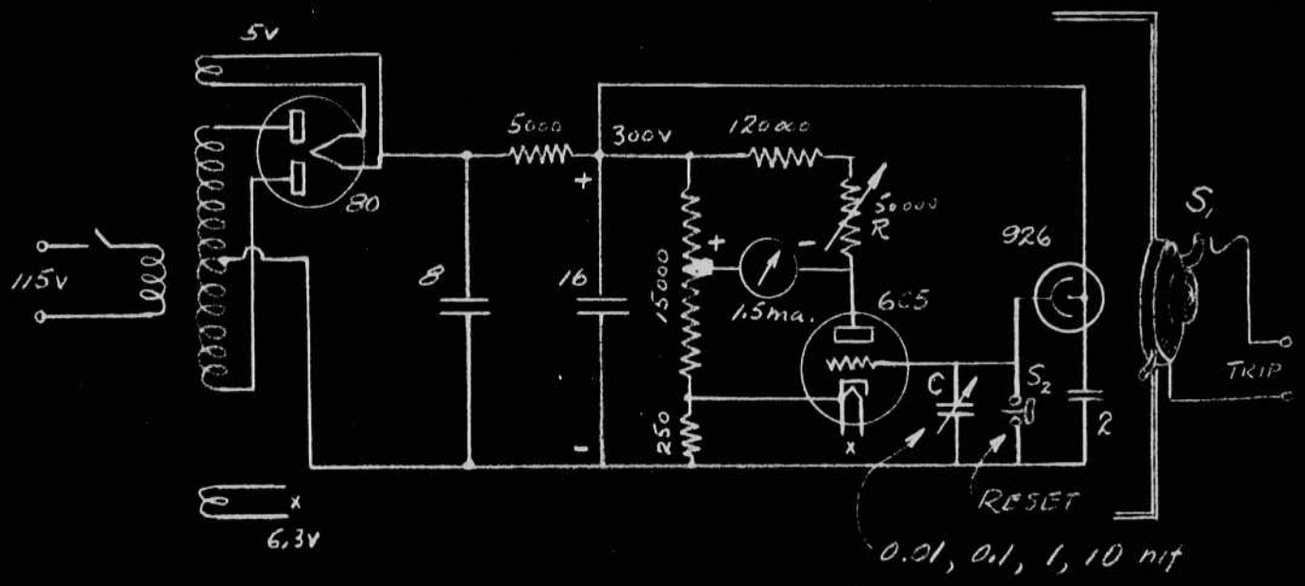


S_1 Shutter and light-tight box for excluding the light from the photoelectric cell and triode except when measurements are made. Provision for synchronizing is provided. The lens is replaced by a ground glass diffusing element.

S_2 Reset switch for discharging the integrating condenser C before each operation.

R Zero adjustment for setting meter to read zero current with S_2 shorted.

Type 605 triode - selected for small grid current.

Type 926 Photoelectric cell - selected for small dark current. If another photoelectric cell is substituted, it must be of the vacuum type. The operating voltage is too high for a gas filled photoelectric cell.

Example: No. 2 Kodatron flashlamp, side view without reflector, 112 mf, 2000 volts, distance 94 cm lamp center to meter, C = 0.1 mf, f8. meter reading 1 ma.

March 30, 1943
H. E. Edgerton

April 7, 1943,

Photo of D.C. 6066 lamps after life test on opposite page.

These lamps have been operated at 1600 mf at 4000 volts also.

The moly electrode marked + fell off after several pops at 1600 mf. It broke loose at base where it was spot welded

The other tube was run for 500+ flashes without serious change in appearance.

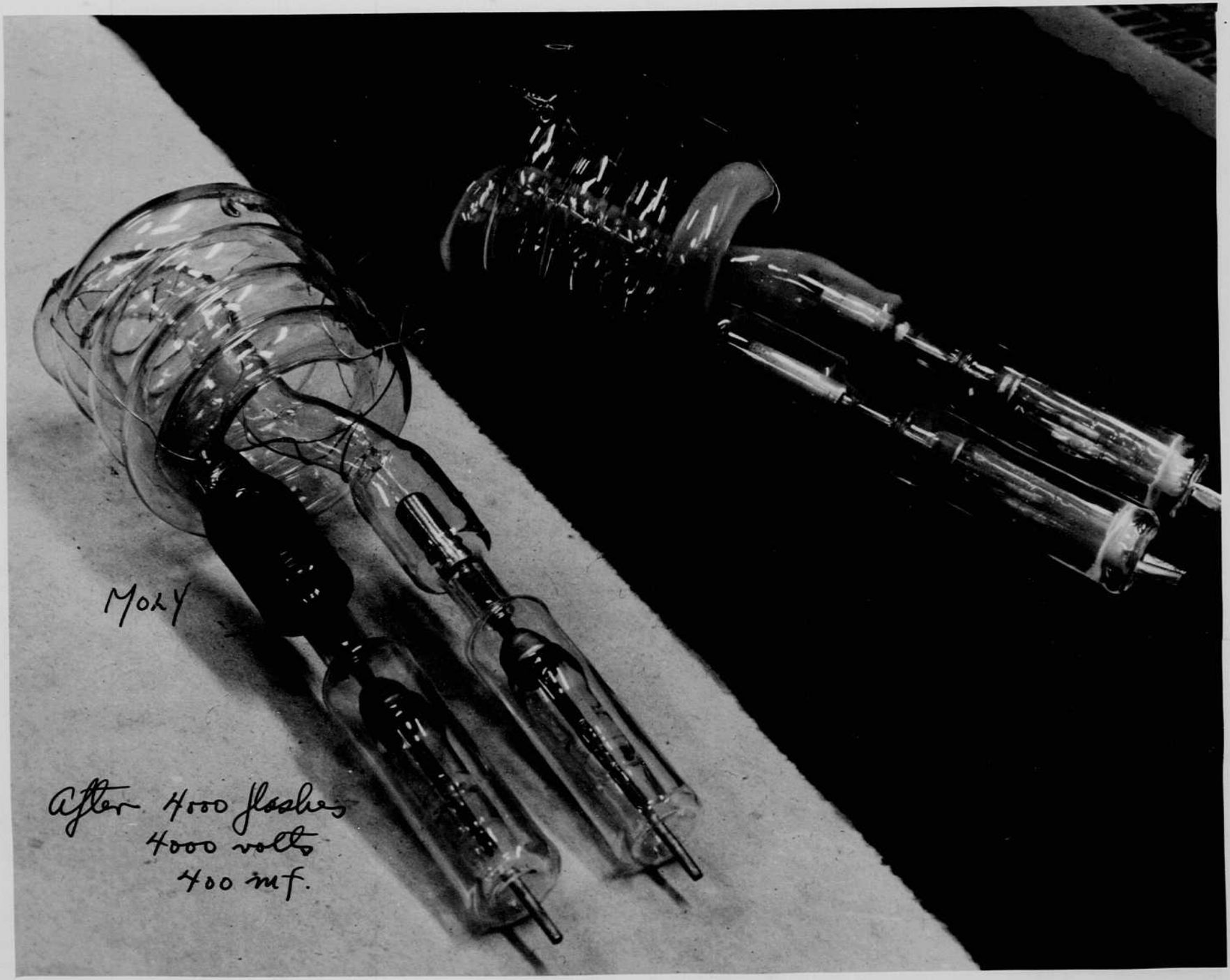
Light measurements were entered in the blue book of data.

Output = 68 Kodatrons.

Meas. at f 22 (94 x 3 cm)
Light about 0.9 on meter.

April 7, 1943

April 7 1943
H. E. Edgerton.



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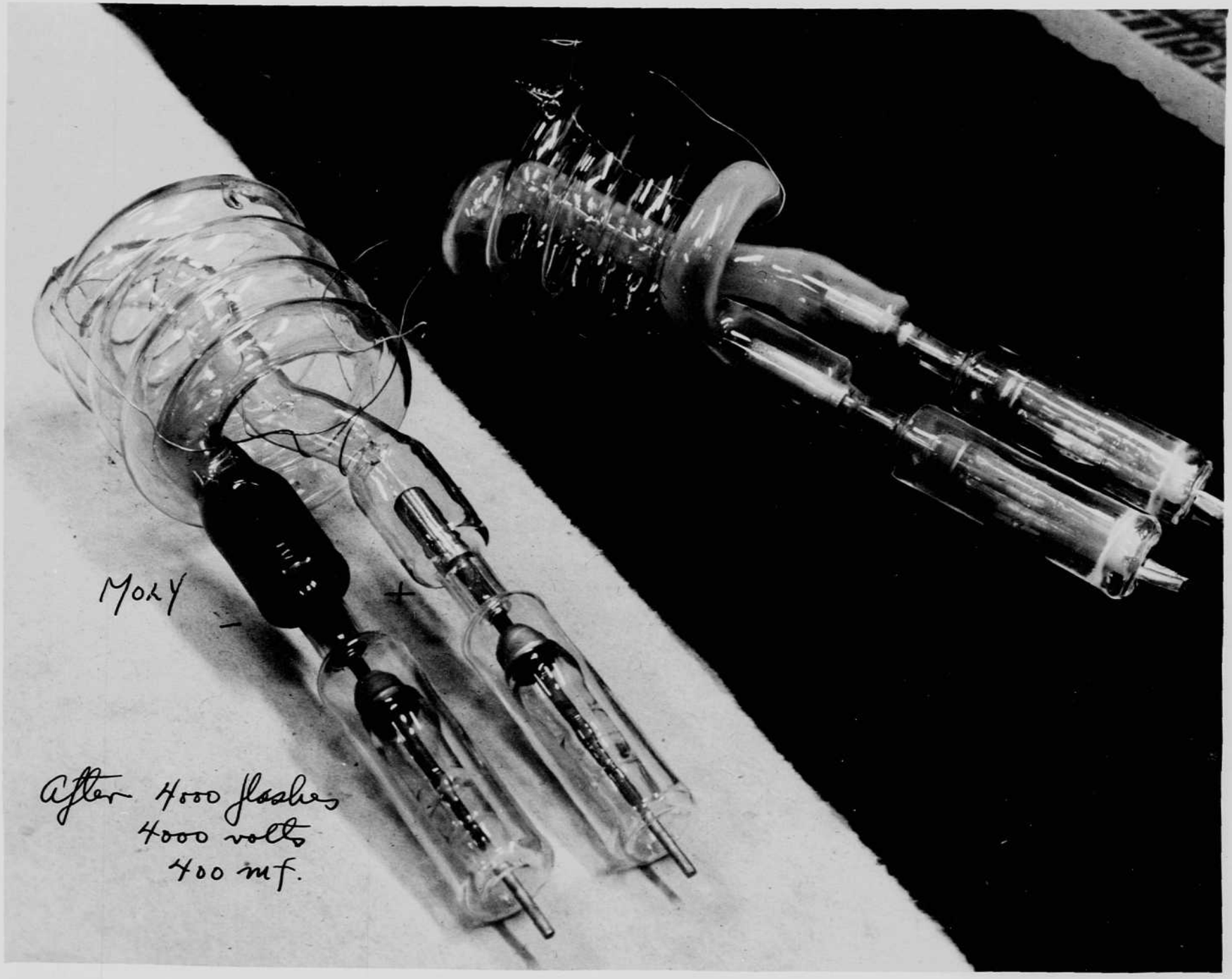
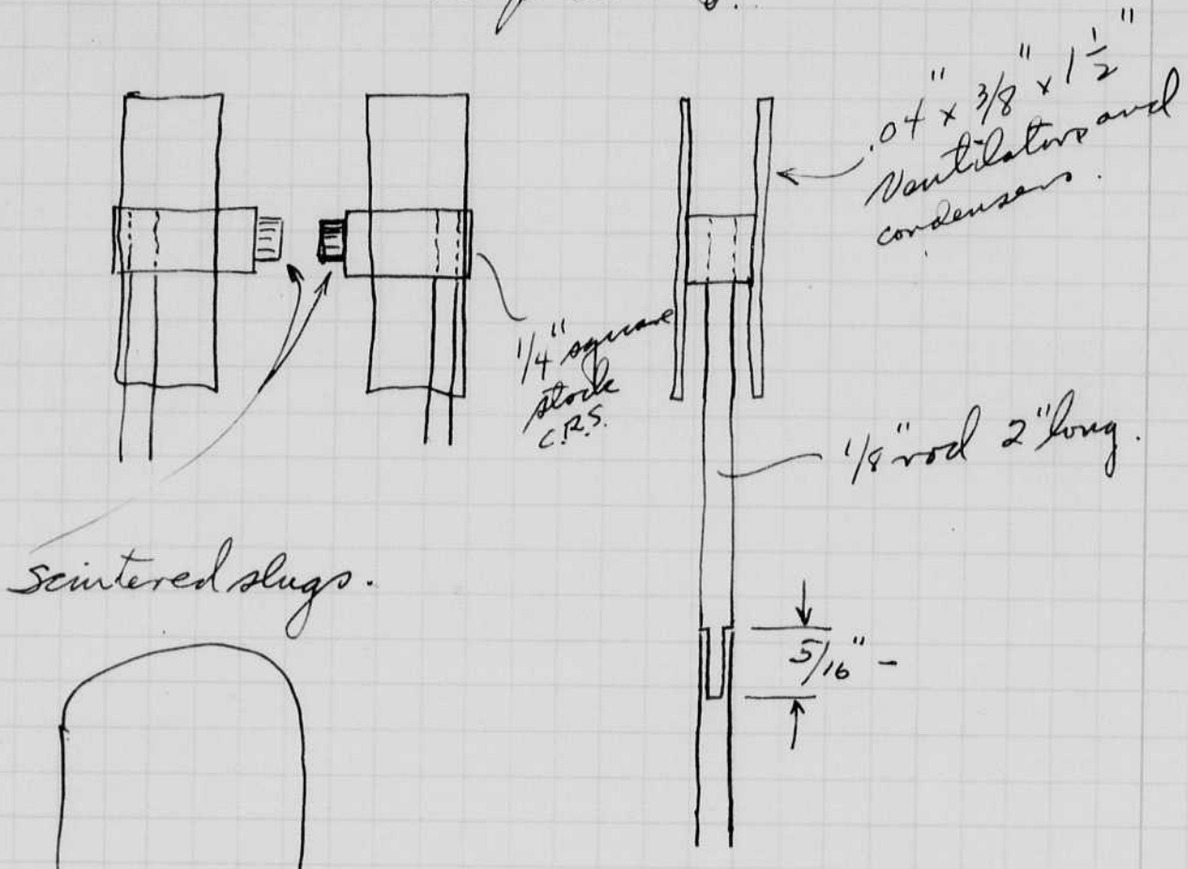
H. E. Edgerton.



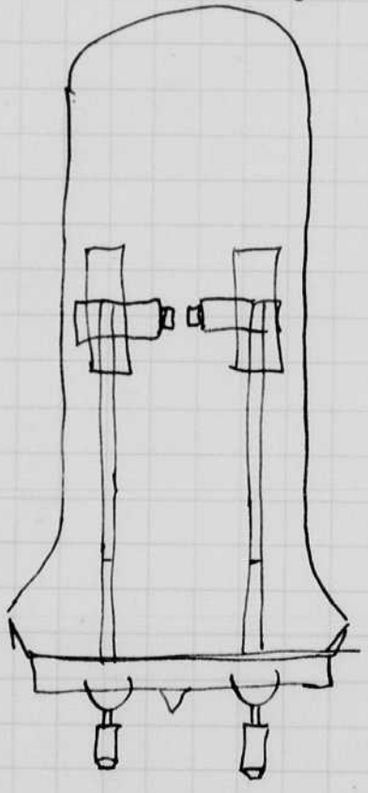
After 4000 flashes
4000 volts
400 mf.

April 7 1943
Frank E Edgerton.

More Gap tubes.



Sintered slugs.



Hardware is being made by Middleton today for six tubes.

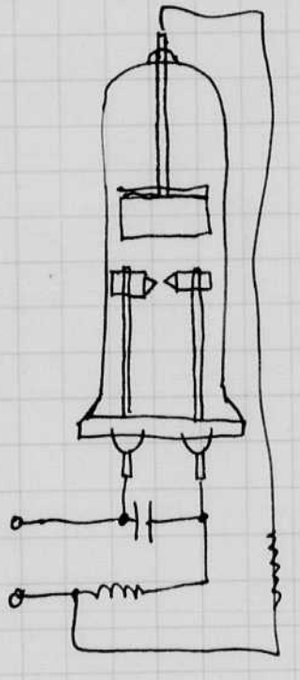
I plan to send some to Liz Reduction for Xe filling at high pressure — 40 to 60 cm.

the tubes will be bombed and treated with H_2 before being sent.

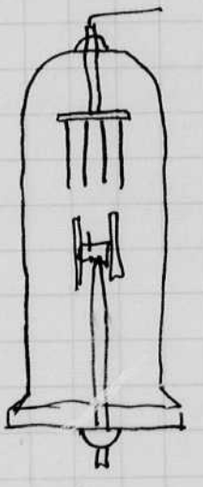
Cont.

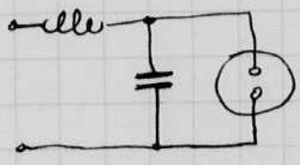
It has been observed that the metal cooling plates also collect sputtered metal from the arc. This is probably due to the potential of the electrodes which attracts the charged particles of sputtered material.

Additional plates could be used which would give additional collection of the material that would normally settle on the glass portions of the tube and thereby stop light.

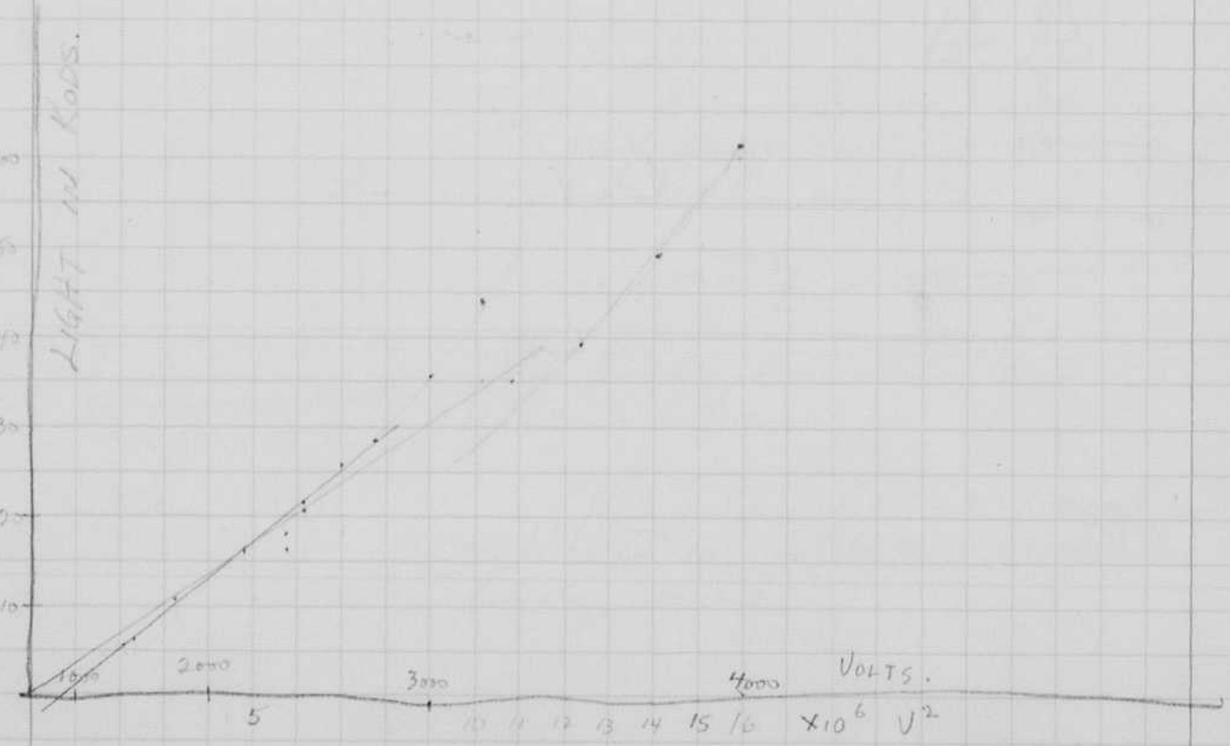


use resistance so arc will not start.





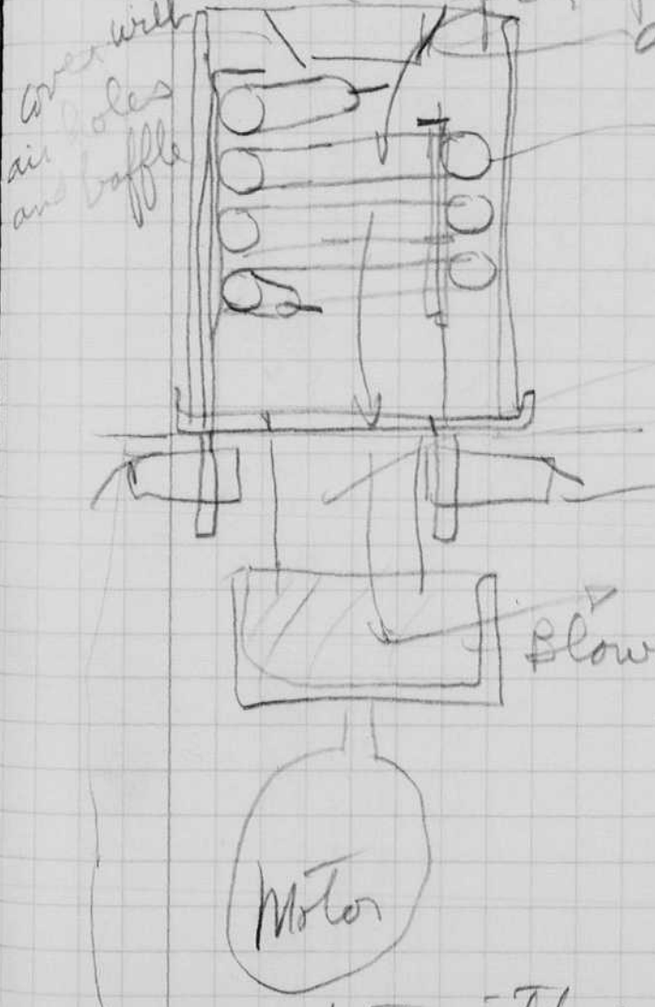
V² vs Light from Data of Apr. 7, 1943.
in Blue Book.



K. 2. Grier
1-7-43

Design of new lamp to take place of Kodatron + No 16 Power tube

this design is based on a new socket design having a pin circle larger than the present 5 prong and having provision so that it can be built with either a socket for a focussing lamp that will be replaceable or with a blower for Power applications

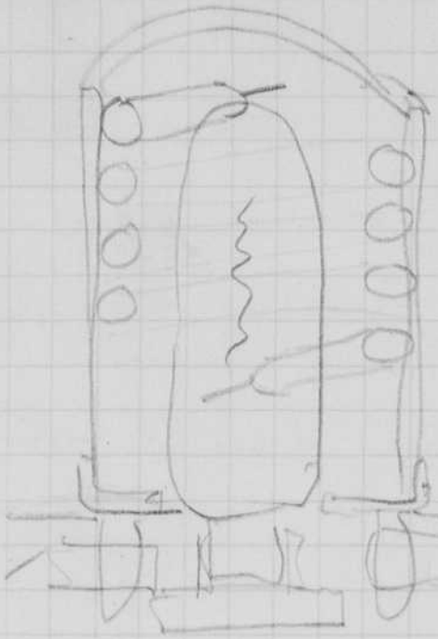


socket with coil
Permanently Mounted

Power tube

Understood and discussed with Mr. H.E. Grier.
April 8, 1943.

N.E. Grier
N.E. 43
A-7-



tube same as on preceding page but with closed end socket and with no blower but with a focusing light socket mounted in the socket where the air blows through. The flash tube forms a hollow cylindrical assembly that fits down over the small incandescent lamps of the projection bulb sigl.

Read & Goodenstood.
Harold E. Edgerton
April 8 1943.

April 8 1943
Harold E Edgerton

The designs of page 9 and 10 depend upon a large pin spacing. This makes possible the double lamp assembley of page 10. Such a construction was discussed at least 3 years ago but was not considered practical since the pin spacing was not sufficient.

Grier has obtained socket parts so that he can assemble samples for trial.

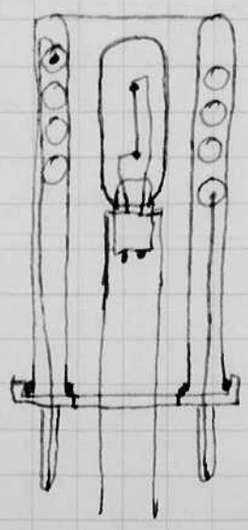
I spent considerable time today on the photographing of a rayon winding machine. It was sent from the Jacobs Lowell Shops from Maine. Mr. Kirkpatrick and Mr. Holmes of Fish Richardson & Neave (Patent attorneys) were here about noon. Mr. Marsh set the machine up yesterday for the tests today.

This twister has a stationary bundle. The yarn goes through a hole in the center to the bottom, then to a wire flier, the balloon, and up to the top.

The object of the photography was to stop the thread in the balloon. Some 2½ dozen shots were made from various angles.

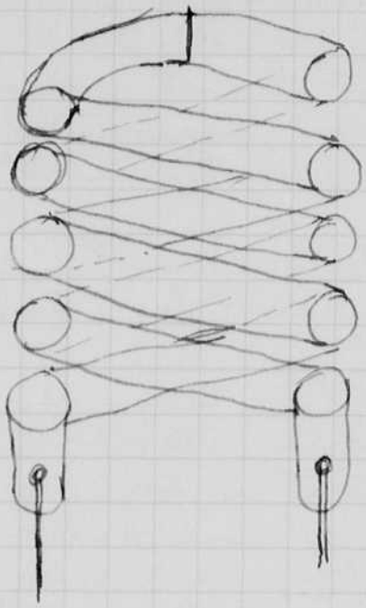
The lamp of page 10 (high-speed flash) is difficult to clean on the inside. Below is sketched a design which can be easily washed.

It consists of a double walled container for the flash bulb which also covers all wire and connections.



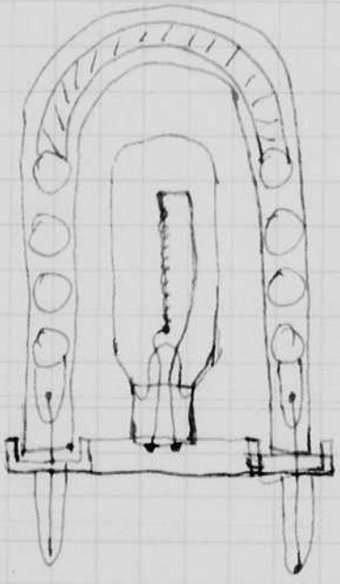
April 8 1943 cont.

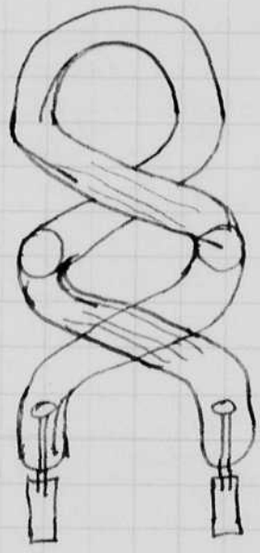
H. E. Edg.



Double twist coil so that both ends will be down.

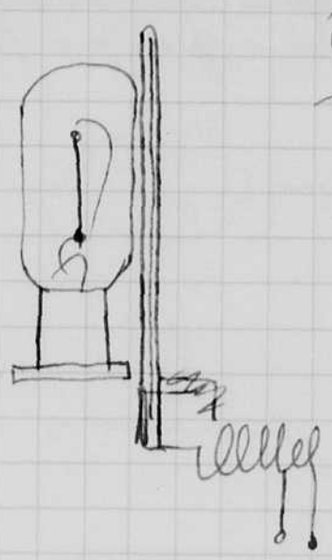
The coils can be spacing 1/8" or so at the bottom so they will spring into the glass envelope.





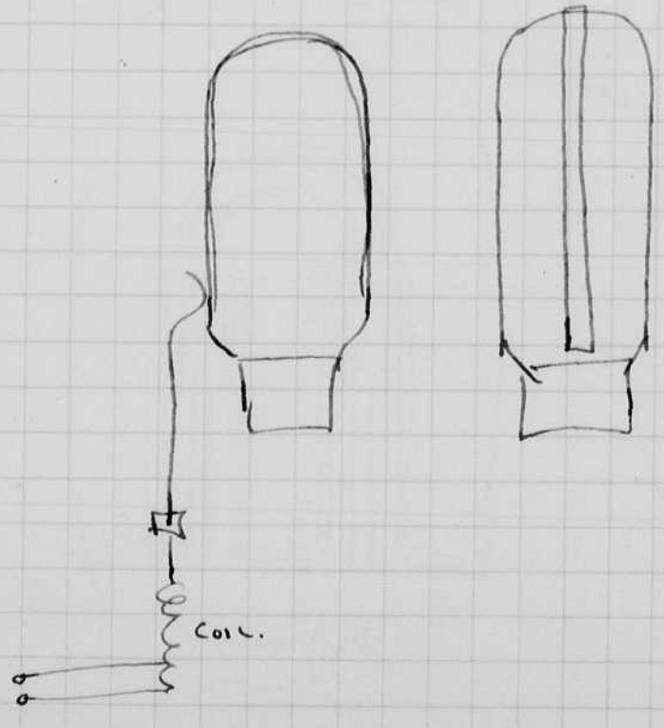
With heavy ~~Pyrex~~ wall tubing no bulb would be necessary. The spark tip could be open or enclosed in glass.

cont.



The coil (lower R.H page 12) would fit over the bulb and spark wire. Possibly two ~~sparks~~ or more spark wires could be used. They would ~~also~~ also serve as bumpers between the two lamps.

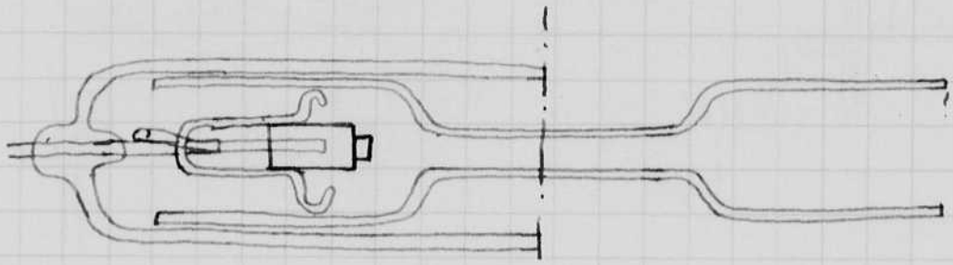
Another method of introducing the spark - Paint a conducting line on the lamp bulb which contacts a spring that connects to the ~~coil~~ spark coil.

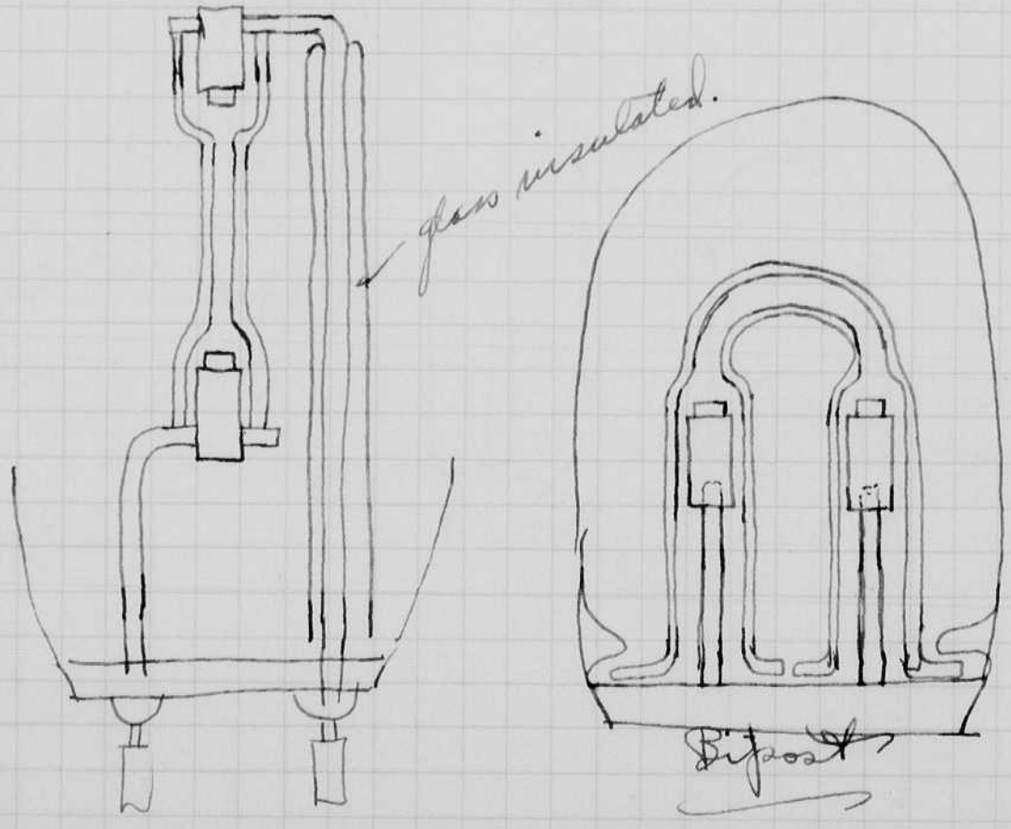


April 10 1943
Frank D Edgerton.

Made several gap tubes yesterday except for pumping. Design as per page 6.

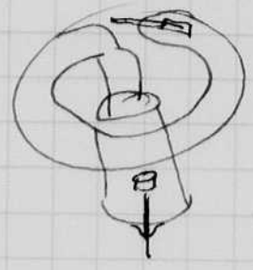
Movie lamp designs





Cont

Prospectus for Aberdeen Md.



5" or 6" of # 10 mm (or 9)

3.5 cm of Xenon gas.

Sintered cathode.

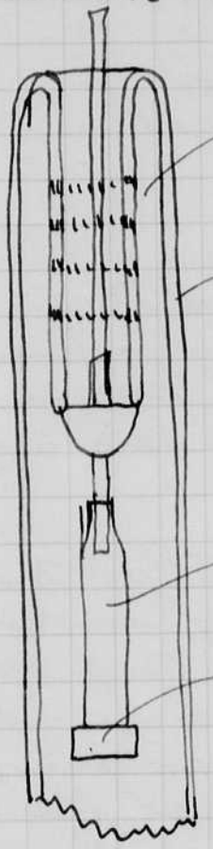
3 A F E T
K O D A K

April 18 1943

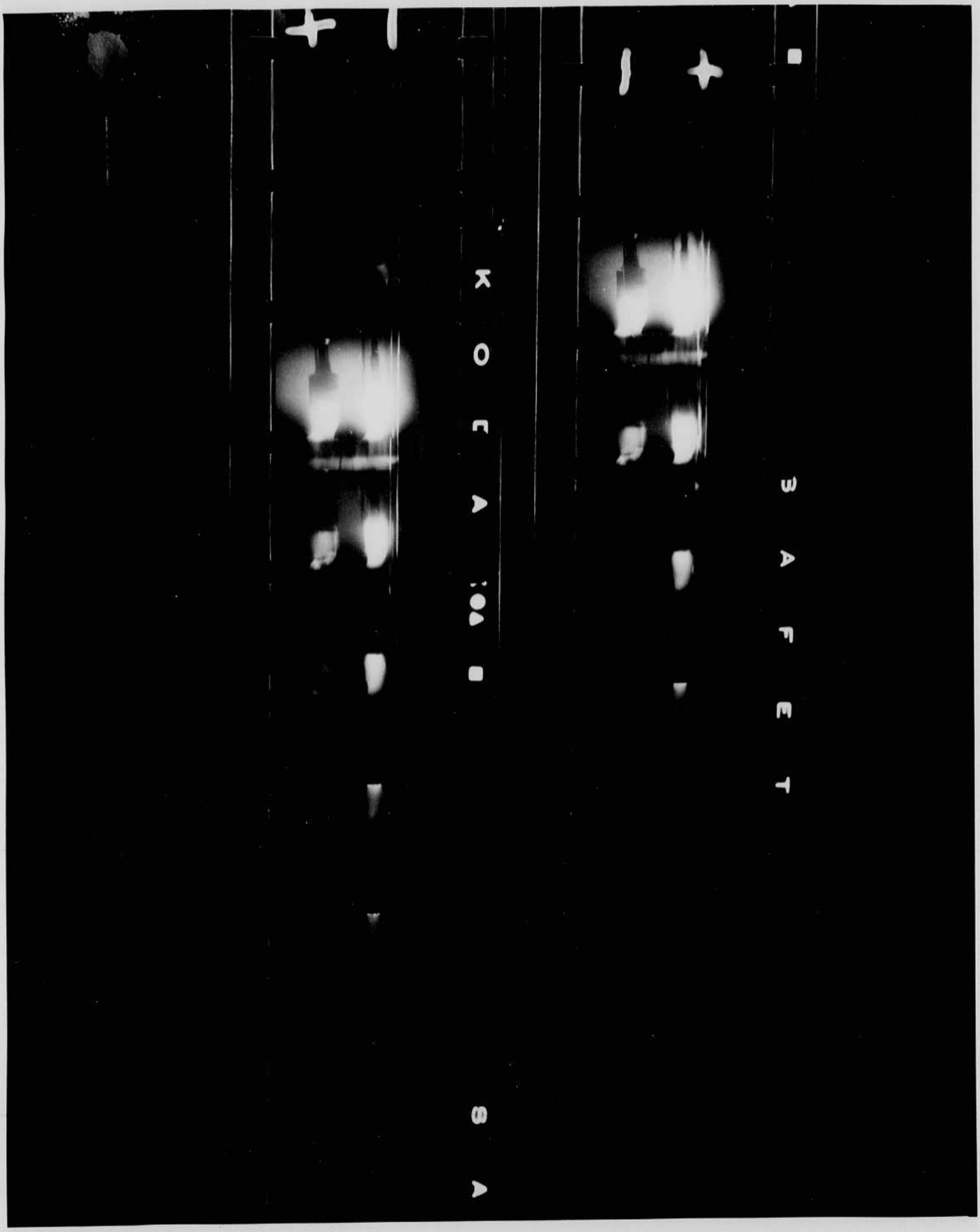
~~Harold E Edgerton~~

← movies taken with W.E. camera at 1000 frames per second of quartz lamp with 1600 mf at 4000 volts. The ~~pictures~~ show that the arc at either end of the tube is concentrated on the end of the electrodes.

The electrode tested had a construction as shown in the sketch below.



This tube has since been flashed about 700 times at 20 second intervals to study life of the electrode shown above. at the end of the test the ~~sputtering was not appreciably different than~~ appreciable. the sputtering was very much less than with moly. electrodes.


3 A F E T
K O R E A 10A
8 A

April 18 1943

Harold E Edgerton.

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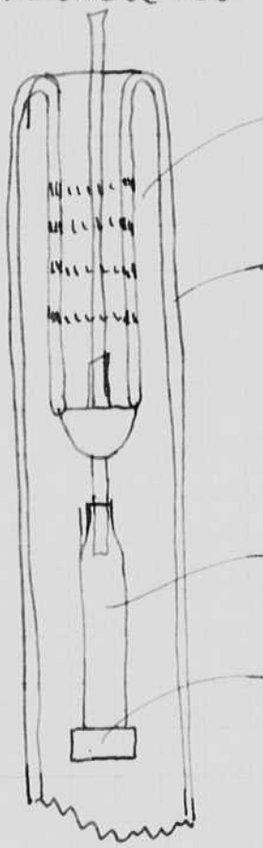

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April 18 1943 cont.

Harold E Edgerton.

I left Boston April 13 with the Jenkins camera on the Federal for Aberdeen. Tom Johnson happened to be in Boston and made the trip with me.

Set up test for night of April 14 with Dr. Sachs of Bal. Res. Lab. Lt. White at Bomb field (camera). 4 500# bombs and 1 1000# bomb was photographed. On the next night 3 more 1000# bombs were exploded. the data is in Sachs and Wyckoff's notebooks.

April 19, 1943. cont discription of trip.

Friday

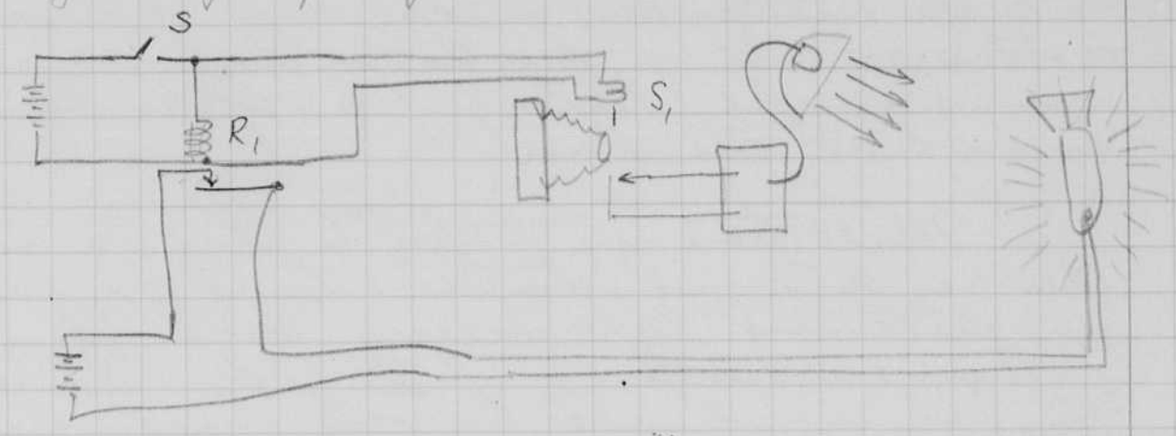
Chas took the 11.03 am on the Bando to Washington with the negatives for processing. I followed on the 2.35 bus. We had dinner at Margaret's and then went to the Signal Corps lab to splice the negative.

On Sat. morning, we visited the Model Basin. Reviewed sound movie of under water explosions, discussed work with Roop, Howard. etc. Campbell took us to S.C. lab in aft. and then to the station. Caught Aberdeen about 7 pm for 8 pm meeting at Ballistic lab. The movies were shown and discussed.

Another attempt will be made to shoot the projectiles on Thursday April 22. I suggested that a single flash photograph would be useful even if the projectiles were blurred.

Last night I made an experiment with the portable in the Tech yard. A bomb fragment was hung in a tree at 100 ft and the light was put on the ground at 30 ft. f 45 on Brecks film. Exposure looks ok.

Plan a circuit as follows to eliminate the flash of light from bomb detonation on film.



Sequence: Close switch S, Relay R_1 fires, bomb just before shutter opens at S_1. Contacts on shutter then flash light about 2500 microseconds after the bomb detonates. R_1 is adjustable in time. It is tested by flashing the lamp with the contacts at R_1 and observing the lamp through the camera lens. The lamp is made to fire about 1 millisecond before shutter opens.

From the Jupiter movie records made last week we know that the bomb flash lasts but one millisecond. Therefore this adjustment should obscure the flash of the bomb from the picture.

If the bomb fragments travel at 7000 ft/sec and the exposure is 10^{-4} sec; the blur will be .5 feet.

For 20 ft travel the delay time is $\frac{20}{7000}$ ft/sec $= \frac{1}{400}$ sec

$= .0025$ sec.

The delay time for a dynamite cap is .0025 sec.

April 21 1943
Harold E. Edgerton

Yesterday Wyckoff and I went to the Polaroid Co to see Vectographs made. Also we arranged to obtain a set of plates so that we could make Vectographs of the large bombs at Aberdeen.

While there we talked to Land about Charlies polaroid shutter. Land suggested an electrical type using polarizers and will give us details if he gets clearance. This scheme should be very useful for the armor plate experiments and muzzle blast etc.

We made tests last night for the Aberdeen experiments that are scheduled. Results are given in Chas note book.

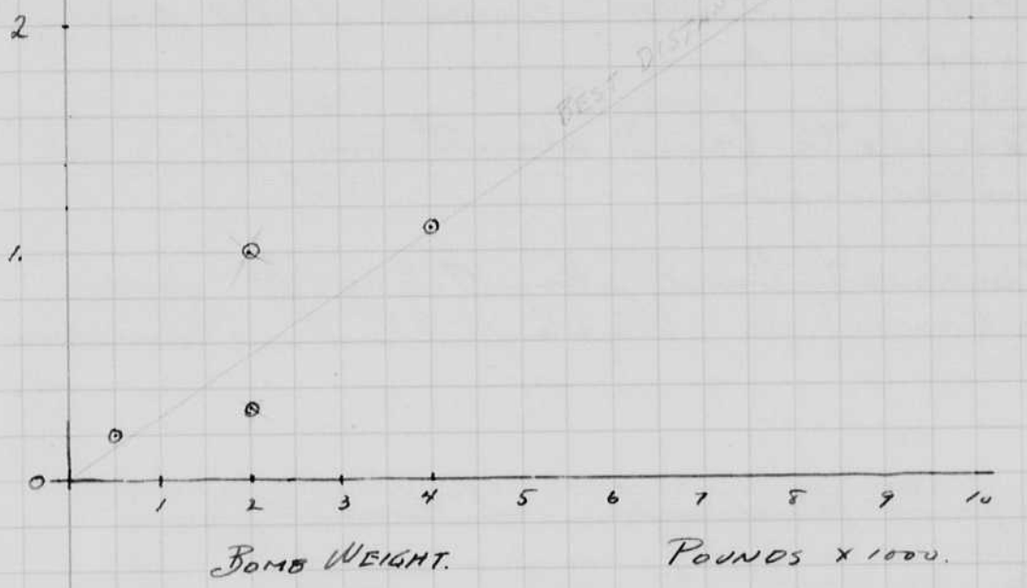
April 23 1943 Aberdeen Md.

Chas. Wyckoff came with me on the Federal Tuesday night april 21. We set up the Jenkins and a single-flash for April 21 evening.

The single-flash pictures showed the bomb before it exploded. Experiments today indicate that 7 to 11 milliseconds are required to flash the #8 detonator blasting caps. We assumed that the ignition time was less than a millisecond.

Two 500 lb bombs were exploded on the night of Apr 21.

Today we took a Jenkins shot of another 500 lb bomb with the camera at 200 ft. It was a clear day with a blue sky. The photo was taken at 10 am with a 45° angle to the sun. Light from the fragments was ample to define them against the light of the sky.



Camera delay test. Speed Graphic + Speedgun, adjusted for min time with 1/400 sec. setting of shutter.

Delay = 5 or 6 milliseconds.

Dupont #8 Blasting caps delay with 45 v Battery. 1/2 ohm line

Variation from 7 to 11 milliseconds.

April. 27, 1943
Harold E. Edgerton

Today in Aberdeen with Charlie Wyckoff. Jenkins camera movies of 500 # bombs at 70° -5", -12" and + 36" above the ground.

Light reading 400 Weston. Over cast sky. Six shots were made, 2 each of the scheme mentioned above.

Camera to bomb about 200 ft.
Jenkins camera.

Camera to bomb about 600 ft for 16 mm 4000 f.p.s. Western Electric Camera.

April 29 in Washington at Model Basin.

" 30 Dahlgren va on 9¹⁵ bus. Returned at 2.15 and took 5 pm train to N.Y. met Mili at Grand Central Station before taking the owl to Boston.

May 1. at M.I.T.

" 2 at home all day.

" 3 M.I.T.

May 8 1943
Harold E Edgerton.

Life test of F.I.11 received recently from G.E. Co. this tube had two electrodes of the sintered type spot welded to iron rods. Data taken as follows

Flashes.	Counter Reading.	time.	Remarks.
0	4985	2.35 pm.	Start of test.
65			Photo taken to show anode darkening.
227	5212		Polarity reversed.
404+227	5616		Test stopped. photo taken.
631 total.			

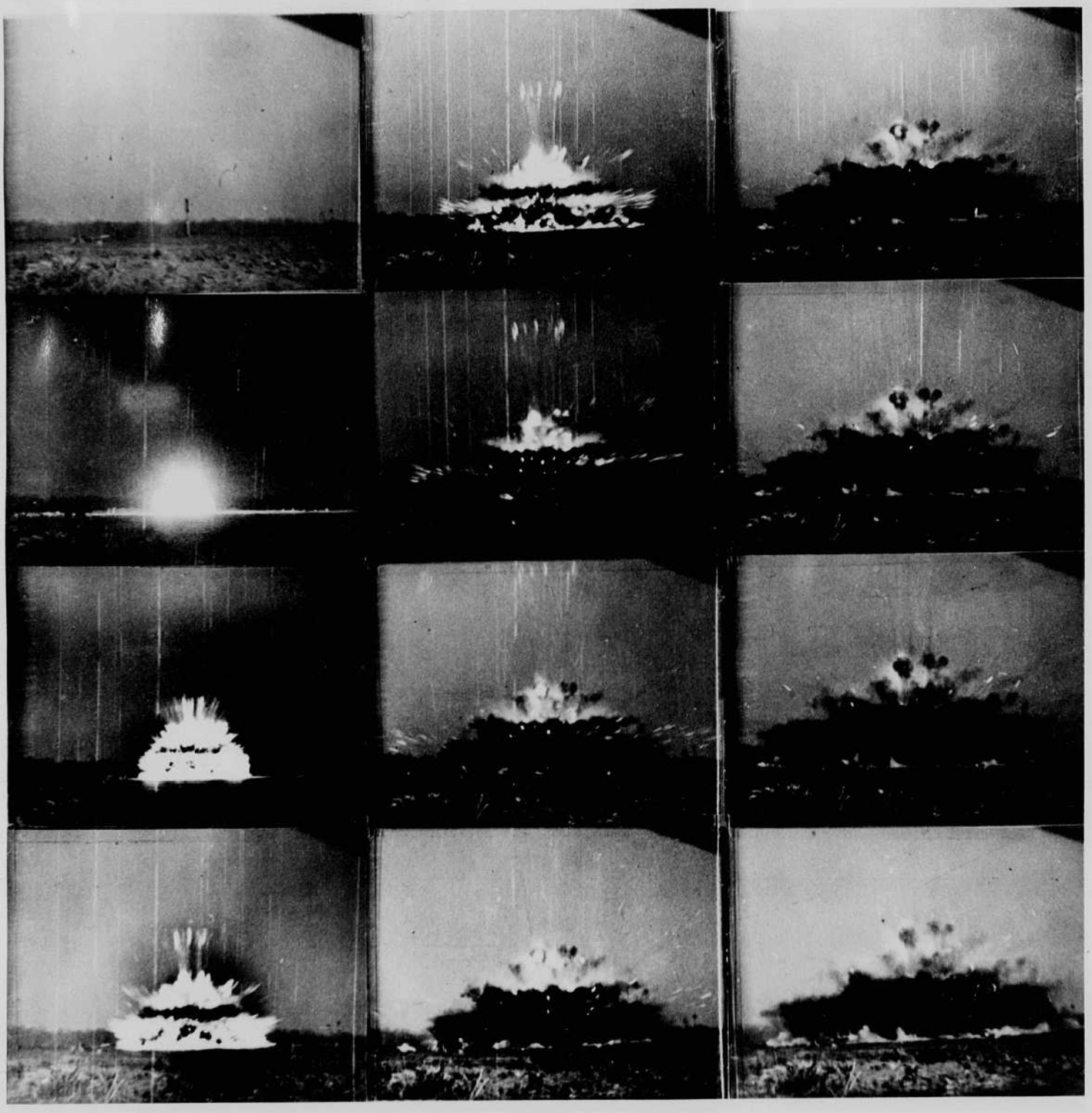
The tube was taken apart so that a spectral analysis could be made of the white material that formed a deposit on the electrodes. Rockwell Kurt of physics dept made the spectral test yesterday.

the quartz showed some crazing.

I talked to Kenyon at Wright field yesterday promising June 7 as the delivery date for the B-24 plane flasher.

Grier estimates an A 29 to follow in a month from then, that is, in July.

Photos of 500 # bomb taken at Aberdeen Md. Speed approx 1000 f.p.s.



May 7 1943

Harold E. Egerton.

The Gap tubes, page 6 of this notebook, were received yesterday from the Air Reduction Co. Four tubes were filled with Xenon gas at 40 cm by Dr. Balcar.

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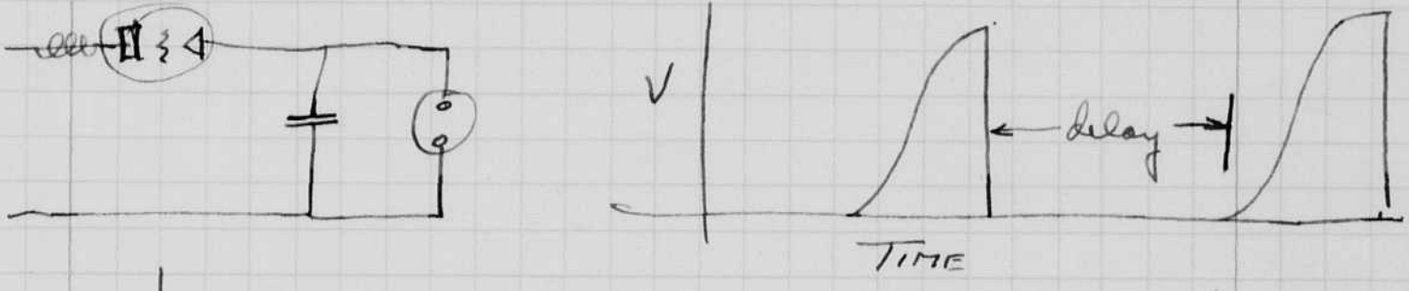
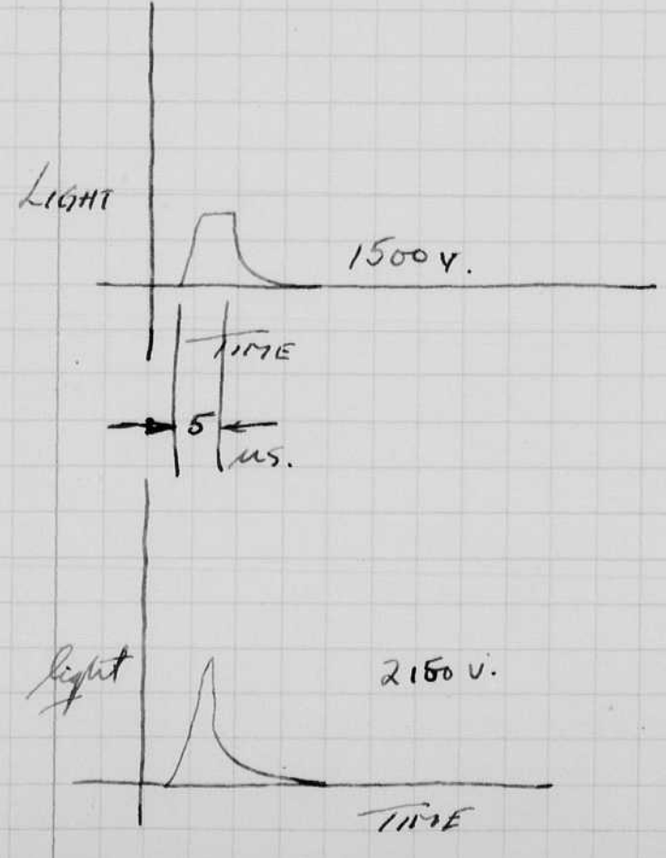
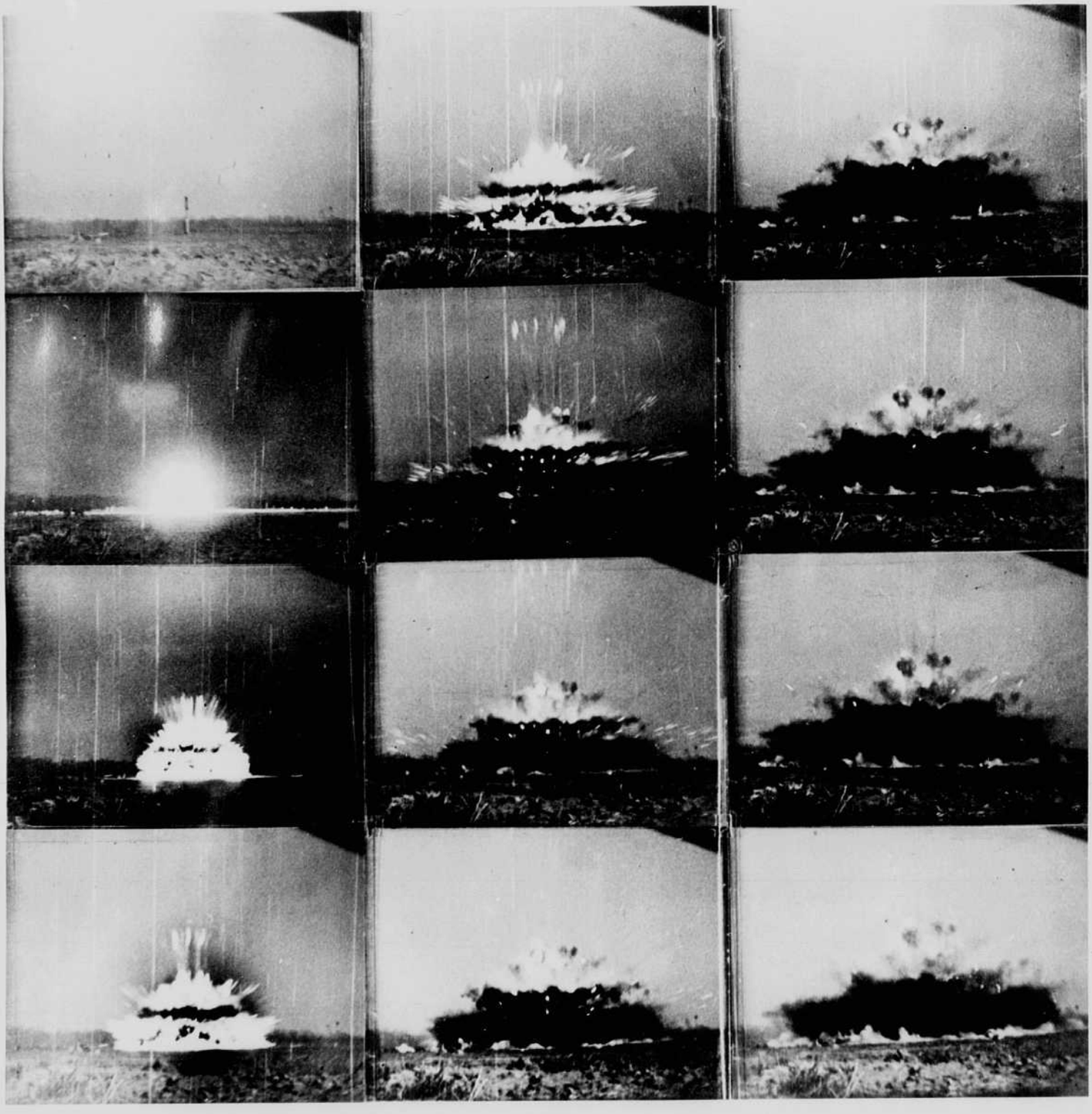
It would be an advantage to use a time delay in the charging system when using this lamp.



Sketch of C. L. Ops taken on 3 element N.E. tube.



Photos of 500 # bomb taken at Aberdeen Md. Speed approx 1000 f.p.s.



May 5 1943

Harold E. Egerton.

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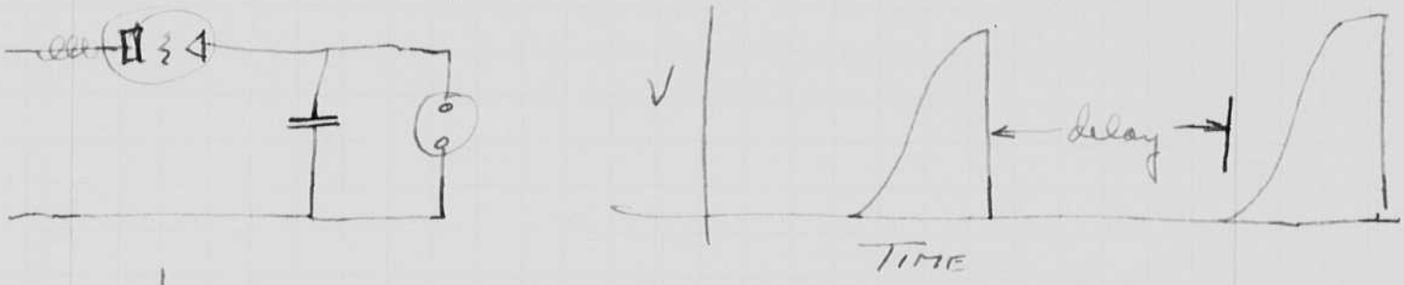
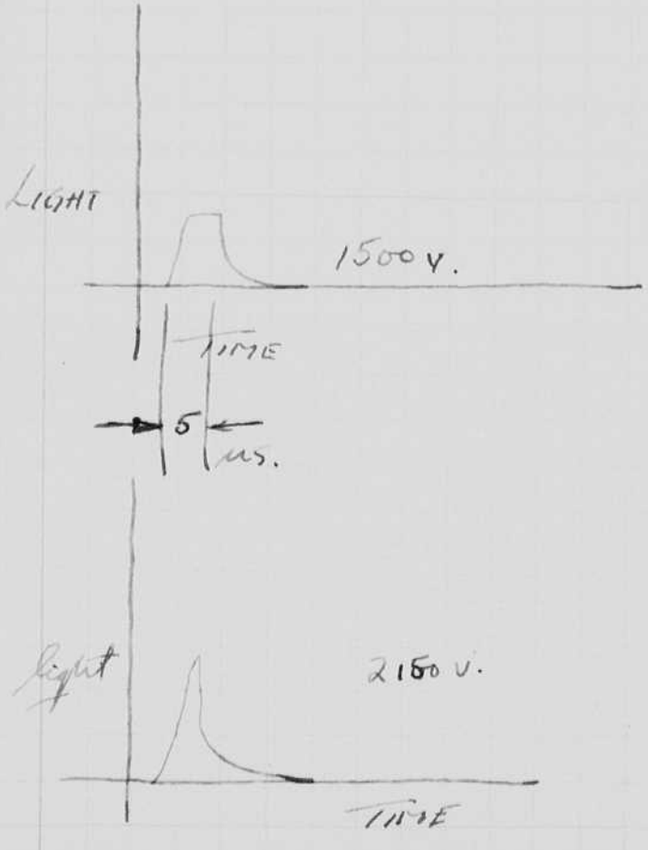
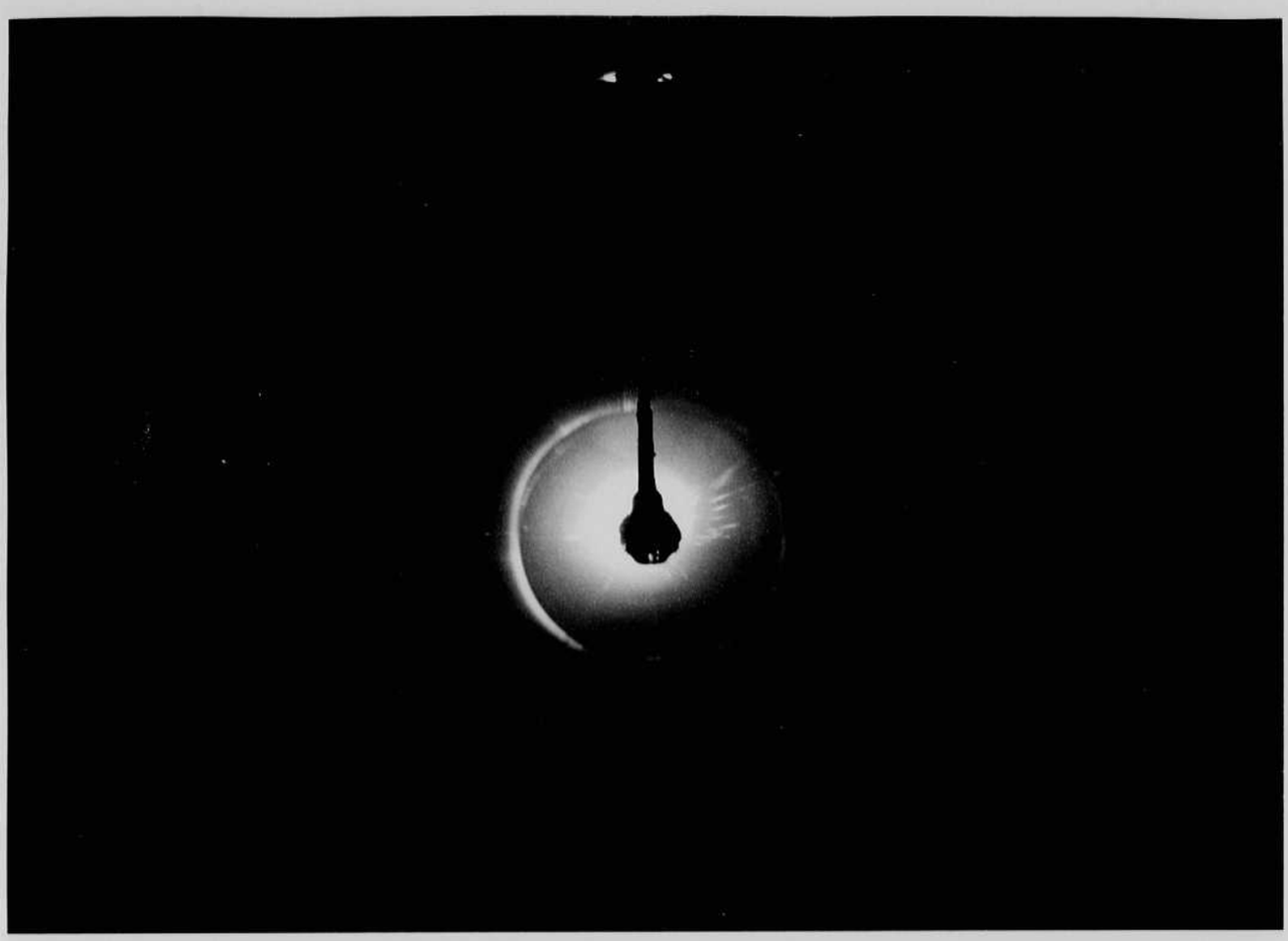
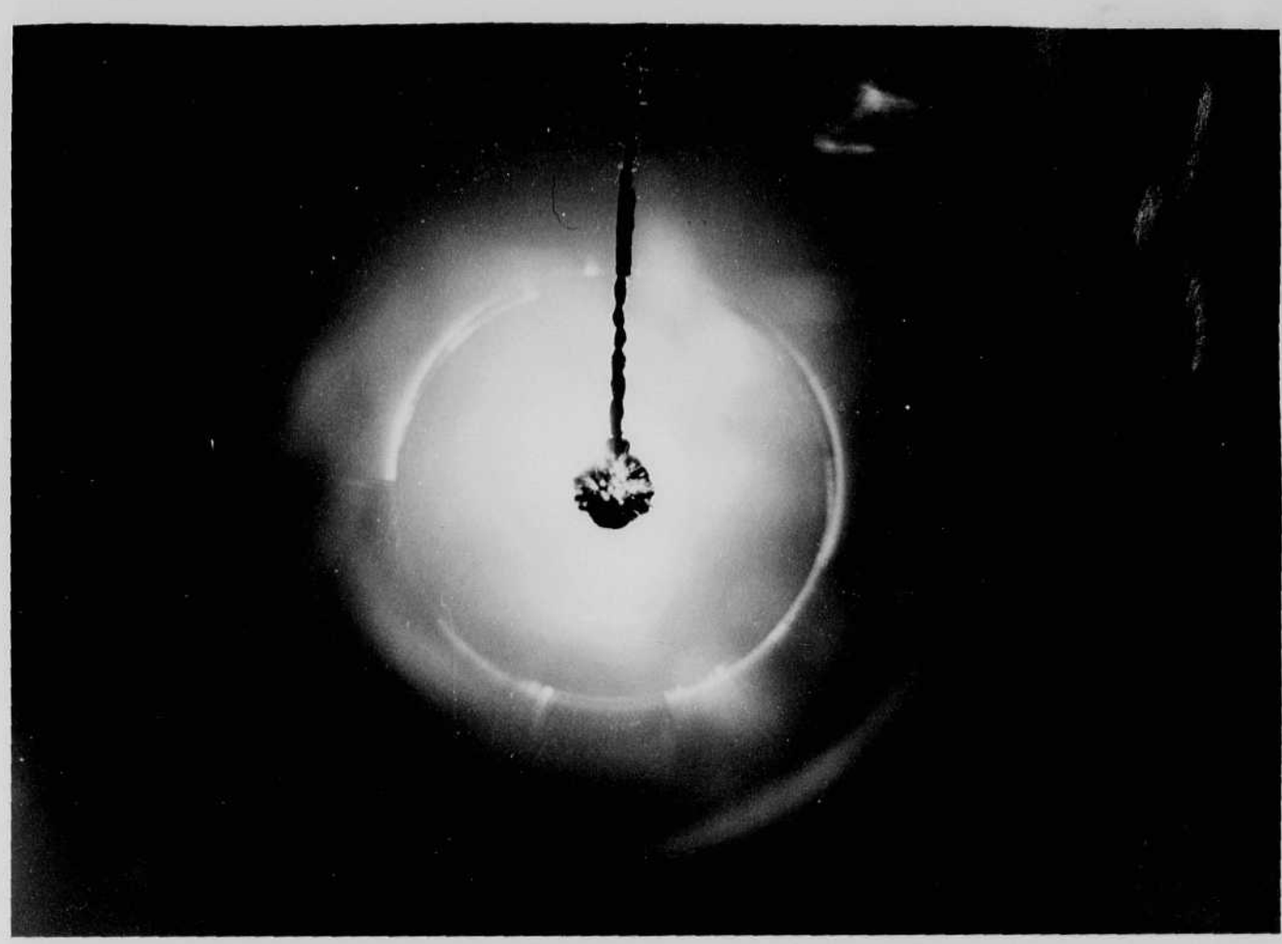


Sketch of C.R. Oscillograph taken on 3 element N.E. tube.



Photos taken by Wyckoff at the model Basin. Wash D.C.





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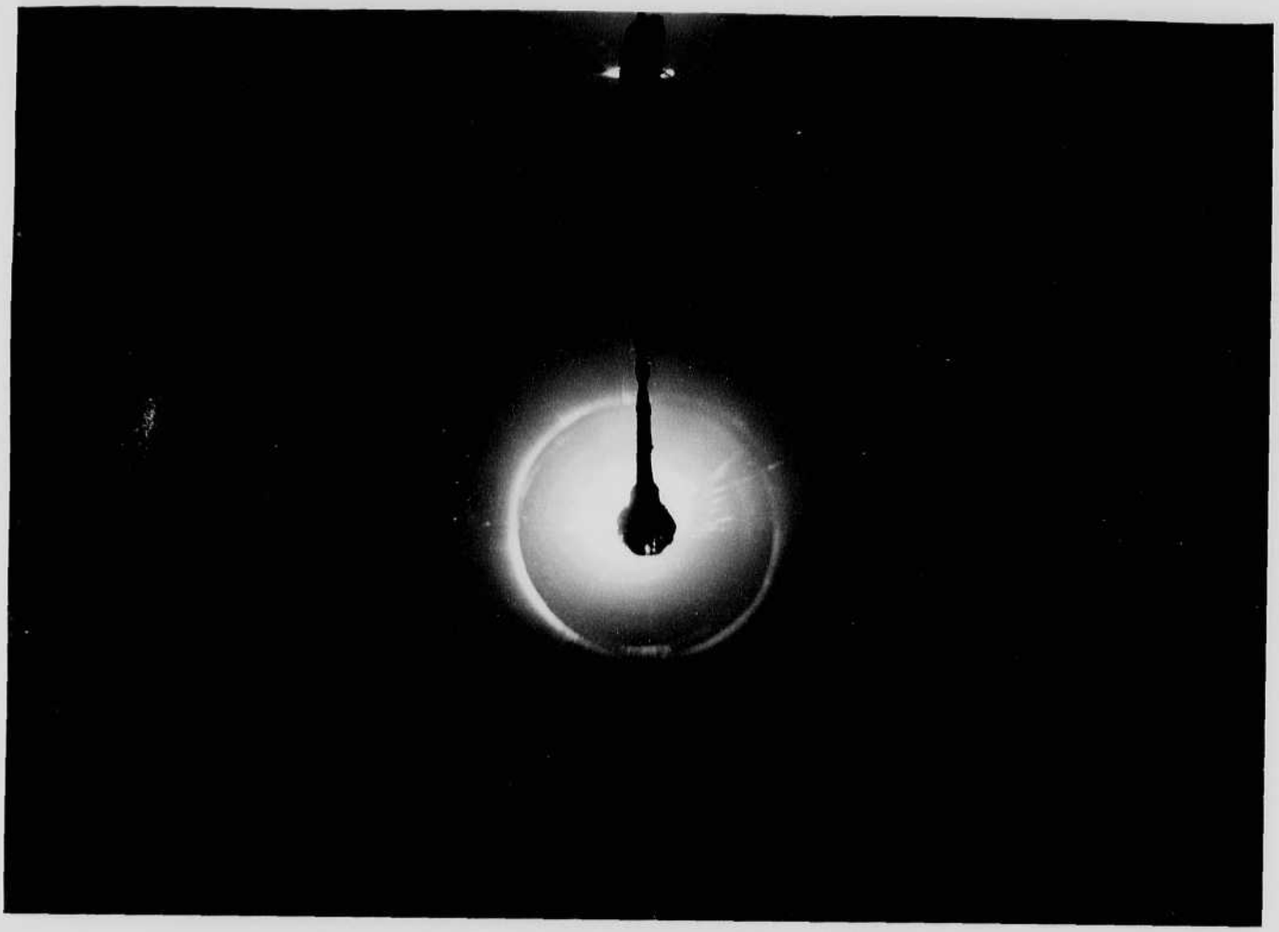
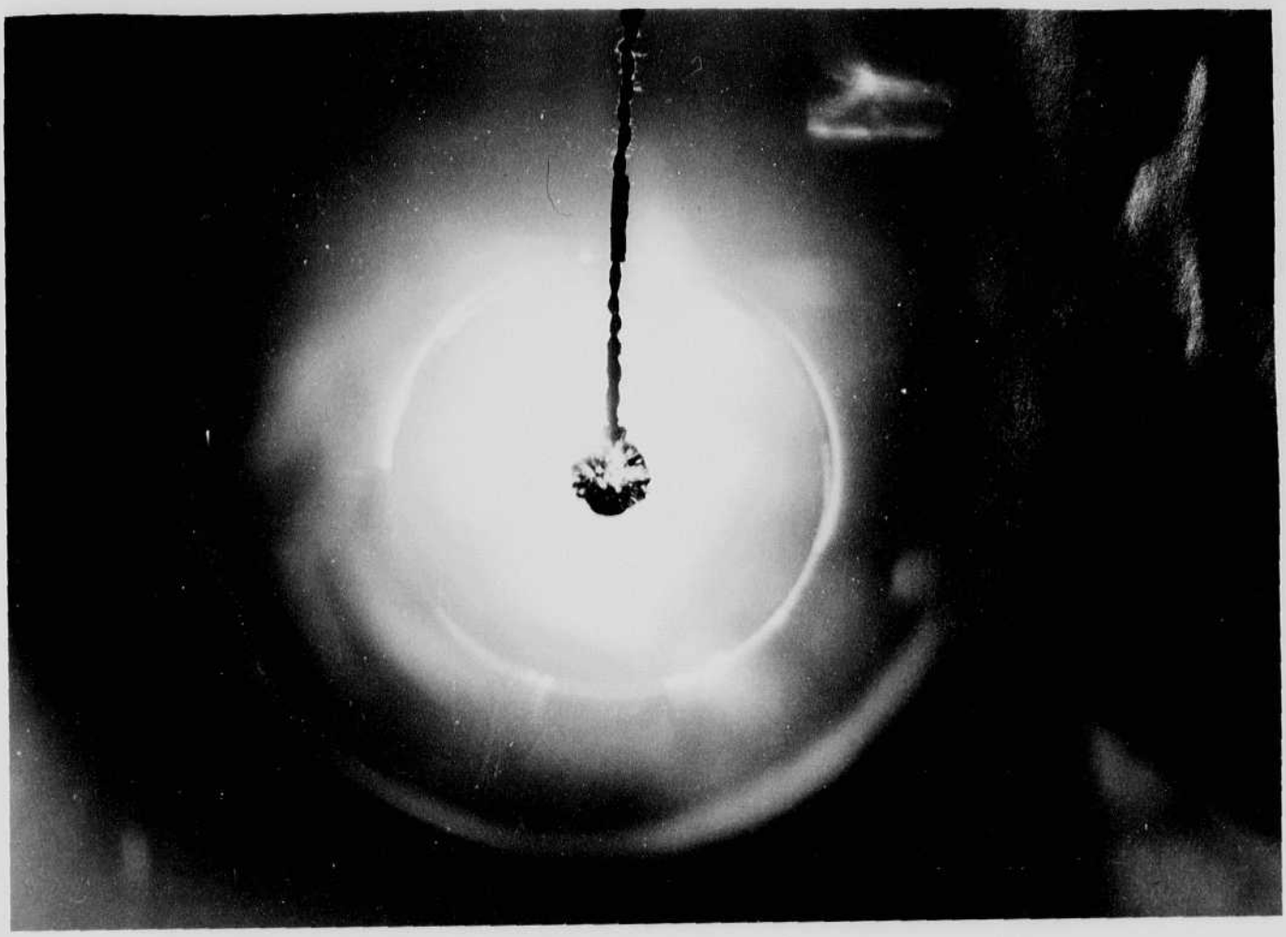
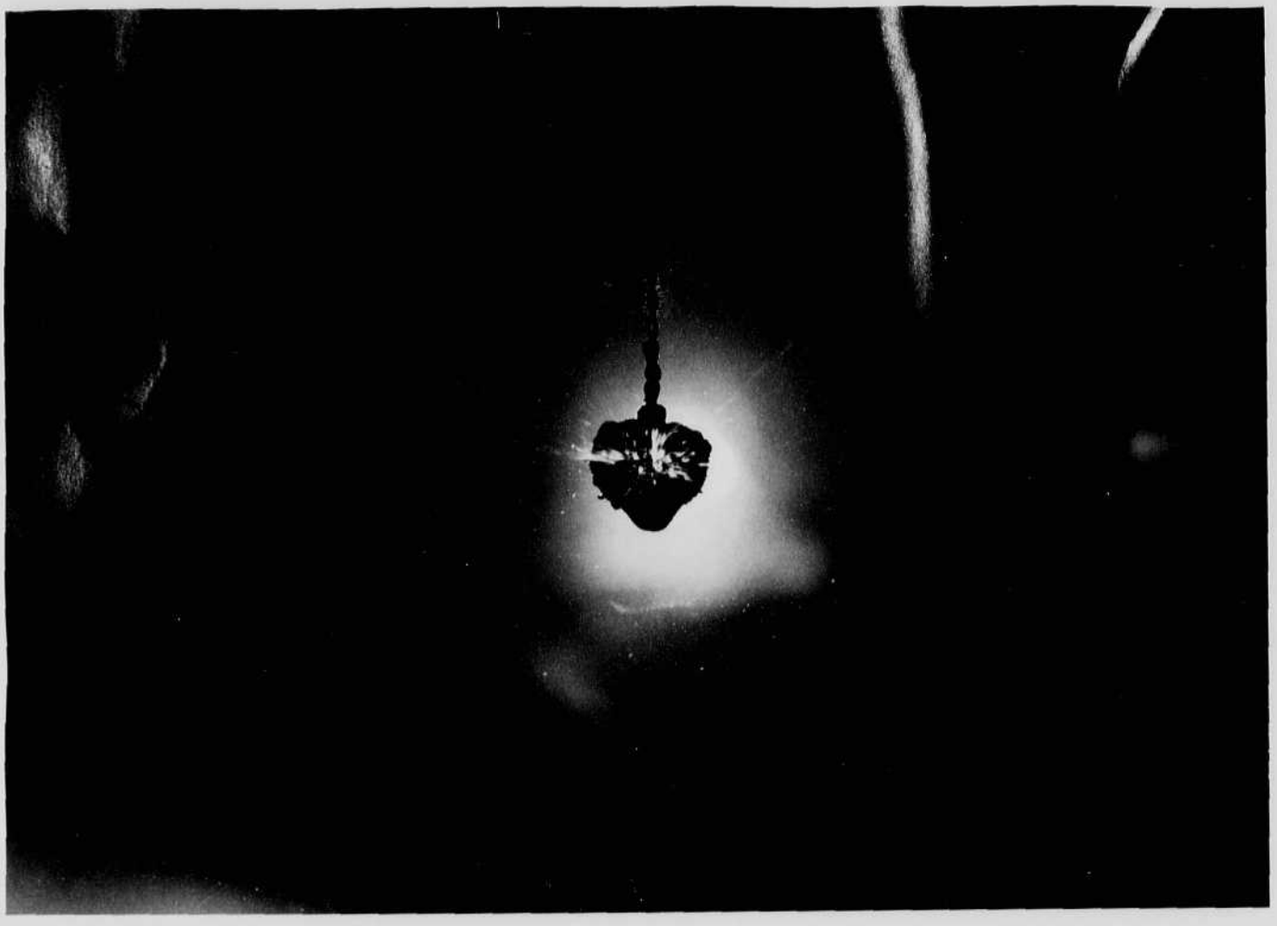
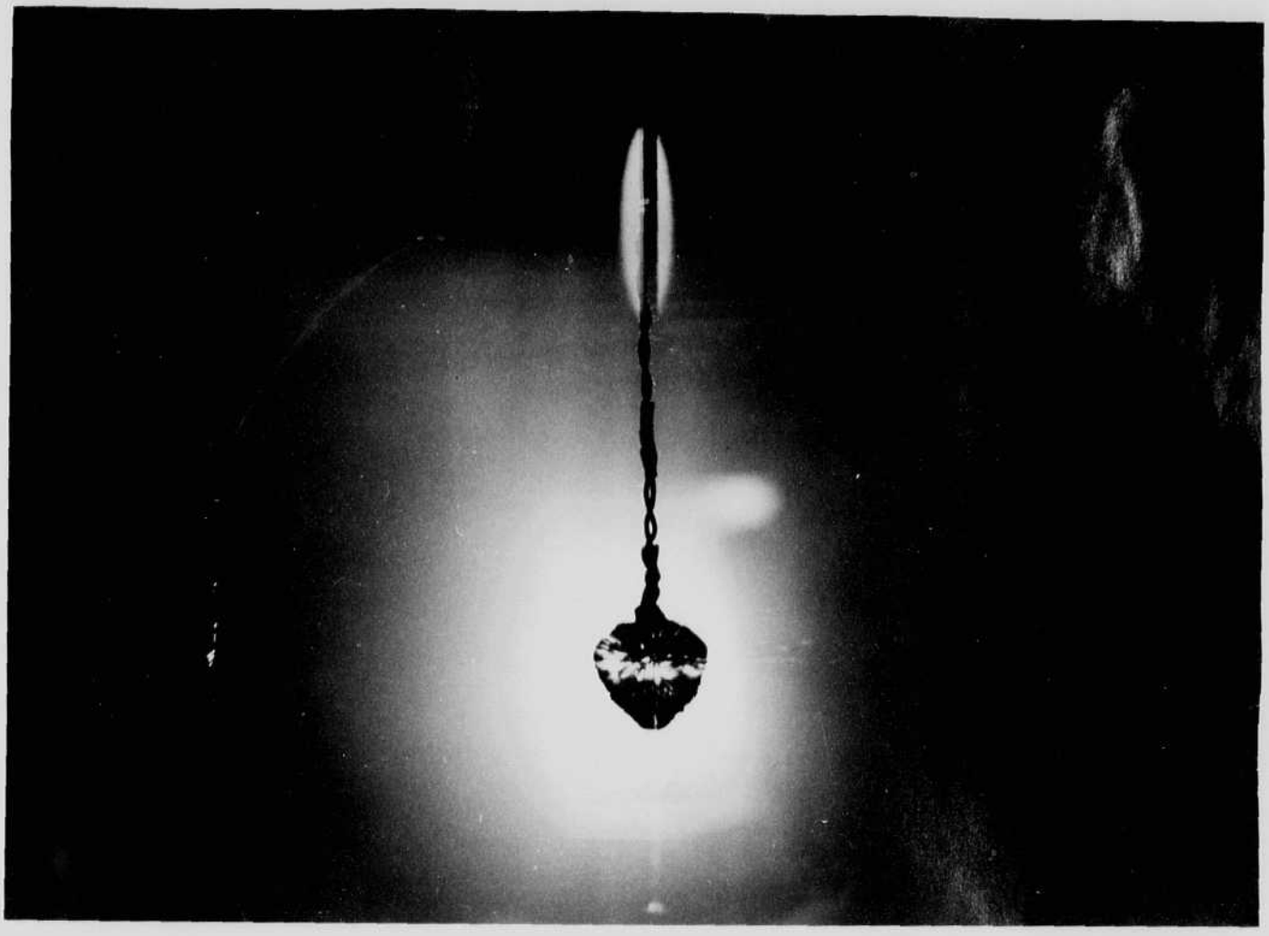








May 17 1943
Harold E. Edgerton

Four tubes were pumped and sent to the Bell Lab. these were of the 621 movie type with a quartz liner.

two were filled with Xenon at 10 cm
" " " " Kr at 5 cm

the tubes would start with an external starter wire with 2000 ± on the main anode-cathode circuit.

I pumped 6 movie lamps yesterday. Filled .5 cm of Hg + 20 cm of Argon. ~~there are~~ for B.R. Co.

On May 10 Wyckoff and I went to Amsterdam and took movies of a knitting machine at the Collins loom Co. for Mr. Kellogg.

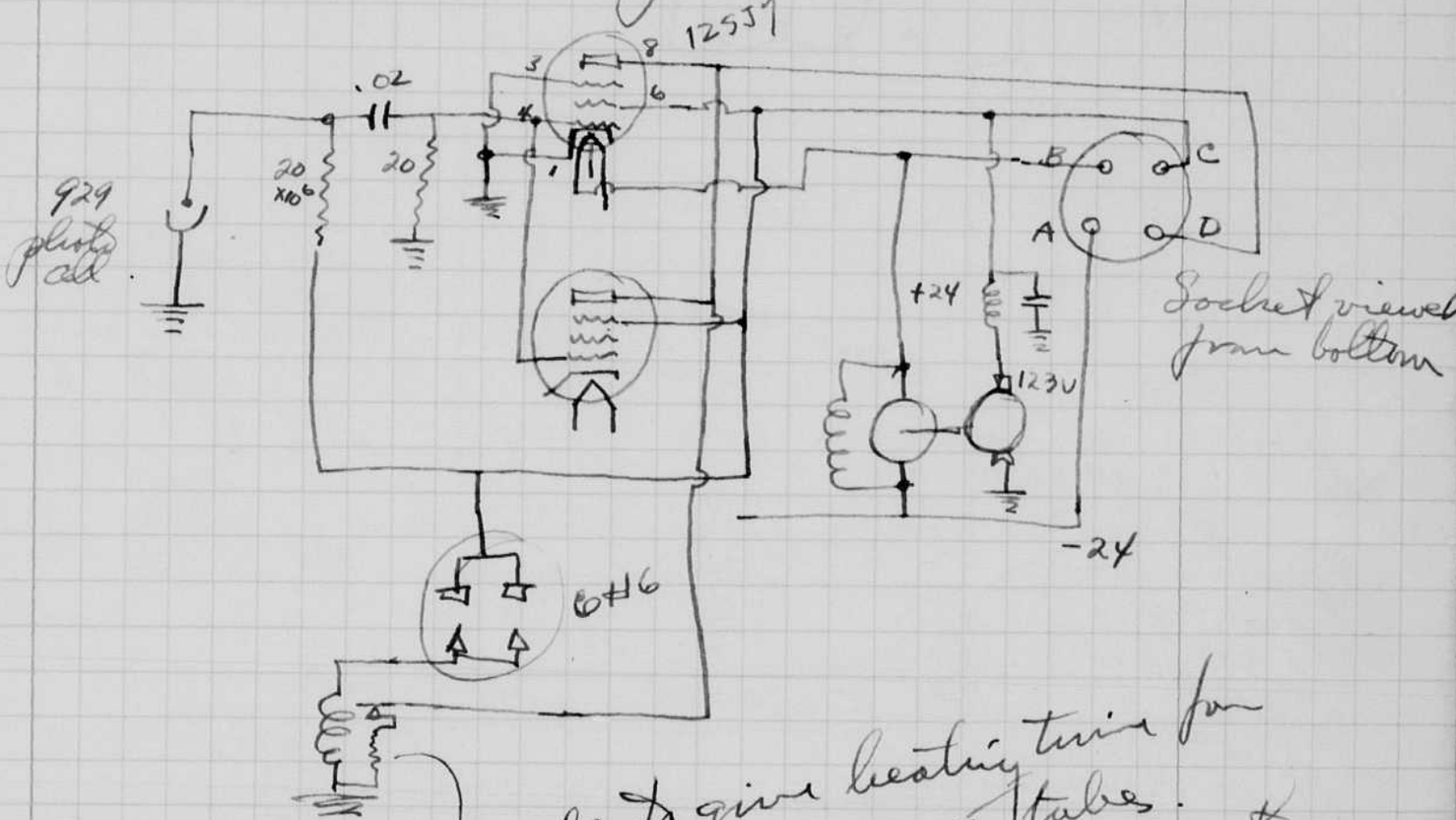
//

May 7 1943

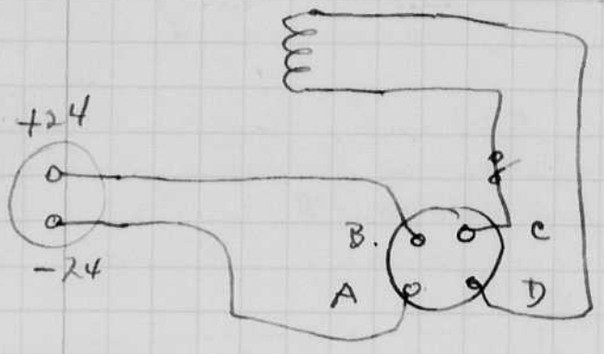
H. E. Edgerton. Sync for K19 camera
Wright field D.K. 6066.

A sync connection was put on a K19 camera f 2.5 lens yesterday. It was put on the ~~cam~~ catch that is released by the trip magnet.

The circuit of the K19 photoelectric unit is given below. This was taken from a handbook dated Jan 10 1942.

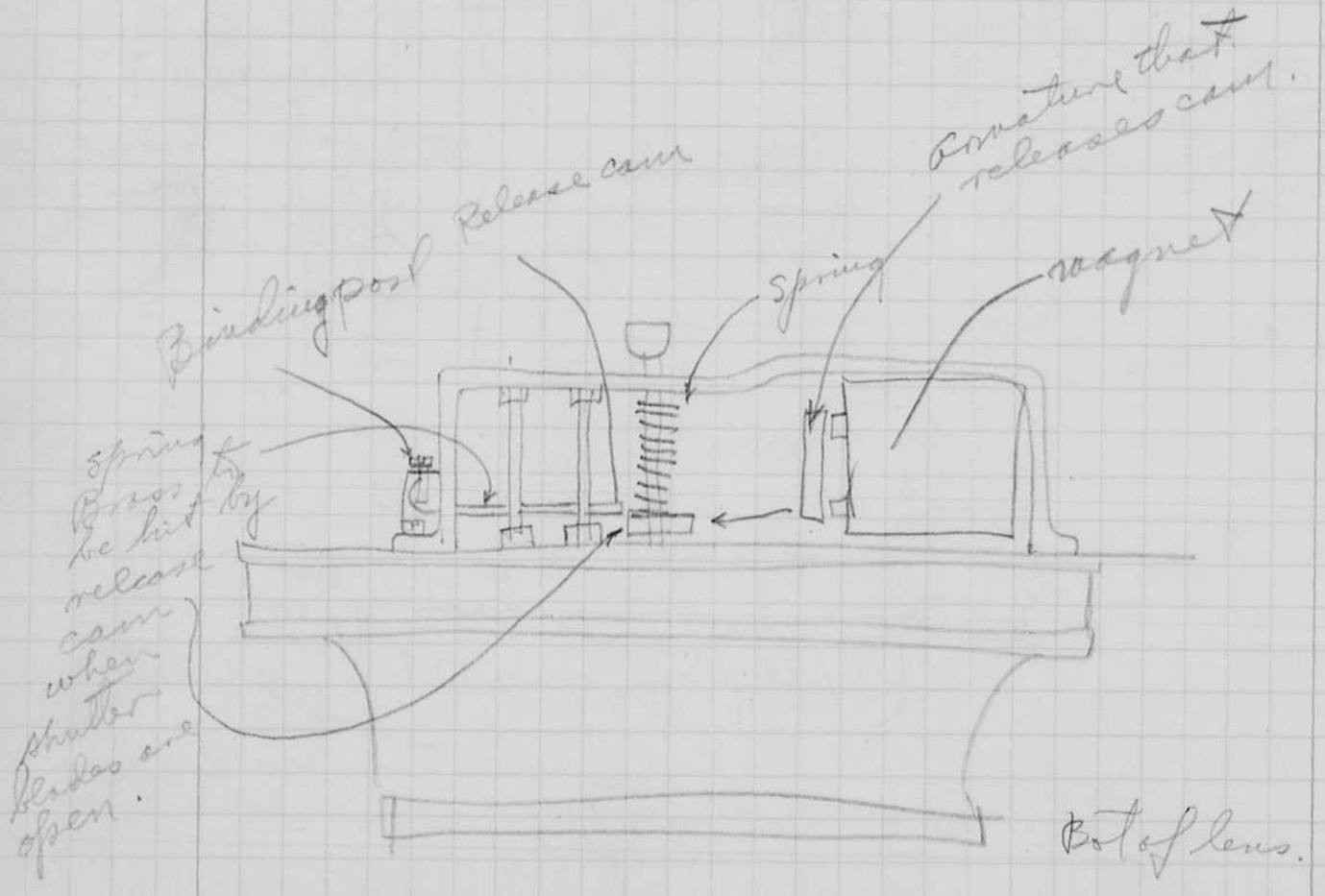


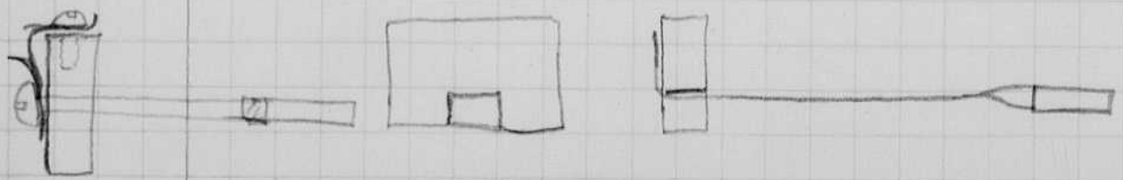
relays give heating time for 12 SJ7 tubes. so camera will not trip.



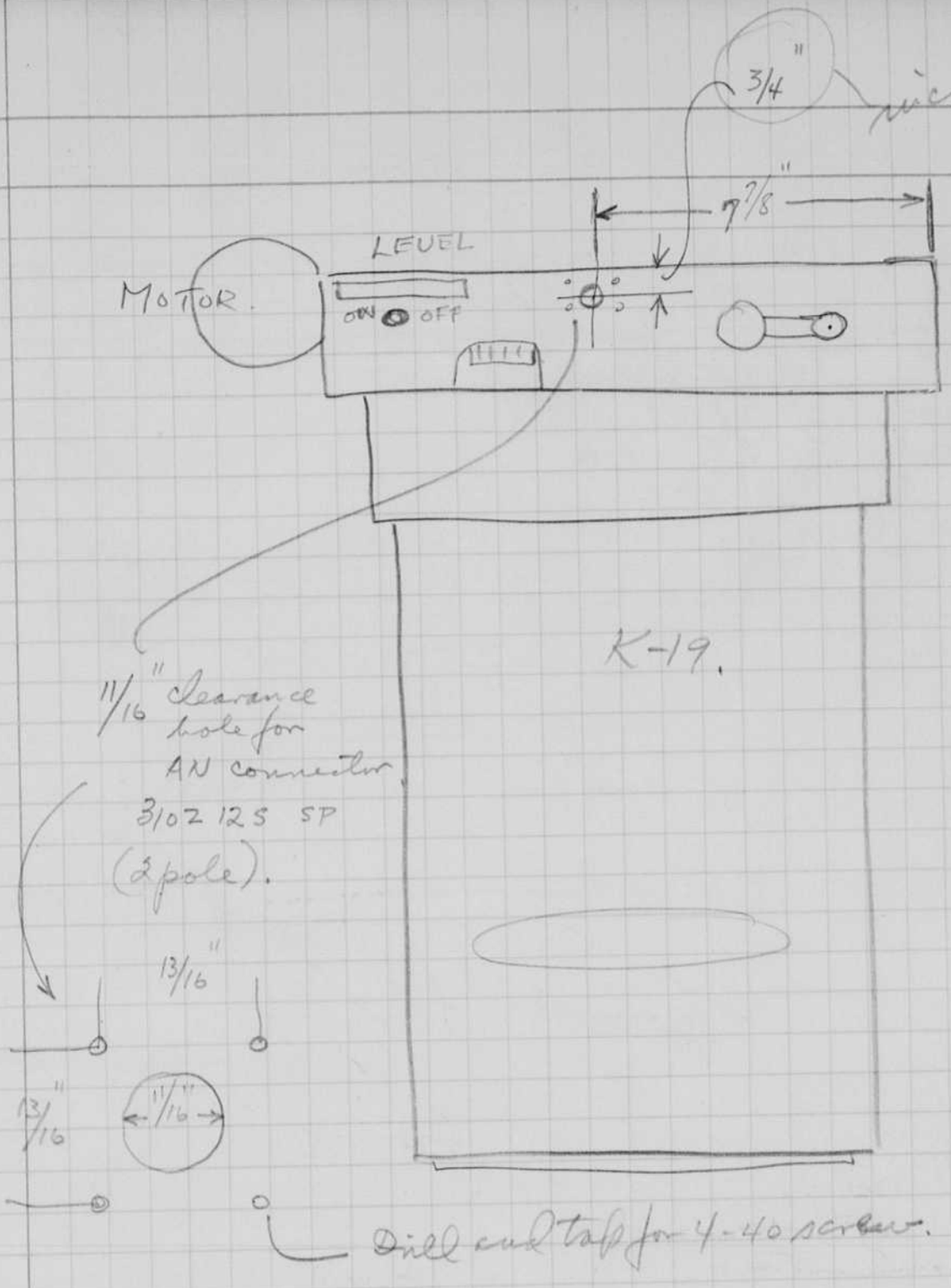
6 ma is operating current (min).

14-16 ma should flow with p.c in dark.



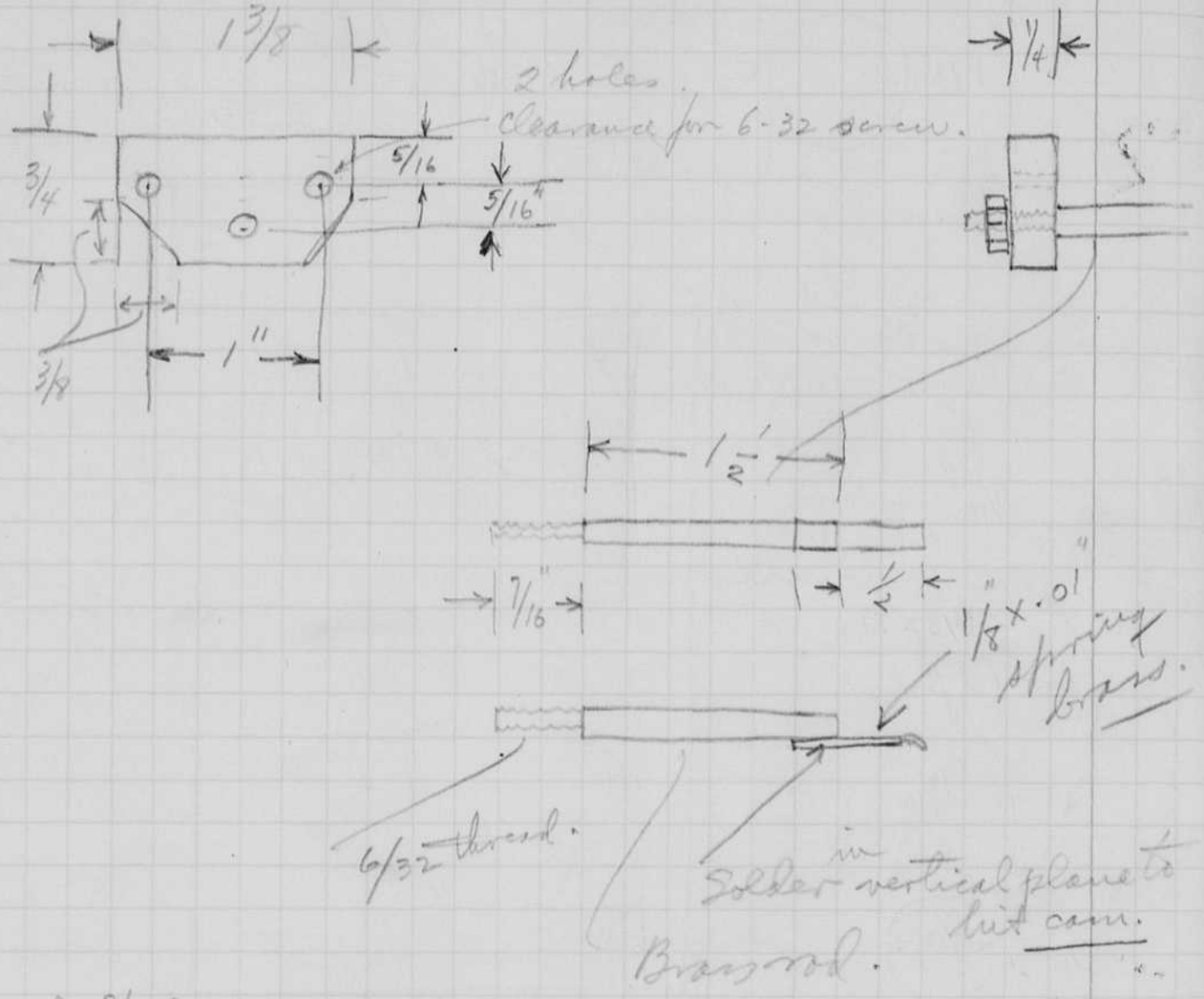


Continued on page 34

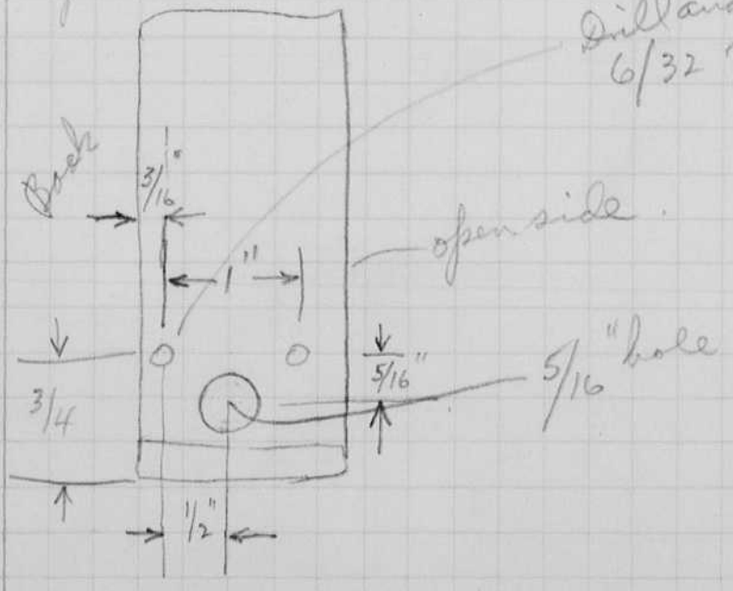

3/4"
increase to 7/8"
7 7/8"
LEVEL
MOTOR.
ON
OFF
K-19.
11/16" clearance hole for AN connector 3102 12S SP (2 pole).
13/16"
13/16"
11/16"
Drill and tap for 4-40 screw.

HOLE LAYOUT.

Detail of sync connection for K-19 camera.



Detail of holes in camera part that covers the magnet and controls.



Coils Wrong. 621 - S.R. high speed movie

Lukas-Harold Ind.
Victor Res. Evans.
~~Bendix South Bend.~~ ok Aug 18 1943 [illegible]
Watertown Ars. (one lamp without x)

May 29 1943

Harold E Edgerton.

Returned last night from trip as follows.

May 19. Left for Wright field to repair relay in B 25 flasher.

" 21 Left W.F. for Posey field. Fort Bragg N.C.

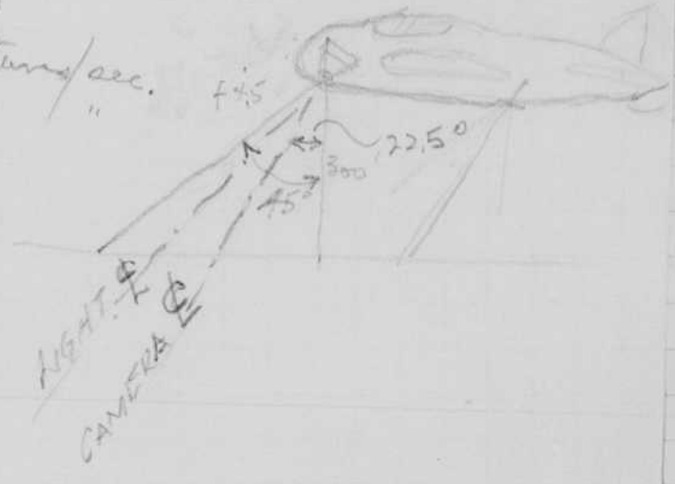
26 Left Posey for Langley

27. Morning at Norfolk with Wyckoff.

28. Aberdeen in morning. N.Y. in aft.

From observations at Pope Field
May 20th

Definition sufficient to find a person on the film or enlargement.
300-600 ft distance max. desirable. Day or night operation.
Dusk or dawn operation particularly useful.
oblique operation desirable so plane can dodge.
Machine-gun type operation of camera by pilot.
Pilot observation of target important.
Wide angle lens on camera?
Overlaps at 300 ft useful 225 ft/sec.
aperture control. 60×60 / 300 = 1.2 pictures/sec
Flash (Dark) f4.5 (Cloudy) f8 (Sun) f16
shutter speed 1/50 sec.
Counter with reset on control panel.
Flash button.
Continuously moving film 2 pictures/sec.
" " "



Film lavier sensitized film.

Major Borden pilot
Capt Kenyon
Lt Warren
Lt. Wade copilot
Mr. Brunner,

June 4 1943

Harold E. Edgerton

Conf with Rice re flap lamps and strobe beacon this morning.

The DIC 6066 unit is almost done. Tomorrow Fred and I go to Chicopee with the M.G. set and 2 condenser banks for fitting to a B-24.

Baisley was scheduled to come June 7. I called him last night calling it off for a week so that

2.5 f 650 1/1000

DATA ON FLASH UNITS

DEVICE	WEIGHT LBS.	MFG.	TUBE	MF. C	VOLTS V	WATT SEC.	INTERVAL SEC,	POWER KW	DISTANCE* FEET	MAPPING INTERVAL 300 mph 60% overlap 48° coverage	POWER FOR STRIP MAP	FLASH DURATION MICRO-SEC.
Strobotac		G.R.Co.	Strobotron 631	1 3	300 300	0.045 0.135	.041 .0167					
Strobolux		G.R.Co.	Strobolux 648	14	800	4.47	.01					
Microflash		G.R.Co.	Microflash 509	0.33	7000	8.1	60					2
Kodatron Portable		E.K.Co.	FT 15	28	2000	55	10	.0055				150
Kodatron		E.K.Co.	Kodatron 2	112	2000	224	10	.022	333 1000	.447 1.35		200
Sea Search	135	M.I.T.	FT 16	56	3500	342	0.33	1.050	416 1250	.565 1.70	0.65 0.20	100
B-25	1200	M.I.T.	FT 11	2000	2000	8000	7	1.140	2000 6000	2.72 8.14	2.95 .98	10,000
A-20	~~650~~ 515	M.I.T.	FT ~~12~~ 17	400	4000	3200	~~1.5~~ 1.1	2.130	1266 3800	1.72 5.16	1.86 .62	1,000
B-24	4000	M.I.T.	FT ~~12~~ 17	4000	4000	32000	6	5.320	4000 12000	5.40 16.20	5.92 1.98	5,000

* Based upon tests at Wright Field with B-25 unit with f 2.5 lens XXX film.
Maximum distance gives thin, but useful negative.

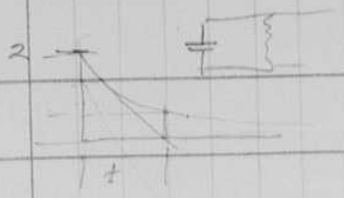
June 11 1943

Harold E Edgerton.

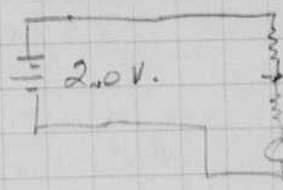
Tested B24 unit with Fred last night. Runs ok with 5. sec charging time. 2 lamps 3500 mf 3900 volts. Flash tubes No. 17.

Talbot's dam Cambridge

$e = E\,\varepsilon^{-t/RC}$ dec. $\quad t = RC$ $\quad e < \frac{E}{2.72} = .365$



$RC =$ seconds $\quad R = 20{,}000 \times 2.5 = 50{,}000$ ohms. (ohms/volt)



2.0 volts
1.48 volts

$$R\left(\frac{2}{R+18500}\right) = 1.48$$

$$2R = 1.48R + 1.48 \times 18{,}500$$

$$.52R = 1.48 \times 18500$$

$$R = \frac{1.48 \times 18500}{.52} = 52{,}700$$ ✓

Upper No 1. $C = \frac{}{.050{,}000} = 560 \times 10^{-6}$ farads.

Upper No 2 RC $\begin{matrix} 34 \\ 36 \end{matrix}\Big\}$ $C = \frac{35}{50{,}000} = 700$ farads. $700/2 = 58$ per cent.

Lower No 3 $\frac{38}{50{,}000}$ $\frac{39}{}$

No 4 $\frac{35}{50{,}000}$.

Multiply above by $\left(\frac{52.5}{35}\right)$ for capacity.

Up 4. $\frac{77.0}{50{,}000} = 1540 \times 10^{-6}$ farads.

June 11 1943

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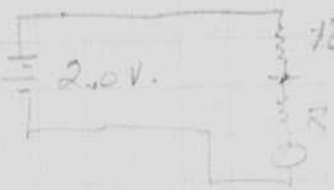
Talbot's room Cambridge

$e = E\,\varepsilon^{-t/RC}$ sec. $\qquad t = RC \quad e = \frac{E}{2.73} = .365$

$RC =$ seconds $\quad R = 20{,}000 \times 2.5 = \underline{\underline{50{,}000}}$ ohms. (per farad)



2.0 volts
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Paper No. 1. $\quad C = \frac{\quad}{.050{,}000} = 560 \times 10^{-6}$ farads.

Paper No. 2 $\quad$ 34, 36 $\quad C = \frac{35}{50{,}000} = 700$ [illegible] $700/2$ [illegible]

Paper No. 3 $\quad \frac{38}{50{,}000}$ 39

No. 4 $\quad$ 35

multiply above by $\frac{52.5}{50}$ for capacities.

Up 4. $\quad \frac{77.0}{50{,}000} = 1540 \times 10^{-6}$ farads.

June 13 1913

Capacity meas by ac.

Za 17 Bank. 10.9 volts.
3.57 amps 60 cycle.

$c = \frac{I}{\omega E} = 892.$ mf.

sheets. 22 volts, 7.2 amps. 870 mf.

Sta 20 22 volt. 7.7 amps. 929

Sta 17 21.9 volts, 6.95 amps 839

Sta 15 21.9 volts 9.0 amps 848.

3486 mf total.

$\frac{3486}{112} = 31.1$

x 4 = 124.4

June 14 1943
H.E. Edgerton

Dunn.

10⁵ 10⁶ 10⁶

Mr. Dunn of Spence Chemical Co brought in 7 mm Jarter camera.

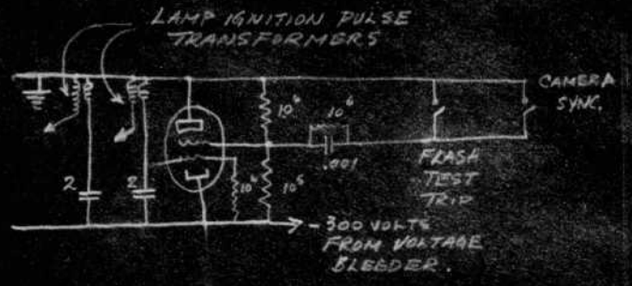
30 R.P.S. Synch motor for timing.
Super X Eastman film

Shot no.	aperture	filter	Subject.	Running motor volts.	comments.
1a	16	none	21'	130V	3300 watts. 12" lamp to grayscale.
1b	16	X100	21'	"	" "
2a	16	X1000	21	"	3900 " " "
no exp. b	16	X100 X1000	21	"	
3a	16	none	7 or 8'	130	3900 8" lamp to grayscale.
b	16	X100	"	"	" "
4a	16	X 1000	"	"	" "
no exp b	16	X1000 X100	"	"	" "
5a	16	none	3¼'	"	
b	16	X100	"		
6a	16	1000	"		
n.g. b	16	X1000 X100	"		
n.g. 7.a	16	X1000	6"		
b	16	1000 100	6"		

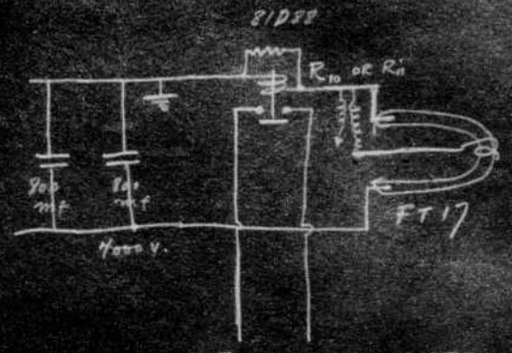
Baisley, Border, Kenyon, Becker arrived at 3½ from Wright field in a B24 no 051. for delivery of 6066. DIC unit.

Diagram of D.I.C. 6066

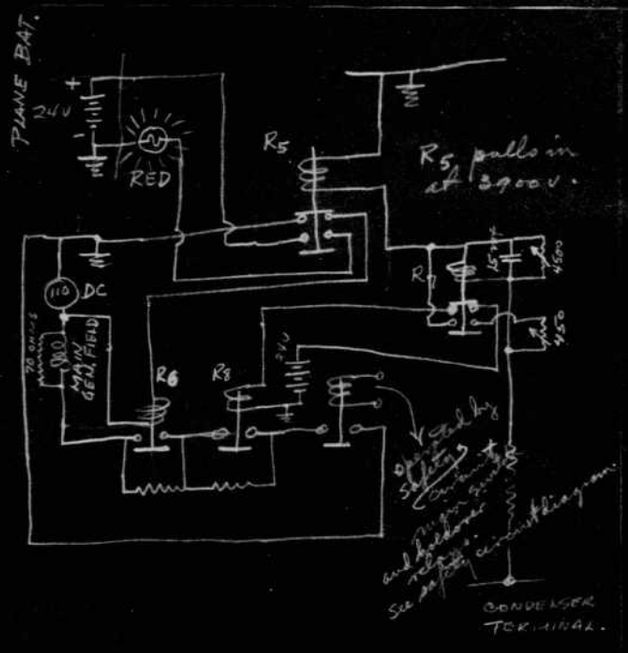
June 21 1943.



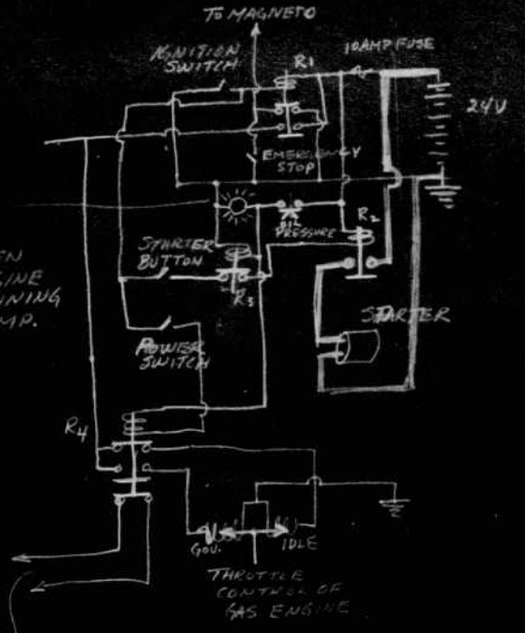
LAMP FIRING AND CAMERA SYNCHRONIZING CIRCUITS



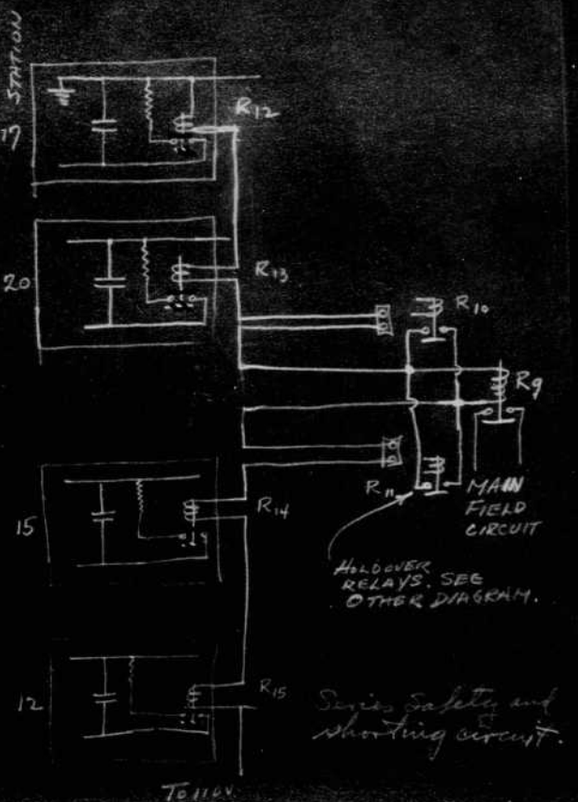
HOLDER RELAY AND FLASHLAMP CIRCUIT



Main Field Regulating and control circuits.



Engine control circuits.



Series Safety and shorting circuit.

~~July~~ June. 21, 1943

Harold E. Edgerton.

Returned yesterday morning from Wright field. Left Westover with D.C. 6066 on June 17 for W.F. Then took photo flight at 9pm from W.F. up to 12,000 ft. f2.5 lens. 3500 mf at 3500 volts. Photos at 6000 ft were o.k. but camera angle was not the most favorable. also the haze filter was not used.

June 18 went to Indiana polis to see Rhodes, Joe Hood, of Mallory about condensers. Set 6 defectives and discussed the purchase of new improved condenser. Rhodes has a new design with series sections each of seven layers of paper, to give 75 mf at 4000 volts.

Hood is going to go into the design of electrolytics ~~etc~~ to complete.

W.A. Bank 12 860
840
1700
2
3400 condensers.
[illegible] G. Set

12800 ft	1018	
175	158	
5800	10.33	170
20p +	10.36	
Engine temp 150		
at 5800 ft.		

Reflector curves. 2R
3 Wiring diagrams.

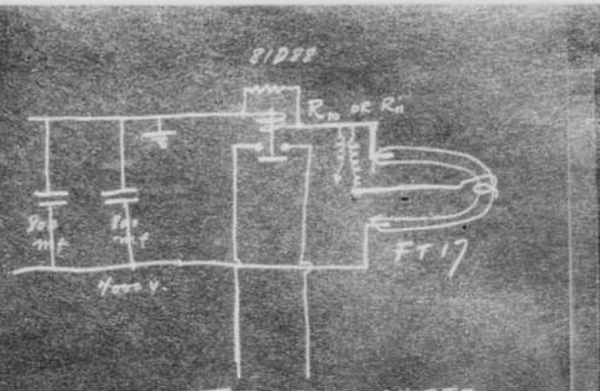
sea level		
6800	9.45 time	il Weight.
6900	7800	
7000	8000	
7000	8000	
7000	8100	
7100	8200	
7200	8200	
7300	8300	
7200	8300	
	8400	
7400	8400	
7500	8500	
7500	8500	
7600	8600	
7700	8800	955
7800	9 pict	
7800	1002 pm	
7800		8800
7800		

← notes made during flight over Dayton on June 17.
Baisley pilot
Border copilot.

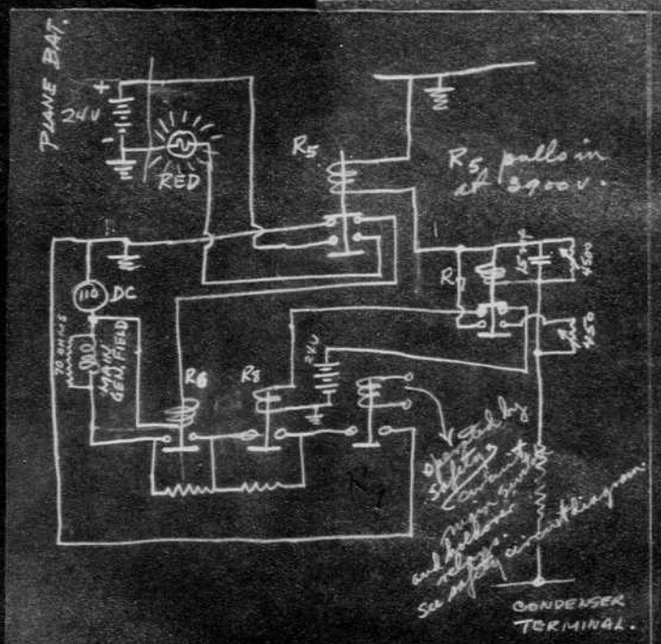
Designation of D/C 6066

June 21 1943.

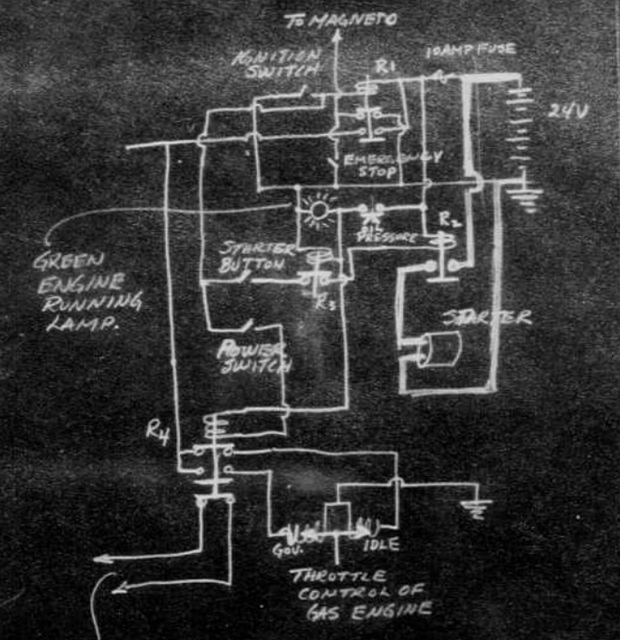
LAMP FIRING AND CAMERA SYNCHRONIZING CIRCUITS



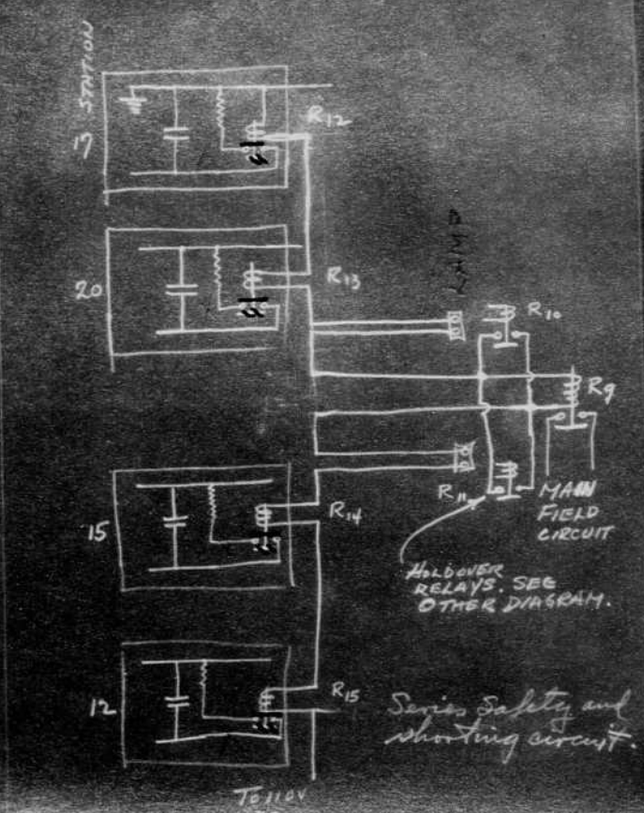
HOLDOVER RELAY AND FLASHLAMP CIRCUIT



Main Field Regulating and control circuits.



Engine control circuits.



~~July~~ June. 21, 1943

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Hood is going to go into the design of electrolytic, etc to compete.

W.A. Bank 12 860
840
1700
2
3400 condensers.
1.4. Set
il Weight.

1280 ft 1018
175 154
5800 10.33 170
20p + 10.30
Engine temp 150
at 5800 ft.

6800 1.45 time
6900 7800
7000 8000
7000 8000
7000 8100
7100 8200
7200 8200
7300 8300
7200 8500
7400 8400
7450 8400
7500 8500
7500 8500
7600 8600
7600 8800 955
9 pict
7800 1002 pm
7800 8800
7800

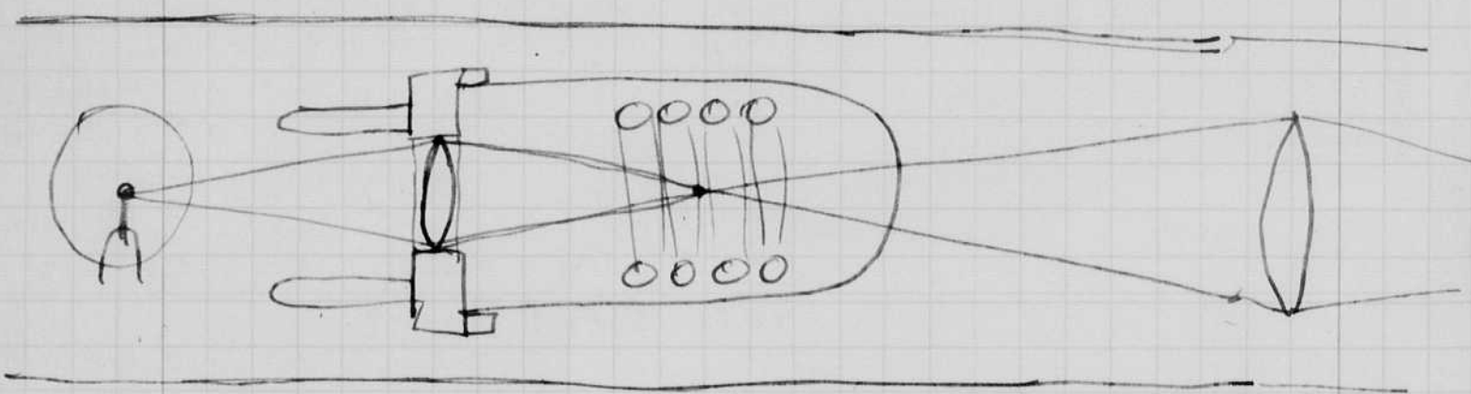
= notes made during flight over Dayton on June 17.
Baisley pilot
Borden copilot.

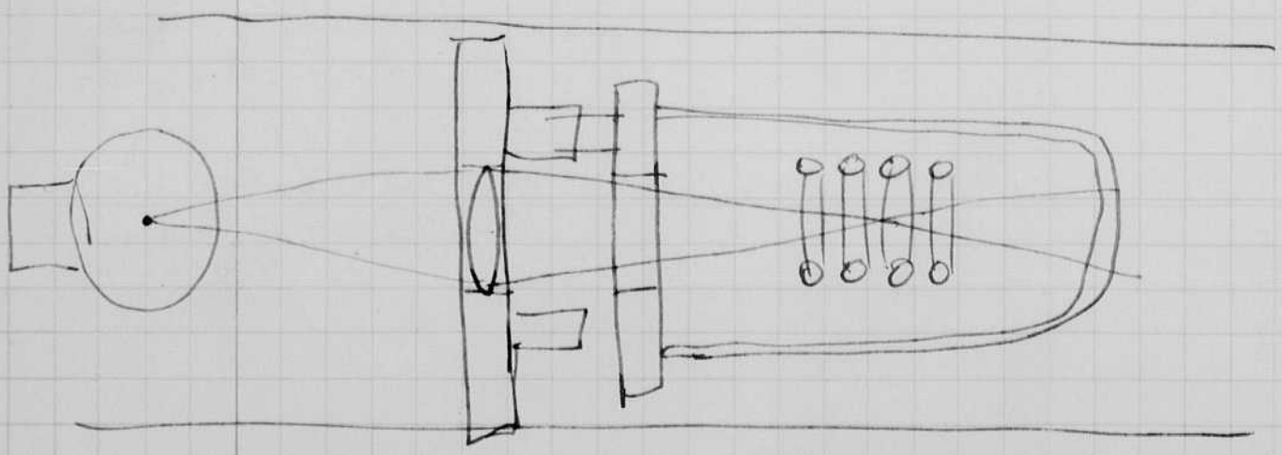
June 23 1943
H.E. Edgerton

Capt. Williamson called yesterday from Washington about the sea search flash units (3) that are now being made for Wright field. It said about one month after conf with Giniger. These are being made by Raytheon.

Lt. Swanson from W.F. (Wyman outfit) called with third tube, $Zr O_2$ in ventilated bases with octal base. I am sending Wyman a No 16 and a No 3 for test (only).

Sent a 1A tube to Sander at Fairchild yesterday to replace one lost in the explosion.





Fort Bragg Pope field North Carolina

Capt A.S. Kenyon
of Wright Field.

B-25 plane with
4000 mf 2000 v flash equipment.

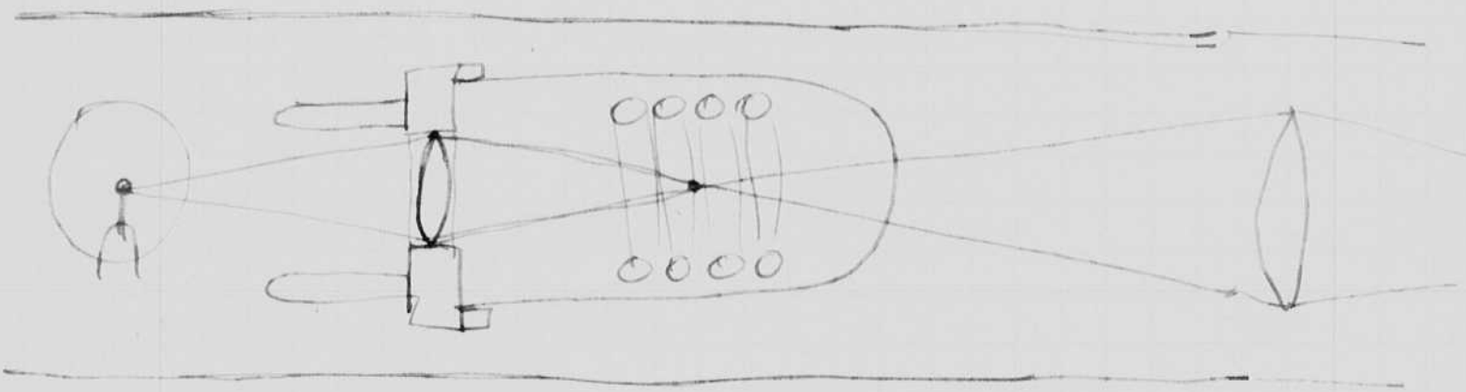
47

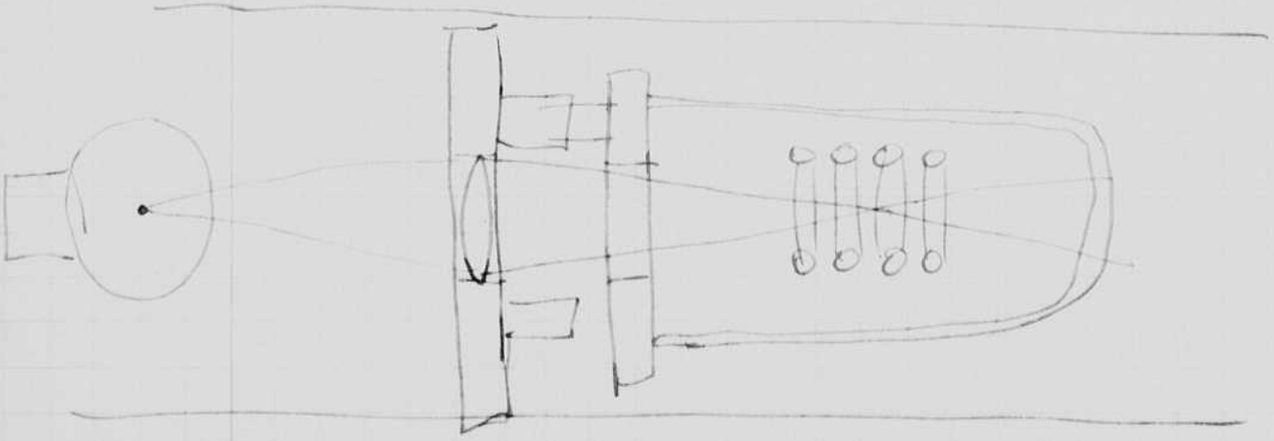
June 23 1943
K.B. Edgerton

Capt. Williamson called yesterday from Washington about the oscillator flash units (3) that are now being made for Wright Field. He said about one month after conf with Grieg. These are being made by Raytheon.

Lt. Swanson from W.F. (Myran outfit) called with tube, $2iO_2$ in ventilated base, with octal base. I am sending Myran a No 16 and a No 3, for test (only).

Sent a 1P tube to Sander at Fairchild yesterday to replace one lost in the express.





Capt A.S. Kenyon
of Wright Field.

B-25 plane with
4000 mf 2000 v flash equipment.

Fort Bragg Pope field North Carolina

47

Efficiency calc.

#14 tube.
28 mf 2000 volts.

energy = $\frac{CE^2}{2}$ watt sec = $\frac{28 \cdot 2000^2 \times 10^{-6}}{2}$ = 56 watt sec.

Light output = 2900 lumen sec.

$\frac{\text{Lumen sec}}{\text{Watt sec}} = \frac{2900}{56} = 51.9$ lumens / watt.

From J.S.M.P. June 1943 data for inc. lamps.

2700° color temp	11 lumens/watt.
2990	20 "
3310	30 "

for type C Mazda lamps.

June 24 1942
Ft Monmouth

Gap.

Sig Corps unit.

Without lamps.	5½ turns x .05	.275"	1900 v.
With lamps, 5c.	2 turns	.1 "	Start & keep arcing
	2½ turns	.125	

M.I.T. Sample.

With lamps.	2½ turns	.125	Same.

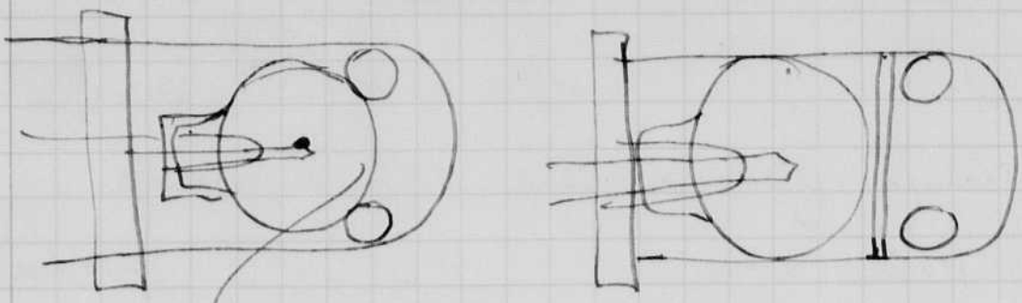
The signal corps ~~Radation~~ above has one lamp that misses when heated by the focus lamp. I have been trying to find out the trouble.

Fred Barstow called from Wright field to report that operation of the B-24 unit was o.k. He asked if damage would result from flash over of the commutator. I told him no - to go ahead. Also to raise the voltage from 3500 to 3800.

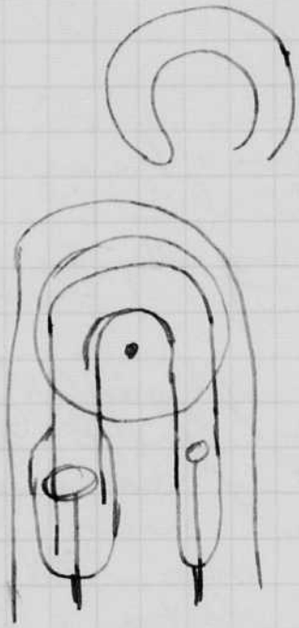
June 25. R.H. Spencer Room 4-C-129 Pentagon Bldg Washington D.C. called today about training of men for experimental work. Points for W.F.

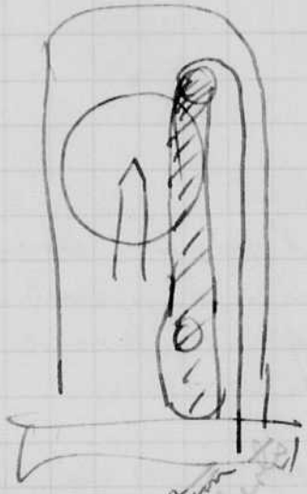
I suggested 2 or 3 men for a month assignment - possibly it should be more.

Tons lamps - flash comb.



Inside frost





Jack Reilly
Bill Robertson
Mac Robertson

Fred Burston
Capt. Al Kenyon
Herb. Brier
Hank Beeker

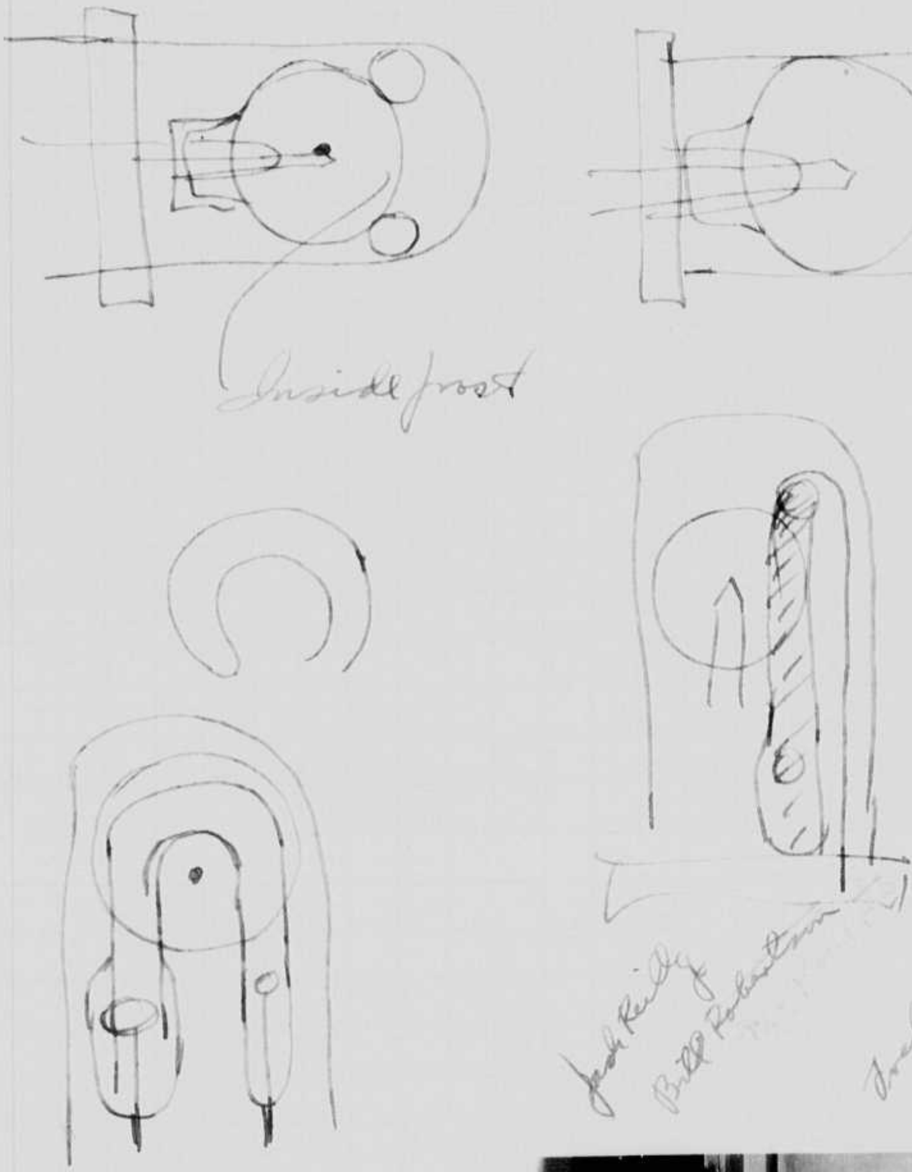
B24 (June 14 1943.)
with DIC 6066
flasher at Boston
airport.

Fred Barstow
M. L. Sandell.

Mr. Gunn
of Spencer
Thermo with
W.E. Camera
8000 8 m.m.

Set up for movies
of electflash
lamps DIC 6066
B-24 unit.

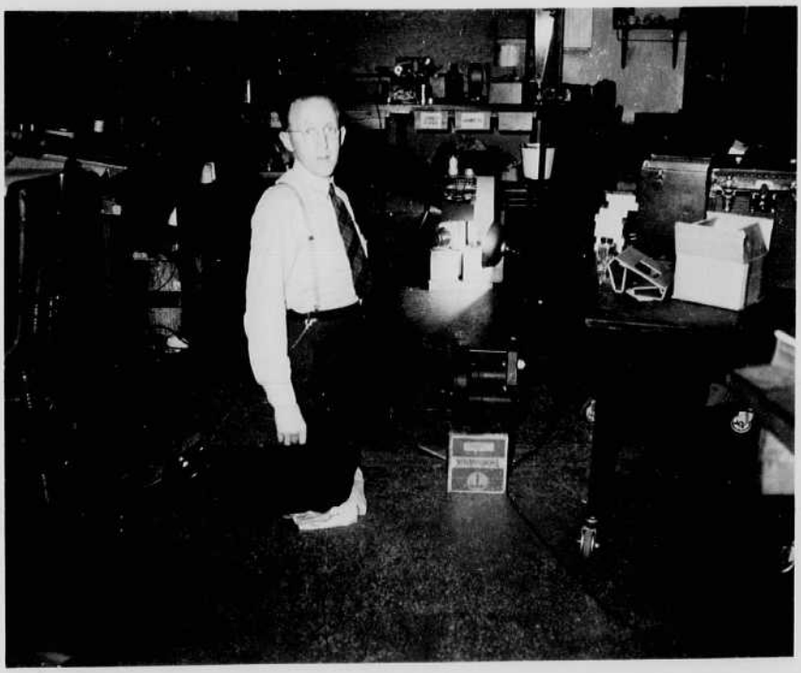
Focus lamps - flash comb.



Jack Reilly
Bill Robertson
Fred Bornstein
Capt Al Kenyon
Herb. Grier
Hank Becker

B24 (June 14 1943.)
with DIC 6066
flasher at Boston
airport.

Fred Barstow
M.L. Sandell.



Mr. Gunn
of Spencer
Thermo with
W.E. Camera
8500 8 m.m.

Set up for movies
of test flash
lamps DIC 6066
B-24 unit.

June 30, 1943

Harold E Edgerton.

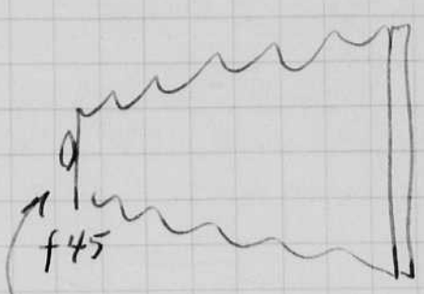
new type micro flash tube gave intermittent self flashes after 500 - 700 flashes. this design was drawn up today and is to be sent to Sylvania for mfg.

Made 10 movie lamps 621 P1. today. Baked Bombed in H2 then filled 0.5 cm H2 + 20 cm argon sealed off without running on pump. all ok but 1 which fate fried.?

July 2 1943
Harold E. Edgerton

Set up point source lamp last night for dirpic red test.

12 mf.
3000 volts.



2 1/4 x 3 1/4 plates
Emulsion
232 870
Eastman
type IV-M.
with 88a filter
1½ magnification ?±.

Exposure weak.

are here. Very little spreading.

Ed. Noel from D.E.Co. Cleveland was here yesterday.
I gave him a demonstration of #2 Kods shipping. also showed him the point source lamp above in operation as a self oscillator. Will send a sample for test.

July 1 1943

Pumped movie lamps 621 P+
filled with 0.4 cm H_2 then argon to 2.0 cms.
After baking - tube bombed with vac.
then Hydrogen 3 cm.

New type sealed cathodes work
fine. Anodes heat more than cathode
although longer.

The xenon tubes do not heat
the anodes as much as the argon ones

July 5 1943. - Called Noel Cleveland, about
#16 tubes for Mr. Lynn.

Shockley called from Washington
about sea gauge - says that it is coming
to M.I.T. for adjustment before going
to England.

Testing 5 flashes see page 100
notebook 13 for circuit.

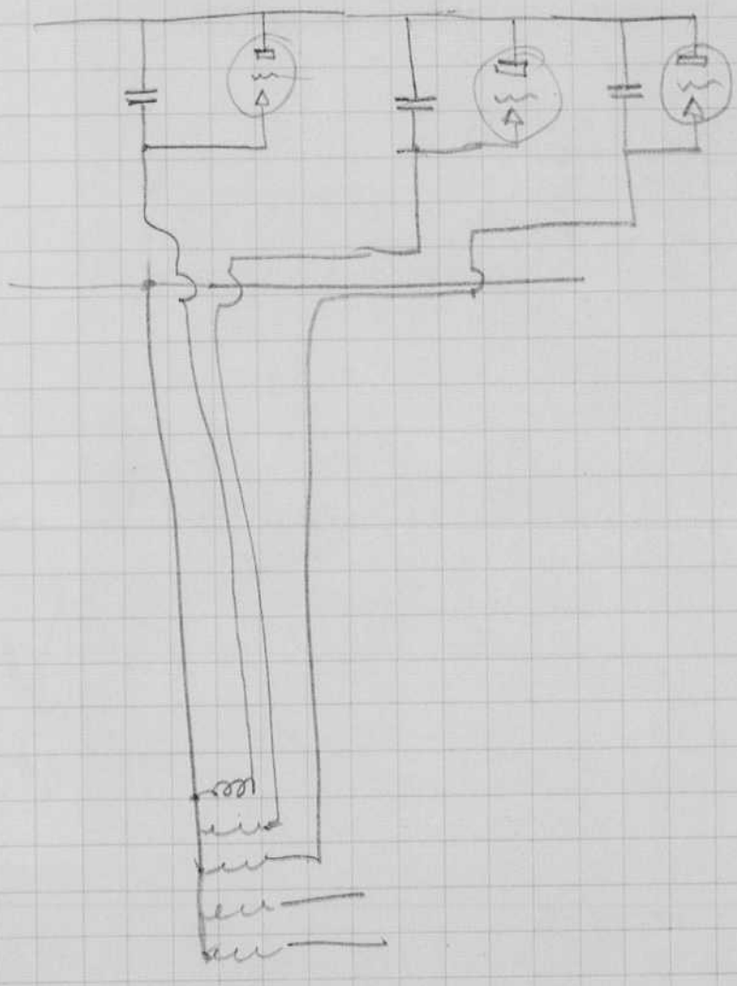
At 7200 rpm 1 rev = $\frac{1}{120}$ sec.

1 div. = $\frac{1}{72} \times \frac{1}{120}$ sec = $\frac{1}{844}$ sec = 118 μs

1 subdiv = $\frac{1}{6} \times \frac{1}{844} = \frac{1}{5064}$ sec.

= 17.7 μs.

Film	Scale	C		
1 film	90	2	7200	f16
2 film	90	1	"	16
3 pafo	90	2	"	4.5
4 pafo	90	1	"	4.5
5 pafo	90	1	"	4.5
6 pafo	45	1	"	4.5
7 film	45	1	3650 no background	f16
8 "	70	1	" " "	f16

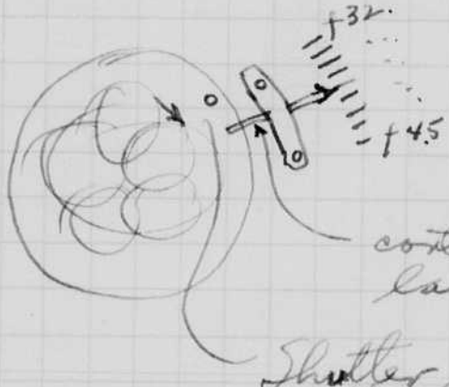


July 7 1943
Harold E Edgerton.

Conf with Richmond K.R. Co and Sandell EK Co. this morning.

Aperature adjustment for electrical flash photography:

It just occurred to me yesterday that the shutter leaves can also be used as a lens diaphram with electrical flash lamps. An adjustable contact is arranged so that the lamps can be flashed at different phases of the operation.



contact to fire lamps.

Shutter leaf operating ring with metal pin for firing lamps.

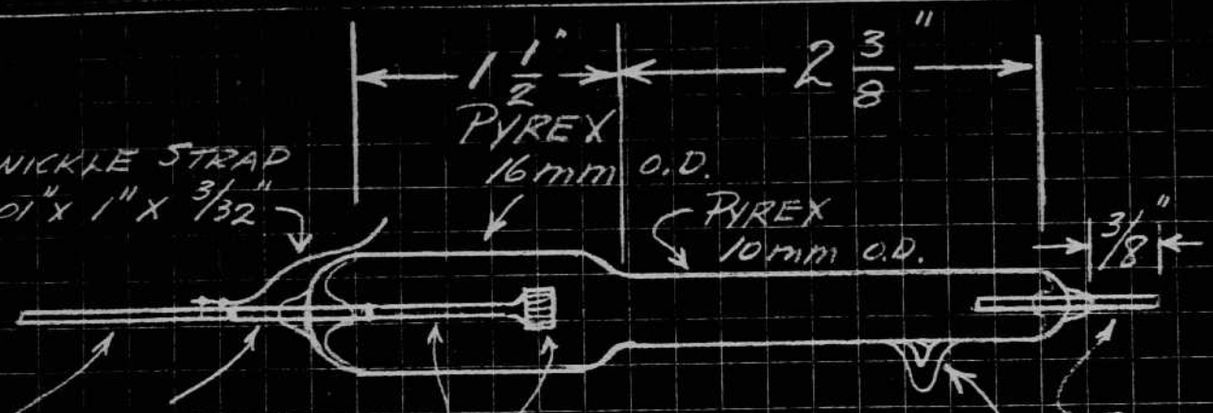
Maynard L. Sandell
July 7, 1943

57

MAT.
FINISH
NO. RQD.

MICROFLASH TUBE GEN. RADIO CO. No. 509.

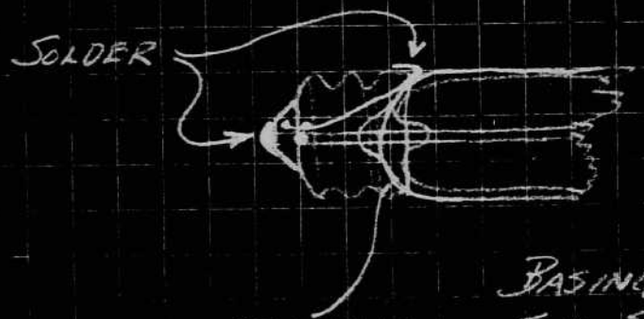
FILE
DATE JUNE 30 1943
SIGN. H. E. EDGERTON



NOTE HEAVY WALL SEAL-OFF.

EXHAUST SCHEDULE

BAKE
BOMBARD
5 mm H_2
ADD ARGON TO
TOTAL PRESSURE
OF 40 cm.



BASING IS SAME AS
FOR STROBOLUX LAMP
G.R. Co No 648-P1

ALL DIMENSIONS IN INCHES — DO NOT SCALE PRINT

EDGERTON, GERMESHAUSEN & GRIER

77 MASS. AVE., CAMBRIDGE, MASS. KIRKLAND 6063

July 7 1943

Harold E Edgerton.

Conf with Richmond D.R. Co and Sandell E.K. Co. this morning.

Aperature adjustment for electrical flash photography.

It just occurred to me yesterday that the shutter-cones cap also may be used as a lens diaphram with ~~non~~ electrical flash lamps. An adjustable contact is arranged so that the lamps are flashed at different phases of the operation.

contact to fire lamps.

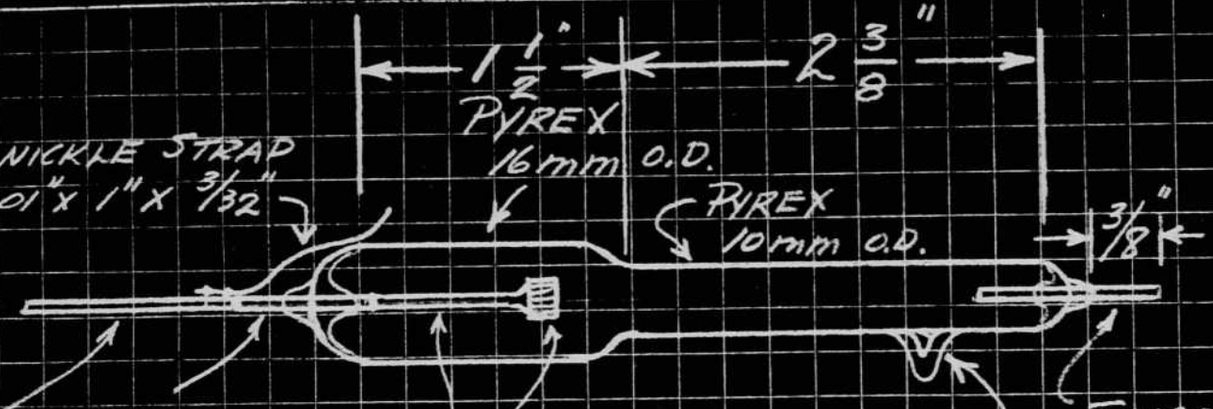
Shutter lens operating ring with metal pin for firing lamps.

Maynard E. Sandell
July 7, 1943

MAT.
FINISH
NO. RQD.

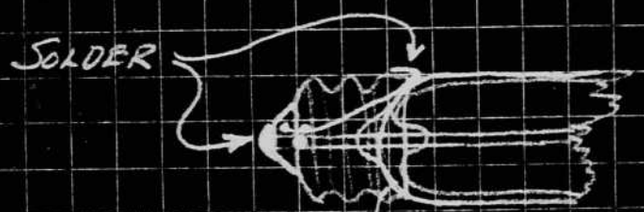
MICROFLASH TUBE GEN. RADIO CO. No. 509.

FILE
DATE JUNE 30 1943
SIGN. H. E. EDGERTON



EXHAUST SCHEDULE

BAKE
BOMBARD
5 mm H_2
ADD ARGON TO
TOTAL PRESSURE
OF 40 cm.



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EDGERTON, GERMESHAUSEN & GRIER

77 MASS. AVE., CAMBRIDGE, MASS. KIRKLAND 6063

July 14 1943

Harold E. Edgerton

Returned to Cambridge yesterday morning from trip to West as per itinery below.

July 7 left on B2A for Buffalo.

July 8 at Buffalo with Jumas at Curtis Wright. Left at 3.15 for Cleveland. Hotel Cleveland that night.

July 9. at G.E. Nela Park in morning left at 11.15 for Chicago to meet Esther at 5 at North Western Station. Left 9.15 for Grand Island Nebr.

July 10 arrived G. I. about noon then to Aurora with my father.

July 11, 12 Aurora.

July 13 left 505 train for Omaha and Chicago.

July 14 Indianapolis at 5 pm Dave Fox at athelitic club.

July 15. Dayton with Capt. Thomas.

July 16. night flight with Col. Baisley. took night train for Cleveland.

July 17 talked to Chas. Wyckoff from station. also Nela and Enfield.

July 18 arrived Boston in morning

I leave tonight at 9.45 for Quebec to work with Mathewman. on bullet problem at Valcartier. Taking microflash unit and camera.

July 24 1943
Harold E. Edgerton

Arrived in Boston via B&M about 8 am on Friday July 23. from Quebec.

Met Matthewman at Montreal on morning of July 20 at Windsor Mills station. then took 9:15 train for Quebec. met by Geo S. Manson chief shell Division munitions and Supply Ottawa out

col A.G. MacWilliams Inspector of shell Inspection board of U.K. & Canada. Ottawa. Ontario

after checking in at Frontenac Hotel, left for Valcartier testing ground.

Col J. A. Caddy — Coast. artillery.
Brig Gen. Dunsterville
Lt. Hagle Allen.

Dinner at Officers club near citadel.
Lt. Col. Magee in charge.

Photog of A.P. shells were made on the night of the 20th. I observed that the yaw was terrific and that the ballistic caps were off. We stopped work about 1.30 am. Matthewman called St Catherine for more shells with different cap attachments. Also asked for Hadfield shells for test.

Tests on 21 night showed Hadfield shells in trouble also in the gun by losing the ballistic caps. Mean over travel in grip showed 18" of shell travel before the driving bands hit the lands.

All ammunition with a new gun barrel was o.k.

the Canadians want some micro flash equipment for this type of testing. I offered to loan them my equipment until they could buy some from the U.S.R. Co.

July 29 1943.
Harold E. Edgerton

Col. Baisley arrived at 3:21 pm yesterday

July 30 1943 ~~Hdq~~.

Meas. of new set of mallory condensers in DIC 6066 flash unit.

Station No.	V	I	Cap.
20	22.45	7.9	935
17	22.3	8.05	958
15	22.3	7.92	940
12	22.3	7.9	940

3773 mf. total.

$\frac{3773}{4000} = .94$

6% low.

Condensers removed see page 42 $\frac{3486}{4000} = .87$ 13% low.

" $\left(\frac{3500}{4000}\right)^2 = .765$

$\left(\frac{\text{new}}{\text{old}}\right) = \frac{3773}{3486}\left(\frac{4000}{3500}\right)^2 = 1.42$

Aug 4 1943
Harold E Edgerton.

8 men from Wright field arrived on Sunday August 1. They are scheduled to spend a month here to learn of electrical flash photography.

See photo on page 63.

Aug. 9. Before leaving on Aug 4 for Indianapolis I measured the light of Capt Smith with electrolytic condensers from mallory.

Electrolytic 6 300 mf in series (300 volts) on 1800 volts.

light .4 (see Blue book).

Paper. 2 - 28 mf (2000 V) condens in parallel. on 1800 volts.

Light .4 "

July 9/3 Dayton News.

Light Flash Is Test Of New Army Photo Equipment

This is the season for lightning bugs. In fact, many Daytonians have noticed a super-dooper 'lightning bug' in the sky during the last week, but its flash is accompanied by the sound of an airplane motor.

A brilliant, quick light, with beam directed earthward has been winking in the darkened skies. People run out of the house to see a falling star . . . but not so . . . the same flash occurs in about 20 seconds over another section of the city . . . but have no fear, lightning bugs are not becoming giants.

Wright Field photographic unit is testing a new type of flashlight for night pictures. Starting out many years ago, Capt. A. W. Stevens experimented in night aerial photography by dropping 50-pound charges of flashlight powder which produced a terrific light and exploded with quite a noise.

These tests were followed by the use of flares, then bombs using powder, and now the very latest in "stop-action" photography . . . the stroboscopic method. This type of picture taking from a plane at night uses no flashlight bulbs . . . and even though the shutter on the camera is operating at a very slow speed, the movement created by the speed of the plane can be stopped "cold" by the ultra high speeds of the light action . . . briefly that's it . . . but there's more to it than is mentioned here, for Wright Field photographic officials will say no more about this intricate new phase of making wartime pictures from a fast moving plane.

Officials at the field said that approximately a half-dozen more flights would be made over the city in testing the equipment.

Men to work with flash
training in planes
Electronic in flight
for photographers.

Edgerton High Hall Sgrorus Henry Weingart Swiderski Miller Baughall.

JULY 1943
Dayton News

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Edgerton High Hall Syrous Henry Weingast Sushecki Miller Baushatt

Men to work with flash equipment in planes. Electronic air flash for flash photo purposes.

Light Flash Is Test Of New Army Photo Equipment

This is the season for lightning bugs. In fact, many Daytonians have noticed a super-dooper 'lightning bug' in the sky during the last week, but its flash is accompanied by the sound of an airplane motor.

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Edgerton High Hall Syrus Henry Weingart Sushenko Miller Barnhart

Men to write flash
training in planes
Electronic air flight
for Phila photography.

Aug 9 1943
Harold E Edgerton

Left Boston 500 (Newtonville) for Indianapolis arrived about 12:30 pm. Saw Henry & Metz Be. 1100 at CAA. also Wm. J. Hudsic. Made tests with Supra Red illuminator and camera.

f 5.6 ok with 14 volts input

f 4 " 8 " 12 " "

16 mm camera with fast trip and synchronized flash.

Left Indianapolis about 8:30 am with CAA plane VC 11 Boeing for Wright Field. Demaree and Adkins pilots.

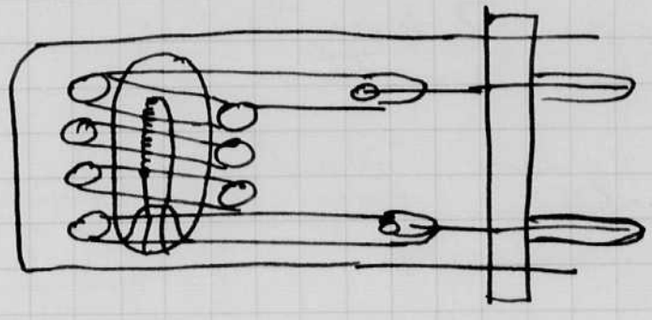
Made photo flights at W. F.
Sat night Aug 7.

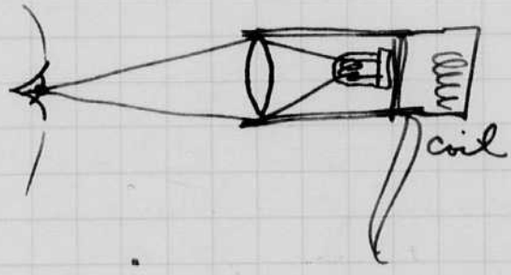
Saw Noel in Denver on Sunday morning at 8 am in Station Aug 8.

Aug 14 1943
Harold E Edgerton.

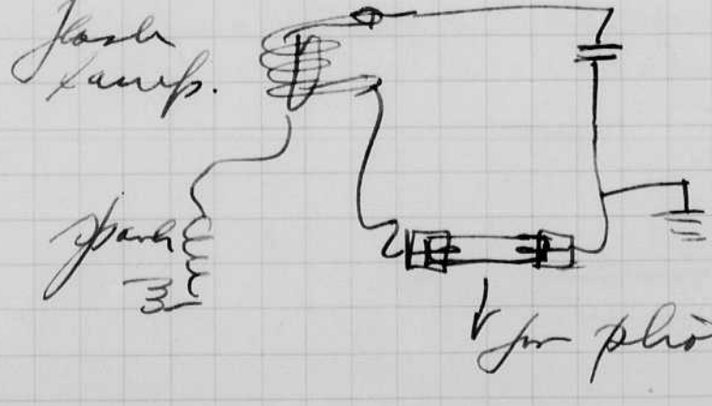
Spent Aug 12 3-4 pm at Windsor Locks plant in New Haven. Dinner with Nicki, Wolfe

Spent Aug 13 in N.Y. saw Brown at Air Reduction. Then Schubert at Fairchild. Design conf. at Gaki's office. Lamp proposed.





Also a short lamp for photographing the data was designed. I suggested a series lamp of the short gap type in the main condenser circuit.



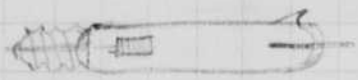
cont.

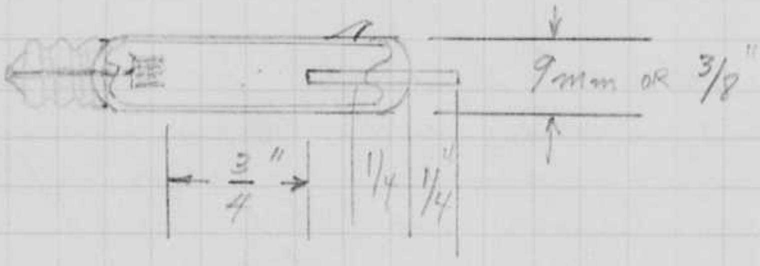
Saw Southworth and at Waugh lab. and had lunch at Chrysler bldg.

Went to Jamaica plant of Fairchild with [illegible] to discuss aerial cameras for day or night work with flash units.

Home on 5 pm train. Saw Caldwell, Shatton, Griggs, etc.

Clifton leaves Sat. today for bombing in Hamilton with flash unit for bullets.



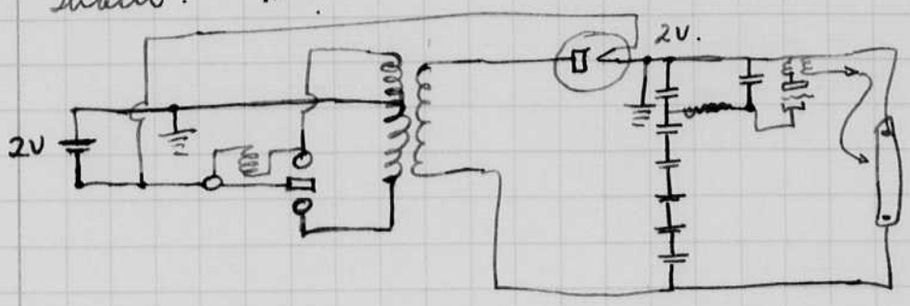


Drawing of #66 and #65 lamps sent to Noel, Cleveland.

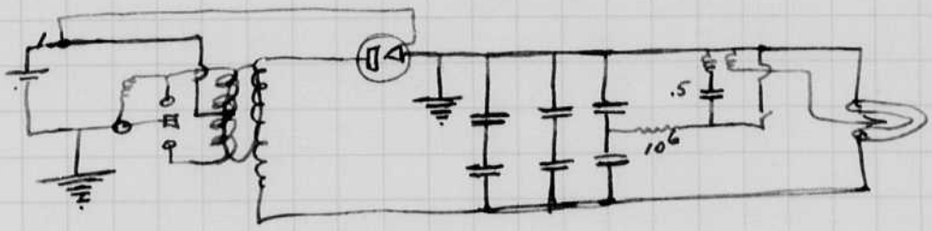
Aug 16 1943

H E Edgerton

Dr. Canfield. Torpedo newport) called Aug. 16, 1943.
Northrup NOL.
Shaw. "

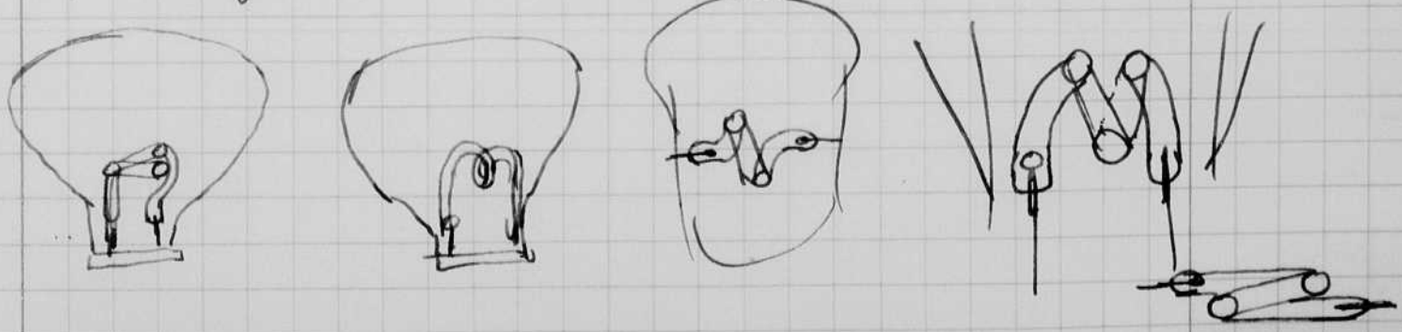


Batt 5. #
Cond 4 #
Trans.



With proper .1
design a
capacity of .1 mf at 300 v should
provide sufficient trip. The
Spark coil should have
more turns than now
used with the stroboturn (25).
so that the currents will be
less in the contacts on the
shutter.

At 600 volts the lamps should be
made of lower impedance? This
will be checked experimentally with
the exposure meter.

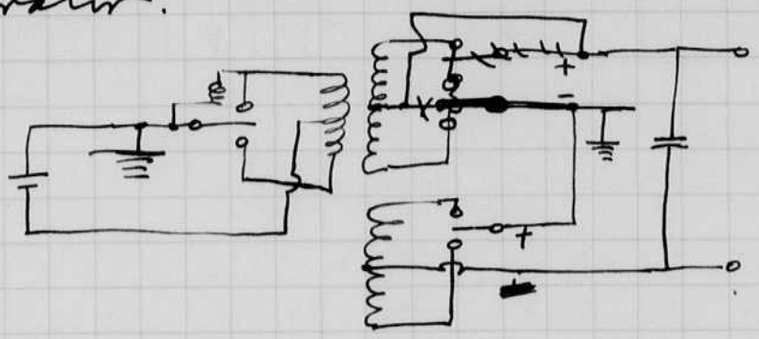


Camera	Film Size	Pict. Int.	Lens. f	F	Shutter	no. pict.
K25	4"x5"	2/3 Sec.	4.5	6"	1/500	60
—	5"x7"	1. sec	2.5	7"	1/225	40
—	2" circle		2	2"	1/100	20

Experimental cameras discussed at Fairchild Aviation Corp., Aug. 13, 1943, with Mr. Schubert and engineers at the Jamaica plant.

Aug 18, 1943.
Jarrell Edgerton

Jarrell Bowen was in a day or so ago and we discussed synchronous vibrators for use as a dc supply for condenser charging. He thought that 600 volts open circuit could be obtained with a 6 contact vibrator.



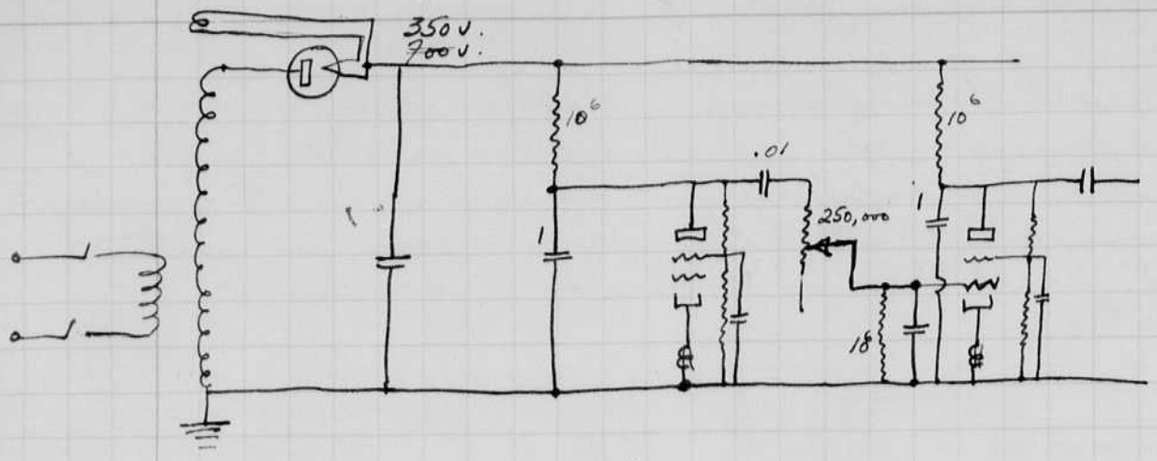
The above has only 400 volts on each vibrator section. The arms could be connected together by the use of suitable polarity of the coils as changed.

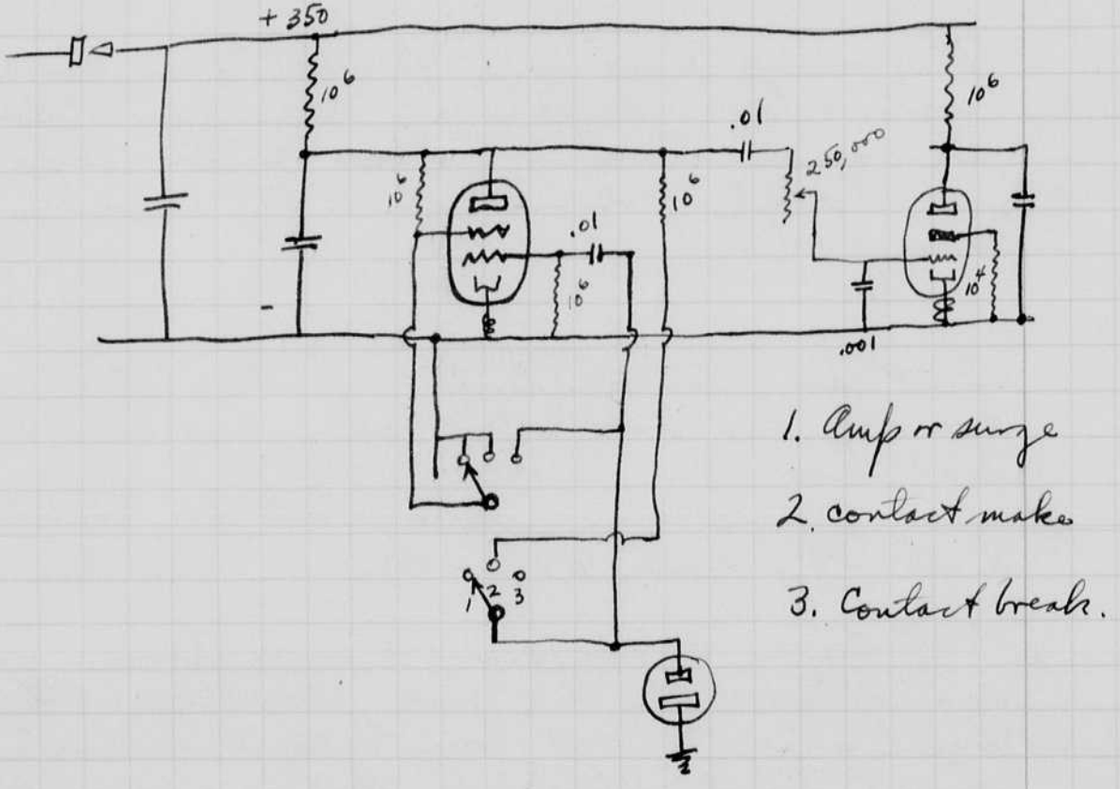
More exposure tests were made last night with the electrolytic condensers 300 mf 300 volt that were supplied by Mallory.

Operation was ok at 700 volts with a short flash Kr tube.

Charlie Wyckoff and I have spent a great deal of time on the five flasher. We have not been able to get consistant results at the short time intervals that is around 10 or 20 microseconds.

Aug 18 1943 H.E. Edgerton.
See page 105 in N.B. 13.





Aug 20 1943.

Harold E Edgerton.

Weight of R40 flash lamp #15 143 grams.
" " PAR 46 Expanded Table 396 grams.

Data on light in Blue Books as of today, shows PAR 46 some 25% better than R40. & about the same distribution of light. This new lamp does not need a socket. It has screw terminals.

Aug 22 1943.

Exposure factor.

In most of the applications of electrical flash lamps, it is desired to know the necessary exposure at a given distance to obtain a adequately exposed negative with a particular type of lamp in a specific type of reflector. Granted that there are many factors with unusual lighting systems, there is still a fundamental formula governing system consisting of the lamp & the camera. Let us call this basic exposure and as such form the basis for the exposure calculation rules that are given in the following.

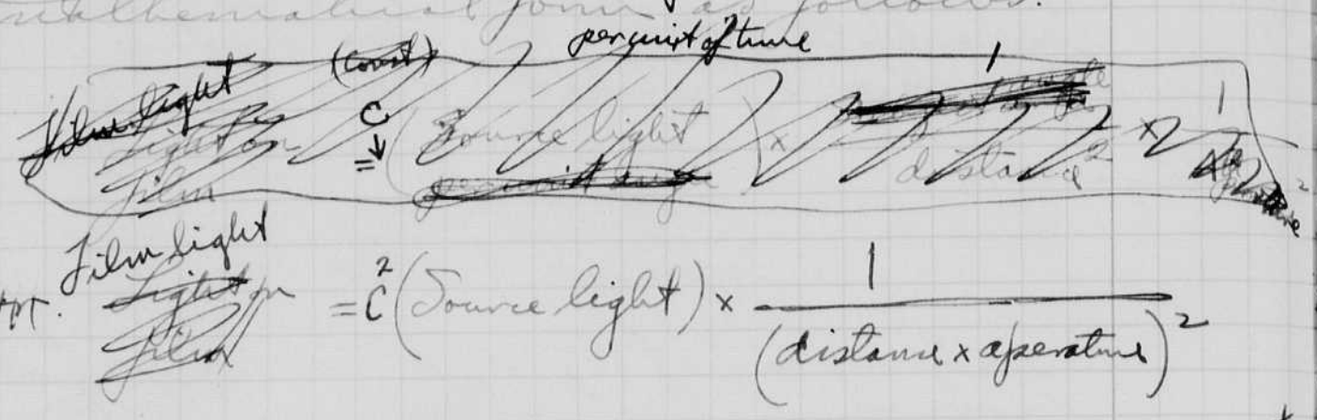
the time duration of the flash is not a factor in the calculation of exposure. neither is the shutter speed as long as other light does not produce appreciable exposure.

Light emanating from the camera decreases in intensity inversely as the distance, thus if the distance to the subject is doubled, the amount of light per unit area at the subject is decreased by one fourth.

The light that strikes the film depends upon the area of the diaphram of the lens. Diaphram openings are defined as a ratio of the focal length of the lens divided by the diaphram diameter. Since the area is proportional to the diameter squared; the amount of light from the subject will be inversely

proportional to the square of the aperture.

The relationships stated above may be expressed in convenient mathematical form as follows.



$$\text{Film light} = C^2(\text{Source light}) \times \frac{1}{(\text{distance} \times \text{aperture})^2}$$

$$\text{or.} \quad \text{distance} \times \text{aperture} = C\left(\frac{\text{Source light}}{\text{Film light}}\right)^{1/2}$$

C = a constant

Let us call the distance x aperture factor, "disap". For convenient

for a given exposure time. the distance is in feet and the aperture in f number.

It now follows that there is a preferred ratio of the source light to the film light² or the film for a suitable picture. This factor varies somewhat with the subject that is being photographed and these variations can be taken into account as desired. For example pictures taken out of doors usually require the factor to be at least twice as much as indoors, since the walls and ceilings are absent. Indoors the reflected light adds materially to the light that is active on the film.

The above relation includes time since the term light is used as the integral of the light as a function of time. With electrical flash photography this time is very short and the instantaneous intensity high so that the integral has a desired value.

With electrical flash photography the amount of light that strikes the film is a constant regardless of the setting of the camera shutter since the flash is very short even compared to the shortest time. The above statement only applies if the ordinary light contributes no exposure. If other light is present, the shutter can be used for mixing the relative effect of the two lights.

Exposure time of the shutter does not influence the quantity of light that strikes the film with chemical flash bulbs since their flash exceeds the exposure time of the shutter.

The basic exposure calculations with electrical flash lamps are greatly simplified since the shutter exposure time does not enter the calculations. As an example consider the reflector-bulb flash lamp no. 15. With fast pres film developed in fresh mixed D19 developer the factor, distance x aperture has been experimentally determined as 160 for the usual type of indoor photograph.

distance (in feet) x aperture (f number) = 160 diaps

To calculate the distance or aperture involves the solution of this simple equation once either distance or aperture are set. For example at a distance of 10 feet the aperture is f 16 for suitable exposure.

Note that the diap factor increases with the square root of the source or camera light. therefore to double the exposure it requires a four times

increase of the source light to double the diap. factor.

The diap. factor is likewise useful in stating the quantity of light that is obtained from an electrical flash lamp. The factor can also express the effectiveness of the reflector-combination. By obtaining ratios for two lamp sources one of which is known, the fundamental relation is found.

$$\frac{\text{Source 1}}{\text{Film light}} = (\text{diap}_1)^2$$

$$\frac{\text{Source 2}}{\text{Film light}} = (\text{diap}_2)^2$$

Since the minimum film light for suitable exposure is the same in both 1 and 2,

$$\frac{\text{Source 1}}{\text{Source 2}} = \left(\frac{\text{diap}_1}{\text{diap}_2}\right)^2$$

integrating exposure meter

As an example; a bare Kodatron #2 lamp operated at 11 mf at 2000 volts gives an exposure reading of 1 on an meter. The same meter reads the light from the portable flash tube #15 as 1.55 units. From the above the diap factor of the Kodatron lamp without reflector is

$$\text{diap} = 160\sqrt{\frac{1}{1.55}} = 129 \text{ diaps.}$$

$4\pi R^2$ = surface area of sphere.

It is proposed to make a scale on the meter which reads directly in diaps; this scale would be a square root one. The aperture and distance corrections would be made ~~de~~ at the first power rather than ~~the~~ as the square. However the meter at present reads light and these values can be readily converted to diaps.

Next it remains to convert from diaps to Lumen seconds. this step has been made experimentally using the integrating exposure meter with known light sources. a 929 photo electric cell is used in the meter. this cell is sensitive in the blue portion of the spectrum and this factor may influence the results somewhat. However the film is most sensitive in the blue portion of the spectrum and it is believed that the combination gives a result that is a close approximation to the true ~~result~~ answer.

The light meter has been calibrated so that it reads light in terms of the Kodatron speed lamps no 2 when operated under standard conditions of 114 microfarads at 2000 volts. the meter for any other condition is read as follows.

$$\text{Light} = (\text{meter reading}) \left(\frac{\text{distance cm}}{103}\right)^2 \left(\frac{\text{aperture}}{16}\right)^2 \text{Kods.}$$

the meter reads 1 when a bare kodatron #2 flash tube is set at 103 cm from the shutter and the aperature set at f16. As just shown the light is also 129 diaps.

For conversion to lumen seconds, a 200 watt Mazda lamp 120 volt was selected as a continuous source. the manufacturer states that this lamp delivers 3700 lumens

of radiant flux. (18.5 lumens/watt). The integrating exposure meter was used with a 0.1 sec. shutter setting at 32.5 cm to produce a 0.87 reading of the meter. The constant for conversion to lumen seconds is then obtained by direct substitution in the equation for light

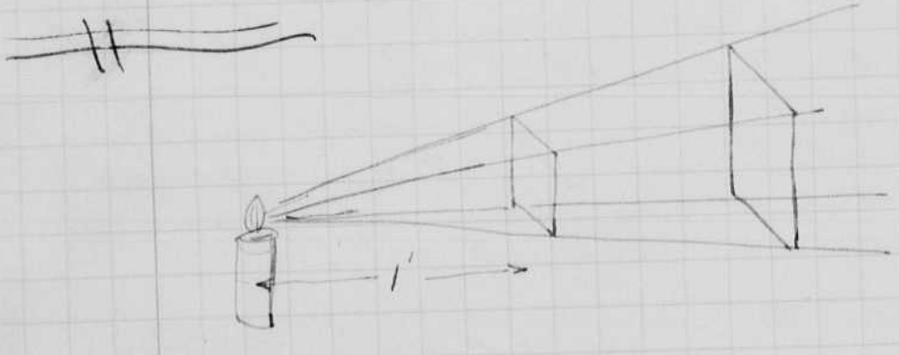
$$\text{Light (lumen seconds)} = K\left(\text{meter reading}\right)\left(\frac{32.5}{103}\right)^2\left(\frac{8}{16}\right)^2$$

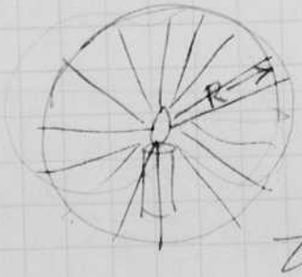
$K = 17,450$ lumen seconds per kodatron.

the corresponding exposure guide number is 129 flips.

$$\text{Energy in condenser} = \frac{CE^2}{2} = \frac{114}{2}\,2000^2 \times 10^{-6} = 228 \text{ joules}$$

$$\text{Efficiency} = \frac{17450}{228} = 76.5 \text{ lumens/watt.}$$





Radiant flux lumens.

$$E\text{(lumination)} = \frac{\text{lumens}}{\text{area}} = \frac{4\pi C.P.}{4\pi R^2} = \frac{C.P.}{R^2}$$

Total lumens = 4π candle power.

Aug 23 1943
J. E. Exposition

Bare Kodalux lamp. 129 diaf.
17450 lumen ~~out~~.

200 watt lamp 120 volts.

output 3700 lumen ~~seconds~~.

$$129\sqrt{\frac{3700}{17450}} = 129\sqrt{.212} \quad 129.46 = 59.4.$$

for 1 sec exposure.

for 2 sec exp. 59.4 x 2 = 118.8

of radiant flux. (18.6 lumens/watt). The integrating exposure meter was used with a 0.1 sec. shutter setting at 32.5 cm to produce a 0.87 reading of the meter. The constant for conversion to lumen seconds is then obtained by direct substitution in the equation for light

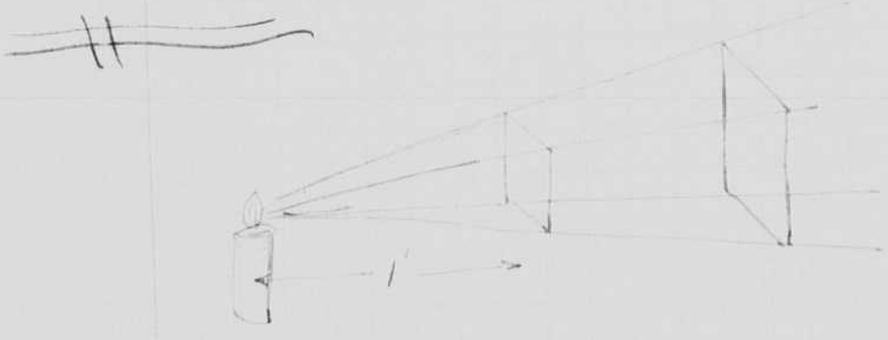
$$\text{Light (lumen seconds)} = K\left(\text{meter reading}\right)\left(\frac{32.5}{103}\right)^2\left(\frac{8}{16}\right)^2$$

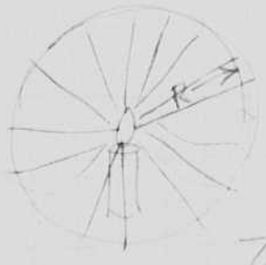
$K = 17{,}450$ lumen seconds per Kodatron.

The corresponding exposure guide number is 129 bispo.

$$\text{Energy in condenser} = \frac{CE^2}{2} = \frac{114}{2}\,2000^2 \times 10^{-6} = 228 \text{ joules}$$

$$\text{Efficiency} = \frac{17450}{228} = 76.5 \text{ lumens/watt.}$$





Radiant flux lumens.

$$E\text{(lumination)} = \frac{\text{lumens}}{\text{area}} = \frac{4\pi C.P.}{4\pi R^2} = \frac{C.P.}{R^2}$$

Total lumens = 4π Candle power.

Aug 23 1943
H. C. Sgarlata

Bare Kodalux lamp. 129 diaf.
17450 lumens ~~out~~.

200 watt lamp 120 volts.
output 3700 lumens ~~incandescent~~.

$129\sqrt{\frac{3700}{17450}} = 129\sqrt{.212}$ 129.46 = 59.4.
for 1 sec exposure.

Cond.	Cap	V	Watt Sec.	Wt. Lb.	Vol Cu. In,	Watt Sec. per Lb.	Watt Sec. per Cu. In.	cost $	Watt Sec. per $	Dielectric
75/4000	75	4000	600	55	970	10.9	.62	122	4.9	Mallory Paper & Castor Oil
85/2000	85	2000	170	11.75	175	14.5	.97	20	8.5	Mallory Film
28/2000	28	2000	56	4.4	64	12.8	.88	11	5.1	Mallory Film
28/2000	28	2000	56	4.95	78	11.3	.72	5.60	10	G. E. Pyranol
300/300	300	300	13.5	.58	17	23.2	.80	1	13.5	Mallory Electrolytic

August 24, 1943

Aug 26 1943
Harold E. Edgerton.

Paul Lee requested a small gravity spinal. 10 flashes a sec. 100 μs duration. To be operated from a plane battery system.

20 μf at 2000 volts should give a 100 μs flash.

$\frac{CE^2}{2} = \frac{20 \times 4}{2} = 40$ watt sec.

10 flashes/sec = 400 watts.

This may be too hot.

First try 200 watts. 10 μf 2000 volts.

$RC = .02$ sec =

$R = \frac{.02}{10} 10^6 = 2000.$ ohms.

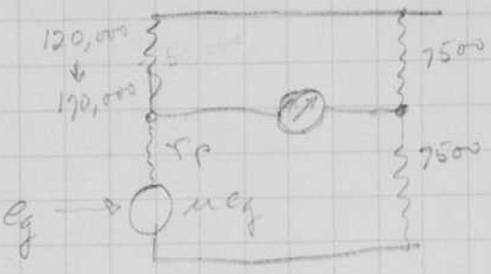
Aug 26 1943

W.F. Rogers

Light Integrating Meter
Exposure Meter.

Designed Exposure meter or light meter with Wilkins of G.E. today. Hope to make sample for production when times are better.

March 30 1943 design.



6C5.

$\mu =$

$r_p =$

$$I = \frac{\mu e_g}{r_p + 7500} = .001 \text{ amp}$$

$$= \frac{20\, e_g}{10{,}000 + 7500} = 1.14 \times 10^{-3} e_g.$$

for a reading of 1 ma.

$$e_g = 10^{-3} \times \frac{1}{1.14 \times 10^{-3}} = 0.875 \text{ volts}$$

duration about 100 microseconds $= 10^{-4}$ sec.

$$i = c \frac{de}{dt} = 0.1 \times 10^{-6} \frac{.875}{10^{-4}} = .001 \times 875 = .000875 \text{ amp.}$$

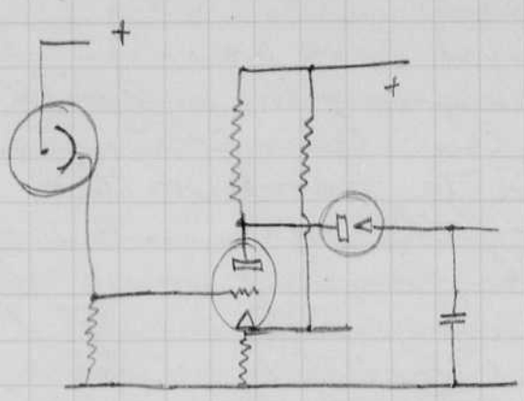
tube grid current

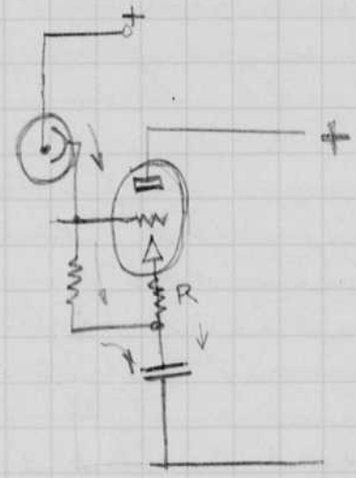
$$i' = .1 \times 10^{-6} \frac{.875}{30.} = .292 \times 10^{-8} \text{ amps.}$$

the ratio of these currents is always the same as the ratio of the two times involved.

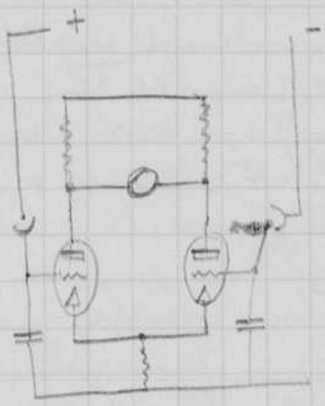
inversely as the

$$\frac{i \text{ photocell}}{i \text{ discharge}} = \frac{30 \text{ seconds}}{10^{-4} \text{ seconds}} = 30 \times 10^{4}.$$





6C5
1 volt = 2 ma.



Aug 26 1943

F. E. Gerlow.

Integrated Light Meter.

The meter described here was developed primarily for measuring the output of electrical flash bulbs. Consideration was given in the design to permit the measurement of the integrated light from sources of ~~the~~ having very short flash durations. Since the instrument has a shutter that is calibrated in time, it is also possible to study continuous light sources. Furthermore the meter can be used to measure shutter times when used with known light conditions.

Direct comparisons are readily made between the different kinds of flash bulbs, both electrical and chemical, and with steady light source. Furthermore with filters it is possible to compare the relative output of the different lamps and bulbs in ~~different~~ various portions of the spectrum.

This meter should be called an exposure meter since it gives a number that is proportional to the amount of light integrated as a function of time. ~~It~~ The reading of the meter is a function of the shutter time. With conventional light meters, erroneously called exposure meters, time is not considered, ~~except as~~ ~~it is used~~ in the reading. ~~It is however calculated.~~ It has been suggested that the meter described here be termed an Integrated Light meter so that it will not be confused with other types of exposure meters.

Description of the light integrating circuit.

Reference is made to fig 1 for an explanation of the theory of the meter. Light enters a shutter, camera type, and strikes a photo electric cell. Synchronization is used with flash bulbs so that the light will occur at the right moment during the shutter opening. The shutter also excludes the ordinary light that would cause current to flow a reading. The effect of any extraneous light is determined experimentaley by making a reading with the meter at the same shutter speed as that is in question. Usually a diffuser is placed in the shutter directly behind the iris in order to break up the direct rays of light that would strike only a small portion of the photo cell. The light is thus diffused over the entire plate of that cathode of the photo cell.

Synchronization with electrical flash bulbs is made by a direct contact on the shutter cocking arm on shutters that are wound up. If the lamp flash follows without delay, the contacts are set to close the circuit at the moment that the shutter is wide open.

Chemical flash bulbs require special synchronization in exactly the same way as in photographic procedure. Either synchronized flashes can be measured or open flash. Standard devices are available for obtaining suitable shutter delays following the closing of the lamp firing circuit.

The photo electric cell must be of the vacuum type since the gas filled type are not suitable for high-voltage or high-current operation. also the gas filled photo electric cells are not linear in response.

It has been found necessary to use a high voltage on the photo electric cell in order to overcome the space charge that results from the large peak currents that are ~~necessary~~ set up by the peak light intensity ~~from~~. It is not unusual to observe peak photo cell currents of a milliampere when measurements are being made, particularly of very short-duration flash sources. Experiments have been made to study the effect of photo cell voltage on the final reading. ~~For example, the~~ The ~~light~~ value selected is such that the meter reading is substantially constant for conditions encountered in operation. A second check is the familiar square law relationship of light ~~from~~ as the source-meter distance is increased.

On the assumption that ~~light~~ photocell current and light are proportional, the voltage across the ~~~~ condenser will be proportional to the time integral of the light. ~~against time~~ This follows from the fundamental law of a condenser which states

~~condenser current = $\frac{1}{C}\int i\,dt$~~

~~~~ voltage = $\frac{1}{C}\int$ ~~i dt~~ current dt.

where C = the capacity of the condenser in farads.

A voltage appearing across the condenser is impressed directly upon the grid of a d.-c. amplifier ~~circuit~~ tube. The Balance of the circuit involving the plate meter is disturbed proportional to the ~~~~ condenser voltage and thereby the ~~time~~ integral of the
~~~~

light.

A reset switch is provided for discharging the condenser so that the same partial setting is used on the meter. With the condenser shorted, the variable plate resistor is adjusted until the meter reads zero.

The condenser voltage will drift slowly due to small currents that are present in the condenser AC circuit. In fact these currents are the factor that determines the minimum condenser that can be used before the meter drift becomes objectionably large. The main currents are:

~~1. Dark current in the photo electric cell~~
~~2. Leakage~~

1. Photo electric cell leakage or "dark" current. This current varies greatly for individual cells. ~~It is the largest important.~~

2. Amplifier grid current. This also has widly different values depending upon individual tubes and the treatment that those tubes have received. Often the grid current of a tube will decrease many fold after it has been ~~used for~~ aged in service.

3. Condenser leakage or absorption currents. ~~The condenser~~ Leakage will cause the meter to drift exponentially to zero after the unit has operated. Absorption will cause a slight change in the reading immediately after operation. It can be either positive or negative depending upon the ~~part~~ dielectric of the particular condenser that is used. Mica and polystyrene condensers are the most acceptable since the absorption currents are practically non existant.

For any particular set of tubes, photocells and elements, the effects of the currents mentioned above can be ~~readily~~ experimentally determined by opening the circuit at A and ~~noting the~~ timing the rate of drift. For example, if the meter changes from zero to 0.5 ma in 30 seconds with the circuit open at A; the average current is ~~found~~ calculated as shown below:

$$i = C \frac{de}{dt} \qquad dt = 30 \text{ seconds.} \qquad C = 0.1 \times 10^{-6} \text{ farads.}$$

The 6C5 has an amplification factor of 20 and a plate resistance of 10,000 ohms. The ~~effective~~ load ~~plate~~ resistance is 7500 ohms in the circuit shown. From this data the change in grid voltage to produce 0.5 ma in the plate circuit is

$$de_g = di_p \times \frac{17500}{20} = 0.437 \text{ volts.}$$

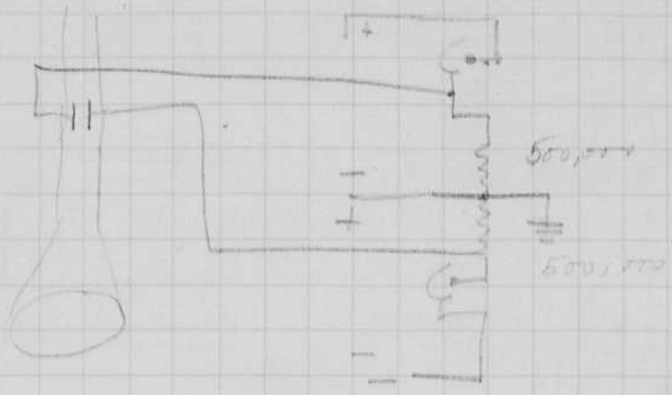
and $$i = C \frac{0.437 \text{ volts.}}{30 \text{ seconds}} = .00145 \times 10^{-6} \text{ amps}$$

This is about the value of current that can be expected with the average 6C5 tube. Better results can be obtained if several tubes are tested and the best selected. Each tube should be operated ~~at its aging rate~~ for several hours before the grid current is measured.

The photocell dark current can be evaluated by the above method also with the circuit made at the point A. The plate current will then be influenced by the sum of the grid current and the photocell current. Condenser leakage current is found by opening the condenser completely except for a momentary connection at the end of a given time to the grid so that a voltage measurement can be made.

Aug 27 1943

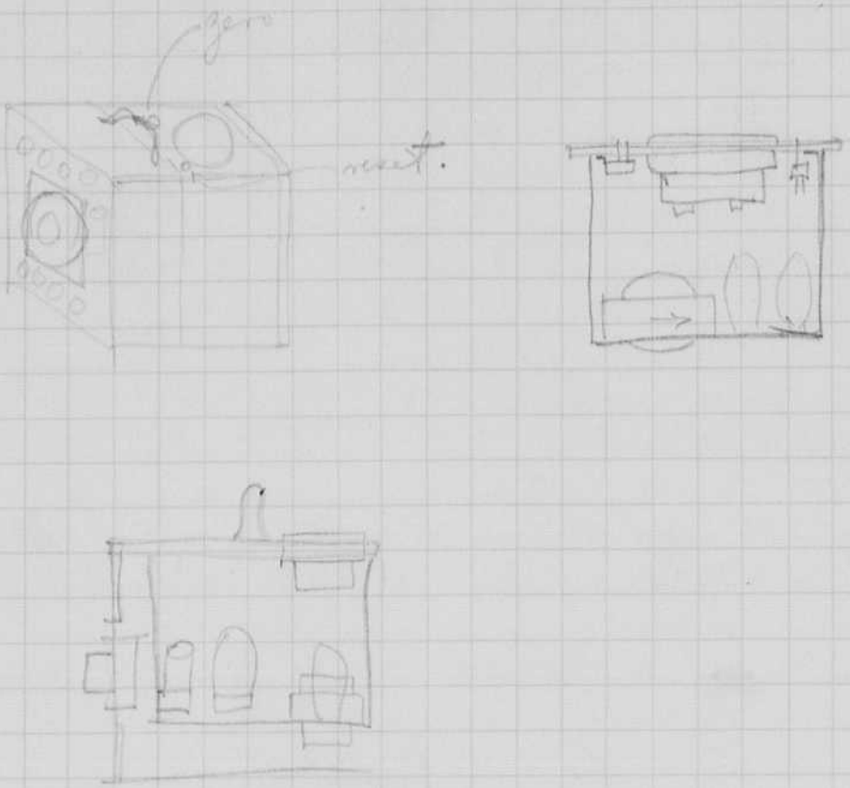
Hand Flash Osc. Light-time Curves.



1000 cycle tuning fork.

Film No	% f	Timing	C	V	Distance	Lamp.	C.R.V.
Test	x100 5.6	1000	—	—	34' 1"	—	
1	100 5.6	1000	114	1910	"	#2 Hood	3000
2	100 "	"	"	"	"	"	3000
3	100 "	"	"	"	"	"	3000
4	100 5.6	1000	1960	2400	45	#17	3000
5	49 5.6	1000	1960	2000	45	17	3000
x 6	49 "	"	1960	4000	45'	17	3000
7	23 "	"	1960	4000	45'	17	3000
8	23 "	"	"	"	"	17	"
9	23 "	"	"	"	"	17	"
out 10	9.2 "	"	414.7	4000	"	17	"
✓ 11	9.2 "	"	414.7	4000	"	17	"
✓ 12	9.2 "	"	1960	4000	"	17	3000
out 13	9.2 "	"	1960	4000	"	17	3000
out 14	9.2 "	"	1960	4000	"	17	3000
out 15	9.2 "	"	84.5	4000	"	17	3000
✓ 16	9.2 "	"	84.5	4000	"	17	3000
out 17	9.2 "	"	84.5	4000	"	17	3000
out 18	9.2 "	"	"	"	"	17	"
19	9.2 "	"	1960	4000	"	17	"
20	9.2 "	"	1000±	4000	"	17	3000

Light Integrating Meter.



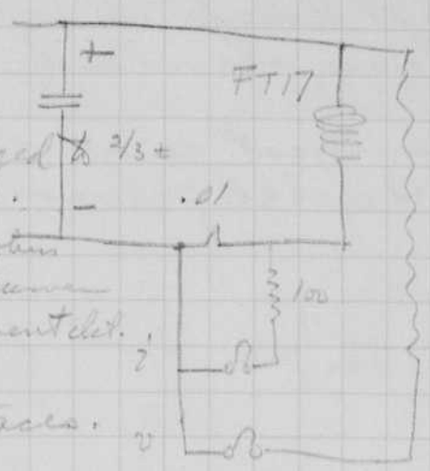
Lamp X200	105 cm	f16	M=1	2000 V	11 ft/mf
902			1.01	"	
905			.95	"	"

Aug 27 1943.

Volt-amp Curves

B.E. osc. 60 cycle tuning wave.

Film	V	C	
1.	1950	414.7	
2.	2460	414.7	
3.	2400	414.7	
4.	3490	417.7	current scale changed
5	3910.	1960.0	current off scale.
6	3855	1960.0	calib changed. 100 ohms in current circ.
7	3855	1960.0	200 ohms in current circ.
8	3890	1960.0	zero shifted
9	3880	1960.0	Oh write zero traces.
10	3990	1000.-	"
11	4000	417 mf	"
12	2030	1960.0	



9.1
6.9
2.2 cm. 10.9 volts.
1 cm = 4.95 volts. or 495 amps.

From Film	I_{max} cm	amp.	R ohms	RC sec
8	3.2	1580	2.46	$\frac{6.5}{24.5}\frac{1}{60} = .00442$
9	3.2	1580	2.46	$\frac{6.7}{25}\frac{1}{60} = .00453$
10	3.4	1670	2.39	$\frac{4.3}{34}\frac{1}{60} = .00211$
11	3.1	1530	2.62	—
12	1 or 1.15	495 570	4.1 - 3.57	$\frac{1.15}{33}\frac{1}{60} = .00580$

Original Oscillograms on page 92 - 93.

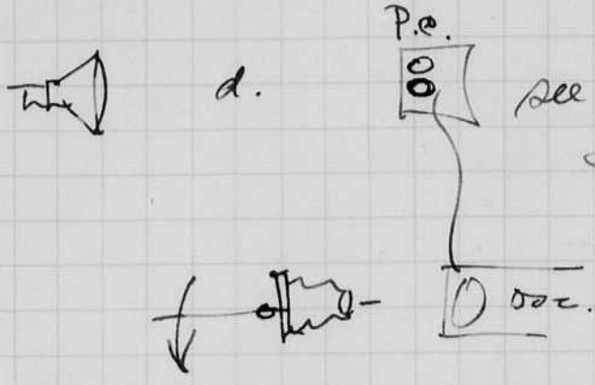
Aug 28 1943
Harold Edgerton

Light-time curves.

FT17 as used in B-24 unit.

a Par 38 lamp 150 watt 115 volt will be used as a standard lamp.

From Boast page 131 Initial max candle power = 2500. (beam).



Assuming spherical distribution

total Lumens = 4π candlepower.

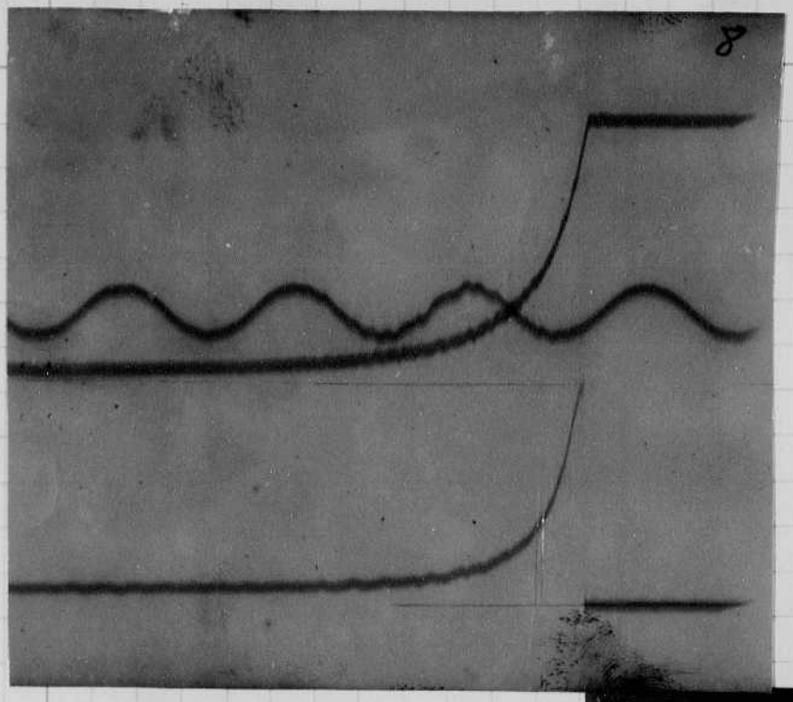
$$= \frac{2500\ 4\pi}{4\pi d^2} = \frac{\text{lumens}}{4\pi d^2} =$$

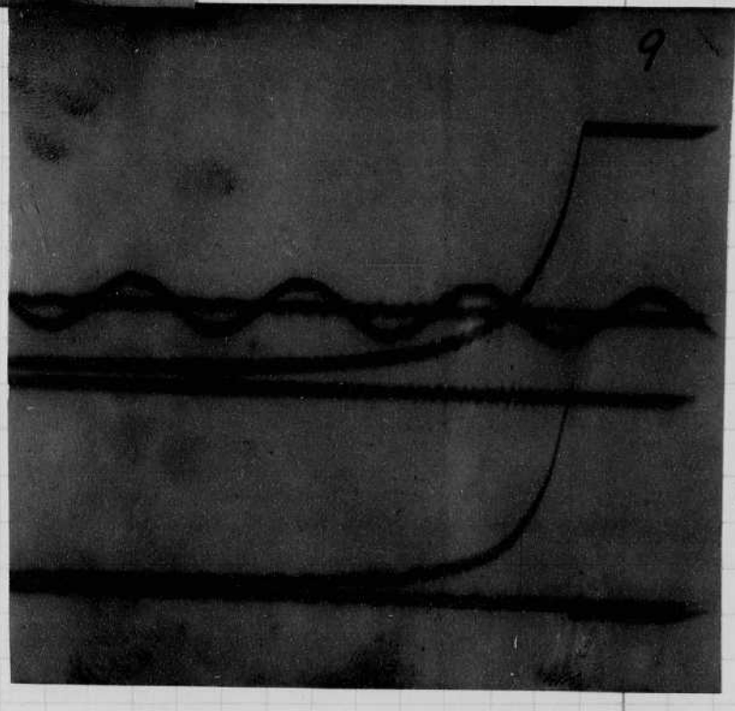
if $d = 10.0$ ft.

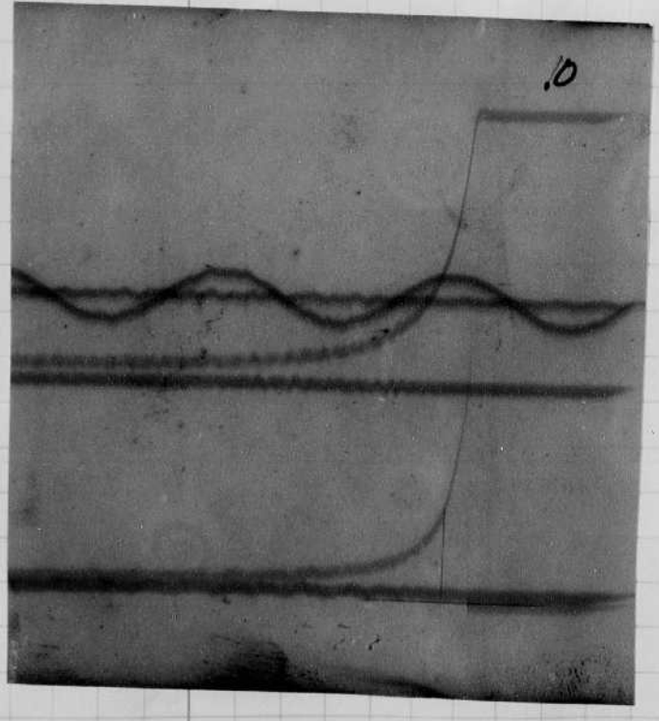
May 29, 1942
Edgerton &
D. Henry.

Film No	% Trans.	C.	V.	dist	Lamps	f.	timing	cr sets.	
1	100	1960	2040	45'	17	4.7	1000	3500	
Calib	100	3 cm def.	PAR 38 150 W 115 V at 15" from plinth cell.					3500	113 volts.
2	100	1960	2010	45	17	4.7	1000	3500.	
3	49	1960	4000	45	17	4.7	1000	3500	off scale.
4	9.2	1960	4000	45	17	4.7	"		
5	16	1960	4100	45	17	4.7	"		
6	16	1960	4000	45	17	4.7	"		
7	16	1960	4000	45	17	5.6	"		
8	16	1960	4000	45	17	5.6	"		
9	16	1007	3990	45	17	5.6	"	"	
10	16	417	4000	45	17	5.6	"		
11	16	74.5	4000	45	17	5.6	"		
12	16	1960	4000	45	17	5.6	"		
13	49	1960	1500	45	17	5.6	"		
14	49	1960	2010	45	17	5.6	"		
15	49	1960	2500	45	17	5.6	"		
16	49	1960	3010	45	17	5.6	"		
17	49	1960	3500	45	17	5.6	"	"	
18	100	#5 G.E.	flashbulb	6'	#5	8	"	3500	
19	16	"		6'		8			
20	41	"		6'					Black velvet back of bulb
21	41 x 9.2	75 W.E.	Bulb	6'					

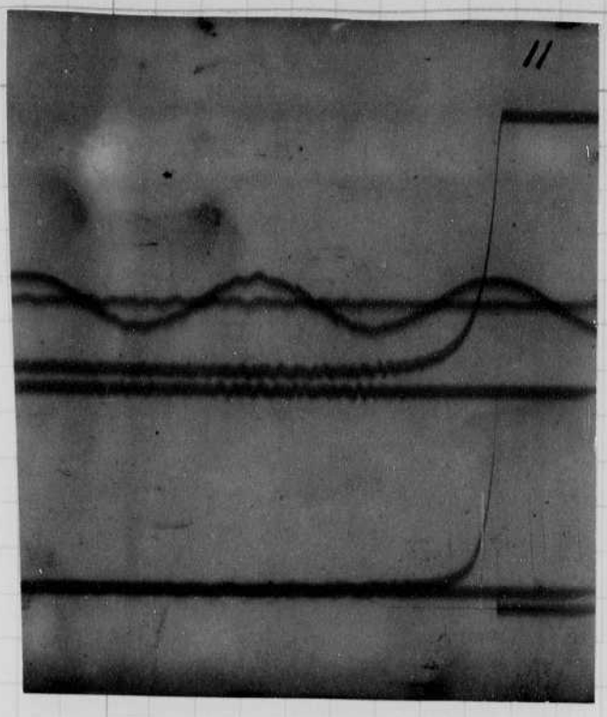
Osc of B-24
Jumps.
FT 17.
1960 mt
4000 volts.
See data page 89.





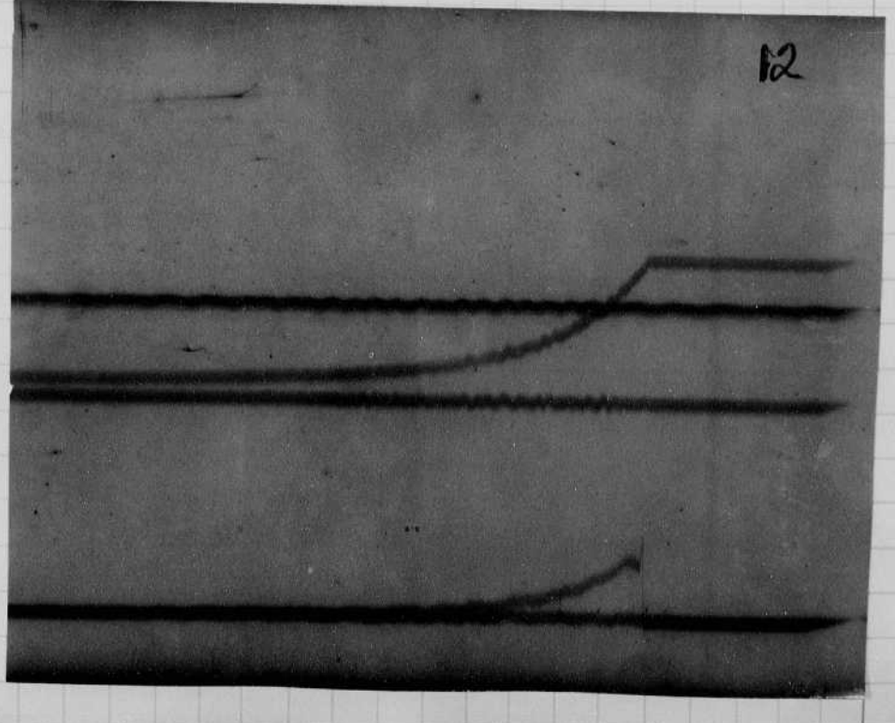


← TIME

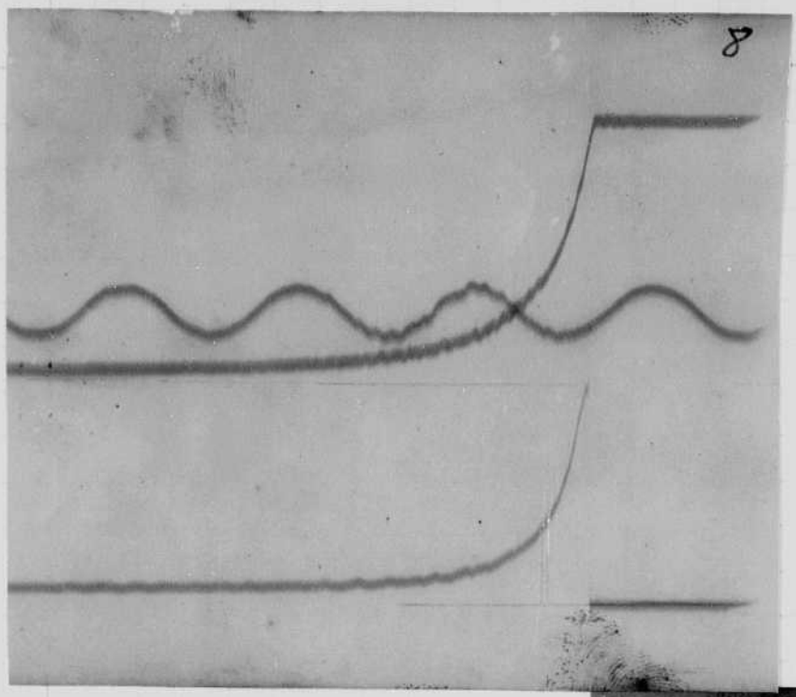


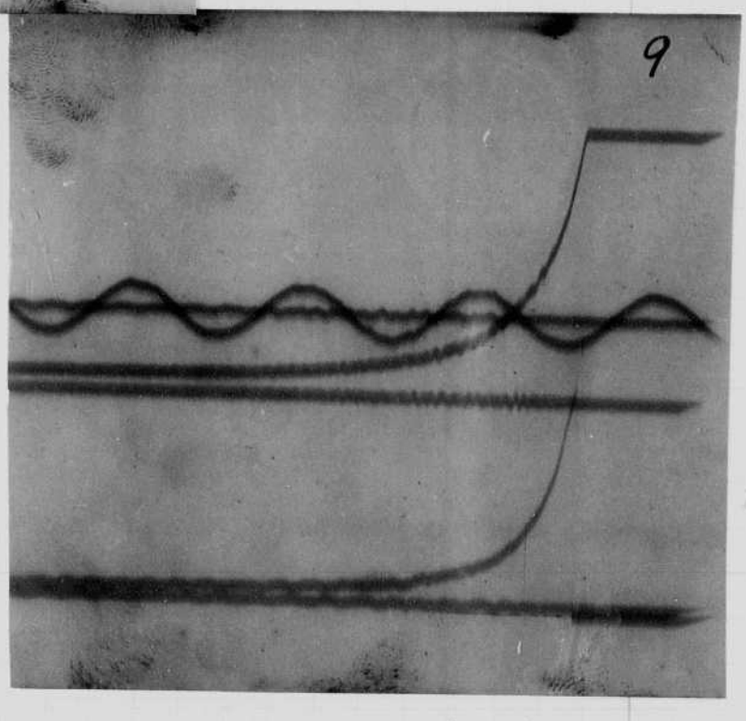
A 20 mm

515 pounds.

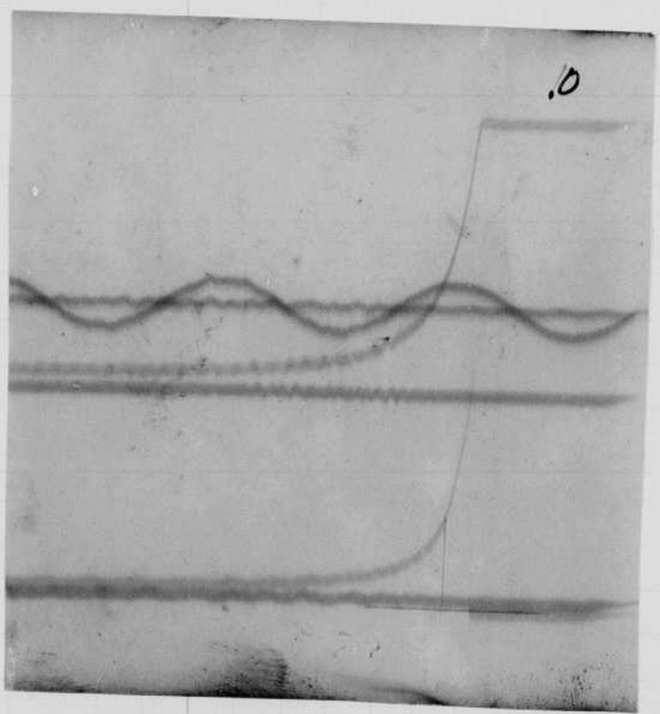


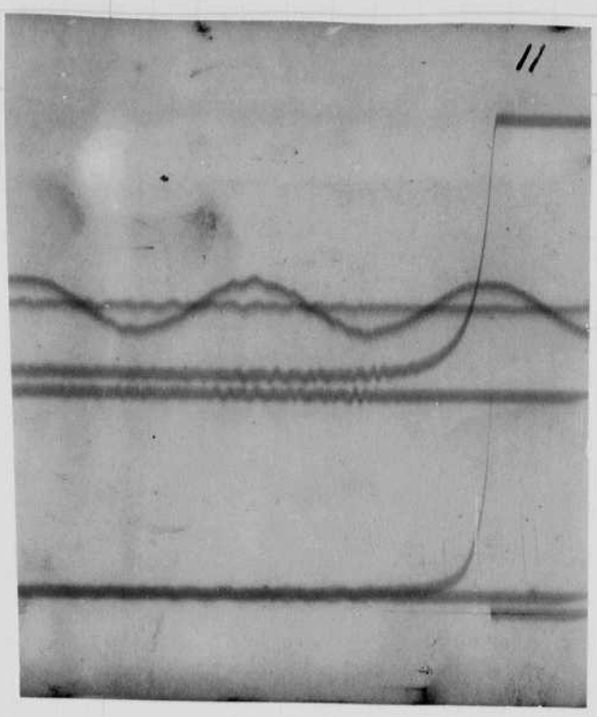
Osc of B-24
Jumps.
FT 17.
1960 mf
4000 volts.
Data page 89.





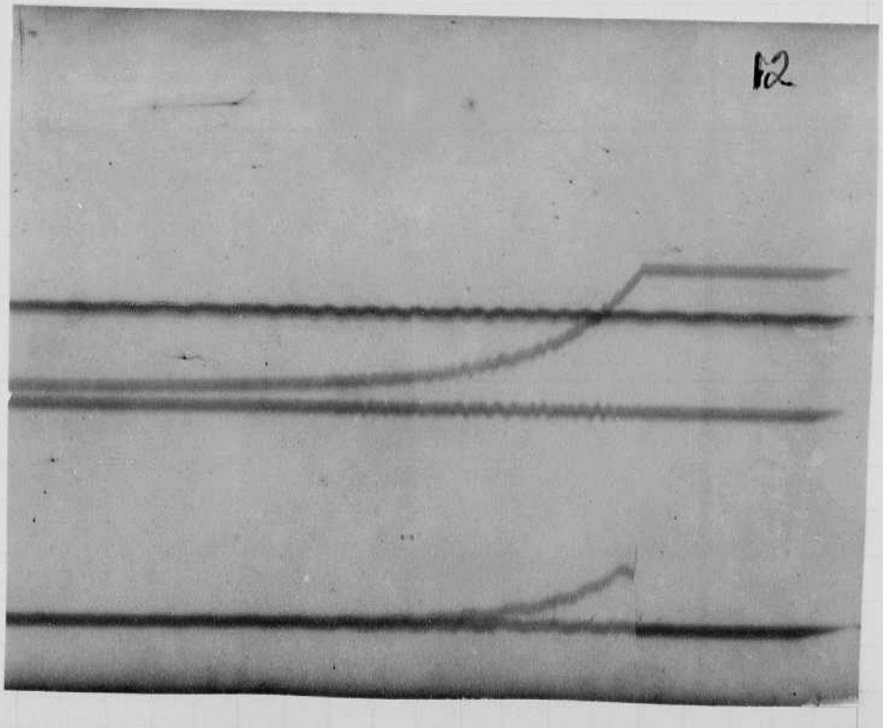
← TIME





A 20 mm

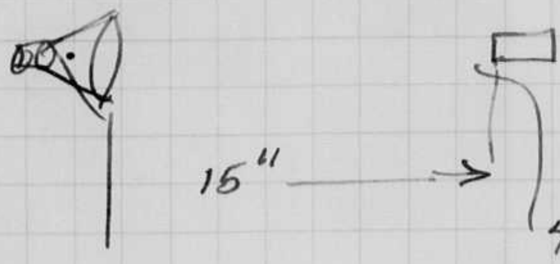
515 pounds



Aug 30 1943 [signature]

Light Calib. for page 91 oscillograms.

Light meas of Par 38 150 watt 115 volt lamp.



Light meter reads 500 ft candles

$$\text{Light} = \frac{500}{.49} = 1020 \text{ ft candles.}$$

this amount of light produces 3 cm deflection on the screen.

Dear Wyeth [illegible] Room 2 Newport R.I. Naval Torpedo Sta.

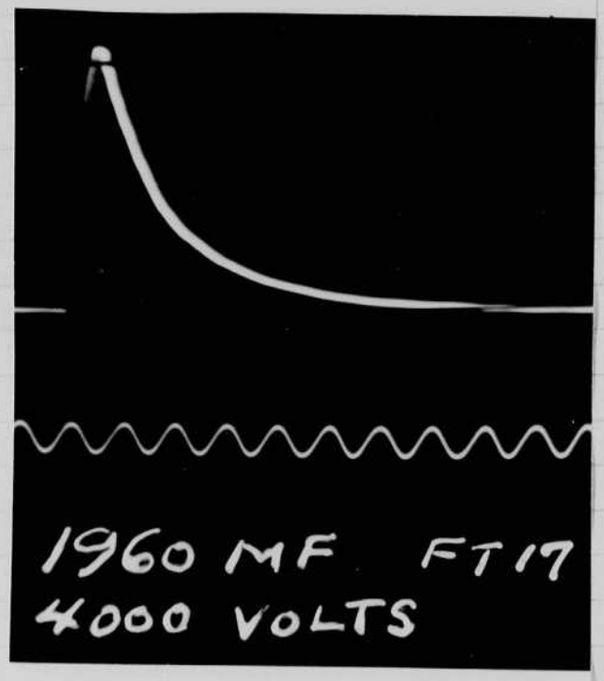
with a source at 45'

$$\text{P.C. Light} = \frac{\text{Source Light}}{(45)^2} \times .16 \quad (\text{screen})$$

$$\frac{45^2}{.16}\ 1020 = \text{Source light for 3 cm deflection}$$

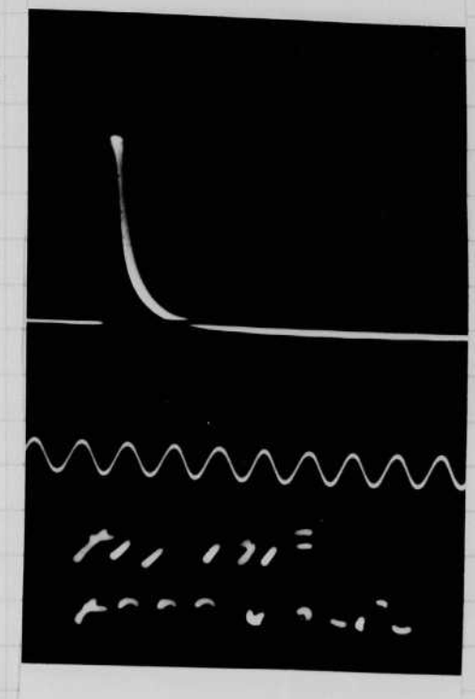
osc 5-12 inc. = 13,000,000 candle power = 3 cm.

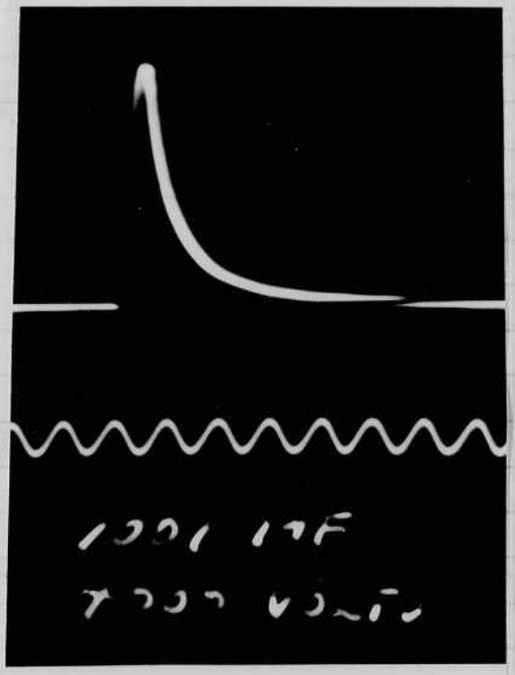
13-17 inc	$\left(\frac{.16}{.49}\right)$	4,250,000	"	"	= 3 cm
19.	$\left(\frac{6}{45}\right)^2$	230,000	"	"	= 3 cm.
21	$\left(\frac{6}{45}\right)^2 \frac{.16}{.0327}$	980,000	"	"	= 3 cm

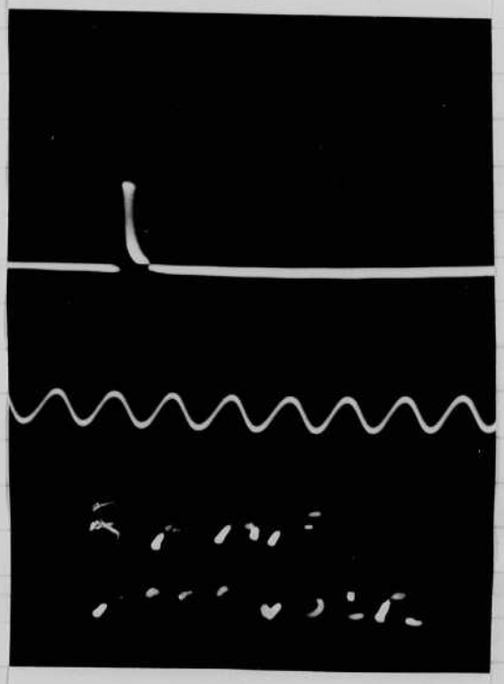


13,000,000 op.

164,000,000 Ohms.







Aug 30 1943
H. E. Edgerton

Light Calib. for page 91 oscillograms.

Light meas of Par 38 150 watt 115 volt lamp.

Dear Wyckoff at Newport R.I. Naval Ordnance Fla.

Light meter reads 500 ft candles

$$\text{Light} = \frac{500}{.49} = 1020 \text{ ft candles.}$$

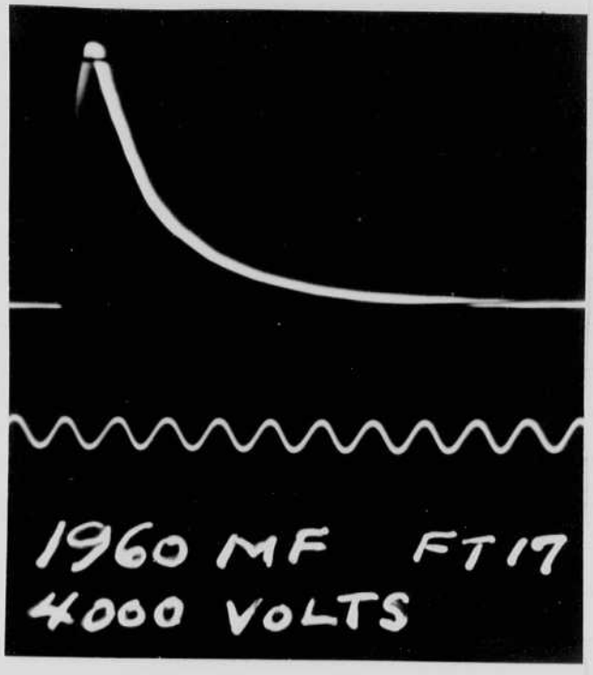
this amount of light produces 3 cm deflection on the screen.

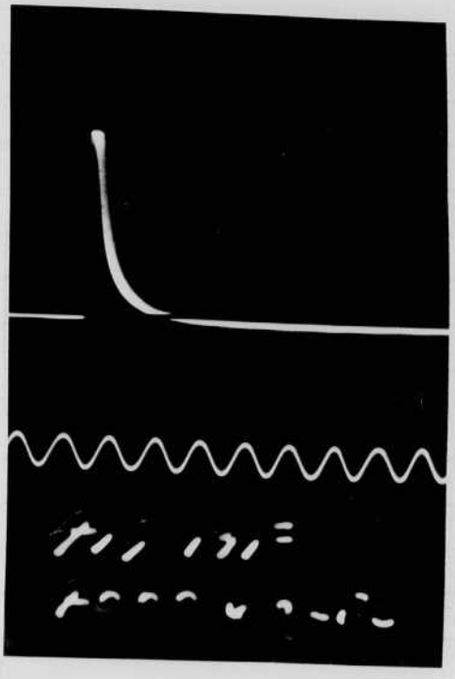
with a source at 45'

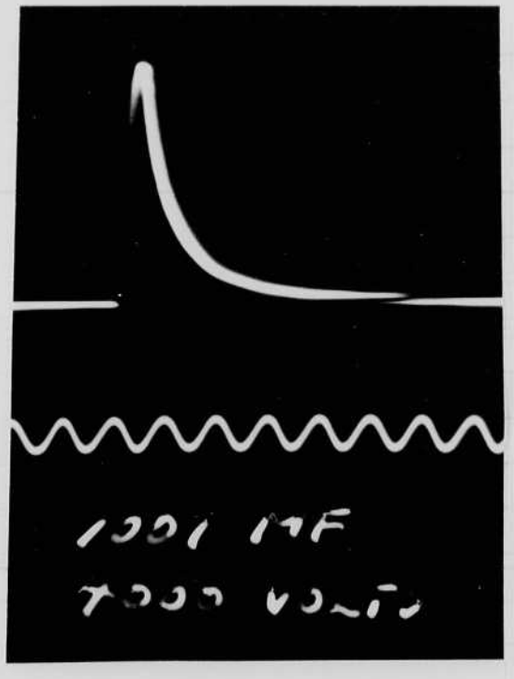
$$\text{P.C. Light} = \frac{\text{Source Light}}{(45)^2} \times \left(\frac{1}{.16}\right) .16 \quad (\text{screen})$$

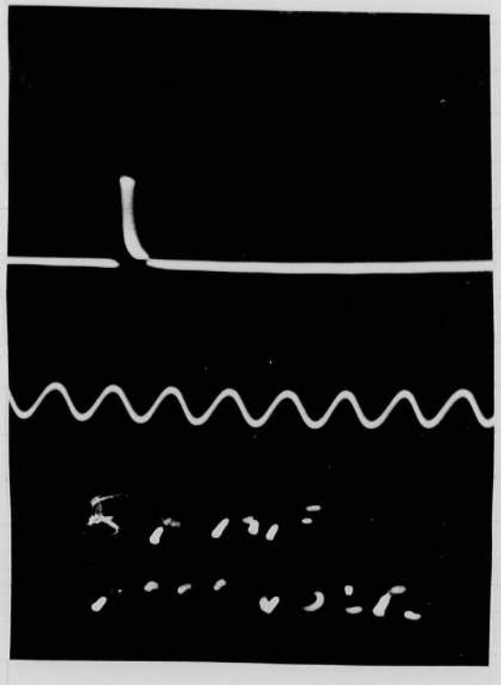
$$\frac{45^2}{.16}\ 1020 = \text{Source light for 3 cm deflection}$$

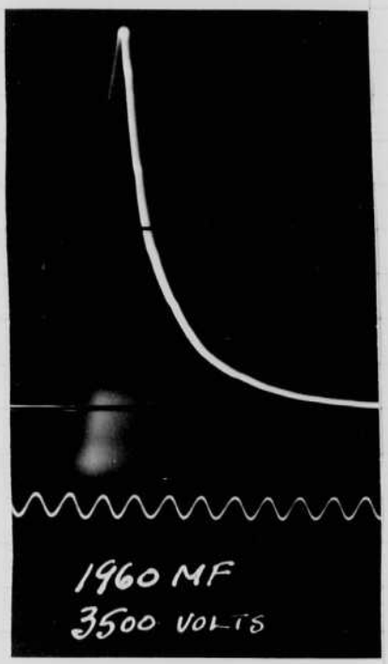
osc 5-12 inc.		= 13,000,000	candlepower		= 3 cm.
13-17 inc	$\left(\frac{.16}{.49}\right)$	4,250,000	"	"	= 3 cm
19.	$\left(\frac{6}{45}\right)^2$	230,000	"	"	3 cm.
21	$\left(\frac{6}{45}\right)^2 \frac{.16}{.0327}$	980,000	"	"	= 3 cm.

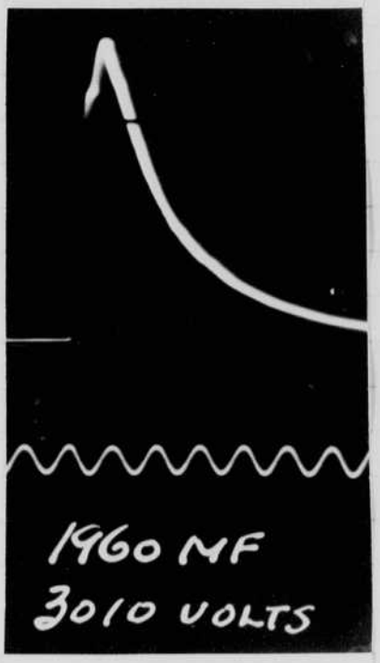

1960 MF FT17
4000 VOLTS

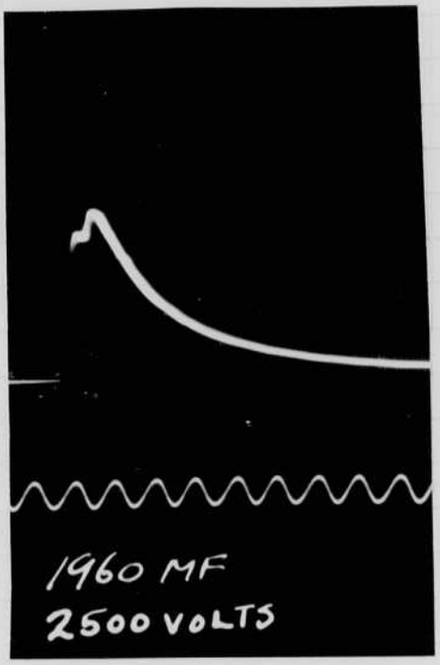


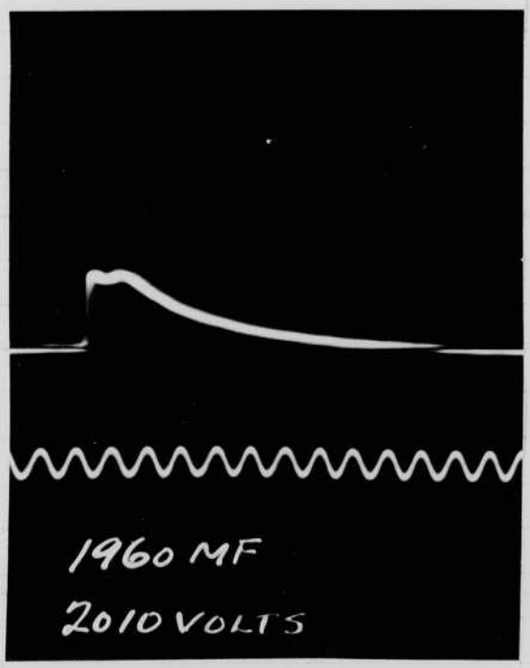


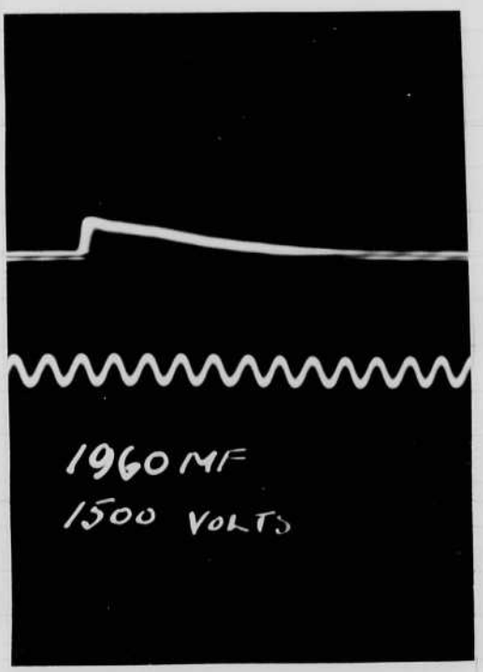


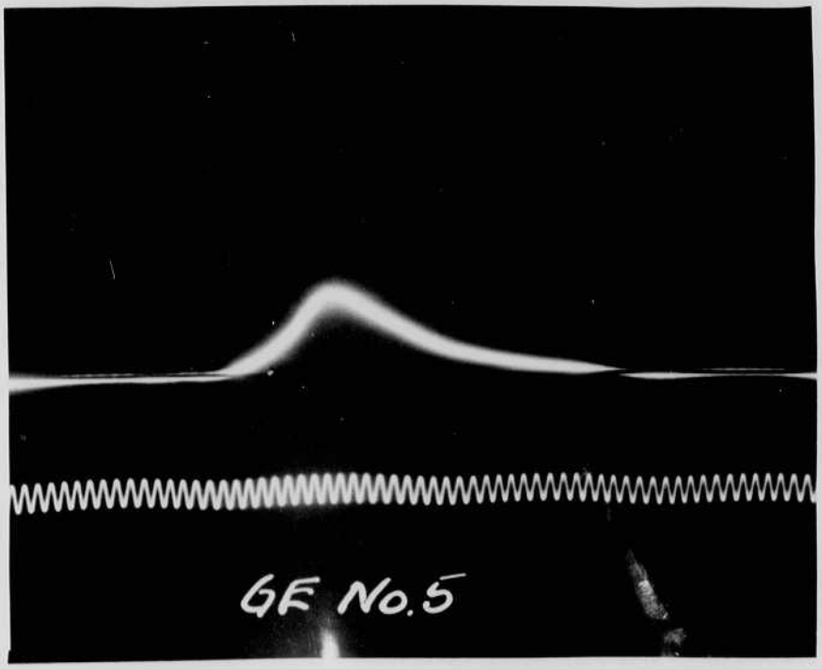

1960 MF
3500 VOLTS


1960 MF
3010 VOLTS


1960 MF
2500 VOLTS

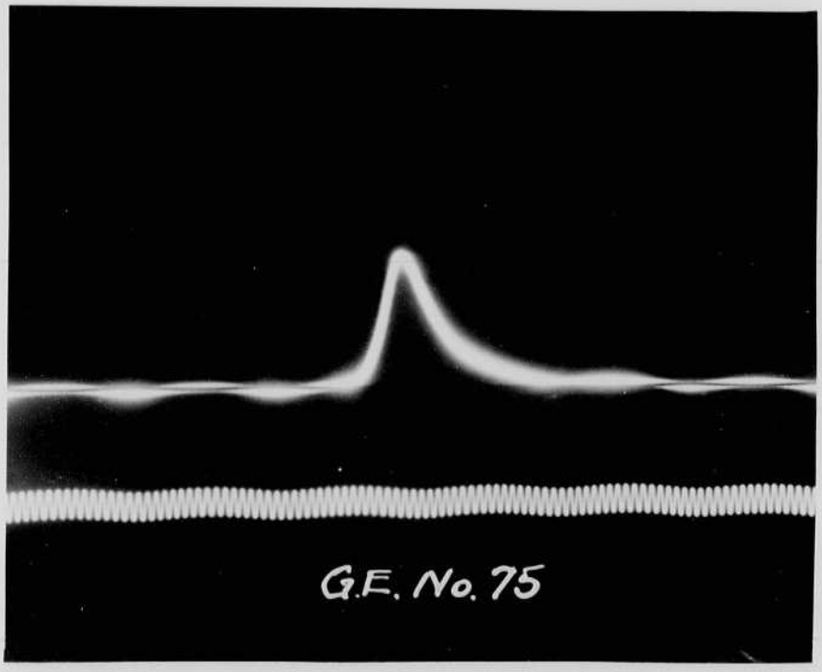

1960 MF
2010 VOLTS


1960 MF
1500 VOLTS



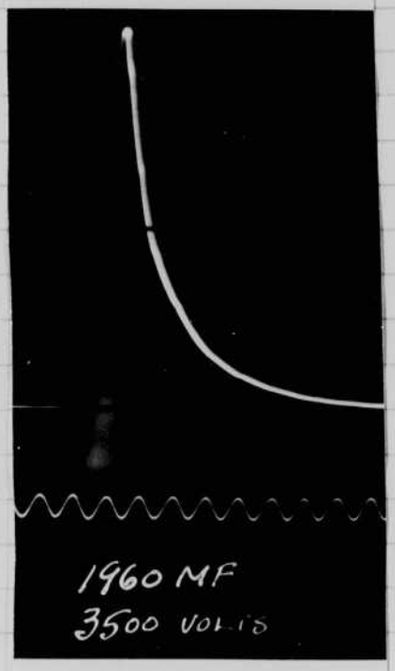
230,000 cp
2900 lumens

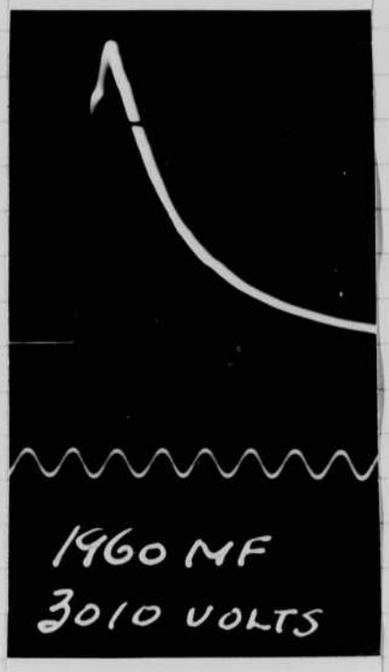
Film No 19

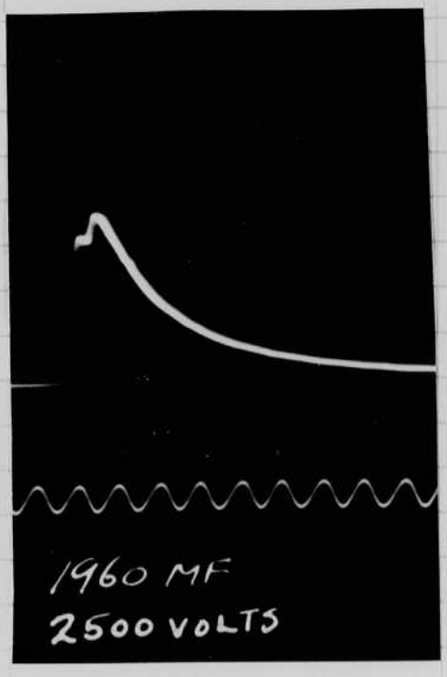


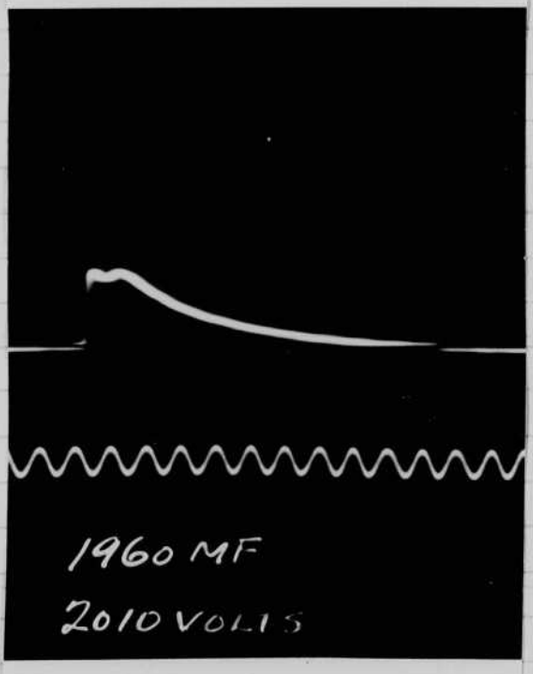
980,000 cp.
12300 lumens.

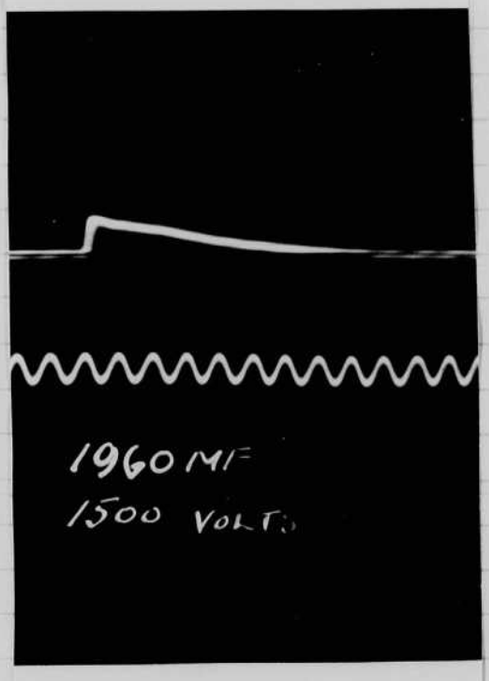
Film no 21

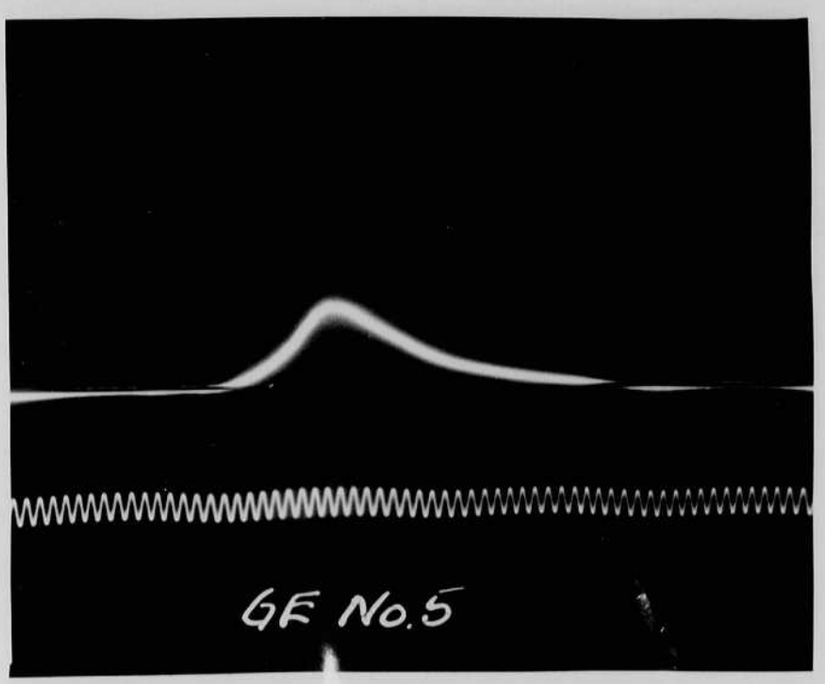

1960 MF
3500 VOLTS


1960 MF
3010 VOLTS


1960 MF
2500 VOLTS

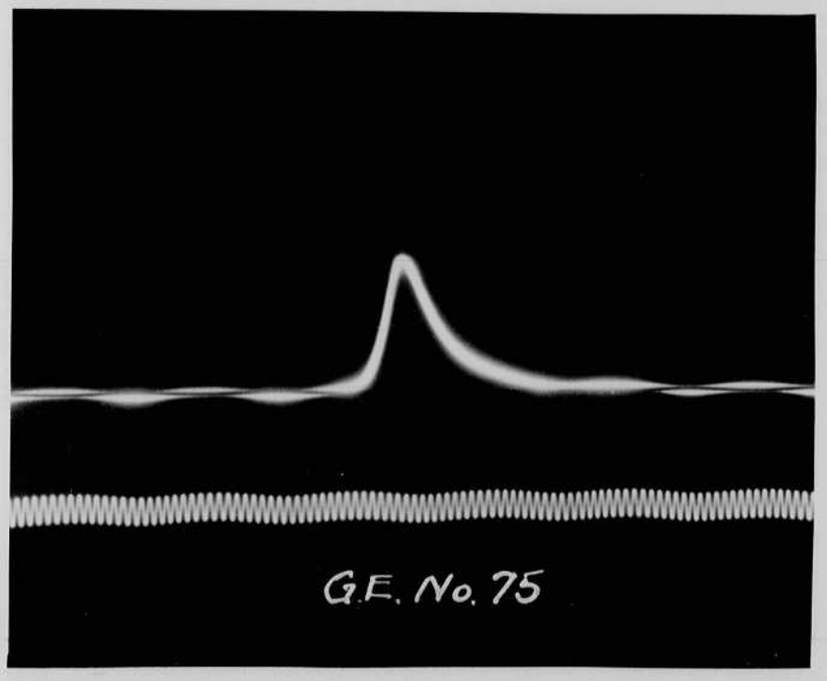

1960 MF
2010 VOLTS


1960 MF
1500 VOLTS



230,000 cp
2900,000 lumens

Film No 19



980,000 cp.
12300,000 lumens.

Film no ~~XX~~ 21

Sept 10 1943

Harold Edgerton. A20 trip to Wright Field.

Aug 31 Col Baisley and Major Tuttle arrived in Boston at airport with A20 plane.

Sept 1. Flash unit (515 pounds) installed. I went with plane to Middletown Penn arriving about 8 30 pm.

Sept 2. Continued to Wright field made two flight that night. Camera K24 out of sync.

Sept 3. Checked sync and made successful flight. 1000 ft f 2.5 class A film gave good exposure.

Sept 4. Made trip with Col Baisley to Indianapolis in A20. took photos on the way and return with the K17 camera with an f 2.5 lens. Some photos were with daylight at 7 30 pm. in rain. came out O.K. except for some blur.

Sept 5. no flight. Processed films with Darby Merrill at lab.

Sept 6. Flight with K25 camera f 4.5 1/500 sec. class A film. Photos too thin at 1000 ft. Determined that filter is not necessary at this height for condition encountered.

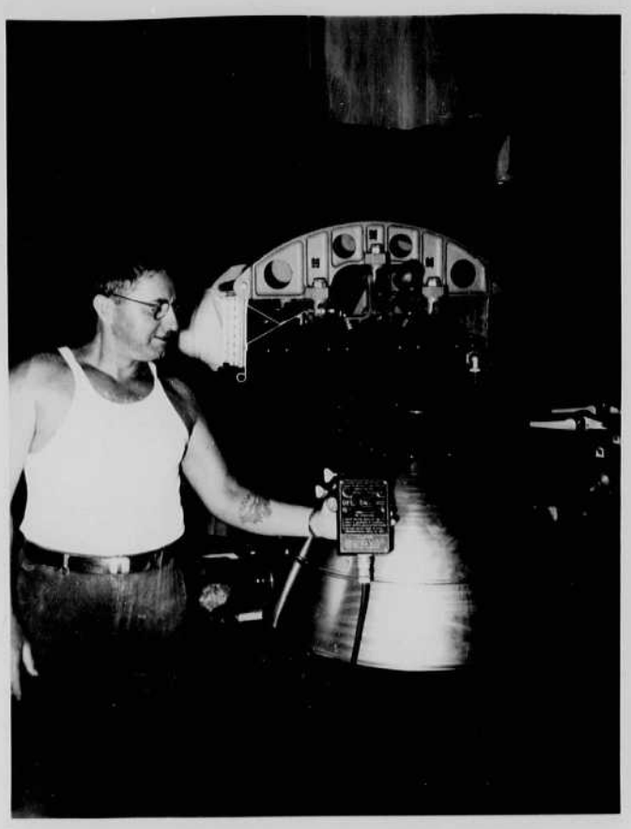
Sept 7. made flight with K 17 again excellent photos at f 2.5 class A film. at 1000 ft.

Sept 8. Baisley train for Washington Do see McClendon. Left for N.Y.

Sept 9. Saw Fairchild Co in new York. about cameras and eye cameras.

I.W. Doyle. Schubert.
Rathbun. Sanders.
J.S. Ogsbury president.

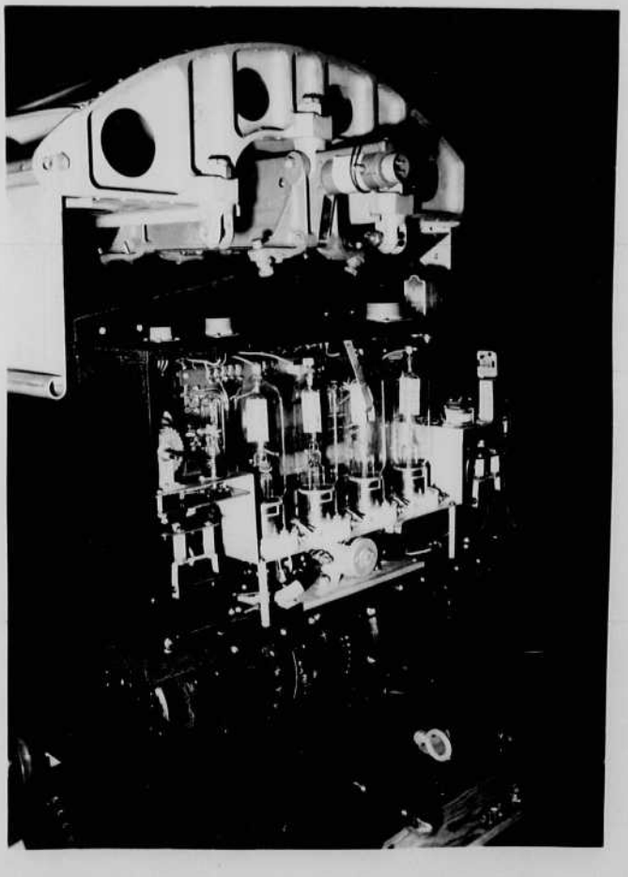
Robt Middleton - Dumsoit - navy.



Harry Lawrence with control.

Lamps & reflector.

Installation in A 20.



Cover off control box.

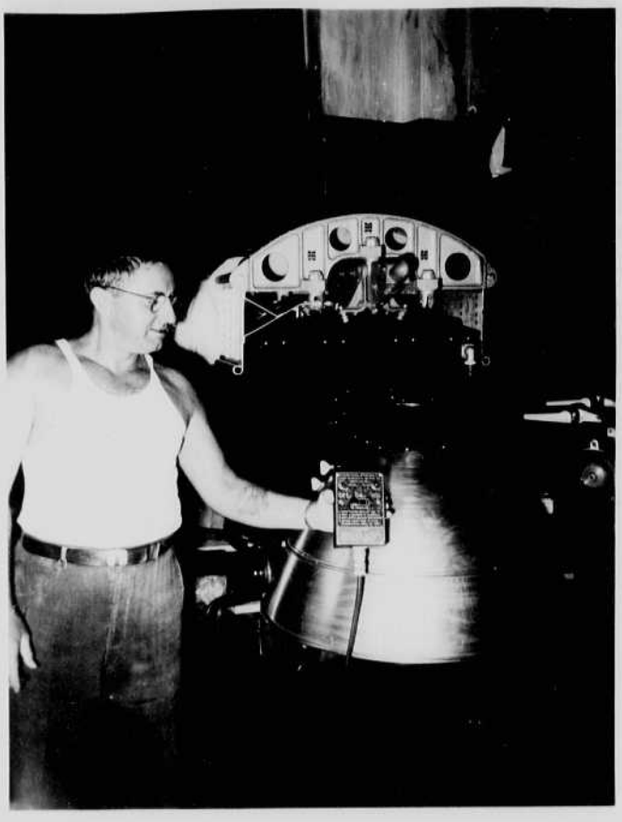
Sept 10 1943

Harold Edgerton. A20 trip to Wright Field.

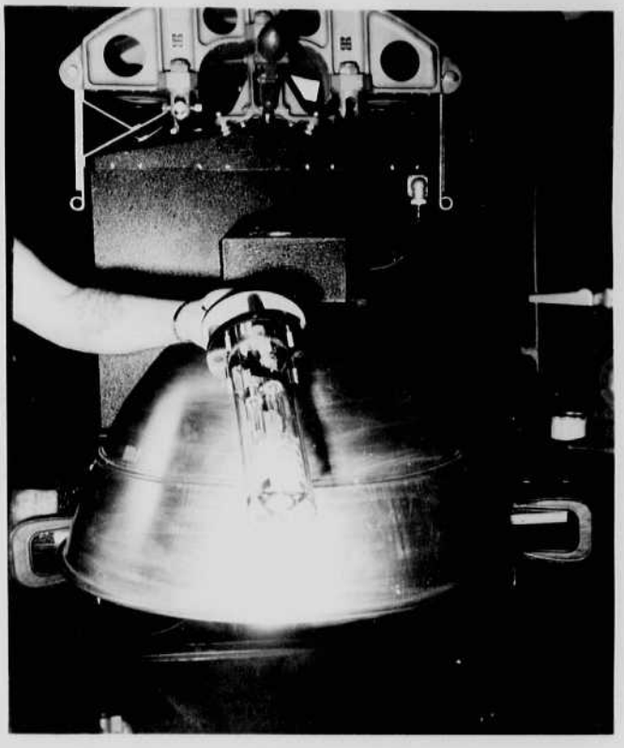
Aug 31 Col Baisley and Major Tuttle arrived in Boston at airport with A20 plane.
Sept 1. Flash unit (215 pounds) installed. I went with plane to Middletown Penn arriving about 8:30 pm.
Sept 2. Continued to Wright field made two flights that night. Camera K24 out of sync.
Sept 3. Checked sync and made numerous flights. 1000 ft f 2.5 class B film gave good exposure.
Sept 4. Made trips with Col Baisley to Indianapolis in A20. took photos on the way and return with the K17 camera with apo f 2.5 lens. Some photos were with daylight at 7:30 pm. in rain. Came out very clear except for some blur.
Sept 5. No flight. Processed films with Darby Merrill at lab.
Sept 6. Flight with K25 camera f 4.5 1/500 sec. class B film. Photos too thin at 1000 ft. Determined that filter is not necessary at this height for condition encountered.
Sept 7. made flight with K 17 again excellent photos at f 2.5 class B film. at 1000 ft.
Sept 8. Baisley train for Washington DC via McClellan. I left for N.Y.
Sept 9. Saw Fairchild Co in new York. about camera's and eye cameras.

I.W. Doyle. Schubert.
Rathray. Sanders.
J.S. Ogsbury president.

Robt Middleton - Pensacola - navy.

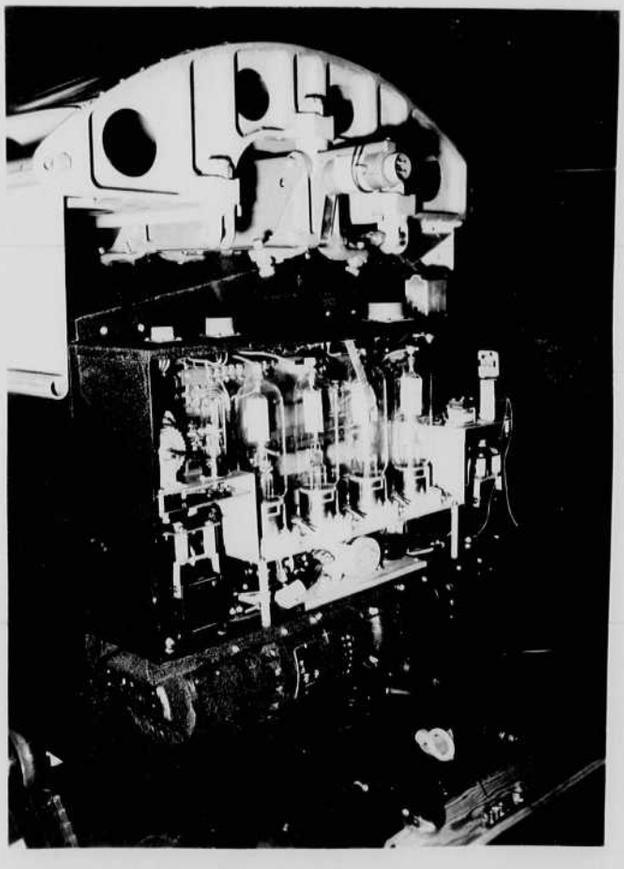


Harry Lawrence with coolant.



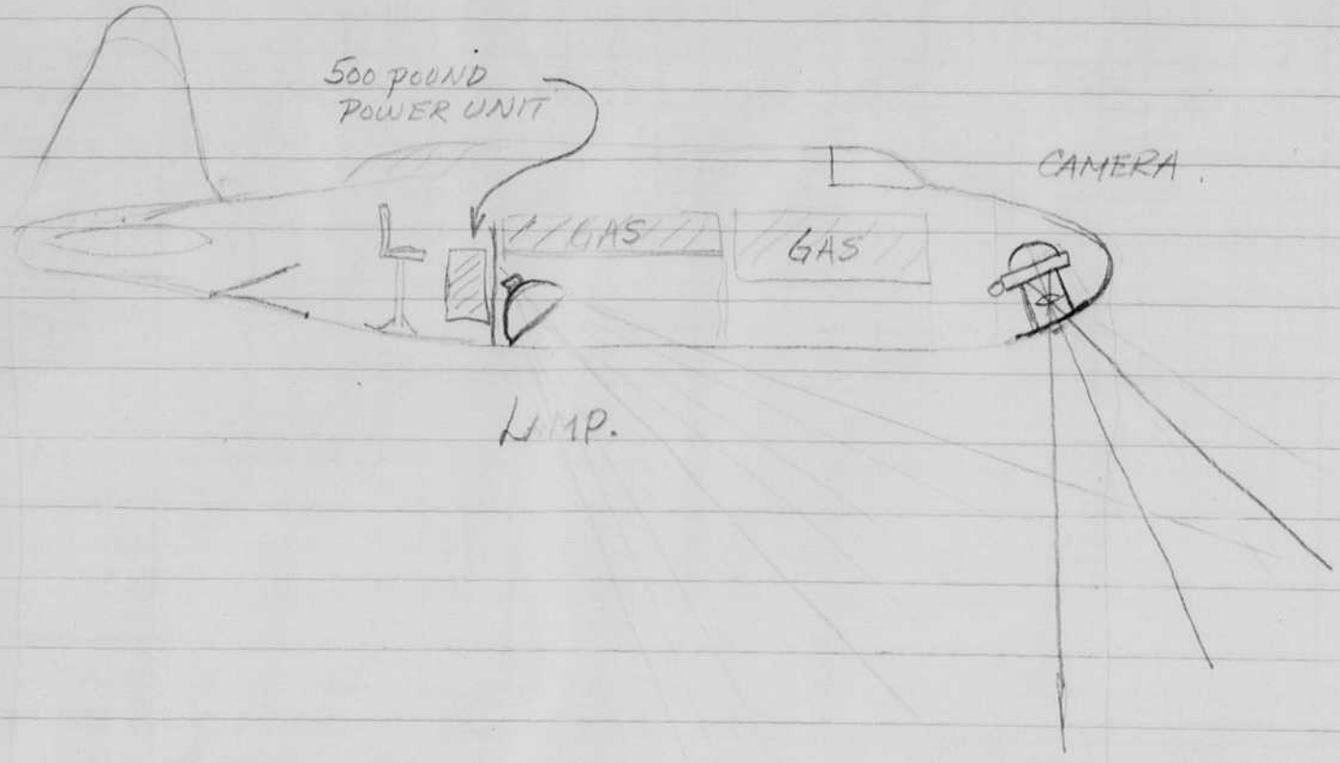
Lamp & reflector.

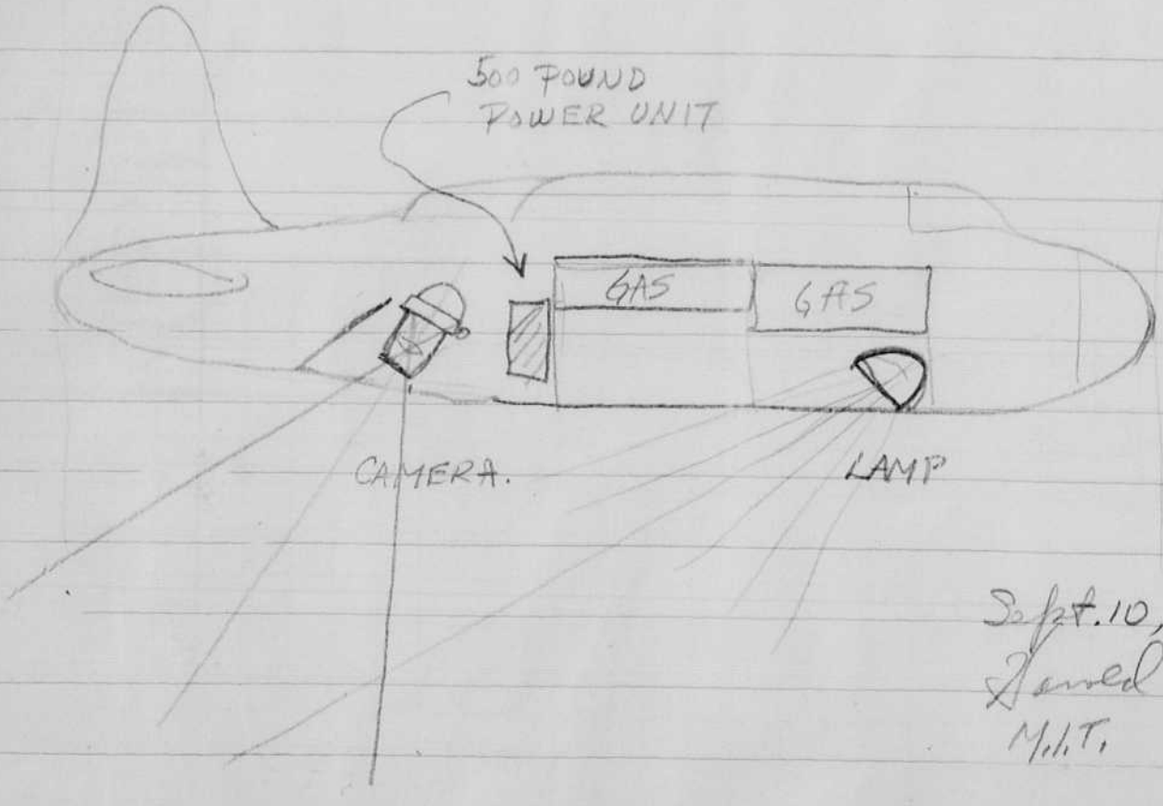
Installation in A 20.



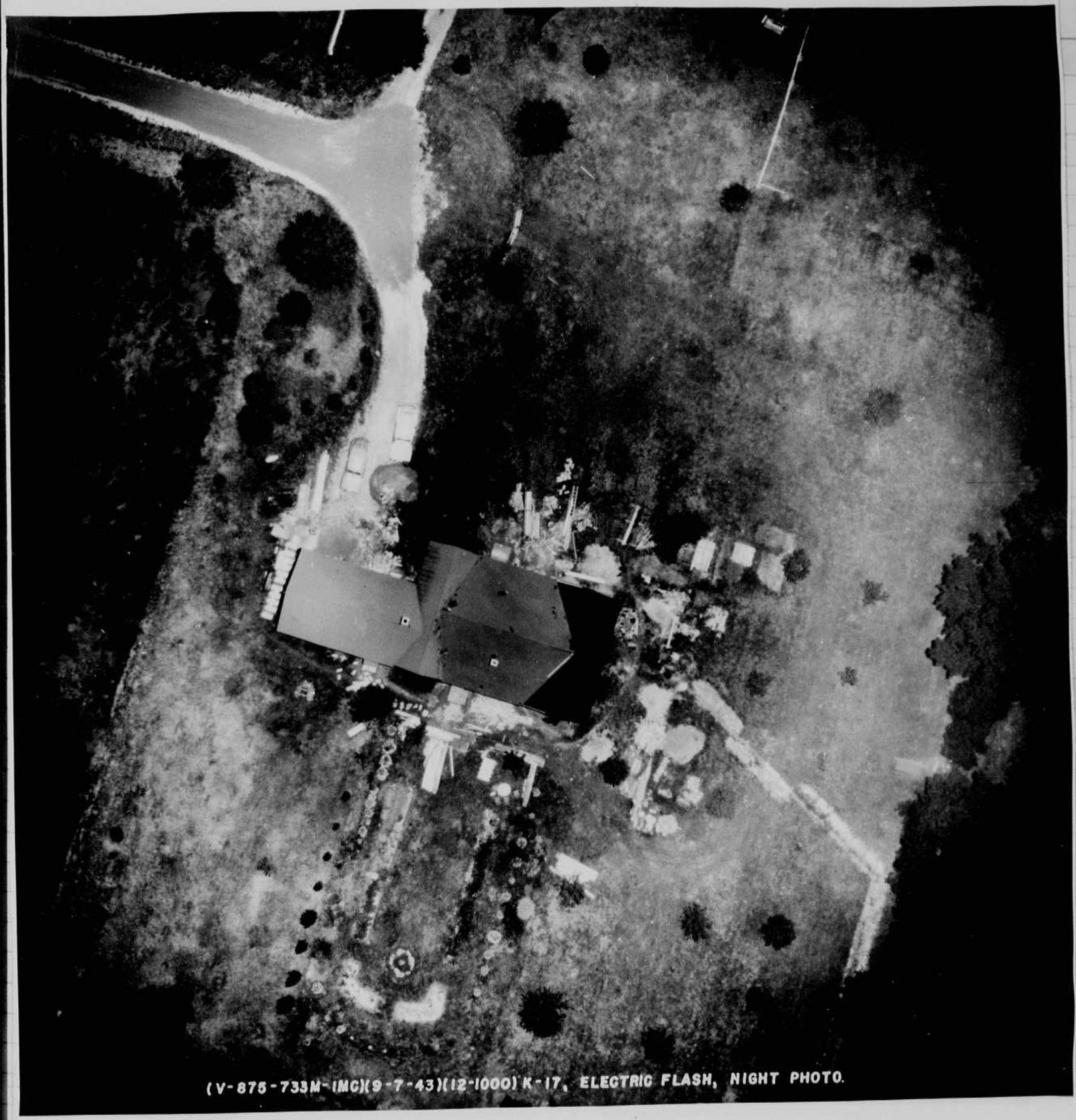
Cover off control box.

A20 Proposed installation





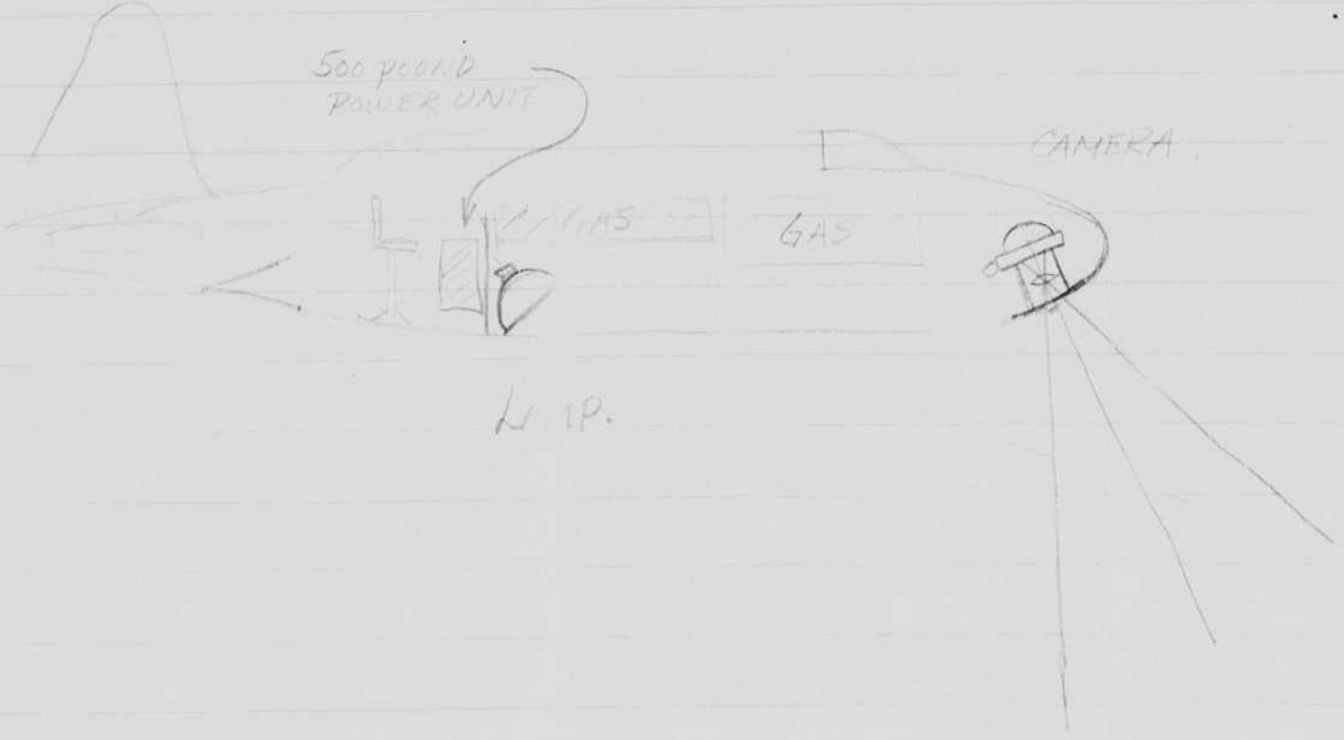
Sept. 10, 1943
Harold E. Edgerton
M.I.T.



f 2.5 Class N film.

Taken in an A 20 plane
2 - 2.30 am.
Col. Baisley.

A 20 Proposed installation



N 1P.

Sept. 10, 1943
Harold E. Edgerton
M.I.T.

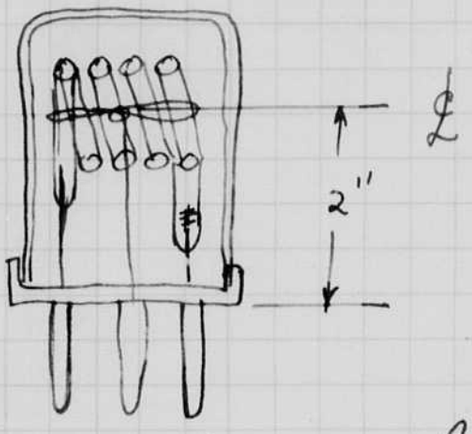
f 2.5 Class N film.

Taken in an A-20 plane
2 - 2.30 a.m.
Col. Baisley.

Sept 14 1943

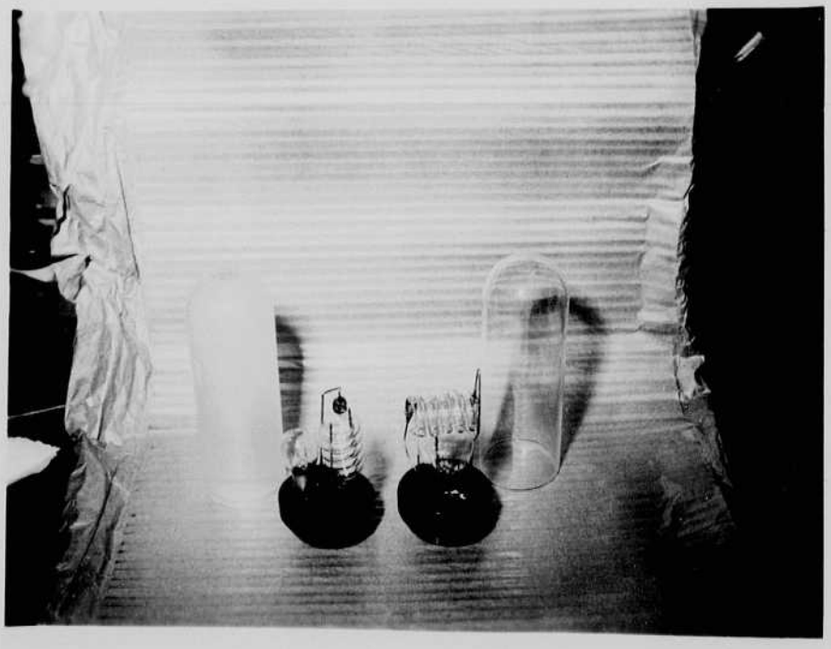
Harold E. Edgerton.

Stook Harlie to the Torpedo Station annex at Newport yesterday. Then I went to the Quonset Air station to see Morris Bell R. A. Midthun (Ens USNR Rockford 500 Ext 674). Capt. A.B. Vosseler and others.



Giant 5 prong base.

Sample lamps sent to Fairchild.



Light behind.

↑ Sound wave from a 4000 lb Bomb.

Sept 14 1943

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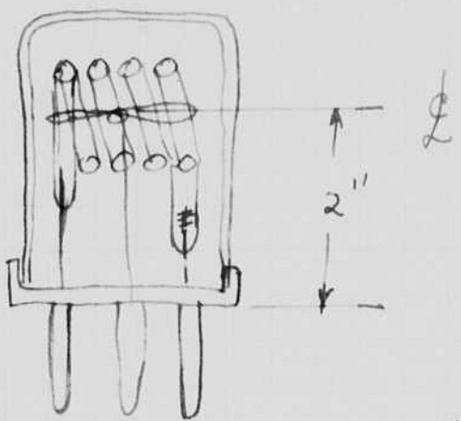

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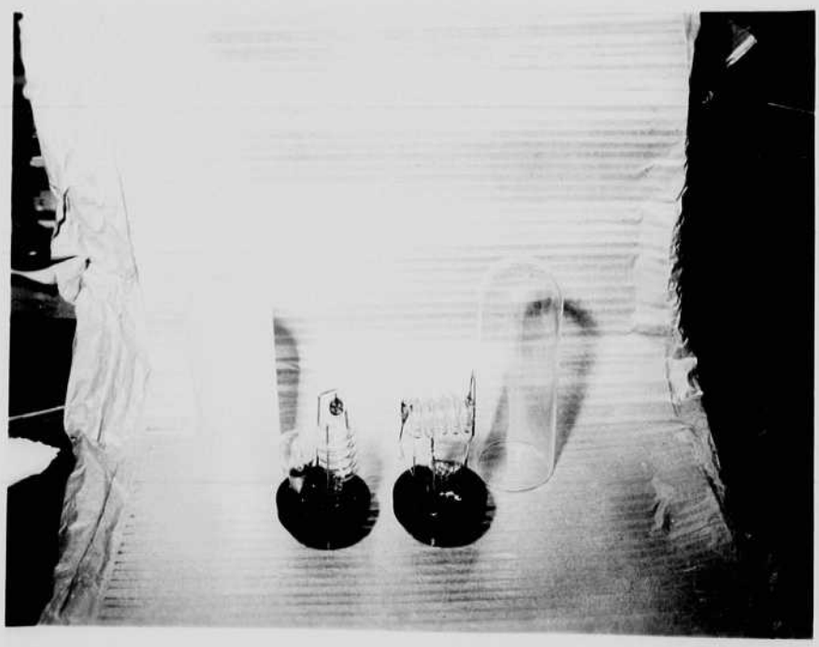

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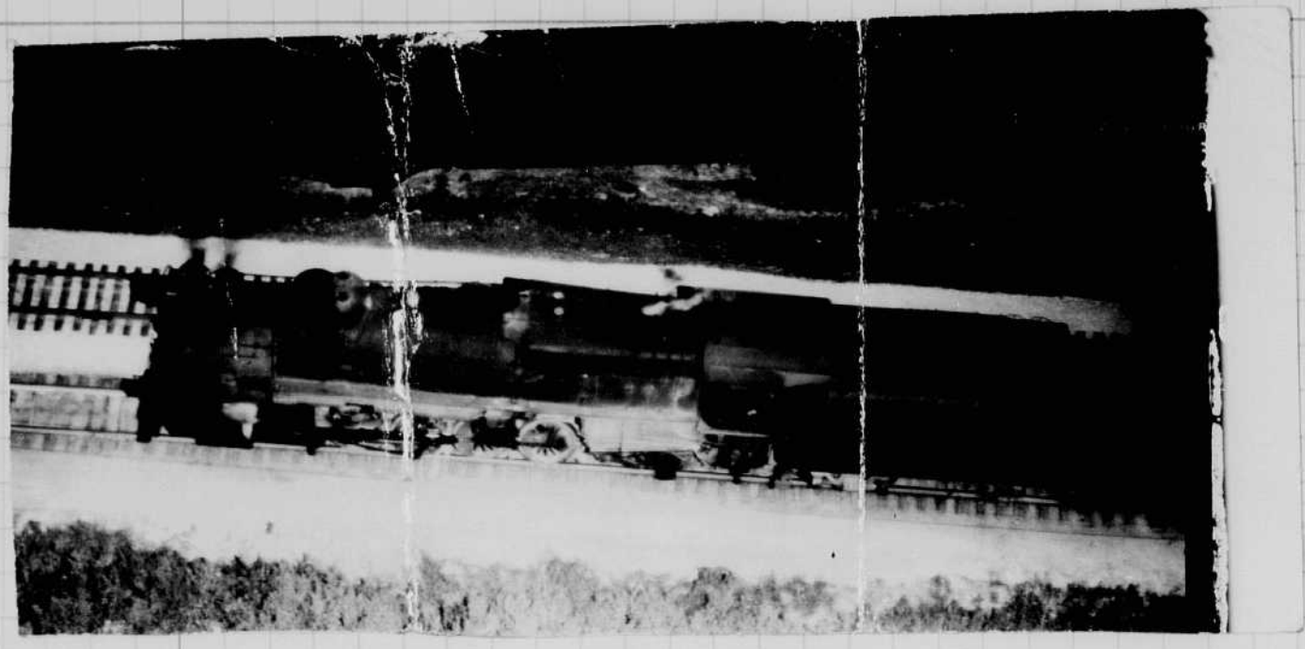


Train photographed on way from Indianapolis to Dayton. K17 camera f 2.5 at 8 pm t on a cloudy day with drizzle.

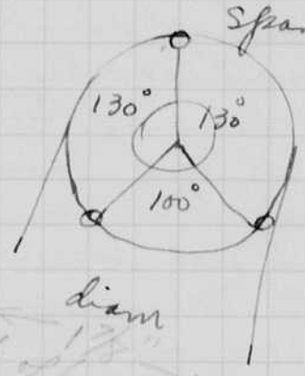
Sept 20 1943 Monday.

Harold E. Edgerton

I returned yesterday morning from Wright field Dayton where I attended a conference on beacons last Friday the 17. Those present.

W.F. Kevorns
G.E. nela Ed Noel Frank Carlson
" A W Janowitz J.P. Rutherford G.A. Eddy.
G.E. Lynn J. Peterson
Raytheon James Babb C. H. Drackley.
Electronics R H Frye

new pin and spacing as set by G.E. Co was selected as standard. Glass cylinder will be tried. Ventilator hole.



Also a glass cover was selected. This cover is the same as used in present boundary lights by the air corps.

A tube clamping device will be supplied by each.

I spent Sat. Sept 18 at W.F. with Baisley. We made a flight the night before with the B-24 unit & test 30° and 40° lamps. Capt. Merrill operated the f 1.5 camera K24. No stopping differences were noted in the negatives. The 30° lamps did give a more spotty negative.

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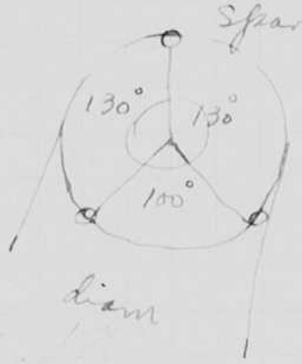

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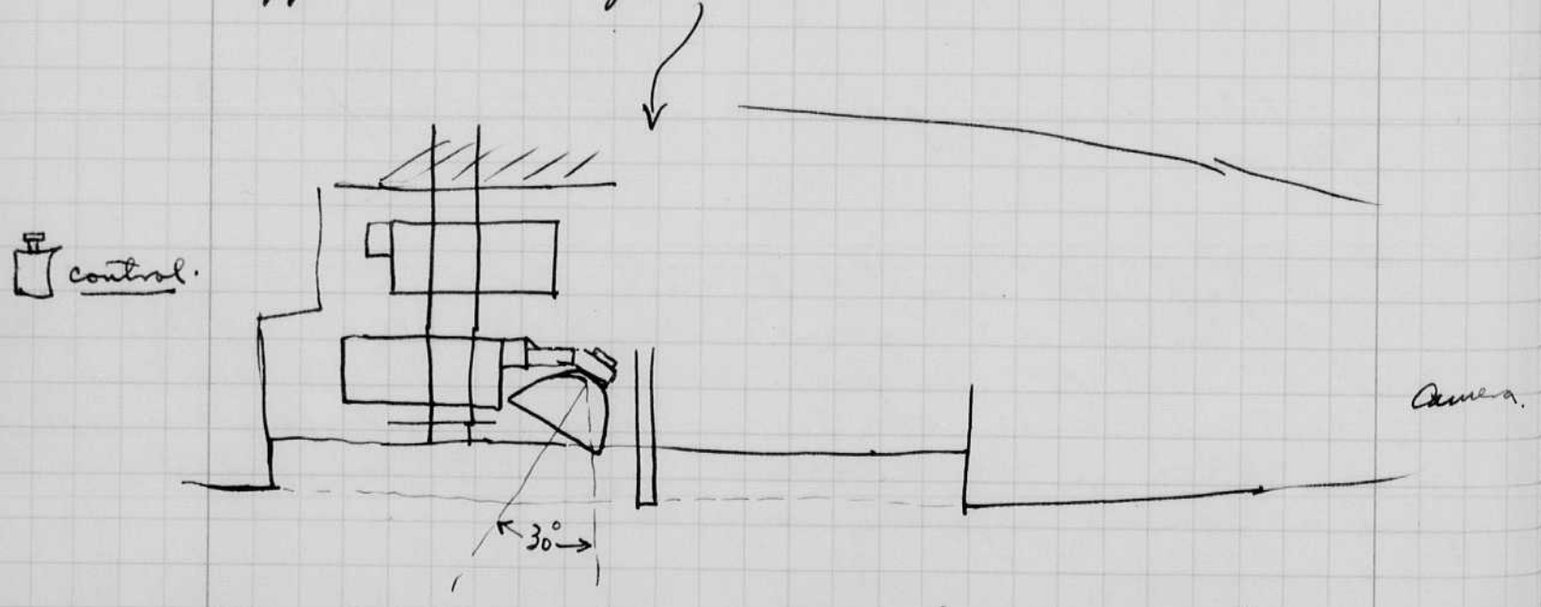
Friday Sept 24 1943
Harold E. Edgerton

I was in Rochester at the Eastman Co all day Wednesday the 22nd.
Discussed 3 per second camera with crumrine, Christie and Green. Rotating discs and special focal plane shutters were covered in connection with the K 24 camera.

Sept 29 → ↑Conf. also with Mentch, Boone, Scott Vaughn, Dillon, Farrow, Clarke, etc.
Retd. to Boston on 6.20 train. Saw Ruth Margaret McMorran at Syracuse.
Baisley - Borden in a B-24 plane had arrived in Springfield Westover field on Wednesday. They brought 4 men with the 4 condenser banks. We are to put a M-G set on the end of each with rectifier tubes etc. A conf was held with Baisley on thursday morning. Then we went to Westover to try the banks in a reversed condition. The lower banks will be reversed and the lamps tipped to 30 degrees.



Two additional banks are to be added to the rear bomb bay making a total of 6 banks that is 6000 microfarads at 4000 volts. Tests show that the Quartz lamp No 17 will operate ok with 4000 mf at 4000 volts.

Total weight = 850 x 6 = 5100 pounds for condensers.
= 700 " " control & chg.
5800 pounds.

Two thirds of this will be in the front bay. 1/3 in the rear.

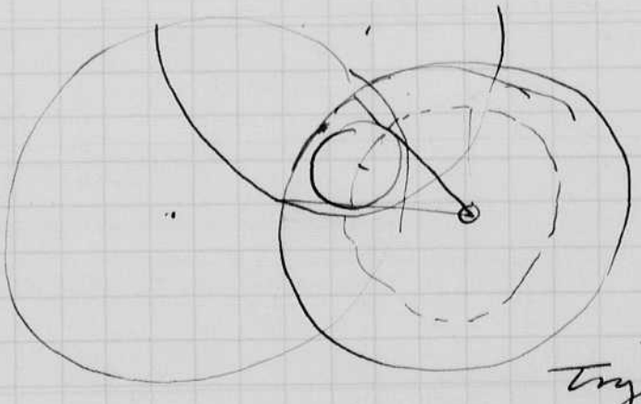
The control will be near the pilot. The camera will be remote control near the rear turret.

More tests were made with the electrolytic condensers. Data in letter to Joe Hood, Mallory and in Blue book on light data. At 70° the electrolytic condensers are 3 times as good as oil per unit weight.

Rotary Shutter

f2.5 lens 8" has a 3" hole to uncover.

I suggest 3 discs geared together to operate at 3" per second.



8 / 45 | 360 — 45° opening.

.01 sec exposure.

.08 sec per rev. or

1/.08 = 12.5 rev per sec.

Try 70° opening and .005 sec.

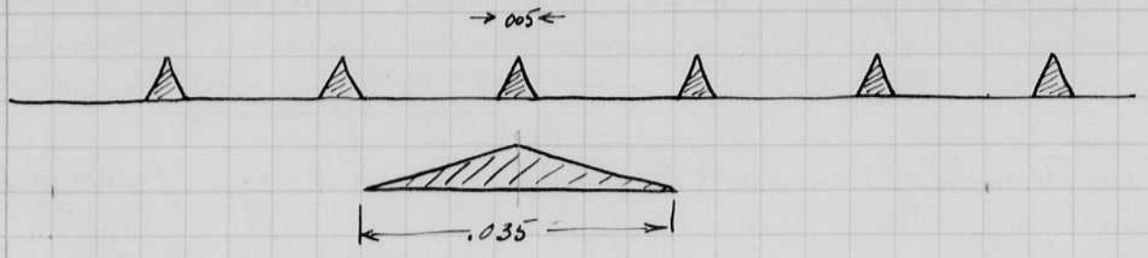
~~80~~.0 rev per sec.
= ~~2400~~ 3000 r.p.m.

The second wheel .01 x 5 sec. min exp.
90° .015 x 4 = .060 sec per rev.
or 1/.06 = 16.7 r.p.s. 1000 r.p.m

Third wheel. Third wheel 90° .06 x 4 = 0.24 sec. 1/.24 = 4.16 r.p.s.

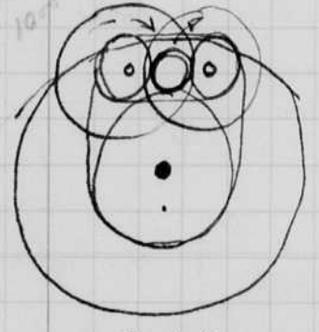
Shutter.

Sept 29. 1943.

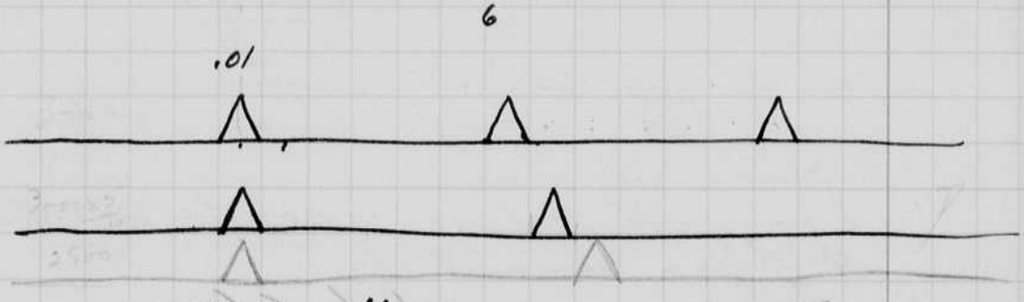


1st disc. Min Exposure = .005 sec 90° disc
Time ~~speed~~ = 4 x .005 = ~~.00~~ .02
speed = $\frac{1}{.02}$ = 50 r.p.s or 3000 r.p.m.

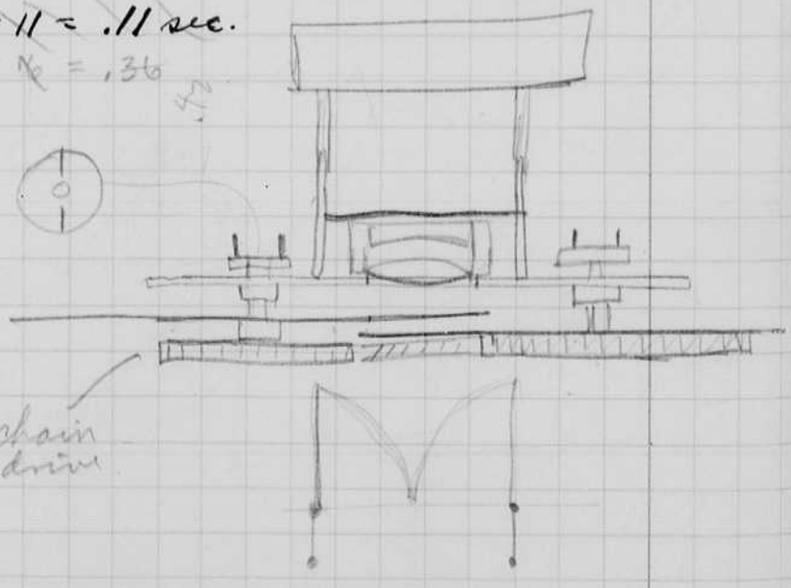
2nd disc min exposure = .035 sec. 90° disc
Time per rev. = 4 x .035 = .140
speed = $\frac{1}{.140}$ = 7.15 r.p.s or .428. r.p.m.

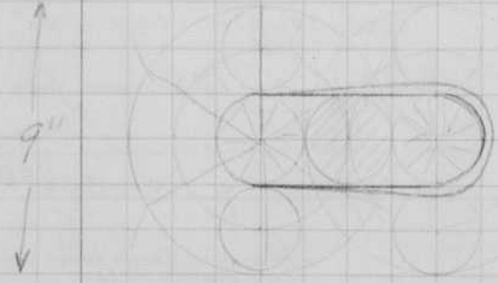


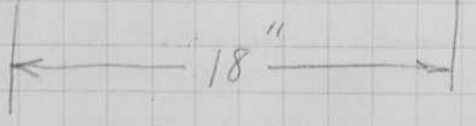
3 r.p.s.

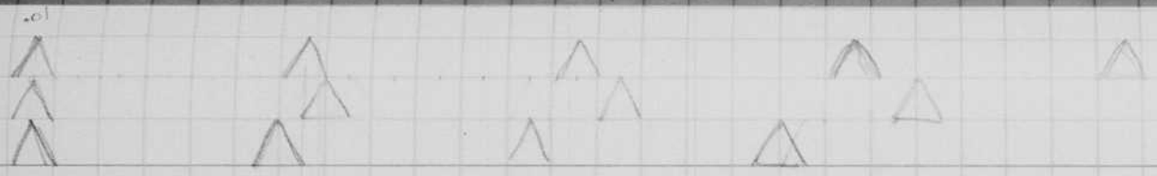


.01 x 11 = .11 sec.









Ratio speed.

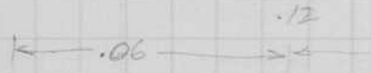
1. 1/6 = 60° hole = .01 sec time = 6 x .01 = .06 speed = $\frac{1}{.06} \times \frac{1 \text{ hole}}{60} = 1000$ rpm 12

2. 60° = = 6.5 x .01 = .065 13

3. = 5.5 x .01 = .055 11

12 holes for full opening to come up.

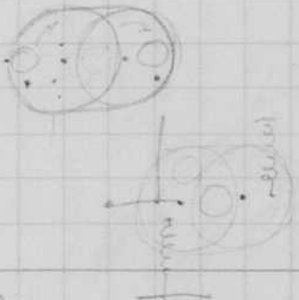
12 x .06 sec = .72 sec. between flashes. too long.



Use two discs as shown 1 hole

7 x .06 = .42 sec. between flashes.

speed up to get 3 per sec. $\frac{.42}{.33} = \underline{1270 \text{ rpm}}$ for fast disc



actual exposure time will be less than .005 sec. since discs rotate in opposite directions.

$\frac{1}{\text{rev}} = \frac{60}{1270} = .054$ sec. $\times \frac{1}{6} = .009$ sec.

Bishop

Oct. 5, 1943.

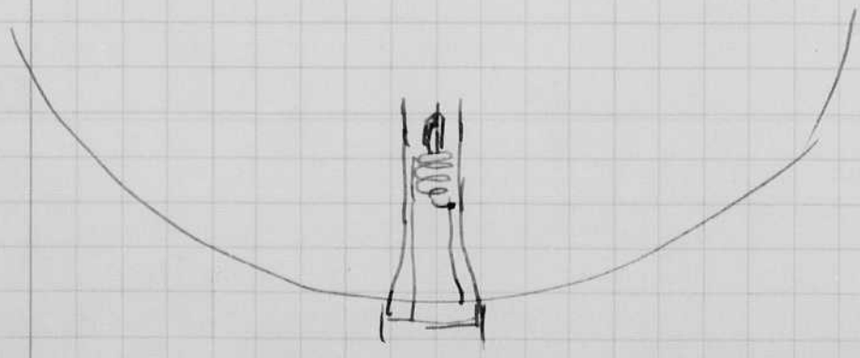
Dowed E Eyerly.

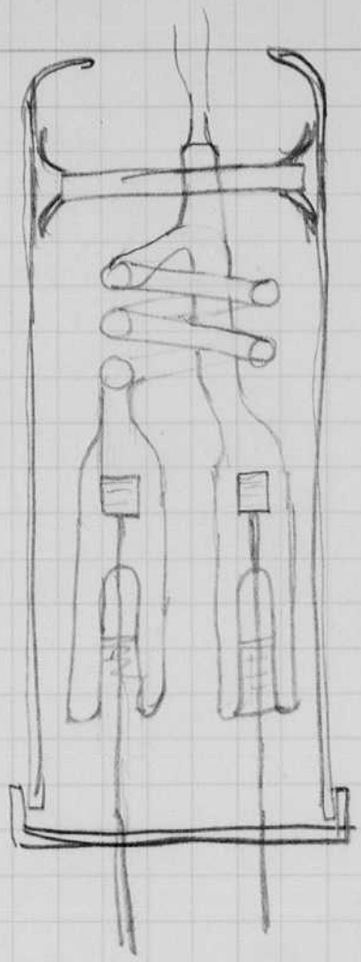
Discussed disc shutter with Dunham and Harrison yesterday. Wrote Commins at Eastman.

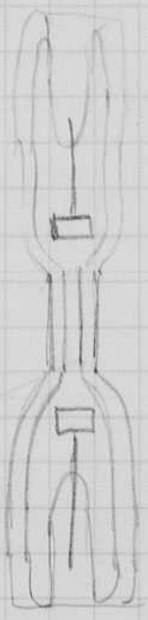
Obtained second glass cylinder (pyrex) with yellow coating from Dave Lee at Polaroid. The first cylinder was just around a No 17 flash tube and which was flashed tried with ~~36~~ 4000 mf at 4000 volts. There was no trouble except for several very small surface cracks.

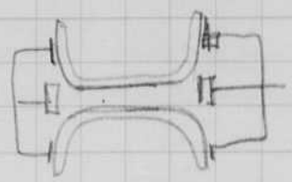
Tried Quartz # 3 tube last night with 14 mf at 4000 volts at 5 flashes per second.
The anode became red hot after a short run of 20 or 30 sec. After a minute ± the tube stopped. It looks like the cathode seal is cracked. This tube had a sintered W & Ni & $BaCO_3$ cathode pill. There was no sputtering.

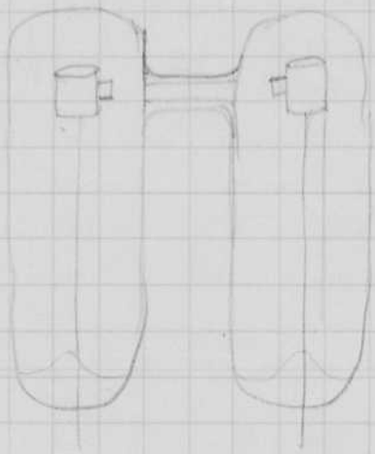
The lamp tended to double flash when hot. If a blast of air from our blower (50 v) was used, there was no double flashing.

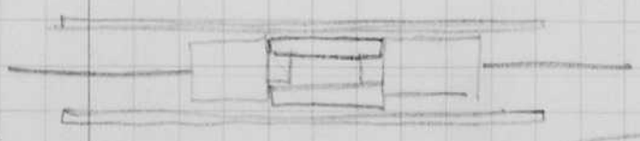


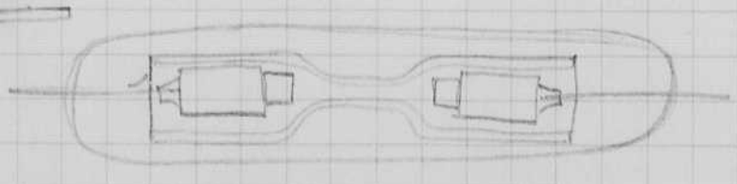


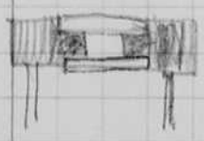


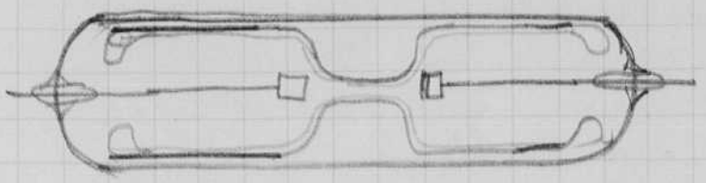


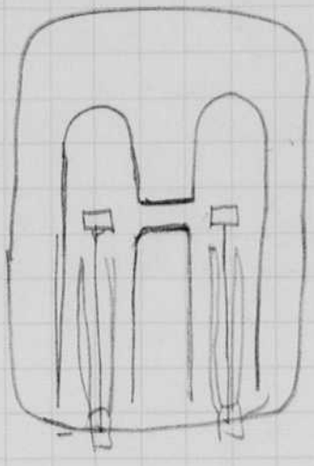


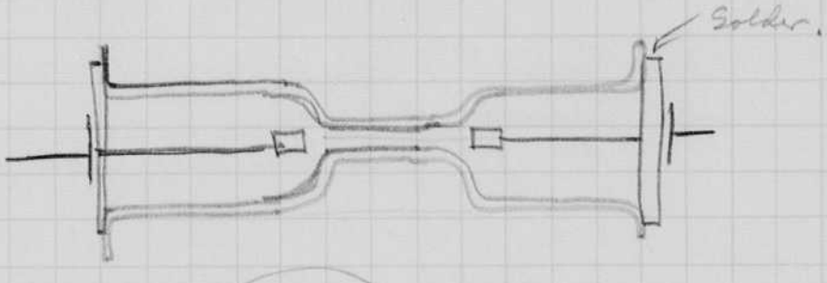


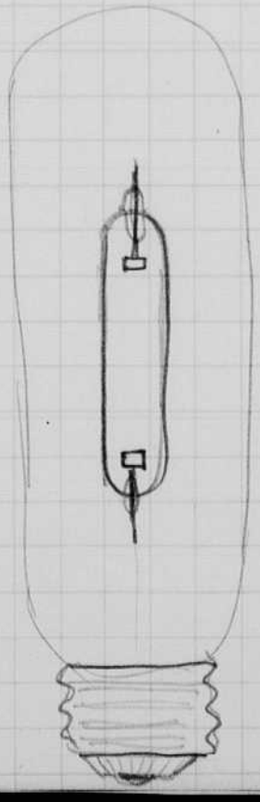









Solder.



Oct. 5, 1943.

Harold E. Edgerton Illumination systems.

Neon gas tubes have been shown experimentally to have a very high efficiency for high currents. The lamps will eventually be used as a continuous light source although now used only for a stroboscopic source. One reference

Comptes Rendus Vol 203 1936
pp 1341 Dec 14 1936 meeting.

Marcel Laporte
Jean Perrin
1 sq. mm? tubes.
$\frac{12{,}000}{1500}$ $\frac{\text{lumens}}{\text{watt}}$ = 8 lumens/watt.

Light meas. See Laporte & Dano C.R. 203 1936 p62
time meas. also Laporte Pierrejean J. de Physique
7th series 7 1936 p248.

Oct 5 1943

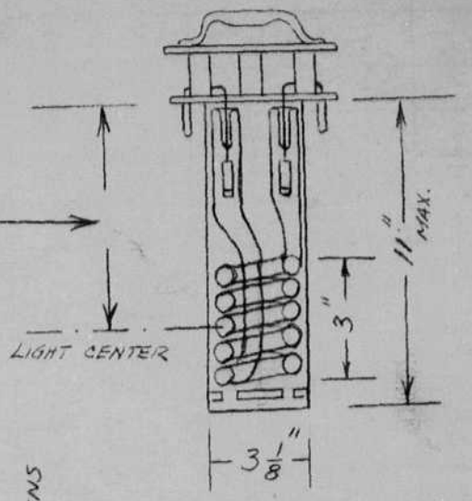
FLASHTUBE FT-17
TECHNICAL DATA (TENTATIVE)

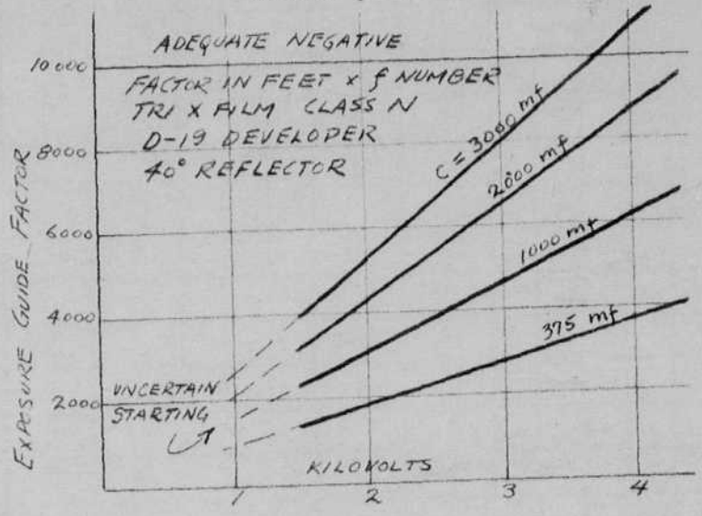
USE: Flash Photography and Visual Signal Beacon.

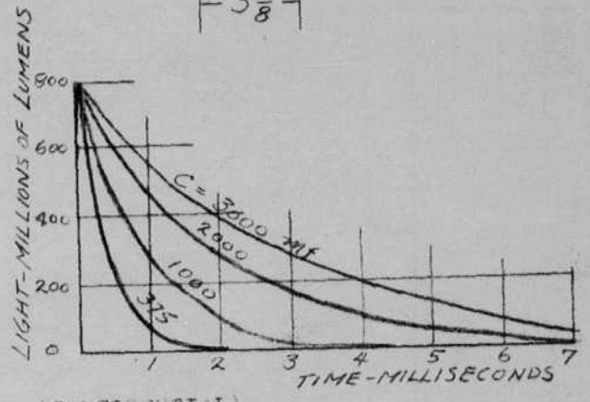
Description: Five turn spiral of 13mm quartz tubing filled with Xenon.

Lamp resistance = 2.5 ohms
Lumens per watt = 125 approx.
Light coverage in 30" reflector 30° 6-3/8"
40° 7-5/16"
50° 8-1/16"

For exact tube and reflector dimensions see M.I.T. prints HA-500 & HA-406







TYPICAL OPERATIONAL PHOTOGRAPHIC DATA (CONFIDENTIAL)

TYPE D-2 Flash Unit (for A-20 Airplane) Weight 500 pounds

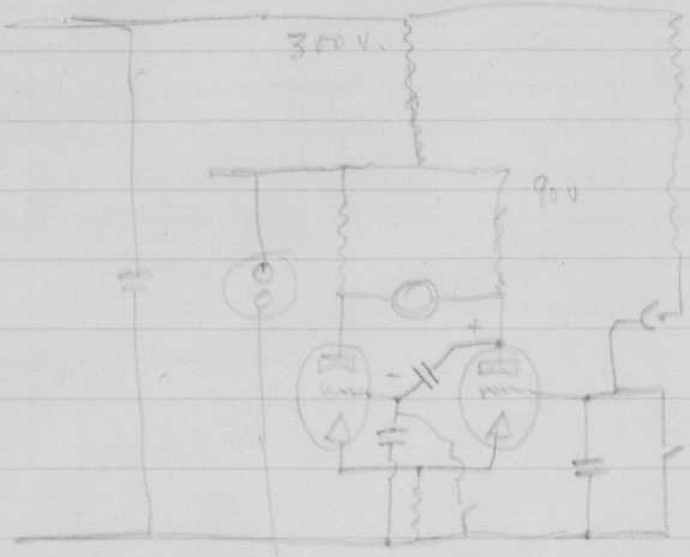
Altitude 5000 ft. (thin negative), 2500 ft. (adequate negative)
Lens f/1.5, Class N Film, D-19 Developer.
Guide factor 7500 (thin negative), 3750 (adequate negative)
Minimum interval between flashes 1.2 seconds.
Exposure time (1/3 peak) 0.7 milliseconds (1/1500 sec.)
One FT-17 tube is flashed from a 375 mf condenser charged to 4000 volts.
With f/2.5 lens - altitude 3000 ft. (thin negative), altitude 1500 ft. (adequate negative)

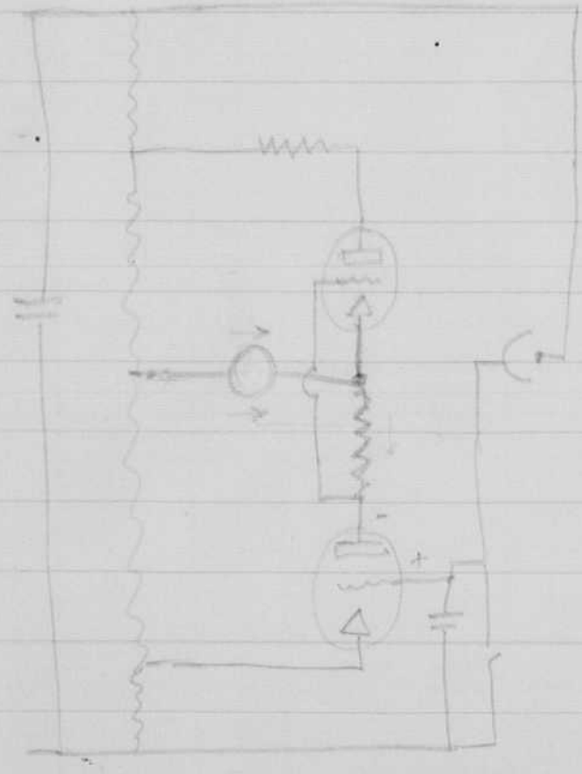
TYPE D-3 Flash Unit (for B-24 Airplane) Weight 5400 pounds

Altitude 20,000 ft. (thin negative), 10,000 ft. (adequate negative)
Lens f/1.5, Class N Film, D-19 Developer
Guide factor 30,000 (thin negative), 15,000 (adequate negative)
Minimum interval between flashes 6 seconds.
Exposure time 3 milliseconds (1/300 sec.)
Two FT-17 lamps used, each with 3000 mf at 4000 volts.
This equipment is in six units, two of which carry the lamps and reflectors.
Weight can be reduced in fractions of 1/6 with corresponding reduction of light.
A filter (minus blue #12) is recommended for high altitude to minimize the fog from scattered blue light from the beam.

M.I.T., Cambridge, Mass., Oct., 1943
H.E.E.

Oct 5 1943 H.E.H. These circuits were drawn several weeks ago. Push pull telegraphing clubs.





Oct 5 1943

HE Edgerton. Tests with lamps, flash.

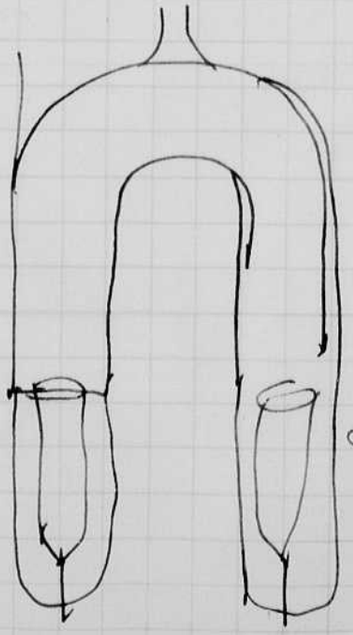
Quartz lamps.

14 mf 3500 volts – exploded tube.

Checked over in Room 8-101
after 1 hour on system 220 volts.
thermo couple gage reads 820° F.
No. M. 12008.

830° F

Short flash tube repumped. .5 O_2 + 20 AR.



Small craze from last pumping.
started at 2000 on pump.

Sealed off 5 movie lamps
at same pressure (3) and
2 at 10 cm.

10 cm movie lamps were
run with an external electrode.
Capillary darkened near one
side after 20 sec operation.
The side next the sparker is
the one that darkens.

A 20 flash unit

Sept. 1943.

Boston airport.

GRIER BAISLEY MCROBERTS
EDGERTON BARSTOW

Weingart Sucheski Baisley
Grier

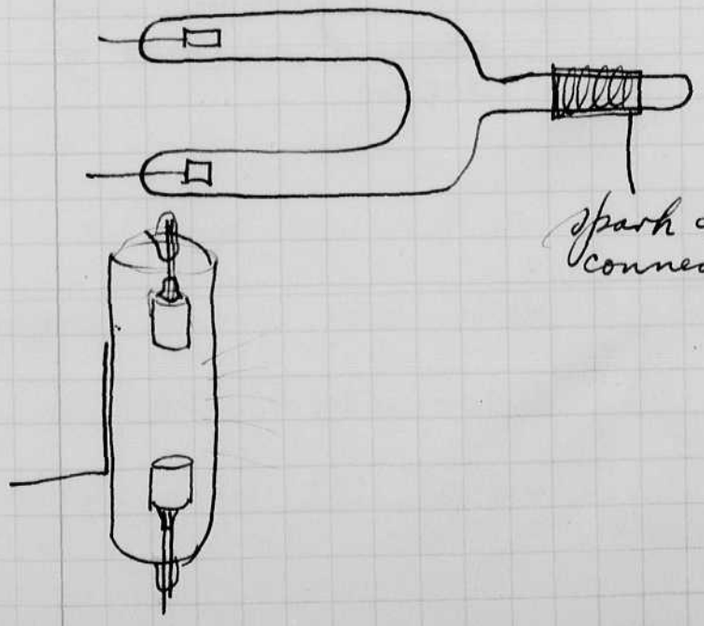
Oct 8 1943
Frank D Egerton

movie lamp design

Oct. 9, 1943.

A movie lamp with .25 cm H_2 + 10 cm argon was run on 2000 volts with 6 mf with an outside starting electrode. After 1/2 minute operation, the quartz liner was examined. It was noticed that the side nearest the spark circuit was darkened. I turned the tube over and repeated the experiment with the same result. Later the lamps were run in a movie apparatus and they ran ok.

A method of doing this without a side spark is shown below



The starting surge will pass down the tube without setting up a field on the surface of the lamp.

Tube on bottom of 117 page would not start as pumped. Repumped and sealed off with argon 20 cm. Exploded with 2 mf 2000 v on test. Glass too thin at seal off.

A 20 flash unit

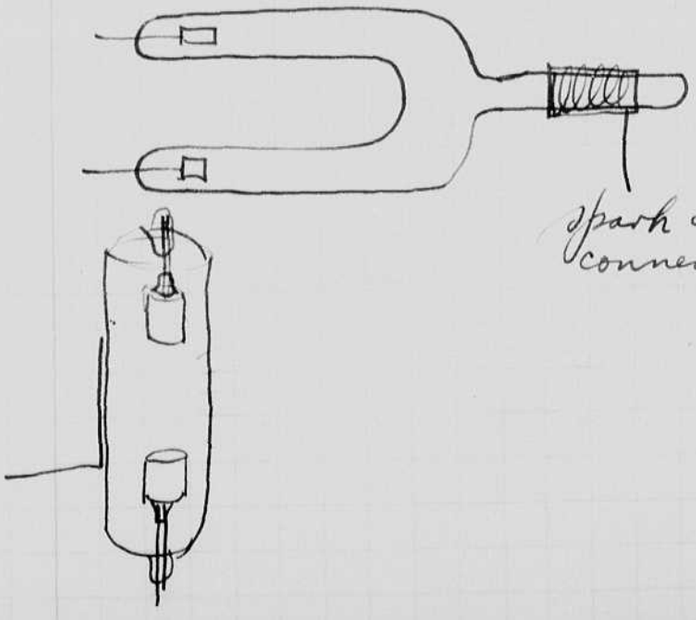
Sept. 1943.

Boston airport.

Oct. 9, 1943.

A movie lamp with .25 cm H_2 + 10 cm argon was run on 2000 volts with 6 mf with an outside starting electrode. After 1/2 minute operation, the quartz liner was examined. It was noticed that the side nearest the spark circuit was darkened. I turned the tube over and repeated the experiment with the same result. Later the lamps were run in a movie apparatus and they ran ok.

A method of doing this without a side spark is shown below

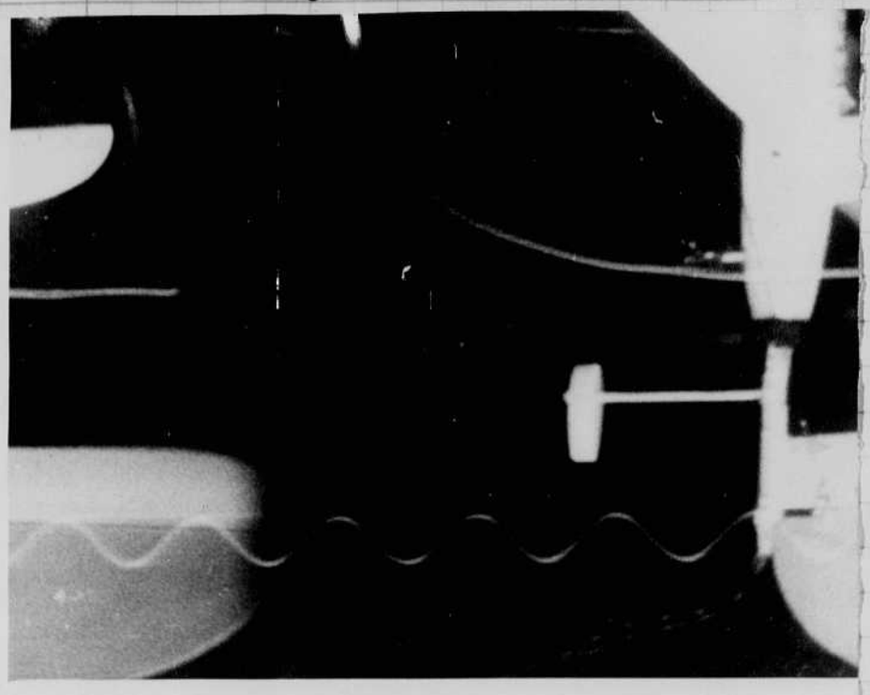


The starting surge will pass down the tube without setting up a field on the surface of the lamp.

Tube on bottom of 117 page would not start as pumped. Repumped and sealed off with argon 20 cm. Exploded with 2 mf 2000 v on test. Was too thin at seal off.

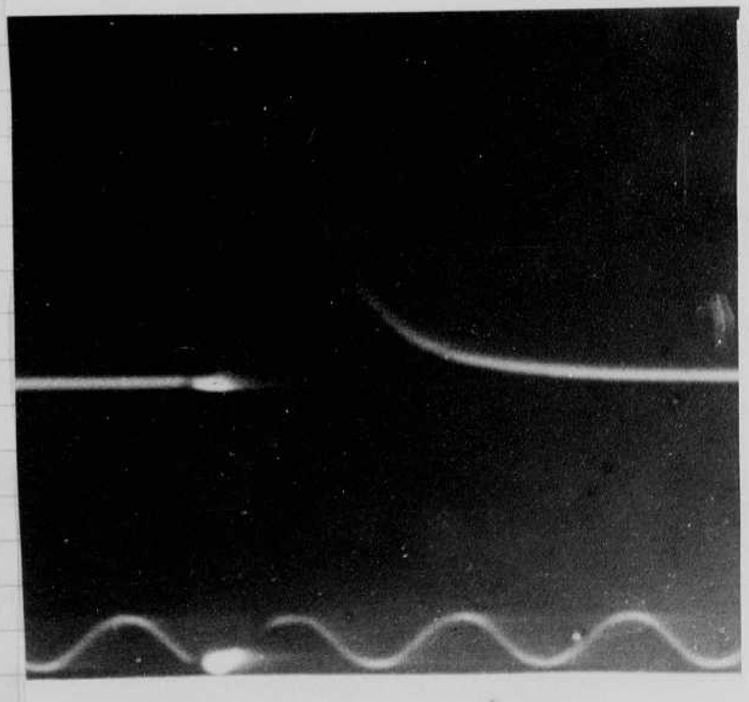
Oct 13 1943

Harold E Edgerton



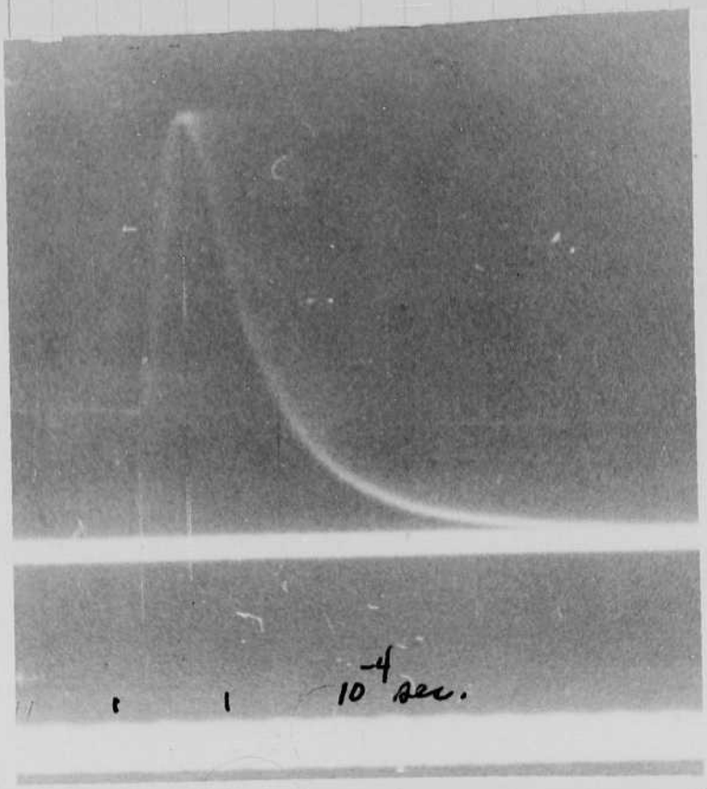
this oscillogram was taken last night with help of Newton Feldman, a senior who is to do a thesis on the volt-amp characteristics of flash lamps.

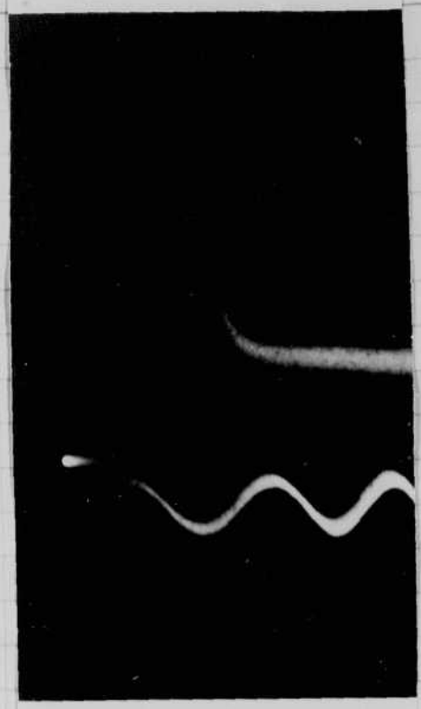
Light-time oscillogram
56 mf 2100 volts.
Quartz spiral, small type
10,000 cycle timing wave.



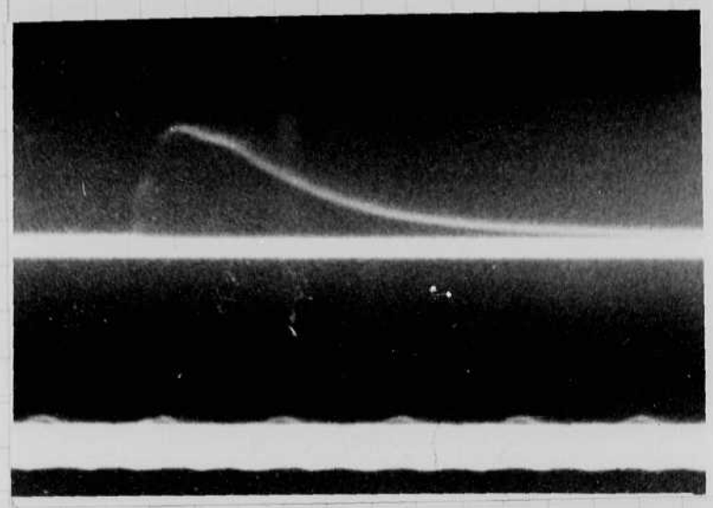
~~Same~~
25 mf
2500 volts.

10,000 ohms in plate ckt. circuit instead of 500,000.





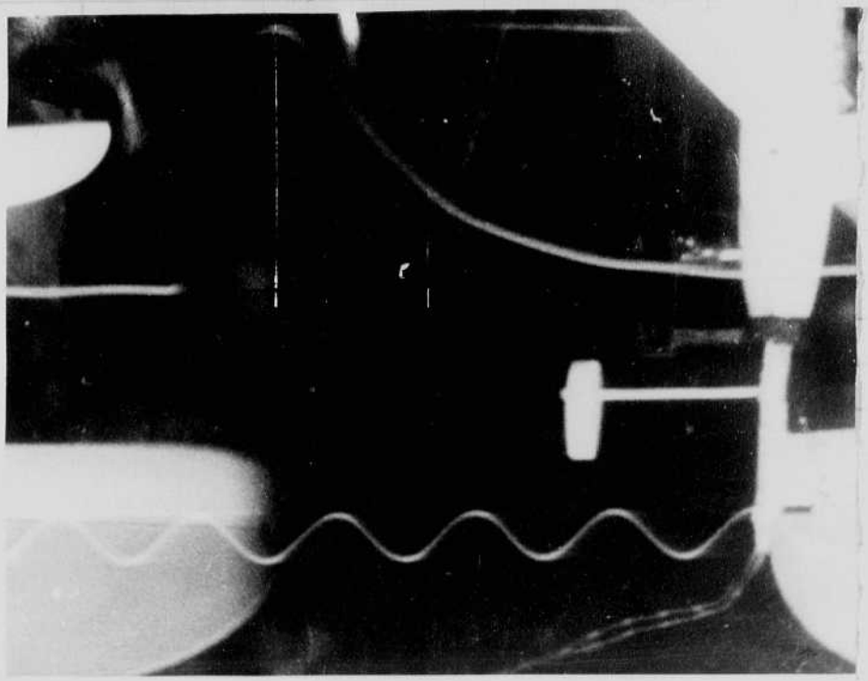
Microflash tube
1/3 mf 4000 volts.
10^5 cycle timing wave.
10 μs per cycle



Small bore Quartz flash lamp
with large sintered electrodes.
Upper. 25 mf 4900 volts.
Lower 25 mf 2500 volts.
10,000 cycle timing wave.

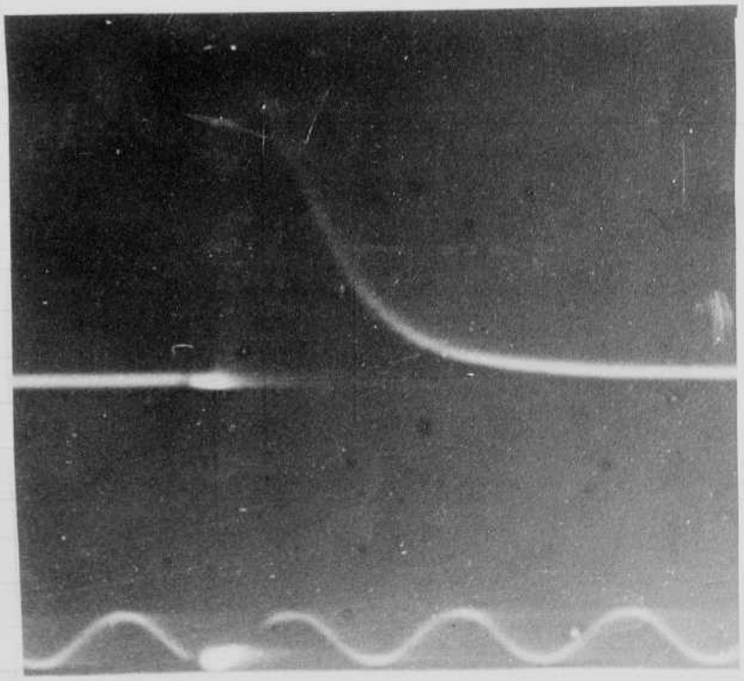
Oct 13 1943

Harold E Edgerton



this oscillogram was taken last night with help of Newton Feldman, a senior who is to do a thesis on the volt-amp characteristics of flash lamps.

Light-time oscillogram
56 mf 2100 volts.
Quartz spiral, small type
10,000 cycle timing wave.



~~Same~~
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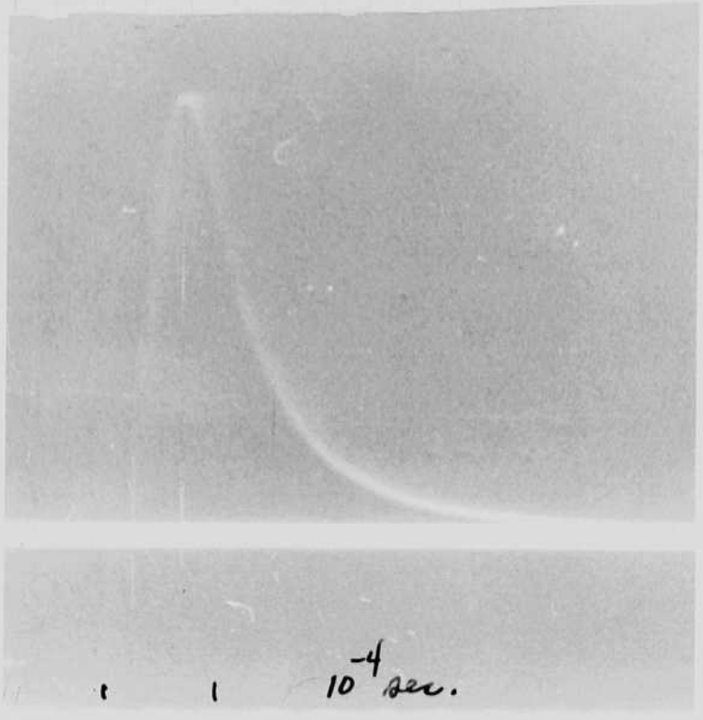

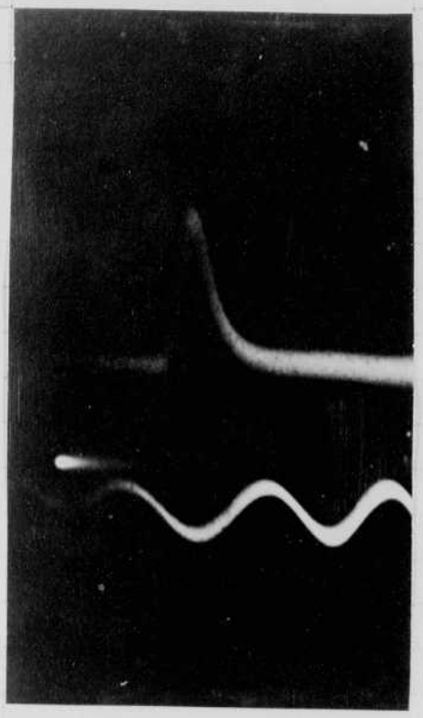

Microflash tube
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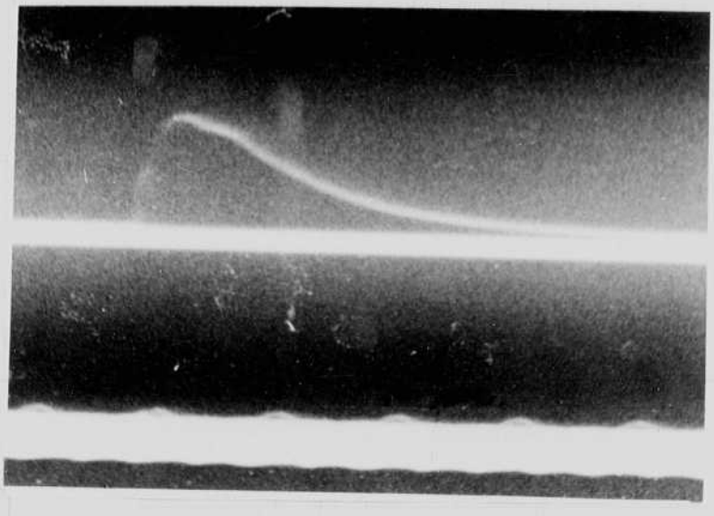
10^5 cycle timing wave.
10 μs per cycle



Small bore Quartz flash lamp
with large sintered electrodes.

Upper. 25 mf 4900 volts.

Lower 25 mf 2500 volts.

10,000 cycle timing wave.

Lamps. Asp. Voltage timing wave. Screen. Distance Results

(1) Film no

1-5	Duf.	0.5	10,000	10^5 cycles	48 49 23 16	6'	Reflector
6	Blank.	"	"	"			"
7 8 9	Duf	"	"	"	49 23 16	6'	"
10, 11	Duf.	"	"	"	23 16.	6'	"
12	Blank.						
13 14 15 Turn 9 mm		12.5	1850	"	23 16	6'	
no flash → 16 17.		"	2400		23 16	6'	
2 blanks. 18 19 20 21 22 24		xgaps. 12.5	2500	"	49 16	6'	
1 blank. 25 26 27 28		microflash 1/3	6000	"	49.	6"	minus.
29 30	"	1/3	7000	"	49	6'	
31 32.		1/3	7000		23		
33 34 35		1/3	8000	"	23		
36		1/3	8000		49		
37.		1/3	8000		0		

(2) New Film.

1 2 3	microflash	1/3	8000	10^5	23	6'	minus.
4, 5, 6, 7 ...	Duf.	1/3	8000	10^5	23	6'	"
12±	"	1/3	8000	10^5	0	6'	"

many plates with out pinh.

(3) New Film

1-8	Spark gaps	1/3	3200 X2	10^5	0	15"	1,000 ohms in series with P.C.
9±							
10-	"	"	" X2	"	0	"	10,000 ohms
15±			" X2.		9.2%	"	

(4) New Film

1 2 3.	microflash	1/3	3150 X 2	10^5	16%	15"	1000 ohms
7 8 9 10	Duf tube	1/3	3150 X 2	10^5	16%	"	"
11-17	"	"	4000 X 2	"	16	"	"
18-23	"	"	4000 X 2	"	7.9	"	"
	"	"	"		7.9	"	"
	"	"	"		16	"	"
	"	"	"		23	"	"
	"	"	"		49	"	"

these last few shots show P.C. over loading.

Oct 22 1943

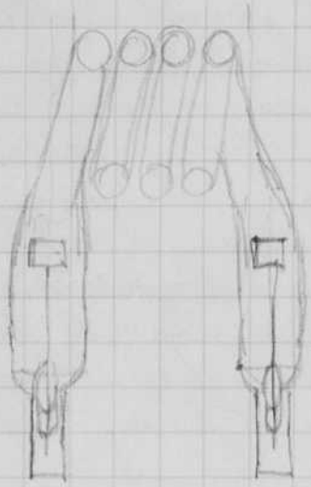
Harold E Edgerton.

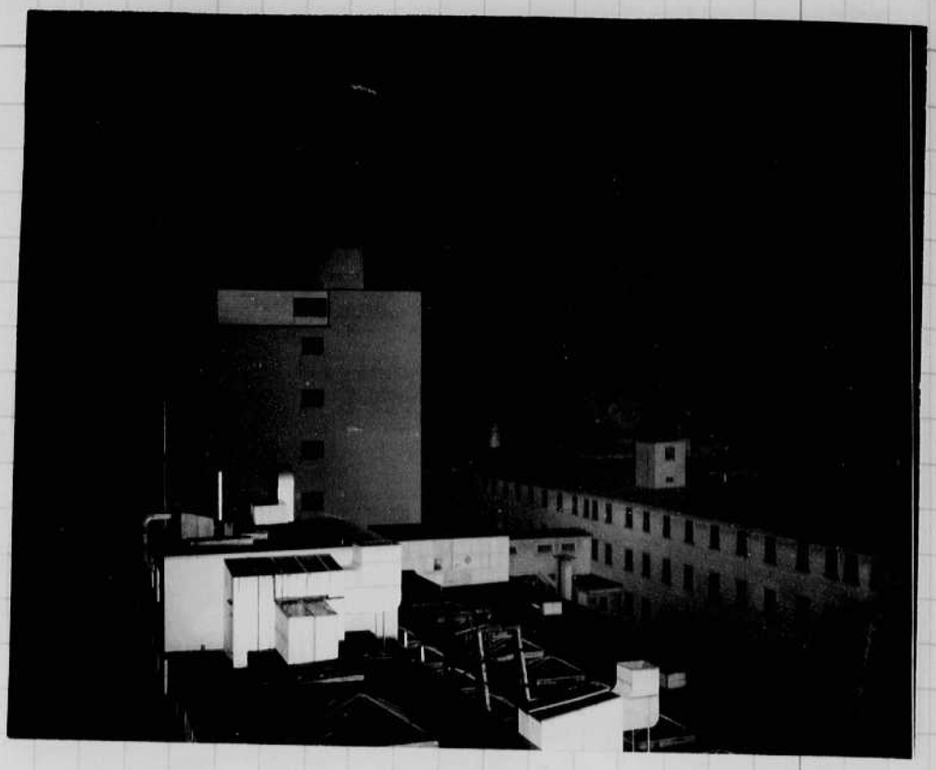
Took D-1 unit to Quonset Air base last night for flight in PBM martin plane with Ensign Rethune. Eastman and Liacono from W.E. went with me. We arrived about 4 pm and had the equipment installed and in the air by seven. Two flash lamps vibrated out of the socket and were lost in the sea. A few photographs were taken with a gassy lamp that went bad during the test. I put on more spark bulbs during the flight and a few photos were made. f2.5 lens K24 Class L film.

A navy photographer Lt. Scheer brought a K 25 camera to Boston with us for synchronization.

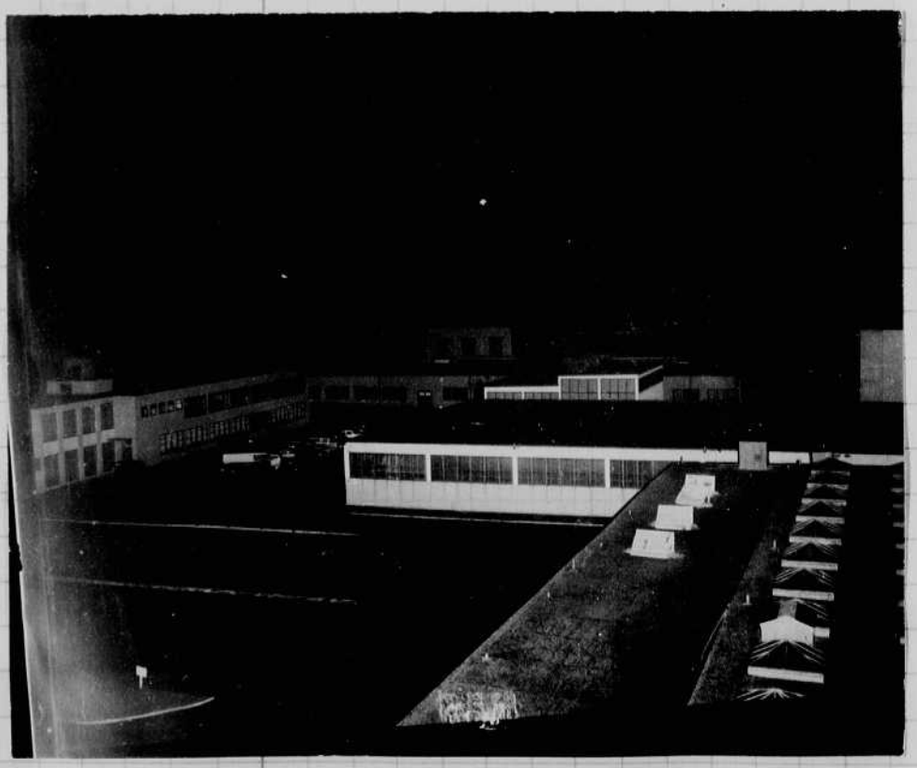
During the past week I have been making lamps for this flash unit. Some trouble was experienced in the puncture of the glass for a hot tube after some 30 to 50 flashes. I overcame this by using an insulator over the spark lead where it contacts the glass spiral. The arc would go from the anode through the glass, along the spark wire, and into the cathode through another hole in the glass.

Two small quartz lamps were tested with 40 mf at 3500 volts using a blast of air for cooling. These were 1 inch diam. Spirals, 1 inch long. Cooling was from a powerful air blower that is used for cleaning.



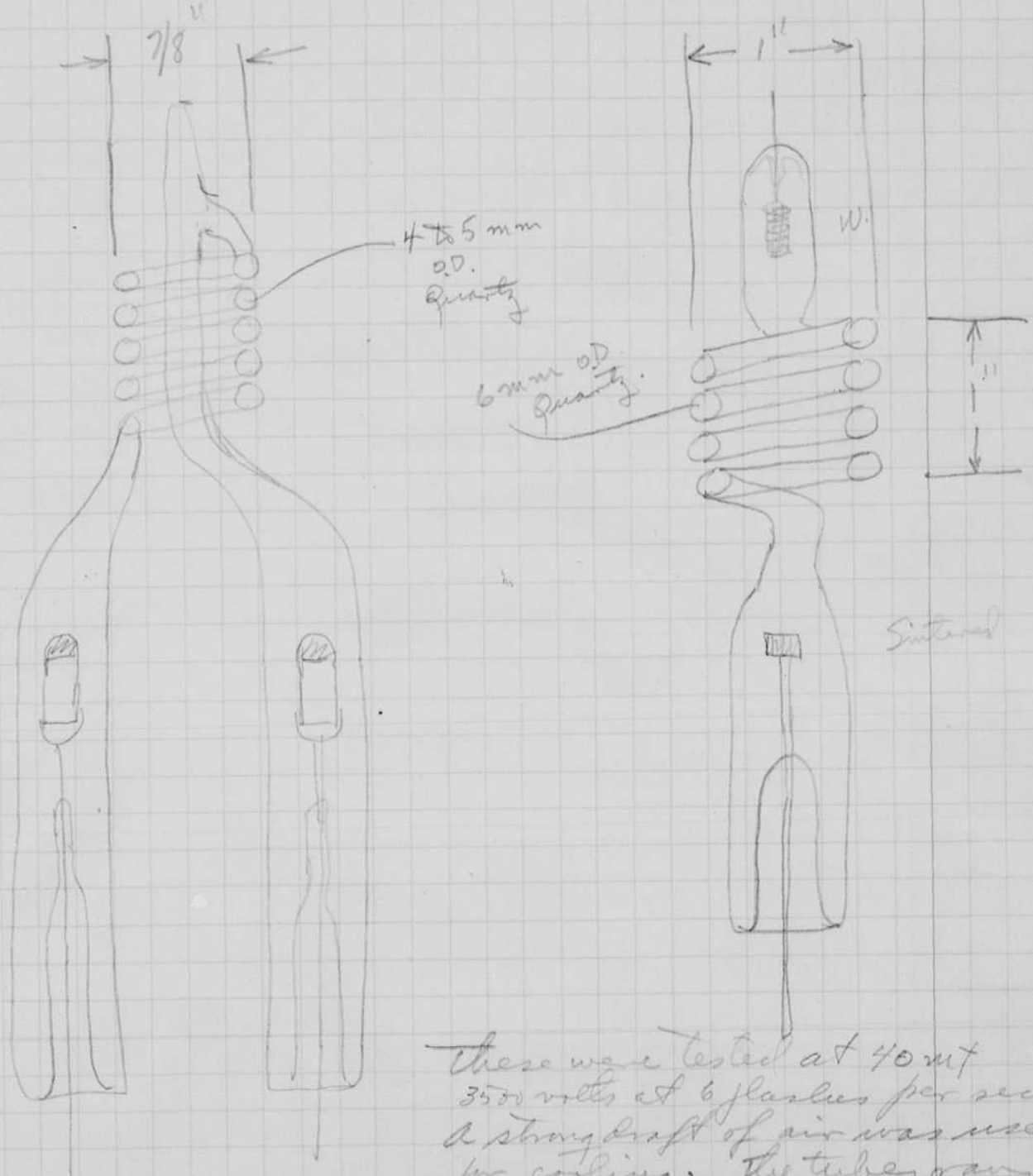


Taken with D-1 unit
~~monday~~ Tuesday Oct 26 1943 in
light rain.
XXX film D-19. K25 camera f 4.5

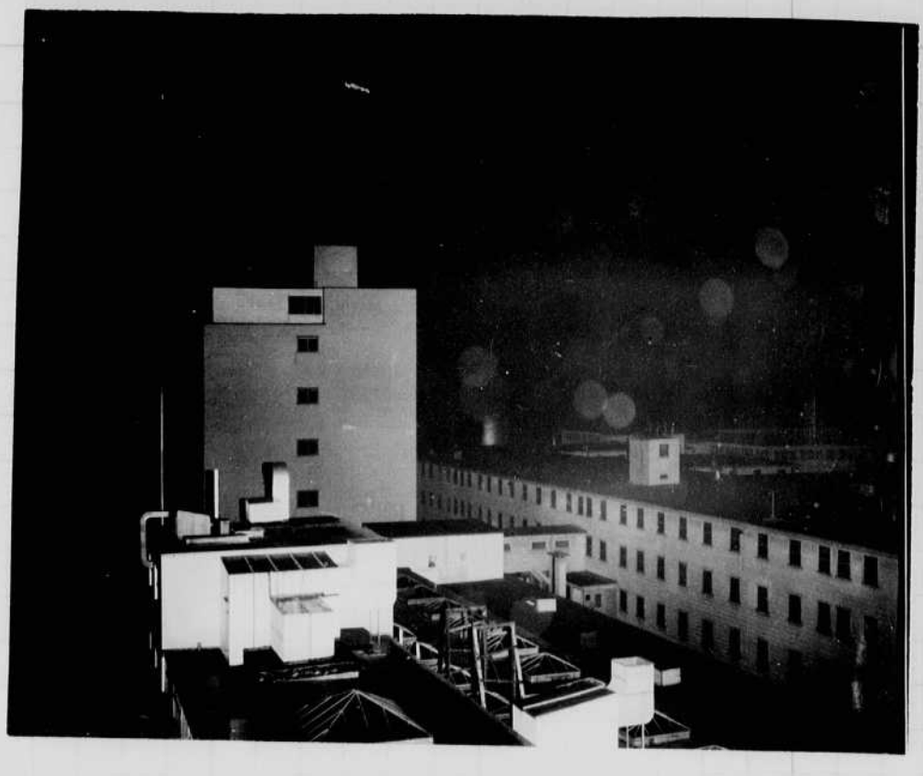


Oct 28 1943
Harold Edgerton.

Took D-1 unit to Quonset yesterday (tuesday) for second installation in ~~PB~~ PBY. I came back last night due to rain. Left Norton Barrow there for tests.



these were tested at 40 mf
3500 volts at 6 flashes per second.
a strong draft of air was used
for cooling. the tubes ran
red hot intermittently.



Taken with D-1 unit
~~monday~~ Tuesday Oct 26 1943 in
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XXX film D-19. K25 camera f 4.5

Oct 28 1943

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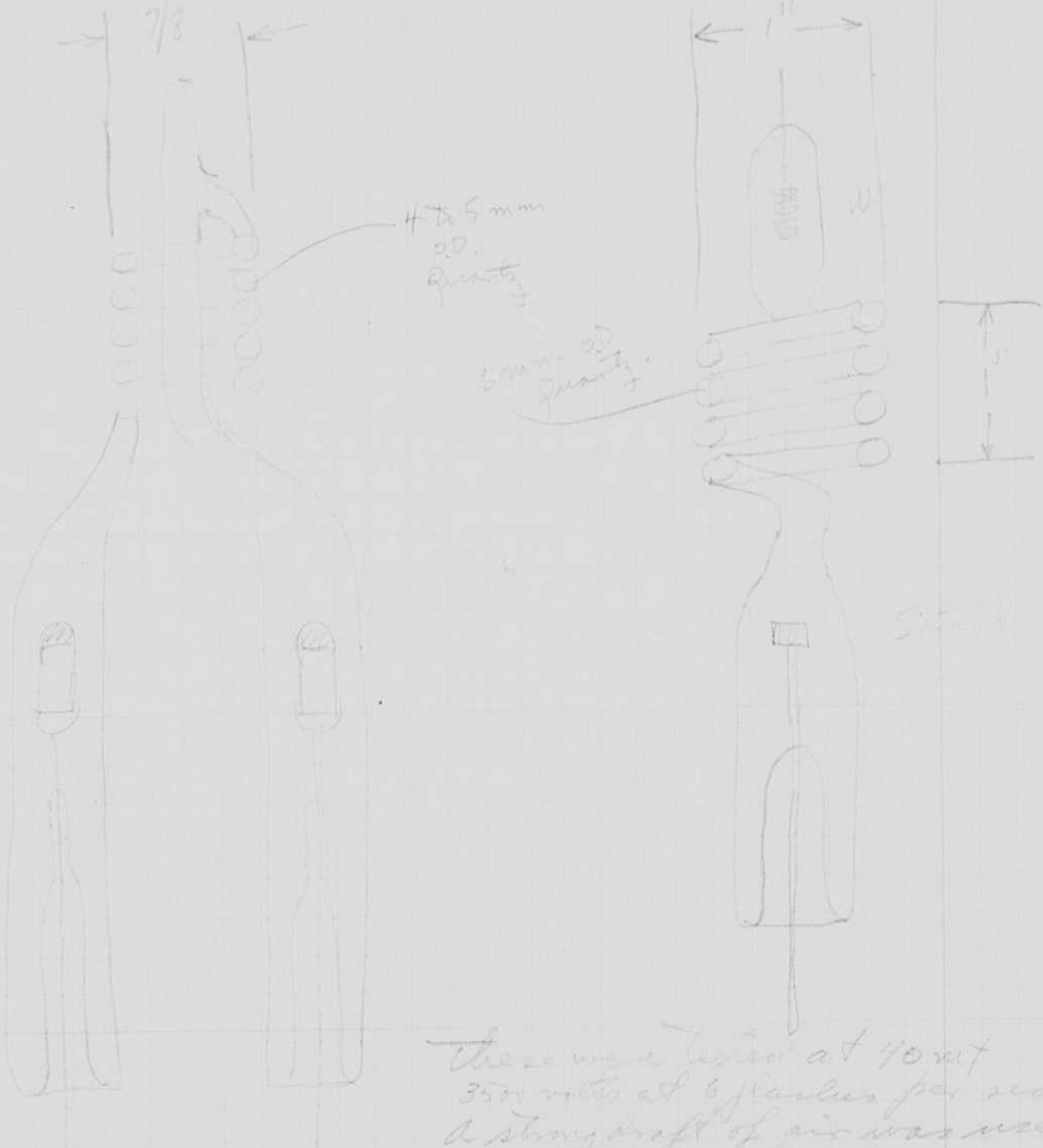
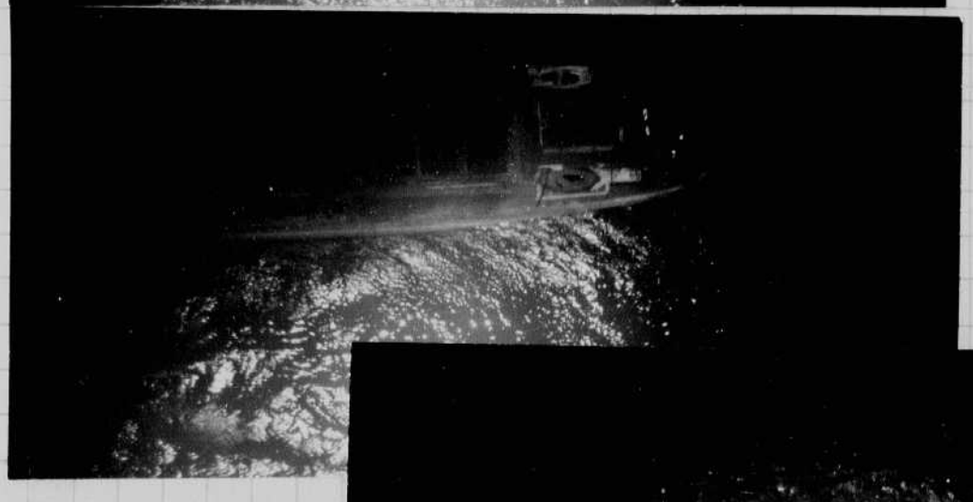
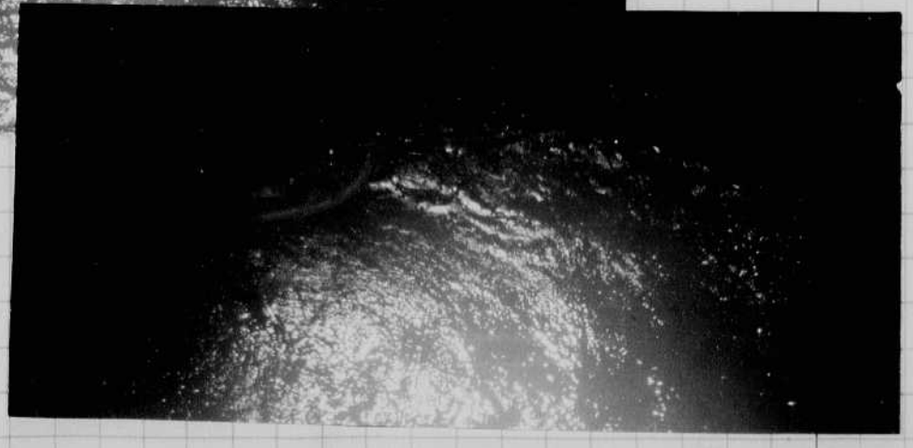
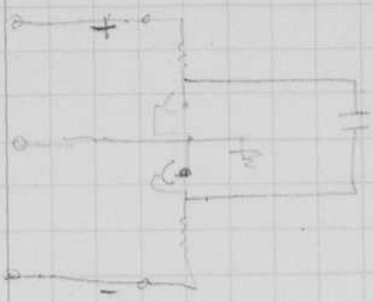


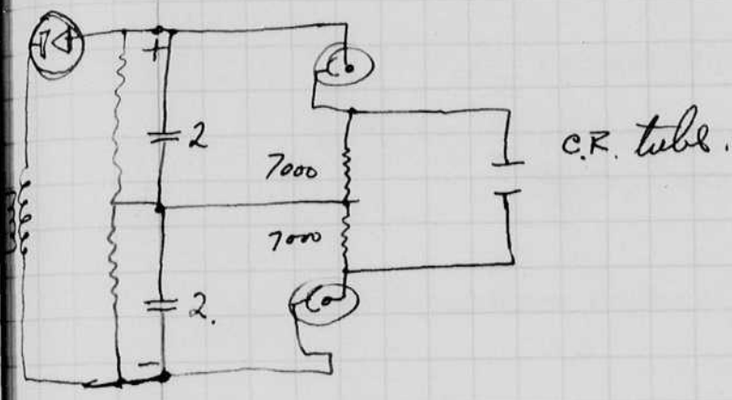
These were tested at 40 mA
350 volts at 6 flashes per second.
A strong draft of air was used
for cooling. The tubes ran
red hot satisfactorily.

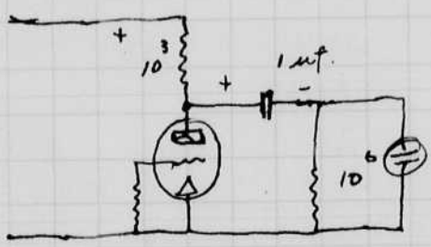


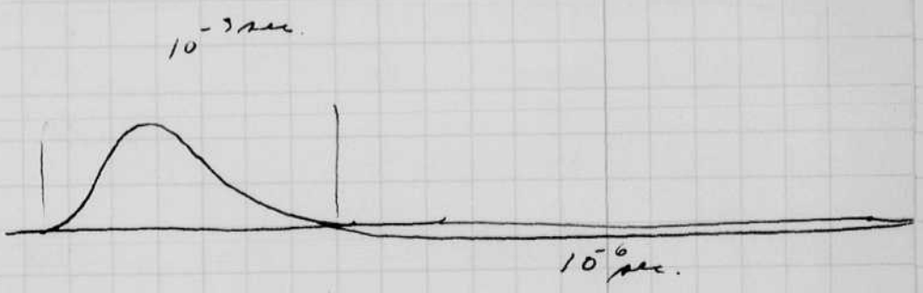


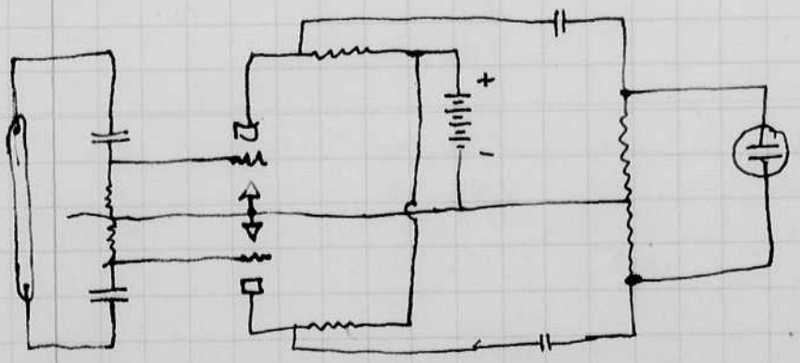
Photos taken
Oct 21 in PBM
with f25 K24 camera

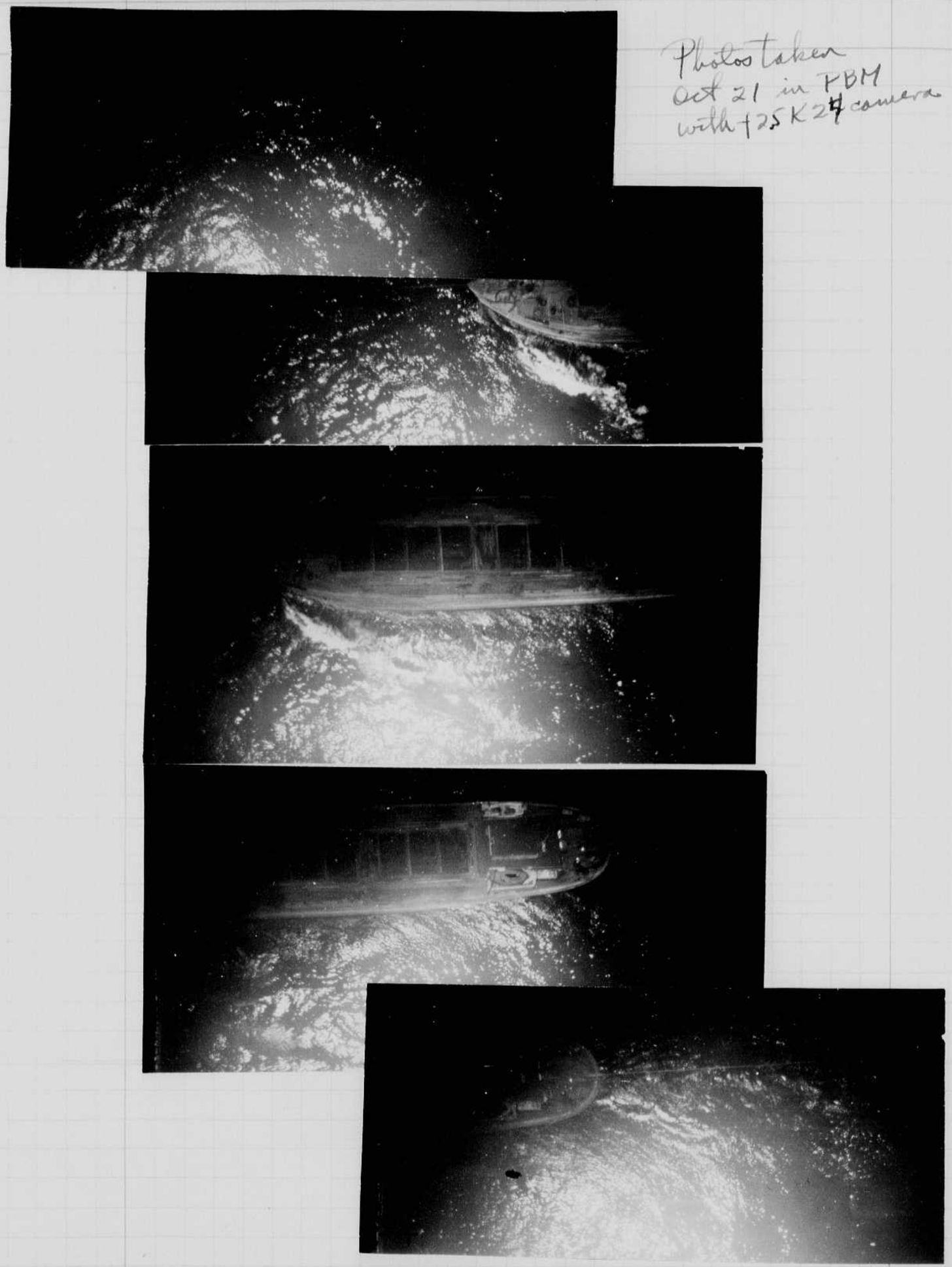



2
7000
7000
2.
C.R. tube.

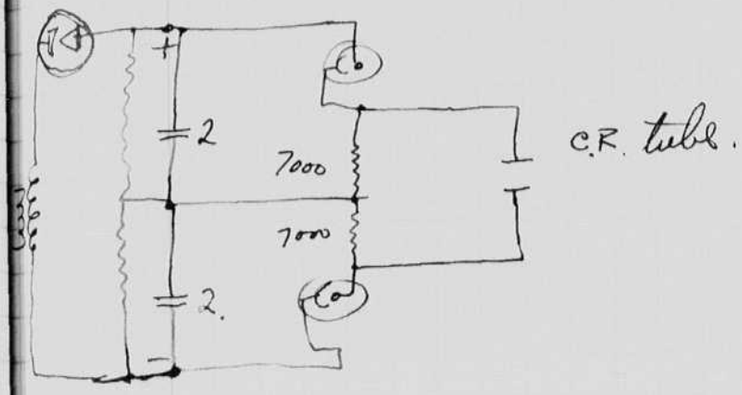

10^3
1 mf.
10^6

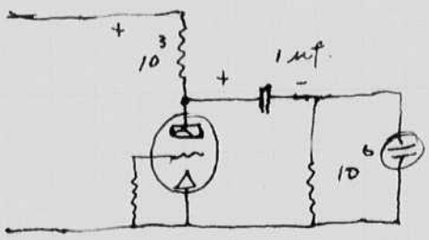

10^{-3} sec.
10^{-6} sec.

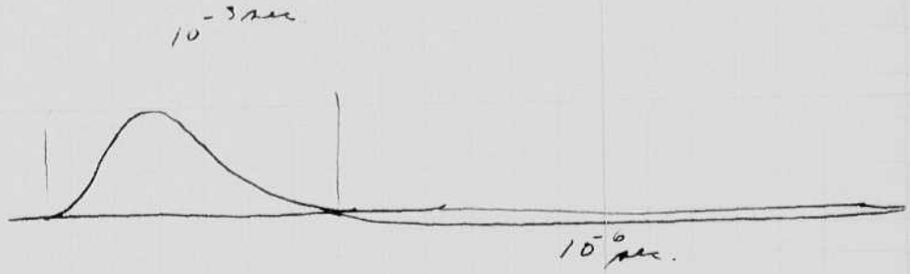

C.R.

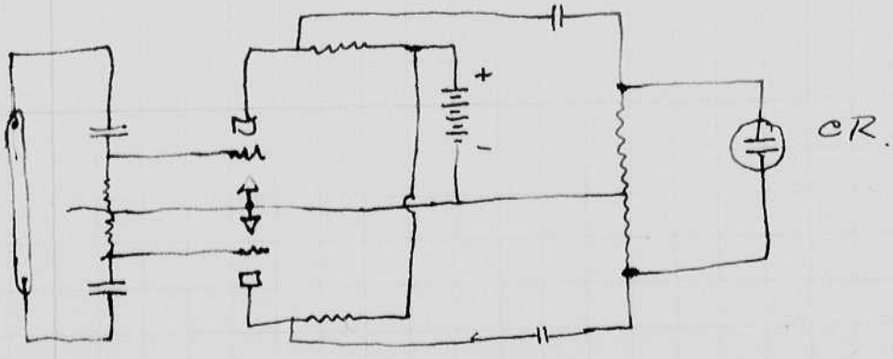


Photos taken
Oct 21 in PBM
with K24 camera


+
2
7000
7000
2.
-
C.R. tube.


+
10^3
+
1 mf.
-
10^6


10^{-3} sec
10^{-6} sec.


+
-
C.R.

128

Oct 30 vacuum

Oscillograms

Film	Lamp	Cap	voltage	timing freq.	Screen	Distance	Remarks. Push-pull. 929 RC. 7000 ~
(1) Blank							
1.	Duff	1/3	7000	10^5 cycles	7.9 %	110 cm	
2.	#226		7000	"	"	"	
3.	d=4-6		7000		"	"	
5	typ 2 200		8000		"	"	
6			8000		"	"	
8-9	GR 509	1/3	7000	10^5	7.9	110 cm	
10	missed		7000				
11.			7000	10^5	7.9 x 49.	"	
12	no sweep						
13 14	no flash						
15			8000		7.9		
16-17	no flash						
18 19	" "						
20	GR 509.	1/3	8000	10^5	7.9 x 49		
22 ±	3/16" spark gap.	1/3	8000	10^5	7.9		
30 ± 3 pics	miss flash but complete.	1/3	?	10^5	7.9	150 at angle in reflector.	
(2)							
1	Micro	1/3	?	10^5	23 %	150	"
"	"	"	"	10^5	7.9 %		
"	"				7.9		for sweep.
"	"				7.9		self for br
B							
5	spark 3/16	"	8000	10^5	7.9	100	
"	"	"	"	"	"	"	
Pencil							
	miss flash	"	7000	10^5	7.9	"	
"	"	"			7.9	"	
"	"	"			7.9 x .49	"	
	Blank.						
"	"	"	8000		7.9 x .49	100	
	Duff	"	7000		7.9 x .49	"	
"	"	"	8000		"	"	
"	"	"	9000	10^5	"	"	

Notebook # 14

Filming and Separation Record

___ unmounted photograph(s)

1 negative strip(s)

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

was/were filmed where originally located between page 128 and 129.

Item(s) now housed in accompanying folder.

128

Oct 30 1928

Oscillograms

Film	Lamp	Cap voltage	tuning freq.	Screen	Distance	Remarks.
(1) Blank						Push pull. 929 RC. 7000 Ω
1.	Duf	1/3	7000	10^5 cycles	7.9 Ω	110 cm
2.	#226		7000	"	"	
3.	d = 4-6		7000	"	"	
4 5	(4 pos 200)		8000	"	"	
6 7			8000	"	"	
8-9	ER 509	1/3	7000	10^5	7.9	110 cm
10	miss?		7000			
11.			7000	10^5	7.9 x 49.	"
12	no screen					
13 14	no flash					
15			7000		7.9	
16-17	no flash					
18 19	" "					
20	ER 509.	1/3	8000	10^5	7.9 x 49	
21	3/16" spark gap.	1/3	8000	10^5	7.9	
30	micaflash	1/3	?	10^5	7.9	150 a Bangle in reflector.
3 pins	unit complete.					
(2)						
1	micro	1/3	?	10^5	23 Ω	150 "
	"	"	"	10^5	7.9 Ω	
	"	"			7.9	faster screen shielded
	"	"			7.9	
B						
	Spark 3/16	"	8000	10^5	7.9	100
	"	"	"	"	"	"
Pencil						
	micaflash	"	7000	10^5	7.9	"
	"	"			7.9	"
	"	"			7.9 x .49	"
	Blanks.					
	"	"	8000		7.9 x .49	100
	Duf	"	7000		7.9 x .49	"
	"	"	8000		"	"
	"	"	9000	10^5	"	"

Notebook # 14

Filming and Separation Record

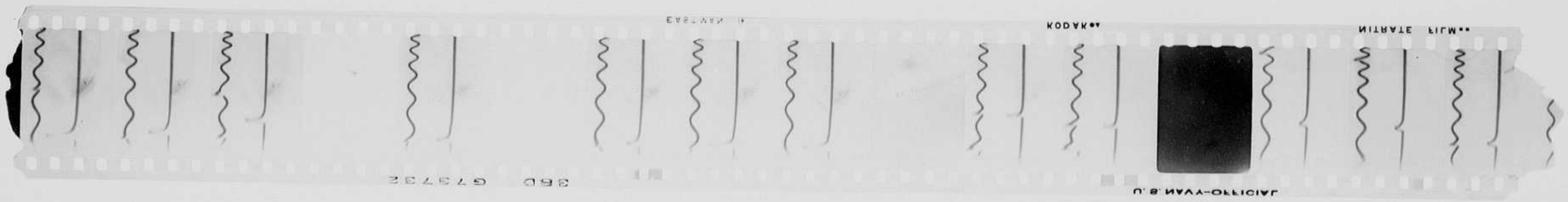
____ unmounted photograph(s)

__1__ negative strip(s)

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

was/were filmed where originally located between page 128 and 129.

Item(s) now housed in accompanying folder.


KODAK
U.S. NAVY-OFFICIAL

(3)

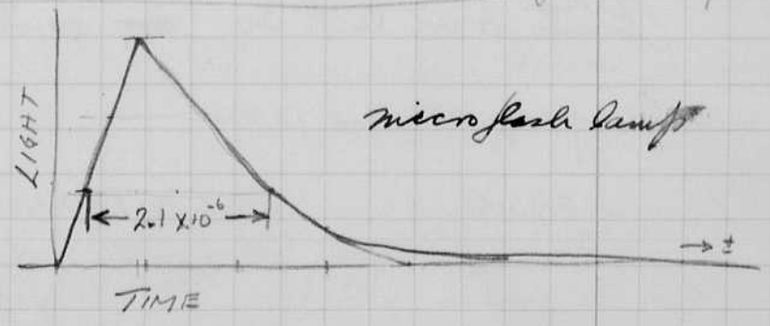
Tube	C	V	Time	Screen	Distance
#2 K-8	100	2000	10^{-4}	23??	100
				"	
				"	
				"	
			10^{-5}	"	

Sweep faster to show rise

	50	2000	10^{-5}	0
	50	2000	10^{-4}	0
			10^{-4}	23
			10^{-4}	23
			10^{-4}	23
			10^{-5}	23
	25	2000	10^{-4}	23
			10^{-4}	23
			10^{-4}	23
			10^{-5}	23
	200	2000	10^{-4}	23
			10^{-4}	
			10^{-4}	
			10^{-5}	23
	400	2000	10^{-4}	23
			10^{-4}	
			10^{-4}	
			10^{-4}	
			10^{-5}	23
	574	2000	10^{-4}	23
			10^{-4}	
			10^{-4}	
			10^{-4}	
			10^{-5}	

fast

no damage to lamps.



micro flash lamps

Calc from enlargement

6.6 cm = 10^{-5} sec.

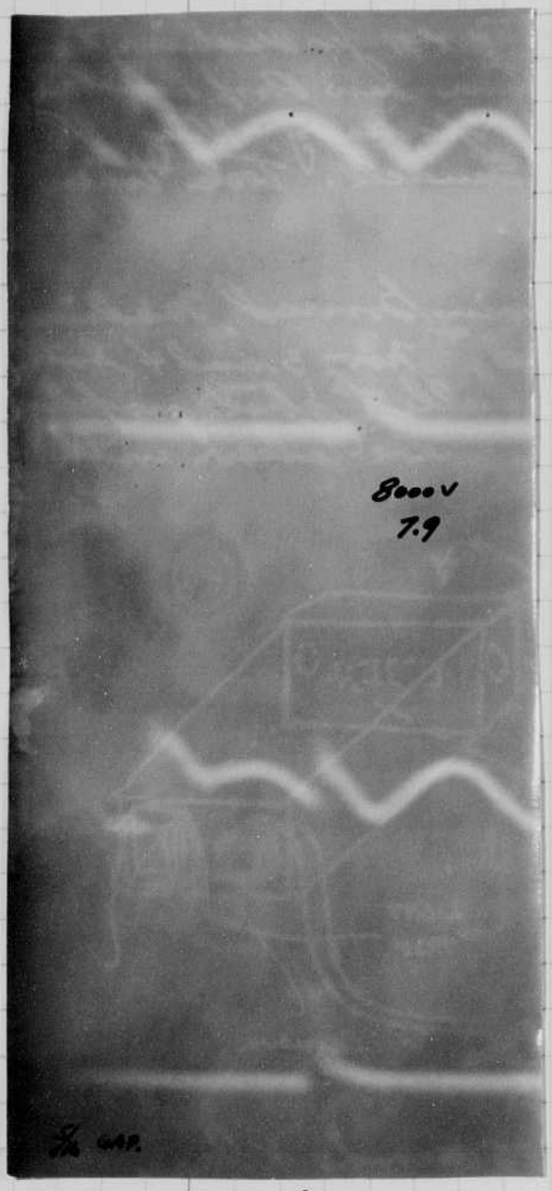
1.4 cm = $10^{-5} \times \frac{1.4}{6.6} = 2.12 \times 10^{-6}$ seconds.

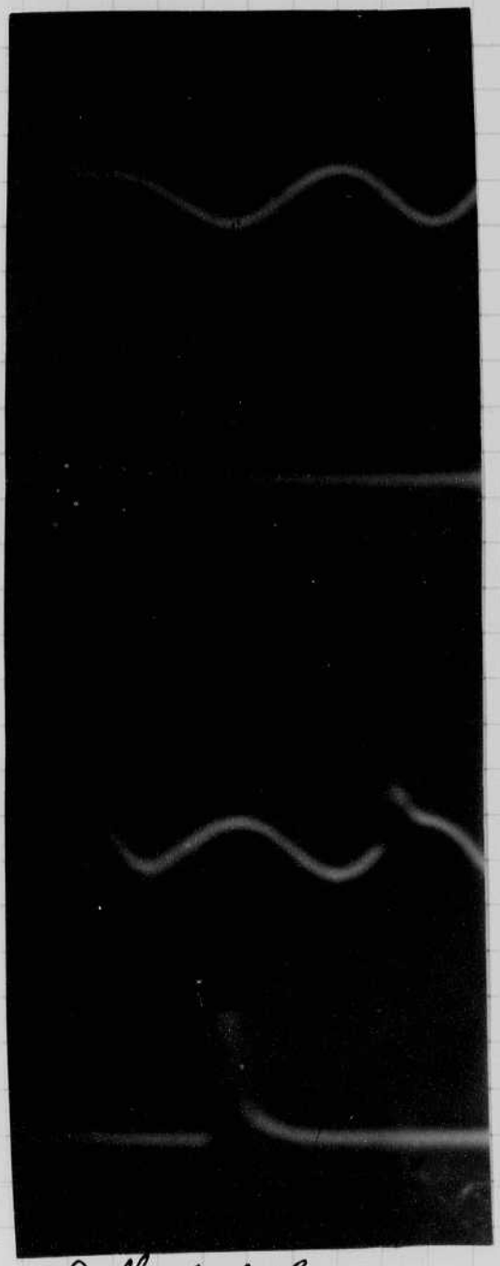
zero to peak = $\frac{1.6}{6.6} \times 10^{-5} = .9 \times 10^{-6}$ sec.

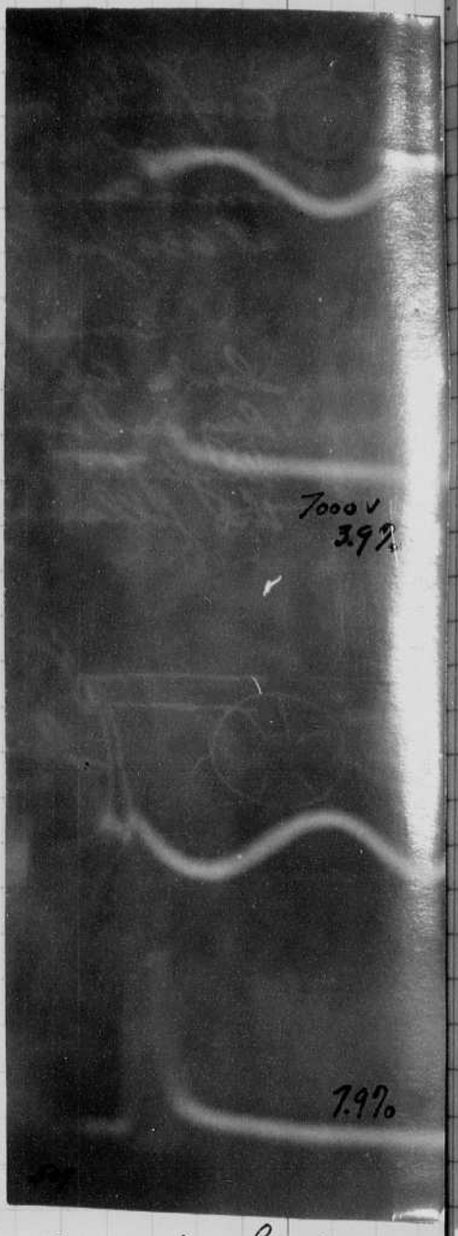
peak to zero = $\frac{1.8}{6.6} \times 10^{-5} = 2.73 \times 10^{-6}$ sec.

Calc $\frac{.2}{2.8} \times 10^{-6} = 0.71 \times 10^{-6}$ seconds.

$\frac{4^{-5}}{3.4} \times 10^{-6} = \frac{1.2 \times 10^{-6}}{1.5}$







~~Spark Gap~~

Duffendack Lamps

509 microflash

Prints from Oct 30 ~~mss~~ oscillograms.

See page 128 and 129.

0.7 ms.

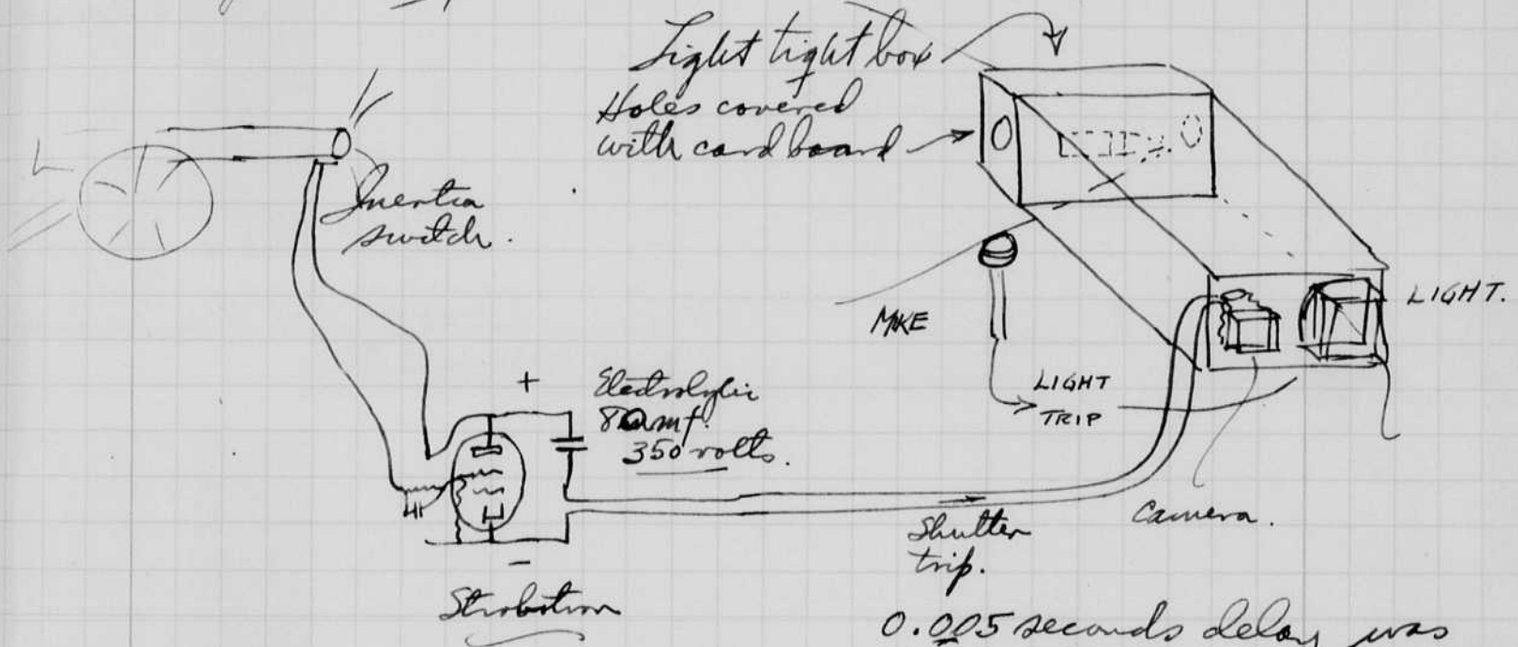
1.2 - 1.3 ms.

2.1 ms.

Nov 9, 1943. Tues.
Harold E Edgerton.

Left Boston on Federal Night Oct 31 for Washington D.C. Conf with Mr. Clayton and Col. Reed. Then saw Prof Bowles and Col Wright. Also conf with Capt Pope, Navy, Wing Commander Scott (R.A.F.) and M. L. Sandell. Took train at 630 for North Vernon Indiana.

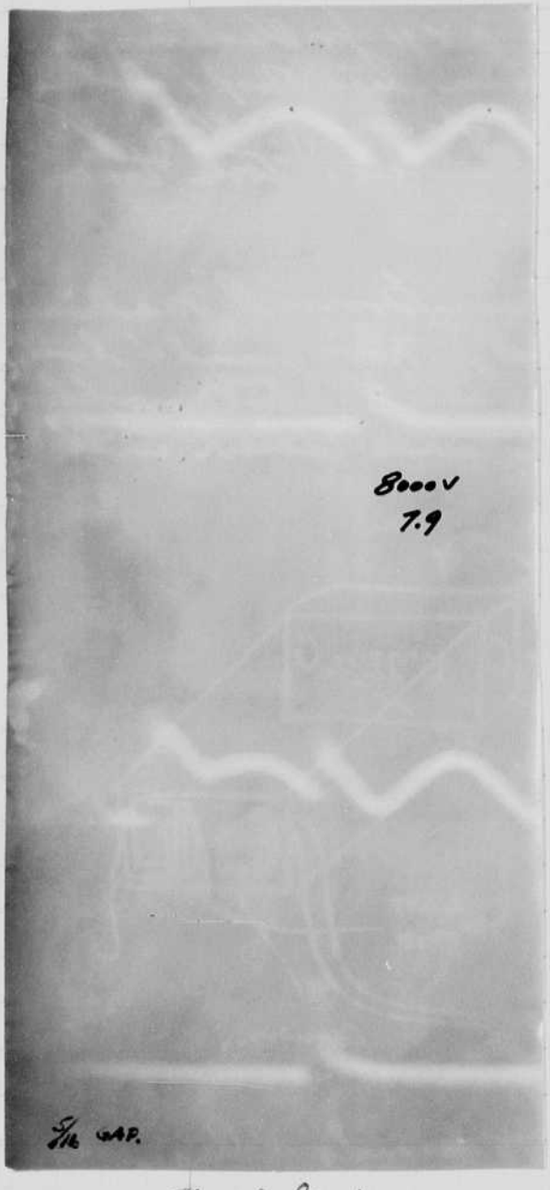
Arrived Nov 2 at Jefferson Proving Ground, Madison Ind. Col W.B. Harding in command. Nov 3 and 4 bottle day and evening was spent upon bullet photography. Daylight photos of 3" projectiles were taken with the following scheme:



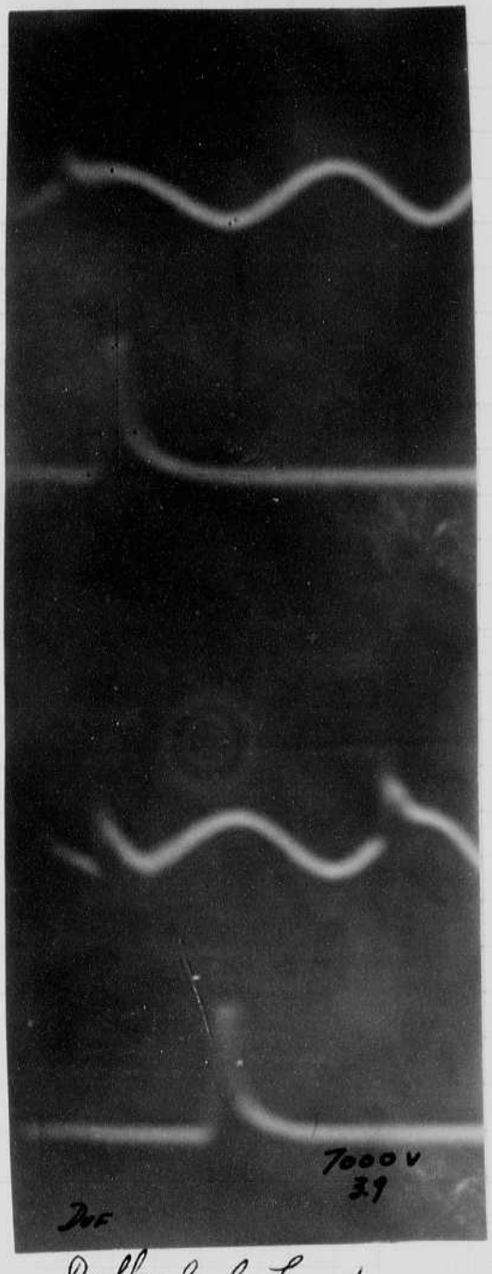
0.025 seconds delay was found between impulse and shutter opening time.

Photos with 1/25 sec. were ok.

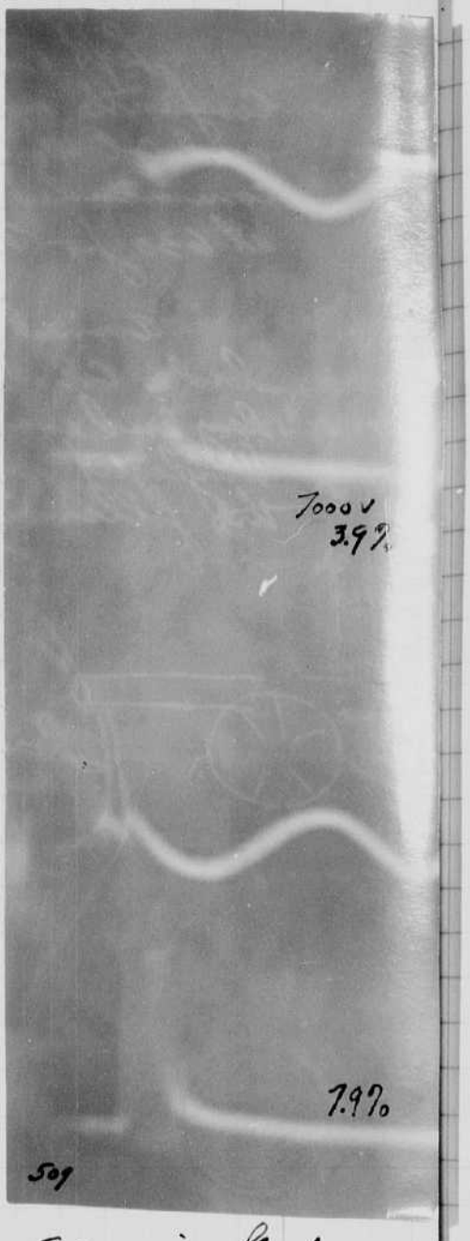
Border and Warburton picked me up in an F2 plane about 130 for Wright field. Went to Vandalia with Col Baisley to see the new B-24 plane.



Spark Gap



Duffendack Lamp



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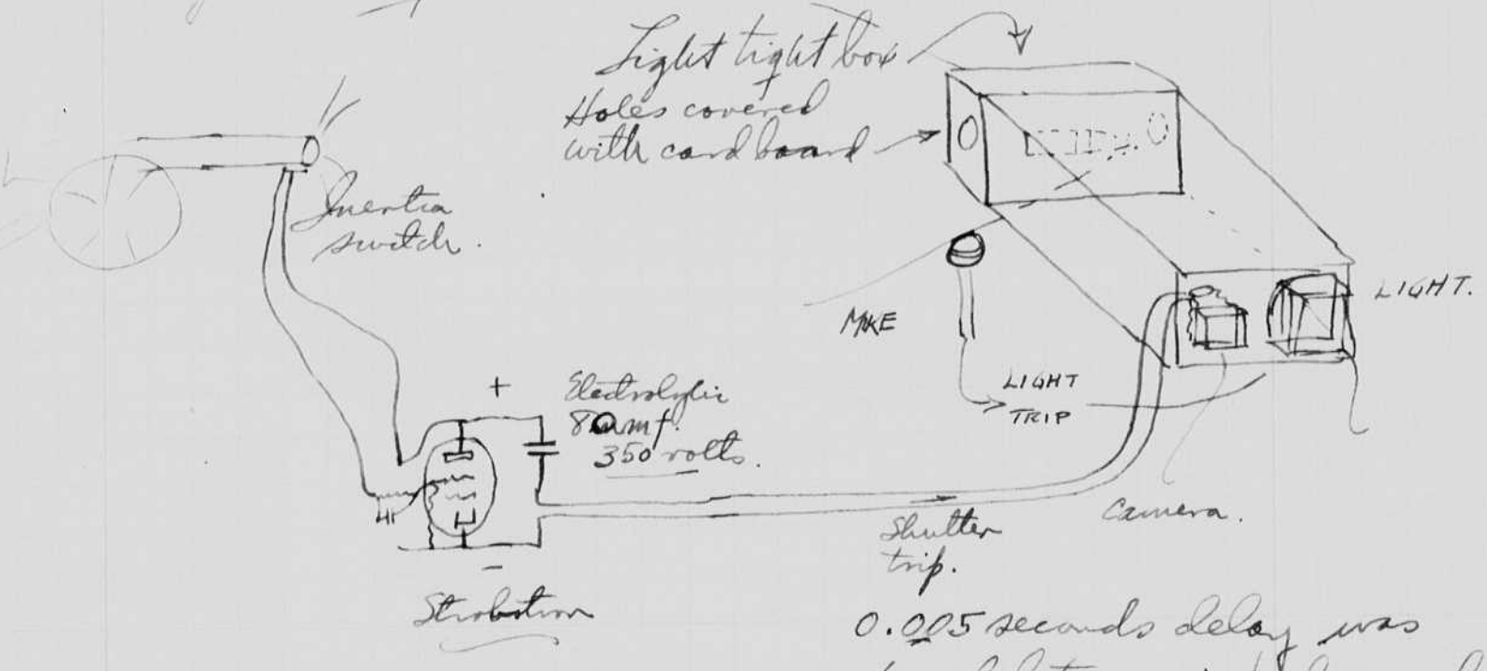

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Nov 10 1943
Harold Edgerton

Copies of photos taken at Jefferson Proving Ground on Nov 3 night. at West AP Range

See p 134 for diagram.

Trial shot of 3" A.P. projectile through card for timing.

Note wind shield.

↑ mike.

↳ armor plate to protect camera and light from splatter.

Windshield was removed before firing.

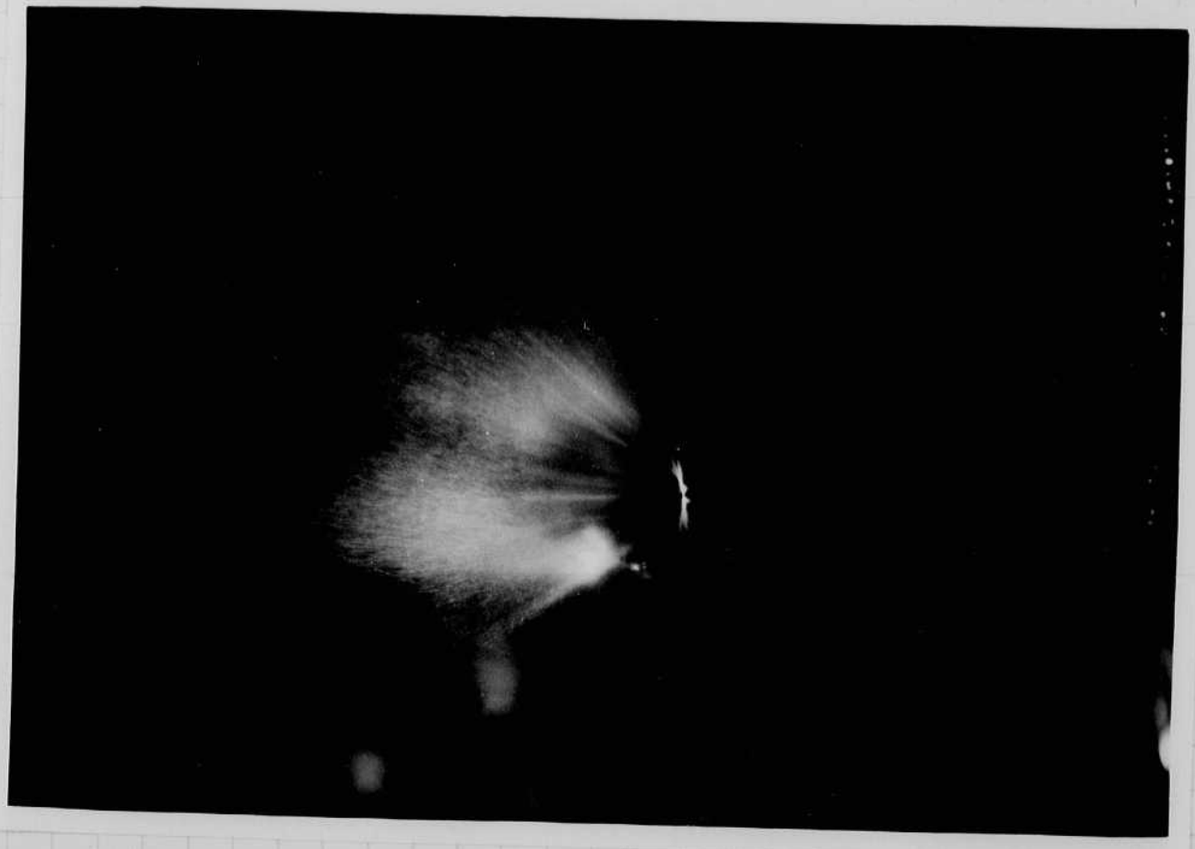
Note light at impact point.

Blobs are out-of-focus dents in mirror.

The flash from the impact is much brighter than that from the microflash unit.

Wind shield removed - 1 sec exposure.

Wind shield removed 1/200 sec exposure Mike 22 ft from plate. to operate shutter.



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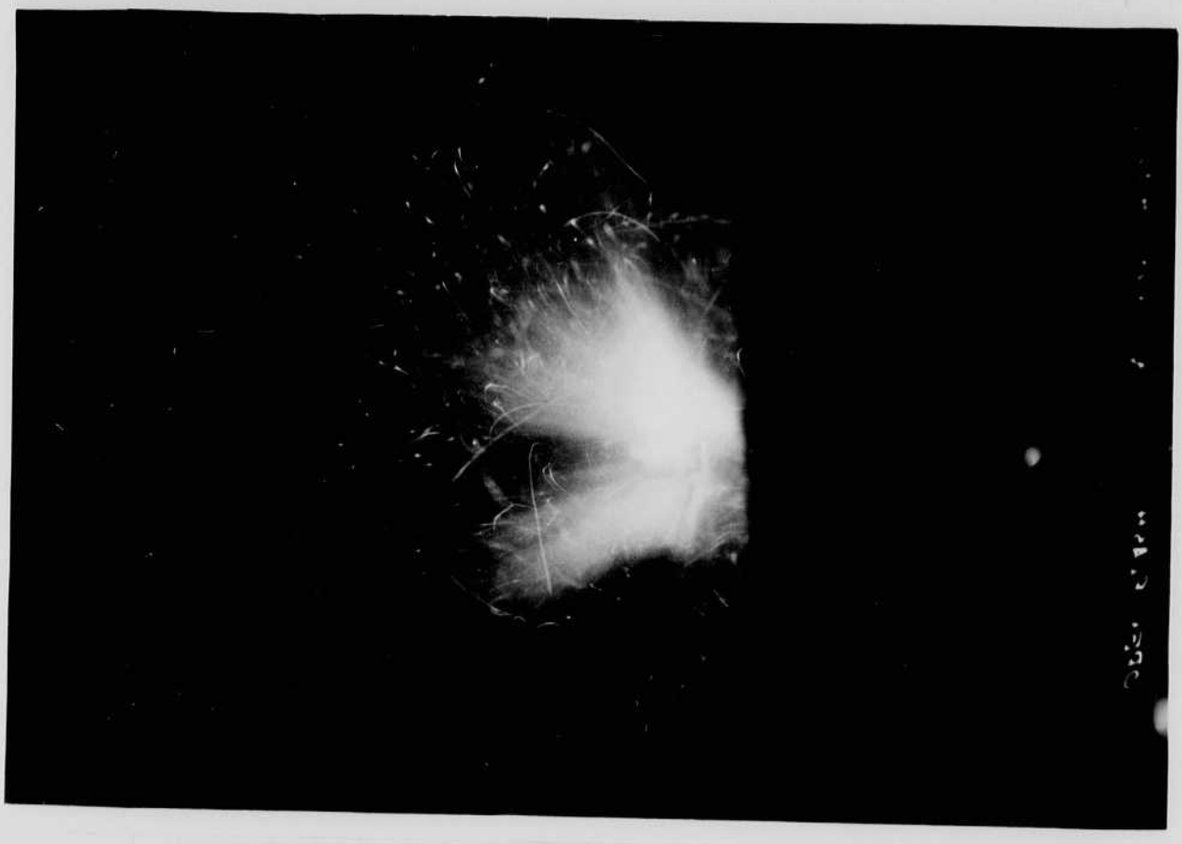

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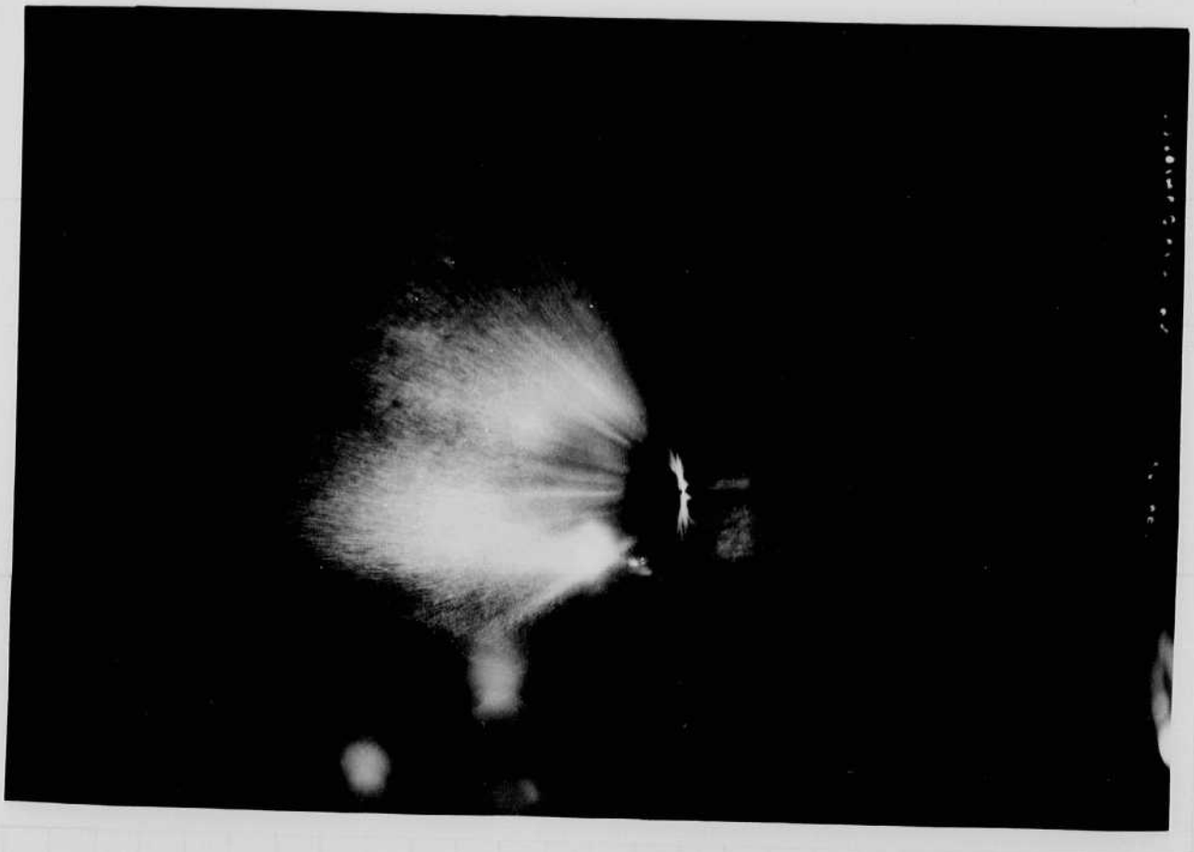
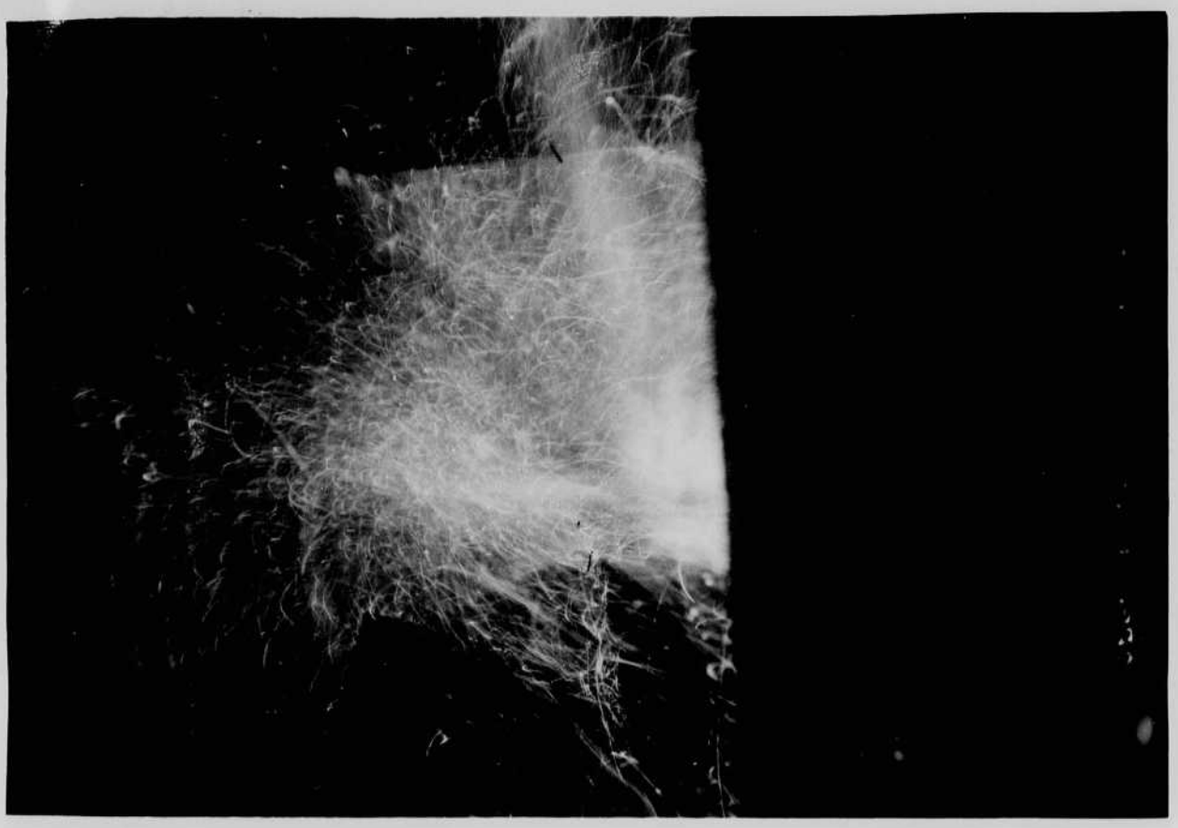
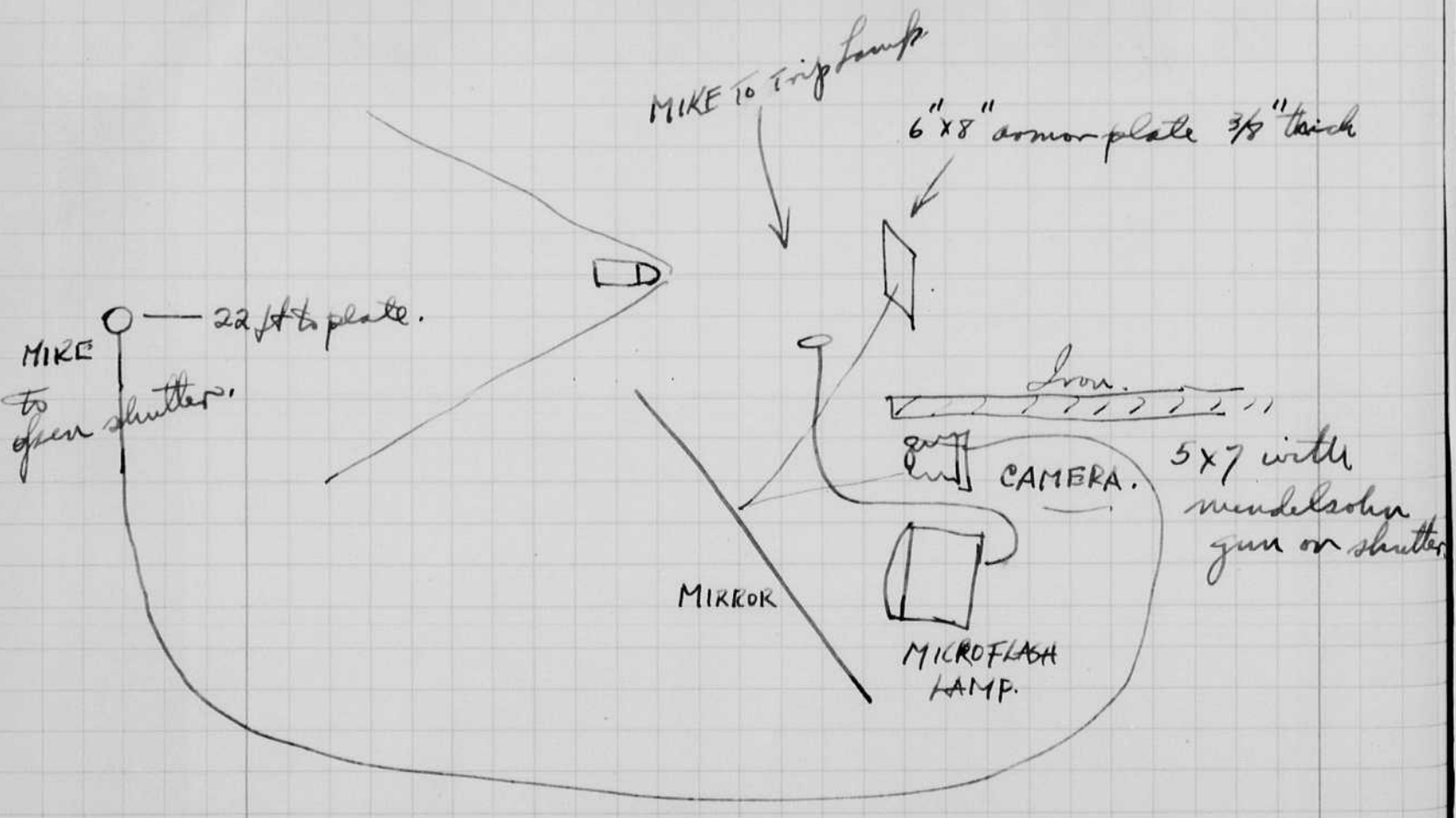


1 sec. exposure Wind shield on bullet.





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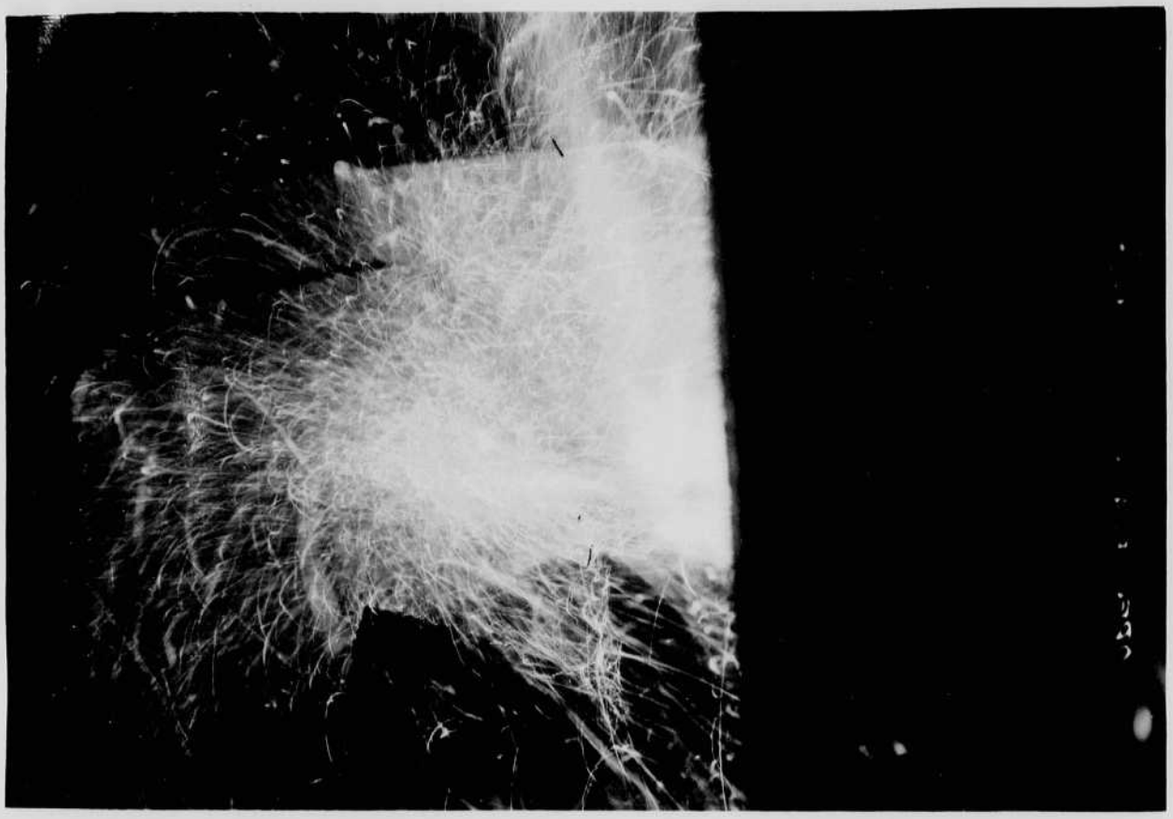
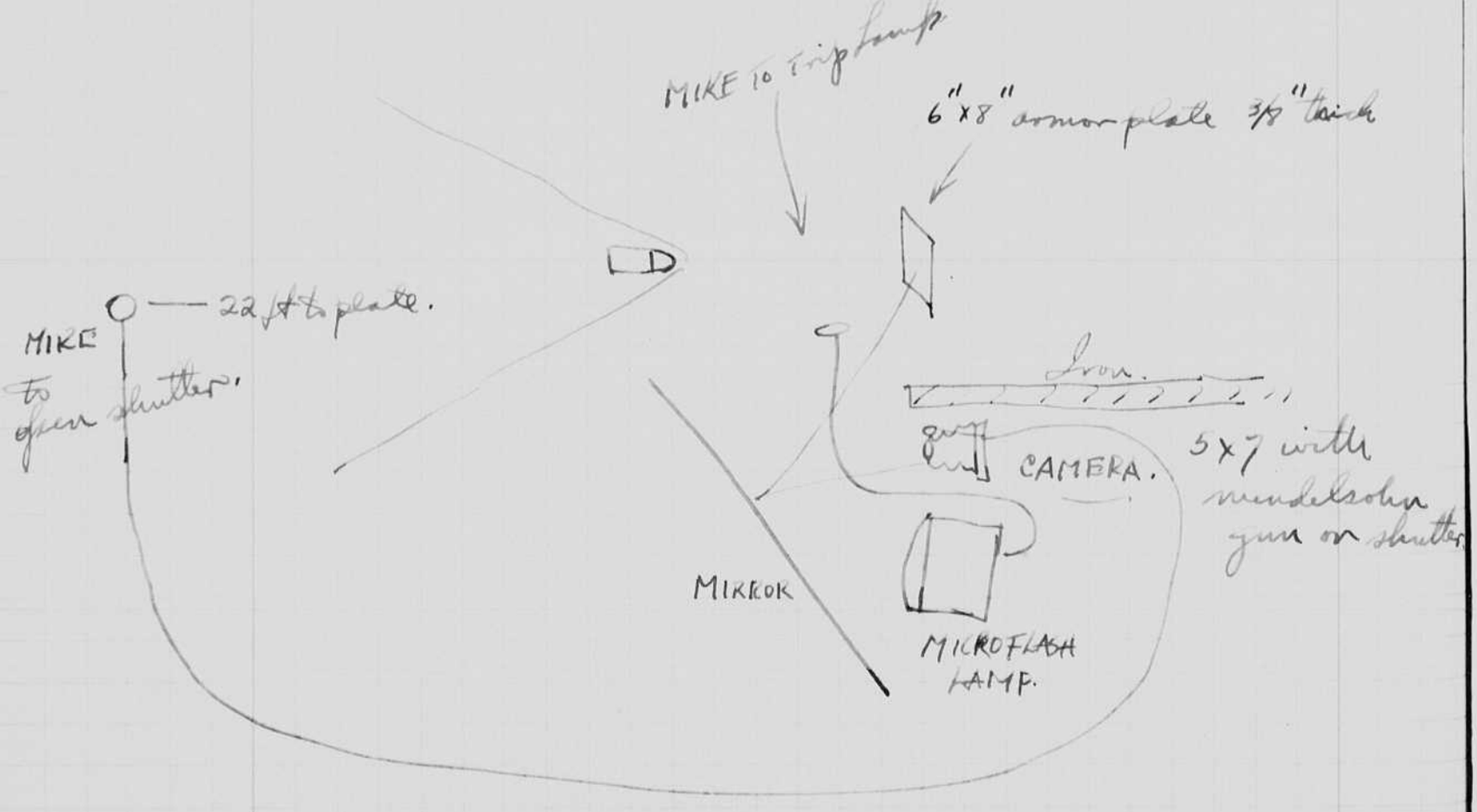
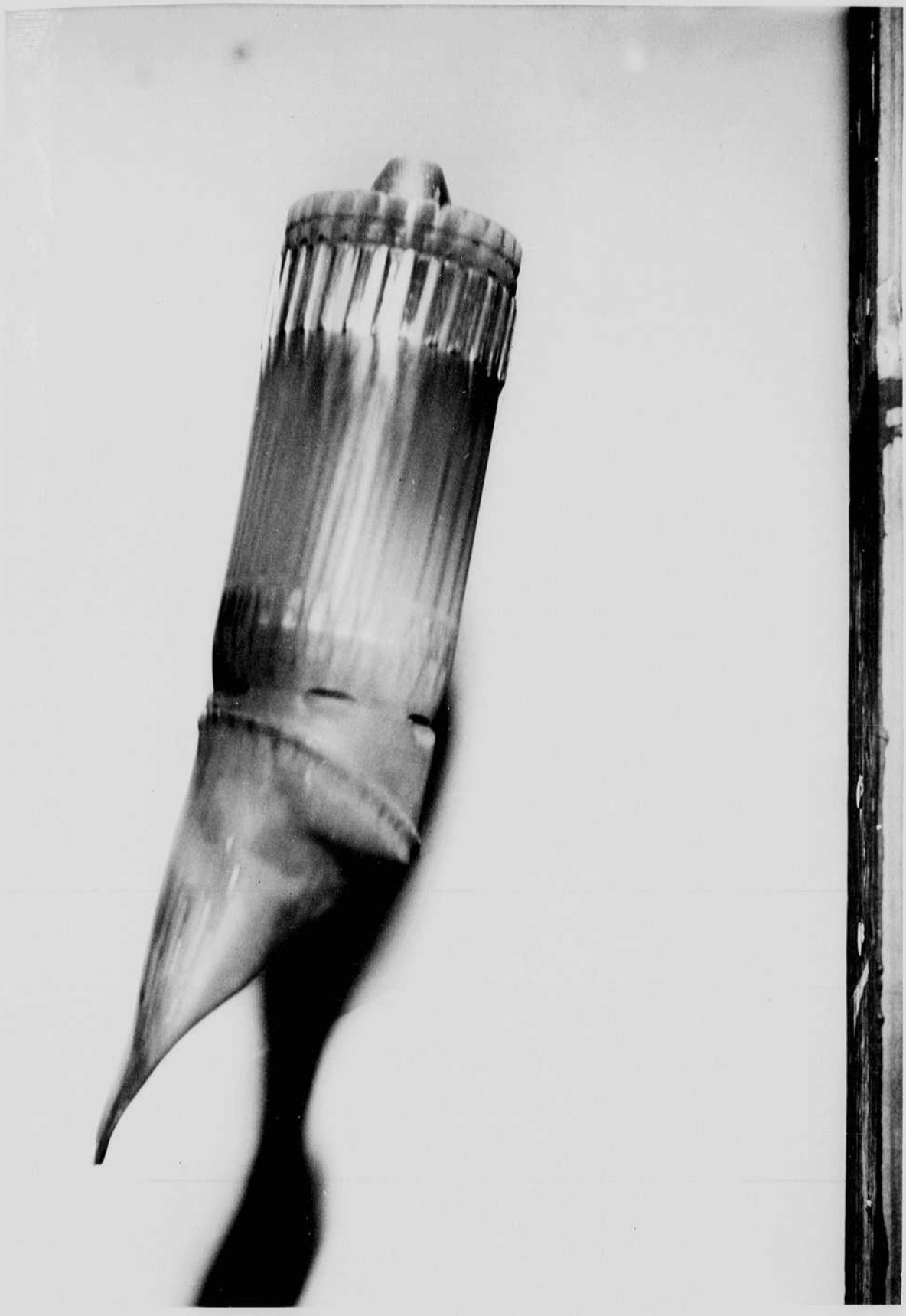






Nov 11 1943
Harold Edgerton.

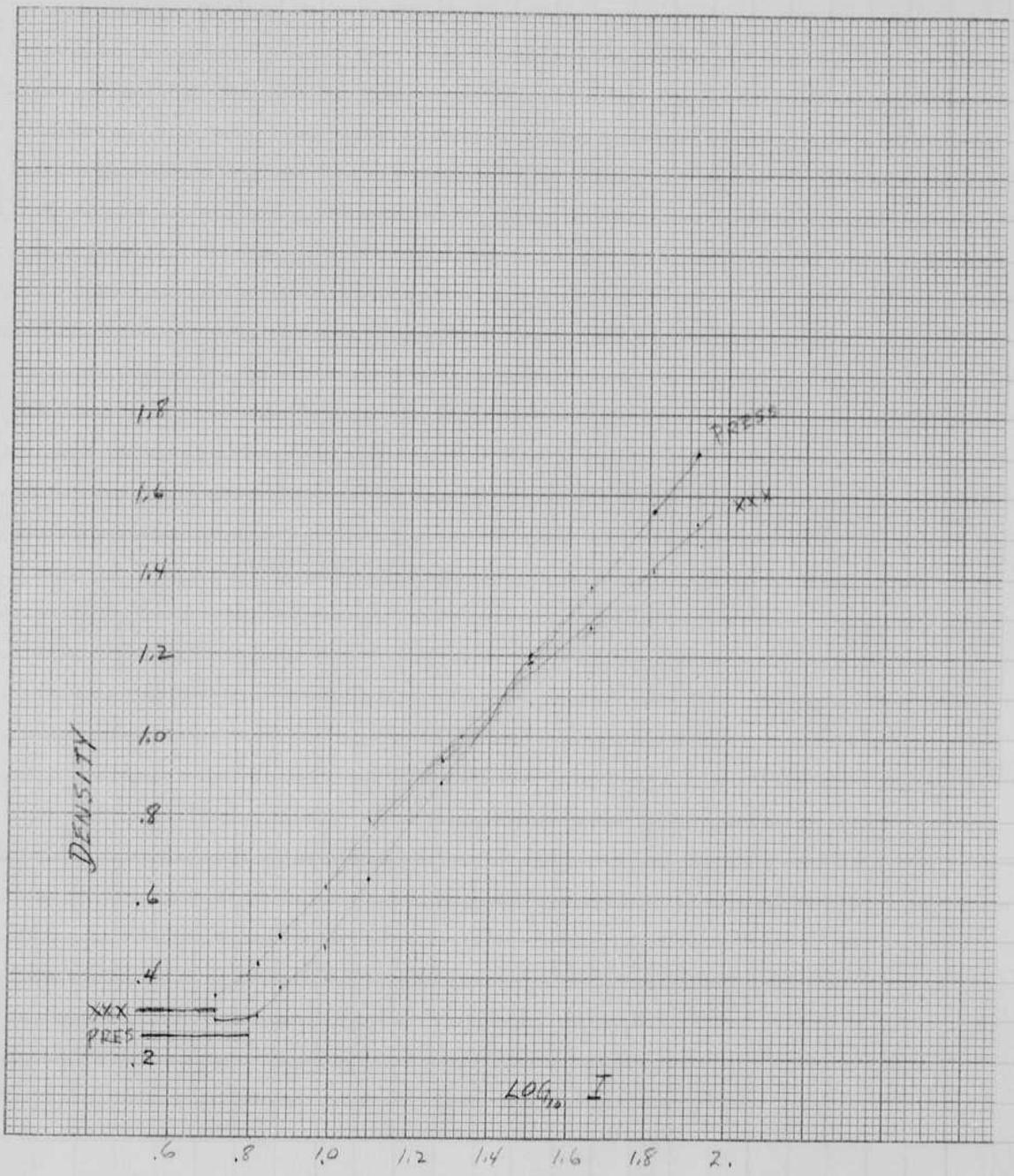
13 in Rows.
8 rows.

FT17 4000 Volts. 112 electrolytic condensers. 5½ meters to Gray scale. f22 10 min D99

Scale	XX	TRI XXX	PANPRESS	AUTHO X	$\log_{10} I$
83.4	1.58	1.53	1.7	1.47	1.921
64.2	1.38	1.41	1.56	1.32	1.8075
45.2	1.22	1.27	1.37	1.18	1.6551
31.3	1.0	1.18	1.2	1.03	1.4955
19.2	.82	.94	.88	.82	1.2833
12.5	.61	.79	.64	.60	1.0969
9.85	.46	.62	.47	.46	.9925
6.92	.40	.5	.37	.36	.884
6.06	.28	.43	.3	.32	.8195
5.29	.28	.35	.29	.275	.7230
fog	.23	.31	.255	.22	.
White	1.57	1.47	1.7	1.54	
Black	.45	.62	.5	.49	
Blue	1.1	1.15	1.31	1.24	
red	.9	1.06	1.01	.705	
yellow	1.07	1.22	1.27	1.1	

90 Degrees

$\log_{10}$ Reflectance.



D-19.
10 min

Nov 15 1943

D. E. Edgerton

Bell Lab. tubes were repumped. Filled with ~~Argon~~ at 17 cm pressure. Shipped Nov 13, 1943.

Baisley, Border, & Kenyon arrived today 3:15 P.M. Boston via pm.

Nov 28 1943. The B-24 six bank flasher (6000 mf 4000 v 2 lamps) was installed by Nov 17 at Bedford. I took night train for Syracuse N.Y. to attend funeral of Mac Watt. then took night train for N.Y. to meet Col Baisley at Mitchell field. We left about 1 or 2 and made W.F. about 5:30.

The bomb bays were opened on the flight to observe vibration of the reflectors. About 1 or 2 inch deflections were noted. the reflectors were then put in the ~~vertical~~ vertical position and satisfactory operation of the reflectors and lamps was obtained. The counters (flash) read 118 and 270 upon arrival at Wright field.

A flight was set up on Nov 20 (Sat.) but one starter did not function. The starter was not replaced on the 21 st. Weather kept us down on Nov 22. Tues Nov 23 was a beautiful clear night and we made a flight which produced successful photos.

I set up a movie outfit (B.R. 621) for Capt Thomas (now major) on Nov 24 and 25.

took night train for Cleveland on Nov 25. Also on Nov 26 at B.F. Goodrich to install 621 BR high speed movie apparatus. Left for Boston that night and arrived about noon.

Nov 15 1943
B-2 Edgerton

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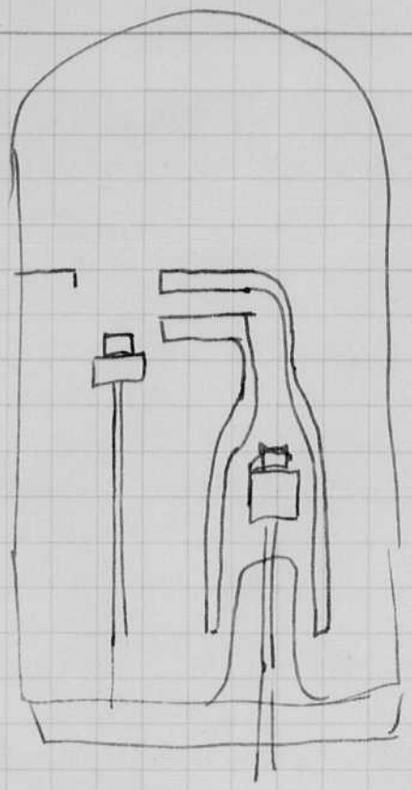
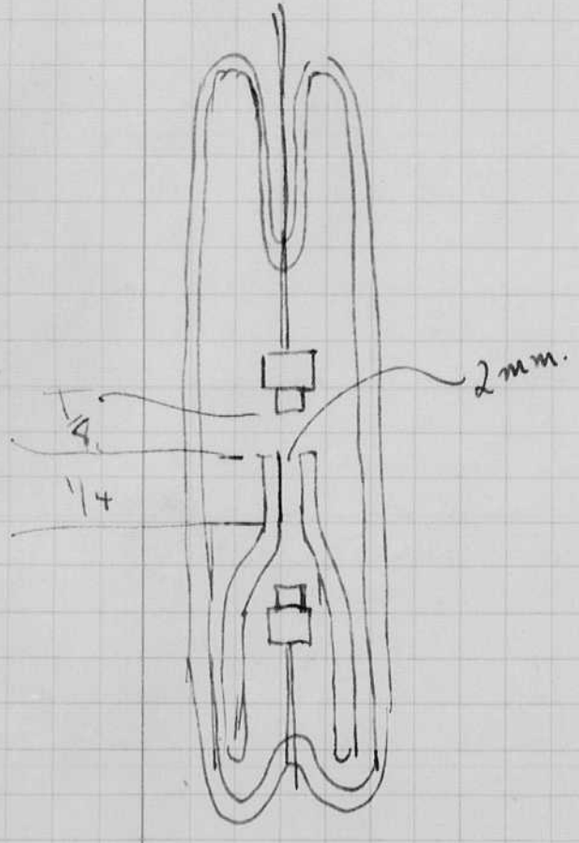
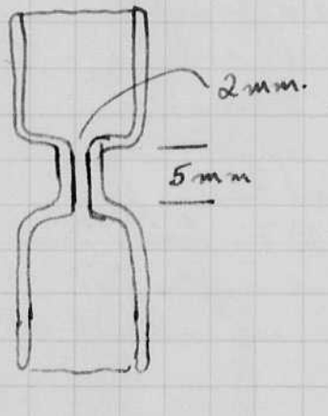



2mm.
4
14


2mm.
5mm

Nov 30 1943

Harold E. Edgerton

Helicopter data

Rotor speed 190 – 250 RPM (3.17 – 4.17)
Rotor diam 38 ft
Rotor height 11 ft.

circ = 40 × π = 120 ft.
velocity = $\frac{120 \text{ ft}}{1/4}$ = 480 ft/sec.
if exp = 10^{-4} sec.
dist = 480 × 12 × 10^{-4} = .575" travel.

d

14" f 9 lens.

Assume 2" image ≐ 480"

$\frac{14}{2} = \frac{d}{40}$

40 × 7 = d

280 ft = d

180 × 9 = 2600 = 1620 guide number.

diap = 19 $\sqrt{C}$ E

or C = $\left(\frac{\text{diap}}{19E}\right)^2 = \left(\frac{1600}{19 \times 4000}\right)^2$ = 3900 mf (1160 mf)

use white paint and 80 mf.

Basis
Kodatron
diap = 400
C = 112 × 10^{-6}
E = 7000
L = 75 lum/sq ft.

$400 = K\sqrt{\frac{75 \times 112 \times 10^{-6} \times 4 \times 10^{6}}{\text{Film light}}}$

diap = 19 $\sqrt{80 \times 10^{-3} \times 4000}$ = 19 × 9.4 = 610
Since the efficiency of the #19 is twice greater than the Kodatron this factor may be $\sqrt{2}$ greater diap = 850

$\frac{K}{\sqrt{\text{film}}} = \frac{400}{\sqrt{75 \times 112 \times 4}}$ = 2.22

33600
181

$\frac{K}{\sqrt{\frac{L}{\text{film light}}}} = \frac{400}{\sqrt{112 \times 4}}$ = 19

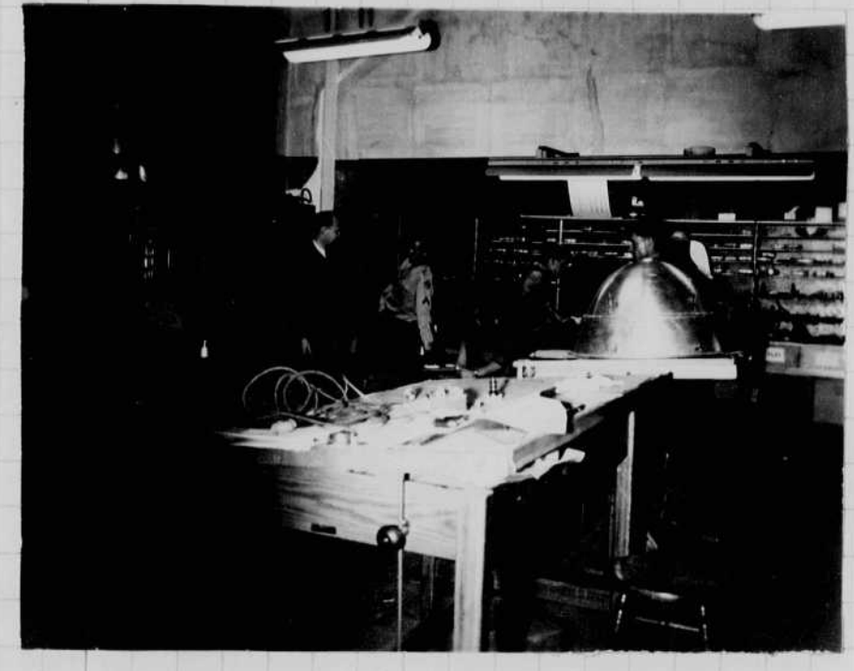
21.2

Dec. 5, 1943.

Harold Edgerton.

The B-25 unit for ~~an~~ a B-24 plane was taken to W. F. on ~~Friday~~ Thursday. Dec 2. by Major ~~Dale~~ Gail Borden, Copilot Hall. Mike Eastman went with the unit.

The unit weighted about 600 pounds. There were 6 condensers of about 80 mf at 4000 volts. Chg time was about 1.5 sec. with the 2 generators 1500 volt amp. Island.



Jutkins camera tests.

			avg. f.p.s.
135 ft of film	6 V on motor	4 sec.	540
" " "	4 V " "	5 3/4 sec.	377.

Fri. Dec. 10, 1943

Harold E. Edgerton

On Sat. Dec. 4th at 10 30 pm a phone call from Col Baisley at Wright field was received. The B-24 flash unit had just exploded a transformer in service during aerial photographic experiments. I made arrangements for the TWA plane from N.Y. and took the midnight to N.Y. after collecting a suitcase of spare parts that I thought would be useful.

Upon my arrival in Dayton I went immediately to W.F. with Col Baisley and went to work on the flash unit. The short circuit was between the primary and the secondary windings of the transformer. By 10 pm that night the equipment was fixed and ready to go. Banow, Jacono, and Capts Shults and Jensen helped with the repairs. We could not test the equipment since our B-24 was in the hangar. The engines and generators must be needed to run to supply the 700 amps that is needed for the charging of the condensers.

On monday morning it was trying to rain. Capts Linn and Cely piloted the plane when we took off about noon. After flying blind for three hours we came down and found ourselves over the ocean just off the bulge in North Carolina. We swung back to the west and landed at Elizabeth city at the coast guard station there. After another flight with some difficulty we located Mackall field which is some 40 miles south east of Pope field (Ft. Bragg).

Dec. 1, 1943.

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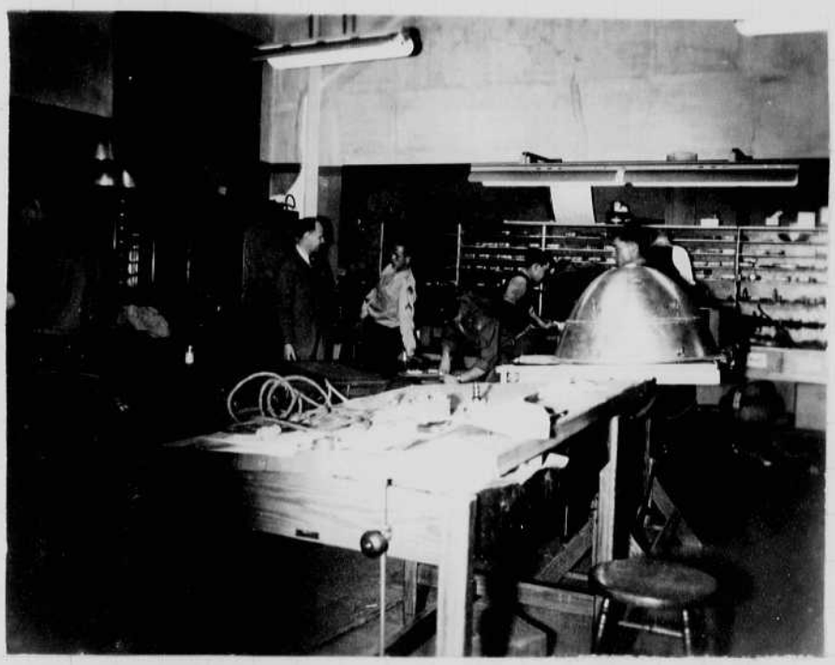

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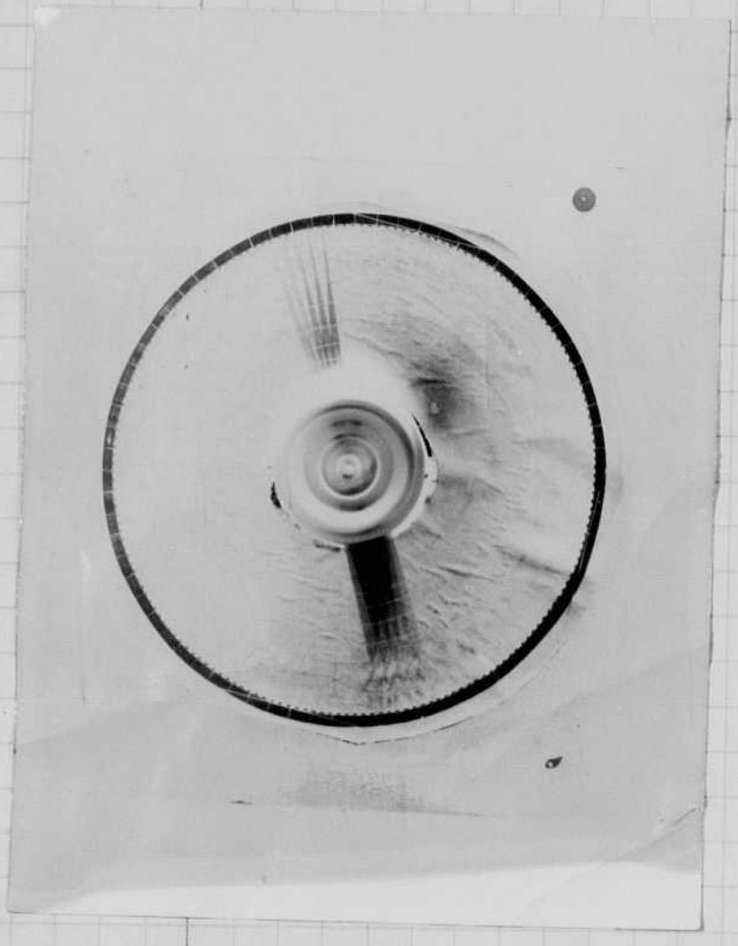
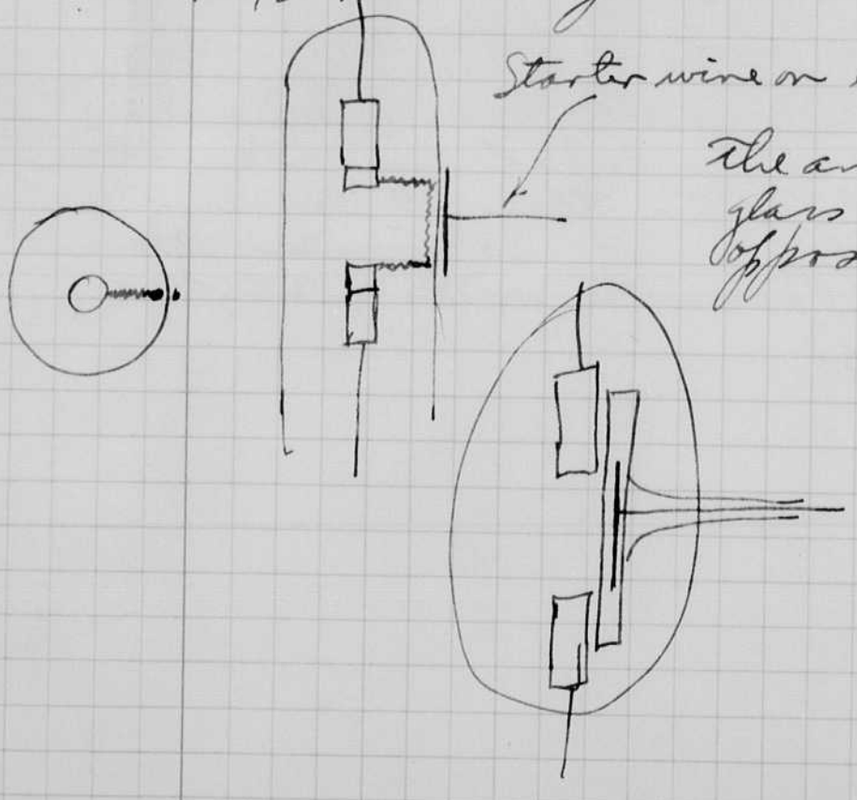


5 flasher test.

7200 rpm.

$\frac{1}{120}$ sec per rev.

Dec 19 1945 Harold E. Edgerton



Harold E. Edgerton Dec 19 1943

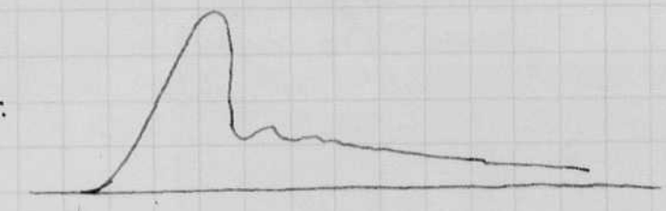
Civil Action 1851 with ~~others~~ Cities Service Oil Co. Judge Arthur D. Healey. Dec ~~10~~ 9, 10, 11, 13, 14. Borden. Miller etc. I was home with a cold on Dec 15 and part of Dec 16.

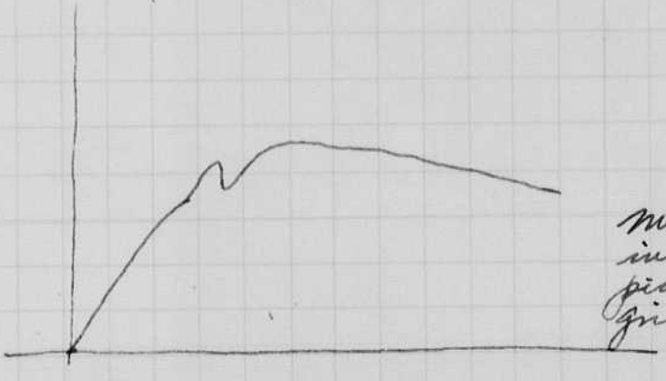
Dec 17. Saw Conversey and Emmons at ~~Harvard~~ about high-speed tunnel.

Dec 18. at E.K. co. ~~Anyhow~~ trying to find trouble with timing circuit or stroboscope. There was pickup in the grid circuits. Placing of the grid resistors on the socket solved all the trouble.

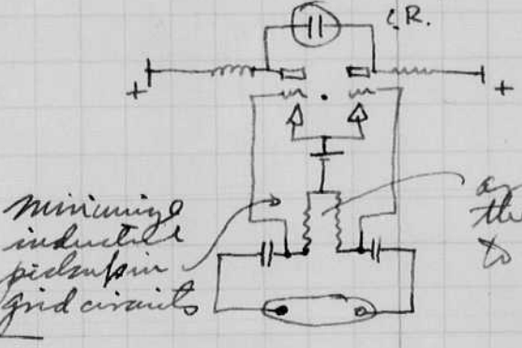
Worked in ~~off~~ with Newton Feldman on the cathode ray oscillographs of flash lamp characteristics. Several pictures were taken of the light, current, and voltage for various conditions.

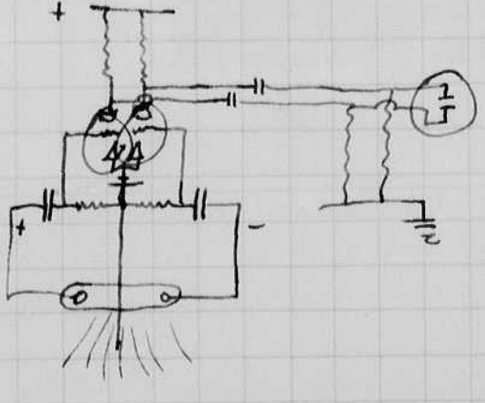
The current curve was done ~~that~~ as follows.





The first part of the curve may be in error due to an inductive effect.





6" wire · 1000 amps in 10 μs.

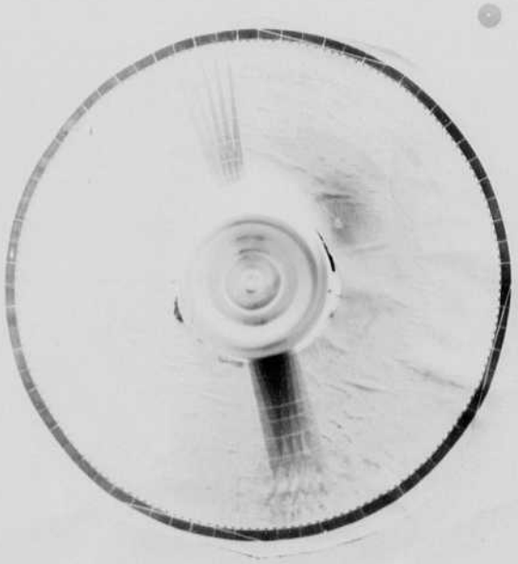
$\frac{1000}{10^{-5}} = 10^3 \times 10^5 = 10^8$ amps/sec.

$e = L \frac{di}{dt}$.

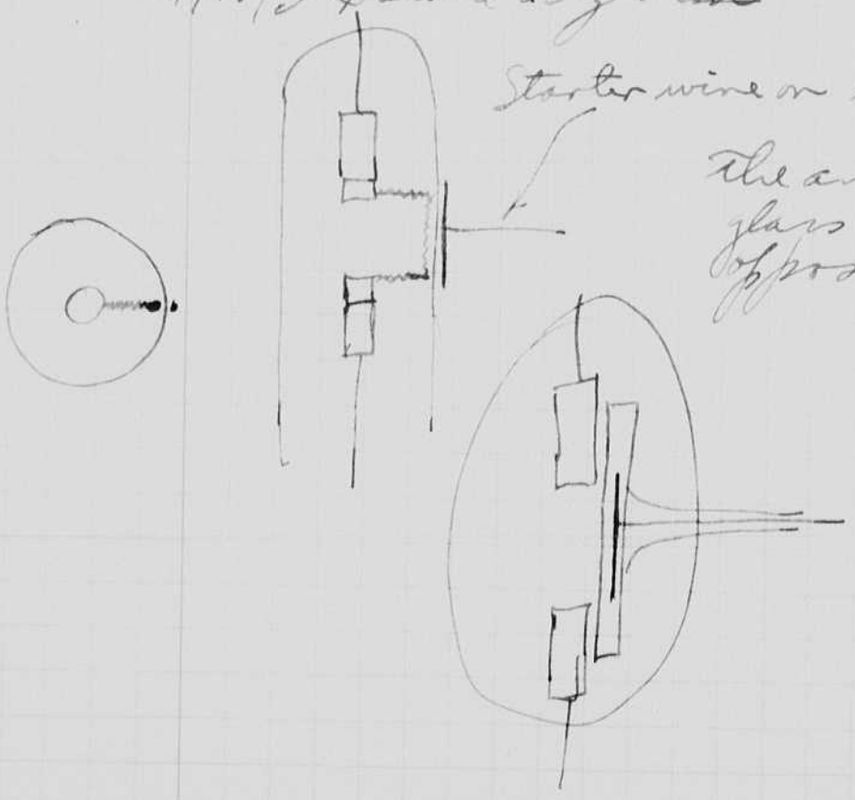
5 flasher test.

7200 r.p.m.

$\frac{1}{120}$ sec per rev.



Dec 19 1945 Harold E. Edgerton



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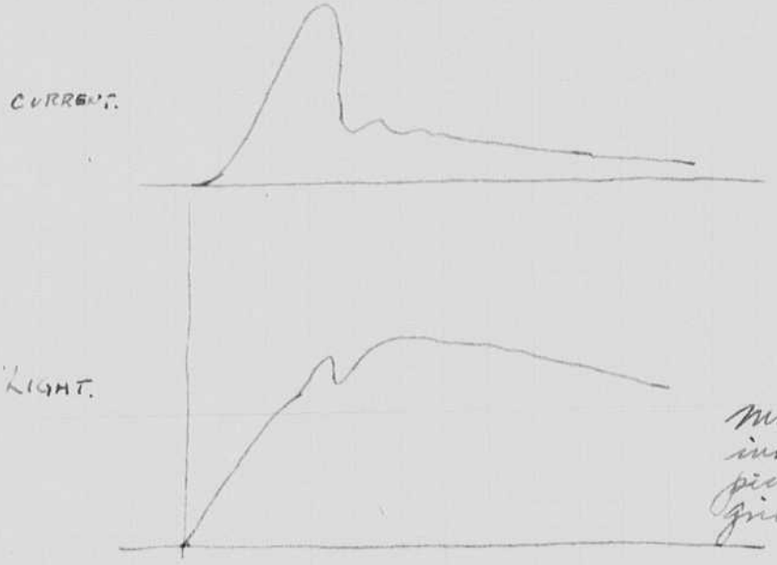
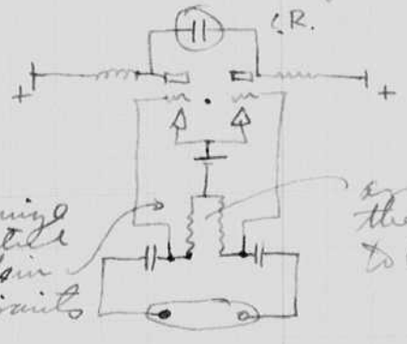
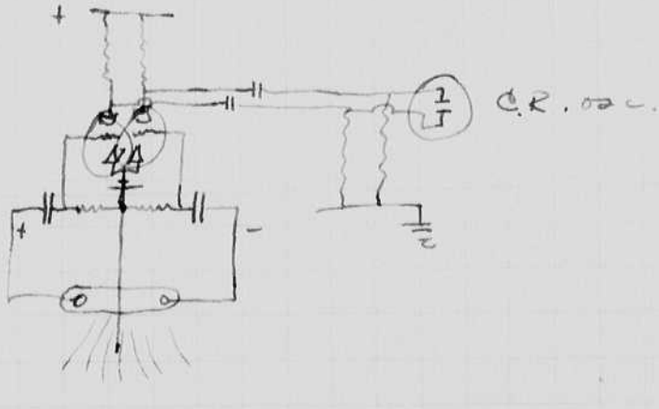


The first part of this curve may be in error due to an inductive effect.





6" wire · 1000 amps in 10 μs.

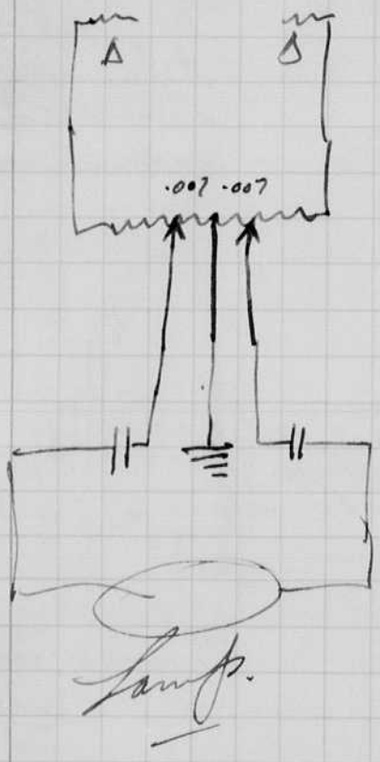
$\frac{1000}{10^{-5}} = 10^3 \times 10^5 = 10^8$ amps/sec.

$e = L \frac{di}{dt}$.

Dec 20, 1943
Harold E Edgerton

The .001 ohm shunts were arranged in parallel (see pg 175) to reduce the inductive effect. It was found that the peak was reduced by about ½ showing that there was an inductive drop in the shunts.

a different shunt was found which had
.076 ohms total in 11 steps.
.007 per step.



the deflection with this was too much with 25 mf at 2000 volts and a No 2. lamp.

Assume 800 amps.

$\frac{.007}{800}$
.056 = 56 volts on grid of each tube at peak.

Osc No	C.	~~Volts~~ Temp	Temp	Tuning	Remarks.
1.	100	2000	±2 Kcd.	200,000.	
2	100	2150	"	"	
3	"	"	"		
~~4~~	100	3000	"		
5		3000			
6		1500			
7		1500			

Fred Barston and D-3 unit which was installed in a B-24 Nov 17 1943 at Bedfordair-prod.

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Harold E Edgerton

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Fred Barston and D-3 unit which was installed in a B-24 Nov 17 1943 at Bedfordair-ports.

148 Photo Tehran Oct 1943 See page 123. P.B.M. Ensign Methvin

Joe Liscano.

↑ D-1 unit.

Dec 27 1943

Harold E Edgerton

On Friday Dec 24 I tested a flasher for polaroid. Those present, Paul Lee, Chas Mattz, Walter Stobie, and Lt Franklin (Wright Field). A D-1 unit was recommended with 14 mf on the condenser. The field shunting relay was opened. Even then the lamps held over into a continuous glow part of the time.

Dec 28 1943.

Lts Beaumont and Stobie arrived today from Wright field. Schneiderman and Scholz came yesterday. Col Baisley was due in a B25 yesterday. He is now planning for Thursday.

Dec, 31, 1943

Baisley, McKay, Dr. Romo White, Wohls arrived Thursday Dec 30 as planned in the B-25 no 51. The D-2 unit was loaded in the plane. It has been rebuilt with 8 rectifiers and with voltage regulators.

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \qquad \frac{1}{.75} = 1 + \frac{1}{R_2}$$

$$\frac{1.33}{1.} \quad \frac{1}{.33} = \frac{1}{R_2} \qquad R_2 = 3 \text{ ohms.}$$

$$P = \frac{7.5^2}{3} = 18.7 \text{ watts.}$$

148 Photo Taken Oct 1943 See page 123.

P.B.M. Ensign Matthews

Jo Liscano.

↑ D-1 unit.

Dec 27 1943

Harold E Edgerton

On Friday Dec 24 I tested a flasher for polaroid. Those present, Paul Lee, Chas Mathy Walter Stobie, and Lt Franklin (Wright Field). A D-1 unit was recommended with 1 mf on the condenser. The field shunting relay was opened. Even then the lamps held over into a continuous glow part of the time.

Dec 28 1943.

Mr Beaumont and Stobie arrived today from Wright Field. Schneiderman and Scholz came yesterday. Col Baisley was here in a B25 yesterday. He is now planning for Thursday.

Dec, 31, 1943

Baisley, McKay, Dr. Romo White, Wohls arrived Thursday the 30 as planned in the B-25 no 51. The #2 unit was loaded in the plane. It has been rebuilt with 8 rectifiers and with voltage regulators.

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \qquad \frac{1}{.75} = 1 + \frac{1}{R_2}$$

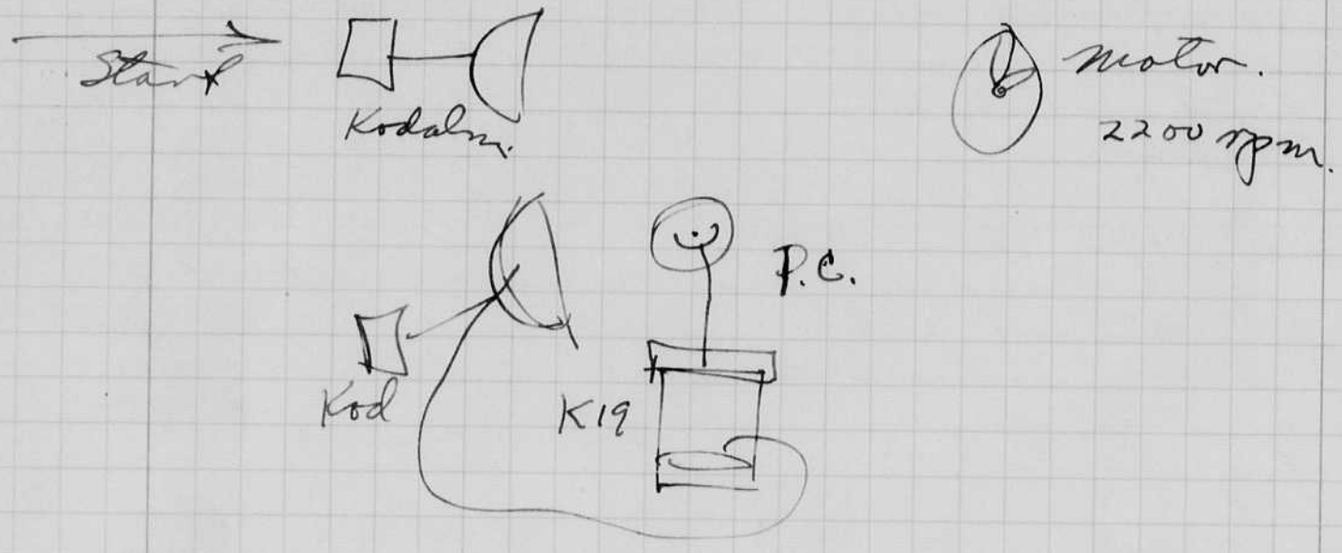
$$1.33$$

$$\frac{1.}{.33} = \frac{1}{R_2} \qquad R_2 = 3 \text{ ohms.}$$

$$P = \frac{7.5^2}{3} = 18.7 \text{ watts.}$$

Jan. 7. 1944
Harold E. Edgerton

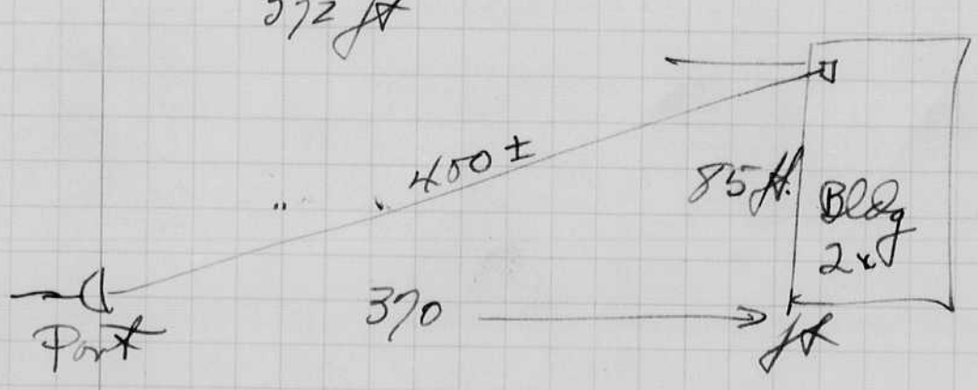
Test of K-19 camera yesterday for time delay.



Time delay between flash and second flash from K-19 arrangement.

$$t = \frac{1}{2}\left(\frac{1}{2200}\right)60 = 0.0136 \text{ seconds}$$

Range with Portable (Long cable lamphouse 20 ft. #15 lamp.)



Jan 12 1944

Harold Edgerton

Chas Wyckoff arrived from Norfolk on Saturday with recording and flash tubes for testing. He has had trouble with double flashing and skipping.

The worst tubes showed gas when excited with a spark coil. A band up half way on the tube made the hard starters work. And increase in charging resistance stopped the double flash.

Chas. left this morning on the 11 A.M. plane that left Boston at 8 am.

I am supposed to go on a trip with Col. Baisley in the near future.

Jan 14. 1944.

Yesterday at Fairchild Aviation 475 Tenth Ave N.Y. Schubert, Sanders, L. Bacchi, Larson, Carl —

Experiments were made with several different optical systems to find the most efficient. It was concluded to try a new #2 lamp which has a replaceable fuse lamp. A sample of this was supplied by Eastman Kodak about 4 months ago. The socket for the small fuse lamp is mounted on a wafer socket that is placed between the base of the lamp and the socket.

Bacchi, Ed Noel (Fr. Cleveland) and Jim Mili had dinner together. Then Noel, Bacchi and I went to the Fairchild plant and had a conference that lasted until 10.30 p.m. I returned to Boston on the night train.

Spent morning in Federal court Judge Sweeney Service Price of Boston.

Jan 25 1944
Daniel E Sayer Jr.

On the 16 I left about noon for W.F. with a D-1 unit a K 19 camera and parts to repair the D-3 that blew up on last Friday. Shultz, Castle and Reding took me to the train.

At Dayton I checked in the Moraine Hotel then called for a truck from W.F. Max Cantin was the driver.

On 17 and 18 had numerous discussions with Glynn, Capt. Castle (ASC) Lt Mandel etc concerning a contract for 15 D-3 units and 15 D-1 units. The hold up is justification and price control. I tried to make it plain that this equipment was new and no manufacturing experience was available. Both Col. Baisley and I insisted that our groups at M.I.T. be responsible for the engineering details and test of the flash units.

A faulty resistor from the outer grid to the cathode was located in the D-3 on Jan 19 and repaired.

The D-2 units was assembled on Jan 20 with hangers for the B-25 airplane. A new cable was made with a ground wire in the synchronization cable.

Further conferences were held on Jan 21 with Col. McGrath, Glynn, Castle, Mandel, Lt. Taylor, Crayille and Capt. Jane.

I left Dayton on the 4:50 pm plane which was about 3 hours late.

Saw Schubert and Bakin on the morning before taking the 10:30 train for home.

Jan 23 helped Scobee with D-1 unit that he is going to take to Florida, Boca Raton.

CONTINUED
ON
NEXT REEL