HAROLD E. EDGERTON

PAPERS

MC 25

Series III

Laboratory Notebooks

Number 16

Dated Feb. 17, 1945 to Mar. 30, 1946

Massachusetts Institute of Technology

Room 4-117 8-103. 8-105

COMPUTATION BOOK

NAME	Number
HAROLD E. EDGERTON	16

Course .....

Used from FEB 17 1945, to MAR 30 1946.

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."

* * * * * * * *"

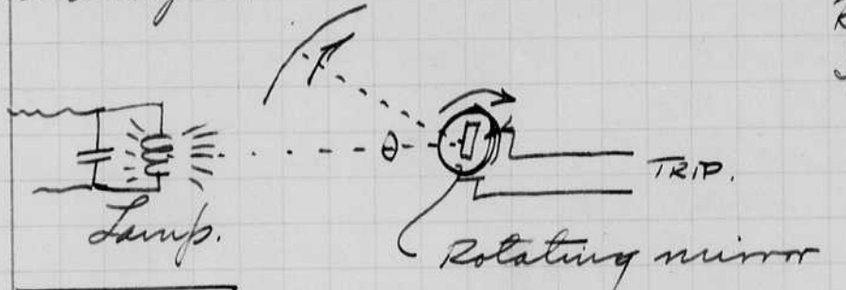
TECHNOLOGY STORE
HARVARD COOPERATIVE SOCIETY, Inc.
40 Massachusetts Ave., Cambridge, Massachusetts

Feb. 17, 1945. M.I.T.
Harold Edgerton

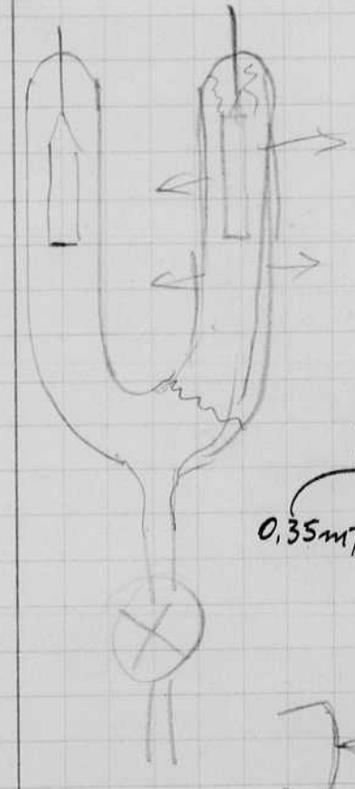
Most of my time is now spent on a project at Bedford field where an A 26 c plane is being fitted with a flash unit (2400 mf 4000 v) and a radar plus other navigational devices. Bayston and Mc Roberts are working with Raytheon on the design and manufacture of the flash unit.

Capt Roll and three soldiers from M.I.T. are learning the radar equipment.

For the last week or so some experiments have been made to measure the time duration of the flashes from short duration lamps.



a V shaped pyrex lamp was re pumped and filled with argon at 25 # sq inch. It exploded when flashed with 1/3 mf at 8000 ± volts.



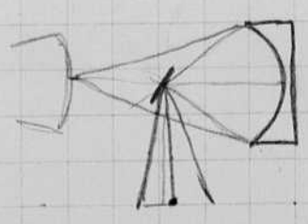
a second tube was pumped and flashed ok at 9000 volts 1/3 mf. Duration is short. Some trailer.

1. 9000 v 1/3 mf U.V. 30 # sq in argon.
2. 9000 v 1/3 mf ⏚ " " " "
3. 14000 v .05 mf C " " " Spot on cathode.

0.046 mf

0.35 mf.

#3 photo is much dimmer than #2 and 1. ? why.



4. 8200 V. 15# □inch argon tube ~~~ 1/3 mf

5 10,000 " " " " 3 atmosphere.

Some self flashing at 10 000 volts.

5

Feb 20 1945

6 10,000 30#sq inch argon 1/3 mf. "

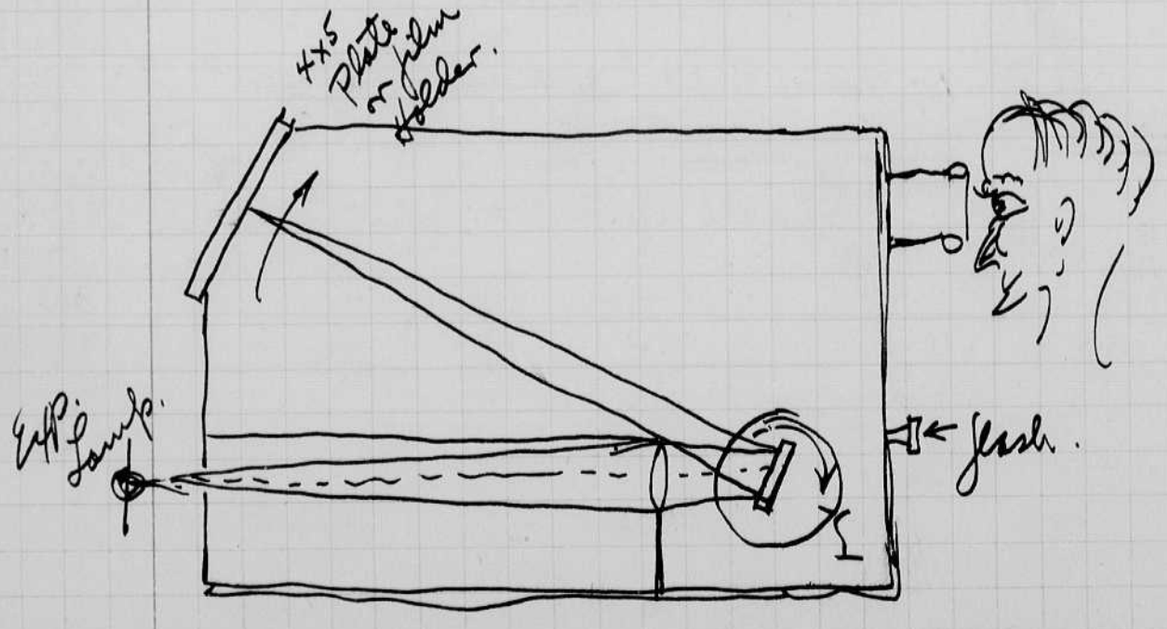
7 7600? Std microflash lamp. 1/3 mf.

8, 7600 30#sq inch argon 1/3 mf microflash lamps.

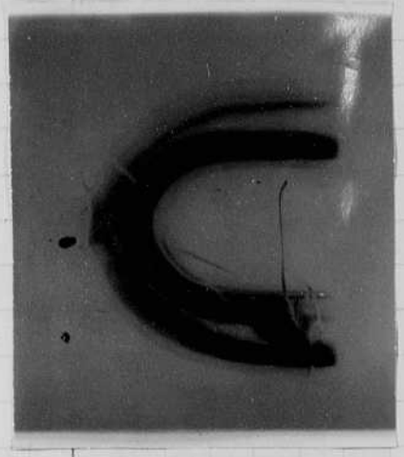
9 7600 0 " " " " " " atmosphere

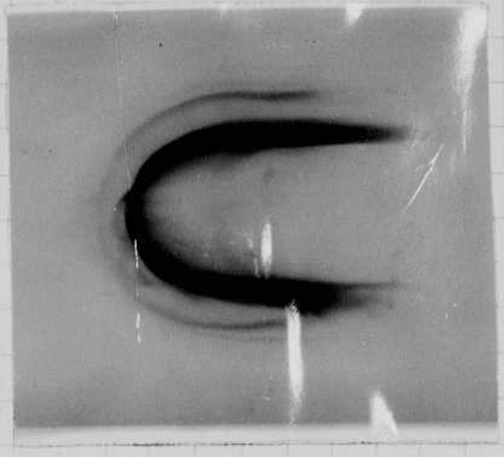
10 7600 0 pres argon 1/3 mf + .5 Same tube as shot 4.
This tube self flashes about 14000 volts

11 Tube run with ~~2~~ 3. mf at 6000 or 7000 volts - Blew up.
flashed ok at 4000 first.
The tube broke along the space opposite the cathode. Usually the arc formed on this surface, for example see shot 6.



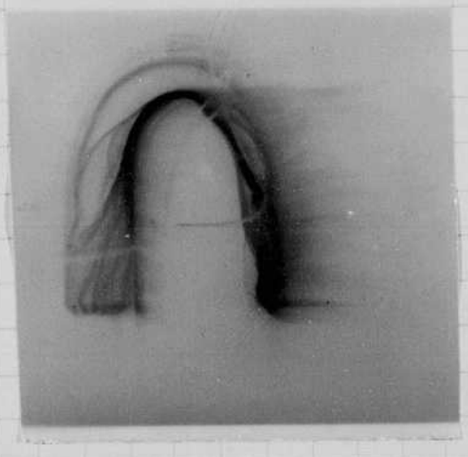
Argon tube 30 lbs per sq inch
240 R.P.S. 1 ft radius



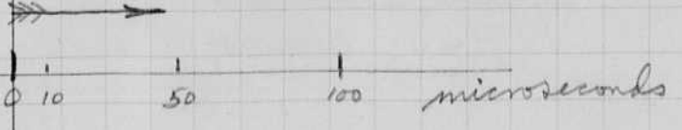


1. 9000 V 1/3 mf

2. 9000 V 1/3 mf



3. 14,000 V .05 mf



4. 8200 V. 15# ☐inch argon tube 1/3 mf

5 10,000 " " " " 3 exposures.

Some self flashing at 10 000 volts.

5
Feb 20 1945

6 10,000 30#/sq inch argon 1/3 mf. "

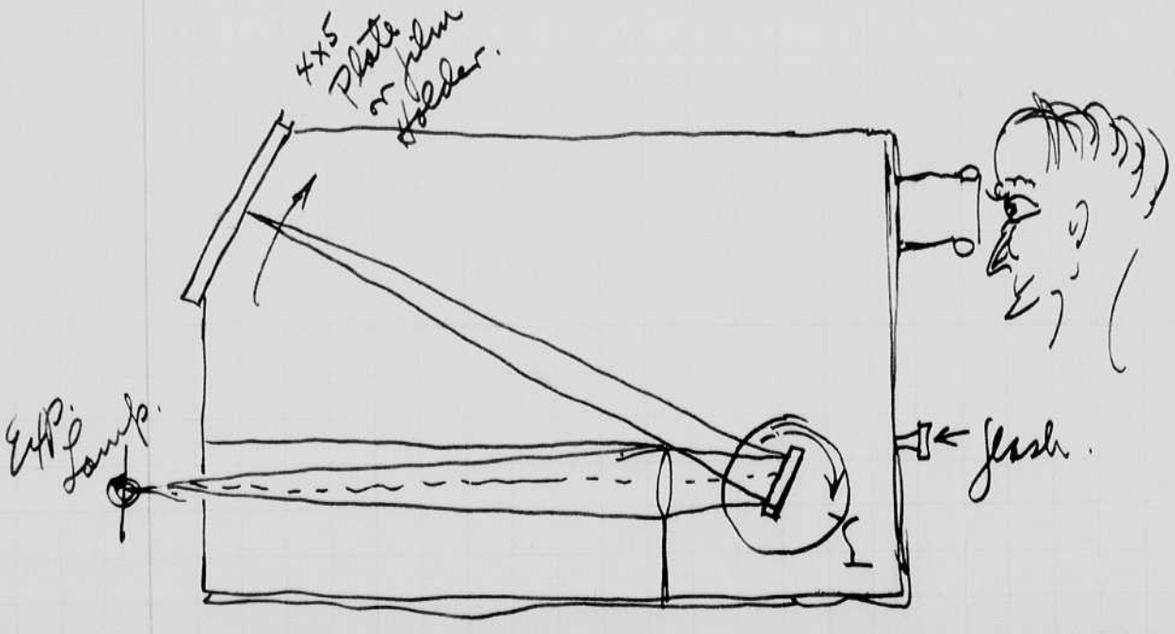
7 7600? Std microflash lamps. 1/3 mf.

8, 7600 30#/sq inch argon 1/3 mf microflash lamps.

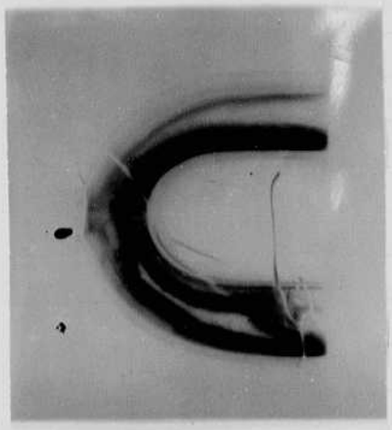
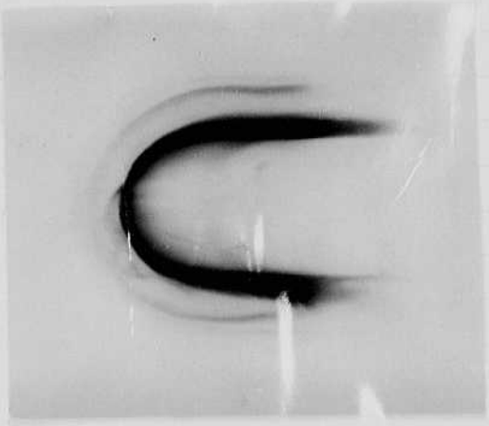
9 7600 0 " " " " " " atmosphere

10 7600 0 pres argon 1/3 mf + .5 Same tube as shot 4.
This tube self flashes about 14000 volts

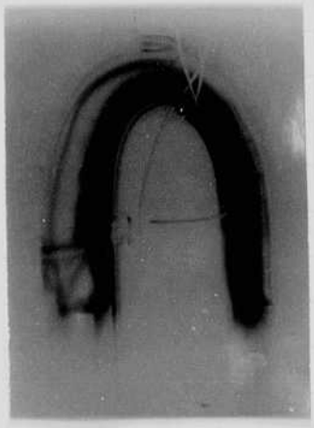
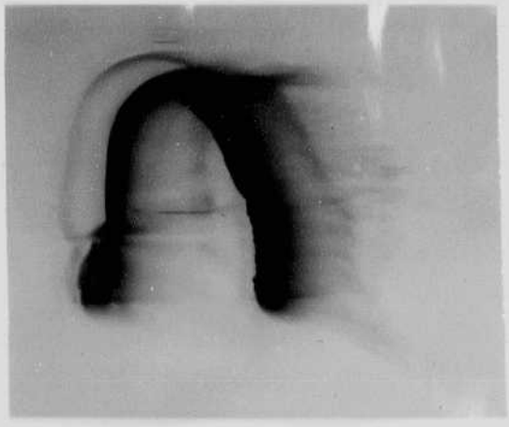
11 Tube run with 3/4 mf at 6000 or 7000 volts - Blew up flashed ok at 4000 first.
The tube broke along the space opposite the cathode. Usually the arc formed on this surface, for example see shot 6.



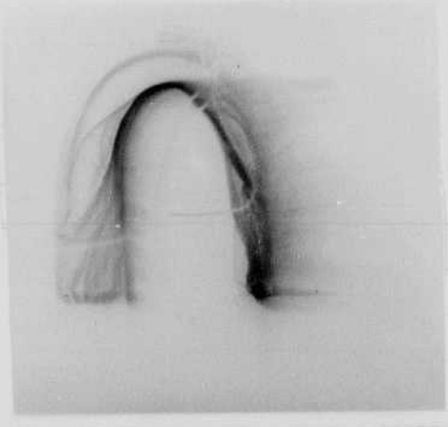
Argon tube 30 lbs per sq inch
240 R.P.S. 1/ft radius

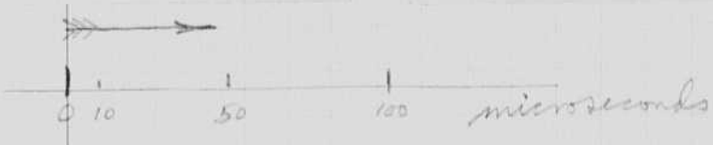
1. 9000 V 1/3 mf

2. 9000 V 1/3 mf

3. 14,000 V .05 mf

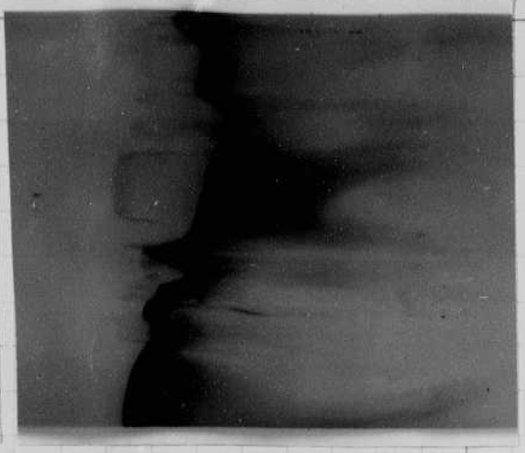


4

8200 V .35 mf 2 atmos.

?

4



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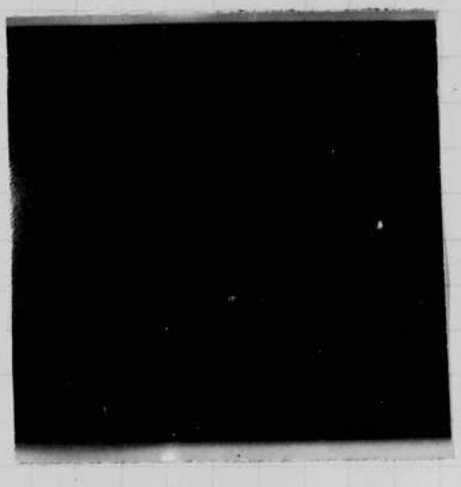
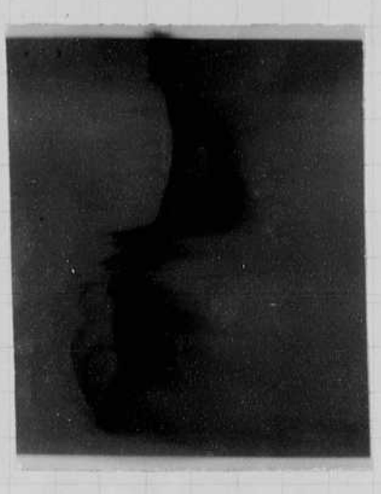


10,000 v
.35 mf
2 atmos

6

10,000V
.35 mf
3 atmos



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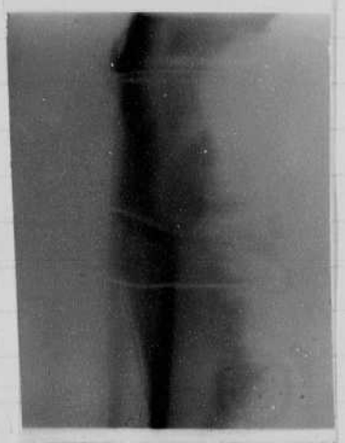
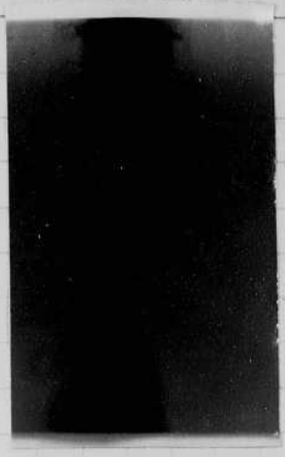
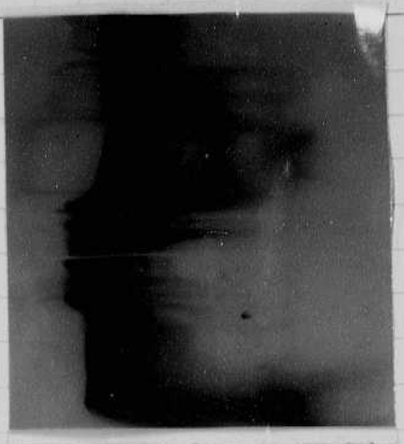


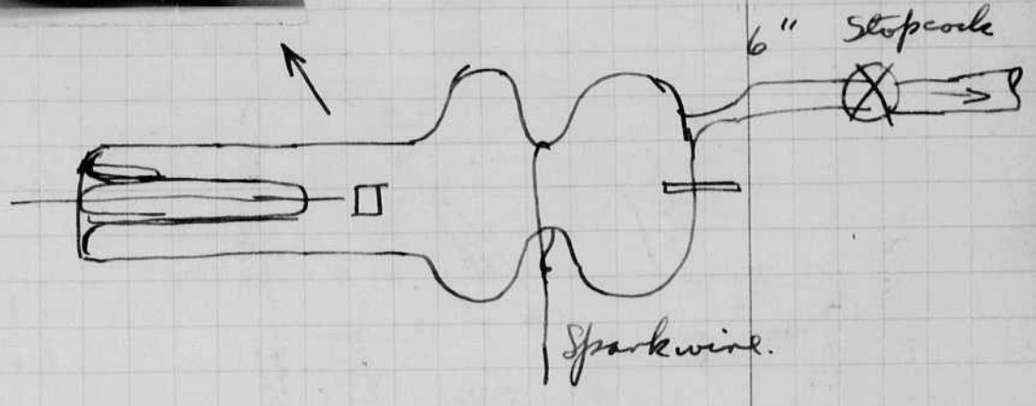
Hygrade microflash
7600 V 0.35 mf

10





1 atmos argon
7600 V
0.85 mf.



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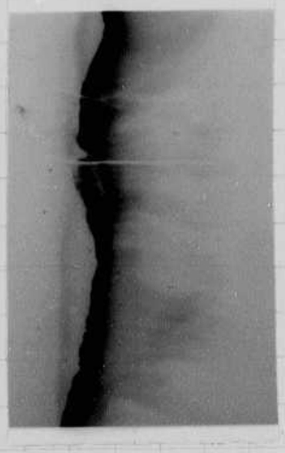
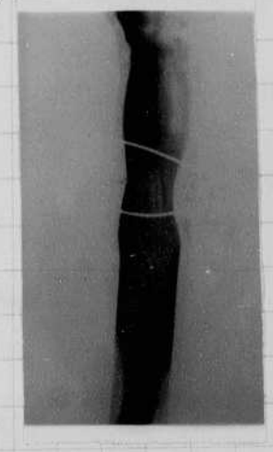


3 atmospheres argon
7600 V 0.35 mf
microflash tube.

9



— 1 atmosphere
7600 V 0.35 mf.
→ Same tube

4

8200 V .35 mf 2 atmos.

?

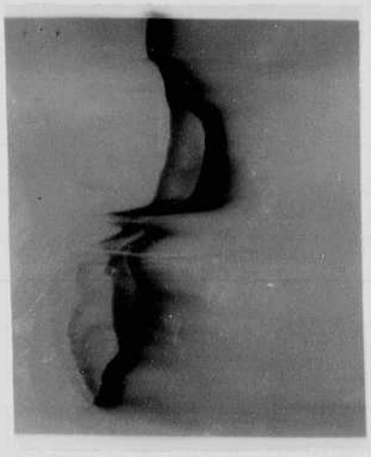
4

5

10,000 v
.35 mf
2 atmos

6

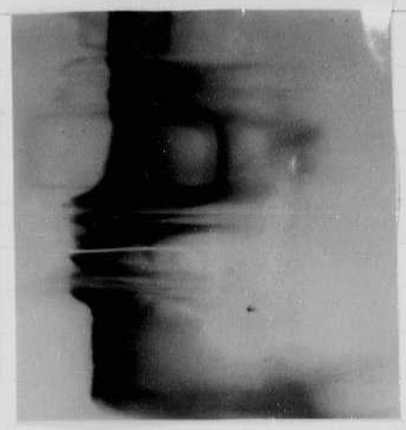
10,000 V
.35 mf
3 atmos



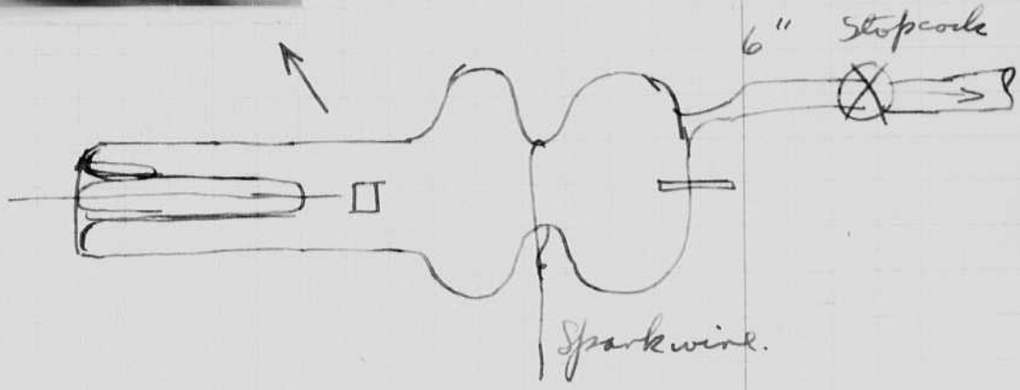
7

Hygrade microflash
7600 V 0.35 mf

10



1 atmos argon
7600 V
0.85 mf.



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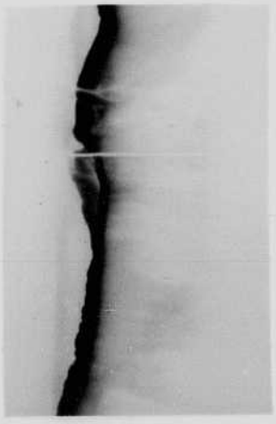
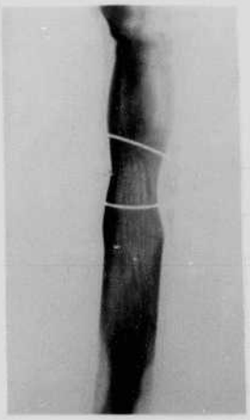


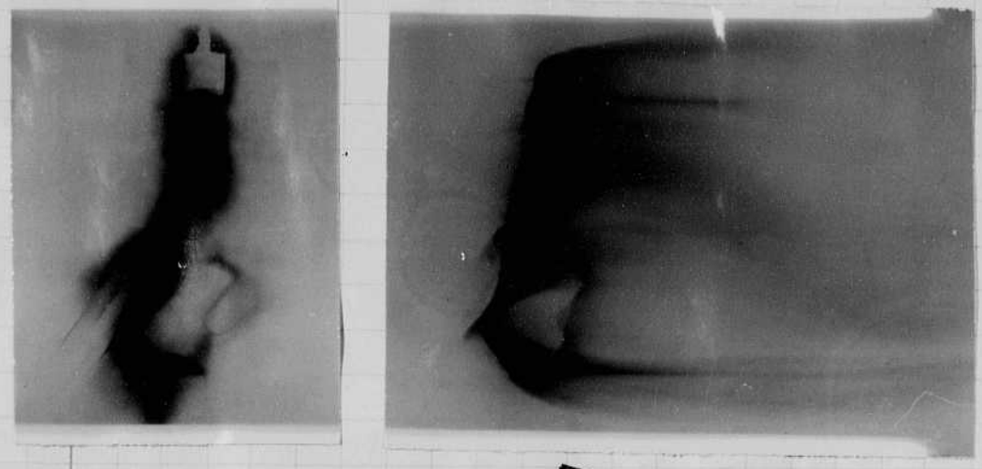
3 atmospheres argon
7600 V 0.35 mf
microflash tube.

9

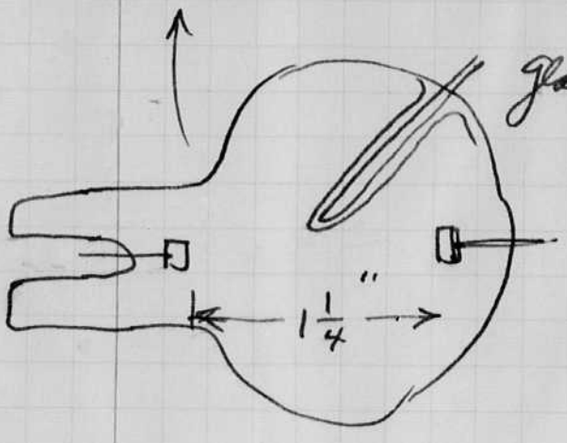


— 1 atmosphere
7600 V 0.35 mf.
—> Same tube

Feb. 26, 1945
Harold E. Edgerton

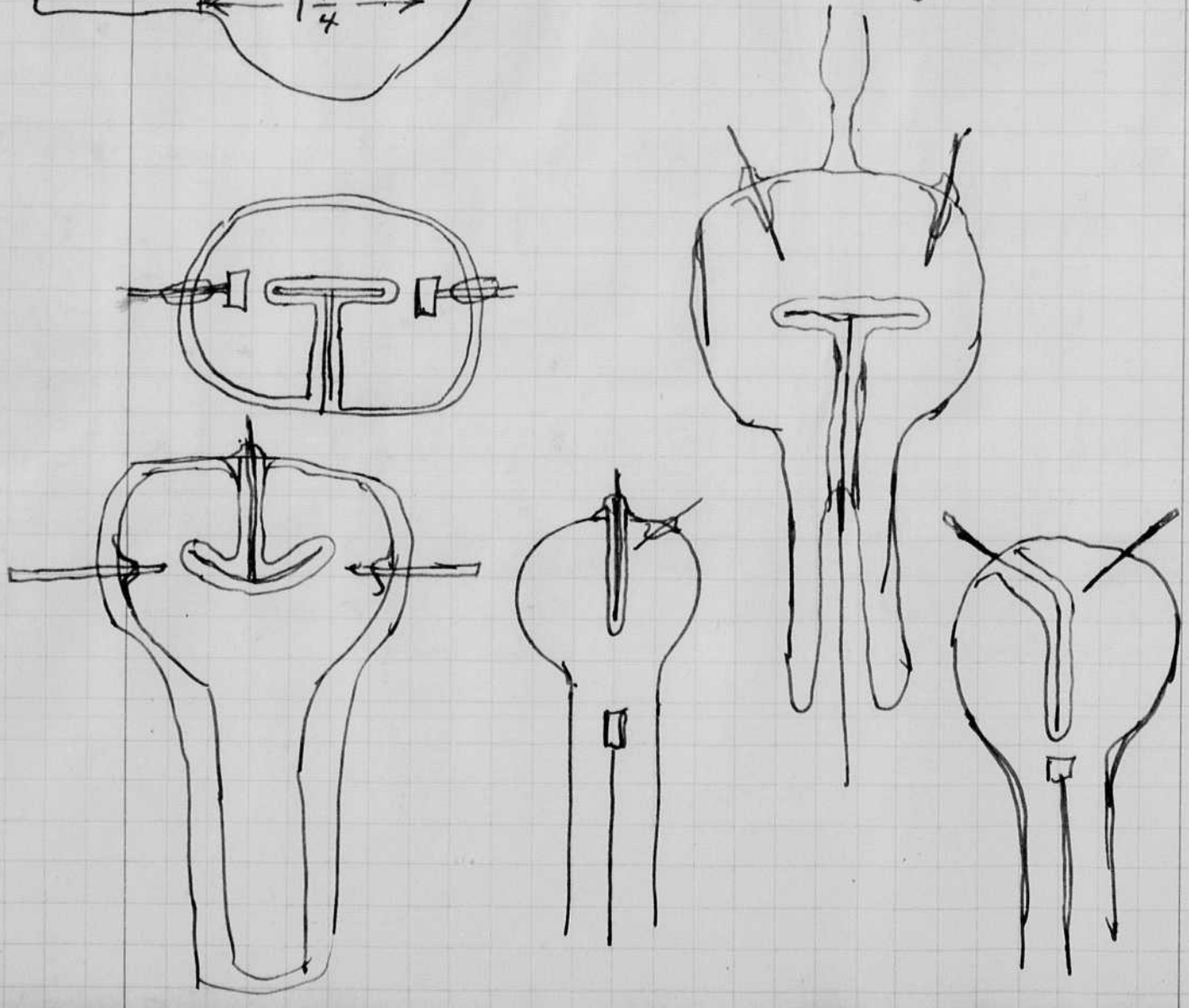


1/3 mf
9000 - 10000 v.
15 # per sq inch
2 atmos.
Argon.



Glass covered starter electrode.

Note short flash where arc strikes the glass starter.



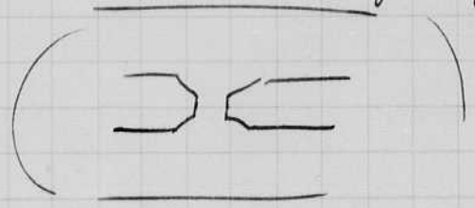
March 1 1945
M.I.T. Cgrnb
Harold E Edgerton.

Work is going fine on the A-26 airplane that is at Bedford for night photography. The radar dome has been put on the bottom over the hole left by the rear turnett. Ready this week for flight. Prof Copper checked air forces.

Two K-19 cameras have been mounted in the nose at an 18° angle with each other. Synchronizers have been put in the shutters for the electric flash.

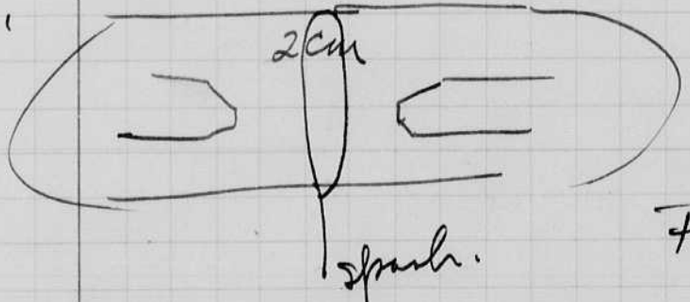
The reflector for the flash equipment is in the tail giving about 50 ft between the lamps and camera.

Mar 2. Argon gap tube.



3/16" gap Argon 30 #/sq inch
Sparks over at 7000 volts by self.

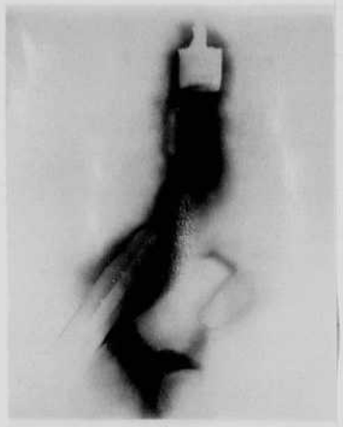
Controls ok with external spark.

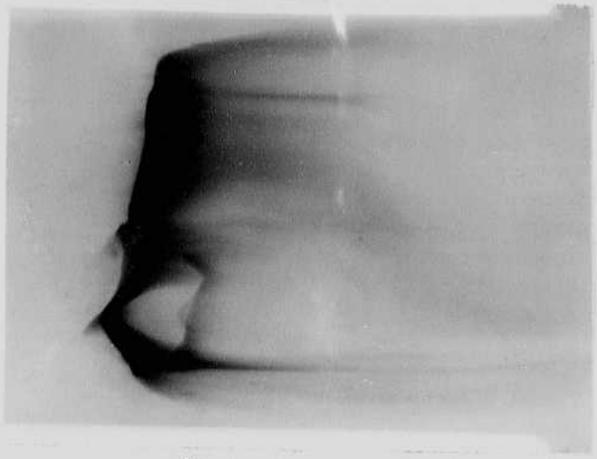


Sealed off stopcock at 45 #/sq in
flashes ok at 5000 to 10,000 volts
Photo taken. Long trailer.

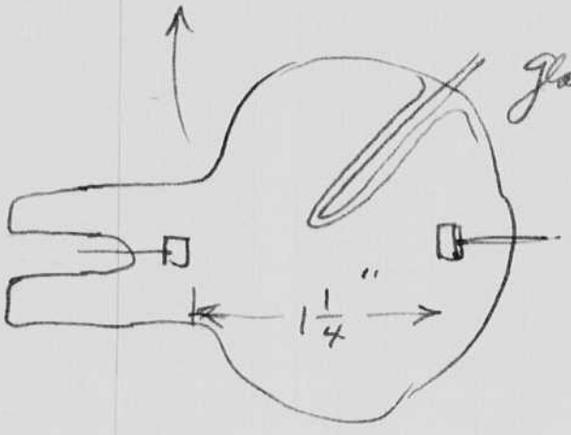
3/16" gap tube repumped and filled with 45 #
1/3 mf 10,000 volts shows 100 flashes + trails!

Feb. 26, 1945
Harold E. Edgerton



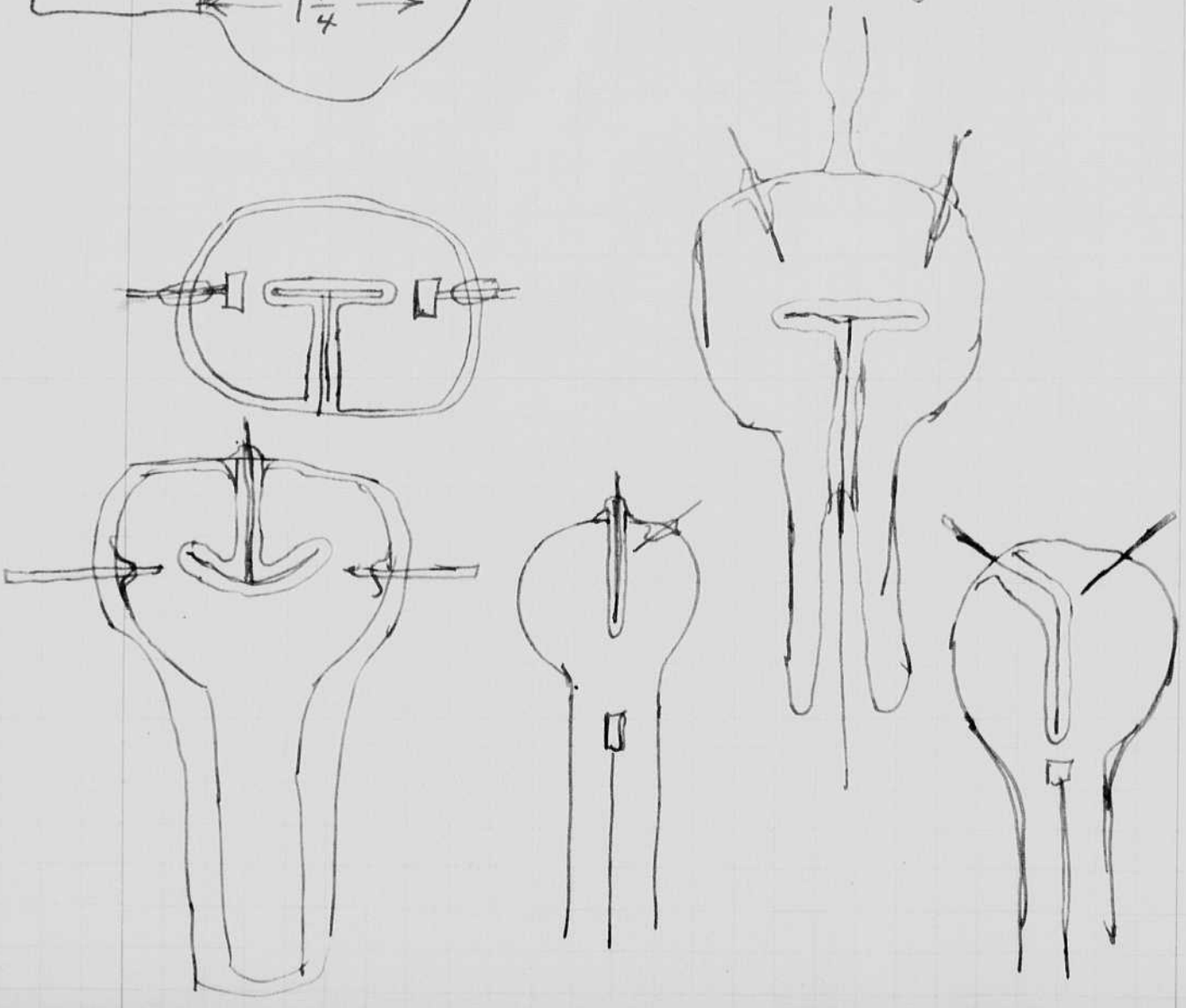


1/3 mf
9000 - 10000 v.
15 # per sq inch
2 atmos.
Argon.



Glass covered starter electrode.

Note short flash where arc strikes the glass starter.



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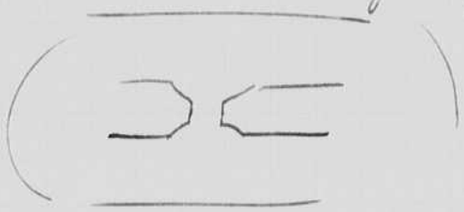
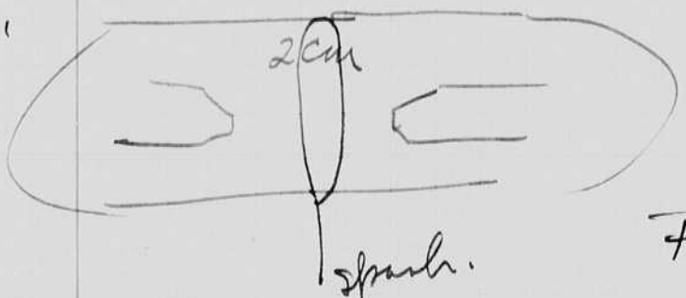


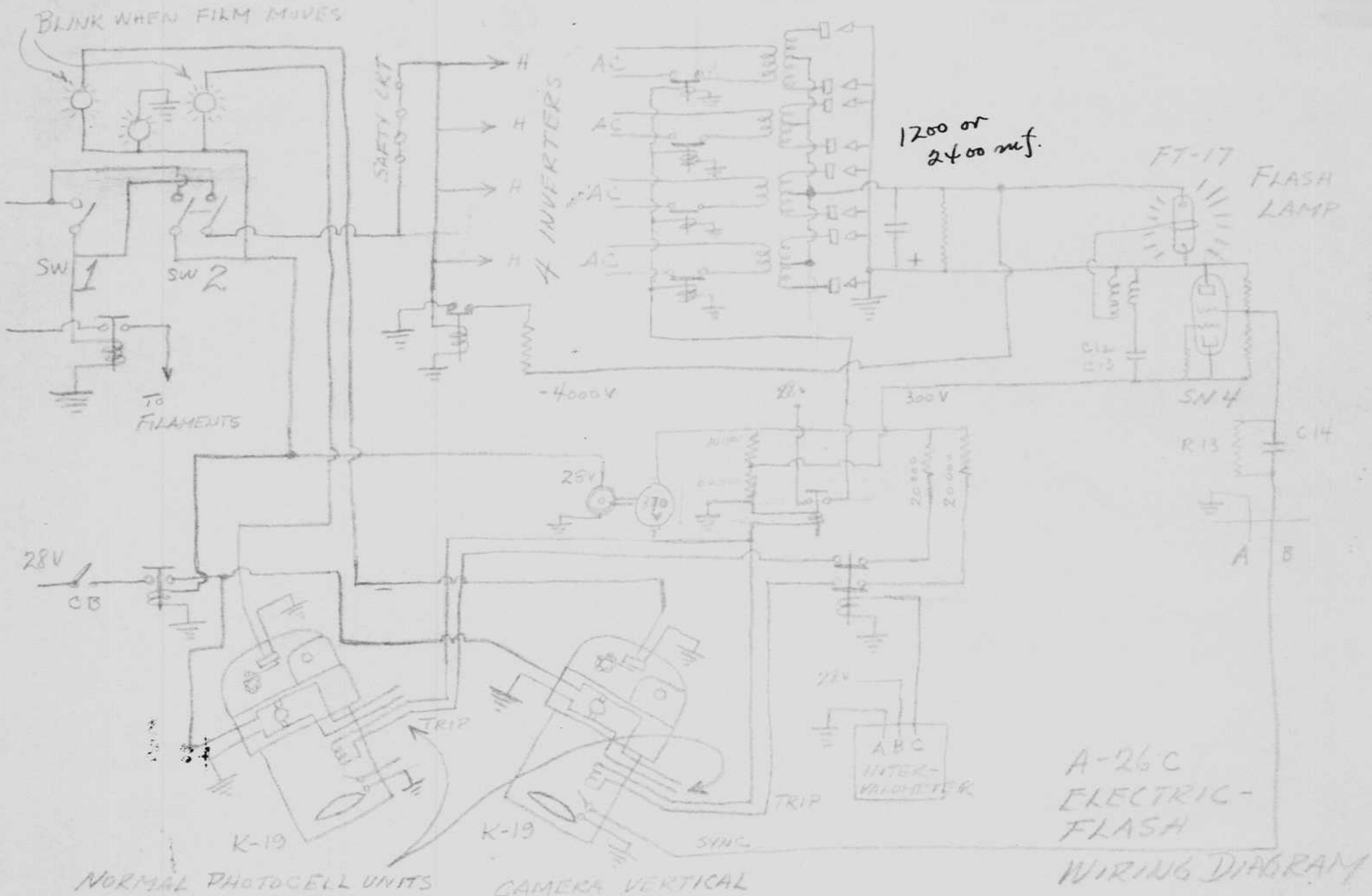
3/16" gap Argon 30 #/sq inch
Sparks over at 7000 volts by self.

Controls ok with external spark.



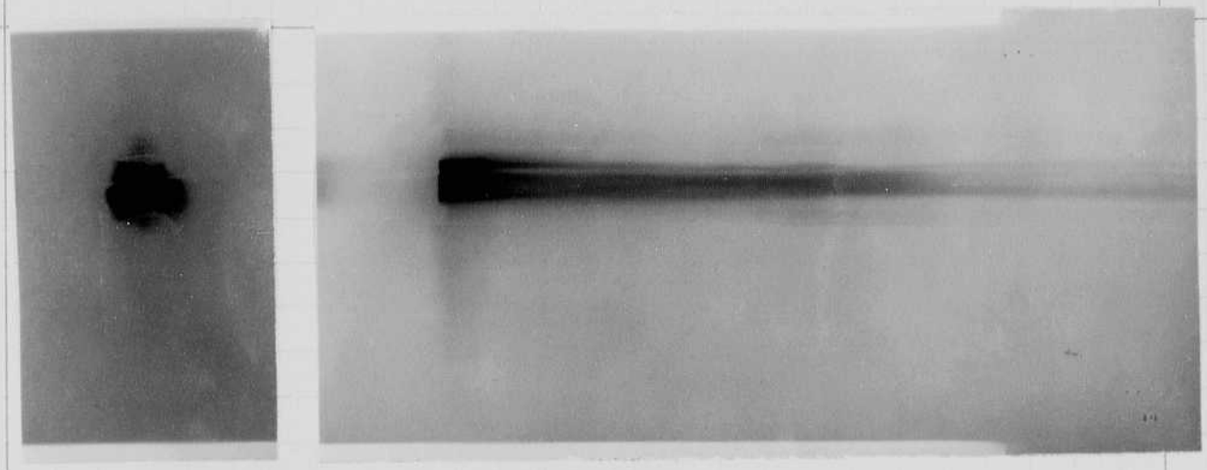
Sealed off stopcock at 45 #/sq in
flashes ok at 5000 to 10,000 volts
Photo taken. Lang trailler.

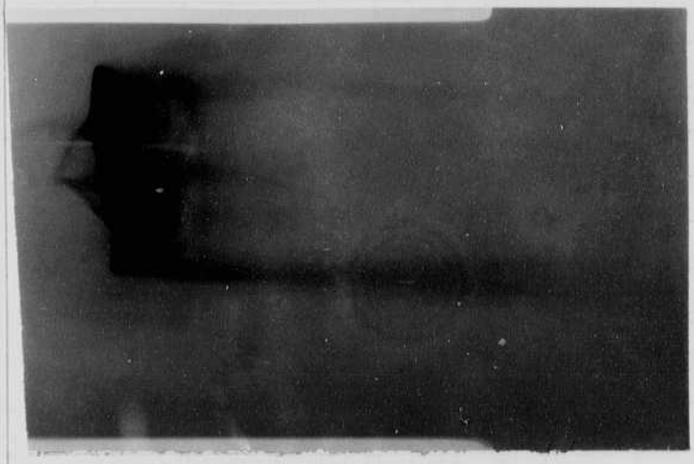
3/16" gap tube repumped and filled with 45 #
1/3 mf 10,000 volts shows 100 [illegible]5 + trailer!


BLINK WHEN FILM MOVES
SAFETY CKT
H
H
H
H
4 INVERTERS
AC
AC
AC
AC
1200 or
2400 mf.
FT-17
FLASH
LAMP
SW 1
SW 2
TO
FILAMENTS
-4000 V
300 V
SN 4
R13
C14
A
B
25V
28V
CB
TRIP
K-19
K-19
SYNC
ABC
INTER-
VALOMETER
A-26C
ELECTRIC-
FLASH
WIRING DIAGRAM
TYPE D-5
M.I.T.
H.E.EDGERTON
FEB. 23, 1945.
NORMAL PHOTOCELL UNITS
USED WITH FLASH
BOMBS
CAMERA VERTICAL
WITH ELECTRIC FLASH.

P 7

3/16" gap tube argon 45 # sq inch 1/3 mf 10,000 v.

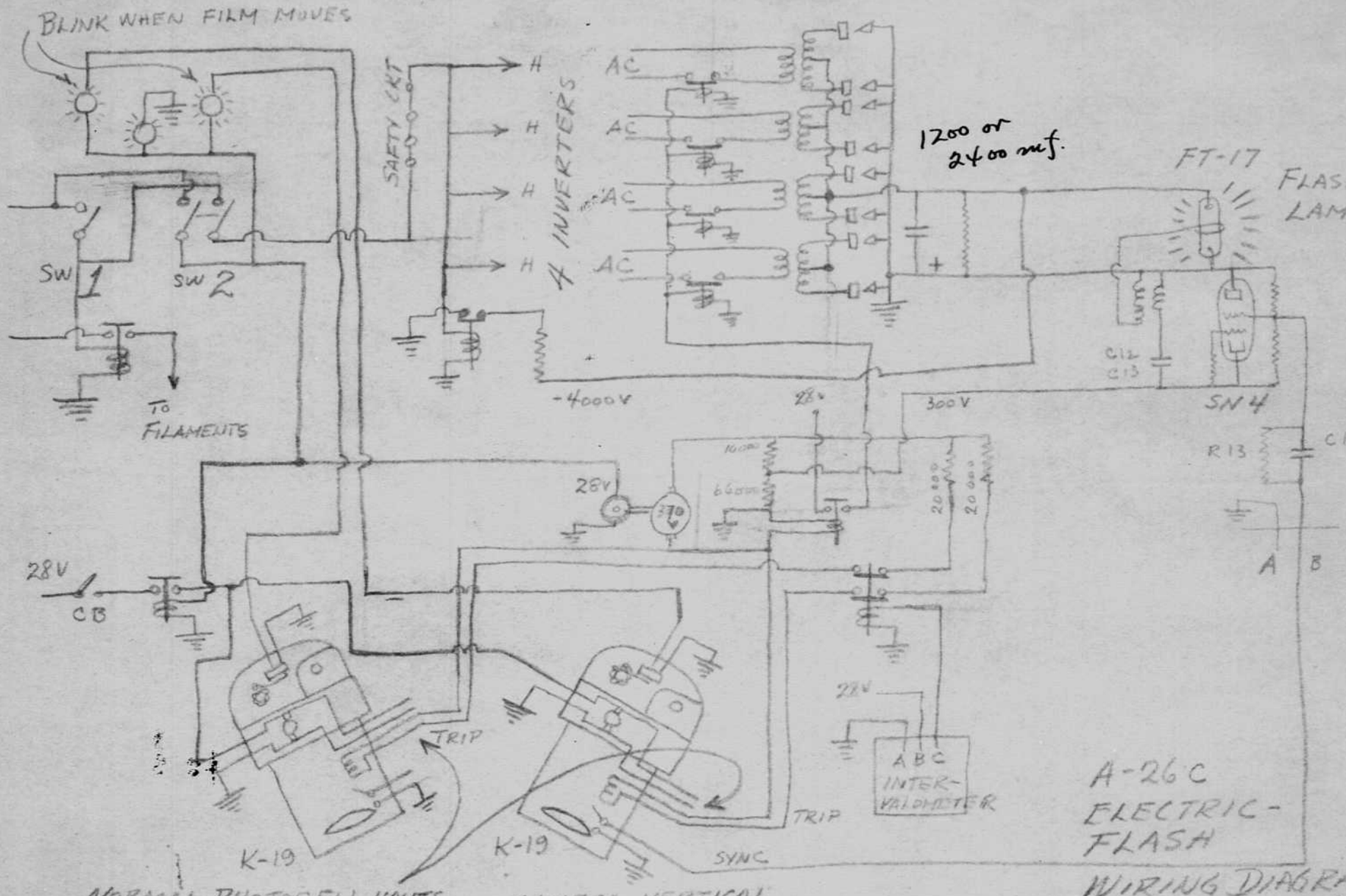


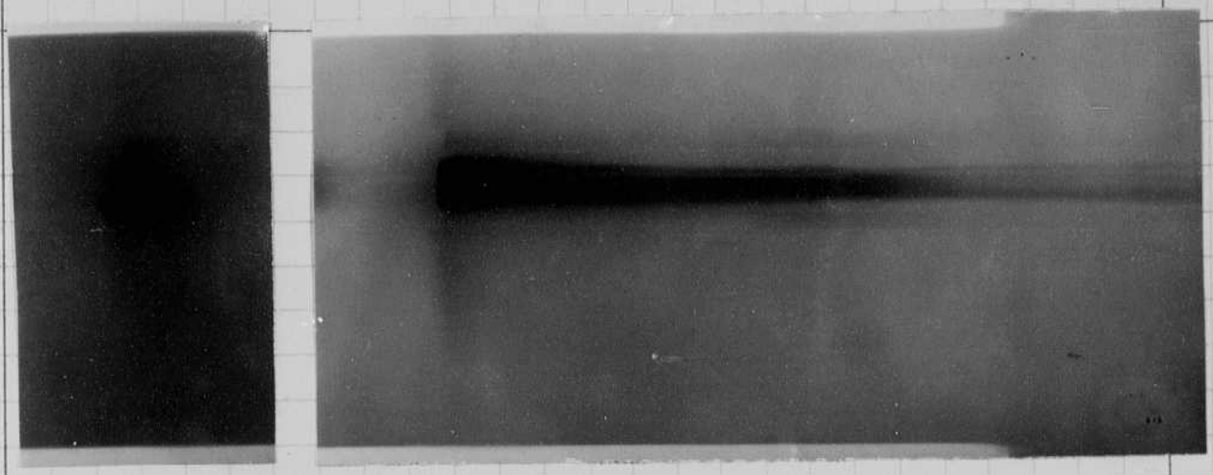


2cm gap argon 40 # sq inch. 1/3 mf 10.000 v.

In this shot the camera mirror motor was not up to speed.

0 50 100 microseconds


BLINK WHEN FILM MOVES
SW 1
SW 2
TO FILAMENTS
SAFETY CKT
H
H
H
H
4 INVERTERS
AC
AC
AC
AC
1200 or 2400 mf.
FT-17
FLASH LAMP
C12
C13
SN 4
-4000V
300V
28V
R13
C14
A
B
28V
CB
28V
28V
A B C
INTER-VALOMETER
TRIP
TRIP
K-19
K-19
SYNC
NORMAL PHOTOCELL UNITS USED WITH FLASH BOMBS
CAMERA VERTICAL WITH ELECTRIC FLASH.
A-26C ELECTRIC-FLASH WIRING DIAGRAM TYPE D-5
M.I.T.
H.E.EDGERTON
FEB. 23, 1945.



P 7

3/16" gap tube argon 45 # sq inch

1/3 mf 10,000 v.

2cm gap

argon 40 # sq inch.

1/3 mf 10.000 v.

For this shot the camera mirror motor was not up to speed.

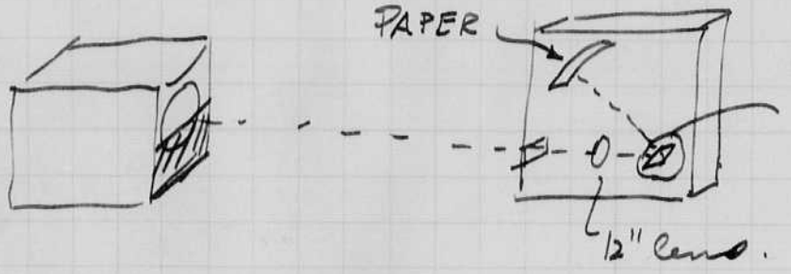
0 50 100

microseconds

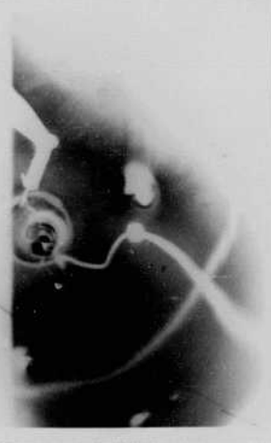
march 4 1945
M.I.T. H.E. Edgerton

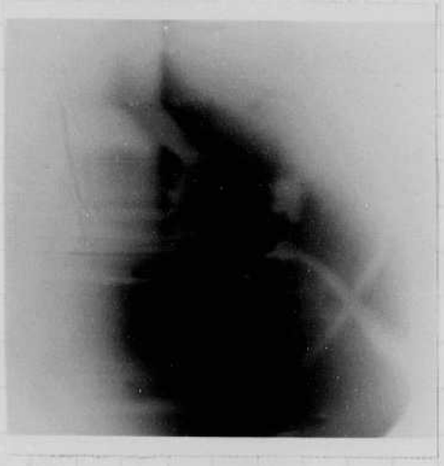
the lens in the rotating mirror camera was changed to an f 9 12". Now the subject is 1 meter from the front plate of the box. a 4:1 reduction of the tube image is photod.

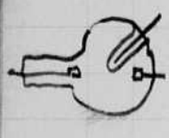
A series of tests were made with the G.R. ~~camera~~ and mirror as shown below

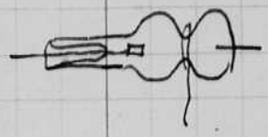


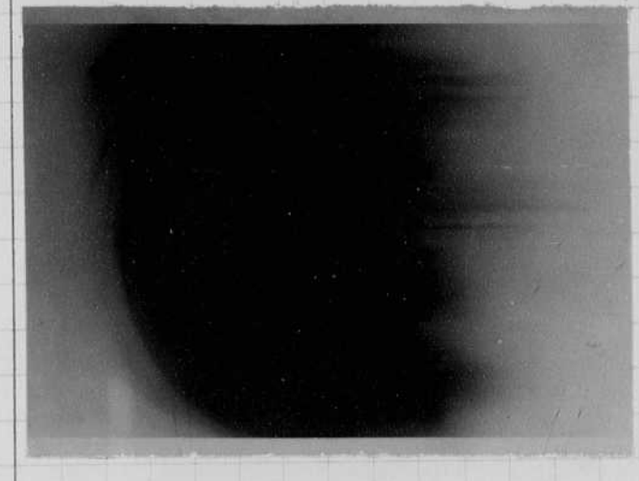
Std thyratron inf. tube











Tube sketched above repumped - filled with
1 cm Hydrogen, then 15 #/sq inch argon.
Photo also taken with 1 atm by opening stop cock
trailer is much less with 1 cm Hydrogen.
about same with 1 and 2 atm.

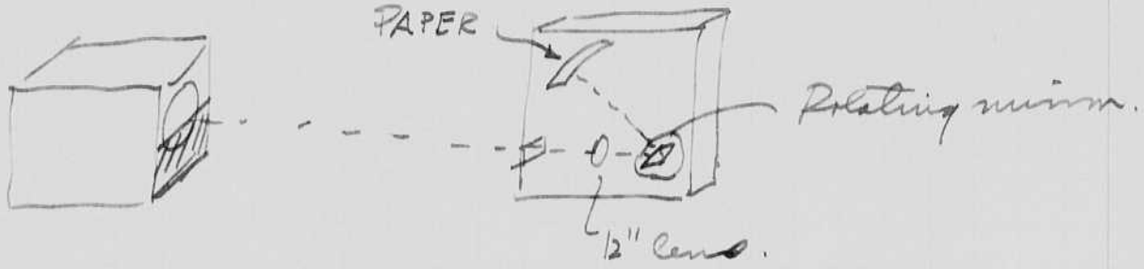
Repumped 5cm H_2 + 15 #/sq inch argon.
Would not start on DR unit but ran it
Reduced pressure to 1 atm - still no reliable
operation. One photo taken - excessive time
delay.
Tried again - delay > 200 μs and photo was not
on the film.

Repumped 2cm H_2 + 15 #/sq in.
Repumped 2cm H_2 + 1 atmosphere argon - sealed off.
Similar test made with a delay of 2.5. Large delay in
starting more than 400 microseconds! Condenser voltage
increased to 9000 - 10000 volts. Delay about 200 μs.

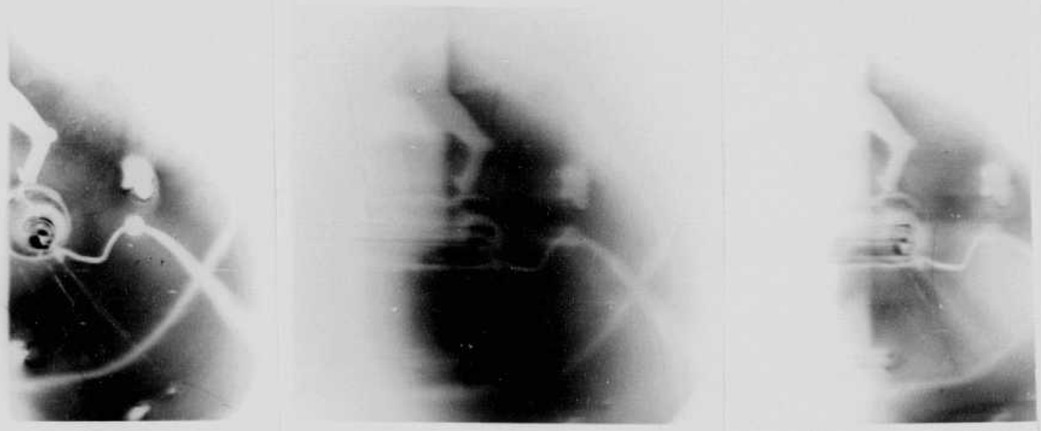
march 4 1945
M.I.T. H.E. Edgerton

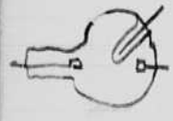
The lens in the ~~rotating mirror~~ camera was changed to an f 9 12". Now the subject is 1 meter from the front plate of the box. a 4:1 reduction of the tube image is photoed.

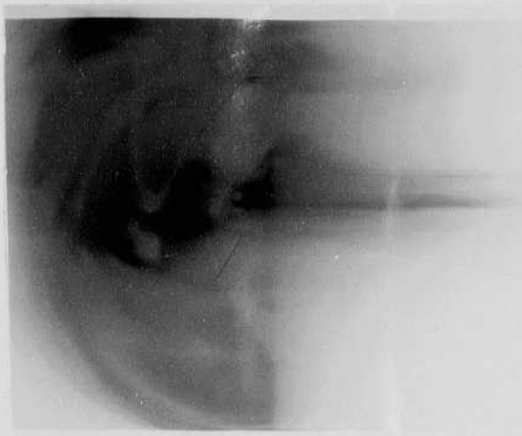
A series of tests were made with the G.R. ~~camera~~ and mirrors shown below

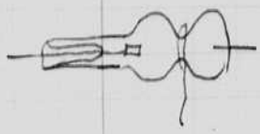


Std type grade mf tube









Tube sketched above repumped - filled with 1 cm Hydrogen, then 15 #/sq inch argon.

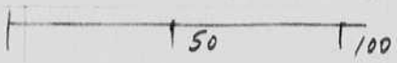
Probe also taken with 1 atm by opening stop cock - filler is much less with 1 cm Hydrogen. about same with 1 and 2 atm.

Repumped 5 cm H_2 + 15 #/sq inch argon.
Would not start on 2K µf but ran it
Reduced pressure to 1 atm - still no reliable operation. One photo taken - excessive time delay.
Tried again - delay > 200 µs and photo was not on the film.

Repumped 2 cm H_2 + 15 #/sq in.
Repumped 2 cm H_2 + 1 atmosphere argon - sealed off.
Similar test made with 2 atm 2.5. Large delay in starting more than 400 microseconds! Condenser voltage increased to 9000 - 10000 volts. Delay about 200 µs.!

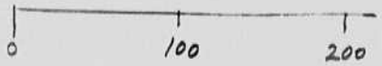
Hygrade microflash lamp
across 1/3 mf condenser — 8000 volts

Still and moving ~~pictures~~ pictures on the
same film. 15 ~~microsec~~ microsec
delay in start.



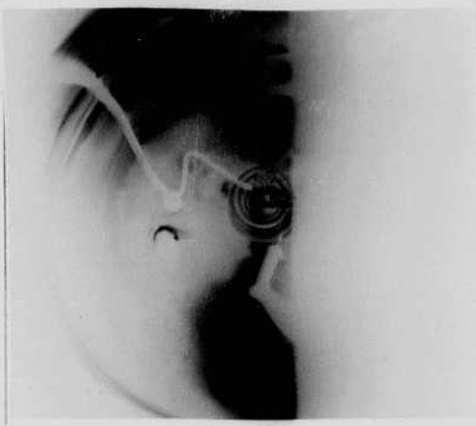
Gap tube. page 11 & 13
2cm H_2 and 1 atmosphere
of argon.

Arditron tube.
1/2 speed (7200 rpm)
of mirror.



45 .

Same tube as page 11.



Standing still.

8000 volts
1/3 mf in
the S.R.
microsecond
flash unit.

2 cm Hydrogen
2 atmospheres Argon.

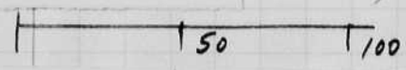
0 50 100 MICROSECONDS.

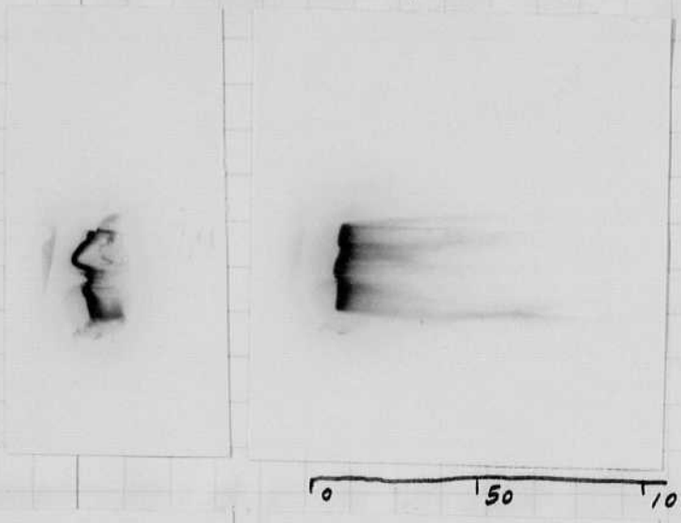
2 cm Hydrogen
2 atmos Argon
reduced to
1 atmosphere

2 cm H_2
1 atmosphere Argon.

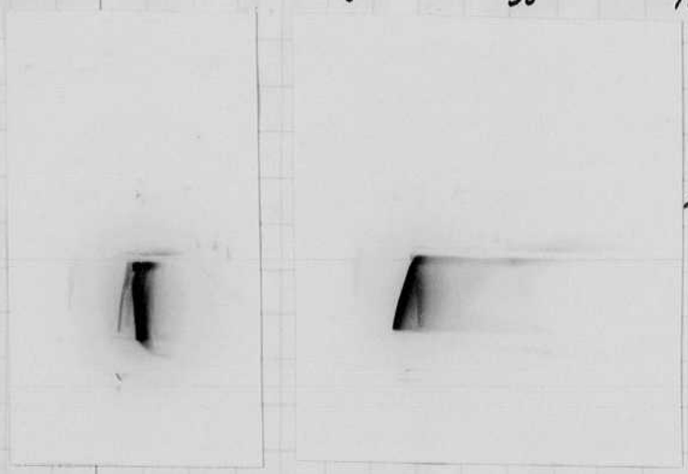
Hygrade micriflash lamp
across 1/3 mf condenser 8000 volts

Still and moving pictures on the
same film. 15 ~~microsec~~ microsec
delay in start.



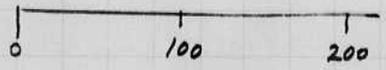


Gap tube. page 11 & 13
2cm H_2 and 1 atmosphe
of argon.

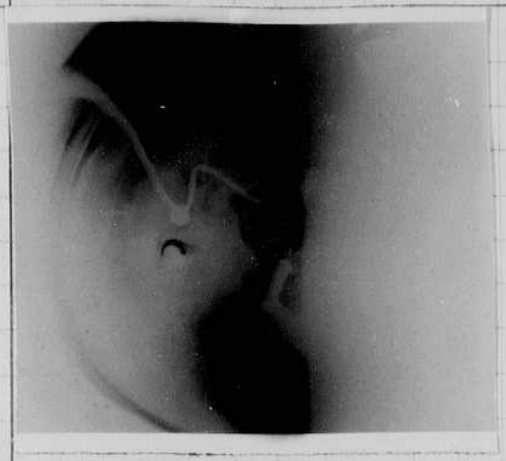


Arditron tube.

← 1/2 speed (7200 rpm)
of mirror.



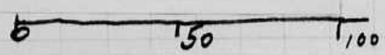
Same tube as page 11.



Standing still.

8000 volts
1/3 mf in
the G.R.
microsecond
flash unit.

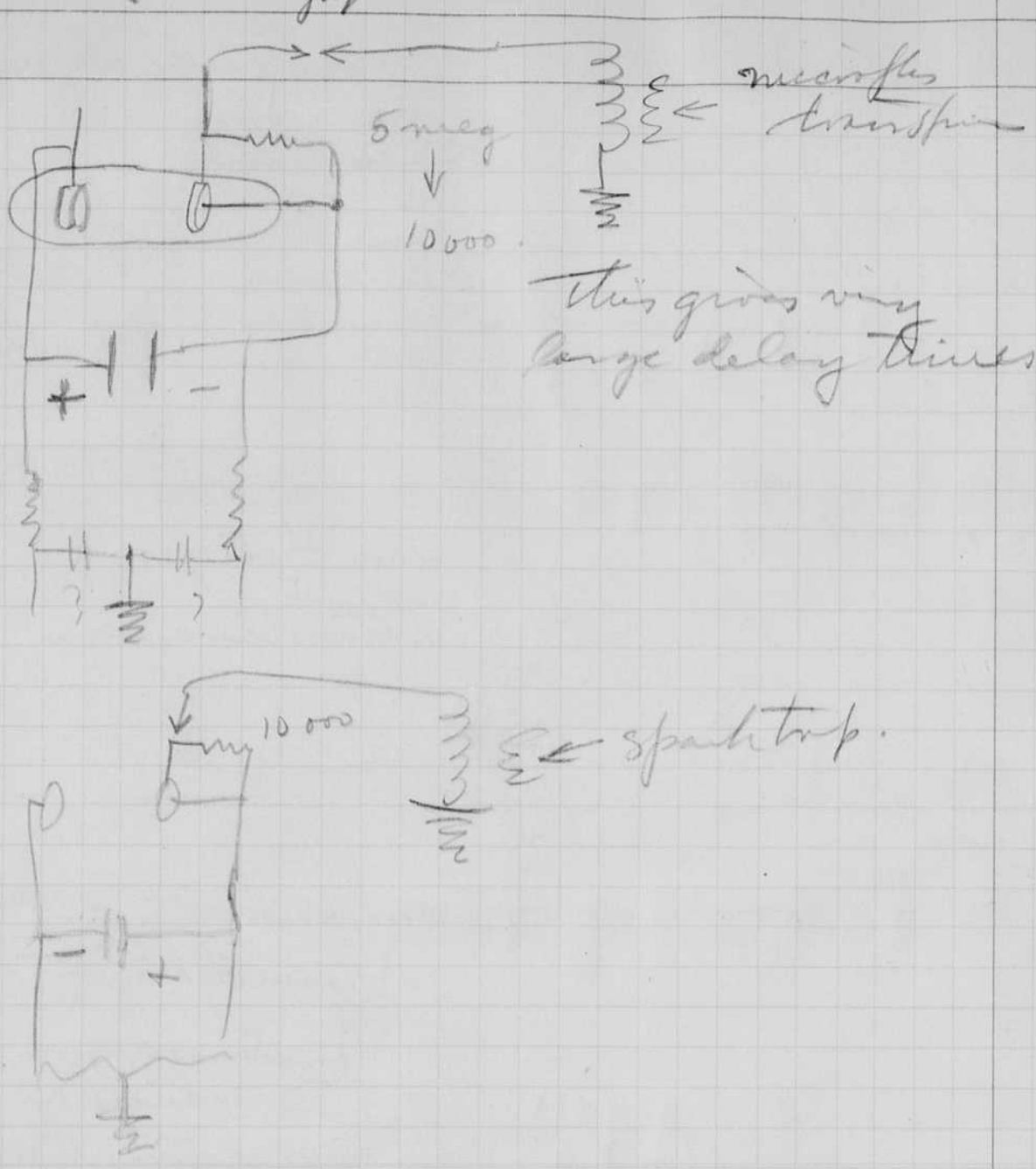
2cm Hydrogen
2 atmospheres argon.



2cm Hydrogen
2 atmos argon
reduced to
1 atmosphere

2cm H_2
1 atmosphere argon.

14 Mar 5 1940 KBE



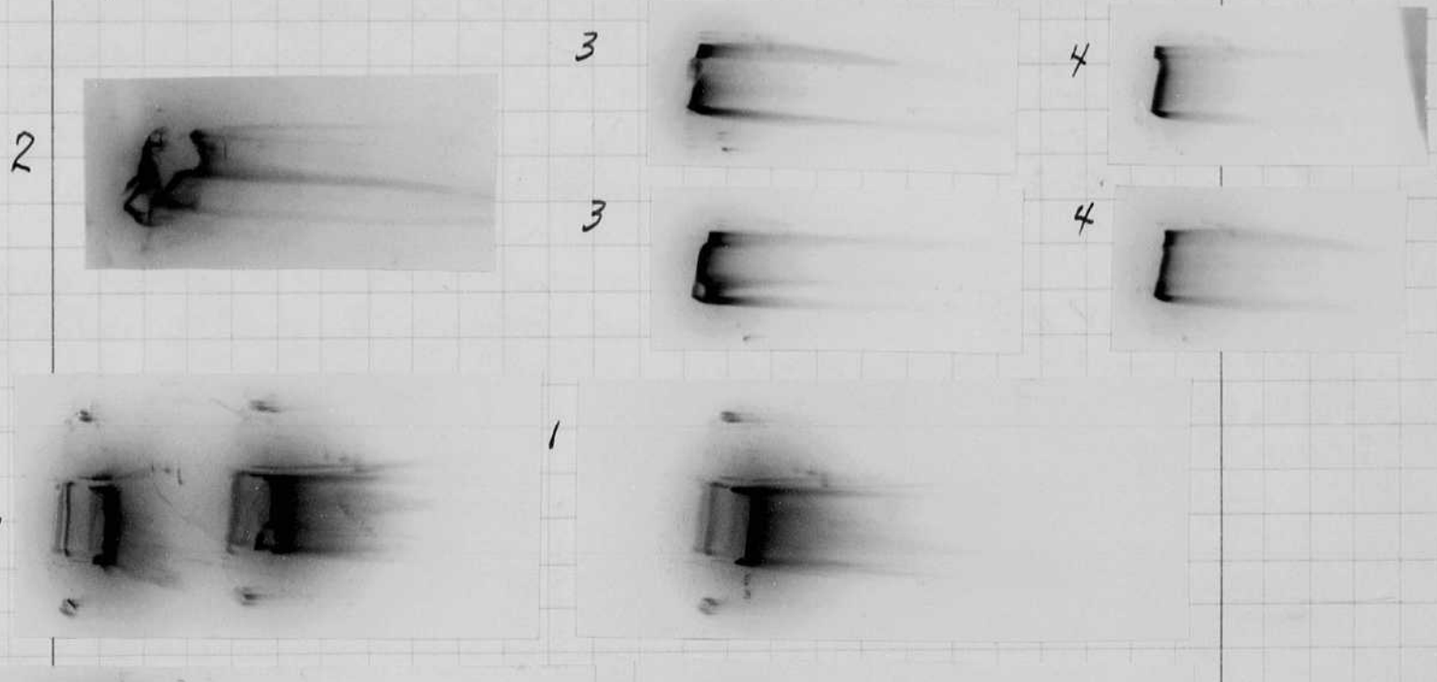
1.	240 r/m	9000 v	.35 mf	Argon	flash & glow
2.	"	7000	.35	1 atm argon.	
3	"	9000 ↓ 10000	"	3 cm N_2 15 # cylinder.	Starts at 6000 v ok at 10,000 v.
4	"			Press reduced to 1 atm	flashed twice. then held glow at 8000 v very dim.

March 11 1945
M.I.T Camb. Mass
Harold Edgerton.

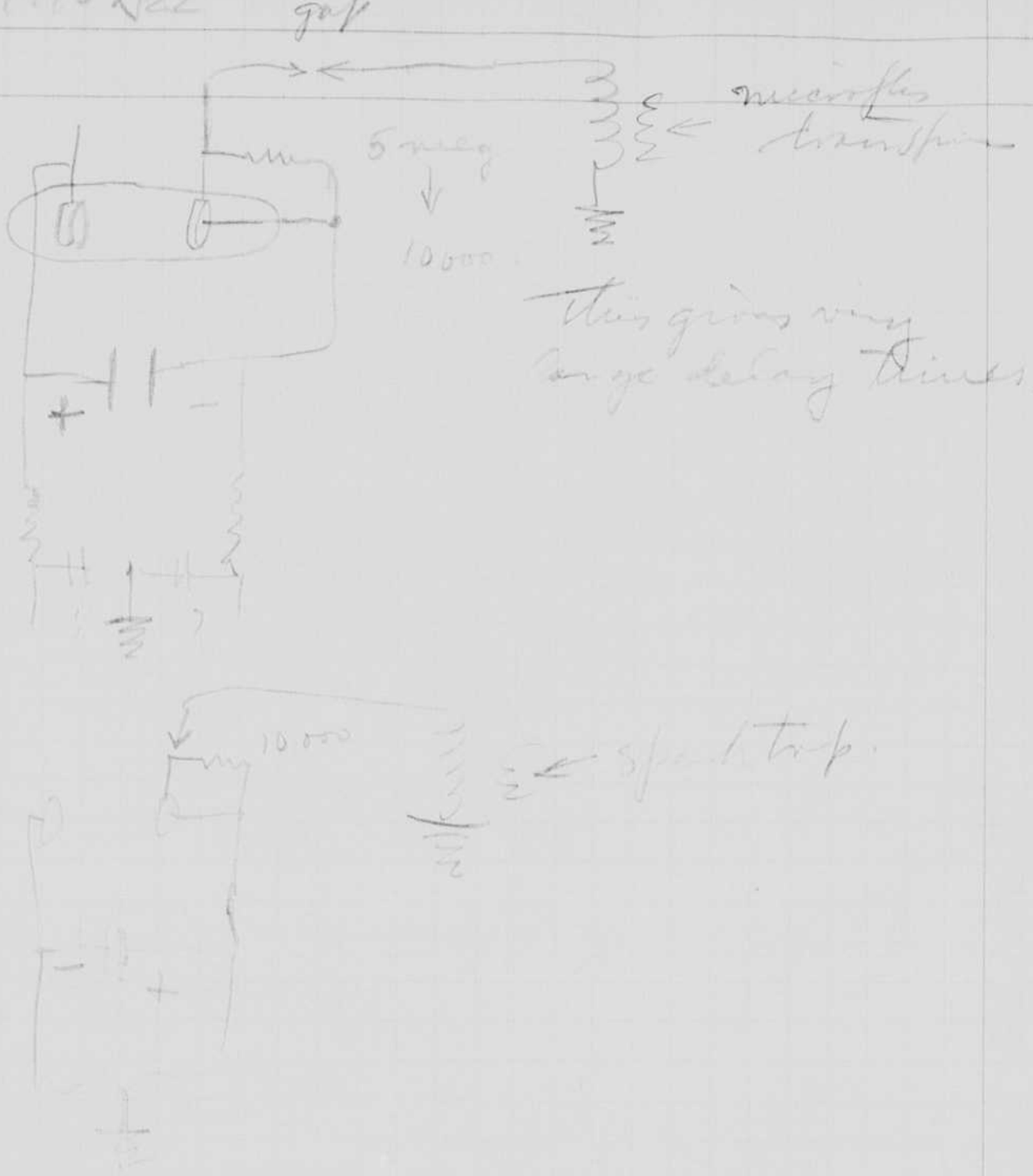
The struggle this week has been with the A 26 flash plane which should have been ready to go on monday last. The radar dome installation took until thursday. Then the inspection was done by M.I.T. and by the army. On friday two flights were made by Capt. Atkins of W.F. the reflector and radar dome worked ok at 300 m.p.h.

Difficulty was experienced in the air with the bombbay doors which could not be closed due to trouble in the hydraulic system. a new regulator was flown in from Rome yesterday and a crew is working on the plane now at Bedford.

Capt Roll returned ~~to~~ yesterday from W.F. Capt Olsen was here the ~~past~~ two weeks.



Mar 5 1940 KBE



1.	240 v/m	9000 v	.35 mf	Aviolator - flash & glow
2.	"	7000	.35	" Aviolator type.
3	"	9000	"	3 section 15 plate condr.
		↓ 10000		Starts at 6000 v will at 12,000 v.
4	"			Prer required to Aviolator flashed twice. then held glow at 8000 v very dim.

March 11 1945
MIT Camt. Mass
Harold Edgerton.

The struggle this week has been with the A26 flash plane which should have been ready to go on monday last. The radar dome installation took until thursday. Then the inspection was done by M.I.T. and by the army. On friday two flights were made by Capt. Atkins of W.F. the reflector and radar dome worked ok at 300 m.p.h.

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Capt Bell returned last yesterday from W.F. Capt Olsen was here the past two weeks.

M.I.T.
March 14 1945
Harold E Edgerton

The first night photo flight with A26c no. 576 was made last night about 9 pm. Atkins pilot.

The air speed is 250 mph with 1950 RPM and 32 inches manifold pressure.

Photos were taken over Bedford at 1000, 2000, 3000, 4000 and 5000. also Boston at 5000 and 3500. Interval 6 sec. The flash unit is called D-5. It has 2 banks of 12 condensers each (100 mf) giving a total of 2400 mf. Four Leland inverters (1500 watts each) are used for power. The charging time is about four seconds.

Trouble was experienced last night before take off due to the photocell failing to fire because of darkness.

A film magazine at the end of the roll caused the case drive of the camera to break. Apparently the paper and film joint was too thick to pass through the magazine.

Capt Roll arrived Mar 10 from W.F.
Capt Olson returned Mar 12. at 4 pm to W.F.

March 23 1945 9:30 p.m.
Bedford Mass Airfield
Harold Edgerton.

Major Kenyon and Walt Haydbaker are making prints of negatives taken in and around Boston on Sunday night March 18, 1945.

The negatives show the need for blanking the fog due to the beam. Fred Barlow suggests a plate of glass with a yellow density surface of variable density so that the hot spot will be absorbed.

The 50 degree lamp may help this condition since the beam spreads more. We plan to try this on the next night flight.

We were in Dayton over the weekend. Left on Friday night about 8 pm. Took pictures over new York then at Dayton with the camera at 18° pan vertical. Saw Baisley Saturday morning with Kenyon, Atkin, Barnes etc. Discussed flash photography at length. Baisley is out of the photo lab at the present.

An eight inch lens is coming for use as a wide angle lens. f 4. It will be coated and tried with a 50 degree reflector and lamp.

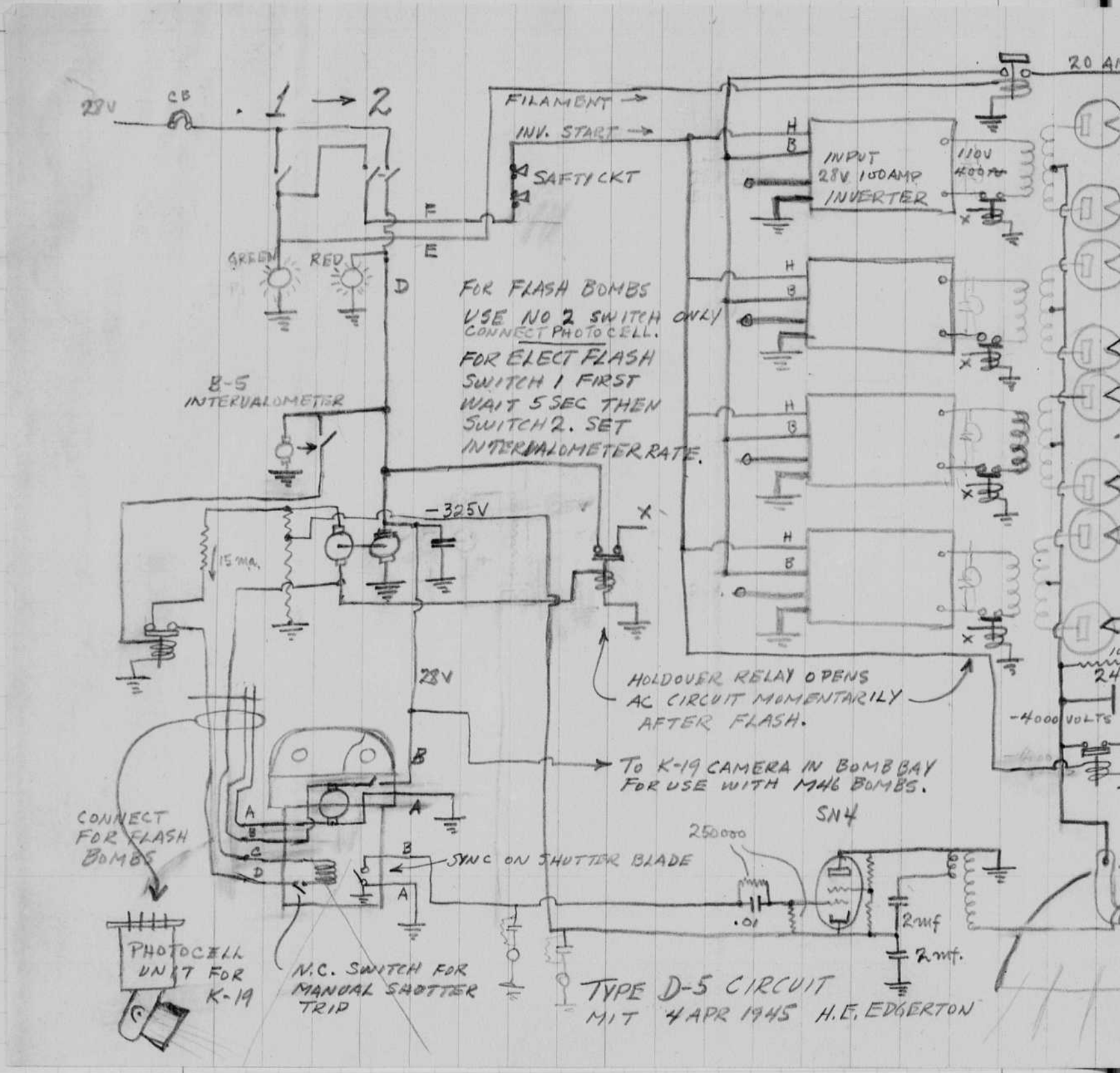
April 4 1945.

Went to Washington Sunday Mar. 25, in A26C no 43-22576 with Atkin pilot Kenyon, Hg Baker, and Oleschlagle. Plane and equipment was inspected at Bolling field by army, navy marine, and British. Retd to Boston via Newark, Mar 26. where we saw Becker and Brattain.

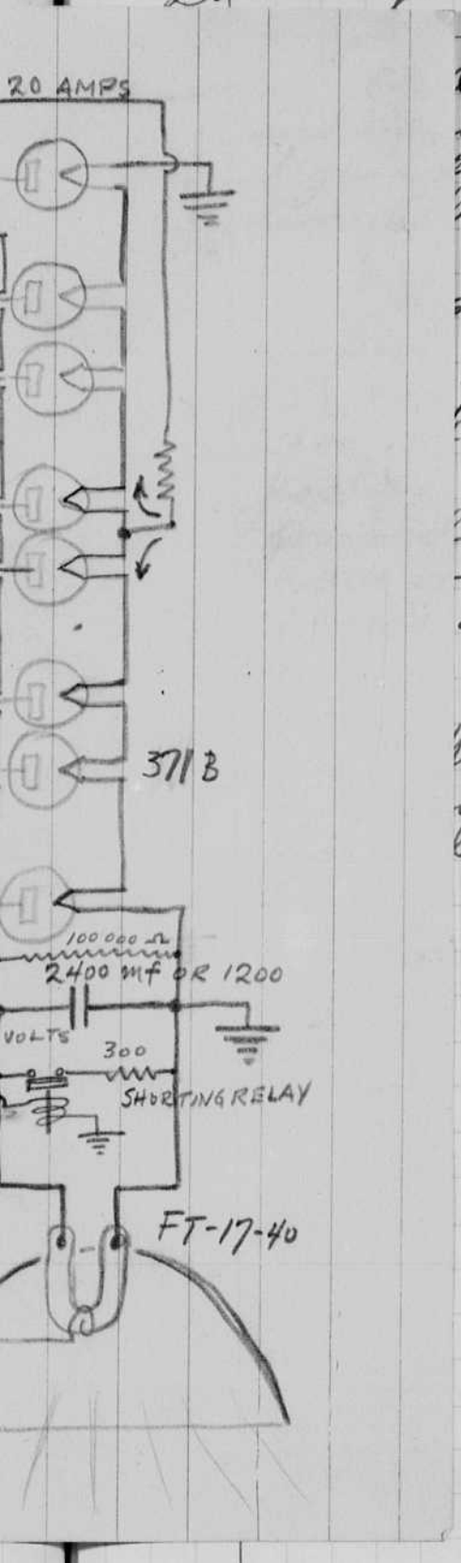
Mar 27 - Rain - no flight

Flew Baker's camera Mar 28
" " " Mar 29.
Mar 30
Mar. 31
Weather.?
Flew 4800 mf. Apr 1. Front wheel trouble.
April 2 Plane grounded.
Apr 3. Plane in Hangar.
McClendon and Baker Apr 4.

Butler came to M.I.T. for conference with Huff Davenport, Thompson, Hazen, etc. on 584.


28V
CB
1 → 2
FILAMENT →
INV. START →
SAFTY CKT
INPUT
28V 150AMP
INVERTER
110V
400~
20 A
H
B
F
E
D
GREEN
RED
FOR FLASH BOMBS
USE NO 2 SWITCH ONLY
CONNECT PHOTOCELL.
FOR ELECT FLASH
SWITCH 1 FIRST
WAIT 5 SEC THEN
SWITCH 2. SET
INTERVALOMETER RATE.
B-5
INTERVALOMETER
-325V
15 MA.
X
28V
HOLDOVER RELAY OPENS
AC CIRCUIT MOMENTARILY
AFTER FLASH.
-4000 VOLTS
TO K-19 CAMERA IN BOMB BAY
FOR USE WITH M46 BOMBS.
SN4
CONNECT
FOR FLASH
BOMBS
A
B
C
D
SYNC ON SHUTTER BLADE
250000
.01
2mf
2mf.
PHOTOCELL
UNIT FOR
K-19
N.C. SWITCH FOR
MANUAL SHUTTER
TRIP
TYPE D-5 CIRCUIT
MIT 4 APR 1945 H.E. EDGERTON

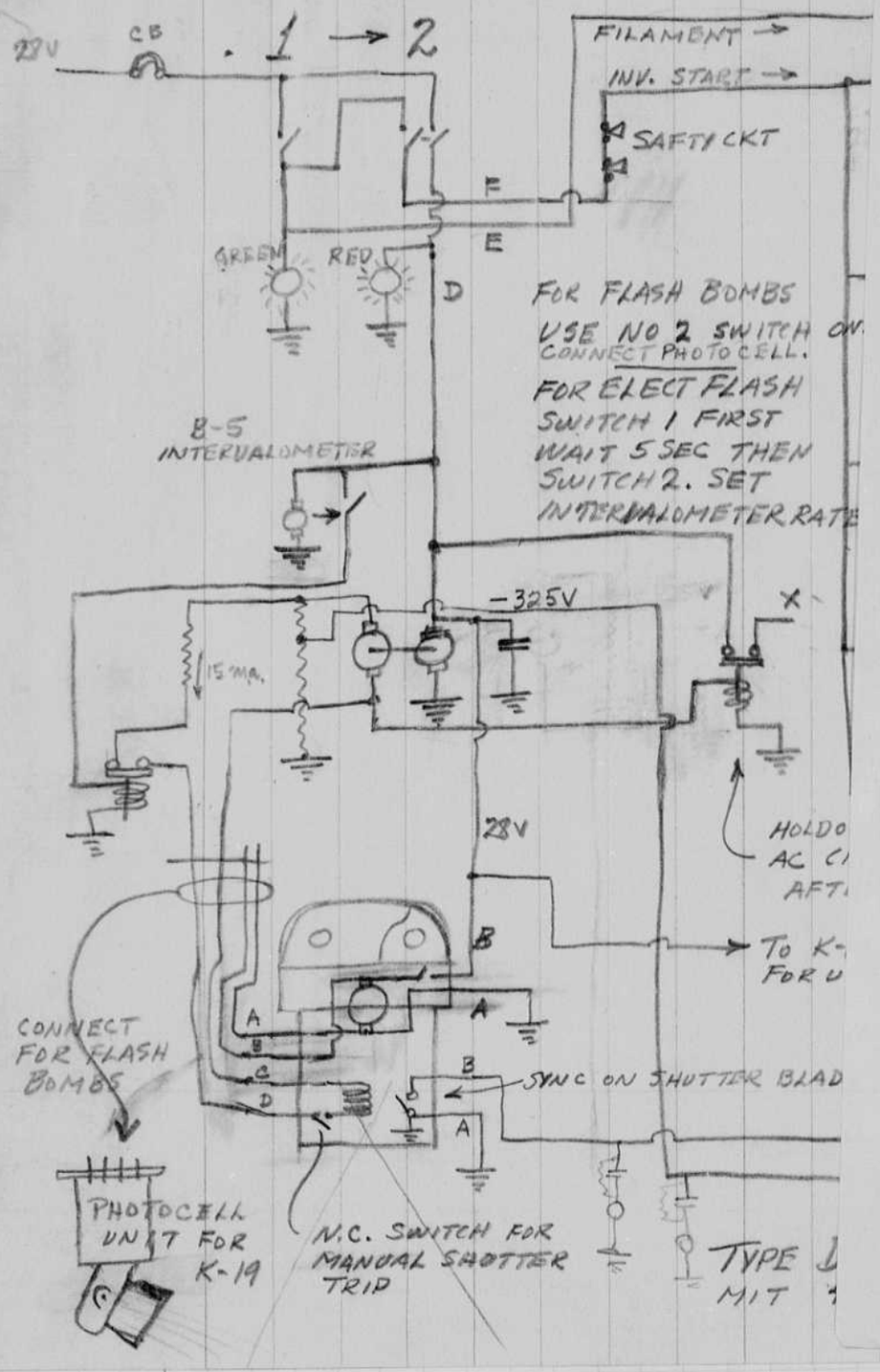
April 14, 1945
M.I.T. 4-117
Harold Edgerton.



Apr. 12 I took the photocell meter to G.R. Co
onstrated it to Wilkins and Eastm.
them a letter proposing that the
he manufactured.

st of my time is spent at Bedford
working with the A26C plane no.
76 which has a D-5 flash unit
4000 volts 4 second interval between
Since monday the plane has been
ed to cure a trouble with the
heel which once in a while refuses
down except when an emergency
pulled.

Difficulties have been experienced with
ar, K band, due to loose wires etc.
being fixed now.


28V
CB
1
2
FILAMENT
INV. START
SAFTY CKT
F
E
GREEN
RED
D
FOR FLASH BOMBS
USE NO 2 SWITCH ON
CONNECT PHOTO CELL.
FOR ELECT FLASH
SWITCH 1 FIRST
WAIT 5 SEC THEN
SWITCH 2. SET
INTERVALOMETER RATE
8-5
INTERVALOMETER
-325V
X
15 MA.
28V
HOLDO
AC C
AFT
To K-
FOR U
B
A
CONNECT
FOR FLASH
BOMBS
C
D
SYNC ON SHUTTER BLAD
PHOTOCELL
UNIT FOR
K-19
N.C. SWITCH FOR
MANUAL SHOTTER
TRIP
TYPE
MIT

April 14, 1945
M.I.T. 4-117
Harold Edgerton.

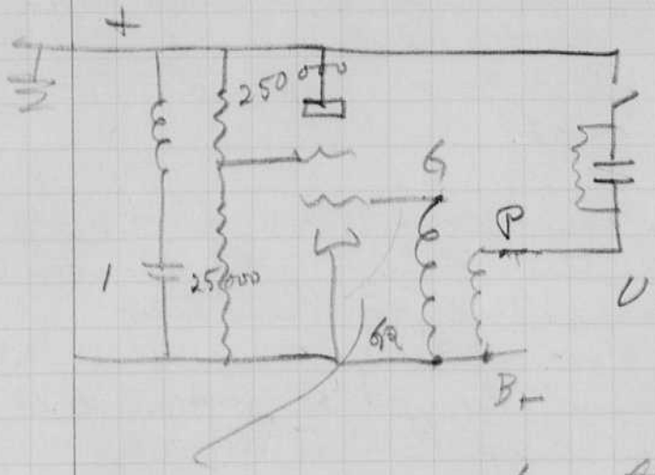
On Apr. 12 I took the photocell meter to G.R. Co and demonstrated it to Wilkins and Easton. I gave them a letter proposing that the device be manufactured.

Most of my time is spent at Bedford airport working with the A 26 C plane no. 43-22576 which has a D-5 flash unit 2400 mf 4000 volts 4 second interval between flashes. Since monday the plane has been grounded to cure a trouble with the nose wheel which once in a while refuses to come down except when an emergency wire is pulled.

Difficulties have been experienced with the radar, K band, due to loose wires etc. This is being fixed now.

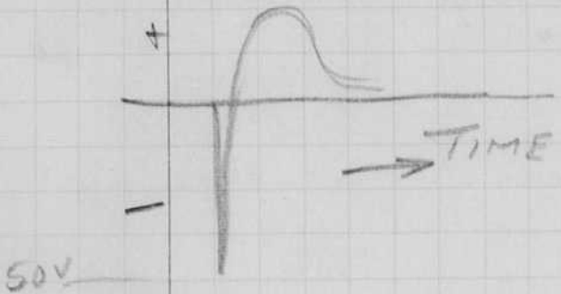
KR Edgerton & McRobert
April 18 1945

Strobe firing circuit



UTC O-15 small transformer.

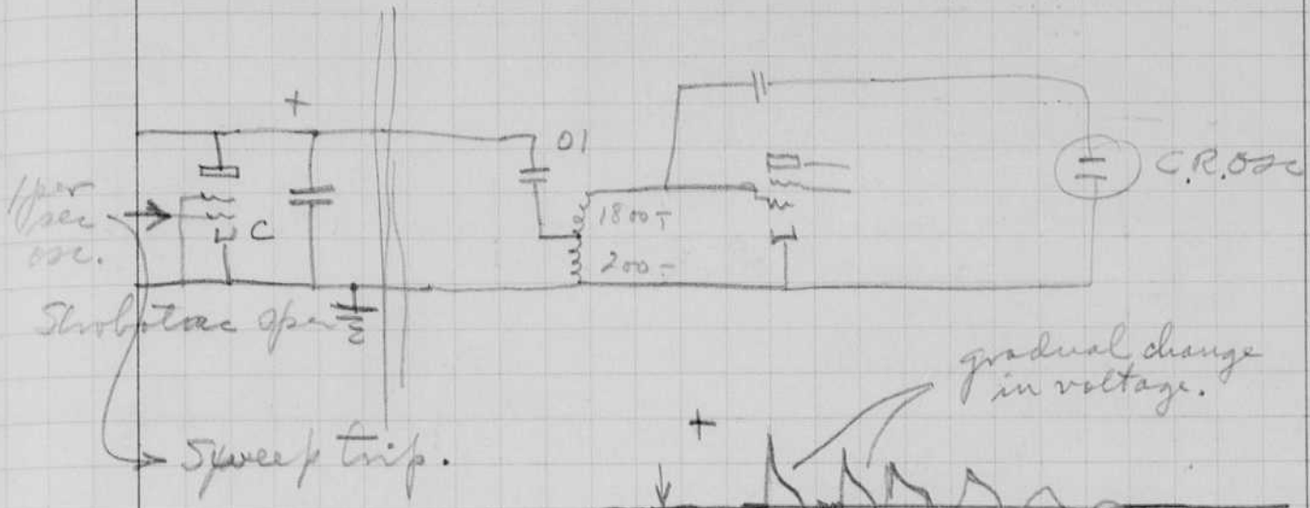
CR meas. of cathode to grid.

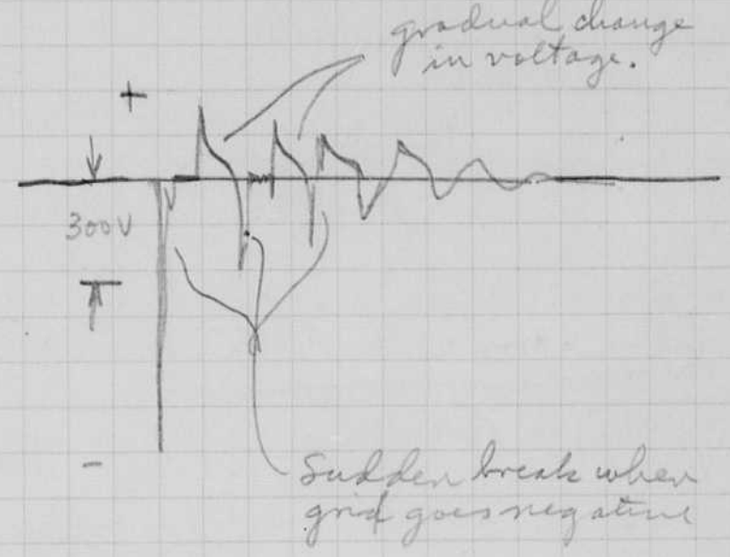


osc. of circuit when switch is closed with strobotar in socket.

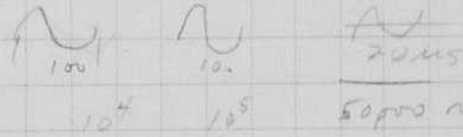
Osc tests of Strob trig circuits

W.E. oscillograph connected as used by Newton Feldman.

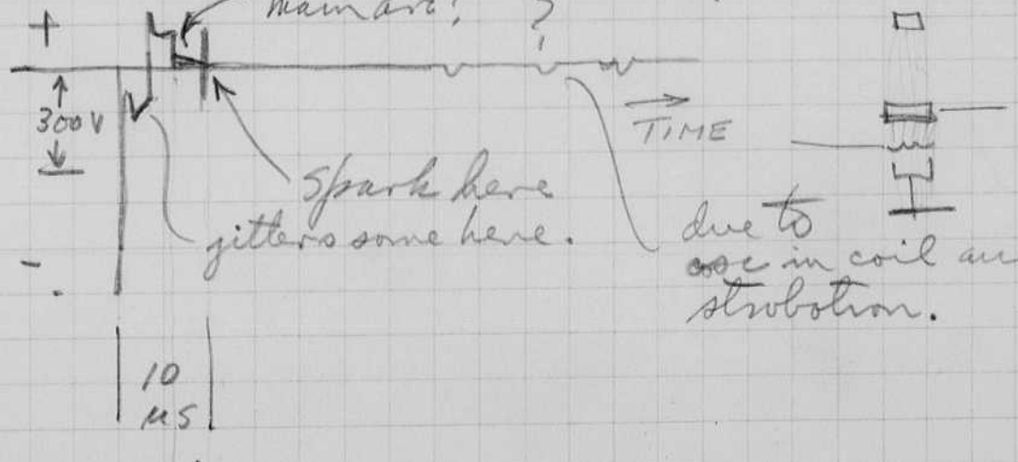




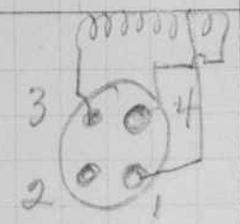
With tube out of the socket, the voltage is a damped sinusoid with a peak volts about double that of the first kick when the tube is in the socket.
4 cycles to ½ value.
45,000 cycles.



Strobotron next connected to power supply 325 V 1 mf. 7000 ohms



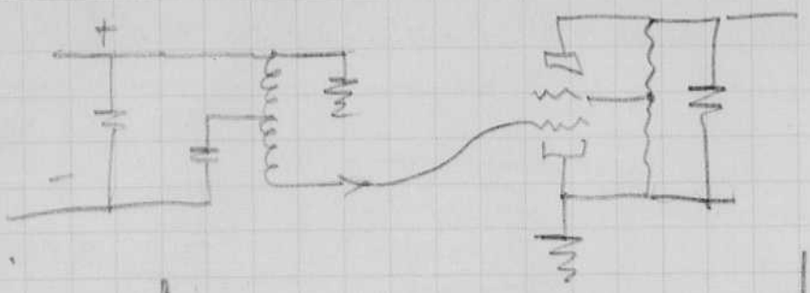
Positive surge

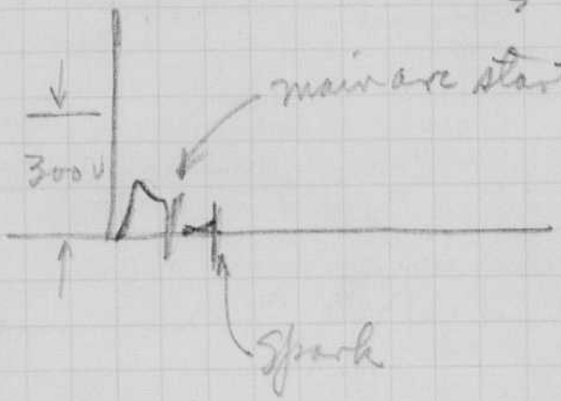


Bottom view.

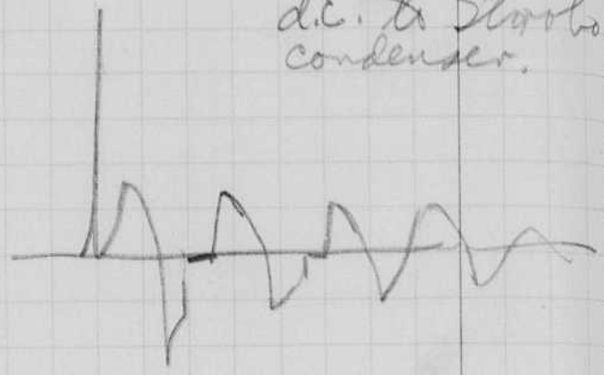
V8185

33 wire.

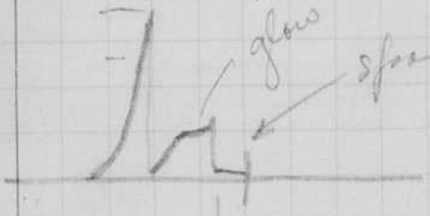




without d.c. to Strobo condenser.

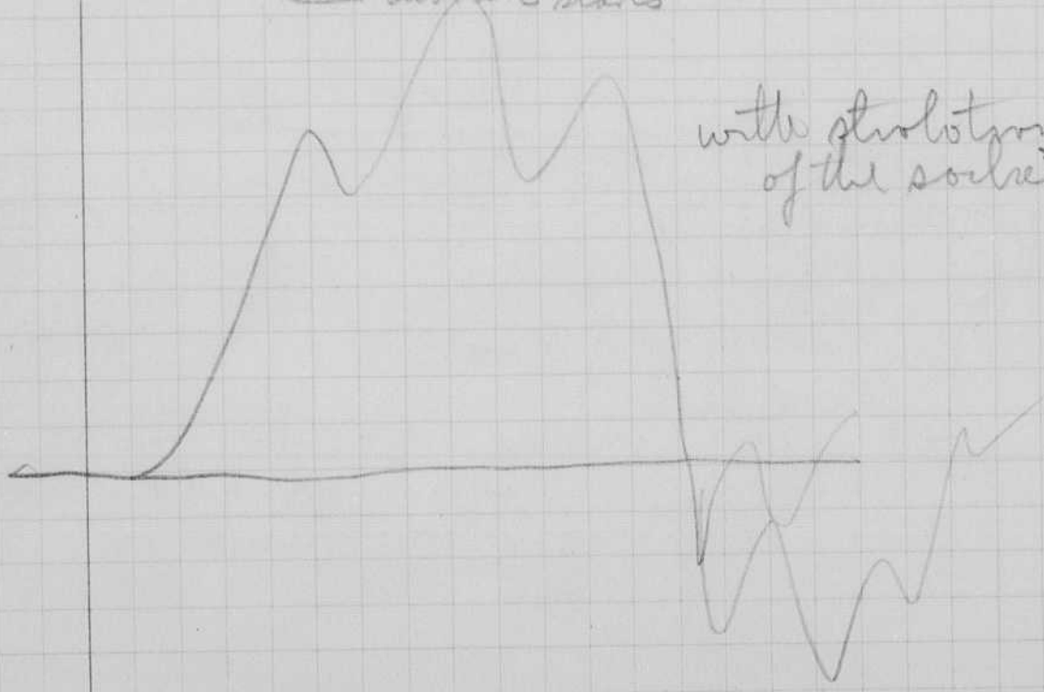


Audio transformer. U.T.C. 0-15

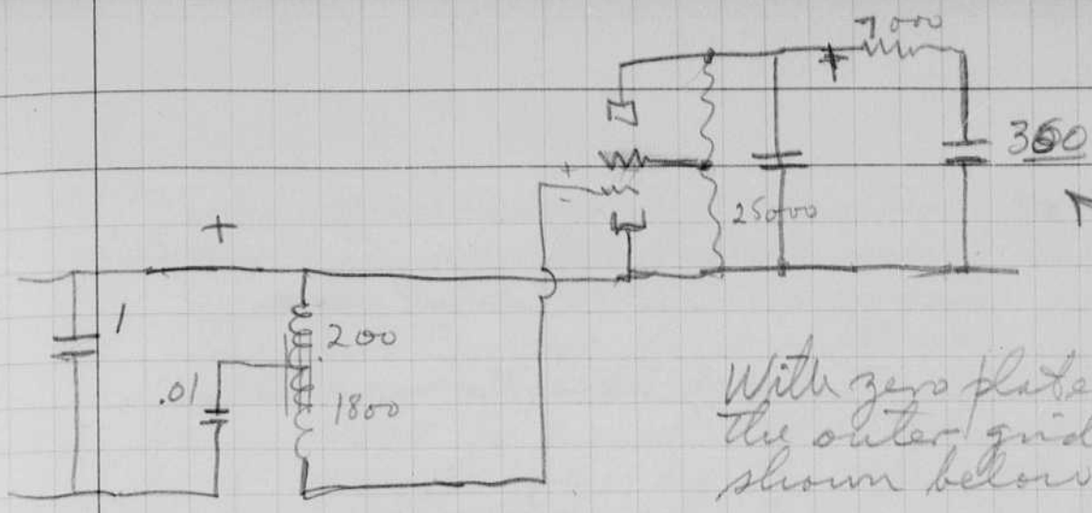


tube arc starts

Slower rise of grid voltage. Trip voltage is lower. An .01 condenser was put across the secondary which resulted in a still lower firing voltage.



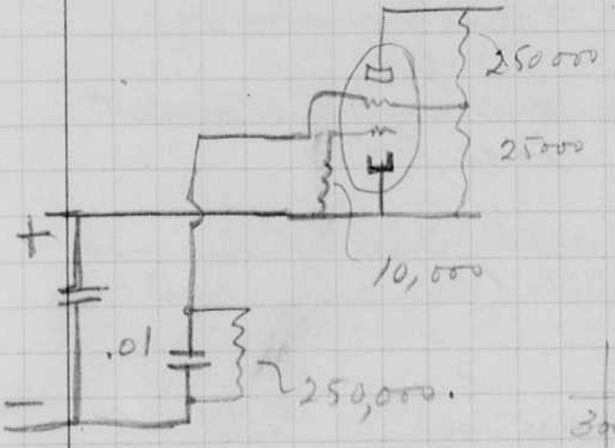
with strobotron out of the socket.



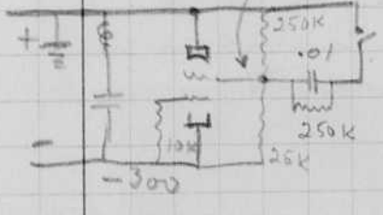
With zero plate volts, the outer grid voltage is shown below.

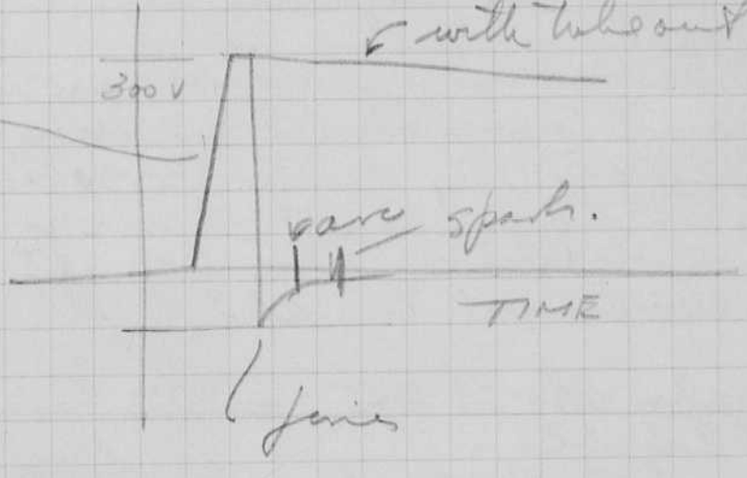
TIME →

might be partly pickup.



D-5 as first used.

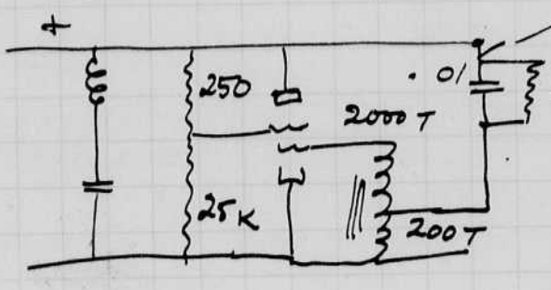




April 23, 1945
Harold Edgerton

Worked with distortion circuits last week with Mac Roberts. He ran tests in the dark on many circuits and many tubes.

The circuit finally selected was the following.



VR185 in 4 prong tube base.

auto transformer 1" x 3/4" in a 4 prong tube base.

C.W. Duncan E.T. Scott and Speak arrived Sat morning the 21st. Visited Dunham and went to Bedford field.

Yesterday went with Duncan to Bedford field to witness the A26 with a 584. Test. Did not fly due to a 50 m.p.h. wind. Tried again at 5 pm with Duncan at Keith. No results due to electrical trouble on the plane.

Wednesday Apr 25 1945 on the Federal to Washington.
H.E. Edgerton

Mr. Hahn of Electronics was in Boston today to discuss the beacon case.

On monday the 584 test was run with the A26C using a beacon. The results were not so good.

Two photos were made of Fitchburg, resulting in an error in range of about 1/2 mile. We had difficulty in holding the plane with the target at that distance, about 25 miles.

Two runs were made over Concord from the town to the West Concord traffic circle.

The first was fine. It was run from East to west. The second was run from West to east. It started late and was displaced to the south of the target. The road was in the edge of the first photo of the series.

Pictures were taken at 5000 ft with 2400 mf 4000 volts at 6 sec. Negatives printed ok but they were very flat.

The picture sequences do not check the flight paths as drawn by the 584. This should be checked.

The plane is now being painted black before being returned to W.F. It then goes to Orlando.

McLendy
Draper
Huff
Duncan
Stewart.

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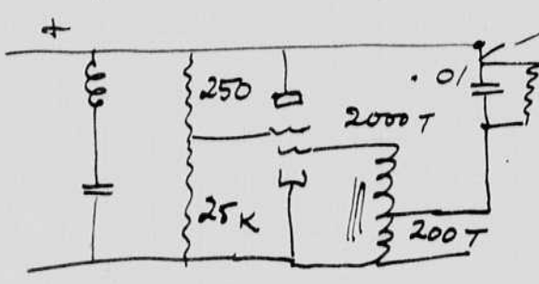

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May 10 1945
Orlando Florida
orange court Hotel.

With Harper as pilot I left Bedford in A 26 43-22576 on april 30 about noon. We stopped over in Rochester for five hours while I saw some people at Eastman Kodak. Took off about seven for Cleveland, but finding a storm there we left for Dayton. I took the night train to cleveland where I met Bier and saw people at the General Electric Co. I went to Dayton on the night train. arranged for Harper to fly 576 to Washington leaving about 8 pm.

May 3 was bad for weather in Washington. I visited Mary Ellen and her family in Chevy chase.

Took off with Stannard and Butler on the 4th for Orlando, stopping at Dohlgren and Florence S.C.

flight to Tampa and Miami → May 5 nothing accomplished due to people being away. May 6. - Sunday. May 7. flight to Tampa and Eglin field. left plane at Kissimee field for maintence.

May 7 Monday - conf with Lt col Guerry. Plane being accepted.

May 8. Visited Kissimee - plane not in condition.

May 9. Flight in A/C to Jacksonville also flight at night with two photo runs at 2000 and 3000 ft. the flow run involved an 18 degree turn during the photo run.

today I was at Kissimee all day working on the films and prints.

May 18 1945

MIT Camb. Mass.

H.E. Edgerton. Left Orlando on Monday the 14 for Washington in the A26 no 576 with Stannard McClendon Butler and the crew chief. Three hours to Washington 770 miles.

On the 15 we visited the O.C.S.R. where I went with Kennedy, McCoy, to see Gen McClelland about APQ 34 sets for reconnaissance use. In the afternoon I was at a conference with the Navy Dept on the TBM/F flash unit. This is to be designed to operate at 1000 fpm at 2 second intervals.

After numerous conferences upon my return to Boston the tentative arrangement will be

2 - Navy Bendix inverters 800-D-1

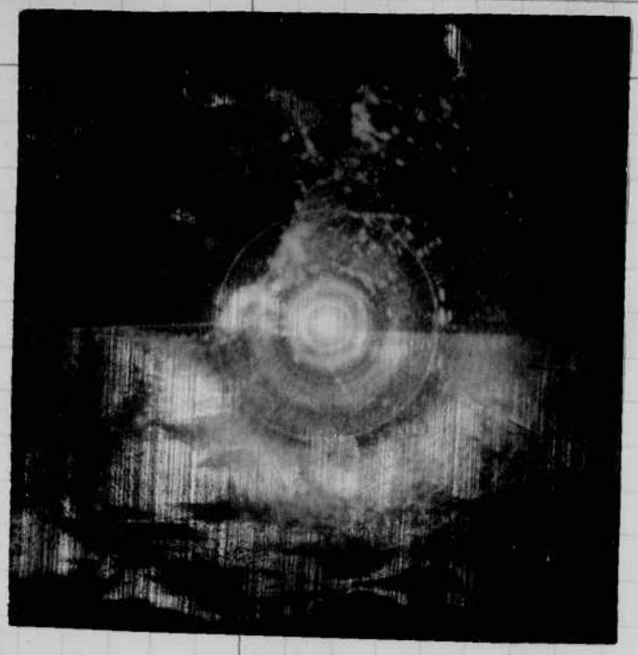
6 - Condensers 80 mf 4000 v G.E. type.

2 - FT-24 lamps will be used in small reflectors if the 24 lamp will take the power from 3 condensers. The lamp will carry the average power, but there is some question about its ability to with stand the flash from three condensers.

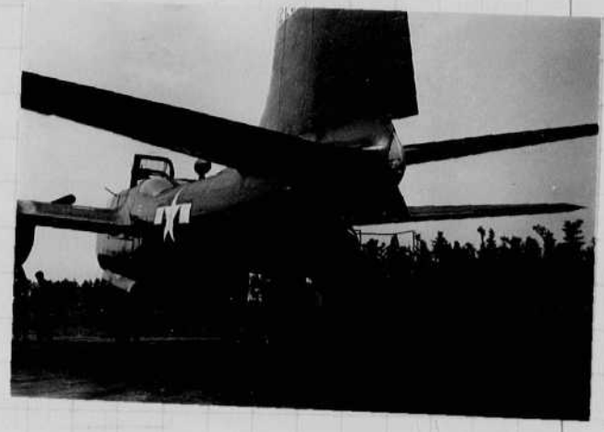
An FT-17 tube will be used if the FT24 is not able to stand the flash.

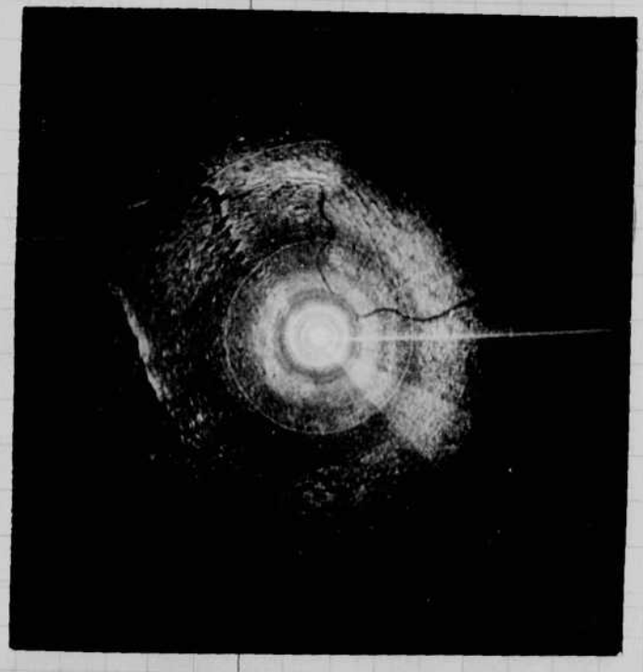
I visited the Bell Lab at Whippany N.J. on the morning of May 16 and then returned by train to Boston.

APS-1-K. May 1945.



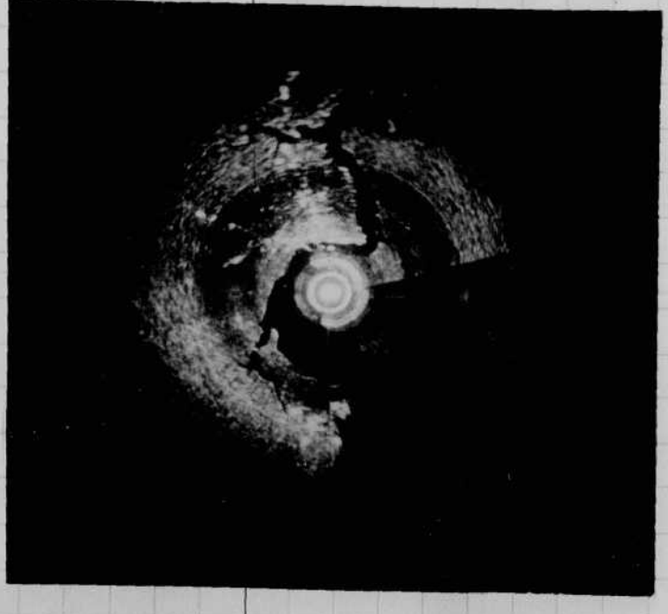
BUFFALO N.Y.





POTOMAC RIVER

HARPERS FERRY



JACKSONVILLE FLA.

Notebook # 16

Filming and Separation Record

1 unmounted photograph(s)

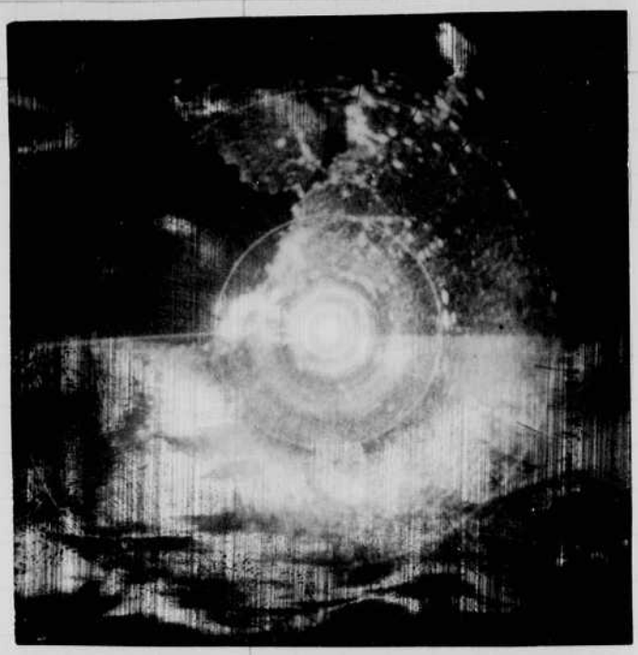
____ negative strip(s)

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

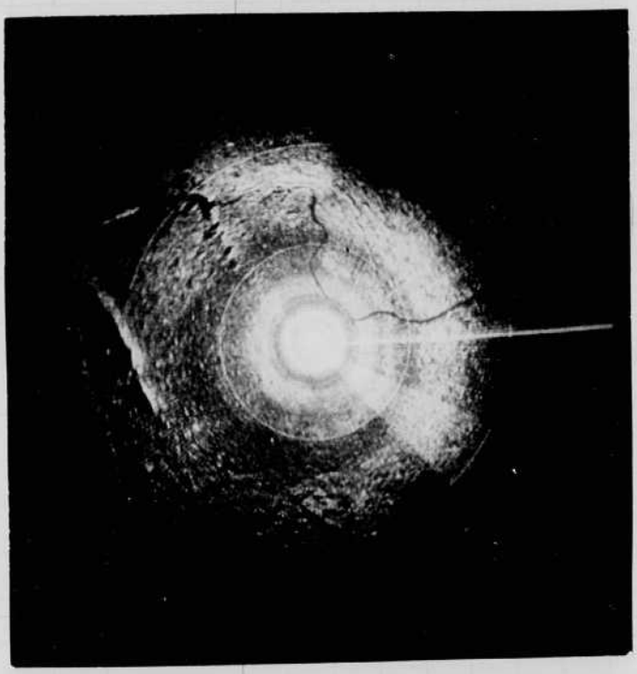
was/were filmed where originally located between page 28 and 29.

Item(s) now housed in accompanying folder.

APS-1-R. May 1945.

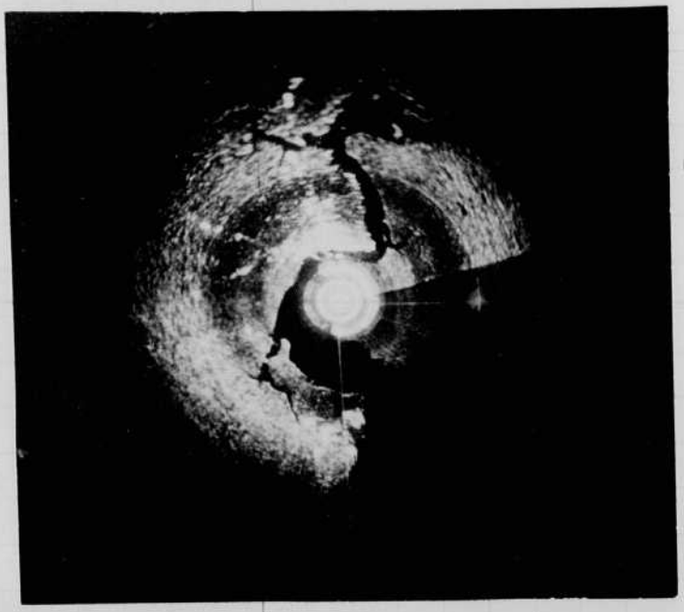


BUFFALO N.Y.



POTOMAC RIV

HARPERS FERRY



JACKSONVILLE FLA.

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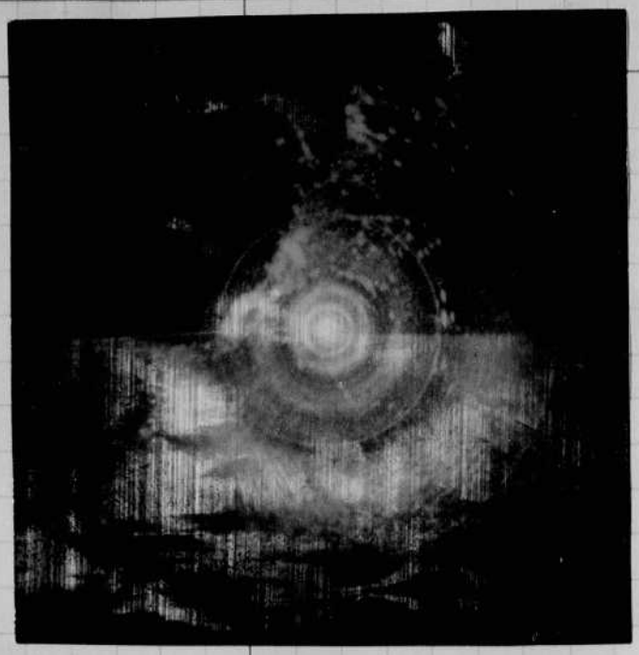
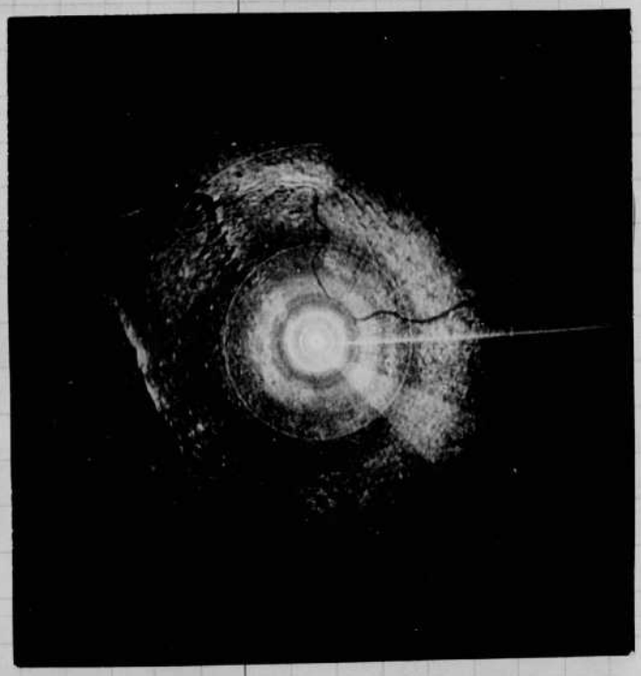
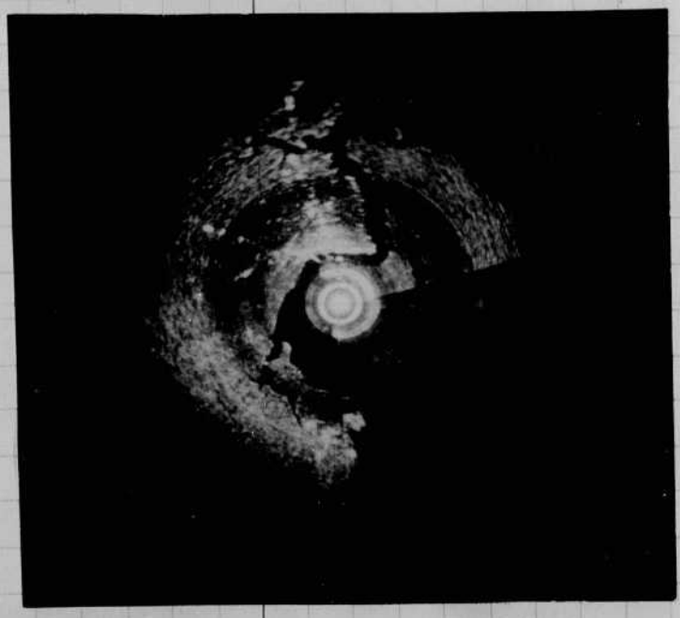


BUFFALO NY.



POTOMAC RIV

HARPERS FERRY



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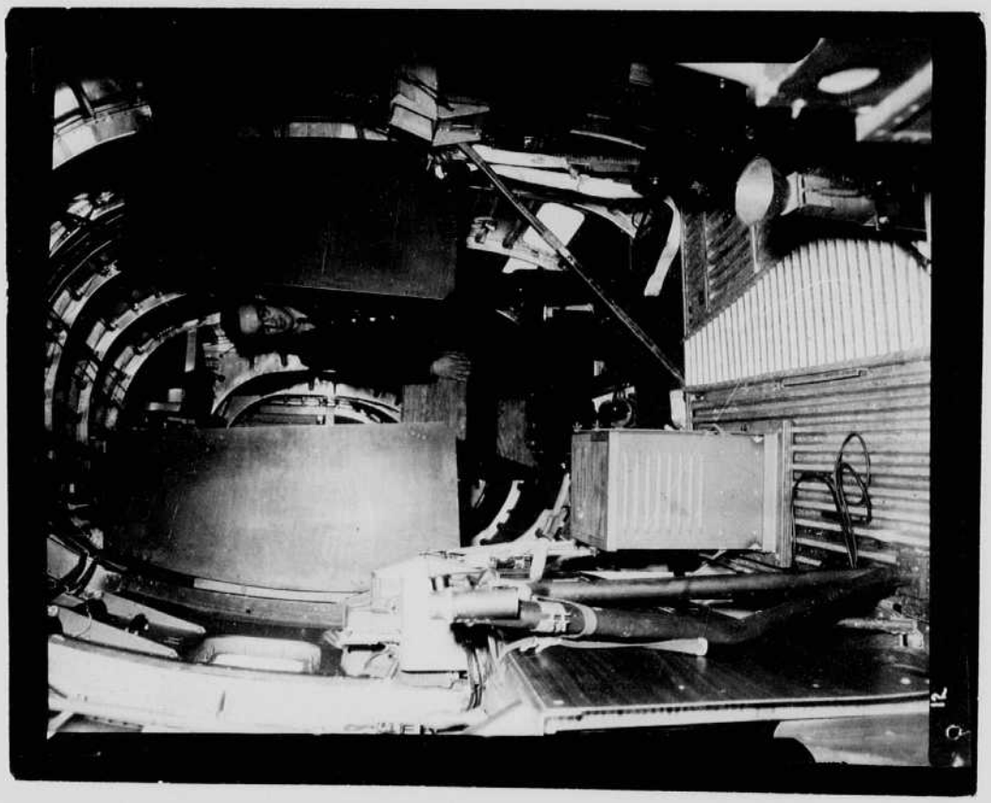
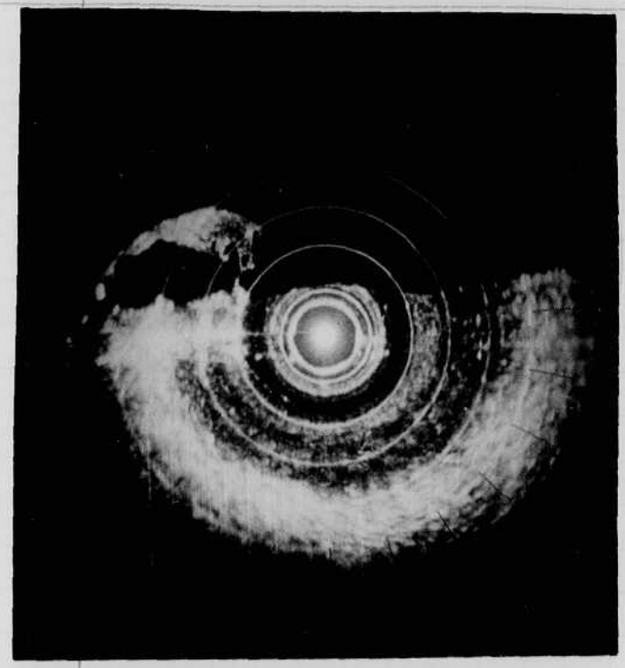
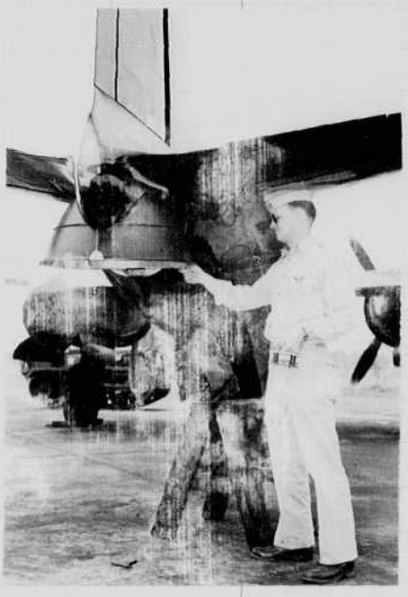
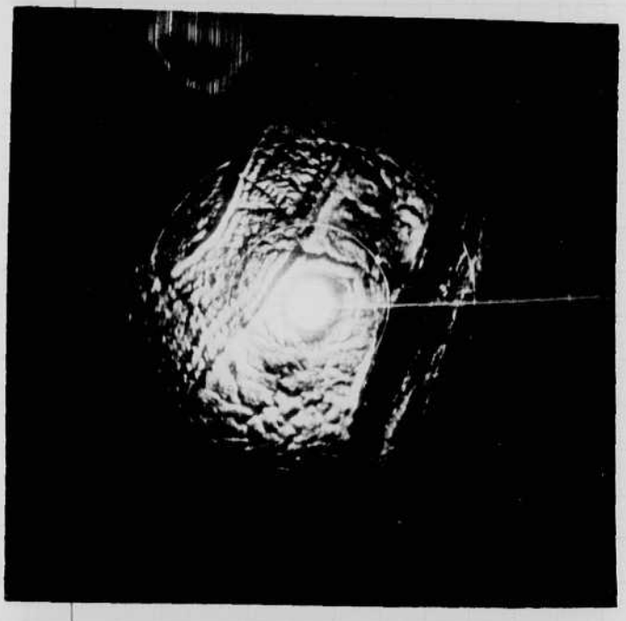




ERIE PA

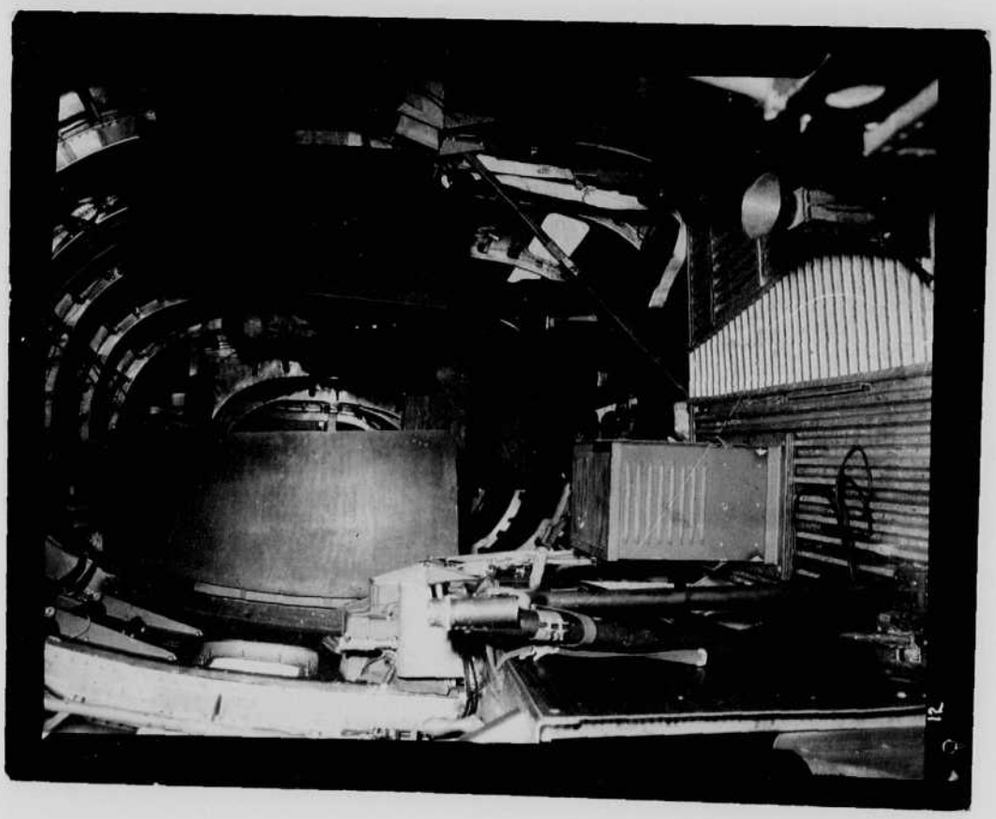


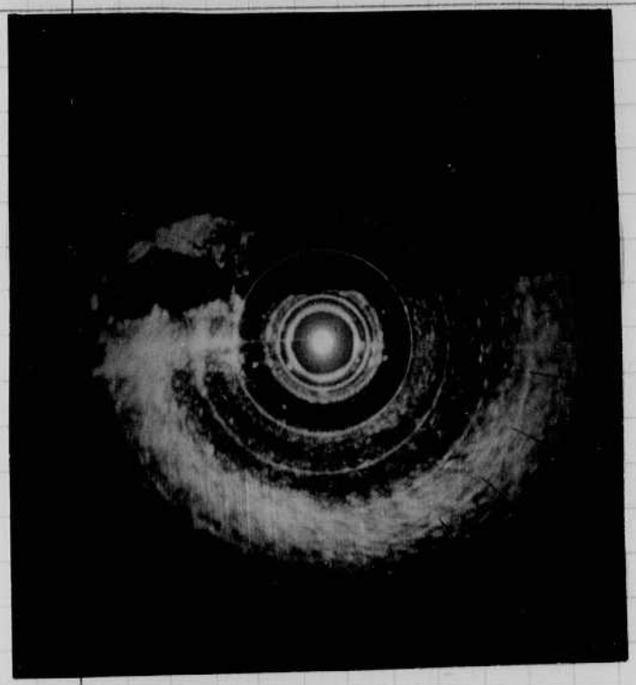


MTS IN PA

COASTLINE

SC. OR FLA.





ERIE PA

MTS IN PA.

COASTLINE

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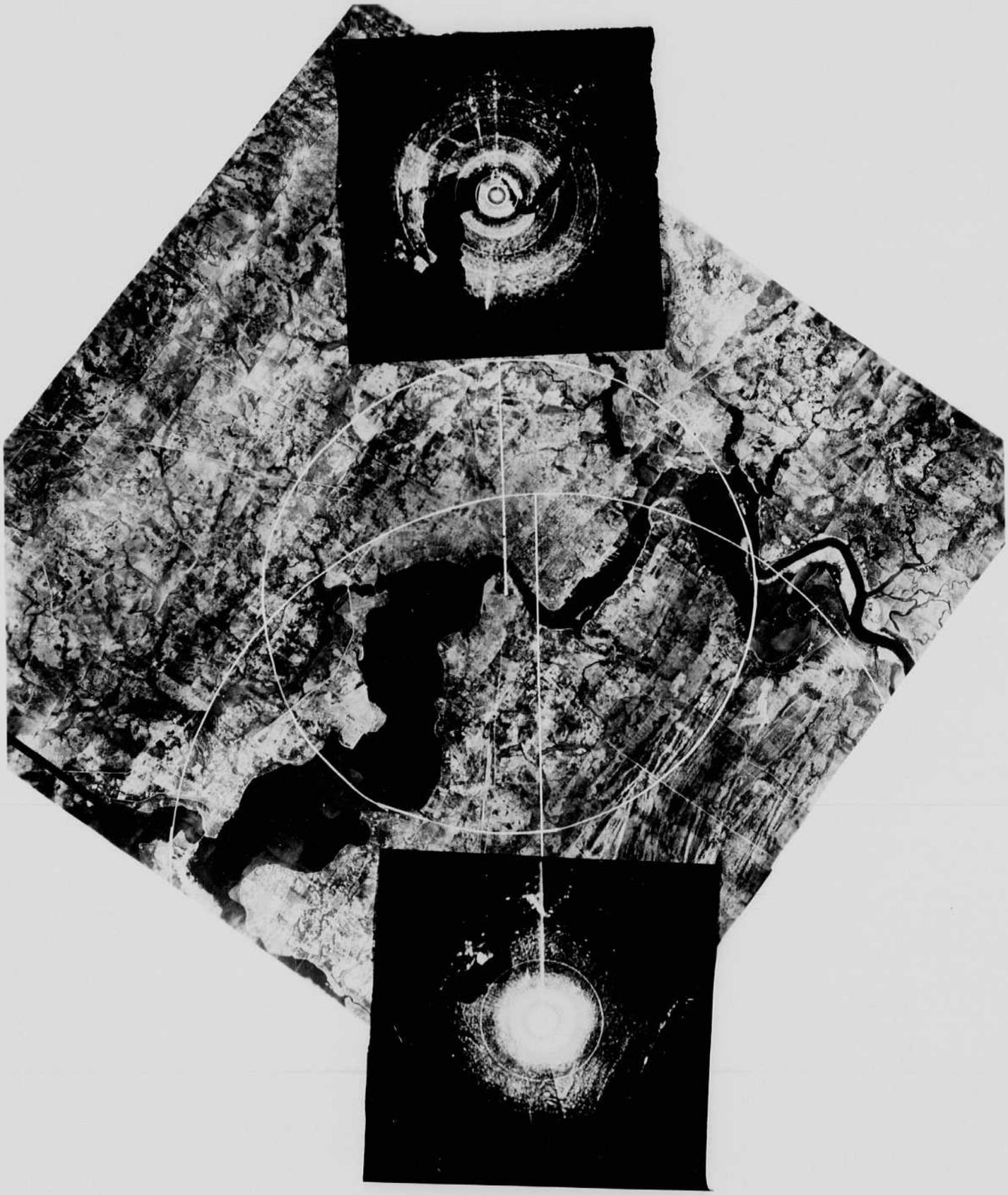
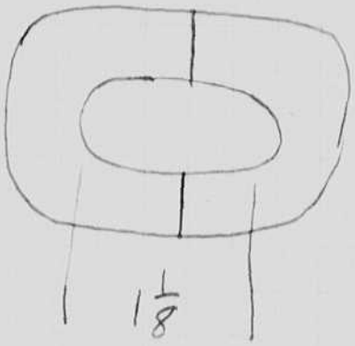


May 26 1945 MIT

Harold Edgerton

Series coil for starting movie lamp.
from Bernashausen.

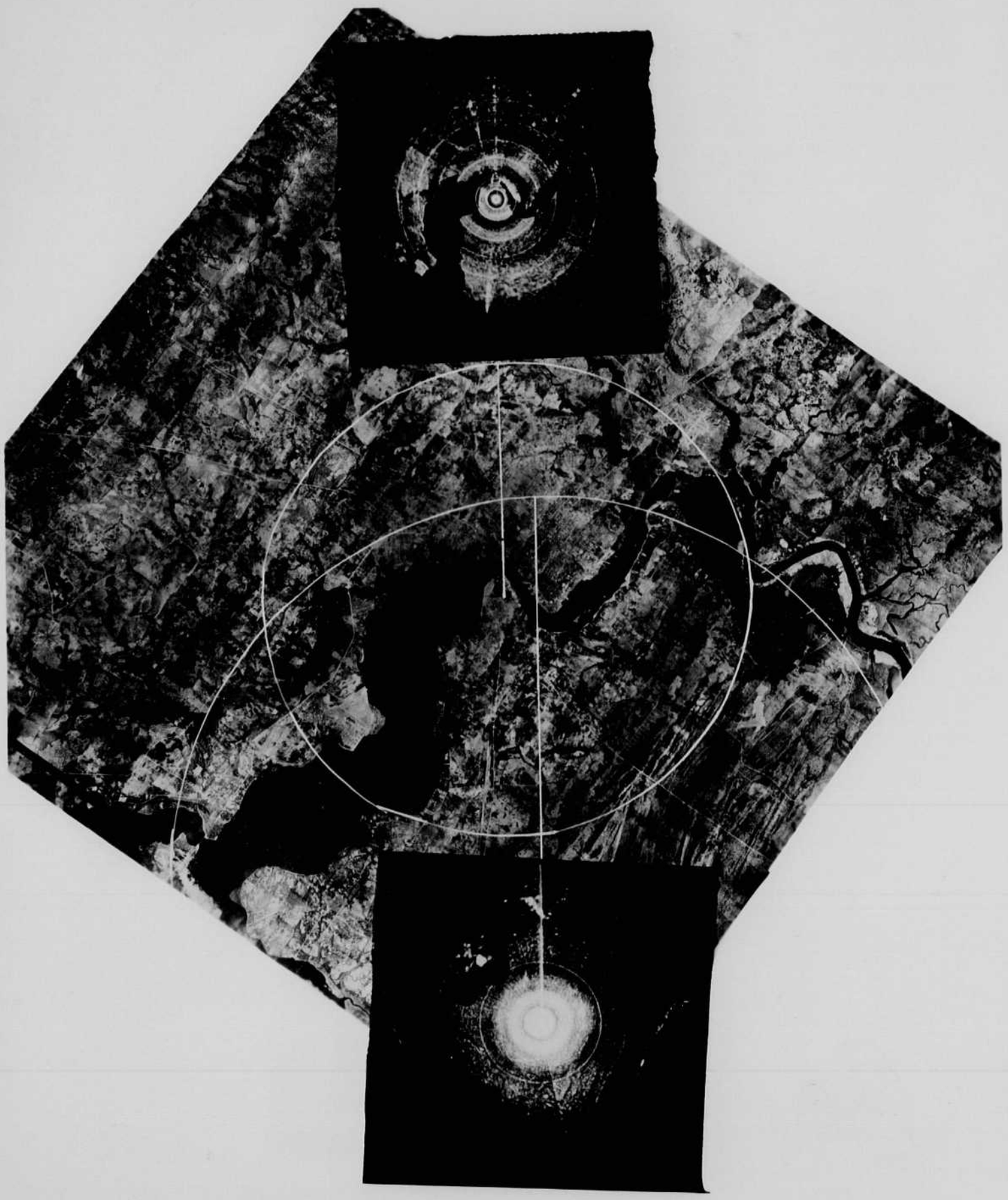


2 mil silicon steel core

20 turns #18 wire solid = ~~.0004~~ 0.004 henry. Q = 2

6 " #18 stranded = ~~.0001~~ 0.001 henry. Q = ~~1~~

as measured on 1000 cycle bridge.



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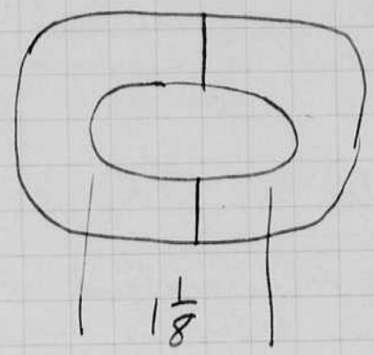

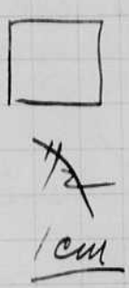

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as measured on 1000 cycle bridge.

Harold Edgerton
May 28, 1945 M.I.T.

Exposure meter measurement of shutter time.

The meter must be read twice for measuring time. The first reading is made with a load resistor and a constant light.

$$V_{calibration} = V_c \cong IR$$

The shutter is next tested with a capacitor in the photo cell circuit giving a reading

$$V_{shutter} \cong \frac{1}{C}\int_0^{\infty} I\,dt \cong \frac{I\,T}{C}$$

Then the shutter time "T" is

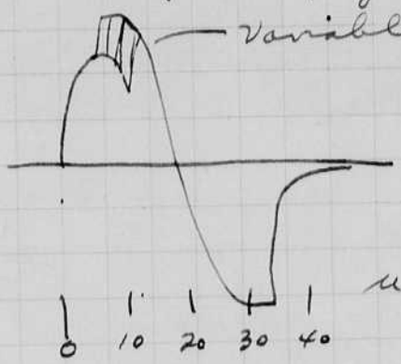
$$T = \frac{V_{shutter}}{V_{calibration}} \frac{1}{RC}$$

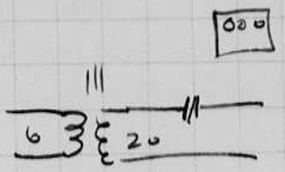
if $T = .01$ seconds

then $R = 10^4$ sec with a cap of $C = 10^{-6}$ farads.

$R \cong 10^6$ ohms	for 1.0 sec
10^5	0.1
10^4	0.01
10^3	.001

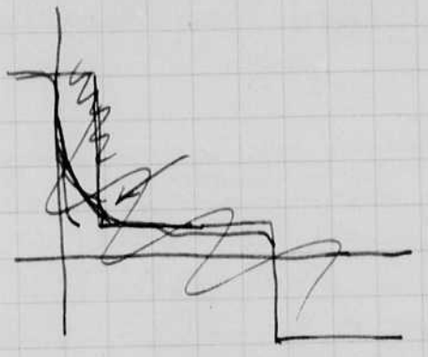
Test of coil page 31. 6 to 20 turns. 7/8 = 300 volts?

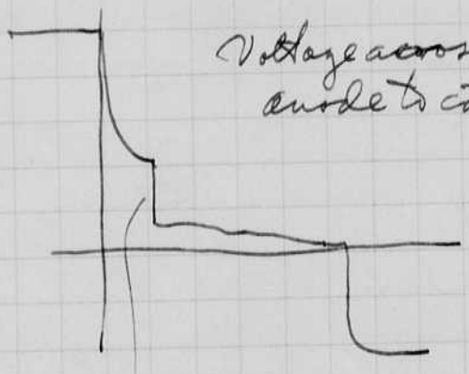




Amp. of signal = 1 1/8 inches.
2 - 20 = 2 1/4 inches.
1 - 20 } = 3 approx.
10 μs total.

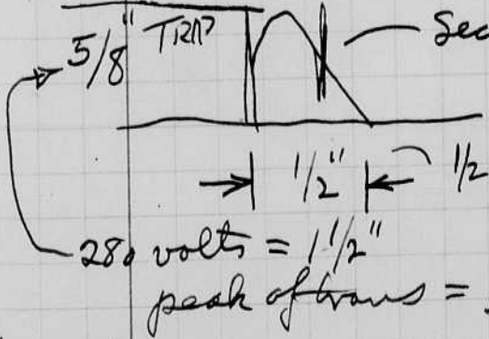
$RC = 10^{-5}$ $R = \frac{10^{-5}}{1 \times 10^{-6}} = 10$ ohms.



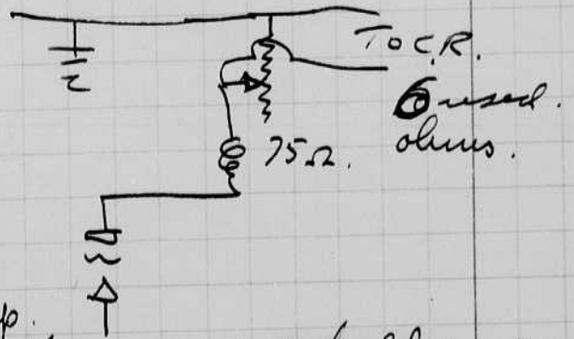


Sudden break to arc. CR 3.5 KV on dial.

521 Movie spark FG-67 thyratron.
.07 μf into coil.



peak of trans = $\frac{115 \text{ volts}}{6 \text{ ohms}} \cong 20$ amp.



with 20 turn coil on silicon core the FG-67 holds over 6 ohms
— the current for the first surge was > 40 or 60 amps.

Experiment to show influence of
sil steel core in series with movie lamp.

Peak current with out = 5/8"
" " with coil = 3/8

this is a 20 turn coil with 10 on
each leg of the lamination.

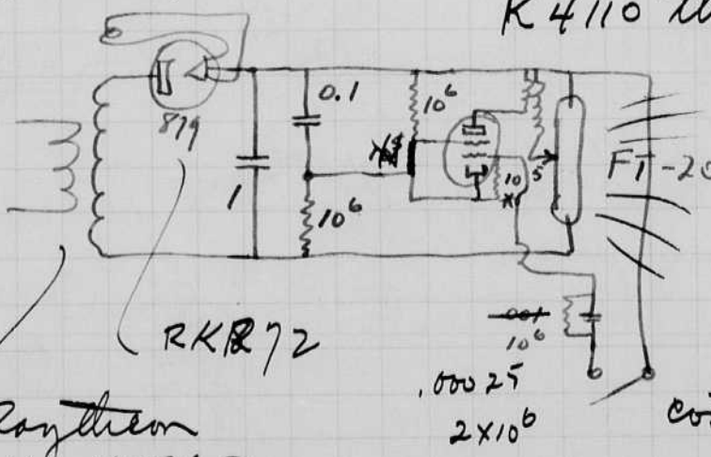
May 31 1945 Duncan C.S. of the RAE arrived May 28
from Toronto and plans to leave tonight for
Ottawa.

June 1 1945. Discussed dark-starting of strobotron reported
with nottingham several days ago. He
suggested 5% thorium in cathodes of
strobotron tubes to give some dark
emission.

I worked with Wilkins on a contactor
stroboscope for loom observation. We used
the strobotron R 4110 which is rated 1000
volts. I had some self flashing so
reduced the plate voltage to 500.
Capacity of 0.1 mf gave enough spark
to trip a strobotron but not enough
for a FT-20.

Had a conf with Sinclair, Nottingham
and Wilkins about the integrating
exposure meter. It was suggested
that Nottingham and I work on the
project on a royalty basis, 2½%
each.

R 4110 thyratron.

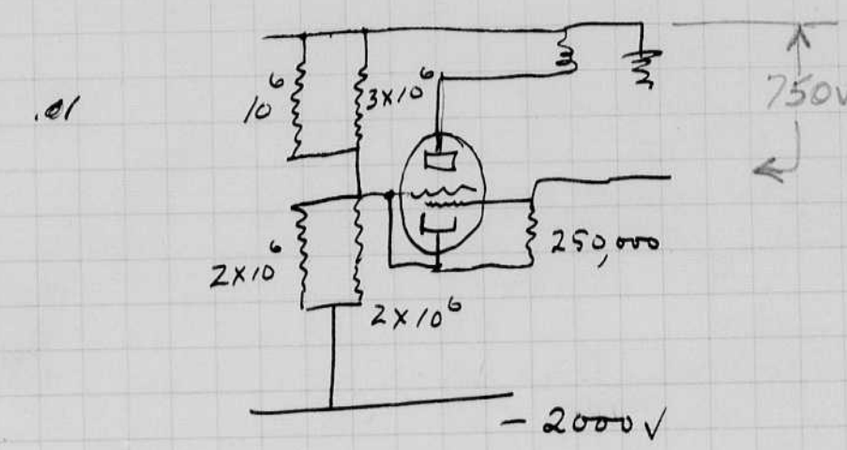


879

Raytheon
V 4576B.

Transformer
Kodaliron type.

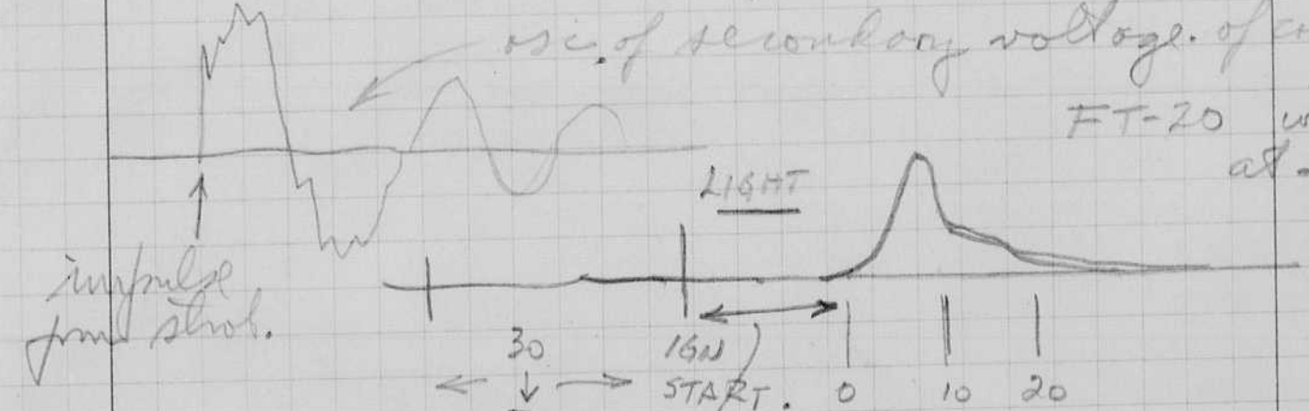
With 2 mf the tube gets too hot and shifts once in a while. The transformer gets hot after a half hour or so with 1 mf at 10 flashes per second.



The 3 meg resistor was put in to stop the self firing of one of the two samples ~~transformers that I had for testing~~.

June 2. cont. Connected above ckt to CR tube.

The CR shows the discharge of the 0.1 mf at 2500 V into the 25 turn pri of the Delco coil to be very fast, that is about 2 microseconds or less. The secondary voltage is like this

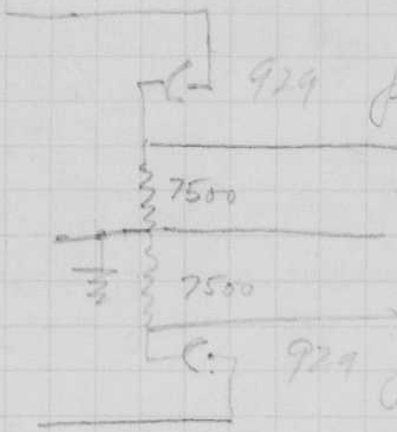


~~for~~ Strobo R4110 to fire. ?

June 4 1945.
H. E. Edgerton.

I set up a camera for recording the C.R. tube that has three elements. yesterday.

Light measuring circuit.



Screens are putting from of the photocells to attenuate the light. These screens have been calibrated in percent transmission.

0.3 ohm for current.

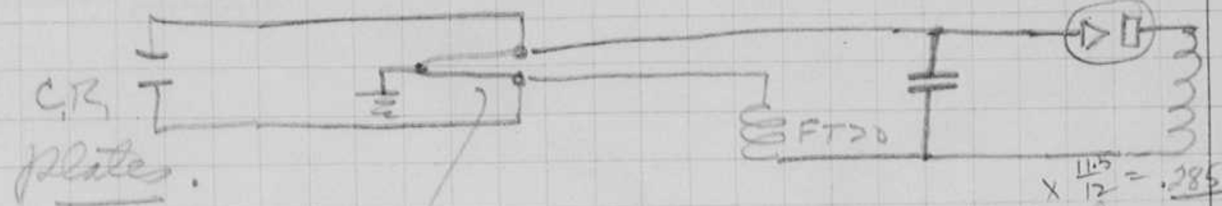
Disc No.	Exps.	Volts.	Screen	10^5 cycles timing 5000 volts on C.R.
1-3	29	2000	9.2 x 48	
3-6	29	2000	9.2	
7-8	29	2000	9.2 x 48	Sweep speed increased x2
9-10	29	2000	" "	" x6
11-15?	29	2000	" "	Traces adjusted.
Blank				
11-19	3	2000	9.2 x 48	fast sweep.
20	3	"	9.2	
21	3	"	23	
22	3	"	49	
23-26.	3	"	23	check.
27-28	3	"	23	current meas shorted.
29-30	3	"	23	current measured check.
31-33	1	"	"	"
34-37	1	"	49	

Developed 10 min in D-19. ok but thin.

1mf = 1.04
2 = 2.05
28 = 28.

GR Bridge in meas lab.

Current meas.



100/.3 = 300.

Cal for current 110 volts brings top two spools together.

5000 V on anode.

2	29 mf	2000 V	9.2 x 48%	
6	29	2000	9.2	
10	29	2000 V	9.2 x 48	fast sweep.
14	29	2000 V	9.2 x 48	
Blank				
3	3	2000 V	9.2 x 48	
4	3	"	9.2	
✓ 5	3	"	23	
✓ 6	3	"	48.	
?	1	2000 V	23.	

1.6 cm on enlargement = 110 volts / .285 = 385 amperes

385 / 1.6 = 240 amp/cm.
= 24 amp/mm.

(from films 17-19, 23, p36.) 17.5/8.5 = 2.05   23/4.4 = 5.23
How come? reflected light!

Readings from film

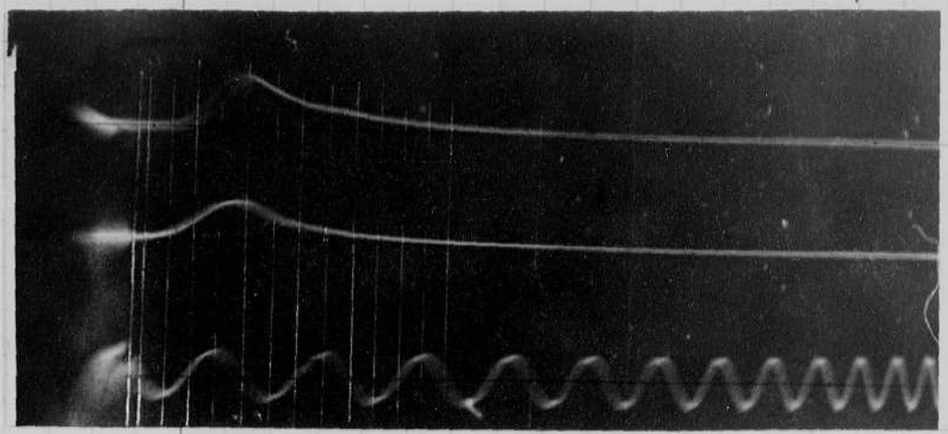
Time μS	Current mm x24.	Current amps.	Light.
29mf 2.5	1.5	36	0
5	4.0	96	2.5
7.5	9.0	215	10.0 13.5 peak.
10	10.5	252.	13.
12.5			
15	10.5	252	14.
20	10.5	252	17.5
25			
50	9.	215	23 peak.
100	6+	144	14
	4	96	9
	3.5	84	6.5

3 mf

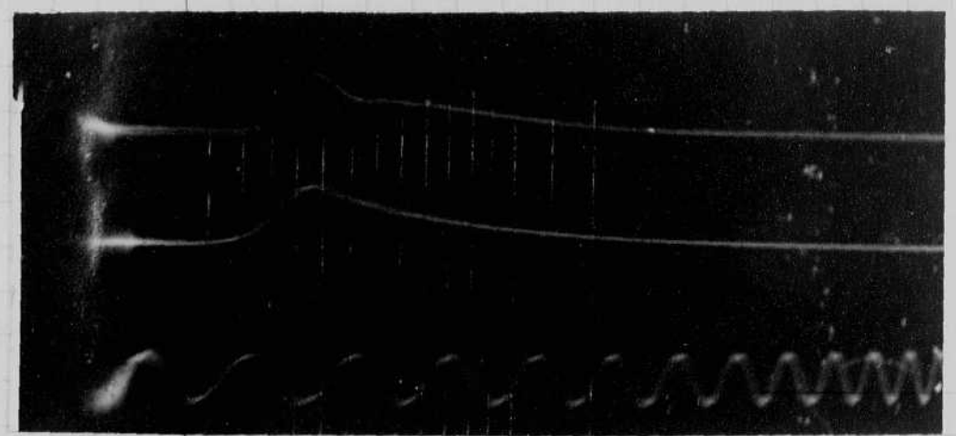
I mm	I amp	Light
1.5	36	0
4.	96	2
7.5	180	6
8	192	8
6	144	4.5
5+	120	4.5
3.5	84	4.0
2.5	60	3.0

1 mf.

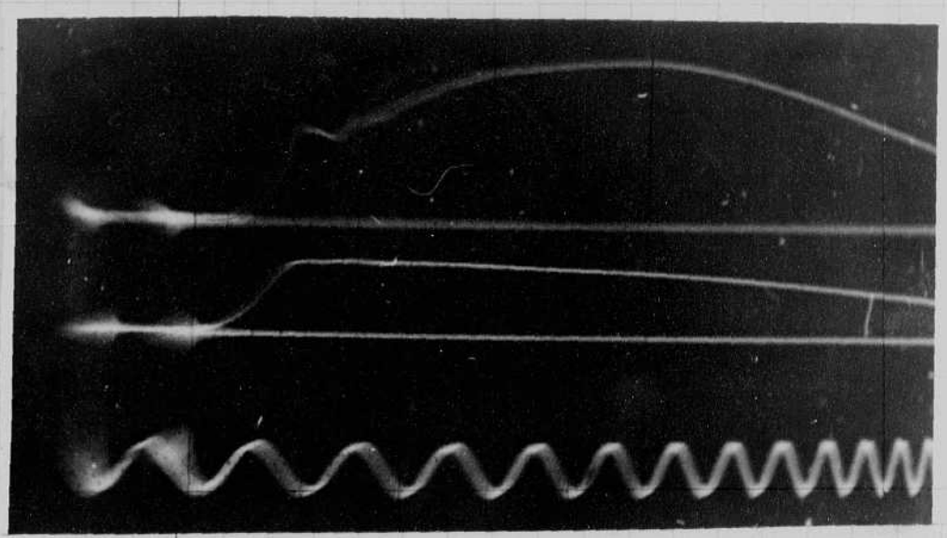
I mm	I amp	Light	Screen x½
1.0	24	0	0
2.5	60	1.0	.5
5.0	120	4.0	2.0
5.0	120	7.0	3.5
3	72	5.0	2.5
2.	48	3.5	1.75
1	24	2	1.0



1 mf 2000 v



3 mf 2000 v



29 mf 2000 v.

Notebook # 16

Filming and Separation Record

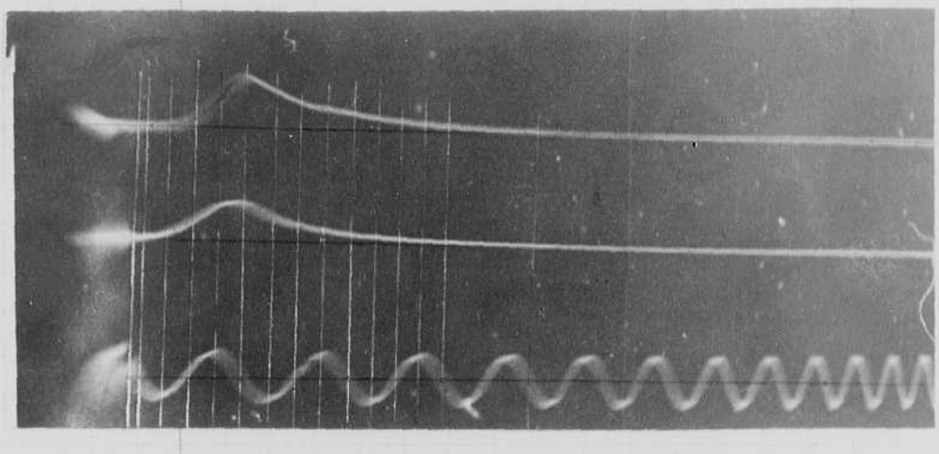
____ unmounted photograph(s)

____ negative strip(s)

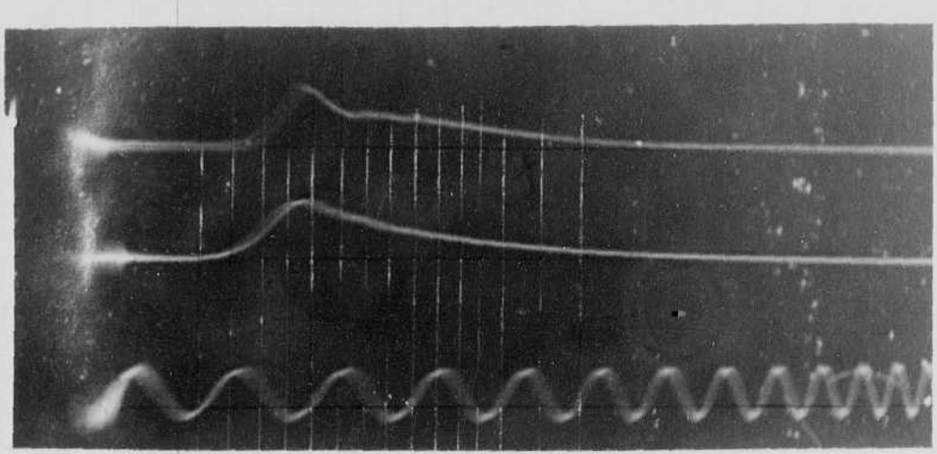
1 unmounted page(s)
(notes, drawings, letters, etc.)

was/were filmed where originally located between page 38 and 39.

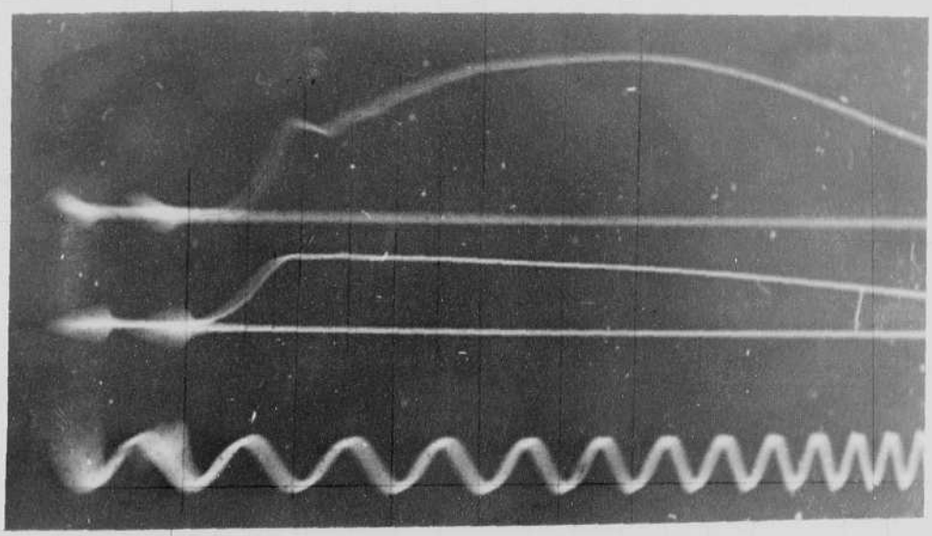
Item(s) now housed in accompanying folder.



1 mt 2000 v



3 mt 2000 v



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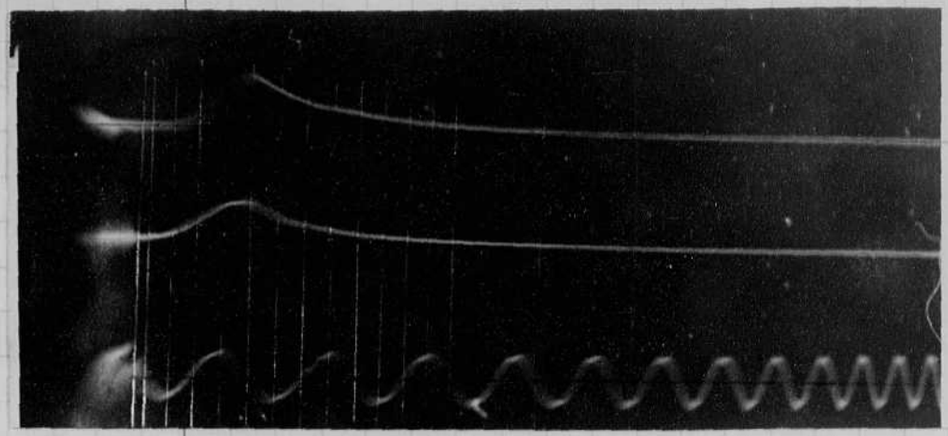
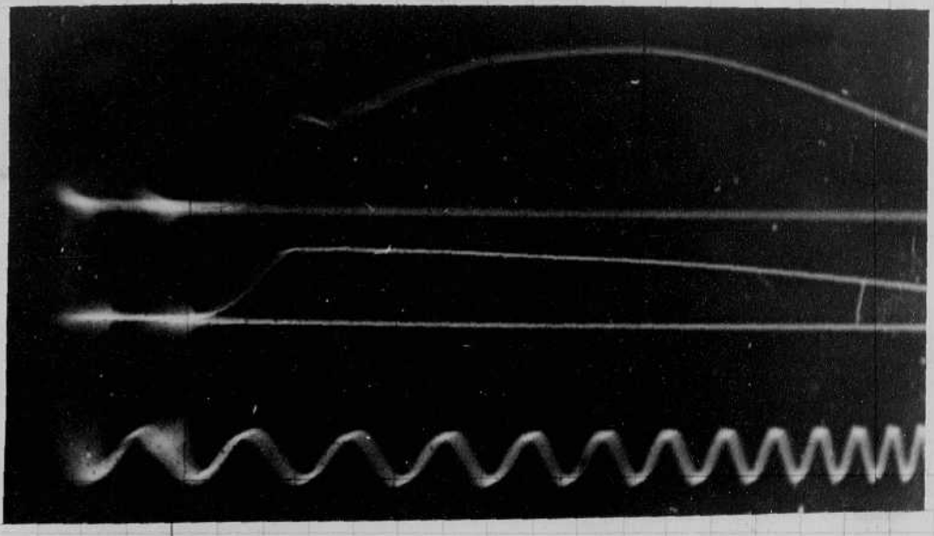


1 mt 2000 v

3 mt 2000 v



29 mt 2000 v.

Notebook # 16

Filming and Separation Record

____ unmounted photograph(s)

____ negative strip(s)

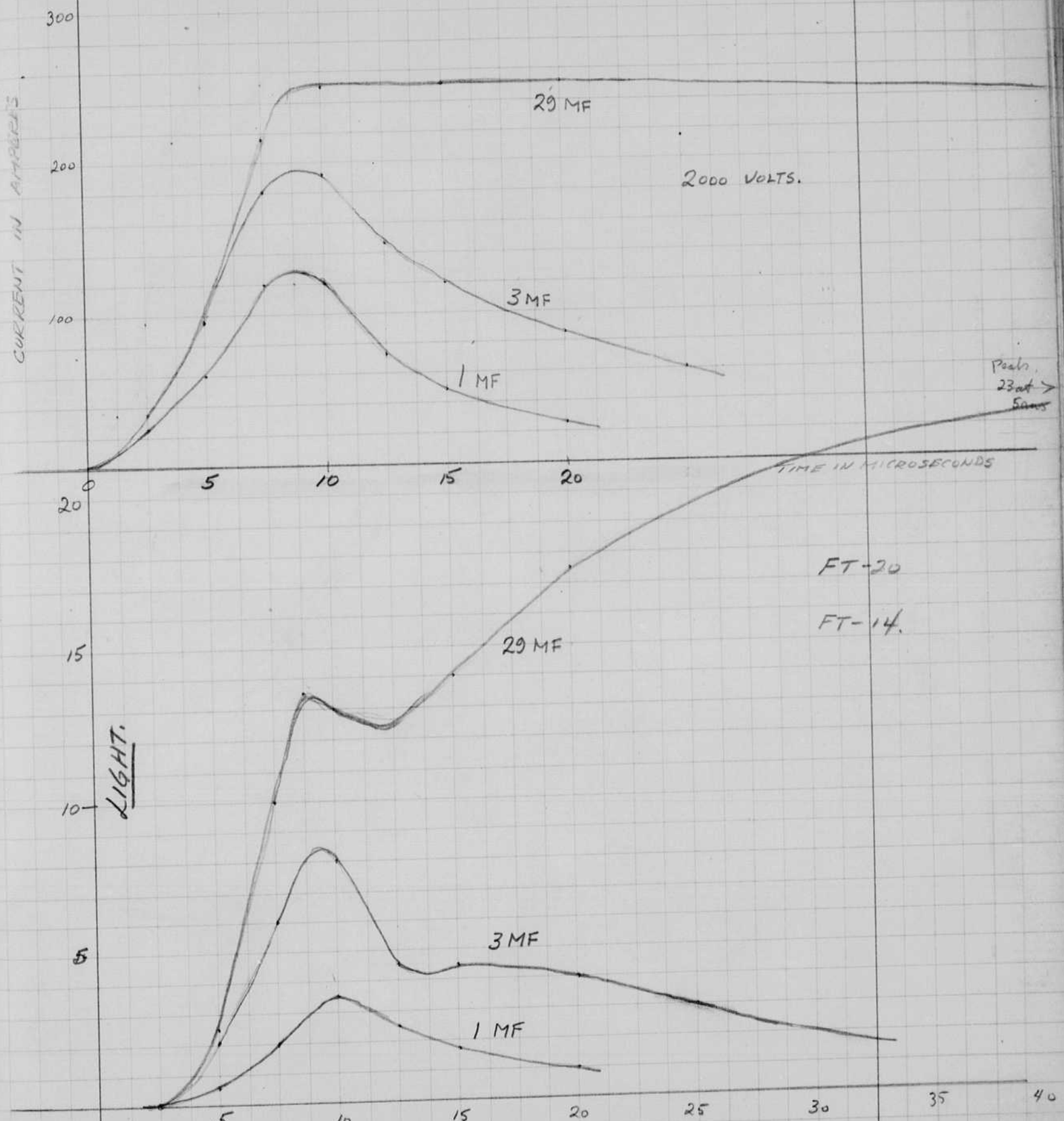
1 unmounted page(s)
(notes, drawings, letters, etc.)

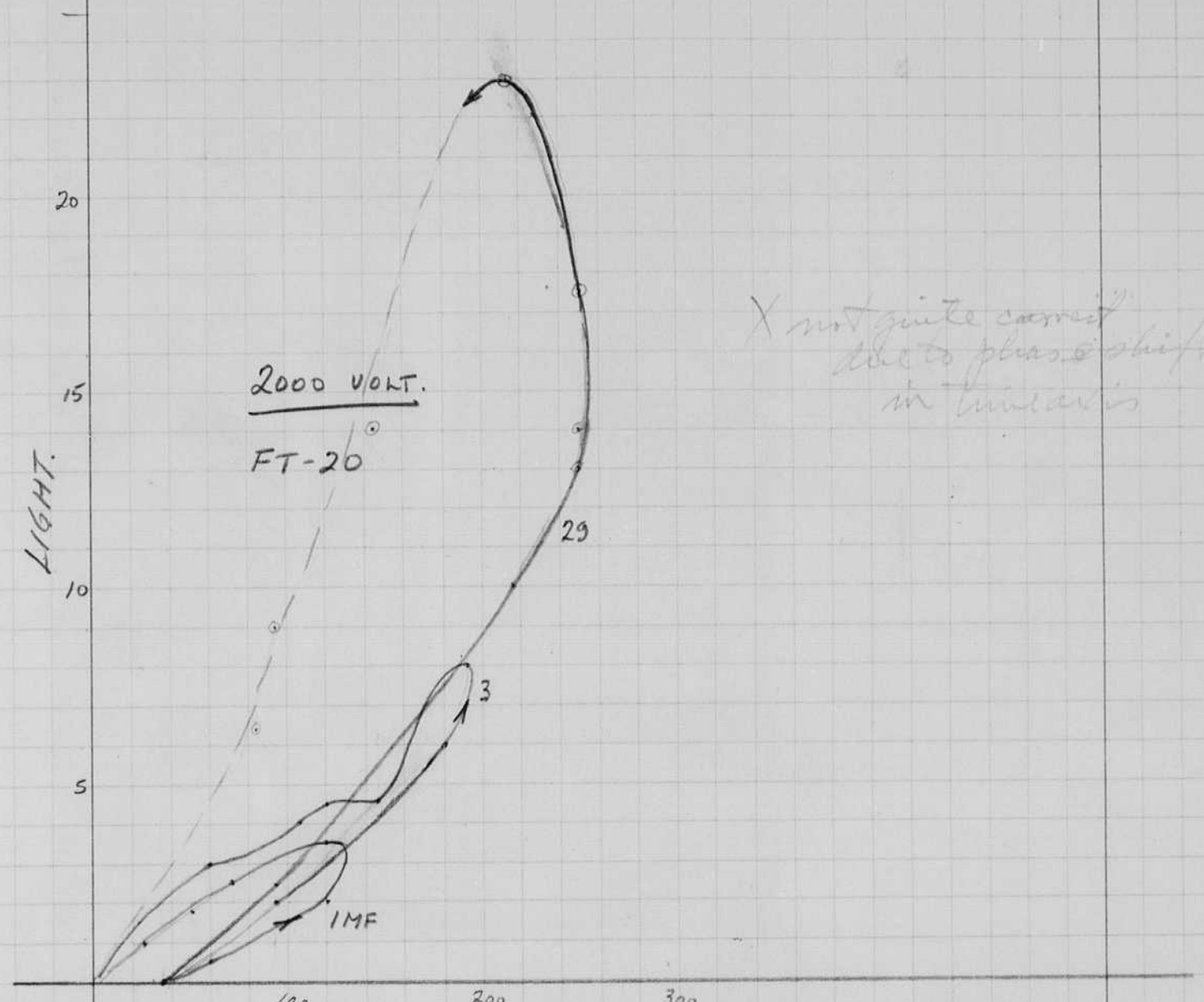
was/were filmed where originally located between page 38 and 39.

Item(s) now housed in accompanying folder.

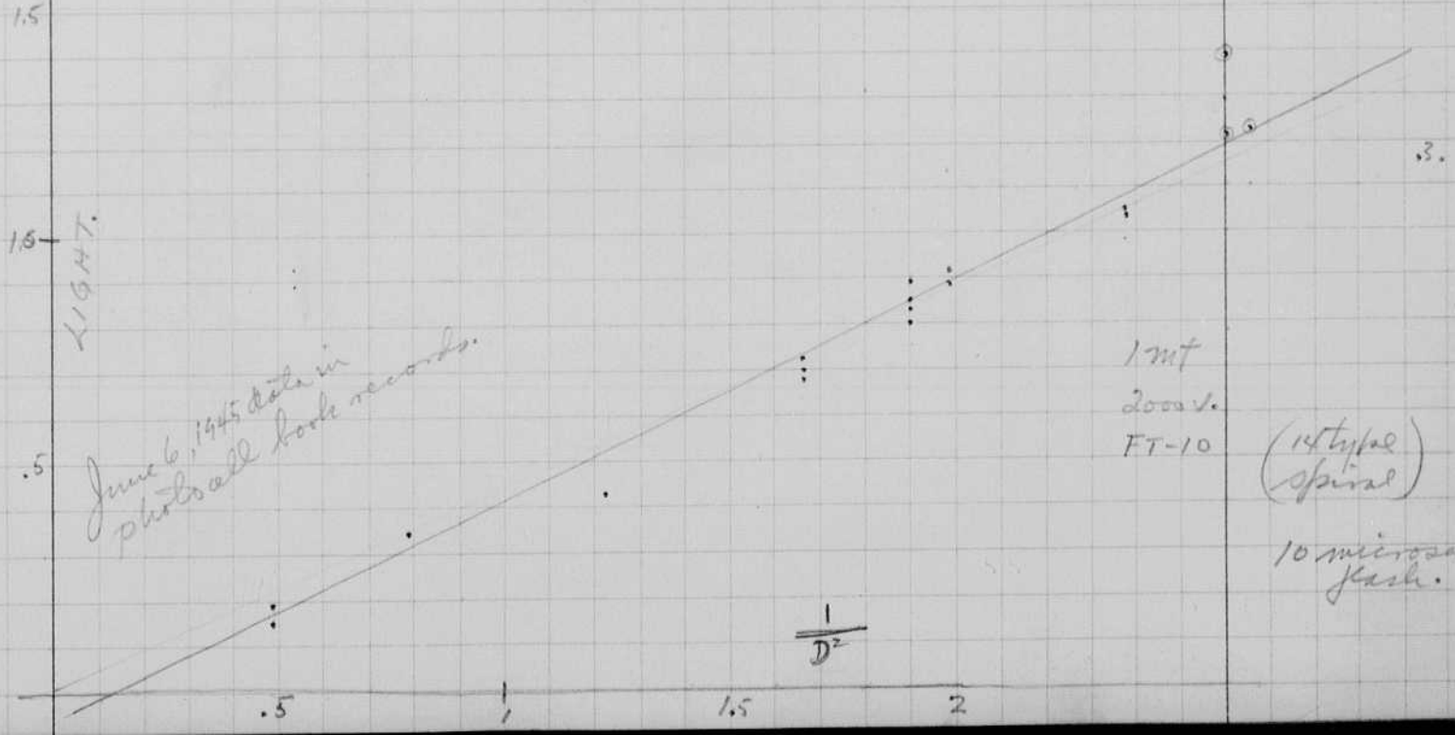
$e = \frac{1}{2} CV^2 = 150 \times 2000 \times 10^{-5} = 300$ joules

$\frac{294}{2} = 58$ joules





X not quite correct due to phase shift in windings



June 6, 1945 data in photocell book records.

June 12 1945
H.E. Edgerton.

Wyckoff and Campbell arrived yesterday morning from the Model Basin, Washington with our old movie equipment and with the new 20 lens (rotating) camera.

Meas. of coil spark from Model Basin

$L_p = .003\ h$ $\quad Q = 3.5$

$L_s = .56\ h$ $\quad Q = 1.4$

Assume $T = 2 \times 10^{-5}$ seconds secondary.

For Pri and secondary to have the same frequency.

$$2 \times 10^{-5}\ \text{sec} = 2\pi\sqrt{LC}.$$

$$\text{Solve for } C = \frac{(2 \times 10^{-5})^2}{(2\pi)^2 L} = \frac{1}{3} \times 10^{-6} \text{ farads.}$$

$$\text{for half period } C = \frac{1}{12} \times 10^{-6} \text{ farads.}$$

June 12 1945
H. E. Edgerton.

Wyckoff and Campbell arrived yesterday morning from the Model Basin, Washington with our Admiral equipment and with the new 20 lens (rotating) camera.

Record of coil spark from Model Basin

$L_p = .003\ h$ $\quad Q = 3.5$

$L_s = .56\ h$ $\quad Q = 1.4$.

Assume $T = 2 \times 10^{-5}$ seconds secondary.

For coil and condenser to have the same frequency

$$2 \times 10^{-5}\ \text{sec} = 2\pi\sqrt{LC}.$$

$$\text{Solving for } C = \frac{(2 \times 10^{-5})^2}{(2\pi)^2 L} = \frac{1}{3} \times 10^{-6}\ \text{farads.}$$

$$\text{for half period } C = \frac{1}{12} \times 10^{-6}\ \text{farads.}$$

June 18 1945
M.I.T. Camb.
Harold E. Edgerton

Wyckoff and Campbell were here on June 11 to experiment with flash tube on the pump for the movie equipment. they left on the night of the 12th after pumping several tubes.

they concluded that a 1 mm H_2 1 atm argon in the standard movie lamp would be a good pressure. much data was taken of performance

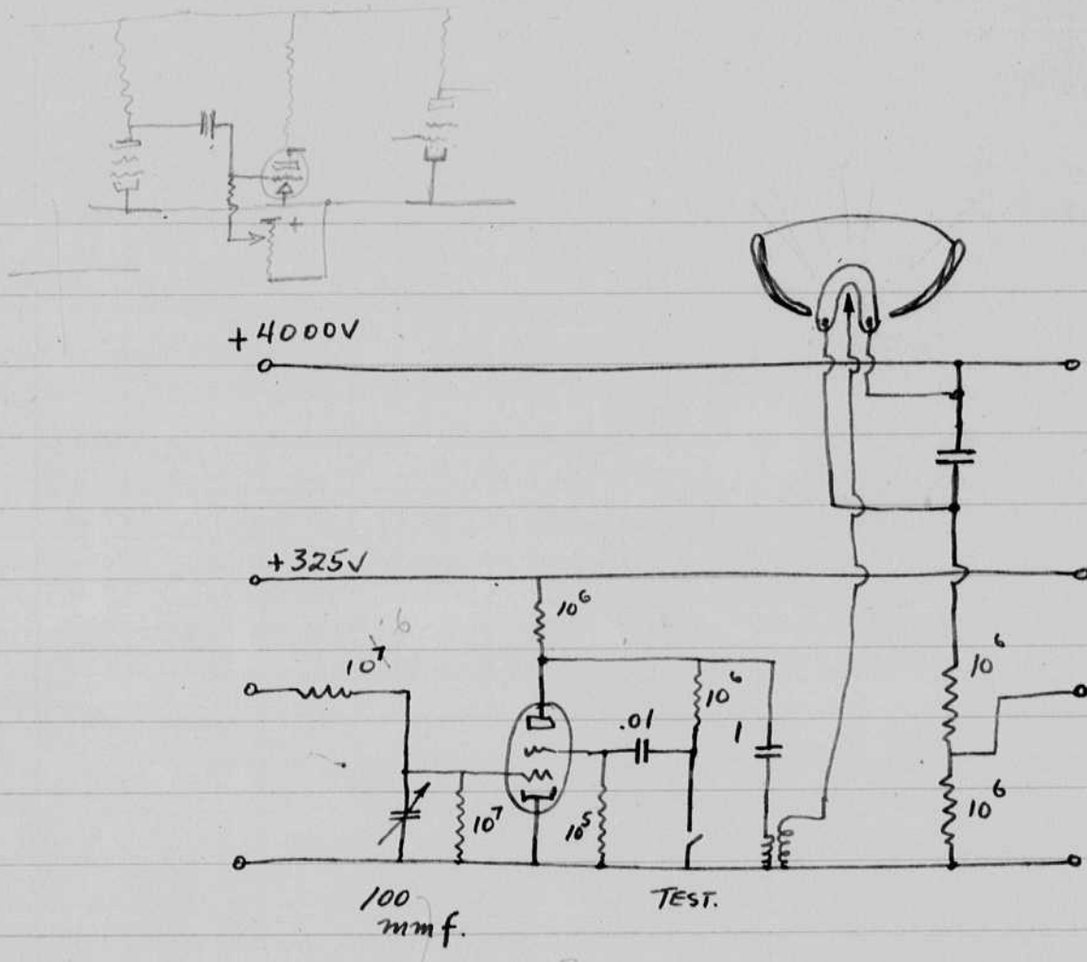
Choke charging with 1 or 2 audio reactors 0.75 h 0.5 ma 30 ohm thordarson T-81C15 chokes. The condenser was 0.1 mf to 4 mf. Usual value 0.25 mf.

Kenyon came on June 12 for the D-3 for installation in plane 228. a flight was made June 14 over Boston at 5000 and 7000 ft. Negs were not processed here. Atkin and Harper were pilot and co pilot.

One condenser popped during the flight over Boston. the equipment worked ok after the pop.

June 22 1945 M.I.T
Harold Edgerton

Charles Coles called from W.F. Dayton for suggestions for a 5 flash unit for photography. He wants 40 micro second flashes at 1000 microseconds apart. I sent him the navy circuit 1942 or 1943.



The above could be cascaded into as many units as desired. with adjustable time lag between them.

June 26 1945 N-2 tests.

Edgerton & Barstow

Dyn lab.

Large D.C. machine operated at 28 volts for current supply.

Series capacity with many meters for finding max condition.

35 mf	2100 volts.
23	2300
15	1700
32	2200
28	2500
18	2150
14	1800
24	2400.

Plan to use 25 mf.

Heat run on a generator. Cold res of alternator = 0.66 ohms. after 1½ min load = 0.87 ohms.

Meters are now connected to measure the D.C. input under load with two inverters. (800 D).

A D-5 or D-3 control box is being used to operate the stroboton circuit the D-5 nitensalometer sets the flashing rate.

The FT-17 with two inverters holdover with any one. We used a coil in series with the condenser to prevent holdover. this coil was of the D-1 type. 0.5 millihenry. this is not quite enough. Possibly double this value would be ok.

no holder with 25 mf on inverter and 0.5 mh coil
current from line 250 amps.
Frequency. = ½ second.
Capacity 400 mf F 7-17.

(the lamp held over with 15 mf and 0.5 coil)

1½ seconds between flashes. 400 mf.
Max voltage on the condenser 3500.

Condenser voltage rises to 5000 volts ± .

100,000 ohms load to stabilize output
Reduces output by 200 volts.

50,000 ohms brings the peak voltage down to
±300 volts.

Fits 3800 with 4 condo 400 mf at 1½ seconds
between flashes.

50,000 ohms ±

Capacity increased to 600 mf.
Speed 2 seconds between flashes.
Line volts 25 at generators.
Voltage adj on inverters on max.
Lamp holds over some.

Voltage adj now moved back to half setting
3700 volts at 2 sec. due to regulator.

at 1½ sec. int 3500 volts.

no flash peak ±200 volts.

With bleeder off. ±750-4800 volts.

cont.

~~25 mf 780 amps avg input V 26 avg input V~~
~~600 mf 2 sec int. Same as C.P. Relat~~

~~15 mf 700 amps avg input V 26 avg input V~~
~~600 mf 2 sec int. " "~~

---

2 second intervals
Regulators at 1/2 on output between
normal and max.

400 mf ±
27,5 volts.
amps.
3500 volts – momentarily.
15 mf series condenser.
0.5 mh inductance
no holdover. 50,000 ohm bleeder.

at 1.5 secnd. all ditto 3500 V just reached.
185 amps..

Next with 600 mf 1.5 sec. 3000 volts. 215 amps

at 2 secd. 600 mf ~~3500~~ volts 210 amps. ok oper

Inv. resist adj max 400 mf 2 sec.
3800 Max I = 210 amps – down to 100

600 mf 1.5 sec 3000-3100 volts. check. Max Reg

Ditto with 25 mf instead of 15. 3600 volts. Max Reg
290 amps input.

15 mf series Reg at 1/2 normal – max. 1.5 sec int.
600 mf with 50,000 bleeder.
3850 volts 70 amps – hold.

Ditto 4200 with 100,000 bleeder. 190 max

Ditto 4600 with no bleeder.

All with 0.5 mh no holdover.

June 27 1945.
cont.

Ind mh.	Ser. Cap.	Lamp.	Input volts. to start Holdover.	C	T Time	Remarks.
none	15.	6 turn.		600	2 sec	no holdover.
none	15	5 turn	32	600	2 sec	H.O.
0.5	yes.	15	5	31	"	"
no	15	6 turn Dif	32	"	"	"
no.	~~39~~ 5	5 turn.		"	"	no H.O. up to 38 volts
no	25	5 "		"	"	no H.O. up to 38 volts.
1.5	15	5 turn		"	"	ok no H.O. up to 38 volts
3.0	15	5 "		"	"	ok no H.O.

Changed capacity from 600 to 400 mf.
Regulators adjustment screws in M.G base backed off 3/16 to 1/8. To give 140 instead of 120 volts. Potentiometer at max value. 1.5 mh not enough to insure no holdover.

With no bleeder 4700 max.
" 50,000 4100 max

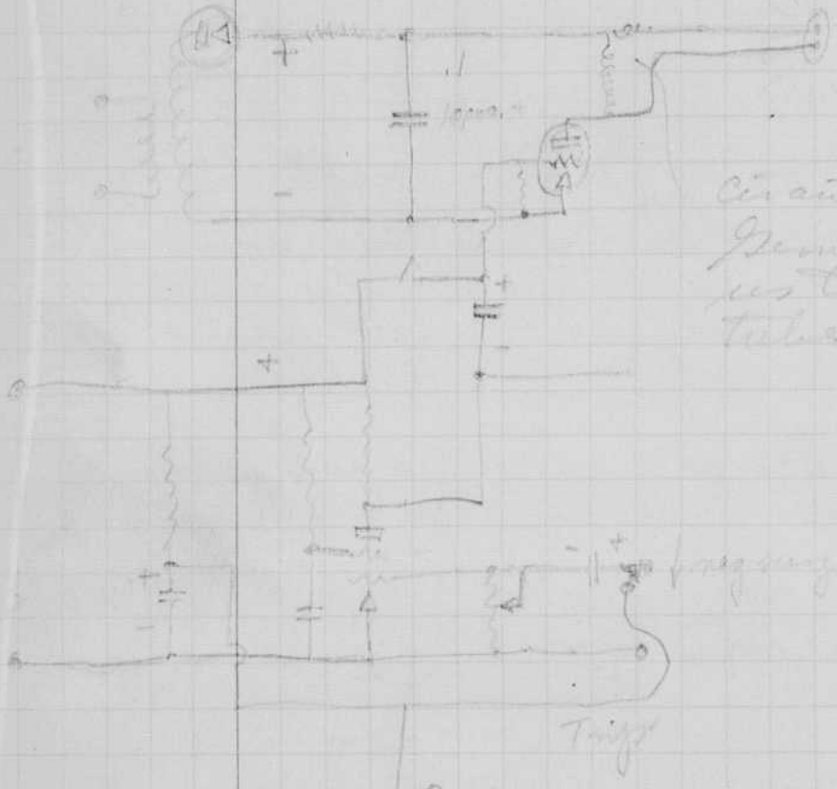
				AC				
1.5	15	5	27.5	145 on line	400	2	4100	max. 4400.
1.5	15	all ditto	27.5	24 cps for	600	2	3700.	
			27.5		500	2	4000	
			24.		500	2	3700.	
			27.5V		500	2	4000	
			27.5 V.		600	2	3700-3800	
			27.5		400	2	4100	→ [redacted]
		50,000 ohms bleeder	27.5		400	∞	4600	
		100,000 " "	27.5		400	∞	4700 - 4800.	
Readj reg.		50,000 ohms.	27.5.		400	2	4000.	
		50,000	27.5		400	∞	4400 - 4500.	
		50,000.	27.5		400	5	4200 - 4250	

Plan to use 5 or 600 mf.
set regulators for 400 v.
2 second external
relay protection for holdover.

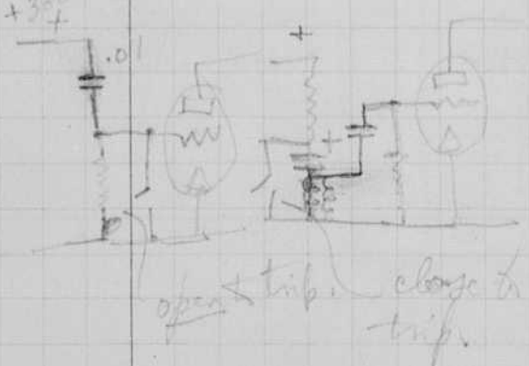
June 28 1945.

Chas. Wyckoff arrived to day to work on remote circuit. - Connected selenium rectifiers for experimental use in the navy N-3 flash unit.

Single flash unit.



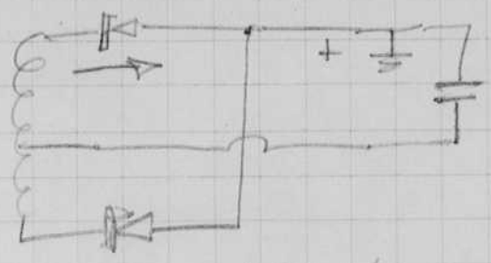
Circuit suggested by Gen. Electronics Laboratories to use high power Tubes.



June 30 1945.

Eby & Barlow Selenium Rectifiers on AV=2

10 stacks x 40 disks in each element Westinghouse



B.G. type 1" diam.

Ind.	Ser Cap	Temp	C	Time	V	V Remaining	
Mfr. 1.5	15	5	no Blk. 600	2.	27.5	3400 Volts.	~~5000~~
1.5	15	6	" 600	2	27.5	3700	Sel
				∞		4300	"
1.5	15	6	" 600	2	27.5	3450	Tubes
1.5	15	6	" 600	∞	11.5	4650	Tubes.
1.5	15	6	" 600	2	"	3800 +	Tubes
	15	6	" 600	∞	"	4750	Tubes
	15	6	100000 600	∞	"	4350	Tubes
	15	6	50000 600	∞	"	4175.	Tubes.
	15	6	~~∞~~ 600	2		3475	Sel
			∞ 600	∞		4650	Sel
			100 000	∞		4300	Sel
			50 000	∞		3800	Sel.
			50000	∞		5100	Sel. ✓
			100,000	∞		4300	Sel. ✓
			~~∞ 50,000~~ 400	2.		3700 3600	Sel 4.0.
gen at max			∞ 600	2		3600.	Sel.
			∞ 600	2		3750	Tubes

3 1/2 mf in parallel with ~~condensers~~ transes.

	15	6	100000	400	2	4000	Tubes
	15	6	"	400	∞	4250	"
	15	6	"	600	2	3650	"
No parallel cond.	15	6	"	600	∞	4250	"
	15	6	100,000	500	2	3800	" pairs slight
	15	6	"	500	∞	4550	"
	"	"	"	600	2	3550	"
	"	"	"	600	∞	4550	"
1.8 mf in ll →	"	"	"	500	2	3750	"
	"	"	"	500	∞	4300	"
	"	"	"	600	2	3450	"
	"	"	"	600	∞	4300	"

June 30
F. Boothe

N-3 Flash Unit.

The following are for optimum adjustments of regulator and 2½–2½ volts input while flashing.

Parallel Cap.	Series Cap	Ind.	Lamp	C	Time	Volt	Remarks
0	1.5	1.5	6 turn	500	2	3800	100,000 w bleed
0	"	"	"	"	∞	4500	"
0	"	"	"	"	∞	4250	50,000 ω "
1 mfd	"	"	"	"	2	3800	100,000 w "
1 mfd	"	"	"	"	∞	4250	" "
½ mfd	"	"	"	"	2	3800	" "
½ mfd	"	"	"	"	∞	4350	" "

Reg readjusted so that 500 mfds would just reach 4000 volts in 2 sec.

0	"	"	"	"	2	4000	50,000 "
0	"	"	"	"	∞	4300-4400?	" "
0	"	"	"	"	∞	4700	100,000 "
½ mfd	"	"	"	"	2	4000	" "
½ mfd	"	"	"	"	∞	4300-4400?	" "

When using 600 mfds, the cond does not reach full charge in 2 secs, so the reg. adjust. can be moved back 300-300 volts & still not affect the max volt reached for the 600 mfds. At the same time the voltage for time = ∞ is decreased 300-300 volts. Thus it would be practical to use a 100,000 bleeder only (no // condensers). However, if the flashing rate is ever ~~increased~~ slowed down to 2½ to 3 per sec., no appreciable gain in light will result in this case.

June 30 1945 ~~Harold Edgerton~~ McRobert + Wyckoff

Cal. Tech. Movie Unit.

3500 volts = 15 division.

3000# .14 (871B.) Hard tube.

.51 air gap Choke = 0.45 h 118 v 60~ I = 0.7 amps

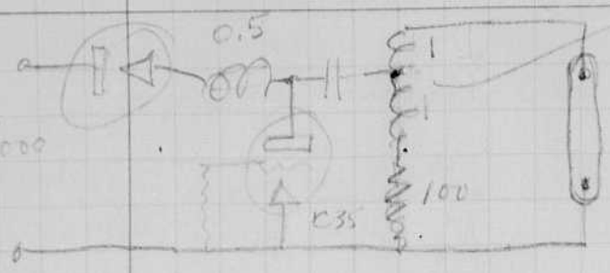
Capacity = .02 × 10^{-6} farads.

freq.	Initial volts. Div.	+ div up from 0	− div down	V.	operation	Remarks.
1000	3500 − 15	30	1.0	.2	3150	
2000	3500 "	28	1.0	.30	2950	
2500	3500 "	28	1.	.4	2900	
3000	3500 "	28.5	3	.450	2850	rough.
1000	4000 − 18	33	0.0	<.200	3650	
2000		32	0.5 → 0	.300	3450	
2500		31	.5	.400	3350	
3000		32	.5	.450–.475	3250	
1000	4500 − 20	—	+1.	.2	4100	
2000		—	+1 → 0	.350	3850–3900	
2500		35±	+1	.400	3800	
3000		35±	+1	.5	3700	
2000	4500		+1 − 0	.370–.390 .45 ma. at zero		
2500			+1 → 0	.46		
3000			+1.	.500+		
3000				.6	4300.	Data from Brier.

230
220
210
205

July 2 1945

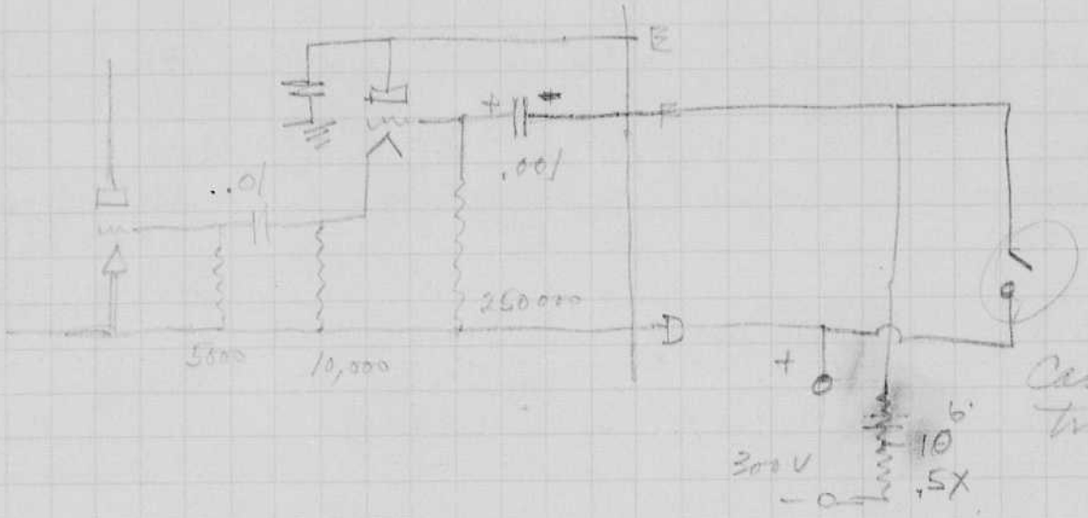
Experimental Synchronizer.

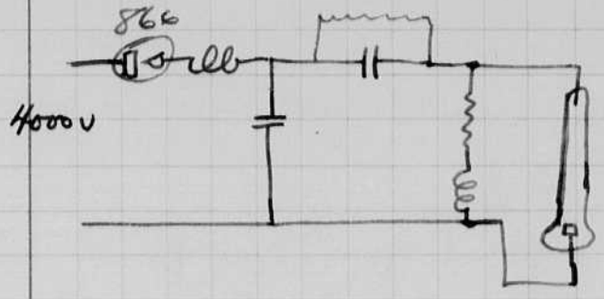


24 volt turns with C.T.
1/2" square core Hypersil

Step-up transformer to increase voltage on lamp.

The core also will saturate.



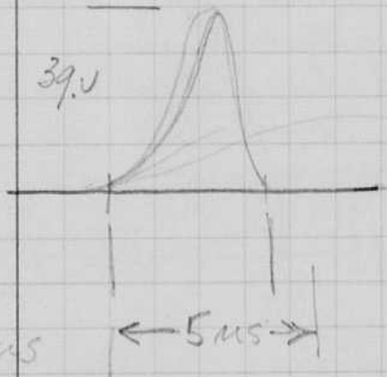


FT27 6 cm Xenon - Hydrogen 6 : 1. volume.

Irregular operation showed two kinds of operation. By some experimentation it was found that the arc sometimes occurred on the reverse cycle in the lamp. this explained the reason that the anode showed darkening.

Other tubes than the two FT27 that had large anodes, showed a breakdown arc after every cycle & they were ~~dead~~ o.k. . that is no jitter.

Impedance in the discharge path.

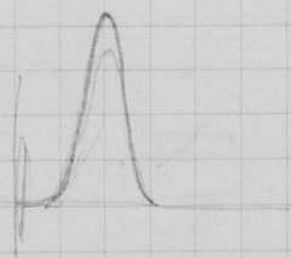


3500 tube no jitter

$I = \frac{39V}{.39} = 100$ amps.

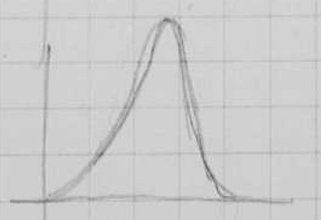
12 turns on 1/2" Hypersil core

Impedance in series with flash lamp.

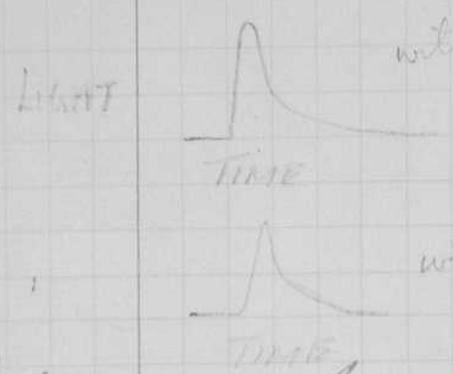


no choke

Build-up time is second due to



24 turns on Hypersil core.

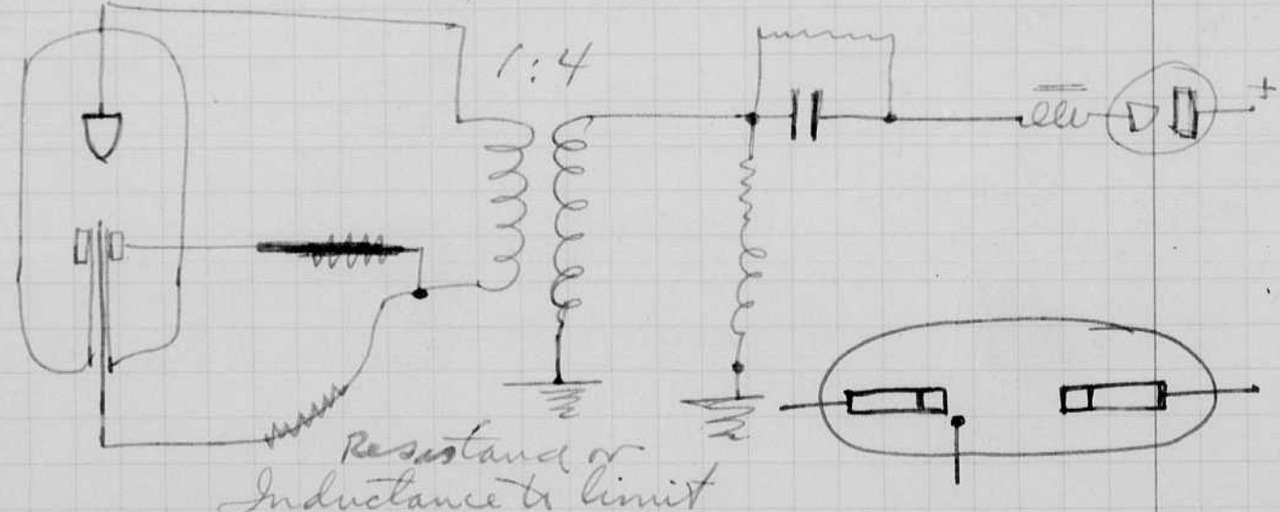


July 3, 1945 Harold Edgerton — Ken Germeshausen. Herb Grier M.I.T.

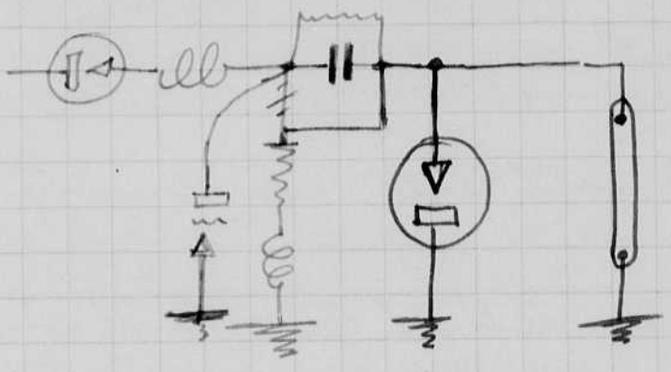
A few experiments were tried with a ~~choke~~ transformer 4:1 step down. Difficulty was experienced in obtaining a tube that would start at the low voltage. By the help of a sparker it was possible to run a gap tube (argon). The tube blew out several times due to holdover.

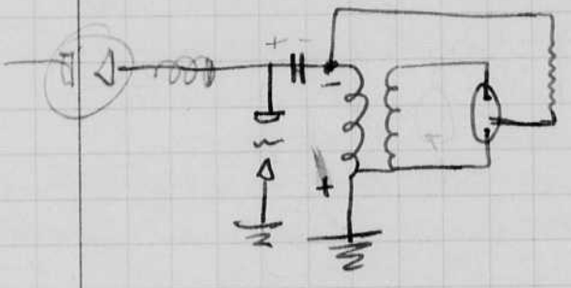
The light from the high pressure argon gap was considerable. The oscillograph showed the same afterglow as found in the Xenon lamps.

A starting electrode might be effective. One type is sketched below.



A reverse rectifier would be useful to overcome accumulating buildup of the d.c. voltage due to swinging.

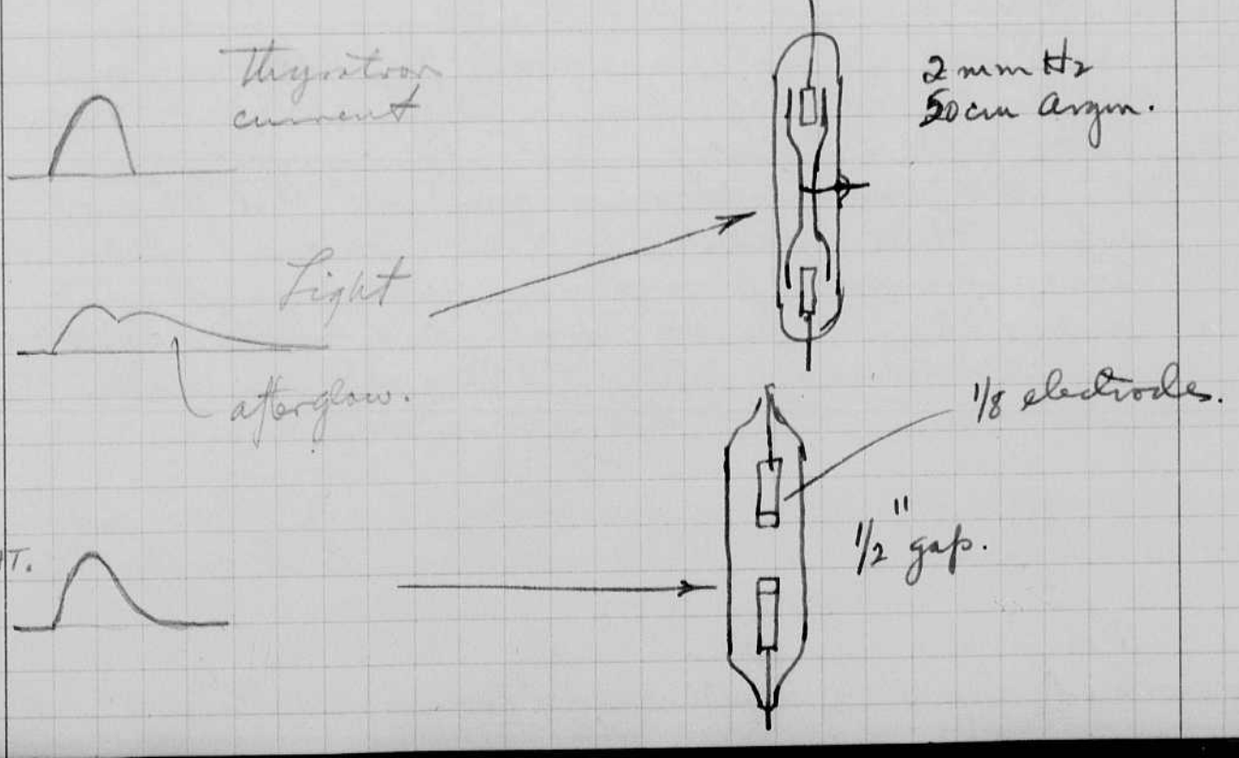




Suggested by Genus for transformer test.

Chas Wyckoff helped with these tests.

Connected and tried. The tube was a FT-21 with an internal 3rd electrode as made by Wyckoff. Worked fine at 500, 1000, 2000, 3000 and 4000 cycles with 4000 volt input.



1/8" gap tube pumped with argon at 1 atmosphere. Static test showed about 2000 volt breakdown when tube was degassed and gas was fresh.

Operated ok at 3500 volts with tendency to holdover at 4000 volts.

Duration ok but with some afterglow.

July 5. 1945. TBM arrived at Bedford on July 3 late. for navy N-2 project.

Family left for Nebraska yesterday.

Lt. Col. Guerry called from Florida on July 1 or 2 to tell me that he would be up here on Fri. or Sat. apparently the radar is out of commission.

July 8, 1945 the A26 576 came in on July 6 with Guerry, Starmont and McLendon, Davis. conf with White, Bonner, Fahnstock on July 6. Guerry went to Washington on July 7. the radar is being overhauled.

I took Mumnis and Judkins to the airport yesterday a.m. to check over the TBM 744. It has a K-19 camera directly ~~over the radar~~ at the place where the rear radar man operates. The camera, magazine and an inverter were brought in to Tech for checking. the B-5 intervalometer was given to Raytheon.

Also we inspected the A26 yesterday and found the flashlamp broken due to vibration. A new FT-17A 50 was installed. this is the tube that has a welded connection at the

bottom end in place of the threaded connection. A comprehensive set of light curves were made on this tube yesterday.

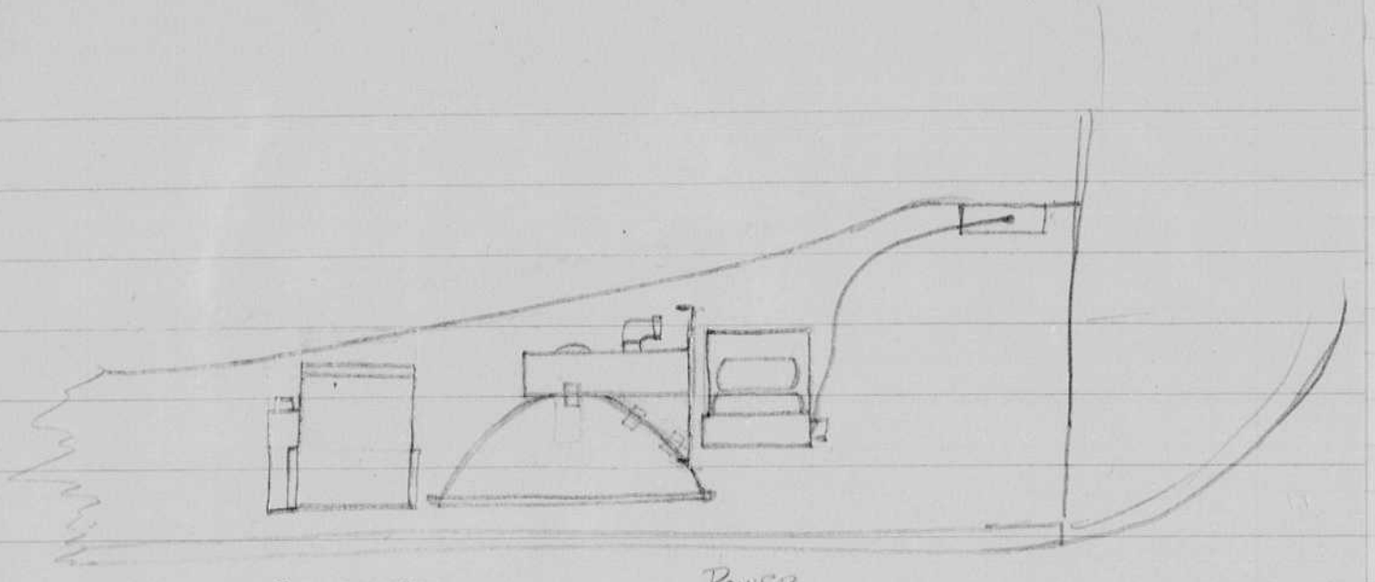
July 26 1945.

I went to W.F. with Stannard in the #26. We left July 18 stopping at Elmira overnight on the way. Had conferences in W.F. on the 8 flash units as per Kenney cable A 75697. July 11. Star had a copy of OC&R letter that he obtained in the pentagon bldg. on July 16 while we were both there. I also saw Bobbes, Vandenberg, Phillips, Schaur, Kennedy, Powers and others. Foster and Stannard wrote up the OC&R letter, which then had to go to the NS&S before transmittal to W.F.

Vibration tests were made on the #26 tail reflector by McGrath and his helpers.

July 28. 1945. The Navy N-2 unit was operated in the Raytheon plant on Wed July 25. Bruce Connor was there from the N.R.L. also Heilpern. 1025 Commonwealth Ave
the N-2 unit was installed in the plane on July 26 and 27. The plane would have flown except for a bad scavenge line.
TBM-3E/ ~~89744~~ ?? 68744

July 30. Worked with Raytheon yesterday and today on the D-5 flash units. Kenyon is due here today in C47 to take them units to California.



CAMERA (60 LBS) AND
CONTROL BOX (11 LBS) IN
REAR COMPARTMENT.

12'-9" spacing
of lamp and
camera.

DIAGRAM TO SHOW
POSITION OF ELECTRIC
FLASH EQUIPMENT
TYPE N-2 IN
TBM No. 68744

JULY 26 1945
H. E. EDGERTON
M.I.T.

Notebook # 16

Filming and Separation Record

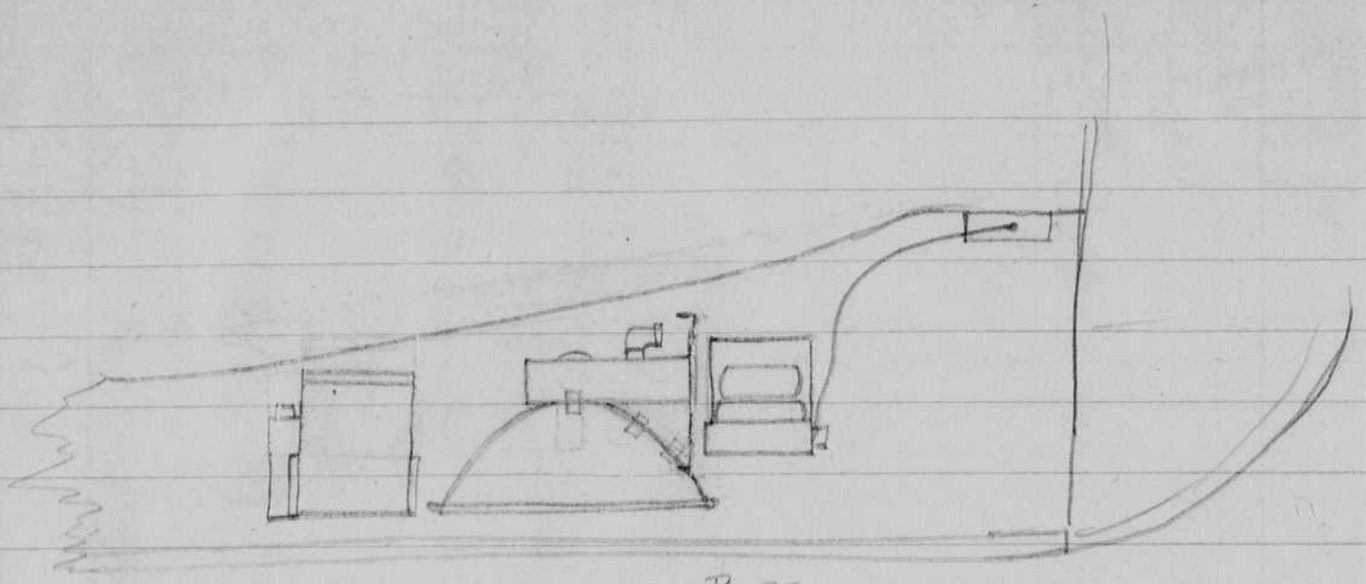
1 unmounted photograph(s)

____ negative strip(s)

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

was/were filmed where originally located between page 60 and 61.

Item(s) now housed in accompanying folder.



CONDENSERS
237 LBS

POWER
SUPPLY
131 LBS.

FORWARD.

REFLECTOR
23 LBS

CAMERA (60 LBS) AND
CONTROL BOX (11 LBS) IN
REAR COMPARTMENT.

12'-9" spacing
of lamp and
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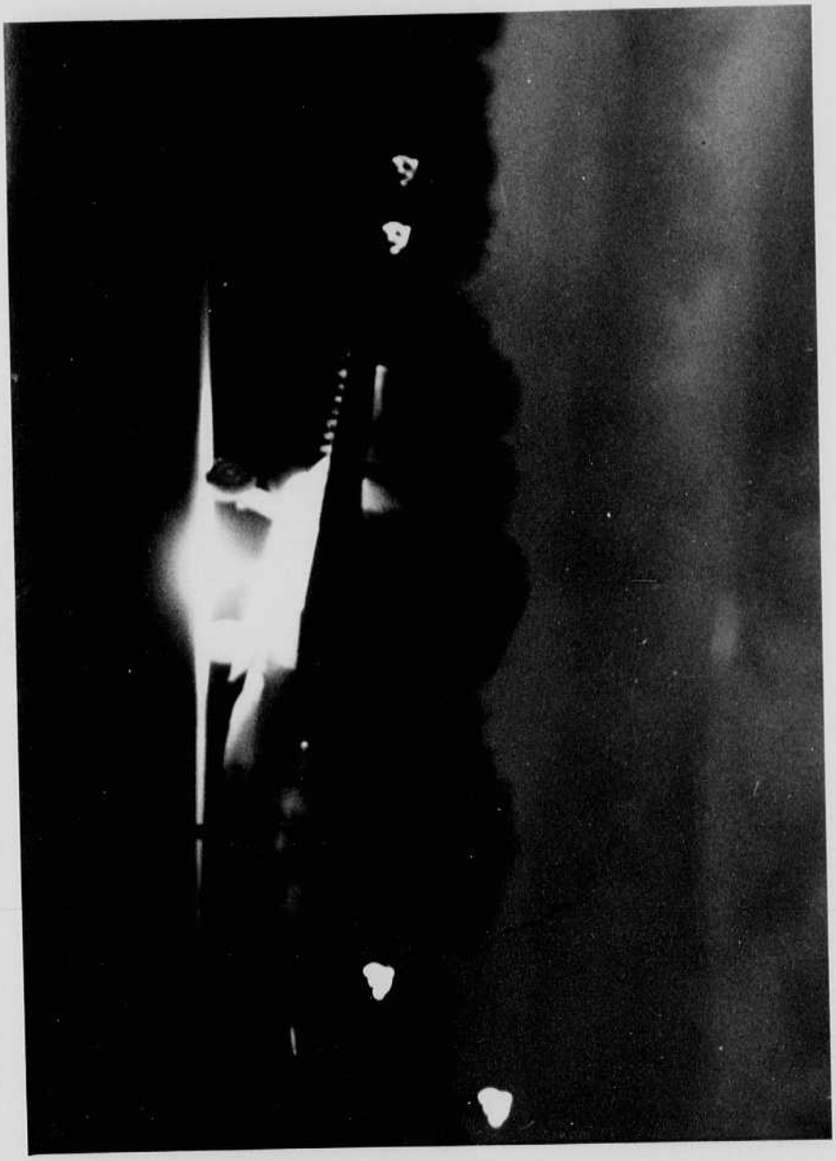
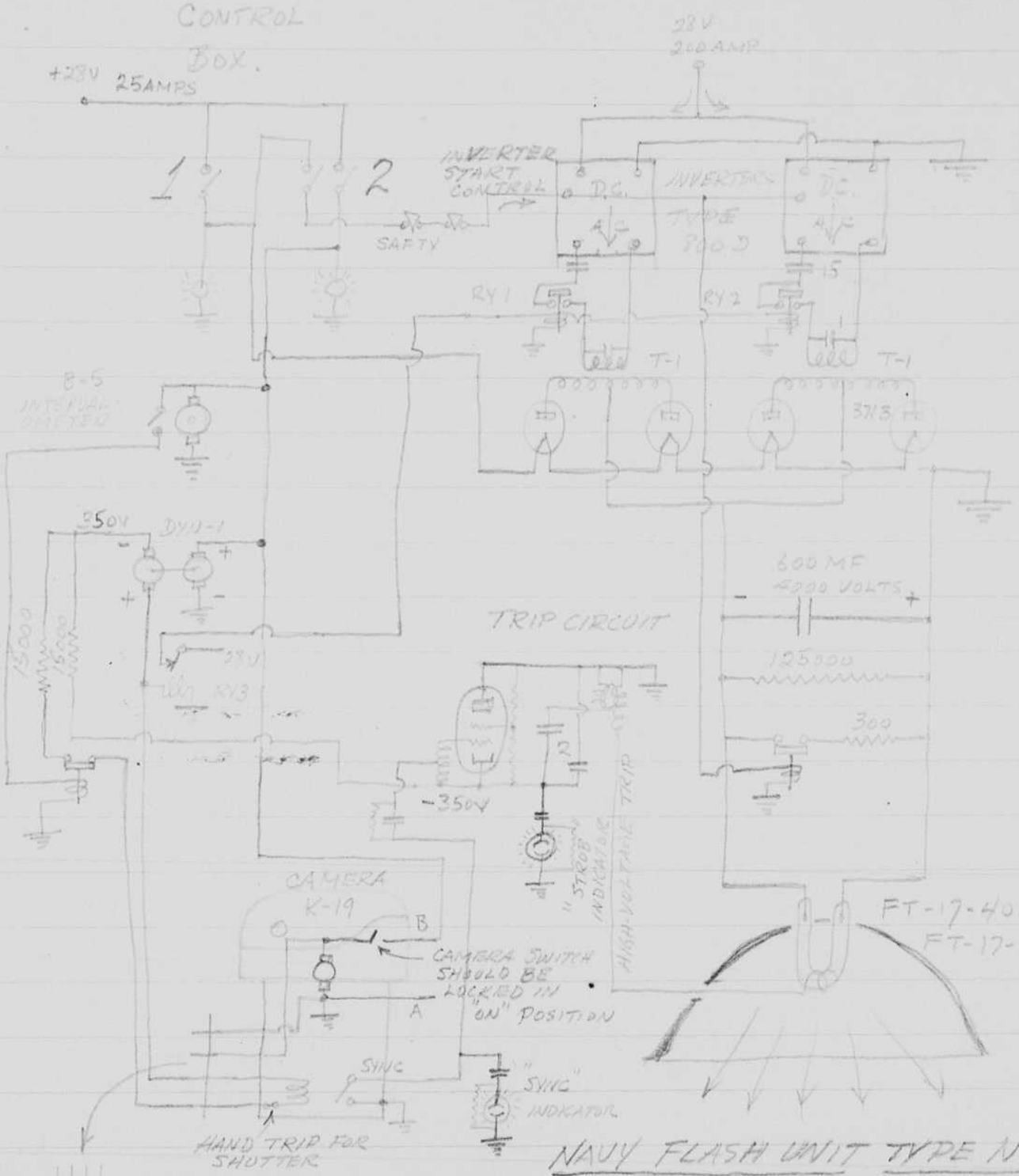


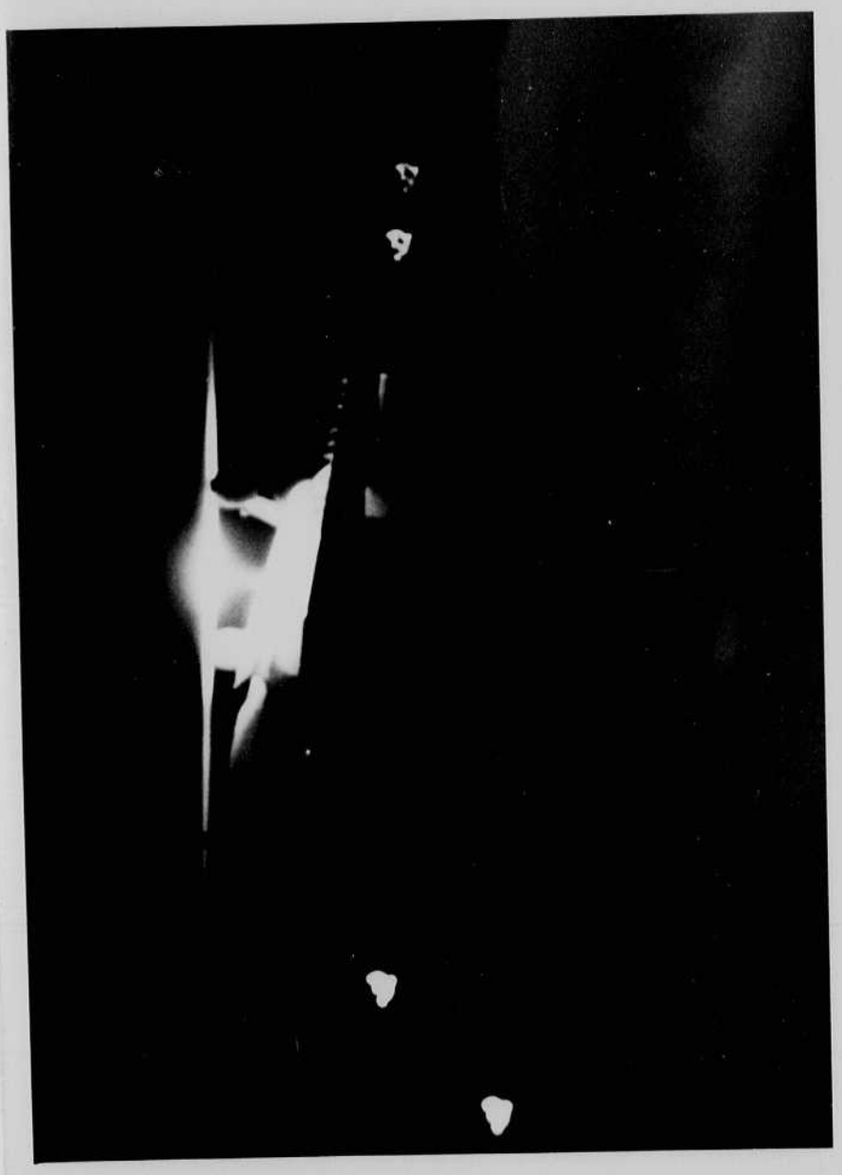


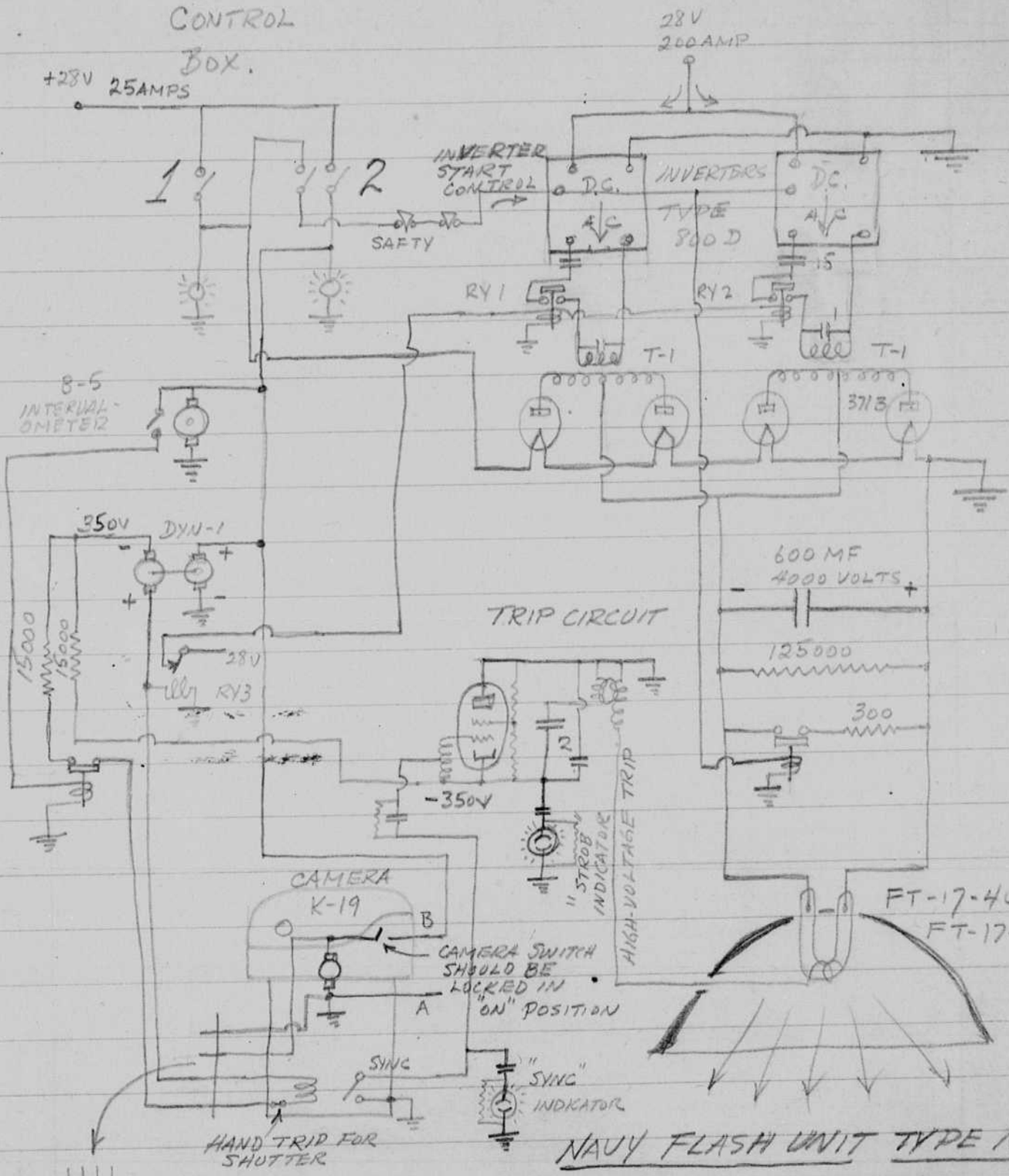
NAVY FLASH UNIT TYPE N-2

M.I.T. JULY 26 1945

H. E. EDGERTON

SCHEMATIC WIRING DIAGRAM.





NAVY FLASH UNIT TYPE N-2

M.I.T. JULY 26 1945

H.E.EDGERTON

SCHEMATIC WIRING DIAGRAM.

H.E. Edgerton M.I.T.
Aug 6 1945

The N-2 flash unit was tested on aug 3 out of Bedford at 500, 1000, 1500 and 2000 ft. The negs at 2 second intervals at 1000 feet were of excellent quality and had ample overlap. At 1½ sec. intervals at 500 ft there was no overlap. The camera probably would have run at 1 second intervals but it was not tried.

The photos at 2000 ft were ok for finding autos, but were thin in the corners.

Lt. A. Mattei was here on aug 2 and 3 for the tests. Photo mate Geo Heitpen has been here for a month to learn the details of the flash unit.

Kenyon arrived July 31 in a C47 with Major Porter of A.T.C. to take the 3 flash units to Long Beach. The plane left aug 2 in the afternoon.

The instruction book for the N-2 was finished in draft form yesterday. The same for the D-3 is being written by Barstow now.

I called Milt White (Rad. Lab.) about installing an APQ 3 in an A26 for our work. He said I could suggest this to O.S.R. The plane would then be a mock up for more if they were desired.

Leaving tonight for Washington and then Nebr, and Calif. Long Beach.

August 25, 1945.

Harold E. Edgerton

I returned from California yesterday afternoon via T.W.A., leaving the day before. Below is a list of where I was during the trip.

Aug 7. Saw Bowles in Washington also Schauer and Mattei-Hooper, at the navy.

Aug 8 Dayton with Kenyon on D-5 in A-26 plane. Left that night for Chicago. Then on Aug 9 by Burlington to Omaha and Lincoln.

Aug 10, 11, 12 in Aurora.

Aug 13 left for Kansas city. Victory over Japs was announced about 6 o'clock. I called Schauer in Washington ~~on Aug~~ who advised proceeding to Douglas at Long Beach.

Aug 14 left K.C. with Laird, Preables, in a C 54 for L.A. arriving on Aug 15.

Aug 16-17, 18 at Douglas were nothing was being done because of contract cancellation. Some 12000 people were fired on Aug 16 or 17.

Aug 18 Saw Knapp at C.I.T. to check over the flash unit. Shapiro postponed his next week vacation in order to work with me. I spent the 19, 20 and 21 tuning up the equipment. On the last day we took three pictures at 1000 f.p.s. of a model at 80 ft per sec.

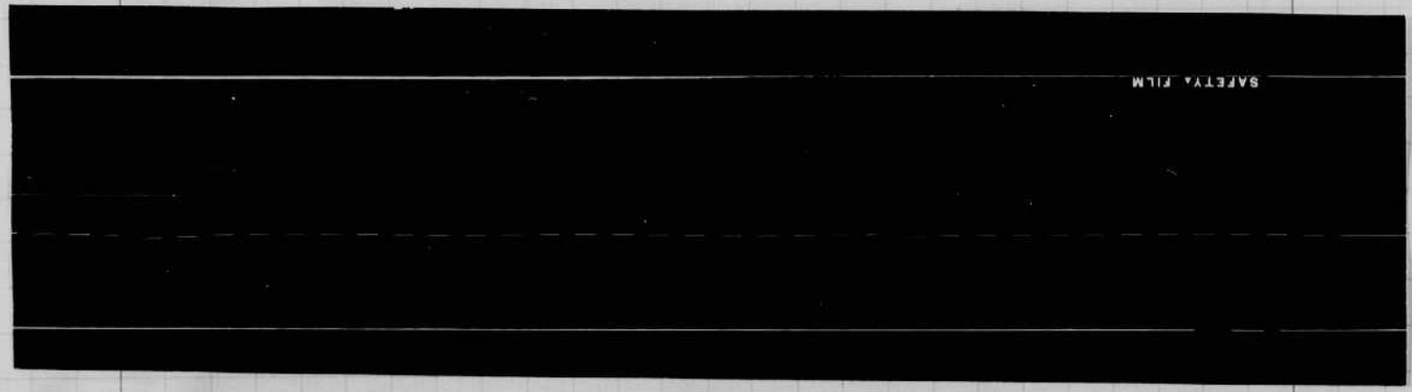
A .0005 mf condenser was put from the grid to cathode of all the mercil panels. This helps to prevent double flashing and fuse blowing.

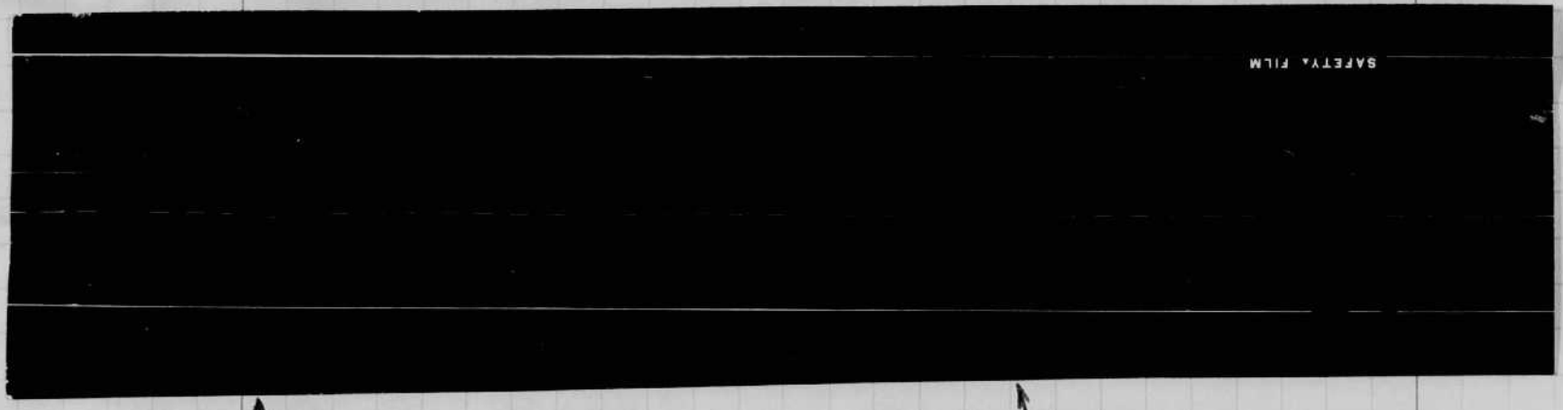
There was also two shorted cables that sparked and two bleeder parallel bleeder resistors that were open.

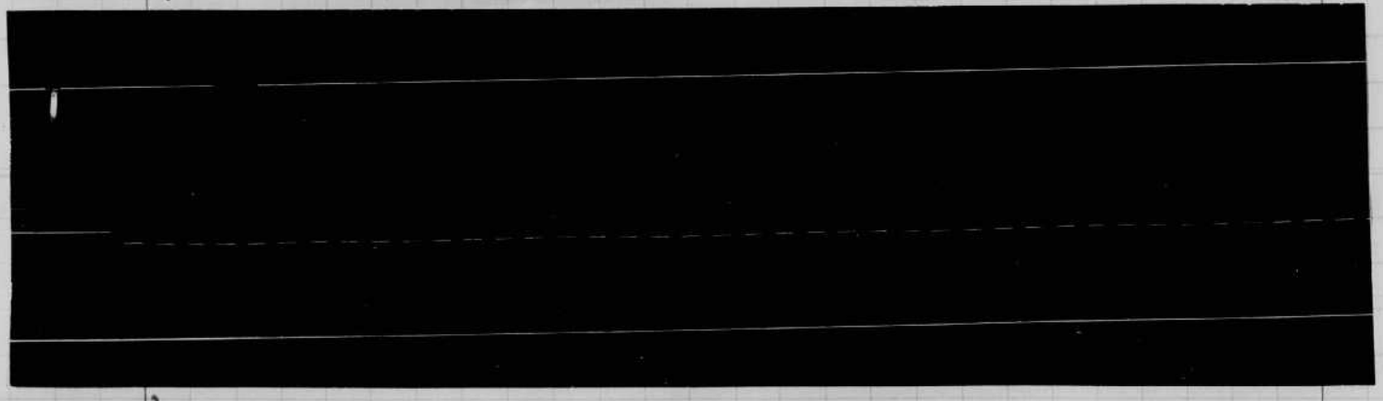
Some of the 6J5 tubes show a glow when the thyratron starts. This is caused by energy feeding back from the grid of the thyratron. cathode-ray oscillograph scans show the voltage to be greater than 500 volts

with a frequency of 10 megacycles ±.
Below are a few oscillograms of the plate voltage against time.

TIME →



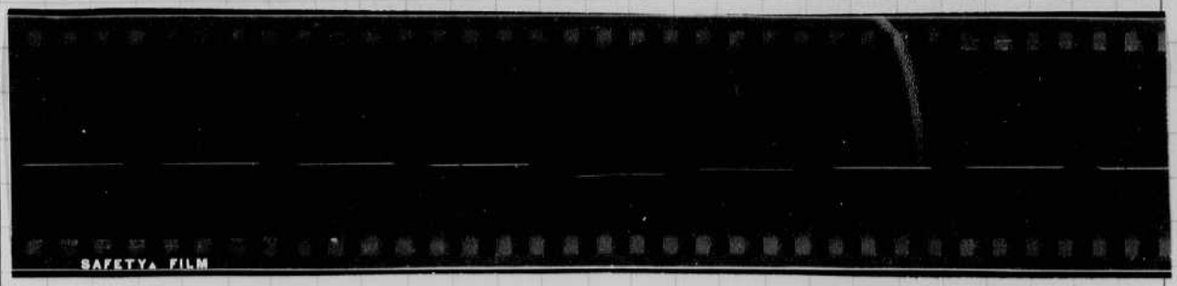


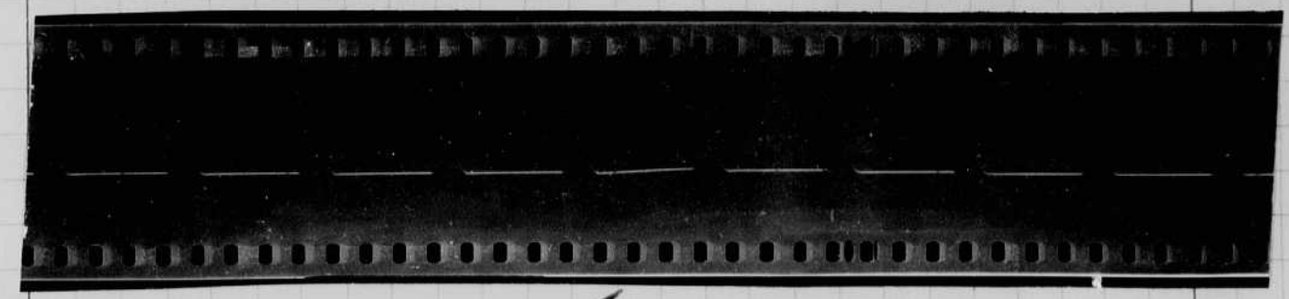


↑ ↑

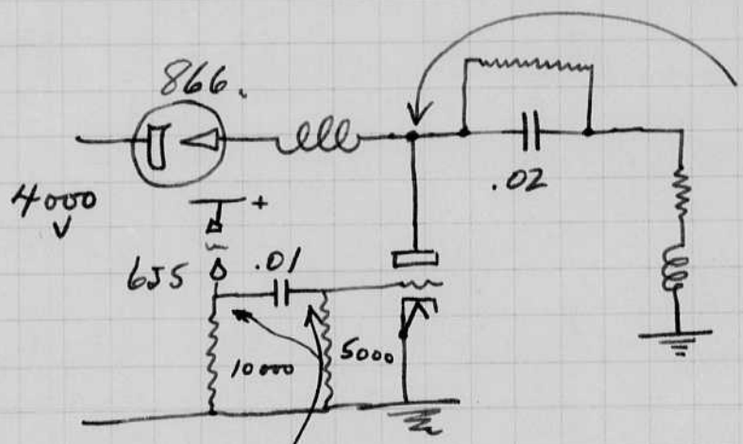
⌊ transient buildup

Double line ↓





↑ note change in leakage ~~and~~ on one charge.

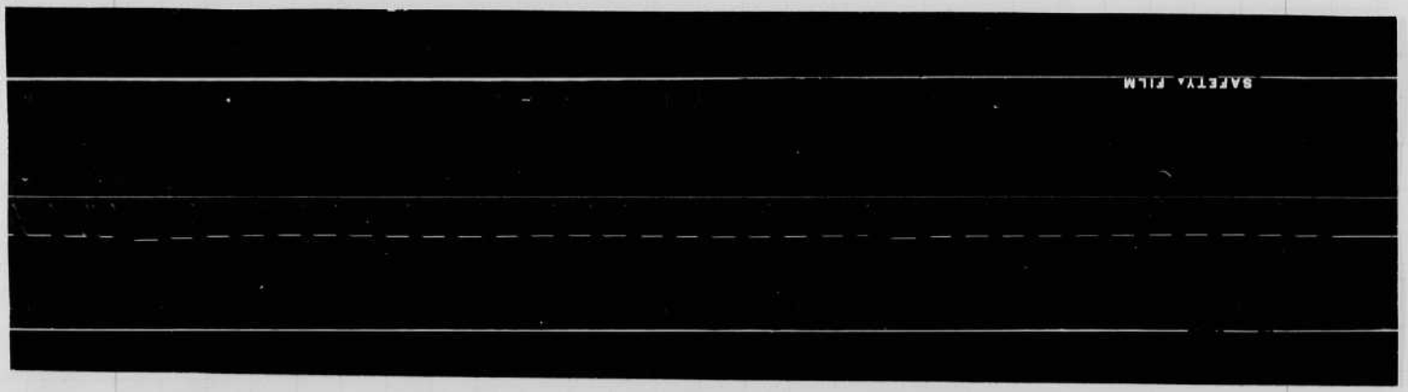


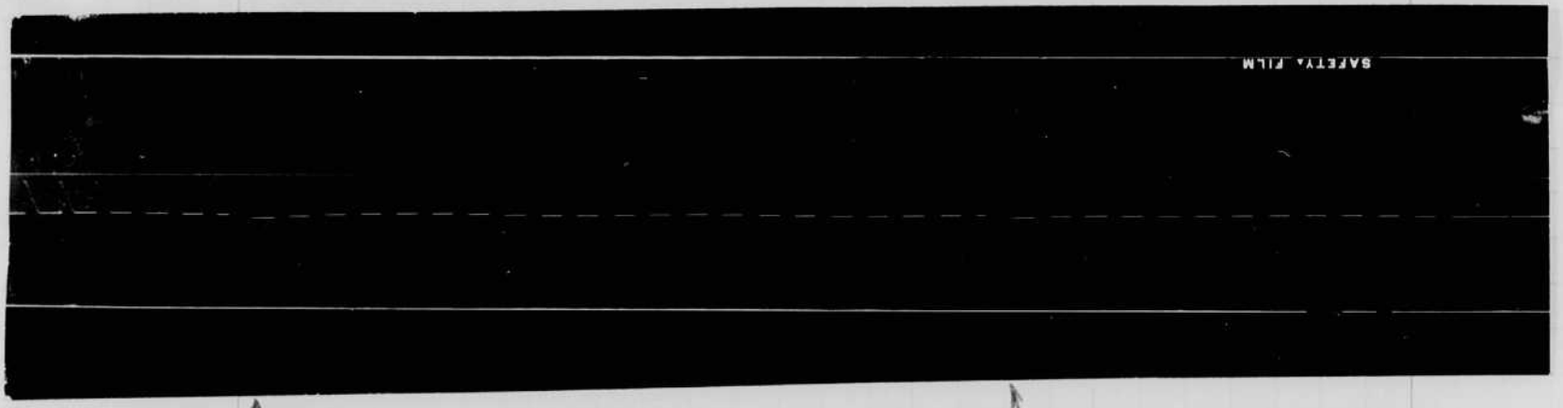
this voltage was measured to ground with a cathode ray oscillograph.

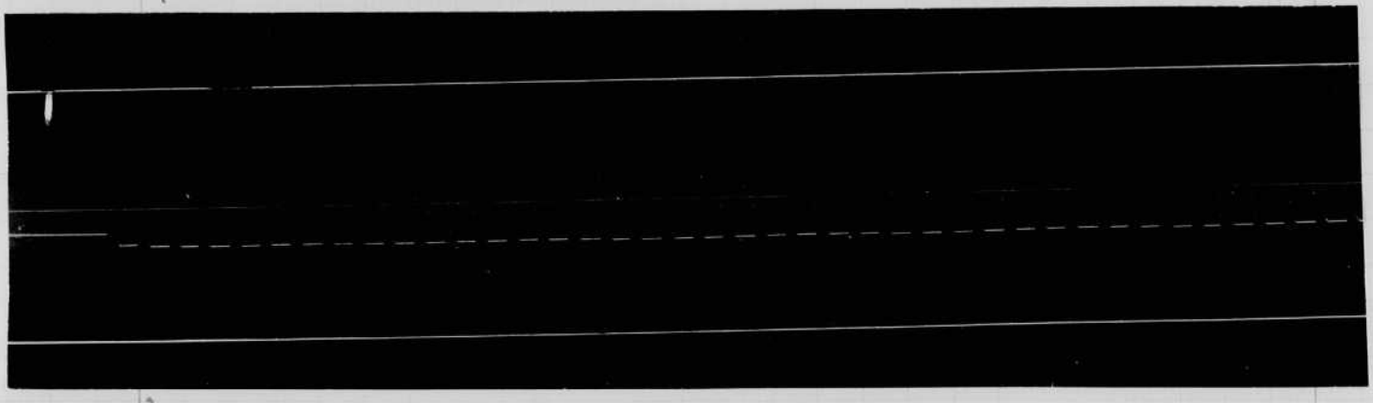
C.R. osc shows a violent surge here which comes from the thyratron. Energy is fed into the 655 and causes a glow to ground from the cathode, burning out the filament. Aug 28.

with a frequency of 10 megacycles ±.
Below are a few oscillograms of the plate voltage again at high.

TIME →

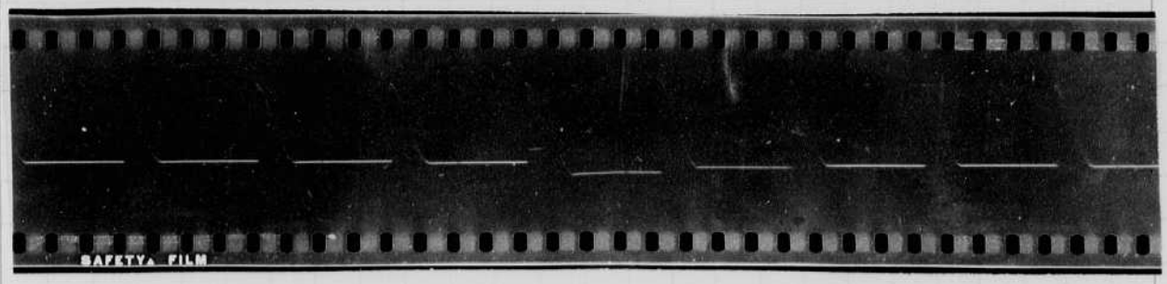


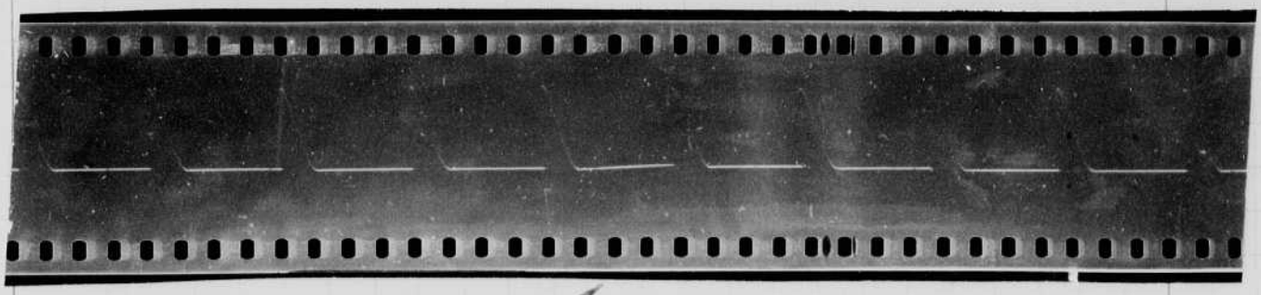




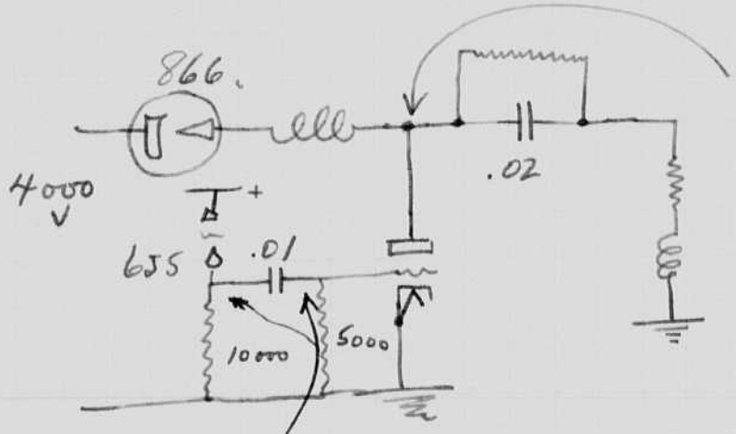
↑ transient buildup

Double line





note change in leakage
~~one~~ on one change.



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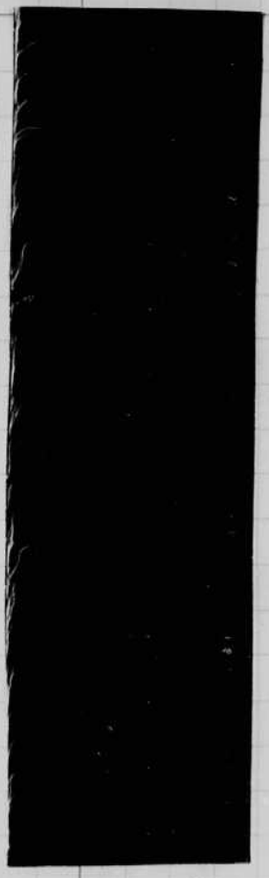
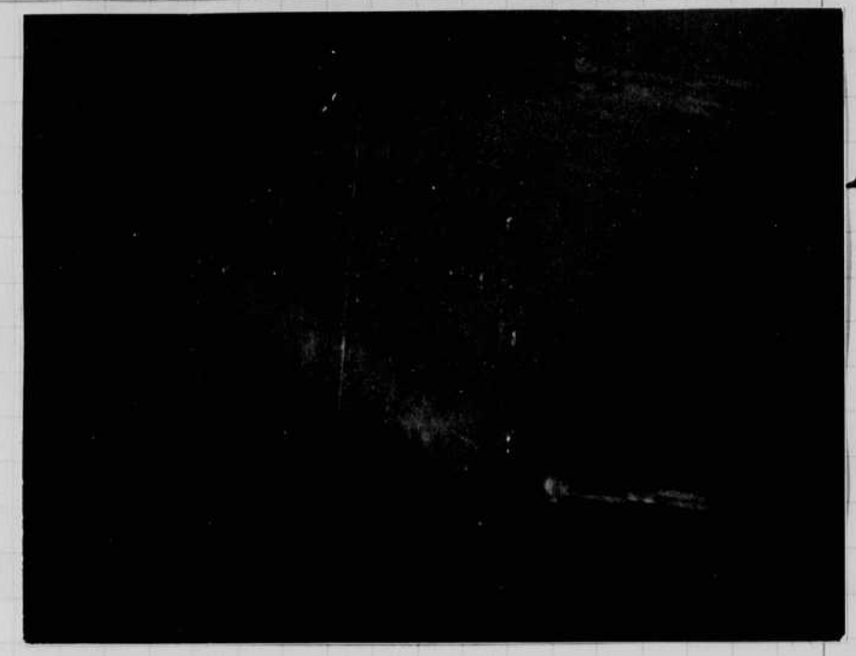
Aug 28.





water surface

1000 frames per second
under water photo of
1/4 st model.

30 lamps were operating
in synchronism.

24 lamps.
6.5 amps
3200 V.

Troubles with movie equip

3600 – 0.4 amps.

1. Amp. 6J5 tubes blow out cathode
   Show visual glow

2. Wire on side of socket strikes ground – lights up tungsten filament in tube bottom,
   Causes shipping!!
   Cut wire shorter.

3. A .0005 condenser prevents self firing or one set if connected grid – cathode of thyratron. a 500 volt ~~paper~~ mica condenser shorted after three bursts.

4. Condenser (main) broke down to case? in one set.

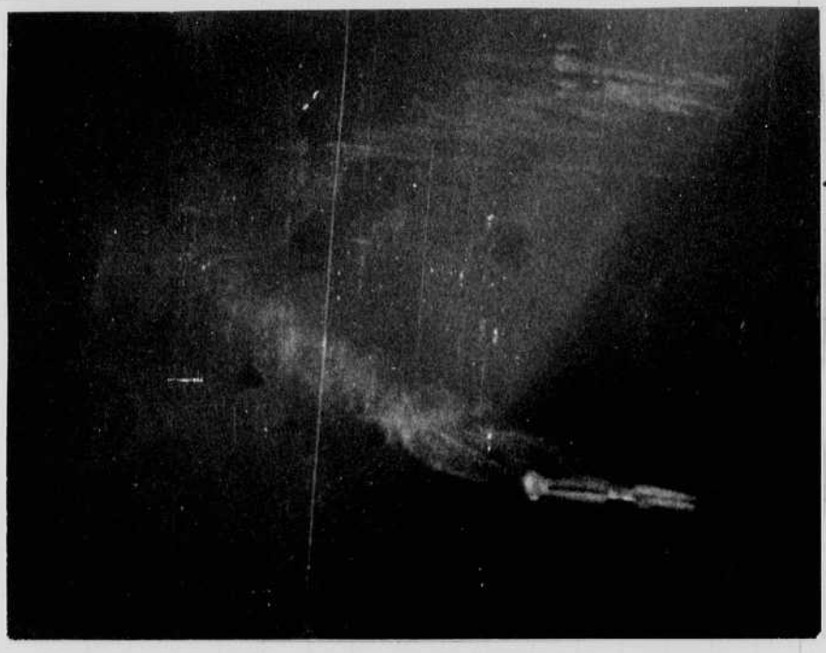
5. Faulty 866 rectifier tube.

6. Shorted cable, causes fuses to blow.

7. 700 ohm resistors changed to 5000.

8. Open 100 ohm resistor causes fuse to blow

A string of 40 60 watt lamps was put across the 4000 volt supply as a bleeder.



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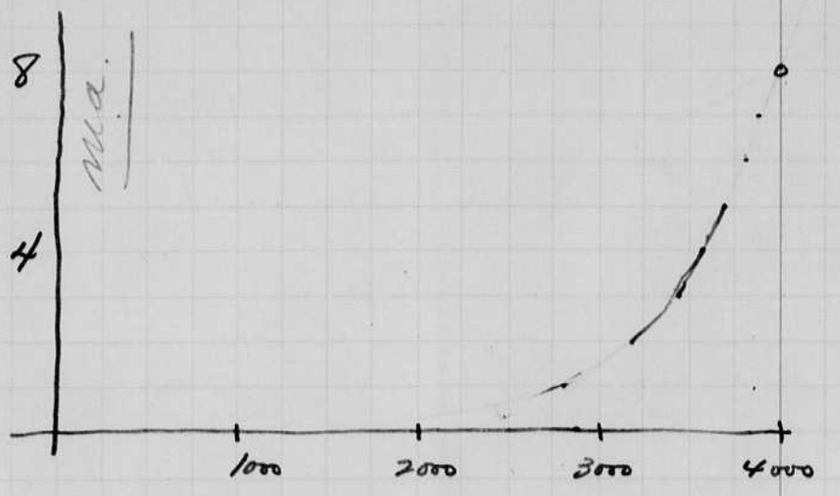
Aug 28 1945
Harold Edgerton.

Test of Thyrite

V volts.	I ma
2800	1
3150	2
3400	3
3580	4
3720	5
3830	6
3920	7
4000	8



3 Thyrite discs cat 388038 in series.
3" diam 3/4" thick 1 3/8" hole.

10° rise of temp in 1 minute with sawtooth voltage.

Rated: 5 - 17 ma 4000 V DC at 20 - 30 °C

Aug 29, 1945.
Yesterday Grier and Barstow went to visit the Sprague co. at North Adams concerning condensers for the Kodatron and the portable. It seems that 4000 volts is the best level to operate the condensers.
A long discussion on Aug 27 was held on the portable, the kodatron and other items with the above men, Germeshausen and myself. Some conclusions were:
1 Portable - use conventional 3 electrode lamp at present instead of proposed new two element lamp. Cut down weight, eliminate charger

Aug 31 1945. Took Wm Bob and Mary Lou fishing in the Sudbury river near Wayland yesterday. We caught enough for supper.

Sept 5 1945
Harold Edgerton.

Tried G.R. model exposure meter on Sept 3 and 5. with Sinclair. It did not work so good today. 10^{-9} amp grid current + must [illegible] to explain the drift. 1D-5 and 1D-8 tubes are used.

Another suggested circuit as of Aug. 25, 1942 except with Nottingham's compensation scheme.

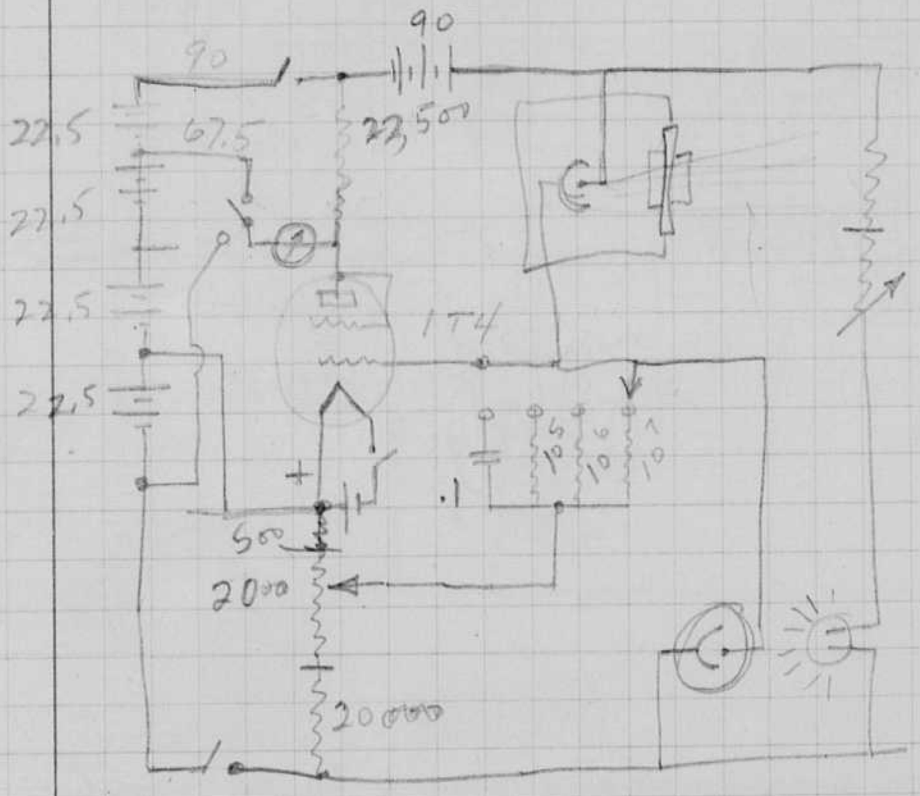
$\frac{45}{1.5 \times 10^{-5}} = 30 \times 10^{-5}$

$\frac{1.0}{0.8\,ma}$

$\frac{22.5}{R} = .001$

$R = \frac{22.5}{.001}$

$= 22,500$ ohms



1T4 Sm = 750.

3A3 Sm = 1800.

3A3 Sm = 625

1S5 Sm = 1,025

1L4 μ = 14.

1E4G μ = 8.

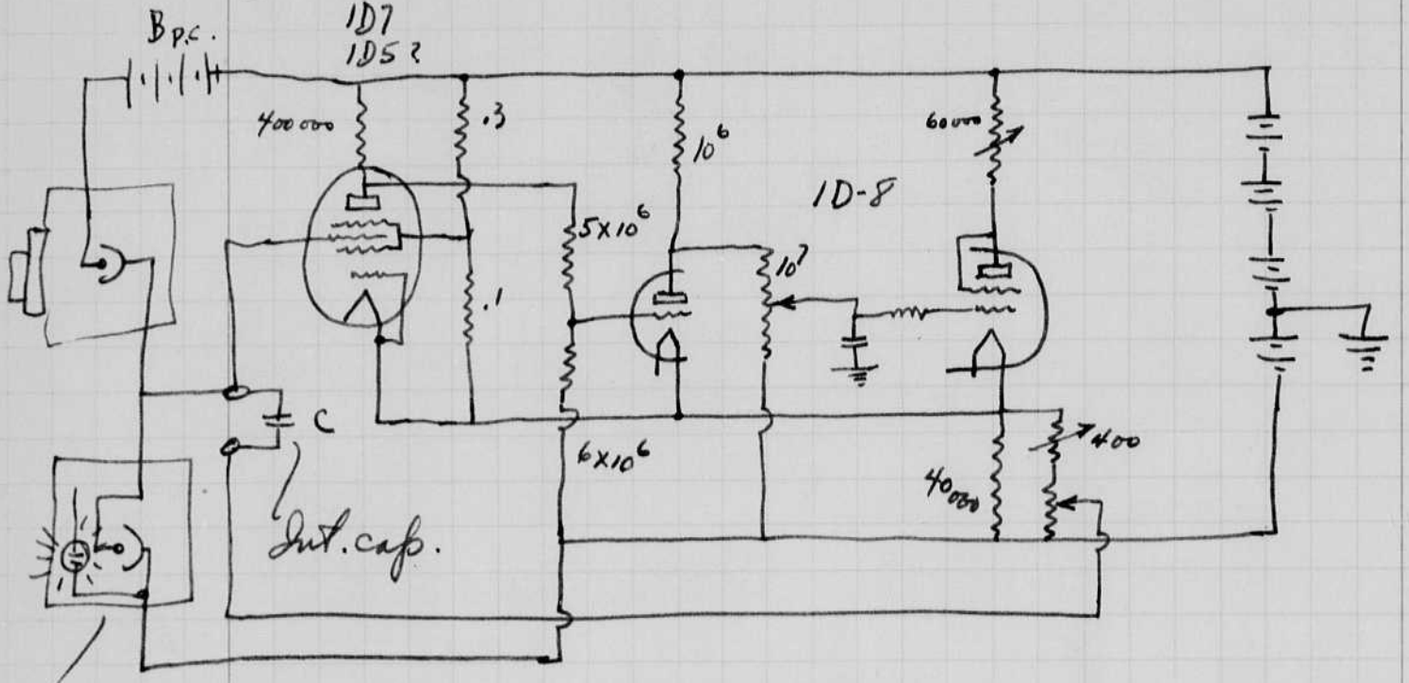
Doubt triode 1G4G

In the GR amp the over all Sm = $\frac{.0002 \text{ amp}}{0.1 \text{ volts}}$ = 2000 umhos.

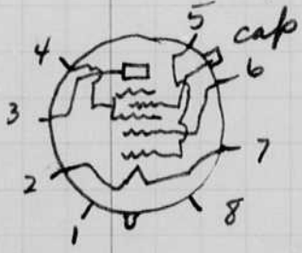
Sept 8 1945 MIT
H E Edgerton.

Exp. Meter circuit.

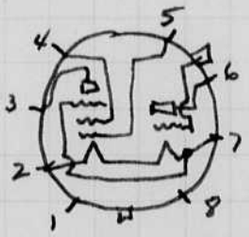
Circuit as wired by Powers of B.R. and Sinclair



Compensating lamp on 1.5 volt circuit. Incandescent.



1D7G.



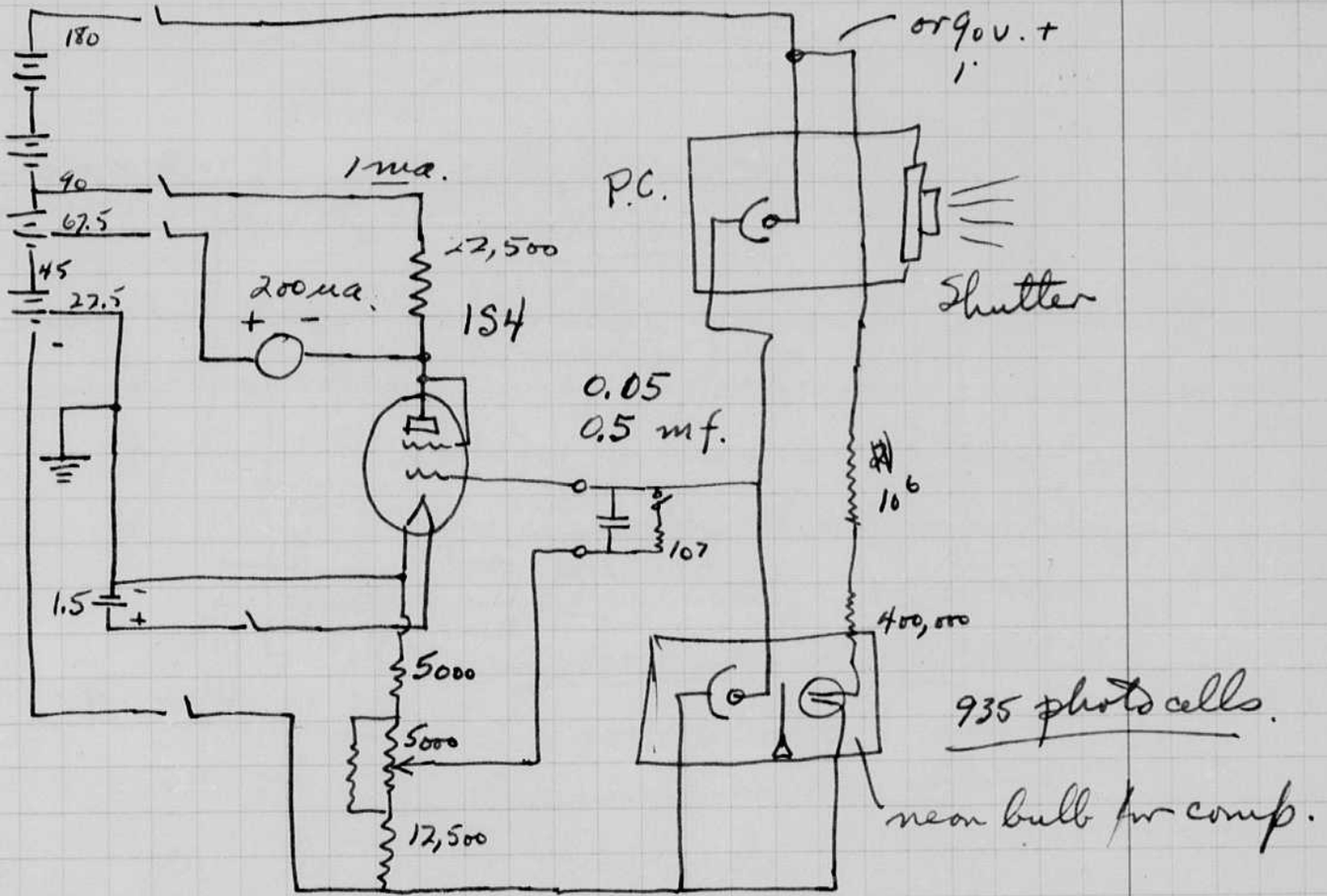
1D-8.

The $B_{P.C.}$ battery was varied from 0 to 90 volts when tested with the microflash. The equipment was not linear for these short flashes.

An integrating capacity of .01 mf was used for experimentation. One test showed leakage of 10^{-8} amps. There was not sufficient compensation to correct it. The current evidently was in the grid circuit since it persisted when all other wires and connections were eliminated. It could

also have been in the condenser.

On the 6th I mixed up the following



Tube grid currents = +48 and +75 units

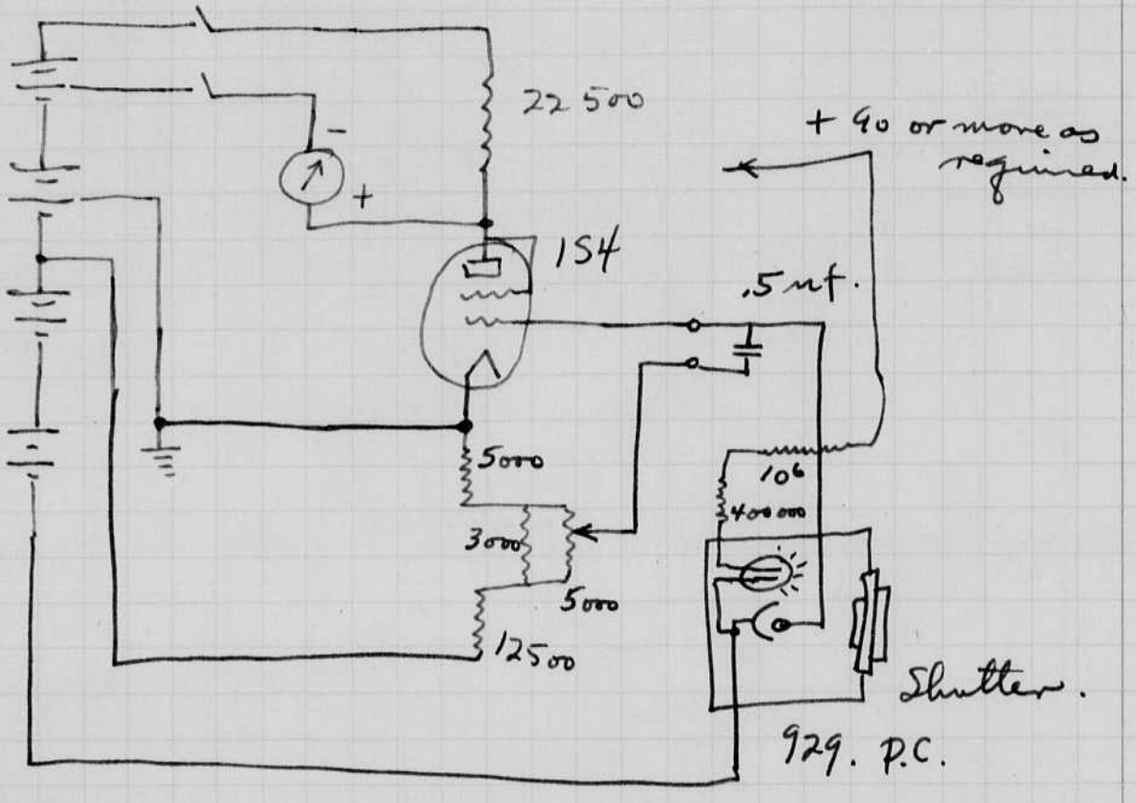
P.C. (upper) leakage = +35 units.

P.C. lower comp. ±60 units.

One P.C. had a large leakage.

Note that the grid current and P.C. leakage add. Therefore the compensation must allow for the sum!

The circuit was changed to the following in order to let the grid current and the p.c. leakage current tend to cancel each other.



compensation only adds to the leakage of the photo electric all current. Therefore the triode must have ample grid current.

Conf with Boone. Sept 18, 1945.

Studio 6 months.
Two lights important.
Possible double outlet on std unit.
External —
Condenser better safety factor.
less light. 5/8 to 7/8

Item 3 Variable capacity. not important
(a) Two bottoms with different capacity.
(b) Double bottom with connector
(c) Plug in variety with short circuiting relay and discharge resistor.
1. Photographer can change at will
2. Modify unit with addition.
3. Purchase different units..

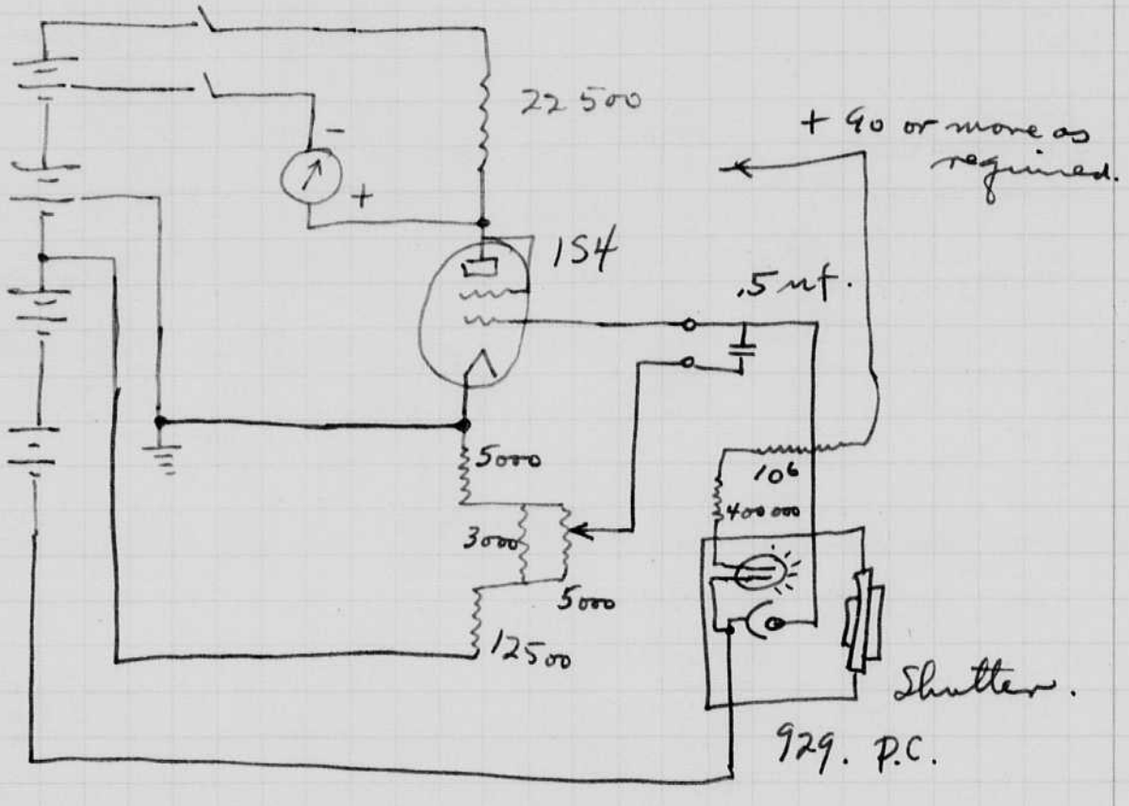
Will do — 1. new condenser.
2. Double connection.
3. More coils.
4. new Lamp.

E.K. will d 4, 5, 6, of spec.

Portable — 1. covering angle (50°).
2. Rate of charging . 6-8 sec.
3. Reduce to minimum weight.
4. 50-75 flashes. 10^{-4} sec. flash.
5. Possible lock of plug. Case for camera and lamp.

ans from E.K.

The circuit was changed to the following in order to let the grid current and the p.c. leakage current tend to cancell each other.



compensation only adds to the leakage of the photo electric all current. Therefore the triods must have ample grid current.

Conf with Boone. Sept 18, 1945.

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Item 3 Variable capacity. not important
(a) Two bottoms with different capacity.
(b) Double bottom with connector
(c) Plug in variety with short circuiting relay and discharge resistor.
1. Photographer can change at will
2. Modify unit with addition
3. Purchase different units.

Will do — 1. new condenser.
2. Double connection.
3. Move cap.
4. new Lamp.

E.K. will do 4, 5, 6, of spec.

Portable — 1. covering angle (50°).
2. Rate of charging . 6-8 sec.
3. Reduce to minimum weight.
4. 50-75 flashes. 10^{-4} sec. flash.
5. Possible lock of plug. Case for camera and lamp.

✓ ans from E.K.

Sept. 13, 1945.
David Edgerton

Transformer clear from Raytheon.

Open cir.	I	0.1	.2	.25	.35	.4	.5
	V.	3.6	7.1	9	.98		
					.9	.96	11.

Ratio with E.S. voltmeter
V_{prim} = 8 volts.
$V_{sec.}$ = 2700 volts.

Short circuit test I 0.5 .2 $x = \frac{2.8}{.2} = 140\ \Omega$
E 4.8 2.8

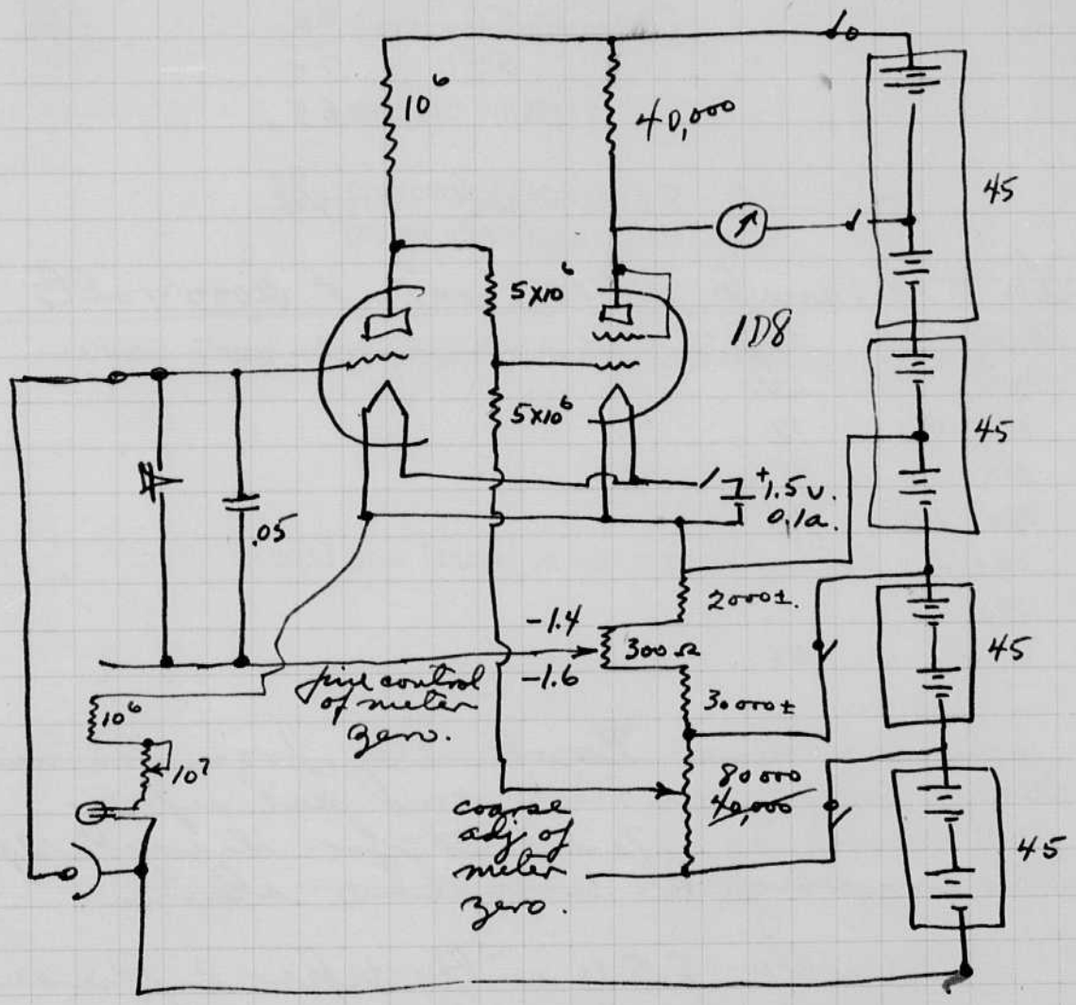
Note large impedance of transformer.

Conclusions from Barstow. study of lamps at different Pressures, length and diams.. at 28 mf, 2000 energy level.
For same light. as present portable.

			Xc.	I.D.
12" glass	4000 V	4.6 mf.	20 cm	
6" Quartz	4000 V	4.15	30+ cm	
4" Quartz	2000 V	16.5	30++	
5" Quartz.	3000 V	7.35	30++.	
2" Quartz. or less.	1000 V	66	30+++	
Portable #15	12" Glass.	2000	28.	7	3.5

Much time was spent last week with P.R. Co. on the photo cell exposure meter. I ended up with a two tube (1D8) circuit which is shown below. The input for a full scale 200 na deflection is 0.1 volt. Grid current initially was 5×10^{-10} amps and it is now about 10^{-11}. Apparently the grid current decreases as the tube ages.

Nottingham's circuit requires 0.4 volts for 100 na on the meter.



Dean Powers of P.R. is working on the circuit shown on page 70. This has degeneration and 10^{-12} amps grid current.

cont.

Tests were made with circuit of page 75/76 with the D.R. microflash. Int. Cap = .05

Voltage on Photo's call # 935	45	90	135
Readings of exposure meter	43	55	63
	45	75	58
	43	73	58
	43	55	62
	50	55	60
		55	73
			65.
	88	125	140.

0.1 mf as filter with 0.1 meg in series.

Test with #14 lamps at 10.5 mf at 2000 volts.

V.	Reading	Cap = .05?
22.5	115	64
45	137-140	77
67.5	180	98
90	190-192	110
115.5	192	113.
135	192	
157.5	194	114

Sept 20, 1945. I was at Amer. Bosch with Ivan Eastman of D.R. yesterday to install and set up 1500 f.p.s. movie equipment for diesel spray photographing. We took three shots.

#1 Silhouette f 5.6 with paper diffuser
Sound recording film

#2 " f 4. " " "

#3 backlighted - negative f 1.9.

P.G. Berman - engineer in charge.

Sept 20. Light Combinator

Notebook # 16

Filming and Separation Record

____ unmounted photograph(s)

____ negative strip(s)

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

was/were filmed where originally located between page 76 and 77.

Item(s) now housed in accompanying folder.

cont.

Tests were made with circuit of page 75/76 with the D.R. microflash. Int. Cap = .05

Voltage on Photo cell # 935	45	90	135
Readings of exposure meter	43	55	63
	45	75	58
	43	73	58
	43	55	62
	50	55	60
		55	73
			65.
	88	125	140.

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Sept 20. Light Combinator 77

Notebook # 16

Filming and Separation Record

____ unmounted photograph(s)

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was/were filmed where originally located between page 76 and 77.

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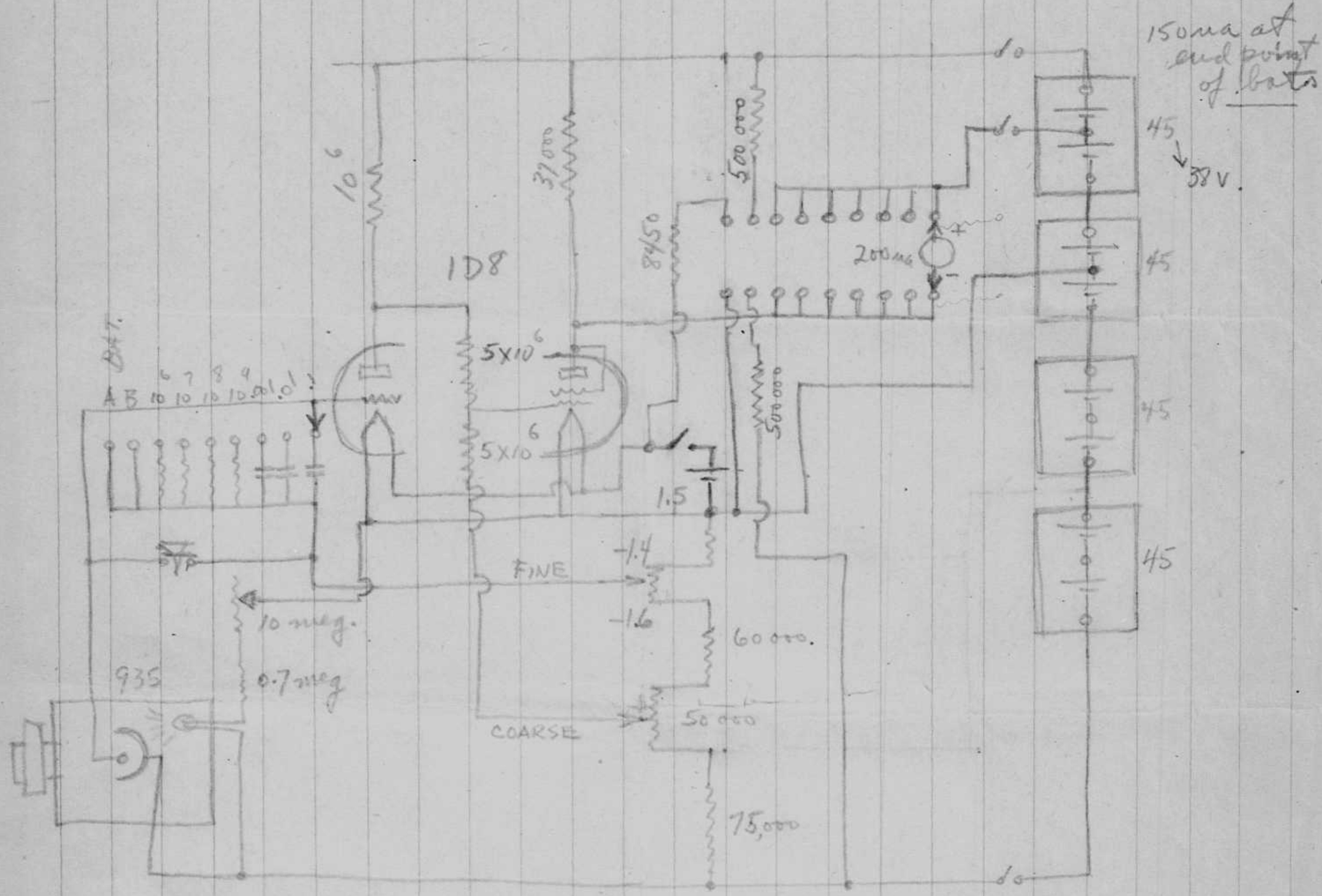
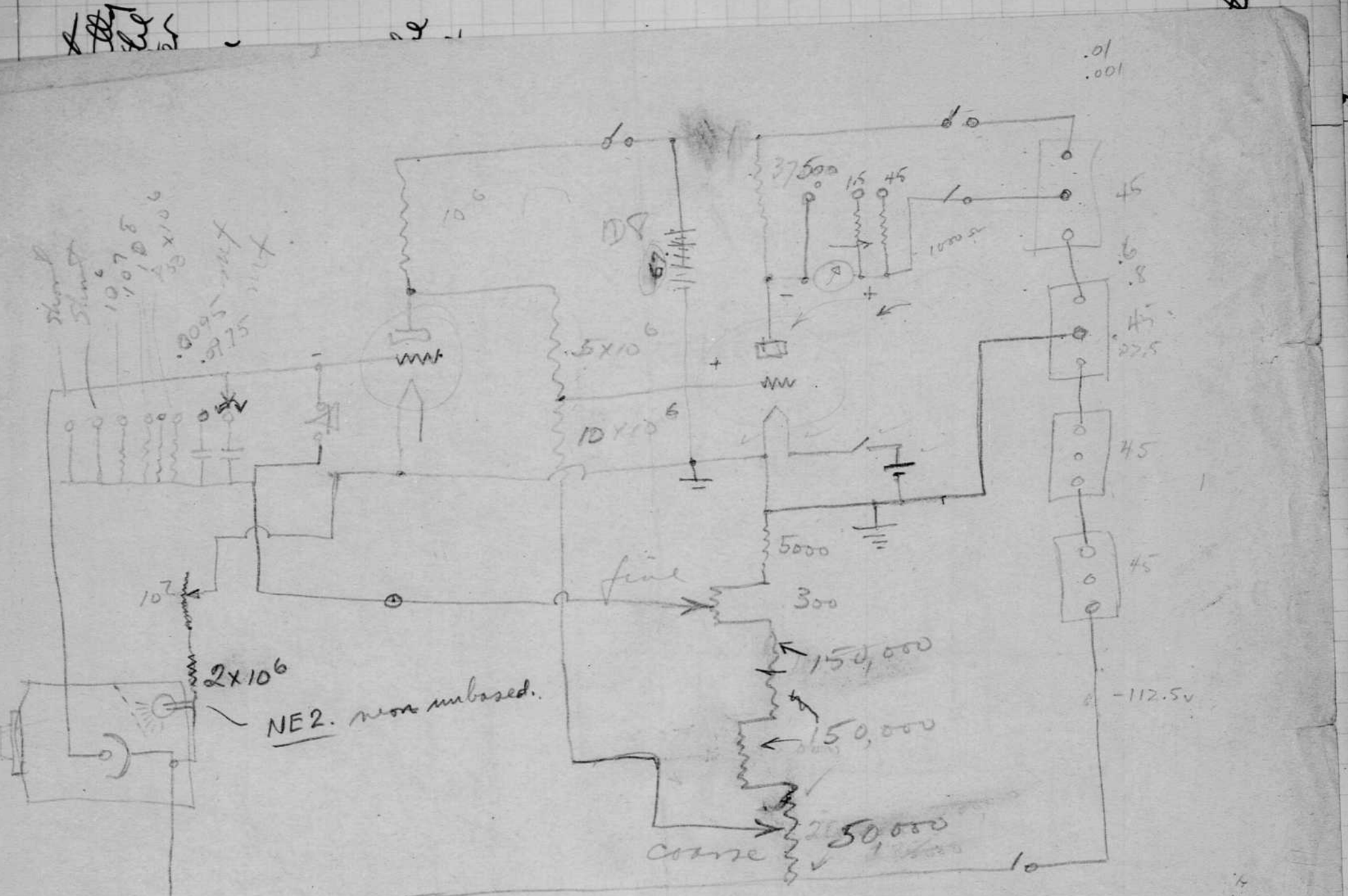


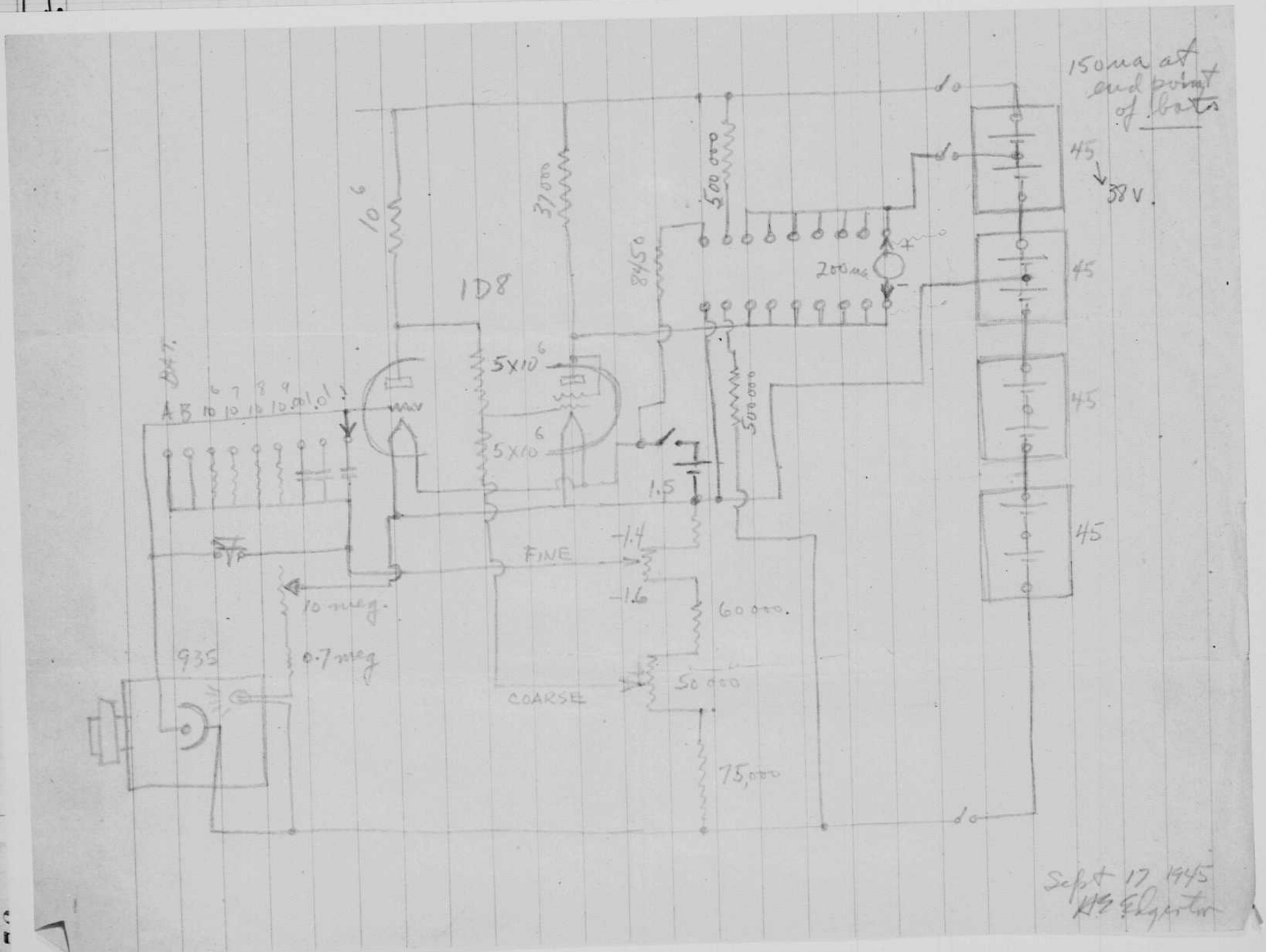
Sept 17 1945
HE Edgerton

77

Light Combat

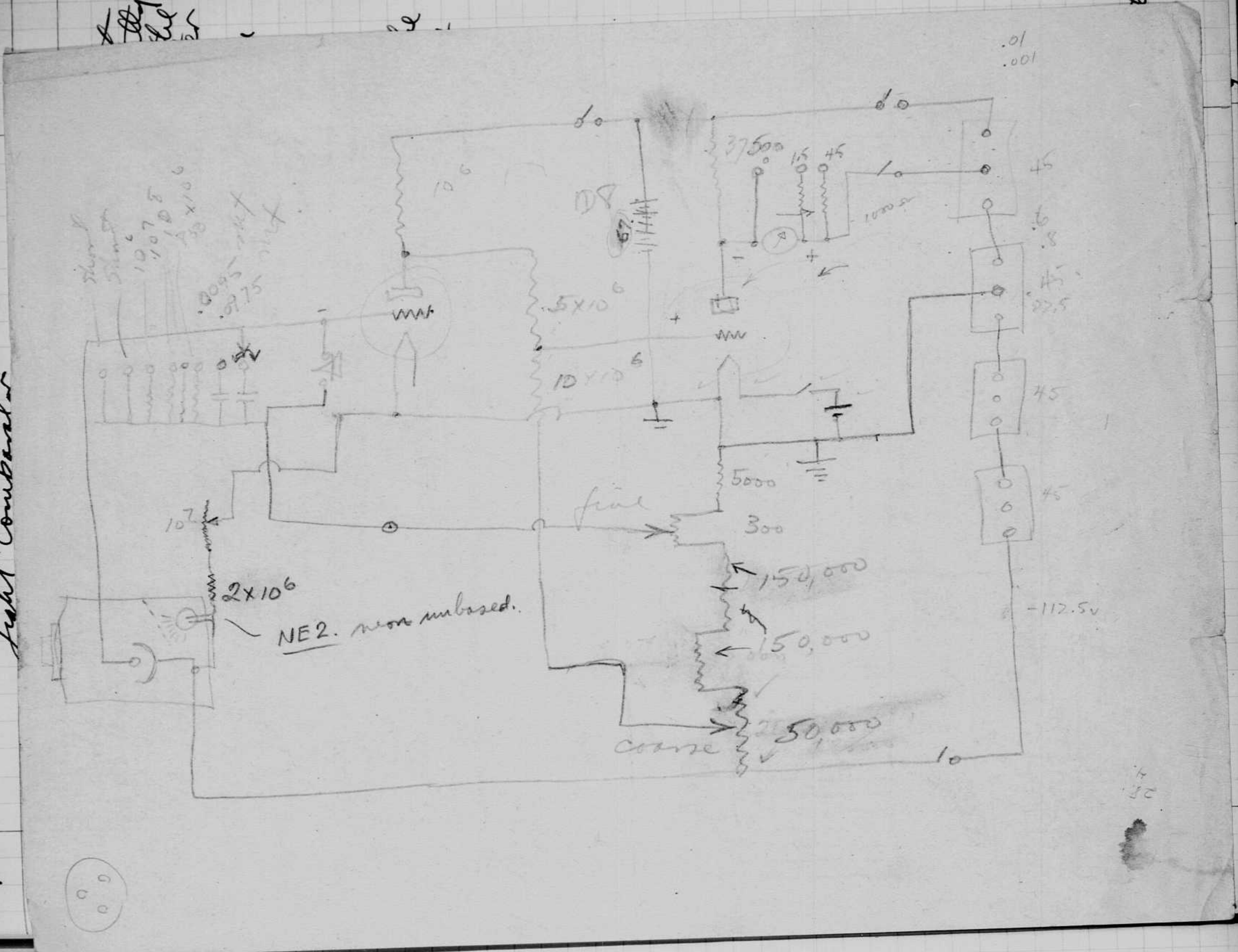
Sept 20.




150ma at end point of batt.
45
45
45
45
45 → 58 V.
10^6
37,000
500,000
200ma
1D8
8450
5X10^6
5X10^6
500,000
1.5
Bat.
A B 10 10 10 10 10 10
FINE
COARSE
-1.4
-1.6
60,000.
50,000
75,000
10 meg.
0.7 meg
935
Sept 17 1945
HS Elgerton

77

Light Comparator

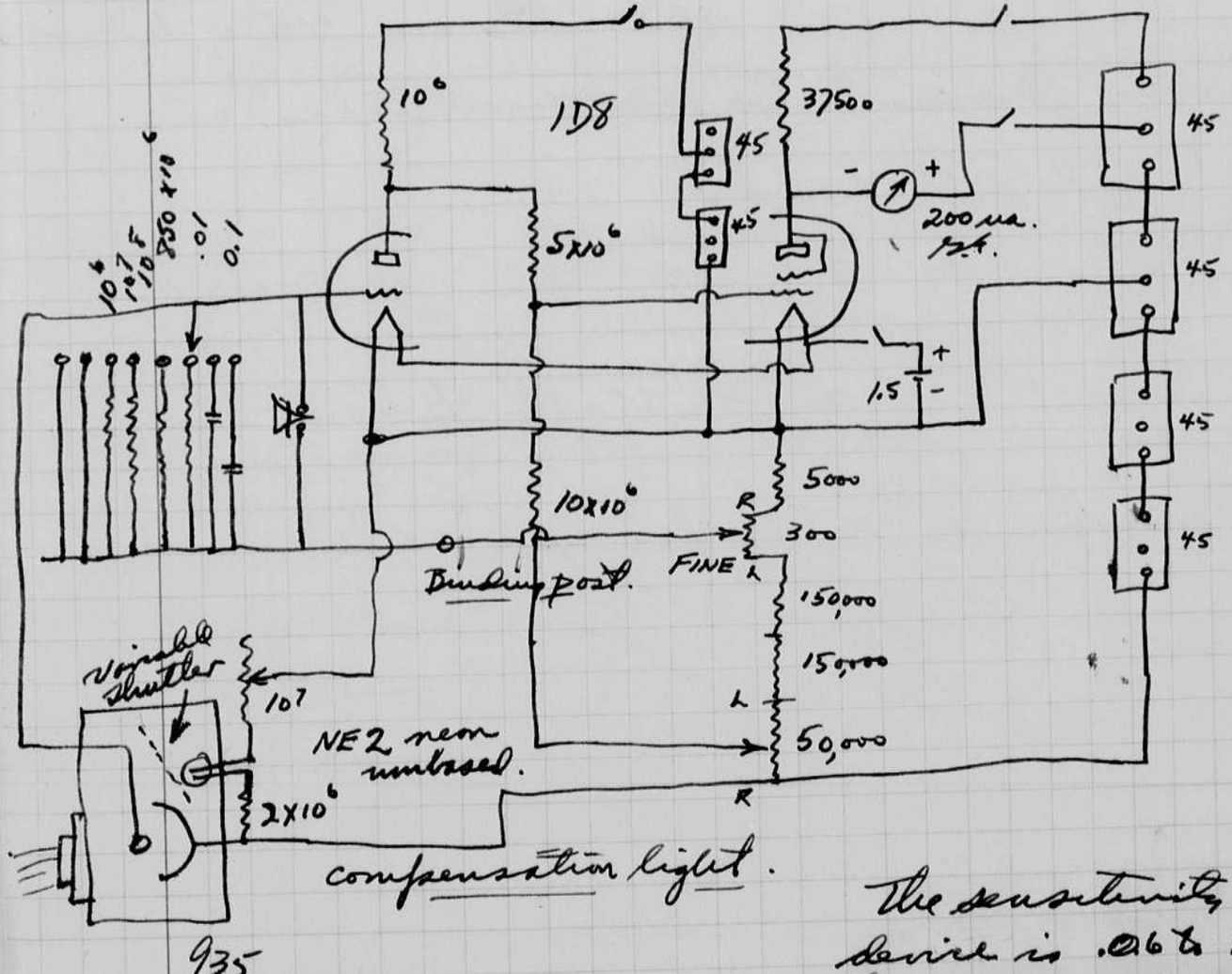


Sept 20.

Light Comparator

The ~~draft~~ drift of the zero after recalling from a deflection was noticed in both the circuit of page 75 and in the circuit of Powers. Apparently the current in the battery or the plate of the output pentode changes when the meter deflects. This change of voltage is coupled into the input grid. after the instrument returns to it initial state the battery continues with the old stable voltage for 10 seconds or more before ~~fadding~~ fading to its new value.

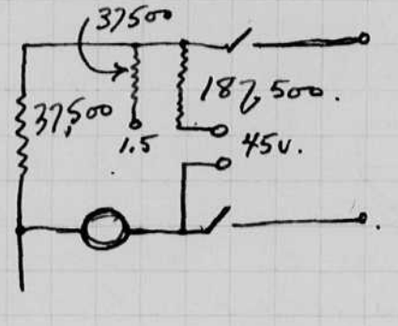
Powers put in a separate battery on the triode. This almost eliminated the trouble. I installed a 67.5 battery in my unit to accomplish the same result.



The sensitivity of the device is .06 to 0.07 volts for 200 ua output.

H.S. Dyer

There should be some method of checking the batteries of the comparator. One method would be to bring out the leads of the meter and a resistance so that it could be used to measure voltage. For example:



$$\frac{45\text{ v}}{.200 \times 10^{-3}\text{ amp}} = 225{,}000.\text{ ohms.}$$

$$\begin{array}{r} 225{,}000 \\ 37{,}500 \\ \hline 187{,}500 \end{array}$$

$$\frac{1.5}{.2 \times 10^{-3}} = \begin{array}{r} 75.000 \\ 37{,}500 \\ \hline 37{,}500 \end{array}$$

this gives full scale with 45 volts or 45 or 1.5 volts.

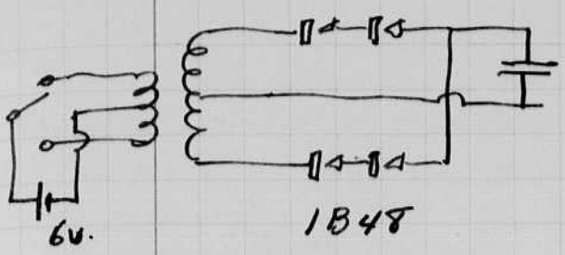
These are grid currents of several tubes.

Initial after 1 min.

-5	-2
-4	-1.5
-3	-1.5
-10	-6 — 5.5 after 1/2 hour.
-3	-1.5

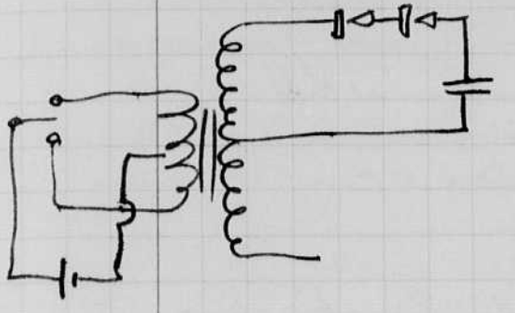
1 division = 10^{-11} amps approx.

Portable Power supply test of Sept 18 with McRobert.



8 amps meter → 0.8 amp.
2½ sec. to 2000 volts.
final 2200 volts.

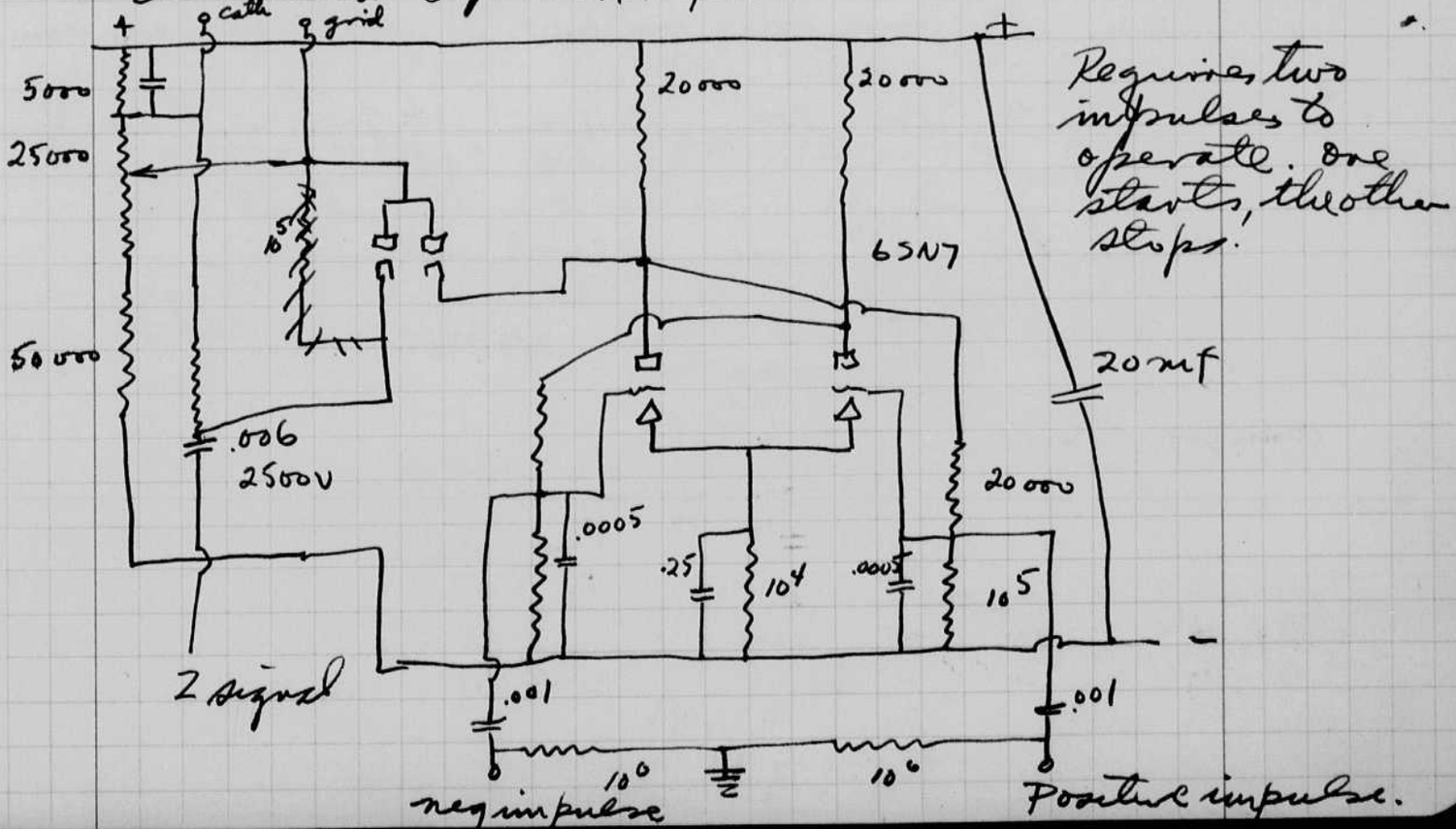
Half wave with half the transformer



3½ seconds charging time.
2 glow tubes used.
7½ amps → 0.65 amp.
final volts 2200 volts.

Half wave – entire transformer gives 4500 volts.
4 glow tubes.

Sept 24 1945 Beam Blanking Circuit – Richter Allis Chalmers.
Electronics. Sept. 1944. p130



Requires two impulses to operate. One starts, the other stops.

Sept. 24, 1945 MIT

Harold E Edgerton.

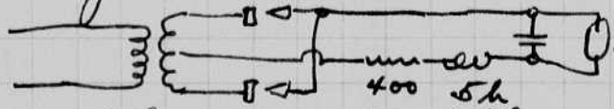
Barstow and McRoberts have been experimenting with flash tubes the past few weeks. The last results were directed to low voltage, 500 or 1000. At 1000 volts a 2" tube of the 4 mm diam. of quartz showed a decided peak. The pressure of xenon in this series of tubes was about 50 cm.

Each tube was tested for light output vs pressure the curves showed a broad maxima of light at 30 to 60 cm of xenon.

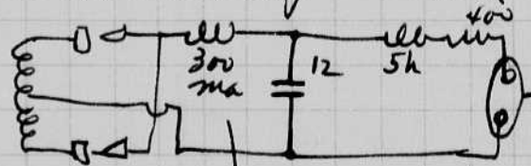
Tests were started today on 48 cycle lamps for use as a movie source.

Tube no.	R	C	V	Comments.
				2880 fpm = 48 cycles.
#24	4½ turn	400	2	2000 holdover and misses 50V
"	"	"	"	" ok = with 5h in series. * Blower
"	2½ "	"	"	" H.O. " " no. "
"	3½ "	"	"	" no. H.O. " misses some."
#24	4½ "	400	12	2000 2700 fpm ok for 12 sec then misses.
				anode & cathode dull red heat.
	"	"	"	" Ok with air blast 50 V.
	4½	400	12	2000 2880 ok with lots of air.

Circuit for above.



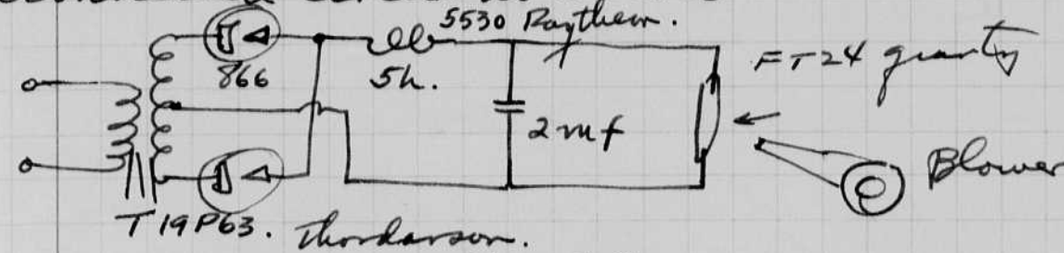
Changes of ~~the~~ circuit to follow.



24	4½	400	2	2000	5 henry choke irregular op
"	"	"	"	"	0 " holdover continuous.

T 15637.

Oscillograph connected to measure ~~entire~~ transient voltage of condenser. Dumont blue tube 7 meg + .1 meg for voltage divider. Last exp on last page shows oscillation of condenser voltage due to charge cycle. Reconnected circuit as below



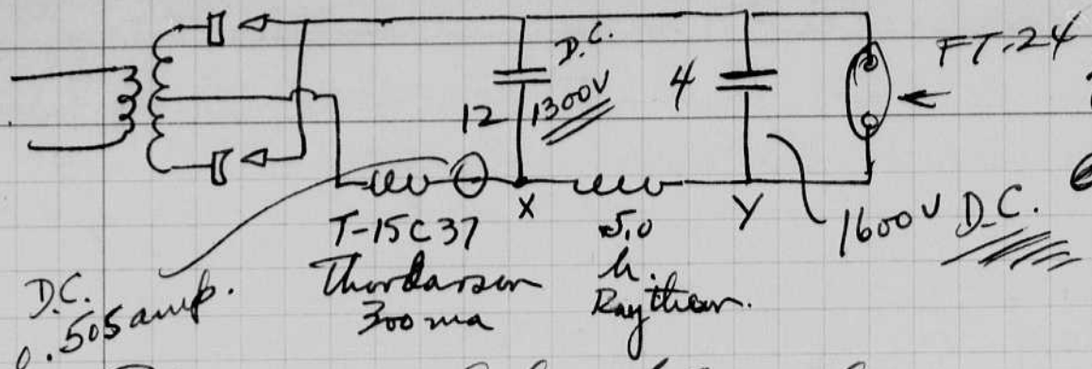
Also will run without blower for more than a minute.

With 4 mf. the variation of the peak charging voltage is more, about 10% total. More air is required for cooling. Anode and cathode both run red hot - with cathode slightly hotter.

With 1 mf the variation of the peak charging voltage was large - about 50%. No air cooling was required. The light variation was objectionable. ~~90 ohms.~~ Another choke, Thordarson 300 ma, was put in series with the 5530 ~~Raytheon~~ 50 ohms. The performance was improved! Operation ok up to 100 cycles before flicker came in. The inductance should be larger still. a 45 h 100 ma R = 200 was tried.

1 mf 45 h (200 ohms) ok up to 4500 c.p.s.
Capacity decreased to 0.5 mf. Works fine up to 120 cycles.

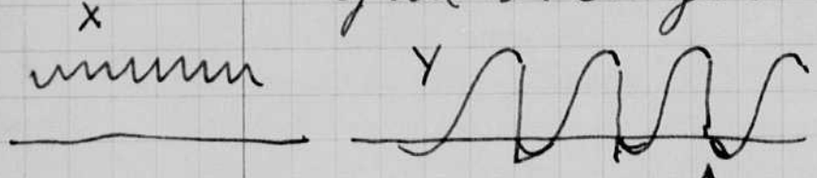
Capacity decreased to 0.1 mf. Holdover
tube ~~then~~ changed to 1½ turn - Holdover
cap " " ~~4~~ 4 mf. " "
tube " " 2½ turn " "
old 4½ turn tube put in as before - operation ok but with variations probably due to overload of choke.
original #5,0 h choke put in, with initial results.



Blower needed at 50 cycles.

Blew 15 amp fuse when operated at slow speed. Light put flash seemed dim since voltage did not rise.

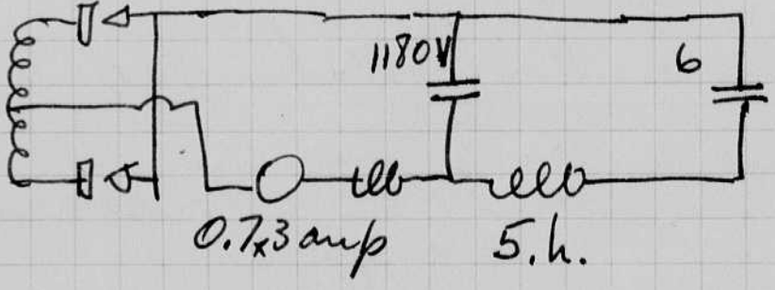
Fuse replaced. at 50 cycles with 4 mf. the oscillograph showed the following variation of the voltage with time.

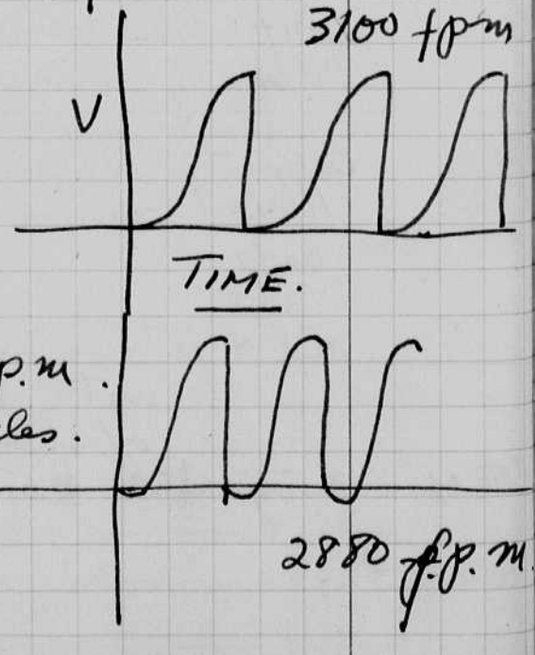


↑ Break where lamp flashes.

Note reverse charge due to initial current in the choke. The current in the choke was actually flowing from the condenser to the power supply at the instant of flash.

Increased discharge capacity to 6 mf.





1320V } at 2880 fp.m.
.66 amp. } 48 cycles.

Capacity increased to 8 mf.

Current = .81 amps at 1200 volts on filter condenser.

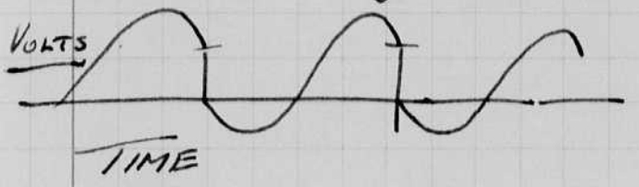
Osc shows freq of secondary charge = 1/2 that of 48 ~.

$$f = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{6.28\sqrt{5\times8\times10^{-6}}} = \frac{1}{6.28\ 6\times10^{-3}} = \frac{1000}{40} = 25 \text{ cycles.}$$

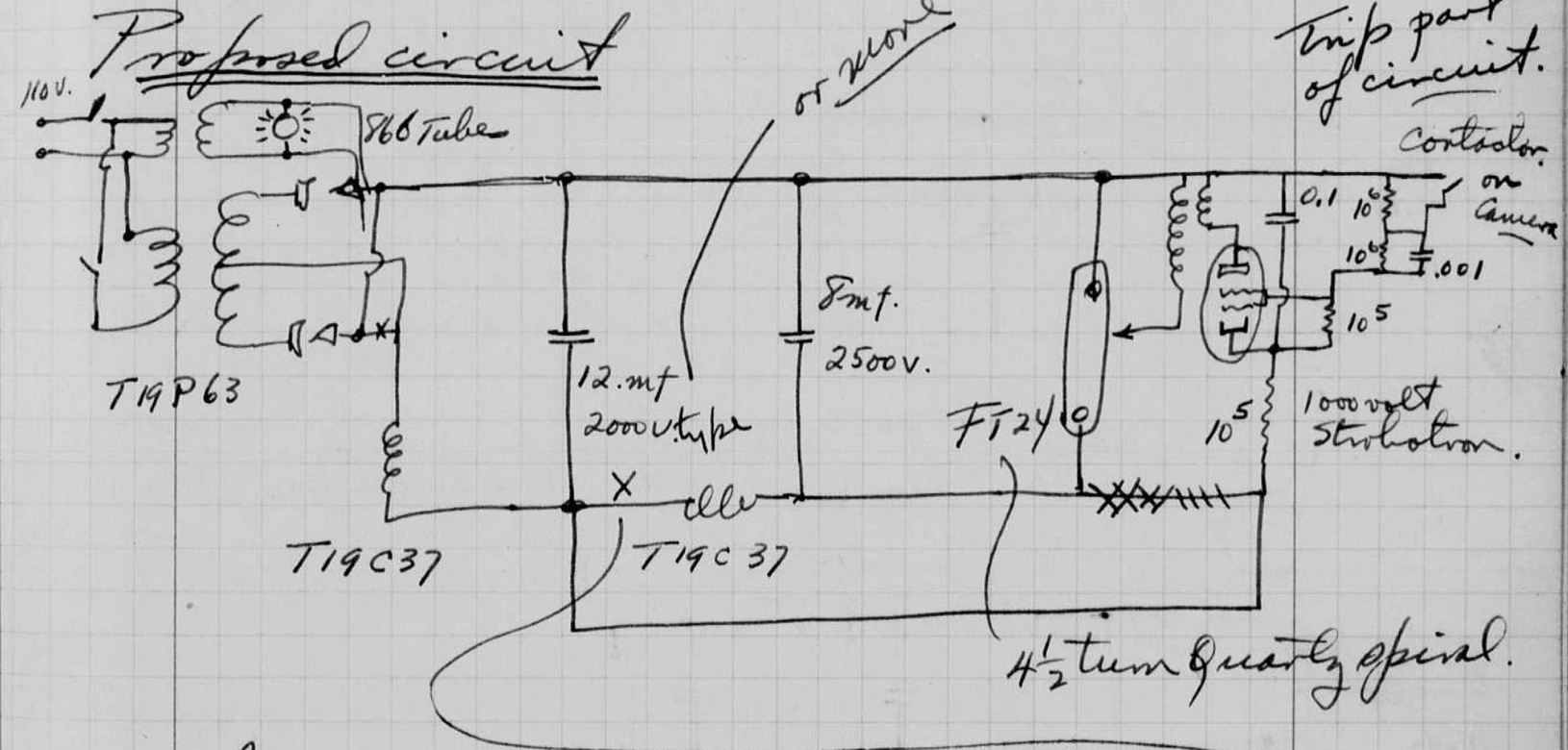
$\frac{1200}{8}$

960.0 watts. or about the rating of the transformer.

A series tube in the charging circuit is not needed except for slow frequency, that is less than 25 cycles. ±



Proposed circuit

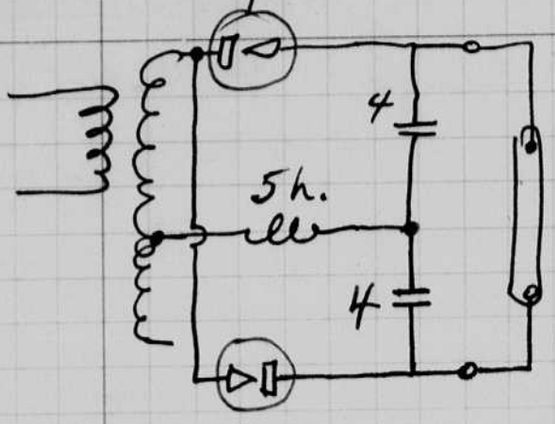


If a series charging tube is used Filament transformer no T19F90 is reqd. 7500 volt test to primary. Insert tube at X

For 96 cycles use 4 mf instead of 8 on lamps.

Sept. 25, 1945 M.I.T.
~~Harold E. Edgerton~~

Voltage Doubler



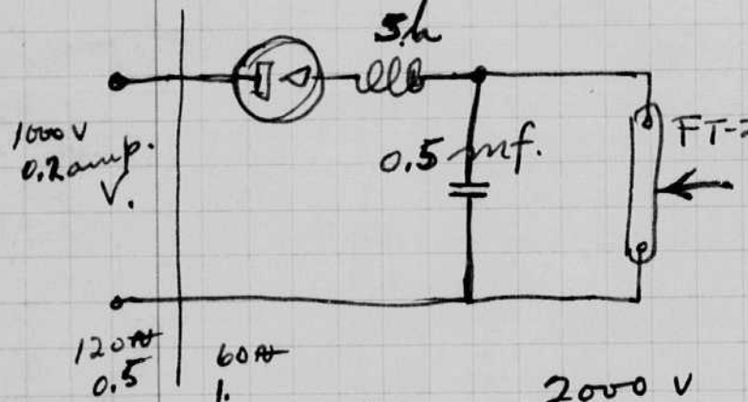
operates o.k. but with slight flicker due to inadequate filtering.

new G.R. Strobolux design.

2000 V 0.5 mf 120 cycles. = $\frac{CE^2}{2} f = 2 \times 120 = 240$ watts.

60 cycle = $\frac{1}{2\pi fC}$ $L = \frac{1}{(2\pi)^2 60^2 C}$ $.5 \times 10^{-6}$

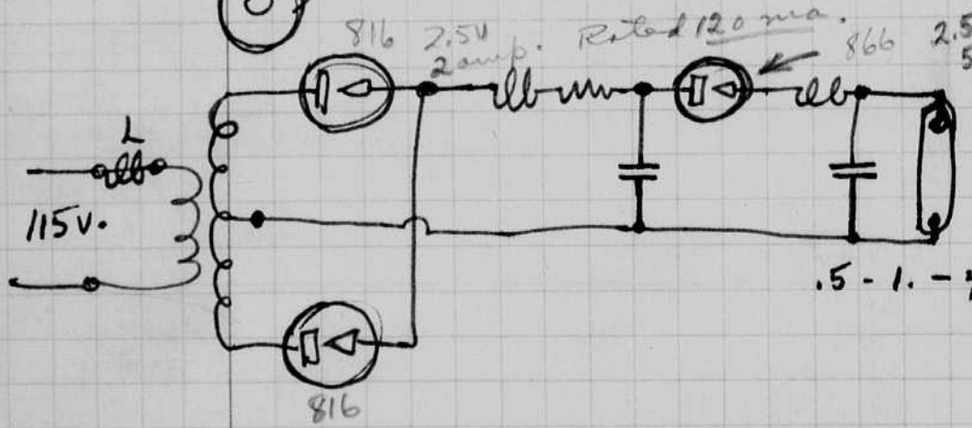
$= \frac{10^6}{39 \cdot 3600 \cdot .5} = \frac{10^6}{71} =$ ~~10.1~~ 14.1 h



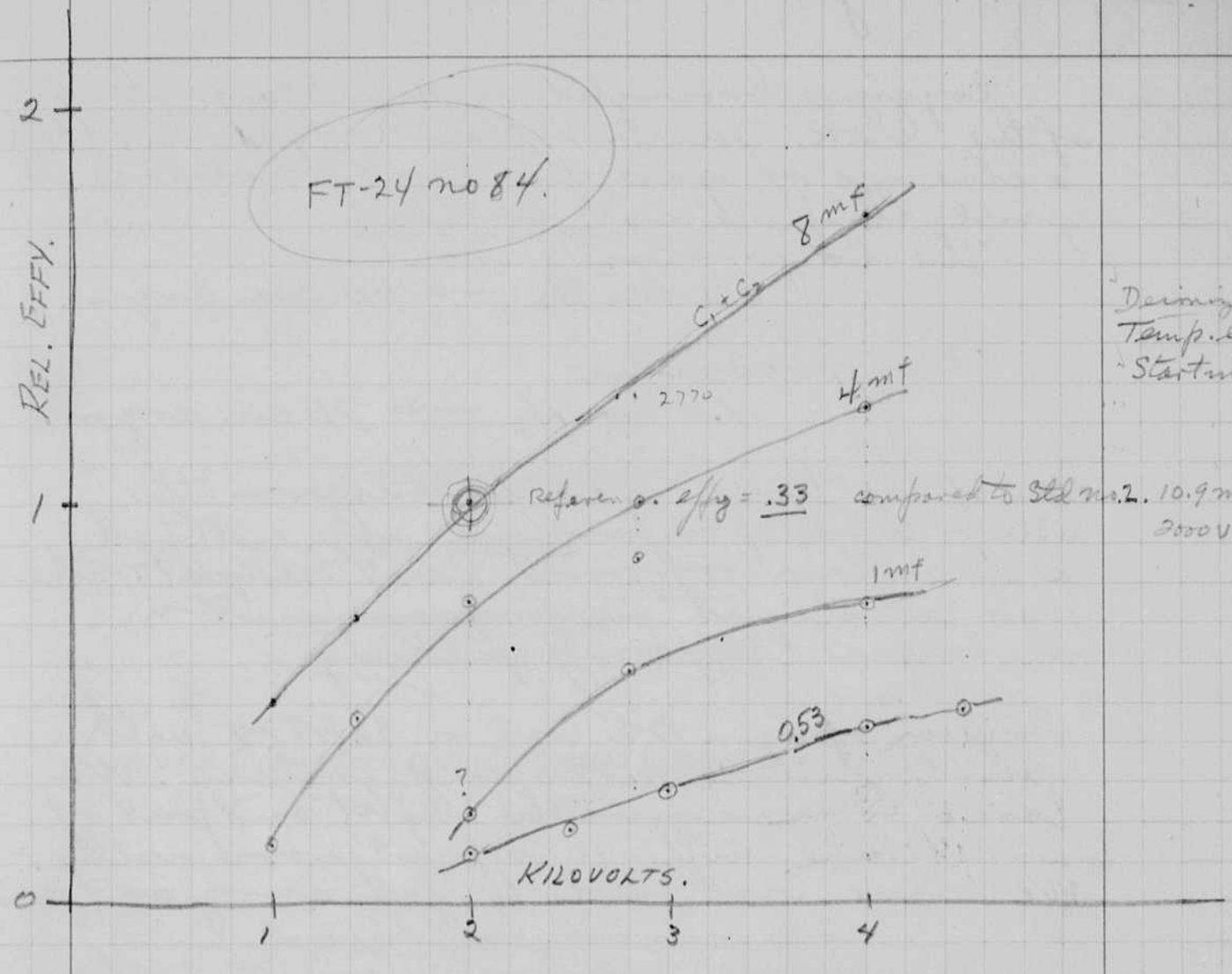
2000 V

.2amp x R = 1000 V R = 5000 ohms.

.5
1.
2.
4.
8.



0 to 5000 volts



Jump Research

current (or current density)
Voltage gradient.
Energy per unit volume.
Pressure
Length
Diameter.

Hold constant - for similar output per unit length.

Initial gradient - volts per cm

Energy per unit length.

Sept 28 1945 MIT
Harold E Edgerton. Microflash tubes.

Coyginis brought in 4 tubes yesterday of the G.R. microflash type with a change of gas content, which I give him last week.

The old pressure was
0.2 cm H_2 → 40 cm argon

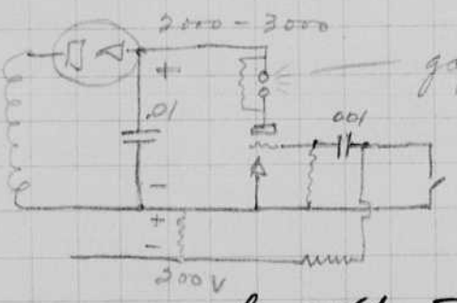
New pressure
1.0 cm H_2 → 75 cm argon.

One of the tubes was a leaker – the other three preformed ok. It took a duration record last night. There was a slight improvement in the new type of filling.

Simpson of Lynn G.E. was in Sept 28 with photoelectric cells and meters. We tried to measure the light output of a #1 tube with 10 mf at 2000 volts. We were not able to get any output.

Suggested stroboscope for Lewis tunnel propeller under water. Johnsonsen suggests 3C45

600 hrs. 40 amp peaks
200 hrs 50 " "



Oct. 2, 1945. Conf. with Sinclair and Wilkins yesterday on Photocell meter. G.R. will build up model with 3 tube circuit for experimental use.

Obtained 5 additional 935 photocells from Nottingham. Of these and two other tubes the leakage currents were as follows. All $\times 10^{-11}$ with 100 volts.

4 60 30 8 ~~8~~ >3 21 6
✓ ✓ ✓

Only 3 which are ✓ could be used with

Notebook # 16

Filming and Separation Record

___ unmounted photograph(s)

2 negative strip(s)

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

was/were filmed where originally located between page 86 and 87.

Item(s) now housed in accompanying folder.

Sept 28 1945 MIT
Harold E Edgerton. Microflash tubes.

Coggins brought in 4 tubes yesterday of the G.R. microflash type with a change of gas content, which I give high last week.

The old pressure was
0.2 cm H_2 → 40 cm argon

New pressure
1.0 cm H_2 → 75 cm argon.

One of the tubes was a leaker – the other three preformed o.k. I took a duralin record last night. There was a slight improvement in the new type of filling.

Simpson of Lynn G.E. was in Sept 28 with photoelectric cells and meters. We tried to measure the light output of a #1 tube with 10 mf at 2000 volts. We were not able to get any output.

Suggested Stroboscope for Swiss tunnel propeller under water. Edgerton suggests 3C45

600 cps. 40 amp peaks
200 " 50 " "

gas fill argon or Xenon.

Oct. 2, 1945. Conf. with Sinclair and Wilkins yesterday on Photocell meter. G.R. will build up model with 3 tube circuit for experimental use.

Obtained 5 additional 935 photocells from Nottingham. Of these and two other tubes the ~~F~~ leakage currents were as follows. All x 10^{-11} with 100 volts.

4 60 30 8 ~~3~~ >3 21 6
✓ ✓ ✓

Only 3 which at ✓ could be used with

Notebook # 16

Filming and Separation Record

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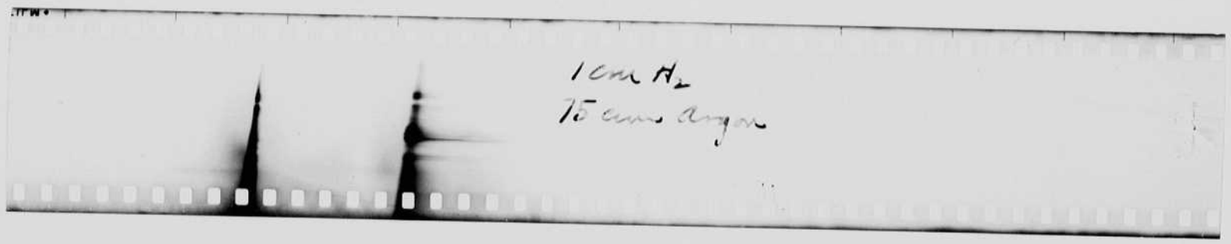
MIRR FLASH.


1 cm H₂
75 cms argon

T.D.d 28 1945 MIT

could be used with

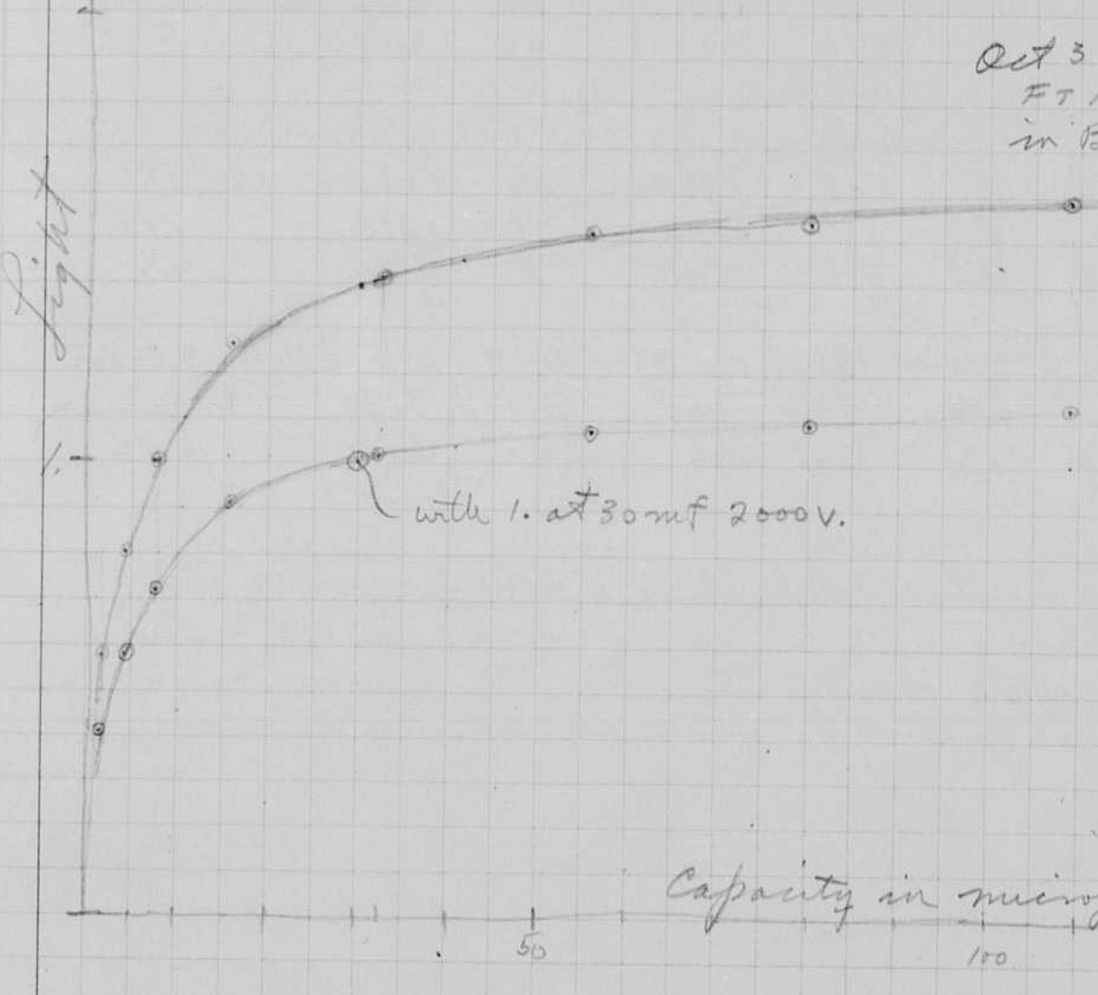
a 1D8 which had a grid current of -4.5×10^{-11} amps.
two other 1D8 tubes had

$I_g = 9 \times 10^{-11}$ in dark.
20×10^{-11} in light

$I_g = 90 \times 10^{-11}$ in dark or light.

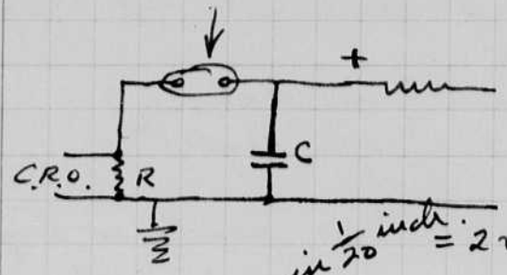
Nolting wrote Ulrey RCA Lancaster Pa today concerning 3 photocells with S1 S3 and S4 surface.

Oct 3 1945 data on FT 14 no N-1 in Blue data Books.



Oct. 4, 1945 M.I.T.
Harold E. Edgerton Peak-current measurement.
FT-14.

V = 2000. rated tube N-1
FT-14.



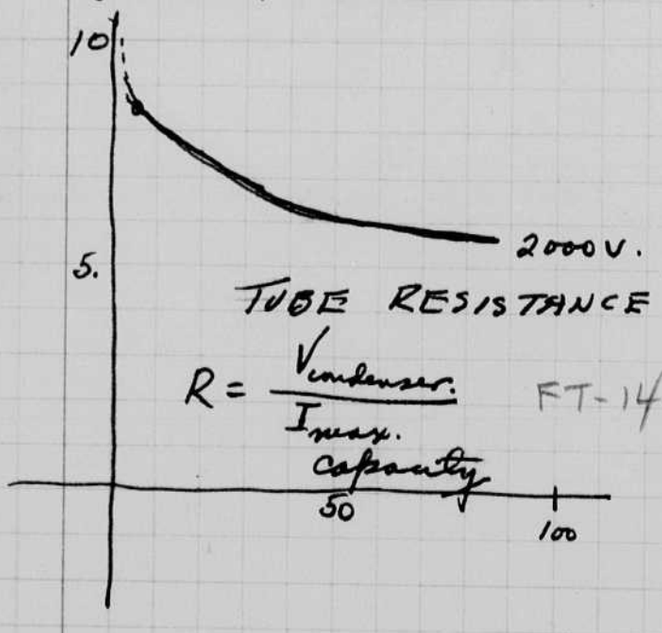
28 mf capacity.

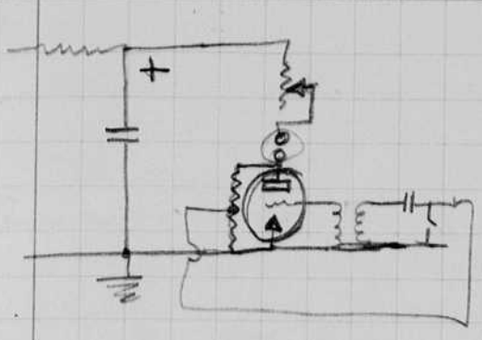
1/20 inch = 2 volts.

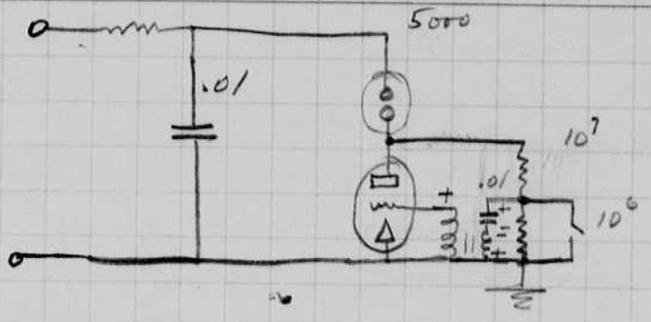
	C	V_c	V_{CR} mm.	V_{CR}.	I	V_{CR}	$\frac{V_{CR}}{.076} = I_{max}$	Tube ohms $\frac{V_{max}}{I_{max}}$
N-1	28.5	2000	13.	20.8	276	26	342.	5.85
	28.5	1500	8	13.	170	16	224	6.70
	28.5	2400	17	27.2	347	34	447	5.35
	28.5	1000	would not flash.					
Ref 2	28.5	2000	13	20.8	276	26	342	5.85
	28.5	1500	8	13.	170	16	210	7.15
	28.5	1000	4.	6.4	84	8	105	9.5
N-1	4.0	2000	8 or 9	13 & 14	170 185	16-18	210-236	9.5-8.5
	41.5	2000	~~13~~ 12	19.2	253	24	315	6.3
	80	2000	13	20.8	276	26.	340	5.85

40 volts per inch. calibration.

~~25~~ R = 0.076 ohms







Oct. 6, 1945
H. E. Lyman.

Hydrogen thyratron 3C45 rated 40 amp. peak.
600 hours.
Cathode 3 sq cm.
15 amp/sq. cm.

Inductance to limit current to 40 amps.
4000 volts .01 mf.

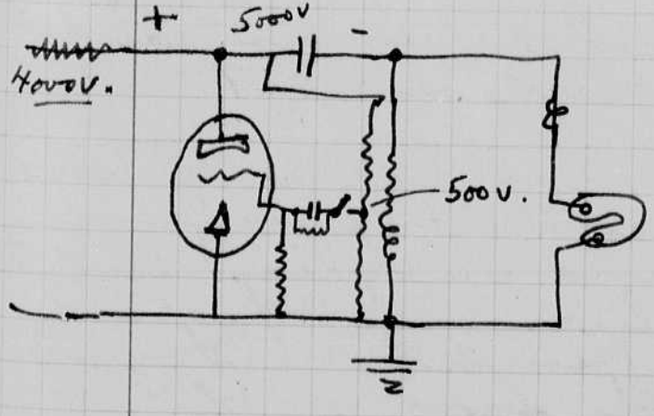
$$I = E\sqrt{\frac{C}{L}} \quad \text{solve for } L = \frac{E^2C}{I^2} = \frac{16\times10^6\ 10^{-8}}{16\times10^2} = 1\times10^{-4} \text{ henries}$$

$$\frac{1}{f} = T = 2\pi\sqrt{LC} = 6.28\sqrt{10^{-4}\ 10^{-8}} = 6.28\times10^{-6} \text{ sec.}$$

$$\sqrt{10^{-12}}$$

a half cycle $= 3.2 \times 10^{-6}$ seconds.

This shows that 0.10 mh inductance can be put in series with the condenser and lamps to limit the current without unduly increasing the duration.



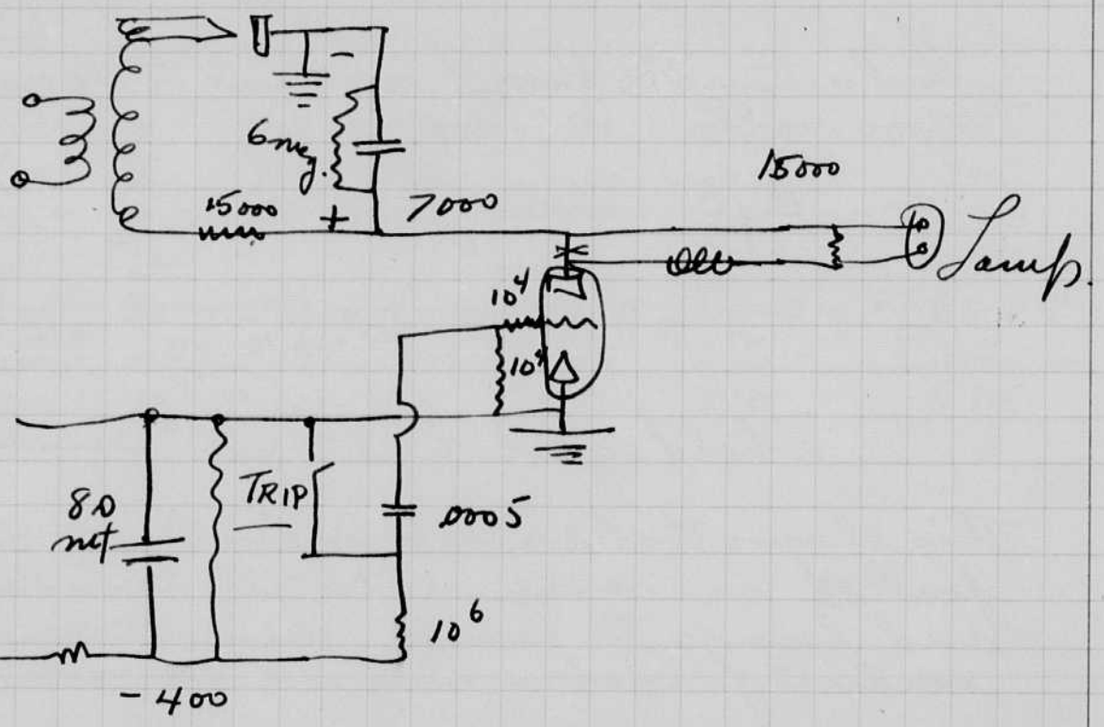
If both blades of the contactor are insulated the tripping is easier for the cathode grounded thyratron.
See diagram.

Oct 9 1945 M.I.T.
Harold E Edgerton

Leaving for for Cleveland at 5 pm today.

Connected fast trip equipment for Lewis yesterday.

4C 45 tube will ~~so~~ self start at 5000 with zero bias. Changed to 3C 35 tube (100 amp. peak)



I tried #15 lamp and an argon spark lamp as well as others in this circuit

There was some modulation of time say about 20 ms, as the trip frequency went through 30 and 60 cycles. This is due to small changes of start time caused by different voltages on the anode of ~~the~~ ~~tube~~ grid.

Cloud Chamber

I went to the 4th floor with [illegible] re.
to see the cloud chamber illumination
device that has been in operation for
about 8 years ±. He wanted the circuit
to send to Prof. Deutsch at Penn.

A new type of lamp would be
better for their work with a cover or
a # 15 base.

Oct 15 1945 Monday
I had a conference in Cleveland on
Oct. 10 with Noel, Carlson, Hammer and others.
Discussed television and color movie lamps with
Carlson and Noel.
Tungsten lamp 5KW → 165000 lumens
33 lumens/watt.
filter for color 2/3 loss for daylight film.
55,000 lumens
1/50 sec
1000 lumen sec per frame.

The noise from the lamps is important!

with a flash lamp effy of 50 lumens/sec.
20 watt seconds per frame are required

Suggest 72 cycle light with two or frame.
Power = 72 x 10 = 720 watts
5 mf at 2000 volts. $\frac{CE^2}{2}$ = 10 watt sec.

Carlson suggest at least 3 times this for start. I proposed
a small spiral with FT-17 electrode at 15 cm xenon.
Noel is going to make a lamp like this for test.

Cont.

I took the ~~night~~ aft. train to Rochester where I met Herb and Fred at the R Hotel in the morning. We met Mentch and had a morning conference with Boon and Leavett and Ford.

We spent practically all the time on the Studio unit. Decided to stay at ~~2000~~ 2000 volts for the time being with new, more efficient tube and new modeling lamps.

Each power unit will have an extra outlet for a second lamp. there will be no way to plug in extra capacity.

Leavitt reports irregular operation of lamps with double lamps on the Kodatron. We suggested new tubes which were ok. when an extra capacity of 1 mf was connected to the spark trip circuit. Double light from 2 tubes is less than light from one since the efficiency drops with capacity.

Decided to use polarized Jones plug on the studio unit.

G.E. reports that 100 watt focus lamp causes one lamp to miss on new design when the other focus lamp is left off. The lamp by itself will fire if the cold ~~stm~~ lamp is disconnected.

Spare parts will be available to rebuild the old Kodatron units that are out now. this will include a socket of the new type and a new plug arrangement.

New improved condensers will be available for the Kodatron unit. This and the double lamp arrangements are the only changes.

After lunch we had a meeting in the Kodak Tower with Farrow, Green, Vaughn, , Boon, Mentch, Barton Brier and myself.

It seems that Kodak want an

Const.

non exclusive licence ~~license~~ and wish to use us for design and consulting services. E.K. wish to make the flash equipment in their own plant starting about six months from now after a move is made. We were asked to make a proposal to E.K. for a license and for a consulting arrangement.

I left that night for Dayton after a dinner at the country club with Farrow, Mench, Vaughn, Lt. Col Dick Leghorn. There was a fair at W.P. where developments were shown in fine style. Of particular interest to me were the displays of the tech data lab. where Major Fanny Thomas, Capt Charles Coles, and Lt Steinmetz were in charge. Also the Photo. lab. had a very fine exhibit with Col. Goddard in the front row. Welch Pogue was in from Washington and we had lunch together.

After several attempts to get a plane, I gave up and returned to Boston on the train. Major Thomas invited Capt Coles and myself to dinner at his home where I saw his family - two boys Meg and Kirby.

I took a rather complete photo record of the stroboscopes at the W.P. affair. These negs were taken to G.R. today and given to Clayton and Worthen.

Noel in Cleveland says the new studio unit should have the following changes.

2 lamp outlets (3 preferable)
200 watt seconds total energy
+ & 5 KV for most economical condenser design.
2000 V 100%
5000 V 45% cost 60% weight.
AN plugs.

Oct. 19, 1945 M.I.T.
Harold E. Edgerton

I visited Dr A.N. Goldsmith in N.Y. on Oct 17 where a conference was held on motion-picture lights. Present was Mengel, Carlson, Farnham, Johnson and Marvin. A list of desired characteristics for the lamps was presented by Dr. Goldsmith. Lunch at Cornell Club.

Met T.T. Goldsmith at Dumont at 5 and went to N.J. with him. Helped at the Mens club Presby church for Goldsmiths lecture on television. Then stayed with Westerberg over night.

At Dumont Oct 18, installed Strobolux lamp in movie projector and ran film through with sound.

A test was made with a 1000 watt projection bulb. Light was picked up with a 929 photocell into a 10,000 ohm resistor (200 volts).

Another test was used with the Strobolux lamp excited with 2 mf (or 1) at 2000 V ±.

The peak of the light with the strobe lamp was 12.4 times that of the 1000 watt lamp after the light of each went through the optical system of the movie (16 mm) projector.

65 ft candles was measured with a weston meter as the peak output of the 1000 watt bulb.

Integrated output on screen

$$I.T. = 65 \times 800 \times 10^{-6} = 52\,000 \times 10^{-6} \text{ f.c. sec.}$$

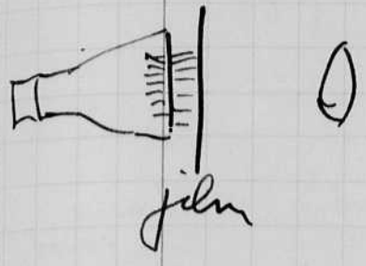
with flash lamp

$$I.T. = 12.4 \times 65 \times 10^{-6} \times 10 = 8100 \times 10^{-6} \text{ f.c. sec.}$$

$$\text{Ratio } \frac{81}{5200} = \underline{.15}$$

Dr. T. Goldsmith suggested the use of a

Special cathode ray oscillograph tube as a plane light source to be located back of the film in the projector. The beam would be designed to be broad so that it covered the entire end of the tube. Light would be modulated by grid or anode voltage to flash at the desired time.

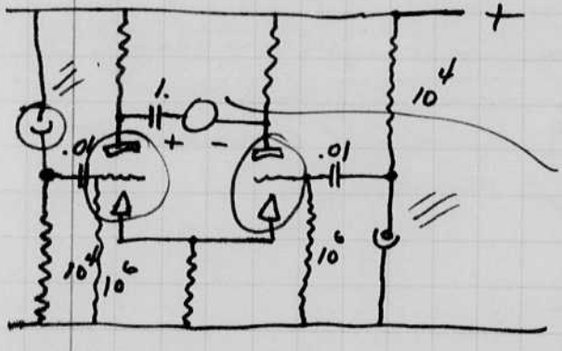


Peak current density = 100 ma per square mm.

Details of the scheme are in Goldsmith's note book as of yesterday.

Ballistic exposure meter.

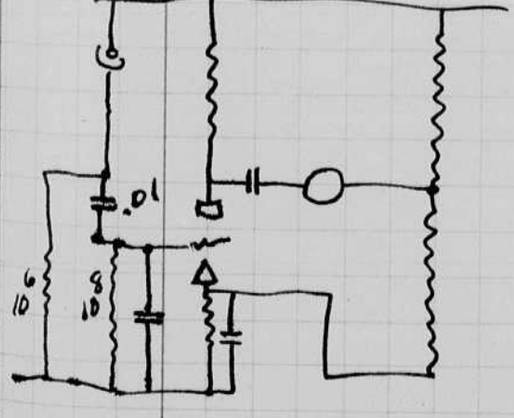
no shutter needed.

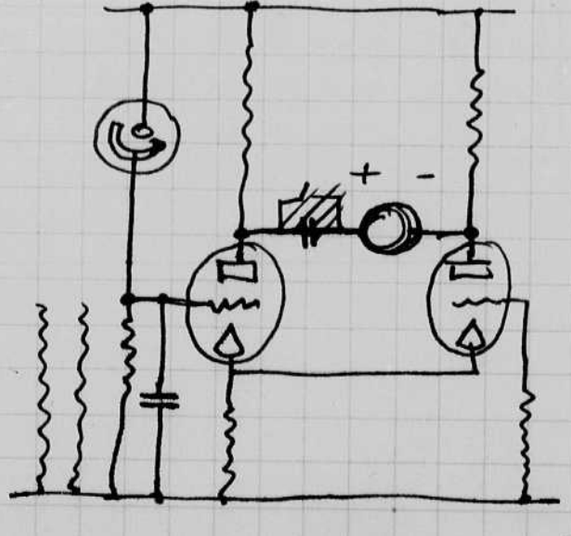


Ballistic meter

RC in grid = 10^{-3} sec or 10^{-2}

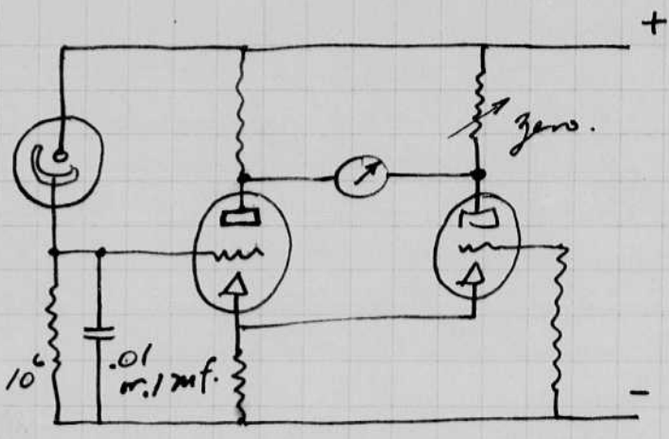
$10^{-2} = RC$ $\quad C = \frac{10^{-2}}{10^6} = 10^{-8}$ farads.





50 ma coulombs.
50 ma for 1 sec.
10^{-4} sec.
50×10^{-4} amp.

cont.



$10^4 - 10^5$ — 10^6

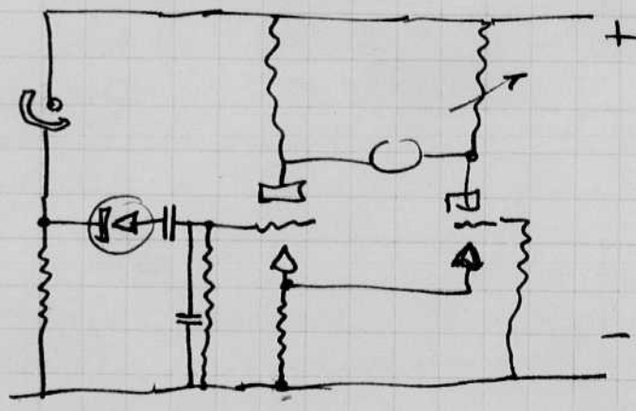
Ballistic meter to measure flashing light.

$10^4 \times 0.1 \times 10^{-6} = 1.0 \times 10^{-3}$ min time const.

$RC = 10^{-2}$ sec. $R = 10^6$ $C = .01$ mf.

In a lighted room this will be off scale due to the drop in the 10^6 ohms.

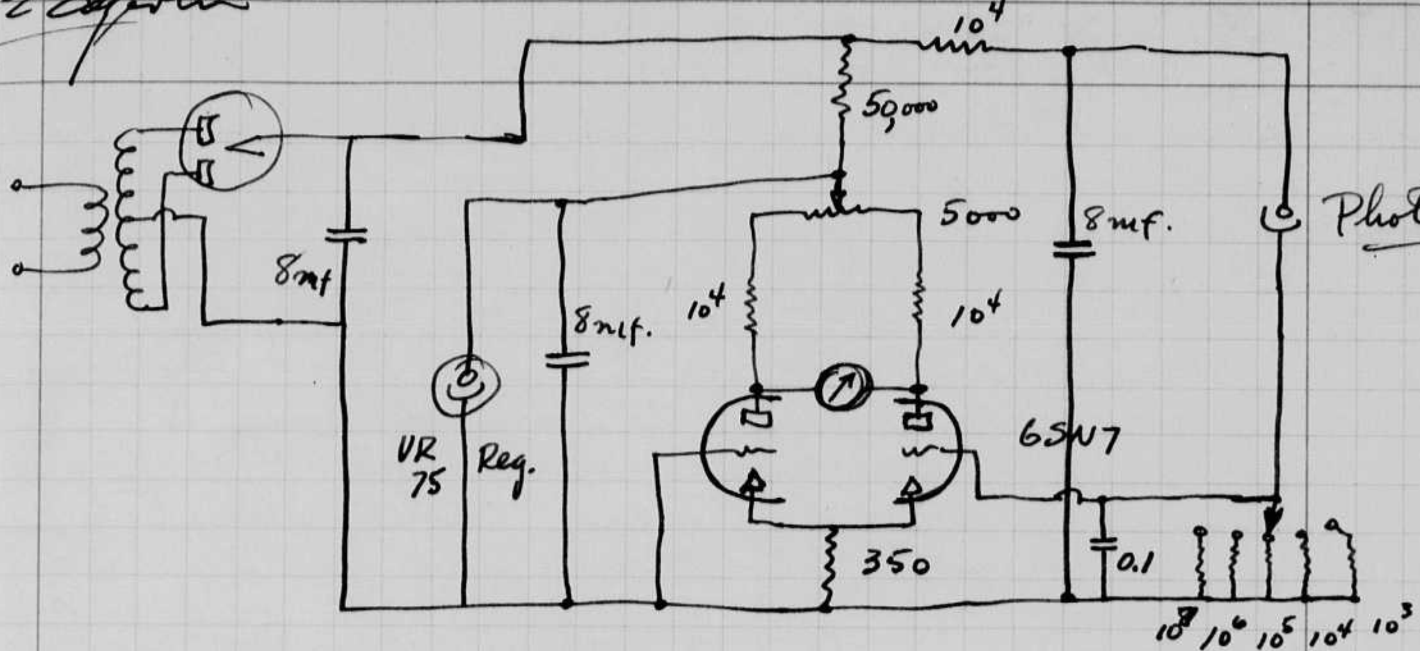
Oct. 20, 1945. meter design continued. It would be desirable to put in a circuit to take out the continuous deflection caused by continuous light. One such circuit would consist of a rectifier and capacity.



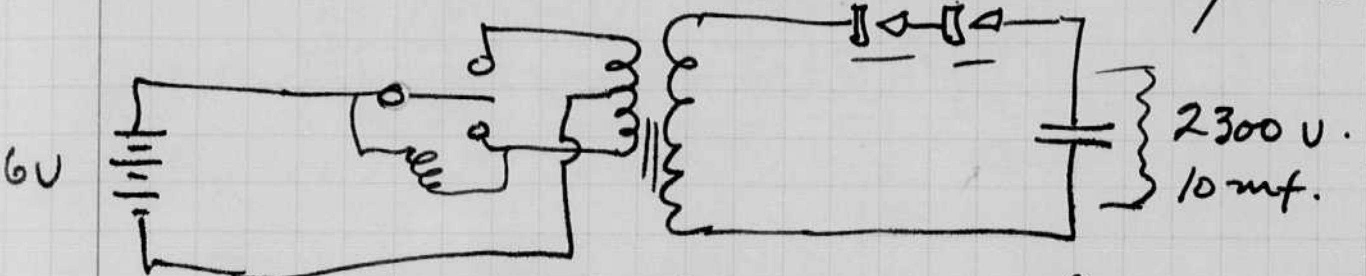
Oct 20 1945.

H E Edgerton

Ballistic Exp. meter.



Portable Power supply.



120 v. trans.

Vibrator.

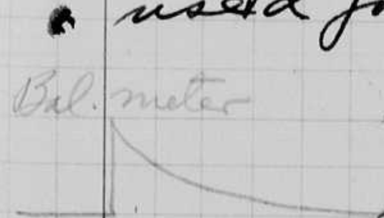
with 3 meg load the voltage drops to 1950 volts.

$$I = \frac{1950}{3 \times 10^6} = 650 \times 10^{-6} \text{ amps.}$$

$$= .65 \times 10^{-3} \text{ amps.}$$

$6 \times 300 = 1800$ v.

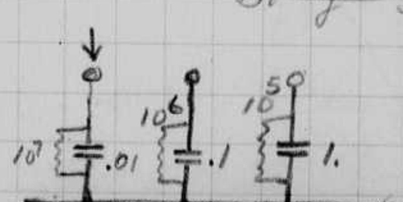
I connected 7 electrolytic condensers in series across the above circuit after a minute the voltage was 900 volts. Excessive
X leakage currents must flow due to shelf life. The conds have not been
• used for some time. 3.9 volts from bat.



Let C = 0.1 R = 10^6 RC = 10^{-1} = 0.1 sec.

assume voltage on grid = 0.2 volt for 0.1 sec.

$\Delta t\, i_g = S_m\, e_g\, \Delta t = \frac{0.2}{} \times 2200\ 0.1 = 44.0$ micro amp. sec.

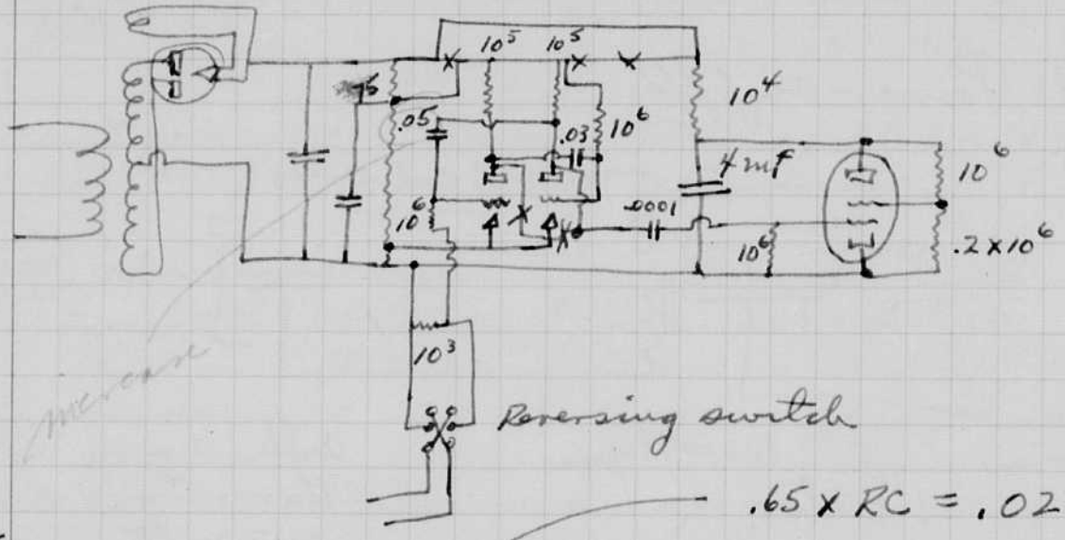


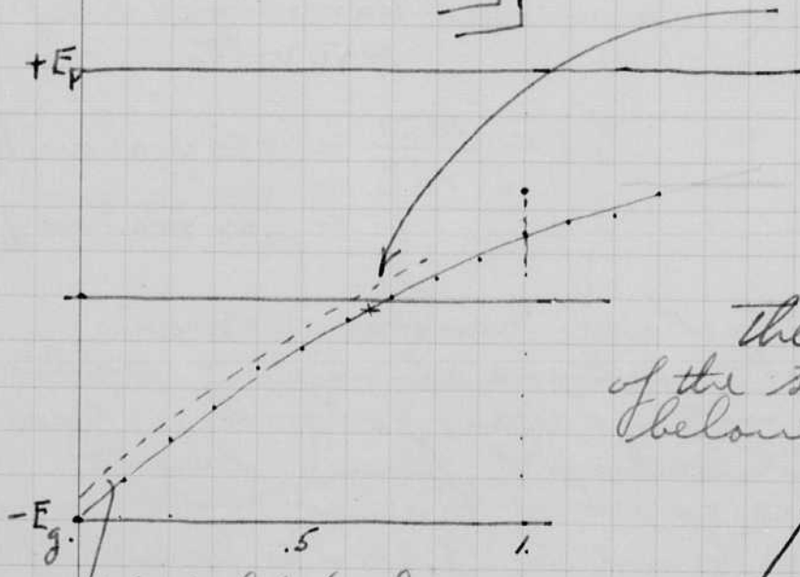
Harold E. Edgerton
Oct 25, 1945 M.I.T.

I started a book on flash photography several days ago. This book had been outlined for several years. The subject I am working on is the basic electrical theory.

Flash bulb adjustment for shutter.

A circuit was given to Bill McRoberts to wire up for testing synchronizers. A time delay circuit 0.02 seconds is introduced between the switch and a strobotron.



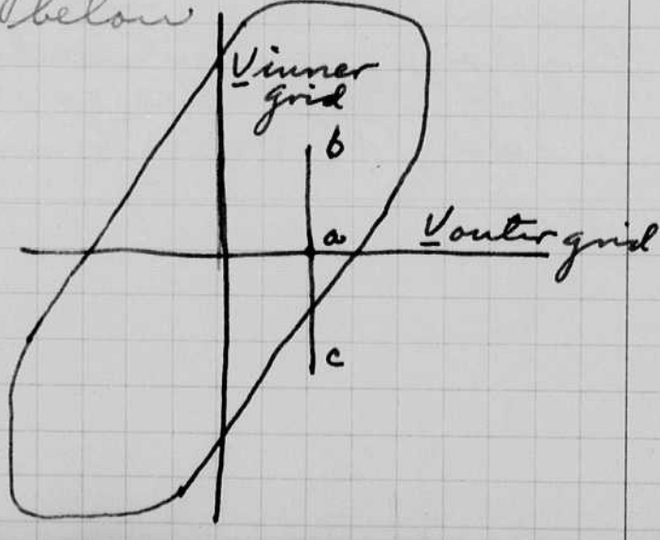


.65 x RC = .02 sec.

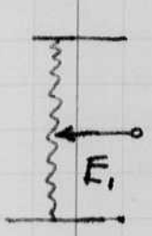
$R = 10^6$

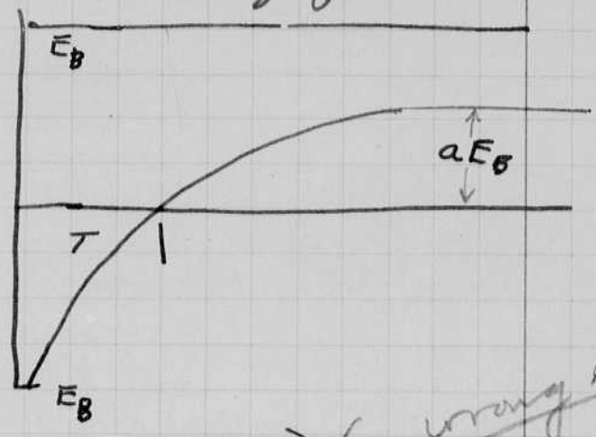
$C = \frac{.02}{.65} \frac{1}{10^6} = .0318 \times 10^{-6}$ farads.

The starting characteristics of the strobotron are the below



the normal potential on the two grids is shown at point a where the voltage on the outer grid is about 75 volts. at the instant of trip the inner grid voltage goes to point b which is not enough to fire the tube. after 20 milliseconds the inner grid voltage swings to point c and the discharge fires the energy in the condenser ($+mf$).





$e_g = (aE_B + E_B) - E_B(1 - \varepsilon^{-\alpha t})$

when $e_g = 0$ the tube fires.

$0 = E_B(1+a) - E_B(1 - \varepsilon^{-\alpha t})$

$\frac{E_B(1+a)}{E_B} = (1 - \varepsilon^{-\alpha t})$

$a = -\varepsilon^{-\alpha t}$.

$\ln a = \alpha t. \qquad t = \frac{\ln a}{\alpha} = RC \ln a$

since $\ln x = (x-1) - \frac{1}{2}(x-1)^2 + \frac{1}{3}(x-1)^3 - \cdots$
x between 0 and 2.

$e_g = -E_B(1+a)(1 - \varepsilon^{-\alpha t}) + aE_B$

when $e_g = 0 \qquad aE_B = E_B(1+a)(1 - \varepsilon^{-\alpha t})$

$\frac{a}{1+a} = (1 - \varepsilon^{-\alpha t})$

$-\ln N = \ln \frac{1}{N}$

$\frac{a}{1+a} - 1 = -\varepsilon^{-\alpha t}$

$\frac{a - 1 - a}{1+a} = -\varepsilon^{-\alpha t} \qquad \frac{1}{1+a} = +\varepsilon^{-\alpha t}$

$\ln\left(\frac{1}{1+a}\right) = -\alpha t = -\frac{t}{RC}$

$t = -RC \ln\left(\frac{1}{1+a}\right) = RC \ln\left(\frac{1+a}{1}\right) \cong RC \frac{1}{x + \frac{1}{2}}$

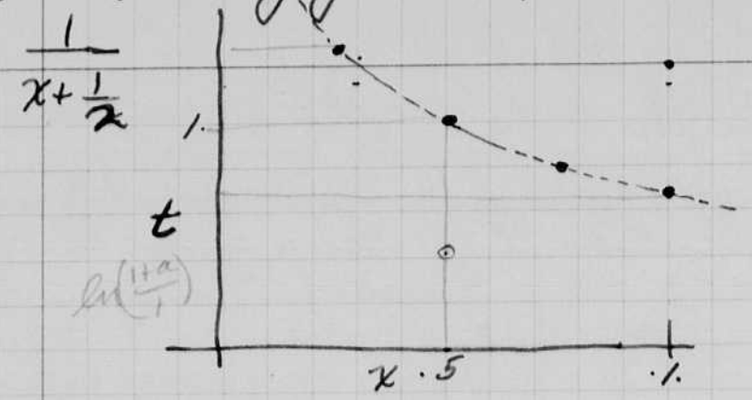
wrong approach

$\ln\left(\frac{1+x}{1}\right) = 2\left[\frac{1}{2x+1} + \frac{1}{3(2x+1)^3} + \cdots\right]$

$\cong \frac{2}{2x+1} +$

$f = \frac{1}{t} = \left(\frac{2x+1}{2}\right)^{RC} = \left(x + \frac{1}{2}\right)^{RC}.$

Let x vary from 1/4 to 1.



$\ln \frac{1+a}{1} = \ln 1.5$.
$\ln A \times B = \ln a + \ln B$
$\ln 1.5 \times 100 = \ln 100 + \ln$
$\ln \frac{1500.}{1000} = \ln 1500 - \ln 1000$

2.7081
2.306
.402
$\ln 1.5 =$
$\ln 1.2 =$ .18

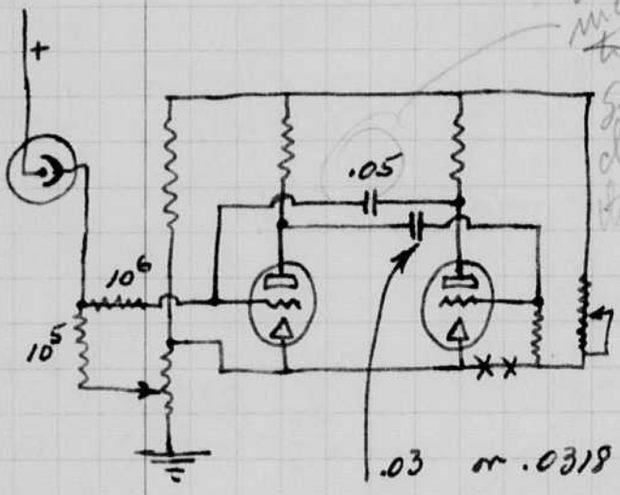
2.485
2.306
.18

$\frac{3}{4} + \frac{2}{4}$
$\frac{5}{4}$ $\frac{1}{4}$ $\frac{2}{4}$

To obtain a linear scale of time, vary C or R.

t.		C
.020	—	.032 mf.
.010	—	.016 "
.005	—	.008 "

increase to 1 mf. Since it changes by a factor of 10^5
$\tau p = 10^5$

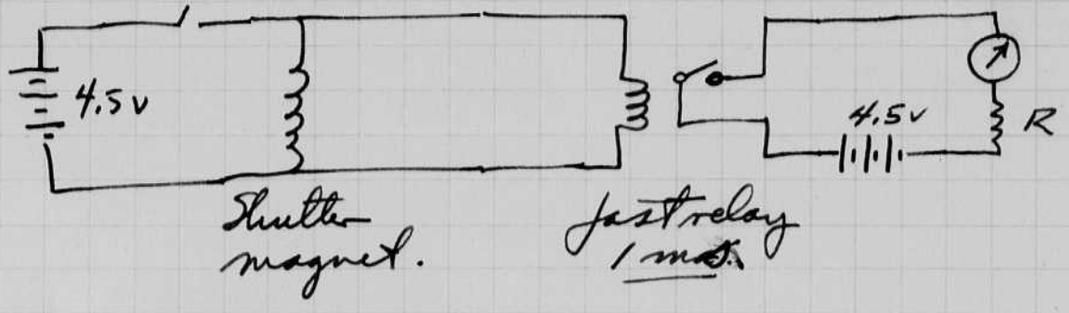


Oct. 31, 1945 H. E. Edgerton. M.I.T.

The shutter delay tester page 98 was wired up by Mc Roberts, while I was in Rochester on the 29th. Wiggin tested it yesterday with two shutters. The sensitivity adjustment seems to vary the time delay.

Yesterday discussed with Germ and Herb the general problem. Suggested a scheme to give the actual time without a hunt and try method. Germ suggested a series of neon lamps with a different delay on each.

A meter needle could be used as a moving device for the test. A sketch of the scheme is given on the next page.



Arrange R so that meter swings to about double full scale. Let full scale equal .03 seconds.

Observe the needle through the lens at a close distand. Read the positin of the needle when the shutter. maps. A Black scale should be used with a white needle. Large numbers should be used on the scall with 5, 10, 20, and 30 milliseconds marked.

10-31-45

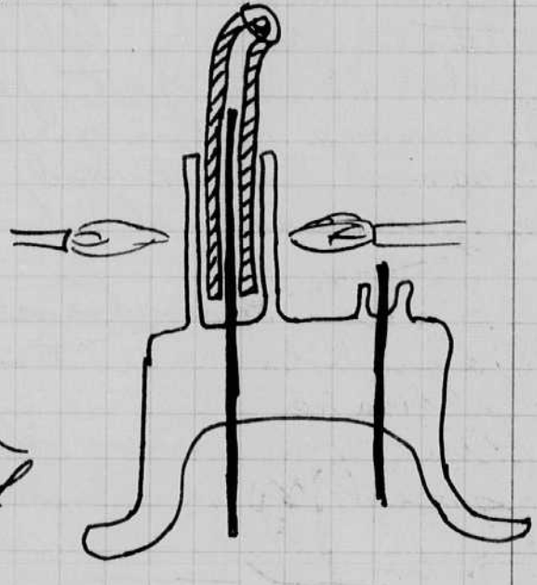
Herbert E. Grier

Chicago Tribune
Sept 9 1945 issue V. Sonya Heine.

MIT
Nov 3 1945
H E Edgerton.

Zemechausen and Barstow made two tubes of the type shown in the sketch. The spiral was of quartz tubing about 6 inches in length, wound into a spiral. One end, the anode, was cemented with Insulate. Both tubes failed through the cement joint.

A suggested method. - Put glass on the outside of the quartz. Heat and press in against the quartz to give a close fit. Pyrex glass probably would not break when it cooled.



Yesterday I obtained from Raytheon a collection of flash equipment to demonstrate in the court on the 10, 11, and 12 of nov. at the open house affair.

Chicago Tribune
Sept 9 1945 issue V. Sonya Heine.

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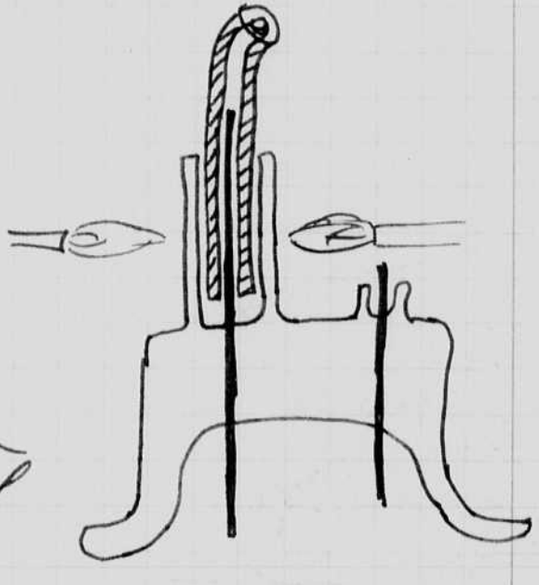

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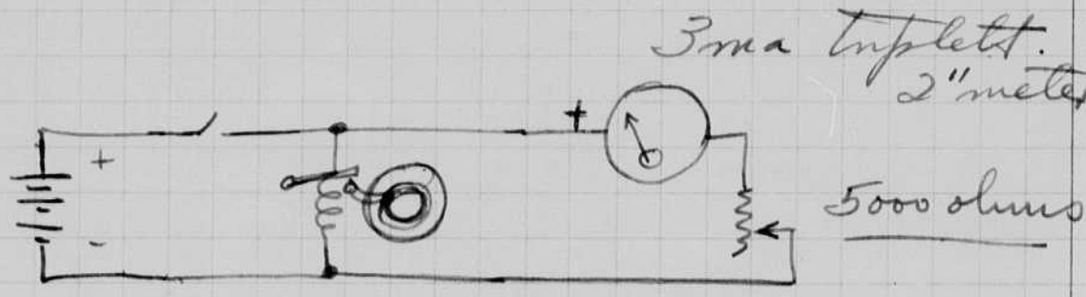
Nov ~~Oct~~ 5 1945 M.I.T.
~~Harold~~ Edgerton

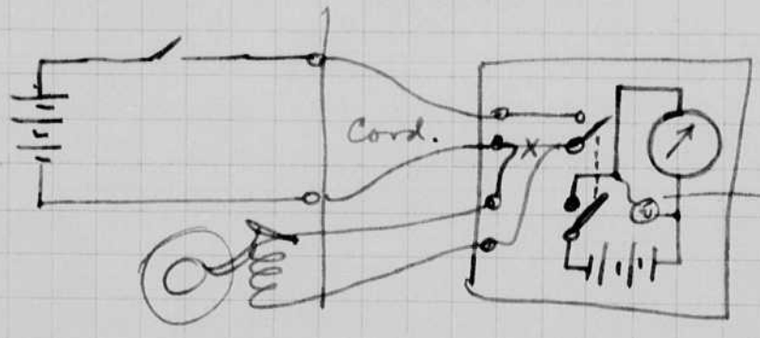
Shutter tester for flash synch.

I set up the following circuit and had Wiggin bring up a speed graphic for shutter test.



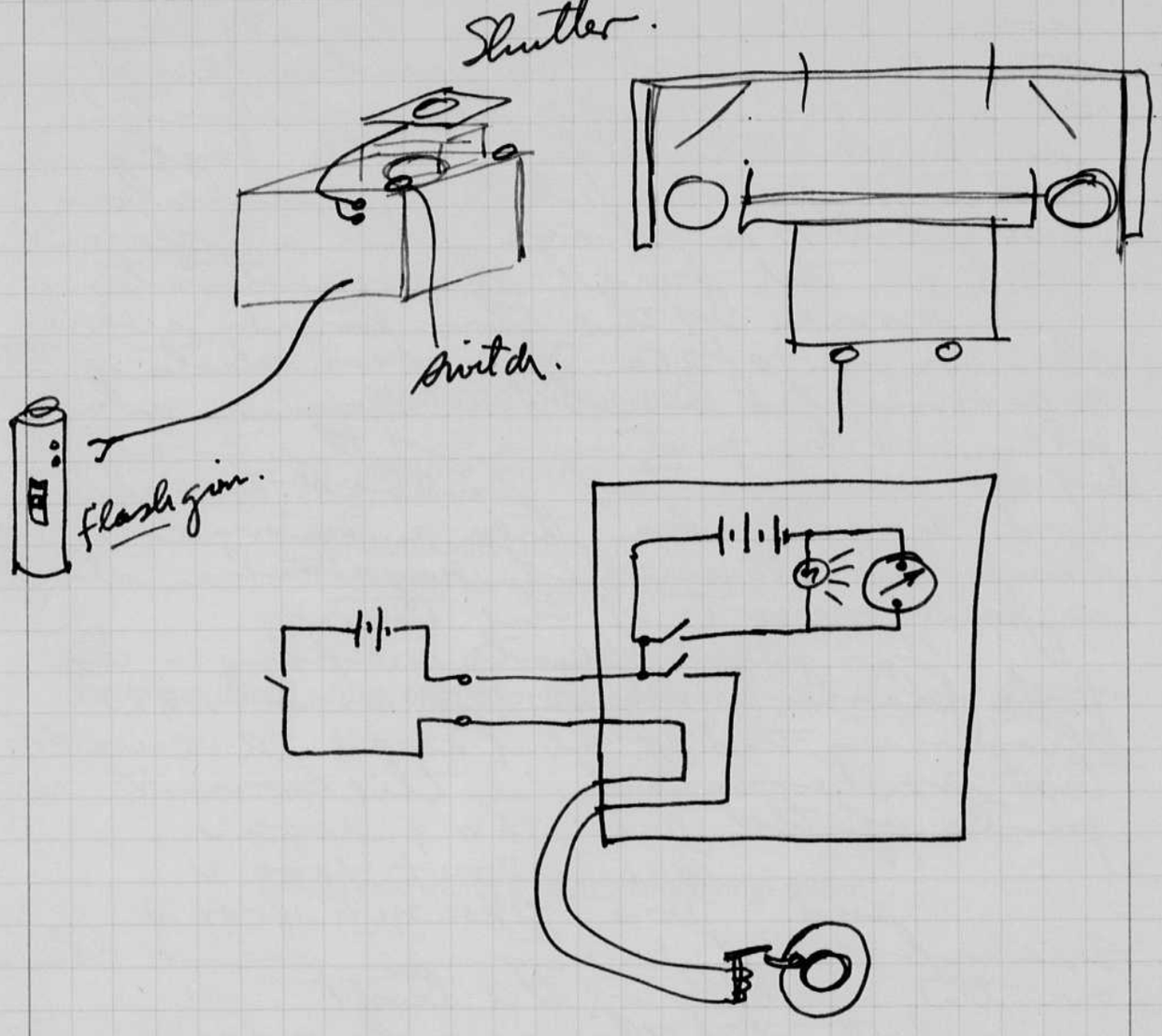
The needle of the meter was observed through the shutter and lens with the lens set for 1/200 sec. A blurred image of the meter at 1/2 m.a. ± was observed when the resistance was set at about 1000 ohms.

Semeshausen suggested a double switch which would eliminate the last relay of page 101. The regular switch would need to be shorted or held shut.



Background black. with white numbers.

Nov 7 1945
H. E. Edgerton



Nov 12 1945 M.I.T.
Harold E Edgerton

An exhibit of the open house type has been going since ~~Friday~~ Sat. noon. Some 10⁵ people have ~~joined~~ passed through the place. Of great interest was the air-sea rescue demonstration in the Charles river with boats and planes participating. A helicopter picked up a man from a speed boat as the final demonstration.

Movies of the atom bomb were shown in 10-250. High speed shots of the experimental bomb in Arizona were followed by pictures of the crews of the planes that bombed Hiroshima and Nagasaka, then a movie of the bomb burst ~~and~~ at Nagasaka and a final shot of the tour.

For night photography - we ~~took~~ photos on Nov 9 over M.I.T. showing the exhibit area. A small tent was erected in the court with parts of the D-1 75 mf 4000 V.
G-1 7 mf 4000 V
and D-5. 2400 mf 4000 V.
Examples of pictures were shown on the walls of the tent.

I started class work again with 8 students in 6.11, Nov. 5. We cover machinery and electronics.

Notebook # 16

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 106 and 107.

Item(s) now housed in accompanying folder.

Nov 12 1945 M.I.T.
Harold E Edgerton

An exhibit of the open house type has been going since ~~Friday~~ Sat. noon. Some 10^5 people have ~~joined~~ passed through the place. Of great interest was the air-sea rescue demonstration in the Charles river with boats and planes participating. A helicopter picked up a man from a speed boat as the final demonstration.

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June 15 1945 M.I.T.

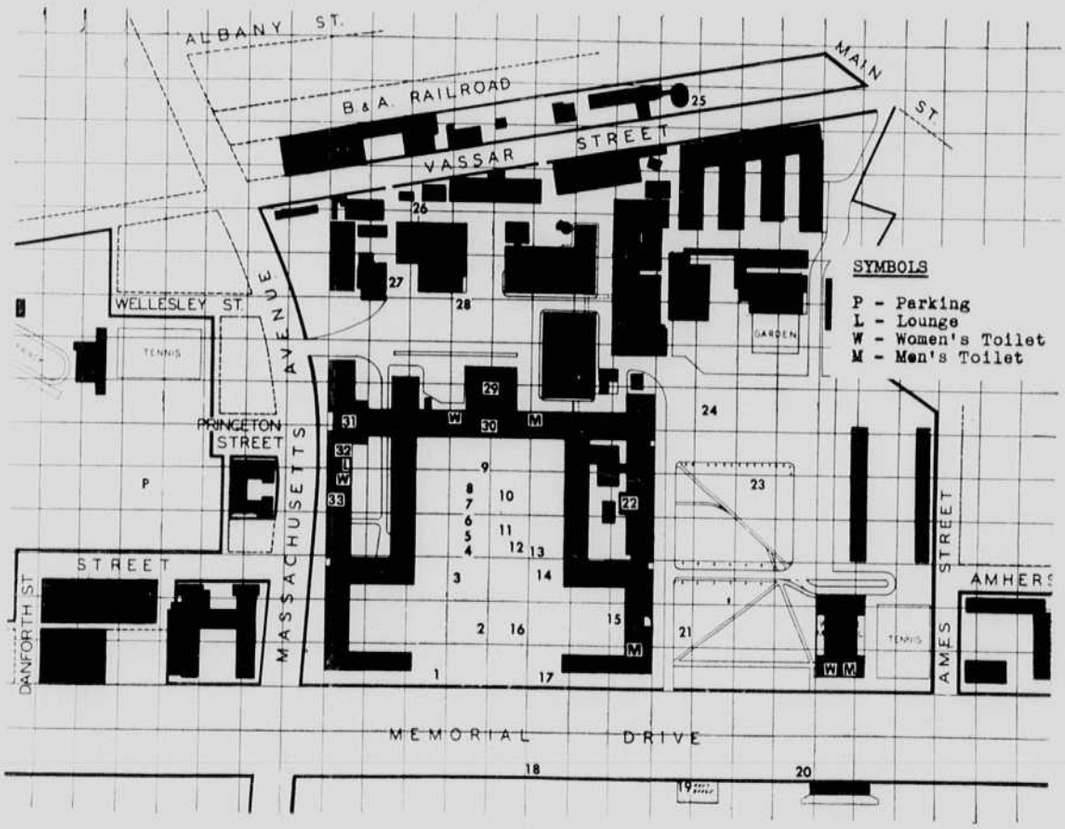
VICTORY IN SCIENCE

sponsored by
MASSACHUSETTS WAR FINANCE COMMITTEE
and the
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

NOV. 10-11-12, 1945

KEY TO EXHIBITS

1. Entrance
2. Radar (Directed Guns & Searchlights)
3. 40MM Director
4. Servo-Mechanisms-Aircraft Instruments
5. Guided Missiles
6. Signal Corps
7. Jet Propulsion
8. Fragible Bullets-Ordnance
9. RP-63-Aircraft
10. Miracle Harbor
11. Shock Waves
12. TBF Aircraft
13. Night Reconnaissance Photography
14. Light Beam Telephone
15. Navy Special Devices
16. V-1 Buzz Bombs
17. Exit (From Great Court)
18. Flame-Thrower Tank
19. Sonar
20. Navy Craft
21. Quartermaster Corps
22. Movies-Room 6-120
23. Helicopter Landing-Fire Fighting
24. Jet Propulsion
25. Van de Graaff-High Voltage Generator
26. High Voltage Generator
27. Wind Tunnel
28. Aircraft Engines
29. Atomic Bomb Movies 2nd Floor-Room 10-250
30. Navy Photographs-Ship Models
31. Power in the Pacific-Gun Models
32. Biology-Food Technology
33. Atomic Bomb Photographs



In order to see all the exhibits, follow the numbers and the red arrows. When you leave the exhibit for special events, which will be announced over the public address system, it is suggested that you return to the exhibit you left and proceed in the designated order.

BUY WAR BONDS TODAY AND WIN THE PEACE

A-20 airplane

Herb Grier

Harold Edgerton

Col Herb. Brisley

Fred Barstow

Bill MacRoberts

VICTORY IN SCIENCE

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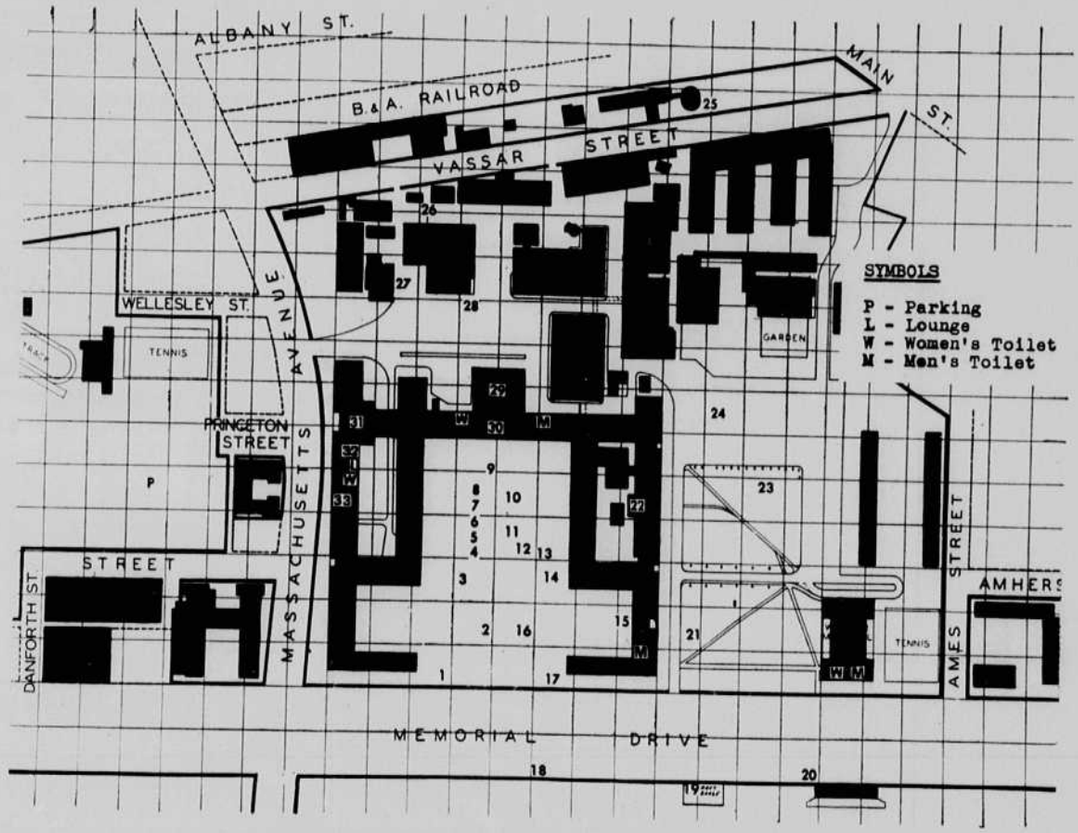

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BUY WAR BONDS TODAY AND WIN THE PEACE

Nov. 20 1945 M.I.T.
Harold E. Edgerton

Capt Tom Stanmont called from Washington today about flying the D-3 to Florida for service tests. He was under the opinion that it was not necessary to make these tests since the D-3 was similar to the D-5.

It may be that 28 D-5 units will be needed for partially outfitting 5 squadrons of night planes.

2" long 2 mm I.D. 50 low Xenon →

Ed Noel was here yesterday to talk about flash lamps. He was given samples of the data that Barstow took on the short tube.

Nov. 22, 1945. Calc. of flash tube. Pressure and Stress.

assume
Argon filled tube 20" long 6 cm pressure
0.6 cm O.D. .4 cm I.D.

molecules per cubic cc at 20° C and 60 mm pressure

n = Loschmidt number $\left(\frac{P}{760}\right)\frac{273}{T}$

$= 2.7 \times 10^{19}\left(\frac{60}{760}\right)\frac{273}{293} = 0.2 \times 10^{19}$ molecules per cm³.

$= 0.2 \times 10^{19}$ molecules per cubic cm.

V = Volume of tube $= 0.2^2\pi\ 20 \times 2.54 = 6.38$ cubic cm.

Total molecules $= V = 1.27 \times 10^{19}$ molecules.

" weight $= 1.27 \times 10^{19}\ 1.66 \times 10^{-24}\ 40 = .00842 \times 10^{-5}$ grams.

Colbine P. 23.

* m.f.p $= 10.\times 10^{-6}\frac{760}{60} = 1.27 \times 10^{-6}$ cm.

* molecular r.m.s. velocity $= 4.13 \times 10^{4}\sqrt{\frac{293}{273}} = 4.2 \times 10^{4}$ cm/sec.

the specific heat of argon gas is 0.133 cal per gram.

$wt \times S\ (t_2 - t_1)$ = calories input.

$(t_2 - t_1)$ = temperature rise.

Consider 100 mf at 2000 volts and assume that all the energy discharges into the flash lamp.

Energy in joules = $\frac{CE^2}{2} = \frac{100\ 2000^2 \times 10^{-6}}{2} = 200$ watt sec.

4.18 watt sec = 1 calorie

$\frac{200}{4.18} = 47.8$ calories

Solve for gas temperature assuming that entire energy goes into the gas

Int Crit Tables. $\delta = 20.9$ at 15°.

$$(t_2 - t_1) = \frac{\text{calories input}}{\text{wt} \times S}$$

argon. per joule.

$$= \frac{47.8}{84.2 \times 1133 \times 10^{-5}} = 4.27 \times 10^5 \text{ degrees}$$

$\frac{11.2}{}$ ✓

pressure = nkT

Initial $p = 0.2 \times 10^{19}\ 1.3708\ 293 \times 10^{-16}$

$= 2500 \times 10^3$

$= 80. \times 10^3$ dynes per cm²

mm = dynes/sq cm $\times$ 1/1335

$p =$ mm.

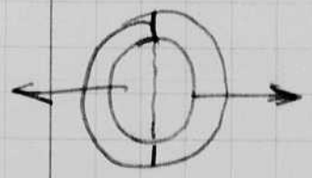
$= 60$ mm check. ✓

at a temperature of 4.27×10^5 degrees K. $+273$

$$p = 60\ \frac{4.27 \times 10^5}{293} = .872 \times 10^5 \text{ mm.}$$

87200. mm

$$p = \frac{1}{760}\ .872 \times 10^5 = 115.0 \text{ atmospheres} \times 14.7 = 1690 \text{ \#/sq inch}$$



area of cross section per unit length = $1 \times .4 = .4$ sq cm.

cm.

$p = 115 \times .4 = 46.0$ atmospheres per cm length

1690 lbs per cm length

1690 × .4

Area of tube wall per unit length = $2 \times .1 \times 1 = .2$ sq cm ✓

Unit pressure = $\frac{1690 \times .4}{0.2} = 3380$ lbs per sq inch.

$= 230 \times 15 \times 2.54^2 = 22800$ lbs per sq inch.

$$(t_2 - t_1) = \frac{W}{wt \times S} = \frac{\frac{CE^2}{2} \times \frac{1}{4.18}}{\underbrace{r^2 \pi l}_{vol} N m_h M \left(\frac{P_1}{P_0}\right)\left(\frac{T_0}{T}\right) S}$$

Max Ratner (N.Y.) called. just back from France. He was the 155 Radar officer.

Joe Condon Photo officer
% Wm J. Burke 2038 Agate St
Phil, Pa.
address

r = tube radius in cm.
l = tube length in cm.
N = Loschmidt no = 2.7×10^{19} molecules/cm³
$(t_2 - t_1)$ = temp rise of gas. °C
$W = \left(\frac{CE^2}{2} \times \frac{1}{4.18}\right)$ energy in calories.

m_h = mass of hydrogen molecule
$= 1.66 \times 10^{-24}$ grams.
M = molecular weight
- A = 39.94
- Kr = 83.7
- Xe = 131.3
- Ne = 20.18.

S = specific heat
S. for ~~Xenon~~
" " Argon = 0.133 cal./gram.
" " Krypton
" " Xenon

$\frac{P_1}{P_0}$ = ratio of pressure in the tube before discharge to N.~~T~~P. $P_0 = 760$ mm

$\frac{T_0}{T}$ = ratio of temperature (Kelvin) of the gas before discharge to N.T. $T_0 = 273$

$\left(\frac{P_1}{P_0}\right)\left(\frac{T_0}{T}\right) r^2 \pi l N m_h M$ = wt in grams of gas in the tube.

$$\frac{1.3708 \times 10^{-16} \quad 1.45 \times 10^{-5}}{8.36 \quad 3.1416 \quad 1.66 \times 10^{-24}} = \frac{1.98 \times 10^{-21}}{43.7 \times 10^{-24}} = 45.3 \times 10 = 45.3$$

$.437 \times 10^{-22}$

Pressure in dynes per sq. cm. $= nkT_2$

where n = concentration in molecules per cubic cm.

$= N\left(\frac{P_1}{P_0}\right)\left(\frac{T_0}{T}\right)$

$T_2 = (t_2 - t_1) + 273$ degrees Kelvin.

$\fallingdotseq (t_2 - t_1)$ since this is large compared to 273.

Pressure per unit length $= nkT_2 2r$ dynes per cm length.

Stress in wall material per cm of length. $= \frac{(nkT_2 2r)}{2a}$ dynes per sq cm.

where a = wall thickness

To convert to pounds per square inch.

Stress $= (\text{dynes per sq cm})\left(\frac{15}{1333\ 760}\right)$ ~~$\frac{1}{2.54^2}$~~ ~~1333~~ (bars.)

dynes $\times 2.248 \times 10^{-6}$ = pounds.

bars $\times 1.45 \times 10^{-5}$ = pounds per sq inch.

Wall Stress $= (\text{bars})\,1.45 \times 10^{-5}$

$= \frac{nkT_2 2r}{2a}\ 1.45 \times 10^{-5}$

$= nk\left(\frac{CE^2 \frac{1}{2 \times 4.18}}{r^2 \pi l \left(N m M \left(\frac{P_1}{P_0}\frac{T}{T_0}\right) S\right)}\right)\frac{2r}{2a}\ 1.45 \times 10^{-5}$

$= \frac{k\,CE^2 \frac{1}{2 \times 4.18}}{r \pi l a\, m_h M S}\ 1.45 \times 10^{-5}$

$= \frac{k\ \ 1.45 \times 10^{-5}}{2 \times 4.18\ \pi\ m_h} \times \frac{CE^2}{rla\,MS}$

$= 45.3\ \frac{CE^2}{rla\,MS}$

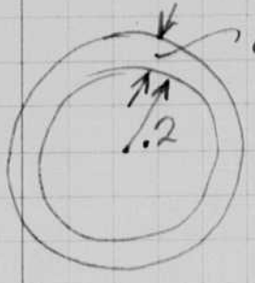
pounds per sq inch

C = ~~coul~~ farads
E = volts

M = molecular wt.
r = tube IR cm.
l = " length cm
a = " wall thickness cm
S = specific heat.

112 Cont. Checks of stress equation.

argon gas $M = 40$



$S = 0.133$
$C = 100 \times 10^{-6}$ farads.
$E = 2000$ volts.
$r = 0.2$ cm
$a = 0.1$ cm
$l = 20 \times 2.54 = 50.8$ cm.

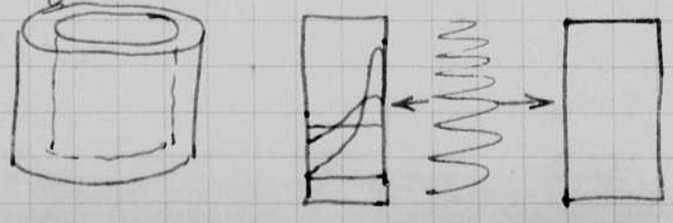
$$\text{Stress} = 75.3 \times \frac{100 \times 10^{-6} \times 2000^{4}}{0.2 \quad 0.1 \quad 50.8 \quad 40 \quad 0.133} = \frac{18100}{5.41}$$

3340 #/sq inch $= 33{,}400$ pounds per sq inch. ✓

~~does not check by $\frac{1}{.15} = 6.66$ why?~~ Oh, now there was an error in P 109.

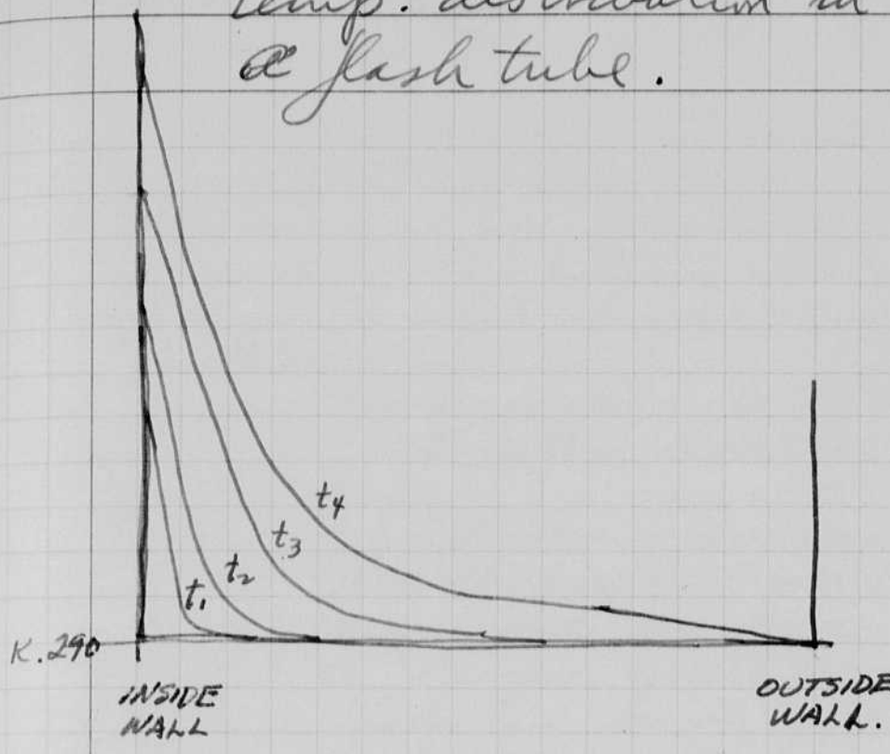
Tubes we use now do not explode and the above shows that the pressure on the glass is not excessive. ~~Short~~ Short tubes or high voltage - high capacity service have exploded, however the limit is usually crazing instead of explosion.

Crazing causes a network of small surface cracks on the inner surface of the tube. There should be some way to calculate the energy transfer to the glass wall as a function of time. I guess that crazing begins when the surface temperature reaches a temperature where the glass surface melts.



cont.

Temp. distribution in the wall of a flash tube.



Heat transfer

$$Q = K\frac{(t_2 - t_1)\,aT}{d}$$

p 1118 tables

Heat ~~cont~~ capacity 1089

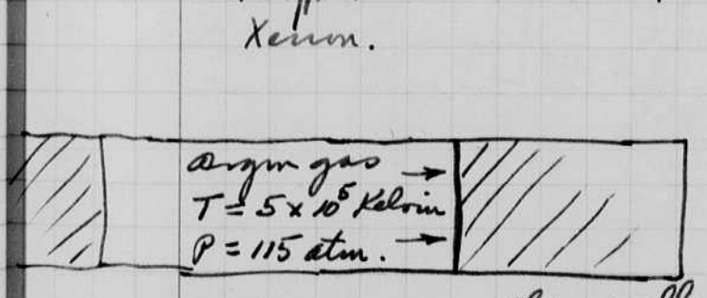
K for glass from table shows

crown	.0025	avg. .002
flint	.002	
Soda	.0018	
aluminum	0.514	
copper	1.00 ±	
argon 0°	.0000389	
Quartz.		.03 .16

Heat capacity

Crown	.161	0.15 average
flint	.117.	
Quartz	.188	
argon	.133	(-180) T ? p 1118.
Krypton		
Xenon.		

Total volume of glass walls
$= (3^2 - 2^2)\,\pi\,20\frac{2}{2.54} = 7.98$ ~~cm~~ cm^3.



Total weight = 5 grams per cm^3 x 7.98 = 40 gm.

Heat cap = 0.15.

$$t_2 - t_1 = \frac{47.8 \text{ calories}}{40 \times .15} = \frac{47.8}{6} = 8\,^\circ C.$$

This is a lot less than the $5 \times 10^5\,^\circ C$ where the entire energy is calculated into the gas. p 109.

Sherwood suggests Schmidt method to calculate temp rise on surface wall.

Pyrex glass softens at 700 °C.

Nov 24, 1947.

Harold E. Edgerton

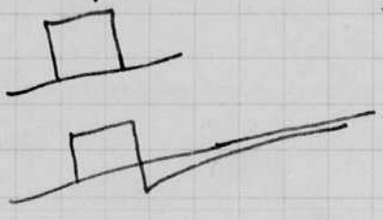
Connected Ballistic photocell meter with a meter that Allen Stimpson brought in yesterday.

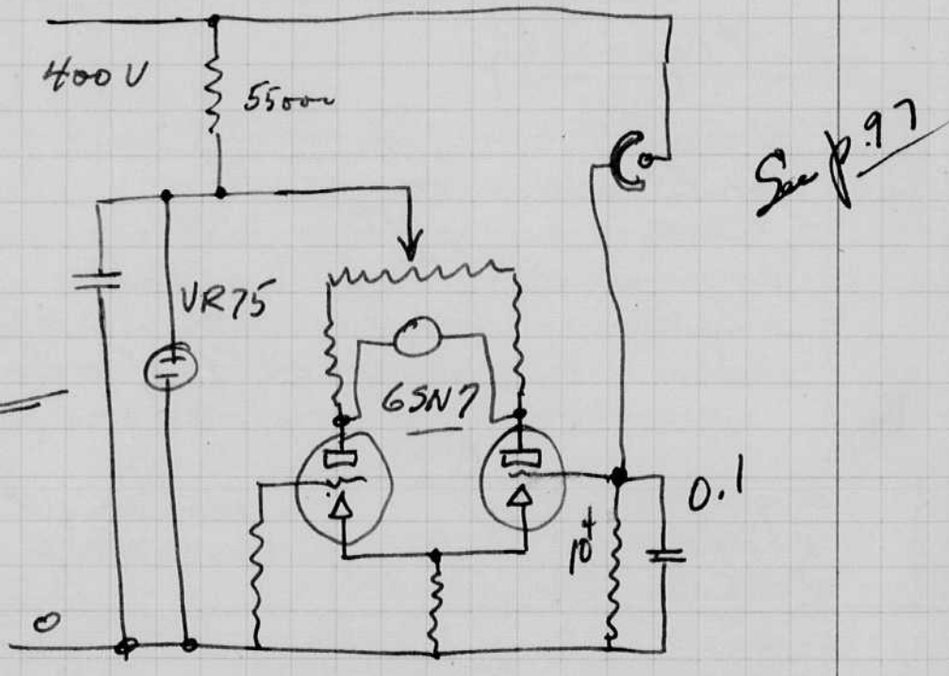
D041 AY 1034 Inster.

Scale 94° 2.46"

Turns	1500
Torque	.060 Total.
F.S. current	12.22 ma.
Resistance	1890 Ω
Damping	none.
Arm. wt.	.27 grams moving system 0.429
type magnet	alnico
Pointer	A021.

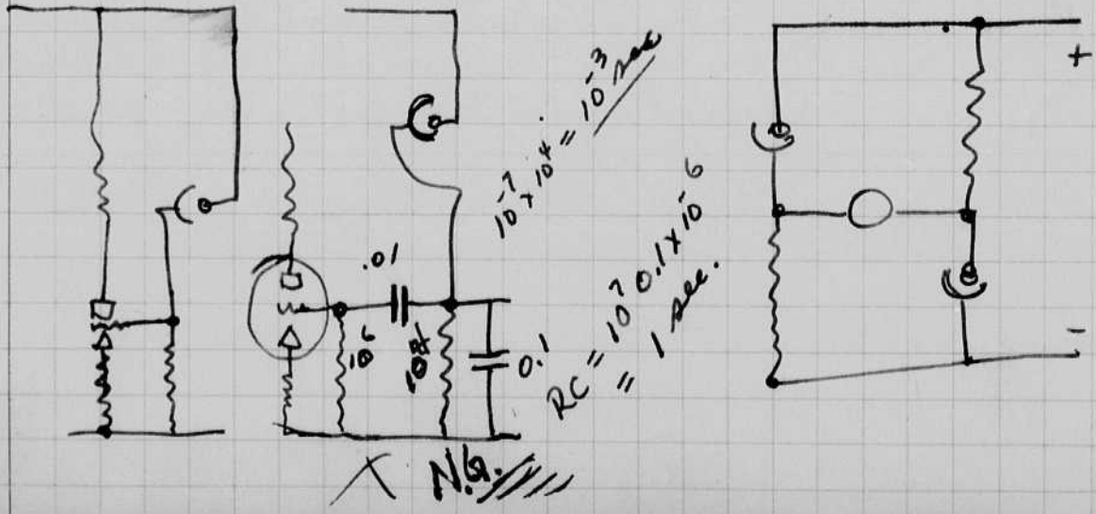
This was tried with Fred Barstow on Nov 25. Works ok with ordinary lights out.





See p. 97

$RC = .01 \times 10^{-6} \times 10^{6} = .01$ sec.



$10^{-7} \times 10^{4} = 10^{-3}$ sec

$RC = 10^{7} \times 0.1 \times 10^{-6} = 1$ sec.

X No. 9.

Prof Knapp was here today from Cal. Tech. and talked to Grier, Germeshausen and I about the high-speed flash unit at C.I.T. It was decided that further research work was to be done at M.I.T. and changes were to be recommended to the group at Pasadena.

1. Bypass choke is to be changed to a saturated core type.

2. a grid resistor may be inserted in the thyratron grid, 1000 ohms ±.

3. a larger condenser is to be used to block the kick back from the C35 thyratron to the driver tube.

Chas. Wyckoff arrived at my house from Washington on sunday night. He returned the Jenkins camera, the fine flasher, and some strobo movie equipment.

On last Friday Nov 24 I went with Versnik to visit Hill in the electronics lab in Building 24. Versnik plans to set up a criteria for deionization of thyratrons as a masters thesis.

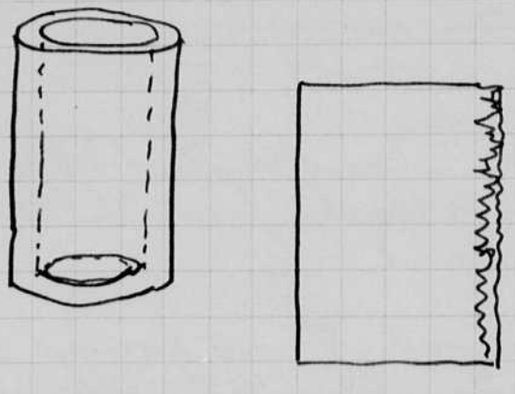
$.60 × 17 = $10.20 for 17 batteries 45V as used by Herb Grier last night for 500 v charger for portable.

 Nov. 27, 1945
Harold Edgerton

Flash tube for large energy.

Tubes at high energy have "crazed" surface due to local heating and cooling of the inner glass surface.

If the inner surface is chemically treated by dissolving the chemicals other than the SiO_2, the surface could be made of SiO_2.



Inner surface of tube is of SiO_2 due to dissolving of other components of glass.

A quartz SiO_2 surface should be able to take the heat without importing cracks to the surface.

Read and understood.
Frederick E. Barstow
Feb. 9, 1946
K. J. Germeshausen
1/9/1946

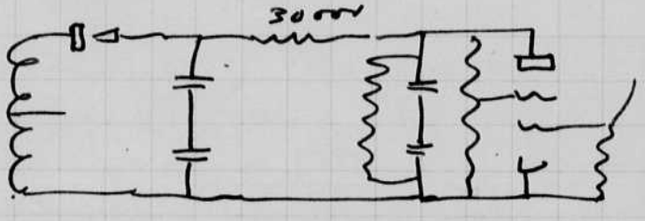
Dec. 4, 1945
M.I.T. Harold Edgerton

Chas Wyckoff returned to Washington D.C. this noon after a week's search for living quarters. The housing situation is bad in Cambridge.

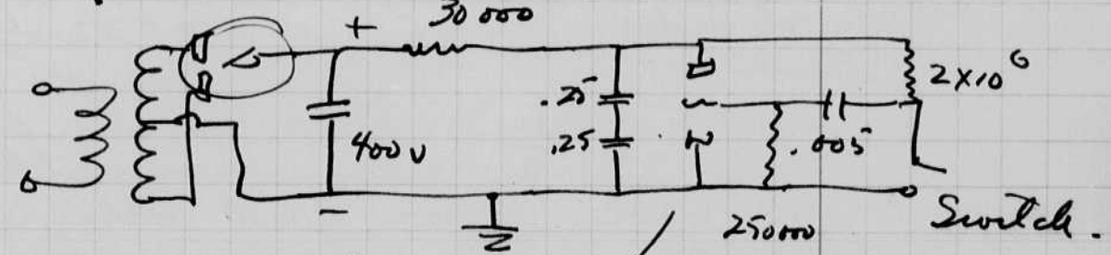
Prof Lewis Harris and brought over a sensitive thermopile (80 ohms) which we tested with the flash machine 28 mf at 2000 volts FT-14. A deflection was obtained with a galvanometer when the lamp was close to the pill. The scheme seems promising if more elements can be connected in series to give more output.

Dec. 7, 1945. Reconnected the strobonoscope in Lewis Propeller Lab.

old circuit

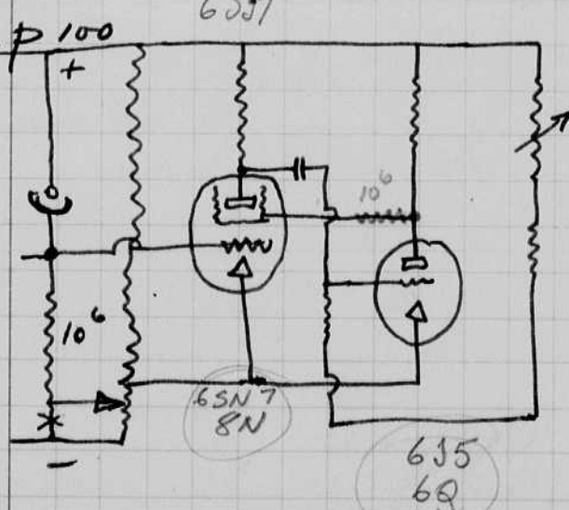


new.



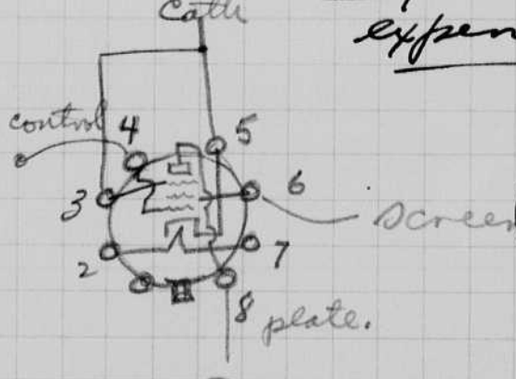
7E
7U
8AF
8AJ
8A5

Dec 10.45.
From p 100

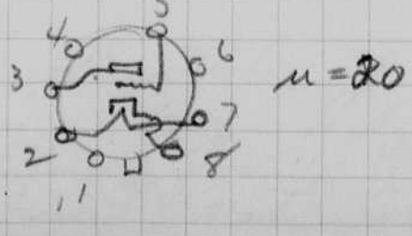


8AU
8AY

Kryptor tube.
experimental.

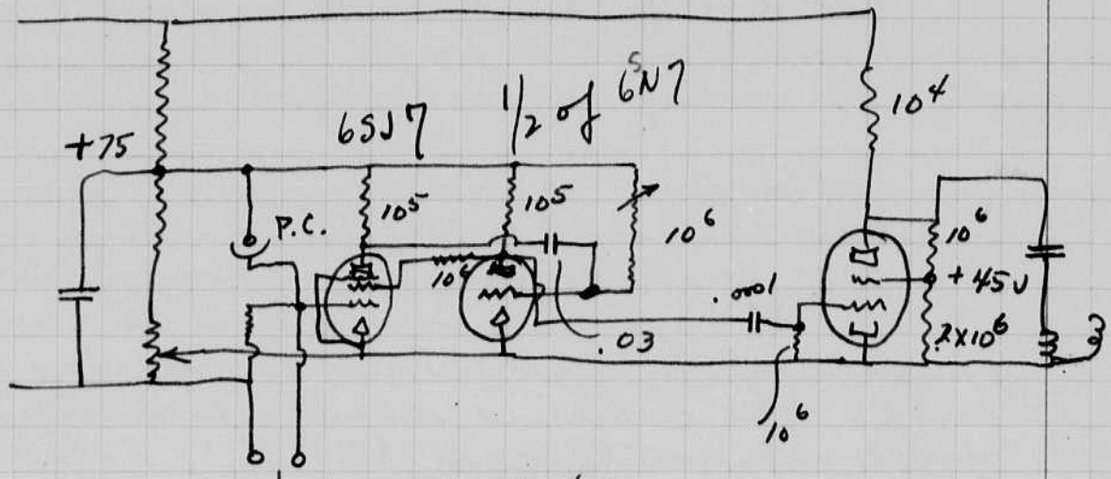


6N7 used before



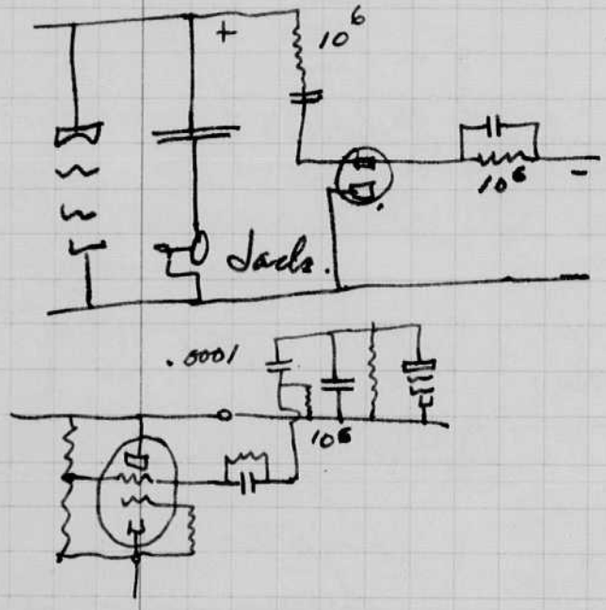
Dec. 10, 1945. Time delay circuit cont.

H. B. Edgerton.



+ surge to start.

crystal mike or flash sync.

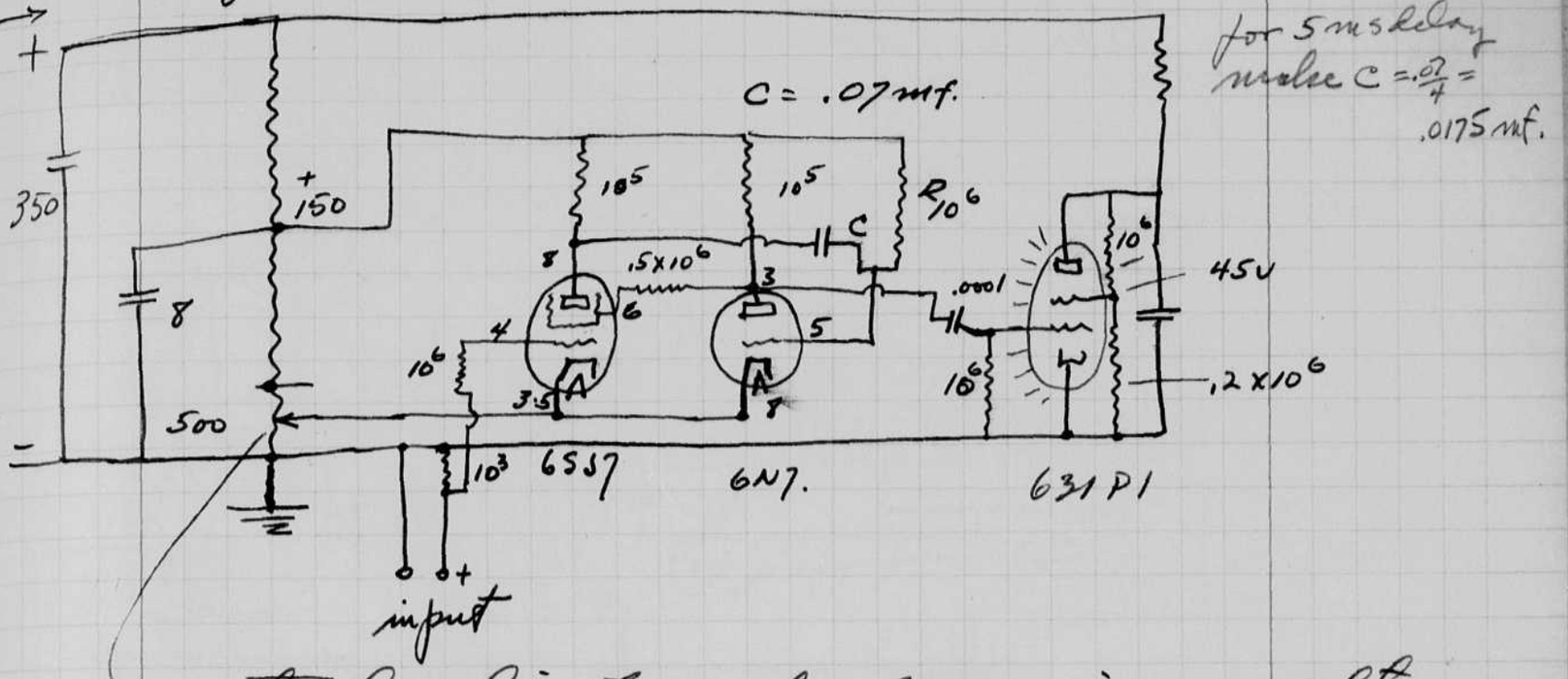


A 6SJ7 was used as the pentode. I had to increase the 10^6 to $\frac{1}{2} \times 10^6$ in the triode plate to screen grid to get operation.

Only one flash results when the surge hits the input grid.

Dec 11 1945. M.I.T.
H.E. Edgerton.

Time delay for testing shutters for photoelectric sync.



for 5 ms delay
make $C = \frac{.07}{4} =$
.0175 mf.

sensitivity adjustment, now gives 9 volts control. The input from the battery is not over 4.5 and may be 2.5 depending upon the battery and load. I suggest a value of −2 volts or (even −1) volts on the bias.

This was tested with the oscillograph today. C was increased from .03 to .07 and with .03 the time delay was less than .0167 seconds. The delay should be .02 seconds for the average flash bulb.

Wiggin tested the camera in photo service with the above device and found that the shutter ~~opened~~ adjusted by after the flash from the tester.

I left the device with Wiggin for use in his work of testing camera shutters.

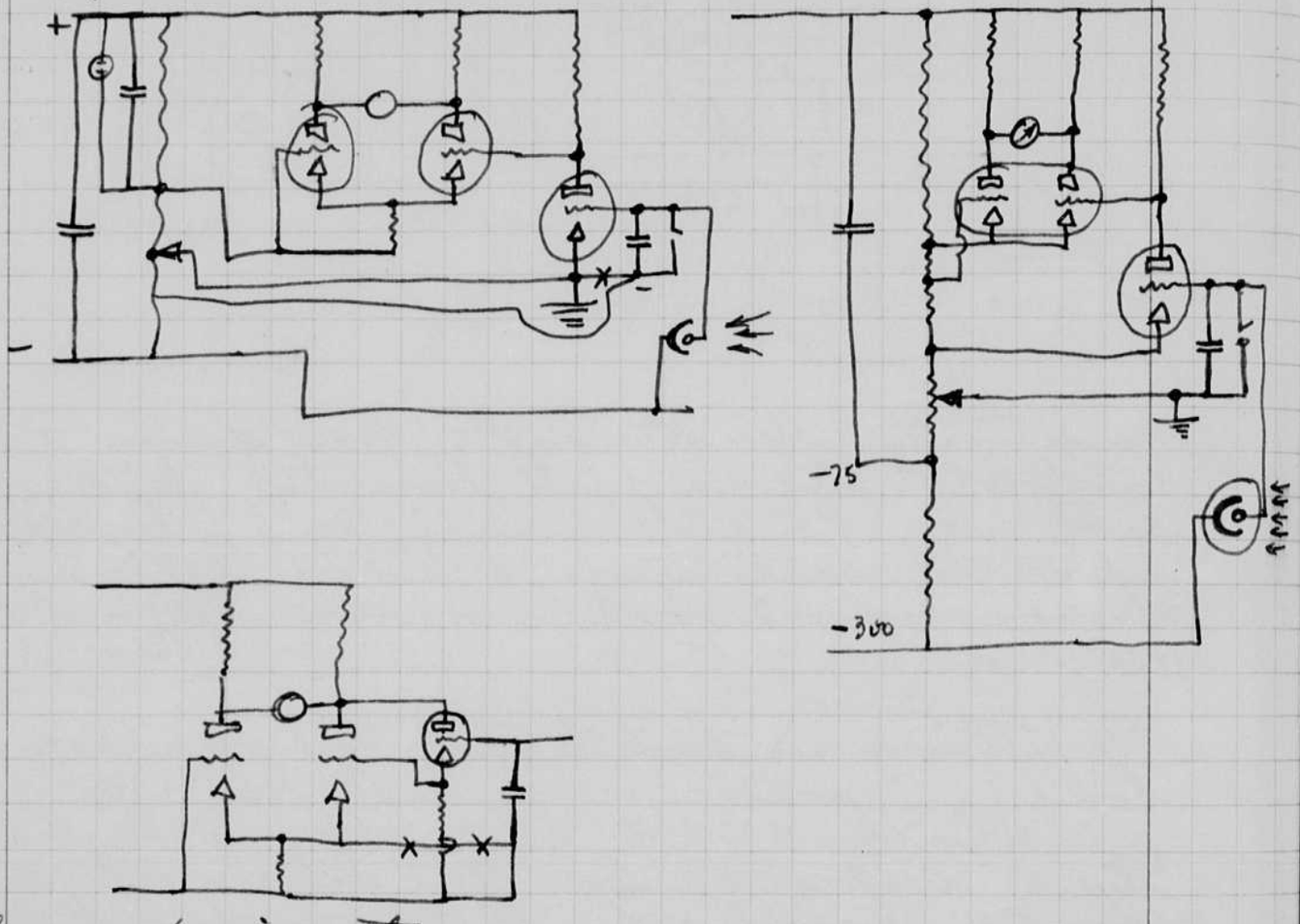
The relay for the other type of synchronizing came in several days ago. As soon as the new meter arrives from Weston I can give it a try. The first tests looked good.

Dec 13 1945

HE Edgerton

Alperin and Martzo who plan to set up a studio in Raymundo called. I introduced them to Wiggin and Jademan for help.

AC Comparitor (Light)



Time delay experiment.

$d = \frac{1}{2} a t^2$ Let $(t_1 - t_2) = .02$ sec. what is d_1 and d_2
also let $d_1 - d_2 = 1/12$ ft.

$(d_1 - d_2) = \frac{1}{12} = \frac{1}{2} a (t_1^2 - t_2^2) \times \frac{1}{2} a .02$

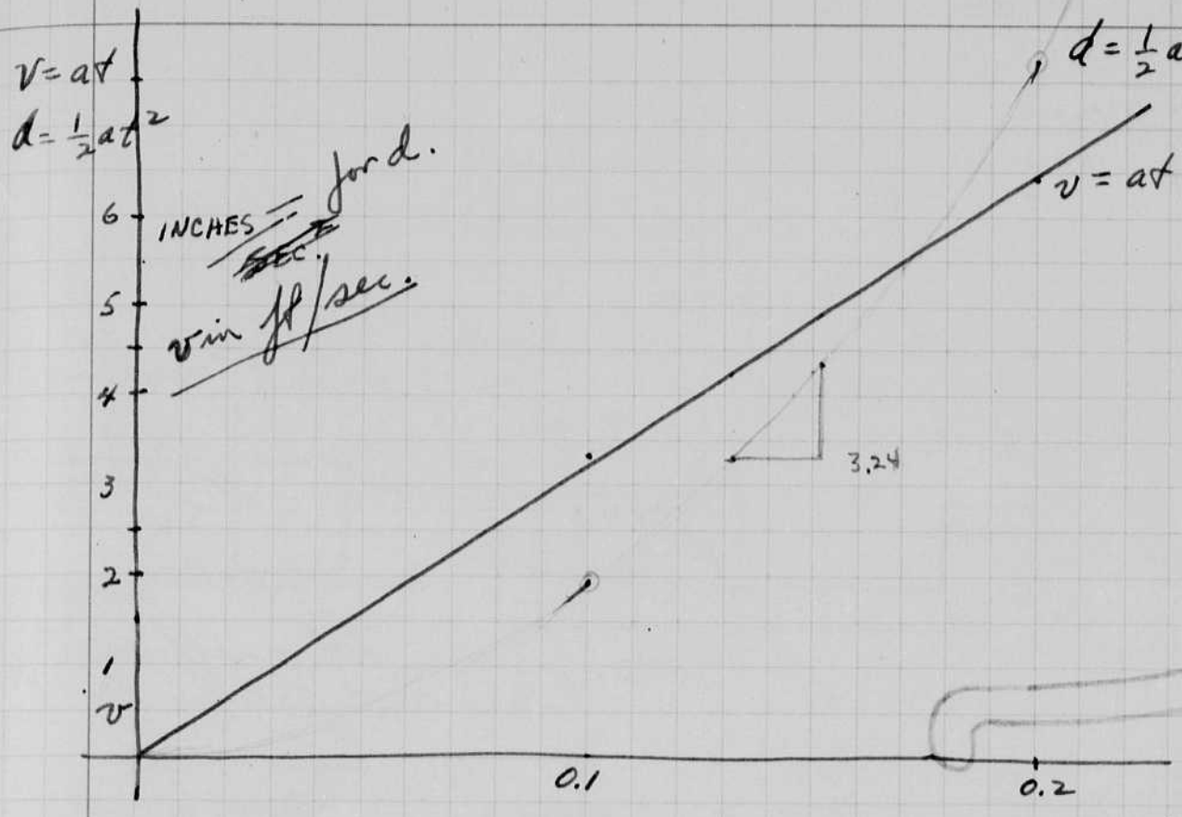
$t = \sqrt{\frac{2d}{a}}$ $\sqrt{\frac{2}{a}} (\sqrt{d_1} - \sqrt{d_2}) = .02$

$\sqrt{d_1} - \sqrt{d_2} = .02 \sqrt{\frac{a}{2}}$

$d_1 - d_2 = \frac{1}{12}$

$d_1 = \frac{1}{12} + d_2$ $\sqrt{d_1} - \sqrt{\frac{1}{12} + d_1} = .02 \sqrt{\frac{a}{2}}$

$d_2 = d_1 - \frac{1}{12}$

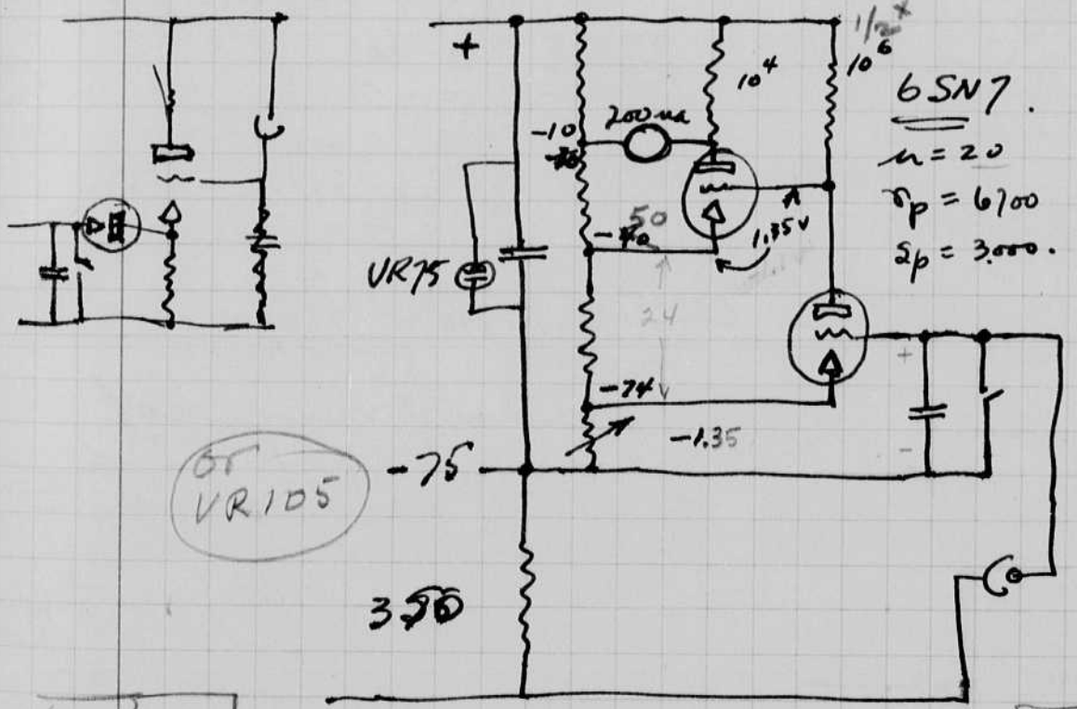


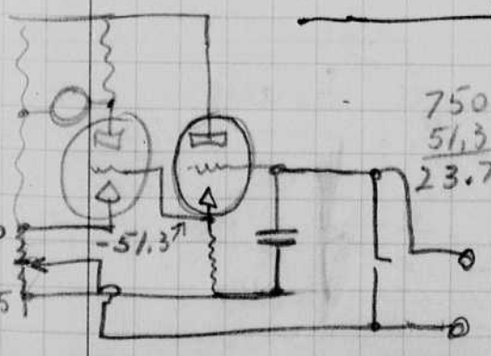
SEC.

$I = \frac{10}{10^4} = 10^{-3}$ amp

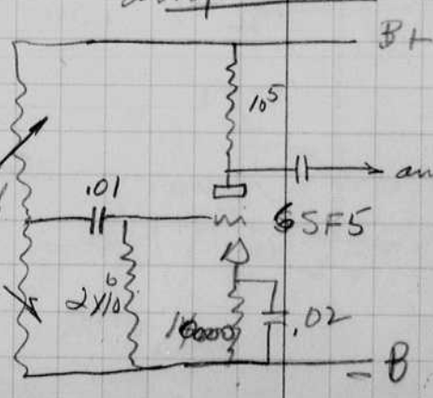
$\frac{4\mu}{10^6} = 4 \times 10^{-6}$
$= 4 \times 10^{-5}$
$I = 0.04$ ma

3 ma per volt.
0.2 ma for .066 volt.
.003 volts





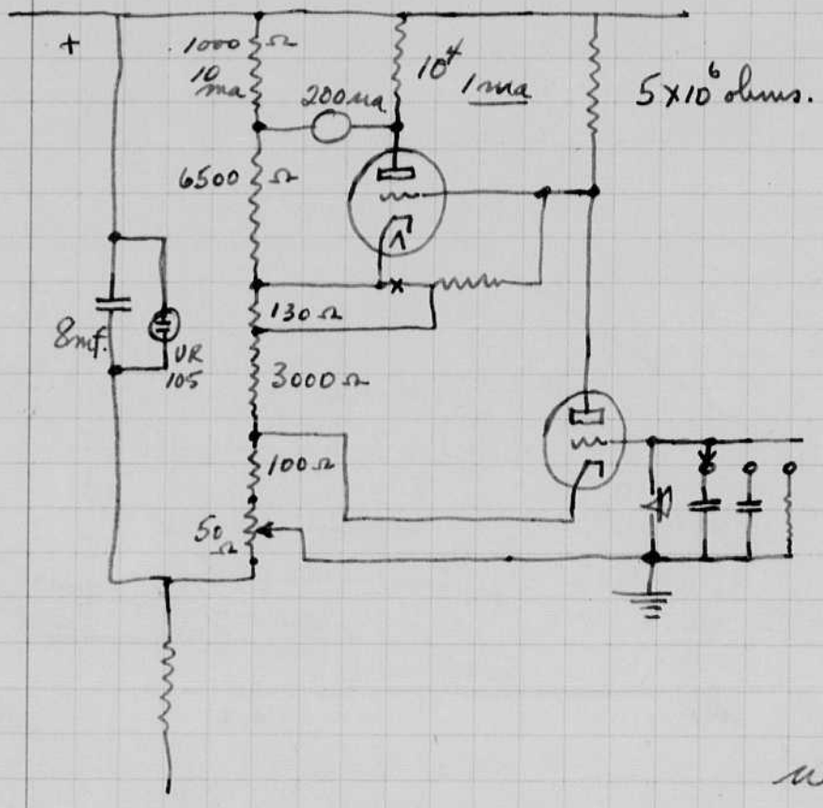
Servo amp circuit for pickup.

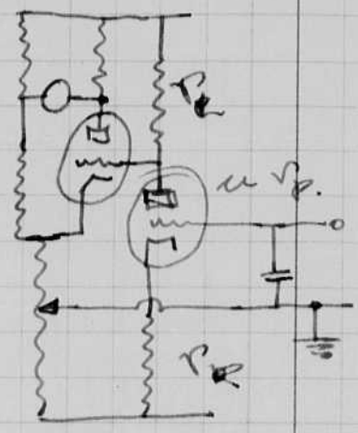


Dec. 16, 1945
Harold Edgerton

Integrating Light Meter.

.010 amps.
300. volts.
3 watts.





Let μ effective of this tube be 3.

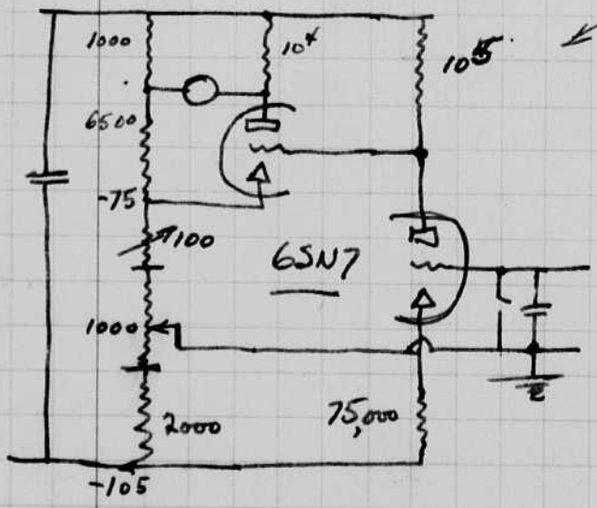
$$\mu' = \frac{R_L \mu}{r_p + R_L + (1+\mu) R_K}$$

Let $R_L = 10^5$
$\mu = 15$
$r_p = 10{,}000$
$R_K = ?$
$\mu' = 3$.

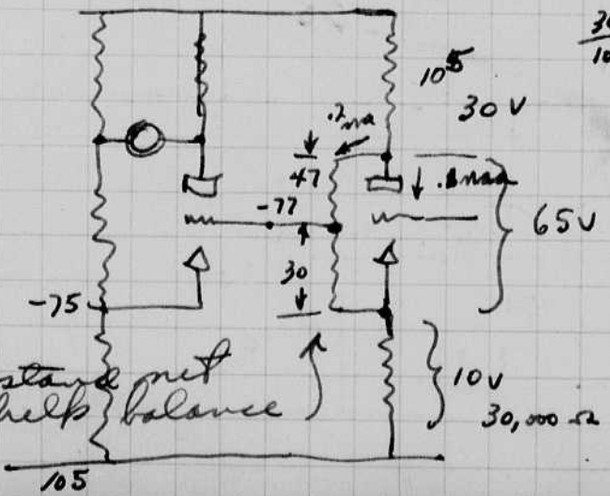
$$3 = \frac{15\ 10^5}{10^4 + 10^5 + (1+\mu) R_K}.$$

$$3(10^5 + 16 R_K) = 15 \times 10^5$$

$$R_K = \frac{15 \times 10^5 - 3 \times 10^5}{16} = \frac{12 \times 10^5}{16} = \frac{3}{4} \times 10^5 = 75000\ \Omega.$$



This circuit may not balance for zero and the plate voltage may be too positive.



$\frac{30}{10^5} = .00030$ amp
.3 ma.

$\frac{77}{.2 \times 10^{-3}} =$ 380 Ω

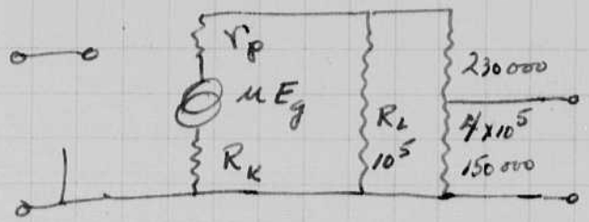
232,000
150,000

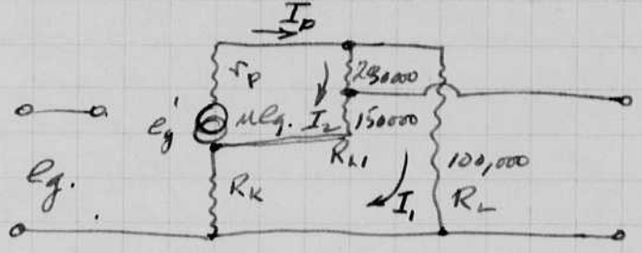
effective amplification of the first tube.

1st stage.

~~150~~	−2.2	0
E_p=52 v.	−2.1	200 ma.
8 V on load.		

2 stages .35 V for 200 ma.





$$I_p = I_1 + I_2$$

$$= \frac{\mu E_g'}{r_p + 380{,}000}$$

$$I_p = \frac{\mu e_g'}{r_p + \frac{R_L * R_{L1}\left(1 + \frac{R_K}{R_L}\right)}{R_L + R_{L1} + R_K}}$$

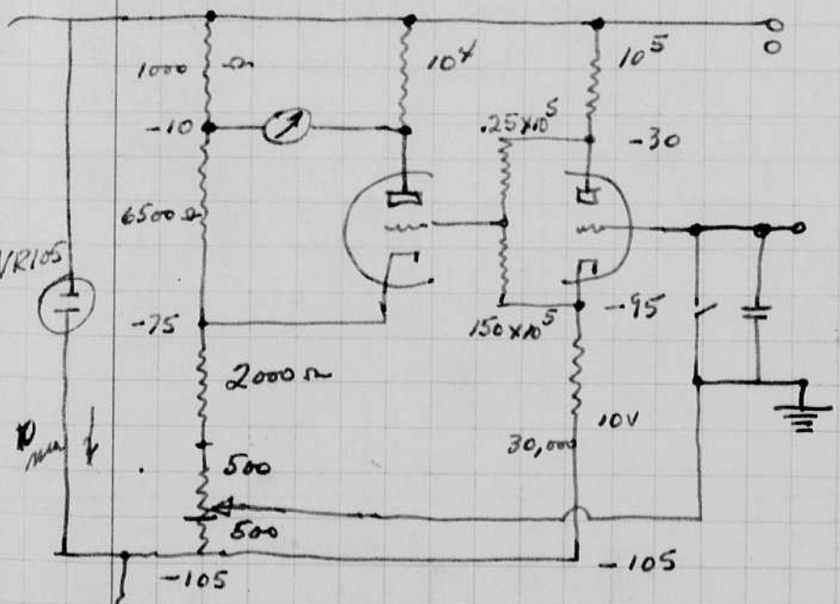
neglect the network.

$$\mu' = \frac{\mu R_L}{r_p + R_L + (1+\mu) R_K}$$

$$= \frac{\overset{15}{\cancel{20}}\ 10^5}{10^5 + (16)\,30{,}000} = 2.54$$

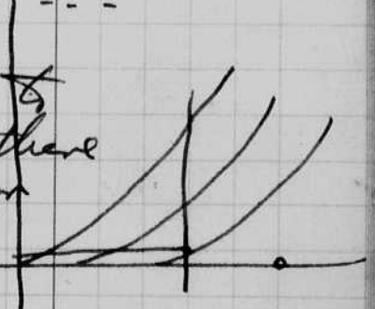
$$\begin{array}{r} 480000 \\ 110{,}000 \\ \hline 590{,}000 \end{array}$$

the actual amp. will be (1) more due to effect of resistance net on self bias. (2) less due to resistance split.



Tube conditions

E_p = 65 V.
I_p = 0.1 ma.
E_b = −1. ? - - -



If E_b is close to −.9 or less, there may be electron grid current which will be excessive.

11 ma

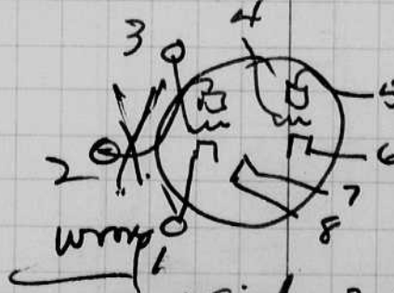
$\frac{245}{.011}$ = 22300 Ω.

assume 10 ma in glow $\frac{245}{.021} \cong$ 11,000 ohms

−350 V

$\frac{6.5^2}{6500} = .65$ watts.

$\frac{245^2}{10^4} = 6$ watts.



80B

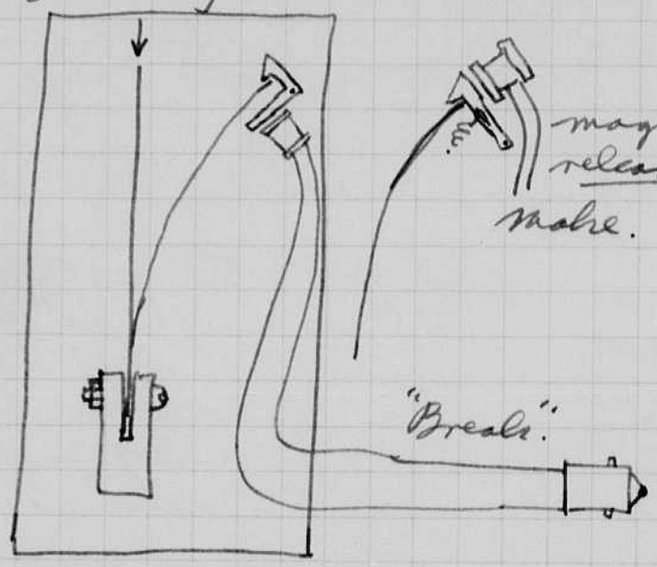
1 grid 2/3 plate cathode

Dec 16 1945

Harold Edgerton.

Flash bulb-Synchronizer tester.

The method described shows a mechanical method of testing a shutter for synchronism. The time delay element is a ~~spring~~ cantilever spring that is released by the trip current of the shutter. A permanent magnet holds the spring and is released by the trip current ~~of~~ there is a catch that releases the spring at the desired moment.

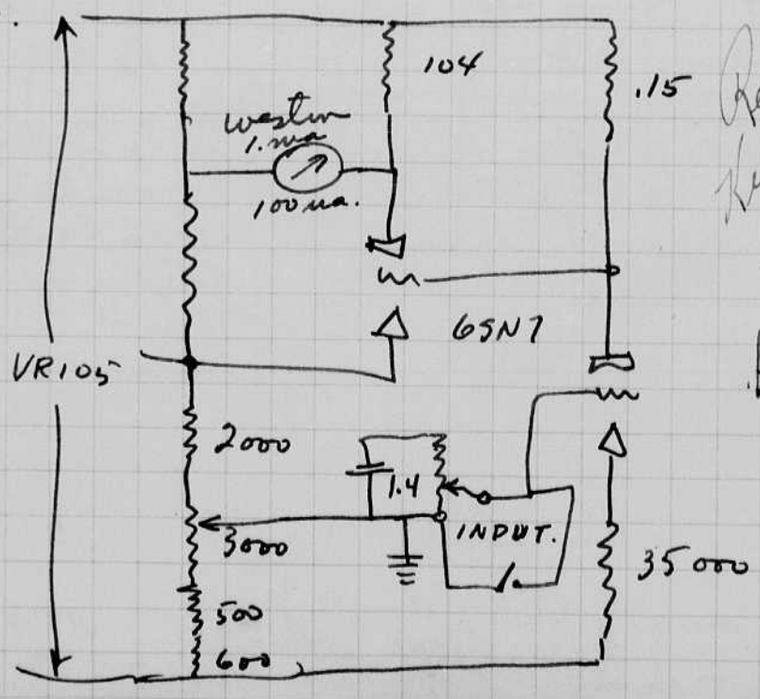


10 x 35 va 3.5 w.

the spring should be tensioned so that One cycle is covered in .08 seconds. the zero at .02 seconds will then be opposite the arrow.

$\frac{1}{.08}$ = 12.5 cycles/sec.

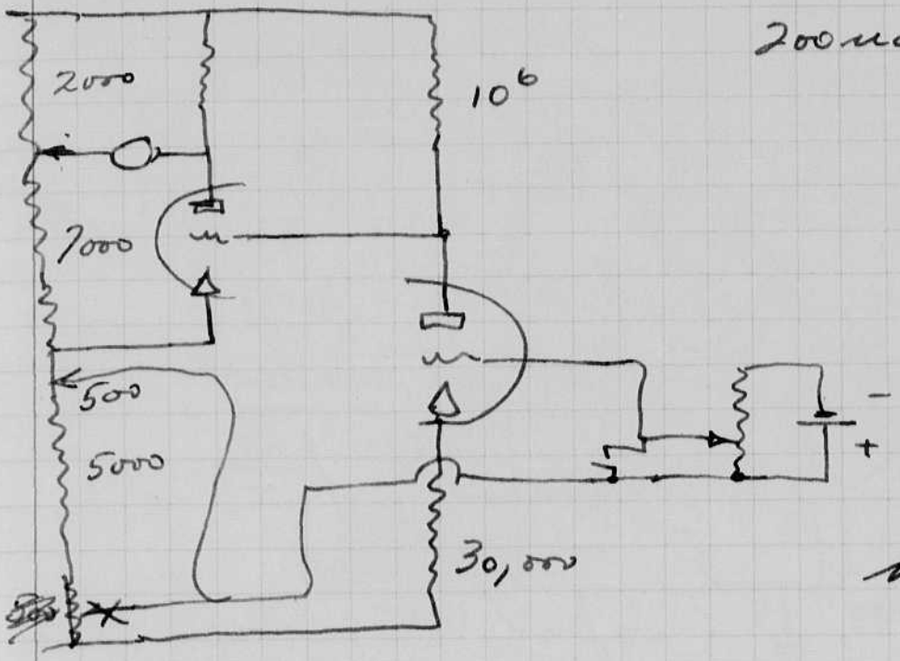
Dec. 17, 1945.



Read & Understood
Kenneth J. Germeshausen
Dec. 16, 1945

Herbert S. Grier
12-17-45

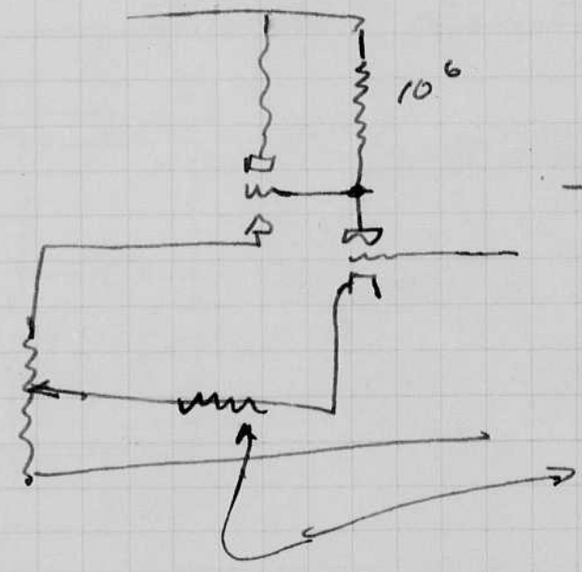
cont.
circuit changed to.



200 ma — 0.25 volts.

$$\mu' = \frac{\mu R_L}{R_L + R_G(1+\mu)}$$

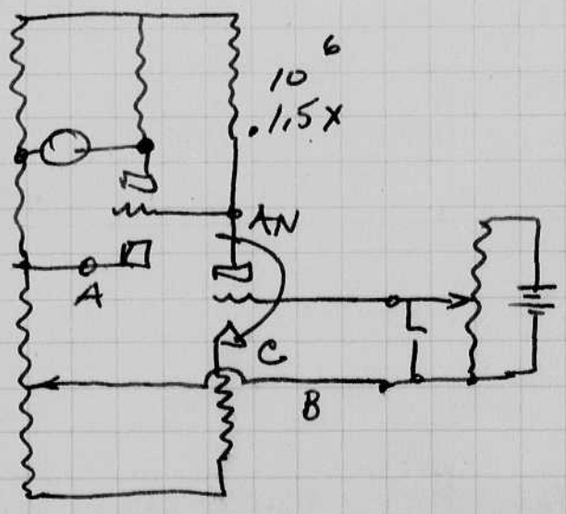
30,000
16
180000
30000
480000



This gives 600 ma with .05 volts. It is too sensitive! Balance drifts badly.

5000 ohms added here.

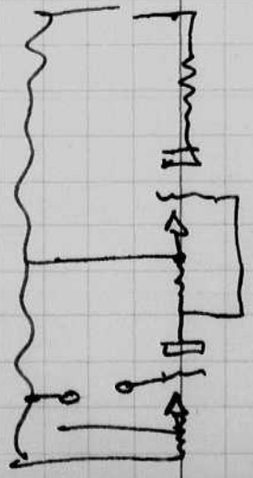
200 ma — .1025 volts input.



RCA Voltohmist shows

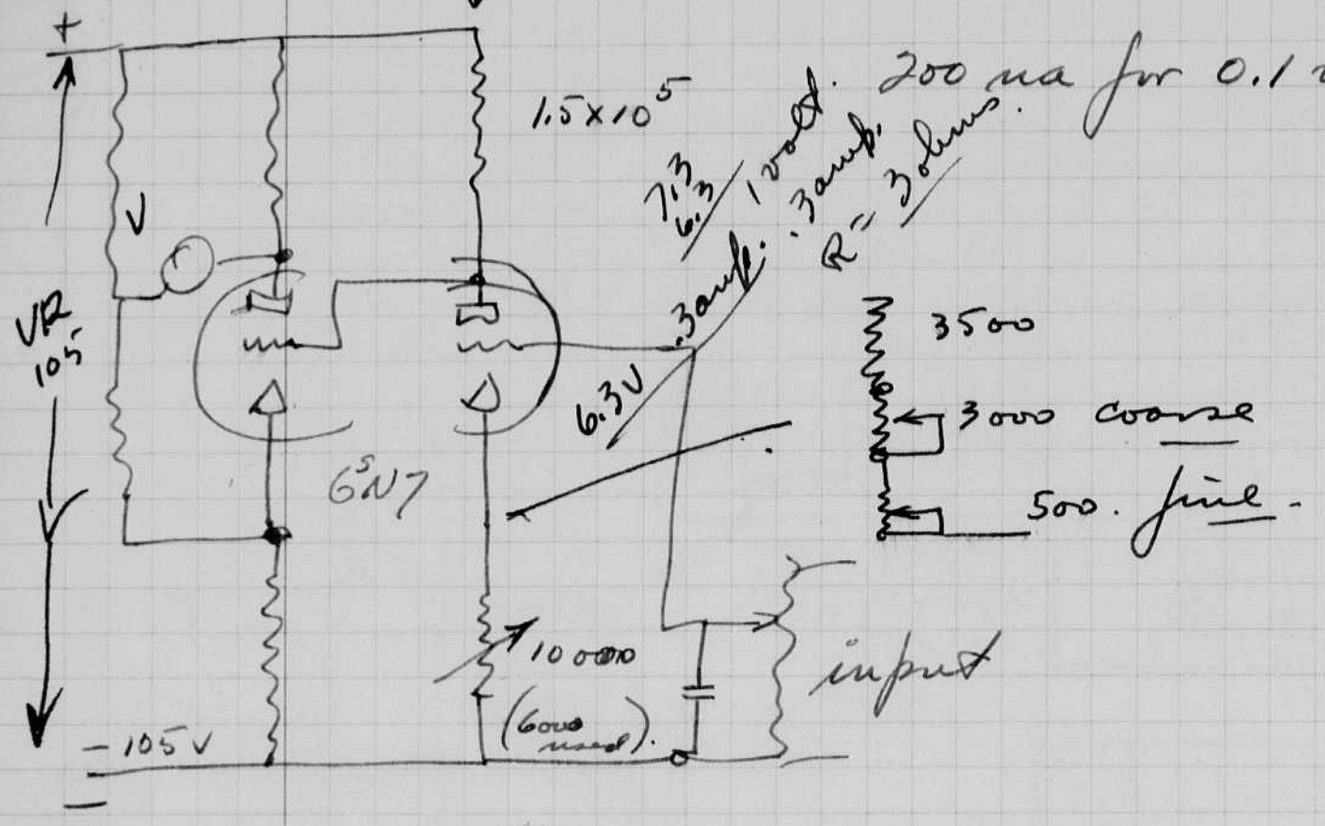
A-B	0
A-C	-3.5
A-AN	-3.5

?



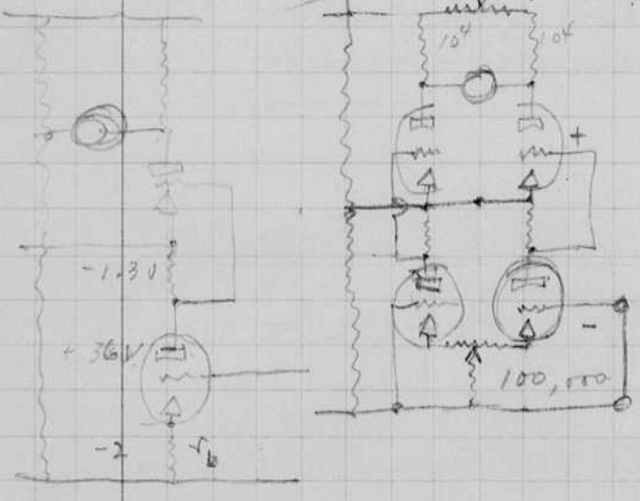
Stability with volts: NG.

110	160 ma.	114
115	15 ma.	114
120	−100	11K



200 ma for 0.1 volt.

1.3 volts.



$\mu = 15$

$r_p = 10{,}000$

Let $i_p = 10^{-6}$ amp.

$\frac{2.0 \text{ volts}}{10^{-6}} = 2 \times 10^6$ ohms.

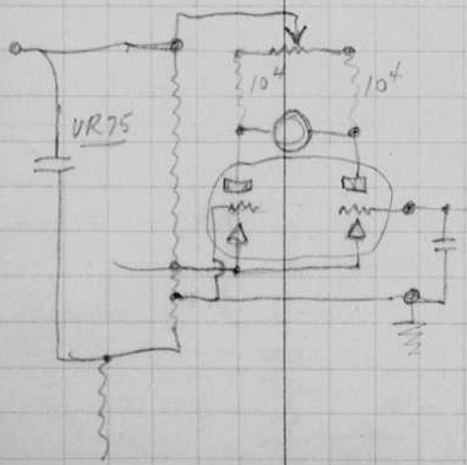
$i_p = 10^{-5}$ amps

$R = 2 \times 10^5$ ohms. =

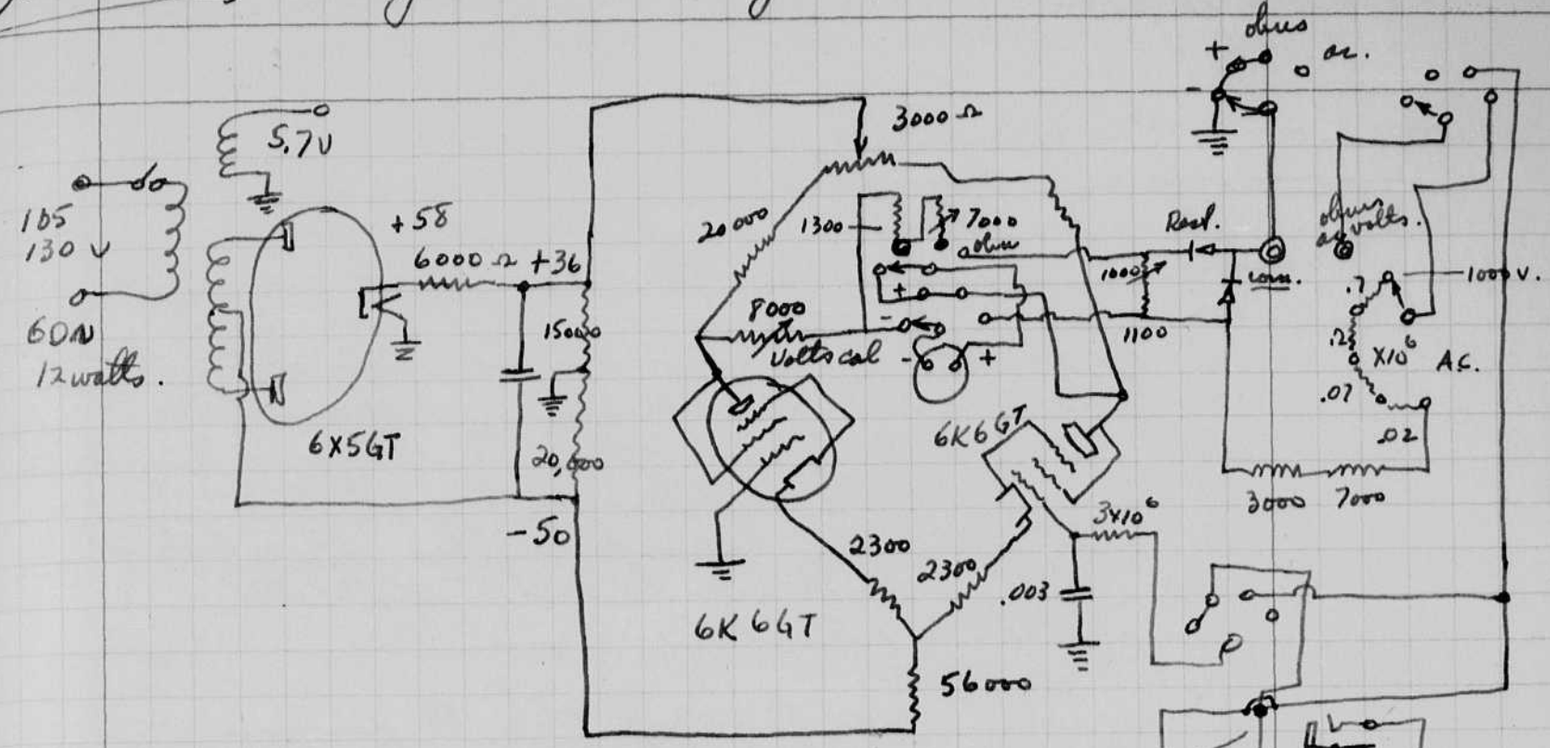
200,000 ohms.

$10^{-5} \times 6000 = .006000$ volts.

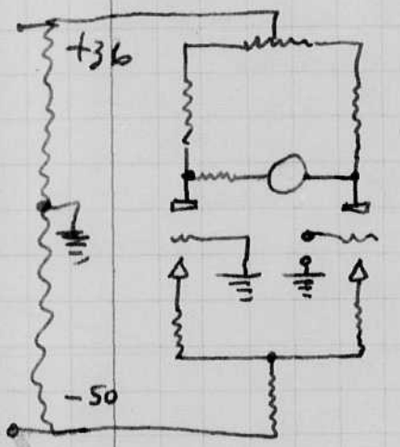
V gain of four needed. plus filament comp.



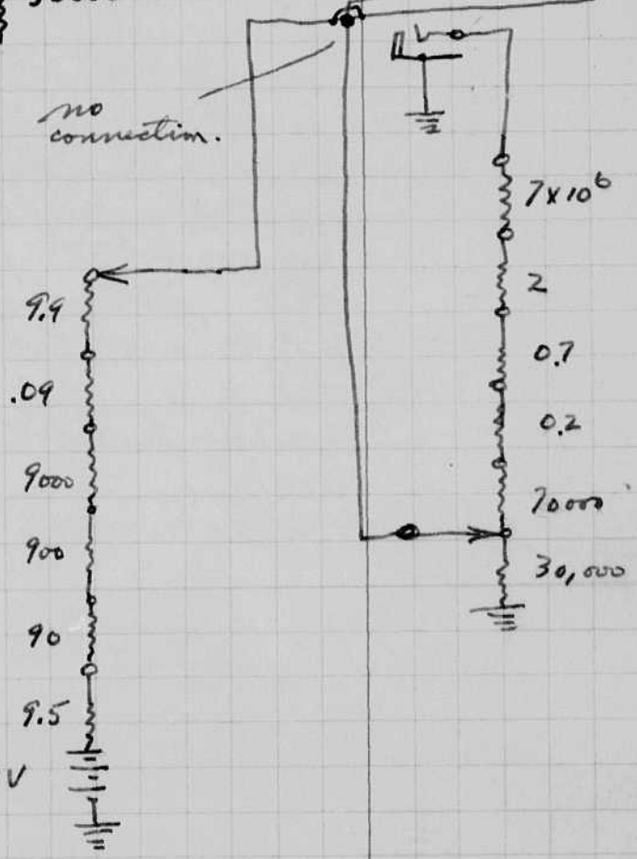
Dec 18 1945 RCA Junior Voltohmyst.



? 1300 ohms in "+" position
corrects for ~~table~~ characteristics



3 volt scale.

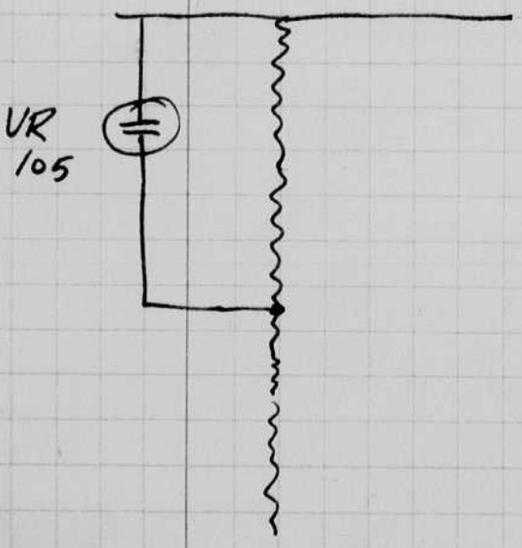


 Dec. 18, 1945
Harold Edgerton.

Conference this morning at G.R. in Richmond's office with Thiessen, Sylvania Bilms and Roach. Generalmen Brier and myself.

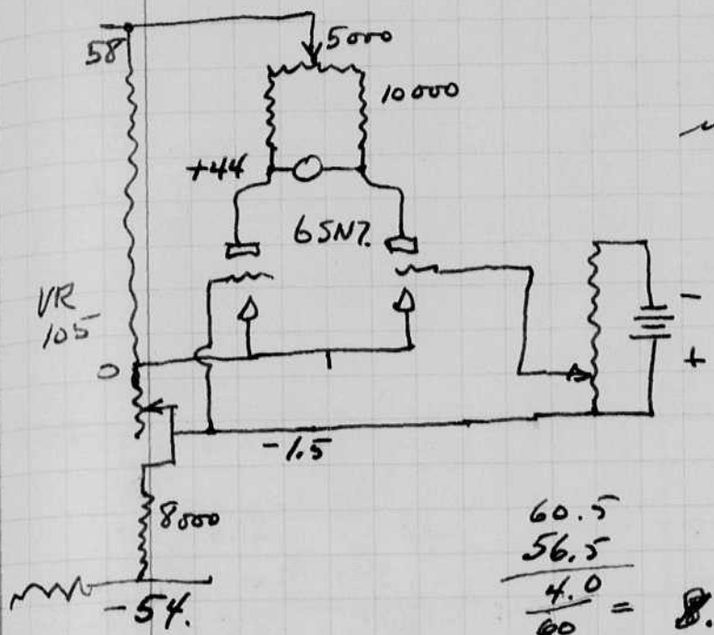
We discussed the names, Strobotac Strobolux and Stroboton. Hygrade will cease to use the first two names. They will not distribute the 648 Strobolux lamp. The Stroboton will be sold under the RMA number 1R21 (?).

Roach mentioned the Sylvania might wish to sell a Strobosnoop for $25. Richmond agreed that this would be satisfactory as long as the price did not reach more than 1/3 of the price of the Strobotac. Sylvania will approach us for a license if they wish to go ahead and we will take it up with G.R. since we have an exclusive agreement with G.R.



Dec. 19, 1945
H. E. Edgerton

Sen. 0.18 volts — 100 ma. 115 volts



ma.	I grid 0	I. Grid 0.1	E input
	25 → 58.5		105
	2 ↙		
	↑ when ~~set~~ went off scale negative for 20 sec ± then settled down at		125.
	1.0	61.5	125.

60.5
56.5
4.0

$\frac{4.0}{60}$ = 8.7% with 105 – 125 change.

The regulated voltage is about ~~130~~ 115 and holds ~~to~~ 115 ± 1 for 105 to 125. The change in sensitivity must be due to the change in filament temperature?

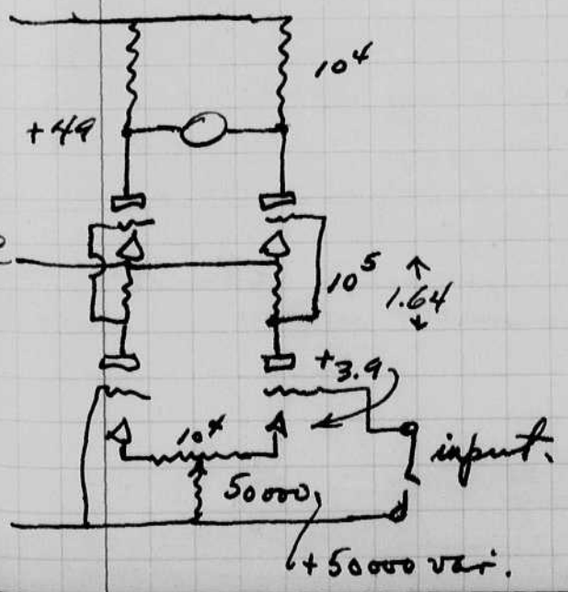
The plate voltage changes from 47 at 105 (Grid 1.48)
to +3 at 125. (1.50)
due to increased filament temperature.

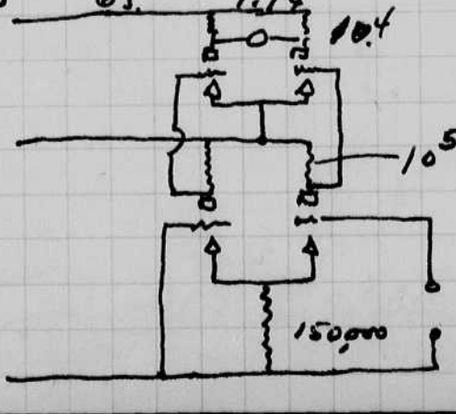
Compensation, change bias to hold E_p = const.

	ma/0.1	E_p	E_b	
105V	57.5	45.5	−1.48	.26 change of grid volts reqd. for compensation.
125	57.	*45.5	−1.74	

Sen. 115 volt. 200 ma for 0.105 v.

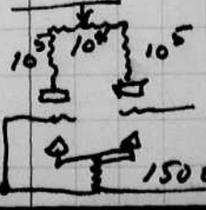
	ma/.05 v.	Eg.
115	65	~~1.64~~
125	68	1.64
105	63.	1.74

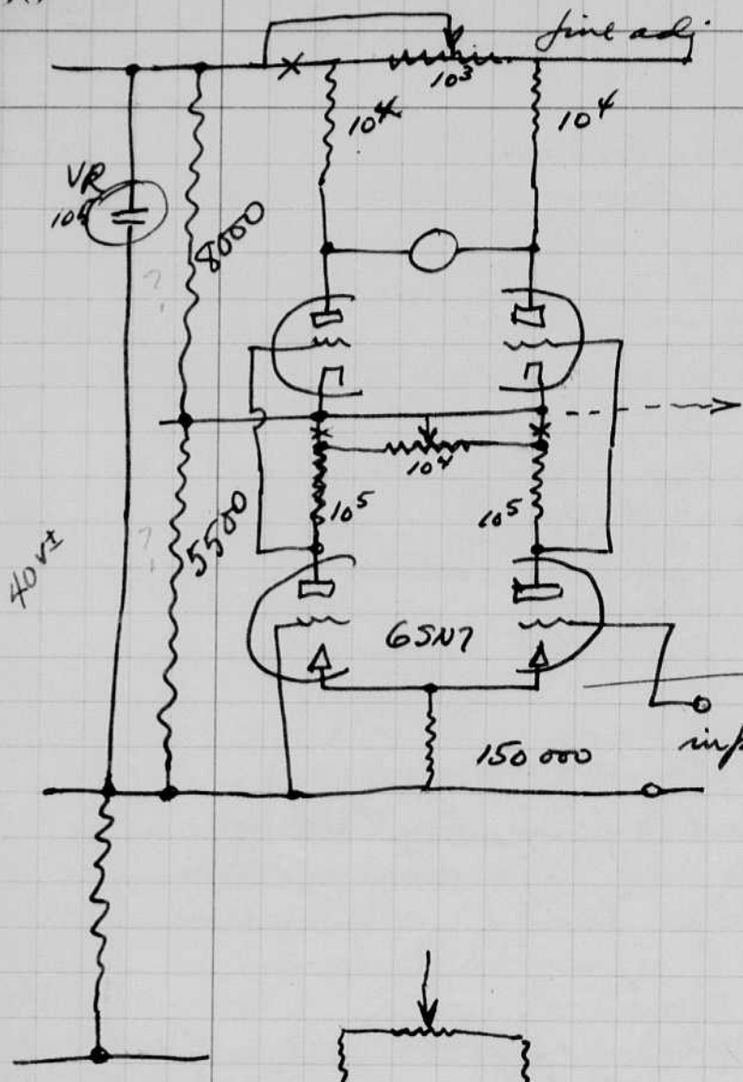




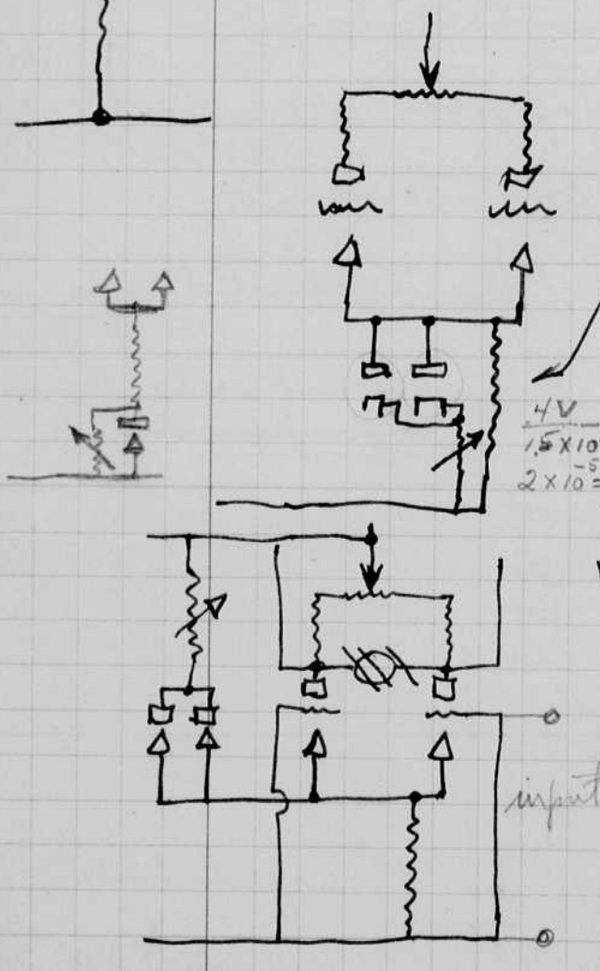
105	69
125	75

1.2 volt bias





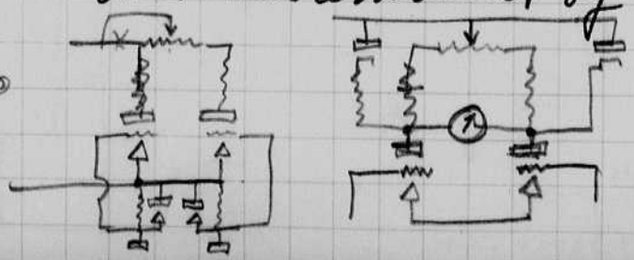
	dc.		
	105V	105	125
	+58	58.5	58.
	44	45	43
10^4 variable	should be		2×10^4
	−1.3	−1.15 → 1.23	
		1.23 → 1.33	0.1 change
	−51.5	51 → 3.95	51.5 → 4.12 bias
	−54.5	54	54.5
	71.		75-76

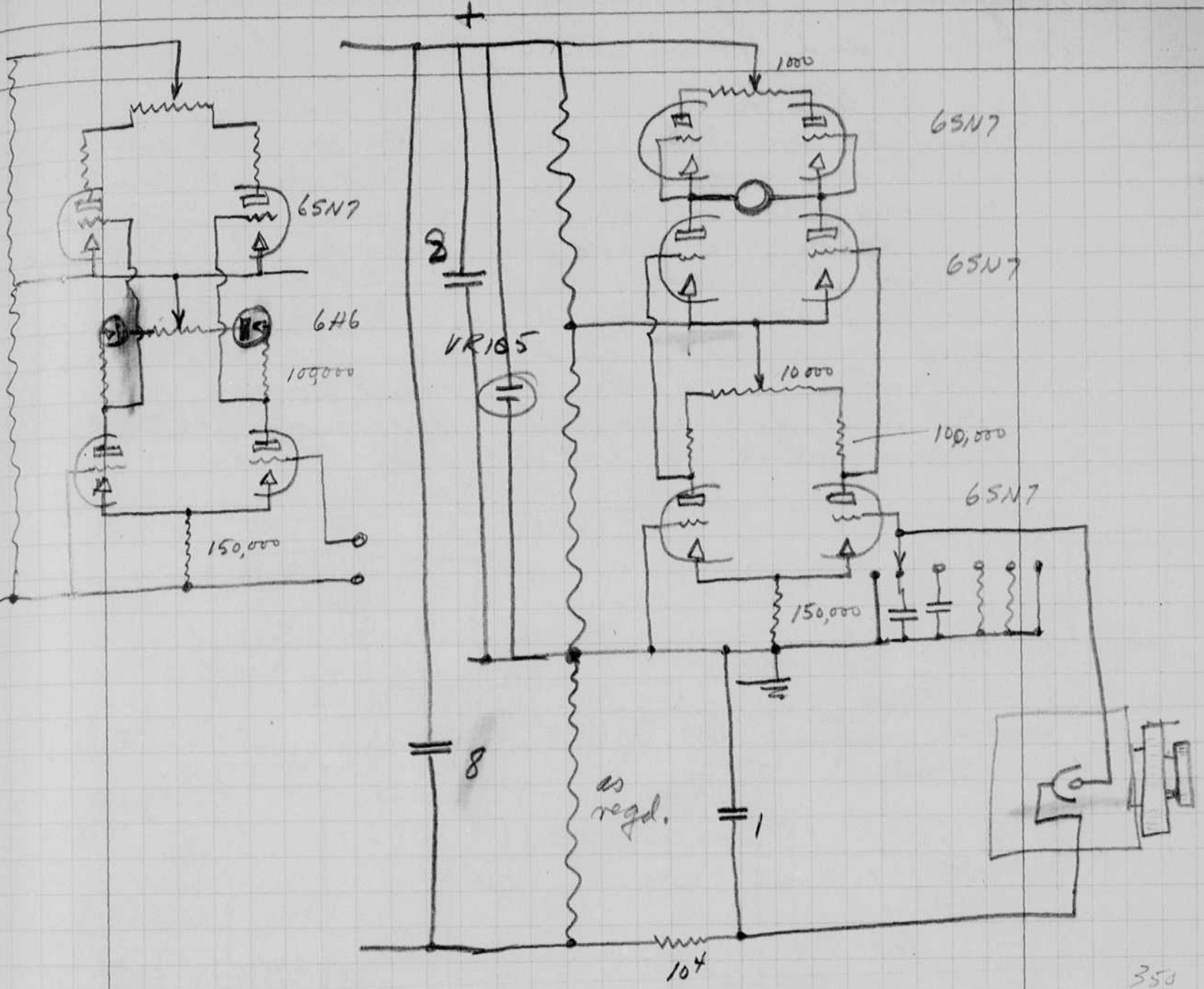


Compensation for cathode temperature variation.

the diode will change its characteristics due to cathode heating and will cause bias unchanged for the

this is the wrong way for the compensation? If so it could be put in as shown opposite. the variable resistor gives a control over the amount of compensation.

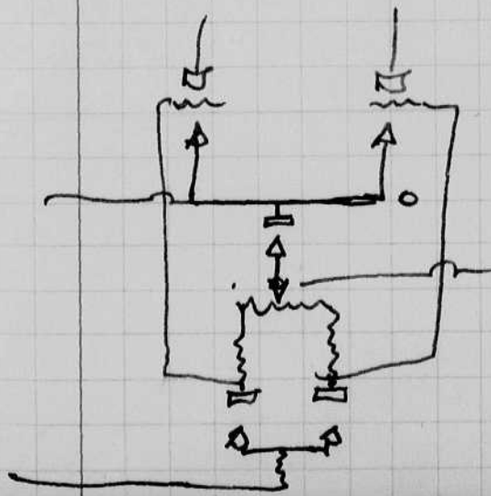




Dec 20 1945 connected as above with 6SN7 as plate resistor.

		E_p
125V	79 ma	44.5
105	69.	45.

the performance is worse with this combination.



	Zero.
125.	87.
105	100.

	e_g	e_g.
125V	1.1	1.27
105	1.19	1.29

this point is $.73 \begin{matrix}+\\+.55\end{matrix}$ with 125 / 105

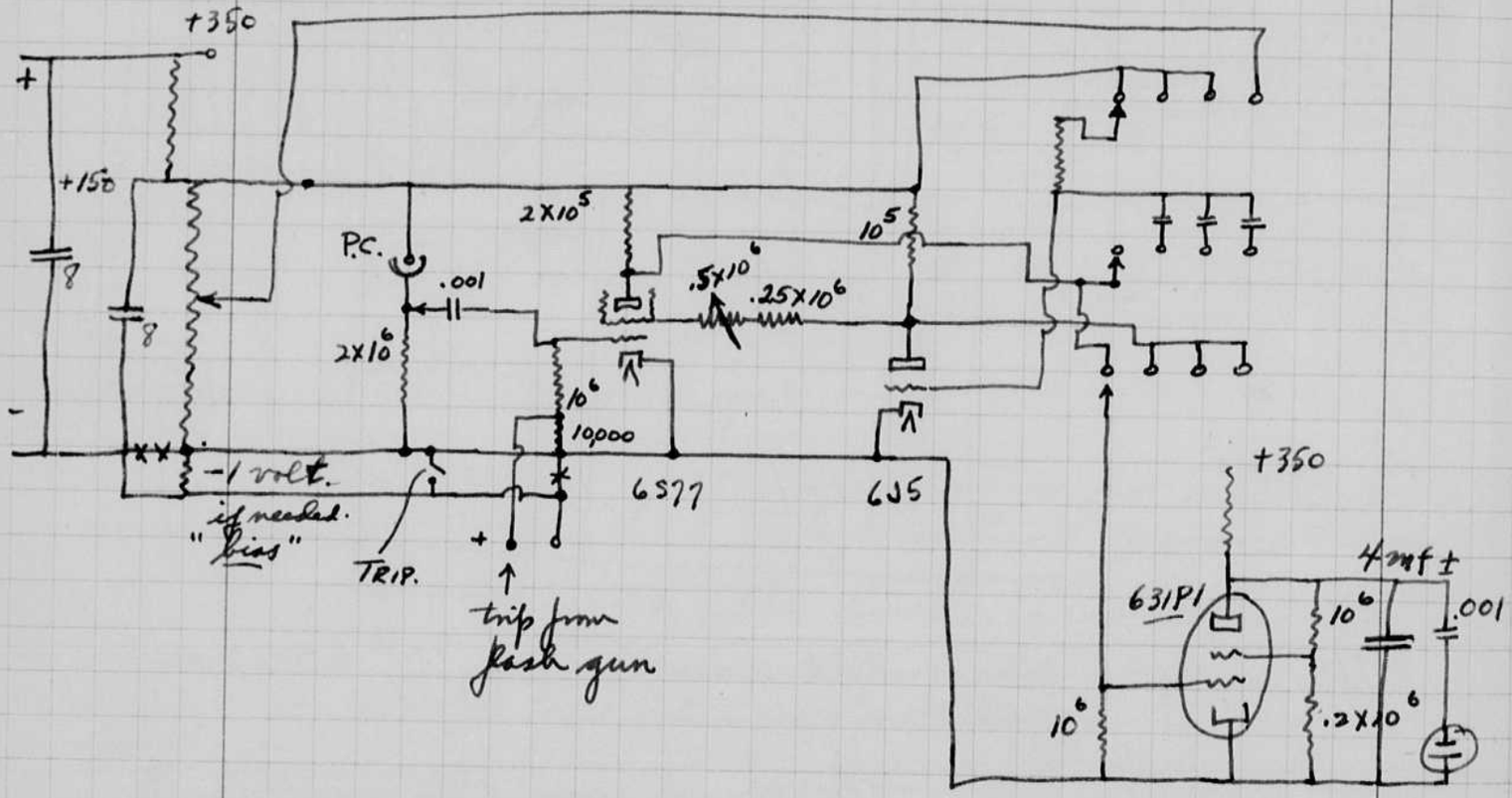
I put additional resistors across the self bias 0.5 and 1. megohm.

cont on p 133

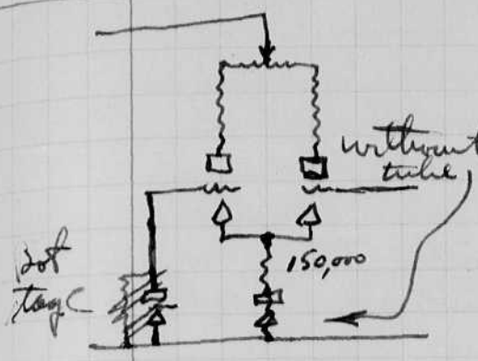
Dec 19 1945 cont. MIT
H. E. Edgerton

Syn. tester for flash bulbs.
and for electric flash. cont from p 119.

It is now proposed to have a decade switch with 0, 5, 10, and 20 milliseconds delay on the first four points. Then there may be an adjustable time delay or selected times might be used. other times that might be interesting would be 1/1. m.s. 50 · 100 and 200 400 and 1 second. (ten values). For shutter work 0, 5, and 20 are all that are needed. For variable time a max value of 200 or even 500 m.s.



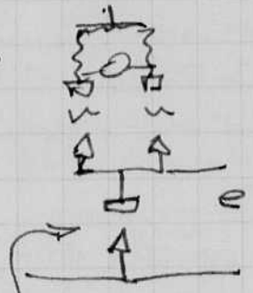
Female jones plug for Kodatron trip.



125	81	1.51	1.35	4.10
105.	72	1.37	1.22	3.95

without tube	125	76	} ? 10%
	105	69.	

Top Stage



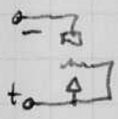
	105	125	
e	162	1.35.	

250 ohm shunt added

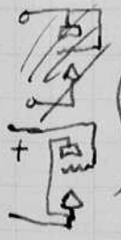
				Sen.
e_g =	1.54	1.66	125	72.
	1.47	1.63	105	60

Without the glow regulator tube the sen goes from 75 to 65

6SN7 e_g



-1.65	125	
-1.47.	105	



+1.2	125	
+.95	105	

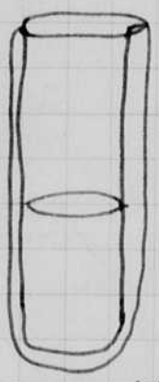
-1.44	125	.16
-1.28	105	

-.77	125	
-.67	105	.10
~~-.77~~	~~125~~	

Dec 24, 1945
H E Edgerton.

Radiant Energy of a flash lamp.

The following method was thought of during a discussion several days ago with Prof Allis. First the lamp is flashed in a calorimeter and the total energy is measured. Then the lamp is flashed outside the calorimeter and then put in before the heat loss from the glass is conducted outward. The ratio of the difference to the total is the per cent unit of radiant energy or the efficiency η.



Large mouthed thermos with oil.

Initial temperature of oil 24.01° C degrees.

Lamp flashed outside and then dunked in oil. 2000 V 128 mf. FT-1

Temp = 24.36°

about 2&3 minutes are required for equalization

Lamp in oil and flashed T = 24.90°

24.90
24.36
.54

$\eta = \frac{.54}{.89} =$

Start. 24.85+ .45

after flash outside the thermos 25.30 .55 .55

" " inside 25.85 55 $\eta = \frac{5}{56} =$

1/2 hr later

Start 25.50 } .60
Inside 26.10 }
outside. 26.40 } .3

$\eta = 50\%$

---

amount of oil reduced about 25%. →

Start 26.2
Inside. 26.95 .75 } .4
outside. 27.3 .35

$\eta = \frac{.4}{.75} =$

Dec 22 1945
Harold Edgerton.

Summary of Kyatt meter circuit Study.

Ballistic type without shutter - this type p 95-97 114 is not practical since the continuous light causes so much variation. The meter that I used had a one second time of oscillation which is too short for that purpose. I have dropped this type of meter for the time being.

A.C. type - double amp. tube for sensitive instrument. p 120 121 122-126, 129-131, 133.

① The double twin tube arrangement is required to compensate for voltage and tube changes.

② The gain can be increased from .4 volt for 200 ma to 0.1 volt for 200 ma by the use of a pre stage amplifier. This is run at 1/10 the plate current of the output tube to decrease the grid current due to ion current.

③. It is important to stabilize the cathode current of the tubes. 10% variation in ~~stability~~ sens is obtained when the voltage varies from 120 to 105.

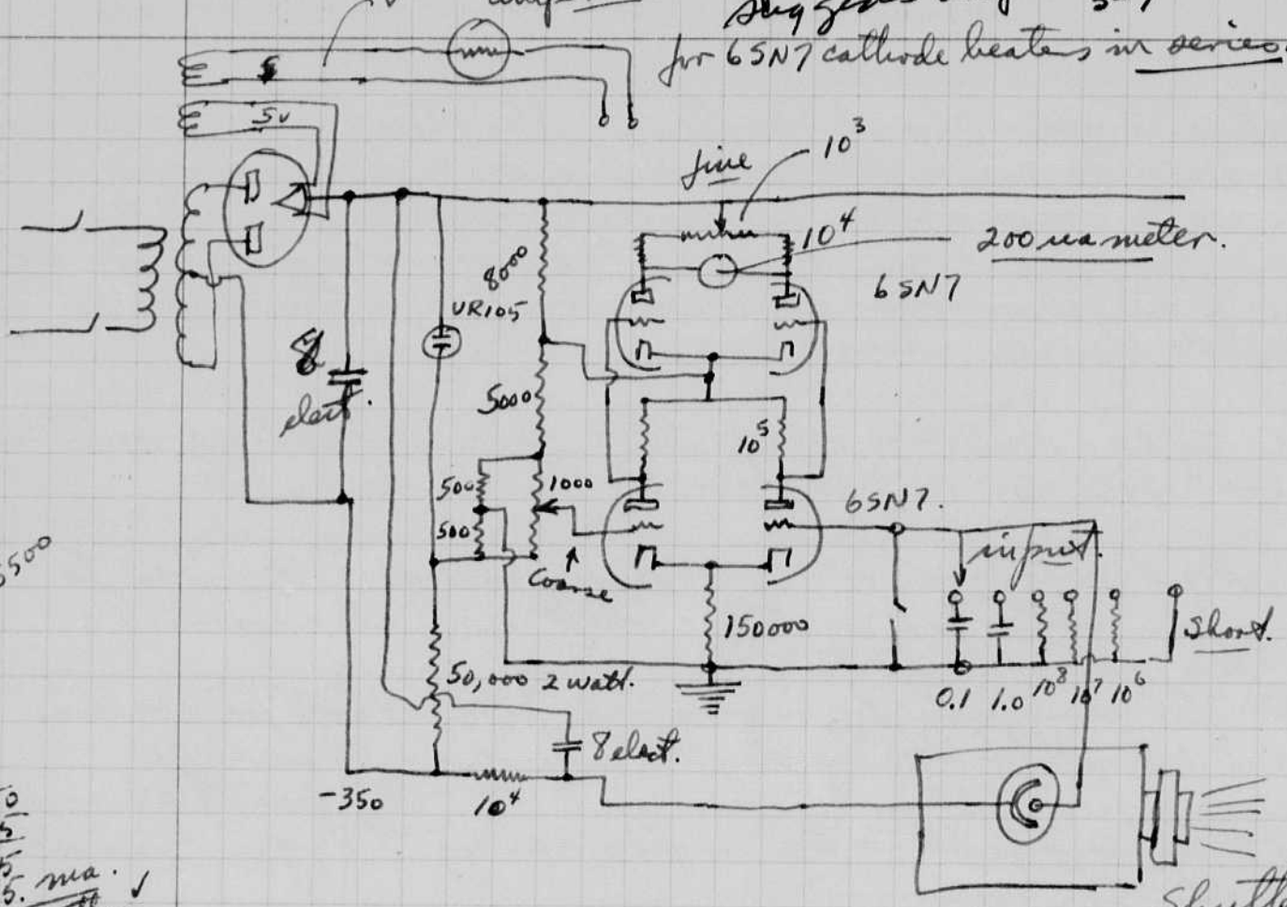
④. Voltage stabilization of the plate supply is desired. I used a VR 105 with success.

See following page for complete diagram as finally evolved.

Cont.

Final circuit for flash light meas. apparatus.

Amperite Co suggests amperite 3-7 for 6SN7 cathode heaters in series.



45 5500

350
105
245
.015 ma. ✓
1.225 watts.
50,000

5) 245.

6.3 - 5.7

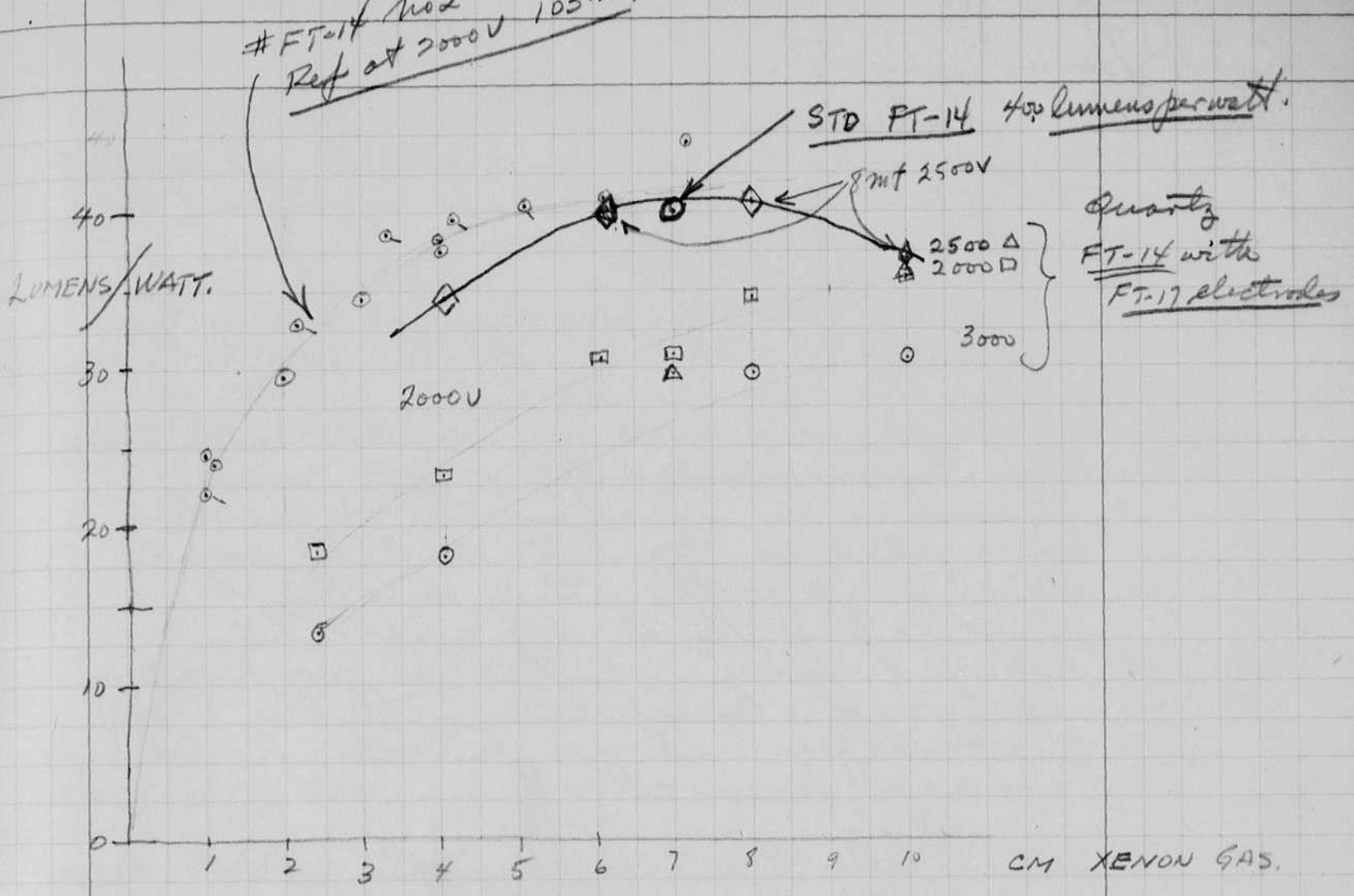
6.3 x .9 = 5.9

300 - 281 ma.

300 Ω 20 ma } 280. 6SN7 Heater.

$\frac{5.9}{.020} = \frac{300}{294.0}$ ohms. in parallel with each cathode heater.

These stabilize for 300 ma.


#FT-14 No2
Ref at 2000V 103mf. 40 lum/watt.
STD FT-14 40 lumens per watt.
8mf 2500V
Quartz
FT-14 with
FT-17 electrodes
2500 △
2000 □
3000
LUMENS/WATT.
40
30
20
10
0
2000V
1
2
3
4
5
6
7
8
9
10
CM XENON GAS.

Jan. 11, 1945

Harold E. Edgerton

I was called to Aurora, Nebr. on Dec. 27 by a serious operation on my mother. I returned to Boston on Jan 6 after she appeared to be on the way to health.

Brier Barstow and I visited Raytheon and tested the Warner Brothers stroboscope.

There was hold over trouble with 8 mf. Operation was ok with 4 mf. Series inductors as used in the D-1 were connected in the high side of each discharge path. This did not influence the 4 mf operation except for a slight increase in output. Operation with the 8 mf was improved as far as hold over was concerned.

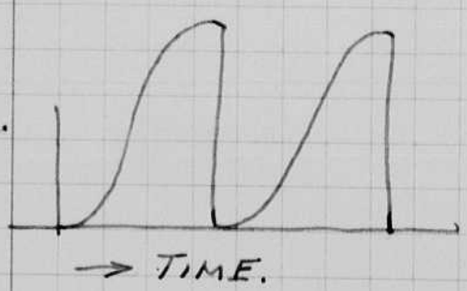
With 8 mf the lamps hold over after a 30 second ± operation. More air might help this situation.

Measured AC input with 4 mf at 48 cycles. Both lamps firing at once.

226 volts.
7.3 amperes. } 1650 volt amp.

D.C. – 130 volts.

The oscillograph showed that the timing of the charging cycle was OK.



$\frac{247}{4\frac{2600}{2}} = \frac{247}{13.5} = 18.3$ flash/sec

If the lamp effy n = 26 lumens/watt
4 mf 2600 volts.

$$Q = \frac{CE^2}{2} 26 = \frac{4\times10^{-6}\ 2.6^2\times10^6}{2} 26 = 135.\ \text{lumen/sec.}$$

$\frac{200}{135} \times 4 = 5.95$ mf.

If the capacity is increased to 6 mf the light output will be 200 lumen/sec per flash and the lamp should be able to run continuously without over heating.

Exposure factor $dxf = K\sqrt{\frac{CE^2}{2}n}\sqrt{M}$

$$= 80\sqrt{\frac{200}{14.1}}\sqrt{M} = \underline{\underline{113.}}\sqrt{M}.$$

$$\cong 200.$$

f 11 $\sqrt{200}$ 20 ft.

Jan. 12, 1945. Further experiments were made yesterday on the Warner Brothers Movie equipment.

Reflector factor = $\frac{135\times4}{50} = \underline{\underline{10.8}}$ D-1 reflector with FT-24.

Light output with 4 mf at 48 cycles (one flash measured).

$$\frac{Q_1}{Q_{sta}} = \frac{M_1}{M_s}\left(\frac{d_1}{d_s}\right)^2\left(\frac{f_1}{f_s}\right)^2 = \frac{50}{97\times\frac{144}{23}}\left(\frac{68.5}{120}\right)^2\left(\frac{5.6}{5.6}\right)^2$$

50 / 1

$$= .0825 \qquad .325$$

$Q_s = \frac{CE^2}{2}\times0$

$= \frac{103\ 2120^2}{2}\times20 = 9250$ lumen/sec.

$Q_1 = Q_s \times .0825 .325$

$= 9250\ .0267 = 247.$ lumen/sec.

Photo tests were made on super XX film at 15 ft at f 4.5, 8, 16, and 32. The f 4.5 and 8 were okay. 15 x f 5.6 = 84 guide factor. The negs. were developed in D 72 for 5 minutes at 70°.

 Jan 14 1946. H B Edgerton

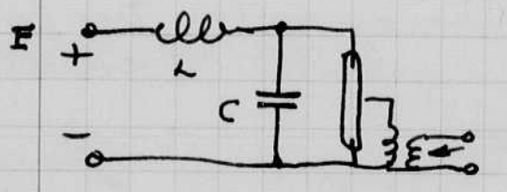
Comstock called in the morning to discuss airport lighting with flash tubes. It appears that experiments have been made at 1½ sec intervals with Sylvania equipment. The intensity seems to be o.k. but the rate should be increased. There was no halo around the light in hazy weather. 40 lights are required for a runway with wave synchronization.

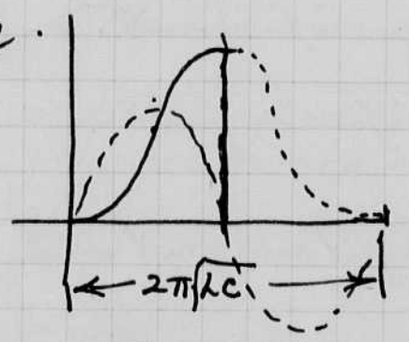
Suggested 3 flashes per second as a good value to use.

Carlson and Snyder called. We went to Raytheon to inspect the Warner Bros flash unit. The efficiency appears to be about 90 % with choke charging.

I had dinner with Carlson and Snyder at the Parker House, after which we discussed flash lamps and circuits.

Choke charging.





$\frac{1}{f} = \pi\sqrt{LC}$ $\quad I_{max} = \sqrt{\frac{C}{L}}\,E$ for choke rating.

$\text{flash freq.} = \frac{1}{\pi\sqrt{LC}}$

$L = \frac{1}{f^2\pi^2 C}$ henries.

Jan 16 1946
H.E. Edgerton.

Power Limitation and frequency limitation of flash tubes.

An experiment was made with a FT-14 tube to determine its power rating. C = 1/4 mf V = 2000 f = 120 cycles. after 20 or 30 seconds the ~~spark~~ punctured a hole in the glass tubing. The loading at this level corresponds to about 60 watts into the lamp $P = (CE^2/2) f$

At 30 cycles this lamp runs continuously without difficulty. A charging resistor of 5000 ohms was used for this experiment.

$$f = P\left(\frac{2}{CE^2}\right) = \frac{15 \times 2}{4. \times C}$$

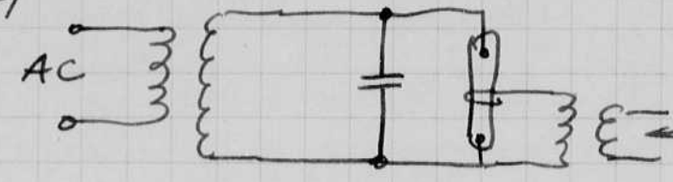
	f	T
C = .25	30 cyc. per sec.	.033
= .5	15	.066
1.	7.5	.133
2	3.75	.267
4	1.88	.532
8	.935	1.07
16	.467	2.14
32	.233	4.30
64	.116	8.64
128	.058	17.2

Jan 21 1946.
H.E. Edgerton.

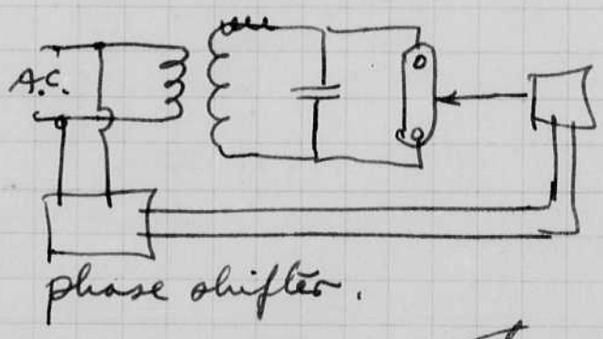
Flash lamp intensity adjustment.

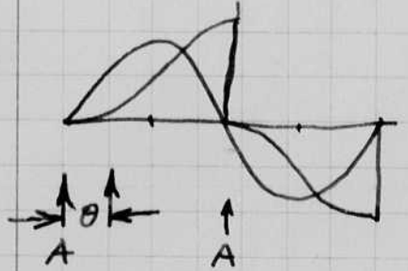
There are to be many uses of xenon flash lamps because of the high efficiency and the desirable color.

An efficient method of regulation of intensity is desired for some of these applications. One such method is described here which is efficient since no power is consumed in the system.



The method is to flash the lamp at different phases with respect to the ac input. In this way the charge on the condenser will have different values depending upon the ac transient.





The maximum output is obtained by firing the lamp at the zero of the cycle. A.

The output will decrease with the angle of firing.

Read + understood
1-21-46
Herbert E. Edgerton

Feb. 9, 1946.
Harold Edgerton.

Yesterday I arranged for Kern to show his electric earrings to Egna Stevens of the Stevens Arnold Co in Boston. I gave a demonstration of the earrings at my home on Jan 25 at which time my 611 class of which Walt Kerr is a member were guests at dinner. A mercury switch was discussed at the time for flashing the lights alternately. This was shown to me this morning by Kerr. I witnessed a demonstration this morning.

On Feb 11 the case on the static inventor is scheduled to be heard in Washington. Frank and Bowles will be experts.

"Deaf" Smith.
the cowboy
photographer.

Mr. & Mrs. Eugene Klein

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H.E. Edgerton.

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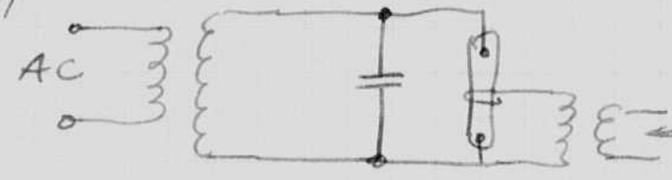
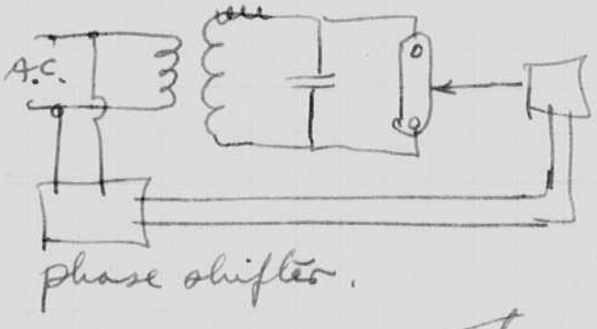
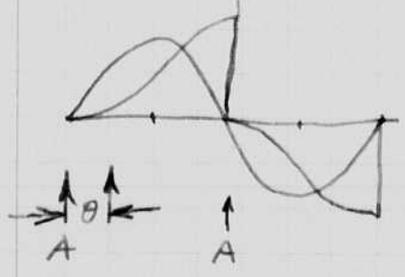
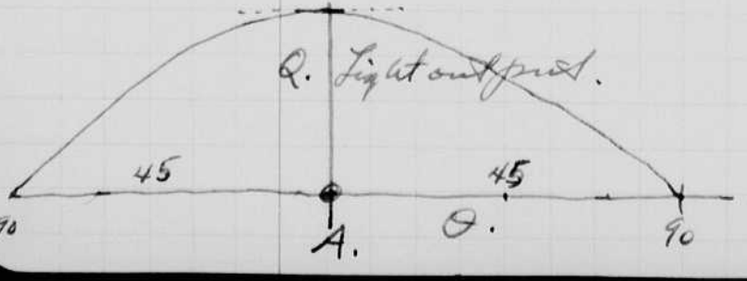


The method is to flash the lamp at different phases with respect to the ac input. In this way the charge on the condenser will have different values depending upon the ac transient.







The maximum output is obtained by firing the lamp at the zero of the cycle. A.

The output will decrease with the angle of firing.

Read + understood
1-21-46
Herbert E. Edgerton

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On Feb 11 the case on the static inverter is scheduled to be heard in Washington. Frank and Bowles will be experts.

"Deaf" Smith.
the cowboy
photographer.

Mr. & Mrs. Eugene Klein

See p. 134.

A DIRECT METHOD OF MEASURING THE RADIANT ENERGY OUTPUT OF AN ELECTRICAL-FLASHLAMP

The radiant energy from an electrical-flashlamp can be measured directly by the following calorimetric experiment where two measurements of temperature rise are made of oil in a thermos bottle. For the first experiment, the flashlamp is flashed under the oil and a reading of the temperature rise, Δt_1, is made after the oil has reached an equilibrium temperature with the flashlamp. Here the <u>entire</u> energy, $CE^2/2$, that entered the lamp is used to produce heat since the radiation is absorbed by the walls and by the oil. A second temperature rise, Δt_2, is measured by flashing the lamp <u>outside</u> of the thermos bottle and then dunking it in the oil before any of the conduction heat inside the bulb can escape. Since the radiant energy is not absorbed in the oil for this second experiment, the temperature rise will be due to energy that does not radiate.

The output of radiant energy is then,

$$(\Delta t_1 - \Delta t_2)K = W \text{ joules}$$

where Δt_1 is the temperature rise of the calorimeter when the lamp is flashed in the oil,

Δt_2 is the temperature rise of the calorimeter when the lamp is flashed <u>outside</u> the calorimeter and quickly inserted,

K is the heat capacity of the system, and since

$\Delta t_1 K = CE^2/2$ = energy in joules from the condenser,

$$(\Delta t_1 - \Delta t_2)\frac{CE^2}{2\Delta t_1} = W \text{ joules.}$$

Likewise the efficiency of the lamp to produce radiant energy is

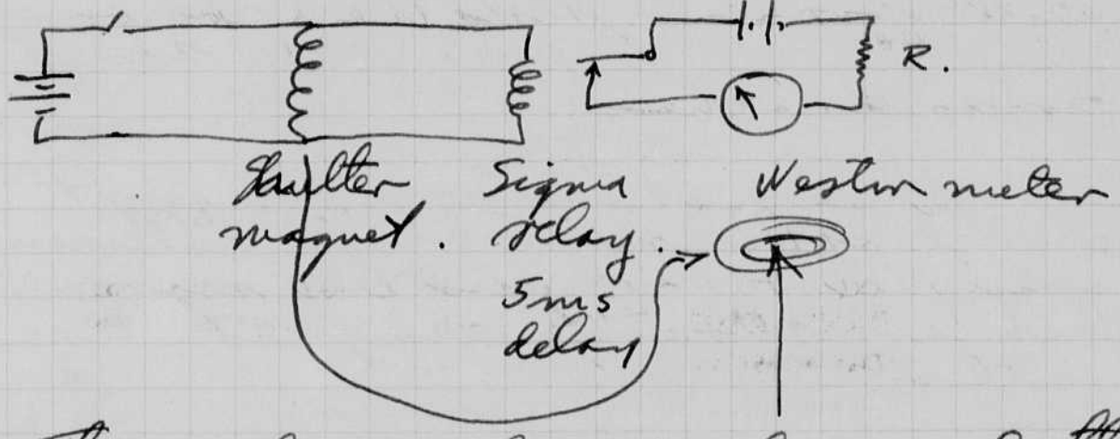
$$\frac{\Delta t_1 - \Delta t_2}{\Delta t_1} = \eta \text{ (<u>numeric</u>)}$$

For a typical flash lamp such as the Kodatron FT-2 the efficiency is 25 to 50 per cent for the first experiments that have been performed. Accuracy of the experiment is limited by the temperature-rise reading which was about one degree centigrade. The experiment needs to be repeated with a smaller quantity of oil and greater energy so that the temperature rise can be more accurately observed.

Harold E. Edgerton
February 8, 1946

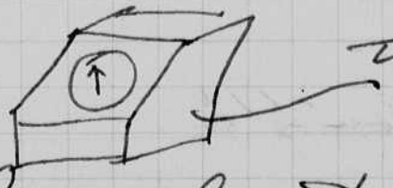
Feb 15 1946
Harold E. Edgerton

Mr. Broadhead of the Western Inst. Co. brought in two experimental meters about a month or so ago. One of these was a blade face oil temp indicator with a wide white pointer. This was for use in the flash bulb synchronizer that is described on p 101. The device was connected up with the sigma relay and tried the same day that the meter was obtained. It worked very well.



The meter needle is observed through the shutter when it snaps. I adjusted the resistance R so that the reading was 20 for 20 milliseconds delay.

Nippon then took the equipment down to Photo service and after resizing it so that, as is, rebuilt it into a box with a slant top.



I was down to see him this morning. Apparently the device is working fine.

Nippon wants a continuously adjustable time delay on the electronic device with the thyratron tube. See page 132 for the step adjustment method.

March 4, 1946

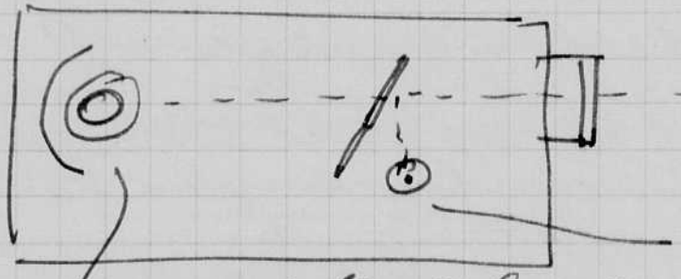
Harold E Edgerton.

Stanmont, Condon, and Martin arrived yesterday and were out to my house last night.

I was at the Technifinish lab on Feb 27 at Rochester and at Eastman on Feb 28 to work on the design of the studio and flash unit.

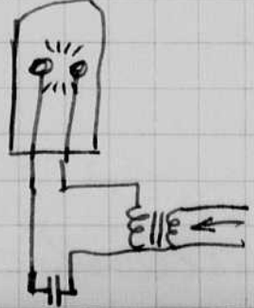
At Technifinish discussed flash equipment with E.G. Edwards and Bill Brown. Told them we would give them a license on the same terms as others.

I saw at Eastman, the first model of the microscope illuminator using the FT-14 and the mirror that moved with a magnet control.



This needs the ~~FT~~ gap tube of the type that I made some time ago.

Series triggering should be very useful for this type of lamps.



Registration today at M.I.T. for the new term.

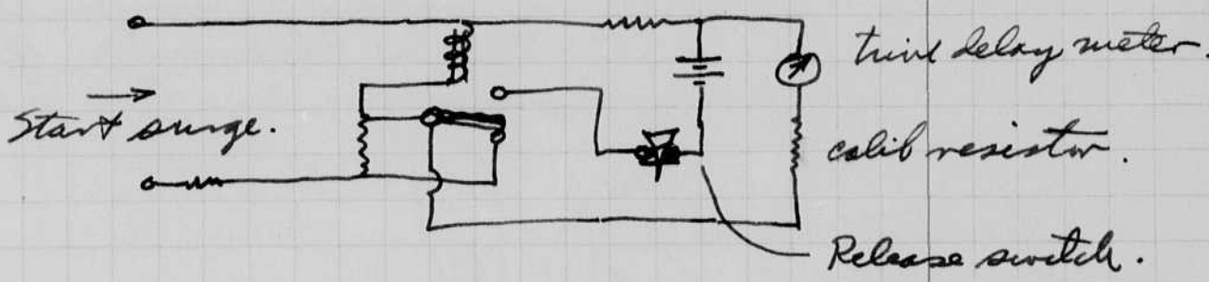
Jack McKinnon arrived last night from Syracuse N.Y.

cont. The magnet synchronizer for photoflash bulbs was tested at great length at the E.K. Co. It did not work on the shutter contacts since they only close for two m.s. I need a relay that self closes with a contactor so that time can be read.

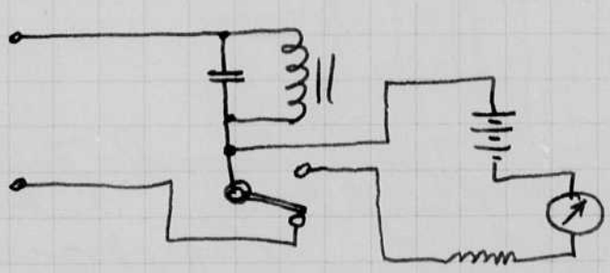
Born, Mentch, Zink, were at Eastman for the tests.

The self-closed contact relay needs a release after .05 seconds, otherwise the battery will be run down. Possibly a condenser of the low-voltage electrolytic type would do the job.

Hold in circuit with release switch.



Condenser to keep relay closed for .05 seconds.



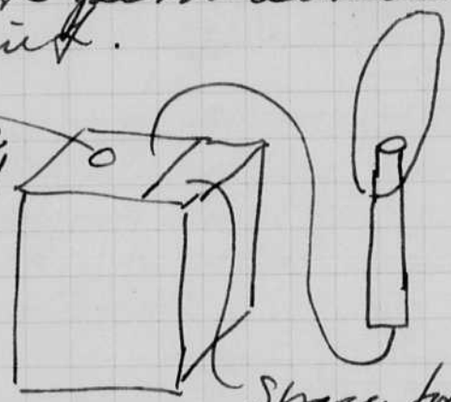
March 5, 1946.

Harold E Edgerton.

Last night at 5 pm, Peek and Handy brought in an ac operated flash unit for Stanmyre, Condon, and Martin to inspect. Bristow also saw the unit.

There was no flash bulb available so we put in an FT-14 and helped kick it off with a spark coil.

The unit has 12 mf at 400 volts with a relay to connect the condenser to the lamps. All cords are permanently connected to the unit.



Space for cords to lamps, ac, shutter and flash trip. a top, hinged, covers the unit. The price has not been determined but will be less than $200. Total weight 15 pounds.

Fredson 13 lbs

Peek also brought in an exposure meter for measuring light.

March 10 1946 Two classes this term 6.19 and 6.632. so I guess I will be plenty busy.

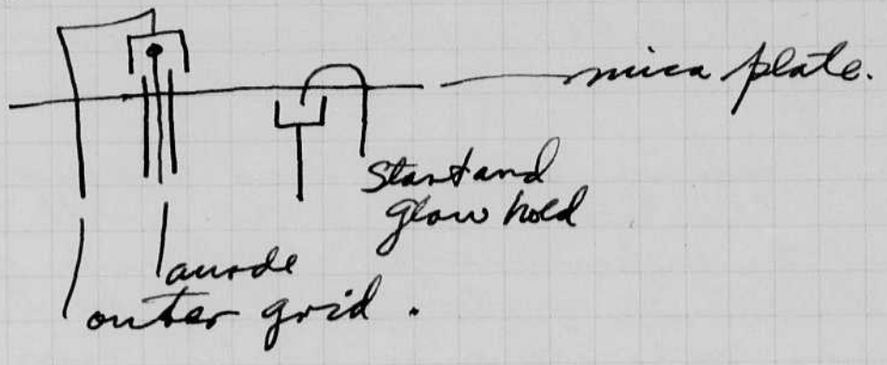
Jack McMorran has been here a week at M.I.T. as a sophomore in architecture. He is living with us.

Hunter from Toronto is to help in 6.632. Edwards from technifinish used my portable one the weekend to take pictures of his children.

March 15 1946.

H. E. Edgerton.

Small central strobotron came in from Hygrade today. Miniature base.



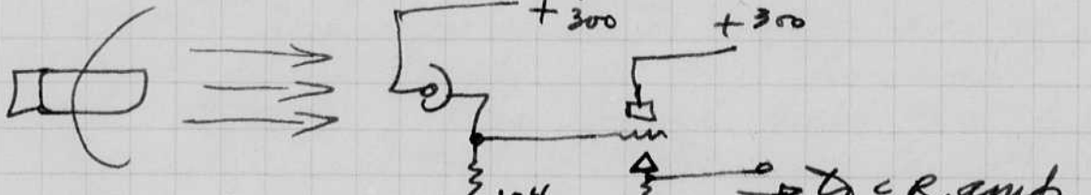
K. E. Edy
Mar. 21, 1946.

Meeting of Basic Research group in Bldg 20 with Stratton at 11 today. Discussed policy and financial support of lab by government and industry.

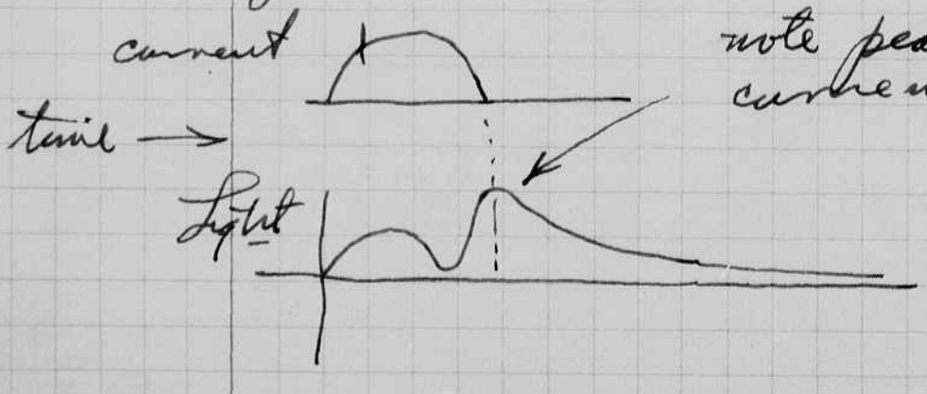
Our lab in 20-236 has 7 students K Hunton from Toronto is assisting with the set up of the experiments. Dynamic gaseous conduction experiments are the ones that we are working on at the moment.

Students. Linvill brothers.
Wong.
Christian.
Loh.
Verouh.
French.

I set up a stroboscope to observe the light output with a photocell



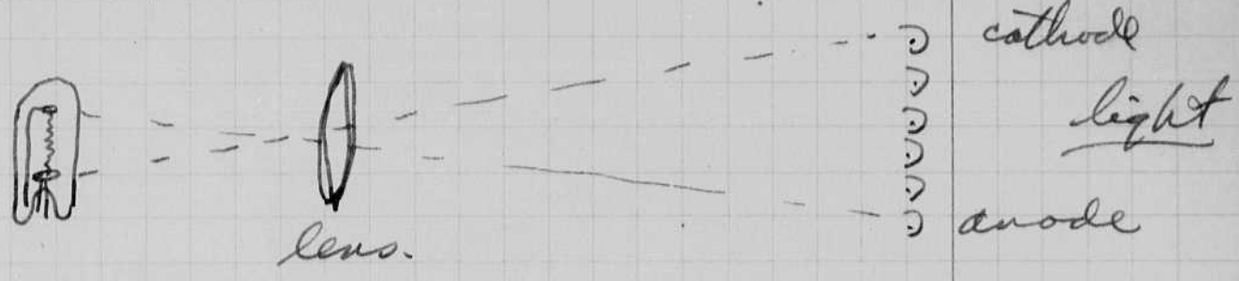
the oscillograph showed most of the light after the current ceased. Of particular interest is the fact that the ~~current drops~~ light drops to zero and then rises



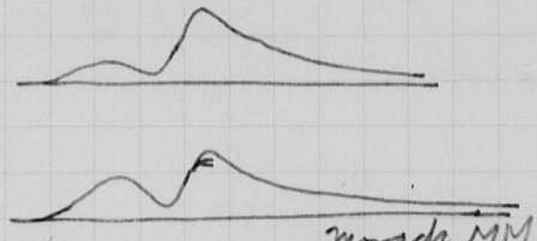
note peak is reached about current zero.

Cont.

a lens was set up yesterday to project different parts of the arc into the photo tube.

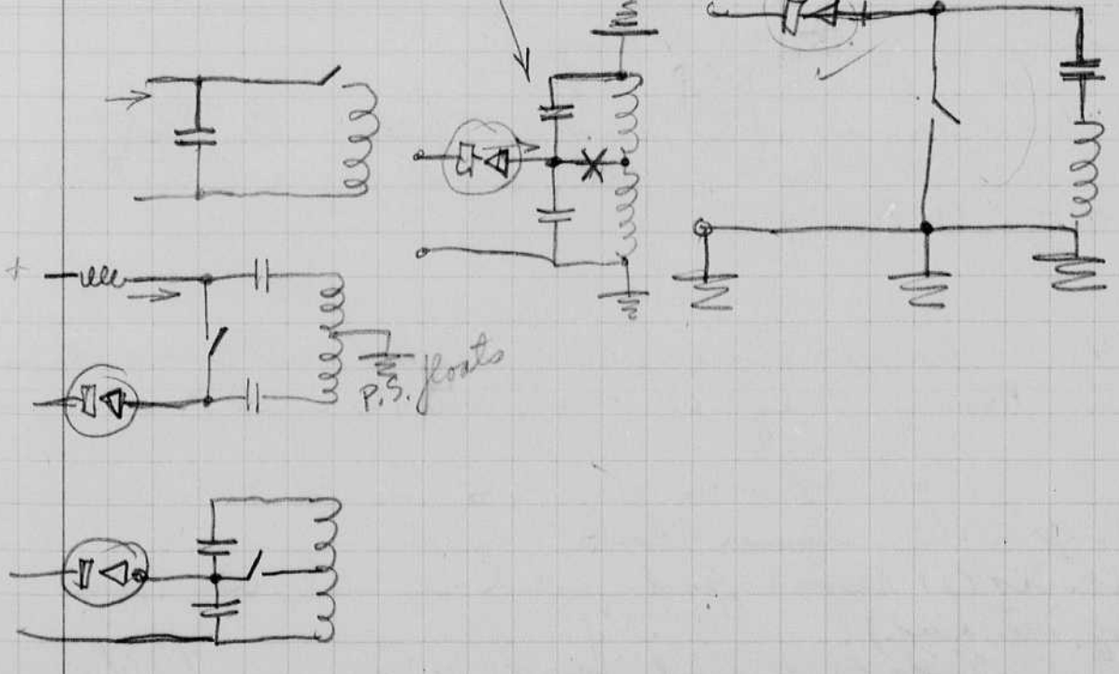


There was a difference in the two pictures. The relative sizes of the first and second peaks were different.

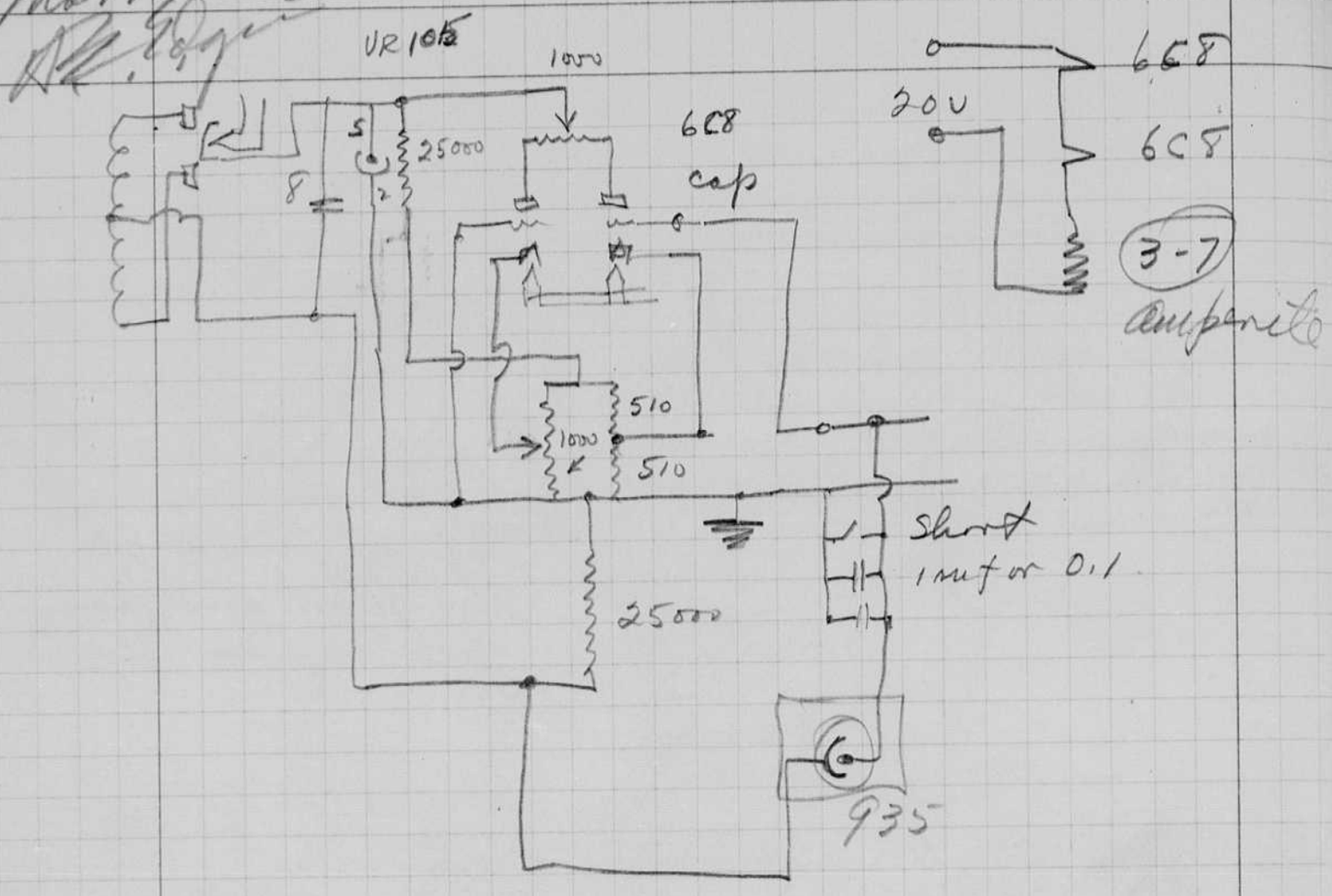


Mar 22 1946 conf with Morack MM, Muzzey, Hubbard & Bellig.

Synchron	Normal	"super"
i_p -	3000	6000
avg -	100	50
V_p -	8500	17,000



Mar 24 1946



March 27 1946.

Herb and Dennis returned from Los Alamos on Mar. 25.

Started glasses today.

French is starting a thesis to test components for a beta and synchrotron for M.I.T. Betatron.

Mar. 30, 1946 Inspected new proposed quarters in Bruing Bldg 20. May move next summer.

Took 35 mm movies in the Schlieren set up in the steam lab yesterday with Watkins (?) Developed pics in the Aero. lab (Prof. McKay.)

Took Bob and Jack McMurran to the M.I.T. Pool for a swim.

Lew Davenport. 1814.

Sterling. 2 Berrien APN 7 to APN-21 for night plus. plane. Huff.
Bird. Mills MEW
1051