HAROLD E. EDGERTON

PAPERS

MC 25

Series III

Laboratory Notebooks

Number 19

Dated June 18, 1948 to Feb. 7, 1950

Massachusetts Institute of Technology

COMPUTATION BOOK

NAME	Number
HAROLD E. EDGERTON	19

MIT 20-D-102

Course .....

Used from JUNE 18 1948, to FEB 7 1950

Notebook # 19

Filming and Separation Record

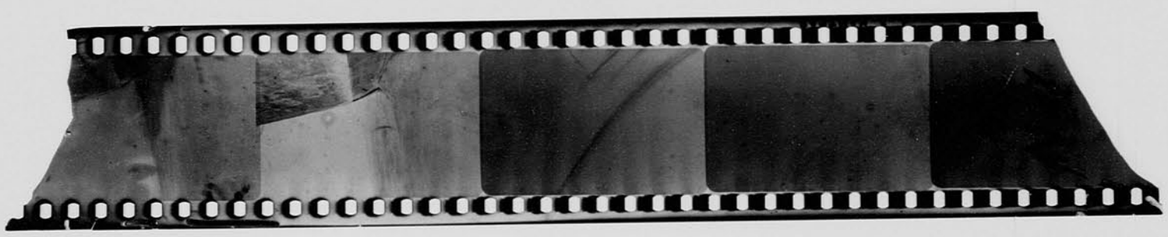
____ unmounted photograph(s)

1 negative strip(s)

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

was/were filmed where originally located between page ____ and ____.
inside front cover

Item(s) now housed in accompanying folder.



HAROLD E. EDGERTON
M.I.T. 20-D-102.
June 18 - 1948.

June 18 1948

Harold Edgerton

MIT. 20D/102.

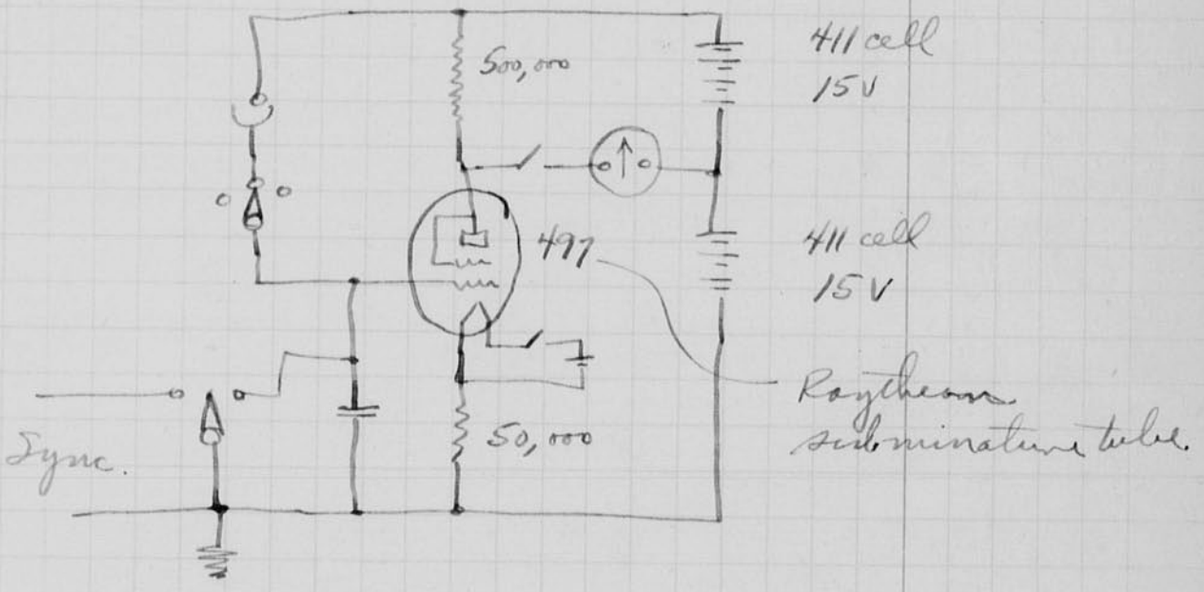
Exposure Meter.

See Notebook 17 page 139 for design. It was found that the 1P42 phototube was not sensitive enough for some problems.

During my absence at Eniwetok, the Continental Electric Co made the cetron tube no # CE-73V for the end on photosensitive device. A sketch is shown of this tube.

wire ring anode.

cathode plate with S4 surface.



Edgerton, Germeshausen & Grier (Partnership)

List of Projects

1. Sun Flash

   Design completed and 4 sold and delivered. Requires sales effort, completion of drawings and specifications, and new price schedule. Publicity and Sales effort.

2. High-Speed Stroboscope

   Prototype completed and tested. Requires completion of drawings, specifications and price schedule. A small amount of additional engineering needed in particular on lamp design.

3. Microscope Illuminator

   Bread-board model tested and found reasonably satisfactory. Requires design of a prototype and additional work on the flash lamp.

4. Microsecond Constructed Source

   Design on paper and special condensers ordered. Test equipment to determine flash duration required. (photo-cell & scope).

5. Monochromatic Flash Source

   Deming's Thesis (Masters, 1948) indicates feasibility of using tube similiar to microscope illuminator but different gas filling. Unit not beyond thinking stage.

6. Photo-cell Exposure Meter for Ground Glass Use

   Various bread-board models have been constructed. Considerable engineering is required.

7. C.A.A. Illuminator

   Report on preliminary tests now in hands of C.A.A. - Design of an illuminator will probably be requested.

8. Air Corps. Night Photography

   Wright Field should be contacted, particularly with reference to possibilities of strip illumination.

9. Cloud Chamber Illuminator

   Lamp designed. Needs power-pack design.

10. Fundus Camera Illuminator

    Microscope Illuminator may serve.

11. Laboratory Illuminator

    A general purpose laboratory power-pack is needed for use in cloud chamber work, instrument photography etc. Should cover a range of CE^2 and frequency.

12. Special Electric Flash and Electronic Devices

    These are of a kind devices occur frequently and are handled as they occur.

13. Stroboscopes

New Strobotac and Strobolux designs are required for G. R.

14. Consulting

This covers Stroboscopes, Electric Flash, Electronic Equipment, Tube Design and High Speed Photography. A number of jobs are active at present.

15. Flash Tube Development

This is generally carried out in connection with specific pieces of equipment.

16. Electric Flash Equipment Design.
This involves keeping in contact with the field and a continuous development program of improvement.

17. Patent Prosecution

List made by Germeshausen
June 18 1948
KE

July 15, 1948

Harold Edgerton.

Leakage currents of electrolytic condensers

Sprague 3601 135 mfd 475 V.

475 V	3 ma
450	2.
450	1.

Power to two capacitors in series

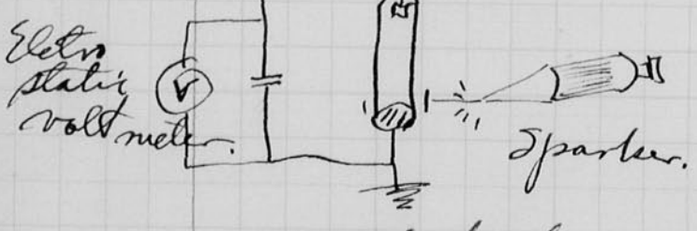
$475. \times 2 \times .003 = 2.85$ watts.

this is too much for portable design. It probably would be ok for the 1 ma current. that is about 1 watt.

From July 7-11 I was in Los Alamos with Chas Wyckoff and a group from the Naval Research Lab. We discussed the outcome of the Sandstone tests at Eniwetok attol.

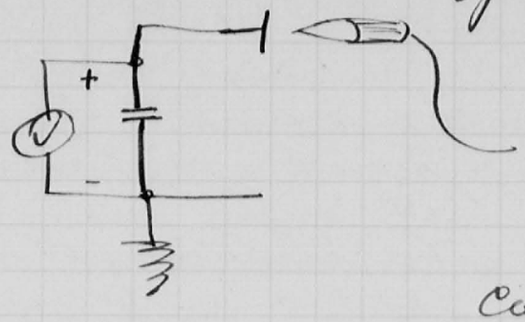
July 22 Esther & Nancy Lou returned from Nebr. on July 28.

July 23. On July 21 Rines and his son Bob came to MIT to see an experiment with mercury tubes.



a voltage was measured with the set up shown with the maximum occuring when the band was slightly above the mercury. It was found that the voltage rose to 5000 volts + when the sparker was held close to the anode. It was the next day that I took out the Hg tube and found that the voltage was the same as with the tube in. In other words the tube had nothing to do with the anode effect observed.

The circuit is then



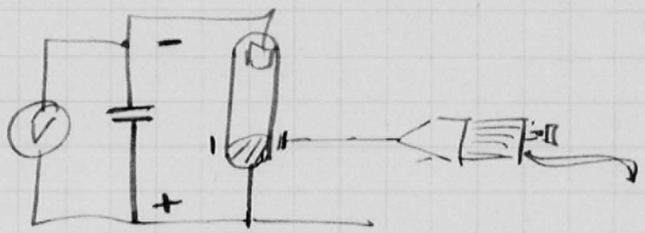
Sparker with 1/2 to 3/4" sparks.

The spacing was adjusted so that the sparker would not glute sparks.

Corona apparently is needed for the effect to be present.

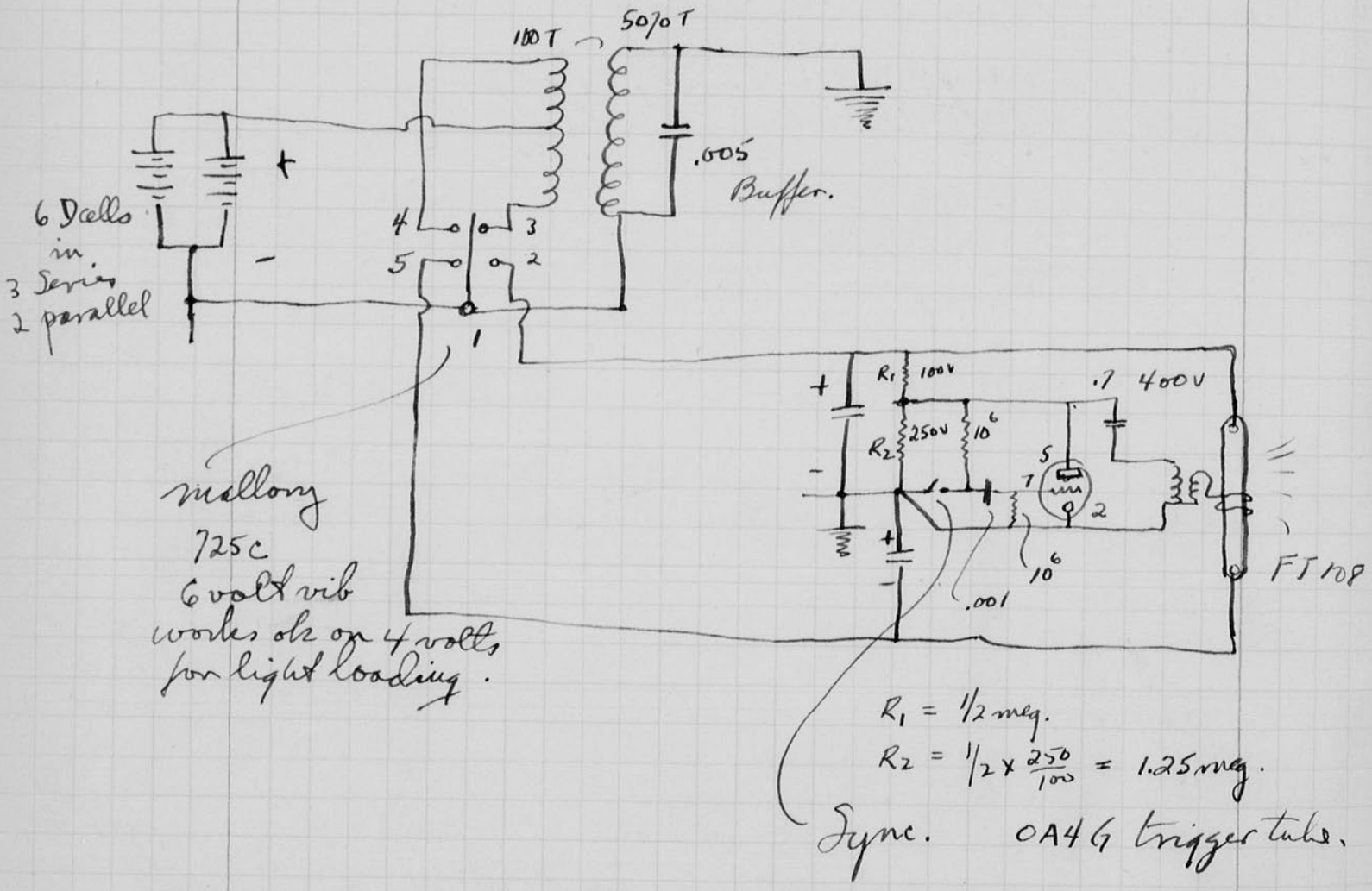
This apparently is somewhat like the point to plane rectifiers that Bennett was using in Ohio.

Note that the polarity is opposite to that obtained with the band starter.



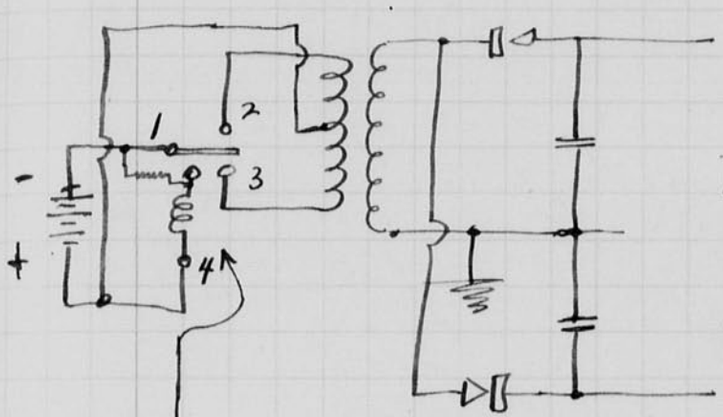
July 23 1948
Harold Edgerton

Some months ago a dry battery portable sometimes called the peanut portable was made using the circuit shown below. This equipment was satisfactory for black & white but only marginal for color. We did take photos at 3 or 4 f/s at f 3.5 that were passable for amateur work. The unit was sent to Boon at Eastman and he has it at the present time. An FT-108 tube was used as a source.

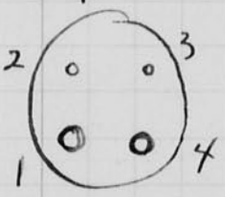


One of the disadvantages of this circuit is the high voltage between the battery and the ground. This is due to the interconnection required by the synchronous vibrator with a common vibrator arm. The synchronous vibrator also is an expensive item.

The following modification may be of interest since it accomplishes several results, of which the battery-to-ground voltage is one. The extra cost of the selenium rectifiers is partially covered by the saving in the synchronous vibrator. The Aerovox company have sent us some sample vibrators, 6V. 250 cycle.



Ditto page 6.



Bottom view of vibrator Aerovox 6 volt. 250 cycle.

8 July 23 1948

Harold Edgerton

60 cycle stroboscope for Stevens Inst.

Haught & Seiler from Stevens were here today and discussed a flash unit for use on the towing tank at Stevens in Hoboken. Ken Germeshausen and Fred Barstow were at the conference.

Experiments were made with the old 60 cycle stroboscope. The capacities are

0.75
2.25
2.85
4.25 mf.

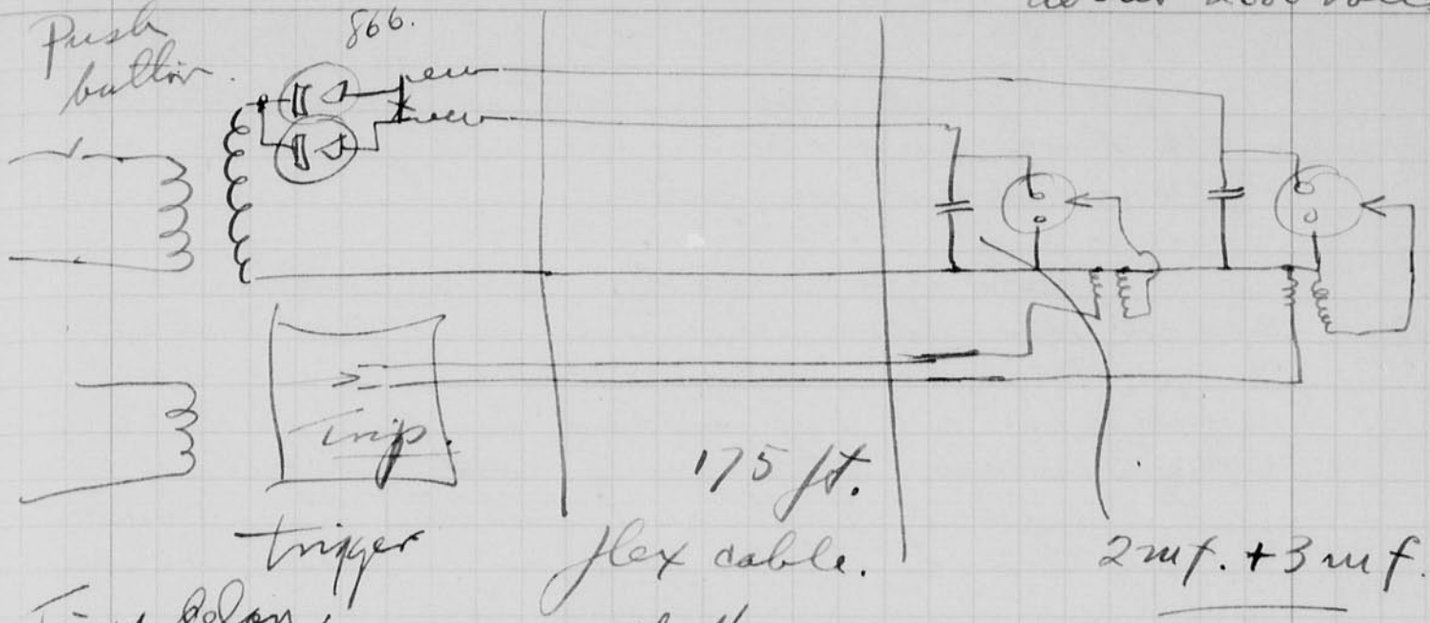
the corresponding voltages are

15.7 /14.3 x 2230	=	2450	volts.
14.5	=	2260	"
13.5	=	2110	"
12.0	=	1870	"

We connected a FT-220 on the circuit and it operated satisfactorily. Also a quartz FT-24 was tried and was o.k.

We are to estimate on the development and manufacture of a unit to drive two lamps at 60 cycles through a 175 ft cable. The weight at the lamps is to be a minimum. It is proposed that the lamps, spark coil and flash condenser be put on the carriage.

about 2000 volts oper.



trigger

175 ft.

flex cable.

2 mf. + 3 mf.

Time delay.

10 sec cut off.

August 2, 1948

Harold Edgerton.

Last week was spent at Lake George with Bob and Bill. We stayed on FORK island site 3.

Tests were made with Eastman Kodak Bantam shutters and SM bulbs. I am trying to show that the synchronizer wire can be adjusted to fire at the maximum opening instead of at an early stage. With the maximum adjustment the camera can be used with electric flash. As now made, the camera is not synched for electric flash.

I had a conference with Mentch. Boor, and others about this on my last visit. A few S.M. bulbs were obtained from G.E. to make the tests.

A 929 photo tube (5-4) was used to integrate the light from the SM bulb. Between the SM bulb and the diffuser was placed the shutters with the two types of synchronizers.

Light from SM lamp - Meter-bulb distance 2.5 ft. atten. at 1.0-meter read 50 lumen sec. per sq. ft. on open flash.

Total light = $\pi\ 2.5^2\ 50 \times 10 = 3125$ lumen sec.

Two tests were made giving 50 and 49 showing that the flash tubes are very consistant. A 1.5 volt battery was used for these tests of the open flash output.

The shutter was now put in position and set for 1/25 second. It would not fire an SM bulb with 1.5 volts, but ok at 4.5 v.

746 battery used 4.5 volts.

meter to bulb Dist in inches.	Polaroid attenuator.	meter Reading	Shutter time and type.	
10	x 1	70	1/25 sec	Instan. I
10	1	70	1/25 "	"
10	1	64	1/50	I
10	1	48	1/100	I
10	1	—	1/200	I Did not flash.
10	1	47	1/100	I.
10	1	70	1/25	Prefire P.
10	1	72	1/25	P
10	1	73	1/50	P
10	1	48	1/100	P
10	1	27	1/200	P
10	1	—	1/200	P Did not fire with several trials - also no flash with 1/100. this bulb had an oxidized spot on the solder point. after cleaning the bulb worked o.k. at 1/100.
10	1	57	1/100	P
10	1	18	1/200	P
10	1	19	1/200	P
10	1	70	1/25	P
10	1	58	1/100	P
10	1	54	1/100	P
10	1	42	1/100	I
		43	1/100	I
		67	1/25	I
		67	1/25	I
		77	Open flash.	

Aug 3. 1948.

10	1	73	P Open flash
10	1	74	P " "
10	1	67	P " "
10	1	74	I " "
10	1	74	I " "

D	Pattern	Light	Sync Shutter	Shutter time
10	x1	67	I	1/50
10	1	65	I	1/50
10	x1	68	P	1/50
		75	P	1/50

Aug. 4, 1948. Eastman is checking this table for values.

TABLE II

FILM		ASA Exposure Index (Daylight)	Suggested filter for Xenon Flash	Average Required Incident Phosage Lumen-seconds per sq. feet
Kodachrome Prof. Sheet Film Daylight		8	CC15	100
Kodachrome Prof. Sheet Film Type B		6	85B	133
Ektrachrome Sheet Film Daylight		8	CC33	100
Ektrachrome Sheet Film Type B		6	85B ?	133
Kodachrome Daylight	35 mm and Bantam	10	CC15	80
Kodachrome Type A		10	TYPE A 85B	80
Kodacolor (Roll only)		25	CC15?	32
Ansco Daylight		—	—	—
Ansco Tungsten		12	Conv. 12	25
Super Panchro Press Sports type		250		3.2
Super XX Panchromatic		100		8
Panatomic X		32		25
Ortho X		125		6.4

Aug 6 1948

Speed Ejector

The ground glass exposure meter was tested today. I changed the integrating condenser from .001 to .01 mfd.

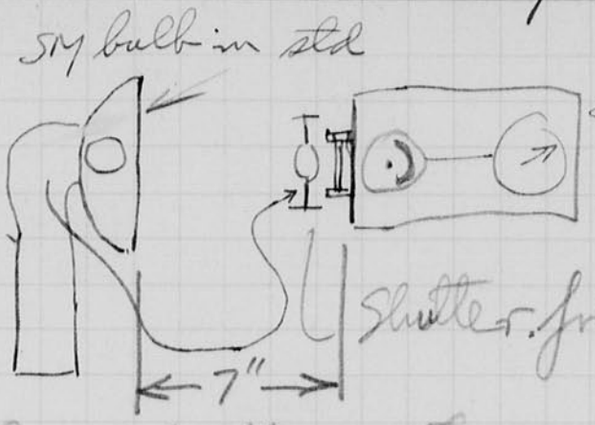
With the 4x5 camera at f 4.7 and the E.K. Kodakrom at 8.5 ft, a white card image produced a reading of about 40.

In the photo service studio I found a reading of 25 to 30 for condition that Ackerman uses for his Kodachrome photography. Again a white card was placed at the subject to reflect the light.

Tests were made on a 6 mm OD 4" 25 cm pyrex lamp today as well as comparison tubes.

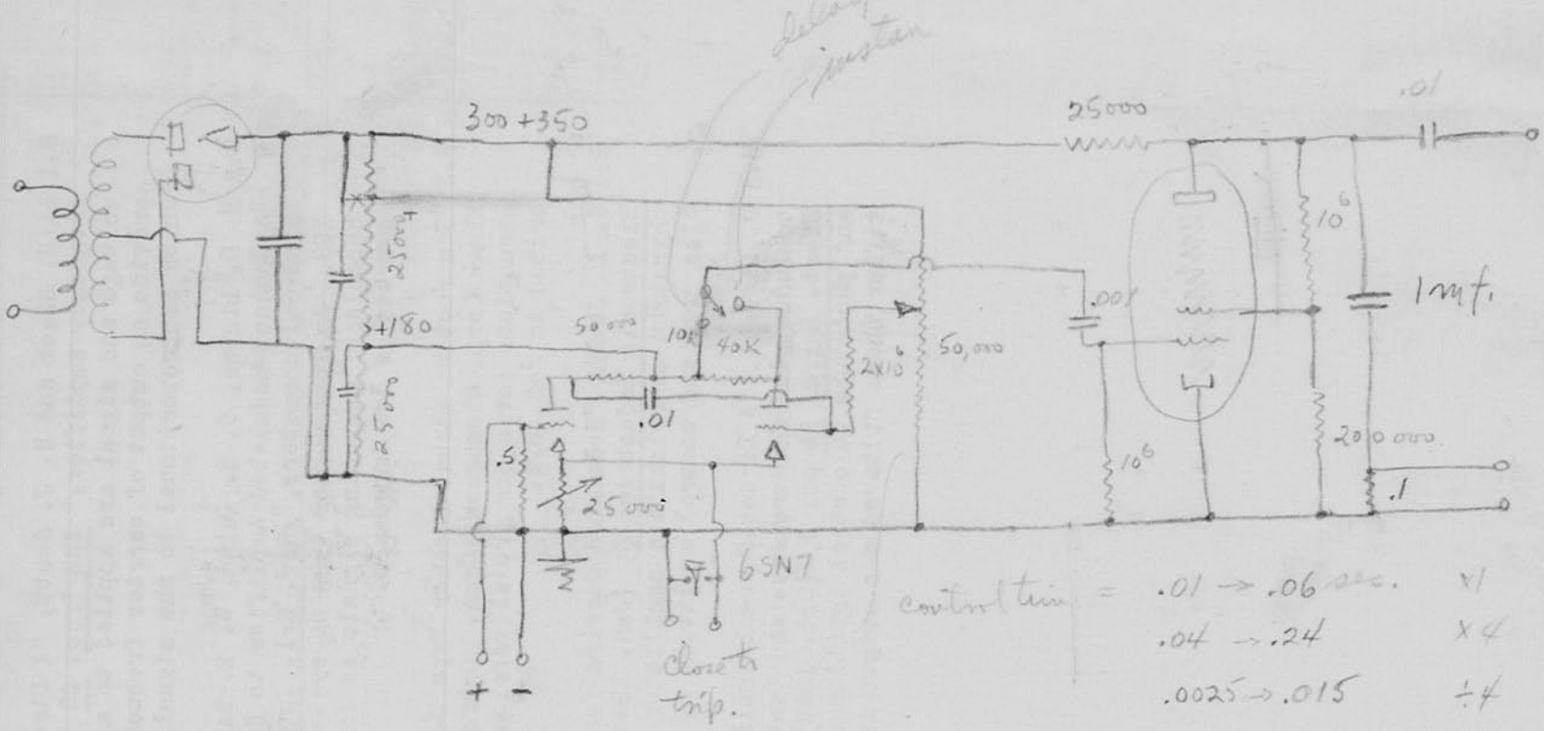
Harold Edgerton
Aug 9 1948

S.M. Lamp tests.



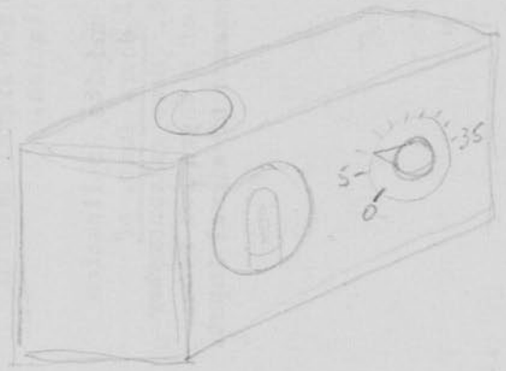
Polaroid attenuator out for "4."

	Shutter type	time.	Light.
Prod.		1/25	180
		1/25	180
		1/50	~~2~~ 173 167
		1/100	15 67 20 15
		1/200	Does not fire.
		1/50	173.
Ilsilan.		O.F.	177
		1/25	137. 162 138 144
		1/50	154 137 124 148
		1/100	— — — Did not fire.
		1/50	165 after 5 min.
Prod.		1/50	185 168.



control time = .01 → .06 sec. ×1 C = .01
.04 → .24 ×4 C = .04
.0025 → .015 ÷4 C = .0025

.005



.5 – 2.5 ms
2.5 – 12.5 ms.
12.5 – 72.5 ms.

1. – 50.
5. – 35. ms.

Aug 10, 1948

H. E. Edgerton

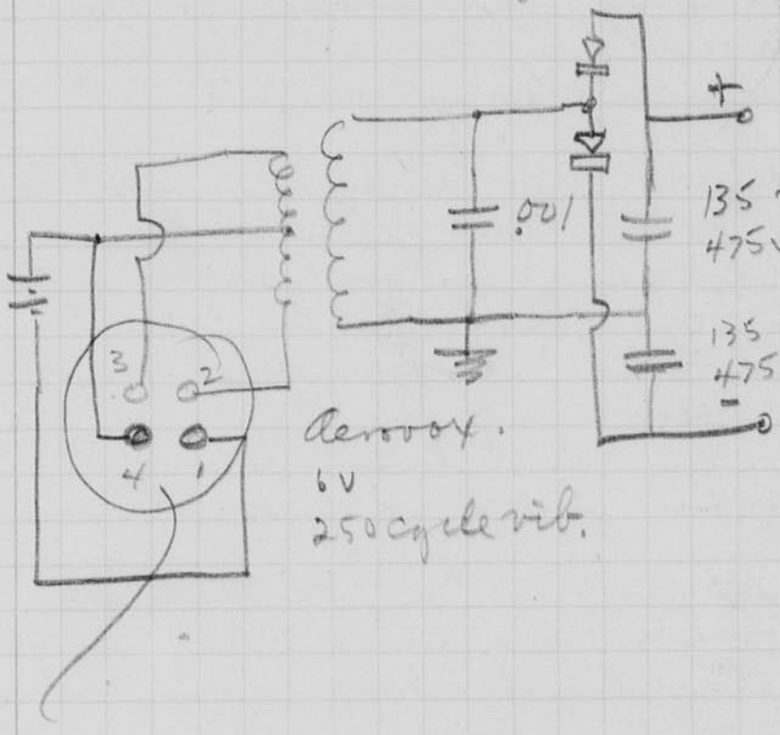
Power supply as per page 6.

A transformer was made of Booster trans.

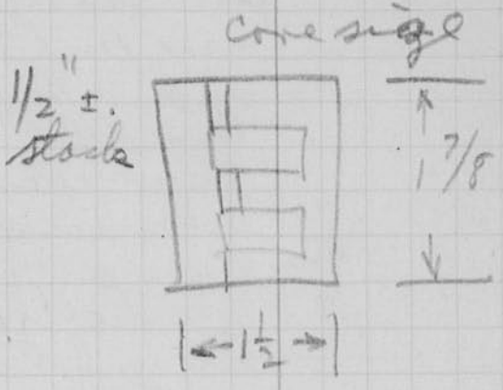
0.5 a Primary 58 turns #24 with C.T.

700 a Sec. 3000 turns #40.

Weight = 8 oz.



Aerovox.
6 V
250 cycle vib.



Sprague.

Shorted. Primary battery current = 4 a

Charged capacitor Bat current = 0.24

710 v output.

$\frac{800}{25} = 32$ used 31 1/4" discs sel. rect on each side

With two 180 mf 350 v Solar

Input 0.57 amp 4 v wet bat.

Output 690 volts.

With input meter out of circuit

Output = 715 volts.

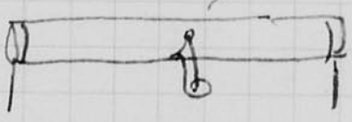
Harold Edgerton
Aug. 12. 1948.

Trouble was experienced with the selenium rectifier yesterday and today. One stack opened after the flash lamps was put on. I replaced one plate today and operation was ok for a short time, then the other stack opened and a bad odor was present. Apparently the selenium was being evaporated into the air.

The trouble was probably caused by the unbalance of capacitors, causing an initial reverse charge on one capacitor. This increases the back voltage and probably starts the disintegration of the selenium surface.

For the above I had been using 31 plates in series for a 400 volt output.

I now am using a cased stack with a C.T. which was made by cutting a slot in a standard 2000 volt stack.



Slot with connection to get a mid tap connection.

3"

(31 discs stacks 1" long.)

The voltage drops from 800 to 720 with the 3" doubler rectifier shown.

Aug 12 1948
H. L. Edgerton.

Transformer design.

Present transformer
EL 625 lamination 5/8" square core = 0.39 sq. inches.

~~EK~~ - 746. GR new design = .248. sq. inches.

3000 (present) $\times \frac{.39}{.248} = 4500$

$4500 \times \frac{800}{700} =$ 5150 turns.

$\frac{5150}{7700} =$ 0.67

58 turns $\times \frac{.39}{.248} =$ 91,3 turns.

$\frac{90}{2} = 45$ turns # 28 wire. $\frac{2}{12} = .167.$

.837 ?.

8 volts.

60 ~~#~~ ac. $B = 12,000$ 20 turns per volt.

90 turns $\times 1/20 = 4.5$ volts 60 cycle.

with 8 volts. 250 cycles.

$B = 12,000 \frac{8}{4.5} \times \frac{60}{250} =$ 6,120 lines/sq. cm.

$\frac{5150}{171}$ #40 = 30 layers.

2 layers of # 28 45 turns each C.T. 90 total turns.

Try ~~5000~~ turns sec. primary = ~~90 $\frac{5000}{5150}$ =~~

Try #27 wire 40 turns per layer 2 layers 80 turns.

Secondary = $\frac{80}{90}$ 5150 = 4590 turns. $\frac{+590}{171} =$ 26 layers

flux density $X = 6120 \times \frac{90}{80} =$ 6880 lines/sq. cm.

H. E. Edgerton
Aug 13 1948

EL 625 transformer P17.

.001 mfd across secondary. gives 670 volts with 4 volts wet storage battery.
D.C. drain with 90 mfd Mallory electrolytics (4 in series-parallel 90 mfd).
0.34 amps.

I propose to change the primary turns from 26 on either side of the C.T. to

$$28\ \cancel{26} \times \frac{1/800}{670} = \begin{matrix} 23. \\ \cancel{22} \end{matrix} \text{ turns.}$$

this will increase the output volts and the flux density.

This was accomplished 46 turns C.T.
with .001 Buffer or 3000 turn coil
Drain = 0.4 to 0.5 amp from 4 volts -
Output = 800 volts. D.C. on 90 mf
Peak drain = 5 amps from wet bat.

.39 volts

Light output 100 lumens per sq ft at 1 ft.
Perpendicular to flat of U tube.
Output = 100 x 10 lumens. = 1000.
Input = 90 $\frac{100^2}{2}$ = 25,50 watt sec.
$\frac{1000}{28.8}$ = 34.7 lumens/watt.
this seems high - the capacity probably is some what less than 90 mfd.

Dry Bat operation 746. (3 Fallon in series. 4.5 volts.
Max current = about 2 amps
Final voltage. 800 ± .38 volts .5 amp drain.

Aug 17 1948
Harold Edgerton

The sockets of the 4 flash units in Photoservice were changed from 5 prong giants to the new 3 prong with a focusing lamp internal socket. New FT-403 tubes were installed the old FT-2 tubes had been in since 1941. and were still going strong. Jackman noticed a slight increase of light with the new tubes.

I took my small light meter for ground glass measure of light over to the studio and shot two photos with Jackman. He recorded the lamps set up in his note book in color. One photo was taken at a setting of 24 and another at 28. (f11) old Kodachrome film. The film came back yesterday. It was slightly fogged around the edges. Exposures were fair, probably o.k. if film was new.

A white card was used to reflect the light into the camera. then the pickup photo tube was put over this spot. The meter now has an 0.01 mf mica integrating capacitor. Raytheon peanut tube. The photo tube is a special one built by in ~~Ceco in~~. Continental (near Chicago).

22 Aug 23 1948.

Harold E Edgerton.

I was in New York on Aug 19. The small light meter was taken for test. After meeting Dwarg on 44th st at his new establishment, we went to the Fogano studio and worked with Blueglow on the ground glass problem.

Blueglow has an early model of G.R. battery operated exposure meter (light meter 1501) with a 3 ft photocell extension and a smaller integrating capacitor. As I recall, the capacity is about 0.013 mfd instead of 0.1?

My new small meter with the 0.01 mfd and the end view photocell gives a reading on the ground glass of 25 for Kodachrome and Ektachrome against a white card. This checks with Jolsman of Photo Service.

0.038?

Light Level for Kodachrome.

Ground Glass Exp meter.

2 mf 2000 volt 220 tube with diffuser

Output. GR light meter 1 ft.

Reading (x1) 65 lumen sec. sq ft.

For reading of 25 on small hand meter as used for Kodachrome tests.

Distance = 15.5 ft.

Light then on ground glass is

$$65 \times \frac{1}{15.5^2} = 0.271 \quad \text{lumen sec./sq ft.}$$

700/65.0 .2

the actual light might be slightly more than this since the ground glass may absorb or diffuse slightly.

Ratio of meter sensitivity = $\frac{65}{0.27} = \frac{15.5^{-2}}{1} = 240.$

for 65 reading → 25. on scales.

Aug. 27, 1948.

Harold E. Edgerton

I attended the convention of the photographers association in the Stevens Hotel on the 24 and 25 th. On the train I met Jim Purcel of Bachrach's studio. He specializes in Wedding photographs and was on the way to Chicago to put on a demonstration for the convention. The Bachrach studio was asked to put on the demonstration by the P.A.A. with a $1000 fee to cover ~~expenses~~ expenses.

The display booths in the basement were very interesting to me since there were many flash units on display. The Eastman company had their new model Kodatron unit on the upper floor. Ozzy Wiegiel (?) gave demonstrations of the use of the equipment for Ektrachrome. The pictures were excellent.

Photogenic had demonstrations of their equipment next to Eastman. I had a talk with mr. Kubiac.

Harry Parker now calls his outfit the American Speedlight Corp, and has big plans for exploitation. There was a 10000 watt second flash unit on display with a single lamp and large reflector. At least two condensers blew during the time I was there. Parker also had some of his smaller units on display including his portable with detachable bottom.

Sturborescarch now has their monostrob unit ready for production. It has 28 mf at 2500 volts (90 watt seconds) in the lamphouse. The entire power supply is there. This eliminates the high voltage plug problem. I met Brian and saw Ed Farber.

I met and discussed flash photography with many other people in Chicago.

Harold Edgerton.
Aug 30, 1948.

Co.6-0190. 25

Otis Barton 12 Fairfield St Boston

Visited Woods Hole yesterday with my son Bob. Talked to Iselin at the W.O.O.I. about the phantom layer. He introduced me to Moore who is working with Harvey's under water flash unit.

Also talked to Royce of the U.S. Fish and Wildlife service (Lyonal Wolford in Wash).

Barnes (with Dr Fry) told me of experiments with argon an explosives. Short flash light source.

OSRD. 6246
NDRC A 368
NAV Report 9-47
OSRD 1488.

Conditions used under water with #5 flash bulb. 44" from water 1/50 sec. Super X film f 11. Camera about 10 ft above bottom on pole.

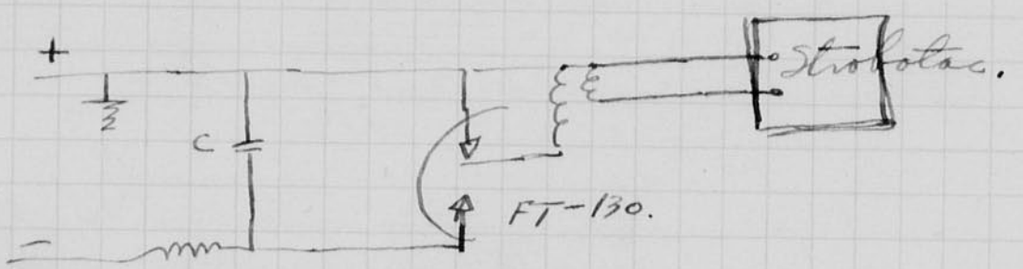
Stroboscope experiments

Sept. 1, 1948.

Daniel Elgerton.

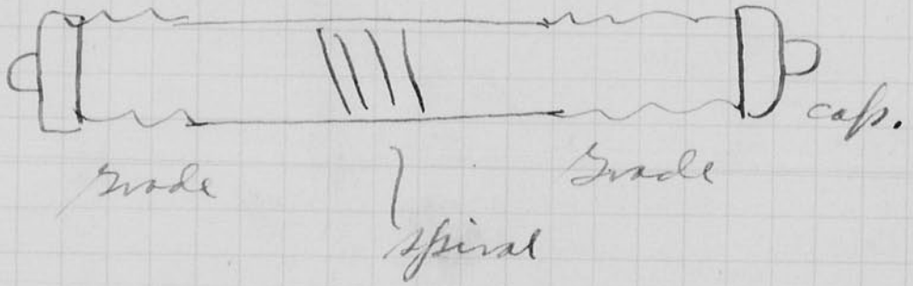
FT-130 was tried as a controlled stroboscope. This tube is an argon gap with a third electrode. Control is difficult since the tube tends to self start.

I used 2 mf at 2000-3000 volts for the tests. With 1000 ohms I experienced holdover this cleared up with 10,000 ohms. Intermittent with 5000.



I also tried E.N. 646 tube with 0.5 at 2000 at 10 P.P.S. Then changed C to 0.1 and operated 10-60 P.P.S. $RC = 0.1 \times 10^{-6} \times 10^{4} = 0.1 \times 10^{-2} = .001$ sec.

D.E. tube. experimental.



0.1 mf 2000 v 10,000 ohms operation ok to 50 P.P.S.

$\frac{CE^2}{2}f = \frac{0.1 \times 2 \times 50}{} = 10$ watts.

Increase power to 30 ~~25~~ ~~50~~ watts.

Conditions 0.3 mf 2000 volts 10,000 ohms operates ok from 0 to 240 cycles/sec.

Power at 50 cycles $= 0.3 \times \frac{2^2}{2} \times 50 = 30$ watts

$RC = 10^{4}\ .3 \times 10^{-6} = .3 \times 10^{-2} = .003$ sec.

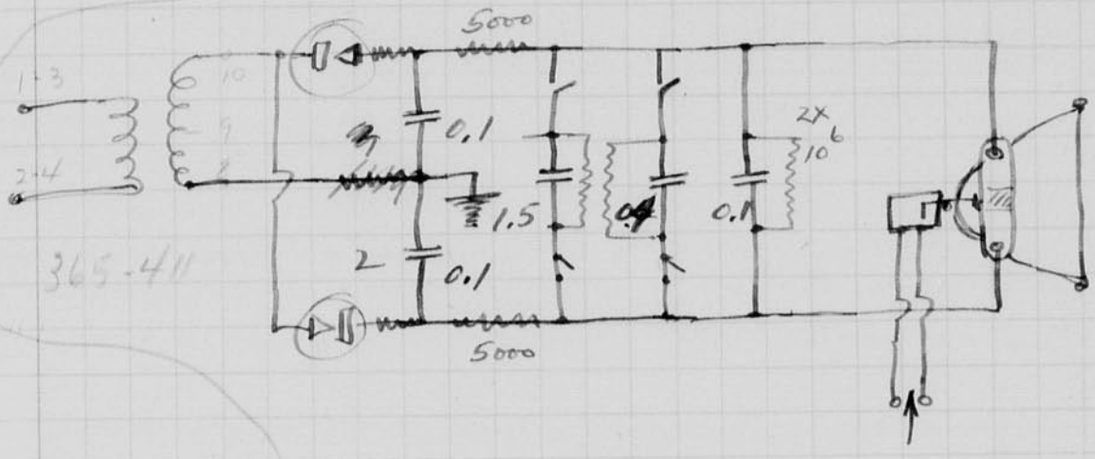
Power increased by changing capacity to 0.5 mf.

at 50 cycles 0.5 mf. P = 50 watts.

Lamp operation seems ok, even at 240 cycles.

Commercial instrument c = 0.1
= 0.5
= 2.0

2000 volt power pack.



2000 I = 100 watts

$I = \frac{100}{2000} = \frac{1000}{20} = .05$ amp

= 50 ma.

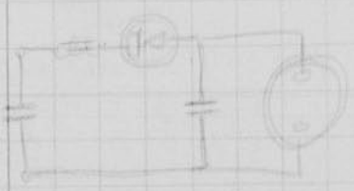
$\frac{2000^2}{2 \times 10^6} = 2$ watts.

0.1 mf.

Hellows at 240 cycles, with 2000 V 10,000 Ω

ok art 15,000 Ω

Hellows also at 15,000 ohms.



$85 Spotlight 19" ADE-16 Crouse Hinds

Narrow beam reflector with plain lenses.

10.4° 11.3° V 38.6% efficient

591,000 C.P.

7000 lumens in beam.

19,000 lumens

1,900

200 ft.

$M = \sqrt{\frac{591,000}{19,000}} = 311.$

Reflector factor $\sqrt{300} = 5.5$

$Df = \sqrt{KMQ}$. Increase guide factor by 5.5. 400 × 5 = 2000.

Data measured by
Jred Barstow
Sept. 9, 1948.

FT-38 101 mfd
10000 ~
Stop 3 on meter
20'

degrees	Reading FT-38	FT-39
−15°	15	36
−10°	52	76
−5°	131	170
0	135	166
+5°	107	160
+10°	33	61
+15°	10	17

FT-38 → 46 side view no ref.
FT-39 → 80 stop 1 at 81" = 6ft 9"
= 6.75'

Refl. Factors
FT-38 → 14
FT-39 → 36

FT-24.
$20^2 \times 2 \times 166 = 133{,}000$ bcps

FT-28.
$20^2 \times 2 \times 125 = 100{,}000$ bcps.

$6.75^2 = 45.5$

$46 \times 45.5 = 2100$ lmcps

$80 \times 45.5 = 3650$ lmcps

45.6

EK Portable at 5 ft 46 lumens sq. ft. 1150 c.p.s. beam.
guide factor = 200.

Guide factor = $200 \times \sqrt{\frac{133{,}000}{1150}} = \frac{2140}{6800}$ 2140

Aperture at 200' = $\frac{2140}{200}$ = f 10.7

18 degrees.

$\frac{2140}{+36} = 60$ ft.

Sept 11 1948
H2 Projector
Fred Barstow

101 mft 200 volts. 200 watts.

#14 spinal 5' at 80 L.S.FT² = 750 l.c.p.s. bare. 37.5 W

20' at 120 avg in reflector. 45,000 l.c.p.s

$M = \frac{45,000}{750} = 64$ reflector factor.

FT-503 in stead of FT-24 118 to 166. Goulds. Reflect.

20°

Parabola. 200 ft distance.

18" diam. -

L-83 Floodlight

Drawing No. T-8957503. AA T 1.

Insert M 8957497 AA T-1.

No. Housing. P-5556489 AA T-1

U shaped piece P-9437496. AA T-1

Degreasing. K-3778967 AA

Base. M-9437015 AA T-1

Gasket.

Sept 19, 1948.

Tests made yesterday at GR.
54 mf 2400 volts.
d = 2.1 ft.

Meter 1501 marked Edg (home-made sample)

102	GR. std tube.
105	GE. Std. #1
106	
103	
104	

	102.5	103	103	Std # 5
	106	105	106	# 111
	107	107	106	# XX
	99	98	99	# 3
	101	100.5	99	102 GR. standard tube.
11.45		102	102	"
12.20				
1pm		99		"

$$\frac{CE^2}{2} = \frac{54(2400)^2}{2} = 155. \text{ watt seconds}$$

$$RC = 5 \times 54 = 270 \times 10^{-6} = \frac{1}{3000} \text{ sec.}$$

$$Q = 35 \times 155 = 5420 \text{ lumen seconds}$$

$$\text{NCPS} = \frac{5420}{10} = 542$$

$$V = 542/d^2 = \frac{542}{4.42} = 125 \text{ ft candle sec.}$$

if effy is 28. then V = 100 ft candle sec.

I visited Ausco on Sept. 13 (Gilman Morse) a light meter no 113 was left with them for tests with color films. Mary Low was left at Cornell in Ithaca in the morning. Sally Andrews went with us to Ithaca. Saw Dexters and McIlroys at Cornell.

Ausco tungsten color film with Corr. 12 filter apparently requires a 32 candle sec. exposure of 32.

On the 14th of Sept I was in Rochester where I saw Tupper at the Research Lab about color exposures. He has started work on the color Kodatron and will have data soon. Saw Boon Sandell and Mentch in the afternoon before leaving for Belmont at 4.30. Arrived 3 pm Sept 15.

On Sept 15 I visited G.R. and obtained the photocell pickup for the ground glass to fit the 1501 meter. In the afternoon I went to Forbes Litho with Barstow to see the photo lith process.

A three way plug (Jones) was put in the panel of my exposure meter for the photocell.

With the Kodatron at 10 ft - camera lens at f 4.7. a white card gave a reading of about 150 on the G.R. meter using the ground glass.

Robt J. Horn Jr finished thesis.

Charles D Rose

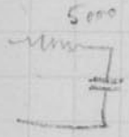
Sept 18 1948

Elgarten Keller UCLA Los Angeles

Ellis was here today to discuss high speed photography underwater.

U is 3" length of 5 mm OD Xenon 12 inches ±.

Lamp tests. U tube



	E	C	mfd.	Light Hcd sec.	
	800 V	165/2	Sprague 4276	83. ✓	
	900	"		107	
	950	"	(82.5)	122	
	800	"		84	
	800	4 Mallory	90 ea per.	51	Probably low! Read about ↑↓ 8s Sept 21
	900		(90)	78	
	950			92	
	800	87.8 paper.		82	
	900			111	
	1000			142	

	E	C	Light
FT-14	800	87.8	49
	900	"	70
	1000	"	97

	900	87.8 P	~~90~~	out of line with outer
	900	87.8 P	105	
FT-14	1900	28.19	140	Portable Kodatron
U	1500	28.19	92	
	1000	28.19	32	
	1800	28.19	134	
	1900	28.19	148	
	1000	28.19	32	
	800	87.5 Sprague + .9	79	
	800	"	79	
other U	800	87.5 Sprague + .9	83.	4 ft leads.
	800	"	85	short leads 2 ft.
	800	135/2 Sprague 3016	51	
	800	2 Mallory 90/2 mfd. SP062259 335804	21	Peanut?
	800	"	27	
	800	"	25	
old FT108	800	"	21	Peanut Port. light?
"	900	"	27	

				wt	wt
2 Sprague capacitors	4276	165 mfd	450V	1# 1.5 oz.	17.5 oz.
2 " caps	3016	135 "	475 V.	8 7/10 oz.	8.9
2 Mallory caps	SPG 62259	90 "	450	7.7	7.7
2 Plastican "	ASCO E2XC35	3.5 and	2400.	18.7 oz.	

V C ft Cond sec

Table. 2000 .9 P —
2000 10.80 P 62
2000 21.52 P 143.
2500 10.80 P 92
3000 10.80 P 124.
800 87. P —
1000 V

Crazing obvious now. 31/11
Does not start. 124. ✓
Starts intermittently.

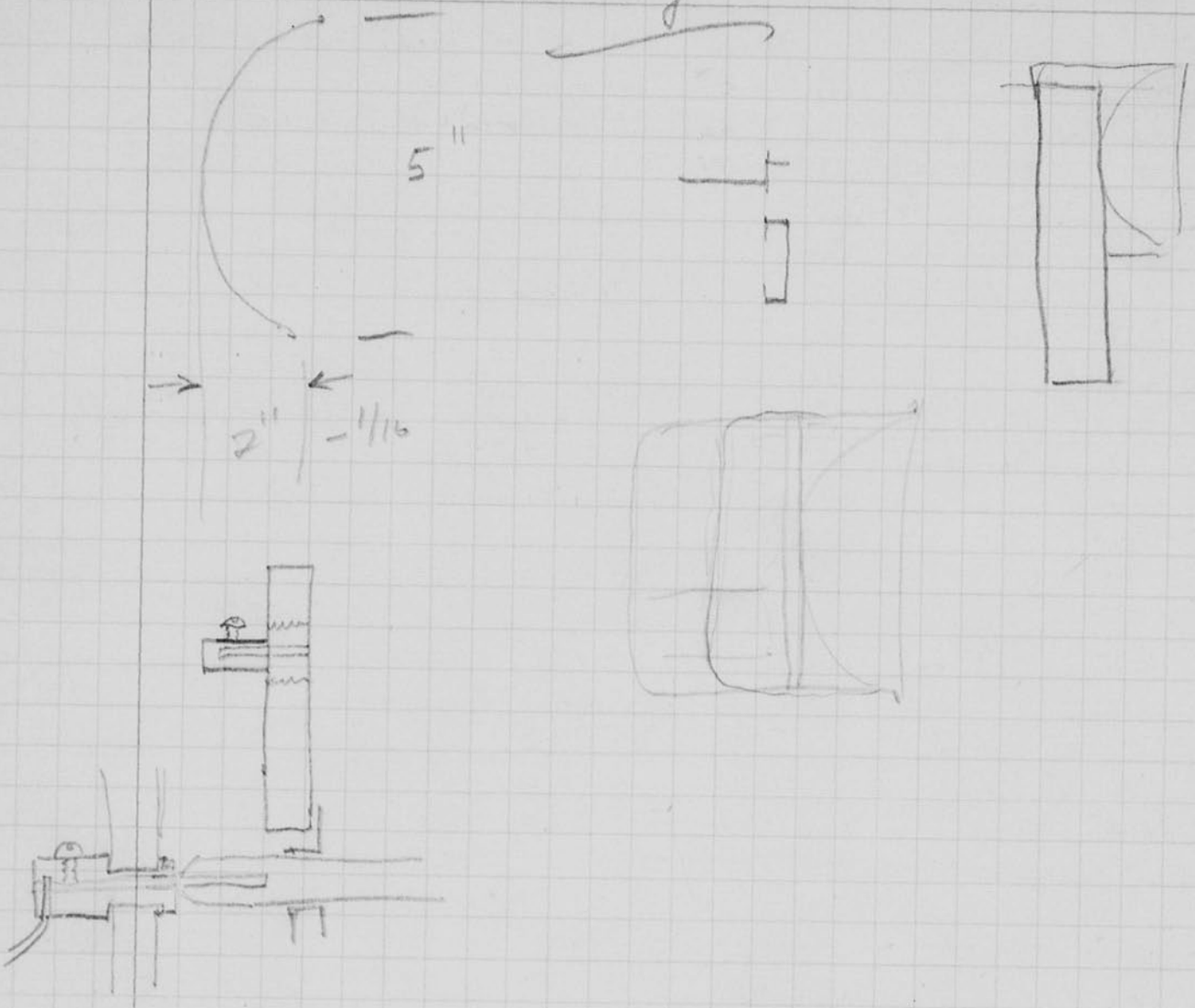
Table C

						400V	Leakage 5 min. ma.
100	Sprague 4276-2	830 lumens	/ 17.5 oz	= 47.5	lumens/oz.		.4 .9
73	" 3016-2	510	8.9	= 57.0	lumens/oz.	✓	0.4
60	Mallory 90-2	210	7.7	= 27.3	" "		.6
120	" 90-4	510	15.4	= 33.0	" "		.6x2
	Pefcar 2-3.5 2400	450	18.7	= 24.0	" "		0

Sept 30, 1948 Can't light meas.

	V	C	
V	2400	6.56. P	42.
	2400	8.62 P	60.
FT-14	2400	8.62 P	58

EK Reflector

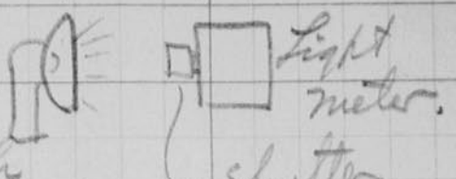


Keytheon #OX9017A 115. 2-5U Rec
29KV Ref for
3B24's.

Plate Ireed #13289 115 - 7.5KV R.M.S.

514 Bulk tests Bantam Shutter

Repeat of tests on page 15.



New batteries put into Kodak flash "Bright Star" 2 size C Dated 6-49.

Shutter	Time	Light.			
Prod	1/25	182			
	1/200	10			
	1/100	100			
	1/100	87			
	1/100	97			
	1/200	0.1 4			
	1/100	93.			
Instantaneous.	1/100	7.	16.		
	1/50	158.	165		
	1/100	36.	16.		
	1/25	140	107	138.	147
	1/25	134			
	1/50	154			
	1/25	131			
	1/100	12.			

Light Check. U tube Electrolytic capacitors for small Portable.

Tube	V	capacitor	ft candle sec.	
U	800	Sprague 3016	51.	
	800	"	53	
	800	2 Mallory 23580Y	25	
	800	2 "	27	
	800	2 Mallory	22	Different set.
	800	2 "	23	
	800	Sprague 4276	77	
	800	"	80	
	800	"	78	
	800	4 Mallory 23580Y	80	
	800	"	82	
	800	2 " 23580Y	28.	

Sept. 23, 1948.
Jarred Edgerton

Ed Noel was with us this morning. At noon I took him to the General ~~Electric~~ Radio Co to see the light standard set up and the light meter.

Bill Mc Roberts and I have been testing condensers, flash tubes, and batteries. The data is in Bill's note book.

Lex 9 595
Sowells
Lex 9 2888M
Bedford

6 volt dry batteries as used for lantern service have some promise.

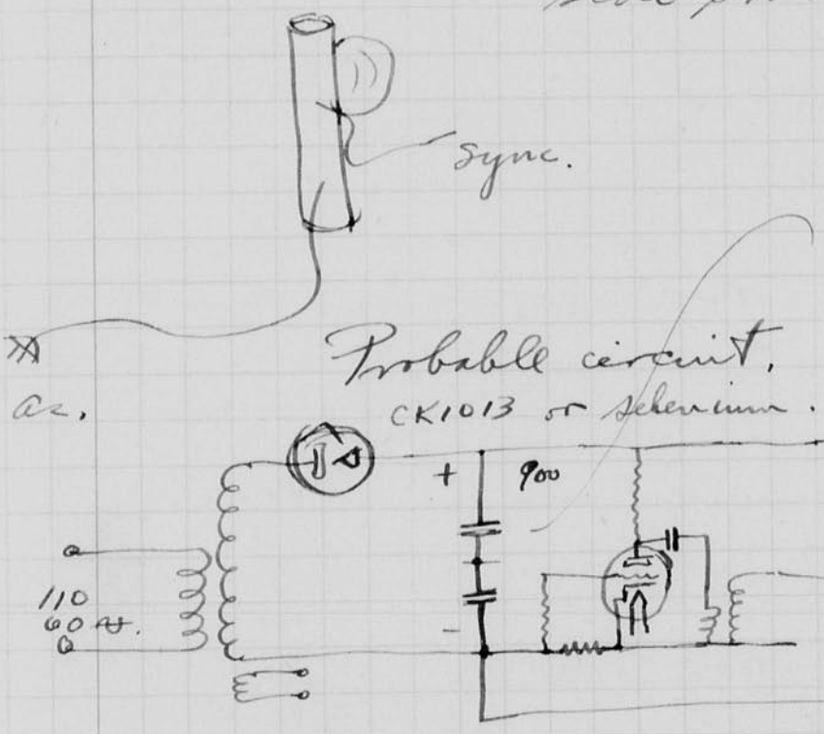
460	Bright Star	Voltage drop after 4 volts
409	Nat Carbon	on a 0.6 amps load.
941	Rayovac	
125	Bond.	

Sept. 24. 1948

Harold E Edgerton.

I came up with a simple idea today. Why not make an a.c. portable within the camera-light structure. With a.c. the electrolytic capacitors give us no problem due to their leakage current. With the new V tube we can get at least half the portable light with a 3 pound affair.

Bill and Fred came up with a cylindrical design with a reflector on the side. The camera will attach on a side bracket.



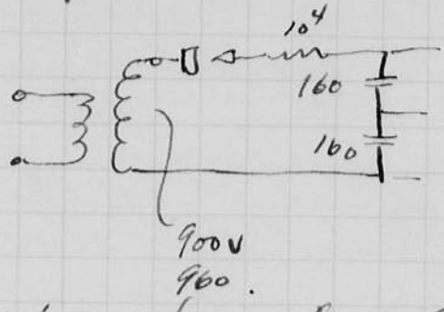
I took Eddie Dx yard over to see Dave Nilsen today. They plan to set up photos of hands in color.

Sanderson of Graflex was here today to see about the McPol work on power supplies.

Dr. Trotter was here today - Eye photographer

Transformer design for a.c. camera light.

Rectifier 1 CK1013.



dry time ole.

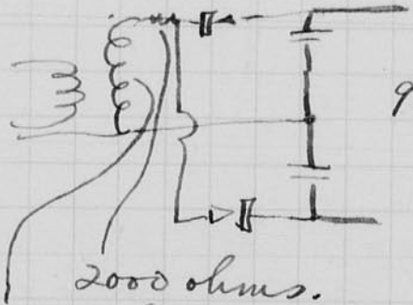
1/2 lb. #745 transformer from G.E. design data. 5/8" square
CK1013
13 turns per volt
117 v = 1520 turns.
Ratio 960/117 Secondary 12,500 turns.

not enough room.

1 lb. #345 transformer 7/8" square leg.
CK1013.
8.96 × 117 = 1050 turns pri
8650 sec.

could use #38 8650 sec.
#29 1050 Prim.

Voltage doubler cuts down turns ratio.
Selenium has lower drop.



2000 ohms.
370 v (Simpson)
400 v (RCA).

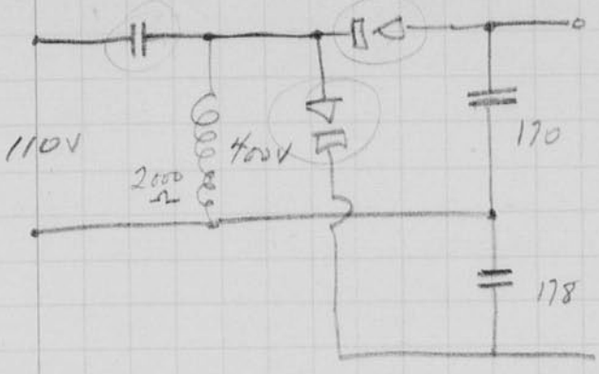
385 - 415.

Ratio now is 400/117 = 3.42

Primary = 1520 turns
Sec = 1520 × 3.42 = 5200.

could use #40 sec 5200 t.
#34 prim 1520.

Design to carry on 5/8 square center core. 1/2 lb trans.



60
60

$T = \frac{1}{60} = 2\pi\sqrt{LC}$

$\frac{1}{(2\pi)^2 3600} = LC$ $\quad C = \frac{1}{2\pi^2 L 3600} = \frac{1}{.144 L}$ 35 - 75 h.

$= \frac{6.95}{L} = .2$ m.f.

$\times 2\pi f L = 13{,}400$ ohms.

377
3.0

Sept 28, 1948 Registration yesterday at M.I.T.

Pumped tube today 5 mm O.D. 3" length, 1/2 between legs. tested on pump. See data in "light" meas. book.

900 volts $\frac{165}{2}$ mf electrolytic 90± 13.5 mm pressure

output on pump was 1450 lumen sec.

$\frac{1450}{36.4} = 39.8$ lumens/watt.

$\frac{CE^2}{2} = \frac{9081}{2} = 36.4$

after seal off $\frac{1200}{36.4} = 33.$

Tested with 0.2 mf 150 volts into contacts on Bantam camera. Ok at 0.1 mf.

Starting band couple on both legs of U tube.

Phone conf. with Hopwood about transformer. 3P.
He says he cannot wound on the windings
mentioned.

1520 — 5200.
#34 #40

Suggest change to 1490 — 5100
#34. #40

Could use 35 or 36. ©

This transformer was finished Oct 8 and
tried out.

Input 115 — 900 out dc after
condensers or charged
for an hour or so

at first they charge
up to 780 - 1800 volts
in about 15 seconds

I believe this design is satisfactory
for final voltage and charging time.

the input final current is about
20 to 40 ma. from the 115 volt
source. this is exciting
current.

The transformer is barely warm
after long operation.

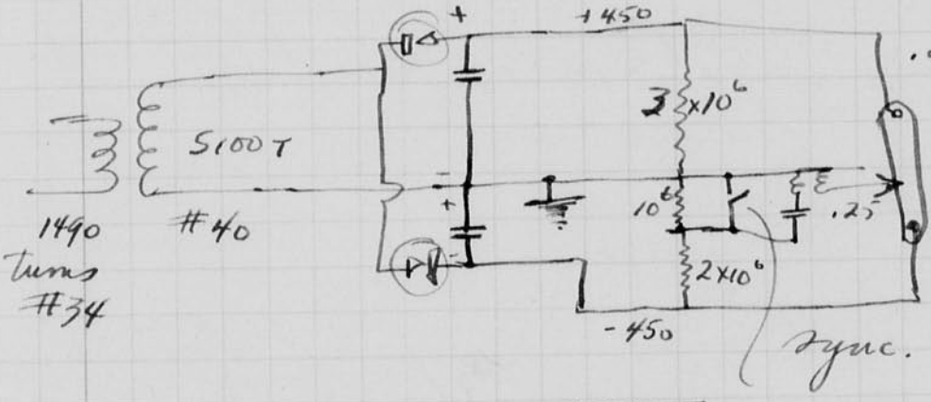
Oct 11, 1948.

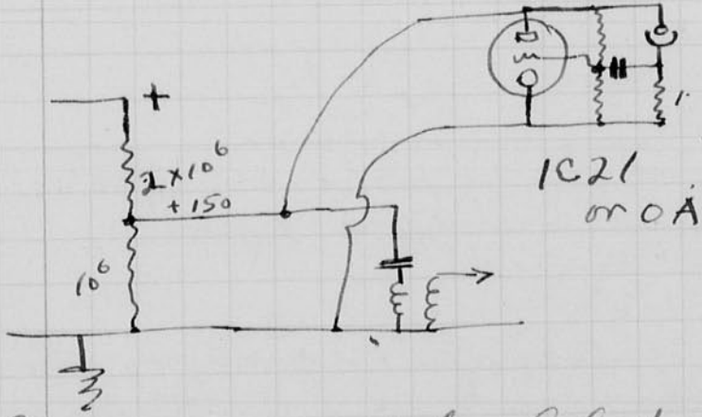
Fred Barlow married Ann Rohwer yesterday at the Wayside Inn in Sudbury.
I shot Kodachromes at 40 guide factor. with the 50 pound transportable.

Oct 12 1948. Portable design. Conference yesterday with Greenbaum on selenium rectifiers for the project. The cheapest combination at present is eight .65 50 mil stacks (130 V each) The cost each is about 2 8/8 ~~ft~~. 2.24

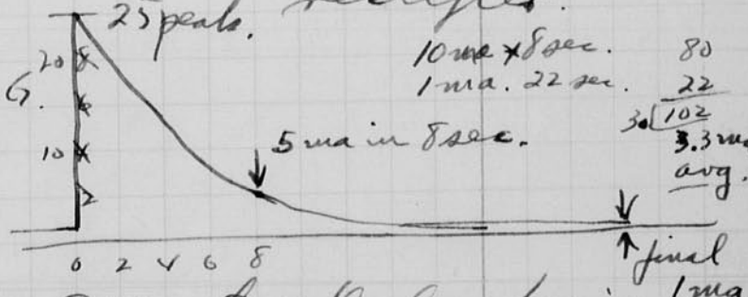
Two 1000 volt stacks were ordered for trial also from A.T.T.

Barlow suggested a contactor trip without a trigger tube. We found that 150 volts with 0.1 mfd was marginal. $I = 45^0/10^6 = .45$ ma.





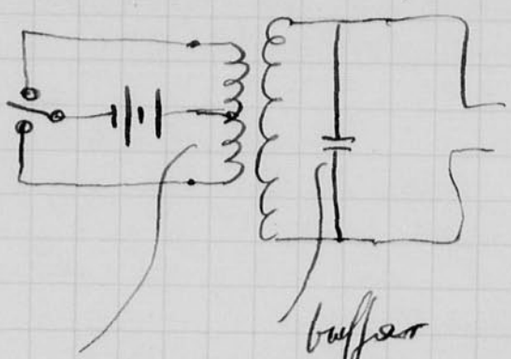
Short circuit current = 25 ma. in Selenium rectifier.



Lamp connected for life tests 8.35 at 2 flashes/min. This lamp has plain tungsten electrodes.

Oct 12 1948
H. E. Edgerton
Cont.

Power supply for $ 110 ac
Camera power supply flash.



output. need 160 v.
flat topped wave
at no load.

buffer

Input about 8 volts from 4 volt battery.
Ratio = $\frac{160}{8}$ = 20 with C.T. on low side.

Strb.

Insert dry bat from top.
Lantern size.

outlet
switch
glow indicator

Life test started on
tube with plain
tungsten electrode
at 1/2 minute
interval.
16 1/2 mf 900 v.
Start 1 p.m.

Hinge

6.3 volt C.T. transformer produces about
120 volts square wave with 0.1 mf.
4 volt wet battery, 1.5 amp drain
when capacitor is fully charged
on flash unit 4 or 5 amps peak
initially.

oct 17 1948

Harold Edgerton M.I.T.

Factors influencing Flash Lamps design.

See J.O.S.A. July ~~1946~~ 1946
Electronics June 1948.

$CE^2/2$ energy stored × η (efficacy) = Light energy Q.

Type of gas. Xenon seems to give the highest efficiency and best color. Krypton is second best followed by argon.

Pressure. For a given tube the efficacy appears to increase with pressure up to 10 cm or thereabouts.

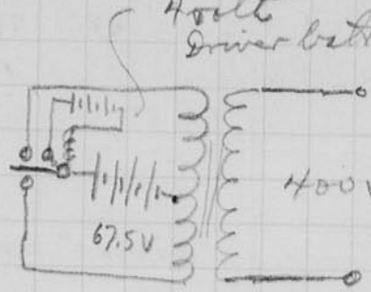
Dimensions Small changes in dimensions apparently do not influence efficacy. ~~so~~ There must however a tie in between length voltage, and pressure. One criteria probably is volts per unit length. Possibly the mean free path should be related to the diameter.

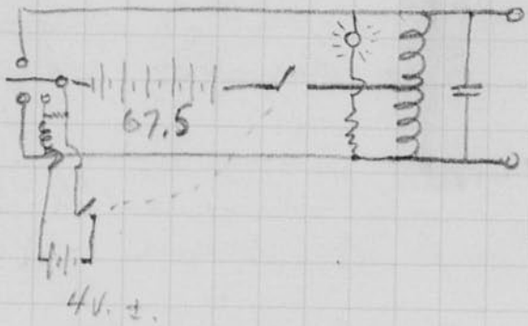
External factors to consider.
Volt amp characteristics
Voltage applied,
Energy - $CE^2/2$ discharged.
Final voltage after flash.
Damage conditions.
Self start voltage
Minimum start conditions.
Color variations
Time of discharge.

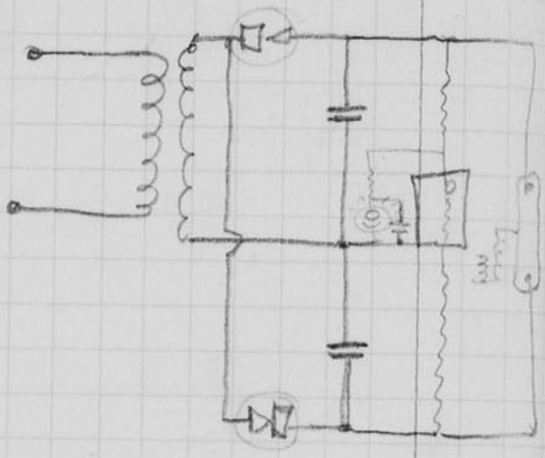
Dec 11/1940

Harold Edgerton

Vibrator power supply for A.C. Hand Pack





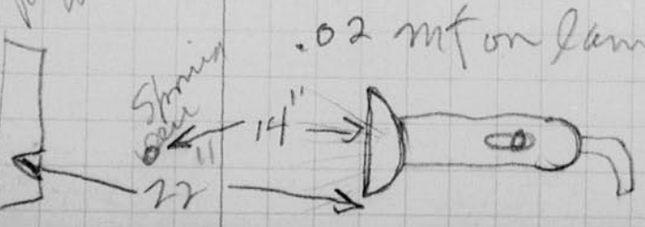


Movie dope from Chas. Wyckoff.
f4. 22" lamp - subject 0.02
Develope

16 mm Fastax with Kerr's new strobe

H. S.
Movie of spring compressing.
f 6.3 Super XX film 100 f.
80 volts on motor
camera, Bass model
without shutter.
.02 mf on lamp in

Fastax camera
without prism
5/8" Round aperature
plate in front of
square framing
device.



Trans Design at Bot of Page 1.

#2 High Speed series of camera shutter Bantam without ratchet. Cover o/f.
Sync wire set for instantaneous.
f 18 lamps focused on spot. 6" lamps - subject.
Super XX film.
Camera voltage 65 on rmac 0.02 mf.

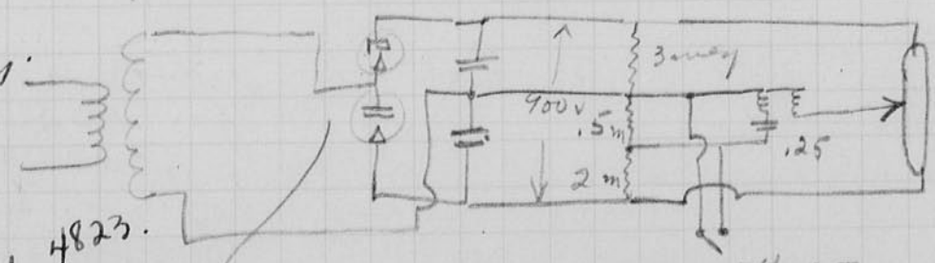
#3 Ditto above but with 1/25 sec instead of 1/200.

ac Portable transformer from my flea transformer.

3/8" square core

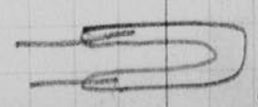
Secondary 5000 turns #40
Primary, 1400 turns #40 with C.T.

this draws 60 ma idling from 120 v into two 165 450 v Sprague condensers. the transformer gets slightly warm with 1/2 min continuous flashing.



Mystic trans:
Morson
Myg. 6 4823.
this transformer should have more primary turns to decrease core loss.
Prim 1500 #34 Prim 5350 #40 3.5 ratio.

9 3/4" length of 5 mm OD Pyrex with 48 stack rod 115 - 935 Ω
15 cm 4 mm
bent into U



Primaries 80-90
Sec " 2000
I" = 36-56 ma

G.R. Light Meter John Clayton

Sylvania photoflash

INCIDENT LIGHT
No 105
Calibrated by
Date Dec 31 1965
TRIP
50
100
150
200
GENERAL RADIO CO.
MFD BY WESTON
MODEL 891
B
AT. CHECK
A
CONTROL

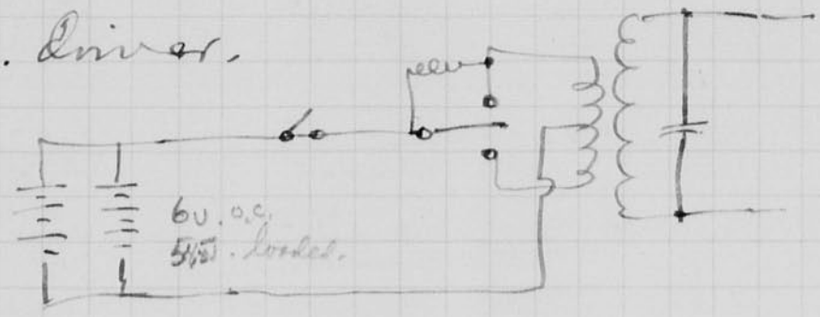
Oct 21, 1948.

I was in Washington Oct 15 to 18 with Rine on 685,501.

Bill MacRoberts finished the AC, portable. It weighs 2½ lbs with a ½ lb cord.

Output is about 90% of FT 220 with 28 mf at 1800 volts. See light book for data.

D.C. Driver.



Get ready #409 6 volts.

3/5 lamination 3/4 square section center core.

8.96 turns per volt at 60 cy is on 12,000 gauss
17. " " " " " " 6000 gauss

Vibrator conditions

5.5 volt x 2 = 11 volts

11 x 17 = 187 turns with C.T.

output 135 flat top.

$\frac{135}{11}$ = 12.3 ratio. 187 x 12.3 = 2300 turns.

Mystic trans ordered Monson

{ Prim. 180 turns of #21 wire with C.T.
Secondary 2220 turns of #32 wire.

Oct 21 1948
Howard Elgert
Chas Wyckoff.

High-Speed movie Shutters

Bantam f 4.5

#1 Blue Backed Film XX Eastman
Lamp-beamed 9" from shutter
f 5.6 C = .01 mf
motor-volts 110 volts.
End speed = 4320 f.p.s.
1/25 setting SM bulb

36
60
21 60

(f:2) #2 1/100 (?) setting SM Bulb. otherwise Ditto above

(f:5.6) #3 1/100 (?) setting SM bulb " " "

#4 1/200 (?) setting " " " " "

#5 1/25 setting " " Instantaneous synchronizer

#6 1/50 " " " " " " plus delay for peak opening

#7 1/100 " " " " " "

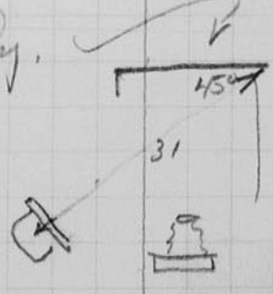
bulb did not fire

#8 1/200 (top speed) " Transportable
full capacity
one FT-220

Performance data estimated. XX film.

speed f.p.s.	C mf.	f	area	distance
1000	.05	4.5	2'x2'	4 ft.
1000	.05	2.	4'x4'	8 ft
3000	.02	4.5	1'x1'	20"
6000	.01	4.5	1/2 x 1/2	10"

Kodachrome copy of Dewel Lab Brown Bill Selby.
f11 X2 transportable at 31"
2 f16.



Oct 22 1948

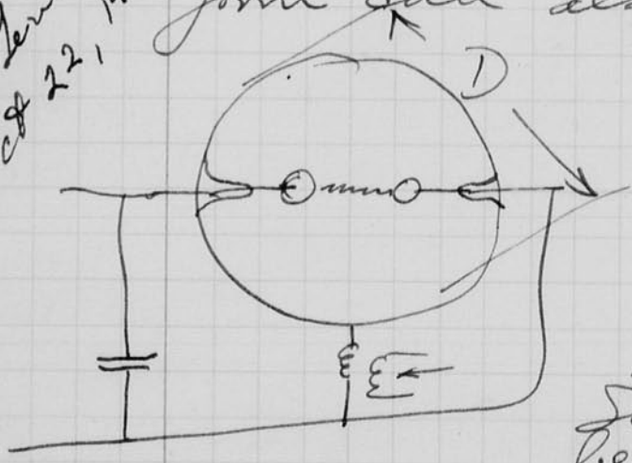
Harold Edgerton.

High Pressure Light Source.

Apparently xenon gas at 10 or 100 atmospheres pressure is a very efficient converter of energy into light even at low candles. Difficulty is experienced in building such tubes because of danger after the tube is sealed off. the glass is always weak in tension and may go off with explosive force.

I propose that a tube at 1 atmosphere or so pressure be used with precise timing so that the wave is at the center at the moment of capacitor discharge. this operation will be stroboscopic but at a high frequency the frequency will depend upon the sound velocity and dimensions of the flash tube. For this work the tube will probably be spherical in dimensions although a cylindrical form can also be used.

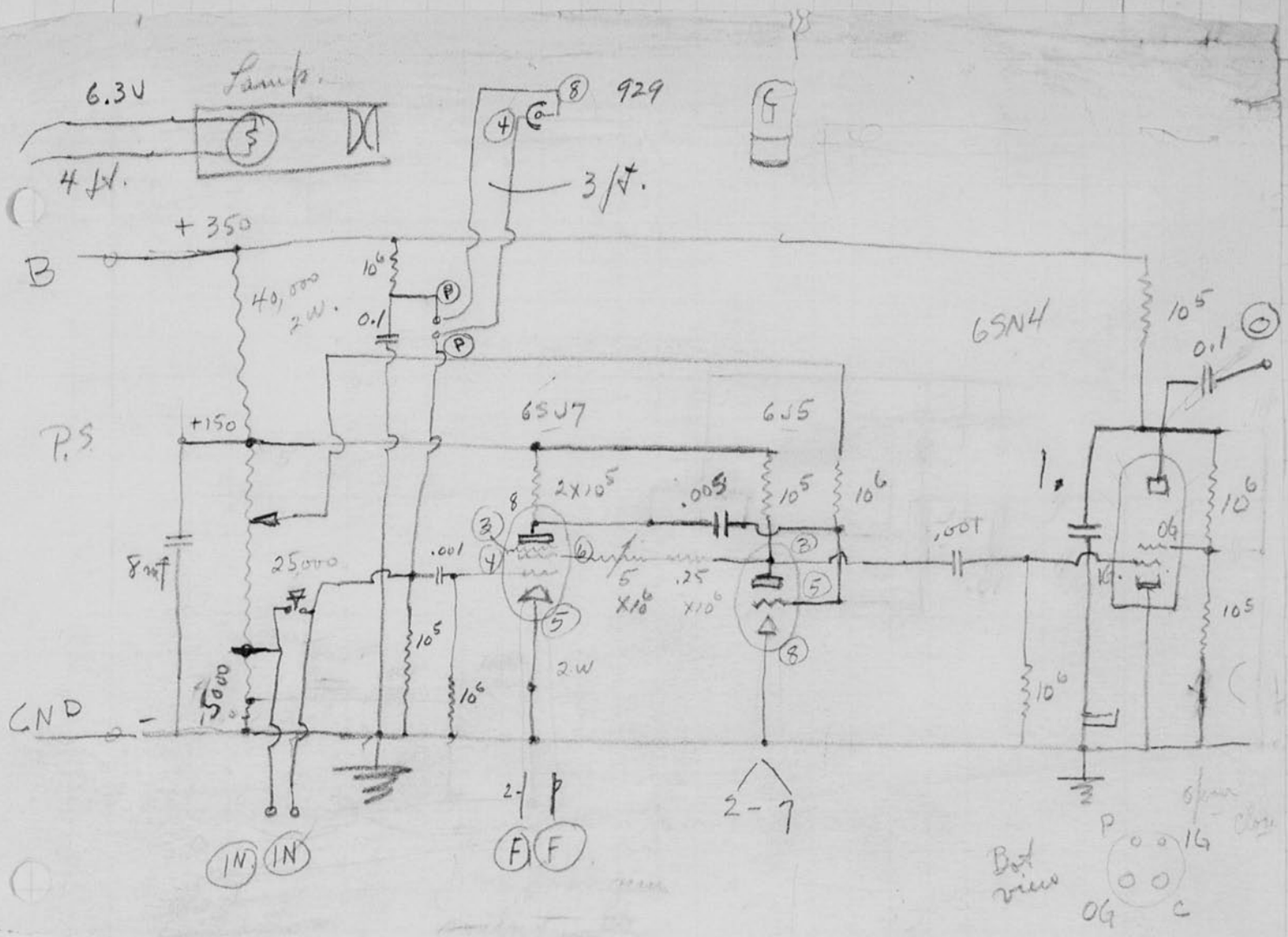
Read & understood by H. E. Germeshausen Oct 22, 1948



the first flash will set up a transient pressure wave. When this wave is reflected back onto the center, a second flash will be called for at the moment of high pressure. Subsequent discharges will be timed to correspond to the peak pressure. adjustment of the flashing rate will be made until the light output shows a maximum.

Assume sound 1000 ft per sec velocity frequency will be $\frac{1000}{D}$ flashes per second. Example $D = 1/3$ ft. then $f = 3000$ per second.

We could use submultiple frequencies such as 1500 or



Wired by Jack Fletchers group Oct 22 1948

Photo tube pickup and time delay circuit.

Switch Movies PIS. Oct 2 48

#1 Load 1000 watt lamps. HH

# ft.	Camera motor Volts	Discharge C	Film	Lamp in beam 6" from sub.
1	100	80	.02	Super X f5.6 60 cycle timing from Stenbotics.
2	100	80	.02	Super XX f5.6 60 " "
3	100	80	.01	f4 60 PIS Despard. Lamp filament bounce.
4	100	80	.02	XX f4 60 Lamp 29" from white board Beam at 1 on mark.

Notes from Meyer Edgar J. amer Opt. Co. Oct 20 48
Buffalo 15 N.Y. letter.

$S = 0.3\lambda f$

f = speed = focal length / diameter
λ = wave length of light
S = smallest separation on object

(1) First determine S on object (required)

(2). Then solve for speed.

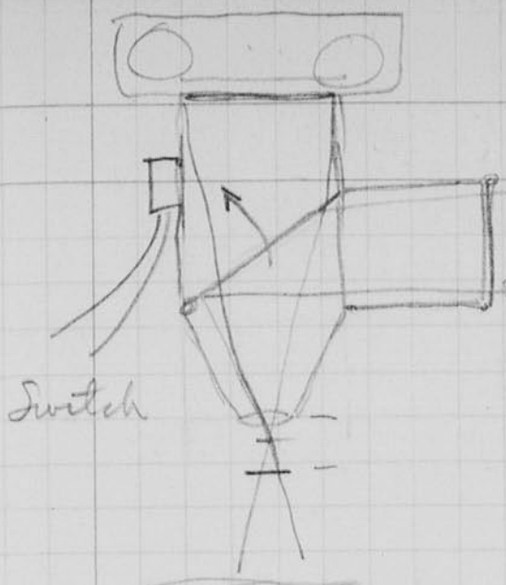
(3) Find magnification so that S is readily observable.

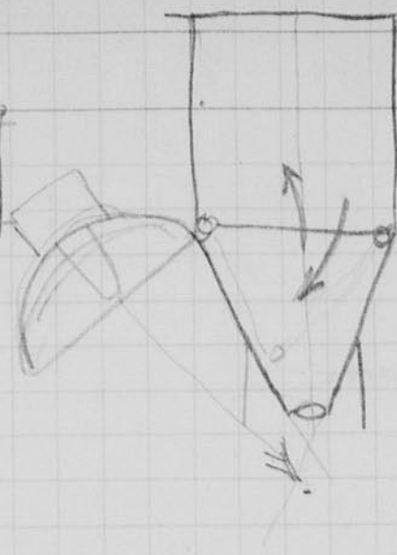
$M = 0.1/S$ the eye can see 0.1 mm

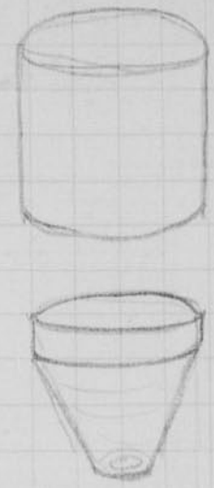
then $M = \frac{1}{3\lambda f}$ let $\lambda = 4.5 \times 10^{-4}$

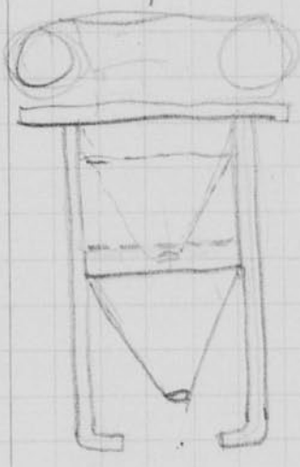
$M = 800/f$ at f 32

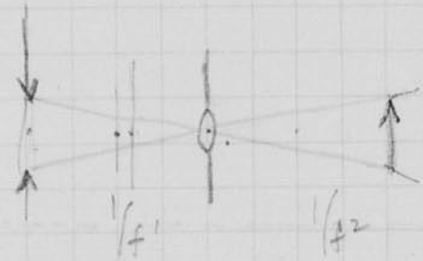
$M = 800/f = 25$

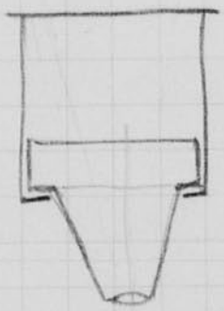












$\frac{1}{2} + \frac{1}{2} = \frac{1}{1}$ 1:1

$\frac{1}{f_1} + \frac{1}{f_2} = 1$

10:1
$f_1/f_2 = 10$

$\frac{1}{f_1} + \frac{1}{10 f_1} = 1$

$f_1 = 10 f_2$

$\frac{10+1}{10 f_1} = 1$

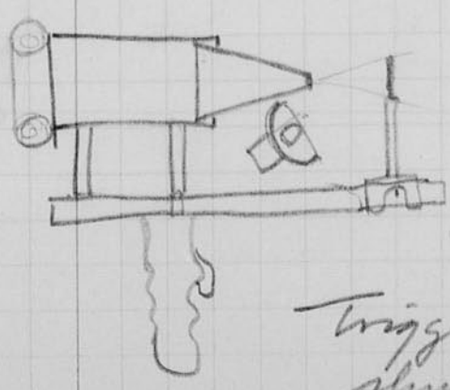
$f_1 = 11/10$

3:1
$f_1 = 3 f_2$

$\frac{1}{f_1} + \frac{1}{3 f_1} = 1$

$\frac{4}{3 f_1} = 1 \quad f_1 = 4/3 = 1.33''$

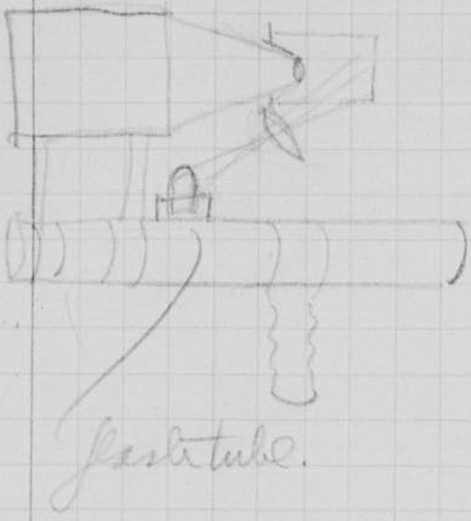
$f_2 = 3 \times \frac{4}{3} = 4''$



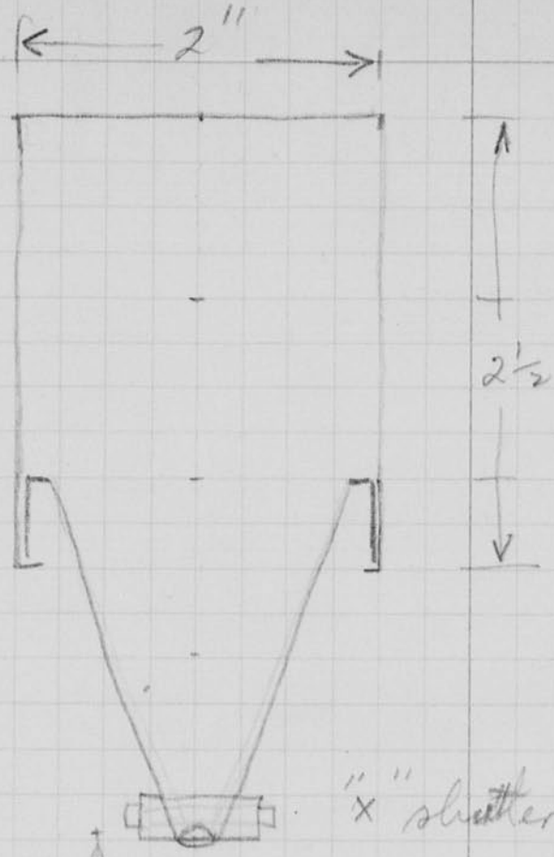
Trigger shutter release.

Oct 26 1948

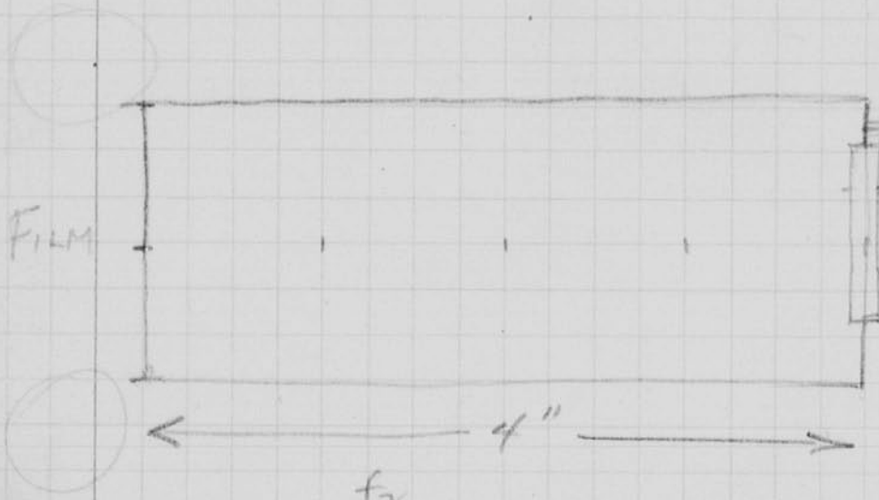
Harold E. Edgerton



Pestitube.



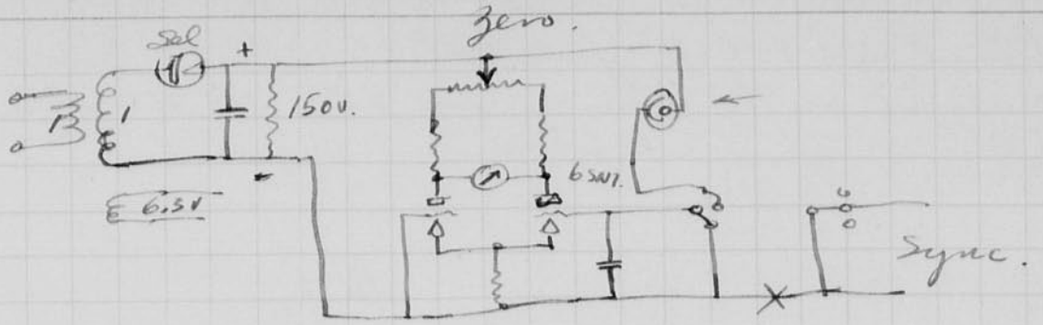
"X" shutter



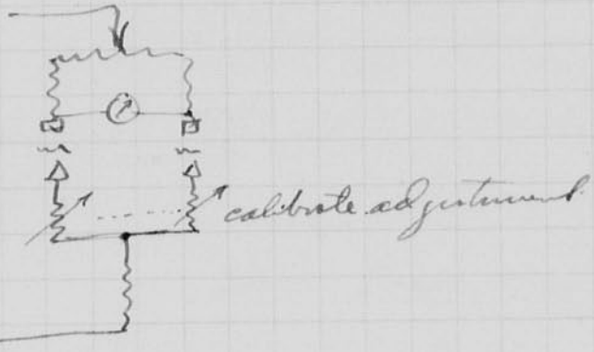
	f2	
2" lens	4"	1:1
1" lens	4/3	1:1

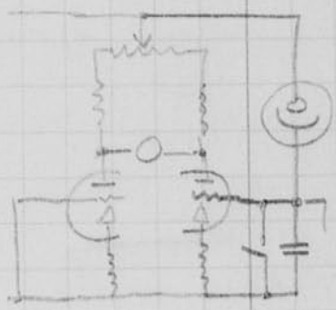
3:1

Probe ac operated light meter.



.1 mf from 6J9 is about right for 1 volt





Weight of ac Portable Oct. 21, 1948.

Flash unit bare	2½ lbs.	
Flash unit with cord and camera bracket, 6 ft.	3 lbs.	
Battery Burgess 4F5H	7 3/4 lbs.	cost ~~3~~ 2.50 retail.
Vibrator power supply	3 lbs.	(p48 trans.)

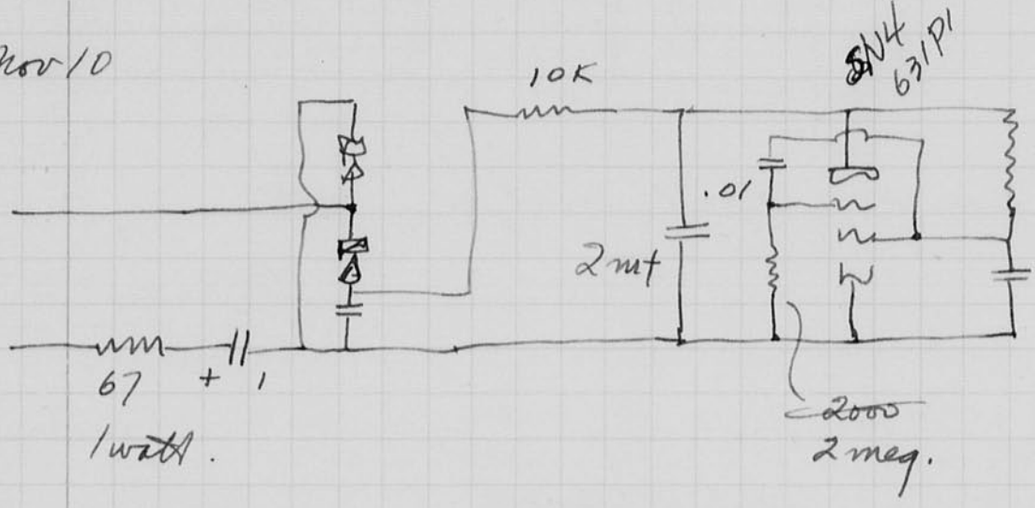
Other Batteries equivalent

Eveready	1562.
Rayovac	651B.
General	651.
Bright Star	156.
Bond	5152.

Nov 8, 1948

SMPE convention in Washington Oct 26, 27.
I returned on Nov. 4. from Washington. Some time was spent with Kinzo on 685501 and 3373 and other applications.

Nov 10



Strobe beacon built by R. Bill Mac

Nov. 11 tests see Light note book.

V tube tested to destruction at low voltage with electrolytic capacitors.

Inside diam of tubing = 3.4 m m.
Arc length = 1.5 x 2 = 3 inches
Gas Xenon. 15 cm.

Starting voltage was about 400 on test set.

Output with 4 (180 mf 475 V sprague in ser par.)

Light	V.	C	CE²/2	4/W
2960 L.S.	900 V	180 c	72.8	40.7
4520 "	900 V	270 c.	109.	41.3

Sprague 270 mf 450 V weigh 2# 10 oz. in 6 cans 1 3/4 " diam 3 1/2 " long

The lamp crazed badly at 1000 V 270 c mf. Efficiency was ok at 900 V after crazing but mechanical failure resulted from crazing cracks

Thus limit is about 100 watt seconds at 900 volt level. Is crazing an area or volume phenomena?

Surface = $3 \times 2.54 \times \frac{3.4}{10} \pi = 8.14$ sq cm.

Radius π

cubic volume of tube = $3 \times 2.54 \times \left(\frac{3.4}{20}\right) \times \pi = 0.64$ cubic cm.

Crazing limit assuming volume

energy = 100 watt sec.
Volume = 0.69 cc.

$\frac{\text{energy}}{\text{cc}}$ = 145 watt sec/cc.

Design lamp for $270 \times 3 =$ 810 mf at 900 volts.

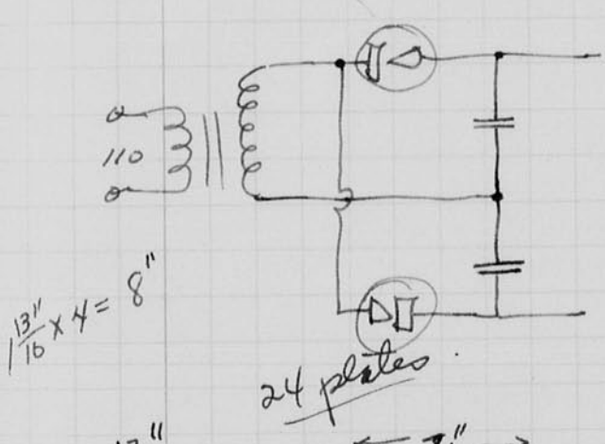
Watt sec = 327 rated.

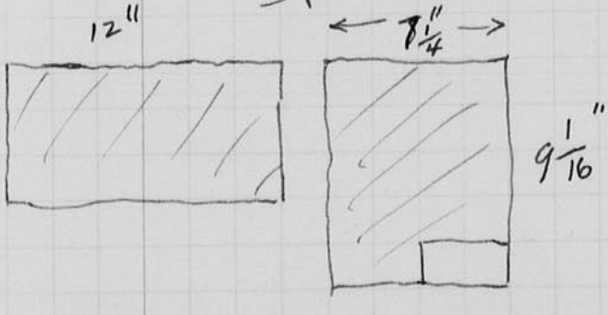
actual = ?

dia of tube for 145 watt sec/cc limit should be

3.4 mm $\times \sqrt{3}$ = 5.9 mm length 3"

24 plates





Ratio = 3.57 pri & sec.
(See p 45).

~~Try 103 VI size 5.6# Lam 365. too heavy~~
~~Kodatron trans = 4.75 lbs.~~

Try Lam 485 3 lbs about 50 VI. G.R.

Primary 660 turns
10 layers #25

(See p 65)

Secondary $660 \times 3.57 =$ 2360 turns.
Use #31 wire (or 32)
15/16 tongue 15/16 stacks.

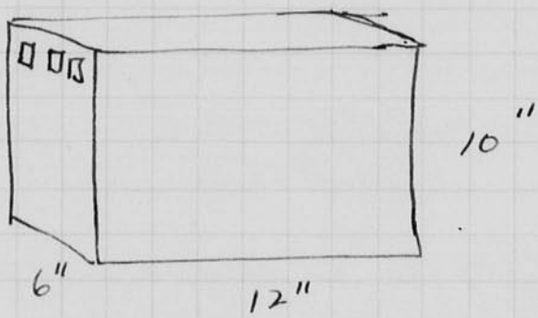
Total leakage in electrolytics.
18 capacitors.
9 series at .5 or 1 mil
say 9 m.a. leakage
Power = $9 \times 900 \times 10^{-3} =$ 8.1 Watts.

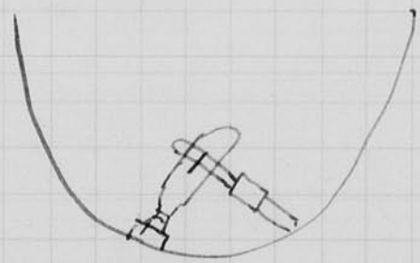
10 second intervals
$\frac{327}{10} = 32.7$ watts.

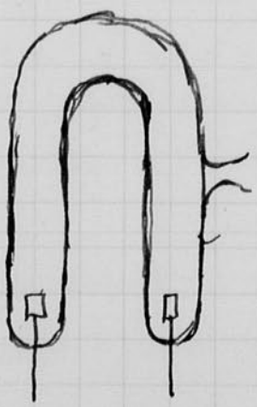
nov 11, 1968 H E Edgerton

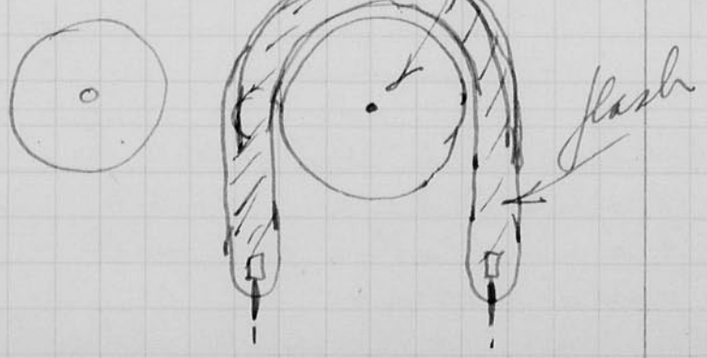
AC unit design.

	Kodatron
Weight = 18 pounds.	35
output = 13,000 lumen sec.	8,500.
Capacity = 18 sprague 180 mf 475 V 5266.	
Weight of capacitors = 2# 10 oz x 3.	
Wt of transformer = 3 lbs.	
Flash tube I.D. = 6 mm.	
Active length = 3" or 3.5"	









Projector

Washington D.C.
Roy Teele. Bur of Std.

BUDDINGS. BASORE GLODT BIRD RIBLETT KAUFFMAN

HULSWIT FARNELL CHRISTMAN THORNBURY PETERSON VITT.

BILL EDGERTON

MRS BIRD.

ESTHER.

MRS CHRISTMAN

BOB.

Kabuszka left early.
Jack McMorran & wife also left early.

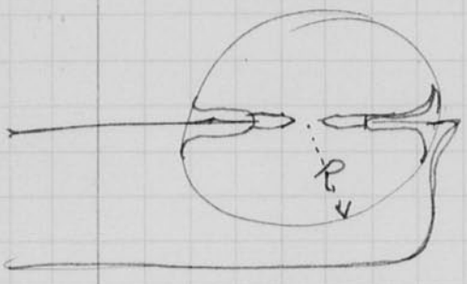
A study has been made of the use of flash lights in the Boston Garden for hockey photographing. A plan an installation of eight lights with synchronizer cables lead to the press boxes. 18" Reflectors with a 15 or 20 degree beam will be used so that the lights can be a long ways off.

 Dec. 1, 1948.

Harold Edgerton.

A sphere lamp is to be made at nela for the pulsating-pressure lamp. Today I sent a final request for a 1 cm gap in Krypton or Xenon at 1 atmosphere.

The frequency will depend upon the dimensions of the sphere.



let v = velocity of sound in Xenon at 1 atmosphere. (approx value).

$$f = \frac{2R/v}{} \quad \frac{v}{2R}$$

I propose to pulse the lamp at a variable frequency near the resonance frequency of the gas pressure wave so that a measurement of the efficiency increase can be measured.

Bird and Miehl came in today to discuss their thesis on the effects of dimensions on the efficiency of a flash lamp under different conditions.

Factors are
1. Tube length
2. Tube diameter
3. Voltage
4. Capacity.
5. Energy per c.c.
6. Energy per sq. cm.
7. Gas type. (Xenon)
8. Pressure > 10 cm.

I also discussed thesis work with Smith and Witter. One proposal was to measure the efficiency curve of the FT-617 flash tube in an effort to finish up the work of Ben Logan.

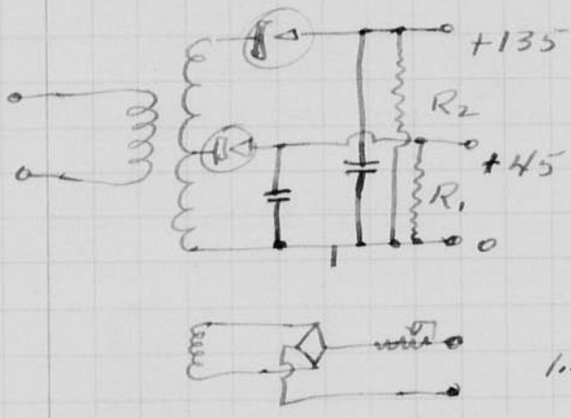
A.C. Power Supply for Light Meter.

745 Laminalin transformer.

Prim 115 V 50-60 cycles. 1490 turns #35. 13 layers

Sec. 70 (69). 900 turns
tap at 300 " #35

Sec. 2.5 V 33 "



.135. ~~5 mils.~~
135 x 10 ma.
= 1.35 watts.
135,000 ohms.
R_2 Suggest 270,000 ohms.
R_1 and 100,000 "

1.5 V 0.1 ma.

Edgerton
Dec 4, 1948.

f 256 aperture.
$\frac{1}{256}'' = \frac{1}{21}''$

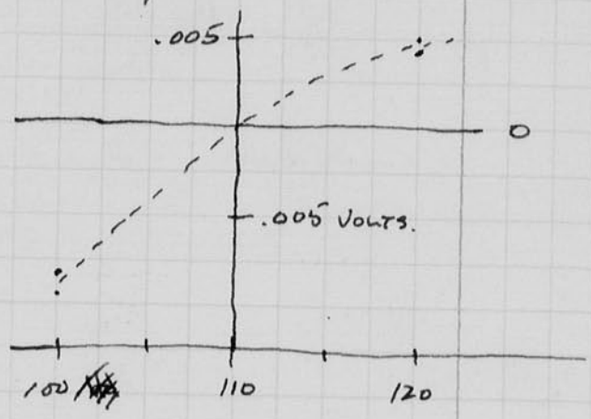
Tests of G.R. meter (Powers Model).

Input 110 volts for 5 or 10 minute warm up.

time min	V input	output ma.
29	110	0
30	120	+.035
31	110	−.005
32	100	−.08
33	100	−.095
34	100	−.10
35	110	−.035
36	110	−.025
38	120	+.02
40	110	−.02

.4 ma = $5 \times \frac{1}{100}$ = .05 volts.

Slow drift to .04 then to .035



.04 ma = .005 volts
equivalent input.

110 volts input to amp
.05 V input → .399 ma.

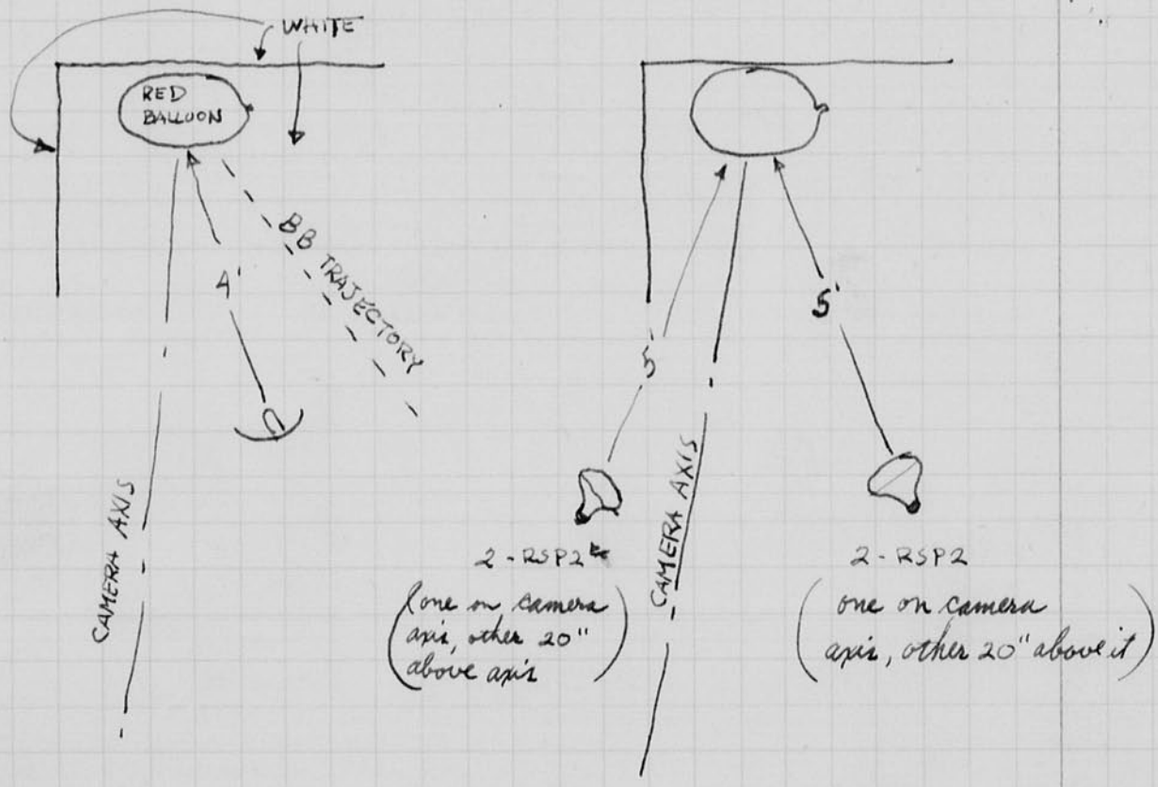
120
.05 " → .395 ma.
ck. 110 .05 " → .399 "
100 .05 " → .399 "

Edgerton Germeshausen & Grier

Movies.

Dec 9 1945 Eastman 3000 per sec camera.

	Film	f	Speed	Strobe	D.	Subject
	Super xx	2.7	3000	.02 mf.	4 ft	white background. BB into Balloon.
	Sent to E.K. for processing.					
blue base	Super xx	2.7	3000	.02	4 ft	" Strobe
	Sent to Master for processing					
	blue base Super xx	5.6	3000	4 x RSP2 110 v. incand.	5 ft ea	" Incandescent.
	Sent to Master for processing					



Dec 17 1948 · A.C. Flash unit. Power Supply

H. Edgerton

See page 57. for transformer.

Prim 660 turns # 25
Sec 2350 " # 31 } 3.51

Tests with electrolytic. 14 ~~Sprague~~ C.D. + 6 Mallory

Input	output.		
100 volts.	465 x 2	} (375 ac)	3.51 ratio.
105	485 x 2		
95.	445 x 2.		

Suppose 130 - 550 for design. $\frac{550}{130} = 4.23$ now is 465.

Decrease turns ratio by $\frac{4.23}{4.65}\ 2350 = 2130$

500
475
450.

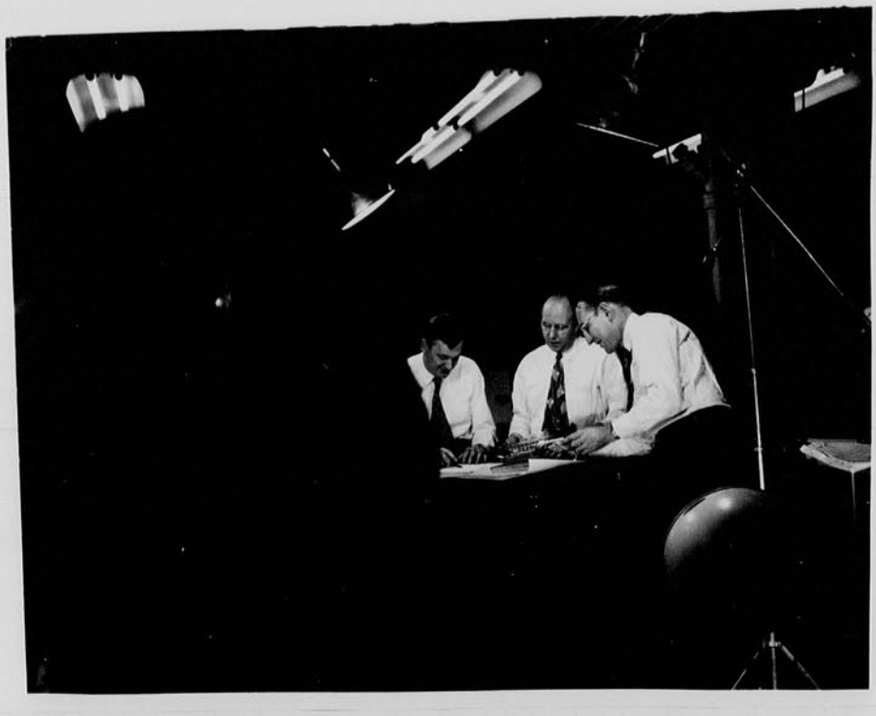
Small trans
$\frac{475}{115} = 3.6$.

Voltage set at 450 x 2 at 117 volts.

500 x 2. 130

Decrease turns ratio $(500/130 = 3.85)$

$\frac{4.23}{4.85}\ 2350 =$ 2050 turns.



As used in ?
600 mf 1000 volt
unit with
FT-220 tube

Capacitors.

Sprague 20.75# No P 15711
4000 volts 6"x8"x 8½"
36 mf.

PAPER. G.E 26F965 14 mf 2500 v 2880v (500 hrs). (1000 h.)
Used at 2000 volts in Eastman Kodalrm post war.
Price Dec 30 1948 from Yohannsan G.E.

1-99	12.08
100-999	10.55
1000-9999	9.94

Mfg discount 60 and 6 .376 factor.

~~W.S./#~~ W.S./# Weight = 2½ lbs.

2.82 7.5 Energy storage = $\frac{14 \times 2000^2}{2}$ = 28 watt sec. 10.6 WS/lb.

4.4 10.85 = $\frac{14 \times 2500^2}{2}$ = 43.8 " " 17.5

5.85 15.50 = $\frac{14\ 2880^2}{2}$ = 58.2 23.2

Cornell Dubilier Electrolytic Capacitors
Rated 200 mf 500 volts.

Weight of 12 capacitors = 7# 2 oz.
Volume of 12 " = 6"x8"x 4 3/4" n.

Energy storage = 600 mf 1000 v $CE^2/2$ = 600 $\frac{1000^2}{2} \times 10^{-6}$ = 300 WS

cost 1.33 x12 (1000 lots) = #16.0

300 W.S./16. = 18.7 WS/#

$\frac{300}{7.\#12}$ = 42.1 WS/lb.

Derating factor = $\frac{28.5}{32.2}$ = .89. $\frac{\text{Paper}}{\text{Elect}}$ $\frac{n}{n} = \frac{1}{.89}$

16.6 W.S./#

37.4 W.S./lb.

Notebook # 19

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 __66__ and __67__.

Item(s) now housed in accompanying folder.

Sprague 20.75# No P 15711

KK

Sprague 20.75# No P 15711

Capacitor Data.

Sprague as used in the Sun flash. P15711
36 mf 4000 volt 20.75 pounds.
288 watt sec.
.072 pounds per watt sec
13.8 watt sec. per pound.

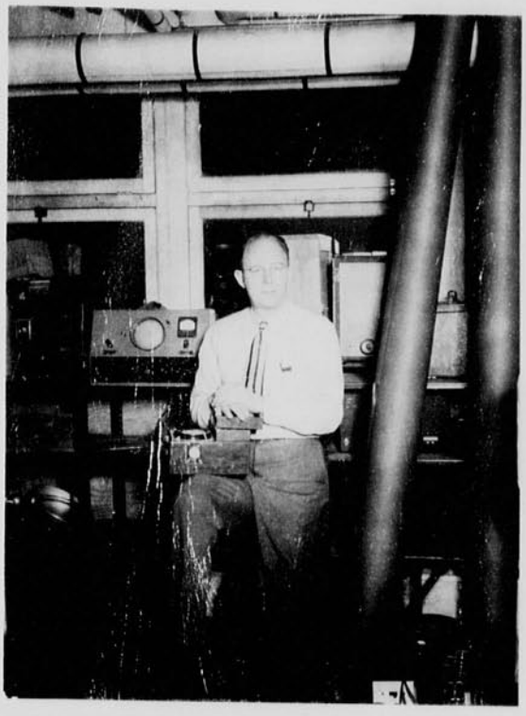
D.C. as used in flash equipment 26F965
14 mf 2500 2880 (500 hr). 2 1/2 pounds.
43.8 watt sec (2500 V) 17.5 watt sec/lb.
58.2 " " (2880 V) 23.2 " " "

25/hr

250 19%

H. Edgerton Lew Rosenblum

700 b.c.p.s



Kodatron at 10' f11
5000 b.c.p.s.

Report on MOVIES.

Balloon hit with B.B. taken Dec 18 1948

Film	f	Speed	Strobe	D.		Subject
XX	2.7	3000	.02	~~3~~ ft.	Exposure and action ok.	Balloon.
XX	f8	1500 (25% R.)	.02 on 50 ft film.	1	" " ok.	Pen
XX	2.7	3000	02	6 ft.	thin.	22 Bullet from nuzzle.

Rate = ~~99~~ $\frac{1}{3}$ $\frac{1}{(30)}$ sec = 2990 f.p.s.

$\frac{31}{12}$" x 40

Jan 6, 1949
H. E. Edgerton & Bol.

Subject	Film	aper	Strobe	Res.	D.	Remarks.
Price Relay	XX	5.6	.02 .05	50%	1 ft.	50 ft Side light
" "	XX	5.6	.02 .05	50%	"	" front lighting.
Bow Pistol	XX	4	.02 .05	75% out.	1 ft	50 ft Side light.
Bow & Arrow	XX	2.7	.02	50	3 ft	50 ft.
Guitar	XX	4	.02	75% out	1 ft +	50 ft. G-C.
Bubbles. Bob blows bubbles.	XX	2.7	.02	50%	1 or 2	50 "
Bullet into Balloon.	XX	5.6	.02	100% out Start from 40	1	50 ft. Side. Broke balloon.
Balloon hit by BB	XX	5.6	02	100% Start from 40	1	Side

Jan. 10, 1949.
above received. all O.K.
on exposure.
Bubbles need white background.

Dry bats tested

Specialite 7920 SM 7 1/2 v 7 1/4 lbs 6204 flashes 6 3 +
Burgess 4F5H " " "

Jan. 10, 1949.

Harold Edgerton.

The Sphere tube came yesterday and I have been driving it from the new movie unit. A frequencies up to 6000 cps are goes between the points. above that freq. the arc seems to swell out.

Probe sent to Schwartz 0.06 Handle sec gives 100 reading.

70 Jan 12 1949.
H.E. Edgerton

Movies Eastman III with strob.

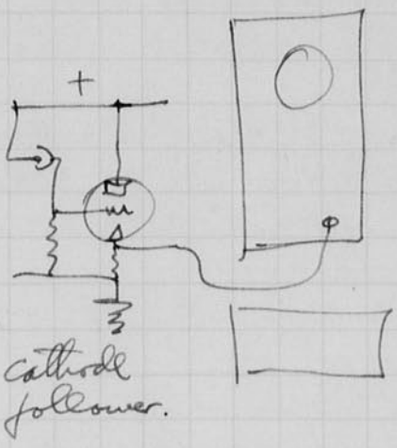
	Subject	Film	Aper	Strob C	Res. D	Remarks
1	Ink drops	XX100	8	.02	50%	7" side, 60° Slope drop.
2	" "	XX 100	27	.02	50%	7" 85° Smooth dropper
3	" "	XX 100	11	.02	50%	7" side 85 finger held over dropper.
4	" " Splash 5" fall.	XX 100	5.6	02	50%	5" side Reflector.
5	7" splash	XX 50	5.6	.02	50%	5" side Reflector
6	7" Ink jets. milk	XX50	5.6	02	50%	6" side "
7	7" milk into Ink	XX50	5.6	.02	50%	6. "
8	7" milk into Ink	XX50	11	.02	50%	6" side "
9	7" milk into Ink	XX50	8	.02	50%	6" side camera back.
10	5" milk Splash.	XX50	16	102	50	6" Back + Reflector
11	23¼ Drop on plate	XX50	11	.02	50	7" Side + Ref.
12	" 2nd drop	XX50	11	"	"	" " "

Exp ok on all
Feb 3 1949

Jan 13 1949.
H. E. Edgerton.

Duration Flash Measurements.

FT-214
1, 5, or 30 mf.
2000 - 2500 V ±.
Std lamps.



AR Scope 256B
#341
408-4326

GR.
oscillator
1301A 324

Film no.	Sweeps.	Cal. freq.	Lamps.	C.	E.	Screen illum'n	Lat.
1.	A 20,000	10,000	214	5	?	50 V 10 sec.	8
	Both on one?!!!					60 10 "	8
1.2	"	"	"	"	"	70 10 sec	8
1.3	"	"	"	"	"	normal	8.
1.4.	2500 ms.	"	214	600	1000	normal.	

Taken Feb 3 1949 at Polaroid with 600 mf 1000 volt 2 light flash unit. AC operated.

Guide number about 110.

Edwin Land

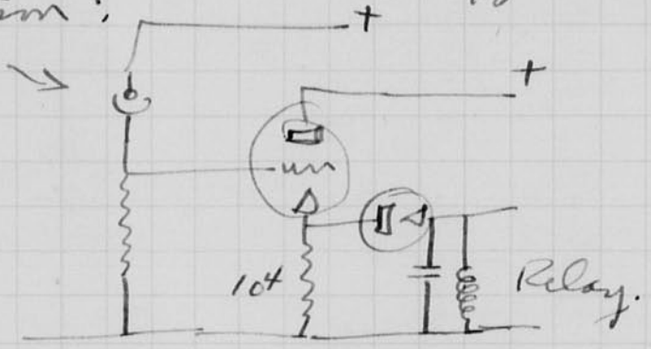
H. E. Edgerton

Jan 20, 1949
Harold Edgerton

Al Groves and Herb Miller were here from Los Alamos today. Inspected the new Bldg on Huntington Ave.

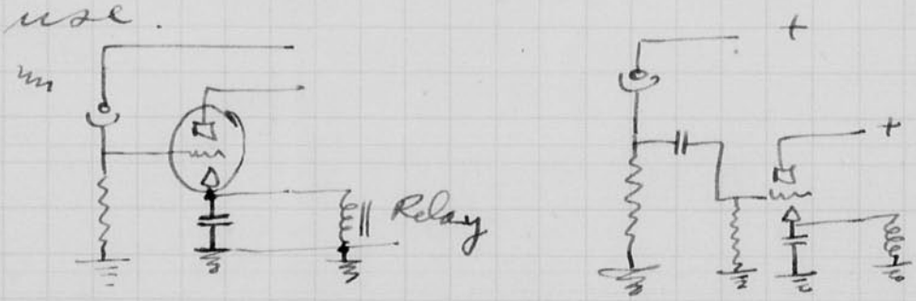
Clifton Andrews of Industrial Electronics Co was here today with a Burglar Alarm System. Barstow, Germeshausen and McRoberts tried a 60 cycle stroboscope with some success.

Pickup circuit suggested for stroboscope:



Andrews took this with him.

Could use.



High peak light through the use of a cathode follower charges a capacitor that holds the relay in a closed position. Dropoff of the light causes the relay to drop.

Read & Understood
H. J. Germeshausen
Jan 20, 1949

Jan 24 1949.
H.E. Edgerton.
220 Temple

Start Lamp Sub.

#	Subject	Film	Aper	Strob	Red	D.	Remarks.
1	Badminton	XX 50 ft	2.7	.02	50	3/20	3 ft. Closeup of Bird impact.
2.	"	XX 50	2.7	.02	100	3/30	3 ft. " " " "
3.	"	XX 50	4.6	.02	100	30	3 ft. " " " White reflector.
4.	"	XX	4.	02	"	"	Low shot.
5	"	XX 5	2.7	.02	"	"	Hand swing.
6	"	XX 50	2.7	.02 + 7 on GE meter.	100		3 ft Closeup of Bird. Wilkins visit.

Black and white at f 5.6
Color at f 2.5. 7 Hands.

7	Tennis	XX 50	4	.02	100	30	3 ft Closeup of Ball.
8	Tennis	XX 50	f4	.02	100	30	3 ft Closeup of Ball.
9	Tennis	XX 50	f4	.02	100	/30	3 ft " " "
10	Tennis.		Ditto.				Edge lit
11	Tennis	XX 50	f	02	110		3 ft. Closeup.
12	"	"		Do			"

FASTAX

74 Jan 5 79

Edg Temple. Cage Rockwell

			f	Hole	Pos	D	Remarks
1	Football	XX 50	2.7	.02	70/40	4 ft	late ?
2	"	XX 50	27	02	70/40	4 ft	early
3	"			Do	80/40	4 ft	early ?
4	"	XX 50	2.7		90/50	4 1/2 ft	ole
5		30	2.7		100/50	4 1/2	Foot lid Ground
6.				Do.			
7.				Do.			
8	"	XX50	2.7		100/50	10 ft	Foot ball early. MG bush.
9	"	XX50	2.7		100/50	10 ft	Football MG
10	"		2.7		100/50	5 ft	" Geiger
11	"		2.7			5 ft	" "
12	"		"			"	Hd sand "
13.							ole
14							Bachrach
15. ✓							" "

Light tests of Portable.

after 650 flashes the light read

65 Standard sec × 3^2 = 585 b.c.p.s.

A new tube was pumped and installed.

1½ turn pyrex filled with xenon 15 cm.

Light now is 110 × 3^2 = 990 b.c.p.s.

Camera — tube type. letter to Boon Feb 4

8" lens

22.5	× 15	ind. field.
15	× 10	"
10	× 6.66	"
6.66	× 4.47	"

Feb 19 Ray Stevens & Dr. Keville went to E 33rd St 160 Brookline with Ken Zimmerman and 2. last week or so.

McLeod Hub 2 0342 called about Rose house photography.

March 1, 1949
H E Edgerton

Photocell leakage meas.

	GR.	V			i leakage
1P39	# 136.	.05	850 meg.	.05/850	5.88×10^{-11} amps.
	129	.07			
	86	.07			
929.	98	.11			
	107	.10			
	96	.09			
	89	.09.			

Phone call to Fred Barstow from Schwartz.

Photo tube with rating of 66 μ/w from RCA

[185-190 in Schwartz meter with .02 mf capacitor.]

$$\frac{145}{125} = \frac{66\ \mu/w\ \text{P.C.}}{\text{Reg 929 p.c.}}$$

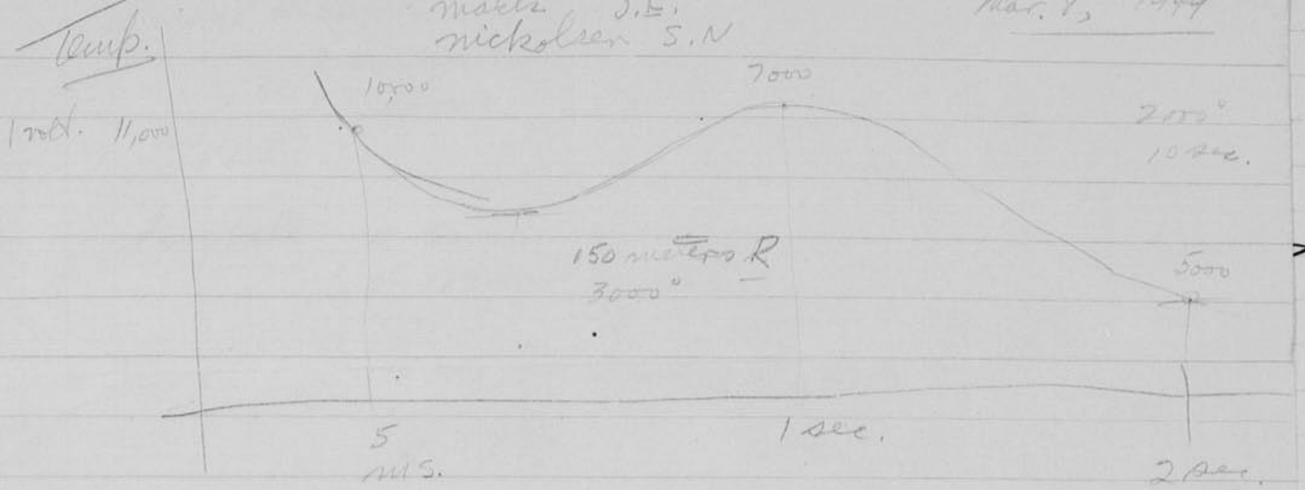
$$185 \times \frac{145}{125} \times \frac{.5}{.02} \times \frac{.02}{.05} = 86$$ meter reading

with .5 mf and 66 μ/w photocell.

Σ Ref.

LA 588 Report. July 16, 1945.
Geiger F.F.
makin J.E.
nickolson S.N

For Allgaier. mtg
H.E. Edgerton
Mar. 8, 1949



Black Body. equilibrium.

Continuous spectrum per sec. Black Body.

Ozone cuts 2900.
Air absorption important.
See O'Brien Cranwade. Temp. 10^5 degrees.
N.O.L. – Total Energy. Bolometer.

Line Spectrum in Region of min.
Resolving time 5 ms to 50 ms. 1/4 ms.
Min at some time for different colors.?
14° Resolution. 10A°
Relative intensities only – no abs.

Cloud motions – 10 minutes. 50 ft.

$$\rho = \frac{7}{6}\, 14.7 \sqrt{\left(\frac{v}{c}\right)^2 - 1}$$

$\gamma = 1.4$ does not vary.
$\rho = f(R)$

$$\frac{\delta \rho}{\rho} \frac{v}{\delta v} = \left(\frac{v/c}{v/c - 1}\right)$$

$$\frac{\delta v}{v} = \frac{\delta s}{s} + \frac{\delta t}{t}$$

over.

March 1, 1949
H E Edgerton

GR.

1939 # 136.
129
86

929. 98
107
96
89

Phone call t

Phi

Paper re Photography. 2 blast gages.

p abs.	V/c	δp/p = γ/8V
100 psi	6	1.2
25	2	2.0

at 100

$\frac{\delta p}{p} = 1.2 \frac{dv}{v}$

half mile

2% accuracy required in pressure

1% " " " velocity

Faulkstone.

Image dissector 200 meter width of field.
7 miles to camera
8" lens

Fire ball 0-50 ms. 1 MS - 40 meters R.
0-175 meters radius

15 ms breakaway of shock.

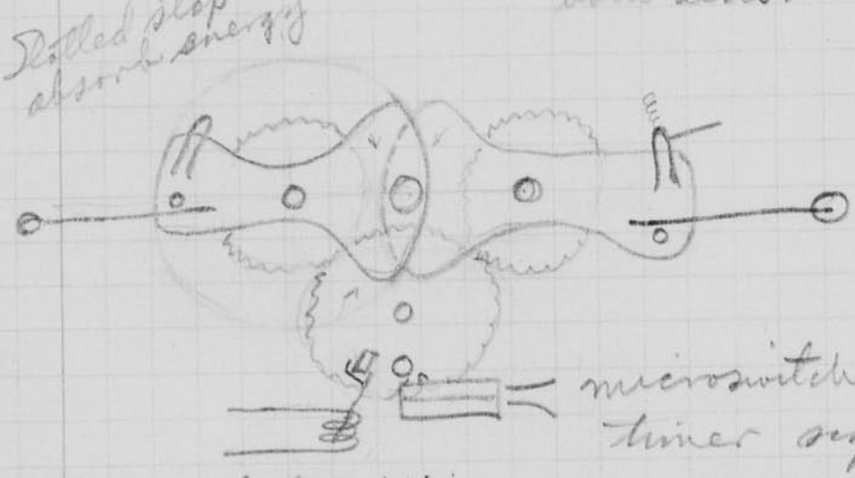
$R - t^{2/5}$ t $w^{1/3}$

Basic exp for ~~second~~ flash.
10 MS 15" lens f16 Super xx Pan x-
Pan x 2 stops.

Exposure = $\frac{t}{f^2} = \frac{10}{256} = \frac{1}{25.6} = \frac{.04 \text{ sec}}{\text{aper}^2}$

#B Edgerton
Nov. 15 1949 Speed Shutter.

method. Two rotating discs with a circular hole in each. The discs overlap so the two holes match at one point in the rotation. A spring system will be used for driving the discs.



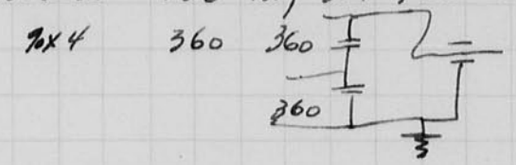
velocity required. 1/2" hole
100 μs. exposure

$\frac{0.5"}{100 \times 10^{-6} sec} = .005 \times 10^6 =$ 5000 inches/sec
= 415 ft/sec. (almost the velocity of sound)

with a 1/8" hole the velocity is dropped to 100 ft/sec.

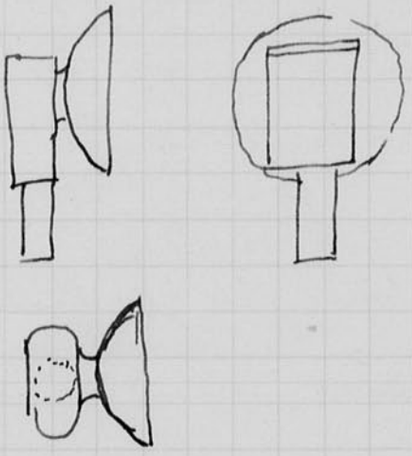
March 16, 1949
Harold E. Edgerton.

Allan Stinson and were in on monday March 14 to discuss portables. they showed me a 10 pound electrolytic unit that had 180 mf at 900 volts.



I showed these men the Red portable that has just been returned from Eastman with a letter from Booa showing that they are not interested.

This Red Portable contains 80 mf at 950 volts. the flash tube is a 1½ turn spiral pushed out from the reflector to give flat coverage. the light is about ¾ that of the old Rodatron.



The dry battery unit to operate this unit operates from a 7½ volt 8 pound ~~unit~~ battery

On this is a vibrator and trans former.

Vibrator transformer. ordered from Meyster.

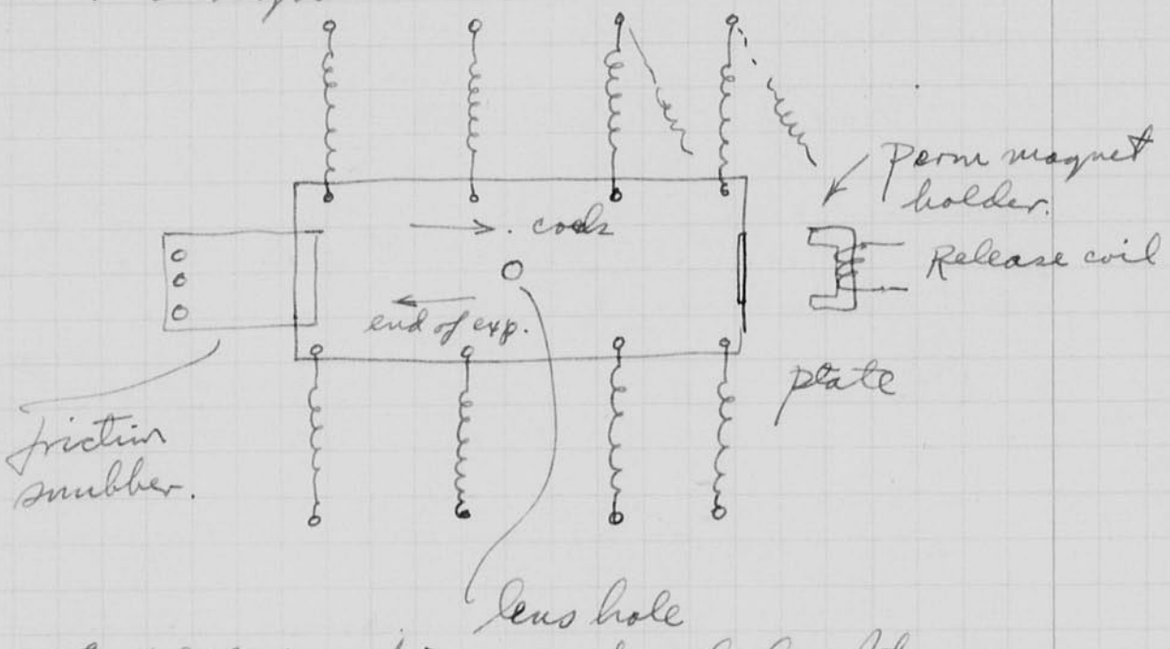
Power supply to operate the Red flash unit from a 2 volt D.C. Wet battery.

Primary 60 turns #14 or 16 with C.T.

Secondary 2220 turns # 32.

Mar 18 1949 #2.

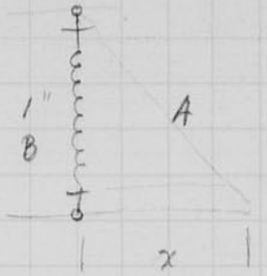
Shutter design



The plate is spring suspended. It over shoots and is held by the friction snubber at the end of the stroke.

Spring data from Hp Hardware Products Co. Solder. 103 Richmond St. Boston Mass

	1/4" outside diam.			
	.023	.031	.047	wire size
Max lbs.	2.7	6.7	25	
Max ins	2.7	1.4	.5	
Initial ten. lbs.	.5	1.3	5.	



		θ	sin θ	tan	x"
~~sins~~	$\frac{1}{1.5} = \sin .66$	48.2	.745	1.118	1.118
cos	$\frac{1}{2.4} = \cos .417$	65.4	.9085	2.17	2.17
cos	$\frac{1}{3.7} = \cos .27$	74.3	.963	3.55	3.55.

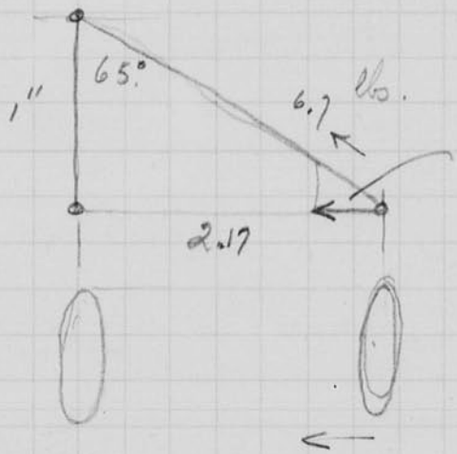
$\cos\theta = \frac{B}{A}$

$\sin\theta = \frac{x}{A}$

$\tan\theta = x/B = \frac{\sin\theta}{\cos\theta} =$

$x = B\tan\theta.$

For first trial suggest middle value of .031 spring wire
max lbs = 6.7



$6.7\cos\theta - 90 = 6.7\sin\theta = 6.7 \times .91 = 6.10$ #.

4 springs = 24.4 lbs to cock.
8 " = 48.8 lbs to cock.

With .023 wire the above pressures become 10 and 20 lbs. for the same throws.

Both sizes are to be ordered for experimentation.

Force = ma $\quad v = \int_0^t a\,dt = \int_0^t \frac{f}{m}\,dt \quad \frac{1}{2}mv^2 = \int_{x_1}^{x_2} f\,dx$

for weak spring Initial = .5 lbs. = zero
in atim axis

Wound = 2.7 x .9 = 2.4

$$\text{Work} = \int_2^0 2.4x\,dx. = 2.4\frac{x^2}{2}\Big]_2^0 = 4.8 \text{ lb-inches.}$$

$\frac{1}{2}mv^2 = 4.8$ lb-inches $= 0.4$ lb-ft.

mass of shutter plate = ?

assume steel or dural 0.01" thick

volume = .01 × 1½" × 5" = .075 cubic inches

Steel 500 lbs/cubic foot = $\frac{500}{12^3}$ = .297 lbs cubic inch

@ .297 × .075 = .0222 lbs.

@ .02 lbs or $\frac{.02}{32.2}$ = .000625 pounds

$\frac{1}{2} m v^2 = .4$ ft pounds.

$v^2 = \frac{2}{m} 0.4$ $\quad v = \sqrt{\frac{.8}{m}}$ ft/sec.

$= \sqrt{\frac{.8}{.0006}} = \sqrt{1. \times 10^3} = \sqrt{10 \times 100} = 3. \times 10 = 30$ ft/sec.

= 360 in/sec.

1/4" slot $\quad (\frac{1}{4}) \times \frac{1}{360 \text{ in/sec.}} = \frac{1}{1440}$ sec. exposure.

1/8" slot gives $\frac{1}{14,400}$ second

69.5 μs.

With 1/4 or 1/8" slot, the travel need not be so great. We could then reduce the mass by a factor of 3, making a smaller shutter.

$\frac{t}{f^2} = \frac{1}{25.6}$ for correct exposure.

(1/8" slot) 100 μs = t.

$f^2 = t\,25.6 = 2560$ $\quad f = 50$

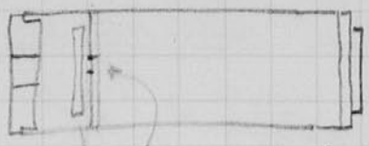
$f = \frac{F}{d}$ = therefore the focal length = 6.3"

With 1/4" hole exposure or = the focal length could be 12"

Next an elliptical hole could be used to increase the accepted light by a factor of 3 or 4, allowing the use of a 20" lens.

Camera design

3¼ × 4¼ holders and backs.
Standard Graphic or Graphlex parts.

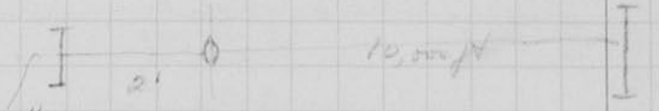


20" special lens ½ inch in diameter
24

Spring shutter 100 secs.
Removable cover with hole

Plywood camera ~~box~~ built to slide together.

Size at 2 miles
covered by
24" lens on
4" film = 1700 ft
= 500 meters.



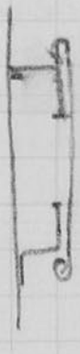
$\frac{1}{3} \times \frac{5000}{2} = 1700$

or Radius = 250 meters.

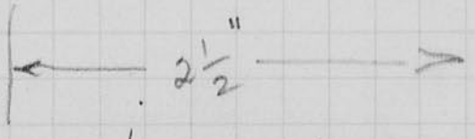
Angle of lens $\tan^{-1} \frac{1/6}{2} = \frac{1}{12}$ $\theta = 4.6°$

---

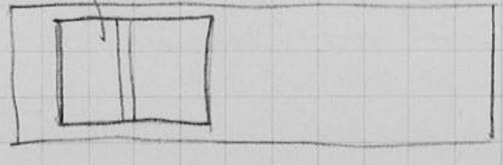
with a ½" or ¼" lens the plate could be smaller

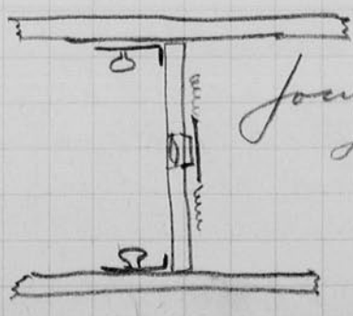


3/4" cock. motion.



Door or side for access to Lens and shutter.





focus adjustment of lens board.

Mar 21 1949

Harold E. Edgerton.

.600 uf 1000 v. FT-220.

The Polaroid co boys had the two light electrolytic flash unit for several months on trial to gain experience with electronic flash.

Their Polaroid camera has a sync connection for 15 ms lead time. There is no provision for instantaneous sync.

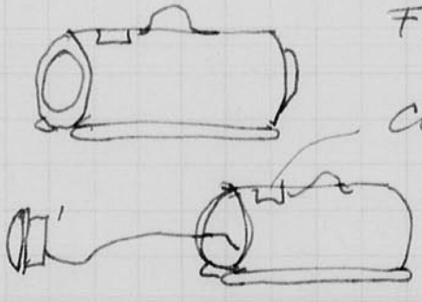
Bennenhausen and I went to the Polaroid plant on Thursday March 17 and discussed flash units. Present Rosenblum Fairbanks. Maty,

Bennenhausen offered to put in a 2D-21 thyratron time delay circuit for the shutter sync. This probably will work since the shutter contacts are closed and remain closed. Furthermore the shutter part always moves at the same initial velocity. A sample shutter will be given to us for experimentation.

We discussed the form of the flash unit. I suggested a slidable pack that would slide along on the floor behind the plug graphics. Had used this unit that way at the E.G.&G. banquet in the Kenmore Hotel.

New form

FT-220 on both ends.



Maty also asked us to consider ways of cooperation on U.V. lights for a microscope project that Polaroid is working on. We plan to see him and others at Polaroid this afternoon so the work can be started.

March 21, 1949.

Harold E. Edgerton

We had a conference at Polaroid with Land, Matz and McCune. Germeshausen and I were there to discuss the application of flash tubes to the ultraviolet microscope that is being developed for the american Cancer society.

The scheme seems to be to use several lamps with a grating so that the lamp acts as a slit. The exposure and energy is under control by the voltage and capacity.

At present the method is to use a moving grating or a series of filters.

A series of lamps were left with Matz to test with flash equipment.

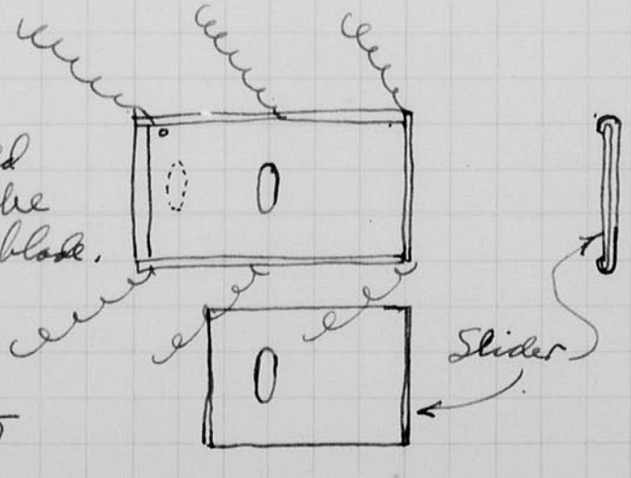
Transformer design see p 65

for 600 mf 1000 volt unit for the ignition delay circuit

15/16" square stack.

Primary	660 turns	# 25	117 V.
Sec.	36 "	# 19	6.3 V
Sec	2050 "	# 31	363 V.

Shutter design



The slider is held against a stop on the back of the shutter block. When the plate is snapped back by the spring the cover plate slides to the closed position.

April 1, 1949

Harold Edgerton

Color Photography of Boston Garden
Churchill speech. March 31 1949.

Two 10,000 watt second units with FT-17A tubes were used for all illumination. Both were in 30" reflectors at 80 ft from the speakers stand.

The camera 8x10 was in the center side entrance at the stadium level. Another camera 4x5 was located at the center entrance near the front row of boxes.

Dave Nillsen shot Ansco color. in the 4x5. I used Kodachrome daylight 4x5 with a CC15 filter. The aperture was f 4.7 for most shots with a few at f 5.6.

The light meter showed about 50 25/sq ft at the podium for each lamp.

We also had a 3000 WS in a beamed reflector directly over head 6.5' up.

John Birmingham
Bill Lewis
Chas Pearlman
Fred Snyder
Chas. Wyckoff
Bill McRoberts
Fred Barston — all helped.

Photo taken at W.E. Lynn

Dobler Lord Kermit Byrnes

noel

Apr 9 1949.

Iwas in N.Y. at the SMPE convention Apr 5 and 6. The subject was high-speed photography. Wydroff, Davis, Morris were there also.

Discussed with Miller the possibilities of photographing at the next Eniwetok affair. He suggested a series of tests of low and slow resolution.

Camera Design for tests.
Single cameras.

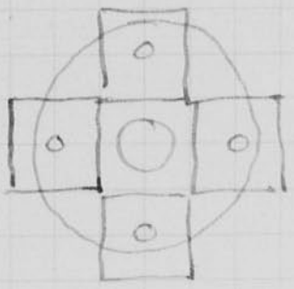
4 x 5 inch cameras of box type with 20 inch lenses. 4 inch width will cover

$$4 \text{ inches} \times \frac{2 \times 5280}{20''} = \frac{2500}{} \text{ ft.} \quad (2650$$

I 0 I 2500
4 20 10,000

with a 36" lens the field will be 1170 ft.

$\frac{4}{36} = \frac{1}{9}$



30 rps motor with disk 16" diam to service four cameras

Velocity at 7" radius

$$\frac{2 \times 7 \times \pi}{1/30} = 1320 \text{ inches/sec.}$$

a one inch hole gives 1/1320 sec exp.

a 1/10 inch " " $\frac{1}{13,200}$ sec. exp.

aperture at 1/10 inch = f = 1/360.

10 us f16

See page 77

$$\frac{\text{sec}}{\text{aper}^2} = \frac{1}{13200} \frac{(\text{1/10})}{(360)^2} = \frac{10^{-9}}{1.1} = .6 \times 10^{-9} = .0006 \times 10^{-6}$$

~~under exposed (40,000 correct value)~~

with one inch hole $\frac{\text{sec}}{\text{aper}^2} = \frac{1}{1320} \times \frac{1}{36^2} =$ ~~.6 x 10⁻⁶~~

~~should be ok.~~
over exposed by factor of 100

Suggest .5" hole

aperture is then f 72 exp = $\frac{1}{2640}$ sec

$$\frac{1}{2640} \times \frac{1}{72^2} = .0730 \times 10^{-6}$$

about right.

Spring Shutter Calc.

Freq meas. 7" 

Two 1" springs
Hooked together. 7" end to end.
frequency = 4150 per min = 69 per second.

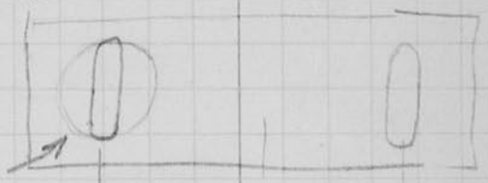
suppose $x = A \cos \omega t$ $\omega = 2\pi f = 2\pi 69$.

$$\frac{dx}{dt} = A\omega \sin \omega t$$

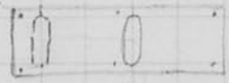
Let A = 2 inches $\frac{dx}{dt} = 2\ 2\pi\ 69 = 870$ inches/sec.
$= 72.5$ ft/sec.

$1" = \frac{1}{870}$ sec. $0.1" = \frac{1}{8700}$ sec

Use elliptical hole 1/2" x 0.1
Effective aperture = f 40 .5" hole
= f 80 or 100 for



Exposure = $\frac{1}{8700} \times \frac{1}{100^2} = .0115 \times 10^{-6}$ Should be $.04 \times 10^{-6}$ p77



← 4 1/2 →

With .02 inch plate 4" x 1" on six springs at 8" centers. f = 3000 per min
= 50 per sec.
0.1 inch = $\frac{1}{500}$ sec.

90 April 18, 1949. H.E. Edgerton. 600 mf 950 V A.C. Polaroid Duration.

Film no	Sweep.	Calib freq.	Lamp	C E	Screen	Remarks.
1.	4500 MS	1000 ~	220	30 mfp 700 e	925.	50	P
2.	"	1000 ~	FT214 Std. #2	30 mfp	1850	50	Std lamp.
3	"	1000 ~	"	30 p	2000	50	" "
4	4500	"	FT220	700 e	920	50	P
5	Blank.						
6	4500	1000 ~	220	700 e	800	50.	
7.	"	"	220	700 e	800 850 900 950	70	
April 11 '49							
8	Blank.						
9.	4500	1000 ~	FT220 FT14	700 e 30 p	900 V 2000 V.	70.	

40 or scale would be better since 50 and 70 are over exposed.

✓	10	A 20,000	10,000 ~	1½ Red flash in Reflector.	90 e	900	50.
	10	"	"	FT-14.	30 p	2000	—
Jogged	11	1500	1000	FT 14	700 e	950 900 850 800	50 one shot
	12	"	"	"	1300 e.	850-800 750	"
	13	4500	1000	"	700 e	950 900 850 800 750 700 650	50
V	14	4500	1000	Std.	~~30 p~~ 5 mf	2000 V.	50. Calib.

Notebook # 19

Filming and Separation Record

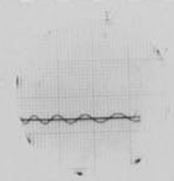
1 unmounted photograph(s)

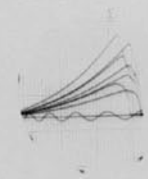
1 negative strip(s)

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

was/were filmed where originally located between page 90 and 91.

Item(s) now housed in accompanying folder.





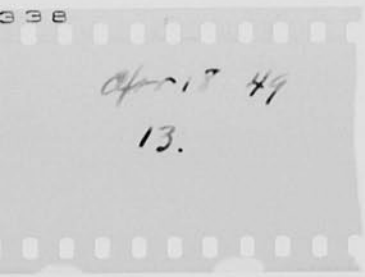
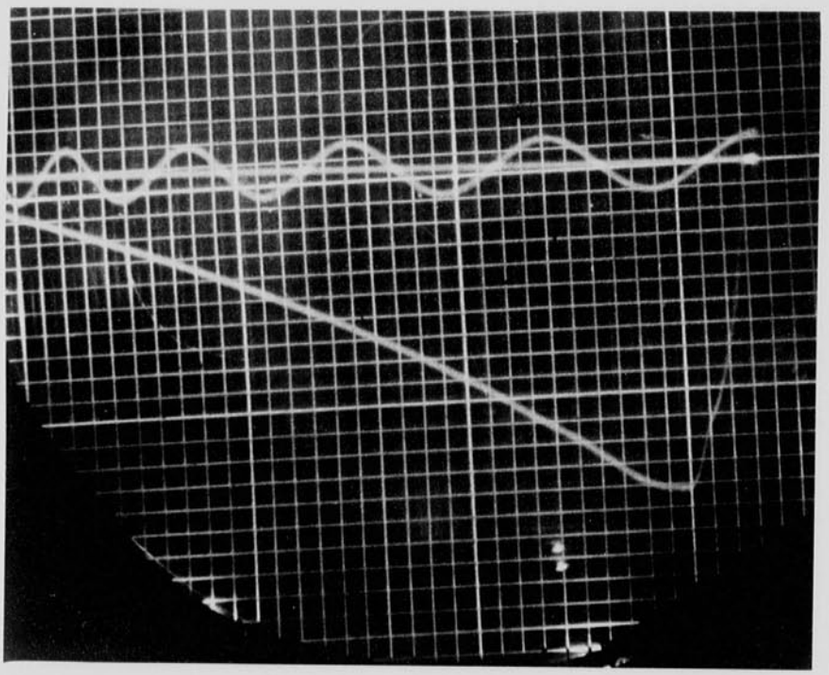
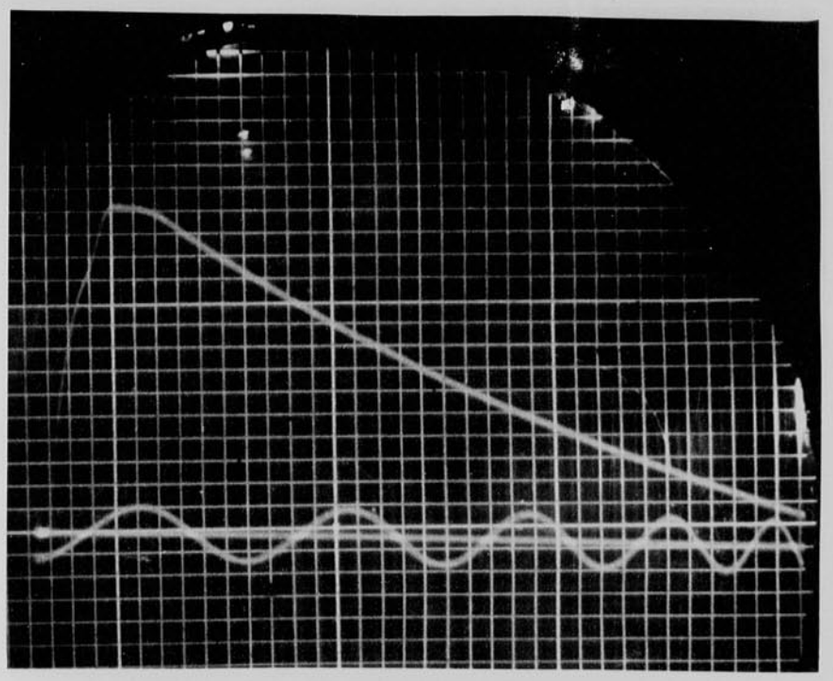


Exhibit #9
13.

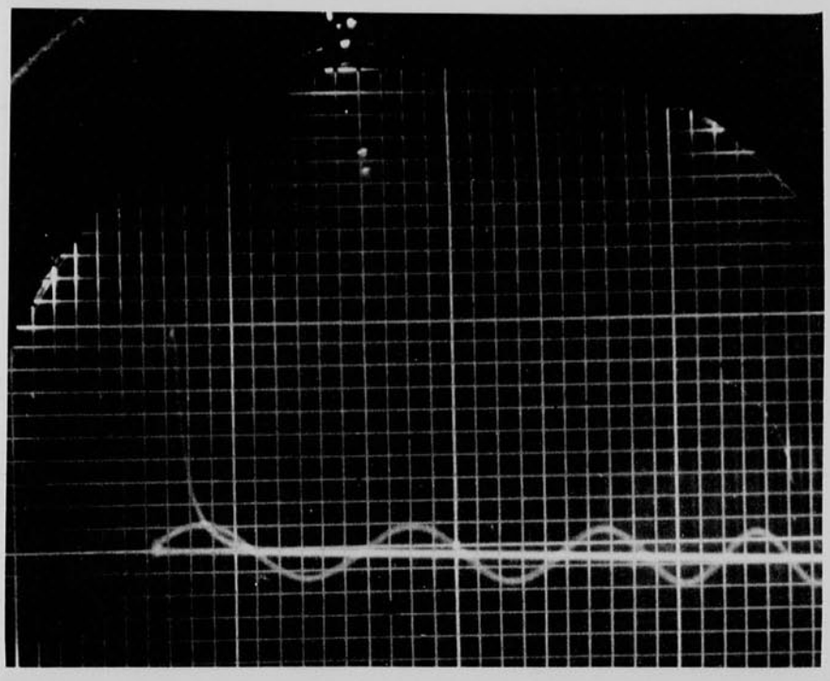




#4

700 mf dist
FT220
920 volts

1000 ft



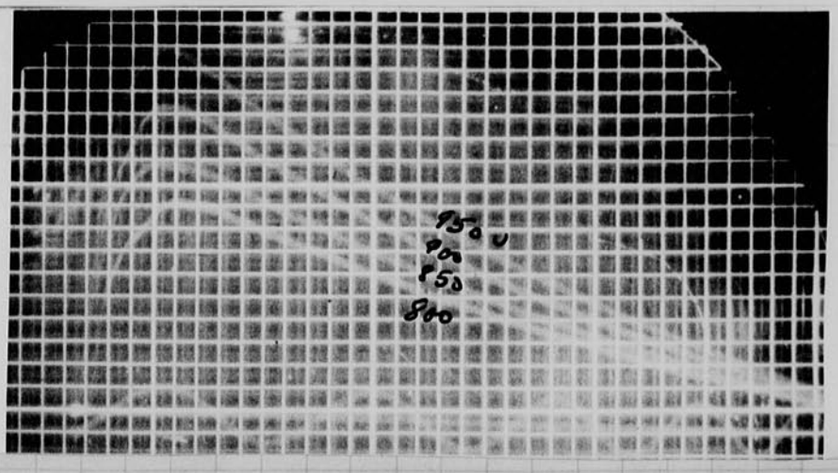
#3

FT-214
mol. Std.
March

30 mf
2000 V

1000 ft.

.95" = 4.5 megalumens.
0.473 megalumens/inch
hcp = 0.473 hcp/inch dep.



FT220
700 mfc

1000 ft

.621 hcp.
=
1.32 x .47
Peak = ~~1.32 x .47~~
= .621 hcp.
with reflector

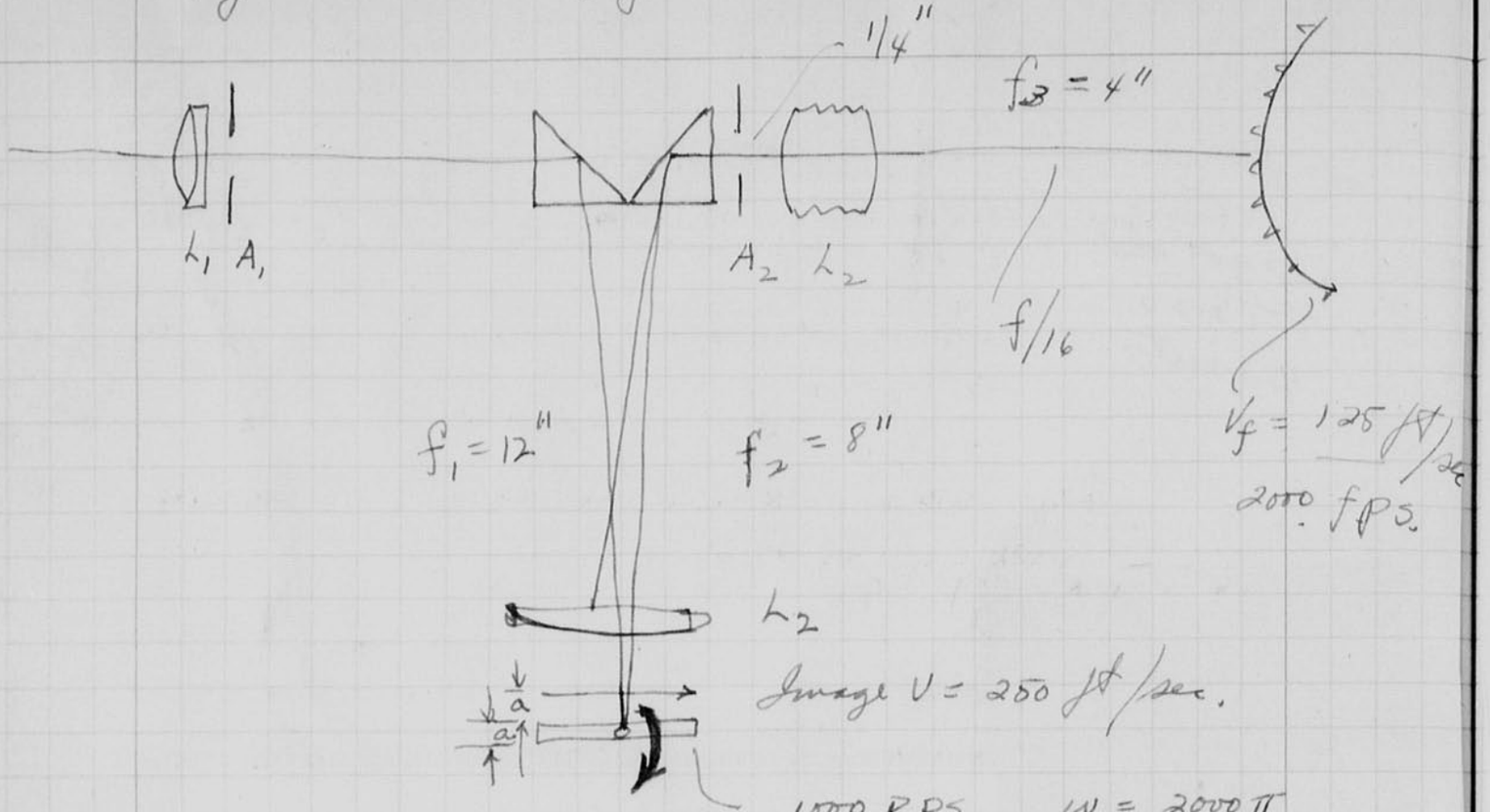
Bare lamp
Peak hcps
= .621
= 62,100 hcp.
~~Lumens~~

M = 10

From June 12 1945 Color
From Carlson of Saturn & lamp
the peak light for 5 mf 2000 V
~~1000~~ = 4.5 megalumens.
output = 0.45 hcp.

Check calc.

High-Speed camera Design for BR Camera
by O'Brien as of Jan 21 1949.



Objective L_1 of any desired focal length f_1
Equivalent focus of complete optical system

is $f'_s = \frac{f_3}{f_2} \cdot f_1$ f_3 and f_2 may be fixed at 8" and 4"

Compensation for continuous film movement provided by primary image L_1 at a distance a from rotating mirror surface where

$a = \frac{V_2 f_2}{2w f_3}$ where w = angular velocity of mirror in radians/sec.

$t_{effective} = \frac{1}{k} \frac{A_2}{2 f_2 w}$

$A_2 = 1$ inch
$f_2 = 8$ inch
$f_3 = 4$ "
$t = 10$ ms f/4 vert.

(also see O'Brien sheet.)

Objective L_1 of any desired focal length f_1

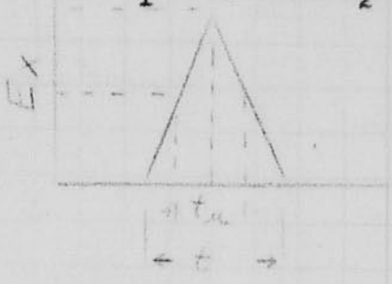
Equivalent focus of complete optical system is $\frac{f_3}{f_2} \cdot f_1$ f_3 and f_2 may be fixed at 8" and 4" respectively.

Compensation for continuous film movement provided by primary image of L_1 at a distance a from rotating mirror surface where

$$a = \frac{V_2}{2\omega} \frac{f_2}{f_3}$$ where ω = angular velocity of mirror, radians/sec.

Field lens L_2 (double passage of light) images aperture A_1 on aperture A_2

Exposure controlled by sweep of image of A_1 across A_2. If $\frac{A_1}{A_2} = \frac{f_1}{f_2}$



Exposure curve of form shown

$$t_{effective} = 1/2t = \frac{A_2}{2f_2\omega}$$

For f_2 = 8 inches and f_3 = 4 inches

A_2	$t_{effective}$	f_3 relative aperture on vertical plane
1/4"	2.5 microseconds	f/16.
1/2"	5 "	f/8.
1"	10 "	f/4.

Rochester, N.Y.
Jan 21, 1949

BOR

Rec'd Washington
Jan 27 1949

FGL-1 tube 50 watt/sec at 2000 v. $\frac{CE^2}{2} = 50$.

$C = \frac{50 \times 2}{4. \times 10^6}$

$= 25$ mf.

15 24.5 mf 2000 volts into FGL-1 10^4
16 " " " 10^4
17 " " " 10^4

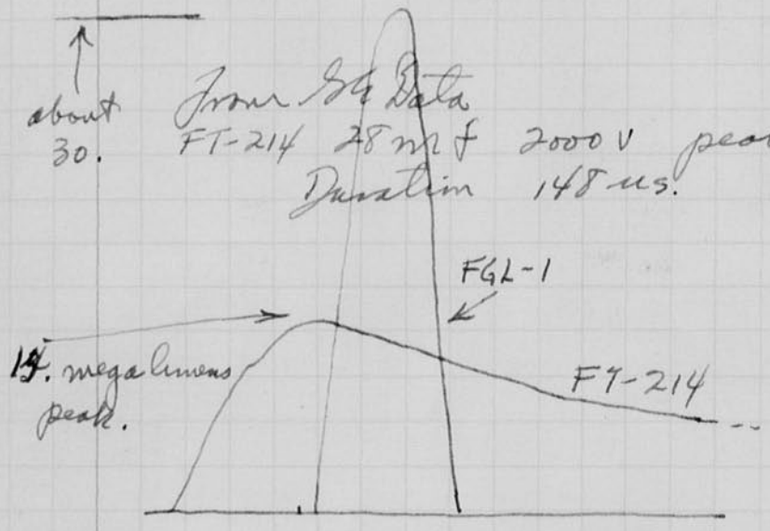
18 30 mf 2000 v into FT-214 Std tube. 10^4 cyc

the peak light of the FGL-1 Westinghouse tube is about double that of the FT-214.

#9 West data.

about 30.

From GE Data
FT-214 48 mf 2000 v peak light = 13.8 megalumens.
Duration 148 us.



17 us according to Westinghouse data

#2 Ed. Apr. 30, 1949

Duration tests of G.E. Experimental U tubes.

Photo no 1. 920 mf. c. 500 v. tube 1. 10^4 cycles timing 1" ≒ 5 megalumens.
2 460 " " 500
3. Both records on one film 920 and 460 mf.

4 115 mf 1000 tube 2. 1" = 10 megalumens. 10^4 cyc.
5. 230 " 1000
6 Double record of 4 and 5.
7. Ditto but with Zero moved down one inch
8. FT-214 30 mf 2000 v 10^4 cycles.

4 Sprague condensers weight #11 oz

Notebook # 19

Filming and Separation Record

____ unmounted photograph(s)

3
____ negative strip(s)

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

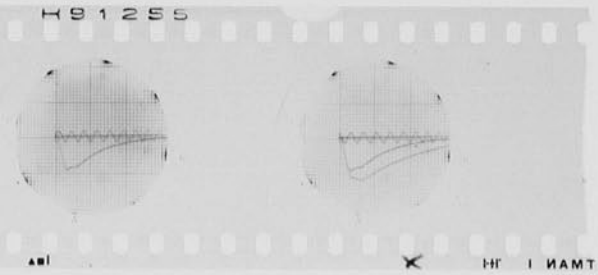
was/were filmed where originally located between page 94 and 95.

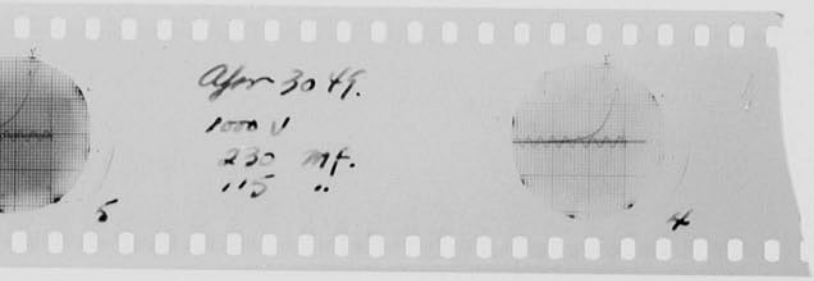
Item(s) now housed in accompanying folder.

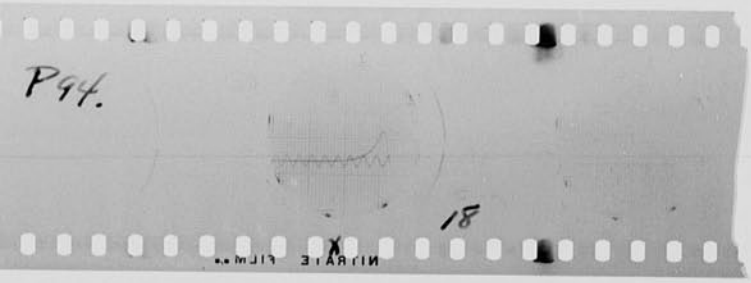
Apr 30 1949
1, 2, 3,
500 V. 920 – 460 μf
NITRATE FILM

8
7
6
5EE H91256

15
16
17
PANCHROMATIC


H91255


After 30 Mf.
1000 V
230 Mf.
115 "


P94.
18

U TUBE TESTS

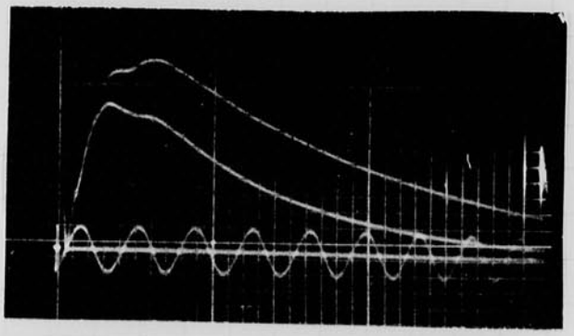
Horizontal Light Output

			Light Meter Reading	Duration
FT-214 #3 Std. Lamp (March 1949)				
	2000 v	101.1 mf. paper	184	
	2000 v	50.74 mf. paper	87	
U Tube Lamp #1		(500 volt)		
3" Arc Gap 6 mm. O.D.				
150 mm. Xenon				
	450 volts	460 mf elect.	34	
	500 "	460 " "	41	350 ms
	450 "	920 " "	68	
	500 "	920 " "	86	600 ms
U Tube Lamp #2				
3" Arc Gap				
300 mm. Xenon 6 mm. OD.				
	900 volts	115 mf elect.	33	
	1000 "	115 " "	42	125
	900 "	230 " "	83	
	1000 "	230 " "	102	225

Capacitors composed of combinations of Sprague 180 mf (rated) 475 volt d.c. Y9868 917. Measured capacity = 230 mf.

H. E. Edgerton
M.I.T.
Apr. 30, 1949.

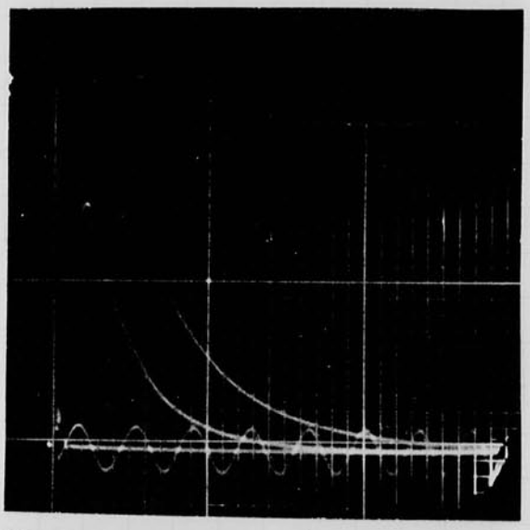
500 V
920 mf
460



3

600 μs.
350

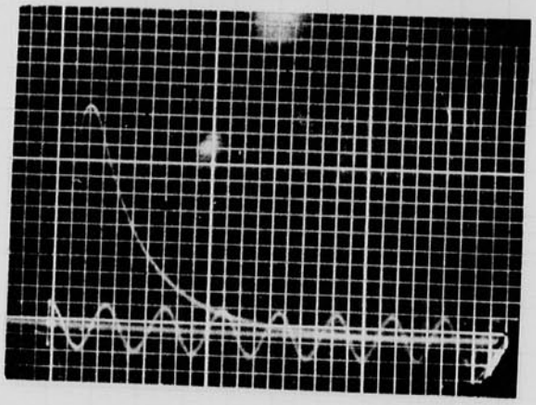
1000 V
230 mf.
115 "



7

225
125

FT-214
30 mf
2000 V



8

140

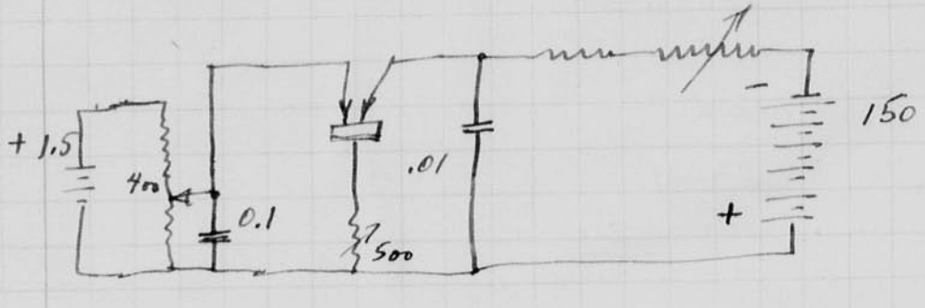
May 4, 1949.
Harold E. Edgerton.

Took 5 flash photos with Larry Hague tonight at 100, 50, & 25? m.s. 22 caliber bullets.

Also helped Gus Pearlman with his lab. problem.

Visited Sylvania with Warwick of Wright Field. Obtained samples of transistors type G T-372.

RCA Review march 1949. P5 article by Webster Eberhard and Barton. Relaxation oscillator.



C = .01 mf

RC = 1/60 sec max $R = \frac{1}{60C} = \frac{1}{.60} \times 10^{+6}$ ~~ohms~~

$= 0.2 \times 10^{+6} = 200,000$ ohms.

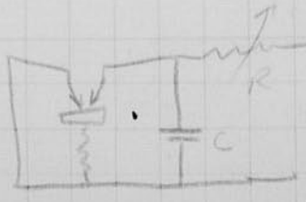
Try 200,000 to 2 megohms.

Power into crystal $= \frac{CE^2}{2} f = \frac{.01 \times 10^{-6} \times 40^2 \times 30}{2} \frac{1}{60}$

$= .3 \times 1600 \times 10^{-6} = .000500$ watts.

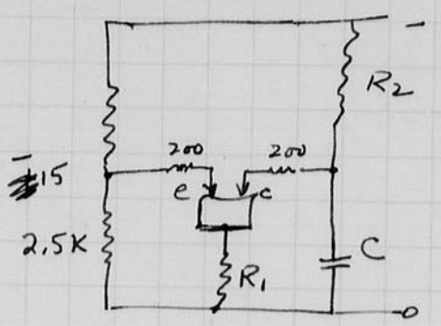
should be ok.

	V_e	I_c	V_c	I_c	
GT-402	0.12v	05ma.	4v	3. ma	Data from Kenrick Sylvania.
965	0.25	1.75	40	4	
923	0.2		50	1.5	



May 27, 1949.

H E Edg Circuit from Eberhardt. RCA. Transistor oscillator suggestion.



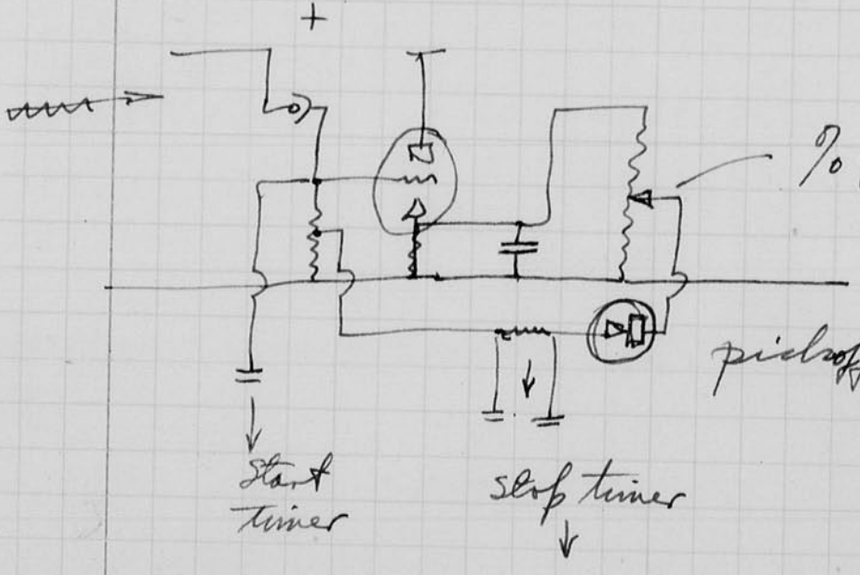
Try R_2 = 50K
C = 1/2 to 1 mf
R_1 = 3 to 5 K.

---

meter to read duration time from a flash.

System operation sequence.

1. Photocell into a cathode follower that charges a capacitor.
2. capacitor voltage sets ratio voltage for a pickoff diode to operate.
3. Circuit measures time from initial light to cutoff on diode



10,000 Watt sec in
Two FT-617A tubes

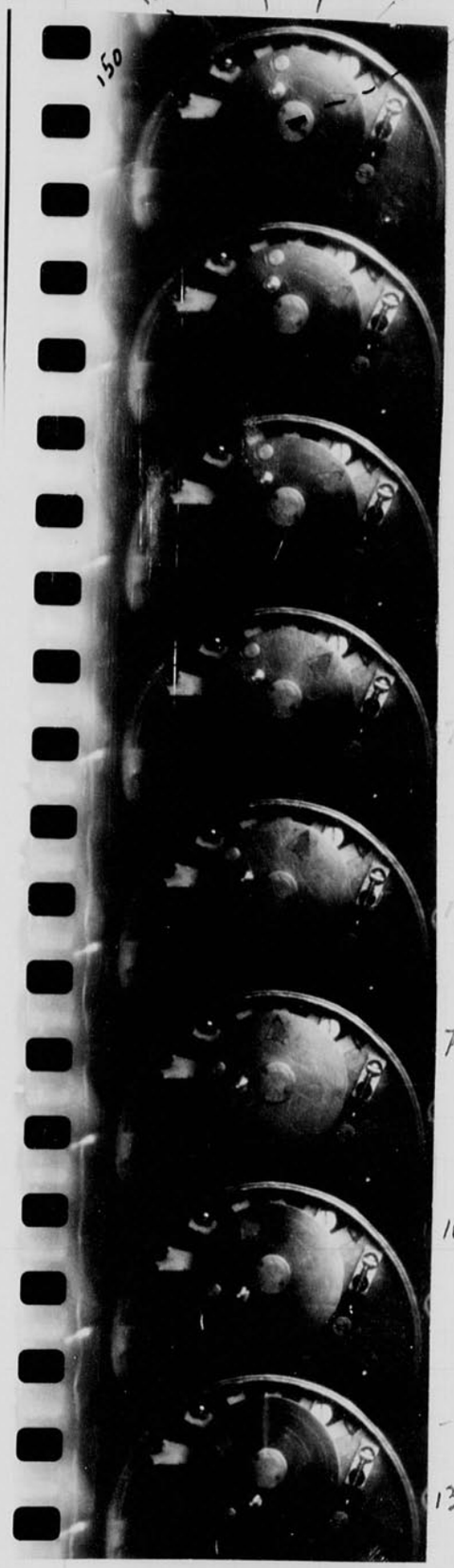
8x10 camera under Balcony.

4x5 Camera at entrance → hand held

Boston Garden
Convocation

March 31 1949

Churchill speaking.



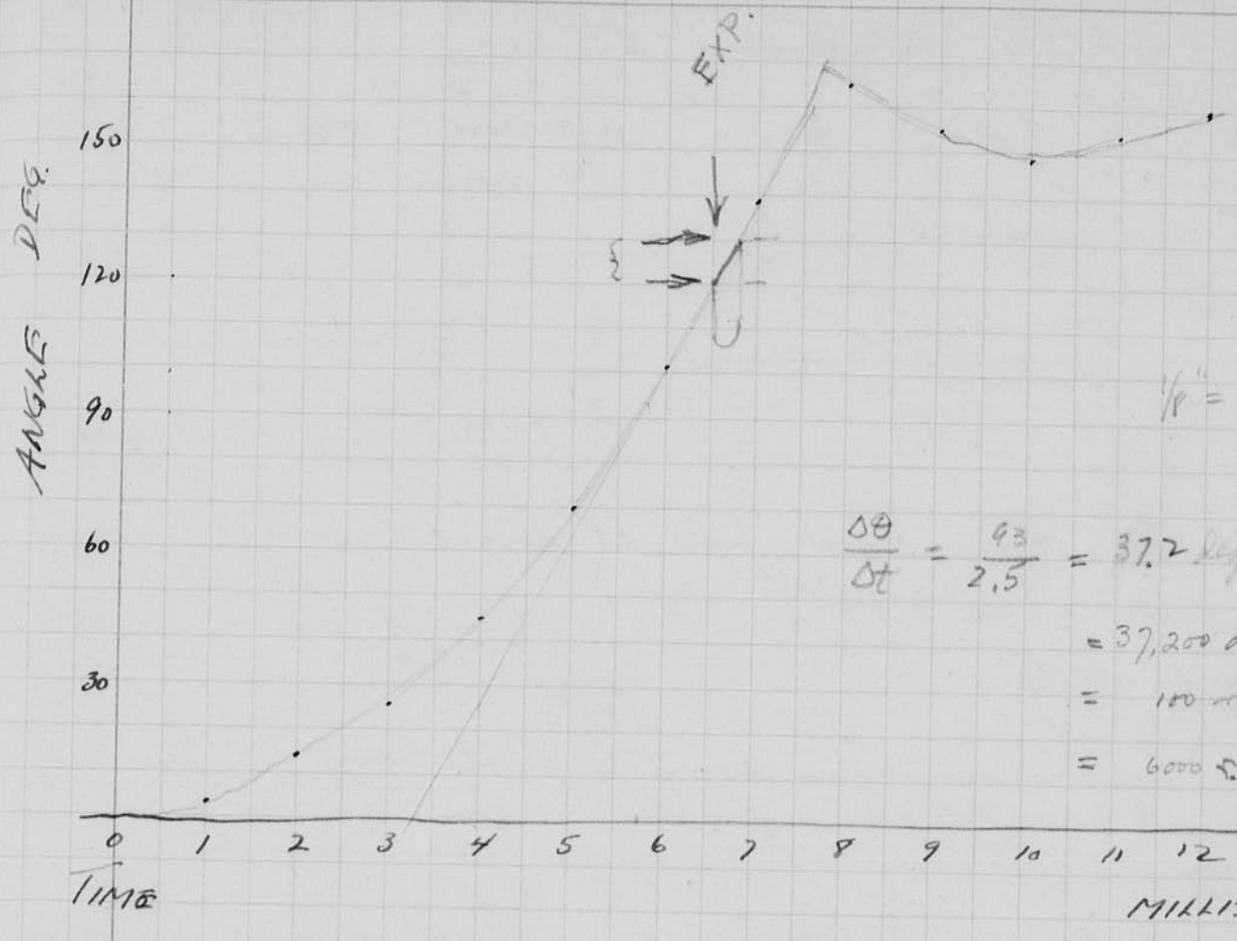
Experimental Shutter
Wollensack
Recd May 29.
1000 f.p.s.

.02 mf 8KV.
Spiral lamps.
1000 f.p.s.
by oscillator

Positive film
f 1.5 ?

Exposure blur.

Shutter is composed of two overlapping discs that rotate together by a linkage.



30 m.s.

1/8" = .125 inches

$\frac{\Delta\theta}{\Delta t} = \frac{93}{2.5} = 37.2$ degrees / 2m sec.

= 37,200 deg / sec.

= 100 r.p.s.

= 6000 r.p.m.

angle is about 10 degrees. (12)

Active time of shutter corresponds to time required to travel through this angle.

$1/T = \frac{37.2}{12} = 3.1$ ms exposure.

$T = .322$ ms.

$T_{eff} = .161$ or $\frac{1}{6200}$ sec

Max. Peterson.

Sun subtends 32'

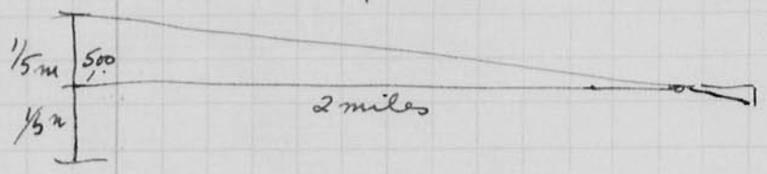
Angular Resolving power of a circular aperture.

$\text{angle res.} = 1.22\,\lambda/d$ $\quad \lambda = 5000\,A^\circ$ $\quad 5''$ arc/diam

$= 1.22$

λ for $5000\,A^\circ = 5000 \times 10^{-10}$ cms.

5" lens required.

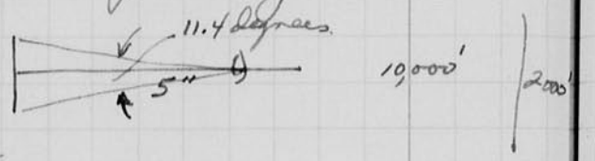


$\frac{\frac{2}{5}}{2} = \frac{2}{10}$ radian

$\frac{2}{10} \times \frac{360}{2\pi} = \frac{72}{2\pi} = 11.4$ degrees

$5'' \times \frac{2}{10} = 1$ inch field at focus of image.

angle $= 2 \times \tan^{-1} \frac{.5}{5} = 2 \times 5.7^\circ = 11.4$ degrees.



June 8 1949

Sam M.I.T.

Experiments by Carlson to show how much continuous light is required to wipe out flicker of 24 cycle stroboscope.

Continuous light. 33,000 lumen source tungsten. Reflector $M = 10$

$L = \frac{33000}{10} \times \frac{M}{d^2} = 330$ lumens/sq ft.

$= 330$ ft candles.

Flash source 50 mf 2000 V 100 watt sec.

lumen sec $= 1200$

hcps $= 120.$

hcp $= 120 \times 24 = 2880$

$L = \frac{2880}{10^2} = 28.8$ lumens/sq ft

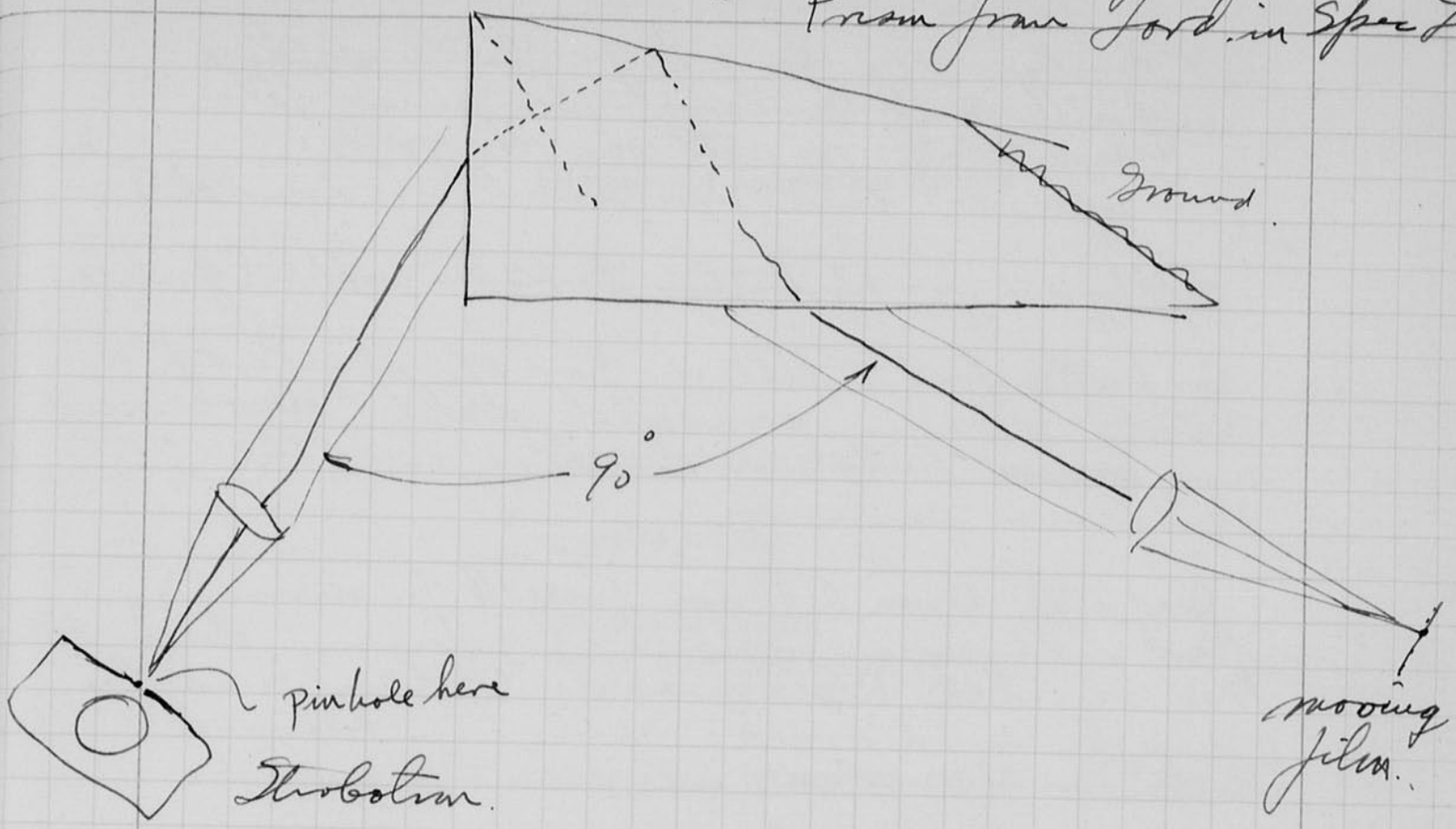
$= 28.8$ ft candles.

Thus the continuous light is about 12 times the strob light for elimination of flicker.

For proper color balance the ratio should about 2 to 1. or 1 to 1.

June, 10, 1949.

Prism from Ford in Space Lab.



 June 16, 1949.

David Ogerlow

Log of trip.

Left Boston 4:30 June 12 for Cleveland Ohio.
Conf. with Noel Carlson, Benjamin etc.
New V-tube 100 watt sec. 1000 volts.
Type 417 tube was found to be available.

Left by air for Rochester to Rochester Hotel June 13

Conf with Ford Tuttle on June 14. Wyckoff Morris & Davis present. Walt / new camb etc. Saw ~~process~~ holes in the disc and the Aberdeen camera.

Conf with Brien O'Brian June 15 in morning after calling on Sandell, Zemen Oberhoetter also visited Wollensack Optical and the Bausch and Lomb Factory. Returned to Boston on the plane at 7.15.

Notebook # 19

Filming and Separation Record

___ unmounted photograph(s)

1 negative strip(s)

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

was/were filmed where originally located between page 104 and 105.

Item(s) now housed in accompanying folder.

Red Flash Unit design.

modification — install thyratron 5696 instead of glow trigger. Use time delay element

Cathode requirement 6.3V 0.15 amps = 0.9+ watts.

the transformer design will require a heater for the thyratron.

5/8" core (745 G.E.)

try Primary 1490 turns of # 36 (115 V 60 ~.)
Sec. 5320 " of # 40

Sec 88 " # 32

% of window from G.E. data.

6. 1/6 = 16%.

36 $\frac{1490}{5150} = 29.0$

40 $\frac{5320}{12800} = 41.6$

32 $\frac{88}{2047} = \frac{4.3}{74.9\%}$

with 34 pwr $\frac{1500}{3110} = 50\%$

$\frac{41.6}{91.6\%}$

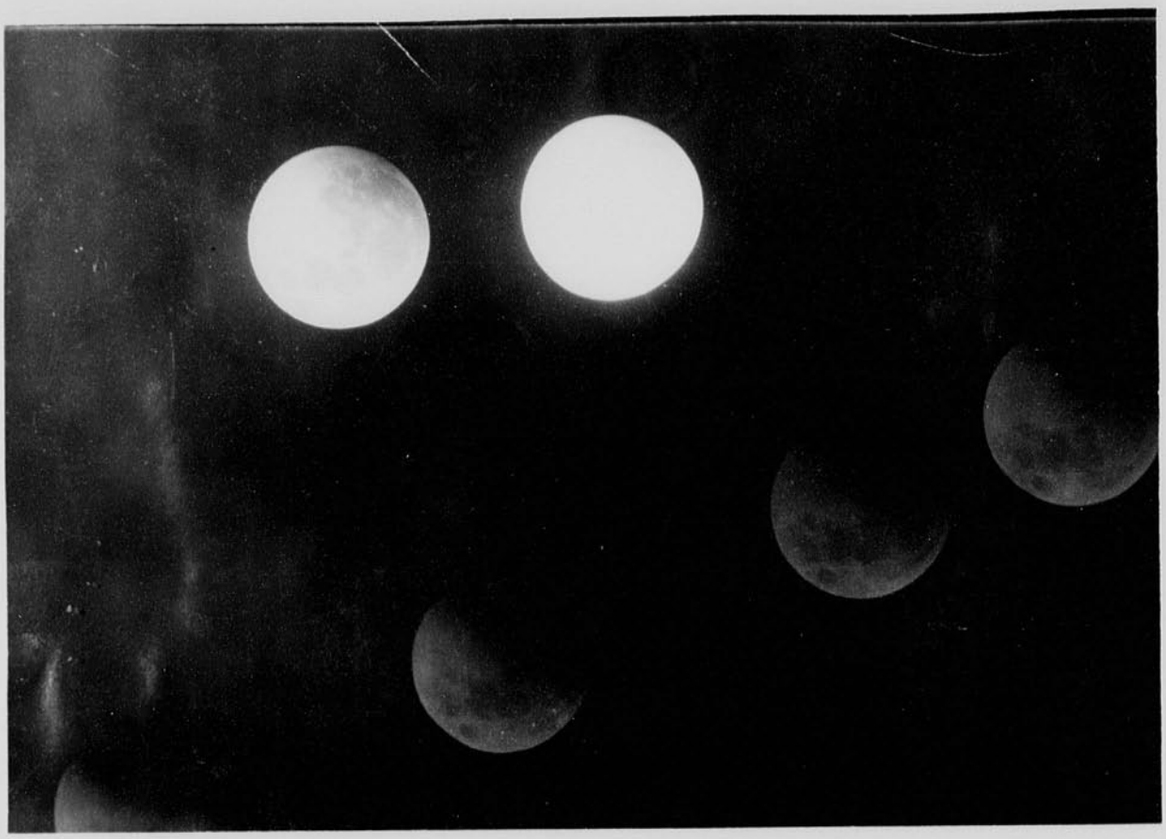
#31 $\frac{88}{1660} = 5.3\%$

#30 $\frac{88}{1330} = 6.6\%$.

try #32 86 turns.

Design to order

Prim 1490 Turns #36
Sec 5320 " #40
Sec 86 " #32



Photos of the moon during eclipse.

July 7, 1949. I spent June 29 in the nescafe plant at Freehold N.J. with John Studer. Microflash photographs were taken of the spray drying process.

Met Joe Costa at 6 pm and went to Long Island to his home. Then we went to the Roosevelt Race way to set up the lights for the horses. Photos were taken June 30 July 1, 2 and 4. Those who helped Vernon McRoberts Milton Schwartz, Sam Carlson, etc.

Monday
July 11, 1949. Walz of Polaroid called Friday to report that the ~~ultra~~ ultraviolet arc tube ~~lamp~~ is no better than the ultraviolet tube. It went to a factor of several hundred over that now available.

Studer is due today to discuss Nescafe photos taken on June 29.

July 19 1949

H.E. Joe Sinclair called from D.R. on July 15 to notify me that D.R. was not interested in the 60 cycle strobe scope that I left with them a number of ago.

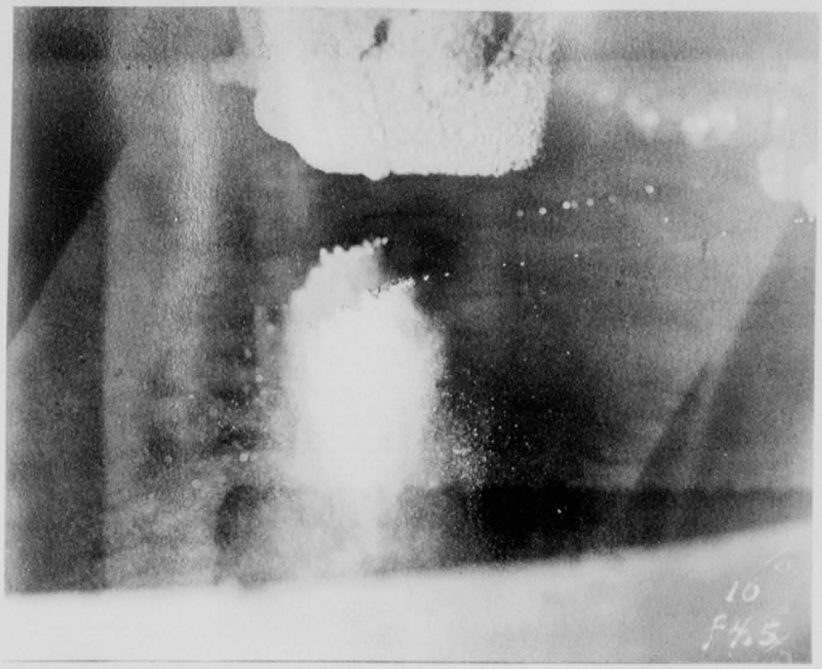
U.S.S. 1948.
Albermarle

Morris Colson Edgerton Smith
Eberhard Wydroff Grier

Enroute to Eniwetok Spring Summer 1948

Herb. Grier

USS Albemarle



July 21, 1949

Harold Edgerton.

Inspected the composing unit with Caldwell yesterday at Charles St in Cambridge. two French workers ran the unit so that I could see it operate.

a thyratron tube is used for light, excited from a 1 MF 500 volt capacitor. An OA5 is used for a trigger. Photocell amp combination synchs the light flash for register. the wheel with the type goes at 600 r p m. the max pasting rate is 20 per sec.

July 16 1958
HEE.

These were made at Envelots in 1949. with a special Rotatronic Shutter.

wrong.

also see page 100

August 1. 1949

Harold E. Edgerton

Movie tests of Special Wollensak shutter.
1000 frames per second.

51 degrees in 1/1000 sec.

↓ ↑ duration caused by light behind.

12 degrees action.

$\frac{12}{51,000}$ = 230 micro seconds.

Sept. 2, 1949.

Harold Edgerton.

Attended the Photo convention in Chicago aug 16 - 25. Saw Kubias, Johnson, Farber, Speedotron, Hennige, Barber, Kennedy (Triumph). Mishard, ~~Ola~~. Adams Shoemaker.

Went to Milwaukee with Dumke and others from the Journal and stayed with Farber's folks. Then visited the Journal on the 19 before going to "Trees of Tomorrow" camp at Eagle River Wisc. to attend press photographer's convention.

Visited S.R in milwaukee aug 22 also A.O. Smith Co.

Took plane for Youngstown Ohio at 7 am. to visit Photogentic Mazda co. Mr. Lester Kubias and son Herman met me at the air port.

then home on the evening plane where Esther met me.

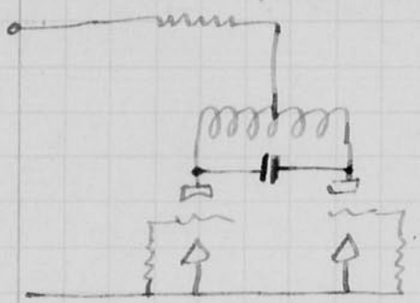
My father came in the next morning, also my mother and son Bill who has been in Nebraska all summer working for Kramer.

 Sept. 6, 1949.
Harold Edgerton

Magneto optic shutter as tested by Zemeshausen

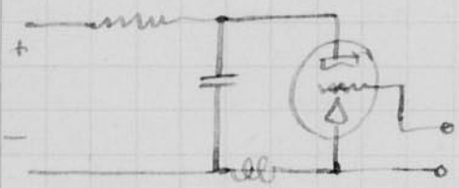
3500 volts 1.5 mf. 10 microhenries.
give 55 degrees ~~tilt~~ with a 2 inch glass section between polaroids.

Inverter drive for this coil to oscillate at 2000 cycles per second.

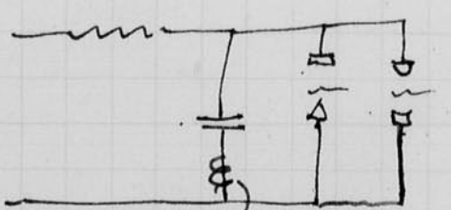


Discharge time must be small compared to charge time.

Deionization time will be difficult due to large back voltage.



Zemeshausen suggested a two tube circuit as follows.



← the thyratrons will need to pass very heavy peak currents to get required exposure time.

magneto optic coil.

Sept 7 1949
Hand Elevator. Bright Star Battery 10-67P 7.5 volts.

Voltage measured on disconnecting of Red Jack.
Input from Line 118 V. 60~ 206 volts (R.C.A. voltohmyst)
Start 7.8 volts #1

	TIME MIN.	V.	I			Flashes
19.57	0	7.5	0.3		Vibrator and trans former only.	
	1	7.2	.63	209	Flash unit plugged in charged (as flash)	
	5	7.1	.55	208+	" "	
17.02	10	6.9	.52	213		
				198	30 sec flash rate.	
				180	20 sec	
				135	10 sec.	
		5.4 at start of dig.		135	10 sec	
11.15				193.	30 sec.	13 9/14 + 10 flashes
		5.3 - 6.3	.	193.	Peak dc bat. current 2.5± amp.	
11.30		5.1	6.1	188	30 sec.	36
11.45		4.9	5.9	186	30 sec. 1. lamp peak.	70
11.57		4.8	5.8	175	14 000	96
			6.7 open circuit.			
12.09		7.7	5.8	172	Single Burgess 6-5 7.5 v batt 14000	0
.12		4.5	5.5	165	(already had 60 flashes)	10
		4.4	5.4	161	?	20
			6.4	200	Burgess 6-5 new battery.	
				185	30 sec. after one flash.	

See MacRoberts's note book for farther tests.

Dr E Edgerton
Sept 10 1949

Portable.

Our "Red Flash" unit with 82 mf 950 volts was tested by Eastman Kodak several months ago and given the "no" because of its lack of light for color. We found a guide number of 12 with daylight Kodachrome. The Red Flash has a beam c.p. sec. output of 800. Capacitors used are Sprague 165 mf rated 475 volts. Lamp - 1½ turn spiral.

The G.E. Co have sent out samples of a V shaped tube capable of 100 W.S. at 1000 volts. We have tried this tube with the sample reflector as furnished by G.E. and find the efficiency is comparable with the 1½ turn tube above.

Our present thinking calls for the following performance.

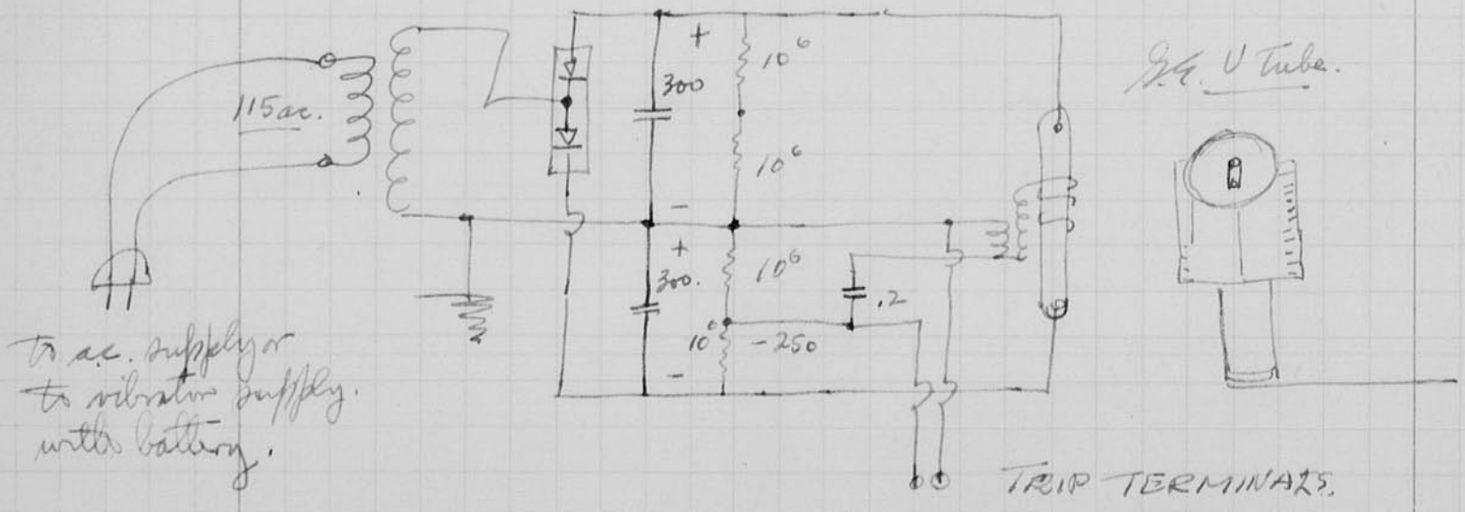
Capacity 150 mf 900 volt
(2 300 mf 450 volt Mallory in series). cost $1.30 in 100 lots.

Output 960 V. 1600 b.c.p.s. or a.s.

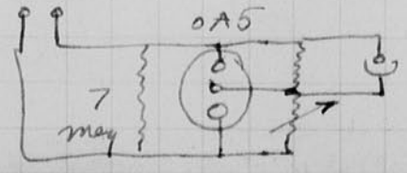
Angular distribution satisfactory.

The color (daylight Kodachrome) guide No. should be about 20 with 35 mm film.

GE 6255KH1 50 calls C.T.

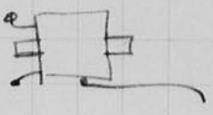


External trigger circuit.



Inductance.

DQ 1000 ℧

1.5 mh. auto coil model 

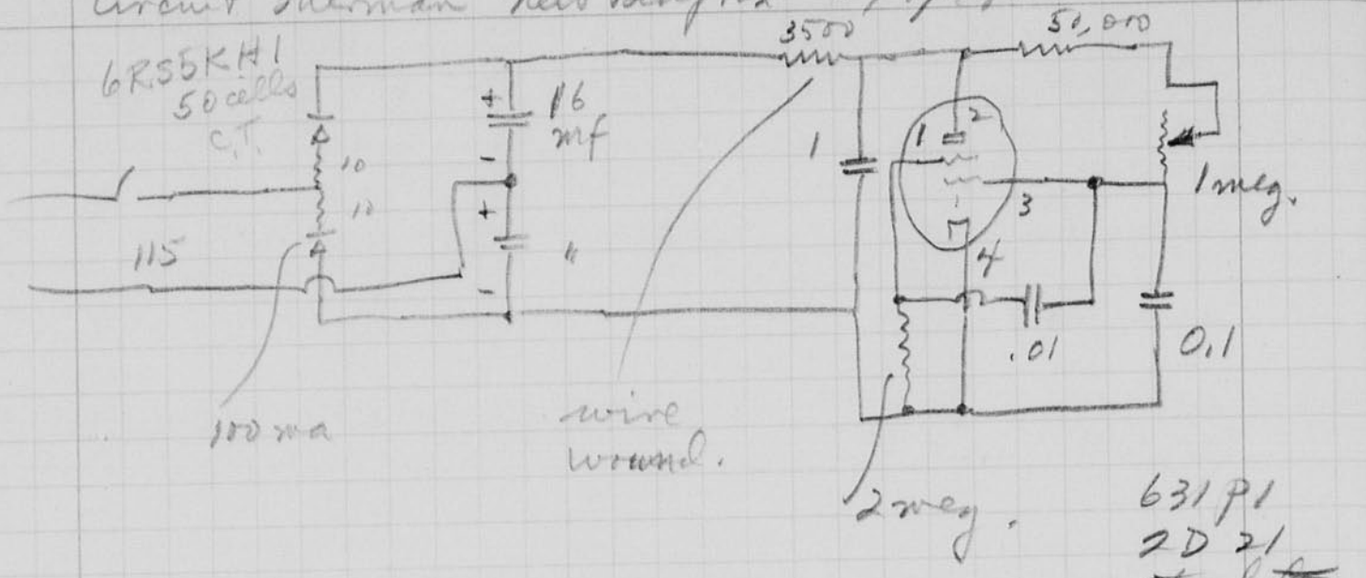
0.100 mh. 8644 G.G. Co 160 V 0.25 mf

0.150 mh. .2 54G736 " 500 v. 0.1 mf tub.

0.3 mh. ?. Thordarson # T-22R44. Spark coil.

MODEL
Model
Electric,
1.02 mh 'Small size. (R & P) ?
0.97 mh. Large. (") ?

Circuit Sherman New Bedford 2/9/49.



Megslic Trans.
41 Henry 5A
Medford.

5696.

Line	Filament	Capacity.	
105 V	5.9 V	850 V	35
110	6.25	885	25
115	6.5	910	25
120	6.8	935	20
125	7.1	955	

477. 525.

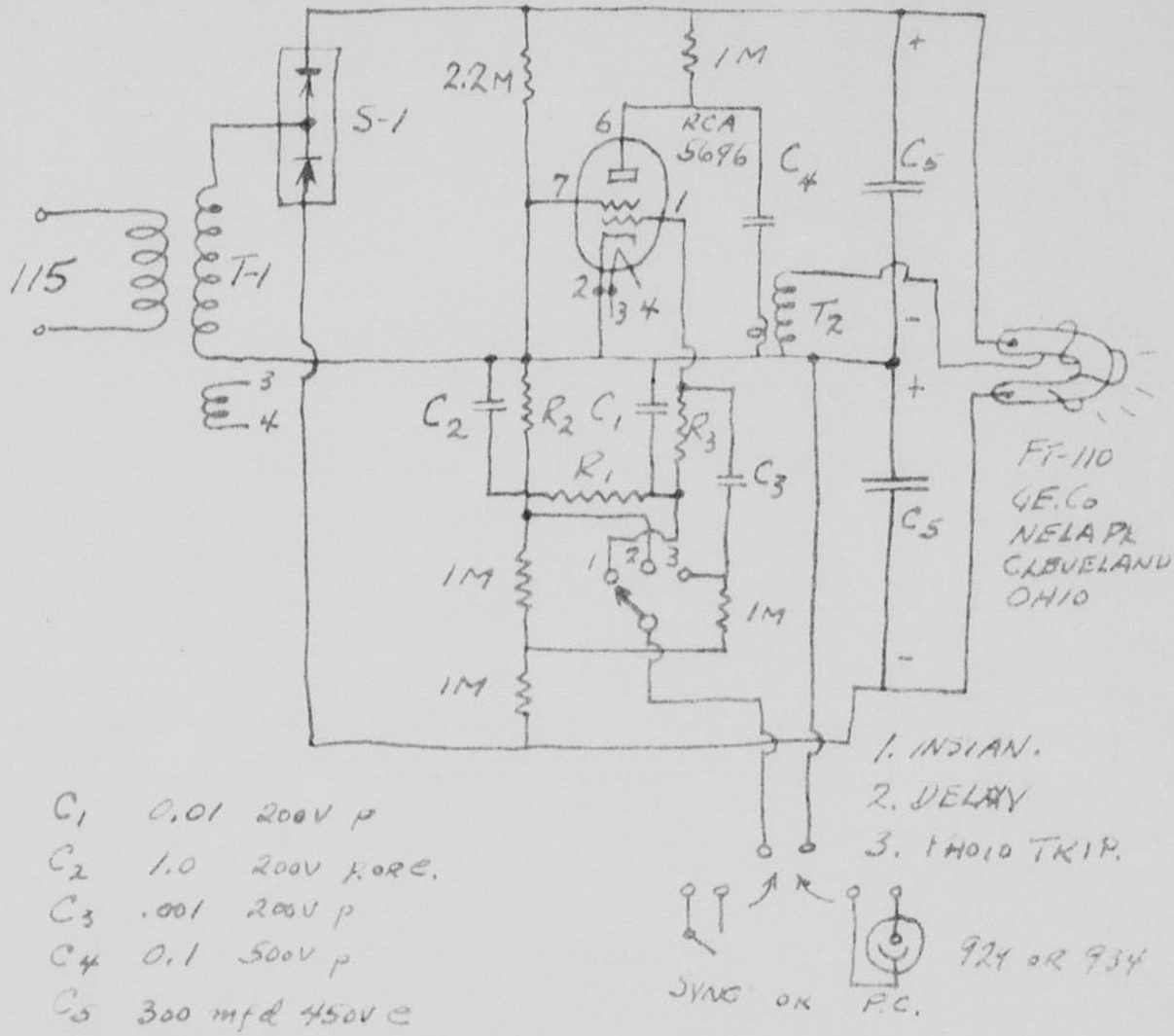
Peck of Mallory Oct 13 letter gives 525 as limit.

Oct 25 trans from. ordered from Megslic.

Turns		
1350	#36 wire	5/8 core.
4850	#40 "	
81	#30 "	

also H.V. by 5%
down filament by 5%

Blue flash



C_1 0.01 200V p

C_2 1.0 200V p. or c.

C_3 .001 200V p

C_4 0.1 500V p

C_5 300 mfd 450V c

R_1 10^5 1W for 3MS DELAY

R_1 10^6 1W " 15MS "

R_2 68000 1W

R_3 ~~10^5~~ 1W 0.22 meg.

S_1 G.E.Co LYNN MASS 6R53KH1 50 PLAILS C.T.

T_1 625-104 Mystic transformer 31 Harry Medford.

T_2 MODEL P COIL MODELECTRIC ASBURY PARK N.Y.

H.E. EDGERTON
SEPT 23, 1944.

Oct. 7, 1949.

H. E. Edgerton

Nestle Co. Freehold N.J.

I took movies at 1200 per second 35 mm of the nescafe jets (Egon) on Saturday Sept 30. My son Bill went with me.

#1. f 1.5 long angle shot of jets.

2 f 1.9 Side view

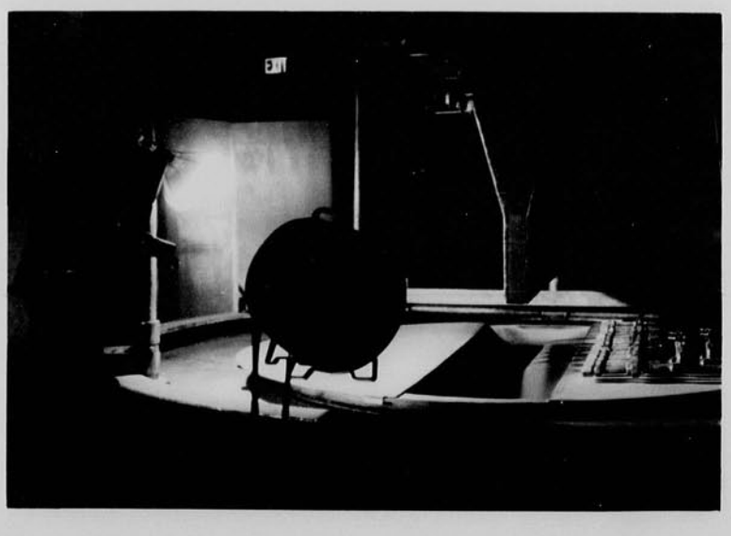
3 f 4 Side view

x

5 f 4 Front Lamps distant

6. f 4 Front. " close.

These were left with Irving Kay at the Deluxe Lab 850 west 10th ave N.Y. on Sept 30.



Oct 23 1949

Returned last night from trip to west coast.
Oct 11 Los Angeles Hotel Roosevelt S.M.P.E.
17 Los Alamos Lecture on Speed photography.
20. St Louis P.S.A. convention. Paper on the light meter and its uses.

Bob Edgerton

205 School St
Belmont, Mass.

Ben Logan

Smith

Mary Lou E.

Los Angeles

Wilcox

PAUL NOLLER

Frank Carlson

MOMI KAI

ED NOCK

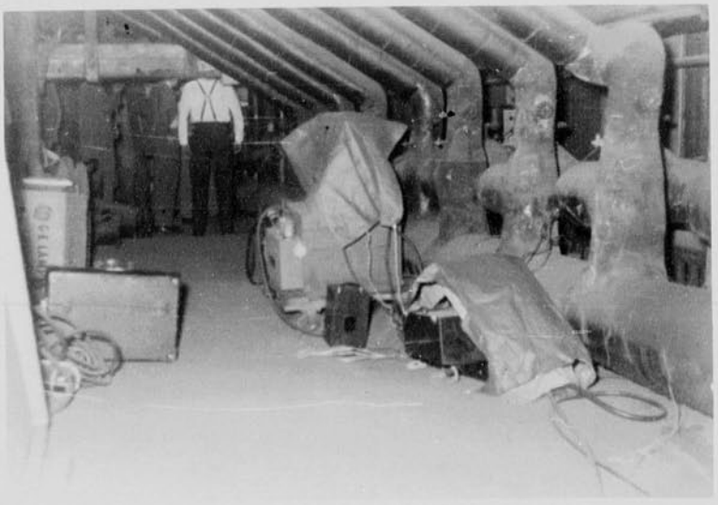
St Louis

Jefferson Hotel

with the FT-110 tube

when presented.

LIPTON FRIT- PARKER GARLAND



20,000 with scenes at the Boston Garden Nov 1949 Rodeo photos.

Nov. 16. 1949

Transformer design. see page 116 for 5/8 core size

1st transformer 625-104 mystic.

115V 60~ 1350 turns # 36
4850 " # 40
81 " # 30.

Design a larger transformer with a 11/16" square core of the same relative dimensions.

To keep the same flux density, the turns will need to be reduced by the area of the core.

$\frac{6.25}{4.84} = 1.1$

area $\frac{A_2}{A_1} = \frac{(5/8)^2}{(11/16)^2} = 1.21$

new turns = $\frac{1350}{1.21}$ = 1120 115

= 4850/" = 4030 400

81/" = 66 6.3.

Wire size change. area of wire increases by $(1.21)^2 = 1.46$

	area.		area	new gage
# 36	25	x 1.46	36.5	34
40	9.8	"	14.2	38
30	100	"	146.	30*

~~Since load~~ is small or called.

New Design 11/16" core. E 1.68

1120 turns # 34. 680-101

4030 turns # 38

66 turns # 30

Hartford M.I.T. Club with Don Severns several weeks ago.

Pittsburgh - Mellon Inst = Gaseous Conduction meeting
Prof. Bill Allis. - Talk on Speed photos.

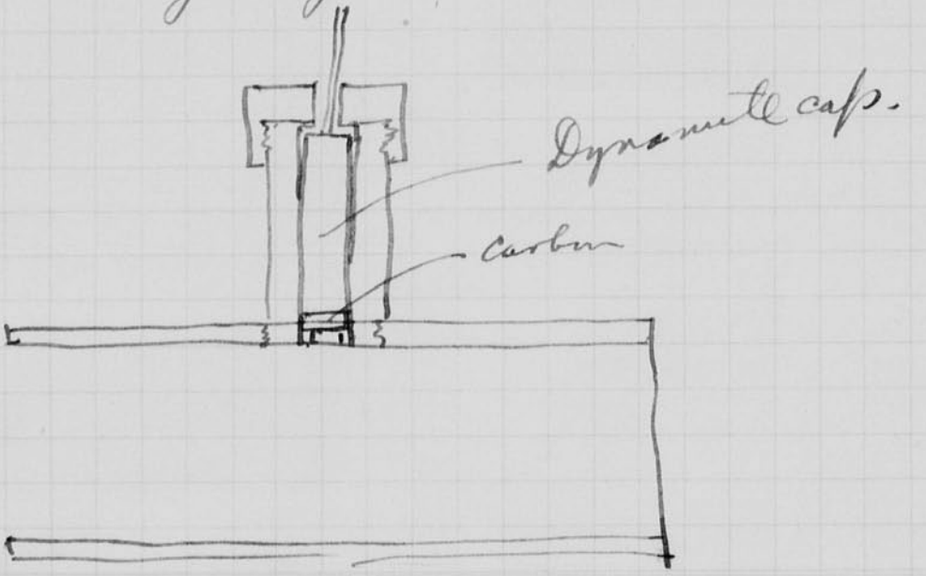
M.I.T. R.L.E. conference talk Nov 15 1949 tuesday.
Visiting committee from Washington D.C.

Nov. 22, 1949.

H. E. Edgerton.

Discussed fast closing shutter with Herb Prier yesterday afternoon. He told me of the "exploding behind a mirror" as used with the Bowen camera.

It seems as though smoke could be blown into a tube to obscure the beam. I suggest a pipe in the path with dynamite caps in the side to blow material into smoke. Fussell suggested graphite, or compressed carbon black as material that would disperse into fine particles.

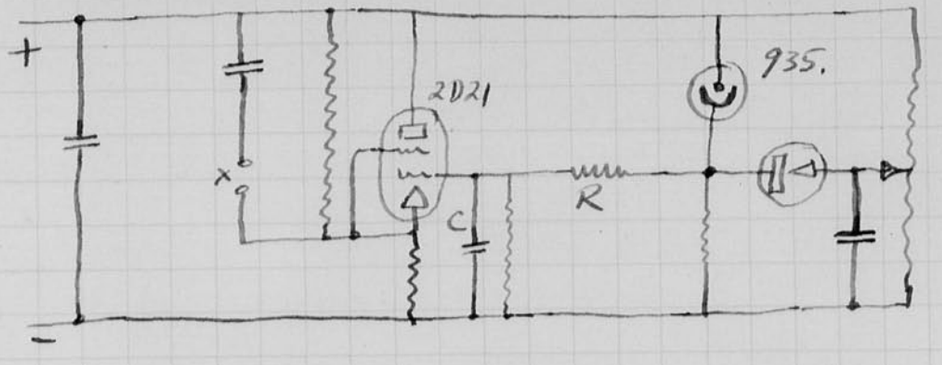


Ditto
obv.

a cloud of material will precede from the end of the cap into the cylinder at a high velocity which may be as much as 5000 ft per second. two clouds will meet and disperse obstructing the optical path.

Herb called on the phone this morning. He is going to design a test structure for the experiment.

cont.
Photocell trip with time delay.



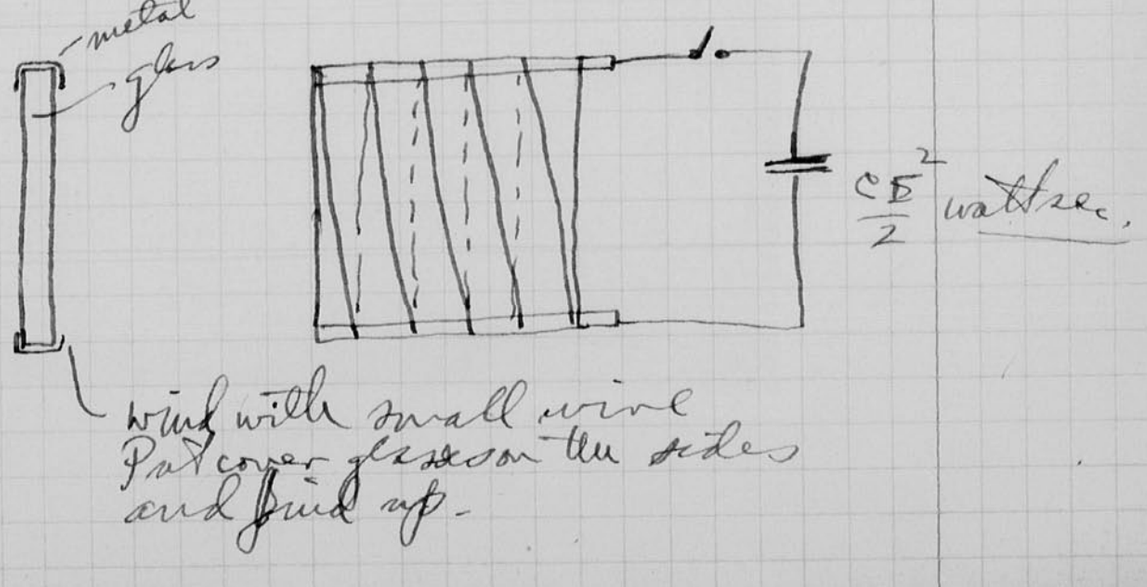
Fast light pulse lights photocell
Diode limiter holds upper value
of voltage on delay circuit.

RC network sets delay time on
firing potential of 2D 21 thyratron.

this system depends upon the light
holding its high value until the delay
network trips.

Nov 28, 1949. Discussed system of heating grid wire with condenser discharge to make smoke in a glass cell with funnel as the plume on Nov 25. He said Emmes Lawson had suggested a parallel grid system of wire to explode.

This wire system could be wound on a glass form as shown below



Nov. 29, 1949.

H. E. Edgerton

Gave talk at Grad. House last night to M.I.T. Alumni Council. Wilkins and Saylor brought over the magnetic contactor. Lou Rosenblum brought over a Polaroid camera. Benson's photos and slides were shown.

Shutter experiment with exploding wires. Copper enamel coated slow a poor pattern due to enamel breaking off in flakes.

Tried 3 glass construction today the first shield had about 20 strands of nichrome .0031" 67 ohms per foot. 76 mf at 2000 volts with a series gap caused the wires to melt but not completely evaporate.

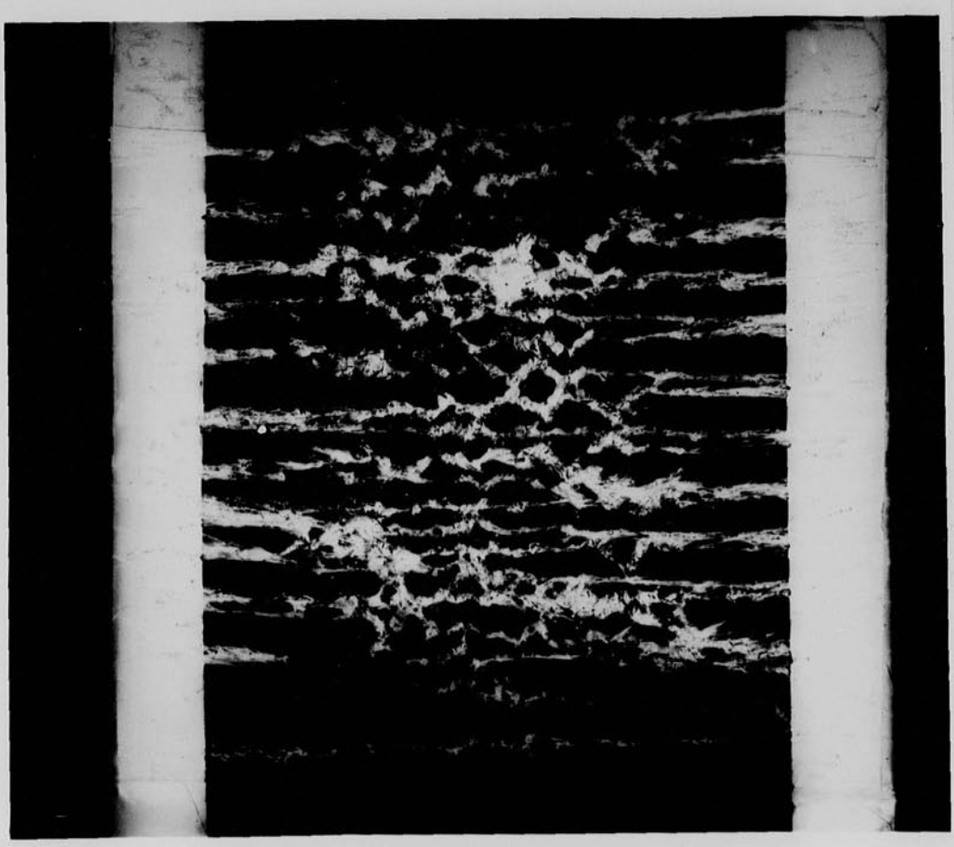
(A)

A second example with ten strands of .0031 nichrome was shot until 76 mf at 2500 volts. One of the end side glasses blew up. The metal film was not very dense. The metal was spread over a width of about 1/8 of an inch but irregular.

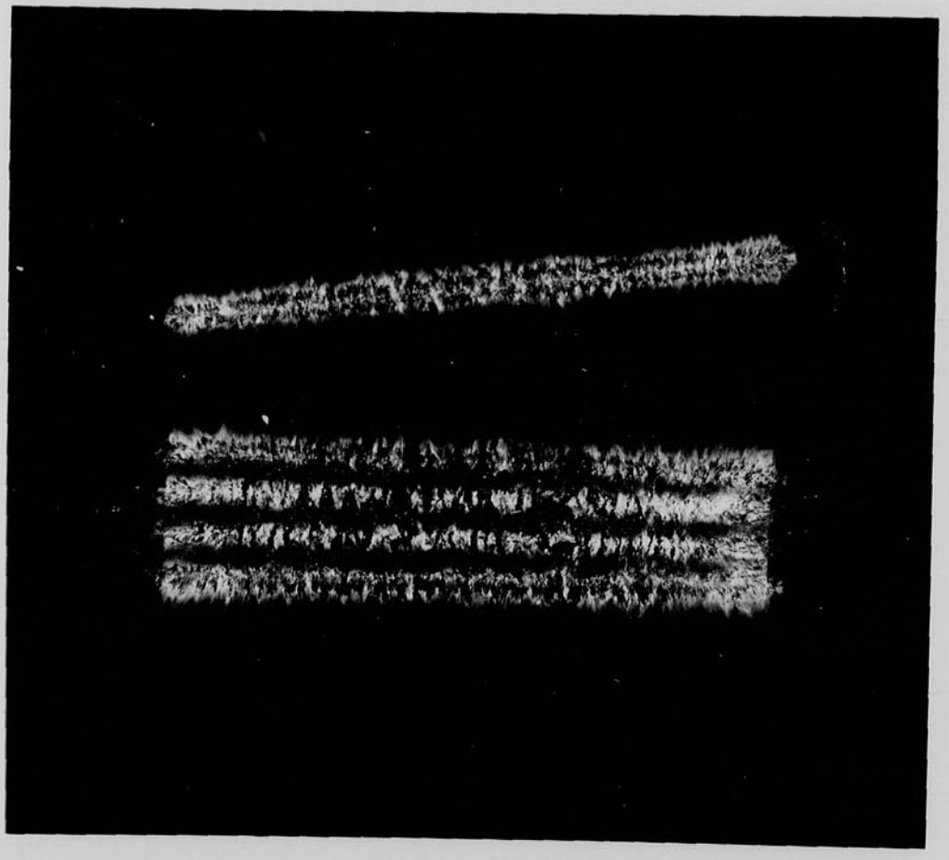
(B)

Next 10 strands of .0056 with 100 mf 2500 V. Both cover glasses blew out. Wyckoff says 1/4 to 1/2 per cent transmission

(A)



(B)



1 Cover

Dec 10 1949

H. Shorter.

6:20 students out to home last night.
Brier left for Sandia and Los Alamos yesterday.

Caping shutter tried again today.

(1) Eight wires copper #38 on 2×2 glass plate with 1/2 inch nickel side connectors. Used five 8 - 1 inch lengths of #38 wire.

(100+10) mf discharged at 2000v. Results were too violent.

The wafer had 1/8+ cardboard spacers between the main glass plate and two outside plates cardboard open at two ends glass plate.

glass with wire

(2) 12,8 mf 2000 V does not explode wires! 2 were burned off at ends.

(3) 100 mf 1500 volts Discharge Both cover glasses broke with a bang.

Monday Dec 12 1949.

Shutter developments.

8 Strands of .0056" nichrome wire on 2×2 inch glass plate 0.1 cm thick with 1/2 inch nickel ribbon connectors on side.

1/2 inch wood spacers with 3/4" hole in center.

1/8" + Glass cover plates.

100 mf. 2000 volts. Did not break glass. Large noise. Fairly dense film on glass slide but not much on the outer plate.

4 ✓

Ditto above but with 45 mf at 2000 volts. Results about same.

5 ✓

Wood spaces reduced to less than 1/4 inch. Ditto except 45 mf at 1500 volts. Wire did not vaporize completely.

6 ✓

7. Ditto except with 45 mf 2000 V Wire exploded ok.

8. Aluminum Gas tried in spaces with flame hammer. no results.

9. 14 Strands .0056 45 mf 2300 V not enough energy. Looks best yet!

10. 14 Strands .0056 100 mf 2000 V ok

Cont'd

5- 2,000
5- 8 KV.

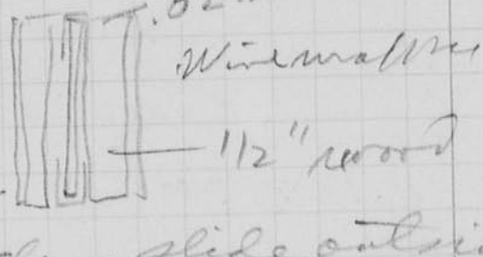
Dec 13
Glen Ellyn.
Barstow.

12 wires .0056 Nichrome
Painted with dag
graphite solution.
100 mf 2000 V. - Result
not impressive.

11

15 wires .0056 slightly separated
12 from middle glass plate
1/4" - spacers to outside
glass plates. 45 mf 2500 V
Best result so far.

3 wire, .025 lead solder.
45 mf 2000 V. Broke all glass
3 layers.



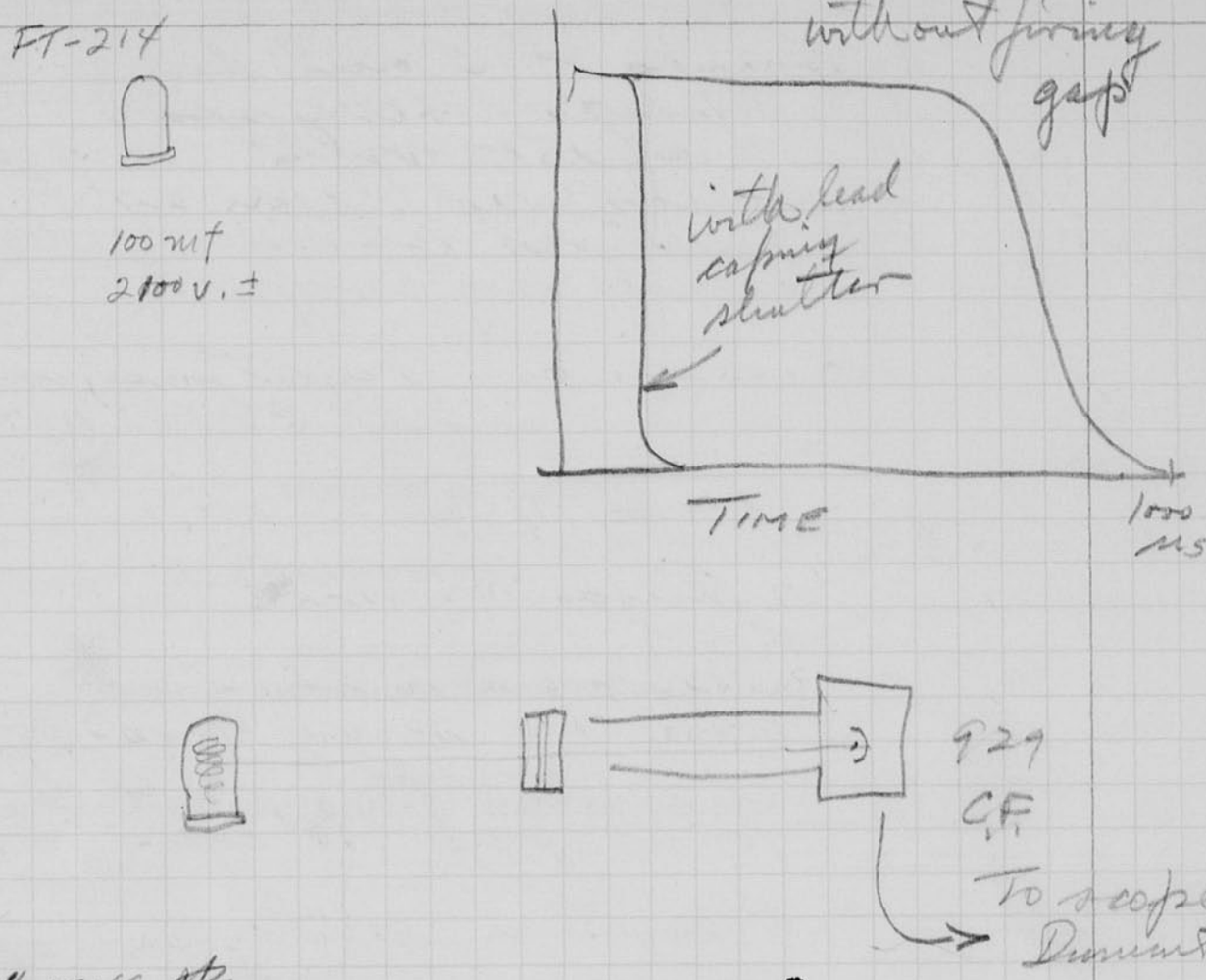
.016 inch

13. 2 wires, ~~.025~~ lead solder
15 mf 2000 V.
.016

.016
14 4 wires ~~.025~~ lead solder
1300 volts ? 45 mf
not enough.

.016
15. 4 wires ~~.025~~ lead solder
2000 volts 45 mf.
Best result yet. looks
good.

Edg & Germeshausen.



Dec 16 1949 Fri.

Frank Strabala, Soule, and Clyde Wagdoff have been working on the shutter problem.

Some 5 mil lead wire was received today. Compared to the 4 strands of .0016 wire we need about 1/10 to give the same volume of material.

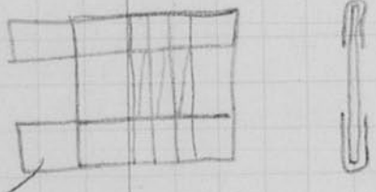
Data on voltage and capacity was taken yesterday. A light measuring circuit was set up today and will be ready at 160 Brookline St next week.

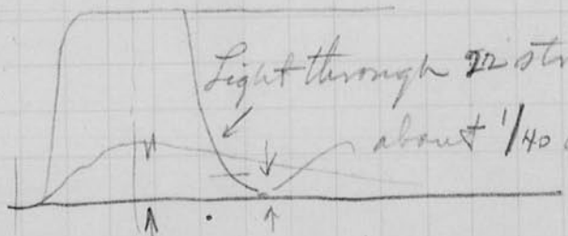
5/8 ?

16 A shutter was made with 20 strands of 5 mil leadwire but this was discharged 45 mf at 1500 volts. One of the glass ends was blown out & the light was recorded with a cathode ray scope.

100 ms sweep. 10^4 cycle timing wave. FT-214 100 mf 2000 V

17. almost Ditto above
22 strands .005" wire lead
45 mf 1500
Outside and inside glass broke (or sound pop? accidental)
100 ms sweep 10^4 cycle timing wave.
Attenuation, oscillogram.
1. None FT-214 30 mf 2000 V
2. Polaroids (x 5?)
3 " x 2
4 " 4





.005 nichle. 1/8 wide bent into a U shape then 1/2 inch cover woods with 5/8 hole. Then cover glasses taped on with scotch tape.

See film for exact data.

Photo tube was broken by a piece of flying glass.

Notebook # 19

Filming and Separation Record

____ unmounted photograph(s)

__1__ negative strip(s)

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

was/were filmed where originally located between page 130 and 131.

Item(s) now housed in accompanying folder.

P131
Dec 17
1949
#18
#19

8E H23354
21?

8E H23353
F20

22.

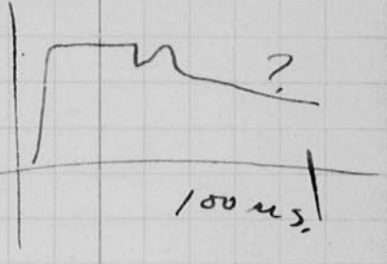
Dec 7 1949 Sat.
HEEdg
Dear Wyckoff.

#18. 4 wires solder 0.016 45 mf at 2000 volts with 6" more leads.

×0
×100
×1000

Did not explode. (melted.) Photo may show shock wave or pickups

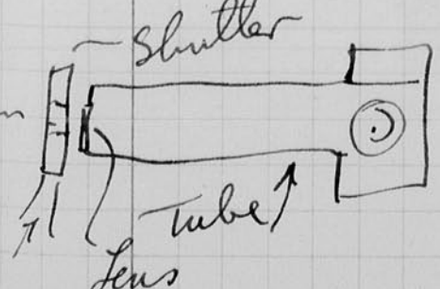
#19. 4 wires solder .016" 45 mf 2200
Osc record made.
shows decrease but not fast. according to eye.
Initial value of absorption was ok.

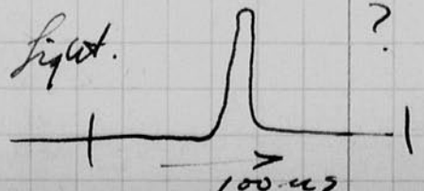


#20 22 wires .005 lead. 45 mf 1500 volts.
Osc showed slow decrease.

#21. Light from 22 wires .005 only
45 mf 1500 volts. Shutter glass broken.
Shutter close to Photocell

#22. Light from 22 wires, .005 only,
45 mf 1400 v. Shutter did not break
Shutter about 6 or 8" from P.C. with a lens between

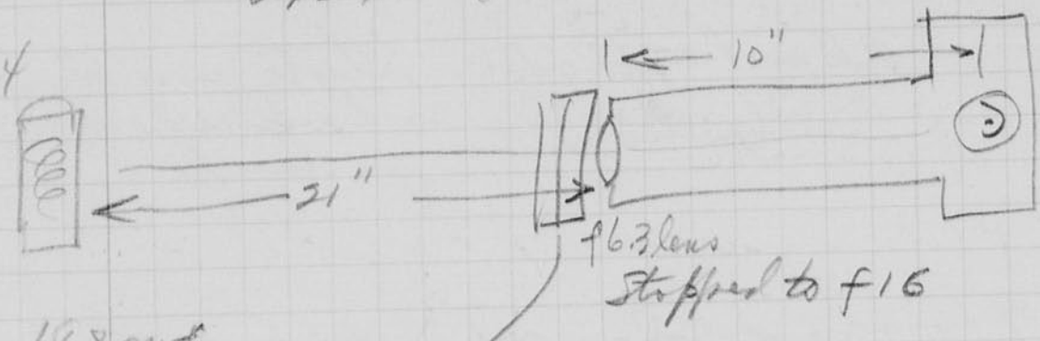




#23

5/8 disc hole 22 strands #.005 lead wire
2×2 slide sandwich.

FT524



64.8 mf.
1400 v.

Sandwich 1400 V 45 mf.

Lightsource 0
×10
×100
filter
"

trigger
for fuse shutter.

24

2" Shutter. 21 strands .005 lead

2200 volts 45 mf.

First calibplots
0
×100

Blew up.
However osc looked ok.

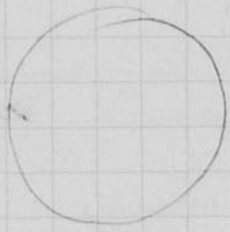
f6.3 set on lens alone.
otherwise O.K. and same.

Dec 18 1949
RZ Esq.

25

21 strands of 005 lead across 2" hole
45 mf at 1800 volts.
One side glass broke but did not explode.
+1 lens used for plate ~~ortho~~ x film
calib plate x0 filter
x100
x1000
Light from FT-624 68.8 mf 4 KV

26,



4 wire of 0.016 solder
45 mf at 2200.

4 | 23 | 23 1/40

27

1850+

22 3/36

22/4 x 1/4

16 strands of .005 lead wire across 1/4 hole
45 µf at 2000 V.

Blew all apart and one side was shattered
very dense deposit on all surfaces.
same camera + film as above
Calib. — x0 filter
x1000 filter
Light 68.8 µf 4 KV.

Light begins to cut off at 35-40 µsec but can see 100 µsec sweep it is simply larger it is down very far.

14 strands .005" dia lead wire and 1¼" balls
45 μf at 1900 volts.
both sides of double glass broken, but remained in place + scotch tape ——
same equipt + calibration as before.
dense deposit as before, but just began to short off when it goes off scope. The have no good mag + will darken this gap is fixing.

12 strands 0.005" dia. lead wire and 1¼" balls
45 μf at 1600 V.
No glass appears to be broken and we have a very dense deposit ~~on~~ > than ×10,000 filter.
Used 1000 μ sec sweep

12-20-49

12 strands .005" dia lead wire + 1/4" hole in shutter.
45 μf at 1600 Volts.
These constants used in all tests listed below.
Light 129 μf at 4 kv.
Calibration
X0
X10
X100
X1000
No light in

27C1 also 10 cps or 1 cycle = 100 μ sec.

27D1 Fired one shutter with the stroboscopic light at the same time with the following results
Down 10:1 at 75 μ sec.
Down 100:1 at 125 μ sec.
never gets down to 1000:1 on screen.

27D1 27E1 Fired two shutters with stroboscopic light off so the only light is the light from the firing of the circuit. Results:
Down 10:1 at 50 μ sec
down 100:1 at 100 μ sec
down 1000:1 at 200 μ sec.

27F1 27F2 Fired two shutters to determine if the condenser-shutter circuit was oscillating and keeping the light on. Results.
oscillates for 50 μ sec

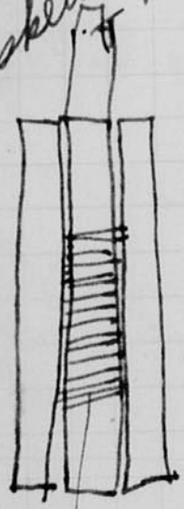
Might need damping if we can get light down to a reasonable length.

Fired one with 100:1 attenuator between the shutter & the cell. Light came on at 25 μ sec after got fired and light was down to zero at 475 μ sec.

Note
No wood blocks used here or on pg 137
shutter as in following sketch.

#27A 22 strand #.005 lead
1400 V 45 MF.
X100 filter over P.C.
no result. light i.e. - no light

#27A 26 strand .005" lead used
1500 V. 45 MF.
no filter over photo cell.
Result.
Light output small — gain up and comes down to ½ the blue line in 15 sec. — Density of shutter = X 200



#27B 14 strand .005 lead used
1350 volts. 45 MF
No filter over photo cell
Result: higher light output; density of filter ½ 200

#27C 14 strands 0.011" lead fuse used together
did not fire at 1400 V.
7 strands of 0.011 fuse used
fired at 1800 V.
No film but it darkened

#27D Look good as a shutter
26 strands 0.005" lead used as shutter.
1400 V. 45 MF
Lay good test — no result.
Increased gap spacing

12-21-49

#27E
26 strands .005" lead wire
1400 volts 45 μf
Low density deposit with balls.
took pictures to determine how it would be as a shutter. – Log paid late
No result.

#27F
36 strands .005" lead wire
2000 volts 45 μf
dense deposit (black) with some small globules of metal (silvery) left on glass.
as a shutter – it closed to 1/10 light in 50 μsec.
1/100 light 110 μsec
1/1000 light 165 μsec.

~~counter~~ after the strobescope light went off. the counter fell in between the gap pulses but from extrapolation it should have fired about 50 μsec after light comes on.

#27G 40 strands .005 lead wire
2150 volts 45 μf
X100 filter between shutter + photocell.
Light follows calibration curve up to where shutter begins to cut off (20 μsec after gap pulse) and comes down to the X100 curve 50 μsec after gap pulse. No readable after that. There is good indication that the light from the shutter is negligible compared to that from the strobescope light source.

#27H
Construction changed
Use 1 thin .038" 2x2" film slide glass for center piece
Use 0008 mil aluminum foil doubled to conduct current to wires. 0.005" lead wire and 2 film slide plates on each side.
40 strands 0.005" lead wire
2200 V 45 μf
X10 filter between shutter & photocell
density about 100.
follows the 10:1 density calibration curve up and begins to close 20 μsec after gap pulse.

12-21-49

#28A

Fired two shutters described bottom page 137 at 2400 volts 45 μf

40 strands .005" lead wire

Both get down 100:1 in less than 50 μsec.

One drops off about 300:1 almost in a pound of zero time. Neither get to 1000:1.

Both broke glass

#28B

40 strands .005 lead wire

2 - 1/8" wood blocks

2400V and 45 μf.

Drops below 200:1 in 50 μ sec.

Broke both sides x - coated 32 film plates both quite dense, after firing, but some of the density seems to form too late

#28C

40 strands .005 lead wire

2 1/8 wood blocks

2400 V. at 45 μf

Use 1/8" mirror glass on sides

same as mixed above

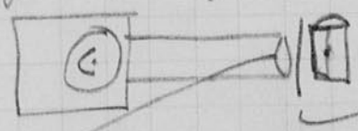
#28D Calibration - light

F. I. S.

Dec 21 1949

Mr Edgerton

#30 Calib of light from shutter



FT-214 # 646 101 μf 2000V

1000 x filter and x100

2 shots made.

10"

1" diam

Doc shows $\frac{646}{1000}$ h.c.p.s. output

or $\frac{2.6 \times 10^6}{1000}$ h.c.p. = 1/2" deflection

$2.6 \times 10^3 = 2600$ h.c.p.

with 1" diam lens at 10 inches the light at the film will be

$\frac{2600}{1 \text{ ft}^2} = 2600$ lumens/sq foot

Notebook # 19

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 138 and 139.

Item(s) now housed in accompanying folder.

10 S-4

2.6×10^6 M.C.S.

exposure time = 2×10^{-6} seconds.

$2600 \times 2 \times 10^{-6} = 5200 \times 10^{-6}$ lumen sec

$= 0.0052$ lumen sec. (1.0 lumen sec)

This is not enough to expose film.??

With lens at 40 inches results will be better by a factor of $4^2 = 16$

the light from the shutter drops rapidly.

31 Ditto 30 except two slits with 1000× filter

#30

74
64
96
576
5.76
16
×45

12-22-49

#33 40 strands .005" lead wire
45 μf 2400V.
Took light output of shutter alone, no filter density. 7 x1000

#34 40 strands .005" lead wire
45 μf 2200 V.
took light output of shutter alone, no filter density — spotty but > 1000 by the looks of it
Let 7 unmelted metal exp. Double flash of light? lasts for 50μ sec or slightly longer.

#35. 40 strands .005" lead wire
45 μf. 2400V.
x10 filter
Took light output of shutter only

#36 40 strands .005" lead wire
45 μf 2400 V.
No filter
Stroboscopic light source 125 μf @ 3500V. 3' from shutter.

#37 40 strands .005" lead wire
45 μf 2400V.
x100 filter
stroboscopic light source 125 μf @ 3500 " " "

#38 same as #36

#39 40 strands .005" lead wire
16 μf @ 4000V
No Filter
Picture of light from shutter
Results: Almost no light and poor shutter

#40 40 ~~strands~~ .005" lead wire
16 μf @ 4800 V.
No Filter
Picture of light from shutter.
Doubled peaked light which is over (down x1000) in 30 μsec. after it begins. Shutter has density of approx x1000.

#41 40 strands .005" lead wire
16 μf @ 5000V
No Filter
Picture of shutter action.

#42 40 strands .005" lead wire 2400V. 45 μf
Fired directly in front of 40" focal length camera. Picture is to determine if light from shutter will expose film & developing time 5 min. density of fog on film.

#43 40 strands .005" lead wire 2600 V 45 μf
Fired directly in front of 40" focal length camera. Picture is to determine if light from shutter will expose film. developing time 5 min

#44 Picture of shutter - 9-11 1 sec with ~~photo~~ flood
~~Fired at 2600V~~ 45 μf

#45 Picture of shutter exploding - integrating light from the flashing wires etc.
Fired 2400V / 45 μf

#46 Picture of shutter 9-11 1 sec with photo flood
2600V 45 μf

#47 Picture of shutter exploding - integrating light from the flashing wires
Fired 2600V 45 μf

H. J. Strabatter

Dec 23 1949
Explosion Fuse shutter

#48 22 strands of .005 between glass (window pane) without air space.

#49 1450 V 1/5 mfd.

4x5 camera plate before and with light from the explosion.

Sparking is shown at the ~~end~~ end where the wire crosses the end straps.

Outdoor photo from Prof. — of 17th floor and John Hancock Bldg.

50 1/2 sec f40

51 1/10 " f40

52 1/10 " f40 Lead wire grid on 2x2 slide glass 1/10" spacing apart

53 1/2 " f40 "

54 1/2 f40 Lead wires as above plus 2 pieces of window glass.

55 1/2 f40 2 Window glass piece in front of lens.

Dec. 31, 1949

H. F. Edgerton

Transformer design Portable 100 WS

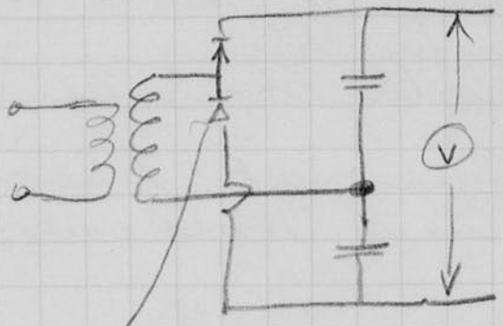
See p 121

11/16 core

1120 34

4030 38

66 #30.



Mallory SPD 67860
300 mf 450 V
V = 900 volts

with .5 mf paper
V = 1100 volts.

with C-D - 300 mf 450 V
FAEX 4546
V = 750 - 800 V ?
~~Eventually~~ went to 900+ volts.

S.S.
Selenium with
1/4 inch plates
fully covered.

Jan 15 1950.
Harold E. Edgerton.

The lead vapor shutter has gone to 160 Brookline ave with Frank Strabala.

I tested the speed of pellets from a Johnson gun and from a Daisy air rifle yesterday with Bernie Hausen.

a 1000 cps lamp was set up above a ruler. Both guns were fired over the ruler.

Spacing for Johnson Gun = $\frac{6\frac{3}{16}}{5} = 1.27$" in 1/1000 sec

or 1.27×1000 inches/sec.

or $\frac{1270}{12} = \frac{106}{\cancel{106}}$ ft/sec.

Spacing for Daisy air rifle $\frac{6.3\frac{1}{8}"}{2} = 3.18$"

or 3180 inches/sec

or $\frac{3180}{12} = \frac{\cancel{265}}{265}$ ft/sec.

Dec
P126

Gallinger Fall Gallop 1949 6.20 class

Wilson

King

Torgerud Moulton Fogarty Daley Ellison

Hasenkus Delong Schoenfeld Edgerton Mueller Hansen Cordemann

Mary Brennan

Jan 29 1950.

Detroit at Cranbrook Inst. Jan 20. talk on speed photography.

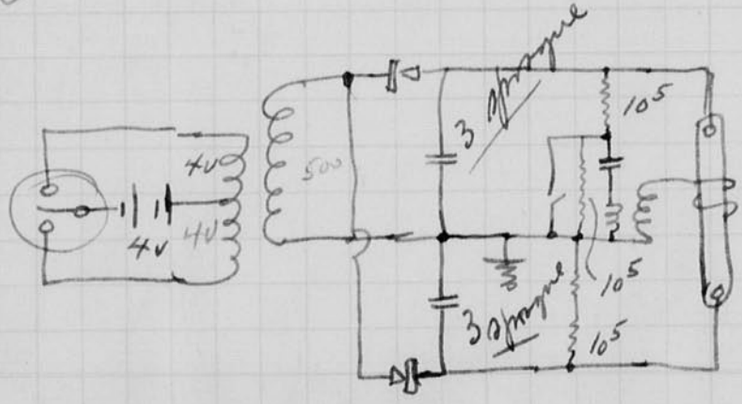
Chicago on Jan 19th to see E.K. Stine and go around with Ed Bartlett to visit studios.

Washington on Jan 26 at Naval ordnance Laboratory for high-speed motion picture committee meeting. Saw Nat. Geo. Society (Mr. Wisherd and Mr. Fisher) on the 27th. also Dr. A. Waltmire at the Smithsonian Institution.

Transformer design for portable for natural studies. Especially underwater.

Underwater model

100-watt sec.



$\frac{1000^2}{400,000} = \frac{1}{4}$ watt loss in blader.

$4V \times I = .25$

$I = \frac{1}{16}$ amp.

8V to 500V for transformer ratio.

FT-110 G.E. Flash lamp. 200 u.s. duration.

3/4" Tongue width. Lamination 345 (GR) 1.5 lbs.

at 12000 gauss 8.96 volts/turn 60 ~. from GR, Data.

Design 6000 gauss for vibrator service

then Volts/turn = 4.5

Sec turns = $\frac{500}{33 \text{ wire}} \times 4.5 = 2250$. (500 volt).

Prim = $8 \times 4.5 = 36.0$ with C.T.

16 wire

3/4" stack.

2250 turns #33

36 " #16 with C.T.

Notebook # 19

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 146 and 147.

Item(s) now housed in accompanying folder.

Lamp	Capacitor Series connection	Voltage	Light output ~~lumens~~ hor. candle power sec
Kenlite	Cornell Dubilier 200 mf 500V FBEX 3816	800	~~40~~ * ~~as used in~~
		1000	88.0 *
Kenlite	Mallory. 300 mf 450 V SPO 67860	800	88.0
		900	125.0
Kenlite	Sprague 180 mf 475V Y 9868 917	800	64.0
		950	112.0
FT110	Cornell Dubilier	800	64.0
		1000	108.0
"	Mallory.	800 ~~132~~	132.0
		1000 ~~150~~	176.0
"	Sprague	800	144.0
		950	172.0

* as used in Trimpl Powerflash.

H.E. Edgerton
M.I.T. / Jan 30 1950

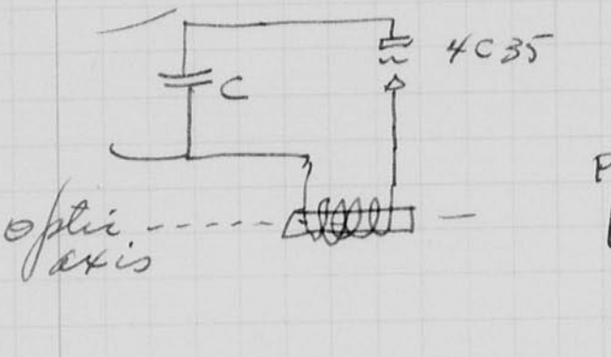
Feb 2 1950

Harold E Edgerton

Rapatronic shutter design.

Conf at 160 Brookline ave yesterday on the shutter. It was decided to use 2 slugs of glass and 3 polaroid sheets.

Conditions for shutter.



$C = 1.5\ mf$ 5 kV

$L = 3\ uh.$

$f = 80{,}000\ kc.$

$T = 12\ us.$

Energy stored $= \frac{CE^2}{2}$ in capacitor

$T = 2\pi\sqrt{LC}$ seconds.

If the electrostatic energy all goes into the magnetic field, then $CE^2/2$ should be constant for a given type.

$$T = 2\pi\sqrt{LC}$$

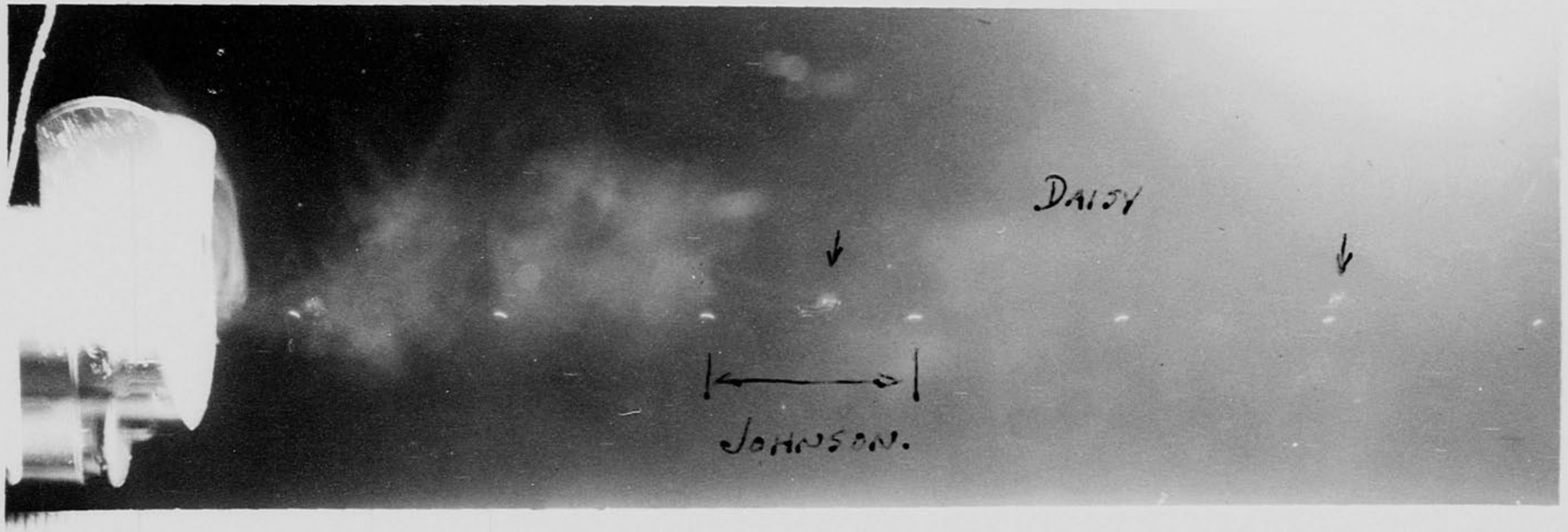
and $\frac{CE^2}{2} = K$ a constant.

$$C = \frac{2K}{E^2}$$

$$T = 2\pi\sqrt{L\frac{2K}{E^2}}$$

$$= \frac{2\pi}{E}\sqrt{L2K}$$

Therefore the duration is inversely proportional to the voltage of the capacitor if the energy is kept constant.



Daisy 1000 Shot Red Ryder Air Rifle - Light Frequency 1000 cycles per second.
265 feet per second.

Vibrator transformer. 4 volt → 900
Doubler

5/8 core 745 BR.

4 volt to 550 volt. ratio.

Primary 100 turns # 22 C.T.
Secondary 6850 " # 40.
Ratio 6850.

The transformer on page 146 has
1½ amp drain at 4 volts.
with two 5 page capacitors.
this is too much.
Charging time with 6 cap is 10 sec.
max dc current 10+ amps.

Notebook # 19

Filming and Separation Record

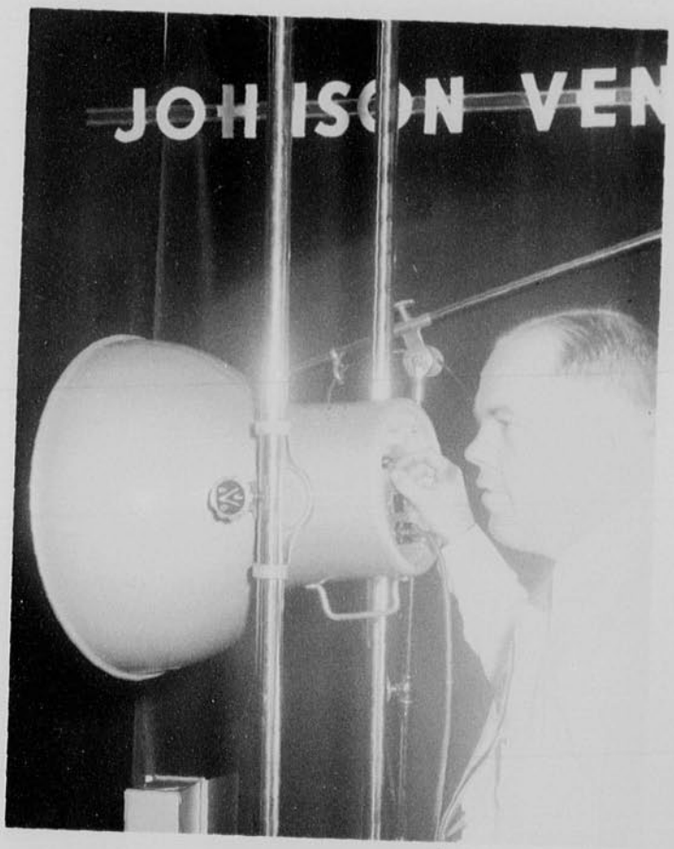
3 unmounted photograph(s)

____ negative strip(s)

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

was/were filmed where originally located between page 150 and 151.

Item(s) now housed in accompanying folder.


JOH ISON VEN

Wollensak fast Shutter $100.

Notebook # 19

Filming and Separation Record

____ unmounted photograph(s)

____ negative strip(s)

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

was/were filmed where originally located between page ____ and ____.
inside back cover

Item(s) now housed in accompanying folder.

PLACE _____

DATE _____

OBSERVER _____

R ATTENUATION RATIO	METER	METER X R INCIDENT FT. CAND. SEC.	D	LIGHT BCPS OR LUMEN SEC'S.	E VOLTS	C CAPACITY (MFD)	$CE^2/2$ ENERGY (WATT SEC.)	L/W EFFICIENCY	LAMP	REMARKS

Scenes

Bullet into Lamp. Ink drop Pen

Machine – Loom

Bats

Mosquito

Tom Daly 148.
7-029

Cut Guitar to show only
Bass plucks.

Show Ink from pen Close up 2 shots

Movie

Scenes of Balloons. Burst.

Scenes of Guitar.

Retake Guitar at better angle.

Drop marble into cup off center.