HAROLD E. EDGERTON

PAPERS

MC 25

Series III

Laboratory Notebooks

Number 23

Dated April 19, 1955 to Dec. 19, 1956

Book No. 23

Massachusetts Institute of Technology

COMPUTATION BOOK

NAME	Number
HAROLD E. EDGERTON	23.

MIT 20D102
CAMBRIDGE MASS

Course.....

Used from APRIL 19 1955, to DEC 19. 1956.

Book 23.

Harold E. Edgerton
205 School St Belmont Mass.

M.I.T. 20 D 102
Cambridge Mass.

Started April 19 1955

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

COMPUTATION BOOK

GENERAL INSTRUCTIONS

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

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

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

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

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

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

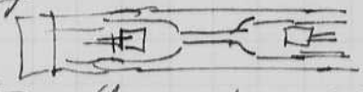
* * * * * * * *"

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

April 1955
Harold Edgerton

Experiments with a stroboscope.

A few tests were made on a high pressure flash tube of low input. The tube was 1 mm in diam and 1/4" long. in Vycor with FX-1 type of sintered electrodes.



I first tested it with 0.6 mfd at 2000 volts at 10 per second. After several hours there was some darkening and the tube missed badly. Then I put an additional 0.7 mfd in parallel and gave it a few flashes. This extra energy blew out the deposit in the capillary.

Next I reduced the input to 0.1 mfd at 2KV The light was located in a 5" diam reflector with a 1 inch focal length. The spot of out of focus light appeared as a square of about 4" on a side at one foot. The light is was very non uniform but probably satisfactory.

The light was measured with the Tectronix and a 935 photo. phototube.

Strobotoc. .045 volts peak x 7. us = .315 units

Xenon. 120. volts " @ 1.5 = 180 units.

Ratio is about 600!!

Xenon has .4 watt sec. per flash
Neon has 0.6 " " " "

The visual ratio is not as high as 600 due to the color of the light and the sensitivity of the photo tube. In any case the xenon light is much stronger than the neon.

The FT-118 flash tube with 0.6 mfd at 2KV is very inefficient.

I feel that a tube without end cavities would be good for flash work. The pressure could be lower.

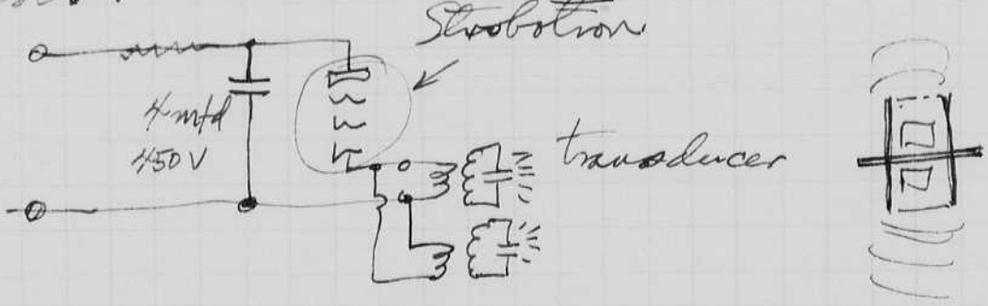
Underwater Cameras

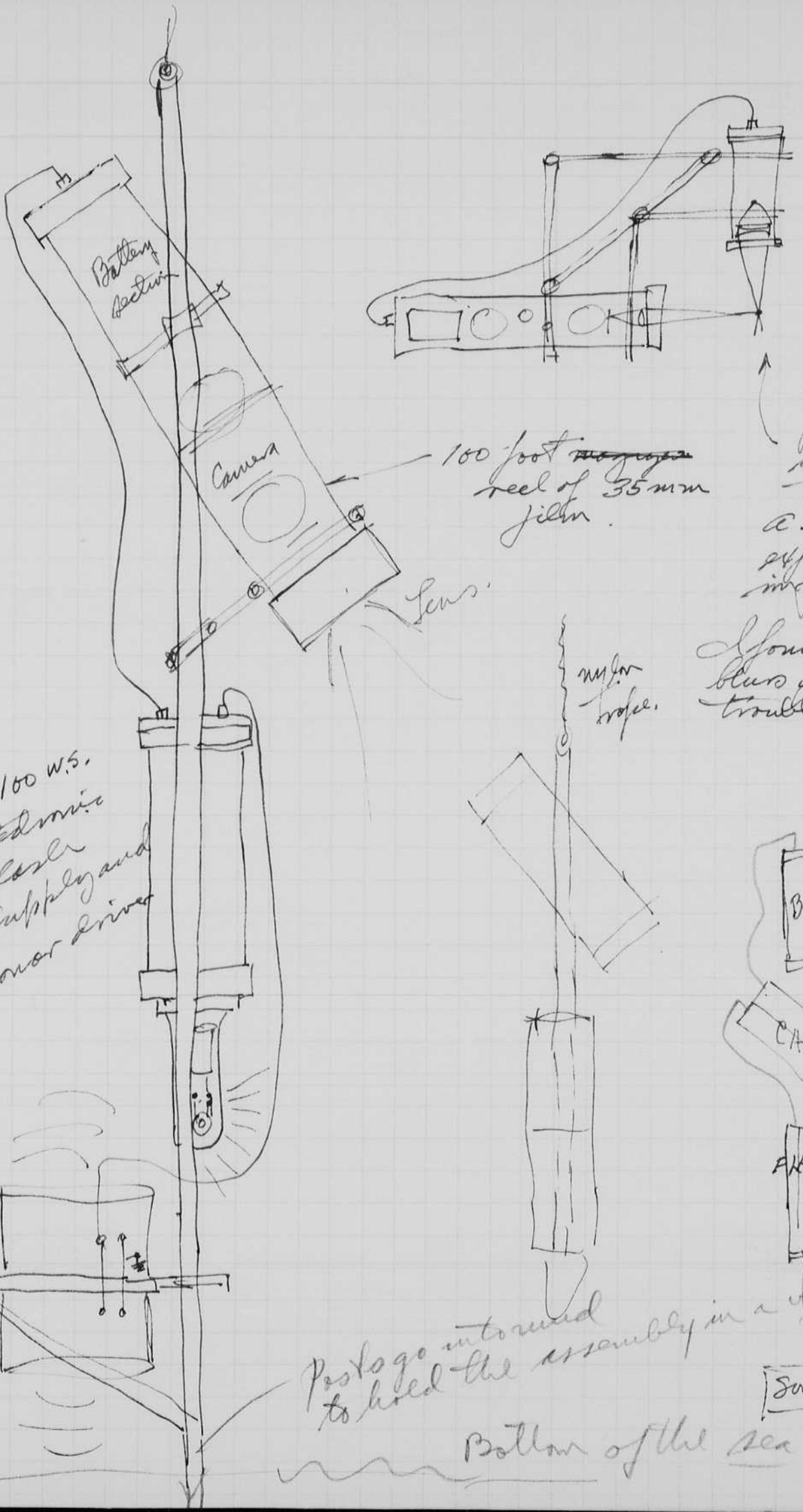
A popular account of the cameras (underwater) appeared in the April national Geographic magazine. I have spent the past two summers with Cousteau on the "Calypso" in the mediterranean.

We also have plans for the coming summer. I am making a camera and sonar for use in the deep spot near Greece. This spot is over 4000 meters deep, although we have a cable of steel for this job, I plan to experiment with nylon of about 1/4 inch. This nylon weighs practically nothing in water as contrasted to steel which is about as heavy as in the air. For great depths the nylon should be just the thing.

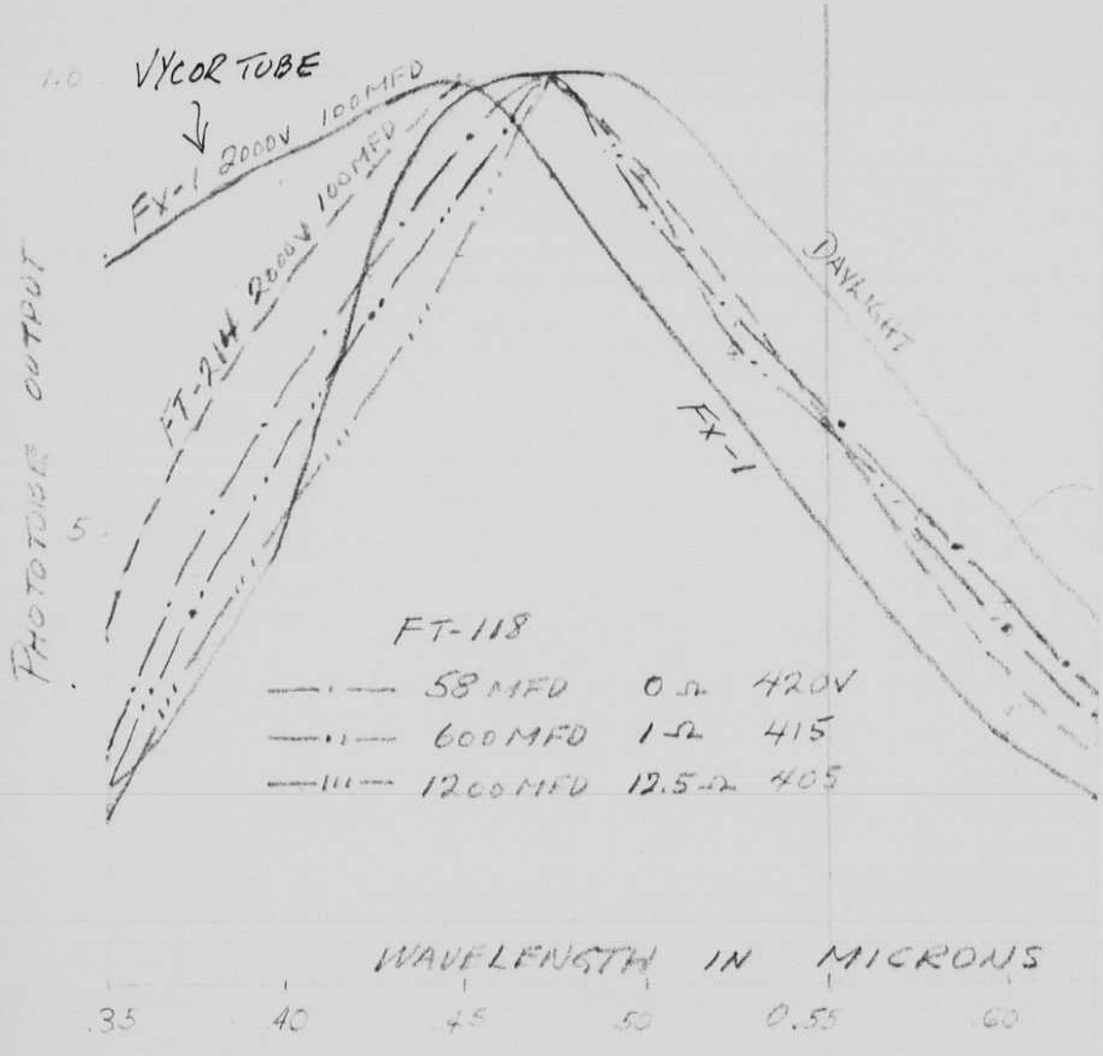
Jack Brown and Bob Hartman are working on the mathematics of the problem. Bill Westell has been helping some. Mr. Chase of the Sampson Co, Shirley mass, has been designing the nylon rope for us. a 5000 yard field is being made now for test.

Dick Ward and Tom Smith are testing a new Edo transducer of submergable type with up and down direction elements. These students visited Edo plant when Geo Sonde helped them make some tests.




Battery section
Camera
Lens.
100 foot reel of 35 mm film.
Closeup photography of small objects in the sea.
A short exposure is important.
I found that blurs were causing trouble last year!
100 W.S. Edgerton flash Sulphyand Sonar driver
Sonar
nylon rope.
BAT
CAM
FLASH
Sonar.
Post to go around to hold the assembly in a vertical position.
Bottom of the sea.

Data taken by Roy Svensen
on April 18 1955 20D102
B&L Monochromator and 926 P.C.



note shift in Blue response with operation of the xenon. This will be worked out in terms of dimensions and loading.

May 1, 1955.
Harold Edgerton.

I was in Chicago with Hoadley and Wyckoff on April 21 (Mary Lou's birthday). With Hoadley a paper on Underwater cameras was presented to the SMPTE. Then with Wyckoff a paper on the electronic flash sensitometer. was also given.

E.K.Co had a showing of equipment at Smiths one day show at the Kenmore Hotel.

I visited Cleveland on April 22 to see the G.E. Co.

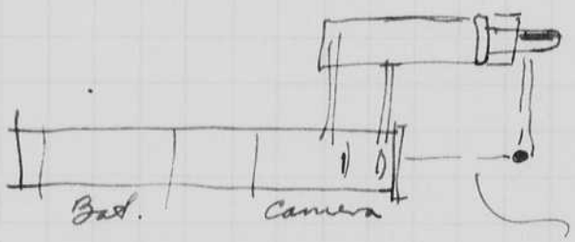
On Sat. Apr. 23 I talked to the PSA technical group at the Powers Hotel in the evening.

Sylvania had a dinner Apr 27 at the Algonquin Club at which I attended.

I gave a talk Apr. 28 at the Boston Camera Club to the nature series - Subject - underwater photography.

This morning at 7 am - Communion and Breakfast for men. Some 5 000 turned out.

Closeup camera design.

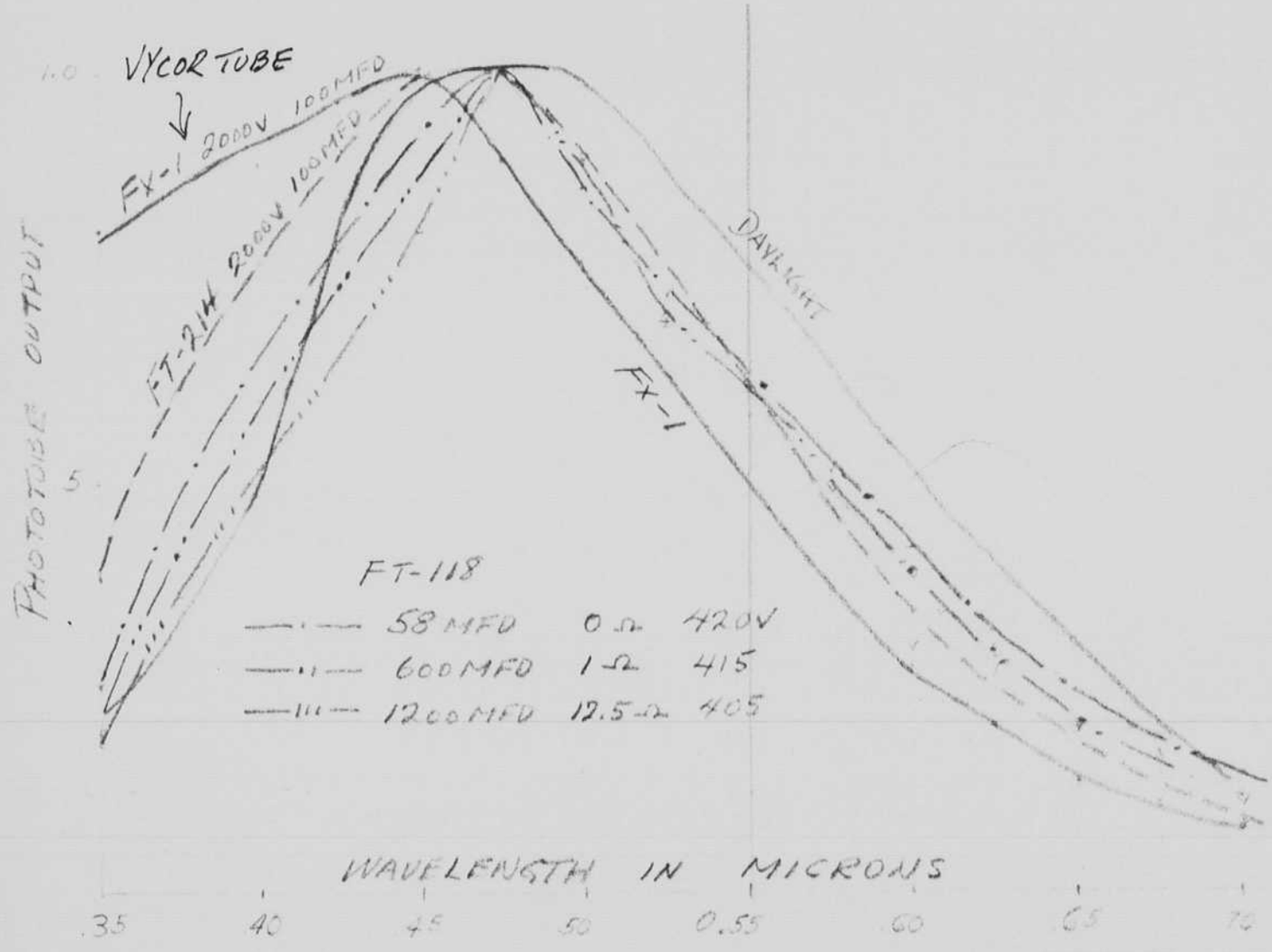


Short-flash lamp.

photos 1/2 size or 1:1 or 3:1. ?
optional.

10" = min distance to subject.

Data taken by Roy Swanson
on April 18 1955 20D102
Bl & L Monochromator and 926 P.C.



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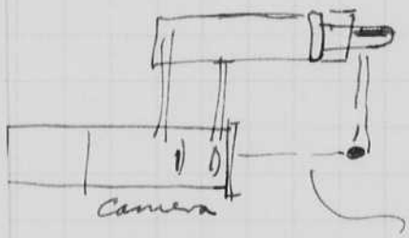

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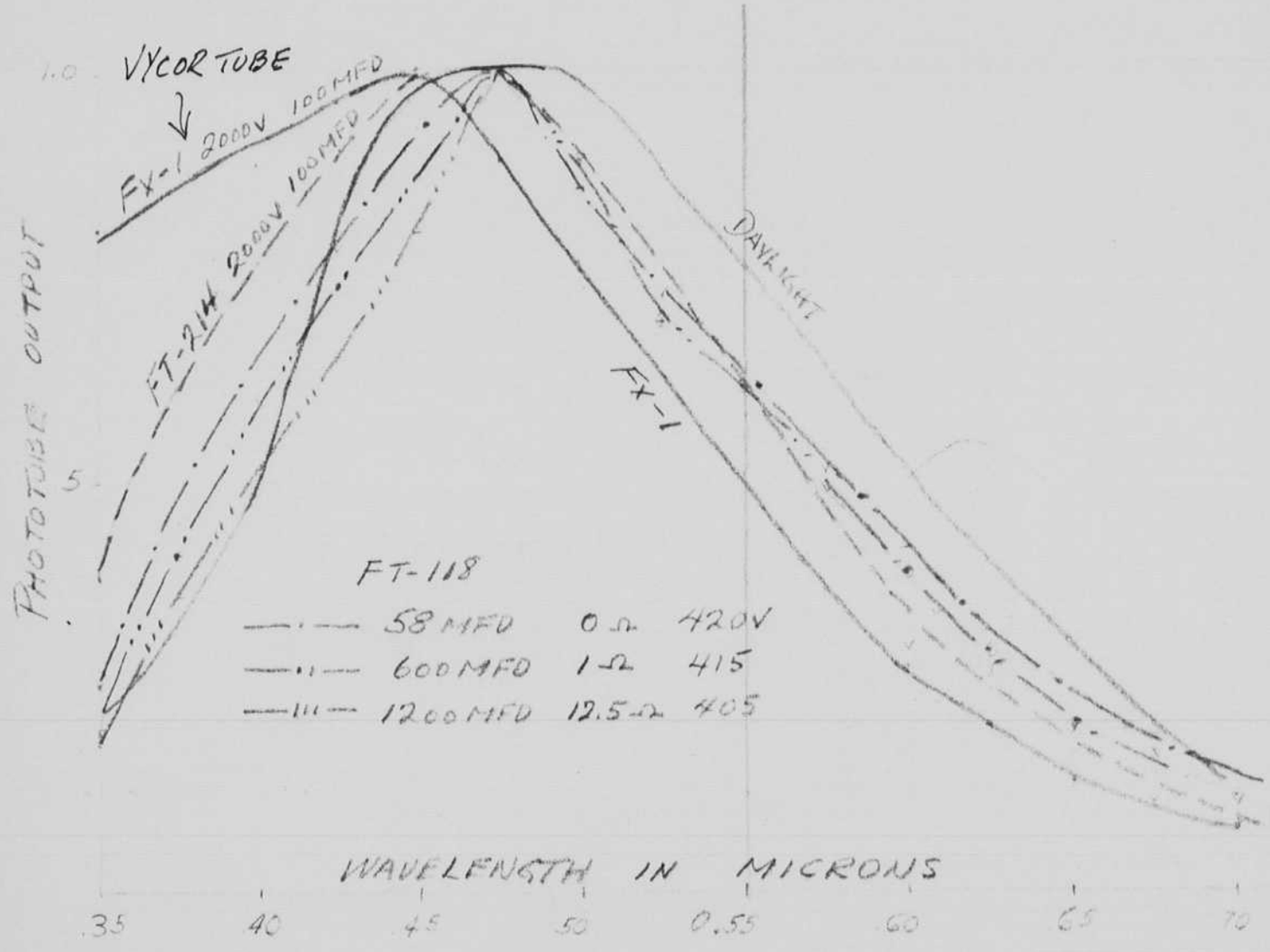

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Closeup camera design.

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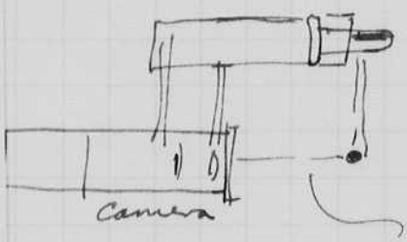
optional.



10" = min distance to subject.

May 14, 1953

Harvey Agentsa.

The capacitors (Sprague 22D9 and 22D10) have a longer flash than the 22D4! I called Charlotte. He is going to realize some samples with extra tabs and with low resistance electrolyte.

Progress is being made on the deep generals, sonar, and nylon line. I hope to leave the last of a slump June 17 from N.Y. for Marseille.

Bob
Jack Brown & Hartman are working on the nylon rope.

Dick Ward and Smith are doing the H2O experiments.

Bill MacRoberts is wiring up the strobes and cameras.

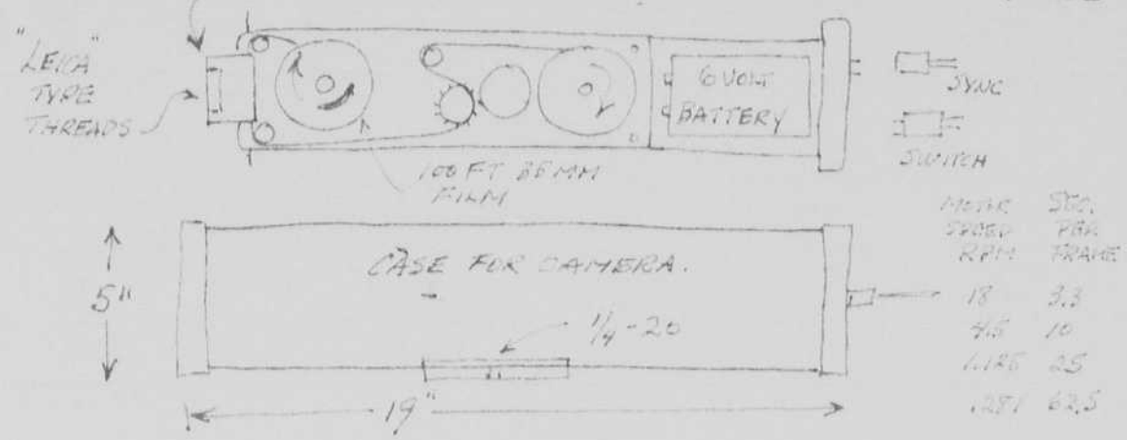
EDGERTON GERMESHAUSEN & GRIER.
160 BROOKLINE AVE BOSTON MASS.

INLINE CAMERAS
35MM FILM, 100 FT.
PRELIMINARY DATA.
APRIL 30 1955 H.E.E.

MODEL NO. 1. BASIC FILM MOVING MECHANISM & CASE

NO SHUTTER OR LENS SUPPLIED.

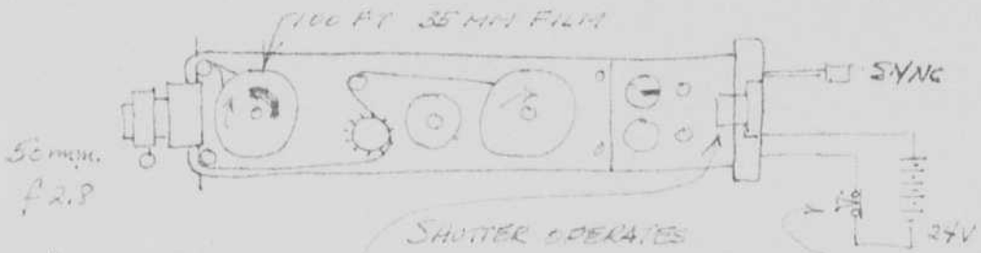
PRICE $350



MOVIE SPEED PER MIN	SEC. PER FRAME
18	3.3
45	10
1.125	25
2.25	62.5

MODEL 2. CAMERA WITH SHUTTER AND FILM ADVANCE 24 V. D.C

PRICE $650



CASE SAME AS ABOVE

SHUTTER OPERATES WHEN CIRCUIT IS OPENED

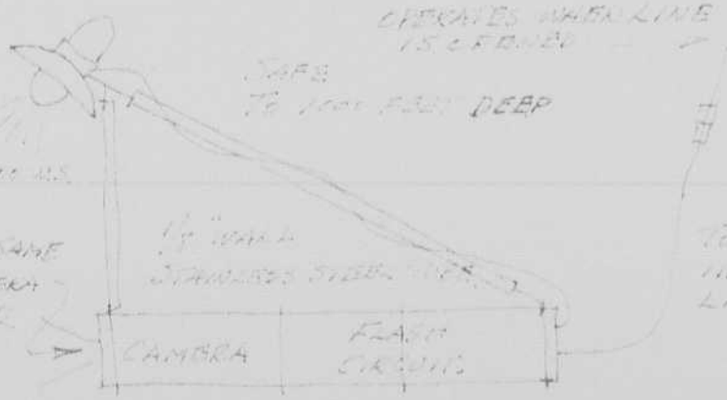
FILM ADVANCES WHEN CIRCUIT IS RECLOSED. 4 SEC. REWIND.

EXPOSURE COUNTER OPTIONAL. ADD $100

AC. 115V 60~ ADAPTER ADD $50

MODEL 3. UNDERWATER CAMERA

PRICE $2000.



CAMERA SAME AS CAMERA NO. 2

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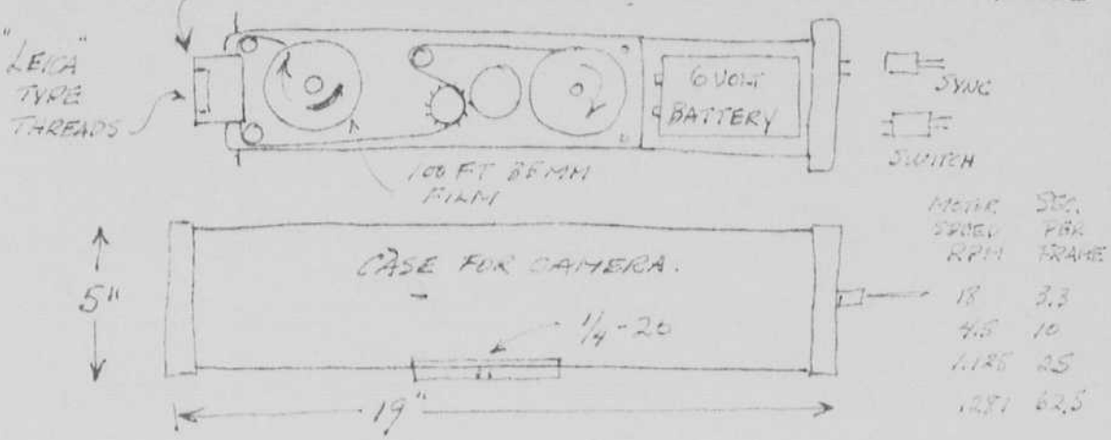
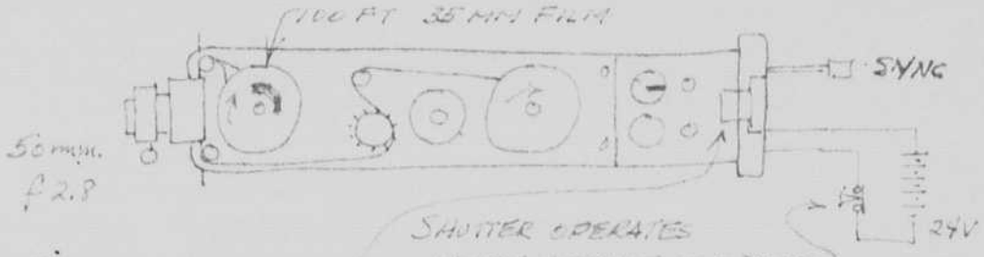


MOTOR SPEED RPM	SEC. PER FRAME
18	3.3
4.5	10
1.125	25
.281	62.5

MODEL 2. CAMERA WITH SHUTTER AND FILM ADVANCE 24 V. D.C

PRICE $ 650



50 mm. f 2.8

CASE SAME AS ABOVE

SHUTTER OPERATES WHEN CIRCUIT IS OPENED

FILM ADVANCES WHEN CIRCUIT IS RECLOSED. 4 SEC. REWIND.

EXPOSURE COUNTER OPTIONAL. ADD $ 100

A.C. (115V 60~) ADAPTER ADD $ 50

MODEL 3. UNDERWATER CAMERA

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impose nonresident income taxes and
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Airline to Test New Lighting System

By a Staff Writer of The Christian Science Monitor

Boston

"Flying Christmas trees" are due to soar over the country in a United Air Lines test of a new high-intensity lighting system which makes aircraft far more visible by day and night.

One of United's DC-6 air coaches has been equipped with the super brilliant system for trials in routine coast-to-coast service. Previously, the lights were tested in overwater operations of Trans-Ocean Air Lines.

The installation consists of seven photographic strobe lights arranged in a row on top and under the fuselage. Flashing in pairs from the tail forward, the lights appear to leap ahead in the direction of the airplane's course. They are visible at distances of 100 miles or more.

United's officials report that the lights not only increase the conspicuity of the DC-6 air coach but also clearly indicate its general direction of flight to other aircraft. The test will continue for about a year, they said.

Volpe Stresses Need for New Route 28

H. E. Edgerton.
May 24 1955. Term just ended.

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Francis Mullin - Starting of a xenon tube } write up at end of term.

HEILAND ASCOR NEWS-CLARKE DINE-MIGHTY MIDGET ALSO DISPLAYED.

NEWS NOTES ALONG CAMERA ROW

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Offerings by companies entering the field for the first time were the self-contained Limelite "60," the FR D-battery-operated unit, E. Leitz' Braun Hobby and DeJur's speedlight, both German imports, and Polaroid's concealed flash operated by radio signal.

The Limelite, which was presented by Howard L. Luray, president of the new Limelite Corporation, 6040 West Jefferson Boulevard, Los Angeles 16, combines battery case and lamp head in a single unit. Weighing less than four pounds, the gun has a universal mounting bracket and costs $99.50. Features include an exposure dial, a built-in correction filter, recycling time of four seconds, and flash duration of 1/750th of a second. The Limelite uses two 240-volt dry-cell batteries, good for up to 1,000 flashes before replacement, and is said to have a color guide number of 57.

The 2½-pound FR gun (FR Corporation, 951 Brook Avenue, New York), which is powered by four 15-cent D batteries reputed to yield up to 300 flashes, consists of a power pack and flash head permanently wired together. The head clips to the pack for carrying. Guide numbers claimed for the $54.95 unit are 50 for Kodachrome, 80-100 for the new fast color films, and 220 for Super XX. Other features include audible signal when unit is turned on, shorting button, universal mounting bracket, and coil cord between case and head.

German Guns

The Braun Hobby, imported from Frankfurt by E. Leitz, Inc., 468 Fourth Avenue, New York, is adaptable to dry battery ($89.45), storage battery, AC ($84.50), or a combination of storage battery and AC ($99.50). Conversion can be done by the user by interchanging parts. The Braun has an adjustable reflector base which may be turned to vary the light beam from the normal 50 degrees to 70 degrees for wide-angle lens use. The base is made of lightweight plastic and is shaped to fit the hip. The reflector clips to the case for carrying.

The DeJur (De Jur Amsco Corporation, 45-01 Northern Boulevard, Long Island City) is a $39.95 German speedlight that uses two standard dry batteries with a capacity of 2,000 to 3,000 flashes. They are stored in a thin leather case with shoulder strap. Flash duration is 1/500th, recycling time three seconds, color guide number 50. The five-inch flat, stippled reflector attaches to the battery case when carrying. The battery case and reflector weigh four pounds.

Electronic Flash Units Are Being Marketed In Many Varieties

Polaroid's unit is an experimental model that employs a small radio transmitter clipped onto the Land camera's accessory shoe to set off a concealed electronic flash unit for bounce-light illumination. Working through the flash contacts of the camera, the transmitter sends a signal to a receiver in the hidden flash gun. When the receiver picks up the signal, the flash goes off. The device is expected to be ready for the market in about a year; the anticipated cost is about $200.

New American Models

New models by companies already in the field included the Hico-Lite No. 228, the Sun-Lite 500 and the new Dormitzer Synctron. Two other new units, the Heiland Strobonar Seven and the Ascor Light 405, were announced in these columns recently.

The Hico-Lite, made by Hauman Industries Company, Inc., 70 Collidge Hill Road, Watertown 72, Mass., a dry battery unit in an attractive leather hip-curved case, has dual extension-light outputs at both ends of the case. It offers a flash duration of 1/500th, guide number 60-75 for color, up to 400 for black-and-white, recycles in about eight seconds, and weighs about six pounds. The price is $179.50. The company also introduced two portable portrait outfits consisting of three lamp heads, three detachable modeling lights, two tilt-top lamp stands and one tilt-top boom stand, and accessories in a compact, fitted carrying case. With the No. 228 pack, the price is $419.50; a smaller unit with half the power of the No. 228 is $349.50.

Highlighted in the Sun-Lite display by Hershey Manufacturing Company, 2425 West Lawrence Avenue, Chicago 25, was the self-contained (power pack and lamp combined in one unit) "500" model. It weighs thirty-six ounces and costs $49.50. The "500" uses a dry battery with a capacity of 500 flashes and is equipped with the new high-efficiency small-diameter Sunflector combination tube and reflector. It has a low-voltage pack, 1/700th flash, and is unusually compact. Color guide numbers are 25 to 65, depending on the film used, black-and-white numbers from 100 to 200. An AC adapter is available.

The Dormitzer Synctron speedlights introduced by the Dormitzer Electric and Manufacturing Company, Inc., Cambridge, Mass., are the Synctron Candid-208B and the Synctron Pro-200B, both powered by the new rechargeable pack, Dynaseal Power. The $190 candid model weighs six pounds, recycles in seven seconds, has a flash duration of 1/2,500th and guide numbers of 70 to 100 for color, 400 for black-and-white. The pro model weighs nine pounds and costs $275. It operates on full power at 200-watt seconds, on half power at 125. On full power, flash duration is 1/1,250th, recycling time fifteen seconds, Kodachrome guide number 90, black-and-white 550. On half power, the flash is 1/2,500th, recycling time six seconds and Kodachrome guide 70, black-and-white, 400. J. D.

P. S. A. MOVIE CONTEST

The Motion Picture Division of the Photographic Society of America announces the 1955 P. S. A. Cinema Competition for 8mm and 16mm amateur films, sound or silent, color or black-and-white, original or duplicate, by film makers anywhere in the world. Ernst Wildi is competition chairman. Entries should be sent to arrive by Sept. 1 at P. S. A. Cinema Competition Headquarters, Rear 404 Cedar Lane, Teaneck, N. J. Awards will include the Harris B. Tuttle Trophy for the best story-telling film about family life; the Dick Bird Trophy for the best nature film, and the P. S. A. gold medal award for outstanding cinematography. For contest rules, write Mrs. E. Louise Gnerich, competition secretary, 650 East 231st Street.

ANNIVERSARY BANQUET

The Rochester Technical Section, the Photographic Society of America, will hold its twentieth anniversary banquet April 23 at the Powers Hotel in Rochester, according to announcement by William Shoemaker of Rochester Institute of Technology, banquet chairman. The principal speaker will be Dr. Harold Edgerton of the Massachusetts Institute of Technology, pioneer in electronic flash, who will discuss techniques of underwater photography in the Mediterranean and show underwater films.

BRIDGE. AS THE CHINESE PLAY IT

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BRIDGE. AS THE CHINESE PLAY IT

impose nonresident income taxes and collect
setts revenue from this source would be "considerably less" than $5,000,000.

Airline to Test New Lighting System

By a Staff Writer of The Christian Science Monitor

Boston

"Flying Christmas trees" are due to soar over the country in a United Air Lines test of a new high-intensity lighting system which makes aircraft far more visible by day and night.

One of United's DC-6 air coaches has been equipped with the super brilliant system for trials in routine coast-to-coast service. Previously, the lights were tested in overwater operations of Trans-Ocean Air Lines.

The installation consists of seven photographic strobe lights arranged in a row on top and under the fuselage. Flashing in pairs from the tail forward, the lights appear to leap ahead in the direction of the airplane's course. They are visible at distances of 100 miles or more.

United's officials report that the lights not only increase the conspicuity of the DC-6 air coach but also clearly indicate its general direction of flight to other aircraft. The test will continue for about a year, they said.

Volpe Stresses Need for New Route 28

H. E. Edgerton.
May 24 1955. Term just ended.

Tom Smith and Dick Ward. Sonar theses. Rebuilt Edo.

Jack Brown - Bob Hartman Camera lowering problem. with nylon string.

Geo. LeCompt. Xenon lamp tests and theory.

Chas. Rockwell - Exposure meter with neon bulb.

Joe Watson - Hyperbolic controlled flashes. } did not complete write up at end of term.

Francis Mullin - Starting of a xenon tube }

HEILAND NEWS-CLARKE ALSO DISPLAYED.
ASCOR DINE-MIGHTY MIDGET

NEWS NOTES ALONG CAMERA ROW

ATLANTIC CITY—The largest presentation of electronic flash units at a single trade show was offered at the recent annual meeting here of the Master Photo Dealers' and Finishers' Association. The emphasis was on operational simplicity, light volume, compactness, portability, versatility, economy and attractive design. The displays included some European imports.

Offerings by companies entering the field for the first time were the self-contained Limelite "60," the FR D-battery-operated unit, E. Leitz' Braun Hobby and DeJur's speedlight, both German imports, and Polaroid's concealed flash operated by radio signal.

The Limelite, which was presented by Howard L. Luray, president of the new Limelite Corporation, 6040 West Jefferson Boulevard, Los Angeles 16, combines battery case and lamp head in a single unit. Weighing less than four pounds, the gun has a universal mounting bracket and costs $99.50. Features include an exposure dial, a built-in correction filter, recycling time of four seconds, and flash duration of 1/750th of a second. The Limelite uses two 240-volt dry-cell batteries, good for up to 1,000 flashes before replacement, and is said to have a color guide number of 57.

The 2½-pound FR gun (FR Corporation, 951 Brook Avenue, New York), which is powered by four 15-cent D batteries reputed to yield up to 300 flashes, consists of a power pack and flash head permanently wired together. The head clips to the pack for carrying. Guide numbers claimed for the $54.95 unit are 50 for Kodachrome, 80-100 for the new fast color films, and 220 for Super XX. Other features include audible signal when unit is turned on, shorting button, universal mounting bracket, and coil cord between case and head.

German Guns

The Braun Hobby, imported from Frankfurt by E. Leitz, Inc., 468 Fourth Avenue, New York, is adaptable to dry battery ($89.45), storage battery, AC ($84.50), or a combination of storage battery and AC ($99.50). Conversion can be done by the user by interchanging parts. The Braun has an adjustable reflector base which may be turned to vary the light beam from the normal 50 degrees to 70 degrees for wide-angle lens use. The base is made of lightweight plastic and is shaped to fit the hip. The reflector clips to the case for carrying.

The DeJur (De Jur Amsco Corporation, 45-01 Northern Boulevard, Long Island City) is a $39.95 German speedlight that uses two standard dry batteries with a capacity of 2,500 to 3,000 flashes. They are stored in a thin leather case with shoulder strap. Flash duration is 1/500th, recycling time three seconds, color guide number 50. The five-inch flat, stippled reflector attaches to the battery case when carrying. The battery case and reflector weigh four pounds.

Electronic Flash Units Are Being Marketed In Many Varieties

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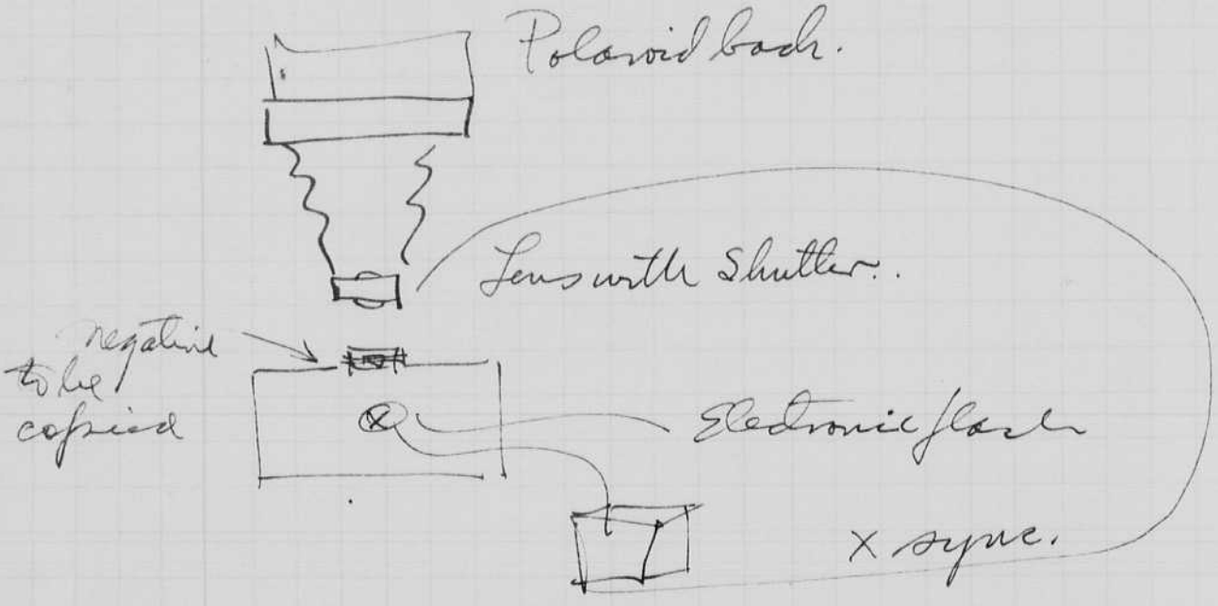
BRIDGE: AS THE CHINESE PLAY IT

June 2 1955
Harold Edgerton.

This morning Dwight Nerrill of Polaroid was in to give me curves of speed and time for our fastax on 115 volts. the curves show a film speed of
120 feet / sec. (4500 frames / sec)
and a 0.9 sec running time for 100 ft.
this fastax does not have a prism.

I told Dwight about the color slide copier that I mentioned to Wyckoff last week. this machine would be sold to stores to copy Kodachromes. a Polaroid film would be used on the top to do the copying instantaneously. With flash, the work could be done in a lighted room.



This is based on charlie's equipment for copying XEC films in Black and White.

The equipment could be used by the customer in the store or by an operator. It would sell a lot of Polaroid film.

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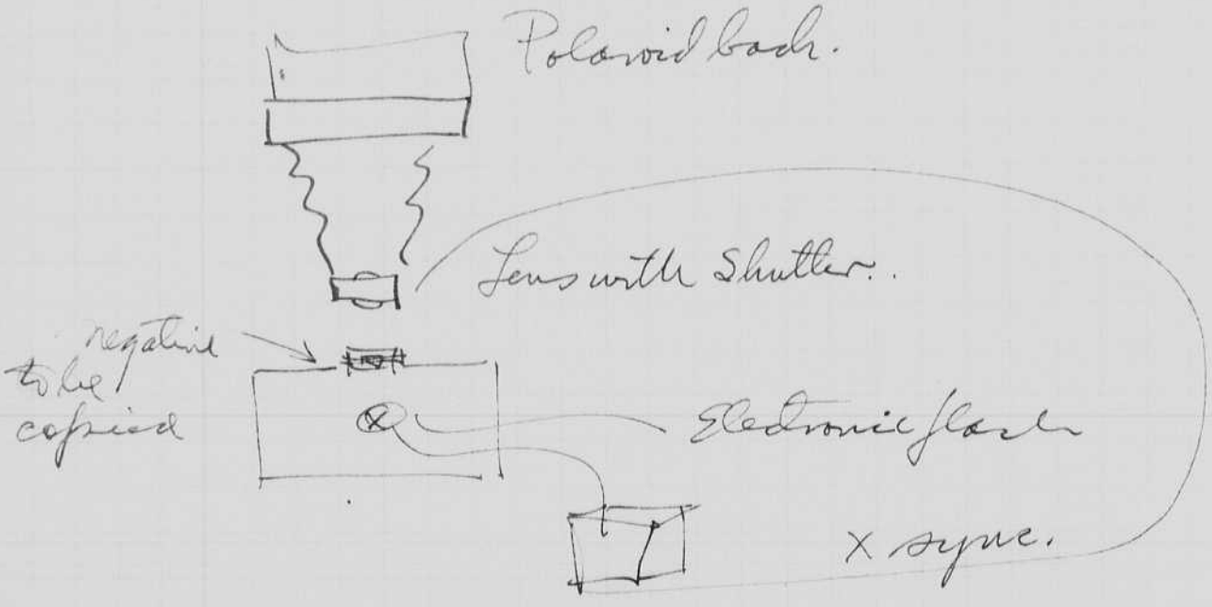

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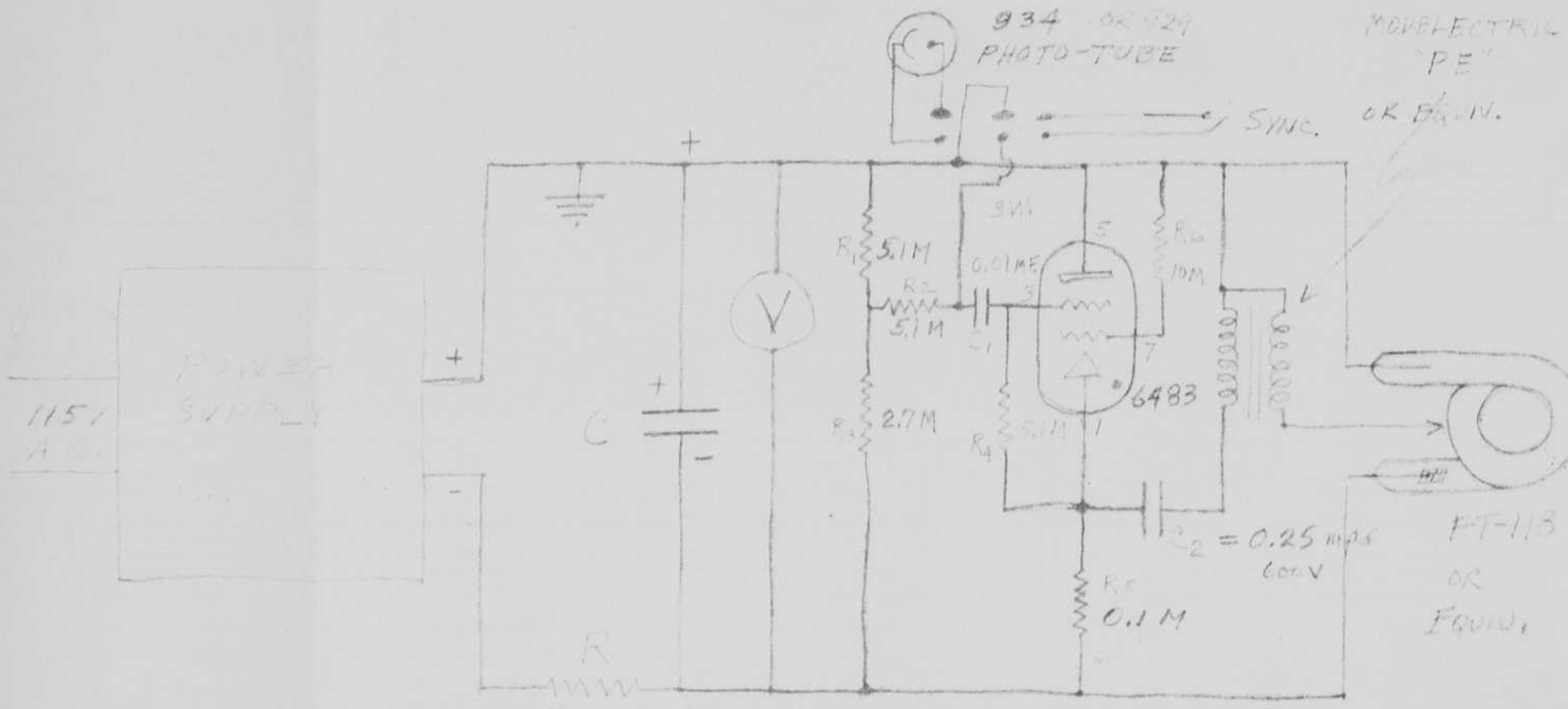
Experimental Trigger Circuit
Using Sylvania #6483 Tube



ALL RESISTORS EXCEPT
"R" - 1/2 WATT.

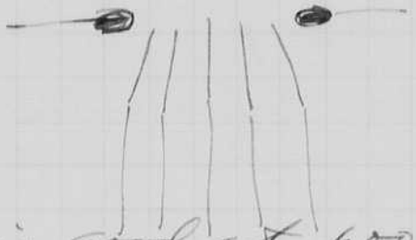
M = MEGOHM

May 21, 1954.
V.E. MacRobert
A.E.E.

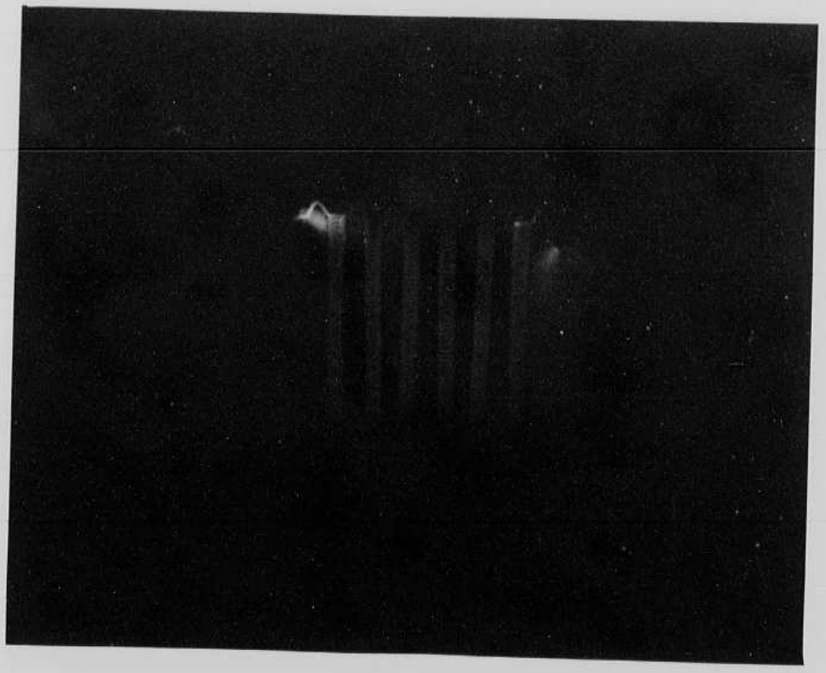
June 3 1955
Harold E. Edgerton

Jennes Jansen brought over his gap tube last week for tests. The data is in the "light" book. Efficiency is almost the same as other tubes.

This tube is in xenon at 1 atmosphere, a series of thin wires stabilize the starting of the arc.



Starting is good at 600 volts (or more) Some misses at lower voltage. The lamp seems to work just as well at high frequency; the light is white and of short duration.



A magneto obtains shutter pulses off the arc over a 500 watt projection bulb
Taken for G.E.

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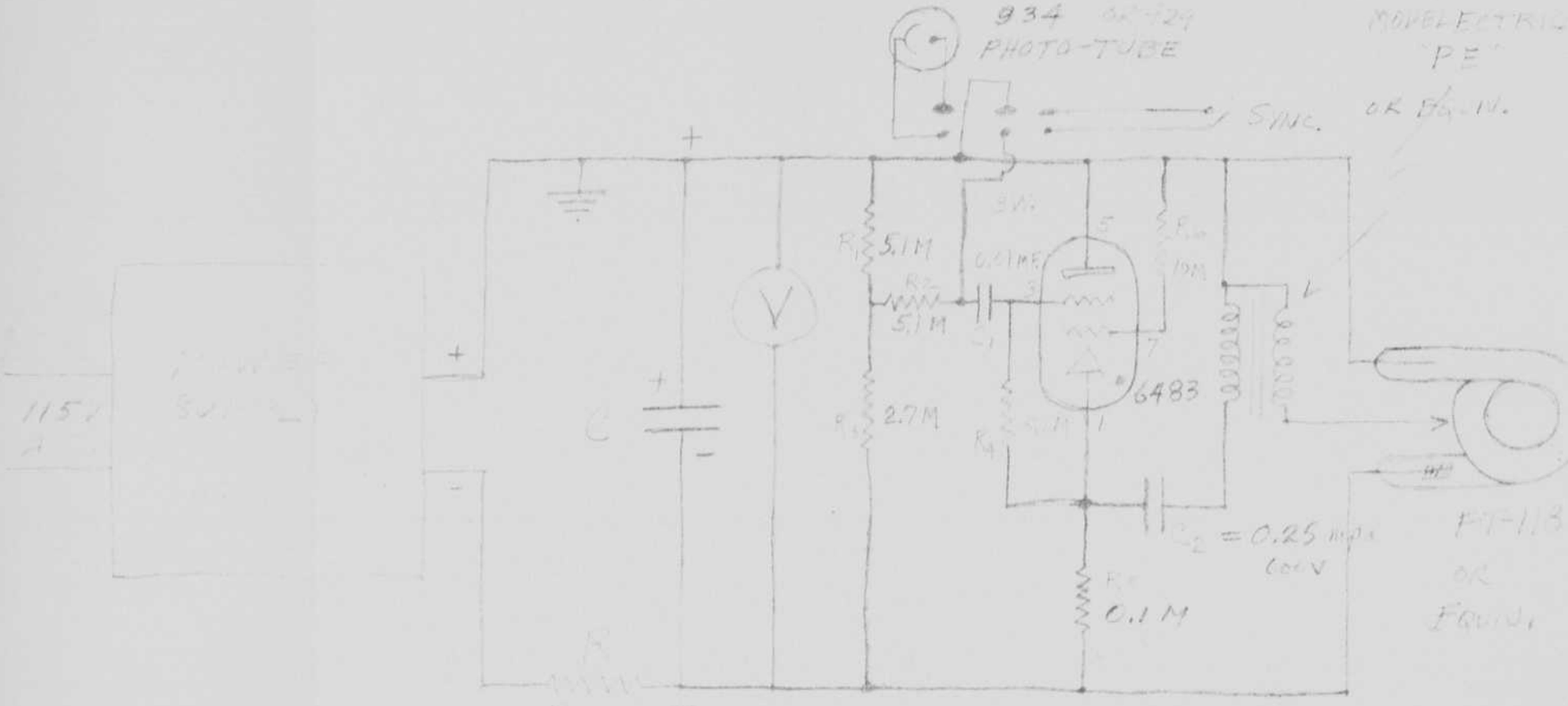

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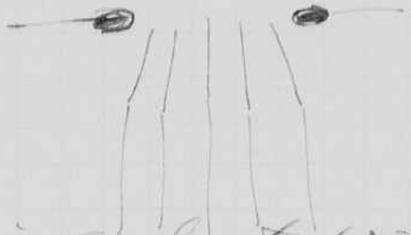

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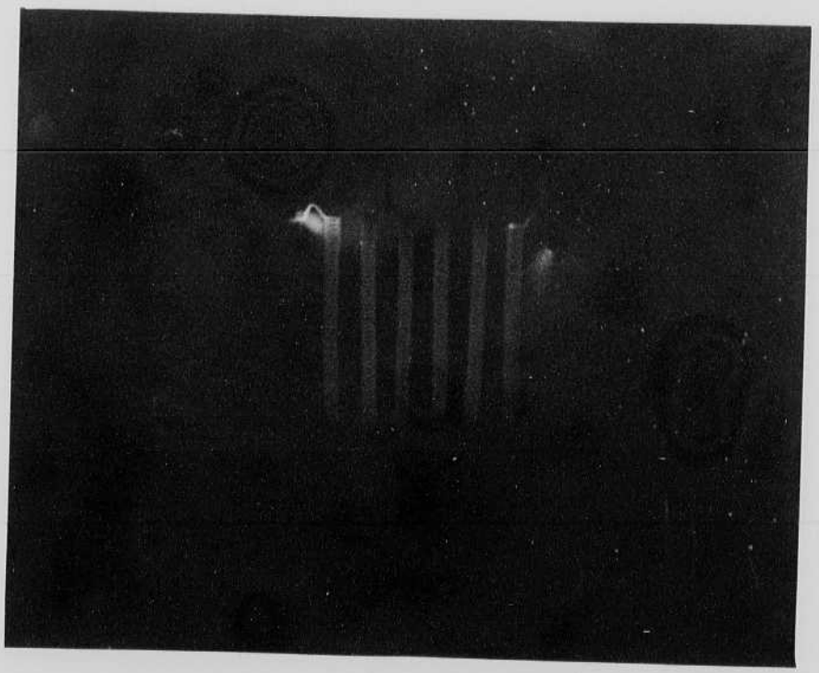


14 August 15 1955

Harold Edgerton.

Janice Dixon is one year old today. Hickory N.C.

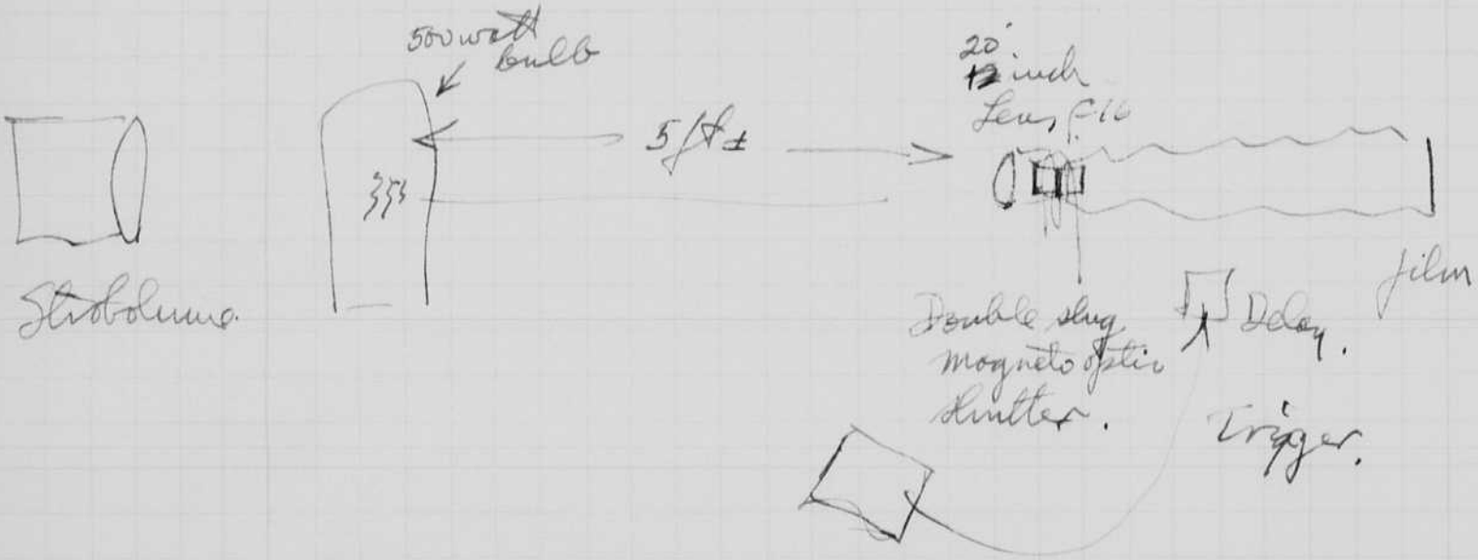
I returned Aug 11 from London. The summer has been spent on the Calypso on an underwater project. Reports of the activities were recorded in a series of letters to Dr. John La Gorce at the National Geographic Society, who sponsored the project. I left the Calypso in Piraeus Greece.

A camera with sonar was used at 4480 meters to photograph the bottom off Greece.

My son, Bob, took over the operation of the cameras when I left. Bob will return in September, His school is late in starting this year due to some complications. This was good.

August 15, 1955. Test were started yesterday on the 500 watt projection bulbs as sent by Dick Blount.

3200 °K Projector

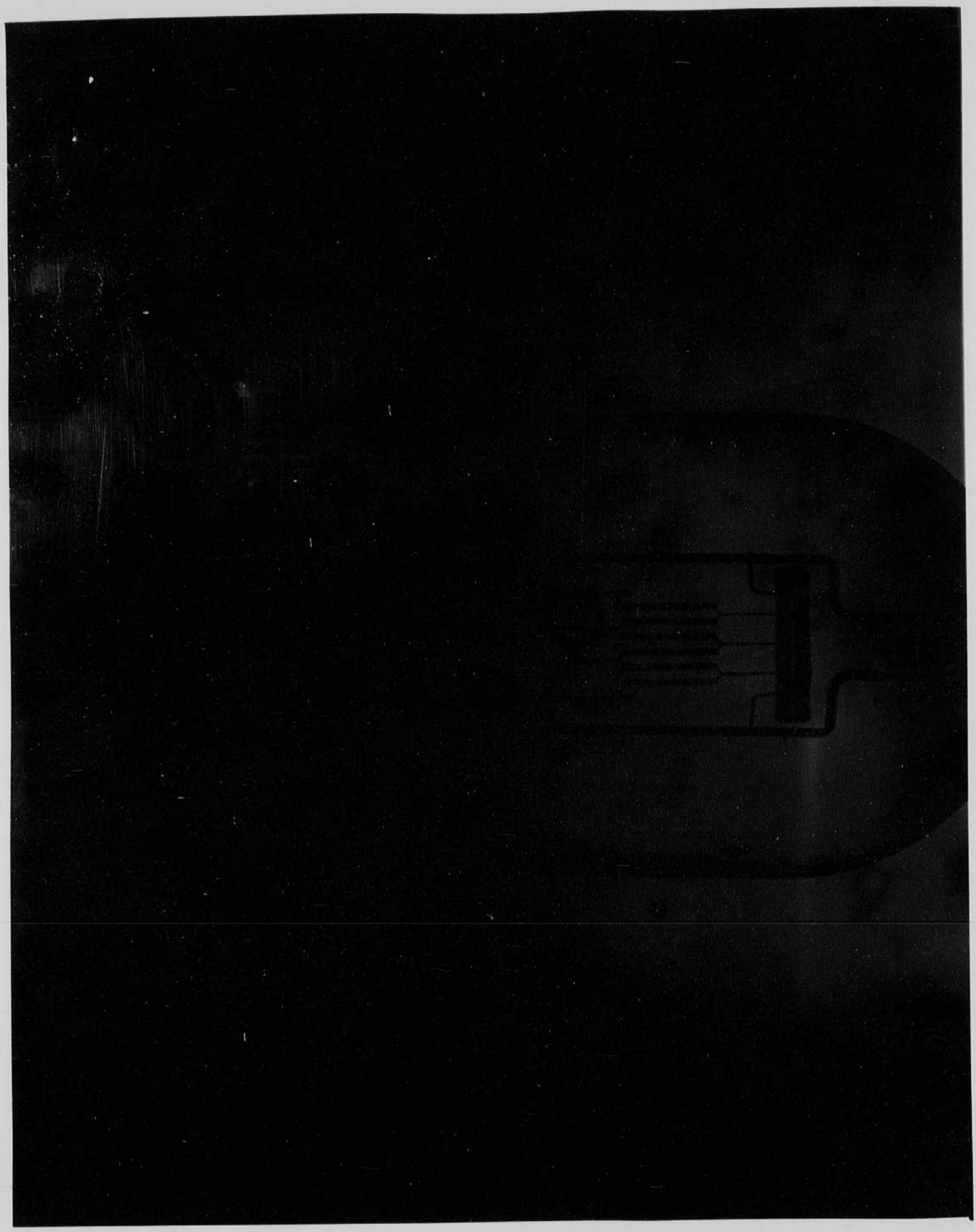


after some tests where I did not obtain triggering from the arc (using a simple photocell) I then used our blast box trigger. This could be too sensitive.

Final test. Photocell distance 18" Sonar at "6" Delay at "50" - (120 ms).

Bulb A

	Photocell gain	Delay.	Remarks
Bulb B.	4	250 m.s. ±.	Exploded wires.
Bulb C.	"	"	"
D	"	"	Did not arc
E	"	"	arc
F	"	200.	arc



Sept 3 1955 M.I.T.

Harold E. Edgerton.

Recent travels.

Aug 16 Dam to newYork to process negative of summer.
at Deluxe Lab. NewYork.

17 Chicago at the Phot. Assn. convention at
the Hilton Hotel.

18 "

Big 12" Rain in Belmont. → 19. To Grand Island and Aurora. to visit parents.

20 Aurora

21 To Boston via United

23 Left for Washington D.C.

24. Nat. Geo. mag.

25 David Taylor Model Basin
Left for Wilmington
Dinner with Greenewalt - Robinsons.

26 Worked on flash with Greenewalt.
Import mech div with Johnson
Aberdeen - Bob Kent.

27 arrived in Hickory N.C. to see daughter
Mrs. Chas. Dixon and family - inc Janice 1 yearold.

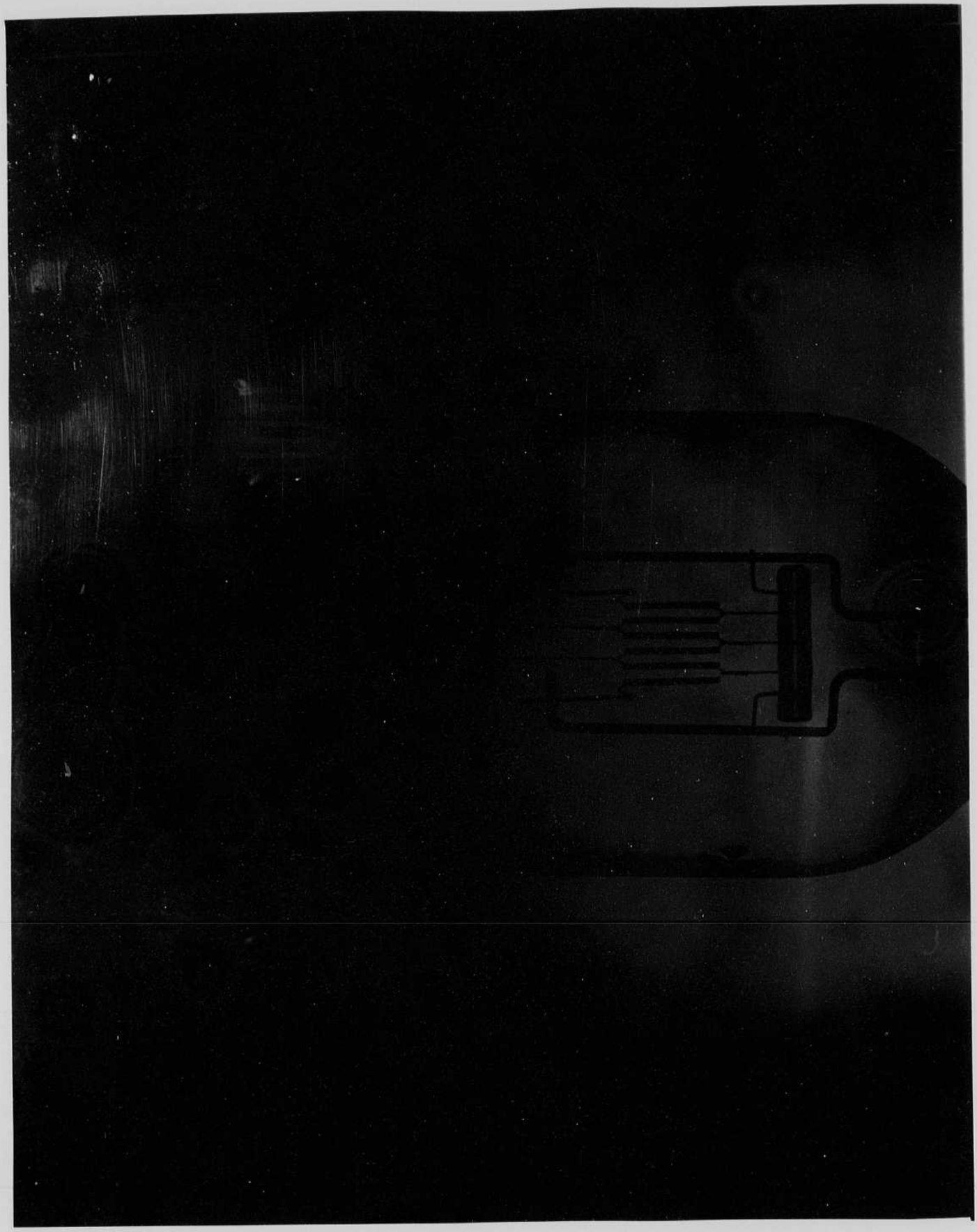
28 Hickory

29. Navy Hydro office. Jaffe. Dean.
F.B.I. Parsons.
At Belvoir John Johnson Kessler Klein
Nat. Geo Mag to pick up prints

30 Aberdeen and all day with Sultan of Pogues in Wash - stayed in Wilmington with Robinsons

31. NewYork to see Mrs. MacMonnies at noon.
Bill Edgerton in off.

Sept. 1 Retd to Boston.



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Flash unit for Greenewald.

Sept 3 1955.

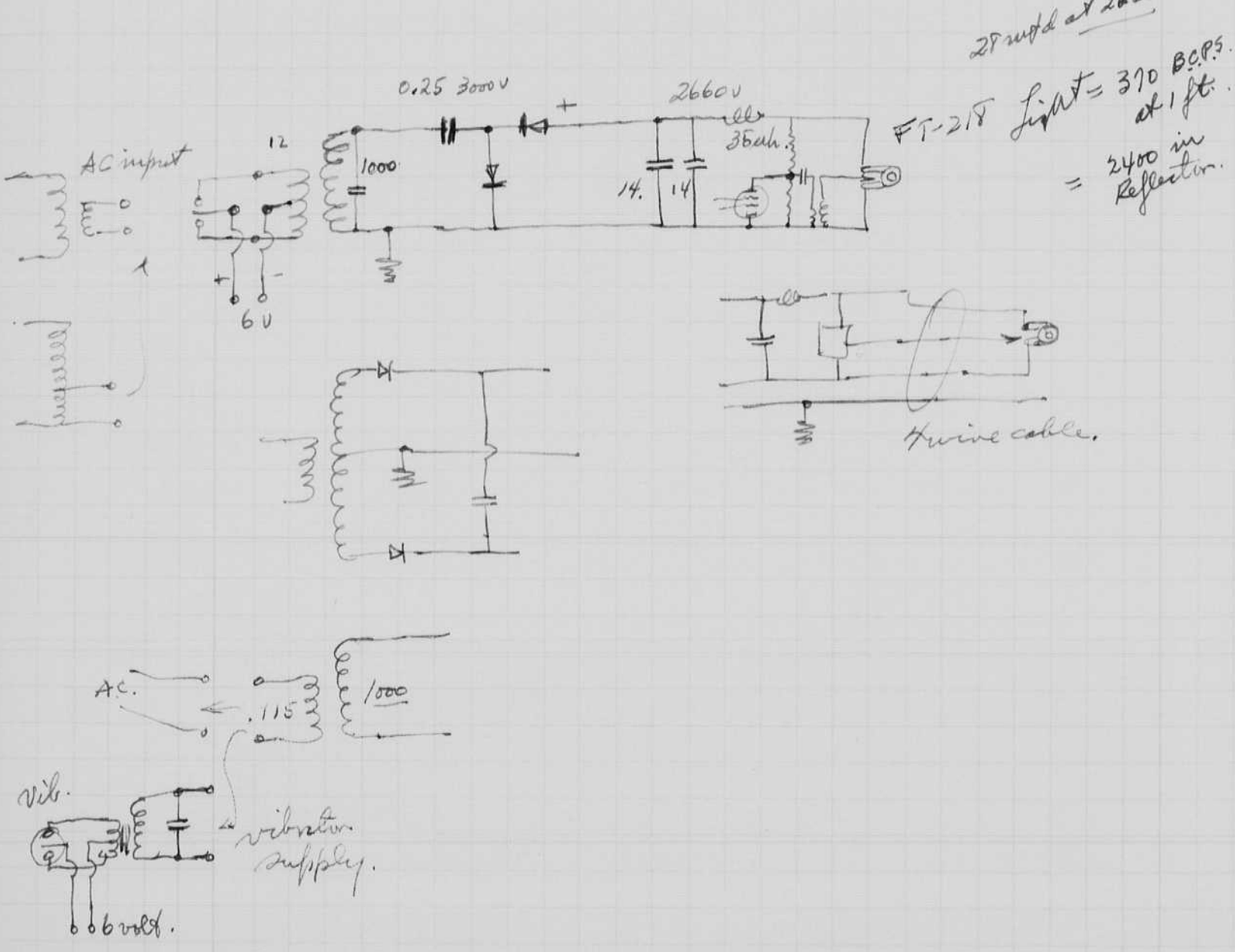
Desired characteristics

Flash duration 50 μs or less. Will compromise with 70 to 100.

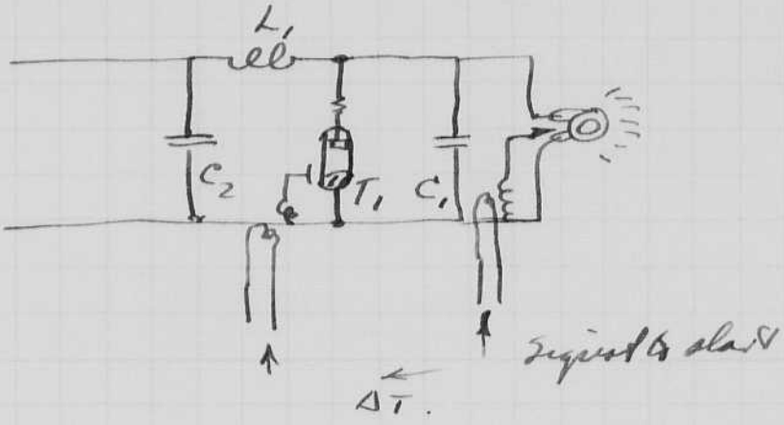
Light about 2000 B.C.P.S. at 2 ft.
in three lamps.

Unit very light weight.

6 volt power acceptable for portable use.
Auto battery etc.
A.C. for use most of the time.



Flat top light: for use with a drum camera or a matrix type using a sliding plate.

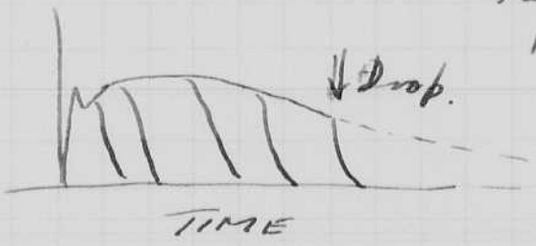


C_1 gives the tube energy for a fast start.

C_2 gives the energy to maintain the light.

T_1 is a low resistance tube to shunt the capacitor and stop the light

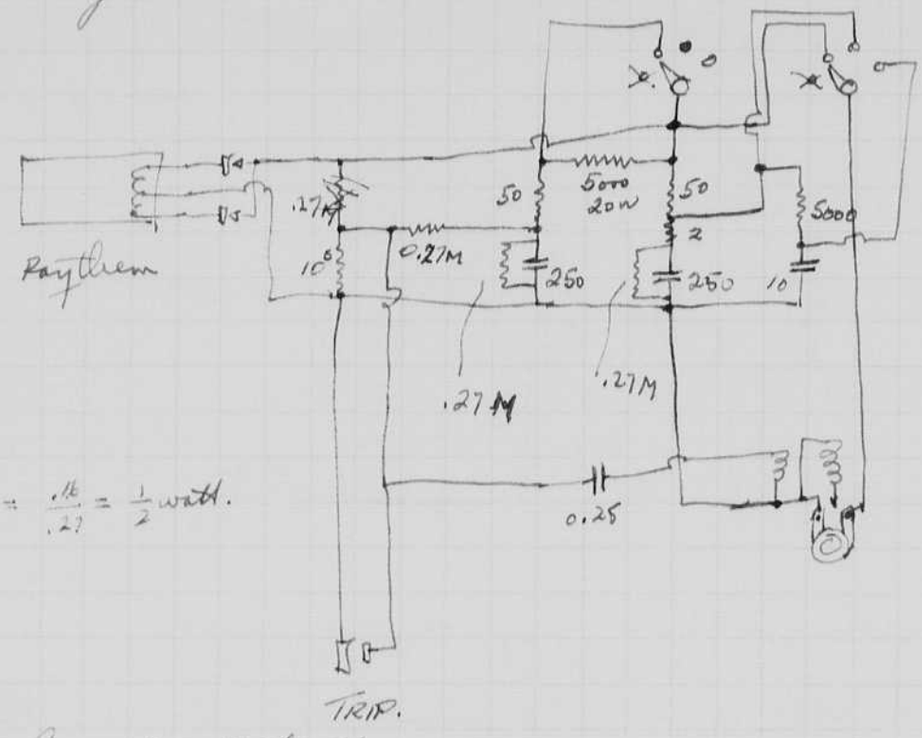
L_1 might be resistance as well as inductance.



Requirement 1/4 to 5 millisec for a special camera that Johnson of Dupont is making.

Sensitometer modification

Sept 5 1955.
Harold E. Edgerton.

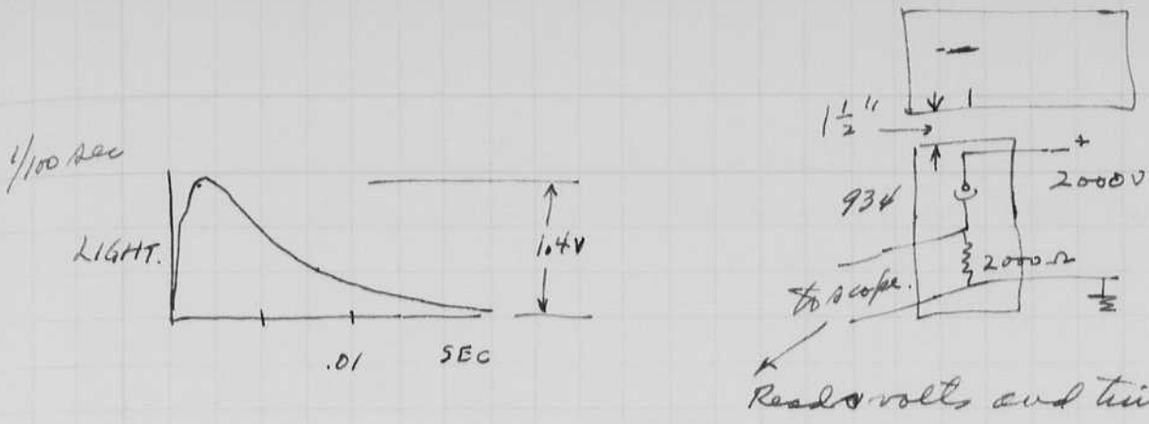


$\frac{400^2}{.27} = \frac{.16}{.27} = \frac{1}{2}$ watt.

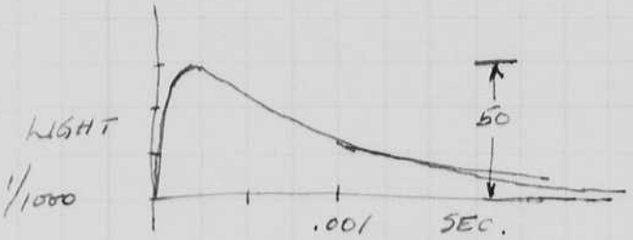
Inputs.	Output Light.	as read with GR 1501 Light meter X1 Lumen sec / sq foot at film position.
80	108	
90	110	All on 1/1,000 scale.
100	114	2
110	113	
120	112	
130	111	
80	111	
90	112	
100	113	
110	115	
120	113	
130	114	
115	115	
115	113	
115	115	
115	112	
115	114	
115	113	
115	113	

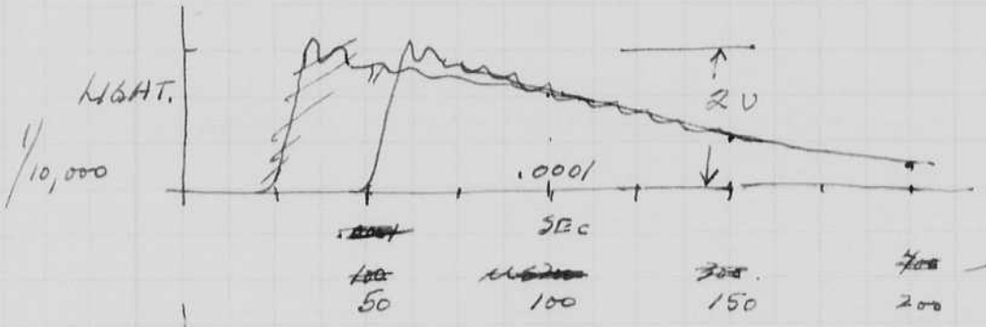
1/100 scale	Light.
115 V	19.
	21

1/10,000 Light — can switch the meter.



Read volts and time.

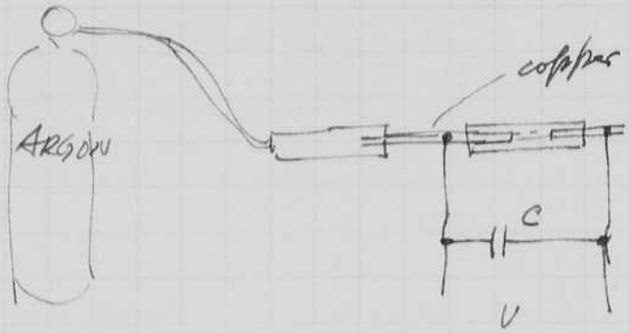




~~100~~ ~~200~~ ~~300~~ ~~400~~ μS.
50 100 150 200 .

J. Edgerton
20 D 10/2 MIT
Sept 9 1955.

Test yesterday were made with argon flash tubes at pressure.

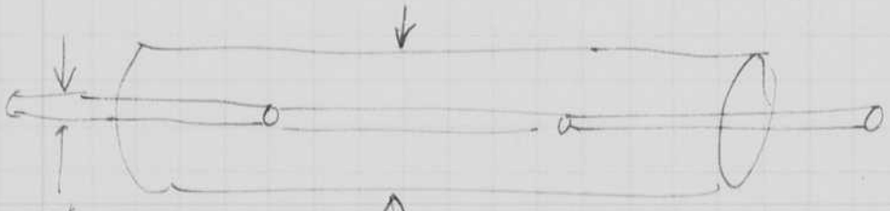


Sealed off one 1 inch gap.

1500 volts first flash. Then went up to 3500 with 1 mfd.

Second tube flashed on pump. up to 10 mfd at 4 KV. Copper metal splatter on the pyrex wall.

Sealed off with pinch seal Ok. after seal.

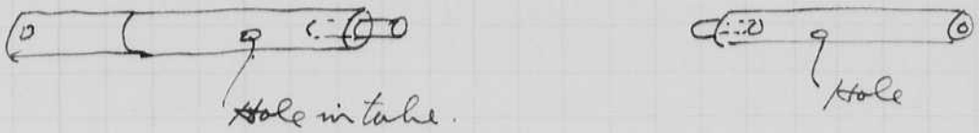


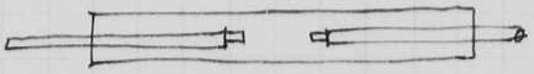
Blew-up with 10 mfd at 3 KV.

Glass wall melted inside
Circumferential craze lines. ?

W.S. $9 \times \frac{10}{2} = 45.$

Tungsten tips were put into the tube.





Starts at 500 to 700 volts.

1/2 inch gap. Flashed at 1, 2, 5 and 10 mfd. the 10 1500 volts shows deep crazing.

Tube above sealed off.

Another tube made.

5 mfd at 1000 volts no crazing some metal spots.

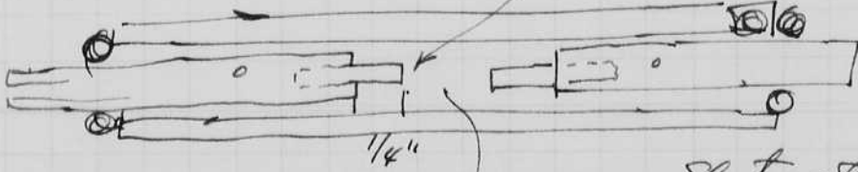
10 mfd at 1000 volts. some crazing after 4 flashes.

Tube above sealed off with pinch seal.

Both the above tubes were leakers. Note that the nickel does not seal when squeezed shut.

Went back to copper with tungsten tips. 50 mil

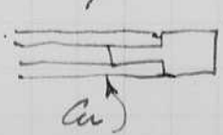
Cement here

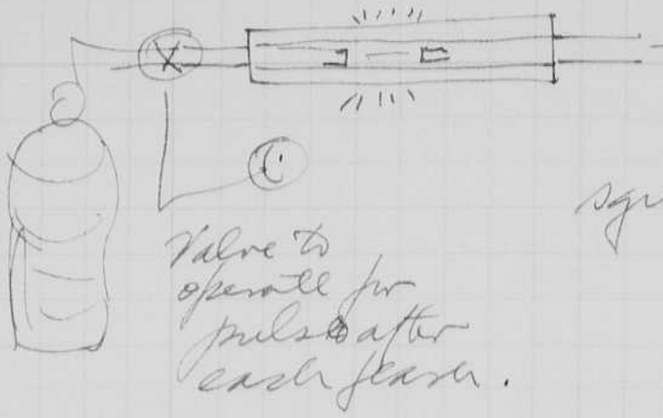


1/4" gap

Starts at 400 volts. Flashed at 30 mfd 1000 v. Sealed off. Shows copper sputtering due to arc spreading back to copper.

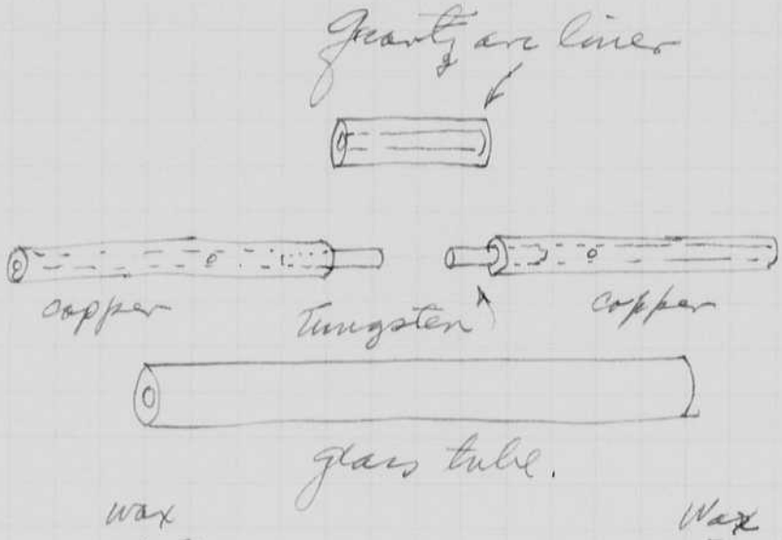
Try this W





the flow of gas could be used for cooling. after each operation a pulse of gas could be squirted through the tube.

Valve to operate for pulse after each flash.



wax joints

Wax joints. cement.

Pinched seals after argon gas is introduced.

These designs have a very small enclosed chamber for gas to go after a flash. This should cut down the ripples and increase the efficiency.

Possible uses. Microscope tube.
Short flash equipment.
Point source for shadow and silhouette photography.

Sept. 10, 1955.
H. Edgerton

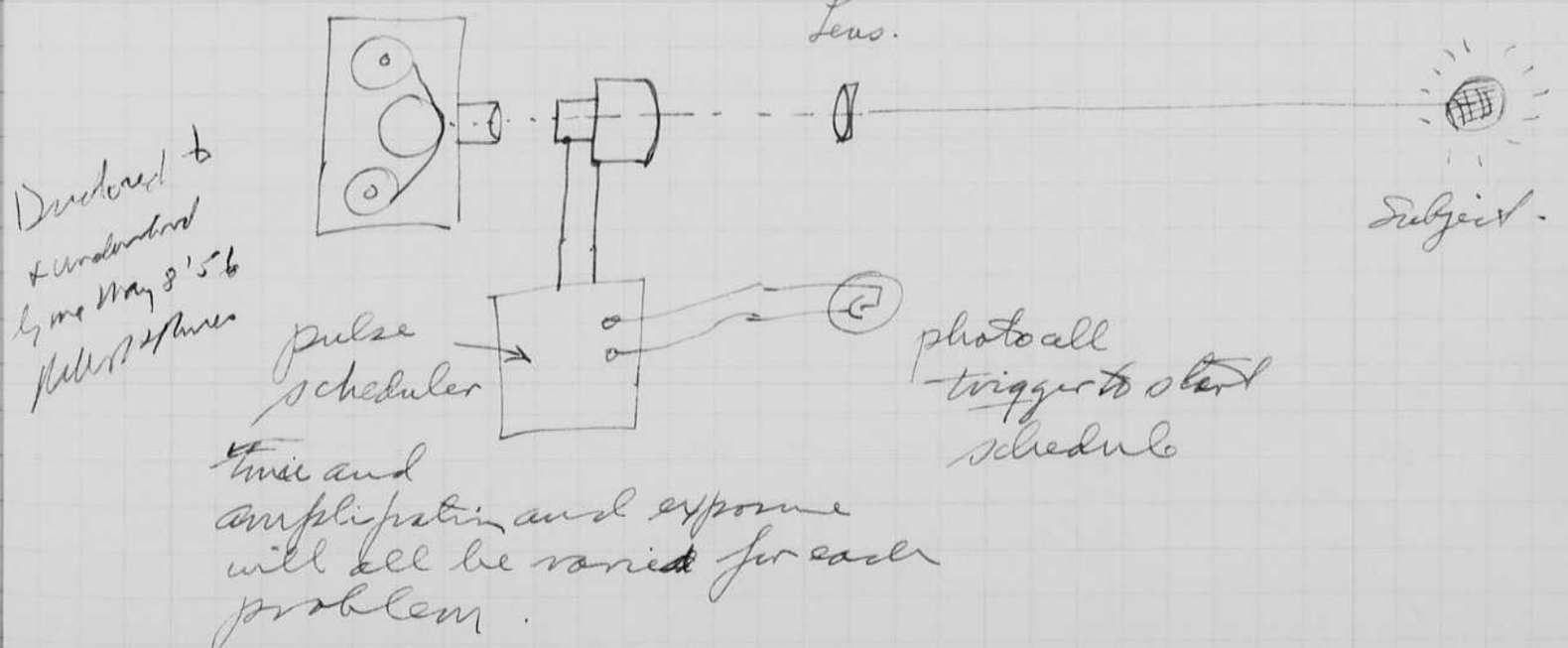
Camera with variable photo time, Exposure time, and effective aperture.

For many technical problems a series of photographs are usually required to study the action. High-speed motion pictures, when used, give a series of constant time spacing from which data can be measured.

I now propose a new system that uses a continuously moving film but with an image converter tube that only puts on photos when they are desired. Further more the exposure of the photograph and the effective aperture, or light amplification, can be varied, either automatically or according to a preset schedule.

A typical problem that requires a camera of the type mentioned above is the study of the radius of the atomic explosion as a function of time. At first the light is tremendous, then the explosion develops in size and as it does the intensity decreases.

A system is sketched below that might be useful.

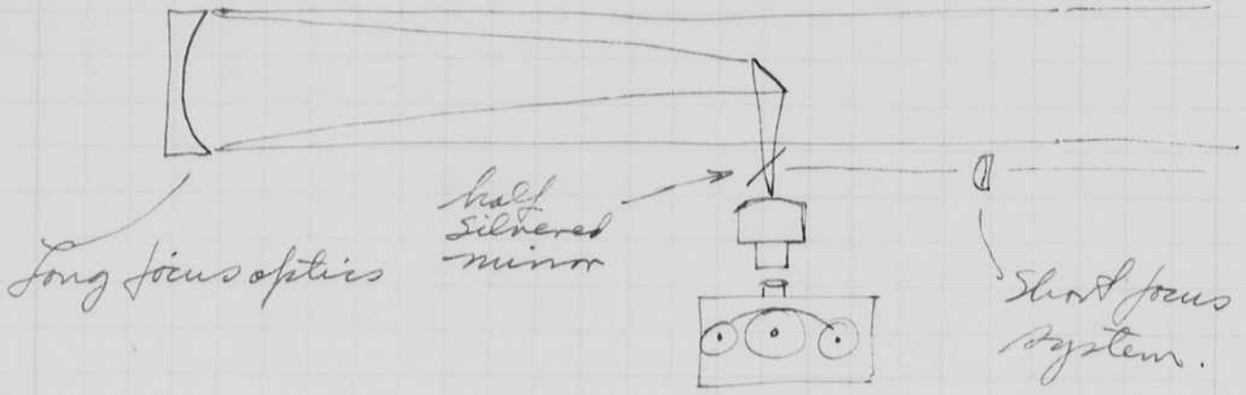


Produced by Underwood & Underwood by one way 8'56 Pellicle Sphere

Time and amplification and exposure will all be varied for each problem.

The system on the previous page was discussed yesterday with Bob Hartman at 160 Brookline ave. I made some notes in his lab note book about the method since he will probably carry through a study of the system.

We talked it over with O'Keefe and with Ben Breitler. Ben had several suggestions to offer regarding the times and exposures that are needed for the atomic reaction desired data. There will be several models made if the method works as I think it will.



The above might be useful since it would give an enlarged image for the first part of the record. Then the short focus lens would take over for the later part.

It may be necessary to run up to 10,000 frames a second. To do this on conventional film requires a very high writing speed for full frame 35 mm photos.

$$\frac{3/4 \text{ inch}}{1/10{,}000 \text{ sec}} = .75 \times 10^4 = 7500 \text{ inches/sec} \cong 600 \text{ ft/sec.}$$

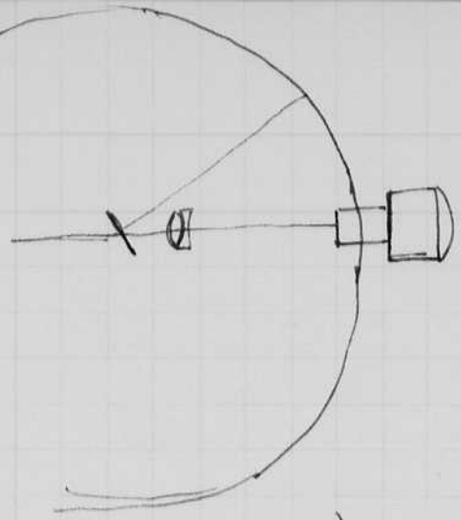
Difficult to attain on moving film.

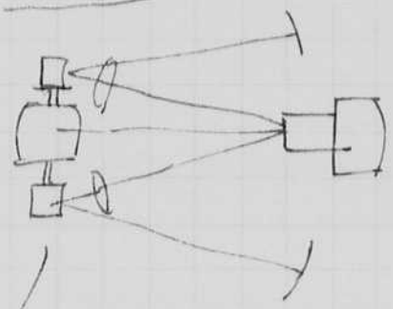
a mirror camera can do this fairly easily. Say a 1 ft radius

3 ft per rev. $\frac{600 \text{ ft/sec}}{3 \text{ ft.}} = 200 \text{ rev/sec.}$

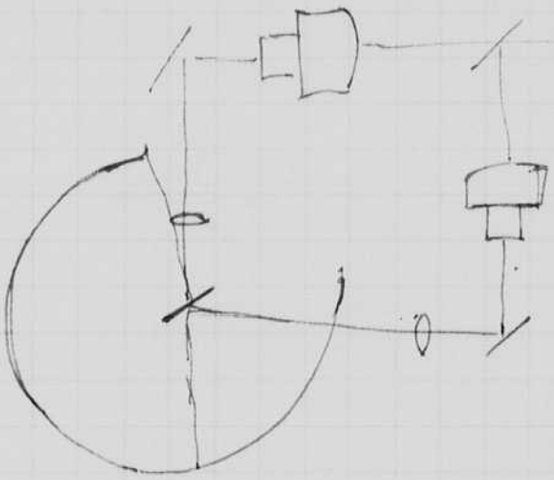
$\frac{60}{12{,}000}$ r.p.m.

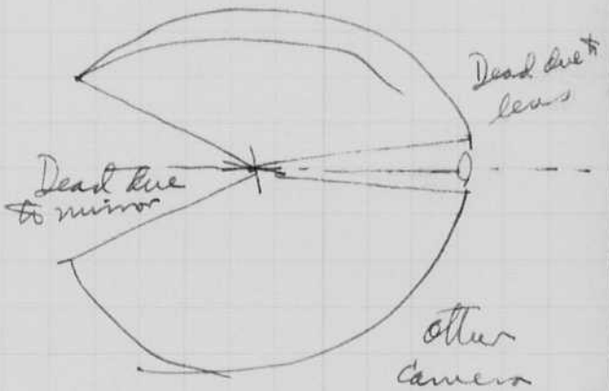
1 ft.





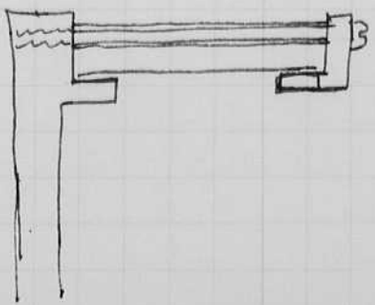
2 mirrors at 90° on axis to give a continuous view.





other camera covers the 2 dead areas.

motor
2 mirrors.

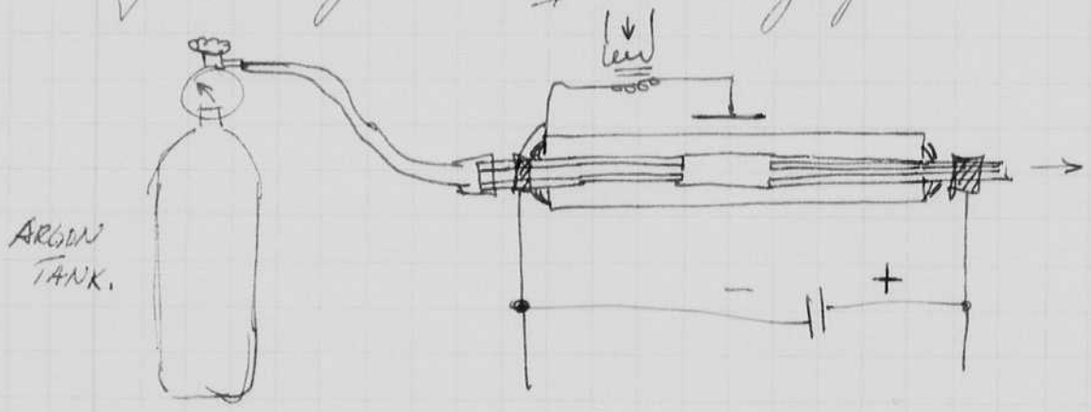


Sept 11 1953
205 School St
Belmont, Mass.
Harold Edgerton.

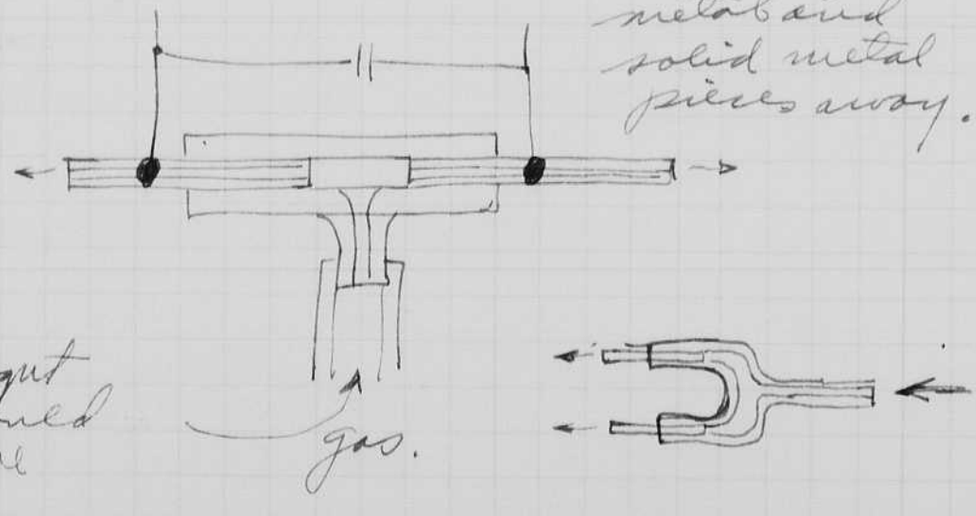
Flash tubes for high intensity.

It has been observed that the anode of flash tubes at high intensity melt and splatter metal around in the tubes. The best metal for anodes is tungsten because of its high melting temperature. It also is well to use tungsten for the cathode since the high current density will evaporate very less easily vaporized metal. When both electrodes are tungsten, the anode sputters the most.

I now propose that a flowing gas through the tube would take away the vaporized metal, thus preventing it from depositing in the gap.



Another way would be to have a flow of gas from the center of the tube with both ends. To take both anode and cathode vaporized metal and solid metal pieces away.



The cooling could be pulsed just before the flash.

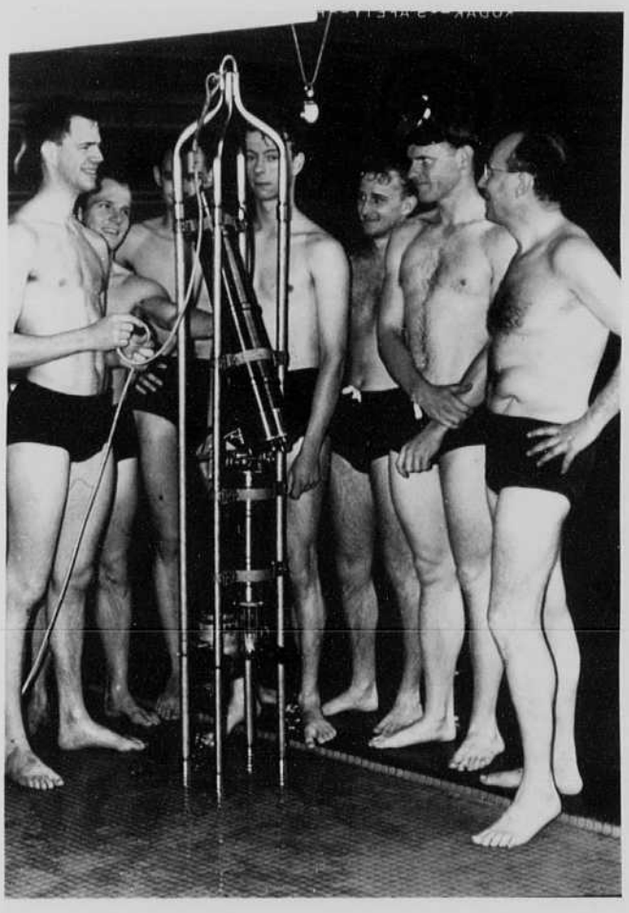
A condenser for the vaporized metal might be needed. This could be connected with the output pipes.

Lacoude.

Bobby

Dive Tarat Cousteau Alex Bellon Marcel Ichac

Ali Brai



Bobby Smith Hartman Coudar Kendall Edgerton.

Deep sea camera

SMPTE Journal July 1955.

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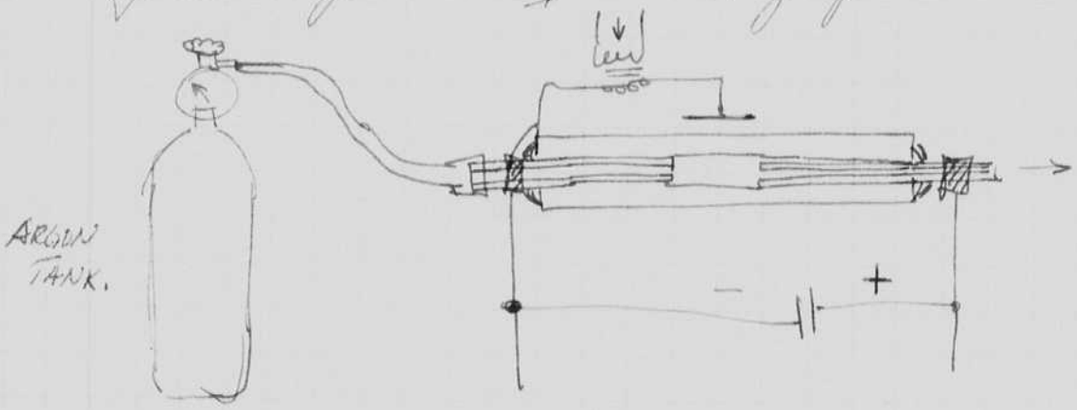

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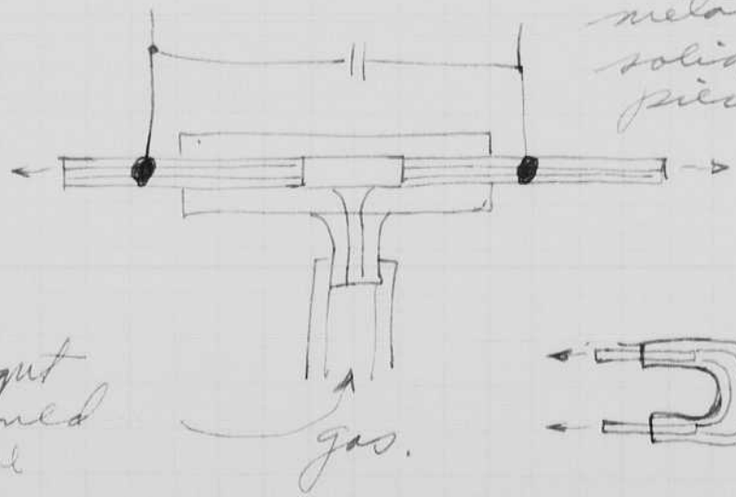

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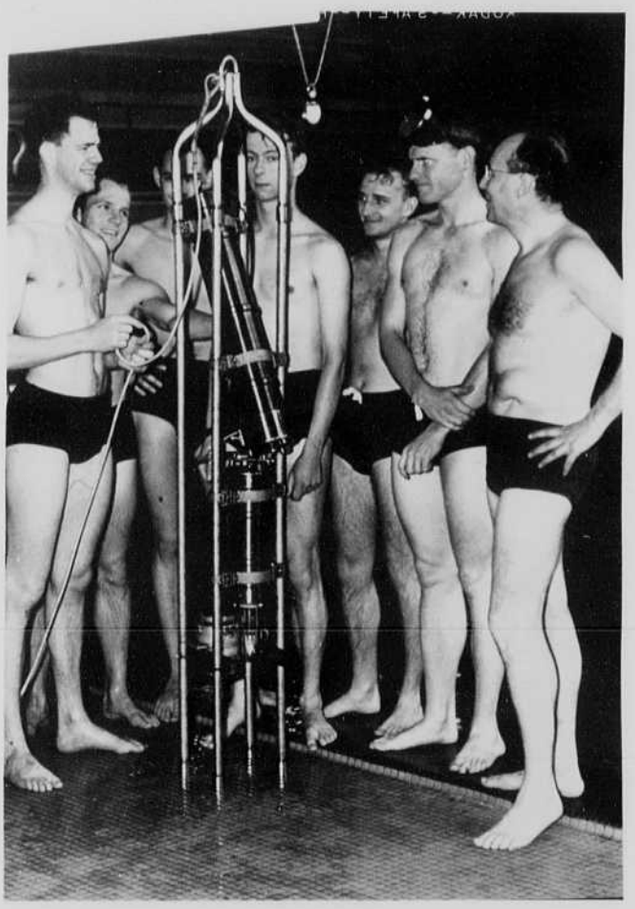
Laconia. PIRAEUS JULY. 1955.

Bobby

Diet Jacques Cousteau Albert Falco Bellon Marcel Lacaubi

Andre



Bobby Smith Hartman Condax Kendall Edgerton

Deep sea camera

SMPTE Journal July 1955.

Sept 17

Dreamcoat tests.

FT-218

13.5 mfd, 2600 volts,

Exp't 1. Two cases with and without 35 mh.
2. none
3. 35 mh.

4. Two cases. 0 and 17 mh.
17 mh.
none.

6 pulsed tubes

Sept 19 1952. Hts. Eng.

Bill MacRoberts and Pierre Cathou worked on this problem above today. Bill used a small inductance which with 6 ft of wire reduced the intensity (peak) to 1/2 of that without a choke.

A life test showed lots of white material in the tube but no loss of light after several hundred flashes.

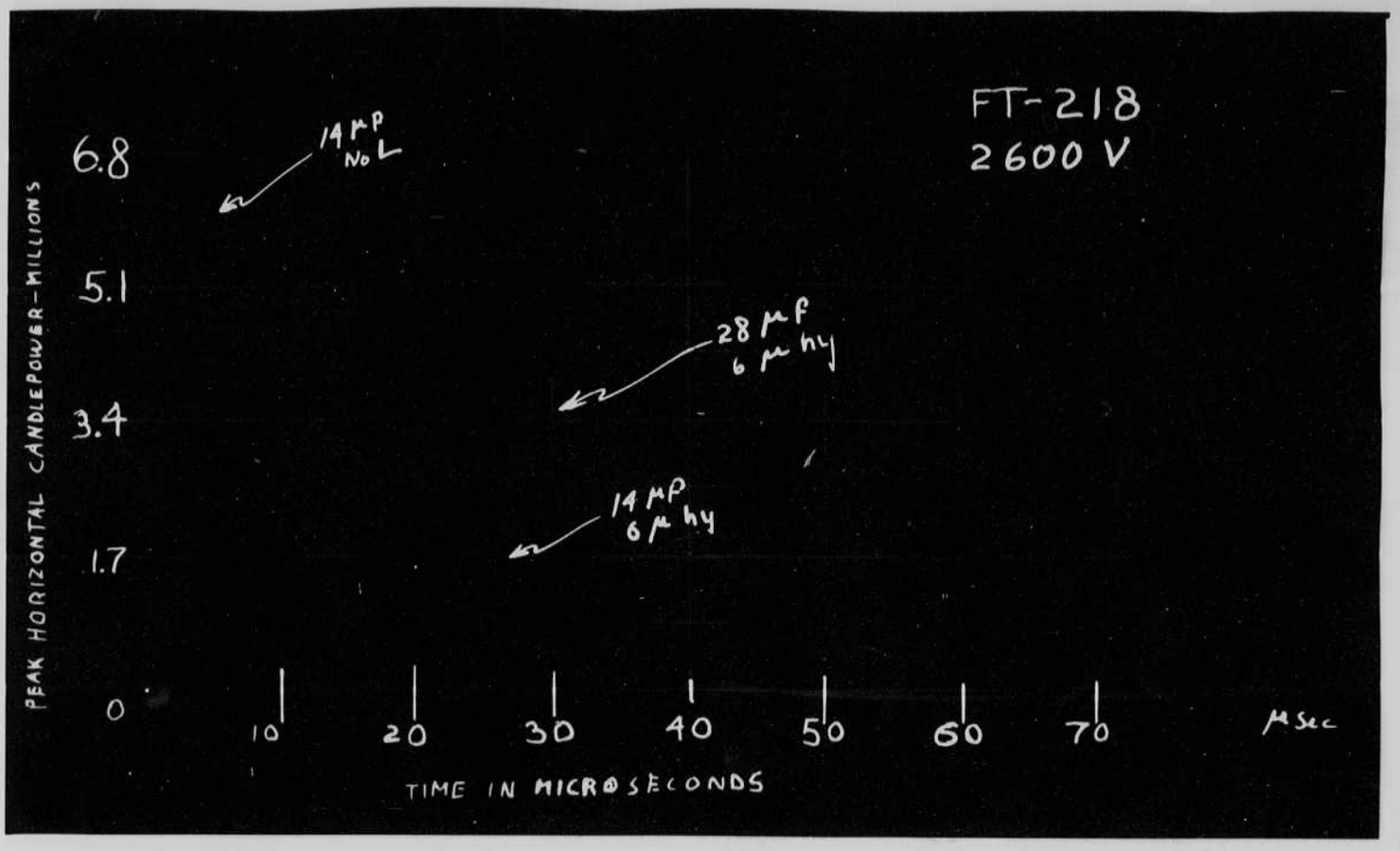
Sept 26 1955
Hts. Eng.

Last week Bill Mack and I made two tube with an gas/atmosphere in double type quartz lined tubes. The tungsten electrodes were 58 mils. the gap 1/8 inch. Copper ends were used and a glass cover. DeKolskini cement on the ends held for a while but eventually leaked due to heat after firing a bubble.

A three hour run showed some scoring of the quartz at the arc portion. I had 0.1 mfd at 1800 volts at about 20 flashes/second.

I showed the above tubes to Rapt Ries and gave him a sample.

The 3 hour tube showed a white deposit on the ends due to evaporated quartz. the gap was not very dirty in this time.



Oscillograms taken last week by Pierre Cattone on an FT-214 with 2600 volts with different series inductors and 14 and 28 mfd capacitors.

This is the condition for Greenwalts flash in Farber's unit.

Brancroft Tests.

Sept 17

FT-218

13.5 mgd, 2600 volts

Exp 1. Two caps with and without 35 mh.

2. none

3. 35 mh.

4 Two caps. 0 and 17 mh.

17 mh.

none.

(6 V. Tubes)

Sept 19 1952. H.E.G.

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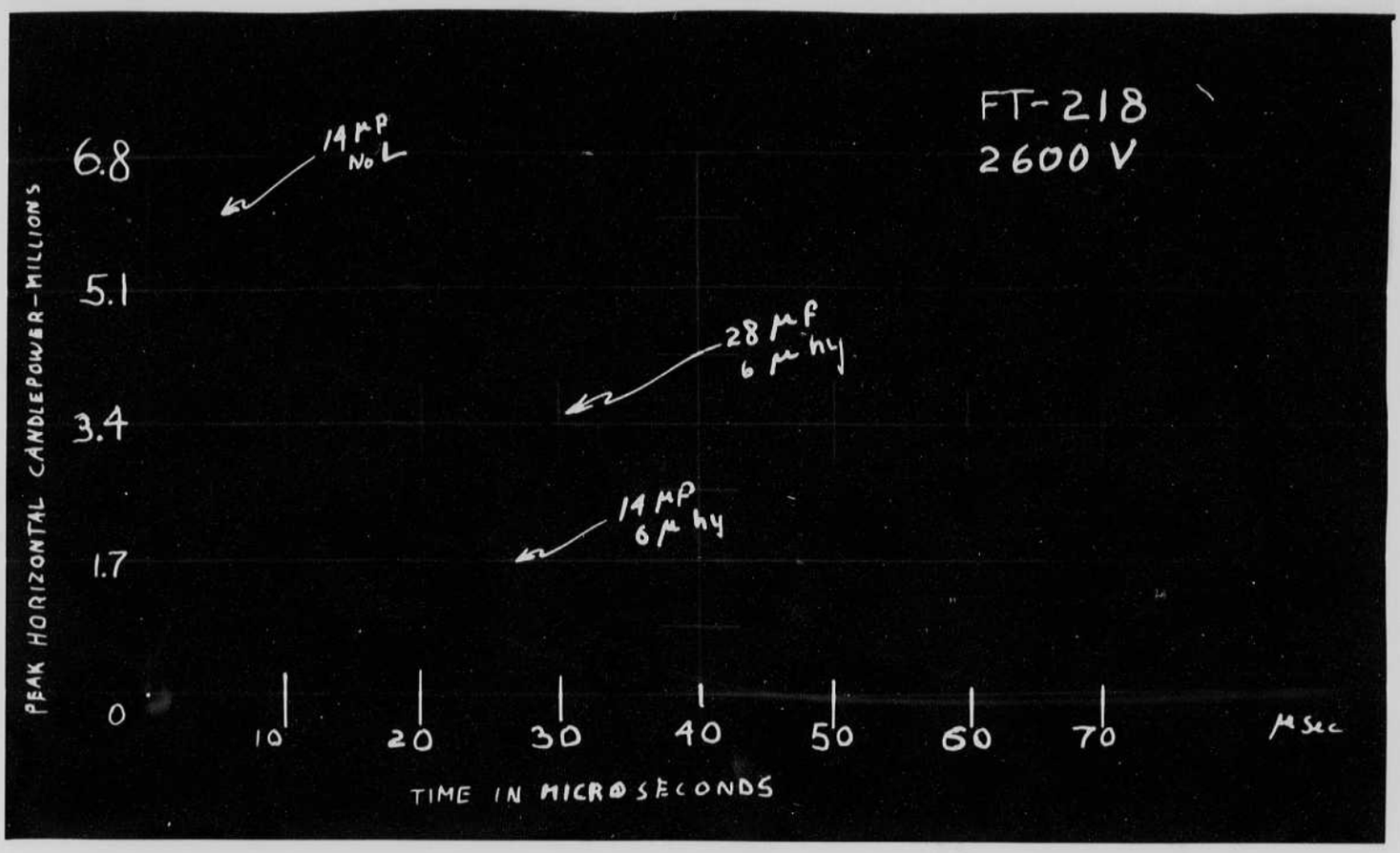


Oscillograms taken last week by Pierre Cattion on an FT-214 with 2600 volts with different series inductors and 14 and 28 mfd capacitors.

This is the condition for Smeewalts flash in Farber's unit.

A supply of Pyrex was purchased recently with a 0.1 inch hole and a 1/4 inch diameter.

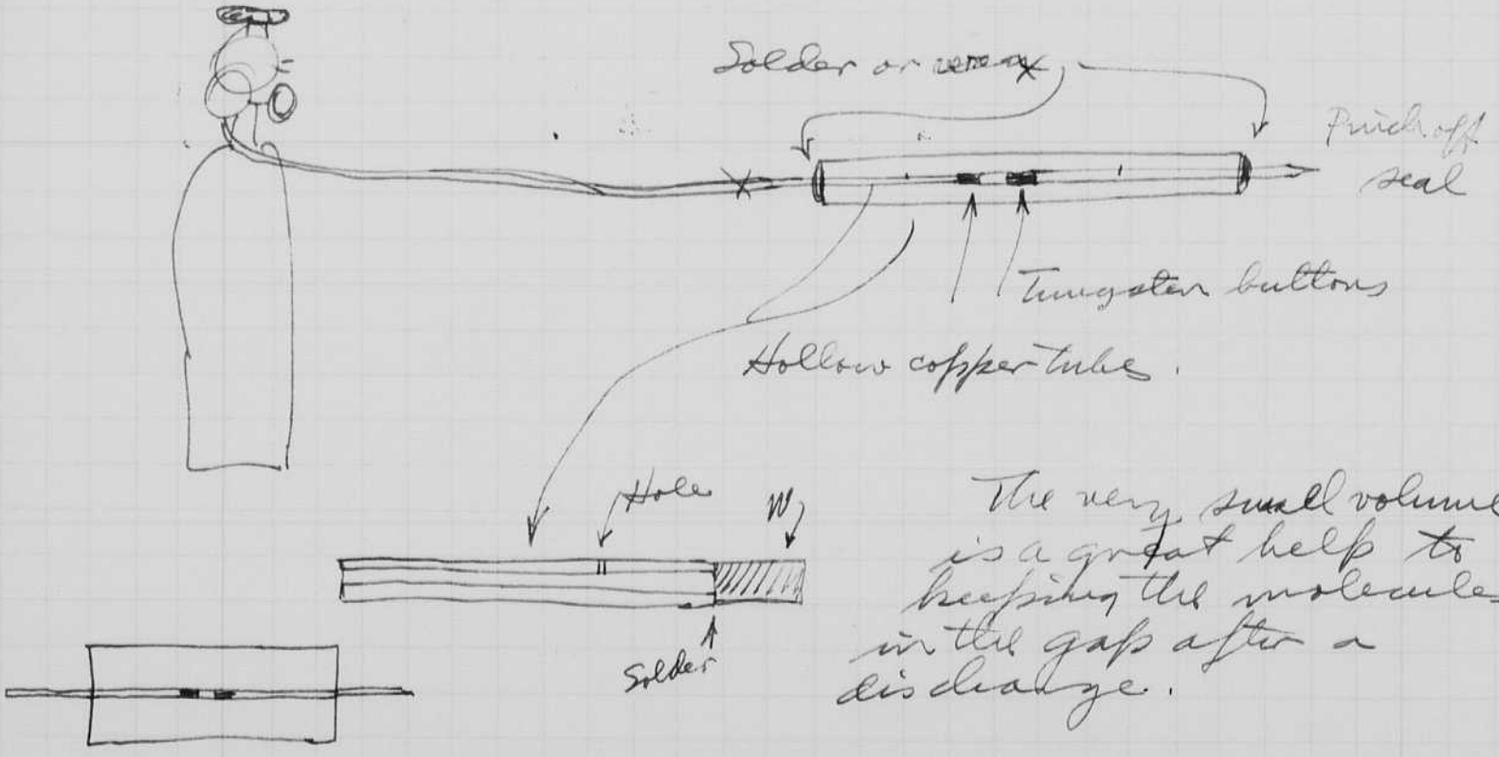
I plan to obtain a .091 inch diam copper tube for ends. The hole is .032".

Tungsten electrodes will be soldered to the copper. Then exhaust hole will be drilled.

Finally the ends will be soldered or waxed into the glass. Sealing will be by pinching.

I have not tried sealing at pressure but believe it can be done without difficulty up to 2000 p.s.i.

There may be trouble with the glass. It may break with the pressure.



The very small volume is a great help to keeping the molecules in the gap after a discharge.

Oct 5, 1955

Harold Edgerton.

One gap tube was tried by my son, Bob, Pierre Cathou and I before I went to Nebraska. The results are in Cathou's book.(5) They show

1. The efficiency increases with pressure up to 40 ? #/sq inch.

2. The second bump due to circuit oscillation is reduced when the pressure is high.

The above tests were made on a 1/8 inch gap in a 25 ~~mil~~ mm diam tank of oil with pressures from atmospheric to 40 or 50 p.s.i. See Cathou's book for data.

There was some jitter in the results which I do not understand. Probably it is due to arc going around the tungsten electrodes.

Oct 8 1955.

Demonstrations of microflash unit at PSA convention last night with Ed Land of Polaroid. We used the microflash to shoot photos of arrows and bullets. Roy Swanson, Pierre Cathou, and Dan Norman helped.

Oct. 10, 1955
H E Edgerton
Roy Swanson

Lineup as per page 17.
BE, 500 watt Bulbs.
3200 K.

Bulb #A Gain at 8.
Triggered when lamp went on also when arc over scanned. Photo under examined M.S.

B Again fired prematurely. 115 volts on Gate

Good lamps - Gap volts increased to 130
when other gap was used in
M.O. Shutter circuit
no damping
Flash of start bluing & slow
glow of filament.
the filament did not show!

Lamp C. Gap volts 130
Trigger at 7 at 2 ft.
Delay at 6. (zero on scale.)

Lamp D. Ditto.
Loud noise in M.O. due to broken wire indicating.

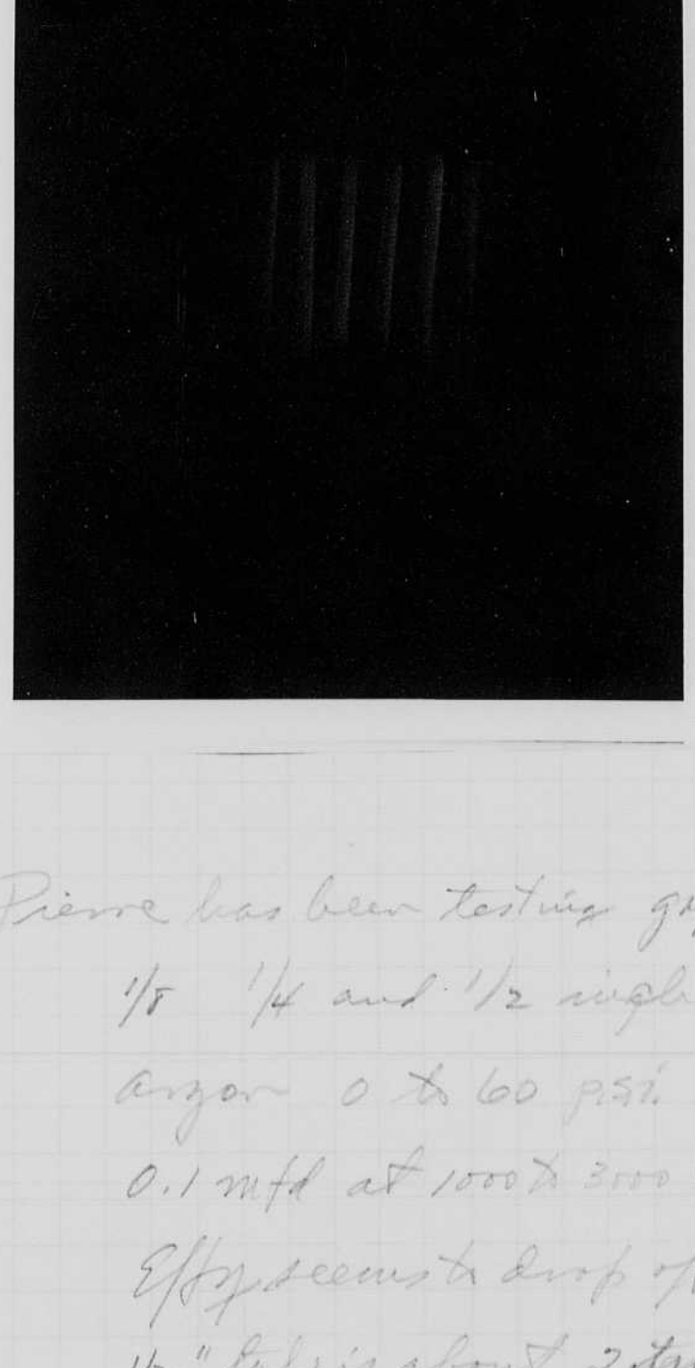
Lamp E ok. Ditto time Blew

Lamp F ok " " Blew

Lamp G ok " " +10 Blew

Lamp H Shutter blown up.

↓



Shows spot forming on the filament.

This was the only negative that showed a spot.

Sent to Nela Park.

Pierce has been testing gap tube.

1/8 1/4 and 1/2 inch gaps

argon 0 to 60 psi. above atm.

0.1 mfd at 1000 & 3000 volts.

Eff. seems to drop off with voltage?

1/2" tube is about 2 times as efficient as 1/4.

Max effy is 0.3 c.p./watt. Low

Linedup as per page 17.

BE, 500 watt bulbs.
3200 K.

Oct. 10, 1955
H B Edgerton
Roy Swanson

Bulb #A gun at 7.
Triggered when lamp went on also when are over exposed. Photo underexposed N.G.

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Dark lamps - Gap volts increased to 130
when other gap was used in
M.O. Shutter circuit
no damping
Flash of photolumy & slow
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Trigger at 7 at 2 f.
Delay at 6. (yes on scale.)

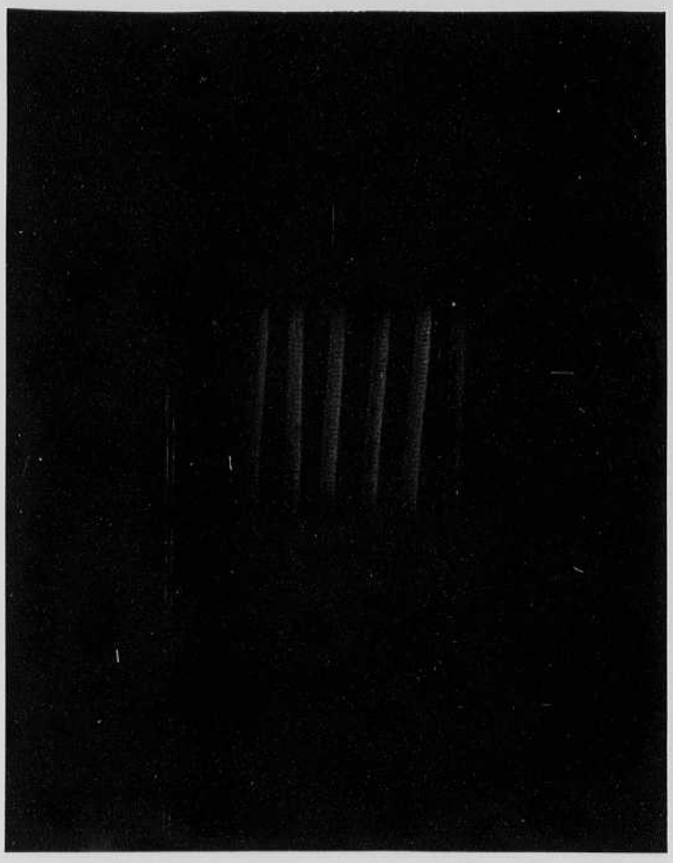
Lamp D. Ditto
Loud noise in M.O. due to broken wire
in discharge.

Lamp E ok. Ditto tube Blew

Lamp F ok " " Blew

Lamp G ok " " " + 10 Blew

Lamp H Stabilator blown up.



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0.1 mfd at 1000 to 3000 volts.

Eff/p seems to drop off with voltage?

1/2" tube is about 2 times as efficient as 1/4.

Max effy is 0.3 c.p./watt. Low

Oct. 23, 1956.

Harold E Edgerton.

I had a session last week with Bill Parkin at the super sonic wind tunnel.

an XP-2 (1/4" gap in a 1 mm tube was tried for exposure using the big mirrors. The first test was with 0.1 mfd at 2000 volts. Results weak when developed. Another test with 2 mfd at 2000 v gave excellent results. Now to design the equipment without worry.

Oct. 24, 1956 The XP-2 with 0.1 mfd at 2 KV was tried as an Infra red source in the Dent house with Bob Hagge and Johnny Bean. Pierre Cathou etc. The output was the same as a type 304 Sylvania (straight) with .25 watt seconds.

The same tube was also tried with Bob Kriebel in the Sloan laboratory on the interferometer. The capacity was increased to 2 mfd.

Photos were taken with a green and a blue filter to give sharper lines on the photographs.

The eff. is about 1 c.p./watt with the XP-2 with at 2 mfd at 2 KV.

FX-1 conditions.
20 cm pressure
6 inches length
4 mm diam
5 c.p./watt
2000 volts.

0.1" = 2.54 mm.

$E/p = \frac{2000}{\frac{6 \times 2.54}{20}} = \frac{E}{20} = \frac{131.}{20} = \underline{6.6}$ volts/cm/cm.

or 0.66 volts/cm/mm.

XP-1 1/2" length
1 atmos plus 76 cm.
1/2 inch length.
2 mm I.D.
1 C.P./watt. 2000 v.

$E = \frac{2000}{.5 \times 2.54} = \underline{262}$ 1520 volts/

$\frac{E}{p} = \frac{1520}{76.0} = 20$ volts/cm/

or 2. volts/cm/mm.

For comparible performance on the FX-1 the XP-1 should have the same, E/p ?

$$\frac{V}{.5" \times 2.54 \times 76.} = 6.6 \text{ volts/cm/cm.}$$

$V = 6.6 \times .5 \times 2.54 \times 76 = 640.$ volts.

(if $l = .25$) then $V = 1280$ volts.

another way to reduce E/p is to increase p.
for example if p were increased in the XP-1 to

$\frac{20}{6.6} 76. = 230. =$ 3 atmospheres. (at 2 KV.)

Energy per molecule in FX-1
volume $= \pi r^2 l = V = \pi .2^2 6\ 2.54 = 9.6$ cubic cm. (1.92)

1.1.4 cm

Gas $= V \times p$ Energy $= \frac{CE^2}{2} = \frac{100 \times (2000)^2}{2} = 200$ watt sec.

FX-1 $= 9.6 \times 20 = 192.$ (38.4) cubic cm cm $\frac{200}{38.4} = 5.22$ watt sec per cubic cm cm.

XP-1 $V = \pi r^2 l = \pi .1^2 .5 \times 2.54 = .04$ cubic cm. cm.
Input $\frac{CE^2}{2} = \frac{2}{2} 2^2 = 4$ watt sec.

$\frac{4}{.04} = 100$ watt sec/cubic cm cm.

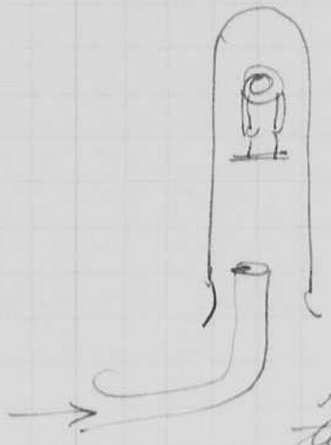
Data computed by Prime Cathon

FX-3	FX-1	$d = 0.4$ cm. $l = 6$ inches	XP-1 $l = 3/8"$ $d = 0.085$
$.13 \times 10^6$	PHCP	8×10^6	1.8×10^6
.15	C.P.S./watt	4.8×200	4 C.P.S.
.01	C	100 mf.	2 mfd
8 KV	V	2000	2000
1.2 m.s.	Dur	140 m.s.	4 m.s.
.32 W.S.		200 W.S.	4 W.S.
0.045×10^6	P.H.C.P./sq cm	0.41×10^6	4.6×10^6
.05	C.P.S./sq cm	50.	10
4.5	W.S./cu. cm	110	400
2.9 sq cm	Area	3 sq in	.06 sq in
.07 cu cm	Volume	0.11 cu inch	.0006 cu inch
.10 cm ?	pressure	20 cm	76. cm ?

38 Oct 25, 1955.
Harold E Edgerton

Hydrogen cooled tubes.

I tried hydrogen as a cooling medium last Saturday, helped by Roy Swanson.



H_2 Small flow.

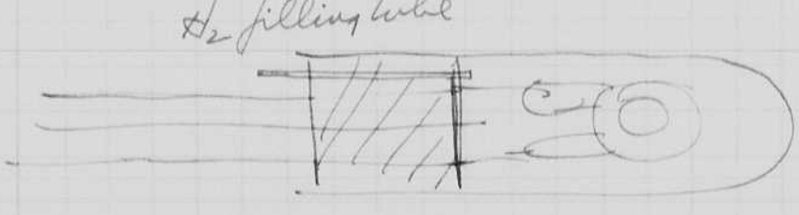
a FT-218 was used at 1000 volts with and 5000 ohms charging.

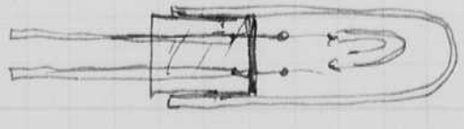
At 60 cycles the tube could be run continuously.

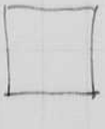
There is other data in Roy Swanson's Book about the tests.

about double the power could be put into the tube before skipping resulted.

It seems to me that a plastic tube might be built for the outer container. In this way no damage would result in case of explosion. The end could be cemented after the tube installed.







Liquid can also be used for cooling.

Pressure will build up.

Light meter tests Sun Rad Meter 1501

Arthur Bosquet recently finished a model of the light meter with a CK 5886 tube in place of the 1644.

The instrument now should read 50 lumen sec. per square foot instead of 200. A 50 ua meter will be substituted instead of the 200.

One object of this change is to increase the probe sensitivity.

Calc. Prob has 929 or 1P39 photo tube

$S = 40$ ua/lumen.
area = 0.5 sq inches.

$$S = \frac{40 \text{ ua}}{0.5 \times 12^2} \text{ ua/lumen/sq. foot.}$$

$i = Sl$

$$S = \frac{80}{144} \text{ ua/lumen/sq ft.}$$

the old 1501 had 2 volts for full scale and an integrating capacity of C microfarads

$$e = \frac{1}{C}\int_0^\infty .5\, l\, dt \text{ volts.}$$

$$\frac{eC}{S} = \int_0^\infty l\, dt \text{ lumen sec/sq foot.}$$

$$\frac{2 \times .05}{\left(\frac{80}{144}\right)} = .2 \text{ lumen sec/sq ft.}$$

C.P.S.
$$\frac{\text{C.P.S.}}{d^2} = .2 \text{ lumen sec/sq ft.}$$

Let $D = 2$ feet C.P.S. $= .2 \times 4 = .8$ candle power sec.

The new meter should be 4x more sensitive.

$\frac{200^{\text{ua}}}{2} = .8$

$C = \frac{16}{400^2} = 100$ mfd

Meter Tests model 1501 G.R.

FT-214 Std tube # 634

10 mfd at 2 KV.

Meter No. ff.

113 1 x1 37

306 1 ff x2 43.

#113 .05 m probe

306 .08

Oct 27 1955 Tests continued.

4 mfd 1000 volts into FT 214.

113 with probe at 8 ft meter $\frac{35}{200}$ lumen sec/sq ft full scale.

306 " " " 8 ft. meter $\frac{45}{50}$ full scale

2-3 lumen sec/ft² at 1 ft C.P.S. = 2.5×1^2

Readings on Meter No 306 With Probe 64) 2.50 (.03 192 58

Using different tubes at 8 ft $\frac{2.5}{8^2} = \frac{2.5}{64} = .04$ lumen sec/sq ft

	Tube	Readings		
1	1P39	52	53	55
2	929	34	32	33
3	929	32	35	35
4	929	30	32	30
5	929	37	35	38

/

6 1P39 47 46 48

Oct. 29, 1955.
Harold Edgerton. 501 EG&G equipment tests.

R110 transformer burned out last week. Replaced by Bill MacRoberts.

Observation of light vs time for 0.1 sec showed violent swing of light due to power unit transient.

A resistor was put across the swinging choke to damp out this oscillation.

Then the frequency could be increased to 10,000 cycles per second.

500 ohms was too much.

1500 oh.

2000 oh.

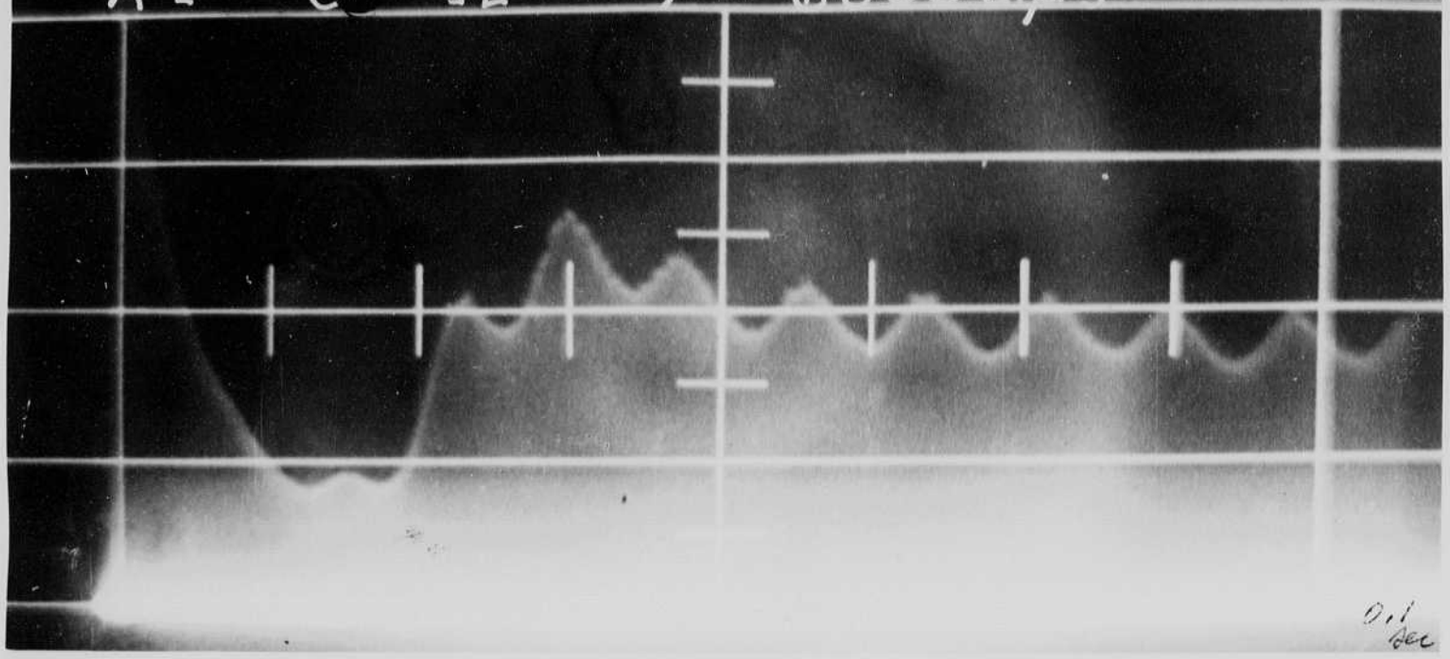
Decided to compromise on 2000 ohms. The lower resistors caused the voltage to drop somewhat.

Oct 30
Nov. 1955.

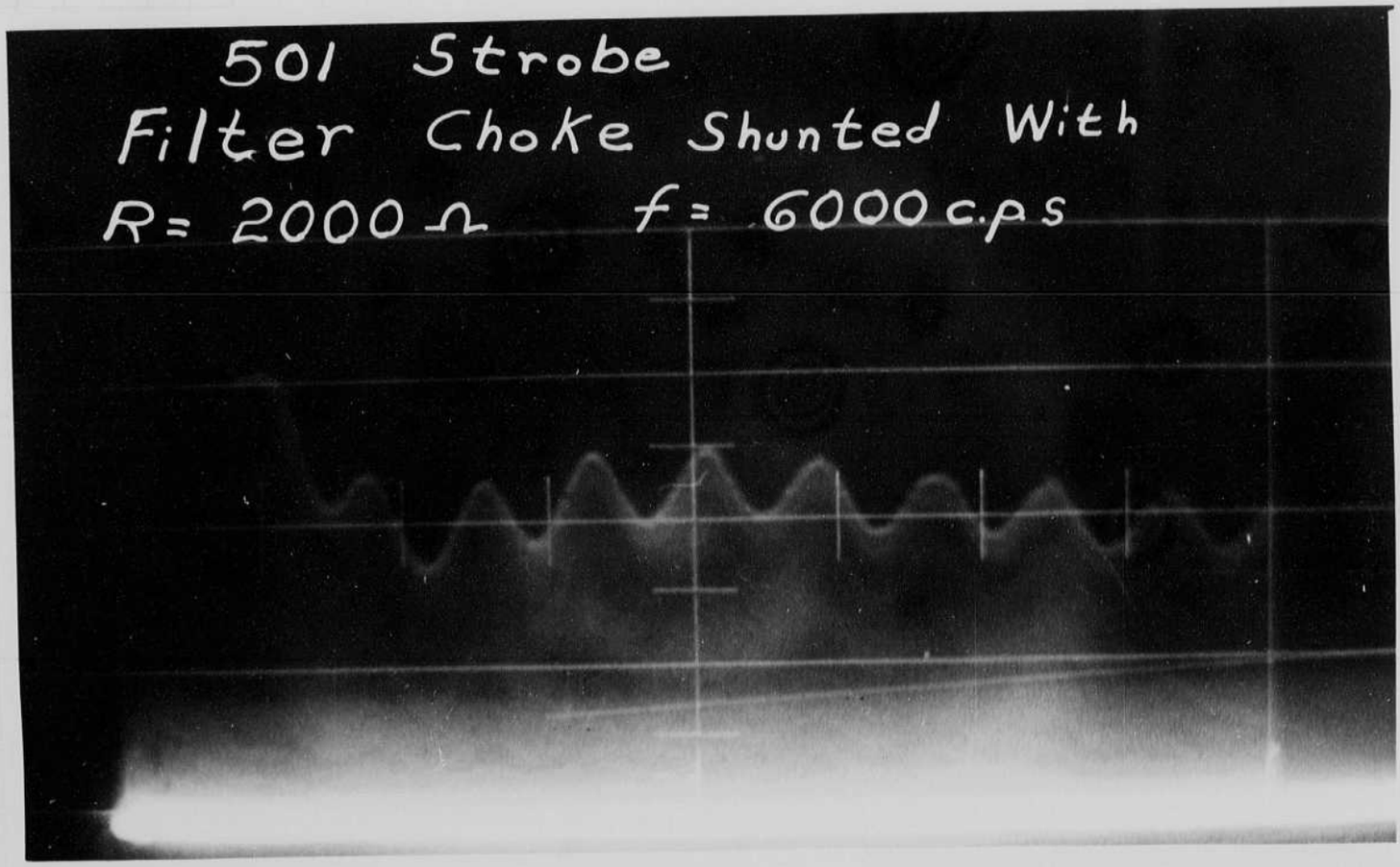
N. Lood - 5100 volts with 2000 ohm resistor across inductance instead 3700 V.

5000	3080	64%	
4600	3070	67%	R = 2000 & choke.
3600	3040	84%	as is.

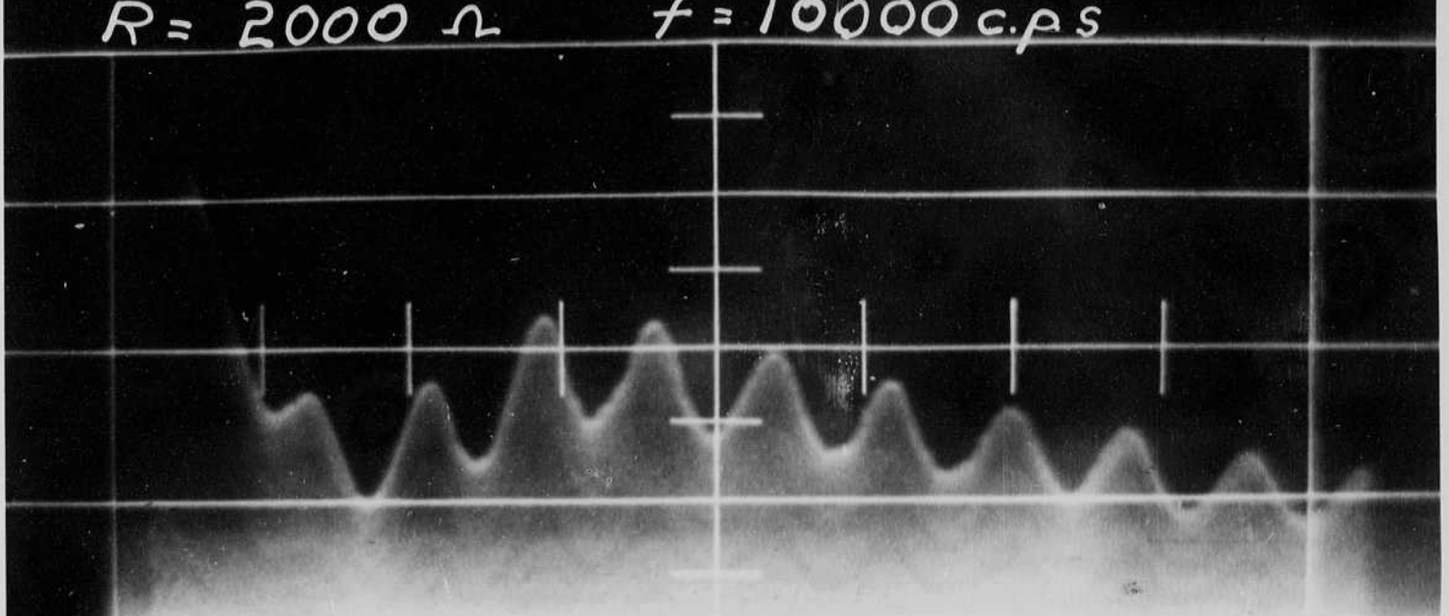
501 Strobe Light Output
Filter Choke Shunted With
R= 0 Ω f= 6000 c.p.s



501 Strobe
Filter Choke Shunted With
R= 2000 Ω f= 6000 c.p.s



501 Strobe Light Output
Filter Choke Shunted With
R = 2000 Ω f = 10000 c.p.s



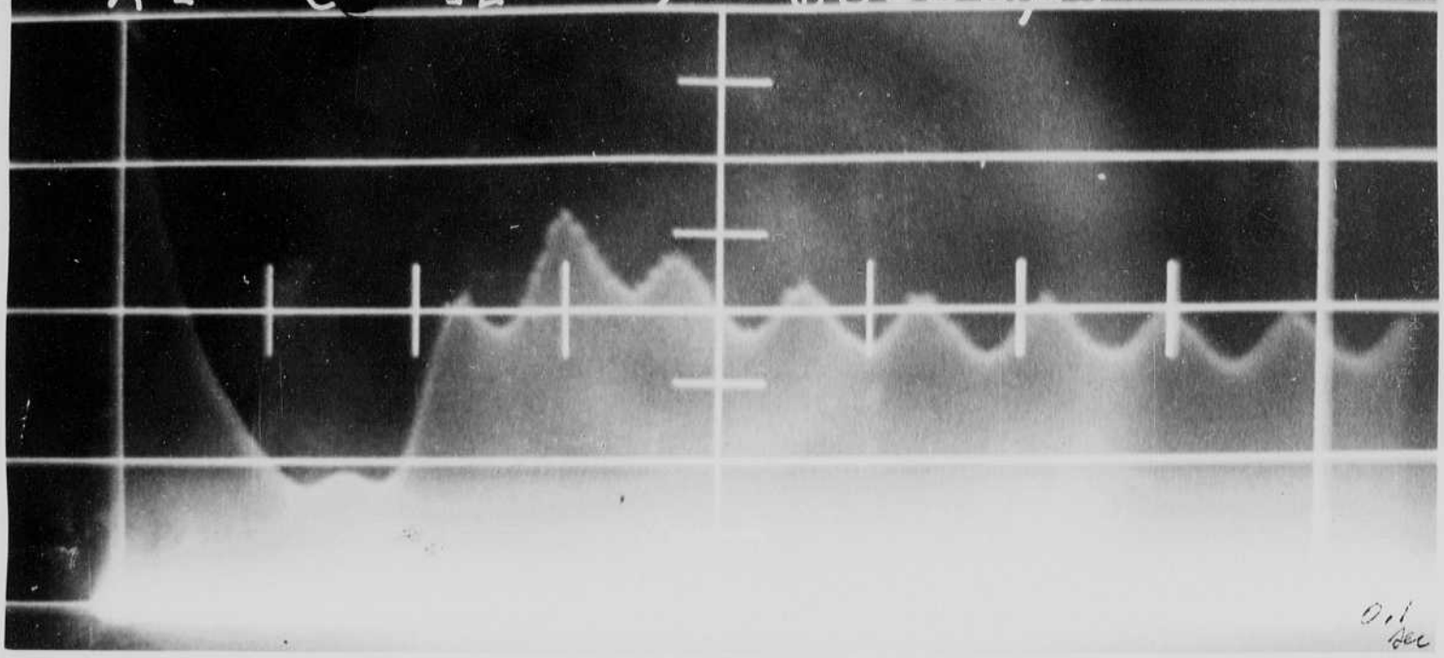
Nov. 1, 1956.

The 501 equipment has a violent transient when turned on as evidenced by the light variation for 0.1 seconds.

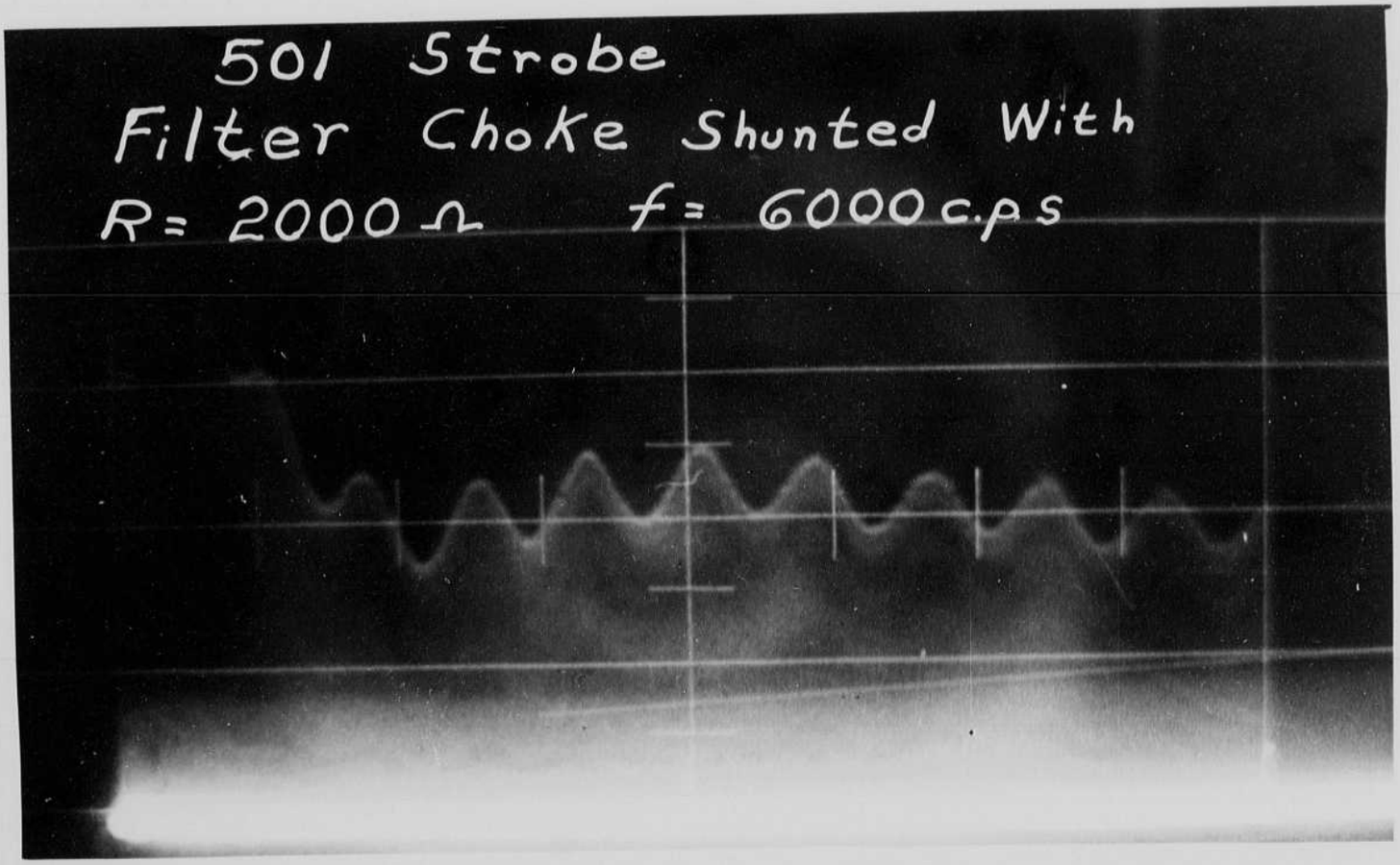
A 2000 ohm resistance across the input choke helps greatly — but the initial voltage is now 5000 volts! Note also that the voltage is higher when operating.

With the 2000 ohm resistor the flash unit now operates satisfactorily at 10,000 cycles/second, but with some voltage oscillation.

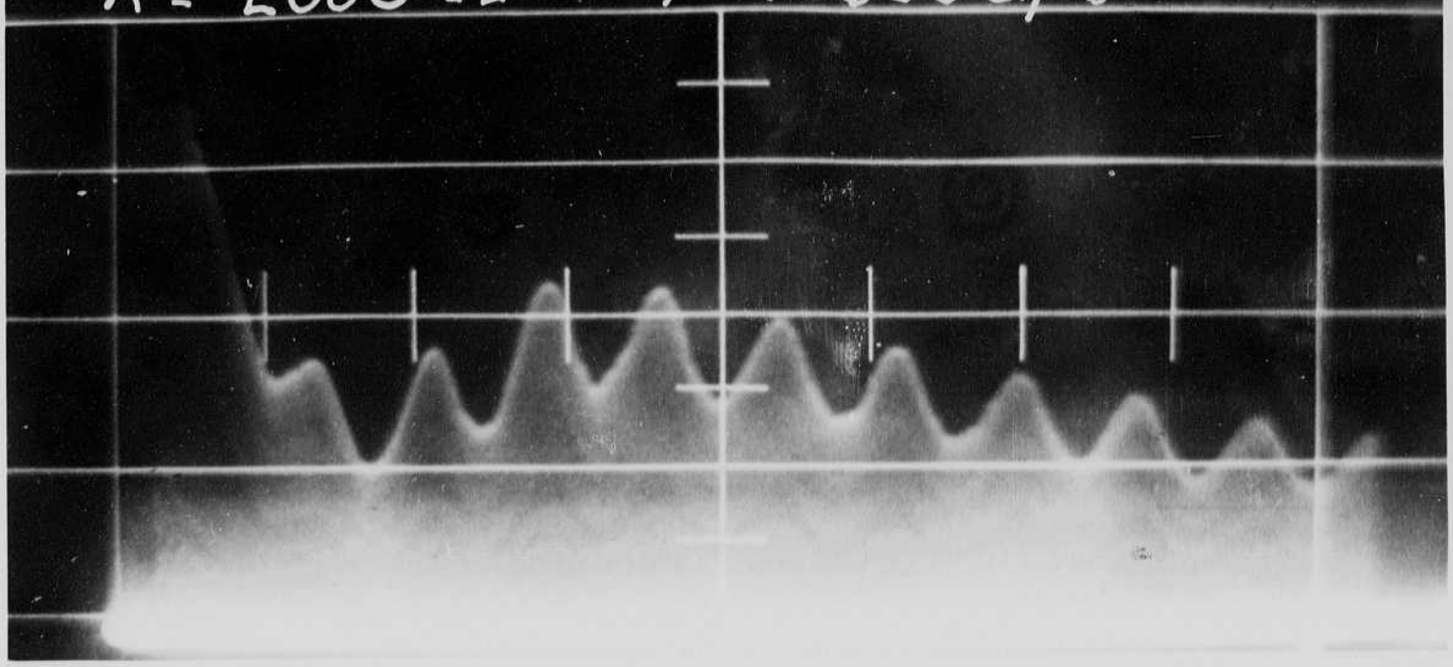
501 Strobe Light Output
Filter Choke Shunted With
R= ∞ Ω f= 6000 c.p.s



501 Strobe
Filter Choke Shunted With
R= 2000 Ω f= 6000 c.p.s



501 Strobe Light Output
Filter Choke Shunted With
R = 2000 Ω f = 10000 c.p.s



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Nov. 1, 1955.

Harold Edgerton.

Our experiments with argon high pressure tubes have been most interesting but not too efficient. It is about time to move to Xenon gas.

With argon - the tank gas was used at high pressure. Now we will freeze the Xenon, to save gas. because of expense. Some $35 per liter.

The 7x-1 is most efficient at $\frac{2000.}{6 \times 2.54} \frac{V}{cm} = 152. \frac{V}{cm}$ at 20 cm of pressure.

Now consider a 1/4" gap at several atmospheres.

$\frac{1000 \text{ volts}}{\frac{1}{4} \times 2.54} = 1570. \times$

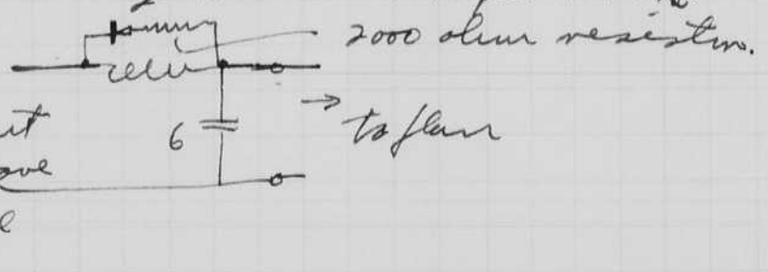
now assume $\frac{1570}{p} \frac{20}{} = 150.$

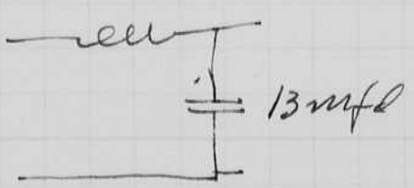
$p = \frac{1570 \times 20}{150} = 210$ cm pressure

$= \frac{210}{76} = 2.76$ atmospheres.

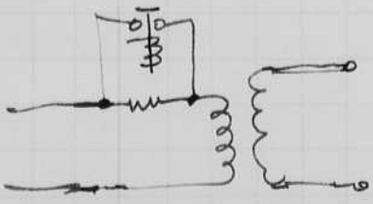
$2.75 \times 15 = 41.4 \#/\text{sq inch.}$

Also tried on 501

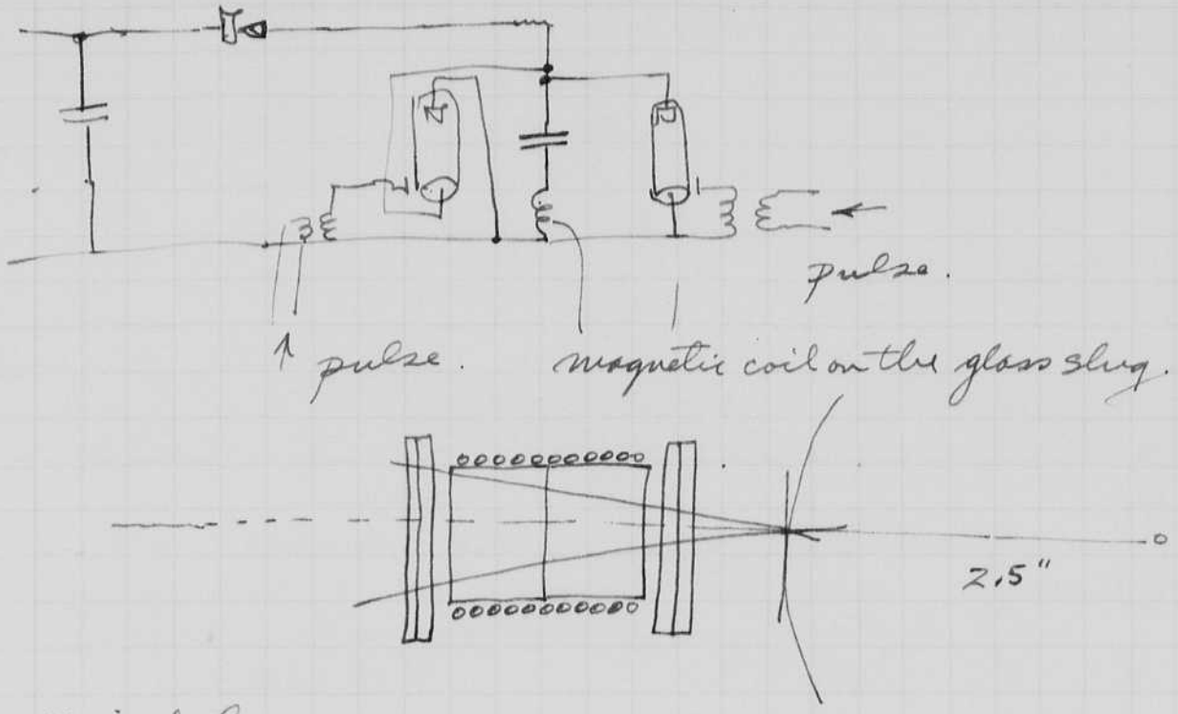




Doubling the filter capacitor helped some. Even so the equipment would not run at 10,000 cycles.



Nov. 10, 1955
Harold E. Edgerton.



40 inch lens.

Ben. Brettler says the Ek. camera is Ok. for film curvature at the focal point.

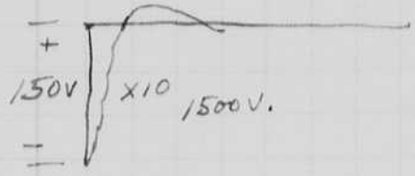
Nov. 11, 1955. Pumped down tube 2 ft diam for the wind tunnel M.I.T. Sealed off with 1 cm of xenon gas. The tube works ok with the Zeh Radio 60 cycle unit. 200 volt ±. with a series mercury tube for control.

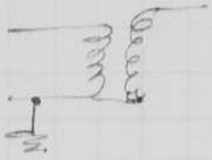
Nov. 12, 1956
Harold E. Edgerton.

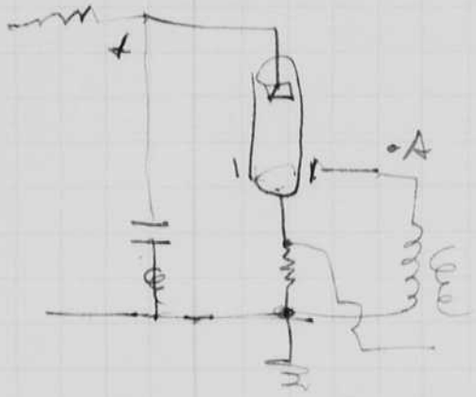
Hg tube circuit

Pulse generator.

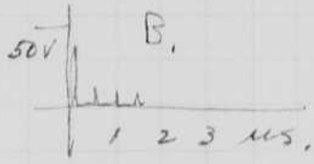
Small Hydrogen thyratron. V 1825 transformer. 0.1 mfd?



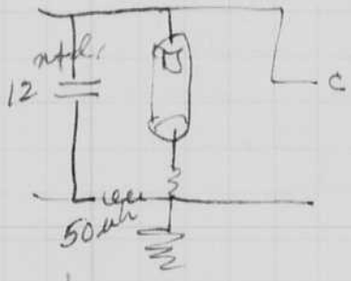


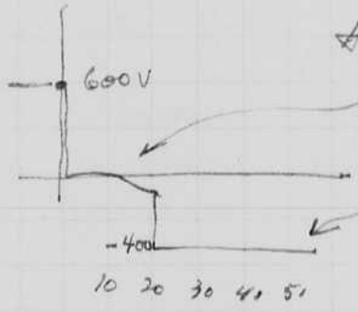


current spikes.



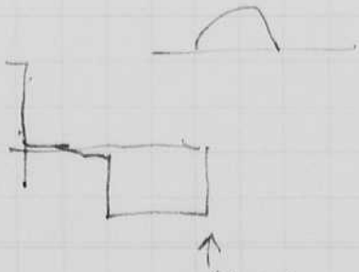
.015 ohms. $i = \frac{50}{.015} = 3000$ amps in surges?





Hg tube acts as a rectifier here.

Charge reversed on the capacitor.



Also OK at 750
800

Double flash	900	43 MS
Hg tube back fires	900	0
	900	43
	900	47
	1000	50
	1000	100+
	1000	42
	1000	36
	1000	100+

$T = 2\pi\sqrt{LC} = 120 \times 10^{-6}$ seconds

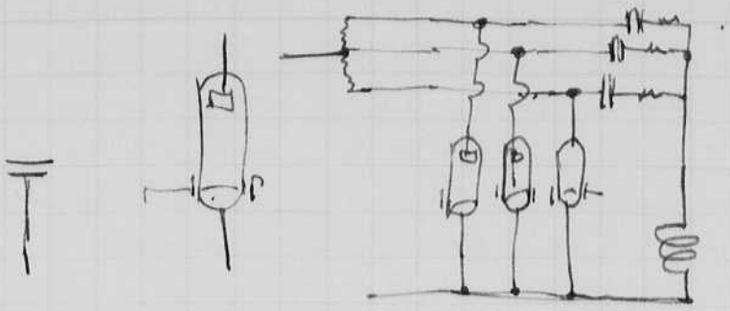
$\sqrt{L} = \frac{120 \times 10^{-6}}{6.28 \times \sqrt{12 \times 10^{-6}}} = \frac{\pi}{4}$.

$4\pi^2 LC = 400 \times 10^{-12}$

$L = 10 \times 10^{-12} / 12 \times 10^{-6} = 10 \times 10^{-6}$ henries.

1.2 KV	47 μs.
1.2	45
1.2	45
1.34	48.

Thus the voltage must be below 600 volts to obtain no back firing of the mercury arc tube!



An old Delco (Large) coil was tried on the above. The discharge was very long in duration. The second peak came at 50 μs.

If a spark over is used the voltage collapses quite quickly to a small value this idea should be useful for the fast operation.

Nov. 15, 1955 Conferred with Brettler.

40 μs exposure double slug capacitance · 20" lens tri x film at 1 M.S. after gives correct exposure, (f16?)

The new setups will be
Single slug.
110° swing of shutter in Blue

10^5 watts/sq meter.

175 lumens/watt.

$\frac{10^5}{175}$ = 570 candle power/sq meter must be cm.

= ~~0.57~~

Nov 23 1955

Harold Edgerton.

Further experiments were made with small volume flash tubes last saturday. The data is recorded in Pierre Cathou's book. The tube was a waxed joint one. The experiment was finished when we tried to freeze the xenon at low pressure temperature and the wax cracked.

Additional tubes are now being built with the soldering technique.

The conclusions from Saturday.

efficiency seems to be constant about 1 or 2 cm of pressure. with .5 mfd at 500 volts.

Tube self flashed at 500 volts with 1 cm of xenon.

Tube operates at 240 cycles from .03 (?) mfd. at 500 volts with 10⁴ ohms leg.

Anode and cathode were of tungsten. Sputtering from electrode seems to be nicely confined to the end chambers.

Nov. 26 1955. During past week other tubes were made and tested as per Cathou's note book.

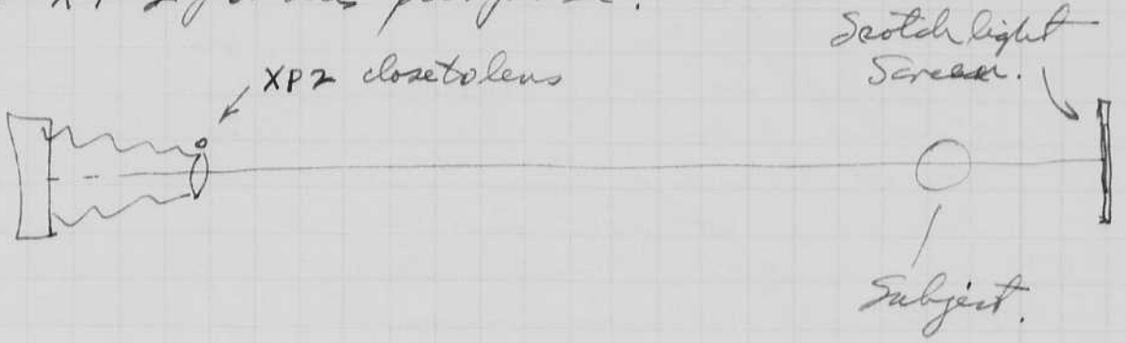
One was sealed off with 10 cm pressure. It works fine at 60 cycles also up to 240 with ~~0.01~~ 0.1 mfd at 700 volts. after 10 hours ±. there was slipping trouble due to tungsten on the guards. I popped this off with a discharge from 0.5 mfd at 4 kv. a series gap was necessary to hold off the voltage.

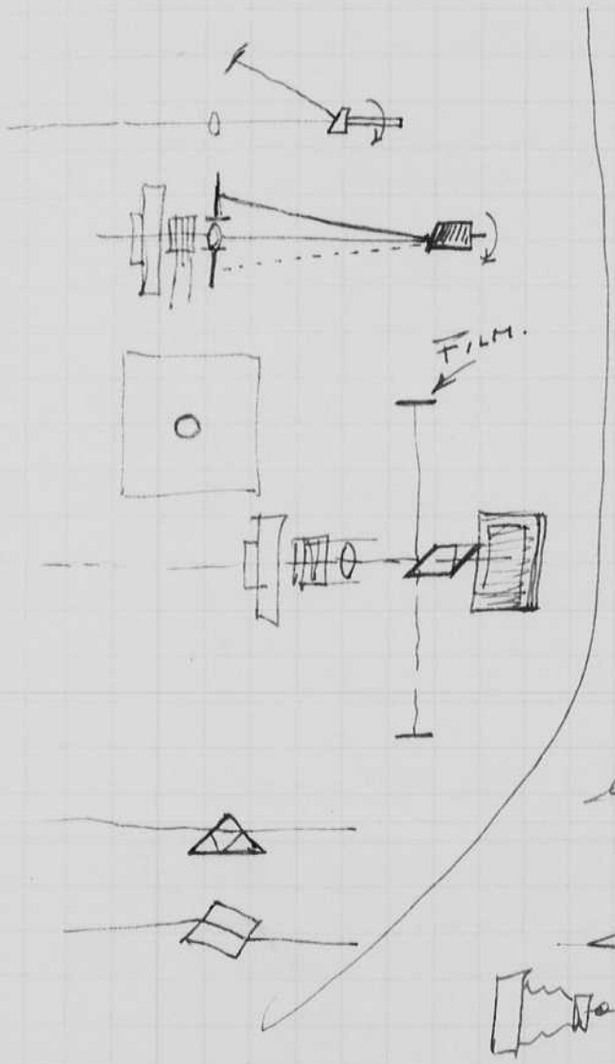
Lunch with Roy today. Discussed afterward the rapatronic with mercury arc tube control. 1000 cycle operation on the General Radio camera.

Yesterday I had lunch with my son Bill and Prof Bears at Walkers. Discussed the Soldiers Field Subs at United Aircraft. Hartford

Exposure with Scotchlight background.

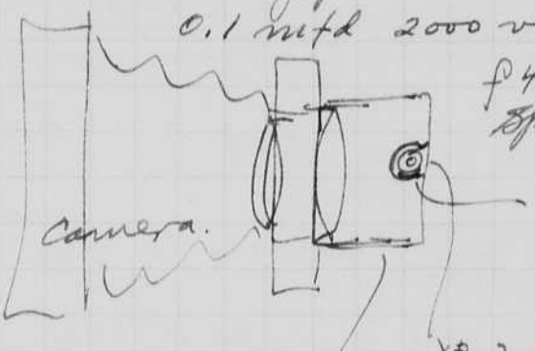
Back light might be efficient with scotch light for ballistic research using a point light source at the camera. I propose to use the ~~EB~~ XP-2 for this purpose.





Experiment.

XP-2 gas tube as a source.
0.1 mfd 2000 volts.



In this way the lamp is directly in line with the camera axis.

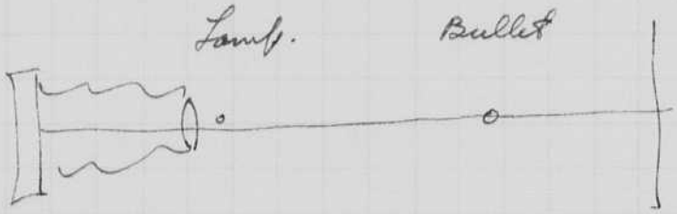
 Dec 3 1955

Dawed E Edgerton.

Several shadowgraphs of bullets, 22 long rifle, were taken on Nov. 26 with the Polish light and the lamp on the lens set up shown on page 49, Ray Swanson shot the gun when he returned from his swim at the pool.

I left Sunday Nov 27 for Rochester, then to Cleveland Nov. 28, Denver, Los Vegas. Nov 29. Board of Directors meeting at E.G.&G Los Vegas all day. Left Nov 30 for El Paso, then by car for Holloman air Base. Alamorgodo. I saw Lt Aven, Chas. Bogley, Ed Hardy etc about a contract to study shock waves on the sled. took 7:05 pm plane to Boston arriving at 8 am.

Shadow with Polish light background.



If the lamp is at the center of the lens then the shadow of the bullet will be directly under its image. the shock wave shadow will traverse the shadow again, but through a different path. Sensitivity of the system probably will depend upon the spacing of the bullet and the background.

a slight displacement of the lamp from the center of the lens may give an increased sensitivity. the size of the source is also an important factor in the definition of the shadows.

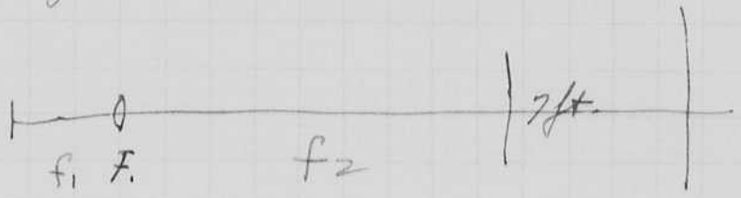
The sled shadowgraphs might have more importance on the top of the models. If so, the lamp could be placed slightly below the lens center. a second camera could be used also at a different angle to record any shadows that were lost.

Charles Bogley at the conference in Salomon air Base stated that he wished to work in daylight. this means

(1). a dark house for the sled to enter at the photo area.

(2) or a magneto optic shutter to sync with the 1/ microsecond flash.

Lens system. 7 ft subject



4x5 film.

Let 4 inch side = 10 feet

$\frac{4"}{10}$ as $\frac{f_1}{f_2}$ = $\frac{10}{\frac{1}{3}}$ = 30 = $\frac{f_2}{f_1}$ reduction on film.

Let F = 20 inch lens.

$\frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{F}$ $f_2 = 30 f_1$ $f_1 = \frac{f_2}{30}$

$\frac{1}{f_2} + \frac{30}{f_2} = \frac{1}{F} = \frac{31}{f_2}$ $f_2 = \frac{31}{1} F = 20" \times 31$

$12 \overline{)620"}$

$\underline{50}$ feet.

Try 12" lens. 12" x 31 = 31 feet.

Near field with Exposure.

.22 cal. Low. 3 ft f8 Pan Royal film. mm

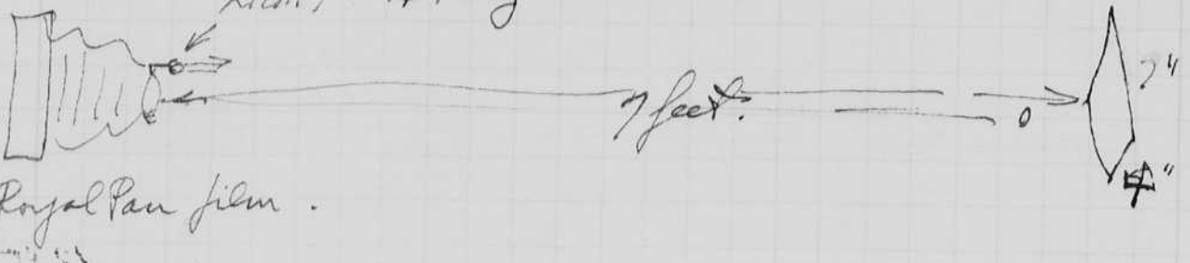
Several dozen photos were taken none showed a good shock wave. Tried quite a few setups. A 6 inch ~~Eight~~ Bullet to screen was the largest. Perhaps a larger space would bring out the shock waves? The above photos were taken with an old style XP-2 tube. Various plans, with black tape over the lamps showing only 1/20 inch ± of the 50 mil bore. Exposure was f8 with the lamps in the middle at f8.

I now have put in a new XP-2 tube with 3 atmospheres in Xenon, a 50 mil diam I.D. tube, and a 1/4 inch gap between tungsten electrode.

about 1/10 inch of collimation was shown

I wrapped a nickle strip around the lamp to cut out the rear light, the ends of the tube were covered with black tape.

Solder light Screen white

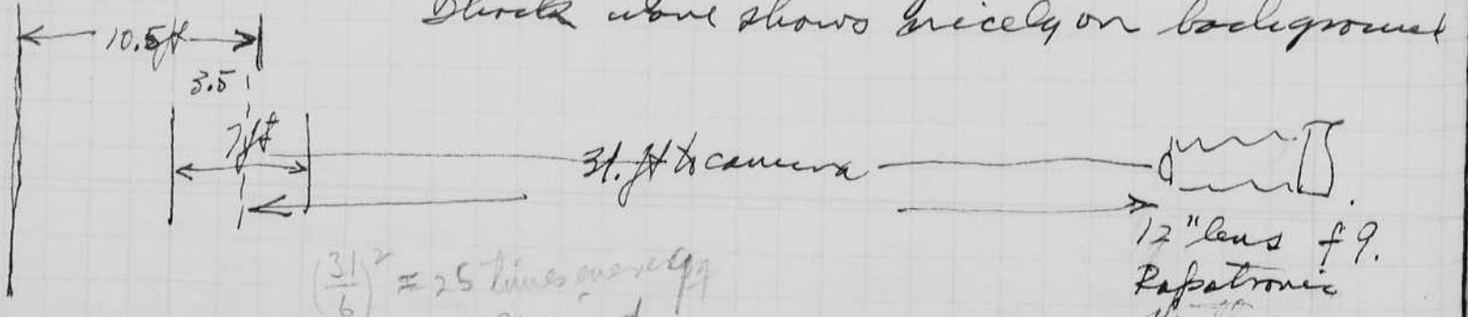


Film #1 f 32 Exposure then. Lamp about 3/4" off axis of camera lens.
0.1 mfd 2000 volts.
Developed 6 min DK 19? 70 degrees.

Film #2. f 32 and f 16. Same set up as above, the camera was moved slightly between the two exposures.

Film #3. f 16 } 22 caliber long Rifle bullets.
4 f 16 } 21" Bullet to back screen.
0.1 mfd 2KV. 3 atmos XP-1
Lamp - lens center (3/4 inch spacing. + about 1/2 inch.
6 ft + lamp to bullet
2 ft - Bullet to back screen

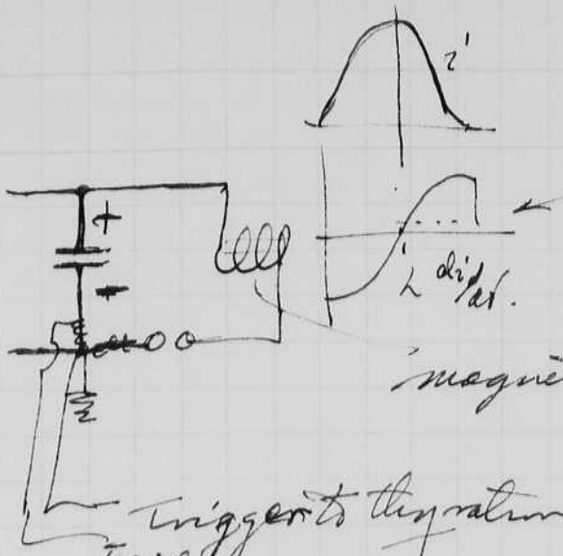
Exposure good on Royal Pan
Shock wave shows nicely on background



$(\frac{31}{6})^2 = 25$ times more light required for extra distance

$(\frac{f16}{f4})^2 = 4$ = will need perhaps more for Magneto optics shutter.

4 x 5" film = 14 x 17 in field



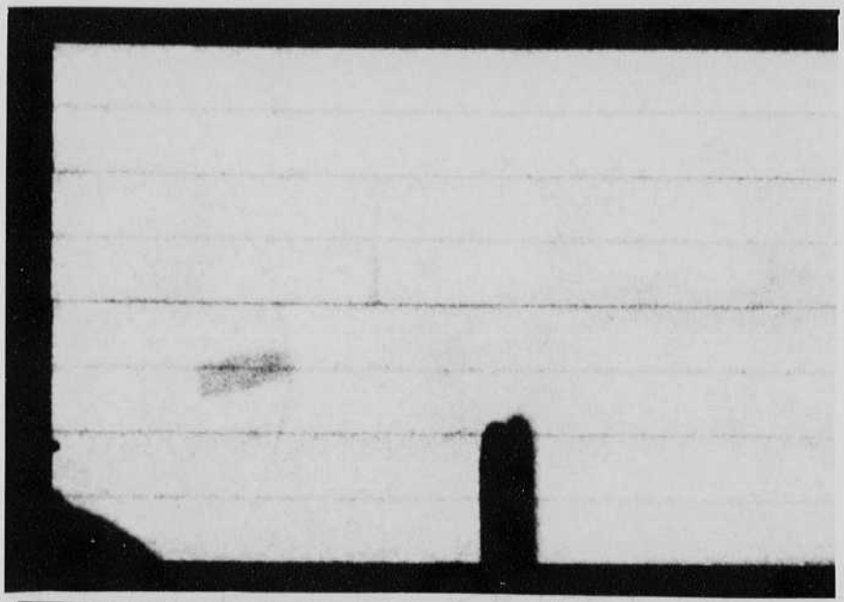
← thyratron fires with + pulse

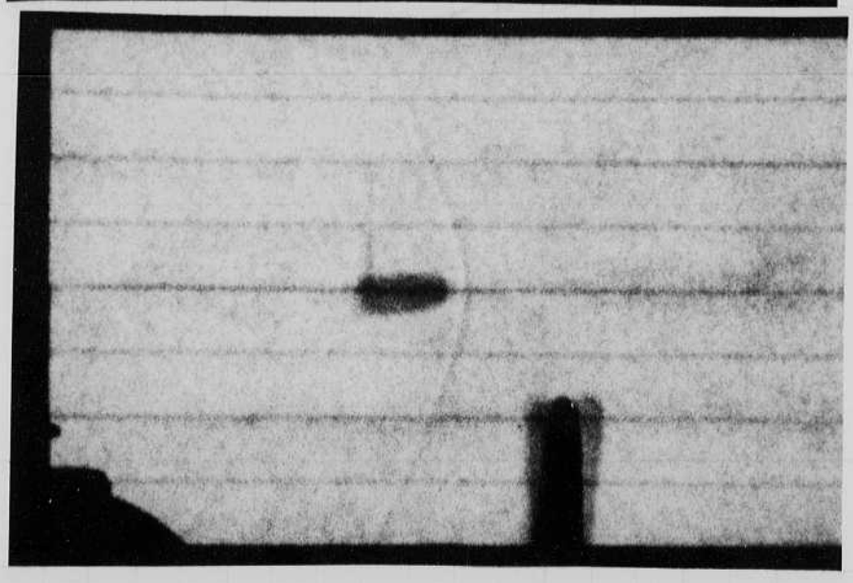
magneto optic shutter

Triggers thyratron in spark circuit.

To grid

circuit to fire shadow spark at the exact moment to catch the shutter open.





22 caliber Long Rifle.

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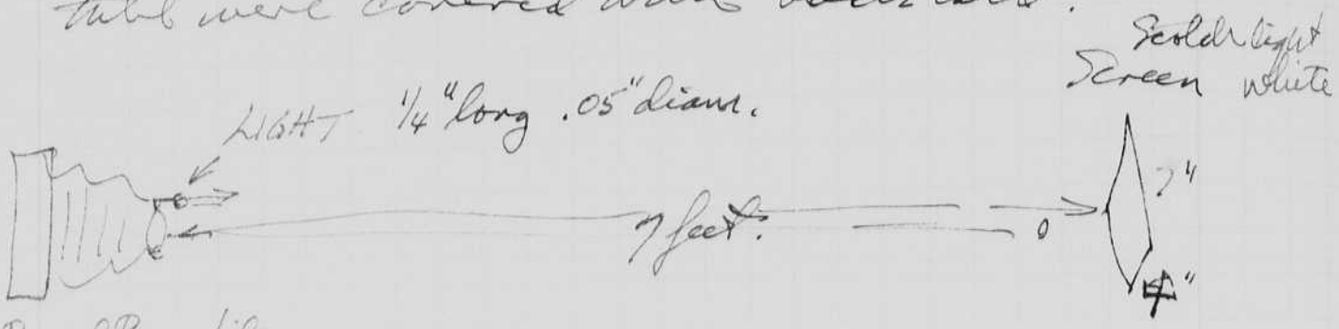
I wrapped a nickle strip around the tube to cut out the rear light. The ends of the tube were covered with black tape.

(about 1/10 inch of calibration was shown)



Royal Pan film.

Film #1 f 32 Exposure then. Lamps about 3/4" off axis of camera lens.
0.1 mfd 2000 volts.
Developed 6 min DK 19? 70 degrees.

Film #2. f 32 and f 16. Same set up as above, the camera was moved slightly between the two exposures.

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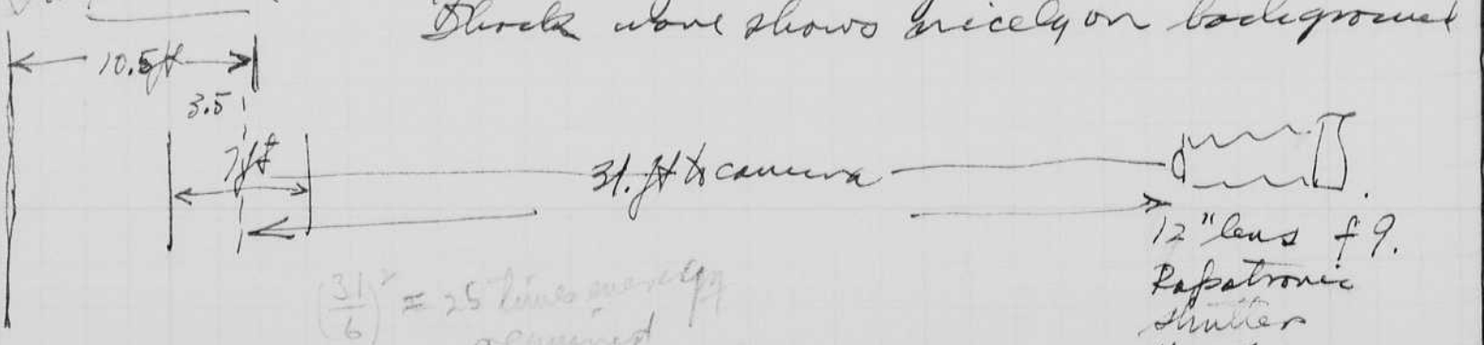
4 f 16 } 21" Bullet to back screen.
0.1 mfd 2KV. 3 Atmos XP-1
Lamps - lens center (3/4 inch spacing. * about 1/2 inch.
6 ft + lamp to bullet
2 ft - Bullet to back screen

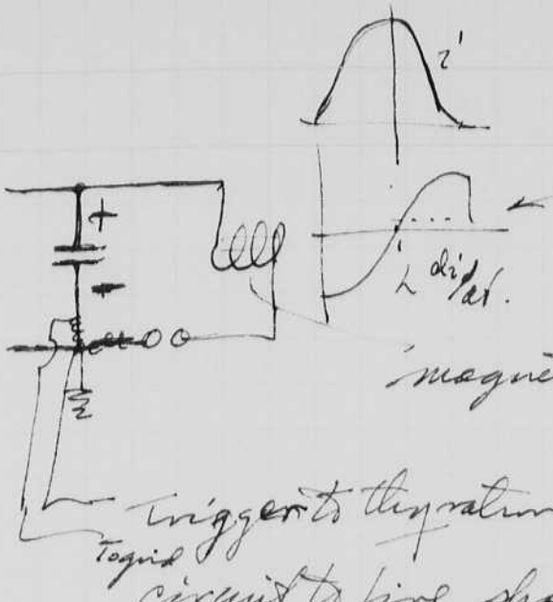
Exposure good on Royal Pan
Shock wave shows nicely on background



$(\frac{31}{6})^2 = 25$ times energy required for extra distance

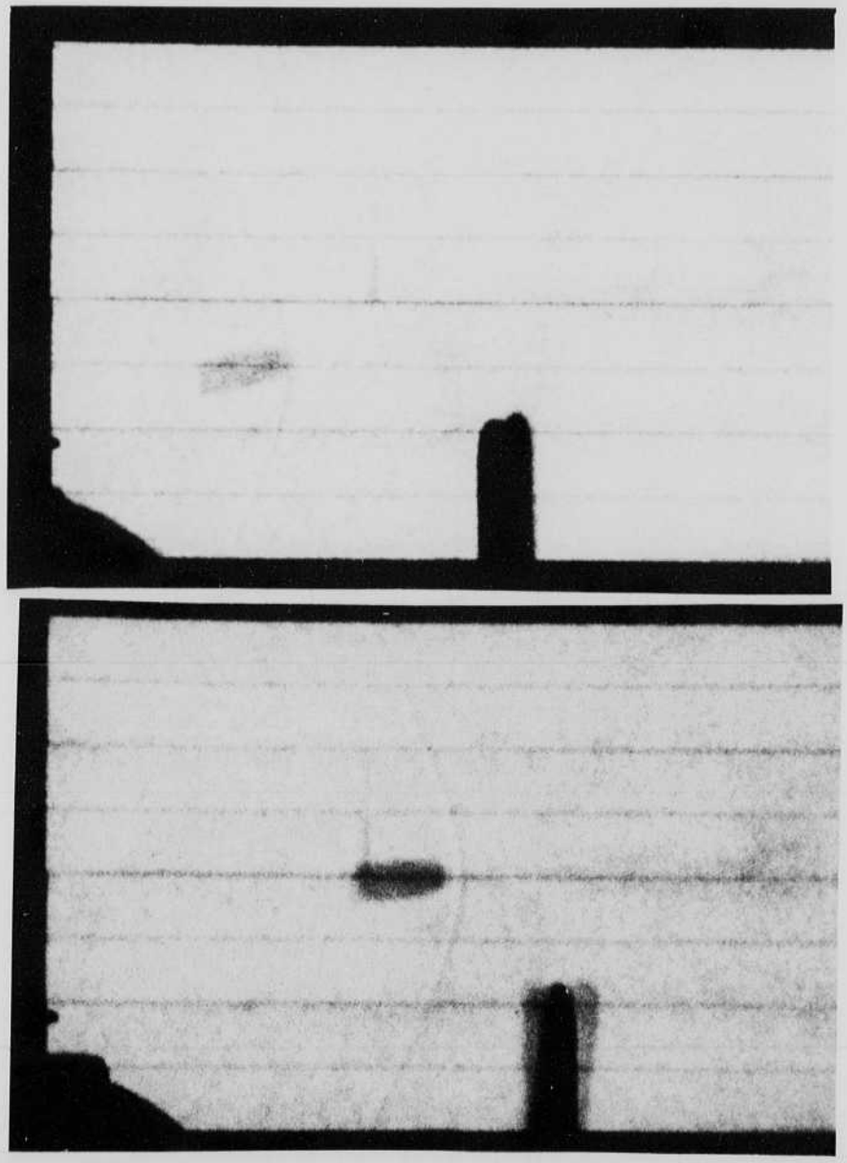
$\frac{f16}{f4} = 4$ = will need perhaps more for Magneto optics shutter.

4 x 5" film = 14 x 17 cm field



circuit to fire shadow spark at the exact moment to catch the shutter open.

22 caliber Long Rifle.

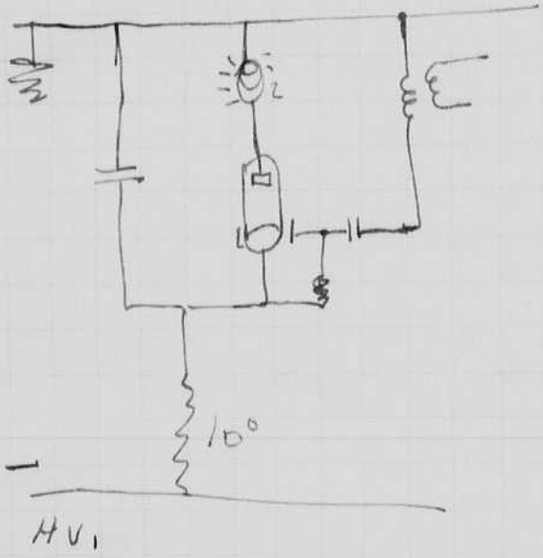


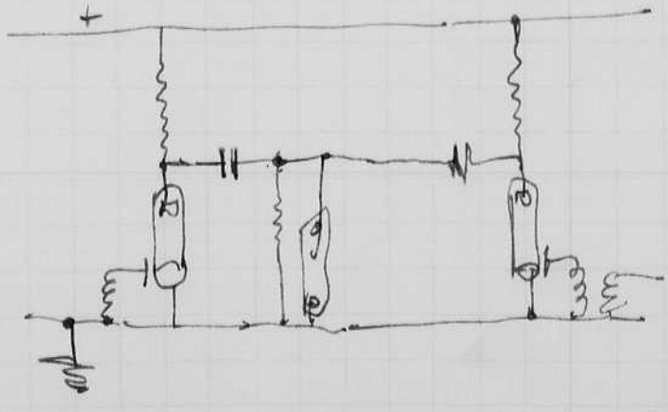
54 Dec. 6, 1955

Harold E. Edgerton

Bill Parkin and Pierre Cathou made some tests today in the Schlieren in the supersonic wind tunnel.

Photos were obtained with 0.1 mfd at 2000 volts into the XP-2 with 3 atmospheres at 1/4" gap with 50 mil diam. The negative was slightly thin on ASA 800 film. Exposure time 0.75 microseconds.





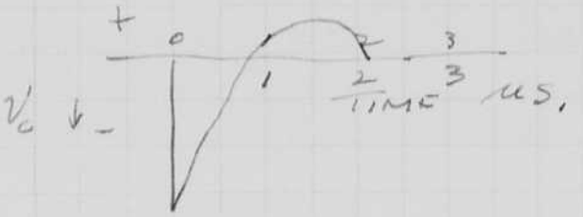
Dec 10, 1955 multiflash unit test.

H. E. Edgerton
Bill Evans Roberts

Trigger circuit gate very slow in charging.
33 K changed to 10 K. Some help but not enough — .10 sec. seems to be min time to wait.

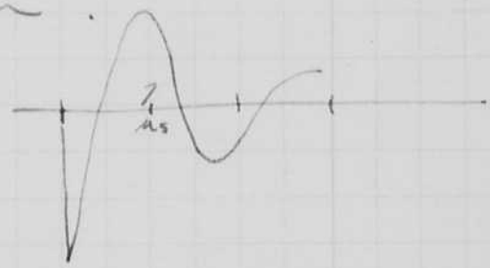
Mercury lamps tested with 15 KV Stalie and installed.

Spark from 0.1 mfd at 300 volts.
about 1/8 inch output.



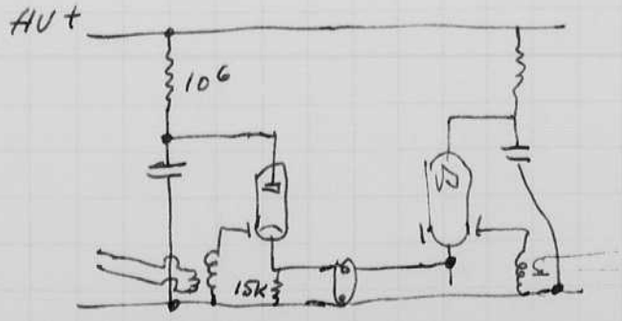
this unit flashed 1/2" lamp ok.
Noise indicance in a while.
probably a loose connection.

Second unit. #1. Transfer pulse



~~Char~~ Circuit changed to + high.
—— Spark changed to positive first
cap on spark = .35 mfd.

Works well with 5000 ohms in parallel with lamps.
50 volts on Variac.
also o/p at 15,000 ohms. 2 ft of H.V. cable.



 Dec, 19, 1955. Multiflash.
Harold E. Edgerton.

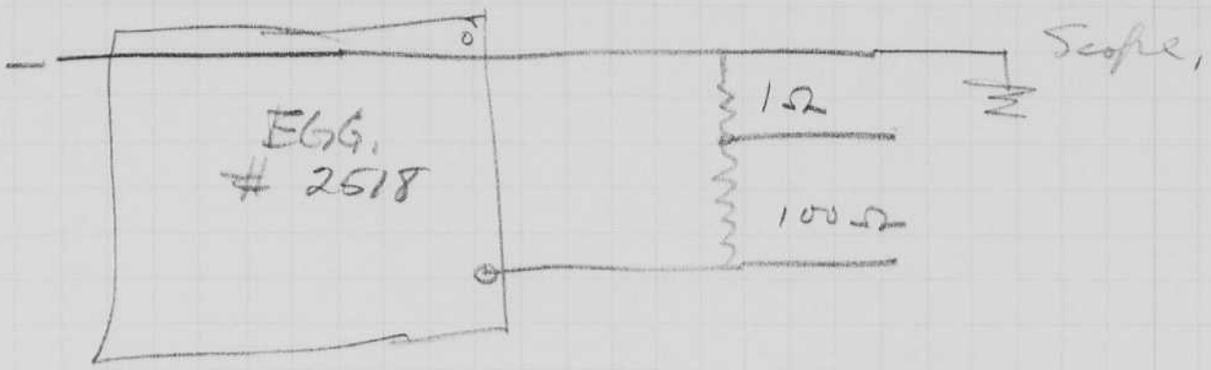
In the past two weeks Bill MacRoberts and I have worked on the 20 flash unit that is being made for the government. This flasher is 9 watt sec per flash and is supposed to go at 50 KC with a 3 μs flash.

A week ago we had installed three mercury-arc tubes in place of the sparkgaps. With these we did get up to 50 KC, actually about 70 or 80.

Then we put in 7 more mercury arc rectifier tubes and have been trying to get good performance. The set works quite well at 10 KC. There is a drop off at 20 or 25 in the last few light pulses. The action is different for different types of flash tubes. We have tried the FX-1
Strobolux
FT-110.
FT-125.

Further tests are contemplated within a week or so.

Load Voltage test.

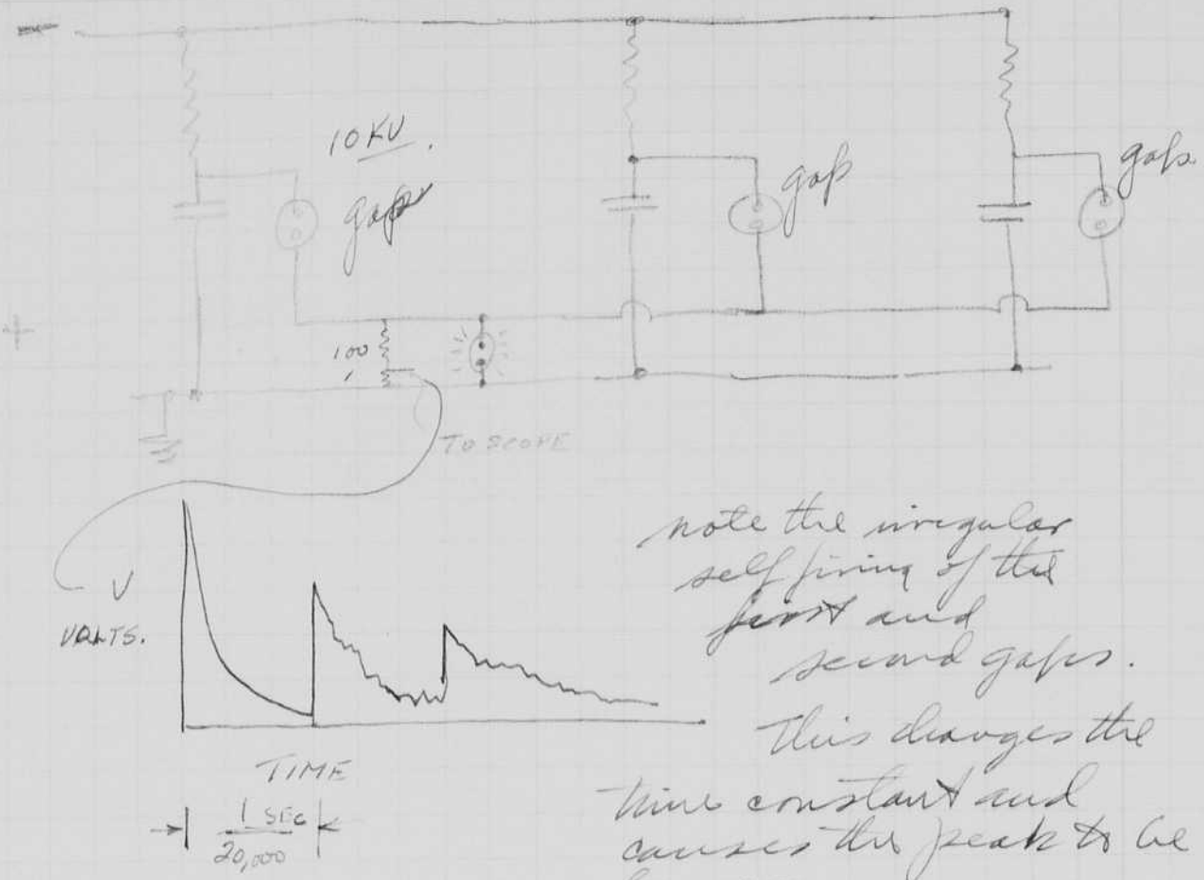


A

Osc.	Sweeps.	f.	ARC Daps.
1. Volts	50 μs/cm.	20,000	
2	"	"	
3	"	"	
4 + ?	"	"	
5	"	20000	with lamp in parallel Strobolux.
6.	"	20000	" " " " " "
7.	10 μs/cm	20,000	" " " " " "
8	300 μs/cm	2000	" " " " " "
9	"	"	" " " " " "
10	"	"	" " " " " "
MERCURY 11	volts.	100.	20,000	Wonderful! Plenty reserve of Hg # 3 on and off the circuit
12	volts.	100	20,000	with Strobolux lamp in parallel.
13	Light	100	20,000	"
14	"	100	20,000	"
15	"	200	10,000	"
16.	"	400	5,000	"
17	"	50	30,000	FT-220
18			50,000	"
19			40,000	"
20 21 22		50	30,000	FX-1 old.

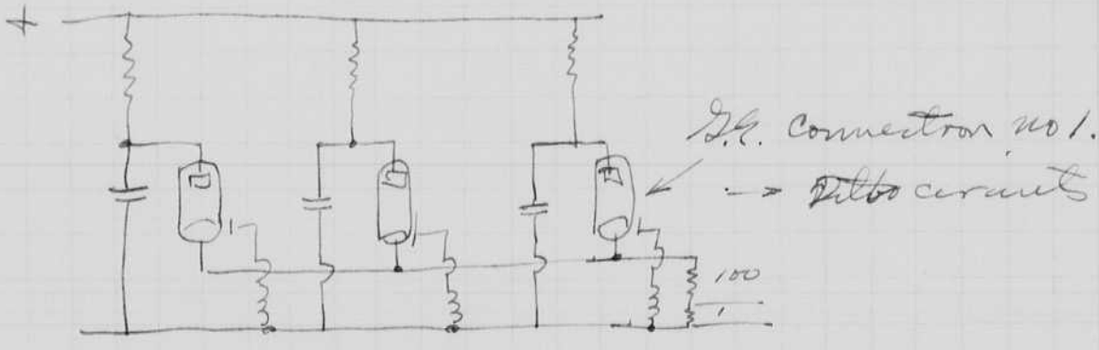
23. 3. Light output. Braun tube.

Original Baf circuit which drops out at 1000 to 5000 cycles.



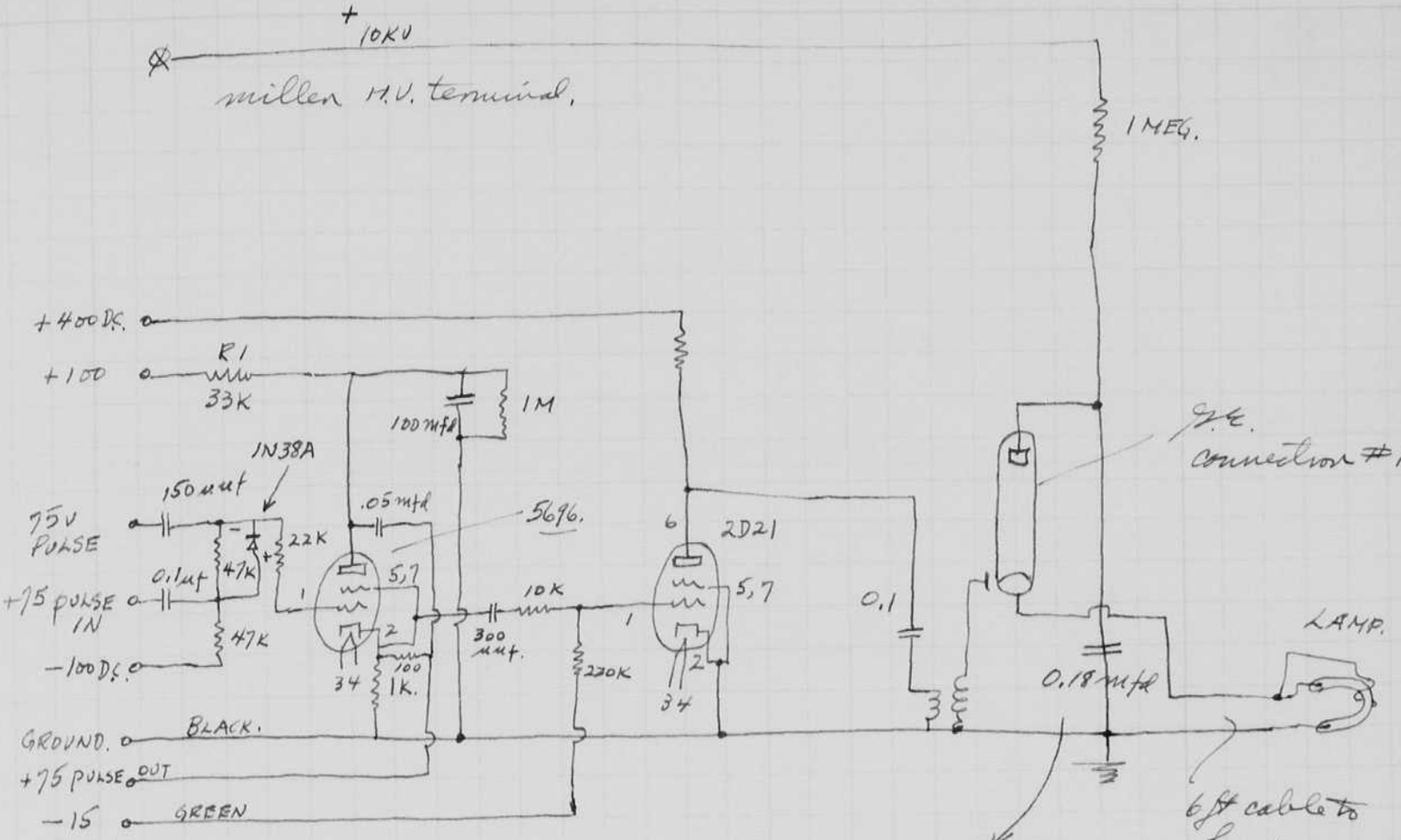
note the irregular self firing of the first and second gaps. This charges the time constant and causes the peak to be lower.

The same experiment was made with mercury tubes.



Operation ok at 20 KC with 100 ohm load.
Operation N.G. with 1 ohm lamp.

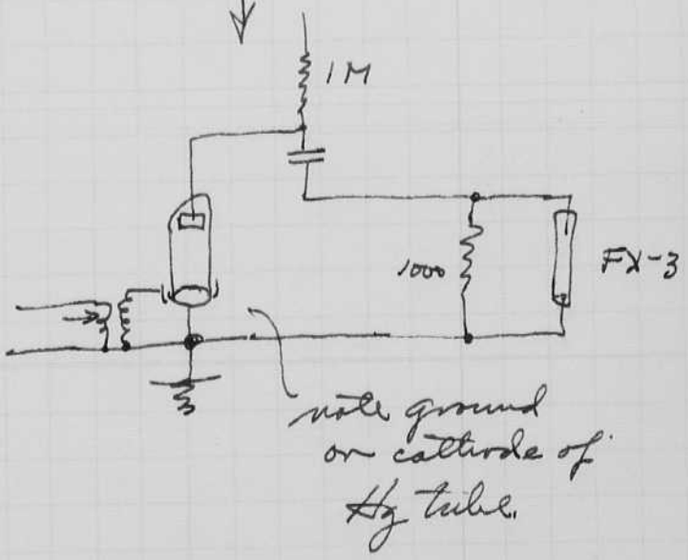
Delay panel for 20 flash unit.



Winchester connector. male.

Mar 10 1956

This circuit was changed later to the following.



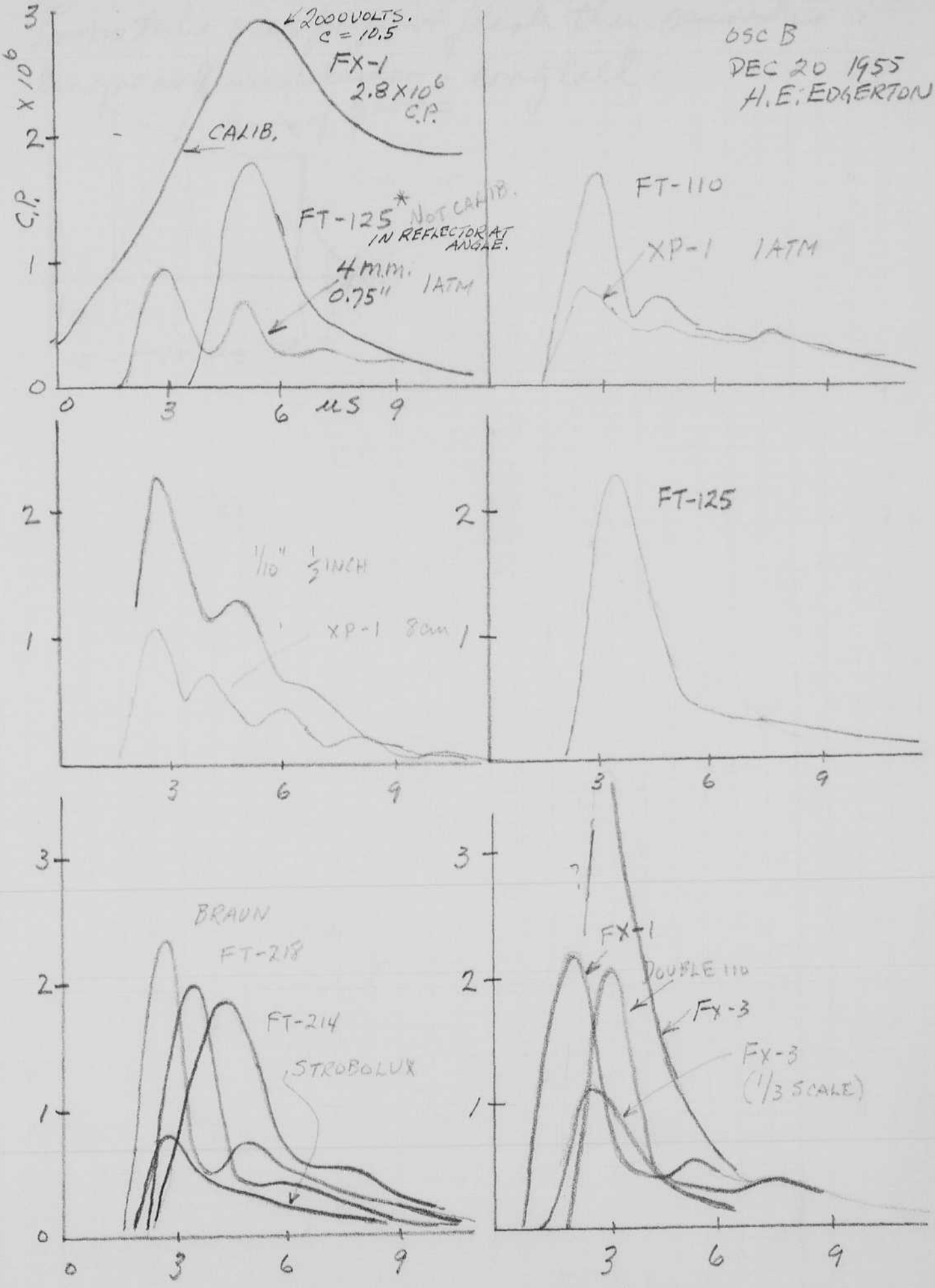
Dec 22 1950 Sight and spect.

C = .18 mfd
10 KV
1000 ohm parallel

Osc. No. Lamp Switch Distance Calib.

B_6

1	Brown	3 cm/sec	30"	3cm = 15V
2	"	"	"	"
3	FT-218	"	"	"
4	"	"	"	"
5	Stabolay	"	"	"
6	Stabolay	"	"	"
7	FT-214	"	"	"
8	FT 214	"	"	"
9	FT-210 Double			
10	"			
11	FX-1	"	"	"
12	FX-1	"	"	"
13	FX-3	"	"	3cm = 15
14	FX-3	"	"	3cm = 45
15	125-Straight	"	"	3cm = 15
16	"	"	"	" "
17	1/10" 1/2" long	geo orch?	"	"
18	"	"	"	"
19	.05" 1/4"	"	"	" 8 compressions
20	"	"	"	"
21	geo			
22	.05 1/4"	"		1 atmosphere
23	"	"		"
24	FT-110			
25	FT-110			
26	1/4 mm 3/4" 1 atm x cm.			all same
27	"	"	"	"
	1/2" orifice 1 atmos. allen tube 1 cm diam - Exploded!			
28	geo			
29	geo			
30	FT-125 in Reflector at 30° angle.			
31	FX-1 10.7 mfd 2000 volts calibration.			assume 2.8×10^6 c.t. peak
32	" " " "			



One flash operation. A second flash is longer than the first.

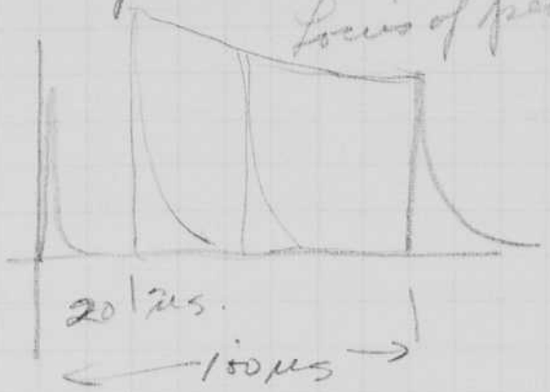
60 Dec 22 1955 Liquid and part. C = .18 mfd

Ore No. 1

B.

	1	B
	2	
	3	FT
	4	"
	5	Finish
	6	Stock
	7	FT-9
	8	FT "
	9	FT "
	10	"
	11	FX-1
	12	FX-1
	13	FX "
	14	FX "
	15	125 "
	16	"
	17	1/10" 1/4
	18	"
	19	.05" 1/4
	20	" "
	21	Zero
	22	.05 1/4"
	23	" "
	24	FT-11
	25	FT-11
	26	4 mm "
	27	"
		1/2" gap
	28	Zero
	29	"
	30	FT-12
	31	FX-1
	32	"

Looks to be 3 μs for first flash then second is longer and maybe higher - long tail.

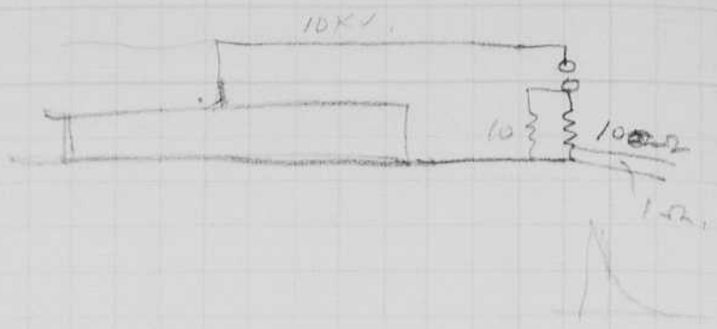


one flash operation. A second flash is longer than the first.

Dec 23 1955

Edgerton
Mac Roberts.

Osc C. Tube f.



220 10, KC
220
220
220

#16 F1-3 10 KC.
"
"
"

Operation ok before
M.G. after ?!!

Shows green glow with
Sparker.

Dec 26 1955

Fred Barstow came in about noon Dec 23 for several hours.

The operation of the 20 flash unit looks black. We cannot meet the specifications at present. These specs are.

3-microsecond exposure.

50 KC flash rate.

9 watt sec. per flash at 1 c.p.s. watt.

It appears that we must comprise in some way to deliver the unit. I suggested to Barstow that we take this up with the people who ordered the unit, since they are best qualified to decide.

Late on Dec 23 I used a strobolux lamp and reduced the voltage. I was able to meet all the requirements except the 9 watt sec. per flash. Possibly this is the compromise to suggest.

There is trouble with irregular firing time when a low impedance lamp is used. We must find why and how the lamp transient trigger the other stages.

Dec 27 1955
H.E. Edgerton.

20 Flash Unit.

106/60 (B)

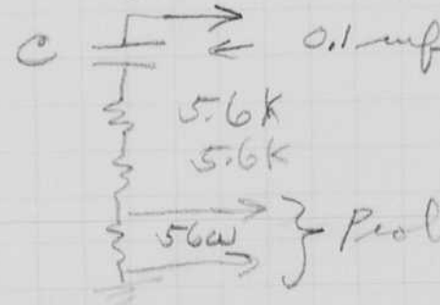
010A

1. Grid signal on 5th stage. trigger from first ✧.
   10-30 volts/cm. 50 KC
   50 μs/cm.
2. Same but with the 10 μs/cm sweeps
3. Spark coil secondary voltage 2nd stage 10 μs/cm
   30-100 volts/cm 0.X10 x ? cap pickup.
4.

Dec. 30, 1955
F.E.B. ristow
V.E. MacRobert

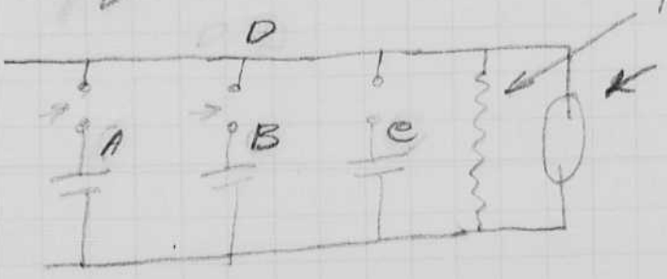
20 Flash Unit

Oscillograms using the following dividers.



Capacitor C is used to block DC when main amplifier voltage is viewed.

1500 ohms.
FX-1



Dec 30 '45
FEB and Boats
VF Proof Boats
cont.

1. Voltage at A — 7000 volts — 1 m-sec/cm
other units disconnected. — 30,000 ~ — Trig from unit A

2. Ditto

3. Voltage at A — 11,000 volts — 1 m-sec
other units disconnected — 30,000 — Trig from Unit A

4. 7 shots taken one showed oscillations, other did not.

New film

4. 3 units connected — 7000 volts — 5 m-sec/cm
Voltage at A — 30,000 ~ — Trig from Unit A.
Usually second time does not occur. Second time triggered by osc. at time B fires.

5. Ditto
except Voltage at B — Trig from Unit B

6. Ditto
except Volt at C — " " " C

7. 3 units connected — 8,000 — 15 m sec/cm
Voltage a D — 30,000 ~ — Trig from Unit A

8. ditto except 10,000 v.

9. " except — 11,000 v — 5 m-sec/cm
10 0,000 ~

Note - other Trigs this occurred at lower voltage & much longer Trig, but necessary to increase to these values for consistency

Dec. 30 - cont'

10. Same condition as 9. except one taken at Position A

11. Ditto 10. except one, at position B.

12. " 10. except one, at position C.

Jan. 3, '56 E. Mack. J.E.B.

The 20 flasher was set up with the hydrogen gap and 3 air gaps.

It was found that the hydrogen gap conducted in the reverse direction when succeeding gaps were fired. This occurred even when high voltage was not applied to the capacitors of the hydrogen gap system, or when the hydrogen gap had not been triggered previous to the gap in the next position firing.

66 Jan 7, 1956. multiflash testing

Harold Edgerton
Vernon MacRoberts. Denys Akhurst moved into Burton Hall on Dana St today

We first sent Greenewalt's flash unit to Wilmington by air to arrive at 5.45 on flight 455. Eastern. 5300 BCPS on 3 lamps. 14 mfd at 2600 volts on each lamp. 30-35 μs duration.

This multiflash unit has caused a lot of trouble due to degeneration of the trigger gaps. I am trying to get the unit out with mercury control tubes.

We are having trouble with spurious (1) firing of the circuit and (2) deionization and (3) length of flash.

Removed units 1 to 5. In
(1) Insulated capacitor cases from ground and each other.
(2) Separated capacitors into 1 and 5 groups so that selection could be made at will. .03 mfd at 10 KV = rating.
(3) Put in new capacitors.
4. Soldered clamping ground or electrolyter capacitor.

Operation on 1-5 tubes at 20 KC. Some flashes weak at 50 KC.

20,000 cycles = 50 μs betw
30,000 = 33 μs

1100 f/sec. = 12,000 inch/sec

$33 \times 12{,}000 \times 10^{-6} = d = 50 \times 10^{-2} = 0.5$ inches.

Dr. Clark visited me at my home at 205 School St Belmont and showed me his records of light as measured with a photomultiplier tube in the ocean. His previous experiments had been with a photovoltaic cell. These only extended to 200 meters below the surface.

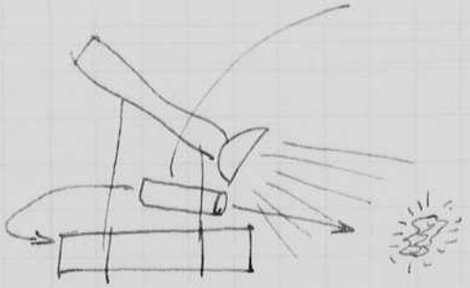
Clark uses a 5819 RCA photomultiplier into a Edin amplifier and a Brush recorder for the transient pulses. The max sensitivity of the system was about 10^{-7} watts/sq cm.

Records at daylight showed a log decrease down to ~~200~~ 1200 feet where the energy was 10^{-7} w/sq cm.

The night time record was most interesting since the light went down to 10^{-6} or 10^{-7} and then showed many flashes. Clark interprets these as being caused by animals etc. Clark also found that the light level goes up with depth since, as he explains it, there is an increase in the animal produced light.

I proposed that the pulses could be used to trigger a camera and thereby photograph the animal that produces the glow. This is a real possibility for a project.

Photomultiplier trigger to flash camera at time when a slowly flash is received.



931A
10^{-7} w/sq cm.
cathode area = ~~0.33 sq~~ 1.0 sq cm.
10^{-7} w received.
sens = 8200 ma/watt.
$i = 10^{-7}$ w x 8200 ma/watt.
$= 8200 \times 10^{-7}$ ma = .008 ma
$\cong$ 0.01 ma.

10^{-8} flash → 0.1 ma.

Better to use a larger cathode device.

Jan. 8, 1956.
Harold Edgerton.

Conductivity of Xenon Gas tube.

Use FX-1 as example.
When at 2000 volts and 100 ~~amps~~ the current is 1000 amperes.

$R = 2 \text{ ohms} = \rho \frac{6''}{\text{area}}$ $\quad 6'' = 2.54 \times 6 \text{ cm}$,

$\text{area} = \left(\frac{.4}{2}\right)^2 \pi$

$2 = \rho \frac{6 \times 2.54}{\left(\frac{.4}{2}\right)^2 \pi} = \rho \frac{15}{.125}$ $\quad .04\pi$ sq cm.

$2 = \rho .062 \quad 120$

πR^2 ○
$R = 2 \text{cm}$.
$\text{area} = .04\pi = .125$

$\rho = \frac{1}{60}$ ~~mho~~ ohms/cm. $= .0166$ ohms/cm

$\sigma = \frac{1}{\rho} = 60$ mho/cm.

$\frac{1}{R} = \sigma \frac{\text{area}}{\text{length}} = .5$

$\sigma = \frac{1}{R} \frac{\text{length}}{\text{area}} = \frac{6 \times 2.54}{2 \; .2^2 \pi} = \frac{6 \times 2.54}{.2 \times 5} = \frac{6 \times 2.54}{.125} = 60$ ✓

Resistance of 1/4" tube with .05" diam

$\text{area} = .025^2 \times 2.54^2 \pi$ sq cm.
$= .062^2 \pi = .0122$ sq cm $\frac{.06}{.06}$ $\frac{.0036}{3}$ $\frac{}{.0108}$
$\text{length} = 1/4 \times 2.54 = .63$ cm

$R = \frac{1}{60} \frac{.63}{.0122} = .86$ ohms

$\frac{2000 \text{ V}}{0.86} = 2330$ amperes.

Real Small tube length = 0.1 inch = .254 cm

area. diam = .010

area $.0122 \times \frac{1}{25} =$

$R = \frac{1}{60} \frac{.254}{.0122} \frac{25}{} = 86$ ohms.

2000 / 8.6 = 232 amps measured.
400 / 8.8 = 45 amps
Experiment at 200 amps 2 ohms

See calculation about this eff.

Experiment shows it much lower than 8.6 ohms ?

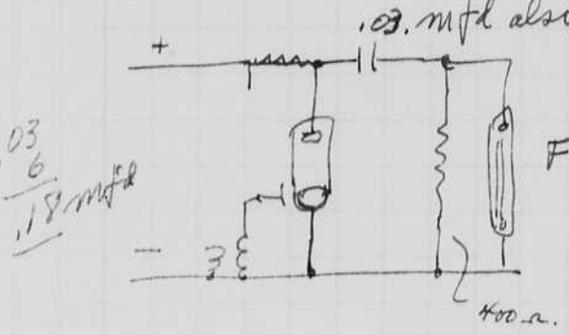
L = ~~0.17~~ lumen sec/sq ft ok for Ektachrome. ASA 10,
L = ~~0.2~~ " " " " " an average value to use.

Jan. 15, 1960.

~~Thursday~~ Wed - conference by Amer acad of Science. Loeb, etc.

Thursday conference at Hascomb field Bedford on
Friday pulsed light etc. Hantz Insider.

Barstow and MacRoberts worked thursday Fri (also sat) on the 20 flash unit. They were working with hydrogen thyratrons with cold cathodes - using them as gap switches.
I hope to continue mercury arc tests next week.



Try this to see if coupling from flash into control circuit is eliminated..

Up to now we are getting trouble from the main bang into the control circuit. I have a suspicion that it comes from sparking (bad connection) capacitors or from the coupling into the spark coil from the cathodes of the mercury-arc tube.

The above circuit will enable me to see if the second cause has any effect.

70 Jan 18 1956.

Harold E. Edgerton.

I worked with Roy last night on the layout for the 5 flash unit.

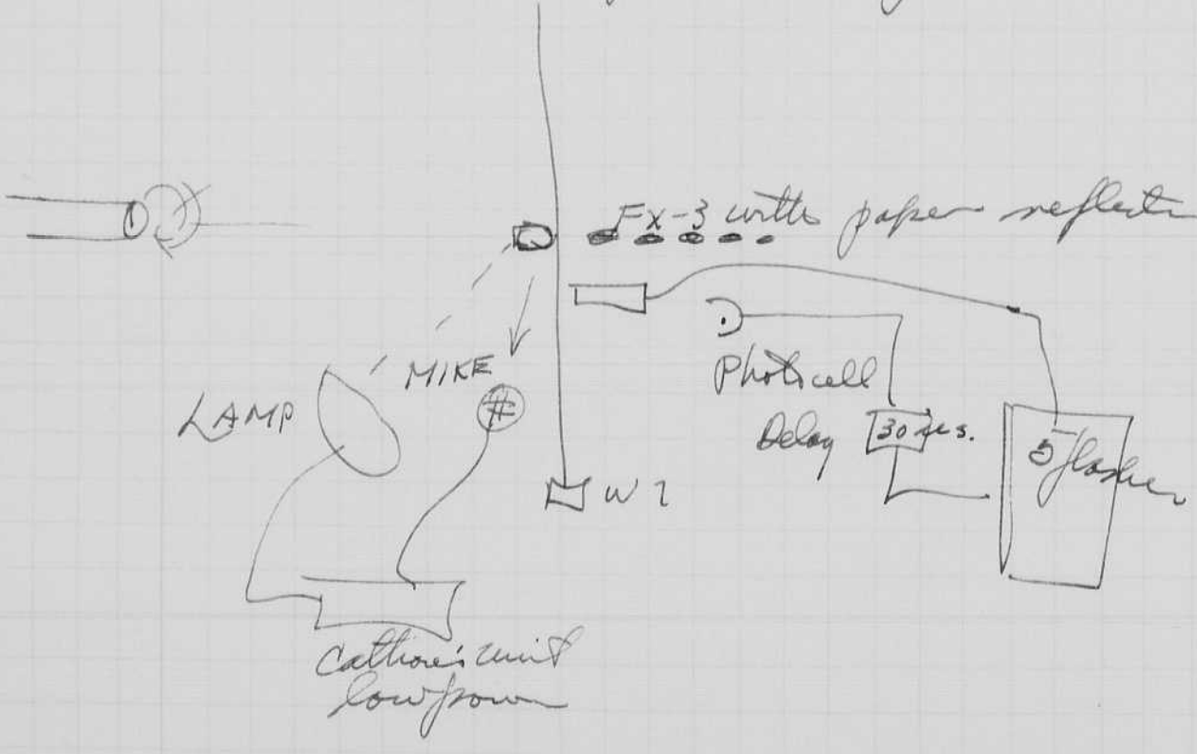
We tested the Explosion Shutter Power unit # 3180

Also looked at 250 c.p.s. marker # 3122.

Jan 18 56 cont. Bill Mack finished wiring the 5 mercury arc tubes as per page 68. He increased the trigger spark capacitor to 0.1 mf from .05. to eliminate skipping of the Hg tubes.

He also put in a 5 ohm resistor in the cathode circuit which seems to even out the flashes and also apparently helps out the starting.

I hooked the equipment up as follows just with a 22 caliber a string was put in the field.



The first photo caught the #1 trigger bullet just as it touched the string. The next 6 from the 5 flasher started after 30 ms. The rate was 50,000 cycles or 20 ms between.

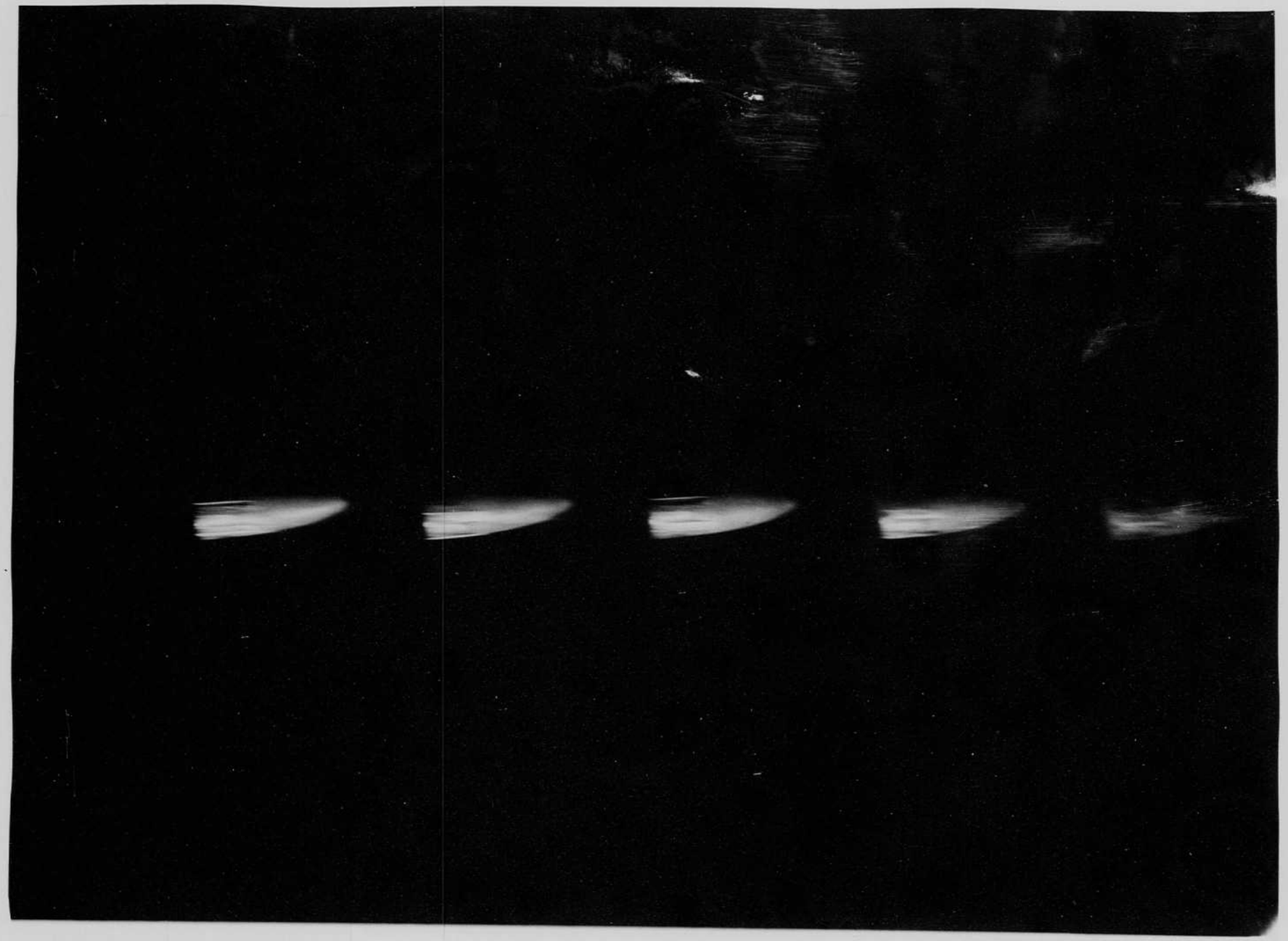
I then took some without a string at 100 KC and another at 25 KC since the images overlapped with the 22,

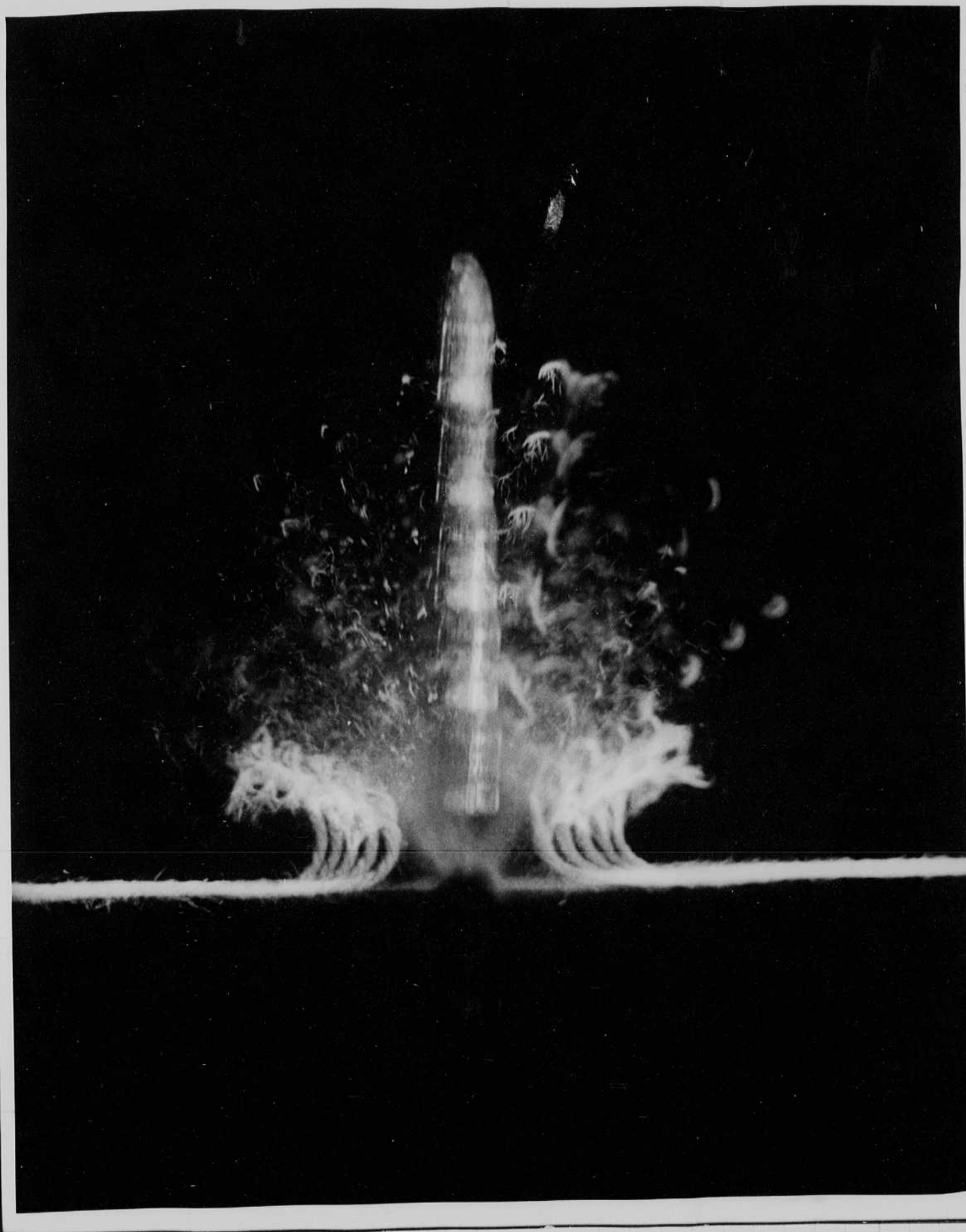
next I fired a 220 Super Speed Swift

1. The first shot was of a string. The photo showed late. 50 KC
2. Ditto on one without a string.
3. String again also late but shows velocity and motion of fragments.
4. Series of mike microscope works ok 5 shots - now show tip of bullet. 50 K.C.

Bullet.

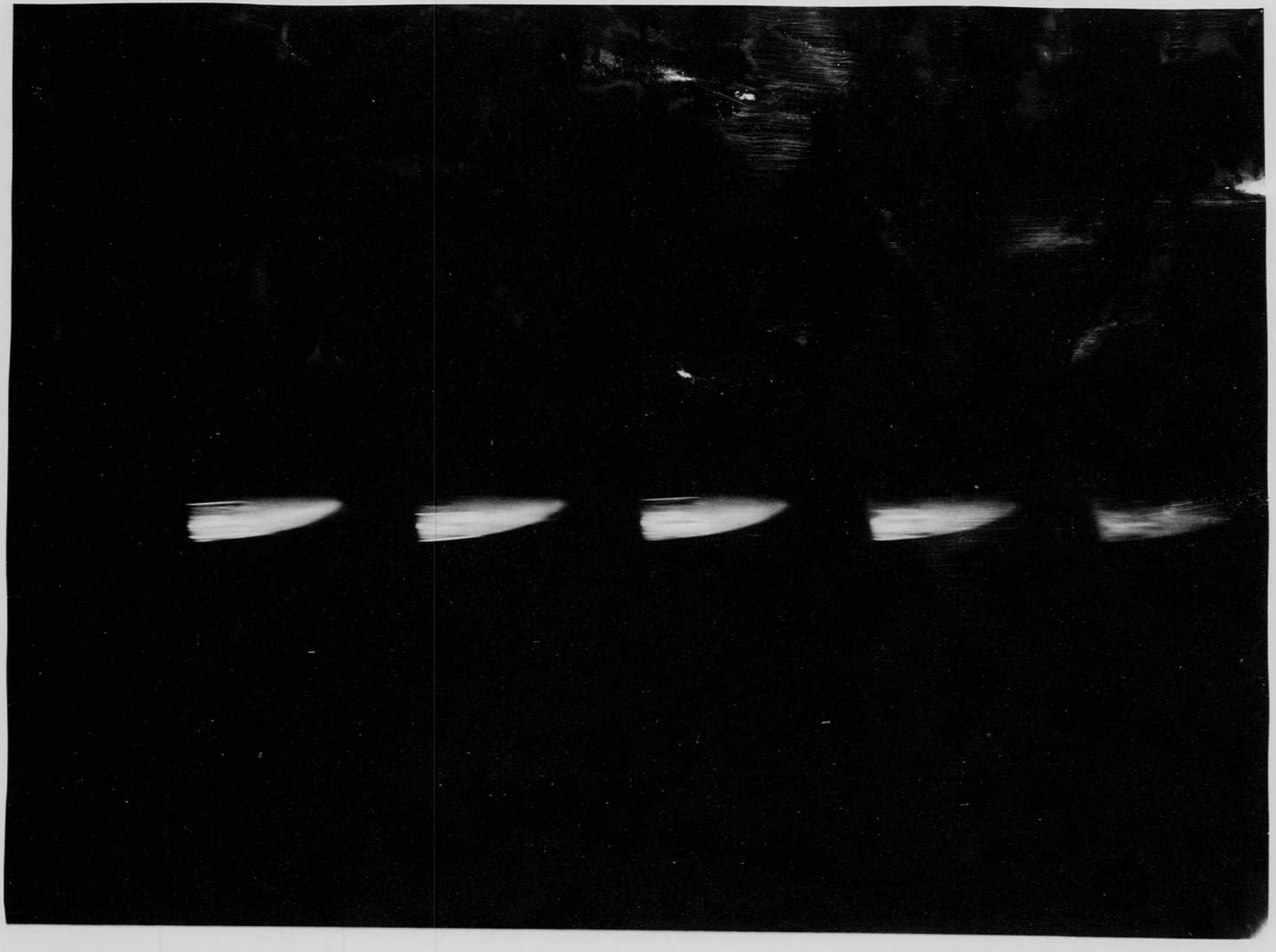
22D SWIFT 50 KC LIGHT.

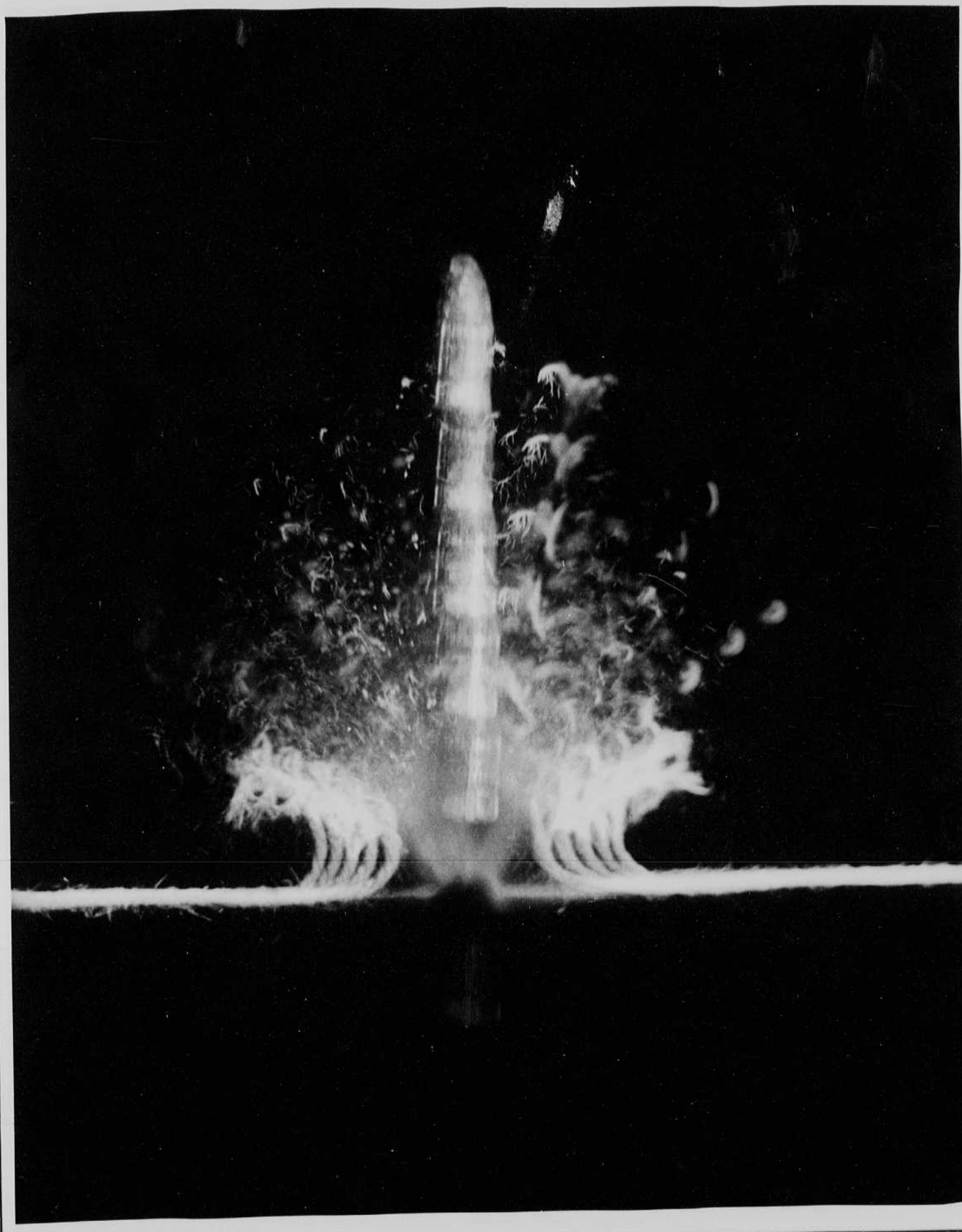




20 CAL. INTO STRING 50 K.C.

220 SWIFT 50 KC LIGHT.





20 CAL. INTO STRING 50 K.C.

74 Jan 20. 1956
Harold E. Edgerton

The results of the multiflash at 50 KC is on the previous two pages. I also took some shots at 100 KC. A capacitor of .03 mfd was used at 10 KV with a FX-3 lamp. The new circuit uses a grounded cathode ~~and anode~~ which apparently gets away from self starting and lock flashing.

Today Bill connected a series of 5 tubes with .1 mfd. The peak light was 2½ times and the duration 3 ~~MS~~ instead of 1.

The equipment ran ok up to 50 KC — also ok at 100 KC. This is great.

Woodbury
Double flash

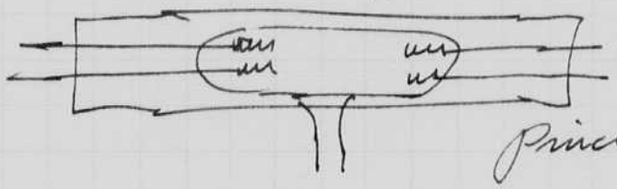
Sol Buchsbaum Jan. 22, 1956.
H. Edgerton

I.D. = 8.6 mm Nonex
length = 8"
1 mfd
Helium gas 10 cm 4 KV for first few tests
Strong yellow green blue lines.

Press	min	Self flash.	
5	3000	4200	Single turn 1/3 from + side
10	4800	4800+	
5	3000	4000	
3.±	2700	3800	
1.	1800	3300	
3.5	2800	4000±.	

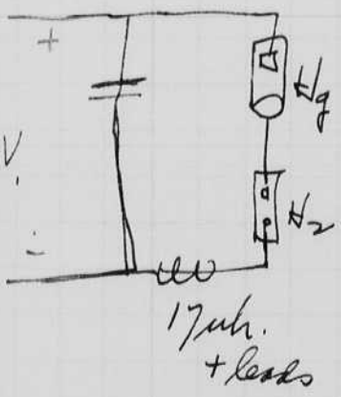
Jan. 24 1956. Tests on Hydrogen tube.

Pumped 3 H. Quartz tube.
about normal size 1 & 1. 2.



Pinch seal.

Heated and exhausted.
Filled with H_2 at 2 cm. Oh at 1 mfd 2 KV
then put in 10 cm H_2.



Broke when flashed 10 times at 1/2 second intervals from 7 mfd at 2 KV. ±.
the seal broke. this seal is a ribbon type.

The mercury tube enables us to fire the Hydrogen tube at high pressure.

Continuous current in tube.

Series of tubes:
20 ~~30~~ cm. in tube 1" space 3/4" apart.
2 mm I.D. quartz.

3 KV with series limit 1 mfd.

Pressure reduced to ~~30~~ 10 cm. (P. 53 min star
Starts at 2 KV. 3 mfd

2 KV. " 7 mfd
continuous and very bright spectrum
only for the 7 mfd example.

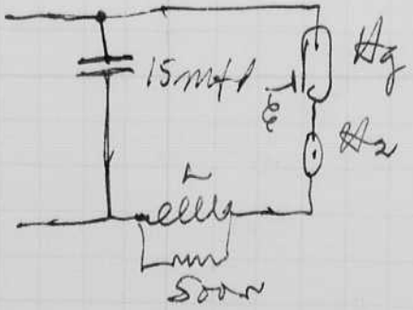
new gas ~~30~~ 10 cm H_2. min breakdown = 1900. volts.
—— 6 cm H_2 " = 1400
—~— 2,5 " H_2 " = 900.

1000 ~ Red line alone
1200 ~ many lines appear.

new gas 11 cm. 2 KV 1 mfd few lines
2 KV. 4 " many lines.

new choke 0.2 mh.

15 mfd. choke 2,2 + 3,5. pressure 7.5 cm.
1800 ~. Red line.
2000 ~ other lines come in.
Sealed off at 7.5 cm?



Jan 29 1956 Tests on XP-2 tube or Pump. xenon gas.

Harold Edgerton

20D-102

Breakdown self-aband 750 to 1000 volts.
Spark - 350. with 2 cm of xenon gas.

these results are higher than those of Cathon.
I did not heat tube.
Now baked.
New gas - about same as above.

Scope 513D Tektronix
P.C. 935 + glass into 1000 ohms 2000 volts.
12" P.C. to tube.

Pressure cm	V.	C.	Dur. μs.	cm.	volts def. V.	
1.9	750	1 mfd.	1.3	2.2.	22.	1.02×10^6 C.P.
"	500	1 mfd.	"	1.4	14	.65
3.3	500			1.7	17.	.78
"	750			3.5	35	1.62
"	1000	Self flashes after first Pols.				
4.7	500			1.8	18.	.835
	750			1.4×3	43	2.0
6.3	750			1.5×3	45	2.1
	500			1.8	18	.835
8.1	500			1.8	18.	.835
8.1.	750			1.5×3	45	2.1
8.1	1000			2.7×3	81.	3.76
8.1	1000	.75 mfd		2.×3.	60	2.8
	1500	Def of breakdown. ±				
	1000	0.1 mfd		1.5 to 1.9 × 1/3.	.5 jittery	.232

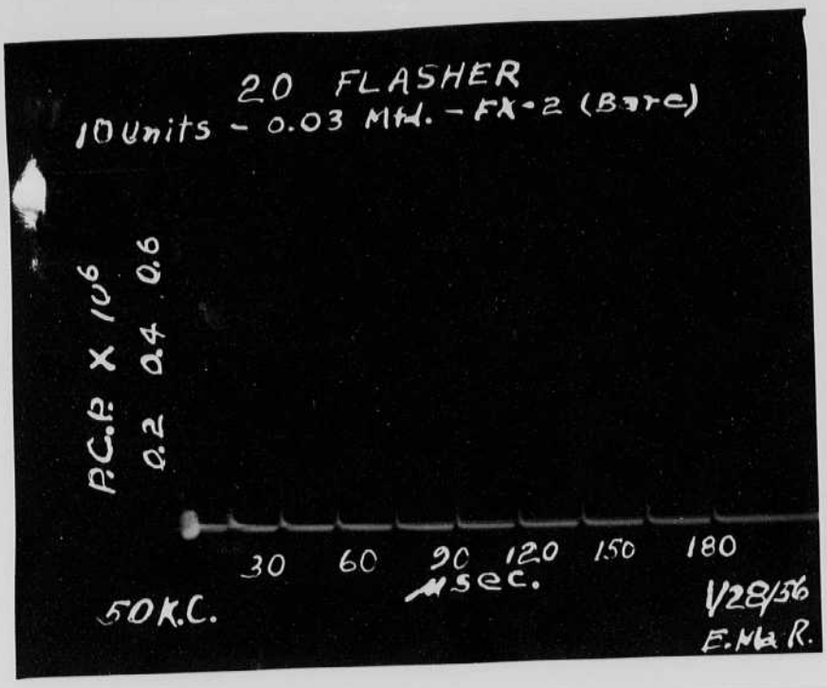
Long rise?

Scaled a/f at 8 1/4 cm.

FT 7.8
Calibration 2000 100 mfd. 2cm×3 60.
629 C.P.S.
peak. 2.6×10^6 C.P.S. at 3 ft.

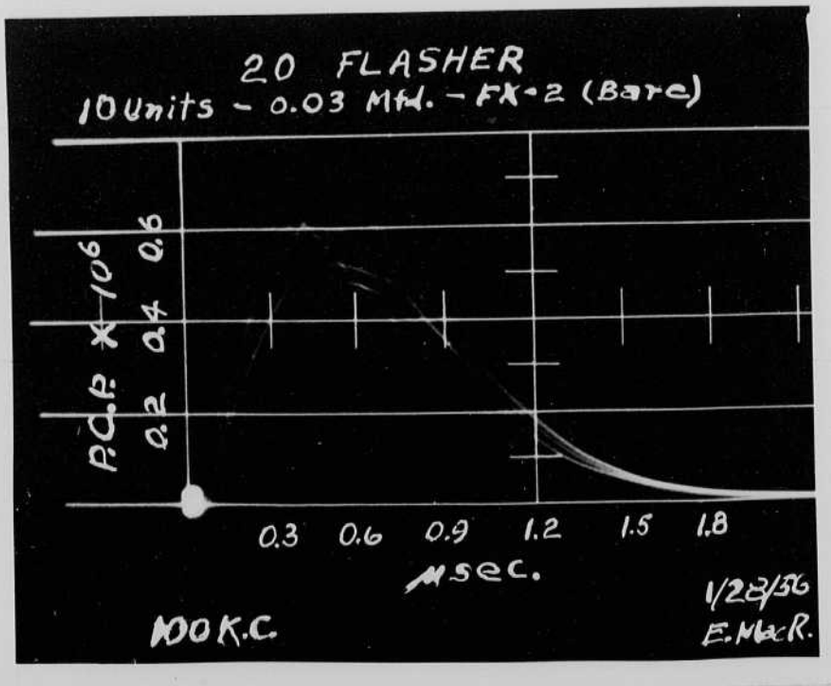
60 volts = 2.6×10^6 C.P./3²
1 volt = $.43 \times 10^6$ C.P./3²
1 = $.047 \times 10^6$ lumens/sq ft at 3 ft.
above at 1 foot 1 volt = $.43 \times 10^6$ C.P.

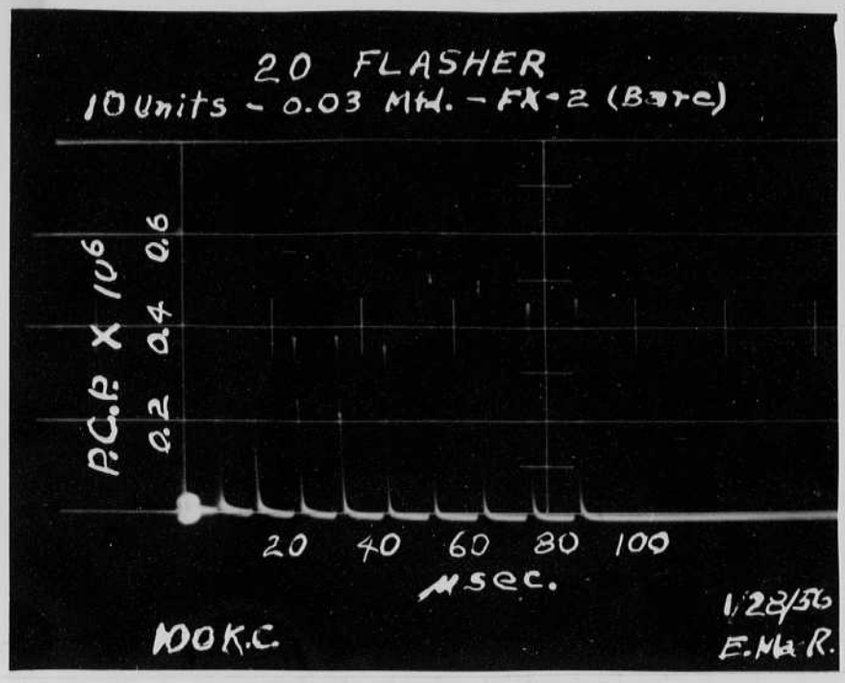
Oscillogram 0.5 μs per cm.
1.5×10^6 C.P./cm, .015 ohms.
50 V = .7 cm calib for comment.



50 Kc operation 20 μs between flashes

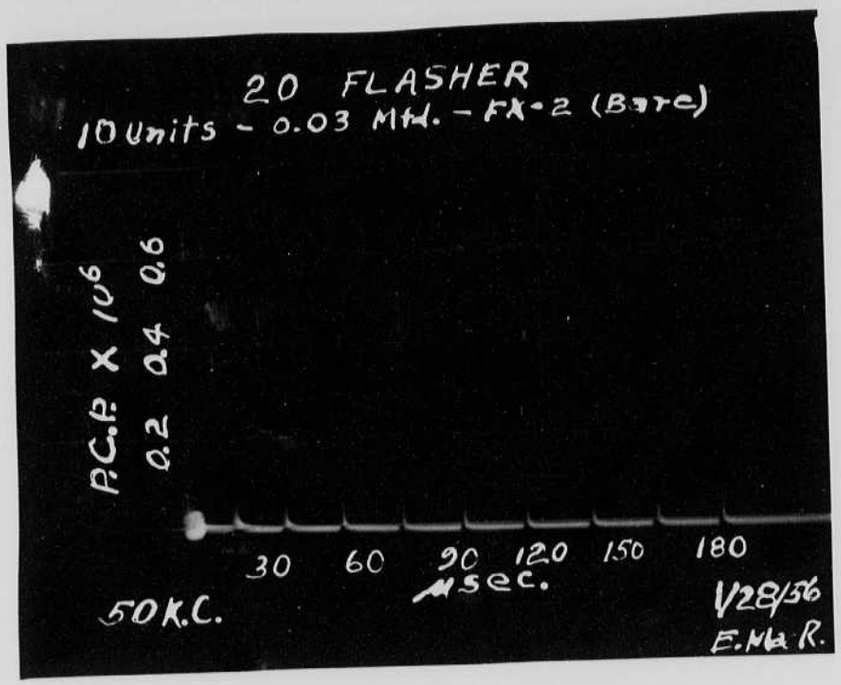
Duration shot 10 superimposed sweeps





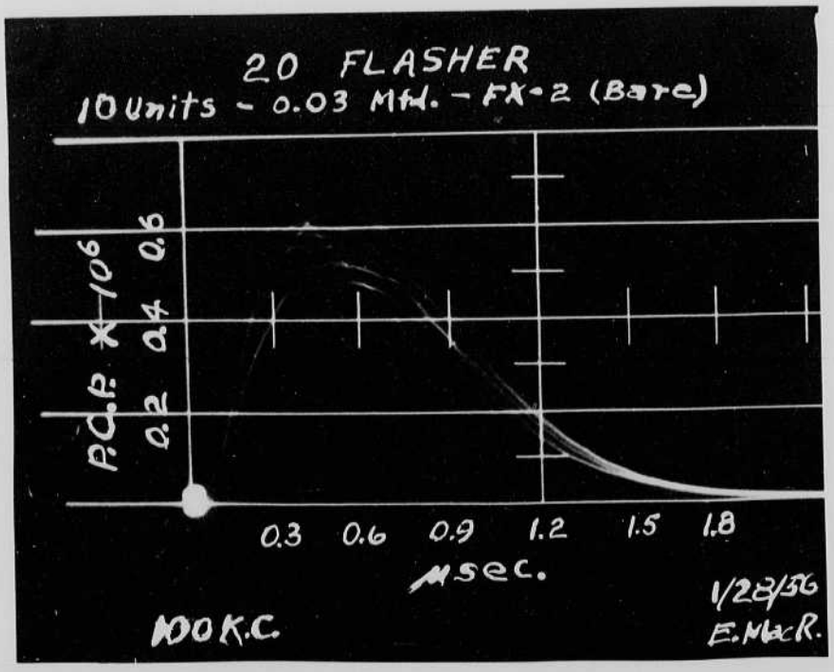
100KC 10 μs between shots.

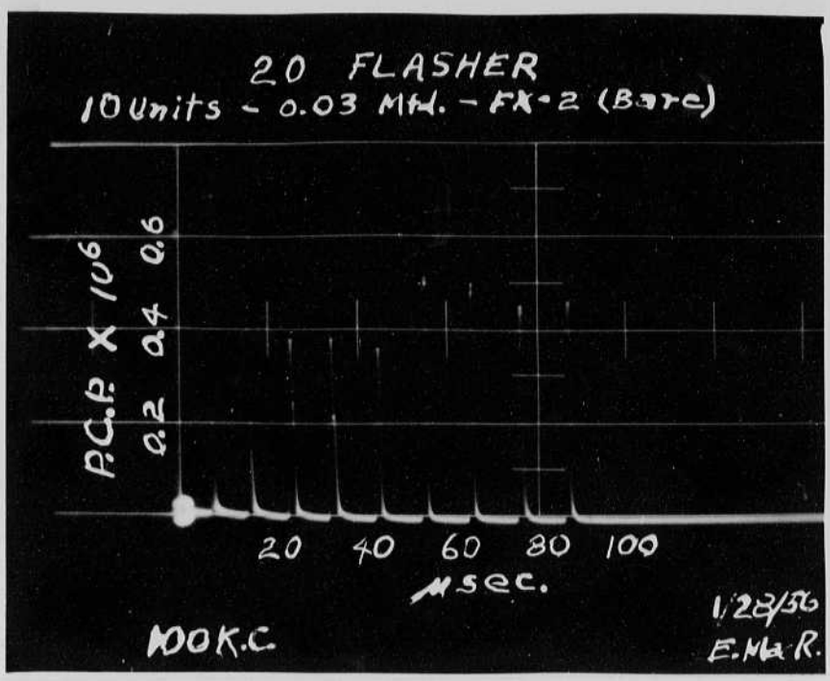
this equipment was operated on Sat at 100 kc for bullet photos of string and 22 caliber bullets. Mr. Grossman was here on Monday for a conference and demonstration. He okeed changes in the contract for 100 kc with 1 μs exposure and 1.5 watt/sec.



50 Kc operation 20 μs between flashes

Duration shot 10 superimposed sweeps





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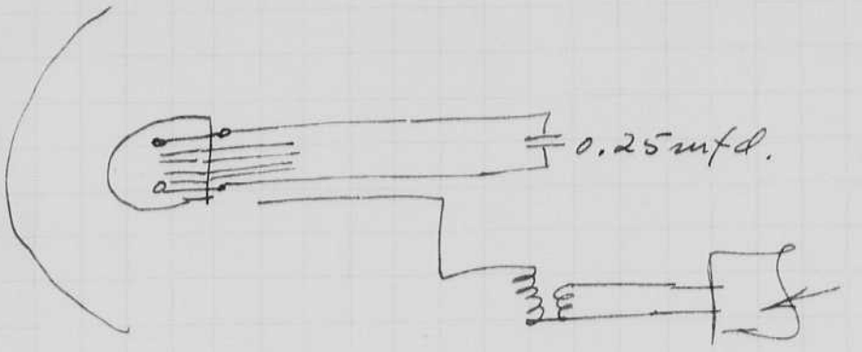
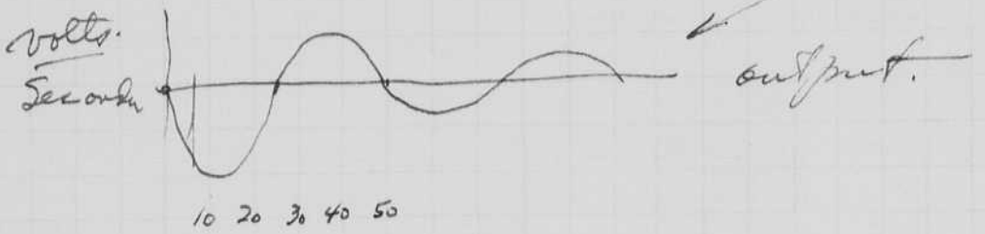
Jan 30 1956.

Harold Edgerton. — Tests of Sennheiser Xenon gap tube.

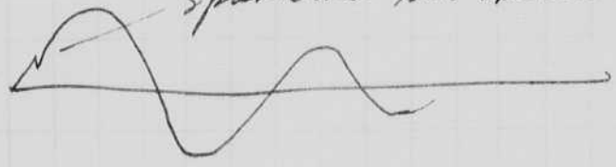


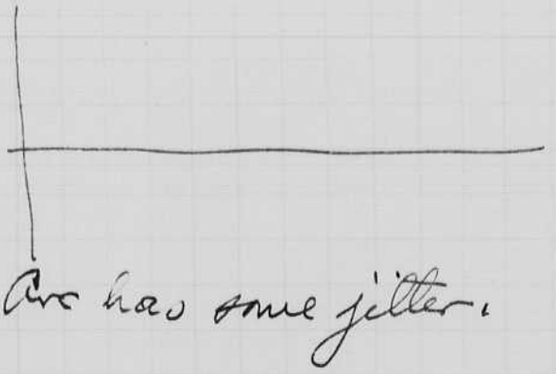
Modelectric coil.



Coil terminals reversed

Sparkover in Xenon tube.





Arc has some jitter.

July 11 1956. This tube was sent to Sennheiser to test with their new and Weltron of 4 K. test circuits.

I put in an XP-2 tube which has about 8.2 cm of xenon.
Starting voltage to glow - about 400 - are 450.

Remark with 1/4 mfd at 600 over ~~60~~ 60 cycles
with 0.25 mfd. S/fly seems higher than the
gap tube. ? 2000 ohm charging resistance.

$\frac{CE^2}{2} = \frac{600^2}{2} \frac{1}{4} = \frac{.36}{8} = .045$ watt sec. $\quad \frac{.045}{60}$

2700 watts for 60 cycles.

at 800 volts 1/4 mfd operation ok up to 240 cycles
on strobotac driver with reduced spark or coil.
About 1/8" spark.
Tube red hot on the inside.

8cm xenon.
Photo cell output
.05" capillary. 2000 Ω 2 μsec duration 2.5 volts 3 ft from photocell
Germ tube 1.5 μsec 5.5 volts

With 82 Ω 11.5 Volts = 3×10^6 PHCP
.05" Capillary $\frac{82}{2000} \times \frac{2.5}{11.5} \times 3 \times 10^6 =$ PHCP $= 2.68 \times 10^4$ PHCP

$$EH = \frac{(2.68 \times 10^4)\ (2 \times 10^{-6})}{.25\ (\frac{1}{2})\ (800)^2} = 0.66$$

Notebook # 23

Filming and Separation Record

1 unmounted photograph(s)

____ negative strip(s)

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

was/were filmed where originally located between page 80 and 81.

Item(s) now housed in accompanying folder.

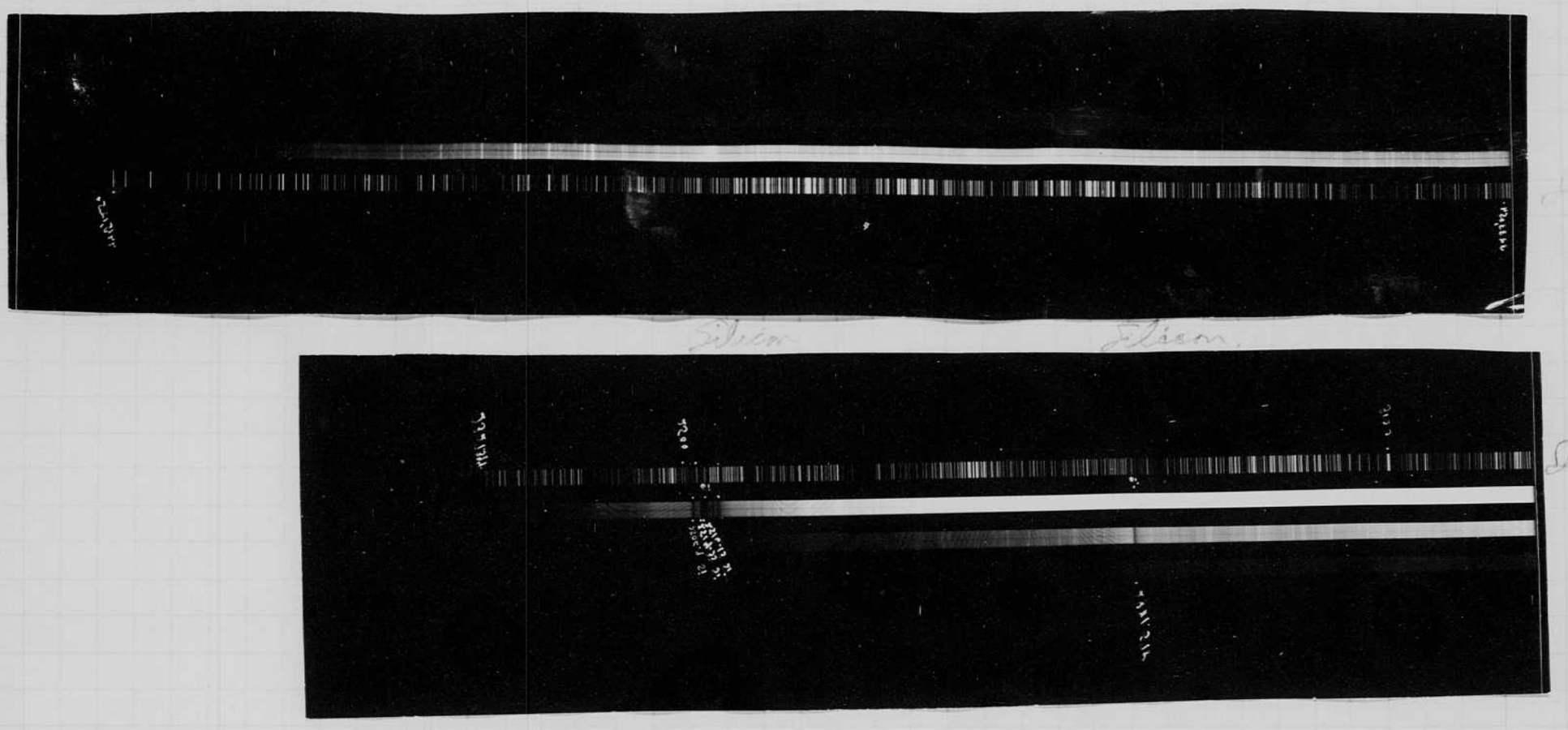
6 μs per division.

3 prop. operation

Strobolux lamps.

50 Kc.

Blue ——→ U.V.



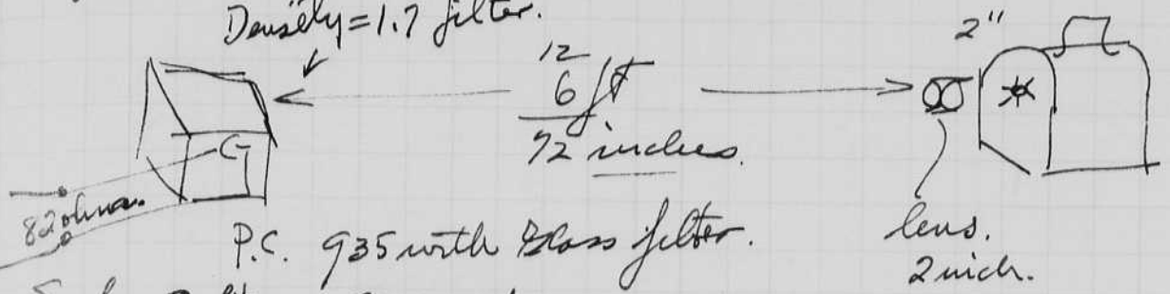
U.V.

Spectrum of the XP-2 Polaroid test tube with 0.5 mfd at 2KV. (or 0.1 mfd) taken at Jewell-Ash in Jan 1956

An Iron spectrum is used as a standard.

Intensity of the Source measurements.

Spark source. E.G.&G. Type 2314.



Scope voltage = 0.7 volts.

FILTER

3 osc. 0.5 ms/cm 82 ohm. $\frac{0.7}{2}$ volts per cm def. 2314 flash unit. D=1.7

Same experimental setup but with FX-1 100 mfd 2KV.

2 osc. 50 ms/cm 1000 ohm. $\frac{5V}{2}$ per cm def. 5½ feet to p.c. D=1.7

XP-2 1 mfd at 3 KV blew up on second flash.
#30
Shows dirt on tube walls.
Ba all O_3 particles.

---

3 osc 0.5 ms/cm 82 ohm. $\frac{7.3}{2}$ V per cm def. NO FILTER 5½ feet to p.c.. 0

XP-2 - .1 mfd 2KV

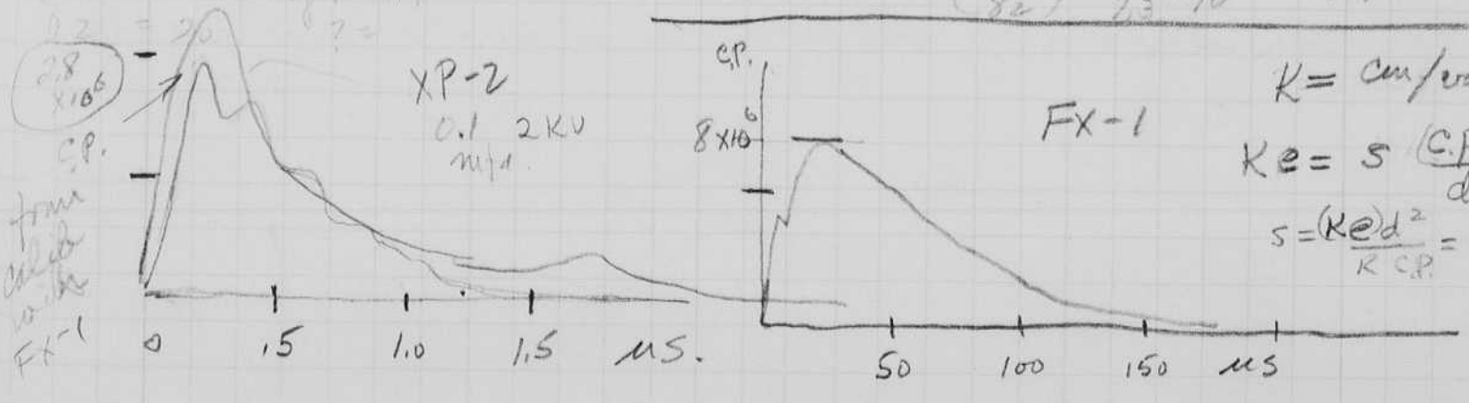
(shows with 1000 ohms about 3 ms!) ✓

Assume. FX-1 has peak of 0.41×10^6 cp/sq cm. then spark gap has.

air gap: $.41 \left(\frac{1000}{82}\right) \times \left(\frac{5}{.7}\right) = 35.6$ cp/cm²

XP2 $.41 \left(\frac{1000}{82}\right) \times \frac{5}{2.3} \times \frac{1}{10} = 4.9$

$P_1 = 10.$
$P_1 = 1.7 =$ $\log ? = 1.7$
$P_2 = 20$ $? =$



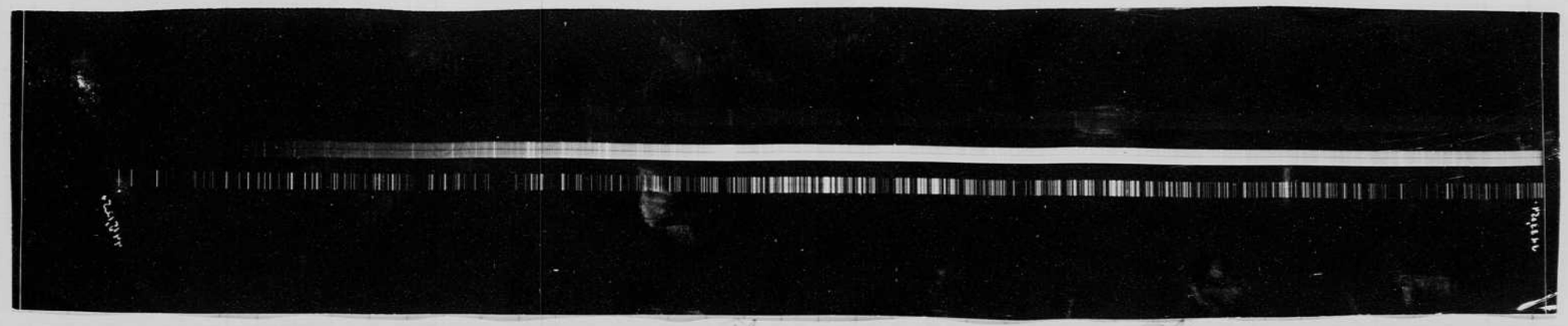
K = cm/volt.

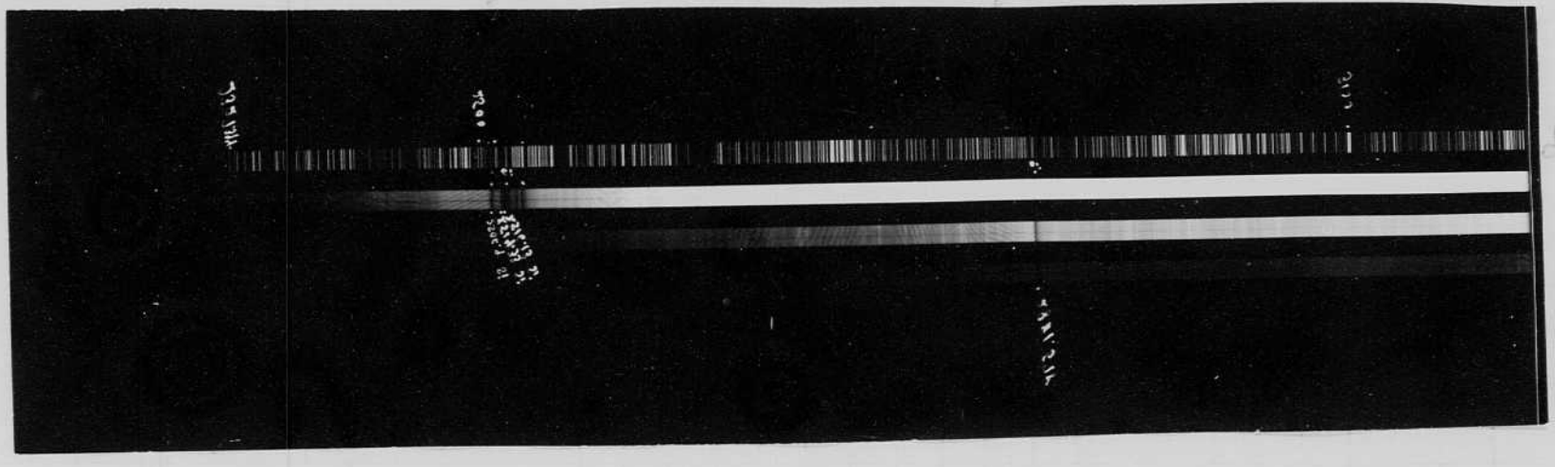
$Ke = S \frac{(C.P.)}{d^2} R$

$S = \frac{(Ke)d^2}{K\ C.P.} =$.

$\left(\frac{8 \times 10^6}{1.3 cm}\right)$:

Blue ——— U.V.





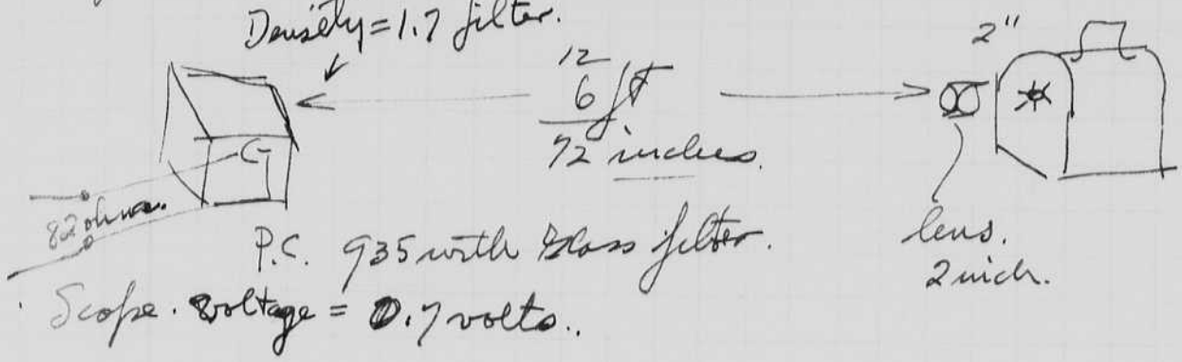
U.V.

Spectrum of the XP-2 Kodak tube with 0.5 mfd at 2KV. (or 0.1 mfd) taken at Forest-Ash in Jan 1956

as Iron specimens used as standards,

Intensity of the Source measurements.

Spark source. E.G.&G. type 2314.



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Same experimental setup but with Fx-1 100 mfd 2KV.

2 osc. 50 ms/cm 1000 ohm. $\frac{5V}{2}$ V per cm def. 5½ feet to P.C. D = 1.7

XP-2 1 mf at 3 KV blew up on second flash.
#30
Shows dirt on tube walls.
$BaAlO_3$ particles.

---

3 osc 0.5 ms/cm 82 ohm. $\frac{7.3}{2}$ V per cm def. NO FILTER 5½ feet to P.C.. 0

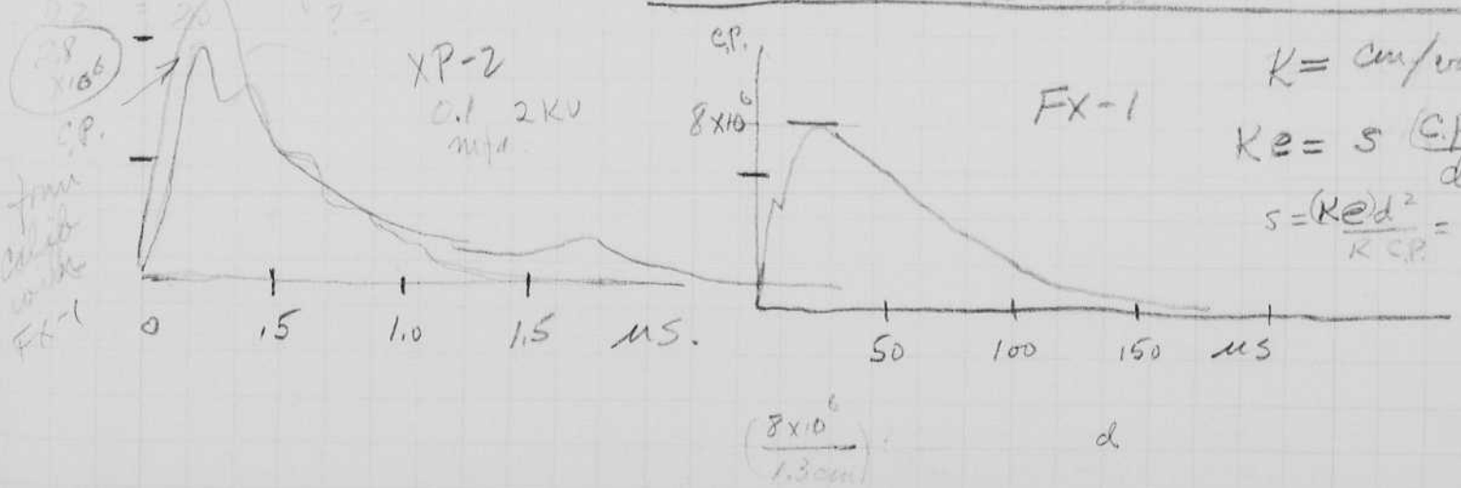
XP-2 .1 mfd 2KV

(shows with 10 ohms about 3 ms!)

Same. Fx-1 has peak of $.41 \times 10^6$ cp/cm² then spark gap has.

air gap: $.41 \left(\frac{1000}{82}\right) \times \left(\frac{5}{.7}\right) = 356$ cp/cm²

XP2 $.41 \left(\frac{1000}{82}\right) \times \frac{5}{2.3} \times \frac{1}{10} = 4.9$



K = cm/volt.

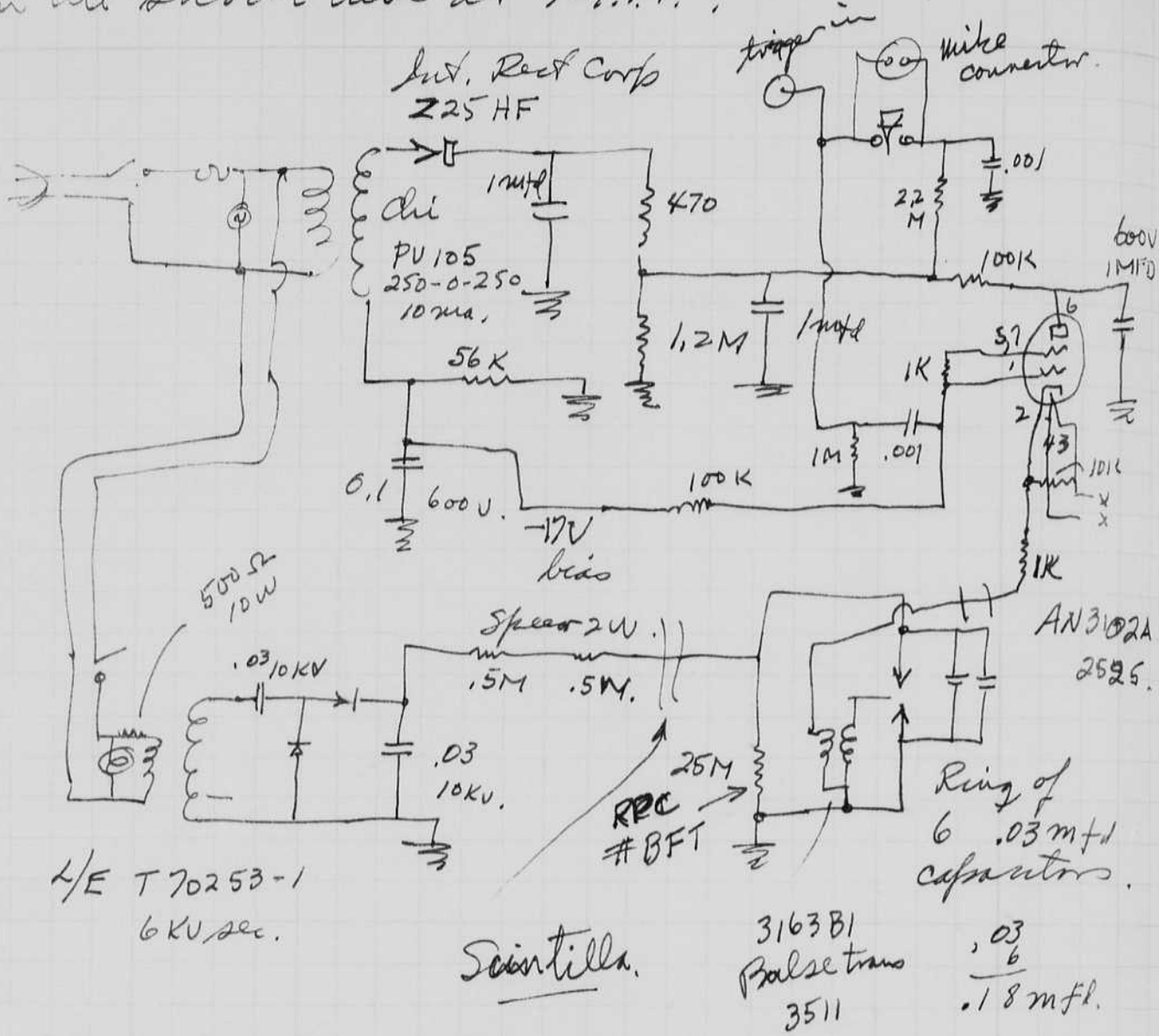
$K_e = S \frac{(C.P.)}{d^2} R$

$S = \frac{(K_e) d^2}{K \, C.P.} =$.

$\left(\frac{8 \times 10^6}{1.3 \text{ cm}}\right)$ d

Point light Source. 2314 B2 type as used in the shock tube at M.I.T.

H.E.Sog
Feb. 2, 1956.



This equipment was borrowed from the Shock tube lab today for measurement of light. It is used in the Schlieren and interferometer at the shock tube on Vassar Street.

The Shock tube is about 1/10 the cost of a wind tunnel. The M.I.T. tube cost about $100,000.

See page 83 for circuit.

Intensity tests of flash tube.

Tube.

	C	E	R	Filter	V_{peak}	Dist.	C.P./sq in
XP-2	0.1	2KV	82	0.3	2.5V	74.	
XP-2	0.5	2KV.	82	0.3	11.5V	74.	
Sir 2314	.18	10?	82	.3	11.5±	74	

Spot diam at p.c. = 3.75" (7.1) at spark diam = $3.75 \times \frac{2}{74} = 0.1$ inches

Sir 2314	.18	?	82	.3	32	74.	

Sweep 0.5 MS/cm 32 V/cm calibration.

FX-1	100	2KV	82	.3	1.1	74.	

E

NOW WITHOUT LENS

							Area.	H.C.P.	HCP/area
FX-1	100	2KV	82	0.3	2.2V	76"	1903 cm	8×10^6	0.41×10^6
"	"	"	"	"	2.4	"			
XP-2	0.1	2KV.	82	.3	.042 V	76"	0.25 cm²	$.153 \times 10^6$	0.614×10^6
XP-2	.5	2KV	82	.3	.275 V	76	0.25	1.00×10^6	4.00×10^6
Sirq+/ 2314	.18	? (10,000?)	82	.3	.562 V	76	0.1 in²	2.04	$20.4^{\times 10^6}$ 0.22

$\frac{CP^2}{2} = .18 \times 10^{8 \times 10^{-6}} = 9.0$ watt/sec. $\frac{C.P.}{Watt} = \frac{2}{9} =$ $1.15 \times 2^{\times 10^6}$ HCP = 2 HCPS.

86 Feb. 3, 1956. Phone call from H.M. Peek Los Alamos Lab today. He wants a bright xenon source for spectroscopic work. Suggests 240×10^6 lumens/sq. cm. with a 1 ms duration this is a bright source. We could do it with the XP-1 and the movie unit giving the lamp a burst of light. Am sending all the dope to Peek today.

Peek suggests ~~and~~ on and on view of a xenon flash lamp such as the FX-1. Told him the intensity might not be much greater than the side view.

Many photos were taken in the evening of ~~&~~ Winchester 220 swift bullets with the multiflash unit. Bill Parbin of the Supersonic wind tunnel helped.
We used 100 KC bullets overlapping
50 KC.
and some at 5 KC.

Strings, wires, etc were hit by the bullets. the unit was set for 10 lights. It worked very well.

Feb 4 56. Last night's photos were taken with the Speedgun reflector and an FX-2 flash tube about 3 ft from the subject.

Today I used an FX-3 about 12" from the subject with a white card above the bullets about 8 miles Royal Pan ~~A~~ X 5 film at f8. freq 100 KC.

Feb 6. Schuster came over today with P to discuss inductors and capacitors.

He wants 10,000 mfd to discharge into a coil to create a magnetic field of 300,000 gauss to deflect particles created in the ~~cyclotron~~ synchrotron.

100,000 gauss 40 joules/cubic cm needs 50cc

SPECIFICATIONS and BALLISTICS

SYMBOL	PRIMER No.	CARTRIDGE	BULLET Wt. Grs.	Type
SS22S	...	22 Short, Super Speed‡	29	Kopperklad
SS22SH	...	22 Short H.P., Super Speed‡	27	Kopperklad
SS22L	...	22 Long, Super Speed‡	29	Kopperklad
SS22LR	...	22 Long Rifle, Super Speed‡	40	Kopperklad
SS22LRH	...	22 Long Rifle H.P., Super Speed‡	37	Kopperklad
SS22LRS	...	22 Long Rifle Shot, Super Speed		No. 12 Shot
SS22WRF	...	22 W.R.F. (22 Rem. Spl.) Super Speed, Inside Lubricated	45	Kopperklad
LD22S	...	22 Short, Leader	29	Lead†
LD22LR	...	22 Long Rifle, Leader	40	Lead†
K2236R	...	22 Long Rifle Smokeless EZXS	40	Lead†
EZX22LR	...	22 Long Rifle Improved (Low Velocity) EZXS	40	Lead†
W22BB	...	B.B. Cap	18	Lead
W22BL	...	22 Short Blank (Black Powder) No Bullet		
SP22S	...	22 Short, Spatterpruf, (Gallery Pack)	29	Disintegrating†
WA22	...	22 Winchester Automatic, Inside Lubricated	45	Kopperklad
*25ST	...	25 Stevens, Inside Lubricated	65	Lubaloy
*32S	...	32 Short	80	Lubaloy†
W32L	...	32 Long	89	Lead†
W9LS	...	9 m/m Long Shot		No. 9 Shot

All Cartridges other than 22 Short Blank loaded with smokeless powder.
* Furnished in Western Brand Only.
‡ Wax Coated.
† Lubricated.

SPECIFICATIONS and BALLISTICS

SYMBOL	PRIMER No.	CARTRIDGE	BULLET Wt. Grs.	Type
W218B	116	218 Bee Super Speed	46	H.P.
W219Z	120	219 Zipper Super Speed	56	H.P.
W22HI	116	22 Hornet Super Speed	45	S.P.
W22H2	116	22 Hornet Super Speed	46	H.P.
W220S	120	220 Swift Super Speed	48	P.S.P.
W222R	120	222 Remington Super Speed	50	S.P.
W22S	120	22 Savage Super Speed	70	P.S.P.
W25203	116	25-20 Winchester High Velocity Super Speed	60	H.P.
W25201	116	25-20 Winchester†	86	Lead

WINCHESTER Rim Fire Rifle Cartridges

VELOCITY Ft. Per Sec. Muzzle	100 yds.	200 yds.	300 yds.	ENERGY Ft. Lbs. Muzzle	100 yds.	200 yds.	300 yds.	MID-RANGE Trajectory 100 yds.	200 yds.	300 yds.
1125	920	...	...	81	54	...	...	4.3	...	...
1155	920	...	...	80	51	...	...	4.2	...	...
1240	965	...	...	99	60	...	...	3.8	...	...
1335	1045	...	...	158	97	...	...	3.3	...	...
1365	1040	...	...	149	86	...	...	3.3	...	...
...	...	...	...	...	...	...	...	...	...	...
1450	1110	...	...	210	123	...	...	2.7	...	...
965	810	...	...	60	42	...	...	5.6	...	...
1145	975	...	...	116	84	...	...	4.0	...	...
1145	975	...	...	116	84	...	...	4.0	...	...
780	570	...	...	24	13	...	...	...	...	...
970		...	...	...	...	...	...	...	...	...
05[illegible]	10	...	...	111	86	...	...	4.6	...	...
	985	...	...	184	140	...	...	3.8	...	...
	840	...	...	158	125	...	...	5.3	...	...
	850	...	...	179	144	...	...	5.3	...	...
	...	...	...	...	...	...	...	...	...	...

WINCHESTER Center Fire Rifle Cartridges

VELOCITY Ft. Per Sec. Muzzle	100 yds.	200 yds.	300 yds.	ENERGY Ft. Lbs. Muzzle	100 yds.	200 yds.	300 yds.	MID-RANGE Trajectory 100 yds.	200 yds.	300 yds.
2860	2160	1610	1200	835	475	265	145	0.7	3.8	11.5
3110	2440	1940	1550	1200	740	465	300	0.6	2.9	8.3
2690	2030	1510	1150	720	410	230	130	0.8	4.3	13.0
2690	2030	1510	1150	740	420	235	135	0.8	4.3	13.0
4110	3490	2930	2440	1800	1300	915	635	0.3	1.4	3.8
3200	2660	2170	1750	1140	785	520	340	0.5	2.5	7.0
2800	2440	2110	1840	1220	925	690	525	0.6	2.9	7.5
2250	1660	1240	1030	675	365	205	140	1.2	6.3	21.0
1460	1180	1030	940	405	265	200	170	2.6	12.5	32.0

Blurred Borders of Physics and Engineering
J. H. Van Vleck, (Harvard) Courtesy Reprint
2nd Edition
Journal of Eng. Ed. 37
Dec 1955 p-336

3650.15 = 0

3021.50
3125.6
3131.56
3131.84
3341.48
10 3650.15
3654.83
3662.87
3663.27
3906.4
3983.99
10 4046.56
4077.8
4339.23
4347.50
10 4358.34

558.7

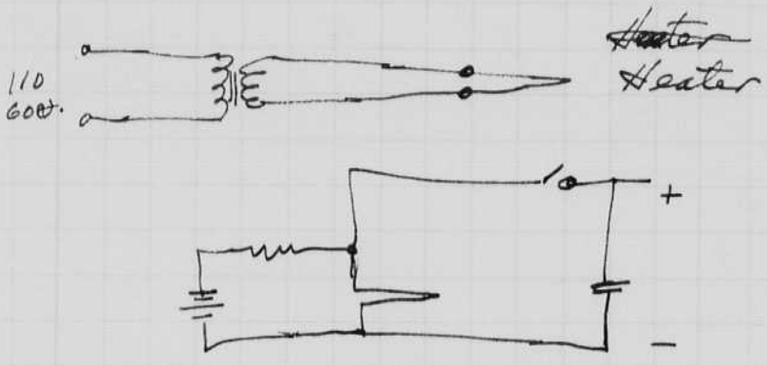
4916.0
4960.3
5460.3
5675.8
5769.60
5790.60

6072.63
6123.47
6234.35
10 6907.5

Feb. 9, 1956. **New Stroboscope.**

A gaptube was given me last week by Fred Conley of E.G.&G. It has a series of internal starting wires to direct the arc. More tests are to be made tomorrow when Zemeckowsen visits the lab.

I called Arthur Miller (Sanborn) about the possibility of pulsing his recorder heater. This would be used to record the bottom to assure distance in the deep sea equipment. He says that 10 watts are used with a 1/10 sec heating time. Thus the energy is 1 watt second.



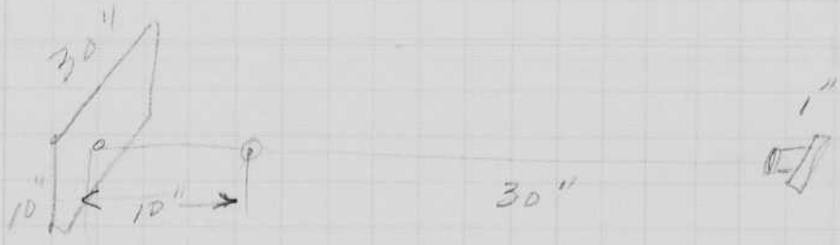
See page 52

Screen for silhouette photos of bullets.

10 ft x 30 ft wide.

Model

10" x 30 inches. 1/12 scale factor.



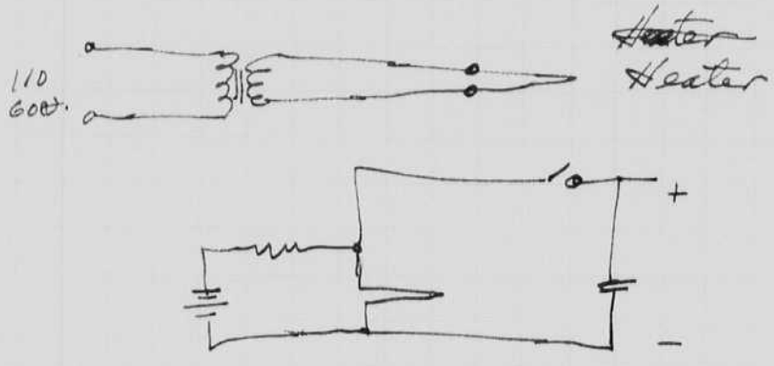
	3021.50
	3125.6
	3131.56
	3131.84
	3341.48
10	3650.15
	3654.83
	3662.87
	3663.27
	3906.4
	3983.49
10	4046.56
	4077.8
	4339.23
	4347.50
10	4358.34
	4916.0
	4960.3
	5460.3
	5675.8
	5769.60
	5790.60
	6072.63
	6123.47
	6234.35
10	6907.5

Feb. 9, 1956.

New Strobosnoot.

A gaptube was given me last week by Fred Conley of E.G.&G. It has a series of internal slanting vanes to direct the arc. More tests are to be made tomorrow when Germeshausen visits the lab.

I called Arthur Miller (Danbom) about the possibility of pulsing his recorder heater. This would be used to record the bottom to camera distance in the deep sea equipment. He says that 10 watts are used with a 1/10 sec heating time. Thus the energy is 1 watt second.



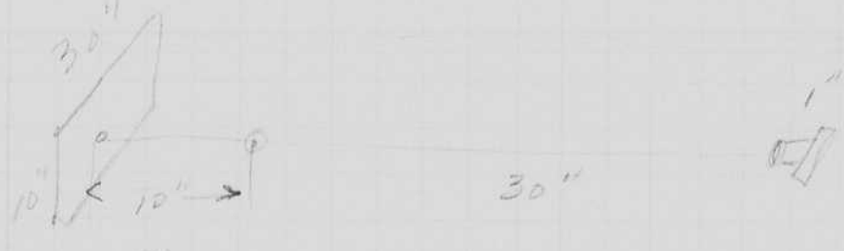
6 watts at 60~
600 volts
$\frac{1}{10} = \frac{600^2}{2}$

See page 52

Screen for silhouette photos of bullets.

10 ft x 30 ft wide.

model
10" x 30 inches. 1/12 scale factor.



90 Jan 8, 1956.

Harold Edgerton.

The lab. was cleaned out today for a demonstration for a group of students from Lexington (High School) and a group of Harvard students from the Graduate Business School.

Reference Uber die elektrische Entladung bei stromstarken Funken.
D. Maser. D. Sautter.
Zeitschrift für Physik Bd 143 544-76 1955.

$j = n_e b_e e E$ n_e = electron density.
b_e = mobility.
e = charge
E = field. = U_f/d
U_f = voltage d = electrode spacing

$$i_f = \frac{\pi r^2 n_e b_e e U_f}{d}$$

and $$R_f = \frac{d}{\pi r^2 n_e b_e e}$$

$n_e b_e e$ = conductivity = 90 mho/cm

but $$n_e = \frac{x}{1+x} \cdot \frac{p}{kT}$$

Peak current in XP-2 flash tube 2000 volts 0.1 mfd.
0.086 ohms resistance in shunt
peak = 120 volts.

$$\frac{120}{.086} = \text{amps.} = 1400 \text{ amps peak.}$$

See page 92

Osc. 1. 0.5 ms/cm. 0.87 V/cm.
Osc 2.
" 3-7 0.5 ms/cm 88 V/cm.

$\frac{\pi r^2 / n_e b_e e^2}{d}$

$G = \frac{1}{R_f} =$

Magneto of Slit Shutter.

Tests by Roy Swanson

0.1 mfd

6 turns
0.1 mf
2½ KV.
1 M.S.

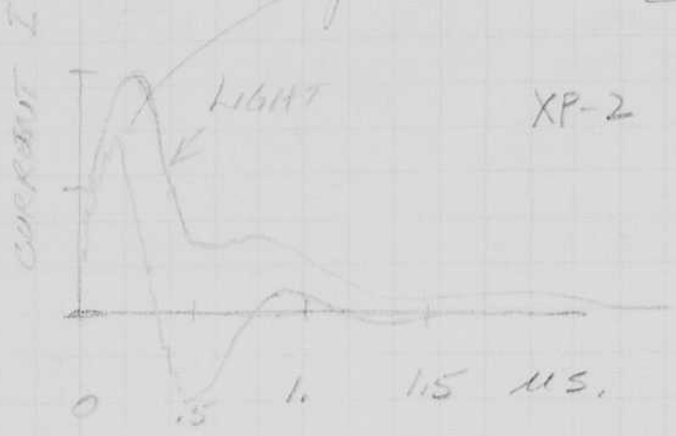
This will give 90 degree rotation.
in Blue light!
Red requires more Watts

XP-2 tube tests

Feb. 12, 1936.
H. Eby

See page 90 for flow data.

peak current = 1400 amperes.



XP-2 0.1 m/d 2000 volts.

frequency of discharge = $\frac{1}{T} = \frac{1}{.75\times10^{-6}} = 1.33\times10^{6}$ cycles/sec.

$C = 0.1$

$T = 2\pi\sqrt{LC}$ crit damped $R = 2\sqrt{\frac{L}{C}}$

$f = \frac{1}{T}$ $R^2 = \frac{2L}{C}$ $L = \frac{R^2C}{2}$

$\frac{1}{f} = 2\pi\sqrt{C\frac{R^2C}{2}}$

$\frac{1}{f} = 2\pi\frac{CR}{2}$ or $f = \frac{1}{\pi CR}$ $R = \frac{1}{\pi Cf}$

$= \frac{1}{3.14\ 0.1\times10^{-6}\ 1.3\times10^{6}}$

$= 2.45$ ohms

$L\frac{di}{dt} + Ri + \frac{1}{C}\int i\,dt = e$

Lamp resistance = 1/4 ohms per 1/4" tube.

$R = \frac{l}{\text{area}\ \sigma} = \frac{6.\times10^{-3}}{1.2^2\times10^{-6}\ \pi\ 6000} = .222$ ohms.

σ = 6000 mhos/meter.

5.

Lamp length for crit damping = 1/4" × 10 = 2.5 inches.

Feb-18 1956
Howard Edgerton

Sun flash Power unit.

Present A.V.C.O.

To charge the Sun flash fast I propose a separate auxiliary power supply to give more current into the capacitors on the beginning of the charge cycle. A slight delay is required to prevent holdover

36
36
216
108
1296

1300 mfd.

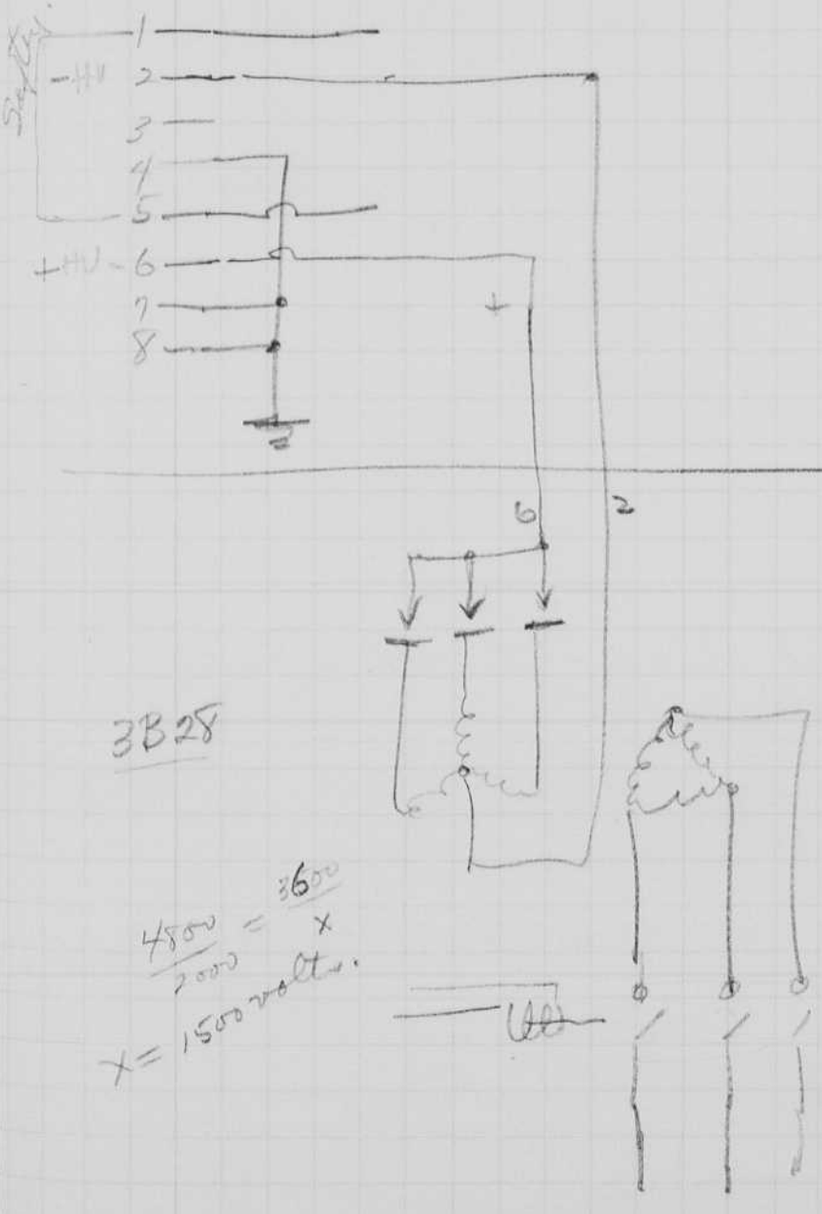
$i = C \frac{dE}{dt}$,

$= 1.300 \times 10^{-6} \frac{1,600}{5 \text{ sec.}}$

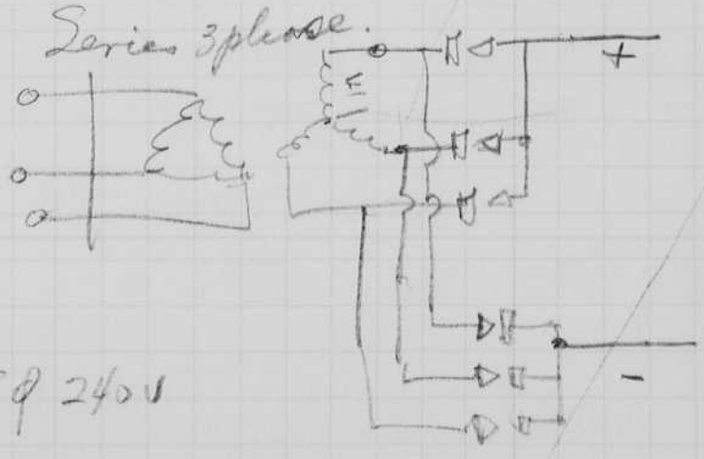
$i = 0.5$ amp.

~~4b~~ for 3B-28
avg. 1/4 amp 10,000 minutes

~~Use~~ 6 tubes in Parallel 3 phase
1.5 amp each pair
4 KV. = 6 kw.



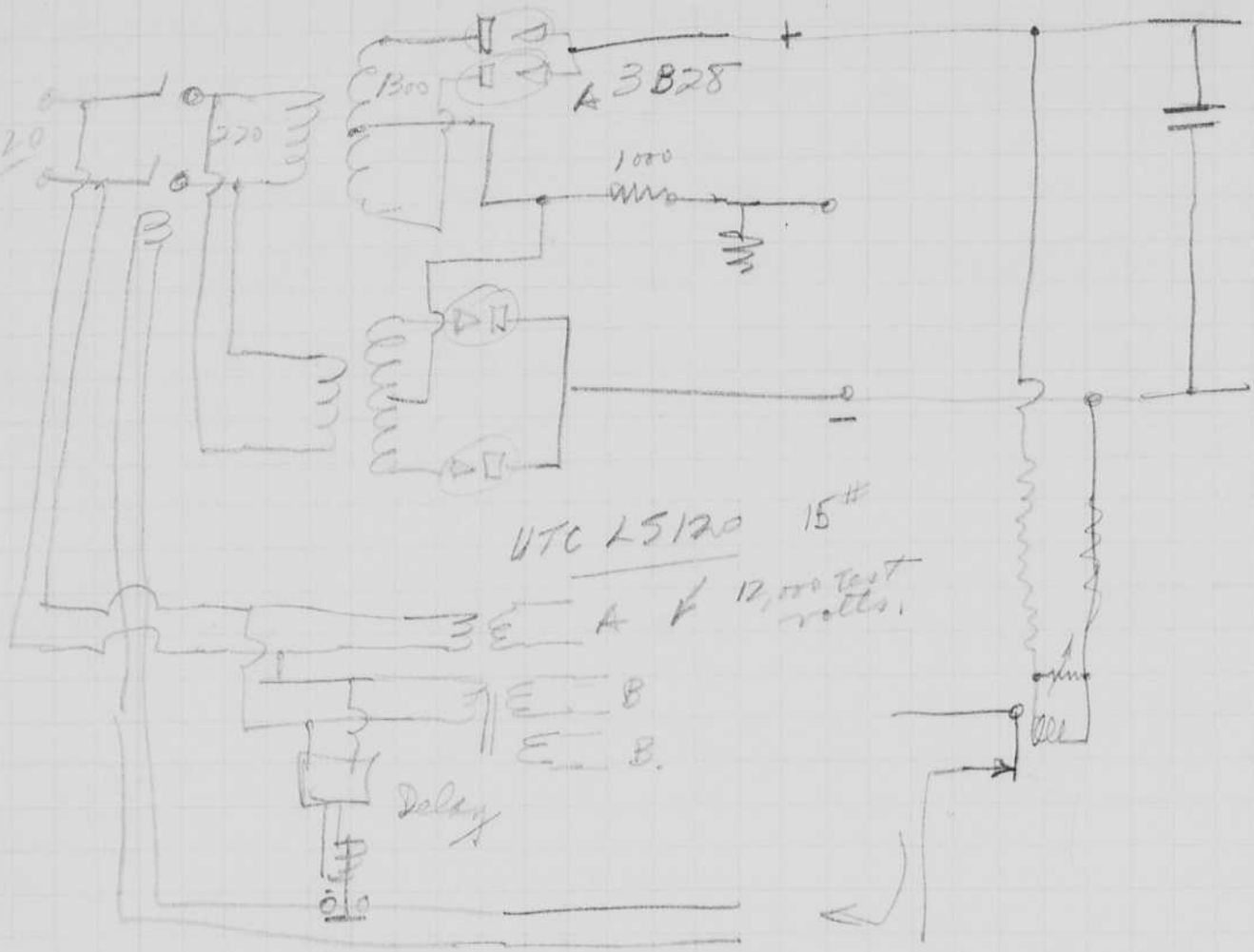
Series 3 phase.



E = 1500 V
E = 2600 V
line to line.

Chicago P1240 150 D.C. mils

~~1150~~ 1425. 26# 360 Va cost 39.50

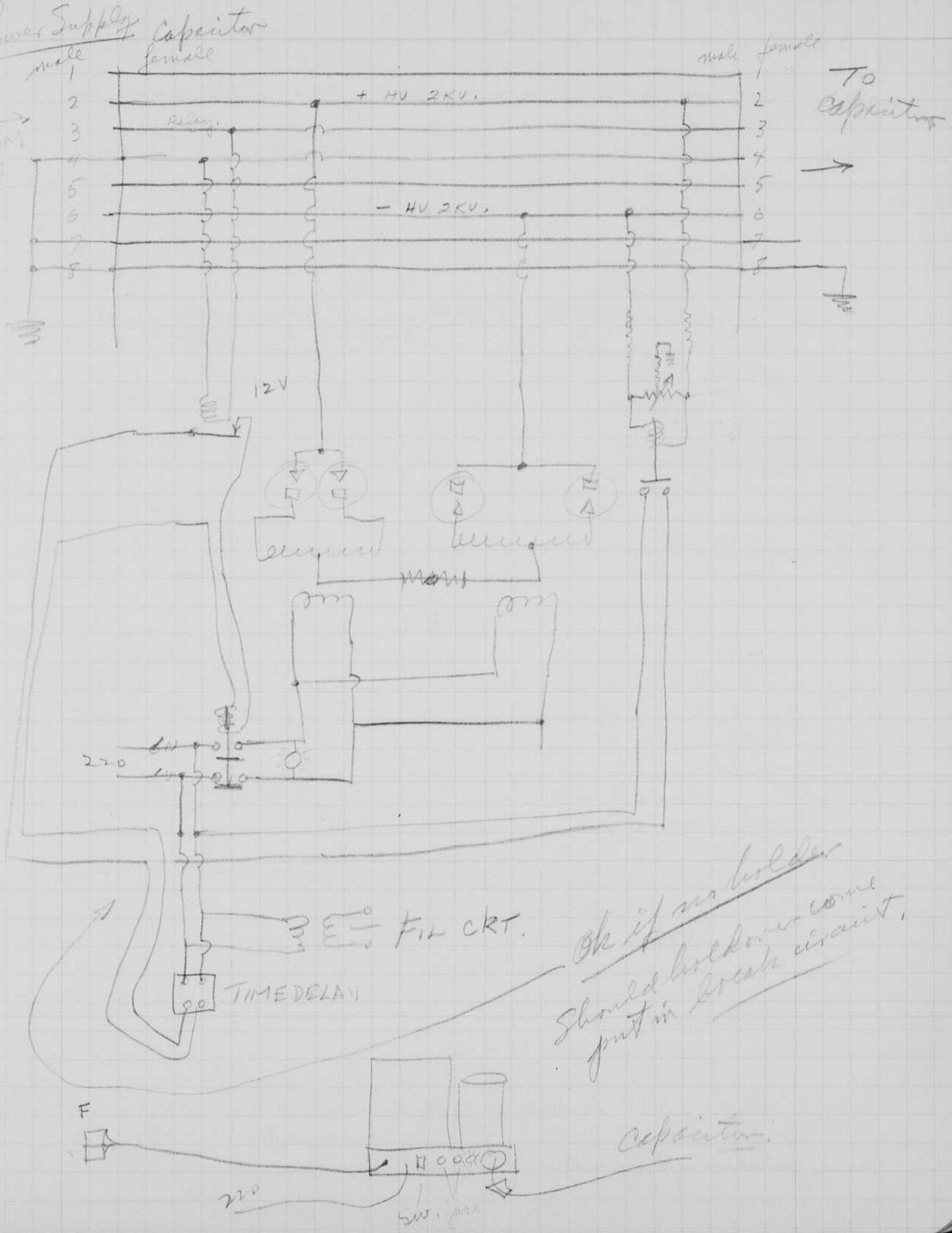


another way.

Plate tube and timer to activate the high voltage circuit.

~~U.T.C. 1500 - 1500~~

UTC CG303 300 ma. 22# 1500-1235-0-1235-1500


Power Supply
Capacitor
male
female
male
female
1
2
3
4
5
6
7
8
+ HV 2KV.
− HV 2KV.
Relay.
FROM P.S
To capacitor
12V
220
FIL CKT.
TIMEDELAY
F
220
SW. fuse
Capacitor.
Ok if no bolder.
Should bolder come
put in break circuit.

96 Feb 21, 1956. Propeller.

Dr. Harold E. Edgerton.

John Light called by phone tonight with further information on the 14 foot Bronze propeller that was lost off a tanker about 14 years ago.

This weight 18 tons. There is a $28,000 reward by the insurance company. The cost of a new prop is $51,000.

Capt Howard was the pilot. He is now in Florida.

John White of Cohasset was aboard the ship. He was not too cooperative with data.

The prop. was lost 500 yards from buoy #1.

Light and I plan a cooperative venture to find the prop. He and his organization with the ship will take 2/3 of the reward. I get 1/3 for furnishing the detecting equipment.

We plan a camera survey first of the bottom, using a chart to accurately determine our position. The work will be done at night. Bob Hartman will help.

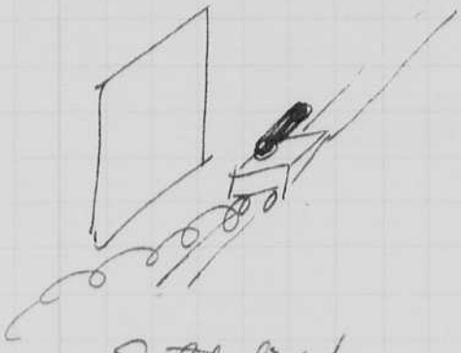
Dinner tonight with group at Harvard Business School

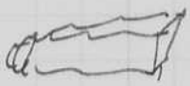
✓ Nick Reinhardt	KI 7 4120
✓ Mike Sawyer	PR 6 9174
Bob Marsh	UN 4 7159
✓ John Ersian	
Elliot Novak	✓ these men wrote the
Lew Stevens	report of 100 pages.
✓ Edward Thayer	
Jacques Bouvard.	

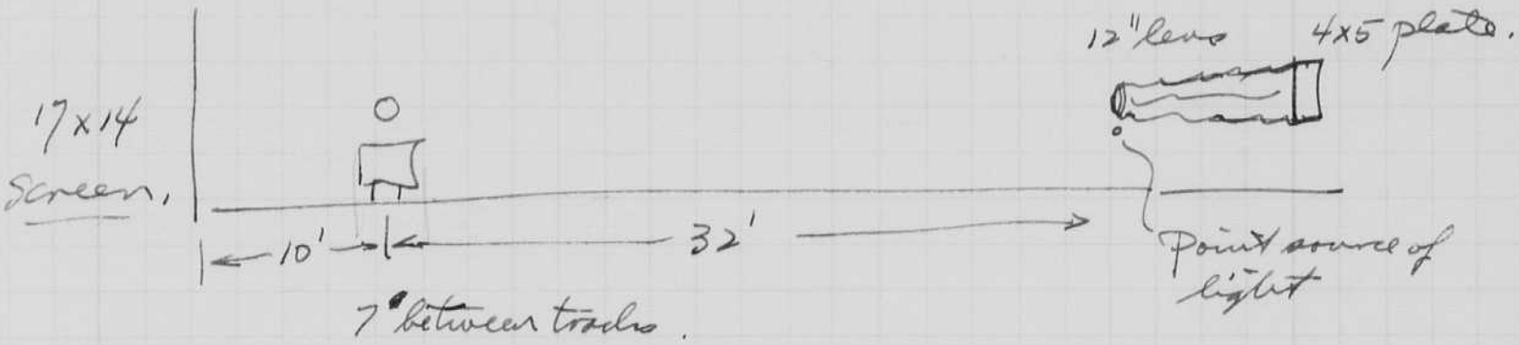
General Doriot in charge of the course. We then went to Baker to see a stroboscope demonstration. It was very well done. From E.E.&G. - Bretler, Johnson, Henley, Cadwalder, and I. —

Feb 22 1956.
Harold Edgerton

Silhouette method of Photogrophy.
for Holloman air base. See page 52.





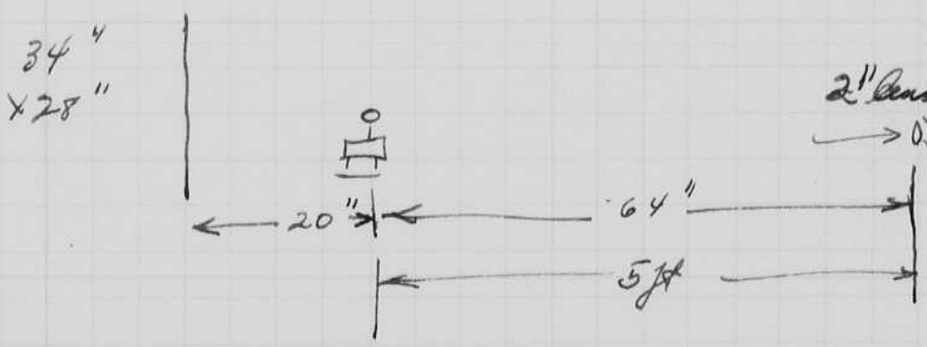


model for test. — use 2" lens instead of 12"
Scale factor is 6.

$\frac{17' \times 12}{6} = 34"$
$\frac{14' \times 12}{6} = 28"$
} screen size.

$\frac{10' \times 12}{6} = 2$

$\frac{32 \times 12}{6} = 64"$



Notebook # 23

Filming and Separation Record

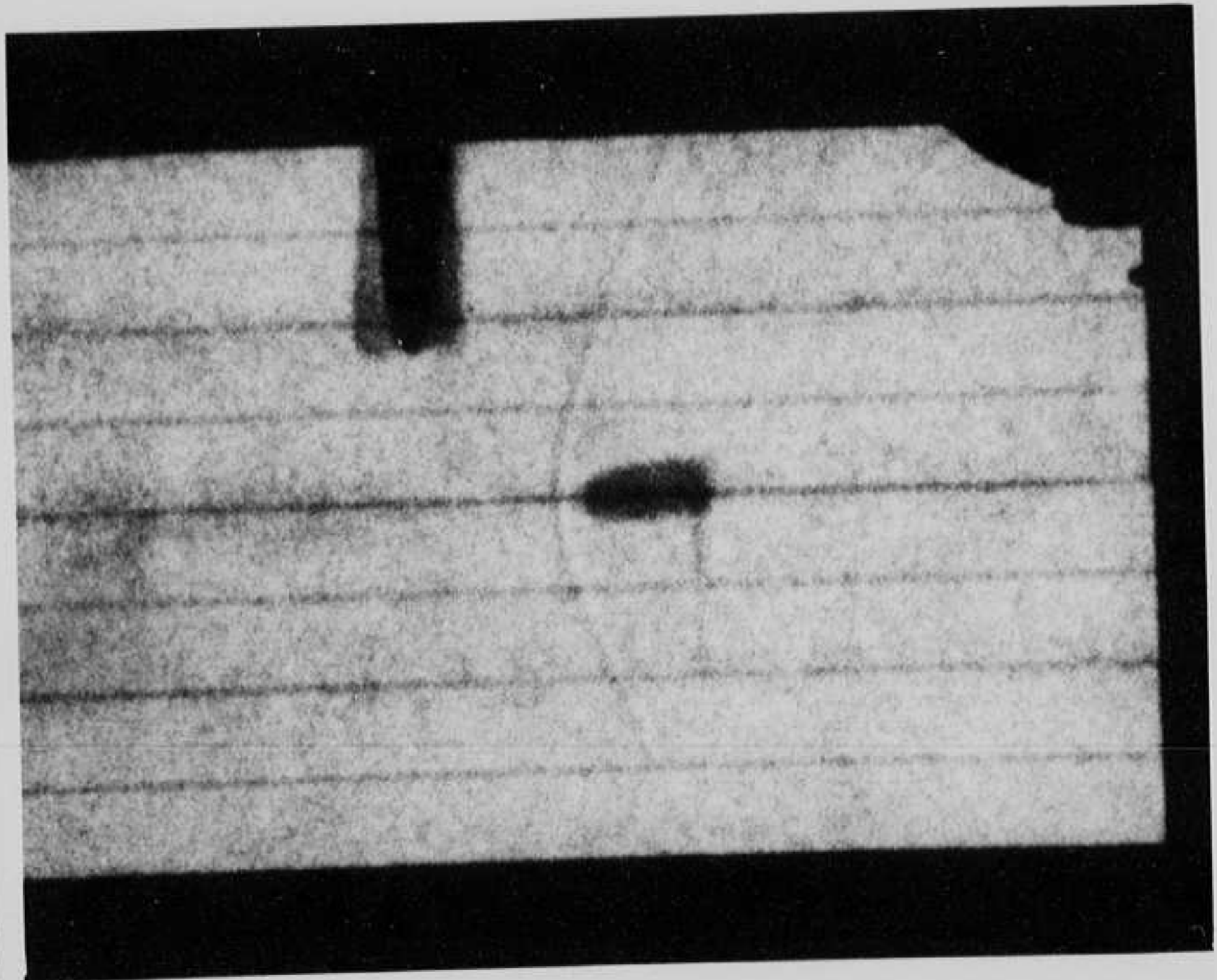
1 unmounted photograph(s)

____ negative strip(s)

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

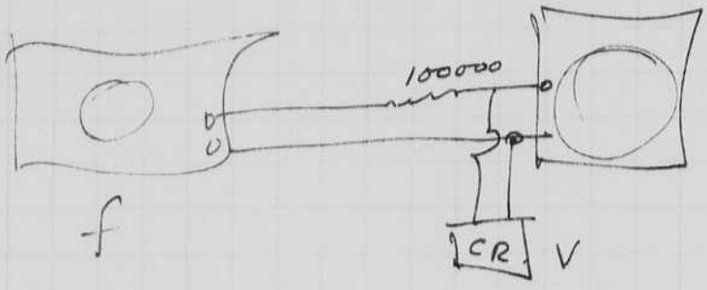
was/were filmed where originally located between page 96 and 97.

Item(s) now housed in accompanying folder.

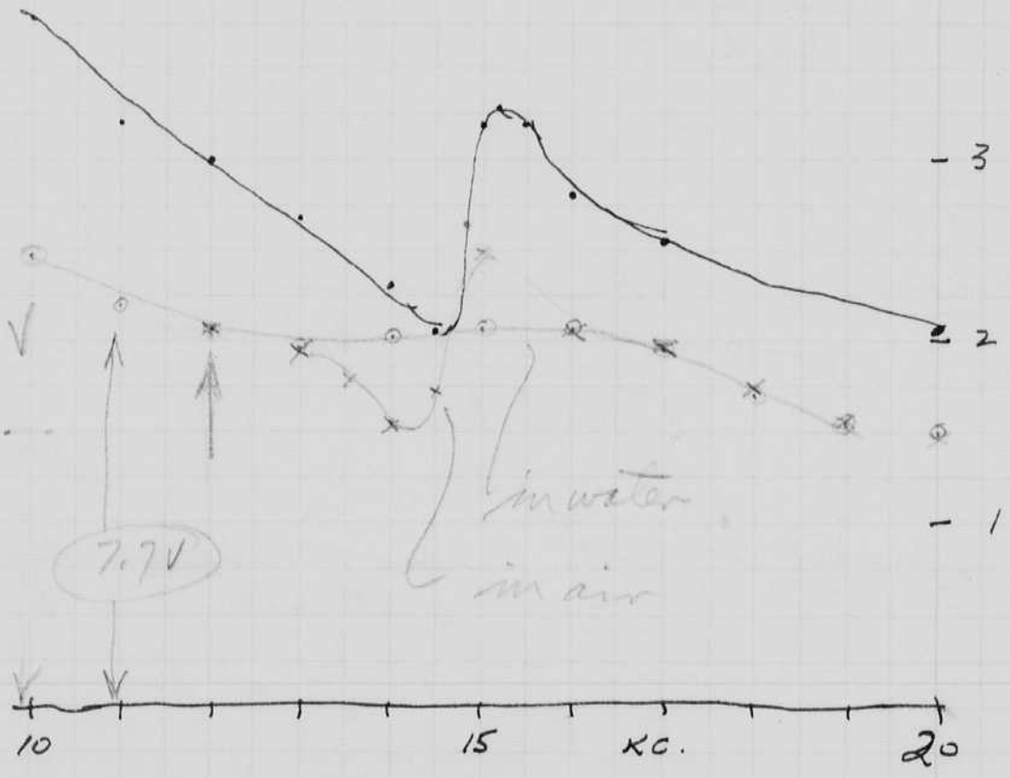


~~Edo~~ X20100 Special transducer

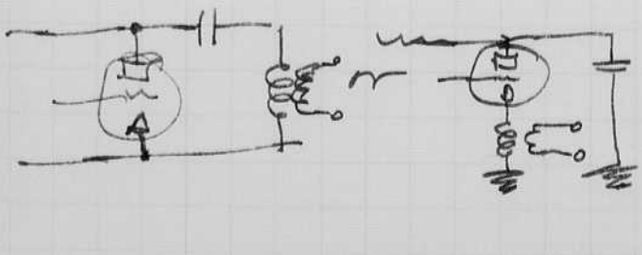
R of end 3.8 megohms.



f cyc/sec.	V. Rel
20	2.1
17	2.6
16	2.8
15.5	3.2
15.0	3.2
15.2	3.3
14.5	2.1
14	2.3
13	2.7
12	3.0
11	3.2
10	3.6
9	3.9.



1.4 a_{in} = 50V
2.6 a_{in} = ? Pencil curves made Apr 14 1956, ① Water ② air
$50 \times \frac{2.6}{1.4}$ on transducer using 9.1K, 80 c.

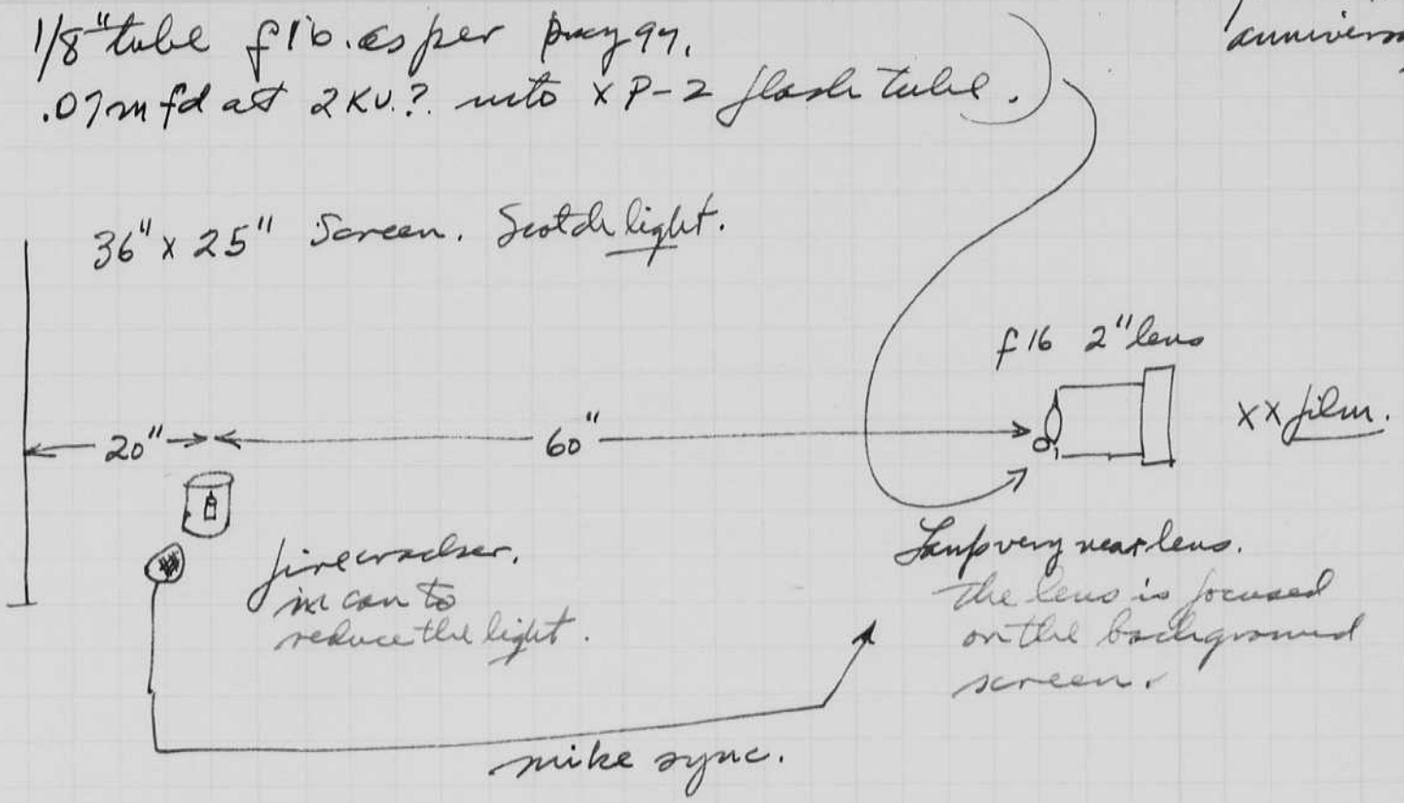


Cross talk! #1 used with unit # 2

Tests.

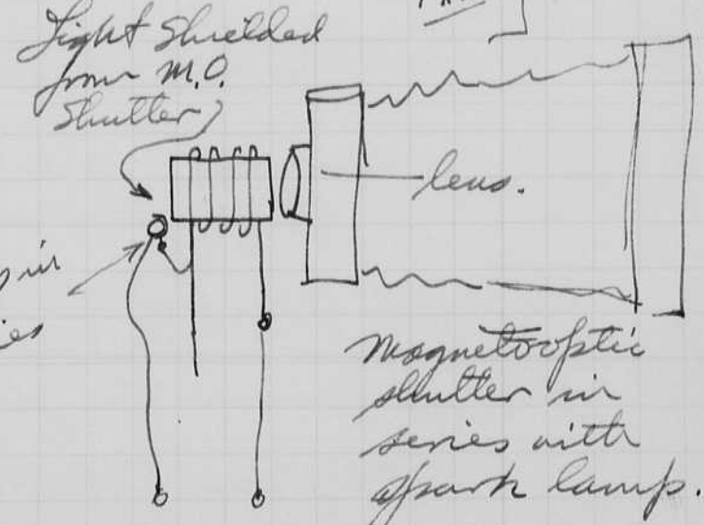
Sat. Feb 25 1956
Jarred Edgerton
29 wedding anniversary

1/8" tube f16. as per page 97.
.07 mfd at 2 KV.? into XP-2 flash tube.

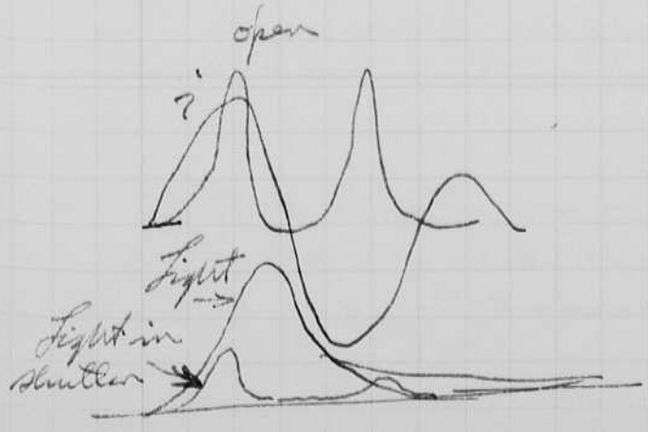


this is a 1/6 mockup of the arrangement for the Holloman air base. Experiments will be made a reduced scale first before the field tests.

20 KV
18 KV.
1 X 2.
cond. prod.



Rendered by understanding me May 8, 1956
Robert A Davies



Small Flash Lamp.

Comparison Sylvania 5413. 0.12 WS.
500 volts 1 mfd.

5413 area = 2.3 sq cm.

$$\frac{0.125}{2.3} = .054 \text{ WS/sq cm}$$

Small lamps. .01" x 2.54 = .028 cm
length 0.1 .25
area = .02 sq cm.

Breen want watt sec .04 watt sec in small lamps.

$$\frac{500^2 V\ C}{2} = .04$$

$$C = \frac{.08}{.25} \times 10^{-6} = .32 \text{ Mfd.}$$

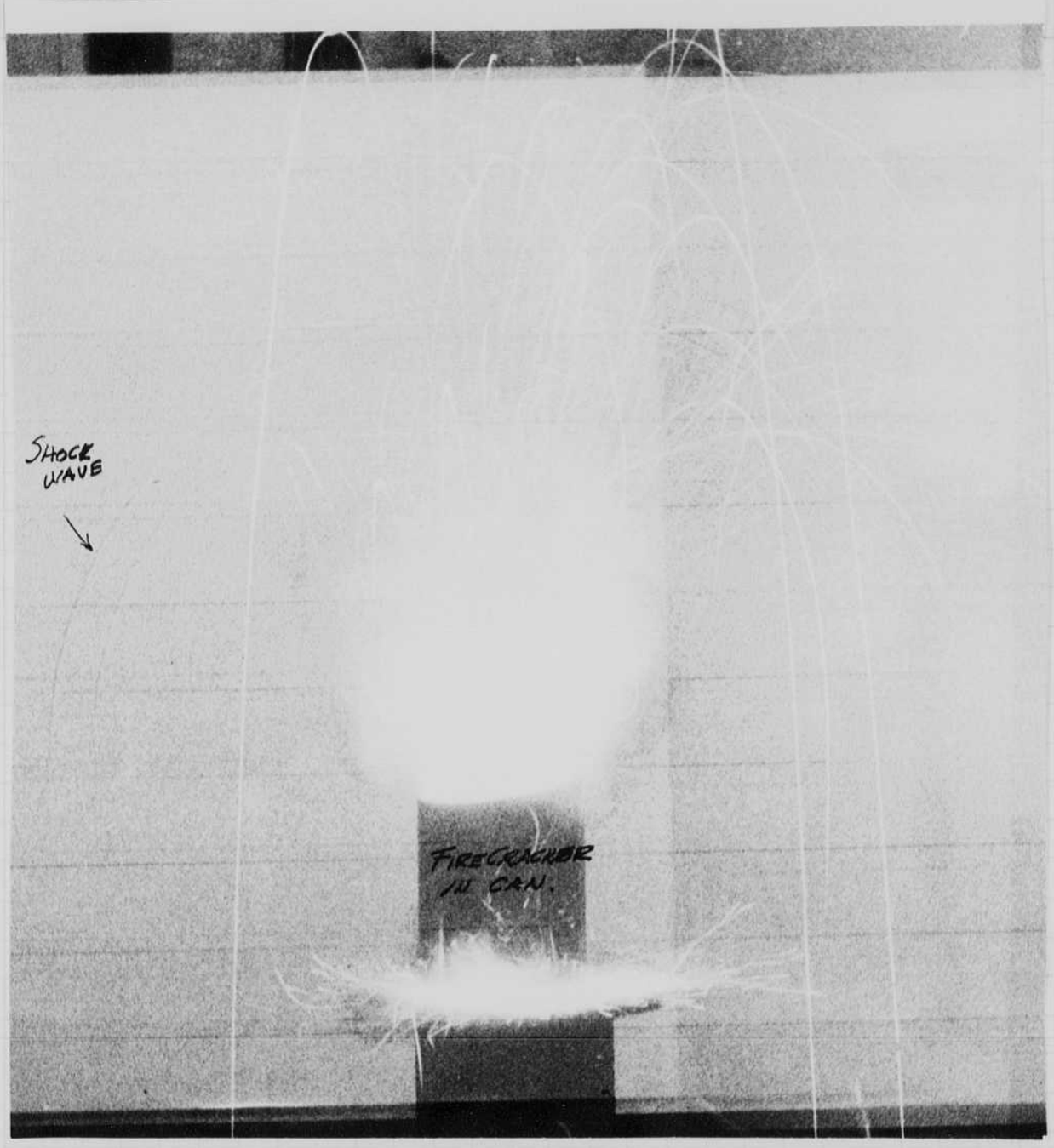
XP-2 14 $\frac{.1 \quad 2000^2}{2} = .2$ watt sec

Above made during conference with John Breen and about a small light source for a digital computer device. I gave them two very small source tubes.
Xenon 0.1" long and 0.01" diam with tungsten electrodes.

Also an XP-2 type of tube with 10 cm of gas pressure.

The photo of the firecracker turned out very well. The shock wave is shown as it leaves the ~~not~~ cylinder that surrounds the fire cracker.

Bill MacRoberts has now started the conversion of the 20 flash unit for production. ~~Ent~~ Deo Hansen sent a manuscript from E.S.&M. to help with the work.



Shock wave from firecracker. Taken with the set up of page 99.

Silhouette of subject with shadows of shock wave in the background.

Small Flash Lamp.

Comparison Sylvania S413. 0.12 WS.
500 volts 1 mfd.

S413 area = 2.3 sq cm.

$$\frac{0.125}{2.3} = .054 \text{ WS/sq cm}$$

Small lamp. .01" x 2.54 = .025 cm
length 0.1 .25
area = .02 sq cm.

Breen want watt sec .04 watt sec in small lamps.

$$\frac{500^2 V\ C}{2} = .04$$

$$C = \frac{.08}{.25} \times 10^{-6} = .32 \text{ mfd.}$$

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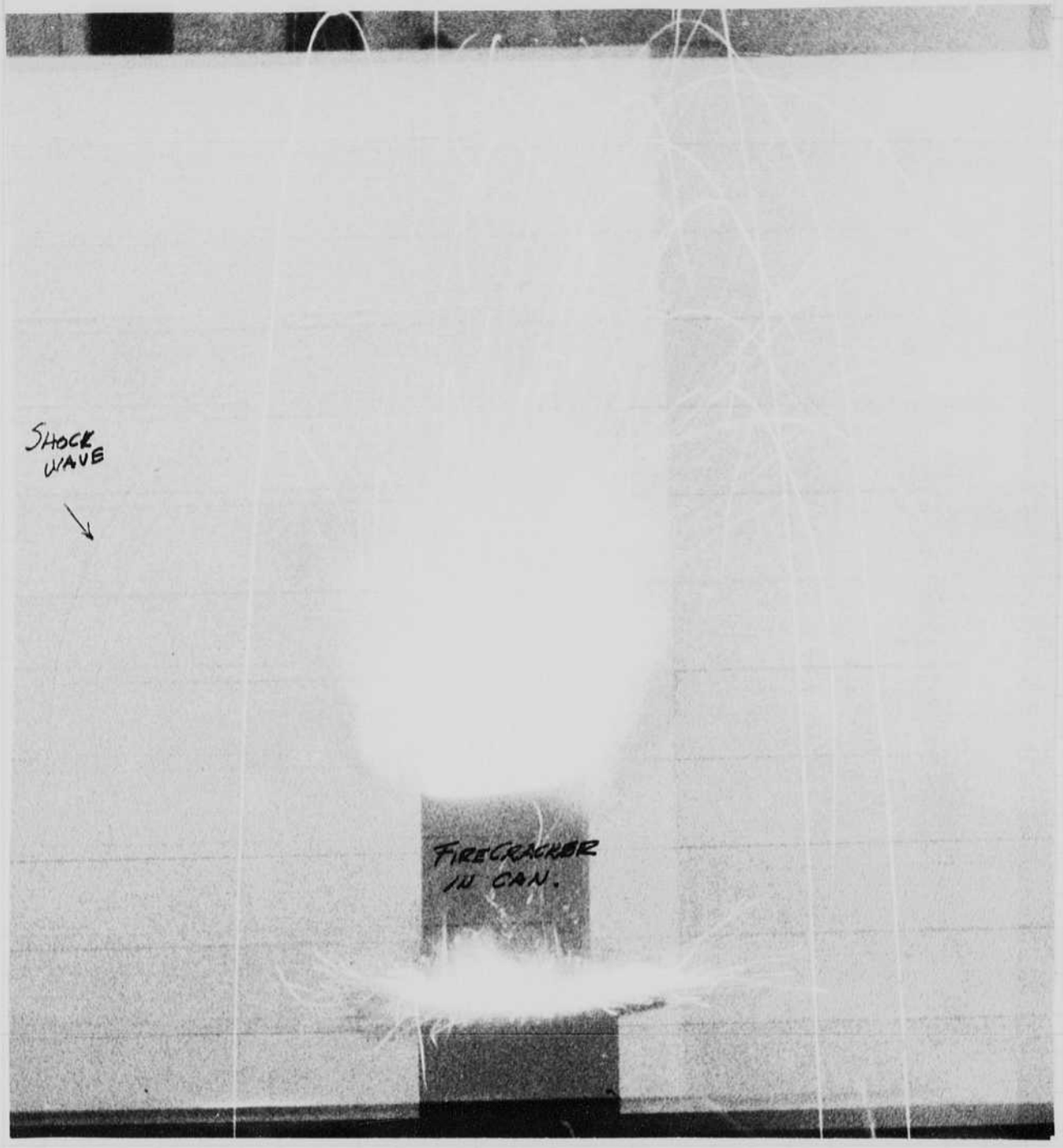


Shock wave from firecracker. Taken with the set up of page 99.

Silhouette of subject with shadows of shock wave in the background.

Mar. 5, 1956.

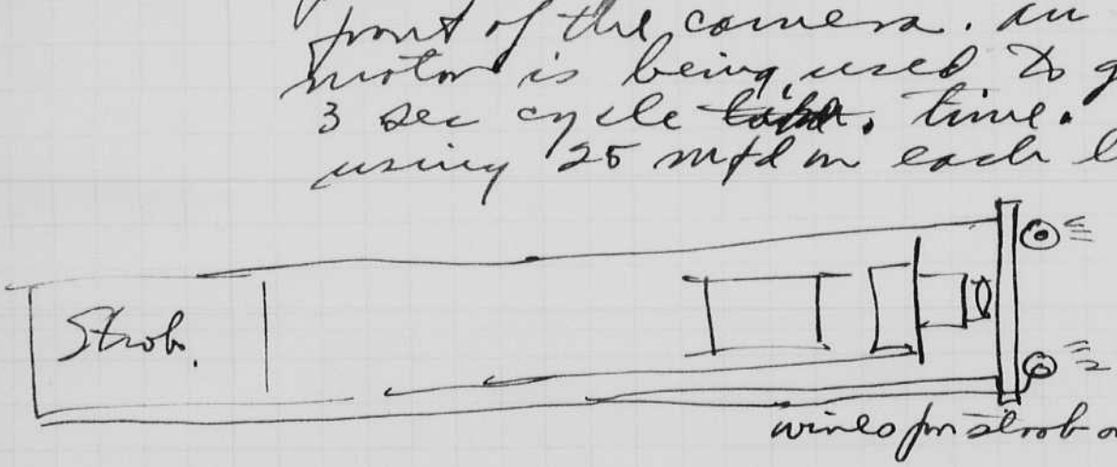
Harold Edgerton.

Geo. LeCompte started working again with me full time. Harold Ray Swanson will be busy on the 5 flash equipment for the magneto optic shutter!

A few shadow photos were taken last Sat with a set up similar to that of page 99. The subject was a 22 caliber bullet in flight. I could see the shock wave on the front of the bullet silhouetted against the back ground screen.

Mar. 7, 1956. A mr. Biladeau came in monday with a brass box camera for use in a gas well. I showed him my deep sea cameras which took his fancy at once. Since then he has stayed in Boston and is helping us to make a unit for trial.

Bill is working tonight on the affair. We are using two of the plastic capsulated lamps on the front of the camera. An 18 RPM motor is being used to get a 2 or 3 sec cycle time. We are using 25 mfd in each lamp, at 460 V.

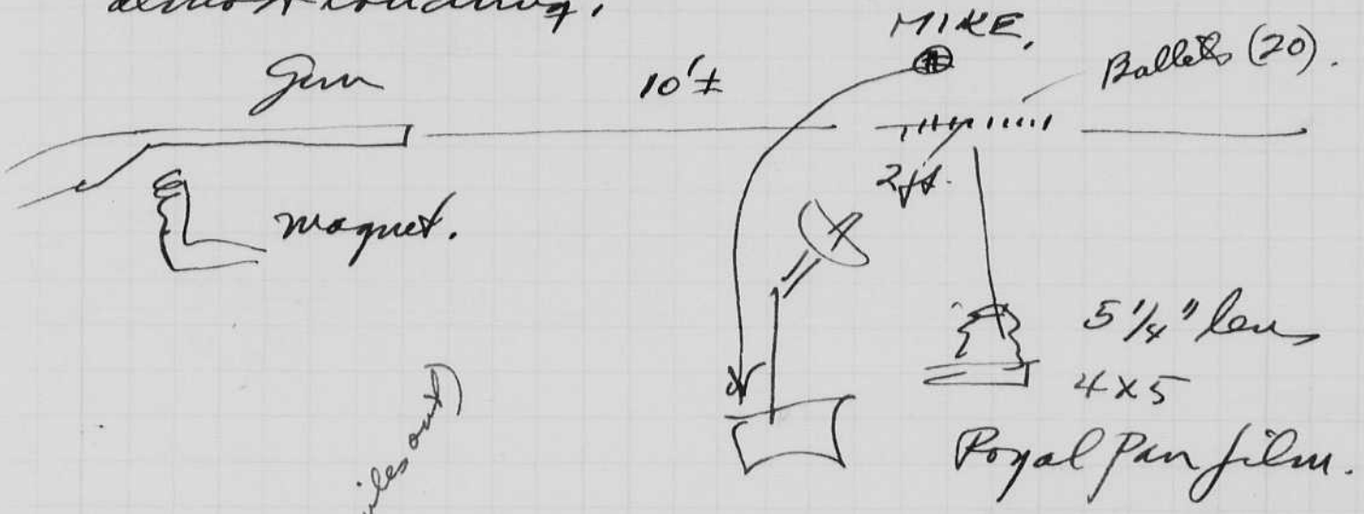


this unit will fit into Biladeau gadjet that goes on the end of the cable into the gas well.

Biladeau

Bill finished the 20 flash unit today and soon trying it tonight on bullets. The device runs ok ~~up~~ to 100 Kc.

22 cal bullet at f8 and f5.6 with loop in spherical reflector at back pointing (wide beam) Photos at 33 Kc show bullets in sleb and almost touching.



March 10, 1956. (20 miles out) Worked with Bill today on the 20 flash. Changed tube #6. which was missing tube #12 was missing some of the last tests. This tube seems ok now.

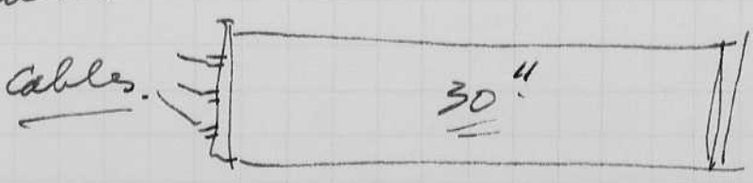
W.J. Biladeau Windsor Mass also ~~Rt~~ Rt 8 North Adams. & Dorsey Calhoun Route 20 Star Route Kettle creek.

Biladeau took the camera yesterday afternoon. It had two plastic impregnated tubes in the front. Exposure at f5.6 seconds ok in a pipe on Tri-x film.

This will be tried in an oil well in Pennsylvania where there is trouble in the drilling.

Conference yesterday at ESRG 160 Bookline and Boston on the sensitometer, Clark, Dennis Randolph, Edg. Wyckoff. Plan to complete this model for final tests.

Light and Hartman came in to discuss television casings. I suggested a glass case.

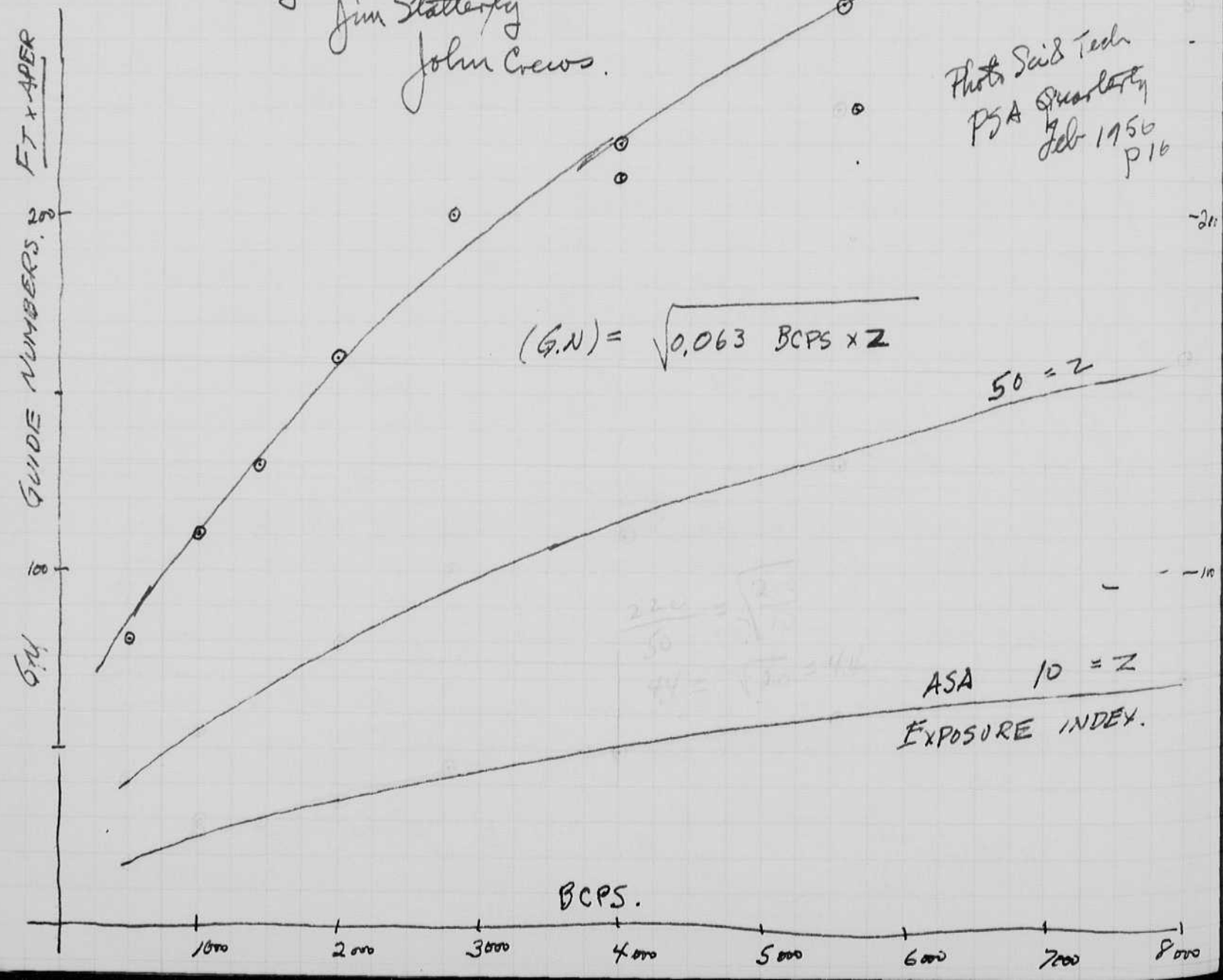


Phi Mu Delta
Slide Polaroid
for Carnival
Nov 10. 1956.

Jerry Roylance
Marty Nickel
Jim Slatterly
John Crews.

Plotted from
John Debes
Ronald Karley

Photo Sci & Tech
PSA Quarterly
Feb 1956
p 16

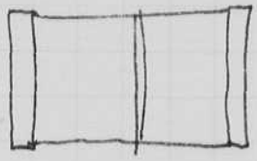


Mar 15 1955 Sonar output.

Camera #as used in Ocean. 1955.

Experiment in air

Sonotone battery 6 volt 5 all.



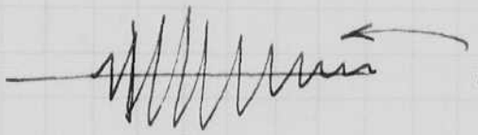
1 ft.

JT-30 ceramic mike.

513D # 1180.

~~Input #1.~~

.035 volts = 1 cm.



1 cm deflection, peak to peak.

12 KC.

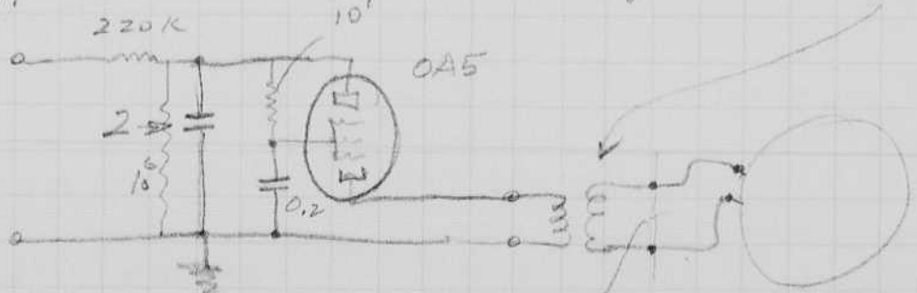
Brush Shure mike

at 1 ft Signal peak to peak = 0.8 volts.

Sat

March 12 1956. New transducer FBONO X 20100 connected to driver with transformer H/E 3131B13 T-70175-1

Snow Storm yesterday! Bad!



500 usec between peaks.

L_s = 295 mh. DQ = 4.4 H/E T70175-1 One shows → 5 sec. Inductance

0.75 mh. V 11825

Sec SF = 2.9 mh 4. 292-1388 61 and capacity of crystal are too

" 4.1 mh 5.3 292-1388 low in freq

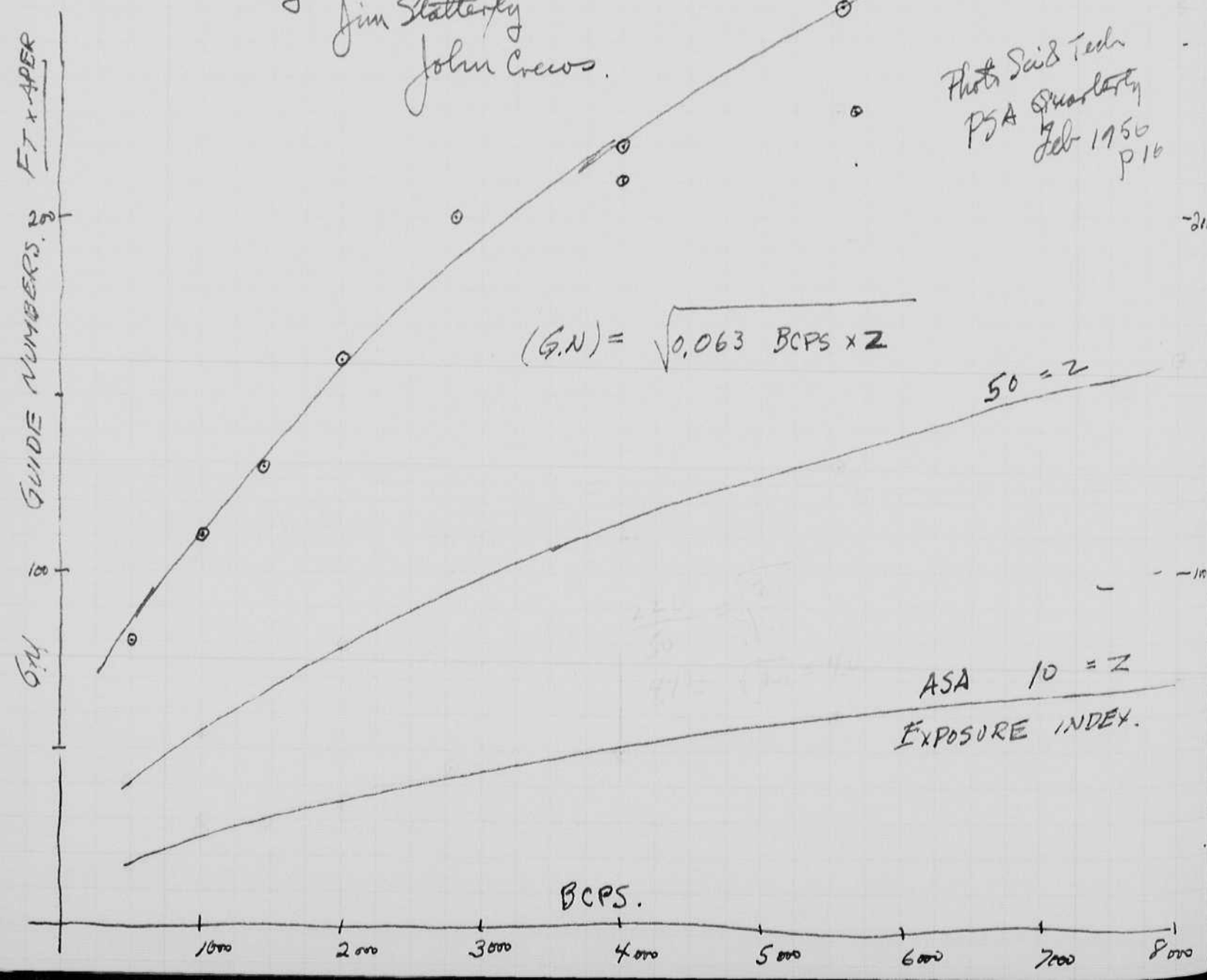
Newton. 1.0 h 3.8 15/1 ?

Phi Mu Delta
Skit Polaroid
for Carnival
Nov 10. 1956.

Jerry Roylance
Marty Mickel
Jim Slatterly
John Crecos.

Plotted from
John Debes
Ronald Karley

Photo Sci & Tech
PSA Quarterly
Feb 1956
p 16

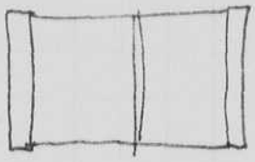


Mar 15 1956 **Sonar output.**

Camera assisted in Ocean. 1955.

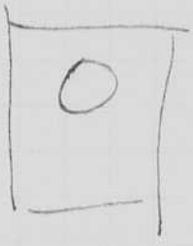
Experiment in air

Sonotone battery 6 volt 3 cell.



JT-30 ceramic mike.

1 ft.



513D # 1180.

Input #1.

.035 volts = 1 cm.

1 cm deflection, peak to peak.

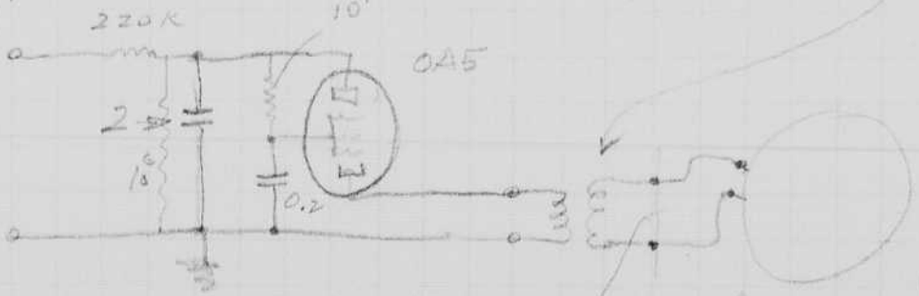
12 KC.

Brush Shure mike

at 1 ft Signal peak to peak = 0.8 volts.

Sat March 16 1956. New transducer FBONO X 20100 connected Sonostone to driver with transformer H/E 3131B13 T-7017S-1

Yesterday's Prod!



50 ohms

Sounds between peaks.

L_s = 295 mh. DQ = 4.4 H/E T-7017S-1 One shows → Sec. Inductance

0.75 mh. V 11825

50 ft = 2.9 mh 4. 2921388 61 and capacity of crystal are too

" 4.1 mh 5.3 292-1388 low in freq

Water 1.0 h 3.8 15/1 ?

Phone to Geo Rand. Mer 2-256

Suggests contactor into series L.R. circuit. or Strobotron.

Transducer has 7000 mmf.

Requires 24 mh.

D.C. Resistance 3 meg. → 1 meg.

Pri. 4 – 7 Sec.

H/E T70487-2 400 mh.

Ls

H/E 3163-B1 210 mh.

T70150-1

This times ... due to high secondary inductance and the sec and T will oscillate at

$f = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{\pi} = 2,500$ cycles.

$2\pi\sqrt{LC} = \frac{1}{12,000}$ sec

$C^2 = \left(\frac{1}{12,000}\right)^2 \frac{1}{40} \frac{1}{L^2} = \frac{1}{1.6\times10^8}$

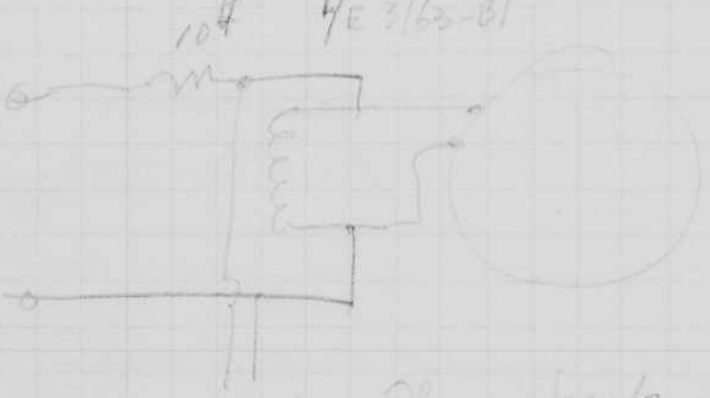
$10^8 \quad 40 \quad .04$

$1.6 \quad .2 \quad .2$

$C = \frac{1}{1.3\times10^4} = \frac{10^{-6}}{.013}$

$.013\times10^6$

$= 80\times10^{-3}$ f



at 5600 cycles $\frac{2.9}{2.55}$ 10^{-3} 10^{-3}

Scope Shows peak at 5600 cycles

Increases 20% when 10T shunted,

also small peak at 15.2 KC. due to crystal.

H/E T-70173 has resonance at 56,000 cycles open circuit

+ E90 + X20100 " " " 44,600 cycles.

X20100 has peak alone at 15000 ~.

Series .03 mfd with X20100 and trans. 5000.

.0015 " " " 11,000

.001 11,600

Tried with galvo – one pop then the capacitor shorted (1000 volt rating)

$T = \frac{1}{f} = \frac{260 \times 10^{-6}}{3}$

$f = \frac{3}{260 \times 10^{-6}} =$ 260 ms / 3 cycles.

T-70713

peak at 17.6 and 14.9 Kcycles.
also at 3200 stray.

11.9 Kc

20 | 30 / 20 / 40 / 26 / 240 / 225

~~$3200 = \frac{1}{2\pi\sqrt{LC}}$~~

~~$3200^2 \times 10 \times 10^{-6} = \frac{1}{(6.28)^2 \cdot 2 \cdot C}$~~

$C = \frac{1}{10 \times 10^6 (40) \cdot 3} = \frac{10^{-6}}{120}$

$= .008 \times 10^{-6}$ ~~farads~~ crystal.

Check $f = 4500$

$C = \frac{1}{(4.5)^2 \times 10^6 \quad 40 \quad .2} = \frac{10^{-6}}{240} = .004 \times 10^{-6}$ farads.

20.2 40 .3

17 / 20 / 240

$2\pi\sqrt{CL} = \frac{1}{12{,}000} =$ .8h. → .04h.

$(6.28)^2 \cdot .004 \times 10^{-6} L = \left(\frac{1}{12{,}000}\right)^2$

$L = \left(\frac{1}{12 \times 4}\right)^2 \frac{10^6}{6.28^2 \cdot .004} = \frac{1}{24} = .04\,h.$

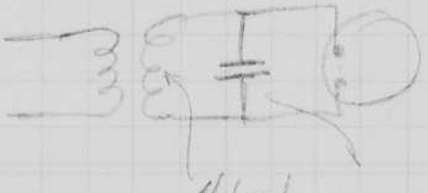
1.44 / 3 — .16 / 12 / 3 / 10 / .2 / 12

$CL = \left(\frac{1}{12{,}000}\right)^2 \frac{1}{(2\pi)^2}$

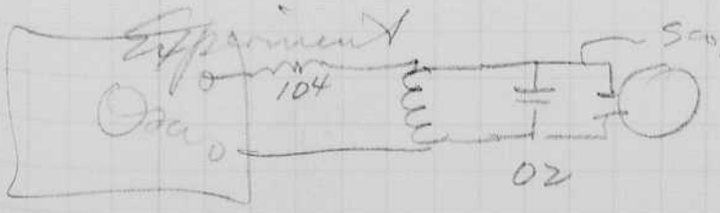
$C = \left(\frac{1}{12{,}000}\right)^2 \frac{1}{2\pi} \frac{1}{.004} = \frac{10^{-6}}{23.0}$

$= .04 \times 10^{-6}$

40 / .16 / 144 / 16 / 544 / 147 / 230.4



Experiment



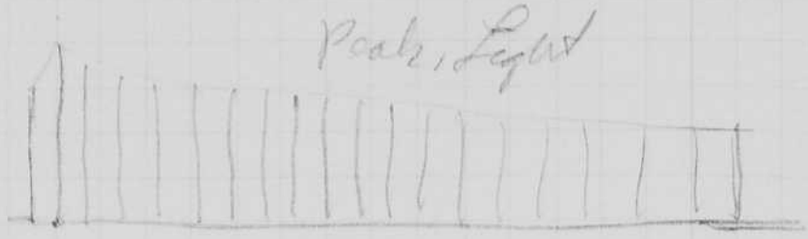
Resonate at 12.5 Kc.
(also peak at 15.2) Kc.

Cont. from page 107

20 FLASH UNIT

Test made at 100 KC - Some irregularity of peak light.

Test at 10 KC.



Peak light = 5×10^5 cp.

Duration 10^{-6} sec.

CPS = 0.5

input = 1.5 WS = $.03 \times \frac{(10^4)^2}{2} = 1.5$ W.S.

Mar 22 1956

Harold E. Edgerton
Geo La Compte
Ray Swansen.

Multiflash Magneto Optic Shutter

Blue Rotation ok. with first last
then went to Red rotation.

8 TURNS. # copper

o o o o o o o o

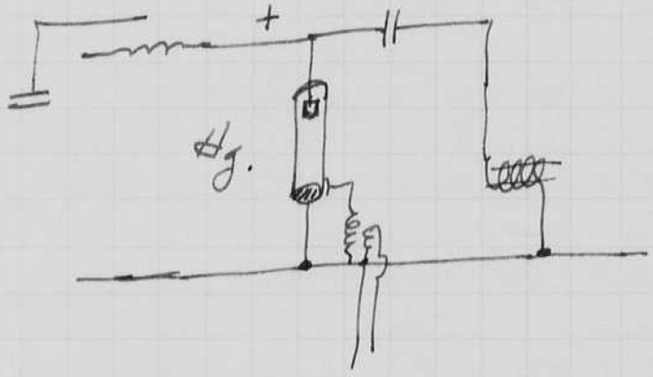
1/" HOLE

o o o o o o o o

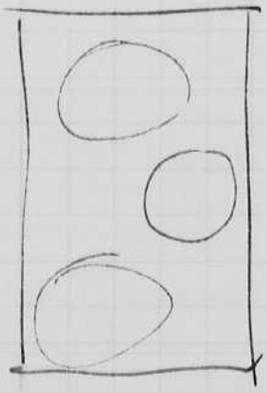
3 glass slugs 0.6 = 1.8" length.
"Pembetley" glass.

Capacity 0.3 mfd.
Voltage 20. KV.
W.S. = 60 W.S. 5 flashes.
= 300 W.S.

0.3 20KV.



Secondary coil to a flash tube FT-118.



March 31 1956
April 1, 1956 Easter Sunday. There is 2 feet of snow on the ground!
Harold Hopton

I left by car (P 13390 mass Plymouth Station Wagon) on Sat. mar. 24 for Newark airport to take the Eastern plane for Charlotte N.C. to see my dau at the Mary Todd Dixon and family. The going was rough by auto since a 10 inch snow storm was in progress. However I did make it. The 20 flash unit was in the back seat of the car for delivery to the army Chem center at Edgewood Maryland.

Monday - Retuned by tram to Newark from Hickory N.C. Visited Sam Pozgin at Picatinny Arsenal. Dover N.J.

Gave talk at Lever Bros Research plant at Edgewater N.J. at 430 pm. Movie of underwater and of nuclear explosions were shown.

I drove to Chad's Ford Pa to spend the night with my sister Margaret Robinson and family.

Tues - am Saw Winston Johnson at the Mech Division at Dupont. Wilmington.

Tues aft. at Aberdeen md to see Kent and several other people.

Wed. delivered 20 flash unit to Army Chem center. Heard lectures at 10 am by Odell, Stuart, Jamison, Pettersork, and Maheany. on body armor developments.

Thurs Mar 29. Ran the 20 flash unit on tests. David Brosman is in charge of the instrumentation section.

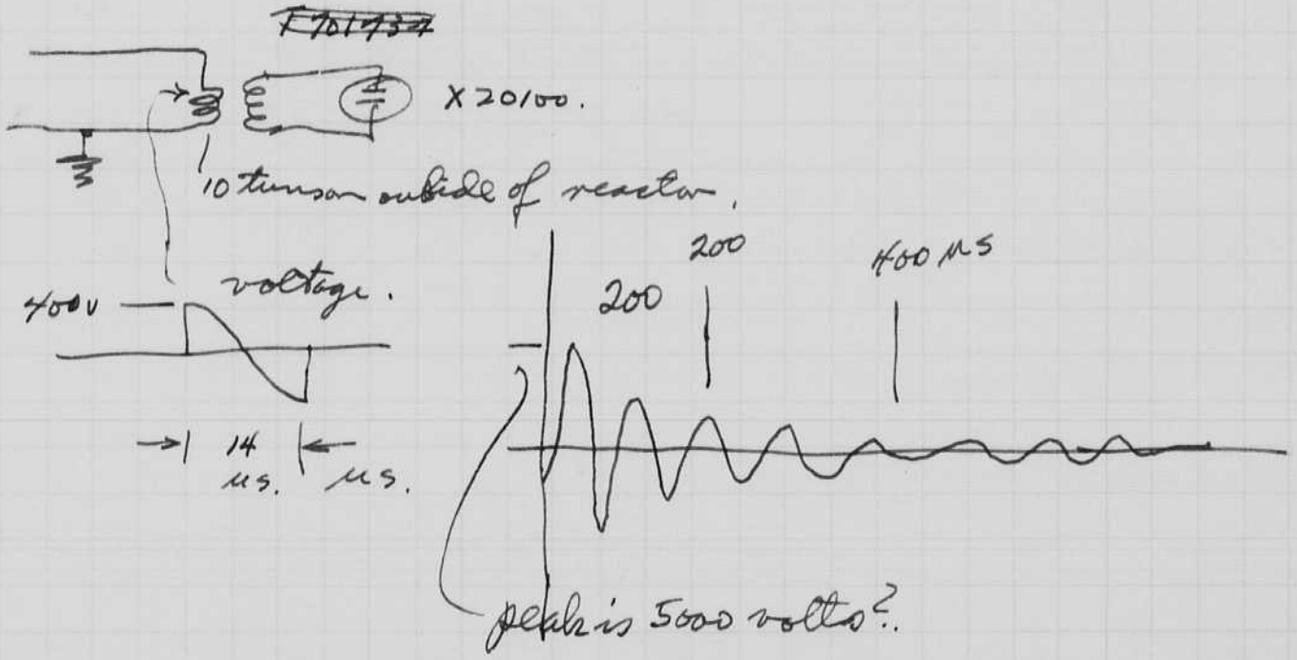
Friday - again visited Aberdeen then picked up my car Bill in N.Y. Bob is home from Univ of Rochester. now a Junior. He will be 21 in May!

Sec Inductance H/E transformer T70173-1 320 mh.
3131B13 Q = 4.4 DQ.

Trans 292-1388. Sec. 44 mh.
Pri 40 mh.

Open coil with loose square 27. mh. This shows Resonance with Elo Transducer at 12KC. X20100

~~T70173A~~



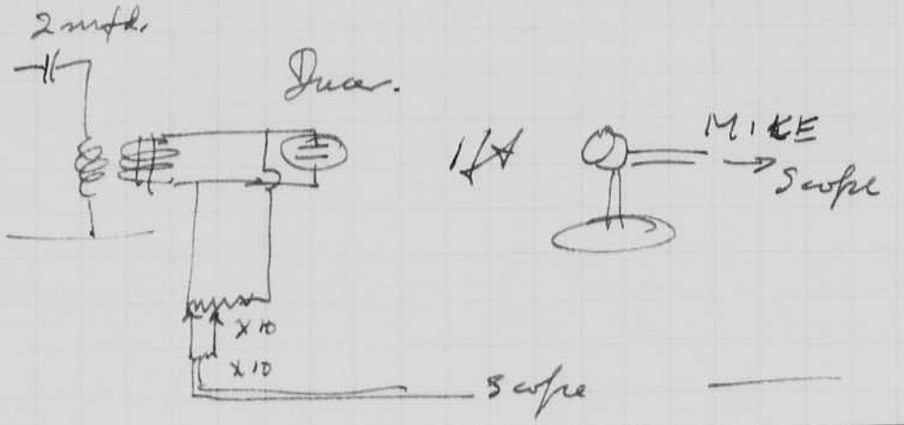
 April 7 1954.

Harold Edgerton

53 years old yesterday!

Transducer experiment.

continued work on transformer.



10 turns on old coil =

20 turns – result about the same.

20 X 10 X 10 = 2000

Old transducer as used last year gave about 1/2 the voltage but a longer pulse.

Inductance = 27 mh.

C =

$f = 12{,}000$

$\omega = 2\pi f$

$\omega^2 = 4\pi^2 144 \times 10^6 = \frac{1}{.027 \times C}$

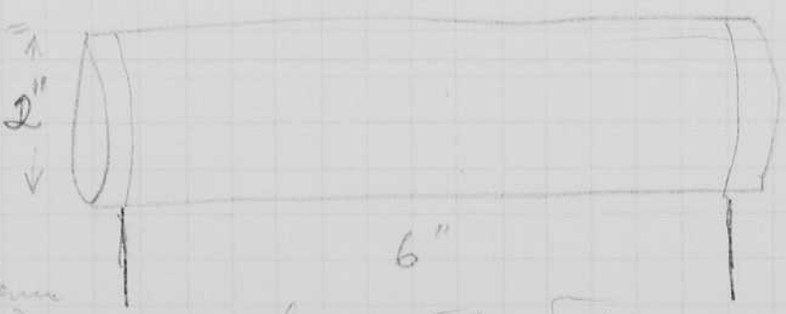
$$C = \frac{1}{.027 \times 10^6 \; 144 \; 4\pi^2} = .00654 \times 10^{-6} \text{ farads}$$

$153. \times 10^6$

$\pi 2^2 \times .036$

.28 per inch

$\frac{27}{16} =$



F = .0072

L = F d N² inductance

$L = .0072 \; 2 \; (28 \times 6)^2 = 407.$ mh

1.68

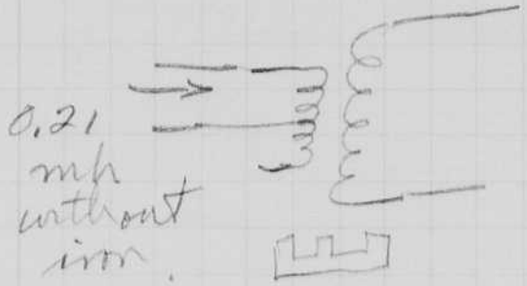
28,200

(27,000 mh)

$\sqrt{\frac{27.}{.4}} = \sqrt{66.3} =$ 8.15 layers

Transformer tests.

apr. 13, 1956.
H.E. Edgerton



15.8 mh without iron.

Distant 2 ft. crystal open Brush.
V = 0.4 peak to peak.
8 cycles above 1/2 meg.

With old coil V = 0.3 peak to peak.

apr 14 1956
H E Edgerton

Ranging system for distance measurement.

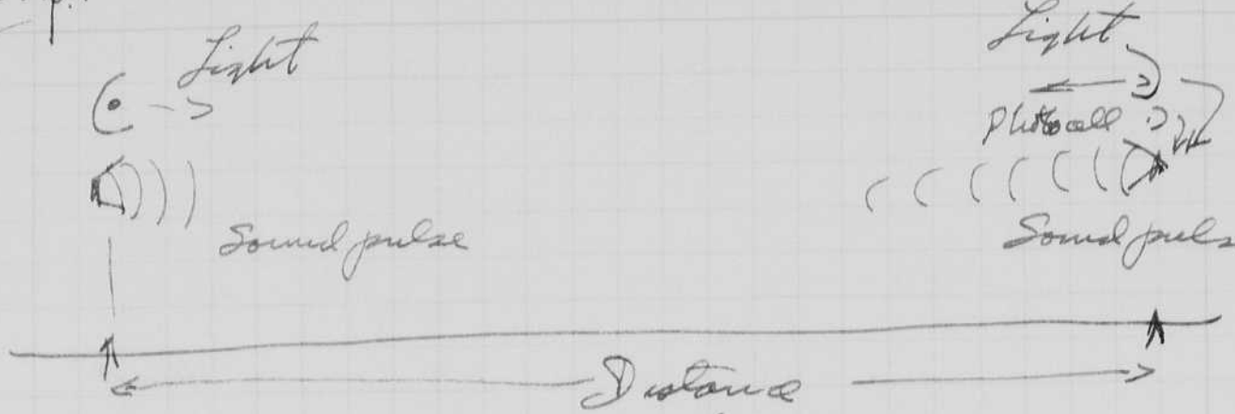
After there is a requirement for measuring short distances accurately. Radio pulses are out because of difficulties in generating high frequency pulses. Sound is inaccurate since the velocity of the air due to wind is bad. Also the velocity of sound varies slightly with temperature and pressure. Light can also be used, accurate measurements cause considerable difficulty unless a very good time resolver is used.

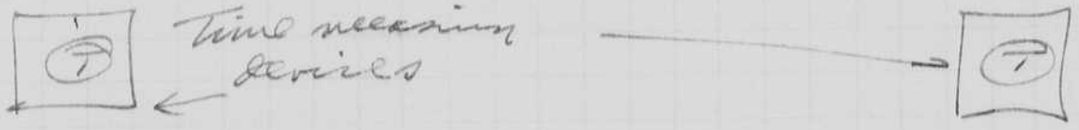
I was discussing the above system at length with Mr. [illegible] of Stewart Warner Co of Chicago who was brought in by Bauman of the M.I.T. Industrial Liaison.

One scheme occurred to me that might be practical. I propose two stations each with a strobe lamp and a buzzer generator. Radio could also be used to trigger the sound generators which are of the sound pulse type. Interval of time measuring systems at each could then measure the travel time. An average would be proportional to the distance when the pressure and temp correction was put in.

Cont.
#2 Eng.

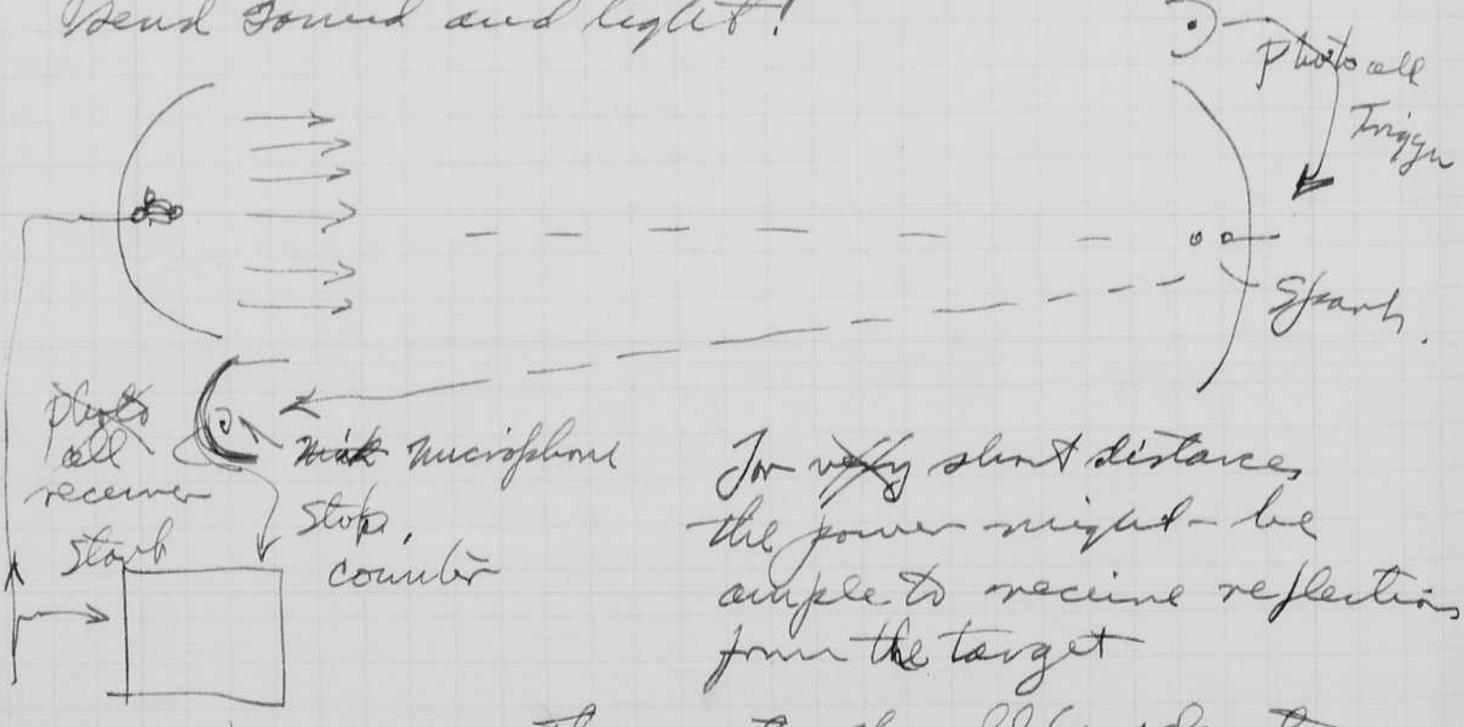
Distance measuring device.





$T = \frac{d}{v}$ $\quad d = vT$ $\quad v$ = velocity

I propose that a spark could be used both as a light source and as a pulse generator. The same reflector would send sound and light!



For very short distances, the power might be ample to receive reflection from the target

The units should be identical so that either end can be a transmitter of the initial pulse.

Devised & understood by me Wray & J. & B. Peter W. Riis

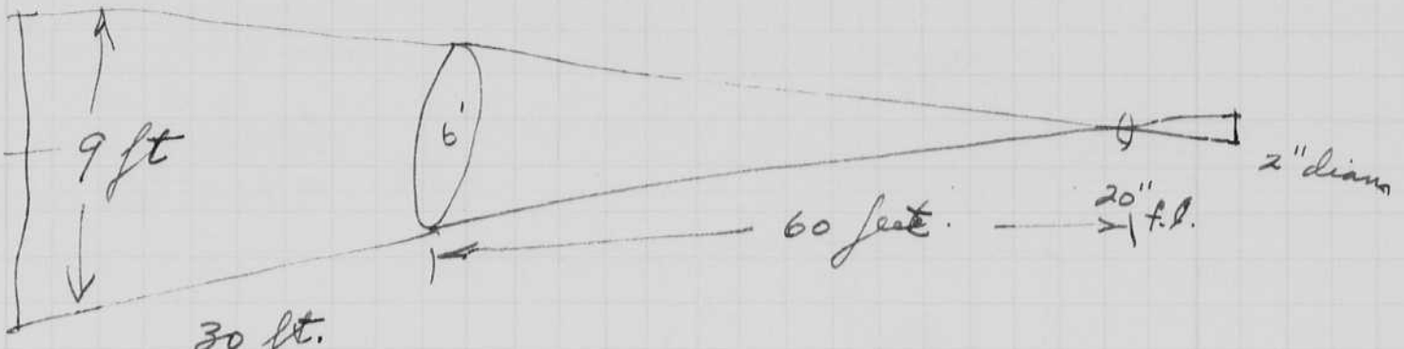
Apr. 17, 1956 Holloman setup.

Harold Edgerton

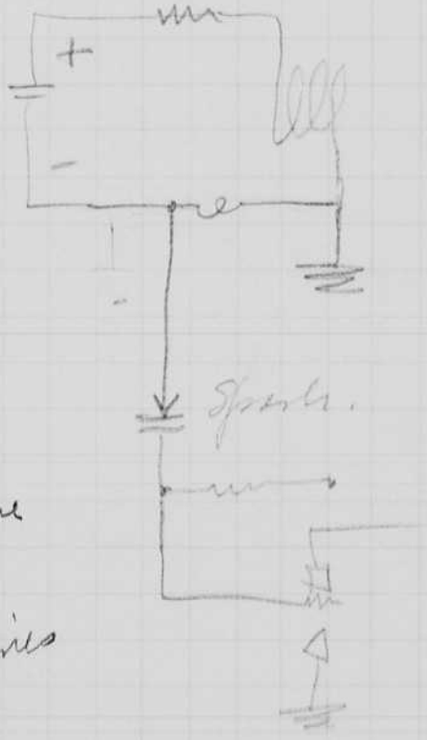
Sep 99 97.

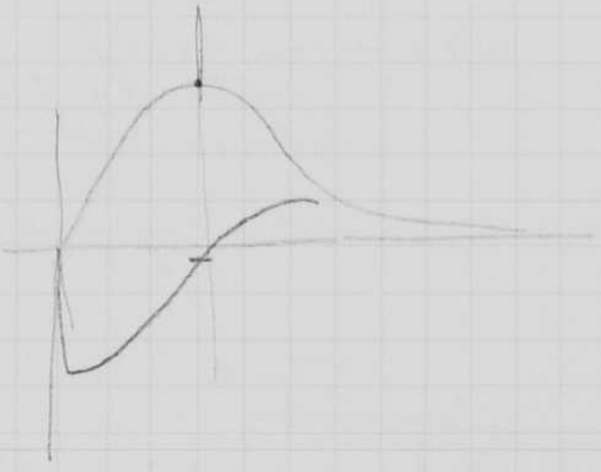
Field of view = 6" diam

Tiny camera lens of 20 inch focal length.
1 inch diam slug.



Scotch light Screen.





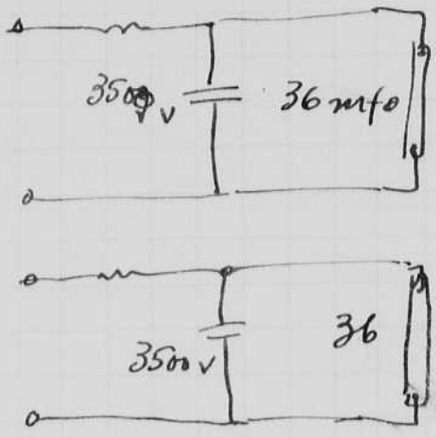
Overlook to understand, me
Mo, 8'5 6
Nebraska Hwies

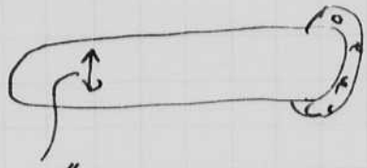
 Apr. 21, 1956

Harold Edgerton.

Bill MacRobertson

Roundy of the David Taylor Model Basin was here Apr 18 and Apr 20 to discuss design of the strob driver for propeller studies. He worked with Bill on the measurements, layout etc.

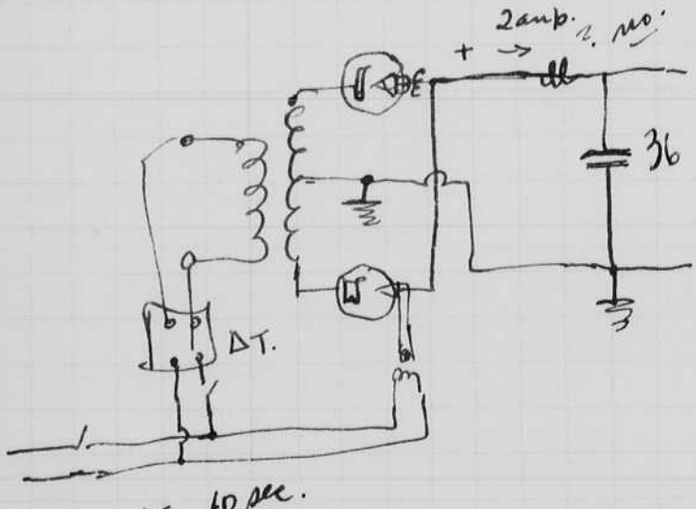




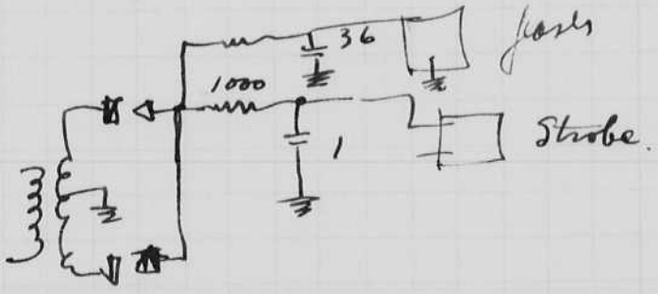
1" diam inside to hold the FX-1 flash tubes.

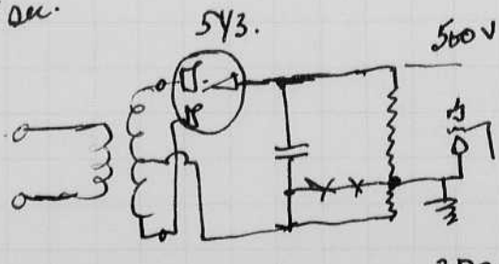
also reconnect for strob at 1 mfd 3500 up to 30 flashes/sec for visual observation.

alternate set of outlets for single flash.



ΔT 10 sec. or 15 sec.



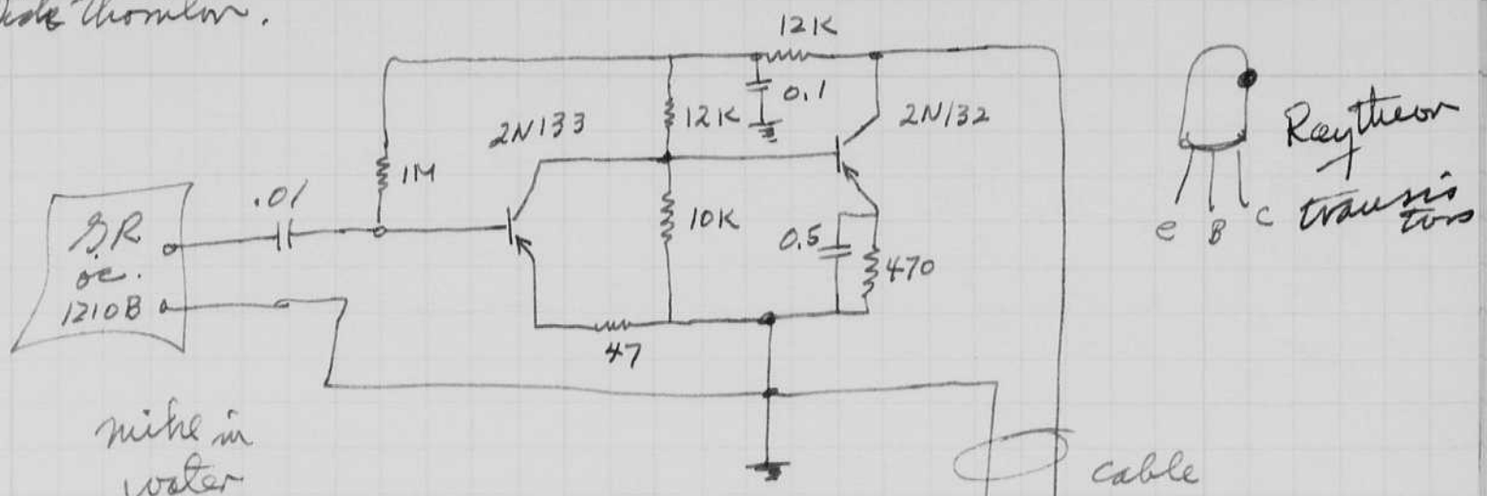


2D21

Transistor amplifier for Sonar.

April 22, 1956

from Dick Thornton.



amplifier in tube.

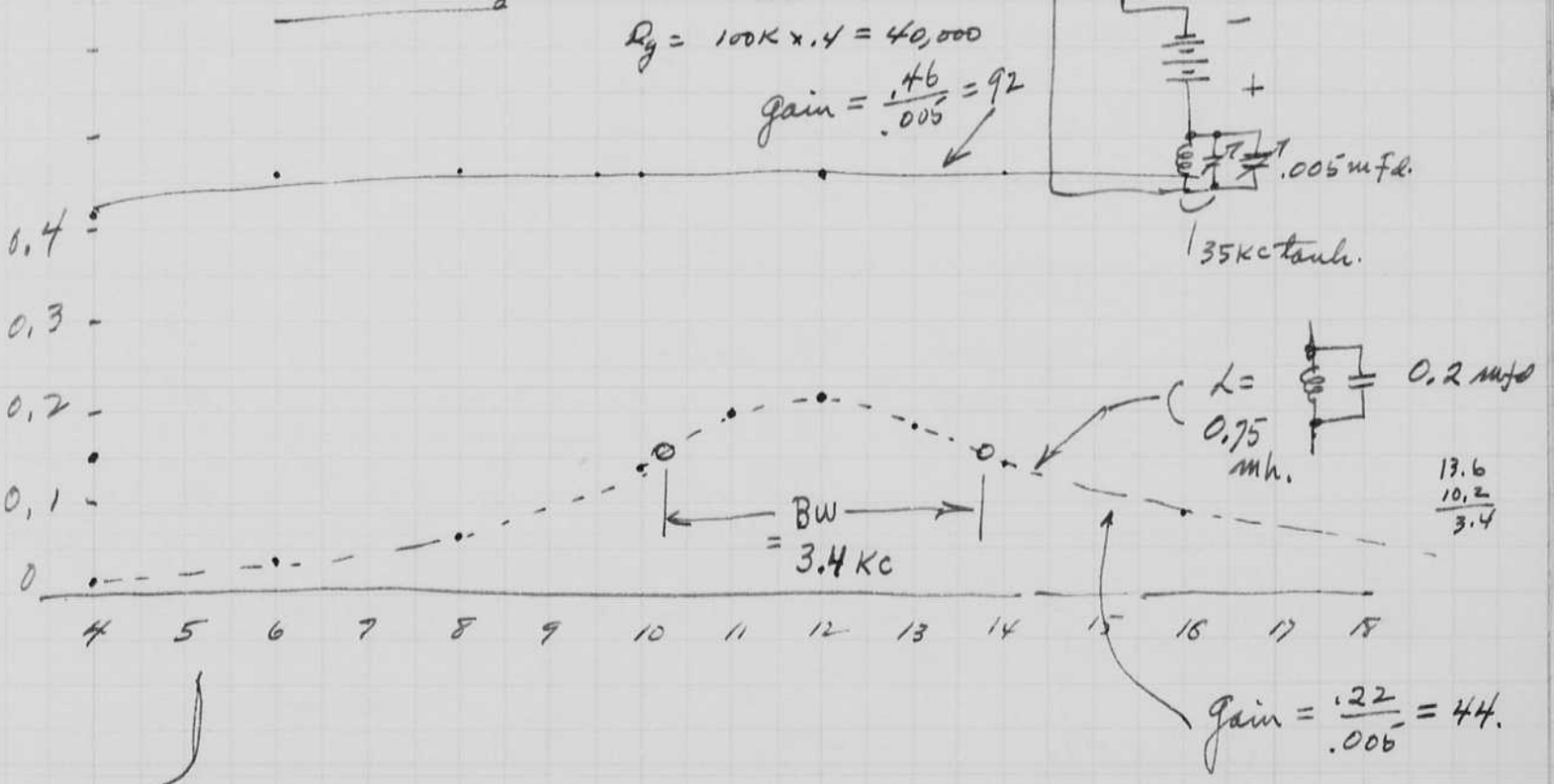
Input = 0.005 volts.

Input test — .07V — 100K — .02V — R_g and ⏚

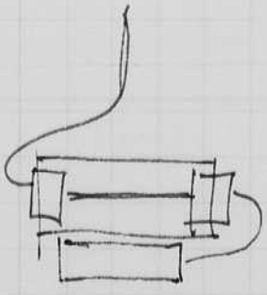
Then $\frac{R_g}{100K} = \frac{.02}{.05}$

$R_g = 100K \times .4 = 40{,}000$

$\text{gain} = \frac{.46}{.005} = 92$



$\text{Gain} = \frac{.22}{.005} = 44.$

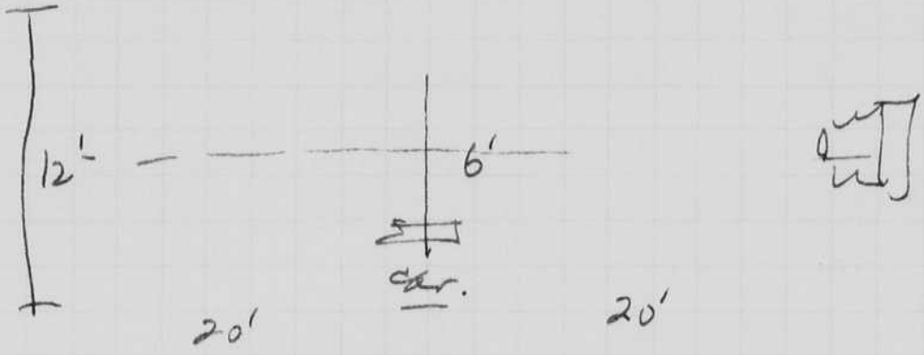


April 26, 1956 Warren Houghton and Robt Phillips of H.E.D. G.E. Co Lynn came in yesterday about a photo problem of turbine blades during fracture. 60,000 r.p.m. = 1000 r.p.s.

LY 3-6000
Ex 2259
4679
Gt. phone us.

We discussed a drum camera and a gated 501 unit at 10 K.C.

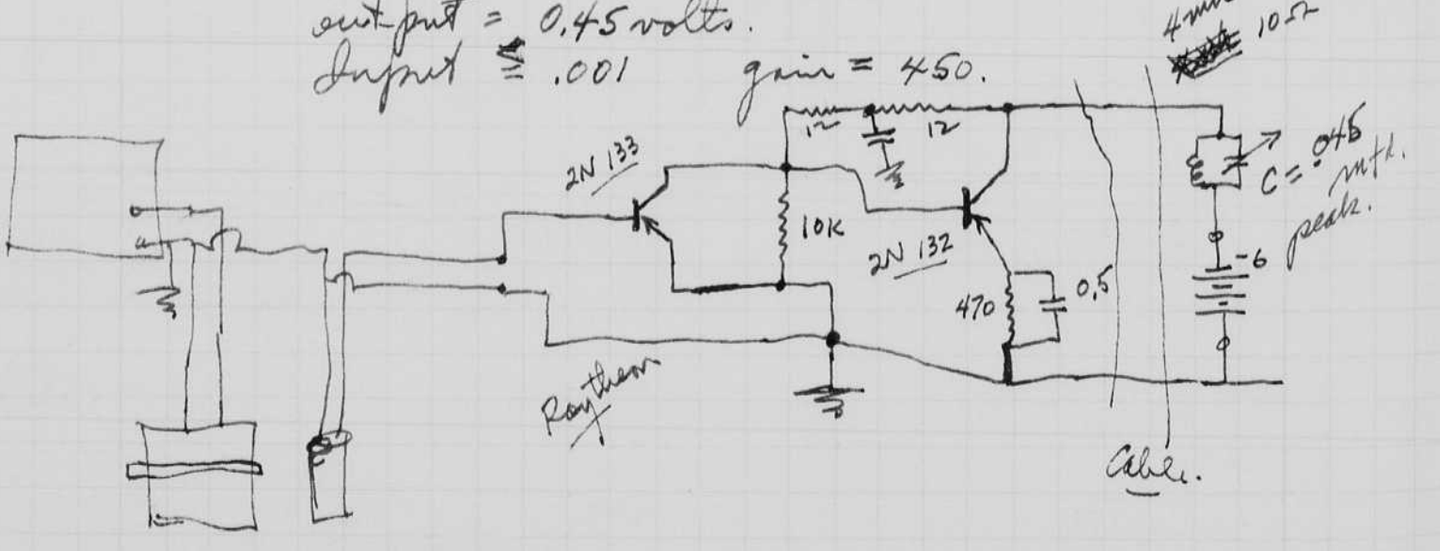
Sync might be a problem. They suggest a rapid overload on the air pressure on the drive.



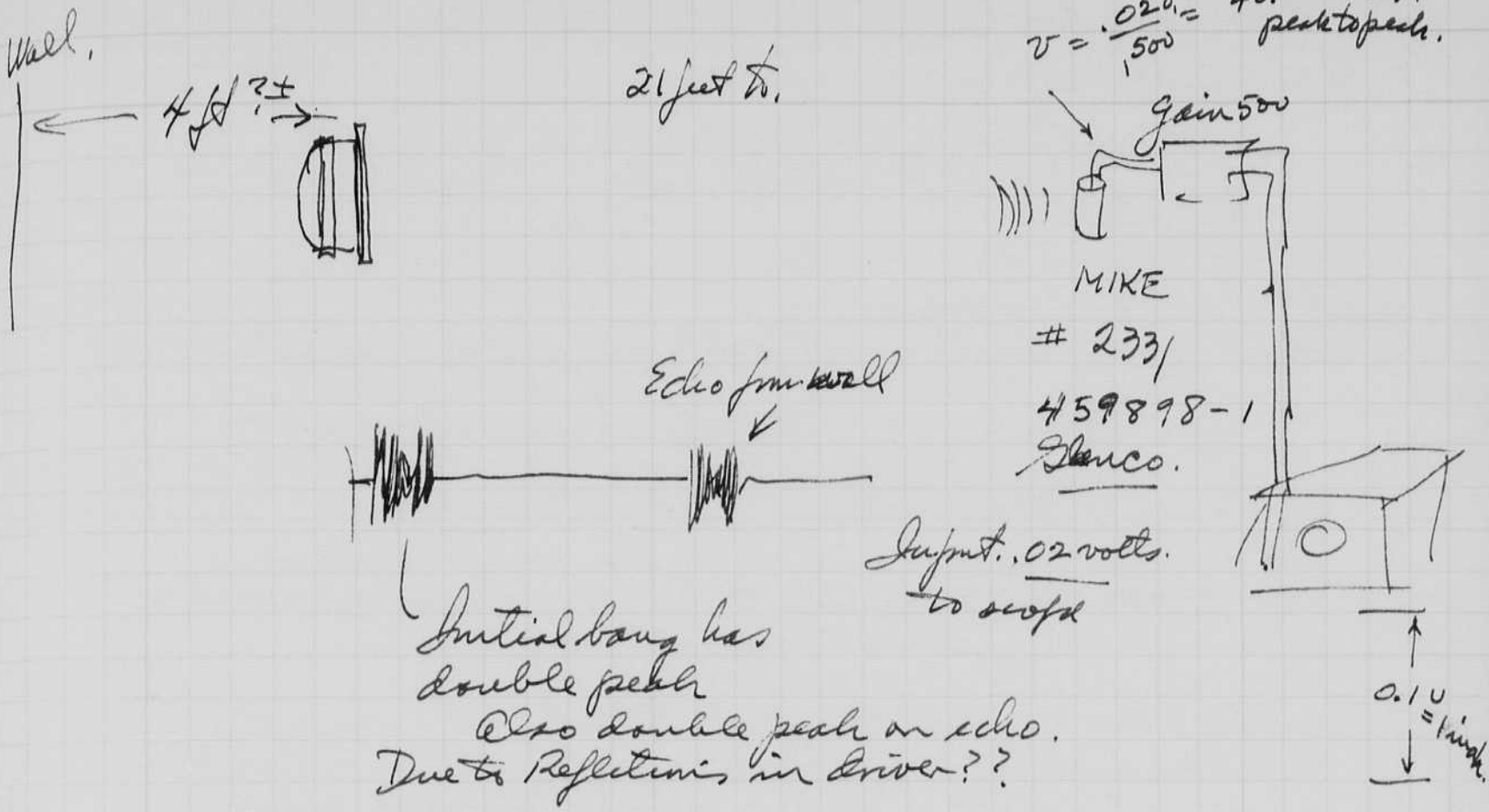
Conf with Rona. and Lecompte about Hallowan.
Decided to try a bone system. Rona will make the 12' screen.

Transistor amplifier as modified by MacRoberts at Thornton's suggestion

out-put = 0.45 volts.
Input ≅ .001 gain = 450.



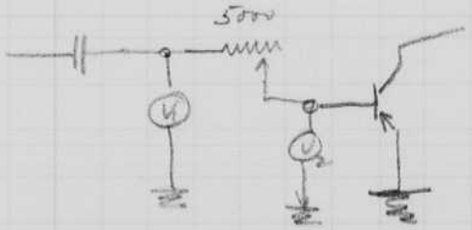
$V = \frac{.020}{500} = 40.\times 10^{-6}$ volts. peak to peak.



Timing changed from 0 to .03. Gain increased especially first peaks. Now get 0.1 volts into scope from back side of transducer.

0.1 volts back side of transducer
0.22 volts front side " "

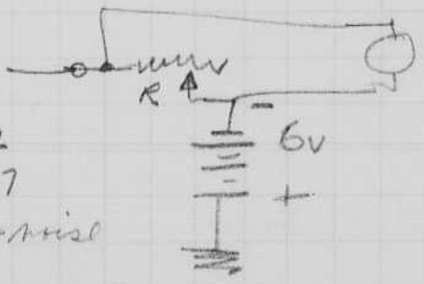
Input impedance



$V_1 = 0.10$
$V_2 = 0.05$

$\frac{5000+R}{R} = \frac{0.10}{0.05} = \frac{2}{1}$

$5000 + R = 2R$
$5000 = R.$

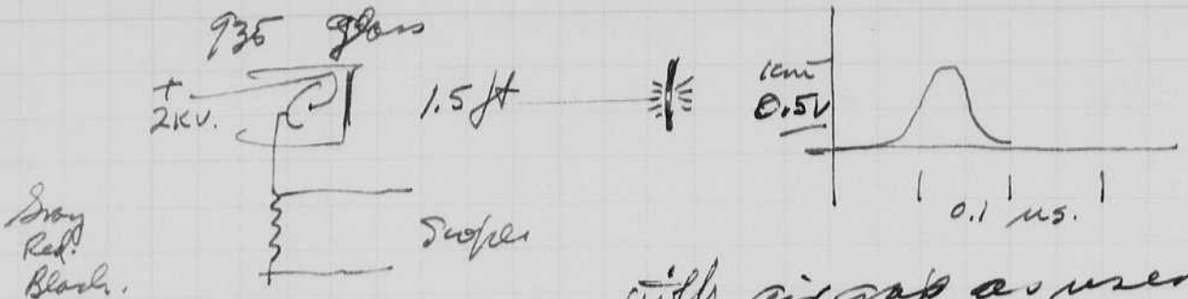


Input shorted
output 5000 Ω V = 0.02
open V = .027
noise = 60 cycle + noise

Ballantine model 300

R_L	V	V_{dc}
1000	0.2	— 1.18
2000	.285	
3000	.31	
4000	.31	— 2.1
5000	.29	
6000	.26	
7000	.23	
8000	.19	
100		.2

May 6 1956 Double flash tests. #6.
Harold Edgerton.



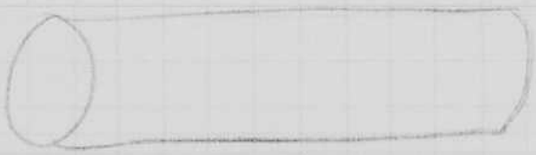
with air gap as used in Standard equipment 2307C-3.

an XP-2 flash tube was now substituted. 1/4" gap in xenon at 1 atmosphere.

The peak light was about 1.5 volt compared to 0.5 volt as per above air gap tube

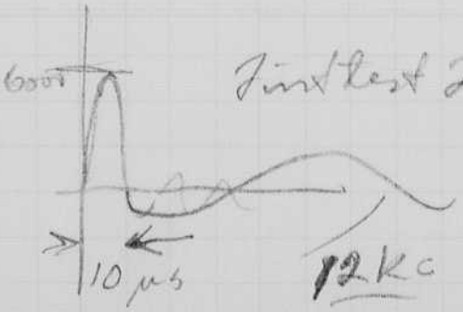
The duralumin was about the same except the trail off was higher..

Tests of Sonar setups.



Sec. 738 turns small wire one turn.

Primary 38 turns



First test 21 turns

12 kc

May. 12, 1956
Harold E. Edgerton
R. Algazi

Deep sea sonar.

Water temp = 50° F

Equipment installed in the Charles on the MIT Boat house.

Distance to transducer about 80 ft.

Received at Dumont scope from transistor amp = 1.5 volts ± peak.

Noise voltage = .01 volts ± from the river.

Note: the amp. has a band width of 3 or 4 kc.

A motor boat at the center of the river – (¼ mile from mike) gives about .05 volts into our system.

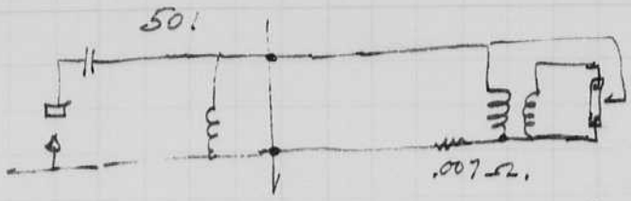
We found useful signals from the transducer when it was 2/3 of the distance from the boat house to the Longfellow Bridge.

May 19. – I showed motion pictures of the underwater research to the M.I.T. club at Sterling Mass. Sterling Dinner last night. Wilson of B.L. was there. also Chapman's daughter Mrs. Woodward.

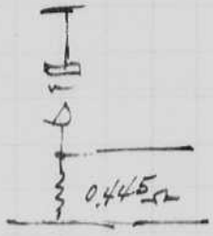
My last class in 605 is Monday.

122 May 19, 1956.
A. E. Edgerton.

501 with Short tube.

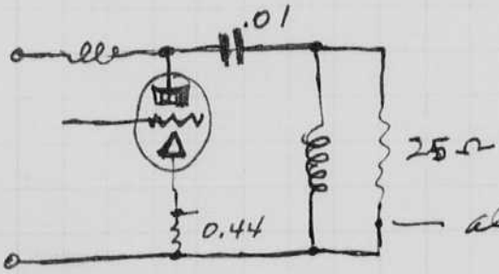


1 volt. = IR = I × .007 $I = \frac{1}{.007}$ = 140 amps. peak.



$\frac{46 \text{ volts}}{.44} \div 100$ amps. into pulse transformer.

with .01 mfd into FX-2 $I = \frac{34 \times 3}{0.44} =$



.C
.02

Eicleon.

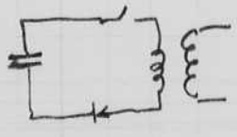
also in series with XP-2 tube.

LFE

T 70487-2 NEW TYPE.

OLD POTTED TRANS

0.43 ~~0.39~~ mh. pri. ‖ .600 ~~mh~~ at 1000 cycles.
.025 mh. sec. ‖ .04 mh.



$I_m = E\sqrt{\frac{C}{L}}$

The old transformer has better iron and seems to give preferred result. Is this worth the difference in performance?

Deep-Sea Camera for Libreville French West Africa tests 1956 summer on Calypso.

H.E. Edgerton
M.I.T. May 26. 1956.

Lens Leica 35mm 378310 with "Baker" corrector
Lens removed from the carrier (Elmar).

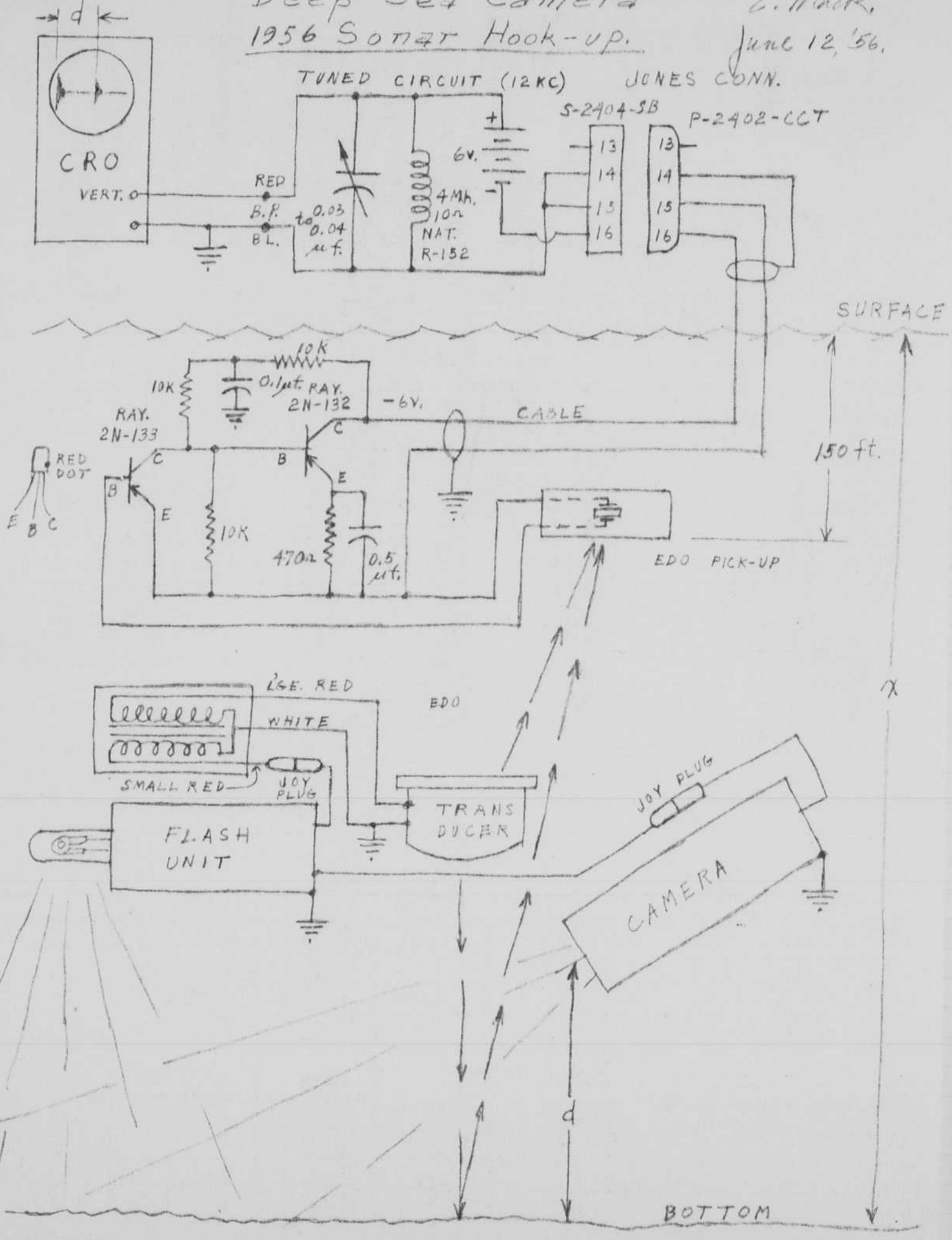
Same camera as used in 1955 summer.
Edo Sonar increased in size.

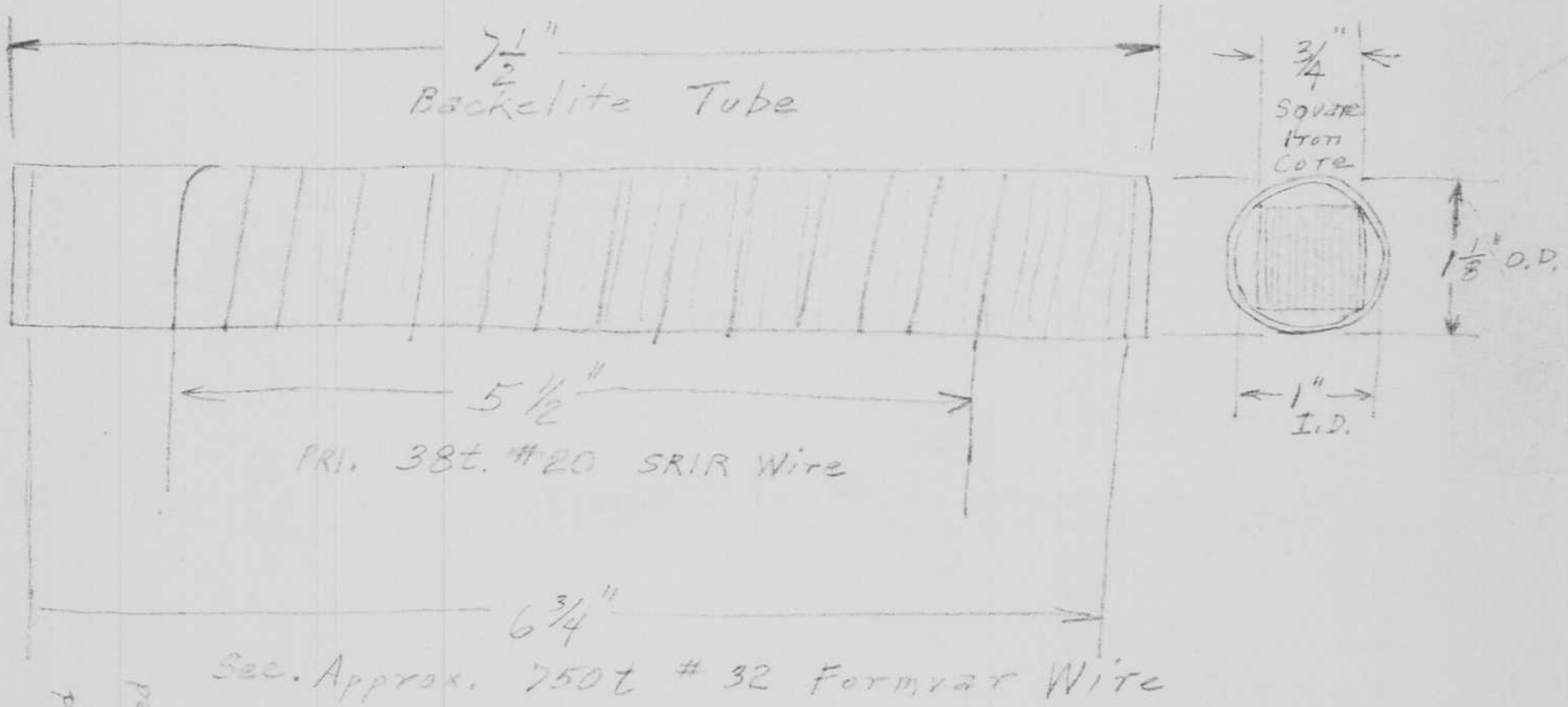
Motor for camera 7100D 6 volt 4.5 R.P.M. Hansen.

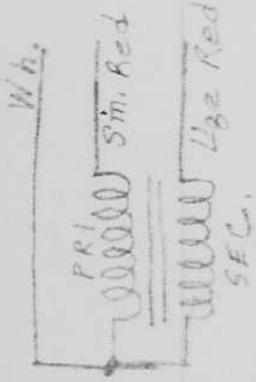
June 10 1956. Graduation was on Friday at M.I.T.
H.E. Edg. Bill is back from Columbia where he is a grad student in math. He is working at Hyannis with John Light. teaching Aqua lung and selling diving equip.
Bob came home last weekend from Rochester where he just finished his junior year in physics. He helped me at B.E. Lynn on Monday and Thursday. We took movies at 12000 flashes/second of the bursting of a small tubbie wheel with blades or pins. a titanium cylinder caught the blades.
Fracture occured at 60,000 r.p.s.
Film XXX at f 2.7 .01 mfd at 600 on each 501.
Lamps about 3 ft.
Two. 501 units used in push pull driven from an oscillator.

Deep Sea Camera
1956 Sonar Hook-up.

E. MacR.
June 12, '56.



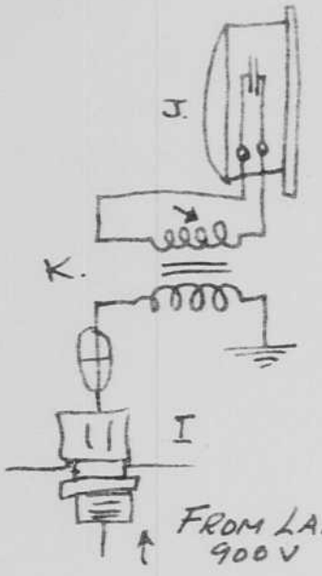


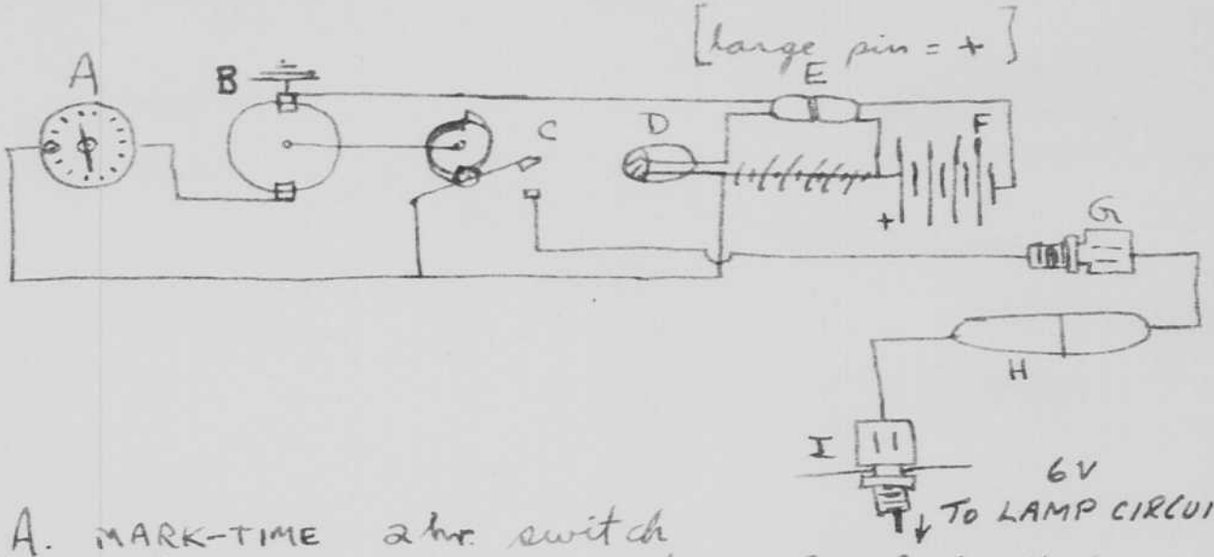


Sonar Transformer

Pot with Scotchcast #2
in 1 3/8" I.D. bakelite tube
9 1/2" long. (Uses approx. 1 lb. Scotchcast)

June 12, '50
E. MacK.





J. TRANSDUCER
EDO # X-20100

K. EDGERTON TRANSFORMER TUNED TO 12 K.C.

A. MARK-TIME 2 hr. switch catalog no. 5201 M. H. Rhodes, Inc. Rockefeller Center N.Y.C.

B. Hansen Motor # 71000 6V. d.c. 4.5 R.P.M.

C. MICROSWITCH # V3-101 with # JV-5 actuator

D. Hg switch E. Jones plug S-302 cct P302 cct

F. 4 Yardley Silver Cells #LR-20 6V. total

G. Conax MPG 3/32" Bore

H. N0103M N0103F JOY PLUG

I. Conax M.P.G. 3/32" Bore.

TRANSDUCER AND CAMERA 1956 — CALYPSO

June 8, 1956
Bob Edgerton HEE ✓

Prepared by GR
Date 6-IV-56

Report 2883
Page

TESTS OF DR. EDGERTON 35,000 FT. DEEP SEA CAMERA WITH EDO TRANSDUCER # X-V0100

SOURCE LEVEL (12 KC) = +114 DB/1 MICROBAR

PER VOLT RESPONSE OF TRANSDUCER = +41 DB/1 MICROBAR (FROM PREVIOUS CALIBRATION)

CALCULATED VOLTAGE ACROSS DUCER = 114-41 = +73DB = 4500 VOLTS AT PEAK OF PULSE

PULSE SHAPE: 

MAXIMUM ENERGY: BETWEEN 10 & 14 KC

CALIBRATION OF SONOBUOY HYDROPHONE & TRANSISTORIZED AMPLIFIER (ATTACHED):
R_R = -49 DB/1V/1 MICROBAR

RESPONSE OF HYDROPHONE ALONE = -96 DB/1V/1 MICROBAR (FROM PREVIOUS CALIB)

GAIN OF TRANSISTOR AMPLIFIER = +47 DB

TESTS WITH AN/UQN EQUIPMENT ON BARGE (USING UQN RECEIVER ONLY):

GAIN OF UQN = +96 DB

WITH SONOBUOY HYDROPHONE CONNECTED, RECEIVING RESPONSE OF SYSTEM IS: -8 DB/1V/1 MICROBAR AT 12 KC.

APPROX CALCULATION OF RECEIVED VOLTAGE AT 35,000 FT.: 60 MICROVOLTS. THIS IS ABOUT 30DB ABOVE NOISE LEVEL OF UQN.

June 16 1956

H E Eg~~lton~~.

Bob, my son, is working in my lab in Bldg 20 at M.I.T. this summer. He will be under Germeshausen and MacRoberts.

Bill is working at Hyannis with John Light on a diving project. The group have a plane and a boat for taking out tourists etc.

Mary Jon and Jan were in Boston for the past two weeks. They returned June 16 by air to Wash and then by train.

Esther and I leave for Honolulu ~~next w.~~ tomorrow morning via Nebraska where we pick up Esther's mother Clara Barnett.

I am scheduled then to go to Eniwetok and then on July 10 ± go west to Abidjan Africa to meet Cousteau on the Calypso. We have a deep sea photographic experiment to perform off Africa where the bottom is 20,000 feet down.

Aug 18 1956 Sat aft.
Harold Edgerton,
M.I.T.

Summer Schedule so far.

Left June 18 for Nebraska
Left June 20 Wed from Nebr. for Honolulu a/tr
spending 2 days in Aurora with my
parents Mr. & Mrs. Frank Edgerton

June 26 Left Honolulu for Eniwetok
29 " Eni for Bikini & return later

July 6 at Mack tower
Coral Head at Eniwetok
July 10 left for Guam via Kwajalein

" 13 left Guam for Tokyo

" 16 left Tokyo for Paris via Air France
19 " Paris for Abidjan F.W.A.

July 26 – Aug 5 at sea on Study of Romanche
Trench. on Calypso.
Aug 2. Telegram rec'd from Dugan about death
of Bill Edgerton, Nantucket island
harbor, in a diving equipment
of Dr. Christian Lamberton of
the Univ of Pennsylvania. 12 feet deep!

Aug 2, 3, 4, 5. Calypso went full speed to
Dakar, then Conakry, where a French
military plane took me to Dakar.
Cousteau went with me on this trip.
Aug 6, 7 to Paris via PAA and to Boston
via PAA. arrived 9:30 am at
Boston airport.
Aug, 8. Bill's funeral – Payson park church
Mount Auburn Cemetery.
We sure miss that Bill
Aug 12 Took Bob to Trapp Music camp Stowe Vt.
" 15 Visit to Hyannis to see John Light
and the Capt Jameson, the ship that
Bill worked on this summer. He taught
about 170 people how to dive.

130 cont-

Aug 16 Jean Michel Cousteau visited us in Belmont and saw M.I.T.

Aug 21, 1956. Directors meeting aug 20 9.30 to 2 pm.

1 2 3/4" Mills spools. { high speed Jestar with 501 .01 mfd at 110 ac on motor.

2 2 3/4" " " Jestar has no prism

3 2 3/4

4 4 1/2"

5 6" drops seem to show crown.

Daylight Kodachrome. 2 #2 photo floods.
5 ft at f 4 for General scene.
1 1/2 ft at f 11 or 16 Close ups.

16 fps. f 22 1 ft. close up 6"
32 " f 16 " "
64 " f 11 1 " "

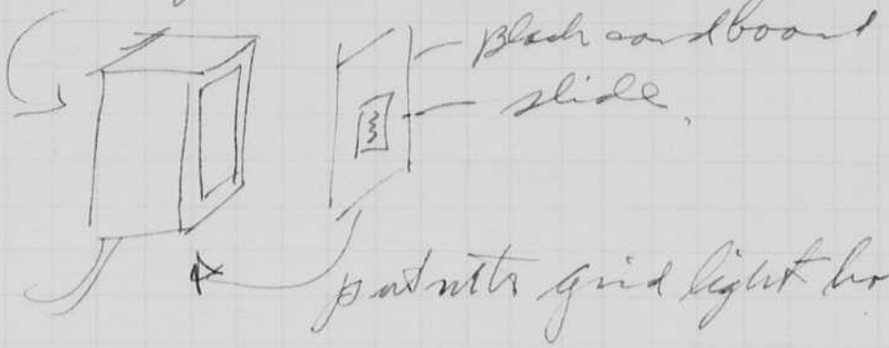
other shots with Daylight Kodachrome Guide no about 20 ± of set ups

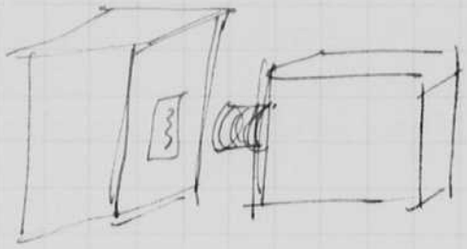
Aug 23 1956

Copy of 2×2 slides · Kodachrome Slides.

Ray Swanson

Aristogrid light 4×5 size.





Camera,

f 2.2 16 fps Daylight

H 2.2 8 " "

4.5 16 f.p.s. colors.

Indoor film also used.

Slide copy

f 4 – 8 f.p.s. of two slides.
E. D. & D.
f 4 – 16 fps. and Tussell,

Highspeed movies. – Projection bulb on table. Strip.

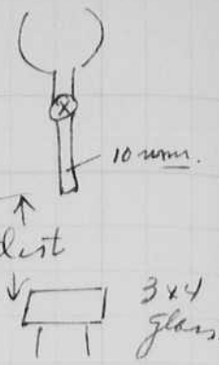
Lamp 2 ~~ft~~ f4. .01 mfd 8 KV. 90 V on variac camera 4 ft.
#1 Telea #1 sup lens on the lens. 2" f 4. f2

#2 Closer. f 4.5 110 on motor

#3 Cameras 2 f 4. 115 on motor. Tastax film Dupont. type 931.

#4 " " " 115 on motor.

Drops. non-fat milk.



#5.	7"	5.6	Dupont 931	Crown.	
6	9 1/4"	f56	"	~~Fat~~ of milk.	
7.	9 1/4	8	~~Drop~~? Fairly thin	crown.	115 v
8	9 1/4	8.		crown?	100 v.

Thursday Aug. 24, 1956.
#22. movies of "Splash" book Worthington
25 Guide factor. 2 balls.
18 1 bulb.

Fringe movie
1st scene - front light with white background.
2nd " Side light 95 & 100 degrees f 11

		f	D.	Motor	Co.	Subject	
High Speed							
3 fr.	~~#1, xxx~~	2.	10"	85 v	.01	orange.	~~8~~ x 5"
1.5 fr.	#2. xxx	2.7	10"	85 v	.01	"	8 x 5

Friday Aug 24 1956 to New York to get Bills things.
" night at Robinsons with Mary Lou, Jan at Chadsford Pa.
Sat. finished Bill's things - saw Pat Gunther at 611 west 114
Sun. Sorted Bill's things.. Bob Silverberg was in the apartment.

Aug 28 1956
H. Edgerton

Movies of milk drops.

Pouring of milk scene. High speed also. Regular.

	Film Box		f	Spee.	dist	Light Remarks.
1.	Plus x	60 ft.	2.8	85 volts.	4 ft.	1 ft. Spout too low. scene also shot with Pathe at 16 fps. 2 photofloods at f 5.6 6 to 7 feet from subject.
2.	Same as other but with beaker higher.					
3.	Plus x	100 ft	f 8	80	1 1/2	10" Close up of drops forming on drop bar. ok.
4	Plus x	100 ft	f 8	90	1 1/2	10" Splash. ok.
			3 pint milk.			
5.	Plus s	100	GN 40			

all processed at Back Bay
Harris Cohen.

Aug 29 1956. HE. cont movies.

Expos. #1	Plus x	100	f 8	90	1 1/2	9"	Splash Regular milk 7"
Expos #2	Plus x	100	f 8	90	1 1/2	9"	" drops " 7"
Updated	3	"	"	"	1 1/2	9"	Johnson Subject. " med 7"
Updated	4	"	"	"	85	"	" Cup with milk.
Good.	5.			80		"	" " 7 1/4"
	6	"	"	f 8	95	1 1/2"	9" cup marble. 7"
	7	"	"	"	"	"	" " " 11"
	8	Tri X	"	f 4	115	4 1/2 x 2 lens.	2.5 ft 22 Bulb on steel plate.

Sept. 5, 1956.

Harold E. Edgerton

The movie was spliced together over the weekend. I have bullet breaking photos. also orange juice being removed to show the jets from the skin. other sequences of milk splash photos were made showing crowns and jets.

Bob left in (P13,380 mass) Plymouth for Rochester mich on Sept 4 early in morning. Bob has a job as Dorm advisor this year at R.U.

Today I went to see Bill Barth with Jamesbaum. Barth is the main person at Photon who are making a stroboscopic setting machine. For years we have helped this company with flash tube designs etc.

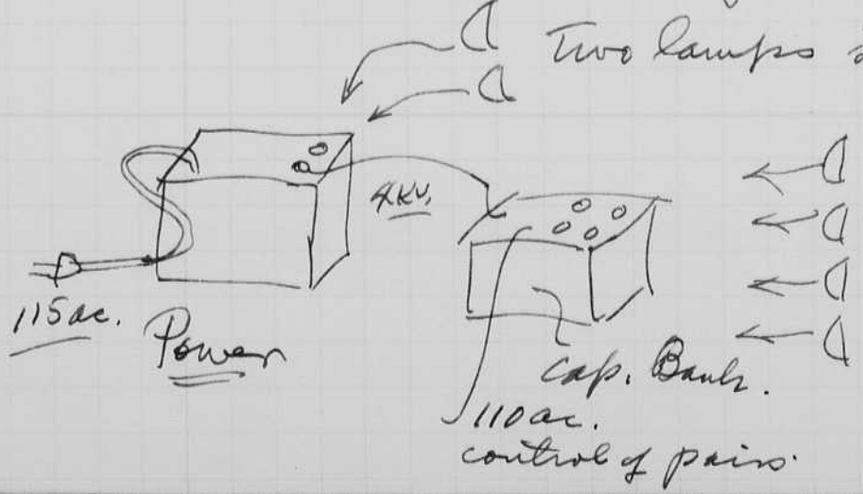
Sept. 7, 1956

Conf. with D.T.M. regarding Prop. photography. Rounds.

18 or 19 of Nov. Key West Florida

Friday preceding "Norfolk D.L.I. Slip.

December installed "albacore" submarine.
Jan. tests of Propeller.
Portsmouth dry dock for installation.



Sept. 7 1956.

H. E. Edgerton - I leave this afternoon PAA flight to London from Boston, My wife Esther goes too.

Oct. 9. 1956 Retd Gast Sat Oct 7 at 1030 on PAA flight 55 from Shannon Ireland.

Sept 7 left for London in aft with Esther. Washington Hotel London.
10 High-Speed Photo Congress Talk on xp-2 flash tube.
11 Lecture in Royal Inst. on Flash.
14 Banquet Rembrandt Hotel.
15. Left for Frankfurt. Bismarck. Frankfurter hof Hotel.
16. Sunday Dr. Lauder, Margot, Hempfel. Pogrell.
18. Eindhoven N. Wassenberg.
19. with Pogrell to Wiesbaden Heiman
20 Darmstadt & Stuttgart
21 Weil am Rhein with H. Schardin
22. To Vienna Herald 2 Seilergasse St
23. Int. Fri Film Conv.
24. - 27
28 - left for Cologne - Dom Hotel.
29. Phot Kina
Oct 2 To Paris D.P. Cousteau M.M. Clompason Y Inst. Curie La Porte
Oct. 5 to Boston PAA 55.
6. home at 1030 am met by H. Sloan Acher and John Haramundanis.

Explorer Photographs 25,000-Foot Sea Floor

The New York Times

Capt. Jacques-Yves Cousteau

9/17 or 20.

Capt. Jacques-Yves Cousteau reported yesterday that he had obtained three photographs of the ocean floor at 25,000 feet below the surface. They were described as the deepest pictures ever mode.

The French underwater explorer described them in the French Consulate, 934 Fifth Avenue.

The photographs were made recently in the Atlantic off Equatorial East Africa on Captain Cousteau's latest oceanographic expedition for the Paris Museum of Natural History and the National Geographic Society of Washington. The camera was a special device invented by Dr. Harold Edgerton of the Massachusetts Institute of Technology.

"The pictures show no sea monsters, I am sorry to say," Captain Cousteau reported. "They do show rocky shelves with little mud. That was unexpected, for we had believed the bottom covered with organic mud. We saw also many organic pebbles on the rock. The pictures also indicated plankton as abundant as in surface waters." TIMES.

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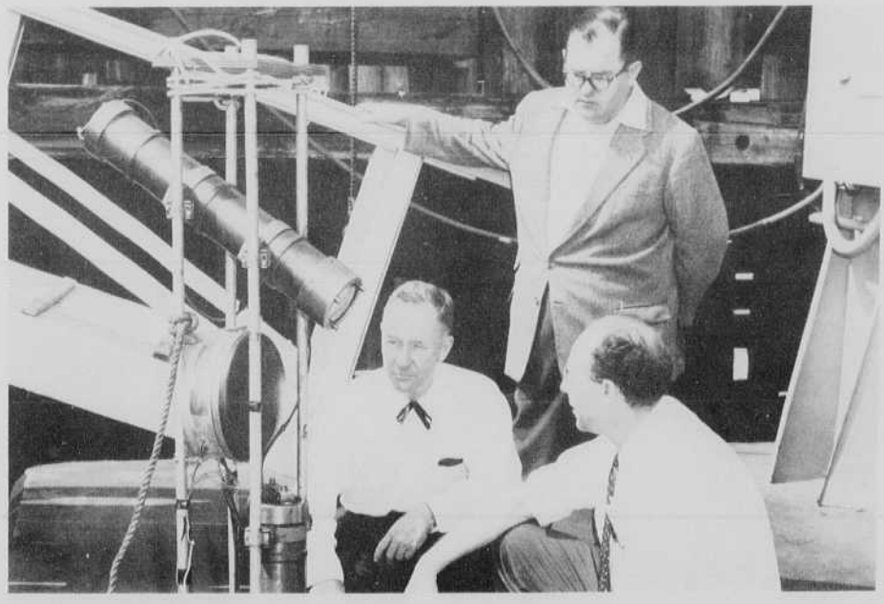

CAMERA'DUCER. DR. HAROLD EDGERTON (right), is shown with his Deep Sea Camera Unit equipped with an Edo transducer for operation at depths to 3,500 feet. Accompanying Dr. Edgerton on this recent visit to Edo is JAMES DUGAN (standing), noted marine author. Edo President NOEL B. McLEAN inspects the camera with the visitors. All of Dr. Edgerton's many friends at Edo were saddened by the death of his son, William, who was engaged in testing new diving equipment in the vicinity of the sunken Andrea Doria.

Edo Log XIV 10 5 Oct 1956

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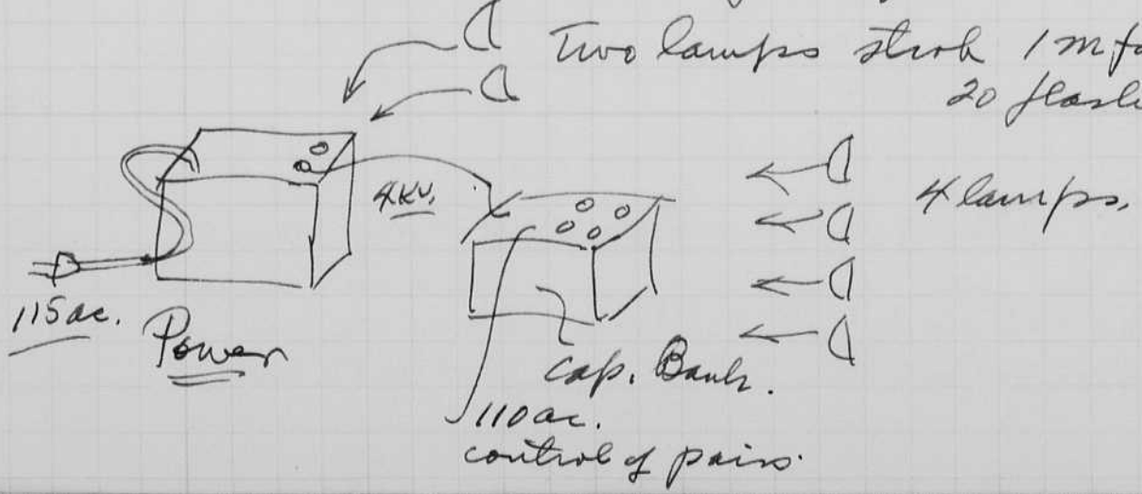

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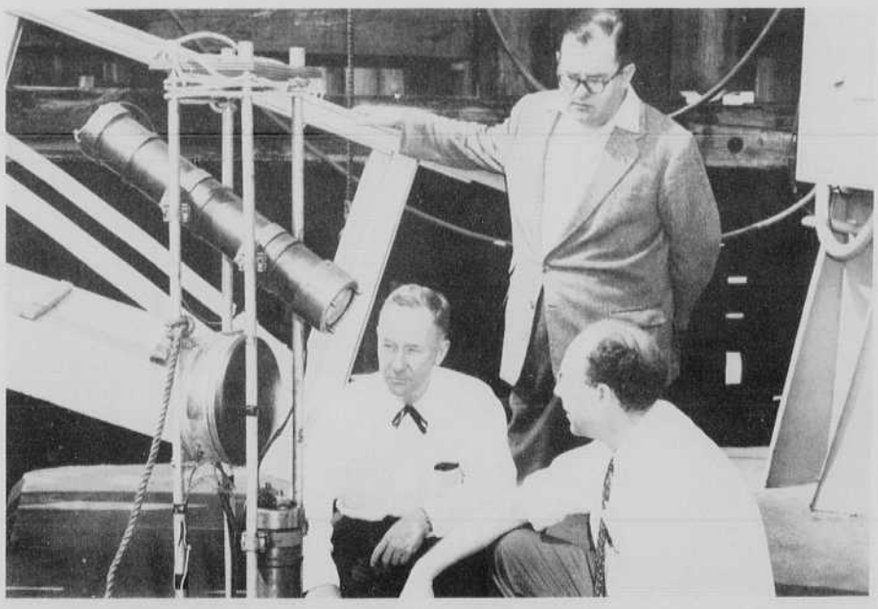

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Edo Log XIV 10 5 Oct 1956

Sept. 5, 1956.

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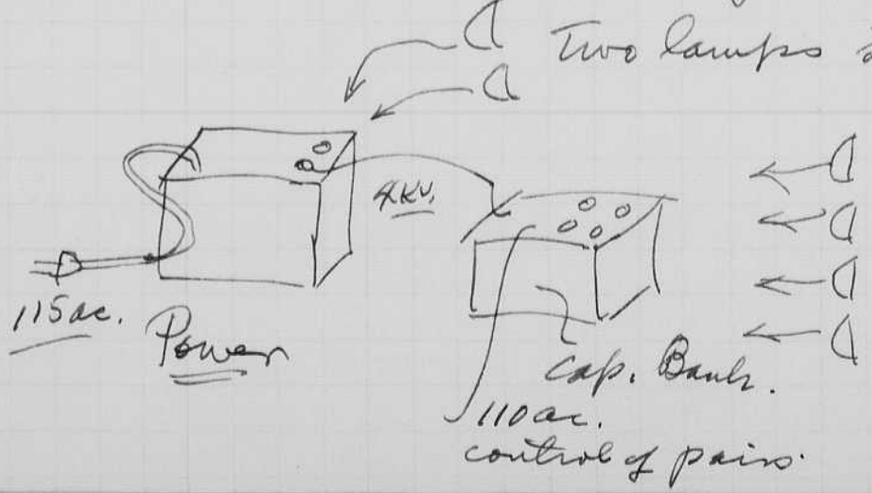

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The New York Times
Capt. Jacques-Yves Cousteau

9/17 or 50.

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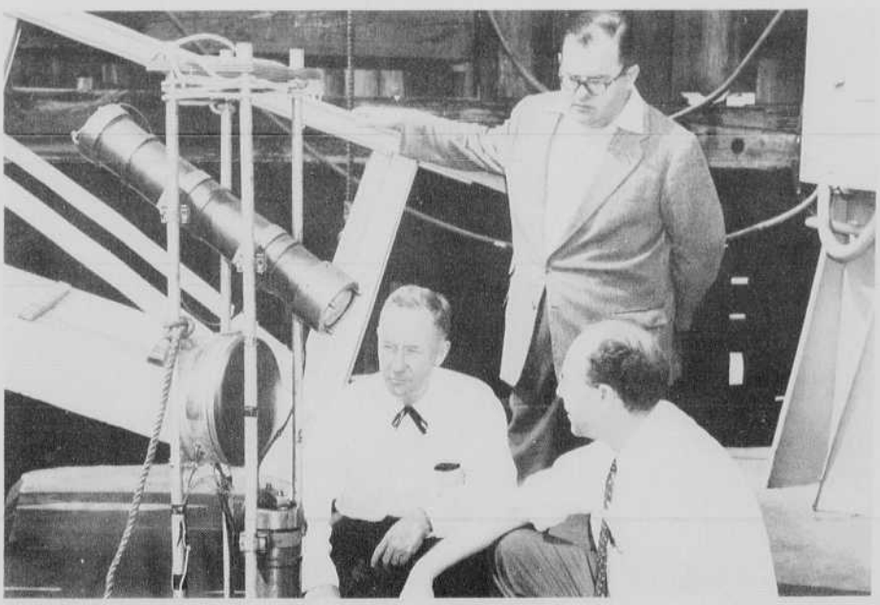

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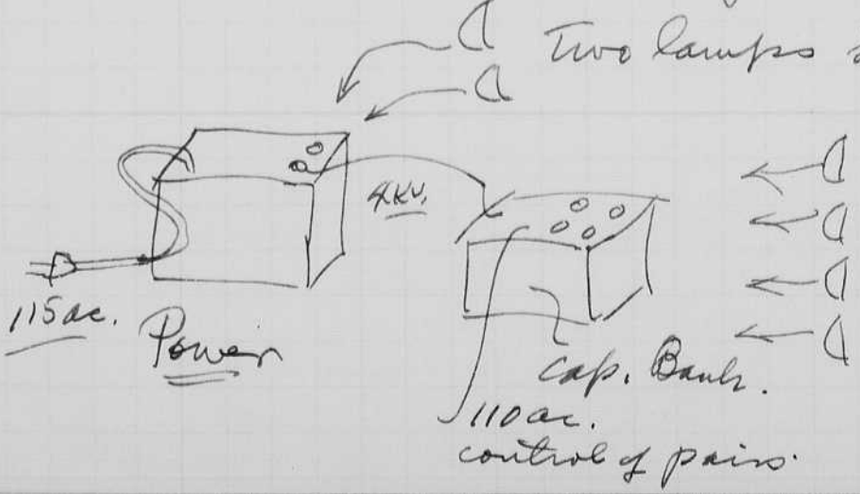

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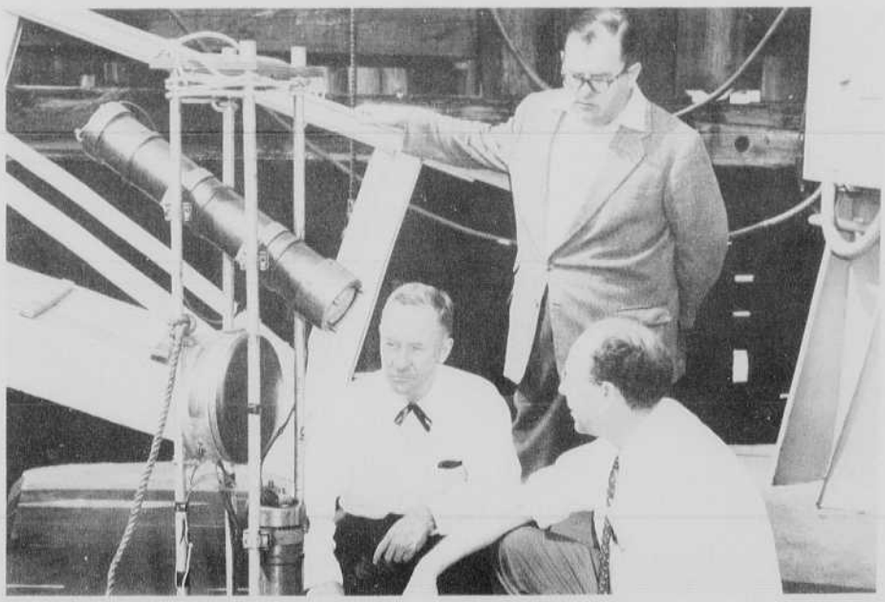

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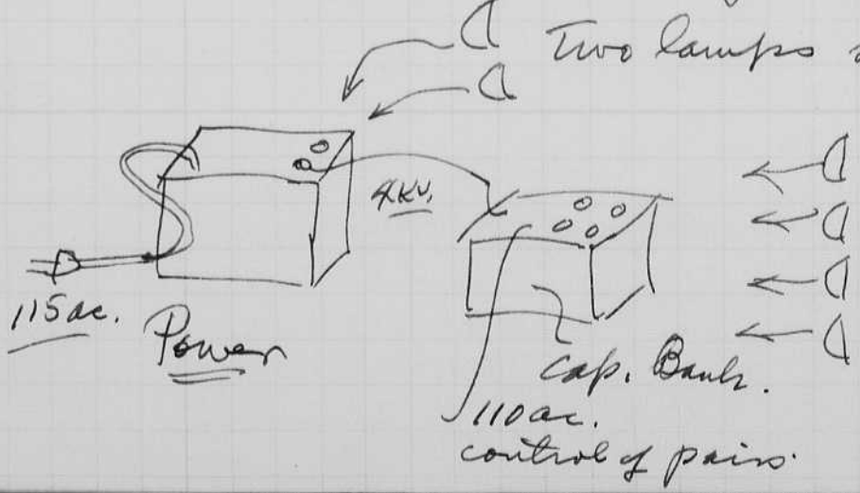

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~~Sept~~ Oct 1956, Lloyd Breslau came in to talk about a thesis for plankton research in the sea. Breslau spent last summer on one of the ships of Lamont Lab. He mentioned Bob Menzies a biologist from Lamont as being interested in the problem.

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SERVICE PIN AWARDS

25 YEARS		
Conrad Hensel der	6- 5-56	
15 Years		
Onofrio Rubino	7- 4-56	
Lillian McKee	7-14-56	
Hans Lilya	7-31-56	
10 Years		
Noel B. McLean	7- 1-56	
5 Years		
Yen with Whitney	6- 4-56	
	6-11-56	
	7- 2-56	

A little boy arrived at the home of Ruth and Nick Medici (Engineering) to the delight of the whole family. The little fellow weighed 6 lbs. 8 oz. and his name is Kenneth Nicholas—his birthday June 9. The Medici's have a little girl, Lynette, age 4½ years. Congratulations and best wishes to the Medici family.

—o—

The Al Bach's are the proud parents of a brand new daughter—Susan, who arrived on June 9. Susan weighed 6 [illegible] and was greeted with open [illegible] 9½ years

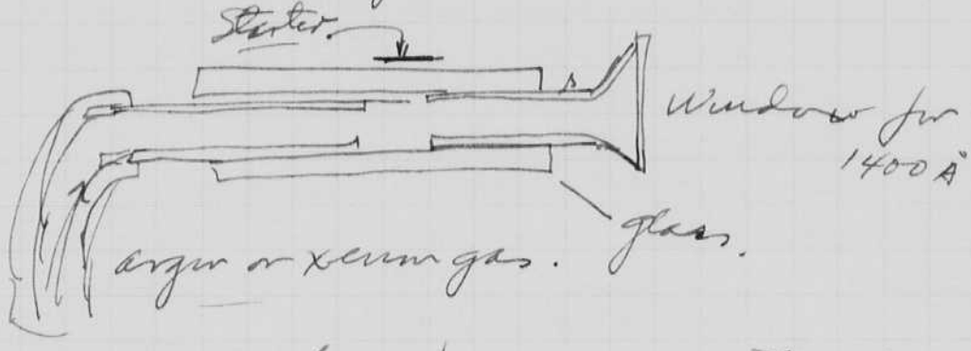
 Oct. 16, 1956

Harold Edgerton.

My wife Esther left this morning for Hickory N.C. to help our daughter Nancy Lou with a new baby boy William Palmer Dixon who arrived Oct 11.

Two men from Avco were in this morning to talk flash lamps. They wish to work at 1400 angstroms to measure the light absorbed by the O_2 molecule. When O_2 goes to O or to a compound, the absorption changes in the 1400 angstrom band.

I suggested a concentric arrangement that should be easy to make and use.

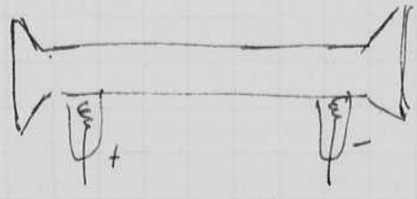


They propose to make a few experiments along this line.

Oct 16'56. Test of Philips tube See Human Retina with a Discharge Lamp
H.J.J. Van Boort
N. Warmholtz
J.E. Winkelman
Medical & Biological Illustrations
July 1956 Vol VI No 3 p 166.
London
Brit. Med. Assn.
Tavistock Square
W.C. 1

Nov 1'56 Neptunes

Tube. no. ?



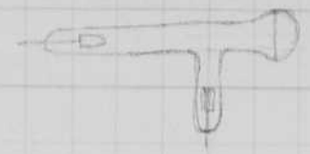
Calib 25 mfd 1500 volts Fx-1 2×10^6 c.p. peak light. 3.25 V/cm. / 10 V

25 mfd 1500 (? tube) peaklight 3.6×10^6 c.p.s. Duration .36 m.s. 1.2 × 3 = 3.6
500 mfd(e) 500 V " " " $.3 \times 10^6$ + ?
500 mfd(e) 450 " " " $\frac{2.5}{3.3} \times 10^6$ 400 m.s.
Tube shows white deposit on anode area inside of the tube.

1000 · 450 " $\frac{3.2}{3.3} \times 10^6$ 500 ?±

The reading are the side view of the tube.

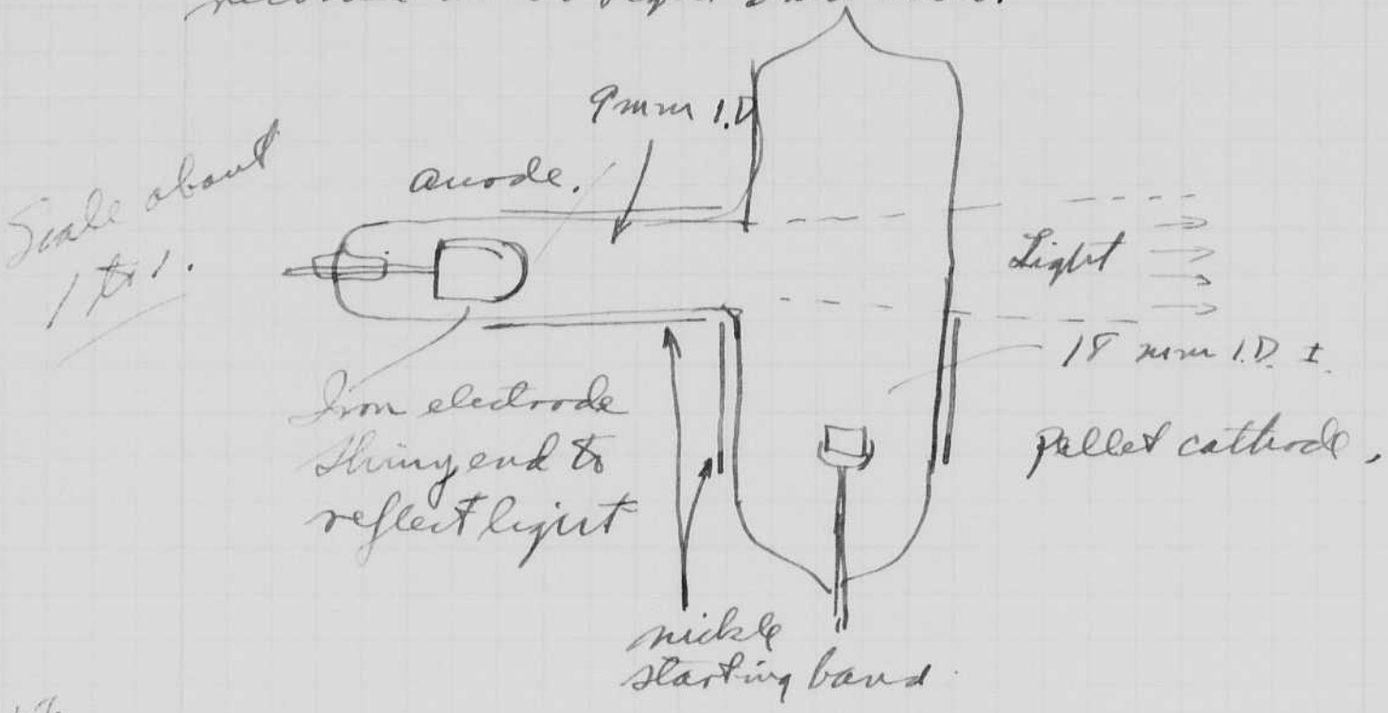
	C	V	C.P. Peak	Dur. m.s.	C.P.S.
side view	1000	450	$\frac{3.3}{3.3} \times 10^6$	500	500.
end view.	1000	450	$\frac{1.8}{3.3} \times 10^6$	500	250
end view	2000	450	$\frac{2.1}{3.3} \times 10^6$	800	310
	2000	450	$\frac{1.7}{3.3} \times 10^6$	950	



138 Oct 18, 1956 Microscope lamp.

Harold Edgerton.

Today I pumped a microscope lamp of a new type as shown below. Tests were also made as recorded in the Light Data book.

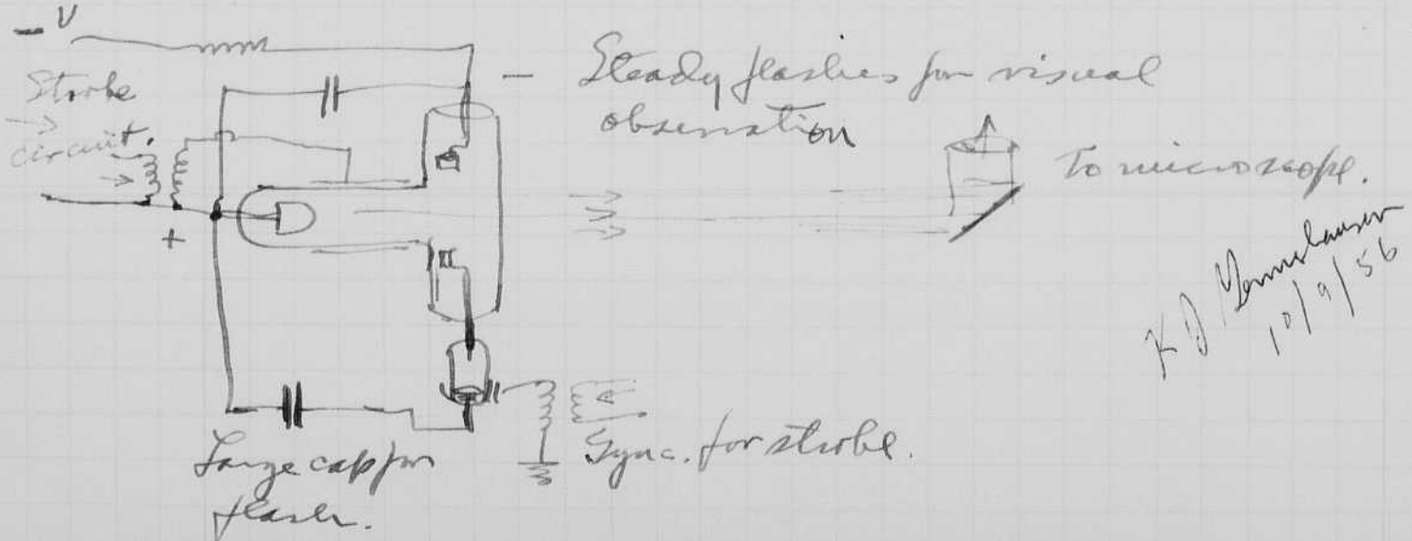


Nov 1956 Physics

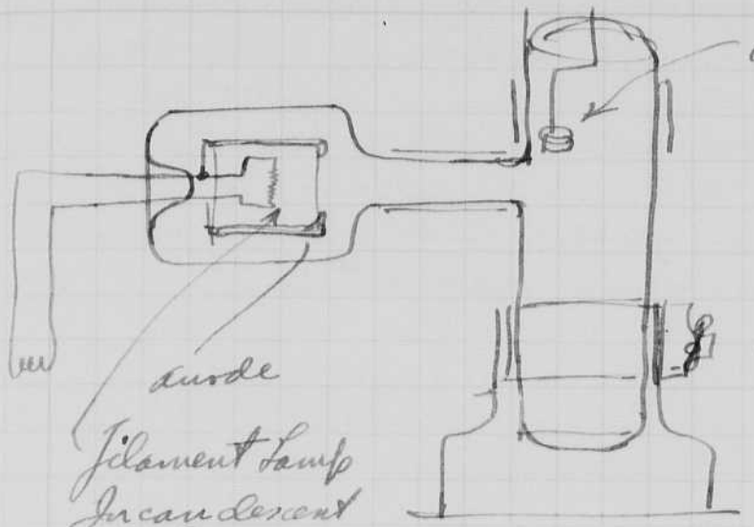
This was pumped by Bill MacDonald. Filled with Xenon at 10 cm.

2000 mfd (electrolytic) at 475 volts gives a 400 μs flash with long afterglow and a 2×10^6 c.p. peak.

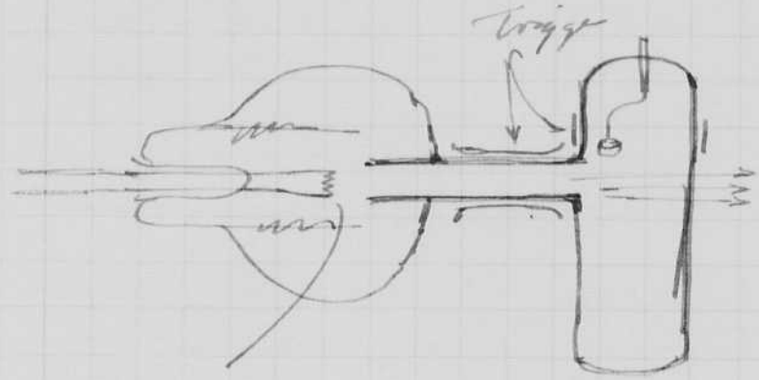
When run as a strobe, the arc does not fill the tube at 30 mfd at 1500 volts. Either the pressure must be lower or the energy greater.



K.J. Germeshausen 10/9/56



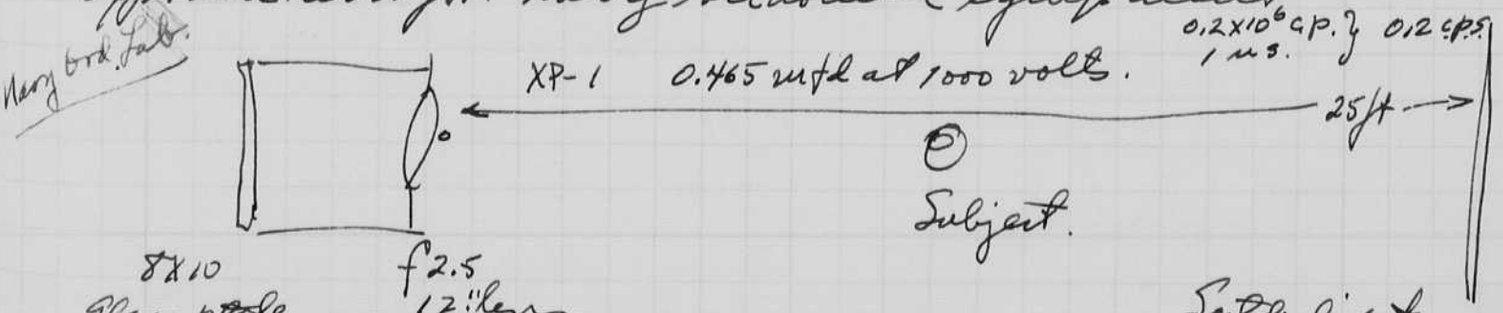
K D Gunshaver
10/19/56



Filament lamp.

The filament is rugged can withstand the push of the arc during the discharge.

Exposure tests for Navy silhouette equipment



Super ortho x plate Eastman. 5 min 1:1 Dektol.
Exposure on Density = 0.49

A second plate was exposed with 0.465 mfd at 2000 volts. D = 0.8

a xxx trix type B plate was exposed with 0.465 at 1,000 volts D = 0.51

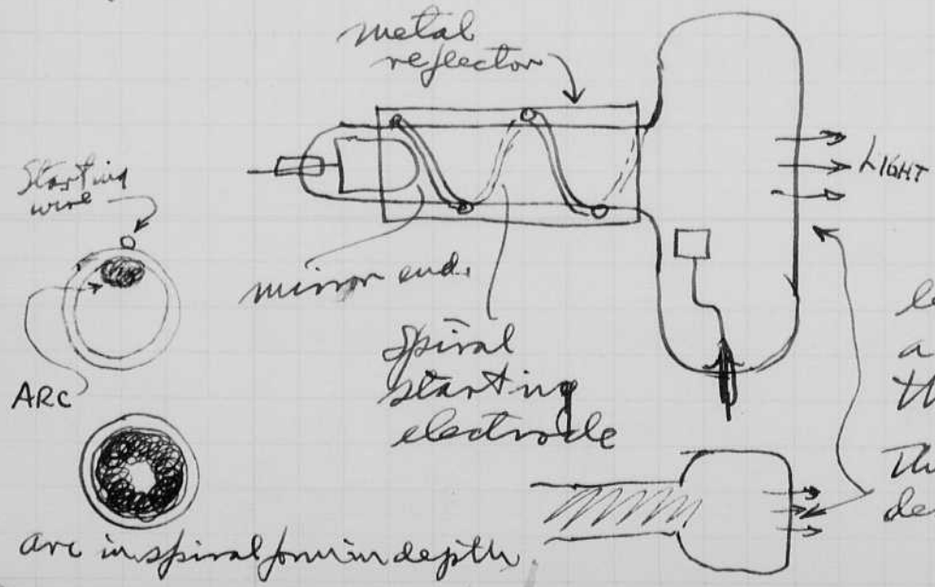
The lamp of page 135 seems to have great promise for microscope illumination. One problem is the continuous light for focus and alignment. If the tube is operated as a stroboscope, the arc does not fill the entire cross section of the tube if the pressure is up so that efficient operation is experienced.

Here are some suggestions to overcome this difficulty.

The arc in a tube always tries to take a position on the inside of the tube adjacent to the place where the trigger electrode is on the outside. If a straight wire is used the arc will be straight. With a spiral, the arc may be a spiral especially if the pitch is large say longer per turn than the diameter.

If the arc spirals on the inside, then the end view will look like a solid ring of light on the inside of the tube. Now the energy per flash must be increased until the arc comes effectively to the center of the tube. Then the appearance of the arc from the end of the tube shows a solid circle of light.

Nov 1, 56 Rec'd Gerundheimer 11/7/56



It may be necessary to reduce the pressure so that the arc will fill the tube.

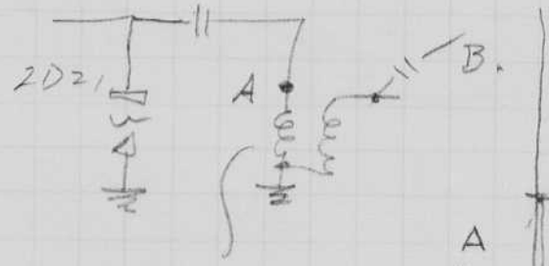
Absorption will be less from the gas with a lower pressure in the tube.

Oct 19 1956
H. Edgerton.

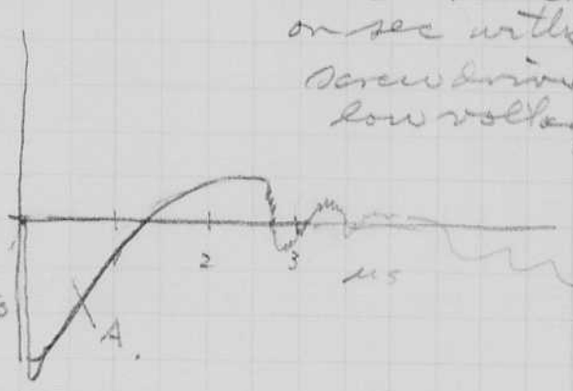
Double flash equipment.

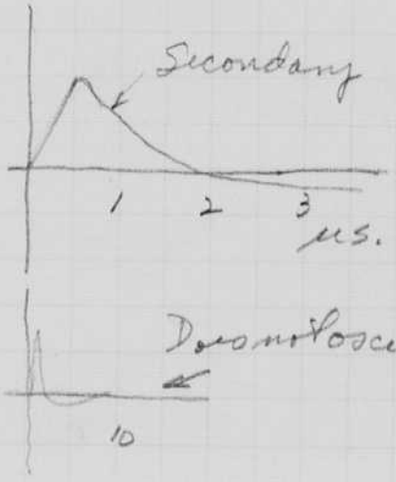
Observed voltage in primary of spark coil. It shows some jitter from .02 mfd into 2D21.

Ignitron a PE model device.

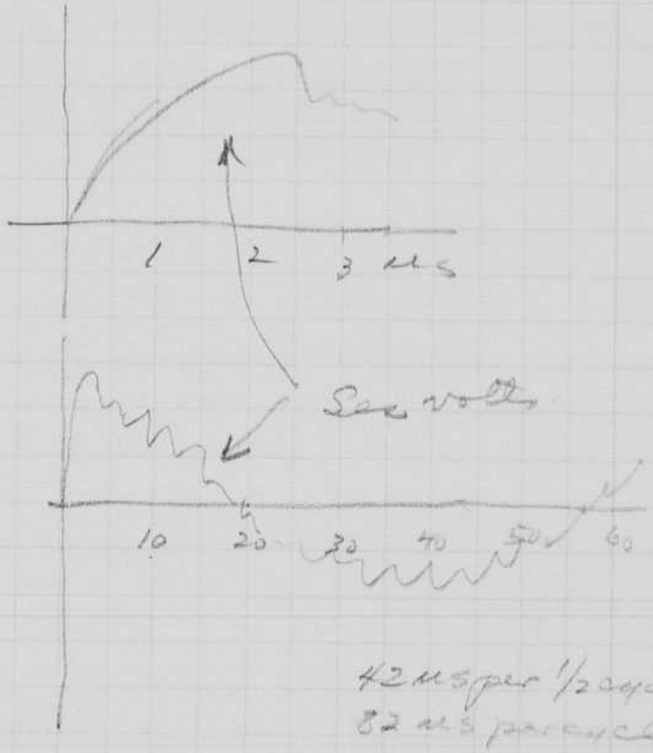


Could not see sparks or see with screwdriver! very low voltage?





LFE Coils.



42 μs per ½ cycle.
83 μs per cycle.

1. Conclusion – Spark seems weak on Double flash.

The spark capacitors or .02 Increased to .02 + .05
now we have ¼" spark.
Rapid rise of voltage in ½ μs.
no jitter of sparks.

2. Delay of 1st flash depends upon the gap setting.
with 1/32" delay is about ¼ μs.
with 1/8" " " " 1 μs.

Cont. Double flash exp.

.07 mfd on spark coils.

now used 2 feet of wire to XP1 gap 1/8" x mm
It did not flash until I used a third electrode.
also used 3500 and 7000 across it to allow
the gaps to fire.

XP-1 gave 7 volts from light. 2ft no filter
Red Black Brown resistor.

XP-2 gave 3 volts from light same cond

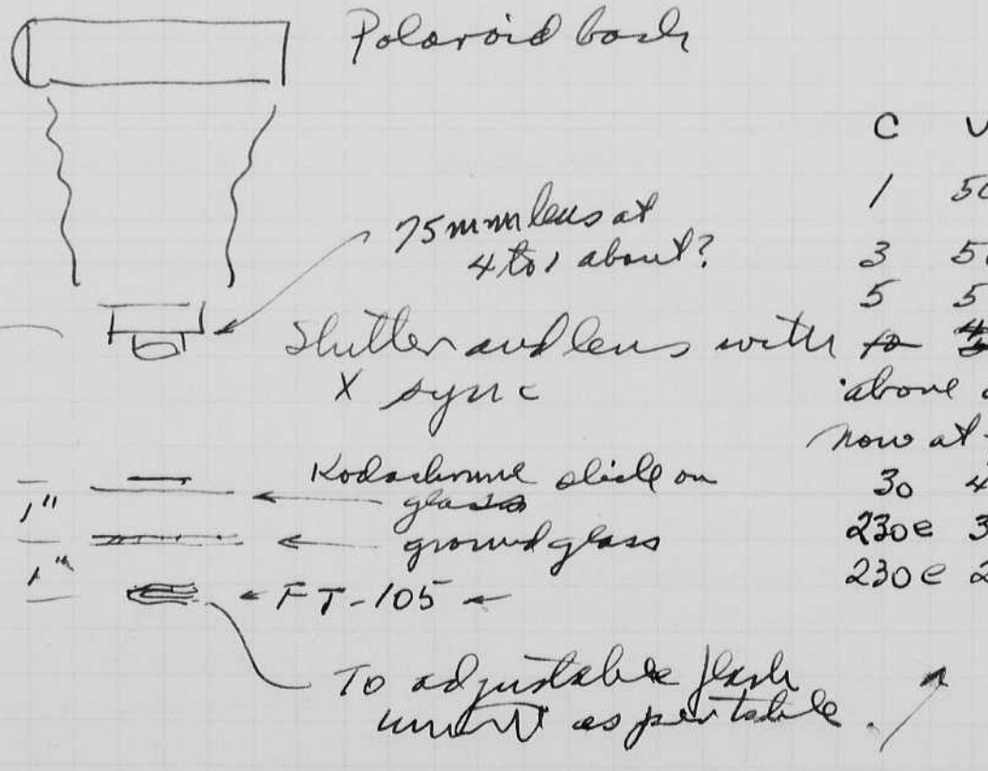
Duration of above is about 1/2 us.

(XP-1 20 volts at 1 1/2 us from 0.5 mfd at 2 KV.
as used for photo tests p 139.
Thus we need more energy by a factor of 3 x 3 = 10.
cap 0.05 mfd. instead of .005)

Monday Oct 24 1956
Harold Edgerton.

Polaroid copier for Kodachrome slides.

The problem is to obtain a simple reliable system for copying color slides into Black and White Polaroid prints.



C	V	Comment
1	500	thin
3	500	Thin
5	500	ok but thin
~~10~~	~~500~~	ok X NG

above at f 4.5.
now at f8.

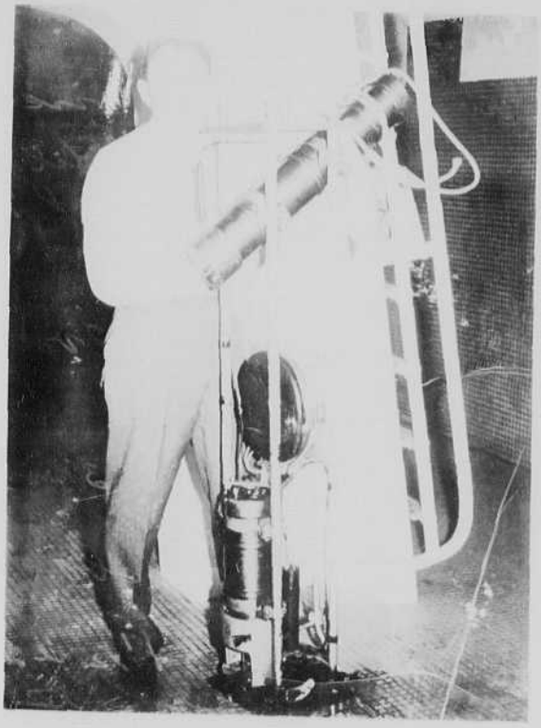
30	400	Thin
230 e	350	over exp.
230 e	250	ok.

Neg of miss Lunt. (Sally)

c	v	f	
230	250	8	over exposed.
230	250	11	over exposed
230	250	16	fine

Bob and camera

230 250 16 fine.



Me →

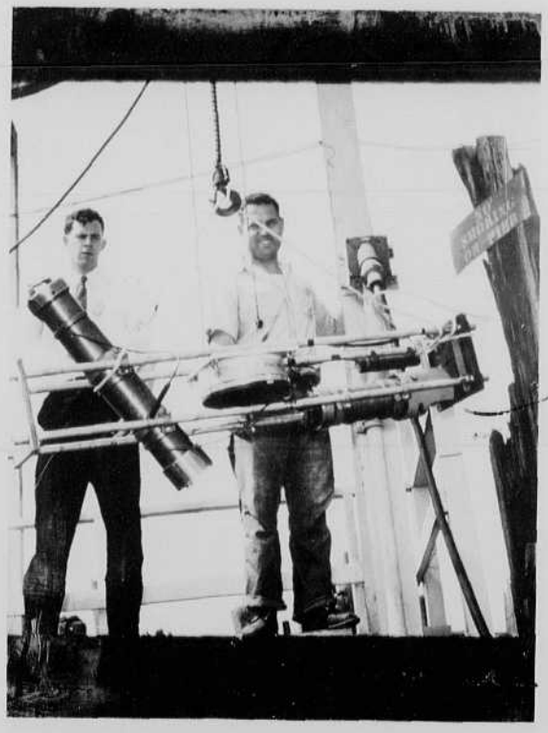
Camera and Battery 6 volt Silvercell

Sonar.

Hasle Lamp

f8 230 mfd 250 volts.

— Nylon anchor line many colors



Bob Edgerton

— Lamp.

Declared to understand by me Nov 1, 52 Ross Nines

at Edo Plant June 1956.

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Red Black Brown resistor.

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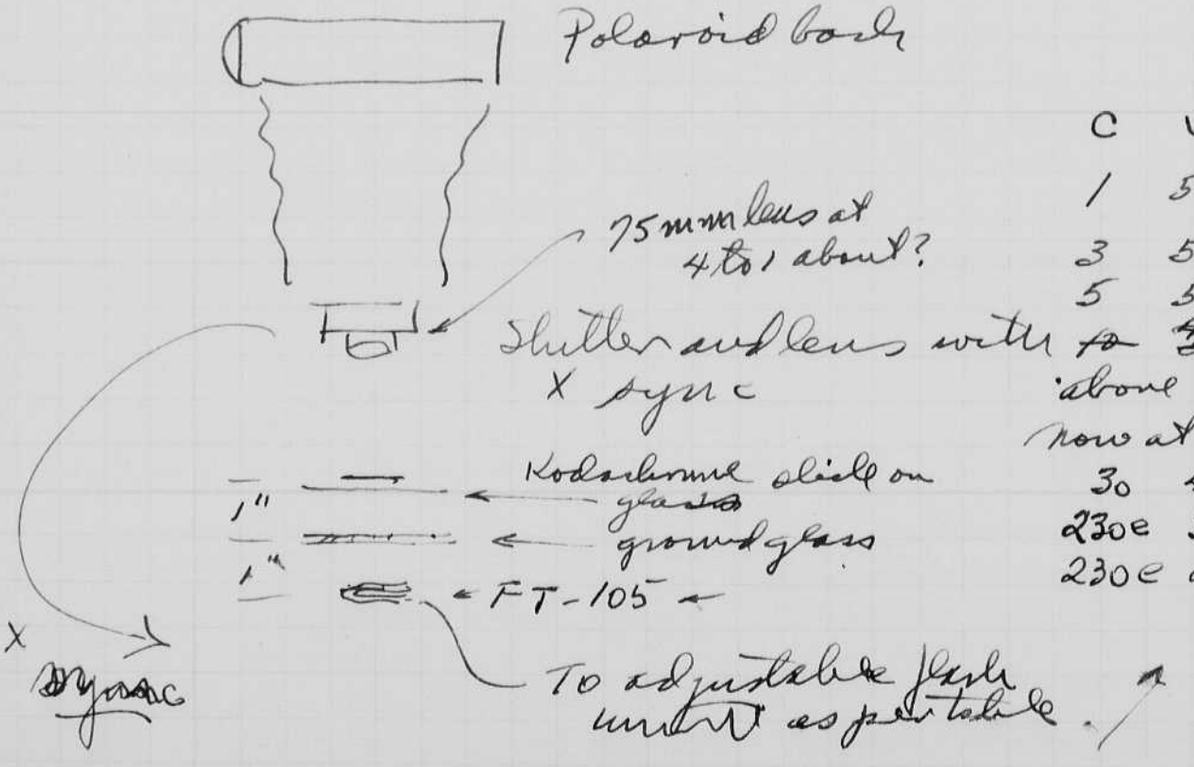


C	V	Comment
1	500	thin
3	500	Thin
5	500	ok but thin
~~10~~	~~500~~	ok X NG

above at f 4.5.
now at f8.

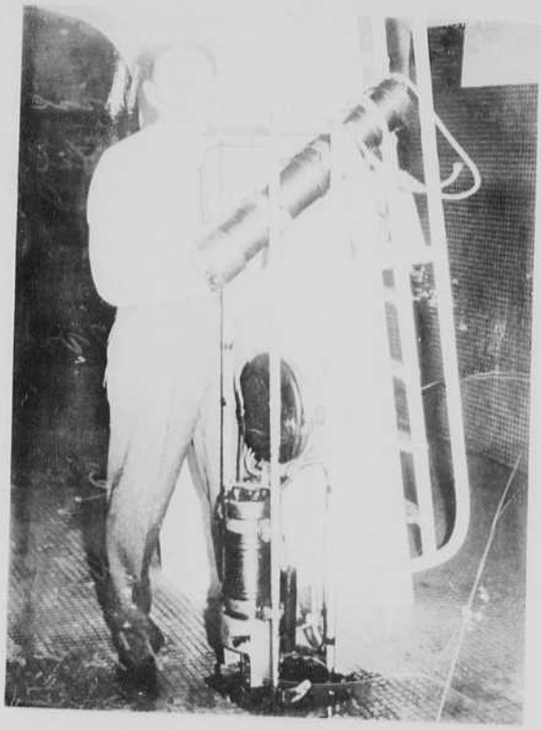
30	400	Thin
230 c	350	over exp.
230 c	250	ok.

Neg of miss Lunt. (Sally)

c	v	f	
230	250	8	over exposed.
230	250	11	over exposed
230	250	16	fine

Bob and camera

230 250 16 fine.



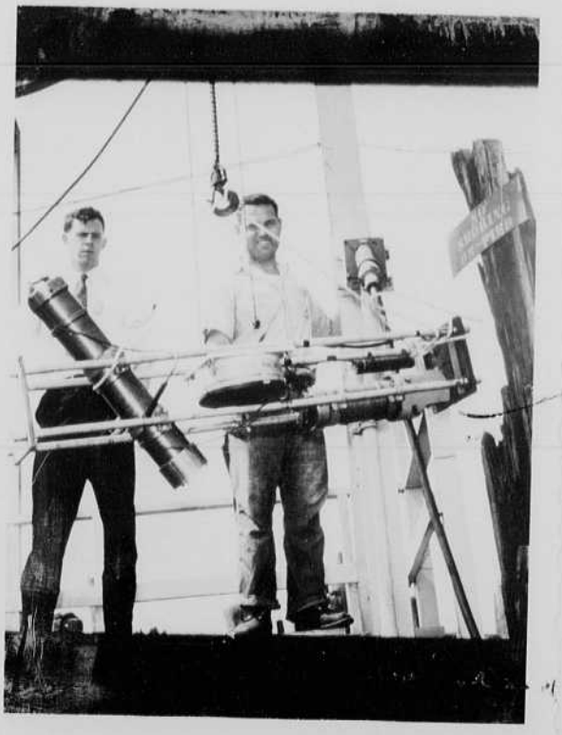
Camera and Battery 6 volt Silver cell

Sonar.

Flash Lamp

f8 230 mfd 250 volts.

— Nylon anchor line many colors



Bob Edgerton

— Lamp.

Declared by understood by me Nov. 1, '56 Ned Nims

at Elo Plant June 1956.

Cont. Double flash exp.

.07 mfd on spark coils.

Now used 2 feet of wire to XP-1 gap 1/8" x axis
It did not flash until I used a third electrode,
also used 3500 and 7000 across it to allow
the gaps to fire.

XP-1 gave 7 volts from light. 2/f no filter
Red Black Brown resistor.

XP-2 gave 3 volts from light same card

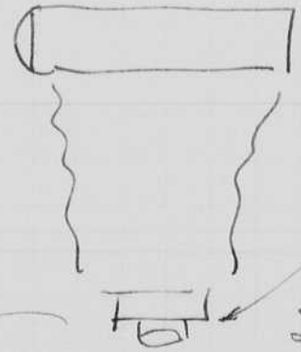
Duration of above is about 1/2 μs.

(XP-1 20 volts at 1 1/2 μs from 0.5 mfd at 2 KV.
as used for photo tests p 139.
Thus we need more energy by a factor of 3 x 3 = 10.
cap 0.05 mfd. instead of .005 ✓

Monday Oct 21 1956
Harold Edgerton.

Polaroid copier for Kodachrome slides.

The problem is to obtain a simple reliable system for copying color slides into Black and White Polaroid prints.



C	V	Comment
1	500	thin
3	500	Thin
5	500	ok but thin
~~10~~	~~400~~	ok X NG
above at f 4.5.		
now at f8.		
30	400	Thin
230 e	350	over exp.
230 e	250	OK.

Neg of miss Lunt. (Sally)

c v f

230 250 8 over exposed.
230 250 11 over exposed
230 250 16 fine
Bob and camera
230 250 16 fine.

Me →

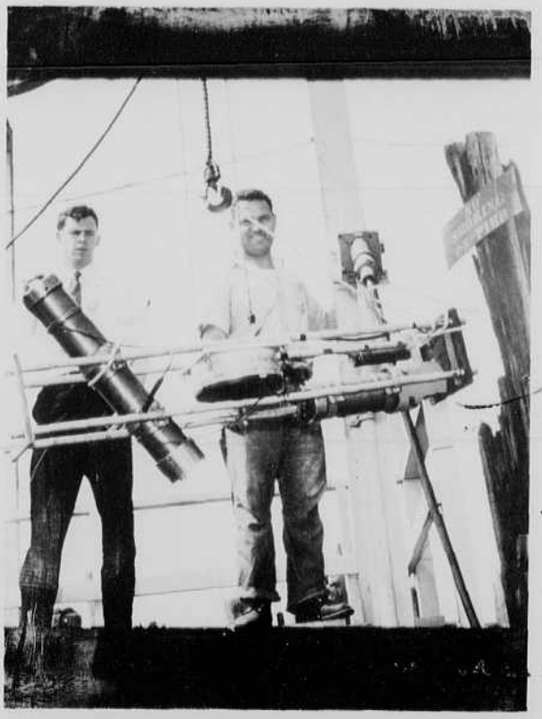
Camera and Battery 6 volt Silver cell

Sonar.

Flash Lamp

f8 230 mfd 250 volts.

— Nylon anchor line many colors



Bob Edgerton

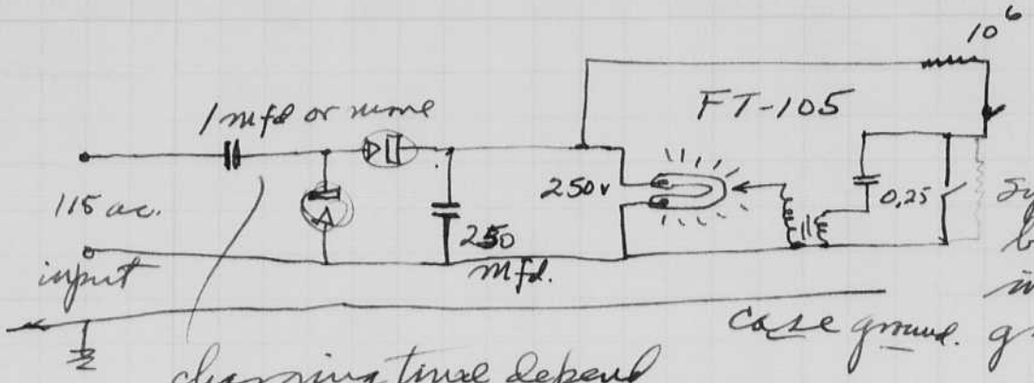
— Lamp.

Declared a condemned by me Nov 1, 52 RLS Rines

at Edo Plant June 1956.

Cont.

ac circuit for copy device.

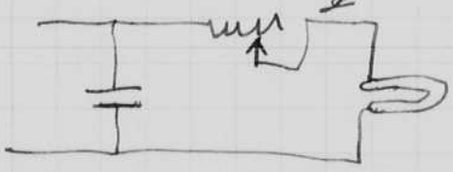


charging time depends upon the size of this capacitor. Increase to a size that gives satisfactory action in discharging.

This device should be perfect for slide copying of color onto color.

The integrating exposure meter should be fine for setting the light level to a constant value.

To adjust output continuously — use a series resistor in the discharge circuit,



Resistance to adjust output. Use about 10 ohms for large variation.

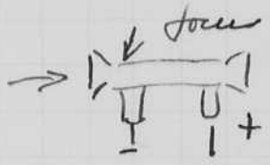
Nov 1 '52

Oct 21 1956 cont
H.E. Edgerton

Brightness tests of lamps with camera.

FX-1 100 mfd 2000 v

microflash lamp.
450 volts.
4 x 500 mfd +.



Eindhoven Lamps.
450 volts.
4 x 500 mfd.

Camera 4 x 5
Panatomic film
f 32
Filter 2.85 density (3).
DK 1:1 6 min.

All on the same negative

Oct 30 1956. HE Edg.

I went to Rochester on the 25 with Chas Wyckoff. We visited EK John Wiemeyer to discuss film scratches on the N.S. cameras as used at Eniwetok.

I discussed high speed shutters with Weber of Wollensak who has a new prism device in the 1 to 10 μs range.

At Bausch and Lomb I talked to Dave Richardson and Jose about the retina camera I propose to make a lamp.

At Wollensak I arranged for a shutter with insulated contacts (x) and an f8 opening.

The color-transparency to Polaroid film printer looking very good.

I want to include the following features.

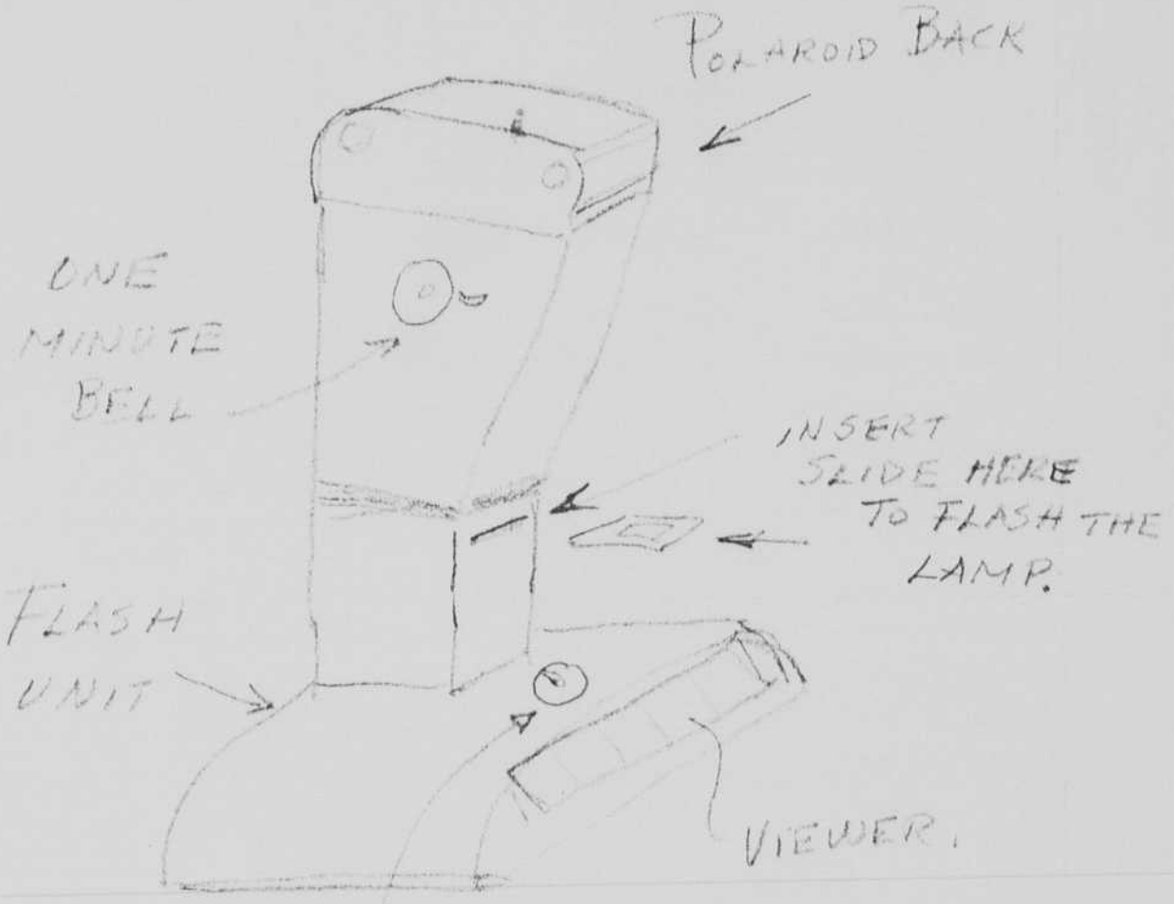
1. no shutter - the slide goes in a light trap door
2. the slide trips the flash lamp.
3. an electrical ~~control~~ method will be used to control the amount of light.
4. a photoelectric device is proposed to read the light and to set the exposure.

5. A viewer on the base will enable the user to see about 6 slides while the one minute is going on for processing.

6. An automatic device is to be used to ring a bell 1 minute after the film is pulled.

7. There could be a coin release to make the device works. Polaroid in large rolls could be provided.

12-1-52
MAMacNeil



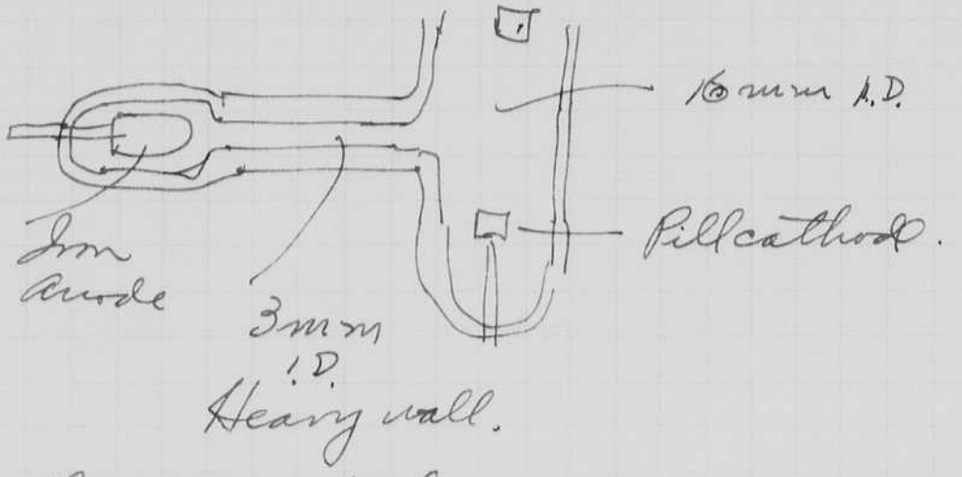
LIGHT ADJUSTMENT

H. EDGERTON
OCT. 30, 1956.

Nov. 8, 1956.

Harold Edgerton.

Progress continues on the microscope tube. I built two more ones over the weekend, as below



Above pumped
Hydrogen heated to remove oxides.

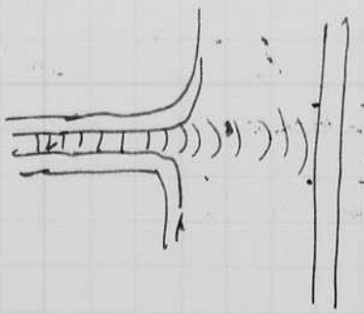
Run at 100 M.S. at 500 volts to drive out gas. 5 cm Xenon gas.

Sealed off at 20 cm Xenon gas.

Severe crazing at 200 watt seconds.

I noted a circle of crazing on the wall opposite the end of the capillary. Also the anode is surface melted showing drop running down towards the end of the tube.

The circle of crazing is about 3 x the diameter of the tube.



doron spectrum and I set up an experiment tonight with a projected image onto photocell so that we could measure the light as a function of space.

With 5 mfd at 1500 volts, there was about 25 microseconds delay when a path length of 1 cm was traversed.

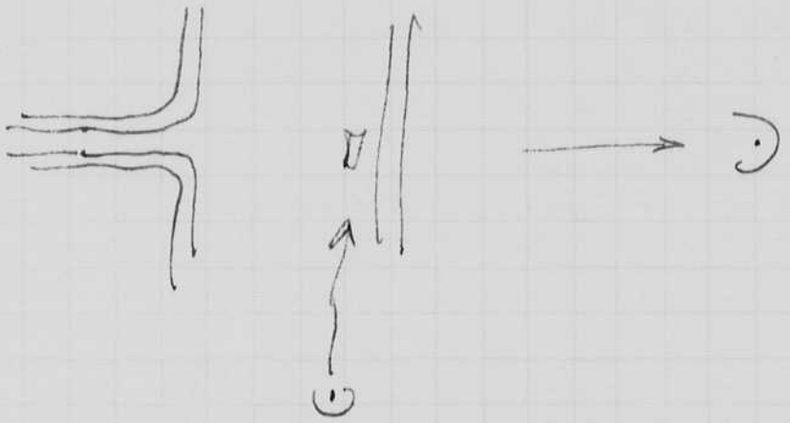
$$\frac{1\text{ cm}}{25\times10^{-6}} = \frac{10^6}{25} = \frac{\text{[redacted]}}{40{,}000}\ \text{cm/sec.} = 400\ \text{meters/sec.}$$

$$= 1200\ \text{feet/sec.}$$

1 cm = 1000 μ

about the velocity of sound.

At 100 mfd at 500 volts, the velocity was about 1/3 the above. The nature of the wave was different in the area away from the jet.



Nov. 28, 1956 Retd from 2 weeks in west on Sunday Nov. 25.

Nov 13 Cleveland
14 Los Vegas E.P.O.M.
15. Sandia
16. Los Alamos.
17. Los Angeles Sat
18 " Sun
19. Livermore
20 Denver
21 Arizona Meteorite with F. E. Elgerton
22-23-24 " Bob from Rochester
Esther

Dec 7 1956 Open house in 20D102 for 620 students. I just gave a series of 5 lectures on electronic flash etc.

1. Stroboscopes - tubes etc.
2. Electronic flash - guide factors.
3. Short flashes - microsecond
4. High frequency strobs. movie etc.
5. Magneto optic and Kerr cell shutters.

Dec 19, 1956

Harold Edgerton

I have been working on the new stroboscopic circuit

This was to have 4 scales as set by Germeshausen some years ago.

I thought of two scales. One was to be a wide range job from 300 to 14,000 with low accuracy. The other was to go from 900 to 4000 with 1% accuracy.

Germeshausen thought this was U.S. and suggested 6:1 scales with a improved upper speed. I tried the unit in the back room and found it went on from a R.C. oscillator up to 600-700 cycles with 15K and 0.05 mfd.

Proposed scales

21,600 — 3600 R.P.M.
3600 — 600 "
600 — 100.

The last scale will probably be optimal.

Germeshausen suggests a blocking oscillator or a thyratron oscillator for the driver.

Dave Cahlendar has been helping with these experiments.

Last night I shot some Ektra color (ASA 24) photos of the pool. Chas Baltzman did the diving from the high board. I used f11 on 8x10 film.

Used 180 mf at 4KV on FT 503 in a spotty reflector at each side of the subject.

Some photos were taken at f16. All were sent to Niemeyer at E.K. Rochester N.Y.

E SIX STUDENT-FACULTY COMMITTEE OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

ND THE CIRCUIT

DECEMBER 1956 NUMBER 2

BIGGEST XMAS PARTY EVER

ON THURSDAY, DECEMBER 20, FROM 4:00 TILL 6:00 IN THE AFTERNOON, the Course VI Student-Faculty Committee will play host to hundreds of EE students, faculty, and their friends in the big EE lab, fourth floor of Building 10. The occasion is to be the Xmas party to end all Xmas parties.

People who attend are sure to be well fed, lavishly entertained, and may even get to know other people who have been sitting next to them in class for the last three months.

Art-lovers will find that this will be a day to remember. The M.I.T. E.E. Philharmonic-Symphony Orchestra will return to the limelight at the party, after an entire year in seclusion. Professor (*Maestro*) Tom Jones, who has often appeared as harmonica soloist with the leading orchestras of the world, will conduct. Professor Edgerton will be there with his infamous gee-tar.

Tradition dictates that all EE's who have a musical instrument smaller than a grand piano will bring it along. For those who can come early, there will be a tune-up session at 3:30. The better you play, the more cider you get, the better you play, etc. Last year, Jack Dennis, leading the singing atop the piano with Coke bottle in hand, proved that you don't need strong liquor to get high.

Although negotiations are just getting under way as we go to press, it is anticipated that the Logarhythms will also entertain.

Doughnuts, cider, pretzels, potato chips, song, dance, and brotherly love. Who could ask for anything more?

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Electrical Engineering

Subject 6.20

Special Lectures

"Short Duration Electronic Flash Equipment"

Wednesday, November 28, 1956
10-11 a.m.-- Room 5-217
and repeated at:
2-3 p.m.-- Room 3-303

"Electronic High-speed Photography"

Friday, November 30, 1956
10-11 a.m.-- Room 5-217
and repeated at:
2-3 p.m.-- Room 3-303

"Electronic High-speed Shutters"

Wednesday, December 5, 1956
10-11 a.m.-- Room 5-217
and repeated at:
2-3 p.m.-- Room 3-303

Open House in Stroboscopic Light Laboratory

Friday, December 7, 1956

4 to 6 p.m.

Professor H. E. Edgerton Stroboscopic Laboratory

Notebook # 23

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 ____ and ____.
inside back cover

Item(s) now housed in accompanying folder.

ELECTRONIC FLASHTUBE

FX-1

FX-1 STANDARD FLASHTUBE

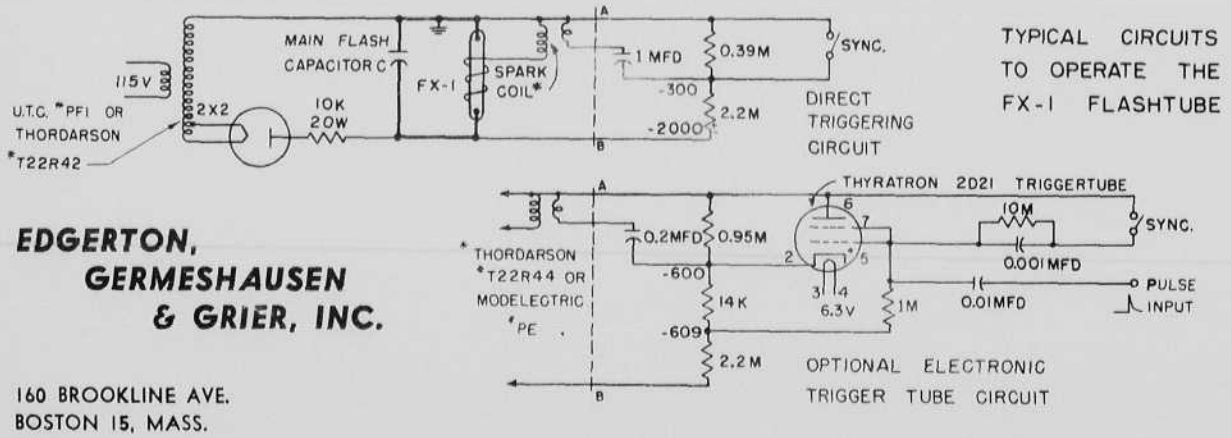
The flashtube is one of the most efficient converters for producing light from electrical energy. When ionization is initiated in the gas between the electrodes by the starter electrode pulse, electrical energy from storage capacitors discharges into the gas and creates an intense radiant energy having a spectral distribution that is continuous and comparable to daylight.

The tube may be operated in any of a wide variety of different types of circuits and may be conveniently triggered with an external electrode consisting of a few spaced turns of wire wrapped around the center of the tube. A voltage pulse source capable of producing a ¼- to ½-inch spark should be connected directly to the external wrap-around trip wire and can be energized at the desired time.

Correspondence is invited regarding special quartz flashtubes and driving circuits. Gap lengths from ⅛ to 50 inches have been made.

FX-1 PERFORMANCE DATA

RECOMMENDED RATINGS	Energy Input	200 watt-seconds (100 μf at 2000 volts).
	Total Output	1000 horizontal candle-power-seconds.
	Expected Life	5000 flashes at 200 watt-seconds.
	Flash Duration	150 μs at rated input (1/3 peak).
OPERATING CHARACTERISTICS	Starting Voltage, Min.	700 volts.
	Self-Flash Voltage	3500 volts.
	Flash Rate, Max.	Once every 5 seconds (200 watt-seconds, 40 watts).
	Spectral Output	Daylight in quality (J.O.S.A., V. 36 No. 7 390-399, July 1946).
	Tube Resistance	Nominal 2 ohms (loading greater than 30 μf, 2000 volts).
PHYSICAL CHARACTERISTICS	Envelope	Vycor.
	Source Volume	Diameter 4 mm I.D. and 6 inches long.
	Gas	Xenon at 20 cm. Hg.
	Maximum Tube Length	8-5/16 inches.
	Maximum Diameter	9/32 inch.
	Mounting	Fits fuse clip No. 101001 ("Littlefuse").



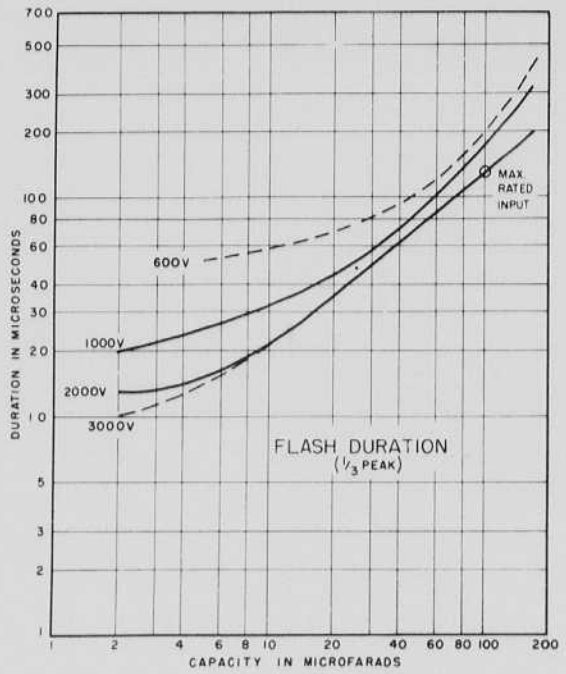
TYPICAL CIRCUITS TO OPERATE THE FX-1 FLASHTUBE

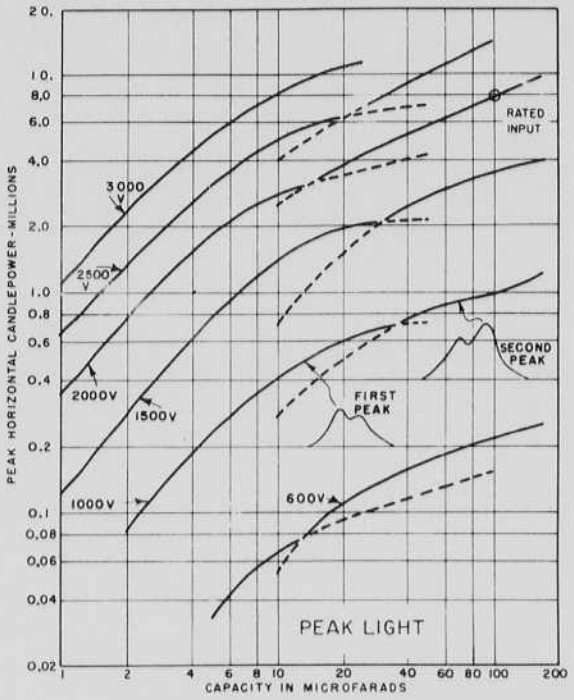
EDGERTON, GERMESHAUSEN & GRIER, INC.

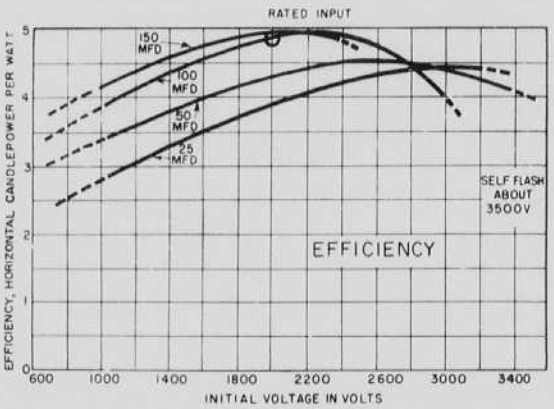
160 BROOKLINE AVE.
BOSTON 15, MASS.

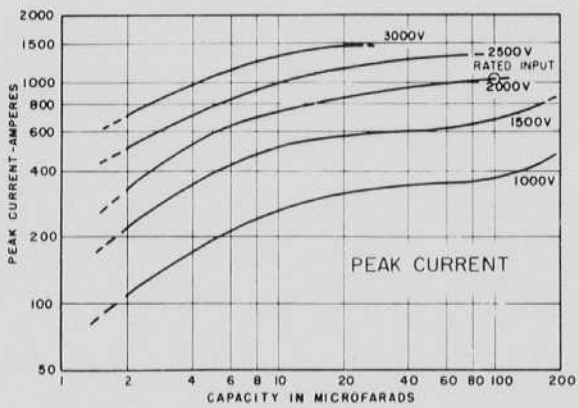
License information relating to the manufacture and sale of this type of circuit is available upon request.

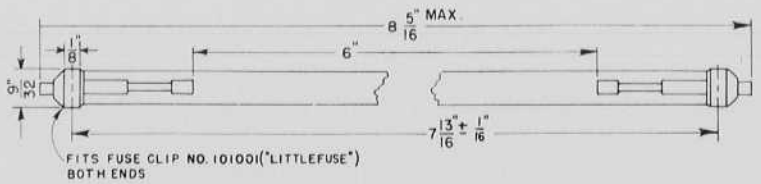
TYPE FX-1











FLASH TUBE TYPE FX-1

EDGERTON, GERMESHAUSEN & GRIER, INC.

160 BROOKLINE AVENUE **BOSTON, MASSACHUSETTS**