HAROLD E. EDGERTON

PAPERS

MC 25

Series III

Laboratory Notebooks

Number —

Dated 15 October 1931 to 14 January 1932

COMPOSITION BOOK

Property of

Name .....

Address .....

No. 1250

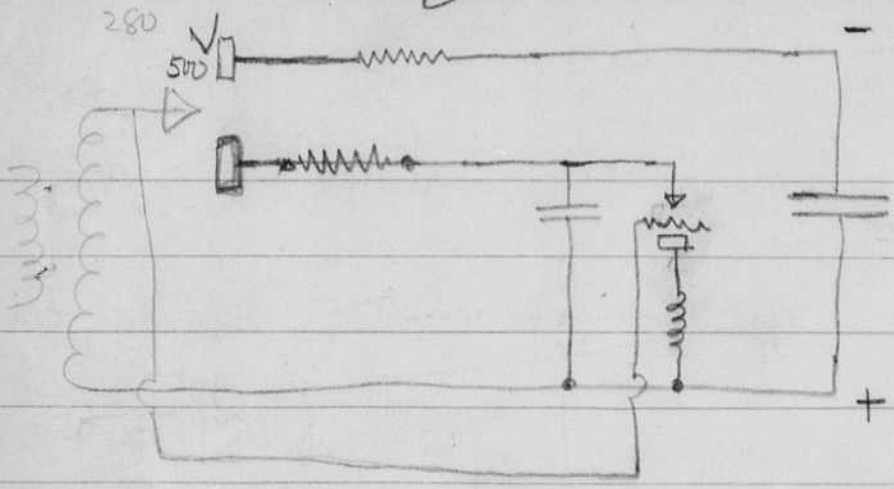
Book #1

Jam
179 St. Botolph St

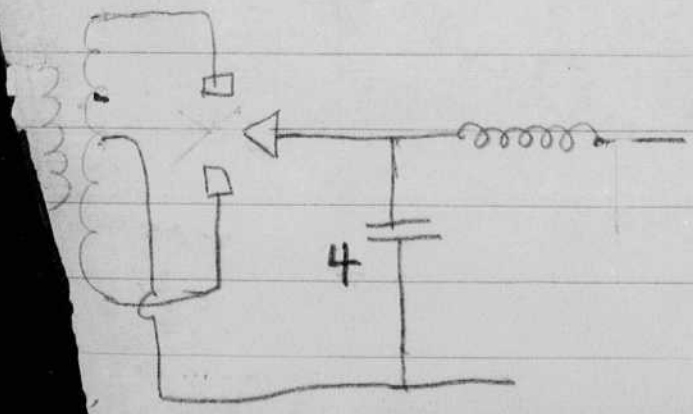
1346790
14710

Property of Kenneth J. Germeshausen
M. I. T.
Cambridge Mass.
Please Return

2



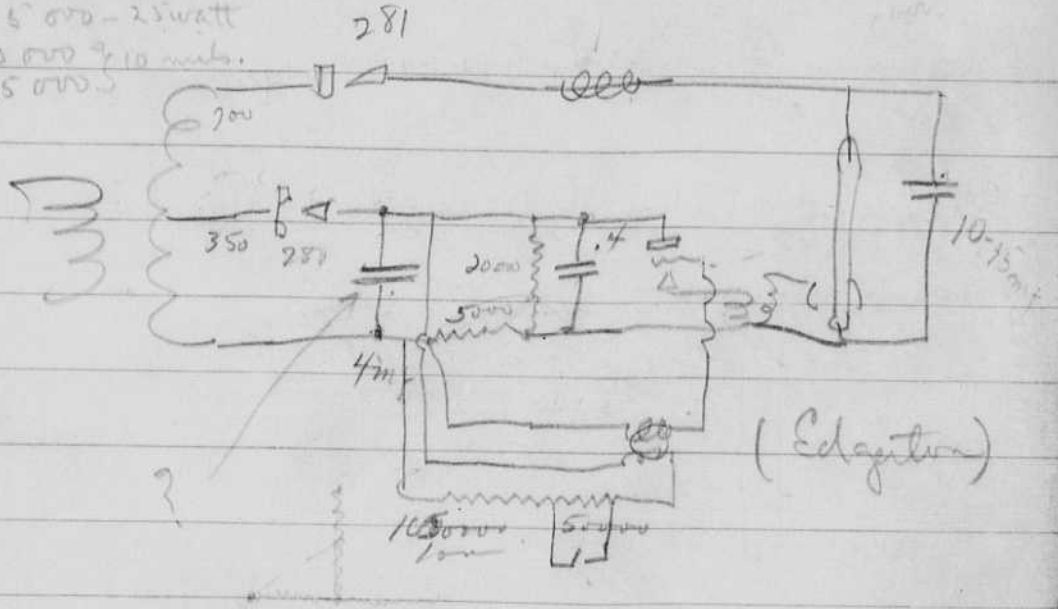
Circuit for 60 ≈



6 Sockets. 4 prong.
1 4 mfd. 400 v
1 .4 mfd. 400 v
1 20 000 ω – 20 watts. – 8 watts.
1 5 000 – 25 watt
1 50 000 ω 10 watts.
1 25 000 ω

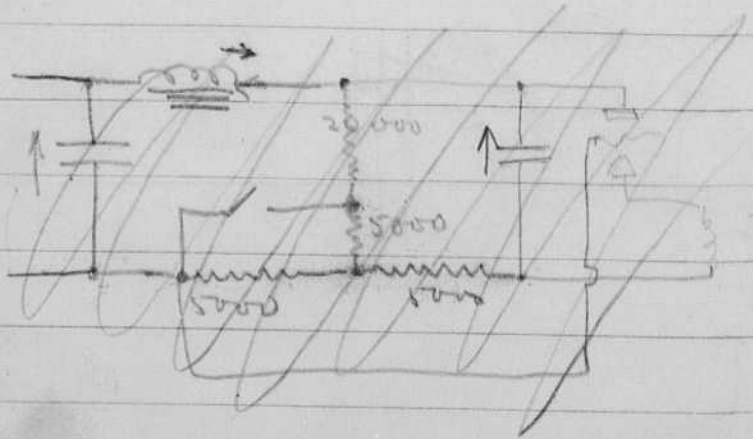
10/15/31

3.



(Edgerton)

Proposed circuit for Strobescope for Box Co. (Mr. Pirke).



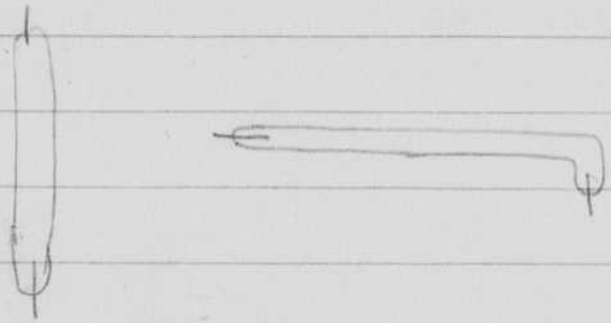
trip circuit

(KT)

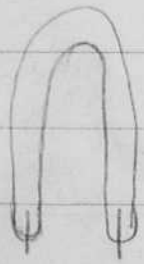
10/15/31

Designs for tubes.

Straight tubes for vertical & horizontal use



glass about ½" tubes about 12"



$A_1 = \pi \times 2.5^2$

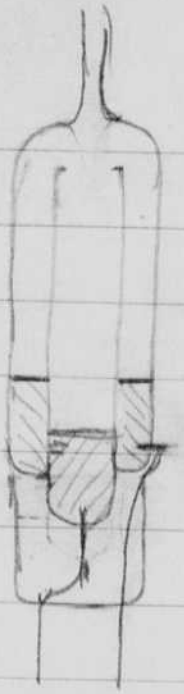
$A_2 = \pi(7.5^2 - 36)$

56.2

$36.$

20.2

5



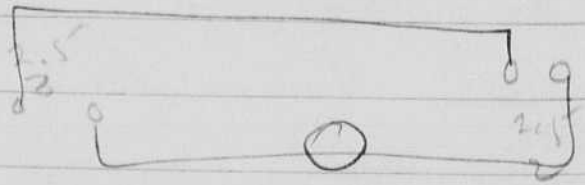
10 cm

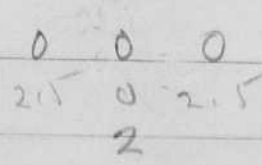
12 cm.

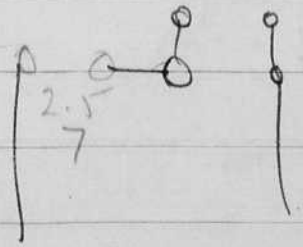
15 cm

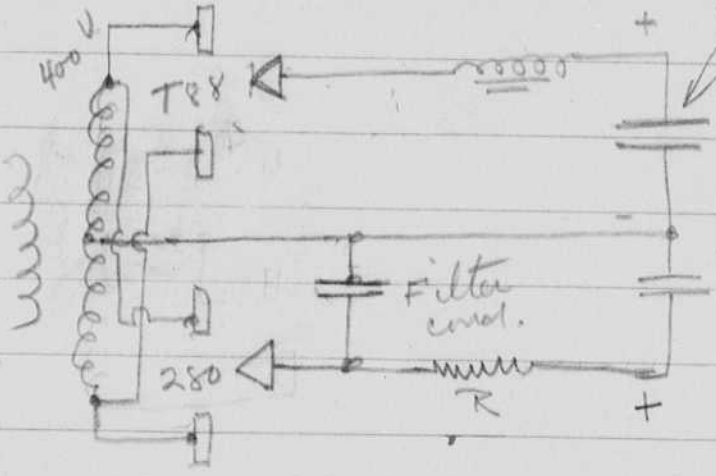
17 cm

Dimensions of tube with 3rd electrode





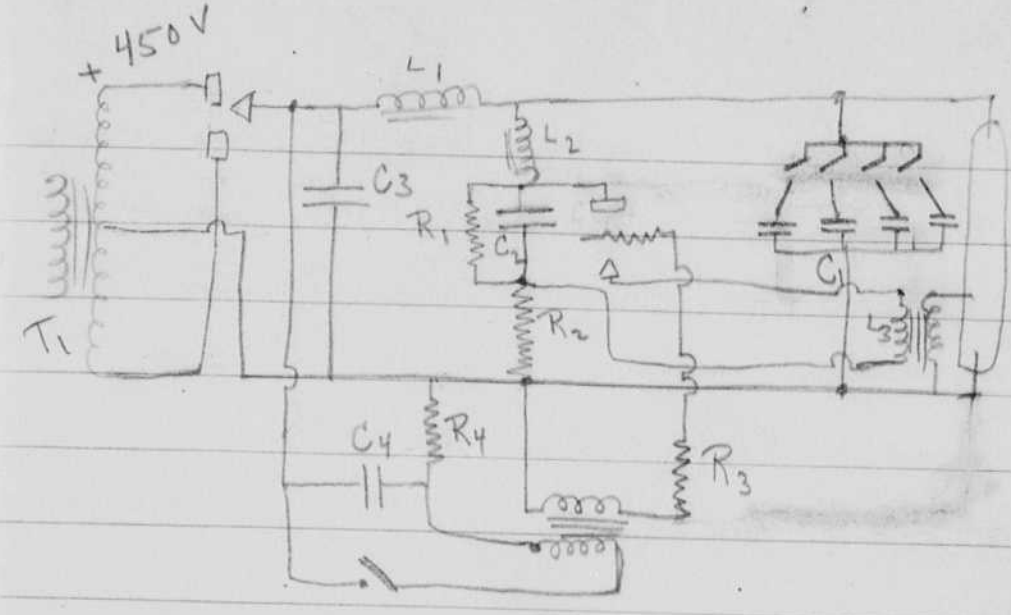




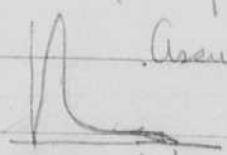
T88 – 300 mils.

280 – 15 to 20 mils.

Windings to be for 350 mils.



Computations: Minimum value of L_1 such that C_1 completely discharges before I_{ch} becomes appreciable.



Assume time of discharge 15×10^{-6} secs and C_1 zero voltage during that time (safe). R_{L_1} is about 200 ohms.

$$i = \frac{450}{200}\left(1 - \epsilon^{\frac{200\times 15}{10\times 10^{6}}}\right) \qquad \epsilon^{3\times10^{-4}} =$$

apparently i will be less than 1 milliampere and 10 h. for L_1 would be sufficient. It follows from this that 10 hs would be more than sufficient for L_2.

20 h. for L_1 would allow 500 cycle operation provided C_3 is large enough. — 3 or 4 times C_1

— Values of C_1 - output of power tube

$\frac{45 \times 12}{10} = 54$ watts.

Say 40 watts to mercury arc, - then:

for 500 cycle operation should have.

$\frac{40}{500}$ watt secs per flash. - this is energy in C_1

W in joules.

$C = \frac{2W}{E^2} = \frac{2 \times 4}{5 \times 16 \times 10^5} = 1 \times 10^{-6}$ farads.

for 30 ~.

$\frac{40}{30} = \frac{2 \times 4}{3 \times 16 \times 10^4} = 16$ mfd.

Values of R_1

Assume $R_{L_2} = 200\ \Omega$ and -50 V bias on grid

take $R_1 = 50{,}000\ \Omega$ $R_2 = 10\,000\ \Omega$

bias $= \frac{10}{60} \times 450 = 75$ V.

take $R_4 = 100\,000\ \Omega$

$R_3 = 5000\ \Omega$.

$i = \frac{2E_L}{R}\left(1 - \varepsilon^{-\frac{2t}{L}}\right)$ 12

$E_L + E_C = 400$

$E_L = 400 - E_C$

$i = \frac{2E_C}{R}\varepsilon^{-\frac{t2}{RC}}$

$E_L = \frac{Ri}{2\left(1 - \varepsilon^{-\frac{Rt}{L}}\right)}$ $E_C = \frac{Ri}{2}\varepsilon^{+\frac{2t}{RC}}$ $C = 8 \times 10^{-6}$

$L = 30\ h.$

$E = Ri\left(\frac{1}{2\left(1 - \varepsilon^{-\frac{Rt}{L}}\right)} + 2\varepsilon^{+\frac{2t}{RC}}\right)$ equation

$\frac{t}{RC} = \frac{10^{-5}}{10^{5} \times .25} = \frac{1}{40}t$

$\frac{(\cancel{7\times10})^2 \times t^2}{\cancel{8} \times 10^{-2}} = .98$

$.98 \times 15 = 14.7$ joules per sec.

$\frac{2 \times 16 \times \cancel{8}}{2 \times \cancel{8} \times 10} = 16$ watts

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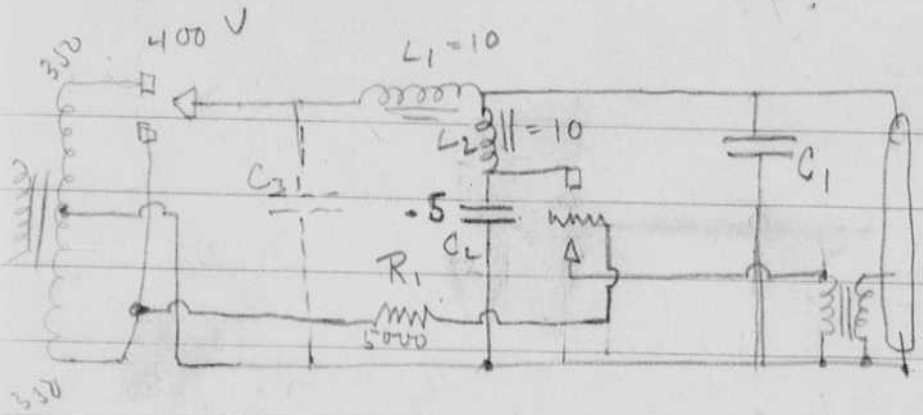
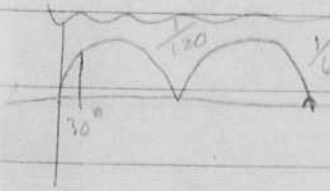


$$W = \frac{E^2 C}{2} \text{ watt secs.}$$

$W = \frac{400 \times 100}{1000} = 40$ watts to M.V. tube.

60 ~ gives $\frac{40}{60} = .667$ joules per flash.

$$C = \frac{2W}{E^2} = \frac{2 \times .667}{16 \times 10^4} = 8.33 \text{ m.f.d.}$$



Condenser C_1 to charge during $160°$ or $\frac{160}{180} \times \frac{1}{60} = .0148$ secs.

Average V 400 V.

Cost.

Transformer.		4.00
Sockets	2 @ 75¢	.30
$L_1 + L_2$	1 @ 1.00	2.00
C_1	600 V 2 mfd.	1.50
C_2		.50
R_1		.50
		10.80

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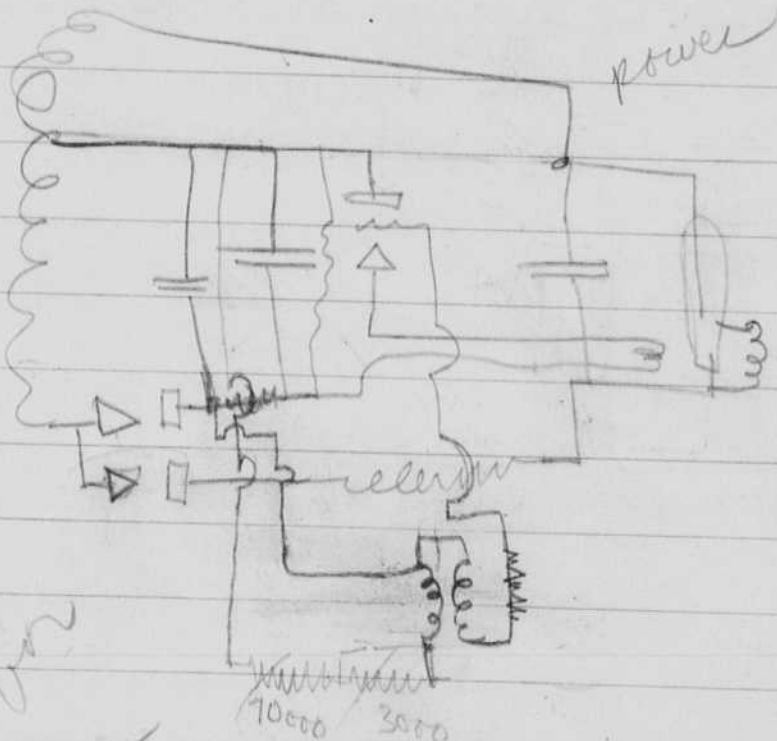
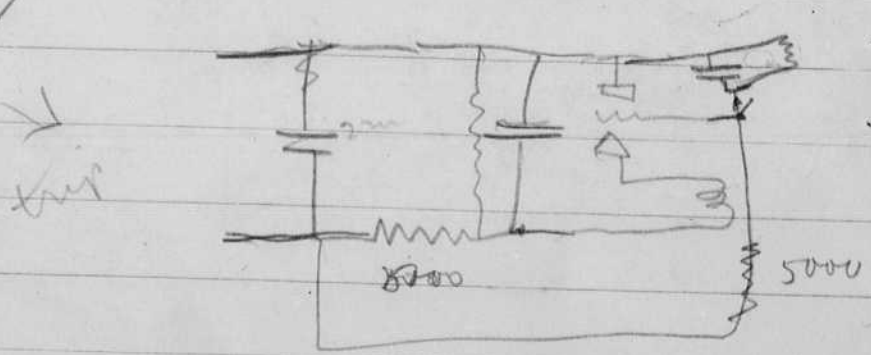
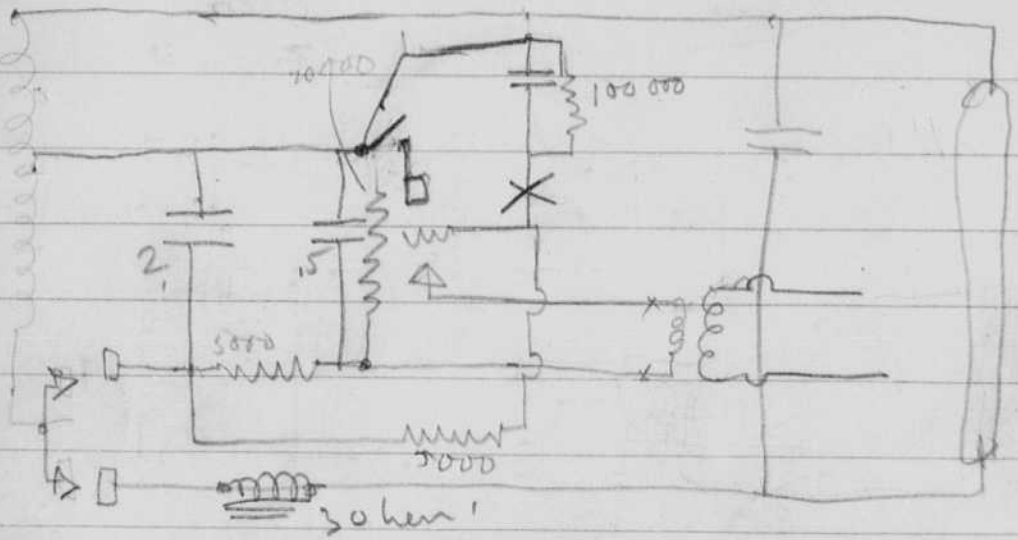


Circuit for Bat Co.





Final Circuit as used for box Co.

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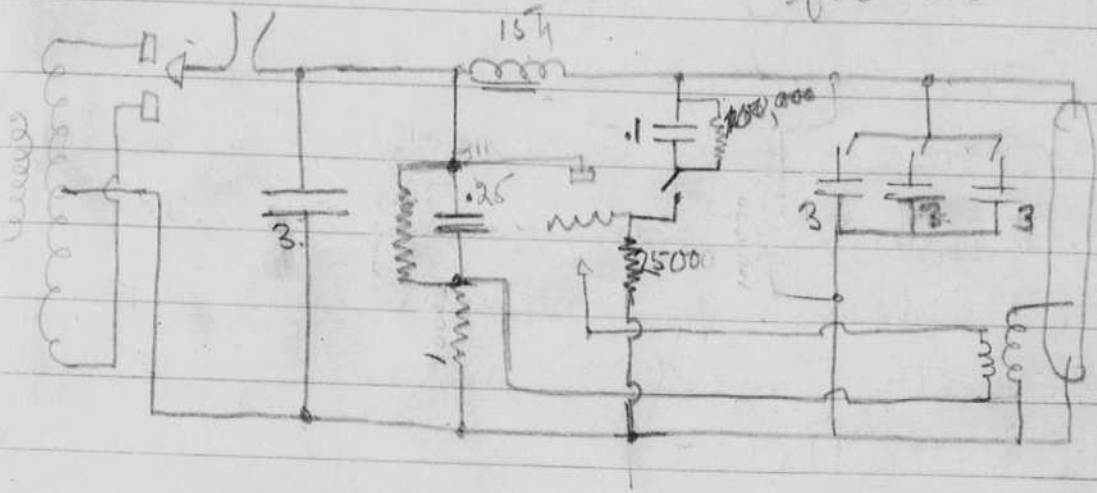
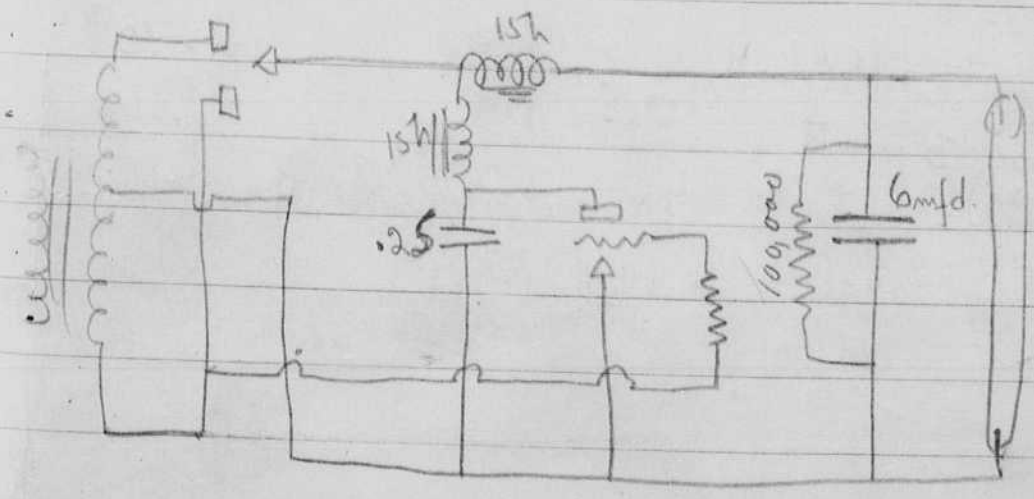
10/20/31

A

Final Circuits for test.



B



List of Parts - A. 18

1 mfd. Hypoltage FC 100	.35
Trans. TF785	3.95
Cond. SP2020 4 @ 50c 3 mfd.	2.00
MU25 .25 mfd. Fletcher unsealed	.30
MU10 .1 mfd. " "	.27
Choke. Double Freed Earl. 2 15h sect. TA726	.90
Sockets 2 @ 15¢	.30
Resisters	
10,000 — 20W. AR240 Vitreous enameled.	.45
50,000 — 40W. and AR-424	.70
5000, 100000, 100000 } 3 watt @ 25c Jewtest Standard type RMA	.75
4 switches Toggle SA 194 @ 17 65	.68

Order to Co.

Town. 3.95 ✓
Cord. 2.00 ✓
" .30 ✓
" .27 ✓
Clarke .90 ✓
Rec. .95
Rec. .80 ✓
Jail .75 ✓
9.72

Property of Kenneth J. Kennebeck

10/21/31

{attempts to reduce
{trip voltage + power.}

Tube.

three electrodes -
3rd electrode to be
about 1 in from mercury
pool.

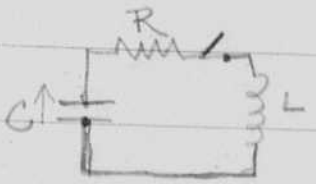
Remarks. — This tube unsuccessful.

Spark Coils. ·2/

For low core saturation

$E_2 = K_1 \frac{d\phi}{dt}$ $\quad \phi = K_2 i$ $\quad \frac{d\phi}{dt} = K_2 \frac{di}{dt}$

$E_2 = K_3 \frac{di}{dt}$



$$Ri + L\frac{di}{dt} = \frac{1}{C}\int_0^t i\,dt$$

Oct. Wed 21 1931

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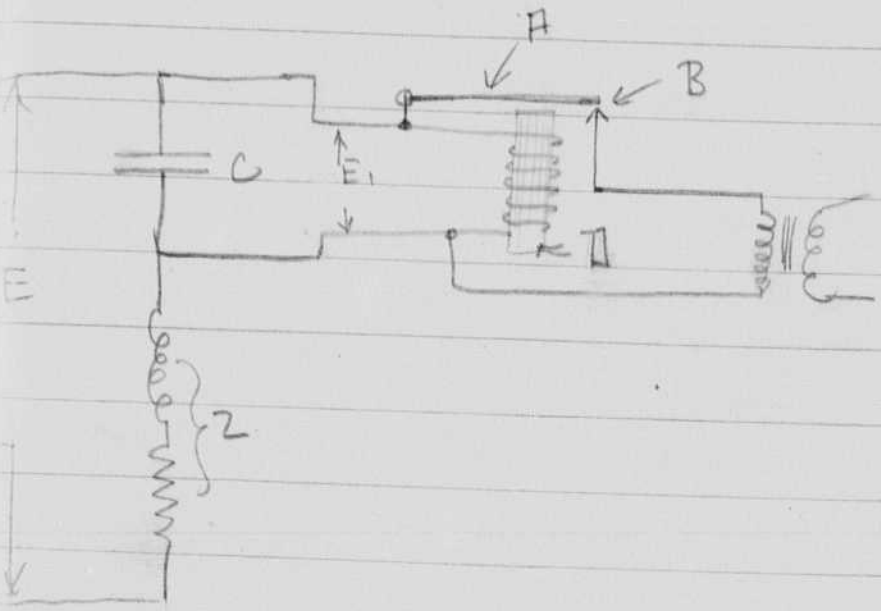
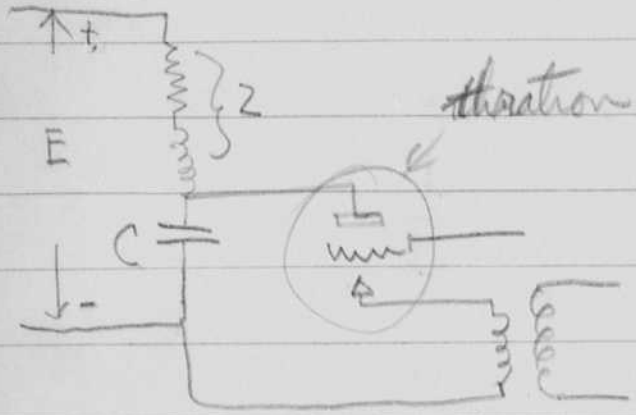
Trip Circuits:



A variable frequency trip. C charges through Z until E_1 becomes sufficient to pull A into contact with B, A will remain in that position until C is almost discharged then spring back opening contacts B and allowing C to recharge. Frequency control through C, Z or A.

Thyratron variable frequency.

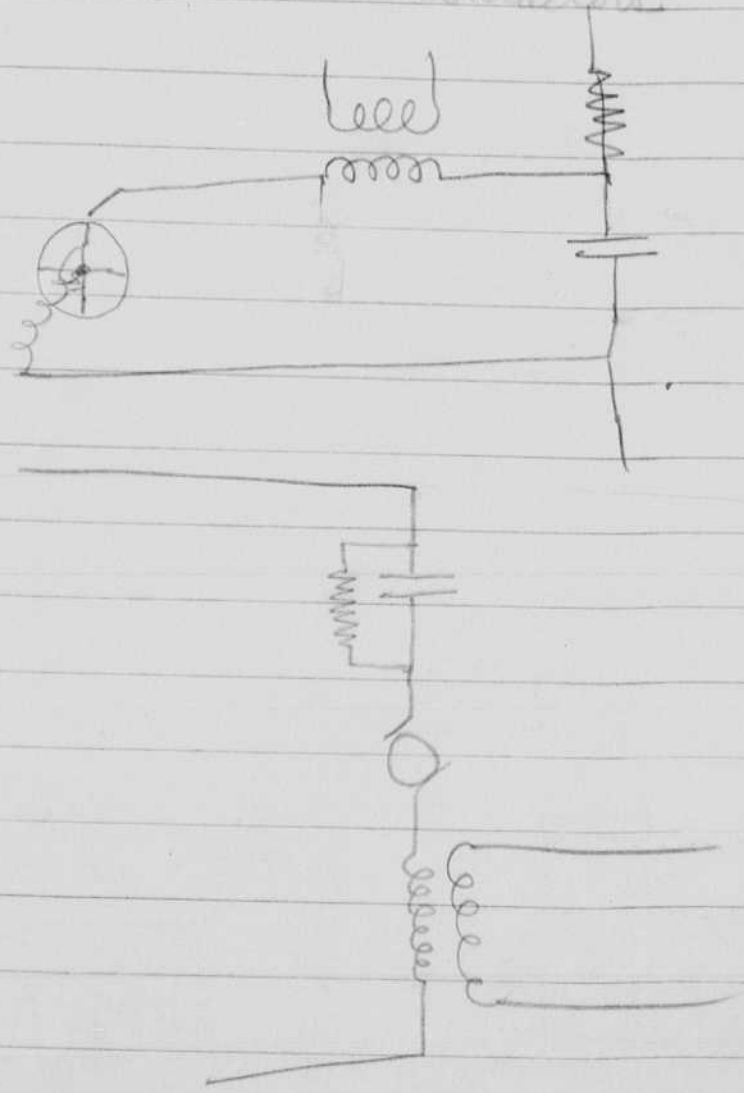


When voltage across C becomes sufficient thyratron trips discharging C through the tube. Frequency control C, Z and grid voltage.

10/21/31

25

Motor driven Contactor

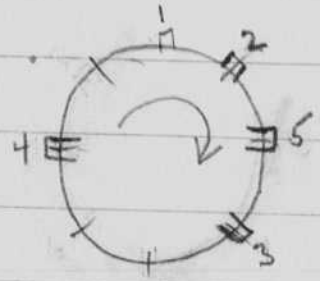


10/21/37

2)

Contactors for sign work:

To secure even transition from one to 2 to 3 etc flashes per revolution.



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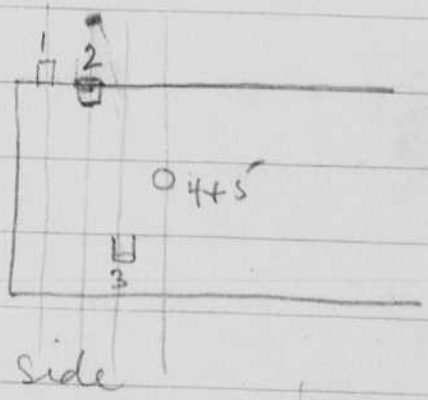
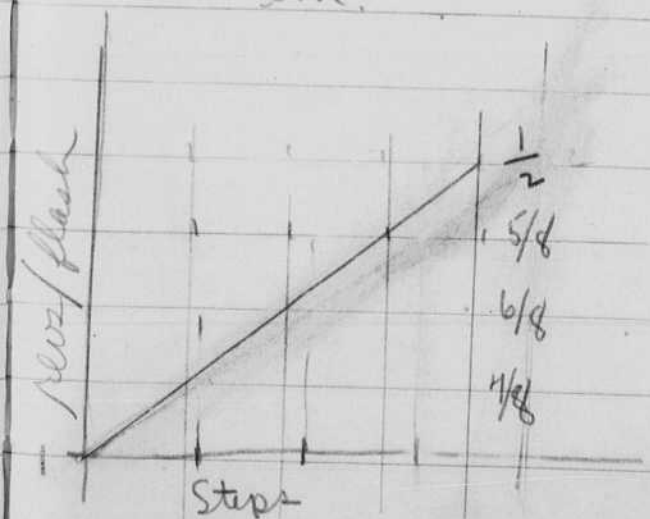
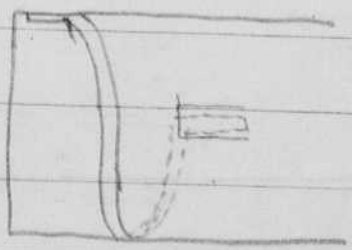
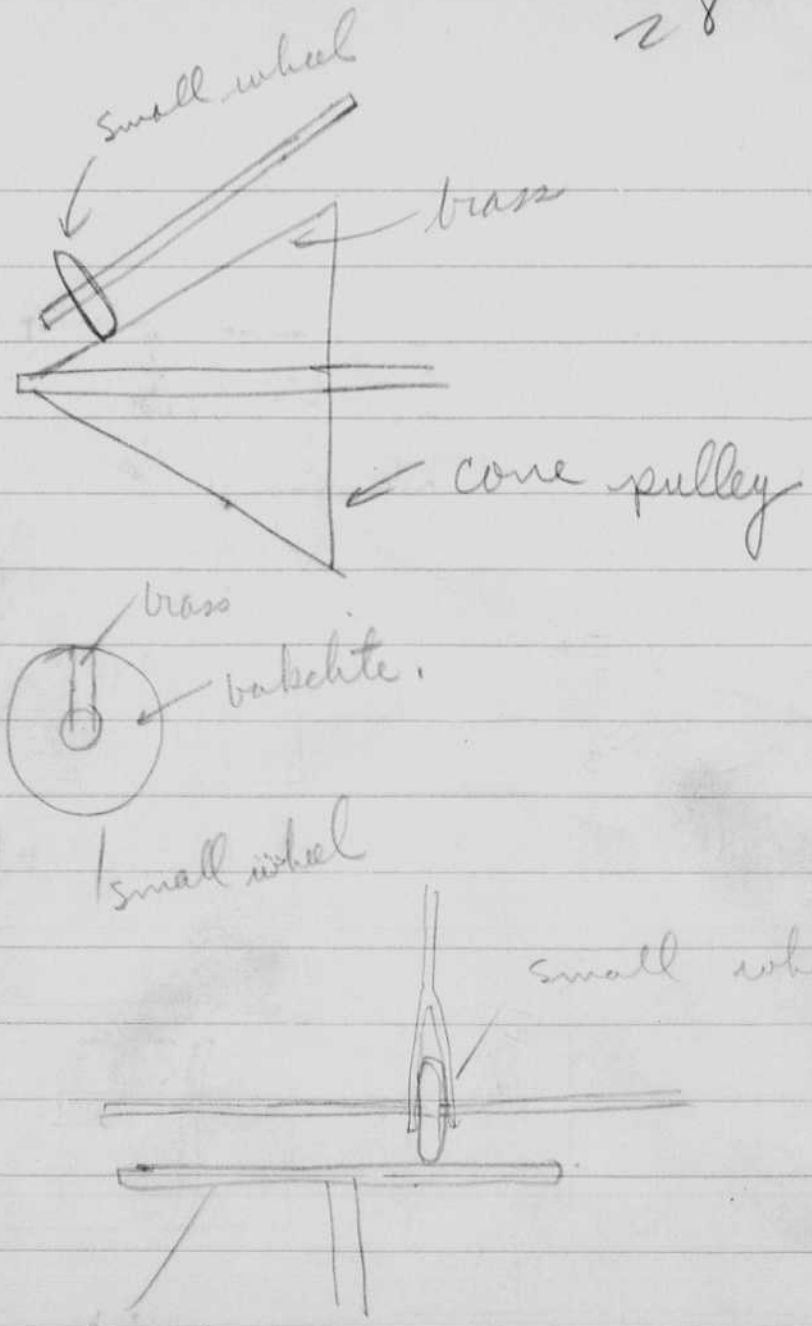


side







Explained Oct 22 1931 by K Germeshausen
H. E. Edgerton.

Oct 22 1931

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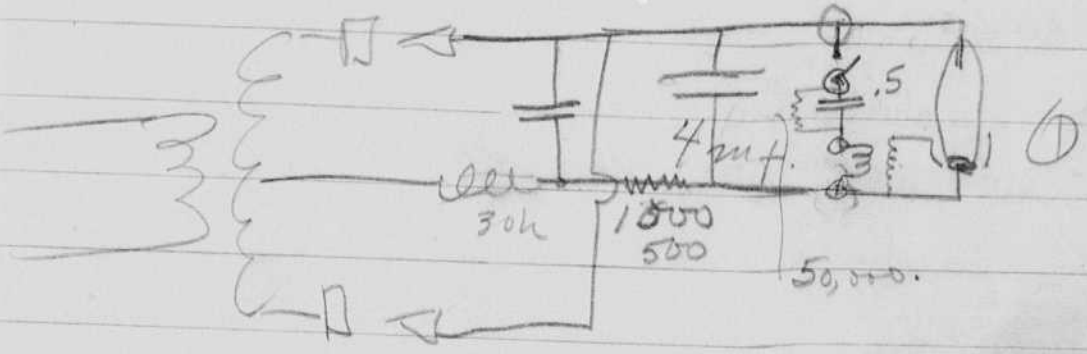
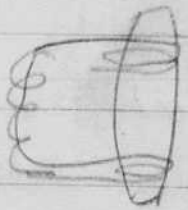
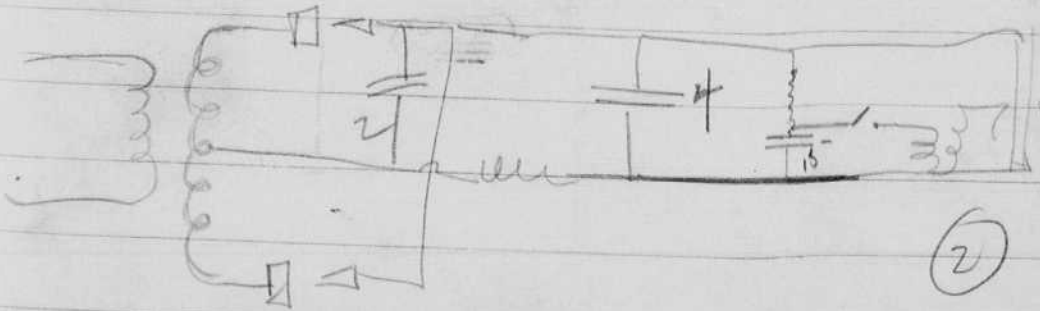


①

Oct 23, 1931





②

Oct 22 1931. 30

Checked circuit for Cox co. Rye 16
and found non regular flashing
caused by to large a choke.
Recomended to use full wave
and a smaller choke.
Secured material from Acme.
Discussed new simplified circuits.
May be advisable to use consider
impedance in Spark circuit to
prevent contact spark.

Oct 23 1931.

31

Had difficulty in making lamps operate continously. misfired very erracticlly. (Circuit #29A) - Trouble proved to be charging of trip condenser lowered voltage on load condenser which for an unknown reason prevented tube discharge. When changed to p 29b. worked perfectly.

(Saw U. Glue mach. Co. not so hot! Stopped at Hygrade met Mr Bolan + Biggs.

10/27/31

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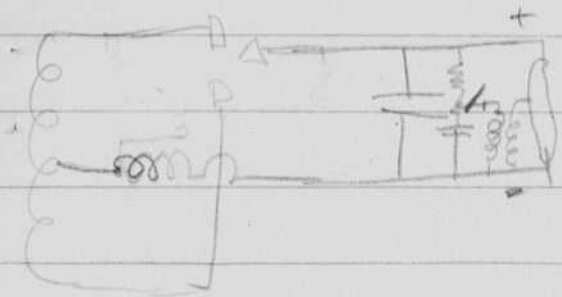
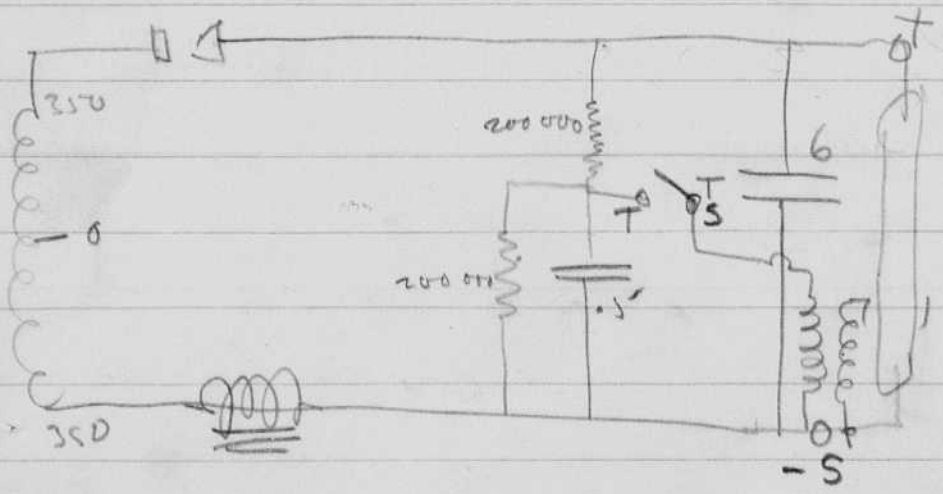


10/28/31



present circuit.

10/26/31

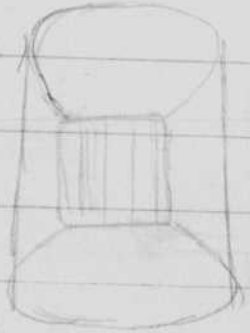
Reflector design

33

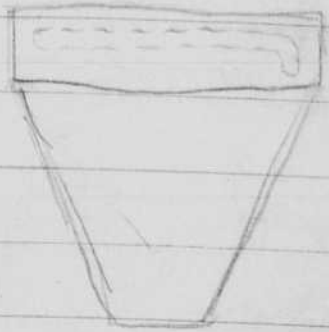
side

Top

Front



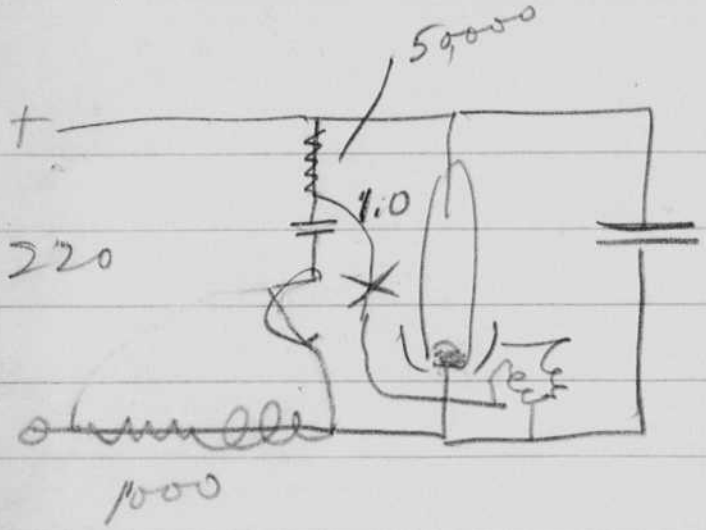
side



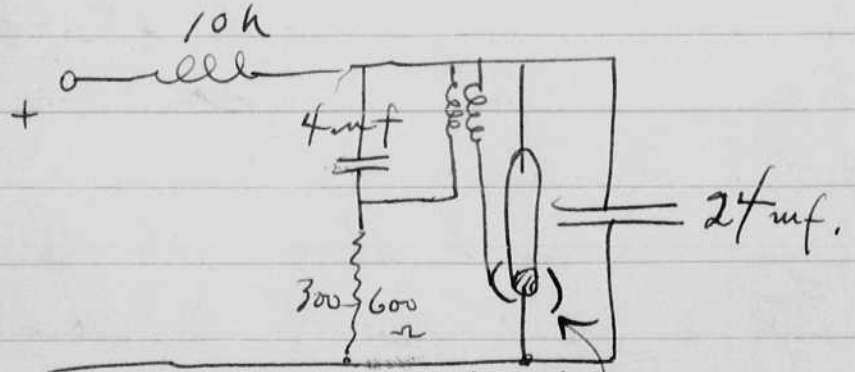
end.

10/26/31

37



did not work



works when hot

H E Edgerton.

From this we draw the conclusion that it is advisable to use high voltages in the discharge circuit (500 volts and up).

10/28/31

Apparently a small choke is necessary to prevent arc discharge (5h). Also experience seems to indicate that for all freq. above about 10N a full wave filtered power supply is necessary. (Except 60N)

Tubes — glass - lead -

inside dia 11 m.m.
outside dia 13 m.m.

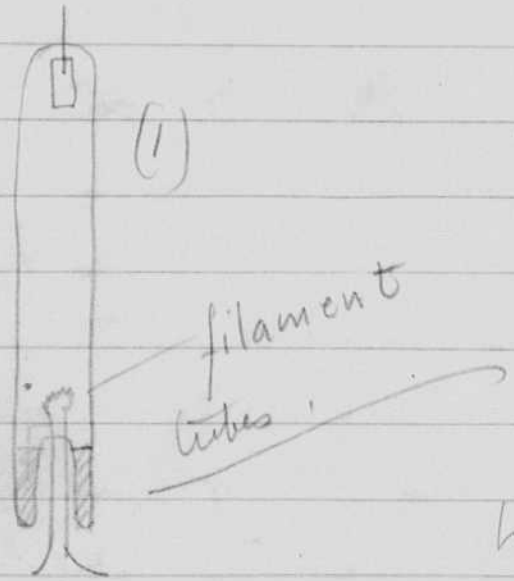
10/28/31

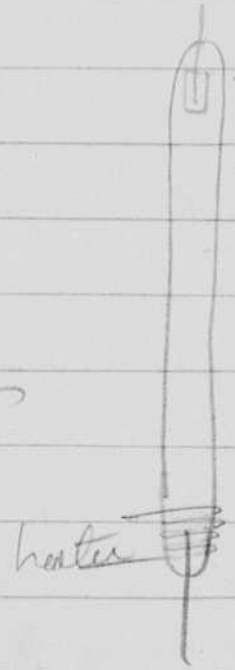
It was noticed that the Hord coil gave a much snappier spark than the other and the tube stripped better with it. — Acme 750 V cond will not stand 181 with 700 V plate.

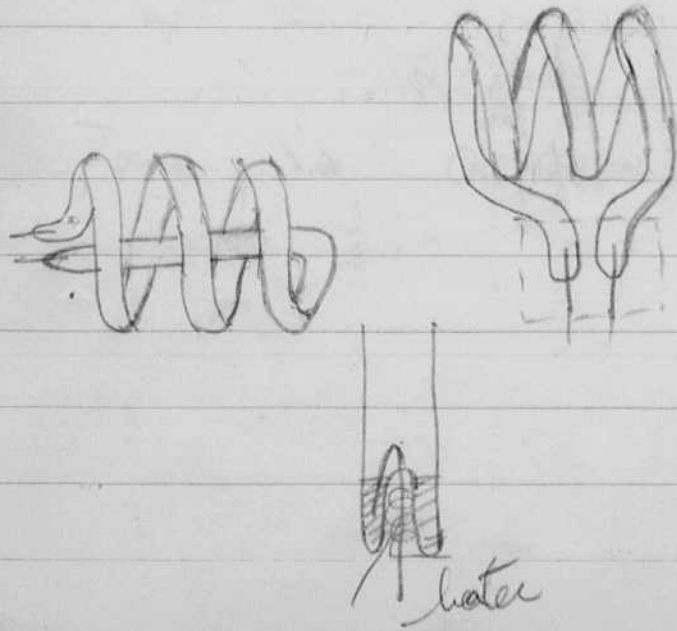
10/29/31 -

Ran today. Pin Edge on rectifiers with Mer. V. Attempt tube with filament

10/28/31







10/29/31

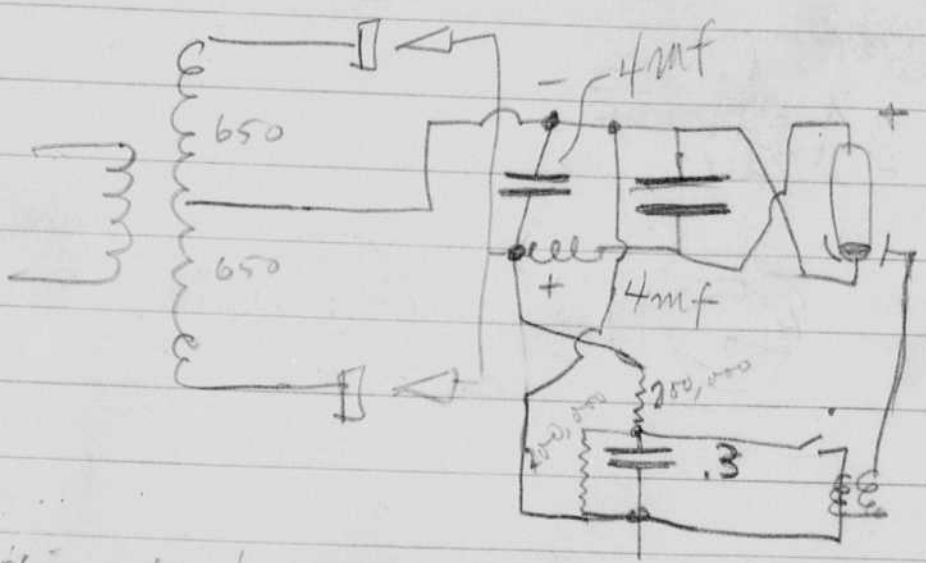
Built lamp with filament as per (1) on opposite page.

Filament – 1.7 amps 5 V

Used with power supply P 29-2

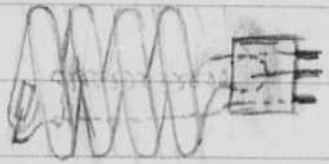
Tube operated practically but operated much better with (old leg) filament on than with it off. – Then we put the tube on the big power supply (1500 V 4 m/a) It operated perfectly and became quite warm. While still warm it was placed on the small power supply and it still operated perfectly until

it began to cool. ....
It was then cooled
completely. When power was
put on again it would not
go until filament had a
chance to warm the tube
As the tube became warm
operation became more and
more regular until it
was perfectly steady.
Filament was then removed
and the tube still operated perfectly



Circuit for 2 2A1's

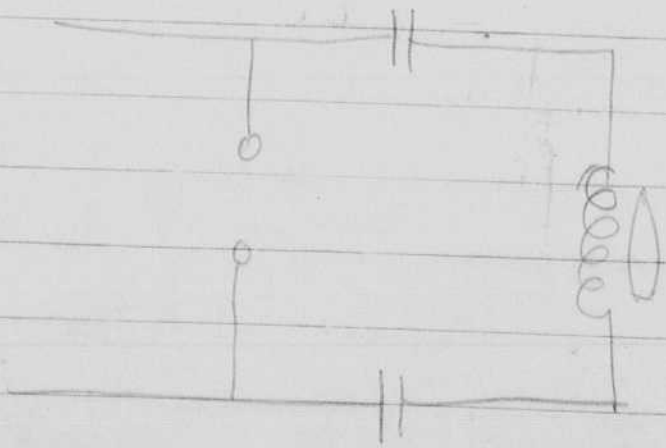
Tube



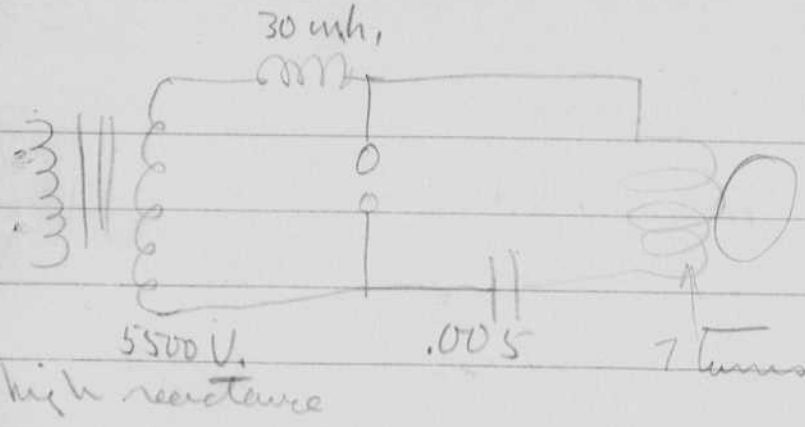
heater

Ted Houlke Journal AIEE.
Feb 1928 43

Induction Lamps.
J. J. Thomson Phil Mag Vol 32 1891



Mercury - minimum critical voltage 10.4



Neon gas to start tube — Air will not do - a chemical reaction forming a nitride + oxide of mercury cleans up the air. — Use of Helium at .5 m.m. or Argon at 4 m.m. Desirable pressure of Argon a little more than minimum to start bulb. for circular bulb, $p = 5.7\, r^{\frac{1}{2}}$ m.m.

High frequency desirable - 2 to 3 million cycles.

Nov 2 1931,

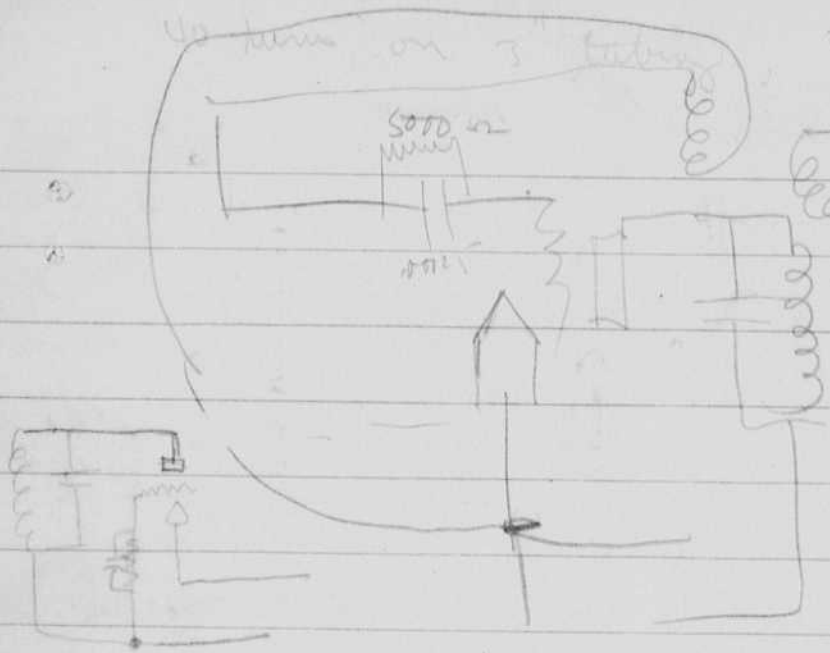
Tried to start tube with Lab. bombarder. Started when mercury pool was included in field so that small amount of mercury was vaporized.

Herriesthauser

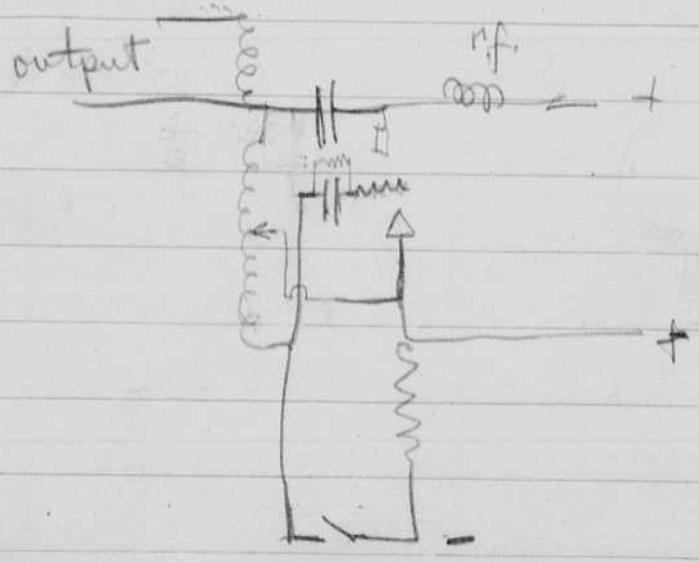
11/2/31

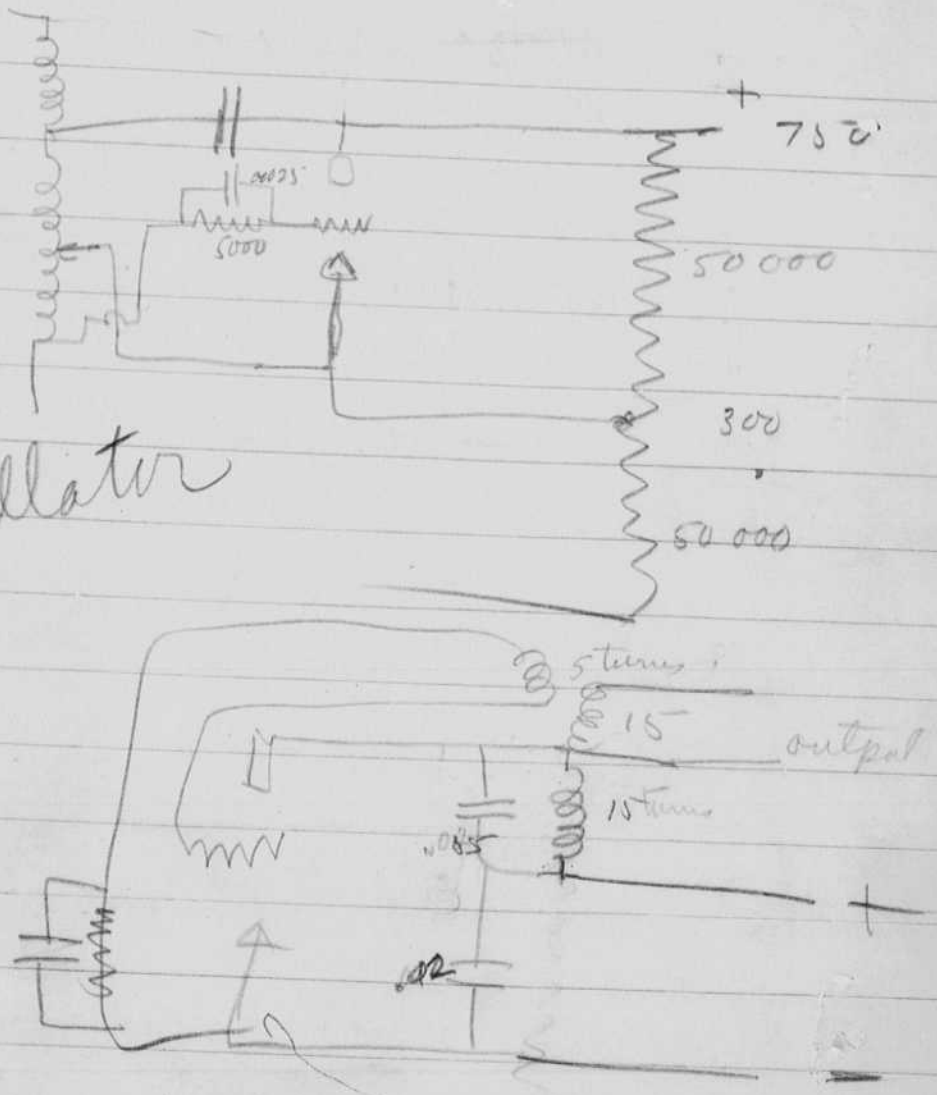
Kennett

4b



vacuum tube oscillator





Oscillator

circuit used.

Inductance of Ford spark coil primary

$r = 0.4$ ohms.

$Z = \frac{1.1 \text{ volt}}{1.6 \text{ amp}} = 0.685$ ohms.

$x = .556$ ohms.

$L = \frac{.556}{377} = .00148$ hen.

Inductance of wound primary for iron secondary

$r = .42$

$I = 1.5$ $\quad Z = \frac{1.1}{1.8} = .83$

$E_1 = 1.8$

~~the~~ coil did not work.

$X = wL$

$L = \frac{X}{w}$

Notebook # 15 October 1931 — 14 January 1932

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 48 and 49.

Item(s) now housed in accompanying folder.

Inductance of Ford K Spark coil primary

$r = 0.4$ ohms.

$Z = \frac{1.1 \text{ volts}}{1.6 \text{ amp}} = 0.685$ ohms.

$X = .56$ ohms.

$\frac{L}{377} = .556 = .00148$ hen.

Inductance of wound primary for mon secondary

$r = .42$

$I = 1.5$ $\quad Z = \frac{1.5}{1.8} = .83$

$E = 1.8$

~~the~~ coil did not work.

$X = wL$

$L = \frac{X}{w}$

Notebook # 15 October 1931 — 14 January 1932

Filming and Separation Record

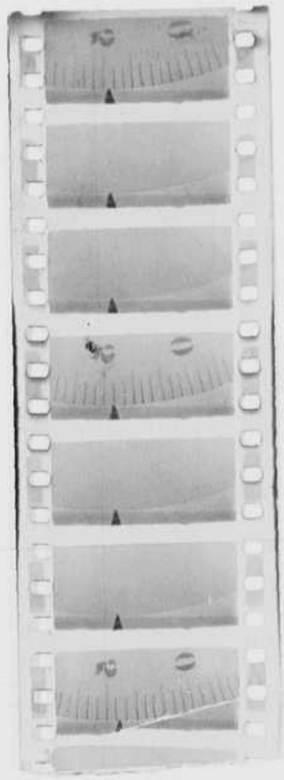
1 unmounted photograph(s)

____ negative strip(s)

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

was/were filmed where originally located between page 48 and 49.

Item(s) now housed in accompanying folder.



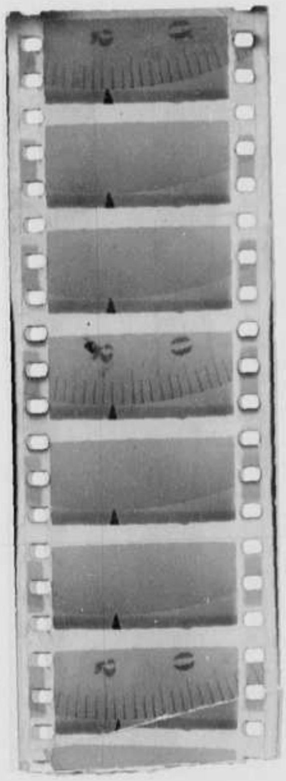
11/3/31

a mm. mm. outside
7 mm. mm. inside

Length of glass 13"

We made two of these.

Both were pumped hard, heated for 30' in oven while pumping and operated to maximum operating temp. Workedsatisfactorily when hot but would not operate when cold.



11/3/31

$i = \frac{350}{25000} = .014$

$= 1.4\%$

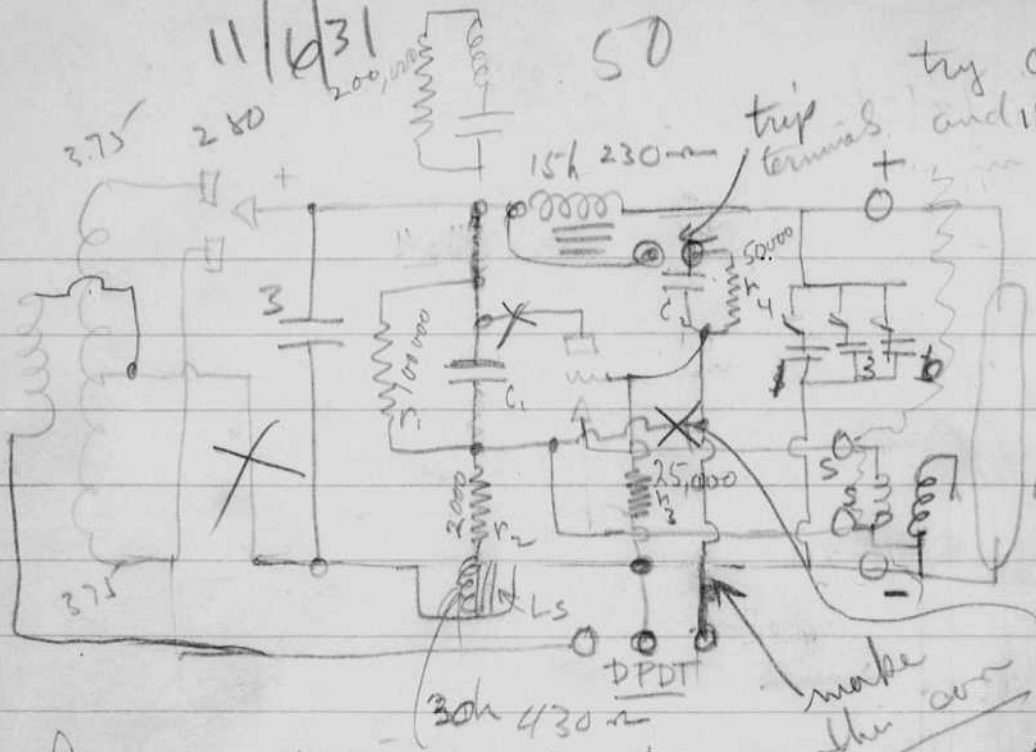
9 m.m. outside
7 m.m. inside

Length of glass 13"

We made two of these.

Both were pumped hard, heated for 30' in oven while pumping and operated to maximum operating temp. Worked satisfactorily when hot but would not operate when cold.

11/6/31



Assume 425 V. D.C.

$V_1 + V_2 = 100\,000$

$I = \frac{425}{100\,000} = 4.25$ mils. O.K.

$E_{R_2} = 20$ V. $R_2 = \frac{20 \times 1000}{4.25} = 5000$

b binding posts ..... 25 000 Ω $2.35

3 SPST } switches. 2000 Ω

1 DPDT } 25 000 Ω

Were

1 mfd. 600 V.

United States Patent Office, Before the Examiner of Interferences, Engelder - Miller, Int 76771

Ledgeder Exhibit 37

Page 50 of Examination, Notebook No 1

January 3, 1940

Clara Schlosser
Notary Public

$I = \frac{400}{500} = 1$ amp.

$\frac{20}{400} = \frac{10000}{x}$ $\quad x = \frac{400 \times 10000}{20} = 200\,000$

With $r_1 = 200\,000$

$r_2 = 10\,000$ $\quad L_5 = 0$

$r_3 = 5000$

Operation erratic - Telegram did not always clear.

With 25000 in r_3 operation much the same - no appreciable improvement. Or perhaps a little better?

~~United States Patent Office, Bureau of Engineering of Telegraphs Engineer, Hull, Telegram 6771~~

$r_3 = 25\,000$

$r_1 = \infty$ $\quad r_2 = 5000, 10\,000, 15\,000$

operate best with $r_2 = 5000$ but misses regularly.

$\frac{10^6}{10^6} \times .00025$ 52

$r_3 = 100000$ - operate irregular best with small load cond.

$r_3 =$

Changed circuit to P 53.

$C_1 = .25$ $C_2 = .00025$

$r_1 = 100000$ $r_2 = 5000$ $r_3 = 25000$

$r_4 = 1$ meg.

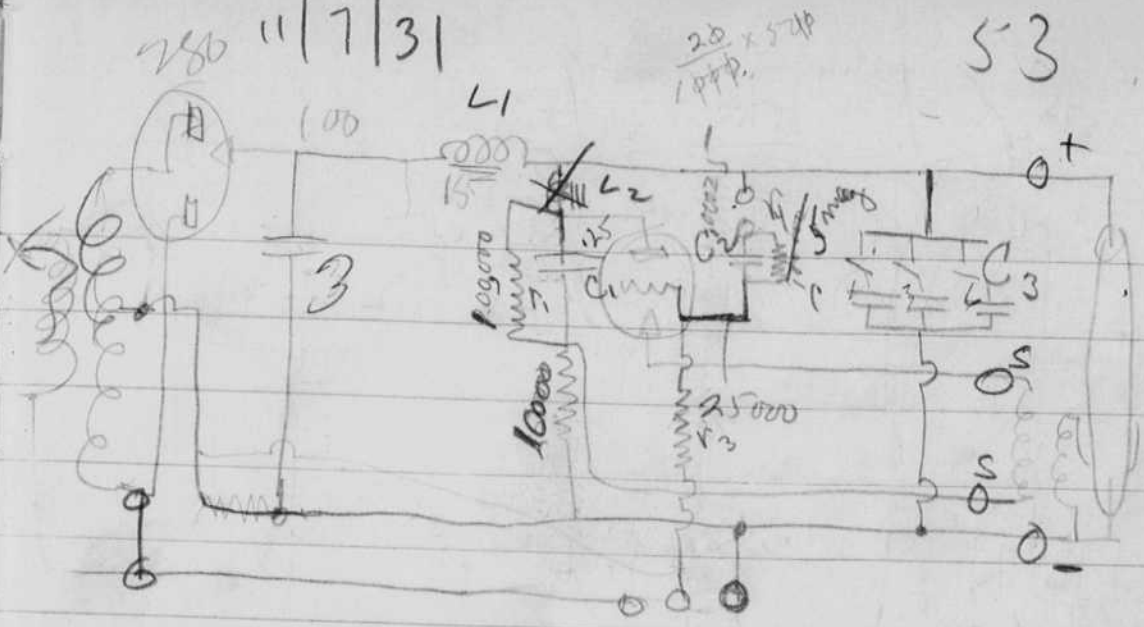
This works at 60~ - Works with or without L_2 but gives more spark with L_2 -

Tends to trip at other frequencies depending on C_3 if grid is free

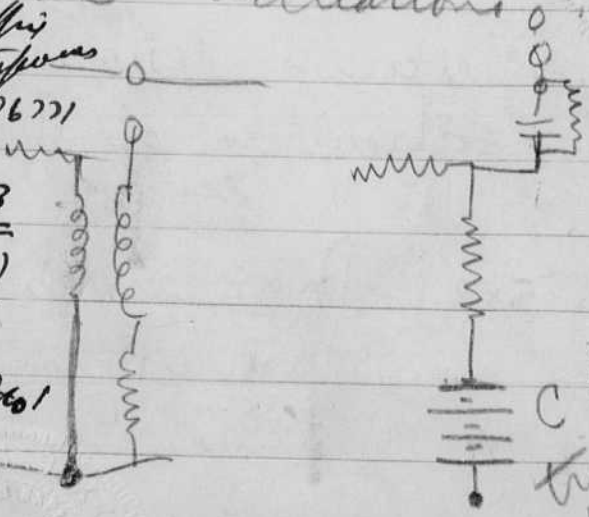
Will also oscillate in this fashion with grid connected to minus if trip contacts are closed. Circuit will operate at low frequencies

11/7/31

53



with contactor if C_3 is large enough, otherwise goes into uncontrollable oscillations.

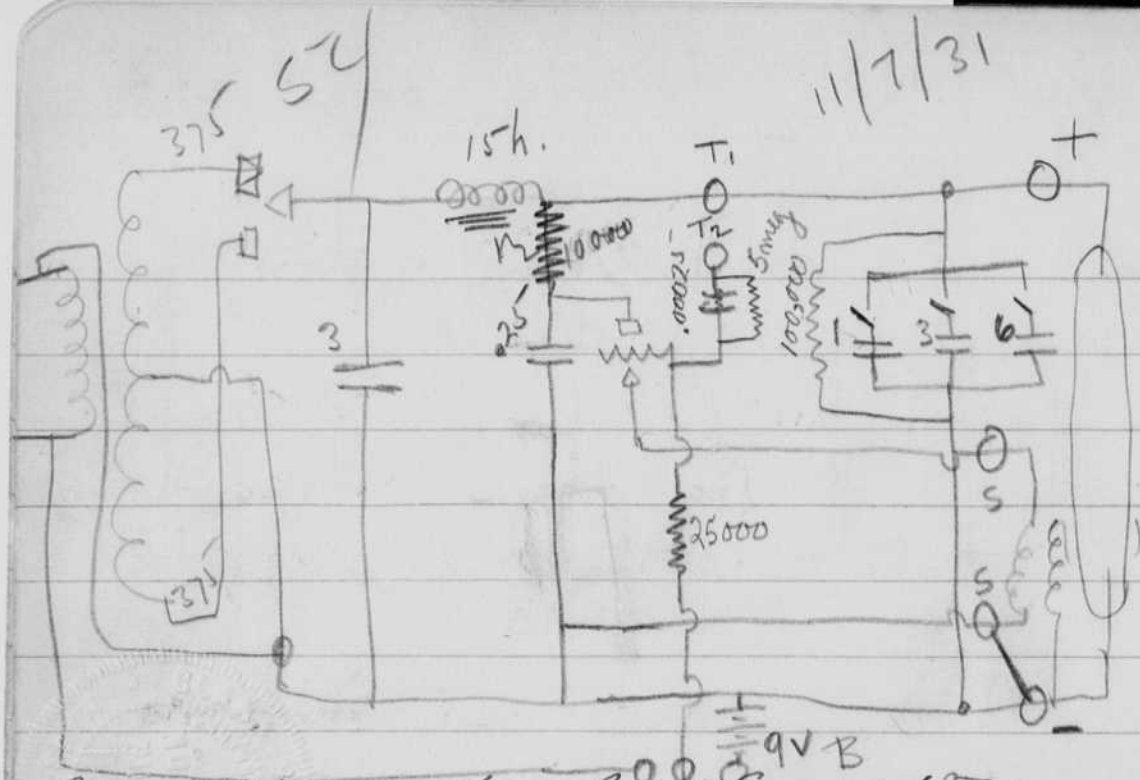


United States Patent Office
Before the Examiner of Interferences
Edgerton, Shedd, Int 76771

Edgerton Exhibit 33
(3 Pages - Page 1)
Pages 53, 54 + 55 of
Research Laboratory Notebook 1

January 3, 1940

Clara Schlosky
Notary Public



11/7/31

54

United States Patent Office - Before the Examiner of Interferences
Edgerton - Multh, Int. 76771
Edgerton Exhibit 33
(3 Pages - Page 2)
Pages 53, 54 & 55 of Specification Exhibit No. 1

This circuit designed to eliminate difficulties of those of P's 52+53

Jan 3, 1940 Clara Schlosky
Notary Public

(1) (P's 52+53) Drop across r_2 not constant a unidirectional to to reversal of potential of C_3 so a constant bias battery B was added and r_2 moved to position shown, P 54 so a bias of 4 1/2 V

could be maintained on the grid.

Will not work reliably on 60~ with r_2 less than 5000 because discharge is maintained through the thyratron.

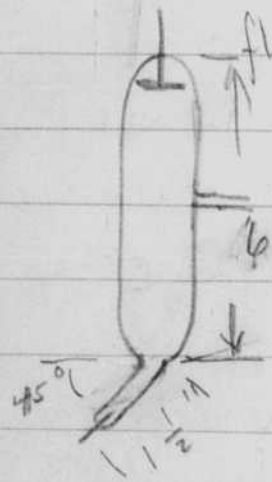
Round C was not necessary. Finally succeeded in making P 5+3 work perfectly, trip condenser increased to .5 for starting and for low frequency - (See reverse book)

United States Patent Office
Before the Examiner of Interferences
Ledgerwood - Wells, Interference 76771

Ledgerwood Exhibit 33
(30 pages - Page 3)
Pages 53, 54 + 55 of Seimsboard Notebook No. 1
Jan 3, 1940

Clara Schlosky
Notary Public

56 11/7/31



7m x 9mm
15" x 17 mm

L_2 L_1 inside area
L_1 d_2

$L_2 = L_1 \frac{d_1}{d_2}$

$L_2 = \frac{14 \times 7}{15} = 8.1$

$L_2 = 9$

$\pi d_1 L_1 = \pi d_2 L_2$

$L_2 = \frac{d_1}{d_2} L_1$

Plate

750 750 Ω
500 Ω

Circuit for 2 2A1's.

11/10/3

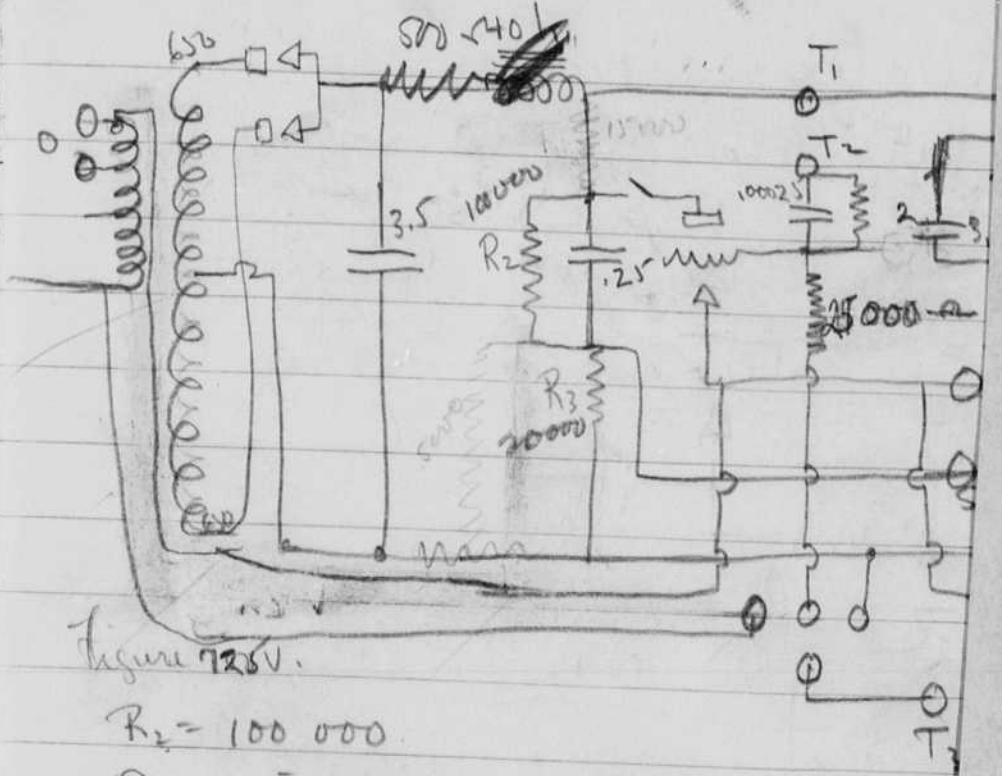


Figure 725V.

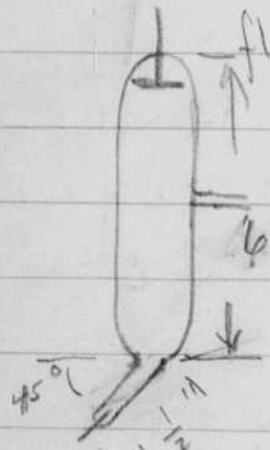
R_2 = 100 000

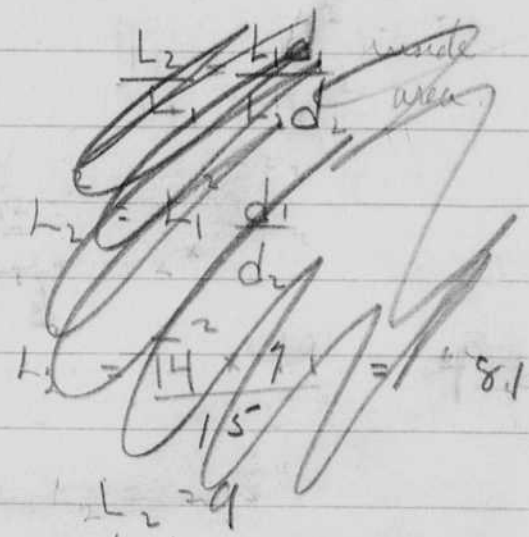
R_3 = 15 000

This circuit did not work right, the thyratron tended to block. - Resistors changed a dozen but this must solve it. H.C. grid returned to B- instead of and circuit was O.K.

56 11/7/31

7m x 9mm
15 x 17 mm

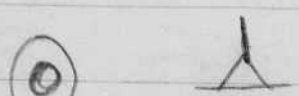




$$\pi d_1 L_1 = \pi d_2 L_2$$

$$L_2 = \frac{d_1}{d_2} L_1$$

Plate



750 750

500

Circuit for 2 281's.

11/10/3

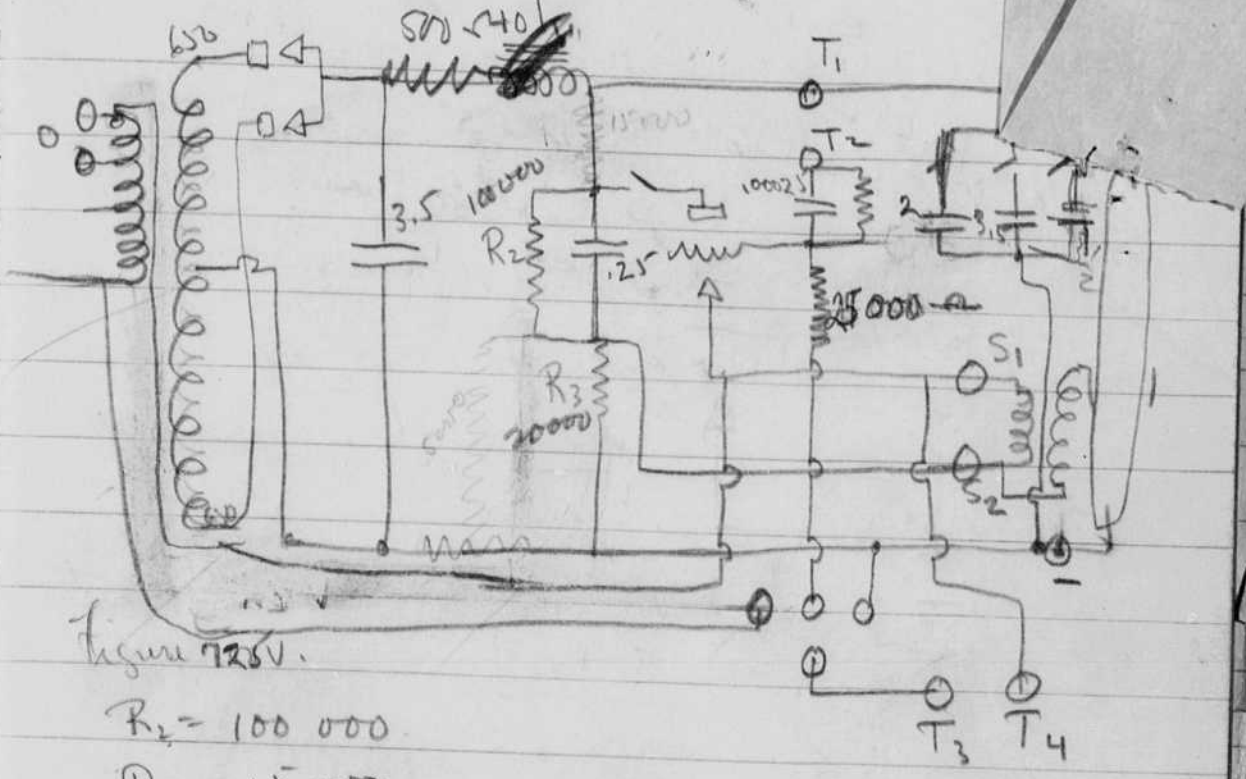


Figure 725V.

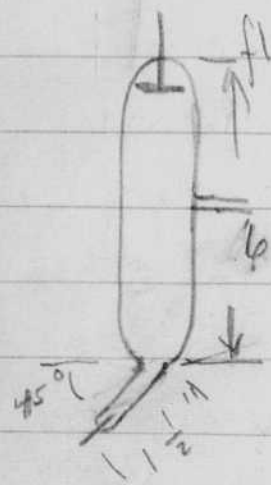
R_2 = 100 000

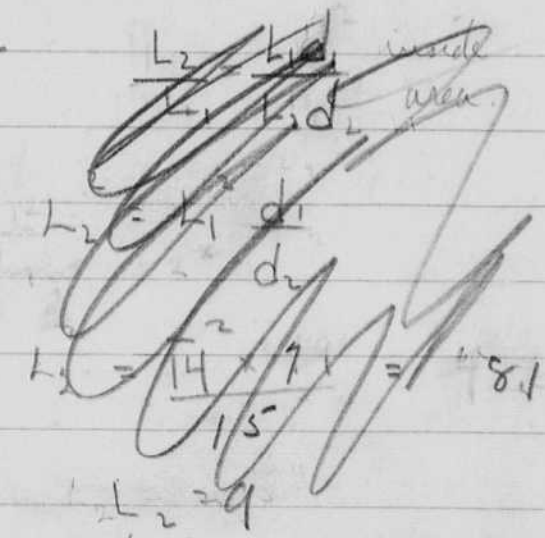
R_3 = 15 000

This circuit did not always work right, the flipation tended to block. - Resistor R.3 changed as shown but this did not solve it. H.C. grid voltage returned to B- instead of cathode and circuit was O.K.

11/7/31

7m x 9mm.
15 x 17 mm.

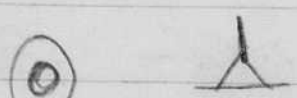




$$\pi d_1 L_1 = \pi d_2 L_2$$

$$L_2 = \frac{d_1}{d_2} L_1$$

Plate



750 - 750 Ω

500 Ω

Circuit for 2 2B1's.

11/10/31 57

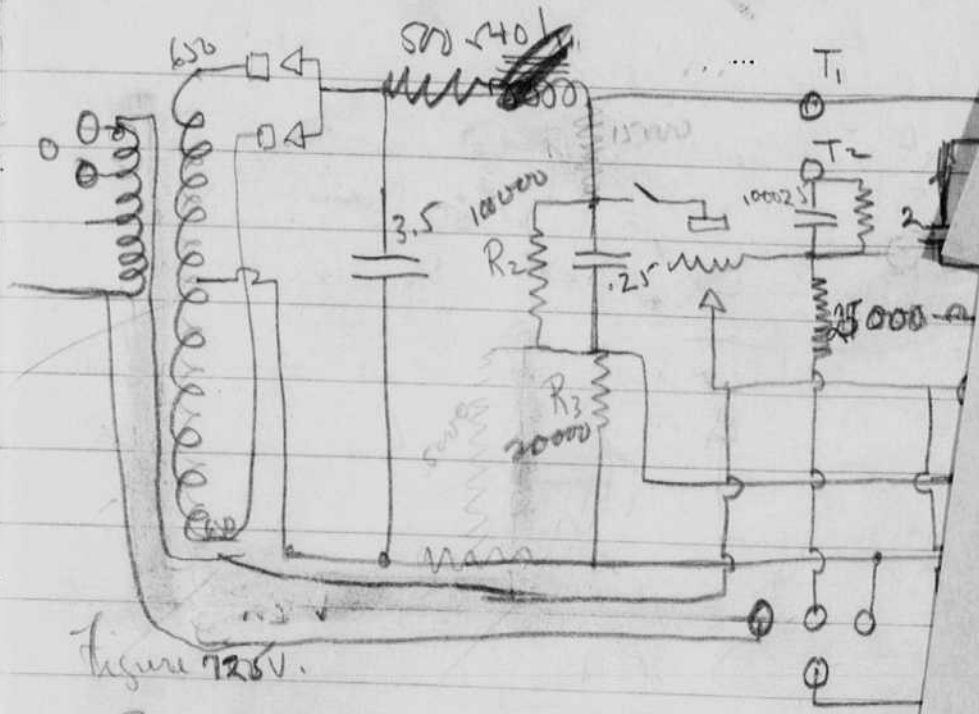


Figure 726V.

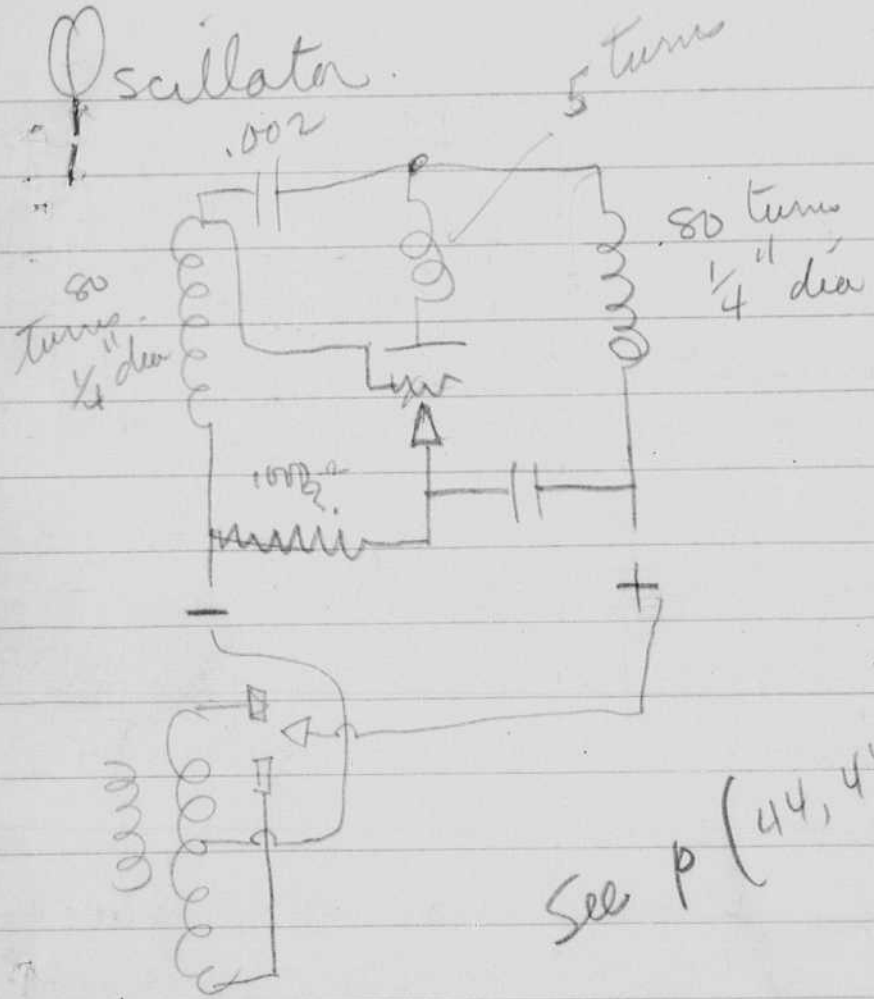
R_2 = 100 000

R_3 = 15 000

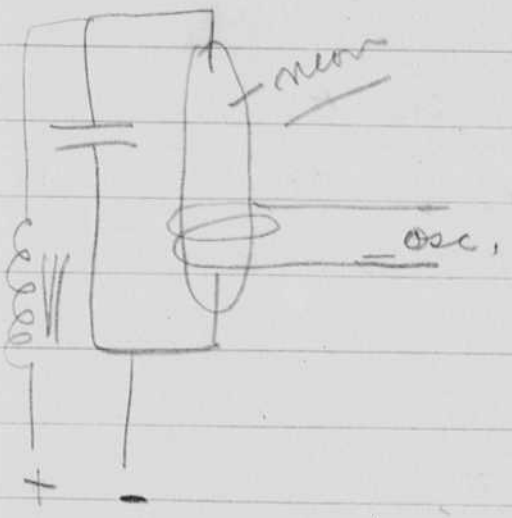
"This circuit did n
work right, the thyrat
tended to block. - Resis
changed as shown but
not solve it. A.C. g
returned to B- instead
and circuit was O.K.

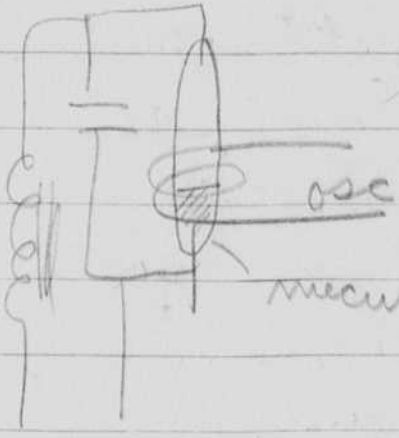
11/12/31 58

Oscillator.

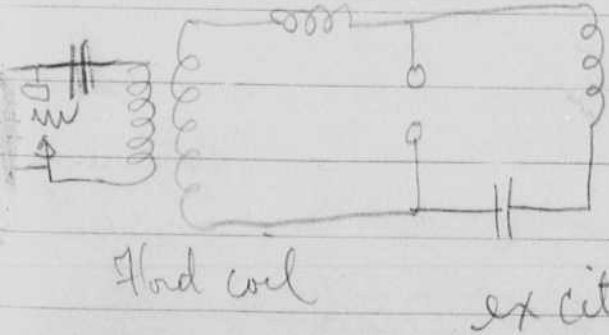


See p (44, 45 + 46)





using oscillator as trip circuit.

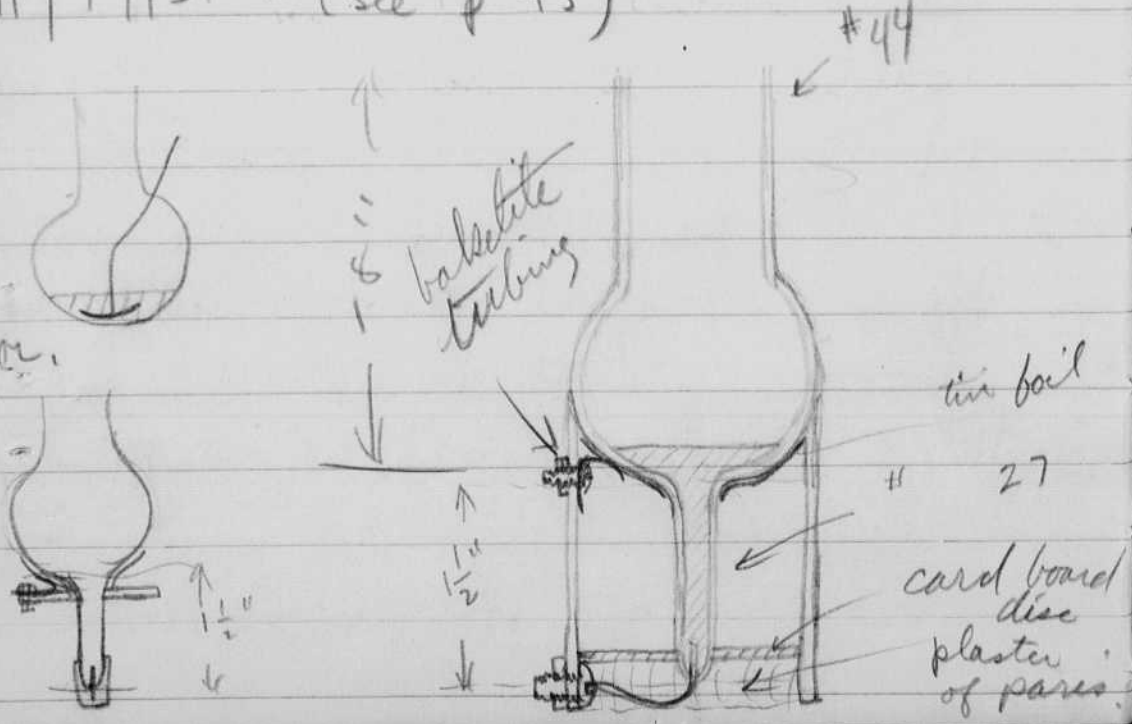


Circuit to give stroboscopic light by high frequency excitation of a gas.

11/14/31

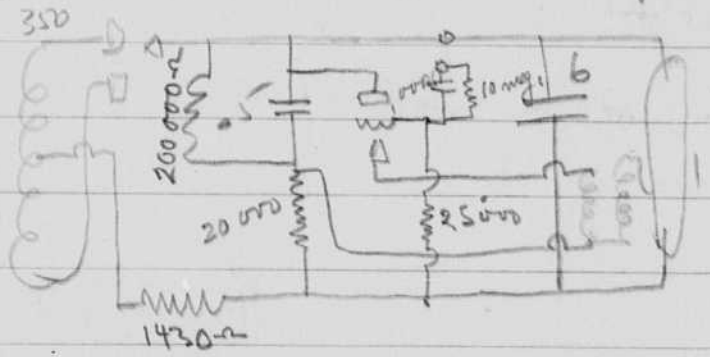
Suggested that reason P 57 would not trip with A.C. grid tied to cathode was that spark coil shuts autotransformer and high voltage fed back through the biasing resister.

11/14/31 - (See p 45)



11/17/31.

Circuit for Russel box Co. on special order for 3 days



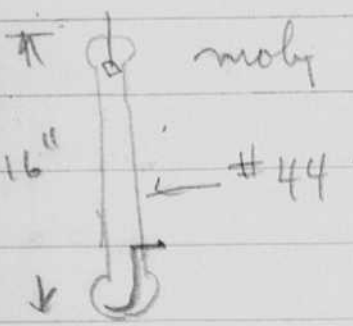
This circuit worked well on trial in the lab.

11/18/31 – Circuit operated first day but missed occasionaly.

11/19/31 – Called at 10 A.M. would not work – Soldered wires to tube. Taped Sparking screen in place. Placed tube in horizontal operation position. Changed thyratron (Worked perfectly without missing) Thyratron + screen placement cau

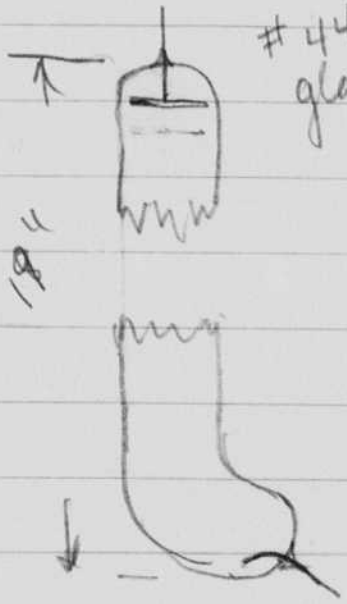
11/17/31

Built tube as shown.

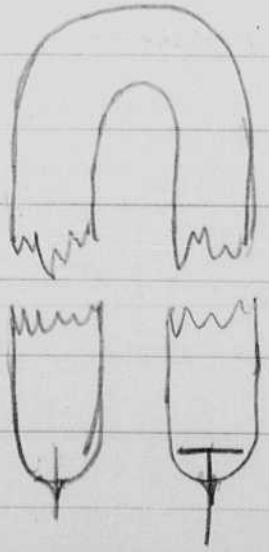


Did not work at all well. Question as to whether it was well evacuated. Decided to try it again at some future date. —

10/17/31

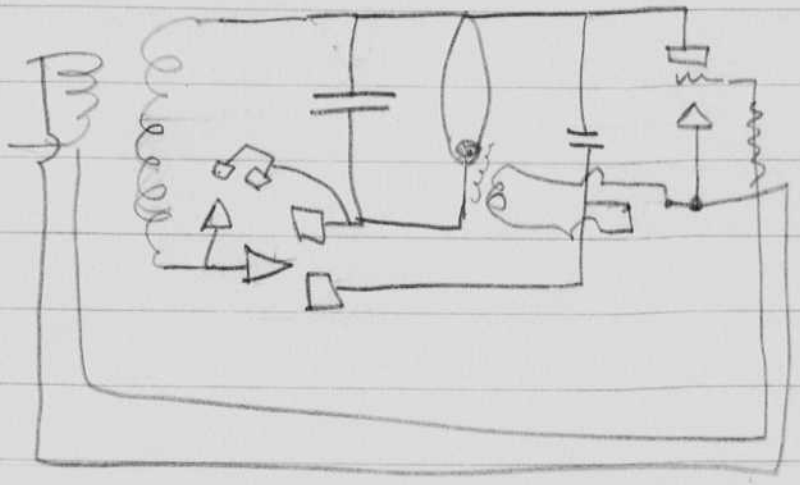


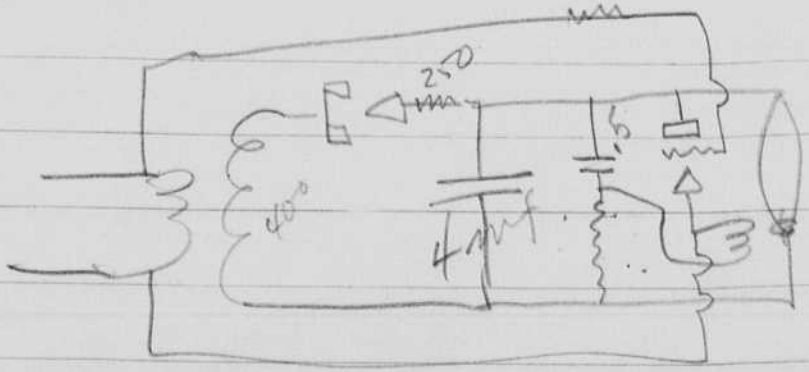
Try some U tubes of this glass in 11" and 19" total lengths.



Built oven - 1200 watts.
Heats to 350°C in 7'

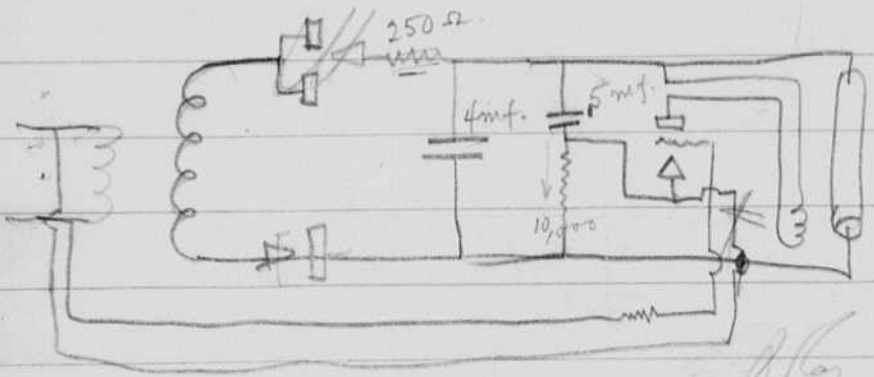
Nov 21 1931
H E Edgerton





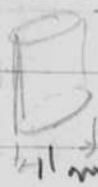
$RC = .5 \times 15{,}000 \times 10^{-6}$ sec =

.007 sec $\frac{1}{120}$ sec = .007


250 Ω
4 mf.
5 mf.
10,000

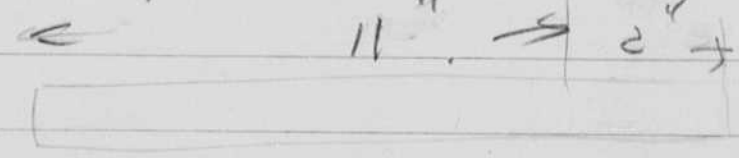
Short tubes

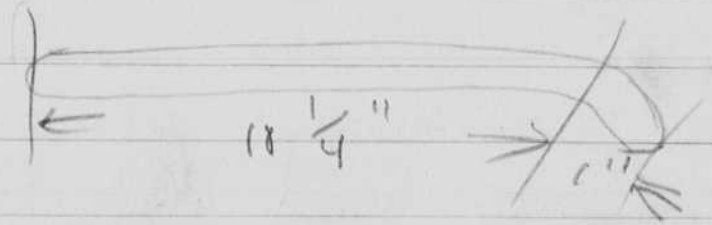
Plate



16 m.m. for long tubes. 18"

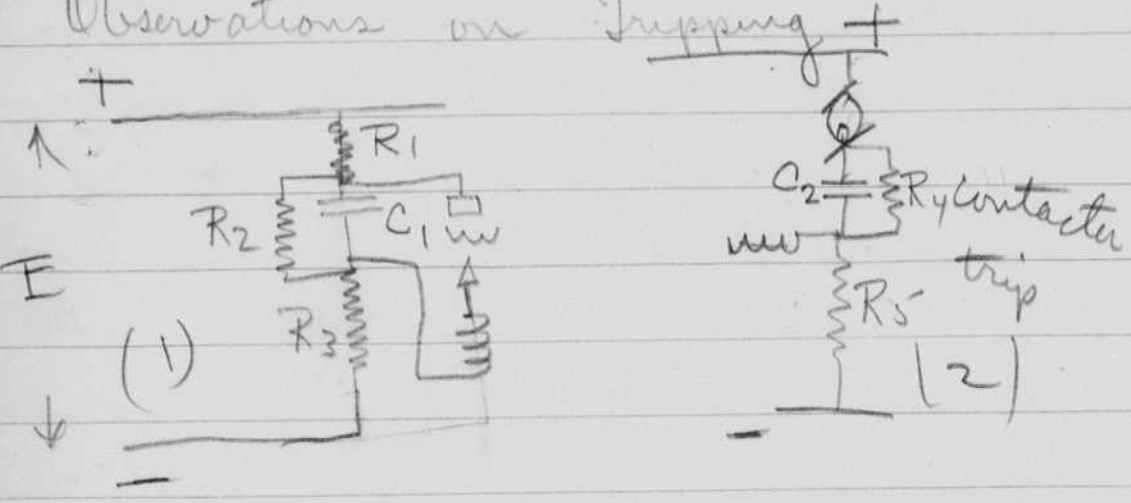
Tube # 44 glass.





11/23/31 66

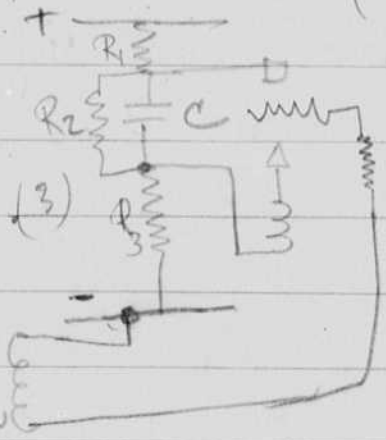
Observations on Tripping



In the contactor trip | fig 2 the grid is pulled plus momentarily and then immediately goes minus. A large negative bias while C_1 is charging gradually decreasing to a value of $\left(\frac{R_3 E}{R_1+R_2+R_3}\right) - \left(\frac{R_5}{R_4+R_5} E\right)$ but remaining minus and hence the thyratron extinguishes + stays so provided R_1+R_3 are sufficient to prevent the main supply from

discharging through it.

For 60 ~ circuit (3) is recommended (On any oscillation control - sine wave)



This works provided:

(1) E is over the peak ∩ and is less than at the time when C is charged.

(2) $R_1 + R_3$ sufficient to prevent main circuit from discharging.

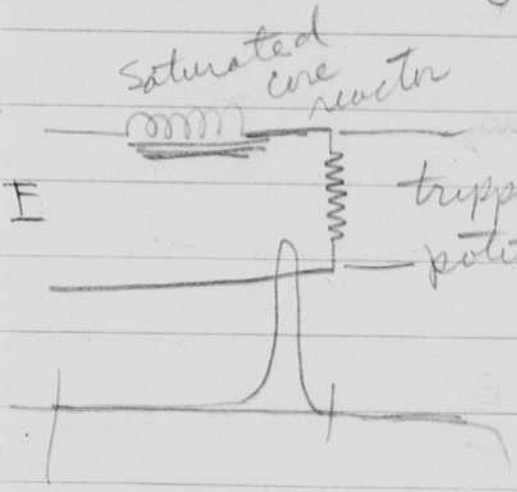
— The cycle is as follows: With C charged let the drop across R_3 be e, then when E becomes sufficiently

greater than e (1 to 2 v) the thyratron discharges. This increases e to a value greater than E putting a negative bias on the grid. For the rest of the cycle e must remain greater than E or the tube may start again. (this explains why the tube will not operate with E directly across grid + cathode).

From the above it would appear that if E could be given a peaked wave shape, then operation could be made more certain and $R_1 + R_3$ could be reduced.

(The successful operation depends upon the reversal of the e.m.f. across the thyratron due to the inductance of the spark

coil primary).



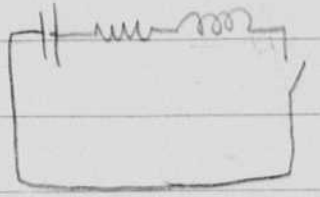
methods of securing peaked waves.

$L\frac{di}{dt} = E$ 70 18 420 / 6 7 5 0 / 11 6 7 0 1.167×10^{4} 1.08×10^{2}

Computations on High Speed Stroboscope. —

$$R + Lp + \frac{1}{Cp} = 0$$

$$p = -\frac{R}{2L} \pm \sqrt{\frac{R^2}{4L^2} - \frac{1}{LC}}$$



$I_s = 0 \quad t = 0 \quad i = 0 \quad \frac{di}{dt} = \frac{E}{L}$

$R = .4$ ohms } Hvd Spark coil.
$L = .00148$ hens 1.48×10^{-3}

$C = .1$ mfd. $\quad \frac{R^2}{4L^2} = \frac{.16 \times 10^6}{4 \times 2.17} = 1.8742 \times 10^4$

$\frac{1}{LC} = \frac{10^4}{1.48 \times 10^{-3}} = 6.75 \times 10^3$ $\quad 6.75 \times 10^4$

$\frac{R}{2L} = \frac{.4}{2.96 \times 10^{-3}} = 135$

$\frac{R^2}{4L^2} > \frac{1}{LC}$ non oscillatory.

$$i = \frac{E}{2L\sqrt{\frac{R^2}{4L^2} - \frac{1}{LC}}}\left(\varepsilon^{\left(-\frac{R}{2L} + \sqrt{\frac{R^2}{4L^2} - \frac{1}{LC}}\right)t} - \varepsilon^{\left(-\frac{R}{2L} - \sqrt{\frac{R^2}{4L^2} - \frac{1}{LC}}\right)t}\right)$$

10^4

$-135 + 108 = -27$

$-135 - 108 = -245$

$\{\mathcal{E}^{-27t} - \mathcal{E}^{-245t}\}$

$-27\mathcal{E}^{-27t} + 245\mathcal{E}^{-245t} = 0$

$-27\mathcal{E}^{-27t} = 245\mathcal{E}^{-245t}$

$\frac{1}{\mathcal{E}^{27t}} = 9.07 \frac{1}{\mathcal{E}^{245t}}$

$\mathcal{E}^{245t} = 9.07\,\mathcal{E}^{27t}$

$245t = \ln 9.07 + 27t$

$t = \frac{\ln 9.07}{218} = \frac{2.205}{218}$

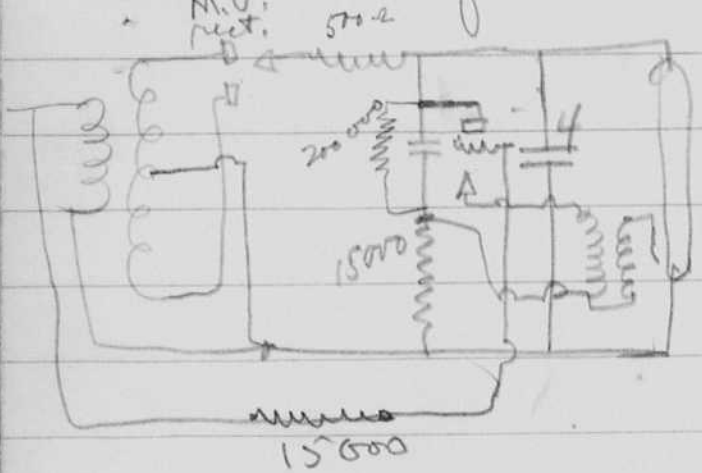
$\frac{1000 \times 4}{103}$ $\frac{4}{1000} = \frac{1}{250}$

$\frac{400\,V.}{5\,W.} = 3\,amp.$

$\frac{25}{2} = 1.25\,w.$

11/30/31

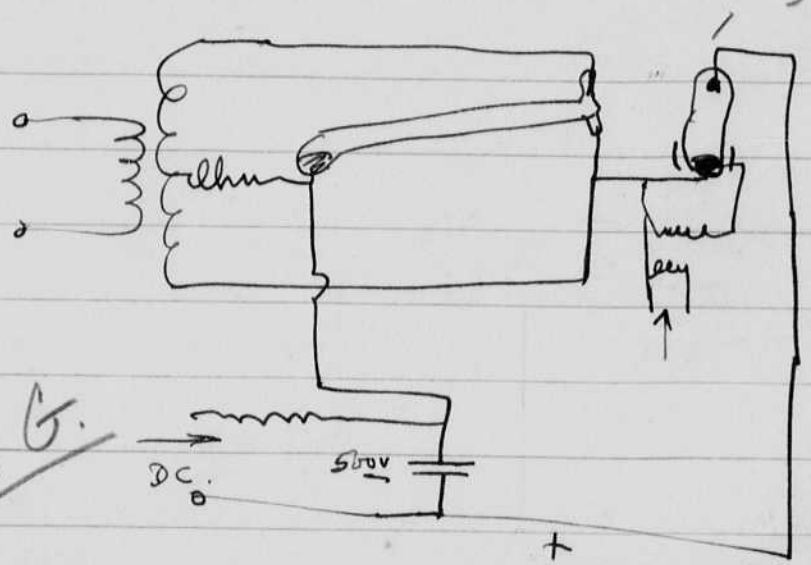
Circuit for Hall.



11/30/31. 73

5000 / 150 ohms = 30 / 1

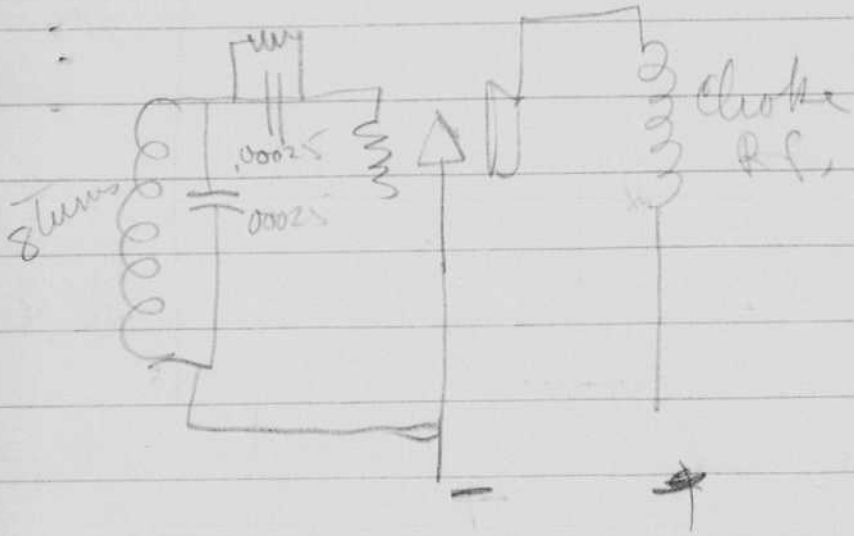
Jump Mercury switch or Stroboscopic tube.



K. J. G.

Discharging a condenser through a M.V. lamp to secure a single brilliant flash for photographic purposes. Studio work etc.

Oscillator



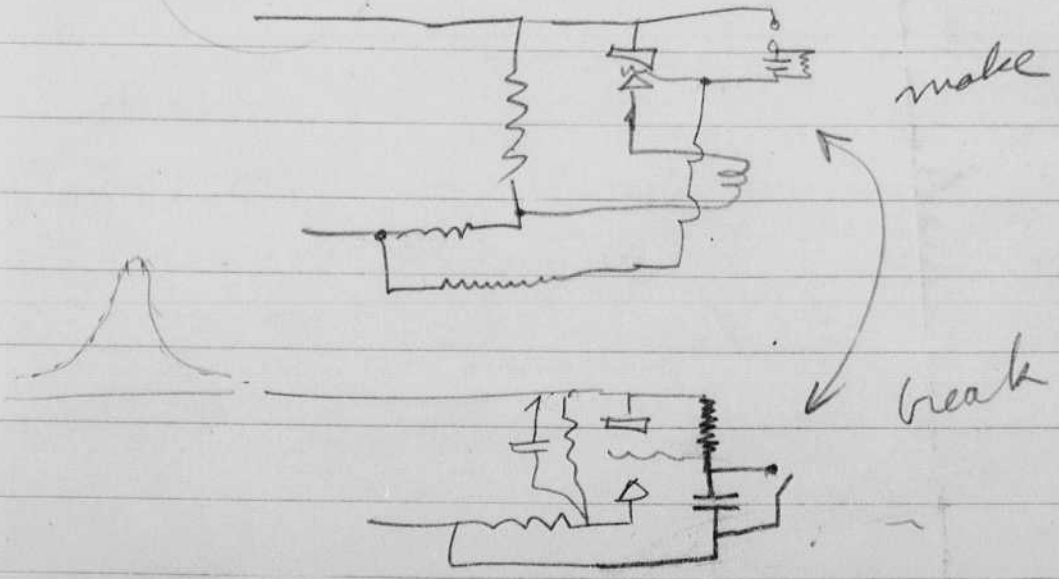
12/9/31

75

Circuits for Engine Lab. pressure recorder.

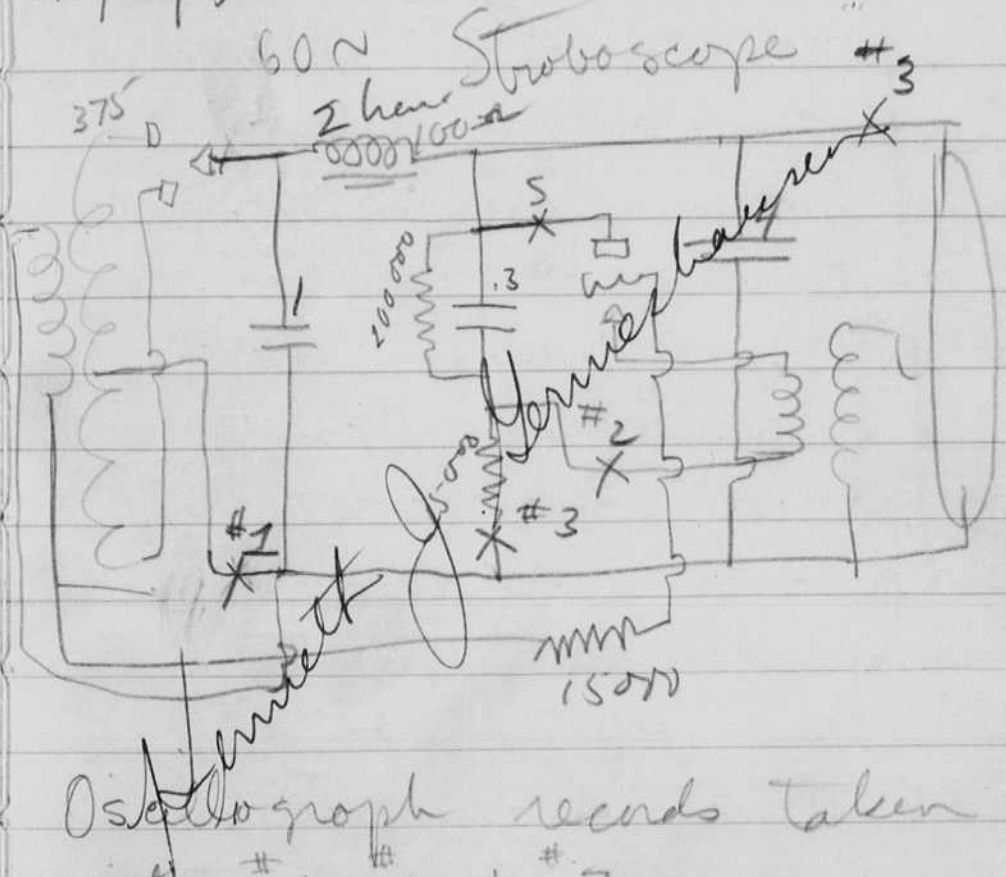
1. Charge quick
2. Min. time lag.
3. Hot spark
4. Ind. of temperature.
5. Same time lag [on & off]

30 r.p.s
2 w. alum.



12/10/31

60 ~ Stroboscope



Oscillograph records taken at points # 1 # 2 + # 3.

Records taken with tube hot.

Readings Taken 78

with outlet hot.

No voltage input to filter 315 V.

D.C. current input to " 160 m.a.

Oscillograph current #1 versus secondary voltage. .05 amps/m.m. 1.6

#2

Current at S. .01 amps. #2.

Oscillograph of current versus Secondary e.m.f.

Average output voltage of filter 290

.05 amps per m.m. (22)

Lamps missed occasionaly indicating added impedance effected discharge.

#3 Current at 3 versus secondary voltage.

Average voltage across lamp. 270

" current. 170

Record, .5 amps per m.m. (~~31~~. (29)

(3) Run #5 15 amps

16x .05 .80

79

2.2 .05 1.10

.16 300 48.00

There was apparently considerable inductance in the measuring circuit as the lamp did not operate as brightly or regularly as with the meter and oscillograph out.

(Meter and oscillograph galvanometer in series

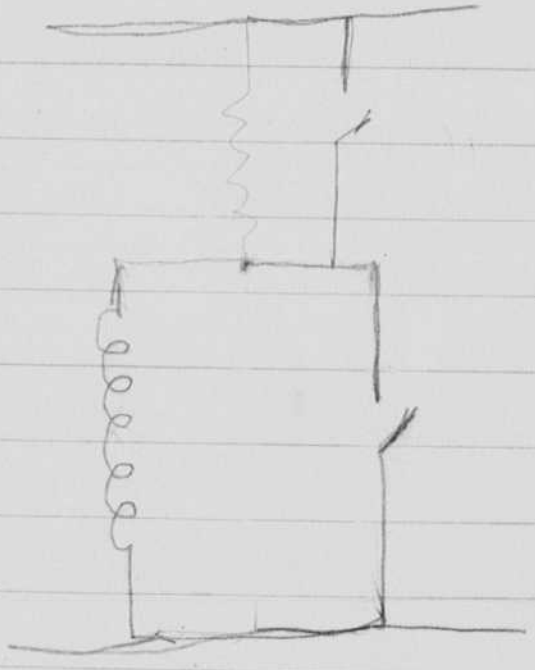
#6 current at #3

.004 amps per m.m.

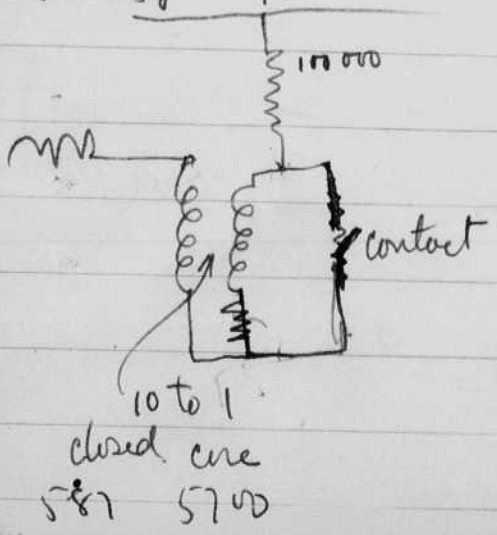
added impedance caused lamp to miss.

Drop across 15 000 Ω 160 V~

Drop across .3 m.f.d. 110 V~



Flow fig. 17

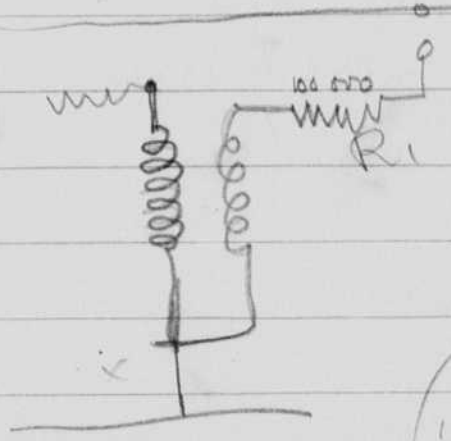


This works O.K.

8 /

Engine Lab.

Circuits for Aeronautics



did not work reliably with (worked better with 1,000 ohms at x)

10 to 1 ratio open core transformer P = 600 S = 5700

Made up coil - P = 585 S = 5700

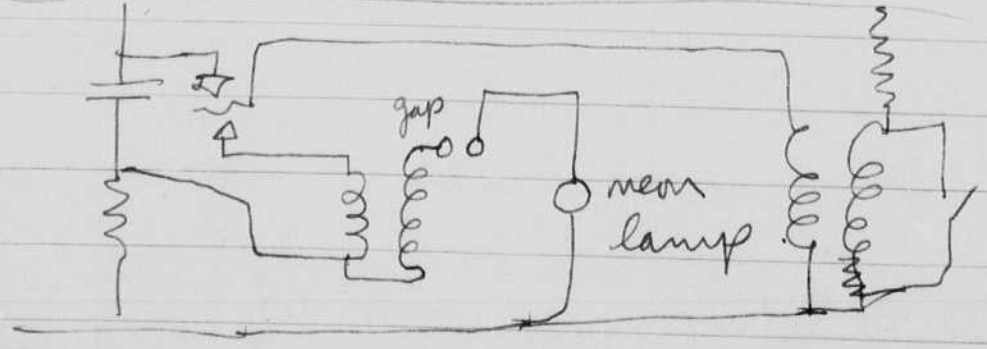
Short fat - Tried open + closed core - open core worked best but still not satisfactory - tended to oscillate

Tried R_1 = 50 000 but did not work (open core)

12/11/31 #2

Tried $R_1 = 50\,000$ and closed core-coil ratio 585 to 5700 worked OK with 15000 at y showed tendency to fire on break. Tried it without 15000 Ω. worked the same but more spark.

Placed neon bulb in spark coil secondary as shown.



12/11/31

Then examined contactors with light.

Startling !!!!

Time lag practically zero.

No flicker

Fired in precisely the same place each time.

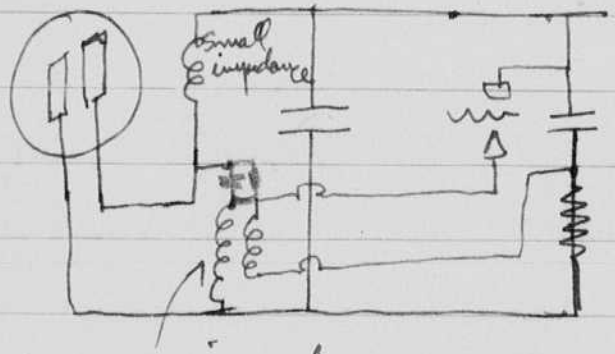
Length of gap practically no effect on time lag indicating extremely rapid build up of secondary voltage.

This information necessitates new data on starting & possibly new starting methods to eliminate gap flicker.

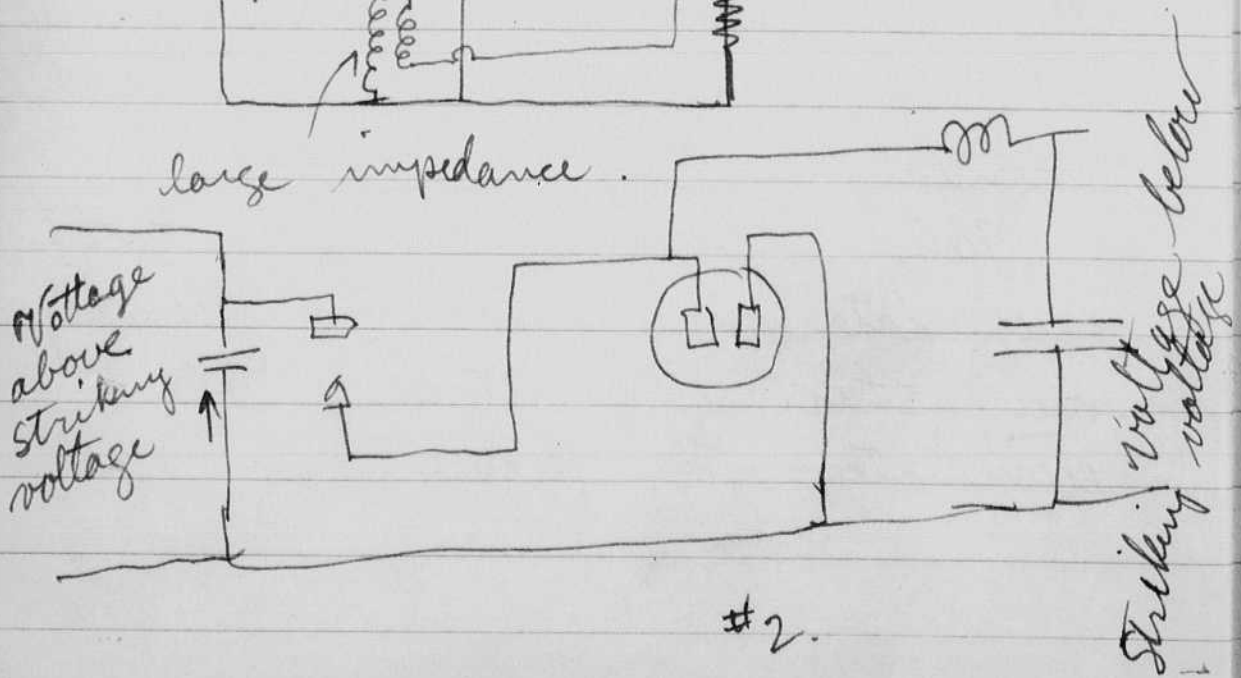
12/11/31 84

This experiment gave rise to several new ideas such as.

Ordinary neon lamp (large ratio of starting to stopping voltage)



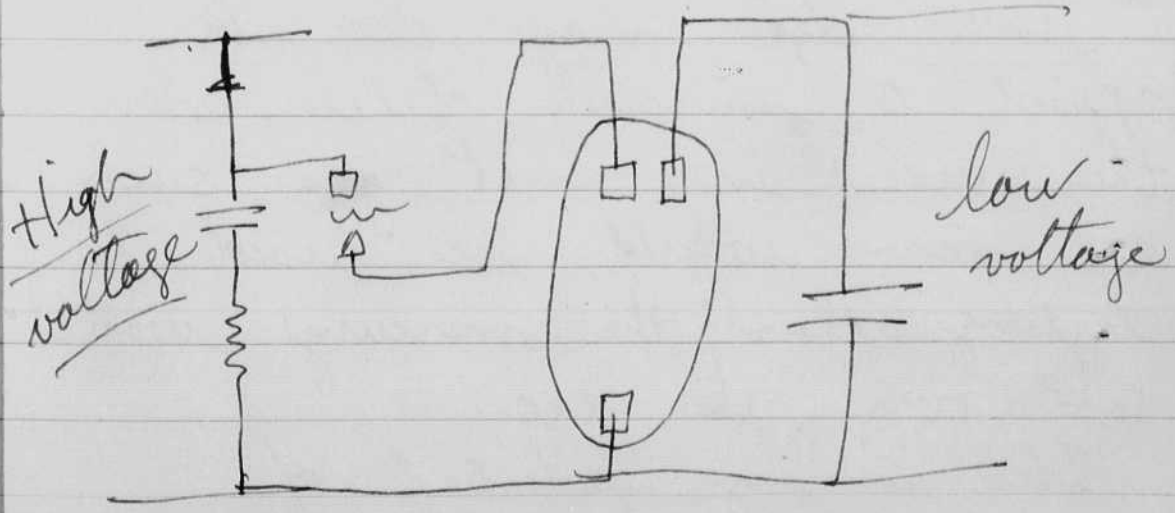
#1



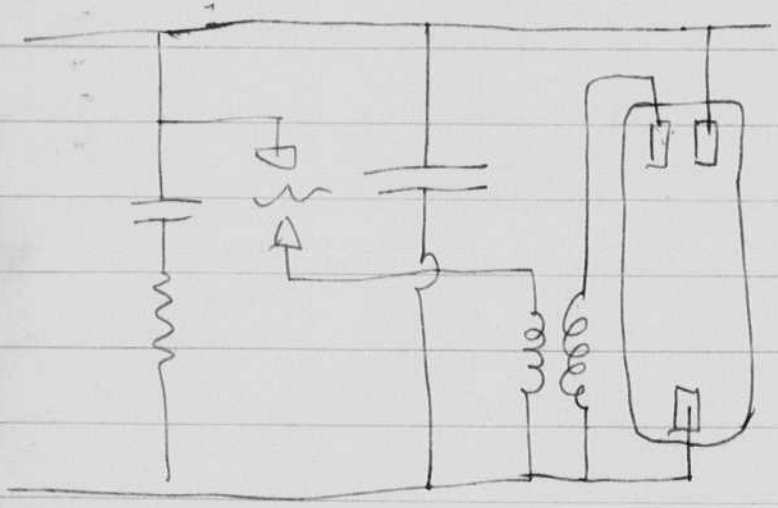
#2.

Circuits #1 + #2 are neon stroboscopes. Any tube with a large ratio of starting to stopping voltage is used. The tube is started by giving it a poke with a high voltage and then the large condenser discharges through it.

A circuit utilizing a special lamp would be.



Or.

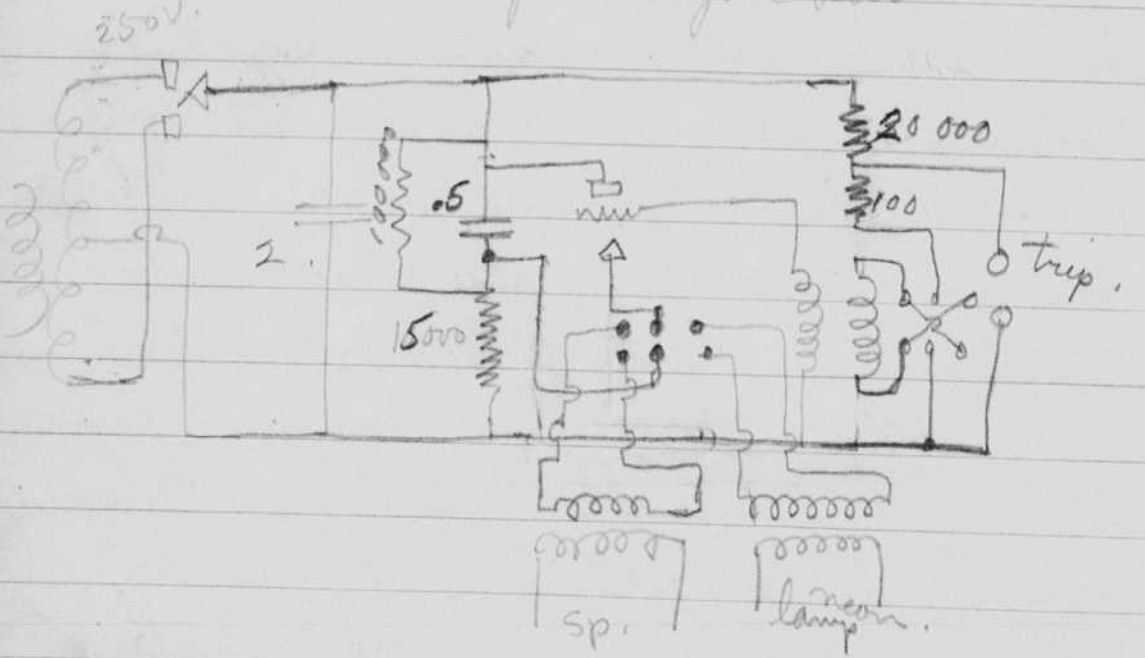


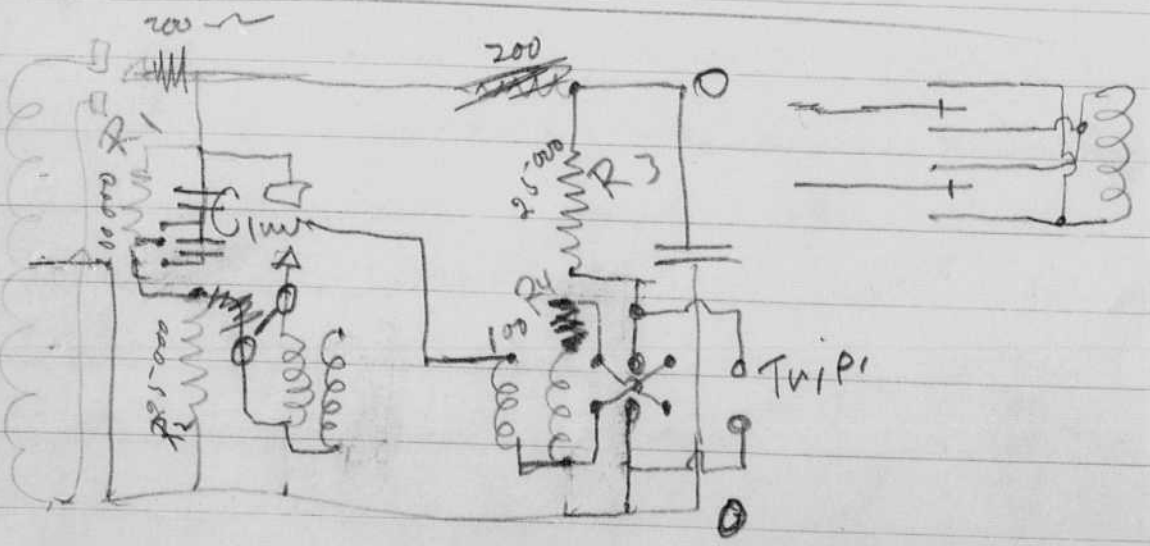
These ideas may also be applied to mercury tubes. In this case an inert gas such as neon would be used for starting then the mercury would take over the arc.

The ionizing potential of mercury and neon for a

given vapor pressure are about the same and when operating temperature is reached the neon will take little part in the process. More power will be required to start the tube but the voltage will be much less. This will mean a low impedance spark coil secondary and hence less secondary loss. 5000 volts secondary should be ample for starting.

Circuit for Engine Lab.



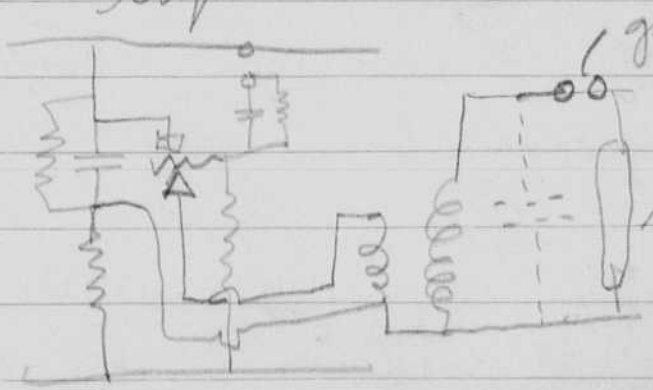


12/12/31

89

Contactor work.

While working with Neon lamp in secondary of spark coil I found that the circuit below gave practically zero time lag and no variation in time lag after trip



Adding a small capacitance to the spark coil secondary (dotted) caused variation in time lag and intensity of spark

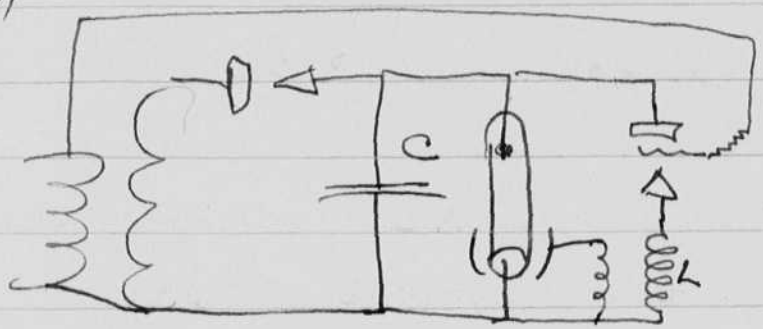
This led to the conclusion that the secondary was oscillating at high frequency and this was what caused the trouble.

— Attempts were then made to apply this information to the mercury stroboscope.

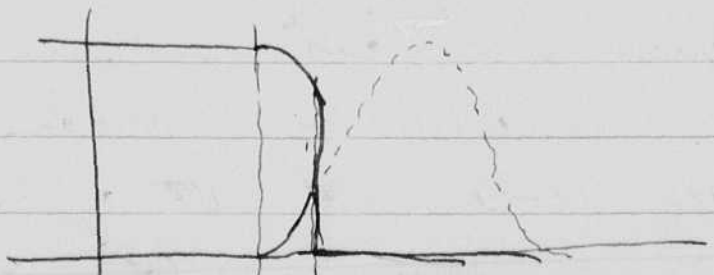
One megohm in parallel with the spark coil secondary slightly improved matters, but still not good. Then the condensers were examined and it was found that most of the trouble was due to them. They were repaired and then the circuit worked well without time lag

variations provided:
(1) Suffisient spark intensity was provided.
(2) The capacity of the trip araut was small enough.
(3) There was suffisient leakage to damp out oscillations

Dec 15/93/



Transient through L C shall not overload the thyrate in case the tube does not start.



12/15/31.

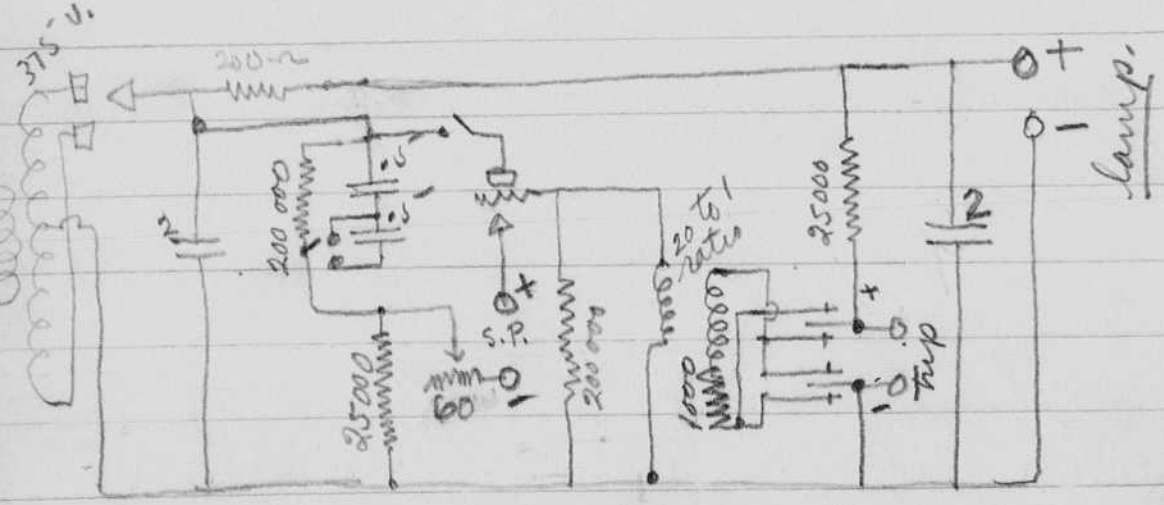
Circuit P188)

When R_2 is large enough to give proper time constant then trip voltage is not enough to overcome grid bias at frequencies about 60 ~. (10 to 1 ratio.) Since it is desired to have R_2 large enough to give stability and the proper time constant a transformer ratio of 20 to 1 or more should be used. As it was the value of R_4 could be varied through wide limits without much effect. (1000 to 10000 Ω)

Another aid would be

the addition of a crude ... filter To make the time constant of the cond. C1 more ~~the~~ nearly the same for stroboscope and spark use.

Suggested circuit.

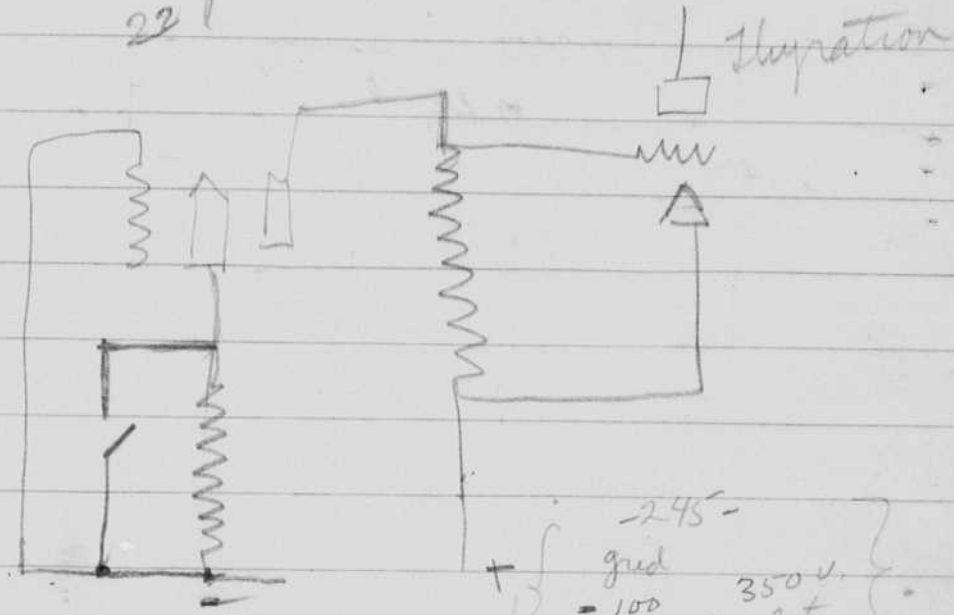


500 to 600 turn primary on open core.

12/16/31

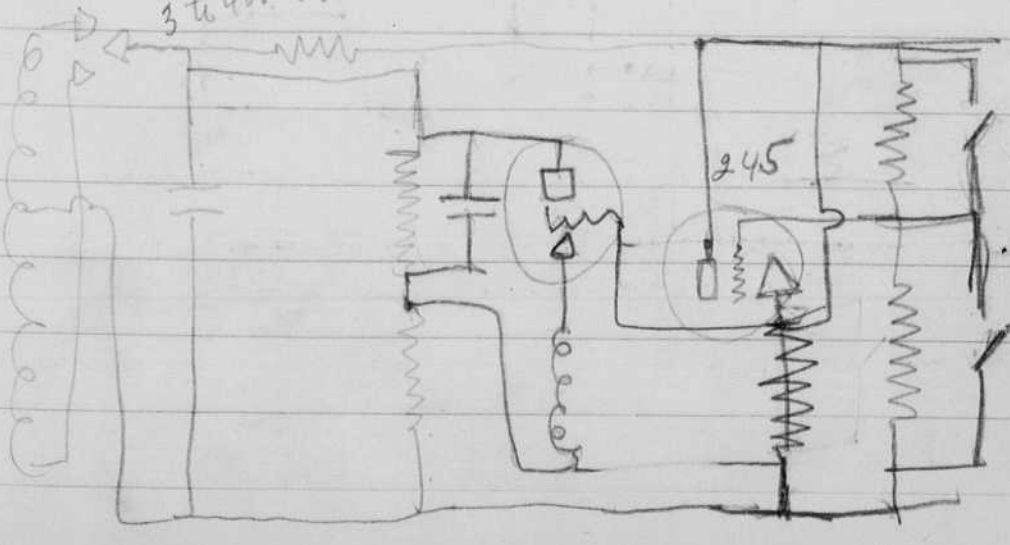
95

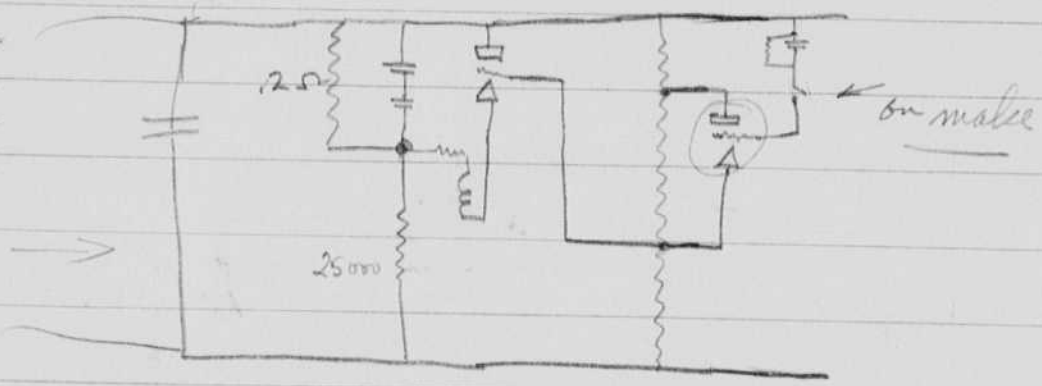
227

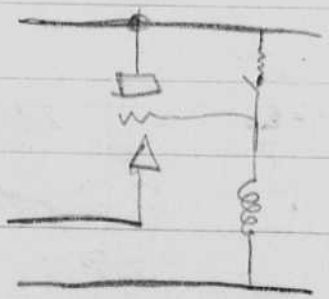


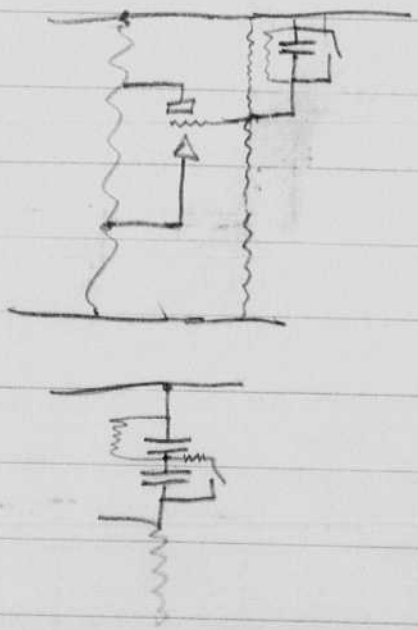
Trip circuit.

See p 106 + 101

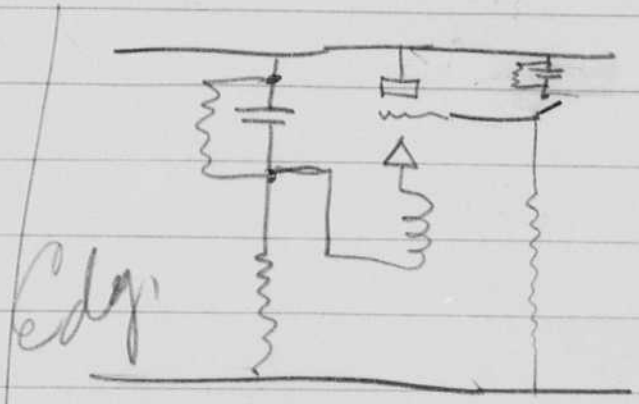



.25Ω
25 000
on make

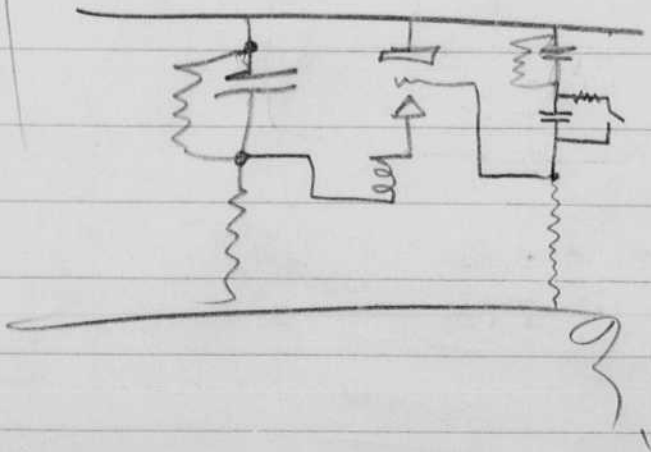




97 ..

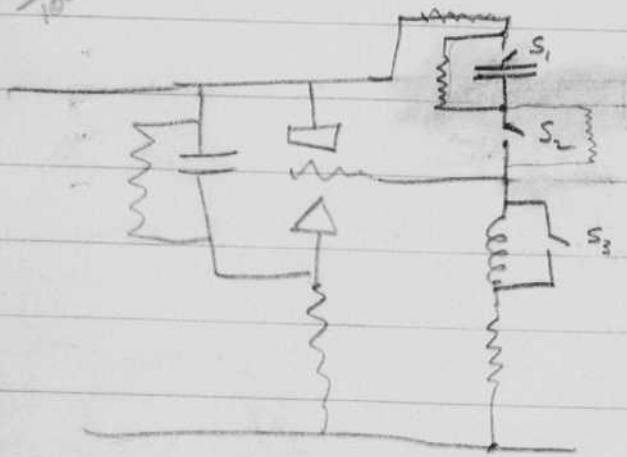


trip or
~~open~~
close



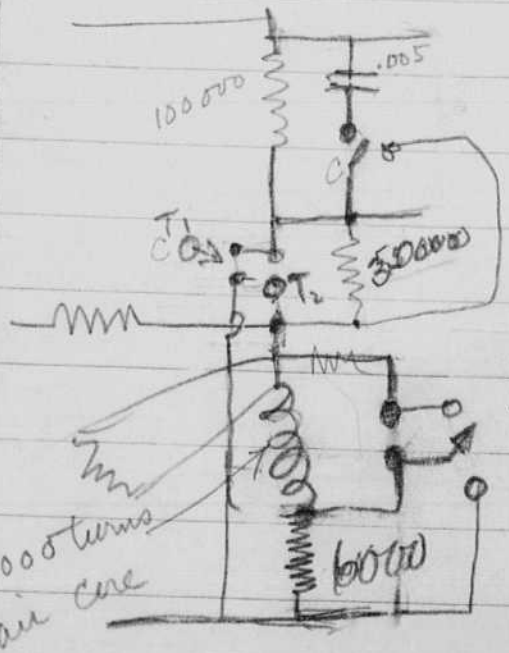
trip or
~~close~~
open.

98



Edg.

N.G.



this worked O.K. up to 3600 R.P.M.

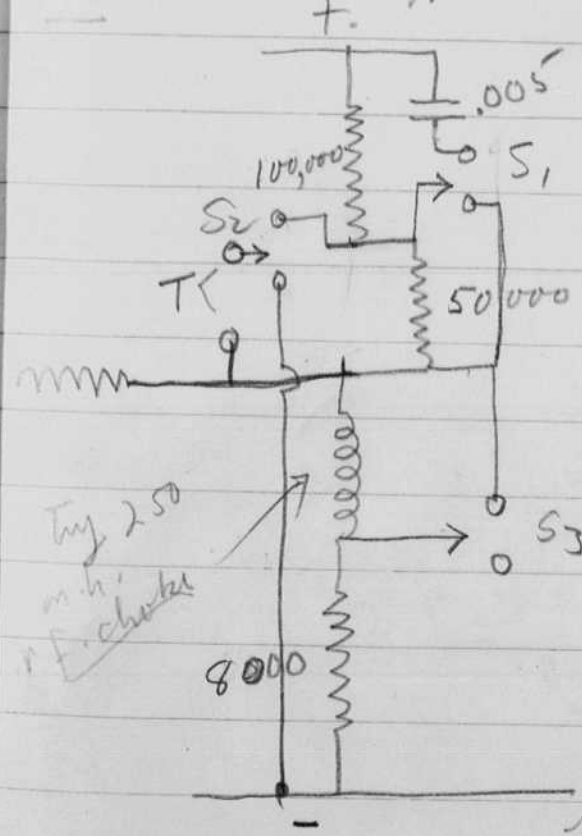
KG1

400 V. 45 V.

bias on grid - constant.

10/17/31

Finally gave up idea of transformer trips as on page 94 because of 1. instability 2. inability to obtain sufficient voltage.



This trip with circuit on page 94 a 3 P.D.T. switch

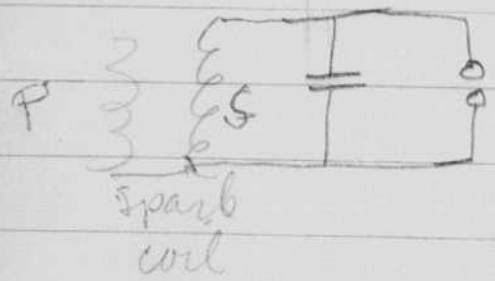
S_{1-2-3}

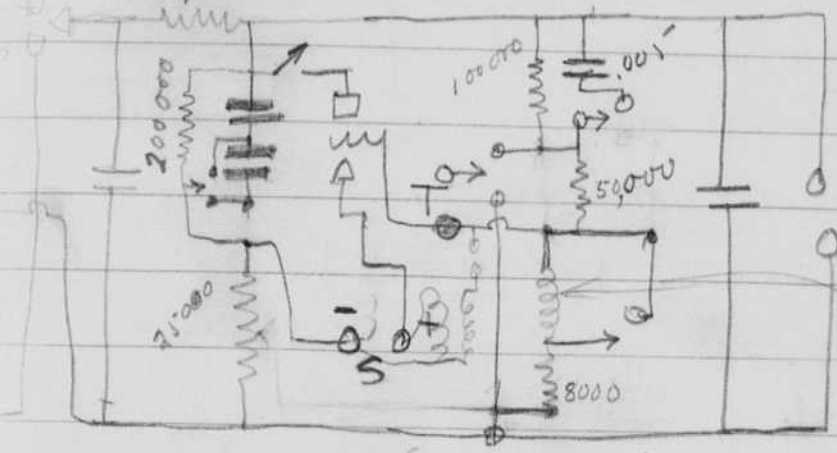
Try 250 m.h. T. chokes

250 m.h. hardly enough.

with circuit p. 101 bias was adjusted until it worked O.K.

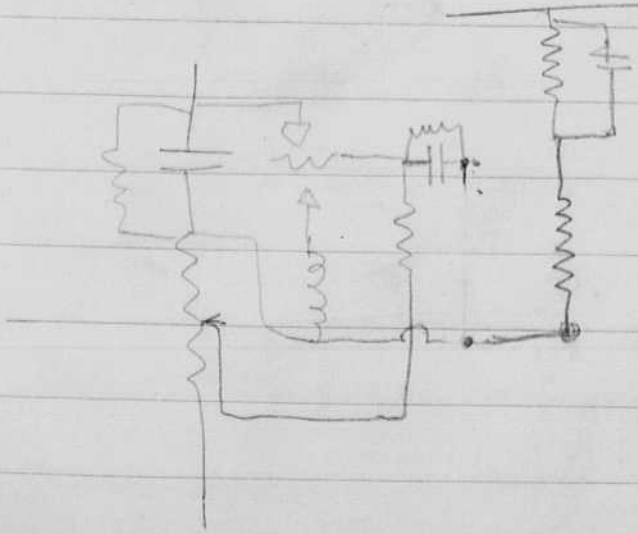
Suggest that a small condenser be used in ~~parallel~~ with the gap to store up energy and give better spark.





probably ½ henry air core

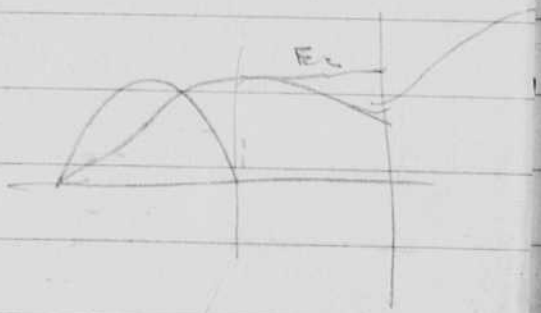
Suggest variable bias resistor to cover speed range. — Gives adjustable time constant.



attempt to put trip spark + terminals at same potential.

See p. 106.


R
R

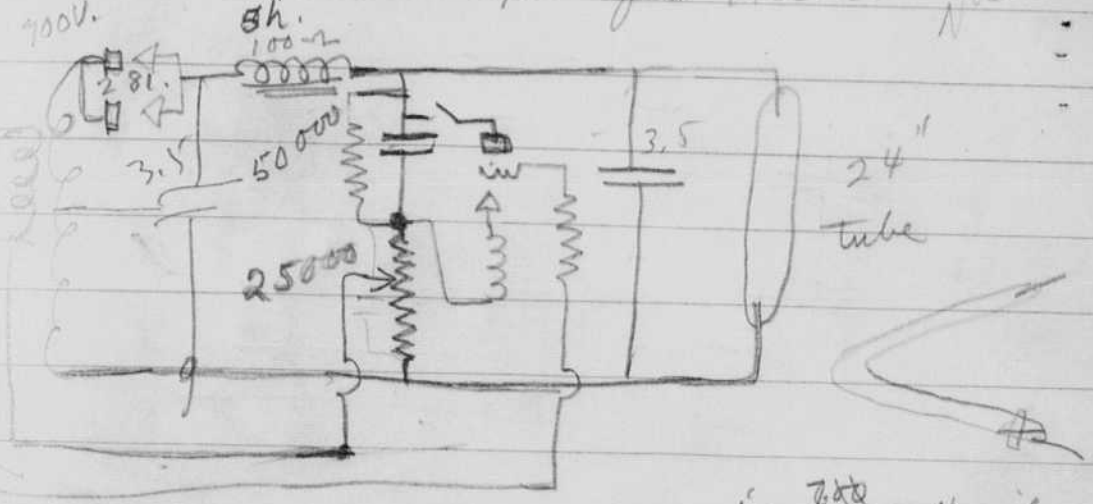

E

12/19/31

103.

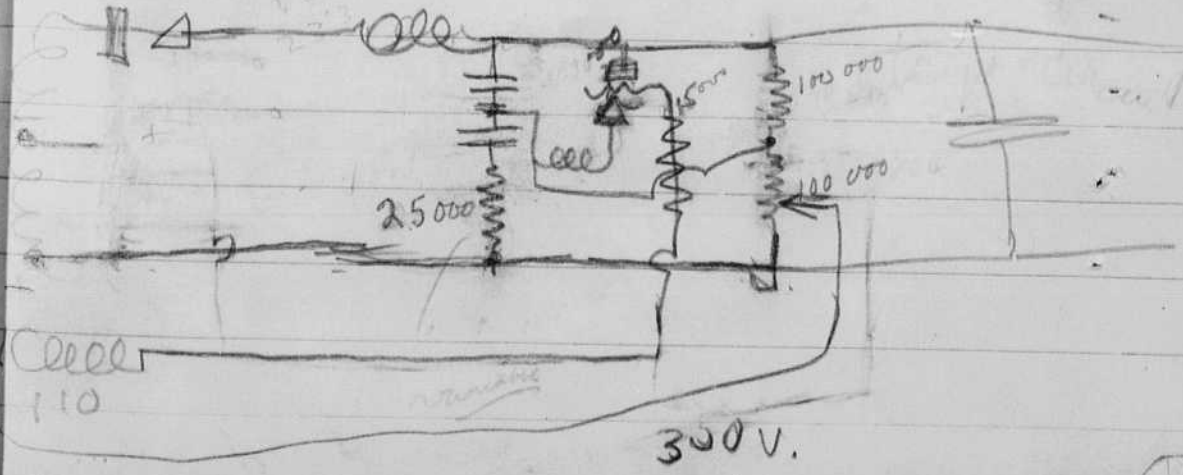
12/19/31.

60 ~ stroboscope for Hall. NO!

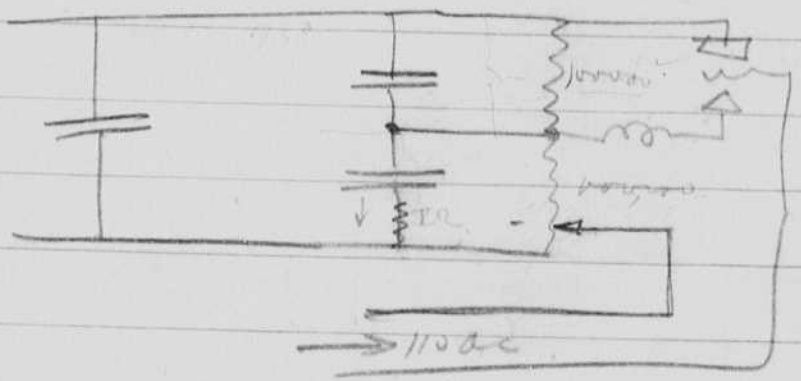


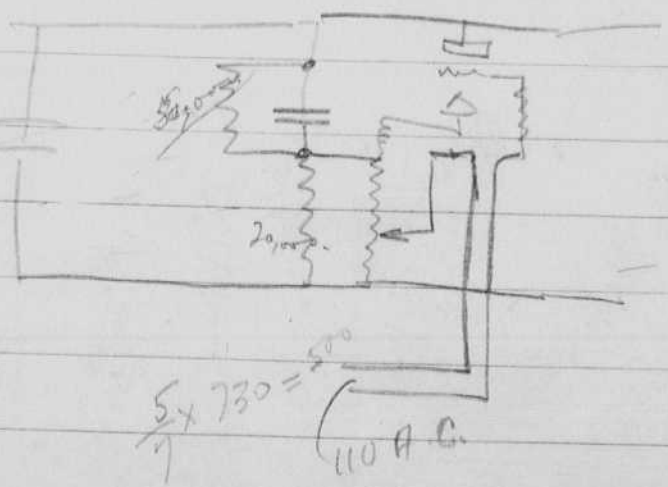
$i = \frac{700}{2 \times 4} = 4$ mils.

$w = \frac{49 \times 10}{20} = 2$ watts.



12/19/31

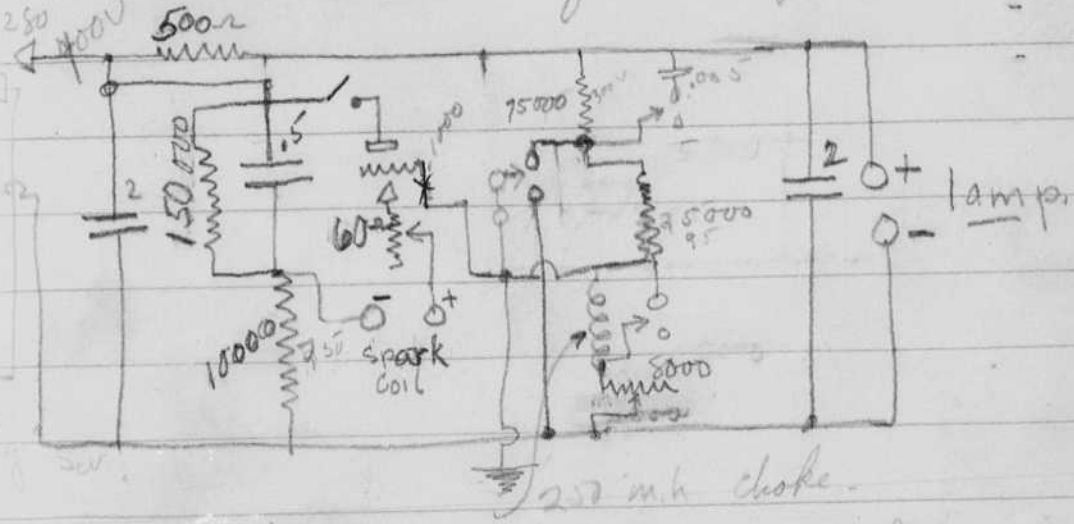




Kenneth J. Grimshaw.

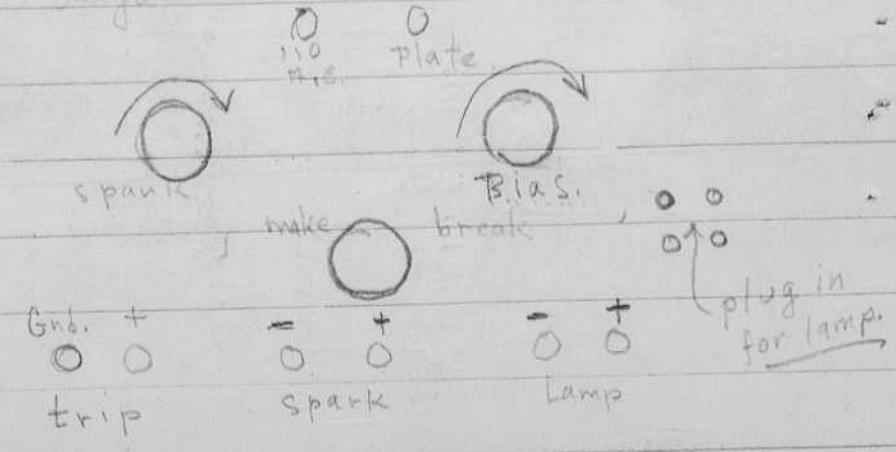
12/21/31

Final circuit for Engine Lab.



Use a spark coil with separated primary and secondary.

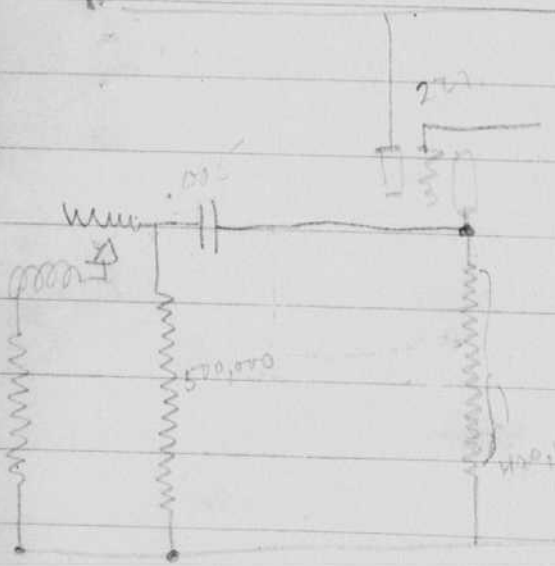
panel layout



104

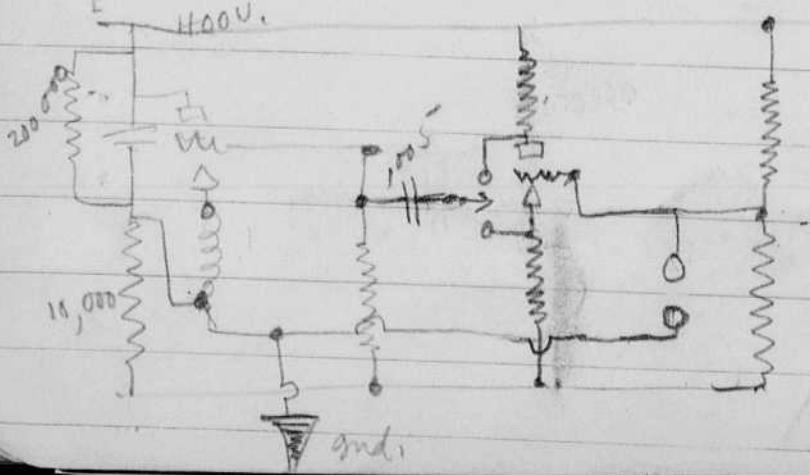
Trip circuit – See p (95)

400V



$E_g = -2.7$
$E_p = 230$
$I_p = .4$

$\frac{10}{210} \cdot 400 = 19$ V.



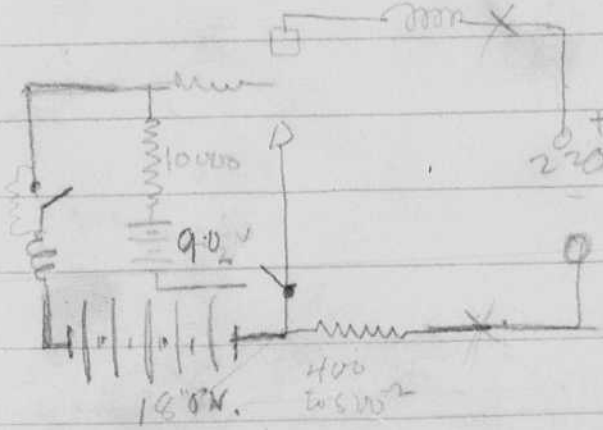
$RC = \frac{1}{1000}$

$C = \frac{1}{1000 \times 10000} = \frac{1}{10}$ 107 $\frac{5000}{103}$ $\frac{10}{1000}$

10/2R/31

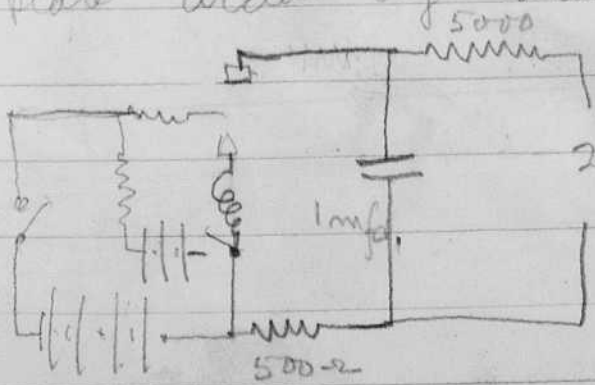
Circuit for wind resistance tests:

1) Separate grid from plate circuit and measure resistance of trip contacts open + closed.

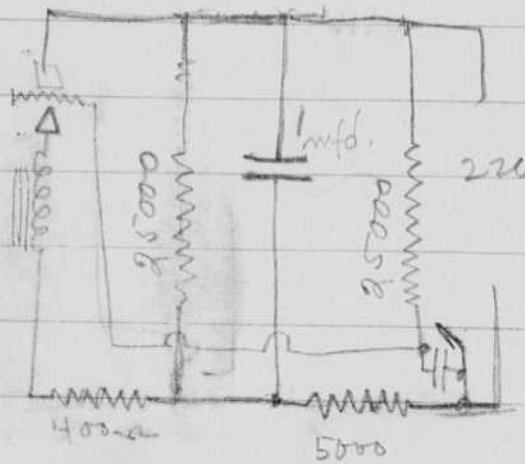


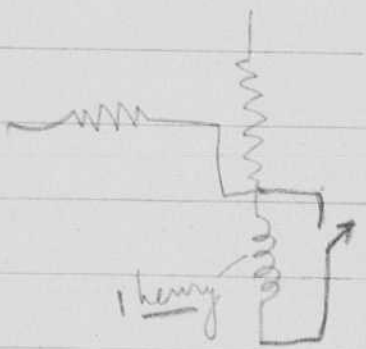
#1

2) If trouble is in mechanical break of plate circuit try stroboscope circuit.



over


1 mfd.
220 V
400 Ω
5000


1 henry

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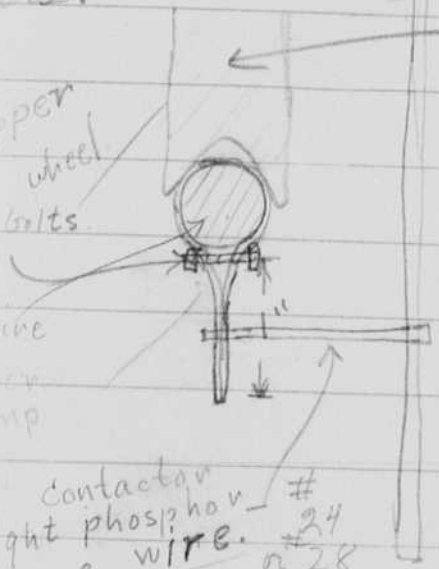
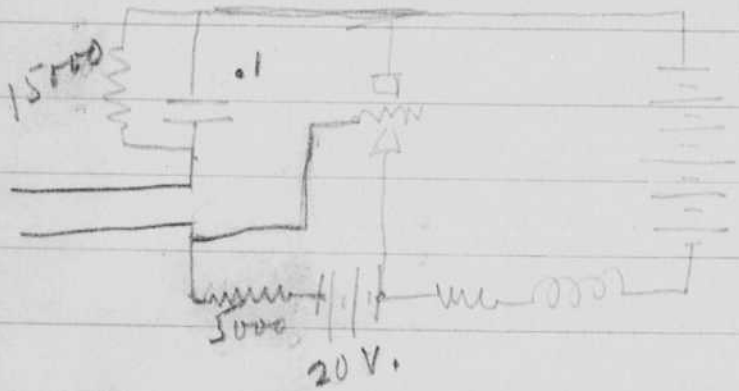
Suggestion for wind resistance bolts.



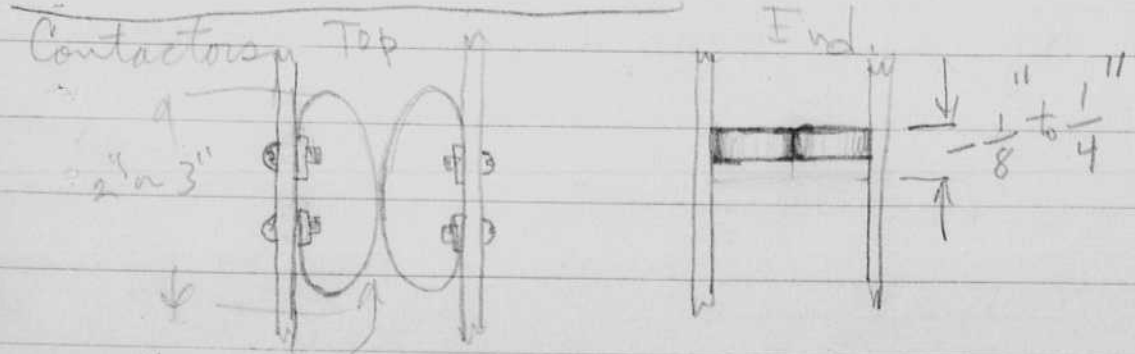
If necessary a very light brush on the lower wire

110

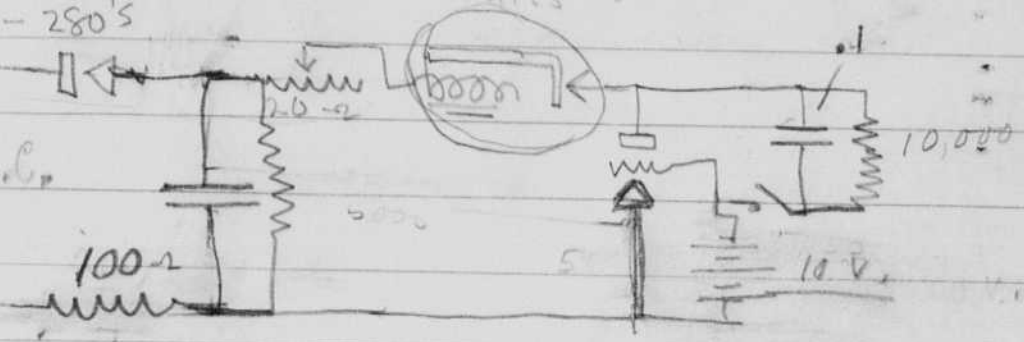
Trip circuit -



Or. to completely eliminate rolling contact resistance put clamps and contactor wires on both trolley wires set to make at same instant.



H.C. circuit. recording units



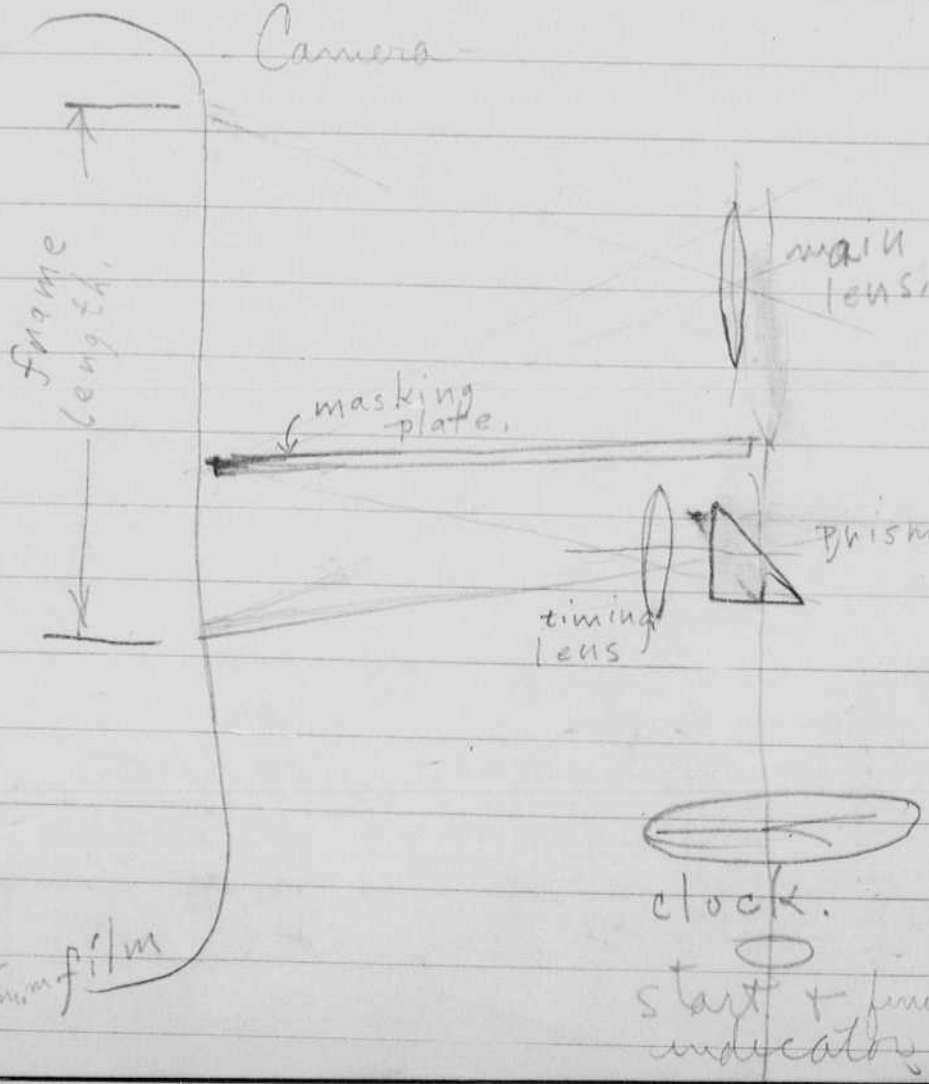
32 mfd.
electrolytic.

use ~~two rectifiers~~ a transformer
to separate power from ground.

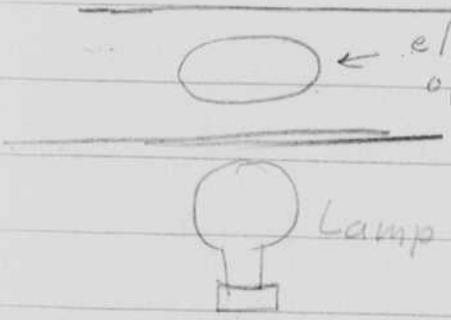
12/23/31

An idea for a record of time versus an event - Adapted to races.

(1) Camera



Clock to have hands or dials reading minutes, seconds, and $\frac{1}{100}$ of a second.
Start and finish indicator



use thyratron to open shutter.

(1)

(2) Use neon lamp as indicator.

If camera is operated at 50 frames per second then an accuracy of $\frac{1}{25}$ of a second may be expected. (error of $\frac{1}{50}$ on start + finish)

25 m.p.h.
40 ft per sec.
1 ft in $\frac{1}{40}$ of a sec.

114

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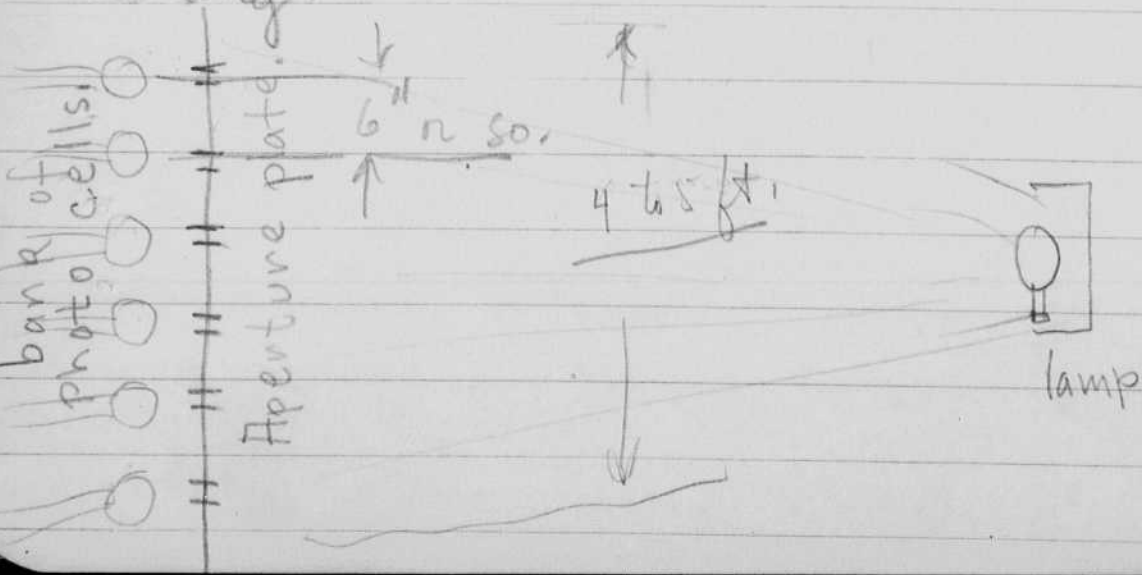
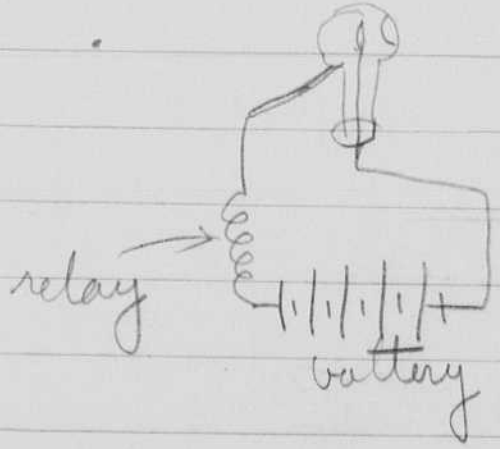
Better idea than on pages 112 + 113.

If electrical make a break is available on start + finish use this to operate shutter + give exposure if clock at that instant on stationary film.

For electrical indication of starting.



Cells so arranged that interruption
light into any one would
trip relay — The time lag
thus arrangement could be
made small & constant &
could be allowed for.

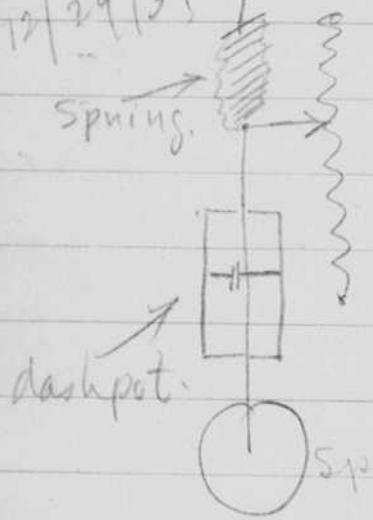


1/Hermelhausen-

116 See pages 107 - 111

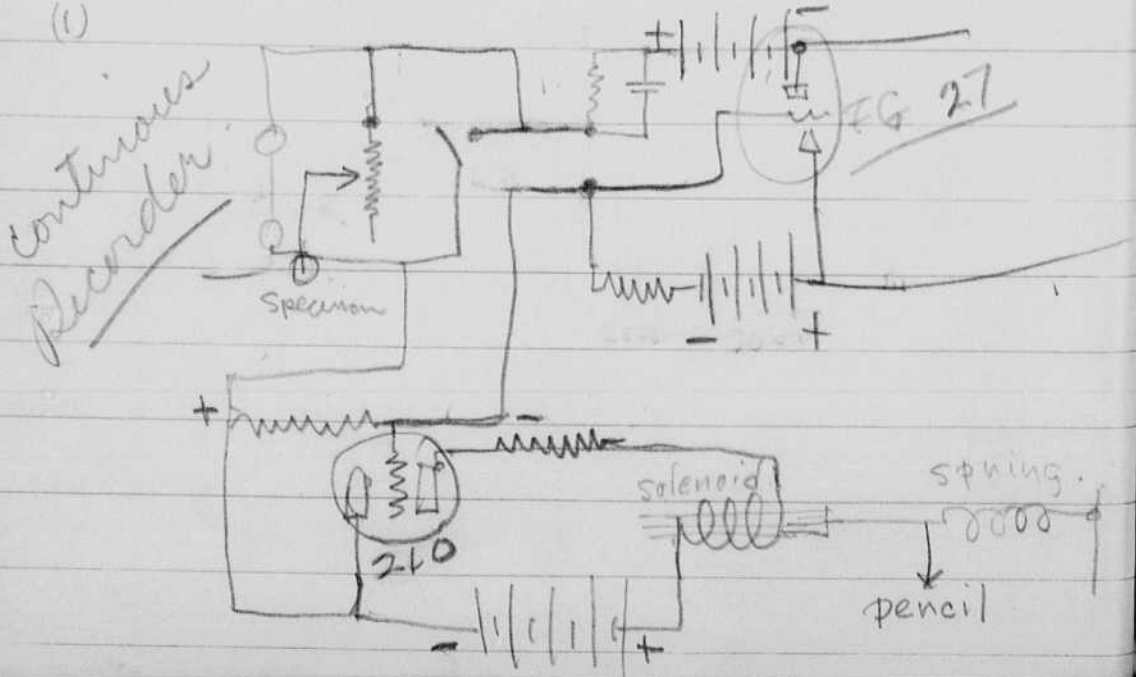
Circuit suggestions for air tests.

12/29/31



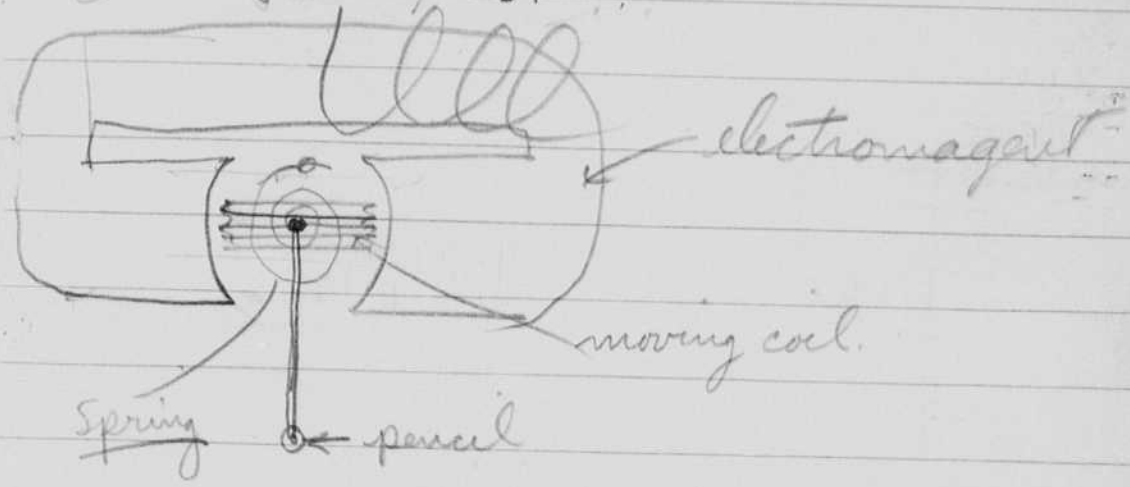
Recorder for air lift.

(1)



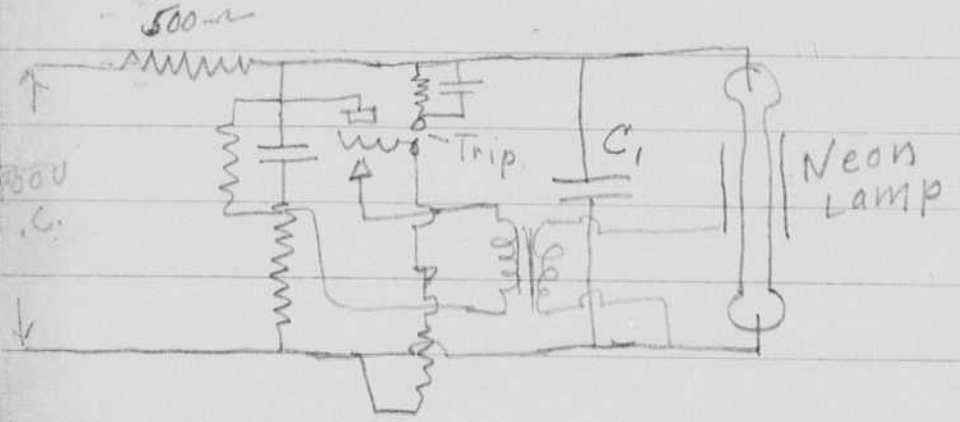
12/29/37

② Recorders.



12/29/31

Experiments on neon stroboscopes.

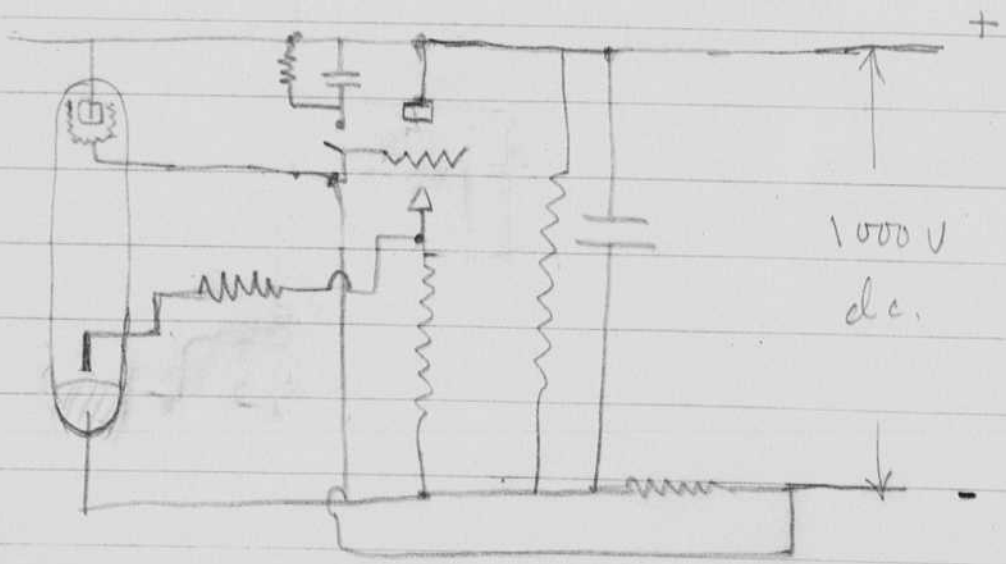


It was found that a neon lamp could be used in place of a mercury lamp. Voltage applied to properly placed external grids could be used to start the discharge thus allowing the condenser C_1 to discharge through the lamp. By proper design of the lamps and grids very satisfactory operation

can be obtained.

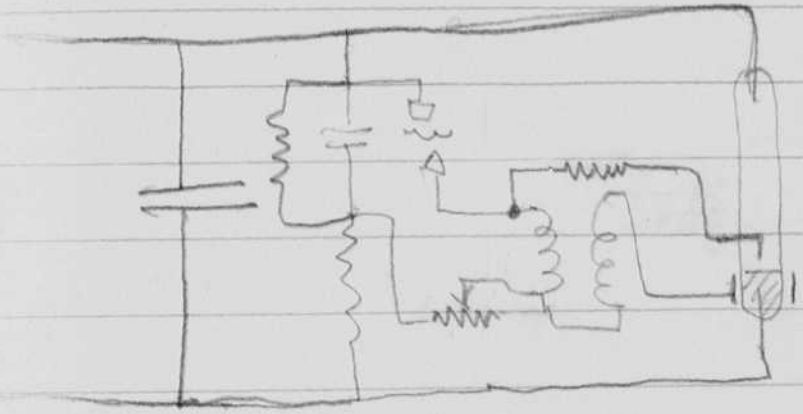
1/1/32

Ideas on operating stroboscopes at high temperatures.



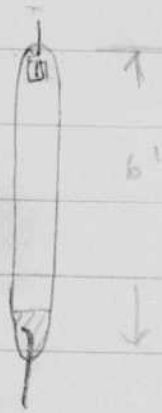
When tube is hot 1000 V should be sufficient to start an arc. Thyatron pulls starting anode to + which forms spot and causes main anode to take hold.

Or to try



1/2/32

Standard tubes.

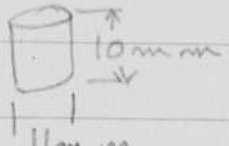


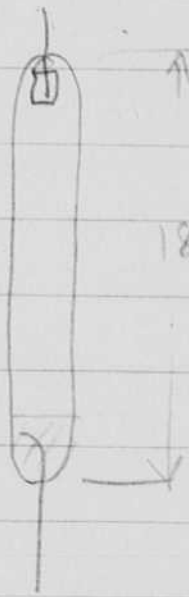
#37 lead glass.

6"

2 or 3 amp seals.

plate

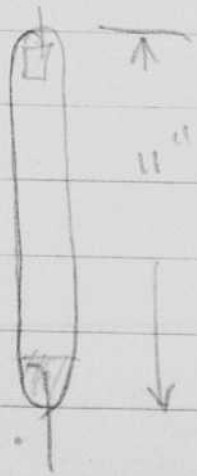




18"

#44 glass

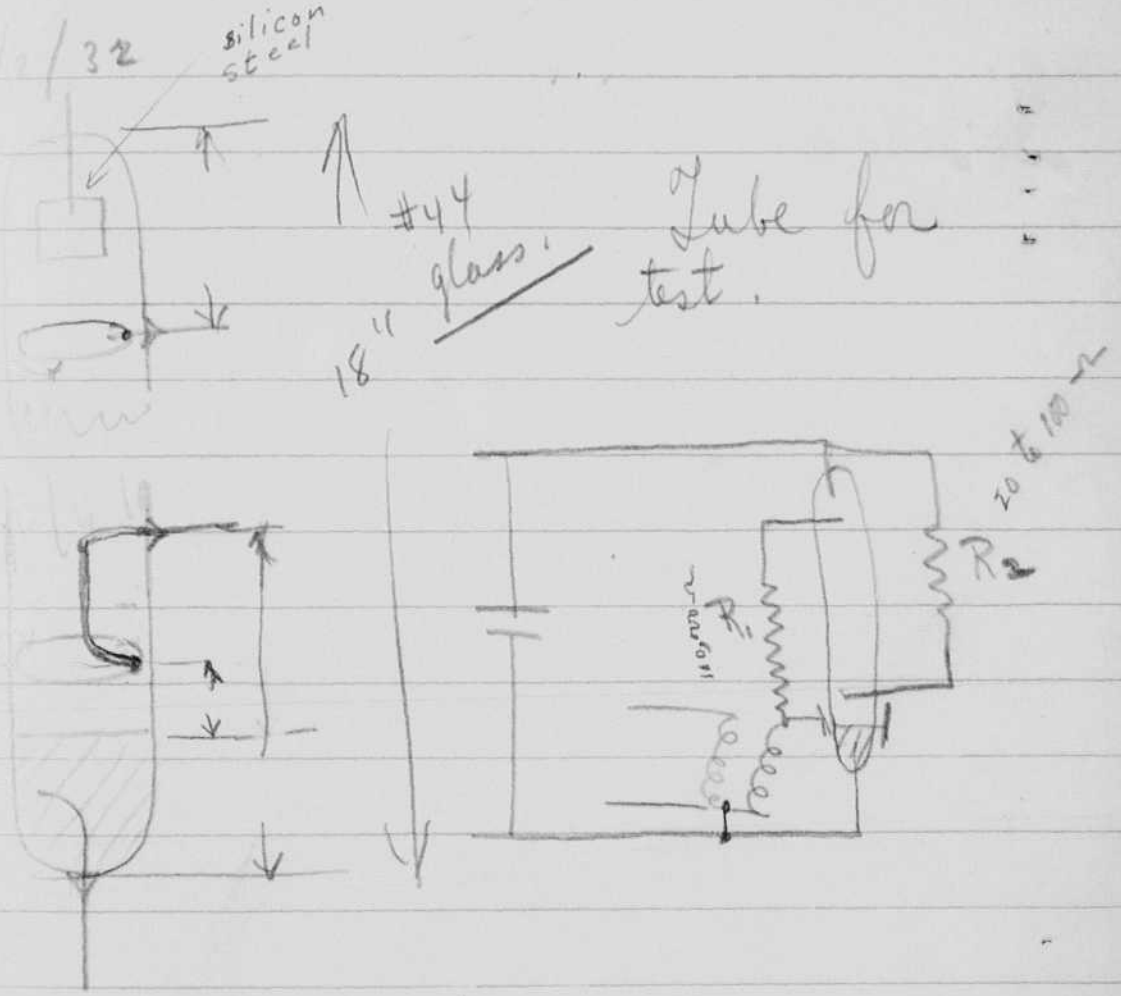
10 amp seals.



11"

#42 glass.

Plates made of a good grade of pure iron or silicon steel.


1/32
silicon steel
#44
glass
18"
Tube for test.
20 to 100 ~
R2
R1
variable

1932

Jan 14 - (93) -

Made three standard tubes

2 25 000 cm² @ 20°C - 40°C,

1 — 100 000 5 watt —

~~45 000 — 25 watt~~

200 — 25 watt - on hand.

2 25,000 - 25 watt —— 1.38

~~10 w. — 2 watt~~

Volt trans. 69 ℓ

solder -25 c 2 4 6 1.280 64¢
tape -20 1 2 4 4
Battery wax
Vulcanite tubing - 2 x 4½" - 30¢
Motor: Papa Plaster paris
List: 15 000 ~ 20 watts, — 1.00
100 000 ~ 5 watts,
25 000 ~ 1 watt, - 20¢
~~2~~ 2 m 1000 V - 1.50
~~1~~ 1m 1000 V -
1 .25 600 V. — .50
1 .00025 — .25
1 3 meg. — .15 .25
3 sockets ✓ 45¢
Panel - 7 x 11 -
Binding posts. 12 — 30¢
Sw. 4 SPST 1.00
1 SPDT - .50
Wire —
Solder —
Choke coil —

Account -

Variable f. 250 unit

Order to N.Y.	9.32	
Kresge - Cond + res + Switches.	2.35	
wire - screws etc.	.20	
Solder	.25	
Tape	.20	
280	.69	6.29
Bakelite tubing	.30	
25 000 Ω	.20	
2 mfd. 1000 V	1.50	
.25 mfd. 600 V.	.50	
.00025 + 3 meg.	.40	
3 Sockets	.45	
Binding posts.	.30	
Switches	1.50	
15000 Ω	1.00	
5000 + 10000 25 watt	1.28	
25 000 @ .20	1.40	
Sw. S P DT knife	.20	

Account

Materials	14.60
3 acc. @ 50.	1.50
vent @ 75	.75
1 cond. 2 mfd 600 V.	1.50
4 sock. UX	.60
1 cond .5 mfd. 400 V.	.50
1. choke coil.	.40
2 Sheet tin	.95
Irons.	7.80
Clips	.60
Wire	.30
— Cash from Edge —	1.45
Glass — 5 sticks #44 & #27	.85
Glass 8 sticks #44	1.10
Spark Coil	2.50
Asbestos	.48

$\frac{1.5}{2\pi 0}$

RC: $\frac{1.5000}{2\ 702} =$ "

Sec. 25 on.

Wire	1.05
Solder	46
Tape	15
Clips	60
100 Fluco + .5 Cond.	90,
500 75W. Heat +	1.00
Hole	@ 2.00 Type 2
"	4.50 16
Plates Lumina	1.50

Hours Length of 280 filament

66 m m. 2.5 V.

Thu 16th - 6 132 m m. 5 V.

Sat. 17 t - 2

Mon. 19 t - 6

Tues 20 - 8

Wed 21 " - 9 Sales - Out to Poles.

Thurs 22 " 8

Fri 23 " 8

Sat 24 " 8

Mon 26th " 8

Expend on Enquire Lab job.

Woodwork - 5.54 - Pol

Panel 90

2 2 mfd. 1000 V. @ 1.50 3.00

1 ½ mfd. 600 V. .50