C H A P T E R - III.

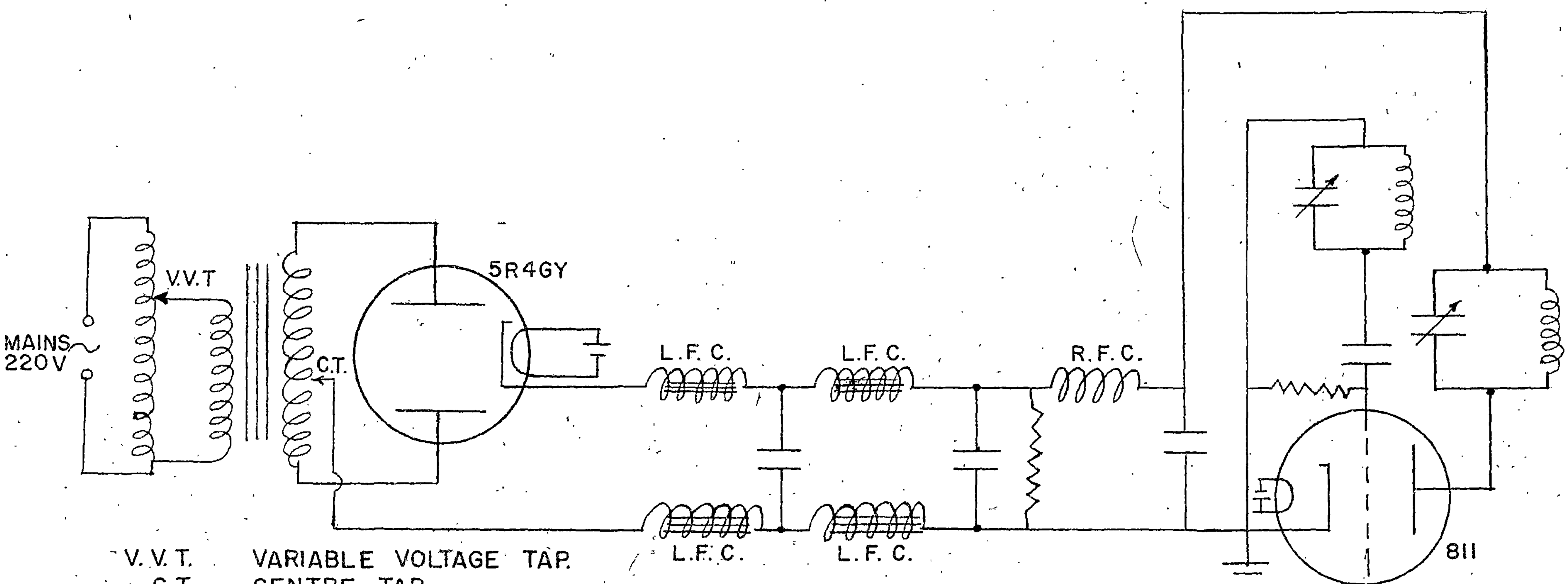
EXPERIMENTAL TECHNIQUE

A. Radiofrequency breakdown measurements (a) without magnetic field (b) with crossed steady magnetic field.

Apparatus :-

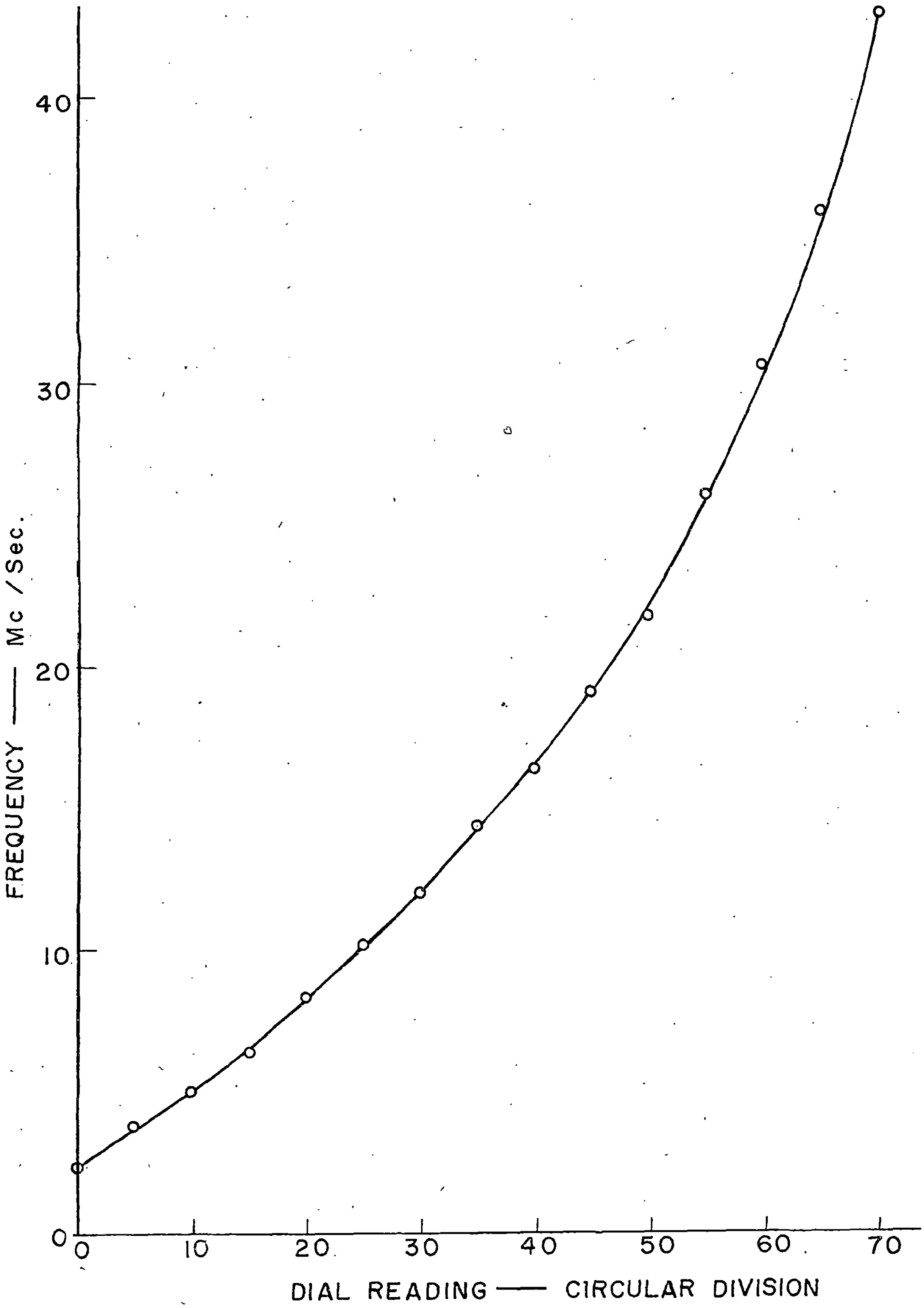
(1) R.F. Oscillator (2) Electromagnet (3) Pirani Penning Gauge (4) Mercury manometer (5) Gas generation and purification system (6) Exhaust Pump. Before the actual experiment is started, it is necessary to calibrate the R.F. Oscillator and the Electromagnet. The radiofrequency oscillator is a tuned plate tuned grid oscillator designed for generation of voltages in the output range of frequency 4 Mc/s to 40 Mc/s in three stages. The oscillator tube used was of the type 811. The plate voltage of the oscillator tube is supplied from a full wave rectifier circuit using tube of the type 5R4GY. The input of the rectifier circuit is made variable by means of a variac connected between the mains and input terminals of the transformer used in the rectifier circuit. By this arrangement the plate voltage of the R.F. oscillator can be varied from zero and hence the R.F. output. The composite circuit in its simplest form is given in fig. (1). To calibrate the oscillator for frequency, the absorption wavemeter as well as the communication receiver have been used. Preliminary measurements of frequency were made with the absorption wavemeter. Then using the receiver the final measurements were taken for frequency correct upto 0.1 Mc/s. The two dials of the condensers are given identical marks and is calibrated in terms of the frequency. A curve is plotted for dial reading against frequency fig. (2).

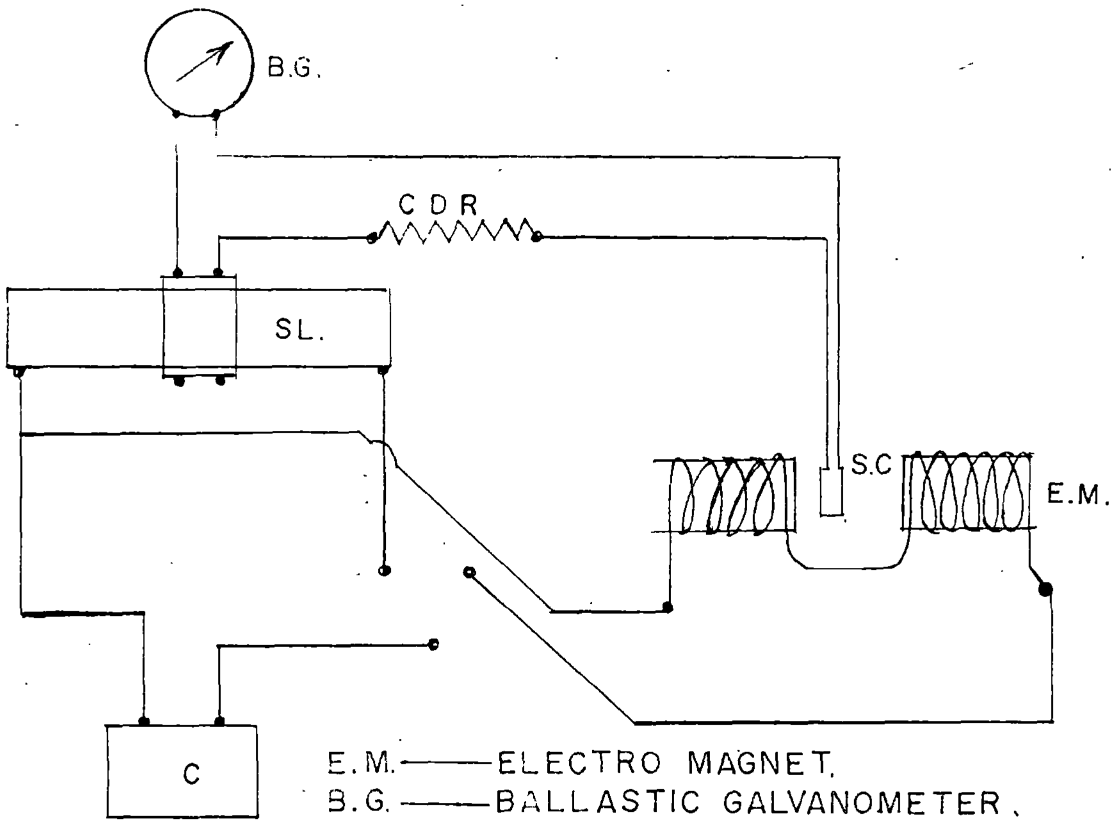
The electromagnet is calibrated using two different methods viz. (1) by using gauss meter and (2) by using a ballistic galvanometer. To calibrate it by using a ballistic galvanometer and search coil, the galvanometer constant is determined first using a standard solenoid fig. (3). When the secondary of the standard solenoid is connected to the galvanometer, the instantaneous



V. V. T. VARIABLE VOLTAGE TAP.
C.T. CENTRE TAP.
L. F. C. LOW FREQUENCY CHOKE.
R. F. C. RADIO FREQUENCY CHOKE.
5R 4 G.Y. FULL WAVE RECTIFIER VALVE
8 1 1 HIGH POWER OSCILLATOR VALVE.

Fig. (1) RADIO FREQUENCY OSCILLATOR.


FREQUENCY —— Mc /Sec.
0
10
20
30
40
0
10
20
30
40
50
60
70
DIAL READING —— CIRCULAR DIVISION
Fig-2



E.M. —— ELECTRO MAGNET.
B.G. —— BALLASTIC GALVANOMETER.
C.D.R. —— CRITICAL DAMPING RESISTANCE.
S. L. —— SOLENOID.
S. C. —— SEARCH COIL.
C —— D.C. CURRENT SOURCE.

Fig.(3) CALIBRATION OF MAGNETIC FIELD.

current through the galvanometer when current i is established in primary, produces a deflection " d_1 " given by

$$\frac{4\pi^2 n_1 n_2 r_2^2 i}{(R+G).10} = K d_1 \qquad \ldots(3.1)$$

where K = a constant of galvanometer

n_1 = number of primary turns / cm

n_2 = total number of secondary turns

r_2 = radius of the secondary coil in cm.

i = current through the primary of the solenoid expressed in amp.

G = Galvanometer resistance in ohms.

R = resistance of the secondary circuit including the search coil.

The resistance of the search coil is a few ohms which is small compared to the total resistance of the secondary circuit which is few thousand ohms. If now a uniform magnetic field H is developed through this search coil, then flux linked with the search coil is $4\pi n_3 r_3^2$ and if this change of flux produces on observed throw " d_2 " in galvanometer, then

$$\frac{4\pi n_3 r_3^2}{(R+G)} = K.d_2$$

where n_3 = number of turns of serch coil

r_3 = mean radius of search coil turns

Hence

$$H = \frac{2\pi n_1 n_2 i r_2^2}{5 n_3 r_3^2} \cdot \left(\frac{d_2}{d_1}\right) \qquad \ldots(3.2)$$

Two sets of observations were made with two search coils of different number of turns and it was assumed that the resistance of the secondary circuit remains uneffected due to the small change of the search coil turns.

Results : Length of primary coil = 50 cm.

Total number of primary coil turns = 250

Diameter of the primary coil = 7.2 cm. (average)

Length of the secondary coil = 9 cm.

Diameter of the secondary coil = 8.5 cm.

Total number of secondary coil turn = 1000

<u>1st set</u>

Mean radius of search coil = 0.7 cm.

Total number of search coil turns = 90

Primary current amp.	Deflection of Galvanometer (cm.) ON	OFF	Average deflection per amp.	Mean deflection of galvanometer amp.
2	21.5	21	10.6	
1	10.5	11	10.7	10.6
0.5	5	5.5	10.5	

Current through the electromagnet (amp.)	Deflection of galvanometer (cm) ON	OFF	Magnetic field (Gauss)
4.25	12	13	3044
4	11.8	12.6	2957
3.25	10.6	11	2630
2.5	9	9.8	2272
2.25	8.5	8.9	2110
2	7.7	7.9	1895
1.5	6.4	6.6	1580
0.75	3.5	3.9	907
0.5	2.3	2.6	590

2nd set.

Mean radius of search coil = 0.8 cm.

Total number of search coil turns = 100.

Current through the electromagnet (amp.)	Deflection of galvanometer (cm) ON	OFF	Magnetic field (Gauss)
4	17.3	18	2955
3.5	16	17	2760
3	14.8	15.2	2515
2.5	13.1	13.6	2230
2	11.2	11.4	1900
1.5	9	9.8	1575
1	6.7	7.1	1153
0.5	3.4	3.7	597
0.25	1.7	1.9	304

The calibration is repeated by means of a gaussmeter. The gaussmeter consists of a rectangular coil rotated along the axis passing through its plane by a synchronous motor of 50 c/s. When this rotating coil is placed perpendicular to an uniform magnetic field, the indused a.c. e.m.f. is generated in the coil which is measured by the C.R.O. The C.R.O. is calibrated previously by small a.c. voltage of 50 c/s applied from a source attached to the C.R.O. itself. The output induced voltage from the gauss meter for magnetic field strength of one gauss is taken from the data supplied by the manufecturer. During measurements the current through the electromagnet coil is gradually increased until the amplitude of the output a.c. voltage shows a discrete value. The current then is noted and the corresponding magnetic field from the C.R.O. calibration of amplitude length / volt is obtained.

Results :-

Amplitude of the output a.c. voltage / gauss of the gaussmeter supplied by the manufacturer " Rawson Electrical Instrument Co. Cambridge, Mass., U.S.A.

= 0.18 mv / gauss.

Calibration of oscilloscope screen :-

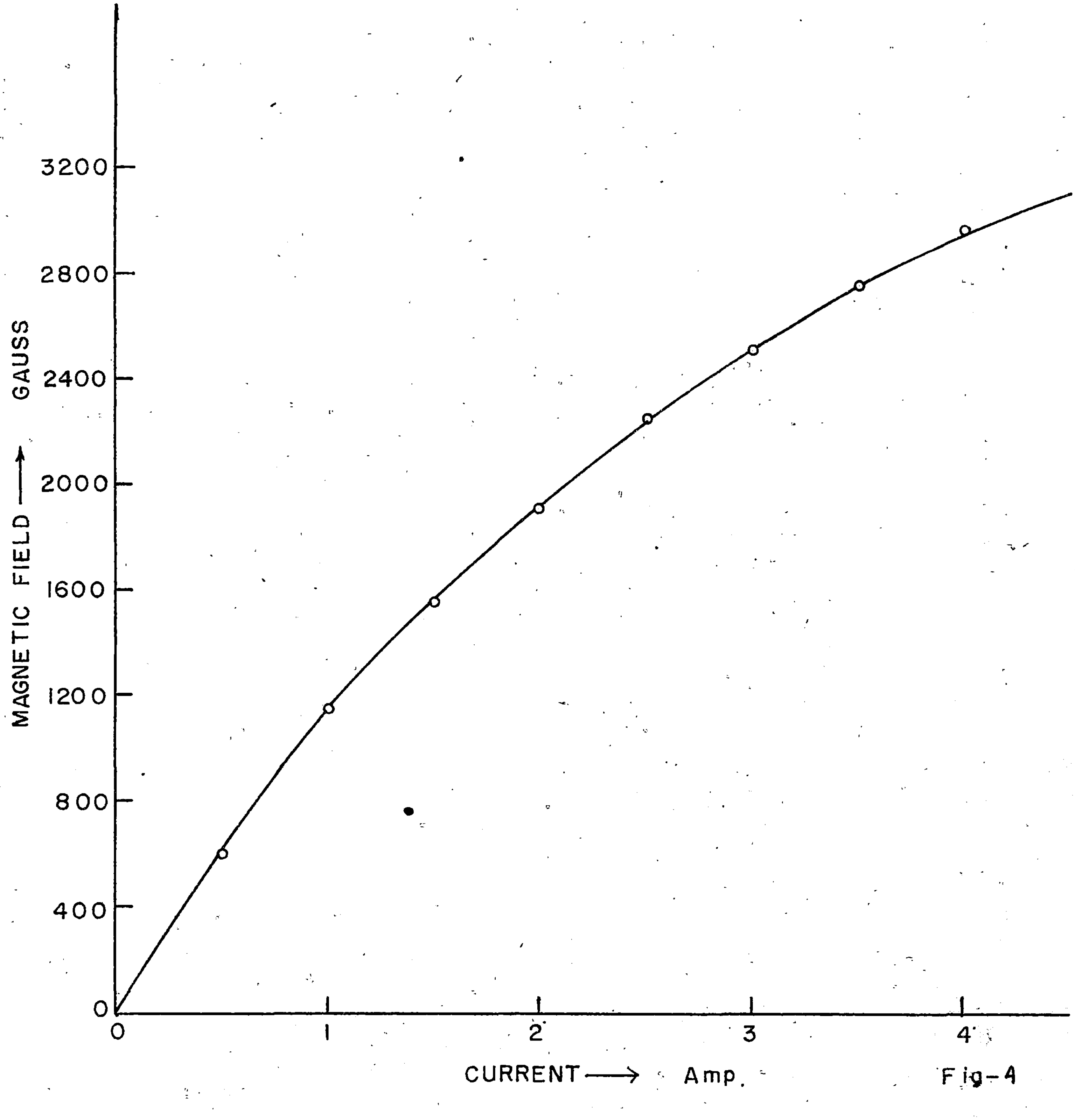
Applied voltage (50 c/s) to C.R.O. plate along y axis (volt).	Amplitude of wave form (cm.)	Amplitude /volt.	Mean amplitude volt.
0.5	10.2	20.4	
0.2	3.9	19.5	19.96
0.1	2	20	

Calibration of electromagnet :-

Current through the coil of the magnet (amp.)	Amplitude of the wave form (cm)	Magnetic field (gauss).
0.2	1	278
0.5	2	556
0.7	3	834
1	4	1112
1.3	5	1390
1.6	6	1668
2.1	7	1946
2.5	8	2224
3	9	2502
3.6	10	2780

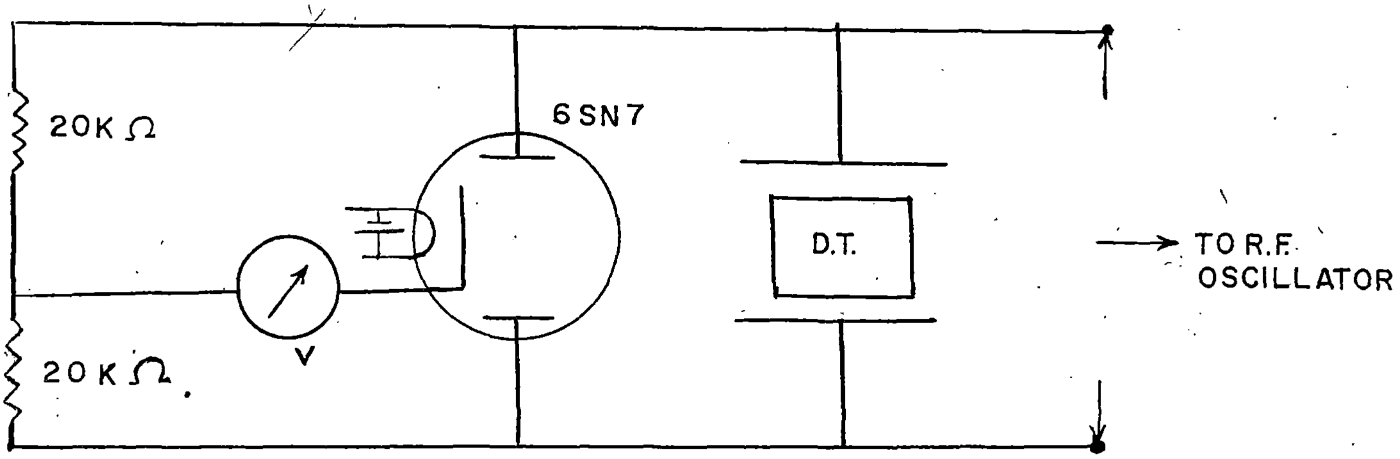
A calibration curve is drawn of the magnetic field against current in the coil of the electromagnet fig. (4).

The measurements of the breakdown potential of the gas in radiofrequency field have been done following the procedure of Gill and Von Engel (1948) and Sen and Ghosh (1963) . The arrangement is shown in fig (5). The R.F. voltage is directly applied from the source to the electrodes by means of shielded cables. The r.m.s. value of the voltage is measured with the help of a V.T.V.M. constructed in the laboratory using a (6 SN 7) tube . The range of the V.T.V.M. is 500 volts r.m.s. The plate voltage of the oscillator is gradually increased and hence the r.f. applied voltage to the vessel also increases. At the point of breakdown of the gas the V.T.V.M. reading shows an abrupt fall of few volts and simultaneously a glow appears in the discharge tube. This point is taken as the breakdown point and the corresponding r.m.s. value of voltage indicated by voltmeter of V.T.V.M. is taken as the breakdown voltage. The whole experiment is performed in two ranges of pressure. The measurement of pressure in the range 0.5 mm. Hg. to higher pressure is done with the help of a mercury manometer. The manometer is connected to the system and its vapour is prevented from entering the discharge vessel by sorrounding its passage by a cold ice trap. The mercury level is measured by a telescope fitted with a vertical scale. This arrangement measured the pressure very accurately from a few millimeters of mercury upto 0.5 mm. of Hg. For pressures below 0.5 mm. Hg. to a few microns, the pirani portion of the Pirani Penning gauge supplied by Edward High Vacuum Ltd. Crawlay, Sussex, England, is used along with their calibration curves of the pirani meter for different gases. Penning gauge portion is also kept connected to the discharge vessel system to test the leak of the system. During investigation different gases are used as dielectric medium like air, oxygen, hydrogen, carbon-di-oxide, neon, helium, argon. The last three gases have been supplied by the British Oxygen Co. in glass cylinders. These gases are directly connected to the discharge tube via a stop cock. Air is passed



3200
2800
2400
2000
1600
1200
800
400
0
MAGNETIC FIELD ⟶ GAUSS
0
1
2
3
4
CURRENT ⟶ Amp.

Fig-4

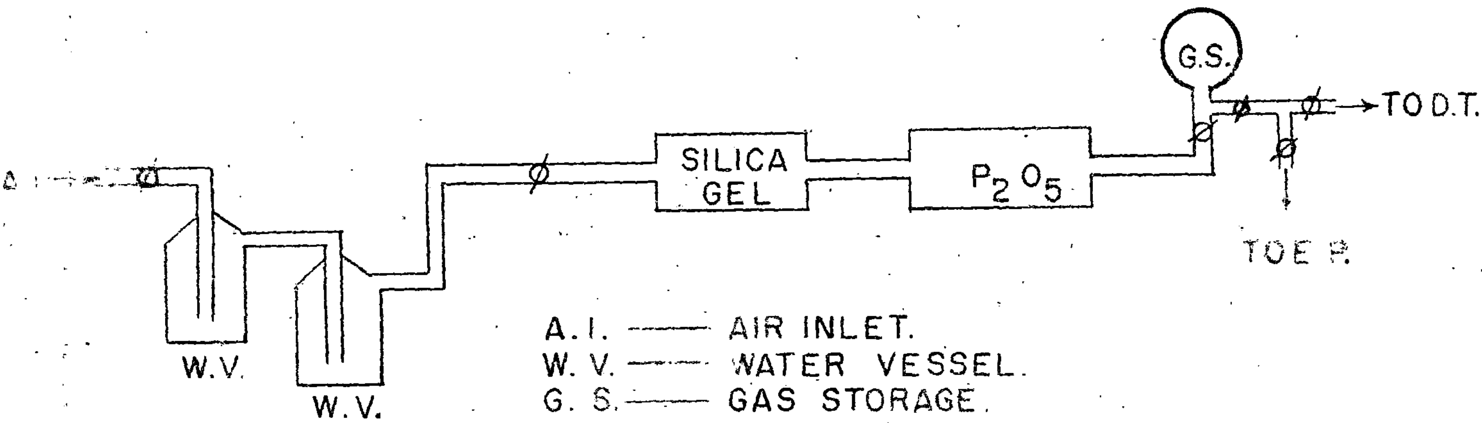


V——D. C. VOLTMETER.
6SN7——TWIN DIODE RECTIFIERS.
D. T.——DISCHARGE TUBE.
R. F.——RADIO-FREQUENCY

Fig. (5) VACUUM TUBE VOLTMETER CONNECTED TO ELECTRODES OF DISCHARGE TUBE through a series of cold water vessel to remove dust and organic matters and dried by silica gel and phosphorous pentoxide and is stored in a highly evacuated and clean glass vessel. Pure oxygen is prepared by the electrolysis of a concentrated solution of barium hydroxide with nickel electrodes in hard glass U tube. Oxygen is evolved at the anode. The gas is passed over red hot platinum to remove traces of hydrogen and dried by passing over pure phosphorouspentoxide and stored like air. Pure hydrogen is evolved at the cathode in the electrolysis, with nickel electrodes, of a warm concentrated solution of barium hydroxide in a hard glass U tube. The gas is passed over heated platinum gauge to burn out any oxygen and is dried by passing over broken pieces of potassium hydroxide, followed by purified phosphorouspentoxide which has been sublimed in oxygen. Storing is done in the previous manner. Pure carbon dioxide is obtained by the action of dilute sulphuric acid, boiled to free it from air, on pure sodium carbonate. The gas is passed through cold water to remove traces of acid and dried by passing over silica gel and phosphorous pentoxide and stored in the evacuated glass container keeping its mouth upward.

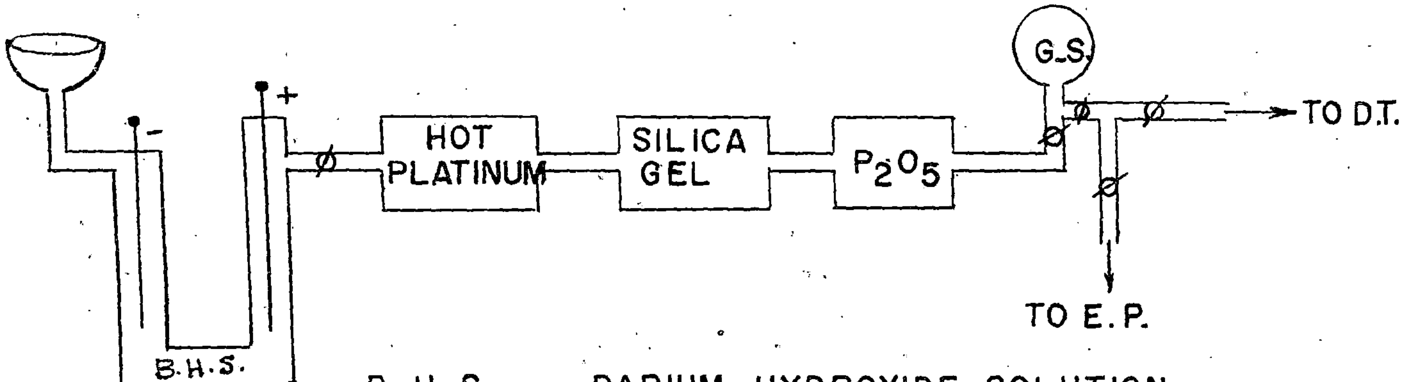
The whole arrangement of gas preparations in the laboratory is shown in fig. (6-a, b, c, d.). In all these preparations the whole system is connected to exhaust pump (Leybold pump). The maximum possible portion of the system is evacuated properly before any gas is allowed to pass through the system from the point of generation. Before making the final collection, a continuous operation of gas preparation and its exhaustion through the system is continued for a sufficiently long hours to ensure a complete atmosphere of the gas inside the system. All the gas containers are separately connected to the discharge vessel via stopcock during the observation. Throughout the experiment the Leybold rotary exhaust pump is used.

Before starting the measurements, the discharge vessel system is continuously evacuated and properly baked to remove occluded gas. The operation proceeds for a considerable period, after which the experimental gas is introduced in the system. The system is flushed a number of times with the gas from the



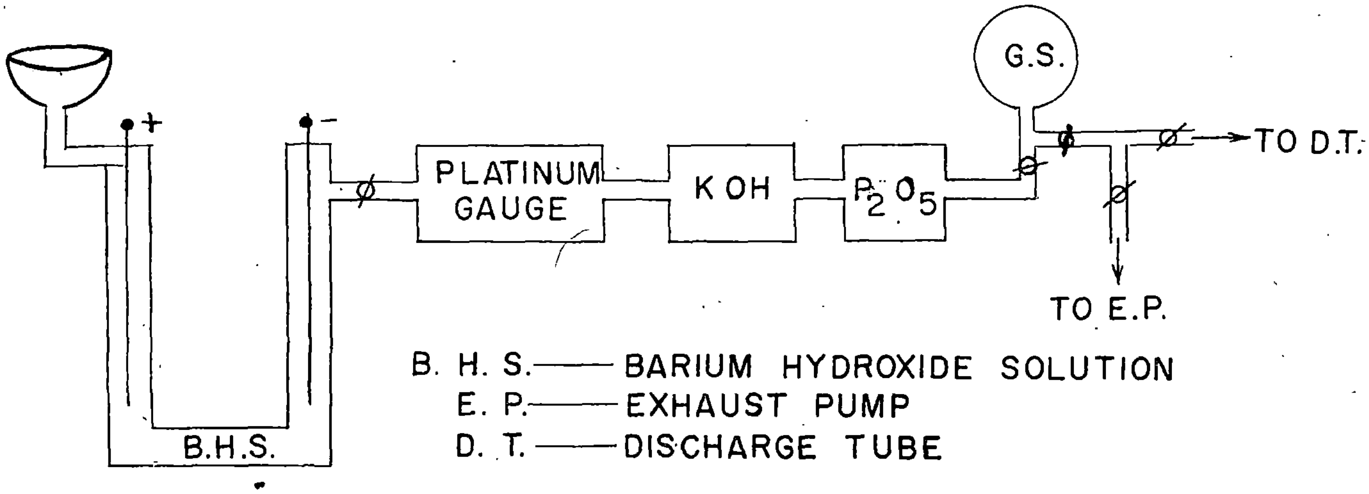
A.I. —— AIR INLET.
W.V. —— WATER VESSEL.
G.S. —— GAS STORAGE.
D.T. —— DISCHARGE TUBE.
E.P. —— EXHAUST PUMP.

FIG.(6 a) STORAGE OF DRY AIR.



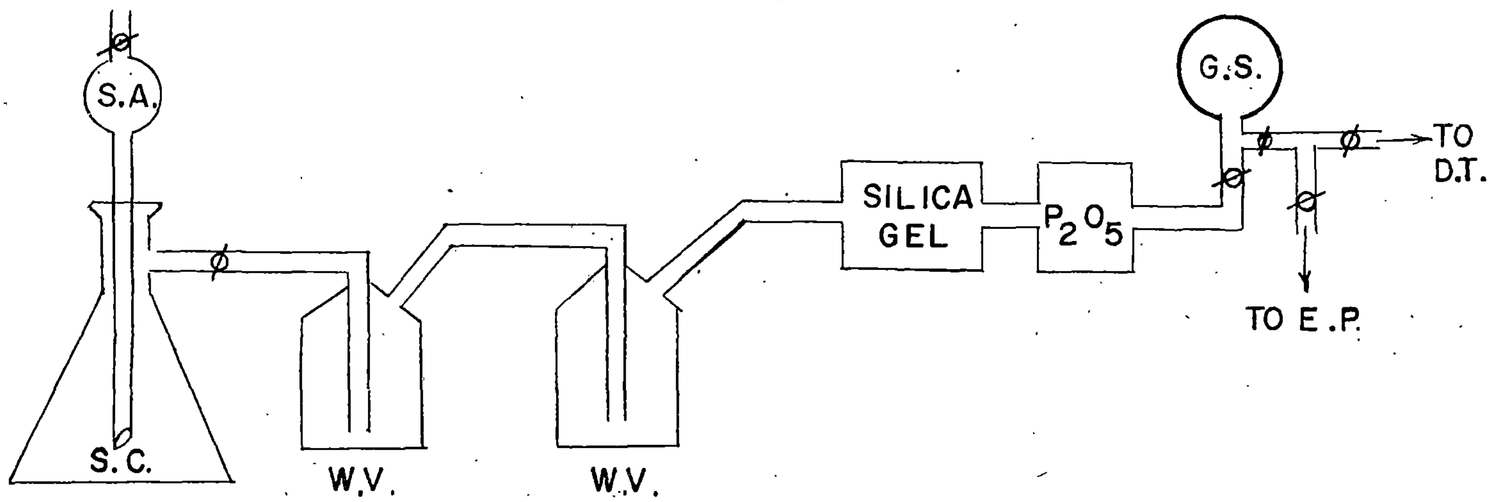
B.H.S —— BARIUM HYDROXIDE SOLUTION
G.S. —— GAS STORAGE.
E.P. —— EXHAUST PUMP.
D.T. —— DISCHARGE TUBE.

FIG.(6 b) PREPARATION OF OXYGEN.



B. H. S. —— BARIUM HYDROXIDE SOLUTION
E. P. —— EXHAUST PUMP
D. T. —— DISCHARGE TUBE

FIG. (6 C) PREPRATION OF HYDROGEN



S. A. —— DILUTE SULPHURIC ACID
S. C. —— GRANULS OF SODIUM CARBONATE
G. S. —— GAS STORAGE
E. P. —— EXHAUST PUMP.
D. T. —— DISCHARGE TUBE.
W. V. —— WATER VESSEL.

FIG. (6 d) PREPARTION OF CARBON-DI-OXIDE.

container to ensure the gas atmosphere inside the discharge vessel. Keeping the pressure fixed by proper manipulation of stop cock, the breakdown voltage is measured by the V.T.V.M. (Internal impedence 20 K ohm) as stated earlier. Observation at different pressures is repeated for several times and the mean values of breakdown potential is noted against the corresponding pressure. The mean value does not deviate more than ± 2 volts for all the observed values at the corresponding pressure.

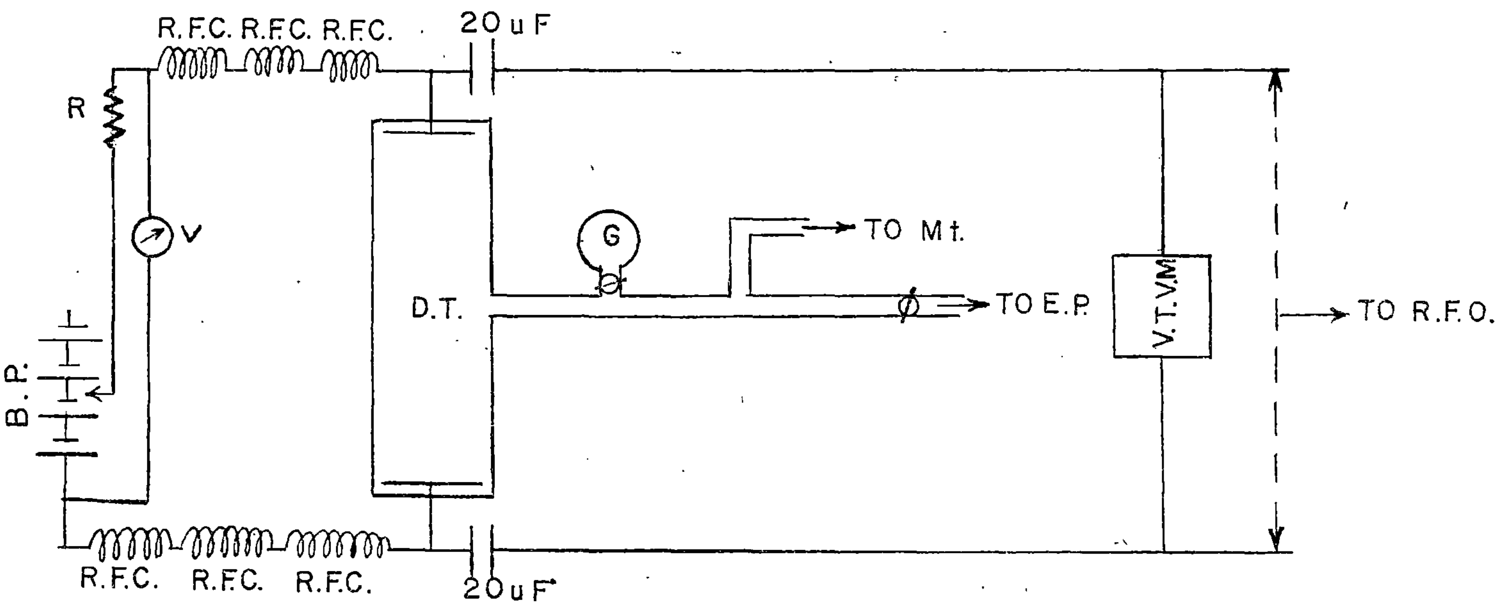
The same process is repeated for all the gases mentioned earlier and the respective breakdown potential data are noted for different pressures. Breakdown potential measurements above the pressure 0.5 mm. Hg. are done with air, oxygen, hydrogen and carbondioxide using a single discharge vessel. And for pressures below 0.5 mm. Hg. another discharge vessel (both of cylindrical shape but of different dimension) is used. In this low pressure range the gases neon, helium and argon are used as dielectric medium.

Measurements with cross steady magnetic field :- The above mentioned procedure has again been repeated for all the gases in crossed magnetic field. The uniform magnetic field which was calibrated at the begining of the experiments is placed perpendicular to R.F. electric field. The current of the coil of electromagnet is supplied from a metal rectifier fitted with proper filter circuits. Keeping the magnetic field at a fixed value, the pressure is gradually changed and the corresponding breakdown potentials are noted. The same procedure is repeated for different values of the magnetic field. The process is repeated several times and mean breakdown potentials are taken. Breakdown potentials corresponding to the same magnetic field but different pressures then constitute one set of reading. In this way different sets are obtained for different descrete values of magnetic field. Repeatition of the process has been made with all the gases mentioned as dielectric medium.

B. R.F. Breakdown in superimposed D.C. Field.

Apparatus :-

(1) R.F. electrical excitation source (2) D.C. voltage source (3) Gas generation and purification system (4) Exhaust pump (5) Mercury manometer (6) Discharge tubes filled with rare gases. The whole experimental arrangement is shown in fig. (7). The r.f. excitation source used in this experiment was the one described in the previous arrangement. The r.f. voltage is applied to the highly polished and clean parallel electrodes fitted in a thick glass cylindrical vessel, through two oil filled condensers each of 10 μF capacity and capable of sustaining a potential difference of 3 K.V. These two condensers act as blocking condenser to the applied d.c. voltage. As the impedence of these two condensers in radiofrequency is very small ($<< 1$) so the V.T.V.M. terminals are connected towards the r.f. source end of the condensers as precautionary measure to protect the valve of the V.T.V.M. The V.T.V.M. that is used in this experiment has been described in the previous experimental arrangement. The source of d.c. voltage is a package of dry batteries connected in series and capable of change of voltage by steps of 90 volts. The d.c. source is connected to the electrodes of the discharge vessel via some r.f. chokes connected in series. A high value resistance is connected in series with batteries to control the current when the vessel becomes conducting. A switch system disconnects the d.c. source from the vessel. The experiment is performed in two ranges of d.c. volts/cm. The whole experiment is performed in the range of pressure 0.5 mm. Hg. to a few mm. Hg. The measurement of this pressure where necessary is done by the mercury manometer in the same manner as described in previous arrangement.



B. P. ——— DRY BATTERY PACKAGE
R. F. C. ——— RADIO FREQUENCY CHOKE
V ——— D.C. VOLTMETER
D.T. ——— DISCHARGE TUBE.
G ——— GAS CONTAINER.
Mt. ——— MERCURY MANOMETER
E.P ——— EXHAUST PUMP
V.T.V.M. ——— VACUUM TUBE VOLT METER.
R.F.O. ——— RADIO FREQUENCY OSCILLATOR
R. ——— [redacted] HIGH RESISTANCE

FIG -7

Before starting the actual experiment with variable pressure and high d.c. volt/cm the whole system of discharge vessel is exhausted by the Leybold oil exhaust pump and simultaneously baked for a considerable period. After that the system is flashed several times by the experimental gas to ensure the atmosphere of this gas only throughout this system. The same procedure is followed for all the gases studied. The d.c. voltage is applied to the electrodes and the r.f. voltage is gradually increased until the gas of the container shows signs of breakdown. At this moment the d.c. source is disconnected to prevent the damage of the polish of the electrode surfaces. By changing the applied d.c. voltage in steps of 90 volts the corresponding r.f. breakdown potentials are measured. The experiment is repeated several times and mean values of the breakdown potentials are taken. The whole experiment is performed for several discrete values of pressure.

Identical procedure, as described above, is followed for different experimental gases and the corresponding observations made at different pressures. The gases used in this experiment as dielectric medium are dry pure air, oxygen, hydrogen, carbon-di-oxide, helium, neon and argon. The preparations and storing of the first four gases have been described previously. Helium, neon and argon have been supplied by the manufacturing company in Geisler tube fitted with aluminium electrodes. These tubes are directly used as discharge vessels. The pressures of the gases inside the tube are given by manufacturer. The experiment with these vessels give results for small superimposed d.c. volts per cm. at constant pressure since here the length of the discharge column was large. Other gases are treated in a small discharge vessel to get the result at high applied d.c. volt/cm and at different pressures.

C. Low pressure gas breakdown by secondary electron resonance (a) Witout magnetic field (b) With magnetic field.

Apparatus :-

(1) R.F. source of variable frequency (2) Diffusion pump with rotary exhaust pump (3) Gas preparation and purification system (4) Electromagnet (5) Pirani Penning Gauge (6) Discharge tubes. The diffusion pump used in the present experiment is an oil diffusion pump made of leak proof metal body. The Leybold exhaust pump decribed earlier acts as fore pump stage of the diffusion pump. Silicon oil is used in the diffusion pump. The R.F. excitation source and the V.T.V.M. to measure the r.m.s. value of the voltage of excitation are the same described in the previous arrangement. The same is the case for electromagnet and Pirani-Penning gauge. The Pirani section of the gauge can read pressure upto few microns of Hg. for different gases and penning section has the range down to 10^{-5} mm. Hg. for pressure measurement. During the experiment the discharge containers used are all of cylindrical geometry having different dimension of length and same radius and made of pyrex glass. All measurements were made with parallel external electrode systems placed perpendicular to the axis of cylindrical vessel. Before using the discharge vessels, they are thoroughly cleaned by concentrated acids and alkali solutions and baked under evacuated condition for some time to remove all contaminations. The experimental container is connected to the diffusion pump and their junction is sorrounded by solid ice to prevent oil vapour to enter the discharge vessel. An "Y" connection is joined here with the discharge tube. The other ends of the connections are fitted to penning head and gas system respectively. For the present experiment only hydrogen and air are used, the preparations and storage of these two gases have been discussed in the previous chapters. The mercury cup stopcock controls the gas flow. The whole experimental arrangement is shown in fig. (8).

Before starting the original experiment, it is necessary to test the exhaust capacity of the diffusion pump. For this purpose the discharge tube system is dismantled and instead Penning head is directly connected to the diffusion pump. The run of rotary pump for a few hours lowers the pressure of the system to about 10μHg. pressure. The diffusion pump is then started by switching the heating coil and running cold water through the cooling pipes of the diffusion pump. After about five to six hours the pressure reading in the Penning gauge shows a steady value of 5×10^{-5} mm. Hg. which is then maximum exhaustion capacity of this diffusion pump. However by connecting the whole discharge tube system during the actual experiment, the pressure could be lowered to a steady value upto 15×10^{-4} mm. Hg. at best by properly baking the system and operating the diffusion pumps for about ten hours. At this stage of pressure the whole experiment is performed keeping the exhaust system in operation throughout the observation.

During the experiment it is proposed first to see that the mechanism of secondary electron resonance breakdown is operative in the present setup.

Measurements without magnetic field :-

The most distinguishing characteristic of the secondary electron resonance breakdown mechanism is that the breakdown voltage must be independent of the nature of the gas in the same vessel. Hydrogen and air are used as two different gases for this purpose. Starting the experiment, the whole system is continously flashed for sometime by the experimental gas with the help of rotary exhaust pump to create the atmosphere of the gas in the discharge vessel. Then the actual operation of exhaustion is started in the manner stated earlier. When the penning gauge shows the steady pressure ~~less than~~ near one micron mercury, the vessel is set for taking observations. Keeping the whole exhaust system in the run, the r.f. breakdown voltage of the dielectric medium of the vessel is measured, which is indicated only through appearance of glow in the vessels but no fall of voltage generally taken place as stated earlier. By varying the frequency of the oscilator, the breakdown voltage measurements is repeated until the cut-off frequency is obtained. At frequencies lower than the cut off frequency, the dielectric medium behaves like an insulator to any amount of r.f. voltage. The whole experiment is repeated for hydrogen and air. The two curves obtained by drawing breakdown potentials against frequency for two gases should be identical if the secondary electron resonance mechanism is operative. Once this is varified, the later part of the experiment is performed using only air as dielectric medium.

Using the cylindrical shaped discharge tubes of different lengths and same radius and each one properly treated for cleaning as described earlier, the breakdown potential measurement is made for all tubes one after another for different frequencies available in the present setup. The measurements are limited by r.f. output voltage in the highest frequency end which is approximately 40 Mc/s. In each case the measurements/are continued upto the frequency slightly lower than the respective cut-off frequencies which are different for different lengths of the discharge tubes. The cylindrical vessels used are all of same diameter (diameter 3.5 cm.) and lengths cm, 5 cm, 7 cm. and 15 cm. The oscillator frequency and corresponding limited output voltage allows only to measure the linear portion of frequency vs. breakdown potential curves for all the discharge tubes mentioned above. It was only possible to get one or two points beyond the cut-off frequency region due to limited r.f. output voltage. However the glow at breakdown in this region is very faint and only appears on the glass surface unlike the normal state where glow appears in the central portion of the discharge vessel.

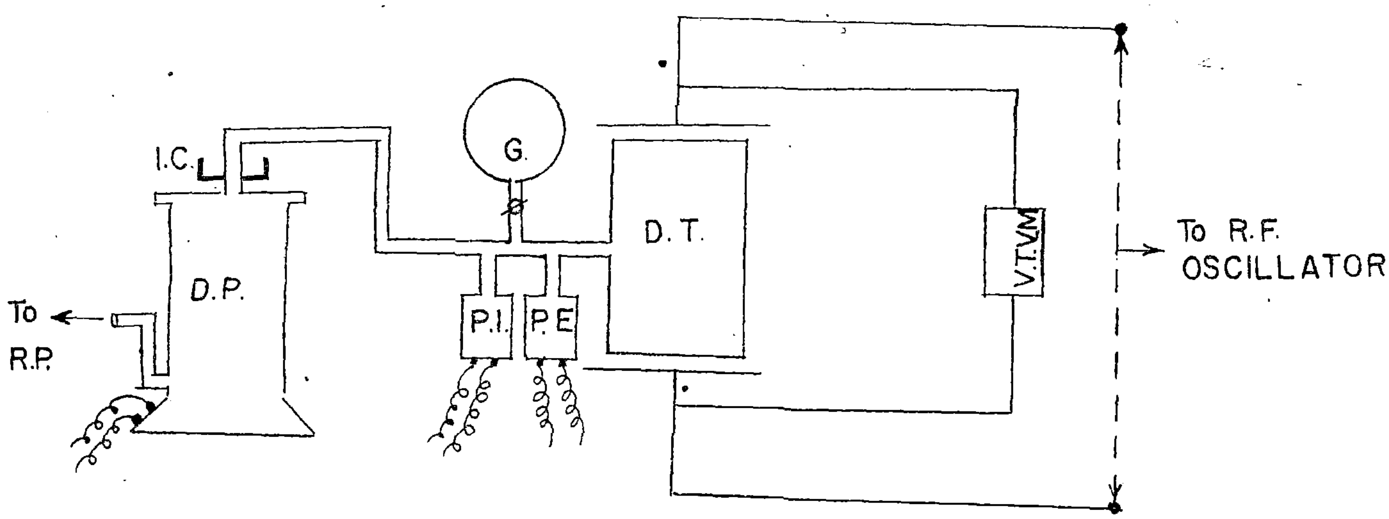
Experiment with magnetic field :- The uniform magnetic field is placed perpendicular to the axis of the cylindrical vessel of length 5 cm. and covering the whole length of the tube in the uniform lines of force. The arrangement makes the magnetic field perpendicular to r.f. electrical excitation field.

As the dimensions of the pole faces of the magnet are 7.5 cm. x 4.5 cm. and the length of the discharge tube is 5 cm., the tube lies entirely within the pole faces. To investigate the effect of uniform magnetic field on the breakdown potential and corresponding cut-off frequency in the secondary electron resonance breakdown mechanism, the single discharge vessel mentioned above is chosen for the whole experiment. Keeping the magnetic field steady at some value, the same procedure, as adopted in the measurements without magnetic field, is followed and frequency versus breakdown potential curve slightly beyond the cut-off frequency is obtained. By increasing the magnetic field by some discrete amount, different such curves are obtained. It is observed that with the increase of magnetic field, the breakdown potential at identical frequency increases and correspondingly the cut-off frequency is shifted towards the lower frequency value, but curves are identical in nature among themselves and also with the curve without magnetic field. The observations were made for higher and higher magnetic field until further observations could not be taken due to limitation in the output power of the tube. It is to be noted that every observation of breakdown potential whether without magnetic field or with magnetic field is repeated several times, and the mean value is taken. It is observed that the breakdown potential never deviates more than ± 2 volts (r.m.s.) from each other in repeated observations.

D. Effect of magnetic field on the light intensity of r.f. discharge column.

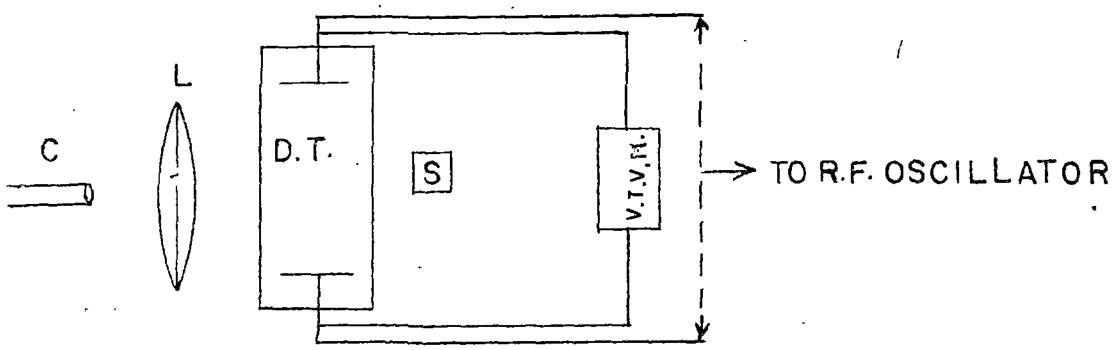
Apparatus :-

(1) R.F. excitation source (2) Discharge tube filled with rare gases (3) Spectrograph (4) Photosurface (5) Microammeter (6) Electromagnet. The R.F. electrical excitation source is the same as before. The discharge tubes are cylindrical tubes fitted with electrodes and filled with rare gases such as neon, argon, helium at pressures of 10 mm. Hg. A constant deviation spectrograph with arrangement to measure the wavelength of the spectral lines directly has been



R. P. ——— ROTARY PUMP
D. P. ——— DIFFUSION PUMP
P. I. ——— PIRANI HEAD
P. E. ——— PENNING HEAD
G. ——— GAS CONTAINER
D. T. ——— DISCHARGE TUBE
V. T. V. M. ——— VACUUM TUBE VOLTMETER.
I. C. ——— ICE CONTAINER
R. F. ——— RADIO FREQUENCY

Fig. 8



C. ——— COLLIMATOR OF SPECTROGRAPH
L. ——— CONVERGING LENS SYSTEM
D.T. ——— DISCHARGE TUBE
S. ——— PHOTO VOLTAIC SURFACE
V.T.V.M. ——— VACUUM TUBE VOLTMETER

Fig. 9

used. The Eel photoelectric cell supplied by serves as a photosurface which yields photo electron current on exposure to light. This is used to measure the direct intensity of the beam by the amount of current that flows. No external voltage is necessary to collect the photoelectrons. When the two electrodes are connected through a microammeter, current flows depending upon the intensity of the light. In the present experiment the surface is always exposed to the whole ~~monochromatic~~ beam from the discharge tube ~~constant deviation spectrometer~~ and comparison of intensities is made without and with the magnetic field. The same electromagnet described earlier is used here. The whole experimental arrangement is shown in fig. (9).

The experiment is performed in two ways. The discharge tubes are excited by r.f. electrical excitation source applying power directly to electrodes. The tubes are used as source to the spectrograph. The magnetic field is placed perpendicular to the axis of the tubes and so perpendicular to the r.f. electric field. Viewing through the telescope, some lines are chosen serially from the spectrum and their wavelengths are obtained from the calibration in the spectrometer. Replacing the eyepiece by a photographic camera, exposures are taken on a photographic plate of those spectral lines. The magnetic field is then established to some discrete values and in each case the spectrum of the same lines are taken exposing the photographic plate by the same amount of time as before. All the exposures were taken in the same photographic plate to ensure uniform developing of all the spectra taken at different magnetic fields. The plates were scanned by microphotometer to get the intensity profiles of all the lines at different magnetic field condition. Some intense lines which were photographed as very dark lines in all the spectra, could not be scanned for change of intensity by the present photometer. Besides these, in all other lines there is a marked increase of intensity with increase of magnetic field.

In the next part of the experiment, the spectrograph is removed and the photo surface is placed before the discharge tube. The R.F. excitation is put off and magnetic field is increased to investigate if there is any effect of the magnetic field on the photosurface. No such effect was found. The tube is excited and the magnetic field is increased. The photocurrent shows a gradual increase with magnetic field. By changing the position of the photosurface with respect to discharge tube and magnetic field the same result is obtained. Hence keeping the photosurface at the same position observations were made for three discharge tubes in the manner described above. Here the photocurrent yield is taken proportional to the intensity of light. It is necessary to mention here that on application of magnetic field in the said manner, the whole discharge column is found to be visibly constricted. This was general in case of all the gases studied.

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