SUMMARY OF THE PRESENT WORK.

A. BREAKDOWN OF AIR IN CROSSED RADIO-FREQUENCY AND D.C. ELECTRIC FIELD.

The dielectric breakdown of air under the action of radio-frequency (5.7 MHz.) electric field and superimposed transverse d.c. electric field has been obtained. Keeping the superimposed transverse d.c. field constant the variation of breakdown voltage with pressure of the gas have been obtained, the pressure of the gas being varied from 60 μ of Hg. to 270 μ of Hg. The same procedure have been repeated for superimposed d.c. field from zero volts/cm. to 30 volts/cm. In all cases it has been observed that the general nature of variation of breakdown voltage with pressure in presence of transverse d.c. field remains same as without d.c. field. The pressure at which breakdown potential becomes minimum in presence of transverse d.c. field is found to shift towards higher pressure with increasing superimposed transverse d.c. electric field. A theoretical expression for the pressure at which breakdown voltage becomes minimum in presence of transverse d.c. field has been deduced from the theory of electrical discharge together with the expression of equivalent length. The theoretical and experimental values of the pressures at which the breakdown voltage becomes minimum in presence of transverse d.c. electric field are in good agreement. The slight discrepencies between the two sets of values may be ascribed partly due to the uncertainties in the values of different parameters and partly due to attachment loss of electrons and ionisation due to d.c. field which have not been taken into consideration in the present analysis.

B. RADIO-FREQUENCY ELECTRIC FIELD BREAKDOWN OF GASES IN PRESENCE OF TRANSVERSE MAGNETIC FIELD.

The work has been done in two parts at two different ranges of magnetic field values with different gases as dielectric medium. In the first part, measurements of breakdown voltage have been made in molecular gases viz. hydrogen, oxygen and air at pressures varying from 0.5 mm Hg. to 8 mm Hg. and with fixed transverse magnetic fields 0, 350 and 500 Gauss - the frequency of the applied r.f. field being 6.2 MHz. Keeping the magnetic field at a constant value the variation of breakdown voltage with pressure of the gas have been obtained. The general nature of variation of breakdown voltage with pressure remains unaltered under the application of transverse magnetic field for all the gases. However, the presence of magnetic field greately reduces the breakdown voltage at values of pressures when the collision frequencies are either lower than or comparable to the electron cyclotron frequency; but increases the breakdown voltage at pressures when collision frequencies are much higher than the cyclotron frequency. In addition, the presence of transverse magnetic field shifts the pressure at which the breakdown voltage becomes minimum towards lower values of pressure. Attempts have been made to explain the results incorporating the possible effects of magnetic field on different mechanisms as are postulated in the breakdown theory of gases and fair amount of agreement is obtained between the experimental observations and theoretical results. The quantitative discrepency between theoretical and experimental observations may be attributed to the variation of χ, the energy loss factor, with E/p for inelastic collisions which has not been considered in the present theory and also ~~the~~ to the uncertainties in the values of the different parameters used and some of the symplifying assumptions made in the theoretical deduction.

In the second part, the variation of breakdown voltage have been obtained with magnetic field varying from 0 to 2.6 K.Gauss in air, hydrogen and oxygen at constant pressures 0.25, 0.50 and 0.30 mm Hg. respectively. For all the gases studied, it is found that the nature of variation of breakdown field in presence of transverse magnetic field is similar to the variation of breakdown field with gas pressures with or without magnetic field. If the magnetic field is greater than the magnetic field at which the breakdown field is minimum another breakdown field is observed at a much lower value of the electric field. This breakdown field is found to increase linearly with the increase of magnetic field for all the three gases studied. After this breakdown has occured if the electric field is increased further keeping the magnetic field constant, the faint glow disappears, indicating the extinction of the discharge. This extinction field is also found to increase linearly with the increasing magnetic field. On further increasing the r.f. electric field, higher than the extinction field, with magnetic field kept constant the self sustained discharge is again established which cannot be extinguished by further increasing the r.f. field; instead the glow becomes more intense with the increase of the r.f. field limited by the present experimental output voltage of the r.f. source. Attempts have been made to explain the results qualitatively and quantitatively using the average motion of electron in transverse magnetic field. Good agreements are obtained between the theoretical and experimental breakdown and extinction potential and their variation with magnetic field. The slight discrepency between the theoretical and experimental observations may be due to some of the symplifying assumptions and also the uncertainties in the energy dependance of collision frequency ν_c .

C. GLOW DISCHARGE CURRENT IN PRESENCE OF LONGITUDINAL MAGNETIC FIELD.

The variation of total discharge current in presence of longitudinal magnetic field for different initial discharge currents 0.2, 0.4 and 0.6 mA in absence of magnetic field, have been obtained for molecular gases viz. hydrogen, oxygen, air and nitrogen. The pressure of the gas is kept at 0.2 torr, 0.5 torr, 0.6 torr and 0.5 torr for hydrogen, oxygen, air and nitrogen respectively, the magnetic field is varied between zero to 500 Gauss. It is found that the discharge current at first increases with increases of magnetic field, attains a maximum value and then decrease with increase of the magnetic field. The value of the magnetic field at which total discharge current becomes maximum is found to remain same for all values of initial discharge current of the respective gases except nitrogen where a small increase of magnetic field values at maximum current are observed for different initial discharge current. Attempts have been made to explain the present experimental results by considering the changes in electron temperature, radial electron density distribution and diffusion rate of electron in presence of longitudinal magnetic field. Taking the value of the magnetic field at which the total discharge current becomes maximum, a value of the electron temperature is obtained which is in good agreement in case of hydrogen and oxygen with that obtained from the universal expression for the electron temperature in terms of similarity formula as obtained by von Engel (1965). But there is some discrepency in case of air which may be due to uncertainty in the values of ionization potential for air used in calculating the electron temperature.

D. MEASUREMENT OF HIGH FREQUENCY DISCHARGE CURRENT IN A GAS DISCHARGE EXCITED BY A RADIO-FREQUENCY ELECTRIC FIELD.

A circuit has been designed to measure the current flowing through the active r.f. discharge which is in phase with the applied r.f. voltage by isolating it from the current which is in quadrature with the applied r.f. field. Keeping the pressure of the gas constant to values 0.2 torr, 0.15 torr and 0.1 torr, the variation of current, in phase with the applied r.f. field, with the applied field have been obtained. From these measurements the resistive impedance and hence the real part of the conductivity of the discharge column and its variation with the applied field have been obtained in nitrogen gas. Attempts have been made to explain the experimental observations from theoretical stand point. Assuming a spatially uniform plasma a fairly good qualitative as well as quantitative agreement have been obtained between the experimental and theoretical values of the bulk properties such as real part of the current, resistance and conductivity of the plasma.

E. ELECTROSTATIC PROBE MEASUREMENTS IN GAS DISCHARGE PLASMA AND IN DIFFUSED PLASMA WITH AND WITHOUT MAGNETIC FIELD.

Electrostatic probe measurements have been made in a cylindrical plasma discharge and in diffused (field free) plasma. The conventional plasma have been obtained as glow discharge of air and nitrogen by an a.c. voltage of 50 Hz. at the two ends of a long cylindrical glass tube fitted with four electrodes. The diffused plasma have been obtained in the central part of the discharge tube by the diffusion of charged particles through the perforations of the two inner electrodes.

The values of electron temperature in absence and in presence of magnetic field in conventional and in diffused plasma have been obtained from the measurements of the variation of probe current and voltage. The value of electron densities have been obtained from the ion saturation current and also from the electron current at space potential. The electron temperature in air and nitrogen is found to decrease with magnetic field while the electron density is found to increase with increasing magnetic field for both types of discharge. The values of electron temperature and electron density as obtained in this set up are found to agree with the published results of the earlier authors by order of magnitude and also agree with the accepted qualitative behaviour.