CHAPTER-II

EXPERIMENTAL SET UP

THEORY OF MEASUREMENT OF RADIO FREQUENCY CONDUCTIVITY.

The block diagram of the experimental arrangement can be represented by a simple net work circuit, shown in the figure (2.1).

Let Z_p be the equivalent impedance and for parallel combination

$$Z_p = \frac{R}{1+j\omega CR}$$

$$Z_p = \frac{R(1-j\omega CR)}{1+\omega^2 C^2 R^2} \qquad (2.1)$$

in case of series combination

$$Z_p = R' - j\frac{1}{\omega C'} \qquad (2.2)$$

From equation (2.1) and (2.2)

$$R' = \frac{R}{1+\omega^2 C^2 R^2} \qquad (2.3)$$

and

$$\frac{1}{\omega C'} = \frac{\omega C R^2}{1+\omega^2 C^2 R^2} \qquad (2.4)$$

and as $\omega^2 C^2 R^2$ is > 1 $\quad C' = C$

Further the resonant current with the cell in the circuit but without liquid,

$$I_0 = \frac{E}{R_0} \qquad (2.5)$$

where R_o is the radio frequency resistance of the secondary tuning circuit, as and is given by

$$R_o = \frac{C_2 - C_1}{2\omega C_1 C_2}\sqrt{\frac{I_1^2}{I_o^2 - I_1^2}}$$

(for deduction please refer to next Section)

Where I_o is the resonant current in the R.F milliammeter and C_1 and C_2 are the capacitances for reducing the resonant current to a value I_1, which is equal to $\frac{1}{\sqrt{2}}$ of I_o.

Further the resonant current with cell filled with the liquid is given by I_2

$$I_2 = \frac{E}{R_o + R'}$$

$$I_2 = \frac{E}{R_o + \frac{R}{1 + \omega^2 C^2 R^2}} \qquad (2.6)$$

Putting $$\frac{I_1}{I_2} = \alpha \qquad (2.7)$$

Simplifying the equation (2.6) and (2.7) we get

$$(\alpha - 1) = \frac{R}{R_o + \omega^2 C^2 R^2 R_o} \qquad (2.8)$$

or

$$R = \frac{1 \pm \sqrt{1 - 4R_o^2(\alpha-1)^2\omega^2 C^2}}{2R_o(\alpha-1)\,\omega^2 C^2} \qquad (2.9)$$

In the present experimental set up,

$$4R_0^2(\alpha-1)^2\omega^2c^2 \ll 1$$

then
$$R = \frac{1}{R_0\,\omega^2 c^2 (\alpha-1)}. \tag{2.10}$$

The radio frequency resistance of the polar liquid,

$$R = \rho \frac{l}{s} \tag{2.11}$$

where ρ is the specific resistance, l is the length i.e. inter electrode spacing, and 's' is the cross section of the electrodes, and

$\rho = \frac{1}{K'}$; where K' is the specific conductivity

$$K' = \frac{l}{s.R} \tag{2.12}$$

The tuning condenser is a parallel plate condenser, so the capacity of turning condenser,

$$C_0 = \frac{s}{4\pi l} \tag{2.13}$$

Therefore the radio frequency conductivity can be expressed as,

$$K' = \frac{1}{4\pi R C_0} \tag{2.14}$$

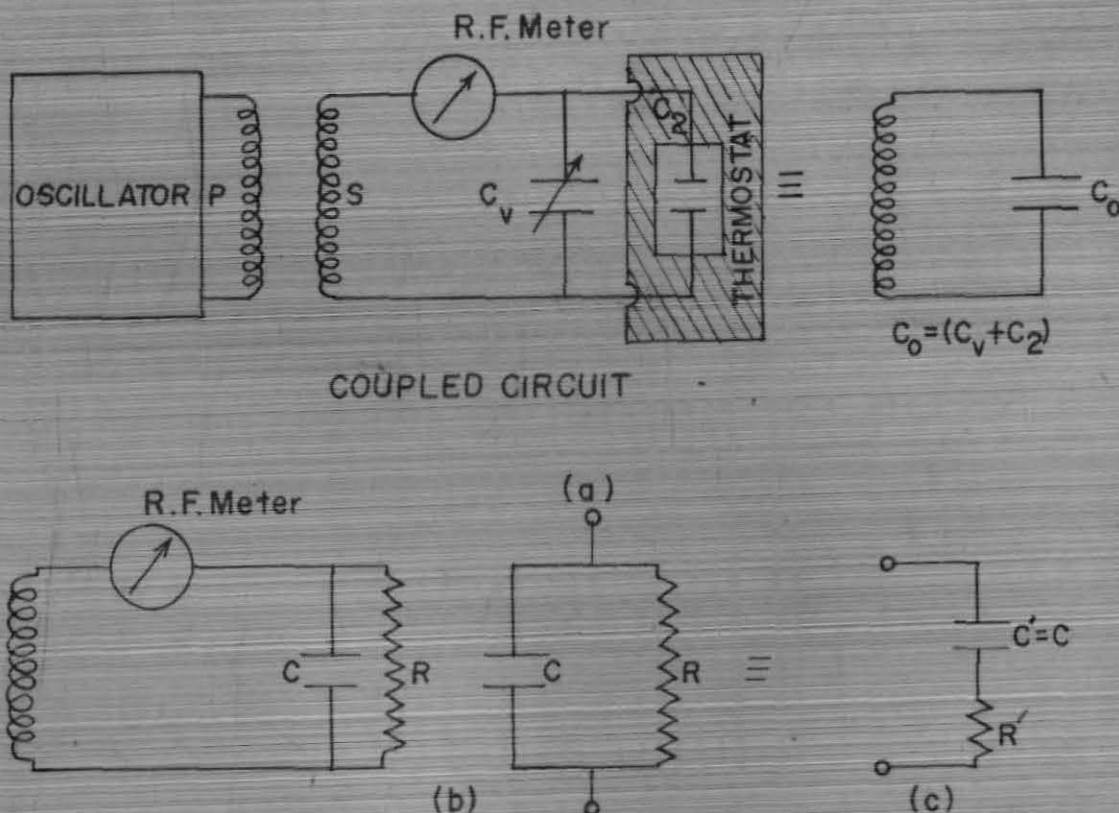


Fig-2.1 Experimental method for Determination of r. f. conductivity of polar dielectrics

(a) Circuit arrangement
(b) Equivalent circuit for the coupled section and
(c) Equivalent circuit for the portion right of r.f. meter in (b)

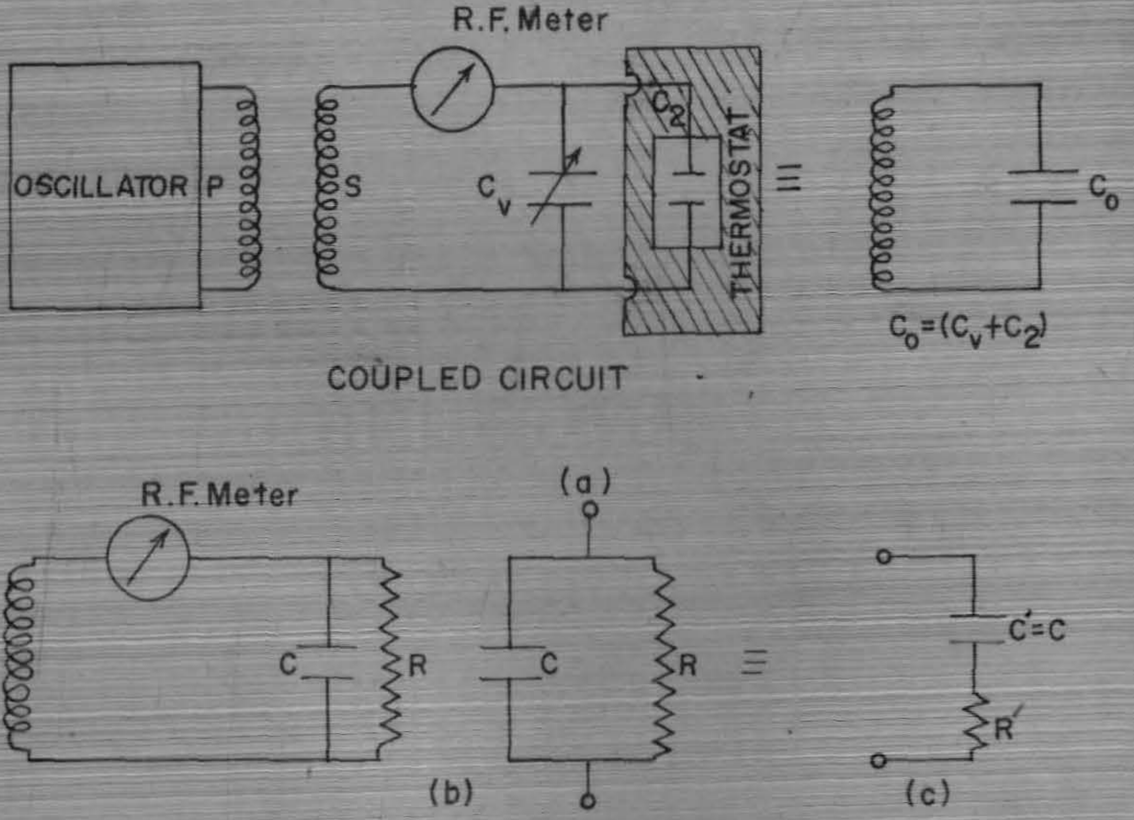


Fig-2.1 Experimental method for Determination of r.f. conductivity of polar dielectrics

(a) Circuit arrangement

(b) Equivalent circuit for the coupled section and

(c) Equivalent circuit for the portion right of r.f. meter in (b)

MEASUREMENT OF RADIO FREQUENCY RESISTANCE OF THE SECONDARY TUNING CIRCUIT AND ITS THEORY.

The method used here for determining the radio frequency resistance may be stated as reactance variation method. The secondary tuning circuit consists of an inductance, a variable capacitance and a radio frequency milliammeter. All the components and the r.f. milliammeter are connected in series. A vernier scale is fitted in parallel to the tuning condenser in order to note the positions of the tuning condenser precisely. The secondary receiving circuit is loosely coupled to the radio frequency oscillator, (Hartley type), which is the driving oscillator of desired frequency shown in figure (2.2). The empty dielectric cell is fitted in parallel to the tuning condenser. The secondary tuning circuit is tuned to the desired frequency of the driving oscillator by proper adjustment of the tuning condenser. The resonant current I_o in the radio frequency milliammeter and the capacitance of tuning condenser are noted. Then the capacitance of the tuning condenser is increased to a convenient value C_2, so that the current in the r.f. meter I_1 becomes $\frac{1}{\sqrt{2}}$ times of resonant current i.e. 70.7% of I_o. After that the tuning condenser is changed to a value C_1 so that the current in the r.f. meter becomes again equal to I_1. The readings for C_2 and C_1 are noted. When the tuning circuit is sharply tuned to desired frequency the induced voltage in the secondary circuit becomes equal to E_o. Therefore $E_o = I_o.R_o$, where R_o is the radio frequency resistance of the circuit. When detuned, then the change in reactance value is ΔX. So the series impedance is,

$$\left(R_0 + j\Delta X\right) \qquad \text{and} \qquad E_0 = I_1\sqrt{\left(R_0^2 + \Delta X^2\right)} \tag{2.15}$$

therefore
$$\frac{I_0}{I_1} = \frac{\frac{E_0}{R_0}}{\frac{E_0}{\sqrt{R_0^2 + \Delta X^2}}} = \frac{\sqrt{R_0^2 + \Delta X^2}}{R_0} \tag{2.16}$$

$$\frac{I_0^2}{I_1^2} - 1 = \frac{\left(R_0^2 + \Delta X^2\right)}{R_0^2} - 1 \tag{2.17}$$

$$\frac{I_0^2 - I_1^2}{I_1^2} = \frac{R_0^2 + \Delta X^2 - R_0^2}{R_0^2} = \frac{\Delta X^2}{R_0^2}$$

$$R_0^2 = \Delta X^2\left(\frac{I_1^2}{I_0^2 - I_1^2}\right) \tag{2.18}$$

The slight change of reactance at the upper half and of the lower half power of maximum power respectively,

$$\Delta X = \left(\omega L - \frac{1}{\omega C_2}\right) \tag{2.19}$$

$$\Delta X = \left(\frac{1}{\omega C_1} - \omega L\right) \tag{2.20}$$

where $\omega = 2\pi f_r$

f_r = resonant frequency.

adding (2.19) and (2.20)

$$2\Delta X = \left(\frac{1}{\omega C_1} - \frac{1}{\omega C_2}\right) = \frac{C_2 - C_1}{\omega C_1 C_2}$$

$$\Delta X = \frac{C_2 - C_1}{2\omega C_1 C_2} \qquad (2.21)$$

Putting value of ΔX in equation (2.18)

$$R_o^2 = \left(\frac{C_2 - C_1}{2\omega C_1 C_2}\right)^2 \left(\frac{I_1^2}{I_o^2 - I_1^2}\right)$$

The radio frequency resistance $R_o = \frac{C_2 - C_1}{2\omega C_1 C_2}\sqrt{\frac{I_1^2}{I_o^2 - I_1^2}}$ (2.22)

So knowing values of C_2, C_1, I_1 and I_o; the radio frequency resistance R_o of the circuit has been calculated by using the equation (2.22).

1. Apparatus used and their description:

(a) R.F. Oscillator, (b) a secondary tuned circuit (c) R.F. milliammeter of thermocouple type. (d) stabilized D.C. Power Supply (e) Thermostat (f) Dielectric cells (g) Communication Broadcasting

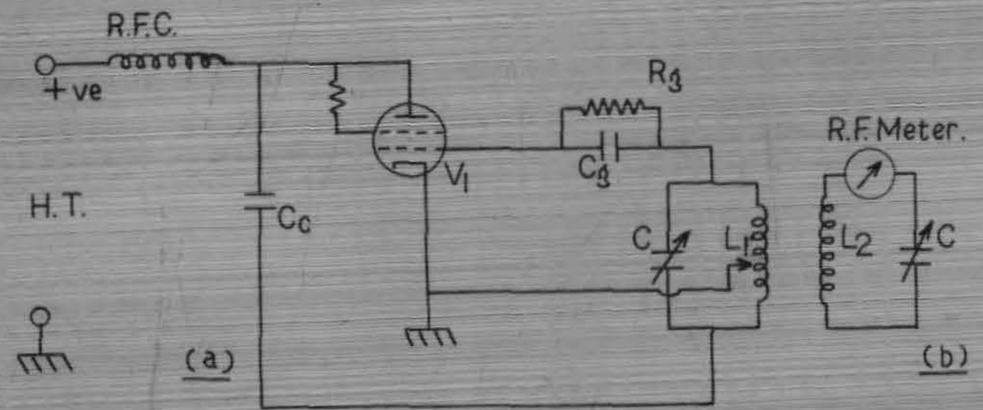


Fig. 2.2, (a) Radio frequency oscillator. (b) Secondary tuning circuit.

List of components.

$V_1 = 6L.6.$
$R_g = 30\ k\Omega$
$C_g = 350$ P.F.
$C = 0-500$ P.F.

$C_c = \cdot 01\ \mu F.$
R.F.C. = Radio frequency choke.
R.F. Meter = Radio frequency milli ammeter.

Receiver and a Wave meter (h) Measuring cylinder, Beakers and Weight bottle (i) Chemical balance and weight box (j) Liquid purification arrangement (k) Electromagnet (l) Ostwald Viscometer (m) Travelling microscope.

R.F.Oscillator: The radio frequency Oscillator used here is of Hartley type and the circuit diagram is shown in the figure (2.2). It has been designed to cover a range of 200 Kc/Sec to 9 Mc/Sec. The inductance L of the tank circuit is divided into two parts L_1 and L_2 and their common point is connected to the cathode terminal of the vacuum tube 6L.6. The end of L_1 is connected to the grid through the $R_g C_g$, a parallel combination which is used for providing the grid bias voltage. The end of L_2 is connected to the plate of the oscillator valve 6L6 through the blocking condenser C_c. A condenser C is placed in parallel with the inductance L, thereby making a complete tank circuit. The current circulating in the resonant circuit passes through both portions of the inductance and developes a voltage for the grid excitation. The connection of the plate voltage supply is known as shunt feed. The direct component of the plate current is supplied from a stabilised power supply, through a radio frequency choke. The blocking capacitor C_c, which has a small reactance compared with load impedance, allows a path to the a-c component, while the d-c from the power supply is prevented. The gang condenser dial has been calibrated against frequency, by the help of a communication broadcasting receiver and also by a absorption wavemeter. A secondary receiving circuit, consisting of inductance, a variable tuning condenser and a radio frequency milliammeter in series is loosely coupled to the Hartley Oscillator's tank circuit. A vernier condenser is fitted in parallel to the tuning condenser of secondary circuit in order to improve the accuracy of tuning the desired frequency. The dial of the tuning condenser has been calibrated in term of capacitance by the help of a L.C.R. bridge.

The dial readings against capacitance are shown in figure (2.3 a to 2.3g).

CALIBRATION OF DIAL OF THE TUNING CONDENSER OF THE RECEIVER CIRCUIT.

Table (2.1)

Dial reading in degree	Capacitance in $\mu\mu F$.	Dial reading in degree	Capacitance in $\mu\mu F$.
0	548.5	13	358
1	533.5	14	341
2	519.5	15	325
3	505	16	309
4	491	17	295
5	476	18	280
6	461	19	265
7	448.5	20	252
8	435	21	239
9	418.5	22	226

Contd..

Table (2.1)

Dial reading in degree	Capacitance in $\mu\mu F$.	Dial reading in degree	Capacitance in $\mu\mu F$.
10	401	23	214
11	388	24	200
12	370	25	189
26	178	39	78.8
27	167	40	73.4
28	155	41	68.5
29	146	42	64.2
30	135	43	59.9
31	128	44	55.9
32	120	45	51.9
33	112	46	48.8
34	105	47	45.4
35	101	48	42.5
36	95.5	49	39.5
37	90.0	50	36.9
38	84.9	51	34.4
		52	32.1
		53	30.15
		54	29.0
		55	27.8
		56	27.5
		56.8	27.0

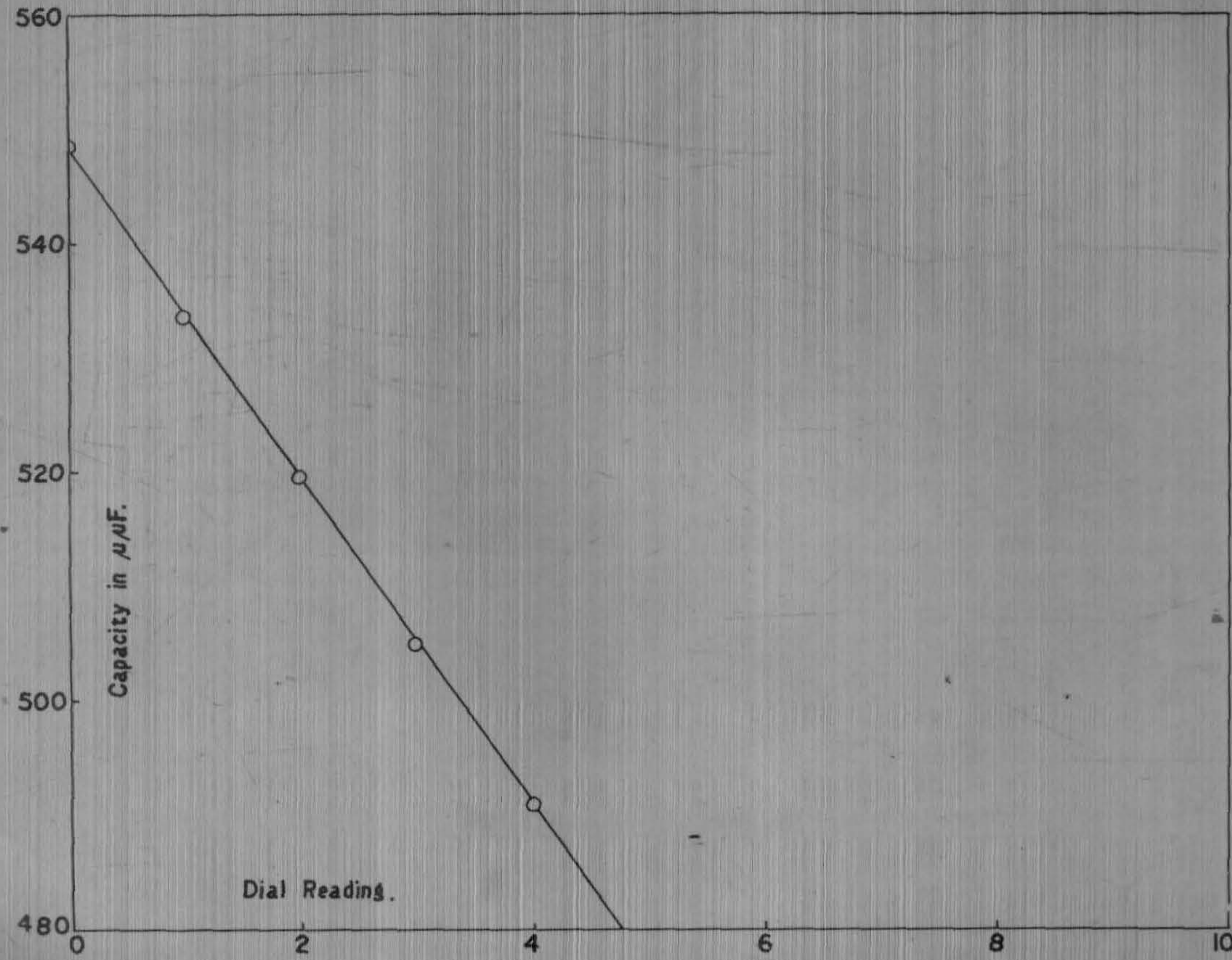


Fig.2.3.a.

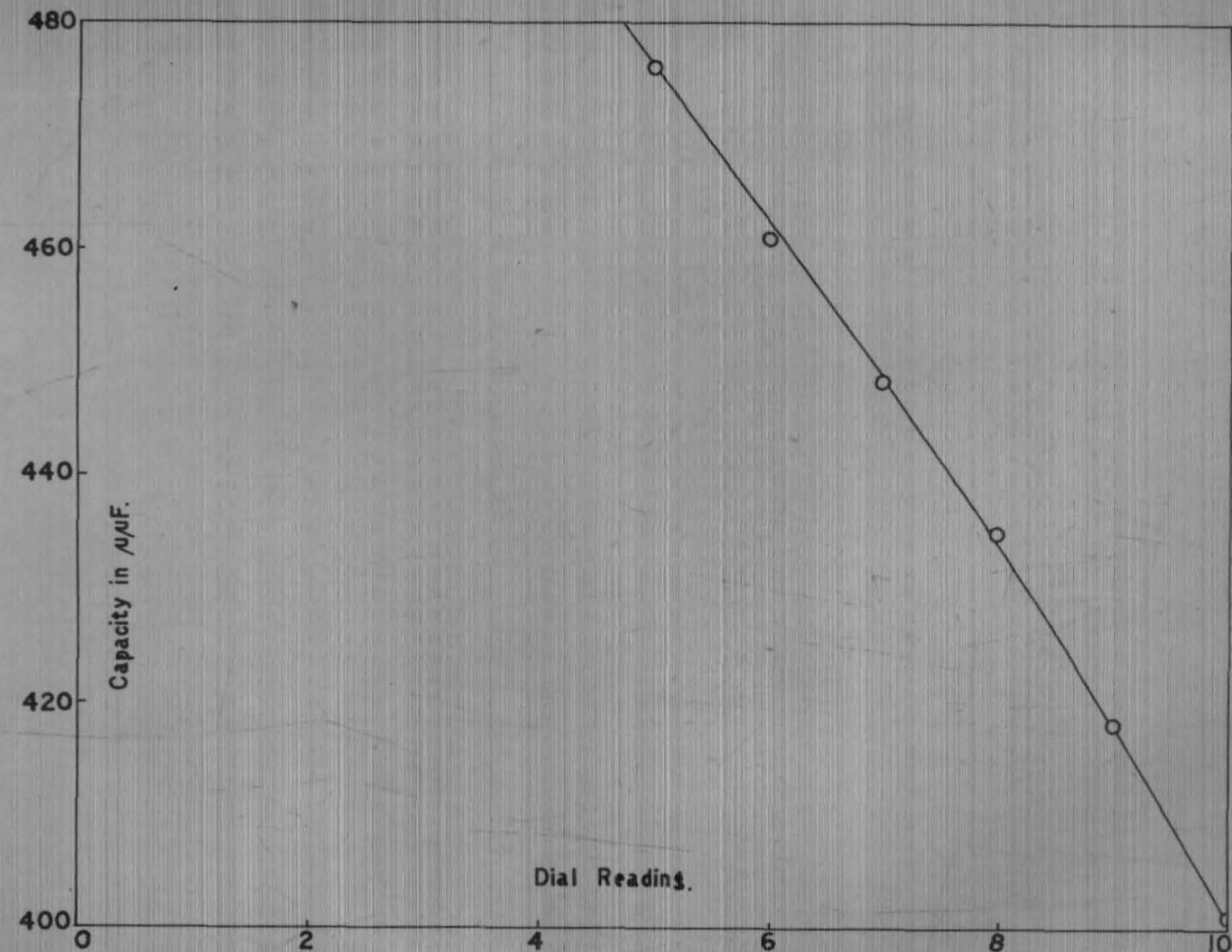


Fig. 2.3.b.

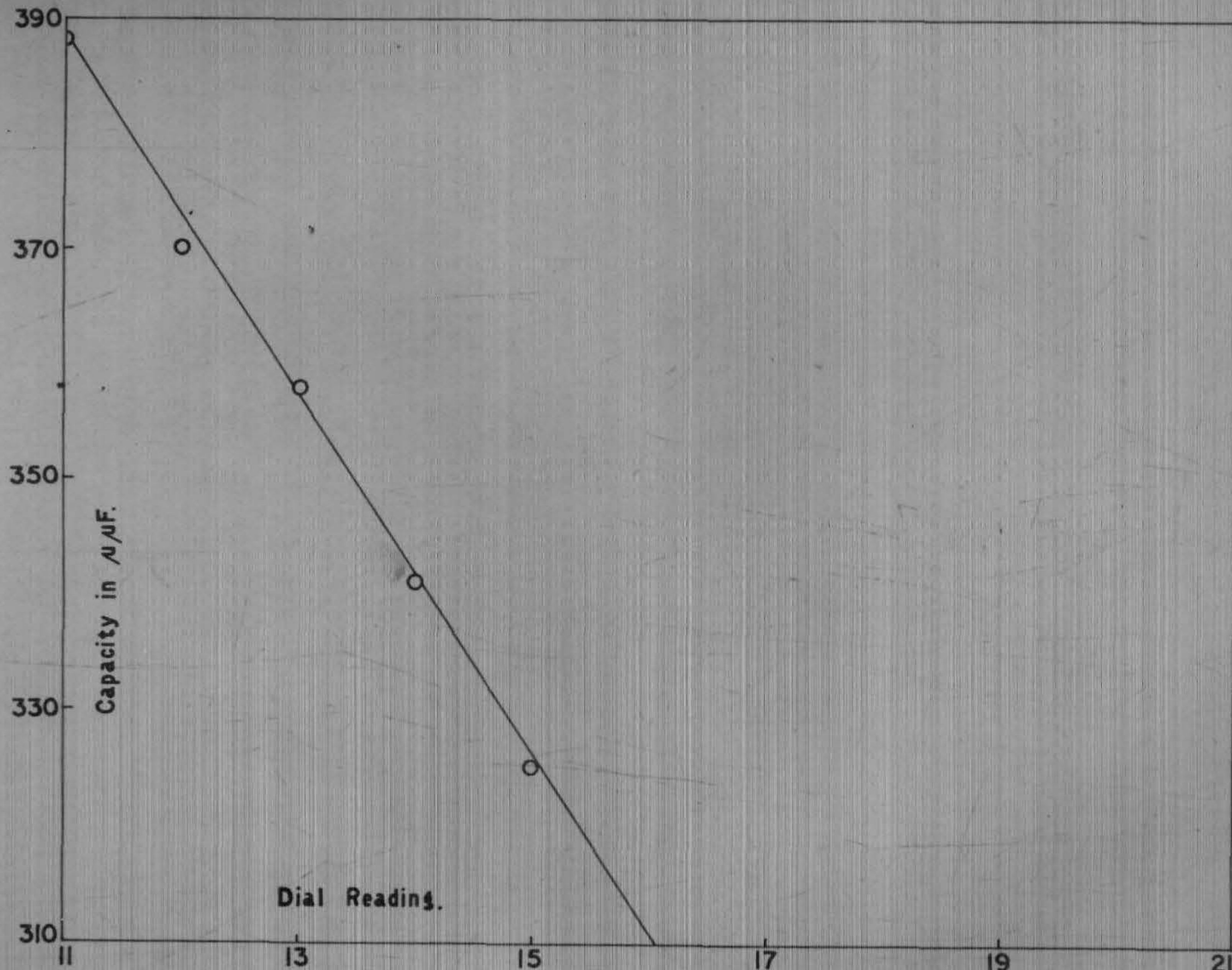

390
370
350
330
310
Capacity in μμF.
Dial Reading.
11
13
15
17
19
21

Fig. 2.3.c.

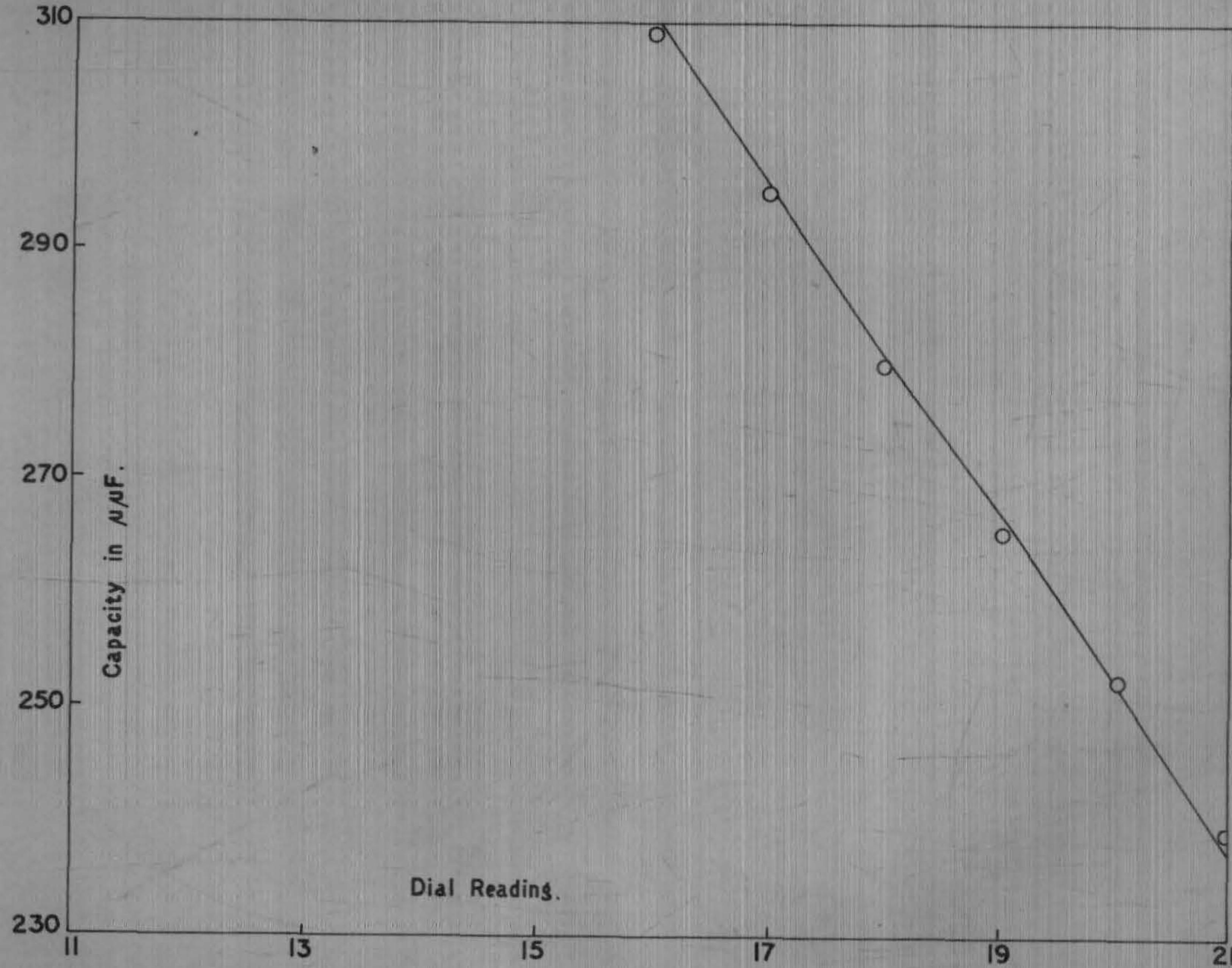

310
290
270
250
230
Capacity in μμF.
Dial Reading.
11
13
15
17
19
21

Fig. 2.3.d.

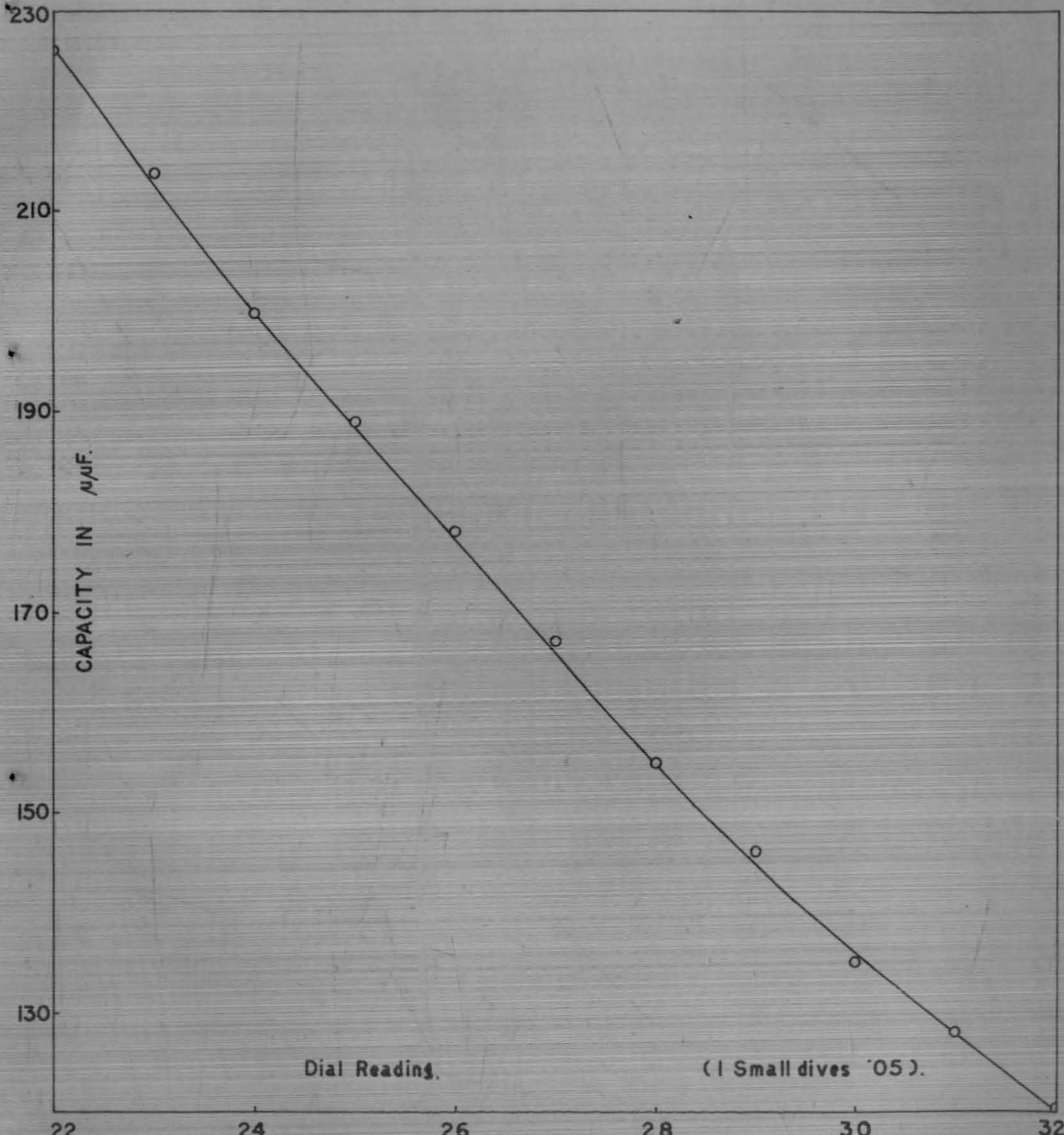

230
210
190
170
150
130
CAPACITY IN μμF.
Dial Reading.
(1 Small dives ·05).
22
24
26
28
30
32

Fig. 2.3.e.

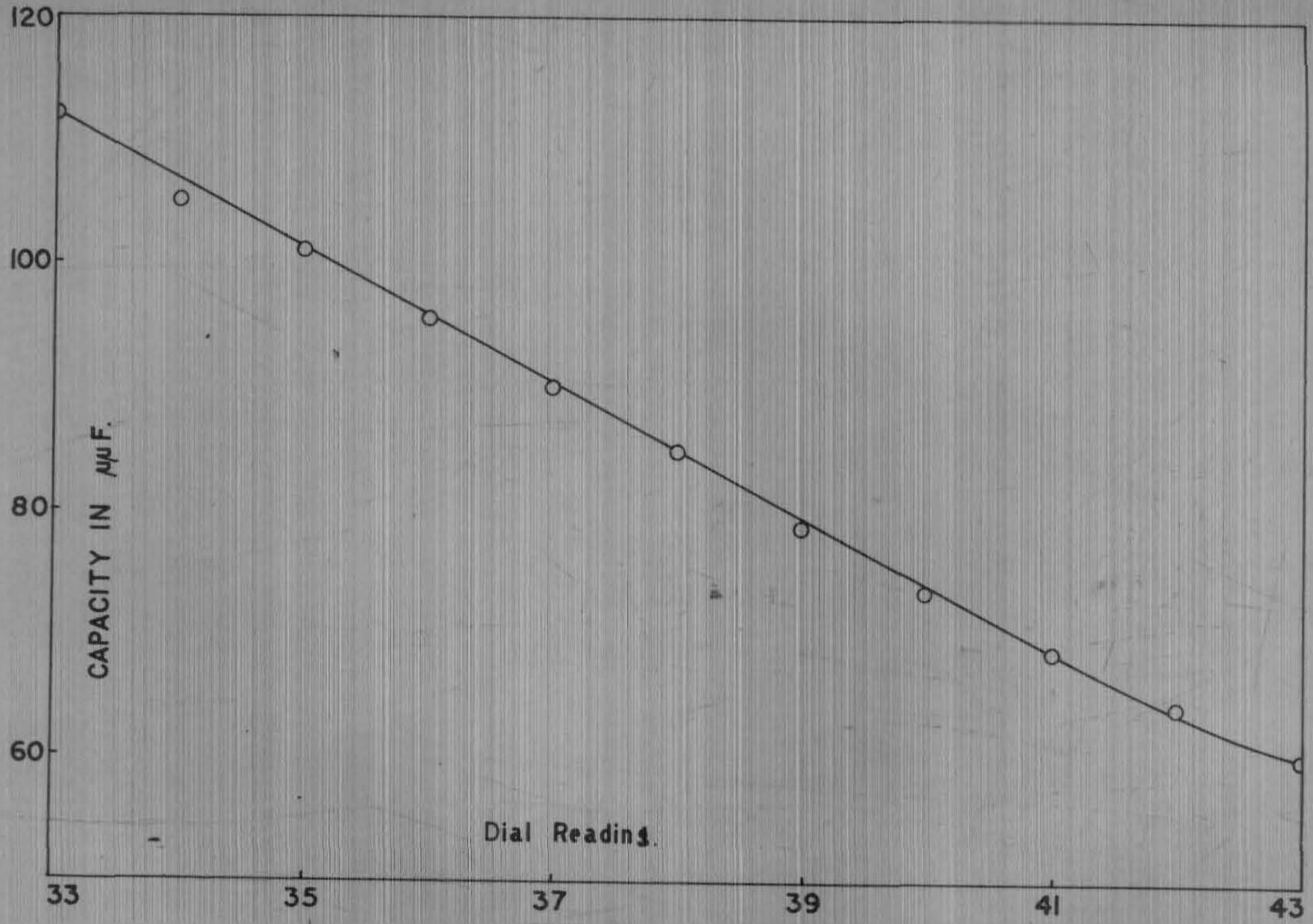


Fig. 2. 3. f.

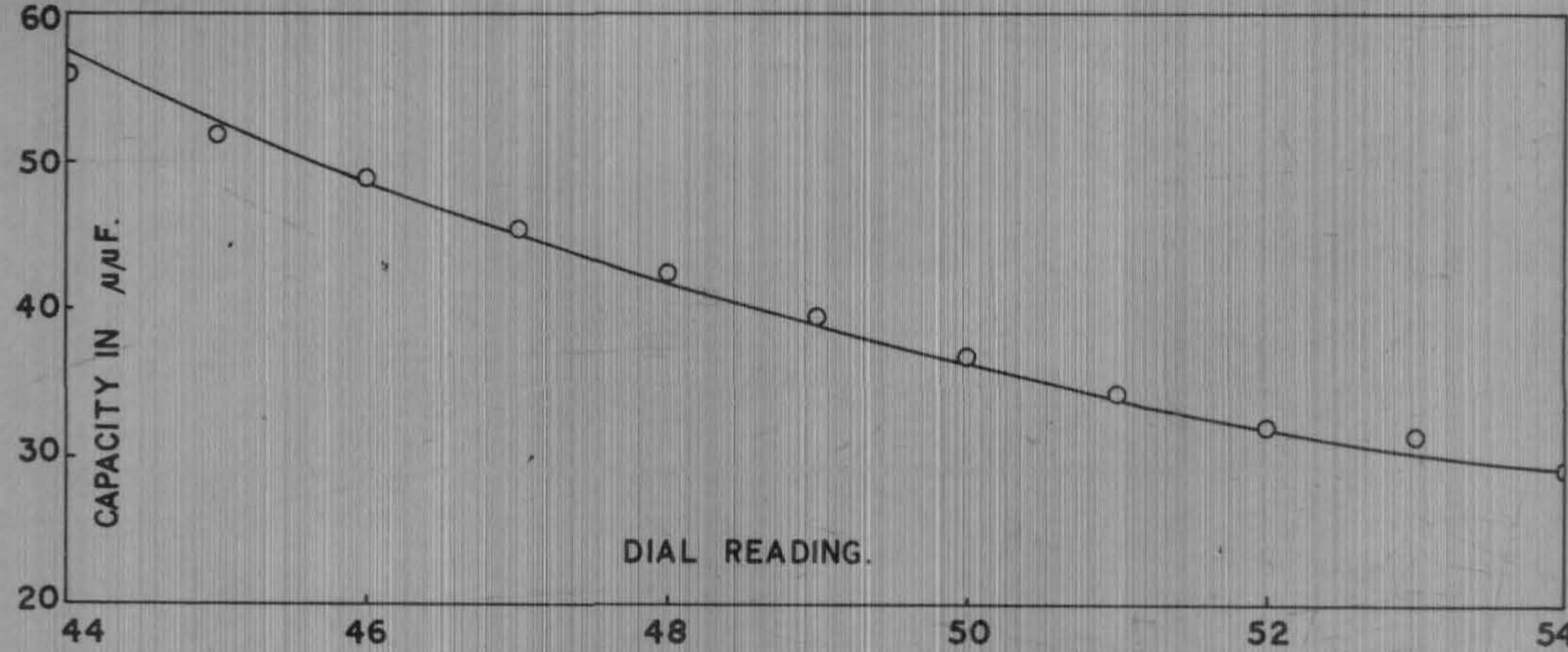


Fig. 2.3a.

Radio frequency milliammeter: The radio frequency milliammeter ranging from 0 to 120 milli amp. is a thermo couple type milliammeter and it is sensitive upto 30 Mc/Sec. This instrument has been obtained from Weston Instruments Division, Weston Instruments, Inc. 614, Frelenghuysen Avenue, Newark, New-Jersey, 07114 U.S.A. The model No. is 308.

Stabilized Power Supply:

A stabilised power supply unit has been used to supply power to the oscillator. The basic circuit of the stabilized power supply of the degenerative type is shown in Fig. (2.4) and actual circuit diagram shown in Fig. (2.5).

The circuit of the fig. (2.4) may be considered as conventional transformer-rectifier and filter (T.R.F) circuit to obtain d.c. voltage from a.c. mains supply. This unstabilized voltage is given to the regulator part consisting of series tube TL (i.e. Pentode power tube) and an amplifier of gain G. A fixed reference voltage E_r (obtained from VR tube) and the difference amplifier of gain G is used to control TL, so as to afford degenerative compensation for any change in circuit conditions that tend to alter the existing output voltage e.d.c. coupling is used throughout and where this type of coupling results in loss or gain, resistors are by-passed by condensers, so that a greater degeneration is obtained for a.c. signals, in particular, for ripple voltage. By a simple analysis of the circuit it can

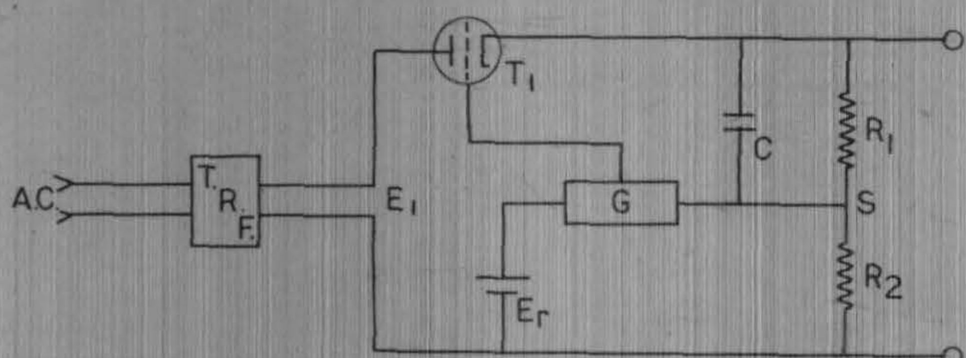
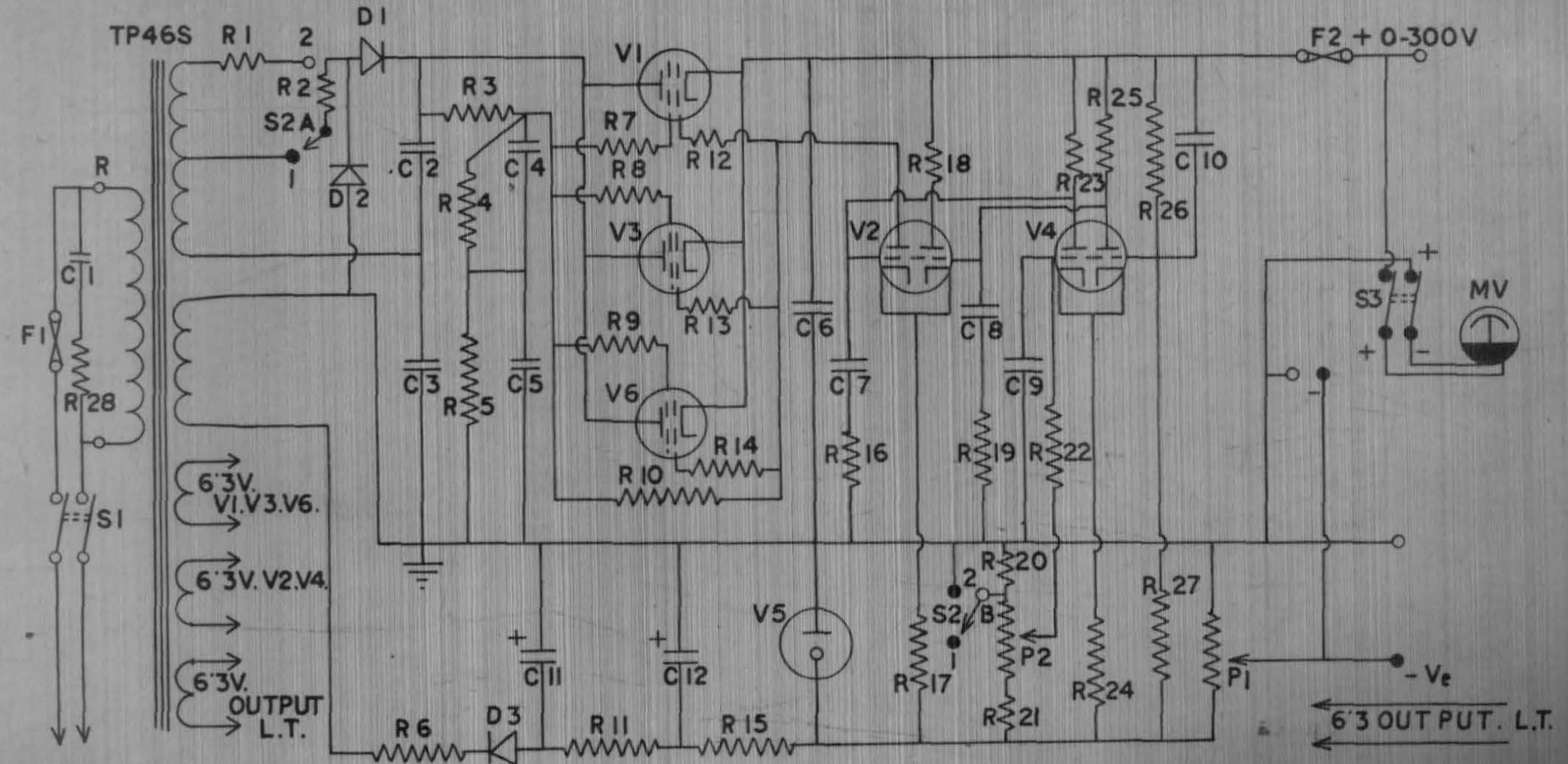


Fig. 2. 4. Basic circuit of the stabilized power supply of the degenerative type.

be shown that any change in EL of the T.R.F voltage E (due to change in Mains or Load) will appear across tube TL and across output and the amount of error voltage that will appear across TL is S times the voltage across output. So the stabilization factor of the circuit is S. The reactance of the condenser C, at ripple frequency may be made small compared with resistance in shunt with it. This condenser helps the stabilizer in reducing the ripple and it is not made large for avoiding undesirable transient oscillation in the output voltage. In order to obtain a practically ripple free output and an almost perfect regulation a two stage d.c. amplification have been introduced in the circuit. The output voltage E_0 is always $\frac{R_1-R_2}{R_2}$ times E_r. The It is observed that under operating conditions the stabilization factor is of the order 5000 and it goes down to 500 under extreme conditions of operation such as full load or too high or low main voltages.

The main supply line voltage is 220 volts 50 cycles/sec. Single phase is connected to the primary of the transformer and regulated d.c. voltage is obtained at output of the circuit whose range is 0 to 300 V and current 200mA maximum.

A circuit arrangement is made along with the stabilized power supply to get-ve bias voltage supply. The-ve bias supply is taken from a separate silicon rectifier Is95 regulated by a tube OA2. The variable-ve bias voltage is obtained from 0 to 100 V by means of a potentiometer providing er maximum load of 5mA only. The ripple



REGULATED POWER SUPPLY UNIT _

FIG. 2.5.

be shown that any change in EL of the T.R.F voltage E (due to change in Mains or Load) will appear across tube TL and across output and the amount of error voltage that will appear across TL is S times the voltage across output. So the stabilization factor of the circuit is S. The reactance of the condenser C, at ripple frequency may be made small compared with resistance in shunt with it. This condenser helps the stabilizer in reducing the ripple and it is not made large for avoiding undesirable transient oscillation in the output voltage. In order to obtain a practically ripple free output and an almost perfect regulation a two stage d.c. amplification have been introduced in the circuit. The output voltage E_0 is always $\frac{R_1-R_2}{R_2}$ times E_r. The It is observed that under operating conditions the stabilization factor is of the order 5000 and it goes down to 500 under extreme conditions of operation such as full load or too high or low main voltages.

The main supply line voltage is 220 volts 50 cycles/sec. Single phase is connected to the primary of the transformer and regulated d.c. voltage is obtained at output of the circuit whose range is 0 to 300 V and current 200mA maximum.

A circuit arrangement is made along with the stabilized power supply to get-ve bias voltage supply. The-ve bias supply is taken from a separate silicon rectifier Is95 regulated by a tube OA2. The variable-ve bias voltage is obtained from 0 to 100 V by means of a potentiometer providing per maximum load of 5mA only. The ripple voltage output is less than 3mV in the +ve supply and less than 10 mV in the -ve supply. A voltmerter calibrated from 0 to 300 volts is connected at the output terminal to read the d.c. output voltage. The practical circuit diagram of the regulated power supply unit is shown in the figure (2.5).

List of the components of Power Supply Unit.

1. Resistance

CeK Ref No.	Description	CeK Ref No.	Description
R_1	5 Ω	R_{17}	180K Ω
R_2	8 Ω	R_{18}	100K Ω
R_3	1K Ω	R_{19}	15K Ω
R_4, R_5	470K Ω	R_{20}	68K Ω
R_6	10 Ω	R_{21}	47K Ω
R_7, R_8, R_9	100 Ω	R_{22}	470K Ω
R_{10}	2.2M Ω	R_{23}	470K Ω
R_{11}	5K Ω	R_{24}	220K Ω
R_{12}, R_{13}, R_{14}	10K Ω	R_{25}	470K Ω
R_{15}	1K Ω	R_{26}	200K Ω
R_{16}	15K Ω	R_{27}	100K Ω
		R_{28}	1.5K Ω

II Capacitor

C_1	.1MFd
C_2, C_4	16MFd
C_3, C_5	16 "
C_6	8 "
C_7, C_8	.001 MFD
C_9	.042 "
C_{10}	0.2 "

III Potentiometer

P_1	10 KΩ
P_2	50 KΩ

IV Valves

V_1, V_3, V_6	EL86
V_2 V_4	ECC83
V_5	OA2

V Diodes

D_1 D_2 D_3	IS95

VI Switches

S_1	DPDt (ON/OFF)
S_2(A.B)	DPDT (0-100V, and 100-300V)
S_3	DPDT (Meter Selector)

VII Transformer

TP	463 Mains transformer

VIII Fuses

F_1	Main fuses 1 Amp.
F_2	H.T. Fuse 250 mA

IX Meter

Milli Volt (0 to 300v Voltmeter)

Thermostat

A thermostat has been used to maintain the temperature around the dielectric cell to be constant and also for the variation of temperature.

A Neo-thermostat Type No LP-202, MTA KUTESZ, Budapest, has been used for the above purposes shown in Fig. (2.6)

Neo-thermostat is composed of the principal parts:

1. Tank
2. Lid
3. Pump system with motor
4. Test vessel with set of rings
5. Contact thermometer
6. Cooling tube system
7. Return pipes
8. Heater and control thermometers.

1. Tank: The tank is a copper vessel of about 18 litres capacity surrounded by an aluminium jacket. The space between tank and jacket is fitted with a heat insulating material.

2. Lid: The lid, closed the vessel and is made of cloth-base phenol securing adequate heat insulation. It is fixed with four fostering screws.

3. The pump system is driven by a (transformer) single-phase 220V 60W VOTP 102/2 motor mounted vertically, equipped with a 7 μF capacitor for auxiliary phase starting. The pump system may have two functions to stir the thermostatic liquid in order to secure uniform heat distribution, and, increase of external temperature regulation, to circulate the thermostatic liquid suction, pressure and combined

suction and pressure circulation can be obtained.

4. The test vessel, made of copper, has a set of rings to permit the introduction of flanged vessels of various diameters into the tank. Heat insulation is improved by a cloth-base phenol cover above the ring, which has two holes for introducing the connecting wires.

5. The contact thermometer has a fine tungsten wire reaching into the capillary. When the wire comes into contact with the mercury column, it makes the circuit for the control device to start operating. The temperature to be kept constant is adjusted by the setting of distance between tungsten wire and mercury bulb. The tungsten wire is fixed to a nut which moves on a fine threaded spindle, to be adjusted with the magnet drum on the upper part of the contact thermometer.

6. The cooling tube system takes care of the dissipation of superfluous heat. The rate of heat dissipation can be adjusted by regulating quantity and flow rate of the coolant. The cooling system surrounds the heater of the lower power greatly improving the sensitivity of adjustment and the constancy of temperature.

7. The return pipe permits the use of either of the pump separately.

8. The heaters heat and keep the thermostatic liquid at constant temperature. The minimum and maximum power of the heater is 400 watts and 1200 watts, respectively. Heat transmission is improved by their cylindrical design.

9. The control thermometer, a precision instrument, is fitted into the holder provided on the lid.

Neo-Thermostat
Type No. LP -202.

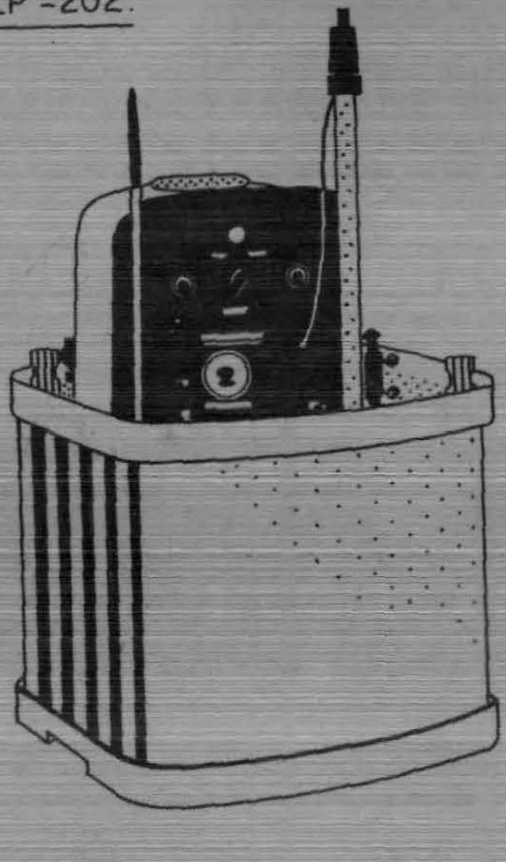


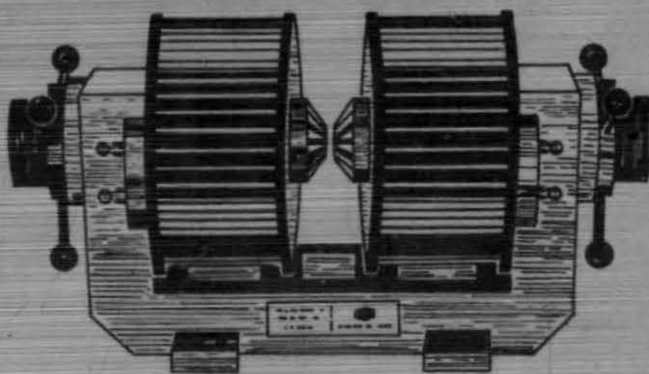
FIG. 2.6.

Pump motor and starting capacitor, control device, the connection of heaters and of earthing are protected by a casing plate covering the lid. The electronic control device receives impulses from the contact thermometer and with a mercury switch, switches on or off the heating accordingly.

Special care is taken for the operation of the thermostat with oil, at temperatures above 100°C. In this case, when heating the oil for the first time, the temperature of the oil should be kept between 100°C and 150°C. (The temperature varies from one oil grade to the other) so as to allow it to froth out. Frothing is caused by water contained in the oil. The temperature of the oil has been kept at a temperature lower than the starting point at which strong frothing has completely ceased; then the oil is continuously heated.

Calibration of Electromagnet.

The electromagnet shown in Fig. (2.7) is calibrated with the help of a Gauss meter. The Gauss meter consists of a rectangular coil rotated along the axis passing through its plane by a synchronous motor of 50 cycle per second. When this rotating coil is placed perpendicular to an uniform magnetic field, the induced a.c. e.m.f. is generated in the coil which is measured by the vacuum tube volt meter (V.T.V.M). The output induced voltage from the gauss meter for magnetic field strength of one gauss is taken from the data supplied by the manufacturer. During the measurements, the current through the electromagnet is gradually increased and the corresponding induced e.m.f. generated in the coil for various currents is noted in



ELECTRO MAGNET.

Field Strength - - -	Upto 22000 gauss at 10mms gap.
Pole Pieces (Conical) -	Dia 3cms length 27'5cms. These pole pieces are made from special Annealed soft iron Distance adjustable up to 7cms.
Coils - - - - -	Dia 27'5cms Number of turns 800 per coil.
Resistance of the coil -	16 ohms per coil approx.
Yokes - - - - -	The yoke has been made from silicon mixedcast iron.
Total weight - - -	150 Kgs approx.

FIG. 2.7.

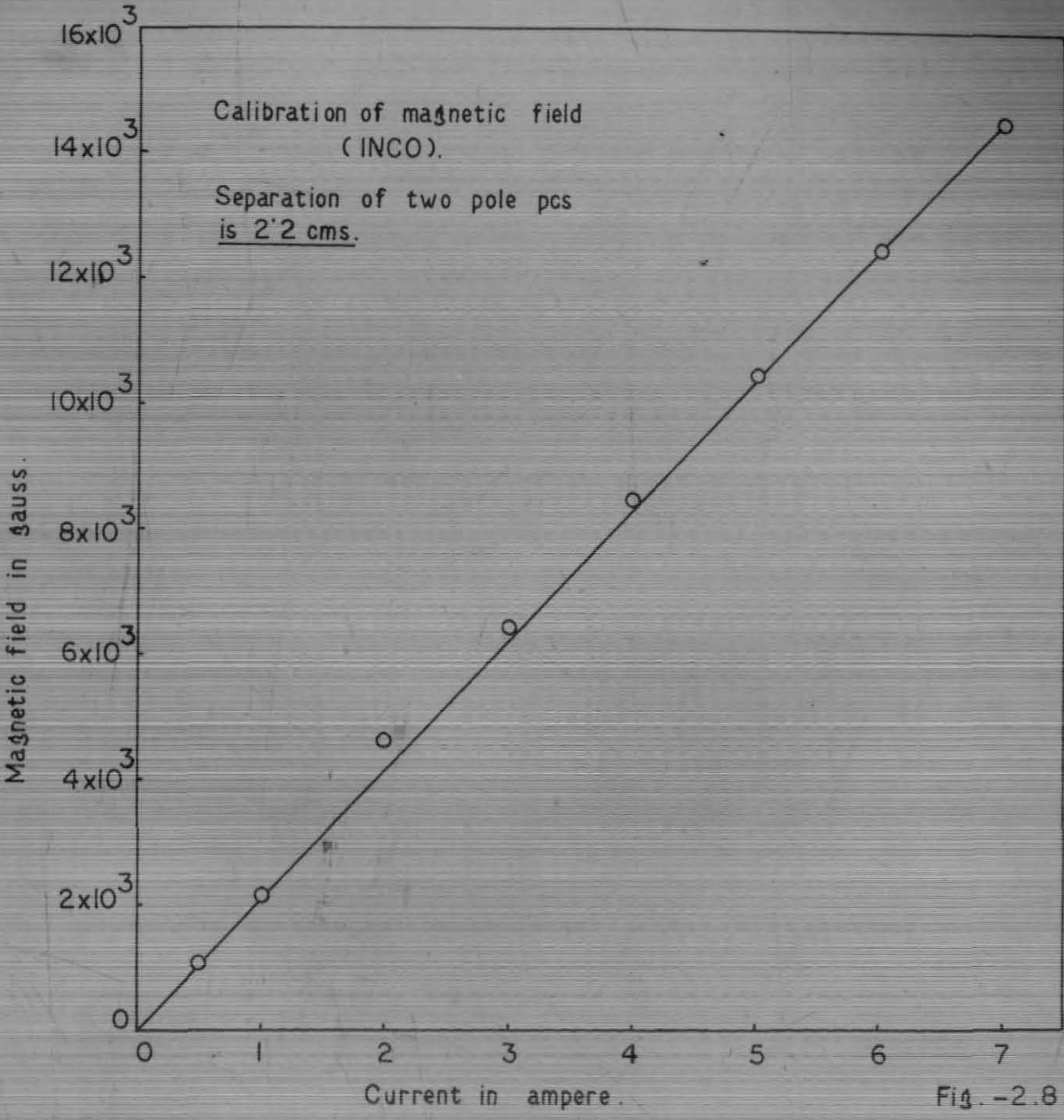
V.T.V.M. The magnetic field for different currents has been calculated from supplied data. A calibration curve drawn of the magnetic field against current in the coil of the electromagnet is shown in the fig. (2.8). Amplitude of the output a.c. voltage/gauss of the gauss meter supplied by the manufacturer "Rawson Electrical Instrument Co., Cambridge, Mass, U.S.A. is 0.18 m.v./gauss.

Calibration of electromagnet

Separation between two pole pieces = 2.2 cm.

Table 2.2

Current in ampere through the Coil of the magnet	Observed V.T.V.M reading in volts	Magnetic field in Gauss.
0.5	0.2	1111
1.0	0.4	2222
2.0	0.85	4695
3.0	1.16	6452
4.0	1.53	8500
5.0	1.90	10490
6.3	2.61	14500



Calibration of magnetic field
(INCO).
Separation of two pole pcs
is 2'2 cms.
16x10^3
14x10^3
12x10^3
10x10^3
8x10^3
6x10^3
4x10^3
2x10^3
0
Magnetic field in gauss.
0
1
2
3
4
5
6
7
Current in ampere.

Fig. -2.8

Figure [illegible] for fractional distillation.

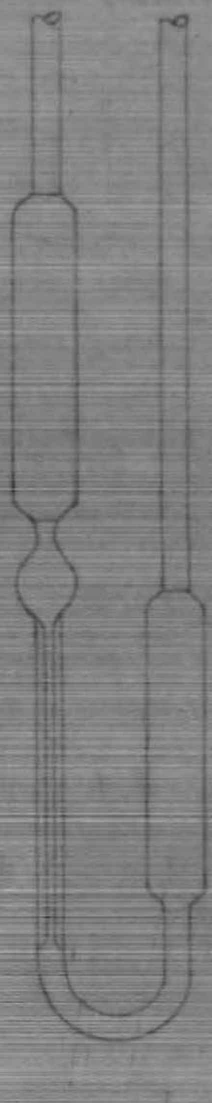


Fig - 2.10

Ostwald Viscometer

Purification of liquids:

The purity of a liquid is a very important factor in the study of electrical conduction and breakdown in dielectric liquids. It is not at all possible to obtain reproducible results if the liquid is of insufficient purity, and the characteristic properties of a liquid are often masked by phenomena arising due to the presence of impurities. Traces of water, and other electrolytic impurities are naturally the most important. The removal of these and small physical impurities, such as dust particles, is very important in all purification method. In our present work, we have used pure quality of chemicals, which we have obtained from reputed manufacturing companies; namely, E.Merck, Fluka and British Drug House (B.D.H). The liquid compounds have been distilled in a fractionating column and proper fraction were dried by dehydrating agents.

The typical fractionating column for laboratory use is shown in Fig. (2.9). The vapour from the boiling liquid passes to the upper portion of the column through a number of glass bulbs closed by glass spheres and inter connected by means of side-arms. The upper part of the columns remain closed by tap K until equilibrium is attained and vapour has reached the upper part. Tap K is then opened and the lower boiling fraction is taken off. A Beckman thermometer inserted in the upper part of the column enables vapour fractions to be separated with an accuracy of hundredths or even thousands of a degree. After purification the liquids have been directly introduced into the cell under vacuum distillation.

It is observed that the values of refractive indices of the distilled liquids agreed well with those given in standard literature.

Measurement of Viscosity:

The coefficient of viscosity of the pure liquids and also of the solutions at different temperatures were measured with the help of Ostwald type of Viscometer. The viscometer shown in Fig. (2.10) was placed in a thermostat (Neo-thermostat) whose temperature was kept constant within $\pm 0.2^{0}C$ at a certain temperature. If the time of fall of the experimental liquid and water between the same two marks in the viscometer were t_1 and t then $\eta_1 = \eta \frac{\rho_1 t_1}{\rho t}$; where η_1 and η are coefficient of viscosities of the experimental liquids and water respectively and ρ_1 and ρ are their respective density at the known temperature. The value of η and ρ of water were taken from international critical table and ρ_1 was measured and the value of η_1 was then obtained from the observed times of fall, using the above expression. The measured coefficient of viscosity by this arrangement agreed well with the literature values.

Dielectric cell:

Two types of dielectric liquid cell have been used for measuring the radio frequency conductivity of organic polar liquids.

(a) Fixed inter-electrode spacing type.

(b) Adjustable inter-electrode spacing type.

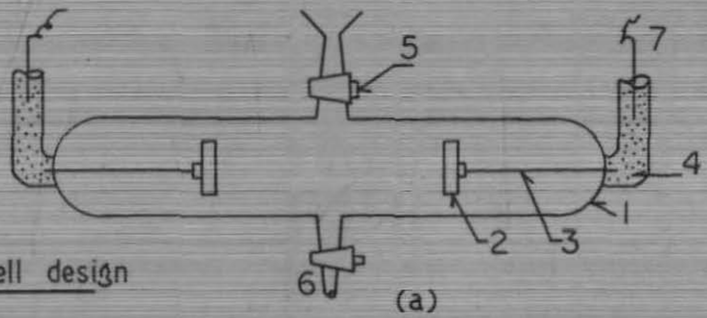


Fig. 2.11.(a) Cell design

(a) Brass electrode cylindrical cell. (1) Pyrex glass. (2) Circular highly polish brass electrode. (3) Tungsten wire. (4) Mercury seal & contact. (5) Filling tube with ground glass stop cock. (6) Out-let tube with ground glass stop cock. (7) Connecting wire.

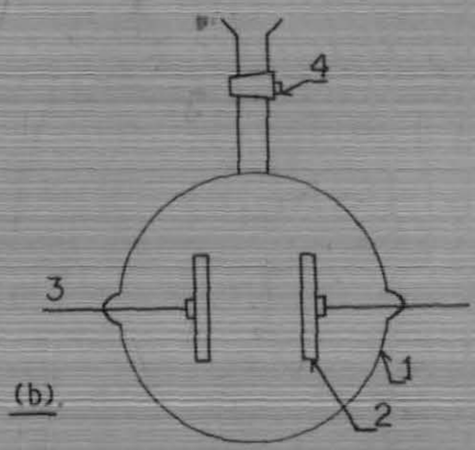
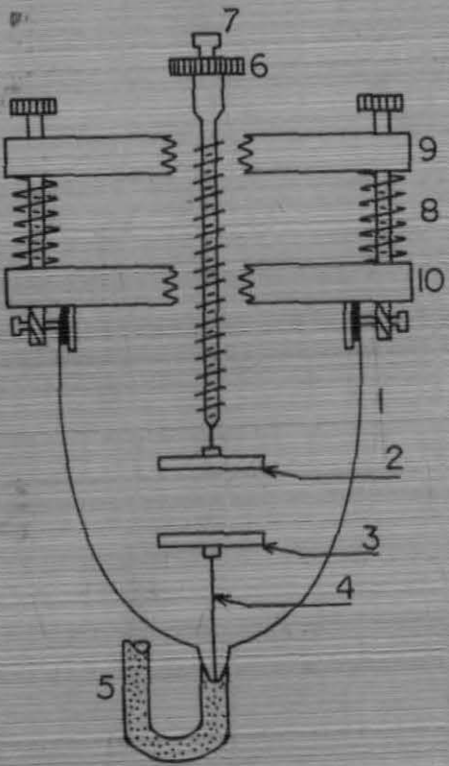


Fig. 2.11, (b) Spherical glass cell. (1) Pyrex glass. (2) Circular highly polish brass electrode. (3) Tungsten wire. (4) Filling tube with ground glass stop cock.



Cell design

(1) Pyrex glass. (2,3) Highly polish brass electrode. (4) Tungsten wire. (5) Connecting glass tube filled with mercury. (6) Ebonite rod. (7) Connecting screw. (8) Spring. (9, 10) Ebonite lid.

FIG. 2.12.

Type (a) Pyrex glass cell is fitted with two parallel plate circular electrodes separated by a fixed distance as shown in Fig. (2.11)

Type (b) Pyrex glass cylindrical dielectric cell is fitted with a fixed lower electrode and movable upper electrode. The upper electrode can be displaced in a well defined perpendicular fashion through the action of a micrometer screw. Both the electrodes are of same dimension. The diameter and thickness of the electrodes are 1.5 cm and 3 m.m. respectively. The smooth surface supporting lower electrode and top surface of the upper electrode is made parallel to each other as far as practicable shown in Fig. (2.12). The material used for electrodes has been mostly brass. In order to find the effect of any electrochemical reaction between the brass electrodes and liquids studied specially nitrobenzene, the experiments have been repeated a number of times with the same sample of liquid after definite intervals of time and in each case same results have been obtained. Brass electrodes have been used by previous workers and more recently by Prabhakar Rao and Gobinda Raju (1970) in case of nitrobenzene.

Washing and Cleaning of the dielectric cell:

The dielectric glass cells are throughly washed with dilute chromic acid, and care has been taken that no chemical reaction took place during washing the brass electrodes of glass cells. After that cells are throughly washed with NaOH solution and washed several times with distilled water. To remove traces of water, the washed cells are kept inside a thermostat. The dried cells are again washed with dehydrated pure benzene and dried.

Other glass articles such as, Beakers, pipet, measuring cylinder and specific gravity bottle are washed and cleaned thoroughly in the same way as the dielectric cell.

R E F E R E N C E S

Adamczewski Ignacy, (1969), Ionization, Conduction and Breakdown in dielectric liquids. Taylor and Francis Ltd. (London).

Daniels F, Mathews, J.H, Bender P and Alberty R.A. (1956), Experimental Physical Chemistry; McGraw Hill Book Company, Inc. New York.

Lange N.A. and Forker G.M. (1961) Hand book of Chemistry MacGraw Hill Book Company, Inc. New York.

Symth, C.P. (1955) Dielectric behavior and Structure, McGraw Hill Book Company, Inc. New York.