A.B.C.

SCIENCE NOTE BOOK

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[illegible] RADIO MECHANIC'S

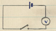
Class.

A.B.C. Co., 80 West Regent Street.

EXPT. IA. To study the effects due to various formations of Cells.

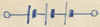
The circuit as shown was arranged with a voltmeter & a spring switch. The various formations used are shown. The cells used were accumulators of approx. 2·2 V.

1. Voltage of 1 cell = 2·2 V.



2. two in series
V = 4·4 V.

3. three in series.



V = 6·6

4. two in parallel

V = 2·2.

5. three in parallel.

V = 2·2

6/ four in series parallel.

V = 4·4

7/ two in opposition

V = 0

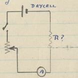
8/ three in opposition

V = 2·2
with bias in left side.

Conclusion ?

EXPT. 1B To shew that $I \propto 1/R$ provided E is constant.

The circuits were arranged as shown, four equal resistances being used in different formations. viz. one, two, three & four in series & four in parallel-series coupling.

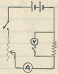


I in m/A	Resistance			
128	one	× 1	=	128
65	two in series	× 2	=	130
43	three ———	× 3	=	129
31	four ———	× 4	=	124
130	four in series-parallel.	× 1	=	130

Within the limits of experimental error these results are identical. This shews the product of I & R is constant. or $I \propto 1/R$.

EXPT. 1C To study the relationship between I & V of various resistances.

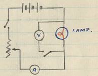
The circuit as shown was arranged with fixed resistors. Of these E, F, H, K & L, H is unity. & E 0.2, F = 0.5, K = 2 & L = 5. The rheostat was used to vary the volts drop across the resistor & thus the current thru' it in order to give several readings. The curves being straight lines ∴, $I \propto V$ if R is constant. i.e. Ohm's law is true.



For graph see i. at end of book.

EXPT. 1D. To study the relationship of the I & V of a lamp.

The circuit was as shown & as the rheostat was progressively moved, different readings of volts & amps. taken. The ammeter reading was taken before the voltmeter circuit switch was closed.
The graph showed that the resistance increased with greater current ie with increased temperature

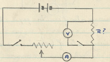


For graph see ii at end of book

V

EXPT. 1E. To find the resistance of various radio components.

The usual circuit for measuring resistance was arranged with a L.F. choke as an unknown resistance.
It should be noted that very erratic results occur when the resistance is very high. This is due to the resistance of the voltmeter being comparatively low. It should be as high as possible & in fact an electrostatic quadrant electrometer, with infinite resistance would be more accurate.



Low Frequency Choke.

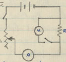
I in Amps	V in volts.	R in ohms.
0.0039	4.1	1051
0.0037	3.6	974
0.0035	3.2	915
0.0034	3.1	911
0.0033	3.0	908

The average resistance = 951.75 Ω

EXPT. 1F. To measure resistances & compare the results with the estimated values.

The circuit used was the "resistance" circuit with given resistors of 100 Ω each in various formations. The values of the formations were estimated & compared with the average result by experiment.

The circuit used was the "resistance" circuit with given resistors of 100 Ω each in various formations



i. The average value of 1 resistor = 95·7 Ω ; the calculated value = 100 Ω

ii. The average value of two in series = 200 Ω : the calculated result = 200 Ω.

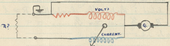
iii. The average value of three in series = 300 Ω : the calculated result = 300 Ω

iv. The average value of four in series-parallel = 95·9 Ω the calculated result = 100 Ω.

V

EXPT. 1 G Measurement of high resistances by the "Megger".

The megger consists of a generator turned by a handle, the measuring part is two coils set at right angles & arranged to turn in opposite directions. One, the voltage coil has a high resistance in series with it. The scale gives direct readings of resistance.



i. Value by megger = 1,100,000 Ω : Estimated value = 1,070,000 Ω

ii. Value by megger = 570,000 Ω : Estimated value = 528,000 Ω

iii. Value by megger = 210,000 Ω : Estimated value = 210,800 Ω.

iv. Value by megger = 500,000 Ω : Estimated value = 467,000 Ω

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EXPT. 1H To show that $R \propto l/a$.

Circuit diagram?

A board carrying three resistance wires, uniform in length & cross sectional area & which could be connected in any way at will by copper links, was in series with the "resistance" circuit. The resistance was found with one, two & three wires in series. The results were in simple proportion 1,2 & 3. With one, two & three in parallel the resistance was halved & thirded. This showed that $R \propto l$ & also $R \propto 1/a$. ie. $R \propto l/a$.

In Series.

I	E	R		
0.66	1.25	→ 1.9 ÷ 1.9 = 1.0	1 wire.	
0.43	1.6	→ 3.72 ÷ 1.9 = 2.0	2 wires.	
0.32	1.8	→ 5.80 ÷ 1.9 = 3.0	3 wires.	

In parallel.

I	E	R	
1.10	1.10	→ 1.0 ÷ 1.9 = $\frac{1}{2}$	2 wires
1.30	0.80	→ 0.62 ÷ 1.9 = $\frac{1}{3}$	3 wires.

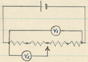
✓

EXPT. 1Ki. To study the relationship of P.D. & resistance.

The circuit was arranged as shown with four equal resistances. Voltmeter V_2 was used to find the P.D. across first one, then two & three of the resistances.

In each case the P.D. was proportional to the resistance showing that Voltage drops evenly in a resistance.

P.D. across 4 resistances by V_1 = 2.08V.
" 1 " V_2 = 0.50V
" 2 " = 1.00V
" 3 " = 1.50V
" 4 " = 2.10V.



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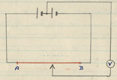
EXPT. IK₂. A further verification of P.D & R.

In this experiment the four resistors were replaced by a uniform potentiometer wire.

A graph, shown at the end of the book iii. was found to be a straight line. Missed purpose of Exp.

ie. R ∝ P.D.



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EXPT. I J. To find the voltage drop in leads.

The circuit as shown below was arranged. The current was varied by the rheostat in order to give several voltage readings. The leads between the voltmeters were of high resistance in order to represent long transmission lines.

The graph (iv) shows that the P.D. in the leads is proportional to the current consumed.

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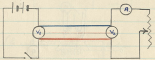
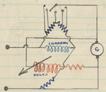


EXPT. 1L. Measurement of resistance by the "Bridge Megger."

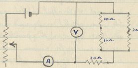
This instrument is a bridge arrangement of resistances in conjunction with a megger. It is used as a megger but when switched to bridge the current coil is used as the galvanometer of an ordinary bridge arrangement so that when the bridge is balanced no current flows i.e. the needle reads infinite resistance. Tappings from the three fixed resistances are provided for convenience when measuring resistances.



Range ?

EXPT. 1M. To measure the resistance of a net of resistors & compare the result with the estimated value.

The "resistance" circuit was used with the network. Several values were determined & the mean taken, by adjustment of the rheostat.



The calculated value = 30 Ω

The average value by experiment = 28.65 Ω Poor

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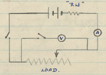
EXPT. 2A. Matching load to Source.

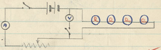
The circuit was arranged as shown & in order that an appreciable internal resistance's effect should be felt, a 10 Ω resistor was put in series in order to make an artificial internal resistance. The load was varied & the output plotted against resistance. The curve reached a maximum at an external resistance of 10 Ω, the equivalent of the internal resistance. Thus for maximum output the load resistance must equal the internal resistance.



For graphs see V at end of book.

EXPT 2A. To shew that when equal output is obtained from different circuits, the energy is equal in each.

The four lamps were used in the circuits in series, then parallel & series-parallel. In each case the rheostat was varied until the lamps just glowed. This ensured that the output was constant.
The wattage of each arrangement was found & within limits of experimental error they were identical.

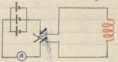


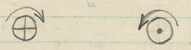
	I in Amps	E in Volts	W = EI in watts
parallel	0·96	0·90	0·864
series.	0·274	3·40	0·816
series–parallel	0·45	1·86	0·837.

The average wattage = 0·839 W.

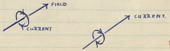
EXPT.'s 5A+5B To examine the magnetic field round a straight & a coiled conductor.

The circuit was as shewn, the leads were of thick copper in order to obtain maximum current. With a charm compass the configuration of the magnetic field was found in both the coil & a straight part of the circuit.





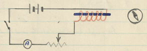
Magnetic field round a straight conductor carrying current.



EXPT.'s 5C+5D. To examine the magnetic field due to a cored, coil conductor.

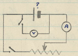
The solenoid was first used with no core i.e. air cored, & the compass needle was unaffected by its field until it was quite close to it. There was no field when the current ceased to flow.

With steel & soft iron, by virtue of their permeabilities the compass needle was affected at a great distance, more so in the case of soft iron. When the circuit was open the steel retained a fair amount of magnetism but the soft iron lost practically all.



EXPT. 3B. To examine the terminal P.D. of primary & secondary cells with load.

The circuit as shown was arranged first with a dry cell & then an accumulator. The load was varied & the terminal volts determined. With large load the available volts of the dry cell were very low showing that this type of cell should not be used for large current. The accumulator with a low internal resistance gave a good performance.

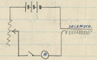


For graph see vi at the end of the book.

The irregular curve for the dry cell is caused by the recovery of the cell from polarisation.

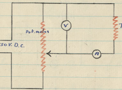
EXPT 5E. To examine the field of a solenoid.

The solenoid was connected as shown. With an iron core & a piece of iron wire outside the solenoid attraction ensued between them. With both inside the solenoid, since like poles were generated opposite each other repulsion occurred. When one pin was placed half in & half out of the solenoid it was attracted to the centre where the magnetic field is strongest when the current is switched on.



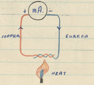
EXPT. 4C. To study the effect of overloading of radio components.

The circuit was as shown. From the given wattage of the component & its resistance, its working voltage was calculated. By the potentiometer half load, full load & overload were applied. The component was quite cool with half load, comfortably warm on full load but unbearable hot on overload. Overload may thus cause a resistance to heat up & may cause serious damage in a radio set.



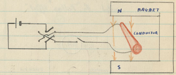
EXPT. 1B. To examine the "Seebeck Effect."

A moving coil meter was connected to a thermocouple consisting of eureka metal (iron) & copper. When the junction was heated an e.m.f. was formed between the ends of the wire & caused a current to flow thro' the meter. The principle can be applied to measure R.M.S. values of A. current but due to the heat being proportional to I^2 the scale is a square law scale. The flow of electricity is from eureka to copper. It should be noted that the converse is true & is called the "Peltier Effect."



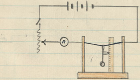
EXPT. 6A. To examine motor effect & show Fleming's "left hand" Rule is true.

The following circuit was arranged. Current was drawn from a cell via a reversing switch & a spring switch to two parallel copper rods fixed to a board & between the poles of a powerful, permanent horseshoe magnet. A copper roller was free to move on the two fixed rods. When a momentarily large current was passed the roller moved in a direction determined by the field & direction of current. These were varied & Fleming's left hand rule for motors was found to be true.



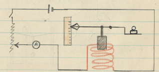
EXPT. 5F. To examine the hot wire ammeter.

The circuit was as shown. Resistance wire to which a pointer was attached on a weight was hung between two wooden supports. The deflection was read off on a linear scale. The graph of current^2 against deflection was a straight line due to deflection being proportional to heat which is proportional to current^2.
This shows that the scale of an instrument working on this principle is a square law scale.
The chief advantage of such an instrument is its ability to measure A.C.



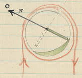
EXPT. 5G. To find the relationship between the torque of a moving galvanometer & the current flowing thru' it.

A moving iron (attraction type) galvanometer was in series with a m/c ammeter & a rheostat. The deflection on a linear scale was noted. with diffent currents.
A graph of deflection against current & current².
The latter was a straight showing that the deflection was proportional to current.² that is, the scale of a direct reading ammeter would be a square law scale.
The experiment was repeated but the pointer was brought back to zero deflection by the addition of weights. The graphs of the two methods are shown at the end of the book at vii.



EXPT. F. To examine a moving iron galvanometer (ammeter)

This consisted of a coil which was capable of carrying a large current. Set, a little out of symmetry, was a crescent of soft iron, another blade of soft iron was arrange to swing with a pointer over a scale. The offset was to allow this blade to be repelled. Damping was effected by a spring. The scale was square law, until the distance between the two poles was appreciable when an inverse square law compensated for this. The scale at the end of the range was rather cramped due to the damping of the spring. The express m^2/r^2 explains the shape of the scale.



EXPT. 7D So study the build of e.m.f. with field of a shunt generator.

7G. So study the external characteristic of a shunt generator

7H So study the external characteristic of a compound generator

7J. So study the external characteristic of a contra-compound generator.

A generator with variable connections was coupled to a prime mover. The generator was connected as a shunt machine & with no load the ~~terminal~~ E.M.F. was examined with a varying field.

With a fixed field. the terminal volts were examined with varying in the case of a shunt generator, & compound generator, both cumulative & contra wound. The graphs are at the end of the book.

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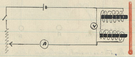
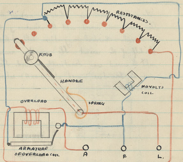
EXPT. 5H So test a contactor or relay.

An electric bell was placed in a circuit as shown. The current was varied until the armature just moved to the coils. Residual magnetism held it there with the help of the current. The armature remained so until the current was drastically removed. The case in view the armature moved at 0.03A & returned at 0.017A.

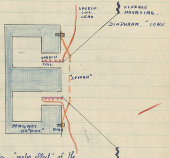


EXPT. 6F. To examine a motor starter.



As the handle is moved, resistence is taken from the armature & the no volts coil energised. If the current stops, due to a short circuit of the no volts coil, the handle flies back. The overload release effects the short circuit of the no volts coil when excess current flows.

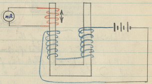
EXPT. 6C. To examine Moving coil Speakers.



The interaction, "motor effect" of the magnetic field, which may be that of a permanent magnet or an electro-magnet & the fluctuating field of the speech coil causes the speech coil & thus the cone to vibrate, producing sound. The spider supplies the spring arrangement for the speech coil.

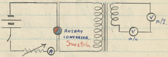
EXPT. 7A. To examine Electro-Magnetic Induction.

A coil of wire to which was attached a centre zero millameter was moved over one pole of an energised electro-magnet. Affecting E.M.F. was induced in the coil & a 2nd. one in the opposite direction was obtained on taking off the coil. The magnitude of this was increased by increasing the speed & also using a larger coil.



EXPT. 8E To study meters in operation.

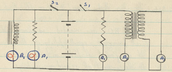
The circuit was arranged as shown with a rotary converting switch. The moving coil ammeter tried to show the A.C. but gave up after reaching a high frequency, the moving iron meter, due to it's non-polarising power, was able to give the R.M.S. value of the current. It was noted that when the core was removed from the transformer the e.m.f. & thus the current in the secondary circuit was reduced.

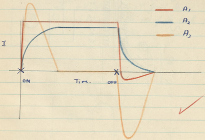


EXPT. 8 A   To study the effect of Inductance.

The circuit was as shewn. When the key S_1 was depressed A_1 immediately rose to the value of the ~~volt~~ current thru' R. while A_2, due to the retarding action of the inductance of the primary winding of the transformer took some time to reach the maximum. Meanwhile a current (e.m.f.) was induced in the secondary in proportion to the rate of change of the primary current. When the circuit was opened A_2 & A_3 took some time to reach zero while A_1 reached it immediately. The current A_2 thereupon travelled thru' A_1 & was shown on that circuit's ammeter.

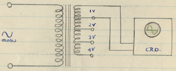
A graph of the currents with time is appended. The other half of the circuit again shows the lag of current for when S_2 is closed L_1 lights up immediately while L_2 takes some time. This again is due to the inductance of the choke.





EXPT. 8 L To shew that induced E.M.F. ∝ Flux linkage.

A. C.R.O. was connected as shewn, with a fixed primary & equal tapping of the secondary it was found that the induced e.m.f. was proportional to the amount of secondary windings.

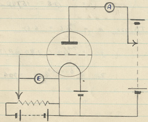


EXPT 19 A&B To examine the anode current with varying grid bias of values & the anode current with varying anode voltage

The circuit as shewn a varying Eg was made to control Ia. This was done for the values of Ea, 120, 96 & 70V on two Valves T.B. 282 & 122

With the grid bias constant reading of Ia with varying Ea were taken for both values with 0V, -1.5V & -3V. Grid bias.

The graphs are at the end of the book. XXI



<u>EXPT. 19C.</u> To calculate the constant values of a valve.

Ro, μ & g for the two valves were calculated from the results of 19 A & B.

<u>T.B. 282</u> $\mu = dE_a/dE_g$

$= 26/1.70 = \underline{15.30}$

$g = dI_a/dE_g$

$= \frac{1.75}{1.70} = \underline{1.029 \text{ mA/V}}.$

$R_o = dE_a/dI_a$

$= 60 \times 10^3/3.8 = \underline{15,790\ \Omega}$

<u>T.B. 122.</u> $\mu = 24/3.6 = \underline{6.67}$

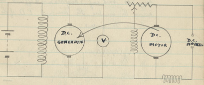
$g = 7.4/3.9 = \underline{1.90 \text{ mA/V}}.$

$R_o = \frac{60 \times 10^3}{16.25} = \underline{3,692.3\ \Omega}$

<u>EXPT. 7C & 7D.</u> To study the E.m.f. of a D.C. generator, seperately excited, under varying conditions.

The generator was driven by an electric motor. With the field current constant, the terminal P.D. was noted with various speeds. Then with the speed constant, the P.D. was taken with a varying field.

The graphs are XII & XIII.



The bend in the second graph is due to the saturation of the iron in the field magnets.

The graphs show that:—

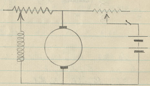
$E \propto I_f$ ie Φ since $\Phi \propto I_f$

& $E \propto N$.

$\therefore E \propto N\Phi$ or NI.

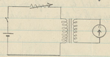
EXPT. 6E. To examine the action of a motor starter & field regulator.

A motor was connected as a shunt motor as shown. With the current switched on, nothing happened. As the resistance was taken off the armature circuit the motor speeded up. The resistance was put off the field circuit & the motor speeded up till the it reached an optimum level, then further reduction of resistance caused it to slow down. This due to there being less back emf. & therefore more effective voltage across the armature. The terminal P.D. of the armature was seen to increase.



EXPT. 8A, B, C & D. To examine Induction

The circuit was as shown. When the switch was closed an emf. was induced in the secondary coil & when opened an emf. in the opposite direction. The core of soft iron considerably increased this effect. The value of the current ~~these~~ I, was seen to increase the e.m.f. induced.

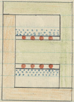


The "flux linkage" was altered by varying the rheostat. It was seen that the emf. depended on the speed of movement. Again the flux linkage was altered by moving the primary coil in relation to the secondary with a constant current. The same effects were noted.

The primary was replaced by a bar magnet. Again the amount of flux & the rate of cutting lines of force was seen to govern the size of the induced e.m.f.

EXPT. 8A. To examine a transformer.

The core was laminated & built up as shown. The primary windings was of thick copper wire & consisted of comparatively few turns. It was capable of carrying high currents. The secondary coils were thin & a great number. In this small transformer the laminations were insulated by means of "iron oxide, "rust". but in larger size the insulation is mica. etc.

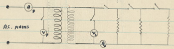


EXPT. 8 H & J. To study the relationship of primary volts & current to secondary volts & current & the turns ratio.

The transformer used had 1500 turns in the primary winding & 2500 in the secondary. A.C. mains supply of 250 V. were used & the output was noted to be 411 V. which agreed with the value as calculated from $T_1/T_2 = E_1/E_2$.

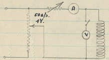
With varying loads it was found that the currents were in inverse proportion to the turns ratio. A slight current in each case was noted but this was for the losses in the core, eddy currents, & heating losses etc.

$$I_1/I_2 = T_2/T_1$$



EXPT. To examine the self Induction of a coil.

The coil was connected as shewn across a 50 c/s 1 volt supply. The volts drop across the coil was varied by means of the rheostat at 9 different values of P.D. across & current thru' the coil. This was repeated with 1, 2, 3 & 4 iron rods in the coil.
The impedance was found to increase with an increase in the core's crosssectional area.
The graphs are shewn in XIII.



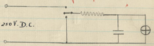
EXPT. 9A. To examine condensers.

1. A roll of waxed paper between two plates of aluminium foil gives large, fixed condenser.
2. This roll used in a tubular, small type.
3. Mica dielectric, & tinplate anode in a bakelite container, Small fixed type.
4. Variable condenser with aluminium plates, comb-shaped, moved on a common spindle in between fixed plates. Air was the dielectric.
5. The same as above but with bakelite or mica dielectric.
6. Electrolytic condensers. Vide Theory Notes.

EXPT. 9B & 9C. To charge & discharge condensers.

Six condenser were used, which could be coupled in parallel at will. 250 Volts. D.C. were put across two thru' a resistance. When the P.D. was 250 V. the charging stopped. The charging was slow due to CR (the time factor) being large ($R = 5 \times 10^5 \Omega$)
The condenser were short circuited (no resistance) & CR was thus small so that the discharge was quick & resulted in a large, noisy spark.
When the condensers were discharged thru' the resistance it took some time for the charge to disappear.

graph?



EXPT. 9D To examine the leaking of a condenser.

The condenser was charged & left. The electrostatic Voltmeter showed that the condenser discharged only very slowly, shewing the danger of leaving charged condensers about.

EXPT. 9E. To charge further condensers from a condenser.

A set of two further condensers were charged from the 1st set. The P.D. was seen to decrease as some of the charge left to charge the 2nd set. With the charing circuit closed, the charging again finished at 250 V.

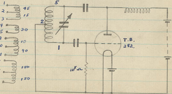
J.P. 6/10/32

EXPT. 21. To construct a Hartley Oscillator.

The circuit as shown was arranged. The first valve holder only was used. The grid leak 100,000 Ω was deliberately made large by in order to obtain "squegging". The graph of anode current against the setting of the condenser is shown graphically xiv.

When the R.f. choke was shorted no "feed-back" was available in the L.C. circuit & so the anode current rose to a maximum. This also occurred when the bias on the grid was cut off by shorting the grid leak. When the tuning condenser was shorted the current again increased owing to the "signal" stopping.

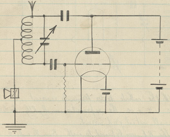
The coil used was an "all-purpose" coil as shown



EXPT. 21A. To modify the Hartley Oscillator as a Transmitter.

The Hartley Oscillator was arranged with series modulation as a transmitter.

It was noticed that undue motion caused the frequency to drift.



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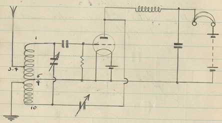
EXPT. 22. To Modify the Hartley Circuit as a Receiver with Reaction.

The circuit was as shown.



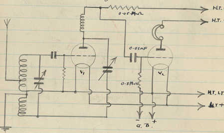
22A. With the cathode heater terminals reversed i.e. the grid leak to L.T. + ve. the reproduction was slightly louder due to the small initial grid current.

22.B. The R.f. was by-passed to earth from the anode & was thus unable to supply any "feed-back" by developing a voltage across the R.f. choke.

22C. With the aerial connected to pin 1 the capacity of the aerial was in parallel with the tuning condenser & the result was that the stations appeared in different orientations of the tuning condenser. The selectivity also became very bad.

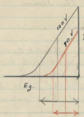
With a small condenser (0.0001) in series with the aerial the aerial capacity was reduced & thus all its bad effects were offset.

EXPT. 23. The Hartley Receiver with stage of R.f. amplification. with R.C. coupling.



The grid bias of V_2 was altered causing grid current to flow at 0 bias & cut off (rectification) at a high bias. This gave rise to distortion. Ia was also altered.

As the anode voltage was varied the grid acceptance was lessened & if the signal was strong, distortion took place. Ia also altered



A R.f. modulated to 100 c/s. was introduced into the circuit. The Potential between grid & cathode of V_a was noted on the C.R.O. & also between anode & cathode. The stage gain was the fraction of the two. $A \simeq 6$.
The voltages were noted to be out of phase.

$$dEg \propto dIa \propto 1/dEa$$
$$\therefore dEg \propto 1/dEa.$$

i.e. as the grid was made more +ve, say, the anode volts dropped.

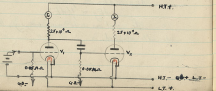
EXPT. 24. To investigate Phase Inversion.

The circuit was as shown.

When a +ve signal is applied to V_1 i.e. the grid is made more +ve. I_1 rises & thus the P.D. across the anode load. The anode potential is decreased, & since this potential is applied, via the potmeter, to the grid of the second valve, the grid becomes more −ve & thus I_2 reduces. & also Ea_2 increases.

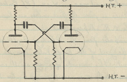
When a change is made in grid potential anode potential varies in an opposite sense.

When only one grid bias is altered, Ia varies & thus, in effect the load on the H.T. supply changes. The resultant change in P.D. across the internal R of the H.T. supply effects both the valves Ea's & thus their Ia's



EXPT. 25. The Symmetrical Multivibrator.

This circuit was arranged. The C.R.O. was used to study the wave forms of the voltage variation between the two anodes, the anode & cathode & the grid & cathode of either valve. By its connections an oscillation having the wave forms as shown were produced, the frequency being determined by the values of C & R. for full notes on the working see theory notes.



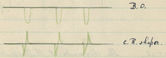
EXPT. 26. The Blocking Oscillator.

For full notes on this circuit see theory notes.
Different values of condensers were used, the smaller caused no "squegging" & the large ones gave squegging at different recurrence frequencies.

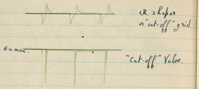
R_1 & $R_1 b$ = 50,000 Ω		$R_3 b$ =	1 MΩ.
R_2	= 50,000 Ω	C_1 =	0.003 μF.
R_3	= 25,000 Ω	C_3 =	0.5 μF.

The valve used was W 42 (Rf. Pentode)
The traces as given by these values are shown later.

EXPT. 26 The C.R. shaping circuit.
The impulse from the Blocking Oscillator are impressed on the grid of the "cut off valve" via the C.R. shaping circuit. This consists of a very small condenser & a ~~large~~ resistance in series giving a low time constant. When there is a downward change in Ea the condenser charges & then discharges when there is no change in Ea. This is made possible by keeping CR very low. If it is high nothing happens & the C.R. shaping circuits behaves as an ordinary coupling. During the change of Ea to a maximum the C charges, this time in an opposite sense. The C.R.O. traces shows this & it can be seen that the C.R. shaping circuit changes the impulses from B.O. into a -ve & a +ve pulse with the same R.f.

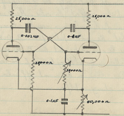


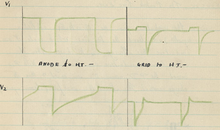
EXPT. 27 The "cut-off" valve.
The impulses from the C.R. shaper are impressed on the grid of a pentode which is biased into cut-off so much that only the +ve tips of the original impulses affect the valve. These show as "kicks" in Ea of this valve in a -ve direction. It can be seen that the shaped impulse from B.O. & the "cut-off" valve are the same shape but the P.D. is much lower in the latter case although R.f is constant. With less bias on the "cut-off" valve it acted as an ordinary amplifier.



EXPT. 28 The Asymmetrical Multivibrator.

This works as the Asymmetrical M'vibrator with modifications in biasing & the couplings giving different wave forms.





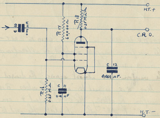
ANODE to H.T. – GRID to H.T. –

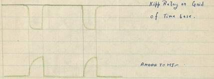
The wave forms may be modified by alteration of the variable bias & grid leak.

The waveform was almost square, the desired waveform!
The bias R15 is used to "cut off" the valves. R14 modifies the waveform by altering the C.R. constant & can achieve a sort of "cut off" when it shorts the grid to earth.
V2 is unaffected by the cutting off of V1, which valve experiences a great change in Ia.
Since V2 grid is directly connected to the cathode via R17, there is no P.D. between grid & cathode no matter how R15 is varied.

Expt. 29. The Pentode Time Base.

The impulses from the M.'vibrator applied a regular -ve bias to the line bias which made it non conductive thus allowing C_{12} to charge. When the valve became conductive C_{12} discharged. With R_{18} varied the P.D. across C_{12} was varied & thus its charge varied. This altered the wave form (became squarer)



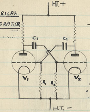


The amplitude & shape is controlled by R_{18} & C_{12}. whilst the r.f. is controlled by the Kipp Relay which is controlled in turn by the B.O.

Expt. 30.

With all the components working together. The Kipp relay was adjusted to give a desired output. with no overloading etc. The "cut-off" valve was biased to cut off. The "f" of the arrangement was controlled by R_{16} & R_2. R_{36} controlled the loading & once set was not retouched. R_{10}, R_{14} & R_{15} were left untouched. R_{18} controlled the amplitude & the shape of the output waveform.

SYMMETRICAL MULTIVIBRATOR

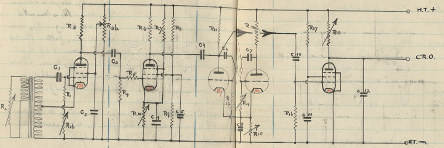


Suppose V_{g_1} changes in –ve sense. – E_{a_1} rises. – This is transmitted via C_1 & R_2 to $V_2 g$. – V_{g_2} rises. (+ve sense) – E_{a_2} falls – this drop in E_{a_2} is transmitted to $V_1 g$. via C_2 & R_1 – V_{g_1} becomes still more –ve. etc. etc. until V_1 is "biassed" to "cut off."

Whilst V_1 is ([illegible]) becoming "paralysed" V_2 is rising to saturation with V_1 non conductive. feed back from V_2 to $V_1 g$ ceases & the system relaxes at a rate governed by the time constant of $C_2.R_1$.

As $V_1 g$ potential → 0 – V_1 becomes conductive & the amplifying properties of both valves are reestablished with $V_1 g$ rising in potential (+ve sense)

Feeding back now takes place in the reverse sense & the voltages build up until V_1 is saturated & V_2 paralysed.



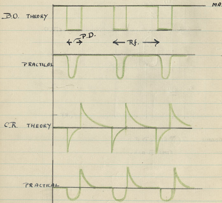
BLOCKING OSCILLATOR

C+R SHAPING CIRCUIT
& CUT-OFF VALVE

ASYMMETRICAL M'VIBRATOR
OR KIPP RELAY

PENTODE
TIME BASE.

Voltage traces of B.O. & C.R. Shaper.



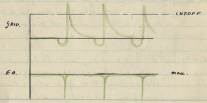
By suitable choice of circuit constants. the ratio P.D. / R.f. may be made as high as 1/10 (ie. P.D. = R.f./10)
The variable leak of the B.O. controls the recurrence frequency.
R_2 in blocking oscillator acts as a fine control on R.f. The P.D. across C_1 varies as I in L.C. When R_2 is decreased the I thru' R_2 is drawn from the L.C. circuit & P.D. across C_1 becomes less. The charge in C_1 is less & leaks away in a shorter time so that R.f. is greater.
C_2 & R_4 constitute the C.R. shaping circuit. The time constant of these is very small (C_2 = 0.0001 μF. & R_4 = 0.05 MΩ.) CR = 0.00005)
The condenser charges during B.O. anode voltage downward excursion, discharges during Ea's period of no change, recharges in opposite sense while B.O.'s Ea is on its upward excursion & discharges during recurrence period. The C.R. circuit shortens the P.D. & inverts the wave form. i.e. changes a –ve pulse into a positive pulse.

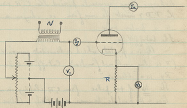
The Cut-off Valve.

This is a pentode which is biased into quiescence by R7 & 10 (R.10 alone would not function). Cut off = 0. Ia = 0 bias.)
R7 is a "bleeder".
The tip of +ve pulse from C.R shaping circuit offsets the bias & the pentode becomes momentarily conductive thus producing a negative pulse of Ea. which has a duration of, say

$\frac{1}{20}$ of the <u>whole</u> of the +ve pulse from C.R.

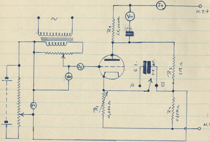
<u>Voltage traces of Cut-off Valve.</u>





EXPT 31. Negative feed back.

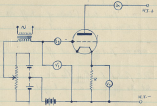
The circuit was as shown



With the switch as shown there was AC & D.C. feed back. ~~And At A~~ current, i.e. A.C. feed back out & at B no feed back. The curves are shown in XV.

1, Ia with change in Eg. - ~~no feed back~~.
2, Ia with no feed back.
3, Ia with D.C. feed-back (absence of cut-off - shallow slope.)
4, Ia } N. A.C. & no feed back - normal valve behaviour.
5, A.C. out }
6, Ia } A.C. & D.C. feed back - no cut-off - A.C. is not amplified.
7, A.C. out }
8, Ia } D.C. feed back only - The A.C. component is amplified.
9, A.C. out } but the D.C. remains unchanged.

EXPT. 32. The Cathode Follower.



R was in turn 5000; 10,000 & 25000 Ω. To offset the high initial bias caused by R the batteries & potmeter were incorporated in the circuit in order to back it off.

R = 5000 Ω V_1	V_2	Bias	R = 10,000 V_1	V_2	Bias
28 V	29 V	1 V	45 V	46 V	1 V
23	25	2	40	41·5	1·5
20	24	4	35	37·0	2·0
15	17·5	2·5	30	32·0	2·0
10	13·0	3·0	25	27·5	2·5
5	9·0	4·0	20	23·0	3·0
			16	18·0	3·0
			10	14·0	4·0

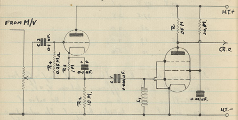
Ia falls to cut-off at a high negative Eg.

R 25,000 Ω. V_1	V_2	Bias.
45 V	47 V	2 V
35	37·5	2·5
25	28·	3·0
15	19	4·0
5	10	5·0

It is seen that the feedback is not 100% effective. or there would be no difference between V_1 & V_2. The A.C. voltage out to in was in the ratio of 0·9 so that C.F. diminishes the signal. Its advantage is that it is an excellent non-f discriminating matching device. if the output is taken from R.

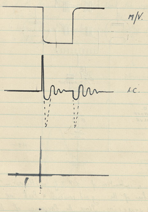
It will be seen that the value (pure) of R has no apparent effect on the results. This is because the effective R is 1/gm.

EXPT. 33 The C.L Shaping circuit or Ringing circuit.

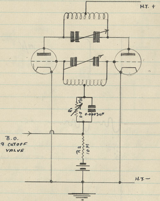


During the downward portion of the M/V's wave of Ea C_1 charges & applies a negative charge to the grid of the amplifier, whose Ea rises. When the M/V.'s Ea is steady C_1 discharges thru' L_1 whose inductance produces a back e.m.f. which tries to make the grid very positive i.e. Ea falls. Ig, however, damps this effect. C_1 & L_1 produce very heavily damped oscillations.
During the upward excursion of Ea of M/V. C_1 charges in the opposite sense & tends to impress a very positive charge on the grid. Again Ig damps this. When the M/V. becomes quiescent C_1 discharges.

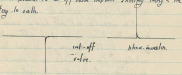
The discharge produces oscillations in L_1 C_1 very heavily damped, of course.

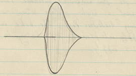


EXPT 34. The P.P. Squegging R.F. Oscillator.



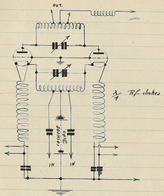
This is a combination of T.P.T.G oscillators in Push-Pull. The values of the grid condenser & leak are arranged to give squegging. Since the frequency of the squeggs is unstable the whole circuit is biased into cut-off by the backing-off battery. The cut-off valve supplies a sharp impulse which is inverted by an amplifier. This, now positive, pulse offsets the bias & the circuit squeegs. The natural f. of the circuit must be higher than the f of the B.O. in order that the squeggs will stop before a second pulse from the B.O. arrives. R2 is to prevent the cut-off valve impulse shorting through the battery to earth.



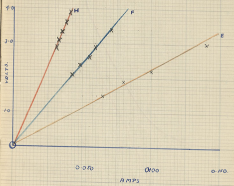


EXPT. 35. The P.P. Inverted Triode Amplifier.

For power R.f. work the pentode is unsuitable for reason of its high R_a. The triode is liable to internal feedback by virtue of C_{ga} & so will oscillate. The triode is "driven" by a difference of potential between grid & cathode & if now the grid is earthed & the tuned circuit put on the cathode the valve will function normally but will have a screen, earthed, between the tuned circuits which will neutralise C_{ac}. Small condensers are provided for external neutralising. The $\lambda/4$ chokes are to prevent R.f. from the cathode coil shorting to earth via the L.T. supply capacity. The amplifier is "current fed" ie. fed from near a current antinode. This is to prevent a high voltage between the two lines causing "dielectric loss." The choke in the H.T. supply is to prevent R.f. shorting to earth via H.T. supply.

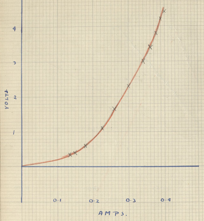


EXPT. 1C.

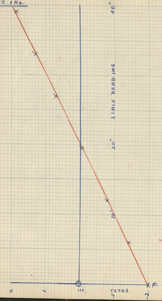


i

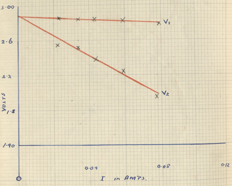
EXPT. I D.



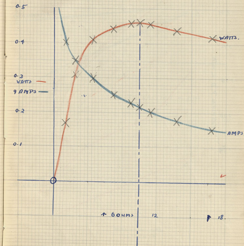
EXPT. I K2



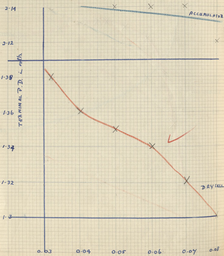
EXPT. 13.



EXPT. 3A.

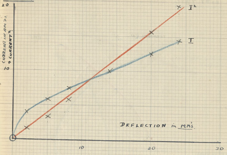


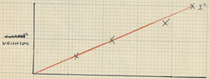
EXPT. 3B.



vi I in amps.

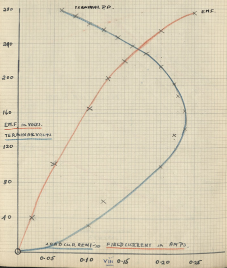
EXPT. 5G.



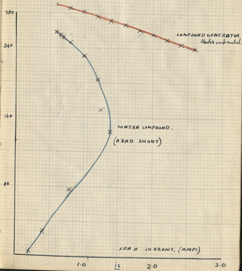


VII

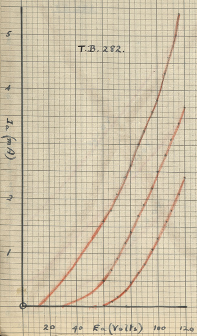
EXPT 7D&G.

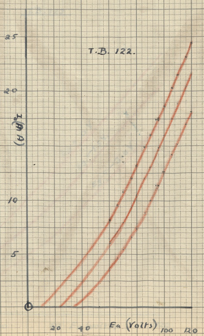


EXPT 7 H+J.

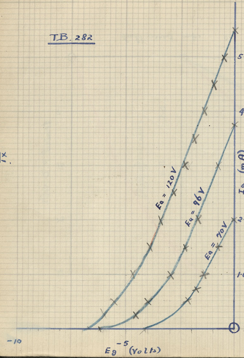


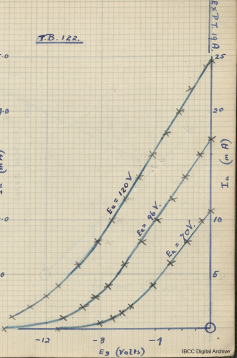
EXPT. 19 B.



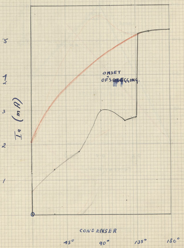


EXPT. 19 A.



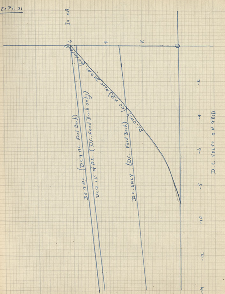


EXPT. 21



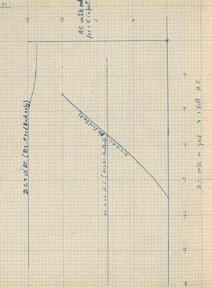
XIV

EXPT. 31



XV

EXPT. 31



D.C. 9 1.V. A.C. (D.C. Feed Back only)
D.C. 9 1.V. A.C. (A.C. & D.C. Feed Back)
D.C. 9 1.V. A.C. (No Feed Back)
A.C. volts outpu for 1 V. input
D.C. volts on grid 9 1 Volt A.C.
16
12
8
4
-2
-4
-6
-8
-10
-12
-14

XVI