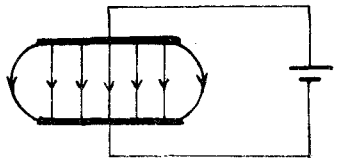
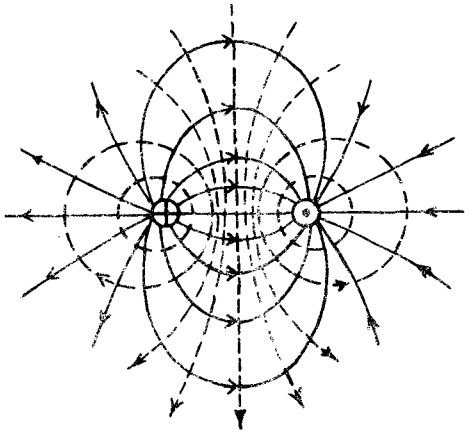
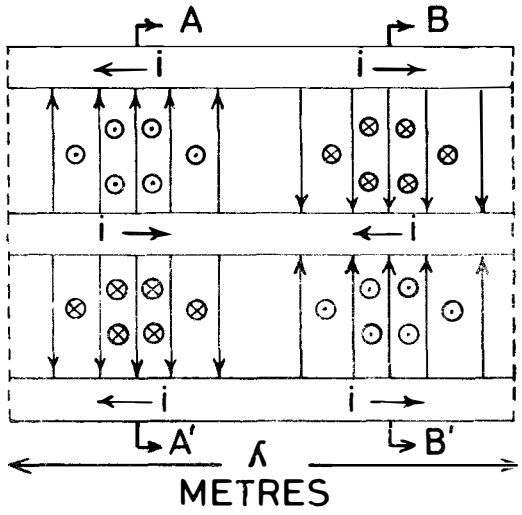


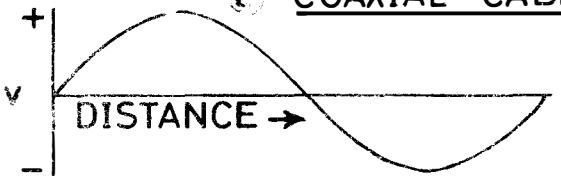
PARALLEL PLATE CAPACITOR

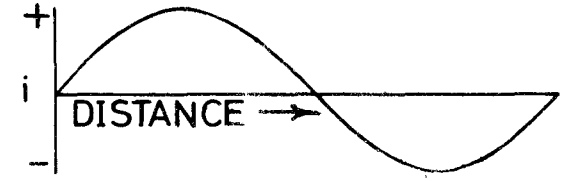


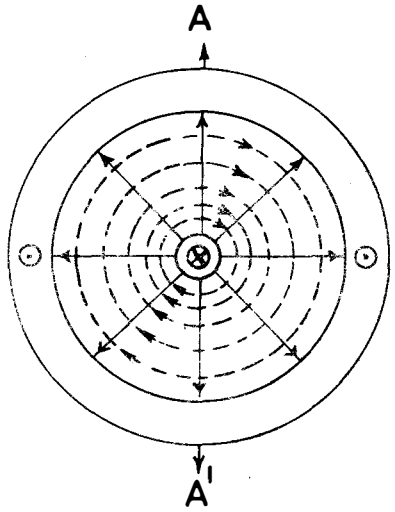
AIR SPACED 2-WIRE LINE

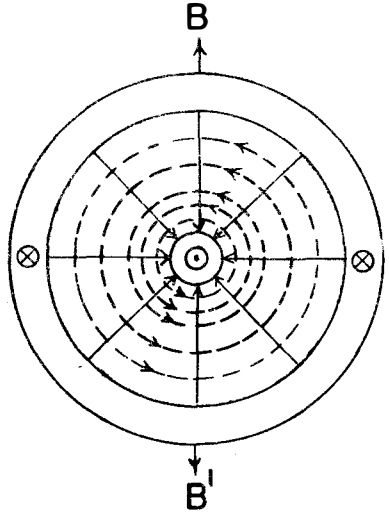


COAXIAL CABLES









⟶ ELECTRIC FLUX
⇢ MAGNETIC FLUX
⊕ CURRENT ENTERING PLANE
⊙ CURRENT LEAVING PLANE

FIELD CONFIGURATIONS

R36659

Fig. 1-1 Field configurations in a Capacitor, 2-Wire Line and Coaxial Cable

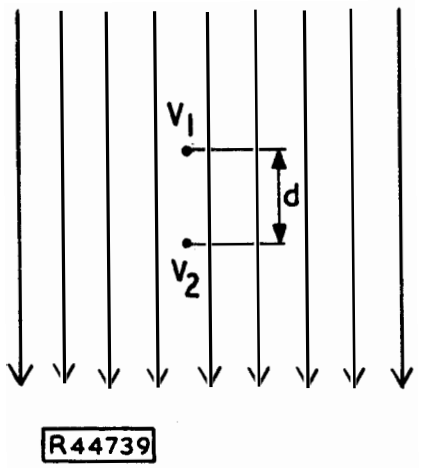
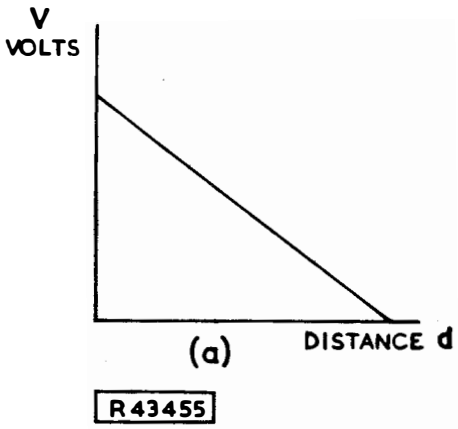


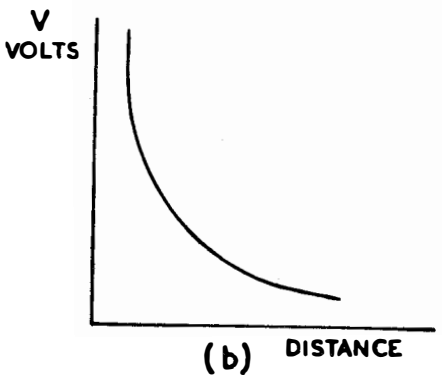
Fig. 1-2 Potential Gradient

$$E = -\frac{(V_1 - V_2)}{d} \text{ volts/metre}$$



Uniform Field

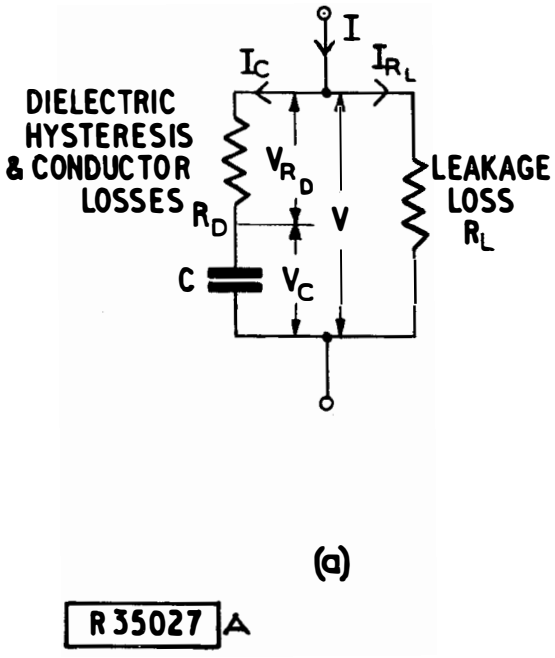
$$E = -\frac{V}{d}$$



Non-Uniform Field

$$E = -\frac{\delta V}{\delta d}$$

Fig. 1-3



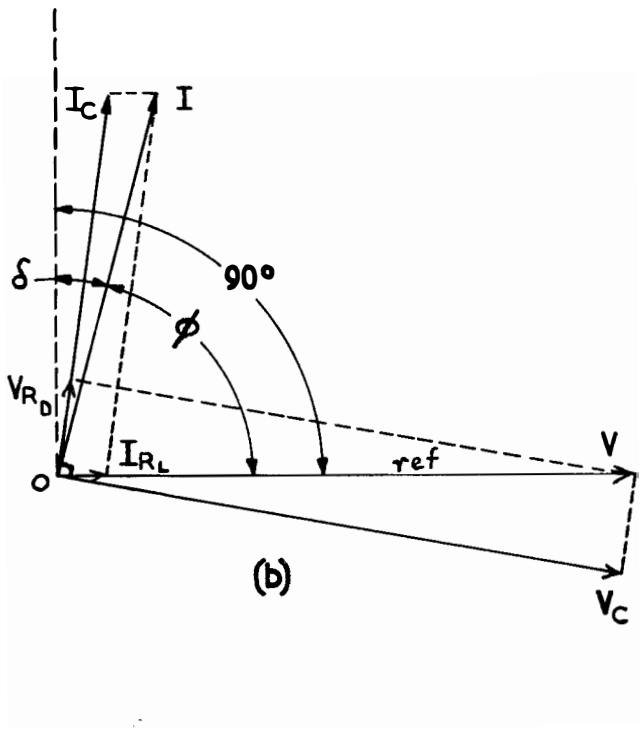


Fig. 1-4 Capacitor complete equivalent circuit and phasor diagram where ϕ is the phase angle and δ is the loss angle

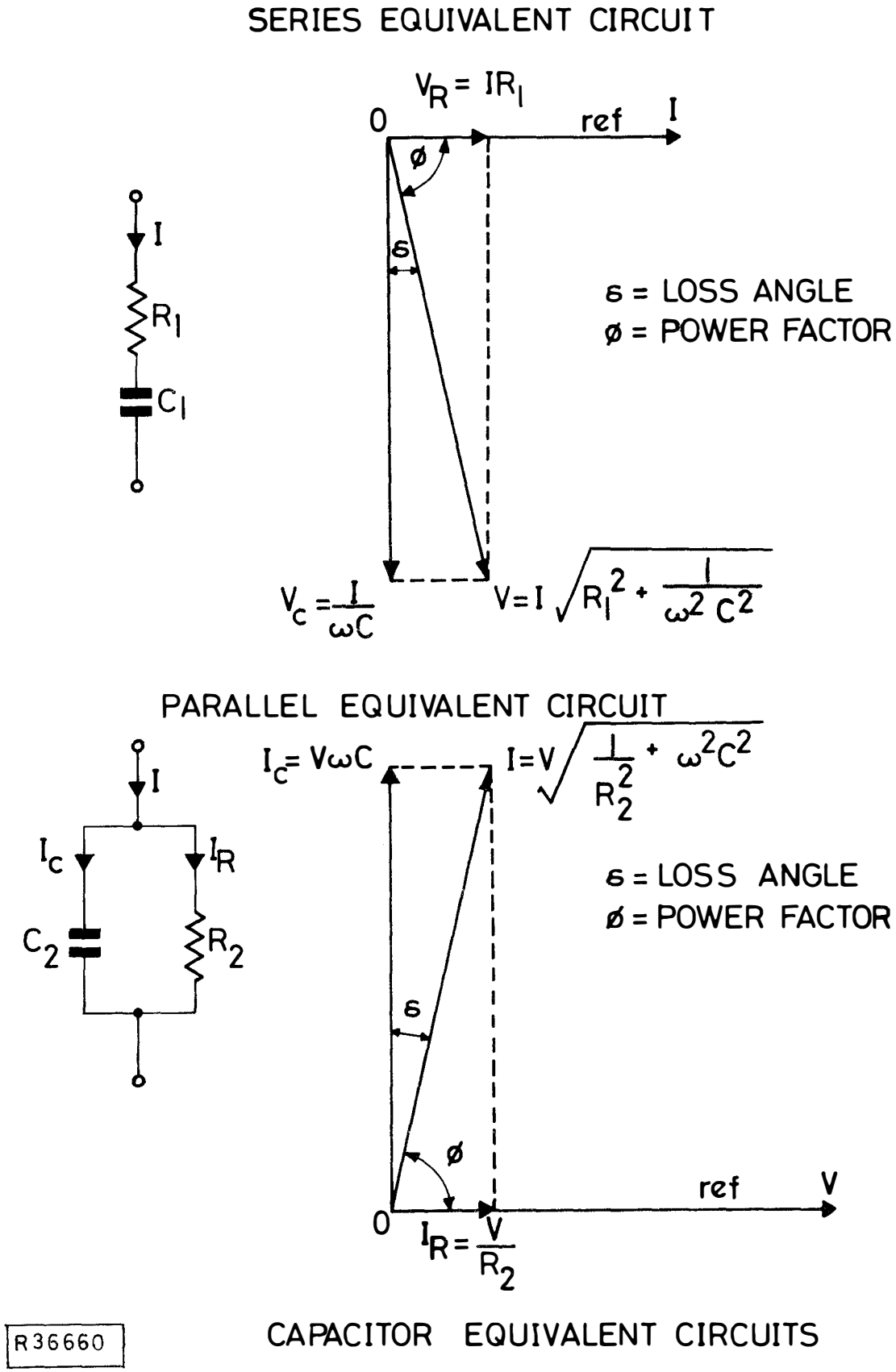


Fig. 1-5 Capacitor; series and parallel equivalent circuits

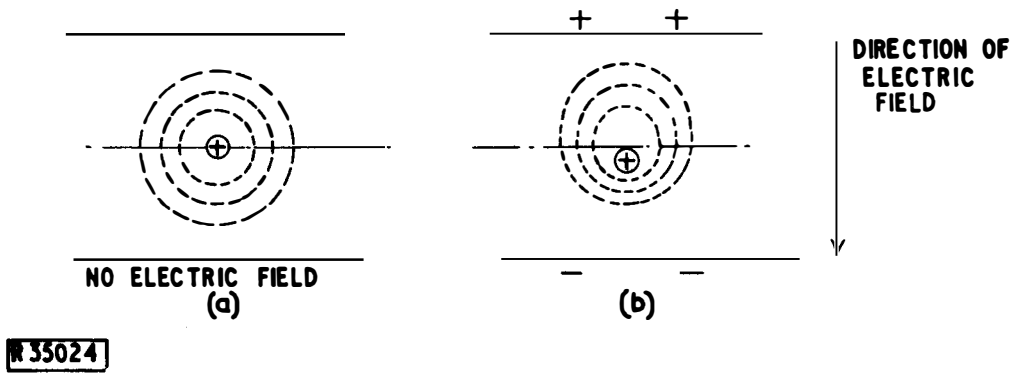


Fig. 1-6 Elliptical distortion of an electron orbit by an electric field

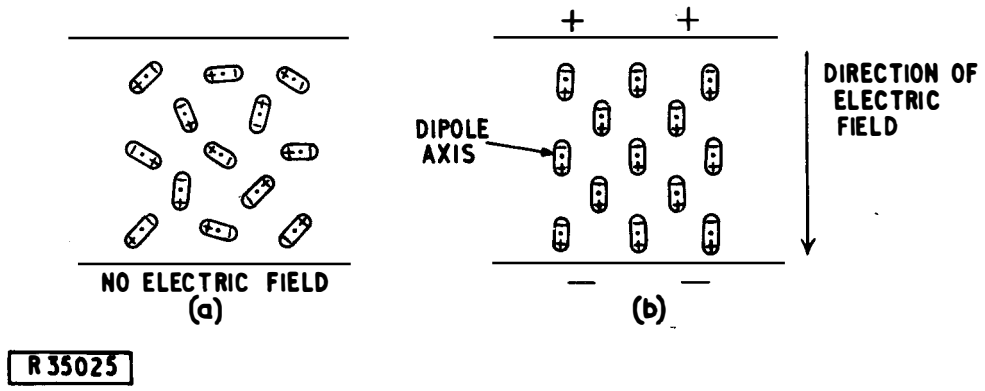


Fig. 1-7 Polarization of molecules in an electric field

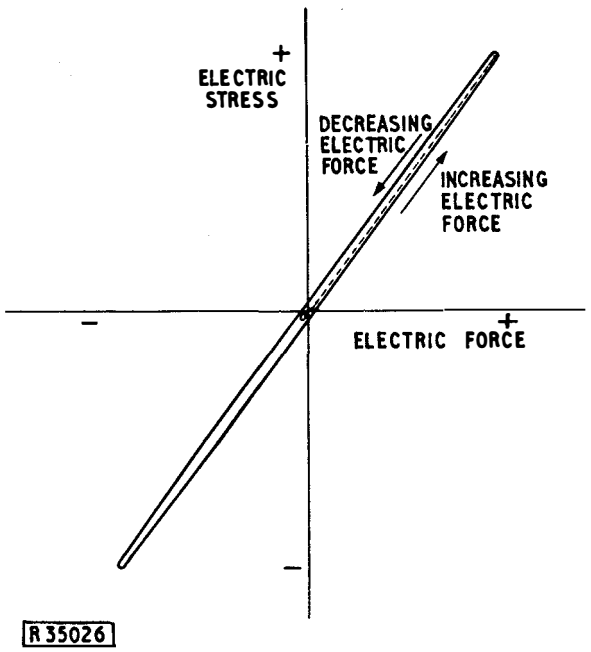
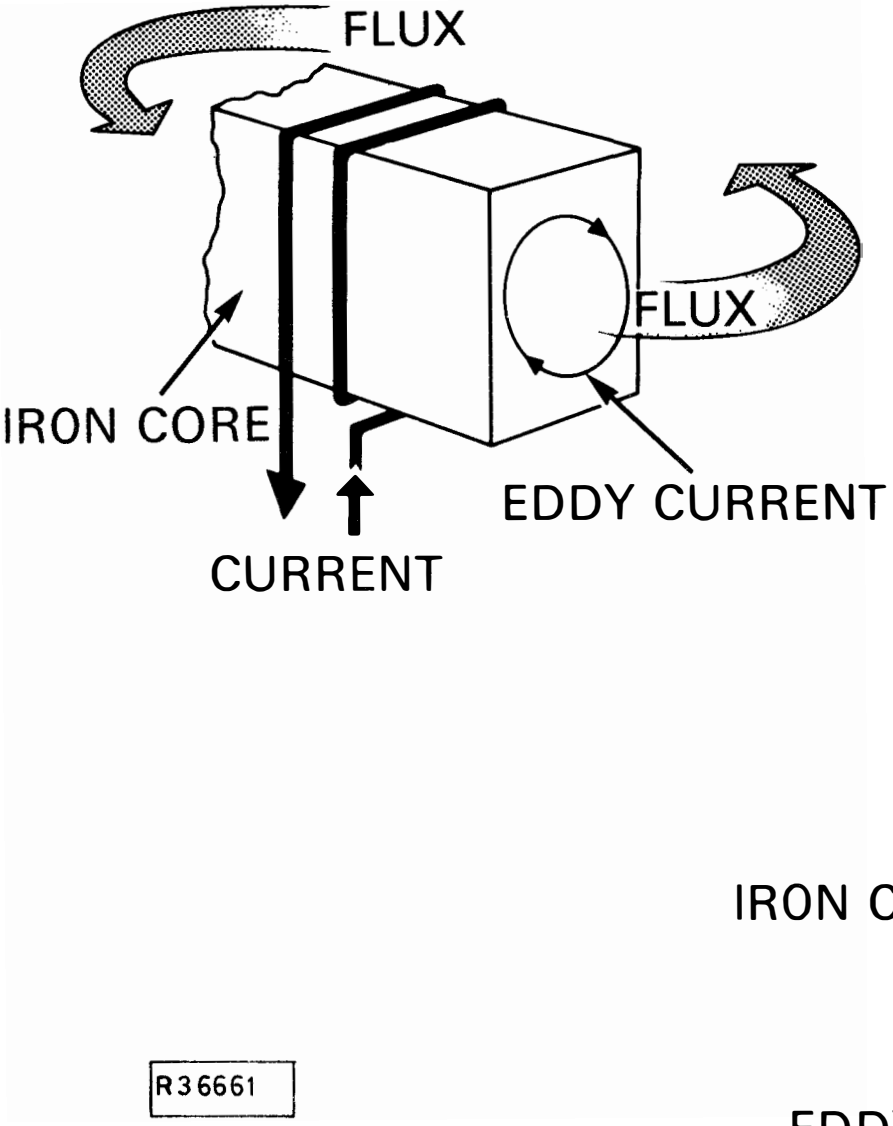


Fig. 1-8 Dielectric hysteresis



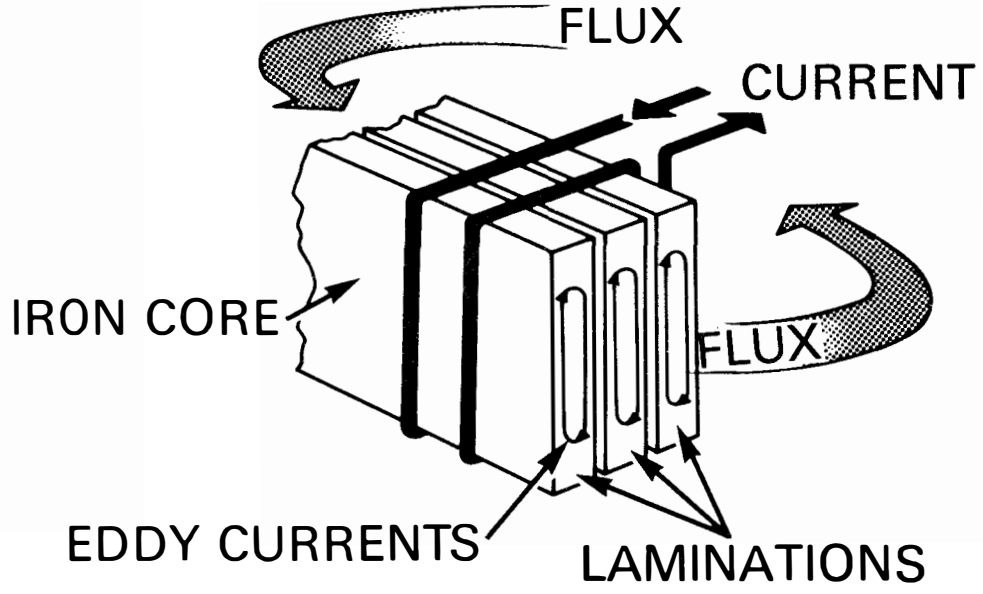


Fig. 2-1 Reducing Eddy Currents by the use of laminations

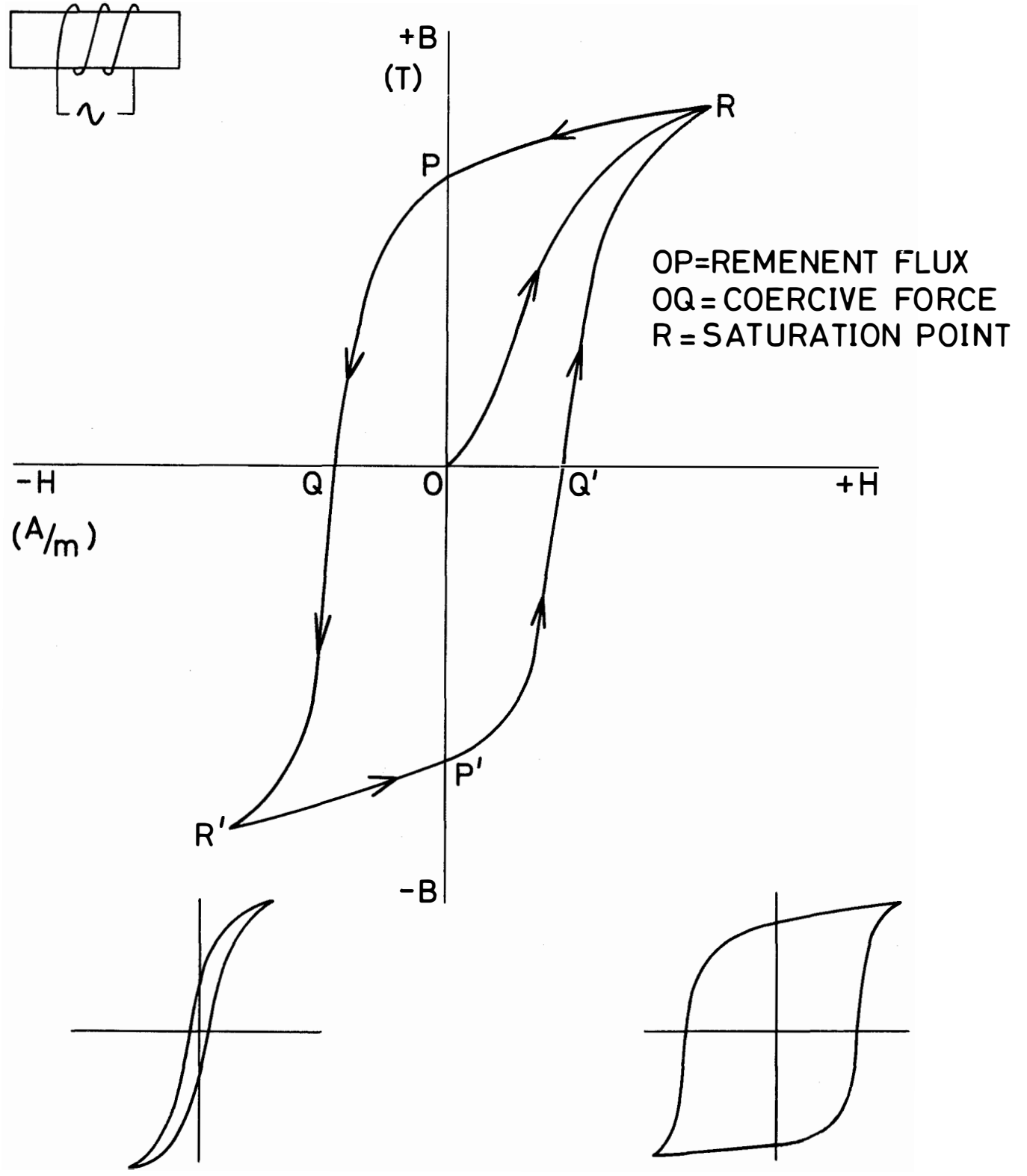
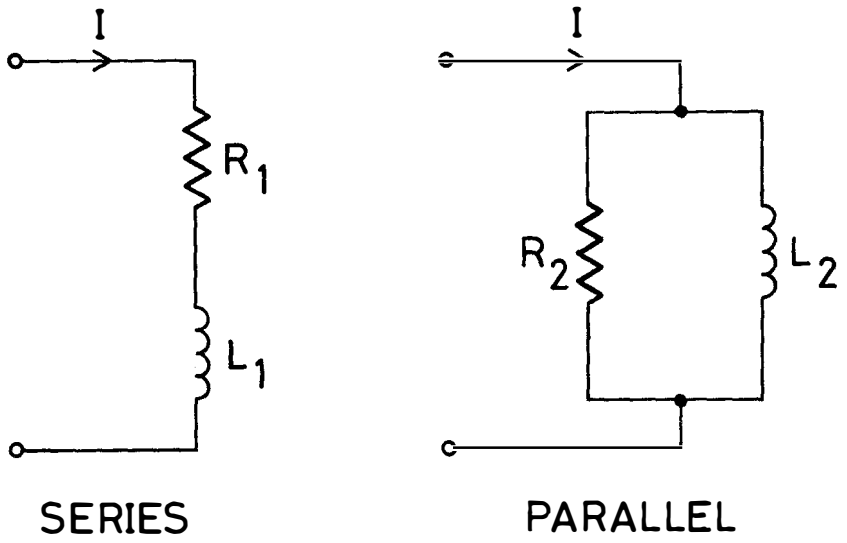
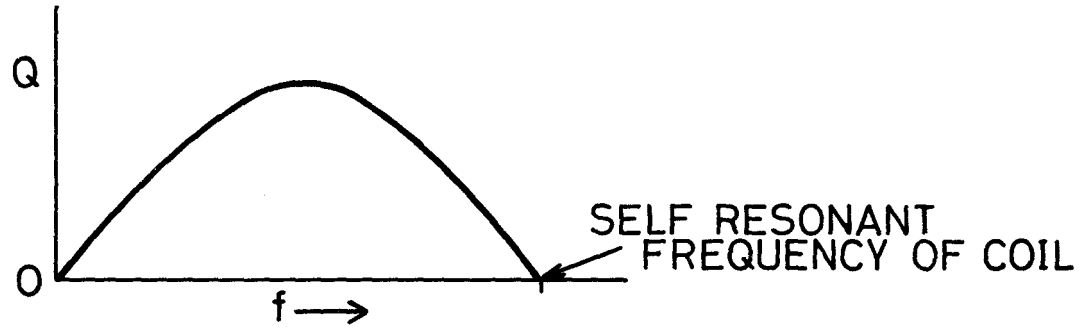


Fig. 2-2 Hysteresis loops for general, hard and soft magnetic materials



INDUCTOR EQUIVALENT CIRCUIT

$$Q = \frac{X_1}{R_1} \quad \underline{OR} \quad Q = \frac{R_2}{X_2}$$



VARIATION OF Q FACTOR WITH FREQUENCY

R36663

Fig. 2-3 Inductor Equivalent Circuits and Q Factor

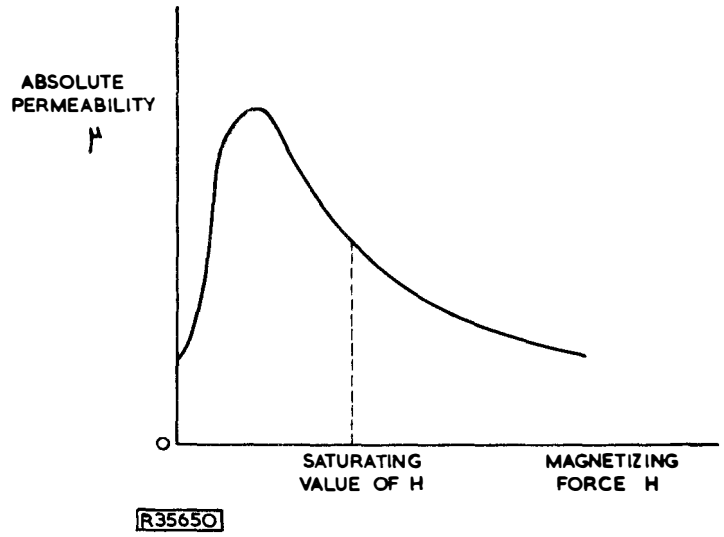


Fig. 2-4 Variation of μ with changes in H in a ferromagnetic material

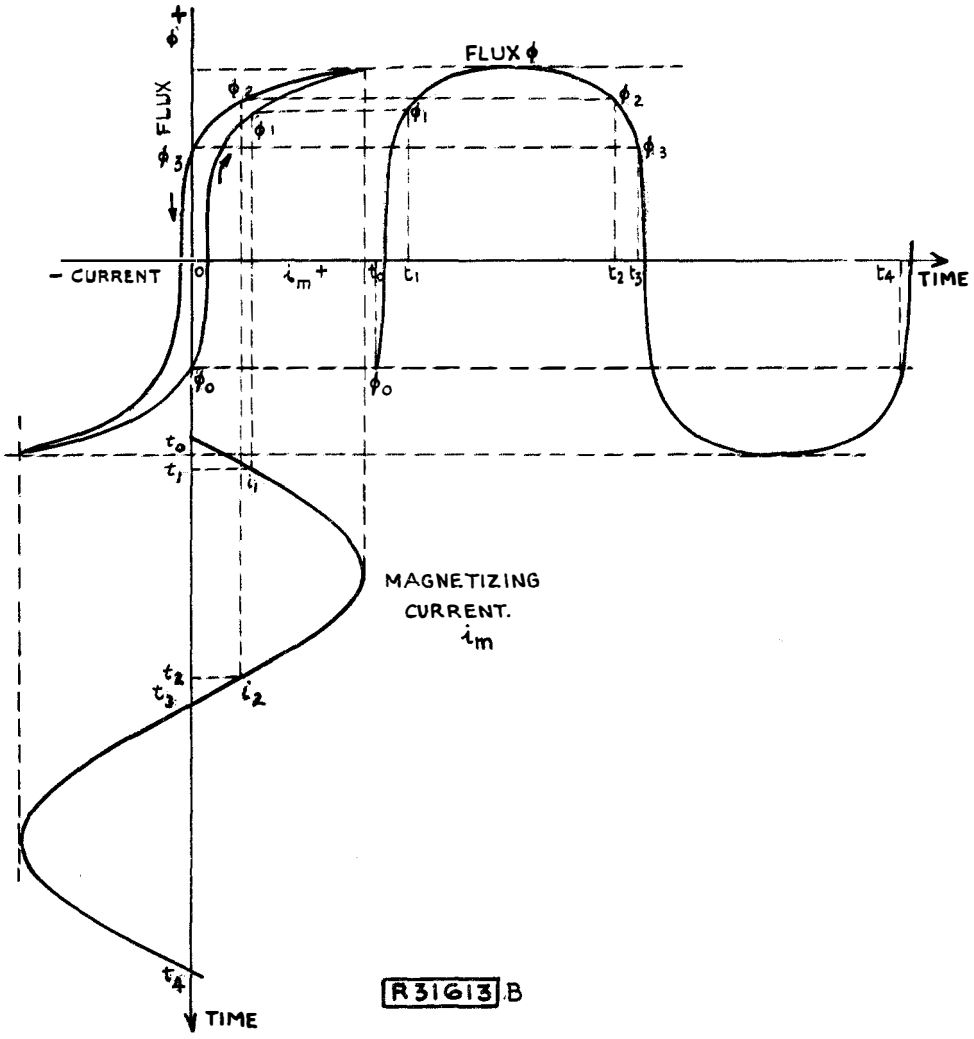


Fig. 2-5 Flux distortion in a saturated iron core

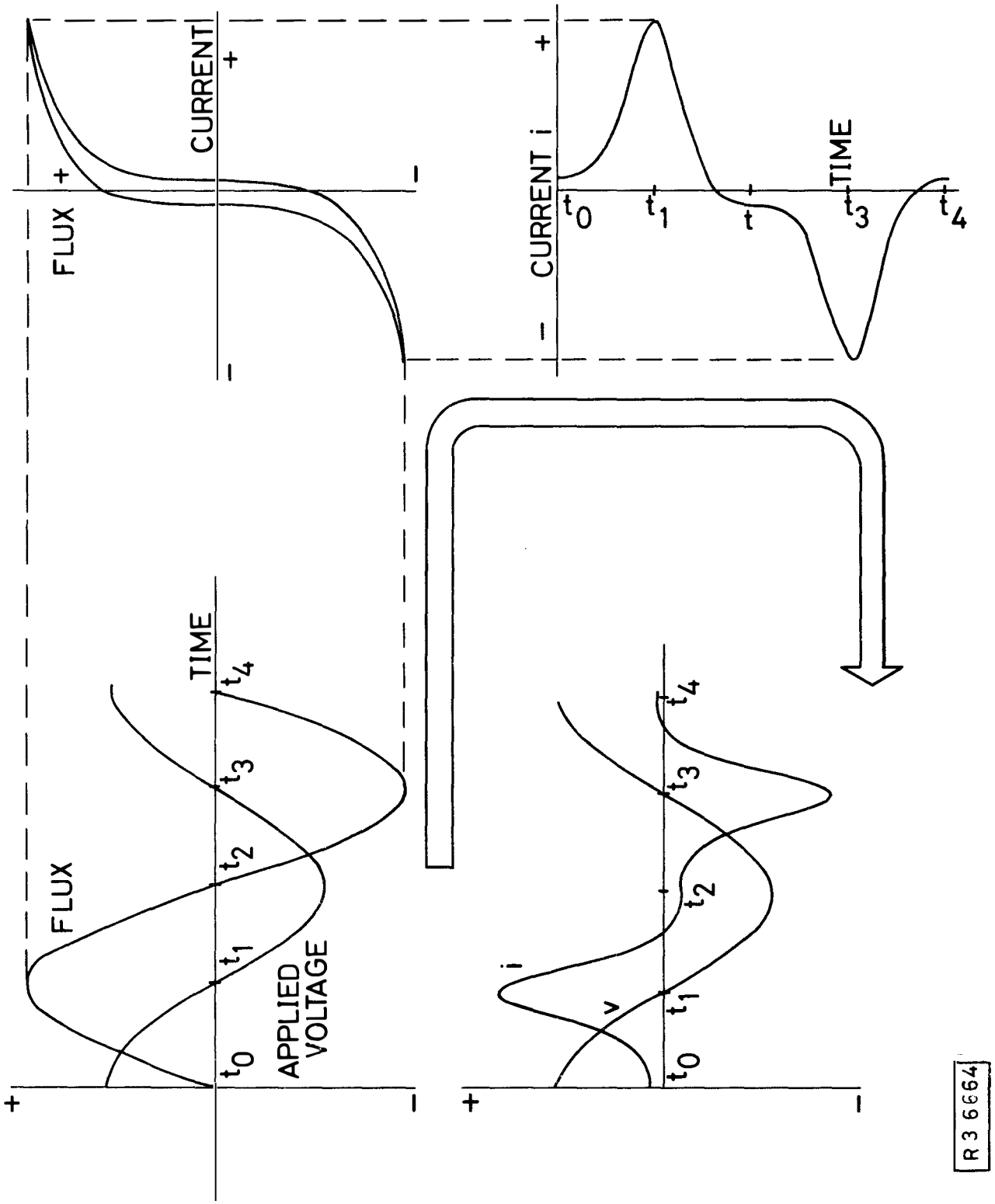


Fig. 2-6 Current distortion in a saturated iron cored inductor

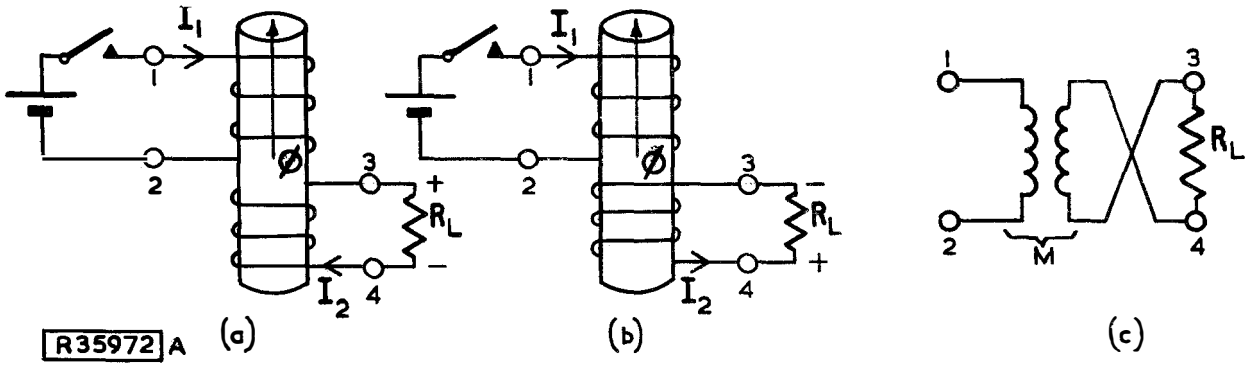


Fig. 2-7 Basic Transformer and direction of induced currents

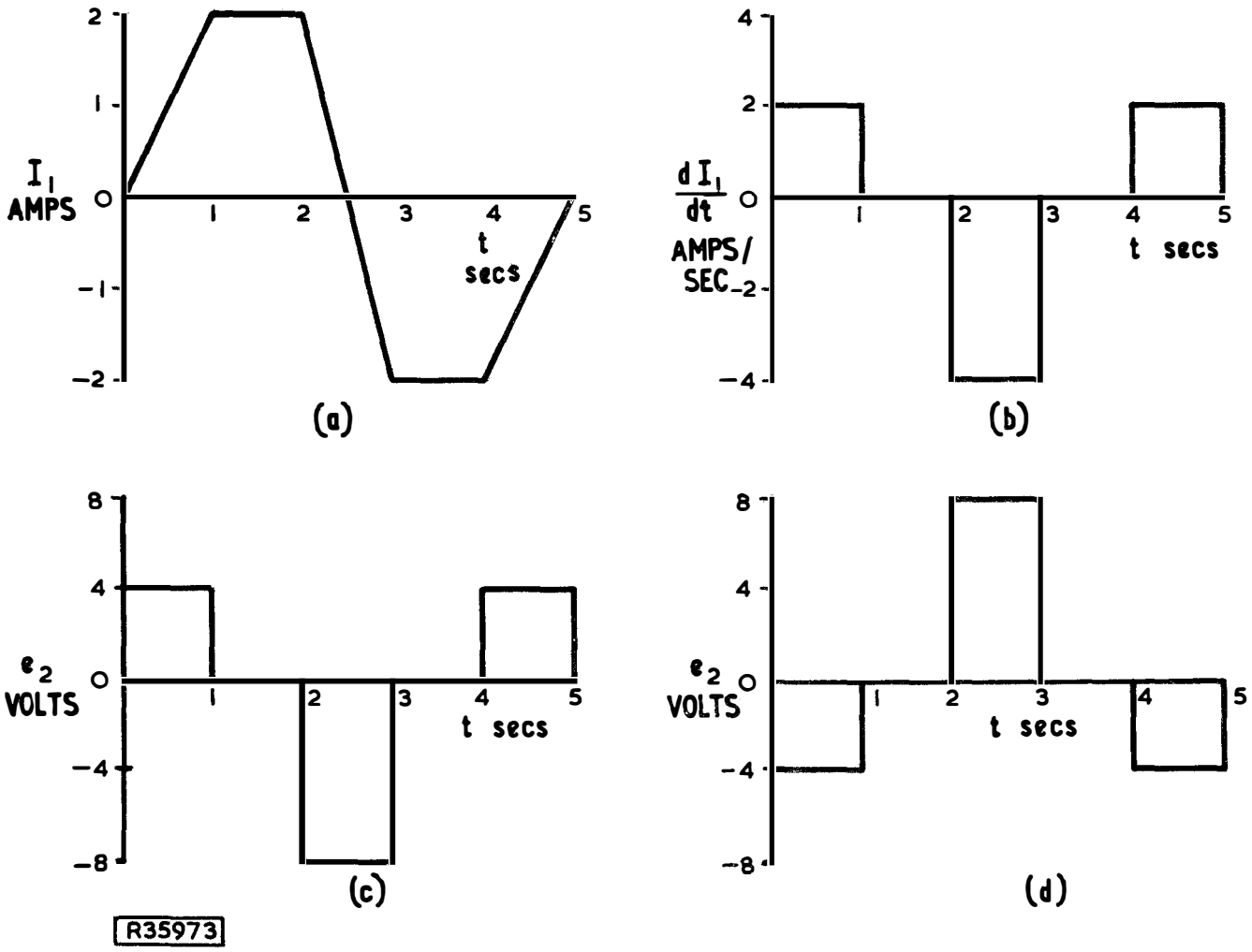


Fig. 2-8 Diagram showing how the secondary induced emf is determined by the rate of change of primary current and the sense of the secondary winding

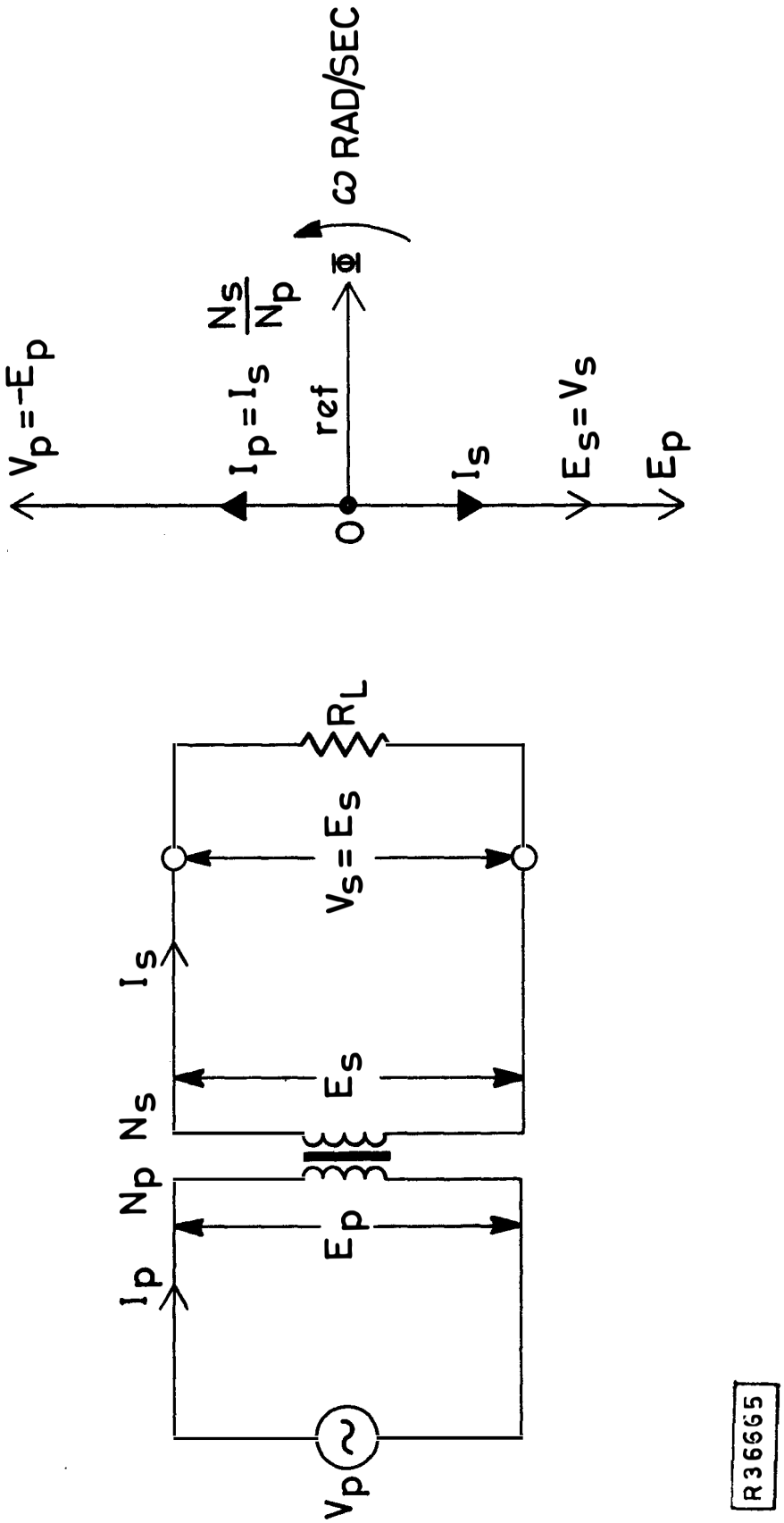
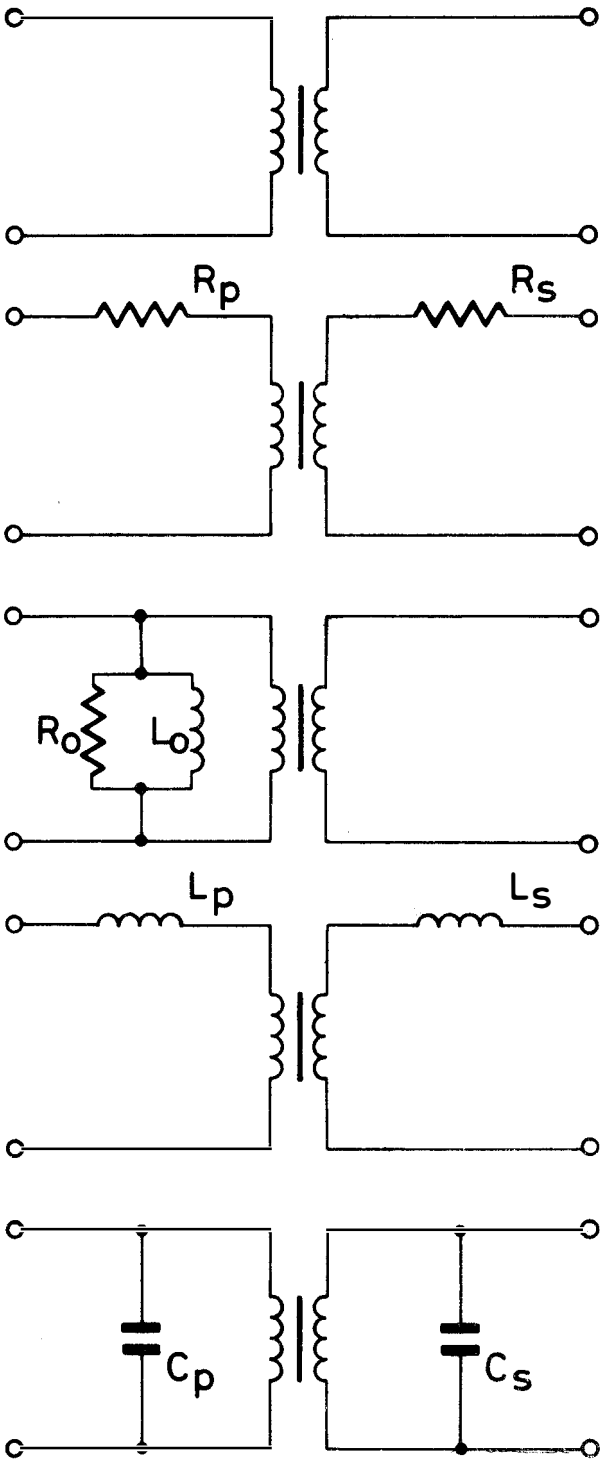


Fig. 2-9 Phasor diagram for an ideal transformer with a resistive load



IDEAL TRANSFORMER

COPPER LOSS

R_p = PRIMARY WINDING RESISTANCE

R_s = SECONDARY WINDING RESISTANCE

IRON LOSSES

R_o = EDDY CURRENT AND HYSTERESIS LOSSES

L_o = PRIMARY WINDING INDUCTANCE

LEAKAGE INDUCTANCE

L_p = PRIMARY LEAKAGE INDUCTANCE

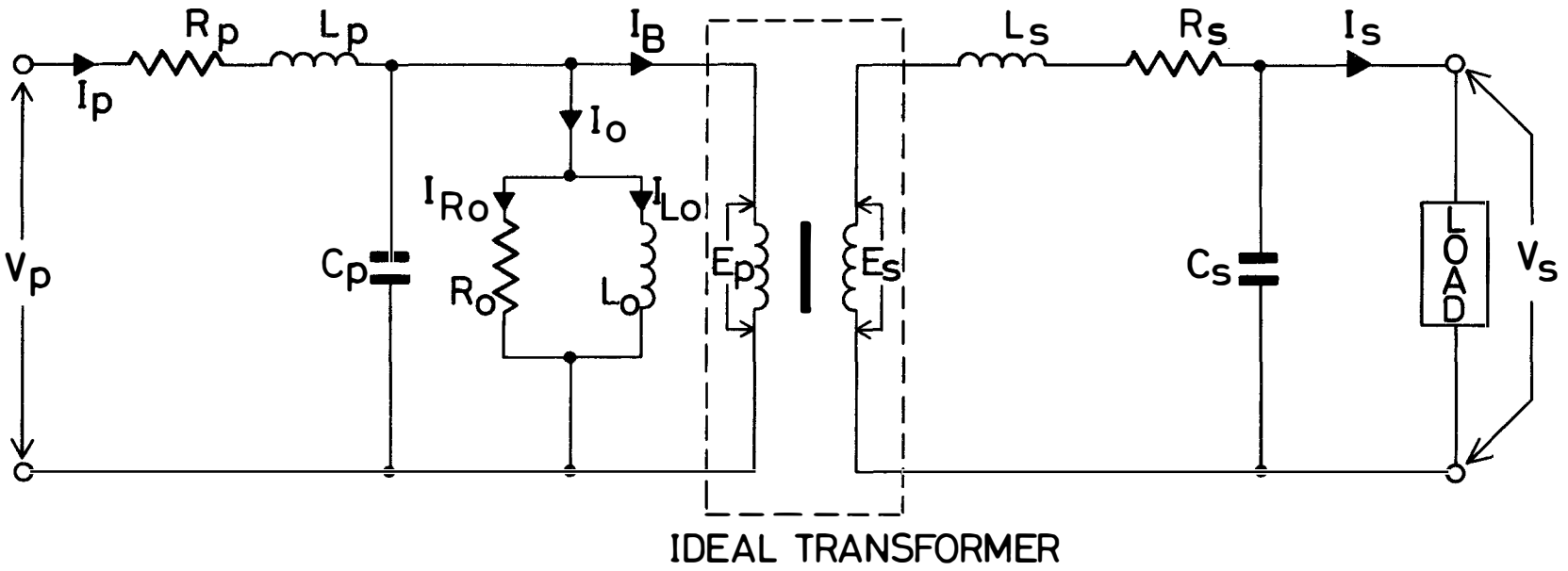
L_s = SECONDARY LEAKAGE INDUCTANCE

SELF CAPACITANCE

C_p = PRIMARY SELF-CAPACITANCE

C_s = SECONDARY SELF-CAPACITANCE

Fig. 2-10 Equivalent circuits of losses inherent in the practical transformer



V_p = APPLIED VOLTAGE
I_p = SUPPLY CURRENT
R_p = PRIMARY RESISTANCE
L_p = PRIMARY LEAKAGE INDUCTANCE
C_p = PRIMARY SELF CAPACITANCE
I_o = NO LOAD CURRENT
R_o = EDDY CURRENT AND HYSTERESIS LOSSES
L_o = PRIMARY WINDING INDUCTANCE
I_B = BALANCING CURRENT
E_p = PRIMARY VOLTAGE

V_s = SECONDARY TERMINAL VOLTAGE
I_s = SECONDARY CURRENT
C_s = SECONDARY SELF CAPACITANCE
R_s = SECONDARY RESISTANCE
L_s = SECONDARY LEAKAGE INDUCTANCE
E_s = SECONDARY VOLTAGE

R36667

Fig. 2-11 Complete transformer equivalent circuit

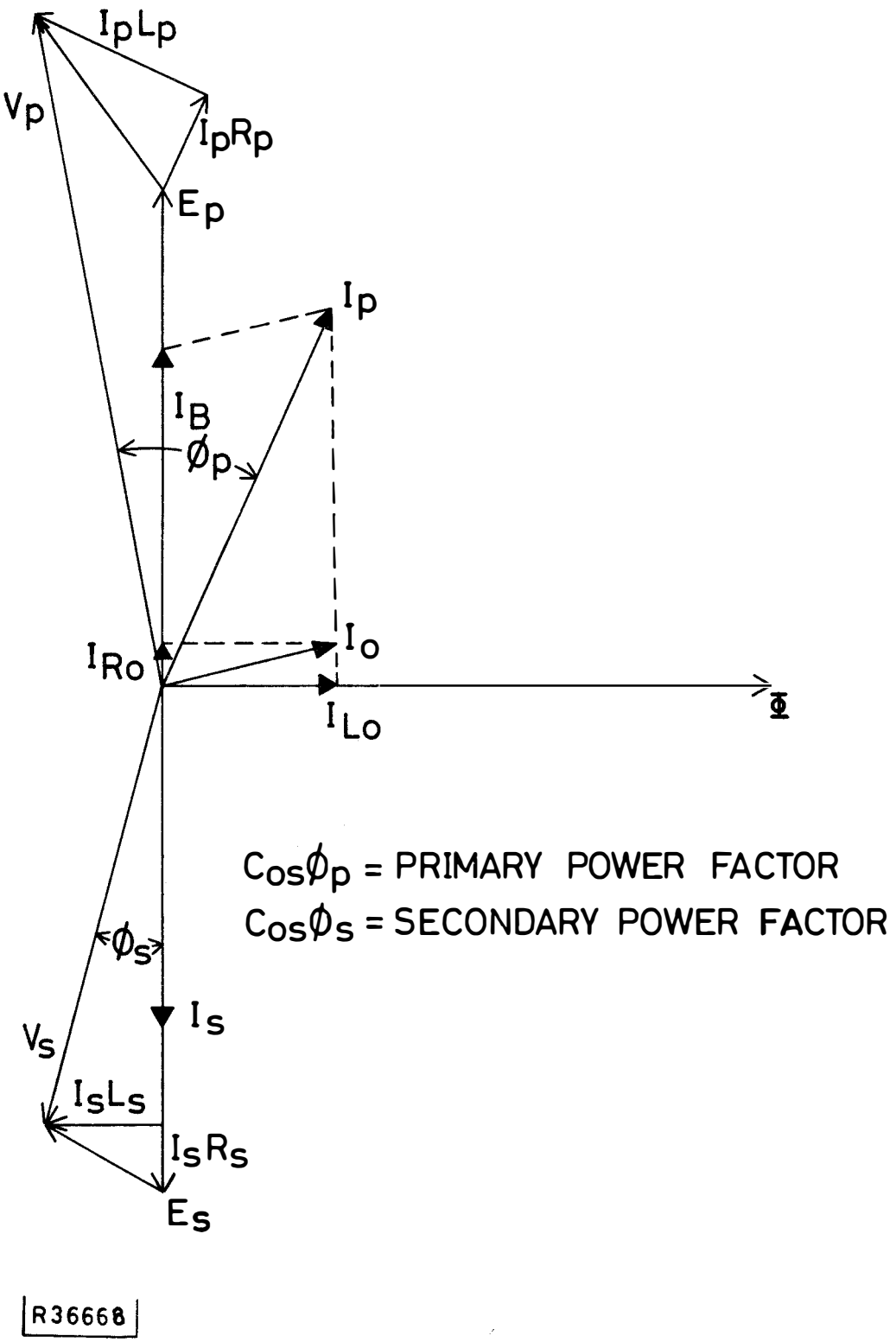
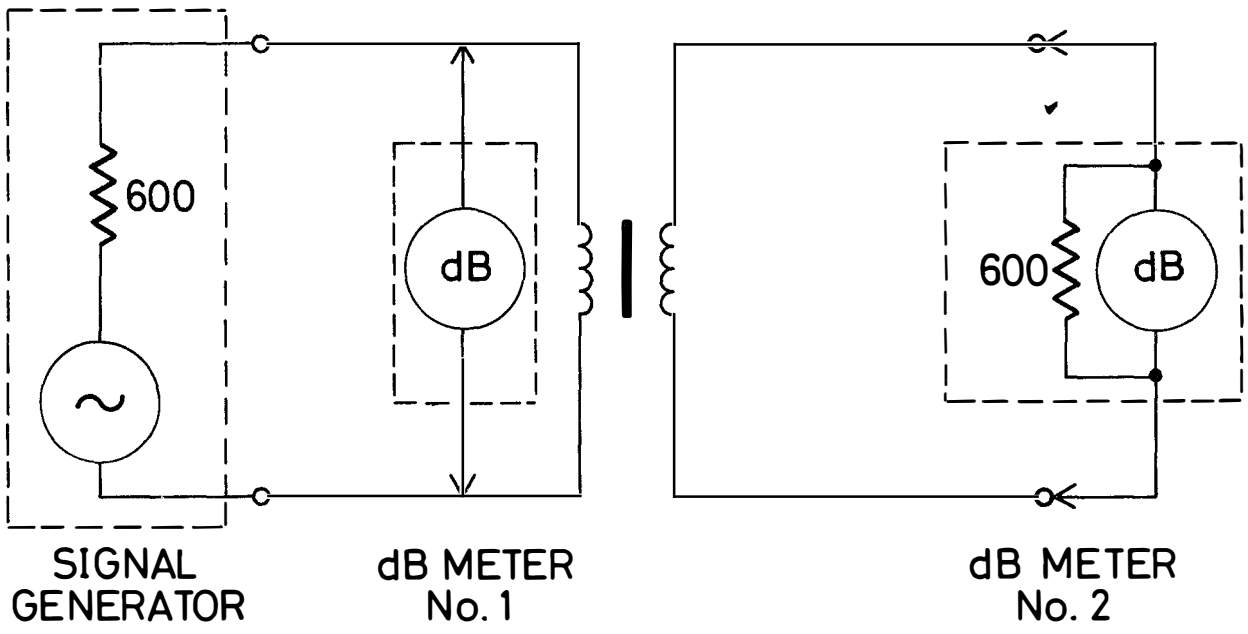
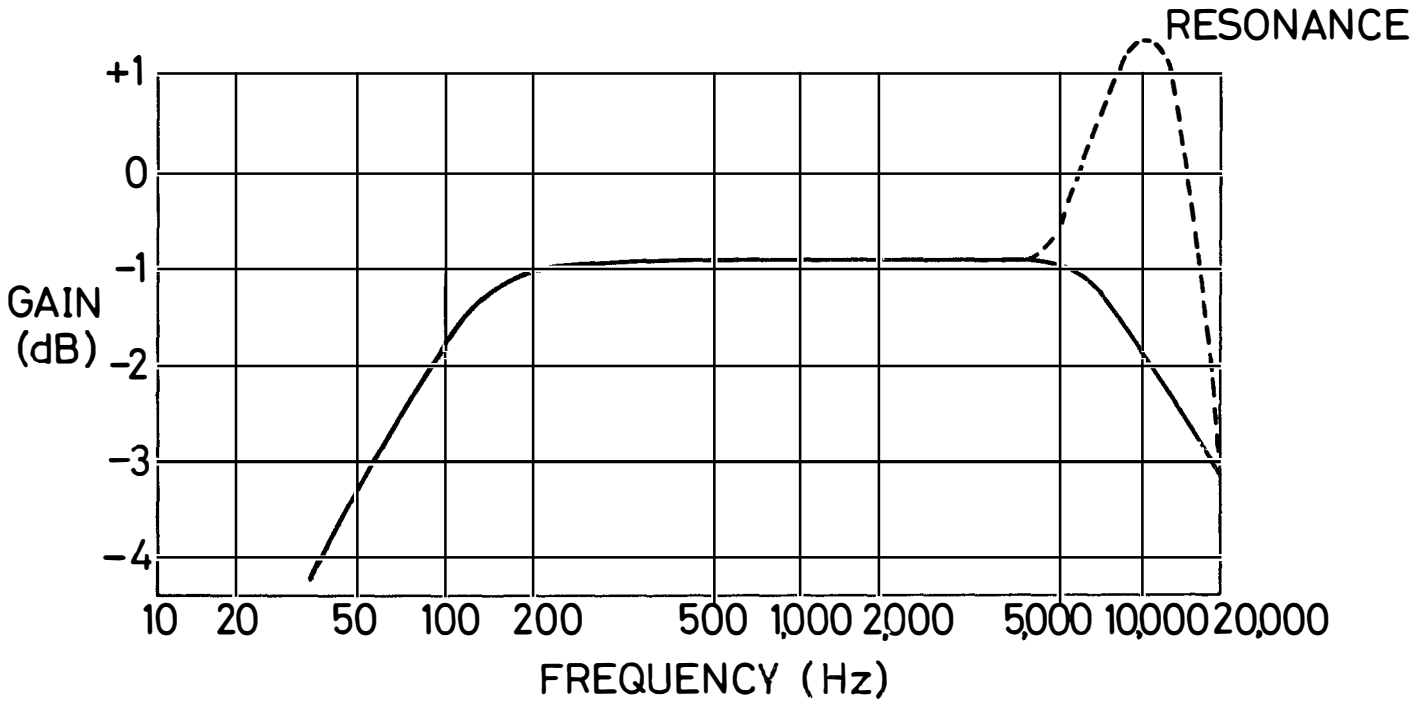


Fig. 2-12 Phasor diagram for a practical transformer having a 1:1 turns ratio and a resistive load



INPUT LEVEL TO BE MAINTAINED CONSTANT

TYPICAL TEST EQUIPMENT



AUDIO TRANSFORMER FREQUENCY RESPONSE

R 36669

Fig. 2-13 Test equipment used and frequency response obtained when a range of frequencies is passed through an audio transformer

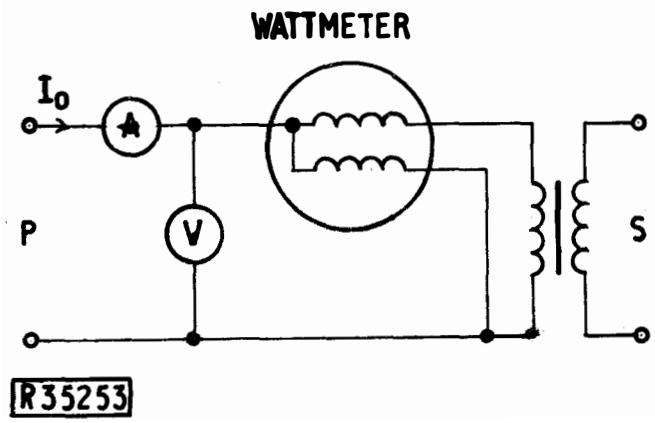


Fig. 2-14 Open circuit test to find core-losses

Core loss W_c = wattmeter reading -

(Power loss in wattmeter + primary copper loss) watts

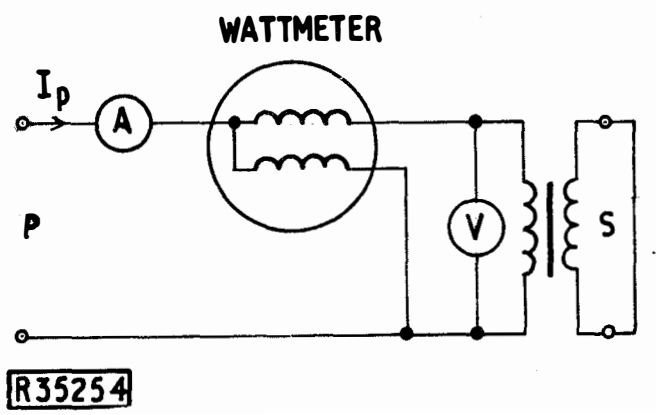
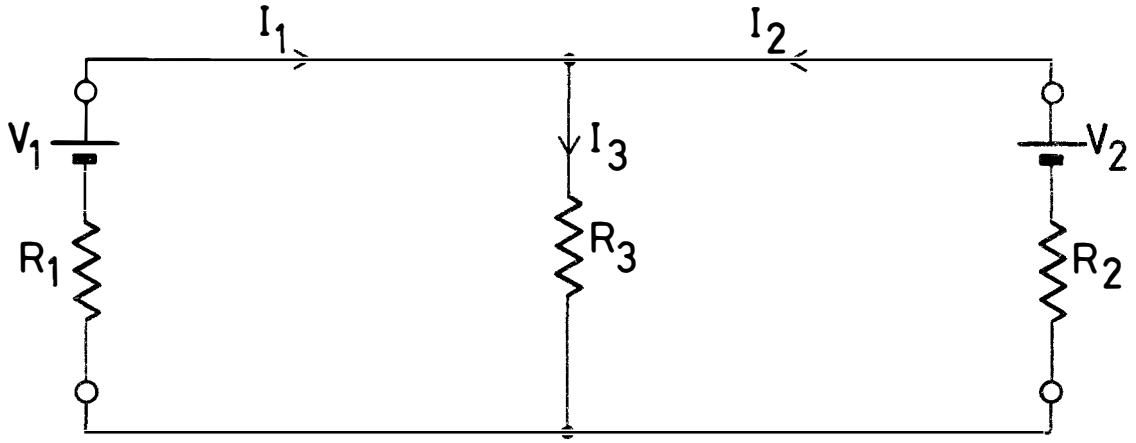


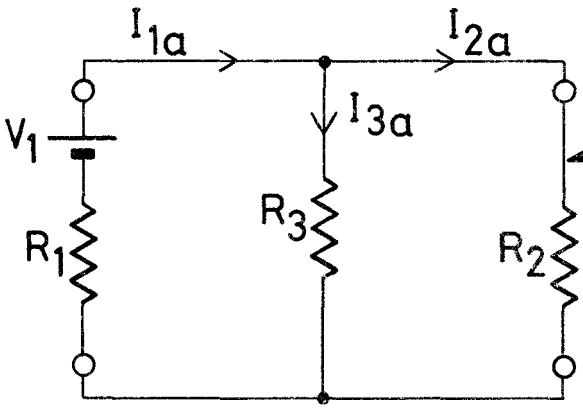
Fig. 2-15 Short circuit test to find copper losses

Copper losses $W_w \approx$ wattmeter reading - power

(loss in wattmeter watts, assuming the core losses are negligible)



CIRCUIT CONTAINING LINEAR IMPEDANCES AND MORE THAN ONE E.M.F.

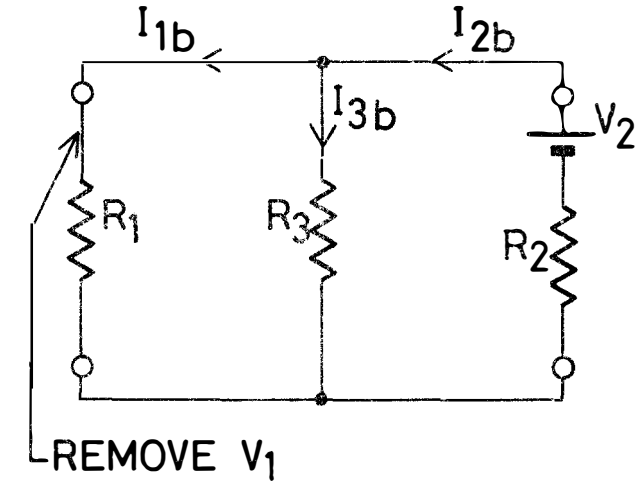


REMOVE V_2

FROM THE SUPERPOSITION THEOREM

$$I_1 = I_{1a} + (-I_{1b})$$

$$\therefore I_1 = I_{1a} - I_{1b}$$



AND

$$I_2 = I_{2b} + (-I_{2a})$$

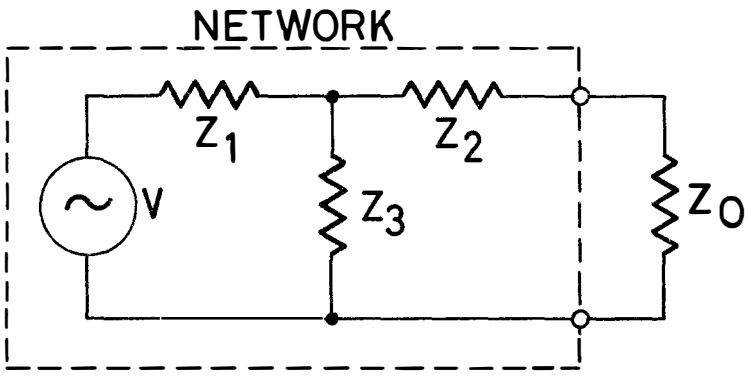
$$\therefore I_2 = I_{2b} - I_{2a}$$

AND

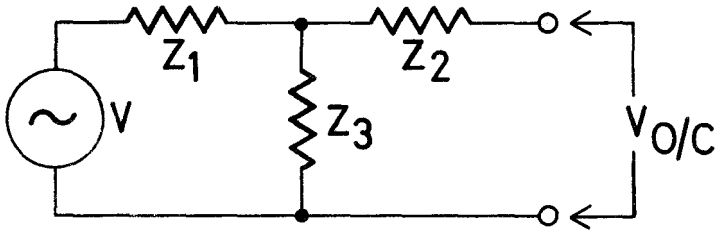
$$I_3 = I_{3a} + I_{3b}$$

R36670

Fig. 3-1 The Superposition Theorem

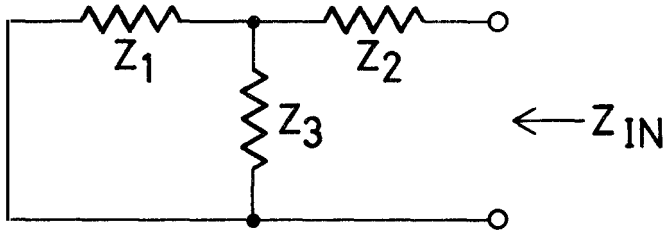


COMPLEX CIRCUIT



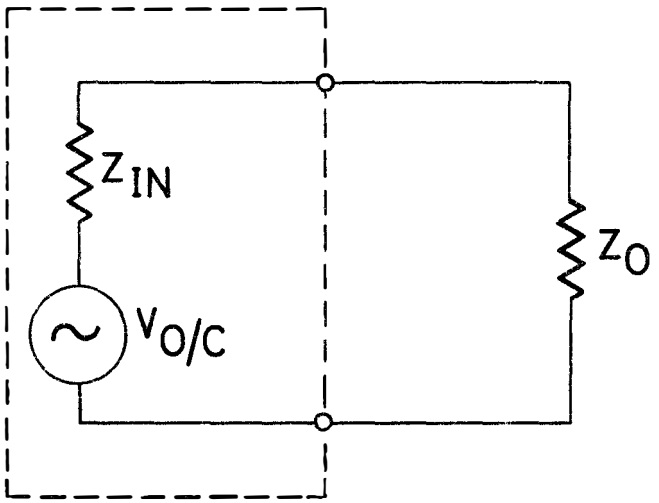
TERMINAL VOLTAGE

$$V_{O/C} = V \times \frac{Z_3}{Z_1+Z_3}$$



INTERNAL IMPEDANCE

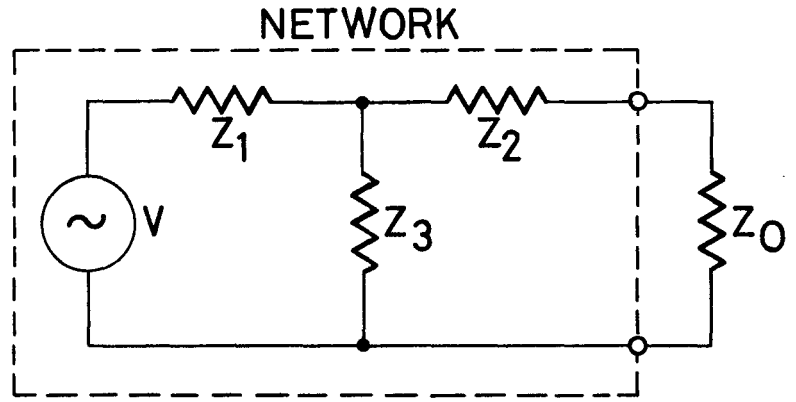
$$Z_{IN} = Z_2 + \frac{Z_1 Z_3}{Z_1+Z_3}$$



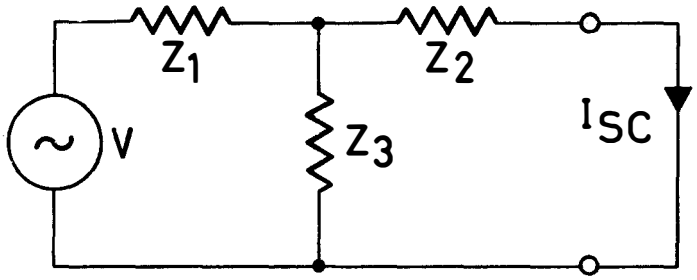
RESULTANT EQUIVALENT CIRCUIT

R 36671

Fig. 3-2 Thevenin's Theorem



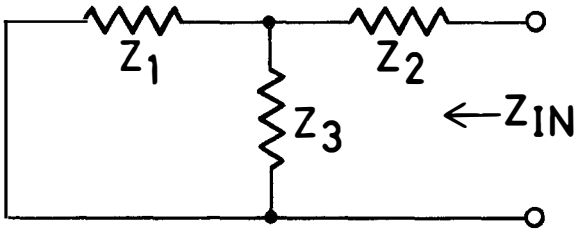
COMPLEX CIRCUIT



OUTPUT CURRENT

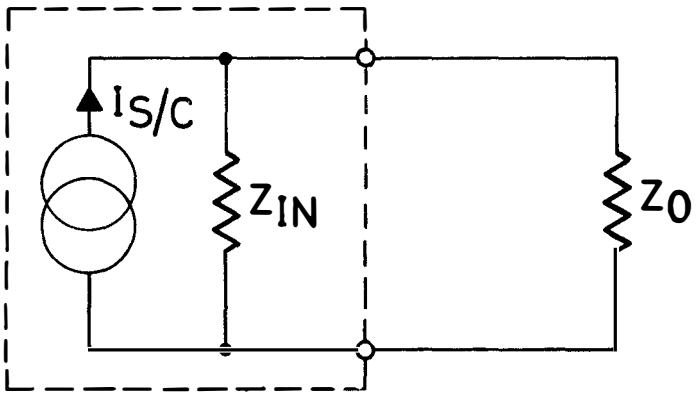
$$I_{SC} = \frac{V}{Z_1 + \frac{Z_2 Z_3}{Z_2+Z_3}} \times \frac{Z_3}{Z_2+Z_3}$$

$$= \frac{VZ_3}{Z_1Z_2 + Z_1Z_3 + Z_2Z_3}$$



INTERNAL IMPEDANCE

$$Z_{IN} = Z_2 + \frac{Z_1 Z_3}{Z_1+Z_3}$$



RESULTANT EQUIVALENT CIRCUIT

R 36672

Fig. 3-3 Norton's Theorem

R366 73

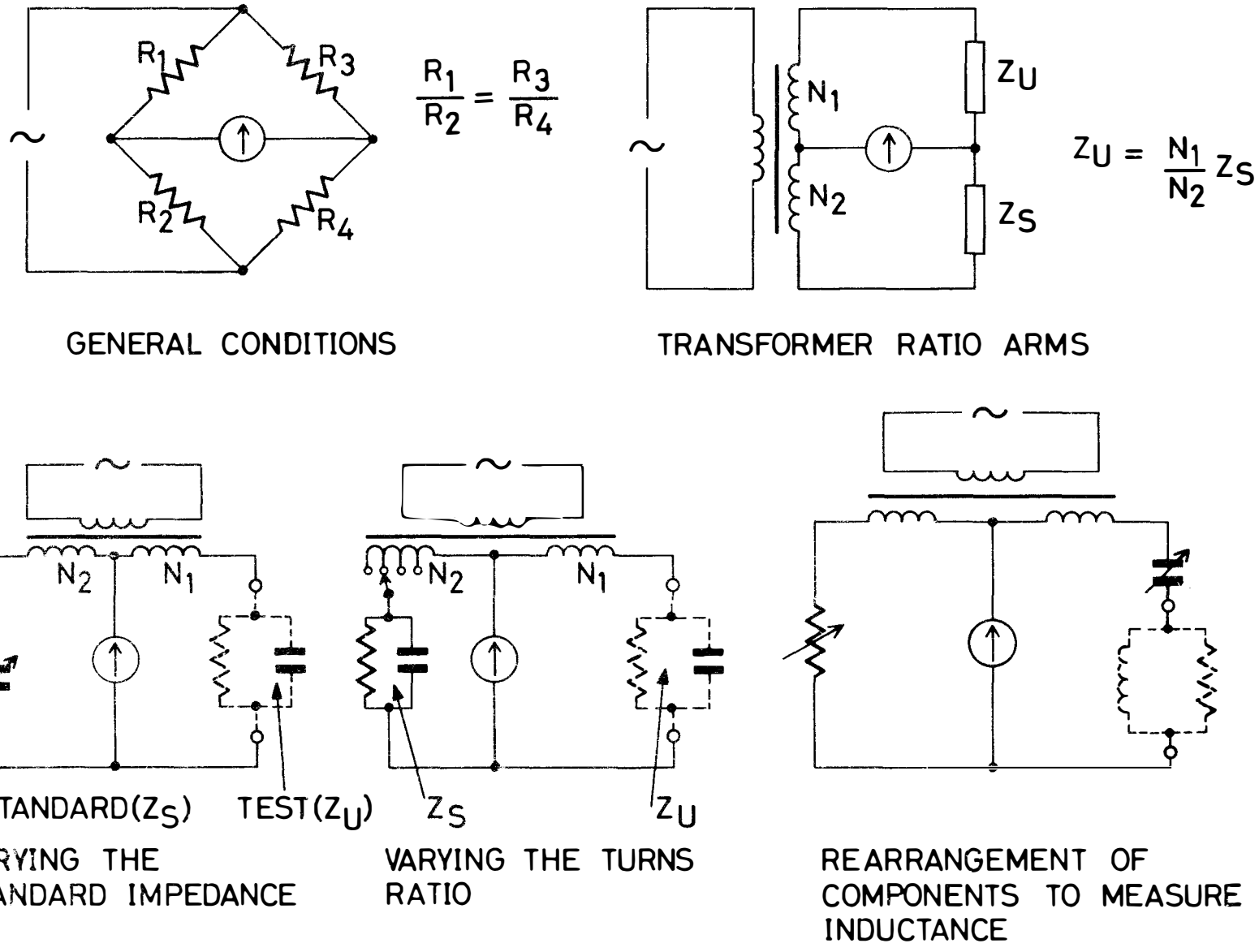


Fig. 3-4 The 3-Winding transformer bridge

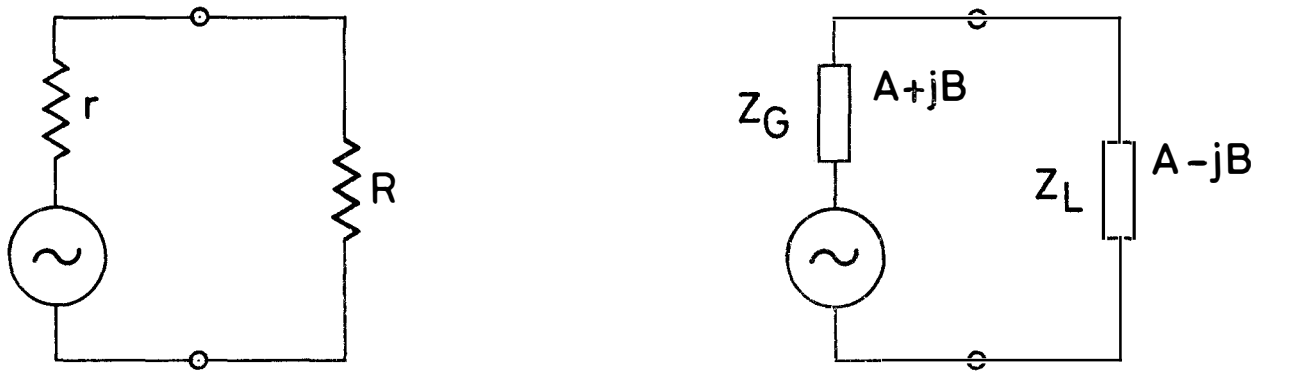


Fig. 3-5 Conditions required for maximum power transfer

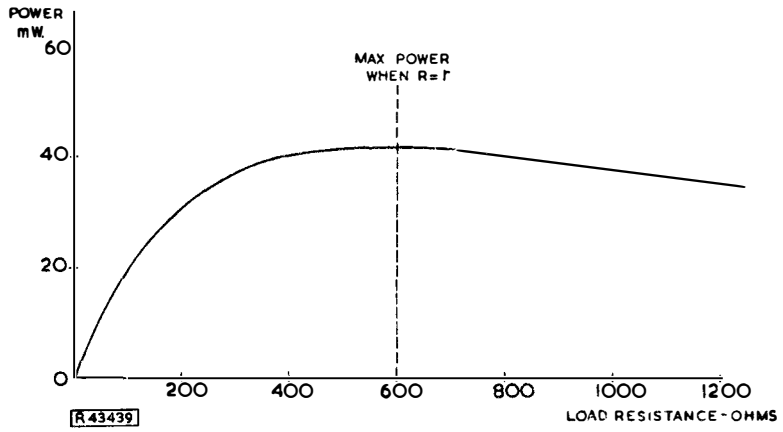


Fig. 3-6 Variation of load power against load resistance when the generator has an internal resistance of 600Ω and a terminal voltage of 10 volts.

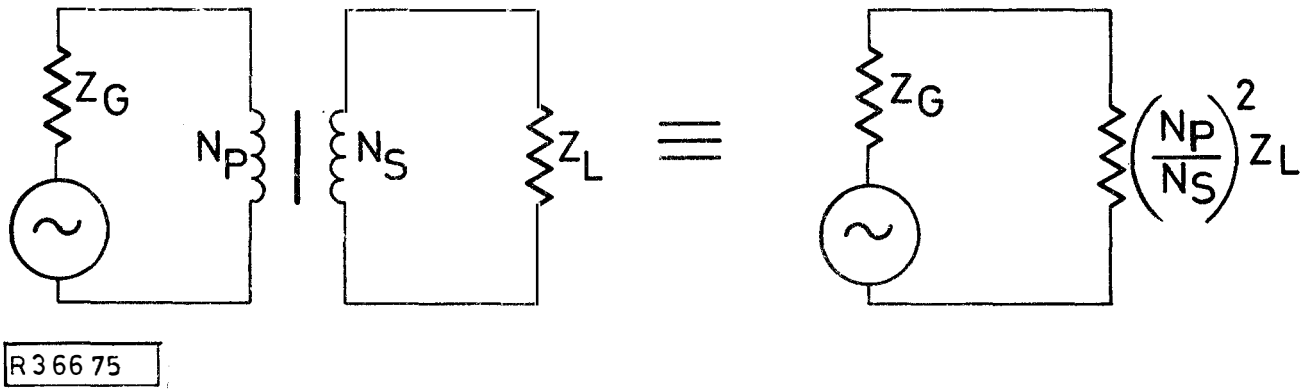


Fig. 3-7 Impedance matching with the aid of a transformer

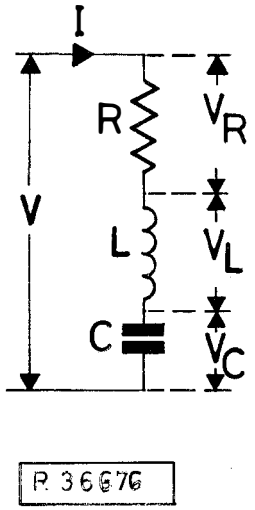


Fig. 4-1 Series circuit

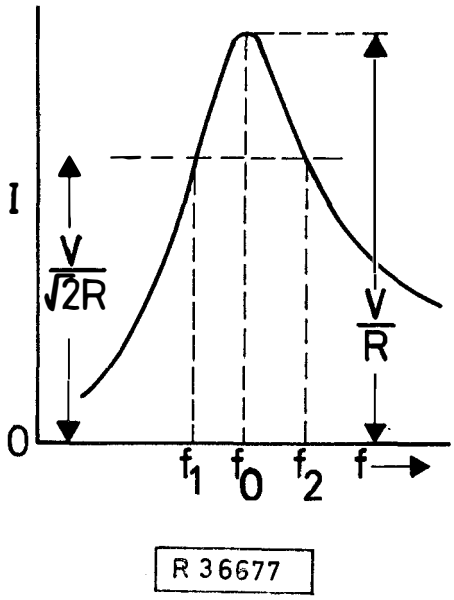


Fig. 4-2 Current response and half power points

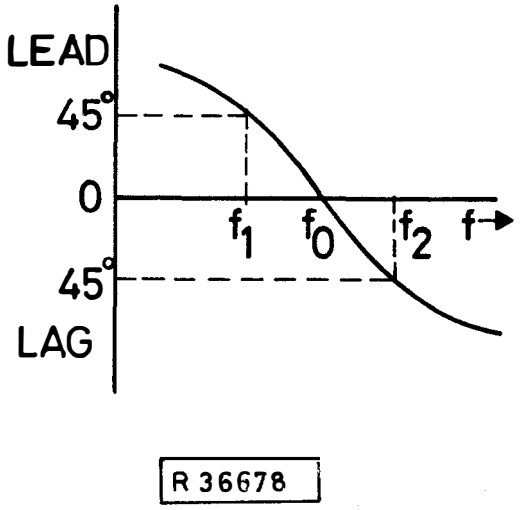


Fig. 4-3 Phase angle

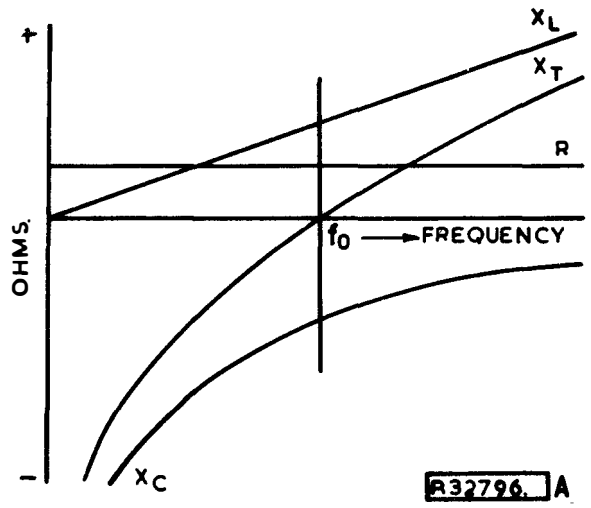


Fig. 4-4 Variation of resistance, capacitive reactance, inductive reactance and total reactance with frequency

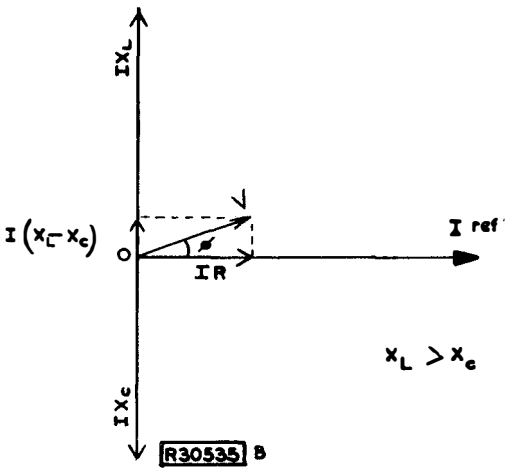


Fig. 4-5 Series circuit phasor diagram

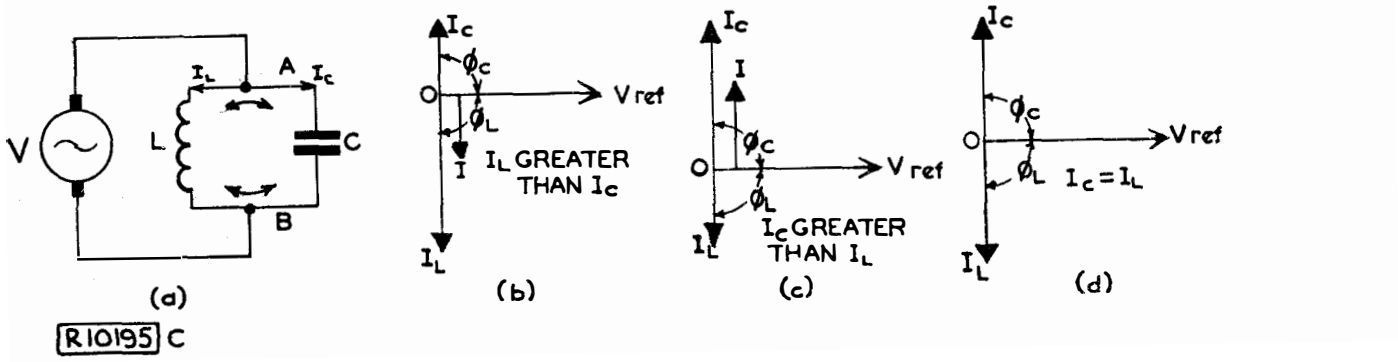
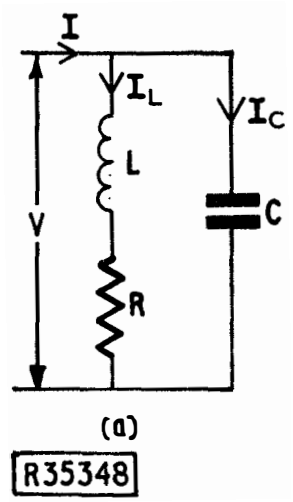
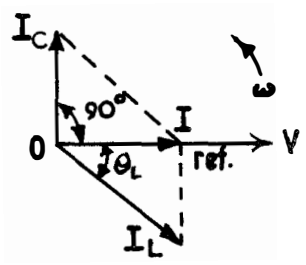


Fig. 4-6 Branch currents in a basic parallel circuit





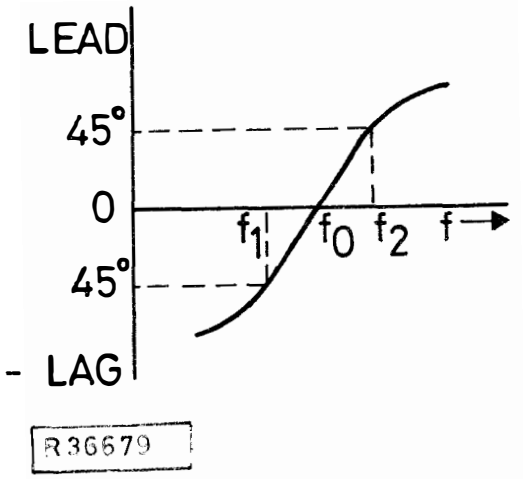
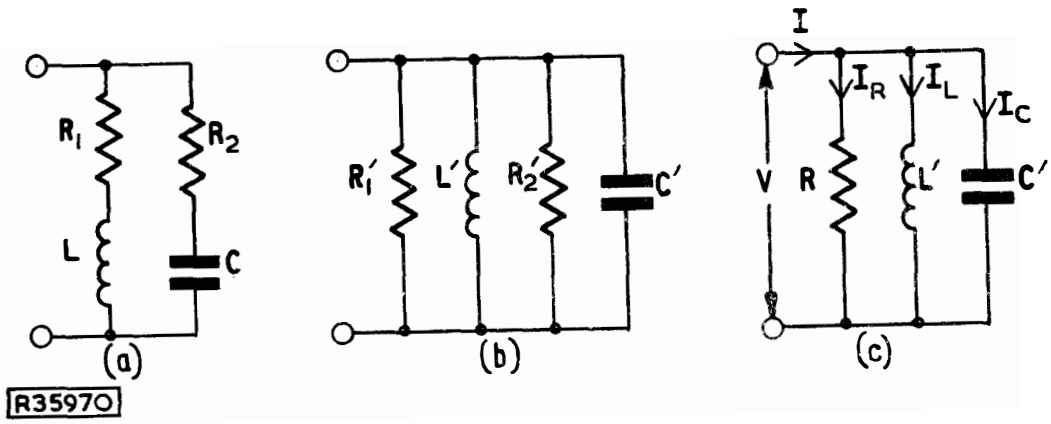


Fig. 4-8 Phase angle against frequency

Fig. 4-7 Parallel circuit and phasor diagram



where

$$R_1' = R_1(1 + Q_L^2)$$

$$R_2' = R_2(1 + Q_C^2)$$

and

$$R = \frac{R_1' R_2'}{R_1' + R_2'}$$

$$C' = \frac{C}{1 + \frac{1}{Q_C^2}}$$

and

$$L' = L\left(1 + \frac{1}{Q_L^2}\right)$$

Fig. 4-9 Simplification of the general parallel tuned circuit

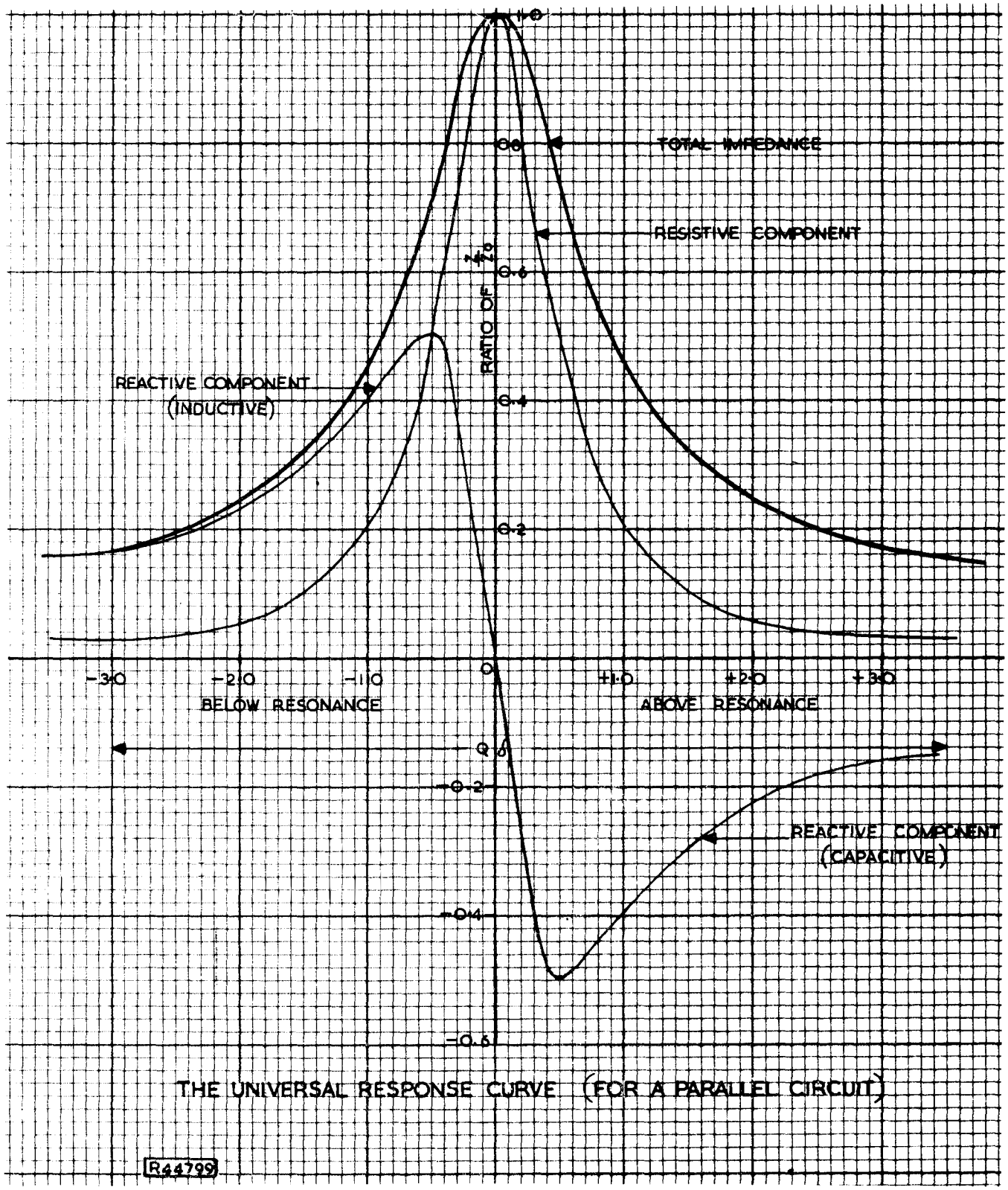
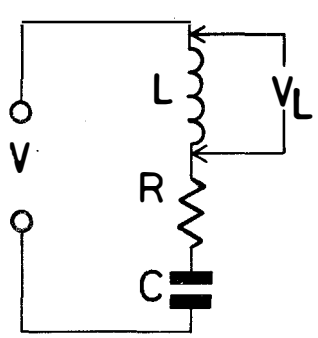
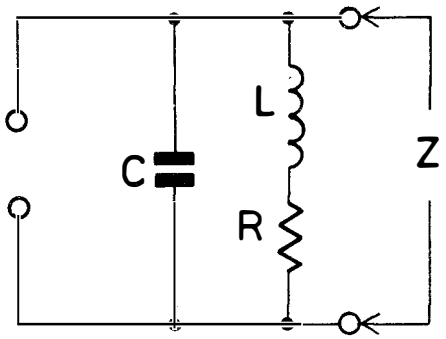
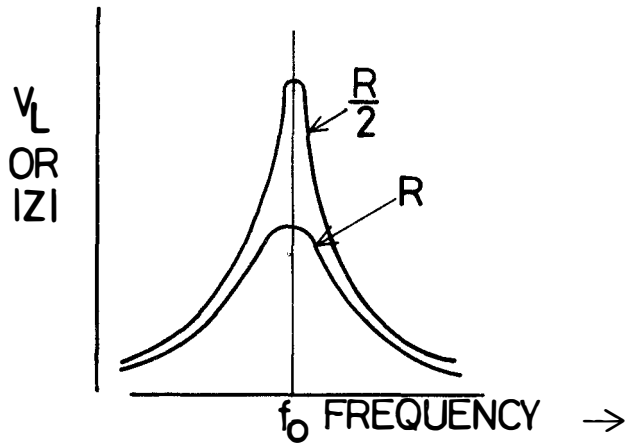


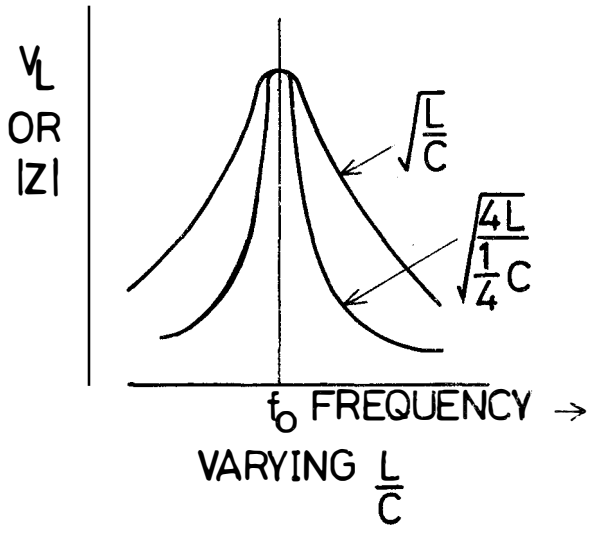
Fig. 4-10 The universal response curve for a parallel circuit showing its resistive and reactive components

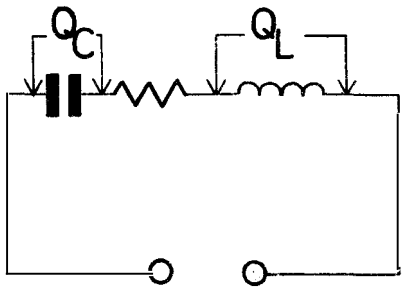




$$Q = \frac{V_L}{V} = \frac{\omega_0 L}{R} = \frac{1}{R}\sqrt{\frac{L}{C}}$$







$$Q_T = \frac{1}{\frac{1}{Q_L} + \frac{1}{Q_C}}$$

R36680

Fig. 4-11 Q factor of series and parallel tuned circuits

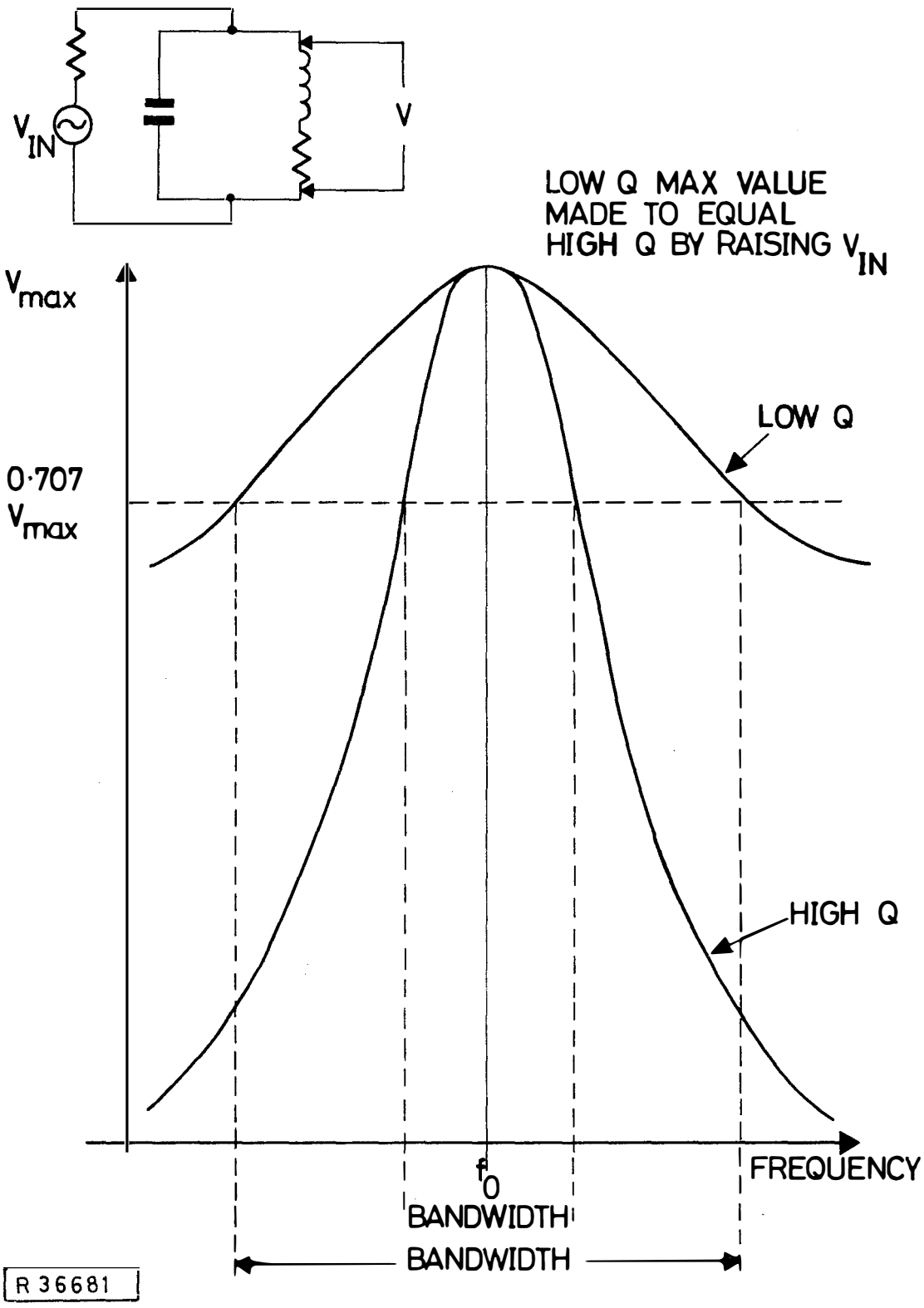
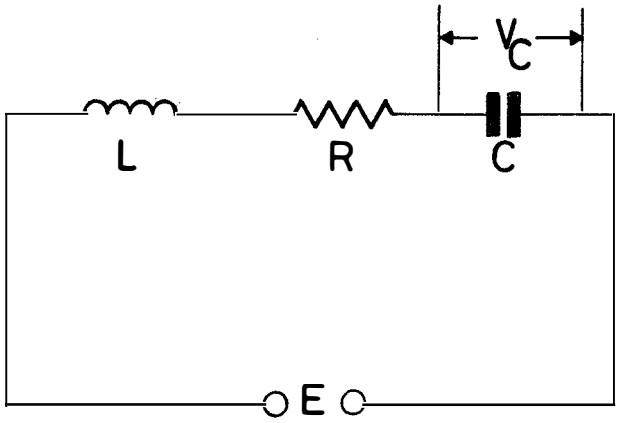
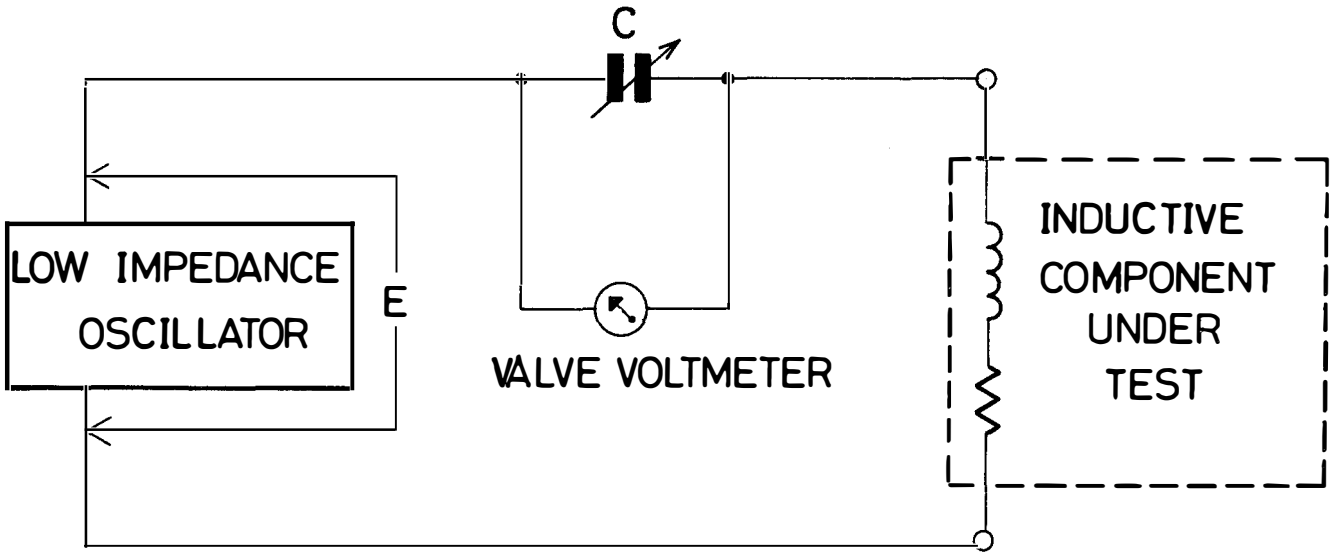


Fig. 4-12 Diagram showing the effect of Q factor on the selectivity of a circuit. The bandwidth is given as the range of frequencies between the half power points.



$$Q = \frac{V_C}{E} = \frac{V_L}{E}$$

PRINCIPLE OF THE Q METER



THE LOW IMPEDANCE OSCILLATOR PROVIDES CONSTANT E.
THE VALVE VOLTMETER IS HIGH IMPEDANCE AND IS CALIBRATED TO READ DIRECT VALUES OF Q.
IF C IS LOW LOSS THE CIRCUIT Q $\approx$ INDUCTOR Q

R 36682

Fig. 4-13 Simple Q meter

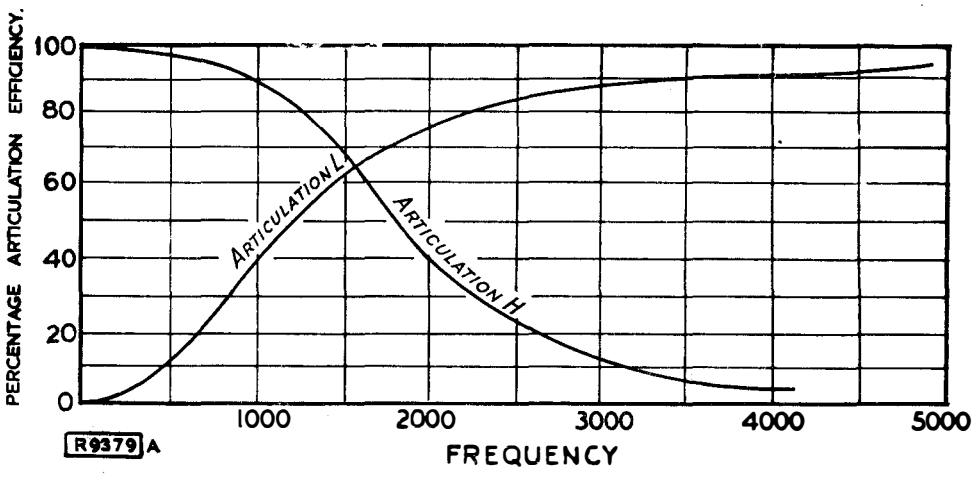


Fig. 5-1 How the articulation efficiency (intelligibility) is affected by the frequency range transmitted.

L = all frequencies transmitted below the frequency shown on the horizontal axis

H = " " " above " " " " " " " "

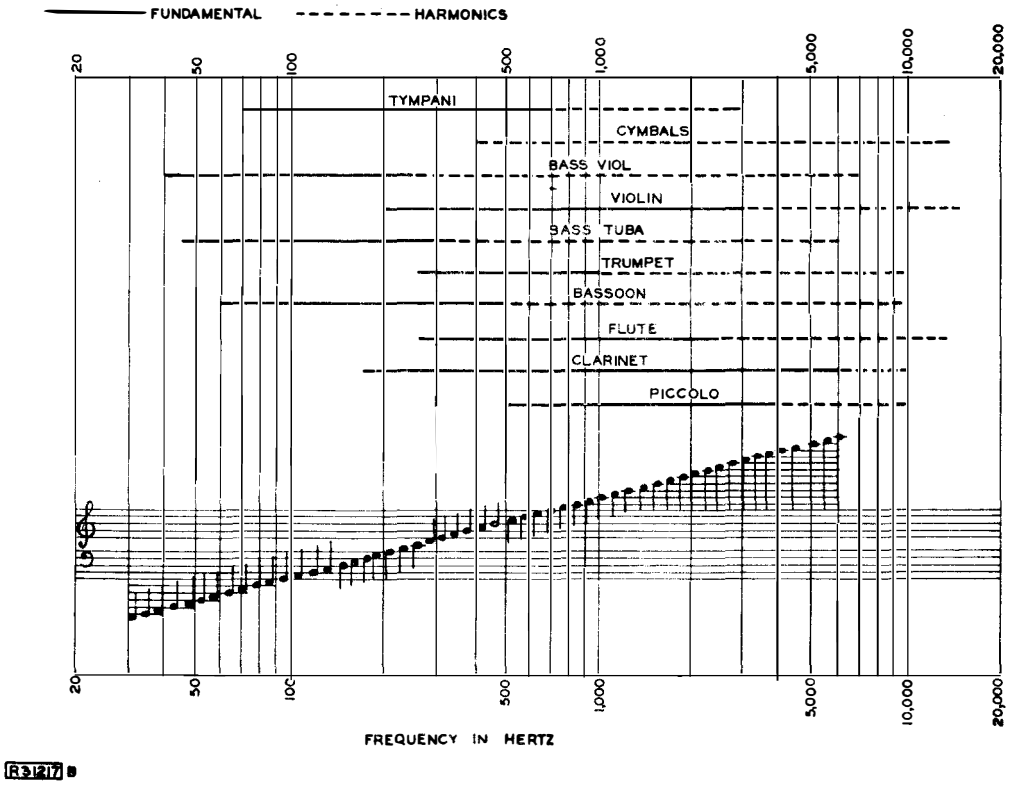


Fig. 5-2 Musical instrument fundamental and harmonic frequency ranges

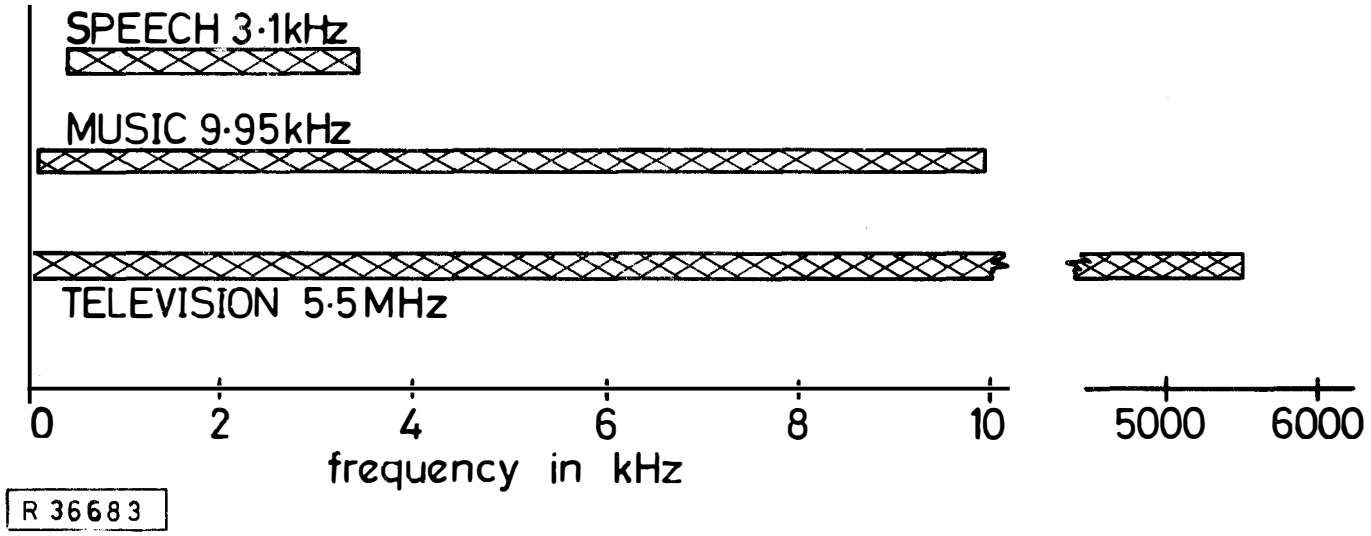


Fig. 5-3 Commercial bandwidths for speech, music and television channels

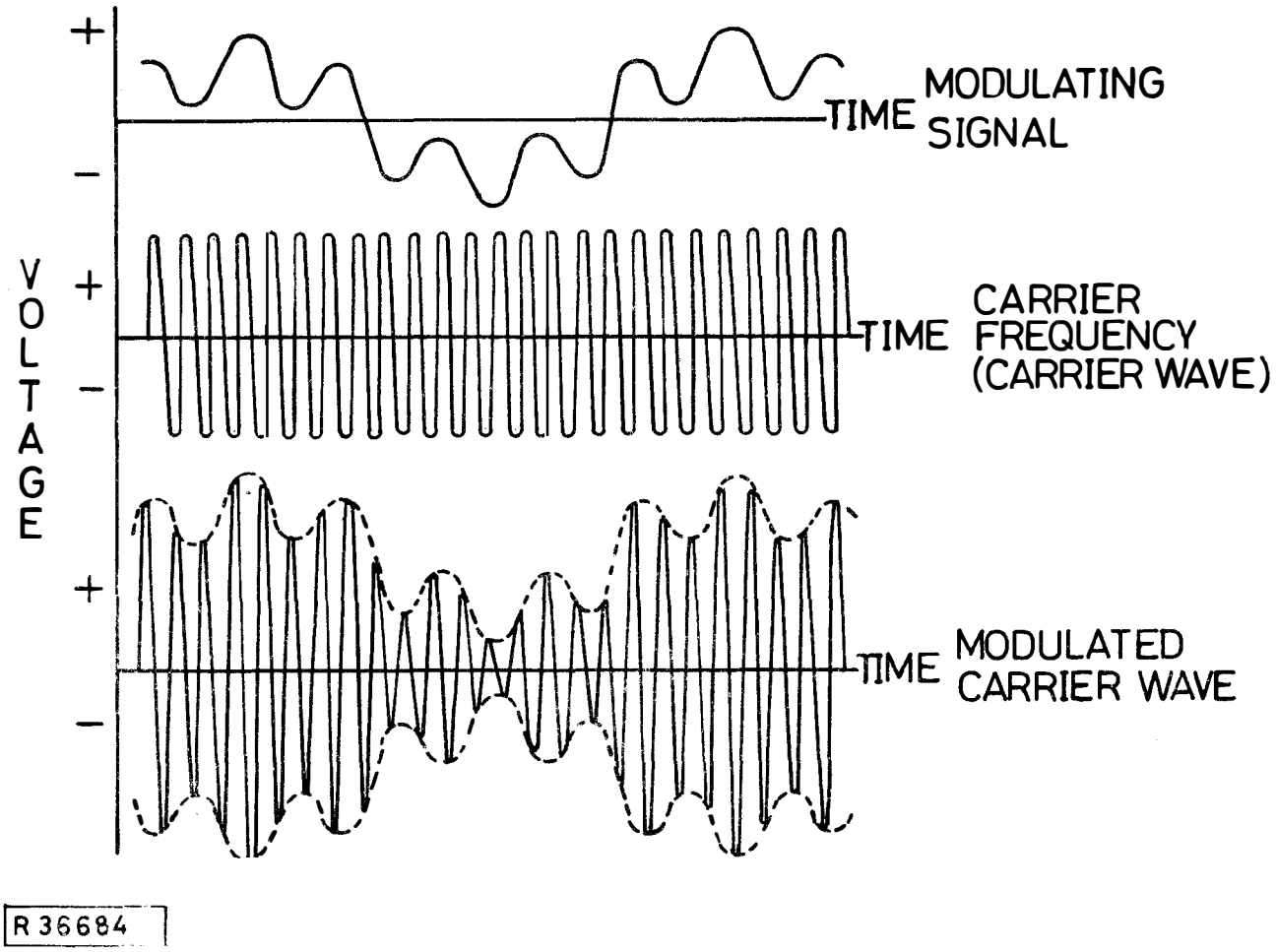
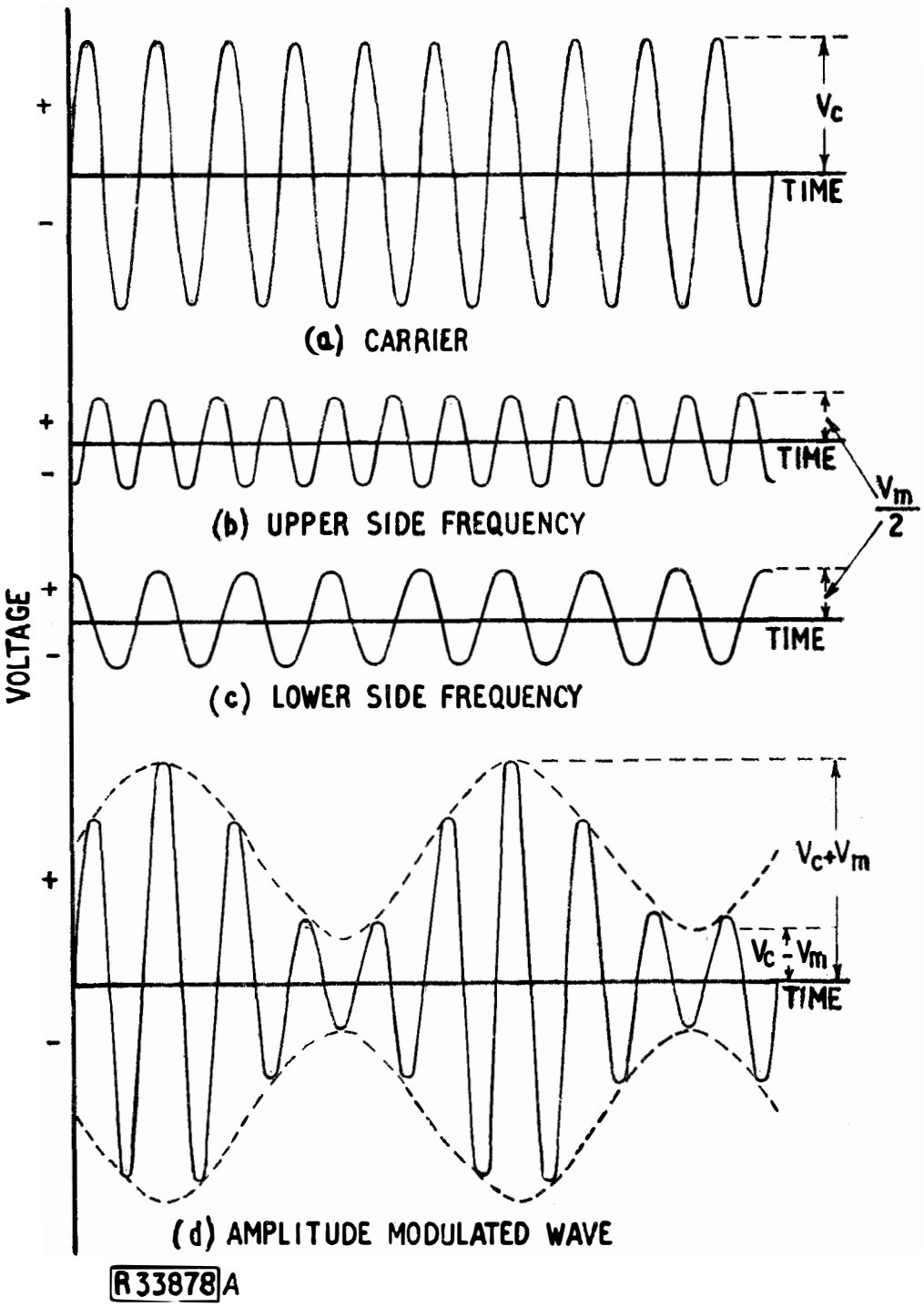


Fig. 5-4 The principle of amplitude modulation

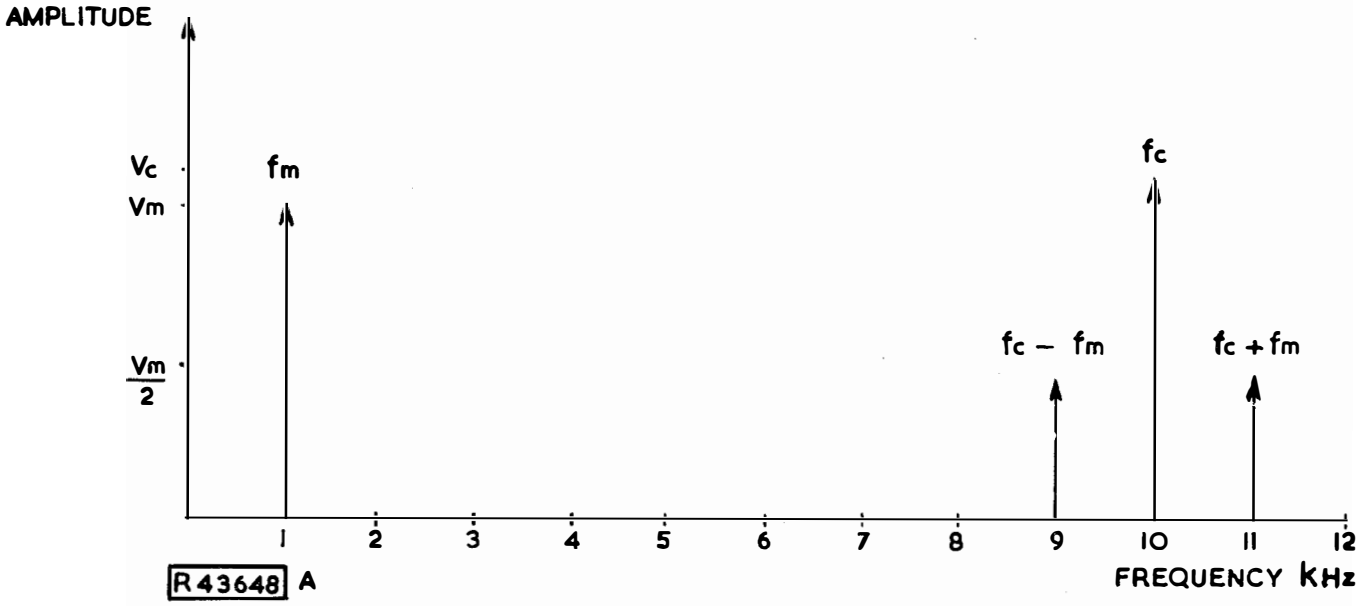


$$v_{mc} = V_c \sin \omega t + \frac{V_m}{2}\left\{\cos (\omega - \rho)\ t - \cos (\omega + \rho)\ t\right\}$$

$$= V_c \sin \omega t + \frac{V_m}{2} \sin\left\{ (\omega - \rho)\ t + \frac{\pi}{2} \right\}$$

$$+ \frac{V_m}{2} \sin \left\{(\omega + \rho)\ t - \frac{\pi}{2}\right\}$$

Fig. 5-5 Component frequencies of an amplitude modulated wave



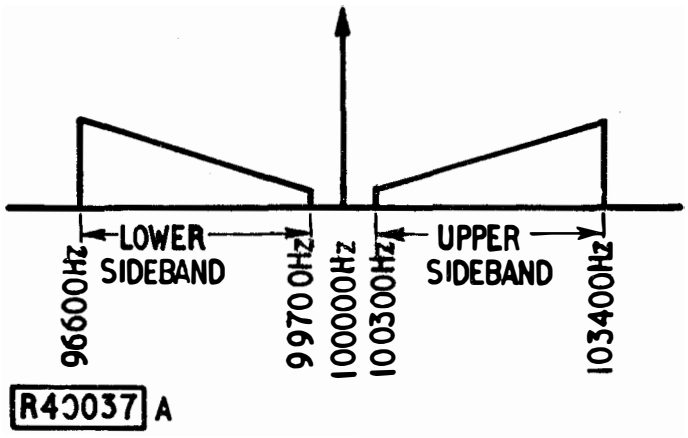


Fig. 5-6 Frequency spectrum diagrams

$$V_{mc} = V_c \sin \omega t + \frac{V_m}{2} \sin\left\{(\omega - \rho)t + \frac{\pi}{2}\right\} - \frac{V_m}{2} \sin\left\{(\omega + \rho)t + \frac{\pi}{2}\right\}$$

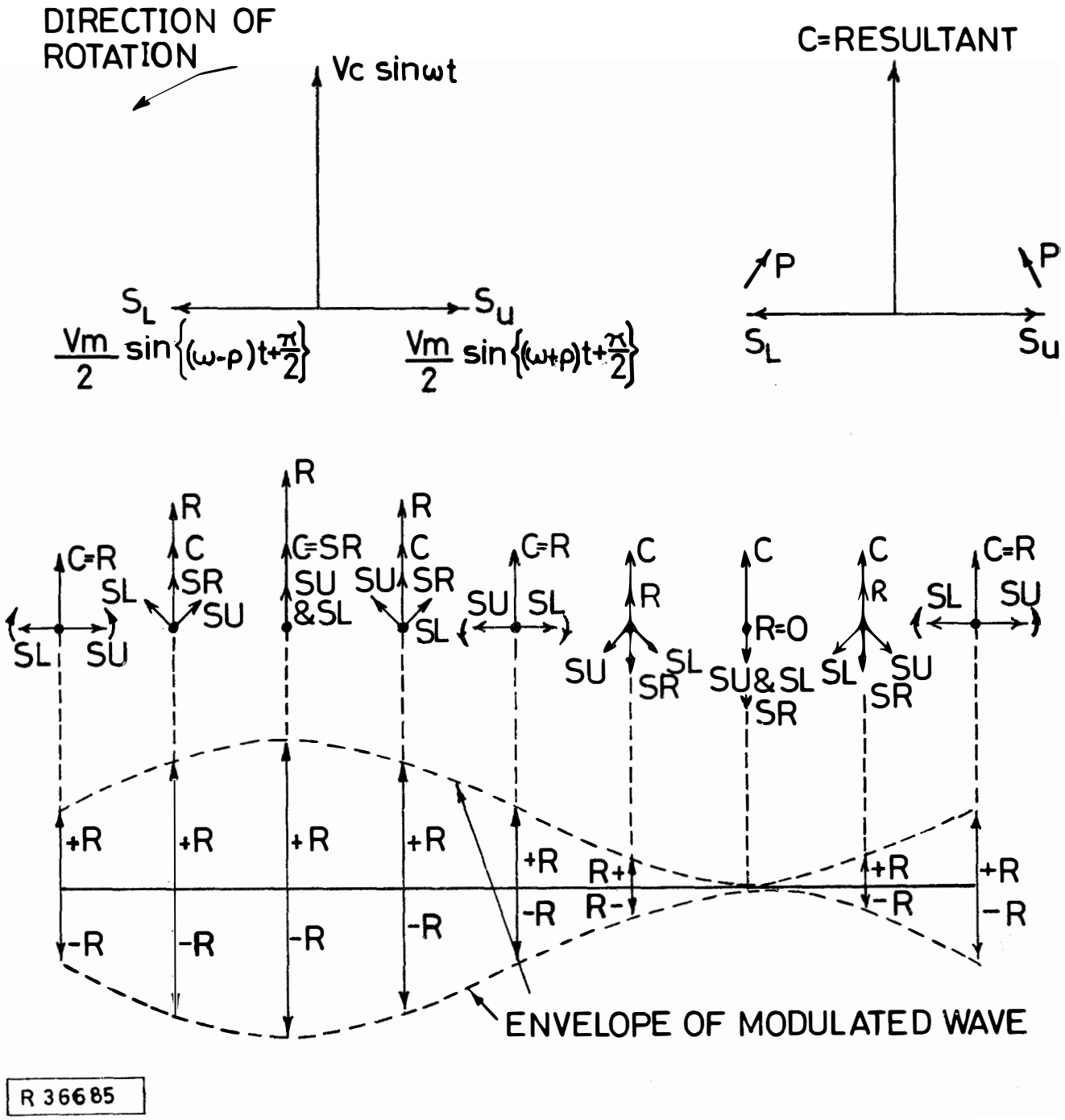


Fig. 5-7 Phasor representation of an amplitude modulated wave showing the revolving side frequency phasors modulating the carrier wave

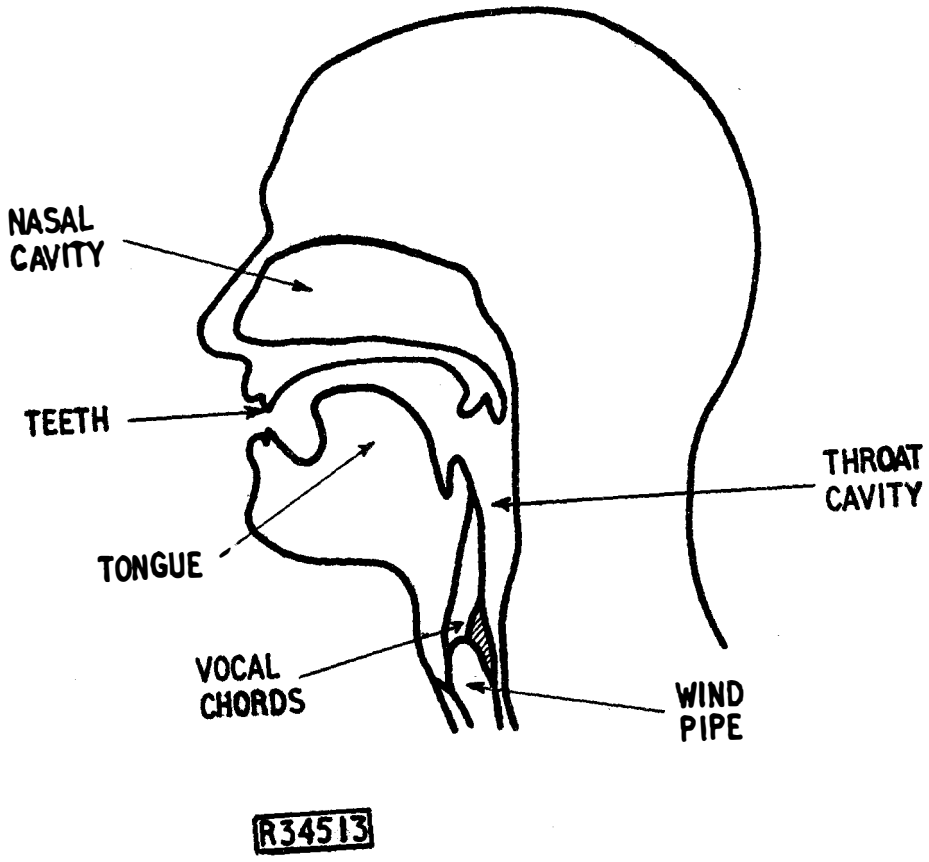


Fig. 5-8 Diagram showing the features of the head involved in producing sound

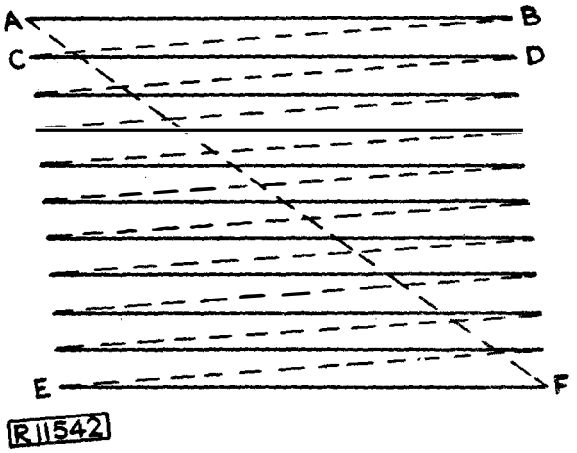


Fig. 5-9 Television picture scanning showing a line trace A-B, line fly-back B-C, and fly-back to begin a new frame F-A

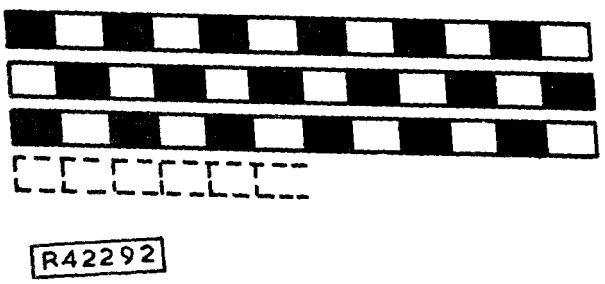
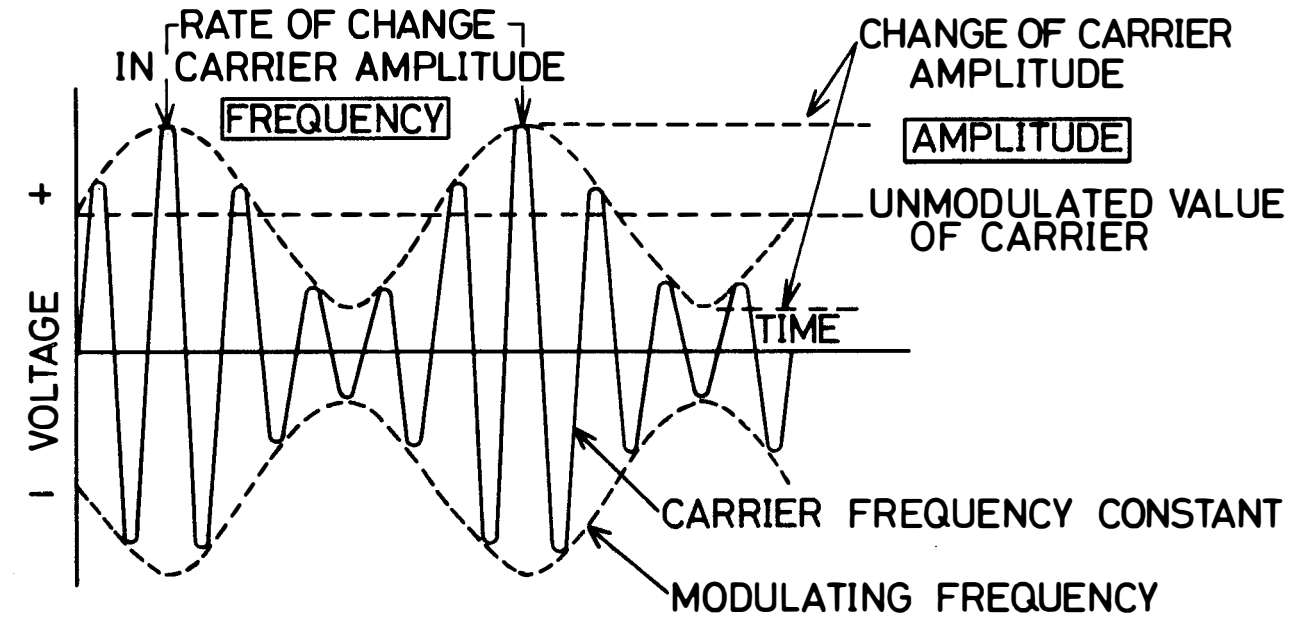
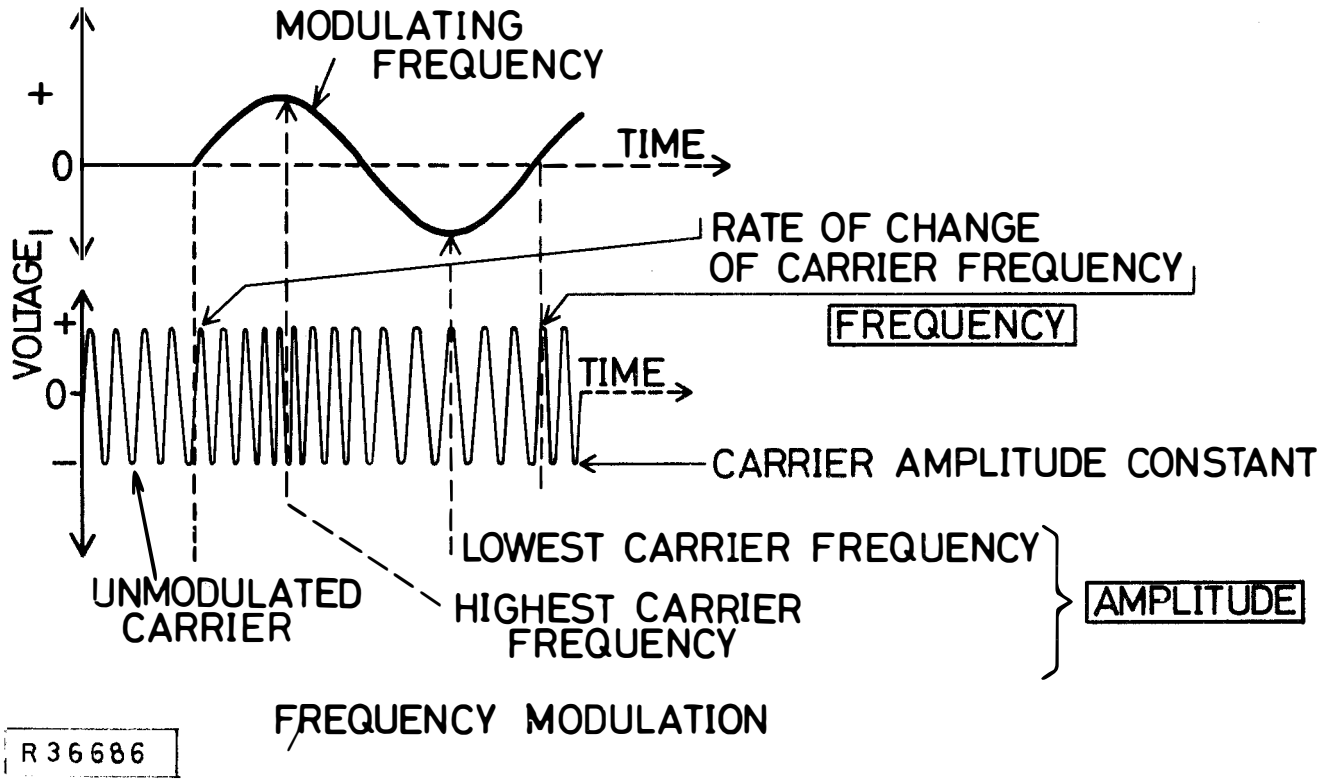


Fig. 5-10 Television picture lines showing how the lines are composed of elements



AMPLITUDE MODULATION



FREQUENCY MODULATION

Fig. 6-1 Comparison of A.M. and F.M.

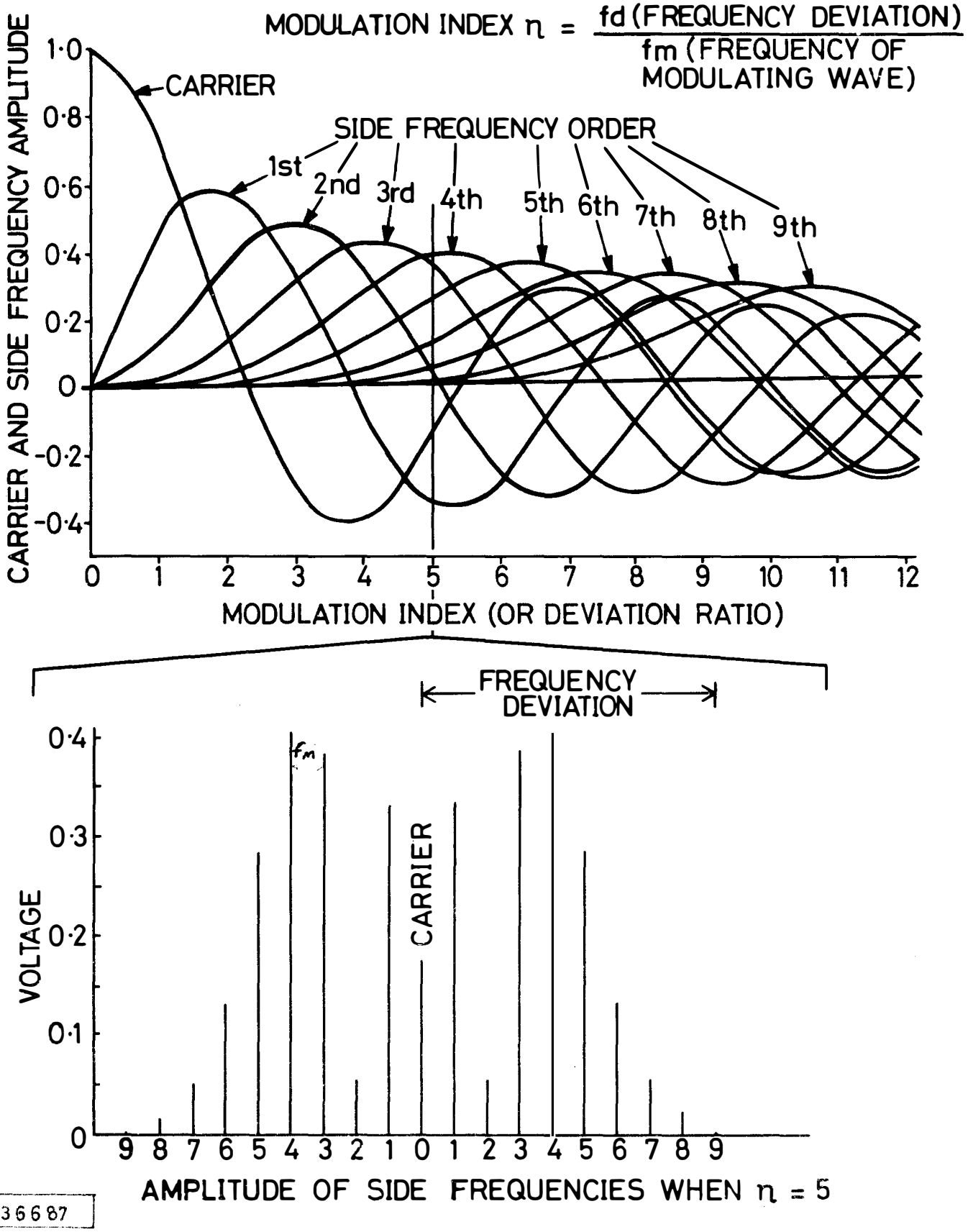


Fig. 6-2 Spectrum diagram showing the amplitude of the side frequencies when the modulation index is 5

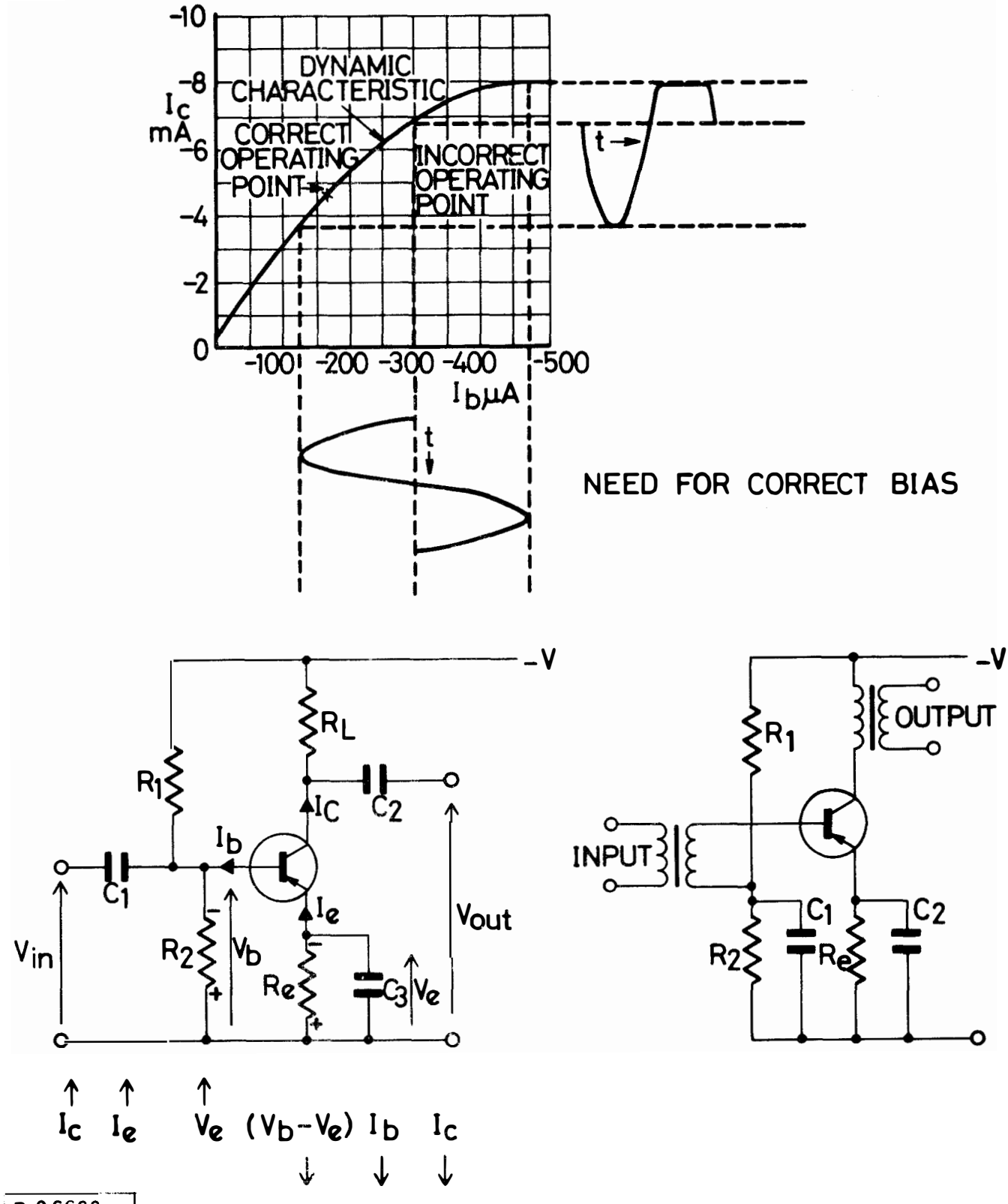
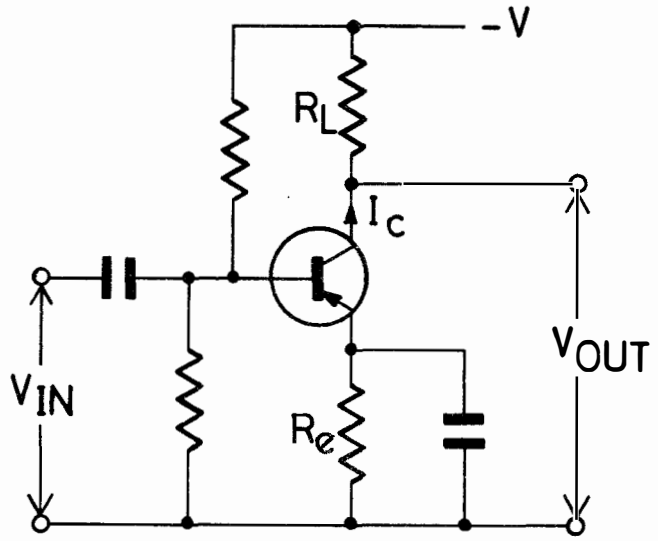
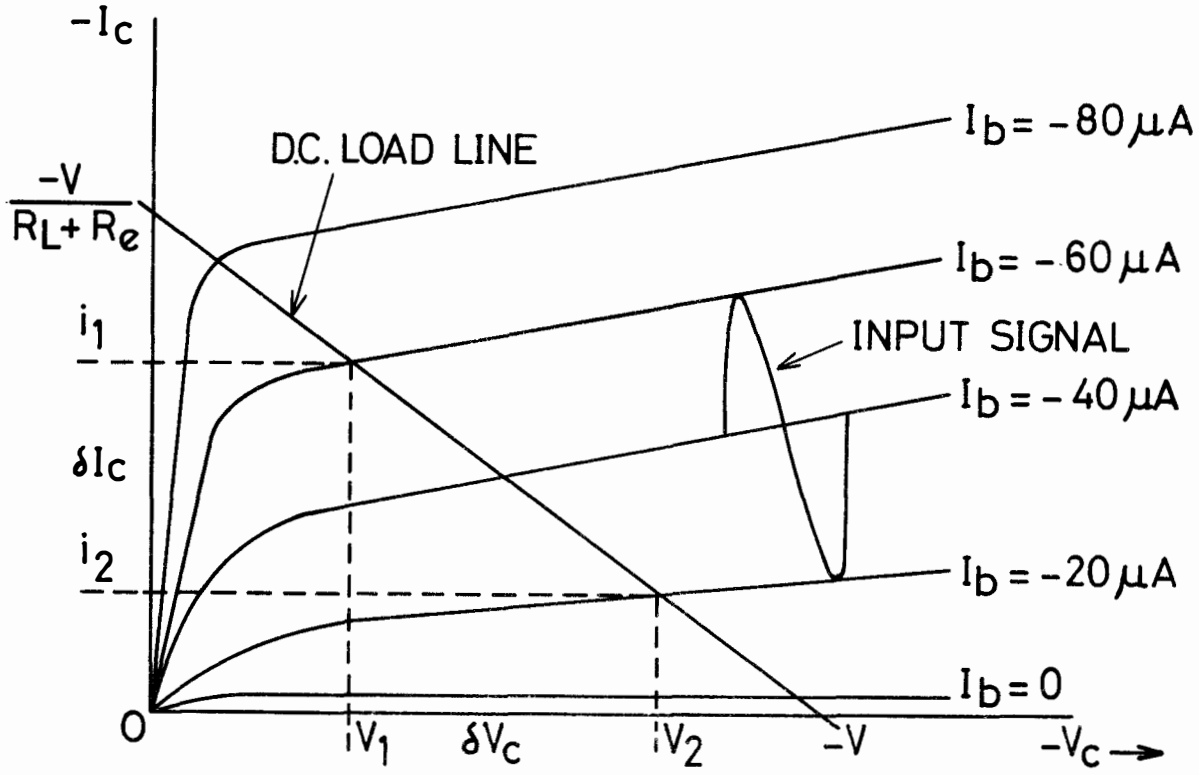


Fig. 7-1 The need for correct bias and the potential divider method of achieving bias stabilization





$$I_{OUT} = \frac{(i_1 - i_2)}{\sqrt{2}.2} \qquad V_{OUT} = \frac{(V_2 - V_1)}{\sqrt{2}.2}$$

$$P_{OUT} = I_{OUT} \times V_{OUT} = \frac{(i_1 - i_2)(V_2 - V_1)}{8}$$

R 36689

Fig. 7-2 Common emitter amplifier. Obtaining output from the load line

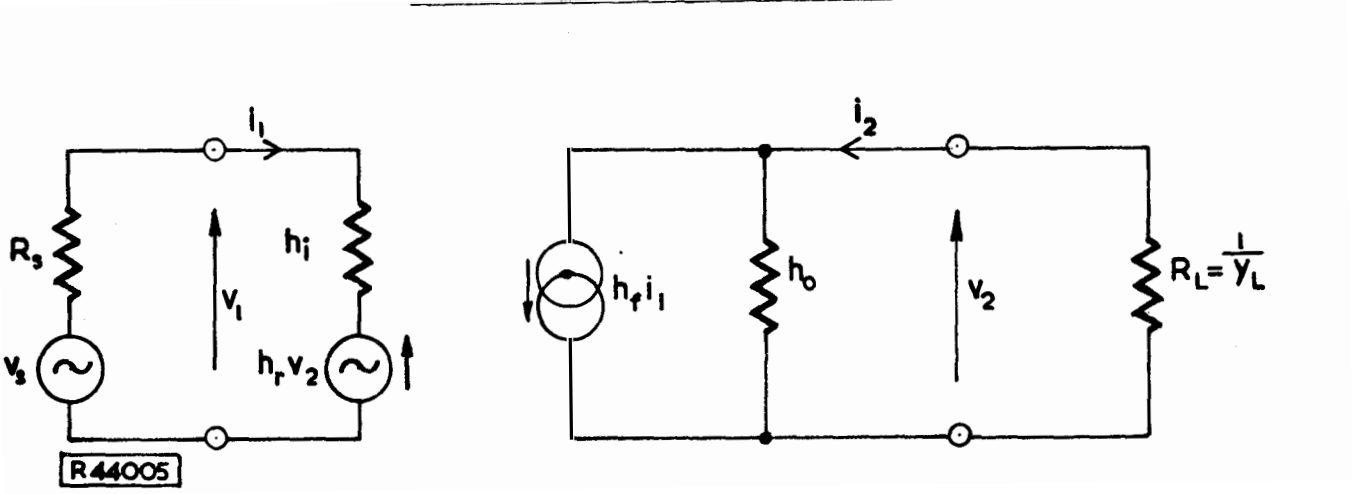


Fig. 7-3 h parameter complete equivalent circuit

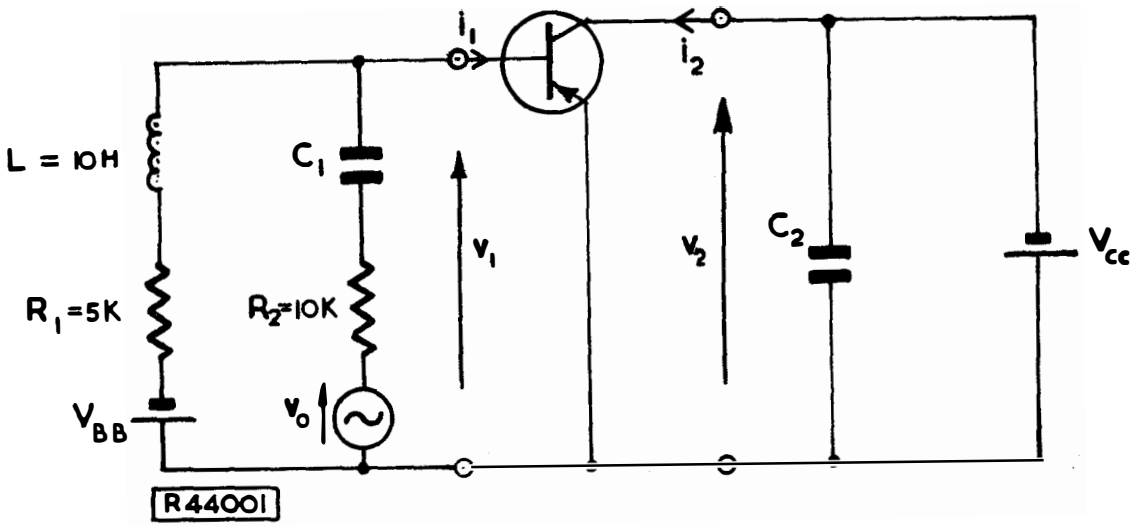
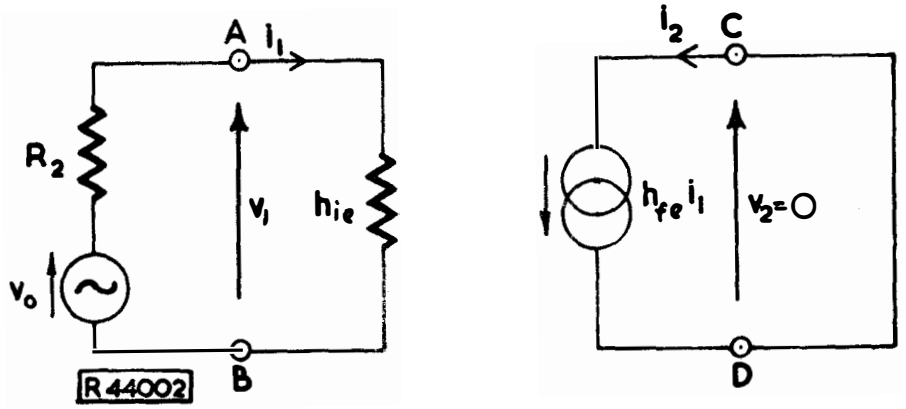


Fig. 7-4 Measuring the input impedance parameter h_{ie} and the forward current transfer parameter h_{fe}



where

$$h_{ie} = \frac{v_1}{i_1}$$

and

$$h_{fe} = \frac{i_2}{i_1}$$

Fig. 7-5 Equivalent circuit

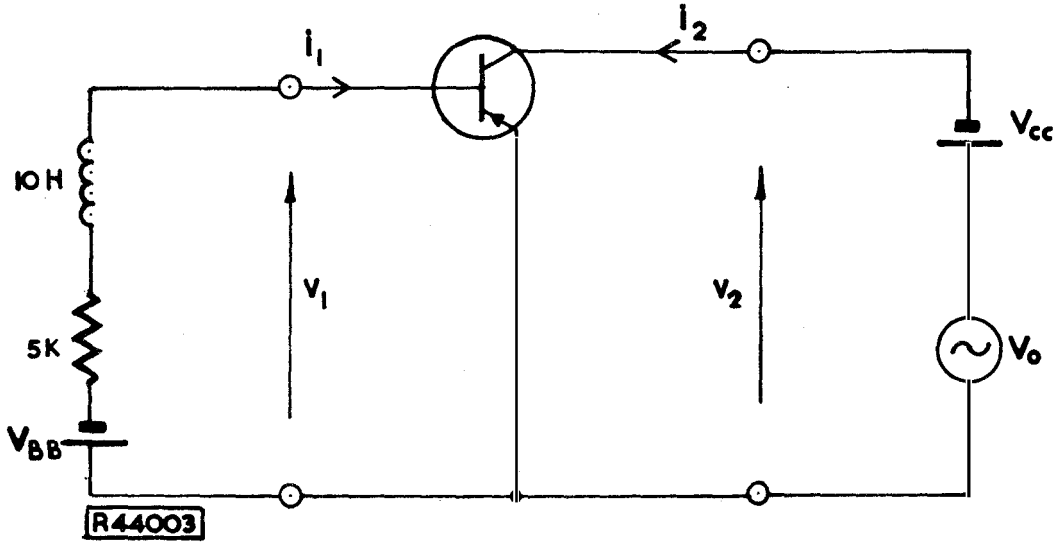
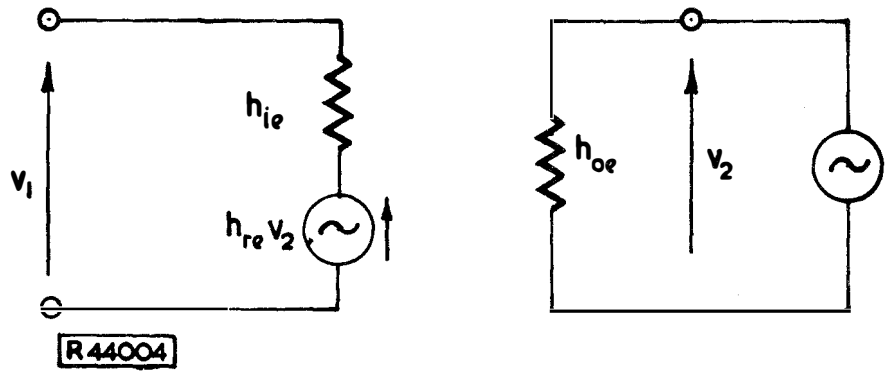


Fig. 7-6 Measuring the reverse voltage transfer ratio parameter h_{re} and the output admittance parameter h_{oe}



where

$$h_{re} = \frac{v_1}{v_2}$$

and

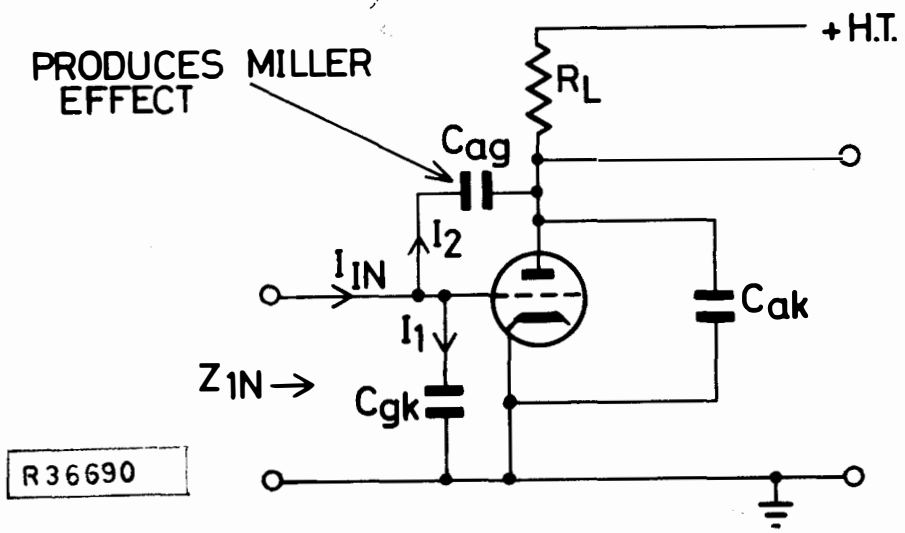
$$h_{oe} = \frac{i_2}{v_2}$$

Fig. 7-7 Equivalent circuit

COMMON BASE	COMMON EMITTER	COMMON COLLECTOR
(h_{11}) h_{ib} = 35 ohms	(h'_{11}) h_{ie} = 1450 ohms	(h''_{11}) h_{ic} = 1500 ohms
(h_{22}) h_{ob} = 10^{-6} siemen	(h'_{22}) h_{oe} = 42×10^{-6} siemen	(h''_{22}) h_{oc} = 42×10^{-6} siemen
(h_{12}) h_{rb} = 7×10^{-4}	(h'_{12}) h_{re} = 7.6×10^{-4}	(h''_{12}) h_{rc} = 1
(h_{21}) h_{fb} = - 0.976	(h'_{21}) h_{fe} = 41	(h''_{21}) h_{fc} = - 42

Note that the Forward Current Transfer Ratio (h_f) for both common base and common collector configurations is negative. The previous symbols used for the parameters are shown in brackets as they are still encountered in some text books.

Fig. 7-8 Typical values of h parameters for an audio frequency transistor



$$Z_{IN} \equiv C_{gk} + (1+A)C_{ag}$$

WHERE A = STAGE GAIN

Fig. 8-1 Anode to grid feedback via C_{ag} producing Miller Effect

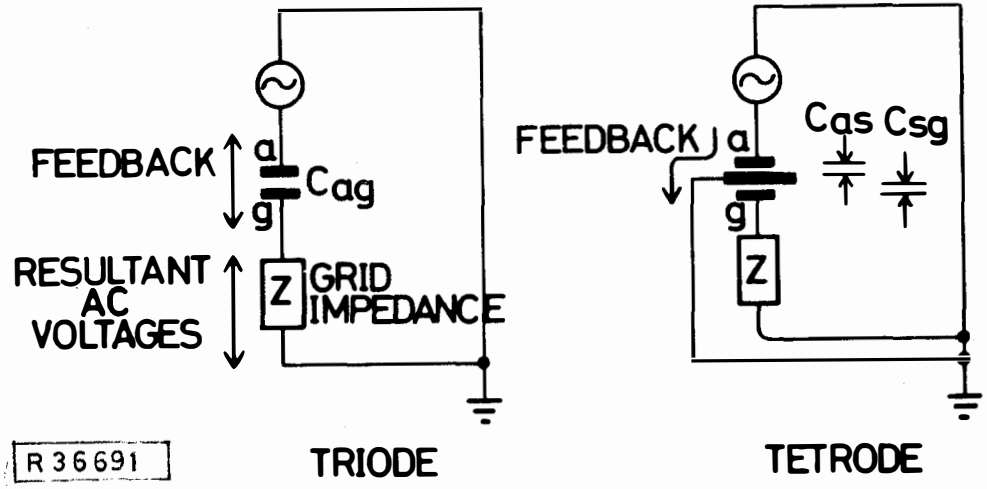


Fig. 8-2 Theory of screening

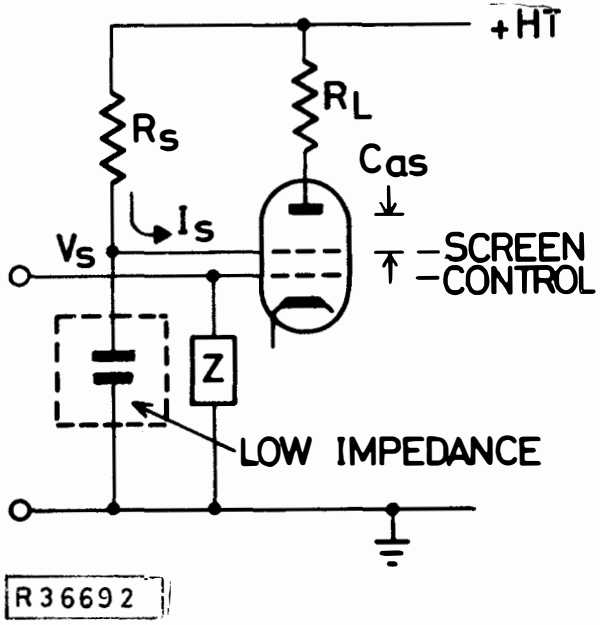
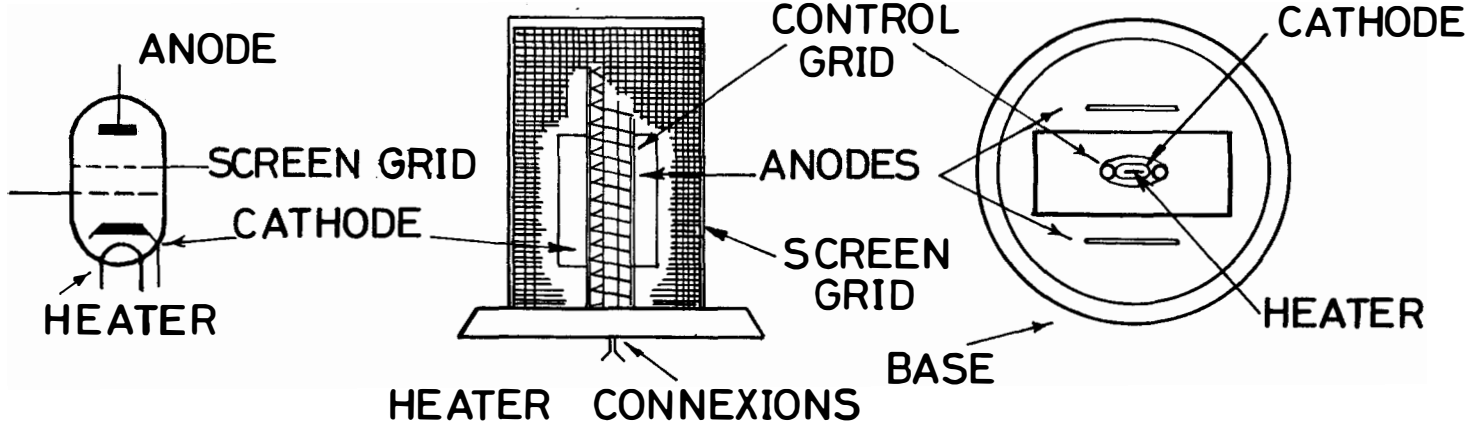
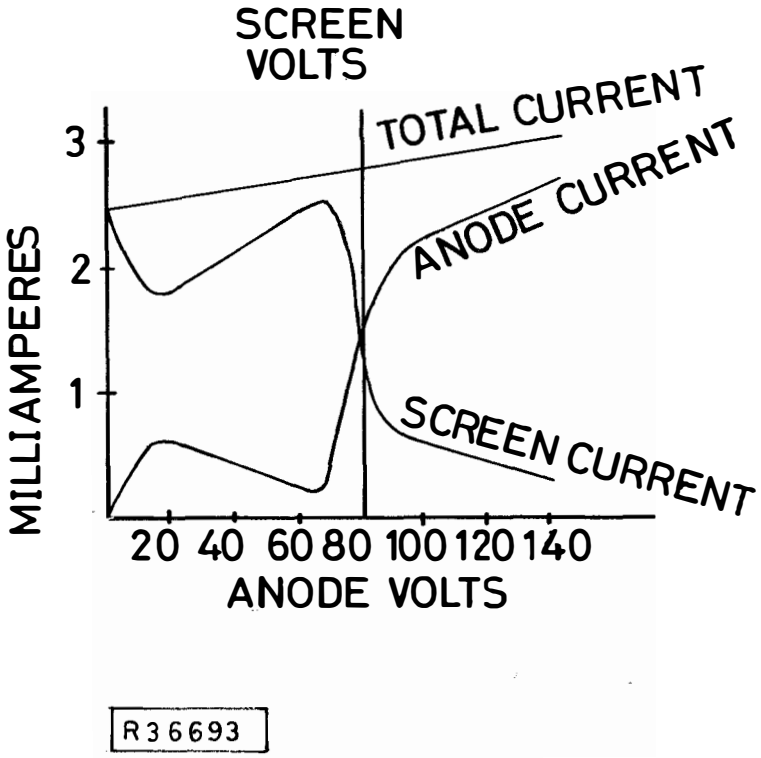


Fig. 8-3 The Tetrode circuit. Note that the screen is at a +ve potential, hence the need for the capacitor connected to the earth line





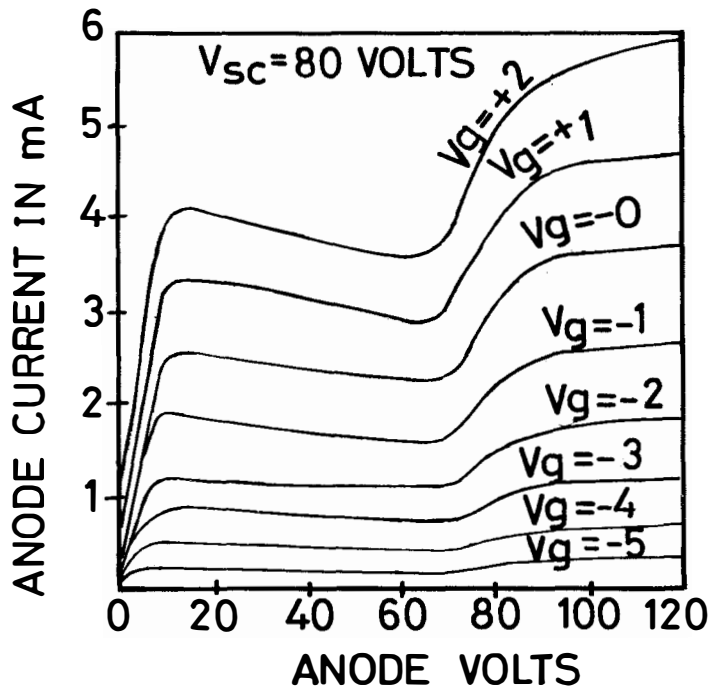


Fig. 8-4 The tetrode valve

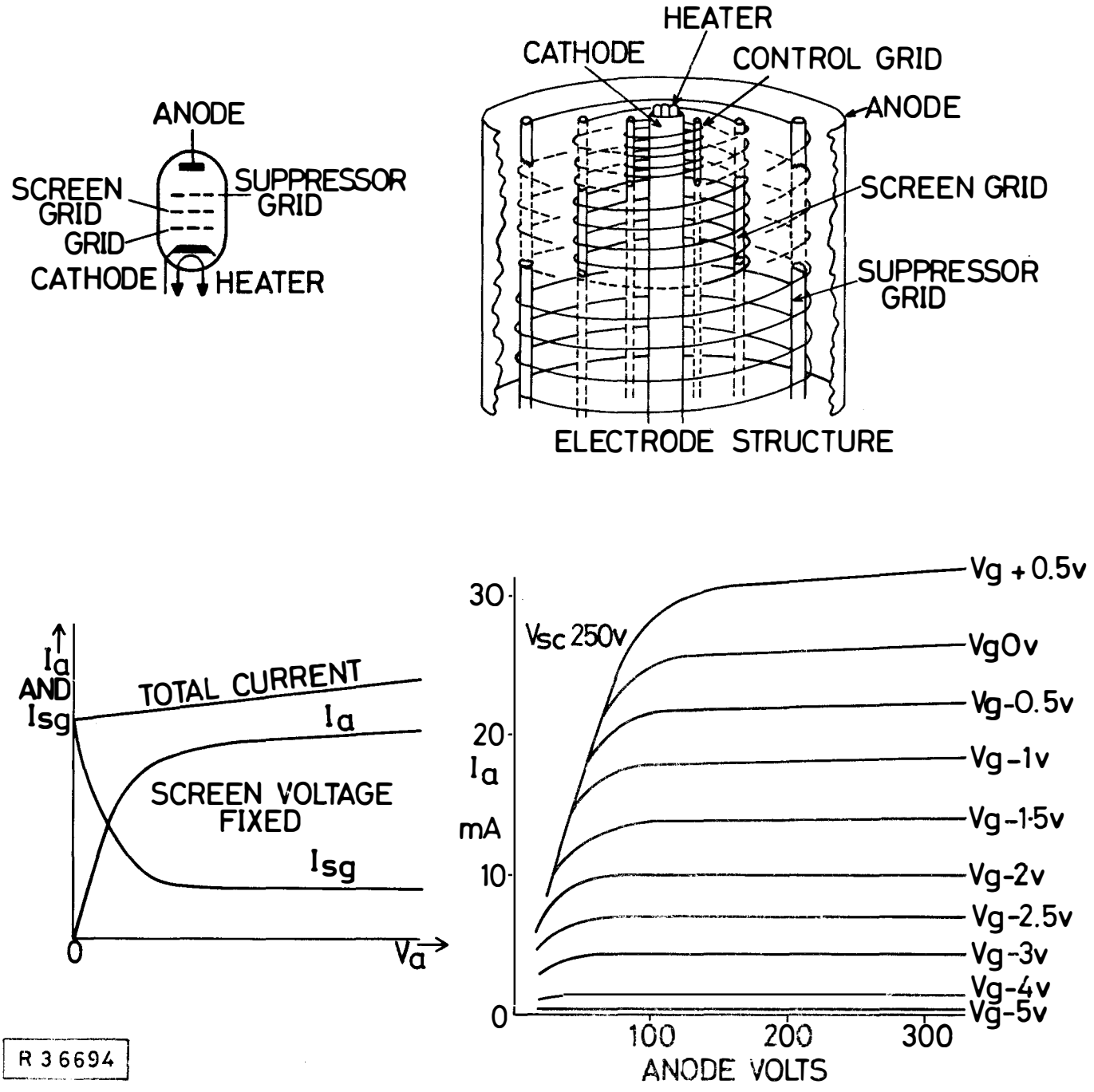
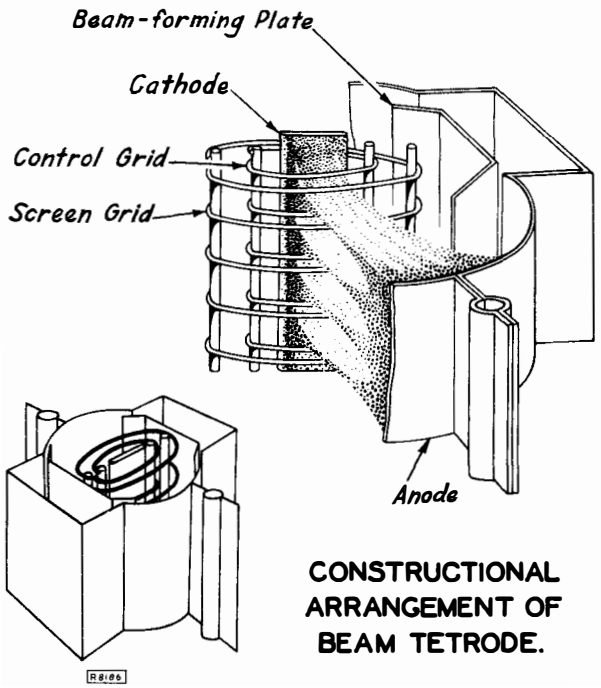


Fig. 8-5 The pentode valve



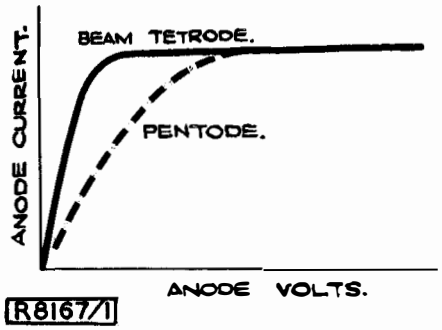


Fig. 8-7 Comparison of Beam Tetrode and Pentode Characteristics

Fig. 8-6 Beam forming plates in the Beam Tetrode

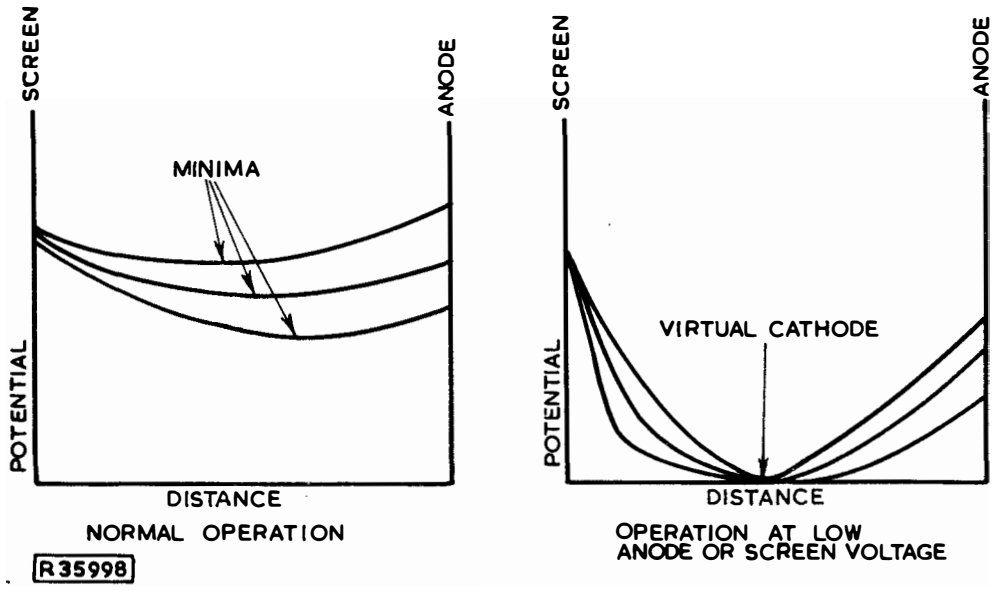


Fig. 8-8 Potential distribution between the screen and anode in a Beam Tetrode

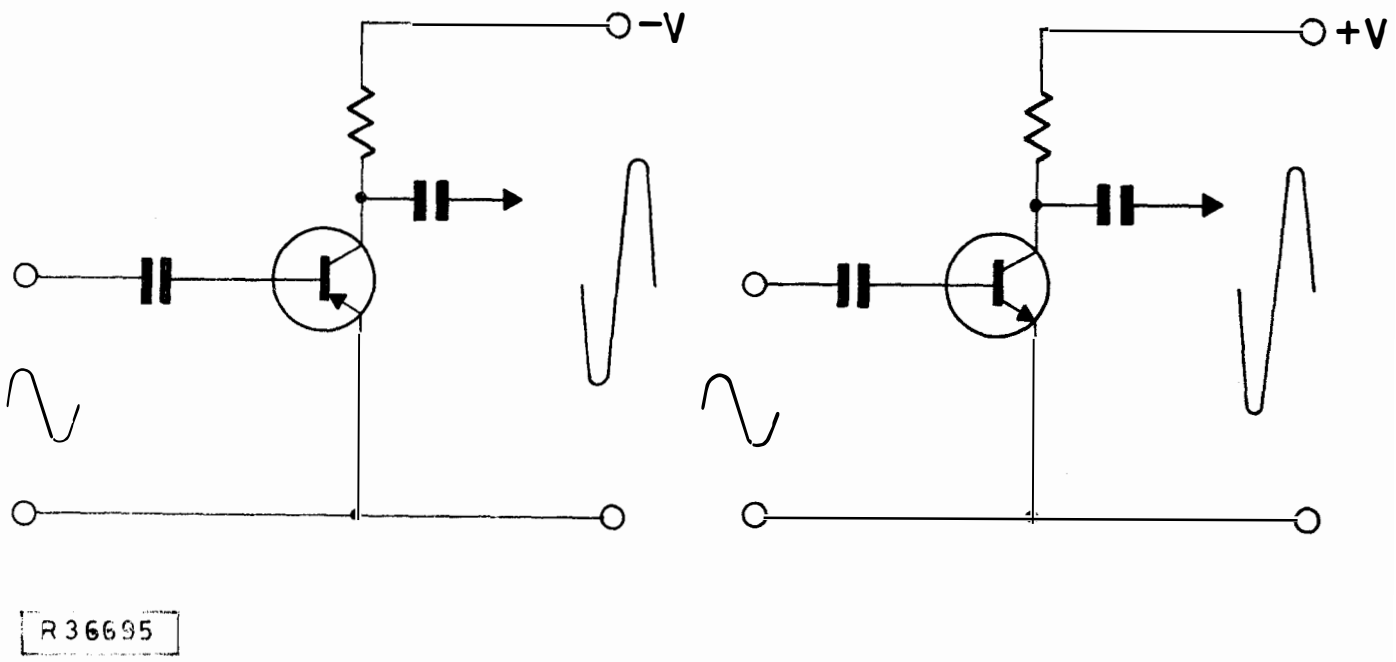


Fig. 9-1 Representation of PNP and NPN transistors. Note that the polarity is reversed

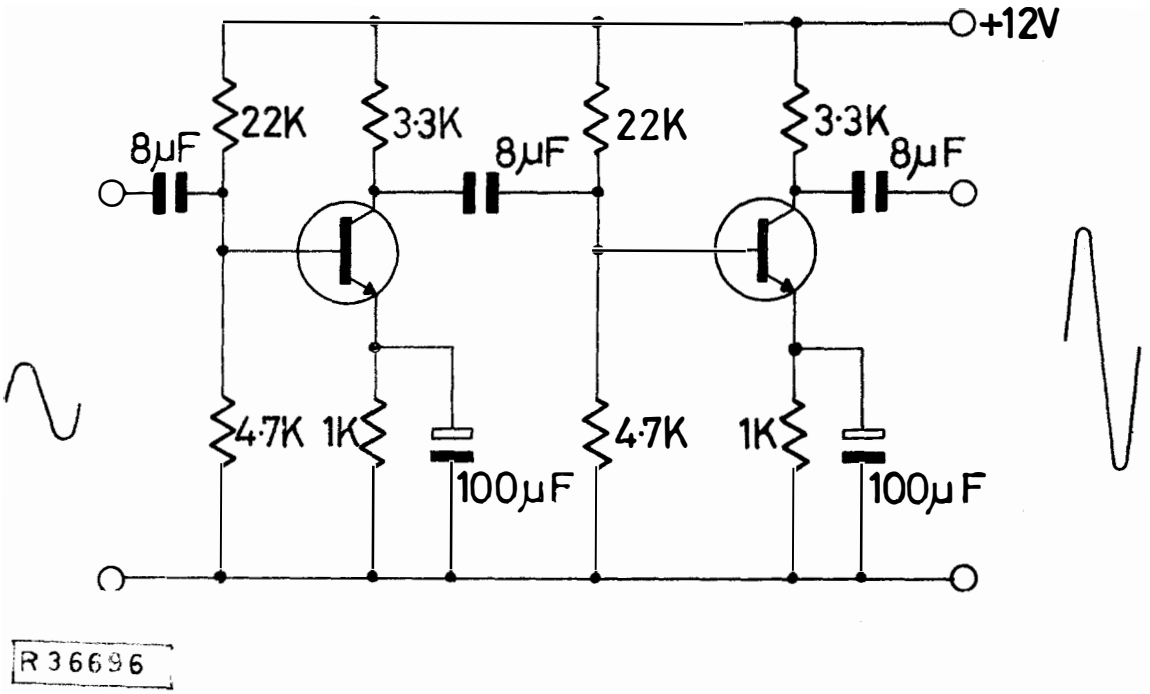
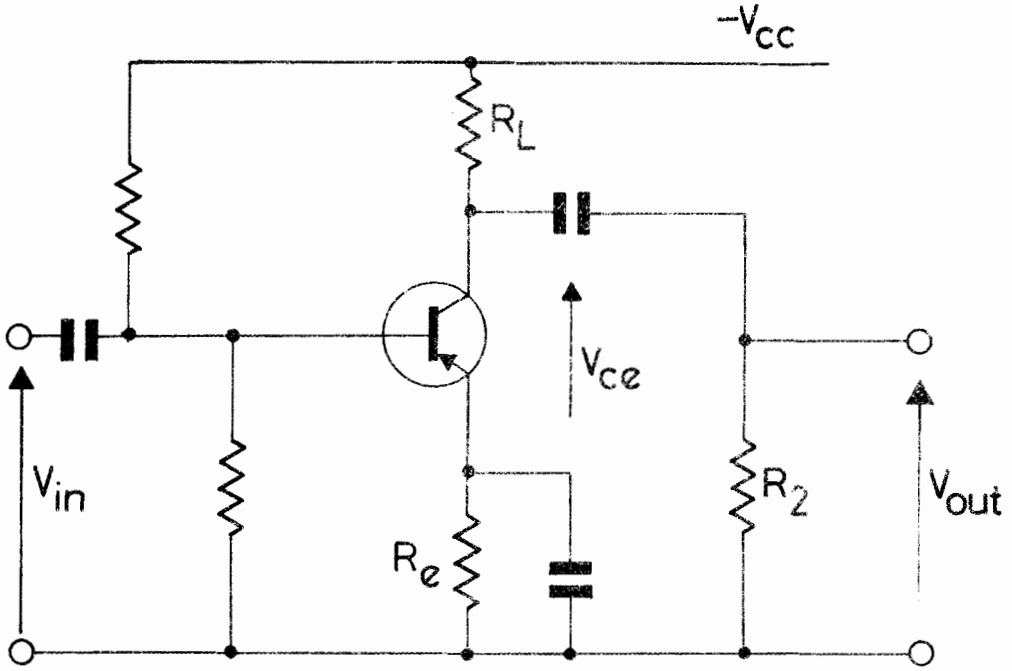
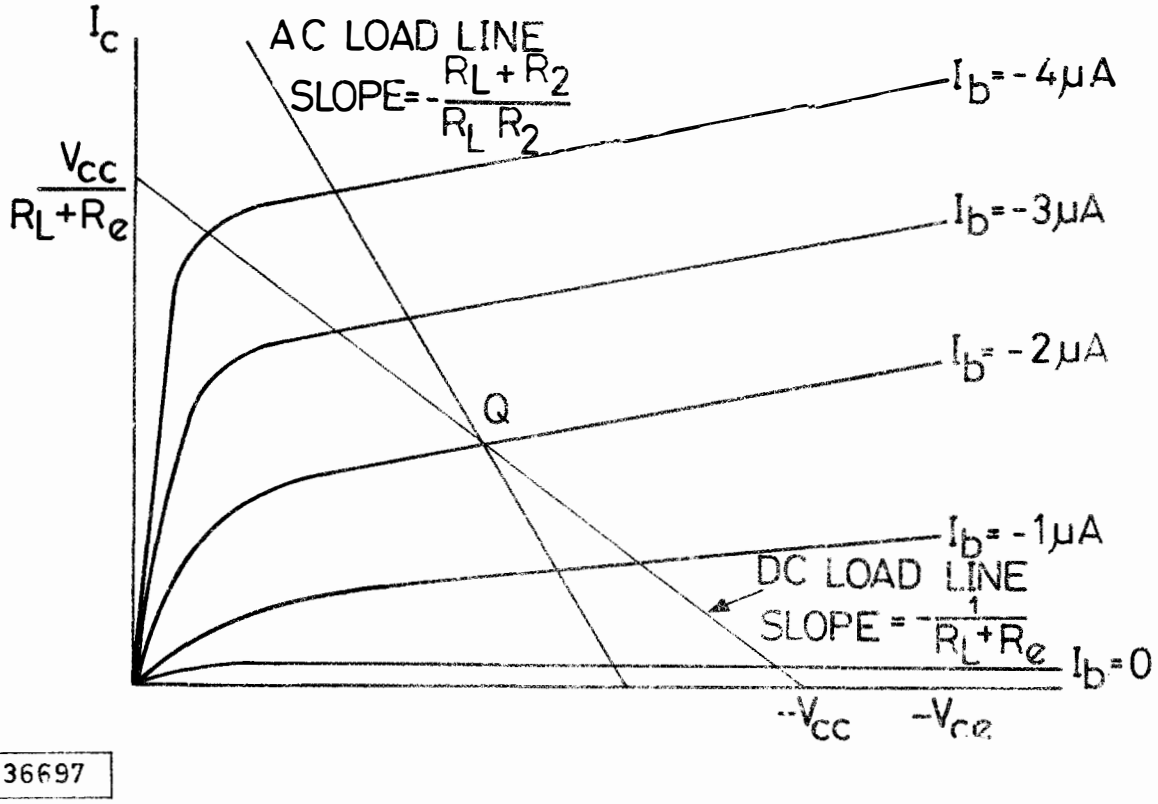


Fig. 9-2 R.C. coupled 2 stage NPN transistor amplifier showing typical component values

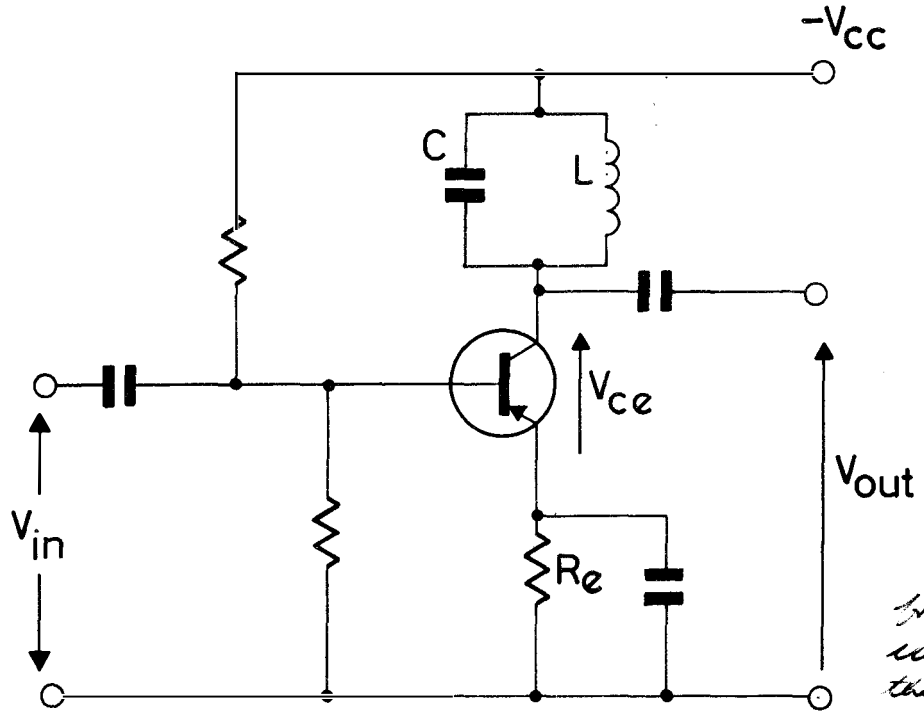


Signal Equivilent cct for output stage of amplifier



R 36697

Fig. 9-8 Resistance loaded transistor amplifier and load line



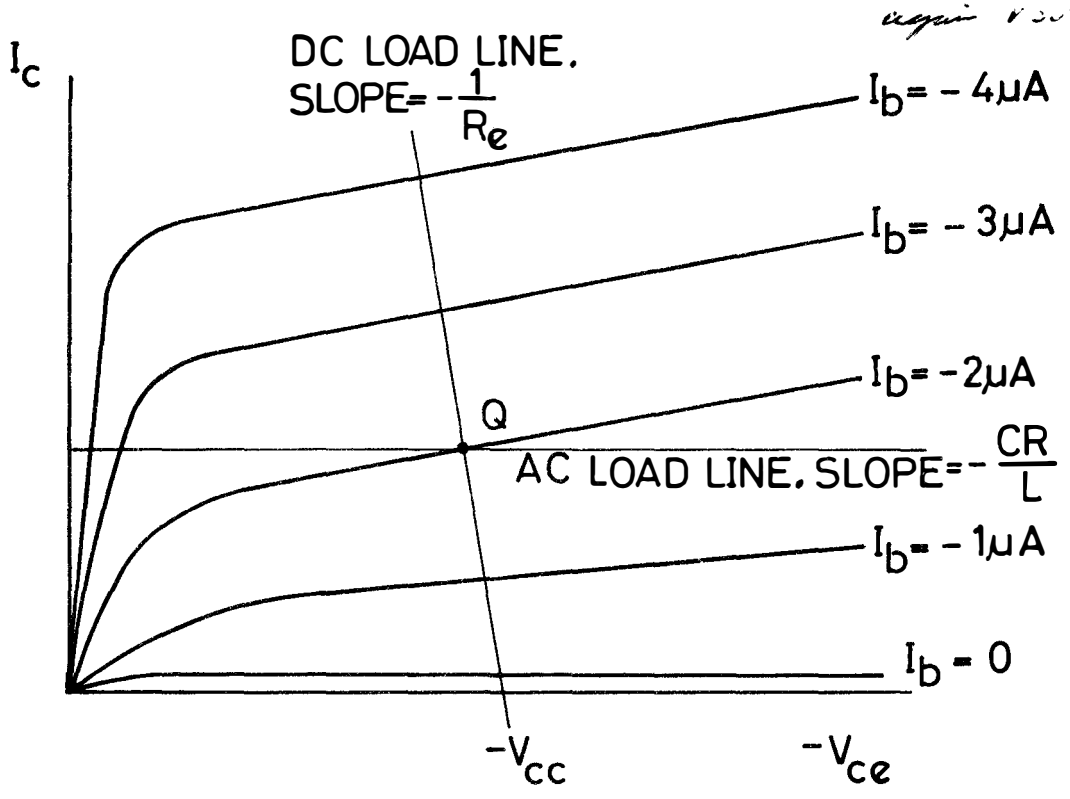
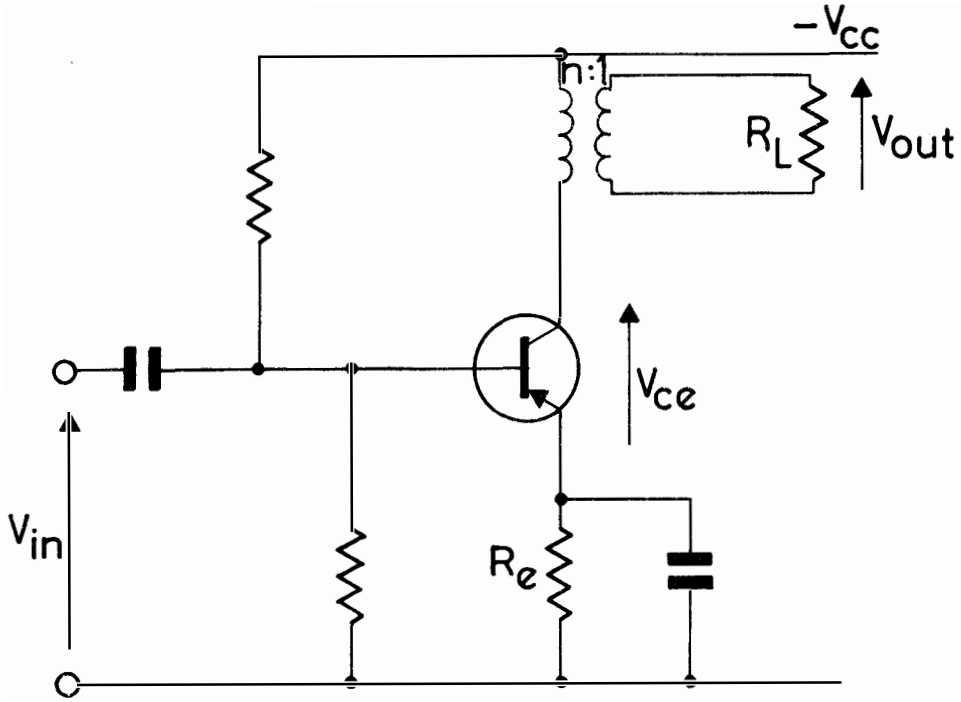


Fig. 9-4 Tuned anode transistor amplifier



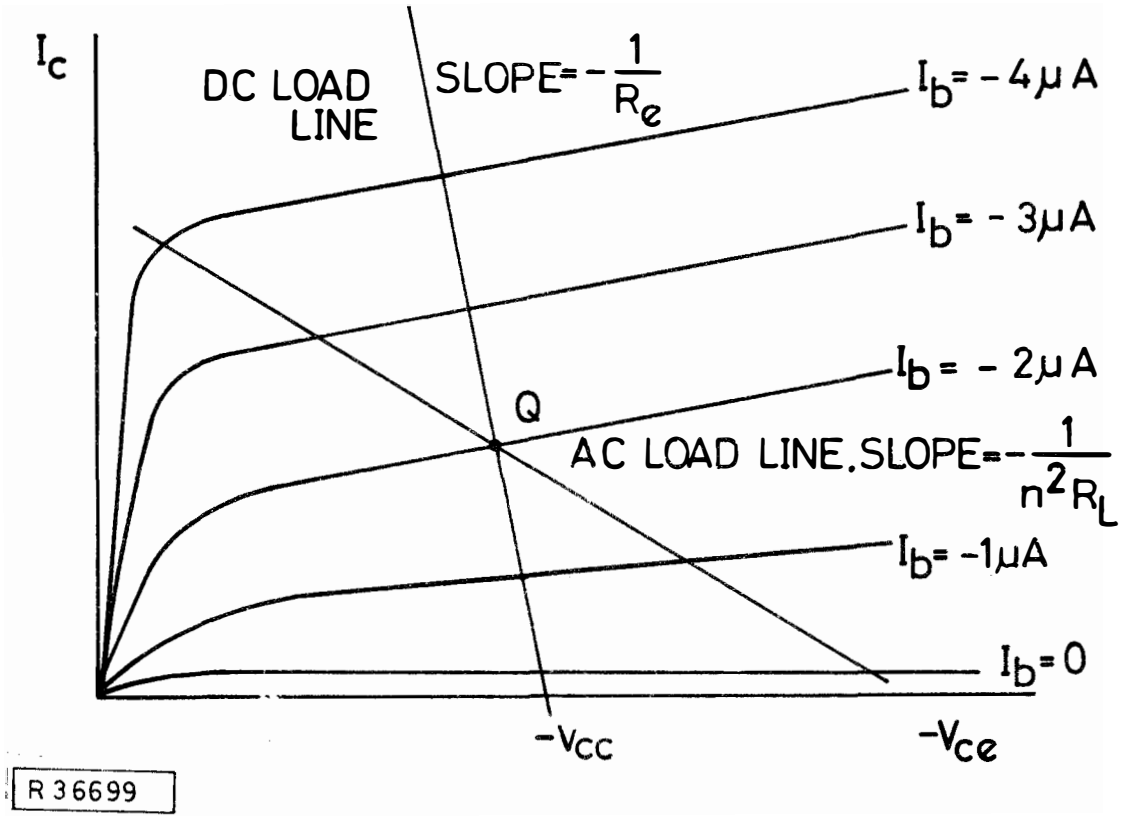


Fig. 9-5 Transformer coupled transistor amplifier

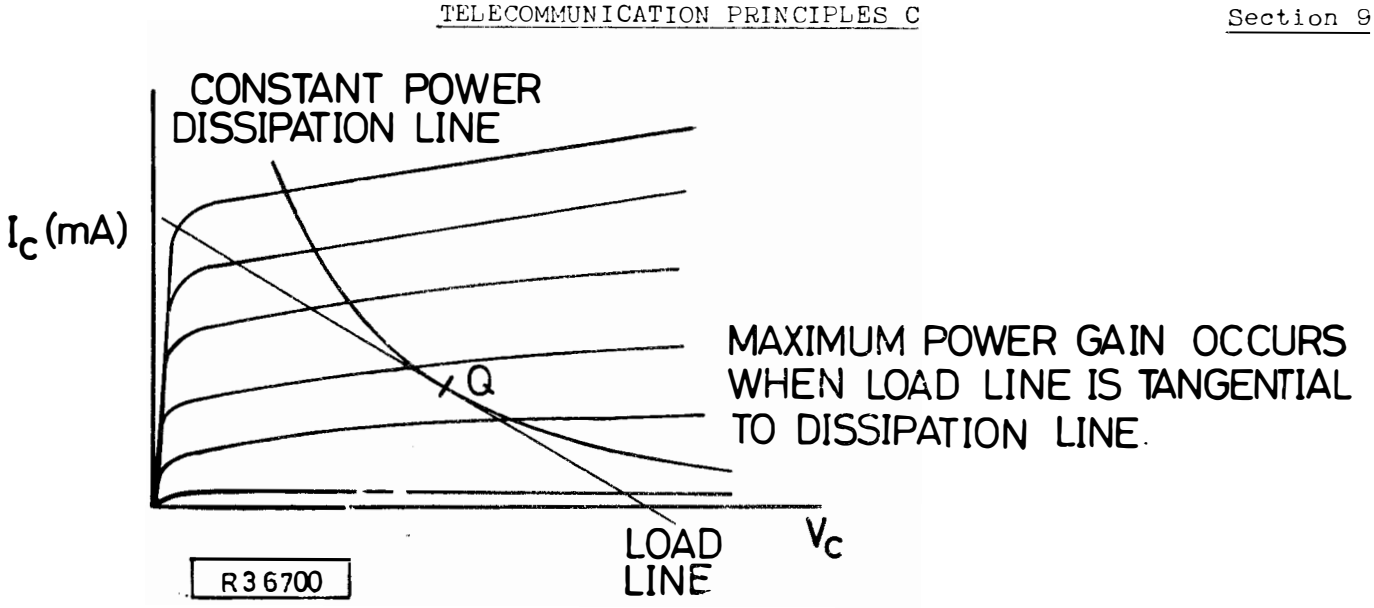


Fig. 9-6 Power dissipation line. The operating point Q must not be above the power line

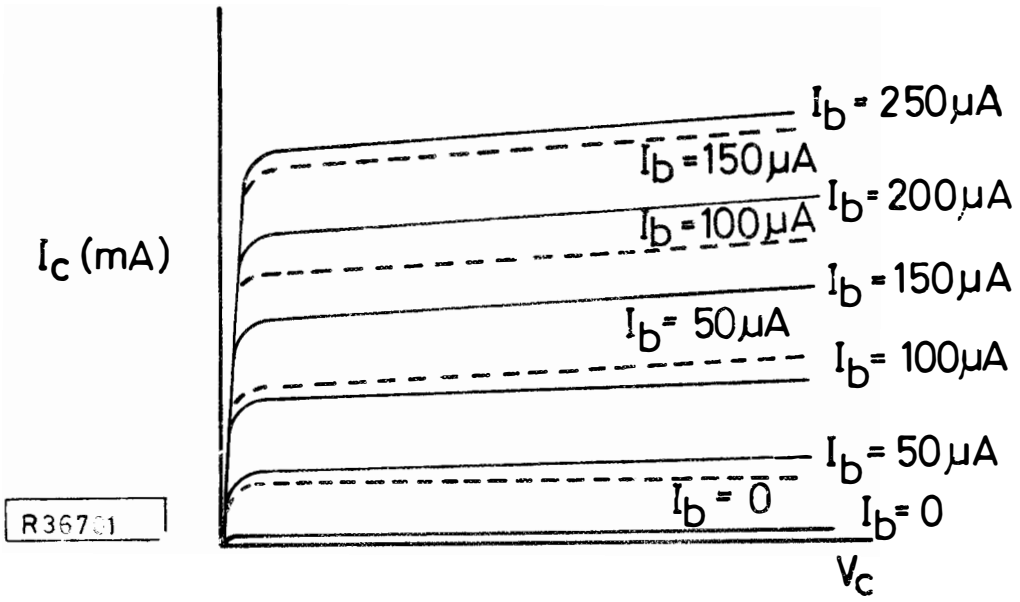


Fig. 9-7 The whole family of curves is raised when the room temperature is increased to 70°C

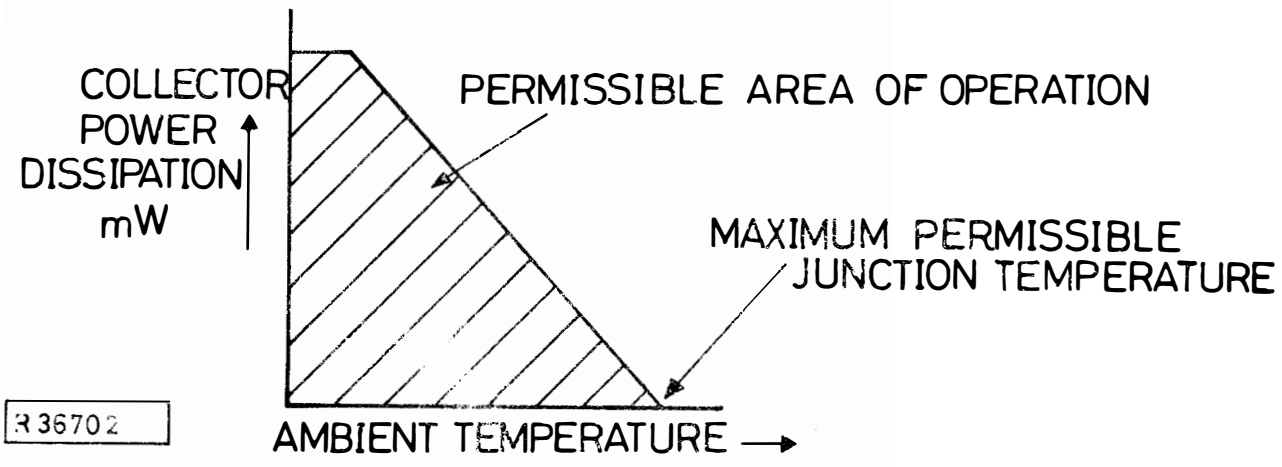
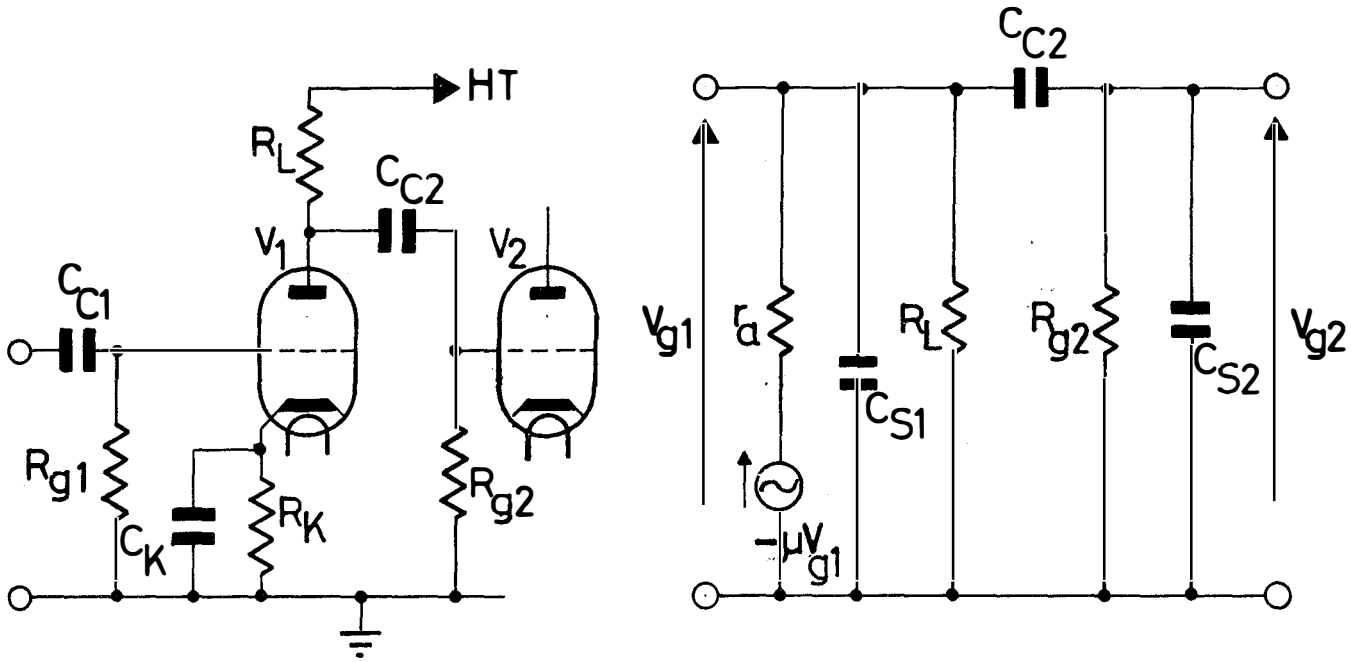


Fig. 9-8 Relationship between allowable collector power dissipation and ambient temperature

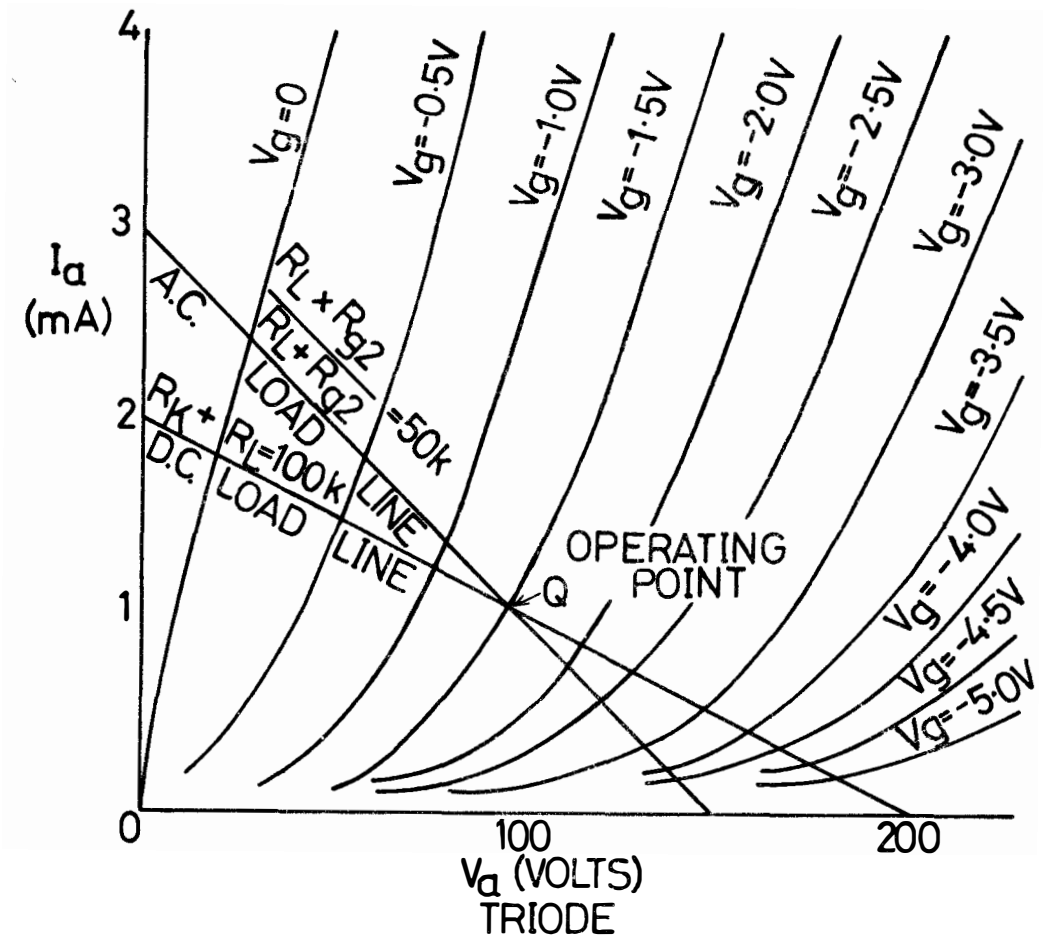


THE FUNCTIONS OF THE COMPONENTS ARE AS FOLLOWS.

C_{C1} INPUT COUPLING CAPACITOR
R_{g1} GRID RESISTOR
R_L ANODE LOAD RESISTOR
R_K CATHODE BIAS RESISTOR
C_K CATHODE DECOUPLING CAPACITOR
C_{C2} INTERSTAGE COUPLING CAPACITOR
R_{g2} GRID RESISTOR
C_{S1} CIRCUIT WIRING CAPACITY AND OUTPUT CAPACITY OF V_1
C_{S2} CIRCUIT WIRING CAPACITY AND INPUT CAPACITY OF V_2

R 36703

Fig. 9-9 R.C. coupled valve amplifier and its equivalent circuit



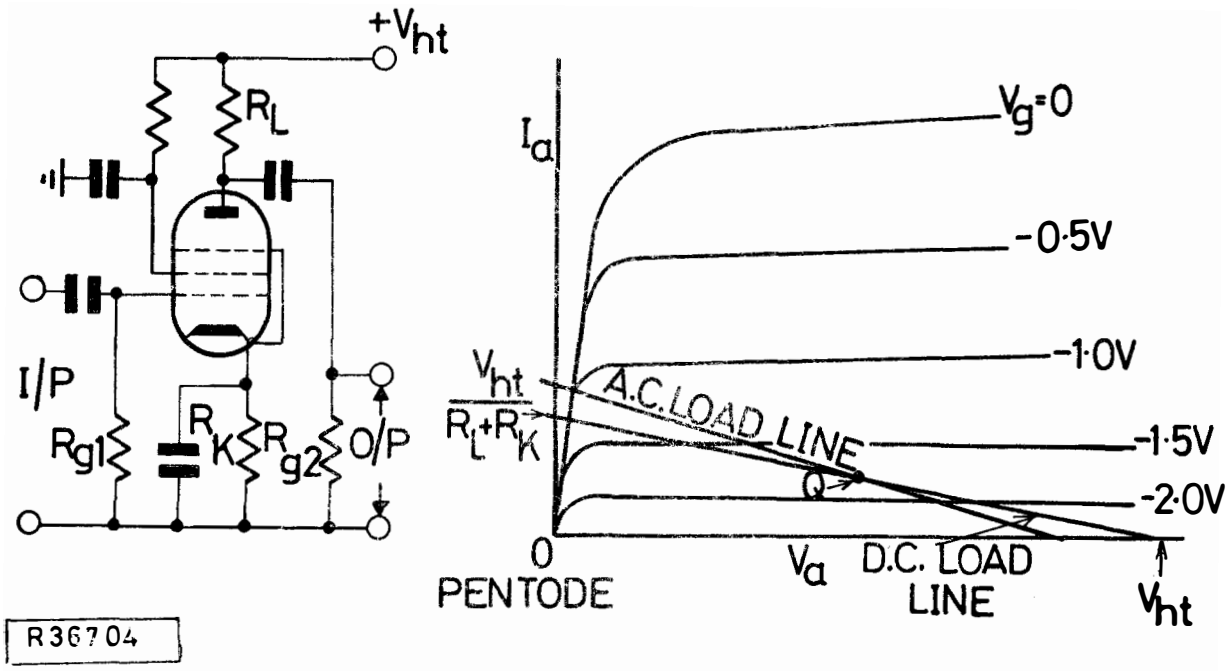


Fig. 9-10 Triode and Pentode load lines

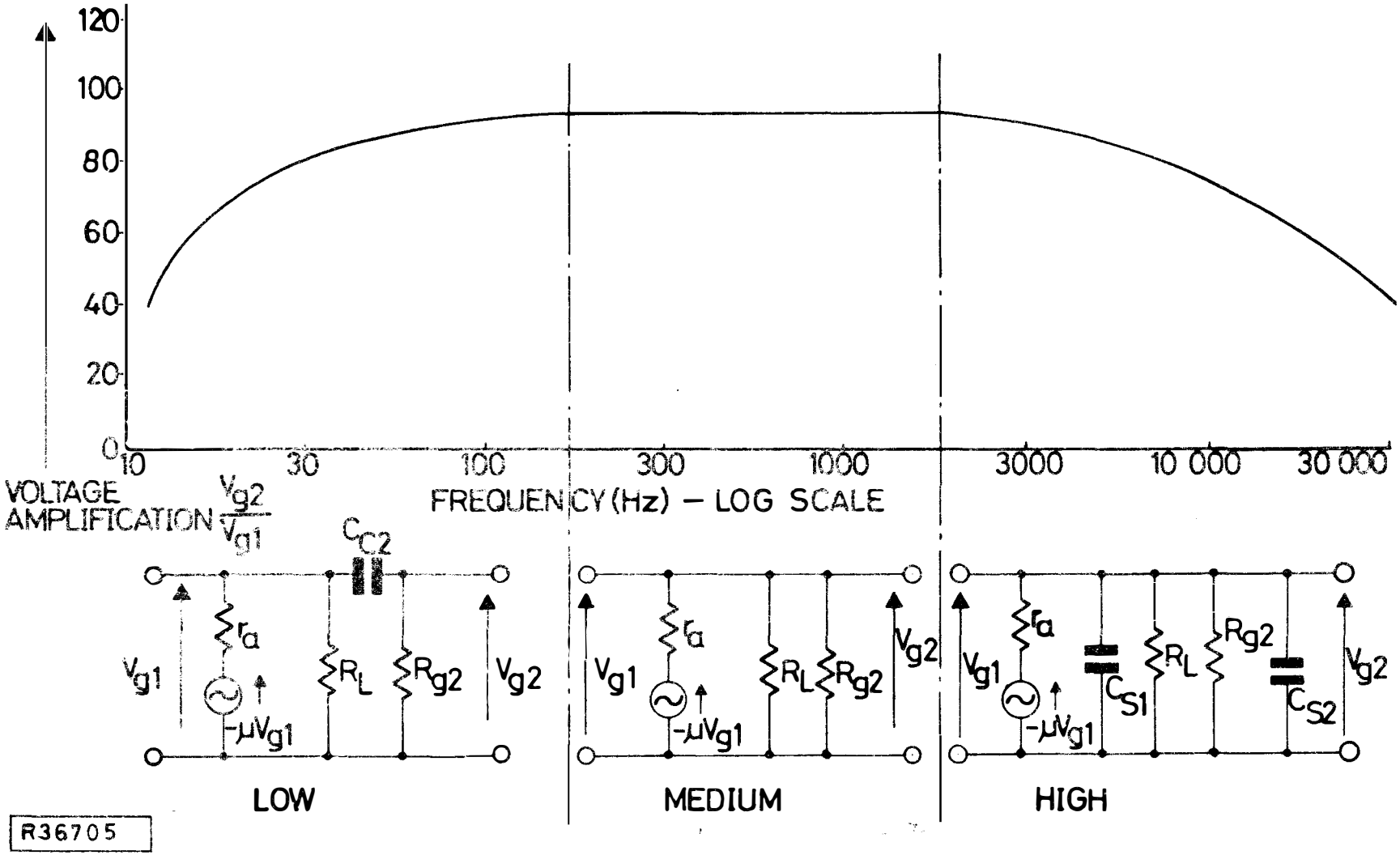


Fig. 9-11 R.C. coupled valve amplifier frequency response and equivalent circuits for low, medium and high frequencies

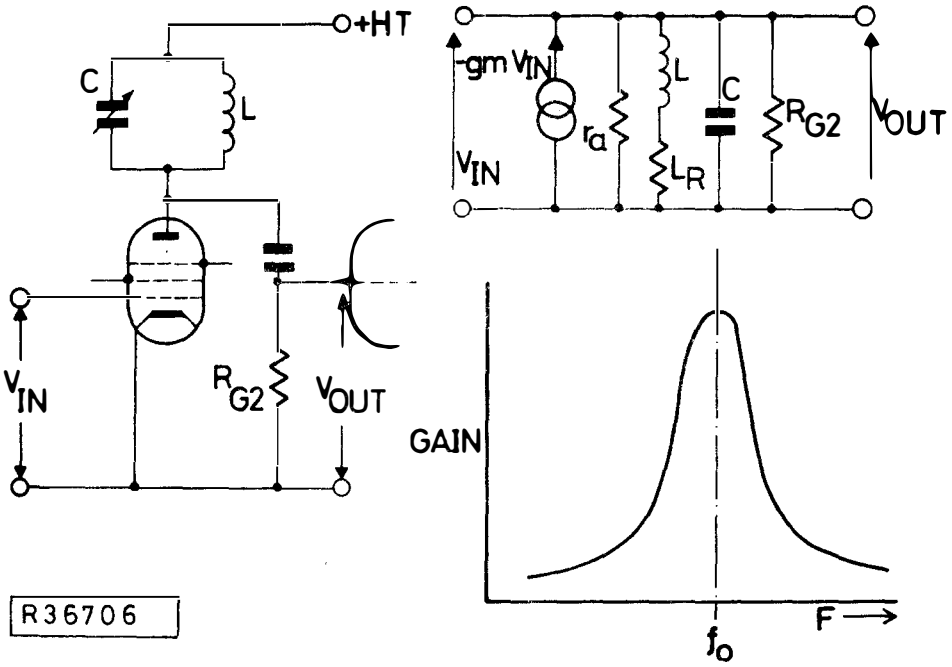


Fig. 9-12 Tuned anode valve amplifier, equivalent circuit and response curve

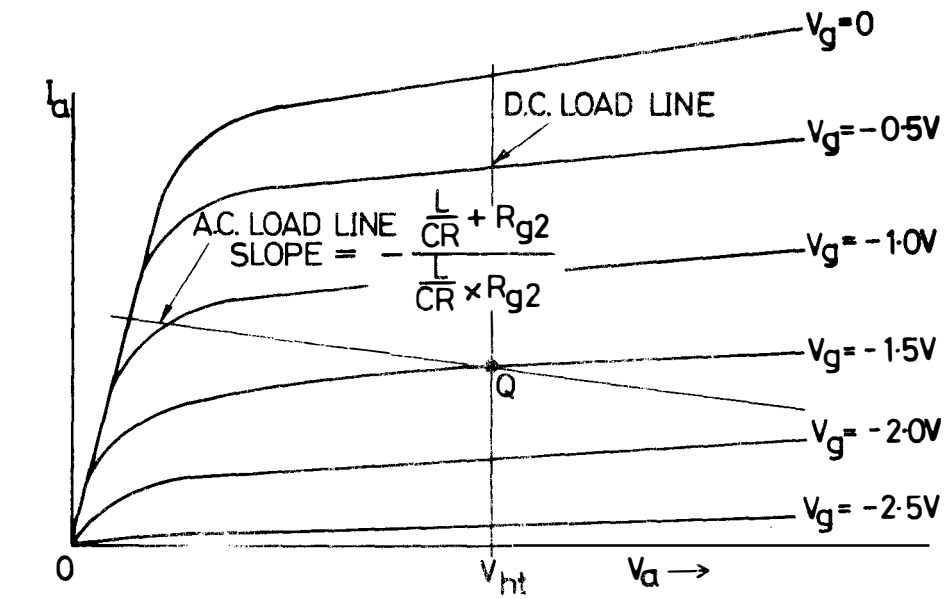


Fig. 9-13 Tuned anode load lines

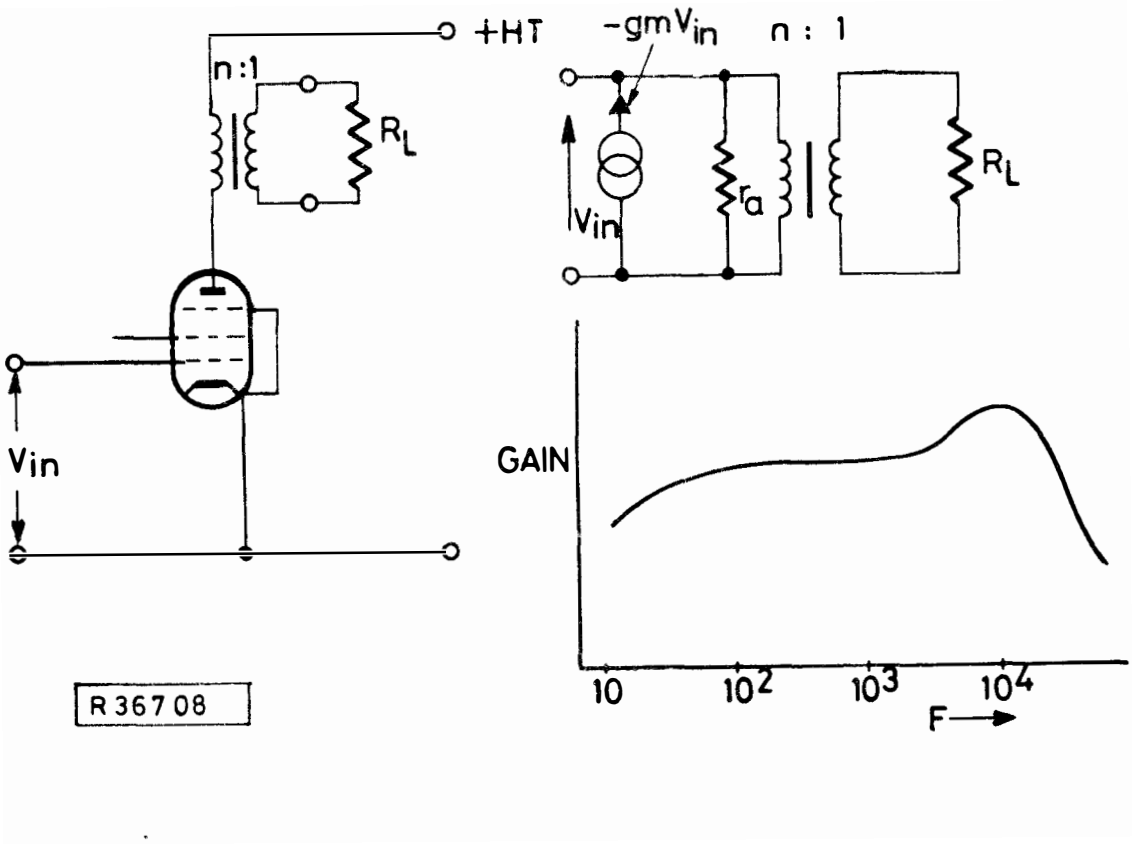


Fig. 9-14 Transformer coupled amplifier, equivalent circuit and frequency response

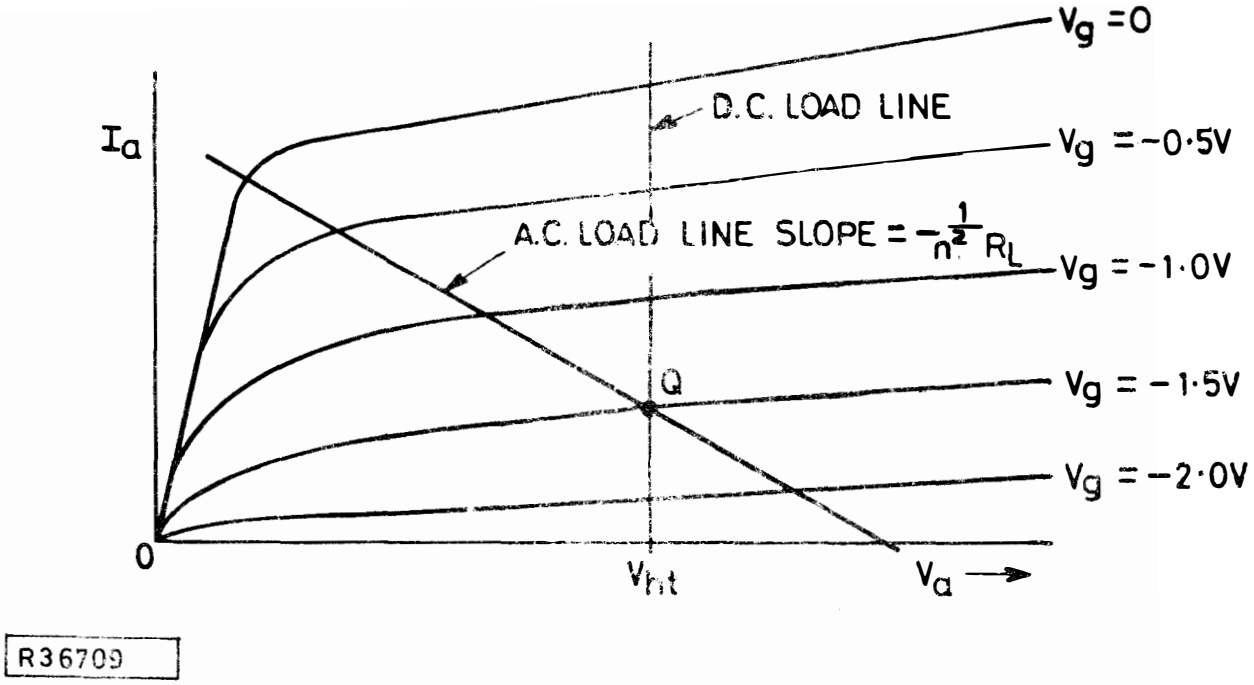
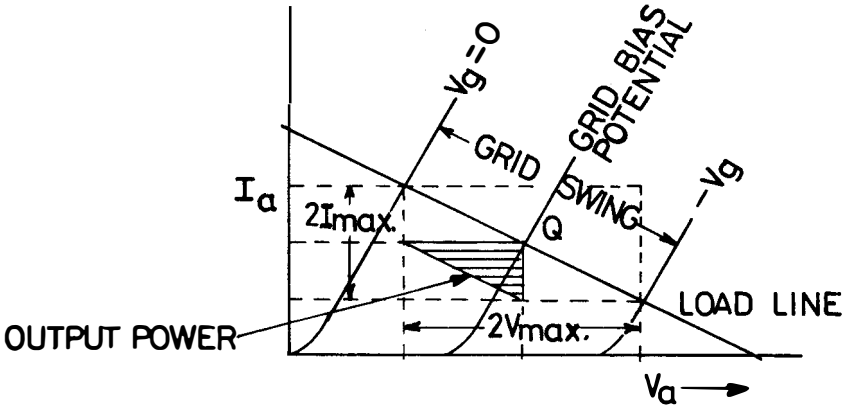


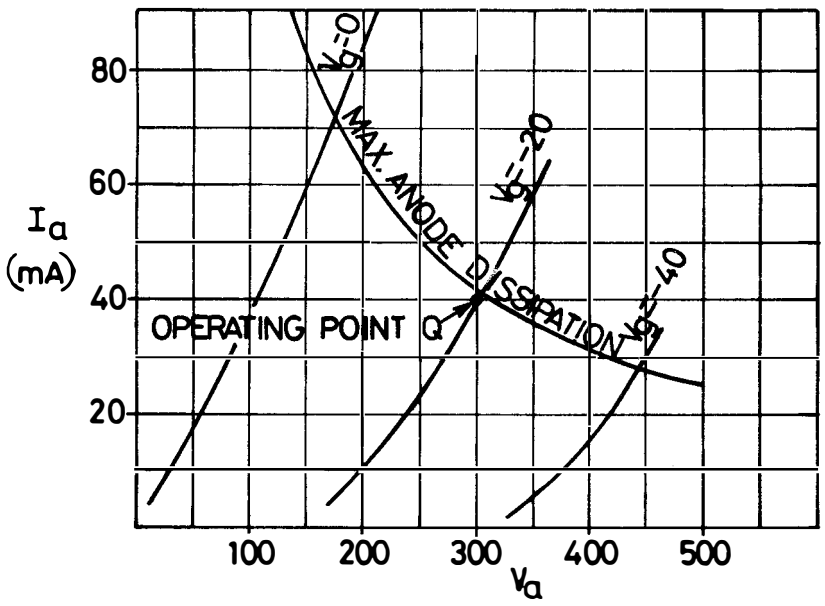
Fig. 9-15 Transformer coupled amplifier load lines



ANODE DISSIPATION P_a

P_a WITHOUT SIGNAL $= V_a \times I_a$

$$P_a \text{ WITH SIGNAL} = \left[V_a \times I_a\right] + \frac{\left[V_{a(max.)} - V_{a(min.)}\right]\left[I_{a(max.)} - I_{a(min.)}\right]}{8}$$



R36710

Fig. 9-16 Maximum anode dissipation

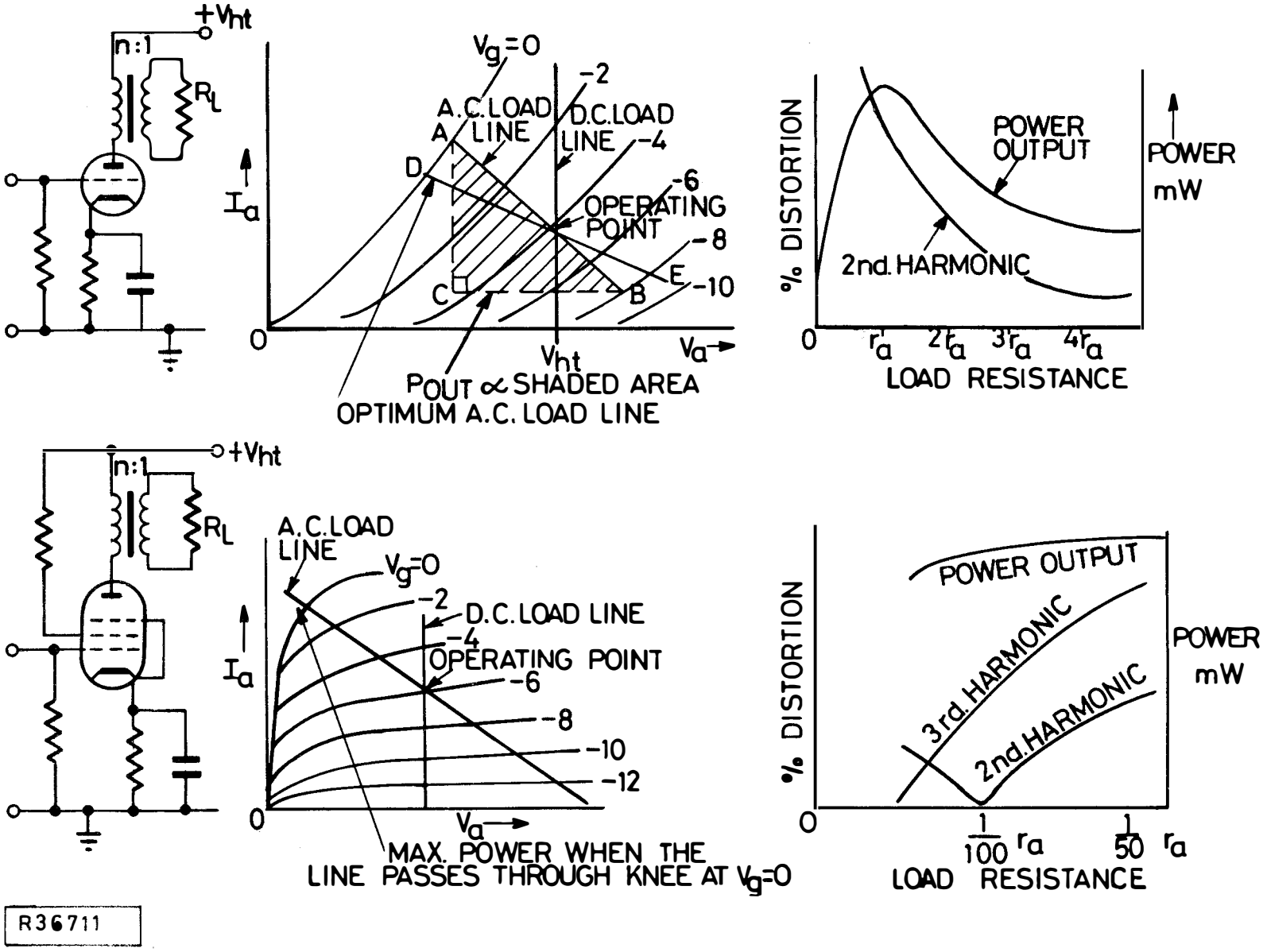


Fig. 9-17 Triode and Pentode anode power dissipation and the relationship between load resistance and harmonic distortion

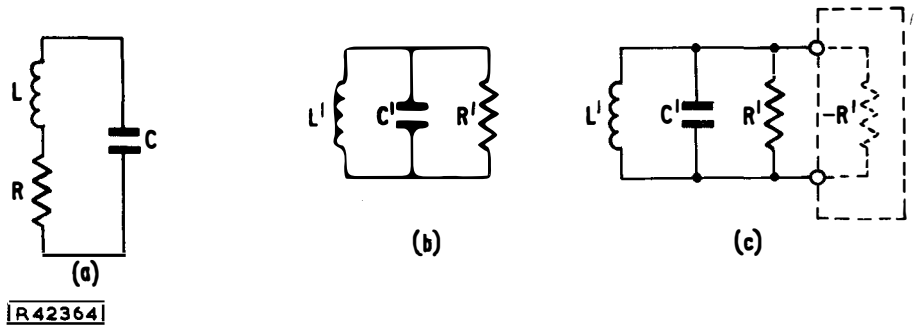


Fig. 10-1 Neutralizing the loss R^1 by connecting a parallel negative resistance ($-R^1$)

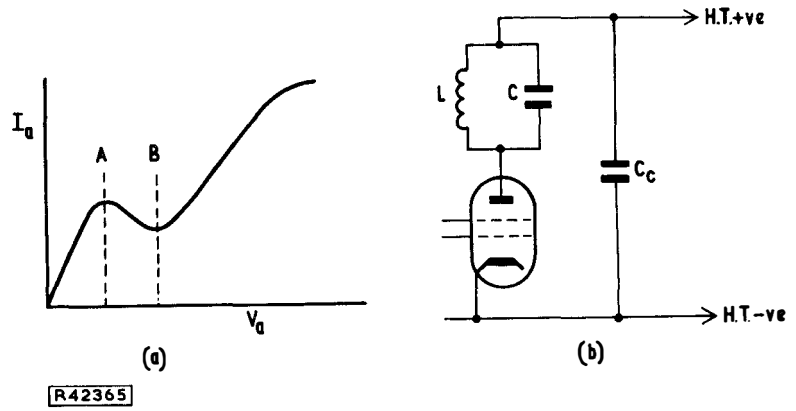
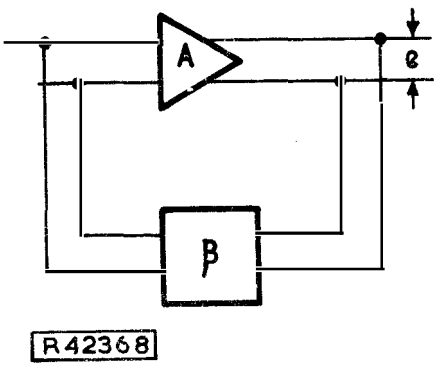


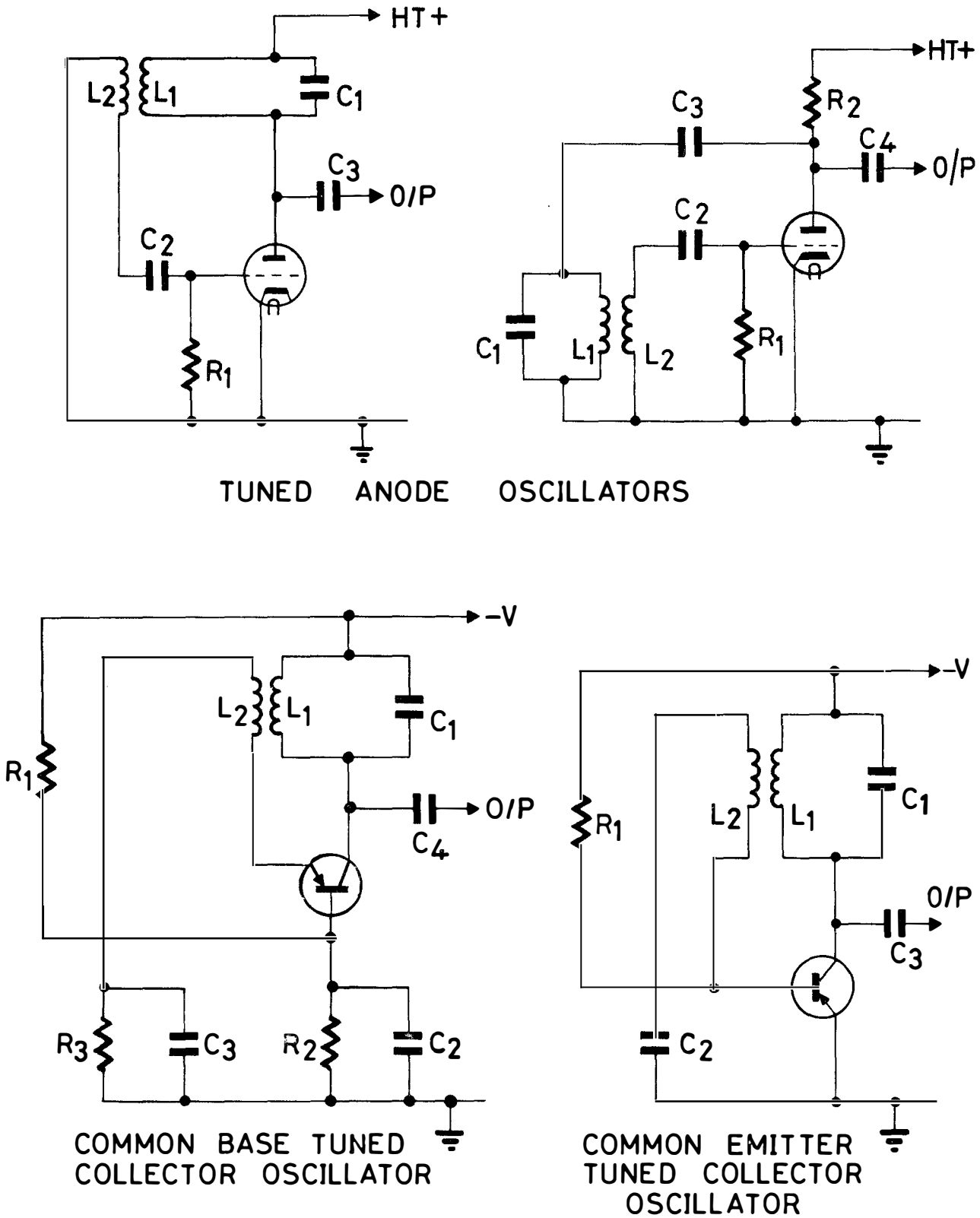
Fig. 10-2 Using the tetrode valve to provide $-R^1$



Condition for oscillation is when

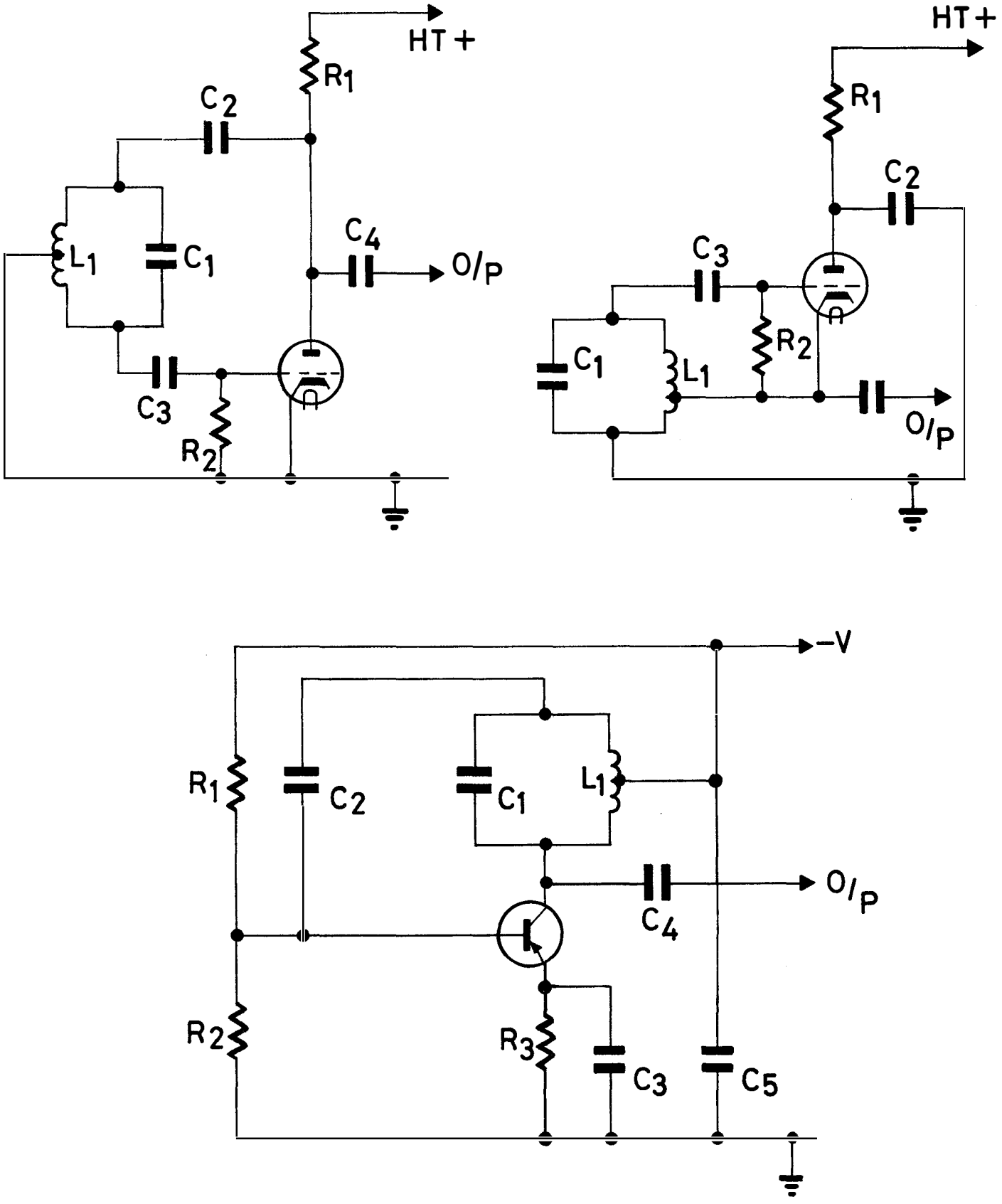
$A\beta = 1\angle 0$ or $1 + j0$

Fig. 10-8 Principle of feedback oscillators



R 36712

Fig. 10-4 Tuned anode valve and transistor oscillators



R36713

Fig. 10-5 Hartley valve and transistor oscillators

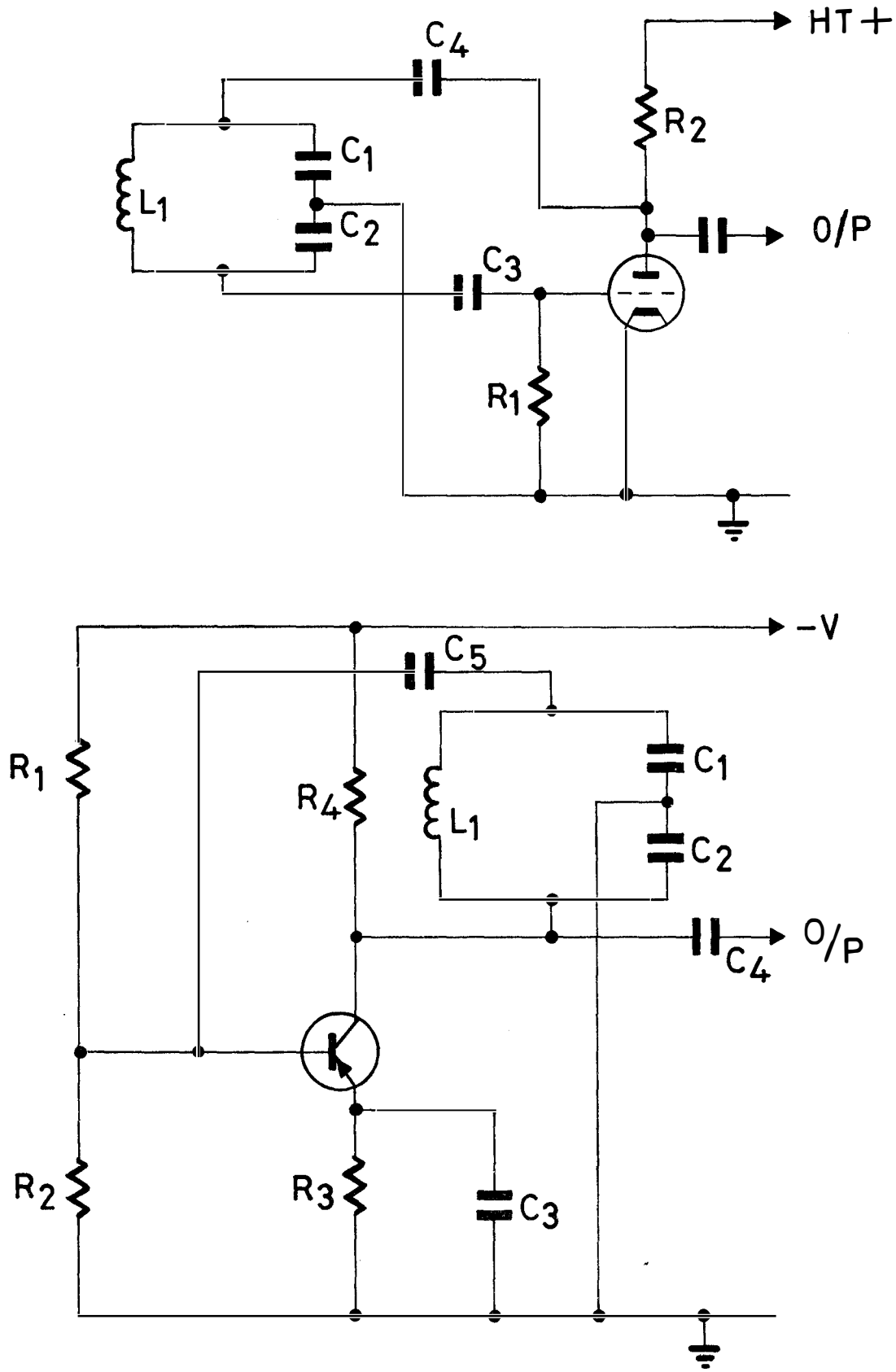


Fig. 10-6 Colpitts valve and transistor oscillators

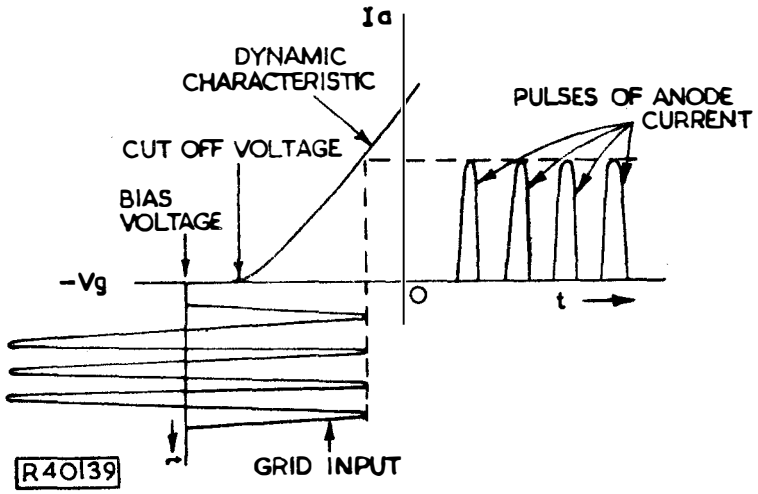


Fig. 10-7 Class C bias

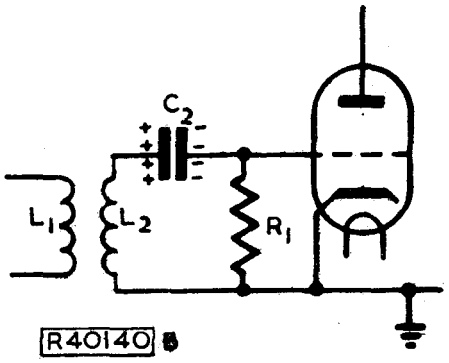


Fig. 10-8 Grid leak bias component arrangement

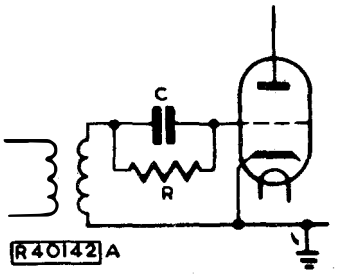


Fig. 10-9 Component variation

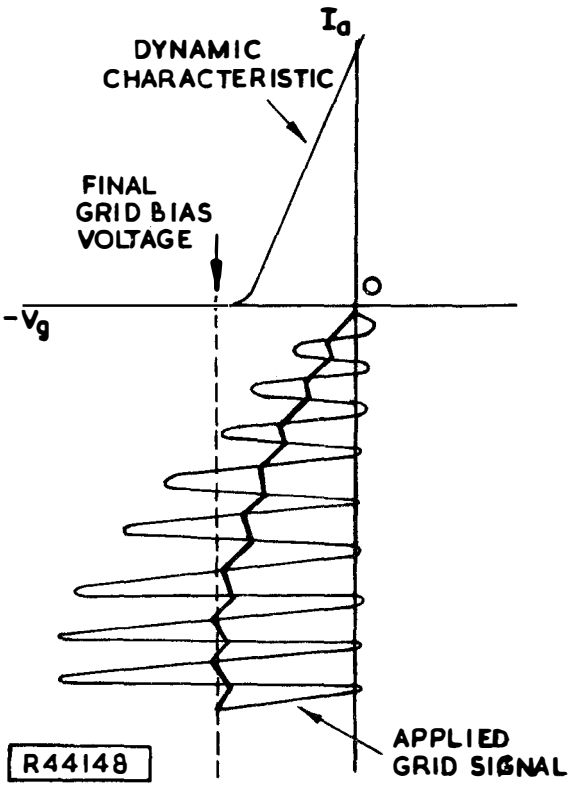
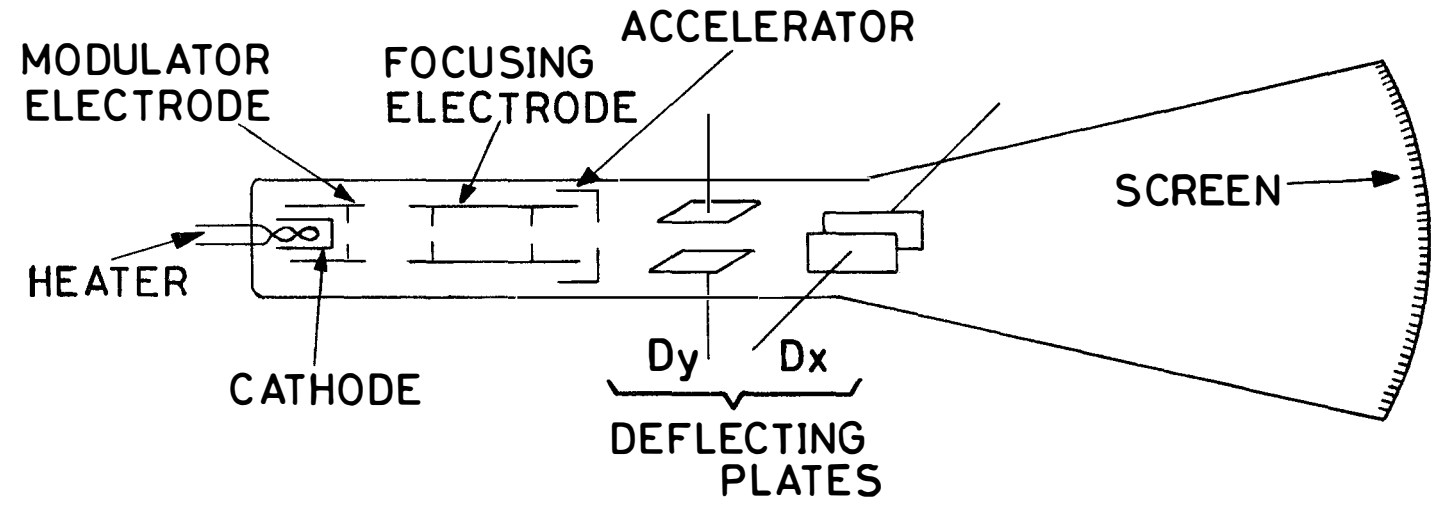
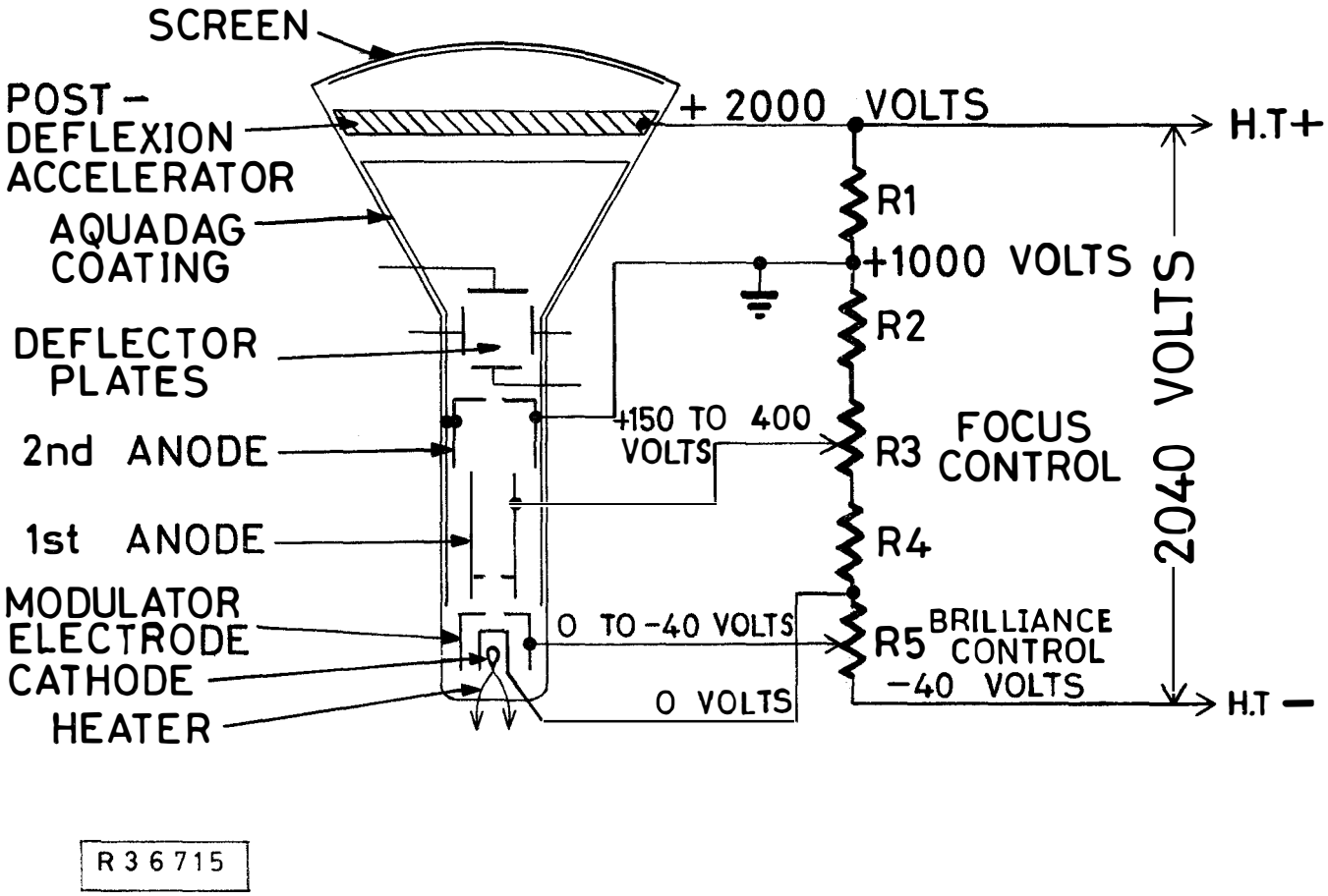


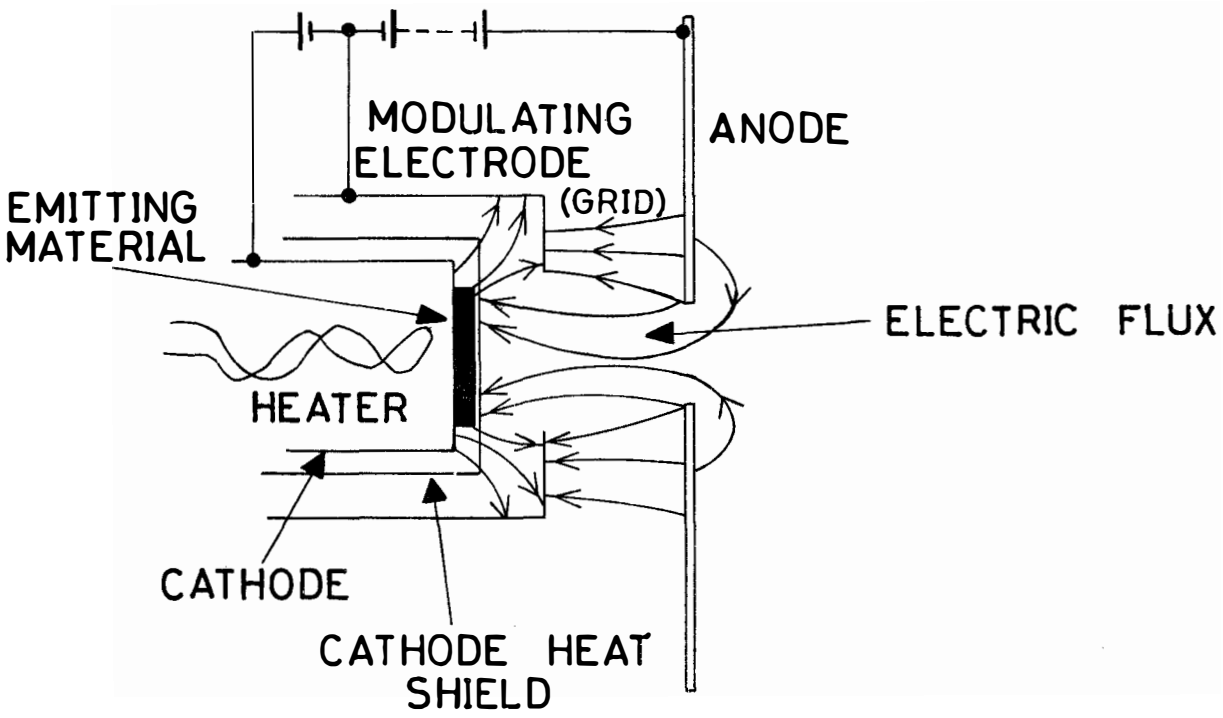
Fig. 10-10 Build up of bias voltage in the grid leak circuit

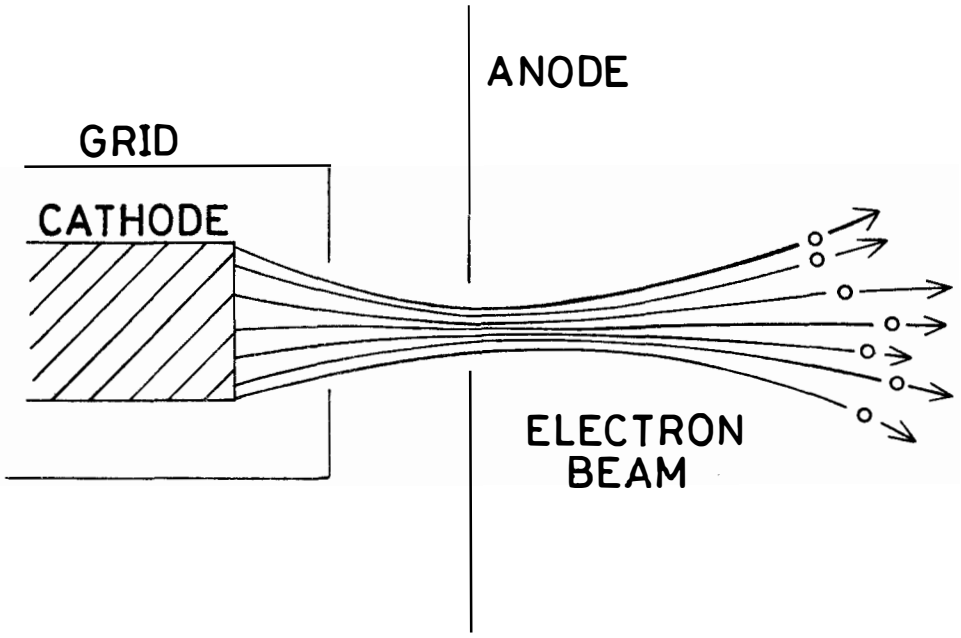




R 3 6 7 1 5

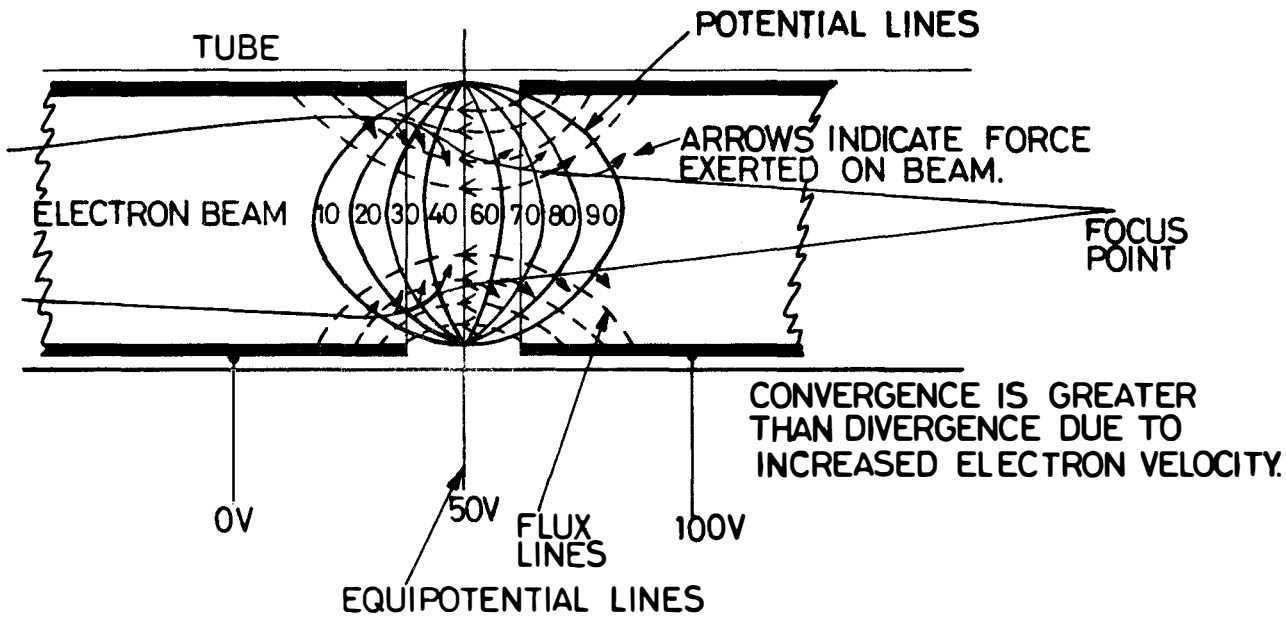
Fig. 11-1 Typical Cathode Ray Tube showing the arrangement of the electrodes and voltage supplies

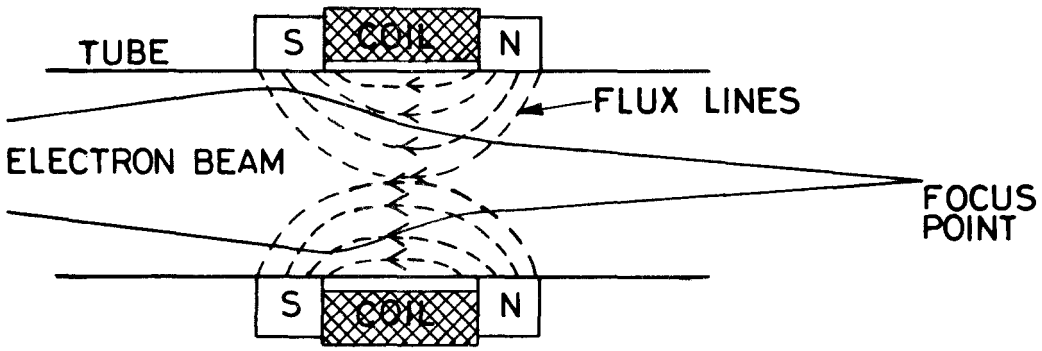




R36716

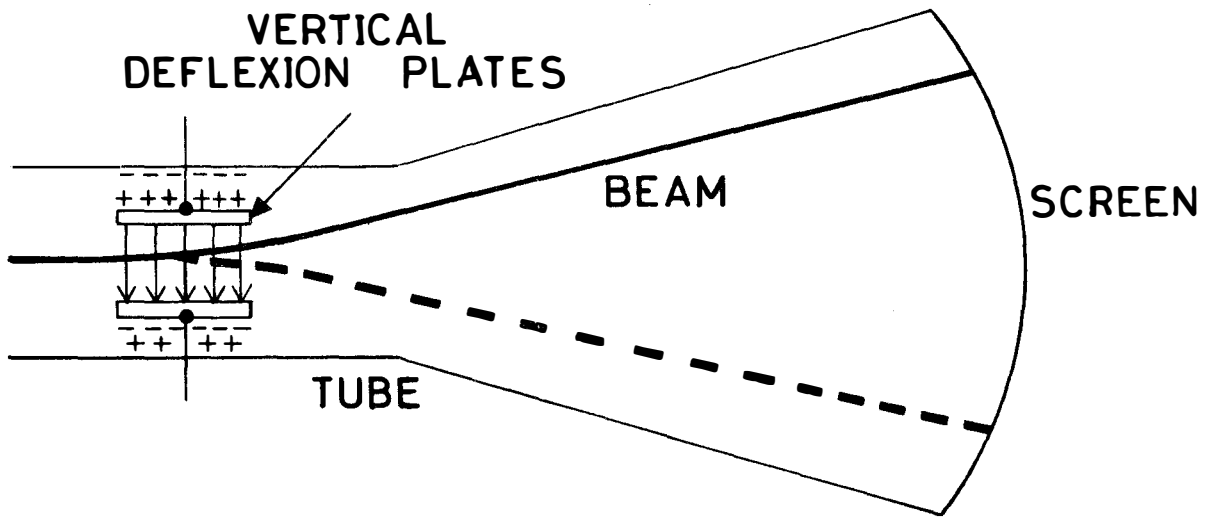
Fig. 11-2 Distribution of electric flux and the effect on an electron beam

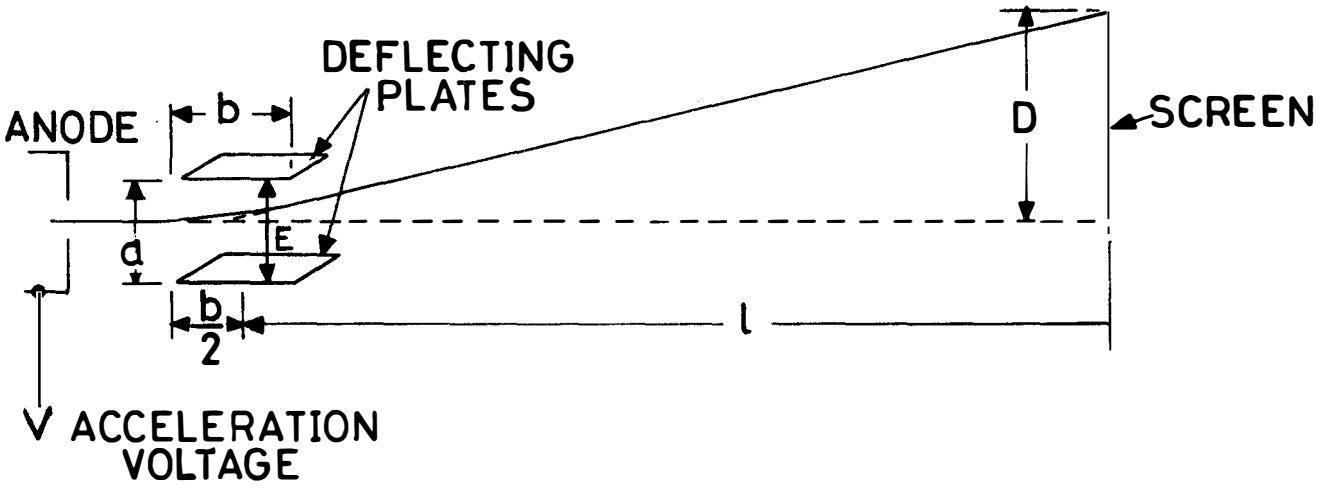




R 36 717

Fig. 11-3 Comparison between electrostatic and magnetic focussing

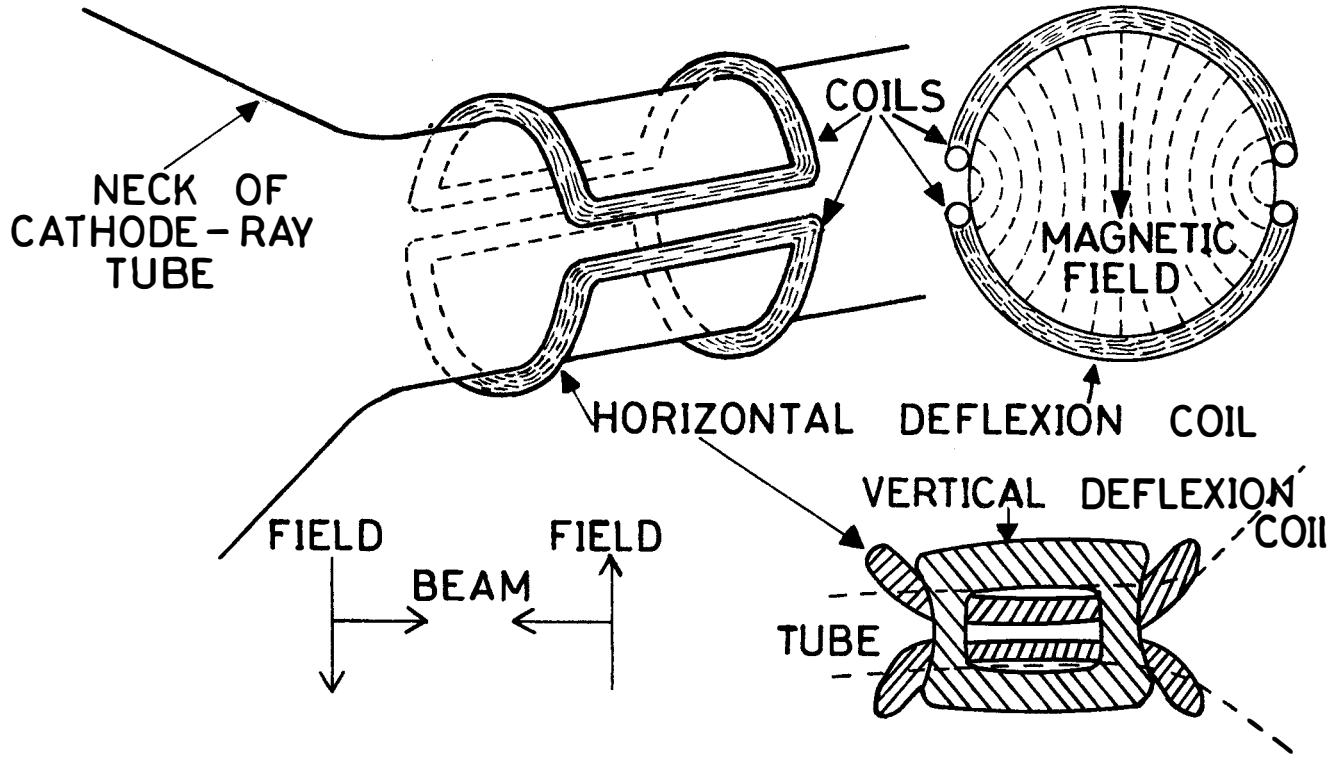


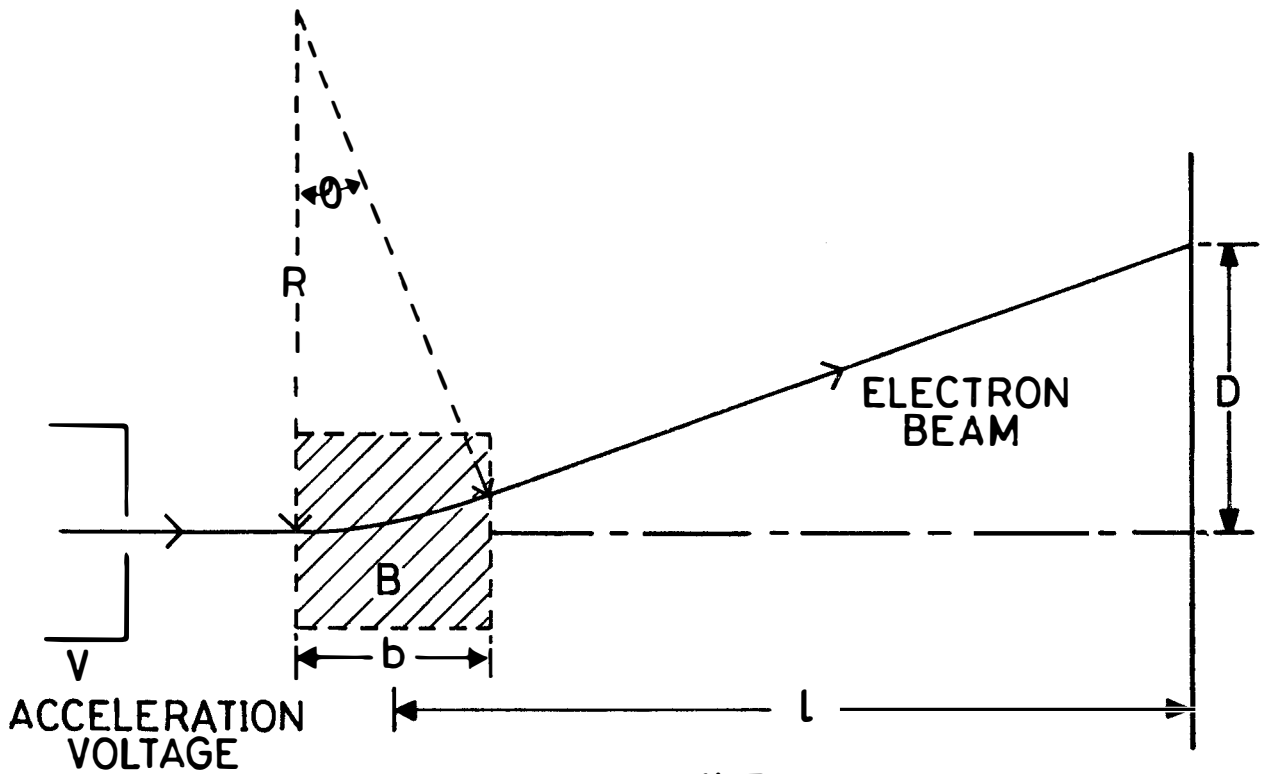


$$\text{DEFLEXION} \quad D = \frac{Ebl}{2aV}$$

R36718

Fig. 11-4 Electrostatic deflexion





$$\text{DEFLEXION } D = \frac{lbB}{3{\cdot}37\sqrt{V}} \times 10^6 \text{ METRES}$$

R36719

Fig. 11-5 Electromagnetic deflexion

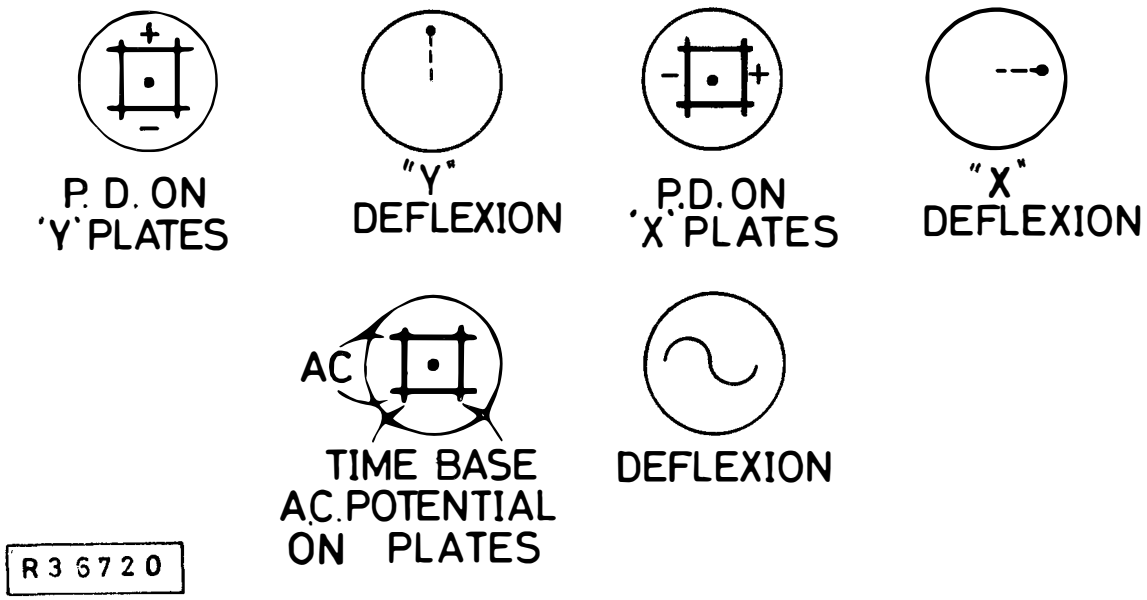


Fig. 11-6 Diagrams illustrating the effect of the deflecting plates on the electron beam

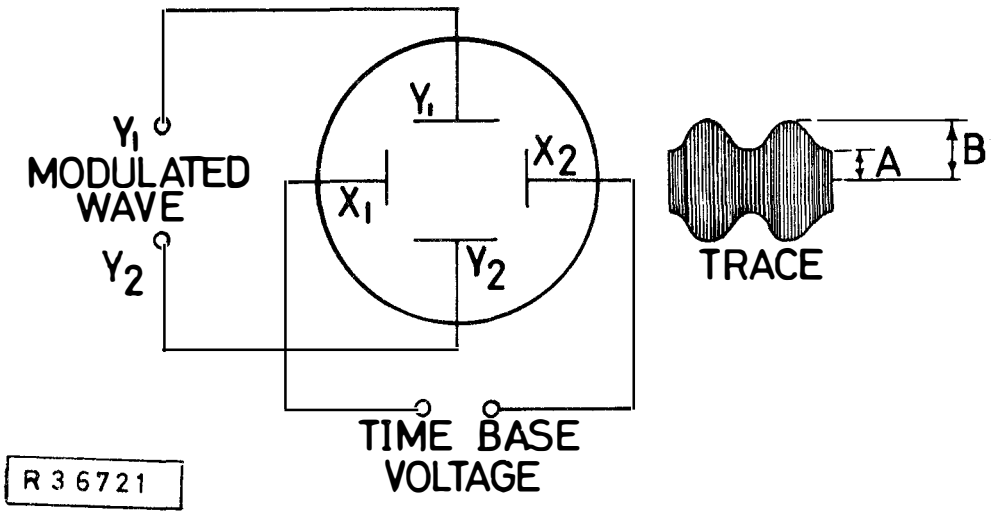


Fig. 11-7 C.R.T. display when the time base has twice the frequency of the modulating signal

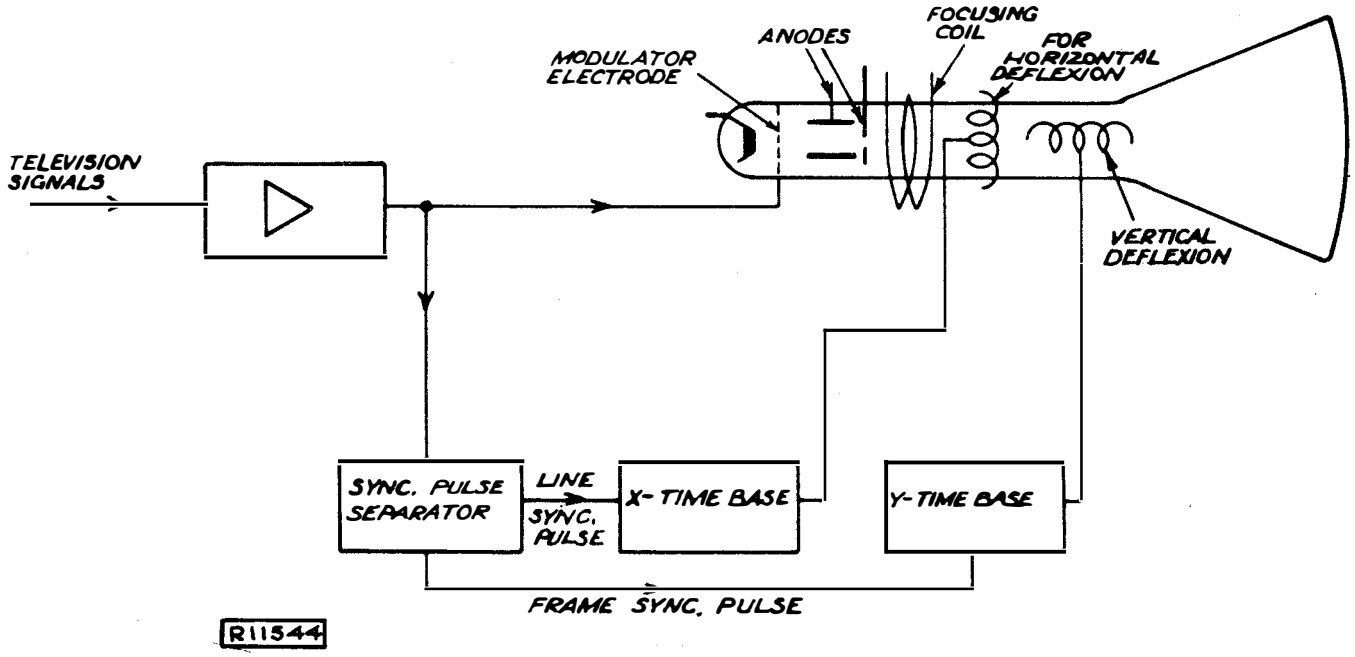


Fig. 11-8 Application of the C.R.T. in a television showing in block form the extraction of X and Y time base synchronizing pulses from the received signal

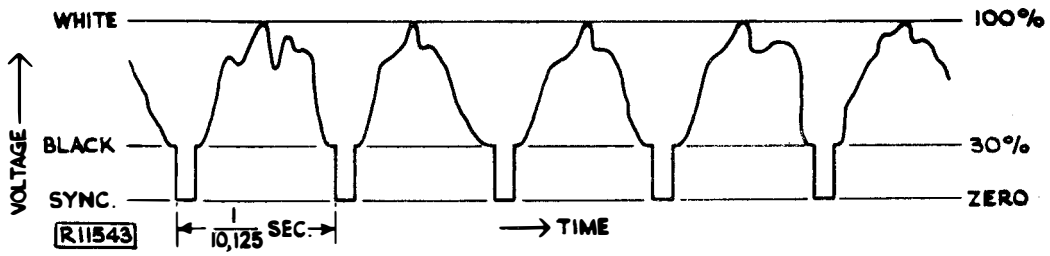


Fig. 11-9 Typical television signal. The portion from zero to 30% is used to synchronize the line and frame whilst that from 30% to 100% is used to modulate the electron stream

	Material	Activator	Chemical Composition	Fluorescent Colour	After-glow (seconds)
1	Zinc oxide	none	ZnO	Violet	
2	Zinc silicate	none	$ZnO+SiO_2$	Blue	
3	Zinc silicate	Manganese	$(ZnO+SiO_2):Mn$	Blue-green	Medium 0.03-0.05
4	Zinc beryllium silicate	Manganese	$(ZnO+BeO+SiO_2):Mn$	Green to orange	Medium 0.05
5	Zinc sulphide	none	ZnS	Light blue	
6	Zinc sulphide	Silver	ZnS:Ag	Blue-violet	Medium 0.05
7	Zinc sulphide	Copper	ZnS:Cu	Green	Long > 1
8	4 and 6	as above		White	Short 0.005
9	Zinc sulphide	Silver with a nickel quencher	ZnS:Ag:Ni	Blue	Very short 10μs
10	Zinc cadium sulphide	Silver	(ZnS+CdS):Ag	White	
11	Zinc cadmium sulphide	Copper	(ZnS+CdS):Cu	Yellow	Long > 1
12	Zinc borate	Manganese	$(ZnO+B_2O_3):Mn$	Yellow-orange	
13	Zinc aluminate	Chromium	$(ZnO+Al_2O_3):Cr$	Red	
14	Zinc germanate	Manganese	$(ZnO+GeO_2):Mn$	Yellow-green	
15	Zinc beryllium zirconium silicate	Manganese	$[ZnO+BeO+(Ti-Zr-Th-O)+SiO_2]:Mn$	White	
16	Calcium tungstate	none	$CaWO_4$	Blue	Very short 5μs

Fig. 11-10 Characteristics of some luminescent screen materials