and for Fig. 9.3b, to the same approximation, it is evident that

$$I \approx E/R_e.$$

These two circuits are equivalent at resonance provided we set

$$R_e = L/Cr = Q\omega_o L = Q/\omega_o C = Q\sqrt{L/C} \quad (20)$$

Note that $Q = R_e\sqrt{C/L}$, and that R_e is the parallel resistance (across C) equivalent to the series coil resistance r.

It has been shown that the circuit Fig. 9.3a with a condenser C having no losses and an inductance L having series coil resistance r may be replaced by the equivalent circuit Fig. 9.3b having an ideal tuned circuit LC, without losses, shunted by the resistor R_e having a value given by equation (20). It is obvious that the impedance of the parallel combination LCR_e in Fig. 9.3b at resonance is R_e, this being the "resonant impedance" of the circuit. At frequencies other than the resonant frequency, the impedance will be less than the "resonant impedance."

The values of Q in terms of series coil resistance r and equivalent parallel resistance R_e are grouped below for convenience.

In terms of r: $Q = \dfrac{\omega_o L}{r} = \dfrac{1}{\omega_o Cr} = \dfrac{1}{r}\sqrt{\dfrac{L}{C}}$

In terms of R_e: $Q = \dfrac{R_e}{\omega_o L} = \omega_o CR_e = R_e\sqrt{\dfrac{C}{L}}$

We can now consider the important practical case of the circuit shown in Fig. 9.4, in which a resistance R appears in shunt with the condenser C. R represents the effect of all insulation losses in condenser, coil, wiring, switches and valves, together with the plate or input resistance of the valves.

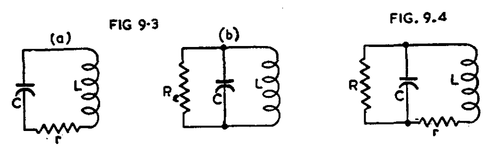

Fig. 9.3(a). *Parallel resonance with series loss resistance.*
Fig. 9.3(b). *Parallel resonance with parallel loss resistance.*
Fig. 9.4. *Parallel resonance with both series and parallel loss resistances.*

In the present case we have R in parallel with our equivalent parallel coil resistance R_e of Fig. 9.3b. The resultant parallel resistance at resonance, which we will call the **resonant impedance** is, of course,

$$R_D = \frac{1}{1/R + Cr/L} \quad (21)$$

Therefore, the **resultant value of Q is**

$$Q = \sqrt{\frac{C}{L}} \cdot R_D = \frac{1}{(1/R)\sqrt{L/C} + r\sqrt{C/L}} = \frac{1}{(\omega_o L/R) + (r/\omega_o L)} \quad (22)$$

Note that at the resonant frequency the expression $\sqrt{L/C}$ is equal to the reactance of the inductance and also that of the condenser, i.e.

$$\omega_o L = \sqrt{L/C} = 1/\omega_o C. \quad (23)$$

See also Sect. 11 Summary of Formulae.