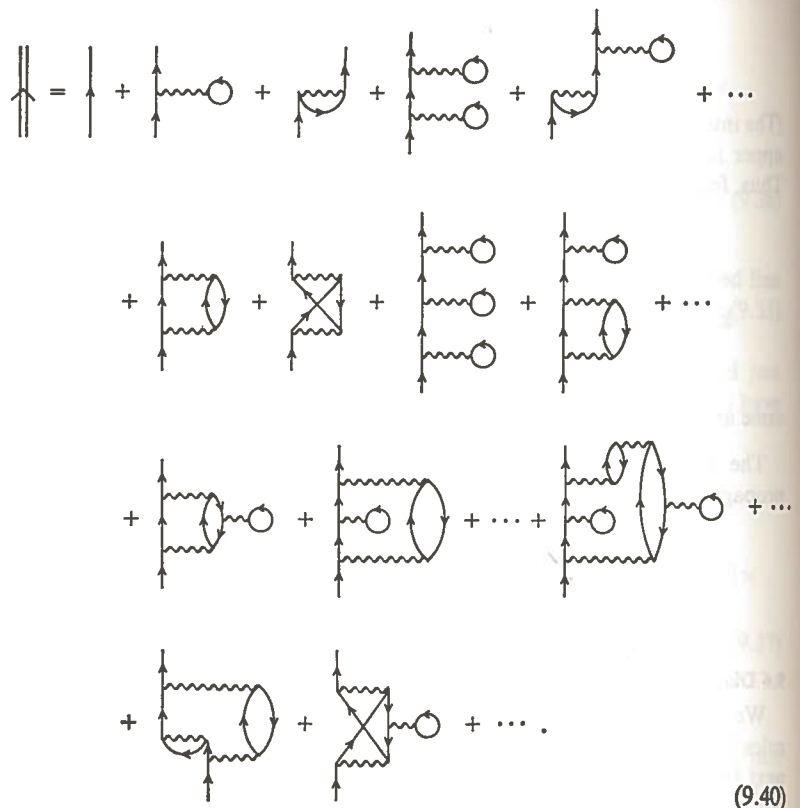
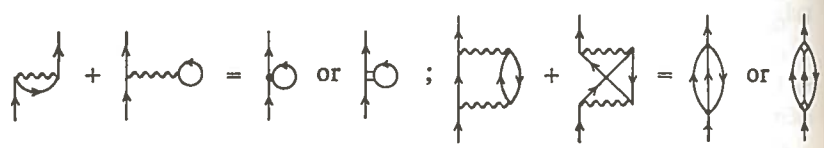
or 'momentum-non-conserving' diagrams, i.e., which have a hole and a particle in the same state. Rules (1)–(3) yield the series:



(9.40)

(4) Evaluate graphs by means of the dictionary in Table 9.1.

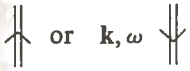
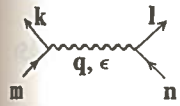
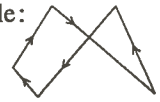
These rules will be seen in action in §9.8. Before going on to this, however, it is a good idea to point out that not everybody draws graphs the same way we do here. Some graphologists use abbreviated diagrams in which the interaction wiggles are compressed to points or little squares. Thus, for example



(9.41)

Note that each abbreviated diagram stands for several Feynman diagrams. Those drawn with points are called 'Hugenholtz diagrams' (see Van Hove (1961), p. 171, or Hugenholtz (1965)), while those with squares are 'Abrikosov diagrams' (Abrikosov (1963), p. 71 ff.).

Table 9.1 *Diagram dictionary for interacting many-fermion system with no external potential (Feynman method)*

Diagram element	Factor
$\mathbf{k},\omega$  or $\mathbf{k},\omega$	$iG(\mathbf{k},\omega)$
$\mathbf{k},\omega$ or $\mathbf{k},\omega$	$iG_0(\mathbf{k},\omega) = \dfrac{i}{\omega-\epsilon_k+i\delta_k}, \quad \delta_{k>k_F} = +\delta, \quad \delta_{k<k_F} = -\delta$
$\mathbf{k},\omega$ or $\mathbf{k},\omega$	$iG(\mathbf{k},\omega)\exp(i\omega 0^+)$ $(0^+ \times \infty = \infty)$
$\mathbf{k},\omega$ or $\mathbf{k},\omega$	$iG_0(\mathbf{k},\omega)\exp(i\omega 0^+)$ $\left(\text{so that: } \int_{-\infty}^{+\infty} \frac{d\omega}{2\pi} iG_0(\mathbf{k},\omega) \times \exp(i\omega 0^+) = -\theta_{k_F-k}\right)$
	$-iV_{klmn}$ or $-iV_q$ (use $V_{klmn}(\epsilon)$ or $V_q(\epsilon)$ for time-dependent interaction)
Each fermion loop Example: 	(-1)
Each intermediate frequency ω	$\int \frac{d\omega}{2\pi}$
Each intermediate momentum, $\mathbf{k}$	$\sum_{\mathbf{k}}$ or $\int \frac{d^3\mathbf{k}}{(2\pi)^3}$ (for $\Omega = 1$) (include sum over spins)