

(ii) *The pressure dependence of the interaction constant, K*

From figure 2 we can deduce a value for  $(V/K) dK/dV$ ; it lies between  $-0.8$  and  $-1.4$ . A review of the theoretical calculations of this coefficient has been given by Lawson (1956) and from this it appears that estimates based on the assumption of free electrons give values in the neighbourhood of  $-1$ . The assumption of free electrons is of course very reasonable in the case of copper.

A more significant agreement with theory is the approximate constancy of the coefficient above  $100^\circ\text{K}$ . Deviations below this temperature might perhaps be ascribed to a change in the 'binding' of the electrons but this is unlikely; it is more probable, as we have indicated above, that failure of the Grüneisen law of thermal expansion is the cause of this discrepancy.

(b) *The pressure coefficient of residual resistivity*

There has been considerable experimental work at room temperature on the pressure and temperature coefficients of the residual resistance of alloys of the noble metals (Linde 1939, 1949); this has been summarized in a recent review article by Gerritsen (1956). In these experiments the concentration of 'impurity' was usually a small atomic percentage. Linde found that, broadly speaking, alloys of the noble metals with non-transition elements had negative pressure coefficients\* all of rather similar magnitude (about  $-0.05\%$  per 1000 atm, corresponding to  $d \ln \rho_0 / d \ln V \sim +1$ ). Linde has accounted for these results in a semi-quantitative manner using Mott's expression for the resistance due to a given small concentration of screened impurity ions (Linde 1949), and Friedel (see, for example, Friedel 1956) has correlated these pressure coefficients with the corresponding thermo-electric power measurements at room temperature.

The effects of pressure on the residual resistance produced by transition elements in copper, silver and gold are much more complicated (Linde 1949). The pressure coefficient depends both in magnitude and sign on the kind of impurity atom which produces the resistance and it is scarcely possible to make any generalization from these results. In several alloys a positive pressure coefficient of residual resistivity is associated with a negative temperature coefficient, and Linde correlated some of these by assuming that the resistance change with temperature arises from the volume change due to thermal expansion. He also suggested that a process analogous to the Ramsauer effect in gases (i.e. an increase in electron scattering with increasing electron velocity) might be important in explaining the complex behaviour of these alloys.

Lenssen & Michels (1935) derived a theoretical expression for the volume dependence of residual resistivity due to either chemical or physical impurities. On the assumption of free electrons and that the scattering cross-section is effectively independent of pressure they deduce that  $d \ln \rho_0 / d \ln V = -\frac{1}{3}$ , and that this parameter is independent of the specific solvent or solute. These assumptions are evidently too drastic.

\* Among those studied, Zn in Au and possibly Mg in Ag had positive pressure coefficients.

Experimentally  $\approx -0.3$ . It is difficult to contribute to the total resistance because they show a minimum in solid solution difference between the two for by the difference

$T$ ( $^\circ\text{K}$ )	$dR_0/dT$ (%)
291.1	42.4
80.0	5.47
78.0	5.15
26.5	0.108
4.2	—

†  $dR_0/dT = 2.1$

‡ We have used

In sample II. Because the impurity is able to make some contribution to both this residual and the total resistivity,  $dR_0/dT$  is not changing with  $\rho_0$  at several points.  $dR_0/dT = \rho_i / (\rho_i + \rho_0) \cdot d(\rho_i / \rho_0) / d\rho_0$ , where  $d(\rho_i / \rho_0) / d\rho_0$  is of order  $(1/\rho_0) d\rho_0 / d\rho_0$  (see table 2). We find from its low temperature that it has changed sign. The reports on pressure coefficient of residual resistivity at room temperature are in agreement with this sign to that of the same size, in fact