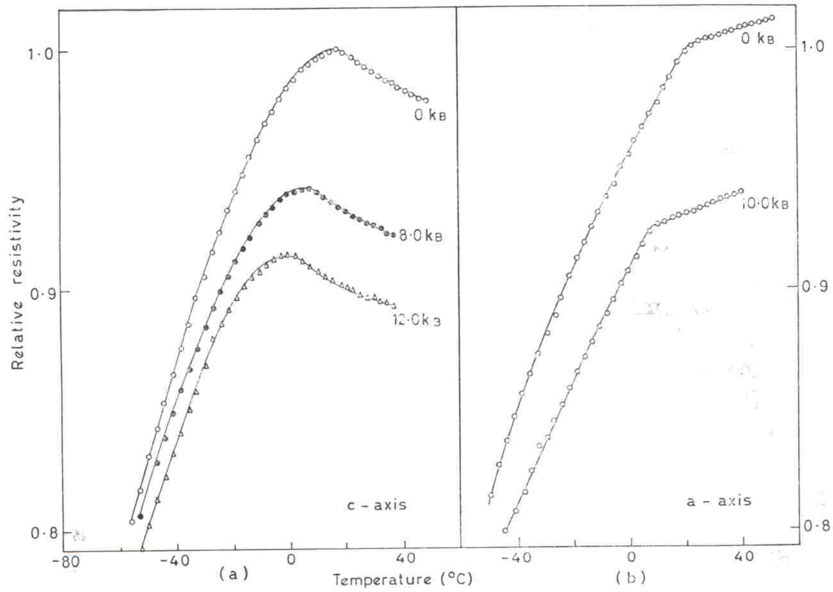
Table 2

Substance	T_c or T_N in °K	$\frac{1}{T_c}\left(\frac{\partial T_c}{\partial P}\right)$ 10^{-6}/bar	$\frac{1}{\rho_{\text{mag.}}}\left(\frac{\partial \rho_{\text{mag.}}}{\partial P}\right)$ 10^{-6}/bar	Compressibility 10^{-6}/bar
Gd	293	$-5{\cdot}3$	$-8{\cdot}4$‡ (310°K)	$-2{\cdot}66$
Dy	172	$3{\cdot}5$†	$-2{\cdot}5$‡ (310°K)	$-2{\cdot}75$
Pd_2MnSb	251	$< 0{\cdot}5$	$\lesssim 0{\cdot}3$ (280°K)	—

† Obtained by Bloch and Pauthenet (1964).
‡ *c*-axis values.

Fig. 2



Resistivity–temperature curves for single crystal Gd at different pressures. (*a*) current along *c*-axis, (*b*) along *a*-axis.

§ 4. DISCUSSION

Liu (1962), and Bloch and Pauthenet (1964) have discussed the pressure dependence of the Curie temperature (T_c) of a ferromagnetic metal with an indirect exchange mechanism like the rare-earth metals. According to the former

$$T_c \propto I^2 n(\epsilon_f) \, . \sum_j F(2k_f \, . \, R_j), \qquad \qquad (1)$$

where $n(\epsilon_f)$ and k_f are the density of states and wave vector at the Fermi level, I is an average matrix element for the exchange interaction and R the position vector of a 4f ion. $\sum F$ is the Ruderman–Kittel (1954) oscillating polarization function and is independent of volume in an isotropic system since $k_f \propto V^{-1/3}$. Differentiating we obtain:

$$\frac{\partial \log T_c}{\partial \log V} = \frac{1}{K}\frac{\partial \log T_c}{\partial P} = \frac{\partial \log n(\epsilon_f)}{\partial \log V} + 2\frac{\partial \log I}{\partial \log V}, \quad . \quad . \quad . \quad (2)$$

where K is the compressibility.

In an isotropic system $n(\epsilon_f) \propto m^*(N/V)^{1/3}$, and

$$\frac{\partial \log n(\epsilon_f)}{\partial \log V} = \frac{\partial \log m^*}{\partial \log V} - \frac{1}{3}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where N is the number of electrons in a volume V and m^* the effective mass.

For a rigid band model the effect of altering the electron concentration is to alter $n(\epsilon_f)$ and k_f in eqn. (1) thus changing T_c. However, from the arguments of Liu (1962) we would not expect the volume dependence of I to change much with N; thus $\partial \log T_c/\partial \log V$ should be insensitive to changes in the electron concentration.

§ 5. RARE-EARTH ALLOYS

The rare-earth alloys examined here have roughly similar unit cell volumes; the difference between pure Gd and $Gd_{0.57}Lu_{0.43}$ is about 4·5%. Moreover, since Lu has a full and Y an empty 4f shell, alloying these elements with Gd is not likely to alter the electron concentration significantly. Estimates of the Ziman parameter (R) from resistivity measurements (Smidt and Daane 1963) indicate a small decrease in Fermi energy on alloying, amounting to a 7% decrease for 30% Lu. The volume dependence of the Curie temperature in these alloys, calculated from the data of Smidt and Daane (1963) is shown in fig. 3, also the volume dependence of T_c in pure Gd calculated from the pressure data and Bridgman's compressibility figures. Clearly the variation in T_c produced by alloying cannot be explained simply in terms of a change in the lattice parameter, and it seems more appropriate to view alloying as a process which dilutes the magnetic ions. Thus in eqn. (1), R will change significantly on alloying, but k_f and $n(\epsilon_f)$ hardly at all. Although a large change in T_c will occur, we expect $\partial \log T_c/\partial P$ to be roughly the same for all the alloys. Table 1 shows that the measured variation in $\partial T_c/\partial P$ is about 25% for Gd–Lu and Gd–Y alloys but $\partial \log T_c/\partial P$ is constant to ± 5% (see last column), in agreement with this argument.

§ 6. HEUSLER ALLOYS

In the two systems of Heusler alloys, replacement of In by Sn and Sb changes the lattice constant only slightly ($\lesssim 1\%$); the main effect is to alter the free electron concentration. If we assume that each indium atom ($5s^2p^1$) contributes one electron and each Mn atom one electron, then