Pressure Coefficient of Resistance

It has been reported that the resistance of manganin (at constant temperature) is a linear function of the pressure,[1] i.e., that the coefficient $(\partial R/\partial P)/R_0$ does not vary with pressure. On the other hand, experience at the Geophysical Laboratory over a period of years indicated a pronounced increase of pressure coefficient with increasing pressure. We now know that a partial explanation of this seeming contradiction is to be found in the dependence of the pressure coefficient upon the method of construction of the coil as well as upon the intrinsic properties of the metal. Indeed, it is very easy to wind a coil in such a manner that its pressure coefficient will increase by 2 or 3 percent in the range from 0 to 1000 bars. Furthermore, the coefficient at some given low pressure will vary within wide limits for coils that are wound in different ways.

Table I shows some of the data which have been accumulated on the pressure coefficient of manganin wire (sample *D*) made into coils of various types of construction. The coil formed one arm of the "fixed bridge" arrangement; the total current through the bridge was maintained constant at 0.018651 ampere by the method previously described;[4] and the unbalanced e.m.f. was measured with a potentiometer to 0.1 microvolt. The pressure was measured on a free-piston absolute gauge, the sensitivity and reproducibility of which was about 0.1 bar, the absolute accuracy being about 1.0 bar. The resistances S and s (see Fig. 1a) were 100.0 ohms each and the initial resistance, R_0, of each coil was approximately 100 ohms. In the third column of the table are given the values of E'/P corrected to correspond to what the values would be if R_0 were exactly 100.0 ohms (see Eq. (4)). The values of the average pressure coefficient, R/R_0P, in the pressure range 0 to 1311 bars, are shown in the fourth column, and were obtained by multiplying E'/P by 4/1.8651 (=2.145).

Table I. *The pressure coefficient at low pressures of manganin coils of various types of construction. Temperature, 25° (wire "D").*

No.	Description	$10^6 \times E'/P$ (corr.), μv/bar 0 to 1311 bars	$10^6 \times \Delta R/R_0P$ 0 to 1311 bars	$10^6 \times \Delta R/R_0P$ 0 to 10,000 bars
1	Several layers on spool 1.75 mm in diameter	1.022	2.192	2.222
2	2 layers on tube of thin paper 5.2 mm in diam.	1.036	2.222	
3	Another coil of same construction as No. 2	1.034	2.218	
4	2 separated single layers, outer diam. 5 mm	1.028	2.205	
5	Single layer on tube of thin paper 9.5 mm diam.	1.045	2.242	
6	Another coil of same construction as No. 5	1.046	2.244	
7	Folded in loose bunch 10 cm long	1.042	2.235	
8	Folded in compact bunch 2 cm long	1.040	2.231	2.239

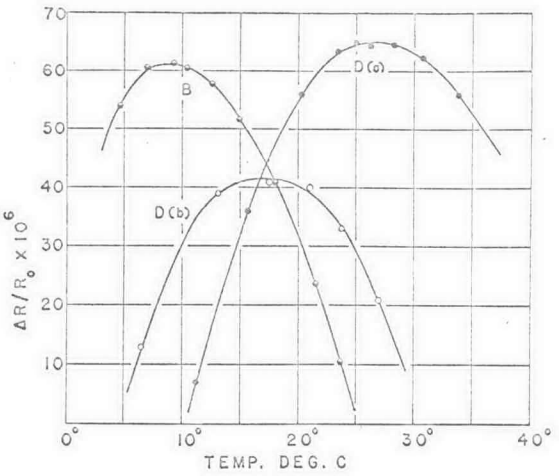

Fig. 2. Relative resistance change, $\Delta R/R_0$, *vs.* temperature of two samples of manganin wire. "*B*" refers to the wire supplied by Baker & Co. and "*D*" to that supplied by the Driver-Harris Co., of which (a) and (b) signify after and before "heat treatment" respectively. The scale for $\Delta R/R_0$ is reckoned from an arbitrary "zero."

The variation in the apparent pressure coefficient of a single sample of manganin wire is quite impressive; in the values shown in Table I there is a total spread of over 2 percent. It is evident that in general the large loose coils have a higher coefficient than the small or compact ones. Moreover, from other measurements, not shown in the table, it was observed that the pressure coefficient of those coils having a low coefficient increased by a considerable amount in the range from 0 to 1000 bars. For the coils with the higher coefficients the value of the coefficient either was practically constant at these low pressures or decreased slightly in the first few hundred bars. It is important to note that all the coils that have been tested were quite reproducible with respect to resistance changes—provided they had been previously pressure seasoned. Even the coil with the lowest coefficient (No. 1), after being subjected to a pressure of 12,000 bars, returned always to the same initial