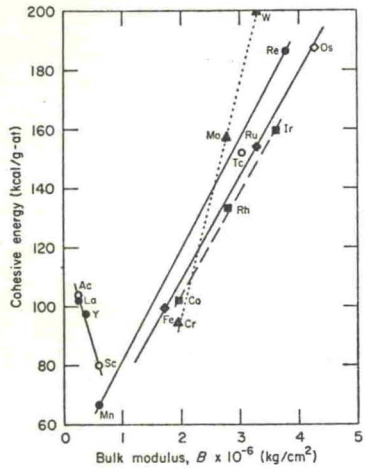

FIG. 8. Bulk modulus versus the cohesive energy of a number of transition metals. Open points are estimated values.

tactinium was assumed to be equal to the mean value of thorium and uranium.

Examination of the values of a number of physical properties indicated that the cohesive energy or the heat of sublimation (see Sections 11 and 12 and Table XII) has roughly a one-to-one correspondence to the bulk modulus. That is, if the bulk modulus is small, the cohesive energy is small; and when the former is large, the latter is also large. Unfortunately this correspondence is not exactly the same for all the elements in the Periodic Table, although it does appear to be the same for all elements in each group. This is shown in Figs. 7 and 8. In Fig. 7 it is seen that alkali and alkaline-earth metals seem to have the same slope; i.e., their bulk moduli are related to their cohesive energies by a constant value. This type of relationship is seen in Fig. 8, where it holds for chromium, molybdenum, and tungsten, and for cobalt, rhodium, and iridium. Assuming that this type of relationship holds for the other groups, it is possible to obtain the slope if both the cohesive energy and the bulk modulus are known for only two elements in a given group. Thus the bulk moduli for technetium, osmium, polonium, francium, radium, and actinium have been estimated from their known or estimated cohesive energies (see Table XII). The value shown for technetium in Fig. 8 is the final estimated value chosen for this element, not the value derived from this plot.

The values for scandium and neptunium were calculated from the experimental value of Young's modulus and the estimated value of Y/μ by use of Eq. (3.1).

Selenium. As has been mentioned in Sections 3–5, the bulk modulus for selenium is probably incorrect. If one were to shift the experimental value for selenium, as shown in Fig. 7, so that it falls on the curve established by rhombic sulfur and tellurium, a much larger bulk modulus would be obtained. By using this value of the bulk modulus, reasonable values for the compressibility, Young's modulus, the shear modulus, and Poisson's ratio are obtained. Since this is quite speculative, this point will not be discussed further.

III. Coefficient of Thermal Expansion

The linear coefficients of thermal expansion at 298°K (25°C) are listed in Table VI for all the elements, and are shown for the elements in the fourth, fifth, and sixth periods of the Periodic Table in Fig. 9 and for the rare earths in Fig. 10. The values of the coefficient of expansion given herein for the noncubic elements are average values. In a few instances the values for the various crystallographic directions of a noncubic crystal have been given in the literature. Such data were averaged by the usual techniques to obtain an average value for the thermal expansion. Most of the values listed here are based on measurements of polycrystalline bulk material. In some instances values based on X-ray measurements are given as the best values for the thermal expansion; these data are identified in Table VI by a footnote.

The experimental values of the coefficient of thermal expansion vary between a minimum value of 1.19×10^{-6} for diamond and a maximum of 124.5×10^{-6} for white phosphorus. The estimated values also lie well within this range.

In Fig. 9 it is noted that the coefficients of thermal expansion when plotted as a function of atomic number show a behavior which is approximately the opposite of that shown by Young's, the shear, and the bulk moduli (Figs. 1, 3, and 6), the melting and boiling points (Figs. 12 and 15), and the cohesive energy (Fig. 17). The coefficient of expansion is very large for the alkali metals but it decreases rapidly as one proceeds through the alkaline-earth and group IIIA metals. The minimum value for each period is attained in the element which has the s^2d^4 configuration, i.e., chromium, molybdenum, and tungsten. As one proceeds beyond these