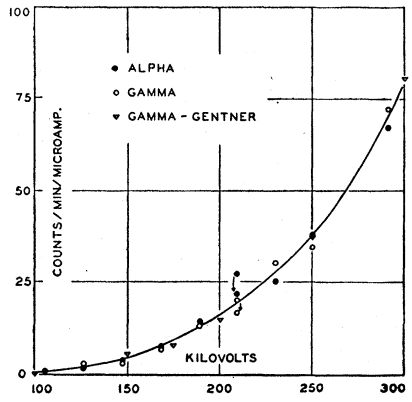

FIG. 1. Gamma-ray and alpha-particle excitation curves of Li+H¹. At 210 kv two points are given for both alpha-particles and gamma-rays. The high point in both cases includes data taken while the lithium film was fresh, while the lower points include only data taken after the film had reached an "equilibrium."

equipment described by Haworth, King, Zahn, and Heydenburg.[4] The gamma-rays were detected by a Geiger-Mueller counter filled with a mixture of air and alcohol,[5] and shielded from x-radiation produced by the apparatus itself by $\frac{3}{4}$ in. lead. The radiation entering the window of this shield was filtered by $\frac{1}{16}$ in. brass, $\frac{1}{16}$ in. lead, and $\frac{3}{8}$ in. aluminum. Despite this shielding, the background count with the proton beam coming down the tube was above the cosmic-ray background. This additional background was probably caused by x-rays produced by secondary electrons striking the high voltage end of the tube. Corrections were made, for the greater part, on the basis of background runs made immediately after corresponding gamma-ray runs, even though the corrections were a fairly regular function of voltage and proton current. The alpha-particles were counted by an ionization chamber and a Dunning-type linear amplifier. The target assembly has been described by Haworth and King.[6]

The data presented in Fig. 1 were obtained from a single lithium film, the yield from which decreased very rapidly for a time, but later gave reproducible results. At 210 kv two points are given for both alpha-particles and gamma-rays. The high point in both cases includes data taken while the film was fresh, while the lower points include only data taken after the film had reached an "equilibrium." We found no radiation in this voltage region from a target of pure carbon, so the inevitable carbon deposit cannot make the proportionality of the two yields fortuitous.

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The Variation with Heat Treatment of the Cold Resistance of Nickel

In order to obtain a clean, stable nickel wire for the study of surface energy losses, the wire was subjected to prolonged heat treatment and its cold resistance (resistance at 0°C) measured at various stages. The initial bakeout at 450°C caused a 13.3 percent decrease in resistance, and subsequent flash annealing at gradually increasing temperatures up to about 900°C caused a gradual decrease in cold resistance to a value 16.8 percent less than the original. Upon increasing the annealing temperature to about 950°C, instead of a continued decrease, an increase of 0.8 percent over the lowest resistance was found. (This difference was well over the experimental error.) In this connection it may be noted that Bittel,[1] investigating the influence of heat treatment on the cold resistance of much purer nickel, reports a gradual decrease in resistance for annealing temperatures up to about 600°C, followed by a sharp increase. Measurements previously made by Tammann[2] and Credner[3] (maximum temperature reached: 800°C and 750°C, respectively) show no rise in cold resistance. This difference Bittel attributes to the greater impurities present in the specimens used in the earlier work, which would cause recrystallization to begin at a higher temperature. This view is confirmed by the present work, for the nickel used approximates Credner's in purity, and the first increase in resistance was found for an annealing temperature higher than any used by Credner.

The above aging process was repeated approximately (except for much shorter annealing times), with quite different results: upon heating for one hour at each of several temperatures from about 400°C to about 950°C the resistance consistently increased, the final resistance being 8.5 percent higher than that previously observed after flashing for 23 hours at the same temperature.

These results suggest that the wide variation in the electrical and thermal properties of nickel as reported in the literature are due in part to the lack of a standardized aging procedure. Different investigations of the temperature variation of the thermal conductivity of nickel, for example, have not even agreed on whether the thermal conductivity increases or decreases as the temperature is raised above room temperature. Sager,[4] who measured the thermal conductivity first with increasing temperature and then with decreasing temperature, found about a 14 percent increase in the value at 54°C, yet in some other reports on the thermal conductivity of nickel, no comparable check on the stability of the specimen seems to have been made.

From work done on the aging of other metals, notably that of Langmuir and Taylor[5] on tungsten, it was expected that an annealing temperature could be found such that after sufficient heat treatment at that temperature, treatment at lower temperatures would produce no change in cold resistance. This was not found to be the case with nickel, at least for annealing temperatures up to about 950°C. For, although after many hours of heating at 950°C, further heating at that temperature did not change the

cold resistance, several hours of heating at about 700°C caused a decrease of 4.0 percent in the cold resistance. Further heating at 950°C brought the cold resistance back to the value formerly characteristic of annealing at that temperature: part of the change in cold resistance with heat treatment appeared reversible.

Further work on the aging of "A" nickel and of 99.9 percent pure nickel is contemplated.

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