pulse is less than five microseconds in duration. These pulses are received at Station B and appear as a broad line upon an oscilloscope which is kept in synchronism with the pulses by the commercial 60 cycle line connecting the two stations. Station B is also sending out 60 pulses per second. These produce a second broad line upon the oscilloscope at B. When these two lines are brought into coincidence by means of a phase changer the wave from B to A is acting precisely like a wave reflected from the ionosphere. The observer at A perceives two lines upon his oscilloscope, one due to his own pulse and the other due to a pulse which has traveled virtually from A to B and back again to A. The spot on his oscilloscope is being pulled across the screen at the rate of 1500 inches per second. He can therefore measure the time distance between the two lines with great accuracy. Twice the distance between the two stations divided by the time gives the required velocity.

Using this method we have found that the velocity of the ground wave between Fairmont and Morgantown is somewhat less than two-thirds the velocity of light. The station B was first set up by Davis and Elkins College, Elkins, W. Va., 80 kilometers away. At this distance with the power permitted, the ground wave was too weak for accurate measurement. The reflecting station was therefore moved to Fairmont State Teachers College, Fairmont, W. Va. The base line between the sending and receiving stations is now 20.3 km or 40.6 km for the total distance of transmission.

The velocity of propagation of any type of signal (light, heat, radio, x-ray, sound, etc.) may be measured by this method.

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The Isotopes of Cobalt and Their Radioactivity

Dunning and his collaborators[1] have measured the absorption of slow neutrons in cobalt and found a large cross section: 35×10^{-24} cm^2, while Fermi and his co-workers[2] have shown that this slow neutron absorption is accompanied by the emission of gamma-radiation. This indicates that the process involved in the slow neutron absorption is radiative capture of the neutron to form an isotope heavier by one mass unit than the nucleus responsible for the capture. Since the only known isotope of cobalt has been Co^{59}, discovered by Aston, this radiative neutron capture should give rise to a water-sensitive radioactivity; but the only activities which have been observed in Co bombarded by neutrons are a 2.5-hour period which has been chemically shown[3] to be due to Mn^{56}, and a 20-minute period which is water-sensitive[4] and hence probably due to an isotope of cobalt, but is far too weak to be the only consequence of the quite large slow neutron absorption mentioned above. The process responsible for that absorption, then, has not so far been identified.

In the present work, cobalt was examined in a mass spectrograph described by Sampson and Bleakney,[5] the source of ions being a molecular beam of cobalt chloride ionized by slow electrons. Co^{57} was found as the CoCl$^+$ ion, peaks being observed at mass numbers 92 (Co^{57}Cl^{35}), 94 (Co^{57}Cl^{37} and Co^{59}Cl^{35}), and 96 (Co^{59}Cl^{37}). Difficulty was experienced in obtaining cobalt ions from metallic Co, and the mass 57 was obscured by impurities. The abundance of Co^{57} is quite small: the ratio Co^{57}/Co^{59} being about $1/600\pm20$ percent. Assuming the packing fraction to be -9, from Aston's curve, the atomic weight comes out to be 58.93, in agreement with the accepted chemical value of 58.94.

The existence of two stable isotopes of Co presented the possibility that another water-sensitive radioactivity might be produced by neutron bombardment, and it seemed likely that it might be a long-period activity. Accordingly, a cylinder of metallic Co was bombarded for nearly a month with neutrons from a Ra–Be source of about 68 mc, source and detector being immersed in a large vessel of water. After it had been removed from the neutron source, the Co exhibited quite a strong activity, as measured with a thin-walled tube counter, almost all of which persisted after the decay of the known short-lived radioactivities. No appreciable decay has occurred in more than two weeks' observation of this activity, indicating that the half-life is of the order of a year or more. The measurements are not very accurate since the number of counts is only about four times the background. The growth of the long-period radioactivity has been observed in another Co cylinder exposed to the neutron source and removed and examined at intervals. The large intensity of this activity after bombardment for a time, short compared with the half-life, indicates that the equilibrium intensity is very big, so that this activity should be adduced to explain the large slow neutron cross section of Co.

Since Ni has stable isotopes of masses 58 and 60, we attribute Rotblat's[4] short-period activity to Co^{58}, formed by the capture of a neutron in Co^{57}; while the long-period activity just mentioned is likely to be due to Co^{60}. This assignment is made on a basis of comparison of the abundances of the Co isotopes with the relative intensities of the two radioactivities, but could be checked if the bombardment of copper with fast neutrons led to the reaction

$${}_{29}\mathrm{Cu}^{63}+{}_0n^1\rightarrow{}_{27}\mathrm{Co}^{60}+{}_2\mathrm{He}^4,$$

a possibility which should be examined.

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[1] Dunning, Pegram, Fink and Mitchell, Phys. Rev. **48**, 265 (1935).

[2] Fermi, Amaldi, d'Agostino, Rasetti and Segrè, Proc. Roy. Soc. **149**, 522 (1935).

[3] Fermi, Amaldi, d'Agostino, Rasetti and Segrè, Proc. Roy. Soc. **146**, 483 (1934).

[4] Narliker and Sastry, Nature **136**, 515 (1935).

[5] Sampson and Bleakney, Phys. Rev. In press.