LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the eighteenth of the preceding month, for the second issue, the third of the month. Because of the late closing dates for the section no proof can be shown to authors. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Communications should not in general exceed 600 words in length.

New Evidence for the Existence of a Particle of Mass Intermediate Between the Proton and Electron

Anderson and Neddermyer[1] have shown that, for energies up to 300 and 400 Mev, the cosmic-ray shower particles have energy losses in lead plates corresponding to those predicted by theory for electrons. Recent studies of range[2] and energy loss[3] indicate that the singly occurring cosmic-ray corpuscles, even in the energy range below 400 Mev, are more penetrating than shower particles of corresponding magnetic deflection. Thus the natural assumptions have been expressed: the shower particles are electrons, the theory describing their energy losses is satisfactory, and the singly occurring particles are not electrons. The experiments cited above have shown from consideration of the specific ionization that the penetrating rays are not protons. The suggestion has been made that they are particles of electronic charge, and of mass intermediate between those of the proton and electron. If this is true, it should be possible to distinguish clearly such a particle from an electron or proton by observing its track density and magnetic deflection near the end of its range, although it is to be expected that the fraction of the total range in which the distinction can be made is very small. To examine this possibility experimentally we have used the arrangement of apparatus of Fig. 1. The three-counter telescope consisting of tubes 1, 2, and 3 and a lead filter *L* for removing shower particles, selects penetrating rays directed toward the cloud chamber *C* which is in a magnetic field of 3500 gauss. The type of track desired is one so near the end of its range as it enters the chamber that there is no chance of emergence below. In order to reduce the number of photographs of high energy particles, the tube group 4 was used as a cut-off counter with a circuit so arranged that the chamber would be set off only in those cases when a coincident discharge of counters 1, 2, and 3 was unaccompanied by a discharge of 4. The tripping of the cloud chamber valve was delayed about one sec. to facilitate determination of the drop count along a track. Because of geometrical imperfections of the arrangement and of counter inefficiency the cut-off circuit prevented

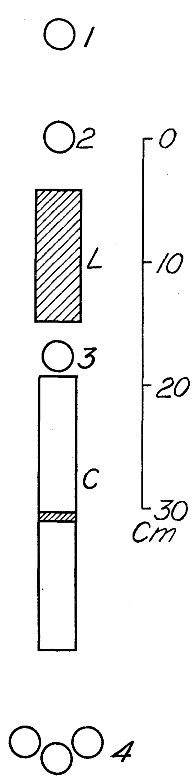

FIG. 1. Geometrical arrangement of apparatus.

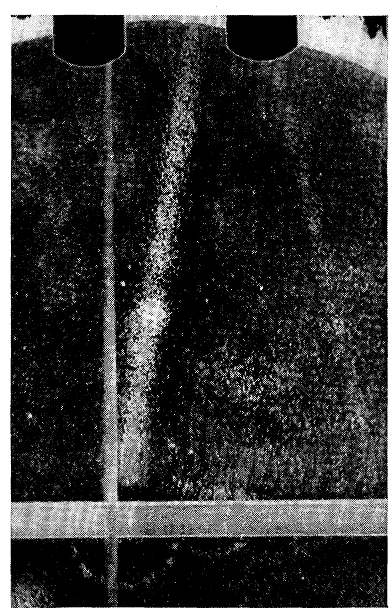

FIG. 2. Track *A*.

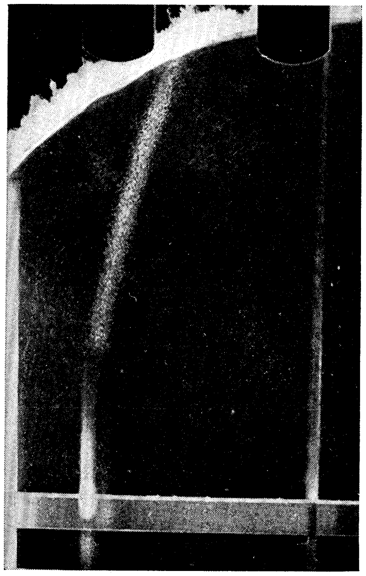

FIG. 3. Track B.

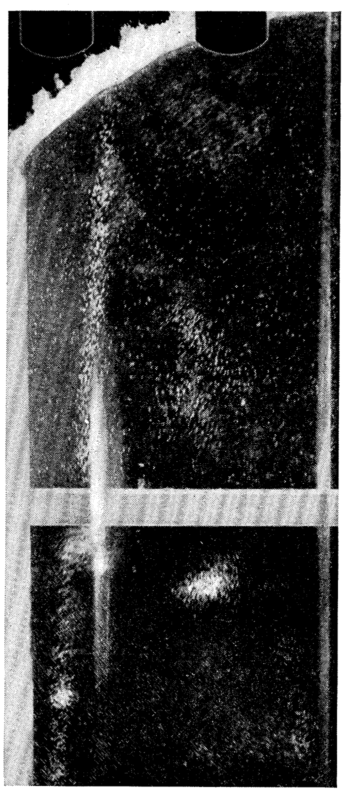

FIG. 4. Photograph of the track of a penetrating particle of high energy for comparison with A and B.

expansion for only $\frac{3}{4}$ of the discharges of the telescope. At the present time 1000 photos have been taken (equivalent to 4000 if the cut-off counter had not been used). Two tracks of interest, in that they have ionization densities definitely greater than usual, have been obtained: one A (see Fig. 2) is believed due to a proton and the other B (see Fig. 3) to a particle of mass approximately 130 times the rest mass of an electron. Track A which terminated in the lead strip at the center of the chamber exhibited an ionization density 2.4 times as great as the usual thin tracks and an $H\rho$ value approximately 2×10^6 gauss cm in a direction to indicate a positive particle. Track B which passed out of the lighted region above the lead plate had an ionization density about six times as great as normal thin tracks (the ion density was too great to permit an accurate ion count) and an $H\rho$ value of 9.6×10^4 gauss cm. If it is assumed, as seems reasonable, that the particle entered from above, the sign is negative. If it is taken that the ionization density varies inversely as the velocity squared, the rest mass of the particle in question is found to be approximately 130 times the rest mass of the electron. Because of uncertainty in the ion count this determination has a probable error of some 25 percent. In any case it does not seem possible to explain this track as due to a proton traveling up, for the observed $H\rho$ value would indicate a proton of 4.4×10^5 electron volts energy and therefore with a range of approximately one cm in the chamber. The track is clearly visible for 7 cm in the chamber.

The only possible objection to the conclusions reached above is that the bending of track A is largely due to distortion, but this is very unlikely, for the deflection is quite uniform and has a maximum value greater than ten times any distortions usually encountered in the thin tracks of high energy particles.

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October 6, 1937.

[1] Anderson and Neddermeyer, Phys. Rev. **50**, 263 (1936).
[2] Street and Stevenson, Phys. Rev. **51**, 1005 (1937).
[3] Neddermeyer and Anderson, Phys. Rev. **51**, 885 (1937).

Variation of Initial Permeability with Direction in Single Crystals of Silicon-Iron

Magnetic measurements at flux densities ranging from about 5 to 100 gauss have been made on single crystals of 3.85 percent silicon iron, in the crystallographic directions [100], [110] and [111]. Up to this time no data have been reported on the magnetic properties of single crystals at such low flux densities and it has generally been assumed that single crystals are magnetically isotropic at these flux densities.

Large crystals were produced in an atmosphere of pure hydrogen by melting silicon iron and permitting it to cool very slowly through the freezing point.[1] Three specimens were cut in the form of hollow parallelograms. Each

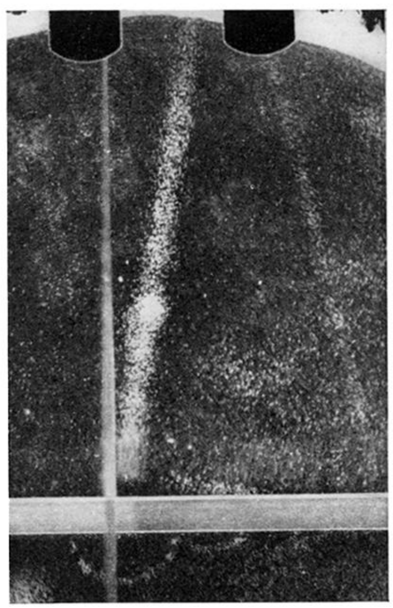

Fig. 2. Track A.

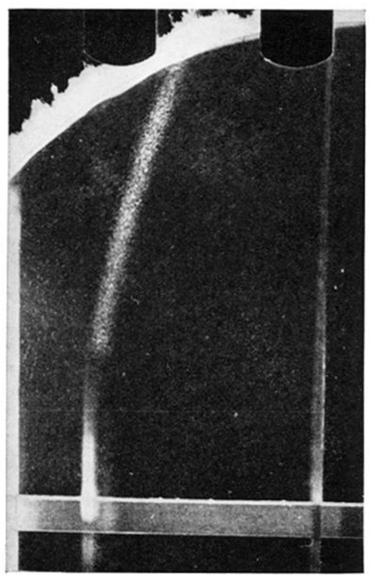

FIG. 3. Track *B*.

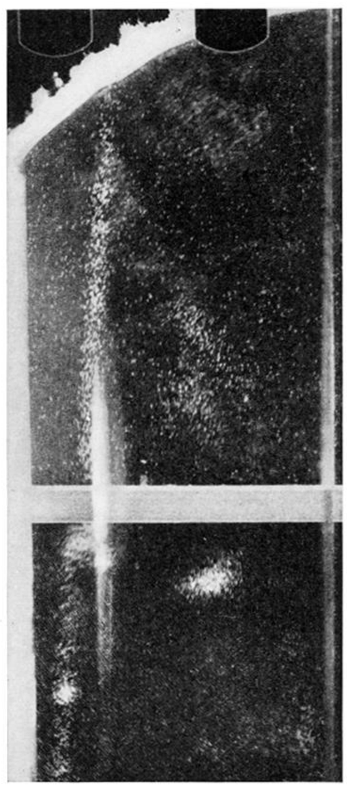

FIG. 4. Photograph of the track of a penetrating particle of high energy for comparison with A and B.