Letters to the Editor

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dales for this department are, for the first issue of the, month, the eighteenth of the preceding month, or 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.

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Acceleration of Elections by Magnetic Induction

For some time it has been realized that it might be possible to make use of the electromotive force induced by a changing magnetic flux to accelerate charged particles traveling in an orbit around the changing flux. Although previous attempts to accelerate electrons by this means have been unsuccessful[1] [2] careful examination showed that it should be possible to get good magnetic focusing by the proper arrangement of a magnetic field to guide the electrons around the changing flux and that if the rate of change of flux within the orbit were sufficiently high it would be possible to capture electrons in usable orbits and that vacuum requirements should not be difficult to satisfy.

It seemed feasible to attempt the experiment with a 600-cycle per second magnetic field, since a sufficiently high rate of change of flux would be obtained and since it seemed that it would not be necessary to have a vacuum better than 10^{-6} millimeter of mercury in the acceleration chamber, in spite

[1]Wideröe, Archiv f. Elektrotechnik **21,** 400 (1938).
[2]E. T. S. Walton. Proc. Camb. Phil. Soc. **25,** 469 (1929).

of the fact that at this frequency the length of the electron path would be of the order of 10^7 centimeters.

To hold the electrons in the acceleration chamber for such a long path it is necessary to fulfill the condition that $\phi = 2\pi R_0^2 H$, where ϕ is the flux enclosed by the orbit and H is the magnetic field at the orbit which causes the electrons to travel in a circle of radius R_0. When this condition is satisfied, the electron orbit neither shrinks nor expands, and the electrons can be accelerated by increasing ϕ and H together.

A laminated electromagnet with pole faces 8 inches in diameter, which satisfied all the necessary conditions, was constructed. The stable orbit was shrunk from R_0 toward the position of a tungsten target by causing saturation of the portion of the magnetic circuit which supplied the flux through the center of the orbit. X-rays produced by the impact of the electrons upon the target showed that the accelerator operated, and a lead collimator in front of a Geiger-Müller counter showed that the only portion of the acceleration chamber from which x-rays came was the target.

By taking the sweep voltage for an oscillograph from a coil surrounding the core of the magnet and putting the pulses from the Geiger-Müller counter circuit on the vertical deflection plates, the phase of the magnetic field at which the electrons struck the target could be determined. It was possible to hold the electrons in the acceleration chamber for one-fourth of a cycle during which the magnetic field changed from a low value to its maximum. Conservative estimates of the magnetic field at the target when the electrons strike it indicated that the energy of the electrons was about 2.2 Mev. This estimate was substantiated by a comparison of the absorption of the x-rays in lead with published data on the absorption of x-rays produced by 2-million-volt electrons[3]. After filtering the x-rays from the accelerator through about 1.8 cm of lead, their absorption coefficient is 0.57 cm^{-1}. A correction had to be made for scattering of x-rays from the magnet yoke. Since the absorption coefficient for x-rays produced by 2.0-Mev electrons is 0.62 cm^{-1}, the electrons in the new accelerator must have reached about 2.35-Mev energy before striking the target. The absorption measurements were taken with Lauritsen electroscopes, and calibration of the electroscopes showed that the intensity of the radiation was greater than the intensity of the gamma-rays from TO millicuries of radium.

Of several suggestions which have been made for naming the apparatus, induction accelerator seems to be the shortest descriptive one.

[3] D. L. Northrup and L. C. Van Atta, Am. J. Roentgenology and Radium Therapy **41.** 633 (1939).

It has been a great help to be able to discuss the theoretical aspects of the accelerator with Professor R. Serber and Professor H. M. Mott-Smith.

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