its minimum point indicates the position of the molecule in the unit cell. The calculations were carried out by means of Beevers–Lipson strips[5], and the results are shown in Fig. 2. It will be seen that a pronounced minimum exists, and this was taken as giving the position of the molecule.

This position represents a shift of about 0·5 A. in the *z*-direction from that found by considering the rings alone. It gave a residual of 0·30 which later refinement has reduced to 0·15. The oxygen and nitrogen peaks are clearly distinguished, by their size on a Fourier synthesis, from the carbon atoms, and these results are in agreement with the configuration of the molecule obtained independently from chemical evidence. The structure must, therefore, be essentially correct.

Further details of the work will be published elsewhere.

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An Experimental Proton Linear Accelerator using a Helical Waveguide

A previous communication[1] proposed the use of a helical slow-wave structure to accelerate protons up to 20 MeV. An experimental section of this type of accelerator has now been constructed at this Laboratory.

The helix structure consisted of a wire helix wound on a glass tube which was evacuated to allow the proton beam to pass along the axis. Outside the tube a pressure of 150 lb./sq. in. was maintained to prevent radio-frequency breakdown between turns of the helix and to assist in cooling. Cooling is important, since in some circumstances the mean dissipation may be as much as 600 watts per metre. The helix radius was 1 cm. and the pitch varied from 4 mm. at the input to 4·6 mm. at the output end to accelerate particles from 2·5 to 4 MeV. This acceleration was obtained in a 1-metre length for a peak power flux of 500 kW. at 300 Mc./s. with a phase stable position of 30°. No attempt was made to counteract the inherent defocusing effect of the radio-frequency accelerating field over the 1-metre length, and it was accepted that some of the beam may be lost into the walls of the beam tube.

Protons were injected into the accelerator by an electrostatic generator[2], the beam being pulsed before injection to reduce wall-charging effects in the accelerator tube. The energy of the beam after acceleration was measured by magnetic deflexion, and the current to the beam-collecting electrode was measured by the rise of voltage across the electrode capacitance, amplified in a screened head amplifier and displayed on an oscilloscope. The accelerator was operated under travelling-wave conditions without external feedback, the full 500 kW. of radio-

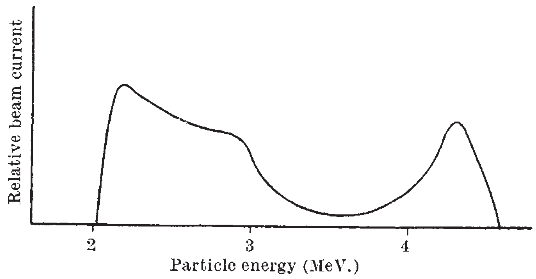

Fig. 1. Energy spectrum for 500-kW. radio-frequency power flux and 2·5-MeV. injection energy

frequency power at 300 Mc./s. being provided by an oscillator specifically designed for this purpose. The oscillator was driven from a radar modulator modified to give a 6-μsec. pulse. The high-frequency power at the input and output of the helix was monitored, providing a constant check on the transmission losses.

The measurements which are of primary interest are the energy spectrum under optimum conditions, and the relative magnitude of the accelerated beam. Fig. 1 shows the energy spectrum for the design values of power flux and beam energy input, which proved to be near optimum. The curve represents the average of a large number of readings necessitated by fluctuations of beam current, presumably arising from wall-charging inside the tube supporting the helix. The peak in the spectrum at 4·3 MeV. was higher than expected from the design figures, but cold measurements of phase velocity indicated a final velocity corresponding to nearly 4·3 MeV. The spread of energy at the accelerated peak was consistent with the theoretically predicted value of ± 5 per cent, and magnetic analyser resolution of 0·2 MeV. The beam current in the range 4·3 MeV. ± 5 per cent represented 20 per cent of the total current in the spectrum. This result compares reasonably with the design value of 25 per cent for a 90° acceptance angle, which suggests that only a small proportion of the beam is lost by defocusing, even though a large (5 mm. diameter) beam was used. The total current in the spectrum, however, represents only 15 per cent of the input beam current, and it is thought that this loss of current is due to deflexion of the beam by charges on the glass walls of the tube supporting the helix.

The results so far obtained with the helix accelerator indicate that it functions in principle in accordance with design. To increase the relative accelerated beam current, however, it would be necessary to surmount the problem of preventing wall-charging and, for a higher-energy accelerator, preventing defocusing.

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