

## V. THE LINEAR ACCELERATOR PROGRAM

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Since the last report it has been possible to test 12 feet of the microwave accelerator, to make certain necessary modifications as a result of these tests, and to show that the behavior of the microwave components is completely satisfactory. This leaves unfinished only the test of actually putting electrons through the cavities. We have also done some preliminary testing on the new 2-Mev Van de Graaff generator and have mounted it in the adjustable mount which will tie it in to the accelerator system. Some details are given below.

It was originally planned that the 20-foot accelerator would be divided into three units separated by drift tubes which would allow electrons through but which would prevent r-f coupling. The purpose of this was to prevent the possibility of exciting more than one mode of oscillation in the cavities. (The longer the cavity is, the closer is the mode spacing, and the more likely it is that the magnetron pulse will excite more than the one desired mode.) Preliminary tests on 5-foot and 6-foot sections showed that two modes were being excited by the magnetrons. Tests on a 4-foot section showed a small amount of excitation in the mode next to the desired  $\pi$ -mode, but the power level in this mode was at least 30 db below the level of the  $\pi$ -mode. It was therefore decided to limit the cavities to 4-foot sections separated by drift tubes.

There has been no difficulty in running four magnetrons into a 4-foot section. When the magnetrons have been tuned sufficiently close to the resonant frequency of the cavity they lock into phase and a single coherent oscillation is built up in the cavity. It has been found that locking into phase takes place most rapidly if one of the magnetrons is pulsed about 0.1  $\mu$ sec before the others. This allows the building up of a little power in the cavity so that when the delayed magnetrons are turned on, they rapidly pull into phase with the original signal.<sup>1</sup> If this prepulsing of one magnetron is not used, there is a considerable period of confusion during which the four magnetrons gradually lock together into a coherent signal.

With three of the 4-foot sections operating independently it was next necessary to arrange for keeping a constant phase relationship

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1. J. C. Slater, "The Phasing of Magnetrons", RLE Technical Report No. 35, April 3, 1947.

between each isolated section so that the proper phase of power will be seen by electrons as they travel from one 4-foot section to the next. This has been done by a method analogous to the prepulsing of one magnetron in a 4-foot section. One of the 4-foot sections is started about 0.1  $\mu$ sec before the others. A signal is taken from the series load of the prepulsed magnetron in that section. This signal is taken from a position on the series water load such that only a small fraction of the power to the load is obtained. This "phasing signal" is then taken through coaxial lines to the waveguides which connect the prepulsed magnetrons of the other sections to the cavities. Just before entering the waveguide the signal passes through a gas discharge T-R box. The power level of the phasing signal is too low to break down the T-R box. Operation is then as follows: A phasing signal from the prepulsed magnetron in the 4-foot section which is pulsed first is fed through T-R boxes into the circuits of the prepulsed magnetrons in the other 4-foot sections. When the prepulsed magnetrons in the other sections are turned on, they tend to lock into phase with the phasing signal, as do other magnetrons which come on a short time later. Finally, when power has begun to build up in the delayed 4-foot sections, the level of power in the T-R boxes becomes great enough to break them down, and they then present an effective short which prevents the leakage of large amounts of power down the phasing line. Since this sequence of events fixes the phase relationships between separated 4-foot sections, it is possible to establish the correct phases by varying the length of the phasing signal line. At present the T-R boxes are filled with  $H_2$  at 10-cm pressure with no attempt being made to obtain highly pure gas. Later it is planned to seal off the T-R boxes with a pure  $H_2$  filling. Observations of the amount of phase uncertainty show that it is well below that which would affect the amount of energy gained by electrons traversing the accelerator.

In order that phase relationships be maintained throughout the 2- $\mu$ sec pulse, it is necessary that all 4-foot sections be accurately tuned to the same frequency. Accurate tuning is accomplished by a tuning plunger in the wall of each 4-foot section.

The additional drift tube sections which will be needed for the 20-foot accelerator are nearly complete and we now await only the additional magnetrons to allow operation of the entire 20-foot unit.

Preliminary tests on the Van de Graaff generator which will be used for electron injection indicated that the temporary test vacuum pump and line had insufficient pumping speed. We have therefore put the generator on its adjustable horizontal mount and attached it to the main pumping system where it was to be ultimately connected. Beam focussing and pulsing controls will be tested and when the tests are completed, the beam will be sent down the cavity for final tests on beam collimation, shielding requirements, and energy spectrum.