SUPERCONDUCTING SOLENOID TRAVELING WAVE MASER SYSTEM

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This paper describes a traveling-wave-maser (TWM) system that obtains its magnetic field from a superconducting air-core solenoid. A photograph of the system is shown in Figure 1.

The maser uses a ruby-loaded comb structure operating at a bath temperature of 4.2°K. It is tunable from 2200 to 2300 Mc and has a stable net gain of about 30 db (Figure 2) with an instantaneous bandwidth of about 18 Mc. Gain stability is accomplished by integrally including yttrium-iron-garnet isolator disks. An effective maser noise temperature of 13 $\pm$ 2°K was measured using a hot- and cold-load noise generator.

The superconducting solenoid, which consists of niobium-zirconium wire, has an extremely large working diameter, 7.5 inches, a length of only 5 inches, and weighs less than 3 pounds. Figures 3 and 4 are photographs of the maser-magnet configuration, and the overall maser superstructure. It can supply stable magnetic fields up to 4320 gauss at a coil current of 6.2 amperes. The magnetic field that the solenoid supplies to the operating maser is nominally 2500 gauss and has a field homogeneity better than one part in a thousand over a volume of 4 by 1 by 1 inches. (The 4-inch dimension is perpendicular to the solenoid axis.)

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The high degree of homogeneity yielded by this relatively small-length solenoid results from the application of a high-u-material magnetic-loading technique, without which an impractical coil length greater than 25 inches would be required.

Previous work on superconducting magnets for TWM application consisted of iron-core configurations with field shaping techniques derived from the Meissner effect of a superconducting sheet (references 1 and 2). It is believed that the solenoid technique described here involves less complicated construction procedures and generally yields a lighter magnet. It is further believed that the air-core approach is capable of TWM application at frequencies greater than 10 Gc.

The relative merits of both the iron-core magnet and air-core solenoid configurations will be discussed, and information on the characteristics and potential of other exotic "high-field high-current" density superconducting materials will be presented. In addition, the techniques of operating the solenoid in the persistent current mode will be described.

REFERENCES

1. P. P. Cioffi, "Approach to Ideal Magnetic Circuit Concept through Superconductivity," Journal of Applied Physics, March 1962.

2. W. G. Nilsen, "Operation of a Traveling-Wave Maser in a Transverse Field Superconducting Electromagnet," Journal of Applied Physics, August 1962.

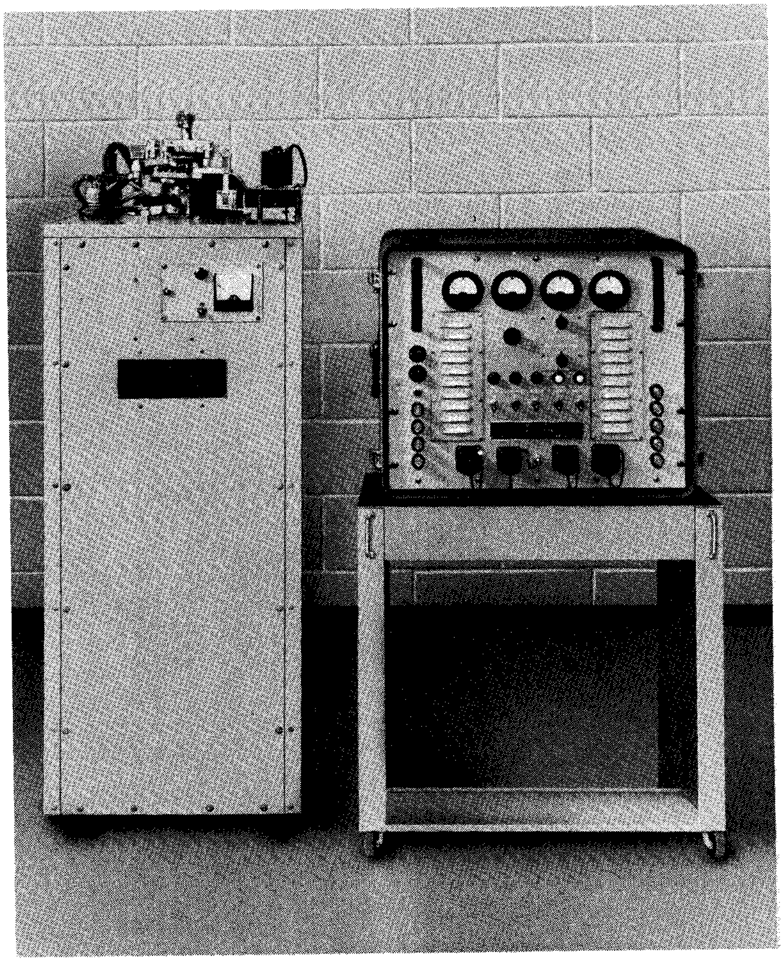

FIGURE 1. PHOTOGRAPH OF OVERALL TRAVELING-WAVE-MASER SYSTEM

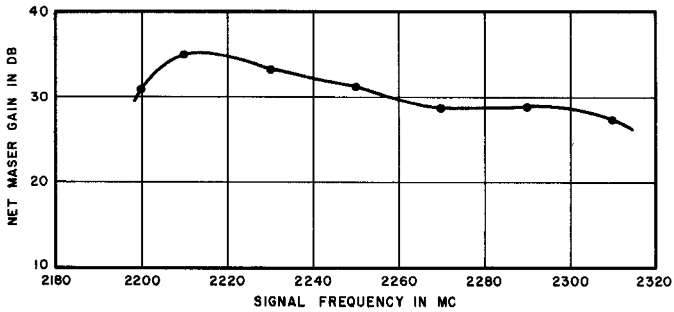

FIGURE 2. NET MASER GAIN VS OPERATING FREQUENCY MEASURED AT 4.2°K BATH TEMPERATURE

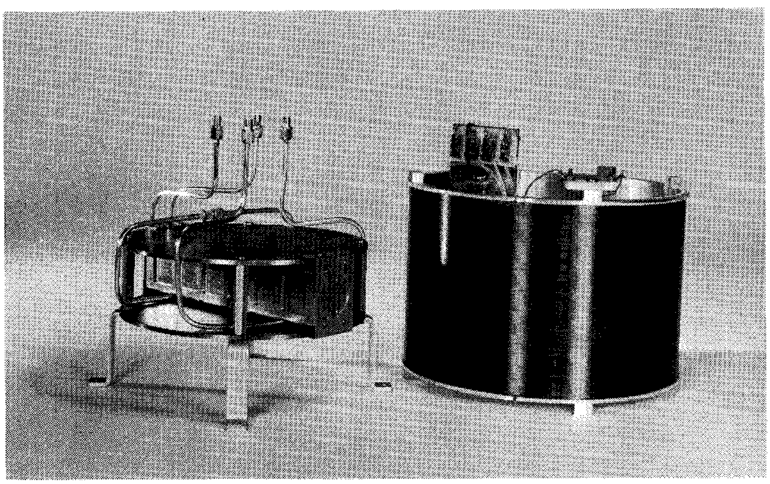

FIGURE 3. PHOTOGRAPH OF SUPERCONDUCTING SOLENOID AND TWM CONFIGURATION

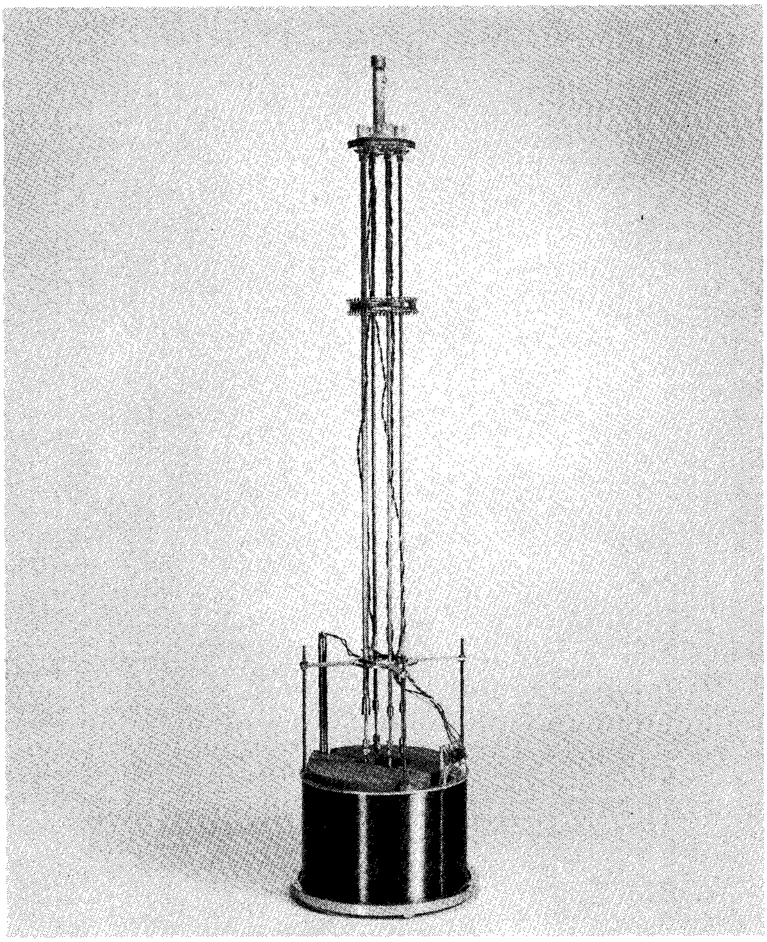

FIGURE 4. PHOTOGRAPH OF TWM SUPERSTRUCTIVE ASSEMBLY

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