VI. MOLECULAR BEAMS*

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A. CESIUM BEAM TUBE

Recent developments in the field of varactor frequency multiplication (1, 2) have led to a complete redesign of the 16.4 mc to 9192 mc multiplier.

The present multiplier design entails multiplications with the following frequencies: 16.4 mc × 4 to 65.6 mc × 2 to 131.2 mc × 5 to 656 mc × 7 to 4596 mc × 2 to 9192 mc. The multipliers from 131 mc to 9192 mc have been constructed by utilizing coaxial components with the preliminary results shown in Table VI-1. The X-band drive level of 6 mw is approximately 10 db higher than that required to drive the cesium beam tube.

Table VI-1. Results from frequency multipliers.

Frequency Range (mc)	Type	Diode	P_{in}	P_{out}	Efficiency (per cent)
131-656	Quadrupler	PSI - 115 - 10	500 mw	200 mw	40
131-656	Quadrupler	PSI - 115 - 10	1.4 w	400 mw	35
656-4596	Septupler	Experimental Diode*	400 mw	20 mw	5†
4596-9192	Doubler	MA-4298	20 mw	6 mw	33

*Microwave Associates: cutoff frequency, 80 kmc; breakdown voltage, 58 volts; C_{min} = 0.7 μμf.

†Theoretical efficiency, now unattainable, was calculated to be 20 per cent.

Construction of the low-frequency multipliers, the quadrupler from 16.4 mc to 65.6 mc, and the doubler from 65.6 mc to 131 mc is underway. When completed,

*This research was supported in part by Purchase Order DDL B-00306 with Lincoln Laboratory, a center for research operated by Massachusetts Institute of Technology with the joint support of the U. S. Army, Navy, and Air Force under Air Force Contract AF19(604)-5200.

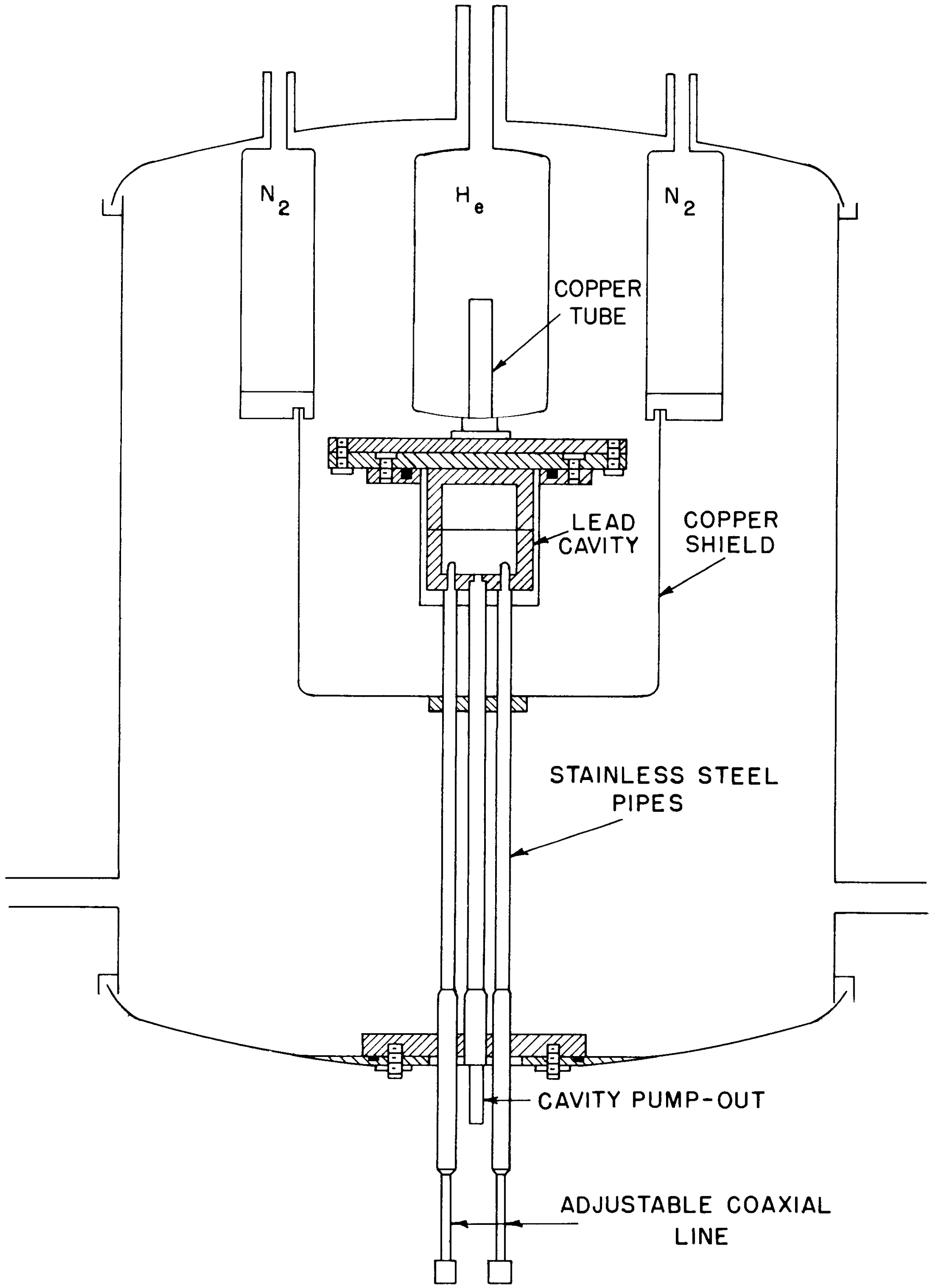

Fig. VI-1. Test system.

the chain is expected to yield approximately 5 mw of 9192-mc signal for 5-10 w of 16.4-mc signal. The chain will multiply passively by a factor of 560 with an over-all efficiency of approximately -30 db.

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References

1. B. L. Diamond, Idler Circuits in Varactor Frequency Multiplier, S. M. Thesis, Department of Electrical Engineering, M. I. T., February 1961.

2. R. P. Rafuse, Parametric Applications of Semiconductor Capacitor Diodes, Sc. D. Thesis, Department of Electrical Engineering, M. I. T., September 1960.

B. SUPERCONDUCTING LEAD CAVITY

A preliminary study was made to determine the optimum mode of operation for a superconducting cylindrical cavity. An empirical approximation for surface resistance which is valid at 3000 mc and at low temperatures is $R_s = Aw^{3/2}$. Under the assumption that Q varies inversely as R_s, the Q's of the various mode configurations for cavities of equal volume were compared. The results are:

Mode	Q
TE_{111}	Q_1
TE_{011}	$0.97Q_1$
TE_{012}	$0.70Q_1$

(The TE_{111} mode has an additional advantage of being free of parasitic modes.) As a result of these studies, the TE_{111} mode was chosen as the operating mode.

In order to make the cavity frequency insensitive to changes in the external circuit, very loose coupling into the cavity is desirable. The radial H field at a point as far as possible from the center of the cavity offers a small H field. Thus a coupling loop at that point would couple the field very lightly.

A sketch of the apparatus is shown in Fig. VI-1. A standard vacuum pump will be used to evacuate the system. After the system is made tight, the pumping action of liquid helium will be used to achieve a vacuum of 10^{-6} cm Hg.

The two outer stainless pipes will contain the input and output lines. The outer pipes will also be connected to a helium leak to maintain helium gas within the cavity. The center line is the pump-out line from the cavity to extract excess helium. The liquid helium will be delivered into the copper tube which transfers the heat from the cavity to the helium vapor.

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