HIGH-POWER MULTIPLE BEAM TWTs AND THE TWT-BASED AMPLIFYING CHAINS

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The results of development of a new class of multimode high-power vacuum devices, named multiple beam TWTs (MBTWTs), and based on their amplifying chains are presented. Technical and technological aspects of their fabrication are considered. The example of such TWT designed for 3-cm wave-length range, pulsed output power of 5 kW and amplifying chain based on it are shown.

The development of multiple beam klystrons (MBKs) in 1970s in the USSR and their high service characteristics strongly increased the demand for them from equipment designers.

The appearance of MBKs made a qualitative leap in klystron development [1], thus it appeared attractive to develop the advantages of these designs on another class of devices, viz, TWTs. However the attempts to solve this problem "straight" by direct incorporation of multiple electron beam stream into TWT did not provide commercial result due to constructional and technological complications.

To solve the problem of fabrication of production compact prototypes featuring elevated average power level of multimode amplifiers based on MBTWT the authors offered the new solution.

Constructional and functional division of a high-power multisection TWT with a focusing solenoid on two tubes, viz, a multisection single beam TWT with periodic permanent magnets (PPM) for preamplification and a multiple beam single section ("transparent") high-power TWT (Fig.1). Short length of the "transparent" tube allowed to distribute the fabrication principles and the assimilated electronic industry precision production technology of MBK on TWTs.

Incorporation of the multiple electron beam stream made it possible to implement a somewhat different mechanism of its interaction with the short electrodynamic system. Intensive EM-field at the input of electrodynamic system forms and accompanies highly admittance electron bunches, that causes the 1.5 time increase of electronic efficiency of MBTWT as compared to the single beam device. Short length of MBTWT allowed its packaging into a permanent magnet that improved current transmission and output power characteristics as compared to conventional PPMTWT.

MBTWT is attractive as a multimode tube. TWO versions of output power variation are implemented in it. The first version is a programme variation of output power by means of programme variation of the electronoptical system current. A peculiar feature of the MBTWT is essentially linear dependence of its output power within the current variation limits from 0.3 I_o to I_o (Fig.2). The tube efficiency remains essentially constant for such current variations. Unlike the well-known two-mode TWTs [2] in this case power variation field is implemented. The second version of output power variation is based on switch on and off the MBTWT. In the latter case tube operates as a waveguide system with low attenuation (0.5 dB) and the amplifier output power is a function of preliminary stage power (Fig.3).

The MBTWT structure is based on the constructional approaches and production technology of MBKs, packaged in permanent magnets. Primarily it is related with the development of 32-beam electronoptical system with grid control. Some interest is a slow-wave structure of the tube of

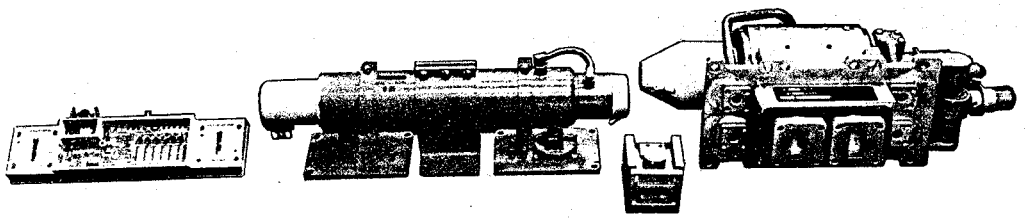

Fig.1. The amplifying chain with the MBTWT.

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coupled cavity chain type, that includes additional absorbing cavities to provide suppression of spurious oscillations. Magnetic focusing system consists of two radially magnetized $SmCo_5$ discs.

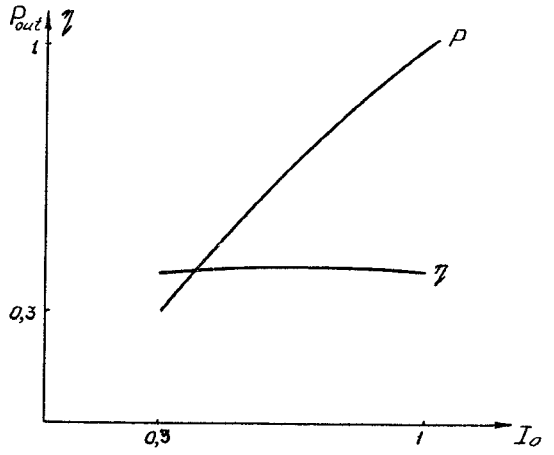

Fig.2. The variation of output power (P_{out}) and efficiency (η) as function of a MB stream current.

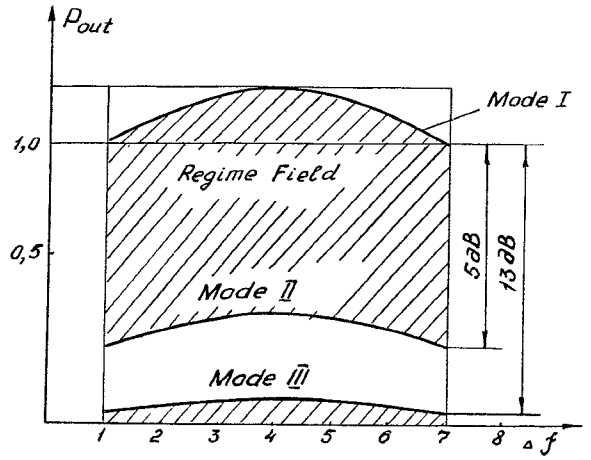

Fig.3. The power variation as function of a work mode of MBTWT.

Thus the idea realization of distribution of creation principles of packaged in permanent magnet MBK on a "transparent" TWT and the division of a multisection TWT on two equal voltage tubes, the voltage being equal to that of an output MBTWT, had a qualitative effect in two aspects:

1. The problem of creation of production multimode chain with MBTWT was first solved.
2. The problem of replacement a focusing solenoid in a high-power 3-cm range TWT on permanent magnet systems in tubes of amplifying chain was solved.

Sometimes a transistor amplifier can be incorporated into the set for increasing the chain gain. All the microwave elements of the chain are interconsistent on regimes and electrical parameters. The constructional implementation of the typical TWT chain can be realized as a single hermetic microwave module with secondary power supplies and modulators.

The example of the 32-beam 3-cm range MBTWT and based on it amplifying chain is given in table I.

Table I

Typical parameters of 3-cm range MBTWT and based on it amplifying chain.

	MBTWT	Amplifying chain
Bandwidth (GHz)	0.6	0.6
Minimum pulse output power (kW)		
Mode I	5	5
Mode II	1.5	1.5
Mode III	-	0.25
Gain (dB)	13	60
Voltage (kV)	8	8
Weight (kg)	4.5	6.8
Focusing	PM	PM+PPM
Modulation	Control grid	Control grid

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2. Herriot R.W., Advances in airborne radar TWTs assure their continued role, Microwave Systems News, 1984, v.14, n. 8, pp.41-49.