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MODULATOR FOR KLYSTRON 5045

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Abstract

The ®rst modulator for a forinjector klystron of VEPP ± 5 is being tested now in BINP in Novosibirsk. The forinjector of VEPP ± 5 will involve a 510 MeV Linac consisting of four accelerating modules. The Klystron 5045 manufactured at SLAC [1] was chosen to drive the accelerating modules. This paper presents a design and some testing results of this modulator.

I. INTRODUCTION

The modulator is a conventional line type modulator with some supplementary characteristics. A simpli®ed electrical layout of this modulator is shown in Fig. 3. The voltage value in a ®lter capacitor C_F is determined by a phase-control system with six SCRs. The C_F charging current is limited by three 500μH inductors connected to the primary winding of the recti®er transformer. In addition, this system provides ºsoft-startº capability and fast protection. The PFN is resonantly charged through a charging high-voltage SCR-switch (HV-switch), a charging inductor, and de-spiking circuits. The resonant PFN charge goes only after starting the HV-switch. A de-Qing system provides precise setting of the PFN voltage by stopping the charge when a required voltage is reached. When the thyratron is ®red, the PFN is discharged through a coaxial cable to the klystron pulse transformer or to the load resistor. The 1:15 pulse transformer delivers a 350 kV pulse to the cathode of the klystron. The thyratrons TGI-2500/50 are used in the modulator. Output pulse waveform at the Klystron 5045 shown in Fig. 1 was obtained in the process of modulator adjustment.

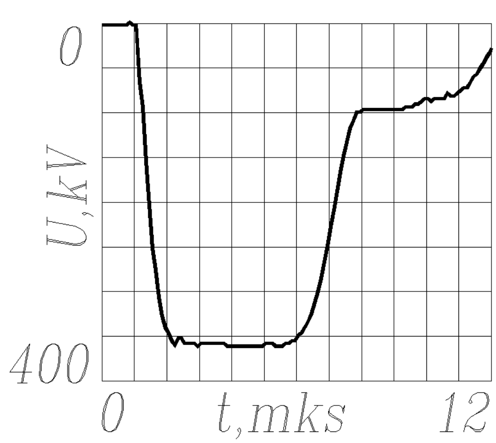

Figure 1. Output pulse waveform

The position of the main modulator components and the Klystron 5045 is shown in Fig. 4. The main elements shown in Fig. 3 are installed in a common cabinet. The control and measurement elements, low-power supply sources, and the CAMAC - facility are placed in two racks in front of the cabinet. The cabinet with a line-operated facilily is also placed in front of the main cabinet between the two racks. To make the service convenient, the racks can be rotated as shown in Fig.4. The photo in Fig. 5 shows a view of the modulator.

The main characteristics are presented in Table 1.

Table 1. Modulator speci®cation

Parameter	Required	Tested
Peak output power	150MW	150MW
Peak output voltage	23.5kV	5 to 22.5kV
Pulse width	5μS	5μS
Flat-top width (tol.$\pm$0.5%)	4muS	3.5μS
Repetition rate	50pps	0 to 50pps
Peak klystron voltage	350kV	360kV
Peak RF power	67MW	60MW

A. *Rectifier assembly*

The recti®er assembly designed earlier [2] consists of 18 1.5 kV sections connected in series and placed on the common core. Each section is protected with fuses; that's why if one or two of them would fail, it would not be necessary to take off and repair the whole recti®er.

II. High voltage switch

A high-voltage charging commutator consisting of 64 thyristors connected in series makes possible to charge the PFN immediately before pulse generating. In addition, such commutator is a convenient and reliable protection element. It allows us also to change the repetition rate 0 to 50 pps. To turn on simultaneously 64 thyristors, the circuit shown in Fig.2 is used.

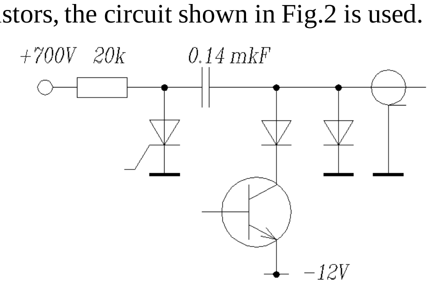

Figure 2. Control HV-SCR circuit

The capacitor and thyristor form a 2 μS leading edge of the HV-switch control pulse, then a 1 mS ¯at-top is formed by the transistor switching-on. The control pulse current is more than 0.1 A. To suppress unwanted oscillation of the charging circuit, the special measures are undertaken. After the charging current has stopped, the de-Qing thyristor is kept in the ON-state till the oscillation caused by the thyratron switching dies down.

III. Pulse Forming Network

The modulator comprises two PFNs in parallel. Each of them consists of 13 sections with a ®xed capacitor and a tunable inductor. It is placed in an oil-®lled tank. The total characteristic impedance of each PFN is 8Ω. The inductors may be regulated from the outside of the tank.

IV. EOLC system

EOLC system comprising a diode and a resistor is used to remove the excessive negative voltage swing and to protect the klystron in the case of a break-down. The EOLC diode is composed of 60 recti®ering elements connected is series and alternating with washers used as radiators with forced air cooling. A small size of diode assembly (total length is 370 mm) provides low inductance of EOLC.

V. Dummy load

The dummy load with the characteristic impedance 4Ω is designed and installed to test the modulator without the klystron in a required range of output power. The dummy load is composed of 8 high-voltage resistors S5 ± 41 connected in parallel. The introduction of water cooling allows us to raise the dissipated power of the load from 4 kW to 40 kW.

VI. Conclusion

Since the modulator is rigged with computer control and measurement, the protection system, the dummy load, and with a wide range of working voltage and repetition rate, it is possible to use it as the stand for testing and studying of both the modulator components and klystrons.

References

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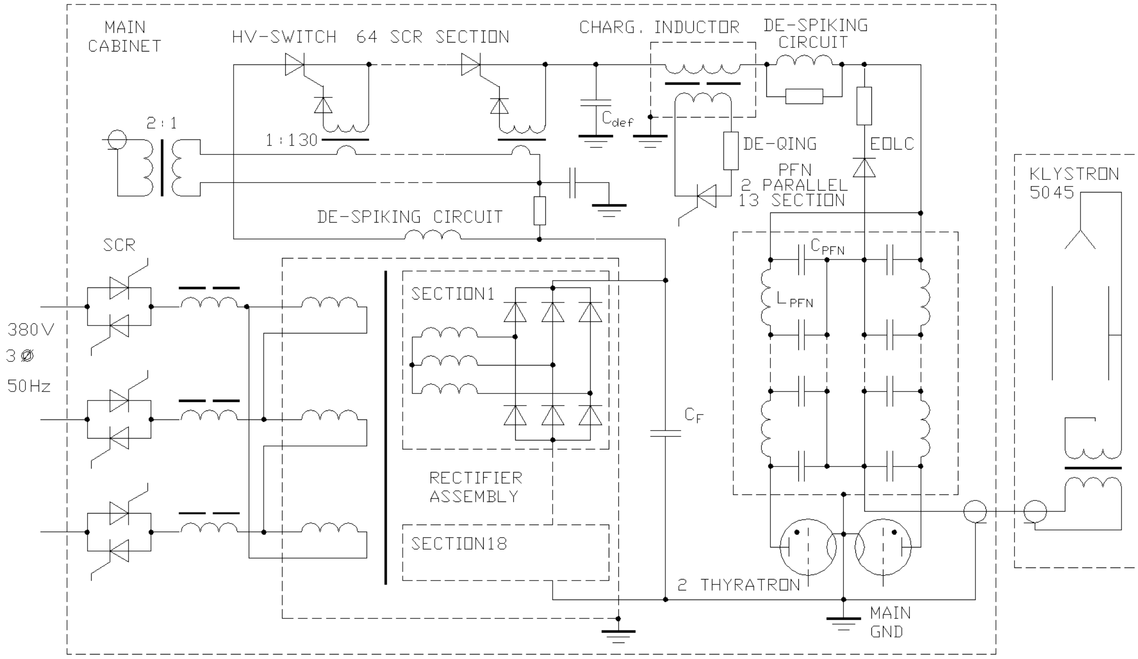

Figure 3. Simpli®ed electrical layout of the modulator

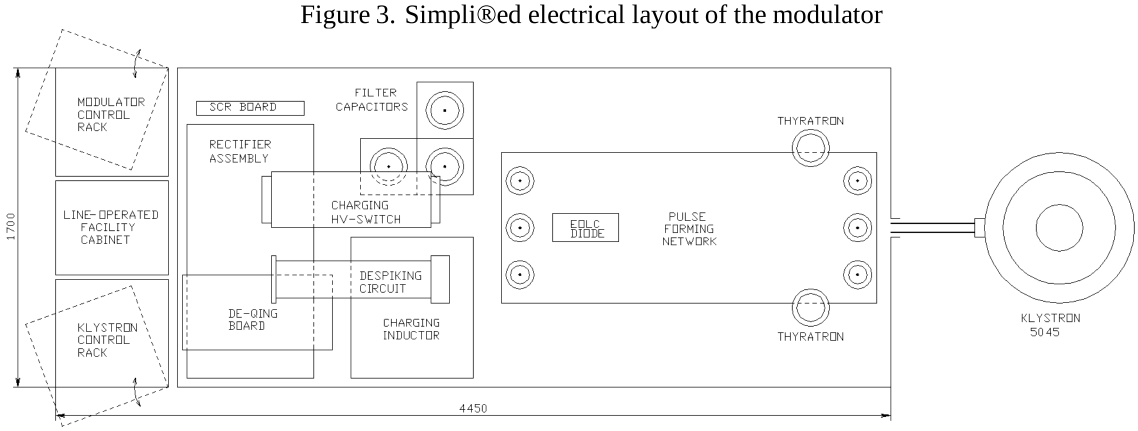

Figure 4. Position of the main components in the cabinet (sizes are in mm).

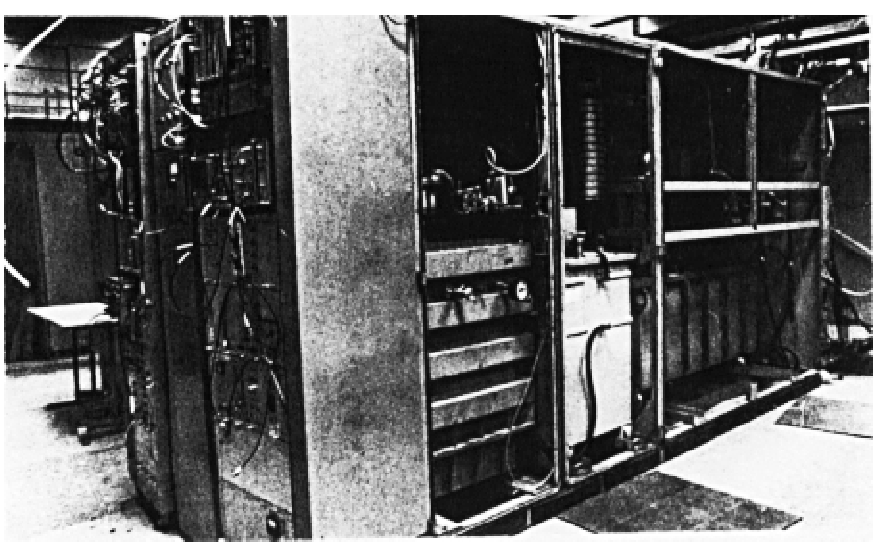

Figure 5. View of the modulator