150 kV MAGNETIC PULSE COMPRESSOR

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Abstract

The generator is based on a magnetic pulse compression circuit, its repetition rate is one pulse per some minutes. The generator consists of a thyratron switch, a resonant transformer (1:7 step up), a storage capacitor, a water-filled pulse-forming line and two saturable magnetic switches from amorphous alloy with a high induction of saturation, a high ratio B_r/B_s and a high resistance of the insulation. A special attention has been paid to the reliability of the installation.

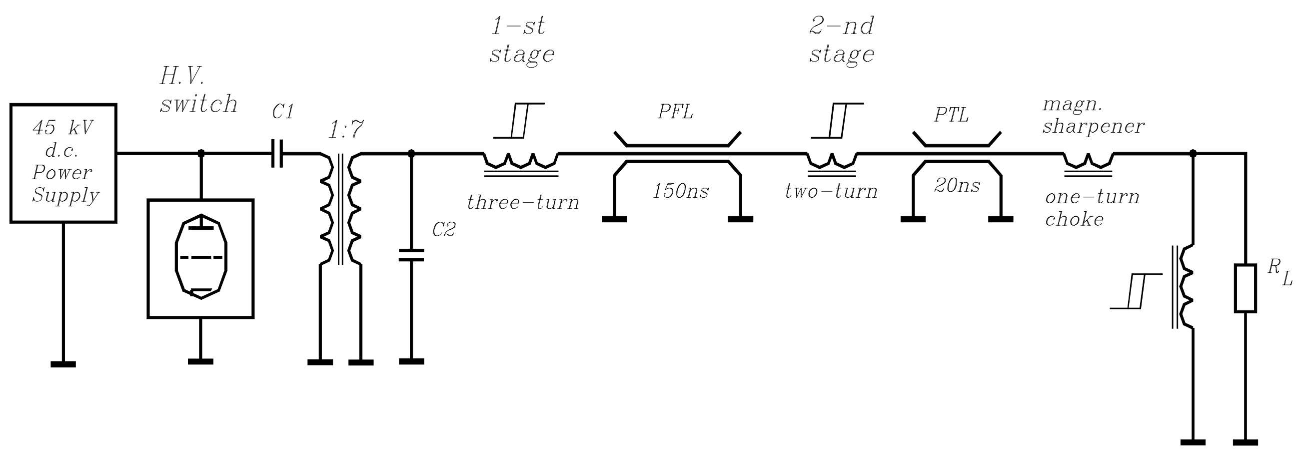
1 GENERATOR DESIGN

The high voltage, high power (6.0×10^9 W) generator with 150 ns duration of the pulse was designed. This generator can be used with low impedance devices. Many applications such as start circuits of high-voltage discharge and high current electron injectors, etc. require a generator with these parameters. The general parameters of the generator are:

Output voltage	150 kV
Output impedance	4 Ohm
Output pulse duration	150 ns
Build-up time	20...30 ns
Pulsed-oscillator starting time (jitter)	5...10 ns
Repetition rate	1 pulse/s

The generator is created under the traditional scheme with a magnetic compression [1]. It consists of a water-filled pulse forming line (PFL), a two stage pulse compressor, capacitor stores, a switch and a step-up transformer. The two stage compressor is placed in two oil-filled tanks. The generator is shown in Fig. 1 and its design is shown in Fig. 2.

Figure: 1 The generator.



Fgure: 2 The generator design.

The generator is based on a two-cycle scheme of demagnetization of switching magnet ferromagnetic cores and a step-up transformer [2]. This scheme of demagnetization allows to reduce corporeal consumption.

The current of demagnetization is formed by a passive LC network and two pulses of different polarity are obtained. The first current pulse serves to demagnetize the cores switching magnets of pulse compressors, the second pulse

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serves to demagnetize the core of the step-up transformer. The low-voltage connection of the secondary winding is used for the demagnetization current supply. The switching on of the generator occurs at a certain time, when the process of demagnetization of the step-up transformer core comes to the end. The demagnetization device is placed in a special box.

The generator is operated in the following way. The controlled up to 45 kV DC voltage source charges the primary store C_1 (1.2mkF, 50 kV). The primary switch is a hydrogen thyratron. The critical pulse current for the thyratron switch, the primary store and the step-up transformer is more than 20 kA. The hydrogen thyratron operates in the regime with a grounding control grid [2]. In this regime the thyratron cathode is used for running the primary switch rather than for current producing. As a result the critical pulse current of the thyratron increases considerably. JINR's investigation of TGI-2500/50 thyratron operating regime exposed its high reliability in the regime with a grounding control grid. It seems to be provided by the effective water-cooling of the anode and grid and pumping of the emitted gas after each pulse of the generator.

The secondary store C2 (0.02 mkF) is a low-inductance high current capacitor of a special design. It is charged up to (300-320) kV in 1.6 mks by the step-up transformer. The design cross section of the three-turn switching magnet core in the first stage pulse compressor is 290 cm^2 and its weight is 200 kg. The permissible discharge current of the secondary store C2 determined by the connector design is 30 kA. The store C2 is discharged through the magnetic switch of the primary stage pulse compressor.

The C2 store being discharged in 0.45 mks through the saturated switch of the first compression stage, charges a forming water-filled line up to (300-320) kV. The water line charging time has been chosen to match the triple duration of forming pulse. The deionized water resistance can be no more than 200...300 kOhm×cm, it simplifies the demands for water supply system. The water line discharging current (of about 37 kA) flows through the short transmission line (20 ns) into a sharper after the second magnetic switch flipping and then into the load. The sharper is not used now. The load consists of several low-inductance bulk TVO-60 resistors. A one-turn magnetic switch can be used in the second compression stage but a two-turn switch is much lighter and cheaper. With a two-turn switch, the built-up time and the pulse droop slightly rise. The designed cross-section is 118 cm^2 and its weight is 87 kg. We expect to have the built-up time of 20-30 ns by the use of the sharper. In adjusting the generator load was shunted by a saturatable one-turn switch with the projected flipping time of above 150 ns. Including the switch cuts the output pulse built-up time.

Permalloy and amorphous alloy cores manufactured using special technology are used in generator switches. This technology was developed especially for amorphous alloy ribbon and it allows to achieve the squareness ratio coefficient more than 0.9, the saturation induction of above 1.45 T and the pack factor coefficient above 0.7 [3]. We could not complete generator adjusting without construction redesigning because of the break-down of the capacitor battery C1 bushing. Then, there was a high concentration of water in the oil. The vacuum desicciation was uneffective due to the low temperature at the production area. We are going to carry out additional desicciation procedures and oil warming.

To provide adjusting and reparing of the generator some capacitor voltage dividers were installed:

at the primary winding of the step-up transformer;
at the secondary winding of the step-up transformer;
at forming line unput and output;
at the generator output.

Two transformers for current measuring were also installed at forming line input and output.

REFERENCES

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