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PULSE GENERATORS FOR PUMPING LOW–PRESSURE NITROGEN LASERS AT PULSE REPETITION RATES UP TO 10 KHZ

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Effective excitation of nitrogen molecules in nitrogen lasers is carried out by direct electron impact at the breakdown stage [1,2]. For industrially produced nitrogen lasers with a discharge channel length of 350–500 mm, the breakdown voltage reaches 100 kV. In this case, the duration of the leading edge of voltage pulses does not exceed 100–120 nanoseconds.

At pulse repetition rates of units and tens of hertz, the formation of such pumping pulses is not very difficult. However, with an increase in the pulse repetition rate to 1 kHz or more, the formation of high–voltage pulses with the above parameters becomes a difficult task.

This work is devoted to the design of compact pulse generators for pumping low–pressure nitrogen lasers and their application for efficient energy input into the gas–discharge gap at the breakdown stage at pulse repetition rates up to 10 kHz.

Low–inductance pulse transformers were chosen as pulse generators. Such choice was due to the simplicity of design, compactness and the possibility of using only one high–current switch.

The following types of pulse transformers have been designed and tested:

– "traditional", in which the turns of the primary winding fit between the turns of the secondary winding. High–voltage wires of the VZM–04 brand with insulation from fluoroplastic tapes and electrical strength up to 20 kV were used as conductors. After their impregnation with transformer oil, the electrical strength increases up to 50 kV;

– "single-turn" [3]. In this version of the transformer, the primary and secondary windings were made of copper strips. The primary winding is one continuous turn, open in the upper part of the magnetic circuit;

– "cable" [4, 5]. The primary windings were segments of the outer sheath of the cable, the secondary winding was the central wire.

In all these pulse transformers, closed magnetic cores made of ferrite rings of the M1000NN brand (125x80x12 mm) were used. To determine the effect of overvoltage on the magnitude of the pumping discharge current and the energy introduced into the gas–discharge gap at the breakdown stage, multi–gap spark gap of the R–30M1 type operating at pulse repetition rates up to 5 kHz were connected in series with high–voltage outputs.

The results of the work carried out showed the following:

1. "Cable" pulse transformers provide the minimum duration of the leading edge of voltage pulses $\tau \approx 40$ nanoseconds and the current value in the gas–discharge gap of 1 kA at duration of ≈ 20–22 nanoseconds.

2. "Traditional" and "one–turn" pulse transformers make it possible to form high–voltage pulses with a leading edge duration of up to 50 nanoseconds and to pass currents up to 800 A through the discharge tube in 20–25 nanoseconds.

3. The use of multi–section spark gaps makes it possible to increase the breakdown voltage of the gas–discharge tube by ≈10 kV and provide the discharge current at a level of 1.2–1.4 kA. The duration of the discharge current at half maximum is 18–20 nanoseconds.

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