THYRATRON HEATING STABILIZATION UNIT USED IN PULSE–PERIODIC LASERS

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A hydrogen thyratron heating stabilization unit build around a voltage convertor without input transformer has been described. Instability of a given load voltage is 1.5% *for* 10% *voltage pulsations in the supply line* 220 V/50 Hz. *The unit can be used in power supply units of pulse–periodic lasers applied to solve different problems in atmospheric optics, navigation, medicine, and other fields.*

At the present time, thyratrons and oscillating tubes are used as commutation switches in various pulsed laser systems[1–3] for generation of pulses pumping an active medium, in particular, in metal vapor lasers. The rated heating instability of such commutation switches should be less than 5%, whereas voltage pulsations in the supply line 220 V/50 Hz reach 10% in most instances. This leads to essential decrease of lifetime of the commutation switches as well as to maloperation of laser system as a whole. So, for example, in copper vapor lasers even small pulsations of heating voltage on a hydrogen generator engender qualitative changes of the parameters of light pulse.

To eliminate the influence of voltage pulsations in power supply line on a load, we have developed a thyratron heating stabilization unit. Its basic circuit is shown in Fig. 1. It is built around a single–cycle converter with choke circuits of alternating magnetization of a power transformer.[4] To increase the blocking rate of a power key, a circuit with interruption of an emitter circuit was used. A simple control circuit built around the special–purpose KR1114EU4 chip provides protection against short circuits in the load and switching on the converter without special power supply unit. The power circuit design embodying the principle of a single–cycle converter eliminates such undesirable phenomena as asymmetrical magnetization of the transformer and occurence of through currents that are characteristic of double–cycle circuit. At the same time, the power transformer is operated on a double magnetic cycle. Thus, our circuit combines advantages of single–cycle and double–cycle converters.

The power key *VT*1 is connected in the circuit with interruption of the emitter circuit. This results in the sharp decrease of losses due to switching off and the increase of the converter frequency up to 40 kHz with the use of relatively low–frequency transistor. Coils of the transformers *T*1 and *T*2 are connected in the *VT*1 collector circuit. When the transistors *VT*1 and *VT*2 are on, the coils *1–2* of *T*1 and *3–4* of *T*2 as well as *3–4* of *T*1 and *1–2* of *T*2 are connected in series. In a stationary regime, the voltage on each of these coils is equal to half the output voltage on a line rectifier. When the transistors *VT*1 and *VT*2 are off, the coils *1–2* and *3–4* of *T*1 and *T*2 are connected in parallel with interposition of the diode *VD*3. The voltage on them changes its sign, and the energy accumulated in transreactor is given to the load. Simultaneously, remagnetization of the core *T*1 occures. The voltage on the *VT*1 is equal to twice the supply voltage at that instant. Remagnetization of the core *T*1 ends in its saturation. The stray capacitors *T*1 and *T*2, charged to twice the supply voltage, recharge fast through the small magnetization inductance of the saturated transistor *T*1. The voltage on the collector of the off transistor *VT*1 drops to the value less than the supply voltage. At that moment, a pulse is generated which unblanks the transistors *VT*1 and *VT*2. Further, processes are repeated.

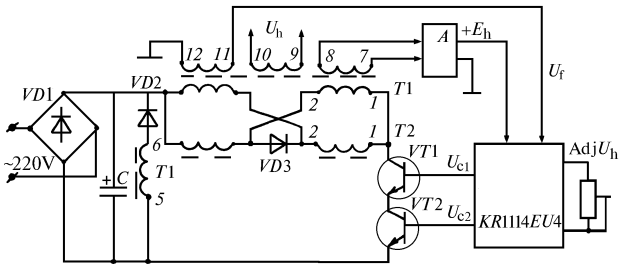

FIG. 1. Circuit for stabilization of heating voltage U_h *on the* TGI1 - 2500/50 *hydrogen thyratron generator.*

Unblanking of the transistor *VT*1 with low collector voltage decreases significantly additional losses due to switching on caused by recharging of the above–mentioned stray capacitor through the power key. A voltage spike on *VT*1 at the instant of its switching off is limited by the recuperating coil *5–6* of *T*1. The coil *7–8* of *T*1 provides power supply of the control circuit in a stationary regime.

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The multipurpose KR1114EU4 chip, which controls pulsed sources of secondary power supply circuit, is also connected in the control circuit. It operates when the input voltage changes from 7 to 40 V, allows us to regulate the commutation frequency up to 200 kHz, and provides the output current up to 200 mA. When external condenser is connected, a regime of "smooth switching" can be provided. In this case, the voltage on output terminals increases smoothly when the source is switched on. Frequency may be tuned within 50% of the cycle duration with the help of external resistor.

A feedback signal is fed into the KR1114EU4 input (the amplifier of mismatch signal). As it increases, the duration of the "on" mode of the power transistor is reduced, and hence the output voltage is stabilized. Analogously, the thyratron heating current can be stabilized when a current feedback signal is picked.

The unit was used for stabilization of heating voltage on the TGI1–2500/50 hydrogen thyratron generator of a copper vapor laser. With no change, it also can be used for heating supply of the TGI1–1000/50 hydrogen thyratron generator. Using the circuit design described above and higher–power elements, one can develop stabilized heating supply voltage on cathodes in hydrogen thyratrons where currents reach several tens of amperes.

In Fig. 2, the dependence of output voltage on the supply voltage is shown. It is seen from this figure that voltage on the load deviates by 0.1 V from its rated value when the input voltage varies from 195 to 250 V. Thus, the unit provides stability of output voltage within 1.5% of its rated value. In most cases, it is sufficient.

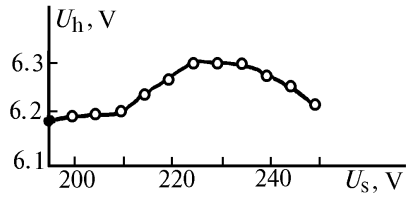

FIG. 2. Dependence of heating voltage U_h on the TGI1 2500/50 hydrogen thyratron generator on the supply voltage U_s.

The unit differs from previously known ones by:

a) absence of power transformer operating at a frequency of 50 Hz and having large overall dimensions and mass;

b) high degree of output voltage stabilization with minimum possible number of circuit elements;

c) absence of auxiliary transformer to supply the unit itself.

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