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N_2 laser tube transversal gas recirculation

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Nitrogen laser tube with transversal gas recirculation is described. It is shown that such a system gives the increase of the laser output power.

Nitrogen lasers are widely used as convenient high power sources of ultraviolet radiation. Due to their high power, simple construction and relatively low cost they are very popular in optics laboratories.

In such a laser a simple circular cross-section tube or a tube with a narrow rectangular cross-section can be used.

The circular tube allows to obtain high peak power of the laser pulse, but the obtainable repetition rate is rather low ($\sim$ 50 Hz). The rectangular tube can work up to several hundreds pulses per sec but the pulse energy is lower than that of the circular tube [1]. One can obtain higher repetition rate in the former case using high speed nitrogen flow through the tube. This results, however, in high nitrogen consumption [2]. The consumption can be decreased using gas recirculation system. The most efficient transversal gas flow arrangement has been studied previously in CO_2 lasers [3].

In this paper a construction of nitrogen laser tube with internal recirculation gas system is described.

Electrical design of the laser is similar to that of Woodward et al. [1], with 60 nF storage capacity and 0.2 Ω transmission line. Construction of the laser tube is shown in fig. 1. Its characteristic dimensions are: length — 130 cm, diameter — 30 cm, distance between electrodes — 2.5 cm.

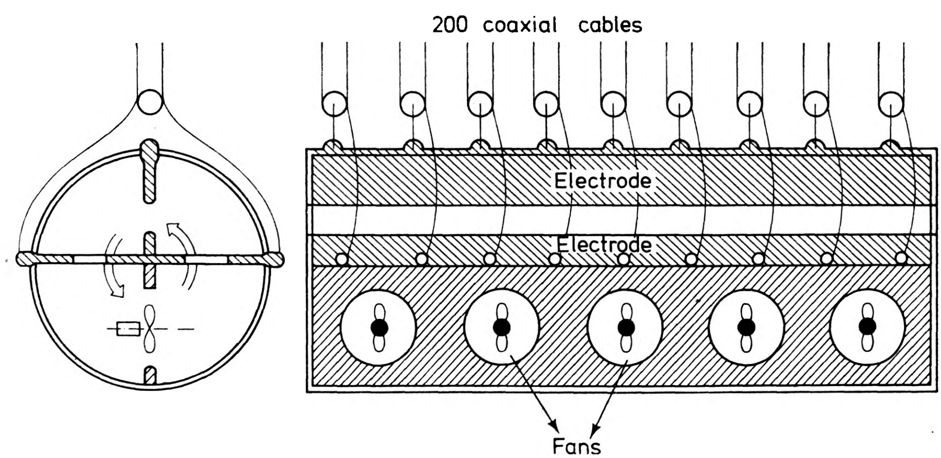

Fig. 1. Laser tube construction: a — transversal cross-section, b — longitudinal cross-section of the laser tube

Nitrogen gas is recirculated by means of five mini fans with propeller of the diameter of 10 cm. In such a configuration one can obtain high gas flow velocity with a small pressure drop across the system. The gas flow velocity between laser electrodes was found to be about 15 m/s (depending on N_2 pressure).

We have been able to vary the repetition rate of the laser from singular pulses to 250 Hz. The repetition rate was limited by the maximum mean current of the power supply (150 mA). Fig. 2 shows the dependence of the average laser output power on

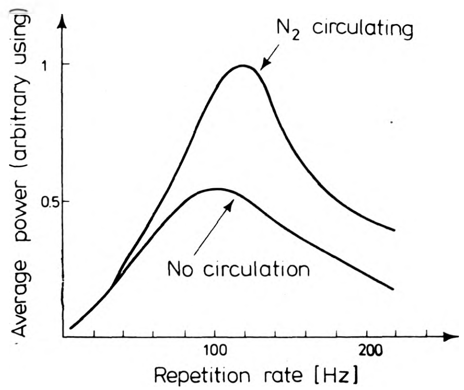

Fig. 2. Average output power vs. repetition rate

the repetition rate with and without N_2 circulation, respectively. As it can be seen the circulation results in the increase of the average power by the factor 1.5 or even higher (at higher frequencies).

Fig. 3 shows the dependence of peak power on laser repetition rate. It is worth to note that the repetition rate corresponding to the maximum peak power is higher than 100 Hz. This value is much higher than in typical circular tube arrangements.

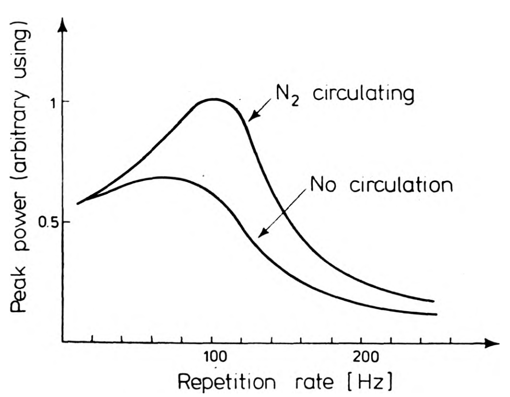

Fig. 3. Peak power vs. repetition rate. Arbitraty unit equals circa 300 kW. Output power was not too high because of relatively high wave resistance of charging cables

Certain additional increase of the power ($\sim$30%) can be obtained by adding triethylamine to nitrogen gas. The effect was, however, observed only in very narrow region of triethylamine partial pressure. The rising of pressure over its optimum value results in a rapid drop of laser power.

It can be stated that the power can be increased alternatively by increasing the energy applied to the laser tube. To this end, however, the supply voltage and/or storage capacity should be increased and the wave resistance decreased, which is much more complicated. All simpler methods seem be to valuable.

References

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Азотный лазер с поперечным течением газа в канале разряда

В работе описан азотный лазер с поперечным течением газа в канале разряда. Показано, что такое решение увеличивает выходную мощность лазера.