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# Influence of some cavity parameters on the experimental performance of nitrogen lasers

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Performance characteristics of nitrogen lasers depend on various discharge cavity parameters. This work reports the influence of some cavity parameters such as electrode shape, length and configuration on the experimental performance characteristics of transversely excited nitrogen lasers.

## Introduction

Starting with Leonard and Gerry [1, 2] constructions employing superradiant $C^3\Pi_u - G^3\Pi_g$ transition in $N_2$ discovered by Heard [3] various versions of transversely excited nitrogen lasers have been successfully developed and improved. The performance achieved (pulse power, duration time and shape) strongly depends on various cavity parameters.

In this work we report on the influence of some cavity parameters such as electrode shape, length and configuration on the pressure and voltage experimental characteristics of the transversely excited nitrogen laser.

## Description of the laser construction

Figure 1 shows the cross-section of the laser channel which is similar to that described by Shank and Metcalf [4]. Dumping capacitors (470 pF ranging in number from 10 to 40) are mounted in two parallel rows along

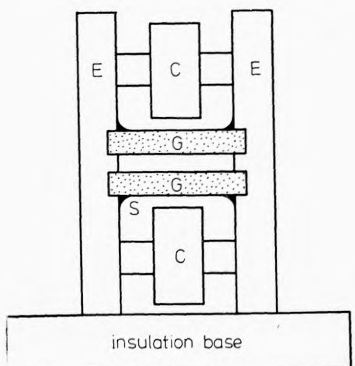


Fig. 1. Cross-section of the laser channel:
$E$ – aluminium electrodes, $C$ – dumping capacitors, $G$ – glass plates, $S$ – seal

the electrodes. The ends of the channel are sealed off by quartz windows with RTV-102 General Electric seal.

A total reflection flat mirror is placed behind one of the windows.

A schematic diagram of the high voltage triggering circuitry is given in fig 2. Low inductance storage capacitor (9 nF) is charged through a resistor (200 k$\Omega$) from a regulated 20 kV power supply. As a switch

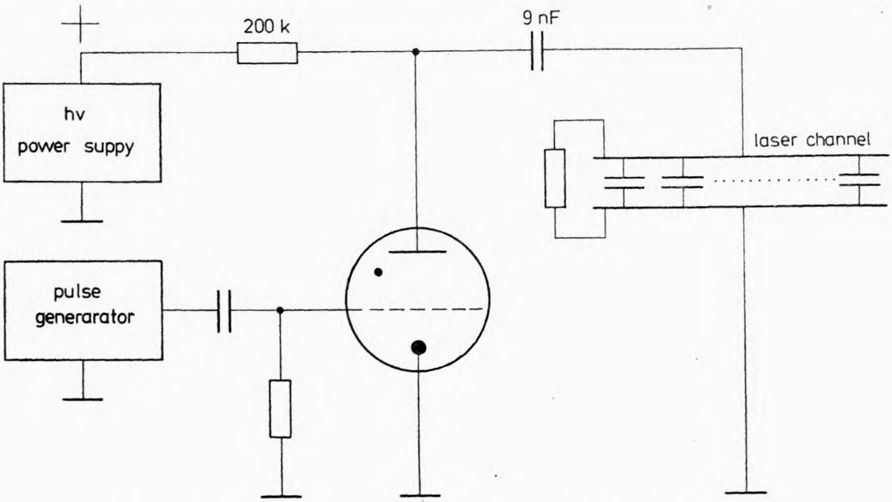


Fig. 2. A schematic diagram of the h.v. triggering circuitry

for the h.v. triggering we use TG I 400/16 (USSR) hydrogen thyratron. A generator with the repetition rate 1 to 30 Hz serves the pulses for thyratron grid. All the connections are made as short as possible to minimize the inductance of the circuitry.

## Experimental performance

The experiments were made to find the influence of cavity design on the laser pulse power characteristics and pulse duration time.

A relative output power as a function of nitrogen pressure and charging voltage was measured with the 1P28 (RCA) photomultiplier and a sensitive galvanometer. The pulse shape was monitored using ITL photomultiplier and a fast oscilloscope (OS 150 ZRK Kasprzak) with PB 110 plug-in sampling unit).

The experiments were made for various lasing lengths, electrode spacings and shapes of one of the electrodes. Two different polarities of the electrodes were taken into account in measurements.

All tested constructions are mentioned in table which also guides to a figure number of an appropriate pressure and voltage performance characteristic.

List of laser constructions tested in this work

| Lasing length $L$ [cm] | Electrode spacing $d$ [mm] | Electrode shape | Polarity of "non-flat" electrode | Characteristics figure number |
|---|---|---|---|---|
| 120 | 37 | saw-blade | — | 3 |
| | | | + | 4 |
| 60 | 37 | saw-blade | — | 5 |
| | | | + | 6 |
| 30 | 37 | saw-blade | — | 7 |
| | | | + | 8 |
| 30 | 18 | saw-blade | — | 9 |
| | | | + | 10 |
| 30 | 9 | saw-blade | — | 11 |
| | | | + | 12 |
| 45 | 38 | rasp | — | 13 |
| | | | + | 14 |
| 50 | 10 | Rogowski profiles* | | 15 |
| 62 | 26 | needles | — | 16 |
| | | | + | 17 |

* for „Rogowski" profiles (see [5])

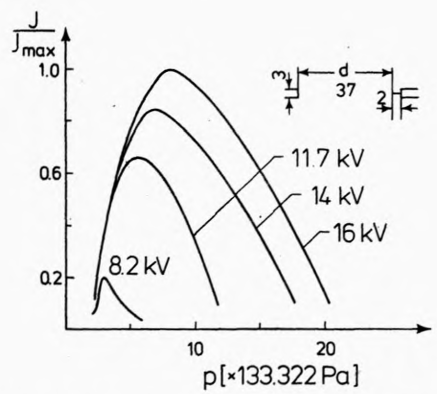


Fig. 3. Laser pulse power as a function of nitrogen pressure for various charging voltages

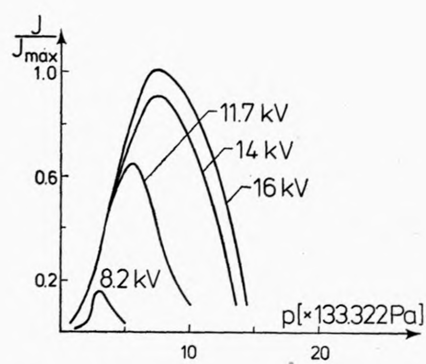


Fig. 4. Laser pulse power as a function of nitrogen pressure for various charging voltages

As can be seen the laser performance characteristics depend on the cavity design. For Rogowski profiles and "needles" the characteristics are extended towards the higher pressures of nitrogen. That is mainly due to more homogeneous discharge in the lasing volume. The maxima for Rogowski profiles are flat in a wide range of nitrogen pressures which results in operation stability of the laser. Shorter cavity lengths and electrode spacings also result in extended pressure characteristics of the pulse output power (fig. 18). The polarity of the electrodes has an influence

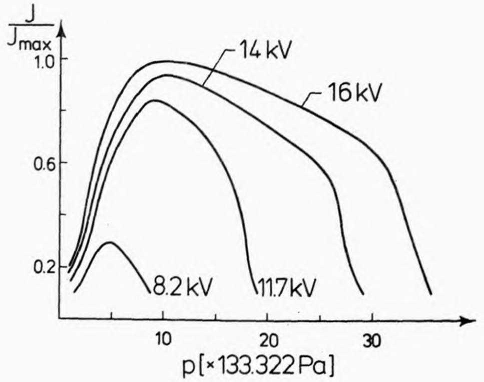


Fig. 5. Laser pulse power as a function of nitrogen pressure for various charging voltages

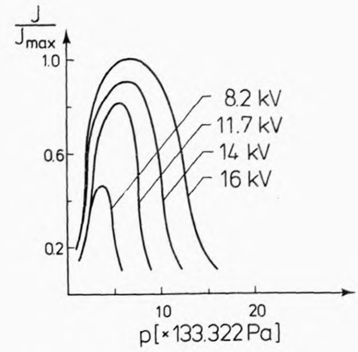


Fig. 6. Laser pulse power as a function of nitrogen pressure for various charging voltages

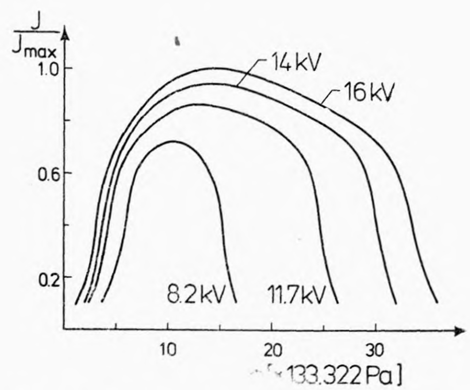


Fig. 7. Laser pulse power as a function of nitrogen pressure for various charging voltages

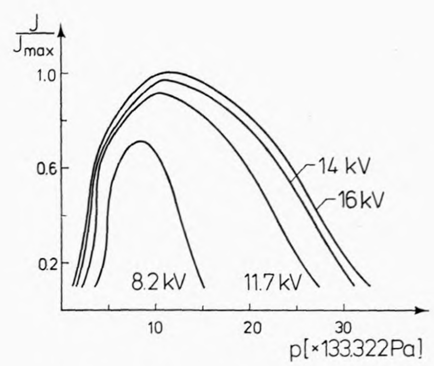


Fig. 8. Laser pulse power as a function of nitrogen pressure for various charging voltages

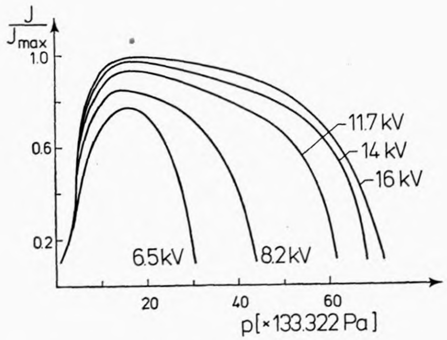


Fig. 9. Laser pulse power as a function of nitrogen pressure for various charging voltages

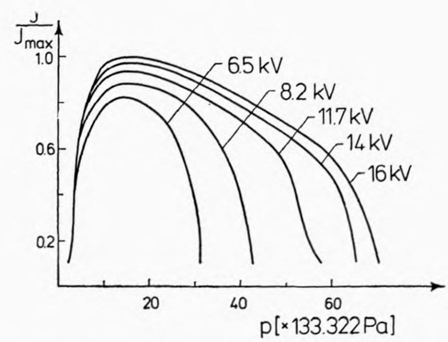


Fig. 10. Laser pulse power as a function of nitrogen pressure for various charging voltages

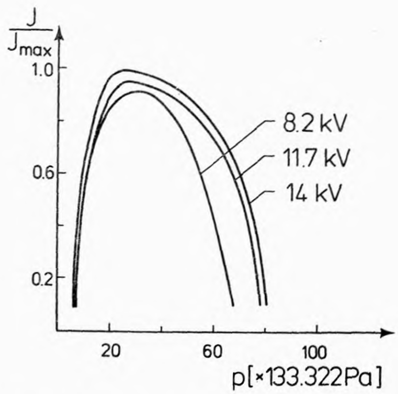


Fig. 11. Laser pulse power as a function of nitrogen pressure for various charging voltages

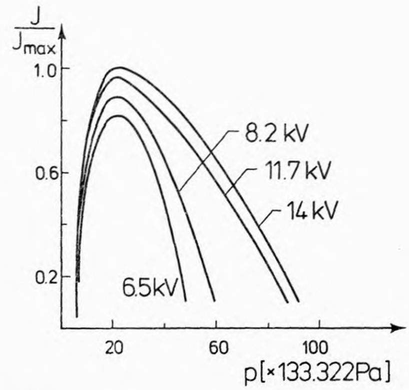


Fig. 12. Laser pulse power as a function of nitrogen pressure for various charging voltages

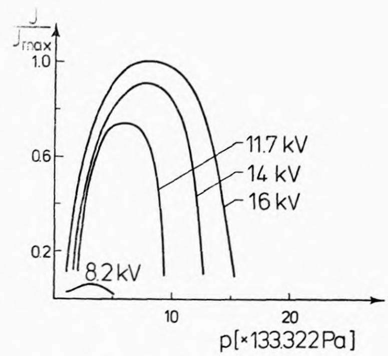


Fig. 13. Laser pulse power as a function of nitrogen pressure for various charging voltages

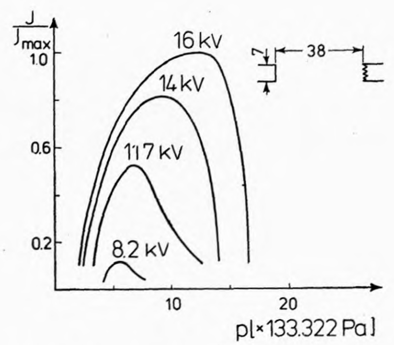


Fig. 14. Laser pulse pressure as a function of nitrogen pressure for various charging voltages

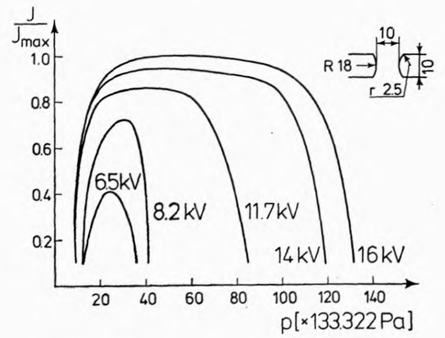


Fig. 15. Laser pulse power as a function of nitrogen pressure for various charging voltages

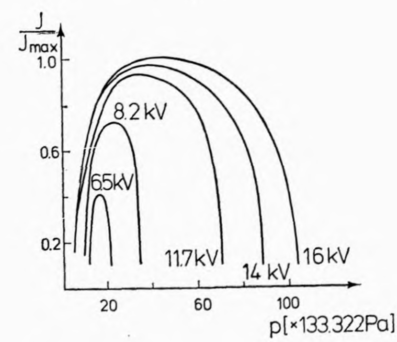


Fig. 16. Laser pulse power as a function of nitrogen pressure for various charging voltage

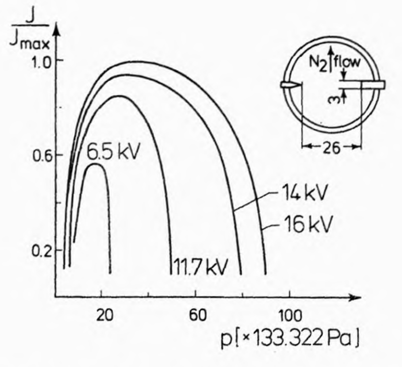


Fig. 17. Laser pulse power as a function of nitrogen pressure for various charging voltages

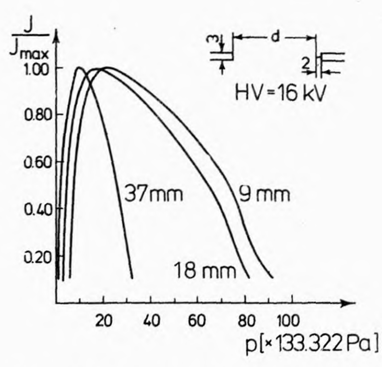


Fig. 18. Laser pulse power as a function of nitrogen pressure for various electrode spacings

on the characteristics. Minus on the "non-flat" electrode increases field excitation which gives characteristic's extension.

Experimental pulse duration times from 3 to 6 ns when a mirror is applied and from 2.5 to 5 ns without it. No correlation has been found between the cavity parameters and the times measured.

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## References

[1] LEONARD D. A., Appl. Phys. Lett. **7** (1965), 4.
[2] GERRY E. T., Appl. Phys. Lett. **7** (1965), 6.
[3] HEARD H. G., Nature **200** (1963), 667.
[4] SCHENCK P., METCALF H., Bull. Am. Phys. Soc. **17** (1972), 475.
[5] ROGOWSKI W., Arch. f. Elektrotechnik, Band **XVI** (1926), 81.

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## Влияние параметров разрядного колодца на работу азотных лазеров

Характеристики работы азотных лазеров зависят от многих параметров разрядной камеры. В настоящей работе обсуждено влияние некоторых параметров разрядной камеры, таких как: форма, длина, расположение электродов на экспериментальные характеристики работы поперечно возбуждаемых азотных лазеров.