LETTERE

VOLUME 9
NUMERO 12
DICEMBRE
1962

ENERGIA
NUCLEARE

Enhancement of the He-Ne laser output during the afterglow

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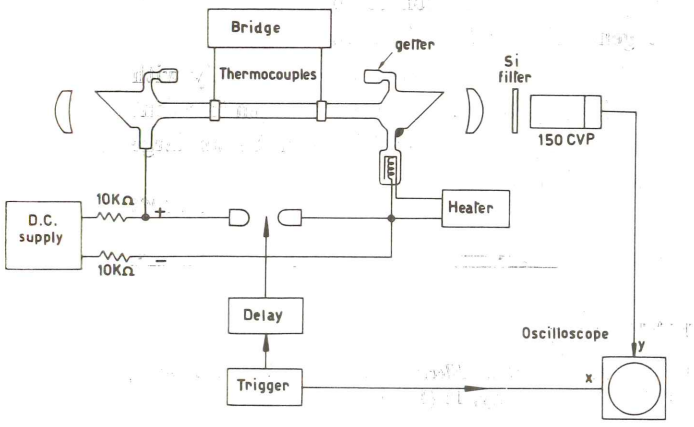

Fig. 1 - Schematic diagram of the experimental set up.

With reference to a detailed analysis of the mechanism of a He-Ne laser [1], we report experimental evidence of an enhancement in the amount of inverted population in the useful laser transition. This is usually limited by the excitation of the metastable Ne (1 s) level to the Ne (2 p) level by impact of the electrons in the plasma discharge with the Ne atoms.

If the discharge is suddenly turned off, the electrons thermalize in a time much shorter then the decay time of the metastable He (2^3 S) level.

Therefore, while the depletion rate of the Ne (2 p) level increases, the pumping mechanism efficiency of the Ne (2 s) goes down with the relatively long decay time of the He (2^3 S) level. As consequence the laser output is enhanced during the afterglow transient.

This effect was first pointed out by Javan [1] with spectroscopic measurements and was then used in connection with a pulsed r.f. discharge laser [2].

We have verified this behaviour in a d.c. discharge

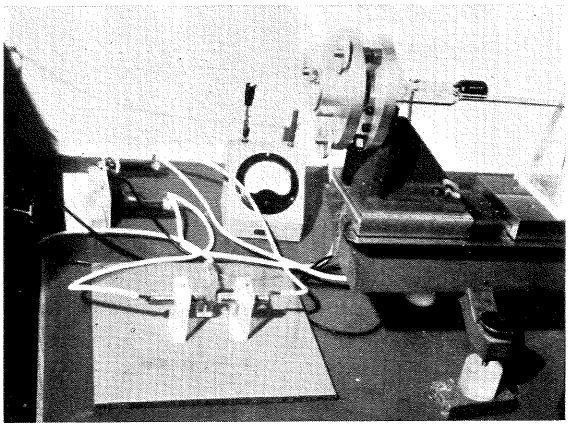

Fig. 2 - Detailed photograph of one end of the laser system and of the spark-gap.

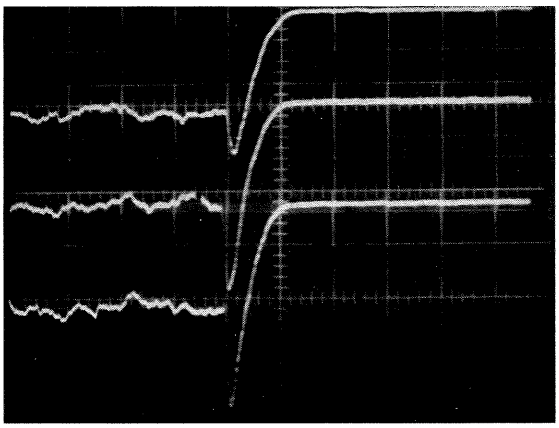

Fig. 3 - Photographs of the laser output enhancement for three different values of the d.c. discharge current, x axis: 20 μs/div; y axis: arbitrary scale.

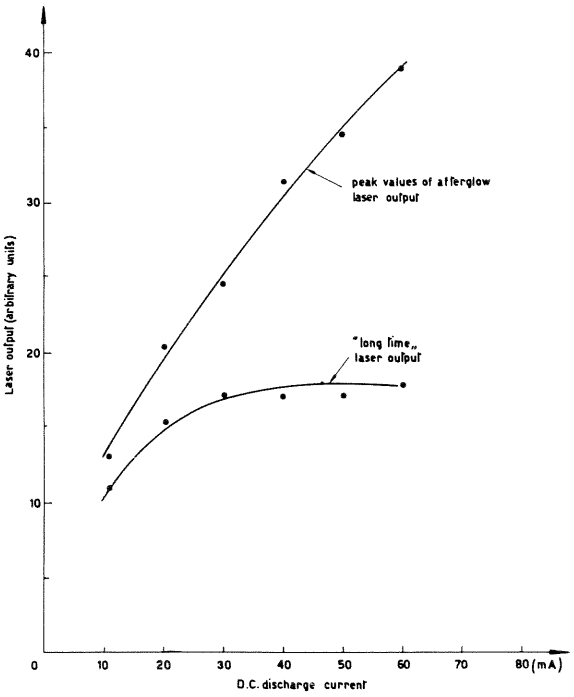

Fig 4 - Plot of afterglow output and « long time » output versus d.c. discharge power.

laser by turning off the discharge with a triggered spark-gap and observing the output enhancement (figs. 1 and 2). The used laser system has been described elsewhere [3].The experimental results are shown in figs. 3 and 4.

To get rid of thermal phenomena [4] we have checked the thermal transient by termocouples.

Every point in the « long time » curve of fig. 3 corresponds to a condition of equilibrium between heat generation and dissipation.

The afterglow output increases monotonically with the discharge power and the ratio between transient and stationary laser intensities can be as large as a factor 2 or 3. ■

Received November 14, 1962

bibliography

[1] A. JAVAN: *Quantum Electronics*. Edited by C. Townes, Columbia University, 18 (1961).

[2] C. BRACHET et al.: Comptes rendus Aca. Sci., *255*, 73 (1962).

[3] F. T. ARECCHI, A. SONA: Alta Frequenza (November 1962 issue).

[4] F. T. ARECCHI: Alta Frequenza (November 1962 issue).