The discharges were accompanied by an anomalously large x-ray flash.

The results thus demonstrate the important role played by the beam heating mechanism during the last stage of development of the PF.

In conclusion, the authors thank N.G. Basov for support and V.S. Imshennik and V.V. Pustovalov for discussions. A detailed description of the processes in PF will be published.

Fig. 3. Hose instability of beam.

Fig. 4. Case of good beam transport.

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QUASISTATIONARY ATMOSPHERIC-PRESSURE CO_2 LASER WITH NON-MAINTAINING DISCHARGE CONTROLLED BY A NEUTRON FLUX

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Submitted 8 May 1973

ZhETF Pis. Red. 18, No. 1, 15 - 19 (5 July 1973)

An atmospheric-pressure CO_2 laser with non-maintaining discharge controlled by a neutron beam is investigated. Lasing is obtained with a pulse duration from tens to hundreds of microseconds and with energy up to 40 J/l.

In a 1968 paper [1] there was described a strong increase in the generation power of a cw electric-discharge CO_2 laser of low pressure ($\sim$10 Torr) under the action of an ionizer (beam of fast protons) that made the discharge non-self-maintaining. The discharge current under condition of non-self-maintenance (several dozen milliamperes at a proton beam current of several microamperes) had a value indicating that it is transported by the electrons, while the current-voltage characteristics [2, 3] indicated that the beam ensures a high degree of ionization of the gas ($\sim 10^{-7}$ at $N_0 \sim 10^{17}$ cm^{-3}).

This phenomenon was also explained in [1]. The gist of the explanation was that turning on the external ionizer eliminates the conflict between the two functions of the electric field, which must produce in lasers with self-maintaining discharge both the ionization and the electron energy distribution needed for effective laser excitation. The possibility of independently varying the electron concentration and their average energy in a non-self-maintaining discharge produces for the CO_2 laser conditions more optimal than in the self-maintaining discharge. Thus, a CO_2 laser with non-self-maintaining discharge, operating at 10 Torr in a cw mode, is described in [1] for the first time. The use of powerful ionization sources (large-current electron beams [4, 5], nuclear-reaction products [6], ultraviolet radiation [7]) has made it possible to produce non-self-maintaining CO_2 lasers operating at high pressures (from one to several dozen atmospheres). Unlike in [1], these lasers operated in the pulsed regime. The generation duration in all these experiments did not exceed several microseconds, owing to the high conductivity of the medium, and hence to the large energy input that rapidly overheated the medium.

We have obtained generation in a CO_2 laser at atmospheric pressure, with a non-self-maintaining discharge controlled by a neutron flux; the laser operates in a quasistationary regime.

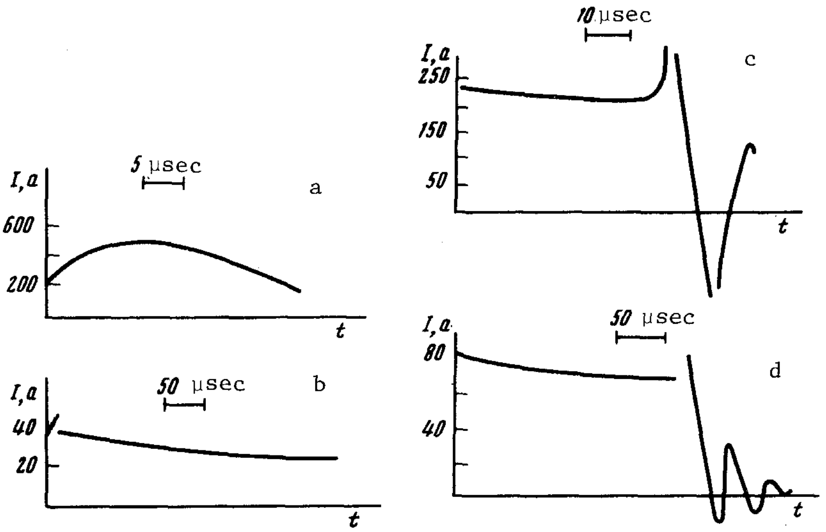
The discharge chamber was made of organic glass and comprised a cavity of rectangular cross section, inside which solid or sectionalized stainless-steel, copper, or duraluminum electrodes were placed parallel to one another. The electrode length ranged from 40 to 120 cm, and the electrode widths and the distances between them varied from 1.5 to 5 cm. The discharge-chamber volume ranged from 100 cm^3 to 3 l. We used copper as well as gold-plated mirrors with different curvature radii (from 3 to 15 m), depending on the resonator base, to ensure production of a caustic coming closest to the geometry of the discharge chamber. The laser beam was extracted through regularly arranged openings in the mirror, of 4 mm diam and spaced 1 cm apart. The number of openings depended on the cross section area of the discharge chamber and ranged from one ($S = 1.5 \times 1.5$ cm^2) to 21 ($S = 5 \times 5$ cm^2). The time behavior of the radiation was registered with a Ge:Au receiver and an oscilloscope. The energy was measured with an IKT-1 calorimeter with sensitive area 15 mm^2 and a sensitivity range from 10^{-2} to 10^2 J. Since the dimensions of the sensitive area made it possible to register radiation emerging from one of the openings, the generation from the other regions of the resonator was monitored by exposing heat-sensitive paper, and the energy was estimated by comparing the darkening of the paper with calibrated samples. The experiments were performed with a pulsed reactor with a thermal-neutron flux density $\Pi \simeq 5 \times 10^{16}$ neut-$cm^{-2}sec^{-1}$ and approximate pulse duration 10^{-3} sec. Unlike the experiment of [6], the laser was located not in the central channel of the reactor, the dimension of which was limited, but outside the reactor, at different distances from the active zone. The possibility of placing the laser in regions with different neutron-flux levels, together with the possibility of varying the fraction of the He^3 in the mixture $CO_2 + N_2 + He^4 + He^3$ has made it possible to vary in a wide range the conductivity determined by the ionization losses in the gas of the products of the nuclear reaction $He^3(n, p)H^3 + 0.8$ MeV. The discharge was fed from capacitors whose switching with the aid of controlled discharge gaps was synchronized with the instant when the reactor power reached a definite level. If sectionalized electrodes were used, each section was fed from a separate capacitor. The ratio of the electric field intensity to the pressure, E/P, ranged from 6 to 20. Simultaneous oscillography of the current and of the voltage on all section and of the light signal has made it possible to obtain a more complete picture of the discharge development.

Figures a - d show oscillograms of the discharge current for the four operating regimes described in the table (the partial gas pressure is in mm Hg). The generation energy in the described experiments ranged from 15 to 40 J/l.

It should be noted that in some experiments the lasing was somewhat shorter than the discharge in the volume. The termination of the lasing while the discharge was still on is apparently due to a decrease of the gain below the threshold level during the course of heating of the gas.

The duration of the uniform-current pulse is obviously connected with the gas overheating time [9], which in our experiments depended on the He^3 concentration and on the value of E/P. During the entire phase of full discharge, the condition $q > (\alpha P v_e)^2/\beta$ for non-self-maintenance of the gas discharge was maintained [9] (q is the rate of electron production by the nuclear-reaction products, α is the first Townsend coefficient, v_e is the electron drift velocity, β is the dissociative recombination coefficient, and P is the gas pressure). The existence of lasing lasting as much as hundreds of microseconds indicates that the medium retains its optical acti-

	a	b	c	d
CO_2	68	75	75	150
N_2	136	675	675	300
He^3	75	10	10	40
He^4	480	–	–	260
u, kV	7	7	35	23
c, μF	0,7	4,0	2,1	4,0
E/P, in cm^{-1}Torr^{-1}	7	7	10	6
i_{max}, A/cm^2	5,4	0,44	1,24	0.43
τ_{gener}, μsec	50	> 300	≈ 50	≈ 200



vity when the electric pump power is decreased to a level of several kW/cm^3. This experimental result confirms the conclusion drawn in [9] that it is possible to develop cw fast-flow CO_2 lasers excited in a non-self-maintaining discharge.

The authors are grateful to A. M. Prokhorov and V. M. Talyzin for discussions and to B. V. Seleznev for help with the work.

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