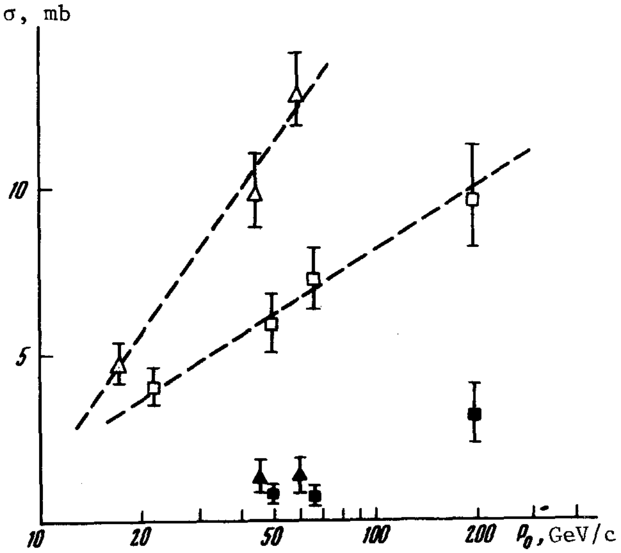

Fig. 3. Momentum dependence of the cross section (per average emulsion nucleus) of coherent generation of three (light symbols) and five (dark) charged particles. The squares and triangles represent primary protons and pions, respectively.

transferred to the nucleus. Here θ is the secondary particle emission angle relative to the direction of the incident proton beam.

Figure 2 shows the distribution with respect to $\sum_{i=1}^{3} \sin\theta_i$ for three-prong events. We see that for "pure" events (Fig. 2a) this distribution is much narrower than for the background proton-nucleon interactions (Fig. 2b). If the distributions of Figs. 2a and 2b are normalized to $\sum \sin\theta_i > 0.2$, the number of coherent events with production of three charged particles (reactions 3 and 4 amounts to $N_3^! = 66 \pm 10$, corresponding to a mean range $\lambda_3 = 21.8^{+3.9}_{-2.8})$ m. A similar procedure yields for the number of coherent events with production of five charged particles $N_5^! = 21 \pm 6$, corresponding to $\lambda_5 = (68^{+28}_{-15})$ m. Figure 3 shows the data (per average emulsion nucleus) on the coherent reactions with production of three and five charged particles at 200 GeV/c, and the corresponding data for the primary protons and pions in the energy region 17 - 67 GeV [1]. As seen from Fig. 3, the cross section for the production of three and five charged particles by protons increases with energy up to 200 GeV. For reactions of production of events with three charged particles by pions, the cross section likewise increases with the momentum, and the rate of this increase differs from that for the protons.

To determine the character of the dependence of the cross section of the pion reactions with production of three and five charged particles on the momentum and for its comparison with the analogous proton reactions, further experiments are necessary.

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CERTAIN CONSIDERATIONS CONCERNING THE THERMONUCLEAR POSSIBILITIES OF A ZETA PINCH

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As is well known, attempts to use strong-current plasma systems in thermonuclear (TN) purposes encounter great difficulties because the discharge is prone to a certain self-organization that counteracts the containment of the hot plasma in the magnetic fields. According to the theoretical concepts, these difficulties are connected mainly with the instabilities of the contained plasma. According to the experimental data, on the other hand, other processes are also responsible, including plasma processes that develop both inside and outside the containment region.

Thus, for example, the theory of an idealized pinch, in which the phenomena next to the electrodes and the walls are taken into account and the presence of rarefied plasma around the pinch is neglected, predicts rather rapid instabilities with modes m = 0 and m = 1; the theory relates the "singularities" of the current-voltage characteristics of the discharge only with the radial pulsation of the pinch, etc. Experiment shows [1, 2], however, that: a) the rise of the current past the "singularities is due to recurring breakdowns along the chamber wall, which reduces the inductance appreciably, b) resultant formation of closed current sheaths enclosing the field of the pinch, c) the pinch is stable enough to both modes whose development is hindered by the currents in the surrounding plasma produced as a result of incomplete capture of the gas by the skin layer or the "inverse skin effect" [1, 3] (the mode $m = 0$ is stabilized by the current shunting the neck, while the mode $m = 1$ is stabilized by the reverse current), d) the recurring breakdowns cause only a small fraction of the initial energy to be used to heat the pinch, while the remaining part is conserved in the magnetic field or is dissipated upon ablation of the matter from the discharge boundaries (the ablation-product impurities eject the pinch energy through radiation, etc. It is clear therefore that the TN shortcomings of the pinch system are connected not so much with the instabilities of the pinch itself as with other difficult-to-eliminate processes of self-organization of the discharge.

In this situation, it is reasonable to search for experimental conditions in which it is possible, without disturbing the self-organization, to turn its undesirable manifestations into favorable factors. We illustrate this, using as an example a system (Fig. 1) in which a) a gas with saturated vapor pressure that is optimal for the production of the pinch is condensed into the solid phase on the inner surface of the chamber and on the electrodes, b) the discharge conditions are chosen such that the formation of the pinch and the repeated ignition occur at the instant of the maximum current I_m (the entire energy of the circuit is concentrated in the pinch inductance L and in the 'parasitic' inductance L_n, with $L_n \ll L$), c) the energy $\frac{1}{2}L_nI_m^2$ is rapidly dissipated outside the chamber whereas the current of the pinch is closed along the wall and a sheath separated from the circuit is produced, d) the energy $\frac{1}{2}LI_m^2$, which constitutes a large part of the initial energy, is consumed mainly in ablation of the matter from the discharge boundaries and its heating (the pinch resistance is low), e) the intense ablation produces a gas "jacket" that expands towards the pinch with a T-layer on the front [4] and compresses the field H_ϕ.

We see that under these conditions part of the energy dissipated in the discharge will be restored through the work of compression of the field H_ϕ; the stabilization of the mode $m = 1$ should improve as the T-layer approaches the pinch, specially because its conductivity σ (the temperature and degree of ionization) depends on the electric field E. The stabilizing increments $\pm\Delta I$ [5], which are determined by the changes $\pm\Delta E$, will then be reinforced by the increments $\pm\Delta\sigma$. The stability of the T-layer is ensured by the fact that it moves against the growing field H_ϕ, etc.

Thus, under the proposed discharge conditions, its self-organization is directed towards a conservation of the system stability during the entire time of the dissipation of the energy $W_m = \frac{1}{2}LI_m^2$. The "lifetime" τ is determined by the equation $W_m = \int_0^\tau I^2(t)R(t)dt$, where $R(t)$ is the value of the resistance averaged over the entire current sheath and takes into account the replenishment of the dissipated energy. According to the experimental data, under the conditions of ordinary pinches 1) ($L \sim 10^{-6}$ H, $R \sim 10^{-2}$ Ω), W_m can decrease by one order of magnitude within a time $L/R \sim 10^{-4}$ sec. When the discharge power is increased and the T-layer moves toward the pinch, τ increases. In addition, the energy level of the field H_ϕ can be maintained by additional acceleration of the T-layer, for example by a current I_z or an external field H_z such that the pinch current increases during the greater part of τ. To this end, the T-layer velocity must exceed $10\,Rr/\ell$ (r is the T-layer running radius and ℓ is the pinch length). Formation of a pinch and a "jacket" of deuterium or of a D-T mixture can also increase τ, since the radiation loss is reduced to a minimum.

These ideas, based mainly on experiment, suggest to us that optimization

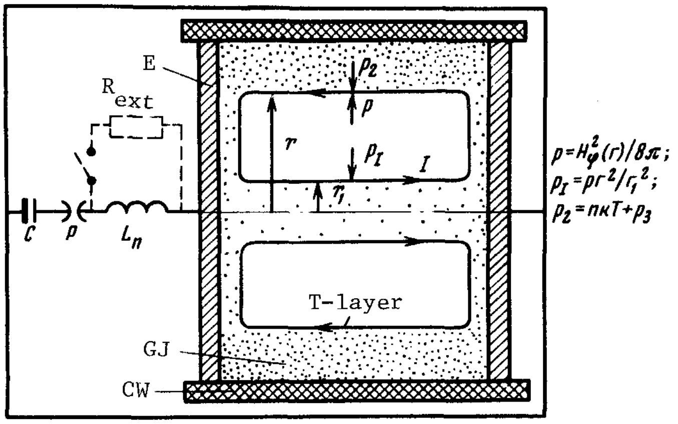

Diagram of pinch setup. C - capacitor, G - discharge gap, GJ - gas "jacket," CW - chamber wall, R_{ext} - external resistor, r_1 - pinch radius, r - radius of T-layer, p_3 - external-field pressure, E - electrodes.

of the reconciliation of the boundary and initial conditions of the discharge with its self-organization improves the possibility of stable forced evolution of the system towards a TN state. At a hot-plasma containment time $\gtrsim 10^{-4}$ sec, according to Lawson's criterion, the particle density for a d-t mixture is $\lesssim 10^{18}$ cm^{-3}. To establish the ability of the system to overcome the TN limit, appropriate experiments must be performed. It is not excluded that such an approach can improve the TN capabilities of a few other systems, too.

We note incidentally that by freezing the working medium on the discharge boundaries it is easy to overcome also the difficulties in the production of pinches with stabilizing "jackets" (in which interest has increased anew [6]), by setting the vapor pressure at a level that is convenient for the breakdown of long gaps. The rate of current growth can then be programmed in such a way that the intensity of the shock waves that transfer the energy to the chamber walls is decreased (to ensure that the total pressure $nkT + H_\phi^2/8\pi$ grows almost uniformly over the discharge cross section).

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[1] Repeated ignition occurs at $I < I_m$ without complete deviation of the current sheath from the circuit (see, e.g., [2]) with almost constant L and R.

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SELF-INDUCED TRANSPARENCY IN SEMICONDUCTOR BY SINGLE-PHOTON EXCITATION BY AN ULTRASHORT LIGHT PULSE

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Self-induced transparency was observed experimentally in a semiconductor following single-photon excitation by ultrashort light pulses.

A number of recent theoretical papers [1 - 4] are devoted to coherent interaction of high-power laser radiation with a semiconductor in the case when the duration of the light pulse is shorter than the transverse-relaxation time of the medium ($\tau \ll T_2$) and $\Theta_0 = (\mu/\hbar)\int_{-\infty}^{\infty}E dt > \pi$, where E is the slow amplitude of the light-pulse field on entering the medium and μ is the dipole matrix element of the transition. The phenomenon consists of an appreciable decrease of the absorption by the semiconductor of the ultrashort light pulses whose group velocities are smaller by one order of magnitude than the velocity of light in the given material. After coherently exciting an electron-hole pair in the interband absorption, the light pulse loses energy on its leading front; this energy is returned to it on the trailing edge by induced reradiation. The condition $\tau \ll T_2$ imposes definite limitation on the relation between the width of the forbidden band of the semiconductor and the exciting-light quantum energy [1], since T_2 depends on the kinetic energy of the produced electrons and decreases when this energy increases, owing to interaction with the optical phonons.

We present here the results of experiments aimed at observing self-induced transparency by single-photon interaction between ultrashort light pulses and a semiconductor[1].

The experimental setup is shown in Fig. 1. A $CdS_{0.6}Se_{0.4}$ sample grown from the gas phase, with a forbidden band width $E_g \simeq 2.3$ eV (T = 77°K) was cooled to liquid-nitrogen temperature to increase the transverse relaxation time T . The sample length ℓ was 4 mm. The crystal was illuminated with ultrashort pulses of the second harmonic ($h\nu = 2.34$ of a mode-locked neodymium laser. The pulse duration ($\tau \lesssim 2\times10^{-11}$ sec) was monitored with an FER-2 photochronograph having a time resolution 2×10^{-11} sec. Measurements by the method of collisions in a two-photon-absorbing ZnS crystal with approximate forbidden band 3.6 eV have made it possible to estimate the average pulse duration in a train of ultrashort pulses ($\bar{\tau} \simeq 5\times10^{-12}$ sec) [7]. The pulsed power density in the unfocused beam could reach 10^9 W/cm^2 in the unfocused beam. The choice of the pump source (giant power, low pulse duration) and of a cooled crystal with forbidden band $E_g \sim h\nu$