EXPLOSION IN AN EXTERNAL ELECTRIC FIELD

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In a number of electrodynamic problems in which account is taken of the interaction between shock waves and external fields, say in problems such as magnetic cumulation [1] or in analogous external problems, the boundary condition on the shock-wave surface is formulated as on the surface of an ideal conductor, and this raises the question of the shock-wave parameters for which this condition is satisfied.

A theoretical estimate shows that an external electric field begins to penetrate into the shock wave when its temperature drops to a value on the order of several thousand degrees. A more accurate estimate is made difficult by the considerable uncertainty of the data on the conductivity of air at these temperatures.

An experimental study of the detonation of an explosive in an external electric field can yield additional data on the state of the gas behind the shock wave, and is also of independent interest as a possible source of stationary electromagnetic effects.

The external field was produced between the ground and a horizontal grid measuring 1.5 x 1.5 m, charged to a potential from -10 to +3 kV. The field produced near the explosion was approximately -3.3 to +1 kV/m.

Copies of the registered oscillograms of the field pulses from the explosion of charges weighing 225 g at a distance R = 250 cm, at different values of the grid potential, are shown in Fig. 1, which shows also for comparison oscillograms of the same explosions without an external field.

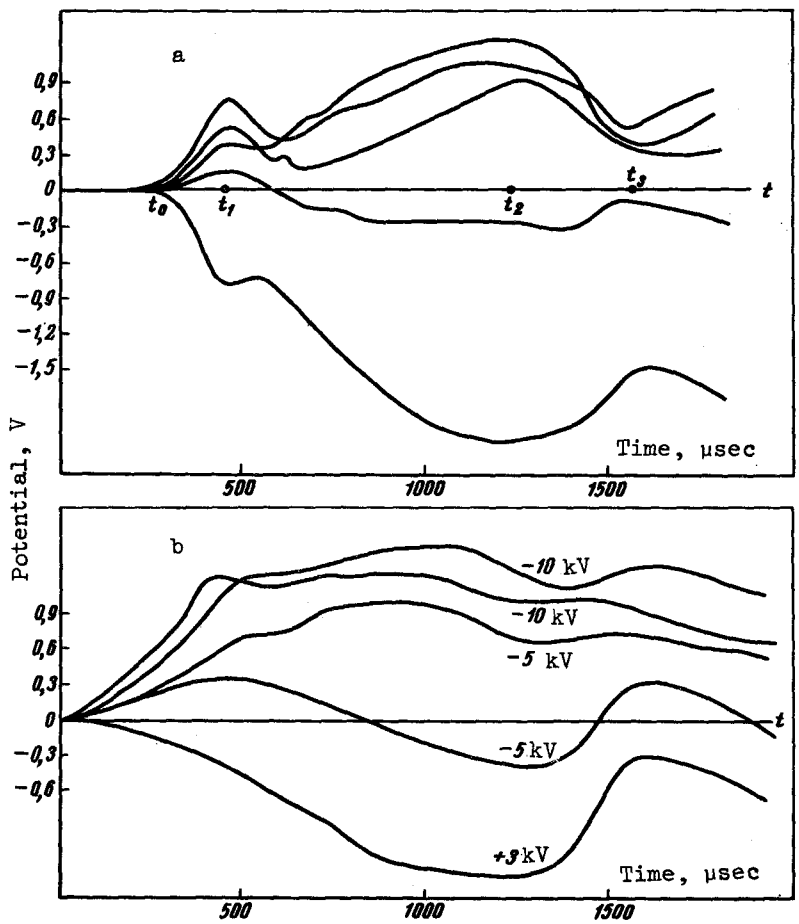

Fig. 1

We see that in the time interval $0 \leq t \leq t_0$ a nonstationary electric field is registered. In all cases without exception (a total of 60 explosions), the polarity of the signal was opposite to the external-field polarity in this time interval. Outside this interval, the pulses differed little from those without an external field.

Thus, the external field begins to penetrate into the volume subtended by the shock wave when $t \geq t_0$ (at the instant t_0 the radius of the front of the shock wave is approximately $2lr_0$ and its velocity is v_f = 1/km sec, where r_0 is the intital radius of the charge), i.e., when the layer of gas between the front of the shock wave and the contact surface of the explosion products, as shown in [2], ceases to screen the alternating field generated by the explosion products; this is perfectly understandable, since the characteristic frequency of the process

$$\omega \simeq 2\pi \frac{\partial}{\partial t} \ln v_f(t)$$

is of the same order as in [2].

The experimental data on the magnitude of the electric field E in the time interval $0 \leq t \leq t_0$, measured at different values of the external field E_0, different explosive charges and different distances R are shown in Fig. 2 in the form of the dimensionless combination

$$\Phi(t^0) = \frac{R^3 E(t^0)}{2 v_0^3 E_0},$$

where $t^0 = tm^{-1/3}$ (t is in seconds and m in kilograms). The figure shows also plots of

$$\Phi_{sw}(t^0) = \left[\frac{v_f(t^0)}{v_0}\right]^3 \text{ and } \Phi_{ep}(t^0) = \left[\frac{v_{ep}(t^0)}{v_0}\right]^3,$$

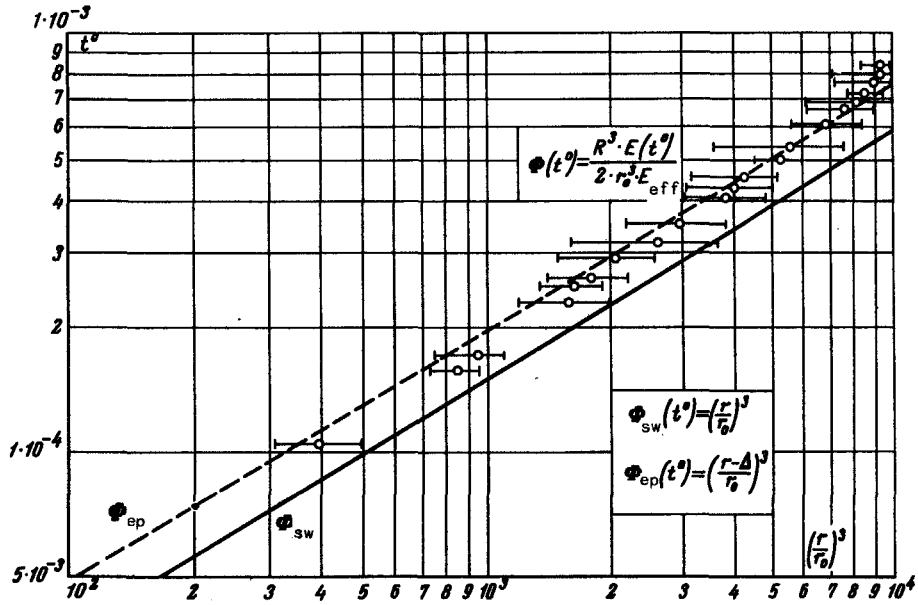

Fig. 2

which characterize the time variation of the volume of the region subtaneded respectively by the shock wave and the forward boundary of the explosion products. The values of $v_f(t^0)$ and $v_{ep}(t^0)$ were calculated from the data of [3]. From the data shown in the figure it follows that when $t \leq t_0$ the region of explosion in an external field behaves like an ideally conducting body with radius v_{eff}. The law of motion of the boundary surface is determined from the condition

$$\int_0 \sigma(v_{eff} t') \, dt' \simeq 2{,}3,$$

which obviously yields, for a strong shock wave, $v_{eff}(t) \approx v_f(t)$ and for a weak one $v_{eff}(t) < v_f(t)$.

The time dependence of the measured perturbed field E(t) (which yields simultaneously the time dependence of the produced dipole moment, since the measurements are made in the near zone) is connected with the space-time distribution of the conductivity behind the front, which in turn is influenced by the distribution of the temperatures, the possible non-equivalence of the ionization processes, and a number of other factors.

A more detailed study of the laws of motion $v_{eff}(t)$ for explosions in an electric field will make it possible to obtain additional data concerning these processes. Difficulties may arise here in connection with the influence of the pulsed field generated by the explosion products [2] also when $E_0 = 0$, but it is obviously that by increasing E_0 it is possible to make the influence of this factor as small as desired.

[1] N. D. Sakharov, Usp. Fiz. Nauk 88, 725 (1966) [Sov. Phys.-Usp. 9, 294 (1966)].
[2] V. V. Adushkin, PMTF (Appl. Math. and Theor. Phys.) No. 5 (1963).

MULTIPHOTON EXCITATION OF THE PHOTOCONDUCTIVITY IN ALKALI-HALIDE CRYSTALS BY LASER EMISSION

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Two-photon absorption in pure alkali-halide crystals (AHC) was first observed by Hopfield and Worlock [1]. They presented the results of a theoretical and experimental study of the two-quantum absorption spectra of KI and CsI in the region of the exciton absorption band. Multiphoton excitation of photoconductivity in an NaCl crystal exposed to light from a Q-switched ruby laser was investigated somewhat later [2]. The results of the latter study point to a 5-photon process of light absorption. Measurements of multiphoton absorption of crystals add greatly to the available spectroscopic data and raise a number of questions connected with the determination of the efficiency of multiquantum processes, satisfaction of the selection rules, the mechanism of the transfer of the electron into the conduction band in the case of exciton absorption, and others.

We observed and investigated the photoconductivity of a number of AHC (NaCl, KCl, KBr, NaBr, KI), produced by illuminating the samples with ruby and neodymium lasers operating in the normal generation regime. The energy of each laser could be varied from 0.1 to 10 J at a pulse duration 0.5 - 2 msec. The laser emission was focused onto the sample, which was