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13. ABSTRACT

This report includes abstracts and bibliographic lists on major contractual subjects that were completed in March, 1972. The major topics are: laser technology, effects of strong explosions, geosciences, and particle beams. A report on geothermal studies, selected as the optional topic for March, will be issued under separate cover. The abstracted material includes some selections prior to 1972 that have not otherwise been reported.

To avoid duplication in reporting, only laser entries concerning high-power effects have been included, since all current laser material will appear routinely in the quarterly bibliographies.

An index identifying source abbreviations and an author index to the abstracts are appended.

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INTRODUCTION

This report includes abstracts and bibliographic lists on major contractual subjects that were completed in March, 1972. The major topics are: laser technology, effects of strong explosions, geosciences, and particle beams. A report on geothermal studies, selected as the optional topic for March, will be issued under separate cover. The abstracted material includes some selections prior to 1972 that have not otherwise been reported.

To avoid duplication in reporting, only laser entries concerning high-power effects have been included, since all current laser material will appear routinely in the quarterly bibliographies.

An index identifying source abbreviations and an author index to the abstracts are appended.

TABLE OF CONTENTS

I. Laser Technology

A. Abstracts

Arifov, U. A., M. R. Bedinov, and K. Khaydarov. On the nature of ion generation from the effect of laser radiation on solid matter. DAN Uzb SSR, no. 7, 1971, 25-26. (RZhF, 1/72, #1G151)

A study was made of ion generation from focused radiation of a free-running ruby laser on a solid target, and was correlated with laser energy and target type. Ion sources included targets of Ni, Mo, W, Zn and Si in a 10^{-6} torr vacuum; plasma components were registered with a cylindrical collector and a photomultiplier. For Mo, Ni and Si targets and an energy range of 0.2-1.3j, the ion current showed a spike shape similar to the laser pulse. Ion current pulses appeared at once, but were shorter than the laser pulses and appeared predominantly at pulse start. For W and Zn targets, ion generation was mainly c-w in nature. Electron current for all targets and laser energies maintained a spiked characteristic. The pulse shape of the ion current was dependent on optical and thermophysical properties of the target, and also on the plasma generated in the beam focal region. A considerable change in power density in this region, following microcratering of the target surface, led shortly to a drop in ion current near the end of the laser pulse.

Butenin, A. V., and B. Ya. Kogan. The mechanism of optical breakdown in transparent dielectrics. IN: Sb. Kvantovaya elektronika. Moskva, Izd-vo Sovetskoye radio, no. 5, 1971, 143-144.

A test is described which demonstrated the strong effect of air particle content on the optical breakdown level of transparent dielectrics. It is shown that in particles in the 0.1-0.3 micron range, which attain $10^5/cm^3$ concentrations in urban areas, can sharply lower threshold even at pulse energies on the order of 1j. Tests were run on thresholds of heptane, ethanol and methylmethacrylate, using a Q-switched ruby at maximum energies of 0.8j, focused at 4 cm. An elaborate dual-chamber system with heating and filtering was used to obtain progressively purer liquid samples, while breakdown level was continuously recorded. Fig. 1 shows relative rise in threshold for

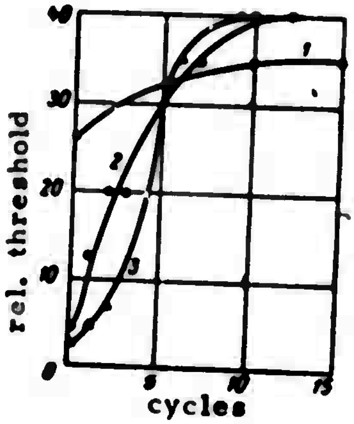


Fig. 1. Breakdown threshold vs. cleaning cycles. 1 - heptane; 2 - ethanol; 3 - methylmethacrylate

the three specimens as a function of the number of cleaning cycles. In addition the clean ethanol sample was re-exposed to ambient air, after which it reverted to its original low threshold. The evidence points to the limiting effect of particle inclusions in active laser elements.

Lisovets, Yu. P., I. A. Poluektov, Yu. M. Popov, and V. S. Roytberg. Passage of a coherent ultrashort optical pulse through a semiconductor. IN: Sbornik. Kvantovaya elektronika. Moskva, Izd-vo Sovetskoye radio, no. 5, 1971, 28-36.

Analytical solutions are obtained describing the passage of an ultrashort laser pulse through a semiconductor. A resonance interaction with the semiconductor is assumed, where the laser pulsewidth is less than the polarity relaxation time of the medium. Conditions are specifically examined for self-transparency, under which the pulse can ideally propagate with no energy loss to the medium. It is shown that the resultant stationary pulse may propagate at a velocity an order of magnitude below the speed of light in the given medium.

Garber, R. I., Ye. I. Stepina, and A A. Stepanov. Features of the destruction of calcite crystals by laser radiation. FTT, no. 1, 1972, 243-245.

An experiment is briefly summarized which was designed to examine laser damage characteristics of a transparent dielectric, for the case where the dielectric has a relatively low absorption coefficient at the irradiation wavelength. This was done with calcite specimens, which have a coefficient on the order of 10^{-4} -- 10^{-5}, using both ruby and neodymium lasers. A variety of energy and power densities were used with the beam focused at the target surface as well as internally; a high dependence of threshold and damage type on orientation of the crystal axis was found. Crack patterns and cratering geometries are discussed also as functions of impact beam polarity. Damage effects were evident only at the higher power density ruby exposure up to 10^{10} w/cm^2; the Nd laser although at a higher pulse energy, did not attain threshold, which emphasizes power density as the main destructive factor. It is also noted that the damaging power levels were several orders less than the predictable levels for nonlinear effects that typically cause damage; hence in the present case a thermal explosion mechanism is indicated. Crater and defect photos are included.

Gusev, N. V., and A. A. Pyarnpuu. Quantitative study of the ejection of matter from a solid surface by the action of powerful radiation. ZhPMTF, no. 4, 1971, 127-133. (RZhF, 1/72, #1G254)

A set of gas dynamic equations is derived and solved for the ejection processes of a solid target under laser irradiation. Radiation energy absorption is accounted for by postulating a discontinuity, at the boundaries of which the gas dynamic parameters follow laws of conservation and, at the initial moment, the Jouguet rule. At small energy densities surface vaporization does not occur, although electrons and ions are emitted. At increased q, the vapor-flare condition appears; at still greater q, the flare region is sufficiently ionized to shield the target surface from the beam. For the small q case, ejecta behavior is determined by vapor temperature and density distribution, and degree of condensation; solutions of this type are presented graphically. It is further shown that at higher q two flow modes can exist; in one of these a shock wave propagates ahead of the "vaporization wave" (thermal mode). In the other case the shock wave coincides with the discontinuity, giving the "detonation" mode. It is noted that the appearance of shock waves, the nonequilibrium of the processes, and other phenomena associated with absorption of powerful radiation, greatly complicate the examination of the problem. It is suggested that a solution for the extended ejecta case may be obtained by the approximation of a stepwise-variable absorption coefficient; this enables comparison of results with a self-similar numerical solution.

Siller, G., E. Buchelt, and H. B. Schilling. Properties of an electron source with laser-induced electron emission. IPP-Berlin, 1971, 25 p. (RZhF, 1/72, #1A386)

A pulsed electron source with currents on the order of several hundred amperes and a 10^{-8} sec duration is described for a ring accelerator. A principle requirement was to obtain a beam with minimal emittance. To achieve this, a focused laser beam on a metallic cathode is used as an emitter, with a working area of 10^{-4} -- 10^{-2} cm^2. Data are given on measurements of emittance and energy distribution of electrons in the emitted pulse.

Mirkin, L. I. Analogies between mechanisms of destruction of transparent and opaque materials by a laser beam. DAN SSSR, v. 201, no. 6, 1971, 1335-1337.

The author notes that laser damage to opaque materials is typically evidenced as fusion and evaporation at the target surface, whereas for transparent materials, damage appears as cracks typical of brittle failure. In spite of the gross difference in destruction appearance, however, it is suggested that in many cases a common damage mechanism applies to either target type. Experiments with NaCl crystals irradiated by a neodymium laser are cited to support this; the beam was defocused so that the effects of cross-section intensity variation in the beam could be observed. Tests were run both below and above threshold levels, and a precise examination of local heating effects and crater profiles was obtained, using a scanning electron microscope. The similarity argument is based on the fact that in transparent media, local areas of less transparency will absorb heat preferentially and with increased opacity become damage centers; following this stage the destructive effects are analogous to those in metal or other opaque materials. Therefore the evident differences in laser damage to transparent and opaque targets arise only from their varying reaction to local thermal stress generated by laser action.

Vodovatov, F. F., and M. S. Chupina. Interaction of laser radiation with solid substances for the purpose of mass-spectral analysis. IN: Moskovskiy institut elektronnogo mashinostroyeniya. Trudy. No. 9, 1970, 89-98. (RZhMetrolog, 1/72, #1.32.1226)

The possibility is discussed of using a laser probe to vaporize and ionize solids for subsequent mass spectrometry. Results are presented on determination of degree of material ionization, and the possible dispersal of kinetic energy in the generated ions.

Afanas'yev, A. A., V. S. Burakov, V. V. Zheludok, and S. V. Nechayev. Nonlinear interaction between laser radiation and an alkali metal plasma. DAN BSSR, no. 10, 1971, 889-891.

Nonlinear optical effects are described on passing a laser beam through sodium and potassium plasma. Dye lasers including rhodamine 6G were used, developing up to 10 Mw and 250j at pulse widths of 25-30 nsec; beam divergence was limited to 10^{-2} -- 10^{-3} rad. In the potassium experiment, nitrobenzol was used, with a spectrum covering the $4S_{\frac{1}{2}} - 4P_{\frac{1}{2}}$ and $4S_{\frac{1}{2}} - 4P_{3/2}$ absorption lines; for Na, rhodamine - 6G was used, excited by ruby second harmonic, and giving a spectral range fully covering the yellow doublet $3S_{\frac{1}{2}} - 3P_{\frac{1}{2}}$ and $3S_{\frac{1}{2}} - 3P_{3/2}$. The nonlinear response was generally seen in the 10^4 - 10^6 w/cm^2 intensity range, where beam spectral spread near the resonant absorption

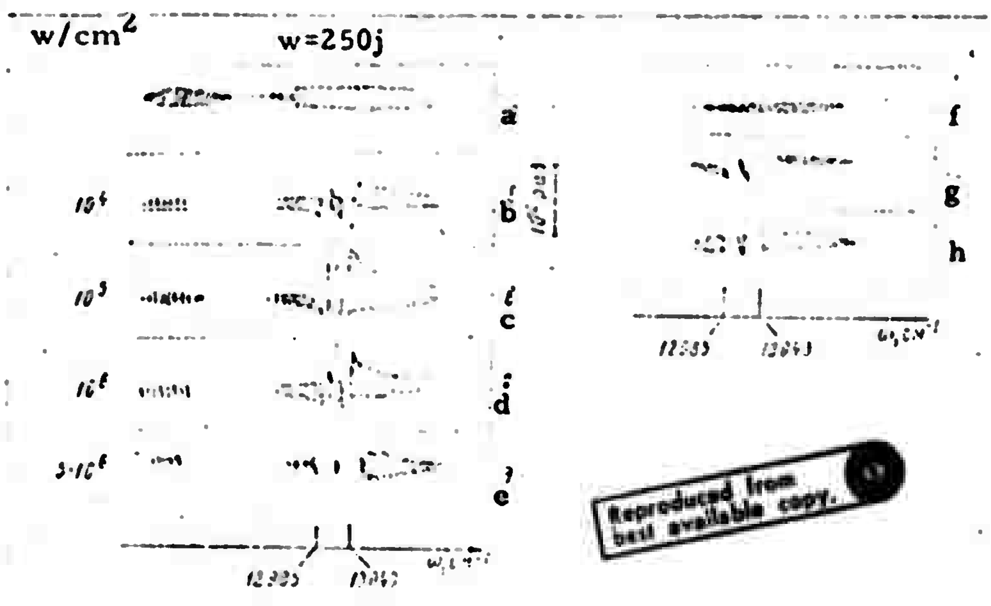


Fig. 1. Spectral response of a dye laser beam passed through potassium plasma.

lines was found to be a function of beam intensity. This is seen in Fig. 1 for potassium, with the non-excited spectrum included for comparison. A strong dependence of spectral characteristic on plasma density was also found; this is seen in comparing Fig. 1g (60j) with 1h (250j), both at 10^5 w/cm^2. Response to the first Stokes component from Raman scattering in the nitrobenzol was also observed, and showed an asymmetric broadening, with the longer-wave portion more heavily absorbed by K lines. Results for K and Na were qualitatively the same.

Anan'in, O. B., Yu. A. Bykovskiy, M. Ya. Minakov, and A. N. Petrovskiy. Self-focusing of ultrashort pulses in transparent media. FTT, no. 11, 1971, 3465-3467.

A comparison of self-focus damage in several dielectrics is briefly given. Filamentary damage tracks were observed in specimens of R-8 glass, quartz, $LiNbO_3$ and KDP, from self-focus effects of picosecond pulses from an Nd glass laser. The laser operated in a mode-locked regime, generating trains of 8-10 picosecond spikes with 10 ns spacing, and pulse power of 1.5×10^9 w. The beam was focused within the target specimens at f = 8cm. Significant differences in damage mechanism are pointed out, e.g. in quartz, $LiNbO_3$ and K-8 glass, filaments appeared directly at threshold, whereas in KDP damage at threshold was initially in discrete point form, becoming filamentary only at intensities well above threshold. The results suggest the usefulness of repeating the tests with a single spike, rather than a series, for better identification of the filament formation process.

Bayramov, B. Kh., B. P. Zakharchenya, and E. M. Khashkhozhev. Self-focusing of argon laser radiation and light scattering by phonons in bismuth germanate crystals. FTT, no. 11, 1971, 3412-3414.

Self-focusing effects are discussed on the basis of results with a c-w argon laser (4880Å) propagating through bismuth germanate ($Bi_{12}GeO_{20}$). Laser power was well below damage threshold at 0.3w, and was adjusted to a 3 mm diameter beam at f = 270 mm. Visual effects showed generation of irreversible color centers acting as self-saturating absorption regions in the beam path. The saturation effect ceased after 20 to 30 sec following exposure, depending on beam intensity. A typical annular beam cross-section pattern in the crystal region was also observed. One factor causing a change in refractive index was evidently local heating and resultant non-uniform stress patterns, since $Bi_{12}GeO_{20}$ is strongly piezoelectric. Spectral data are included which show regions of substantial variance in optical phonon scattering between first-order and nonlinear scattering; however no shift, split or broadening of phonon lines was observed. A brief mention is also made of the effect of argon laser self-focusing on phonon scatter of He - Ne laser light (6328Å).

Brekovskikh, V. F., Z. I. Mezokh, A. V. Ovodova, A. A. Uglov, A. K. Fannibo, and V. A. Yanushkevich. Dislocation structure of germanium subjected to a laser beam. FIKhOM, no. 6, 1971, 6-10.

Crystallographic alterations in laser-irradiated Ge are discussed. Single crystals of Ge both with and without initial dislocations were subjected to pulsed radiation from a ruby laser which was run in either a spike or spike-free regime. Pulse width was 1 millisec, energy was 0.5 j and density was 2×10^4 w/cm^2. Specimens were cut in the (111) plane with the impact surface being polished before testing. Exposure was done in air at temperatures from room up to 550°C, while dislocation characteristics were observed for both specimen types and laser regimes. Resultant dislocation density in all cases was clearly greater for the spike mode. The results also verify that polygonization in semiconductors with a high dislocation level will proceed at considerably lower ambient temperatures than previously stated in the literature. Microphotos of generated dislocations are included.

Kolokolov, A. A., and G. V. Skrotskiy. Kinetics of the self-focusing process for short optical pulses. OiS, v. 31, no. 4, 1971, 650-652.

Factors determining the self-focus characteristics of short optical pulses are analyzed. Pulse duration is assumed comparable to the time required for generation of nonlinear polarization in the medium, hence transient processes in the medium must be taken into account. Using this model the authors evaluate the degree of light absorption as a function of nonlinear polarization relaxation, for the case of Kerr effect orientation and for striction. The development rate of the lightguide filament is also determined for the striction nonlinearity case; it is shown from calculations that striction has a negligible effect on formation of narrow filaments.

Orekhov, M. V., and B. S. Slavin. On the nature of material ejection from the action of laser radiation on materials with varying thermophysical properties. ZhPS, v. 16, no. 1, 1972, 153-155.

A comparative beam-target study on ejecta behavior is reported for two target materials of widely differing thermal conductivities. A ruby laser was used developing 10j pulses of 1 millisec duration, and focused at f = 75 mm on steel and ferrite targets at a density of approximately 10^7 w/cm^2. A portion of the beam was split off to drive a high-speed scope, so that an extended view of laser pulses and the corresponding target flares could be seen. This display showed a cyclic nature in flare amplitude for the steel target, not evident in the ferrite target. The difference in behavior is linked by the authors to the substantially greater thermal conductivity of steel, as a result of which a portion of the crater walls melts during repeated pulse action and provides a periodic shielding effect to the incoming pulse. For ferrite, with several orders lower conductivity, the beam effect remains relatively localized and no periodic variation occurs. This is shown in the cross-sections of laser craters in the two specimens in Fig. 1, where evidence

Fig. 1. Crater generation from free-running ruby laser impact on ferrite (a) and steel (b). X60.

of melt and run-down is seen for the steel target, while the ferrite crater is comparatively clean.

Plyatsko, G. V., M. I. Moysa, and L. P. Karasev. Using a laser to eliminate residual weld stresses. F-KhMM, no. 6, 1971, 87-89.

Laser heating of a butt weld to relieve residual stress is briefly described. The test specimens were type VT-14 steel cylinders of 300 mm ID and 3 mm wall thickness, welded by argon arc at a rate of 12 m/hr. Following the weld operation a 10 mm long section of the weld external surface was subjected to laser irradiation sufficiently intense to cause a slight surface melting, but no metal ejection (no other data on laser parameters are given). After laser exposure, strain gage data showed the impact area to have returned to a nearly unstressed state, from post-weld stress levels as high as 18 kg/mm^2. The effect is attributed to two factors: generation of thermoelastic waves which permit dynamic relaxation of stress, and the creation of a surface layer whose physical properties differ from those of the base material. Further study of the technique is planned to clarify the relief mechanism.

Zakharov, V. P., and Yu. M. Pol'skiy. Velocity of the temperature front in carbon films during their interaction with laser radiation. FIKhOM, no. 6, 1971, 3-5.

A simple technique is described for determining the mean radial velocity of a temperature front, generated by focused laser radiation on a carbon thin film. The carbon film is overlaid with a thin Ge film and two photomultiplier arrays are aimed in the vicinity of the impact point, offset by a known distance (200 microns in the example given). At a sufficient laser exposure the Ge film melts, causing a discrete change in optical density; the time for the melt region to reach the remote monitored point then yields mean temperature front velocity. In the cited tests a free-running ruby laser was used, giving a mean front velocity of 1.5 - 2 m/sec, although the rate nearest the impact region was evidently higher. The results also indicate a slower and more complex fusion mechanism in the Ge with increased distance from the focal point, suggesting an interim reordering of its crystal structure prior to melting. The resolution of the technique is limited by the dimensions of the sensing photocathodes; for the tests described, error was put at not over 25%.

B. Recent Selections

i. Beam-Target Effects

Ashmarin, I. I., Yu. A. Bykovskiy, V. A. Gridin, V. F. Yelesin, A. I. Larkin, and I. P. Sipaylo. Shock waves generated by the action of laser radiation on transparent bodies. IN: Sbornik. Kvantovaya elektronika. Moskva, Izd-vo Sovetskoye radio, no. 6, 1971, 126-128.

Askar'yan, G. A., V. G. Mikhalevich, V. B. Studenov, and G. P. Shipulo. Nonlinear effects during propagation of a powerful c-w optical beam through a medium. ZhETF, v. 59, no. 6, 1970, 1909-1910.

Avotin, S. S., E. P. Krivchikova, I. I. Papirov, P. J. Stoyev, and V. I. Tereshin. Change in electrical resistance of beryllium from laser irradiation. ZhETF, v. 62, no. 1, 1972, 288-293.

Basov, N. G., O. N. Krokhin, G. V. Sklizkov, S. I. Fedotov, and A. S. Shikanov. A powerful laser apparatus and effectiveness studies on high temperature heating of a plasma. ZhETF, v. 62, no. 1, 1972, 203-212.

Belozerov, S. A., G. M. Zverev, V. S. Naumov, and V. S. Pashkov. Destruction of transparent dielectrics by radiation from a mode-locked laser. ZhETF, v. 62, no. 1, 1972, 294-299.

Belyayev, V. P., A. O. Vercheba, V. F. Martynov, Yu. G. Protsvetov, and Ye. V. Shchennikov. Results of modelling a thermomechanical destruction process in rock, using a laser as heat source. IVUZ Geologiya i razvedka, no. 7, 1971, 125-126.

Bol'shov, V. F., V. M. Gur'yanov, G. A. Machulka, and L. P. Muratova. A laser apparatus for cutting glass sections. IN: Sbornik. Kvantovaya elektronika. Moskva, Izd-vo Sovetskoye radio, no. 6, 1971, 84-86.

Bondarenko, B. V., and A. A. Shchuka. Electrical resistance and structure of tungsten, molybdenum and chromium films obtained by laser vaporization. FMM, v. 30, no. 1, 1970, 207-210.

Bonch-Bruyevich, A. M., V. A. Khodovoy, and V. V. Khromov. Nonlinear phenomena during propagation of wide-band laser radiation through atomic potassium vapor. ZhETF P, v. 11, 1970, 431-434.

Bozhkov, A. I., and F. V. Bunkin. Optical excitation of surface waves in transparent condensed media. ZhETF, v. 61, no. 6, 1971, 2279-2286.

Epshteyn, E. M. Thermal instability of a semiconductor in a laser beam. IVUZ Radiofiz, no. 1, 1972, 33-37.

Kapel'yan, S. N., and Z. M. Yudovin. Duration of vaporization after termination of a powerful thermal flux. DAN BSSR, no. 3, 1972 214-216.

Kemoklidze, M. P., and L. P. Pitayevskiy. Nonlinear propagation of e-m waves through a pure metal. ZhETF P, v. 11, 1970, 508-510.

Kuklev, Yu. I., and G. A. Machulka. Using a laser to scribe a wedge. IN: Sbornik. Kvantovaya elektronika. Moskva, Izd-vo Sovetskoye radio, no. 6, 1971, 86-89.

Laboratory for mechanical effects of laser beams. Nauka i zhizn', no. 2, 1972, 54-56.

Laboratory for mechanics of polymers. Nauka i zhizn', no. 2, 1972, 53-54.

Lugin, E. V., V. M. Mikhaylov, and S. D. Tvorogov. Attenuation of pulse energy in media with a dispersed absorption line. IVUZ Fiz, no. 1, 1972, 155-156.

Mandzhikov, V. F., A. P. Darmanyan, V. A. Barachevskiy, and Yu. N. Gerulaytis. Photochromism in organic compounds from the action of laser radiation. OiS, v. 32, no. 2, 1972, 412-413.

Nusinov, M. D., K. P. Florenskiy, A. V. Kuznetsov, A. I. Kosolanov, Yu. B. Chernyak, L. I. Ivanov, V. A. Yanushevich, L. V. Obukhov, and V. V. Vysochkin. Modelling possible processes of glass particle formation in lunar regolith. DAN SSSR, v. 202, no. 4, 1972, 811-814.

Pashinin, P. P., and A. M. Prokhorov. Obtaining a high-temperature deuterium plasma from laser heating of a special gas target. ZhETF, v. 62, no. 1, 1972, 189-194.

Zakharov, V. P., V. N. Chugayev, V. I. Zaliva, and Yu. G. Poltavtsev. Study of the graphitization process of thin carbon films from the effect of powerful light pulses. UFZh, v. 17, no. 2, 1972, 279-283.

Zhirovetskiy, V. M., M. I. Moysa, G. V. Plyatsko, and N. P. Turchenko. Characteristics of alteration in weld properties following treatment by laser beam. F-KhMM, no. 1, 1972, 84-87.

Znamenskiy, V. B. A variant in determining optical constants of a metal by the reflection method. OiS, v. 32, no. 2, 1972, 410-412.

II. Beam-Plasma Interaction

Afanas'yev, Yu. V., and V. B. Rozanov. Energy spectrum of multiply-charged ions in a laser plasma. ZhETF, v. 62, no. 1, 1972, 247-252.

Basov, N. G., V. A. Boyko, V. A. Gribkov, S. M. Zakharov, O. N. Krokhin, and G. V. Sklizkov. Gas dynamics of a laser plasma during heat-up. ZhETF, v. 61, no. 1, 1971, 154-161.

Bessarab, Ya. Ya., Yu. V. Tkach, V. P. Zeydlits, N. P. Gadetskiy, and V. V. Dyatlova. Study of collective processes in a plasma using light of stimulated emission. ZhETF, v. 62, no. 2, 1972, 569-572.

Burakov, V. S., P. A. Naumenkov, and G. A. Kolosovskiy. Using a tunable laser to determine absorptive properties of a plasma. ZhPS, v. 16, no. 1, 1972, 54-57.

Burakov, V. S., P. A. Naumenkov, V. P. Ivanov, and G. A. Kolosovskiy. Study of the passage of powerful laser radiation through an optically dense plasma. ZhPS, v. 16, no. 2, 1972, 239-242.

Dolgov-Savel'yev, G. G., and V. N. Karnyushin. Determination of laser plasma temperature from examining radiation in the x-ray and visible ranges. ZhPMTF, no. 1, 1972, 114-117.

Gribkov, V. A., V. Ya. Nikulin, and G. V. Sklizkov. Dual-beam interferometry method for studying axisymmetric configurations of dense plasma. IN: Sbornik. Kvantovaya elektronika. Moskva, Izd-vo Sovetskoye radio, no. 6, 1971, 60-68.

Gusev, V. K., G. M. Malyshev, G. T. Razdobarin and L. V. Sokolova. Measuring electron temperature and density by laser radiation scattering in the Tuman-2 device. ZhTF, no. 2, 1972, 340-343.

Kochelap, V. A. Negative absorption of light in a dense ionized gas. ZhTF, no. 2, 1972, 449-451.

Petrov, G. D., A. I. Petryakov, and P. A. Samarskiy. Submillimeter laser interferometry of a carbon arc plasma. TVT, no. 1, 1972, 181-182.

Shvarts, G. Effect of a magnetic field on plasma generated by laser irradiation of a solid target. IN: Sbornik. Kvantovaya elektronika. Moskva, Izd-vo Sovetskoye radio, no. 5, 1971, 102-105.

Sizonenko, V. L., and K. N. Stepanov. Excitation of kinetic instability in a plasma by a nearly monoenergetic beam. IVUZ Radiofiz, no. 1, 1972, 144-145.

Tamoykin, V. V., and S. M. Faynshteyn. Nonlinear interactions of waves in a plasma having random inhomogeneities. ZhETF, v. 62, no. 1, 1972, 213-218.

Zaritskiy, A. R., S. D. Zakharov, P. G. Kryukov, Yu. A. Matveyets, and A. I. Fedosimov. Variation in the backscatter radiation spectrum from laser heating of a plasma. ZhETF P, v. 15, no. 4, 1972, 184-186.

2. Effects of Strong Explosions

A. Abstracts

Denisov, Yu. P. and N. M. Kuznetsov. Ionization rate constant at high temperature. High electron concentrations. ZhPMTF, no. 2, 1971, 32-40.

Furthering work on monatomic gas ionization begun by Petschek and Byron, the authors have simplified the kinetic equation of the electron distribution function $f(t,\epsilon)$ and derived an expression for the ionization rate constant K of gas atoms under shock wave conditions. These conditions imply that the electron distribution by energy and K is a function of temperature T of heavy particles (atoms and ions) of an optically dense gas. T is assumed to be high enough to cause transition of an atom to the first excited state, i.e., ϵ is assumed to exceed E_1, the energy of the first excited state. At $\epsilon > E_1$, $f(t,\epsilon)$ differs from the Maxwellian function. The excitation cross-section σ_i of an atom under electron impact can, in effect, be described as a linear function of ϵ. Under the given conditions, $f(T_e)$ is expressed by a Fokker-Planck equation. Solution of this equation for f_2 made it possible to calculate K using the function of a parabolic cylinder $Dp(Z)$ and plots of $\lg(N_e/N_a)$ versus $\beta = E_1/T_e$ at the index p = const. In the region $p > 0$, $K = K(T_e)\Pi f_1$ differs the most from the Maxwellian, and K at a given T_e is consequently significantly lower ($\Pi < 1$) than in the region where f_1 is nearly Maxwellian ($\Pi \sim 1$), in other words the region of low T_e and a high concentration of N_e.

Derzhavina, A. I. and O. S. Ryzhov. The perturbation method in the problem of a short-duration shock. PMM, no. 5, 1971, 908-918.

The method of small perturbations was applied to solve the problem of propagation of a cold diatomic gas, initiated by a powerful shock of a short duration. A perfect gas with a heat capacity ratio $\varkappa = 7/5$ was assumed to occupy a half space adjacent to a vacuum. Shock wave propagation in the gas with superimposition of small perturbations is described by Euler equations with Hugoniot boundary conditions. The equations in linearized form were reduced to a single differential equation of the second order, which was transformed for a diatomic gas into a hypergeometric Gaussian equation, with or without allowance for counter-pressure. This equation was solved by calculus of variations of analytical functions near the singular point determining the position of boundary characteristics in the initial self-similar solution. According to this solution, the integral of energy near an infinitely distant point is divergent. To eliminate complications arising from this divergence, solution of the Euler equations was extended to a region with coordinates $x \longrightarrow -\infty$ using the method of joining external and internal asymptotic expansions. The random functions which determine density and pressure of a gas complete the description of flow in the internal region adjacent to a vacuum.

Generalov, N. A., V. P. Zimakov, and G. I. Kozlov. Infrared spectral method of plasma diagnostics and its application to xenon ionization and recombination behind a shock wave front. ZhETF, v. 58, no. 6, 1970, 1928-1937.

A reliable and sensitive method of plasma diagnostics in the region of relatively high electron densities e.g., $n_e = 5 \times 10^6/cm^3$ was developed and applied to the study of the electron avalanche and near-equilibrium regions behind a shock wave front in xenon. An experimental method for simultaneous recording of plasma emission and absorption of IR radiation ($\lambda = 10.6\mu$) by plasma behind a shock wave front is outlined. The experimental assembly comprised a CO_2-N_2-He laser, emitting 600μsec, nearly flat single pulses with 10 w power; a diaphragm-type shock tube with a 6 mm thick Ge window; an IR emission recording system with a filter to eliminate plasma emission during absorption measurement; and a system for measuring shock wave velocity. The experiments were carried out at 3 torr initial Xe pressure and Mach 11.2 - 12.7. Time profiles of N_e and the electron and atomic temperatures T_e and T_a were plotted using oscilloscope traces of emission and absorption and formulas derived on the basis of Kirchhoff's law. At M<12.7, the T_e and N_e profiles, in agreement with theory, exhibit a maximum corresponding to the equilibrium state of gas; both then decrease during plasma radiation cooling. The experimental N_e profiles were in satisfactory agreement with profiles calculated from a Saha equation. The experimental equilibrium N_e values also agreed well with the N_e calculated from shock adiabats for T<9,000°K. A plot of ionization rate constant α versus T_e (Fig. 1) was calculated using the experimental N_e and T_e profiles and a formula derived from the Saha equation. The experimental activation energy of ionization $E^* = (8.4 \pm 0.4)$ ev and the effective excitation cross-section $C_e = (5.7 - 5.8) \times 10^{-18}$ cm^2/ev were found to equal the excitation energy of the first electron level of Xe and about 1/3 the cross-section of nonelastic electron-atom collisions, in Xe, respectively. The recombination rate constant β of Xe^+, calculated from $\alpha/\beta = K(T_e)$ (Fig. 2) is in good agreement with theoretical β values obtained by modified diffusion approximation, but disagrees substantially with calculations based on a set of balance equations for discrete atomic levels.

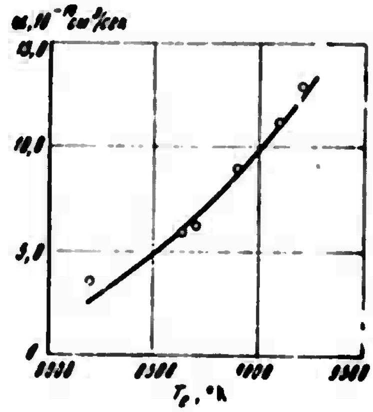


Fig. 1. Ionization rate constant of Xe versus electron temperature.

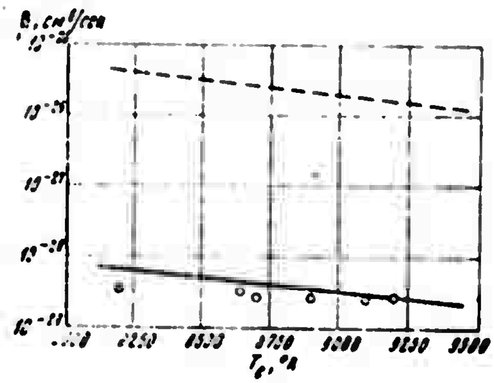


Fig. 2. Recombination rate constant of Xe^+ versus temperature in triple collisions; points - experimental values, solid curve - theoretical values of Biberman-Vorob'yev-Yakubov, dotted line - theoretical values of Chen.

Gogosov, V. V., and V. A. Polyanskiy. Discontinuities in electrohydrodynamics. PMM, no. 5, 1971, 761-772.

Electrohydrodynamic relations were derived for a nonremovable discontinuity with a dielectric constant and magnetic permeability equal to unity. Tangential, shock-contact, and shock wave discontinuities were analyzed using these relations, and assuming that the tangential component $E_{\tau 1}$ of the electric field equals 0 in front of the discontinuity. It was shown that parameters behind a shock wave front can be determined only when the intensity σ of the surface charge accumulated at a discontinuity and the normal component E_{n2} of the electric field behind the discontinuity front are given, along with shock wave parameters ahead of the discontinuity and the propagation velocity U_2 of discontinuity. The formulas,

$$E_2 = -u_2/b \qquad (1)$$

$$\sigma = \frac{1}{4\pi}(E_2 - E_1) = -\frac{1}{4\pi}\left(E_1 + \frac{u_2}{b}\right) \qquad (2)$$

where b is the mobility, derived from analysis of the shock wave structure, complete the description of parameters at a shock wave front. A surface charge forms at the shock wave front when there is a discontinuity of E_{n1} (i.e., when $U_2 + bE_1 < 0$, $U_1 > 0$, and $E_1 < 0$). The ionic density in this case may exceed the charge density in front of the wave by several orders of magnitude. A qualitative analysis of the shock wave structure permits a numerical solution of the electrohydrodynamic equations for a small interaction parameter. Analysis of the evolution of the shock waves shows that necessary conditions are: $U_{n1} > a_1$ and $U_{n2} < a_2$. An equation for the electrohydrodynamic shock adiabatic curve was analyzed for the case when the electric field behind the wave can be disregarded.

Gorelov, V. A. and L. A. Kil'dyushova. An experimental study of parameters of ionized air in front of a strong shock wave. MZhiG, no. 2, 1971, 147-151.

Electron and ion concentrations N_e and N_i, electron temperature T_e, and electrical conductivity σ of ionized air at 10 - 100 cm ahead of a shock front were measured in an electron discharge shock tube at an initial pressure p_0 = 0.2 - 0.5 torr and shock wave velocity V_s in the 8.4 - 11.3 km/sec range. Single or double probes, with plane-parallel or cylindrical electrodes, were placed along the flow channel axis at 4 m from the discharge chamber, to measure electron (I_{pe}) or ion (I_{pi}) saturation currents. The I_{pe} and I_{pi} data were used to calculate N_e, T_e, and N_i. Experimental plots of lg n_e versus x (the distance from the shock front) (Fig. 1) show:

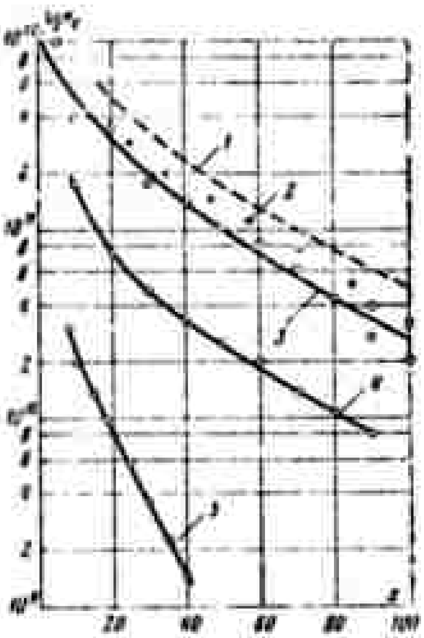


Fig. 1. Electron density distribution ahead of a shock wave front: 1 - literature data; 2 - single probe data; and 3, 4, 5 - double probe data at, respectively, p_o = 0.2, 0.5, and 0.5 mm Hg and V_s = 11.3, 10, and 8.4 km/sec.

N_e and N_i values ahead of the wave front, especially at V_s>10 km/sec; good agreement between single and double probe measurements; and satisfactory agreement between probe and UHF interferometric (curve 1) measurements. The possibility of studying a precursor ionization region by probes and an earlier conclusion that air photoionization is the main source of a significant N_e value ahead of the wave front were confirmed. The T_e in the precursor ionization region, based on slope of I-V characteristic of a single probe, was determined to be 4000 - 6000°K at 20 cm ahead of the front. Using auxiliary electrodes, conductivity σ was measured as 0.4 - 1.3 x $10^{-1}\Omega^{-1}$ cm^{-1} at p_o = 0.2 torr and V_s = 11.3 km/sec.

Ivanov, A. A., V. D. Rusanov, and R. Z. Sagdeyev. Electron shock waves in a collisionless plasma. ZhETF P, v. 12, no. 1, 1970, 29-31.

Dispersion of a cloud of hot electrons in a collisionless plasma is described by the nonlinear wave equation

$$\frac{\partial}{\partial t}\left(\frac{dn_\Gamma}{d\phi}\frac{\partial\phi}{\partial t}\right) = n_0 \frac{e\alpha^2}{3M}\frac{\partial^2\phi}{\partial x^2}, \qquad (1)$$

where n_Γ is the density of hot electrons and α is a constant for given ion and electron distribution functions. It is shown that dispersion of the hot electron cloud can lead to formation of a stationary compression shock of hot electrons due to a slowdown in propagation of the counter flow of cold electrons. Formation conditions of a compression shock were determined by analogy to a shock wave, from conservation laws. The "shock wave" formation depends on the velocity distribution function of the hot particles. Generally, the $n(\phi)$ dependence, which is determined by the distribution function, is complex and indicates a simultaneous diffusion and increase in wave steepness in different front areas. Information on the distribution function can be obtained from the shape of the front. It is concluded that heat waves in a collisionless plasma propagate according to the described mechanism and may be accompanied by formation of a steep wave front. A similar effect can be significant during plasma heating by a powerful relativistic beam.

Kestenboym, Kh. S., and Z. N. Kuzina. Propagation of a plane shock wave in an exponential atmosphere. MZhiG, no. 5, 1971, 31-35.

A boundary-value problem is formulated for an explosive shock wave in the plane X = 0. The shock wave propagates upward (X>0) and downward (X<0) in the atmosphere with an exponential density-height distribution (Fig. 1).

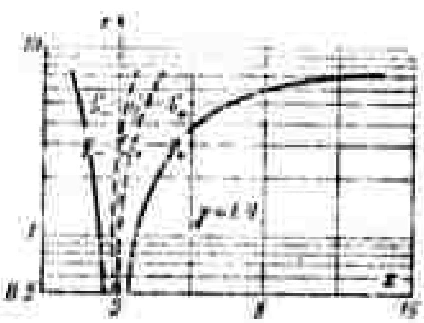


Fig. 1. Diagram of a plane explosion in an exponential atmosphere.

The problem is solved by approximation of implicit differences. Matching of a numerical solution for the G+ and G- regions with an asymptotic solution for an arbitrary Go region determines Go dimensions. The evolution of the planar explosion is calculated for Ag = Ap = 0, where Ag and Ap are gravity and counter-pressure parameters. Calculated characteristics of propagation are plotted for G+ and G- regions. It is shown that propagation in both regions has the characteristics of a boundary self-similar regime. The self-similar expressions are derived for a Lagrangian coordinate, and the velocity of the upper and lower fronts and the time of atmospheric breakdown are determined. The solution accounts for flow of energy from G- to G+ and is therefore more accurate than the approximation of sectors. The maximum errors for mass and energy balances were 3 and 2%, respectively. The error rate increases near the breakdown point.

Kosarev, V. I. Calculation of a supersonic steady gas flow with internal compression shocks. ZhVMMF, no. 5, 1971, 1263-1271.

A numerical analysis is made of complex structural flow past various bodies using a simplified computation method which neglects surface discontinuity discrimination. Equations for steady motion of a perfect gas were approximated by a set of difference equations which were solved for unknown flow parameters by the method of proportional parts with discontinuity smoothing in the difference solution. Graphical numerical solutions illustrate shock waves in the flow past bodies composed of two cones or separated by a conjugate zone; a spherically blunted or pointed head cone; a tail cone; or a conjugate zone. The graphs show the "hanging" shock position within the streamline flow under the given conditions. The internal hanging shock forms in a supersonic flow past a body when the characteristics emerging from the concavity region intersect before they reach the surface of the bow shock wave. Conditions under which an internal shock wave may be formed evidently could be generalized by analyzing a larger volume of data on streamline flow past bodies of the cited type. A maximum 3 - 5% discrepancy was found between the numerical solutions without surface discontinuity discrimination and those obtained by a continuous computation method. The simplified method described yields usable data on complex-structural flow with only a weak compression shock and a maximum angular shift of 15°.

Larin, O. B., and V. A. Levin. Study of the attenuation of a detonation wave with a two-front structure, using the boundary (shock) layer method. MZhIG, no. 3, 1971, 59-65.

The transition of a plane supercompressed detonation wave to a Chapman-Jouguet condition was studied in a two-front model, with allowance for changes in adiabatic flow parameters in the interval between shock wave and thermal shock fronts. Equations for the flow parameters between the fronts were derived from adiabatic gas flow equations in the interval between the fronts. The derived equations were solved by the Chernyy approximation method for the boundary (shock) layer, assuming that detonation wave intensity only slightly exceeds that of the Chapman-Jouguet wave. Application of the Chernyy method is justified here because the detonation wave velocity is high (on the order of several km/sec) and the gas is strongly compressed between the compression shock and the combustion front. Solution of the characteristic equation of the flow parameters was reduced to the problem of determining conditions which would satisfy the Hurwitz criterion. A necessary and sufficient criterion of detonation wave instability was then derived by solving the Hurwitz problem. This criterion is satisfied automatically for second and higher order reactions, and is nearly always satisfied for first order reactions as well, because of the high activation energy of detonating mixtures.

Lazovskaya, V. R. and G. K. Tumakayev. Measurement of concentration of excited mercury atoms behind a shock wave front by continuous recording of the shift of interference fringes. OIS, v. 31, no. 3, 1971, 483-484.

The time-dependence of $N_{\widehat{6p^3P_2}}$ concentrations of excited Hg atoms in the relaxation region behind a wave front was determined by continuous recording of interference fringe shifts in the spectral regions on both sides of the $\lambda \approx (5461 \pm 20)$ Å spectral absorption line. The concentrations ΔN_a and N_e of the atoms in the ground state and electrons were simultaneously determined in the equilibrium flow by the interferometric method of continuous recording with the use of Boltzmann and Saha equations. Typical interferograms of the two spectral regions are shown. They illustrate the changes in the refractive index of a plasma behind a shock wave front. The experimental curves in Fig. 1 show that changes in $N_{\widehat{6p^3P_2}}$ and N_e follow the same pattern. The

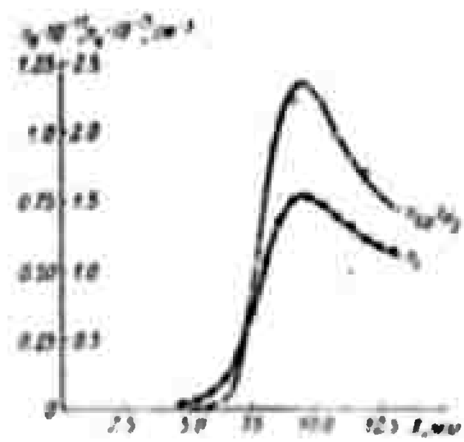


Fig. 1. Distribution of concentrations of the Hg atoms in excited state ($N_{\widehat{6p^3P_2}}$) and of electrons (N_e) at M = 10.3 and 7.2×10^{16} cm^{-3} initial concentration of Hg atoms in ground state.

minimum measurable $N_{\widehat{6p^3P_2}}$ was of the order $10^{14}/cm^3$ using the cited method, compared to a value of about $10^{13}/cm^3$ obtained by the Hook method. The cited method can be used in plasma diagnostics, e.g., in a pulsed discharge.

Akhiyezer, A. I., and R. V. Polovin. Oscillation profile of a shock wave in plasma. UFZh, v. 16, no. 9, 1971, 1467-1472.

A theoretical study was made of the effect of internal friction in ion and electron plasma components of a shock wave structure. A shock wave propagating in a negative direction along Z axis is described by two linear equations for the regions in front and behind the wave, i.e., at $Z \rightarrow \pm \infty$. The equations were derived from hydrodynamic equations of motion and Maxwell equations, assuming electron frictional viscosity to be negligible. The shock wave profile at $Z \rightarrow \pm \infty$ is oscillatory if the imaginary parts of the constants μ_1 and μ_2 in

$$\mathrm{Re}\,\mu_1 > 0, \quad \mathrm{Re}\,\mu_2 < 0. \qquad (1)$$

differ from zero. The linear equations are solved for μ_1 and μ_2 in two boundary cases. In the case of an intrinsic ion viscosity $\nu_i \gg \nu_m$, (magnetic viscosity), five roots ($\mu_1^{(1)}$, $\mu_1^{(3)}$, $\mu_1^{(4)}$, $\mu_2^{(1)}$, and $\mu_2^{(2)}$) were found to satisfy the conditions in (1). Shock wave width is expressed by

$$L \sim \max \frac{1}{|\mathrm{Re}\,\mu_{1,2}|}. \qquad (2)$$

where $\mu_{1,2}$ is the root $\mu_1^{(4)}$ whose real part is lowest in absolute value. By substituting the $\mu_1^{(4)}$ value for $\mu_{1,2}$ in (2) shock wave width L was found to be inversely proportional to the magnetic field H. In the case of $\nu_i \ll \nu_m$, L was found to be directly proportional to H. In both cases, L was proportional to the mean free path and the oscillation period $\Lambda = \lambda$. The shock wave profile therefore depends essentially on relative values of intra- and intercomponent friction in the plasma.

Biberman, L. M., A. Kh. Mnatsakanyan, and I. T. Yakubov. Ionization relaxation behind strong shock waves in gases. UFN, v. 102, no. 3, 1970, 431-462.

Experimental and theoretical studies on shock wave propagation in gas published in 1957-1970 are reviewed and some unsolved problems of ionization relaxation are indicated. About 45% of the 116 literature citations are to Soviet publications. The review centers on ionization kinetics in low-temperature plasma, the mechanism of initial ionization, and structure and radiation of the relaxation region. The survey data on ionization and recombination kinetics in atomic plasma clarifies the role of electron shock and the effects of radiation and interatomic collisions on kinetics and electron energy balance. Data on atomic-molecular collisions, radiation transfer, and processes involving impurities are examined as possible causes of ionization in the initial relaxation stage. Theoretical data are compared with experimental data on plasma parameters and relaxation times in the relaxation region behind shock waves at M = 10-20 and M = 30-40 in monoatomic and molecular gases. Radiation in the recombination region is examined in terms of: the distribution of excited states of an atom in a nonequilibrium plasma; nonequilibrium spectral lines and continuum emissions; and the effect of relaxation on aerodynamic heating in hypersonic streamline flow.

Borisov, A. A., B. Ye. Gel'fand, S. A. Gubin, S. M. Kogarko, and O. V. Krivenko. Shock wave attenuation in a two-phase gas-liquid medium. MZhiG, no. 5, 1971, 176-180.

Shock wave parameters were measured in a N_2 - H_2O mixture in a vertical shock tube at three different H_2O concentrations in the 0.25 - 1.04 g/cm range. Flow time δt was variable behind the wave front, which was controlled by the variable length of a high-pressure chamber. Diameter of water droplets was 1 and 2.5 mm. The purpose was to analyze the effect of fragmentation of water droplets on shock relaxation in a two-phase mixture. Tabulated experimental data and plots of $\varphi = \delta p / \delta p_0$ versus Mach number M show that a decrease in δt beyond a certain value does not affect shock wave propagation in the presence of the liquid phase. The critical δt^* at which transition occurs from $\varphi < 1$ to $\varphi = 1$ was determined experimentally for M in the 1.07 - 1.3 range, and the time τ of the onset of droplet fragmentation was calculated. Both τ and δt^*

were expressed by Strouhal numbers S and S*. The S versus M plots indicate that relaxation interaction of shock waves with the two-phase mixture and parallel shock wave attenuation become significant, with intense fragmentation of water droplets behind the wave front. Formulas were derived for the limits of the relaxation region. Analysis of the experimental data reveals that a stepwise change in shock wave parameters is related to an intensive destruction of droplets at a time close to τ .

Borisov, M. B., S. G. Zaytsev, Ye. I. Chebotareva, and Ye. V. Lazareva. Experimental study of shock wave interaction with a magnetic field. MZhiG, no. 3, 1971, 153-163.

Argon plasma flow created by an ionizing shock wave S was studied in an experimental arrangement consisting of a diaphragm-type shock tube and a Faraday-type magnetogasdynamic channel with sectional electrodes positioned along the channel. One electrode pair was short-circuited to achieve a maximum turbulence effect in the hypersonic flow. A maximum value of the magnetogasdynamic interaction parameter Q was obtained by setting initial Ar pressure at 5 torr, at $M_s = 12$, flow temperature $\approx 11{,}000^{\circ}K$, and transverse magnetic field induction = 1.5T. Using the interferometric plasma diagnostics technique, a recording was made of shock front formation T (drag wave), which at time $t^* = 25 - 30\ \mu$ sec begins to propagate towards the channel entrance. Trajectories of S and T waves are shown in and beyond the channel (Fig. 1). An

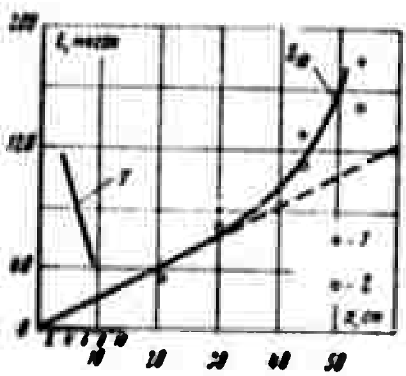


Fig. 1. Trajectory x-t of the shock and drag waves at $M_s - 13 \pm 0.2$. S_{10} is the calculated trajectory.

experimental profile shows T formation and propagation at different times. The measured density ρ and concentration of charged particles in the channel behind T revealed an approximately uniform flow in the center of the channel at some distance from T. The experimental intensity of T, drag on S, distribution of ρ and degree of ionization in the subsonic region behind T, and t* agreed with corresponding theoretical values within 10 - 20%.

Muminov, M. M. Effect of diaphragm opening time on gas flow in shock tubes. IN: Volny v neuprugikh sredakh. AN Mold SSSR. Kishinev, 1970, 173-181.

In connection with research on the problems of atmospheric reentry of satellites, supersonic gas flow in motors, strong explosions, and electrical discharge, shock wave intensity $\overline{p}$ along a shock tube was calculated at an initial pressure differential P'_o/P''_o in the 10^4 - 10^6 range. Calculations were based on a gas flow model in which gas volume in each chamber of the tube is divided into 20 parts separated by impermeable cross-sections. Gas particle propagation, within the framework of the model, was described by ordinary differential equations in Lagrangian coordinates. Allowance was made for the diaphragm opening time by introducing the linear relation

$$z_t = \frac{l}{t_{op}} \cdot t \qquad (1)$$

for the aperture radius Z_t, as a function of opening time t_{op} and the radius r = 0.0375 m of the high-pressure chamber. The flow in the opening diaphragm is approximated by the flow along two truncated cones tapering off at the diaphragm. Cone vertex radius varies with t_{op} from 0 to l and (1) is in agreement with experimental variations of the aperture cross-section area. Plots of $\overline{p}$ versus tube length $\overline{Z}$ (dimensionless) at t_{op} = 0.5 - 1,000 μsec with He as a driver gas and air as compressed gas, show a strong effect of t_{op} on $\overline{p}$ at the initial $P'_o/P''_o > 10^4$. This effect is due to the formation of a second shock wave which overtakes the first and strongly affects its $\overline{p}$ along the tube. The merging coordinate of the two shock waves moves further along the tube, when P'_o/P''_o is increased. At $P'_o/P''_o = 10^6$, $\overline{p}$ at any t_{op} is significantly higher than $\overline{p}$ after instantaneous opening, because $\overline{p}$ in the latter case is determined by P'_o/P''_o on the second decompression wave and not by a much higher P'_o/P''_o. A plot of the shock wave velocity $d\overline{Z}/d\overline{t}$ versus coordinate $\overline{Z}$ (Fig. 1) shows a discrepancy between the calculated (upper) curve for H driver gas and Ar compressed gas $P'_o/P''_o = 10^4$ and t_{op} = 1,000μsec, and the corresponding experimental (lower)

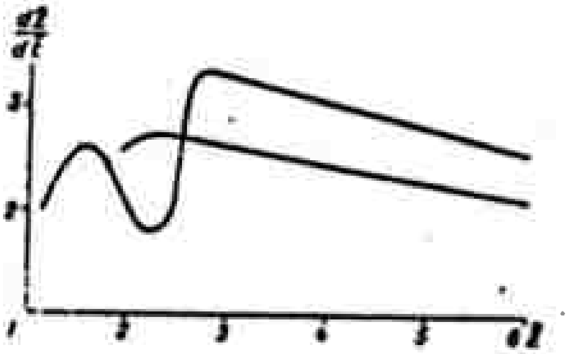


Fig. 1. Shock wave velocity versus tube length coordinate.

curve. This discrepancy is due to a disregard of the losses at the opening diaphragm. Experimental data confirmed the calculations of $\overline{p}$ and $d\overline{z}/d\overline{t}$ variations of non-stationary shock wave propagation.

Magnetova, N. N., N. T. Pashchenko, and Yu. P. Rayzer. Structure of a shock wave with multiple ionization of atoms. ZhPMTF, no. 5, 1970, 11-21.

The structure of a very strong shock wave at an equilibrium temperature on the order of hundreds of thousands of degrees and multiple ionization kinetics behind the wave front were calculated. A plane shock wave was assumed to propagate in a monatomic gas in an infinite space. The one-dimensional stationary flow of a multicomponent gas mixture is described by differential equations for ionic energy, heat conductivity, and ionization kinetics. The equations together with three conservation integrals and certain boundary conditions were used to determine shock wave structure. A simplified kinetic equation was substituted for the initial set of equations by introducing an approximation value of equivalent ions with one fractional charge $\langle m \rangle$ coincident with the ionization level α. This method of approximation, introduced by Yu. P. Rayzer, made it possible to derive formulas for the ionization potential and the excitation rate constant. Two other kinetic constants, the time of the electron-ion energy exchange and coefficient of electron heat conductivity, were calculated using known formulas. The solution of the modified equations for derivatives $d\theta_e$ and $d\theta$ of dimensionless electron and ionic temperatures reduces to the two equations

$$\frac{d\theta_e}{d\alpha} = \frac{f_2(\alpha, \theta, \theta_e)}{f_1(\alpha, \theta, \theta_e)}, \qquad \frac{d\theta}{d\alpha} = \frac{f_3(\alpha, \theta, \theta_e)}{f_1(\alpha, \theta, \theta_e)} \tag{1}$$

where α is considered to be an independent variable. The equations (1) and the algebraic equation of density

$$n^2\vartheta - an + 1 = 0 \tag{2}$$

where

$$\vartheta = \theta + \alpha\theta_e, \quad a = 1 + \vartheta_0, \tag{3}$$

solve the shock wave structure problem. Equations (1) indicate that an integral curve linking the singular, equilibrium points in space in front of and behind the shock wave represents the solution. The near-equilibrium state of the system is determined by a characteristic third degree equation

$$\lambda^3 - J_1\lambda^2 + J_2\lambda - J_3 = 0 . \tag{4}$$

Evaluation of the invariants J_k in (4) disclosed a considerable electron heat conductivity effect on the wave structure, producing noticeable gas ionization in front of the shock wave. Analysis of the roots of (4) revealed that in the near-equilibrium state behind the wave $\theta = \theta_e$ and $d\theta/d\alpha < 0$, hence T_e is at a maximum in the wave. Graphical presentation of the θ, θ_e, α, and n data calculated for air at three sets of initial N_0, D, and T values confirmed the conclusions.

Zagorodnikov, S. P., G. Ye. Smolkin, Ye. A. Striganova, and G. V. Sholin. Measurement of turbulence level of a magneto-acoustic collisionless shock wave by means of stark splitting of H_β Balmer line. ZhETF P, v. 11, no. 10, 1970, 475-478.

Development of turbulent electrostatic oscillations in hydrogen plasma was studied by measuring splitting $(\Delta\lambda)_{exp}$ of the H_β line of a Balmer series. The oscillations were generated by a magneto-acoustic shock wave propagating in parallel $\tilde{H}$ or transverse H_p magnetic fields. Measurements of $(\Delta\lambda)_{exp}$

were made in front of, at, and behind the shock wave in the θ pinch regime at a 8×10^4 sec^{-1} frequency and a 5 koe amplitude H_1 of magnetic field. Plasma radiation was analyzed by high-speed electro-optical spectrochronography using a Fabry-Perot interferometer combined with an ISP-51 spectrograph. The mean intensity of the nonequilibrium electric field behind the shock wave front was evaluated (as a function of $(\Delta \lambda)_{exp}$), to be 17 and 20 times higher than the mean interparticle field $E_o = 2.6\ eN^{2/3}$ in the case of H and H_p magnetic fields, respectively. The corresponding turbulence level $\xi_1 = E^2/8\pi NT$ of electrostatic low-frequency oscillations was 0.5×10^{-2}. At the front itself, the profile of the H_β line verified the existence of nonequilibrium electric fields of high-frequency (Langmuir) oscillations. The ξ_o at the wave front was determined to be $= 5 \times 10^{-3}$. Findings show that high-frequency noise develops much more rapidly and relaxes earlier than low-frequency noise.

Zaytsev, S. G., and I. K. Favorskaya. Calculation of shock wave propagation in a magnetogasdynamic channel. MZhiG, no. 5, 1970, 180-184.

Gas flow velocity u, Mach number M, density ρ, temperature T, and ionization level α were calculated behind a shock wave propagating along a magnetogasdynamic channel across a magnetic field. Shock wave propagation was described by a set of differential magnetogasdynamic equations, equations of state, and Ohm's law, approximating one-dimensional flow. The approximation assumes that the induced current is drawn off by means of a sectional electrode system. The effect of induced magnetic field is also disregarded, because the magnetic Reynolds number is considered to be < 1. Numerical solution of the set of equations in Lagrangian coordinates takes into account an artificial viscosity ω by substituting the function $G = p + \omega$ for p. A thin transitional layer is thereby substituted for a discontinuity surface. The set of equations approximated by implicit differential schemes is then solved for the flow parameters by an iteration method developed by Tikhonov and Samarskiy. Computation results are shown in Fig. 1 for Ar at $M_s = 12$ and magnetic field intensity = 2 tesla units. Computations were made for the length of the interaction region with magnetic field L = 1 and 14.5 cm, and 1, 5, 10 torr pressures in front of the incident wave. Compression wave formation is brought about by a drag on particles in the channel, as the result of ponderomotive force action. The compression waves create T^* at a time t^* in point x^*, where the region of maximum change in gas parameters begins. The simultaneously formed expansion wave causes attenuation of the wave S. Formation of a T-layer in the region of contact discontinuity and a simultaneous increase in α peak along

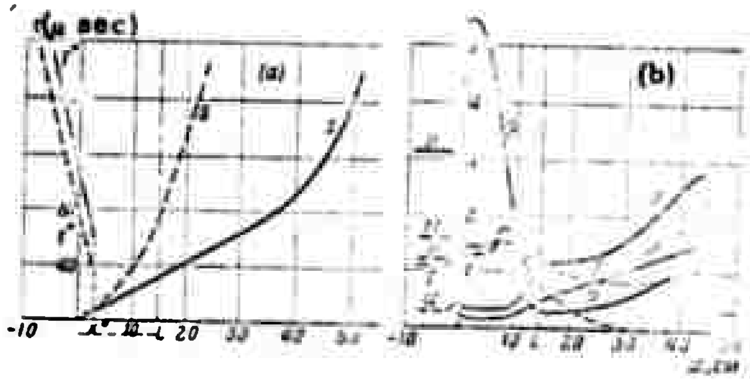


Fig. 1a. Trajectories of ionizing shock wave S and drag wave T* propagating in the channel at distance $0 \leq x \leq L$: solid line - with allowance for relaxation; dotted line - relaxation time = 0.
Fig. 1b. Flow parameters distribution along propagation direction.

$0 < x < L$ region is shown. Comparison of ρ computations with experimental data revealed a satisfactory agreement which supports application of the computation method to the description of shock wave propagation in a pulsed magnetogasdynamic channel.

Sinkevich, O. A. Stability of a plane ionizing shock wave. DAN SSSR, v. 199, no. 1, 1971, 48-50.

Stability of a supersonic shock wave front is analyzed with respect to small shifts of the frontal plane from the equilibrium position. The wave propagates with the yOz plane in the direction $x < 0$. Electrical conductivity behind the front is assumed to be $= \infty$. The initial shift is given by

$$\xi(y) = \xi_0 e^{ik_y y}. \quad (1)$$

Linearized equations with boundary conditions describe small perturbations of gas dynamic parameters behind the shock front. These perturbations are seemingly caused by a small initial shift from the equilibrium position. Only perturbations which propagate in a plane perpendicular to an unperturbed magnetic field are considered. Variations in amplitude $\xi(t)/\xi_0$ of the shift are expressed by an integral. Integration by the method of steepest descents gave the condition of stability of the plane shock wave front,

$$\xi(t)/\xi_0 \sim t^{-1/2} \tag{2}$$

which differs from the condition obtained for a finite σ. In the analyzed case, the existence of the stable and unstable regions and a region of neutral oscillations was deduced from the cited integral expression. The relative positions of these regions shift with changes in magnetic field induction and a derivative along the shock adiabatic curve.

Poluboyarinov, A. K. and N. I. Spirin. <u>Interaction of a shock wave with a tangential discontinuity.</u> I-FZh, v. 21, no. 2, 1971, 251-256.

Flow instability is examined for noncalculable supersonic jets reflected from an obstacle and interacting with a line of tangential discontinuity. A shock wave equation was derived in the form

$$A\xi^3 + B\xi^2 + C\xi + D = 0, \tag{1}$$

where ξ is a parameter of shock intensity and the coefficients A, B, C, D are functions of $k = C_p/C_v$ and Mach numbers M_1 and M_2 of gas flow below and above the line of tangential discontinuity, respectively. The computed real roots ξ of (1) were plotted versus M_2 = 1-20 at M_1 = 1-6. The $\xi = f(M_2)$ plots were used to determine the relative M_1 and M_2 values for which a stable stationary interaction is possible between the compression shock and tangential discontinuity. The region of stability is shown to the right of the BAC line in Fig. 1. In the case of a shock wave reflected from an obstacle, the region of

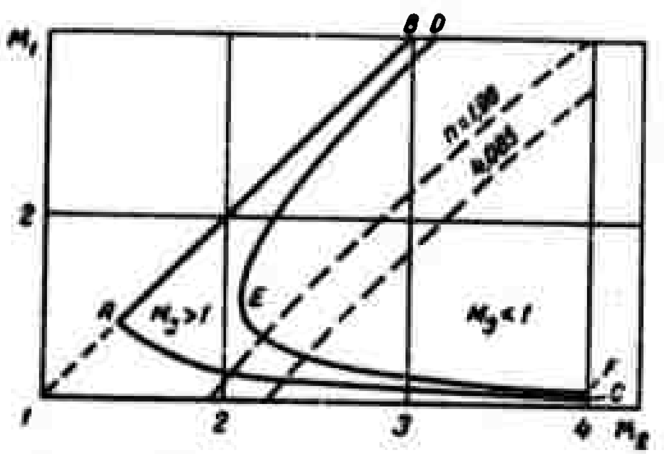


Fig. 1. The region of M_1 and M_2 values, in which stationary interaction is possible.

stable interaction ($M_3 < 1$) is reduced to that shown to the right of the DEF line. The configuration of the region of stable interaction in this case suggests that a stationary position of the reflected shock is impossible in the underexpanded jet zone immediately behind a critical cross-section of the near-axial flow from the Mach disc.

Maksimov, A. M., and Yu. A. Nikuyev. Discharge characteristics in an induced electric field in argon behind a shock wave front. TVT, no. 2, 1971, 236-239.

Current-voltage characteristcs and the time sweep of discharge between cold W and Cu electrodes in an MHD channel were studied in a supersonic argon plasma, both in the presence and absence of a transverse magnetic field. The region of weak currents was carefully examined to measure the breakdown voltage U_0. The I-U characteristics (Fig. 1) show that U_0 measured

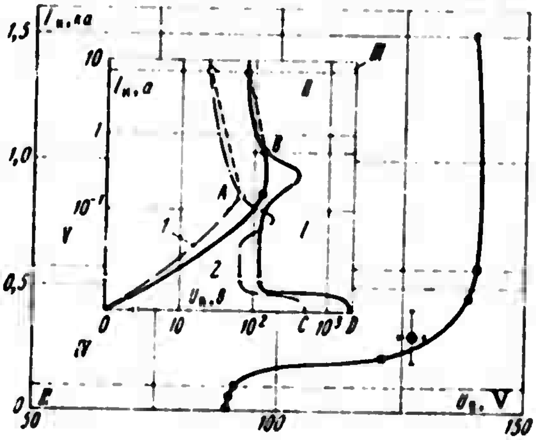


Fig. 1. Current-voltage characteristics of discharge between W electrodes in applied (1) and induced (2) electric fields (B - 1.25 T, R-variable). A, C-U_0 in field (1), with and without preliminary ionization; B, D-in field (2).

in field (1) at B = 0 is lower than U_0 calculated in the absence of ionization at B = 0 (65 vs 500 V), and U_0 at B = 1.25 T equals 140 V (at the end of sector I of the characteristic). The II and III sector boundaries indicate transition from high-pressure glow discharge to arc discharge. The substantial increase in conductivity in sector V is due to the Joule energy dissipation which becomes large enough to produce ionization in approximately 1 μsec. Assuming that breakdown occurs in the cathodic surface layer, the cited data and U_0 data at a variable B and a constant load were in good agreement with a theory in the literature which accounts for a decrease in electron mobility in a transverse magnetic field. Photographs are given of time sweeps of the arc discharge at B = 1.25 T showing a stretching of arc in the direction of propagation and periodic breakdowns along the chord of the stretched arc as the result of arc interaction with supersonic gas flow. These phenomena lead to formation of inhomogeneous conductivity regions in the MHD channel.

Naboko, I. M. and T. V. Bazhenova. Flow parameters in CO_2, N_2 and CO_2-N_2 mixtures behind a shock wave. TVT, no. 3, 1971, 550-556.

Nonequilibrium values for Mach number M_2 were calculated for the flow immediately behind a shock wave front under a variety of assumptions concerning molecular vibrational excitation and dissociation. The front propagated at M_1 = 5-10 in CO_2-N_2 mixtures and in pure N_2 and CO_2. The best agreement between the calculations and the earlier experimental M_2 data was obtained under assumptions of the absence of asymmetric stretching vibration and dissociation in CO_2, as well as of molecular vibration of N_2 in pure N_2 and the CO_2-N_2 mixtures. The boundary layer effect along the wall of a shock tube on values of M_2 and flow velocity along the vapor lock was evaluated experimentally and theoretically on the basis of the method of Mirels. The M_2 data calculated for N_2 without allowance for boundary layer effect were 10% higher than the experimental M_2 data obtained at a distance greater than or equal to 1/3 of the length of vapor lock. The agreement between calculated and experimental M_2 in N_2 and a 70% N_2-30% CO_2 mixture was improved by introducing a correction calculated by the Mirels method. In contrast, a correction for M_2 in CO_2 and a 75% CO_2 - 25% N_2 mixture by this method increased the discrepancy with the experimental M_2 because of a different flow structure in a gas with complex molecules. The difference in flow structure between an N_2 or N_2-rich mixture and CO_2 was evident in Shlieren photographs of the streamline flow in a shock tube. It was concluded that the flow behind a shock wave with M = 5-10 at 1 atm pressure does not attain equilibrium in 100 - 150 μsec, dissociation does not occur, and N_2 molecular vibration and CO_2 asymmetric stretching vibration of CO_2 are absent.

Sysun, V. V., Yu. G. Basov, B. V. Skvortsov, and V. I. Roldugin. Optical phenomena in the interaction of opposing shock waves with gas discharge plasma. TVT, no. 2, 1971, 257-261.

Plasma emissions were studied experimentally in an H-form Xe-filled discharge tube (Fig. 1) in an effort to improve the characteristics, and expand applications of pulsed gas discharge sources of optical emissions.

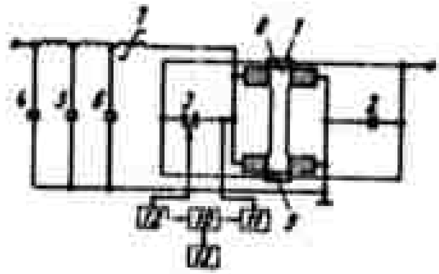


Fig. 1. Schematic diagram of an experimental H-shaped discharge device.

The optical emission in this tube device results from interaction between two opposing strong shock waves and between the fronts of the reflected waves and the gas discharge plasma. The shock waves were generated between two parallel discharge gaps located at opposite ends of a 108 mm long quartz tube (1) at 50 torr Xe pressure. An initial low-energy flash was created by the discharge of a battery of capacitors (4, 5, 6) of a total inductance of 40 μ H, which increased the rise time of the following short flash current by diminishing the thermal shock effect on the walls of the flash-lamp. A second main flash initiated by the discharge of a low-inductance ($\sim$ 0.3 μ H) capacitor battery (2) at 15-29 kV was delayed by 100 μ sec relative to the start of the first flash. High-speed photorecordings and x-t plots of the shock wave propagation show that the maximum energy of the short (10-50 μ sec) discharges is increased by a factor of 5 and erosion of the electrodes and wear of the tube is decreased in the H-form device, in comparison to standard cylindrical lamps of an equal capacity. The experiments thus demonstrate the feasibility of designing high-intensity pulsed light sources with short flash times.

Morozova, I. V., and Ye. I. Ruzavin. Optimum parameters of a double-diaphragm shock tube with allowance for the boundary layer behind a shock wave in the middle chamber. MZhiG, no. 3, 1971, 53-58.

Optimum parameters of shock waves S_1 and S_2 (see Fig. 1) are described

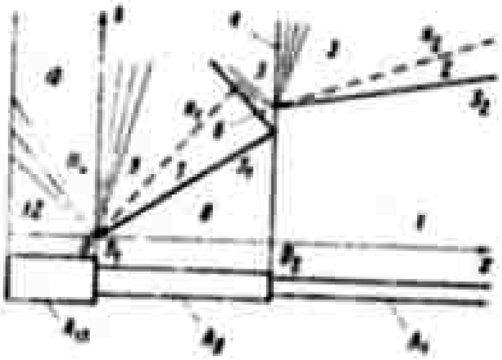


Fig. 1. Wave system in a double-diaphragm shock tube: t - time, x - distance; 1-12 - regions of uniform parameters; A_1, A_8, A_{12} - cross-sections of chambers; K_1, K_2 - contact surfaces.

by a set of 19 equations. Allowance was made for perturbations Δp_7, caused by the boundary layer in the middle chamber, by introducing the parameter

$$G = (l_8/d_8)^{n+1}[p_8\gamma_8 d_8/(a\mu)_8]^n \qquad (1)$$

where l_8 and d_8 are the length and ID of the middle chamber, μ is the viscosity coefficient, and $n = -\frac{1}{2}$ or $-1/5$ for a laminar or a turbulent boundary layer, respectively. Using the cited equations, optimum M_{s8} and U_3/a_8 parameters were calculated for different p_{12}/p_3 values in a shock tube with $A_{12}/A_8 = A_8/A_1 = 1$ and chambers 8 and 12 filled with hydrogen. Tabulated data calculated both without allowance for boundary layer ($G = 0$) and with allowance for laminar ($G_e = 0.01 - 0.1$) and turbulent ($G_t = 0.5 - 3.0$) layers, yield optimum parameters for a tube of known geometry, a known gas in chamber 1, and any two parameters. A comparison of the velocities U_2 and U_2^* of S_2

calculated with and without allowance for the boundary layer behind S_1, respectively, with the U_2^0 data measured at $l_8 = 2m$, $d_8 = 0.05m$, $p_{12} = 200$ atm, and $p_1 = 0.01$-10 torr shows that U_2^0 is consistently closer to U_2^* than to U_2^{**}. It is concluded that U_2^* data more effectively approximates experimental $\bar{U}_2$ in a double-diaphragm shock tube.

Testov, V. G., Yu. S. Lobastov, and T. V. Bazhenova. Study of nonequilibrium ionization by means of microwave radiation in a shock wave propagating in argon. ZhTF, no. 6, 1971, 1196-1200.

Testov, V. G., Yu. S. Lobastov, and T. V. Bazhenova. Study of ionization relaxation behind the front of a reflected shock wave in argon. TVT, no. 4, 1971, 849-851.

Experimental results are presented for self-radiation, absorption, and reflection of microwaves at 12.5 GHz ($\lambda = 2.4$ cm) in Ar heated by a shock wave at a 2 - 10 torr initial pressure and 6 - 9 M_0 velocity of the incident wave. This study was carried out in a shock tube, with the aim of clarifying the problem of initial ionization of monatomic gases by using microwave radiation. This thermal radiation provides information on electron temperature T_e and electron concentration N_e in the plasma. The experimental set-up, measurements and oscilloscope recordings of self-radiation, and the absorption coefficient are described. Radiation detected at a distance of 15 cm in front of the compression shock indicated the presence of free electrons with $N_e = 0.01$ of the equilibrium value behind the shock wave. A delay in absorption of electromagnetic waves in relation to emission pulse indicated further that microwave emission in front of and behind the shock wave is epithermal at $N_e < 10^{10}/cm^3$. The observed pre-ionization under the experimental conditions was shown to be caused by a sodium impurity of $\sim 10^{-5}$% in the shock tube.

More discussion of the same experiment is given by the authors in the second source reference. Here they also note that ionization relaxation time behind the reflected wave, as a function of Mach number, showed systematically higher values than the adjusted results of Rayzer et al (PMTF, 1, 140, 1968). It is concluded that ionization in the reflected wave is considerably slower than in the incident wave under the same conditions, because of large radiative losses in the former.

Yefimov, A. S. Propagation of shock waves in a free space. MZhiG, no. 5, 1971, 163-166.

Emergence of a shock wave from an axisymmetric channel and its propagation into a free space are analyzed by the method of characteristics. Propagation from the channel cut-off through an infinite medium of an ideal gas is described by nonlinear equations of motion,

$$\frac{dy}{dx} = \frac{S \pm f}{1 \mp Sf}, \qquad dS \pm \frac{1+S^2}{f}\frac{dM}{M} \pm \frac{Sf(1+S^2)}{S \pm f}\frac{dy}{y} = 0 \qquad (1)$$

where S and f are independent variables, and x and y are coordinates of the frontal points in the direction of the symmetry axis and perpendicular to that axis, respectively. Problem solution was consequently reduced to calculation of one-dimensional waves propagating along and interacting with the shock wave front surface. The method of characteristics was applied starting from the first characteristic emerging from the angular point x = 0, y = 1 and described by an equation for a straight line. The flow parameters in the region immediately adjacent to the shock wave front were computed for initial Mach numbers M_a = 1.6 - 20.0 and a 1.4 ratio of specific heat capacity $\varkappa$. Families of x(y) curves computed for different times at M_a - 4.0 and M show that the wave front becomes curved and at $\varkappa > 12$ nearly spherical, while shock intensity decreases in both directions. Nearly self-similar formulas were derived from the data by introducing the variables x, relative to the length of undisturbed region, and ξ_0, a characteristic of the pressure differential at the shock wave front.

Zolotovskiy, O. A., V. I. Koroteyev, R. Kh. Kurtmullayev, and V. N. Semenov. A thermal shock wave in plasma. DAN SSSR, v. 197, no. 3, 1971, 564-567.

Heat transfer in a collisionless plasma along a magnetic field was investigated in a UN-4 device under conditions favorable to generation of shock waves. Turbulent heating of a hydrogen plasma was accomplished in a cylindrical vessel, by mutual annihilation of two counter magnetic fields: a longitudinal quasi-stationary field $H_0 \cong 200$ - 1,800 oe, and a rapidly variable $H_\sim$ field induced by a narrow coil at one end of the plasma volume. The measurements indicate that the magnetic field and plasma density in the turbulent region decrease simultaneously with the appearance of hot electrons. The experimental profiles of magnetic field, hot electron concentration, and plasma potential in the (1 - 6) x $10^{13}/cm^3$ region of initial densities N_0(A region) differed sharply from profiles in the $N_o < 10^{13}/cm^3$ region (B region). The data were interpreted in terms of the counter flow of cold electrons created by the hot electron cloud generated by the induction coil. The existence of the stationary front in the A region is related to the friction between cold electrons and ions, caused by acousto-ionic instability. The measured magnetic field front parameters agree with theoretical thermal shock wave parameters. It is concluded that stationary propagation of the shock wave type could be achieved by dispersion of a hot electron cloud along a magnetic field. Heat generated in the wave is transferred by hot electrons only.

Tumakayev, G. K., T. V. Zhikhareva, and V. R. Lazovskaya. Kinetics of physico-chemical processes in mercury vapors in a shock tube. I. State of gas in front of a shock wave. ZhTF, no. 9, 1971, 1986-1995.

A theoretical analysis was made of the kinetics of excitation and ionization of Hg atoms ahead of a shock wave front with allowance for a combination of the predominant radiative atom-atom and electron-atom collision processes. The rates of elementary processes and kinetics of electron gas heating were calculated at 2 cm ahead of an incident shock wave propagating at M = 10 in a shock tube with radius R = 3.65 cm. Concentrations of the absorbing, 6^3P_1 emitting, and 6^3P and 6^3P_2 metastable atoms were assumed to be 2 x 10^{17}, 10^{13}, 0.8 x 10^{13}, and 0.7 x $10^{13}/cm^3$, respectively, and relaxation zone length to be 0.92 cm. The analysis was based on the authors' earlier experimental data on the population of the $6^3P_{0,1,2}$ states ahead of the front of a shock wave, and on Western source data on resonance radiation diffusion, gas discharge, and plasma decomposition. The electron gas temperature was found to be T_e = 6000°K versus a 500°K atomic temperature. This heating of electron gas highlighted the importance of nonelastic electron--atom collisions in the population of $6^3P_{0,1,2}$ states within a limited region ahead of the shock wave. The cross-sections of atom-atom collisions for the $6^3P_0 \rightleftarrows 6^3P_1 \rightleftarrows 6^3P_2$ transitions and the rate constant of formation of the excited Hg molecule are also calculated. When the cited values are constant, associative ionization is the predominant process.

Tugazakov, R. Ya. and A. S. Fonarev. Initial collision phase between blast waves. MZhiG, no. 5, 1971, 41-48.

A mathematical analysis was made of the collision of two blast waves propagating in opposition as well as blast wave reflection from a plane, cylindrical, or spherical wall. Collision was analyzed in its initial phase assuming a random distribution of gas parameters, i.e., p, ρ, and u, behind the wave front. Each of the four regions formed by collision of two plane waves (Fig. 1) is described by a set of gas dynamic equations with boundary

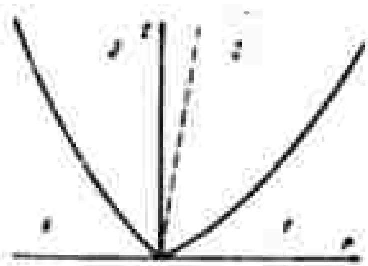


Fig. 1. Diagram of collision of two plane waves in the rt plane: r - coordinate, t - time, dotted line - contact discontinuity.

conditions. A solution of these equations for p, ρ, and u in the first approximation (for regions 2 and 3) is presented in the form of linear functions

$$p_{ii} = A_i + B_i\xi, \quad u_{ii} = C_i + H_i\xi, \quad \rho_{ii} = F_i + G_i\xi \qquad (1)$$

where ξ = r/t and A_i, B_i, C_i, F_i, G_i, H_i are arbitrary constants. The conditions for determining these constants were formulated for given parameters in regions 1 and 4. The linear functions (1) and the formulas for unknown constants were applied in a specific case characterized by p(r) and ρ(r) plots for different t. The parameters p_2, ρ_2, and U_2 in region 2 behind a blast wave reflected from a rigid wall were formulated as functions of ξ and t using (1). It was shown that in a first approximation p_2 is a function of t only, and U_2 is a function of r only. A specific example of p_2, ρ_2, and U_2 calculations demonstrates the applicability of linear formulas to a description of the initial phase of wave reflection.

B. Recent Selections

1. Shock Wave Effects

Aleksandrov, V. V. Phase plane method solution of one-dimensional problems in radiative gas dynamics. MZhiG, no. 1, 1972, 144-155.

Alekseyev, Yu. L., V. P. Ratnikov, and A. P. Rybakov. Impact adiabats for porous metals. ZhPMTF, no. 2, 1971, 101-105. (RZhMekh, 10/71, #10V808)

Al'tshuler, L. V., and M. N. Pavlovskiy. Magneto-electric method for determining the density in front of colliding shock waves. ZhPMTF, no. 2, 1971, 110-114. (RZhMekh, 9/71, #9B13)

Anufriyev, V. M., G. I. Kozlov, and D. I. Roytenburg. Diffuser characteristics in an aerodynamic shock tube. MZhiG, no. 1, 1972, 156-161.

Aslanov, S. K., and P. I. Kopeyka. Satisfying the law of conservation of momentum during spin detonation. Dopovidi AN URSR, no. 9, 1971, 819-822. (RZhMekh, 2/72, #2B232)

Bezglasnyy, P. A., and N. D. Verveyko. Shock wave propagation in a visco-plastic medium. IAN. MTT, no. 5, 1971, 71-76. (RZhMekh, 2/72, #2V448)

Bondarev, S. N., Yu. I. Fadeyenko, and V. P. Chistyakov. High velocity impact on basalt. Kosmicheskoye issledovaniya, no. 1, 1972, 129-130.

Breusov, O. N., A. N. Dremin, V. N. Kochnev, S. S. Nabatov, and V. V. Yakushev. Shock polarization of water. ZhETF, v. 61, no. 3, 1971, 1106-1111. (RZhMekh, 2/72, #2B94)

Burminskiy, E. P., V. L. Foryachev, and I. V. Novoselov. Piezoelectric sensor for pressure measurements behind a shock wave front. I-FZh, no. 1, 1971, 168-171. (RZhMekh, 12/71, #12B1637)

Bykovtsev, G. I., and L. D. Kretova. Shock wave propagation in elasto-plastic media. PMM, no. 1, 1972, 106-116.

Denisov, Yu. P., and N. M. Kuznetsov. High-temperature ionization rate constant. High electron density. ZhPMTF, no. 2, 1971, 32-40. (RZhMekh, 9/71, #9B851)

Deych, M. Ye., G. A. Saltanov, A. V. Kurshakov, and I. A. Yatcheni. Kinetics of shock wave phase transitions in moist steam flow. Teploenergetika, no. 4, 1971, 83-85. (RZhMekh, 9/71, #9B161)

Dubovik, A. V., and V. K. Bobolev. Shock excitation of explosion in liquids. IN: Sbornik. 3-y Vsesoyuznyy simpozium po goreniyu i vzryvu, 1971. Chernogolovka, 1971, 221-223. (RZhMekh, 11/71, #11B130)

Fonarev, A. S. Calculations of shock wave diffraction on a profile with subsequent appearance of stationary supersonic and transonic flow. IAN. MZhiG, no. 4, 1971, 34-40. (RZhMekh, 11/71, #11B115)

Fortov, V. Ye. Acoustic radiation from a shock wave front in cesium vapor. ZhTF, no. 2, 1972, 333-335.

Galiyev, Sh. U., and N. N. Shikhranov. Periodic shock waves excited in a dissipative medium. IN: Sbornik. Konferentsiya po kolebaniyam mekhanicheskikh sistem. Tezisy dokladov. Kiyev, Naukova dumka, 1971, 21-22. (RZhMekh, 11/71, #11B113)

Gel'fand, B. Ye., S. A. Gubin, and S. M. Kogarko. Amplification of shock waves with triangular pressure profiles in a combustible two-phase medium. ZhPMTF, no. 1, 1972, 119-122.

Gel'fand, B. Ye., S. A. Gubin, S. M. Kogarko, and V. N. Mironov. Ignition dynamics for gas-liquid fuel mixtures behind a weak shock wave front. IN: Sbornik. 3-y Vsesoyuznyy simpozium po goreniyu i vzryvu, 1971. Chernogolovka, 1971, 202-204. (RZhMekh, 9/71, #9B834)

Gogosov, V. V., and V. A. Polyanskiy. Detachments in electrohydrodynamics. PMM, no. 5, 1971, 761-772. (RZhMekh, 2/72, #2B93)

Grachev, B. Ye., and V. M. Kryachko. Excitation device for shock deformation of compressed solids. Zavodskaya laboratoriya, no. 3, 1971, 376-377. (RZhMekh, 9/71, #9V1184)

Gratskova, N. S., and A. Khalilov. Experimental investigation of transverse shock on a flexible membrane. IAN KazSSR. Ser. Fiz.-mat. nauk, no. 1, 1972, 24-31.

Il'gamov, M. A., and A. V. Sadykov. Cylindrical shells and plates reaction to periodic shock waves. IN: Sbornik. Konferentsiya po kolebaniyam mekhanicheskikh sistem. Tezisy dokladov, Kiyev, Naukova dumka, 1971, 43. (RZhMekh, 10/71, #10V256)

Jasinska, E. Effect of underwater air obstacles on shock wave parameters. Rozpr. hydrotechn, no. 28, 1971, 109-122. (RZhMekh, 12/71, #12B302)

Karpov, V. P. Shock wave effect on a flame front. IN: Sbornik. 3-y Vsesoyuznyy simpozium po goreniyu i vzryvu, 1971, Chernogolovka, 1971, 148-149. (RZhMekh, 9/71, #9B822)

Kashkarov, V. P. High velocity, thermally asymmetric gas jet. IN: Sbornik. Matematika i mekhanika. Tezisy dokladov, 4-y Kazakhstanskaya mezhvuzovskaya nauchnaya konferentsiya po matematike i mekhanike. Ch. 2. Alma-Ata, 1971, 197. (RZhMekh, 2/72, #2B395)

Khesin, G. L., Kostin, I. Kh., and A. G. Melik-Yelchyan. Coefficients of stress wave motion in layered media. Fiziko-tekhnicheskiye problemy razrabotki poleznykh iskopayemykh, no. 1, 1971, 51-55. (RZhMekh, 12/71, #12V149)

Klepaczko, J. and M. Korzun. Optical and electrical method of measuring mass velocity behind a shock wave front. Biul. WAT J. Dabrowskiego, no. 5, 1971, 123-133. (RZhMekh, 12/71, #12B310)

Knorre, V. G., and N. K. Mamina. Carbon and oxygen high temperature interaction in a shock tube. IN: Sbornik. 3-y Vsesoyuznyy simpozium po goreniyu i vzryvu, 1971. Chernogolovka, 1971, 287-289. (RZhMekh, 11/71, #11B741)

Kokin, G. A., and Ye. V. Lysenko. Pitot tube pressure in supersonic rarefied gas flow. MZhiG, no. 1, 1972, 195-199.

Kopytov, G. F. Shock wave attenuation in a gas-liquid medium. VLU, no. 1, 1972, 97-104.

Krishtal, M. A. Metal behavior during high speed deformation. FiKhOM, no. 1, 1972, 63-69.

Kumaraswamy, S., and R. Subramanian. Stochastic model for shock problems. Rozpr. inz., no. 1, 1971, 85-95. (RZhMekh, 2/72, #2V230)

Kurdyumov, S. P. Begushchiye temperaturno-gidrodinamicheskiye volny, dvizhushchiyesya po fonu s postoyannym davleniyem. (Thermal hydrodynamic traveling waves moving in a region with constant pressure.) Institut prikladnoy matematiki AN SSSR. Preprint no. 45. Moskva, 1971, 32 p. (RZhMekh, 2/72, #2B217)

Kuropatkin, V. G. Calculation of shock adiabats in argon. TVT, no. 1, 1972, 205-206.

Makarewicz, J., J. Rutowski, and R. Krzewinski. Snow-layer damping of shock energy generated by an explosion. Biul. WAT J. Dabrowskiego, no. 6, 1971, 71-77. (RZhMekh, 12/71, #12B304)

Maksimov, A. M., and Yu. A. Nikuyev. Discharge characteristics of the induced electric field behind a shock wave in argon. TVT, no. 2, 1971, 210-214. (Phys abst, 1972, #12380)

Maksimov, A. M., and Yu. A. Nikuyev. Argon plasma volt-ampere characteristic behind a shock wave with cold electrodes in a non-selfsustaining discharge regime. TVT, no. 2, 1970, 272-276.

Medvedev, S. A. Plane detonation wave development during discontinuity decay in combustible gas. IN: Nauchnyye trudy. Institut mekhaniki Moskovskogo universiteta, no. 11, 1971, 72-82. (RZhMekh, 2/72, #2B235)

Minchev, I. Dynamic theory for elasticity of diverse -module orthogonally anisotropic media. Teoriticheskaya i prikladnaya mekhanika, no. 2, 1970, 39-44. (RZhMekh, 9/71, #9V59)

Morozova, L. V., and Ye. I. Ruzavin. Optimal parameters for a dual-diaphragm shock tube with allowance for boundary layer behind the shock wave in the middle chamber. MZhiG, no. 3, 1971, 53-58. (RZhMekh, 11/71, #11B347)

Naboko, I. M., and T. V. Bazhenova. Flow parameters behind shock waves in CO_2, N_2 and $CO_2 + N_2$ mixtures. TVT, no. 3, 1971, 550-556. (RZhMekh, 12/71, #12B307)

Nevskiy, L. B. Application of interferometer mirror shift for gas dynamic investigations. OMP, no. 2, 1972, 9-11.

Novitskiy, Ye. Z., Ye. S. Tyun'kin, V. N. Mineyev, O. A. Kleshchevnikov, and B. F. Rozhdestvenskiy. Shock wave properties and depolarization of TsTS-19 type piezoceramic. IN: Sbornik. 3-y Vsesoyuznyy simpozium po goreniyu i vzryvu, 1971. Chernogolovka, 1971, 255-257. (RZhMekh, 12/71, #12V1629)

Ovsyannikov, L. V. Approximation method for recalculating the law for one-dimensional shock wave propagation. ZhPMTF, no. 1, 1972, 55-57.

Rusakov, M. M., and M. A. Lebedev. Energy release during modeling of meteorite impact. Kosmicheskoye issledovaniya, no. 1, 1972, 128-129.

Sakhapova, G. M. Dynamic bending of a nonelastic circular plate. IN: Trudy Irkutskogo politekhnicheskogo instituta, no. 65, 1971, 35-41. (RZhMekh, 2/72, #2V460)

Shestakov, V. N., Yu. M. Chernomazov, and B. A. Zhlobinskiy. Selecting sample thickness with allowance for stress wave effects during impact crushing. IN: Trudy. Groznenskiy neftyannoy institut, no. 33, 1971, 83-84. (RZhMekh, 12/71, #12V1632)

Shock wave laboratory. Nauka i zhizn', no. 1, 1972, 57-59.

Sinkevich, O. A. Stability of a plane ionizing shock wave in a magnetic field. MZhiG, no. 1, 1972, 122-128.

Soldatov, G. P. Theory of two-way transport flow. PMM, no. 5, 1971, 941-944. (RZhMekh, 2/72, #2B229)

Soloukhin, R. I. Shock waves in nonequilibrium gases. IN: Sbornik. Simpozium po mekhanike sploshnoy sredy i rodstvennykh problem analiza, 1971. Annotatsii dokladov. Tbilisi, 1971, 42. (RZhMekh, 2/72, #2B228)

Strokin, V. N. Hydrogen ignition and combustion process in supersonic flow. IN: Sbornik. 3-y Vsesoyuznyy simpozium po goreniyu i vzryvu, 1971. Chernogolovka, 1971, 152-153. (RZhMekh, 9/71, #9B824)

Testov, V. G., Yu. S. Lobastov, and T. V. Bazhenova. Determining nonequilibrium ionization from shock wave propagation in argon by means of microwave emission. ZhTF, no. 6, 1971, 1196-1200. (RZhMekh, 11/71, #11B122)

Vinokurov, A. Ya., Ye. M. Kudryavtsev, V. D. Mironov, and Ye. S. Trekhov. Vibrational relaxation of carbon monoxide. IN: Sbornik. 3-y Vsesoyuznyy simpozium po goreniyu i vzryvu, 1971. Chernogolovka, 1971, 282-284. (RZhMekh, 11/71, #11B123)

Vompe, G. A. Gas jet density during unstabilized discharge into a vacuum. MGU, no. 3109-71. Moskva, 1971, 8 p. (RZhMekh, 2/72, #2B397 Dep)

Voskoboynikov, I. M. Hexogene decomposition in detonation waves. IN: Sbornik. 3-y Vsesoyuznyy simpozium po goreniyu i vzryvu, 1971. Chernogolovka, 1971, 192-193. (RZhMekh, 11/71, #11B742)

Yarembash, I. F., V. V. Bakhtin, and S. M. Danilevich. Scattering of toxic impurities in turbulent flow with allowance for absorption. IN: Sbornik. Sovershenstvovaniye razrabotki ugol'nykh mestorozhdeniy. Donetsk, 1971, 65-71. (RZhMekh, 2/72, #2B863)

Yaushev, I. K., and A. P. Chereshnev. Discontinuity breakdown in branching channels. IN: Chislennyy metody mekhaniki sploshnykh sredy. Inform. byul., no. 2, 1971, 93-103. (RZhMekh, 2/72, #2B370)

Yefimov, A. S. Propagation of shock waves in free space. MZhiG, no. 5, 1971, 163-166. (Phys abst, 1972, #6125)

Yeselevich, V. G., A. G. Yes'kov, R. Kh. Kurtmullayev, and A. I. Malyutin. Isomagnetic discontinuity in a collisionless shock wave. ZhETF, v. 60, no. 6, 1971, 2079-2091.

Yeselevich, V. G., A. G. Yes'kov, R. Kh. Kurtmullayev, and A. I. Malyutin. Fine structure of shock waves in plasma and the mechanism of ion-acoustic turbulence saturation. ZhETF, v. 60, no. 5, 1971, 1658-1681.

Zaydel', R. M. Shock wave passage through a curved boundary interface between two media. MZhiG, no. 1, 1972, 111-121.

Zaytsev, S. G., Ye. V. Lazarev, V. P. Motulevich, K. V. Chaykovskiy, Ye. I. Chebotareva, and E. K. Chekalin. Plasma flow in a magnetogasdynamic device pulse channel, and electrode erosion in an arc regime during nonequilibrium plasma flow. IN: 5th International Conference on Magnetohydrodynamic Electrical Power Generation, v. 2, 1971, 353-367. (RZhMekh, 11/71, #11B27)

Zhigalko, Ye. F. Near-normal shock wave reflection from a rigid wall, in a linear approximation (axisymmetric case). VLU, no. 7, 1971, 77-83. (RZhMekh, 12/71, #12B303)

Zimin, A. G. Diffusion approximation of kinetic equations for ionization processes. TVT, no. 1, 1972, 41-48.

Zimont, V. L., V. K. Ivanov, and S. Kh. Oganesyan. Conditions for self-ignition and cutoff of combustion, under hypersonic flow of fuel past a projection or a recess. IN: Sbornik. 3-y Vsesoyuznyy simpozium po goreniyu i vzryvu, 1971. Chernogolovka, 1971, 149-152. (RZhMekh, 9/71, #9B823)

Zubkova, N. G. Attenuation characteristic changes in hydraulic shock waves during air injection in a water pipe. IN: Sbornik nauchnykh trudov. Moskovskiy gidromeliorativnyy institut, no. 2, 1970, 201-204. (RZhMekh, 11/71, #11B465)

Zubkova, N. G. Experimental investigation of hydraulic shock in air-water mixtures. IN: Sbornik nauchnykh trudov. Moskovskiy gidromeliorativnyy institut, no. 2, 1970, 187-200. (RZhMekh, 11/71, #11B464)

ii. Hypersonic Flow

Akomov, A. I., Yu. G. Lisin, F. V. Shugayev, and Yu. F. Makovskiy. Flow pattern for an incident shock wave on a body in supersonic flow. Uchebnyye zapiski Tsentral'nogo aerogidrodinamicheskogo instituta, no. 2, 1971, 94-97. (RZhMekh, 12/71, #12B299)

Andreyev, G. N., and Yu. D. Shevelev. Spatial boundary layer on a segmented body at supersonic speeds. MZhiG, no. 3, 1971, 41-48. (RZhMekh, 12/71, #12B1123)

Antonets, A. V., A. V. Krasil'nikov, and V. I. Lagutin. Experimental determination of center-of-pressure position for hypersonic gas flow past blunt bodies under angles of attack. MZhiG, no. 2, 1971, 142-143.

Antonov, A. N. Calculating turbulent boundary layer interaction with external hypersonic flow behind a projection. MZhiG, no. 3, 1971, 33-40. (RZhMekh, 11/71, #11B602)

Antonova, A. M. Approximate solution to a system of gas dynamic equations for flow past a slender three-dimensional body. IN: Respublikanskiy mezhvedomstvennyy sbornik. Matematicheskaya fizika, no. 9, 1971, 159-162. (RZhMekh, 12/71, #12B419)

Arkhipov, V. N., and A. N. Polenov. Flow of a hypersonic viscous relaxing gas past a sphere. MZhiG, no. 3, 1971, 74-81.

Avduyevskiy, V. S., V. K. Gretsov, and K. I. Medvedev. Flow stability with leading separation zones. MZhiG, no. 1, 1972, 74-81.

Averenkova, G. I., E. A. Ashratov, T. G. Volkonskaya, Yu. N. D'yakonov, N. I. Yegorova, D. A. Mel'nikov, G. S. Roslyakov, and V. I. Uskov. Sverkhzvukovyye strui ideal'nogo gaza. Ch. 2. Istecheniye struy v zatoplennoye prostranstvo. (Supersonic ideal gas jets. Part 2. Jet discharge into a submerged space.) Izd-vo Moskovskiy universitet, 1971, 170 p. (RZhMekh, 9/71, #9B358K)

Bakum, B. I., Yu. N. Shestakov, and V. N. Shmanenkov. Anomalous flow past blunt bodies in hypersonic wind tunnel dust flow. I-FZh, no. 5, 1970, 925-928.

Bochkarev, A. A., V. A. Kosinov, V. G. Prikhod'ko, and A. K. Rebrov. Diffusion distribution effects during collisions in hypersonic mixed rarefied gas flow. ZhPMTF, no. 2, 1971, 149-153. (RZhMekh, 9/71, #9B210)

Bogatko, V. I., and G. A. Kolton. Newtonian approximation in problems on flow past planar and axisymmetric bodies moving with variable velocity. VLU, no. 7, 1971, 63-66. (RZhMekh, 11/71, #11B178)

Breyev, I. M. Hypersonic viscous gas flow around blunt bodies. ZhPMTF, no. 3, 1971, 134-136. (RZhMekh, 11/71, #11B189)

Bulakh, B. M. One type of boundary layer and external viscous flow interaction at supersonic speeds. PMM, no. 4, 1971, 633-637. (RZhMekh, 12/71, #12B408)

Carafoli, E., and S. Staicu. Comparative applications of a theoretical model of hypersonic flow past a delta wing with flow separation at the leading edges. Revue Roumaine sci. techn. Serie mec. appl., no. 2, 1971, 395-407. (RZhMekh, 12/71, #12B433)

Chushkin, P. I. Combustion analysis for two- and three-dimensional hypersonic flow. IN: Sbornik. Problemy prikladnoy matematiki i mekhaniki. Moskva, Izd-vo Nauka, 1971, 189-198. (RZhMekh, 2/72, #2B265)

Davydov, Yu. M. Heavy particles method for calculating flow past arbitrarily shaped bodies. ZhVMMF, no. 4, 1971. (RZhMekh, 12/71, #12B409)

Dem'yanenko, V. S., and Ye. K. Derunov. Hypersonic flow past a right dihedral angle. SOAN SSSR. Seriya tekhnicheskikh nauk, no. 2, 1971, 22-25.

Dzygadlo, Z., and A. Wielgus. Induced vibrations of plates with multiple mounts in planar hypersonic flow. Biul. WAT J. Dabrowskiego, no. 4, 1971, 55-72. (RZhMekh, 9/71, #9V405)

Filatov, Ye. I. Optimum lifting body configuration at hypersonic velocities. MZhiG, no. 1, 1972, 82-86.

Gavin, L. B., and Yu. P. Lun'kin. Nonequilibrium ionized radiative gas flow around a body with allowance for electron and ion temperature variance. ZhPMTF, no. 1, 1972, 9-14.

Gilinskiy, S. M. Hypersonic nonstationary fuel gas mixture flow in the vicinity of a blunt body critical line. IN: Nauchnyye trudy. Institut mekhaniki Moskovskogo universiteta, no. 11, 1971, 98-109. (RZhMekh, 2/72, #2B267)

Gilinskiy, S. M. Linear hypersonic nonequilibrium flow of gas fuel mixtures around a wedge. IN: Nauchnyye trudy. Institut mekhaniki Moskovskogo universiteta, no. 11, 1971, 127-138. (RZhMekh, 2/72, #2B272)

Gilinskiy, S. M., and L. I. Zak. Hypersonic nonstationary gas-mixture fuel flow around bodies of varying shapes. IN: Sbornik. 3-y Vsesoyuznyy simpozium po goreniyu i vzryvu, 1971. Chernogolovka, 1971, 146-148. (RZhMekh, 11/71, #11B190)

Golomazov, M. M. Flow past blunt bodies under angle of attack by hypersonic dissociated gas. ZhVMMF, no. 4, 1971, 1063-1071. (RZhMekh, 12/71, #12B412)

Gonor, A. L. Optimum profiles for planar and axisymmetric bodies at hypersonic speeds. IN: Nauchnyye trudy. Institut mekhaniki Moskovskogo universiteta, no. 11, 1971, 35-43. (RZhMekh, 2/72, #2B271)

Gonor, A. L., M. N. Kazakov, A. I. Shvets, and V. I. Shein. Aerodynamic characteristics of star-shaped bodies at supersonic speeds. MZhiG, no. 1, 1971, 97-102.

Gonor, A. L., and N. A. Ostapenko. Calculation of the entropy layer for a delta wing surface. IN: Nauchnyye trudy. Institut mekhaniki Moskovskogo universiteta, no. 11, 1971, 4-11. (RZhMekh, 2/72, #2B284)

Gostintsev, Yu. A., V. S. Ilyukhin, and N. F. Pokhil. Reverse flow zone in strongly rotational hypersonic gas flows and jets. I-FZh, no. 6, 1036-1041. (RZhMekh, 12/71, #12B593)

Gubanova, O. I., and V. V. Lunev. Central separation zone during interaction between a supersonic nonstationary jet and an obstacle. MZhiG, no. 2, 1971, 135-138. (RZhMekh, 9/71, #9B333)

Gusev, V. N., and Yu. V. Nikol'skiy. Experimental investigation of heat transfer at the critical point of a sphere in rarefied hypersonic gas flow. Uchebnyye zapiski Tsentral'nogo aero-gidrodinamicheskogo instituta, no. 1, 1971, 122-125. (RZhMekh, 11/71, #11B634)

Keldysh, V. V. Effective interference of a wing and body at hypersonic velocities. Uchenyye zapiski Tsentral'nogo aero-gidrodinamicheskogo instituta, no. 1, 1971, 17-24. (RZhMekh, 12/71, #12B431)

Kireyev, V. T. Nonuniform flow in the vicinity of sphere and cylinder critical points during pulse motion. IN: Volny v neuprugikh sredakh, 1970, 86-93.

Kogan, M. N., and V. V. Mikhaylov. Application of a nonstationary analog in plotting hypersonic flow around blunt bodies. PMM, no. 6, 1970, 1053-1057.

Kokhi, D. A. Wave impedance in ideal hypersonic gas flow based on nonlinear theory. ZhVMMF, no. 4, 1971, 982-991. (RZhMekh, 12/71, #12B418)

Kuznetsov, A. F., P. I. Sham, Ye. A. Kapustin, R. D. Kuzemko, V. A. Bol'shakov, I. G. Zel'tser, B. N. Mel'nikov, G. Z. Gizatulin, and V. D. Pugach. Gas dynamics of oxygen jets. IN: Sbornik. Tezisy dokladov i soobshcheniye III Respublikanskoy konferentsii USSR. Teoriya i praktika kislorodno-konverternykh protsessov. Dnepropetrovsk, 1972, 12-13. (RZhMekh, 2/72, #2B394)

Lapygin, V. I. Bodies with maximal aerodynamic characteristics in hypersonic flow. IN: Nauchnyye trudy. Institut mekhaniki Moskovskogo universiteta, no. 11, 1971, 44-50. (RZhMekh, 2/72, #2B286)

Lapygin, V. I. Flow regime past V-shaped wings with supersonic leading edges. IN: Nauchnyye trudy. Institut mekhaniki Moskovskogo universiteta, no. 11, 1971, 12-17. (RZhMekh, 2/72, #2B293)

Lapygin, V. I. Calculating hypersonic flow past V-shaped wings using the method of adjustments. MZhiG, no. 3, 1971, 180-195. (RZhMekh, 12/71, #12B430)

Leutin, P. G., and Yu. B. Lifshits. Applicability of flow theory for slender bodies in transonic flow. Uchebnyye zapiski Tsentral'nogo aerogidrodinamicheskogo instituta, no. 2, 1971, 73-75. (RZhMekh, 12/71, #12B422)

Lifshits, Yu. B., and E. G. Shifrin. Transonic flow past a convex angle. MZhiG, no. 2, 1971, 67-69.

Lysenko, Ye. V. Experimental investigation of Mach number distribution in a compressed layer in front of a cylinder. DAN SSSR, v. 199. no. 5, 1971, 1029-1031. (RZhMekh, 12/71, #12B383)

Lyubimov, A. N. Critical streamline length in ideal gas flow around bodies of a single class. DAN SSSR, v. 199, no. 3, 1971, 556-559. (RZhMekh, 12/71, #12B414)

Mamadaliyev, N. A., and Kh. A. Rakhmatulin. Flow around a slender profile in a two-phase medium with solid particles. IN: Volny v neuprugikh sredakh, 1970, 146-152.

Mikhaylov, V. V., V. Ya. Neyland, and V. V. Sychev. Perturbation distribution in viscous hypersonic flow. IN: Sbornik. Problemy prikladnoy matematiki i mekhaniki. Moskva, Izd-vo nauka, 1971, 232-243. (RZhMekh, 2/72, #B283)

Morozov, M. G. Similarity of hypersonic separation zones. MZhiG, no. 6, 1970, 115-118.

Neyland, V. Ya. Flow behind a hypersonic boundary layer separation point. MZhiG, no. 3, 1971, 19-32. (RZhMekh, 11/71, #11B591)

Nuzhina, T. S. Optimum mean profile in linear hypersonic gas flow. IN: Trudy Kazanskogo aviatsionnogo instituta, no. 130, 1971, 51-59. (RZhMekh, 11/71, #11B183)

Pogorelov, V. I. Udar neraschetnoy sverkhzvukovoy strui v ploskost'. (Non-calculable hypersonic jet impact in a plane.) AN BSSR. Minsk, 1971, 10 p. (RZhMekh, 11/71, #11B288 Dep)

Rusanov, V. V. O metodakh resheniya zadach gazovoy dinamiki s razryvami. (Problem solving methods for gas dynamics with discontinuities.) Pr. Co PAN, no. 27, 1971, 31 p. (RZhMekh, 9/71, #9B231)

Saltanov, G. A., and A. V. Kurshakov. Particle motion behind an inclined compression shock wave during hypersonic two-phase flow around a wedge. IAN. Energetika i transport, no. 6, 1970, 177-181.

Shapiro, Ye. G. Shock layer radiation during hypersonic air flow around a spherical segment. MZhiG, no. 1, 1972, 101-106.

Shegurova, G. I. Sonic wave emission from extended finely streamlined bodies moving past a half-plane. Akusticheskiy zhurnal, no. 2, 1971, 284-289. (RZhMekh, 9/71, #9V399)

Staicu, S. Hypersonic flow around a cross-shaped configuration with a horizontal surface supersonic leading edge, allowing for flow on a vertical fin with a subsonic edge. Stud. si cerc. mec. apl., no. 1, 1971, 39-51. (RZhMekh, 12/71, #12B434)

Temkin, L. A. Approximate solution to the problem of the ground zone in a rarefied gas. MZhiG, no. 1, 1972, 139-143.

Ul'yanov, G. S. Hypersonic flow past penetrable plates at low angles of attack. IN: Nauchnyye trudy. Institut mekhaniki Moskovskogo universiteta, no. 11, 1971, 64-71. (RZhMekh, 2/72, #2B294)

Yelishakov, I. B., and V. Ye. Khromatov. Panel vibrations in hypersonic flow under random effects. MTT, no. 1, 1971, 54-58.

Yershin, Sh. A., U. K. Zhapbasbayev, I. D. Molyukov, and V. V. Pak. Aerodynamics of hypersonic compressed gas flow. IN: Sbornik. Matematika i mekhanika. Tezisy dokladov. 4-y Kazakhstankaya mezhvuzovskaya nauchnaya konferentsiya po matematike i mekhanike. Ch. 2. Alma-Ata, 1971, 203-205. (RZhMekh, 2/72, #2B392)

Zakharchenko, V. F., M. V. Tsvetkova, and Ye. E. Borovskiy. Hypersonic flow around a porous cone. PM, no. 2, 1972, 132-134.

iii. Soil Mechanics

Denkhaus, H. G., and E. R. Leeman. Measuring displacement, deformation, and pressure in rocks. Ber. 10. Landertreff. Int. Buros Gebirgsmech, Leipzig, 1968. Berlin, 1970, 311-318. (RZhMekh, 9/71, #9V707)

Drukovanyy, M. F., V. M. Komir, V. N. Kharitonov, N. I. Myachina, and G. R. Meypariani. Methods for varying stress field parameters during blasting operations involving falling rock hazards. IN: Sbornik. Vybrosy porody i gaza. Kiyev, Naukova dumka, 1971, 177-183. (RZhMekh, 12/71, #12V904)

Durov, V. V. Theory on spherical deformation of loose media. IN: Sbornik. Dinamika sploshnoy sredy. Novosibirsk, no. 6, 1970, 50-57. (RZhMekh, 12/71, #12V772)

Dymek, F. Solutions to two- and three-dimensional problems in theory of continuous, linearally elastic media with application to rock mechanics. Zesz. probl. gorn, no. 4, 1971, 3-26. (RZhMekh, 12/71, #12V860)

Dymek, F. Three-dimensional problem in elasticity theory for an unbounded layer with application to rock mechanics. Zesz. probl. gorn., no. 2, 99-107. (RZhMekh, 9/71, #9V11)

Fialko, A. I., F. B. Fast, P. N. Kudin, and V. S. Gorbenko. Internal threshold pressure effect on gas permeability in rocks. IN: Sbornik. Voprosy tekhniki teplofiziki. Kiyev, Naukova dumka, no. 3, 1971, 114-117. (RZhMekh, 12/71, #12V871)

Filippov, I. G. Plane wave propagation in a three-layer anisotropic medium. Geologiya i geofizika, no. 1, 1971, 92-98. (RZhMekh, 10/71, #10V52)

Gamsakhurdiya, Sh. G., and N. D. Keyser. Visco-elastic model of rocks. Nauchnyye soobshcheniye. Institut gornogo dela im A. A. Skochinskogo, no. 84, 1971, 132-137. (RZhMekh, 12/71, #12V862)

Gol'dshteyn, M. N. Mekhanicheskiye svoystva gruntov. Izd. 2-ye, pererabot. (Mechanical properties of soil. Revised second edition.) Moskva, Izd-vo stroyizdat, 1971, 367 p. (RZhMekh, 9/71, #9V680)

Grigor'yev, A. S. Stress state and deformation of a rectangular tensile massif under lateral shear. IN: Sbornik. Tektonofizicheskiye i mekhanicheskiye svoystva gornykh porod. Moskva. Izd-vo Nauka, 1971, 61-72. (RZhMekh 10/71, #10V497)

Gzovskiy, M. V. Contemporary methods for evaluating tectonic stress in the earth crust. IN: Sbornik. Tektonofizicheskiye i tekhnicheskiye svoystva gornykh porod. Moskva. Izd-vo nauka, 1971, 5-37.

Isolevich, V. A., and B. I. Didukh. Plastic strength theory and soil deformation description. IN: Sbornik. Voprosy. Mekhanika gruntov i stroitel'stva na lessovykh osnovaniyakh. Groznyy, 1970, 125-133. (RZhMekh, 9/71, #9V589)

Khakala, V. Surface settling due to an underground atomic explosion. IN: Sbornik. Mekhanika. Periodicheskiye perevody inostrannykh statey, no. 4, 1971, 150-168. (RZhMekh, 12/71, #12V779)

Kheyfits, V. Z. Metrology of dynamic stress in soils. Osnovaniya, fundamenty i mekhanika gruntov, no. 4, 1971, 35-36. (RZhMekh, 12/71, #12V779)

Kolchin, A. D., P. I. Perlin, and V. V. Sokolovskiy. Plane contact problem for an elasto-solid medium. MTT, no. 4, 1971, 74-80. (RZhMekh, 12/71, #12V740)

Kolomenskiy, V. F. Deformations in a layer of dilute water-saturated sand. IN: Sbornik. Nauchnyye raboty aspirantov Inzhenernogo fakulteta. Universitet druzhby narodov im. Patrisa Lumumby, no. 8, 1971, 58-64. (RZhMekh, 12/71, #12V763)

Koshelev, E. A., V. M. Kuznetsov, S. T. Sofronov, and A. G. Chernikov. Statistics on fragments from explosive destruction of solids. ZhPMTF, no. 2, 1971, 87-100. (RZhMekh, 9/71, #9V583)

Kucheryavyy, F. I., A. V. Kurilenko, L. V. Zuyeva, V. D. Vorob'yev, and Yu. B. Golubitskiy. Effect of closely joined fissures on stress wave energy propagation and rock crushing from explosive destruction. IVUZ. Gornyy zhurnal, no. 6, 1971, 86-90. (RZhMekh, 10/71, #10V506)

Mashukov, V. I., and S. I. Dekhtyarev. Explosive destruction of rock and determination of parameters for blast hole drilling. Kemerovo, Knigoizdat, 1971, 221 p. (RZhMekh, 9/71, #9V746K)

Matveyev, G. A. Laboratory investigation of dynamic properties of sandy soils. IN: Sbornik statey molodykh nauchnykh rabotnikov. Leningradskiy institut vodnogo transporta, ch. 3, 1971, 96-102. (RZhMekh, 12/71, #12V777)

Mikhalyuk, A. V., and G. I. Chernyy. Rheological relationships of compressed rock under dynamic loads. PM, no. 8, 1971, 106-110. (RZhMekh, 12/71, #12V744)

Milovic, D. Potential application of finite difference method to solution of soil mechanics problems. Teknika, no. 4, 1971; Nase gradev, no. 4, 1971, 649-653. (RZhMekh, 12/71, #12V742)

Prikladnyye zadachi mekhaniki gornykh porod. (Applied problems in soil mechanics.) Institut matematika i mekhanika. AN KazSSR. Alma-Ata. Izd-vo nauka, 1971, 220 p. (RZhMekh, 12/71, #12V915K)

Rappoport, R. M. Generalized solution to equilibrium equations for orthogonal anisotropic elastic bodies used for studying layered rock bases and multilayered thick plates. Izvestiya VNII gidrotekhnika, no. 95, 1971, 41-48, 306-307. (RZhMekh, 12/71, #12V859)

Rashidov, T. Seismic dynamics of complex underground structural systems in terms of a system with a finite number of degrees of freedom. IAN UzbSSR. Seriya tekhnicheskiye nauki, no. 3, 1971, 31-40. (RZhMekh, 12/71, #12V905)

Sobin, G. P. Clay soil classification tables. IN: Trudy Khabarovskogo instituta inzhenerov zheleznodorozhnogo transporta, no. 40, 1971, 184-189. (RZhMekh, 12/71, #12V758)

Termetchikov, M. K., and N. I. Kovshov. Interrelationships between rock strength and elasticity characteristics. IN: Sbornik. Ustoychivost' podgotovitel'nykh vyrabotok i krovli kamer, Frunze. Izd-vo Ilim, 1971, 104-117. (RZhMekh, 12/71, #12V864)

Turkiya, B. Sh., and V. S. Moivani. Multiapproach investigation of bedding deformation. IN: Trudy. Tbiliskiy institut sooruzhenij i gidroenergetiki, no. 3, 1971, 169-174. (RZhMekh, 12/71, #12V870)

Tuyebayev, M. K. Uprugiye napryazheniya i peremeshcheniya naklonno-sloistogo massiva vblizi krugloy vyrabotki, tselikom nakhodyashcheysyva v plaste. (Compressive stress and dislocations in a sloping-layered mass near a working area completely located in a stratum.) IAN KazSSR. Seriya fiziko-matematicheskikh nauk. Alma-Ata, 1971, 25 p. (RZhMekh, 12/71, #12V880 Dep)

Urazbayev, M. T., M. A. Valiyev, and Yu. N. Kokonkov. Torsional structural vibration and inertial seismic force of soils. IAN UzbSSR. Seriya tekhnicheskikh nauk, no. 3, 1971, 25-30. (RZhMekh, 12/71, #12V778)

Ushakov, S. A., and M. S. Krass. Deep-level mechanics in contemporary tectonic activity regions. IN: Sbornik. Svyaz' poverkhnostnykh struktur zemnoy kory s glubinnymi. Kiyev, Izd-vo naukova dumka, 1971, 223-231. (RZhMekh, 10/71, #10V496)

Yevdokimov, P. D., and L. P. Fradkin. Shear strength mechanism of rocks along faults. Gidrotekhnicheskoye stroitel'stvo, no. 9, 1971, 27-30. (RZhMekh, 12/71, #12V865)

Zakharov, S. D., G. M. Lyakhov, and S. D. Mizyakin. Determining dynamic compressibility of soil using plane explosive wave parameters. ZhPMTF, no. 1, 1972, 137-140.

Zaretskiy, Yu. K., and S. S. Vyalov. Structural mechanics of clay soils. Osnovaniya, fundamenty i mekhanika gruntov, no. 3, 1971, 1-5. (RZhMekh, 9/71, #9V602)

Zhakynbekov, A. Dependence between strongest and weakest primary stresses for limited equilibrium states. IN: Sbornik. Ustoychivost' podgotovitel'nykh vyrabotok i krovli kamer. Frunze. Izd-vo Ilim, 1971, 92-103. (RZhMekh, 12/71, #12V863)

iv. Exploding Wire

Kotov, Yu. A., M. A. Mel'nikov, and V. V. Nikitin. Electric explosion of wires. Izvestiya Tomskogo politekhnicheskogo instituta, no. 180, 1971, 98-103. (RZhF, 2/72, #2G333)

Labuda, A. A., and G. M. Novik. Pulse plasmatron with electric exploding wire. VBU, no. 3, 1971, 87-88. (RZhF, 2/72, #2G335)

Yel'vashevich, M. A., A. A. Labuda, L. Ya. Min'ko, I. G. Nekrashevich, G. M. Novik, and G. I. Bakanovich. Pulsed accelerator generation of high-velocity plasma beams based on electric explosion of wires and dielectric erosion. DAN BSSR, no. 2, 1972, 115-117.

V. Equations of State

Andreyev, V. V., I. F. Mikhaylov, and L. V. Tanatarov. Temperature relaxation of a highly rarefied gas. UFZh, no. 5, 1971, 721-733. (RZhMekh, 9/71, #9B219)

Anolik, M. V., and R. N. Miroshin. Calculating continuous integrals for problems on reflection of gas atoms from rough surfaces. VLU, no. 7, 1971, 52-55. (RZhMekh, 11/71, #11B167)

Belokon', N. I. Equations of state for real gases. IN: Trudy Moskovskogo instituta neftekhimicheskoy i gazovoy promyshlennosti, no. 97, 1971, 3-13. (RZhMekh, 12/71, #12B1507)

Byrkin, A. P. Exact solutions to Navier-Stokes equations for compressed gas flow in channels. Uchebnyye zapiski tsentral'nogo aero-gidrodinamicheskogo instituta, no. 6, 1970, 15-21. (RZhMekh, 11/71, #11B531)

Derzhavina, A. I., and O. S. Ryzhov. Perturbation method in short-duration shock problems. PMM, no. 5, 1971, 908-918. (RZhMekh, 2/72, #2B210)

Galkin, V. S., M. N. Kogan, and O. G. Fridlender. Free convection in gas without external force. MZhiG, no. 3, 1971, 98-107. (RZhMekh, 11/71, #11B628)

Ivchenko, I. N., and Yu. I. Yalamov. Diffusion shear of binary gas mixtures. MZhiG, no. 4, 1971, 22-26. (RZhMekh, 11/71, #11V174)

Kashkarov, V. P. Thermally asymmetric high velocity gas jet. IN: Sbornik. Tezisy dokladov 4-y Kazakhstanskoy mezhvuzovoy nauchnoy konferentsii po matematike i mekhanike. Chast' 2. Alma-Ata, 1971, 197. (RZhMekh, 2/72, #2B395)

Kogan, M. N. Problems in molecular gas dynamics. Uchebnyye zapiski Tsentral'nogo aero-gidrodinamicheskogo instituta, no. 1, 1971, 49-59. (RZhMekh, 11/71, #11B160)

Korotkina, M. R. A possible description of a thermodynamic nonequilibrium state in crystal. DAN SSSR, v. 199, no. 4, 1971, 792-894. (RZhMekh, 12/71, #12V3)

Makarov, V. V. Nonequilibrium states of an ideal gas. IN: Sbornik. Issledovaniye i ekspluatatsii porshnevykh dvigateley. Angarsk, 1971. 14-20. (RZhMekh, 12/71, #12B1513)

Minster, J. Equations of state for simple nonthermally -conductive materials of the rapid type. Acta technika CSAV, no. 2, 1971, 310-319. (RZhMekh, 12/71, #12V2)

Novikov, V. S., and V. L. Chumakov. Linearization errors as perturbation functions for solution of the Boltzmann kinetic equation. IN: Sbornik. Voprosy tekhniki teplofiziki. Kiyev, Naukova dumka, no. 3, 1971, 72-75. (RZhMekh, 2/72, #2B252)

Rubinshteyn, I. L. Equation of diffusion transfer in thin capillaries. IAN Lat. Seriya fizicheskikh i tekhnicheskikh nauk, no. 4, 1971, 40-44. (RZhMekh, 2/72, #2B251)

Skakauskas, V. I. Boundary conditions for viscous gas equations. VLU, no. 1, 1971, 116-122. (RZhMekh, 9/71, #9B205)

Skakauskas, V. I. Using integral representations of distribution functions to obtain a system of approximate equations for aerodynamics of rarefied gases. VLU, no. 7, 1971, 107-121. (RZhMek, 11/71, #11B161)

Tsepilevich, V. G. Approximate equation of motion for a subsonic gas. IN: Sbornik. Nauchnyye trudy Tomskogo inzhenerno-stroitel' nogo instituta, no. 17, 1971, 150-155. (RZhMekh, 2/72, #2B280)

Vasenin, I. M. State-of-the-art review on gas dynamics of two-phase flow in supersonic nozzles and jets. IN: Sbornik. Spets. gidromekhaniki i gazovoy dinamiki dvukhfazovykh sred. Tomsk, 1971, 3. (RZhMekh, 2/72, #2B346)

Zielinski, A. Isentropic index for monatomic and diatomic gases under high temperature. IN: Pr. Inst. masz. przepl. PAN, no. 53, 1971, 65-87. (RZhMekh, 12/71, #12B1512)

vi. Atmospheric Physics

Danilov, A. D., and V. K. Semenov. Investigation of elementary ionospheric processes using air discharge devices. Geomagnetizm i aeronomiya, no. 2, 1971, 248-251.

Kulakovskaya, V. P., D. D. Krasil'nikov, S. I. Nikol'skiy, L. F. Snegurova, and F. K. Shamsutdinova. Electron-photon avalanches in the atmosphere at high energies. KSpF, no. 5, 1971, 47-50.

Vulf'son, N. I., and L. M. Levin. Explosive breakup of developing cumulus clouds. FAiO, no. 2, 1972, 156-166.

vii. Miscellaneous Explosion Effects

Al'tshuler, L. V., V. T. Ryazanov, and M. P. Speranskaya. Heavy impurities effect on detonation regimes of condensed explosives. ZhPMTF, no. 1, 1972, 122-125.

Aristov, V. V., K. S. Karplyuk, and V. P. Pavlenko. Three-wave interaction coupling effect on development of explosive instability. UFZh, no. 2, 1972, 307-314.

Aslanov, S. K., and P. Kopeyka. Combustion theory for transverse waves for the case of spinning and multi-frontal detonation. AN UkrSSR. Dopovidi, Seriya A, no. 5, 1971, 472-475. (RZhMekh, 9/71, #9B174)

Aslanov, S. K., and P. I. Kopeyka. Developing a closed theory for spinning detonation. IN: Sbornik. 3-y Vsesoyuznyy simpozium po goreniyu i vzryvu. Chernogolovka, 1971, 200-202. (RZhMekh, 11/71, #11B131)

Batalova, M. V., S. M. Bakhrakh, V. L. Zaguskin, and V. N. Zubarev. *Calculation of detonation wave structures*. ZhPMTF, no. 3, 1971, 73-80.

Bekrenev, A. N., and Yu. S. Terminasov. *Substructure properties during annealing of explosively deformed fcc-metals.* IN: Uchebnyye zapiski Petrozavodskogo universiteta, v. 16, no. 6, 1971, 214-219. (LZhSt, 8/71, #25022)

Gubchik, A. A., E. P. Kazandzhan, and V. S. Sukhorukikh. *Experimental optical data on surface appearance of first and second order discontinuities in gas dynamic flow.* MZhiG, no. 1, 1970, 169-173.

Kurbangalina, R. Kh., and N. N. Timokhin. *Effect of water on the critical diameter of melted hydrazine mononitrate (hydrazonium).* FGiV, no. 4, 1970, 515-520. (RZhMekh, 9/71, #9B170)

Lesnyak, S. A., and Ya. K. Troshin. *Experimental data on heterogeneous detonations.* FGiV, no. 4, 1970, 560-564. (RZhMekh, 9/71, #9B176)

Plakhotnyy, P. I. *Spherical stress wave propagation in an elastic medium.* PM, no. 5, 1971, 112-116. (RZhMekh, 10/71, #10V51)

Shvedov, K. K., and S. A. Koldunov. *Physical state and trotyl charge structure effects on decomposition time of a detonation wave.* IN: Sbornik. 3-y Vsesoyuznyy simpozium po goreniyu i vzryvu. Chernogolovka, 1971, 189-190. (RZhMekh, 11/71, #11B137)

Slutskaya, O. B., and V. D. Garmash. *Explosive pulse investigation of structural dynamic properties.* IN: Sbornik. Dinamika i prochnost' mashin, no. 12, 1971, 112-118. (RZhMekh, 9/71, #9A131)

Vasil'yev, A. A., T. P. Gavrilenko, and M. Ye. Topchiyan. Location of a Chapman-Jouget surface structure in multifrontal gas detonations. IN: Sbornik. 3-y Vsesoyuznyy simpozium po goreniyu i vzryvu. Chernogolovka, 1971, 199-200. (RZhMekh, 11/71, #11B135)

Vel'min, V. A., V. F. Korets, Yu. A. Medvedev, and B. M. Stepanov. Effects of radio wave passage through an explosion region. ZhPMTF, no. 2, 1971, 136-139. (RZhMekh, 9/71, #9B169)

Vokac, F. Determining wave compression amplitude for triggered explosives. Prumysl chemicky, v. 16, no. 1, 3-22. (RZhMekh, dinamika i aerodinamika, 12/71, #12B314)

Voskoboynikov, I. M. Hexogene disintegration in detonation waves. IN: Sbornik. 3-y Vsesoyuznyy simpozium po goreniyu i vzryvu. Chernogolovka, 1971, 192. (RZhMekh, 11/71, #11B742)

3. Geosciences

A. Abstracts

Krylov, S. V., A. L. Rudnitskiy, V. D. Suvorov, and A. L. Krylova. Deep seismic research in the Salair Ridge region. Geologiya i geofizika, no. 7, 1971, 79-85.

The structure of the Earth's crust along a 500-km-long profile (see Fig. 1) crossing the western Siberian plate, the exposed part of the Salair anticlinorium, and the Kuznetsk depression has been studied using the point deep-seismic sounding method. The results are presented in Figure 2 in the form of a velocity section along the Ovechkino--Barnaul--Ust'-Naryk profile.

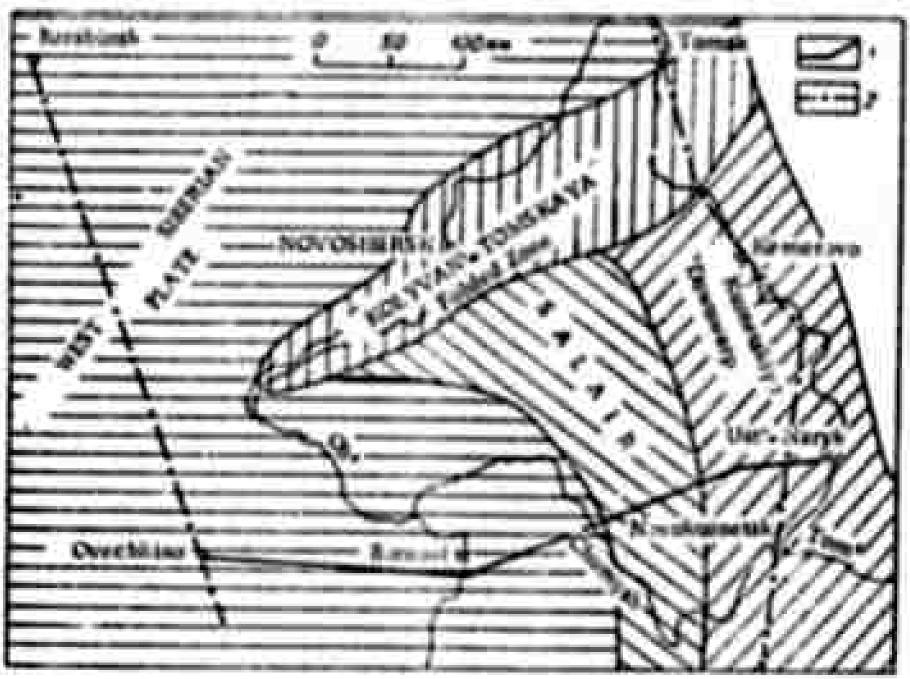


Fig. 1. DSS Profiles

1 - Present profile; 2 - previous profiles.

The seismic discontinuities observed (φ, I, II and M) are interpreted as the basement surface, two interfaces within the consolidated crust, and the Mohorovicic discontinuity, respectively. Three large blocks corresponding to major geological structures have been identified.

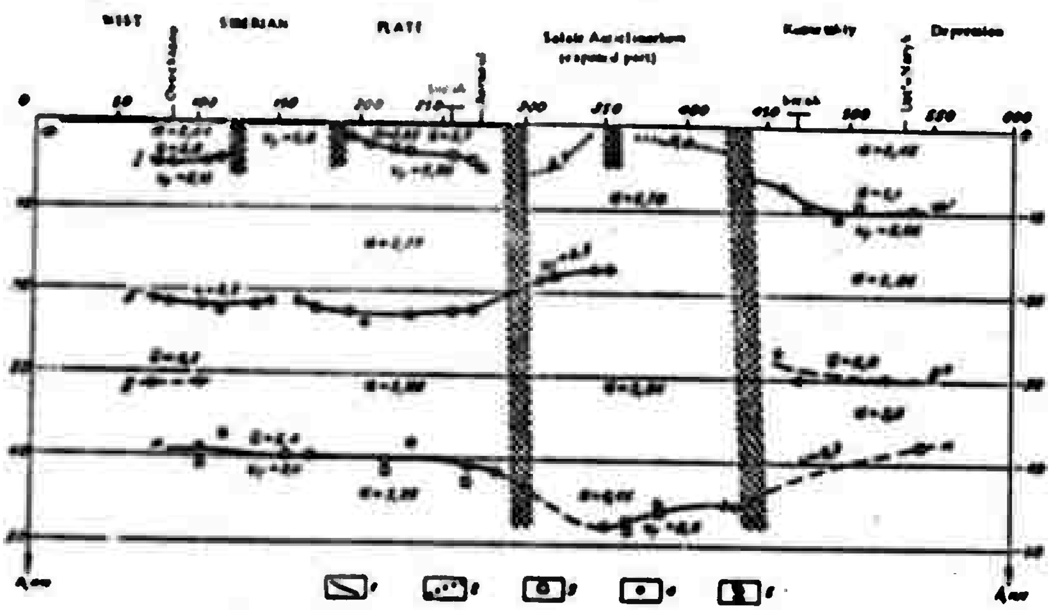


Fig. 2. Velocity Section.

1 - Seismic discontinuities: φ-basement surface in the western Siberian platform; φ'-basement surfaces in the Kuznetsk depression; I, II - intercrustal discontinuities; M - Mohorovicic discontinuities; 2 - isolines of layer velocities in km/sec; 3 - depths based on refracted-wave data; 4 - depths based on reflected-wave data; 5 - assumed deep faulting zones; v_r $\bar{v}$ - refractor and mean velocities in km/sec; σ - density in gr/cm^3.

1) The western block with crustal thickness of 40 km corresponds to the western Siberian platform segment of the profile. Sedimentary cover in this block is very thin, i.e., about 1 km. Refracting surface I is at a depth of 4-5 km, with v_r = 6.16 km/sec, and at a depth of 2-5km,

with v_r = 6.05 km/sec, at the western and eastern parts of the block, respectively. Surface I is not detected in the central part of the block. Reflecting surface II' is at a depth of 22 km, and the mean velocity in the rock above this surface is 6.2 km/sec. The Mohorovicic discontinuity is an almost horizontal surface at a depth of 40 km with v_r = 8.0 km/sec. This mean velocity above this surface is 6.4 km/sec.

2) The central block corresponding to the Salair anticlinorium segment of the profile is separated from the other two blocks by deep faulting zones. The crustal thickness of this block increases sharply to 46 km on the average. Refracting surface I is not observed and velocities in the upper part of the crust in this block are high, i.e., 6.0 - 6.3 km/sec. Reflecting surface II' at a depth of 17-18 km, is observed only in the western part of the block. The mean velocity above this surface is 6.3 km/sec. The Mohorovicic discontinuity with v_r = 8.0 km/sec is down-warped. The mean velocity of 6.4 km/sec above the Mohorovicic is higher in comparison with the adjacent blocks. This block is characterized by inverse structural forms of intercrustal interfaces relative to the Mohorovicic discontinuity.

3) The eastern block corresponds to the Kuznetsk depression. The crustal thickness of this block decreases to 38 km, while the basement surface, dipping to the east, is at a depth of 6-10 km. Reflecting surface II at a depth of 30 km ends abruptly at the boundary with the central block.

Gravity anomalies along the profile have been calculated and found to be in agreement with observational data with an accuracy of $\pm$ 10 mgals. The degree of isostatic equilibrium between the blocks using $P = \sum_{i=1}^{n} \sigma_i H_i =$ const (where P is pressure, σ_i and H_i are density and thickness of the layers) has been evaluated, and 14.53, 14.40, and 14.51 kbar values for the central and eastern blocks are obtained. This indicates that the blocks are in a state close to isostatic equilibrium.

Bulin, N. K. Structure of the earth's crust along the Caspian Sea - Hindu Kush profile. Sovetskaya geologiya, no. 1, 1972, 139-146.

The deep structure of the earth's crust along a 1820-km-long profile through Central Asia is studied. The results of the seismological analyses of earthquake records made at 126 observation stations in the

1957-1965 period and deep seismic sounding along a number of profiles carried out in the 1958-1966 period are summarized. The analyses are based on PS waves generated by near and distant earthquakes, SP waves from deep earthquakes, and 5 different vertical profiles compiled from deep seismic sounding data.

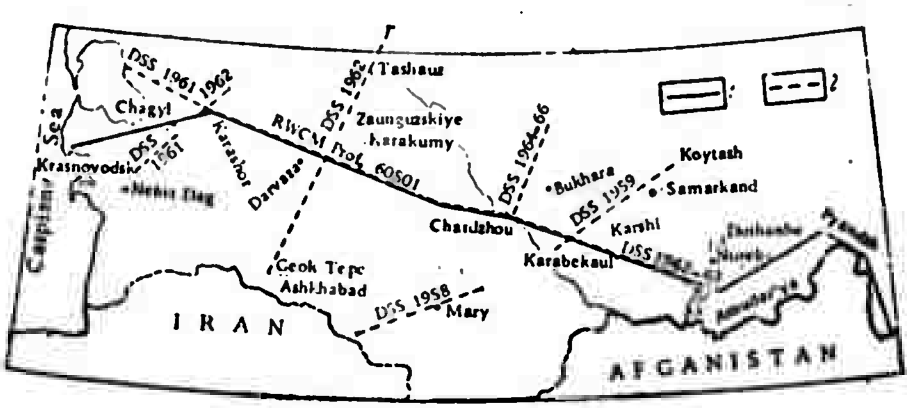


Fig. 1. Caspian Sea -- Hindu Kush Profile

1 - Joint profile; 2 - DSS and RWCM (refracted-wave correlation method) profiles with year indicated.

A combined geological seismic section along the Caspian Sea-Hindu Kush profile is shown in Figure 2. Three major tectonic structures are crossed by the profile, i.e., the Turanskaya platform, the Tadzhik depression and Pamir.

The following seismic discontinuities are identified and one (A) is given geological interpretation:

1) Palezoic folded basement surface at a depth of 0--8 km, with refraction velocity v_r = 5.6--6.3 km/sec. It is interpreted as the surface of the consolidated crust.

2) Discontinuity A within the granitic--metamorphic layer at a depth of 8--20 km, with v_r = 6.0--6.7 km/sec. This discontinuity is interpreted as the surface of the crystalline formation of the granitic-metamorphic layer. It is conformal with the Paleozic basement surface within uniform tectonic structure and non-conformal in regions separating major tectonic structural elements.

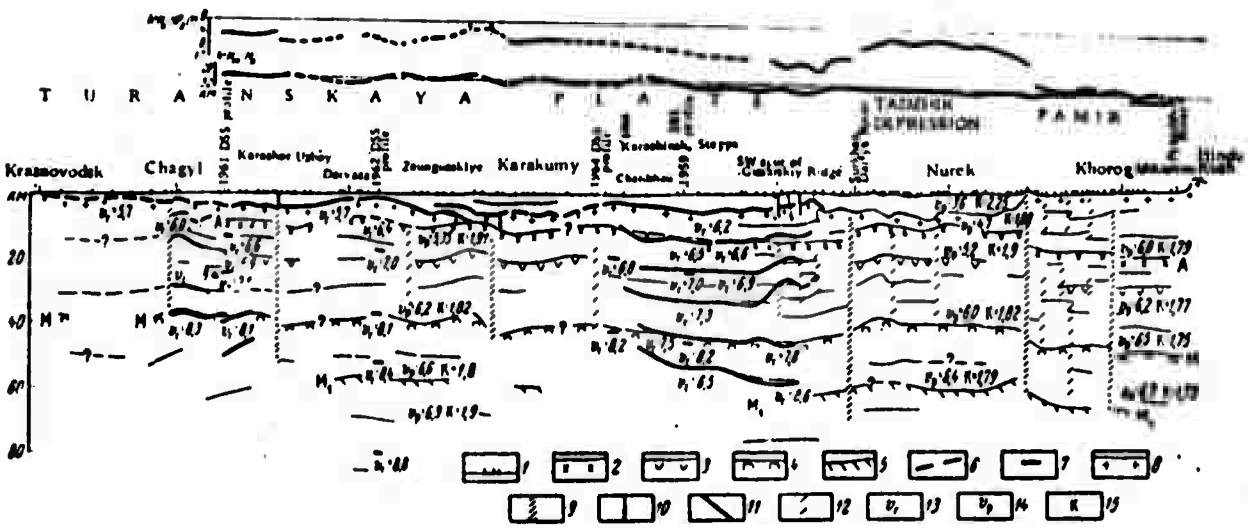


Fig. 2. Deep geological-seismic section along the Caspian Sea - Hindu Kush profile

1 - Earthquake recording points; 2-6 - seismic boundaries determined by PS earthquake waves: 2 - discontinuity A; 3 - discontinuity B; 4 - discontinuity M; 5 - discontinuity M_1 in the upper mantle; 6 - other discontinuities in the earth's crust and upper mantle; 7 - seismic boundaries determined by deep seismic sounding (DSS) of refracted-wave correlation method (RWCM); 8 - refraction surface, interpreted as the surface of the basement; 9 - zones of deep faulting, based on geological-geophysical data; 10 - fault zones in the granite-metamorphic layer and sedimentary cover, based on DSS and RWCM data; 11 - faults based on DSS and RWCM data; 12 - subvertical deep zones within the consolidated crust (based on PS earthquake waves); 13 - refraction velocity of compressional seismic waves in km/sec, based on DSS and RWCM data; 14 - the same, mean velocity; 15 - $K = v_p/v_s$ mean velocity ratio for compressional and shear waves.

3) Discontinuity B or the Conrad discontinuity is found at a depth of 16-30 km, with v_r = 6.8--7.0 km/sec. Along many segments of the profile, this discontinuity is only approximately identified. It is interpreted as a surface below which crustal rocks are characterized by a compressional wave velocity of 7.0 km/sec and higher.

4) Discontinuity M or the Mohorovicic discontinuity at a depth of 37--52 km, with v_r = 8.1--8.3 km/sec except for v_r = 7.5--7.8 km/sec in the Karshinskaya Steppe region which implies an anisotropy of seismic wave velocity at the 40--45 km depth interval for that segment of the profile. The M discontinuity is an interface of strong reflections and mode changes for seismic waves along almost the profile. The A_{ps}/A_p ratio varies from 0.05--0.3 for the Turanskaya platform to 0.2--0.8 for Tadzhik depression and Pamir regions.

5) Discontinuity M_1 at a depth of 56--66 km is the deepest discontinuity and is identified almost exclusively by PS earthquake waves. It is interpreted as one of the discontinuities in the upper mantle.

A number of deep subvertical discontinuity zones extending from the earth's surface to the Mohorovicic discontinuity, as well as deep zones within individual layers (along which intercrustal interfaces and the Mohorovicic discontinuity are dislocated) were observed (see Fig. 2). These are interpreted as deep faulting zones.

On the Turanskaya platform part of the profile, the crustal thickness is 37--46 km with a predominant value of 40 km. The Tadzhik depression is characterized by a crustal thickness of 39 $\pm$ 2 km. In the Pamir region, the crustal thickness increases to 46--52 km.

The Turanskaya platform and Tadzhik depression are characterized by the same crustal thickness, despite their different geological development. Thus, the conclusion was made that deep seismic and seismological studies of deep crustal structures have to be more detailed and should include the analysis of detailed features at crustal interfaces and the dynamic characteristics of PS waves corresponding to the same interfaces, if they are to be used for comparative studies of tectonic structure.

Rulev, B. G. The earthquake and explosion focus as a double projector of seismic waves. IN: Eksperimental'naya seysmologiya (Experimental seismology). Moskva, Izd-vo Nauka, 1971, 65-75.

An attempt to apply the results of the study of focus and wave dynamics of explosions to the study of earthquakes has been made. Data on seismic waves and study of their sources in the case of explosions have been reviewed.

Three types of seismic waves are observed in a continuous medium in the case of an explosion; two as first arrivals and one as a later arrival. One high-frequency wave observed as a first arrival is identified as a compressional P-wave. Another, designated as a P_L-wave made it possible to propose the existence of an additional source of seismic waves in the case of explosions. This proposal was verified by a study of the processes in the medium after an explosion.

Analysis of P_L waves from earthquake are discussed (Somvile 1931, Oliver and Major 1960, Solov'yev 1964, Kondorskaya 1967, and others) and their interpretation of that wave is questioned. An interpretation of P_L waves from an earthquake (on the basis of the analogy between wave fields of explosions and earthquakes) concludes that long period waves occur due to a focus consisting of two sources. The two sources emit almost simultaneous short and long-period waves.

The focal region of explosions and earthquakes is considered as a region emitting elastic waves. The dimensions of earthquake foci of different energy classes are determined using an analogy with explosions. Dislocation velocities (in P-waves) are extrapolated to the critical value U_P^{cr} = 50 cm/sec. The distance R_o, corresponding to the critical value, is regarded as the boundary of the focus. Using the formula $U_P = 50(R_o/r)^{2.5}$ [cm/sec], R_o is determined: $R_o = 0.21rU_P^{0.4}$ (m). The values obtained in this way are compared with experimental data and found to be in good agreement.

A comparison of the proposed two-source model of an earthquake focus was made with the tectonic fracture mechanism of Belousov. Short period P and S waves are associated with the generation of ruptures and long period P_L and S_L waves with the shearing of blocks along the plane of shear fracture. It is pointed out that the focal mechanisms of both weak and deep earthquake could be explained by this model.

It is found that dislocations in long period waves in case of earthquakes depend upon absolute focal depth, and not on relative focal depth, as for explosions. This is explained by the fact that long-period waves are generated by shearing of blocks, while on the other hand, dislocation depends on frictional forces, and not on the size of the focus.

Shamina, O. G. Ultrasonic modelling of possible patterns of the structure of the upper mantle. IN: AN SSSR. Institut fiziki Zemli. Eksperimental'naya seysmologiya (Experimental seismology). Moskva, Izd-vo Nauka, 1971, 254-258.

Three different laboratory models, which were constructed according to Jeffreys, Lehmann and Gutenberg two-layer velocity models of the upper mantle, have been studied with ultrasonic waves. Epicentral distances $\Delta \leqslant 3000$ km and focal depths $H \leqslant 300$ km were modeled with an interface at a depth of 170 km assumed for all three models. Time distance curves for first arrivals, A(x) - amplitude distance curves for P-wave different values of focal depth h - and A(h) - amplitude depth curves for different values of epicentral distances - were plotted and analyzed.

The main characteristic of the three models is found to be a minimum in the shadow zone on A(h) curves which uniquely indicated the existence of a waveguide. Comparison of A(h) curves for laboratory models was made with A(H) curves obtained from Hindu Kush earthquake seismograms of the vertical component (epicentral distances 100--2300 km, focal depths to 250 km). A(H) curves for the Hindu Kush earthquakes agree best with A(h) for the Gutenberg model. It is concluded that in the upper mantle in the Central Asia region, there exists a waveguide centered at a depth of 160 km.

Bugayevskiy, G. N., and V. A. Rogozhina. Determining the dip of the base of the crust based on seismic-wave arrival times at an array of stations. IN: AN SSSR. Institut fiziki Zemli. Eksperimental'naya seysmologiya (Experimental seismology). Moskva, Izd-vo Nauka, 1971, 270-281.

Three groups of seismograms (165 in all) recorded in 1961-1963 by three seismographic arrays located in the Dushanbe-Garm-Namangan region were analyzed in order to determine the orientation of the bottom of the earth's crust. The method for determining the orientation of refracting surfaces, using components of wave front orientation calculated from the arrival times at a seismograph array has been used. Azimuthal directions of arrival and angles of emergence for P-waves are calculated. Azimuthal anomalies, differences between calculated and true azimuths and angle-of-emergence anomalies, differences between calculated and Jeffrey's angle are obtained. Orientation of the bottom of the earth's crust is determined from the characteristics of the variations of these anomalies with azimuth. Distributions of signs of anomalies with respect to azimuths and azimuths corresponding to zero anomalies obtained for three groups of seismograms give evidence of a dip in the azimuthal directions 120°, 130° and 150°. It is suggested that the bottom of the earth's crust in the Dushanbe-Garm-Namangan region is characterized by downwarping in the direction toward Pamir, as well as by the existence of a root under the Pamir mountain range.

Veytsman, P. S., and I. N. Galkin. Certain capabilities of seismic methods for studying the crust. IN: AN SSSR. Institut fiziki Zemli. Eksperimental'naya seysmologiya (Experimental seismology). Moskva, Izd-vo Nauka, 1971, 210-217.

The capabilities of the deep seismic sounding method for detailed and precise study of velocity distribution in the Earth's crust and upper mantle have been considered, and data on deep seismic sounding at sea in the transition zone from the Asian continent to the Pacific Ocean have been analyzed. On the basis of this analysis, capabilities of the method have been evaluated and some improvements suggested.

Absolute amplitude distance curves for a minimum and maximum signal are compared with an average (from more than 1000 observations) absolute amplitude distance curve. It is believed that the dispersion of amplitudes around the average curve contains useful information on fine structural details; however, the average amplitude of first arrivals are comparable with average microseism level at a distance of 200 km. This distance is regarded as the maximum distance for deep seismic sounding at sea and the corresponding depth of investigations is 30-40 km. The relationship between deep seismic sounding and seismological methods has been discussed. It has been verified that the deep seismic sounding method can be combined with seismological data to yield sufficiently precise depth determinations, if first arrivals are missing at long distances.

Seismic wave field composition has been discussed and the limit of the seismic method, due to random fluctuations of amplitudes, is found to be 1000 km. At that distance, certain characteristics of the amplitude distance curve are shaded by random amplitude components.

The nonuniqueness of the interpretation of deep seismic sounding data caused by the uncertainties of the assumed crustal model is discussed. A solution for this problem is suggested by computer selection of the best crustal models out of a large number of possible ones. On the basis of 27 such selected crustal models (out of 900 possible) for the continental region of the transition zone, the interpretation of the deep seismic sounding data obtained for a profile at Tatarskiy Strait on the island of Sakhalin has been accomplished. The depth of the Mohorovicic discontinuity is determined with an error of 1-4 km, crustal velocity with an error of 0.2-0.4 km/sec, and the velocity gradient with an error of 0.001 sec^{-1}. The existence of a low velocity layer in the lower part of the Earth's crust with the negative velocity gradient not exceeding 0.02 sec^{-1} cannot be either positively proved or denied.

Pevnev, A. K., et al. Recent vertical movements of the earth's surface in the Garm region and their geological-geomorphological interpretation. IN: AN SSSR. Institut fiziki Zemli. Eksperimental'naya seysmologiya (Experimental seismology). Moskva, Izd-vo Nauka, 1971, 376-387.

Geodetic observations over two loop traverses (Garm and Nimich) run in the seismically active Garm region have been analyzed in order to study recent deformations of the Earth's surface as an indicator of future earthquakes. A geological-geomorphological interpretation of observed vertical movements has been made. Data from repeat leveling along the traverses in the period 1957--1967 have been used. The location of the geodetic traverses relative to geomorphological structures is shown on maps given in the text. The results of the analysis in terms of displacement rate for datum points relative to the 1960 level are given in the form of graphs and tables. A very steady displacement rate during the entire observational period with a maximum of 10--11 mm/year and less regular, not exceeding 2--3 mm/year, have been found for the Garm and Nimich traverses respectively. The interpretation that vertical motions of the Earth's surface revealed by geodetic observation indicate recent tectonic processes in the crust has been made. Thus, the vertical motion observed on the Garm traverse reflects the contrast of the recent dislocation in the deep-seated Surhab fault which is characterized by a complex structure. It is suggested that the analyzed data are too limited to permit solution of the problem of the possible use of geodetic observations in earthquake prediction.

Lukk, A. A. Seismicity of the Pyandzh River basin and nonlinear patterns in the reoccurrence graph. IN: AN SSSR. Institut fiziki Zemli. Eksperimental'naya seysmologiya (Experimental seismology). Moskva, Izd-vo Nauka, 1971, 297-313.

The reoccurrence graph for earthquakes in the Pyandh River basin (~ 200,000 km^2) has been analyzed in order to verify the assumption of its linearity in the entire energy-class range and to study its form. It was shown that the relationship between number of weak and strong earthquake for the whole region is nonlinear. The slope of the graph increases for stronger earthquakes starting at K = 12. Variations of the form of the reoccurrence graph for five different parts of the region were noticed. No correlation was found between the reoccurrence rate and geological characteristics of the region. It was concluded that the high-level of reoccurrence of weak earthquakes is not a positive indication of seismic danger. In addition, it was suggested the slope of the reoccurrence graph rather than A_{10} should be a criterion for defining a seismically active zone.

Tsvetkov, Ye. P. Statistical study of the spatial distribution of earthquakes. IN: AN SSSR. Institut fiziki Zemli. Eksperimental'naya seysmologiya (Experimental seismology). Moskva, Izd-vo Nauka, 1971, 282-297.

The spatial distribution of earthquakes observed in the Garm-Dushanbe region in the energy range K = 7--13 has been studied. As a measure of stability, the correlation coefficient and mean square distance between the functions of epicentral density determined for successive periods of observation have been introduced.

The effects of the size of the area of averaging, periods of observation and energy class on stability and magnitude of fluctuation have been evaluated. It was found that the spatial distribution of earthquakes in the Garm-Dushanbe region is static and stable in time. The character of fluctuation due to different periods of observation is non-random. The distribution of higher energy class earthquakes is more stable relative to the lower energy class of earthquakes.

Gayskiy, V. N., and R. S. Mikhaylova. Study of some characteristics of the seismic process, based on weak earthquakes. IN: AN SSSR. Institut fiziki Zemli. Eksperimental'naya seysmologiya (Experimental seismology). Moskva, Izd-vo Nauka, 1971, 313-322.

Observational data on weak earthquakes (K = 4--11) in the Garm epicentral region, obtained by a high sensitivity seismic recording system, have been used to reveal some characteristics of the seismic process in time. From an analysis of the temporal behavior of the seismic process it was found that there existed sufficiently sharp separation of the time of the process into a period of seismic activity and seismic background. Active periods initiate suddenly and end slowly. A fairly stable background level represents the major part of the seismic process both in time and space. The characteristics of the seismic process revealed from weak earthquakes were compared with those for intermediate earthquakes (K = 8--12) in the same region and found to be similar.

Khalturin, V. I. Seismic-wave attenuation in the crust of northern Tien Shan. IN: AN SSSR. Institut fiziki Zemli. Eksperimental'naya seysmologiya (Experimental seismology). Moskva, Izd-vo Nauka, 1971, 125-136.

Attentuation characteristics of the earth's crust beneath northern Tien Shan have been evaluated for the purpose of a comparative study of the attenuation characteristics of the different regions and their correlation with the seismicity of those regions.

Observational data on 423 local earthquakes with epicentral distances ranging from 10 to 200 km and energy class from 6 to 9 have been analyzed. Seismograms were recorded by the frequency-selective ChISS seismic recording system consisting of a SVKM-m vertical seismograph (period 4,0 sec, damping D = 0,55), and a set of seven band-pass filters in the 0.24 - 29 Hz frequency range. The spectrum-averaging method for evaluating attenuation parameters has been used. The average variation of the amplitude ratio A_m/A_n with distance for various pairs of adjacent frequency channels is obtained from seismograms of a large number of earthquakes recorded at the same seismograph station.

Different factors causing dispersion, such as complex wave field, local structure, energy load of the earthquakes, are discussed. Graphs of $K = \log A_n / A_m$ vs distance r for P - and S - waves are constructed and analyzed. Using these plots, differences of attenuation coefficients $\alpha_m - \alpha_n = \Delta\alpha$ and from them attenuation decrements γ were determined. It was noted that: 1) attenuation decrements decrease with frequency, and 2) the regional variations of the attenuation parameters for compressional waves are significantly higher than for shear waves, which is in agreement with results obtained by Frantti, 1965, Summer 1967, and Boldyrev, Fedotov 1969.

It was pointed out that K(r) curves may indicate the crustal attenuation decrement distribution $\gamma(h)$, and that their plots may be affected by a low velocity layer, especially distinct at high frequencies.

Evaluated attenuation decrements for the northern Tien Shan epicentral region were compared with results obtained for the southern Tien Shan and northern Pamir. It is graphically shown that the attenuation decrements for northern Tien Shan are 2-3 times smaller than for southern Tien Shan and 6-8 times smaller than for northern Pamir. An explanation has been given that the differences in attenuation decrements for southern and northern Tien Shan which are composed of rock of approximately the same composition and seismic wave velocity are due to different states of tectonic dislocation.

It was pointed out that regions with the lower attenuation decrement are characterized by higher seismicity. The strongest earthquake (M = 8) is associated with northern Tien Shan, weaker with southern Tien Shan (7, 3) and weakest with northern Pamir (M = 6).

The author thinks that dissipative characteristics of the individual crustal blocks or seismically active regions could be used for the study of seismicity.

B. Recent Selections

Belen'kaya, B. N. Impedance of a stratified medium for nonhomogeneous surface waves. AN SSSR. Izvestiya. Fizika Zemli, no. 2, 1972, 83-86.

Gayskiy, V. N., and N. D. Zhalkovskiy. Space and time distribution of the foci of earthquakes of various magnitude. AN SSSR. Izvestiya. Fizika Zemli, no. 2, 1972, 13-22.

Kissin, I. G. Problem of earthquakes caused by engineering projects. Sovetskaya geologiya, no. 2, 1972, 68-80.

Kulagina, M. V. Relief characteristics of the surface of the Mohorovicic discontinuity with the limits of the Afgano-Tadzhik depression, the Pamirs, and southern Tien Shan. AN Tad SSR. Doklady, v. 14, no. 8, 1971, 18-21.

Kurbanov, M., and V. I. Lykov. Relationship of recent tectonic movements and seismicity of southern Turkmeniya to characteristics of crustal structure. AN Turk SSR. Izvestiya. Seriya fiziko-tekhnicheskikh, khimicheskikh i geologicheskikh nauk, no. 1, 1972, 32-37.

Lursmanashvili, O. V. Possible effect of solar activity on the distribution of Caucasus earthquakes. AN Gruz SSR. Soobshcheniya, v. 63, no. 3, 1972, 309-312.

Perepelina, V. A. Reduction to zero of the reflection coefficient of PcP waves. AN SSSR. Izvestiya. Fizika Zemli, no. 2, 1972, 63-65.

Ryl'ko, M. A. Estimation of the thickness of a layer detached from an elastic half-space by a compression wave. AN SSSR. Izvestiya. Fizika Zemli, no. 2, 1972, 31-37.

Vinnik, L. P. Measurement of the statistical spectrum of frequencies and wave numbers of a random seismic field. AN SSSR. Izvestiya. Fizika Zemli, no. 2, 1972, 23-30.

Yepifanov, A. A. Crustal thickness in eastern and central Ciscaucasus. AN Gruz SSR. Soobshcheniya, v. 65, no. 2, 1972, 313-316.

Antsyferov, M. S., et al. Seysmoakusticheskiye issledovaniya i problema prognoza dinamicheskikh yavleniy (Seismoacoustic research and the problem of predicting dynamic phenomena). Moskva, Izd-vo Nauka, 1971, 135 p.

Morseyenko, F. S. Vzaimosvyaz' glubinnogo i pripoverkhnostnogo stroyeniya zemnoy kory (Interrelationship of the deep and subsurface structure of the crust). Novosibirsk, Izd-vo Nauk, 1971, 86 p.

Ullman, W. Analytische Seismometrie (Analytical seismometry). Berlin, Akademie-Verlag, 1971, 339 p. (SERIES NOTE: Deutsche Akademie der Wissenschaften zu Berlin. Veroffentlichungen des Instituts fur Geodynamik Jena, Series A, No. 16, 1971).

4. Particle Beams

A. Abstracts

Anatsky, A. N., R. A. Alexeev, V. D. Ananjev, P. S. Antsupov, V. P. Beloov, P. V. Bukaev, O. S. Bogdanov, Yu. P. Vachrushin, V. K. Gagen-Torn, V. A. Glukhikh, N. I. Kolesov, Ye. G. Komar, O. L. Komarov, V. S. Kuznetsov, I. F. Malyshev, I. M. Matora, L. A. Merkulov, A. V. Popkovich, P. A. Fefelov, C. P. Khalchitsky, R. V. Kharjuzov and Yu. S. Jazvistly. Design of a 30-MeV high-current linear induction electron accelerator-injector for UEP-2 pulsed reactor. IEEE Trans. Nucl. Sci., v. 18, no. 3, 1971, 625-628. (RZhElektr, 1/72, #1A499)

The design of a 30 MeV linear induction accelerator is described for pulsed currents of 250 a, pulse duration of 0.5 μ sec and pulse rate of $0 \sim 50$ Hz. The accelerating elements are inductors assembled in 6 sections. In the inductors of the first section solenoids are mounted for beam focusing by a linear magnetic field. Added focusing is accomplished by lenses, spacing between which increases according to the increase in beam energy. The electron source is a thermoionic cathode of 500 mm diameter with a 100 a/cm^2 emission density.

Solodovnikov, A. P. Accelerator tube. Author's Certificate, USSR. No. 299991, published May 21, 1971. (RZhElektr, 1/72, #1A498)

An accelerator tube is proposed consisting of alternate electrodes of axisymmetric form, which have central openings and cylindrical isolators, placed coaxially with electrodes and connected with them in a vacuum seal. For improving electrical stability of the tube, the electrodes are corrugated at the isolator connections such that corrugations of adjacent electrodes are oriented in opposing directions.

Gulova, L. A., Yu. Ye. Kreyndel' and N. A. Nikitinskiy. Plasma source of charged particles. Author's Certificate, USSR. No. 291652, published April 7, 1971. (RZhElektr, 1/72, #1A476)

A plasma source of charged particles is proposed in which extraction of electrons and ions produces from the plasma a concentrated discharge through an anode gap. The device includes two cathodes, two anodes and two permanent magnets. The source provides a new method for securing non-criticality in vacuum conditions, i.e., the discharge chamber of the source is constructed of two plane-parallel cold cathodes, placed in the permanent magnet gap in the form of right angle frame with a concentrating opening in one of its faces. A ferromagnetic anode is used, which is placed outside the magnetic gap.

Volfson, L. Yu., A. N. Kabanov, A. A. Kafafov, Yu. M. Kushnir, and Ye. Ye. Chernova-Stolyarova. Behavior of intense electron beams in liquid. FiKhOM, no. 5, 1971, 129-131.

An experiment was conducted in a device (no description given) for observing the process of passing an electron beam through type VKZh-94 oil in vacuum at beam intensities $P = 0.6 \sim 2.0 \times 10^{12}$ watt/m^2 and initial electron energy $E_o = 50 \sim 100$ Kev. The luminescent region generated from this discharge was photographed by a standard high-speed camera. Due to the intense heat produced by the interaction between electrons and oil, a channel is created in the region of luminescence. The duration of this channel, t_k is many times greater than the duration of the discharge impulse, and is determined by the parameters of the first impulse. It was noted that during channel formation no loss of energy took place; however, owing to ejection of oil from the channel during its collapse, a small amount of energy was seen to be lost. Fig. 1 shows the speed of formation and the depth of channel in relation to the pulse duration. Photographs taken at various values of E_o, t and $I_n = 6.0$ ma, showed that increase of E_o and t greatly affected the size and length of the channel. In the case of a continuous discharge, a narrow luminescent channel was observed. Similar results were noted also in the case of a mercury and oil layer combination.

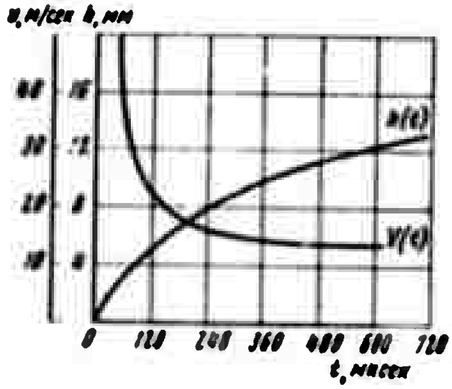


Fig. 1. Variation of speed of formation and depth of channel, with time.

Karashokov, K. Ye., N. T. Ostroverkov, and V. K. Popov. Experimental study of the structure of electron beams. FiKhOM, no. 2, 1971, 9-14.

Structures of an electron beam with a specific power in the range $10^5 \sim 10^8$ w/cm^2 have been experimentally studied. Experiments have been carried out for the specific power a) $10^5 \sim 5.10^6$ w/cm^2 and b) $5.10^6 \sim 5.10^8$ w/cm^2 separately, using electron-optical systems designated as types A852.26 and A852.17 respectively. Fig. 1 gives a diagram of the experiment. It was found

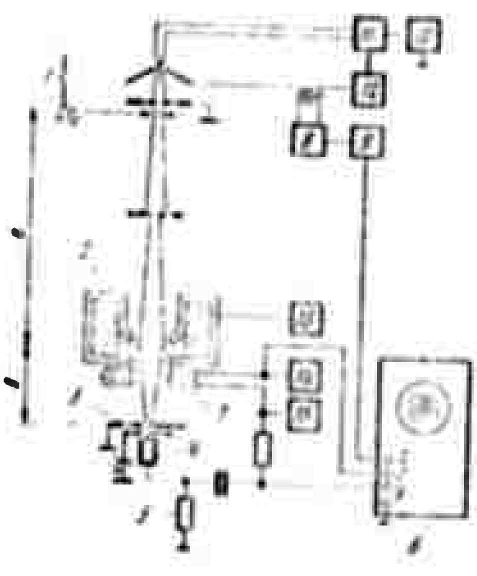


Fig. 1. Sketch of experimental device for studying electron beam. 1 - Gun; 2 - Electromagnetic lens; 3 - Diaphragm; 4 - Collector; 5 - Resistor; 6 - Oscillograph; 7 - Deflecting system; 8 - Modulator; 9 - Delay unit; 10 - High voltage source; 11 - Heating source; 12 - Displacement source; 13 - Stabilizer of lens current; 14, 15 - Time-base generator.

that in both cases, the distribution of current density in the cross section of the electron beam was Gaussian (Fig. 2). Electron beam diameter was found to vary according to beam current, which in turn was regulated by either cathode temperature or electrode voltage. On increasing the current

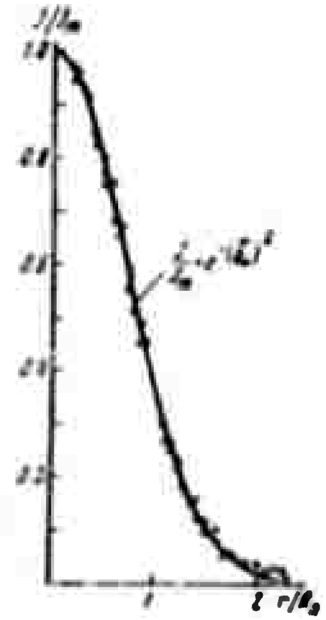


Fig. 2. Distribution of current density in the smallest cross section of the electron beam.

in the beam I_n, the image plane of the cross-over beam was found to shift along the optical axis of the system. These results were more pronounced at densities of $10^5 \sim 5 . 10^6$ w/cm^2 than at the higher range.

Perevodchikov, V. I., A. L. Fedorov, and K. A. Yumatov. Pulse electron gun designed for currents up to 1 Ka. UFZh, v. 16, no. 6, 1971, 971-976.

Construction of a pulsed high-perveance electron gun with a current capacity of 1 Ka is described. The operation was evaluated using a 60 mm dia. Faraday cylinder placed 100 mm from the anode. It was observed that with a LaB_6 cathode of dia = 30 mm, a 700a current was obtained at 70 Kv, which assured the capacity of the described construction, i.e., with a LaB_6 cathode of variable diameter, 2Ka is attainable. Advantages of using a thermo cathode are briefly outlined and the possibility of constructing pulse electron guns for currents up to 10 Ka is pointed out. Fig. 1 gives a sectional view.

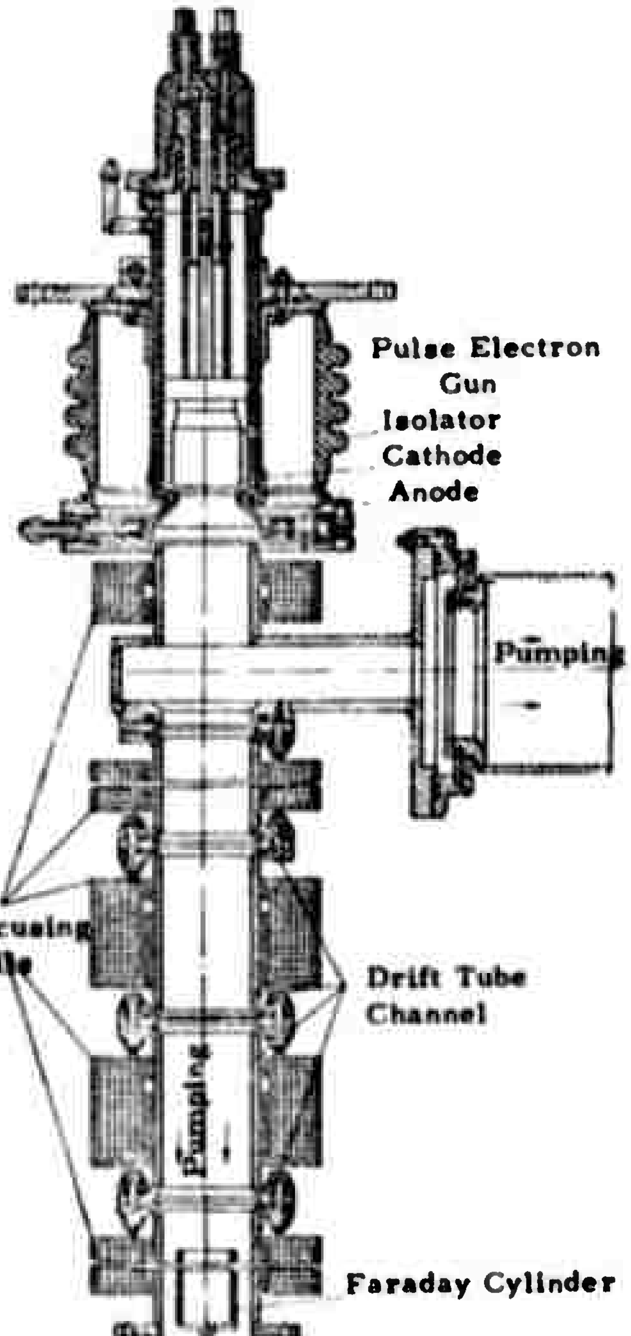


Fig. 1. Experimental pulse electron gun.

Noskov, D. A. and N. G. Pankovets. Explosive processes during impulse treatment of materials by an electron beam. FIKhOM, no. 4, 1970, 16-20.

Observations of processes during an intensive pulsed electron bombardment of solid bodies are described. Experiments were conducted with steel, molybdenum, glass, diamond, ruby, ceramics and other target materials. It was found that during impact of the pulse, an explosive process corresponding to the ejection of materials from the interaction region took place. The factors causing this are given as thermal explosion; increase of material volume due to structural transformation; generation of thermal stress greater than the endurance limit; and in some cases, increase of stress due to chemical combination in the solid body. During the explosive process, an intensive ejection of materials in the form of droplets or particles was observed. The quantity of ejecta was found greater than the evaporated mass over the same time interval. Results show that the character of this type of explosive process depends upon the exposure regime and the parameters of the beam, thus making regulation possible. Surface damage photos and crater profiles are included.

Onishchenko, I. N., A. R. Linetskiy, N. G. Matsiborko, V. D. Shapiro and V. I. Shevchenko. Nonlinear theory of excitation of monochromatic plasma waves by electron beam. ZhETF P, v. 12, 1970, 407-411.

A study of nonlinear theory of beam excitation of plasma waves has been dealt with for two limiting cases 1) eroding, $\Delta v/v_0 >> (n_1/n_0)^{1/3}$ and 2) monoenergetic beams, $\Delta v/v_0 << (n_1/n_0)^{1/3}$, where V - velocity spread in the beam, V_0 - average speed; n_1, n_0 - density of beam and plasma, respectively, $n_1 << n_0$. In both cases mathematical expressions are found and the corresponding characteristic curves drawn. In the first case, amplitude of oscillations

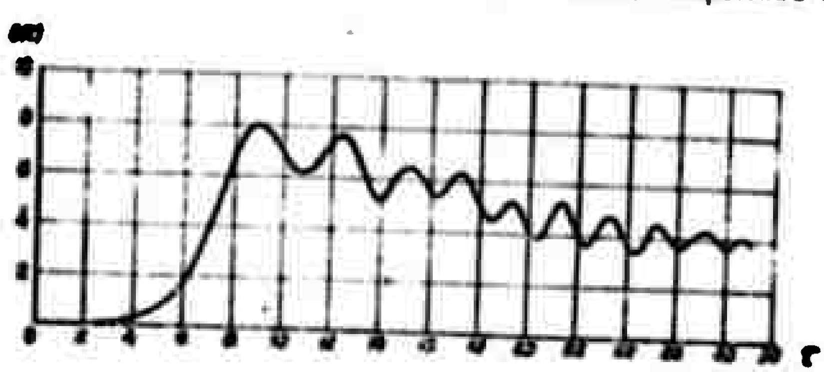


Fig. 1. Eroding Case

decreases with increase of τ, and at $\tau > 25$ is nearly constant (Fig. 1). In the second case, when the beam is monoenergetic, the damping of oscillations is practically nil (Fig. 2), and the amplitude varies between +0.5 and +1.5.

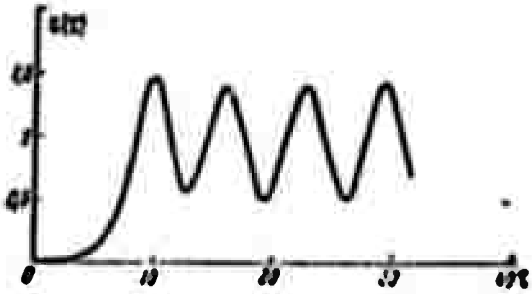


Fig. 2. Monoenergetic case.

Suladze, K. Ye., B. A. Tskhadaya and A. A. Plyutto. Characteristics of intensive electron beam formation in bounded plasma. UFZh, v. 16, no. 6, 1971, 992-994.

A technique for formation of high-current electron beams has been studied by filling the acceleration gap with plasma prior to pulse discharge. Beam current was found to depend on the concentration of plasma and the accelerating voltage. Experimental measurements (Fig. 1) showed that at a plasma concentration of $10^{12} \sim 10^{13}/cm^3$, the critical value of current increased to 5×10^4 a. After reaching the critical value, the ohmic resistance of the gap

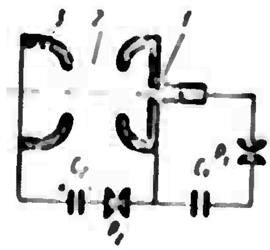


Fig. 1. Source diagram.
1 - Plasma source; 2 - Acceleration gap; 3 - Accelerating electrode; C_1, C_2 - capacitors; P_1, P_2 - arresters.

increased, which resulted in a sharp decrease of current and increase of potential difference in the gap. Beam current in this case was found to be 2×10^4 a at approximately 45 Kv, current pulse duration was 3×10^7 sec. By increasing the plasma concentration to $10^{14} \sim 10^{15}/cm^3$ and acceleration voltage to $10^5 \sim 10^6$ v, it should thus be possible to obtain a beam current of $10^5 \sim 10^6$ a.

Kikvidze, R. R., V. G. Koteteshvili and A. A. Rukhadze. Excitation of linear electromagnetic waves by electron beam in plasma of a solid body. FTT, no. 1, 1972, 183-186.

A study is made on the possibility of generation and acceleration of linear electromagnetic waves by means of an electron beam passing through a cylindrical gap in a solid specimen, in the absence as well as the presence of an external linear magnetic field. The dissipation effect of the dispersion of current-carriers in the solid body on instability is taken into account. By means of hydrodynamic equations and following the method used by Bogdankevich (ZhETF, 57, 315, 1969), the authors obtain mathematical terms for natural oscillations of a solid-body plasma, increment of oscillations, and threshold beam current, the increase of which results in instability. It is shown that excitation of oscillation is possible not only under conditions where increment of growth is more than the effective collision rate of free carriers, but also in the opposite case. However, in the opposite case, the spectrum of the excited oscillations becomes narrower. An expression is also derived for determining the amplitude of steady state nonlinear waves.

Matora, I. M., L. A. Merkulov and I. I. Shelontsev. Formation of an electron beam in a linear induction accelerator. ZhTF, no. 7, 1971, 1469-1471.

Problems of accelerating an electron beam in a linear induction accelerator are discussed. In an intensive laminar electron beam, accelerated in an accelerator, it has been found possible to avoid any loss of electrons in the working portion of the impulse by suitably choosing the parameters of the optical system and by keeping the axial magnetic field constant. However, at the beginning and end of the impulse, a considerable loss of electrons was found to occur. Pulse rise and decay times were approximately 0.15 μ sec.

Energy loss from the beam was determined by the instantaneous voltage at the cathode, while the beam current was found using Schottky's law. All calculations were done by computer; analyses of different programs are given. Measures are suggested for lowering the loss of accelerated electrons.

Mkheidze, G. P. and Ye. D. Korop. Formation of intensive electron beams from current flow through plasma. ZhTF, no. 5, 1971, 873-879.

An experimental study of the formation of an intense electron beam pulse during the current flow through a plasma is reported. Fig. 1 gives a sketch of the experiment. Energy level in the electron beam was found to be

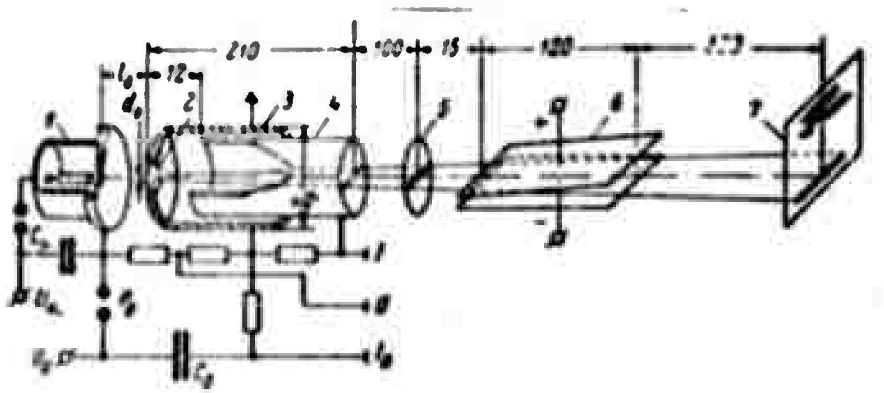


Fig. 1. Pulsed electron beam experiment. 1 - Faraday cylinder; 2 - Insertion hole; 3 - Accelerating electrode; 4 - Faraday cylinder; 5 - Slotted diaphragm; 6 - Electrostatic condenser; 7 - Photo plate.

$W_e \geq eU_0$, where $U_0 \approx$ 30-40 Kv is the initial condenser voltage, discharge of which generates the plasma current. Characteristic curves for the current in the Faraday cylinder relative to aperture diameter, d_o (Fig. 2) and for the beam current density relative to acceleration gap, l_o (Fig. 3) were calculated. Higher values of current, I_{max} = 4 Ka and density $J_{max} \approx 1\text{-}3 . 10^4$ a/cm^2 have been obtained by changing appropriate parameters. The erosion of the accelerating electrode, from atomization due to the intensive electron beam, was observed. The direction of the electron beam was found to be independent of the location of the accelerating electrode.

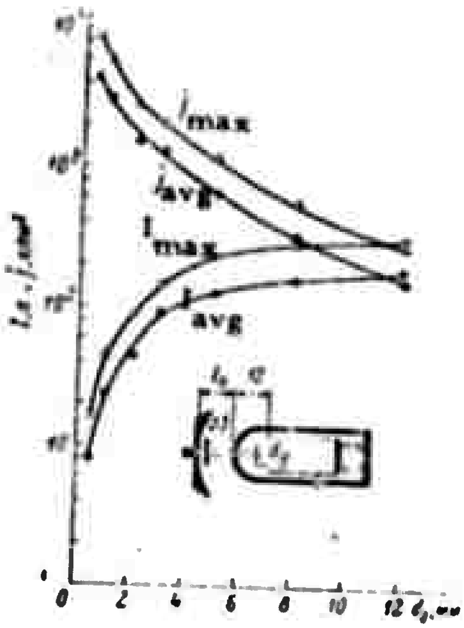


Fig. 2. Relation between Avg and Max beam current in Faraday cylinder and current density, and aperture dia. d_o. $U_o = U_c = 30$ Kv, $l_o = 1$ cm, $C_o = 5 \times 10^{-9}$f, $C_u = 2 \times 10^{-9}$ f.

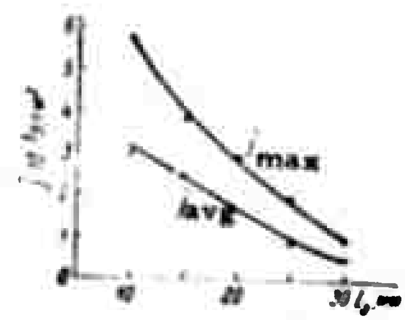


Fig. 3. Relation between Max and Avg beam current density and acceleration gap l_o. $U_o = U_c = 30$ Kv, $d_o = 1$ mm, $C_o = 5 \times 10^{-9}$f, $C_u = 2 \times 10^{-9}$ f.

Denyak, V. M., A. A. Nemashkalo and V. I. Startsev. Device for determining the position of an electron beam. Author's Certificate USSR #298013, published April 19, 1971. (RZhElektr, 1/72, #1A597)

For determining the position of electron beam, a device is proposed, based on the use of secondary emission effects, and consisting of converging and split emitting electrodes. For improved sensitivity, electrodes are made in the form of two groups of successively placed elements with mutually perpendicular cross sections, such that the section width in every successive electrode is greater than for the previous one.

Barwicz, W. Application of electron beams for metal welding in vacuum vessels. Prace Przemysl. Inst. Elektron (Poland), v. 11, no. 3, 1970, 165-167. (Phys. abst., v. 75, no. 933, 1972, #76301)

Advantages of metal welding by means of high power density electron beam ($\sim 10^6$ w/cm^2) in comparison with other welding methods are described. Classification of welding devices and their construction are presented. Particular attention is given to thermocathodes. Some examples of welding of various details by means of electron beam are taken from publications issued by the world's leading manufacturers and from the experimental results of PIE.

Ur'yash, F. V. and V. K. Gusev. Electric-arc evaporator of metals. Author's Certificate, USSR, #297707, published May 19, 1971. (RZhElektr, 1/72, #1A610)

The subject device is an electric-arc metal vaporizer, consisting of arc electrodes and an ignition electrode. In order to avoid clogging of foreign deposits, one of the arc electrodes is designed with a cavity, inside which the ignition electrode is rigidly mounted.

Barwicz, W. Electron gun chamber. (Przemyslowy Instytut Elektroniki) Pat PNR, #61820, published November 20, 1970. (RZhElektr, 1/72, #1A593)

A design for an electron gun chamber has been patented for powerful electron radiation devices, e.g., for metal smelting and welding. The chamber has an elongated form and is placed nonsymmetrically relative to the working space of the device. The top of the chamber has a hermetic seal, installed over the gun. On the projection within the working space is attached a hermetic head with leads to the gun; leads are connected inside the chamber with contact pins of the gun.

Nikolayevskiy, V. G., V. D. Pis'mennyy, and A. T. Rakhimov. Initial stage of electric discharge in xenon at high pressures. ZhTF, no. 2, 1972, 364-366.

Results are noted of an experimental study on the initial stage of a quasistationary discharge in xenon at 300 torr, under conditions where the

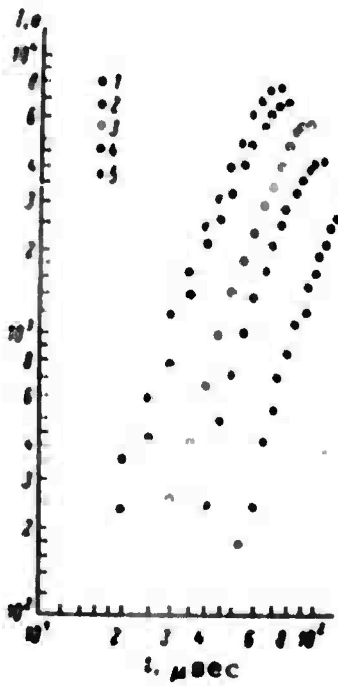


Fig. 1. Time-current characteristics. U_0 (Kv): 1 - 2; 2 - 2.4; 3 - 3; 4 - 3.4; 5 - 3.8.

increase of current is governed by processes taking place in the discharge itself. The experiment was performed with a xenon impulse lamp with a 58 cm discharge gap, internal diameter of 16 mm, and pressure of 300 torr. Volt-ampere characteristics of the discharge and dynamics of the development of current channel are determined; different stages of the development of the discharge are also outlined. Following the energy balance equation and assuming the conductance of plasma to be constant in the stage of current channel widening, the authors obtained a mathematical expression which corresponded to the experimental time characteristics of current, I(t) (Fig. 1). The time characteristic of the diameter of the current channel, 2a (t) was also experimentally plotted, and was found to be similar to the time characteristics of current, thus proving the above assumption that plasma conductance remains constant over the period of current channel widening.

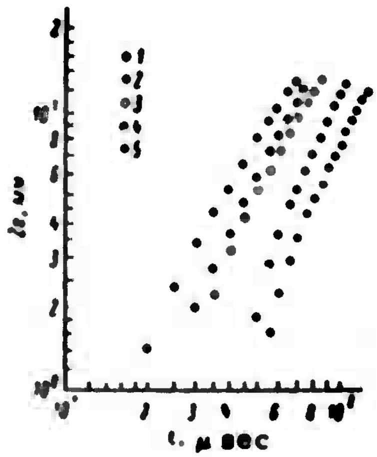


Fig. 2. Relation between the diameter of discharge channel and time.
U_0 (Kv): 1 - 2; 2 - 2.4; 3 - 3; 4 - 3.4; 5 - 3.8.

Vakhrushin, Yu. P., V. S. Kuznetsov, O. L. Komarov, V. I. Bogdanova, and N. I. Ivanova. Focusing of heavy current electron beams in linear induction accelerators. Atomnaya energiya, v. 31, no. 3, 1971, 294-295.

In focusing a heavy-current electron beam in a linear induction accelerator, the method depends largely on the deflected beam stability relative to initial equilibrium parameters. It is pointed out that in a homogeneous electric field, focusing an accelerated electron beam with currents of hundreds of amperes is possible by a linear magnetic field up to 2~3 MeV (Anatskiy et al, Atomnaya energiya, v. 21, 1966, 439). In the case of beams accelerated to the level of 10 MeV or more, a linear magnetic field may be used only for the initial part of the accelerator; a discrete focusing system is best suited for the remaining acceleration region. The stability of an accelerated beam with a system of focusing lenses, spaced at various distances was numerically investigated using a previously established stability equation.

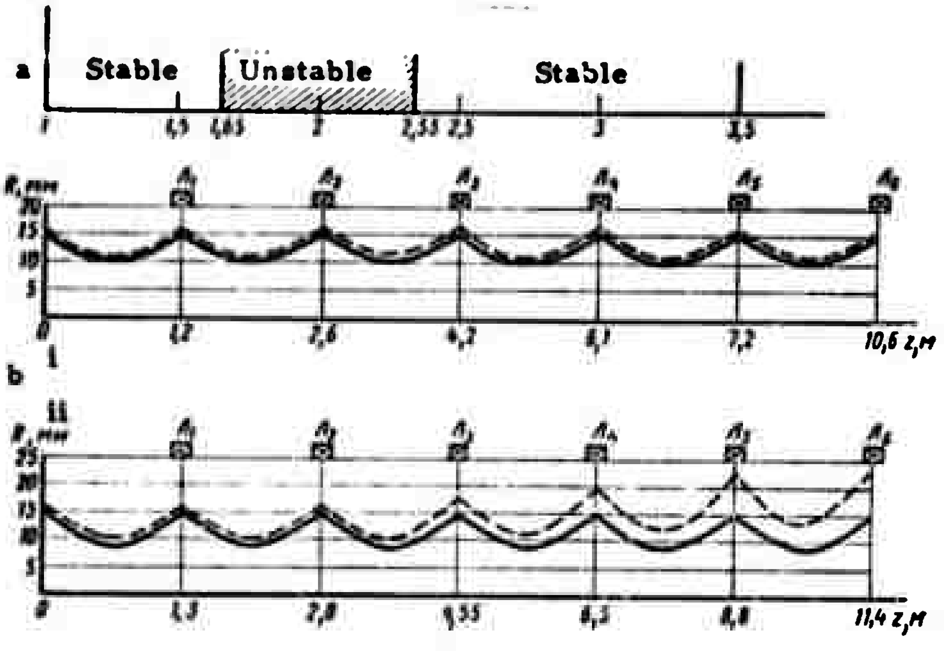


Fig. 1. Stability states for beam acceleration. a) -Stable region depending on k, b(i) -Stable system, b(ii) - Unstable system, ——— Equilibrium profile ----- Profile deflected from initial equilibrium.

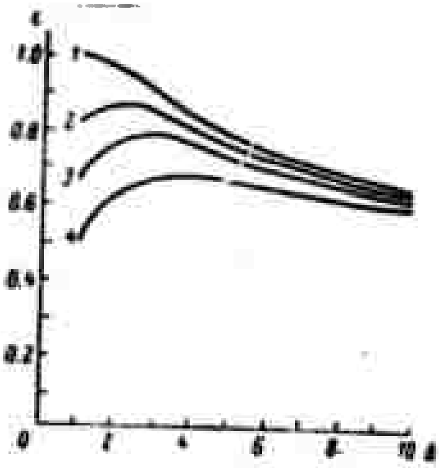
It was noted that the spacing between lenses had to be increased due to the defocusing effect of the space charge. The stability of moving charged particles in an accelerated beam was found to depend upon the parameter, $k \equiv \frac{R_{max}}{R_{min}}$, where R_{max} - maximum value of deflected beam at the lens location; and R_{min} - minimum value of deflected beam between lenses. Fig. 1 illustrates stable and unstable conditions.

Vorob'yev, A. A., and L. T. Murashko. Formation of cavities during flash-over of ionic crystals. FTT, no. 1, 1972, 256-258.

A description is given of the mechanism of structural damage of alkali halide crystals caused by electric flash-over on them. Experiments were performed with NaCl, KCl, and KBr subjected to voltage pulses of 2.5~4 Kv. The resultant cavity formation is explained by the formation of pores of various size and quantities due to the fusion of vacancies produced by deformations, and ultimate combination of these pores. The largest pores were found to occur in KBr specimens where linear dimensions reached as much as 50 microns. Formation of pores results only after the flash-over, i.e. after the completion of discharge with a shock wave, as in metals. Methods of increasing pore formation and mechanisms of their combination are briefly outlined.

Gubarev, V. Ya., N. P. Kozlov, L. V. Leskov, and Yu. S. Protasov. Coefficient of monochromaticity of an erosive pulse accelerator. ZhTF, no. 2, 1971, 379-381.

The coefficient of monochromaticity is theoretically determined for an erosive pulse accelerator, taking into account the acceleration factors during the formation of distributed discharge. The analysis is similar to calculations already reported by Balagurov et al (ZhTF, no. 3, 1970). A model was used with a modified variation of electrodynamic approach. An approximation calculation method, based on the solution of the equation of motion with a non-uniform magnetic field, is suggested, which shows that the coefficient of monochromaticity depends on (1) the value of internal (r_1), and external (r_2) radii of the electrode, and their ratio, $\Delta \equiv r_2/r_1$ (Fig. 1) and (2) the value C_1



1 - $C_1 = 0$
2 - $C_1 = 0.2$
3 - $C_1 = 0.5$
4 - $C_1 = 1.0$

Fig. 1. Relationship between coefficient of monochromaticity and Δ.

of the ratio of mean square thermal rate to the square of mean velocity of controlled movement. The conclusion of Balagurov on optimal electrode radii is thus shown to be applicable to the distributed charge case.

Novikov, B. V., A. Ye. Cherednichenko and P. G. Shlyakhtenko. Spectral investigation of field emission from CdS monocrystals in pulsed and stationary regimes. FTT, no. 1, 1972, 19-23.

A comparative study is described of the spectral characteristics of field photoemission from CdS single crystals in stationary and in pulsed voltage regimes. Experiments were conducted for both regimes, with measurements being made at room temperature in vacuum at not less than 10^{-9} torr. Fig. 1 shows the experimental setup. Spectral characteristics as obtained by oscillogram show that in both regimes two maxima appear - one from interzone transitions and the other a supplementary maximum connected with transitions between levels lying in the forbidden zone. The process of establishing the

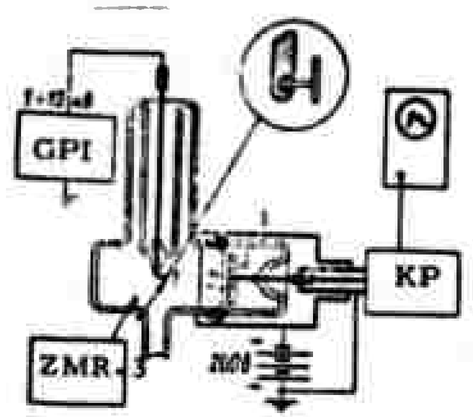


Fig. 1. Experimental sketch. GPI - impulse generator; KP - cathode follower; ZMR-3 - monochromator; 1 - emitter, CdS; 2 - metallic screen; 3 - collector; 4 - copper cylinder.

photo field current was studied (Fig. 2) in the pulse voltage regime, with a pulse duration of 3 millisec. An analysis of current transients is also included.

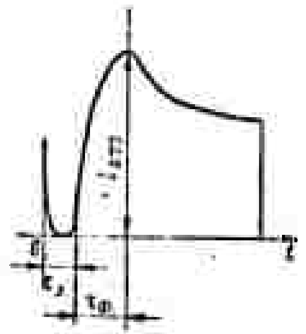


Fig. 2. Form of current.

The authors point out the possibility of using the cited method in the study of energetic structures of semiconductor and other types of field-emitter cathodes.

Bereznyak, P. A., and V. V. Slezov. Calculation of characteristics of ion current bombarding the tip of a needle field emitter. RIE, no. 2, 1972, 354-358.

The article deals with the determination of the number of ions in a residual gas bombarding the tip of a field emitter. With some simple approximations, the equation of motion of charged particles in the field of the tip is obtained, and is solved by computer, using the Runge-Kutta method. The number of ions is found to be practically independent of the spacing between point and anode. The space distribution of ions bombarding the tip is found and characteristic curves are drawn. The authors point out a wide discrepancy between their results and those obtained by Muller and Tsong (Field ion microscopy, American Elsevier Publishing Co., Inc., New York, 1969).

Ryutov, D. D. Quasilinear relaxation of an electron beam in an inhomogeneous plasma. ZhETF, v. 57, no. 1, 1969, 232-246.

The problem of quasilinear relaxation of an electron beam in a low-density plasma is investigated, and the mathematical solution is developed.

Fig. 1

Fig. 2

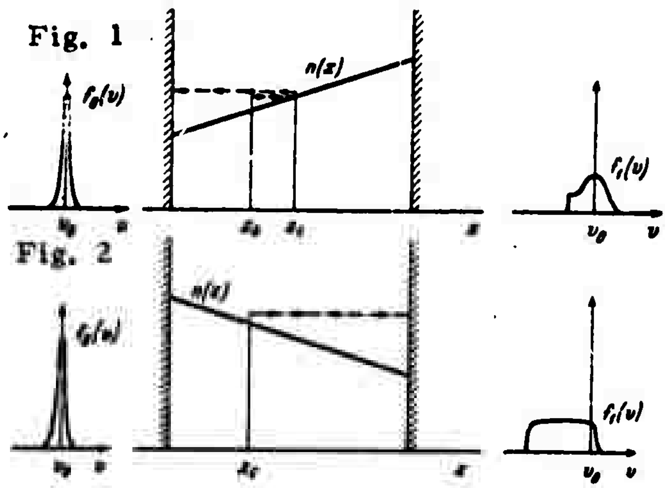


Fig. 1 and Fig. 2. Quasilinear relaxation of electron beam in plasma with change in density $n(x)$. Arrows show the movement of quasiparticles. $f_0(v)$ - electron distribution of the beam at entrance to plasma; $f_1(v)$ - electron distribution of the beam at exit from plasma.

It is shown that quasilinear relaxation must always be followed by acceleration of electrons; furthermore, in the presence of inhomogeneities in the plasma, it results in the appearance of electrons with velocities appreciably exceeding the initial beam velocity. If plasma density increases in the direction of beam motion, the movement of the quasiparticles causes the beam to accelerate (Fig. 1). On the contrary, if the density decreases, acceleration of electrons does not occur (Fig. 2).

Belan, N. V., V. F. Gaydukov, G. I. Kostyuk, Ye. K. Ostrovskiy, and I. V. Strelkov. Conditions for breakdown in an electron beam vacuum discharger. ZhTF, no. 2, 1972, 382-384.

An investigation is presented of the development of breakdown in a vacuum discharger using an electron beam. Oscillograph recordings show that breakdown results from the formation of an instability in the region of electron irradiation, which gives rise to an avalanche-like increase of cathode emission. This instability is related to a certain critical pressure of metal vapor, P_{ocr}, which can be taken as the criterion for arc breakdown. The critical pressure of metal vapor depends on the geometry of the vacuum discharger, the ionization area of the vaporizing body, and cathode temperature, and varies under different conditions. For the conditions under study,

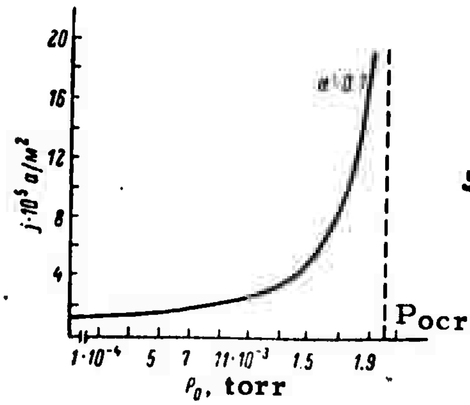


Fig. 1. Relation between calculated current density and the pressure at evaporating surface.

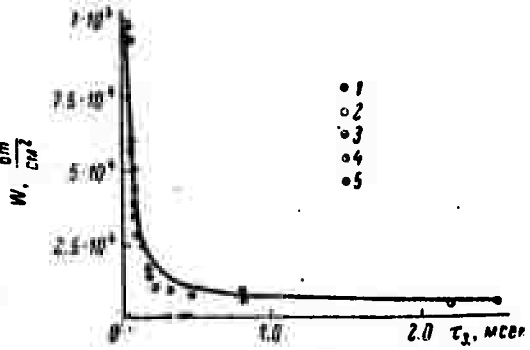


Fig. 2. Experimental and calculated relationship between time lag and beam power density.

the characteristic curve (Fig. 1) of current density vs. pressure gives the critical pressure $P_{ocr} \approx 2 \cdot 10^{-3}$ torr. The duration of the pulse until beginning of arc-over depends on the beam power density. Fig. 2 gives the experimental as well as calculated curves for the relationship between pre-breakdown time lag and beam power. The calculated results are seen to be in good agreement with experimental ones.

Churayev, V. A., and V. N. Petrov. Accelerating a plasma in a conical inductive source. ZhTF, no. 2, 1972, 372-378.

A system of expressions is developed to define the parameters of a conical induction accelerator whose geometry is shown in Fig. 1. The problem

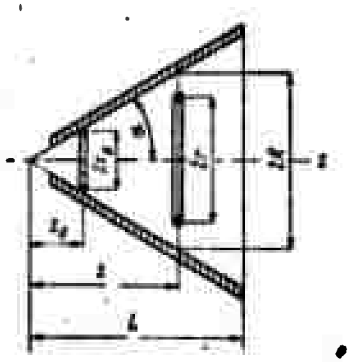


Fig. 1. Model for induction accelerator.

is considered for the general cases of high and low values of $\tau_0 \equiv \omega t_0$, ω being current frequency in the inductor and t_0 the movement of bunch formation. At low τ_0 conversion efficiency is not better than 1%, which eliminates this case from practical consideration. Assuming the large τ_0 case, and the realistic conditions of a finite discharge energy source and parasitic inductance in connector elements, the authors derive approximate expressions for design parameters. Some examples of computer solutions are given; Fig. 2 shows the theoretical dependence of plasma velocity on current frequency and cone angle. The analysis shows a strictly limited set of parameters for which the conical design would prove useful. However, within this range it should be

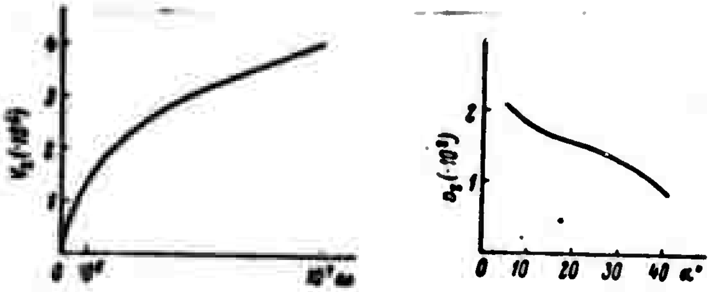


Fig. 2. Plasma velocity vs. ω
and cone angle.

possible to get 20 to 40% efficiency and plasma velocities on the order of 10^8 cm/sec.

Iremashvili, D. V., S. V. Kuril'nikov, N. I. Leont'yev, T. A. Osepashvili, A. P. Timoshenko and Yu. K. Udovichenko. Interaction of a 30 Mw electron beam with plasma. ZhTF, no. 8, 1971, 1624-1626.

An experimental study is reported on the reaction of a 30 Mw electron beam, formed by a spark source, with plasma penetrating into the reaction chamber from the source. An electron beam of 3.5 cm diameter was injected from the spark source into a metallic reaction chamber with an internal diameter of 13 cm and length of 25 cm. In the chamber the electron beam was observed to interact with the injected plasma, giving rise to intensive linear high-frequency oscillations near the anode. Highest oscillations were found in the absence of magnetic field and at a distance of 3 cm from the anode; further away the oscillation amplitude decreased with the decrease of beam density (Fig. 1). In the presence of a magnetic field, the intensity of linear high-frequency oscillations was found to decrease greatly with increase in field intensity H_0. The intensity of oscillations was also found to decrease with a rise in chamber pressure. The frequency spectrum for conditions of highest oscillations ($H_0 = 0$, $L = 3$ cm) is given in Figure 2. Oscillatory power in the 800~7000 MHz range was measured to be 300 kw, which was 1% of the beam power. The authors point out that the interaction of a high-power electron beam with plasma may still be greater, if the following are considered:

Fig. 1. Amplitude curve of high-frequency oscillations along the length of the reaction chamber.

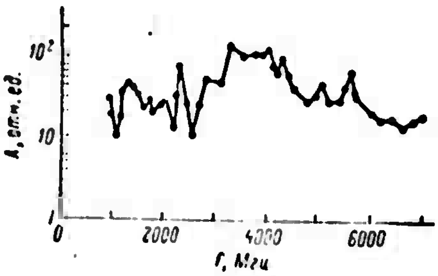


Fig. 2. Frequency spectrum
$H_o = 1$; $p = 10^{-5}$ torr.

1) the actual frequency spectrum, which is wider than that considered;
2) non-linearity of waves in the low frequency range of the spectrum;
3) the significant nonuniformity in plasma density over the distributed electron beam in the system.

Danilovskaya, V. I., and E. M. Shefter. Temperature field and stress, arising in an elastic semispace due to axisymmetric radiant flux. FiKhOM, no. 3, 1969, 13-19.

The article considers the temperature and stress arising in an elastic isotropic plate, when an axisymmetric radiant flux of intensity I(t) impinges on it. Mathematical expressions are derived on the assumptions that: a) absorption of radiant energy is according to the Bouguer law; b) thermophysical coefficients are independent of temperature; c) non-linear effects and energy loss due to radiation and convection are ignored; and d) radiant flux intensity is insufficient for fusion and sublimation.

The radiant energy falling on the plate converts to heat, so that the surface temperature rises according to a linear relationship, and the increase in temperature proportionately increases the stress in the surface layer of the isotropic body. The stress thus developed reaches its maximum value at the end of the pulse cycle. Depending on the characteristics of the radiant flux and properties of the material, two general cases may be considered: a) at the end of the pulse, if the stress value is lower than the viscosity limit, then the body displays a reversible change; and b) if the stress value is higher than the viscosity limit, the body surface undergoes plastic deformation. After cooling, residual tensile stress may lead the body surface to cracking and peeling, if this residual stress is higher than the stability limit. A similar phenomenon is often seen in experiments where a body is irradiated by low-power radiant flux and also in laser-active materials when excited by flashlamps.

Sultanov, M. A. Investigation of the destruction mechanism of certain solids under the action of supersonic plasma flow, as a function of their thermophysical properties. TVT, no. 5, 1970, 963-968.

The destruction mechanism of several metallic and non-metallic materials under the action of supersonic plasma flow is reported. Plasma

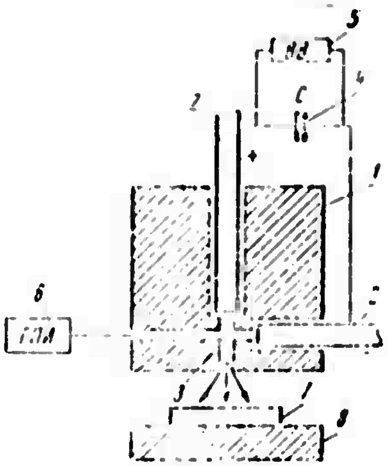


Fig. 1. Hypersonic plasma generator.
1 - chamber dielectric material; 2 - electrodes, e.g. carbon; 3 - exit nozzle; 4, 5 - discharge pulse source, 2-3 Kv; 6 - trigger; 7 - target; 8 - holder.
Mean plasma exit speed = 6--12 km/sec.

impact experiments are described and photographs of destruction are given: Fig. 1 shows the plasma generator. A supersonic plasma flow striking a metallic body produces local heat as high as 3000°K at the impact spot, due to which the body melts forming around the spot a thin film, which in turn is carried away by the plasma flow. With non-metallic substances, excepting glass, fusion of the material does not occur, but owing to the intense heat at the spot, destruction takes place from evaporation of the material. Destruction of material was found to depend largely on the speed of plasma flow: with a decrease in plasma speed, destruction also decreases, and at subsonic speeds, is practically negligible. The amount of destruction of a metallic body was found to vary with the temperature of fusion, latent heat of fusion and the quantity of heat required for heating a unit volume of the specimen substance.

Belan, N. V., Ye. K. Ostrovskiy, V. F. Gaydukov, I. V. Strelkov, and L. N. Kalashnikov. Electric arc-over in vacuum initiated by electron beam. ZhTF, no. 3, 1971, 563-566.

In low pressures, an electron beam emitted by a cathode and focused at an anode can act as an initiator of breakdown. An experiment demonstrating this effect was conducted with a constant voltage of U_o = 3 Kv across two electrodes spaced 1 cm apart, the anode material being lead. Regulation of beam power was obtained by voltage pulses in the range of U_{reg} = 2.3~3.4 Kv. The pressure in the chamber was maintained at 2 x 10^{-5} torr. Breakdown of stability in the vacuum gap was observed, and was characterized by a time lag between the initial beam pulse and the moment of arc-over (Fig. 1).

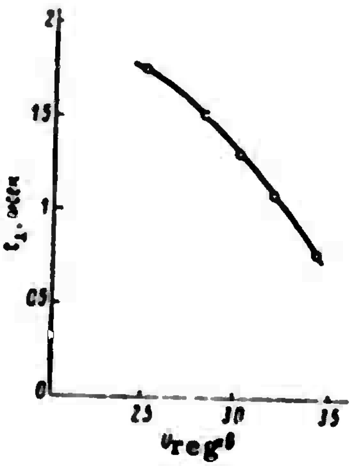


Fig. 1. Relationship between time lag, t_z and U_{reg}.

The time lag t_z is determined by the concentrated power on the anode surface, which results in an intensive heat higher than the melting point. Characteristics of the beam power density q_o with respect to its radius r for three different values of U_{reg} (Fig. 2) and the characteristics of temperature rise on the anode surface as a function of pulse duration (Fig. 3) were also obtained. At the initial beam pulse, the temperature of the anode surface was 300°C, while at the moment of arc-over the temperature was 580°C (melting point of lead = 327°C). At this temperature, lead was found to melt at the

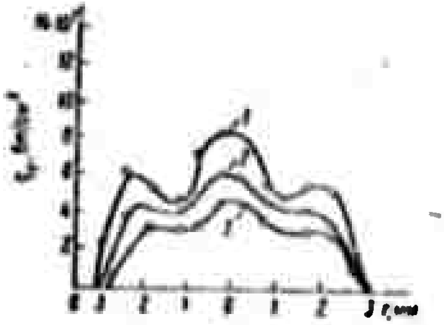


Fig. 2. Distribution of the beam power density. 1 - U_{reg} = 3.4 Kv; 2 - U_{reg} = 3.0 Kv; 3 - U_{reg} = 2.5 Kv.

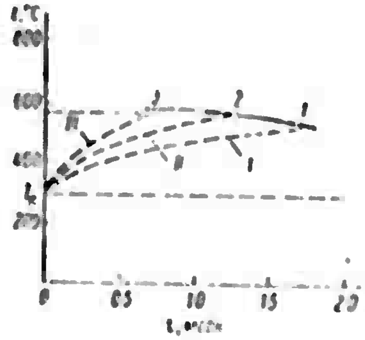


Fig. 3. Temperature rise at anode surface with time. I - $q_o = 3.5 \times 10^3$ watt/cm^2; II - $q_o = 4.8 \times 10^3$ watt/cm^2; III - $q_o = 6.64 \times 10^3$ watt/cm^2.

rate of $\omega = 10^{-4}$ gm/cm^2/sec, which led to a local pressure rise at the anode, P = 10^{-3} torr. The experiment thus shows the trigger possibilities of a pulsed electron beam in vacuum discharges, and relates the trigger action to anode surface heating.

Grishin, V. K. Linear stability of a charged beam in an inductive system. ZhTF, no. 1, 1972, 9-12.

The article considers the theoretical linear stability of a highly-charged beam, produced by a linear induction accelerator made up of circular inductors with ferromagnetic cores. It is assumed that the charged particles are accelerated in a channel, bounded by a medium of magnetic permeability $\mu > 1$. A local nonhomogeneity of charged particle density will occur in the beam, which is acted upon by the interval or the self-field of the charged particles, consisting of two components: a coulomb and an inductive part. The inductive component gives rise to the inhomogeneity of the current. In the case $\mu \beta > 1$, where β is the ratio of the particle velocity to that of light, c, the inductive component of the charged particles predominates, thereby causing linear instability in the beam. Mathematical expressions for quantitative analysis of the phenomenon are derived, and are applied to an example using actual parameters of the LIU-3000 device. This shows that beam current fluctuations must be held to the order of tens of amperes, if beam energy uniformity is to be maintained within 10%.

Davydov, B. B. and L. Ya. Min'ko. The nature of discontinuity of plasma formations in erosion--type pulse sources. ZhTF, no. 1, 1971, 73-79.

Discontinuity in plasma formations was studied experimentally in pulsed plasma accelerators (PPA) using electrodes of cylindrical, conic, or parallel track geometry in a 10^{-2} - 10^{-3} torr vacuum as well as at atmospheric pressure. The nature and kinetics of the material input from the electrodes and dielectric wall inserts, and the relationship of plasma discontinuity with erosion of the plasma-forming working media, were of special interest. Three variants of cylindrically and conically-shaped central electrodes were tested, including rod and the hollow cylinder forms (Fig. 1). In the case of the rod-shaped central electrode, the firing electrode was a hollow cylinder, and vice versa. Different discontinuous plasma structures were observed in all cases from high-speed scanning photographs of emission. The photographs and micrographs of the electrode and dielectric insert surfaces confirm that the observed plasma micro-bunches or plasmoids are formed during erosion of either electrode or dielectric insert surfaces. It was concluded that the

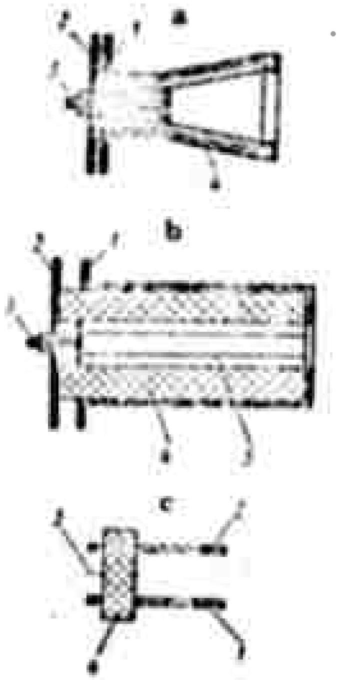


Fig. 1. Pulsed plasma accelerators.
a, b: 1 - ring electrode; 2 - plane electrode;
3 - rod electrode; 4 - dielectric filler;
5 - axial window. c: 1, 2 - electrodes;
3 - ignition.

erosion is connected with the spatially and temporally discrete contribution of material from the plasma-forming working media. The discrete nature of the input results from the spatial and temporal nonuniformity of energy release at the electrode or dielectric insert surfaces.

Zubkov, I. P., A. Ya. Kislov, and A. I. Morozov.
Ion beam emitted from a double-lens accelerator.
ZhTF, no. 5, 1971, 880-889.

Spatial distribution, energy spectra and mass composition were experimentally determined for a hydrogen ion beam emitted by a high-intensity plasma accelerator. The accelerator was designed earlier by the authors as the first step in the development of an injector for fission. A wide spread of the ion beam was indicated by accelerator emission cross-section images at varying observation angles δ. The images were obtained using a pinhole camera placed at some distance from the accelerator. Ion beam energy spectra were measured by a multigrid probe and a mass-analyzer located 20 cm and ~1 m from the accelerator. The data obtained by both methods confirmed that most of the ions are formed near the first lens and that their energy spectrum $g(E_{\parallel}) = dI/dE_{\parallel}$ is broad (between 0.9 and 2.0 KeV) with a mean $\bar{E}_{\parallel} = 1.3 - 1.7$ KeV. Ion beam mass was measured by time-of-flight mass spectrometry using the same mass analyzer with a special modulator. The presence of H^+ and H_2^+ ions at $\delta = 50°$ was detected in about equal quantities. At $\delta = 35°$, an additional N^+ peak was observed, spatially separated from the H^+ and H_2^+ peaks. At $\delta = 5°$ and $15°$, the ion beam comprised N^+, O^+, O_2^+ impurities only. The experimental energy spectra qualitatively agree with theoretical evaluations. The experimental energy spectra width is however greater than the calculated width for H ions. This discrepancy and the presence of ions with energy exceeding the discharge potential are explained by the electric field oscillations in the accelerating channel. Techniques for eliminating these defects are recommended.

B. Recent Selections

Abramovich, V. U., and V. I. Shevchenko. Nonlinear theory of dissipative instability of a relativistic beam in plasma. UFZh, no. 2, 1972, 329-332.

Andronov, A. N., and V. N. Lepeshinskaya. On the destruction of oxide films by electron beam. RiE, no. 10, 1971, 2005-2006.

Berman, L. S., L. B. Kreynin and F. S. Nasredinov. Study of capacitive properties of silicon n^+-p diodes, irradiated by fast electrons. FTP, no. 2, 1972, 294-299.

Beylis, I. I., G. A. Lyubimov, and V. I. Rakhovskiy. Diffusion model for the cathode region of a high-current arc discharge. DAN SSSR, v. 203, no. 1, 1972, 71-74.

Bugayev, S. P., V. V. Kremnev, Yu. I. Terent'yev, V. G. Shpak, and Ya. Ya. Yurike. Grazing discharge in vacuum upon dielectrics of barium titanate. ZhTF, no. 9, 1971, 1958-1962. (Phys. abst., 1971, #82622)

Bykhovskiy, D. G., S. M. Golubovskaya, Yu. V. Golubovskiy and Yu. M. Kagan. Spectroscopic study of plasmatron output parameters. II. OiS, v. 30, no. 5, 1971, 836-840. (Phys. abst., 1972, #8993)

Bystrov, L. N., L. P. Zhukova, and Yu. M. Platov. Effect of electron radiation on mechanical properties of Fe-Cr and Fe-Mo alloys. FiKhOM, no. 1, 1972, 19-22.

Danilov, V. N., and V. A. Syrovoy. Approximate solution of the Cauchy problem for the Laplace equation applied to the formation of dense space-heterogeneous beams of charged particles. PMM, no. 4, 1971, 656-668. (RZhMekh, 12/71, #12B166)

Fisher, R. and Kh. Noyman. Avtoelektronnaya emissiya poluprovodnikov (Field emission from semiconductors). Moskva, Izd-vo nauka, 1971, 216 p. (Translated from German by G. N. Fursey and B. I. Saprykin)

Fursey, G. N., and G. K. Kartsev. Stability of field emission and migration processes, preceding the development of an arc in vacuum. ZhTF, no. 2, 1970, 310-319.

Gabovich, M. D., and V. P. Kovalenko. Character of the nonlinear interaction of an electron beam with plasma. DAN SSSR, v. 199, no. 4, 1971, 799-801. (RZhMekh, 12/71, #12B227)

Gavrilenko, V. G., G. A. Lupanov and N. S. Stepanov. Dynamic optical effects in plasma. IVUZ Radiofiz, no. 2, 1972, 183-190.

Golubentsev, A. F., and A. S. Shapovalov. A method for accounting for the statistical nonuniformities of a cathode. IVUZ Radiofiz, no. 2, 1972, 266-271.

Golubentsev, A. F., A. S. Shapovalov and L. I. Golubentseva. Investigating the effect of emitting surface micro-contour of a cathode on its emitting properties. RiE, no. 11, 1971, 2173-2182.

Karchevskiy, A. I., and Yu. I. Strakhov. Thresholds of beam instability of current in direct discharge. ZhETF P, v. 13, no. 11, 1971, 595-599. (RZhElektr, 11/71, #11A41)

Kolesnikov, P. M., N. S. Kolesnikova and I. B. Gavris. Uskoreniye plazmy v koaksiale s optimal'nym induktivnym nakopitelem energii. (Acceleration of plasma in a coaxial device with optimum inductive energy storage). AN BSSR, Minsk, 1971, 17 p. (RZhF, 2/72, #2G329DEP)

Kondratenko, A. N., and I. N. Onishchenko. Reflection of an electromagnetic wave from a magnetically active plasma at oblique incidence. II. UFZh, no. 7, 1969, 1060-1069.

Kosarenkov, V. A., Ye. I. Ryabtsev, G. P. Stel'makh, N. A. Chesnokov and V. P. Shimchuk. Distribution of thermal flux in a sectioned channel of a plasmatron working in a hypersonic plasma flow regime. Izvestiya SOAN SSSR, Seriya tekhnicheskikh nauk, v. 8, no. 2, 1971, 13-17.

Kudelainen, V. I., I. N. Meshkov and R. A. Salimov. The formation of an intense electron beam in a magnetic field. ZhTF, no. 11, 1971, 2294-2296. (Phys. abst., 1972, #7845)

Laboratory of plasma mechanics. Nauka i zhizn', no. 2, 1972, 52-53.

Laboratory of polymer mechanics. Nauka i zhizn', no. 2, 1972, 53.

Levin, A. L., and B. A. Khmelinin. Measurement of plasmatron jet velocity by a magnetohydrodynamic method. TVT, no. 2, 1971, 413-419.

Mesyats, G. A., A. S. Nasibov, and V. V. Kremnev. Formirovaniye nanosekundnykh impul'sov vysokogo napryazheniya. (Formation of nanosecond pulses of high voltage.) Moskva, Izd-vo energiya, 1970, 152 p.

Morozov, A. I., and A. P. Shubin. Parameter of similarity for near-electrode processes. ZhPMTF, no. 1, 1972, 117-118.

Nagaibekov, R. V. The processes of ionization and recharging of ions in the cathode spot of an arc discharge in vacuum. ZhTF, no. 11, 1971, 2350-2352. (Phys. abst., 1972, #9012)

Pasechnik, L. L., M. M. Prokhorov and V. V. Yagola. Movement of ions in a magnetic field under the influence of an induced electric field. ZhTF, no. 2, 1972, 275-279.

Perevodchikov, V. I., O. L. Federov, and K. O. Yumatov. Pulsed electron gun with current up to 1 Ka. UFZh, no. 6, 1971, 971-976. (RZhElektr, no. 11, 1971, #11A24)

Podshivalov, V. N., and N. P. Sobenin. Calculating the axial dynamics of particles in the bunching sections of high-current linear electron accelerators. ZhTF, no. 10, 1971, 2094-2097.

Poshekhonov, P. V., and V. I. Solov'yev. Initiation of a vacuum arc at pulsed voltage during break-off of macroparticles from the electrode surface. RiE, no. 9, 1971, 1705-1711.

Potapov, L. P., and P. P. Shiryayev. Method of determining the form of ion field emission needles. PTE, no. 2, 1971, 236-238.

Rukhadze, A. A., and V. G. Rukhlin. Injection of a relativistic electron beam into a plasma. ZhETF, v. 61, no. 1, 1971, 177-189.

Rylov, Yu. P., and Z. A. Pigulevskaya. Experimental determination of the current density on electrodes during power vacuum discharge. ZhTF, no. 11, 1971, 2466-2469. (Phys. abst., 1972, #8994)

Slavin, G. A., and A. F. Khudyshev. Some features of crystallization of the liquid metal pool during pulse electron beam welding. FiKhOM, no. 1, 1972, 37-44.

Smiyan, O. D. Stimulating the speed of a chemical reaction by the effect of a high energy electron beam. FiKhOM, no. 1, 1972, 163.

Sorokin, Yu. M. and N. S. Stepanov. Reflection and refraction of electromagnetic waves by a moving region of ionization. IVUZ Radiofiz, no. 5, 1971, 686-689.

Uglov, A. A. Summary of works of the seminar on physical and chemical processing of materials by concentrated energy flow. FiKhOM, no. 1, 1972, 174-175.

Vishnevskiy, A. I., V. I. Krizhanovskiy, A. I. Soldatenko and A. I. Shendakov. The trioplasmatron: A new pulse-regulated gas discharge device with crossed fields. IVUZ Radiofiz, no. 1, 1972, 117-118.

Zhukov, M. F., A. S. An'shakov, G-N. B. Dandaron, and M. I. Sazonov. Erosion of a tungsten cathode in nitrogen. Izvestiya SOAN SSSR, Seriya tekhnicheskikh nauk, v. 8, no. 2, 1971, 7-12.

Zolotykh, B. N., A. I. Marchuk, and M. S. Sen'kina. Investigation of the surface of tungsten single crystals after electro-erosion treatment. FiKhOM, no. 1, 1972, 145-150.

5. Miscellaneous Interest

A. Recent Selections

Bredikhin, M. Yu., B. V. Glasov, R. V. Payl, Ye. I. Skibenko and V. B. Yuferov. Magnet system for investigating Lorentz ionization of highly-excited hydrogen atoms. IN: Fizika plazmy i problemy upravleniya termoyadernogo sinteza. Respublikanskiy mezhvedomstvennyy sbornik. 1971, 251-260. (RZhF, 2/72, #2G78)

Brovman, Ye. G., Yu. Kagan and A. Kholas. Structure of metallic hydrogen at zero pressure. ZhETF, v. 61, no. 6, 1971, 2429-2458.

Ivanov, Yu. S., V. V. Ryukkert, G. V. Sklizkov, and S. I. Fedotov. Sharply focused source of short-pulse soft x-radiation. KSpF, no. 7, 1971, 34-37.

Kirko, G. Ye. Elementary theory of the hydrothermomagnet. TVT, no. 1, 1972, 161-167.

Kotyrlo, G. K., and G. M. Shchegolev. A thermoelectric device immersed in a fluid moving in the direction of heat flow. Teplofizika i teplotekhnika, no. 19, 1971, 132-135. (Phys. abst., 1972, #7823)

Kozyrev, B. P., and V. A. Bazhenov. Effective method of designing infrared radiators with a given directional pattern. IVUZ Priboro, no. 2, 1972, 104-107.

Malyarevskaya, T. N., and N. V. Studentov. A system of square coils for developing a highly homogenous magnetic field. IN: Trudy metrologicheskikh institutov SSSR, no. 113, 1970, 46-51. (LZhS, 9/72, #27304)

Morozov, Yu. G., and A. Ya. Ender. The influence of a transverse magnetic field on the operation of a thermoemission converter in the under-compensated Knudsen mode. ZhTF, no. 11, 1971, 2412-2419. (Phys. abst., 1972, #7822)

Yermolayev, E. A., Yu. L. Shelekhin and M. P. Votinov. Interaction of ruby with ionizing radiation. IN: Trudy Leningradskogo politekhnicheskogo instituta, no. 325, 1971, 78-80. (RZhRadiot, 1/72, #1D325)

Zhidkova, Z. V. Photochromic properties of films, dyed by perinaphthioindigo and 2-perinaphthpenthiophene-2'-(5'-methylthionaphthene)-indigo dyes. ZhPS, v. 16, no. 2, 1972, 325-330.

SUBJECT: Comments on Soviet "Topaz" nuclear-powered thermionic generator

SOURCE: Sovetskaya Kirgiziya, 1 February 1972, p. 3, cols. 1-4

A recent newspaper article comments on the Soviet "Topaz thermo-emission reactor/converter" used for the thermionic conversion of nuclear-generated heat into electricity. Previously, details on the Topaz were first announced by Professor Vyacheslav Kuznetsov at the 4th International Conference on the Peaceful Uses of Atomic Energy, held in 1971 in Geneva, Switzerland. In the Topaz, the encased inner nuclear fuel element (cathode) is separated from the outer casing (anode) by a cesium-vapor-filled gap of fractions of a millimeter. The author states that the design principle behind the Topaz consists of interconnecting tens or hundreds of individual thermionic elements . The Topaz is equipped with a neutron moderator and reflector, an output control, and a heat-transmission medium. It is mentioned that the wide variety of materials (affecting the neutron balance) used in the active area greatly complicated the design phase, and many supplementary experiments were required.

In tests, the Topaz successfully delivered 10,000 watts (relative to operating mode) over the entire testing time. This is said to be better than a tenfold improvement of the Soviet "Romashka" and the U.S. SNAP-10A, both of which had outputs below 500 watts. Doctor D. Khatsopulos (?), an American scientist, and Doctor B. Deven (?), a French scientist, are reported to have stated that the Topaz has facilitated the development of compact power sources for deep-ocean research, polar expeditions, mining and geological prospecting, and space applications.

6. SOURCE ABBREVIATIONS

DAN BSSR	-	Akademiya nauk Belorusskoy SSR. Doklady
DAN SSSR	-	Akademiya nauk SSSR. Doklady
DAN Uzb	-	Akademiya nauk Uzbekskoy SSR. Doklady
FAiO	-	Akademiya nauk SSSR. Izvestiya. Fizika atmosfery i okeana
FGiV	-	Fizika goreniya i vzryva
F-KhMM	-	Fiziko-khimicheskaya mekhanika materialov
FiKhOM	-	Fizika i khimiya obrabotka materialov
FMM	-	Fizika metallov i metallovedeniye
FTP	-	Fizika i tekhnika poluprovodnikov
FTT	-	Fizika tverdogo tela
IAN Energetika i transport	-	Akademiya nauk SSSR. Izvestiya. Energetika i transport
I-FZh	-	Inzhenerno-fizicheskiy zhurnal
IVUZ Fiz	-	Izvestiya vysshikh uchebnykh zavedeniy. Fizika
IVUZ Geologiya i razvedka	-	Izvestiya vysshikh uchebnykh zavedeniy. Geologiya i razvedka
IVUZ Gornyy zhurnal	-	Izvestiya vysshikh uchebnykh zavedeniy. Gornyy zhurnal
IVUZ Priboro	-	Izvestiya vysshikh uchebnykh zavedeniy. Priborostroyeniye
IVUZ Radiofiz	-	Izvestiya vysshikh uchebnykh zavedeniy. Radiofizika
KSpF	-	Kratkiye soobshcheniya po fizike
LZhSt	-	Letopis' zhurnal'nykh statey
MTT	-	Akademiya nauk SSSR. Izvestiya. Mekhanika tverdogo tela

MZhiG	-	Akademiya nauk SSSR. Izvestiya. Mekhanika zhidkosti i gaza
OiS	-	Optika i spektroskopiya
Phys abst	-	Physics abstracts
PM	-	Prikladnaya mekhanika
PMM	-	Prikladnayay matematika i mekhanika
PTE	-	Pribory i tekhnika eksperimenta
RiE	-	Radiotekhnika i elektronika
RZhElektr	-	Referativnyy zhurnal. Elektronika i yeye primeneniye
RZhF	-	Referativnyy zhurnal. Fizika
RZhMekh	-	Referativnyy zhurnal. Mekhanika
RZhMetrolog	-	Referativnyy zhurnal. Metrologiya i izmeritel'naya tekhnika
RZhRadiot	-	Referativnyy zhurnal. Radiotekhnika
TVT	-	Teplofizika vysokikh temperatur
UFN	-	Uspekhi fizicheskikh nauk
UFZh	-	Ukrainskiy fizicheskiy zhurnal
VLU	-	Leningradskiy universitet. Vestnik. Fizika, khimiya
VBU	-	Belorusskiy universitet. Vestnik
ZhETF	-	Zhurnal eksperimental'noy i teoreticheskoy fiziki
ZhETF P	-	Pis'ma v Zhurnal eksperimental'noy i teoreticheskoy fiziki
ZhPMTF	-	Zhurnal prikladnoy mekhaniki i teoreticheskoy fiziki
ZhPS	-	Zhurnal prikladnoy spektroskopii
ZhTF	-	Zhurnal tekhnicheskoy fiziki
ZhVMMF	-	Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki

7. AUTHOR INDEX