AD-779 755

SELECTED MATERIAL FROM SOVIET TECHNICAL LITERATURE, DECEMBER 1973

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Informatics, Incorporated

Prepared for:

Air Force Office of Scientific Research
Advanced Research Projects Agency

28 February 1974

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: AFOSR - TR - 74 - 0784	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER: AD 779755	
4. TITLE (and Subtitle): Selected Material from Soviet Technical Literature December, 1973	5. TYPE OF REPORT & PERIOD COVERED: Scientific . . . Interim
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Stuart G. Hibben	8. CONTRACT OR GRANT NUMBER(s): F44620-72-C-0053
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Informatics Inc. 6000 Executive Boulevard Rockville, Maryland 20852	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: ARPA Order No. 1622-4 Program Code No. 62701E3F10
11. CONTROLLING OFFICE NAME AND ADDRESS: Advance Research Projects Agency/STO 1400 Wilson Boulevard Arlington, Virginia 22209	12. REPORT DATE: February 28, 1974
	13. NUMBER OF PAGES: 177
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office): Air Force Office of Scientific Research/NP 1400 Wilson Boulevard Arlington, Virginia 22209	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Scientific . . . Interim

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

High Power Lasers
Explosion Effects
Geosciences
Particle Beams
Material Science
Energy Conversion

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report includes abstracts and bibliographic lists on contractual subjects which were completed in December, 1973. The major topics are: laser technology, effects of strong explosions, geosciences, particle beams, and material sciences. Sections on energy conversion and items of miscellaneous interest are included as optional topics.

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SELECTED MATERIAL
FROM
SOVIET TECHNICAL LITERATURE

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Sponsored by

Advanced Research Projects Agency

ARPA Order No. 1622-4

February 28, 1974

ARPA Order No. 1622-4
Program Code No: 62701F3F10
Name of Contractor:
Informatics Inc.
Effective Date of Contract:
January 1, 1973
Contract Expiration Date:
December 31, 1973
Amount of Contract: $343,303

Contract No. F44620-72-C-0053, P00001
Principal Investigator:
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Short Title of Work:
"Soviet Technical Selections"

This research was supported by the Advanced Research Projects Agency of the Department of Defense and was monitored by the Air Force Office of Scientific Research under Contract No. F44620-72-C-0053. The publication of this report does not constitute approval by any government organization or Informatics Inc. of the inferences, findings, and conclusions contained herein. It is published solely for the exchange and stimulation of ideas.

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INTRODUCTION

This report includes abstracts and bibliographic lists on contractual subjects that were completed in December, 1973. The major topics are: laser technology, effects of strong explosions, geosciences, particle beams, and material sciences. Sections on energy conversion and items of miscellaneous interest are included as optional topics.

Laser coverage is generally limited to high power effects: all current laser material is routinely entered in the quarterly laser bibliographies.

An index identifying source abbreviations and a first-author index to the abstracts are appended.

TABLE OF CONTENTS

1. Laser Technology

A. Abstracts

Aleksandrov, V. I., A. G. Solov'yev, and P. I. Ulyakov. Space-time distribution of laser radiation with generation duration of the order 1 msec., and its effect on interaction with a substance. FiKhOM, no. 4, 1973, 30-33.

An experimental study of space-time distribution of neodymium laser emission in the near and far zones is presented, to explain some effects of laser beam-metal interaction. The experiments are described using a free-running (irregular spiking), a regular spiking, and nonspiking pulsed lasers with optical pumping. In all experiments, pulse duration was ~2 msec and energy output was 100 to 400 j. Spiking characteristics are given.

The experimentally determined space-time distribution of the free-running emission was found to be nonuniform, while distribution of the regular spiking and nonspiking emissions was spatially uniform and practically continuous in both near and far zones. Experimental plots are shown of the specific recoil impulse I/E from vaporization products of iron and aluminum versus the incident power density q on the target. In the nonspiking regime, the threshold q^* of the initial I exceeds by one order of magnitude the q^* values in the regular spiking and free-running regimes. The data on regular spiking and nonspiking emission space-time distribution show practically equal local peak q^*_ℓ values - i.e. 2×10^6 and 10^6 w/cm^2, for aluminum and iron. The vaporization onset at a constant q^*_ℓ value is confirmed by equality of q^* for aluminum in the free-running and regular spiking regimes.

Balitskiy, A. A., and M. S. Baranov. Effect of thermophysical properties on deep fusion of various metals by laser radiation. FiKhOM, no. 4, 1973, 8-13.

Heat transfer during fusion of a series of metals by laser radiation was studied experimentally to help in selecting welding procedures and to clarify the discrepancy between the theoretical and experimental depth of fusion, h. Nickel and Ni-coated specimens of Kovar, constantan, and molybdenum were irradiated with 1 to 6 msec pulses of variable output energy from an Nd glass laser at $\lambda = 1.06\ \mu$. Oscilloscope traces of laser pulses were recorded and h was measured under constant size and space-time structure of the focused light spot.

The tabulated experimental data, experimental plots, and micrographs of deep fusion cross-section show that, for metals with nearly the same thermal conductivity λ the higher the heat capacity c of a metal, the higher is its threshold energy E_o. At a power density W below a critical value, W is correlated with λ and c of a solid metal. For the same W, diameter d and h are lower in a metal with higher c and λ. As W increases from threshold to critical value, d and h in all metals increased nearly linearly. The limiting W value, below which the model of a plane heat source is applicable for calculation of metal heating for the purpose of welding, is determined from microsections of deep fusion shapes with the factor $\psi = d/h = 1$. The limit W of most metals studied is $(2.5\text{-}4) \times 10^3$ j/cm^2. At a constant W, d and h increase also linearly with increase in pulse duration.

Gurevich, G. L., and V. A. Murav'yev. Effect of the temperature dependence of reflection coefficient on thin film heating by laser radiation. FiKhOM, no. 4, 1973, 26-29.

Formulas previously derived by the authors (May 1973 Report, p. 13) for heat transfer in the center of a small laser-illuminated area of a thin film are generalized here to account for the temperature dependence of reflection coefficient R(T). Stationary θ^* (0) and nonstationary θ (t) temperature fields in the center r = 0 of an elementary area of the film surface are formulated. Solutions are given for θ^* (0) and θ (t) in metals, where the absorption capacity A = 1-R of the film varies linearly with T. The solutions show that accounting for A(T) results in decrease of the threshold power density for film breakdown by the factor $A(T_c)/A(T_o)$, where T_c and T_o are the breakdown and initial temperature respectively. In the nonstationary case, θ of the film at a time t is approximately proportional to A at the same time. The condition is formulated under which allowance for R(T) becomes negligible.

Uglov, A. A., A. N. Kokora, and M. A. Krishtal. Distribution of various elements in interaction zones of a laser beam during treatment of alloys. FiKhOM, no. 4, 1973, 3-7.

Redistribution of alloying elements in the iron-carbon alloy zone affected by radiation from a free-running laser is discussed, on the basis of earlier Soviet experimental data. A qualitative discussion leads to the conclusion that the final distribution of alloying elements in the zone around a crater must be different from their initial distribution. Possible

mechanisms of this redistribution are outlined. Accordingly the element redistribution during laser beam-metal interaction is presented as a three-step process: a nonstationary step followed by a quasistationary breakdown step and finally, crystallization of a thin melt film after cutoff of the laser pulse.

Accumulation of the impurity elements by diffusion into the liquid film or depletion of the film occur mainly during the quasistationary phase. The authors' experimental data are given on distribution of C and Cr in the interaction zone of Kh12M, 45, 3 steels and Armco iron, exposed to a 50 j, 1.8 msec pulse from a free-running Nd glass laser. Local spectrochemical analysis shows a maximum C and Cr concentration below the laser boundary of the crater.

Volod'kina, V. L., and V. L. Komolov.
Thermal breakdown of semiconductors by light. ZhTF, no. 8, 1973, 1766-1769.

A solution is obtained to the problem of thermal breakdown of a semiconductor from the effect of an optical radiation normal to its surface, at a frequency lower than the forbidden energy gap, such that radiation absorption is due to the presence of free carriers in the conduction band. In contrast with a study by Epshteyn (May 1972 Report, p. 3) a solution is obtained up to third order boundary values in the problem of the heat transfer, instead of assuming a constant temperature T on the surface.

The boundary value problem is analyzed for the cases of a plane and a cylindrical model. The latter model is assumed to be a long cylinder ($L \geq \ell$) with heat transfer only at its lateral surface. Critical conditions for thermal breakdown are formulated as functions of heat transfer

coefficients β in the 0.1 to ∞ range and, in the case of a cylinder, as a function of the optical beam radius $\rho_o = \ell/R$. Numerical values of the threshold optical intensity μ_{cr} for breakdown are tabulated. It is shown that thermal instability threshold differs significantly from that calculated in the approximation of a constant $T(\beta = \infty)$ for cases of a sufficiently small β value. ($\beta \leq 1$ for a plate, and $\beta \leq 1/\rho_o \log \rho_o$ for a cylinder).

Nemchinov, I. V. Gas dispersion behind deflagration waves, actuated by powerful radiation flux. ZhPMTF, no. 3, 1973, 41-48.

The problem of two-dimensional nonstationary gas dispersion into vacuum behind a deflagration wave is analyzed. The problem arises when a powerful radiation flux causes vaporization of condensed matter and generation of subsonic deflagration waves which obey the laws of conservation. The problem is self-similar if the incident flux density varies in time according to a power law $q \sim t^n$, where transmittance temperature T_* and enthalpy of combustion are constant.

Two cases are analyzed separately. In the case of a completely transparent gas behind the wave and adiabatic propagation, an analytical solution is obtained to the set of equations which describe two-dimensional nonstationary gas propagation. From this solution it follows that at $n < 0$ the Jouguet rule is invalid, wave propagation is subsonic and parameters of a deflagration wave depend on the flow behind it. At $n > 0$ the Jouguet rule is valid and subsonic flow is impossible. In the boundary value case, when coefficient of radiation absorption varies stepwise from ∞ to 0 at $T = T_*$ and gas dispersion is nonadiabatic an isothermal wave propagation is assumed. In this case the adiabatic solution in which $\gamma \to 1$ shows that, for $n \geq 0$, the effective optical depth $\tau_e = 0.25$, i.e., radiation absorption by dispersed gas is insignificant, and for $n < 0$, $\tau_e > 0.25$.

Bondarenko, G. G., L. I. Ivanov, and V. A. Yanushkevich. Interaction of giant laser pulses with the microstructure of aluminum. FiKhOM, no. 4, 1973, 19-21.

The authors review an electron microscope study of defect formations in metals from giant laser pulses. Specimens used were aluminum (99.99%) discs of 50 μ thickness. Specimens were first annealed in a vacuum oven at 600° C for four hrs, then were exposed at room temperature in 3 different regimes, identified as I, II and III depending on the level of laser pumping, with regime III corresponding to the maximum radiant energy. Maximum radiation pulse duration was 50 nsec. All specimens were bombarded under identical geometric conditions.

A slight damage crater of diameter ~1.5 mm was typically noted on specimen surfaces after bombardment, owing to the evaporation of an aluminum layer. Specimens were then studied under a type UEMV-100V electron microscope. It was seen that giant pulses led to the formation of structural damage in the form of dislocation loops and zones with increased concentration of dislocations. The character and level of damage in specimens depended on the bombarding regime, as well as the distance of the investigated region from the crater epicenter. Microphotos typical of all three tests regimes are included.

Bondarenko, B. V., V. A. Kuznetsov, and A. A. Shchuka. Field-emission microscopy of the interaction of laser radiation with a tungsten single crystal. ZhTF, no. 9, 1973, 1993-1995.

Critical laser radiant power was determined for tungsten single crystals by means of a field emission projecter with resolving power

of 40-60Å. Desorption of residual gases on the crystal surfaces was also studied durir a laser irradiation process (ruby laser, $\lambda = 6943$Å). The electron projecter was of a typical construction with a tungsten point, which was irradiated at a residual gas pressure $p \sim 10^{-8}$ torr. The residual gas spectrum was determined by an RMO-4s Omegatron type device (Table 1).

Table 1

Mass spectra of residual gases

Mass	Gas	Partial Pressure (torr)
40	Ar	$1.2 \cdot 10^{-10}$
28	$CO + N_2$	$4.4 \cdot 10^{-9}$
18 17 16	H_2O	$1.1 \cdot 10^{-10}$
16 15 14	CH_4	$2.8 \cdot 10^{-10}$
4	He	$4.6 \cdot 10^{-10}$
2	H_2	$1.08 \cdot 10^{-8}$

Cleaning of the tested tungsten single crystal surface from adatoms was done by temporary heating of the point up to 2600° K. Field emission images of a pure tungsten single crystal are shown in Fig. 1. In the course of time the cold point became covered with residual gas adatoms, which fixed the change of field-emission images during simultaneous measurement of emission current in the adsorption process.

The time required for changing electron work function during adsorption process was about 35 min. (Fig. 1). Critical power density for tungsten was found to be 1.1×10^7 watt/cm^2. Radiation at densities enough above critical caused destruction of the tungsten crystal surface, while at

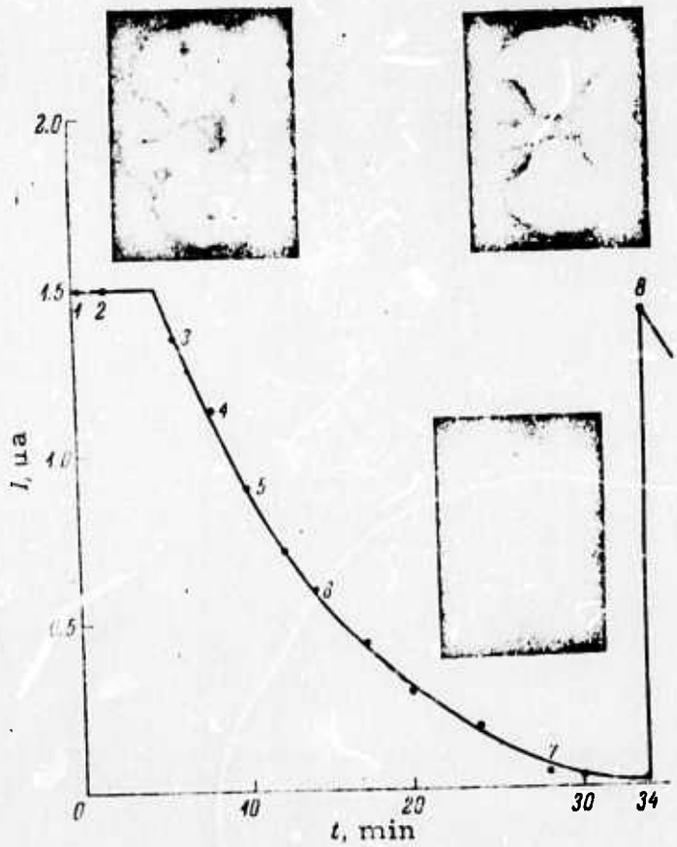

Fig. 1. Time dependence of field-emission current, explosive adsorption of residual gases, and subsequent desorption by laser radiation. Photos are field-emission images of single crystal point during adsorption (1-7) and desorption (8) of residual gases.

densities below critical only local heating and desorption of residual gases were noted. The authors point out that the combined use of laser radiation and field-emission microscopy is highly promising for studying interaction processes of radiation with metal and semiconductor surfaces at levels close to atomic.

Marin, O. Ye., N. F. Pilipetskiy, and
V. A. Upadyshev. Self-oscillating propagation
of laser cracks. MP, no. 3, 1973, 475-481.

The abrupt character of laser crack propagation was experimentally investigated in PMMA. Both ruby and neodymium lasers were used in the experiment, working in a multipeak regime with nominal pulse duration $\tau_i = 10^{-3}$ sec, and pulse energy = 10^8 erg. Fig. 1 is a photo of a crack surface with curved lines, showing traces of the abrupt propagation

Fig. 1. Crack surface with curved lines.

of crack surfaces. Propagation occurred such that the crack forms remained circular. This made the cracks more stable, since the whole perimeter of the crack remained in an equal stress condition. Cracks formed by beams of rectangular cross-section were also seen to have a circular form (Fig. 2). In this case the successive propagation of crack surfaces

Fig. 2. Crack surface from exposure to a rectangular laser beam.

took place perpendicular to the longer dimension of the rectangle, until the crack became circular. Fig. 3 illustrates the character of laser crack formation, showing pressure drops estimated in the cracks during jumps. The development of cracks up to macrosizes thus takes place in discrete jumps. Self-oscillating crack propagation is very stable; it was obtained here with a spike-free laser pulse. Cracks develop because of the splitting action of gas in them, the gas being generated as a result of polymer dissociation. However, the mechanism causing opacity of the cracks to laser radiation requires further study. A quantitative formulation of laser crack formation will be more complete, when the dynamics of radiant energy absorption by cracks is taken into account.

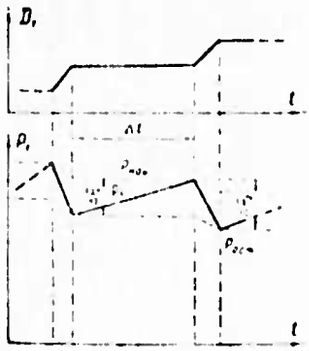

Fig. 3. Graph illustrating discrete propagation of laser cracks. D_T - crack diameter; P_T - gas pressure in crack; t - time.

$\Delta p_1 = 0.2\ P_{T\ limit}/D_T$ - pressure increase in stationary crack;

$\Delta p_2 = 0.3\ P_{T\ limit}/D_T$ - pressure drop after jump, i.e after increase of diameter by ΔD_T; Δt - pause interval.

Kask, N. Ye., L. S. Korniyenko, and G. M. Fedorov. Thermal destruction mechanism of optical glass by laser radiation. DAN SSSR, v. 211, no. 6, 1973, 1317-1319.

The thermal destruction mechanism of optical glass was investigated, using a 2 kj pulsed neodymium laser with pulse duration in the range of 1-10 nsec. The laser operated in a random as well as quasicontinuous pulsed regime with modulation level less than 5%. Laser radiation was focused internally or on the surface of optical glass by a lens with f = 80 mm. Fig. 1 shows relationships of threshold energy density of

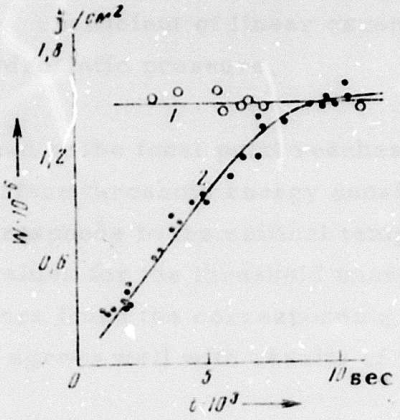

Fig. 1. Relationship of threshold energy density vs. duration of laser radiation.

1- smooth generation; 2- spike generation.

K-8 glass destruction as a function of laser pulse duration. At an energy density about 1/2 of threshold, a fusion was first observed at the focal point in K-8 glass; the fusion action was independent of lens focal distances.

Destruction of the glass took place in two stages: a) crack formation at the boundary region of liquid and solid phase of the glass, owing to hydrostatic pressure; and b) heating of liquid glass. The energy density is given by

$$KW = C_\ell \rho_\ell T_{avg} + P\Delta V/V; \text{ where}$$

K = linear absorption coefficient ($K = 5 \cdot 10^{-3} cm^{-1}$)

W = incident energy density (joule/cm^2)

T_{avg} = average temperature increment

$C_\ell \rho_\ell$ = corresponding heat content and glass density in liquid state

$\Delta V/V$ = volume deformation = $3\alpha_\ell T_{avg}$, where α_ℓ = coefficient of linear expansion for liquid glass, and P = hydrostatic pressure.

When the fusion formed at the focal point reaches the surface, P = 1 kg/cm^2. In such a case the surface threshold energy density heats the surface up to $\sim 2000^\circ$ C, which corresponds to the critical temperature of SiO-O destruction. Using experimental values for the threshold energy density for glass destruction, the authors found the corresponding hydrostatic pressure to be $6 \cdot 10^4$ kg/cm^2, which agrees well with results of previous works.

Voronov, G. S., and A. P. Prokhorov.
Studying the effectiveness of laser plasma confinement by a magnetic field. ZhTF, no. 8, 1973, 1641-1645.

The process of arresting and confining a laser plasma by a magnetic field was experimentally investigated. The experiment was conducted in a cylindrical vacuum chamber of 10 cm diameter and 100 cm in length (Fig. 1). A uniform magnetic field of 2 kgs intensity was applied

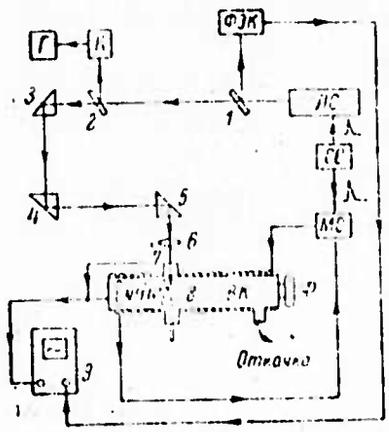

Fig. 1. Plasma chamber experiment.

by a solenoid wound on the chamber; the geometry of the injecting cross-section was similar to that used in experiments on the TOR-1 stellarator.

A 100 mw neodymium laser was focused on a lithium target, consisting of a solid disc 25 cm in diameter and 5 mm thick placed similarly as in the TOR-1. The focal point on the target surface was variable from 0.5 to 5 mm by a lens. The quantity of plasma trapped by the magnetic field was measured by an 8 cm diameter collector, placed perpendicularly to the magnetic field at about 40 cm from the injecting cross-section. The collector was composed of two stainless 0.3 mm steel plates with the front plate grounded. The ion component of the plasma was then recorded by the rear plate. An ion collector of similar construction recorded the plasma drift to the chamber walls.

Movement of plasma across the magnetic field was studied by photographying the plasma in the green line of singly ionized lithium, $\lambda = 5485$Å. Curves were drawn for the quantity of generated and confined plasma (Figs. 2. and 3). The amount of confined plasma was found preportional

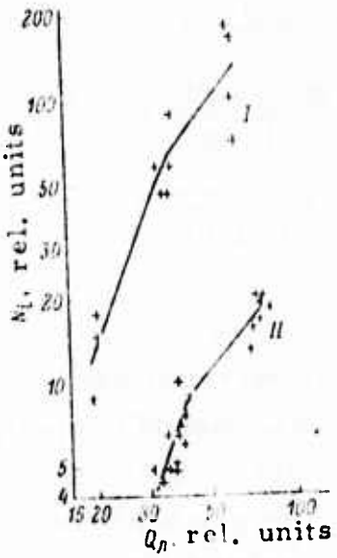

Fig. 2. Quantity of generated (I) and confined (II) plasma as a function of laser pulse energy.

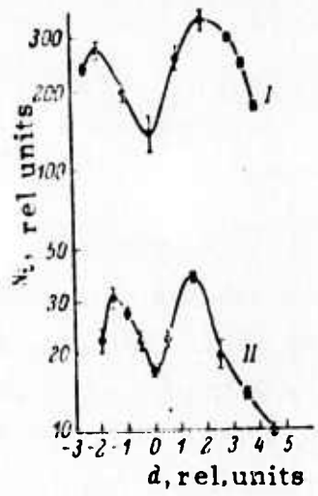

Fig. 3. Quantity of generated (I) and confined (II) laser plasma as a function of the position of lens focus relative to target surface.

to the quantity generated; in the present configuration the effectiveness of plasma confinement was measured at 10%. A method is suggested for increasing the effectiveness of plasma confinement by increasing the angle φ between target plane and magnetic field direction, as seen in Fig. 4.

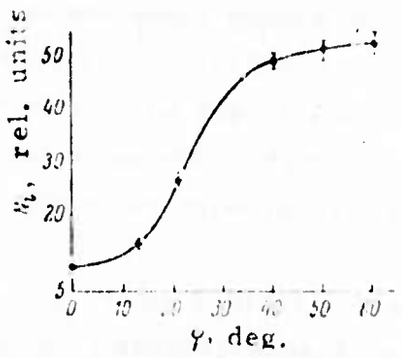

Fig. 4. Relationship of the confined plasma as a function of angle φ and magnetic field.
(laser beam $\perp$ mag. field).

Uglov, A. A. Seminar on physics and chemistry of material processing by concentrated energy flux. FiKhOM, no. 4, 1973, 157-159.

Laser radiation interaction with materials was the main topic at the 38th regular Seminar, held January 11, 1973 at the Baykov Institute of Metallurgy, AS USSR under the chairmanship of Academician N. N. Rykalin. A brief summary is given of the seven papers presented to an audience of over 100 representatives of scientific organizations from different Soviet cities. Four papers deal with interaction of laser radiation

with transparent dielectrics, and three are devoted to the problems of interaction with metals. Two papers-one given by V. G. Andreyev, (Moscow) and the other by S. I. Anisimov, and B. I. Makshentsev (Moscow) dealt with the theory of crack formation in glass from exposure to CO_2 laser radiation, and optical breakdown of transparent dielectrics, respectively. The authors of two other papers on transparent dielectrics, Yu. N. Lokhov, et al. and S. I. Zakharov, et al (both from Moscow) - presented some theoretical and experimental data on the effect of giant pulse radiation absorption on the surface and shock wave formation by interaction with a single laser pulse focused within a dielectric.

Experimental data on laser beam interaction with metals were presented by M. S. Baranov, et al.(Moscow) in a paper on the mechanism of deep fusion from interaction with pulsed laser radiation, and by A. A. Uglov, et al (Moscow and Saratov) in their paper on sealing of holes produced in metal plates by a laser beam. The only theoretical paper on interaction with metals was given by M. N. Libenson (Leningrad).

Aliyev, Yu. M., O. M. Gradov, and A. Yu. Kiriy. Parametric instability theory of a confined uniform plasma. ZhTF, no. 6, 1973, 1163-1169.

Stationary nonlinear penetration of a semi-confined ($z > 0$) transparent plasma by a transverse electromagnetic wave is analyzed. Nonlinearity of penetration is due to parametric interaction between the plasma and longitudinal ion-acoustic waves. Normal incidence of the transverse wave is considered, and its frequency ω_o is assumed to be close to that of the plasma, ω_p. The Maxwell equations of electromagnetic field

and hydrodynamic equations of nonisothermic plasma are used to describe nonlinear penetration by the incident field.

Dissipation of the incident field owing to transverse wave excitation is described by an approximate expression for transverse electric current, j_{diss}. Using the expression for j_{diss}, the averaged absorbed power and the effective conductivity σ_{eff} are formulated. It is shown that in the case of a weak dissipation, σ_{eff} is inversely proportional to the depth L of penetration by the pumping wave. The L value is estimated here with logarithmic accuracy. In this way a significant increase in σ_{eff} with a decrease in L is deduced from comparison with linear penetration.

Chernenko, V. M. Electron scatter near a laser focus. ZhETF, v. 64, no. 6, 1973, 1975-1985.

Results are presented of a comparative theoretical and experimental study of slow electron scatter from passing near the focus of a Q-switched ruby laser. The scattering angle θ of an electron is calculated by the averaging method as a function of the electron impact parameter, using either a classical or quantum mechanical description of electron motion in a laser field. Experimentally, θ was determined by methods similar to those used for detection of the Kapitsa-Dirac effect. A single-stage Q-switched ruby laser ~10 Mw was used in the experiments. Laser pulse duration was ~50 nsec and pulse repetition rate was one per minute. A ~30 eV electron beam with ~0.1 x 1 mm^2 cross-section and ~5×10^{-3} rad divergence was passed near the laser focus. The experimental data are shown to be in qualitative agreement with the theoretical curves.

Thus, the effect of electron scatter by a focused laser beam is experimentally established, although a quantitative interpretation of the effect is difficult. The cited effect is treated as a stimulated Compton effect and, as such, may be connected with the problem of plasma heating by laser radiation.

Bonch-Bruyevich, A. M., L. N. Kaporskiy, and A. A. Romanenkov. Effect of dielectric surface on optical breakdown of a gas. ZhTF, no. 8, 1973, 1746-1747.

The effect of dielectric surface on the threshold value of optical breakdown of air (OBA) was experimentally investigated. The experiment (Fig. 1) was conducted using a laser of the inorganic solution

Fig. 1. Experimental sketch.
1- Glass specimen, 2- Focusing lens.

$POCl_3SnCl_4:Nd^{3+}$, which generated a burst of 4-5 giant pulses with peak power = 50 Mw, followed by an interval of 100 μsec; angular divergence of the radiation was 8 mrad. Distribution of radiant power density around the focal point, whose diameter was 400 μm, was smooth and bell-shaped. Duration of a single pulse (or any one of the giant pulses) equalled 50 nsec, at an energy of 2-3 joules. Radiation was focused by a lens at f = 50 mm, and a K-8 glass plate was placed at a distance L from the focal plane (Fig. 1).

At large values of L, the threshold breakdown value corresponded to that of a single-pulse with no glass plate, and equalled 5.7×10^{10} watt/cm^2. The threshold value continuously dropped by 2-5 times as the glass plate was brought nearer to the focal plane, ultimately reaching a value close to the threshold of glass surface destruction. The threshold value of OBA was also found to increase at distances very close to the glass plate surface. Effect of dielectric surface on OBA was observed over distances L = 5-30 mm, and depended on the quality of the surface. Dull surfaces, having low radiation stability, showed the biggest long-range interaction.

Bunkin, F. V., and V. M. Komissarov.
Optical excitation of acoustic waves.
Akusticheskiy zhurnal, no. 3, 1973,
305-320.

Theoretical and experimental data on excitation of acoustic waves during interaction of a powerful laser beam with liquids are reviewed and discussed. The review is based on 1950-1972 publications, about half of which are Soviet-bloc.

For discussion purposes, the various mechanisms of acoustooptical excitation are divided into two main groups, according to the medium behavior as a function of light. A pulsed excitation proceeds from nonuniform heating of a light-absorbing medium by radiation of nonuniformly distributed intensity, or on account of a sudden change in aggregate state of a light absorbing medium, e.g., evaporation or ionization; the electrostriction effect is another type of sound excitation mechanism in transparent media. Radiation can be absorbed either within or on the surface layer of a

medium. In the first case, the absorbed energy density can be high, i.e., of the order of 10^6 j/cm^3; in this case a high-power acoustic wave is generated by explosive boiling with a rapid expansion of vapor cavities, or by optical breakdown if incident radiation intensity attains the threshold value. The optical breakdown is the most efficient mechanism of sound generation. Also, the internally absorbed energy may be low and insufficient for liquid evaporation. In this case, sound is generated by high-power incident radiation owing to expansion of rapidly heated liquid volume.

Radiation absorption is weak also in a thin surface layer. In this case, an acoustic wave can be generated from a laser pulse interaction with the medium by a thermoelastic stress mechanism without evaporation, or by the recoil impulse produced by liquid evaporation. Sound wave harmonics can also be generated from electrostriction and photoelasticity effects by interaction of two optical waves of different frequency within a medium. The cited theories of acoustic wave excitation are illustrated, with numerical estimates of excitation in water under conditions typical for the described experiments. The authors conclude that optical generation of HF acoustic waves may acquire importance in devices based on light diffraction by hypersonic waves.

B. Recent Selections

i. Beam Target Effects

Ashmarin, I. I., Yu. A. Bykovskiy, A. I. Larkin, and E. A. Manykin. Dynamic characteristics of laser destruction in glass. ZhTF, no. 11, 1973, 2397-2401.

Bondarenko, G. G., L. I. Ivanov, and V. A. Yanushkevich. Nature of structural damage in aluminum caused by giant laser pulses. FMiM, no. 4, 1973, 879-880.

Bozhkov, A. I. Instability of a transparent liquid layer in an intense optical radiation field. IVUZ Radiofiz, no. 8, 1973, 1183-1194.

Devyatykh, G. G., N. V. Larin, G. A. Maksimov, and A. I. Suchkov. Ionizability of chemical elements under laser radiation. ZhFKh, no. 11, 1973, 2917-2919.

Kask, N. Ye., L. S. Korniyenko, and G. M. Fedorov. Destruction of optical glass by laser radiation. ZhTF, no. 11, 1973, 2388-2396.

Larionov, N. P., A. V. Lukin, and K S. Mustafin. Nonscattering component of laser radiation, passing through a rough surface. OiS, v. 35, no. 5, 1973, 907-910.

Lisitsa, M. P., and I. V. Fekeshgazi. Energetic and time characteristics of a laser pulse, passing through a damaged region of glass. IN: Sb. kvantovaya elektronika, Kiyev, no. 7, 1973, 64-70.

Lisitsa, M. P., and I. V. Fekeshgazi. Effect of ambient atmospheric pressure on the destruction process of transparent glass surfaces by laser radiation. IN: Sb. Kvantovaya elektronika. Kiyev, no. 7, 1973, 71-76.

Litvinova, L. I. Study of factors affecting the interaction of ruby laser radiation with tantalum plates. IN: Sb. Materialy II Resp. konf. molodykh uchenykh po fiz. In-t fiz. AN BSSR, 1972, no. 2 Minsk, 1973, 93-94. (RZhRadiot, 11/73, no. 11Ye166)

Plis, A. I., Ye. L. Tyurin, and V. A. Shcheglov. Thermal wave in a substance, initiated by laser radiation. ZhTF, no. 11, 1973, 2267-2272.

ii. Beam-Plasma Interaction

Andreyev, N. Ye., V. V. Pustovalov, V. P. Silin, and V. T. Tikhonchuk. Nonstationary parametric turbulence of a plasma. ZhETF P, v. 18, no. 10, 1973, 624-629.

Gribkov, V. A., O. N. Krokhin, G. V. Sklizkov, N. V. Filippov, and T. I. Filippova. A powerful neutron source based on a Z-pinch. ZhETF P, v. 18, no. 9, 1973, 541-544.

Kudrevatova, O. V., L. V. Norinskiy, and V. A. Pryadein. Investigating the frequency dependence of optical breakdown in air. ZhTF, no. 11, 1973, 2347-2353.

Pustovalov, V. V., V. P. Silin, and V. T. Tikhonchuk. Nonlinear conversion of radiation into plasma waves. ZhETF, v. 65, no. 5, 1973, 1880-1892.

2. Effects of Strong Explosions

A. Abstracts

Gryaznov, V. K., I. L. Sosilevskiy, and V. Ye. Fortov. Calculating shock adiabats of argon and xenon. ZhPMTF, no. 3, 1973, 70-76.

Shock adiabats of Ar and Xe were calculated for the range of parameters which are to be found in experimental recording of expansion isentropes of an inert condensed medium and detonation products, or in an explosion-generated radiating plasma. Accordingly the electron excitation, ionization, and Coulomb interaction among free charged particles are taken into account in thermodynamic calculations. Solutions of hydrodynamic and thermodynamic sets of equations were computed separately. An iteration method was used to calculate equilibrium composition and thermodynamic functions of multiple ionized gas for given T and p.

The calculated data are presented graphically as functions of the shock front propagation rate D at initial gas pressure P_o = 0.2-30 bar. The state of isentropic expansion can be determined from the calculated p and D/u plots (u is the mass velocity at the gas-shock compressed barrier boundary) and the measured D values. It is shown that the contribution of bound states to plasma thermodynamic functions and the effect of plasma deviation from ideal state, increase with increase in P_o. At low P_o, optical radiation flux in Xe may attain half the value of hydrodynamic flux but only < 0.05 of that flux value in Ar. The estimated energy loss by radiation is small in the region of gas transmittance from $\lambda = \infty$ to 0.1 μ.

Makovskiy, Yu. F., and F. V. Shugayev. Interaction of a shock wave with blunt bodies in supersonic flow. I-FZh, v. 25, no. 1, 1973, 107-110.

An experimental determination was performed of gas density field near a cylindrical body with a flat or spherical nose, during interaction of a two-dimensional shock wave with the body in supersonic gas flow. Such a problem arises in the study of detonation wave effect on a supersonic body in the atmosphere.

A test model was placed in a double-diaphragm shock tube and two successive shock waves were generated at a 100 μsec interval. The Mach numbers behind the first and in the second shock wave were M_1 = 1.44-1.50 and M_2 = 1.4-1.5, respectively. Gas density ρ was measured with a Mach-Zender interferometer using a Q-switched ruby laser as the light source. A typical interferogram and density fields near the spherical nose at different times t are shown. These data indicate that the relative density ρ/ρ_1 distribution in the gas layer between the leading and the reflected waves is nearly the same as the original. The plotted ρ/ρ_1 versus t data show that ρ in a given point of perturbation region is stabilized after a characteristic time interval t_4 between the onset of wave interaction and the body contact with the merged reflected and leading shocks.

Tyunyayev, Yu. I. and V. N. Mineyev. Polarization mechanism of doped alkali-halide crystals in shock waves. FTT, no. 6, 1973, 1901-1904.

The impurity component P_ρ^i of shock polarization P_o was determined experimentally in Ca^{+2}, Mn^{+2}, Sr^{+2}, I^{-1}, or F- doped NaCl crystals, and in Mg^{+2} doped LiF crystals, compressed by shock waves at

pressures in the 20-276 and 56-676 kbar ranges, respectively. Before compression the specimens were isothermally annealed at $T^* = 300\text{-}600^\circ$ C and cooled to 20° C at a rate $T = 0.5\text{-}10^3$ deg/min. Some were aged at 20° C for about 20 months.

The experimental P_o^i plots show that $P_o^i(C)$ increases with increase in C, the dopant concentration; also $P_o^i(T)$ exhibits a maximum and $P_o^i(T^*)$ exhibits a characteristic step at $T^* = 400\text{-}500^\circ$ C. Age dislocations and monovalent anionic impurities did not affect P_o. The four possible mechanisms of impurity polarization are discussed in the light of the cited data.

The conclusion was drawn that emergence of P_o^i within a larger than atomic volume in a minimum time of $5 \cdot 10^{-8}$ sec. can be explained only by dipole rotation in the field of dislocations moving with the shock wavefront. In the framework of this mechanism, P_o^i is $\sim N_d$, the single dipoles concentration, in agreement with the analysis of earlier data on the state of M^{+2} ions in alkali-halide crystals.

Breusov, O. N., A. N. Dremin, V. N. Drobyshev, and S. V. Pershin. Action of shock waves on tantalum pentoxide. ZhNKh, v. 18, no. 2, 1973, 295-299. (RZhKh, 12/73, no. 12B866). (Translation).

The interaction of shock waves with tantalum pentoxide is studied. Interconvertibility of the low-temperature β-phase with the high-temperature α-phase is shown during nondestructive shock compression of Ta_2O_5. The cited conversions are adequately explained as the effect of a highly defective structure of the substance and an elevated residual temperature. Under more rigid conditions of P and T in compression, the

nonstoichiometric $Ta_{0.83}O_2$ subtraction phase was obtained. The $Ta_{0.83}O_2$ phase crystallizes in a tetragonal system of the rutile type with lattice parameters a, c, and c/a equal to 4.768 Å, 3.069 Å, and 0.644, respectively. X-ray density is 8.67 g/cm^3.

Pereverzev, A. Ye., D. A. Vlaso, and D. Kh. Kulev. Action of shock waves on polymers. ZhPKh, no. 8, 1973, 1847-1849.

X-ray diffraction data and electron microphotographs of several amorphous polymers, shock-compressed to 60 kbar, are given to illustrate shock-induced structural changes in these polymers. Hardened epoxy- and polyester-resins; poly(diethyleneglyeol adipinate) with polyurethane rubber plasticizer (PPK); divinyl (SKD); and acrylonitrile (SKN) synthetic rubbers were shock-compressed under 20-60 kbar pressures for 2-5 μ sec. All cited polymers exhibited an increased deformation of the supermolecular structure segments, and an increase in amorphization with increase in shock wave amplitude.

The band structure of the SKD and SKN rubbers was re-oriented to a nearly spherulitic structure under 39 kbar pressure. The band structure of the PPK specimens was broken under 60 kg pressure into smaller structural elements which gave rise to a more organized secondary structure. The degree of orientation, however, of the chain molecules in the original bundles did not increase from the shock effect. The secondary structure of the resins remained morphologically unchanged.

The band aggregation in rubber-like polymers after their shock breakdown is a noteworthy phenomenon, because it is accomplished in a time (10^{-12} sec) without precedent under usual conditions of chemical transformations in polymers.

Kanel', G. I. and A. N. Dremin. Electric signals during shock-wave compression of metals. DAN SSSR, v. 211, no. 6, 1973, 1314-1316.

It was noted in a previous investigation that when determining the pressure profiles in shock waves passing through metal specimens by means of manganese detectors, the recorded signals were distorted by electric noise at the moment of entry of the shock-wave front. The present paper presents a preliminary investigation of the electric signals generated by metal specimens compressed by a shock wave under conditions similar to those during operation of manganese detectors. The specimens tested included N-1 copper, AD-1 aluminum, Armco iron and nickel. The pressure behind the shock-wave front in the copper, iron and nickel was 350 ± 15 kbar and that in aluminum was 280 ± 15 kbar. The entrance of the shock-wave front into the specimen was noted by relatively weak perturbations, and passage of the shock-wave front through the electrode was accompanied by a sharp voltage drop. The polarity of the signals related to passage of the wave front through the electrode was negative and signal amplitude decreased monotonically in time without variation of polarity up to the moment of approach of the reflected rarefaction wave fron the free surface of the specimen in experiments with copper, nickel and iron.

There was a net pressure drop directly behind the shock-wave front on the load resistor, e.g. 1.2 ± 0.2 V for copper, 1.0 V for nickel and 2.0 ± 0.5 V for iron. The signals had a somewhat different nature for aluminum specimens; during passage of the wave front through the electrode a positive signal with an amplitude of 2.0 ± 0.4 V was recorded; the signal changed polarity within 0.3-0.4 μsec. Replacing the copper electrode for aluminum in the experiments with copper and aluminum specimens did not reveal any appreciable variations of amplitude or nature of the recorded signals. It is concluded that the more probable source of the observed signals is dynamic redistribution of the volume electric charges in the metal specimens, caused by the shock-wave front.

Karasev, A. B., and T. V. Kondranin. Certain laws of heat exchange in a hypersonic shock layer under conditions of mass removal. MZhiG, no. 3, 1973, 136-143.

A systematic analysis is presented of heat transfer characteristics in a thermally conductive, selectively radiative gas flow around a blunt body, in the vicinity of the zero-flow line, with gas injection into the boundary ablation layer. The analysis was necessary to draw generalized conclusions about the effect of optical and transport characteristics of gaseous components on radiative and convective heat-transfer. Using simplified Navier-Stokes equations a closed set of differential equations was derived to describe flow field in the vicinity of the stagnation point. Calculations were made for a wide range of gas injection flow rates around a body of 0.3 to 3.0 m radius at stagnation pressures from 0.1 to 10 atm and stagnation temperatures in the 11×10^3 - 18×10^3 ^{o}K range. A generalized conclusion on the efficiency of the shielding effect of radiation from the inviscid region was drawn from the calculated data, which are graphically illustrated. It is shown that the magnitude of convective heat flux is practically unaffected by taking into account the radiant energy transfer in the case of injection of gaseous products of different spectral characteristics. Maximum variation in the integral radiative heat flow to the surface was $\leq$ 20-30%.

Nazin, V. V. Construction methods which reduce seismic effects on buildings. IN: Sbornik Seysmichnost', seysmich. opasnost' Kryma i seysmostoykost' str-va. Kiyev, izd-vo Nauk dumka, 1972, 147-159. (RZhMekh, 5/75, no. 5V819) (Translation).

A double-chord structure of reinforced concrete with reinforced cement ellipsoids of revolution between the chords is proposed as a joint

between the foundation and a wall of a building. The upper chord may shift its position in relation to the lower chord (and vice versa) by an amount equal to the amplitude of a 7-9 scale earthquake (the structure is designed on the basis of stable equilibrium). Having the response fall outside the range of earthquake frequencies is made possible by changing the ratio of the minor to major axes of the ellipsoid of revolution, which controls the free oscillations period of the structure. Insertion of restraints allows a smooth working of the nearly aperiodic system. Efficiency of the structure was confirmed by testing on a seismic platform. Load on the ellipsoids of revolution remained practically in a state of rest during loading of the platform. Test loading indicated that an ellipsoid of revolution can sustain up to 1,000 kg loads, i.e., a load of a 5 to 15 story building. A neoprene or nondecaying rubber elastic insert between a wall and the antiseismic chord decreases the vertical component of seismic force.

Vovk, A. A., G. I. Chernyy and A. V. Mikhalyuk. Control of the crack formation process in compressible rocks during a confined explosion. Fiziko-tekhnicheskiye problemy razrabotki poleznykh iskopayemykh, no. 6, 1972, 70-74.

A series of experiments is described for studying the laws of crack formation during the explosion of charges in air cavities in soils with different moisture contents. Experiments were conducted with explosions of concentrated charges for scattering effects in clay (density 1850 kg/m^3) and moisture content 23.5% by weight and for confined effects in loam (density 1990 kg/m^3 and moisture content 14.2% by weight). The explosive used was trotyl, and weights of the charges were 0.2 kg and 0.4 kg for clay and loam respectively. The volume of the air cavity was varied from zero to 100%.

It was observed that with an initial increase in cavity size, the relative surface area of the cavity X, forming a part of the cracks, decreased sharply; with further increase, the value of X increased slightly and then dropped continuously. The depth of crack propagation depended considerably on the value of air cavity X. The moisture content of soil massifs was similarly seen to have a considerable effect on their cracking during the confined explosion. Graphical data illustrating these relations are included.

Prishchepa, Ye. A., Yu. F. Kucheryavyy, and V. I. Maynov. Effective method of reducing seismic effects in the near zone. IN: Goreniye i vzryv; Materialy simposiuma. Moskva, izd-vo Nauka, 1972, 181-184.

To reduce the seismic effect of large explosions in nearby areas of the Kremenchug granite quarry, a series of test explosions were conducted with borehole charges 190 mm in diameter with and without air compensators (gaps) (Fig. 1). Figure 2 shows the layout of two series of experiments conducted. The overall weight of the charge in the first series (without air gap) was 4480 kg (50% trotyl and 50% NO 6-Zh V ammonite), and in the second series (with air gap) - 2960 kg (65% trotyl and 35% NO 6-Zh V ammonite). Seismograms were made (Fig. 3), and it was seen that the velocity of ground motion in the first case was 42 cm/sec and in the second, 30.7 cm/sec (which is about 11% less, when reduced to the weight of first series). It is concluded that:

1) The use of charges with an air gap at the borehole bottom provides a reduction of seismic shocks in nearby areas.

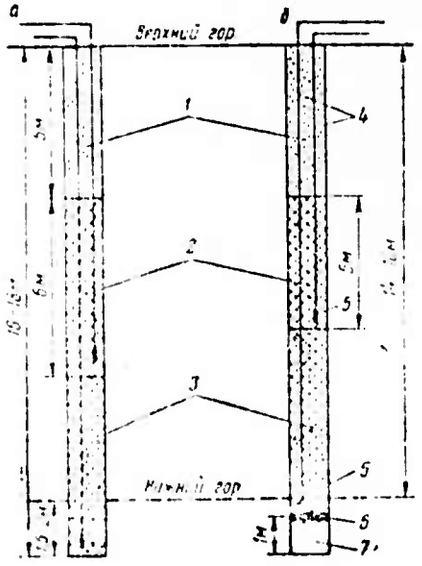

Fig. 1. Sketch of full charge (a) and charge with air gap (b).

1 - Tamping; 2 - NO 6-Zh V ammonite; 3 - trotyl; 4 - main and back-up detonator lead; 5 - detonator; 6 - paper wadding; 7 - air gap.

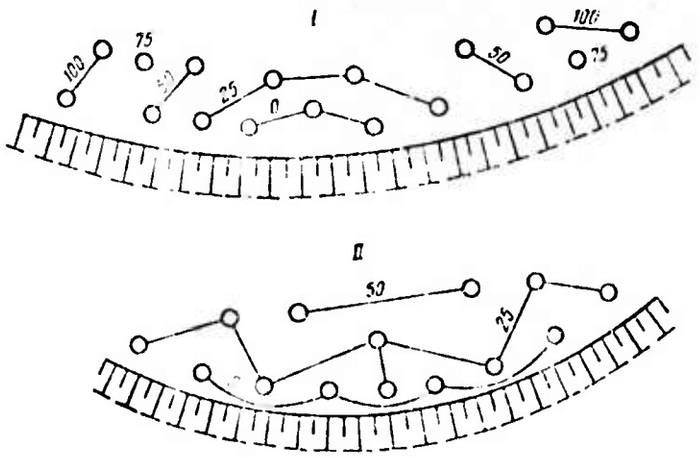

Fig. 2. Arrangement of experimental charges.

I - Conventional full charges; II - Charges with air gaps.

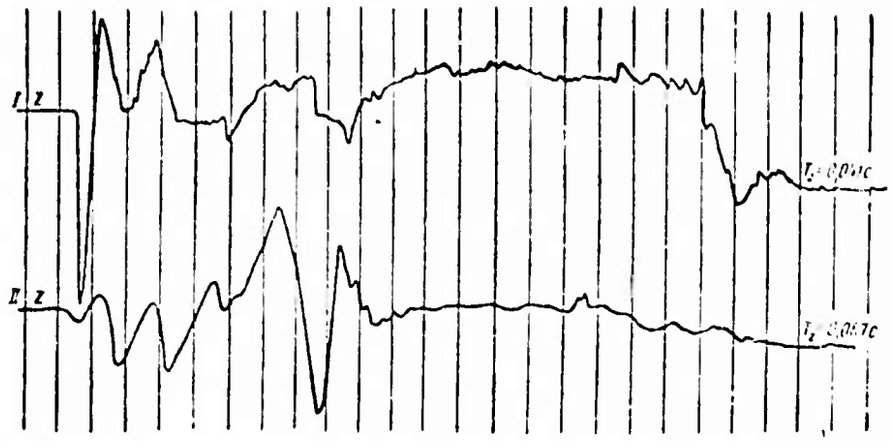

Fig. 3. Seismograms of test explosions.
I- Without air gap; II- with air gap.

2) The use of such a charge reduces the amount of explosive used, which yields a considerable annual savings with a simultaneous reduction of expenditures for equipment repairs;

3) By using such charges, it is possible to increase the capacity of large explosions by 20%, with no increase in seismic effects.

Rakhuba, V. K., and N. N. Stolovich.
Optimizing the energy transfer process during electric wire explosion in liquid. ZhTF, no. 6, 1973, 1222-1227.

Experimental electric explosions of various metal wires with different diameter d and length ℓ are described. The experiments were designed to optimize the conditions for conversion of electrical energy stored

in a capacitor to mechanical energy.

Experimental data previously obtained by different authors has showed that the earlier assumed independence of the optimum volume V_{opt} of exploding wire from the frequency of self-oscillations of the discharge circuit was incorrect. In these experiments, the relative maximum increase in diameter of a cylindrical thin-wall detector was used as the only criterion of the efficiency of the explosion energy conversion into mechanical energy of deformation. As a result of numerous experiments including earlier ones of the authors (February '73 Report, p. 13), V_{opt} was expressed by an approximate formula as a function of the discharge circuit parameters f and U/l. This approximation was found to be in good agreement with the earlier data, including the authors' own data. The conclusion was drawn that selection of V of exploding wire with the help of the cited approximation insures the maximum input energy into the discharge channel.

Kuchinskiy, V. G., V. T. Mikhkel'soo, and G. A. Shneerson. Megaampere switch with exploding foil for studying magnetic cumulation. PTE, no. 3, 1973, 108-112.

A switching device using exploding aluminum foil was designed for reproducibly switching electric currents up to 1 Ma in a low-inductance circuit for studying applicability of simple models to the description of magnetic cumulation. The experimental arrangement for magnetic cumulation is described. The system consists of a single-coil solenoid and the switching device with two discharge gaps. Reduction of the circuit inductance is obtained by connecting the switch directly to busbars of a step-down transformer, and placing one of the discharge gaps directly below one

of the solenoid connections. Power is supplied by a capacitor bank through the transformer. The magnetic field of the solenoid served to compress a thin cylindrical shell in the bore of the solenoid.

The method for selecting the parameters and dimensions of the exploding foil is outlined under conditions of experimental shorting and actual operating conditions. A maximum $\sim 5 \times 10^{11}$ a/sec. current rise time was obtained in the shorting experiments; a magnetic induction field of 150 T was obtained in one experiment. Commutation time was in the 1.1-4.4 μsec range. A numerical analysis of the commutation process under actual operating conditions indicated that the process can be described as intermediate between two simplified phenomenelogical models of the switch resistance changes.

Chachin, V. N., V. K. Rakhuba, and N. N. Stolovich. Investigating the deformation rate of tubular parts during their expansion by electric explosion. IAN B, ser. fiz-tekhn., no. 2, 1973, 79-81.

Experimental data are given on dynamics of a high-speed radial expansion S of tubular copper parts from axisymmetric electric explosion of a 0.3-0.9 mm diam. metal wire in water. Copper or low-carbon steel wires were exploded by discharge of a capacitor bank with 100-800 μf capacitance C at an initial charge potential U = 2.4-6.5 kV. Tubes with 1-3 mm wall thickness t_w were used in the experiments.

The maximum radial deformation rate V_{max}, time $t_{v_{max}}$, and relative circular deformation ϵ_d of the tubes were determined from high-speed photographic scanning of expansion. The experimental plots show

a nearly exponential decrease of V_{max} and ϵ_d with tubes of increasing t_w and a simultaneous increase in t_{Vmax} and V_{max} was observed in experiments with exploding wires of different materials and diameters. Optimum wire diameter values are given.

Other conditions being equal, variation of C and U affects tube deformation dynamics significantly more than the wire material. It is shown that V_{max} of a tube is attainable under conditions of an efficient conversion of stored electrical energy into mechanical deformation work.

Alenichev, V. S., M. A. Mel'nikov, and L. F. Panichkina. Optical investigations of hydrodynamic characteristics of electric wire explosions. FOM, no. 3, 1973, 60-63.

Electric wire explosion was studied as a method for shock wave generation in an ambient medium. The experimental pressure P at a shock wavefront and shock wave energy E were determined from optical recordings of shock waves, using a shadow photographic technique and from energy balance of the discharge circuit, respectively. The P data are plotted versus distance from the explosion axis in water for 5 to 80 mm long wires. Also, experimental plots are given of P and E versus wire length ℓ for explosion in water and air, respectively.

It was established that the maximum P for a 5 mm wire is twice that for a 80 mm wire, although exponential P decay for a shorter wire is accomplished in a shorter time than for a longer wire. There is an optimum ℓ = 30 mm corresponding to a maximum P in water and to a maximum E in air. Thus, the initial P is correlated with the earlier determined volume energy density at distances longer than 100 wire radii. It is concluded that volume energy density is the factor which determines the initial P at the shock wavefront.

Krivitskiy, Ye. V. Investigating effects of conductor explosion products on the characteristics of energy release during a high-voltage discharge in liquid. EOM, no. 2, 1973, 68-71.

Data are given on an experimental study of exploding wire diameter effect on electrical and energy characteristics of the explosive discharge channel. Exploding wires were divided here into three categories: ultra-thin, thin, and thick, using as a criterion the relation of the time lag before an explosion to parameters L and C of the discharge circuit. In the experiments, the time-dependent resistance of a channel formed by the conductor explosion products was determined at different durations of discharge current and different initial voltages across the interelectrode gap. The current and voltage oscilloscope traces clearly show an overvoltage peak simultaneously with a sharp discharge current drop. Experimental plots of energy release rate in the channel also show an optimum wire diameter value for which peak power is maximum. The optimum peak power exceeds the peak power of wireless discharge by 3 and 12-15 factors in the case of a rapid ($\pi < LC \geq 10^{-4}$ sec) and a slow ($\pi < LC > 10^{-4}$ sec.) discharge, respectively.

Analysis of the energy characteristics obtained in the experimental wire explosions led to the conclusion that an exploding conductor controls power released in discharge channel, because conductor characteristics determine the time of metal vapor expansion.

Bordzilovskiy, S. A., S. M. Karakhanov and V. V. Polyudov. Electron emission during dynamic heating of wires by a current pulse. ZhETF, no. 9, 1973, 1987-1992.

Current-heated wire tests are described in which the amplitude and time characteristics of an electron current preceding the shunting discharge stage were measured and compared to x-radiation. The role of various electron sources during the discharge process was also investigated to determine the mechanism of emission and its effect on development of the shunting discharge. Pulse heating of W and Ni wires in a vacuum chamber, during the stage preceding the shunting discharge, revealed an electron current several orders higher than the thermoemission current. The recorded current varies with a typical time of 10-15 nsec and excites correlated X-radiation. The data indicate that electrons appear at the end of the first stage of the process in the chamber, which, impinging on the collector or one of the electrodes, induce X-radiation. The occurrence of electrons leads to an increase of the discharge gap conductivity and to a decrease of voltage on it and, subsequently, to a decrease of X-ray intensity. Possible sources of the electron emission are thermoelectron emission, the Schottky effect, explosive emission, and the heated specimens themselves.

Krestovnikov, A. N., I. A. Timoshin, and A. A. Kostryukova. Relation between pressure, temperature and composition during vaporization of variable composition phases in a CdSe-CdTe system. ZhFKh, v. 47, no. 6, 1973, 1400-1403.

The temperature dependence $p_o = f(T)$ of total saturated vapor pressure over the entire composition range of CdSe-CdTe solid solutions was determined by the Knudsen method or by a static method using a quartz

membrane manometer in the 0.1 to 0.5 or 1 to 30 torr range of pressures, respectively. Using experimental p_o, T, and solution composition data, the equation

$$\ln p = A - B/T + CT + D \ln T. \tag{1}$$

is derived, which describes adequately the $p_o = f(T)$ dependence for all solution phases. The coefficients A, B, C and D in (1), which reflect the curvature of the log $p_o = f(T)$ plot, are tabulated for 0 to 1 molar fractions of CdSe in the solution, and different temperature ranges between 800 and 1,400° K. Comparison is also made between the experimental and theoretical data on total vapor dissociation pressure P over the variable composition phases of the CdSe-CdTe system. Temperature dependence of sublimation enthalpy ΔH_T is calculated from the P data in approximation of dilute solutions more reliably than from equality of the vapor phase and condensate compositions. The ΔH_T data thus calculated for CdS, CdSe, and CdTe are shown to be in good agreement with literature data.

Kuznetsova, T. I., D. B. Kazarnovskaya, A. Ya. Galitskiy, and Ya. S. Kazarnovskiy. Equation of state for nitrogen-hydrogen-ammonia mixtures at high pressures and temperatures. Khimicheskaya promyshlennost', no. 2, 1973, 130-132. (RZhKh, 13/73, no. 13B744). (Translation)

Molar volumes under pressures to 500 atm. and temperatures in the 150-400° range were determined experimentally for an N_2-H_2-NH_3 system with 7.9, 12.3, and 24.8 vol. % NH_3 and an N_2:H_2 constant ratio equal to 1:3. The data thus obtained were correct to 0.2% relative to the available literature data. Applicability is discussed of theBeattie-Bridgman,

Benedict-Webb-Rubin, and Krichevski-Kazarnovski equations of state. The equation of state in virial form was found to describe most accurately the experimental data. An ALGOL-60 program was developed and 35 coefficients of the compressibility expression were calculated to describe the experimental data accurate to 0.3%.

Krektuleva, R. A., and P. B. Makarov. Equation of state in collision problems. IN: Materialy 3-y Nauch. Konf. Tomsk. un-ta po mat i mekh., no. 2, Tomsk, Tomsk. un-t, 1973, 132. (RZhMekh, 6/73, no. 6V965) (Translation)

Different equations of state are considered which are applicable to calculations of flows induced by collisions. Recommendations are given on practical application of these equations for a group of materials and the causes of possible errors are considered. A new equation is suggested for a multicomponent medium, based on known equations of state of its components. The results of the calculations are compared with experimental data.

Popov, Ye. I., V. G. Poyarkov, and Yu. A. Finayev. Investigating the rate of the pressure increment during explosion of powdered aluminum. VAN BSSR, no. 3, 1973, 92-94.

Various grades of powdered aluminum were investigated to determine the rate of pressure increase in the specimens during explosions.

Different methods of protecting buildings and equipment against such explosive effects are discussed. The studies show that the rate of the pressure increment during explosion is not identical in time. During the initial period of the explosion, when only particles in the region of theinducing source participate in the reactions, the rate of the pressure increase is insignificant. During the next interval there is a sharp increase in the rate of pressure increment where a large part of the powdered metal enters the reaction. During the final period, the rate of pressure increment begins to decrease, which corresponds to the final stage of the process when a significant amount of reaction products has accumulated in the reaction explosive chamber. After reaching a maximum, the pressure slowly decreases due to heat losses through the chamber walls and partially due to leakage through the chamber seals. Maximum explosive pressure is achieved during the short time interval when it varies from 5 to 50 msec as a function of the powder sample and experimental conditions. The experimental results of the maximum rate of explosive pressure increment are in good agreement with data of Hartmann and Clark. Explosions of metallic aerosols have a more destructive nature than gas explosions, and special measures are required to prevent and localize such explosions during production and use of metals in a finely dispersed state.

B. Recent Selections

i. Shock Wave Effects

Boltneva, L. I., I. M. Nazarov, T. I. Sisigina, B. A. Fedorovich, and V. P. Chirkov. Transfer velocity of loose deposits, identified as products of nuclear explosions. IAN Geografii, no. 5, 1973, 114-122.

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Stolovich, N. N., N. S. Minitskaya, and V. G. Maksimov. Comparative study of the electrical explosion of bare and insulated copper wires. IAN B, Seriya fiziko-energeticheskikh nauk, no. 4, 1973, 56-57.

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Zhdanov, V. A., V. V. Polyakov, and V. F. Konusov. The equation of state of sodium chloride. FTT, no. 11, 1973, 3439-3440.

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Kushnarev, D. M. Ispol'zovaniye energii vzryva v stroitel'stve (Use of explosive energy in construction). Moskva, Izd-vo stroyizdat, 1973, 288 p. (RBL, 9/73, no. 736).

Lavrik, V. I., and I. A. Luchko. Hydrodynamic solution to the problem of explosion of deep paired charges. IN: Sb. Analit. metody v teorii fil'tratsii i teploprovodnosti. Kiyev, 1973, 45-53. (RZhMekh, 11/73, no. 11B208)

3. Geosciences

A. Abstracts

Rybicki, K. Local stresses associated with a fault plane swing (in English). Acta Geophysica Polonica, no. 1, 1973, 27-44.

The problem of stresses associated with a fault swing is considered on the basis of the dislocation theory of a continuous medium. Formulas for stress field, as well as its graphic representation, are given for a two-dimensional model of fault swing. It is shown that considerable stresses exist in the area of a fault swing. The suggestion that a concentration of aftershocks from strong earthquakes may occur in that area was confirmed by the results of an analysis of aftershocks of the 1966 Parkfield-Cholame (California) earthquake.

Mostovoy, S. V. Design of filter for the separation of compressional and shear wave fluxes from seismic records. IN: AN Ukr RSR. Dopovidi. Seriya B. Heolohiya, heofyzika, khimiya ta biolohiya, no. 5, 1973, 412-414.

The design of a filter for the separation of signals from seismic records, which were postulated to be a superposition of compressional waves, shear waves and uncorrelated noise, is considered. Expressions are given for a posteriori intensity fluxes of compressional and shear waves used for the separation of signals. It is pointed out that the problem is identical to the separation of single-class waves from seismic records.

Verbitskiy, T. Z. Estimate of the relief coefficient of rocks from the velocity of elastic waves. IN: AN Ukr RSR. Dopovidi. Seriya B. Heolohiya, heofyzika, khimiya ta biolohiya, no. 5, 1973, 409-412.

Theoretical curves were constructed which can be used for estimating the relief coefficient of a two-phase porous medium with perfect bond between phases, based on elastic wave velocity and porosity. The average value of the relief coefficient for arenaceous argillaceous rocks from the Dnepr-Donets depression was found to be $n \approx 0.8$.

Sinitsyn, Ye. S. Criterion for detection of seismic signals with unknown shape. IN: AN SSSR. Sibirskoye otdeleniye. Geologiya i geofizika, no. 5, 1973, 88-95.

A criterion for the detection of a reflected signal of unknown waveform is considered, assuming that the time-distance curve of the signal is known and that noise is additive, stationary, uncorrelated, and has zero average value. Expressions for the probabilities of correct and erroneous signal detections are developed, and detection curves are plotted which facilitate isolation of the region of effective operation of the criterion considered. A simple function was found, the maximization of which with respect to the variable Δ ($\tau_1 - \Delta$, $\tau_1 + \Delta$ - detection interval) corresponds to the maximizing of the probability of correct signal detection within the integration interval of the correlation integral. It is shown that the probability of correct detection of a signal does not depend on its waveform.

Davydova, N. I. Capabilities of the DSS method in the study of properties of deep seismic interfaces. IN: Seysmicheskiye svoystva granitsy Mokhorovichicha (Seismic properties of the Mohorovicic discontinuity). Izd-vo Nauka, 1972, 5-19.

This article briefly reviews experimental data on the velocity parameters in the lower crust and upper mantle on continents and in the ocean, the dynamic characteristics of waves from the Moho discontinuity, and theoretical data on the dynamic characteristics of the reflections for different models of the Moho discontinuity. The criteria for the determination of the Moho discontinuity model are defined. Two examples are given of the construction of the Moho discontinuity model on the basis of dynamic characteristics of subcritical reflections. The possibilities of the DSS method in the study of the properties of deep seismic interfaces are evaluated.

Velocity Parameters

Continents. The lower crust (base) is characterized by an average layer velocity of 6.6-7.0 km/sec and a refractor velocity of 6.8 ± 0.4 km/sec. High velocities are observed in the Caucasus, Central Asia, Kazakhstan, the Kola Peninsula, the Dnepr-Donets aulacogene, the Fergana depression (V_r = 7.4-7.8 km/sec), and the Peri-Caspian syneclise (V_r = 7.2 km/sec). The layer with a velocity of 7.4-7.8 km/sec is considered by some authors to be a crust-mantle mix, by others a basite-eclogite layer. Prevailing values of the refractor velocity along the Moho discontinuity are 8.0-8.2 km/sec.

High values (V_r^M = 8.3-8.5 km/sec) are observed in the Ural-Kazakhstan block and its adjacent regions. Low values of V_r^M = 7.8 km/sec are observed in the Dnepr-Donets aulacogene and Kurile-Kamchatka island arc.

Oceanic plains. The average velocity in the lower crust is 6.5-6.6 km/sec. High velocities are not observed. The Moho discontinuity velocity varies from 8.0-8.2 to 8.5-9.0 km/sec. Its distribution is characterized by pronounced linear or blocklike patterns.

Both on continents and oceanic plains, the upper mantle is found to be layered to depths of 80-120 km. On continents, the thickness of the layers varies from 5-8 to 12-20 km, while the velocity reaches 9.0-9.5 km/sec (Central Kazakhstan). For oceanic plains, the thickness of the layers is less and the velocity gradient greater.

Experimental Data on Waves from Moho Discontinuity

Head waves. Wave amplitude is small and they attenuate rapidly. The ratio of the amplitudes of head and reflected waves does not exceed 5, with their apparent frequencies either equal or the frequency of head waves higher.

Supercritical reflections. These are dominant in the wave field at distances of 60(80) - 200(300) km. However, the reflections from the interface occurring 6-10 km above the Moho discontinuity are sometimes more intense (Central Asia, Kazakhstan and others). The correlation of these waves is very often interrupted. Although they can be traced continuously over a 100-km range, more often they are traced over a 20 - 30 km range. They can represent a compact wave, a group of two-three equally intense waves separated in time or long, quasisinusoidal or interference oscillation.

Subcritical reflections. These can represent a relatively simple compact wave which is very often continuously traced only over 5 - 10 km intervals, an intricate short wave which is traced over short intervals of 5 - 10 km, and a long wave which is traced over short intervals of 1 - 3 km.

The subcritical reflections recorded along the Magadan - Kolyma profile have a compact sustained waveform, an apparent frequency of about 13 Hz, and amplitude higher near the source than at critical distances. These wave characteristics fit a periodic, thin-layered transition model for the Moho discontinuity (consisting of alternating low- and high- velocity thin layers).

The subcritical reflections recorded on the eastern shore of the Caspian Sea are characterized by a high apparent frequency of 35 Hz (compared to 13 Hz on the Russian platform and 11 - 15 Hz in western Uzbekistan). This high frequency suggests a thin-layered transition between the crust and upper mantle, with individual low- and high-velocity layers having thickness less than that in other regions by 2-3 times.

It is concluded that on the basis of the analysis of the dynamic characteristics of supercritical reflections, blocks with anomalous properties of the lower crust and upper mantle can be identified. An analysis of the dynamic characteristics of subcritical reflections facilitates the selection of a Moho discontinuity model.

Mikhota, G. G. Frequency composition of waves originating at the Mohorovicic discontinuity. IN: Seysmicheskiye svoystva granitsy Mokhoronchicha (Seismic properties of the Mohorovicic discontinuity). Moskva, Izd-vo Nauka, 1972, 20-36.

The results of an analysis of frequency and amplitude data on waves from the Moho discontinuity observed in the Ukraine, Caucasus, Uzbekistan, Kazakhstan, the Sea of Okhotsk, the Pacific Ocean, and western Europe are described. The observation data are compared with theoretical data, and some conclusions are drawn on the nature of the Moho discontinuity. The theoretical spectral characteristics of the interference head wave from a thin layer between two half spaces are discussed.

Frequency Composition

Observed amplitude spectra for reflections from the Moho discontinuity (P^{M}_{refl}) (see Figs. 1 and 2) have resonance shape. They are characterized by a major (infrequently two) maximum and several minor ones. The prevailing frequencies vary from 2-20 Hz: low, at sea as well as continental regions with thick sedimentary cover, (e.g., Trans-Caucasian trough); high (12-16 Hz), in the Ukrainian shield; and intermediate (8-12 Hz), in the Dnepr-Donets depression.

Amplitude spectra for subsequent waves in the P^{M}_{refl} wave group observed in Uzbekistan and Kazakhstan (See Fig. 3), repeat the shape of the spectra for the first waves in the group, while their major and minor maxima fall into the same frequency range.

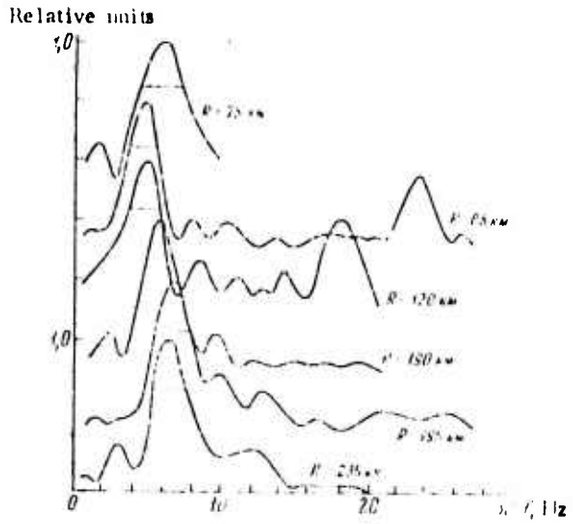


Fig. 1. Composite of the Normalized Spectra of P^{M}_{refl} Waves Recorded on a Black Sea - Caspian Sea Profile.

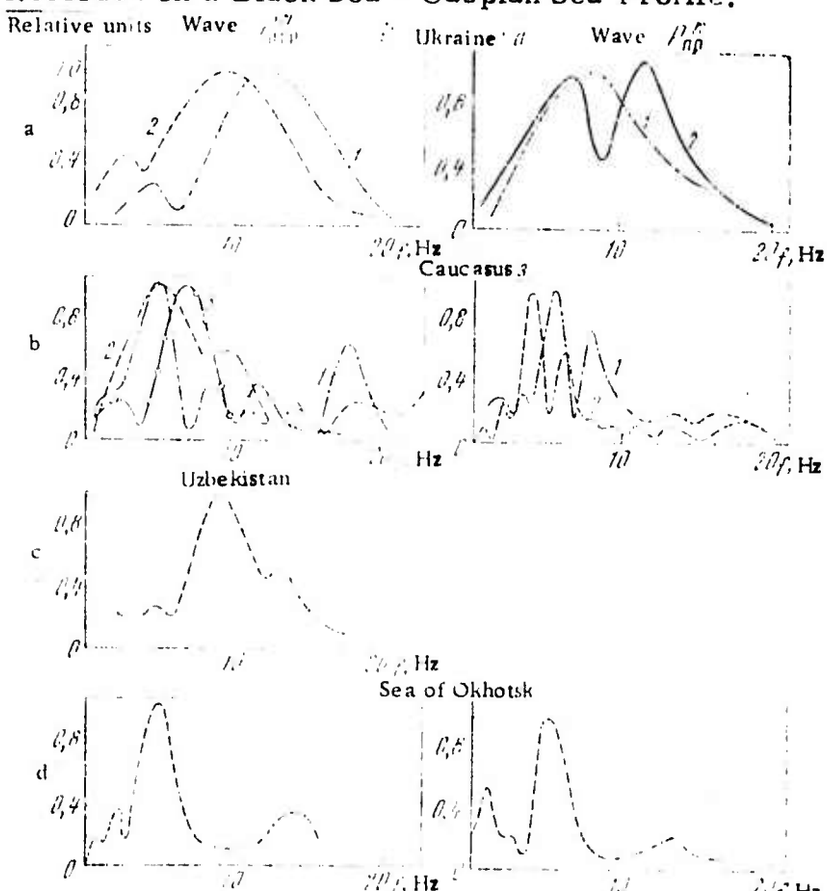


Fig. 2. Normalized Spectra of P^{M}_{refl} and P^{M}_{h} Waves.

a- P^{M}_{refl}: R = 100 km, 1- shield, 2- depression; P^{M}_{h}: R = 256, 1- $\Delta t = 1.5T$, 2- $\Delta t = 3T$. b- P^{M}_{refl}: 1- R = 120 km, 2- R = 196 km, 3- R = 236 km; P^{M}_{h}: 1- R = 196 km (Δt = 0.46 sec), 2- R = 256 km (Δt = 0.5 sec). c- R = 80 km. d- P^{M}_{refl} : R = 113 km; P^{M}_{h}: R = 90 km.

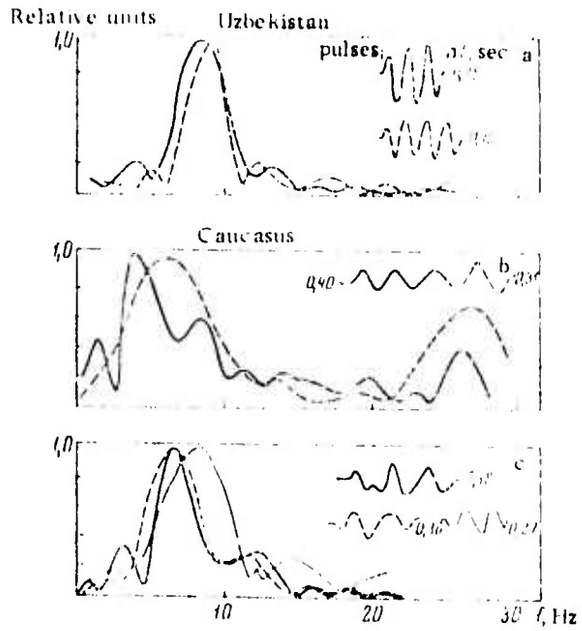


Fig. 3. Normalized Spectra of the First and Subsequent Waves in the P^M_{refl} Group at Different Δt.

a - R = 121 km; b - R = 172 km; c - R = 236 km.

Amplitude spectra of head waves (P^M_h) have, as a rule, complex shape (see Fig. 2). The prevailing frequencies are 2 - 12 Hz on land and 4 - 6 Hz at sea.

A comparison of the amplitude spectra of P^M_h and P^M_{refl} shown that, in the Ukraine and Caucasus, both waves have a low frequency component (see Fig. 4).

Amplitude-distance curves $A(R, \varphi)$ for P^M_{refl} observed in the Trans-Caucasus trough (see Fig. 5) are compared to theoretical amplitude data calculated for a first-order discontinuity and gradient transition models of the M discontinuity. It is concluded that, in the Trans-Caucasian trough, at frequencies less than 5 Hz, the M discontinuity represents a first-order discontinuity, while at frequencies of 10-15 Hz, a gradient transition with h = 0.2 km and ΔV = 2 km/sec.

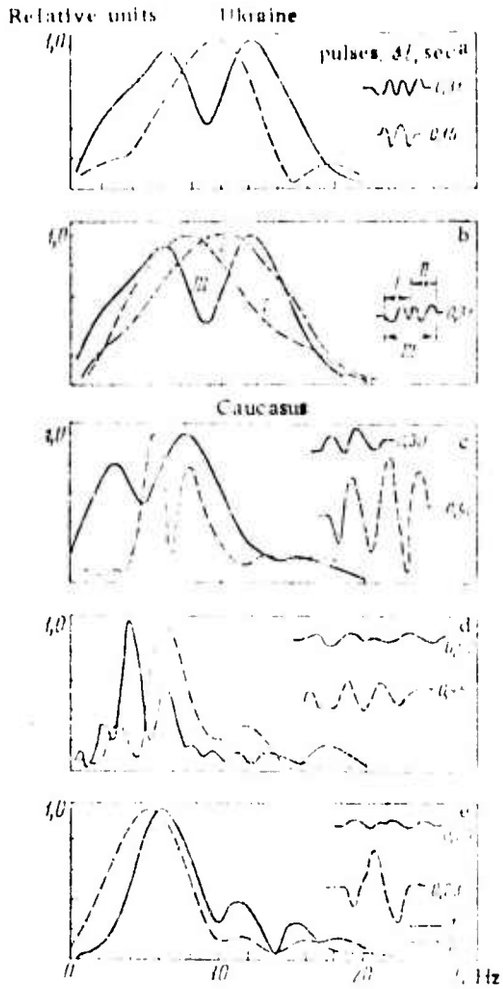


Fig. 4. Spectra of P^{M}_{refl} and P^{M}_{h} Waves.

1- P^{M}_{h}; 2- P^{M}_{refl}; a- R = 256 km. b- r = 256 km; I- $\Delta t = 1.5T$; II- $\Delta t = 1.5T$; III- $\Delta t = 3T$; c- R = 196 km; d- R = 236 km; e- R = 240 km.

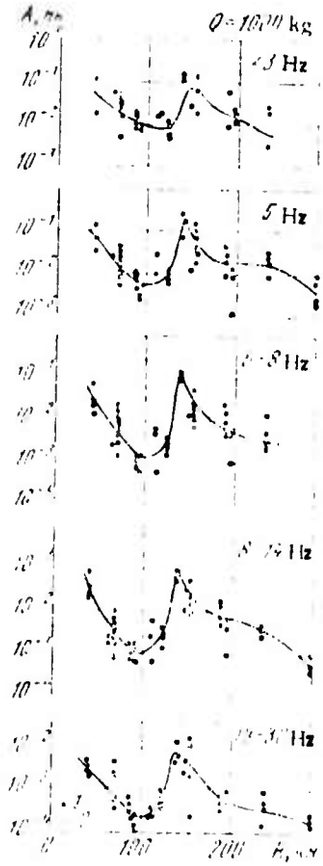


Fig. 5. Amplitude Curves A(R) for the P^{M}_{refl} Wave, Recorded in the 1-30 Hz Passband on a Black Sea - Caspian Sea Profile (Amplitudes are given in microns).

An analysis of the theoretical spectral characteristics for the interference head wave from a thin layer showed that they depend on velocity drops at the top and the bottom of the layer and on the thickness of the layer. For small velocity drops (0.87-0.97), the Wp (f) and Wp (H_1/λ_1)

curves are almost smooth. For a small velocity drop at the bottom (0.87-0.97) and a large one at the top of the layer (0.33-0.7), they are very jagged. The amplitudes of subsequent maxima and minima differ by 3-5 times for a layer thickness of 0.4 km.

Davydova, N. I., Yu. F. Ivantsov, B. B. Tal'-Virskiy, A. N. Fursov, and G. A. Yaroshevskaya. Properties of deep seismic interfaces in the western Uzbekistan. IN: Seysmicheskiye svoystva granitsy Mokhorovichicha (Seismic properties of the Mohorovicic discontinuity). Izd-vo Nauka, 1972, 37-49.

An attempt is made to study the properties of deep crustal interfaces using the dynamic characteristics of wide-angle reflections recorded during DSS investigations along the Farab - Tamdy-Bulak profile (see Fig. 1).

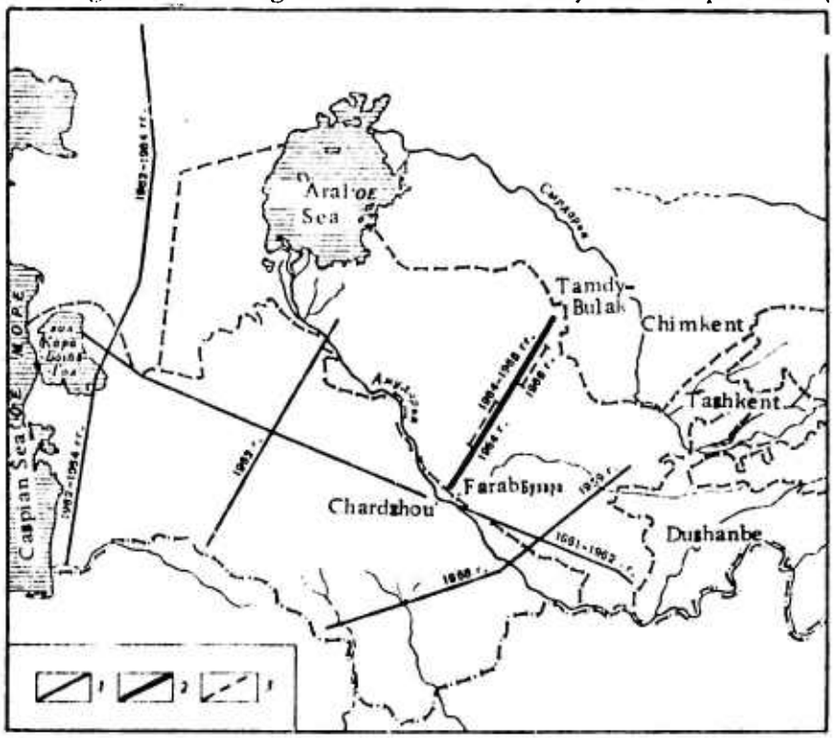


Fig. 1. Lay-out of DSS Profiles in Central Asia.
1- DSS profiles; 2- Farab - Tamdy-Bulak profile; 3- sectors of detailed studies.

Detailed observations to study the properties of deep interfaces were conducted along two sectors of the profile having a total length of 230 km (see Fig. 2). The observation system on the first sector

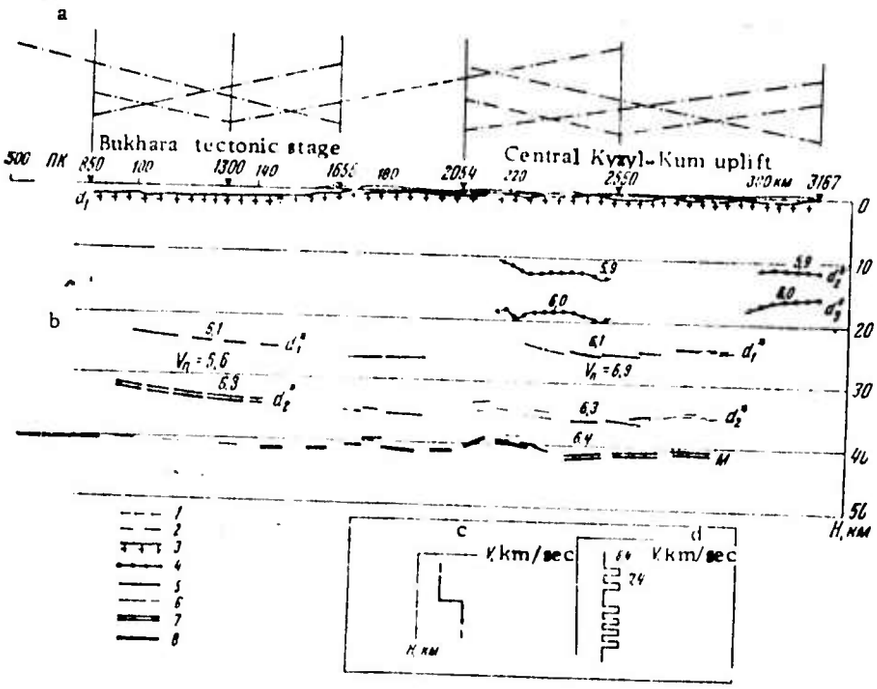


Fig. 2. Observation System (a), Crustal Section (b) along the Farab - Tamdy-Bulak Profile, Seismic Boundary Model of the First Type Between Thick Layers (c), and Layered Periodic Transition Model (d) Satisfying Experimental Data on Dynamic Characteristics of Subcritical Reflections from d_2^* Interface.

Parameters of the model: ℓ_1 = 0.110 km, ℓ_2 = 0.115 km the thickness of low- and high-velocity layers.
1- Observation system for deep reflections; 2- "Spetsgeofizika" data; 3- basement surface; 4- crustal interfaces from refracted waves; 5- crustal interfaces from reliable reflection data; 6- crustal interfaces from unreliable reflection data; 7- d_2^* from dominant reflections; 8- M from dominant reflections. Number above interfaces is the average velocity in km/sec used in the depth determination.

(observation points 514 - 1650) consisted of three 35-45 km-spaced shot points, and on the second sector (observations points 2054 - 3137), of three 60 km-spaced and one offset shot points. Elastic waves were generated by charges of 800 - 2000 kg, set off in 25-35 m-deep shot holes, in groups of three to five holes. The instrumentation consisted of the Zond seismic system with SN-3 seismometers ($f_{res.}$ = 4 Hz) and a frequency selective seismic system with VEGIK seismometers (flat frequency response at f > 1 Hz). The Zond seismic system consists of: a Zond-1 48-channel recording unit with a 3-100 Hz pass-band, a 100 Hz carrier frequency and a 30 db dynamic range. The Zond-2 24-channel rerecording unit used with the above has a SS-30/60-KMPV amplifier and a UKG set for combined grouping. The frequency selective seismic system is a single-channel system with a set of narrow pass-bands ($f_{res.}$ = 2.5, 5.0, 10, and 20 Hz) and a wide pass-band (2-50 Hz).

The crustal section inferred from the DSS data is shown in Fig. 2.

On the basis of the analysis of the dynamic characteristics of supercritical reflections P_2^* refl and P^M_{refl} (confined to d_2^* and Moho interfaces), it was revealed that the Bukhara block, between observation points (OP) 1000 and 1470, has anomalous properties in the base of the crust: namely, the d_2^* interface is a better reflector than the Moho discontinuity. As shown in the article, at distances of 60 (80) - 220 (250), A (P_2^* refl) > A (P^M_{refl}). The observation data are found to agree with the theoretical data for a homogeneous layered crustal model with high velocity in its lowermost part (see Fig. 3, a and b).

On the basis of the analysis of waveform, frequency, and amplitude of subcritical reflections from d_2^* it was found that the observational data best fit a thinly stratified periodic model of d_2^* interface, i.e. a model consisting of alternating low- and high-velocity layers.

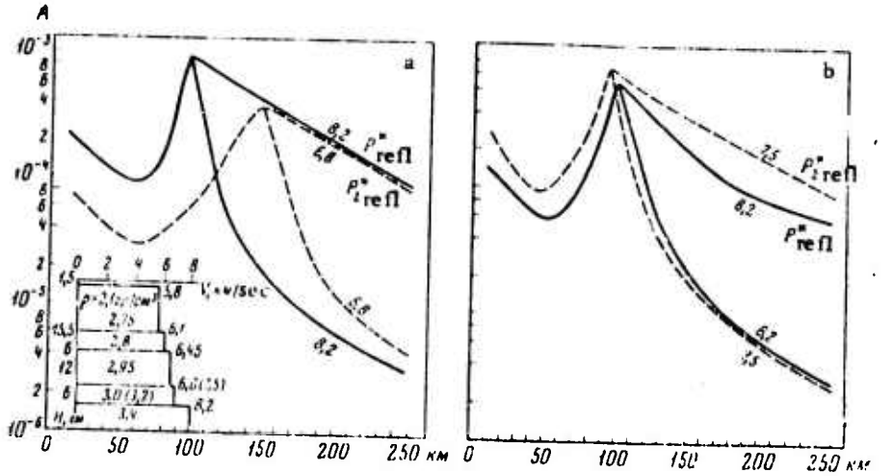


Fig. 3. Amplitude Graphs for P^{M}_{refl} and $P^{*}_{2\,refl}$, Calculated for a Homogeneous Layered Crustal Model with Velocity Distribution Similar to That Observed on the Farab - Tamdy-Bulak Profile, Within the Bukhara Tectonic Stage, with Low Velocity in the Basement (a) and High Velocity in the Basement (b).

Tulina, Yu. V., S. M. Zverev, G. G. Mikhota, and Ye. N. Zaytseva. Characteristics of waves from the Mohorovicic discontinuity in the ocean and transition zone. IN: Seysmicheskiye svoystva granitsy Mokhorovichicha (Seismic properties of the Mohorovicic discontinuity). Moskva, Izd-vo Nauka, 1972, 50-56.

An attempt is made to revise the interpretation of seismic waves from deep interfaces, as well as the model of deep interfaces, to avoid inconsistencies between observational and theoretical data commonly encountered

in DSS practice in the ocean and in transition zone. The interpretation of the first arrivals observed in the ocean and transition zone and models of the crust - mantle transition suggested by Nakamura (1968) and Helmerger (1968) are considered.

The wave field observed during DSS in the ocean and transition zone is illustrated, and theroretical data on kinematic and dynamic characteristics of elastic waves calculated for two crust - upper mantle models are shown.

The first arrivals observed at distances of 70 km (except for those confined to the uppermost and lowermost interfaces), which are usually interpreted to be head or weakly refracted waves confined to first-order interfaces, are suggested to represent summary waves. These consist of head waves from deep interfaces and reflections from the next deeper interfaces ($P_h^{6.6} + P_{refl}^{8.0}$ and $P_h^{8.0} + P_{refl}^{8.6}$). The fact that pure reflections are not observed even at distances exceeding 70 km (where head waves and reflections are resolved in time according to the theoretical data for a homogeneous layered crustal model with first-order interfaces) is explained by introducing a crustal model with gradient transitions. Theoretical data on deep waves calculated for such a model fit well with observational data.

The frequency dependence of the amplitude of first arrivals is illustrated as observed in the Pacific Ocean and near the southern Kurile Islands.

Davydova, N. I. Study of deep-seated faults by DSS. Seysmicheskiye svoystva granitsy Mokhorovichicha (Seismic properties of the Mohorovicic discontinuity). Moskva, Izd-vo Nauka, 1972, 57-65.

The capability of the DSS method at the present level of its development in revealing zones of deep-seated faults is discussed. The criteria for the identification of deep-seated faults are defined.

Crustal sections along the Black Sea - Voronezh massif (see Fig. 1) and Stepnoye - Bakuriani (see Figs. 2 and 3) illustrate DSS data on deep-seated faults.

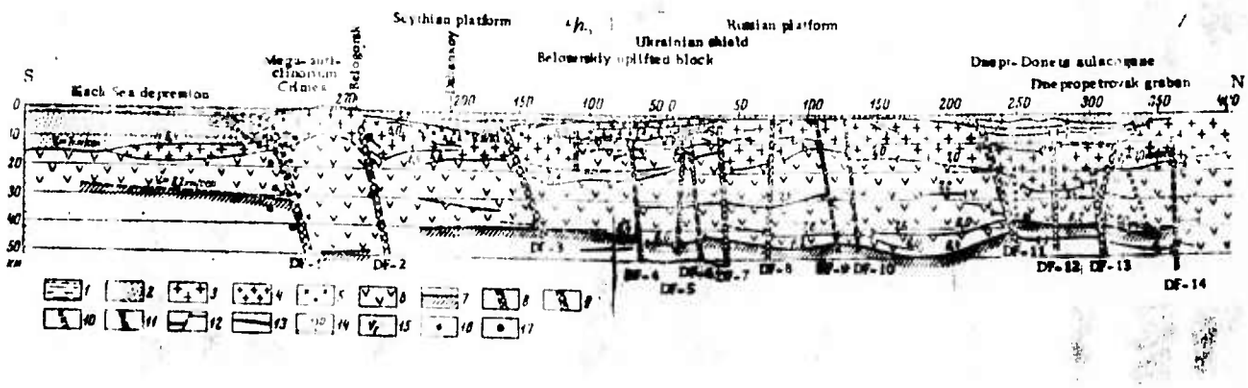


Fig. 1. Seismic Crustal Section along DSS Profile Black Sea-Voronezh Massif (Sollogub, 1967).

1- Water; 2- sedimentary layer; 3- granitic layer; 4, 5- metamorphic formations within the grantic layer; 6- basaltic layer; 7- M discontinuity; 8 - deep-seated faults dividing main geological regions (DF-1 - DF-14); 9- deep-seated faults dividing crustal blocks; 10- the same, less reliable; 11- faults within individual blocks; 12- dislocation at the basement surface and in the sedimentary layer; 13- seismic interfaces; 14- km-marks; 15- refractor velocity in km/sec; 16- earthquake foci; 17- diffraction points.

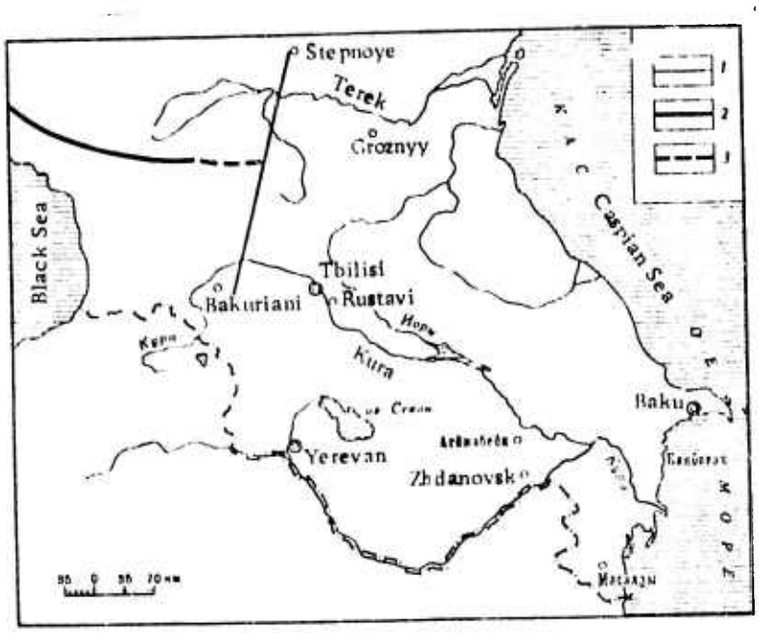
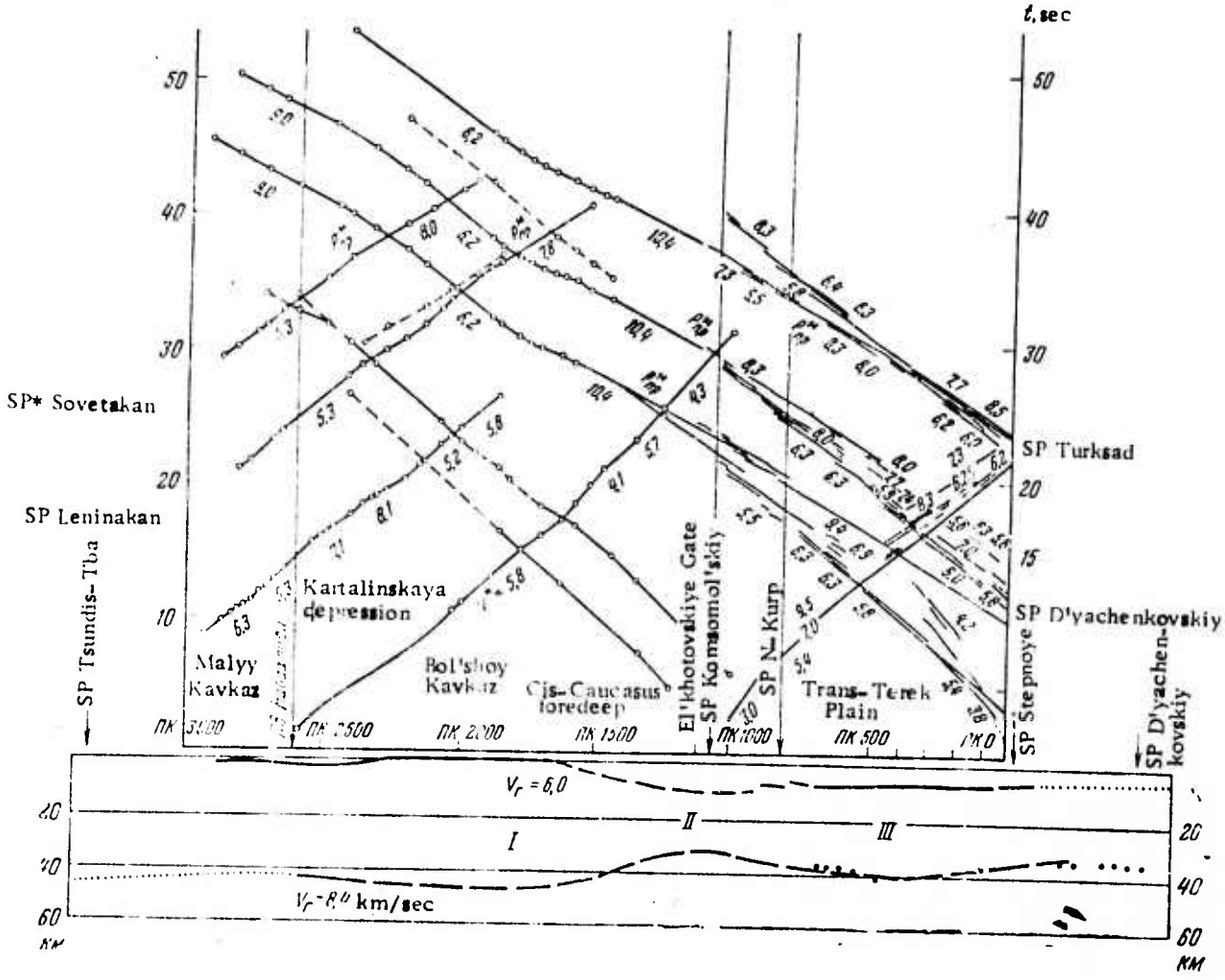


Fig. 2. Location of DSS Profile Stepnoye-Bakuriani and Ancient Deep-Seated Faults (At the extension of that fault on the DSS profile, a block with very thin crystalline crust is revealed).

1- Stepnoye-Bakuriani profile (Yurov, 1963); 2- ancient deep-seated fault; 3- its extension to the DSS profile.

The crust along the Black Sea-Voronezh massif is intersected by numerous deep-seated faults (indicated by numerals 1-14 in Fig. 1), which separate blocks with different thickness and structure. It is pointed out that sharp attenuation of P^{M}_{refl} is observed in the zone of deep-seated faults which separates the Scythian Plate and Russian platform. Although this phenomenon cannot be interpreted uniquely, the change in the composition and state of the matter in the lower crust-upper mantle is suggested to be one of its possible causes. Thus, at present, the DSS method reveals intrinsic structural features in the zones of deep-seated faults, while still yielding a small amount of information on the characteristics of crust and upper mantle matter.



*SP = shot point

Fig. 3. System of Observed Time-Distance Curves and Seismic Section Along Stepnoye - Bakuriani Profile (Yurov, 1963).

I, II, III- crustal blocks with different thickness of crystalline crust;
I- Greater Caucasus, II- Cis-Caucasian trough (800-1500 km), III- Trans-Terek plain.

The criteria for the identification of deep-seated faults by the DSS method are classified as: wave criteria, i.e., dynamic and kinematic characteristics which are anomalous with respect to those for plane horizontal interfaces; structural criteria, i.e., abrupt changes in crustal thickness and relief of intercrustal interfaces; and physical criteria, i.e., the velocity, reflection, and absorption characteristics of the crust and upper mantle.

B. Recent Selections

Avetisyan, R. A., and T. B. Yanovskaya. Expansion of the group velocities of Rayleigh waves, based on spherical functions. IN: AN SSSR. Izvestiya. Fizika Zemli, no. 11, 1973, 27-33.

Droste, S., and R. Teisseyre. Analysis of the signs of first impulses in the case of a three-dimensional station network (in English). Revue Romaine de geologie, geophysique et geographie. Serie de geophysique, vol. 17, no. 2, 1973, 149-153.

Gel'fand, N. I. Possible nature of the Mohorovicic. Geologiya i geofizika, no. 11, 1973, 107-109.

Gzovskiy, M. V., et al. Problems of the tectonophysical characteristics of stresses, deformations, and ruptures of the Earth's crust, and its deformation mechanisms. IN: AN SSSR. Izvestiya. Fizika Zemli, no. 12, 1973, 3-31.

Iosif, T., and S. Iosif. Data on crustal and mantle structure. Studii si cercetari de geologie, geofizica, geografie. Serice geofizica, vol. 11, no. 2, 1973, 203-219.

Kats, S. A., and N. G. Mikhaylova. Minimax interference systems for the suppression of wave noise with curvilinear fronts. IN: AN SSSR. Izvestiya. Fizika Zemli, no. 11, 1973, 34-42.

Kharkevich, G. A. Density at the top of the mantle based on a statistical analysis of deep seismic sounding data. Geologiya i geofizika, no. 11, 1973, 75-80.

Maaz, R., and G. Purcaru. On the magnitude distribution and prediction of earthquakes (in Fnglish). Revue Romaine de geologie, geophysique et geographie. Serie de geophysique, vol. 17, no. 2, 1973, 155-163.

Osaulenko, V. I. Diffraction of plane waves on a smooth, rigid disk in an infinite elastic medium. IN: AN SSSR. Izvestiya. Fizika Zemli, no. 12, 1973, 49-57.

Pan'kov, V. L. Equation of state for the D layer of the mantle. IN: AN SSSR. Izvestiya. Fizika Zemli, no. 11, 1973, 70-71.

Petrosyan, A. L. Method of determining the structure of the Earth from surfaces waves recorded at one station. IN: AN SSSR. Izvestiya. Fizika Zemli, no. 11, 1973, 72-77.

Potap'yev, S. V., G. G. Beletsky, and I. I. Levin. Procedures for aerial seismic research at sea. Geologiya i geofizika, no. 11, 1973, 102-106.

Teisseyre, R. Earthquake processes in a micromorphic continuum (in English). Revue Romaine de geologie, geophysique et geographie. Serie de geophysique, vol. 17, no. 2, 1973, 145-148.

Terent'yev, V. A. Compact pulsed ultrasonic seismoscope for field use. IN: AN SSSR. Izvestiya. Fizika Zemli, no. 11, 1973, 78-81.

Vasil'yev, O. B., and N. G. Vitman. Method of observing natural oscillations of the Earth based on seismic tiltmeter records and the identification of modulating oscillations. IN: AN SSSR. Izvestiya. Fizika Zemli, no. 12, 1973, 58-65.

Vostrikov, G. A. Recurrency distribution of earthquake faults, and certain consequences. IN: AN SSSR. Izvestiya. Fizika Zemli, no. 12, 1973, 32-48.

4. Particle Beams

A. Abstracts

Bugayev, S. P., G. M. Kassirov, B. M. Koval'chuk, and G. A. Mesyats. Generating intensive microsecond relativistic electron beams. ZhETF P, v. 18, no. 2, 1973, 82-85.

An electron flow up to 5 kA and pulse length up to 4 μsec was achieved in a diode with a multipoint cold emission cathode at an accelerating voltage of 1.2 Mv. Experiments show that at a voltage of 10^6 V and current from a single point of less than 100 a, the cathode plasma ceases to affect switching in the accelerating space, if expansion of dimensions of 1 cm or more is achieved. Current pulse length will be determined by the discharge time of the capacitor to the diode resistance. The beam structure differs considerably from that obtained in the same diode at a pulse length of 30 nsec. Whereas it consists of individual rings obtained from each emitter in the first case, at microsecond pulses there are irregularities which are apparently the result of interaction of the individual cathode flares.

Baksht, R. B., S. P. Vavilov, and M. N. Urbazayev. Luminescence of the lateral surface of a point cathode in a vacuum diode with explosive emission. IVUZ Fiz, no. 8, 1973, 142-143.

A cathode flare occurred during explosion of a needle emitter placed in a vacuum (10^{-5} torr) at pulse voltages up to 80 kV with a pulse length of 300 nsec and a rise time of 10 nsec. The discharge current was limited by an external circuit resistance of 66 ohms. The apparatus permitted recording of both the integral luminescence of the cathode flare plasma in the visible region of spectrum and luminescence of individual ion lines for materials with different atomic weight.

A more rapid growth in intensity of luminescence on the lateral surface of the point compared to that in a vacuum indicates explosions of the microprotuberances on the lateral surface during formation of the cathode flare. Spectral analysis of the plasma which forms on the lateral surface showed that the material of the needle cathode actively participates in formation of the plasma. The experiments also show that the lateral surfaces of cathodes of different metals work differently; thus a lateral surface of an aluminum point is more active in formation of the cathode flare, that of copper and tin is less active.

Bogomaz, A. A., V. S. Borodin, A. I. Zaytsev, and F. G. Rutberg. Problems in the study of heavy-current discharge in a high-pressure chamber. Part 2. ZhTF, no. 7, 1973, 1507-1512.

The nature of a heavy-current discharge in hydrogen and the mechanism of heat transfer between the arc and the working gas in a high-pressure chamber was investigated. The pressure measured at the chamber walls and along the discharge axis is delayed with respect to current by 200 μsec, and reaches a maximum during the second half-period of current, after which it drops to a certain value which hardly varies over a period of several hundred microseconds. The lag of a pressure increase at the discharge chamber wall with respect to the first half-period of current indicates minor heat transfer between the arc and gas during the initial stages of discharge development. The values of pressures achieved were 500-1500 atm at an average mass temperature in the chamber of (5-14) x 10^{3o} K. As magnetic pressure decreases, the discharge column collapses and there is subsequently more intensive heating of the gas in the chamber.

Fal'kovskiy, N. I. Controlled plasma-jet discharger for commutation of high pulsed currents. PTE, no. 3, 1973, 112-114.

A controlled plasma-jet discharger is described, in which the main operating gap is excited by a plasma jet formed from a discharge in a capillary tube. The construction of the discharger and its schematic are shown in Fig. 1, and a detailed description is given of its operation.

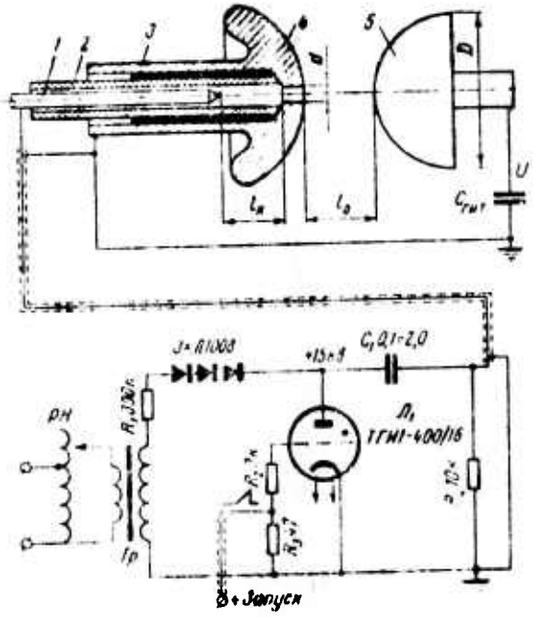


Fig. 1. Discharger construction and its ignition schematic.

1- ignition electrode; 2- ceramic tube; 3- ceramic cement; 4, 5- main electrodes ℓ_k- discharge gap (15-30 mm) ℓ_0- main gap (5-60 mm) D- electrode diameter (100 mm) TGI1 - 400/16 - standard thyratron.

The discharger is used for commutating voltages of 10-150 kv at discharge currents of 5-200 ka, with a capacitive storage up to 20 μF. Control voltage for commutation is comparatively low at 15 kv. Accuracy of

commutation is acceptably high - a fraction of a microsecond. The discharger can be simultaneously used as an experimental gap during the physical study of a heavy-current pulsed discharge channel, in particular during the study of a plasma column by opticospectral methods. Some performance curves are included.

Bosamykin, V. S., and A. I. Pavlovskiy. A nanosecond voltage pulse generator. Author's certificate, USSR, no. 353370, published October 13, 1972. (RZhElektr, 6/73, no. 6A380 P).

A nanosecond voltage pulse generator is proposed for supplying an acceleration tube, consisting of a charging device, starting commutator, load commutator and a coupling line with distributed parameters connected to the load. To increase the transformation coefficient and the pulse power, the coupling line is made in the form of a shielded solenoid, where one of the ends of the solenoid shield is connected to the grounded solenoid plate, and is connected to the high-voltage plate of the solenoid through the starting commutator; and the other end of the shield is connected through the load and load commutator to the high-voltage plate of the solenoid.

Zolototrubov, I. M., Yu. M. Novikov, I. P. Skoblik, and A. G. Tolstolutskiy. Studying the operation of a coaxial accelerator in the dense and highly energetic plasma generation mode. IN: Sb. Plazmen. uskoriteli. Moskva, Izd-vo Mashinostroyeniye, 1973. 214-218. (RZhElektr, 6/73, no. 6A300)

Plasma parameters developed by a coaxial gun were investigated in a mode when a dense plasma formation -- a plasma focus -- is generated

at the end of the coaxial. This mode is obtained at negative central electrode polarity in a volume of emitted gas > 2 cm^3 and discharge current amplitude > 200 kA. The length of the copper electrodes was 52 cm, the diameter of the inner electrode was 7 cm, the diameter of the outer electrode was 3 cm, and the distance from the point of emitting the gas to the end face of the gun was 24 cm. The working gas was hydrogen. A unique diagnostic apparatus was used to investigate the plasma. It follows from the results obtained that a dense plasma forms at the axis of the coaxial at its end in the investigated mode; the moments of maximum density and intensive emission from a plasma of high-energy ions and soft X-radiation coincide with the maximum carrier currents; the pulse length of soft X-radiation and of high-energy ions is approximately identical and equal to 0.6-0.8 μsec; and the lifetime of the plasma at a density of 1×10^{17} cm^{-3} is equal to 3 μsec.

Gubarev, V. Ya., N. P. Kozlov, L. V. Leskov, Yu. S. Protasov, and V. I. Khvesyuk. Experimental determination of high-speed characteristics of a pulsed erosion accelerator. IN: ibid., 211-214. (RZhElektr, 6/73, no. 6A332)

Experimental investigations of the high-speed characteristics of a plasma jet were carried out on a model of a pulsed erosion plasma accelerator with coaxial configuration. The diameter of the inner electrode (cathode) was 10 mm and that of the outer electrode was 50 mm, and the length of the accelerating channel was 67 mm. The electrodes were of copper. The working material was polytetrafluorethylene. The maximum discharge current was 136 kA at a voltage of 200 V. A probe method of measuring the velocities in the plasma jet, based on measurement of the velocities of the inhomogeneities in the jet, was developed and used. Based on the data obtained, it is concluded that there is considerable inhomogeneity of velocities in the plasma jet as a function of time. It is shown that an increase of discharge current leads to an increase of velocity inhomogeneities in the plasma jet.

Azizov, E. A., V. S. Komel'kov, and M. M. Stepanenko. Two-stage acceleration of plasma. IN: ibid., 195-198. (RZhElektr, 6/73, no. 6A335).

A two-stage plasma accelerator was investigated in which an injector with finite electrodes was used as the first stage. Two ring electrodes of the second acceleration stage with an inner diameter of 18 cm. separated by a glass insulator, were located at a distance of 25 and 55 cm from the end of the accelerator. A quasi-longitudinal magnetic field with an intensity of 0.5-3.0 kA/m was generated in the entire plasma guide. The dynamics of interaction of the plasma jet and the cascade current was studied by means of magnetic probes, photographic scanners and volt-ampere characteristics. It was found that currents up to 80 kA are maintained up to a distance of 25 cm. The frontal currents carried by the plasma are considerably less and have a complex volumetric distribution.

Plyutto, A. A., K. S. Suladze and V. N. Ryzhakov. Ion acceleration in heavy-current electron beams. IN: ibid. 47-53. (RZhMekh, 6/73, no. 6B89)

This experiment was devoted to study of the phenomenon of ion acceleration in heavy-current (10^4-10^5 a) electron beams. The beams were formed under conditions of preliminary charging of the accelerating space of a plasma at an accelerating voltage of 30-50 kV. Pulsed plasma sources of two types -- coaxial and spark -- were used. In the first case capture and acceleration of the ion bunch occurs in the stage of electron beam formation, the accelerated ion flow being proportional to the square root of the accelerating voltage, and the energy spectrum of the ions is diffuse. In the

second case, radial motion of the plasma in the accelerating space plays a significant role. The experiments showed that the beam current passing into the anode aperture and the accelerating ions comprise 0.3-0.5 of the total current. Qualitatively the acceleration process is a wave structure of the two-layer type, in which electric field intensity may reach 10^5-10^6 v/cm.

Zablotskaya, G. R., V. A. Ivanov, S. A. Kolyubakin, A. S. Perlin, V. A. Rodichkin, and V. B. Shapiro. The REP-5 pulsed heavy-current accelerator of relativistic electrons with a 50 ka beam current. Atomnaya energiya, v. 34, no. 6, 1973, 471-474.

Results are described of the first stage operation of the REP-5 accelerator which is based on the EG-5 electrostatic generator and intended for generating heavy-current relativistic electrons at 2-3 Mev. Fig. 1 shows a functional sketch of the accelerator; the authors give a detailed description of its operational procedure. The principle scheme of the accelerator is similar to that described by Graybill and Nablo, (Appl. phys. lett., 8, 18, 1966). Electron beam with a current amplitude 50 ka and pulse duration ~20 nsec was generated at a charging voltage ~4 Mv. A relationship of the electron current amplitude as a function of charging voltage at an anode-cathode spacing of 18 mm and chamber pressure $\sim 3 \times 10^{-2}$ torr is shown in Fig. 2. Owing to defocusing of the beam, only a part of the net current was recorded.

The relationship of the shape and amplitude of current pulses with anode-cathode spacing showed that a second peak occurred at ℓ = 13 mm; its amplitude sharply decreased with ℓ which is a function of the distribution in the acceleration gap of plasma clouds, generated during explosive cathode emission. Beam energy was found to peak at a pressure of 0.3 torr, reaching

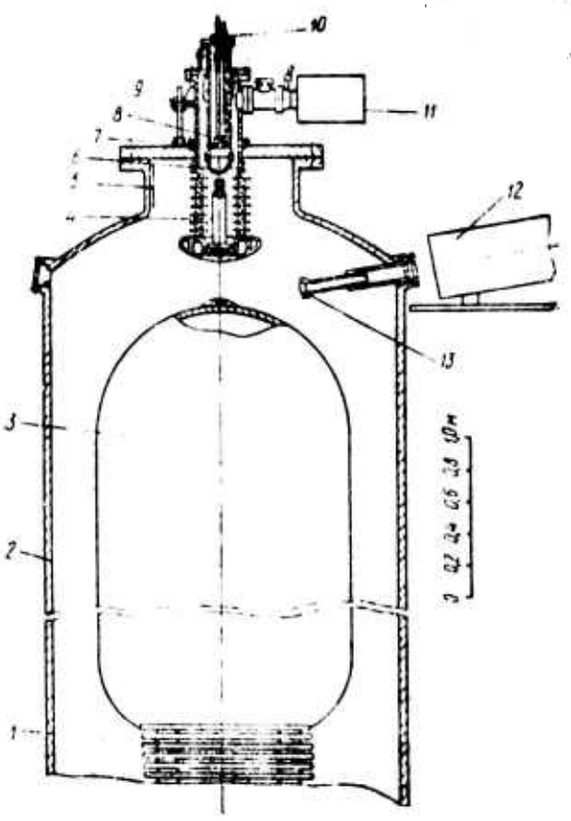


Fig. 1. Section of Accelerator.

1 - Charging generator;
2 - high pressure tank;
3 - high voltage electrode;
4 - acceleration tube;
5 - capacitive pickup;
6 - anode foil;
7 - Rogowsky belt;
8 - calorimeter;
9 - drift chamber;
10 - shunt;
11 - titanium pump;
12 - laser ignition system;
13 - lens.

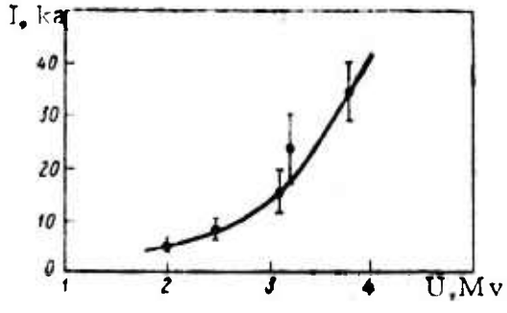


Fig. 2. Electron current as a function of charging generator voltage.

700 joules. The diameter of beam under focusing was measured at < 1 cm. Relationships were also determined of the shape of total pulsed current in the drift chamber as a function of pressure (Fig. 3). The change in pulse

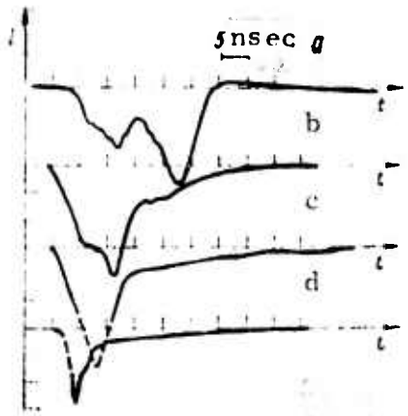


Fig. 3. Current pulse shape as a function of pressure in the drift chamber.

a- 0.045 torr; b- 0.1 torr; c- 0.16 torr; d- 0.35 torr.

shape is explained by the appearance of feedback current with increased gas density.

Suprunenko, V. A., Ye. A. Sukhomlin, and V. T. Tolok. Current heating of a dense plasma during collective interactions in a heavy-current gas discharge. IN: Fizika plazmy i problemy upravlyayemogo termoyadernogo sinteza. Resp. mezhved. sb., no. 4, 1973, 5-15.

The present work offers a review of previously obtained data on current instabilities in plasma, and analyzes the physical processes in the

excitation of high-frequency instabilities, leading to an effective plasma heating. Discussions are subdivided into the following topics:

1) Criteria and successive development of current instabilities in a strong gas discharge;

2) Electron heating;

3) Ion heating;

4) Measurement of diamagnetic effect during plasma heating and the energy balance.

Temperatures of electron and ion components of the plasma, and the kinetic energy density confined in the plasma are found to be in good agreement, on the assumption that a considerable portion of plasma is heated effectively. The analysis shows that the anomalous resistance observed by previous authors and the effective heating of plasma electrons and ions are the results of a complex combination of current instabilities, which are successively excited during a heavy-current gas discharge.

Drobyshevskiy, F. M., Yu. A. Dunayev, and S. I. Rozov. Ring discharges in electrolytes. ZhTF, no. 6, 1973, 1217-1221.

Ring discharges were investigated in a spherical chamber of 8 cm diameter consisting of two stainless steel electrodes, and a polyethylene diaphragm of thickness = 0.2 mm with a center hole (Fig. 1). The chamber was filled with electrolyte ($\delta \leq 0.735$ mho), from which plasma was formed during discharge. The feeding source was a capacitor bank with C = 3-6 μF and charged to 5-50 kv. Plasma bunch formation and the rate of its expansion was recorded by streak camera; two sets of discharge photographs

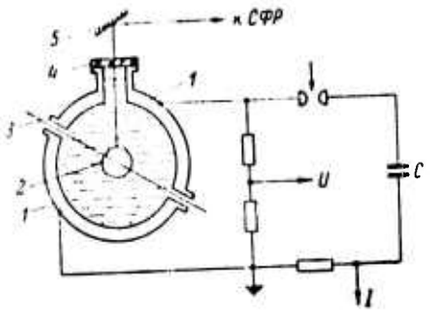


Fig. 1. Experimental sketch.

1- Hemispherical electrodes
2- Plasma near diaphragm hole
3- Dielectric diaphragm with hole
4- Observation port
5- Mirror.

are given. The pressure at internal walls of the chamber was measured simultaneously with the discharge photography. Maximum pressure was recorded in compression waves on the order of hundreds of atmospheres at a distance 4 cm from the discharge center, and was directly proportional to the initial voltage. The rate of compression wave propagation was found to be equal to the velocity of sound in the electrolyte.

It was observed that the center hole (diameter 0.5-1.0 mm) in the diaphragm did not undergo any changes up to 20 kv, but at higher voltages it increases after discharge and finally is torn. Experimental results show that the penetration rate of plasma front into substances becomes commensurable with streamer intergrowth rate and significantly increases the speed of gas dynamic expansion of a plasma bunch. This is in contrast to linear discharges, where the channel expansion due to heating is negligibly small compared to the gas dynamic expansion.

Kolomenskiy, A. A., V. M. Likhachev, I. V. Sinil'shchikova, and O. A. Smit. Structural characteristics of a heavy-current electron beam during transit through a low-pressure gas. ZhETF P, v. 18, no. 3, 1973, 153-156.

Experiments are described with transmission of high-current (30 ka maximum) electron beams with energy E = 300 and 700 keV through gases (air, He, Ar, Xe) at different low pressures P. The Impul's high-current electron pulse accelerator was used in the experiments. This consists of a Marks bank, a dual shaping line, a transformer line and an electron gun with a cold cathode. Pulse duration was 50×10^{-9} sec.

The electron beam was transmitted through a 2-meter drift chamber filled with a gas at a pressure of 10^{-2} to 1 torr. At E = 300 keV and P = 0.1-0.4 torr, photographs of light emission from air in the chamber show a bright filament along the chamber length with spikes emitted by the filament at an acute angle. This structural peculiarity of the beam, which was not observed earlier, is explained tentatively by beam interaction with its own magnetic field. Beam self-focusing was observed at P ~ 0.4-1 torr and 30 cm distance. The cited effects, except the spikes, were also observed with 700 keV beams. In addition, at P ~ 1 torr, development of instability was observed as transverse shifting of the beam.

Sindinskiy, V. V. The solution of phase-energetic equations of a heavy-current accelerator, taking into account losses in the waveguide walls. ZhTF, no. 8, 1973, 1789-1791.

A procedure is outlined for calculating the phase φ of dynamic slip, and hence the traveling wave phase velocity, which is one of the fundamental

characteristics of an irregular accelerating waveguide. Phase velocity together with waveguide electroconductivity is used in calculation of waveguide geometry. The starting point in calculations is the integral equation of the synchronous effective field E_S in the waveguide, allowing also for losses in the waveguide walls (Zhileyko et al, IAN Arm SSR. Fizika, no. 2, 1972, 150).

It is confirmed that the method of solving the integral equation for φ is not affected by introduction of losses, i.e., the attenuation factor $\alpha(z)$ of a wave in the waveguide. Solutions are obtained for φ and its derivative $d\varphi/d\zeta_o$, where $\zeta_o = z/L_o$ is the dimensionless waveguide length, z is a longitudinal coordinate, and L_o is the waveguide length. The plotted numerical solutions for φ versus ζ_o at different total attenuation(αL_o) values and constant E_S, and effective field amplitude E_D, show that losses have a significant effect on φ only in the end-section of a waveguide.

Bakhrushin, Yu. P., and I. M. Matora. Linear induction accelerators - new powerful relativistic electron beam generators. UFN, v. 110, no. 1, 1973, 117-137.

This article reviews and generalizes the results obtained by well-known authors in the field of new accelerator technology. During the past 60 years, a number of linear induction accelerators (linacs) have been designed and constructed, which have been used for studying new methods of acceleration and the control of nuclear synthesis. A considerable body of work on the physics and techniques of linacs has been published. Linacs can be used for accelerating beams carrying up to thousands of amperes at low energy dispersion and good emittance, which makes them highly attractive for researchers in the physical sciences. The linac is reliable and simple in operation, does not require special external conditions, and has a high efficiency. The authors point out that portable, cheap and simple equipments based on linacs can be made for x-ray structure analysis, gamma-coring

defectoscopy, etc., which are capable of working under field as well as factory conditions.

Table 1 lists a number of accelerators in operation and under construction and their parameters, including some made in the USA.

The discussion includes design theory, photographs and schematic details of several currently produced Soviet linacs.

Table 1

Name of accelerator	Place of installation	Beam Energy Mev	Beam Curr. a	Pulse duration, μsec	Pulse frequency imp/sec	Energy dispersion %	Emittance cm · mrad.
Injector "Astrona" (before reconstruction)	Livermore, USA	3 7	350	300	0—60 (5)	<3	50
LIU-3000	Dubna, USSR	3 (1,8)	200	350	0—25 (<1)	—	—
Injector Astrona (after reconst.)	Livermore, USA	4,2	800	300	0—60 (5)	<2	25
LIU-30/250 (under construction)	Dubna, USSR	30	250	500	0—50	<3	—
Injector ERA	Berkeley USA	4,25	500	45	<1	<0.5	<70
SILUND (under construction)	Dubna, USSR	3	2000	20	0—50	<2	—
Plasma Betatron	Khar'kov, USSR	0,05—0,1	500—1000	—	Single	wide spectrum	—
Iron-free LIU	Moscow, USSR	2	2000	70 (semi-sinusoidal)	Single	—	—

B. Recent Selections

Aretov, G. N., V. I. Vasil'yev, A. P. Lototskiy, and Yu. V. Skvortsov. Parameters of a nitrogen plasma jet in a heavy-current pulsed accelerator. ZhTF, no. 11, 1973, 2324-2331.

Bekhtev, B. V., and I. S. Shchedrin. Method of smooth energy control at the output of a linear charged particle accelerator. Author's certificate, USSR, no. 366825, published June 21, 1971. (Otkr izobr, 41/73, p. 239)

Bondarenko, B. V. Stability of electron emission and the service life of various field emission cathodes. ZhTF, no. 11, 1973, 2441-2447.

Chogovadze, M. Ye. Nonlinear interaction of a low density electron beam with monochromatic oscillations of a spatially confined plasma. ZhTF, no. 11, 1973, 2286-2291.

Ivanov, A. A., S. M. Korshunov, N. S. Beryuleva, and S. P. Tarasov. Nonlinear interaction of space charge waves with trapped electrons. ZhETF, v. 65, no. 5, 1973, 1857-1865.

Ventova, I. D., and G. N. Fursey. Characteristics of the surface self-diffusion process under conditions of critical (surface) reconfiguration. ZhTF, no. 11, 1973, 2432-2440.

Yevdokimov, O. B., V. V. Kremnev, G. A. Mesyats, and V. B. Ponomarev. Field distribution in a volumetric gas discharge, initiated by fast electron beam. ZhTF, no. 11, 1973, 2340-2346.

5. Material Science

A. Abstracts

Kompaneyets, A. L. Matter in a superdense state. Zemlya i vselennaya, no. 3, 1973, 12-17.

The modern theory of the state of matter under ultra high pressure and its implications to astrophysics are presented in popularized form. High and ultrahigh pressures are defined in terms of their effect on atomic arrangement in a crystal lattice and structure of atoms and nuclei, respectively. Atomic rearrangement is illustrated by the examples of graphite-to-diamond conversion and solid hydrogen metallization, which is predicted to occur under 2,500,000 atmospheres.

The significance of metallic hydrogen superconductivity is underlined for magnetic fields of the planets as well as technological applications. A practical method is described for generating ultra high pressures of the order of 2×10^7 atm. for extremely short periods of time. Formation of a Fermi gas at absolute zero and even higher pressures is explained in terms of quantum theory. The theory of the energy states in a Fermi gas in conjunction with the Einstein theory of gravitation is applied to describe the models of white dwarfs and neutron stars (pulsars). Energy states of the Fermi gas are presented schematically for a low-density state and above-nuclear density state.

Maazheliy, V. G., B. G. Udovidchenko, and V. B. Yesel'son. Possible phase transition in solid parahydrogen. ZhETF P, v. 18, no. 1, 1973, 30-32.

Results are given of the thermal expansion and compressibility measurements of solid parahydrogen in a pre-melting region of temperatures

($T < 14.8^{\circ}$ K) under 30 atm pressure. The experimental procedure was similar to that described before by two of the authors (J. Low Temp. Phys., v. 3, 1970, 429). The test specimens contained 98 ± 0.5% parahydrogen. The experimental plots (Fig. 1) show a 0.15% average jump in V, which

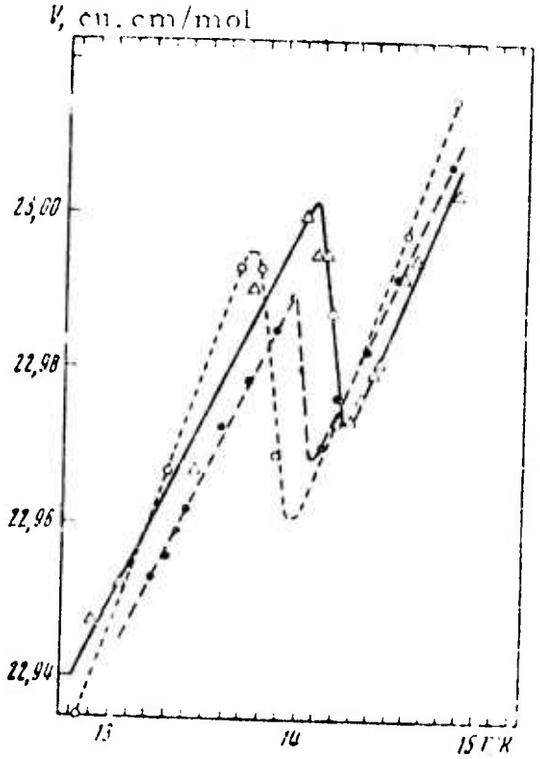


Fig. 1. Molar volume V of parahydrogen at P = 31 atm versus temperature: Δ and ●- on heating, o - on cooling.

occurred in the 13.7-14.2° K range. A V jump hysteresis, i.e., a difference in jump temperature on heating and cooling, was noted. The slower the crystallization of the specimen the greater is hysteresis. The upper temperature of the V jump at 30 atm. depends on direction of temperature change and on the history of the solidified gas specimen. V jumps were also detected in preliminary experimental determination of thermal expansion under 150 atm pressure and of compressibility.

The cited phenomena are interpreted as the effect of first-order phase transition in the solid state. The rather unusual decrease in V during transition from a low-temperature to a high-temperature phase is attributed to inaccuracy of transition temperature measurement. Earlier experimental data of different Western authors are discussed in terms of the phase transition. In particular, the most recent data of R. Wanner and H. Meyer (in print) on ultrasound absorption and sound velocity in solid parahydrogen are connected with a possible existence of phase transition. The authors plan to make a detailed study of the cited phenomenon at pressures to 200 atm.

Tokiy, V. V., V. I. Zaytsev, and B. P. Filatov. Mechanism of formation of ordered dislocation structure in metals, deformed by a high hydrostatic pressure. UFZh, v. 18, no. 7, 1973, 1178-1181.

The nonlinear elastic theory previously applied to explain the effect of hydrostatic pressure on dislocation interactions in a solid (Galkin, A. A., et al. DAN SSSR, v. 204, no. 2, 1972, 313), is expanded further to explain the mechanism of formation of an ordered dislocation structure from the cited effect. It is shown that hydrostatic pressure determines formation of an ordered structure of cellular type in metals deformed without heating.

It follows from nonlinear elastic theory that, at a high hydrostatic pressure, 1) the interaction force between dislocations increases; 2) a force proportional to the pressure P and contributing to mechanical polygonization is exerted on two parallel edge dislocations; 3) the interaction force between an edge dislocation and the wall increases; 4) two edge dislocations of the same sign tend to order one above the other in a plane normal to the glide plane, and 5) stability of dislocation walls increases.

The cited theoretical deductions reflect peculiarities of the mechanism of formation of ordered dislocation structure. An ordered cellular structure was observed in a Nb-Ti alloy at a relatively low pressure (3-10 kbar), as indicated by electron micrographs.

Simakov, G. V., M. A. Podurets, and R. F. Trunin. New data on compressibility of oxides and fluorides and a hypothesis of Earth's homogeneous composition. DAN SSSR, v. 211, no. 6, 1973, 1330-1332.

New experimental data on shock compressibility of natural cassiterite (SnO_2) and synthetic barium fluoride (BaF_2) single crystals are presented in comparison with earlier data on rutile (TiO_2) and fluorite (CaF_2) obtained by Al'tshuler and the authors (October, 1973 Report, p. 59). Study of materials with rutile-type crystal structure is of special interest to the controversial problem of composition of the Earth's core.

The experimental data are plotted in a density ρ - pressure P (up to $\sim$3.5 Mbar) coordinate system. Qualitatively all compression curves thus obtained are similar, and reflect the $TiO_2 \rightarrow CaF_2 \rightarrow MgCu_2$ phase transitions. The cited data give sufficient support to the probability of transformation of stipoverite, the most dense (ρ_o = 4.28 g/cm^3) rutile-like SiO_2 modification, into an even denser structure ($\rho_o \approx$ 10 g/cm^3) under P-T conditions prevalent in the lower mantle of the Earth. Thus a real possibility exists of interpreting chemical composition of the Earth's core on the basis of the Ramsey hypothesis for phase transformations. In summary, the new data allow taking in consideration the model of a chemically homogeneous planet along with the presently more widely accepted hypothesis of iron-nickel composition of the core.

Gural'nik, E. Kh., L. Yu. Maksimov, G. G. Mukhin, and V. Ye. Slobtsov. Increase in plasticity of molybdenum after hydrostatic compression. FiKhOM, no. 4, 1973, 89-92.

Hydrostatic extrusion of brittle molybdenum rods with 0.12% C was studied, to verify an earlier reported increase in plasticity of metals from the effect of high pressure and the resulting feasibility of cold working brittle metals under high pressure. Hydrostatic compression to 16 kbar was carried out at room temperature to 74-82% reduction. The tabulated and plotted mechanical characteristics of the Mo test specimens before and after compression show, as expected, an increase in strength, hardness, and plasticity, even with 82% reduction.

Micrographs of the hydrostatically compressed Mo specimens revealed breakdown of carbide particles originally located along the grain boundaries, and their re-orientation parallel to the direction of metal flow. This breakdown of brittle boundary interlayers of carbide phase is considered to be the main factor in plasticity increase. Simultaneously, brittle molybdenum can be hydrostatically formed without fracture. Voids observed in the vicinity of carbide particles can be considered as the first step of a fracture process; the solid carbide phase particles are the sites of the microvoids generation during compression.

Kositsyn, V. P., T. M. Platova, and I. Ye. Khorev. Phase transitions in low-carbon steel at high pressures. FiKhOM, no. 4, 1973, 143-146.

Phase transitions from high-speed impact loading of low-carbon steel were studied by micrographic analysis, with reference to the known pressure-temperature phase diagram of Armco iron. Micrographs are shown of the target area in the vicinity of a crater from the impact of a metallic plate at ~2000 m/sec. The P-T phase diagram (up to 150 kbar and 2,000° C) shows two possible phase transitions from impact loading: the high-temperature α- Fe (b.c.c.) $\rightleftarrows$ γ- Fe (f.c.c.) transition above the triple point, and the low-temperature α- Fe (b.c.c.) $\rightleftarrows$ ϵ- Fe (h.c.p.) transition below that point.

Analysis of the micrographs confirmed that the $\alpha \rightleftarrows \gamma$ phase transition occurs in the surface area of the striker contact with the target and below that surface, at the sites of localized plastic deformation of the slip band type. The $\alpha \rightleftarrows \epsilon$ phase transition may occur, if a rapid cooling of the near-crater area is supplied. The presence of a recrystallized structure in the surface area of the striker contact with the target is an indirect confirmation of a high temperature produced in that area by the high-speed impact of a solid.

Shekhter, B. I., and L. A. Shushko. Shock adiabats of some plastic laminates. FGiV, no. 4, 1973, 599-601.

Experimental shock adiabats are plotted for PT textolite KAST-V fiber glass laminate and type A asbestos-textolite laminate. Composition and characteristics of the materials are tabulated. Compressibility was

determined during shock wave propagation across the lamina. Propagation rate u was measured with an rms error of 40-50 m/sec. Based on the experimental p-u points, p can be approximated by

$$p = A(\sigma^n - 1), \tag{1}$$

where p is the pressure at the shock wave front, A and n are constants determined from the experimental data in the p = 15-300 kbar range, and σ is the ratio of material density in the shock wave to its initial density.

Shock adiabats thus obtained deviate from the experimental shock adiabats obtained by Andreyev et al (FGiV, v. 7, 1971, p. 3) by as much as 50%. The theoretical shock adiabats of the cited phenolic plastic laminates, which were calculated on the basis of their composition and additivity of component compressibilities, differ from experimental values by a maximum 6-10%. This good agreement between the author's experimental data and theory confirms their reliability, as well as the error of the experimental method used by Andreyev et al.

Demchenko, N. S. Baking dispersed oxide compositions for high-temperature protective coatings. Poroshkovaya metallurgiya, no. 7, 1973, 18-21.

Kinetics of high-temperature (500-950° C) sintering of dispersed oxide composites with activating oxide additives are studied experimentally to develop gas-tight dense diffusion coatings on metals. The compositions studied were of SiO_2 with alkaline earths; ZnO; BeO; and MoO_3 or $SiO_2 + B_2O_3$ with alkaline earths, ZnO, and BeO or transition metal oxides in given proportions. The additives were surface-active oxides or fillers, e.g., Al_2O_3, Cr_2O_3, TiO_2, MgO, CaO. High-temperature

densification process was monitored continuously by differential resistance and dilatometric techniques.

It is shown that the surface-active additives are effective in the initial stage of sintering, particularly if the sintered material is humidified before forming. At elevated temperatures, the additives which form eutectics with powder grains accelerate densification by surface diffusion. The curve of temperature of the effective sintering initiation versus the Me-O bond electronegativity ($\chi_{Me} - \chi_O$) of an additive exhibits a peak. The efficiency of an additive decreases with increase in its content; the optimum effect is observed with 3-5% additive.

Levitskiy, V. A., N. N. Shevchenko, Yu. Khekimov, and Ya. I. Gerasimov. Studying interactions of strontium oxide and strontium tungstate with zirconium at high temperatures in hydrogen or in vacuum. DAN SSSR, v. 211, no. 4, 1973, 916-919.

Experimental data are given on the high-temperature reactions of SrO and Sr_3WO_6 with Zr which is used as the activator of thermionic emission from the alkaline earth and alkaline earth metal tungstate cathodes. The reactions were studied of SrO with Zr in vacuum at 1,100° C, Sr_3WO_3 with Zr in vacuum at 1,000-1,800° C and Sr_3WO_3 with Zr in a hydrogen flow at 1,100-1,600° C. Most of the compacted mixtures were held for 2-3 hours at the specified temperature. In a few experiments, reaction time in vacuum was extended up to 300 h to study intermediate reaction products.

The tabulated x-ray diffraction and thermodynamic data show that the solid end-products of all Sr_3WO_6 + Zr reactions studied are $SrZr_3O$

and W in varying ratios, depending on the Zr amount in the initial mixture. The solid end-product of the SrO + Zr reactions is $SrZrO_3$. In addition, liquid Sr inequilibrium with Sr vapors is formed by reduction of SrO or Sr_3WO_6. At the lower temperatures, intermediate reaction products are Sr_2ZrO_4, Sr_2WO_5, and ZrO_2. The amount of these products decreases as the reaction time and temperature are increased. Finally, the Sr_3WO_6 + Zr reaction is accelerated significantly in a dry hydrogen stream.

Kozlov, L. F., and V. G. Mizyuk. Approximate integration of the equations of a laminar boundary layer on a porous heat-insulated surface in a compressible gas with suction. IN: Gidromekhanika. Resp. mezhved. sb., no. 23, 1973, 26-40. (RZhMekh, 8/73, no. 8B613). (Translation)

Compressible gas flow around a porous heat-insulated surface with suction is described by a unified set of three Loytsyanskiy momentum equations. Solution of the set is given. The case of a plate is analyzed in detail. Solutions obtained for particular cases are compared with exact solutions.

Yurevich, F. B., and V. M. Kaptsevich. A nonstationary method of separating radiative and convective components of a heat flux during a complex heat exchange. IAN B, seriya fiz.-energ. navuk, no. 1, 1973, 84-85. (RZhMekh, 8/73, no. 8B616).

A theoretical basis is developed for a new method of separately determining the radiative component q_R of the total heat flux under conditions

of a high-intensity heating by radiation and convection. Such a problem arises in some [unspecified] new technological fields. Basically, the new method consists in jointly solving the heat equation and the equation of nonstationary heat flow for two infinite plates with given emissivities ϵ_1 and ϵ_2 and coefficients λ_1 and λ_2 of thermal conductivity. Thus an expression for $(\partial T / \partial x)_{x=0}$ is derived, then q_R is expressed as a function of $(\partial T_1 / \partial x)_{x=0}$, $(\partial T_2 / \partial x)_{x=0}$, ϵ_1, ϵ_2, λ_1, and λ_2. Experimentally, q_R can be determined by approximating an infinite plate and recording the time dependence of temperature on the front and back surfaces of the plate.

Petrak, D. Numerical computation of convective heat exchange between spherical particles and gas flow. IN: Sb. Teplo-i massoperenos, v. 9, pt. 2, Minsk, 1972, 27-44. (RZhMekh, 8/73, no. 8B623). (Translation).

A joint numerical solution is presented of the Rantz-Marshall equation for convective heat exchange with the equation of particle motion. A specific example illustrates detailed computation of the solution. It is shown that the suggested numerical method can be applied also to the heat exchange problem in u eady-state flow around a body.

Poluboyarinov, D. N., A. S. Metushevskiy, D. M. Karpinos, V. M. Groshevch, Ye. P. Mikhashchuk, and A. S. Vlasov. A refractory material. Author's certificate, USSR, no. 357183, published January 25, 1973. (RZhKh, 15/73, no. 15M40 P). (Translation).

A method is introduced for preparing magnesia-base heat-resistant refractories from a mixture of (% by weight) 80-85 MgO and 15-20 MgO crystal whiskers. A finely-dispersed MgO powder

is mixed with MgO crystal whiskers in the required ratio. The mixture thus obtained is hot-molded in graphite compression molds for 20 min. at 1600° under 150 kg/cm^2 pressure, then cooled with the compression mold. Characteristics of the finished products are: 8.7% porosity. 1,200 kg/cm^2 bending strength, and heat endurance of over 50 cycles from 20 to 1000° in air.

Gulayev, V. M., K. I. Ryabtsev, V. S. Bakunov et al. Strength and deformation characteristics of quartz glass. Steklo i keramika, no. 6, 1973, 14-16.

An experimental determination is described of the bending strain characteristics, static elastic modulus E, and bending strength σ_b of high-purity, fused, transparent quartz glass within a 20 to 1400° C temperature range. The cited characteristics are of special importance to the use of quartz glass as a high-temperature (1000-1200° C) structural material.

Bending tests were carried out in vacuum using four different procedures. The experimental strain-temperature curves at three different loads; creep rate $\dot{\epsilon}$ - temperature curves at a constant load and $\dot{\epsilon}$ - stress curves at 1,300° C; strain-stress curves at different temperatures, E- and σ_b - temperature curves, are given. Creep rate $\dot{\epsilon}$ is described adequately by a semi-empirical expression. It is shown that irreversible deformation under load sets in above 800° C. Temperature dependence patterns of E and σ_b at 1,000° C is explained by stress relaxation at the onset of plastic deformation. At 1,100° C σ_b decreases, as deformation rate becomes significant. Hence, the cohesive strength of quartz glass must decrease above 900° C; the cited increase is related to stress relaxation at the onset of irreversible high-temperature deformation.

Gerasimov, Ya. I., I. A. Vasil'yeva, Zh. V. Granovskaya, and A. F. Mayorova. Thermodynamic properties of nonstoichiometric zirconium dioxide in the 1173-1373° K temperature interval. DAN SSSR, v. 210, no. 6, 1973, 1347-1349.

The partial thermodynamic functions ΔG_{02}, ΔH_{02}, and $-\Delta S_{02}$ of monoclinic ZrO_{2-x} were determined in the 1173-1373° K range, using an emf method with a solid electrolyte. Temperature dependence of emf of the cell

$$-Pt,\ ZrO_{2-x}|O^{2-}|Fe,\ Fe_{0.95}O,\ Pt, \qquad (1)$$

where x = 0.003-0.012, was measured to an accuracy of ±1.5 mV. Preparation and chemical analysis of the ZrO_{2-x} samples are described. The statistical error of x determination was $\pm 1 \times 10^{-3}$. The $\Delta G_{el.} = \Delta G_{el}(T)$ dependence was derived from the experimental emf data. The $\Delta G_{02} = \Delta G_{02}(T)$ dependences thus calculated, the ΔG_{02} values at T_{min}, T, and T_{max}, and the ΔH_{02} and ΔS_{02} values at T are tabulated for six x values. It is shown that ΔH_{02} and ΔS_{02} decrease sharply, when deviation from stoichiometry of ZrO_2 is increased. This composition dependence of ΔH_{02} and ΔS_{02} can be interpreted in different ways in terms of defect structure of nonstoichiometric zirconia.

Nikolayeva, V. A., G. M. Kafarova, A. I. Rekov, Yu. I. Pugachev, V. N. Veretennikov, and Yu. P. Solodov. A method of obtaining tantalum carbide coatings. Author's certificate, USSR, no. 387047, submitted March 19, 1970. (Otkr izobr, 27/73, p. 83).

A method of obtaining tantalum carbide coatings on graphite parts by heating them in a charge of tantalum oxide in an inert atmosphere

is described. The method is distinguished by the fact that to increase the thickness of the coatings with simultaneous decrease of the process temperature, the articles are preheated to 800° C for 20-30 min, then to 1400° C for not less than 1 hour, with dwelling at this temperature for 1.5-2 hours, then subsequent heating to 1500° C for 20-40 min and dwelling at this temperature for 0.5-1.5 hours.

Polezhayev, Yu. V., and V. V. Gorskiy. Heat and mass transfer on the surface of glassy material in a high-temperature gas flow. IN: Sbornik. Teplo-i massoperenos, v. 9, part 2. Minsk, 1972, 261-266. (RZhMekh, 6/73, no. 6B756) (Translation).

The results of numerical calculations of the effective enthalpy of glass and of glass-graphite material near the critical zone of a blunt body during laminar and turbulent boundary layer states are presented. It is shown that when the thermal conductivity of molten glass decreases and its viscosity increases, the effective enthalpy increases. It follows from the given data that the current level of knowledge of the thermal physical characteristics of molten glass permits calculation of its effective enthalpy within an error of ±35%. The effective enthalpy of homogeneous glass is weakly dependent on the composition of the gas in the incident flow. However, if the material contains free carbon, mass transfer depends considerably on the composition of the gas. Calculations carried out for glass-graphite plastic showed that, as the oxygen content in the incident flow increases, the effective enthalpy decreases considerably due to a decrease of the degree of silicon dioxide dissociation. Deviation from this rule was observed only at relatively small values of enthalpy of gas deceleration, when the thermal effect of chemical reactions occurring on the surface also had an appreciable effect on the effective enthalpy of the material.

Likharev, K. K. Nonlinear properties of granular superconducting films. FTT, no. 8, 1973, 2524-2527.

Static current-voltage (I-V) and other nonlinear characteristics of granular superconducting thin films, e.g., tin, with a constant current I applied to the film, are calculated. A microbridge model of high-impedance film with weak superconducting links between grains is used. Formulas are derived for voltage V_N across a microbridge segment with $N \geq 1$ weak links, the critical current density $W(I_o)$ through a weak link, and the characteristic current I_r through the grains. It was assumed that grains are hemispheric, temperature is near T_c, and coherence distance and penetration depth are not too great.

The calculated I-V_N characteristic, I_r value, SHF impedance R_ω and third harmonic voltage $V_{3\omega}$ versus SHF current I_ω through a microbridge are found to be in good agreement with the experimental data of Bertin and Rose (. Appl. Phys., v. 42, 1971, 631). The observed low inertia of the I-V characteristic vs. the SHF field is particularly well explained in the framework of the described model as the result of Josephson current generation in the weak links between grains.

Alekseyevskiy, N. Ye., N. V. Ageyev, and V. F. Shamray. Effect of mechanical deformations on superconducting properties of an Nb_3Al-Nb_3Ge alloy system. DAN SSSR, v. 211, no. 2, 1973, 322-324.

The effects are studied of hydrostatic compression up to 100 kbar. and uniaxial compression to fracture, on temperature of the superconducting transition T_c and phase composition of cast $Nb_{12}Al_3Ge$ specimens. This

composition exhibits a maximum T_c of 18-19° K on the T_c versus composition curve. Experiments with hydrostatic compression to 6 kbar revealed a very small reversible shift toward lower T_c on the transition curve T_c versus Δ/Δ_t, but a strong broadening of the curve with irreversible shifting toward lower T_c at pressures over 100 kbar. The effect of ~100 kbar pressure is believed to result from decomposition of $Nb_{12}Al_3Ge$.

An x-ray structural analysis of the specimen under 100 kbar pressure indicated the presence of Nb-base and Nb_2Al-base solid solutions. Uniaxial compression to fracture (at 20 t/cm^2 pressure) of the cast specimen, and the powder obtained by grinding the specimen, had a similar effect on the T_c curve. Substructure analysis indicated a reduction in size of mosaic blocks and a small increase in lattice constant by uniaxial compression to fracture. Apparently these changes in the substructure are the cause of decrease in T_c and broadening of the transition curve.

Bertel', I., K.-Kh. Bertel', K. Fisher, R. Gebel', et al. Superconductivity and electron structure of ultra-pure niobium. Part 1. Obtaining ultra-pure niobium. FMiM, v. 35, no. 5, 1973, 921-931.

A detailed description is given of the preparation procedure of ultrahigh purity niobium single crystals for use in the subsequent study of superconductivity and electron structure of Nb. This later study was made at the Institute of Physical Problems, AS USSR and the Central Institute of solid state physics, [East] German Academy of Sciences. The study was undertaken because of a discrepancy between the theory of type II superconductors and experimental data on Nb.

The described procedure consists of the following steps; preparation of ultrahigh purity Nb_2O_5 by solvent extraction of substitutional impurities (Ta, Zr, Mo, W, Fe) from purified Nb_2O_5; chlorination-reduction of ultrahigh purity Nb_2O_5; vacuum thermal decomposition of $NbCl_5$ to polycrystalline Nb rod; electron beam zone refining of Nb rods in high vacuum to obtain purified Nb single crystals in the form of cylinders or ellipsoids of revolution annealing the single crystals first at 2,000° C in an oxygen stream at $p_{O2} = 5 \times 10^{-5}$ torr, then at 2,300° C for 30 hours in ultrahigh vacuum (end pressure = 10^{-10} torr). The substitutional impurity content was determined by chemical analysis of the product after each operation. The interstitial impurities content (C, N, O) was evaluated from the measured residual resistance ratio $r_o = R_o/R_{300° K} = 1/\alpha$ of Nb with an impurity addition. The data show that the best Nb single crystals obtained had $\alpha = 10^5$. The estimated maximum contents of the interstitial and substitutional atoms were 0.4 and 2.5 ppm, respectively, i.e., within the required limits.

Vasenko, S. A. Detecting electromagnetic radiation by superconducting point contacts. RiE, no. 8, 1973, 1694-1697.

The problem of electromagnetic radiation detection by a superconducting point contact is analyzed, on the assumption that the contact satisfies the conditions imposed by the Aslamazov-Larkin theory. The vertical current step of the current-potential curve at the potential $V = h\omega/2e$, where ω is the frequency of applied monochromatic radiation, is used to detect radiation. A strong diffusion of the step caused by fluctuations of the normal current component is accounted for in calculations of the critical Josephson current T_c and the maximum potential difference $V_2 - V_1 = \Delta V$ across the contact in the presence and in the absence of a weak monochromatic radiation with $\omega > \omega_o \quad 2eI_cR/t_v$. In this case, ΔV is expressed as a function of ω and power $P(\omega)$ of applied monochromatic radiation.

It is shown that power equivalent P_{en} of the noise in the far infrared spectral region, e.g., $\lambda = 600\,\mu$, significantly exceeds the threshold sensitivity of known detectors. A formula is also derived for response $\Delta V(J)$ of the point contact to a nonmonochromatic radiation. The $\Delta V(J)$ can be calculated, if $P(\omega)$ is known. In summary, the possibility of estimating P_{en} in the far infrared region from the derived formula suggests the feasibility of a high sensitivity detector based on nonstationary Josephson effect.

Likharev, K. K., and V. K. Semenov. Effect of fluctuations on the SHF impedance of superconducting point contacts. RiE, no. 8, 1973, 1757-1759.

The effects of intrinsic noise and external induction noise on the impedance Z of a superconducting point contact are analyzed in the framework of Aslamazov-Larkin theory. In the case of thermal intrinsic noise I_f and a small SHF pump signal at frequency ω, Z is expressed through the distribution functions σ, σ' of the phase $\theta = \varphi - \pi/2$, where φ is the phase difference at the contact. In the case of an external low-frequency induction noise, Z is the average weighted value of Z in the absence of noise. The calculated maximum differential resistance $Rd_{max}/R-1$ of the contact and the corresponding time averaged voltage V across the contact are plotted for both noise types. It is shown that the singularity of Z is smeared by noise at generation frequencies equal to zero or the signal frequency. Thus the frequency region in which the contact exhibits a negative resistance shrinks from the effect of fluctuations. There exist optimum frequencies $\Omega = \omega/\omega_o = 1$ and 1.5 at which the effect of the external and intrinsic fluctuations, respectively, is minimum, where ω_o is the critical Josephson frequency. At small $I_f = I_o$, Re(Z) attains extreme values at a frequency differing by about one line width from Josephson generation frequency.

Serdyuk, A. D. and I. I. Fal'ko. Spin-lattice relaxation of a two-band superconductor, taking into account the interband scattering of electrons by phonons. FMiM, v. 36, no. 2, 1973, 427-429.

The effect is analyzed of interband scattering of conduction electrons by phonons on the time of spin-lattice relaxation in superconductors having large or small concentration of nonmagnetic impurities. At temperatures $T < T_c$, the T_c/T dependence of the relaxation rate ratio R_s/R_n in superconducting and normal states is described in a good approximation by the sum of two exponential functions. Thus, the plot of log (R_s/R_n) versus T_c/T exhibits a discontinuity. The R_s/R_n ratio is calculated from the expression of reciprocal relaxation time $1/\tau$, in which the term BT^3 accounts for interband electron scattering. In these calculations it was assumed that $\Delta_1 \geq \Delta_2$.

Analysis indicates that at a small impurity concentration $(1/\tau\Delta \leq 1)$, the log $(R_s/R_n) = f(T_c/T)$ curve is similar in shape to that of a pure superconductor, if the parameters Δ_1^* and Δ_2^* are substituted for Δ_1 and Δ_2. Only the slope of the curve segment associated with Δ_1 is steeper, when the BT^3 term is introduced. In the case of large impurity concentration $(1/\tau\Delta \geq 1)$, the discontinuity characteristic of a two-band structure disappears and the slope of the $\log(R_s/R_n) = f(T_c/T)$ curve is determined by the $1/2(\Delta_1 + \Delta_2)$ term.

Abrikosov, A. A., and V. M. Genkin. The theory of optical Raman scattering in superconductors. ZhETF, v. 65, no. 2, 1973, 842-847.

The problem is discussed of calculating the amplitude of optical Raman effect in superconductors, more accurately than was done by

Abrikosov and Fal'kovskiy (ZhETF, v. 40, 1961, 262) on the basis of the simplest electron model of a neutral isotropic Fermi gas. Modifications are introduced to the original theory of Raman scattering. These resulted from taking into account simultaneously the effects of metal anisotropy and shielded Coulomb interactions between electrons. Accordingly, the original function of the transmitted frequency $f(q_o)$ is reformulated with allowance for anisotropy and Coulomb interactions.

Analysis of the new formula for $f(q_o)$ indicates a fairly sharp rise of scattering amplitude near the absorption threshold in spite of some diffusion due to anisotropy. Anisotropy-induced variations in probability of Raman scattering are evaluated in relation to the Fermi surface-Brillouin zone intersection. It is shown that the probability will decrease by a 10^{-3} - 10^{-4} factor, or increase several times relative to the previously obtained value for an isotropic model, depending on the polarization direction of the scattered light.

Osipov, K. A., A. F. Orlov, T. L. Borovich, A. K. Milay, and L. S. Sobiyeva. Superconductivity in films of niobium mixtures with aluminum oxide. FMiM, v. 35, no. 5, 1973, 1174-1178.

T_c of the superconducting transition, resistances R_r and R_N at room temperature and a temperature just above T_c, and critical current j_c in a 0-40 Oe magnetic field were measured in hard superconductor films obtained by simultaneous high-vacuum deposition of Nb and alumina in varied proportions. The plotted experimental data show that at low Al_2O_3 concentrations, T_c and ρ_r/ρ_N are much lower than in pure Nb films of the same thickness. T_c remains at this low level and ρ_r/ρ_N even increases in films with up to 5 at% Al_2O_3; films with up to ~20 at % Al_2O_3 are superconducting. The T_c of the films is believed to depend on grain size of their metallic component,

which decreases with increase in dielectric content. Destruction of superconductivity is therefore correlated with the minimum grain size. The critical field value H_{c2} and current-carrying capacity of the films in a magnetic field at 4.2° K are maximum at an optimum oxide concentration of 8-10 at %. Analysis of $j_c(H)$ variations suggests that a mixed state sets up in a magnetic field and vortices in a magnetic flux are pinned down rigidly by dispersed oxide inclusions within the cited range of H.

Sirota, N. N., and A. K. Fedotov. Electric conductivity and superconductivity of vanadium-niobium-chromium solid solutions. DAN BSSR, no. 7, 1973, 613-616.

Results are presented of resistivity ρ measurements of pure V and Nb metals, their binary alloys, and ternary V-Nb-10 at % Cr solid solutions in the 2-350° K range. The measurements were done to evaluate superconductivity parameters from high-temperature electric conductivity data of the alloys in their normal state. The experimental plots show three distinct temperature dependence regions: quadratic $\rho(T^2)$ from 10-15° K to $T_q^{max} > 50\text{-}60°$ K; intermediate, from T_q^{max} to $T_{lin}^{min} = 190\text{-}260°$ K; and linear $\rho(T)$ at $T > T_{lin}^{min}$. The $\rho(T)$ plot in the intermediate region features a slight curvature. The T dependence of the relative temperature coefficient $\alpha = (1/\rho_{300})(d\rho/dT)$ is rectilinear at $T < T_q^{max}$, exhibits a peak in the $T_q^{max} - T_{lin.}^{min}$. The T_q^{max} and T_{lin}^{min} vary with composition of the alloys.

The observed $\rho(T)$ regions are in agreement with theory. The linear $\rho(T)$ dependence data and BCS theoretical formula for T_c are used to correlate superconductivity parameters T_c and λ with ρ of the alloys at $T > T_{lin}^{min}$. This correlation agrees well with the experimental T_c for dilute V-Cr and Nb-Cr alloys, but not for concentrated V-Nb and V-N-10 at % Cr alloys.

Galitskiy, V. M., V. F. Yelesin, and Yu. V. Kopayev. Possibility of high temperature superconductivity in nonequilibrium systems with repulsion. ZhETF P, v. 18, no. 1, 1973, 50-53.

The possibility is analyzed of obtaining a high transition temperature in nonequilibrium systems with repulsive interaction between electrons ($g > 0$) from the effect of a strong electromagnetic field ϵ. A dielectric gap $\lambda = d_{cv}\epsilon$, where d_{cv} is the dipole moment of interband transition is made possible by application of ϵ. It is shown that electron quasiparticles in a metal can transit through the gap λ from a state below the Fermi level to a state above λ on account of multiphonon processes, but only if $2\lambda \geq \omega_F$, the frequency on the order of Debye frequency. In this case, besides the trivial solution with superconducting gap $\Delta = 0$, the solution with $\Delta = \Delta_o^2 - \lambda^2$, where $\lambda \to 0$, becomes possible. This new solution with gap Δ_o such that $2\Delta_o > \omega_F$, in a nonequilibrium state in the presence of ϵ, is self sustaining in the sense that the gap promotes electron distribution inversion which in turn sustains the gap. The possibility of quasiparticle transition through the gap owing to interaction between electrons is noted. The response of the system to an applied weak field is also calculated for a constant as well as an alternating magnetic field.

Vodop'yanov, F. A., and Yu. F. Tagintsev. A superconducting synchrotron with a mechanically shifting time-independent magnetic field. IN: Tr. Radiotekhn. in-ta. AN SSSR, no. 11, 1972, 111-120. (RZhElektr, 9/73, no. 9A279). (Translation).

A superconducting circular accelerator is examined whose magnetic system consists of constant field magnets mechanically counter

Galitskiy, V. M., V. F. Yelesin, and Yu. V. Kopayev. Possibility of high temperature superconductivity in nonequilibrium systems with repulsion. ZhETF P, v. 18, no. 1, 1973, 50-53.

The possibility is analyzed of obtaining a high transition temperature in nonequilibrium systems with repulsive interaction between electrons ($g > 0$) from the effect of a strong electromagnetic field ϵ. A dielectric gap $\lambda = d_{cv}\epsilon$, where d_{cv} is the dipole moment of interband transition is made possible by application of ϵ. It is shown that electron quasiparticles in a metal can transit through the gap λ from a state below the Fermi level to a state above λ on account of multiphonon processes, but only if $2\lambda \geq \omega_F$, the frequency on the order of Debye frequency. In this case, besides the trivial solution with superconducting gap $\Delta = 0$, the solution with $\Delta = \Delta_o^2 - \lambda^2$, where $\lambda \rightarrow 0$, becomes possible. This new solution with gap Δ_o such that $2\Delta_o > \omega_F$, in a nonequilibrium state in the presence of ϵ, is self sustaining in the sense that the gap promotes electron distribution inversion which in turn sustains the gap. The possibility of quasiparticle transition through the gap owing to interaction between electrons is noted. The response of the system to an applied weak field is also calculated for a constant as well as an alternating magnetic field.

Vodop'yanov, F. A., and Yu. F. Tagintsev. A superconducting synchrotron with a mechanically shifting time-independent magnetic field. IN: Tr. Radiotekhn. in-ta. AN SSSR, no. 11, 1972, 111-120. (RZhElektr, 9/73, no. 9A279). (Translation).

A superconducting circular accelerator is examined whose magnetic system consists of constant field magnets mechanically counter

shifting in the process of charged particle acceleration. Tolerance in magnet shift, magnitude of the field, and the field gradient are determined. The neces: ry law of radial variations in the magnetic field is established. The conductor configuration suitable to form a given field is found. Resonance excitation of the mechanical magnets is analyzed.

Troitskiy, A. M. Optimizing the winding geometry of a superconducting inductive energy storage device. IN: ibid., 138-141. (RZhElektr, 9/73, no. 9A272). (Translation)

A method is described for determining the parameters of a toroidal inductive energy storage device with a minimum-weight superconducting coil for a given stored energy. Calculations are made on the assumption that coil thickness is small relative to the radius, and that the critical characteristic of the coil is linear.

Tagintsev, Yu. F. An experimental superconducting quadrupole lens with 1 kg/cm magnetic field gradient and a 65 mm aperture. IN: ibid., 142-147. (RZh Elektr, 9/73, no. 9A273). (Translation).

An experimental quadrupole lens is described with a coil made of Nb-Ti cable. The lens is designed to generate a 1 kg/cm field gradient. Diameter of the lens aperture is 65 mm, its O.D. is 160 mm, length = 210 mm, and weight $\tilde{=}$ 8.5 kg.

Babenko, B. F., F. A. Vodop'yanov, Yu. F. Dushin, et al. A 900 Mev superconducting isochronous cyclotron. IN: ibid., 90-99. (RZhElektr, 9/73, no. 9A278). (Translation)

The possibility was explored of using a ~900 Mev isochronous proton cyclotron with superconducting coils as injector for a 18 Gev booster synchrotron with a 40 cps acceleration cycle rate and 2.5×10^{12} particles output.

Litvinov, V. N. Superconducting accelerating resonators with variable frequency tuning. IN: ibid., 148-156. (RZhElektr, 9/73, no. 9A274). (Translation).

The location and method of connecting a superconducting rotating capacitor are examined to decrease the amount of stored electrical energy and the peak voltage across the capacitor. The capacitor is intended to achieve tuning of an accelerating resonator of a proton synchrotron accurate to $\Delta f/f \sim 10^{-3}$. A small ferrite modulator with $\sim 10^{-3}$ modulation index is introduced for a more accurate tuning. The minimum Q of the resonator is then 10^5. Selection is made of the number of accelerating resonators to minimize power supply demand.

Burshteyn, L. M., and V. A. Rabinovich.
The equation of state of liquid parahydrogen.
IAN B, Seriya fizika-energeticheskikh navuk,
no. 3, 1973, 74-82.

A method for composing a simple equation of state for liquid parahydrogen is introduced to describe thermodynamic properties of the liquid and phase equilibrium states. Establishment of a new equation of state was necessary because of the inadequacy of known equations for potential application in space technology. The consecutive mathematical operations described are: derivation of a general equation of state of a liquid or gas from the known thermodynamic relation; and determination of the three functional terms of this equation in explicit form using known experimental C_V, P, ρ, and T data for liquid parahydrogen, in that order. The resulting equation of state is presented in the form

$$P = f_0 + f_1\rho + f_2\rho^2 + f_3\rho^3 + f_4\rho^5, \qquad (1),$$

$$f_0 = -392{,}7123 + 14{,}5445\,T,$$
$$f_1 = 39177{,}9 - 1400{,}74\,T,$$
$$f_2 = -128{,}5185\cdot 10^1 + 2{,}4444\cdot 10^1 T + 23{,}1888\cdot 10^1 T(\ln T - 1) - 2{,}76899\cdot 10^1 T(\ln T)^2,$$
$$f_3 = 559{,}2701\cdot 10^1 - 42{,}8603\cdot 10^1 T(\ln T - 1) + 52{,}09466\cdot 10^1 T(\ln T)^2,$$
$$f_4 = 4{,}794669\cdot 10^9.$$

where f_{0-4} are expressed as functions of T containing 12 constants. The comparative tables and plots of ρ, C_p, C_V, and sound velocity W data show that equation (1) accurately describes various experimental thermodynamic data within the 13.8-33° K range of T, 30-46 g-mol/m^3 range of ρ, and 0.07-400 atm range of P. The mean relative and maximum errors of the ρ, C_p, C_V, and W data calculation from (1) are given.

Buturlakina, N. F., and A. I. Pavlov. Low-temperature mechanical properties of polymer films after processing by explosion. IN: Tr. Volgogr. politekhn. in-ta, no. 4, 1972, 119-128. (RZhMekh, 5/73, no. 5V1336). (Translation)

Mechanical characteristics of poly (tetrafluoroethylene) specimens were determined at (-) 196°. The effect was studied of an explosion-generated high pressure P on sealing microcracks in the specimens. The artificial cracks were produced by uniaxial stretching of the film specimens to different degrees at room temperature. P was varied by selecting the type of explosive and was calculated from the shock adiabat. In a specimen with an open crack, the elastic modulus increases very sharply and ultimate strength increases significantly with increase in P from explosion to about 50 kbar. At the maximum 80 kbar pressure attained in the experiments, a significant local overheating and consequent destruction of poly(tetrafluoroethylene) resulted from plastic deformation of the material adjacent to a crack. Sealing of large cracks created by deformation before fracture can be achieved at a lower P without destruction; the larger the crack, the lower P must be. About 20 kbar is sufficient to seal an internal crack in poly(tetrafluoroethylene). Increasing the stretch to 80% causes an increase in ultimate strength and elastic modulus of the film, because of the increased number of cracks sealed by shock treatment.

Uglov, A. A. Seminar on "Physics and chemistry of materials treatment by concentrated energy beams". FiKhOM, no. 3, 1973, 158-159.

This is a summary of five papers presented on December 7, 1972 at the 37th regular seminar held at the Baykov Institute of Metallurgy

with Academician N. N. Rykalin presiding. The seminar was mainly devoted to theoretical problems of heat physics. Over 80 people representing organizations from Moscow and other Soviet cities participated in the proceedings.

Theoretical papers dealt with solution to the problems of heat conduction, heat transfer (Stefan problem), calculations of temperature fields in welding of cylindrical shells of two different metals, and of temperature distribution in welding with deep melting. The only experimental research paper was presented by V. I. Rakhovskiy (Moscow) on the subject of the constrained discharge regions in the vicinity of electrodes. Rakhovskiy reported studies on cathodic spots using a unique experimental arrangement with an image converter. Two types of cathodic spots were detected: a fast moving type with current density $\sim 10^3$ a/cm^2, and a quasistationary type with current density in the 10^3-10^5 a/cm^2 range. The effect of the first type spot is to promote formation of small craters, that of the second type is to erode bulk material.

Fialkov, A. S., and V. D. Chekanova. A polymeric graphite carbon material: glassy carbon. Plasticheskiye massy, no. 6, 1973, 65-66.

Preparation, properties, pore structure and applications of glassy carbon are reviewed. Electrical, thermal, and other physical properties and mechanical characteristics are tabulated for types SU12, SU20, and SU30, which are designed to withstand 1200, 2000, and 3000° C, respectively, in an inert or reducing media or in vacuum. The chemical stability of glassy carbon in extremely aggressive media is emphasized with respect to its use

as material for equipment and laboratory ware. Experimental data are cited in support of using glassy carbon electrodes in various molten salt mixtures, as a substitute for more expensive materials, such as platinum, titanium or molybdenum.

Gol'denfel'd, I. V., R. N. Bondarenko, and V. G. Golovatyy. Metallic whisker emitters with a developed surface. PTE, no. 3, 1973, 166-168.

An electrochemical procedure is described for preparing needle-form tungsten field emitters with a developed surface to be used in field ionization mass spectrometers. The procedure consists of electrolytic deposition of Zn, Cu, or Fe dendrites on a thin (12μ diam.) tungsten wire cathode. Optimized conditions of electrolysis are tabulated. Needle-form field emitters can be obtained with dendrites deposited either symmetrically in relation to the wire axis or on one side only, as shown by shadow and stereo photographs taken with optical and electron microscopes, respectively.

It is shown that the field emitters thus obtained exhibit high strength characteristics, particularly those with an Fe dendrite coating, and can be reconditioned at a high temperature. Mass spectra of various compounds illustrate the reliability of electrochemically-coated field emitters in field ionization of gases and vapors, and in field desorption of compounds, e.g., aminoacids deposited directly on the emitter.

B. Recent Selections

i. High Pressure Research

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ii. High Temperature Research

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vii. Miscellaneous

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Bobkova, M. V., N. I. Kozlova, S. S. Plotkin, et al. Properties of solid electrolytes and characteristics of silver iodide solid electrolytic elements. IN: Sb. Fiz., khim. i elektrolitov. Ch. 1. Sverdlovsk, 1973, 139 (RZhKh, 19ABV, 21/73, no. 21B1164)

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Denisov, I. P. Osnovy ispol'zovaniya vodnoy energii (Fundamentals of hydro energy use). 2nd ed. Izd-vo energiya, 33 p. (to be published 1st quarter of 1974). NK, 38/73, 13.

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Meliksetov, A. A. Wind engine. Author's certificate, USSR, no. 408049, published July 29, 1971. Otr izobr, no. 47, 1973, 115.

Morachevskiy, A. G., Ye. A. Mayorova, and M. A. Bykova. Thermodynamic properties of sodium solutions in liquid bismuth. Elektrokhimya, no. 11, 1973, 1647-1649.

Potapov, V. M. Ispol'zovaniye vodnoy energii (Use of hydro energy). Moskva, Izd-vo Kolos, 1972, 343 p. (LC-VKP)

Yushina, L. D., I. V. Kochergina, and S. V. Karpachev. Cathode materials for a low temperature galvanic element. IN: Sb. Fiz. khim. i elektro khim. rasplavl. soley i tverd. elektrolitov. Ch. 2. Sverdlovsk, 1973, 131-132. (RZhKh, 19ABV, 21/73, no. 21B1222)

7. Miscellaneous Interest

A. Abstracts

Leonov, G. S., and S. P. Khrameyeva. Investigating instabilities of an ultrahigh pressure short-arc discharge during current modulation. TVT, no. 3, 1973, 487-492.

Discharge instabilities which occur during current modulation in short-arc spherical gas-filled lamps were studied experimentally to determine the relationship between the acoustic resonance wavelength and the bulb diameter D. Previously different authors have related the discharge instability to acoustic resonance, but failed to define precisely or to justify this relationship.

Experiments are described in which arc deformation, i.e., instability, was observed visually in Xe lamps with D = 5-13 mm, the electrode gap ℓ = 0.3-2.4 mm, at 3-10 A discharge current I modulated from 0 to 100% at frequencies ν of 200 Hz to 200 kHz. The first six resonance ν_{1-6} at which arc deformation was observed were measured as functions of I, D, and ℓ and their ratio was determined. A theoretical analysis of the spherical and cylindrical lamp models gave ν_{1-6} ratios in satisfactory agreement with the experimental ν_{1-6} ratio. An equally good agreement between the temperature measured on the lamp surface and the theoretical bulb wall temperature led to the conclusion that the theoretical quantitative description of the unstable modulation frequencies was correct. The importance of this study was noted for its practical application to modulated light sources in optical communication devices.

Stakhanov, I. P. The nature of ball lightning. ZhTF, no. 3, 1973, 193-196.

The hypothesis that ball lightning forms during breakdown of the ordinary lightning channel in the presence of a large amount of water was investigated, to explain why ball lightning does not disappear as a result of recombination, despite its low temperature. The water molecules, having a large dipole moment, are attracted to the positive and negative ions, forming solvate shells around them. The distance between the ions and the dipole center is 2-2.5 Å and the binding energy of the water molecule and the ion is 1.4-0.9 eV. Calculations are given which define lightning stability criteria with respect to excitation of surface waves, and which specify the conditions required in order that the lightning have a spherical shape. This means that the density of the lightning material ρ should hardly differ from the surrounding air temperature ρ_o. It is concluded that during non-explosive breakdown, the lightning should disappear due to development of instability rather than due to lack of energy, by ejecting pieces of material.

Kuliyev, D. A. Wave impedance of a lightning channel. ZhTF, no. 6, 1973, 1233-1237.

The magnitude of wave impedance Z_o of the lightning channel section adjacent to the striking point is reevaluated, on the basis of the widely accepted theory of leader formation and numerous experimental data on velocity v of inverse discharge. Accordingly, Z_o is assumed to be a variable which depends on leader configuration, charge distribution in the leader channel, and v. The formula used to calculate Z_o is $Z_o = 1/vC$, where C is the capacitance of a conductor relative to ground and depends on the geometry of the conductor. It is noted that Z_o has its minimum value at

the onset of leader discharge inversion, then increases logarithmically. It is assumed that Z_o attains its maximum value (~2000-3000 ohm) after the entire leader channel is converted to the inverse discharge channel. The calculated plots of Z_o versus radius of the leader head and v illustrate variations of Z_o during various phases of the discharge for cylindrical and oblate spheroidal geometry of the leader, respectively. Calculations show that, similarly to Z_o, the resistivity of the highly ionized leader head-ground gap is insignificant during the first few microseconds of discharge. It follows that the resistance of grounding devices significantly affects formation of the wavefront of inverse discharge current.

Grishchuk, L. P., and M. V. Sazhin.
Emission of gravitational waves by an electromagnetic cavity. ZhETF, no. 2, 1973, 441-454.

The possibilities of gravitational wave emission under terrestrial conditions are considered for spherical and plane cavities. A qualitative formula is derived which yields the upper limit for the gravitational radiant flux from an arbitrary source with a small gravitational potential. The formula takes into account coherence of the source and "focusing" of its gravitational radiation. An electromagnetic cavity is considered as a specific emitter. It is shown that an emitter whose parameters seem to be quite reasonable from a technical viewpoint can create a gravitation energy flux of the order of 10^{-7} erg/cm^2. sec over an area of 1 cm^2 at a distance of 10^3 cm from the emitter. The possible parameters of the emitter are a superconducting resonance system with a total volume of about 10^9 cm^3 in which a standing wave 4 cm long exists, the mean energy density of the electromagnetic field being 10^{10} erg/cm^3.

Kopvillem, U. Kh. Generatsiya i priyem γ-kvantov i γ-gravitonov pri pomoshchi lazerov. (Generation and Application of γ-Quanta and γ-Gravitons by Means of Lasers.) Kazan. fix.-tekhn. in-t, AN SSSR, Kazan, 1972, 27 p. (RZhF, 5/73, no. 5B167).

The possibility of generation and reception of coherent gravitons in the x- and γ-bands is discussed in this monograph. It is shown that quantum systems of many particles in a coherent state have the property of selective interaction with elementary particles, which have a specific de Broglie wavelength λ_B. Due to the large value of the corresponding superscattering cross-section of elementary particles in the quantum graviton counter, these processes must be distinguished from the effect of gravitons, which is especially significant in the γ-band of gravitational emission. It is shown that the superscattering process may be used to accelerate neutral particles. It is suggested that an acceleration field be used to simulate gravitational fields and to check the principle of Einstein equivalence.

Pushkin, V. N. Kvantovaya telepatiya? (Quantum telepathy?). Sotsialisticheskaya industriya. July 6, 1973, p. 4.

The Einstein-Podol'skiy-Rozen paradox, which states that elementary particles having the same quantum properties are firmly bound to each other, regardless of distance, is compared to the biophysical processes of telepathy in man. Experiments carried out by S. Krippner and L. L. Vasil'yev, in which patterns are suggested to subjects either during their natural or hypnotic sleep, are discussed. It is suggested that if the biophysical processes in living cells are actually of a quantum nature, direct contact between cells is very possible. Since in this case the material related to encoding of cellular information interacts, under specific conditions

there may be direct transfer of information from one cell to another. This interaction will be instantaneous and independent of the distance between the cells. Although there is not yet any proof that the information processes occurring in cells actually carry the bases of quantum physical processes, there is some basis for the hypothesis of the quantum nature of bioinformation processes.

Askar'yan, G. A., and V. A. Pogosyan. Waves and forces in a homogeneous medium, whose properties change with time. ZhETF, v. 65, no. 1, 1973, 117-122.

Exact expressions for the wave field in a homogeneous nondispersive medium with time-varying properties are presented; the dielectric permeability or refractive index is assumed to vary linearly. Expressions are obtained for both the transmitted and reflected waves. Variation in the properties of the medium may appreciably affect the averaged forces exerted by the wave field on charged particles or the medium itself. Some applications of the results to wave processes in non-stationary media are indicated. It is pointed out that the appearance of a reflected wave field and of averaged forces may be a factor in initiating various stimulated processes. The authors suggest that similar effects may arise in the case of acoustic waves propagating in a medium with time-varying acoustic properties.

Deryugin, L. N., and T. K. Chekhlova. Investigating optical microwaveguides of gelatin films. OiS, v. 35, no. 2, 1973, 362-365.

The techniques of manufacturing single-mode optical microwaveguides of gelatin films on a glass substrate were investigated to determine the attenuation factors of such waveguides. Both plane and circular waveguides were investigated. The experiments show that gelatin waveguides have relatively low losses and are distinguished by simplicity of manufacture. Losses in these waveguides can apparently be reduced even more by improving the techniques of manufacture, in particular by removing the mineral substances from the gelatin in which additional scattering occurs. Improving the quality of the substrate surface also permits a decrease of losses. It is held possible to develop both film and strip waveguides and to construct microwaveguide optical circuits on a single substrate by the process of photolithography.

Morr, G., and H. Lauterbach. Thermodynamic calculation of plasma-chemical reactions. Wiss. Z. F. Schiller-Univ. Jena. Math. naturwiss. R., v. 21, no. 3, 1972, 565-579. (RZhKh, 13/73, no. 13B728). (Translation).

Statistical thermodynamics methods using molecular, atomic, and ionic spectral constants are recommended for calculations of equilibrium at plasma temperatures, because of insufficient accuracy of extrapolation of the experimental thermodynamic functions of state into the region of the cited temperatures. Application of the methods is discussed. Equilibria in the H-C-N system are calculated and phase boundary diagrams of the

system are presented. Also, isobars and isotherms are shown of the HCN equilibrium concentration peak in the 2000-6000° K range at pressures to 10^6 atm.

Mitin, R. V., A. V. Zvyagintsev, and K. K. Pryadkin. Electrodeless high-pressure UHF discharge. TVT, no. 3, 1973, 493-497.

Experimental data are given on induction discharges at 150 MHz frequency in inert and molecular gases (N_2, H_2, air) under pressures to 10 atm. A self-pulsed UHF oscillator developed at the Physicotechnical Institute of the Academy of Sciences was used in the experiments. The oscillator and discharge circuit are described. A stationary discharge is analyzed in the cited gases at input powers ranging from 200 W for Xe to 1.5 kW for H_2. With a 2-4 cm high inductor, discharge in Ar, Kr, and Xe at atmospheric pressure was observed in the form of concentric narrow rings, uniformly distributed along the height of the inductor. The number of plasma rings increased with increase in input power and decreased with the increase in pressure.

The observed stratification of discharge in heavy inert gases is tentatively explained by a decrease in impedance of theplasma bunch. Stable discharge in molecular gases at a low input power was obtained in the region of plasma skin layer depth $\delta \leq r$, the discharge radius. In that region, the input power of discharge threshold decreases with increase in conductivity (temperature). In summary, phenomena unpredictable by theory of HF-discharge in dense gases were detected in induction discharge at 150 MHz in heavy inert gases, and an HF discharge was obtained at a low power in molecular gases.

Bulekov, V. P., L. E. Graf, D. D. Dryuchenko, et al. Conducting an experimental sampling of soil from the lunar surface with the Luna-20 station. Kosmicheskiye issledovaniya, no. 3, 1973, 460-464.

Operation is described of the remote-controlled soil sampling device on the lunar surface. The device was carried by the Luna-20 station; the sampling operations described were carried out on February 21-23, 1972.

The sampling device consisted of an impacting-rotating drive element fastened at the end of a rotating rod, which drives a drilling and sampling tool. Current utilized by drive motor torque, drilling depth, and temperatures of the drilling machine and the electric motor were measured during actual drilling and afterwards. The data are presented graphically and compared with the data obtained during the Luna-16 drilling operation and those of the preliminary development test drilling in analogous soil. Conclusions are drawn with respect to lunar soil density, adhesive property and homogeneity. The drilling data obtained by Luna-20 operation are comparable to those obtained in drilling a porous gravel aggregate. The total drilling depth was ~300 mm.

Podzemnyy radar. Underground [acoustic] radar. Krasnaya zvezda, June 15, 1973, p. 3.

Development is reported of an acoustic radar for exploration of the shape and volume of underground cavities, created by an alluvial technique for salt extraction from mines. The radar was designed by scientists

at the Institute of Basic Problems, Polish Academy of Sciences, and was intended to avoid the danger of cave-ins in the Inovrotslav salt mines by exact charting of the cavities. Acoustic waves of appropriate frequency penetrate the earth strata; the device records reflected signals which serve to chart the cavities.

Morokhov, I. At the heart of matter: Soviet-American cooperation in peaceful uses of atomic energy. Sotsialisticheskaya industriya, 15 July 1973, p. 3.

The history and trends of Soviet-American cooperation in the atomic energy field are reviewed briefly by the author, who is the first deputy chairman of the USSR State Committee on Atomic Energy Uses. The fifteen-year history has culminated with the signing on June 21, 1973 of the intergovernment agreement on scientific and technical cooperation. This agreement is hailed as a more stable and durable basis of cooperation. The agreement embodies the mutual desire to join U. S. and Soviet efforts in satisfying the fast-growing energy requirements of both countries and the world by developing high-efficiency energy sources. The agreement stipulates cooperation in research and development of energy sources for the near and distant-future uses.

A short-term solution to the problem of the energy crisis is seen in accelerated construction of atomic power plants with fast neutron breeder reactors. The following Soviet breeder reactors are cited as now operational: the experimental BR-5 in Abninsk and the BOR-60 experimental pilot reactor in Dimitrovgrad [Bulgaria?]. Industrial exploitation of the world's first nuclear power plant with a fast neutron breeder has been started

in Shevchenko on the Caspian Sea. Construction of the even more powerful BN-600 fast breeder is in progress at the Beloyarskaya atomic power plant.

The cooperation in the long-range development of energy sources covers nuclear fusion reactors (Tokamak) and theoretical and experimental research in high-energy physics and design of related equipment. Basic research is also expected to lead to development of new energy sources, e.g., anti-matter, and new high-temperature, high-pressure, and radiation resistant materials.

B. Recent Selections

Azimi, Sh. A., A. V. Kalinin, V. V. Kalinin, and B. L. Pivovarov. Experimental investigation of an electric-arc source of pressure pulses in sea water. IN: Sb. Kompleks. issledovaniya prirody okeana, no. 4. Moskva, Mosk. un-t, 1973, 136-145. (RZhMekh, 11/73, no. 11B33)

Braginskiy, V. B., L. P. Grishchuk, A. G. Doroshkevich, Ya. B. Zel'dovich, I. D. Novikov, and M. V. Sazhin. Electromagnetic gravitational wave detectors. ZhETF, v. 65, no. 5, 1973, 1729-1737.

Demin, V. F., and G. N. Popkov. Uspekhi i perspektivy termoyadernykh issledovaniy (Progress and prospects of nuclear investigations). Moskva, Izd-vo Znaniye, 1973, 64 p.

Kikineshi, A. A., and D. G. Semak. Sensitization of a photochemical process in semiconducting layers of BiI_3. ZhNiPFiK, no. 6, 1973, 464-465.

Konovalov, S. M. Optoacoustic phenomena and possibilities of their use in information systems. IN: Sb. Optimiz. issled. operatsiy. Bionika. Moskva, Izd-vo Nauka, 1973, 161-167. (RZhRadiot, 11/73, no. 11Ye153)

Nasibov, A. Laser television. Pravda Ukrainy, November 20, 1973, p. 3.

Penkin, N. P., and O. D. Tsygir. Studying dissociation of oxygen in a discharge. VLU, no. 16, 1973, 34-43.

Vlasov, S. N., L. I. Zagryadskaya, and M. I. Petelin. Resonators and waveguides using whispering gallery modes for masers at cyclotron resonance. IVUZ Radiofiz, no. 11, 1973, 1743-1750.

Yanovskiy, M. S., and B. N. Knyaz'kov. Quasioptical matching transformer. Author's certificate, USSR, no. 371642, published May 17, 1973. (RZhRadiot, 11/73, no. 11B203 P)

Zholkevich, G. A., and I. Yu. Shabliy. Planar memory elements based on films of zinc and cadmium sulfides. UFZh, no. 11, 1973, 1894-1898.

8. SOURCE ABBREVIATIONS

AiT	-	Avtomatika i telemekhanika
APP	-	Acta physica polonica
DAN ArmSSR	-	Akademiya nauk Armyanskoy SSR. Doklady
DAN AzSSR	-	Akademiya nauk Azerbaydzhanskoy SSR. Doklady
DAN BSSR	-	Akademiya nauk Belorusskoy SSR. Doklady
DAN SSSR	-	Akademiya nauk SSSR. Doklady
DAN TadSSR	-	Akademiya nauk Tadzhikskoy SSR. Doklady
DAN UkrSSR	-	Akademiya nauk Ukrainskoy SSR. Dopovidi
DAN UzbSSR	-	Akademiya nauk Uzbekskoy SSR. Doklady
DBAN	-	Bulgarska akademiya na naukite. Doklady
EOM	-	Elektronnaya obrabotka materialov
FAiO	-	Akademiya nauk SSSR. Izvestiya. Fizika atmosfery i okeana
FGiV	-	Fizika goreniya i vzryva
FiKhOM	-	Fizika i khimiya obrabotka materialov
F-KhMM	-	Fiziko-khimicheskaya mekhanika materialov
FMiM	-	Fizika metallov i metallovedeniye
FTP	-	Fizika i tekhnika poluprovodnikov
FTT	-	Fizika tverdogo tela
FZh	-	Fiziologicheskiy zhurnal
GiA	-	Geomagnetizm i aeronomiya
GiK	-	Geodeziya i kartografiya
IAN Arm	-	Akademiya nauk Armyanskoy SSR. Izvestiya. Fizika
IAN Az	-	Akademiya nauk Azerbaydzhanskoy SSR. Izvestiya. Seriya fiziko-tekhnicheskikh i matematicheskikh nauk

IAN B	-	Akademiya nauk Belorusskoy SSR. Izvestiya. Seriya fiziko-matematicheskikh nauk
IAN Biol	-	Akademiya nauk SSSR. Izvestiya. Seriya biologicheskaya
IAN Energ	-	Akademiya nauk SSSR. Izvestiya. Energetika i transport
IAN Est	-	Akademiya nauk Estonskoy SSR. Izvestiya. Fizika matematika
IAN Fiz	-	Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya
IAN Fizika zemli	-	Akademiya nauk SSSR. Izvestiya. Fizika zemli
IAN Kh	-	Akademiya nauk SSSR. Izvestiya. Seriya khimicheskaya
IAN Lat	-	Akademiya nauk Latviyskoy SSR. Izvestiya
IAN Met	-	Akademiya nauk SSSR. Izvestiya. Metally
IAN Mold	-	Akademiya nauk Moldavskoy SSR. Izvestiya. Seriya fiziko-tekhnicheskikh i matematicheskikh nauk
IAN SO SSSR	-	Akademiya nauk SSSR. Sibirskoye otdeleniye. Izvestiya
IAN Tadzh	-	Akademiya nauk Tadzhikskoy SSR. Izvestiya. Otdeleniye fiziko-matematicheskikh i geologo-khimicheskikh nauk
IAN TK	-	Akademiya nauk SSSR. Izvestiya. Tekhnicheskaya kibernetika
IAN Turk	-	Akademiya nauk Turkmenskoy SSR. Izvestiya. Seriya fiziko-tekhnicheskikh, khimicheskikh, i geologicheskikh nauk
IAN Uzb	-	Akademiya nauk Uzbekskoy SSR. Izvestiya. Seriya fiziko-matematicheskikh nauk
IBAN	-	Bulgarska akademiya na naukite. Fizicheski institut. Izvestiya na fizicheskaya institut s ANEB
I-FZh	-	Inzhenerno-fizicheskiy zhurnal

IiR	-	Izobretatel' i ratsionalizator
ILEI	-	Leningradskiy elektrotekhnicheskiy institut. Izvestiya
IT	-	Izmeritel'naya tekhnika
IVUZ Avia	-	Izvestiya vysshikh uchebnykh zavedeniy. Aviatsionnaya tekhnika
IVUZ Cher	-	Izvestiya vysshikh uchebnykh zavedeniy. Chernaya metallurgiya
IVUZ Energ	-	Izvestiya vysshikh uchebnykh zavedeniy. Energetika
IVUZ Fiz	-	Izvestiya vysshikh uchebnykh zavedeniy. Fizika
IVUZ Geod	-	Izvestiya vysshikh uchebnykh zavedeniy. Geodeziya i aerofotos"yemka
IVUZ Geol	-	Izvestiya vysshikh uchebnykh zavedeniy. Geologiya i razvedka
IVUZ Gorn	-	Izvestiya vysshikh uchebnykh zavedeniy. Gornyy zhurnal
IVUZ Mash	-	Izvestiya vysshikh uchebnykh zavedeniy. Mashinostroyeniye
IVUZ Priboro	-	Izvestiya vysshikh uchebnykh zavedeniy. Priborostroyeniye
IVUZ Radioelektr	-	Izvestiya vysshikh uchebnykh zavedeniy. Radioelektronika
IVUZ Radiofiz	-	Izvestiya vysshikh uchebnykh zavedeniy. Radiofizika
IVUZ Stroi	-	Izvestiya vysshikh uchebnykh zavedeniy. Stroitel'stvo i arkhitektura
KhVE	-	Khimiya vysokikh energiy
KiK	-	Kinetika i kataliz
KL	-	Knizhnaya letopis'
Kristall	-	Kristallografiya
KSpF	-	Kratkiye soobshcheniya po fizike

LZhS	-	Letopis' zhurnal'nykh statey
MiTOM	-	Metallovedeniye i termicheskaya obrabotka materialov
MP	-	Mekhanika polimerov
MTT	-	Akademiya nauk SSSR. Izvestiya. Mekhanika tverdogo tela
MZhiG	-	Akademiya nauk SSSR. Izvestiya. Mekhanika zhidkosti i gaza
NK	-	Novyye knigi
NM	-	Akademiya nauk SSSR. Izvestiya. Neorganicheskiye materialy
NTO SSSR	-	Nauchno-tekhnicheskiye obshchestva SSSR
OiS	-	Optika i spektroskopiya
OMP	-	Optiko-mekhanicheskaya promyshlennost'
Otkr izobr	-	Otkrytiya, izobreteniya, promyshlennyye obraztsy, tovarnyye znaki
PF	-	Postepy fizyki
Phys abs	-	Physics abstracts
PM	-	Prikladnaya mekhanika
PMM	-	Prikladnaya matematika i mekhanika
PSS	-	Physica status solidi
PSU	-	Pribory i sistemy upravleniya
PTE	-	Pribory i tekhnika eksperimenta
Radiotekh	-	Radiotekhnika
RiE	-	Radiotekhnika i elektronika
RZhAvtom	-	Referativnyy zhurnal. Avtomatika, telemekhanika i vychislitel'naya tekhnika
RZhElektr	-	Referativnyy zhurnal. Elektronika i yeye primeneniye

RZhF	-	Referativnyy zhurnal. Fizika
RZhFoto	-	Referativnyy zhurnal. Fotokinotekhnika
RZhGeod	-	Referativnyy zhurnal. Geodeziya i aeros"-yemka
RZhGeofiz	-	Referativnyy zhurnal. Geofizika
RZhInf	-	Referativnyy zhurnal. Informatics
RZhKh	-	Referativnyy zhurnal. Khimiya
RZhMekh	-	Referativnyy zhurnal. Mekhanika
RZhMetrolog	-	Referativnyy zhurnal. Metrologiya i izmeritel'naya tekhnika
RZhRadiot	-	Referativnyy zhurnal. Radiotekhnika
SovSciRev	-	Soviet science review
TiEKh	-	Teoreticheskaya i eksperimental'naya khimiya
TKiT	-	Tekhnika kino i televideniya
TMF	-	Teoreticheskaya i matematicheskaya fizika
TVT	-	Teplofizika vysokikh temperatur
UFN	-	Uspekhi fizicheskikh nauk
UFZh	-	Ukrainskiy fizicheskiy zhurnal
UMS	-	Ustalost' metallov i splavov
UNF	-	Uspekhi nauchnoy fotografii
VAN	-	Akademiya nauk SSSR. Vestnik
VAN BSSR	-	Akademiya nauk Belorusskoy SSR. Vestnik
VAN KazSSR	-	Akademiya nauk Kazakhskoy SSR. Vestnik
VBU	-	Belorusskiy universitet. Vestnik
VNDKh SSSR	-	VNDKh SSSR. Informatsionnyy byulleten'
VLU	-	Leningradskiy universitet. Vestnik. Fizika, khimiya
VMU	-	Moskovskiy universitet. Vestnik. Seriya fizika, astronomiya

ZhETF	-	Zhurnal eksperimental'noy i teoreticheskoy fiziki
ZhETF P	-	Pis'ma v Zhurnal eksperimental'noy i teoreticheskoy fiziki
ZhFKh	-	Zhurnal fizicheskoy khimii
ZhNiPFiK	-	Zhurnal nauchnoy i prikladnoy fotografii i kinematografii
ZhNKh	-	Zhurnal neorganicheskoy khimii
ZhPK	-	Zhurnal prikladnoy khimii
ZhPMTF	-	Zhurnal prikladnoy mekhaniki i tekhnicheskoy fiziki
ZhPS	-	Zhurnal prikladnoy spektroskopii
ZhTF	-	Zhurnal tekhnicheskoy fiziki
ZhVMMF	-	Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki
ZL	-	Zavodskaya laboratoriya

9. AUTHOR INDEX