The necessary conditions for stability of a plasma with an anisotropic distribution of particle velocities located in a helical magnetic field are derived on the basis of kinetic theory without taking close collisions into account.

Equation of State of Partially Ionized Hydrogen, L. P. Kudrin, pp. 798–801.

We propose a method for approximate evaluation of the thermodynamic functions of a partially ionized gas, taking into account deviations from ideality. We obtain an equation of state and an ionization formula which is appreciably different from the Saha formula.

Polarization of Recombination Radiation, B. A. Lysov, L. P. Belova, and L. I. Korovina, pp. 816–819.

The polarization of radiation following the capture of a relativistic electron into the K shell is considered. Partial elliptical polarization is shown to occur in this case. The expression for the intensity of the unpolarized part of the radiation is given. The electron-spin contribution is discussed. The calculations are performed to the lowest order in αZ.

Momentum Distribution of Particles in a Dilute Fermi Gas, V. A. Belyakov, pp. 850–851.

The first two terms of the expansion in powers of the gas parameter of the momentum distribution of particles in a nonideal Fermi gas are obtained by means of a perturbation method.

Magnetohydrodynamics for Nonisothermal Plasma without Collisions, Yu. L. Klimontovich and V. P. Silin, pp. 852–859.

The magnetohydrodynamic equations are considered for a plasma without collisions. Dissipation due to the absorption of magnetohydrodynamic and magneto-acoustic waves by electrons is taken into account. The resultant equations are applied in the analysis of the smearing out of a packet in the plasma. It is shown that under the conditions assumed, when the spatial dimensions considerably exceed the Debye and Larmor ranges, stationary shock waves with a width much smaller than the mean free path cannot exist.

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Volume 3, Number 8, February 1962

Effect of Halogen Additions on the Thermal Conductivity of Lead Telluride, E. D. Devyatkova and I. A. Smirnov, pp. 1666–1674.

The thermal conductivity, electrical conductivity, Hall coefficient, and thermo-emf of 14 pairs of single-crystal and polycrystalline specimens of PbTe and one pair each of polycrystalline specimens of the solid solutions PbTe + 1% PbSe and PbTe + 1% SnTe, have been measured in the temperature range 80°–460°K. Specimens of n-type PbTe were obtained by alloying with the binary addition: PbI_2 (or $PbBr_2$ or $PbCl_2$) + Pb.

It is shown that additions of chlorine, bromine and iodine considerably reduce the thermal conductivity of the PbTe crystal lattice. With $n \sim 3\cdot10^{19}$–$2\cdot10^{20}$ cm^{-3} the additional thermal resistivity due to the additions is proportional to the concentration of the halogens introduced. It is found that the thermal conductivity of the lattice changes to the same extent, irrespective of the amount of halogen introduced (chlorine, bromine, or iodine). This effect of the halogen additions may be due to the large static dielectric permeability of PbTe. The scattering cross section for phonons has been calculated in the case of the halogens, selenium, and tin.

It is also shown that the electrical conductivity and thermo-emf of PbTe are independent of the form of the alloying addition (chlorine, bromine, or iodine) and of the amount of excess lead introduced (from 0.3 to 3 wt %).

Conclusions: From the investigation of PbTe described, it is possible to draw the following conclusions:

1) Additions of chlorine, bromine, and iodine markedly reduce the thermal conductivity of the crystal lattice of PbTe. The additions begin to exert a marked effect on χ at a concentration of $1\cdot10^{19}$ cm^{-3}.

2) Between $n \simeq 3\cdot10^{19}$ and $2\cdot10^{20}$ cm^{-3}, the additional thermal resistivity is proportional to the concentration of current carriers.

3) The thermal conductivity of the lattice varies by the same amount, irrespective of the mass of the halogen introduced (chlorine, bromine, or iodine). The similar effect of the different additions can be explained if it is assumed that PbTe has a large static dielectric permeability.

4) In contrast to halogen additions, selenium and tin have smaller scattering cross sections for phonons.

5) The varying effects of additions of halogens, tin, and selenium are evidently connected with their different positions relative to lead and tellurium in the Periodic Table.

6) The electrical conductivity, thermo-emf, and thermal conductivity do not depend on the kind of alloying addition (chlorine, bromine, or iodine), or on the amount of excess lead introduced, in the temperature range investigated.

Photoconductivity and Quantum Yield in Germanium under the Action of x Rays, M. G. Kamoldinov and É. M. Reikhrudel', pp. 1713–1717.

The influence of x rays on the electrical conductivity (concentration, mobility, and lifetime of carriers) of a uniform germanium specimen was investigated by taking simultaneous measurements of the conductivity and Hall effect as a function of absorbed radiation dosage. The energy of electron-hole pair production and quantum yield were determined in a wavelength range from 0.248 to 0.062 Å. The photoconductivity increases "superlinearly" with increasing x-ray dose rate.

Conclusions:

1) The variation in electrical properties of germanium under the action of x rays generated at voltages of 100–200 kv have been investigated; the variation in conductivity and other quantities depending on it was demonstrated experimentally. X-ray absorption leads to the appearance of additional bound states in the forbidden zone and causes an increase in carrier lifetime and the observed "superlinearity."

2) For a certain minimum dose, saturation of the photoconductivity of germanium sets in. The steady-state value of the photoconductivity depends on the x-ray quantum energy and on the dose rate. For the same given value of the quantum energy and equal absorbed doses, the photoconductivity is approximately proportional to the dose rate.

Study of Dopant Distribution in the Surface Layer of Photoelectric Solar Energy Converters Made from n-Type Silicon, A. K. Zaitseva and A. Ya. Gliberman, pp. 1724–1727.

A model of a silicon photoconverter in which the p-n junction is obtained by means of thermodiffusion of boron into n-type Si is described. It permits one to conduct a layer by layer study of the diffusion layer up to the depth of occurrence of the p-n junction.

From the data of the measurements made on this model, the character of the concentration distribution of the impurity which was diffused is studied over the entire layer, and the optimum depth for occurrence of the p-n junction in the photoconverter is determined. Data are presented on the change of open-circuit voltage, short-circuit current, maximum power, and resistance of the doped layer as a function of its gradual etching.

Photoconductivity of Neutron-Irradiated p-Type Silicon, V. S. Vavilov and A. F. Plotnikov, pp. 1783–1784.

We present new data regarding the dependence of the photoconductivity of silicon for silicon containing radiational defects. We complete the system of energy levels for defects in silicon, and present conclusions regarding the electrical nature of some of the newly discovered levels.

Volume 3, Number 9, March 1962

Electrical Properties of Cadmium Antimonide Single Crystals at Low Temperatures, I. K. Andronik, M. V. Kot, and O. V. Emel'yanenko, pp. 1853–1856.

In this work, results are presented on the study of the temperature dependence of two components of the conductivity tensor, of the Hall effect, and of the magnetoresistivity in the range 2.4° to 78°K. It is shown that with a defect concentration of the order of 10^{15} cm^{-3} an acceptor impurity band is formed in cadmium antimonide crystals. The discussion of the results is carried out on the basis of the concept of the existence of an impurity band.

In the present work the electrical properties of undoped CdSb crystals in the temperature range from 2.4° to 78°K are described.

Conclusions:

1) It has been established that in cadmium antimonide monocrystals with a defect concentration of $3\cdot10^{15}$ cm^{-3}, an acceptor

impurity band is formed which lies from 0.005 to 0.008 ev above the valence band.

2) The mobility of holes in the valence band is approximately 3000 times as great as in the impurity band.

3) The hole mobility in the valence band increases with decrease in temperature approximately as $T^{-3/2}$ down to 20°K, indicating that the holes are scattered by thermal (acoustical) lattice vibrations.

4) At 4.2°K, the Hall constant and $\Delta\rho/\rho H^2$ decrease with an increase of the magnetic field intensity.

Thermal Breakdown of Heterogeneous Dielectrics with Asymmetrical Boundary Conditions, S. N. Koikov and A. N. Tsikin, pp. 1857–1863.

A solution is given for a general problem on thermal breakdown of dielectrics with direct current and asymmetrical boundary conditions. Accurate and approximate relationships are obtained for calculating the breakdown voltage from which the relationships derived in the Fock theory and also in papers noted follow as special cases. An analysis of the solution makes it possible to improve the accuracy of ideas on the thermal breakdown of solid dielectrics, and the plotted graphs can be used to evaluate the breakdown voltage in practical calculations.

Summary:

1) A solution has been obtained for a unidimensional problem on the thermal breakdown of solid dielectrics with a direct current for a case which was more complex than in the Fock theory. In the calculation, allowance was made for the following factors which could occur during the technical use of dielectrics: a) different conditions of cooling from the side of the first and second electrodes, which are characterized by the parameters ν_1 and ν_2; b) flow of heat from one electrode to the other; c) the heterogeneity of the dielectric, expressed in the form of an exponential dependence of the specific resistance on the coordinate (the plane case) or a power dependence on the coordinate R (cylindrical case). The heat flow and heterogeneity of the dielectric are characterized by the parameter μ. For the calculation of the breakdown voltage, one of two relationships is suggested, depending on whether the resistance of the layer of dielectric needed for the calculation is determined in weak or strong fields.

The dependence of the breakdown voltage on the parameters ν_1, ν_2, μ is determined by the functions Φ and Φ^*, for the calculation of which accurate and approximate (for large values of μ) equations have been derived.

2) Approximate relationships have been used to plot graphs for the dependences $\Phi(\mu, \nu_1, \nu_2)$ and $\Phi^*(\mu, \nu_1, \nu_2)$. In the first place, these graphs can be used to find the breakdown voltage during thermal breakdown of heterogeneous dielectrics with asymmetrical boundary conditions for given values of μ, ν_1, and ν_2. In the second place, the obtained results can be used to analyze qualitatively the deviation of the calculated breakdown voltages from those values which are obtained from the Fock theory. Finally, an example is given of the practical use of the obtained relationships in calculating the breakdown voltage of alundum coatings.

3) All special cases of the unidimensional problem on thermal breakdown of dielectrics with direct current, including the relationships of the Fock theory, proceed from the general relationships obtained in this work.

Scattering of Slow Neutrons in Antiferromagnetics, V. A. Popov, pp. 1883–1893.

In this paper are studied elastic and inelastic (single-magnon) scattering of slow neutrons in a uniaxial antiferromagnetic which is located in a magnetic field.

The theory of spin waves is applied to antiferromagnetics at sufficiently low temperatures. It is of appreciable interest to verify the applicability of this theory to antiferromagnetics by performing a neutronographic investigation of them. The scattering of neutrons by spin waves in antiferromagnetics was studied theoretically in other papers, but the analysis was not sufficiently thorough.

In this paper we shall study the scattering of neutrons by spin waves in a uniaxial monocrystalline antiferromagnetic as a function of the external magnetic field and the magnetic-anisotropy crystal properties.

Noise in p-Type Indium Antimonide in a Magnetic Field at Room Temperature, V. F. Zolomarev and D. N. Nasledov, pp. 1918–1921.

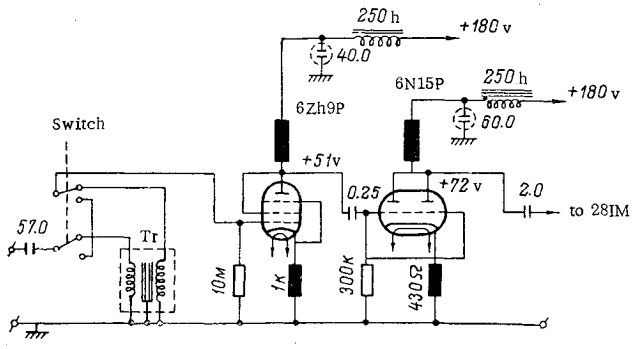

Fig. 1. Schematic of a preamplifier having an equivalent input noise resistance of 8 ohms.

Investigations of noise due to the photomagnetic effect and of the current noise in the presence and in the absence of a magnetic field in thin layers of indium antimonide was investigated at room temperature. It was found that the photomagnetic-effect noise is of thermal origin and that it does not change under the illumination of the sample by high-intensity light. Current noise has a $1/f$ spectrum at frequencies up to 10 kc. The noise spectrum does not change when the sample is placed in a magnetic field. It was found that the theory of current noise derived under the assumption of the equality of the mean square values of fluctuations of the majority and minority current carriers in a semiconductor was applicable. A deduction was made on the basis of these investigations about the equivalence of the noise due to semiconductor resistance in a magnetic field and of the conventional resistance of the same magnitude.

Preparation of Monocrystalline Layers of Cadmium Selenide, I. P. Kalinkin, L. A. Sergeeva, V. B. Aleskovskii, and L. P. Strakhov, pp. 1922–1927.

By means of electron diffraction, microscopic and electron microscopic methods, the structure of thin layers of CdSe has been studied as a function of the nature of the orienting substrate (NaCl, KCl, and KBr), mechanical and thermal treatment of the substrates, the substrate temperature during sublimation of CdSe, and the rate of sublimation. A method of preparing single-crystal layers of CdSe with hexagonal syngony (thicknesses up to 0.1 μ) by evaporation of CdSe onto a (111) face of NaCl, KCl, or KBr crystals was developed.

Conclusions: The electron diffraction studies of CdSe films, and also electron microscope and light microscope studies of CdSe films and the surfaces of the NaCl, KCl, and KBr crystal substrates (111) face, demonstrated the following:

1) The orientation of the evaporated films of CdSe does not depend to any significant degree on the "micro" and "macro" relief of the substrate surface.

2) In order to obtain single-crystal films of CdSe, it was found that the most important parameters were the substrate temperature during the evaporation and the rate of deposition. Furthermore, a preliminary heating of the crystal substrate increased the ability of the substrate to cause orientation of the film.

The conditions for preparing single-crystal films of hexagonal CdSe have been worked out. Such films, which had areas of 2 to 12 cm^2, were readily removed from the NaCl or KCl substrates.

Investigation of the Thermomagnetic and Galvanomagnetic Properties of p-Type PbTe, I. V. Mochan and T. V. Smirnova, pp. 1936–1941.

The thermoelectric mobility force, the electric conductivity, the Hall effect, and the transverse Nernst effect have been investigated for four p-type PbTe samples, whose concentration at room temperature was of the order $5\text{–}8\cdot10^{17}$ cm^{-3}.

In agreement with another paper it is shown that the Nernst mobility u_N is less than the Hall mobility u_H. Above 140°K the temperature behavior of u_N agrees with the behavior of u_H; below this temperature the Nernst mobility is found to deviate from the stepwise behavior. It follows from the analysis of the results that the impurity scattering should distort the temperature dependence of the Nernst mobility much more than was found in practice. The assumption is made that the lower Nernst mobility as well as the deviation of the temperature dependence can be explained by an auxiliary scattering mechanism, e.g., the optical spectrum.

New Type of Photoconductivity, M. I. Korsunskii, N. S. Pastushuk, and G. D. Mokhov, pp. 1942–1943.

A new type of photoconductivity has been found in which the photoresponse does not depend on the light intensity but does depend on its wavelength. We prepared selenium samples, treated with mercury, which displayed unusual photoconductivity under certain conditions.

Long-Time Strength of Metals and How It Is Affected by Surface-Active Metallic Melts, L. S. Bryukhanova, I. A. Andreeva, and V. I. Likhtman, pp. 2025–2028.

The dependence on time and on temperature of amalgamated zinc and gallium-treated cadmium was investigated. It is shown that the graph showing the dependence of the time required for rupture on stress in the presence of a surface-active melt discloses an abrupt change in the region of small stresses. The lifetime of the samples under loading drops within an extremely narrow interval of stresses from one of days to one of seconds or fractions of a second. This sudden drop in the graph of $\log \tau = f(P)$ in the presence of a thin film of active melt is associated with the transition to a new rupture mechanism in connection with the very large drop in surface energy in the presence of the active melt. This mechanism comes into play only after a definite level of normal stresses has been reached, corresponding to the brittle strength of the metal, which is greatly reduced in the presence of the active melt. The kinetics of the increased cracking in this case is fully determined by the surface migration rate of the active melt in the rupture zone and is no longer connected with thermal activation of the rupture process.

Investigation of Macroradicals Arising during Mechanical Breakdown of Polymers, S. N. Zhurkov, É. E. Tomashevskii, and V. A. Zakrevskii, pp. 2074–2078.

Volume 3, Number 10, April 1962

Method of Homogeneous Static Deformation for Calculating Elastic, Piezoelectric, and Dielectric Tensors of an Ionic Crystal, V. S. Oskotskii, pp. 2132–2140.

The method of homogeneous static deformation was used to calculate the elastic characteristics of ionic crystals. It was possible to disregard the boundary conditions by separating the macroscopic electric field according to the Ewald method. The results coincide with those of the method of long waves in the absence of initial stresses.

Solution of the Kinetic Equation for Anisotropic Electron Scattering, A. G. Samoilovich, I. Ya. Korenblum, I. V. Dakhovskii, and V. D. Iskra, pp. 2148–2156.

The vibrational scattering of electrons is examined in an external electric field, when a temperature gradient is applied. It is assumed that the constant energy surfaces are ellipsoidal. The kinetic equation leads to an infinite system of linear algebraic equations. A convenient equation is obtained for the coefficients of the system. The projection of the nonequilibrium correction of the distribution function on the first spherical harmonic, which is necessary for calculating the current, is established in the form of a rapidly converging series. The problem of anisotropic scattering is analyzed from the viewpoint of the method of eigenfunctions.

Production and Investigation of Thermoelectric Materials Based on Bi-Sb-Te, A. D. Goletskaya, V. A. Kutasov, and E. A. Popova, pp. 2189–2193.

Specimens of n-type Bi_2T3E and of p-type solid solution consisting of 75% Sb_2Te_3 + 25% Bi_2Te_3, with maximum efficiencies of $2.4 \cdot 10^{-3}$ and $3 \cdot 10^{-3}$ deg^{-1}, respectively, have been produced by controlled crystallization. The maximum temperature difference ΔT_{max} attained by a thermocouple made from these materials reaches 70°C (with a hot junction temperature of +30°C).

The marked increase in the practical application of thermoelectric cooling in recent years has aroused considerable interest in the various thermoelectric materials. In a series of papers thermoelectric materials based on Bi-Te-Se and Bi-Te-Sb are regarded as the most promising. But whereas the greater part of the work by foreign authors has been devoted to studying the properties of single crystals and oriented crystals prepared from the forementioned materials, in the USSR systematic studies have been carried out on extruded specimens prepared by the powder-metallurgy method. It must be noted that there are considerable differences in the values obtained by various authors for the efficiency of materials having the same composition; these differences may be due either to the methods used in preparing the specimens or to certain inaccuracies in measuring their parameters.

The object of the present work was to obtain materials for the positive and negative branches of thermocouples by controlled crystallization and to determine their thermoelectric properties: thermal-emf α, specific thermal conductivity $\varkappa$, specific electrical conductivity σ, efficiency z, and maximum attainable difference ΔT_{max} of a thermocouple consisting of these materials.

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Magnetohydrodynamic Surface Waves, L. S. Solov'ev, pp. 294–301.

Nonlinear waves on the plane surface of an incompressible ideally conducting plasma in the presence of an external magnetic field are studied. The equations for steady helical flow of an incompressible plasma are given, and with their help the problem of stability of a plasma cylinder rotating about its axis is investigated in the linear approximation.

Shock Ionization and Detonation in Magnetohydrodynamics, V. P. Demutskii and R. V. Polovin, pp. 302–307.

Possible shock ionization and detonation regimes are determined for the motion of a conducting piston in a magnetohydrodynamic medium. We investigate which types of magnetohydrodynamic shock and progressive waves can be accompanied by shock ionization and detonation waves. We consider the conditions for which detonation occurs at the Chapman-Jouget point. The piston velocity, the Alfvén velocity, and the reaction energy are assumed to be small.

We determine the possible detonation and shock-ionization regimes in a magnetohydrodynamic medium. This problem is of interest in astrophysical work.

Detonation in a magnetohydrodynamic medium, in the case when the magnetic field is perpendicular to the direction of propagation of the wave, has been considered by Larish and Shekhtman and by Lyubimov. The ionization shock wave for the same magnetic-field direction was investigated by Kulikovskii and Lyubimov. In these articles, for simplicity, the authors neglected the absorption of energy in the ionized wave.

In the present work, this problem is solved for arbitrary magnetic-field direction with the energy of ionization taken into account.

For simplicity, we will assume that the medium is bounded by a perfectly conducting piston moving with a constant velocity $\mathbf{u}$. We will also assume that the piston velocity and the Alfvén velocity $\mathbf{U} \equiv \mathbf{H}/\sqrt{4\pi\rho}$ are much smaller than the sound velocity c, and that the energy of reaction referred to zero temperature $q = (w_2 - w_1)_{T=0}$ (where w is the heat content) is much smaller than the square of the sound velocity.

We will limit ourselves to the case where the magnetic field, the piston velocity, and the normal to the piston surface are coplanar (in the xy plane).

If the shock ionization wave is propagated in a nonconducting, i.e., a non-ionized medium, then in front of the wave there will be an electromagnetic wave with an amplitude determined by the relation between the dissipation coefficients. There will be no such wave if the medium is originally ionized, and an increase in the degree of ionization in the shock wave will be produced. We will consider this case.

Study of Feasibility of Obtaining Steady Magnetic Fields in Coils Cooled with Liquid Hydrogen, E. S. Borovik, F. I. Busol, and S. F. Grishin, pp. 331–335.

One of the methods of thermally insulating a hot plasma is by its containment in magnetic traps. In order to obtain steady magnetic fields of high intensity great expenditure of power is involved. The reduction of the power expenditure on the creation of the magnetic field may facilitate the realization of a controlled thermonuclear reaction with a useful energy yield.