JPRS 82870

16 February 1983

USSR Report

ELECTRONICS AND ELECTRICAL ENGINEERING

No. 98

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ELECTRONICS AND ELECTRICAL ENGINEERING

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CONTENTS

UDC 621.396.2.019.4

TRIODE OSCILLATOR SUBJECT TO NOISE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82
(manuscript received 7 Dec 79, after correction 4 May 81) pp 1965-1971

VAKMAN, D. Ye.

[Abstract] Modulation noise in a triode oscillator, namely flicker noise, is analyzed in the second-order approximation. Regarded as a normal stationary $\omega^{-\lambda}$-process, its principal effect is to alter the transconductance of the tube. Low-frequency flicker within the $0 < \omega < 1$ band is found to cause both slow static and fast dynamic fluctuations of the instantaneous frequency. High-frequency flicker within the $1 < \omega < 3$ band is found to be reducible to additive noise, but much weaker than thermal and shot noise. Analytical expressions for the signal and the spectrum are derived on this basis, for use in the oscillator equations and in the design of filters. Figures 1; references: 5 Russian.
[91-2415]

UDC 621.396.96

OPTIMAL OUTFITTING OF INSTRUMENTS FOR MEASUREMENT IN PARTIALLY NON-WHITE OBSERVATION NOISE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82
(manuscript received 25 Sep 81) pp 1949-1956

YARLYKOV, M. S. and MIRONOV, M. A.

[Abstract] The problem of outfitting instruments optimally with respect to accuracy and efficiency is treated from the standpoint of the general theory of conditional Markov processes, of particular interest being the case where some vector diffusion process distorts part of the white background noise. The complex of random processes observed during a given time interval is represented as the sum of two vector-columns. The non-white noise is described

by a first-order stochastic vector differential equation with the time derivative of the noise vector equal to the sum of two vector functions continuous in all arguments and continuously differentiable with respect to all arguments except time. Optimal and quasi-optimal algorithms for complex processing of data are constructed on this basis. The simplest set of two first-order quasi-optimal algorithms is demonstrated on a set of two instruments for primary processing of data where a process

$$\xi_1(t) = \frac{dy}{dt}1 = s(t,x_1) \text{ signal} +$$

$+ \sqrt{1/2N_1}\, n_1(t)$ noise appears at the input of the first one and a process

$\xi_2(t) = y_2(t) = x_1(t) + u(t)$ is to appear at the output of the second one. The optimum instrument set constitutes a nonlinear filter with two inputs consisting of a discriminator, three filters and three corresponding amplifiers, two adders and a high-speed signal shaper. The algorithms can be constructed in the form of difference rather than differential equations, for implementation on a digital computer. They can be modified for various forms of Markov processes, also for measurements with a priori indeterminacy. Figures 1; references 9: 8 Russian, 1 Western (in translation).
[91-2415]

UDC 621.396.96:621.396.26

ALGORITHM FOR DETECTING TRAJECTORIES AND ESTIMATING COORDINATES OF MOVING OBJECT

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82
(manuscript received 24 Sep 81) pp 1942-1948

LEVIN, B. R., TEGINA, N. V. and YUDITSKIY, A. I.

[Abstract] The multialternative problem of simultaneously detecting and estimating several signals, namely trajectories and coordinates of a moving object, is solved by the Bayes method without resorting to the theory of random signal fluxes. The loss function is considered with the number of estimates $\hat{c}$ either larger than the number of signals c (arbitrary extra estimates) or equal to or smaller than the number of signals c. The algorithm is demonstrated on signals representable as polynomials, specifically two trajectories with probability distributions $P(c = 2) = 0.7$, $P(c = 1) = 0.3$, $P(c = 0) = 0$. The signals are assumed to correspond to the same hypothesis, a constant. The systematic error of this algorithm and the dispersion of errors are calculated, by averaging the estimation errors, for a sample size $n = 5$ with $\sigma^2_{meas} = 1$ and an $f(c,\hat{c}) = \sigma^2_{meas}(c - c)^2$ component of the loss function associated with estimating the number of signals, assuming a uniform noise distribution. References 7: 5 Russian, 2 Western (1 in translation).
[91-2415]

UDC 621.371;551.466.31

NONLOCAL NATURE OF SOME EFFECTS OBSERVED DURING DISTANCE OCEAN SOUNDING

Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian
Vol 25, No 5, May 82 (manuscript received 4 May 81, after completion 9 Nov 81)
pp 583-585

KRAVTSOV, Yu. A. and ETKIN, V. S., Physical Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] The authors note that customarily it is assumed that effects observed with the aid of distance methods (microwave and laser Scatterometry, microwave and infrared radiometry) have a local nature, i.e., they appear just where perturbation factors proceed. Examples of such factors are petroleum films, output of internal waves (slick) and local currents. Also, in a number of cases nonlocal effects appear, caused by the fact that, to start with, the initial perturbation modifies the energy carrying components of the seaways, and the changes of the waves are observed afterwards beyond the action of the perturbation. In the present brief communication consideration is given to the possibility of a simple model description of nonlocal effects of the basis of transfer equations and the possibility connected with them of obtaining additional information on the dynamic characteristics of seaways. The following items are studied: 1) Transfer equations for energy of seaways; 2) Solution of transfer equation in the case of small perturbations; and 3) Time effects. Figures 1; references 4: 2 Russian, 2 Western.
[29-6415]

UDC 550.388.2

PROPAGATION OF SHORT PERIODIC WAVES IN IONOSPHERE

Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian
Vol 25, No 5, May 82 (manuscript received 21 Apr 81) pp 495-507

SOROKIN, V. M. and FEDOROVICH, G. V., All-Union Scientific-Research Institute of Optical-Physical Measurements

[Abstract] In order to verify certain assumptions that have been advanced as well as to investigate the propagation characteristics of short-periodic waves in the atmosphere, the present paper analyzes records concerned with the geomagnetic field. These records were obtained during various geomagnetic observations in an interval of time on the order of 30 minutes after violent earthquakes. Also analyzed were records of a geometrical field obtained during observations in areas of the Pacific Ocean and the USA. During processing of experimental data, short-periodic waves were shown to propagate in the low ionosphere with a velocity on the orders of 20 km/s. The pulse function of these waves is found and an analysis is made. The properties of theoretically calculated short-periodic shock waves of a geomagnetic field are found in full accordance with the results obtained during analysis of experimental data. Figures 8; tables 1; references 20: 10 Russian, 10 Western.
[29-6415]

UDC 550.388.2

DIFFERENCE OF RESPONSE OF IONOSPHERE F_2 REGION TO ACTION OF INTERNAL GRAVITATIONAL WAVES UNDER DAYTIME AND NIGHTTIME CONDITIONS

Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian
Vol 25, No 5, May 82 (manuscript received 2 Nov 81) pp 577-579

SMERTIN, V. M. and NAMGALADZE, A. A., Kaliningrad State University

[Abstract] On the basis of observations cited in the literature, the authors note that moving ionospheric perturbations resulting from internal

gravitational waves (IGW) develop in different ways into day and night high-level profiles of electron concentration N_e at the F2-region of the ionosphere. In the daytime significant deformations are possible of the high-level profiles of N_e with the appearance of stratifications and noticeable changes at the half-thickness of the layer. At night the F2 layer moves as a unit, not changing substantially the form of the high-level profile N_e. This difference in the reaction of the day and night F2 region to the passage of IGW also appears in the results of numerical solutions of the problem of the effect of IGW on the atmosphere. A. A. Namgaladze (see above) participated in 5 of the 7 reports cited in the present work. The present brief communication is concerned with an attempt at physical interpretation of the substance of the above phenomena. This interpretation is closely based on the reports from the literature mentioned above. In the text figure 1 presents the high-level profiles Δv_{nx} (v_{nx} = meridional component of the rate of movement of a neutral gas), obtained by numerical solution of a problem concerned with generation of IGW by an aurora electrojet, for the moments of time 60 minutes, 100 minutes and 160 minutes reckoned from the beginning of perturbation. Figure 2 presents the results of calculations of the high-level profiles N_e with the presence of the wave perturbation shown in figure 1. Figures 2; references 7: 5 Russian, 2 Western.
[29-6415]

UDC 621.37/39:534

NONLINEAR INTERACTIONS IN COUPLED WAVEGUIDES WITH SURFACE ACOUSTIC WAVES PROPAGATING IN OPPOSITE DIRECTIONS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82
(manuscript received 3 Apr 81) pp 2056-2058

ZHGUN, S. A. and SHTYKOV, V. V.

[Abstract] Nonlinear interaction of surface acoustic waves propagating in opposite directions through coupled waveguides was studied experimentally. A specimen of such a pair of waveguides was built on a YZ-cut $LiNbO_3$ substrate with aluminum coating. Surface acoustic waves were excited by means of interdigital transducers with an f_0 = 47 MHz center frequency and fed to the waveguide through matching horns. Electric convolution signals, indicators of energy transfer from one waveguide to another under conditions of acoustic nonlinearity, were measured synphasally (both waveguides connected) and antiphasally (one waveguide grounded). Their magnitudes were found to depend on the mutual delay between input radio pulses. Subsequent calculations reveal that the maximum amplitudes of these signals are, depending on the input terminals, either cosine or sine function of the delay time multiplied by the linear waveguides in a convolver, the signal at the center frequency f_0 must be applied immediately to all four inputs. Figures 3; references: 2 Western.
[91-2415]

UDC 621.315.592

NONLINEAR INTERACTION OF ELECTROMAGNETIC WAVES IN SUPERLATTICE

Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 25, No 5, May 82 (manuscript received 1 Jul 81) pp 570-576

ORLOV, L. K. and ROMANOV, Yu. A., Scientific-Research Physicotechnical Institute affiliated with Gorkiy University

[Abstract] The nonlinear interaction is investigated of three electromagnetic waves with frequencies which satisfy the conditions of decay

$$\ell\omega_1 = \omega_2 + \omega_3 \quad \ell = 1, 3, 5$$

where $\omega_{1,2,3}$ are, respectively, the pumping frequency, idler wave and signal, in a superlattice with a sinusoidal law of dispersion of the energy of electrons. It is shown that with specific conditions, amplification of the signal wave in a given pump field can have an explosive nature. The instability considered in the present paper can be called explosive only with respect to the nature of the spatial build-up of the signal. It is connected with the growth of the negative conduction of the superlattice during an increase of the signal amplitude in a specified pump field. In so doing only one of the interacting waves increases, and not all, as this takes place in the case of ordinary instability. Figures 4; references 12: 10 Russian, 2 Western. [29-6415]

UDC 621.371.3.029.65

STATISTICAL CHARACTERISTICS OF MILLIMETER WAVES REFLECTED BY VEGETATION

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82 (manuscript received 2 Apr 81) pp 1863-1868

ANDREYEV, T. A., POTAPOV, A. A. and KHOKHLOV, G. I.

[Abstract] A phenomenological model of scattering of millimeter waves by forests is considered for a theoretical interpretation of experimental data. A forest covering the ground is regarded as an ensemble of randomly vibrating scatterers with inertia which affect the time characteristics and the spectrum of a reflected signal. Measurements were made with equipment consisting of a radiation source, transmitter-and-receiver antenna, heterodyne oscillator, mixer, i-f amplifier, i-f detector, envelope detector, low-pass filter and recording instrument. Signals at 135 GHz frequency were beamed into a birch (leaf tree) forest and into a pine (needle tree) forest, at wind velocities up to 7 m/s. A correlation and regression analysis of the data has yielded a correlation function with a second derivative and a correlation coefficient decreasing exponentially with increasing correlation time for the intensity of

the scattered field (95% confidence interval 8±0.8 ms for birch trees and 22±2.2 ms for pine trees at wind velocity of 2 m/s). The analysis has also yielded a power spectrum decreasing not slower with increasing frequency than according to the inverse fourth-power law and, on the basis of spectrum width measurements, random modulated by the wind velocity within the $m_V \simeq 0.05 - 0.1$ range. Comparative measurements of the effective cross section for scattering have yielded -3 dB for a birch forest and -11 dB for a pine forest during a rain of 2 mm/h intensity and wind of up to 5 m/s velocity. Figures 4; references 12: 10 Russian, 2 Western.
[91-2415]

UDC 621.372.826:621.396

MULTIMODE INTERFERENCE OF SURFACE LIGHT WAVES IN MICROWAVEGUIDE INTERFEROMETER

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82 (manuscript received 10 Dec 80) pp 1869-1874

OSTROUMENKO, A. P., PRUDKIY, V. P. and SHMAL'KO, A. V.

[Abstract] Multimode interference of surface light waves was studied by a Mach-Zander interferometer consisting of optical microwaveguides with a dielectric stripline load. An analysis on the basis of analogy to integrated optics with negligible continuous part of the wave spectrum yields an added phase shift which increases monotonically to saturation as the effective refractive index increases, at a faster rate for a higher-order mode, and a modulation factor which varies as an oscillatory function of the phase difference between interfering modes of same order. The swing of the modulation factor decreases somewhat but its maximum value does not decrease much as the number of modes in the interferometer increases, because then the absolute values of their derivatives become larger with smaller difference between them. The authors thank V. A. Voznesenskiy and V. N. Pilipenko for assistance. Figures 4; references 13: 3 Russian, 10 Western (1 in translation).
[91-2415]

UDC 621.396.24

AZIMUTH DEVIATION OF SHORT RADIO WAVES ON MERIODINAL EXTENDED TRACES

Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 25, No 5, May 82 (manuscript received 13 Apr 81) pp 508-516

MANAYENKOVA, N. I. and TSEDILINA, Ye. Ye., Institute of Terrestial Magnetism, Ionosphere and Propagation of Radio Waves, USSR Academy of Sciences

[Abstract] This work studies the azimuth deviations of short radio waves on extended (including around-the-world) meriodinal traces. The following items

are considered: 1) Azimuth deviation of angle of arrival; 2) Calculation of azimuth deviation of ray slipping along extended meriodinal traces; 3) Azimuthal deviation; and 4) Antipode displacement. A diurnal variation of azimuth deviations is found for different receiving points on the around-the-world meriodinal traces. Calculations are made for a shift and flattening of the focal "point" in the antipode. At present it does not appear possible to compare the results of calculations with experimental measurements of the azimuth deviations on extended meriodinal traces in connection with the absence of such data in the literature. At the same time it is possible to show that sharp horizontal gradients of a concentration of electrons in the polar regions of a real ionosphere, not considered in models of the ionosphere constructed for calm levels, can produce a substantial effect on the azimuth deviations on extended meriodinal traces. However, as shown in the literature, calculations made on the basis of a model of the ionosphere by the adiabatic method using extended traces including the polar ionosphere have a high precision.
The authors thank V. V. Vas'kov and A. V. Gurevich for discussion of the work and for valuable comments, and G. M. Smirnov for assistance in computer calculations and processing of the results. Figures 4; references 21: 13 Russian, 8 Western.
[29-6415]

UDC 621.396.67.012.12

RADIATION CHARACTERISTICS OF LONGITUDINAL SLOT RADIATORS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82 (manuscript received 4 Jan 81) pp 2022-2024

GOROBETS, N. N. and LYASHCHENKO, V. A.

[Abstract] Three characteristics of a slot radiator, namely its radiation pattern, direction gain and power gain, have been calculated for a narrow slot of arbitrary length. The electric field in the slot was represented as a Fourier series of space harmonics and an infinitely large shield was assumed to adjoin the waveguide. Computer data obtained for wavelengths λ = 2.4, 3.2, 4.1 cm and various ratios of slot length L to wavelength λ agree closely with experimental data obtained with $L/\lambda = 1$. The results should be useful for the design of multielement antenna arrays. Figures 4; references: 2 Russian.
[91-2415]

UDC 621.396.96

POLARIZATION STATISTICS OF OBLIQUE PROBING SIGNALS IN APERTURE OF LINEAR ANTENNA ARRAY

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82
(manuscript received 9 Mar 81) pp 2040-2041

NOVOZHILOV, V. I.

[Abstract] Measurements of the polarization pattern of decameter-wave signals in the aperture of linear antenna arrays for oblique probing of the ionosphere at middle latitudes have been made since 1977. As a result, statistical data have been accumulated which reveal the trend of the space correlation function for fluctuations of the inclination angle of the polarization ellipse (its major axis) at frequencies ranging from 9.7 to 18.8 MHz, the correlation coefficient decreasing from 1.0 at zero distance to 0 at a distance of about 100 m. Histograms of the difference between inclination angles and of its mean-square fluctuations, referred to a measurement base of 120 m, indicate an appreciably nonuniform polarization pattern of signals propagating through the ionosphere, attributable to a shifting of their interference pattern. Figures 2; references 3: 2 Russian, 1 Western.
[91-2415]

UDC 621.396.96'03

RESOLVING POWER OF RADAR STATIONS WITH ANTENNA ARRAYS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82
(manuscript received 12 May 80) pp 2037-2039

KREMER, I. Ya., PON'KIN, V. A. and ROMANOV, A. D.

[Abstract] The resolving power of radar stations with antenna arrays for continuous simultaneous tracking of all targets by simultaneous probing of space and holographic processing of reflected signals can be increased by widening the spectrum of the probing signal. The principle of this method is based on the known dependence of the complex amplitude of the electric field $\dot{\vec{E}}(r,t)$ at a point $r_2 = \{x_2,y_2\}$ of the receiver antenna on the scattering function of the target $f(\xi)$ and on the location $r_1 = \{x_1,y_1\}$ of the radiator in the far zone of space. It is demonstrated on a linear antenna array whose two extreme elements at both ends emit mutually orthogonal signals with complex amplitudes and whose all elements receive the signals reflected by a point target. The expressions for the intensity of the holographically reconstructed image reveal that the major lobe in this case is half as wide and, consequently, the resolution is twice as high as in the case of only one radiating element at the center of the array. Figures 1; references 7: 6 Russian, 1 Western in translation.
[91-2415]

UDC 621.396 + 523.164

RADIO ASTRONOMY USING SUPERLONG BASE RADIO INTERFEROMETERS WITH SYNCHRONIZED TIME SCALES

Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 25, No 5, May 82 (manuscript received 9 Jul 81) pp 485-489

ALEKSEYEV, V. A. and ANTONETS, M. A., Scientific-Research Institute of Radio Physics

[Abstract] The paper examines the use in radio astronomy of superlong base radio interferometers (RISB), and considers methods of determining the coordinates of cosmic radio sources, as well as the parameters of earth chords in their systems. It is shown that use of RISB with synchronized time scales make it possible to obtain both dynamic and geometrical solutions of radio astronomical problems and that these systems are simpler than in the case of use of RISB with systems of independent reception. This makes it possible to attain great precision. In addition to this, RISB-complexes which contain an earth satellite in its structure can operate in a real time scale. By and large this gives a reason to depend on the high efficiency of the use of such RISB for solution of radio astronomical problems and their applications. References 8: 7 Russian, 1 Western.
[29-6415]

UDC 621.396.677.85

SHAPING CHARACTERISTICS OF ZONAL FRESNEL LENSES IN MILLIMETER-WAVE RANGE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82 (manuscript received 28 Apr 81) pp 2027-2030

ANDREYEV, G. A., BAZARSKIY, O. V., KOLESNIKOV, A. I. and KHLYAVICH, Ya. L.

[Abstract] The characteristics of zonal Fresnel lenses which, in addition to light weight and small heat loss, make these devices suitable for shaping space spectra and radio images are analyzed in the millimeter-wave range. In an experiment, a ten-zone Fresnel lens made of acrylic glass with a 400 mm aperture and a 500 mm focal length with a frequency 75 GHz was used for producing radio images. The equipment also included a 40-80 GHz oscillator, a horn antenna, a corrective lens, a scanning antenna, a tuned amplifier and a photographic recording instrument. The performance of this lens was tested in paraxial and nonparaxial configurations. An important consideration is the performance of such a lens in a nonparaxial configuration with the object off the optical axis of the antenna. The pulse response in this case is evaluated in a Fresnel approximation with third-order aberration and paraxial aberration taken into account. Using the Rayleigh criterion for phase leads, the angular field of vision is calculated as a function of the relative distance from the object. Figures 5; references 5: 4 Russian, 1 Western in translation.
[91-2415]

UDC 621.396.677.494

RELATION BETWEEN POWER GAIN AND DIRECTIVE GAIN OF PHASED ANTENNA ARRAYS WITH SPREAD OF PARAMETER VALUES

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82 (manuscript received 12 Mar 81) pp 2024-2027

ZAYTSEV, E. F. and BABENKO, A. I.

[Abstract] The ratio of power gain G to directive gain D of phased antenna arrays characterizes the efficiency of passive antennas and "internal" amplification in active antennas, as well as the receiver sensitivity when referred to the aperture of equivalent noise temperature or to the noise factor. Here this ratio G/D is evaluated for an array with spread values of channel parameters. A wave of unit power is assumed to appear at the input. All intermediate devices (mixers, filters, amplifiers, distributor) are matched and decoupled at their outputs so that this ratio becomes equal to the ratio of output power to input power and independent of the direction to the point where measured. The feeders are generally mismatched at both ends so that the equations describing incident and reflected waves include the scattering matrix. On this basis, the ratio G/D is evaluated taking into account the effect of random deviations of parameters. Random errors are first disregarded and then also taken into account, as is reflection and coupling between radiator elements. Calculations made in the approximation of a large array, i.e., of exciting radio pulses with linear phase lead reveal that phasing errors reduce the output power and thus also the efficiency of or "internal" amplification in active arrays. Figures 2; references 9: 7 Russian, 2 Western (1 in translation).
[91-2415]

UDC 621.396.677; 621.372.83

ANALYSIS OF MODEL EXPERIMENTS AND CALCULATIONS OF CORNER-REFLECTOR ANTENNA FOR SUBMILLIMETER MIXER

Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 25, No 5, May 82 (manuscript received 3 August 81) pp 585-587

KRAYEV, N. P. and STRUKOV, I. A., Institute of Cosmic Investigations, USSR Academy of Sciences

[Abstract] This brief communication analyzes the directivity characteristics of the corner-reflector antenna of a submillimeter wavelength mixer with a short-circuit at the end of the Γ-shaped contact wire of a diode, taking account of the radiation of all its parts. The results are presented of a calculation of the input impedance of the antenna, which are compared with data from measurements of antenna models in the 3-centimeter range. The models were 90° corner reflectors. Figures 1; tables 1; references 10: 3 Russian, 7 Western.
[29-6415]

UDC 621.314.1

OPTIMUM CHARGING OF CAPACITIVE STORAGE DEVICE FROM DC LINE VIA CONVERTER

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 4, Jul-Aug 82
(manuscript received 25 Dec 80) pp 45-47

DOROSHENKO, B. I., KIREYEV, S. P. and OKOROKOV, A. A., Kharkov Aviation Institute

[Abstract] An analysis is made of charging circuits that use intermediate DC-to-AC voltage converters to charge capacitive storage devices to voltages considerably higher than the potential of the available DC supply line. By using an inductance in such circuits with time constant longer than the half-period of operation of the converter, the rectified voltage is controlled by changing the duration of the pulses taken from the source of electric energy, i.e. by pulse-duration modulation in the converter. Two versions of such charging devices are considered in which the inductances are in the alternating or rectified current circuits. In the first the inductance is provided by step-up transformer windings, and in the second by a choke in the rectified current circuit. A varional calculus technique is used to find the optimum laws of current regulation which minimize losses in the circuits at predetermined values of the storage capacitance and charging time. Figures 2; references: 2 Russian.
[34-6610]

UDC 621.314.572

HIGH-POTENTIAL ELECTRONIC VOLTAGE CONVERTER

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 4, Jul-Aug 82
(manuscript received 7 Mar 81) pp 37-44

KOCHKIN, V. I., OBYAZUYEV, A. P. and TOLSTOV, Yu. G., MONIIPT [Moscow Branch of the Scientific Research Institute of Direct Current]

[Abstract] The authors analyze the electromagnetic processes in a voltage converter with completely controllable electronic diodes capable of rectification

and inversion without taking reactive power from the AC line. The operational characteristics of the converter are considered with regard to the working conditions of the diodes and their effect on the quality of the converted energy. Expressions are derived for determining the parameters of the converter from predetermined operating conditions and coefficient of harmonics of the phase current, and for determining working conditions from known parameters. It is shown that the harmonics of the phase current do not influence the average input current. An expression is given for finding the amplitudes of the sine and cosine components of harmonics of the input current. Examples are given of calculation of some converter characteristics under operating conditions with consumption of reactive power and generation of reactive power. Figures 5; tables 1; references: 5 Russian.
[34-6610]

UDC 621.314

WALSH SPECTRUM OF FREQUENCY CONVERTER WITH DIRECT COUPLING

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 4, Jul-Aug 82
(manuscript received 21 May 81) pp 34-37

TSAGARAYEVA, F. O., Northern Caucasus Mining and Metallurgical Institute

[Abstract] A comparative analysis is made of the effectiveness of using trigonometric functions and Walsh functions as a basis for approximating electromagnetic processes in frequency converters with direct coupling and natural commutation. It is assumed in the analysis that commutation of diodes is instantaneous, and that currents across the output of the frequency converter are maximally continuous. The preferable system of approximating functions is selected by expanding the commutated emf's in a series with respect to orthogonal Walsh and Fourier functions, where the period of the expansion is equal to that of the controlling signal. The number of approximating functions z was determined by the passband of the system, the frequency band of the system being broken down into z values of the control signal frequency. The results show that Walsh functions should be given preference for studying the dynamics of such converters. Figures 3; references: 5 Russian.
[34-6610]

UDC 621.391.2

OPTIMIZATION OF INPUT SIGNAL TO LINEAR FILTER FOR MAXIMUM SIGNAL-TO-NOISE RATIO

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82 (manuscript received 25 May 81) pp 1923-1927

POLYAK, B. I.

[Abstract] The optimum input signal with additive correlational noise is determined for a linear filter, taking into account constraints on signal duration and filter bandwidth. Maximum signal-to-noise ratio is used as the optimality criterion and the noise is assumed to be Gaussian with known energy spectrum. The filter is represented as a combination of two four-pole networks in series, the first one converting the correlational input noise to "white" noise and the second one restoring the transfer function of the filter. The maximum attainable output signal-to-noise ratio is calculated on this basis. The transfer function of the complementary second four-pole network and the spectrum of the optimum output signal are found to depend only on the energy spectrum of the input noise and on the spheroidal wave functions which satisfy the integral equation describing the optimum finite-duration input signal for given values of parameter $c = 1/2\omega_m T$ (ω_m - filter cutoff frequency, T - signal period). For comparative estimates is also calculated the optimum signal-to-noise ratio attainable with three different nonoptimum signals (exponential, rectangular, Gaussian), and an $N_1(\omega) = N_0\omega_N^2/(\omega_N^2 + \omega^2)$ noise spectrum, the signal having either the same effective duration of the same spectral width as the optimum signal. The optimum signal improves the signal-to-noise ratio by an amount which increases as the product of signal duration by filter bandwidth decreases. Figures 3; references 6: 5 Russian, 1 Western.
[91-2415]

UDC 537.876.23

CONTINUOUS ASYMPTOTICS OF SOLUTIONS IN THE CASE OF LINEAR INTERACTION OF WAVES IN ABSENCE OF POLARIZED DEGENERATION

Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian
Vol 25, No 5, May 82 (manuscript received 13 Feb 81, after completion 22 Dec 81)
pp 536-545

YASHIN, Yu. Ya. and YASHNOV, V. A., Gorkiy State University

[Abstract] This paper considers a linear transformation of normal waves in 3-dimensional media. A system of coupled equations for the amplitudes of interacting waves is obtained. A first integral is written on the basis of this system. The integral has the sense of the law of conservation of the total energy flux of the interacting waves. Criteria determining the degree of connectedness of the waves are obtained. The radius of interaction within which a noticeable transformation of energy from one wave to another takes place is also found. Only the case of strong interaction is considered. This is when the parameters characterizing the magnitude of the effect of interaction are large or on the order of $(KL)^{-1}$. ($K = 2\pi/\lambda$, λ = length of the wave, L = characteristic measure of the nonuniformity of the medium). Such interaction takes place in the neighborhood of the point of synchronism. It is assumed that a finite number of synchronism points exists along the original ray. Problems are solved concerning the interaction of normal waves in a medium. The properties of the medium change in accordance with the cosine law. Similar problems are also considered mathematically. These problems, particularly nonlinear problems, are described by analogous systems of equations. In these cases a solution is constructed on the basis of a number of perturbation theories. The radius of interaction is determined. The authors thank N. S. Bellyustin, N. G. Denisov, S. Ya. Vyshkind and Yu. A. Kravtsov for dis ussion of various sections of the work and for a number of helpful comments. Figures 2; references 24: 18 Russian, 6 Western (1 in translation). [29-6415]

UDC 621.3.01

MODELING DISCONTINUOUS FUNCTION IN ELEMENTAL BASIS OF AMPLITUDE SELECTORS

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 8, Aug 82 (manuscript received 11 Sep 80, after completion 4 Dec 81) pp 946-951

VOLGIN, LEONID IVANOVICH, doctor of technical sciences, professor, Ul'yanovsk Polytechnic Institute

[Abstract] An adequate basis of logic functions for selection of the largest and smallest of two signals x_1 and x_2 is proposed, namely

$$y = \max(x_1,x_2) = 0.5(x_1 + x_2 + |x_1 - x_2|)$$

$$y = \min(x_1,x_2) = 0.5(x_1 + x_2 - |x_1 - x_2|)$$

naturally duplicating any elementary discontinuous function (mod, sign, lim, $\int$, ext). It also provides a convenient tool for synthesis and analysis of electric circuits with nonlinear control and regulation algorithms modeling such functions, namely amplitude selectors in the form of analog logic elements with transformation function $y = \text{ext}(x_1,x_2\ldots,x_n)$. The applicability of this selection basis to all standard discontinuous functions as well as several nonlinear and logical signal transformations is demonstrated on four types of amplitude selectors also constituting unilateral parallel limiters with adjustable limiting: maximizing, minimizing, maximizing with one inverting input, maximizing with one inverting input and a doubling inverting output. Its applications are further demonstrated on two different amplitude selectors in series, a "pedestal", a median extractor, and a threshold surpassor. Open-loop amplitude selectors can be built with passive or active elements, closed-loop amplitude selectors with feedback require active elements with characteristics of controllable voltage sources. Figures 9; references: 10 Russian.
[62-2415]

UDC 621.316.729.01

ADEQUACY OF DIGITAL MODEL OF PHASE-TYPE AUTOMATIC FREQUENCY CONTROL

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82 (manuscript received 27 Mar 81) pp 2046-2048

RUSSKIKH, N. P.

[Abstract] The prevalent digital model of phase-type automatic frequency control is considered, where the phase detector subtracts the total phase of the reference signal from the total phase of the signal from the controlled

oscillator and then calculates the sine of their phase difference. The model also includes a filter, an amplifier behind the phase detector, and an element which produces a phase delay per cycle equal to the discretization step for the oscillator. Considering the fact that analog components have been replaced with digital equivalents and the phase delay is fictitious, it is necessary to test this model for adequacy prior to its use for design and performance analysis through simulation. This is done here with stability of the system "in the large" and "on the whole" in the absence of noise serving as adequacy criterion. On this basis, the transient processes are found to be identical in two analytically describable variants of a phase-type automatic frequency control system and in this model of such a system: 1) system without filter and 2) system with proportional integrating filter ($m = 0.4$). Numerical experiments indicate that the simulation error caused by introduction of the phase delay becomes negligible when $\omega_h T \leq 0.1$ ($\omega_h = 2\pi\Delta f_h$, Δf_h- frequency holding band, T- discretization step). The frequency locking band will then also be adequately simulated. Figures 3; references: 2 Russian.
[91-2415]

UDC 621.391.037.372:621.325.658

ADAPTIVE DIGITAL METHODS OF SIGNAL PROCESSING

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82 (manuscript received 2 Feb 81) pp 1916-1922

ABRAMOVICH, Yu. I., KRYUCHKOV, V. V., MIKHAYLYUKOV, V. N. and SARYCHEV, V. A.

[Abstract] Digital communication channels with protective compensating channels are considered, and the (N-1)-dimensional vector of signal processing which will ensure minimum interference output power is synthesized by two adaptive methods. The conventional method maximizes the signal-to-interference ratio while minimizing the mean-square error and is based on a representation of the Wiener-Hopf solution which makes it possible to directly estimate, on the basis of the correlational interference matrix and with the aid of the appropriate recurrence relation, the dependence of the interference suppression efficiency on the volume of the learning sample. The other method is based on Gramme-Schmidt iteration and orthogonalization, which in the case of finite-length arithmetic leads to solutions with different properties. The latter makes this method most preferable where the number of simultaneously processed channels must be minimized, while the conventional method remains preferable where the number of channels must be increased until a quasi-isotropic radiation pattern is obtained. Figures 9; references 10: 4 Russian, 6 Western (3 in translation).
[91-2415]

UDC 621.396.96:621.391.26

ALGORITHMS OF SPACE-TIME PROCESSING OF SIGNALS WITH INTERFERENCE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82
(manuscript received 15 May 81) pp 2041-2044

PON'KIN, V. A.

[Abstract] The signal-to-noise ratio at the output of systems for optimal processing and matched processing of signals with interference from an external source is estimated by an approximate method which uses measurement errors in locating a target through optimal processing of signals without interference. Calculations are based on arbitrary locations of target and interference source relative to the receiver antenna. The correlation function is evaluated approximately, with the aid of Taylor series expansion and replacement of its first two terms with an exponential one. The error of this method is evaluated through comparison with exact calculations for a linear antenna with uniform aperture function and narrow-band space-time processing of signals. Both methods are then used for calculating the energy utilization factor in the case of optimal processing and in the case of matched processing, with the target in the far zone and with the interference source in the Fresnel zone of the receiver antenna. Figures 2; references: 5 Russian.
[91-2415]

UDC 538.574.6

DEVELOPMENT OF METHOD OF NONORTHOGONAL SERIES AND INVESTIGATION OF PROBLEM OF DIFFRACTION BY DIELECTRIC BODIES

Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 25, No 5, May 82 (manuscript received 27 Jul 81) pp 580-583

SVESHNIKOV, A. G. and YEREMIN, Yu. A., Moscow State University

[Abstract] This brief communication is concerned with a farther development of the method for solution of the problem of diffraction by a dielectric body of revolution which is presented in a 1980 report by A. G. Sveshnikov and Yu. A. Yeremin (see above). It is concluded that the numerical algorithm developed is effective and that the simplicity and reliability of the computation scheme of the method, as well as the presence of the interior criteria for evaluation of the quality of the approximate solution obtained make it possible to vary the parameters of the geometry of the scatterer and the nature of the filling medium. In problems of optimization of the geometry of the form of the scatterer or interior filling (ε,μ), the algorithm developed can also be used for the purpose of realization of the specified energy nature of the scattered field in the wave zone. Figures 3; references 6: 5 Russian, 1 Western in translation.
[29-6415]

UDC 621.313/314.048.019.9

ABSORPTION CURRENT IN PLANE-PARALLEL PIECEWISE INHOMOGENEOUS INSULATION

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 4, Jul-Aug 82 (manuscript received 27 Oct 81) pp 3-10

IYERUSALIMOV, M. Ye., IL'YENKO, O. S., ABRAMOV, V. B. and VASILENKO, N. V., Kiev Polytechnical Institute

[Abstract] In a previous paper by Iyerusalimov and Il'yenko [see ELEKTRICHESTVO, No 10, 1980 pp 36-41], a mathematical model of absorption

processes in isotropic media was considered in which absorption current i_a was expressed in terms of the free component E_{CB} of electric field strength in insulation because of redistribution of charges in the volume of the dielectric:

$$i_a = \int_{S_э} (\sigma \vec{E}_{CB} + \varepsilon \frac{\partial \vec{E}_{CB}}{\partial t}) d\vec{S}. \quad (1)$$

Here σ and ε are the volumetric conductivity and permittivity of the medium, and $S_э$ is the electrode area. The process of spatial and temporal behavior of electrical field strength in inhomogeneous isotropic insulation is defined by the differential equation

$$\frac{\partial}{\partial t} \operatorname{div}(\varepsilon \vec{E}) + \frac{\sigma}{\varepsilon} \operatorname{div}(\varepsilon \vec{E}) + \vec{E}(\operatorname{grad} \sigma - \frac{\sigma}{\varepsilon} \operatorname{grad} \varepsilon) = 0, \quad (2)$$

where

$$\vec{E} = \vec{E}_{CB} + \vec{E}_y, \quad (3)$$

($\vec{E}_y$ is the field strength in the steady state). In the general case, solution of (2) is complicated as it is not represented in elementary functions. However, in most cases of practical importance, high-voltage insulation can be represented as a piecewise-homogeneous medium in which the interfaces between homogeneous regions are parallel planes. Using this approximation, the authors simplify the solution of (2) and determine absorption current. It is shown that absorption currents in multilayered insulation are equal in magnitude but opposite in sign with carging and discharging. Figures 1; references: 4 Russian.
[34-6610]

UDC 621.396.677.494.71.001.1

EXTERNAL NATURAL AND MUTUAL CONDUCTANCES OF SLOTS IN INFINITE PLANE SHIELD COVERED BY DIELECTRIC LAYER

Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian
Vol 25, No 5, May 82 (manuscript received 21 May 81) pp 554-561

BODROV, V. V. and GRIDNEV, V. I., Moscow Power Engineering Institute

[Abstract] This work describes a means for calculation of the mutual and natural conductances of slot emitters, located under a dielectric layer. Examples are presented which show the necessity for consideration of the effect of the dielectric layer on the parameters indicated. It is noted that the necessity in such a means is caused by the fact that the mutual conductances with respect to various basic functions are an intermediate parameter for calculation of all the technical characteristics of a slot antenna array. The calculation is accomplished by taking into account the mutual effect, both with respect to the interior and the exterior space

wave guide of the slot antenna. In the calculation, the distribution of the electrical field across the slot is described by the function $\psi(X_r')$. This function is either a constant or it takes into account the special features of the field close to the edge of the shield. It is shown that the form of the function $\psi(X_r')$ weakly affects the amount of the conductivity, especially in the resonant region. Graphs are shown of the natural conductance for various dimensions of the slots and the parameters of the dielectric layer. In addition, graphs are shown of the mutual conductances of two slots for two forms of bias. Figures 9; references 9: 7 Russian, 2 Western. [29-6415]

UDC 621.382.2.029.64

PECULIARITIES OF CONTINUOUS OPERATION OF GUNN-EFFECT DIODE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82
(manuscript received 9 Jan 81) pp 2058-2060

KHUCHUA, N. P., SHOYKHET, L. Kh., GUTNIK, L. M. and MAMATSASHVILI, N. N.

[Abstract] The equation of steady-state heat conduction for the "sandwich" model of a Gunn-effect diode with its active region mounted directly on a massive heat sink yields anomalously high hot-spot temperatures at the upper boundary of the active region during constant-bias operation when the active region is mounted on the heat sink through a thin n^+-GaAs sublayer, a metal contact, and a conducting adhesive interlayer. In order to explain this, the equation of heat conduction has been modified so as not to disregard convective heat transfer from active region to ambient medium even when the thickness of the n^+-GaAs sublayer (40-50 μm) by far exceeds the length of the active region (10 μm), as in many practical situations. Temperatures calculated on this basis agree more closely with those obtained experimentally by the method of liquid crystals. The difference between hot-spot temperature and cathode temperature is found to depend less on the "cold" resistance as the thermal conductivity of the interlayer decreases or as the thickness of the sublayer increases. Figures 2; references 8: 2 Russian, 6 Western.
[91-2415]

UDC 621.383.8

DESIGN OF ELECTROOPTIC DIFFRACTION DEFLECTOR TAKING INTO ACCOUNT EDGE EFFECTS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82
(manuscript received 11 Feb 81) pp 2016-2021

DIANOVA, V. A., MUSTEL', Ye. R., SVESHNIKOV, A. G. and SHAPKINA, N. Ye.

[Abstract] A deflection system with a "brilliant" phase grating induced in an anisotropic electrooptic crystal is considered for switching light from

one diffraction peak to another. The longitudinal profile of the phase delay and dependence of the latter on the electric field distribution as well as on the light intensity distribution are calculated from the Laplace equation and the diffraction law, with edge effects at the electrode surfaces taken into account. The corresponding Riemann-Hilbert problem with appropriate boundary conditions is reduced to an infinite system of linear algebraic equations of the Ax = b kind with elements of the A-matrix in the form of Legendre polynomials. A numerical solution based on a 21 x 21 matrix has been obtained, with the aid of a BESM-6 computer, for an $LiNbO_3$ crystal with an electric field parallel to the optical axis. A deflector grating has been designed on this basis for light at the $\lambda = 0.63$ μm wavelength with transverse polarization. Its performance is compared with that of an ideal deflector capable of 100% switching. The results are also compared with experimental data. Figures 5; tables 2; references 5: 3 Russian, 2 Western. [91-2415]

UDC 534.6:551.46

DEVICE FOR MEASURING SPEED OF SOUND ON CONTINUOUS WAVEFORMS WITH FEEDBACK

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 8, Aug 82 pp 70-71

STEFANOV, S. R. and CHISTOSERDOV, Yu. P.

[Abstract] The authors have developed a device for measuring the speed of sound in which the circuit for emission and reception of acoustic waveforms with positive feedback permits realization of a simple form of the phase method of measurement with frequency output. By introducing the feedback between the receiver and emitter via an amplifier, the sensitivity of the device is made independent of the measurement base when the number of acoustic wavelengths between emitter and receiver is much greater than $\phi/2\pi$ (ϕ is parasitic phase advance in electric circuits). A peculiarity of operation of the device is that the length of a sound wave in the medium remains constant: the oscillation frequency automatically varies when measuring the speed of sound. Another advantage of the device is high stability caused by the fact that phase lead in the electric circuits generally does not exceed 2π, so that when the number of acoustic wavelengths between emitter and receiver is much greater than $\phi/2\pi$ the frequency stability is weakly dependent on the measurement base and may reach 10^{-6}-10^{-7}. Disadvantages are the necessity for stand calibration and limited measurement range. It is proposed that circuits with extra receivers be used to overcome these advantages. A two-receiver arrangement has static response with 100 times the slope of the sing-around system. Figures 3; references: 3 Russian.
[33-6610]

UDC 621.3.027:621.317.77

MICROWAVE WIDE-BAND STRIPLINE AMPLIPHASE METER

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 8, Aug 82 pp 66-68

BESPALOV, V. B. and ASLAMAZYAN, A. S.

[Abstract] The authors describe the working principles of a microwave ampliphase meter in which the reference signal and the phase-modulated signal to be measured are sent to the inputs of a ring power divider. The reference signal is equally divided and sent through two channels without phase shift to balanced mixers that act as phase-sensitive components. The signal to be measured is equally divided with a phase shift between halves of 90°, and sent to the second inputs of the same mixers. The resultant currents at the mixer outputs are porportional to the sine and cosine of the relative phase of the signal being measured and its amplitude. A printed-circuit stripline version of this device is proposed. By using a circuit board of foil-covered Teflon 1.5 mm thick with wave impedance of the channel of 50 ohms, admissible nonuniformity of transient attenuation of 0.2 dB in a relative frequency band of 57%, the stripline with wave impedance of 50 ohms will have a width of 2.52 mm. In the coupling region, the stripline will be 0.96 mm wide with a gap of 0.05 mm and length equal to $1/4\lambda$ on the central frequency. For ampliphase meter error of less than 2°, the VSWRs of the individual components and input should not exceed 1.35 with VSWR of the device to be tested of at least 1.1. Tests of the proposed device in a relative frequency band of 54.5% at power of no more than 10 mW in the reference channel showed rms phase error of 1.5°, relative error of amplitude measurement in a dynamic range of 0-20 dB of no more than 0.6 dB, and sensitivity of 10^{-10} W. Figures 2; references 8: 7 Russian, 1 Western.
[33-6610]

UDC 621.317.7

AUTOMATING OSCILLOSCOPIC FREQUENCY DEVIATION MEASUREMENT METHOD

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 8, Aug 82 pp 61-62

ITSIKSON, A. I. and OBUKHOVA, L. N.

[Abstract] The authors suggest a modification of the oscilloscopic method of measuring frequency deviation which can be automated. At the difference frequency between the carrier and heterodyne frequencies, a quasi-horizontal section appears on the oscilloscope, and the voltage is $u_p = U_m \sin \pi\beta$, where β is the ratio of the difference frequency to the modulating frequency. For all but whole-number values of β the voltage is non-zero and depends on β. Signal and modulating frequency requirements are determined for specific radio applications, and a block diagram is given of a device which realizes the proposed method. Figures 1; references: 6 Russian.
[33-6610]

UDC 621.373:621.37/.39.08

MEASUREMENT OF SPECTRUM OF PULSE-MODULATED SIGNAL PHASE FLUCTUATIONS BY FREQUENCY DETECTION METHOD

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 8, Aug 82 pp 58-61

KASHIRIN, V. N.

[Abstract] An examination is made of the spectrum of voltage components in the case of frequency detection of a pulse-modulated signal, and the relation between this spectrum and the continuous spectrum of phase fluctuations. The analysis is based on a typical circuit for measurement of frequency fluctuations with suppression of the carrier, including a modulator, attenuators, phase shifters, a balanced bridge, a resonator, a double waveguide tee, a shorting device, microwave phase detector, and a filter that isolates the frequency band to be investigated. The energy signal spectrum is found in terms of the noise power at the output of the phase detector. It is shown that measurement of the spectrum of phase fluctuations of a pulse-modulated signal necessitates preliminary analysis of the shape of the spectrum of the low-frequency signal in the corresponding frequency range, as well as analysis of the amplitude spectrum of the modulation pulses. The proposed circuit is suitable for measurements except where the spectrum of fluctuations of low-frequency signal phase at the modulator input falls no more slowly than the reciprocal of the square of the frequency band being analyzed. Figures 2; references: 3 Russian.
[33-6610]

UDC 621.382.029:621.317.784

PRECISION WATTMETER FOR PULSED MICROWAVE POWER

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 8, Aug 82 pp 64-66

MYL'NIKOV, A. V.

[Abstract] A pulse wattmeter is described which gives high measurement accuracy and can be calibrated without using laboratory pulse power measurement equipment. The device is based on an energy comparison method: the total energy of the measured pulse $W = \int_0^T P(\gamma)d\gamma$ (T is the pulse recurrence rate) is compared with the energy on a known time interval. The pulse power is then found as the ratio of energy to the duration of this interval. Peak power, or power on any pulse segment can be measured by this method, using appropriate selection of the time interval, which is a complete analog of sampling. A block diagram is given of a device for realizing this method, containing an integrating bolometric converter, an average power

readout unit, an amplifier with two opposed-phase outputs, a cutout with delay line, an adder, pulse voltmeter and frequency meter. The error of such an instrument is 2.5-5%, and is determined mainly by the error of measuring average power. Figures 3; references: 5 Russian.
[33-6610]

UDC 621.315.592

CONTROL OF SEMICONDUCTOR-TYPE POWER SWITCHES BY MEANS OF MICROWAVE RADIATION

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 9, Sep 82 (manuscript received 21 Jun 81, final editing 3 Dec 81) pp 1572-1579

GREKHOV, I. V., KARDO-SYSOYEV, A. F. and KRIKLENKO, A. V., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] Fast switching of heavy power by means of dynistors is analyzed, charge carriers being generated by impact ionization in a field of strong microwave radiation. A p-n structure is considered with the dopant acceptor concentration much higher than the donor concentration in the p-region and with a constant voltage applied to the metallic contact tabs driving the p-n diode toward cutoff. The electric field distribution and the thermal losses in the entire structure, including the space-charge region, are calculated from the Maxwell equations with appropriate boundary conditions. Both electrodes are assumed to be lossless, with infinitely high electrical conductivity. All field components are assumed to be functions of the normal y-coordinate and thus to represent a lowest-order mode. At subthreshold field intensities the carrier concentration in the space-charge region is determined by the leakage current from the p-n junction and is negligible under real conditions. The frequency of the field is sufficiently high to make any change in the thicknesses of the p-region and the n-region because of displacement of the space-charge-region boundary in one half-period negligible. The structure is inserted into a waveguide with a microwave oscillator at one end. Propagation of an electromagnetic wave through this waveguide and its attenuation due to power absorption are calculated, taking into account wall losses. A practical case of exciting a "symmetric" electromagnetic field by means of two identical oscillators, one at each end of the waveguide, and two corresponding transmission lines is also evaluated. Figures 2; references: 3 Russian.
[67-2415]

UDC 621.372.413-434.1

CORRUGATED CYLINDRICAL RESONATORS FOR SHORT-WAVE RELATIVISTIC MICROWAVE GENERATORS

Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian
Vol 25, No 5, May 82 (manuscript received 29 May 81) pp 562-569

DENISOV, G. G. and REZNIKOV, M. G., Institute of Applied Physics, USSR Academy of Sciences

[Abstract] The results are presented of theoretical and experimental investigations of corrugated resonators for relativistic electron generators based on a multimode waveguide of circular cross section with periodic and quasi-periodic corrugations. Part of the results of this work was reported at the 9th All-Union Conference on Microwave Electronics (Kiev, 1979). Conditions and equations of selective interaction of two waves, and coupling coefficients are considered. An experimental investigation was made of several resonators based on a multimode axisymmetric waveguide with rectangular corrugations. The investigation was conducted in the range of 10 mm and 4.0-5.0 mm. The scheme is presented of an arrangement for measurement of resonance frequencies and the Q of oscillations. It is shown that operation of the resonators is based on the effect of the phasing selective reflective of a waveguide wave from periodic inhomogeneities. The authors thank S. N. Vlasov and M. I. Petelin for attention to the work and for helpful council. Figures 6; tables 1; references 14: 9 Russian, 5 Western.
[29-6415]

UDC 621.3.014.7

EFFECTIVENESS OF PROTECTIVE SHUNTING OF PERSON WHO HAS TOUCHED LIVE PHASE

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 4, Apr 82 (manuscript received 16 Oct 81) pp 38-41

GLOVATSKIY, G. G., docent, Order of Lenin L'vov Polytechnic Institute imeni Lenin Komsomol

[Abstract] High-speed phase grounding devices are installed in 3-10 kV electric power networks for protection of a person who has touched a live phase. The development these devices follows an extensive study of the effect of transient low-frequency (50 Hz) current on the human body, both magnitude and duration of the current having been found to determine whether or not fibrillation of the heart can be avoided. Here the performance and effectiveness of a phase grounding device are analyzed in relation to processes occurring after the shunting path has been closed. The resistance of a human body is assumed to remain within 600-1000 ohms independently of the voltage across it, above 1000 V as well as when the voltage drops below that level. On this basis, the voltage across a person to ground is calculated as a function of the distance from the protective device and of relevant circuit parameters. The design of such a device is considered next, namely calculation of its resistance. Its minimum resistance is determined by the substation grounding resistance (not higher than 0.5 ohm), its maximum resistance is determined by the maximum allowable voltage across a person (65 V), on the ratios of resistive and capacitive components of line and fault impedances, on the compensation mismatch factor, and on the capacitive current through the metallic phase grounding conductor. A worst-case design allows for a fault resistance of at least 1000 ohms and a fault location near the protective device. Article submitted by Department (Kafedra) of Electrical Systems and Networks. Figures 2; references: 2 Russian. [63-2415]

UDC 621.316.1:621.311.4

SYNTHESIS OF HIGH-VOLTAGE DISTRIBUTOR CIRCUITS

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 8, Aug 82 (manuscript received 1 Oct 81) pp 17-20

MYSLIN, D. A., candidate of technical sciences, Siberian branch, VGPNII (possibly All-Union State Design and Scientific Research Institute) "Energoset'proyekt" (All-Union State Planning Surveying and Scientific Research Institute of Powers Systems and Electric Power Networks)

[Abstract] The method of graphs is applied to synthesis of power distributing circuits from the standpoint of optimum tradeoff between flexibility, reliability, and economy. The constraints are defined accordingly, the number of necessary interconnections for a given number of power sources and a given number of power users being the major criterion. A tree, a graph characterized by the minimum number of branches for a given number of vertices, is considered more specifically. For any given number of vertices n there is only one configuration possible when $n \leq 3$ but several configurations are possible when $n > 3$ and the number of possible configurations increases fast as n becomes larger. Also various symmetries are considered, e.g., central symmetry leading to a star graph and translational symmetry leading to a chain graph. The effects of adding or removing circuit elements on network flexibility, reliability, and economy are analyzed in terms of adding or removing branches in both types of graph. Figures 2; references: 5 Russian.
[65-2415]

UDC 621.316.721.001

VOLTAGE REGULATION UNDER LOAD IN ELECTRICAL NETWORKS BY MEANS OF THYRISTOR-TYPE DEVICES

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 8, Aug 82 (manuscript received 23 Apr 81) pp 30-34

GUREVICH, V. I., engineer, and SAVCHENKO, P. I., candidate of technical sciences, docent, Kharkov Institute of Mechanization and Electrification of Agriculture

[Abstract] A comparative performance analysis of mechanical and thyristor-type under-load voltage regulators is made on the basis of normalized costs, according to the A. N. Mel'nikov method. The economic effect of changeover from smooth to stepwise regulation without waveform distortion is included in the analysis, taking into account the consequences of nonsinusoidality of the voltage waveform as far as operation of distribution and appliance transformers and of induction motors is concerned. Calculations, using

standard formulas for equipment operating cost factors, have been programmed in FORTRAN on a YeS-OS digital computer. Results indicate that the cost of using thyristor-type under-load regulators can reach levels which, depending on voltage and power rating as well as on the type of load, may yield a negative overall economic effect. Article submitted by faculty council. Figures 3; references: 4 Russian.
[65-2415]

UDC 519.2:681.2.082

DIGITAL PROCESSING OF LASER DOPPLER VELOCITY MEASURER SIGNALS WITH NONUNIFORM DISCRETIZATION

Novosibirsk AVTOMETRIYA in Russian No 3, May-Jun 82
(manuscript received 23 Dec 81) pp 51-57

GAPONOV, V. A. and TOMSONS, Ya. Ya., Novosibirsk

[Abstract] Nonuniform discretization of the measured process is a characteristic feature of optical instruments such as laser Doppler velocity measurers (LDIS), one which affects the subsequent processing of signals and thus also the choice of electronic equipment for this purpose. Here are shown algorithms for estimating the integral characteristics of a random input process, namely its sample mean and spectral density, on the basis of stochastic discretization in some cases but not always into a Poisson distribution. These algorithms have been programmed, and were used in numerical experiments with various sinusoidal test signals. A quadrinomial Blackman-Harris window was used for discretization of these signals into Poisson distributions with $\lambda = 1$ or 0.25. Discretization into an exponential distribution was also tried. The procedure includes special "fitting" of the sequence of readings to the discretization model. This procedure is particularly useful when the mean intensity of the point process which determines the instants of discretization depends on the amplitude of the measured process. The "fitting" can be effected with appropriate hardware or appropiate software. Its effectiveness is demonstrated by the example of a random process discretized first periodically, then into a Poisson distribution, and then into a distribution with the intensity linearly dependent on the amplitude of the signal generated according to the more general model. Figures 5; references 16: 11 Russian, 5 Western (1 in translation).
[61-2415]

UDC 533.6.071.08.532.57

ACOUSTOOPTICAL BEAM SPLITTERS IN TWO-COMPONENT LASER DOPPLER VELOCITY MEASURER

Novosibirsk AVTOMETRIYA in Russian No 3, May-Jun 82
(manuscript received 22 Dec 80) pp 45-50

ANTONOV, S. N., LITVINOV, V. M., PROKLOV, V. V., SKVORTSOV, V. V. and FILATOV, A. N., Moscow

[Abstract] Acoustooptical cells for producing a frequency shift in laser Doppler velocity measurer (LDIS) are designed to ensure minimum light losses and thus accurate measurement with low laser power, and to ensure a sufficiently large temperature-independent angular deviation of the diffracted beam so that the latter can, after splitting, be separated from the nondiffracted one without additional optics. A cell with Bragg diffraction is most promising for this application, and dividing the intensity equally between diffracted and nondiffracted beams makes it possible to combine splitter and frequency modulator in the same element. An acoustooptical cell has been precisely designed and manufactured on this basis, with a paratellurite crystal serving as acoustic waveguide, a (Y + 163°)-cut $LiNbO_3$ crystal serving as converter of ultrasonic waves, and a TeO_2 crystal serving as absorber. Adequate acoustic contact between these components is provided by $C_9H_{11}O_2$ ether, crystalline in the solid state below 100°C, and optical reflectivity of surfaces is reduced by SiO_2 coatings. Cells of this type cover the 4.5-40 MHz frequency range and require only 0.1-0.3 W of power for splitting a light beam into halves. A distinguishing feature of such a cell is its ability to split two light beams simultaneously at different wavelengths. A laser LDIS with such a cell was used experimentally for measuring velocity components and fluctuation parameters of supersonic streams. The authors thank professor G. L. Grodzovskiy for steady interest and helpful discussions. Figures 3; references 7: 4 Russian, 3 Western. [61-2415]

UDC 621.373.826:62

LASER DOPPLER VELOCITY MEASURER WITH LIGHT GUIDE

Novosibirsk AVTOMETRIYA in Russian No 3, May-Jun 82
(manuscript received 21 Jan 81, final version received 9 Oct 81) pp 109-111

YEVSEYEV, A. R., Novosibirsk

[Abstract] Unlike conventional laser Doppler instruments, those with fiber optics as light guides are capable of measuring velocities in optically opaque media such as blood and in two-phase streams with high concentration of solid or liquid particles in the gas or of solid or gaseous particles in the liquid. Measurement is possible here with an optical fiber, or a bundle

of them, accommodated within a sufficiently small locality in the stream. Such an instrument operating with a single fiber and a reference light beam has been built for measuring the velocity of buoyant gas bubbles in a liquid and was tested on air bubbles in glycerin. It consists of a laser source, a mirror with a hole for passing the laser beam, an objective, and a 12 m long optical fiber (core diameter 50 μm, sheath diameter 150 μm, ends cut at right angles to the axis) from which at the other end immersed in the liquid emerges a convergent conical probing light beam. The wave reflected by the fiber wall at this end back into the fiber serves as reference beam, while light scattered by an approaching gas bubble also enters here. Both are transmitted through the fiber to the objective on the front side, which passes them through an aperture lens to a polaroid and from here through a focusing lens to a photoreceiver followed by a band-pass filter before an oscillograph, a spectrum analyzer, and a Doppler signal processor operating in parallel. In the experiment with air bubbles in glycerin an 8 mW LG-52-1 laser and an FD-10 KP photodiode with a 0.3 mm diaphragm yielding a signal-to-noise ratio of the order of 20 dB was used. Bubbles were generated by injection of air into the glycerin container at pressures up to 600 mm H_2O. For verification, measurements were also made with a conventional laser Doppler velometer in the differential mode. Both method of measurements have revealed a linear dependence of bubble velocity on gas pressure. The buoying velocity corresponds to the highest-frequency Doppler signal and pricking a bubble slows it down. Figures 3; references 5: 2 Russian, 3 Western.
[61-2415]

UDC 532.574.082:54

LASER DOPPLER ANEMOMETRY WITH SELECTION OF COHERENT COMPONENT IN OPTICAL SIGNAL

Novosibirsk AVTOMETRIYA in Russian No 3, May-Jun 82
(manuscript received 8 Dec 81) pp 23-29

DUBNISHCHEV, Yu. N., ZHURAVEL', F. A. and PAVLOV, V. A., Novosibirsk

[Abstract] The optical signal appearing in a laser Doppler anemometer is analyzed after passage through a medium with high concentration of scattering particles. Such a signal consists of a coherent component and a "noncoherent" one with overlapping frequency spectra. The probing field of Gaussian beams is assumed to cross a homogeneous stream of scattering point particles. The possibility of extracting the coherent component, the one contained within a narrow band relative to the carrier frequency, is considered in a differential scheme with interference of incoming beams and with the aid of a selective filter. Such a device consists of a laser with a beam shaper containing a frequency shifter, a space where the light beams form the probing interference field with fringes moving at a known constant velocity, and an objective preceded by an aperture stop and followed by a 45° beam splitter. One part of the beam passes through the splitter into the incoherent

channel, namely to a second objective and from here to a photoreceiver. The other part of the light beam is reflected by the splitter into the coherent channel, where it passes through an even space-frequency filter in the Fourier plane of the first objective to a photoreceiver. The filter is matched to the concentration of scattering particles and the parameters of the measurement region in the Fourier plane of the first objective. The performance of this device is demonstrated on a one-dimensional Poisson beam of scattering particles moving at constant velocity. The statistical mutual independence of phase noise in each component can beuutilized for improving the accuracy of measurements with correlational laser Doppler anemometers, the cross-correlation function for the two frequency-demodulated components being obtainable with suppressed phase noise in each and coinciding with the autocorrelation function for the analyzed process. Figures 3; references 5: 3 Russian, 2 Western.
[61-2415]

UDC 532.574.7

DEVELOPMENT OF LASER DOPPLER AND STROBOSCOPIC ANEMOMETERS FOR STUDY OF FAST PROCESSES

Novosibirsk AVTOMETRIYA in Russian No 3, May-Jun 82
(manuscript received 26 Jan 81) pp 38-45

ALKHIMOV, A. P., BOYKO, V. M. and PAPYRIN, A. N., Novosibirsk

[Abstract] Various laser Doppler velocity measurers (LDIS) with direct spectral analysis are available for measuring supersonic two-phase streams, a typical one using an LG-159 helium-neon laser (λ = 632.8 nm, P = 5 mW). They are of the scanning type, and the tracking type. Confocal scanning interferometers are simple in construction and ensure high luminosity, but their time resolution is limited by such factors as pressure variations in the test cell. The time resolution can be improved by use of a Fabry-Perot etalon as a dispersing element with a constant free-dispersion region or a cuniform Fizeau-Tolanskiy interferometer. A drawback of scanning interferometers is the "dead" time during measurements. Continuous measurement is possible with a tracking system using such devices as a spherical interferometer or a cuniform multibeam Fizeau-Tolanskiy interferometer. Another class of LDIS for measurement of fast processes are stroboscopic ones with multiexposure photographic recording and optical processing of data by such methods as space-spectrum analysis. The performance of such an instrument is demonstrated on streams of particles moving at a velocity which does not depend on their size and measurement of this velocity through three exposures (bronze particles, mean diameter 50 μm) and two exposures (particles of acrylic glass, mean diameter 200 μm). Most suitable as light source for these instruments, generating short pulses at given repetition rates, are solid-state lasers with Q-switching such as a ruby laser with a Kerr-effect electrooptical modulator. Figures 2; references 19: 14 Russian, 5 Western (1 in translation).
[61-2415]

UDC 535.8:532.514.4

MEASUREMENT OF SPATIAL CORRELATIONS WITH TWO-CHANNEL OPTICAL DOPPLER ANEMOMETER

Novosibirsk AVTOMETRIYA in Russian No 3, May-Jun 82
(manuscript received 13 Jan 81, final version received 8 Dec 81) pp 102-105

SMIRNOV, V. I. and TIMOFEYEV, A. S., Moscow

[Abstract] All optical Doppler anemometers can be classified into two groups, each utilizing different statistics of the measured optical field for determining the correlation between turbulent fluctuations in the medium. Instruments of the first group analyze second-order statistics of the scattered field and their operation is analogous to that of an astral Michelson interferometer. Instruments of the second group analyze fourth-order statistics of the scattered field and their operation is analogous to that of a Braun-Tviss interferometer. An instrument of the second type includes a special correlator for averaging the product of light intensities at two points of measurement, within a wide solid angle to ensure a high signal-to-noise ratio. A special-purpose two-channel Doppler anemometer of the second type has been developed for measuring the local velocity field and fluctuation intensity as well as the spatial structure of a turbulent stream including the various components of the velocity space-correlation tensor. It consists of a coherent radiation source, a light beam splitter, an ultrasonic modulator in one channel and a mirror followed by another ultrasonic modulator in the other. Light beams are used which correspond to zero-order and first-order diffraction, all the others are diaphragmed. A set of mirrors forms two pairs of probing beams. The scanning system consists of a plane-parallel plate rotating about its axis of symmetry and two half-lenses movable relative to one another. Each of the two receiver channels consists of a prism, an aperture stop, an objective a field diaphragm, and a photoreceiver. The method of measurement with this instrument is based on analysis of two spectra similar to the probability density distributions of projections of two local velocities on two mutually orthogonal sensitivity vectors. Figures 4; references 6: 4 Russian, 2 Western (1 in translation).
[61-2415]

UDC 532.574.7

INSTRUMENT FOR MEASURING LOCAL VELOCITY WITH SCANNING-TYPE OPTICAL FREQUENCY DISCRIMINATOR

Novosibirsk AVTOMETRIYA in Russian No 3, May-Jun 82
(manuscript received 5 Jan 81) pp 107-109

BELOUSOV, P. Ya., Novosibirsk

[Abstract] An optical instrument for measuring local velocity has been developed which uses a scanning frequency discriminator for analysis of the

scattered light and formation of the probing coherent optical signal, instead of a confocal interferometer continuously tracking the signal frequency and requiring complex electronic equipment for automatic frequency control. The performance of this instrument, with a continuously scanning multibeam interferometer used as the discriminator, is explained in terms of relations between laser beam intensity, probing signal, output signal, Doppler frequency shift and measured component of the velocity vector. Such an instrument built with a laser (0.2 mW), Rochon prism, confocal interferometer (200 mm), sawtooth-voltage generator, piezoceramic plate, aperture stop, phase plate, semitransparent mirror, scattered-light intensimeter, focusing lens, rotating disk as test object, tachometer generator, photoreceiver, integrator, and oscillograph has a linear range of 0-30 m/s. In the experimental determination of its discrimination characteristic the oscillograph beam was controlled vertically by the tachometer signal proportional to the disk speed and horizontally by the integrator output signal. The author thanks Yu. N. Dubnishchev for assistance. Figures 2; references 3: 2 Russian, 1 Western.
[61-2415]

UDC 535.231.15

EFFECT OF INTERFERENCE ON REFLECTION OF LASER BEAM POWER BY MULTILAYER RECEIVER

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82 (manuscript received 10 Aug 81) pp 1906-1910

IVLEV, Ye. I.

[Abstract] Reflection of laser radiation power by a multilayer calorimeter-receiver is analyzed, assuming that each layer has uniform optical properties and that a strong "greenhouse" effect minimizes reradiation losses of absorbed long-wave energy. The receiver consists of a 0.2 cm thick quartz window in the front wall of a plane-parallel housing and two separate parallel plates, one 0.1 cm thick of NS-11 glass and one of black oxidized aluminum with a voltage coil around, immersed in flowing water as coolant between the window and the back wall of the housing. The power of reflected radiation is calculated on the basis of interference of beams reflected by each boundary, with the three-dimensional incident beam treated as a superposition of plane waves. The results reveal an almost uniform suppression of interference over a range of window wedge angles up to 10^{-5} rad for a Gaussian incident beam and up to 10^{-3} rad for a "normally" incident beam, also an almost constant reflection coefficient over the 0.4-1.2 μm range of wavelengths. The results can serve as basis for designing the calorimeter window. Figures 4; references 25: 21 Russian, 4 Western.
[91-2415]

UDC 621.383.333

CONFIGURATION OF CONTROLLING ELECTRIC FIELD FOR ELECTRO-OPTIC DEFLECTORS OF LASER RADIATION

Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 8, Aug 82 (manuscript received 10 Jun 81, after completion 5 Apr 82) pp 889-893

NOVGORODTSEV, ALEKSANDR BORISOVICH, candidate of technical sciences, docent, Leningrad Polytechnic Institute

[Abstract] The configuration of gradient-type electro-optic deflectors is considered which will ensure maximally linear field intensity components in the cross section. The configuration of a quadrupole deflector with polygonal cross section is relatively simple, but the field here is necessarily distorted. Taking into account the anisotropy of dielectric properties, the crystal dimensions are calculated which will minimize this distortion. Analysis of the problem involves isotropization of the region with a plane-parallel field and application of the Keldysh-Sedov method to the electric potential in the plane of a complex variable. Expansion of the field intensity gradient into a Taylor series in the vicinity of the center leads to a system of algebraic equations with solutions which are unique and linear, in the form of rational fractions, for the desired cross sections. Figures 1; tables 1; references 6: 3 Russian, 3 Western.
[62-2415]

UDC 629.7.018:1.621.373.8

EFFECT OF FLUCTUATIONS IN MEDIUM ON DIFFRACTIONAL IMAGE OF FOCUSING SYSTEM

Novosibirsk AVTOMETRIYA in Russian No 3, May-Jun 82 (manuscript received 13 Jan 81) pp 114-117

IVANOV, V. V., Moscow

[Abstract] The effect of fluctuations in a turbulent nonhomogeneous medium on local measurements by optical methods in gas streams is evaluated for instruments with circular aperture and spherical aberration. Calculations are made for a lens with focal length f placed at the origin or rectangular Cartesian coordinates in the xy-plane at a distance d, within the Fresnel zone, from a point source of radiation at wavelength λ on the z-axis. The corresponding equation for the light intensity distribution, taking into account diffraction by the lnes and refraction in a randomly nonhomogeneous medium, has been solved numerically after prior simplifying expansion into a Fourier-Bessel series and application of the Graf addition theorem. The results reveal the dependence of the dimensionless normalized intensity at the center of the diffractional image on the level of phase fluctuations in a spherical wave and also the dependence of the characteristic dimension of

the diffraction spot as well as on the intensity at its center on the diameter of the lens aperture. They indicate that, in the case of a strongly fluctuating medium, the signal level at the output of a photoelectronic recording device can always be increased by widening the entrance aperture of the optical receiving instrument. Figures 3; references 5: 3 Russian, 2 Western (in translation).
[61-2415]

UDC 621.315.592

PHOTOEMISSION IN CHARGE-COUPLED DEVICES BEYOND FUNDAMENTAL-ABSORPTION EDGE FOR SILICON

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 7, Jul 82 (manuscript received 17 Jun 81, final version received 5 Nov 81) pp 1239-1243

KLYAUS, Kh. I., OVSYUK, V. N., RZHANOV, A. V., SERDYUK, Yu. N. and CHEREPOV, Ye. I., Institute of Semiconductor Physics, Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] The spectral characteristics of surface photoemission at the $Si-SiO_2$ interface were studied in an experiment with photoexcitation of three-phase charge-coupled devices operating in the storage mode, with three transfer electrodes on a dielectric (SiO_2) layer on an n-Si substrate. Dependence of the photocurrent on the d.c. bias voltage was measured with the photoexcitation energy below 1.1 eV. Dependence of the photoemission efficiency on the photoexcitation energy over the $0.6<\hbar\upsilon<1.2$ eV was measured at 230, 259, 270 K and the results compared with theoretical calculations for 140 and 295 K. The experiment revealed that the photocurrent does not depend on the bias voltage when the latter is lower than the planar-bands level or higher than the threshold level but increases sharply when the latter changes from the lower toward the higher of these two levels. The impurity photoemission efficiency within the impurity range of absorption is now evaluated, assuming a uniform density of surface states over the forbidden band of the semiconductor and a sufficiently short time of hole migration from under the biasing electrodes to the load electrode. The coefficients of thermal electron and hole capture from allowed bands by surface states as well as the cross sections for photon absorption during photoemission of electrons from valence band to surface states and from surface states to conduction band are all assumed to be independent of the energy of thermal levels. The results reveal that to each temperature there corresponds a threshold photon energy below which no hole photoemission signal appears and above which the photoemission efficiency increases linearly with the photon energy. The coefficients of thermal electron and hole capture at the $Si-SiO_2$ do not differ much and are not smaller than

10^{-9} $cm^3 \cdot s^{-1}$. The basic results of this work were reported at the 7th All-Union Symposium on Electron Processes at the Surfaces of a Semiconductor at the Interface Semiconductor-Dielectric, held at Novisibirsk, June 1980. Figures 4; references 12: 6 Russian, 6 Western.
[66-2415]

UDC 621.315.592

NATURE OF EMISSION LINES OF UNDOPED GALLIUM ANTIMONIDE

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 7, Jul 82 (manuscript received 29 Sep 81) pp 1273-1275

AVERKIYEV, N. S., FILIPCHENKO, A. S. and CHAYKINA, Ye. I., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] A study was made of the p-GaSb emission spectrum at 4.2 K, with the two lines J_1 ($\hbar\omega$ = 777 meV peak) and J_2 ($\hbar\omega$ = 797 meV peak) comprising it, under strain. Measurements were made in order to determine the dependence of the degree of linear polarization in the photoluminescence spectrum on the magnitude and the direction of uniaxial strain. Specimens of p-GaAs crystals, undoped with a hole concentration $p = 2 \cdot 10^{17}$ cm^{-3} and [100] or [111] orientation had been cut into 1 x 1 x 4 mm^3 parallelepipeds. Under longitudinal compression, excess charge carriers were excited with a beam from an LG-126 He-Ne laser focused to produce a power density of 6 W/cm^2. Recombinational radiation was detected with a PbS photoresistor and analyzed with an ST-50 monochromator on a grating of 600 lines/mm. Under compression, the J_1-line shifted toward higher energy and the J_2-line broadened with its maximum shifting toward shorter waves. The trend was similar under compression along the [111] axis and along the [100] axis, but in the latter case the J_2-line as well as the α-line were weaker. An evaluation of the pressure dependence of polarization, with the strain-potential constants as free terms, confirms that the J_1-line is associated with "conduction band - double acceptor" recombination and suggests that the J_2-line must be associated with the A^0E-complex (recombination of exciton bound to fine neutral acceptor). The nature of the α-line, appearing only at high pressures above $2 \cdot 10^3$ kgf/cm^2, could not be identified. The α-line could be tentatively associated with states linked to the L-minimum, but further study is needed in order to confirm this. Figures 3; references 8: 6 Russian, 2 Western.
[66-2415]

UDC 621.315.592

CHANGE IN STATIC CONDUCTIVITY OF n-InSb UNDER CONDITIONS OF ELECTRON-PARAMAGNETIC RESONANCE AT SUBMILLIMETER WAVELENGTHS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 9, Sep 82 (manuscript received 24 Aug 81) pp 1548-1553

GERSHENZON, Ye. M., FOGEL'SON, M. S. and KHALITOV, V. Yu., Moscow State Pedagogical Institute imeni V. I. Lenin

[Abstract] An experimental study was made of the change in electrical conductivity caused by electron-paramagentic resonance at submillimeter wavelengths, specifically in n-InSb characterized by an anomalously high g-factor so that EPR occurs already in weak fields. This material is also of particular interest, inasmuch as a new mechanism of "jump" photoconductivity has been discovered in it. Measurements were made with a submillimeter-wave spectrometer using a backward-wave tube rated for 0.55-2 mm wavelengths. Resonance was recorded over the $n = 5 \cdot 10^9 - 8 \cdot 10^{15}$ cm^{-3} range of concentrations difference ($n = n_{donor} - n_{acceptor}$) at temperatures from 1.6 to 12 K in electric fields of 0-0.75 V/cm intensity. The concentration dependence and the temperature dependence of the EPR conductivity change signal is evaluated by comparing the experimental results with estimates based on treating the change in conductivity as a special case of photoconductivity, no other theory being applicable or available. Such estimates are made for specimens with high impurity concentration and for specimens with different types of impurity conductivity. The discrepancy is smallest for specimens where "jump" impurity conductivity occurs. Figures 3; references 17: 10 Russian, 7 Western (3 in translation).
[67-2415]

UDC 621.315.592

INTERIMPURITY ABSORPTION OF INFRARED RADIATION IN WEAKLY DOPED SEMICONDUCTORS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 9, Sep 82 (manuscript received 2 Feb 82) pp 1606-1609

BARANOVSKIY, S. D. and UZAKOV, A. A., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] Absorption of infrared radiation is analyzed which occurs because of phonon-free direct electron transitions within pairs of vacant and occupied impurity centers. The analysis is based on energy relations in a donor impurity band with compensating acceptors. The absorption coefficient as a function of the frequency of the applied electric field is calculated from the integral of probability of such a pair existing in a unit volume, with respect to the difference between the Coulomb electron energies in its two nodes. Numerical calculations have been made through simulation on a digital

computer by the Monte Carlo method for degrees of compensation from 0.1 to 0.9, an analytical expression also being available for low degrees of compensation. The results agree closely with experimental data. The authors thank B. I. Shklovskiy and A. L. Efros for helpful suggestions. Figures 1; tables 2; references 14: 7 Russian, 7 Western.
[67-2415]

UDC 621.315.592

NEGATIVE DIFFERENTIAL PHOTOCONDUCTIVITY INDUCED IN INDIUM ANTIMONIDE BY MAGNETIC FIELD

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 9, Sep 82 (manuscript received 9 Dec 81) pp 1629-1631

MALYUTENKO, V. K., TESLENKO, G. I. and MALOZOVSKIY, Yu. M., Institute of Semiconductors, UkSSR Academy of Sciences, Kiev

[Abstract] Photoconduction and, for comparison, dark conduction current-voltage characteristics of InSb were measured at T = 170 K, of particular interest being the range of n-type negative differential photoconductivity induced by the magneto-concentration effect rather than by heating. The magnetic field crossing the electric field controls the total number of current carriers where their concentration increases with increasing electric field intensity while the probability of nonlinear recombination increases and the effective carrier life time decreases. Measurements were made on 40-100 μm thick n-InSb crystal specimens in a nonheating electric pulse field of intensities up to levels above the range of Schottky-Reed linear recombination (>40-50 V/cm), first without a magnetic field and then with one of 10^3 Oe intensity. One face of a plate specimen was polished mechanically for maximum surface recombination rate and its other face was etched in SP-4 solution for minimum surface recombination rate, the latter side being then illuminated with radiation from a He-Ne laser. Theoretical calculations for small-signal photoconductivity in crossing fields with strongly absorbed radiation impinging on the face with low surface recombination rate confirm that negative differential photoconductivity appears in at least two cases, namely when either Auger inverse cubic-law volume recombination or inverse square-law surface recombination takes place in a crystal in E and H fields oriented so that charge builds up at the illuminated surface. Figures 2; references: 3 Russian.
[67-2415]

UDC 621.315.592

RADIATIVE DEFECTS PRODUCED IN SILICON BY HIGH-ENERGY PARTICLES

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 9, Sep 82 (manuscript received 18 Jan 82) pp 1642-1644

DMITRIYEV, V. M., KOSMACH, V. F. and MOLCHANOV, V. M., Leningrad Polytechnic Institute imeni M. I. Kalinin

[Abstract] Radiative defect buildup in silicon single crystals by light nuclei with an energy of 100 or 400 MeV/nucleon was studied by computer simulation of the processes occurring here. These include successive atom-atom collisions, nuclear reactions (fission), elastic nucleon scattering and Coulomb scattering. Three groups of primary particles (p, α, N) and various secondary particles (p, d, α; Li, Be, B; C, N, O; F, Ne, Mg, Al, Si) were considered. The numerical values obtained for the mean length of disorder domains in silicon (24 Å) agree closely with available experimental data (from 22 Å for pure silicon to 30 Å for proton-doped silicon). Tables 2; references: 6 Russian.
[67-2415]

UDC 621.315.592

CALCULATING KINETIC CHARACTERISTICS OF HOLES IN INDIUM ANTIMONIDE IN STRONG ELECTRIC FIELD BY MONTE CARLO METHOD

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 9, Sep 82 (manuscript received 3 Feb 82) pp 1646-1648

OSADCHIY, V. M. and LUCHININ, S. D., Institute of Semiconductor Physics, Siberian branch, USSR Academy of Sciences, Novisibirsk

[Abstract] Kinetic characteristics of holes in InSb in electric fields up to and exceeding 1500 V/cm at T = 77 K were calculated by the Monte Carlo method, on the basis of the two-band model of the valence band. A parabolic dispersion law was assumed for heavy holes and the Kane law in the two-band approximation was used for light holes. Because of the low population in the band of light holes, the method of trajectory splitting could be applied to analysis of their kinetics. Their population was found to decrease further with increasing field intensity, because of an attendant increase of the frequency of their transitions into the band of heavy holes and a decrease of the frequency of reverse transitions. Intraband as well as interband scattering by polar and nonpolar optical and strain acoustic phonons, also by charged impurities with concentration $N_i = 3 \cdot 10^{14}$ cm^{-3}, were taken into account. The field dependence of drift velocity was found to be qualitatively similar for both kinds of holes; quantitatively the drift velocity of light holes being 4-4.5 higher than that of heavy holes and at most one half that of electrons. Figures 3; references: 7 Russian.
[67-2415]

UDC 621.315.592

ROLE OF SIZE EFFECT IN GLASSY CHALCOGENIDE SEMICONDUCTORS IN STRONG ELECTRIC FIELD

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 9, Sep 82 (manuscript received 23 Oct 81, final edition received 8 Feb 82) pp 1648-1651

KALMYKOVA, N. P., SMORGONSKAYA, E. A. and SHPUNT, V. Kh., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] The behavior of glassy chalcogenide semiconductors in a strong electric pulse field was studied, in a field sufficiently strong for electronic processes to become as pronounced as thermal ones. Transients of pulse currents were measured from the instant offfield application to the steep rise after turn-on. Single voltage pulses of 10^3 V amplitude and 10^{-2} s duration were applied to 70 μm thick "sandwich" specimens of $Si_{12}Te_{48}As_{30}Ge_{10}$. Two sets of current electrodes were alternately used with each specimen, one with a large area of $4 \cdot 10^{-7}$ m^2 and one with a small area of 10^{-7} m^2. The experimental data have been processed in terms of Ohm's law and Joule's law equations in finite differences, with the time period subdivided into n = 10 intervals. The unknown radial profiles of current density and temperature were assumed to be rectangular at each instant of time. For a material with specific heat $c = 3.2 \cdot 10^6$ $J/(m^3 \cdot K)$ and thermal conductivity $\lambda = 5 \cdot 10^3$ $W/(m^2 \cdot K)$, the evolution of the high-temperature channel is calculated in terms of current density, temperature, and cross-sectional area as functions of time. The results confirm the validity of the model of nonuniform current flow and heating in which both increase with decreasing area of the electrodes and their distributions become more nonuniform with time. The "size effect" is thus manifested in dependence of channel parameters and, consequently, of switching parameters on the area of the electrodes. Figures 3; references 8: 6 Russian, 2 Western. [67-2415]

UDC 621.382.2

EFFECT OF LASER IRRADIATION ON ELECTROPHYSICAL PROPERTIES OF EPITAXIAL PbTe FILMS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 9, Sep 82 (manuscript received 28 Dec 81, final edition received 5 Mar 82) pp 1687-1689

GORIN, Ye. A., BEREZHNAYA, I. A., GENERALOVA, D. A., YEMELIN, S. N. and YANKO, G. I.

[Abstract] An experimental study was made of changes in concentration and mobility of charge carriers in PbTe films produced by the "hot wall" epitaxial

process under vacuum and then irradiated by a neodymium pulse laser (λ= =1.06 μm). These films were grown to a 2-5 μm thickness in the (111)-plane of freshly cleaved BaF_2 single crystals. The specimens were heated by laser radiation in the Q-switching mode with pulses of 100 ns duration and energy densities from 0.2 to 0.8 $J \cdot cm^{-2}$, above the melting threshold, to avoid cracking of the BaF_2 surface layer and destruction of the PbTe film by either Q-switching pulses of longer duration or quasi-continuous free-emission pulses. Measurements were made on pure p-type specimens and on specimens with copper or indium metallization films for doping by means of the laser radiation. Irradiation at an energy density higher than 0.4 $J \cdot cm^{-2}$ was found to invert a p-PbTe film with 0.03-0.05 μm thick copper metallization to an n-PbTe film, at 300 K as well as at 78 K. The experimental data and theoretical calculations of the temperature profile produced by a rectangular surface-absorbed laser pulse, with attendant superheating of the material to 1500°C taken into account, indicate that fast local heating and cooling of the material results in formation of acceptor-type defects in it. Figures 2; tables 1; references 10: 7 Russian, 3 Western. [67-2415]

UDC 621.315.592

KINETIC THEORY OF LONGITUDINAL HALL EFFECT IN HIGH-FREQUENCY ELECTRIC FIELD

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 9, Sep 82 (manuscript received 9 Mar 82) pp 1689-1691

PANKRATOV, A. A. and EPSHTEYN, E. M.

[Abstract] A kinetic theory of the longitudinal Hall effect in semiconductors has been constructed where nonlinearity of this effect is caused by heating of charge carriers by the high frequency electric field. The frequency dependence of this effect is also accounted for when that frequency becomes comparable with or higher than the relaxation frequencies. The theory is based on the kinetic equation for electrons (or holes) in two constant fields, electric and magnetic, and a high-frequency electric field, also on the classical Boltzmann equation with quantum effects disregarded. Scattering is assumed to be quasi-elastic. The components of the conductivity tensor and then the Hall effect (ratio of values of Hall constant with and without parallel high-frequency electric field respectively) are calculated by the method of successive approximations, with the amplitude of the high-frequency field in the quadratic approximation. The one component of the conductivity tensor which vanishes in the phenomenological theory does not vanish here when dispersion is included. The theory also establishes a power-law dependence of relaxation time on energy. References: 3 Russian. [67-2415]

UDC 621.315.592

QUANTUM OSCILLATIONS OF PHOTOCONDUCTIVITY IN SEMICONDUCTORS DURING ELECTRON HEATING BY RADIATION

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 9, Sep 82 (manuscript received 24 Dec 81, final edition received 6 Apr 82) pp 1706-1709

GASAN-ZADE, S. G., SAL'KOV, Ye. A. and SHEPEL'SKIY, G. A., Institute of Semiconductors, UkSSR Academy of Sciences, Kiev

[Abstract] Quantum oscillations of photoconductivity in semiconductors are analyzed which occur during heating of electrons by light, considering that the energy spectrum of electrons in a strong magnetic field acquires a discrete (Landau) structure. Photoconductivity measurement under these conditions is shown to be more advantageous, from the practical experimental standpoint, than measurement of Shubnikov-deHaas oscillations of other kinetic or thermodynamic coefficients, inasmuch as it makes possible modulation and extraction of the oscillatory component of a semiconductor characteristic as a function of the magnetic field intensity. Such measurements were made on specimens of $Cd_x Hg_{1-x}Te$ ($x \tilde{-} 0.2$), n-InSb and n-InAs ($n = 5 \cdot 10^{15} - 5 \cdot 10^{17}$ cm^{-3}) at $T = 4.2$ K in a magnetic field of intensities not exceeding 70 kOe produced by a superconducting magnet. The specimens are irradiated by a light-emitting diode ($\lambda = 0.93$ μm), and LG-126 laser ($\lambda = 0.63$, 1.15, 3.39 μm), and a CO_2-laser ($\lambda = 10.6$ μm), with the radiation modulated by means of a mechanical chopper at frequencies up to 10 kHz. The field dependence of the magnetoresistivity and its oscillatory transverse component was determined, the latter being measured through compensation of the linear component, also that of the useful photoconduction voltage signal and the μ-photoconductivity. The method is quite sensitive and, because equilibrium electrons are efficiently heated by hot photocharge carriers, requires very low radiation power. Figures 2; references 8: 7 Russian, 1 Western.
[67-2415]

UDC 62.83

ZERO-OVERSHOOT RESPONSE IN GATED DC ELECTRIC DRIVES WITH ON-OFF CONTROL

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 4, Jul-Aug 82
(manuscript received 22 Dec 80) pp 70-73

ZELENOV, A. B. and PIKHAY, A. G., Kommunarsk Mining and Metallurgical Institute

[Abstract] An examination is made of the influence that the frequency of zero-overshoot operation has on the limiting dynamic and static capabilities of an on-off system for controlling a gated DC electric drive. A method is proposed for calculating the parameters of such control systems with regard to particulars associated with the final frequency of the zero-overshoot operation. Analysis shows that the minimum permissible frequency of zero-overshoot operation determines the limiting dynamic and static indices in an on-off control system working in this mode. Figures 3; references: 2 Russian. [34-6610]

UDC 721.011.658

SCIENTIFIC AND TECHNICAL RESEARCH IN ELECTRIC POWER: STATE OF ART AND TASKS AHEAD

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 4, Apr 82 (manuscript received 12 Feb 82) pp 3-10

VENIKOV, V. A., doctor of technical sciences, professor, Order of Lenin and Order of October Revolution Moscow Institute of Power Engineering, chairman, Electromechanics and Power Engineering Section of Scientific and Technical Council to USSR Ministry of Higher Educational Institutions, distinguished promoter of science and engineering in the RSFSR, distinguished holder of Lenin and State Prizes

[Abstract] Soviet electric power research and development are characterized by the system approach to their three different but closely interrelated aspects: scientific-technical, ecological (biospherical), and socio-political. In the scientific-technical arena the main four tasks are devising a universal methodology for solution of all problems in this complex cybernetic-type system; devising for this purpose a new principle of inquiry based on synthesis rather than analysis and aimed at controlling, adaptively if possible, rather than demonstrating and explaining system performance; providing an adequate mathematical apparatus; and utilizing all applicable new means at disposal in the solution. Fulfillment of these tasks should stimulate changes in design and forecasting procedures as well as faster introduction of new equipment. Specific areas where this applies, where new available possibilities should stimulate almost revolutionary changes in concept and approach are a.c. electric power transmission, regulation of reactive power with attendant alleviation of stability problems, selection of voltage levels, choice between overhead and underground construction, hardware design and manufacture, changeover from older to newer equipment, and automation. The main three requirements for carrying out those tasks are training of engineers to do the job, training of instructors to teach the engineers, and targeting of the scientific research activities in higher educational institutions toward the future. References: 31 Russian. [63-2415]

UDC 535.31

EVALUATING DEGREE OF COHERENCE IN PHOTOLITHOGRAPHY PROJECTION SYSTEMS

Moscow ZHURNAL NAUCHNOY I PRIKLADNOY FOTOGRAFII I KINEMATOGRAFII in Russian
Vol 27, No 5, Sep-Oct 82 (manuscript received 23 Dec 80) pp 323-327

GUREVICH, E. S., SHALAPENOK, A. A., LOPATENKO, V. Ye. and NISKOVSKIKH, B. F.

[Abstract] The authors determine the optimum degree of filling of the entrance pupil of the object lens in raster systems of projection photolithography which give fields of illumination 100-150 mm in diameter with nonuniformity of 2-5%. In the illuminator used in the experimental part of the work, a collector-condenser system illuminates the first raster, while the second raster is located in the focus of the first, and is followed by a lens system which produces a magnified image in the object plane. In this system, the images of all lenses of the first raster are superimposed, giving the required nonuniformity of 2-5%. Two parallel slits in an opaque screen in the object plane produce an interference pattern from which the degree of coherence between points in the centers of the slits can be determined. The results show that the optimum degree of filling of the entrance pupil is 0.3-0.4 for elements measuring 1 μm, and 0.4-0.5 for elements smaller than 1 μm. It is concluded that the best illumination with minimum nonuniformity is given be rasters of small lenses (3.5-4 mm in diameter) with the thinnest possible separators, the entrance pupil of the objective lens being partly filled, while the raster is completely filled with light from the source. Observance of the proposed recommendations should give optical projection systems for photolithography that can produce elements as small as 0.8-1 μm. Figures 5; tables 2; references 10: 2 Russian, 8 Western.
[41-6610]

UDC 537.529

MECHANISM OF ELECTRICAL EXPLOSION OF CONDUCTORS

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 4, Jul-Aug 82
(manuscript received 4 Mar 81) pp 22-28

KRIVITSKIY, Ye. V. and KHAYNATSKIY, S. A., Planning and Design Office of Electrohydraulics, UkSSR Academy of Sciences, Nikolayev

[Abstract] An analysis is made of the dynamics of adiabatic heating of a conductor by high-density current ending in an explosion. The singular part of resistivity predominant near the critical temperature T_c is considered (where T_c determines the instant of explosion where conductivity vanished because of destruction of the conductor). In this region, the temperature dependence of resistivity is given by $\rho(T) = \rho_0(1 - T/T_c)^{-n}$. In addition to this relation, the initial system of equations includes the equation of the RLC discharge circuit and the equation of heat balance. The analysis is

based on analogy between the behavior of electrical conductivity in the vicinity of the critical temperature and the behavior of the order parameter in the theory of phase transitions of the second kind. A relation is derived for resistance of the conductor as a function of current and the threshold energy that determines the explosive nature of conductor destruction. The derived threshold condition that sets limiting values of circuit parameters for explosive destruction agrees well with experimental data, showing that the proposed thermal mechanism of explosion of conductors is based on effects analogous to critical phenomena. Figures 1; references: 14 Russian. [34-6610]

UDC 621.315.55:537.312.52

INVESTIGATION OF SUPERCONDUCTORS IN LOW-AMPLITUDE VARIABLE MAGNETIC FIELDS

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 4, Jul-Aug 82 (manuscript received 15 Feb 82) pp 17-22

MILOSHENKO, V. Ye., PANTELEYEV, I. N. and SHUNIN, G. Ye., Voronezh Polytechnical Institute

[Abstract] A method of torsional ostillations is used to study losses in superconductors caused by the action of alternating magnetic fields on cryoelectromechanical devices. In the experimental part of the work, a specimen in the form of a plate was secured to a string stretched between holders and forming a capacitor with a stationary electrode 0.1 mm away. This capacitor acted as a sensor for determining the logarithmic decrement and frequency of oscillations of the specimen. Frequencies used ranged from 50 to 1000 Hz, and the alternating field was set up in the specimen as a result of oscillations in a magnetic field of $0-8\cdot10^4$ A/m. The proposed technique is sensitive enough to study losses in thin-film superconductive coatings down to 30 nm thick. The specimens were plates of niobium, vanadium, lead-indium alloys with different indium contents, and also films of these metals made by vacuum sputtering on sapphire and "polikor." Relations are derived for magnetic field dependences of the relative change in natural frequency and of $\delta = \Delta W/2W_0$, where ΔW are losses per period, and W_0 is the total kinetic energy of a plate with given moment of inertia, oscillating with given amplitude and angular frequency. The specimens were studied in the normal and superconductive state with changes in the orientation of the magnetic field and the natural frequency of oscillations. The results show that the proposed method is an effective means of studying losses and the nature of penetration of an alternating magnetic field into a superconductor. Figures 4; references 9: 8 Russian, 1 Western. [34-6610]

UDC 621.372.2

ELECTROMAGNETIC WAVES IN THIN-FILM SUPERCONDUCTING LINES

Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian
Vol 25, No 5, May 82 (manuscript received 7 Aug 81) pp 527-535

NIKITINA, N. Ye. and OSTROVSKIY. L. A., Institute of Applied Physics,
USSR Academy of Sciences

[Abstract] A solution is presented for the problem of the drop of electromagnetic waves at superconducting layers of finite thickness. An analysis of this makes it possible to single out two interesting cases of propagation of electromagnetic waves in an open laminated structure. These are: 1) Non-radiating rapid modes which are directed along a line and are analogous to slow Sichart waves, but with a nonzero field at the outer surface; and 2) Leaky waves which represent another type of radiation from the line than that considered in a 1970 report by C. S. Owen and P. J. Scalapino (J. Appl. Phys., 1970, 41, p 2047). The following items are studied in the present paper: 1) Reflection and refraction of electromagnetic waves in the case of drop at a superconducting layer; 2) Leaky waves in thin-film superconducting structure; and 3) Waves guided along layers. It is shown that the special features of the propagation of electromagnetic waves in a structure which includes a thin-film superconducting line are connected with the fact that the shielding properties of a superconducting layer are determined by the distribution of superconducting currents in them. In the quasi-statistical case considered, the distribution depends on the nature of the nonuniformity of the magnetic field along a normal to the layer. With determined angles of drop of a wave, the layer is equivalent to an ideal conductor of a diamagnetic. The effect of shielding is much less in the intervening region. As a result the thin-film superconducting line with $\varepsilon_1 > \varepsilon_2$ possesses some directional effect on the leakage of the nonuniform waves. With $\varepsilon_1 < \varepsilon_2$ the structure in question does not have a sharply expressed directional effect and with drop angles at the thin layer, which correspond to internal reflections, sustains propagation along the line with an arbitrarily small thickness of the film. References 7: 2 Russian, 5 Western.
[29-6415]

UDC 621.315.21:537.312.62

SELECTION OF POWER RATING AND SPACING OF COMPENSATING DEVICES FOR CRYOGENIC ELECTRIC TRANSMISSION LINES

Minsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ENERGETIKA in Russian No 4, Apr 82 (manuscript received 29 Sep 81) pp 11-16

POSPELOV, G. Ye., doctor of technical sciences, professor, FEDIN, V. T., candidate of technical sciences, docent, and GONCHAROV, V. M., engineer, Order of Labor Red Banner Belorussian Polytechnic Institute

[Abstract] The load capacity of cryogenic a.c. electric transmission lines is determined essentially by the stability limit in parallel operation and the stability limit for the superconducting state. The former constraint requires compensation, which is considered here in the case of coaxial pairs of phase conductors with columbium stannide as superconducting material. The line operates without voltage drop when the voltage at both ends is maintained at the same nominal level by compensators spaced symmetrically along the line. Calculations based on voltage and current relations in such a circuit yield first the maximum power transmittable without compensation as a function of the distance and then the power of longitudinal compensation, as well as the power of attendant transverse compensation, as functions of the nominal load power at various line voltages. The results reveal that capacitive transverse compensation is required at or near full load and inductive transverse compensation is required near no load. Numerical data covering the load range of 1-20 GW for cryogenic 50-500 km long 110, 220, and 330 kV lines indicate that longitudinal compensation is required approximately every 250-200 km, the closer spacing of compensators corresponding to higher line voltage. Article submitted by Department (Kafedra) of Electrical Systems. Figures 4; references: 3 Russian.
[63-2415]

UDC 771.351.7

OBJECTIVE LENS FOR FOURIER ANALYSIS OF LARGE-SCALE PHOTOGRAPHS

Moscow ZHURNAL NAUCHNOY I PRIKLADNOY FOTOGRAFII I KINEMATOGRAFII in Russian Vol 27, No 5, Sep-Oct 82 (manuscript received 13 Aug 81) pp 358-360

BELINSKIY, A. V., Moscow Institute of Engineers in Geodesy, Aerial Photography and Cartography

[Abstract] An objective lens is proposed for use in the method of coherent spatial filtration in which an immersion fluid is used as an element of the optical system. Such an objective can be made equivalent to a three-lens system by using glass and immersion fluid with different refractive indexes, and by making the fluid-glass interfaces spherical. The objective operates

with linear magnification of -1, and has a symmetric optical system with parallel rays in the fluid and with pupil in the plane of symmetry. A formula is derived for calculating the radii of curvature in such a lens to give zero shperical aberration. The proposed method is used for calculating an immersion objective to operate with helium-neon laser emission. Resolution in the center of a frame measuring 180 x 180 mm is about 50 mm^{-1}. Minimum values of spherical aberration of higher orders are realized by using grades of glass with index of refraction of 1.63-1.69. Figures 2; tables 1; references: 2 Russian.
[41-6610]

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