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JPRS L/9648

7 April 1981

USSR Report

ELECTRONICS AND ELECTRICAL ENGINEERING

(FOUO 3/81)

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AMPLIFIERS

UDC 621.375

MICROWAVE TRANSISTORIZED LINEAR AMPLIFIERS

Moscow LINEYNYYE TRANZISTORNIYYE USILITELI SVCH in Russian 1980 (signed to press 19 Mar 80) pp 2, 365-368

[Annotation and table of contents from book "Transistorized linear SHF Amplifiers", by Naum Zinov'yevich Shvarts, Izdatel'stvo "Sovetskoye radio", 10,000 copies, 368 pages]

[Text] The book is devoted to the theory, design and principles of the construction of transistorized linear microwave amplifiers. Questions of modeling, stability and broadband matching of such amplifiers are treated, as well as methods of their design and realization.

It is intended for radio specialists involved in the development of transistors and amplifiers designed around transistors.

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ANTENNAS

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SHIP ANTENNAS

Leningrad SUDOVYYE ANTENNY in Russian 1979 (signed to press 10 Jul 79) pp 4, 270-272

[Annotation and table of contents from book "Ship Antennas", by Marat Vladimirovich Vershkov, Izdatel'stvo "Sudostroyeniye", 4500 copies, 272 pages]

[Text] The book generalizes and systematizes original material on the methods of studying, constructing, calculating and designing ship antenna devices, and also on methods of measuring their major parameters.

This work is based on the author's book "Ship Antennas" published in 1972. The second edition includes additional material from research and development done over the period from 1970 to 1977, which is of interest to specialists in the area of marine electronics and radio communications.

The book also gives information on such new types of ship antenna devices as top-loaded vertical antennas, antennas with meander-line and inductive-capacitive loading, the wide-band multidipole antenna, the log-periodic directional shortwave antenna, magnetic dipole reception antennas, UHF antenna devices and so on.

The book is intended for readers acquainted with general antenna theory. It is written mainly for scientists, technicians and engineers working in development and design of ship antennas and radio equipment. The book will also be of use to radio specialists in steamship lines, instructors, and students majoring in the corresponding fields.

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[114-6610]

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CERTAIN ASPECTS OF PHOTOGRAPHY, MOTION PICTURES AND TELEVISION

UDC 621.397.331.001.57

ON THE CHOICE OF THE NUMBER OF SCANNING LINES OF A TV STORAGE CAMERA DURING TRANSMISSION OF DOT OBJECTS

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 11, Nov 80 pp 46-50

[Article by V. P. Mandrazhi, L. L. Polosin, and A. Ya. Ryftin]

[Text] Television systems using storing tubes are being used widely not only in television broadcasting, but also in industry, space studies, medicine, nuclear technology, and astronomy. Television systems used in these areas not only reproduce images, but also automatically determine the position, brightness, dimensions, or the shapes of individual details of the image. For example, operation of the automatic raster matching device in three-tube color TV cameras is based on the determination and comparison of the coordinates of reference marks of a special text in the red, green, and blue channels. TV systems for astronomy not only expand the operational radius of a telescope, but also measure the coordinates and brightness of dot objects of stars.

However, during the reading of the charge pattern from the target of transmitting storage tubes, the pulsation effect -- adaptation of the reading beam is observed [1, 2], which causes the shifting of the coordinates and distortion of the brightness of small details of the image. These distortions, which, in principle, are characteristic of light-signal converters using storing tubes, differ with respect to the field of vision of TV systems [6], depend on the dimensions, brightness, and the number of scanning lines, and until recently did not lend themselves to calculations with the necessary accuracy.

The work [3] proposed a method of computer modeling of nonlinear processes of storing, reading, and formation of the signal current in transmitting storing tubes with preswitching amplification (secon, supersilicon) which are highly sensitive. This, in turn, made it possible to create programs for mathematical computer simulation of a TV storing camera from "light" to output signals and to select the parameters of a TV storing camera during the transmission of dot objects.

The possibilities of mathematical simulation are shown by us below on an example of the optimization of the main parameters of the TV camera -- the number of scanning lines. Optimization was done by coordinate shifts in measuring the brightness, brightness distortions, and the value of the signal-noise ratio. However, this method, as is shown below, can be used without substantial changes for any TV images.

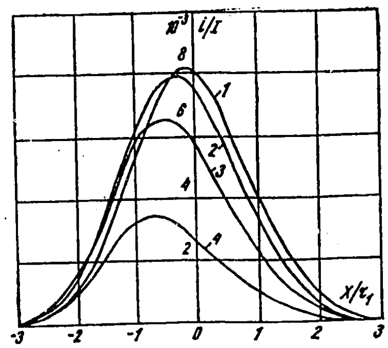

Figure 1. Shapes of maximum-amplitude line video pulses for U_T = 2 B, r_0 = r_1 = 18 microns for various numbers of lines in the frame: 1 — z = 800 (g_σ = 0,375); 2 — z = 400 (g_σ = 1,5); 3 — z = 200 (g_σ = 3); 4 — z = 100 (g_σ = 6)

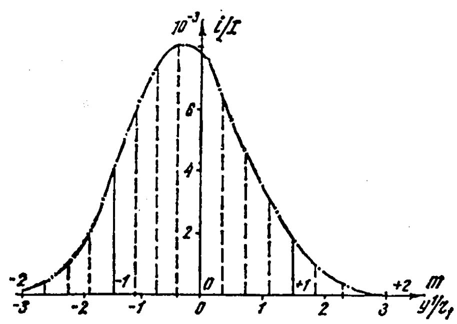

Figure 2. Envelope of video pulses in the frame at z = 400 (g_σ = 1.5), U_T = 2B, r_0 = r_1 = 18 microns.

The results of mathematical simulation conducted in accordance with the method of [3] ensured good coincidence with the experimental data. Let us assume that we are given the Gaussian distribution of the electrons in the beam j(u,g) with a conditional radius r_1 and full current of the beam I, as well as the Gaussian distribution of illumination in the image of the dot object E_1(u,g) with a conditional radius r_0 on the target of the tube. As a system of coordinates, let us take an orthogonal normalized system $u = x/r_1$, $g = y/r_1$ with the center coinciding with the beginning of the raster.

At a constant height of the target h, changes in the number of lines z lead to changes in the relative shifting of the lines $g_\sigma = h/zr_1$ and the band of the transmitted frequencies $F = (z/z_o)^2 F_o$, where F_o is the optimal frequency band for the number of lines z_o. The effectiveness of the accumulation of the potential on the target will be approximated by a function of the kind of $\alpha(U) = \cos^2(a_H U)$, where U -- potential accumulated on the target; $a_H = \pi/2U_{s.p}$ -- coefficient inversely proportional to the potential of the signal plate $U_{c\pi}$.

We shall approximate the secondary-emission characteristic of the target by a function of the kind of

$$\sigma(U) = 1 - (1-\sigma_M)\sin^2\left[\frac{\pi}{2}\cdot\frac{U-U_K}{U_M}\right],$$

where σ_M -- minimal value of the secondary emission coefficient: U_M -- potential of the target at which $\sigma = \sigma_M$; U_k -- cathode-target contact potential difference.

The above approximations correspond to the relations obtained experimentally for tubes with preswitching amplification [4] under the conditions that $0 \leq U \leq (1.0-1.2)\, U_M$ and $0 \leq U \leq U_{s.p}$ which are practically always fulfilled. The method of calculating the video signal consists in the following. From the solutions of the appropriate differential equations describing the processes of the storing and reading of the charge pattern, let us determine the stored potential in each frame and the postswitching potential after the reading by z-lines. This makes it possible to determine the potential of the target $U_{n,m}(u,g,z)$ in the m-th frame after reading the n-th line. The accumulated potential is the initial condition for the solution of the differential equation of reading, and the postswitching potential is the initial condition for the solution of the differential equation of storing. By the obtained potential $U_{n,m}(u,g,z)$ with consideration for formula (2), it is possible to determine the signal current at the output of the tube

$$i_c = \iint_{-\infty}^{\infty} j(u,q)\,[1-\sigma(U)]\,du\,dg = (1-\sigma_M)\iint_{-\infty}^{\infty} j(u,g)\sin^2\left\{\frac{\pi\,[U_{n,m}(u,g,z)-U_K]}{2U_M}\right\}\times du\,dg.$$

This formula was used to compute two-dimensional characteristics of the video signal for the following parameters[1]: storage $a_H = 0.1$, r_o = 10-40 microns, T_H = 0.04 C, U_T = 0.5-15 V, reading r_1 = 18.3 microns, g_σ = 0.375-6 (z = 1600-100), $\sigma_M = 0.4$, U_M = 15 V, I = 2 microamperes. Here, in accordance with [3], the following designations are taken: $U_T = \varepsilon k E_o T_H/C_o$ -- potential proportional to the maximum illumination of the object; ε -- integral sensitivity of the photocathode; k -- amplification factor of the target; E_o -- maximum illumination on the photocathode; T_H -- accumulation time (frame period); C_o -- specific capacitance of the target.

1. The values of the parameters a_H, r_1, σ_m, I were selected in accordance with the experimental data given in works [3] and [4].

Due to the large volume of computations, simulation was done on an YeS-1050 electronic computer. It was done for one-inch supersilicons and secons and a square shape of the working area of the target of 11 X 11 mm2.

Simulation showed that the shape of video pulses from fixed dot objects depends little on the number of lines and is close to the Gaussian distribution (Figure 1). When the number of lines decreases, the trailing edge of the video pulse becomes somewhat flatter than the leading edge, and the video pulse shifts in the direction opposite to the direction of the movement of the beam. In Figure 1, the point $x'/r_1 = 0$ corresponds to the position of the center of the dot object.

At the illumination of the dot objects corresponding to the linear section of the light-signal characteristic, the length of the video signal in the units of length adjusted to the target does not change when the number of lines changes.

Figure 2 shows the distribution of the amplitudes of video pulses over the frame lines m. Here, at m = 0, we took a line coinciding with the true position of the object, dashed lines are used to show the amplitudes of video pulses when the position of the lines shifts in relation to the center of the object, and the dot-dash line shows the envelope of the video pulses in the frame.

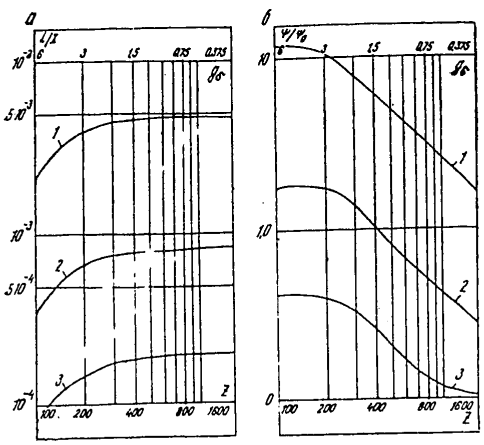

Figure 3. The dependence of the amplitude of the video signal (a) and the ratio (b) on the number of lines in the frame for $r_o = r_1 = 18$ microns for different intensities of illumination of the dot object: 1 -- U_T= 15 V; 2 -- U_T = 2 V; 3 -- U_T = 0.5 V

When the conditional radii of the switching beam and the image of the object are equal ($r_1 = r_o = 18$ microns), the length of the video signal both along and across the lines at a level of 0.5 of its amplitude is 2.2-2.4 r_1 (Figures 1 and 2). For one-inch secons and supersilicons this corresponds to 40-44 microns on the target or 65-70 microns on the photocathode of the tube. When the frame was broken into 287 active lines, the experimentally measured length of the video pulse was 46 microns on the target of the supersilicon diode tube, which coincides with the results obtained through computations.

An increase in the number of lines (decrease of $g_б$) leads, on the one hand, to a linear increase of the signal amplitude due to an increase in the rate of reading, and, on the other, to a drop in the signal due to an increase in the preliminary reading of the charges [1]. When the number of lines is changed in tubes with preswitching amplification, changes in the reading affect greatly the value of the signal. Therefore, the amplitude of the video signal increases as the number of lines increases (Figure 3, a). And when the frame is broken up into a small number of lines $z \leq 260 (g_б = 2.25)$, there is practically no preliminary reading and the amplitude of the signal increases considerably as the number of lines increases. Further increase in the number of lines is accompanied by an increase in the preliminary reading of charges which slows down the growth of the amplitude of the video signal, and in the range of z = 300-1600 lines it depends little on the number of lines. The obtained dependence of the amplitude of the video signal on the number of lines in the frame was confirmed experimentally for an one-inch supersilicon diode tube in the range of z = 200-800 lines. The greatest increase in the amplitude of the video signal resulting from an increase in the number of lines is observed for images of dot objects with lesser illumination and with smaller dimensions. For example, for U_T = 2 V, when the number of lines increases from z = 200 to z = 800 ($g_б$ = 3-0.75) and the conditional radii of the image of the object are r_0 = 10 microns and r_0 = 40 microns, the amplitudes increase 7.2 and 2.9 times, respectively.

The signal amplitude depends on the position of the object in relation to the lines of the frame, i.e., on the microdisplacement G (Figure 4) -- displacement of the position of lines in relation to the center of the image. The fewer lines in the frame, the stronger is this dependence. Let us evaluate the changes in the amplitude of the video signal during the changing of the microdisplacement G by the coefficient of signal variation $L = i_{max} - i_{min}/i_{max}$ whose dependence on the number of lines is shown in Figure 5.

A thirty-fold change in the illumination of the object leads to a change in the value of L not more than by 10%. The value of the coefficient increases sharply as the number of lines decreases, exceeding 50% at 180 scanning lines ($g_б$ = 3.3) and 70% at a 140-line scanning ($g_б$ = 4.3). It follows from this that, when the video signal is quantized by the 0.5 i_{max} level, the signal may disappear at z = 180, and when quantized by the 0.3 i_{max} level, it may disappear at z = 140. This limits the possibility of using the decomposition into $z \leqslant 200$ lines when detecting the object by the amplitude of the video signal.

Changes in the number of lines in the frame leads to the shifting of the position of the pulses of the video signal in relation to the center of the image of the dot object both along and across the lines [5]. The line and frame coordinate shifts of the center of gravity of the video signal in fractions of the radius of the switching beam were determined by the following formulas [6]:

$$u_0 = \frac{\sum_m \sum_k k i_{mk}}{\sum_m \sum_k i_{mk}}, \quad v_0 = \frac{\sum_m \sum_k m i_{mk}}{\sum_m \sum_k i_{mk}} g_б,$$

where k -- reading number along the line in relation to the center of the image of the object (Figure 1); m -- number of the line being switched (Figure 2); i_{mk} -- value of the k-th reading of the video signal along the line on the m-th line.

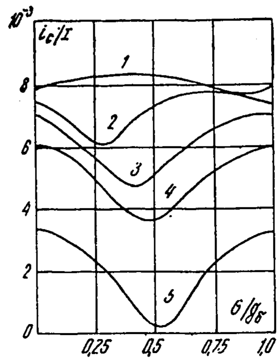

Figure 4. The dependence of the amplitude of the video pulse on the position of the object in relation to the switching lines for U_T = 2 V, $r_o = r_1$ = 18 microns for different number of lines in the frame:
1 — z = 800 (g_σ = 0,75); 2 — z = 400 (g_σ = 1,5); 3 — z = 266 (g_σ = 2,25): 4 — z = 200 (g_σ = 3); 5 — z = = 100 (g_σ = 6)

The dependence of the line and frame coordinate shifts on the number of lines is given in Figure 6. As the number of lines increases, the frame coordinate shifts g_o increase due to the increase in t'e preliminary reading of the charges, while the line coordinate shifts, on the contrary, decrease due to the decrease in the stored charge after the reading by the preceding lines. The values of the coordinate shifts increase as the illumination of the object increases [3] and may exceed 0.6 r_1. For example, at U_T = 15 V their values were u_o(z = 100) = -0.83 and g_o(z = 1600) = -0.62.

In developing TV systems intended for measuring the coordinates of objects, increments of coordinate shifts Δu_o, Δg_o during changes in the light levels of dot objects are of primary interest because, unlike the absolute values of u_o, g_o, they are difficult to compensate. When the number of lines increases, Δg_o increases and Δu_o decreases, and their values may exceed 0.5 r_1 when the light level of the object changes by 30 times (Figure 7).

It is expedient to select the number of lines in the frame at which the measurement errors of the coordinates do not exceed the prescribed value by the minimal values of increments of coordinate shifts $\Delta u_o = \Delta g_o$ and the minimal total error $\Delta = \sqrt{\Delta u_0^2 + \Delta g_0^2}$.

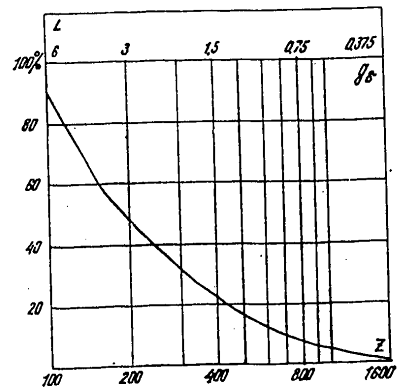

Figure 5. The dependence of the signal variation coefficient on the number of lines in the frame at $U_T = 2$ V, $r_0 = r_1 = 18$ microns.

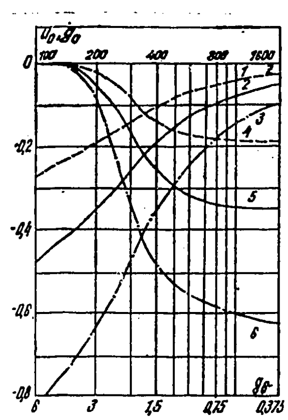

Figure 6. The dependence of the line (1, 2, 3) and frame (4, 5, 6) coordinate shifts on the number of lines in the frame for $r_0 = r_1 = 18$ microns at various light levels of a dot object:
1, 4 -- $U_T = 0.5$ V; 2, 5 -- $U_T = 2$ V; 3, 6 -- $U_T = 15$ B

Due to the exchange nature of the relations $\Delta u_0 = f(z)$ and $\Delta g_0 = f(z)$, the number of lines by the first criterion should be determined from the condition $\Delta u_0 = \Delta g_0$ which is fulfilled for $r_1 = r_0$ at $g_б = 1.76$ (Figure 7). At $r_1 = 18$ microns, this corresponds to the decomposition into 330 active lines. In this case, the values of the increments of the coordinate shifts do not exceed $\Delta u_0 \doteq \Delta g_0 = 0.3$ in the dynamic range of the light levels of 30.

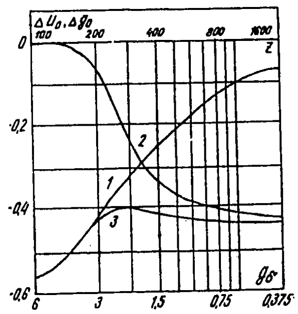

Figure 7. The dependence of the increments of the line Δu_0 (1) and frame Δg_0 (2) coordinate shifts, as well as $\Delta = \sqrt{\Delta u_0^2 + \Delta g_0^2}$ (3) on the number of lines in the frame.

The number of lines by the second criterion should be found from the condition of the minimum of the value of Δ (curve 3, Figure 6) which is fulfilled at $g_\sigma = 2.2$. However, in the broad range $g_\sigma = 0.75$-2.85, the value of Δ changes little and at $g'_\sigma = 1.76$ it practically coincides with the value of Δ at $g_\sigma = 2.2$. Therefore, it is hardly practical to use the second criterion.

Let us examine the dependence of the signal-to-noise ratio at the output of the camera on the number of scanning lines. The noise of transmitting cameras using a secon is determined by the noise of the input stage of the preamplifier. When the number of lines in the frame changes, the frame frequency is constant, and, consequently, when the upper cutoff frequency F of the preamplifier changes, it is expedient to change the resistance of the tube load R_H in inverse proportion to the cutoff frequency F so that $R_H C_{input} = a/F$ (a -- proportionality factor; C_{input} -- spurious capacitance). In this case, the frequency characteristics of the input circuit of the amplifier normalized to the cutoff frequency F will not change. When R_H is changed, let us also maintain a constant transmission coefficient of the input current preamplifier, for example, by changing the amplification of its output stages. In this case, the effective noise voltage $\sigma_{ш}$ at the output of the preamplifier will change in proportion to $\sqrt{F}$, and the signal amplitude -- in proportion to the output current of the transmitting tube i_c.

Let us determine how the signal-to-noise ratio $\psi = U_c/\sigma_{ш}$ will change at the camera output in relation to the signal-to-noise ratio ψ_0 determined for the number of lines z_0 and the prescribed light level U_T:

$$\frac{\psi(z)}{\psi_0} = \frac{U_c(z)}{U_c(z_0)} \cdot \frac{\sigma_{ш}(z_0)}{\sigma_{ш}(z)}. \quad (1)$$

As has been shown above,

$$\frac{\sigma_m(z_0)}{\sigma_m(z)} = \sqrt{\frac{F_0}{F}}, \quad \frac{F_0}{F} = \left(\frac{z}{z_0}\right)^2,$$
$$\frac{U_c(z)}{U_c(z_0)} = \frac{i_c(z)}{i_c(z_0)}. \qquad (2)$$

From the expression (1), with consideration for the relations (2), we shall obtain

$$\frac{\psi(z)}{\psi_0} = \frac{i_c(z)}{i_c(z_0)} \cdot \frac{z_0}{z}. \qquad (3)$$

By using formula (3), given $i_c(z_0)$ and z_0 (determined, for example, from Figure 3,a), it is possible to find how the signal-to-noise ratio changes with changes in the number of lines.

The noise of a transmitting camera using a supersilicon tube in the absence of a light background is determined by the noise of the preamplifier. With the accuracy necessary for practical work, it is possible to assume that the noise of a supersilicon tube, just as the shot noise of the first stages of the amplifier, have an even spectral composition. Therefore, formula (3) can also be used for cameras using the supersilicon-type tubes.

Let us take the signal-to-noise ratio at z = 400 and U_T = 2 V as the initial value of ψ_0. The dependence of the signal-to-noise ratio ψ normalized to ψ_0 on the number of lines for various light levels of a dot object are shown in Figures 3,b. The signal-to-noise ratio remains practically constant at $g_\sigma \geqslant 2.5$, and then decreases as the number of lines increases, which is due to the increase of noise to a greater degree than that of the video signal. For great light levels, the decrease of ψ with an increase of the number of lines becomes sharper (Figure 3, b, curve 1).

The above analysis makes it possible to select an optimal number of lines in the frame not only on the basis of the maximal signal-to-noise relation, but also by the minimal increments of two-dimensional coordinate shifts appearing during the changes in the illumination of a dot object, but also by permissible fluctuations of the amplitudes of the video signal at various positions of the object in relation to the lines. This is a line-by-line decomposition with a relative shift of lines of g_σ = 1.7-1.8, which, at r_1 = 18.3 microns, corresponds to the decomposition into 320-350 lines. In this case, the loss in the signal-to-noise ratio at low light levels of the object is 20% in comparison with the maximal attainable ψ for the given light level (Figure 3, c, curve 3), and the change in the amplitude of the video signal due to a random position of the object in relation to the lines does not exceed 30%.

It should be noted that the characteristics of the detection can be improved if the object is detected not by the maximum signal, but by the sum of the values of the readings of the video signal $\sum_m \sum_k i_{mk}$ from all lines where the signal exceeds the threshold level. The simulation has shown that, in this case, the coefficient of the unevenness of the video signal L increases considerably less as the number of lines decreases. When this detection algorithm is used, the relative shifting of the lines can be increased to g_σ = 2.5-3 and a gain can be obtained in the signal-to-noise relation with an insignificant decrease in the accuracy of measurements of the coordinates along the line.

Conclusions

1. The mathematical simulation of the characteristics of a TV storage camera from "light" to output signals makes it possible to give recommendations for selecting its basic parameters.

2. The increments of the coordinate shifts caused by changes in the light level of a dot object are minimal at distances between the lines of 1.7-1.8 of the radius of the switching beam, which corresponds to line-by-line decomposition into 320-350 active lines for one-inch secons and supersilicons.

3. The signal-to-noise ratio does not change when the number of scanning lines increases to 200, and then begins to decrease.

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All-Union Scientific Research Institute of Television

[108-10,233]

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CERTAIN ASPECTS OF RADIOASTRONOMY, SATELLITES AND SPACE VEHICLES

UDC 629.7.054.07:629.78.058.53

ASTROORIENTATION METHODS AND INSTRUMENTATION EXAMINED

Moscow SISTEMY ASTRONOMICHESKOY ORIYENTATSII KOSMICHESKIKH APPARATOV in Russian 1980 (signed to press 24 Mar 80) pp 2-4, 144

[Annotation, foreword and table of contents from book "Space Vehicle Astroorientation Systems", by Valentin Ivanovich Kochetkov, Izdatel'stvo "Mashinostroyeniye", 950 copies, 144 pages]

[Text] This book presents the basic questions of the theory and principle of constructing space vehicle orientation-control systems with the help of star-tracking sensors which sight on single stars in the star field.

Equations are introduced which relate the orientation parameters to astronomical measurements. Laws of reorientation control are synthesized which are optimal with respect to response time and energy expenditure. Considerable attention is devoted to the design and the statistical analysis and optimization of parameters of astrosystems which are subject to random perturbations.

This book is intended for senior technical personnel engaged in the design of space vehicle control systems.

Foreword

A space vehicle flight-control system is designed to control the movement of the vehicle's center of mass and to control its orientation (its movement around the center of the mass). For the majority of space vehicles, orientation control is the basic mode of movement control and is carried out continuously or periodically during the operation of onboard scientific apparatus requiring a specific attitude for the space vehicle.

The accuracy of orientation control can vary and is determined by the vehicle's purpose. For example, an accuracy of 10-20° [28] is sufficient for the orientation of solar batteries and antennas with a wide aperture of directivity. The majority of space vehicles require an accuracy of orientation on the order of a few degrees or a little more. There are, however, a number of missions, such as the study of space and the trajectory correction for interplanetary space vehicles, which require an accuracy of orientation control no worse than a few degrees or even fractions of angular minutes [2, 28].

Various means can be employed for orientation control. Optical means based on the use of solar, planetary and astral sensors are the most widely used. At the present time, the accuracy of solar and planetary sensors is limited to tens of angular minutes [15].

Star sensors (astrosensors) can, in essence, offer very high accuracy (up to a few angular seconds [28]), since stars are point-sources of light and their coordinates in the celestial sphere are known with very great accuracy. This is explained by the fact that experts in recent years have devoted a great deal of attention to the problems of constructing highly accurate astronomical systems for space vehicle orientation control.

At the present time, various types of star sensors have been created which can be successfully employed on space vehicles. A number of books and articles [5, 11, 13, 17, 19, 24, 30, et al.] are devoted to questions of employing star sensors for navigation on aircraft and space vehicles.

This book is an attempt to summarize and systematize certain data. Along with the theoretical aspects (the derivation of the basic equations relating celestial measurements to the parameters of orientation, the synthesis of laws of reorientation control, etc.), data are presented on the selection of functional arrangements for the various types of astroorientation systems. Examples of solutions to problems of statistically optimizing their parameters are also cited.

The book is logically structured in the following manner:

- principles for the construction and classification of astroorientation systems are presented; data for celestial reference points and the characteristics of practicable instruments for their direction finding are cited (chapters 1 and 2);

- basic astroorientation equations are derived and optimal laws for reorientation (turn) control of space vehicles are synthesized (chapters 3 and 4);

- different versions for the construction of functional arrangements realizing the astroorientation equations are proven to be valid; steps are proposed for the statistical optimization of the parameters of the arrangement selected; the criterion of "maximum probability" and the method of "statistical points" are substantiated for this purpose (chapters 5 and 6).

The application of astronomical devices which insure a high degree of accuracy to orient space vehicles is expedient only on those segments of the orbit where high accuracy is necessary, for example, during the operation of the scientific apparatus. This is explained by the fact that highly accurate orientation demands a higher than usual expenditure of energy (propellant). For this reason, when a high degree of orientation is not required, the space vehicle, as a rule, is oriented in an economical mode with reduced accuracy and the use of simpler methods and instruments, without calling upon complicated computer equipment.

A number of the astroorientation equations presented in the book belong to the "accuracy" stage of dual-mode space vehicle angular movement control. With the aid of other equations (when using star sensors that sight on the star field), one can determine the space vehicle's attitude with great accuracy, even when it is grossly disoriented in space; that is, when its prior attitude is not known. After determining the attitude of such a space vehicle, it is necessary to reorient the craft in the required attitude by turning it about its center of mass.

The author expresses gratitude toward his reviewer, Candidate of Physicomathematical Sciences P. A. Barankov, for his valuable advice and notes which contributed to improving the book.

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COMMUNICATIONS, COMMUNICATION EQUIPMENT, RECEIVERS AND TRANSMITTERS, NETWORKS, RADIO PHYSICS, DATA TRANSMISSION AND PROCESSING, INFORMATION THEORY

OPERATION AND ORGANIZATION OF RADIOTECHNICAL SYSTEMS AND COMPLEXES DESCRIBED

Moscow EKSPLUATATSIYA RADIOTEKHNICHESKIKH SISTEM in Russian 1980 (signed to press 19 Mar 80) pp 2-3, 222-223

[Annotation, introduction and table of contents from book "Operation of Radiotechnical Systems", by Aleksey Yakovlevich Alekseyenko and Ivan Vladimirovich Aderikhin, Voyenizdat, 15,000 copies, 223 pages]

[Text] This book examines the bases for safe operation of radiotechnical systems and complexes and provides practical recommendations for the organization of these operations among the troops, based on ergonomic requirements. The material is illustrated with examples of radiotechnical systems used in testing and controlling aircraft.

This book is intended for military specialists engaged in the operation of radiotechnical systems and complexes and will also be useful for students in higher educational institutions of the corresponding fields.

Introduction

The present-day development of the USSR Armed Forces is characterized by the continuous improvement of their technical equipment. The scientific and technical progress has brought about the emergence among the troops of new technical means of transmitting, processing, radiating and storing information. To these also belong complicated data and measurement radiotechnical systems and complexes (RT's and RTK's).

In order to maintain the equipment in a high state of readiness, it is necessary not only to know and operate the equipment to perfection, but also to organize and carry out its operation on scientific bases. Commanders and engineers who deal with questions of operation must clearly present the conditions and factors upon which depend the successful execution of the assigned mission. They must also be able to monitor changes in the operating conditions and the technical status. Only the strictly scientific organization and performance of the entire complex of measures associated with the operation of the equipment will make it possible to solve the problems of radiotechnical systems and complexes with a given degree of effectiveness.

In this book, the reader is presented with a statement of the scientific bases for the organization of operations, proceeding from common methodical positions.

Also presented are the methods of insuring a high degree of readiness for complicated radiotechnical systems and complexes among the troops. Standard measures associated with preparing the equipment for use and with maintenance, repair and storage are examined. Methods of evaluating the influence of various operational characteristics are provided, as well as indicators of the quality of operation, based on ergonomic requirements. The basic regulations for establishing the safe operation of radiotechnical systems and complexes are cited. The presentation is carried out with the use of computing equipment accessible to commanders and engineers operating complicated radiotechnical systems and complexes.

The book was written using information from open domestic and foreign literature, with consideration given to the requirements of State Standards for equipment and terminology.

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PHOTOELECTRIC PHENOMENA AND DEVICES, ELECTROLUMINESCENCE, ION DEVICES

UDC 535.37

ANTI-STOKES LUMINESCENCE AND ITS POSSIBLE APPLICATIONS DESCRIBED

Moscow ANTISTOKSOVA LYUMINESTSENTSIYA I NOVYYE VOZMOZHNOSTI YEYE PRIMENENIYA in Russian 1980 (signed to press 4 Mar 80) pp 2-4, 193

[Annotation, foreword and table of contents from book "Anti-Stokes Luminescence and New Possibilities for Its Application", by Yuliya Petrovna Chukova, Izdatel'stvo "Sovetskoye radio", 3000 copies, 193 pages]

[Text] This book presents the current ideas in physics regarding the mechanism of "upward frequency transformation" and summarizes the experimental data accumulated in recent years on the properties of a new class (anti-Stokes) of luminophores which convert infrared (IR) radiation into visible light. It examines the possibilities of their technical application for visually observing and recording the infrared radiation fields of lasers, for creating lasers and light diodes with different colors of luminescence and for constructing small-scale alphanumeric indicators.

Designs and parameters are presented for domestic and foreign instruments based on anti-Stokes luminophores. The characteristics of these devices and those of some previously known devices of similar purpose are compared. The problem of optical cooling is examined and the thermodynamic limits of anti-Stokes processes are established.

This book is intended for a broad circle of experts working in the areas of quantum and semiconductor electronics, luminescence, optics, illumination engineering and thermodynamics.

In recent years, quantum optics has undergone rapid growth associated with work on the generation of induced radiation. No less interesting and very consequential have been two other directions in this work--electron processes in stimulated crystals and anti-Stokes luminescence with its increase in frequency (the frequency of luminescence quanta is several times higher than the frequency of the exciting quanta).

The broad application of luminescence in the economy has at present become commonplace. Its use in the home (fluorescent lamps, televisions, portable calculators, etc.) causes no surprise. What is surprising, perhaps, is the speed with which scientific discoveries and the results of everyday research have been applied in practice. For example, the time taken to introduce anti-Stokes luminescence with its frequency multiplication (to which this book is devoted) amounted to a little over two years. Debates among physicists regarding the mechanisms causing the frequency multiplication had only just begun when a design was suggested for the first device using this phenomenon for purposes of indication.

The debates among physicists over the mechanism of this phenomenon have still not ended. This can be explained to a considerable degree by the fact that, in a number of cases, an experiment does not make a well-defined choice possible. The adoption of this or that point of view is sometimes explained by the situation's past history. Adhering to the view of P. L. Kapitsa, who believed that "science ends when doubts cease," the author in these cases (this particularly relates to chapters 2 and 4) does not express a personal point of view, but rather describes the existing situation while attempting not to gloss over the inconsistencies.

This book attempts to systematically present a great deal of information regarding questions of theory, research and the technical application of anti-Stokes luminescence.

A brief presentation of the results obtained up to 1960 is given in the first chapter. The second chapter describes a new phenomenon--luminescence with a large anti-Stokes shift. It also examines the mechanisms of the physical processes and presents the basic characteristics of anti-Stokes luminophores.

The third chapter is devoted to the application of increased frequency in devices for different functional purposes. The design and basic parameters of domestic and foreign instruments based on anti-Stokes luminophores are cited. A comparison is made between their characteristics and the characteristics of familiar devices of similar purpose.

Attempts to generate optical cooling on the basis of classical anti-Stokes luminescence processes are presented in chapter 4.

The fifth chapter examines the anti-Stokes processes and established the limits imposed by thermodynamics on the efficiency of anti-Stokes luminescence.

This book is intended for readers of various professions. This can be explained to a considerable degree by the structure of the book and the nature of the information presented. The mathematical computations presented within are held to a minimum and the primary attention is devoted to the physical processes and the devices based upon them.

The reader for whom the statement of the problem in this book nevertheless proves to be complicated can familiarize himself with it through popular-science articles by contributors from the USSR Academy of Sciences Institute of Physics in the periodicals KHIMIYA I ZHIZN' [Chemistry and Life] (1974, No. 11) and PRIRODA [Nature] (1975, No. 1) as well as in the author's review published in the collection ELEKTROTEKHNICHESKAYA PROMYSHLENNOST'. SVETOTEKHNICHESKIYE IZDELIYA [Electrical Equipment Industry. Illumination Engineering Products] (1973, section 5(20)). It is recommended that the reader wishing to understand more deeply the quantum mechanics aspects of the problem familiarize himself with the review of Ozel' (see [71] in the bibliography).

This book was written on the initiative of M. V. Fok, who, after reading through the manuscript, made numerous observations which contributed in many ways to improving the book. The author is obliged to thank him for the help he rendered. The author likewise considers it his duty to express his gratitude to I. Ya. Lyamichev, who had a kind word for this book when it was first published.

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PUBLICATIONS, INCLUDING COLLECTIONS OF ABSTRACTS

METHODS OF ANALYZING AND SYNTHESIZING LINEAR AND NONLINEAR ELECTRIC CIRCUITS

Moscow TRUDY MOSKOVSKOGO ORDENA LENINA ENERGETICHESKOGO INSTITUTA: METODY ANALIZA I SINTEZA LINEYNYKH I NELINEYNYKH ELEKTRICHESKIKH TSEPEY in Russian No 432, 1979 (signed to press 29 Dec 79) pp 2, 141-144

[Annotation and table of contents from book "Works of the Moscow Power Engineering Institute: Methods of Analyzing and Synthesizing Linear and Nonlinear Electric Circuits", edited by M. Sh. Kulakhmetova, Moskovskiy energeticheskiy institut, 600 copies, 150 pages]

[Text] This collection presents research done by instructors and colleagues of the departments of theoretical principles of electrical engineering and electrophysics and information measurement technology in 1977-1978.

The papers included in the book deal with methods of analyzing and synthesizing electrical and electronic circuits, systems and devices that contain linear and nonlinear elements.

Topics that are covered are methods of calculating electromagnetic circuits, problems of studying and designing electrophysical devices and instruments, and also the use of computer facilities for calculating and modeling electrophysical processes in a variety of media.

In addition to theoretical papers, the book also contains works of applied significance. However, the content of all articles is tied up at base with the solution of practical problems for automation, computers and information measurement technology.

The material of the collection may be of use to specialists working in the field of research and development of electrical and electronic circuits, electrophysical processes in various media and devices for measuring electrical and magnetic quantities. The theoretical, procedural and applied aspects of the papers may be of use to upperclassmen majoring in automation and computer technology.

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CSO: 1860

UDC 621.383.29

MONOELECTRONIC PHOTOSENSORS

Moscow ODNOELEKTRONNYYE FOTOPRIYEMNIKI in Russian 1979 pp 2, 188-189

[Annotation and table of contents from book "Monoelectronic Photosensors", by S. S. Vetokhin, I. R. Gulakov, A. N. Pertsev and I. V. Reznikov, Atomizdat, 192 pages]

[Text] The book examines the noise and monoelectronic characteristics, selection criteria and methods of improving threshold sensitivity of monoelectronic photosensors. The optical properties of input windows are described, and also the effect that luminous and ionizing radiations have on the characteristics of multiplier phototubes. The authors discuss the part played by monoelectronic characteristics in selection and investigation of time-interval photocells. Data are given from comparison of methods of registration of weak luminous fluxes and techniques for realization of the monoelectronic method of measurement in the investigation of unsteady luminous fluxes and detection of weakly luminescent objects in metric problems. An appendix summarizes research on monoelectronic photomultipliers.

Figures 116, tables 26, references 462.

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UDC 621.315.2(03)

MUNICIPAL TELEPHONE CABLES: A REFERENCE

Moscow GORODSKIYE TELEFONNYYE KABELI: SPRAVOCHNIK in Russian 1979 (signed to press 13 Jul 79) pp 2, 167-168

[Annotation and table of contents from book "Municipal Telephone Cables: A Reference", by Anatoliy Samoylovich Brisker, Aleksandr Dmitriyevich Ruga and David Leonidovich Sharle, Izdatel'stvo "Svyaz'", 23,000 copies, 168 pages]

[Text] Basic information is given on municipal telephone cables produced in the USSR with paper/air and polyethylene insulation, and methods are presented for calculating the structural and electrical characteristics of these cables.

The reference is intended for engineering and technical personnel employed in designing and producing municipal telephone cables, planning, constructing and using local telephone networks, and also for instructors and students in colleges and vocational schools.

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CSO: 1860

PROBLEMS OF ELECTRIC MATERIALS SCIENCE IN THE PRODUCTION AND OPERATION OF ELECTROMECHANICAL DEVICES

Moscow TRUDY MOSKOVSKOGO ORDENA LENINA ENERGETICHESKOGO INSTITUTA: VOPROSY ELEKTROMATERIALOVEDENIYA V PROIZVODSTVE I EKSPLUATATSII ELEKTROMEKHANICHESKIKH USTROYSTV in Russian No 414, 1979 pp 2, 102-103

[Annotation and table of contents from book "Works of the Moscow Power Engineering Institute: Problems of Electric Materials Sciences in the Production and Operation of Electromechanical Devices", Moskovskiy energeticheskiy institut, 103 pages]

[Text] This collection gives the results of research and development on new electrical engineering materials and structures based on them, solutions of problems of labor protection in the production and use of elements of electromechanical devices.

The articles included here cover problems of optimization of electrical engineering material for a number of specific fields of application such as low-temperature and microwave technology, and optoelectronics. Some of the papers deal with problems of developing mathematical models of processes of producing and designing electromechanical devices, machine methods for thermal and electrical calculations of the structural elements of semiconductor power devices and electrical insulation components. Results are given on development of technological processes for producing electrical engineering materials, including materials for laser technology and film materials for microelectronics, ceramic materials for optoelectronic equipment. A number of papers are concerned with questions of human safety when working in the electric field of superhigh-voltage facilities, in direct contact with the live sections of power facilities up to 1000 V, and an examination is also made of the influence that electric lighting has on eye fatigue with consideration of the brightness of the working surface. The materials of the collection are of practical interest to workers in the electrical engineering industry, and also to advanced students majoring in related fields.

The collection was prepared for publication by Senior Engineer V. V. Panina.

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CSO: 1860

PROBLEMS OF IMPROVING THE EFFECTIVENESS OF PROTECTIVE MEASURES IN ELECTRIC FACILITIES

Moscow TRUDY MOSKOVSKOGO ORDENA LENINA ENERGETICHESKOGO INSTITUTA: VOPROSY POVYSHENIYA EFFEKTIVNOSTI ZASHCHITNYKH MER V ELEKTROUSTANOVKAKH in Russian No 444, 1980 (signed to press 19 Mar 80) pp 2, 67-68

[Annotation and table of contents from book "Works of the Moscow Power Engineering Institute: Problems of Improving the Effectiveness of Protective Measures in Electric Facilities", edited by M. Sh. Antipova, Moskovskiy energeticheskiy institut, 300 copies, 71 pages]

[Text] This collection presents the results of research by the department of labor protection of Moscow Power Engineering Institute. The papers cover measurement of conductances of the phase insulation in power grids with isolated and dead-grounded neutral relative to earth, investigation of protective cutout devices, the hazards of superhigh-voltage electromagnetic fields and the development of organizational and engineering steps for protection from such fields. Some articles deal with the solution of problems of technical-economic evaluation of the sector-wide standards of artificial lighting, and investigation of eye fatigue. The authors also discuss questions of firebreaks between conductors, and calculation of the spreading resistance of complex grounding electrodes.

The material of the collection is of practical interest for workers in the electrical engineering industry and Gosenergonadzor, as well as for advanced students majoring in fields of power engineering.

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CSO: 1860

TABLES OF GENERATION LINES OF FAR INFRARED BAND LASERS WITH OPTICAL PUMPING

Khar'kov TABLITSY LINIY GENERATSII LAZEROV DAL'NEGO INFRAKRASNOGO DIAPAZONA S OPTICHESKOY NAKACHKOY in Russian 1979 (signed to press 6 Dec 79) pp 3-4

[Introduction from Preprint No 137 of monograph "Tables of Generation Lines of Far Infrared Band Lasers with Optical Pumping", by S. F. Dyubko and L. D. Fesenko, Institute of Radiophysics and Electronics, UkSSR Academy of Sciences, 180 copies, 56 pages]

[Text] Optically-pumped lasers working on vibrational-rotational and rotational transitions of polyatonic molecules have made it, finally, possible to obtain monochromatic radiation with a power from a few to hundreds of milliwatts on a large number of discrete frequencies in the far infrared band of electromagnetic waves which had been little studied perviously.

Creation of such sources has opened up broad possibilities for using waves of that band for scientific and applied purposes.

The materials given here contain information on generation lines in the 20-400 micron band and cover published sources from 1968 to March 1978.

The tables are compiled in the following manner. The first column gives wavelength of laser radiation arranged in increasing order. The second column shows line frequencies measured, as a rule, by the heterodyne method accurate to 10^{-6} or better. The frequencies of the radiation lines obtained by calculations are given in parentheses. Whenever the frequency of the same generation line was measured by different authors, the results of all measurements are given. The third column shows chemical formulas of substances; the fourth, fifth, and sixth columns give the source, the line and wavelength of the pumping radiation, respectively. The designation CO_2^T means that the pumping was done by a CO_2 laser working on the transitions $00^02 \longrightarrow [10^0 1, 02^0 1]$.

The seventh column gives the distance between the central frequencies of the pumping and absorption lines. Subsequent columns (8th, 9th, and 10th) provide information on the output power of submillimeter radiation in the continuous mode, pulsed mode, and the superluminosity mode. Relative intensity of radiation is given in parentheses. As a rule, it was evaluated by indications of a point-contact detector using a pair InSb -- beryllium bronze. In the absence of information on the intensity of radiation, the symbol "+" is used, which indicates the mode in which generation was obtained on a given wavelength.

Column 11 gives the polarization of the output submillimeter radiation in relation to the polarization of pumping radiation. The next two columns (12th and 13th) identify the pumping and radiation transitions. The remarks (14th column) give information on the characteristics of working transitions. The following designations are used:

γ -- amplification factor of laser transition,

α -- absorption factor of pumping transition,

$\Delta\nu_p$ -- uniform width of line,

Is -- saturation intensity of pumping transition.

The last column gives references to the original sources on whose basis these tables were compiled. The absence of reference to a source indicates that the results included in the tables were obtained directly by the authors.
[131-10,233]

10,233
CSO: 1860

USE OF PERMANENT MAGNETS IN ELECTRIC MACHINES, EQUIPMENT AND INSTRUMENTS

Moscow TRUDY MOSKOVSKOGO ORDENA LENINA ENERGETICHESKOGO INSTITUTA: PRIMENENIYE POSTOYANNYKH MAGNITOV V ELEKTRICHESKIKH MASHINAKH, APPARATAKH I PRIBORAKH in Russian No 416, 1979 pp 2, 97

[Annotation and table of contents from book "Works of the Moscow Power Engineering Institute: Use of Permanent Magnets in Electric Machines, Equipment and Instruments", Moskovskiy energeticheskiy institut, 97 pages]

[Text] This collection includes papers dealing with problems of developing and using permanent magnets in electric energy converters.

The book examines the current state and outlook in development of new materials for permanent magnets with high magnetic energy.

The authors examine prospects of development of magnetoelectric generators with new permanent magnet materials, and their fields of application. The results of developments in automated design of these generators are given.

An examination is made of problems of developing an "electric shaft" based on magnetoelectric thyratron motors. The advantages of the newly developed "electro-shaft" system are demonstrated.

Questions of the outlook for development of low-power magnetoelectric motors are considered.

The theory of the preferable method of controlling rotor magnetization is outlined.

The possibilities for developing sealed-contact switches and fields of application are discussed.

Research results are given on automated design of static systems.

The book is intended for scientists, technicians and engineers.

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CSO: 1860

RADARS, RADIONAVIGATION AIDS, DIRECTION FINDING, GYROS

UDC 538.56:519.25

RADIO BRIGHTNESS CONTRASTS OF GROUND COVER ON MILLIMETER AND CENTIMETER WAVES*

Gor'kiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 23, No 10, 1980 pp 1266-1268 manuscript received 19 Jun 79, after revision 18 Jan 80

[Article by G. A. Andreyev, L. F. Borodin and S. N. Rubtsov, Institute of Radio Engineering and Electronics, USSR Academy of Sciences]

[Text] Measurements made with microwave equipment have a considerable advantage over measurements in the infrared and visible optical bands -- capability of operations under cloud cover and at night. For some problems of wave propagation, or for example getting radio images of the surface of the ground from flightcraft [Ref. 1], and also for radiometeorology and studying natural resources it is important to know the spectral distribution of radio brightness contrasts of ground cover, and their dependence on seasonal conditions in the millimeter and centimeter wave bands.

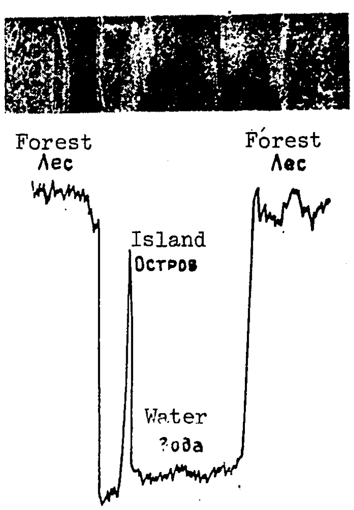

Fig. 1

Fig. 1 shows a section of terrain (including shores covered by forest, a river and an island) and a line recording of its radio brightness temperature on a wavelength of $\lambda = 8 \cdot 10^{-3}$ m. The experiments were done with superheterodyne radiometers on frequency channels of 1, 1.5, 3, 8.8, 13.3, 22.2 and 37.5 GHz operating simultaneously on board an aircraft [Ref. 2]. Aerial photographs were taken during the flights to tie in the resultant data with the corresponding sections of the ground surface. The air and water temperatures were measured, and notes were taken on weather conditions and type of underlying surface.

In flight at an altitude of 100 m at a velocity of 100 m/s, the linear resolution of the equipment in the direction of flight was 10 m on 37.5 GHz at $\tau = 0.1$ s, i. e. two beamwidths.

Calibration was based on sequential reception of the radiothermal signal from the forest and from the water surface. The radiant emissivity of the forest κ_f was calculated according to [Ref. 3] by the formula

*The results of the research were reported at the Second All-Union Symposium on Millimeter and Submillimeter Waves, 15 September 1978.

$$\kappa_f = (1 - e^{-\alpha h}), \quad (1)$$

where α is the linear absorption in the crown, and h is the height of the crown.

The radiant emissivity of fresh water was calculated for each emission frequency by Debye formulas that satisfactorily describe its dielectric constant in the millimeter and centimeter wave bands [Ref. 4].

The spectral dependences of radio brightness contrasts measured under identical weather conditions in 1977 and 1978 (Fig. 2 and 3) indicate that there is a tendency

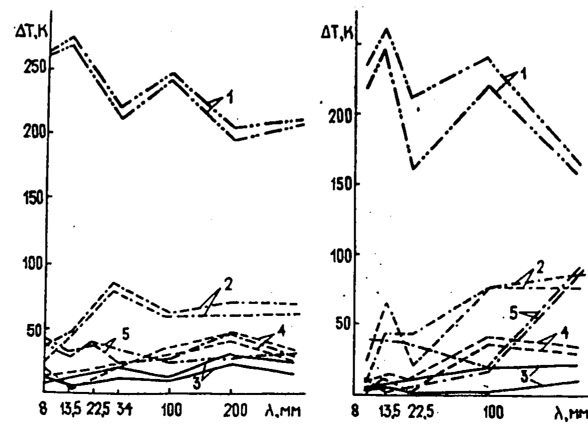

Fig. 2 Fig. 3

Fig. 2. Spectral distribution of radio brightness contrasts at T = 295 K measured in the summer of 1977. Lines of the same type show the upper and lower limits of the ranges of observed contrasts between forest and: metals (1), concrete (2), sand (3), grass (4), field crops (5).

Fig. 2. Spectral distribution of radio brightness contrasts at T = 295 K measured in the summer of 1978. Notation the same as in Fig. 2.

toward an increase in contrast for highly reflective surfaces such as metals in the millimeter section of the radio band. The metal surface was a covering on part of the airport runway. When precipitation falls on the metal surface, its brightness temperature increases, which leads to a slight (5-10%) reduction in contrast. And vice versa, the presence of a water film on sections of the concrete surface reduces its brightness temperature and increases contrast. The influence of light precipitation on the contrasts of vegetative cover and sand is insignificant since the movement of the moisture is from the surface downward, beyond the limits of the effective radiating layer.

The spectral dependences of contrasts have a maximum in the vicinity of the line $\lambda = 13.5 \cdot 10^{-3}$ m, reaching 15% as compared with the contrasts on other sections of the spectrum.

The effective temperature $T_{ef.c}$ of ground cover is described by the expression

$$T_{ef.c} = \kappa T_s + (1 - \kappa) T_{b.a}, \quad (2)$$

where T_s is the thermodynamic temperature of the surface of the ground cover, $T_{b.a}$ is the brightness temperature of the atmosphere, κ is the radiant emissivity of the ground cover depending on its dielectric characteristics, unevennesses of the interface between cover and air, and other physical properties.

In the long-wave part of the millimeter band ($\lambda = 8 \cdot 10^{-3}$ m) the radio emission of the layer of atmosphere in the direction toward the nadir is characterized by a brightness temperature T_z of about 15 K [Ref. 5], which means that the second term in (2) will not exceed a few kelvins for any but metallic underlying surfaces.

From the definition of radio brightness contrast in terms of effective temperatures $\Delta T = T_{ef.f} - T_{ef.c}$ and expression (2) we get the relation

$$\Delta T = (\kappa_f - \kappa_c) T_- \quad (3)$$

where κ_f, κ_c are the radiant emissivities of the forest and the cover to be compared, $T_- = T_s - T_{b.a}$ is the difference between the temperature of the cover and the brightness temperature of the atmosphere.

It was assumed that the thermodynamic temperatures of covers and the ground layer of air were the same. At the nadir $T_{b.a} = T_z$.

It can be seen from Fig. 4 that linear dependence of radio brightness contrast on temperature difference T_- has been experimentally confirmed. The error of the radio measurements was no more than 5 K.

As a result of in-flight measurements it has been established that in the frequency sector between 1 and 37.5 GHz there are steady radio brightness contrasts of ground covers that change insignificantly in the case of light rain (no more than 5 mm/hr). In the long-wave part of the millimeter band, contrasts relative to forest are from 220 to 260 kelvins for metallic bodies, of the order of 60 K for concrete, 15 K for sand, from 10 to 15 K for grass, and 30-40 K for field crops.

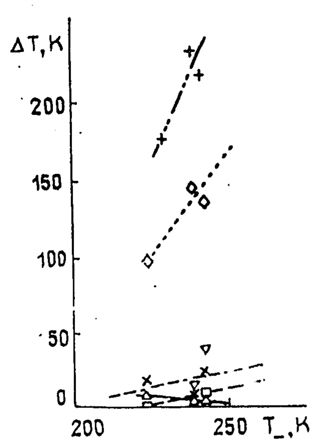

Fig. 4. Dependence of radio brightness contrasts ΔT on temperature difference T_- for channel $\lambda = 8$ mm. For notation see Fig. 2.

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ON THE SPECTRUM OF RADIO WAVES BACK-SCATTERED BY A SEA SURFACE

Moscow RADIOTEKHNIKA in Russian Vol 35, No 11, 1980 pp 77-80 manuscript received 4 Jan 80

[Article by I.Ye. Ushakov and I.F. Shishkin]

[Text] Important characteristics of a radio emission scattered by a sea surface are the spectral width ΔF and the placement of its center frequency F relative to the frequency of the irradiating field. Working from the hypothesis that the scattering of the waves occurs at a periodic structure, an expression was proposed in [1] for F, which explains the results of measurements in a radio wavelength range of from 3 cm to 200 m for various degrees of sea wave agitation. The values of ΔF obtained by means of calculations are in satisfactory agreement with experimental values only in the case of strong wave agitation [1-4]. The prevailing factors in this case are those which are theoretically taken into account such as the orbital motion of the ripples in a large wave [2] and the pulsation of the velocity of the surface drift of the water [1]. In the case of weak wave action, these phenomena are disregarded and the widening of the radio emission spectrum in the case of radar sounding of the sea surface is explained by the "geometry" of the problem: by the finite dimensions of the scattering area of the sea, the warping of the incident wave front, etc. [5]. However, the calculated values of ΔF obtained in this case are less than the experimental values [3, 4]. An attempt is made below to ascertain the causes of the spectral widening of a radio emission scattered by a sea surface in the case of weak wave action.

An experimental study of the spectra of a radio emission back-scattered by a wind ripple was made in an open water reservoir with dimensions of 180 x 70 m^2 and a depth of 4 m for a wind velocity of 4 to 6 m/sec. A coherent CW radar was mounted on a platform, set up on piles in the center of the water reservoir at a height of 1.2 m. The radar characteristics were: the electromagnetic transmission wavelength was 3.2 cm; vertical polarization; the transmitted power was 20 mW; the antennas were horn types with a directional pattern (DN) width at the 3 dB level in both planes of 10°.

The results of processing a large number of tests are shown in the Table. Also included in it are the results of calculations based on the formulas given in

[1] and [5]. The satisfactory agreement between the measured and calculated values of F mentioned above is confirmed, as well as the explicit lack of agreement between the experimentally obtained and theortically calculated values of ΔF.

TABLE

Ψ°	Эксперимент Experimental		Расчет [по 1,5] Calculated [1,5]		Расчет по ф-лам (4) и (6) (1)		ΔF_c, Гц Hz
	F, Гц Hz	ΔF, Гц Hz	F, Гц	ΔF, Гц Hz	F, Гц	ΔF, Гц	
30	16,1±0,4	7,5±1,3	12,6	0,1	13,1	1,8	6,7
45	12,9±1,3	10,1±1,2	10,4	0,3	11,2	2,6	7,7
60	9,4±0,9	8,4±2,4	7,9	0,7	8,9	3,1	8,6

Key: 1. Calculated from formulas (4) and (6).

The back-scattering of radio waves by a sea surface at grazing angles of $\Psi \leq 70°$ is of a selective nature. However, the back scattering does not occur for one "resonant" component of the sea wave agitation spectrum as was assumed in [1-4] as a simplification, but rather in an entire section of this spectrum [6]. The width, $\Delta 0.5$, at the 0.5 level of the resonance characteristic of the back-scattering of waves by a statistically rough surface is defined by the expression [7]:

$$\Delta_{0.5} \approx 1.1/2\pi \cos\Psi.$$

The expression $l/\lambda = (l/\lambda)_{opt} = 1/2\pi \cos\Psi$ corresponds to the maximum of the resonance curve. Thus, the Q of the resonance characteristic, $Q = (l/\lambda)_{opt}/\Delta \approx 0.91$, does not depend on the grazing angle.

By expressing the spatial correlation radius of small scale wave agitation, l, in terms of the average wavelength $\bar{\Lambda}$ [8], we obtain:

$$\bar{\Lambda}_{opt} = \lambda/\sqrt{2}\cos\Psi. \qquad (1)$$

This expression differs from the well known condition for resonance scattering, $\Lambda = \lambda/2\cos\Psi$ (see, for example, [1, 3, 5]), in the fact that the random nature and isotropic character of small waves are taken into account.

The shift in the center frequency of the spectrum of a radio emission scattered by an agitated sea surface, following [1], can be defined using the formula:

$$F = \frac{2v_\phi(\bar{\Lambda}_{opt})}{\lambda}\cos\Psi, \qquad (2)$$

where v_Φ ($\bar{\Lambda}_{opt}$) is the phase velocity of the surface wave, defined by the expression:

$$v_\Phi(\bar{\Lambda}_{opt}) = \left(\frac{g\bar{\Lambda}_{opt}}{2\pi} + \frac{2\pi\gamma}{\rho\bar{\Lambda}_{opt}}\right)^{1/2}, \qquad (3)$$

which g is the free fall acceleration; γ is the surface tension and ρ is the density of the liquid [9]. Taking (1) and (3) into account, formula (2) assumes the form:

$$F = \left(\frac{\sqrt{2}g\cos\Psi}{\pi\lambda} + \frac{8\sqrt{2}\pi\gamma\cos^3\Psi}{\rho\lambda^3}\right)^{1/2}. \qquad (4)$$

The functions computed from (4) for $F = f(\lambda)$ in the centimeter band (Figure 1) agree in form with those given in [1], and as follows from the Table where the values are found for $\lambda = 3.2$ cm, are in good agreement with the experimental data.

Taking account the finite width of the resonance characteristic, the spectral width of a scattered emission is determined by the expression:

$$\Delta F = \frac{2}{\lambda}\cos\Psi \left| v_\Phi(\bar{\Lambda}_{opt}[1+Q/2]) - v_\Phi(\bar{\Lambda}_{opt}[1-Q/2])\right|. \qquad (5)$$

The velocity difference in (5) is taken in terms of the absolute value, since the function $v_\Phi(\Lambda)$ is a decaying function in the region of capillary waves and an increasing one in the region of gravitational waves [9].

After substituting $Q \simeq 0.91$, taking (1) into account, expression (5) assumes the form:

$$\Delta F \approx \left| \left(\frac{2g\cos\Psi}{\pi\lambda} + \frac{8\pi\gamma\cos^3\Psi}{\rho\lambda^3}\right)^{1/2} - \left(\frac{g\cos\Psi}{\sqrt{2}\pi\lambda} + \frac{16\sqrt{2}\pi\gamma\cos^3\Psi}{\rho\lambda^3}\right)^{1/2} \right|. \qquad (6)$$

The curves for $\Delta F = f(\lambda)$ calculated from (6) are shown in Figure 2. The reduction in the spectral width in a range of $\lambda \simeq 2$ cm is due to the fact that in this case, the "resonance" waves are surface waves located at the boundary of capillary and gravitational waves, which have a minimal phase velocity. The values of ΔF when $\lambda = 3.2$ cm are included in the Table. These data are closer to the experimental values than those obtained in [1, 5], however, the calculated spectral width of a scattered radio emission is nonetheless several times less than that obtained under natural conditions.

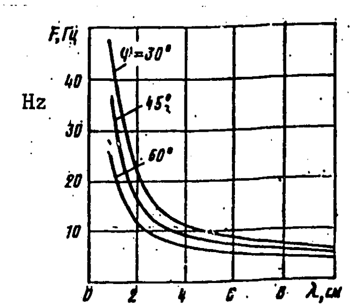

Figure 1.

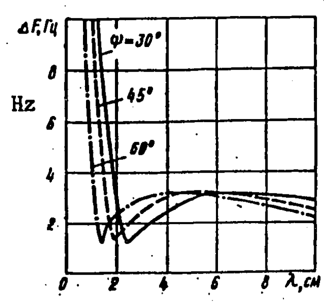

Figure 2.

To estimate the spectral widening due to orbital motion of an "resonance" ripple with the action of larger waves, measurements were made for the case of vertical irradiation (Ψ = 90°) of the water surface. In this case, the spectral width which is determined practically solely by fluctuations of the reflecting surface with the action of a large ripple, proved to be 4.8 Hz.

The results of a spectral width calculation for scattering by an agitated water surface are given in the last column of the table, taking into account all of the factors causing spectral widening considered in this paper. These data are in agreement with the measurement results.

Thus, the mechanism considered here for the spectral widening of microwave radiation scattered by a wind ripple (the influence of the finite width of the resonance characteristic of the scattering and the orbital motion of the "resonance" ripple on larger waves) makes it possible to explain experimental results obtained in the case of weak wave action.

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VARIOUS MISCELLANEOUS ITEMS, INCLUDING THEORIES

UDC 656.816.5:686.12.056

INNOVATIONS IN EQUIPMENT FOR DESTROYING DOCUMENTS*

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 12, 1980 pp 42-43

[Article by E.B. Gorbatyy, engineer, and A.L. Raykhtsaum, candidate of historical sciences]

[Text] The state of the art of management is characterized by an increase in the volume of documental information recorded on paper media. Whereas at the beginning of the decade for the implementation of the managerial work of institutions, enterprises and organizations in our country were created about 60 billion sheets of documents [1], by the end of the 70's this figure had already grown to 500 billion sheets [2]. For the sake of information let us point out that according to the data of American specialists in the USA in 1968 the quantity of documents reached 175 billion sheets per year, and no tendency toward a reduction in this amount was envisioned [3]. Furthermore, such an enormous array of documents is by no means intended for prolonged storage in various kinds of archives. Many documents are of an operating nature and are destroyed when there is no longer a need for them. Of this we are convinced by management data according to which a comparatively small amount of documents is consigned to archival storage. In this connection questions relating to the recycling of unneeded paper documents begin to play an important role.

It is possible to single out the following aspects of this recycling: prevention of restoration of the text of a processed document in order to avoid divulging its contents and the possibility of further use of the processed document, and the observance of environmental protection regulations.

At the present time paper destroying machines are used for the purpose of recycling documents while taking all these aspects into account. Here let us note the definite inconsistency between the name of the machine and the functions it performs In this case it is a question not of destroying documents, but of processing, of recycling them.

*From materials of a seminar organized by the USSR All-Union Chamber of Commerce and Industry and the Austrian firm Otto und Heinz Korotin GmbH.

Being a component of the combination of office systems equipment for processing documents, paper destroying machines are equipment without which not a single subdivision of the administrative apparatus specializing in clerical services can manage today. These machines serve the purpose not only of recycling business papers in general, but also of maintaining the secrecy of the information contained in them. Grinding paper into illegible pieces, shreds, etc., these machines provide an efficient solution to problems of getting rid of documents which have become unnecessary to a specific organization while their content can be of interest to other organizations.

In this connection it can be mentioned that these machines completely solve the problem of destroying documents without inflicting damage on the environment. Relatively recently the burning of archives was practiced for these purposes. However, this method should be omitted since it results in pollution of the air basin (burning of this sort is prohibited in the majority of countries of the world). In addition, it is practically impossible to have an incinerator in each institution; therefore, documents not to be transmitted for use by other organizations had to be delivered to central incineration plants, as the result of which the danger of their being lost or of falling into the hands of undesirable people increased. The economic side of the matter is also not to be forgotten. Grinding paper up makes it possible to recycle it, which will promote to a definite degree the conservation of forest tracts.

In designing paper destroying machines are observed a number of principles ensuring their high performance.

Taking into account the fact that these machines as a rule are found in office areas where administrative personnel of quite different levels are located (for example, in individual cases it is possible to recommend the installation of such a machine directly in the manager's office), required of them first of all is a minimum of noise interference. They must also be transportable regardless of whether the unit is a portable one or is a high-output machine. Equipment for preventing failures in overloading is necessary in machines. For this purpose reversing equipment is used, making it possible to withdraw material serving as the reason for overloading, as well as automatic equipment registering overloading.

The servicing of these machines and their repair must be performed in the shortest time, since here undesirable access to the contents of machines is made possible.

Foreign firms produce a number of paper destroying machines whose operating characteristics are of definite interest.

The "Fordishred-Elektroshredder-Alpha" machine is very compact and can be used in any office area. It cuts paper at a speed of 10.5 m/min and can process in one operation five to eight pages of paper with a density of 70 g/m^3. The shredded paper is guided into a polyethylene bag, which ensures cleanliness and convenience in processing it further. The design of the machine makes it possible to install it on any work table.

The "Fordishred-Elektroshredder-246" machine is designed for equipping a manager's work place and is installed beside a desk. It has three different cutting widths:

2, 4 and 6 mm, depending on which in a single operation are destroyed six to 16 sheets of documents,

The "Fordishred-102" machine series consists of four models with a cutting width of 0.78 to 4.8 mm. The 0.78-mm machines shred documents completely and are widely used in foreign government institutions, embassies, on submarines, etc. In case the power supply fails, these machines are furnished with hand controls making it possible to shred documents manually.

The "Fordishred-X9" model is quite promising. It not only cuts paper into practically illegible strips 0.78 mm wide, but also chops them into pieces measuring 0.8 X 10 mm. This machine converts a sheet of A4-format paper into 7000 pieces in one second. It is furnished with a special basket for refuse and with a hand control for manual drive.

Special consideration is to be given to machines having fundamental differences from other machines with a similar purpose, and primarily to a machine designed for recycling documents produced in the process of the functioning of computer equipment. The wide distribution of computers has entailed an increase in the amount of printouts and other similar documents. Their recycling has become an urgent problem. The "Kompjutershred-Elektroshredder-1600" machine can be used for this. It cuts a printout and continuous tapes into strips 6.4 mm wide and in a single operating cycle shreds 25 sheets 21 cm thick. Mounted on the machine is a work table to accommodate the material to be recycled.

The "Husmann" machine, type EDV, used for the same purposes, has a productivity of 350 kg/h.

The first paper destroying machine with electronic devices in the world is the "Fordishred-1800-Electronic." The electronics make it possible to stop a working machine without an operator and the machine shuts off automatically when reloading. It can shred as much as 750 kg of paper per hour. More than 50 sheets are processed in a single working cycle. It can shred cards, boxes, etc.

Of certain interest are machines of the Gerhard Husmann firm furnished additionally with presses for converting waste into bales. For example, the HSM4 machine under a pressure of $8 \cdot 10^5$ Pa presses waste into plastic bales weighing 40 to 60 kg (six to eight bales per hour). These machines make it possible to recycle cardboard, large and small cardboard boxes, tin containers and the like. Their use is most advisable with the existence of considerable amounts of material to be processed.

"Cancelling" model machines designed for invalidating documents are also produced. In this case the document to be processed is not shredded, as in ordinary machines, but perforated. It retains its form and is suitable for visual recognition, but it loses its legal validity. In foreign practice foreign passports, checkbooks and savings passbooks, accounts, etc., are processed in this way. The processed documents can be used only for reference purposes.

The machines for recycling documents talked about in this article considerably improve the standard, quality and efficiency of the work of administrative personnel.

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