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USSR Report

ELECTRONICS AND ELECTRICAL ENGINEERING

(FOUO 14/80)

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ANTENNAS

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SATELLITE COMMUNICATIONS GROUND STATION ANTENNAS

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[Article by A.M. Pokras]

[Text] The electrical and structural characteristics of satellite communications station (SSS) antennas are primarily determined by the following factors. Artificial earth satellites (ISZ) in an elliptical "Molniya" type orbit with an apogee of about 40,000 km and in a circular geostationary orbit at an altitude of about 36,000 km are the most widely used for communications. In the first case, the satellite moves relative to the ground station within a range of wide sectors of elevation angles and azimuth, and in the second, it moves fractions or units of a degree. The tasks of tracking the antenna beam on the satellite in these cases are solved by means of fully steerable and simpler non-fully-steerable devices (OPU) on which the antenna reflector is mounted, as well as systems for programmed guidance and automatic tracking [1].

It follows from the data cited on the orbital altitudes that the distances between the corresponding points and the satellite repeater amount to tens of thousands of kilometers. At the same time, the power flux level radiated by the on-board antenna is limited, something which is due both to the limited power of the on-board power supply and the impermissibility of transmitting powerful signals towards the earth which are capable of interfering with other radio facilities operating at the same or close to the same wavelengths. Under these conditions, an adequate signal-to-noise ratio at the input to the ground station receiver can be obtained by using an antenna with extremal high gain, and this means, one with large geometric dimensions, as well as receivers with high sensitivity which can be achieved by means of low noise input devices (MShU). The signal to noise ratio is proportional to the ratio of the antenna gain (G_a) to the sum of the noise temperatures of the MShU (T_p), the antenna (T_a) and the antenna-waveguide channel (AVT) (T_{tr}). The values of T_{tr} are reduced by means of shortening the antenna-waveguide channel for the receiver;

T_a and T_p are commensurate with each other. Thus, T_a is one of the important parameters which has an influence on the power potential of the satellite-to-ground radio link. T_a is determined by the power level of the noise generated by the environment and received by the antenna. One of the major noise sources is the earth ($T_n \approx 300°$ K). In the case of communications at low elevation angles, the earth noise is received via the side lobes close to the maximum of the directional pattern (DN), and their levels are relatively high and the noise level incoming into the receiver input is likewise high. For this reason, the minimum working elevation angle is limited to 5°. A considerable contribution is made to the noise temperature by space noise and the noise generated by absorption in the atmosphere. When the elevation angle increases, the path length in the atmosphere decreases, and consequently, absorption and the noise related to it fall off. Practically speaking, T_a for modern antennas at elevation angles of 5 and 90° amounts to 40-60° K and 10-20° K respectively.

Not only the form of the satellite orbit (stationary or elliptical) has an impact on the structural design of an antenna, but also climatic conditions, especially the working and maximum wind speeds.

Thus, the following major requirements are placed on antennas of ground stations for satellite service:

—The antennas should have a high gain and a low noise temperature;

—The support and steering devices and control systems should provide for beam guidance on a satellite as well as automatically tracking it;

--The construction and dynamic characteristics of an antenna system should assure reliable operation while maintaining the requisite electrical characteristics under specified climatic conditions.

A number of antennas which were used previously - the parabolic horn antenna, the "dishpan", antennas with covers [2], are not treated here because of a lack of space.

During the 1970's, fully steerable double reflector axially symmetric antennas were the most widely used in the domestic and foreign satellite communications stations. The diameter of the antenna reflectors at class one stations was 25 to 32 m, 12 m at class two stations and 2.5 to 11 m at mobile stations. By the end of the 1970's a number of foreign companies developed stations with simplified non-fully-steerable guidance systems capable of operating only through a satellite in a geostationary orbit, as well as fully steerable antennas equipped with a beam guide.

A typical example of a fully steerable tower type OPU [support and steering system] is the OPU of the antenna for the transportable "Mars" station with a 7 m diameter reflector (Figure 1) [not reproduced]. The OPU is fully steerable in azimuth and elevation. Included in the OPU equipment complement are a stationary base, sections which rotate in azimuth and elevation, as well as electrical and auxiliary equipment. The main support structure which carries all of the loads of the rotating section is the stationary base with the vertical axis of the azimuth guidance mechanism secured to it, as well as the toothed rim and the support assemblies of the azimuth guidance mechanism. The steerable portion — a machine bench with housings, on which all of the major drive mechanisms and the power electrical drive are mounted — rotates on the bearings of the support assemblies. The equipment room is fitted flush up against the rear end face of the bench support.

The swinging portion of the OPU includes a trunnion bearing beam and sectors. The electrical equipment of the OPU consists of the electrical guidance drives (the EPN), and the devices for illumination, heating, ventillation and cables. The devices for securing the adjusting instruments, the cables and the microwave channel, as well as the traps and barriers are the auxiliary equipment. The OPU remains operational in an ambient temperature range of -50 to +50° C, and wind speeds up to 20 m/sec. The maximum wind velocity head is up to 40 m/sec.

An example of a station with a non-fully-steerable antenna for working through a satellite in a geostationary orbit is shown in Figure 2 [not reproduced] (a design by the NEC company [6]). Reflectors 10 m or 13 m in diameter (depending on the volume of data to be transmitted) can be installed on the OPU, which has a system of X-Y axes. During assembly, the antenna is installed in a position close to the working position. After this, using two screw jacks, one can obtain continuous beam guidance along the Y axis ± 10° and along the X axis from 5 to 90° in a simplified automatic tracking mode.

Normal operation is assured with a wind velocity of up to 27 m/sec, and from 27 to 35 m/sec, the antenna can be fixed in any position. The antenna is secured to a reinforced concrete foundation and it sustains the wind loading with speeds up to 60 m/sec. Where such systems are used, there is no need for major capital construction, since the antenna is placed in containers.

The utilization of a modified surface shape of the reflectors is characteristic of all modern antennas for the purpose of increasing the surface area utilization factor (the KIP), or in other words, increasing the effective area of the antenna. In a dual reflector antenna, this modification is accomplished in the following manner. The original hyperboloidal shape of the surface of the subdish is changed so that the energy of the spherical wave which is incident to its central portion is reradiated in the direction of the peripheral portion of the main reflector. As a result of this, the amplitude distribution of the field in the aperture of the latter is close to a uniform distribution, however, the deviation of the modified shape of the surface of the subdish from the hyperboloidal form leads to the distortion of the phase distribution of the field in the aperture of the main reflector. In order to correct this distortion and obtain a plane front in the aperture, an appropriate modification is made in the surface shape of the main reflector.

A high surface area utilization factor (KIP) of the antenna is provided through the modifications described here [3]. For example, for domestic fully steerable antennas with diameters of 7, 12 and 25 m [4], the KIP, measured at the input to the subdish, is approximately 0.7 at the receive frequency and 0.6 at the transmit frequency. In this case, the noise temperature of the antennas with reflector diamters of 7 and 25 m "into the zenith" is 20° K, and for an elevation angle of 5°, is 50° K. For an antenna with an aperture diameter of 12 m for the same elevation angles, the noise temperature is 12 and 35° K respectively. This relative decrease is explained by the large angular size of the aperture (180°) of the 12 meter reflector (as compared to 128 and 116° for antennas with diameters of 7 and 25 m) i.e., by its greater depth.

A standardized subdish is utilized in the antennas indicated here. It takes the form of a conical horn with an aperture diameter of 300 mm, where a ribbed structure with an inductive reactance is applied to the inside wall of the horn, and this structure, in exciting the EH_{11} mode produces an axially symmetric directional pattern of the subdish and low sidelobe levels. To obtain conical scanning of the antenna beam, the horn is equipped with a scanning attachment [1], in which a dipole array is placed; these dipoles are resonant at the receive and deflecting beam frequencies. The dipoles are rotated at a specified rate by means of the scanner mechanism and the beam scans at the requisite frequency. Simultaneously, the rotor of the reference voltage generator rotates, based on the signal of which the automatic tracking system is phased. Antennas with modified surfaces have good electrical characteristics. However, the dimensions of their subdish systems are large: the diameter of the subdish is 1 to 3 m and the horn diameter is 0.3 to 0.8 m, and its length reaches several meters for some antennas; it is necessary to install powerful support to support the subdish on the reflector. Such irradiating systems are complicated to manufacture, install and align, and have a high cost. For this reason, a small and simple irradiating system (MOS [1, 7] was designed for the antenna of the "Orbita" mass network, where this system effectively irradiates a reflector having an angular aperture size of 180°. This system (Figure 3) [not reproduced] consists of a small conical horn 1 90 mm in diameter and a subdish with a conical portion 440 mm in diameter, which abuts against the flat ring with an outside diameter of 640 mm. To achieve the scanning, the cone is split into the following sections: the stationary one 2 and the moving section 3. The moving section is shifted in a transverse direction and rotates at a specified rate [1, 8]. The small dimensions and weight of the subdish have made it possible to mount it on three thin plastic supports 4, the other ends of which are secured not to the main reflector, but to the central tube 5, which supports the horn and the waveguide channel. The small dimensions and weight, and the structural simplicity of the MOS have made it possible to reduce the cost of the irradiating system by a factor of three. In terms of its electrical characteristics, the antenna with the MOS does not differ from an antenna with a modified subdish and a standardized irradiator, something which is confirmed by the results of radio astronomy measurements of the KIP and measurements of the noise temperature performed for a large number of stations.

Consequently, antennas with reflector diameter of 7, 12 and 25 m, which are used on domestic satellite communications stations operating in the four and six GHz international bands, have high technical parameters.

We shall deal with the prospects for the development of satellite communications antennas separately. There are aspects here: one is related to the refinement of satellite communications stations operating in the 4 and 6 GHz bands, and the second is related to the mastery of the 11 and 14 GHz as well as the 20 and 30 GHz bands. One of the refinements is operation with polarizations which rotate in opposition to each other, something which permits making double use of each of the working frequencies of a microwave trunk, and thereby doubling the traffic capacity of a satellite communications station. In order to prevent crosstalk produced by signals transmitted at a common frequency when working with opposing polarizations, it is necessary to have practically ideal circular polarizations: the coefficient of ellipticity (KE) should be no worse than 1.06. In this case, it is insufficient to have such a KE for the antenna itself. The fact is that depolarization occurs during the propagation of a wave with rotating polarization along a path when it is raining. The vertically and horizontally polarized components of the field experience different delay and losses, and as a result become unequal in amplitude and the phase shift between them ceases to be 90°. For this reason, when working with opposing polarizations, special devices are inserted in the antenna-waveguide channels which correct the polarization based on a pilot signal transmitted from the satellite bringing the coefficient of ellipticity up to the requisite value.

Another refinement consists in the fact that the antenna is equipped with a beam guide: a system of periscopic reflectors which transmit the signal from the irradiator to the subdish and back [9]. We shall consider the operation of a four reflector beam guide, 9 (Figures 4 and 5), in the transmit mode. Horn 7 usually serves as the irradiator, which generates an axially symmetric amplitude pattern, which has a shape close to the optimal gaussian form, and a spherical wave front. Following reflection from the first plane reflector 1 which is inclined at an angle of 45°, the spherical wave changes the direction of propagation by 90°. The second reflector 6 is paraboloidal, it transforms the spherical wave to a plane wave and changes the direction of propagation by another 90° towards the third reflector 5. This reflector (likewise paraboloidal) transforms the plane wave to a converging spherical one and directs it towards the fourth reflector 2, which is a flat one. The latter, in a manner similar to the first, rotates the radiation through 90°. Following reflection from 2, the spherical wave converges to the focus point 3 and then begins to diverge. The focus of hyperboloidal subdish 8 coincides with point 3, where the subdish thus proves to be irradiated by a quasi-point radiator positioned at the focus, and the situation corresponds to that situation which occurs in a conventional Cassegrain antenna with primary reflector 4.

When the antenna rotates in azimuth, all four beam guide reflectors rotate with it. Since the centers of reflectors 1 and 2, as well as the axis of the horn are coincident with the axis of the azimuthal rotation, the operational conditions of the beam guide remain constant. During rotations of 4 relative to the elevation axis, reflector 2 of the beam guide rotates along with it. The center of reflector 2 is coincident with the elevation angle axis, and therefore during rotations of the antenna in elevation, the operating conditions of the beam guide do not change. Thus, in any antenna position, when it is rotated in azimuth and elevation there is normal irridation of the subdish and the beam guide thereby likewise forms the functions of rotating joints. This makes it possible to combine several frequency bands in one antenna, since narrow band rotating joints are eliminated. The losses introduced by the beam guide are extremely low.

In conclusion, it must be noted that the term "beam guide", which has come in recent years to designate conductorless transmission lines on analogy with optical lines is particularly conditional. In reality, the beam treatment does not permit either the design of a system or the disclosure of the complete physical picture of its operation. This question has been treated more fully in [9]. Yet another important merit of the beam guide can be seen from an analysis of the structural configuration of an antenna with a four reflector beam guide (Figure 5): the possibility of positioning the receiving and transmitting equipment directly at the irradiator, something which makes it possible to substantially shorten the antenna-waveguide channel over this section. Moreover, antenna-waveguide channels are eliminated which are usually run through the antenna. Thus, a substantial reduction is achieved in the losses in the antenna-waveguide receive and transmit channels. This is especially important in a receive channel, since these losses degrade the G/T ratio, reducing the gain G and increasing the noise temperature of the channel.

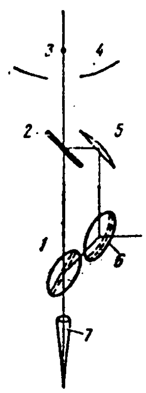


Figure 4.

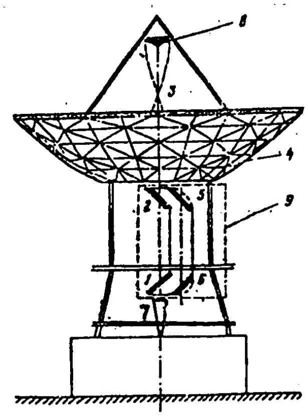


Figure 5.

The Mark-4 [10] antenna of the Japanese company NEC is designed in the configuration of Figure 5 with a diameter of the main reflector of 32 m. With the path length of about30 m which the wave travels from the input of the irradiator to the subdish, the losses in the beam guide amount to a few tenths of a decibel. By modifying the surface of the subdish and the main reflector in accordance with the structure of the amplitude and phase distributions of the wave field incident on the subdish, it proved possible to obtain a surface utilization factor at the receive and transmit frequencies of above 0.7 and 0.6 respectively.

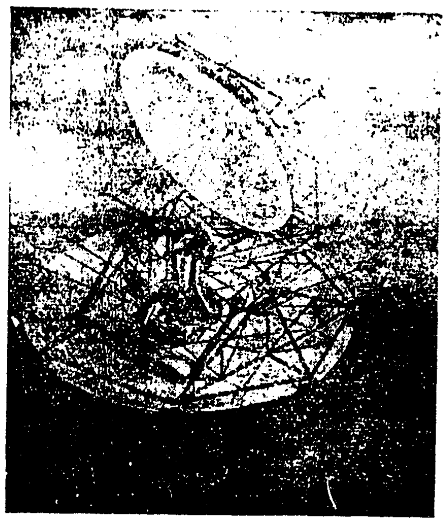
There is yet another refinement which has its goal of further simplifying the OPU of stations working through satellites in a geostationary orbit. It is based on the possibility of shifting the antenna beam within a very small range by means of changing the position of the subdish [11]. As studies have shown, the beam can be swept through 2 to 2.5 times the width of the main lobe at the 3 dB level with gain losses of no more than 1 dB. The set standard amount of diurnal displacement of a satellite in a geostationary orbit amounts to ±0.1°. The width of the main lobe of antennas with diameters of 7 and 12 m at frequencies of 6 and 14 GHz (the upper frequencies of the bands) is as follows: 26' and 12' for antennas of 7 m, and 16' and 7' for 12 m. The permissible deviation of the beam amounts to ±1 and ±0.5° for an antenna with a diameter of 7 m and ±40' and ±18' for 12 m respectively. It follows from this that the precise tracking of satellites with the beam of antennas having the indicated parameters in the 4 to 6 and 11 to 14 GHz bands can be accomplished with acceptable losses by means of steering the subdish. The small dimensions and weight of the latter make it possible to effect this steering by means of low power tracking drives. The coarse setting of the reflector with this solution can be accomplished by a manual drive or by a primitive nontracking drive. All of this makes it possible to eliminate expensive high power electrical tracking drives which serve beam guidance be means of steering the large main reflector.

Axially symmetric reflectors are utilized in all of the antennas being described above. Inherent in this class of antennas is the already mentioned fundamental drawback that the axially symmetric reflector presupposes positioning in the central portion of the aperture of the subdish, which along with its supports, creates shading which reduces the antenna gain, increases the noise temperature and degrades the noise immunity be decreasing the levels of spurious radiations. Moreover, a portion of the wave energy reflected from the subdish is returned to the irradiator and picked-up by it. This degrades the antenna matching. Along with this, the reflected wave, when working with circular polarization, degrades the coefficient of ellipticity for the working direction of rotation after the reflected wave passes through the polarizer twice.

The shading of the aperture and the drawbacks related to this can be eliminated by using a non-axially symmetric reflector antenna with an offset irradiating system. The first variant of such an antenna for satellite communications stations was proposed with the classically unmodified reflector shapes: paraboloidal and hyperboloidal [12]. In this variant, the subdish and its supports are offset out of the field and shading is completely eliminated, however the azimuthal rotating joint and the waveguide channel between the radio equipment and the irradiator are retained. Moreover, there is a hole in the surface of the reflector in which the irradiator is placed, something which degrades the directional properties of the antenna. The major drawback of the antenna though is the lack of the modified shape of the reflectors, something which has precluded the possibility of obtaining a high surface utilization factor.

Although the advantages of nonaxially symmetric antennas have been known for a long time, as a rule, antennas having a high surface utilization factor with axially symmetric reflectors, the surface shapes of which have been modified, are utilized in satellite communication stations. Nonaxially symmetric reflectors are used only in multibeam antennas. However, the advantages mentioned above for an antenna with an offset irradiating system have stimulated us to search for methods of solving the problem of synthesizing reflector surfaces [13, 14].

Such solutions were found in Japan also [15]. This opened up possibilities for the realization of such antennas. The structural configuration



[Best reproduction available]

Figure 6.

of a domestic fully steerable antenna which is under development is shown in Figure 6 [16, 17, 18]. It is a combination of a device with an offset irradiating system, the primary reflector and subdish of which are modified, and a beam guide, and correspondingly possesses the entire aggregate of advantages inherent in the devices described above. Here, 1 is the primary reflector, 2 is the intermediate truss on which the panels generating the specified surface shape are used as facing; 3 is the subdish; 4 is the conical horn irradiator with a ribbed structure; 5 and 6 are the paraboloidal and flat rotating reflectors of the beam guide; 7 is the housing of the beam guide; 8 are the structures for the support and steering unit [OPU]; 9 are the traveling trolleys of the azimuth system; 10 is the drive for the elevation rotation system; 11 is the support for the elevation rotation axis; 12 is the central pivot.

The operational principle of the antenna system differs somewhat from that explained for the configuration of Figure 5, since in the beam guide here there are two and not four reflectors. The focus of paraboloidal reflector 5 coincides with the phase center of the horn irradiator, and for this reason, the spherical wave radiated by the horn irradiator is transformed into a plane wave. The reflectors of the beam guide, 5 and 6, are arranged so that the elevation axis runs through their centers. In space though, these reflectors are oriented so that the plane wave reradiated by reflector 5 is directed to reflector 6, following the reflection from which it falls on the subdish. The latter has a modified shape and reradiates the wave incident on it with a decaying amplitude distribution along the wave front such that in the aperture of the primary reflector, it becomes close to a uniform distribution. The distortions arising in this case in the phase distribution, as usual, are corrected by means of modifying the surface shape of the primary reflector. In the receive mode, all transformations of the fields occur in the reverse order.

The axis of symmetry of the horn coincides with the axis of azimuthal rotation and the center of the reflector of beam guide 5. During rotation in azimuth, both reflectors of the beam guide, the subdish and the primary reflector are moved simultaneously, and their mutual positioning does not change. Because of this, the irradiator and all of the electronic receive and transmit equipment connected to it remain stationary during guidance of the antenna in azimuth.

The elevation axis runs through the centers of beam guide reflectors 5 and 6. When the antenna is steered in elevation, reflector 5 remains stationary. Reflector 6 and the subdish are rigidly coupled to the primary reflector and move simultaneously when the antenna is guided in elevation. For this reason, nothing changes in the travel of the wave from reflector 5 to the primary reflector.

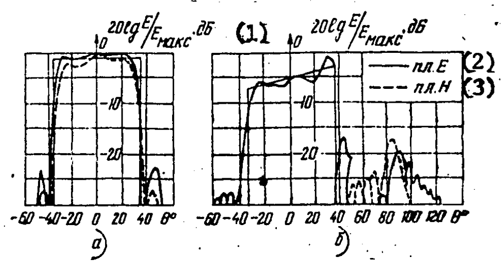


Figure 7.

Key: 1. 20 log E/E_{max}, dB;
2. The E plane;
3. The H plane.

Consequently, even with a light guide of two reflectors in all, all of the functions of the microwave channel are successfully carried out, assuring the connection of the transmit and receive equipment to the fully steerable antenna.

The adequacy of the precision for engineering purposes of the approximate solution which was found for the synthesis problem [14], utilized in the design of the antenna, which is shown in Figure 6, was confirmed by experimental studies. Measurements of the directional pattern of the horn--beam guide--subdish system using a model are shown in Figure 7 (the ideal patterns with a rectangular and trapezoidal shape are indicated by the fine lines: a) The directional pattern in the transverse plane, b) In the longitudinal plane). An analysis of the directional patterns shows that the irradiating system actually creates an amplitude distribution close to a normal distribution in the aperture of the primary reflector, since in the direction of the most remote portion of the primary reflector there is the requisite rise in the output level.

TABLE 1

Antenna Characteristics	Type of Antenna: Non-axially Symmetric	Type of Antenna: Axially Symmetric
Aperture diameter	11.5	11.5
Irradiating system	Dual reflector beam guide, subdish, ribbed horn guide	The same
Guidance sectors	Azimuth ±22° (±6° continuously) Elevation ±5° (continuously)	Along the X axis, 47° ±8° Along the Y axis, ±12°
Precision of the surface*	0.18 mm (mean square deviation)	0.16 mm (mean square deviation)
Weight	19.4 tons	23.9 tons
Frequency band	17.7—21.2 GHz (receive) 27.5—31.0 GHz (transmit)	17.7—21.2 GHz (receive) 27.5—31.0 GHz (transmit)
Antenna gain* (KIP)	66.3 dB (76%) at 19.5 GHz 69.5 dB (69%) at 29.5 GHz	66.1 dB (72%) at 19.5 GHz 69.3 dB (68%) at 29.5 GHz
Noise temperature	13° K at an elevation angle of 45° at 18.75 GHz	13° K at an elevation angle of 45° at 18.75 GHz

Note: The asterisk indicates measured quantities.

The numerical integration of the experimental patterns which was performed with a computer yielded a product of the aperture surface utilization coefficient of the primary reflector times the coefficient taking into account the "overflow" of energy beyond the edge of the reflectors, equal to 0.94.

Extremely high precision in the execution of the surface of the reflectors have been achieved in the newest antennas: the mean square deviation from the specified shape is 0.2 mm. With such precision, it can be anticipated the KIP [surface area utilization coefficient] of the antenna will reach 0.75--0.8. The horn irradiator and the system of reflectors are arranged in space so that the spurious radiation levels in the direction of the ground

TABLE 2

Characteristic	Values
Frequency bands	10.95--11.20 GHz (receive) 11.45--11.30 GHz (receive) 14.0--14.50 GHz (transmit)
Polarization (Communications channels)	Two linear orthogonal ones
Cross-polarization	On the axis, less than -42 dB; within limits of the 1 dB level of the main lobe, less than -38 dB.
Gain in the receive band	65 dB + 20 log (f/11,375) dB; the KIP at a frequency of 11,375 MHz is 0.62, where f is the frequency in MHz
Gain the transmit band	66.8 + 20 log (f/14,250) dB; the KIP at a frequency of 14,250 MHz is 0.6
Noise temperature (during clear weather)	81° K at an elevation angle of 30° and a frequency of 11,375 MHz

are extremely low. The noise temperature of the antenna should be correspondingly low.

Because of the newness of the antenna system described here, we shall touch on the details of its construction. The support and steering unit (Figure 6) consists of a support system (for rotation in elevation), to which the reflector system and the system for azimuthal rotation, which serves as the base for the elevation system, are fastened through an intermediate support truss. Rotations in elevation are accomplished by means of a mechanism in the form of two parallel screw-nut swinging transmissions. These transmissions are coupled through beveled gears and universal joints to the common electrical drive, which is located on one frame. Such a structural configuration, along with high rigidity and precision of the gearing, assures a long service life, wear resistance and high efficiency of the mechanism.

Some five single wheel travel trolleys are used in the azimuthal rotation mechanism, where these are arranged at angles on the support frame and move around the swing circle. They are all driven, and on some of them, auxiliary motors and reducers are mounted in addition to the main drives for emergency rotation of the system when the main tracking drive fails. Tachogenerators are installed on the travel trolleys to determine the angular speed of the azimuthal drives in the control system.

A central pivot - a rigid cylinder around which the entire system rotates - is mounted in the center of the swing circle. The central pivot consists of a support plate which is secured by means of foundation bolts to a concrete base and the swing ring. The latter is mounted on the support plate and is adjusted in the horizontal plane and secured by means of wedge thrust spacers.

The horizontal frames of the central pivot are installed in a circle in the support frame of the antenna, and are brought flush up against the swing ring by means of a wedge clamp. The vertical rolers, which are installed in the support frame between the horizontal rolers, keep the deformations and displacements of the primary reflector of the beam guide at one level during azimuthal rotation, where this primary reflector of the beam guide is mounted on the support frame. The swing ring is equipped with a gear rim, and the instrument reducer for azimuthal rotation is engaged in this gear rim. The overall weight of the mechanisms and supports of the elevation and azimuthal steering systems for an antenna with an aperture diameter of 12 m amounts to about 12 tons. The weight of the metal structures of the primary rèflector is 4.5 tons and that of the intermediate support structure is 6.5 tons. In conclusions, we shall consider the antennas which are finding applications in the new high frequency bands. Among them, two antennas with an aperture diameter of 12 m, which were presented at the exhibition in Kyoto in 1978 [19], are the newest and ones having high performance characteristics. One of them is a non-axially-symmetric antenna, equipped with a two reflector beam guide, which is identical to the antenna of Figure 6 in its configuration. The Japanese antenna is not fully steerable and its steering unit has been correspondingly simplified. The other antenna, with an axially symmetric reflector and a two-reflector beam guide is likewise not fully steerable. The characteristics of these antennas are given in Table 1.

If follows from the data cited here that antennas for the new bands do not differ in their configuration from contemporary antennas for the four and six gigahertz bands, which are equipped with a beam guide. The specific features here are the higher reqirements placed on the precision of the execution of the working surfaces of the reflector, and especially, the guidance of the antenna beam. We shall indicate for the sake of illustration that the 3 dB level width of the directional pattern of an antenna with a diameter of 12 m amounts to about 3 minutes of an angle overall at a frequency of 30 GHz.

An antenna with an aperture diameter of 19 m is provided for class 1 stations in the 11 and 14 GHz bands. Such an antenna, for example, has been developed by the Marconi company; it is similar in its configuration to the "Mark-IV" antenna described above (see Figure 5) and has a four reflector beam guide. The above mentioned increased requirements placed on precision were taken into account in its development. The antenna possesses the modern high radio engineering characteristics shown in Table 2.

BIBLIOGRAPHY

1. Pokras, A.M., et al., "Sistemy navedeniya antenn zemnykh stantsiy sputnikovoy svyazi" ["Guidance Systems for Satellite Communications Ground Station Antennas"], Moscow, Svyaz' Publishers, 1978.

2. Pokras, A.M., "Antennyye ustroystva zarubezhnykh liniy svyazi cherez iskusstvennyye sputniki zemli" ["The Antenna Equipment of Foreign Communications Links working through Artificial Earth Satellites"], Moscow, Svyaz' Publishers, 1965.

3. Bandukov, V.P., Pokras, A.M., ELEKTROSVYAZ' [ELECTRICAL COMMUNICATIONS], 1973, No 10.

4. Pokras, A.M., ELEKTROSVYAZ', 1977, No 3.

5. Pokras, A.M., et al., "Ustroystvo konicheskogo skanirovaniya" ["A Conical Scanning Device"], Patent No. 4245 (USSR).

6. Prospectus of the NEC Company, Catalog No 316-8-E, Tokyo, 1977.

7. Basilaya, I.Sh., Pokras, A.M., "Obluchayushchaya sistema" ["An Irradiating System"], Patent No. 310609 (USSR).

8. Pokras, A.M., et al., "Dvukhzerkal'naya antenna s konicheskim skanirovaniyem" ["A Dual Reflector Antenna with Conical Scanning"], Patent No. 473490 (USSR).

9. Pokras, A.M., TRUDY NIIR [PROCEEDINGS OF THE SCIENTIFIC RESEARCH INSTITUTE FOR RADIO], 1974, No 2.

10. Yukio Sato, et al., "NEC Research and Development", 1974, No 35.

11. Pokras, A.M., Tsurikov, G.G., "IV Nauchno-tekhnicheskaya konferentsiya po antennam i fidernym traktam dlya radiosvyazi, radioveshchaniya i televideniya" ["The Fourth Scientific and Engineering Conference on Antennas and Feed Lines for Radio Communications, Broadcasting and Television", Moscow, 1977, 4 - 7 January.

12. Pokras, A.M., et al., "Osnovy tekhnicheskogo proyektirovaniya apparatury sistem svyazi s pomoshch'yu ISZ" ["Engineering Design Principles for the Equipment of Satellite Communications Systems"], Edited by A.D. Fortushenko, Moscow, Svyaz' Publishers, 1972.

13. Bandukov, V.P., TRUDY NIIR, 1975, No 2.

14. Basilaya, I.Sh., Pokras, A.M., TRUDY NIIR, 1976, No 4.

15. Mizuguchi, Y., et al., THE INSTITUTE OF ELECTRONICS AND COMMUNICATIONS ENGINEERS OF JAPAN, 1975, Vol 58-13, No 2.

16. Basilaya, I.Sh., Pokras, A.M., "The Fourth Scientific and Engineering Conference on Antennas and Feed Lines for Radio Communications, Broadcasting and Television", Moscow, January, 1977.

17. Pokras, A.M., ELEKTROSVYAZ', 1977, No 3.

18. Basilaya, I.Sh., Pokras, A.M., TRUDY NIIR, 1977, No 4.

19. Technical Exhibition on the Occasion of the 14th Plenary Assembly of the CCIR, 1978, Kyoto.

20. Brain, J.R., Gill, J.A., "An 11/14 GHz 19 Satelite Station Antenna [sic]" IEE Conf. Public. No. 169, P 1, Antennas, 28 - 30 Nov., 1978, London.

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CERTAIN ASPECTS OF PHOTOGRAPHY, MOTION PICTURES AND TELEVISION

UDC 778,5(47+57) (048.8)

REVIEW OF THE MAIN WORKS ON THE TECHNOLOGY OF PROFESSIONAL CINEMATOGRAPHY COMPLETED IN 1979

Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 5, 1980 pp 4-16

[Unsigned article]

[Excerpts] In 1979 a prototype of the 3KSU movie camera for high-speed filming (up to 240 frames/second on 35 mm film) was developed, tested and confirmed for series production by the "Ekran" Scientific Production Association of the Moscow Design Bureau of Movie Equipment (MKBK NPO "Ekran") on the basis of initial data from the NIKFI [All-union Scientific Research Institute of Motion Pictures], and the development and production of prototypes for the hand-held "Kinor 35R" camera for 35 mm film were also completed.

The 3KSU is intended for filming sporting events and rapidly occurring processes in popular science movies. The given camera may be used to film multiple exposure frames of small-scale moving models in cinematography for feature-length films.

The 3KSU mechanism provides accuracy of film transport down to 0.02 mm over the whole range of speeds. The Camera is equipped with a parallax-free optical viewfinder which permits viewing through the finder during filming; it may be replaced by a TV viewfinder.

It is possible to set the filming conditions and start the camera by remote control. The 3KSU is equipped with modern movie lenses and has small dimensions and weight for similar types of cameras. The 3KSU is in no way inferior to similar foreign cameras on the basis of technical and operating parameters.

The "Kinor 35R" camera surpasses the models 1 KSR-1M and 1 KSR-2M in its technical characteristics (weight 6 kg, sound level 45 dB). A complex pull-down mechanism with counter-pull, providing accuracy of film transport down to 0.01 mm, is used in the camera. Camera sighting is done by optical parallax-free viewfinder; an attachable TV viewfinder may also be employed. There is a built-in, semi-automatic exposure meter in the camera. The camera is intended for filming documental-newsreel, popular science and feature films. In its main technical and operating parameters, it is a a modern camera for 35-mm film.

The camera was displayed at the "Television and Movie Technology-80" Exhibition in Moscow, and its description is given in (TEKHNIKA KINO I TELEVIDENIYA) No. 4, 1980.

Working in conjunction with the MKBK NPO "Ekran," the NIKFI developed a device for stabilizing the position of the movie camera based on the use of a hydraulic stabilizer; The device is intended for filming from transport devices at the 1980 Olympics. The operating principle (two-circuit indicator stabilization) of the experimental model is analogous with the NIKFI's model described in No. 9, 1979. The main difference between the unit and the model is the positioning of the hydraulic stabilizer inside of an aerodynamic protective housing using a suspension device which allows linear displacements of the camera. Such a design decision permits the unit to be mounted on practically any transport device, including in places which are inaccessible for direct control. Remote control of the movie camera is incorporated in conjunction with TV sighting, as well as remote control of the camera's position in space with a broad range of panning speeds.

The aerodynamic housing is made from opaque materials and has a vertical, glass-covered slit. Vertical panning and tilting the movie camera can be handled without regard to the housing. Horizontal panning is executed both with the aid of the hydraulic stabilizer and, at the same time, with the aid of a suitable turn of the aerodynamic housing. A tracking system is used for this purpose: an induction pickup for the hydraulic platform's position angle, a signal conversion system and a slack-free drive system. The hydraulic stabilizer's suspension system, having a fundamental frequency of 1.5-2 Hz, is intended for damping its linear movements.

Specifications in Brief

Stabilization accuracy	2"
Number of stabilization axes	3
Horizontal panning angle	360°
Vertical panning angle	+30° -90°
Tilting angle	±30°
Panning speed range	0.05-30° per second

There is automatic horizontal frame positioning and horizontal panning relative to true vertical.

Optics for Movie Filming

In 1979 the TsKBK [Central Design Bureau of Movie Equipment] of NPO "Ekran" developed the extrawide-aperture lenses OKS 10-50-1 with $\underline{f}'$ = 50 mm, 1:1.3 (Fig. 1) and OKS 14-75-1 with $\underline{f}'$ = 75 mm, 1:1.4 (Fig. 2).

Fig. 1. OKS 10-50-1 Lens

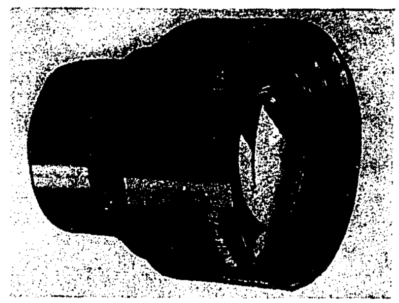

Fig. 2. OKS 14-75-1 Lens

The OKS 10-50-1 lens is intended for filming feature and documental-newsreel films on black-and-white or color 35-mm film with cameras in which the rotating shutter is situated 19 mm from the image plane. The lens consists of 9 elements, with a length of 63 mm; the rear apical focal length is 38.12 mm and the effective relative aperture is 1:1.6. In lens speed the OKS 10-50-1 lens surpasses the OKS 1-50-1 now being produced with $\underline{f}'$ = 50 mm, 1:2 and provides for filming dimly-lit subjects in natural interiors without additional illumination.

The OKS 14-75-1 lens consists of 6 elements and has a length of 68.1 mm. The rear apical focal length is 39.47 mm, and the effective relative aperture is 1:1.6. The OKS 14-75-1 lens has a high light transmission coefficient -- 0.82. In lens speed it surpasses the OKS 6-75-1 lens which is being produced with $\underline{f}'$ = 75 mm, 1:2 and provides for filming dimly-lit subjects in natural interiors without additional illumination.

Lens Specifications

	OKS 10-50-1	OKS 14-74-1
Relative aperture	1:1.3	1:1.4
Rear apical focal length, mm	38.12	39.47
Dimensions, mm.		
Length	80	72
Width	55	65
Weight, kg	0.35	0.37

A Set of Equipment for Underwater Filming

A set of equipment for underwater filming was being intensively developed last year at the NIKFI. The following models were produced at OP [expansion unknown] NIKFI:

- a box for the 1 KSShR 70-mm camera;
- a PUSh universal underwater tripod;
- an SPK-1000 underwater lamp;
- an underwater tripod for the lamp.

These devices will be tested under production conditions in 1980 during filming of the movie "Through the Thorns to the Stars" (Producer-director R. Viktorov, Main Cameraman A. Rybin) at the Yalta Movie Studios.

The PUSh universal underwater tripod is designed for mounting a movie camera or an illumination device under water (Fig. 3). Height adjustment range is 0.5-1.8 m, vertical panning angle is $\pm$ 60° and horizontal panning angle is 360°. Panning may be done both mechanically, using control wheels and a reducing gear, and manually. The tripod weighs 10 kg in air.

The tripod reducing gear is made as a single unit situated in an oil bath, and it is fully protected from the infiltration of sea water. All of the external elements of the tripod are made from materials which are corrosion-resistant in sea water.

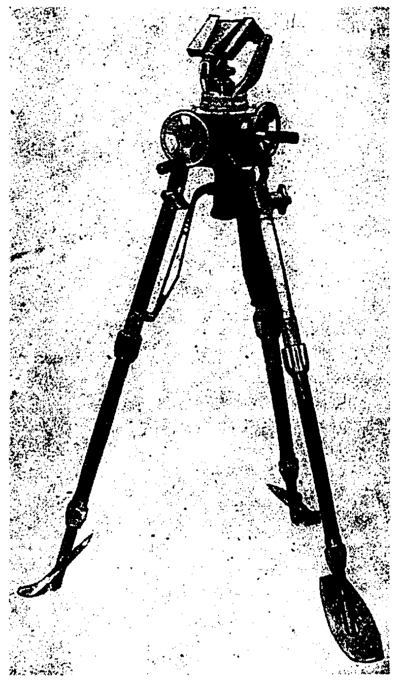

Fig. 3. The PUSh Universal Underwater Tripod

The underwater tripod for the lamp is designed for mounting illumination devices and positioning them on the bottom under conditions in natural and artificial bodies of water (Fig. 4). The height adjustment limits are 0.8-2.0 m, number of simultaneously mounted lamps is 1-4, and the adjustment angle is 360° in the horizontal and $\pm 60°$ in the vertical; the weight is 7 kg.

The tripod supports are equipped with locks of an original design permitting the supports to be clamped in any position and at any angle using a single

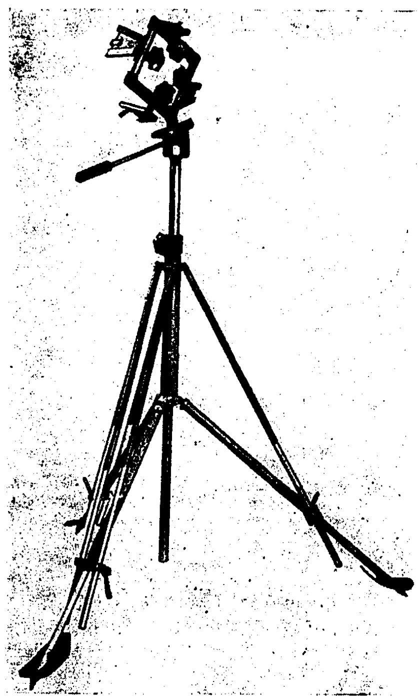

Fig. 4. Underwater Tripod for Lamp

handle. The tripod is outfitted with a special head for simultaneous installation of 4 lamps with the capability of adjusting their relative position. All of the tripod elements are made from materials which are corrosion resistant in sea water.

The underwater box for the 1KSShR70-mm camera is intended for underwater filming on 70-mm film in any body of water, fresh or salt, at depths down to 30 m.

Technical data

Working submersion depth, m.............................30
Buoyancy, H..± 1
a 1KSShR movie camera is used in the set. Casette capacity is 45 and 75 m.
Lenses: with $\underline{f}'$ = 28 mm "Gidro"; in air with $\underline{f}'$ = 28, 40, 56 mm.

Magnification of attachable viewfinder, G = 0.17^x
Apparent magnification of the parallax-free
viewfinder magnifier, G = 3.85^x
Power supply from 10KNG-3S-11U2 storage battery.
Box weight, kg.......................................35
Dimensions with viewfinder, mm.......................545x600x530

For the first time in the history of underwater movie camera design, the box has been equipped with an attachable optical viewfinder with automatic parallax correction. During simple filming sessions, the viewfinder can easily be removed without disturbing the balance, buoyancy or hermetic seal of the box. The box outfit comes with a special "Gidro" underwater lens with f' = 28 mm, the front element of which is also an illuminator at the same time. The parallax-free viewfinder magnifier has a ± 5 D diopter correction for the eye of the camera operator, and it is possible to set this correction under water. All of the external parts of the box are made from materials which are corrosion-resistant for sea water.

The SPK-1000 underwater lamp is intended for operation in sea or fresh water at a depth of down to 20 m (Fig. 5). A 220-V KIM 220-1000-1 (or KIM 110-500) bulb rated at 1,000 W, axial luminous intensity in air 200 x 10^3 cd; power supply cable length - 50 m; insulation resistance no less than 20 MΩ; dimensions, mm: Ø 190x315, weight - 5 kg. Underwater operating time is unlimited.

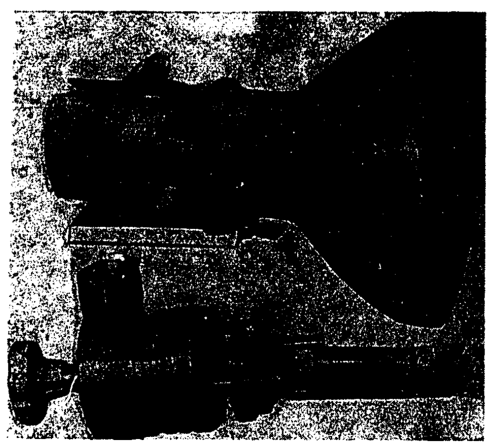

Fig. 5. The SPK-1000 Underwater Lamp

The lamp is used as a hand-held device or may be mounted on a tripod. The design permits the device to be focused and turned on and off under water. All of the components are made from materials which are corrosion-resistant in sea water.

Lighting Equipment for Movie Filming

Work is continuous at the NIKFI in conjunction with the All-union Illumination Engineering Institute (VNISI) to improve the illumination properties of halogen-metal electrical discharge with short arc rated at 575, 1200, 2500 and 4000 W. These lamps are standardized with HMI lamps made by the "Osram" company (FRG) based on their primary parameters and dimensions and they are interchangeable with them. Work has been done by the VNISI on stabilization of color reproduction of lamps used in filming on multilayer color negative film as well as work to prolong the service life of lamps. The lamps correspond to the analogeous import lamps in quality of color reproduction, but they are somewhat inferior to "Osram" lamps in length of service life. The question of the possibility of creating more powerful halogen-metal lamps with short arc, a 7 kW lamp in particular, which could replace the powerful carbon arc for movie lighting was studied at the VNISI on the basis of initial requirements from the NIKFI. The results of the research were positive.

The following methods for eliminating fluctuations in the optical density of a negative which may arise because of pulsations in the luminous flux when halogen-metal lamps with short arc are powered by alternating current.

1. Movie filming at a speed which is a multiple of the lamp's electric power supply frequency, e.g. at 25 frames/second.
2. An appropriate change in the included angle of the rotating shutter, e.g. 173° at a film speed of 24 frames/second and 50 Hz electric power supply frequency.
3. Electric power supply to the halogen-metal lamps using current with higher frequency, e.g. 250-2000 Hz.
4. Electric power supply to the halogen-metal lamps using a non-sinusoidal current, but one which has been specially distorted, e.g. one with rectangular form.

The first two methods impose restrictions on the work of the cameraman.

The third method produces good results with regard to reducing pulsations in the luminous flux, however there is a limit to the increase in frequency imposed by instability of burning in the lamp. High-power lamps are the most "sensitive," and therefore a check of the operation of 2.5 and 4 kW lamps powered by current with an increased frequency was performed at the NIKFI. The study showed that the indicated lamps permit the frequency of the electric power supply to be raised to 400 Hz; at 500 Hz significant spatial discharge instability, noticeable in the projector beam with a Fresnel lens 600 mm in diameter (particularly in its "aureole"), appears.

The fourth method--power supply using rectangular-shaped curren -holds great interest since it permits luminous flux pulsations to be sharply reduced with 50-Hz electric power supply. Research performed at the NIKFI and jointly at the VNISI and the Kaunas Polytechnical Institute (KPI) has demonstrated the promise of this method.

A set of illumination equipment with 4 kW halogen-metal lamps is being worked up on the basis of the research which was performed to provide lighting on location for movie filming.

Experimental models of two types of lighting devices for illumination when filming in mines and shafts have been designed and produced by the KF OKBK [Experimental Movie Equipment Design Bureau?] according to initial requirements of the NIKFI. The devices have linear quartz halogen incandescent lamps rated at 500 W (the "Krot 500") and 1000 W (the "Krot 1000").

The devices underwent extensive testing for safety of operation in the mining industry at the Makeyevskiy Scientific Research Institute, with positive results.

Sound Engineering Equipment

The NIKFI, in conjunction with the "Elektropribor" Production Association (Cheboksary) developed the F4286 electronic digital delay line, designed for regulating the delay of electric signals from the sound frequency range in artificial reverberation, sound amplification and sound recording systems and permitting sounding to be enriched and the creative capabilities of the sound director to be expanded (Fig. 6).

The F4286 delay line is the first domestic piece of equipment of a fundamentally new generation of sound engineering equipment based on the transmission and processing of a sound signal in digital format. The input signal is converted by a digital-analog converter into electrical impulses which are delayed the required time by shift register microcircuits and fed to the analog-digital converter. The signal is inverted in the converter, after which a low frequency, filtered, amplified signal passes to the output. This operating principle permitted the creation of a fully electronic delay line with high electroacoustical properties, one which is reliable and convenient to use.

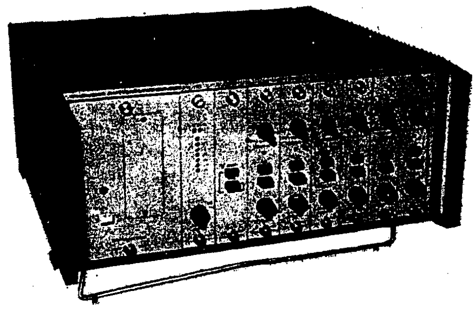

Fig. 6. F4286 Digital Delay Line

Working frequency range, Hz	31.5-16,000
Coefficient of linear distortion, %	no more than 0.2
Signal:noise, dB	no less than 72
Number of analog outputs	6
Maximum delay time at output, μs	
First	51.2
Second	102.4
Third	153.6
Fourth	204.8
Fifth	256.0
Sixth	307.2
Spacing of delay line switching, μs	6.4
Dimensions, mm, no greater than	490x210x515
Weight, kg	40

The device contains a low-frequency assembly with a light-emitting diode level indicator and input signal level switch, the digital-analog converter unit, six identical delay units with delay time switches and output signal level and a power supply block.

Series and parallel connection of the delay units, a by-pass of the digital part of the device, remote control of the delay time (Fig. 7), Series connection of several delay lines using digital input and output, parallel synchronous operation of several units to obtain strictly identical delay time in different channels, synchronization from an external oscillator and signal output by internal synchronization are incorporated for expansion of operating capabilities.

The F4286 delay line has undergone laboratory, plant and use testing and has been recommended for series production. The first industrial batch will be produced in 1980. The experimental prototype is being used successfully at "Mosfil'm" studios.

The specialists at NIKFI, LOMO [Order of Lenin (3 times) Leningrad Optical-Mechanical Association] and the "Mosfil'm" studios imeni Gor'kiy and imeni A. P. Dovzhenko performed a great task in the creation of new models of "TON" monitor speakers with increased power-handling capabilities based on improved cones, using modern materials, modern production technology and new computation and design methods.

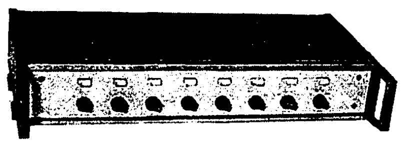

Fig. 7. Remote Time Delay Control Unit

A series of "TON" monitor speakers of the highest category (30A-136, 30A-162, 30A-180) was developed on the basis of the newly created cones (2A-16, 2A-16-1, 1A-26, 1A-28) and a single two-channel transistorized amplifier with electronic separation filter and graphic equalizer for operation as a component in equipment used for recording music (KZM-26, KZM-28, KPZU-2) and for listening to source materials. All of them have identically high specifications, differing only by the dimensions, weight, number of cones used, amplifier power and reproduction level.

The "TON" monitor speaker with increased power handling capacity (30A-180) is a two-way acoustic system consisting of two parts, the low- and the high-frequency sections. The acoustic configuration of the low-frequency unit is as a sealed cabinet with external dimensions of 680x720x420 (mm), to the front panel of which 4 2A-16-1 low-frequency cones (50 W) are attached. The high-frequency unit, consisting of 8 1A-26 units (12.5 W) distributed about in a sealed cabinet with external dimensions of 390x600x300 (mm), is a truncated pyramid, the upper base of which forms the central radiating group in the form of a square made up of 4 cones, and each pair of outside cones is rotated at a 30° angle to the central group.

The speaker should come with a 2-channel amplifier (100 W/channel) with graphic equalizer; a passive separation filter, permitting it to be connected to a wide-band amplifier with a rated power of up to 200 W, is also included; input directly to the cones of the low- and high-frequency groups is provided for monitoring.

Basic Specifications

Cross-over frequency, kHz	1.8
Rated electrical resistance, Ω	4
Rated power per channel, W	100
Total rated power, W	200
Rated frequency range, Hz	20-20,000
Effectively reproduced frequency range, Hz	40-18,000
Characteristic sensitivity, Pa x $W^{-1/2}$	1.0
Axial level of non-linear distortion at rated power, dB	no more than-36
Average rated efficiency, dB	no less than-26
Sound pressure level at total rated power, dB	117

An electronic speaker counterpart. There are a number of difficulties associated with research on speaker operations in the low frequency regions. It was necessary to change the speaker cone parameters and shape many times during the developmental phase of the low-frequency unit using the "trial and error" method, which is costly and inconvenient. Large phonometric chambers, the cost of which is very high, are necessary to obtain reliable results for measurements at low frequencies. A modeling method turned out to be very effective in solving similar problems.

An electronic speaker counterpart, being a specialized analog computer built on 12 monolithic general-application operational amplifiers, was developed at the NIKFI's Electroacoustics Laboratory to study the operation of a loud speaker at low frequencies (Fig. 8).

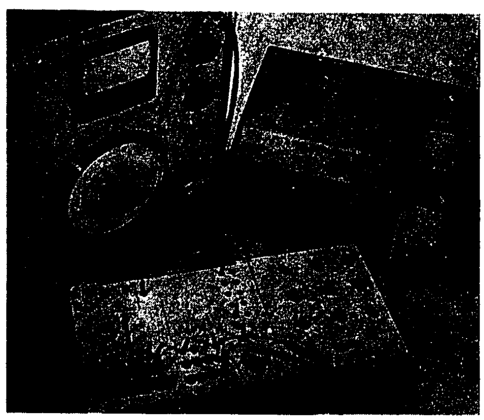

Fig. 8. The Electronic Speaker Counterpart

The device which was developed is equal to an electronic analog which models the operation of a speaker at low frequencies. It is not inferior to the electric analog in visible features, but it surpasses it significantly in operating and technical parameters. Independent assignment of individual parameters, low sensitivity to induced stray currents and interference and the absence of inductance in the circuit are among the device's merits.

When compared with a mathematical model, where frequency, phase and other characteristics receive corresponding solutions on a digital computer with the aid of a numerical solution, the electronic speaker counterpart which was developed is more convenient since it

makes good use of visual features;

permits results to be obtained in the form of customary charts and is easily connected with standard measuring devices;

insures high efficiency for producing results with adequate accuracy;

permits the structure of the model to be changed easily;

is inexpensive, accessible and small in size.

The electronic speaker counterpart permits frequency shift characteristics, speed and acceleration of the diaphragm, cavity velocities in the phase-inversion aperture, inside the cabinet and in the cabinet slots, the sound pressure frequency characteristics and the voltage at the power amplifier output to be modeled in the form of electrical voltages.

Within the electronic speaker counterpart there are elements which model all of the mechanical-acoustical components of a speaker: the mass M_{md}, flexibility C_{ms}, the equivalent loss resistance R_{mt} of the moving system, the acoustic mass of the air in the phase-inversion aperture M_{ap} and the equivalent acoustic resistance of losses and leakage P_{al}.

The equivalent speaker counterpart which was developed was used for solving the following problems:

1. Construction of frequency and other characteristics corresponding to an arbitrarily assigned set of cone parameters and the shape of an acoustic speaker.
2. Checking the accuracy of assigning the set of speaker parameters by constructing the corresponding frequency characteristics.
3. Modeling the frequency and other characteristics of existing speakers according to a known set of parameters.
4. Studying the sensitivity of frequency and other speaker characteristics to deviations in cone parameters from the optimal.
5. An approximated search for a set of parameters insuring the required speaker frequency characteristic when synthesis of this set by other means has been complicated or is impossible.

6. An approximated assessment of speaker properties which are difficult to calculate analytically, e.g. determining maximum diaphragm displacement amplitude in a speaker-phase-inverter with large losses in its shape.
7. Analysis of a speaker with electromechanical feed-back.

The electronic speaker counterpart was used successfully in development and modernization of the 30A-172, 30A-138 and 30A-142 movie theatre speakers. A speaker-phase-inverter with electromechanical feed-back was developed using this device.

Film-printing Equipment

The 25AMO-1 film printer which was developed in 1978 by the TsKBK NPO "Ekran" based on initial data from NIKFI underwent interdepartmental testing in 1979 at the Moscow Film-printing Factory and was recommended for series production (Fig. 9).

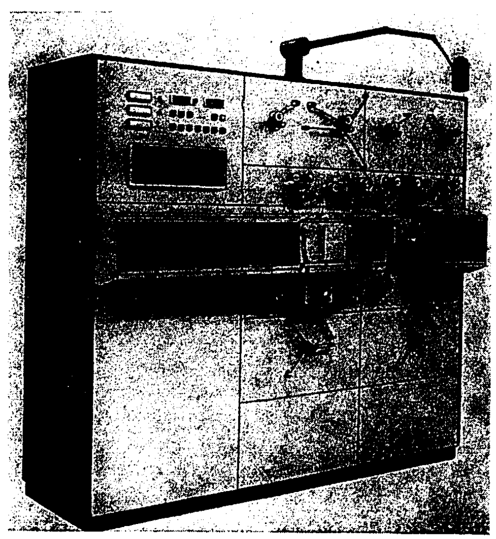

Fig. 9. The 25AMO-1 Film Printer

The 25AMO-1 35-32 (2x16)mm additive printing unit is intended for large-run optical printing of 32 (2x16)-mm film copies with optical soundtrack from 35-mm originals (negatives and duplicate negatives) at film studios, film-printing factories and in film processing laboratories.

A unit for optical and additive printing has been developed for the first time. Its specifications are as follows:

Speed of the unit--660 and 330 m/hour (24 and 12 frames/second) for 32-mm film,

Stability of the printed image in the horizontal and vertical directions is not more than 0.02 mm.

Resolution of the image is not less than 65 mm^{-1}.

Illumination uniformity of the exposed field $\Delta logE=0.045$.

Amplification of the optical system $\beta = 0.470$.

Illumination of the printed windows in the green zone is 150,000 lux.

A system for regulating the amount of light insures automatic changing of the illumination in 3 zones over 50 "colors" when the plans for the initial material are changed, and manual changing of the illumination on 24 colors for mounting the axial filter; the degree of light regulation is 0.025 log E.

Automatic changing of intensity is done with light valves, and manual changing also provides for evening up the zone illuminations and installation of the axial filter.

The print of the sound track is made on a smooth drum using a guaranteed slipping method. The photooptical system for printing the sound track provides an illumination level of 250,000 lux for the printing lines.

A device for regulating the illumination is included in the sound track unit. The device is designed for 24 colors, with the degree of light regulation being 0.025 log E.

An automatic stop for the drive mechanism is built into the unit. It is activated when the printing lamps burn out, when a film breaks or comes to an end, at the end of the printing process after the operation of the automatic cutting knife and when any of the doors is opened.

The dimensions are 2050x830x1810 mm.

The basic specifications are identical to parameters for the best foreign models.

An experimental prototype of the K23UTO-3 additive printing complex for the precise, optical, additive, immersion, intermittent printing of 32 (2x16)-mm from 35-mm originals of the standard format was developed, produced and tested at the Moscow Film-printing Factory in 1979 by the TsKBK NPO "Ekran" based on initial data from NIKFI (Fig. 10).

The creation of an additive photooptical system and program control facilities went into the development of the complex. The complex is mounted on the 23 UTO-1 print makers in use at film-printing factories and film processing laboratories. Additive interference light filters are used in the illumination system. In their effect on color film, the characteristics of the zone illumination fluxes are analogous to the characteristics of the additive printing unit made by Bell and Howell.

A system for regulating the amount of light insures automatic changing of the illumination in three zones over 50 colors when the plans for the initial material are changed, and manual changing of the illumination on 24 colors; the degree of light regulation is 0.025 log E. Automatic changing of the illumination is accomplished with the aid of light valves controlled by the program tape. (The program tape is identical to that used in the Bell and Howell and OZKhA-1 units). Manual changing of the illumination provides for both evening up the zone illuminations and installation of the axial filter. The zone illuminations can be evened up within an interval of not less than 4 colors with an accuracy of 0.025 log E.

For an average window, the unit's illumination level throughout the green zone is E_{ave} = 147,000 lux; for the extreme it is E_{ext} = 153,000 lux at a voltage of 120 V on a KGM 120-1200 lamp and at the highest color number behind additive light filters.

The difference in illumination between the frame windows is $\Delta \log E = 0.03$;

The variation in illumination inside the frame window is $\Delta \log E \leq 0.045$.

The resolution R_{center} = 80-85 mm^{-1}; R_{ext} = 75-85 mm^{-1}; image instability is not more than 5 μm. The unit is recommended for series production.

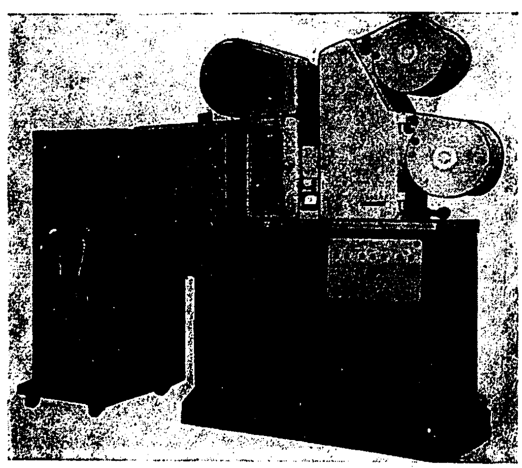

Fig. 10. K23UTO-3 Additive Printing Complex

Device for Building up Mass Color Film Copies

Thw PKTsF is a specialized three-channel photometer with computer designed for sorting by color and optical density level of the parts of film copies during mass production (Fig. 11). Color samples are measured simultaneously in 3 spectral zones behind blue, green and red filters.

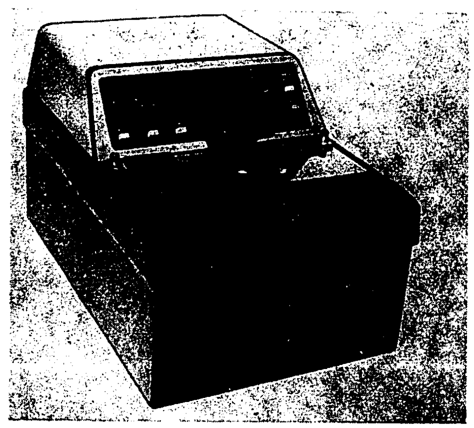

Fig. 11. Device for Building up Mass Color Film Copies

The light signals which are obtained are converted to electrical ones, proportional to the measured optical densities, which pass into the logic block and the computer. The color shading and optical density level of the sample being measured are determined in the device according to a method for instrumental build-up of film copies.

In addition to building up color film copies, the PKTsF may be used as a control and inspection device when monitoring the manufacturing process at all stages in the production of color film copies--it measures the optical densities in the three spectral zones and displays these values on a digital read-out. Results of all measurements are displayed simultaneously.

The PKTsF can be used in an automated manufacturing process control system since an output to interface with a computer is included in the device. The unit was developed by the NIKFI and produced by the OP [expansion unknown] of NIKFI. An experimental batch of the devices was produced in 1979. They underwent use testing at film-printing factories and were recommended for series production.

The PKTsF was displayed at the "60 Years of Soviet Movies" (1979) and "Television and Movie Technology-80" exhibitions. This is the first device of its kind to be made, there is nothing similar.

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Specifications

Format for movie film being measured, mm.......16, 2x16, 35, 70
Light filters..............................Blue, green and red
Read-out..digital
Accuracy of measurement............................0.02 units
Number of color groups......................................7
Number of optical density level groups......................7
Voltage, V..220
Power consumption, W.......................................35
Dimensions, mm.....................................270x390x250
Weight, kg...10

Movie Projection Equipment

A 35-KSA "Automat" movie projection equipment complex based on a standardized series of 35-mm movie projection equipment was created in 1979 by the OKBK [Experimental Movie Equipment Design Bureau] in conjunction with the NIKFI (Fig. 12). It provides automated operation of a movie set-up during an entire day.

Any of the complexes with 1-, 2-, 3- and 5-kW xenon lamps may be used for automatic operation because the design of the movie projectors is identical with the exception of the interchangeable parts of the optical-illumination system.

A 35-KSA-01 projector and the following devices are included in the complex with 1-kW lamp: a VKT-1 rectifier, an RUK 2-1 separator, a "Zvuk T2-25" sound reproduction device and a PU-AKP movie showing control unit.

The device automatically performs the following operations:

start and stop of the movie projector mechanisms;
turning the xenon projection lamps off and on;
showing the movie program with one or two projectors;
rewinding the film right on the projector in rewind without overloading the film-drive loop;
setting the lenses and film windows according to the type of film;
control of the curtain mechanism, the screen roll-up device, the light dimmer and the gong.

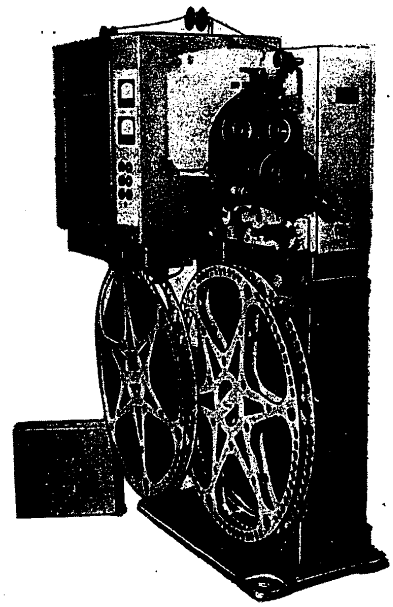

Fig. 12. 35KSA "Avtomat" Movie Projector Complex

The 35-KSA "Avtomat" projector works on a reverse system and permits showing of films up to 3,000 m long.

A feature of the reverse system in the 35-KSA "Avtomat" projector is the like speed in forward (showing the film) and reverse (rewind); the projector mechanism will wear substantially less in rewind than in reverse systems where the rewind speed is greater than the forward speed.

When the rewind time of a movie program which has been shown is greater than the program time at any given showing, rewinding is completed between showings, a procedure which is mandatory under the domestic movie operation system.

The following operating variants are possible in a movie theater equipped with two 35-KSA "Avtomat" projectors:

showing of a single film wound on two reels with one automatic shift from projector to projector during an entire day;

showing of a two-episode film or two films alternately.

It is possible to show one, two or three movies in any sequence with a 3-projector movie set-up.

It was only necessary to make changes in the design of individual assemblies of the 35-KSA "Avtomat" projector (the winder, lens holder, jump sprocket tension roller carriage* and sensor assembly) as well as putting the PU-AKP program control block into the complex for fully automatic operation.

The specifications and design features of the standardized series 35-KSA movie projectors turned out to be extremely suitable for creation of a fully automatic movie set-up:

the block-module design principle permitted the necessary changes to be made easily;

the significant reserve of the most heavily burdened components (including the Maltese-cross system) made it possible to reduce it somewhat, which is unavoidable in a reverse system;

the stability of quality characteristics, the extent to which the ergometric and use indicators were well thought out simplified preventive maintenance and preparation of the unit for uninterrupted operation in the automatic mode;

a high-quality take-up device and rewinding the film at its regular speed produce substantially less wear on the surface of the copies than is the case when the film is rewound on an electric rewinder in the standard system of working part by part.

An operating model of the 35 KSA "Avtomat" complex was demonstrated at the "60 Years of Soviet Cinematography" exhibition.

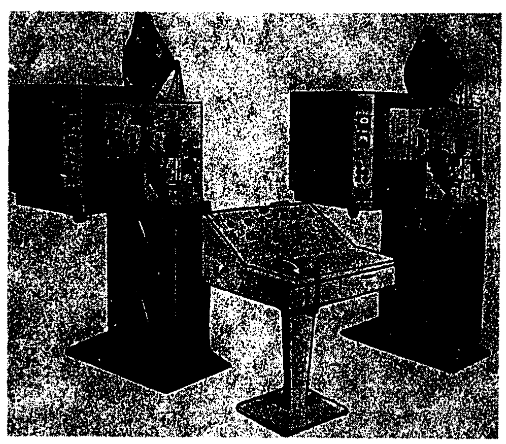

Fig. 13. A-177-A Movie Control Set-up

*Russian - 'karetka priderzhivayushchego rolika skachkovogo barabana.'

The A-177-A movie control set-up (Fig. 13) was developed and recommended for series production in 1979 by the OKBK NPO "Ekran" based on initial data from the NIKFI. The equipment is designed for visual control of 35-mm film copies in the previewing rooms of film-printing factories. It consists of two movie projectors, a control panel, two rectifiers and a set of tools, accessories and spare parts.

Technical data are as follows:

- projection speed..............................48 frames/second
- useful illumination flux.............................450±50 lm
- vacuum film holder
- reel capacity.....................................up to 600 m
- power consumption......................................3 kW

The A-177-A movie set-up has the following advantages over available models of control movie projectors: greater productivity, better preservation of film copies, simple loading of the film-drive loop and improved uniformity of screen illumination.

Holographic Methods in Cinematography

The GDP-2 holographic epiprojector was developed and produced at the NIKFI for projection of three-dimensional and holographic images from a small-format holder onto a holographic screen (Fig. 14). The epiprojector's light source is a DRSh-500 mercury vapor lamp and condenser with OS-13 light filter for forming a collimated beam of orange light. The translucient holographic screen with two viewing zones has the image recorded on it according to a design with diverging light beams.

The epiprojector is designed for projecting three-dimensional images with shallow depth of field. This limitation permitted its design to be simplified because of the slackening of requirements for homocentricity and monochromaticity of the light beam illuminating the hologram. The epiprojector was in a system for determining the quality of castings made from steel and alloys by their fractures, preserving information on the basic fracture traits of sheen and roughness thanks to the holographic projection. Here experience in using the GDP-2 demonstrated its effectiveness and permitted the incorporation of a small series of similar projectors into plants to begin.

Characteristics of the GDP-2 Projector

- Dimensions of the holographic screen, mm............500x600
- Focal length of the screen, mm.......................1100
- Dimensions of the holograph carrier, mm.............90x120
- Number of viewing zones.................................2
- Diameter of projection lens, mm.......................200

Focal length of the projection lens, mm.................300
Ratio of screen dimensions to dimensions
of the field of the hologram carrier.................5:8

The GEP-1 holographic epiprojector was also developed and produced at the NIKFI for projection and viewing of three-dimensional and stereoscopic images of objects and scenes (Fig. 15). Projection is made on a 30x40 cm translucent holographic screen. Reflection holograms and stereoholograms

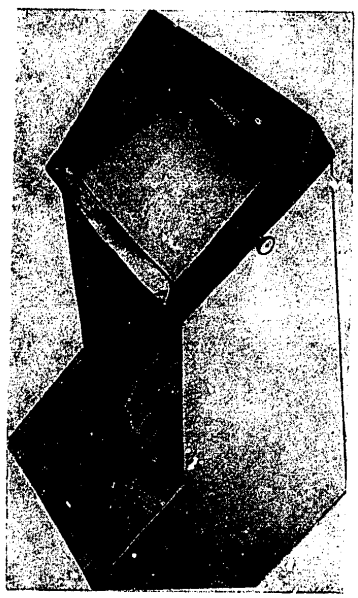

Fig. 14.
GDP-2 Holographic Epiprojector

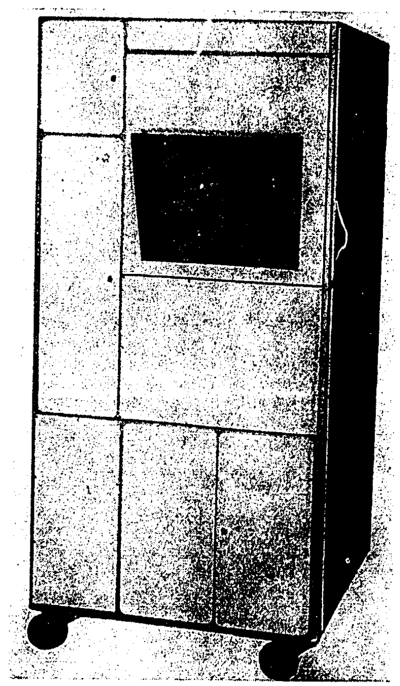

Fig. 15.
GEP-1 Holographic Epiprojector

on photographic plates with field size in the range of 60x80 to 90x120 mm can be used as the image carrier. Initial scenes may be photographed moving along an arc using an ordinary movie camera. The series of stereophotographs with differing angles of foreshortening which is obtained is printed on a single hologram, the stereohologram. The image which is recreated from the stereohologram is magnified to the size of the screen by the projection lens and transferred into the area of the holograph screen.

An OKP wide-aperture lens with a photo diameter of 200 mm and f' = 250 mm which was developed at the NIKFI is used as the projection lens.

The ratio of the screen dimensions to the dimensions of the field of the holographic carrier may be set from 3 to 5.

The ratio of a full-scale scene to the dimensions of the screen image can be from 10^5 (aerial photograph of space objects) to 10^{-5} (microphotography, an electron microscope picture).

There are 8 holograms in a disc, and the projector comes with 4 discs. The holograms in a single disc is done automatically using a control button; discs are changed manually; the device accommodates 3 viewers.

A distinctive feature of the holographic epiprojector is the fact that images can be changed automatically after a given time interval. The use of a light-intensive* holographic screen permitted the three-dimensionality of the projected image to be retained. An additional advantage of the projector is the capability for accurate matching of the stereohologram viewing zone and the holographic screen, thereby improving the quality of the viewed image. Using the special OKP projection lens permitted aberration of the image to be reduced.

A holographic stand for displaying three-dimensional images of cognitive, cultural-aesthetical or artistic value was developed at the NIKFI in 1979. The stand is used for showing life-size three-dimensional images of single items, assemblies, machinery, devices, sculptures and museum pieces. The stand includes holograms in a frame, stands for the holograms, illumination devices on supports and devices for shielding the light beams. The hologram dimensions are 300x400, 400x500 and 500x600 mm. The stands are made from plexiglass (polymethyl methacrylate) and permit the hologram to be mounted at any angle within the range 5-30° relative to the vertical. KN light sources from a movie projector with K30-400 lamps, on which 70x70x4 mm OS-13 light filters are mounted, are used as the illumination devices. When the light sources are used, the light beam reflected by the reflector is diverted from the hologram's illumination zone. The hologram is illuminated only by the beam emerging from the lamp's incandescing body to avoid splitting of the image.

The holographic stand differs from similar ones in its capability to show dynamic effects on static holographic images. The two light sources in the shielding device are aimed at a single hologram at different angles. A disc 500 mm in diameter, mounted on the axle of a RD-09 reversible motor

*Russian - 'svetosil'nyy.'

(30 rpm), is placed between the light sources. A hole in the disc permits one of the beams to be cut off while the other beam falls on the hologram.

Cleaning the emulsion from the part of the hologram's surface not containing the image made it possible to use the clean surface of the glass for combining the holographic image with a color photographic and artistic image.

The holographic stand can be used to demonstrate the achievements of Soviet technology and science, for display at movie festivals and for diverse exhibitions in movie theatre lobbies.

The NIKFI developed and produced the UPG-1 portable hologram viewing device (Fig. 16). The device is designed for transportation with the possibility of rapid set-up for showing and changing of static three-dimensional images of movie theater structures, scenes from films, decorations, natural landscapes and vistas, portraits and group portraits, samples of movie equipment and cinematic engineering complexes recorded on stereoholograms and holograms for propagandizing Soviet cinematographic art and the achievements of motion picture technology.

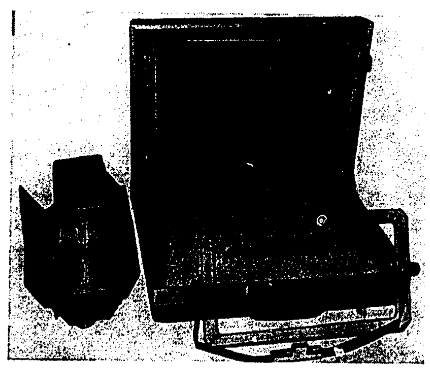

Fig. 16. UPG-1 Portable Hologram Viewing Device

The unit includes a set of 90x120, 180x180 and 300x300 mm holograms contained in a 470x350x120 mm briefcase, a "Svet-1000" light source with a KG-220-1000-1 halogen lamp, a stand and viewing zone limiter. The light source is equipped with shutters to eliminate illumination from the room and to isolate a light beam directed in the area in which the hologram is located. The viewing zone limiter is used when viewing images from stereoholograms and it provides rapid location of the viewing zone. Because a linear light source is employed, we are able to extend the viewing zone vertically to 100 mm and provide viewing comfort.

This survey of work in motion picture technology was prepared by the ONTI NIKFI.

The results of certain work of the NPO "Ekran," which were published in our magazine (1979, No. 12), were not included in the survey.

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SATELLITE COMMUNICATIONS AND BROADCASTING IN THE USSR

Moscow ELEKTROSVYAZ' in Russian No 4, 1980 pp 14-20

[Article by V. P. Minashin]
[Text]
The successful launching of the first artificial earth satellite in the world which was realized in the Soviet Union in October 1957 became the beginning of a qualitatively new phase in the studies of outer space. This event caused sharp acceleration of the development in practice of all branches of science and engineering and soon led to the occurrence of a new form of radio communications -- communications via artificial earth satellite.

It is natural that the work on the creation of communications satellites in our country has been closely connected with other areas of the broad scientific program of space research, and the developers have based their technical designs on the achievements of Soviet engineering in the field of the creation and insertion into orbit of spacecraft of the most varied purposes.

In April 1961, the "Vostok" spacecraft was launched. It was piloted by the first cosmonaut Yu. A. Gagarin. During subsequent launches of the "Vostok" spacecraft, and in the multiplace "Voskhod" spaceships, in addition to providing telephone and telegraph communications between the cosmonauts and the earth, experiments were successfully performed with respect to the transmission of moving television images from on board the satellite. A serious step in the development of Soviet satellite television was the television transmission in 1965 of the entire operation of a space walk by cosmonaut A. A. Leonov. This was the beginning of the use of wide-band radio communication lines between the satellite and the earth. A great variety of new radio equipment, instruments and individual units appeared in the arsenal of space engineering at that time, which became the technical base for the creation of satellite communications systems.

The communications with the application of satellites theoretically is analogous to radio relay communications; the transmission of information from one terminal station of the communication line to another is realized by a chain of intermediate relay stations located within the line of sight and following each other. However, in the satellite communications systems, independently of the distance between the terminal stations, only one relay station is used, which is placed on board the satellite.

It is known that the higher the intermediate relay station, the greater the distance can be between the communication points. This is fully realized in the satellite systems. The relay station placed on the satellite is a distance of many thousands of kilometers from the earth's surface and can provide for the transmission of messages between stations located in a broad territory. Thus, if the satellite is 36,000 to 40,000 km from the earth the service area will be approximately one third of the earth's surface, and the distance between the ground stations can reach 10,000 to 12,000 km. The satellite relay station permits the coupling of any points of the earth's surface, that is, organization of communication lines in any direction. The indicated property has made satellite communications irreplaceable under complex geographic conditions where the construction of ground lines is connected with great organizational and structural difficulties.

Moscow-Vladivostok Communication Line. The launching of the first "Molniya-1" communication satellite in the Soviet Union took place on 23 April 1965 to provide for the operation of a radio communications line between Moscow and Vladivostok [1]. This line was designed for two-way television and telephone-telegraph radio communications.

The "Molniya-1" satellite was inserted into an elongated elliptical orbit, the plane of which was inclined to the plane of the equator at an angle of about 64°, with apogee approximately 40,000 km above the Northern Hemisphere and perigee about 500 km above the Southern Hemisphere. The orbital period of the satellite around the earth was 12 hours. With this orbital period the "Molniya-1" satellites passed through the apogee twice in 24 hours: once when they are moving in orbit over the territory of the USSR, and a second time over the territory of North America (the odd and even orbits). If the orbital period differs from the indicated one, then in order to keep the time the satellite is visible from the given stations on the ground constant, its speed is corrected to keep the trajectory of movement of the projection satellite on the earth's surface invariant.

Moving slowly in the vicinity of the apogee (about 4 hours), the "Molniya-1" communication satellites are in the zone of visibility from the territory of our country for a long time, and this permits insurance of prolonged communication sessions (8 to 10 hours) between Moscow and remote points in Siberia, the Far North and the Far East when operating through one communications satellite.

On the "Molniya-1" satellite, a radio relay was used which operated on frequencies in the range of 800 to 1000 megahertz at 40 watts, a parabolic antenna was used with a gain of about 18 decibels, it had 6 panels of solar batteries which opened up in space, chemical storage batteries, command radio channel equipment and other equipment.

At the ground stations of the communication line between Moscow and Vladivostok, Cassegrainian antennas were used with a gain of 40 decibels, which tracked the movement of the satellite by a given program, and the transceiving equipment operated in decimeter wave band. An amplifying klystron with a power to 10 kilowatts and carrying capacity of 12 megahertz operates in the transmitter; an uncooled parametric repeater with a noise temperature of 150° K was installed at the input of the receiver. The noise temperature of the entire receiving system with antenna was 230° K. The signals were transmitted using frequency modulation of the carrier with a frequency deviation of the megahertz (peak-to-peak) during transmission of television programs and a frequency deviation of 200 kilohertz corresponding to the measurement level in one telephone channel. The capacity of the communication line was 60 duplexed telephone channels, the signals of two ground stations were frequency-separated in the satellite relay station. The line provided commercial communications between Moscow and the Far East by telephone, telegraph, phototelegraph and also the exchange of TV programs.

"Orbita" Satellite Communications System. In 1966, the development of the "Orbita" ground station was completed. It was designed to receive circular information, primarily TV programs from the center through the "Molniya-1" communications satellite [2]. The station was equipped with an antenna with a 12 meter reflector installed on a rotating support providing for displacement with respect to amplitude by ±270° and with respect to elevation from -2 to 90°. The satellite was tracked automatically by a program. A parametric repeater cooled by liquid nitrogen was used in the receiver. The noise temperature of the receiving system with the antenna was 140° K.

The first step in providing remote parts of the North, Siberia and the Far East difficult of access with the central television programs was solved on the eve of the worthy holiday of the 50th anniversary of the Great October Socialist Revolution. In October 1967 a network of 20 "Orbita" ground receiver stations went into operation. Thus, the first national satellite television distribution system was created.

At the beginning of the 1970's the "Orbita" stations were modified in connection with conversion of the network to operation in a frequency band set aside for satellite communication purposes by the International Union of Electrocommunications (VAKR-1971) [3]. For the section of the satellite communication link from the ground to the satellite, frequencies of 5725-6425 megahertz were satisfied, for the section from the satellite to the ground, 3400 to 4200 megahertz used on a joint basis by the line of sight radio relay systems.

The first communications satellite operating on frequencies in the indicated band (the "Molniya-2" satellite) was inserted into orbit on 24 November 1971. The orbital parameters of the "Molniya-2" satellites were analogous to the parameters of the "Molniya-1"; therefore their use did not introduce changes into the dimensions of the visibility zone or the duration of the communications sessions. The insertion of these satellites into orbit and the re-equipment of the ground stations made it possible significantly to improve the characteristics of the communications channels.

The new set of equipment for the ground stations (Orbita-2) included transceiving equipment, wave guide channels and the antenna exciter, and also the equipment for automatic aiming of the antenna at the communications satellite by the received signal. The radio equipment was transistorized with the exception of the powerful transmitter stage. The development of the new radio equipment of the radio stations took place considering the possibilities for its use in a larger complex of prospective satellite communications systems.

In November 1974, the three-stage "Molniya-3" satellite was launched into the same orbit in place of the "Molniya-2" satellites. In December 1975, the "Statsionar-1", which was called the "Raduga" was inserted into geostationary orbit. This satellite had six radio relays, each of which has a pass band of 56 megahertz and equivalent isotropic-excited power (EIIM) of ?9 decibel-watts. The second such "Statsionar-2" satellite was launched in August 1977. Now both of these geostationary satellites and a system of several "Molniya-3" satellites provide for the operation of the national satellite communications network of the country.

In the "Orbit-2" ground station network, the number of stations in which exceeds 80, in addition to the central station, there are two types of stations in operation: 1) the receiving stations for the reception of TV programs, the radio broadcast programs transmitted by the phototelegraphic method of images of the pages of central newspapers; 2) transceiving stations which provide for the reception of the TV and radio broadcast programs, images of newspaper pages and also commercial telephone communications. The transceiving stations located in the vicinities of large cities and industrial centers are equipped with additional t[illegible]inal and transmitting microwave equipment for the possible exchange of TV programs.

Figure 1 shows a simplified diagram of the organization of satellite communications. The electric signals bearing information from the remote center TTs, the long distance telephone office MTS, typography, and so on coming to the central station TsS of the network over ground cable or radio relay connecting lines are transmitted after the corresponding transformations by the central station to the artificial earth satellite. In the onboard radio relay the received signals are carried over to the frequency band satisfied for the satellite-ground communication link, and they are relayed to the ground stations ZS. The received signals undergo the inverse conversion, and they are transmitted over the trunks to each user respectively (typography, TTs, MTS and so on).

The TV programs are transmitted by the method of frequency modulation of the radio signals emitted by the transmitters of the ground stations. The frequency deviation to 15 megahertz is selected to insure optimal energy parameters and the signal/noise ratio at the output of the video channel required in accordance with the international standards.

The television sound accompaniment channel is formed by time multiplexing of the TV trunk and using the pulse-width modulation (Figure 2). The sound-

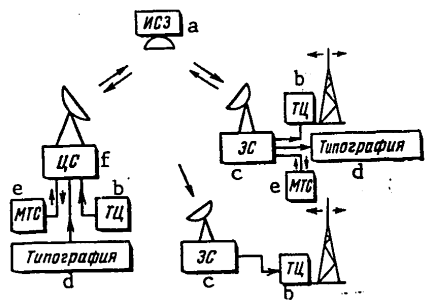

Figure 1.

Key: a. artificial earth satellite
b. TTs remote center
c. ZS ground station
d. typography
e. MTS long distance telephone office
f. TsS central station

carrying pulses modulated with respect to width by the sound signals are superimposed on the free sections of the extinguishing line pulses of the videosignal. For transmission of the sound accompaniment in the 60 hertz to 10 kilohertz band, two pulses are used in each line interval.

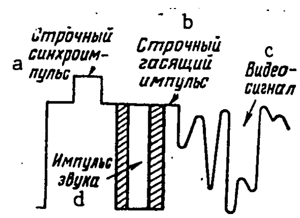

Figure 2.

Key: a. line synchropulse
b. line extinguishing pulse
c. videosignal
d. sound pulse

In case of necessity, instead of the channel with the 10 kilohertz band, two channels with 6 kilohertz band can be organized; in this case one channel is designed for sound accompaniment of the television, and the other can be used to transmit the radio broadcast programs for the other circular information.

In 1977 the first satellite transmission line for transmitting images of the pages of the central newspapers between Moscow and Khabarovsk was put into operation. The newspaper transmissions by the phototelegraphic method take place simultaneously with the transmission of television programs in the common channel of the satellite communications line, and they can be received at all ground stations of the network. The method of frequency separation of the video channel is used in the network by introducing an additional signal above the spectrum of the TV image -- the 8.2 megahertz frequency subcarrier -- which is frequency modulated by the signals in the 12-252 kilohertz band arriving by ground channel from the phototelegraphic equipment for transmitting the newspaper images. This method is the simplest and does not require separate transmission at the ground station. The frequency deviation of the subcarrier ± 250 kilohertz insures the required transmission quality (the signal/noise ratio at the output of the newspaper channel must be no less than 26 decibels). All of the channel parameters are selected considering the possibility of joint transmission of the television programs and the images of the newspaper pages without noticeable worsening of the quality of the color TV image.

In the network two types of multistation access are used -- with frequency and time separation of the signals. The multistation access with frequency separation of the signals is used on the links with little traffic. For each transceiving station of the network within the limits of the pass band of the radio relay channel, a defined section of the frequency spectrum is set aside, and also the stations can operate simultaneously in the frequency bands set aside for them, emitting the carriers modulated by the telephone messages. The communication lines with time multistation access are designed for communications between large administrative-economic centers.

In 1977 the first satellite system with a capacity of 120 duplexed telephone channels was put into operation. At each station of this line the signals of two 60-channel groups coming from the MTS [long-distance telephone office] over the radio relay or cable system are converted in digital form, and two flows are formed with a speed of about 5 Mbits/sec each. After time compression, synchronous packets are formed lasting 62.5 microseconds which follow with a repetition period of 125 microseconds. These packets are transmitted by phase modulation of the radio signal. The packets include special code words for mutual synchronization of the stations and the preamble required to synchronize the coherent demodulator on the reception side. The inaccuracy of the mutual synchronization of the stations is less than 100 nanoseconds, and the system for initial putting of the drive station into sinch is no more than 125 microseconds.

The "Orbit-2" network stations (Figure 3) are equipped with full-rotating antenna systems including the 12 meter parabolic dish, the double-mirror exciter, the antenna-wave guide channel with filter, drives and homing system. The variation in orientation of the antenna is realized using electric drives. The homing equipment which controls the electric drives can operate in two modes: by the program and in the automatic tracking of the communications satellite mode.

Figure 3.

The use coefficient of the mirror surface is high -- more than 0.7. This is achieved as a result of the application of a specially designed exciter. The noise temperature of the antenna does not exceed 10° K with good weather conditions and orientation in the zenith. The antenna gain is no less than 54.8 decibels when transmitting and 51.9 decibels for reception.

The structural design of the antenna permits insurance of the established quality indexes of the communication channels under wind loads occurring at wind velocities to 25 m/sec and a temperature within the limits of -50 to +50° C.

In order to exclude the losses created by the excessively long receiving antenna-wave guide channel, the design of the antenna provides for the possibility of suspending special enclosures for the installation of the low-noise input repeaters in direct proximity to the antenna exciter.

The base for the low-noise input devices is the parametric repeaters operating in the reflection mode, the noise temperature of the input devices is about 70° K. This permits insurance of a total noise temperature of the station of 100-150° K depending on the orientation of the antenna and the location of the low-noise repeaters. The transmitters installed at the microwave stations permit output power level control within the required limits (2-5 kilowatts). Powerful rectilinear repeating klystrons which have high gain with wide pass band (50 megahertz), high efficiency and other high operating parameters are used as the output stages.

MARS Station. In a number of cases the necessity has arisen for the transmission of television reports of important urgent events on location. For operative organization of the wide-band communication channels using the "Molniya-2" satellite and later using the "Molniya-3" and "Raduga" satellites, in 1972 portable MARS satellite communications stations were developed [MARS is an acronym from the Russian words for small radio relay station] [4].

The station is delivered by any form of transportation to the transmission point -- by rail, on motor transportation, aircraft or by sea. All of the radiotechnical equipment, including the transmitted cooling system and the ventilation system, is mounted in three containers which at the point of deployment of the station are connected to each other and form a common machine room. The station can be deployed and ready for operation in practice on any site in two or three days.

The station set includes the double-reflector antenna system with a diameter of the basic reflector of 7 meters and a parametric repeater enclosure. The noise temperature of the receiving system with the antenna is no more than 125° K. Electric drives and program homing and automatic tracking equipment are attached to the antenna. This equipment is placed in one of the containers. The three-kilowatt transmitter, monitor receiver, the equipment for matching the television signals and two sound accompaniment channels, and the service communications equipment are placed in two other containers, respectively.

The station has high electrical and operating indexes. This was clearly confirmed when realizing direct television reports with its help during the visits of the Secretary General of the Central Committee of the CPSU, comrade L. I. Brezhnev to India (November 1973) and to the republic of Cuba (January-February 1974)during transmissions from Sofia to Moscow in September 1974 of the television information about the celebration of the 30th anniversary of the socialist revolution of the People's Republic of Bulgaria, during transmission of the television reports from the location where the "Soyuz" spacecraft landed after completion of the Soviet-American Apollo-Soyuz experiment in 1975.

A second, improved version of the station of this type, MARS-2, was shown at the "Svyaz'-75" International Exhibition in Moscow (Figure 4).

"Ekran" System. The resolutions of the 25th Congress of the CPSU stated the goal of the further development of television and, above all, the provision of television broadcasting for the regions of Western and Eastern Siberia. Complete encompassing of the territory of the Soviet Union with a TV broadcast as applied to the geographic conditions of our country having enormous areas with population density of less than 1 man/km^2 and difficult of access areas with severe climate presents significant difficulties. The solution of the stated problem by a satellite television distribution system is entirely realistic. It is possible to increase the cost effectiveness of such a system by increasing the emitted power of the artificial earth satellite, which permits the receivers to be simplified and to be made cheaper.

Figure 4.

Decreasing the size of the station antenna naturally causes a drop in the signal level emitted by the satellite at the receiver input. For compensation it is necessary to raise the field level several times at the reception location by a corresponding increase in the satellite EIIM. The latter is a quite complex scientific engineering-technical problem, in the solution of which a number of serious problems on the power engineering and heat engineering level arise. The size and weight indexes of the satellite increase, and its cost increases significantly.

However, this direction of achievement of the goal with a large number of ground stations is the most economical, and on the whole the expenditures on creating this system become small [5]. The "Ekran" distribution system built in 1976 was such a system [6].

The first satellite of this system "Statsionar-T" -- "Ekran" was inserted into geostationary orbit on 26 October 1976 at a point with the coordinates of 0° latitude and 99° east longitude. The area of the service zone was more than 9 million km^2 (about 40% of the territory of the USSR). It encompasses the regions of Siberia, the Far North and part of the Far East. More than 20 million people live in these regions, and of them more than 7.5 million did not have previous possibilities for receiving television programs.

For the "Ekran" system, a range of 0.7 gigahertz was selected. The advantage of this range is the possibility of insuring simplicity and low cost of the receivers. Thus, using cheap transistorized input repeaters it is possible to obtain a noise temperature of the receiver on the order of 600° K; the multielement antennas of the "wave channel" type used in the system have low wind resistance with high gain; the structural design of the satellite radio relay with high output power is simple.

In the range of 0.7 gigahertz the satellite broadcasting coexists with ground TV broadcasting, in connection with which the power flux density in the territory of other countries is limited by the Radio Communication Rules (Article 332A and the Recommendations No KOSM 2-10). In the territory of the USSR it turned out to be possible to release the required number of DTsV [decimetric wave] channels for satellite broadcasting and then, under the condition of sufficient spatial selectivity, it was possible to observe the norms of the interference field for the territory of other countries when high power flux density is achieved within the boundaries of the service zone (approximately -116.5 decibel-watts/m^2). The Ekran system includes the ground transmission station, the communications satellite and the class I and II ground receiving stations (see Figures 5 and 6).

The satellite radio relay has an output power of 200 watts, it operates in the frequency band of 6200 $\pm$ 12 megahertz on reception and in the band of 714 $\pm$ 12 megahertz on transmission. The class I receivers are designed to feed the TV signal with the required quality (the signal/noise 55 decibels) to the local television centers and powerful TV radio relays. They are completed with the "wave channel" type antenna consisting of 32 or 16 arrays and a receiver which provides for reception, demodulation and separation of the image and sound signals. The class II installations are used to feed the TV signal to the low-power television relays or to the cable distribution network. Antennas of the "wave channel" type with four arrays analogous to the arrays of the class I antenna are used in them.

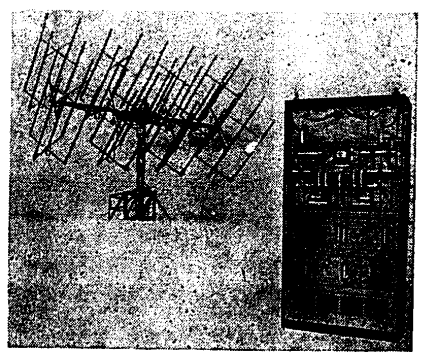

Figure 5.

The sound accompaniment in the "Ekran" system is carried on the subcarrier frequency. The subcarrier frequency is selected as 6.5 megahertz in order to simplify the formation of the standard TV signal, that is, it is equal to the frequency separation of the video and sound signal carriers. The frequency deviation of the subcarrier is for the same reasons a standard value of 50 kilohertz for the television sound accompaniment.

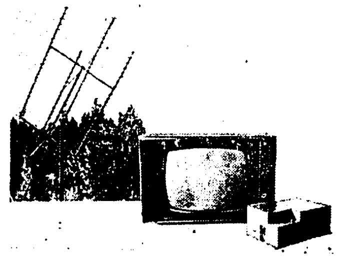

Figure 6.

The "Ekran" system, as a result of simplicity and relatively low cost of the receivers, develops quickly. Whereas at the time of launching the "Ekran" satellite there were 60 class I and II ground stations in the network, by the end of the Tenth Five-Year Plan their number will exceed 1000 [7].

Moscow System. The "Ekran" system was planned for sending the television programs to a limited, but quite large part of the territory of our country. Its use for TV broadcasting outside the boundaries of the selected zone is coupled to the serious difficulties of insuring electromagnetic compatibility with the ground television means operating in the same frequency band. Accordingly, the necessity arose for the creation of a distribution system operating in the range of 4 gigahertz, the basic one of which would be, just as in the "Ekran" system, small, simple and cheap ground receivers, but which would be used in the entire territory of the country (Figure 7).

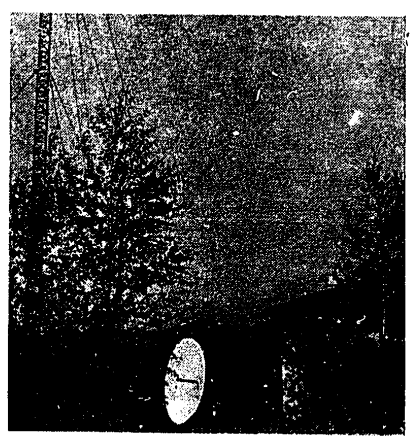

Figure 7.

For normal functioning of such a system a significantly more powerful signal is required than for the Orbita-2 stations. The higher the signal level, the simpler the construction of the ground stations. However, there is a limit which is determined by the maximum admissible power flux density at the earth's surface emitted by the satellite in the 4 kilohertz band equal to -152 decibel-watts/m^2. The restriction of the power flux density was established by the Radio Communications Rules in connection with the joint use of the frequency band of 3400-4700 megahertz by satellite and ground surfaces and, in particular, the radio relay systems. Thus, the EIIM created by the satellite radiorelay must be such that the power flux density at the earth's surface in the 4 kilohertz band will not exceed the indicated value.

The powerful stage of the "Gorizont" satellite has the required value of the EIIM [8]. On the basis of this space segment in 1978 a new system was developed called the "Moskva" [9].

The integral power flux density at the earth's surface created by the radio relay of the "Gorizont" satellite is approximately -120 db-watts/m^2. As a result of the introduction of the dispersion signal (triangular shape with a frequency of 2.5 hertz), the above indicated recommendation for the magnitude of the power flux density in the 4 kilohertz band will always be insured. With this power flux density, the ground receiving station can operate with a small antenna, in the "Moskva" system, in particular, an antenna is used with a total diameter of 2.5 meters with a radiation pattern width of $\pm1°$.

The input unit of the receiver of the "Moskva" ground station was constructed on the basis of a simple, uncooled parameter repeater with a small number of stages with noise temperature of no more than 100 K.

The energy characteristics of the communications line of the "Moskva" system are such that along with organization by the FM method of one television channel it is possible to separate two sound accompaniment channels. The frequency deviation for the video signal will be ±13 megahertz, and for the sound accompaniment and radio broadcast channels organized on the subcarrier frequencies of 7 and 7.5 megahertz ±1 megahertz. Thus, the total peak deviation of the frequency will be ±15 megahertz.

The "Moskva" system includes the ground transmitting station, the space segment -- the powerful trunk of the "Gorizont" satellite, and the network of ground stations. In order to cover the regions of the Soviet Union with TV broadcasting, several "Gorizont" satellites can be required which will be located at points on a geostationary orbit requested for the "Statsionar" series satellites. Each of these satellites will operate with its "own" transmitting station which will be equipped with a complete set of transceiving equipment for all relay trunks.

The frequency-modulated signal formed at the TV station will be emitted through an antenna that is common with the other trunks in the direction of the satellite. This signal is received on the satellite, it is frequency-converted and emitted in the direction of the corresponding service zone.

The signal relayed by the satellite is received by the network of "Moskva" ground receivers, and then it goes to the TV transmitter with a power of 1, 10 or 100 watts, by means of which the received program is delivered to the subscribers. In the receiver provision is also made for the possibility of operation on the cable distribution network. The radio broadcast channel signals can be fed to the local a-f rediffusion net or to the ultrashortwave FM radio broadcast transmitter. Instead of the radio broadcast channel there is a possibility of organizing transmission of images of newspaper pages.

The construction of the "Moskva" station does not require large material expenditures; the equipment can be placed in the existing buildings, for example, in the communications junction building, in the agricultural club facility or low-power TV radio relay. The antenna is installed on the roof or on the ground on a concrete or rock slab, on simple metal structures. The erection, installation and putting into operation take several days.

The further development of satellite TV broadcasting is provided for in the 11.7-12.5 gigahertz band in accordance with the Plan for Frequency Assignments and Orbital Positions for the Radio Broadcast Satellite Service with Individual and Collective Reception adopted by the World Administrative Radio Conference in February-March 1977 [10].

The implementation of the principles of the plan will in the future make it possible to insure complete coverage of the territory of our country with four-program TV broadcasting with a time shift which corresponds to each time zone.

BIBLIOGRAPHY

1. I. Bogachev, N. Dudinkov, K. Ogorodnikov, V. Rychka, "Long Distance Multichannel, Space, ..." AVIATSIYA I KOSMONAVTIKA (Aviation and Astronautics), No 5, 1967.

2. N. V. Talyzin, L. Ya. Kantor, M. Z. Tseytlin, "Orbita Ground Station for Receiving Television Programs from Satellites," ELEKTROSVYAZ' (Electrocommunications), No 11, 1967.

3. L. Ya. Kantor, V. A. Polukhin, N. V. Talyzin, "New Orbita-2 Satellite Communications Stations," ELEKTROSVYAZ', No 5, 1973.

4. N. V. Talyzin, L. Ya. Kantor, "Portable MARS Satellite Communications Station and Some Results of Its Application," ELEKTROSVYAZ', No 11, 1974.

5. N. V. Talyzin, L. Ya. Kantor, "Use of Communication Satellites to Transmit Unidirectional (Simplex) Programs," RADIOTEKHNIKA (Radioengineering), Vol 22, No 6, 1967.

6. V. P. Minashin, A. D. Fortushenko, S. V. Borodich, L. Ya. Kantor, V. L. Bykov, "Ekran Satellite Television Broadcast System. Basic Principles of the Ekran System," ELEKTROSVYAZ', No 5, 1977.

7. V. A. Shamshin, "State of the Art and Prospects for the Development of the Television Broadcast Transmission Network," ELEKTROSVYAZ', No 5, 1977.

8. Special Section on the RA AA/108/1210 for the International Frequency Registration Board Circular No 1210 as of 20 April 1976.

9. L. Ya. Kantor, V. P. Minashin, I. S. Povolotskiy, A. V. Sokolov, N. V. Talyzin, "Moskva Satellite Television Broadcast System," ELEKTROSVYAZ', No 1, 1980.

10. A. L. Badalov, "Radio Broadcast Satellite Service in the Frequency Band of 11.7 to 12.5 gigahertz," ELEKTROSVYAZ', No 12, 1977.

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[260-10845]

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CONFERENCES, SEMINARS, EXHIBITIONS, SYMPOSIUMS

MATHEMATICAL MODELING COMPLEX CHEMICAL TECHNOLOGICAL SYSTEMS

Moscow PRIBORY I SISTEMY UPRAVLENIY in Russian No 4, 1980 p 49

[Article by Candidates of Technical Sciences V. P. Meshalkin, Yu. K. Todortsev]
[Text]
In December 1979 a second all-union conference on "Mathematical Modeling of Complex Chemical Technological Systems"(SKhTS-P) was held in the city of chemists, Novomoskovska in Tul'skaya Oblast.

It was participated in by more than 150 representatives of industrial organizations, institutions, scientific research and training institutes from 22 cities of the Soviet Union.

At the conference where the broad exchange of opinions on mathematical modeling of complex chemical technological systems (SKhTS) on the computer took place insuring a reduction in the time and cost of designing these technological processes, the intensification of the technological conditions of the existing production facilities, the creation of economical wasteless processes, the complex utilization of raw materials and fuel, more than 100 reports were heard.

The work of the conference was organized in three sections.

The discussion of the reports, the topics of which were published, demonstrated that in the four years since the first conference in Yerevan in the field of mathematical modeling of SKhTS a basically scientific methodology of calculation and an automated design system (SAPR) have been created which use the ideas of systems analysis and the modern methods of optimization theory, automatic control, reliability, sensitivity theory; effective algorithms and programs for the calculation and optimization of the chemical technological systems on a computer have been developed. The collective of the chemical cybernetics department of the MKhTI Institute imeni D. I. Mendeleyev has actively worked on this problematic under the direction of academician of the USSR Academy of Sciences V. V. Kafarov. In many scientific and production collectives, definite experience has been accumulated with respect to optimization, SAPR, the control of a number of technological production facilities, important for the national economy of the country and the fulfillment of the plans of the Tenth Five-Year Plan.

At the same time the conferences noted that the volume of use of scientific developments in this area does not correspond to the demands and the rates of development of modern sciences and industry. Frequently, the application of the tested methods and algorithms is complicated by the absence of reliable mathematical models of the process, the shortage of computer equipment or limited capabilities of the computers available to a number of the scientific research, planning and design organizations and especially the institutions of higher learning.

In addition, the information and training of a significant number of the designers, planners and teachers of the high school with regard to daily use of the ideas and methods of mathematical modeling and SAPR in their work are still inadequate.

At the conference the most important research areas were formulated which will permit the use of computers as a means of accelerating the introduction of scientific achievements in the chemical industry to increase the production efficiency, and improve the quality of production: the methods and algorithms of structural analysis of SKhTS, qualitative and quantitative analysis of the characteristics of the SKhTS (stability, sensitivity, reliability, controllability, and so on), and the synthesis of the optimal SKhTS and their calculations; automation of the programming of the calculations and optimization on a computer; automated construction of the mathematical model of the apparatuses and the SKhTS and their modeling; the practical application of the methods of mathematical modeling for the design of new and modification of existing equipment and SKhTS.

The conference defined the organizational and scientific measures aimed at solving the problems revealed during the discussion, considering the problems facing the national economy of the USSR in the next decade.

In particular, it was decided to request that the Ministry of Higher and Middle Specialized Education of the USSR provide modern computers and peripheral devices (terminals, displays, plotters, and so on) with the corresponding help of the Ministry of Instrument Making for the institutions of higher learning working in the field of mathematical modeling and automated design of SKhTS and training the specialists in this area.

The next conference is planned for 1982.

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CONVERTERS, INVERTERS, TRANSDUCERS

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SM3-1 AND SM3-2 MAGNETORESISTORS FOR ELECTRONIC CONVERTERS OF ANGULAR AND LINEAR DISPLACEMENTS

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 4, 1980 pp 30-31

[Article by Candidate of Technical Sciences V. N. Novikov, Engineers A. F. Puzhlyakov, I. A. Vinogradova]

[Text]

In recent years magnetoresistive displacement gages [1-3] have begun to be used to measure angular and linear displacements, the positive properties of which include small size, torque and intake power, large admissible rpm, absence of noise, high reliability and resolution. In such converters it is especially convenient to use bridge circuits based on magnetoresistors (MR). In this case a zero signal in the initial position of the converter and partial compensation of the temperature dependence of the output signal are insured.

However, it must be noted that the previously developed types of magnetoresistors, for example, SM1-1 [4], have low suitability for such applications in view of the significant dispersion of the parameters of the individual models (deviation from the rated value of the resistance and the magnetoreistive ratio ±20%). In addition, these magnetoresistors have a high thermal coefficient of resistance.

The SM3-1 and SM3-2 magnetoresistors (see Figure 1,a) in which there are four magnetoresistive elements on one ceramic substrate, were developed especially r electronic converters of angular and linear displacements. In the SM3-1 .pe magnetoresistor the sensitive element is made in the form of a ring 10 mm in diameter with width of the conducting track of 0.1 mm, having four leads arranged symmetrically. The individual elements are connected into the bridge circuit directly as a result of the configuration of the sensitive element.

In the SM3-2 type magnetoresistors (Figure 1,b) the sensitive elements are two parallel linear resistors 0.1 mm wide and 10 mm long with unsolderings along the ends and from the middle of each resistor. The individual elements form the bridge circuit by means of corresponding connection of the six leads from each of the elements. When necessary the SM3-2 magnetoresistors can be included otherwise, for example, by the double potentiometer circuit. In both magnetoresistors the sensitive elements are made of eutectic alloy of indium antimonide and nickel antimonide alloyed with tellurium, which permits significant simplification of the process of manufacturing them, for there is no necessity to apply a metal raster to the conducting tracks to suppress the Hall field [1]. Moreover, the use of this alloy in the ring type magnetoresistors (SM3-1) decreases the operating angular range from ±30 [2] to ±25° inasmuch as the location of the nickel antimonide phase needle location with respect to the current direction changes along the ring. The parameters of the SM3-1, SM3-2 magnetoresistors are presented in the table.

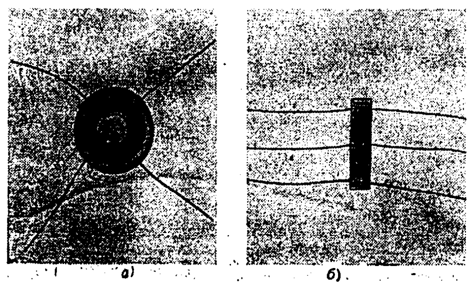

Figure 1. Outside views of the SM3-1 (a) and SM3-2 (b) type magnetoresistors.

The electrical characteristics of the magnetoresistors are determined by the properties of the nickel antimonide and indium antimonide alloy from which they are made. The relations for the electrical conductivity of the alloys as a function of temperature at various values of the magnetic field induction and the magnetoresistive ratio as a function of the magnetic field induction at various temperatures are presented in Figures 2 and 3, respectively.

The SM3-1 type magnetoresistors are designed for application in angular displacement gages. The structural design of the gages with analogous magnetoresistors was investigated earlier [2]. In this gage the magnetoresistor is located in the clearance between two pairs of permanent magnets made in the form of quadrants and fastened to the shaft passing through a hole in the substrate of the magnetoresistance.

Theoretically the maximum range of operating angles for such gages is ±45°: in practice it is less as a result of the effect of the dispersion fields and also as a result of variation in the location of the nickel antimonide phase needles along the ring, and it does not exceed ±25°.

The SM3-2 magnetoresistors can be used in the angular and linear displacement gages. In the former case the angular displacement of the shaft of the gage

Parameter	Type of magnetoresistor	
	SM3-1	SM3-2
Resistance of individual elements of the magnetoresistors at T = 25° C and B = 0 in ohms	51 ± 10%	34 ± 10%
Maximum difference between the resistance of the individual elements of the same magnetoresistor at T = 25° C and B = 0 in %	≤5	
Magnetoresistive ratio at T = 25° C and B = 1 tesla	≥2.7	≥3.5
Thermal coefficient of resistance in the interval of 25-70°C and B = 0 in %/°C	<|0.3|	
Maximum admissible power in watts when gluing the magnetoresistor to a plate with a thermal resistance of ≤10 C/watt with an ambient temperature of:		
T = 25° C	1	
T = 85° C	0.5	
Overall dimensions in mm	Outside diameter 14.8; inside diameter t; thickness ≤0.6	13.3×3.2×0.6

is converted to linear displacement of the magnetic field along the magnetoresistor, for example, by using a magnetic conductor in the form of a screw [3].

The theoretically maximum operating range of angles here will be 0 to 360°, and in practice, as reported in reference [3], it is 0-270°. When using magnetoresistors of the SM3-2 type in the linear displacement gages the maximum operating range corresponds to a length of 1 arm of the magnetoresistance, and it ±2.5 mm.

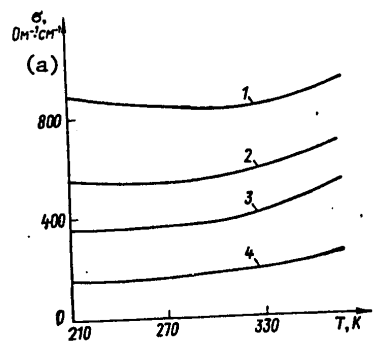

Figure 2. Electrical conductivity σ of the InSb-NiSb alloy ($n = 7.5 \cdot 10^{16}$ cm^{-3}) as a function of temperature T for values of the magnetic field induction of 0, 0.3, 0.5 and 1 tesla (curves 1-4 respectively).

Key: a. σ, $ohm^{-1} \cdot cm^{-1}$

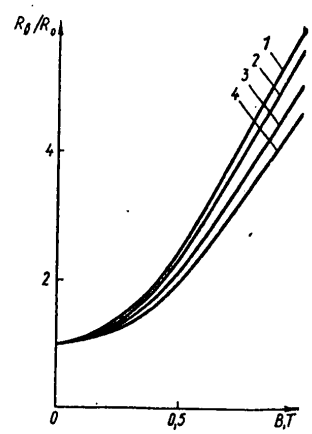

Figure 3. Magnetoresistive ratio R_B/R_0 of the alloy InSb-NiSb ($n = 7.5 \cdot 10^{16}$ cm^{-3}) as a function of the induction B of the magnetic field at various temperatures: 213, 253, 298 and 348° K (curves 1-4, respectively). Key: a. B, tesla

When using the magnetoresistors type SM3-2 with magnetic system in which the width of the magnet is equal to the length L of one arm of the magnetoresistance, the voltage at the output of the bridge as a function of the displacement can be represented in the form $U_{out} = U_{inp}((K - 1)/(K + 1))(2x/L)$, where x is the displacement (which varies from -L/2 to +L/2); K is the magnetoresistive ratio in the field of the gap of the magnetic system; U_{inp} is the feed voltage of the bridge.

The value of the induction in the clearance of the magnetic system can be comparatively easily obtained in the induction range B = 0.4 to 0.5 tesla. The value of K will be about 1.6-2.

The magnitude of the feed voltage of the bridge will be limited by the dispersion power and the resistance of the arms, and for SM3-2 it is equal to approximately 5 volts. Here the sensitivity when using the magnetoresistance of the SM3-2 type in the linear displacement gage will be approximately 4-6 millivolts/micron, and in the angular displacement gage, about 6-9 millivolts/deg. The analogous estimates for the sensitivity of the magnetoresistance type SM3-1 give a value of about 30-40 millivolts/deg for their application in the angular displacement gage. Checking the characteristics of the magnetoresistance types SM3-1 and SM3-2 in the angular displacement gages demonstrated that in the range of operating angles of ±25° for the magnetoresistances type SM3-1 and ±135° for the magnetoresistances type SM3-2, the deviation from linearity of the static characteristic of the converters did not exceed 1-1.5%.

BIBLIOGRAPHY

1. G. Vayss, FIZIKA GAL'VANOMAGNITNYYKH POLUPROVODNIKOVYKH PRIBOROV I IKH PRIMENENIYE (Physics of the Galvanomagnetic Semiconductor Devices and Their Application), Moscow, Energiya, 1974.

2. S. Kataoka, SOLID STATE SENSORS SYMPOSIUM, USA, 1970, pp 56-61.

3. V. Borcke Ulrich, Paul Hini, SIEMENS ZEITSCHRIFT, No 6, 1973, pp 491-496.

4. V. N. Novikov, A. F. Puzhlyakov, "SM1-1 Magnetoresistors," ELEKTRONIYA PROMYSHLENNOST' (Electronics Industry), No 7, 1975.

[256-10845]

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INSTRUMENTS, MEASURING DEVICES AND TESTERS, METHODS OF MEASURING, GENERAL EXPERIMENTAL TECHNIQUES

MICROELECTRONIC INSTRUMENT-MAKING TECHNOLOGY -- THEMATIC SELECTION[1]

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 4, 1980 p 36

[Article by Chief Engineer of the Soyuztekhnopribor All-Union Association, Candidate of Technical Sciences I. D. Goloto]

[Text]

The assimilation of microelectronic technology in instrument-making will permit a theoretically new solution to the problems of improving the accuracy, reliability and speed of instrument-making products. The technical-economic indexes of their production, operation and maintenance are being improved significantly.

The broad use of microcircuits in instrument making will insure an increase in the degree of mechanization and automation, a reduction in the labor consumption of the assembly and installation operations, a decrease in the development time, a reduction in the duration of the production cycle and also expenditures on technical servicing and power expenditures, an increase in service life and miniaturization of the equipment.

However, the broad nomenclature of instrument making products based on special electrical circuits with specific functional, metrologic and electrical characteristics will give rise simultaneously with the series-produced microcircuits to the creation and application of specialized microcircuits, microassemblies and functional units and modules in the microelectronic execution. The development and manufacture of such microcircuits and microassemblies in the organizations and at the enterprises of the Ministry of Instrument Making are being carried out on the basis of the standard technological processes of hybrid and semiconductor technology of the radio electronic industry.

The proposed thematic selection includes a number of articles written by the authors considering the experience in the development and mastery of the production of microcircuits and microassemblies in the organizations and at the enterprises of the instrument-making branch.

---

[1] Beginning.

The materials of the selection encompass a large class of problems connected with the design and manufacture of hybrid, thin and thick-film microcircuits, the mastery of the production of specialized large integrated circuits by the p-channel MOS-technology, with the application of which under the conditions of the experimental plant, the manufacture of a number of specialized semiconductor solid-state units were started for the means of the ASPI complex.

In the articles of the selection an analysis is made of the actually attainable limiting degrees of integration for various types of structures based on cylindrical magnetic domains designed for the creation of the power-independent magnetic memories; the classification of methods of determining the quality and reliability of the systems and elements of electronic engineering in the design, manufacture and test stages is proposed.

Thus, the selection materials indicate the variety and multiplan nature of the operations performed in the instrument-making branch with respect to the mastery of the technology of microelectronics for the development and the performance of instrument production.

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MICROELECTRONIC HYBRID-FILM TECHNOLOGY IN INSTRUMENT-MAKING

Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 4, 1980 pp 36-38

[Article by Candidate of Technical Sciences Yu. V. Isayev, Engineers V. V. Doshchatov, Ya. G. Brodyanskiy]

[Text]

At the present time the special-application micro-circuits (MSP) made by the methods of hybrid-film technology and having a number of advantages over the discrete circuits made on printed plates are becoming more and more widespread in the instrument-making branch. Thus, the reliability of the hybrid MSP with wire mounting is 10 to 100 times higher than the reliability of the equivalent circuits realized on printed plates; the size of the hybrid MSP with caseless transistors and integrated circuits is 10 to 30 times less than the equivalent printed assemblies; by comparison with the printed units the hybrid MPS have lower cost in series production, and their parameters have higher stability.

As is known, the hybrid-film MSP can be made by the method of thin and thick film technology. It is already entirely obvious at this time that these technologies are not competitive, but supplement each other. Each of them has found its area of application.

The thick-film technology is used to create circuits that operate up to frequencies of 10-100 megahertz; with large values of the resistances; operating on sufficiently high power levels; with significant overall dimensions of the elements.

It is highly significant that when manufacturing the thick films the requirements on the vacuum hygiene are appreciably lower than when producing thin films.

In turn, the thin-film technology insures small dimensions of the elements, high electrophysical parameters of the resistor. Therefore thin films predominate in the areas connected with the production of precision high-reliability products. Thus, if the operating parameters and the overall dimensions are more important than the cost, then thin films must be used, and vice versa.

The instrument making enterprises have developed the hybrid-film MSP. Their industrial production has been organized, and instrument production has been set up on the basis of them.

At the present time the basis of the thin-film MSP in the branch is the technology of selective etching of successively deposited structures (the method of double photograph). For the formation of the resistive layers, the alloys RS-3710, RS-1004, K50S, chromium, and so on are used, and for the wires, copper and aluminum.

The thick-film MSP are made with the application of the method of screen stenciling. The resistors and wires are made using palladium-silver pastes. The basic method of assembly of the mounted active elements with flexible leads made of gold or aluminum wire for the thick-film MSP is soldering, and for the thin-film welding.

The thick-film microcircuits (except the MOS for digital programmed control devices) are made in the caseless execution; the finished microcircuit is sealed by epoxy premixes.

The series-manufactured metal-glass cases, types K151-K157 are used to seal the thin-film MSP.

On the basis of the presented technological method the organizations of the branch have created a significant nomenclature of hybrid-film MSP. Thus, the organizations and enterprises of the "Soyuzelektropribor" VO have developed and are series manufacturing more than 50 types of precision thin-film analog MSP. These include the precision voltage dividers with an error of the resistor ratios of about 0.01%, high-quality stabilizer, sources of reference voltages, operation amplifiers, comparators, series of thin-film MSP for the heat engineering sensors of the central part of the GSP, and so on.

Series of seven types each of thin and thick-film MSP have been created for the monitoring and control unit means.

The thick-film MSP are being series manufactured for digital program control systems for metal-cutting machines and the ASKR complex means. The series manufacture of thick and thin-film MSP is being organized for small testers.

The series-manufactured hybrid-film MSP are microcircuits of the second level of integration (to 100 elements in a case) which is determined by the microelectronic technologies introduced into the branches. At the present time the necessity has arisen for a sharp increase in the degree of integration of the hybrid-film MSP, the application of the functionally completed hybrid microassemblies and microunits. Only in this case is it possible to solve the problems of complex microminiaturization of the deposits; a further decrease in overall dimensions and weight of the products, the optimal use of the semiconductor microcircuits with hydrid film MSP.

Therefore the development of a hybrid-film technology is proceeding along the path of creating the technological processes which provide for the production of MSP of the third level of integration (to 1000 elements in the case), finding the specific method of applying the microelectronic technology, all-around utilization of the achievements of semiconductor and hybrid-film technologies.

The requirements of the GSP (State System of Industrial Instruments and Means of Automation) on accuracy determine the creation of the precision of thin-film resistor microassemblies placed on the substrates of different sizes and guaranteeing good reproducibility in the range of resistor ratings from 10 ohms to 10 megohms, TKS to $2 \cdot 10^{-6}$ 1/deg. The technology of the creation of such microassemblies requires the introduction at the batch enterprises of the method of ion-plasma deposition which will permit us to obtain the film in practice from any materials used in thin-film technology with high reproducibility of their chemical composition and nonuniformity of thickness of the film on the substrate 60 x 48 mm of no more than $\pm 3\%$. The basic method of obtaining the configuration of the microcircuit must become the method of ion pickling instead of the existing method of chemical pickling. In combination with the methods of laser fitting this offers the possibility of bringing the error of the thin-film resistors to 0.005% of the rated value. The combination of the enumerated methods with the plasmochemical methods of finishing the substrates will permit significant increase in the percentage output of good microassemblies of the third level of integration.

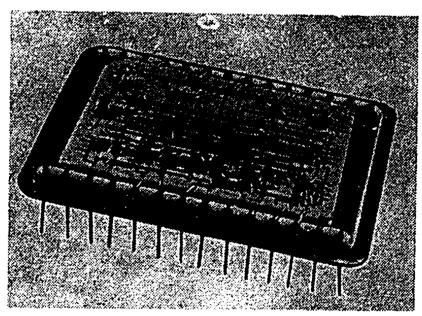

Figure 1.

One of the most important areas in the development of hybrid-film technology is the creation of multilayer commutation film structures as the basis of multichip designs. The modern semiconductor microelectronics is beginning to get away from the placement of the semiconductor crystal in an individual case and is going to the placement of the group of crystals in one case (the multichip circuit), which gives a sharp decrease in area occupied by the semiconductor microcircuits in a specific device. These multichip circuits are possible only in the case of multilevel electrical connections between the individual crystals inside the case. Such multilevel combinations are insured by multilayer thin-film microassemblies with the use of organic (polyimide lacquers) as inorganic (low-melting glass) dielectrics of the insulating layers. The PTNII Institute (Planning-Technological and Scientific-Research Institute) has developed the technology and produced models of multilayer multichip microassemblies (see Figure 1) for the PS class computer built on the basis of polyimide lacquer.

In the near future the multichip circuits must become the structural base for computers (SM EVM, PS). In their manufacturing technology it is necessary to use inorganic dielectrics as the insulating layers, which by comparison with polyimide lacquers have higher stability of the basic parameters.

The effort to maintain the primary advantage of the thick-film MSP -- their cheapness -- and at the same time to insure the possibility of manufacturing MSP which are similar with respect to characteristics to the thin films, requires technological operations to create resistive and conducting pastes of new types and to improve the methods of formation of the MSP configuration.

The most important in this area are the prjects of the PTNII Institute to obtain resistive pastes on the basis of ruthenium compounds insuring good reproducibility of the high-resistance of the resistors, high TKS [thermal coefficient of resistance] and stability. The prospective areas of development of thick-film technology also include the development of new methods of building the MSP with the application of photopastes.

The methods of structural formation of the thick-film MSP significantly reduces the cost. The method used for caseless sealing of microcircuits with epoxy premixes is not ideal. The method of sealing the thick-film microcircuits by lacquering the substrate with polymer materials is widespread abroad. The cheap, highly reliable process of producing thick-film MSP requires a set of equipment for the manufacture and application of the pastes, their assembly and sealing of the MSP.

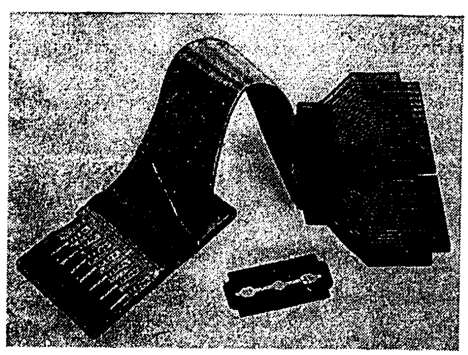

Figure 2.

An important area in the hybrid-film technology is the creation of the microjunctions based on it. An example of this is the thin-film thermoprinters. The noiseless thin-film thermal heads based on the principle of thermal printing, which are simple with respect to structural design (see Figure 2), can replace the awkward mechanical printers in various instrument-making products.

The possibilities of the hybrid-film technology for the creation of microsensors has been studied very little. This is a problem of the future. An effective area is combined application of the methods of semiconductor and film technology. The flexible-film technology will become one of the basic areas of microminiaturization of the products of instrument making, and it must become the same ordinary technological process of the technology of the production of the printed plates when manufacturing the instruments.

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OPTOELECTRONICS, QUASI-OPTICAL DEVICES

UDC 621.382:53.084.85

RESISTOR OPTRONS

Moscow PRIBORY I SISTEMY UPRAVLENIY in Russian No 4, 1980 pp 28-30

[Article by Candidate of Technical Sciences V. P. Gorokhov, doctor of technical sciences A. O. Olesk]

[Text]
Among the optoelectronic instruments, the resistor optrons (RO) have important independent significance and are widely used as the key decoupling elements and variable resistors with electronic control [1, 2].

The radiation receivers in the RO are photoresistors, the characteristics of which are primarily determined by the systems engineering capabilities of the optrons of this class. The Soviet RO industrial types which are designated as OEP, were developed on the basis of the element base: photoresistors, emitting diodes and miniature incandescent tubes are series produced by industry.

The systems engineering advantages of the RO are the wide range of output characteristic with respect to resistance, linearity of the volt-ampere characteristic of the the output circuit, two-way and symmetric conductivity, in practice complete reactionless controlled circuit, and so on. These advantages of the RO arise from the application of photoresistors in them made of semiconducting materials of group A^{II} B^{VI} and, above all made of cadmium selenide and sulfide and solid solutions based on them.

The cadmium sulfide photoresistors have higher thermal stability than the cadmium selenide photoresistors, but they are inferior to the latter with respect to speed [3, 4]. In addition, as a rule the cadmium selenide photoresistors have greater steepness of the lux-ampere characteristic, which insures a higher value of their dynamic multiplicity. The cadmium sulfoselenides are characterized by properties that are between cadmium sulfide and cadmium selenide. In solid solutions of the mercury selenide and cadmium selenide system, an increase in speed to several hundreds of microseconds is observed [5].

For effective operation of an optron coupled with a photoresistor, it is necessary to match it with respect to spectrum with the radiation source, among which it is necessary to give preference to the emitting diodes and the miniature incandescent tubes.

Figure 1 shows the normalized spectral characteristics of the photoconducting materials $A^{II} B^{VI}$ which are distinguished by high sensitivity, and also the radiation spectra of industrial emitting diodes based on gallium arsenide and phosphide and the radiation spectrum of the incandescent tube. The photoresistors based on cadmium selenide are matched with the emitting diodes based on gallium phosphide; the photoresistors based on the cadmium selenide and mercury selenide system are matched with the emitting diodes based on gallium arsenide. As a result of the broad emission spectrum, the incandescent tube can be used successfully coupled with photoresistors based on cadmium selenide and sulfide and also their solid solutions. The miniature incandescent tubes, in spite of their low mechanical properties, are widely used in Soviet and foreign optrons.

The emission sources in the optocouple with the photoresistor can also be electroluminescent powder emitters, but their practical use is limited as a result of low emission power and the necessity to feed high voltage of increased frequency. Therefore at the present time the optrons based on the photoresistor and electroluminophor pair are finding application for the solution of only certain special problems. For this reason the gas discharge tubes also have low suitability: in addition to the high feed voltage characteristic of them, they have comparatively large size.

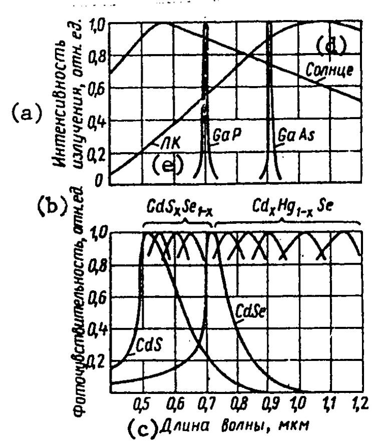
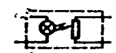
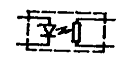
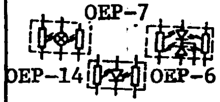
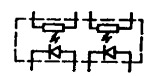


Figure 1. Spectral characteristics of photoresistors and emission sources: LK -- incandescent tube type SMN 6.2-20

Key: a. radiation intensity, relative units
b. photosensitivity, relative units
c. wavelength, microns
d. sun
e. LK

Type of optron	Type of emission source	Rated control parameters: U, volts	Rated control parameters: I, mamps	Commutation parameters (of output circuit): U in v	Commutation parameters: I in mA	Commutation parameters: P in watts	Output resistances: open state R_{CB} in ohms	Output resistances: closed state R_T in ohms	Inclusion time: in mil. sec	Inclusion time: to level in ohms	Circuit diagram	Overall dimensions of case in mm
OEP-1	Incandescent tube	to 5,8	16	250	3,5	0,05	$\leq 2\cdot10^3$	$>3\cdot10^8$	≤ 200	$4\cdot10^6$	 OEP-1, OEP-2, OEP-9, OEP-10, OEP-11, OEP-12, OEP-13	ø11,7×9,5
OEP-2					7	0,08	$\leq 4\cdot10^2$	$>3\cdot10^7$		10^5		
OEP-3	Light diode	to 3,8	15		3,5	0,04	$\leq 1{,}2\cdot10^3$	$>3\cdot10^8$	≤ 150	$4\cdot10^6$	 OEP-3	
OEP-9	Incandescent tubes	to 5,8	16	20	0,2	0,025	$\leq 10^4$	$>10^9$	≤ 100	$2\cdot10^7$		
OEP-10							$\leq 10^6$	$>10^{11}$		$2\cdot10^9$		
OEP-12				250	2		$\leq 4\cdot10^2$	$>1{,}5\cdot10^7$	≤ 200	10^5		
OEP-13							$\leq 3\cdot10^3$	$>1{,}5\cdot10^8$		$4\cdot10^6$		
OEP-11			16; 10	10	1		$1{,}5\cdot10^2$—10^3; $1{,}5\cdot10^3$—10^4	$>10^7$		10^5		
OEP-14						0,015	$1{,}5\cdot10^2$—10^3; $1{,}5\cdot10^3$—10^4				 OEP-7, OEP-14, OEP-6	ø10,7×8
OEP-6		to 3,8		35	0,2	0,01	$\leq 2\cdot10^3$	$>10^6$	≤ 120	$2\cdot10^5$		
OEP-7												
OEP-16	Light diode	to 2,5	10	5	—	0,005	$\leq 10^3$	$>10^7$	$\leq 0{,}5$	10^5		12×20×24

Among the RO, the most universal are the optrons with emitting diodes, for the latter have small size, low intake power, good speed and long service life. At the present time Soviet industry is producing a large variety of RO (see the table). As the emission source, the industrial optrons use emitting diode types AL 301 and AL 107 and miniature incandescent tubes type SMN 6,3-20.

Structurally, the RO are executed in small sealed cases. The outside appearance of the optrons of certain types appears in Figure 2. Their basic parameters are presented in the table.

In the OEP-1, OEP-2, OEP-9 to OEP-14 optrons the emission source is the SMN 6.3-20 incandescent tube; in the OEP-3, OEP-6, OEP-7, OEP-16 optrons, emitting diodes. The OEP-1 to OEP-3 and OEP-9 to OEP-13 optrons are the simplest. They have one input circuit and one output circuit. The OEP-6, OEP-7, OEP-14 optrons are two-channel. They have two output circuits.

The rated parameters of the control circuit are as follows: for optrons with an incandescent tube the current is up to 16 milliamps, the voltage is no more than 6 volts; for optrons with emitting diodes, the current is 10 milliamps, the voltage is no more than 4 volts. The resistances in the open and closed states, the upper value of the switch-off time and the commutation parameters -- the voltage and current -- are presented for the output circuit of the optrons. The dynamic range of the output characteristic with respect to resistance will be 3-6 orders depending on the type of optron.

The OEP-1 to OEP-3 optrons are high voltage: they are capable in the closed state of commuting an ac voltage of up to 250 volts. Their operating commutable current in the open state is several milliamperes.

The optrons of other types are designed for low-voltage circuits; their maximum commutable voltage is no more than several tens of volts.

The OEP-9, OEP-10 optrons have the highest resistances in a number of resistor optrons of the OEP type, and they are used for commutation of the high-resistance radio equipment circuits. The OEP-11, OEP-14 optrons have a defined, given dispersion of resistances with respect to the transmission characteristic (see the table).

In the OEP-6, OEP-7 and OEP-14 optrons there are two electrically decoupled output circuits controlled either by one input as is done in the OEP-7 and OEP-14 optrons, or two, as in the OEP-6 optron. The optrons of these types are used for level control of the analog signal with variable amplitude in stereophonic and other two-channel equipment. The value of the switch-off time of the optrons is presented for a capacitive load of several hundreds of picofarads. The time constant of the optrons defined as the time of variation of the resistance by e times and measured in direct current and under an active low-resistance load, will be 10-15 milliseconds. With an increase in the temperature, the time constant decreases.

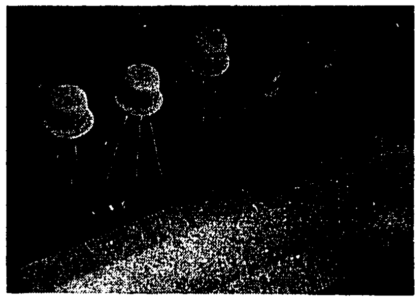


Figure 2. Outside view of the optrons.

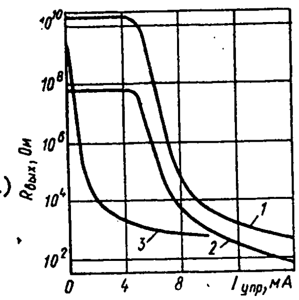
It must noted that in the RO with emitting diodes, as a rule, matching of the elements with respect to speed is not provided. The speed of the RO is completely determined by the inertia of the photoresistor, which for the cadmium sulfide and cadmium selenide photoresistors in the best case will be several milliseconds with a high excitation level. The low speed of the RO limits their application in a number of fields of engineering and, above all, in the devices for the functional processing of analog signals.

At the present time the fastest of the Soviet RO of industrial type is the OEP-16 optron, which is two optically and galvanically decoupled optocouples made up of the AL 107 emitting diodes and photoresistors based on cadmium selenide and mercury selenide combined in one case. The speed of the OEP-16 is 300-500 microseconds; this is more than order higher than the RO of other types. The OEP-16 optrons are used as direct current and dc voltage converters to ac. In Figure 3 we have one of the basic characteristics of the optron -- the output resistance R_{out} as a function of the input current I_{contr}. From the figure it is obvious that the multiplicity of variation of the output resistance with variation of the input current from 0 to the rated value reaches 10^5 to 10^6.

The wide dynamic range of the output characteristic with respect to resistance and also the linearity of the volt-ampere characteristic in a wide range of voltages make the resistor optrons highly convenient for application for automatic regulation of radio engineering systems. Figure 5 gives the volt-ampere characteristic of optrons of certain types in the open state. The bend in the volt-ampere characteristic at high voltages is caused by the heating of the photosensitive element of the optron by the joule heat P_{pd}. This bend is at the limits of the admissible dispersion power of the optron.

The electrical decoupling resistance between the input and output circuits of the optrons is more than 10^{10} ohms; the electric strength is up to 500

(a)

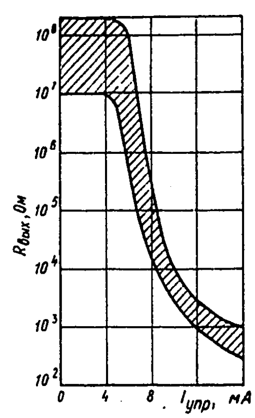


(b)

Figure 3. Transmission characteristics of the optrons of certain types: 1-3 -- for the OEP-1 to OEP-3 optrons respectively.

Key: a. R_{out}, ohms b. I_{contr}, milliamps

(a)



(b)

Figure 4. Transmission characteristics of the OEP-11 and OEP-14 optrons.

Key: a. R_{out}, ohms b. I_{contr}, milliamps

volts. The construction of the optrons insures reliable operation under various climatic conditions and under mechanical effects.

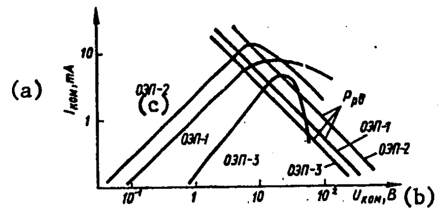


Figure 5. Volt-ampere characteristics of the optrons: I_{com}, U_{com} -- commutation current and voltage.

Key: a. I_{com}, milliamps
b. U_{com}, volts
c. OEP-...

BIBLIOGRAPHY

1. Yu. R. Nosov, OPTOELEKTRONIKA (Optoelectronics), Moscow, Sov. radio, 1977.

2. Yu. R. Nosov, A. S. Sudorov, "Application of Optrons," ZARUBEZHNAYA RADIOELEKTRONIKA (Foreign Radioelectronics), No 8, 1977.

3. A. O. Olesk, FOTOREZISTORY (Photoresistors), Leningrad, Energiya, 1966.

4. V. P. Gorokhov, B. T. Kolomiyets, A. O. Olesk, "New Industrial Cadmium Selenide Photoresistors," PRIBORY I SISTEMY UPRAVLENIYA (Control Systems and Instruments), No 7, 1971.

5. Yu. V. Andreyev, V. P. Gorokhov, A. O. Olesk, V. I. Perchukov, "Photoelectric Properties of Elements Based on Solid Solutions of $Cd_{1-x}Hg_xSe$," ELEKTRONNAYA TEKHNIKA (Electronic Engineering), Series 5, RADIODETALI (Radio Parts), No 2, 1973.

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PUBLICATIONS, INCLUDING COLLECTIONS OF ABSTRACTS

BASIC PRINCIPLES OF INFORMATION PROCESSING AND TRANSMISSION

Moscow TEORIYA PEREDACHI SIGNALOV (Theory of Signals Transmission) in Russian 1980 signed to press 18 Dec 79 p 2, 287-288

[Annotation and table of contents from book by Andrey Glebovich Zyuko, Daniil Davydovich Klovskiy, Mikhail Vasil'yevich Nazarov and Lev Matveyevich Fink, Svyaz', 24,000 copies, 288 pages]

[Text] The book gives an account of the general mechanisms in the transmission of information on communications channels, determines the potential feasibility for various methods of signal transmission and reception, compares various communications systems with one another and discusses the basic trends in the technical application of modern systems and the prospects for their development.

The theory of signals transmission is examined as a unique scientific discipline whose basis is formed by the theory of signals, the theory of interference immunity and the theory of information.

The book is intended for students at electrical engineering institutes of communications. It may also be useful for a wide circle of specialists in radio engineering and in telecommunications.

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DESIGN FEATURES AND OPERATIONAL CHARACTERISTICS OF MULTIPURPOSE RADIO COMPONENTS DESCRIBED

Moscow MNOGOFUNKTSIONAL'NYYE MAGNITNYYE RADIOKOMPONENTY (MNOGOFUNKTSIONAL'NYYE ELEKTRONNO-MAGNITNYYE TRANSFORMATORY) (Multipurpose Magnetic Radio Components (Multipurpose Electronic-Magnetic Transformers)) in Russian 1980 signed to press 30 Jul 79 p 2

[Annotation and table of contents from book by Gennadiy Panteleymonovich Zaderey, Sovetskoye radio, 8200 copies, 136 pages]

[Text] Multipurpose magnetic radio components (MMRK's) are examined in which various physical effects are simultaneously employed in a solid body. Classifications are introduced and the principles of operation, electrical characteristics, power specifications, design features and production methods of various MMRK's are described.

Recommendations of a practical nature are cited, a· well as reference data which make it possible to construct various MMRK's.

The book is intended for engineers specializing in the areas of radio-electronic engineering and automatic systems as well as for students at institutes of higher education.

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VARIOUS MISCELLANEOUS ITEMS, INCLUDING THEORIES

ELECTRODEPOSITED MAGNETIC FILMS AND THEIR PHYSICOCHEMICAL PROPERTIES EXAMINED

Minsk ELEKTROLITICHESKI OSAZHDENNYYE MAGNITNYYE PLENKI (Electrodeposited Magnetic Films) in Russian 1979 signed to press 12 Jun 79 p 2, 276-278

[Annotation and table of contents from book by Larisa Fedorovna Il'yushenko, Mikhail Ustinovich Sheleg and Anatoliy Vasil'yevich Boltushkin, Nauka i tekhnika, 1,500 copies, 280 pages]

[Text] The book is devoted to the techniques of obtaining electrodeposited films and to the investigation of their properties as they depend upon the composition of the films and the method of deposition. The magnetic characteristics are examined for films made from pure iron, nickel, cobalt and their binary and ternary alloys, as well as for those made from alloys of transition metals and other elements. Comparative data are cited for the properties of electrodeposited and vacuum-deposited films. The results of studies obtained in the area under investigation by scientists in this country and abroad are discussed as well as the results of work carried out by the authors and their co-workers in the Institute of Physics of Solids and Semiconductors of the USSR Academy of Sciences.

In contrast to the book of L. F. Il'yushenko which was published in 1972 under the same title, this second edition has been supplemented considerably with new data which are very important for developing the physical bases of a production process that will obtain magnetic films with the given properties.

The book is intended for scientific and engineering workers employed in obtaining and researching these properties and applying them in ferromagnetic film technology.

13 tables. 128 illustrations. Bibliography pp. 252-272.

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