2 Cop
STOC

OTS: 60-31,359

JPRS: 3493

5 July 1960

TELEVISION FILM-REPRODUCTION SYSTEM AND WITH RECORDING WITH OPTICAL DOUBLING OF SCANNING RASTER

- USSR -

by A. A. Gol'din, D. A. Taranets

Distributed by:

OFFICE OF TECHNICAL SERVICES
U. S. DEPARTMENT OF COMMERCE
WASHINGTON 25, D. C.

U. S. JOINT PUBLICATIONS RESEARCH SERVICE
205 EAST 42nd STREET, SUITE 300
NEW YORK 17, N. Y.

FOREWARD

This publication was prepared under contract by the UNITED STATES JOINT PUBLICATIONS RESEARCH SERVICE, a federal government organization established to service the translation and research needs of the various government departments.

JPRS: 3493
CSO: 3624-D

TELEVISION FILM PROJECTION AND A VIDEO RECORDING SYSTEM WITH OPTICAL DOUBLING OF THE SCANNING RASTER*

[Following is a translation of an article by A. A. Gol'din and D. A. Taranets in the Russian periodical Tekhnika kino i televideniya (Motion-Picture and Television Technology), Vol. 3, No. 11, November 1959, Moscow, pages 25-33.]

Existing systems of TV film projection and video recording are classified. The prospective direction of developments of such systems are indicated. A new system which can be used for black-and-white and color TV film projection or for video recording on movie film is examined.

At present, in the universal engineering practice not a single trend in equipment development for TV projection and video recording has evolved. A great number of systems, differing from one another in design and principle, have been created by various firms, but not one of these systems completely satisfies the established requirements. The absence of a single developmental trend and the variety of the created installations are explained by the different standards of scanning in a number of countries as well as by a number of difficulties in principle to which, in the first instance, belong the following:

(1) various frame speeds in movies and television;

(2) short duration of the field quenching pulse (according to USSR television standards the duration of this pulse should not be more than 4% of the frame speed period).

The first circumstance does not entail any substantial complications for the USSR and European countries, because as a result of the small difference in frame speeds it is possible to project film in synchronization with television scanning without any noticeable disturbance of sound tonality and rhythm of motion. For countries whose television standards provide for a speed of 60 fields per second, synchronized projection is unacceptable.

The second circumstance is due to the fact that the film transport mechanism of standard movie projectors and cameras does not allow the scanning of two television fields during the time the film is not in motion. Therefore the transmission of movie film by a simple combination of a theater movie projector and a studio television camera, and also video recording by photographing the image from the screen of a monitor by means of a synchronized movie camera, cannot be successfully accomplished.

Depending on the method of film advance by the transport mechanism, all existing systems are subdivided into systems with interrupted and continuous (smooth) film movement.

---

*The TV projector featuring optical doubling of the scanning raster which is mentioned in this article is being used to demonstrate TV color films at the Exhibition of the Achievements of the National Economy of the USSR (1959).

In turn, systems with interrupted motion according to the principle of solving the problem of matching the film advance with the operation of vertical TV scan, can be divided into the following groups:

1. A group of systems in which matching of interrupted film motion with the scanning operation is achieved, but with the loss of some useful information.

TV film projectors belonging to this group operate with field quenching pulses whose duration is increased up to the time required for film advance. On account of their simplicity, similar devices are sometimes used for laboratory purposes, but cannot be used for telecasting because of significant reduction in the number of lines and distrubance of the image format on the screens of TV receivers.

Video recording systems operating on this principle have been widely used in the USA [26, 27, 28] because they allow a rather simple solution of the problem of converting 30 frames of the television standard to 24 film frames. In conformity with the European standard, video recording installations with transmission of every second or third field have been put in operation [25]. Attempts have also been made to create a system in which the selected field is replaced by the neighboring field. The inevitable reduction of resolution or the decline in the transmission of the rhythm of motion can be considered a general shortcoming of video recording systems of this group.

2. A group of systems using interrupted film motion and storage components for storing information about the image during a field.

Television film projectors of this group operate on tubes with storage [21, 23]. The electrical storage of the tubes makes it possible to establish conditions for independent operation of the film transport mechanism and the vertical TV scan. Similar television film projectors have been extensively used in black-and-white television, because they allow the use of standard film transport mechanism and, with the utilization of transmitting tubes with photoresistors, permit obtaining a high quality of film transmission. The use of this method for color television film projection is hampered by the irregularity of the image background and the complication of obtaining a temporary combination of colordivided signals from three transmitting tubes.

Video recording using luminophor afterglow for recording the field, during which time the film is transported, have been used in the USSR and France [11, 12, 16, 17]. The inevitable narrowing of the brightness operating range of the recording kinescope, it being necessary at the same time to introduce modulation of the video signal for equalizing the exposure of adjacent fields, must be considered a shortcoming of these systems.

3. Systems in which the film advance time is reduced to the duration of the quenching pulse [30].

Similar devices are considered for practical application only in the case of video recording on 16-mm movie film. The film transport mechanisms in these devices are complicated and have a short life. Further, the quality of the recording is poor, due to vibrations of the film in the frame window during a fast stop.

At present, the use of smooth film motion is always accompanied by splitting of the image by the scanning beam method. The absence of the problem of compatibility of color-divided images, linearity of the light characteristic, stability of the black level, and uniformity of background make this method more or less indispensable in color television film projection. Therefore, systems with smooth film motion will be examined only from the viewpoint of the utilization of scanning by a scanning light beam.

Before examining concrete systems, let us find the law of migration of a scanning spot in the plane of the frame window of the TV film projector. Refer to Figure 1. The film moves evenly from bottom to top, as shown by the arrow, at a rate of 25 frames/second.

Lines 1, 2, 3, 4 represent the displacement of the lower boundary of the n-th frame, the upper boundary of the (n + 1) frame, lower boundary of the (n + 1) frame, etc., as a function of time. Let us assume that at the time instant t_{n1} scanning of the first field of the (n + 1) frame (point a on the graph) is begun. At the end of the time of the first field, the scanning spot should have moved along the vertical to the level of the lower boundary of the (n + 1) frame (point b on the graph). For scanning the second field during the field quenching pulse, the scanning spot should return to the upper boundary of the (n + 1) frame (point c) and finish scanning the second field at the moment of appearance of the next quenching pulse (point d). Then, in the same order, the (n + 2) frame is scanned, etc. From an examination of the graph it follows that for interlaced scanning of smoothly moving film according to current television standards in Europe and the USSR, the vertical displacement of the scanning spot in the frame window plane should conform to the law expressed by curve abcdef. Thus, at the expense of combined operation of vertical and horizontal scans, two strict identical half-rasters (shown in Figure 1 on the right), each of which is repeated with a frequency of 25 cycles and contains half a scan line, should be formed in the frame window.

Let us find the basic sizes and mutual location of half-raster.

The height of half-rasters (L') can be determined (cf. Figure 1) when:

$$L' = h_k - C, \tag{1}$$

where h_k is the height of the frame being transmitted, and C is the distance through which the film passes during scan of active field lines.

Let us determine this distance:

$$C = V\,(T_p - \tau_i) = VT_p\,(1 - \frac{\tau_i}{T_p}), \qquad (2)$$

where V is the film speed, T_p is the full field time, and τ_i is the duration of the vertical quenching pulse.

During scanning of the frame tape is displaced by the magnitude of spacing of the film (H), i.e.,

$$V = \frac{H}{2\,T_p}, \qquad (3)$$

from which:

$$C = \frac{1}{2}\,H\,(1 - \frac{\tau_i}{T_p}). \qquad (4)$$

Substituting (4) in (1), we derive:

$$L'_1 = h_k - \frac{1}{2}\,H\,(1 - \frac{\tau_i}{T_p}). \qquad (5)$$

Because for the full time of the field the film goes through clips equal to one half a film step, the distance between the centers of half-rasters (S') is equal to:

$$S' = 0.5H. \qquad (6)$$

The interval between half-rasters will be:

$$\Delta' = S' - L' = H\,(1 - \frac{1}{2}\,\frac{\tau_i)}{T_p} - h_k. \qquad (7)$$

The width of the half-raster (B') may be determined as:

$$B' = h_k K, \qquad (8)$$

where K is the format of the television image.

As is known, the area of the frame window of a motion-picture camera is somewhat larger than the frame window of a movie projector, which explains the necessity for allowances in the inaccuracies of a frame stop in filming, copying, and projecting. In television the role of a limiting framework is played by the framing of the receiver screen. Thus in television film projection it is desirable to transmit the area of the film frame defined by the dimensions of the frame window of the motion-picture camera.

Accepting in conformity with USSR standards [4, 5]

$$H = 19 \text{ mm}; \; h_k = 16.1 \text{ mm};$$

$$\frac{\tau_i}{T_p} = 0.075; \; K = \frac{4}{3}$$

and substituting the indicated values in (5), (6), (7), and (8), we obtain: height of the half-raster in the frame window plane $L' = 7.3$ mm, distance between the centers of half-rasters ("jump" size) $S' = 9.5$ mm, size of the interval between half-rasters $\Delta' = 2.2$ mm, width of the half-raster $B' = 21.5$ mm.

Irrespective of the fact that the graph in Figure 1 was considered as applicable to the transmission of movie film, it is evident that the obtained law of motion of the scanning spot is true even for video recording on smoothly moving tape. This law is only possible for nondistorted reproduction and recording independent of how and what kind of equipment is used. Hence it can be concluded that in the development of television film projection and video recording systems it is necessary to strive for such a solution as would permit the fulfillment of this law with a maximum simplicity of design and a high light-gathering power of the device.

According to operating principle, systems with smooth film motion may be divided into the following basic groups:

1. Systems in which the smooth motion of the film is compensated by movable opticomechanical elements [1, 8, 14, 18, 19, 24].

In the overwhelming majority of cases these are the film projection systems with film frame change by means by gradual "displacement" of the image of the previous frame by the image of the next frame. Such a method of frame change is accompanied by a doubling of the scanning spot, which leads to lack of sharpness and zonal flickering which is greater than the time of "displacement" [8].

Typical representatives of this group are systems with compensators in the form of rotating many-sided prisms. The Philco television film projector can be considered the best in this group [8]. In it compensation is achieved by a prismatic crown being rotated by the film itself. In contrast to the systems examined below, deviations of the rate of film motion here does not lead to mismatching in the relative position of the compensating element and the film frame, and consequently does not reduce the quality of the image. The latter circumstance, as well as simplicity of design, are merits of this compensator, because they permit a sharp lowering of accuracy tolerances in manufacturing mechanical parts and exclude individual fits during assembly and periodic maintenance.

The Philco compensator operates with a relative aperture of 1:8 with light transmission of 0.36 [8]. The physical lens power of the system can be found from the well-known expression

$$J \equiv \tau \frac{\pi \cdot \cos^4 \omega}{4K^2 \left(1 \quad \frac{1}{m}\right)^2}, \qquad (9)$$

where τ is the light transmission factor of the optical system, ω is the angle between the axis of the objective and the main beam of the band, K is the denominator of the relative aperture of the objective, and $\frac{1}{m}$ is the scale of the image.

The value (m) is defined as the ratio of the nominal width of the raster on the screen of the scanning tube (B) to the width of the half-raster in the frame window plane (B'). In using Soviet scanning tubes of the 18LK-8Zh type B = 124 mm, and consequently:

$$m = \frac{B}{B^1} = \frac{124}{21.5} = 5.8.$$

Substituting the data of the Philco optical system in (9) for $\omega = 0$, we obtain J = 1:310.

The low light-gathering power, the greater "displacement" time, and the inaccuracies, in principle, of operation due to a lack of strict proportionality between displacement of the scanning beam and the angle of rotation of the prismatic crown, prohit the use of this compensator in high-grade systems.

Substantially better results are provided by the "Mechau" compensator [8, 18], the latest model of which was produced by AEG in 1932. This compensator has a shorter "displacement" time and ensures the operation of an objective with a 1:2 relative aperture with a 0.37 light transmission factor of the optical system [8]. Substituting in (9) the data presented above, when m = 5.8 we obtain a physical lens power of J = 1:19. A shortcoming of the "Mechau" system is the exceptional complexity of the opticomechanical section, which has a large number of kinematic parts with individual fits.

Simpler in design is the compensator suggested by A. N. Tarasov and I. L. Sakin [8]. Compensation of film motion is accomplished by two oscillating mirrors driven by rotating cams. The mirror works alternately so that one of the mirrors compensates the motion of the film and the other mirror at the same time covers the obturator and returns to its initial position. Thus this compensator uses half an operating opening of the objective, which is its essential shortcoming. Despite this fact, the compensator has comparatively high indices. For a short displacement time and an optical system transmission factor equal to 0.6, an objective with a 1:2 relative aperture, which corresponds to a physical lens power of J = 1:23, is used in it. A compensator of this type is used in a television movie projector designed and built in one of the opticomechanical plants [8]. The television movie projector is finished with a high degree of accuracy and is guaranteed to provide a color image of good quality.

An examination of the systems of this group shows that here a high-quality image can be obtained only by using designs whose manufacture and operation are complicated. An essential shortcoming of the systems is the presence of distortions connected with the change of images being transmitted or recorded by means of "displacement." It should be noted that there has been created in England [22], on the basis of the "Mechau" system, an installation for video recording which lacks this shortcoming because in it the charge of the compensating element is accomplished in a time not exceeding the duration of the quenching pulse. Attempts at creating a compensator with a "fast" reset of the compensating element are well known; however, reports on the practical utilization of similar devices for television movie projection are not to be found in the literature.

The advantage of the systems in this group is the possibility of utilizing them at different TV and movie frame speeds (nonsynchronous projection), which is extremely important as regards the USA and Japan. Regarding the USSR this advantage does not have any substantial significance.

2. Systems with electronic and optical splitting [2, 10, 20, 29].

In a system with electronic splitting, the fields required for accomplishing interlaced scanning are formed in appropriate scale directly on the screen of the scanning tube, and by an ordinary light-gathering objective are projected on the plane of a frame window. The law of vertical shifting of the scanning spot is here realized by the joint operation of 50-cycle sawtooth and 25-cycle Π- shape scanning frequency. The optical scheme of the system consists of only one objective, which depends on small losses of light and high lens power. Computation shows that in using a high-grade objective with a 1:2 relative aperature of the physical lens power of the system with electronic splitting $J = 1:8$, i.e., it significantly exceeds the lens power of the systems examined above.

A model of the installation with electronic splitting was constructed by the Television Department of the Leningrad Electrical Engineering Institute of Communications [LEIS] [2]. Transmission of color movie films by means of this installation was done in 1955. Also, a number of test video recordings of TV programs on movie film were made. Tests of the model showed that under laboratory conditions a high-grade image can be obtained. Some shortcomings of the system are the complexity of obtaining strict identical fields on the scanning tube screen and the dependence of the distance between centers of the latter on the total amplitude of the Π -shape scan and the accelerating voltage. Computation shows that for undistorted reproduction and recording, this distance should not deviate from the nominal by more than (0.1-0.2)%. The necessity of using precise stabilizing devices lessens the operational reliability of the system.

Systems with electronic splitting allowing the scanning of 60 fields per second have been constructed in the USA and England. Non-synchronous projection is accomplished by running the film at a rate of 24 frames/second and by transmitting two adjoining movie frames by means of five television fields.

In systems with optical splitting, a single narrowed raster is formed on the screen of the scanning tube. From this raster the light is split into two beams alternately creating two images with a frequency of fields being overlapped by the obturator. Because of the simplicity of their design and high operational reliability, systems with optical splitting are used widely in Western Europe for the monochrome televising of movie films. However, their utilization for video recording and color television film projection is hindered by the inadequate lens power of the existing splitting devices.

The television movie projector of the EMI firm [10] is a typical example of systems of this type. Its splitting system consists of two truncated lenses joined at the plane of cut. The optical scheme of the television movie projector operates with a 1:45 relative aperature with a light transmission of 0.55 [10] which corresponds to a physical lens power of J = 1:64.

The Television Department of the Leningrad Electrical Engineering Institute of Communications proposed and developed a system of television movie projection and video recording whose simplicity of design makes possible obtaining a high lens power close to the lens power of devices with electronic splitting.

The optical diagram of the system is shown in Figure 2. Its operating principle consists in the following: a raster with a height/width ratio of approximately 1:3 is imposed on the scan tube screen 1. The light beams from the scanning spot C can strike the objective 5 only by reflection from the flat mirror 4, because the direct passage of light is excluded by a gate 2. After the objective, the light beams are reflected from the mirror 4' and form in the plane of the frame window 6 two images C' and C" of the scanning spot C staggered one to another at a half-step of the film. Obturator 3 with a field frequency commutates the light flow so that upon the scanning of one field the upper mirror works (position fixed in Figure 2); and upon scanning the other field, the lower mirror works. Thus, in the presence of a raster on the tube and the operation of the obturator in the frame window plane 6, two fields required for accomplishing interlaced scanning in TV film projection and video recording are obtained. At the expense of combined action, mirror 4 of the scanning tube is as if doubled, because the objective "sees" two completely identical rasters in the plane of its screen. Therefore, in contrast to systems with splitting, this system can be called a system with optical doubling of the scanning raster. In the optical scheme examined, there is no splitting of the light beam or loss of light as a result of this. The objective operates at full opening, which specifies high optical efficiency.

For a quantitative evaluation of the efficiency of this system it is necessary to determine its physical lens power. The utilization for this purpose of expression (9) in connection with the operation of the system by means of oblique light rays leads to the anticipation of high results, because the expression does not take into account the real directivity pattern of the scanning tubes.

As is known, in the usual case the physical lens power can be determined by

$$I = \frac{E}{B_o}, \tag{10}$$

where E is the luminance of the scanning spot in the frame window plane, B_o is the brightness of the spot of the scanning tube in the direction of its optical axis.

Expressing E and B_o respectively by the luminous flux Φ in the frame window plane and the light power I_o in the direction of the optical axis we obtain

$$I = \frac{\Phi}{I_o} m^2, \tag{11}$$

where $\frac{1}{m}$ is the image scale.

For determining the luminous flux Φ we shall use Figure 3.

Considering the aperture of the scanning spot of the tube as a point light source, we have:

$$\Phi(\alpha) = \tau \cdot I(\alpha) \cdot \Omega(\alpha), \tag{12}$$

where α is the angle between the main ray of the beam and the optical axis of the system; $I(\alpha)$ is the light power being radiated by the scanning tube in the direction α; $\Omega(\alpha)$ is the solid angle under which is seen the diaphragm of the objective from the center of the light source; τ is the transparency factor of the optical system.

From expression (12) it is seen that for determining luminous flux it is necessary to know the analytic expression of the directivity pattern of emission of the scanning tube, i.e., the ratio of I to α.

Research conducted in the Television Department of LEIS [3] shows that the directivity pattern of the light radiation of 18LK-8Zh type scanning tubes are subject to the law

$$I(\alpha) = I_o \cdot \cos^{1.8} \alpha . \tag{13}$$

In connection with the fact that the use of expression (13) for practical calculations is not suitable because of the fractional exponent of the power, we shall consider that the given dependence can be described by the function:

$$I(\alpha) = I_o \cos^2 \alpha . \qquad (14)$$

Thus, for working angles not exceeding ± 40°, the error in calculations does not go beyond the 5% limit [3].

The objective aperture angle Ω can be expressed in the following form:

$$\Omega(\alpha) \doteq \frac{\pi D^2}{4a^2} \cos^3 \alpha, \qquad (15)$$

where D is the diameter of the objective diaphragm, α is the anterior combined focal length.

Expressing the combined focal length by the main focal length, we obtain:

$$\Omega(\alpha) \equiv \frac{\pi}{4} \cdot \frac{1}{K^2} \cdot \frac{1}{(1+m)^2} \cdot \cos^3 \alpha , \qquad (16)$$

where K is the denominator of the relative aperture of the objective.

Substituting (16) and (14) in (12), we find:

$$\Phi(\alpha) = \frac{\pi}{4} \cdot \tau \cdot I_o \frac{1}{K^2} \cdot \frac{1}{(1+m)^2} \cos^5 \alpha . \qquad (17)$$

In determining the physical lens power we shall use the value of the mean luminous flux by which we understand the flux from the position of the scanning spot in the center of the raster (Figure 3). Expressing α_m by the design dimensions of the optical scheme, we obtain:

$$\mathrm{tg}\, \alpha_m = \frac{l}{a} = \frac{l'm}{f(1+m)}, \qquad (18)$$

where f is the focal length of the objective.

Because the distance centers of fields consists of half a film space (H), from Figure 3 it is evident that the value l' can be accepted as equal to 0.75H, and consequently:

$$\mathrm{tg}\, \alpha_m = \frac{0.75\, Hm}{f(1+m)} . \qquad (19)$$

Expressing cos α by tg α and substituting (19) for (17), we find:

$$\Phi_m = \frac{\pi}{4} \cdot \tau \; I_0 \cdot \frac{1}{K^2} \cdot \frac{1}{(1+m)^2} \; X \; {\frac{f\,(1+m)}{f^2\,(1+m)^2 + (0.75\ Hm)^2}}^{5} . \tag{20}$$

From which:

$$J = \frac{\pi}{4} \cdot T \cdot \rho\, 2 \cdot \frac{1}{K^2} \cdot \frac{1}{\left(1+\frac{1}{m}\right)^2} \; X \; {\frac{f\,(1+m)}{f^2\,(1+m)^2 + (0.75\ Hm)^2}}^{5} , \tag{21}$$

where ρ is reflection factor of the mirror, T is the transparency of the objective.

Using the data of the optical scheme of an experimental installation ($f = 80$ mm; $K = 2.8$; $T = 0.9$; $m = 5.8$) and accepting for the mirror an aluminum coated one $\rho = 0.9$, we obtain $J = 1{:}19$. Thus this system has a significantly larger optical efficiency than the existing systems with optical splitting, and is surpassed only by the system of electronic splitting. It should also be noted that the system does not exclude the use of a more powerful, specially designed objective.

An external view of the apparatus, constructed according to the principles examined, is shown in Figure 4.

The design of the installation provides for the light-proofing of the film transport section and consequently permits utilizing the system for video recording.

A kinematic diagram of the film-transport mechanism is shown in Figure 5. The mechanism is constructed on the basis of the SKP-31 movie projector converted to continuous film motion. The drive of the mechanism is accomplished by a synchronous electric motor (3,000 rpm). The rotation by sprocket wheels 5,6, and 20 is transmitted by a vertical spindle and worm gear couples 16, 17, and 18. Film tension between rollers 5 and 6 is accomplished by a spring 8 and a balancing device 7. Stabilization of film speed for a section of film track is produced by flywheels 3 and 4 being driven by smooth rollers 1 and 2. The balancing device 7 accomplished counterpoised stabilization. Natural oscillations in the system are extinguished by air dampers 13 and 14. Framing is done by means of a crank 11 and a spring 10, which is displaced by an eccentric 12.

Figure 6 shows the tape transport track of the installation, the design of the optical system, the shutter arrangement, and the electric light converter.

Conclusions

1. Systems with interrupted film motion are poorly suited for color TV film projection and high-grade video recording on 35-mm movie film.
2. Opticomechanical compensators are of extremely complex designs. Their use is expedient only with a television standard of 30 frames per second.
3. For a standard of 25 frames per second, systems in which film motion is used in image scanning, i.e., systems not containing changeable optical elements, should be considered the most prospective.
4. Among the latter systems it is advantageous to note the simplicity and high lens power of the system with optical doubling of the scanning raster developed by the Television Department of LEIS.

LITERATURE

1. Goldovskiy, Ye. M., Kinoproyektor i fil'm [Movie Projector and Film], "Iskusstvo" Publishing House, 1953.
2. Taranets, D. A., Color TV Movie Projection," Informatsionnyy sbornik "Tsvetnoye televideniye" [Information Collection "Color Television"), "Sovetskoye Radio" Publishing House, 1957.
3. Gol'din, A. A., "Experimental Investigation of the Directivity of Light Radiation of Cathode Ray Scanning Tubes," Trudy nauchno-tekhnicheskoy konferentsii LEIS [Transactions of the Scientific and Technical Conference of the Leningrad Electrical Engineering Institute of Communications], No 1, 1957.
4. USSR Television Standard GOST 7845-55.
5. USSR Movie Standards GOST 4896-49, OST-movie-3.
6. Burgov, V. A. Kinotelevizionnaya tekhnika [Movie Television Technique], "Iskusstvo" Publishing House, 1959.
7. Semenov, L. G., "Television Movie Systems," Trudy televizionnoy filial-laboratorii [Works of the Television Laboratory Affiliate], No 2, 1956.
8. Tarasov, A. N., "Optical Aligning in TV Movie Projection," Tekhnika kino i televideniya, No. 5, 1958.
9. Braude, G. V., Method of TV Movie Transmission (Photography of a TV Image), Author's Certificate No. 111225, dated 3 July 1956.
10. Tarasov, A. N., "TV Movie Transmitter with a 'Traveling Spot' Made by the EMI Firm," Tekhnika kino i televideniya, No. 10, 1958.

11. Amiridi, V. F., Tel'nov, N. I., "Apparatus for Recording Television Programs on Movie Film," Tekhnika kino i televideniya, No 7, 1958.
12. Arushavov, G., "Recording Television Programs on Movie Film," Radio, No 5, 1958.
13. Bogatov, G. B., "Transmission of Movie Films by Television," Tekhnika kino i televideniya, No. 8, 1957.
14. Goldovskiy, Ye. M., Problemy kinoproyektsii [Problems of Movie Projection], "Iskusstvo" Publishing House, 1955.
15. Taranets, D. A., Tsiklis, M. I., "Video Recording," Sbornik materialov po televizionnomu veshchaniyu [Collection of Materials on Telecasting], Leiningrad-Riga, 1956.
16. Tager, P. G., Tel'nov, N. I., Khinchuk, G. A. Blazhenkov, V. A., "Equipment for Recording Television Programs on Movie Film," Teknika kino i televideniya, No. 3, 1957.
17. Khvylya, I. A., "The UZTP-57 Device for Recording Television Programs," Informatsionnyy byulleten', "Televideniye, priyem i retranslyatsiya"["Television, Reception, and Retranslation Information Bulletin"], No. 1, 1957.
18. Burmester, L., Mechau, E., "Investigation of the Mechanical and Optical Principles of the Mechau Projectors," Kino-Technik, No. 10, 1928.
19. Traub, E. H., "New 35-mm Television Film Scanner," SMPTE, Vol. 62, No. 1, 1954.
20. Holman, H. E., Newton, G. C., Quinn, S. F., "A Flying-Spot Film Scanner for Color Television," Proc. IEE, Part B, No. 22, 1958.
21. Kozanowski, N. M., "Vidicon Film-Reproduction Cameras," SMPTE, No. 2, 1954.
22. Kemp, W. D., "Television Recording," SMPTE, No. 4, 1953.
23. Mayer, N., "Film Recording with the Vidicon," Electronische Rundschau, No. 8, 1955.
24. Wittel, O. A., "Continuous Projector for Television," SMPTE, No. 6, 1955.
25. Gregor, E., "Technique of Film Recording From a Screen," Kino-Technik, No. 5, 1956.
26. Fraser, R. M., "Motion Picture Photography of Television Images," RCA Review, No. 6, 1948.
27. Boon, J. L., "Television Recording Camera," SMPTE, No. 8, 1948.
28. Fraser, R. M., "New 35-mm Single-Film-System Kinescope Recording Camera," SMPTE, No. 6, 1954.
29. Felgel-Farnholz, "Transmission from Film in Television Transmission Operations," Kino-Technik, No. 5, 1956.
30. "The Markoni Telerecording Equipment," Journal of the Televison Society, Vol. 8, No 5, 1957.

- END -

FIGURES

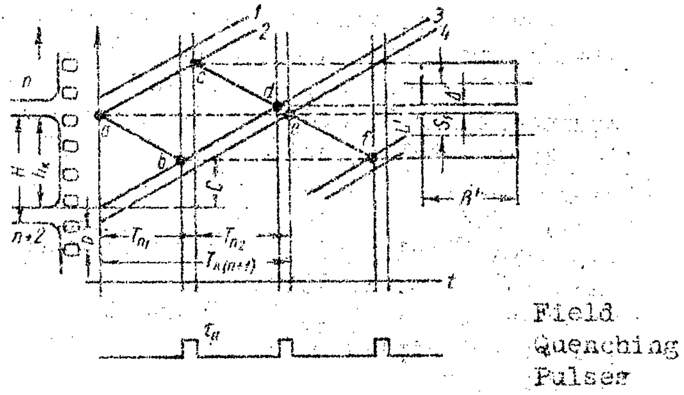


Figure 1. Determination of the law of displacement of the scanning spot during continuous film motion.

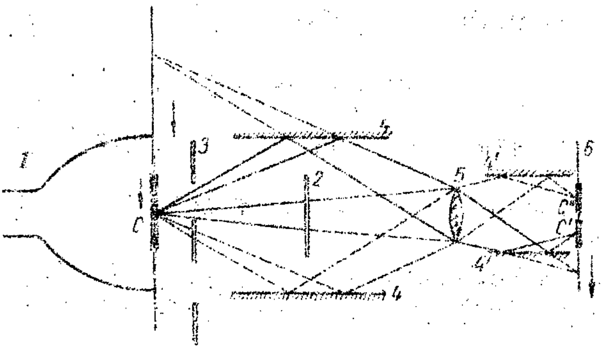


Figure 2. Optical scheme of the LEIS system.

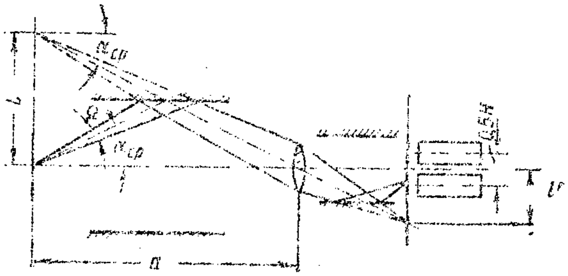


Figure 3. Design of a light-gathering system with optical doubling of the scanning raster.

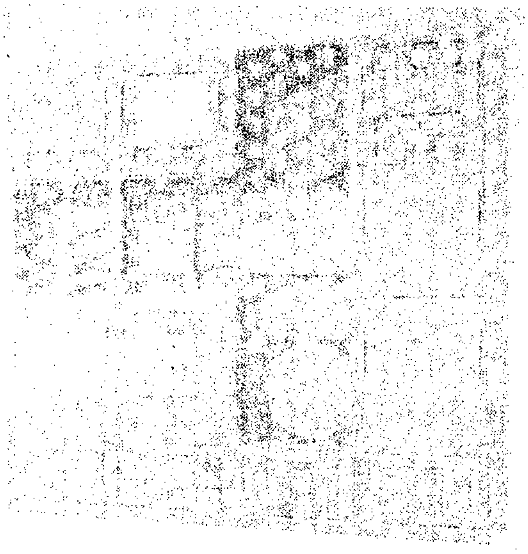


Figure 4. External view of the equipment for television film projection and video recording.

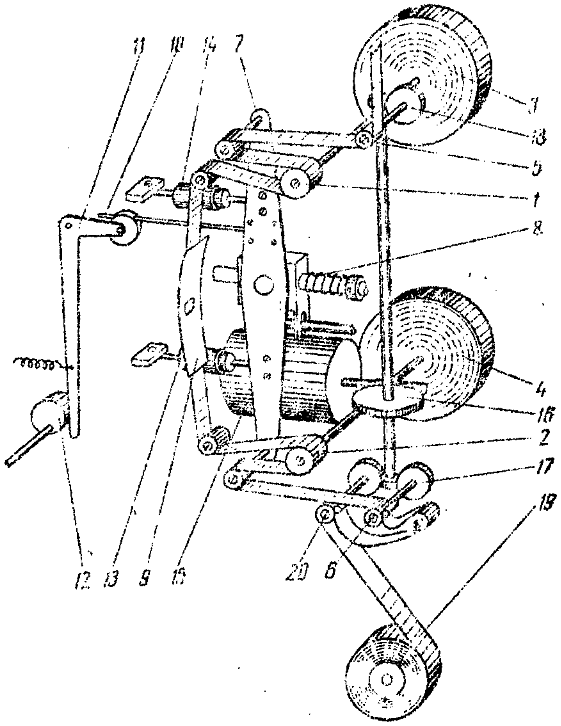
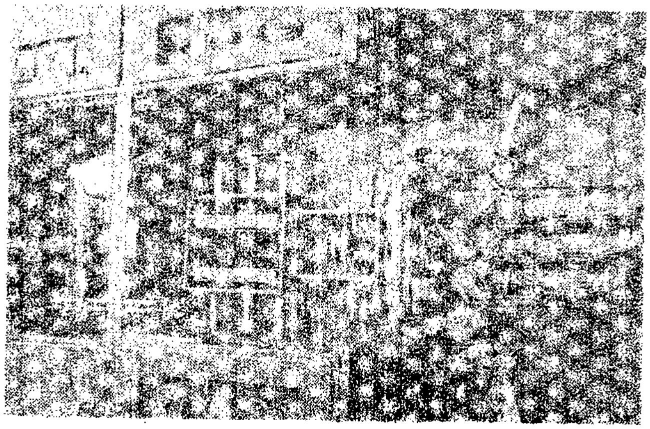


Figure 5. Kinematic diagram of the film transport mechanism.



[illegible] of the optical system, furnace, and the [illegible]
[illegible]