

Osnovi Kinetekhniki (Fundamentals of Cinetechnics)

By E. M. Goldovskii. Published (1965) by Eeskustvo, 25 Tsvetnoi Bulvar, Moscow E-51. 636 pp. Illus. Diagrams. 8½ × 5½ in.

Edit. Note: This book is not available in English. Its substantial content has prompted special attention contributed by Dr. Deane R. White, Photo Products Dept., E. I. du Pont de Nemours & Co., Inc., Parlin, N.J. 08859, who has translated the Table of Contents and the Section on "History of Systems of Common Cinematography." This special contribution is greatly appreciated and deemed more valuable than would be a brief assessment.

The author of the book is Dr. E. M. Goldovskii. At the time of his 60th birthday, in 1963, E. M. Goldovskii had written more than 140 papers and 70 books, reports the *Zhurnal Nauchnoi i Prikladnoi, Fotografii i Kinematografii*, of the Academy of Science of the USSR. These cover broadly and in depth many aspects of cinematography which he had seen and helped develop during 40 active years of professional life. His work ranged from teaching to popular writing, from development of 16mm systems to 70mm and panoramic systems. He has written on sound recording, motion picture lighting, projection and theater design. He has been on the editorial boards of the chief Soviet technical photographic magazines. He served for years as the Assistant Director in the scientific section of NIKFI (the main photographic research center in the USSR). It appears difficult to find any person with broader background of observation and work in this field than that of E. M. Goldovskii.

The references to the many illustrations have been retained in the translation even though reproducing the illustrations is not feasible. Page numbers are shown for major subheadings to indicate the extent of attention given by the author.

Because of the detailed and historical nature of this translated extract, readers' comments, possibly in the form of Letters to the Editor, will be welcome.

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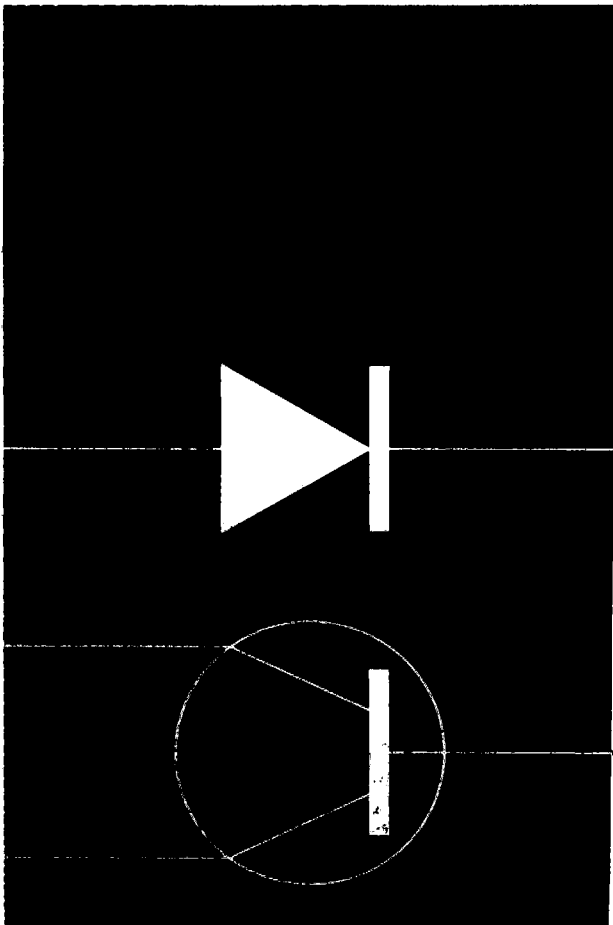
whatever happens when the button is pressed. It takes the pictures first and then submits to having its exposure index adjusted in processing. Among the professionals it has won more respect for that—and for its marvelous resolution—than it has for the spectacular shots of the Pyramids caught from orbit and seen in the picture

magazines. The name is KODAK EKTACHROME MS Film, ESTAR Base. The source of up-to-the-minute information is Instrumentation Products, Eastman Kodak Company, Rochester, N. Y. 14650 (phone 716-325-2000, Ext. 3257).



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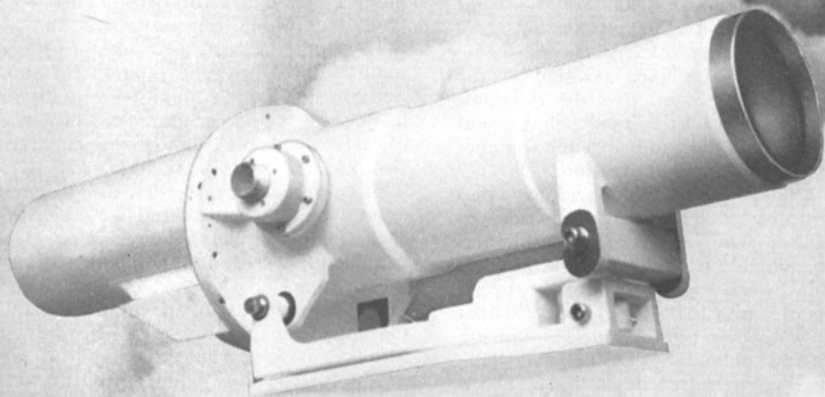
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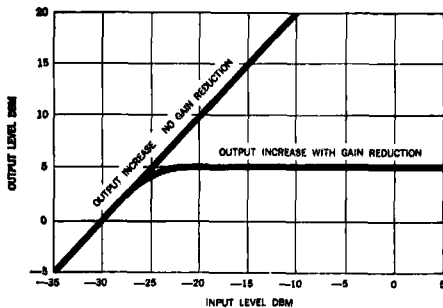
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TRANSLATION, PAGES 373-384

Sec. 25. History of Systems of Common Cinematography

Invention of Cinematography

In the first years of the development of cinematography the ordinary system experienced the chief expansion. To a great degree, this is explainable by the level of cinetechnics of that time. Light flux of cine projection equipment produced in the best case a few hundred lumens, and this enabled one to illuminate a modest screen with images of a low level of brightness. Even a quarter of a century later, after the opening of the first cine theaters, the screen brightness did not exceed 25 apostilb, and the width was limited to 5 to 6 meters. Consequently, one is obliged to consider the opportunity for observation by the viewer of the screen within the limited horizontal angles of vision, i.e., 40° for the front row of seats in the auditorium and about 12° for the rear. Viewers became "acclimated" to a fixed position of the head, as in these conditions the eye completely encompasses the images shown and even a turn of the head brings the frame of the screen into the field of vision.

At the beginning of 1894 ordinary cinematography, based on the use of perforated cine films, was introduced by Thomas Edison. Flexible transparent films for photography were suggested already by I. Boldyrev (Russia 1878-1881) and were used in apparatus for photography of moving images in England by Le Prince (1888-1889), W. Friese-Greene and M. Evans (1889) and E. Marey (France 1893). The credit to Edison is, first of all, that he chose the 35mm film width with a 19-mm frame as four on each side, as retained in our day. Moreover 35mm films were used for photographing and exhibition of the moving images in commercial equipment, not in patent claims or experimental devices. In the development of the dimensions of cine films Edison originated 25.37mm, i.e., 1 in. as maximum width of frame with frame height 3/4 in., which corresponds to 19 mm.

The specification for the design of the perforations, was necessary to the movement of the film in the kinetograph (as Edison called his camera) and kinetoscope (for exhibition) and that made necessary the increase of the width to 1 1/4 in., about 35 mm. Further, it was necessary to separate the image frames, one from another, and at the same time separate somewhat the edge of the photograph from the perforation since wearing out of the latter can show in the area of the frame. Establishment of the interframe distances with a width of 1 mm, i.e., with a frame height of 18 mm, generated, correspondingly a frame width of 24 mm and a space of 0.75 mm between the vertical boundary of the frame and the perforations on each side. A great number of "movies" of 15-16 m length were photographed on such film, with the frame dimensions specified.

The kinetoscope [a peep-hole device], with the aid of which these films were examined, did not meet the requirements of cine exhibition which involves the simultaneous viewing of the picture by a large audience. Nevertheless, the invention of the kinetoscope stands as a significant landmark in the course of development of cinematography.

In 1839-96 a great number of works were reported by inventors in various countries directed toward the solution of the problems of cine projection. An important role was played by the work of I. Timchenko (Russia) in construction of an intermittent mechanism ("helix" type) and the combination of it with screen projection (1893). L. Lumière produced an intermittent mechanism of the claw type (1895—France). G. Demyen and V. Continsouza and Bunzli (France) developed a "pin" intermittent motion (1893-94) and used a four-arm maltese cross (1896): A. Samarskii (Russia 1896) invented a mechanism of a type with opposed pins with pulsing carriage (drive). Many assisted cine apparatus designers in the construction of a series of types of cine projectors—G. Le Roy, W. Latham, E. Skladanowskii, L. Lumière, R. Paul, A. Samarskii and I. Akimovii, T. Armat and C. F. Jenkins and others.

L. Lumière achieved the greatest success as he succeeded in producing a light, stable and convenient cine apparatus, equally useful for the taking, printing and projection of motion pictures (the first French patent, No. 245,032 was issued Feb. 13, 1895). This equipment far excelled the designs of other inventors, who offered in a majority of cases single and incomplete models, which, in general, were not manufactured. Also, the first, and basic type, of films with a duration of showing of one minute was photographed by L. Lumière, sometimes with his participation as actor.

The first public showing of films by Lumière was given in Paris, March 22nd 1895; likewise, the first showing for pay occurred in the Indian Salon, Grand Cafe on Avenue des Capucins the 25th of December 1895. It lasted 20 minutes during which 10 sections of film were shown, each section of 15 to 16 meters.

The 90's of the last century were particularly favorable for the development of cine technics; in this period great advances were made in the areas of heat engineering, electrical engineering, light technology, optics, chemistry and precision mechanics. After projection of the first motion picture in Paris, the cinema started to spread throughout the world.

In January 1896, films were projected in Lyons (France), in February they were shown in London, Bordeaux, and Brussels for the first time, in Berlin in April, in Vienna (Austria-Hungary) in May 1896, in Spain and in North America in June, in Serbia and in Petersburg in July and in Rumania in August.

Silent Cinematography

The years from 1895 to 1928 are called the epoch of silent cinematography. During this period in the area of cine technology, important things were done, directed toward the improvement of the processes of photographing, printing and projecting of motion pictures.

Great attention was given to the improvement of the quality of cine films. The light sensitivity of photographic emulsions was increased approximately 10 times and panchromatic emulsions were achieved. Film base was improved, while great effort was required in the establishment of film dimensions and particularly perforations, which determined the steadiness of feed of the film.

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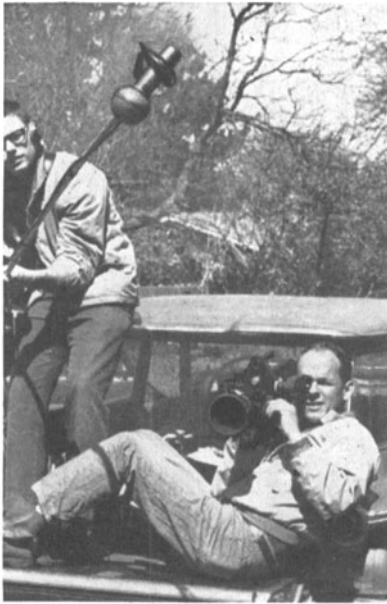
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In the early years of the development of cinematography there were various changes in perforations, width of film and dimensions of the frame. For 35mm films L. Lumière used round perforations of 2.9mm diameter which were arranged like today's 16mm films. They were selected by Lumière in order that the circular hole could be punched through with the help of cylindrical punches, which were manufactured as long ago as this with the precision of a fraction of a hundredth of a millimeter. Nevertheless this form of perforation caused difficulties during the execution of forward motion of the film by the sprockets on account of the conical shape of thin teeth, which did not guarantee sufficient steadiness of the frame.

In spite of this failing, circular perforations were widely used in 1895 to 1900 on account of the fact that French cinematography during this period led all the world. American films were manufactured mostly with the straight-sided perforation introduced by Edison which produced the required steadiness of the frame during projection and simplified production of sprocket teeth for driving the film.

At first the two forms of perforation of cine films caused trouble in the international exchange of films. A Congress of cine industry owners, called in 1909 under the initiative of G. Méliès (France), decided on the introduction of the straight-sided perforation of Edison.

In the first years of the development of cine films prints were sold to individual owners, who, moving around the country, projected them until the films were completely worn out. In connection with the development of groups of stationary cine theaters, distribution by sale changed to distribution by rental. Thus, in 1902, the commercial leasing of movies originated. During this process it developed that the straight-side perforations wore rapidly. In order to lengthen the service time of 35mm prints a perforation was developed which shows itself part of a circle, which is limited bottom and top by parallel straight sides (Fig. IX-33).

Similarly, this perforation proved unreliable and Eastman Kodak Co. suggested the manufacture of a rectangle with rounded corners (1923). The French firm Pathé appearing in this year, as one of the largest scale European producers of film, also adopted this perforation for use for 35mm positives. Simultaneously, for increase of the service life of prints, the thickness of cine film base was increased. At the turn of the century nitrate base was used of a thickness about 0.1 mm, this dimension was raised in 1915 to 0.12 mm and in the 30's set at 0.14 mm.

Thus, in 1925 the greatest distribution was with the form of perforation for positive film shown in Fig. IX-4a. Negative films, which have less aging wear, are produced in the majority of cases, with the perforation shown in Fig. IX-33. At the International Congress for Cinematography in July 1925 in Paris both forms of perforation were officially approved.

The location of the frame relative to the perforation was an important matter. In 1895-1910 it varied, which caused a series of difficulties, in particular, continuous adjustment of images to be "inframe" during cine projection. During repair of films, cases

occurred where splicing was required in the image field of the frame. Only in 1925 was the way cleared to standardize for all the world the proposal of the firm "Pathe" which is in use now—the configuration of the frame relative to the perforation of 35mm film (see Fig. IX-4a).

Cameras were improved, and specialized cine projectors began to be used for projection. This is understandable since cameras are designed for intermittent but very exact work while projectors must work under very difficult conditions and work for long periods.

Special apparatus was built for printing film, for manual development carrying out photographic processing of films in special baths and finally for production machines for film printing plants.

Already no one worker appeared simultaneously as operator, developer, director and cine mechanic. Cine studios were built which were engaged only in the taking of pictures. For this a special staff was established, director, operator, stagehands and actors so that most films began to be artistic. Auxiliary personnel appeared, construction men, lighting men, make-up men and other specialists. Arc lights and mercury lamps were substituted for the sunlight of the first exposures by Lumière. Cost of production of a picture already was measured in many thousands of rubles; at first a film was limited to 300 m but later reached 1500-2000 m.

Films began to be projected in buildings specially designed for these installations. Projectors were considerably improved, with sources of light and optics so much improved that even with large screens the illumination remained adequate. The light flux of cine projectors increased in this first period by a factor of ten.

Thus, cinematography became a strong section of industry, into which enormous capital was invested; special studios were constructed and even cine cities, for example, Hollywood in the USA. The number of pictures issued began to increase rapidly and with the issuance of certain pictures movies began to be valued as one of the greatest arts.

Sound Cinematography

In 1928-29 the epoch of sound cinematography began. The idea of combining sound with moving images originated far in advance of the invention of cinematography. In 1877 W. Donisthorpe used Edison's phonograph, connected it with the zoetrope of W. Horner and matched the sound recorded on the phonograph with the character of image exhibited. In 1894 Dickson synchronized the kinetoscope with sound records and showed sound cine pictures the first in the World in which Dickson was shown welcoming Edison and asking him how he likes the new invention.

In 1900 Gaumont added sound to the cine projector of Lumière, connecting the phonograph of Edison with it by means of a flexible shaft. The first demonstration of this arrangement was carried out on the 12th of September, 1902 in the French Academy of Science, and in 1910 similar apparatus was manufactured for cine theaters.

A similar installation was made by Messter in 1903 and soon thereafter by



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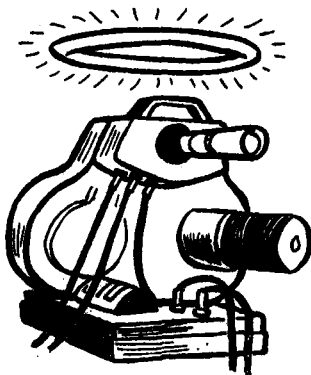
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others in which instead of the cylinder of the phonograph, there was a gramophone disc, actuated by means of an air jet. For synchronization between projected pictures and sound reproduced by the phonograph or gramophone, in this system, complicated apparatus was used which worked uncertainly. Moreover, uninterrupted reproduction of sound with the plastic disc lasted only 5 minutes. Therefore, in most of the later designs for sound pictures, continuing to the thirties of our century, gramophone discs 400 mm diameter were used which could play for 15 minutes.

In spite of many attempts made in all countries of the world to improve the gramophone system of sound cinematography, it ended in the 30's of this century principally on account of the separation of cine film and the disc.

This fault (lack of synchronization) was corrected by Pino (1909) who proposed the use of a mechanically recorded soundtrack directly on the base of 35mm film prints. The invention was not commercialized on account of the poor quality of sound records, and greater convenience of sound pictures shown with photographic sound records.

Our compatriot J. Polyakov, in 1900 first referred to photographic sound records, taking a patent on the reproduction of sound by means of a reading (scanning) lamp and photoelement. The first person, who produced a photographic record of sound on cine film was E. Rühmer, who in 1901 used a "talking" arc lamp (mentioned in Sec. II of the book). In 1910, the Russian inventor S. Lifshitz reported work on sound recording by means of slits in cine film, corresponding in form to transverse photographic sound records. Sound reproduction was by means of an air jet, blowing through the soundtrack of the moving film.

Only after the advent of amplifiers and photoelements were sound movies produced on a good technical basis. In 1914-1916 Mikhali worked and produced practical sound record with simultaneous cine exposure, employing amplifying devices for this. On the 7th of June 1916 he demonstrated an 8-meter cine picture in which, on a single film, records were made of the sound and of the image. For the reproduction of the sound track Mikhali used selenium which changed resistance under the influence of the incident light.

In 1922, J. Engl, J. Massole, and H. Vogt completed development of a system for recording and reproducing sound on cine film, employing for this the current type of electrical apparatus and photoelements. They invented and used a new type of vapor lamp, special microphones and equipment for amplifying the microphone current. Reproduction of sound was accomplished by means of photoelements, amplifiers and loud speakers.

Successful projection of films photographed in accordance with the Tri Ergon system, forced much more energetic work in the development of sound movies. In 1926 related work in this field was begun by the Soviet inventors A. Shorin, P. Tager and V. Okhotnikov. For the modulation of light A. Shorin used a ribbon oscillograph, introducing a type of string galvanometer. P. Tager in 1926-29 made a system of sound cinematography in which the light modulator used a Kerr cell.

A. Shorin and P. Tager were able to se-

cure such results that exploitation of their system of photographic sound recording received industrial distribution and became the basis on which the techniques of the Soviet sound movies were developed. In March 1927 the P. Tager group showed their sound equipment for the first time. In March of 1928 in Moscow there was a public showing of sound reproduction with film, for which the sound was recorded by the Tager method.

In the same year in September in Leningrad, the first test occurred of apparatus developed under the leadership of A. Shorin.

In 1929-30 a Soviet sound cine theater was opened in which the equipment developed by A. Shorin and P. Tager was installed.

In 1930 the first experimental program of sound films was issued, recorded by the method of Shorin (Director A Room). The first full length artistic film (*Pass to Life*—Director N. Ekk) with its soundtrack recorded by P. Tager's method, appeared in 1931.

In the capacity of light modulators for sound recording on cine films, another Soviet inventor, V. Okhotnikov, used an incandescent lamp with very thin filament, powered by current at sound frequencies. Several Soviet sound films were recorded in the early period by this method. V. Okhotnikov used another light modulator—a steel coil spring oscillating under the influence of sound frequency currents flowing through coils.

In 1929 the Western Electric Co. developed the light modulator called "light valve" widely and currently used in the USA cine studios, the basic part of which was a wire ribbon in the shape of a loop, located in the field of a magnet. In 1934 Dimmick reported designs of a mirror galvanometer used as a modulator of light and of other equipment for recording sound in the USA.

Over the past 30 years there has been a decrease in the amount of work of inventors in connection with the construction of new systems of sound cinematography. The basic attention is directed toward continuous improvement of types cine sound equipment.

For exposure of sound films, it was necessary to carry out a great amount of scientific research, engineering, designing and organizing work. It was necessary to develop special kinds of cine films, to design optical equipment, amplifiers, photoelements, loud speakers, microphones, equipment for recording and other apparatus. Photographic processing and making of prints was complicated in comparison with the similar processes of silent cinematography and necessarily required new machines and equipment. For sound theaters, complicated projection and amplifying equipment was needed.

For 35 years the development of the techniques of sound cinematography proceeded at a great rate. It is necessary to set out three basic problems; the solution of which characterizes the development: elimination of noise during the recording and reproduction of sound, naturalness of sound reproduction, and the battle with distortion.

A basic problem appeared to be the battle with noise. During the recording of



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sound in cine studios exterior noise penetrated. It was necessary to develop rooms with acoustic isolation by means of special materials with special construction of walls, floors and ceilings. Noise of cameras made impossible simultaneous sound and picture exposures, particularly for heavy duty types, when they were required close to the microphone. At first equipment was installed in an absorbent housing, but there were difficulties in this method. Then cameras with noiseless mechanisms were developed for synchronous exposures.

Apparatus with arc lamps, used in silent movies for set illumination, produced noise which prevented their use in sound recording. This was eliminated by means of equipment for smoothing out the fluctuations of the direct current, of the power supply for the lighting equipment. Noiseless equipment was constructed for incandescent lamps up to a power of 10 kW and greater.

Noise from cine film appeared a great obstacle to the projection of sound pictures, but it was considerably reduced when noise reduction equipment was used in sound recording apparatus.

Noise from photoelements greatly interfered with the reproduction of sound, but reduction of it was possible only as result of construction of new types of these units. The range of the battle was extended to the characteristic noise of the amplifier designs.

Modulation of light carried out in the recording of sound and the emulsion of cine films, at first limited the upper boundary of sound recorded frequencies to 5000 to 6000 cycles. Improvement of these characteristics permitted raising this boundary to 8000 to 9000 cycles. As a result of much work, mi-

crophones and loud speakers were constructed which permitted recording and reproduction of the necessary frequency range.

To replace hand regulation of control of sound volume, compression of the sound range accomplished automatically was introduced. Use of re-recording of sound permitted recordings in various types of track to be changed into the one of needed type.

Microphone amplifiers, light modulators, photoelements and loud speakers were the cause of major defects in the early period of sound movies. These elements underwent important changes and as a result reached such a stage of perfection that they do not appear an obstruction to the further improvement of quality of the sound of cine films.

Possibly the cine film remains one of the chief sources of defects in the current technology of sound movies. Continuous improvement of its photographic characteristics and also of the methods of release printing copies nevertheless contributed to significant reduction of distortion in photographic sound tracks.

In 1920 V. Kovalinkov first proposed fine steel wire embedded in the cine film as the carrier of sound. This idea was not used on account of the low quality of magnetic sound records. In 1945-50 work increased, providing rapid progress in cine production with magnetic sound records.

In accord with the necessity to use photographic soundtracks for distribution on 35mm films, reduction of the frame was necessary, which, of course, showed up in the quality of photography of the pictures. Desiring to eliminate this disadvantage,

Chretien (France) in 1927 suggested production of cine films with the aid of an anamorphic optics. Placed in front of the lines, it permitted compression of the horizontal image photographed in the frame of the object, leaving space on the film for the sound track (Fig. IX-34a). In the USSR P. Taber proposed photography on 35mm cine film with a horizontal frame, not vertical, as is the customary arrangement (Fig. IX-34b). In connection with the increase of area of the frame in this case placing the sound record on the film did not change the images for the worse. These suggestions were not exploited in practice, and in 1932 a new dimension for the frame was standardized—16×22mm in size in place of the 18×24mm of 35mm silent cinematography.

Taking into account all the many requirements of image quality, attention was turned to this—that on account of the difference of height of the negative and positive perforations of cine film, it is impossible to fill the perforations by teeth in a series of processes using registration pins (c.f. Chapter V). Accordingly, one does not always secure extremely steady frames during projection.

A question arises about a changeover to one perforation for negative and positive films. Such a perforation could be the perforation on positive film. This question was solved in 1938 in Budapest at the Conference of the Technical Committee for Cinematography of the International Organization for Standardization (ISO).

In succeeding years, the question of introduction of a single (positive) perforation was considered in International Congresses of ISO in 1952, 1955 and 1958. Finally, at the insistence of the Delegates of the USSR and Czechoslovakian Technical Committee, ISO adopted a resolution to consider the positive perforation preferable to the negative—applicable in future positive changes.

Narrow films, with widths less than 33mm, were used already in the early development of cinematography. In the 20's in connection with the development of amateur cine interest arose in these again. The firm Pathe released 9.5mm film with a frame 6.5×8.5mm. The perforations on it were placed between the frames, which used nearly all of its width (Fig. IX-35a). The firm Kodak (USA) introduced 16mm film in 1923. In 1923-24 Pathe and Eastman Kodak entered into negotiations with the aim of eliminating differences of format of narrow films which accomplished nothing.

Currently 16mm film distribution is much greater than 9.5mm which is used to some extent in France and Germany.

Special features of narrow film cinematography were developed in 1926-27. In 1926 the firm Pathe introduced 17.5mm film on which in 1932-33 photographic soundtracks were produced (Fig. IX-35b). Currently this film has limited use in France.

In connection with the development of sound pictures on 16mm film one row of perforations was eliminated and the sound track was placed in this area. Beginning in 1932, such cine films were produced for general exhibition in all the world.

In the middle of 1932 the Kodak Co. reported introduction of its contemporary narrow cine film, of 8mm width.

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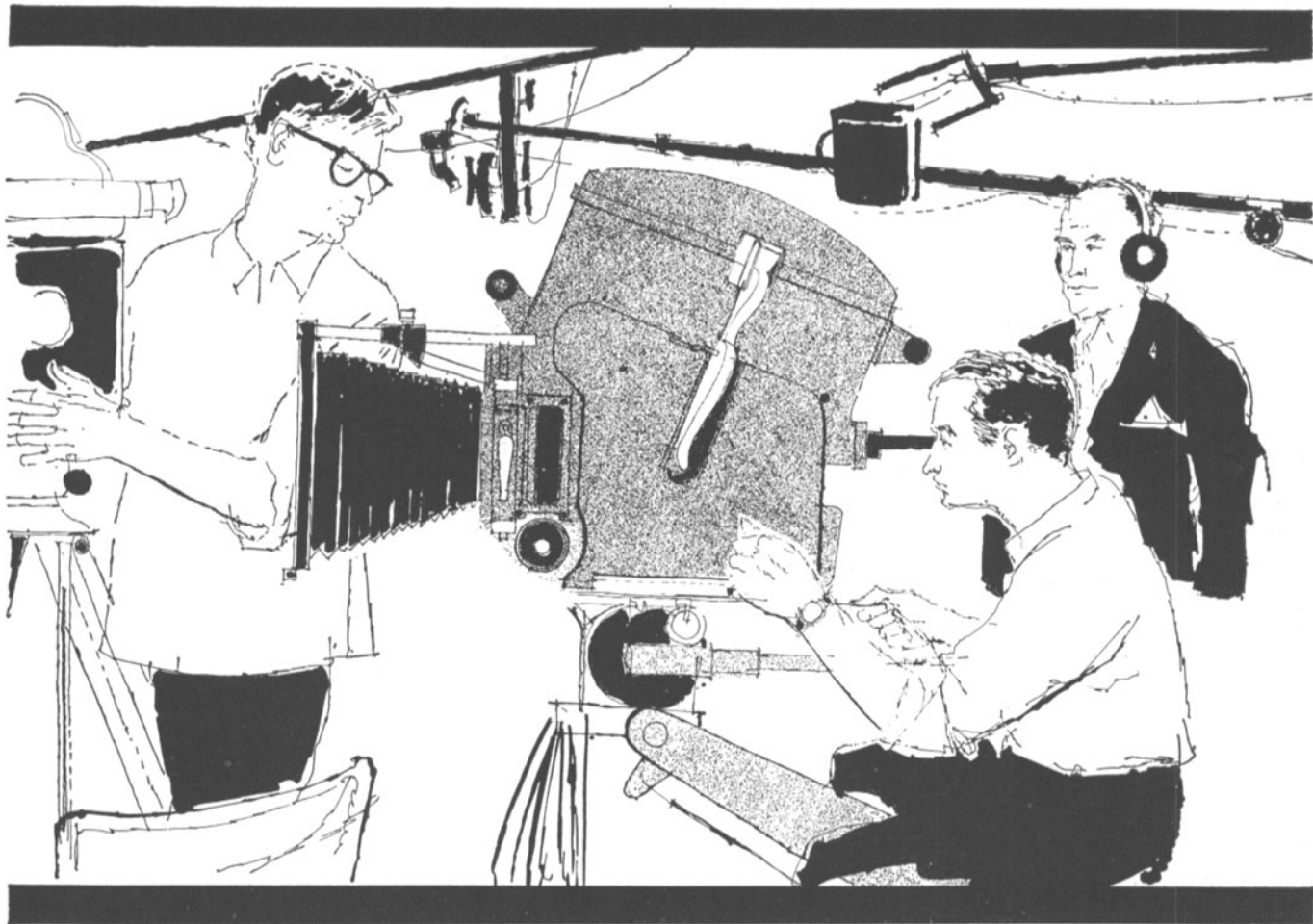
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in December 1897 and was concerned with the additive process. In 1898 Friese-Greene likewise described an additive process in which a rotating shutter was used, the blades of which carried three light filters. In 1900 he patented a projector for this method.

In 1906 G. A. Smith developed a two-color additive method; Kinemacolor, in which the shutters of the camera and projection equipment had red and green light filters. This method was exploited in the years, 1907-1913.

In a span of more than 20 years two color additive processes were produced by inventors of many countries—Anoshchenko (USSR, 1929), DuPont (France, 1925) and others. In 1939-1945 this method was used in the USA for release of a great number of war training pictures (Thomascolor Method).

Deficiencies of two colors for reproducing the colors of nature stimulated much work toward creation of a three color additive process of color cinematography. From these attempts certain work must be mentioned that conducted in Russia by the firm Biokhim, according to the Russian patent (inventors Maksimovich and Prokudin-Gorskii) during the years 1910-1914; the three color additive method of the French firm Gaumont (1912) and the realization of the method "Francita" (1928) with which certain feature pictures were made—shown in the years 1932-37.

Already in 1906 Yoll introduced a suggestion that printing with a matrix system absorbing dyes to give a subtractive synthesis of colors (the so-called hydrotype process) solves the problems of color cinematography. In 1915 the Technicolor firm was organized which, following a series of investigations, in 1928 introduced a two-color hydrotype method, and in 1933 the existing and current three-color hydrotype process. In the USSR in 1929 investigations were conducted in the region of subtractive methods of producing color movies. As a result, two- and three-color methods were developed and a native hydrotype method was devised for production of color movies.

The processes of exposure and especially the production of film prints are complicated in the hydrotype method of color cinematography. Therefore much work was directed to methods which transferred the problems of the color process to cine film factories, leaving technology of production to resources like those for black-and-white films.

In a basic idea, put forward already in 1908 by Berthon a lenticular film was used, "Agfacolor" (old) and "Kodacolor," the base of which had a lenticular raster. The use of lenticulated cine film, is currently limited on account of difficulties, inherent to this additive process.

Multiplication of emulsion layers on cine films created a great many possibilities for solution of the problems of color cinematography. Thanks to work started in the 30's, a series of multilayer color films were created by Kodak and others which are basic in the current system for production of color movies in all the world.