ABSTRACTS OF PAPERS OF THE SPRING CONVENTION

AT

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The Papers Committee submits for the consideration of the membership the following abstracts of papers to be presented at the Spring Convention. It is hoped that the publication of these abstracts will encourage attendance at the meeting and facilitate discussion. The papers presented at Conventions constitute the bulk of the material published in the Journal. The abstracts may therefore be used as convenient reference until the papers are published.

Five New Models of 16-Mm Sound Kodascopes; W. E. Merriman, *Eastman Kodak Co.*, Rochester, N. Y.

A new line of Eastman 16-mm sound projectors identified by the model numbers *F, FB, FB-25, FS-10,* and *FB-40* will be described. The picture mechanisms and sound-heads of all models are identical. The difference among the models lies in the finish, the carrying cases, the power output of the amplifier, and the speaker equipment. The first three models will operate on alternating or direct current; the last two are for 50–60-cycle duty. Some of the standard features of these projectors are a 750-watt projection lamp and a 2-inch projection lens of $f/1.6$ aperture. There is a focus adjustment on the scanning optics to permit satisfactory reproduction from either reversed negative or positive contact prints. A carefully designed rotary stabilizer is common to all models. A rotary snap switch, which turns on the pilot light, motor, and projection lamp in the proper sequence, is also standard equipment.

Air-Conditioning Safety Device for Theaters; E. R. Morin, *Connecticut State Police*, Hartford, Conn.

A new fire damper release and method of preventing smoke from being recirculated or pumped into a theater auditorium through the air-conditioning system in the absence of heat or flame has just been developed by the Motion Picture Division of the Connecticut State Police, and will be described in the paper.

Some Properties of Polished Glass Surfaces; F. Jones, *Bausch & Lomb Optical Co.*, Rochester, N. Y.

A discussion of work done at Mellon Institute as the Bausch & Lomb Fellow on the investigation of the durability of polished glass surfaces exposed to ordinary atmospheric attack; efforts to perfect accelerated tests so as to permit rapid determination of the durability characteristics of different kinds of glass; the application of this phenomenon to increasing light transmission; and to the artificial stabilization of surfaces on glass normally not very durable.

Improvements in Methods of Surface Treatment of Lenses; W. C. Miller, *Vard Mechanical Laboratories*, Pasadena, Calif.

As early as 1892 it was known that the reflectivity of polished glass surfaces was reduced and the light transmission increased when a suitable thin film was present on the surface of the glass. Many efforts to produce such a thin film artificially met with only partial success. In the last five years two different methods were discovered which achieved the desired results. Only one of the processes, however, was satisfactory for commercial application. Great improvements have been made in the durability and weather resistance of the thin films deposited on the lens surfaces by this process. Lenses coated with these improved methods require no more careful handling than any good lens is entitled to, and fingerprints and dust can be removed without detrimental effects to the coating. The thin films can not be scratched with anything less hard than a metal point. By this process reflectivity can be reduced from 5 per cent for untreated polished surfaces to as low as 0.5 per cent for treated ones. Experiments show that even greater reductions are possible and should be available in the near future.

New and Old Aspects of the Origins of 96-Cycle Distortion; J. O. Baker, *RCA Manufacturing Co.*, Camden, N. J., and R. O. Drew, Indianapolis, Ind.

The work of previous investigations is reviewed and correlated with the results obtained in a comprehensive study of 96-cycle distortion due to the presence of sprocket-holes adjacent to the sound-track.

This distortion has been known for some time. Much improvement has been made by the adoption of the magnetic-drive recorder, the non-slip printer, and the rotary stabilizer sound-head for the purpose of overcoming the problem of slippage.

Recording of sound on doubly perforated film will introduce 96-cycle disturbances of both amplitude and frequency modulation because of the film flexure and possible variations of film speed at the sprocket-hole rate.

Processing of sound records on doubly perforated film will introduce a 96-cycle hum and amplitude modulation depending upon the processing technic.

Printing of sound records on doubly perforated film introduces 96-cycle hum and disturbances of both amplitude and frequency modulation, due to film flexure and variations of film speed at sprocket-hole rate.

Reproducing of sound records on doubly perforated film introduces 96-cycle disturbances because of film flexure.

The use of doubly perforated film for any one of the four steps of recording, printing, processing, or reproducing will result in a 96-cycle disturbance of the reproduced sound.

Since it has been proved that the presence of the sprocket-holes adjacent to the sound-track is the source of all 96-cycle distortion, and the omission of the sprocket-holes entirely eliminates this distortion, it becomes obvious that singly

perforated film should be used throughout all phases of sound recording and reproduction if complete freedom from 96-cycle distortion is to be obtained.

A substantial improvement can be realized if the singly perforated film is employed only for the original negative, master positive, and re-recorded negative, and doubly perforated film for the release prints.

The use of singly perforated film throughout all phases has a decided advantage of providing additional space, without affecting the picture dimensions for a double-width sound-track or two sound-tracks, one for control or other purposes.

An All-Purpose Sound-Track Printer; G. M. Best, *Warner Brothers-First National Studios*, Burbank, Calif.

When Warner Bros. Studio changed the type of recording from variable-density to ultraviolet variable-area several years ago, existing printers were unable to handle more than one type of printing on a production basis. Hence, certain printers had to be set aside for variable-density printing only, to take care of the sound-effects library; others for ultraviolet printing only; and one was segregated for white-light and blue-light printing of fine-grain duplicating negatives and positives. As all these printers were from twelve to seventeen years old, they were not capable of producing prints completely free from weave or slippage, so under the supervision of A. J. Tondreau, head of the camera and laboratory repair shop at the Studio, a completely new printer was designed and built to handle all sound-track printing, both for the studio and release printing.

Incorporated in one printing head is a novel, non-slip film movement, a selection of filters for ultraviolet or fine-grain negative printing at the turning of a dial, accurate regulation of light over a scale nearly three times as broad as previous printers, and equipment for variable-density printing. Negative and positive weave is limited to ± 0.001 inch, the negative setting being adjustable to take care of negative shrinkage. Operating at nearly twice the speed of previous printers, four of the new machines provide adequate service with ten companies shooting and three or more pictures in the dubbing and release stages.

Some Equipment Problems of the Direct 16-Mm Producer; Loyd Thompson, *The Calvin Co.*, Kansas City, Mo.

The increased use of direct 16-mm production for industrial and educational use has caused a need for more and better equipment. A great deal of the 16-mm equipment on the open market has been designed for amateur use. Most of this equipment gives perfectly satisfactory service even when used for industrial purposes. However, much of it could be redesigned and built better so that it would stand up under hard use and would also allow the user to work faster and easier. A limited survey was made among the 16-mm film producers to find what was most wanted in 16-mm equipment and film. Some suggestions are made for improvements in film stocks, cameras, and sound-recording and projection equipment. Improvements are also suggested for 16-mm laboratory service.

Some Recent Advances in the Photographic Process; C. E. K. Mees, *Eastman Kodak Company*, Rochester, N. Y.

A popular discussion of recent advances in our knowledge of what happens when photographic materials are exposed and developed.

The Stereophonic Sound-Film System—General Theory; Harvey Fletcher, *Bell Telephone Laboratories*, New York, N. Y.

The general requirements are discussed for an ideal recording-reproducing system as determined by the characteristics of hearing of a typical group of persons listening in a typical concert hall or theater. Quantitative values are set down as ideal objectives. Although microphones, loud speakers, and amplifiers which had been developed for the stereophonic transmission system were available for meeting these objectives, no recording medium was known which would record the wide dynamic range of intensity levels which the objectives indicated was necessary. However, this wide intensity range objective was met by using a compandor in the electrical system. A general discussion is given of the reasons for choosing the particular compandor used, for using variable-area rather than variable-density on the recorded film, for using three instead of a greater or lesser number of channels. A general description of the stereophonic sound-film system is given, including the enhancement feature. This feature makes it possible to re-record from the original recording, at the same time making any desirable changes in the dynamic range or frequency response in each of the three channels.

Mechanical and Optical Equipment for the Stereophonic Sound-Film System; E. C. Wente, R. Biddulph, L. A. Elmer, and A. B. Anderson, *Bell Telephone Laboratories*, New York, N. Y.

The same mechanism is employed for propelling the film in both recording and reproducing. To permit recording of the longer orchestral selections without interruption, the machines are designed to handle film in 2000-ft lengths. Special features of the film-propulsion system for obtaining great uniformity of speed at the translation points are described. The three signal and one control-channel currents are recorded by means of light-valves of identical construction. All four tracks are exposed while the film is passing over a free-running supporting roller, mounted on the same shaft with a new type of internally damped impedance roller. In reproduction, each track is exposed through an objective of high aperture to light from an incandescent source. After passing through the film, the light from each track is carried by a glass rod to a photoelectric cell.

The Stereophonic Sound-Film System—Pre- and Post-Equalization of Compandor Systems; J. C. Steinberg, *Bell Telephone Laboratories*, New York, N. Y.

In order best to fit the volume range of the program material into the volume range available in sound-film, it is generally advantageous to pre-equalize the program material before recording, and to compensate for the equalization by means of a complementary post-equalizer on reproduction. The type and amount of pre-equalization depends upon the properties of hearing and on the characteristics of the program material and the film noise. This paper discusses the relations between these quantities for systems using compandors, where the film noise varies up and down in level as the compandor gains vary. Ideally, different types of pre-equalization are needed for different types of program material, and a compromise must be made if a single type is to be used. The considerations leading to the choice of the pre-equalization used in the stereophonic recording and reproducing system are discussed.

Electrical Equipment for the Stereophonic Sound-Film System; W. B. Snow and A. R. Soffel, *Bell Telephone Laboratories*, New York, N. Y.

An electrical system is described which permits the use of sound-film, with its limited signal-to-noise ratio, as a recording medium for wide-range stereophonic reproduction of symphonic music. Noise reduction is accomplished both by pre-equalization, rising to 18 db above 8000 cycles, and by automatic signal compression and expansion of 30 db.

To secure maximum suppression of noise and freedom from distortion, a pilot-operated, flat-top compandor system was selected. In each channel low-level signals are recorded on a separate track with constant gain 30 db above normal, which places them above the film noise. Higher-level signals cause automatic gain reductions and are recorded at substantially full modulation. These signals vary the intensity of a pilot tone, which in turn controls the compressor gain. There is a pilot frequency for each of the three channels, and the three are combined and recorded together on the fourth film-track. During reproduction they are separated by filters, and operate expandors which restore the signals to their original forms but reduce the noise to inaudible levels.

The compressor and expandor gains are made proportional to pilot level in db, and the expandor range over which this relation holds is 45 db. Therefore a 15-db variation in average pilot level during reproduction causes a corresponding average level change but no distortion. This is used to allow expansion of the original signal intensity range during recording or re-recording by simple gain controls in the pilot circuits.

The paper describes the apparatus and circuits developed to accomplish these results, and discusses the frequency, load, distortion, noise, and dynamic characteristics of both constant and variable-gain elements. Also included are considerations of microphone and loud speaker arrangement and equalization to secure high fidelity of reproduction.

A Light-Valve for the Stereophonic Sound-Film System; E. C. Wente, R. Biddulph, *Bell Telephone Laboratories*, New York, N. Y.

This paper describes a light-valve incorporating large electromagnetic damping and operating directly through the ribbon resonance region. Resonance response is only 5 db above low-frequency response and so permits easy equalization. A suitable equalizer provides uniform string displacement per unit driving voltage over the band 30–14,000 cycles with very nearly constant phase-shift per cycle. Problems of structure and size have furnished a mechanical design having several interesting features, among which are mechanical robustness, protection against dirt and moisture, built-in ribbon and optical adjustments, and an optical system integral with the valve structure, thus permitting rapid replacement of valves in the recording machine. This unit has proved a rugged, stable, light-modulator especially free from intermodulation products.

Internally Damped Rollers; E. C. Wente and A. H. Müller, *Bell Telephone Laboratories*, New York, N. Y.

Special damping rollers, capable of damping oscillations of rotating shafts without adding a steady load, were first devised by Prof. H. A. Rowland. These rollers had either an annular channel along the periphery filled with a liquid, or a wheel mounted loosely on a shaft co-axially fixed in an outer shell, the interspace

being filled with a liquid. The theory of the action of such rollers in reducing fluctuations in the speed of rotation caused by disturbances from either the load or the driving side is developed and the results are illustrated by graphs. A new form of roller is described in which liquid filling an annular channel within the shell of the roller is coupled to the shell by a mechanical resistance.

A Non-Cinching Film Rewind Machine; L. A. Elmer, *Bell Telephone Laboratories*, New York, N. Y.

Cinching, or the sliding between layers of film within a reel, produces scratches and surface abrasions which increase the film noise level. Cinching is more likely to occur in rewinding than anywhere else in the normal usage of sound-film. At the beginning of rewinding, when the supply reel is full and the take-up reel is empty, a small amount of torque is needed for rotating the take-up reel. Under this condition the film will be wound rather loosely. When the supply reel is nearly empty, relatively high film tension is required to produce a given torque on the supply reel. The torque to be applied to the take-up reel will then be high, on account of both the high film tension and the large radius arm of the film spiral on the reel. This high torque is almost certain to cause cinching in the loosely wound bottom portion of the reel. The conditions to be satisfied, if cinching is to be avoided, are analyzed. A power-driven rewind is described which meets these requirements. The film tension is controlled by the weight of the film on the supply reel at all times during the rewind.

Some Theoretical Considerations in the Design of Sprockets for Continuous Film Movement; J. S. Chandler, *Eastman Kodak Co.*, Rochester, N. Y.

After a brief introduction into the subject, the paper gives a discussion of the steps of sprocket design with the ultimate aim of keeping the flutter to a minimum.

First the selection of the proper sprocket-tooth pitch is considered, then the steps required in arriving at the proper basic tooth profile and finally the modified tooth profile are illustrated by an example.

Curves of theoretical flutter *versus* per cent of film shrinkage are given for several cases for a 24-tooth sprocket. The effect of number of teeth is also shown by curves.

An analysis of film and friction forces gives a clue to proper film guide design.

A word about sprocket-tooth shapers and results obtained from an experimental sprocket conclude the paper.

The degree of accuracy and the directness of the method, as well as the resulting optimum performance, are noteworthy.

The Subjective Sharpness of Simulated Television Images; M. W. Baldwin, Jr., *Bell Telephone Laboratories*, New York, N. Y.

Small-size motion pictures, projected out of focus in simulation of the images reproduced by home television receivers, are used in a statistical study of the appreciation of sharpness. Sharpness, in the subjective sense, is found to increase more and more slowly as the physical resolution of the image is increased. Images of present television grade are shown to be within a region of diminishing return with respect to resolution. Equality of horizontal and vertical resolutions is

found to be a very uncritical requirement on the sharpness of an image, especially of a fairly sharp one.

Development and Current Uses of the Acoustic Envelope; H. Burris-Meyer, *Stevens Institute of Technology*, Hoboken, N. J.

The acoustic envelope was developed in August of last year for Paul Robeson. Its purpose was to produce on the concert stage a zone in which acoustic conditions would approximate those of a small, highly reverberant studio. Such conditions were considered desirable since in them the artist hears himself easily and makes no unusual effort to project. The lack of such conditions, usually the case in the concert hall, may lead to tension and the technical faults incident thereto.

The technic consists in reproducing in the restricted zone the significant harmonics of the voice or instrument. The area within which the harmonics are audible must be limited since, for concert use, it is generally requisite that the audience hear nothing emanating from an electronic device. The technic has been employed by Mr. Robeson in all his concerts this season, in halls of widely varying acoustic characteristics, accompanied by piano and by full symphony orchestra. It has also been employed experimentally with full orchestra and settings on the stage of the Metropolitan Opera House; for a violin soloist with piano accompaniment; and for choruses of over one hundred voices. It can be used without affecting radio pick-up.

Notes on the Mechanism of Disk Recording and Playback; O. Kornei, *The Brush Development Company*, Cleveland, Ohio.

A theory is developed to explain the well-known amplitude losses, in particular of the upper frequency range, occurring in the transcription of lateral-cut sound recordings. These losses may be attributed to two different causes, one based upon the recording, and the other upon the playback process.

The recording loss is due to the effect of the mechanical load imposed by the record material upon the cutting stylus. The influence of this cutting load upon the cutter performance is discussed briefly, the experimental determination of the load is described, and an empirical law for it is established.

The playback, or translation loss, is caused by the elastic deformation of the sound groove under the influence of the static and dynamic pick-up stylus forces. The resulting deviation of the stylus excursion from the actually recorded value is, according to the theory, equal to the difference between the lateral components of the elastic deformations at the convex wall and the concave wall of the record groove and can be calculated. The playback loss may be positive, zero, or even negative, depending upon the conditions. The theory is set forth, its limitations and accuracy are discussed, and experiments for its verification are described. Calculated curves are shown for the translation losses to be expected under various conditions.

Certain general conclusions are derived with a particular view to proposed construction principles for pick-ups with reduced translation loss.

In contradistinction to an ideal pick-up with infinitely small vertical force and stylus impedance, the conditions in a practical pick-up with finite vertical force are found to call for a certain definite stylus mass and a low resonance frequency in order to counteract the playback loss effectively. The necessary stylus mass is

found to increase with the vertical pick-up force and stylus radius and to decrease with the record velocity.

It is shown that in systems with constant record groove velocity, perfect elimination of the translation loss is possible. In other systems, the loss can not be avoided completely but may be reduced, and the absolute level of the high-frequency reproduction may be raised.

Analytic Treatment of Tracking Error and Notes on Optimal Pick-Up Design; H. G. Baerwald, *Brush Development Co.*, Cleveland, Ohio.

A complete analysis is given of a class of distortions arising in the reproduction of lateral-cut disk recordings. These are due to the varying angular deviation between the direction of the pivotal axis of the pick-up stylus and the groove tangent, commonly referred to as "tracking error."

As long as the overall distortion present in the reproduction is moderate, the system is "almost linear," and it is permissible to superpose the different components of distortion. This permits separate treatment of the tracking error distortions.

In the simple case of a sinusoidal signal, the complete Fourier spectrum of the pick-up signal is obtained. For general signals, an explicit analytical expansion is obtained for the picked-up signal.

The kinematical effect of the tracking error is an alternating advance and delay of the picked-up signal with respect to the recorded one. The harmonic distortions may thus be characterized as side-bands of phase modulation of the signal by itself. Compared with the ordinary type of non-linear distortion as, *e. g.*, met in tubes, which can be correspondingly characterized as amplified automodulation, the spectral distribution of the tracking error distortions is different by emphasis on the higher frequency components. For the second-order distortion, which is the prevalent type, this emphasis is proportional to frequency.

The analysis shows that the distortions due to tracking error are considerably greater than commonly assumed, regarding both their absolute and their nuisance value. Some values given in the literature are more than 50 per cent too small, due to the omission of rigorous procedure. The recording characteristic does not affect the relation between ordinary type and tracking distortions. The distortion is given approximately by the weighted tracking error which is inversely proportional to the groove radius, and is referred to the mean groove radius of the record.

The pick-up design should reduce the weighted tracking error as much as possible. The optimal design is uniquely determined as soon as the type of approximation is prescribed. It is argued that the Tschebychew approximation, which is commonly used in the design of electric wave-filters, is also adequate for the present case. For pick-ups without offset angle, only second-order approximation is possible, while with the right value of offset angle, third-order approximation becomes possible. In the first case, sufficiently small values of distortion can barely be obtained with conventional arm lengths, and in order to avoid unnecessary distortions, the pick-up should be carefully mounted to obtain the optimal underhang. With an offset arm, distortion can easily be reduced to negligible magnitude. The right mounting is again fairly critical, while the optimal offset angle is not.

Simple design formulas of immediate applicability are developed covering the whole practical field of record sizes, speeds, and arm lengths, and the effect of deviations from the optimum designs is given. The magnitude of the centripetal effect in offset arms is also investigated.

Performance of the Visual Mechanism in the Viewing of Motion Pictures; Brian O'Brien, *Institute of Applied Optics, University of Rochester,* Rochester, N. Y.

The impression gained by an audience in viewing motion pictures depends to a considerable extent upon the performance characteristics of the human eye. The ability of the average observer to distinguish fine detail, small differences in brightness, and small differences in color bears directly upon the standards for prints and projection. These and certain other characteristics of the visual apparatus will be discussed with particular reference to the viewing of motion pictures.

The Projection Room—Its Location and Contents; J. R. Prater, *Congress Theater,* Palouse, Wash.

The location of the projection room should be governed by the following factors: (*1*) Effect on screen image of (*a*) Projection angle, (*b*) Projection distance, (*c*) Light-beam clearance; (*2*) Accessibility; (*3*) Fire Hazard; (*4*) Heating and ventilating; (*5*) Plumbing; (*6*) Noise isolation; (*7*) Additional space immediately adjoining.

The contents of any projection room should be limited strictly to that which is necessary to carry on the performance with safety, dependability, and excellence. Minimum requirements for projection rooms are discussed.

Projection Room Equipment Requirements; J. J. Sefing, *National Theater Supply Co.,* New York, N. Y.

Modern projection rooms should be planned to accommodate the needs and requirements of up-to-date sound and motion picture equipment. The convenience and safety of the projectionists and the public should be considered at all times. The equipment should be selected and installed that will be best suited for the needs of the theater. The lamp houses, projector bases, mechanisms, magazines, take-ups, and miscellaneous accessories should be up-to-date and efficient in order to produce a trouble-free sound and picture presentation. The projection room, rewind, motor-generator, and toilet rooms should be designed for practicability, fire-retardation, and noise absorption. The projection room layout should receive the complete approval of all Local, City, or State departments having jurisdiction before completion, and all necessary precautions should be taken to reduce hazards to a minimum. When in doubt as to specific requirements and regulations governing projection room layouts, reliable information should be obtained from sources that are thoroughly familiar with the needs of modern projection. The Society of Motion Picture Engineers' specifications cover in detail the important and desirable features required in ideal projection room layouts.