mittee that in order to enable the members who did not have the opportunity to attend this meeting and to hear all these intimate discussions to vote intelligently, the report might be somewhat elaborated, including a few of these reasons why the Committee has arrived at this decision.

MR. JONES: It seems to me that the Committee has proposed a very definite disposal of this report. As Mr. Hardy points out, the Committee is not proposing a standard to be adopted by the Society at present, but has presented the conclusions it has reached up to the present time. If I understand correctly, the Committee proposes to let the matter rest in this state until such time as it seems expedient for the Society to take a definite action and I think Mr. Hardy, after this discussion, will present further facts for the adoption of this matter. Our course is to accept the report of the Committee and to do with the report just what the Committee asks us to do. This is a tentative recommendation.

MR. SHEA: It is greatly to be hoped that at the next convention Mr. Sponable will be able to give a demonstration with his apparatus such as he gave to the members of the Standards Committee, and it is also to be hoped that Mr. Griffin will describe his projector. Until this shall have been done, discussion of details seems ineffective.

MR. GRIFFIN: The equipment will be available at the next convention if it is desired. The wide film program was started by one manufacturer and did not meet with the approval of other producers. We do not want to force the matter of standardization but we do want the producers to study the matter carefully and come to their own conclusions.

REPORT OF PROJECTION SCREENS COMMITTEE

The Projection Screens Committee commenced its operations in March. The first meeting was held on April 16th in New York, N. Y., at which the Chairman submitted a preliminary outline of the work proposed for the Committee to undertake. This outline was discussed and elaborated and as a result a second and more detailed outline was prepared and distributed among the members. The second meeting was held on May 14th. This preliminary report is based largely on material submitted and examined at that time.

The main lines of endeavor are outlined as follows: Manufacture of Screens, Mechanics, Light Reflection Properties, Sound Transmission, Illumination, and Rear Projection Screens. Responsibility for the different sections has been assumed by the members with regard to their familiarity with the different fields. Considerable data will be collected on light reflection properties, brightness values of screens in theaters, and manufacture, installation, and maintenance of screens. It is also hoped that the Committee will be able to make recommendations as to the type of screen to employ under specified conditions of use.

The following is in the nature of a preliminary report and, therefore, is not as complete and conclusive as we should like it to be. Nevertheless, it is our opinion that it offers material which the Society may find of interest at the present time and will indicate what may be looked for in our later report.

MANUFACTURE OF SCREENS

Bases.—The manufacture of sound screens is a critical undertaking in which all details must be given due consideration in order that uniformity and high quality of finished product may result. Most screens employ a fabric as a base although there are some which employ a metal. Essentially, the purpose of the fabric is to provide the necessary strength for the screen and to serve as a carrier for the light reflecting surface. Quite often the fabric is coated with a cellulose compound and the combination employed as a base. With some screens a slight translucency of the fiber from which the fabric is woven is desired. This is the case when the rear surface of the screen is colored in an attempt to impart to the reflected light a slight tone of the particular color used. It is more customary, however, to make the fabric as nearly white and opaque as possible in order to improve its light reflecting qualities.

Surface Treatment.—The base fabrics are treated in various ways to give various reflection characteristics to the screens. The surfaces are classified as matte or diffusing, beaded, or metallic, the latter two being somewhat directional in their distribution of illumination. They may be applied by a knife spreader process, by printing with rollers, or by spraying or painting. Great care must be taken to secure a uniform and sufficient thickness of coating to provide good light reflection characteristics while staying within the limits imposed by other conditions. As yet, no detailed information has been collected in regard to the materials which are commonly used for surfacing.

It is present practice to color the backs of screens for purposes of identification. As mentioned before, however, color is sometimes used with thin surface layers to provide a slightly selective reflection characteristic.

Materials for coating vary greatly in their properties. Some diffusing screens are slightly glossy and others have perfectly flat white surfaces. Flat white seems best for avoiding surface glare and undesirable reflection at the seams. Diffusing surfaces may be hard or soft, smooth or rough. A hard smooth surface without sheen is apparently desirable since it is less apt to collect dirt and is easier to clean. Beaded screens require ingredients to hold the beads firmly in place. Most surfaces are formed from pigments and gums, oils, or other binders. In general, the gums and oils cause screens to become yellow with age.

Fireproofing.—At various times there has been agitation in regard to fireproofing of screens. This situation grew out of the practice of using highly inflammable nitrocellulose bases. Screens of this type are undoubtedly fire hazards and their use has been largely discontinued. At present, practically all screens are either slow-burning or fire-resistant. They are made so by properly selecting the materials and by flame-proofing the base fabric prior to treatment of the surface. This Committee has found that it is impossible to successfully fireproof a screen after manufacture or when in place in the theater. It must be remembered that the screen is a small item in the stage equipment of a theater, that it is usually much less inflammable than the surrounding draperies, and that usually it is hung vertically and stretched tight, so that it is not likely to be the cause of fire. We know of no case in which slow-burning or fire-resistant screens have caused fires. In general, it devolves upon the exhibitor to make his choice of screens, depending on his own local ordinances and conditions. The Committee is considering a recommendation relative to the marking of all screens which have been flame-proofed so that difficulties arising in this connection may be eliminated.

Sound Requirements.—After many tests, the necessary requirements as to the ratio of open to solid space in sound screens have been determined by producers of sound equipment, and screen manufacturers have guided themselves accordingly. Screens of the perforated type in present use have a ratio of open to solid space of approximately 8 per cent; screens of the porous type have a rather larger ratio. Acoustic theory indicates a minimum of 5 per cent as desirable. Perforations generally are made after the screen is surfaced.

Seams.—In assembling screens the seams should be placed vertically. Care must be taken not to stretch the screens too tightly. Butt joints are used with some metallic and beaded screens employing cellulose coated fabric as the base but are not generally used with others.

MECHANICS

Size.—The distance between the front row of seats and the screen is one determining factor for the size. The larger the picture, the more plainly imperfections in the film, such as graininess, show up. This is very noticeable and objectionable in the nearer seats. Also, since the eye can satisfactorily accommodate itself to movement throughout a 60-degree angle, the distance between the front row and the screen should approximate 0.87 foot for each foot of screen width. For a 15-foot picture, a distance of at least 13 feet should therefore be provided.

The size of picture should be determined by its distance from the rear seats. The width of the screen should be equal to approximately one-sixth the distance from the screen to the rear seats. For a distance of 120 feet, therefore, a 20-foot picture should be used, provided there are no seats nearer the screen than 17 feet and the projection angle is not very great. These rules are intended only as guides.

The standardization of sizes is of primary importance to both manufacturer and exhibitor. Many errors are made in ordering screens because of confusion in description, resulting in considerable monetary loss. Sizes have already been standardized by several manufacturers and large users, but not always in the same way. The Committee is considering for recommendation a set of dimensions to be used as standards and sub-standards.

Mounting.—Each manufacturer should determine the best method for mounting his own screens and advise purchasers accordingly. By taking proper care in mounting the screens, damage and cost of installation can be reduced considerably. A survey of instructions sent by manufacturers may lead to general rules. These may be drawn up into a revised instruction sheet for consideration by manufacturers.

Masking.—The usual masking is black. This results in a very marked frame which reduces the effect of "jumping" of the picture caused by the film or projecting equipment. It has been felt that the resulting contrast is too great and various persons have advocated an intermediate gray. We are considering a suggestion that the mask be graded from black to lighter grays with the black edge next to the picture.

Deterioration.—All screens deteriorate with age: "silver" screens tarnish, other types become yellow. Yellowing of the surface is accompanied by a reduction in reflection value and by an undesirable color tone which is imparted to the picture. Yellowing is usually caused by gums and binders and not by the pigments. We are informed that of late there has been marked improvement in this respect.

In addition to discoloring screen, accumulated dirt also causes a deterioration of reflecting qualities. The amount of dirt collected depends on the condition of the air in the theater, the precautions used to protect the screen, and the nature of its surface. It is essential that draperies surrounding the screen be cleaned regularly and that circulation of air through the openings of the screen be prevented. If possible, it should be enclosed when not in service, even though with the cheapest kind of material. The average useful life of a sound screen varies from one to two years, depending on the conditions of use.

Cleaning.—Even with these safeguards the screen will gather dirt. An examination will indicate whether the dirt is dry or oily and, therefore, whether the screen may be brushed or not. If brushing is permissible, a long handled special brush should be obtained and the screen brushed once a week. It is also helpful to use a vacuum cleaner on the rear surface. More thorough cleaning should be done by experts who have sufficient scientific knowledge of screen materials to devise safe and suitable methods. Furthermore, certain types of screen cannot be cleaned satisfactorily at all. Each manufacturer should advise the users of his screens as to the possibilities.

Reprocessing.—Renewing of the surface of diffusing screens by spraying is receiving considerable attention. When carefully done and when the proper materials are used, completely satisfactory results seem to be attainable. The spraying pigment should be highly reflecting, should not fill up perforations, and should not become yellow with age. The screen and surroundings should be thoroughly cleaned before the processing is undertaken. Such a renewal of the surface is not feasible on all types of screens.

LIGHT REFLECTION

Total Reflection Factor.—There are several ways of defining the total reflection factor, based on the methods of test used in different laboratories. The laboratory which makes most of the commercial measurements of screen reflection characteristics employs a method in which the light is incident on the test sample from all directions within a cone of 180 degrees. The angle of observation is 12 degrees from the normal, and the light returned in this direction is taken to indicate the total reflection factor. The Committee advocates the adoption of this definition as standard.

Angular Distribution.—One of the most important attributes of a screen is its ability to reflect the incident light to the observers. Angular distribution curves in the past have been obtained with light at normal incidence. Data collected by this Committee show that the average projection angle is approximately 15 degrees, measured to the perpendicular to the screen. Therefore, we believe that measurements with light incident on the test sample 15 degrees above the normal will give information more in keeping with conditions of actual practice. The reflected light would be measured in

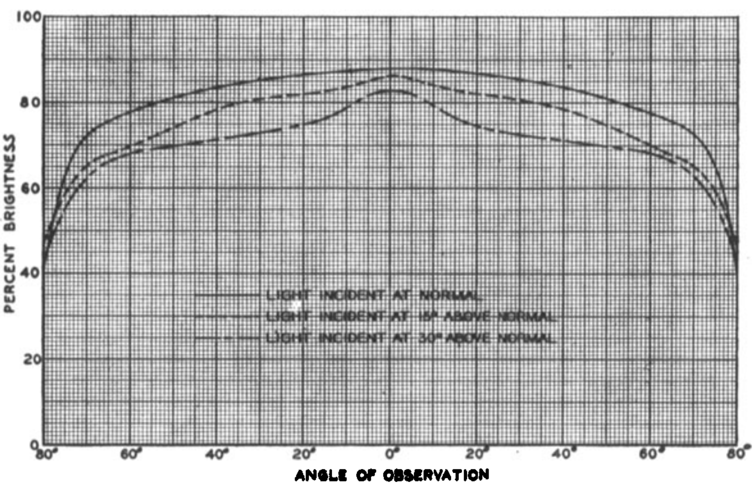

FIG. 1. Distribution of brightness in horizontal plane for diffusing screen.

a horizontal plane and in a vertical plane containing the light beam, both normal to the screen sample. A more complete discussion of this question will appear in our later report.

The accompanying curves, Figs. 1–6, illustrate the variation in distribution of light at three angles of incidence, 0, 15, and 30 degrees from the normal. It will be noted that with a smooth diffusing type of screen the difference beween measurements at zero and the other angles is appreciable but that the distribution is relatively uniform. In the horizontal plane, there is considerable diminution of reflected light and some equalization in distribution for both beaded and metallic types. In the vertical plane for a beaded screen it is a distinguishing feature that the axis moves to follow the incident light beam so that a good portion of the light is reflected back upon itself. With a metallic screen, the axis is at the specular angle. It is planned to make recommendations for the types of screen to be employed in theaters of different architectural design, as is now being done to some extent, but as yet the Committee is not ready to go on record with definite suggestions.

Variation across Screens.—Because of non-uniform light incidence over the total area of the screen and because of the non-uniform reflection characteristic, there will usually be variations of bright-

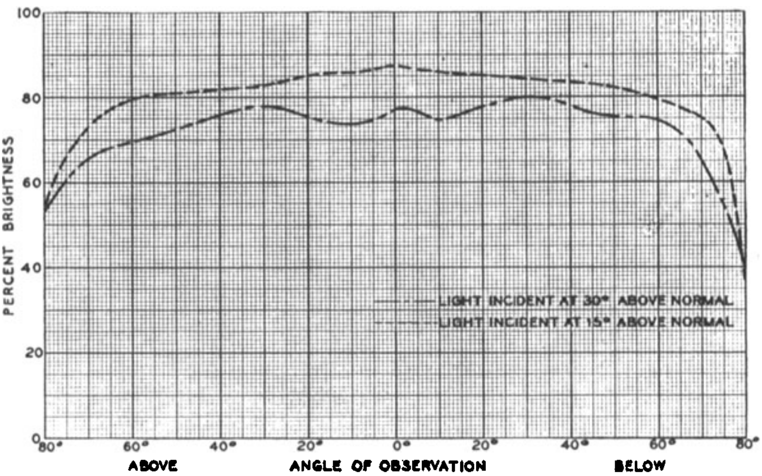

FIG. 2. Distribution of brightness in vertical plane for diffusing screen.

ness in a projected picture. All theaters are subject to this effect at the front of the house but, of course, the continuous change of intensity in the pictures reduces its noticeability. We shall propose limits for allowable brightness differences.

SOUND TRANSMISSION

Theory.—The design of screens from the standpoint of sound transmission presents problems which are simple in comparison with optical considerations. The great importance of good sound transmission characteristics should, however, be recognized. An analysis of the general problem of transmitting sound through a material such as a screen indicates several possible methods; certain practical considerations, however, limit the designer to the use of two. A screen may be expected to radiate sound as a result of being set into vibration by sound impulses emanating from the loud speaker immediately behind it, or the sound impulses may be transmitted through the air spaces in the screen material. These air spaces may simply be those due to the porosity of the material itself, but better control of the transmission characteristic may be effected by deliberately providing air passages of the proper size and number. This may be accomplished by careful weaving, punching, or other means. All commercial types of screen depend largely upon this method of transmission although many depend upon the diaphragm

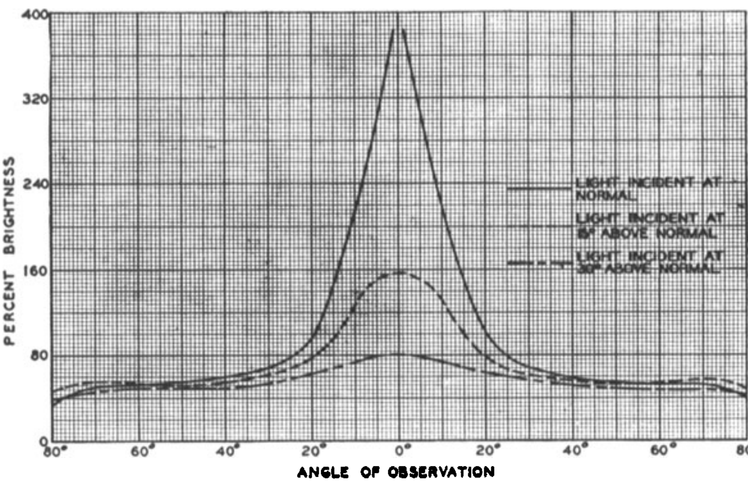

FIG. 3. Distribution of brightness in horizontal plane for beaded screen.

action of the screen to overcome a loss which may occur at low frequencies due to a decrease in the radiation resistance of the air passages in this part of the frequency range.

Because of the desirability of affecting the optical characteristics of the screen to as small an extent as possible, the perforations or air spaces in the screen are made as small as is practicable and their number is limited to the absolute minimum. Fortunately, it is possible to obtain quite satisfactory sound transmission by using rather small, widely spaced openings which, in the aggregate, offer a comparatively small total open area in the screen. It is felt that an aggregate open area amounting to 5 per cent of the total screen area may be considered tolerable from the light reflection standpoint. On this basis it is found that the sound requirements may be met without impairing the detail of the picture. The relations between the screen thickness and the size and number of the holes may be worked out rather easily by applying the known acoustical theory; an approximation will serve, however, for the practical designer. For perforated screens it has been found, in general, that if the diameter of the perforations is equal to three or four times the thickness, the aggregate area of the openings being 5 per cent of the total screen area, satisfactory results may be obtained. This applies to the usually used materials and, of course, must at present be considered true only for them. Furthermore, it applies only over a

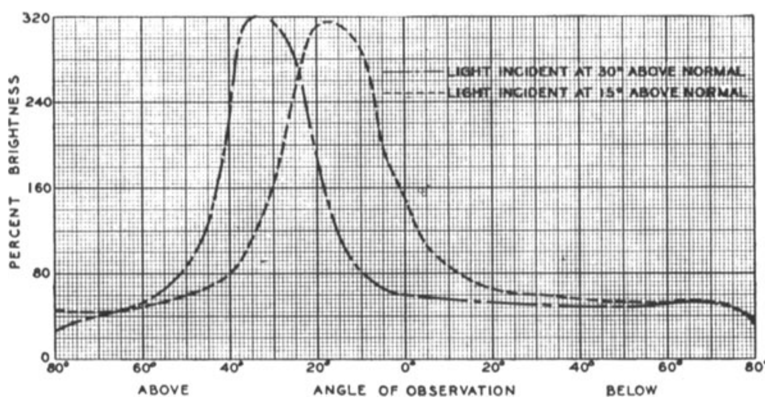

FIG. 4. Distribution of brightness in vertical plane for beaded screen.

limited range of screen thickness. This relation shows that it is desirable to keep the screen thickness at as low a value as is mechanically and optically practical.

Test.—It is the present practice to measure the sound transmission characteristics or response characteristics of each type of screen before approving it for use with sound projecting equipment. Although there are various methods by which these acoustical measurements may be made, the commonly used method involves response-frequency measurements of the output of a loud speaker with the screen placed before the speaker in its normal position and with the screen removed. In order to adhere as closely as possible to actual field conditions in making these measurements, a loud speaker of the type used in the field should be employed. Since this method of test approximates closely the theater conditions and since it includes the effect of the diaphragm action of the screen, if present, it is probably the most desirable method of making the measurements. The response measuring technic should conform with accepted loud speaker response measuring methods.

Tolerances.—There are three factors which must be determined before a proper judgment of screen performance may be made. The general loudness attenuation effect, the frequency range for sound transmission, and the regularity of frequency response all enter into the determination of the suitability of a screen from the acoustical standpoint. In general, little trouble is experienced in obtaining efficient low frequency response. Usually, however,

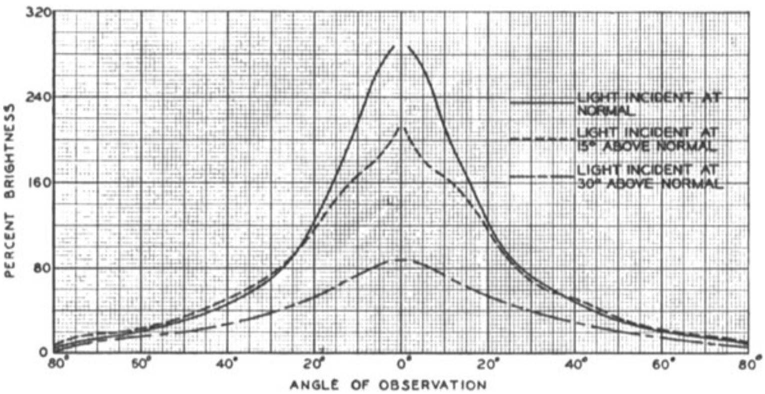

FIG. 5. Distribution of brightness in horizontal plane for metallic screen.

screens exhibit a drooping characteristic at high frequencies. Since the droop at high frequencies is usually rather gradual, no definite frequency range may be assigned to the screen response; the allowable loss at certain high frequency points relative to the 1,000-cycle response should be specified. On the whole, it must be observed that it is difficult to set absolute limits for screen response, covering all possibilities. The following have been applied successfully to the great majority of cases by the two largest manufacturers of sound equipment:

A loss of 2.5 db., as given by the average response curve, at 6,000 cycles, relative to the 1,000-cycle response, is considered a desirable limiting value for existing types of sound equipment. Screens that meet this requirement are usually found to attenuate less than 4 db. at 10,000 cycles. As to regularity of response, variations greater than ±2 db. would not be tolerable. Because of standing wave effects in the measuring room, inaccuracies of measurement may occur, causing variations somewhat greater than this below 300 cycles. It is felt that no limits for regularity should apply below this frequency. The interpretation of measurements must be left to the discretion of one closely acquainted with the measuring conditions. A general attenuation in loudness, as judged from the measured screen transmission characteristic, greater than 1 db., is not considered tolerable. Although this limit may appear rather stringent, there are many screens available which meet

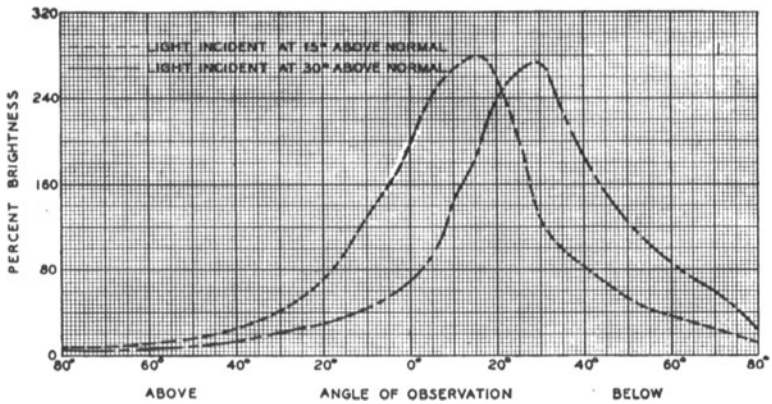

FIG. 6. Distribution of brightness in vertical plane for metallic screen.

this requirement. It seems advisable to maintain this high standard for sound transmission.

ILLUMINATION

The study of screen illumination is one of the primary aims of this Committee. We hope to determine average values of brightness encountered in theaters and to discuss these in relation to stray light, print density, and physiological factors. Also, we plan to consider and standardize methods of measuring brightness, which, at the present time, because of their lack of uniformity, render the comparison of data difficult. Some information on screen brightness has been accumulated but not sufficient for presentation at this time.

REAR PROJECTION

Rear projection is attracting wide attention at the present time in New York and promises to develop into a field of interest throughout the country. The manufacturers of this type of screen are not as yet willing to release engineering information so that we are postponing discussion of this for our later report.

S. K. WOLF, *Chairman*

D. S. DE AMICIS W. F. LITTLE
F. M. FALGE A. L. RAVEN
H. GRIFFIN C. TUTTLE
D. F. WHITING

THE HISTORICAL COMMITTEE

On account of the wide geographical distribution of the members of the Historical Committee it has not been possible to accomplish as much as was desired, but largely through the efforts of one of its members, Mr. W. Theisen, an exhibit of historical films and apparatus was arranged for the Hollywood Convention. It is the hope of the Committee that this exhibit has aroused the generosity of the members and others who have objects of historical value to the end that these objects may be placed in the hands of the Committee to be housed in fitting museum repositories where they will be available for public inspection, and accessible particularly to the interested members of the Society of Motion Picture Engineers.

Much historical data and records have been collected by the Committee and are being classified in loose-leaf binders for final museum deposition. Under this classification records are being filed, mainly according to outstanding personalities in the early days of the industry. Among these personalities are included: Georges Demeny, Wm. Kennedy Laurie Dickson, Thos. A. Edison, Wm. Friese-Green, C. Francis Jenkins, Eugene Lauste, Louis Aimé Augustin Le Prince, Auguste and Louis Lumière, Jean A. LeRoy, Ettienne-Jules Marey, Eadward Muybridge, and others.

The Historical Committee wishes to express its gratitude for the kindly and generous coöperation and contributions to its work of such men as E. Kilburn Scott, London; Will Day, London; Jean A. LeRoy, New York; Wm. Kennedy Laurie Dickson, Channel Islands; J. Tarbotton Armstrong, Museum of the University of California;