CORNING GLASS WORKS

ELECTRO-OPTICS LABORATORY

RALEIGH, NORTH CAROLINA

IMPROVED SCREEN FOR REAR PROJECTION VIEWERS

Technical Report No. - 9

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I. Theoretical Investigations (Mie Scattering)

Theoretical investigations of light scattering by particles with sizes comparable with the wavelength of illumination was concluded. Additional light scattering functions have been computed for M = .8, 1.30, and infinite, for particle sizes from α = 1, to 10 in increments of 1. We have also computed additional scattering functions for M = .9, 1.05 and 1.20 for values of α from 6 to 10 in increments of 1. Here α is the ratio of the scattering particles circumference to the wavelength of illumination, $\alpha = \pi D/\lambda$; and M is the relative index of refraction between the particle and the surrounding medium. An infinite refractive index implies metallic particles. The data has been summarized in gain vs. angle curves showing the scattering functions. Additional data processing of this data has corrected it for broading of the angular gain curves by refraction at the air-glass interface and the trapping of light by total internal reflection. The new data have also been summarized to show the gain at θ = 0 vs. particle size, efficiency vs. gain and α. We have also considered factors such as change of scattering coefficient with particle size and wavelength, which determine the color fidelity of a material.

The experimental work of phase III will utilize the results from these theoretical studies to direct specific materials investigations. In this regard we will specify parameters such as the relative index of refraction between the particles and the surrounding glass, the size and distribution of sizes of particles, their number density and the thickness of the samples.

These will be translated into glass compositions and, if necessary, subsequent heat treatments by the individual materials groups. Materials of primary interest are; a, the glass-ceramics; b, Fotoform and Fotoceram; and c, the sintered glasses. The particles of initial interest have sizes which lie between .3 and 1.0 micron and a refractive index between the particle and surrounding glass of .8, 1.20 and 1.30, i. e., as far from unity as possible using glasses but without using metallic particles. We are also concerned with limiting the range of particle sizes as particles which are too small produce undesirable Rayleigh scattering and particles which are too large produce a screen with hot spots because of too little light scattering. Number density will be chosen to produce sufficient scattering from thin samples, i. e., not more than 2 millimeters thick. This is required if these screens are to have sufficient resolution between 10 and 20 line pairs/mm. The results of these first materials investigations will then be used to direct further materials studies.

We have also investigated the feasibility of approximating the angular gain curves with an empherical equation. The preliminary results of this indicate that over the viewing angles of interest it is possible to use an equation of the form

$$\text{gain}\ (\theta) = (A\alpha + B)e^{-K\theta^2}$$

with the curve fit being good to at least the half power point, and less than 10% error out to 3 times the angle at half power. This approach is particularly useful when computing the scattering function for a distribution of particle sizes. This will also be treated in detail in the final report of phase II.

A. Other Materials and Approaches

1. A louvered screen discussed in previous technical reports and patented by A. H. J. De Lassus St. Genies[1-3] has been constructed. The screen was made by placing 13 - ¼" plates measuring 1" x 4" together as shown in Figure 1. A hole was drilled down each side and bolts were then inserted and tightened, holding the blocks firmly together.

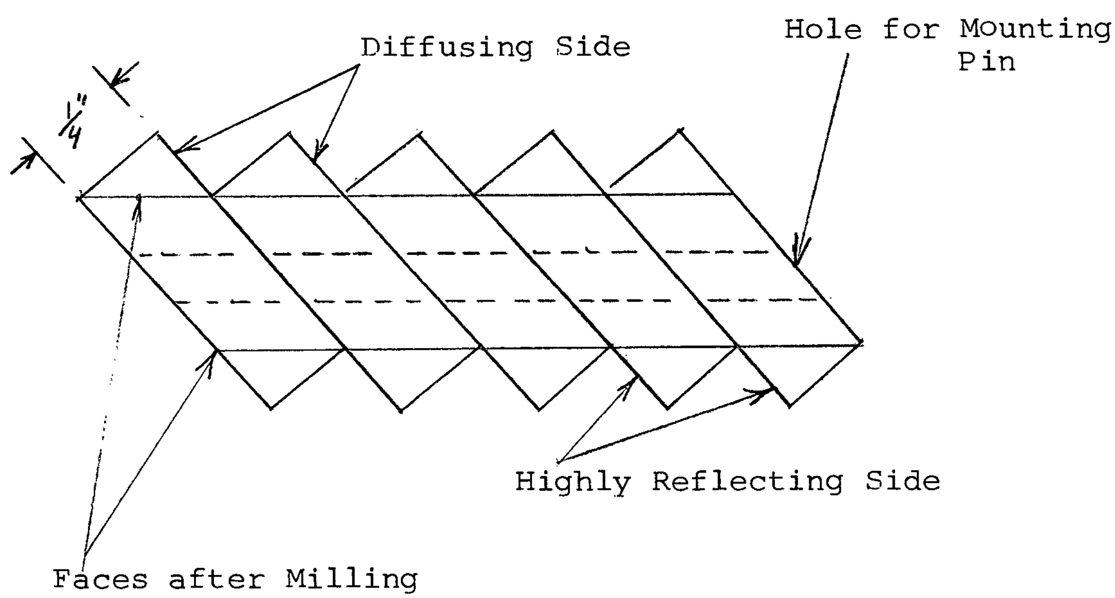

Figure 1
Construction of the Louvered Screen

The top and bottom of the stack was then machined flat to a .35" overall thickness. The two faces were then sanded and polished. Each block was then numbered and the stack disassembled. One inside face of each block was sanded so when aluminized it would be diffusely reflecting. Both faces were aluminized and the stack reassembled. The resulting screen has a usable area measuring 3 - 3/4" x 3 - 3/8". An analysis of this model will be made next period to determine what major optical problem exist when viewing this type of screen and also some of the technologies which may be of value in building practical samples.

2. Ultraviolet Sensitive Screen

There are many applications where only black and white material is to be viewed such as microfilm, maps, line drawings, and etc. For these applications it may be useful to use near ultraviolet illumination and a fluorescent screen. These screens could be coated on the projector side to pass the ultraviolet portion of the spectrum and reflect most of the visible light from the projector. A second coating under this would absorb the residual visible from the projector and the ambient light from the viewing area. A mixture of phosphors would give a white background with black lines as opposed to a blue or green background which is objectional.

Two 6" x 6" samples of a fluorescent type of glass without any coatings have been obtained. Preliminary evaluation will begin next period.

II. Instrumentation

A. Goniophotometer

The goniophotometer is being put through final testing and will be ready for use within two weeks.

B. Modulation Transfer Function Analyzer

The delivery of components for this is about 70% complete. Already certain parts of the system are together and completion is expected near May 1, 1966. The first use of the system will be in making the sine-wave resolution pattern. After this is completed these masks will be used for measuring the resolution properties of samples of rear view screen materials.

References

[redacted] "Improved Screen for Rear Projection Viewers," Technical Report No. 4, November 5, 1965. 25X1

[redacted] "Improved Screen for Rear Projection Viewers," Technical Report No. 8, March 8, 1966. 25X1

[3] A. H. J. De Lassus St. Genies, Projection Screen with Reflex Light-Transmission, U. S. Patent No. 2,931,269, April 5, 1960.

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