ANNULAR PANORAMIC PROJECTION

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A simple and unique optical technique which yields a projected 360° field perspective, is under development in the Naval Training Device Center's Physical Sciences Laboratory. This "Annular Panoramic Projection Technique" permits the presentation of panoramic scenes as either stills, movies or possibly as a TV projected picture.

The system utilizes a basic optical idea known as "the reversing principle of light" which I will describe in the following figures:

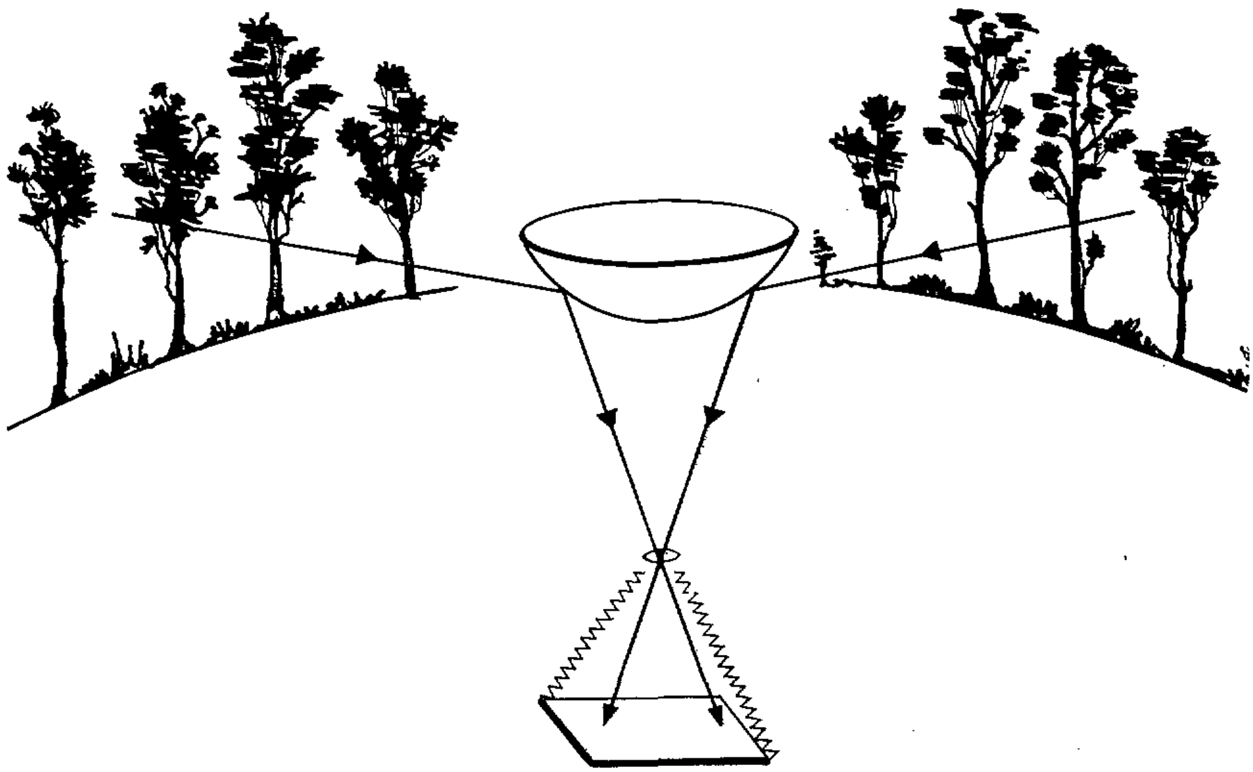

Figure 1

The 360° horizontal field, from all around the horizon, is reflected from the bottom of a hemispherical mirror, down through the camera lens and onto a film transparency.

Figure 2

The resulting picture, which appears similar to figure 2, always has the camera lens at the center of the photograph, and a distorted horizon in a doughnut shape around it.

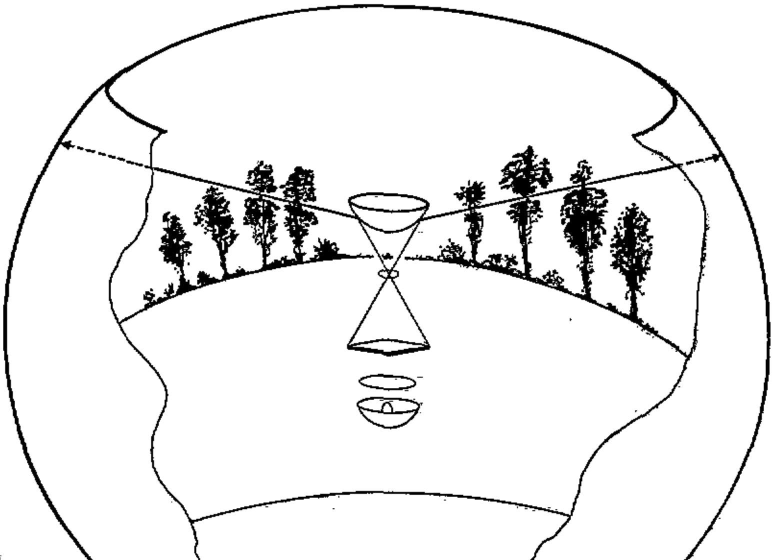

Figure 3

Figure 3 shows the camera location of figure 1 replaced with a projector and the transparency projected onto a spherical screen. If the same mirror was used for both taking and projecting, the distortions should be nullified. Several problems exist in this simple reflecting optical arrangement. First I will talk about what they are and then discuss our approach to solve them.

A major problem to be solved is: There is no "Viewer Position". A viewer would either have to look directly into the "bright shiney ball" or at his own shadow on the screen. And, from any viewing position other than near the center, distortions begin to show. Since motion picture presentation is one of our goals, there is a maximum limit to the film size. There is a minimum size because of the tremendous enlargement of subjects on the film, as they are to be spread over the entire 360^{o} screen. An extremely bright lamp must be used for the same reason.

Something that may not be very obvious is that this system will not yield a good clear picture even if a precision ground, first surface, hemispherical mirror is used. Optical problems, such as: astigmatism, spherical abberation and field curvature cause the picture to be unsharp or "fuzzy." Also, vibrations from a cooling system may help aggravate the situation.

A problem, concerned with the taking of the picture, might be: How do you support the spherical mirror above the camera if you want to take a 360^{o} picture?

Figure 4

This is a picture of the camera system, set out-of-doors. The spherical mirror is supported by an arm attached to a vertical post. On a future model, the spherical mirror could be mounted inside a clear glass ball and thereby eliminate the post. The "black can," below the spherical mirror, isn't the camera in this "set up." The camera is situated inside the sphere and is pointing downward through a hole. There is a second mirror, facing upward, inside the "black can" —which is being used for a sunshade. The reasoning for this is explained in figure 5.

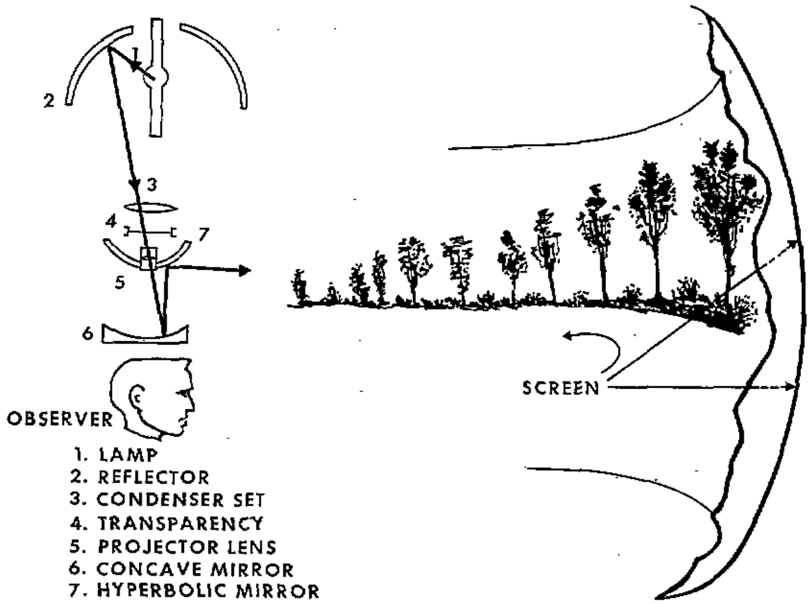

Figure 5

This is a schematic diagram of our projection system. It has a hyperbolical mirror at the center and a second mirror below. The introduction of a second mirror allows the projector to be suspended from above viewer's head. This gives a "viewing position," plus it helps to reduce the optical problems.

The beam from a bright arc lamp, item 1 above, will reflect from a hemispherical reflector, down through a condenser set and through the film transparency. A computer designed lens and mirror system, which reduces the optical problems to an acceptable level, will be employed as shown, items 5, 6, 7. The projector lens will direct the light to a lower, and slightly concave mirror. The light is then reflected up to the hyperbolic mirror and then onto a spherical screen.

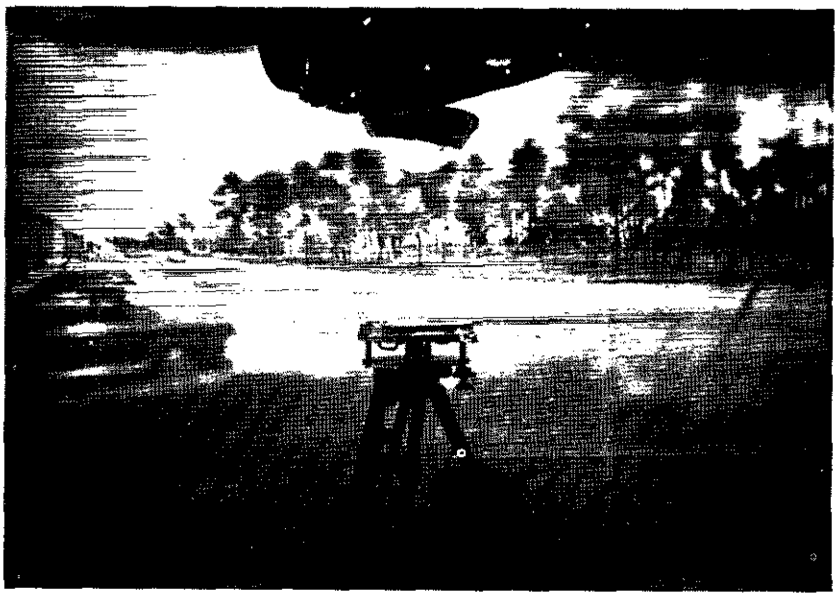

Figure 6

Figure 6 is a photograph, taken with a wide angle lens, of a portion of the projected picture. With our new computer designed lens and mirror system we expect considerable improvement in the picture quality. For this experiment we are projecting a 50mm diameter image on a 70 by 70mm slide, shot on Kodak's Panatomic -X film at F-22 for 1/25 second. The 70mm size was selected because it is the largest film available for motion pictures. The projector is an almost unaltered commercial projector which has been rigged to project downward. Several modifications have been made on the slide carrier, mainly to contain light. Inside there is a 3000-watt tungsten lamp, but only about 10% of the light is getting out. With the new design we will probably use a zenon lamp and expect a 50 to 60 percent light output. The light level on the screen in this picture runs in the neighborhood of 1-1/2 to 2 foot lamberts with our next experiment. The projection screen is a rearranged plastic planetarium dome that has been painted flat white. We are now in the process of investigating several materials that will absorb or break-up sound as well as give us a good projection surface. The following figure 7 is the transparency being projected in figure 6.

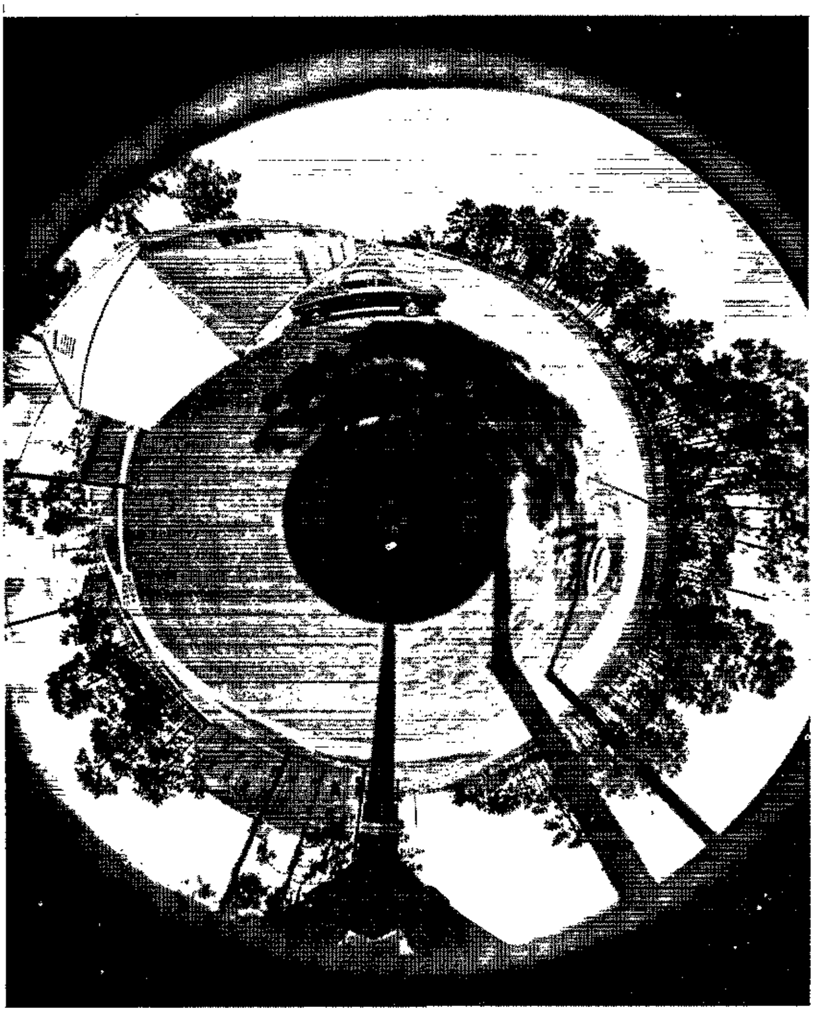

Figure 7

Something that has not been mentioned yet is the vertical angle projected. Human engineers tell us that the eyes see about 90° vertically and that the head in a normal position, tilts downward approximately 10°. Using this information, the projected picture should cover an area at least 35° above the horizontal and 55° below it. The Annular Panoramic System is being designed to cover this area.

I feel that by increasing the angular coverage of the screen both horizontally and vertically, the viewer is placed near the center of action and there he has a greater feeling of "participation." A good example of this "participation" is Fred Waller's famous gunner trainer, used during World War II, which saved an estimated 350,000 casualties. The device was used to train four men at a time and utilized an extremely wide angle movie of enemy planes. The presentation was so realistic that it would, at times, almost drive the new trainees crazy. Waller's trainer was the final step which led to Cinerama, a system with a 55° by 165° field and uses 3 projectors.