FINAL REPORT
ON AN OPTICAL INSPECTION DEVICE
FOR CURVED WINDSHIELDS

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Submitted by

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This project involved the development of a method of inspecting curved automobile windshields before lamination. Curved windshields are manufactured at the Shatterproof Glass Corporation by sagging a double layer of two pieces of plate glass into the desired curve by heating in a furnace. After cooling, a thin sheet of plastic is placed between the two curved plates, and the entire unit is placed in an autoclave where the heat and pressure bonds and seals the windshield. However, the success of this lamination depends on a good contact between the two sheets of glass after bending, but before inserting the plastic.

The previous method of testing the glasses for good contact involved observing the reflections from the windshield of a multiple line light source. If the two pieces of glass are in proper contact one sees in practice three images of each line (reflections from the inner surface, outer surface, and the interface between the two pieces). If the two pieces are not in contact, four images are seen, two of which originate from the separated interface. However, the multiple line source used on the flat windshields cannot be used on the newer

curved type, because the source is of such a shape and location that the reflected lines are not visible in the extremely curved ends or "wings" from the inspector's position.

For this project is was agreed that the visual inspection be modified, retaining the inspector and product in the same relative position but modifying the line source so reflections would be visible from all portions of the windshield.

The first phase of the work consisted of a series of ray tracings, to determine the position and shape of light source necessary. To do this, a curve was drawn corresponding to the average curvature of a windshield, and normals were erected at one inch intervals along this curve. Rays originating at the observer's eye position were extended to the intersection of the normals with the windshield curve, and the reflected rays were projected back. From this tracing, a region was found in which all reflected rays converged into a small area. This was done for three windshields, one with the greatest curvature, one with an average curvature, and one with the least curvature. It was found that all three tracings showed a convergence of the reflected rays within a few inches of the windshield surface. An example of the path of the rays in shown in Figure 1.

On the basis of what was learned from the ray-tracings, a light source was designed as shown in Figure 2. This source is mounted within two inches of and parallel to the windshield surface. After tests in the laboratory on a preliminary model of this source, another model was built up in a form which permitted testing on the production line at the Shatterproof Glass Corporation. These tests proved the source to be satisfactory for the production testing of curved windshields, and the work on the project was closed at this point.

The technical work on this project was done by R. Blythe and C. Mitchell of the Willow Run Research Center and E. A. Boettner and F. White of the Acoustics and Optics Group at the Cooley Laboratory.

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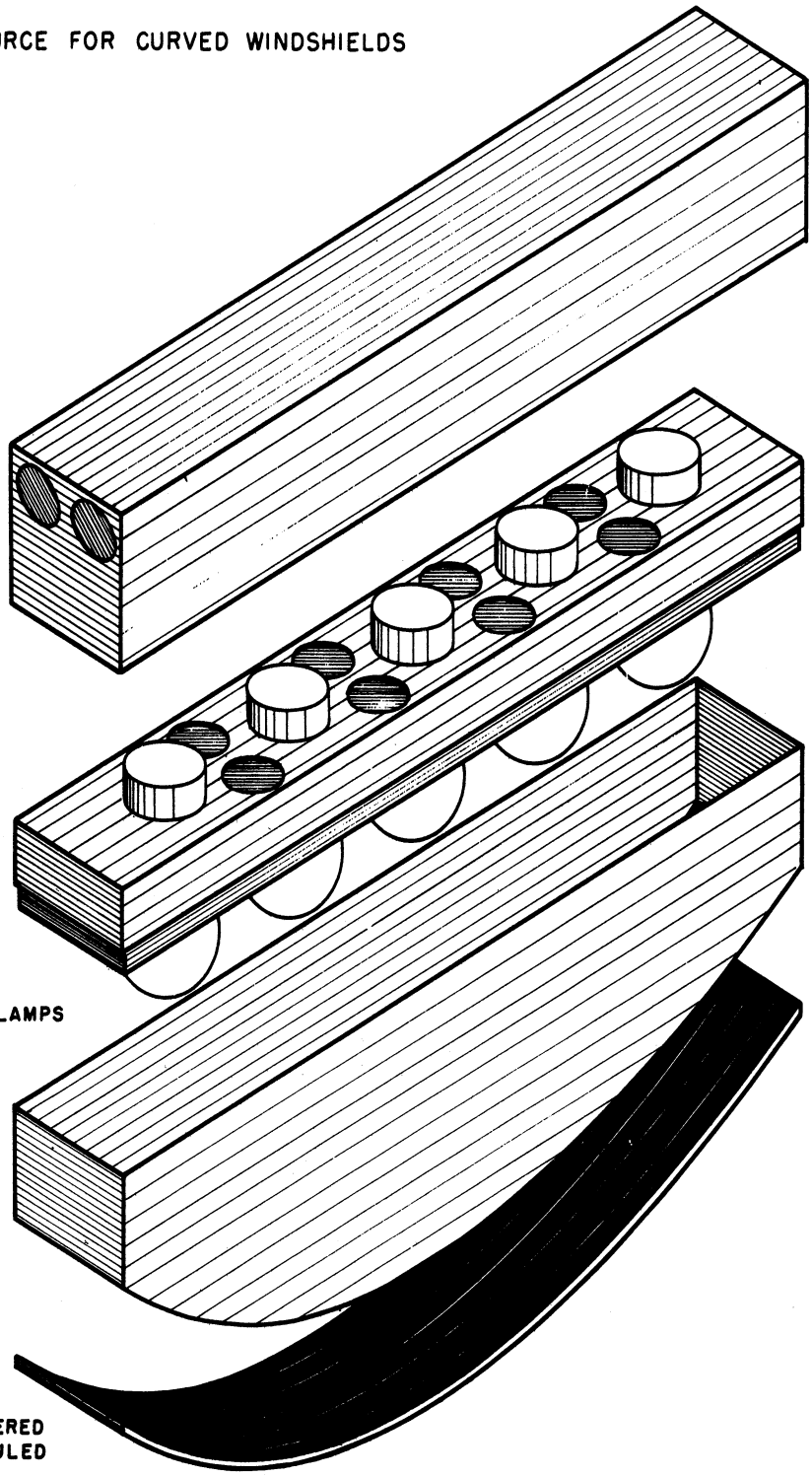
LINE LIGHT SOURCE FOR CURVED WINDSHIELDS



5 - 25 WATT
INCANDESCENT LAMPS

OPAL GLASS, LAQUERED
BLACK WITH RULED
LINES

FIGURE 2