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REPRINT

MULTIPLE-SOURCE SCHLIEREN SYSTEM (TRANSONIC WIND TUNNEL)

by

H R Spahr

and

R E Kyrlach

APRIL 1960

DISCLAIMER

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MULTIPLE-SOURCE SCHLIEREN SYSTEM (TRANSONIC WIND TUNNEL)

A flow visualization system has been developed for the Sandia Corporation 12 x 12-inch transonic blowdown wind tunnel. The system is a multiple-source schlieren system with sharp focusing properties to keep the perforated plexiglas side walls out of focus.

The detailed mechanical design of the schlieren system is not completed. However, a bench-type setup representative of the final system has been made at the wind tunnel. This system is shown in Figure 1. Each component will be discussed briefly.

Two photo floods were used for the light source. A piece of drawing vellum was placed between the photo floods and the source plate to diffuse the light.

The source plate is a 24 x 30-inch piece of commercially available perforated steel plate. The perforations are 1/16 inch in diameter and the porosity of the plate is 22.8%. Provisions will be made in the final system for interchangeable source plates to permit changing the range and sensitivity of the system. Some of the plates will be slotted to permit the study of density gradients normal to the slots.

The plenum windows are 2-inch thick optical glass. The test section walls are 0.187 inch thick plexiglas with 0.192 inch 60 degree inclined holes. Porosity of the test section walls is 6%.

An Ilex 2-1/2-inch diameter shutter was used in the bench-type setup. Since the minimum exposure time for any commercially available, large aperture shutter is 1/50 of a second, provisions will be made in the final system for an intermittent flash-type light source to permit short exposure times.

A Bausch and Lomb F4.5 Tessar lens with a focal length of 12 inches was used in the bench setup. An F3.5, 10-inch focal length lens will be used in the final system to obtain sharper focusing characteristics, further minimizing the effect of the perforated walls.

The cutoff plate is made photographically on a 4 x 5-inch glass photographic plate with a 5D Spectrographic emulsion. It should be noted that the dots on the cutoff plate are 0.020 inch in diameter. The cutoff plate holder has provision for translation along the axis of the system. Fine adjustments were provided to translate the cutoff plate vertically and horizontally.

A Graflex camera back with a ground glass was used to hold 4 x 5-inch film holders when pictures were taken. With the film holder removed, it was possible to watch the image on the ground glass.

Two figures are presented to show schlieren photographs taken with the bench type setup. The two photographs were taken using Royal Pan film (ASA exposure index of 200) requiring an exposure time of 1/50 of a second.

The cutoff plate was adjusted to obtain as complete a cutoff as possible. Therefore, both shock waves and expansion waves appear as increases in light intensity.

Figure 2 shows the forward portion of a bluff body at a Mach number of 0.92. Note the expansion regions around the corners and the normal shock on the body.

Figure 3 shows the same bluff body at a Mach number of 1.30. Note the normal shock in front of the model, the expansion regions around the corners, flow separation at the nose of the model, and the shock waves from the changes in body diameter and the launching lugs. Also note the very weak disturbances from the perforations in the top and bottom walls.

The system is now being designed to increase the ease of operation and adjustment. Provisions will be made to permit horizontal traversing of the portion of the test section visible through the plenum windows.

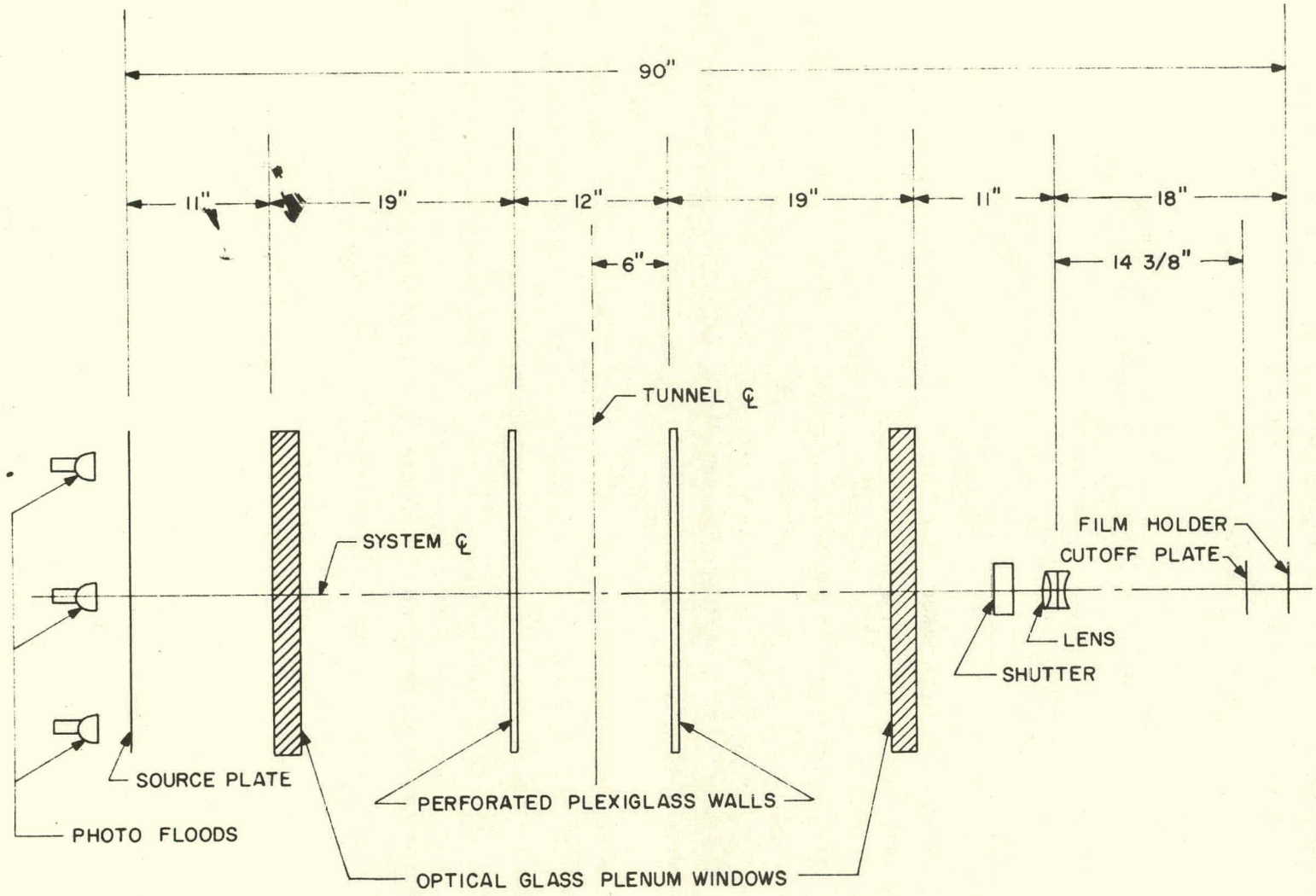

Figure 1. Multiple-source bench-type schlieren setup--Sandia Corporation 12 x 12-inch transonic wind tunnel

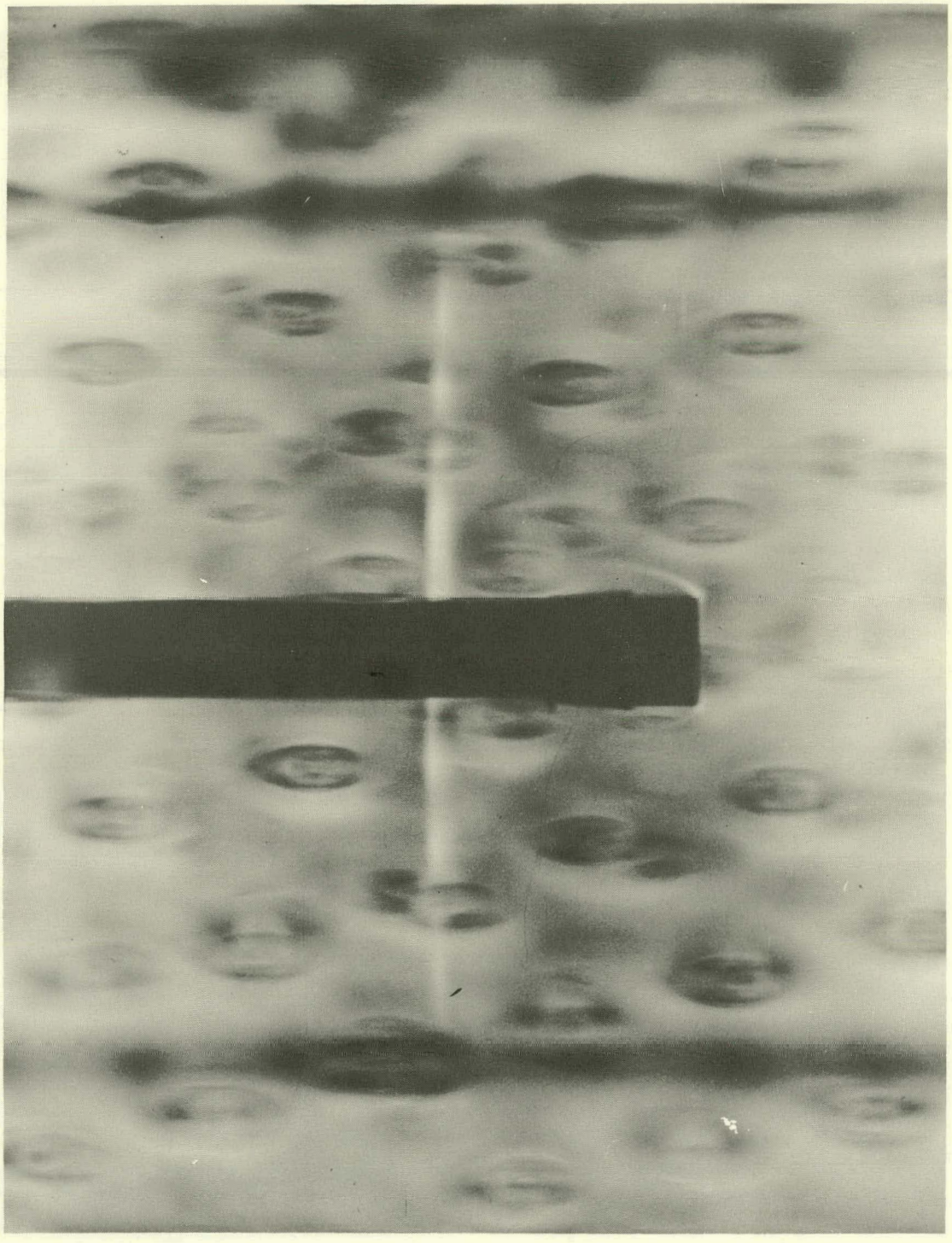

Figure 2. Bluff body (0.60 inch diameter) at M = 0.92--Sandia Corporation 12 x 12 inch transonic wind tunnel

Figure 3. Bluff body (0.60 inch diameter) at M = 1.30--Sandia Corporation 12 x 12 inch transonic wind tunnel