DEPARTMENT OF COMMERCE
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AERONAUTICAL CENTER
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STRAIN PATTERNS IN AIRCRAFT SAFETY WINDSHIELDS AND VISIBILITY THROUGH POLAROID SUN GLASSES

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STRAIN PATTERNS IN AIRCRAFT SAFETY WINDSHIELDS AND VISIBILITY THROUGH POLAROID SUN GLASSES

John J. Swearingen and George R. Johnson, Civil Aviation Medical Research Laboratories, CAA Aeronautical Center, Oklahoma City, Oklahoma

If polaroid* lenses are worn in the cockpit of a modern commercial aircraft, outside visibility is markedly reduced by the appearance of numerous dark irregularly shaped areas in the windshield. When the head, or the polaroid lenses are rotated, the light areas of the windshield become dark, and the dark areas light. This was described by United Airlines observers in 1942 (1) but, perhaps because of the limited distribution of the report, the occurrence is not very generally recognized or understood.

Three factors combine to produce this optical phenomenon:

Light from a blue sky is polarized in a horizontal plane by scattering.

Polarization of light by scattering is a well-known physical event. If a beam of white light is passed through a solution in which a very fine precipitate is suspended, the beam has a distinctly bluish cast when viewed from the side and an orange-reddish shade when viewed from the end. The particles of the precipitate have diameters comparable with the mean wave length of visible light. The particles are too small to give rise to a reflected wave front but act as independent centers sending out disturbances in all directions. Scattering is responsible for the blue of the sky, for the blue sometimes seen in rising cigarette smoke, and for the redness of the setting sun.

Polaroid sun glasses polarize light in a vertical plane.

Strain patterns in transparent materials become apparent when viewed between two crossed polarizers.

One of the more important uses of polaroids is in testing glass and other transparent materials (e.g., plastics) for strain patterns. When placed under stress, these transparent materials, which ordinarily are isotropic and exhibit no double refraction, become double refracting and send off two beams of light from areas of strain. The strain pattern, which normally passes unnoticed

** Polaroid is used as an adjective in this report, and does not refer to the various products of the Polaroid Company.*

(1) United Airlines Test Report No. 346F, August 7, 1942.

becomes evident by the appearance of interference colors when the glass is placed between two crossed polarizers. A similar situation occurs when an airman in the cockpit of certain planes wears polaroid glasses and looks at a blue sky through two windshields which contain areas under strain as transparent materials are being examined between two crossed polarizers. The strain pattern becomes evident as irregular dark areas which obstruct vision.

The outer windshield of the American Airlines DC-6 and DC-4 is a single plate of 1/4" tempered glass mounted in rubber. Examination of this glass before installation revealed numerous irregular strain patterns. The inside windshield is removable and is constructed by bonding a piece of 3/16" tempered glass to each side of a piece of 3/16" vinal plastic, in the DC-6, and 1/8" plastic in the DC-4. The vinal plastic is bent to fit the metal frame during the laminating process and then bolted into position. A polaroid examination of this windshield revealed a strain pattern resembling in some cases a grating of about a 2" mesh and in others a series of more or less parellel light and dark lines (photographs 1 and 2). It is believed that all of the various patterns result from strain induced in the process of tempering the glass. The AT-6's, the Beechcrafts, and the Douglas planes fitted with the original Douglas windshield exhibit no areas of strain. The Lockheed Constellation, the Convair, and the Douglas planes fitted with the heavy duty windshields as a protection against pressure and high speed collision with birds, hail, and other objects, present many strain patterns.

Care should be taken to avoid inadvertent selection of polaroid lenses for use in these planes, as the reduction in visibility is distracting and constitutes a hazard to flight safety.

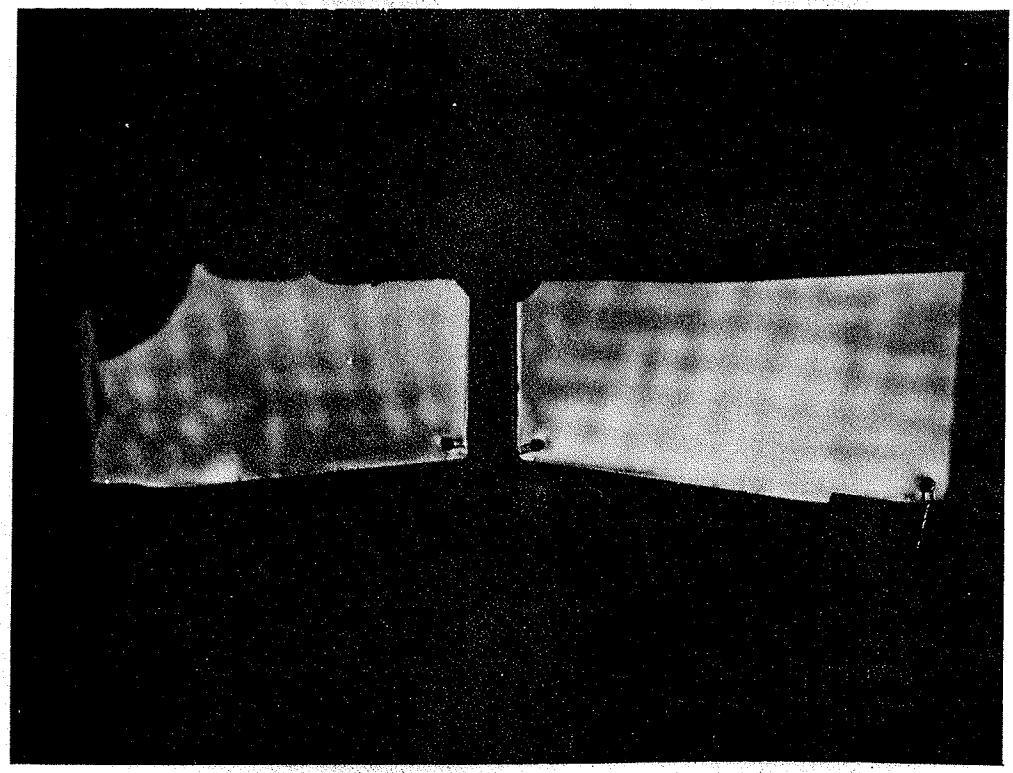

FIGURE 1. STRAIN PATTERN IN SAFETY WINDSHIELDS OF THE CONVAIR MODEL 240 (POLAROID FILTER ON CAMERA - BLUE SKY - 11 1/200 SEC.)

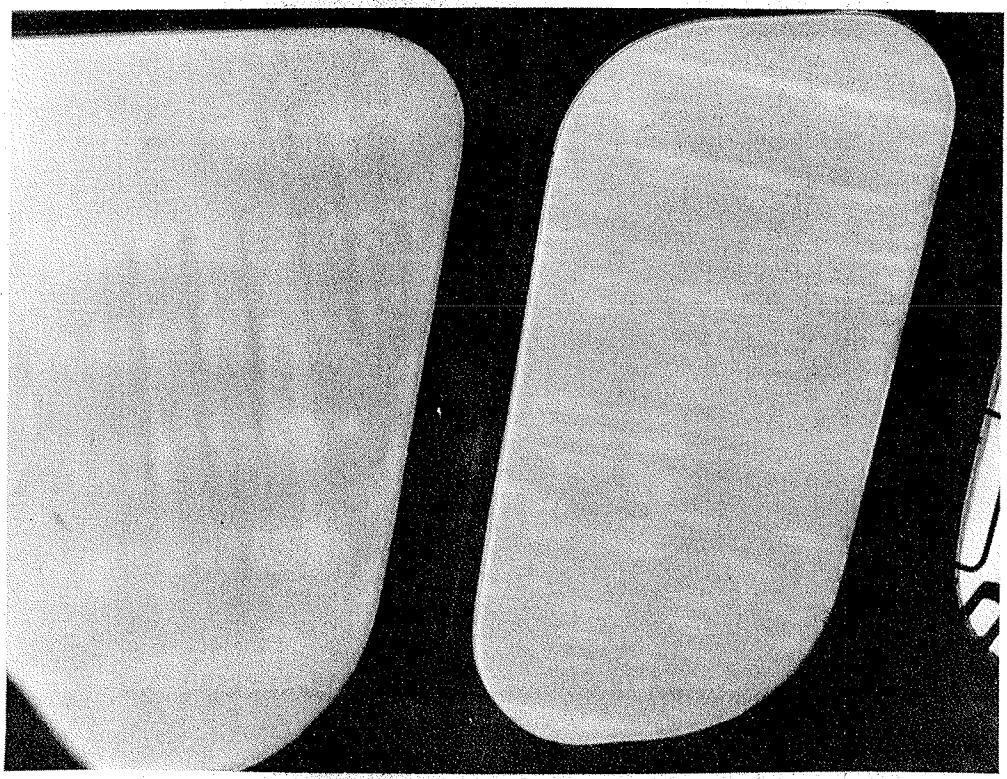

FIGURE 2. STRAIN PATTERN IN WINDSHIELD OF LOCKHEED CONSTELLATION