



## Technical Information

ATS -157  
October 4, 2000

### The Appearance of Quench Marks in Heat Strengthened and Tempered Glass

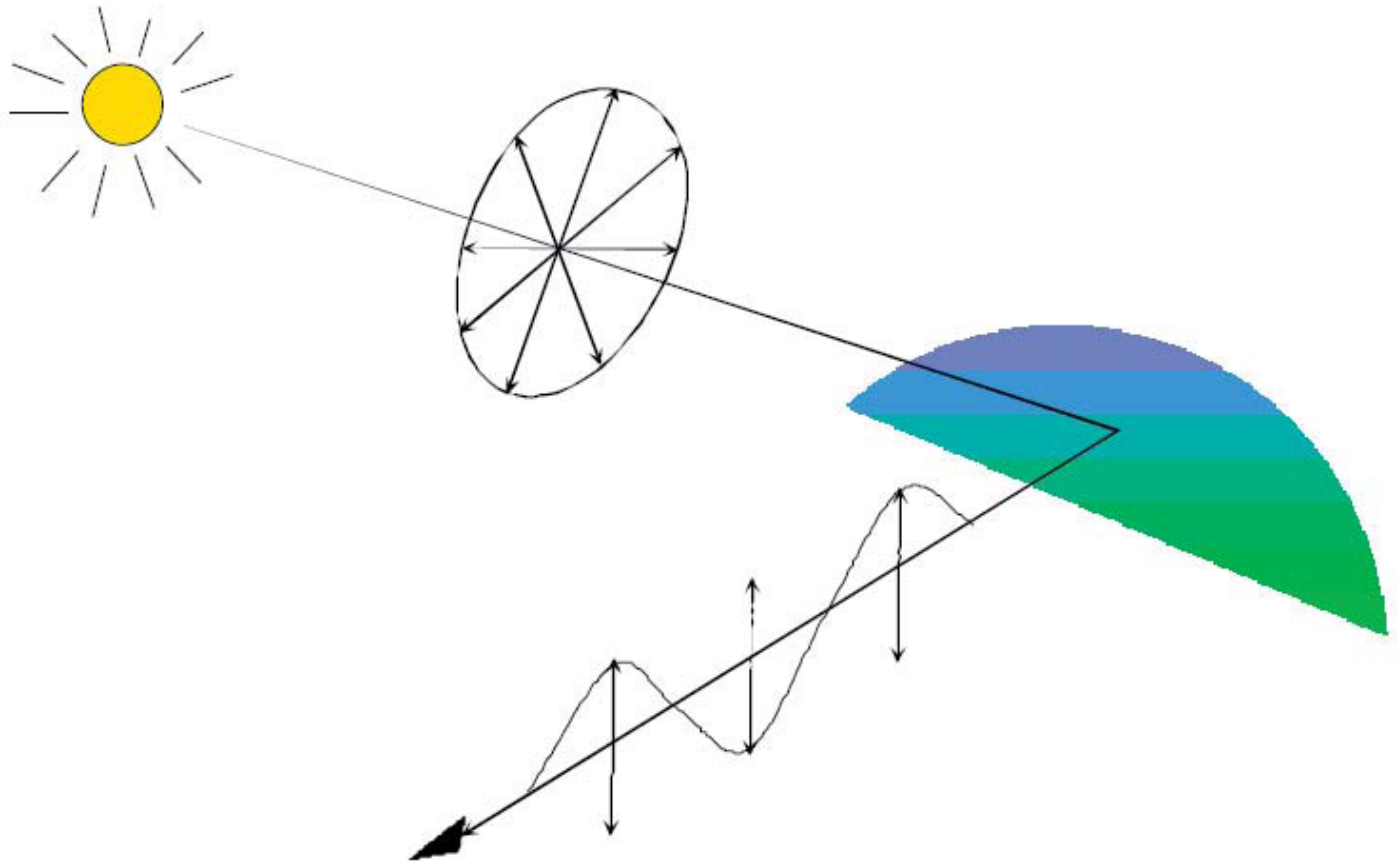
When viewed under particular lighting conditions, especially when viewed at a grazing angle, faint shadowy spots caused by the air quench process can often be seen in heat treated glass. These spots can be seen in transmission and in reflection, and at most viewing angles, other than directly facing the glass. They become very visible when polarizing sunglasses are worn. They are easily seen on a sunny day when the light comes from the blue sky or is reflected from clouds. They probably would not be visible on a grey, cloudy day. These spots are a normal function of properly tempered glass and are mentioned in section 7.5 of ASTM C 1048 standard for heat-treated glass. They are more visible when both lights of glass in an insulating glass (IG) unit are tempered. They are often seen in the sloping tempered back windows of cars, and in Asia they are very obvious in some small truck tempered front windshields.

The attached illustrations show a simplified explanation of the physics involved in their formation:

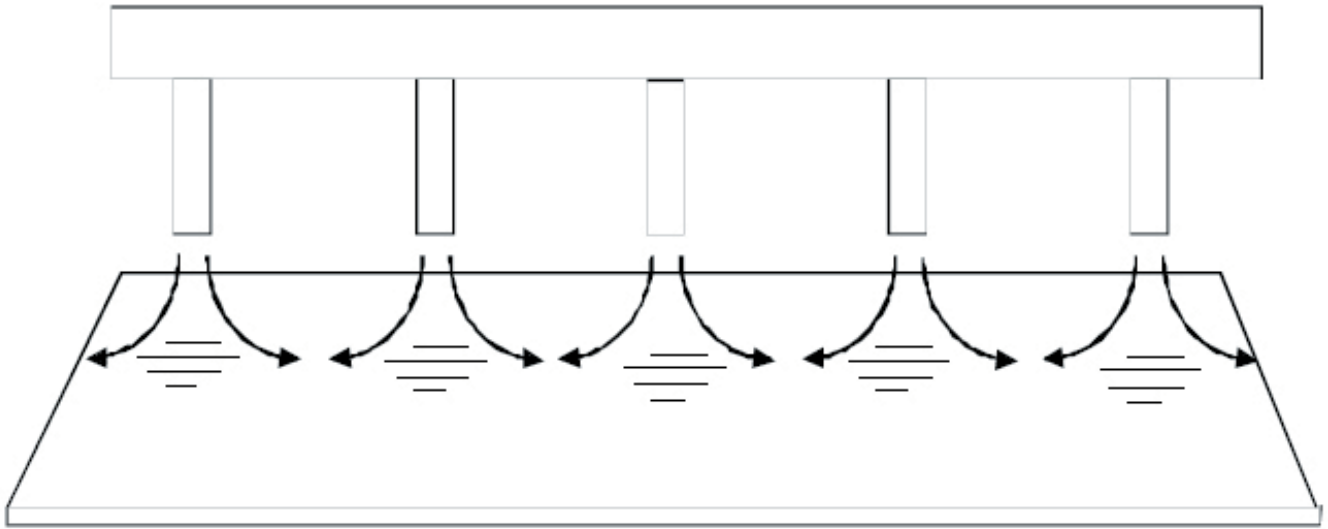
**Illustration #1** shows how light coming from the sun is made up of oscillating waves in planes at different angles to each other. When sunlight interacts with molecules of air and very small dust particles in the sky it becomes polarized. The polarized waves vibrate mostly in one direction.

**Illustration #2** shows how the quench jets in a tempering furnace cannot cool the glass completely uniformly. As a result some areas are cooled faster than others, resulting in differential shrinkage which creates areas of different compressive stress. When glass is stressed in the quenching operation, with its corresponding very slight change in density, it becomes birefringent or polarizing, that is it partially blocks or passes polarized light. The greater the stress the greater will be the polarizing effect.

**Illustration #3** shows schematically how vertically polarized light can easily pass through the vertically polarized sections of the glass to give bright spots but it is diminished when passing through other areas polarized at a different angle to give relatively darker spots. The spots are not an indication of absolute tempering level; they simply show areas of relatively more, or less, tempering stress. Given the nature of the quenching process it is physically impossible to quench a plate with absolute uniformity. The degree of tempering and the uniformity of tempering throughout the plate can be tested by other methods such as surface stress instruments or by examining the break pattern after fracture.

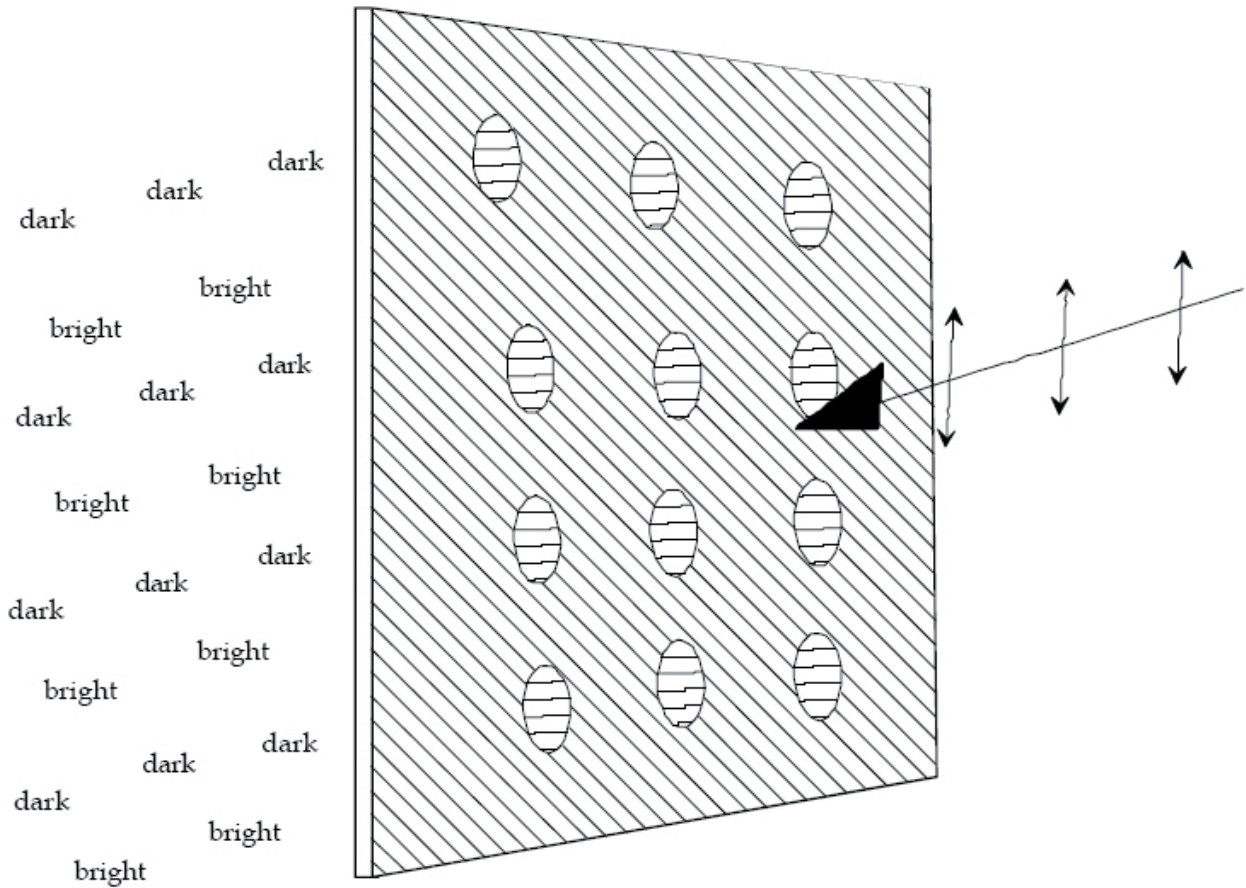


## Polarization of Sunlight by Interaction with Blue Sky



**Tempering Quench Jets**

**2**



## Polarized light through Tempered Glass 3

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