PILKINGTON
NSG Group Flat Glass Business

Technical Information

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Interference Fringes in Insulating Glass

Interference fringes are a series of faint, irregular, roughly parallel lines, which are grey or colored, and are sometimes visible in clear insulating glass (IG) units. They are typically a fraction of an inch wide and many inches long. They are caused by interference effects when light waves reflect from parallel, or nearly parallel, glass surfaces.

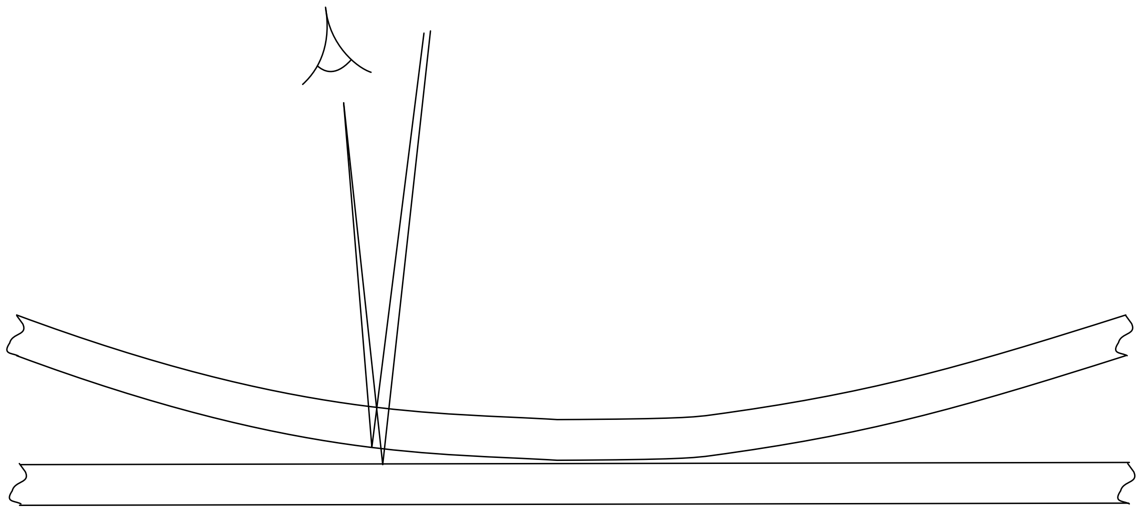
Interference fringes are caused by reflections between the various glass surfaces of an IG unit when one light wave is delayed relative to another. Fringes are seen because of the constructive or destructive interference which occurs when two light waves combine. If the waves are in phase the resulting light will be stronger and brighter. If the combining waves are in opposite phases they cancel each other and the resulting light is weak.

The easiest fringes to see are the colorful Newton's Rings which occur when the two glasses of an IG unit touch at the center. The contacting glass area will be surrounded by concentric curving fringes. Tapping on the glass usually has no effect on these fringes because the glass to glass contact prevents any change in the geometry of the reflecting surfaces.

These fringes are caused by the slight delay between two light waves reflected from the two surfaces on either side of the very narrow tapered air gap, resulting in constructive or destructive interference.

Newton's Rings can result from an IG manufacturer failing to control the sealed air space pressure when a unit is sealed, or when two very heavily dished tempered pieces of glass are fabricated with both concave sides facing outwards. Fabricating very large sealed units when the sides overhang the edges of a narrow conveyor can also bend the glass sufficiently to cause glass contact in the center. The glass in a properly made IG unit (i.e. both glass lights parallel to each other, at room temperature, when the air space is sealed) will never touch at the center no matter what the unit size, air gap width (typically between ¼" (6mm) and 1" (25mm)), wind load, or atmospheric temperature and normal barometric variations experienced. Extreme changes in barometric pressure caused by altitude differences of more than a few thousand feet between sealing and installation locations may be enough to cause glass touching at the center.

Newton's Rings in an IG unit can often be cured by inflating the sealed unit through a temporary hole in the spacer and resealing the unit when the two glasses are parallel. Units should be inflated before the glass surfaces have had time to rub against each other, creating a visible mark or abrasion.



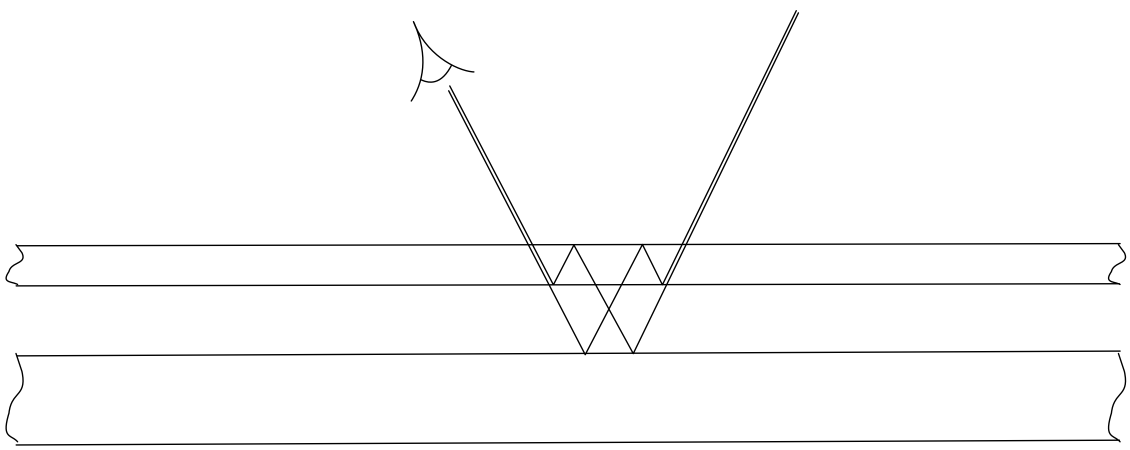
Newton’s Rings Formation

Another type of fringe pattern, sometimes called Brewster’s Fringes, is less easily seen but can occur in a sealed unit with two pieces of nearly identical glass thickness (“4 Surface Reflection”) or very rarely with two pieces of flat glass of different thickness (“3 Surface Reflection”).

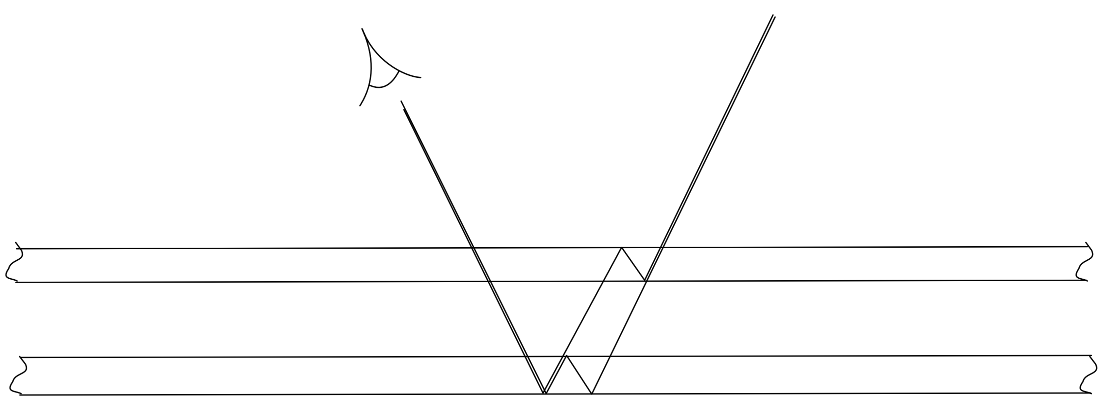
At a glass surface a light wave can be split, because of partial reflection, into two new waves. These new waves can travel different paths, of slightly different lengths, and then recombine after further reflections as shown in the two diagrams. A variation in glass thickness of only 0.00004” (0.0001 mm) can sufficiently delay one wave relative to its partner to cause fringe formation.

Brewster’s Fringes often require special lighting and viewing conditions to be seen, such as viewing at an angle rather than directly at the glass and with a shaded area beyond the glass. Most people never see Brewster’s Fringes because their eyes are focused upon the exterior view which is considerably brighter and masks the fringes. To see fringes, it is necessary to look at the glass rather than through it, an unnatural condition for the untrained eye. Brewster’s Fringes have little color or are simply grey. When the glass surface is tapped or lightly pressed the fringes move in response to the small changes in the geometry of the surfaces.

There is no cure for Brewster’s Fringes. They can often be minimized by making IG units with glasses of two different thicknesses. Insulating glass manufacturers often use DS (3.0 mm) and DST (3.2 mm) glass in the same unit to prevent this condition. A thickness difference of at least 0.003” (0.08mm) is needed to stop ‘four surface’ Brewster’s Fringe formation. Often glasses cut from opposite sides of the same float ribbon can have just enough thickness difference to prevent fringes. But two pieces of glass cut one after the other along the length of the float ribbon, and which preserve the same orientation during assembly, will have a greater chance of matching the small thickness variations and of creating Brewster’s Fringes. Fringes are sometimes seen because today’s float glass is so flat and free of distortion that it allows this optical phenomenon to be observed.



Three Surface Reflection Interference Fringe Formation



Four Surface Reflection Interference Fringe Formation