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ENGINEERING ANALYSIS OF ACCIDENTS

HEADLIGHTS ON OR OFF?

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Have you ever noticed someone driving at night without headlights? This occurs frequently when a driver travels from a lighted area, such as a convenience store, and forgets to turn on the lights. Drivers also neglect to use their headlights under reduced visibility conditions of fog, dusk, and rain. But then, on the other hand, other drivers just simply don't see a well lighted vehicle. Following a collision it is often possible to determine whether a vehicle was driven with its headlights illuminated.

First, it is usually easier to demonstrate that the lights were in use than it is to demonstrate that they were off. Usually, one positive indication that a headlight was illuminated is sufficient to conclude that the headlights were "on". However, this conclusion must be exercised with some caution, since it is possible for some of the lights to be burned out, missing, or otherwise damaged prior to the collision. To demonstrate that the headlights were off, requires either very positive evidence or an accumulation of "off signals" from a number of bulbs.

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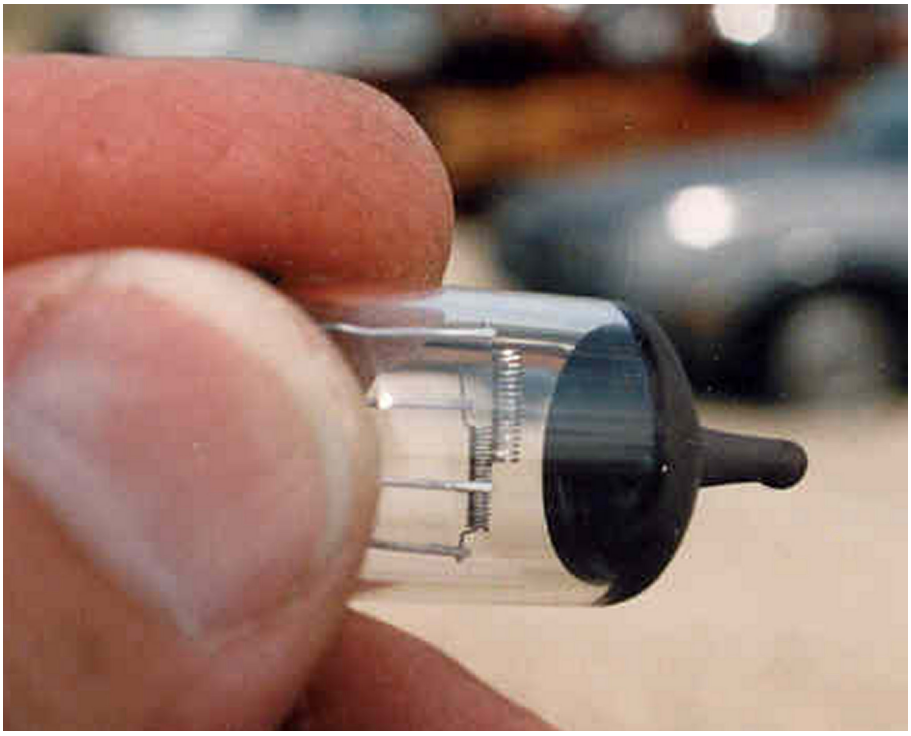
Headlights, or headlamps as they are technically referred to, generally are of two basic types, sealed beam or halogen. Both consist of a coiled tungsten filament surrounded by a glass envelope. The glass envelope of the sealed beam lamps is large, 4 to 6 inches across and shaped like a small TV picture tube. The air inside is removed and the glass envelope is "sealed" so that the tungsten filament is heated in a vacuum. In contrast, the filaments in halogen headlamps are surrounded by a small cylindrical glass envelope, approximately ½ inch in diameter and 1 inch long. They are called halogen headlamps, because the glass is filled with an inert halogen gas. The halogen bulbs also have an outer glass or plastic covering which provides additional protection and focuses the emitted light. In the sealed beam headlamps, all of these functions are provided by the glass envelope.



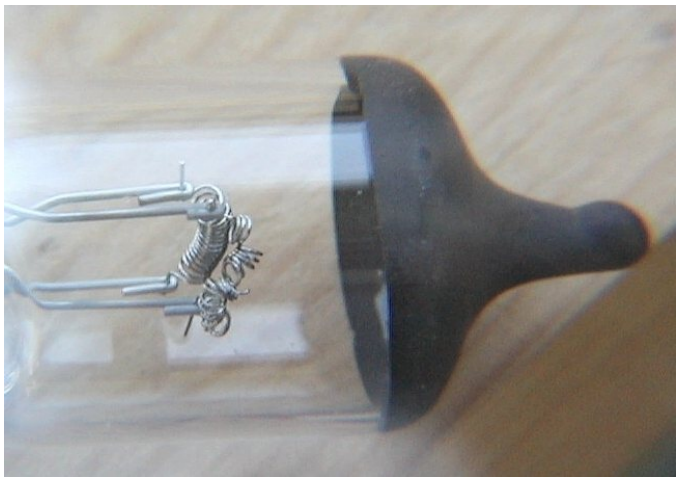
Undamaged Headlamp Filaments

When a headlamp is illuminated, the coiled tungsten filament is heated by electrical resistance to a temperature of 4500 degrees F. At this temperature, the filament emits radiation in the form of white light. If the glass covering is broken during a collision, several things are likely to happen. The "shock" or impact which breaks the glass will cause the headlamp to move violently. When this occurs, there will be inertial loads imposed on the filament coils. If the filament is cold, it will sustain very high inertial loads without deforming the filament coils. However, when the filament is white hot, the metal is relatively malleable and most impacts which break the glass will also deform the filament. This results in a filament which has bends, bows or other non-uniformity in the coils.

When the glass covering breaks, in a sealed beam bulb, the vacuum is lost and in a halogen bulb, the halogen gas dissipates. In either case, the hot filament is exposed to the atmosphere which contains oxygen. Oxygen will chemically combine with the hot tungsten to form tungsten oxide on the surface of the filament. This changes the color of the filament from a shiny silver color to a blue/black color. If the filament remains energized, the filament metal will continue to combine with oxygen, producing a yellow green powder of tungsten oxide. The filament will continue to decompose until it separates and the electric circuit is broken. Where it separates, the ends of the filament will taper down to the separation.

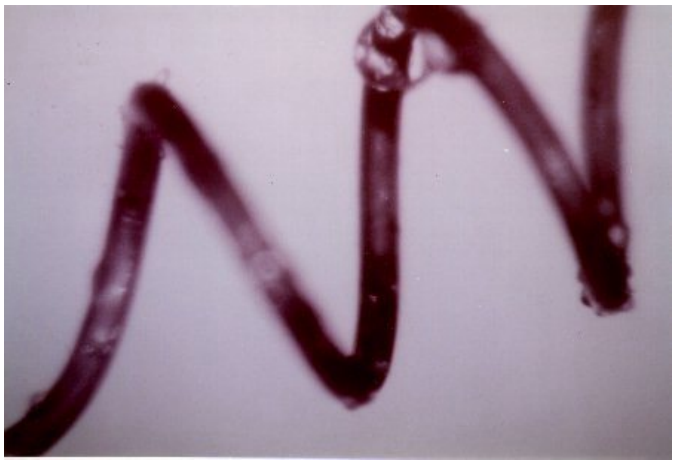
When the glass envelope is broken, the breaking glass will generate many small fragments. These small fragments are swirled around and may contact the tungsten filament. If the filament is cold, the glass particles simply bounce away. However, if the filament is hot, the glass melts onto the surface of the filament, forming little glass nodules. This effect is usually more pronounced with a sealed beam headlamp, because the air rushes inward to fill the vacuum carrying the glass

particles toward the filament at the center.



Hot Filament Deformed by Inertial Forces Generated During Impact

Notice the Adjacent Undeformed Filament



Microscopic view of glass melted onto a filament

In some situations, the headlamps may be turned on after the collision. These filaments will exhibit oxidation but none of the other conditions. Careful examination will usually allow a determination of whether the lights were on, off, or turned on after the collision.