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CASE REPORT

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Interpretation of Automotive Light Bulb Examination Results: An Intriguing Case

ABSTRACT: During the examination of light bulbs from a vehicle involved in a road accident, the headlights did not reveal any evidence regarding whether they were energized or not. Additionally, a police officer turned the lights on after the accident to verify their functioning, thus damaging some of the evidence. By examining the vehicle, it was determined that the park lights could provide answers regarding the conditions of the headlights. After observations, it was concluded that the park lights and headlights were off at the time of the impact. This case report demonstrates how important it is to integrate the circumstances surrounding the case into the interpretation of the results. Nevertheless, it also demonstrates the necessity for examining both the vehicle and all light bulbs in order to reach the most pertinent and proper conclusion.

KEYWORDS: forensic sciences, criminalistics, light bulb, automotive accident, road accident reconstruction, filaments, scanning electron microscopy, tungsten oxide

Recently, the author was retained to examine a 1992 Ford Crown Victoria that was involved in a road accident with another vehicle at dusk. The Ford was traveling on a highway in the southern part of the United States with four individuals on board when it collided with another vehicle that was turning onto the highway from a left side street, resulting in a total loss. The driver of the other vehicle testified that he did not see the Ford coming because the Ford did not have its lights on. The driver and passengers of the Ford vehicle stated that the lights were on and that they remember turning the headlights off after the accident. One of the police officers at the scene, faced with this discrepancy in the two testimonies, decided to turn the lights on to verify their proper functioning. He reported that the lights were in working order. The tow truck driver also testified that while loading the vehicle on the bed of his truck, he had to turn the lights off, as the right headlight was blinding him. In order to evaluate the degree of responsibility of each party, one of the insurance companies requested a forensic examination to determine whether the headlights of the 1992 Ford Crown Victoria were on or off at the time of the accident.

Material and Methods

Additional background information regarding the circumstances of the accident was sought, without success. The author traveled to the towing yard to examine the vehicle. The damage was observed and recorded and the remaining front and rear light bulbs and/or light assemblies were preliminarily examined at the scene and collected as evidence. The electrical circuit of the vehicle was then evaluated by visual observation and with a multimeter along with the help of available technical literature (1). The light bulbs and light assemblies were brought back to the laboratory, where they were observed under the naked eye, photographed, evaluated with an ohmmeter when applicable, and finally observed with light macroscopy and scanning electron microscopy (SEM). Additional information was obtained from Ford dealers, and the interpretation of the results was carried out.

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Vehicle Examination

The vehicle presented heavy collision damage in the front, and more particularly in the front left area, as shown in Figs. 1 and 2. The rear end of the vehicle did not sustain any damage. The right front park/turn light assembly sustained some damage. The plastic cover was missing and the light bulb's glass was broken, but both filaments were still present, as shown in Fig. 3. The right front headlight assembly was intact, as shown in Fig. 1. The left front park/turn light assembly was demolished, as shown in Fig. 2. Fortunately, the base of the light bulb was found still attached to its socket and to a small portion of the reflector, as shown in Fig. 4. The left front headlight assembly was missing at the time of the inspection. The plug of the low-beam light bulb was found to be intact with no light bulb attached to it. The base of the high-beam light bulb was found still attached to its connector; however, the light bulb glass, filament, and filament supports were missing. The right front park/turn light bulb, right front headlight assembly, left front high-beam light bulb remains, left front park/turn light assembly, and rear light assemblies were collected and brought to the laboratory for further examination.

Then, the electrical circuit of the vehicle was evaluated. The battery still provided 12+ V, and no fuses were open. The light switch worked properly, and when turned on with the door open, the alarm (buzzing sound) worked. Light circuit testing did not reveal any abnormalities. Also, it was noted that when the (ignition) contact was in the "on" position, the headlights (low or high beam) could not be energized without the parking lights being

FIG. 1—*View of the right front corner of the 1992 Ford Crown Victoria showing damage to the right park/turn light assembly.*

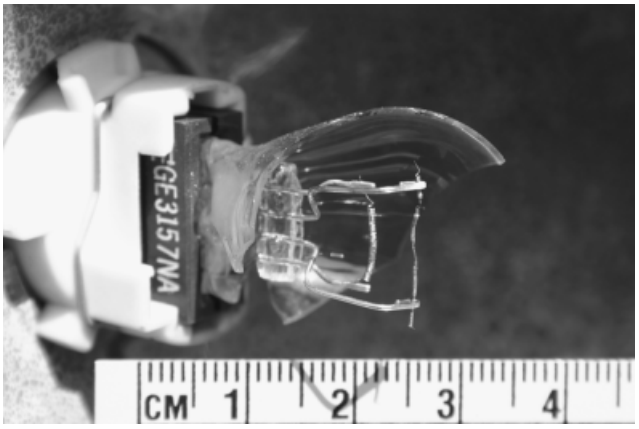

FIG. 3—*View of the damaged right front park/turn light bulb.*

energized. Finally, the brake pedal switch also worked properly, energizing the rear brake lights when depressed.

Laboratory Examinations

Right Front Park/Turn Light Bulb

The light bulb is of incandescent double-filament type with a plastic wedge-type base and bears the marking *H1 GE3157NA*. This character sequence is coded information: "GE" stands for General Electric (the brand of the bulb) and "3157NA" is the SAE trade number of the bulb (2). The Society of Automotive Engineers (SAE) is a nonprofit educational and scientific organization that develops standards and technical information for vehicles. The SAE number defines most of the building specifications of the bulb, including the powers of the filaments, which are 8 and 27 W for the park and turn lights, respectively. The "NA" contained in the trade number stands for "Natural Amber," which is the color exhibited by the remaining portion of the glass.

The park filament presents slight distortion and is ruptured close to one of the filament supports, as shown in Fig. 5. Black tungsten oxide is present on some portions of the filament, yellow tungsten oxide is present close to the fracture, and the filament's diameter diminishes (see Fig. 6) as it approaches the fracture point shown in Fig. 7. Notice the melting of the filament and the distinct globular appearance of the rupture point.

FIG. 2—*View of the front part of the 1992 Ford Crown Victoria showing extensive damage to the left headlight and park/turn light assemblies.*

The turn filament exhibits very slight distortion and is intact, as verified with the ohmmeter. The coils are evenly spaced, and the filament's surface is bright and shiny, free of any glass beads, glass splinters, or tungsten oxide. Significant direct current (DC) notching on the wire surface is present, as shown in Fig. 8.

Right Front Headlight Assembly

The two light bulbs contained in the right front headlight assembly are intact and working. The filament of the low-beam bulb, a halogen-type bulb Sylvania model 9006/HB4, exhibits extensive wear but no noticeable distortion. The filament of the high-beam bulb, a halogen-type bulb Sylvania model 9005/HB3, does not reveal any wear and is free from distortion as the coils are evenly spaced.

Left Front High-Beam Light Bulb Remains

The remnants of the light bulb consist of the base of a halogen-type bulb Sylvania model 9005/HB3. The filament is missing and the bulb is broken at the stem. No pertinent information could be extracted from this light bulb.

Left Front Park/Turn Light Assembly Remains

The light bulb is of incandescent double-filament type with a plastic wedge-type base and bears the marking *SYLVANIA* on one side and the marking (only partial reading) *315 . . . 2* on the other side. The author did not obtain authorization to conduct destructive examination; thus, no attempt to remove the base from its socket was made for fear of destroying any evidence. Consequently, it was not possible to observe the markings completely, but it is very likely that the light bulb was an SAE trade number 3157NA, equivalent to the right front park/turn light bulb. The light bulb's glass is missing and the filament supports underwent heavy mechanical distortion, as can be seen in Fig. 4. The filament of the turn light is completely missing as denoted by the two small portions of tungsten wire remaining in the crimp clamps (identified as "A" in Fig. 9). The lack of authorization to conduct destructive examination prevented the SEM examination of the item. SEM examination of this item would have required the removal of the bulb from its socket or the complete coating of the item, both processes being potentially destructive. Observation under an optical microscope revealed that the two fractures appear brittle, but without SEM examination it was not possible to confirm this observation. Nevertheless, as the filament was not recovered, it is not

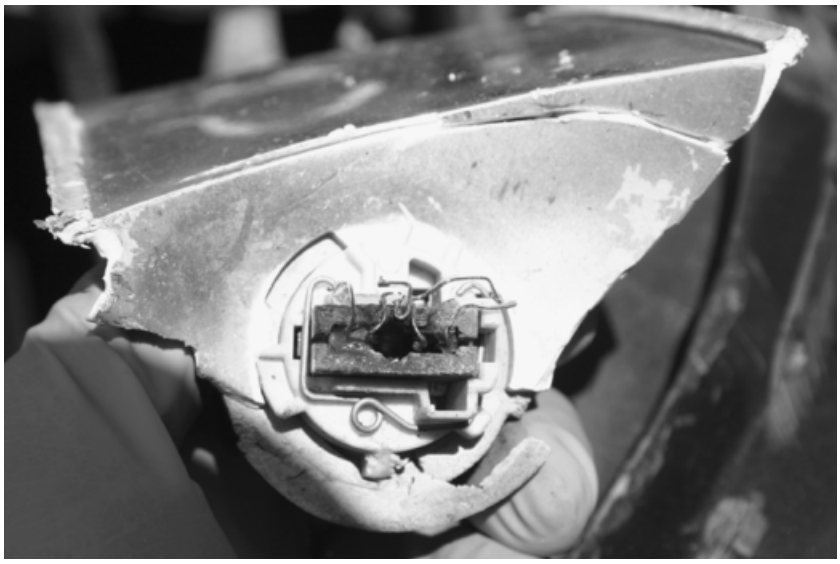

FIG. 4—*View of the remnants of the left front park/turn light bulb assembly.*

known whether other preceding fractures occurred, and thus, the significance of these two fractures is null.

Interestingly, the park light filament is intact as can be seen in Fig. 9, identified by the letter "B." The filament is heavily distorted and shows a few slight localized discolorations, but is unbroken and does not exhibit any evidence of tungsten oxide (yellow or black), glass beads, or glass splinters. The coils are evenly spaced on the left side of the filament and the filament shows some stretching toward its right side. One of the supports of the park filament is ruptured, as identified by letter "C" in Fig. 9. Evidence of electrical activity is present between the two filament supports. A weld seam and melted portions of the supports are present and are designated by the letter "D" in Fig. 9. Furthermore, the plastic of the wedge base in the area surrounding the melted filament supports is slightly charred.

Rear Light Assemblies

All the light bulbs contained in the rear taillight assemblies were extracted and examined. No significant distortion of the filaments was observed, and all the light bulbs were working. Interestingly, one of the receptacles of a wedge base-type incandescent park/turn light bulb did not incorporate any metal connectors, thus preventing the bulb from being energized, even though the light worked. No other pertinent information was gleaned from the examination of the rear lights.

Additional Information

The author contacted a few Ford dealers in the vicinity of Atlanta, Georgia, and obtained confirmation that this vehicle was not equipped with daytime running lights. Daytime running lights (DRL) is a system imposed in some countries where the headlight switch is overridden by the ignition switch and the headlamps are energized when the ignition switch is in the on position. While not mandatory in the United States, more and more vehicles sold in the United States are now equipped with DRL.

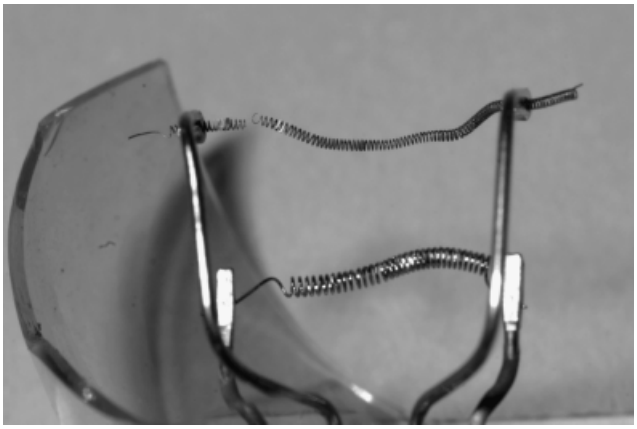

FIG. 5—*Macrophotograph of the filaments of the right front park/turn light bulb. Notice the park filament ruptured close to the left support. Yellow tungsten oxide is present on each side of the fracture and black tungsten oxide on some portions of the filament itself.*

FIG. 6—*Scanning electron microscopy photograph of the right front park light filament. It is possible to see that the thickness of the filament diminishes as it gets closer to the fracture (toward the top of the photograph). Also, notice the heavy presence of tungsten oxide deposits on the filament.*

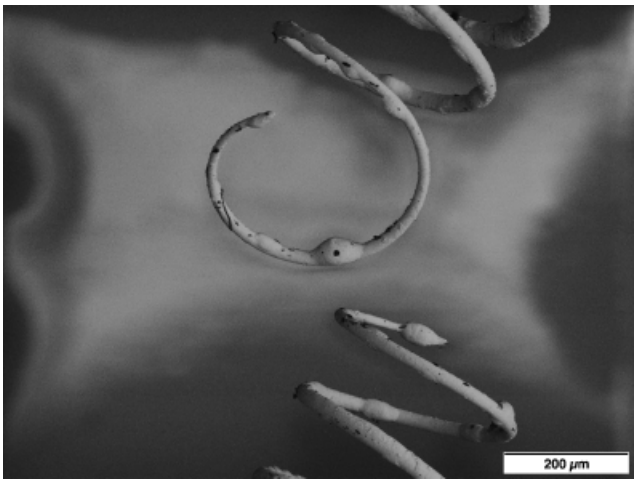

FIG. 7—*Scanning electron microscopy photograph of the fracture of the filament from Fig. 6. Notice the thinning and melting of the filament. The fracture surface is of globular type.*

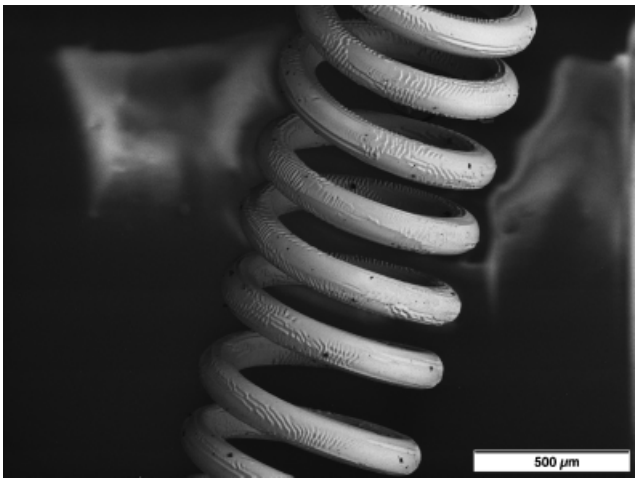

FIG. 8—*Scanning electron microscopy photograph of the right front turn light exhibiting some direct current notching on its surface, but free of tungsten oxide and glass beads or splinters.*

Interpretation of the Results

The question to be answered in this case was whether the headlights (low or high beam) were energized at the time of the accident. The forensic scientist must always keep in mind that the impact that broke the light bulb might not be related to the accident in question (3). Under most circumstances, proper scientific reasoning expresses the results based on the impact that broke the glass and/or the filament rather than based on the accident. However, the investigator wanted to know the conditions of the light bulbs at the time of the accident. It is important for the forensic scientist to integrate this limitation in the interpretation of the results whenever necessary.

In this particular instance, the owner of the vehicle stated that no damage was present in the front of the vehicle before the accident. However, this statement is probably as reliable as the statement that the lights were on and, thus, must be taken with extreme caution. While the damage observed on the left park/turn light is consistent with the accident, it is not certain that the damage created to the right park/turn light is due to the accident in question, as the right headlight did not suffer any damage. Because the author could not visit the scene and because no accident reconstruction was performed, it is not possible to ascertain that the damage on the right park/turn light is the result of the accident. Conversely, the damage that led to the final state of the left front park/turn light can be clearly attributed to the accident.

The left headlight assembly was critically damaged during the accident and its modest remains did not bear any pertinent information. In spite of this, the right headlight assembly was intact. The fact that the filaments of the two halogen-type bulbs did not present any significant distortion slightly supports the hypothesis

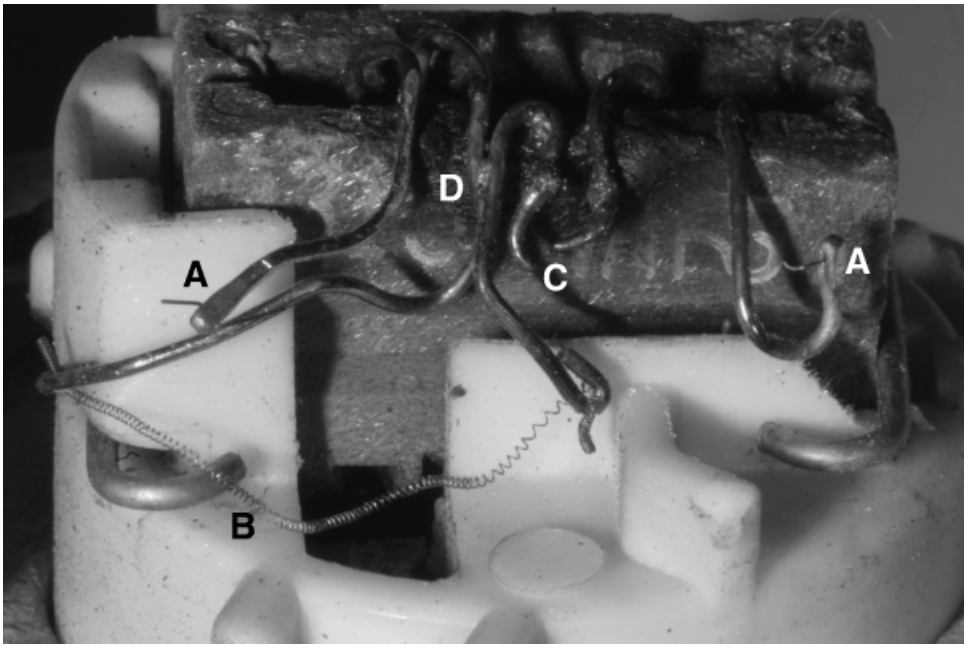

FIG. 9—*Detailed view of the left front park/turn light bulb. (A) Remaining portions of the turn light filament. (B) Intact park light filament. (C) Ruptured filament support. (D) Evidence of electrical activity between the filament supports and plastic wedge charring.*

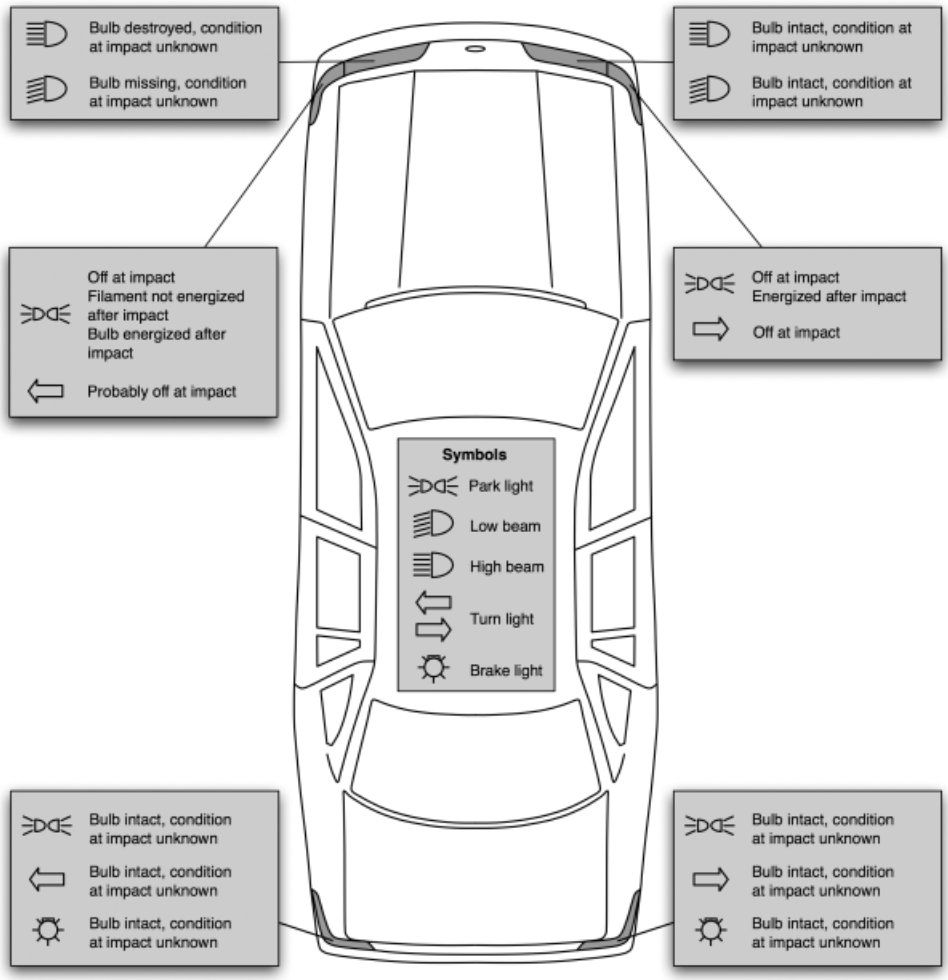

FIG. 10—*Summary of the light bulb examination results.*

that they were cold (off) at the time of the impact. However, it is also possible that no significant distortion resulted from the shock, as the right headlight did not undergo direct impact. Thus, no clear information concerning the on or off condition of the headlight bulbs at the time of the accident can be gathered from the headlights.

Based on the evaluation of the lighting electrical circuit of the vehicle and the information collected from the Ford dealers, it was established that when the vehicle is driven, the headlights cannot be energized without the park lights also being energized. The only exception to this rule would occur if the driver permanently activated the headlight flasher switch (normally used to energize temporarily the high beams as to flash another vehicle), which would result in the high beams being on independently of the low beams and park lights. While this hypothesis is somewhat possible, it is extremely unlikely, particularly in this scenario. When assuming that the headlight flasher switch is not permanently depressed, the condition of the park lights might provide some insight into the conditions of the headlights. If the park lights were on at the time of the accident, no new information is gained about whether the headlights were on or off at the time of the accident. However, if the park lights were off at the time of the accident, then the headlights were off, too.

The examination of the right park/turn light reveals that the turn filament is intact. This filament is shiny and does not present any glass splinters or tungsten oxide. Thus, it is possible to conclude that the filament was off at the time of the shock that broke the glass and was not energized thereafter (4). The park filament is not intact, as it ruptured. The globular aspect of the fracture clearly indicates that the filament was energized at the time of its rupture (5). However, the fact that the filament's diameter diminishes toward the rupture and that there is tungsten oxide on each side of the fracture in great quantity indicates that the filament did not rupture due to a shock, but rather by simply burning in the air (6). Also, the complete absence of any glass beads on the filament is not consistent with a filament being energized at the time of the breakage of the bulb (7). This is also supported by the absence of any significant distortion (4). All the observations made on the park filament are consistent with the filament being off at the time of the impact that broke the glass bulb. However, these observations also indicate that the filament was energized (until it burned out) after the glass was broken. The shock that broke the bulb's glass could have been anterior to the accident in question and the park light filament could have burned out much before the accident while the vehicle was being driven and all other light bulbs were properly working. This scenario is possible, but very unlikely, because the turn light filament is intact and was not energized after the glass breakage. If the glass had been broken prior to the accident, it is likely that the right blinkers of the vehicle would have been used at least once, thus damaging the turn filament, which is not the case.

The examination of the left park/turn light reveals pertinent information about the park filament. The fact that the park filament is still intact, does not present any glass beads, glass splinters, or tungsten oxide indicates not only that it was off at the time of the breakage of the light bulb but also that it was not energized after the glass envelope failed. Regardless of whether the shock that broke the light bulb glass was anterior to or due to the accident, it is possible to conclude that the park filament was not energized during or after the accident.

Thus, it is possible to conclude within reasonable scientific certainty that as the park lights were off at the time of the impact that broke them, the headlights were not energized either. Figure 10 summarizes the results. While all the evidence supports this conclusion, a serious discrepancy arises: the police officer stated that he turned the lights on to verify their proper functioning and that they were working. No further detail on which light was verified is available, but the burned-out right front park light is consistent with this statement. On the contrary, the left park light filament is not consistent with this testimony. If the right front park light was energized, then the left front one must have been, too, as the electrical circuit functions properly. The reason for this "discrepancy" is explained in Fig. 9. One of the left front park light filament supports was severed during the impact (see Fig. 9, letter "C"). The mechanical distortion of the filament supports brought them closer together. When the officer turned the lights on, the two conductors arced, as witnessed by the evidence of electrical activity (welding and melting) shown in Fig. 9 right of letter "D." This electrical shortcut prevented the filament itself from being energized, thus preserving its integrity. Therefore, the condition of the left park/turn light bulb is consistent with the lights being turned on after impact.

Conclusion

When performing automotive light bulb examinations, it is crucial for the forensic scientist to either communicate with the field investigator or to completely examine the vehicle him/herself (8). In this case, the lack of evidence from the headlights led to no possible conclusion from their examination. Nevertheless, a thorough evaluation of the vehicle's electrical lighting system revealed that the information exhibited by the park lights was valuable in determining whether the headlights were on or off at the time of the impact. The two front park light bulbs indicated that the lights of the vehicle were turned off at the time of the impact; however, the examination of the filaments revealed that one was energized after the impact, while the other one was not. This inconsistency is explained by a filament support that was severed, which prevented the filament of one bulb from being energized. Drawing conclusions in this case, while successful, was made more difficult because the lights of the vehicle were energized after the impact by the police officer responding to the scene. This also demonstrates the importance of continuing education in evidence preservation among field responders.

Acknowledgments

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