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BAD CONNECTIONS & BAD GROUNDS

Probably nothing in the electrical system causes more grief and trouble than bad grounds and/or bad connections. One of the best things you can do during the process of restoration is to thoroughly clean/repair/replace all connectors and grounds. Doing this up front, before you actually get into doing electrical restoration, can often make it unnecessary to do any further trouble shooting. Amazingly, things just might work right the first time!

BAD CONNECTIONS

In the left hand side of **figure 1**, below, I have recreated one of the series circuits from figure 8 of chapter one. In this circuit, a 5W lamp has been placed in series with a 65W headlamp bulb.

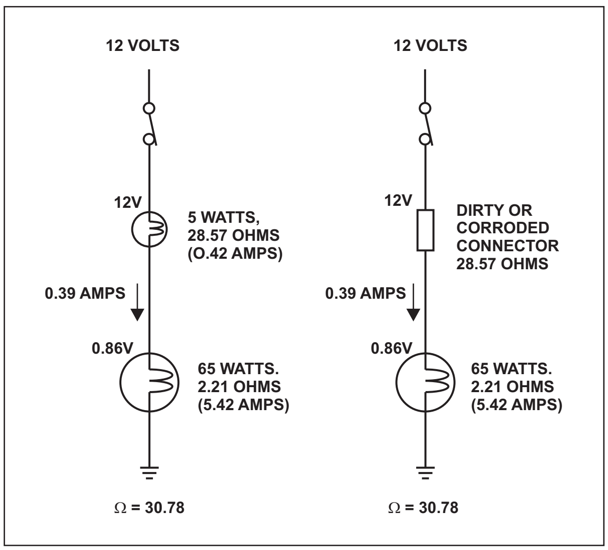

FIGURE 1

If you will recall from chapter 1, the 5W bulb limits the current in the circuit to 0.39A - enough to light the smaller bulb, but not the headlight. On the left side of **figure 1**, I have replaced the small bulb with a bad connector, which just happens to have, to make comparisons easier, exactly the same resistance as the small bulb, or 28.57Ω. The resistance of this bad connector will have exactly the same effect as the small bulb. It will limit the current in the circuit to 0.39A just as the bulb did. This current flowing through the connector will produce the same wattage in the connector, in the form of heat, as it did in the small bulb.

The connector will get quite warm to the touch, but the headlight will not be lit. Looking for a warm connection is one of the ways to find bad connections. Bad connections are one of the ways in which fires start. It can generate enough heat to melt insulation, and if it's bad enough, can actually cause the insulation and/or surrounding material to ignite.

Bad connections can throw off the results of your trouble shooting efforts as well. **Figures 2** and **3**, below, illustrates the potential problems bad connections can cause.

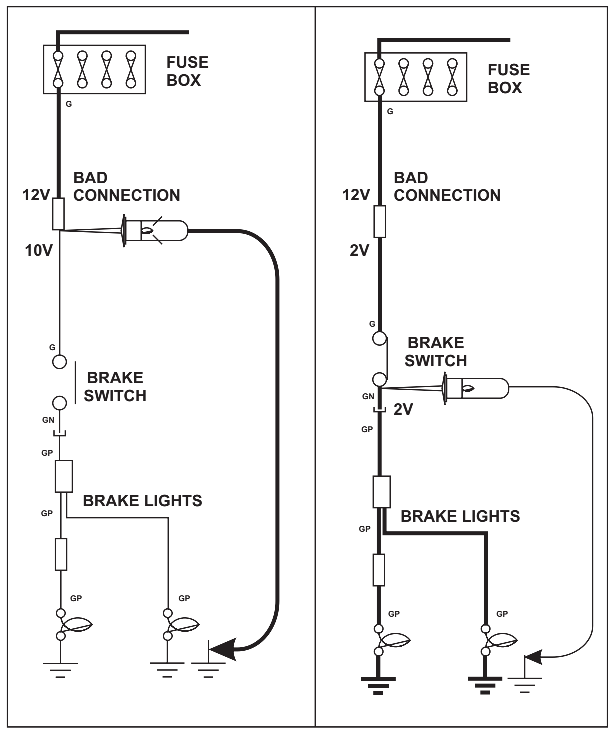

FIGURE 2

In these examples, assume the resistance of the bad connection is 5 times the resistance of the combined cold resistance of the two bulbs in parallel, and 1/5 the resistance of the test lamp - a very reasonable set of parameters.

In the circuit on the left of **figure 2**, with the brake light switch open, the test lamp forms a series circuit with the bad connector, just like the series circuit on the right of **figure 1**. With a resistance ratio of 5:1, voltage in the circuit will be divided in the same ratio - two volts will be dropped across the bad connector, and the remaining ten volts will be dropped across the test lamp. Ten volts is enough to light the test lamp to near full brilliance, at least near enough that the difference wouldn't be readily apparent to an observer.

In the circuit on the right, the brake switch has been depressed, placing the parallel combination of the two brake lights and the test light in series with the bad connector. The test lamp, having 25 times the resistance of the brake lights, changes the overall resistance of the lights by very little, so we still have an approximate 5:1 ratio of resistance between the lights and the bad connector. In this case, though, as compared to the situation on the left, the bad connection has the highest resistance, so it will drop the most voltage. This gives a 10 volt drop across the bad connector, and the remaining two volts are dropped across the lamps. Two volts are not enough to operate the test lamp, giving the impression that the brake switch is faulty, when in reality, it is perfectly good.

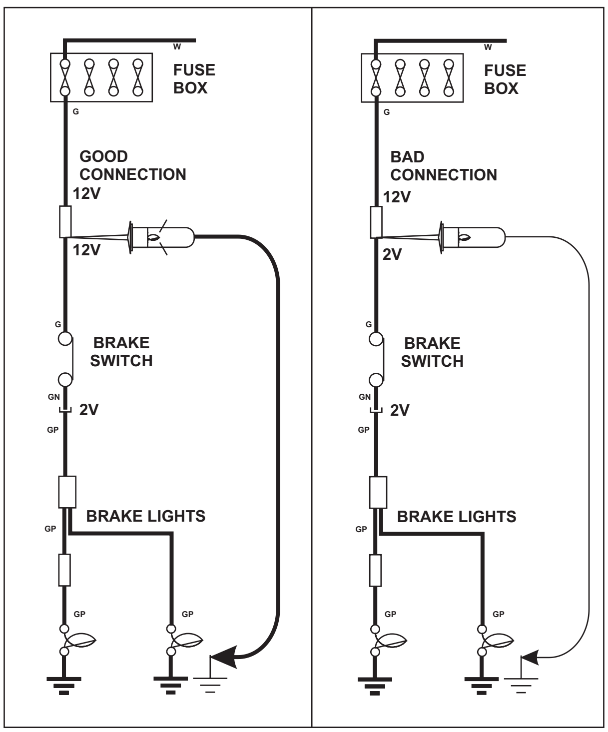

FIGURE 3

There are a couple of things you can do to help prevent obtaining misleading results:

1. Always check both sides of any connector or switch you are testing. As shown in **figure 3**, if they are good, the voltage will be the same on both sides of the item. If you have a significant noticeable difference, the connector or switch should probably be replaced or repaired. Replacement or repair is most definitely called for if the difference is near one volt or more.

2. If you can, try to have the circuit in operation, or at least as much in operation as possible, given that the circuit is probably not working or you wouldn't be testing it in the first place. Put the switch in the "ON" position at least, so the circuit will draw as much of it's normal current as it can.

BAD GROUNDS

Bad grounds can create pretty much the same type of problems as bad connections, plus they can create some pretty weird and hard to diagnose problems. For an example of a typical "bad ground" type problem, refer to **figure 4**, below. This figure is just a redraw of **figure 1**, but I have reversed the order of the components in the circuits. On the left, I have placed the smaller bulb at the bottom of the circuit, near the ground connection.

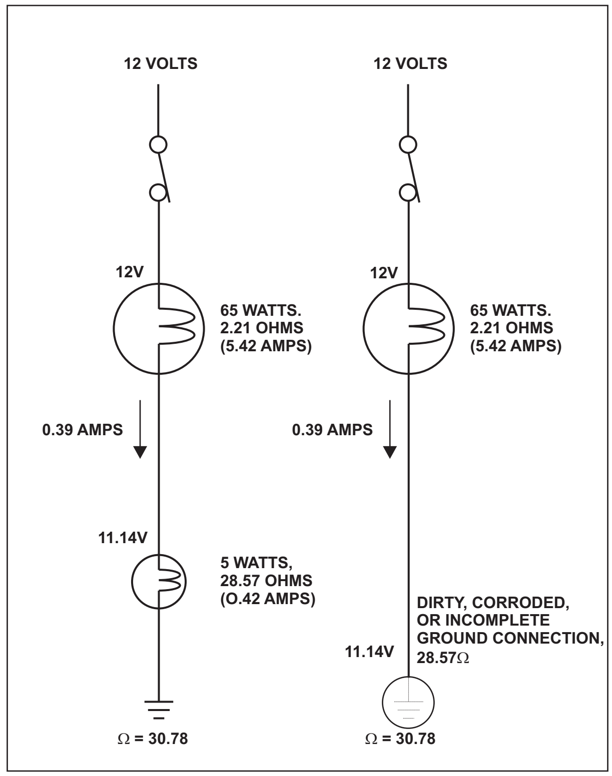

FIGURE 4

The total circuit current is the same as before, as are the voltage drops across the two bulbs. Because the bulbs are reversed, so is the relative circuit voltages. The large bulb still drops 0.86 volts as before, leaving 11.14 for the smaller bulb, just as before; however, instead of reading 0.86 volts on the wiring between the two bulbs, we now read the 11.14V of the smaller bulb (larger resistance).

On the right, I have replaced the smaller bulb with a "bad ground" of the same resistance as the original bulb. This bad ground reduces the circuit current just the same as the small bulb did, and will produce the same 5 watts of heat that the bulb did. This gives a clue as to one of the ways of finding a bad ground connection: a voltmeter placed in the circuit near the ground connection should read zero volts. If it reads more than that, the ground connection is bad. The higher the voltage reading, the worse the ground connection.

WEIRD THINGS

As stated earlier, bad grounds can cause some pretty weird problems. For an example of this, take a look at the three figures below. In **figure 5**, I have drawn a very simplified version of the combined brake and tail light circuit, leaving out some of the bulbs. The bulbs used for these functions are dual filament bulbs, each having one 5W element and one 21 watt element. The brake light uses the 21W, and the tail light uses the 5W. Both elements share the same ground connection internal to the bulb. With every thing working as it should, and the parking lights are switched on, the parking lights come on full, as shown by the heavy lines in **figure 5**.

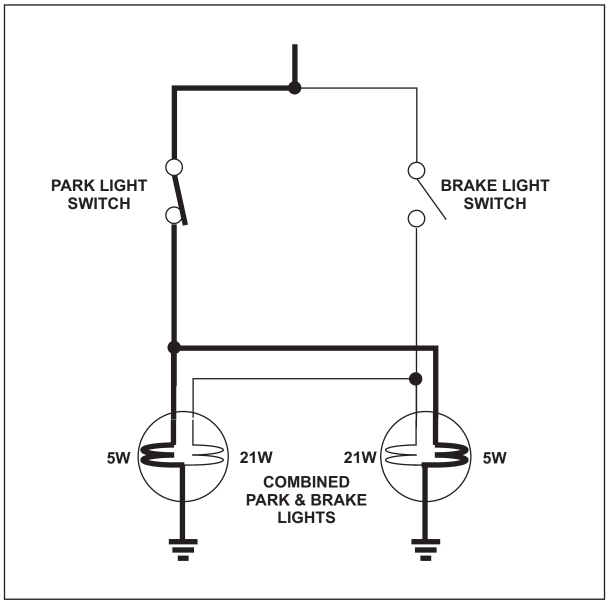

FIGURE 5

Figure 6 shows the condition where the ground connection to the left hand bulb is missing. In this case, the right hand bulb lights as normal, but the two 21W elements (RH and LH bulbs) are now in series with the 5W element of the RH bulb. These three series connected elements are now in parallel with the 5W element of the RH bulb. With 12 volts applied to the series combination, the current is reduced through the series elements, and the voltage applied to each is split, according to the relative resistance of the bulbs. If you do the numbers (using hot resistance values), you'll find that the current through the three elements is about 70% of the rated value for the parking light element. Given that the same current is only about 16% of rated current for the 21W elements, they will not get enough current to heat up, let alone illuminate. Therefore, the 5W element will get a good bit more than 70%, probably in the neighborhood of 85 - 95%, of rated current, so it will be lit to near full intensity (the cold resistance of the 21W elements being much less than the hot resistance, more current will flow than originally calculated using hot resistance values). The end result is that the parking lights will appear to be normal, even though one ground connection is missing.

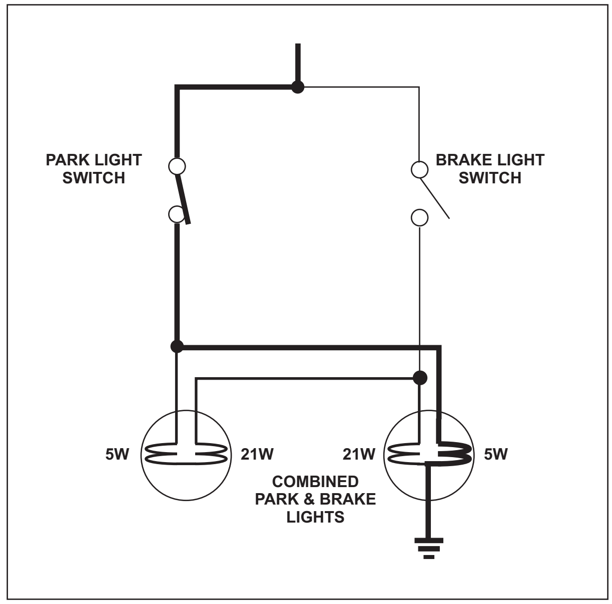

FIGURE 6

Now take a look at **figure 7**. In this figure, the brake light switch has been closed. As you can see, this places 12 volts on both sides of the LH bulb, as well as on the 21W element of the RH bulb. With 12 volts on both sides, and no ground, the LH bulb goes completely out - neither element is lit - while both elements on the right work as they should. This is certainly an oddity - turning on a switch causes a light to go ***OUT?*** Like I said, bad ground connections can cause some very funny things to happen.

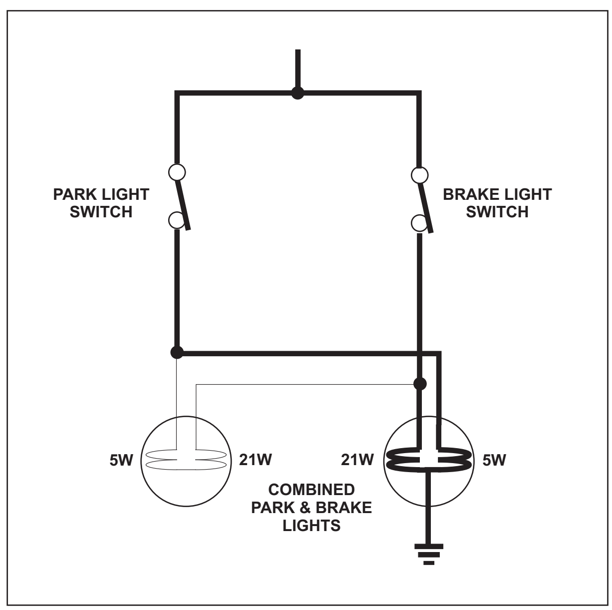

FIGURE 7