LED Illumination Retrofit

By Glenn Abello

A bit more than two years ago, *Austin-Healey Magazine* published an article on the conversion of the Original Equipment (OE) incandescent lighting to the more modern LED illumination (November-December 2011, Volume 43 Number 6, pages 32-34). The following provides an update for those of you who would like to upgrade your car to LEDs.

***NOTE:* It is highly advisable to convert your car to NEGATIVE EARTH (ground) prior to upgrading to LED lighting, as most automotive LEDs are polarity sensitive and designed for cars utilizing a Negative Grounded System.**

By now, we have all become familiar with LED illumination (Light Emitting Diode) in everyday usage, as it represents one of the alternatives to the incandescent lighting in our homes. The advantages of this type of illumination in our Austin Healey automobiles are quite startling.

- Longer Lasting (up to 10K hours of continuous lighting compared to 500-1200 hours for the OE bulbs)
- Provides a brighter, whiter light per watt of output
- More energy efficient, with the current draw measured in milli-amperes
- A cooler operating temperature (about 80 degrees F)
- Safer within the existing electrical system found in the car

Converting to LED lighting is a relatively straight-forward process, although it does take some patience and time, along with the ability to cram yourself into tight places. Virtually all lighting in the car can be upgraded to LEDs.

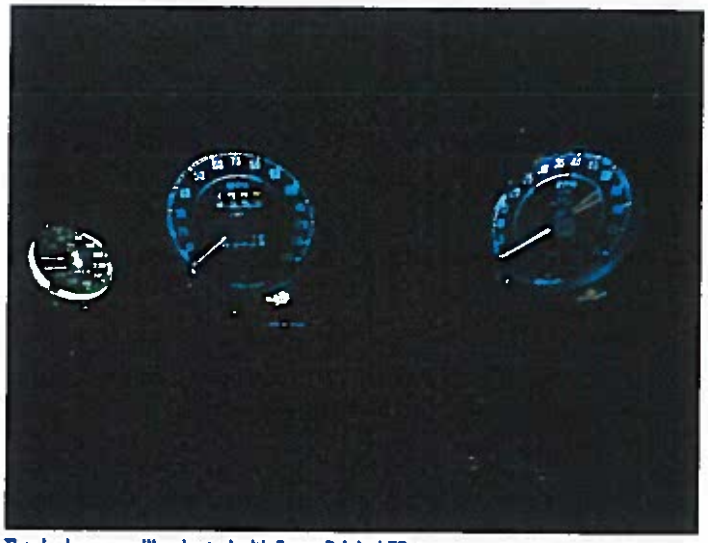
DASH PANEL

Gauge Lighting: This is an area of most concern when driving at night, as it's quite important to be able to read the instrument output. The OE bulbs were essentially screw-in flashlight units that had between a 2 and 5-watt output, so the instruments were never well-lit.

The original and replacement bulbs plus typical receptacles for gauge lighting.

The LED conversion will require changing the old screw-in receptacles of the OE wiring harness to the wedge-type receptacles*. These may be purchased from a variety of sources, including Nisonger Instruments (www.nisonger.com) and APT Instruments (www.gaugeguys.com). Both of these companies also are distributors of our Smiths Gauges.

Once this receptacle replacement is made, all that is left is to go to an automotive LED website and select your bulbs, such as Super Bright LEDs (www.superbrightleds.com). There are a variety of choices, but you'll want the equivalent of a Number 194 incandescent wedge-type bulb to provide the necessary illumination for your gauges.



The dash gauges illuminated with Super Bright LEDs.

Other Dash Lighting includes the High Beam Indicator Lamp and the Turn Signal Flasher lamps (there is only one dash flasher on all models except for the BJ8, which has two). Be sure that you match the color of the LED bulb with the color of the indicator gel on the dash (that is, use a BLUE LED for the High Beam and GREEN for the Turn Signals).

***NOTE:* The Generator/Alternator Warning Lamp MUST remain in its original configuration and cannot be converted to an LED. This is due to certain circuit requirements for the charging system that precludes the use of a low current LED.**

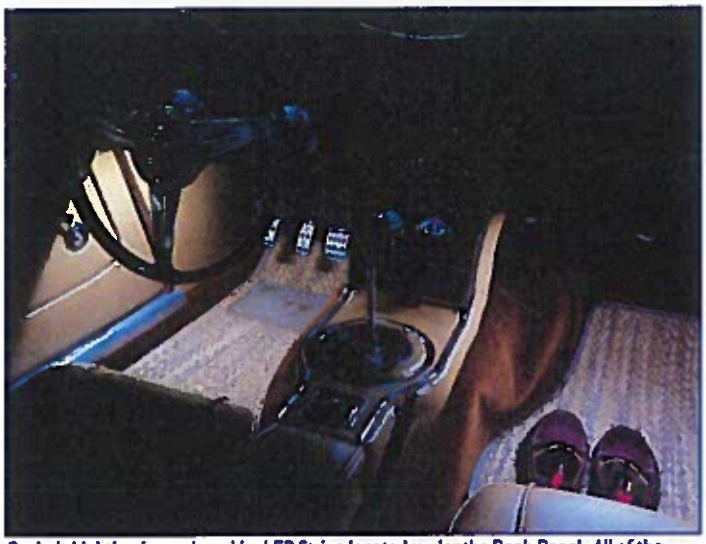
INTERIOR LIGHTING

The Austin Healey cars did not come with any auxiliary lighting for the interior of the car, so you had to carry a torch (flashlight), bring along a Guide Dog or get in the car during the daylight hours to avoid entering or exiting the car by "feel".

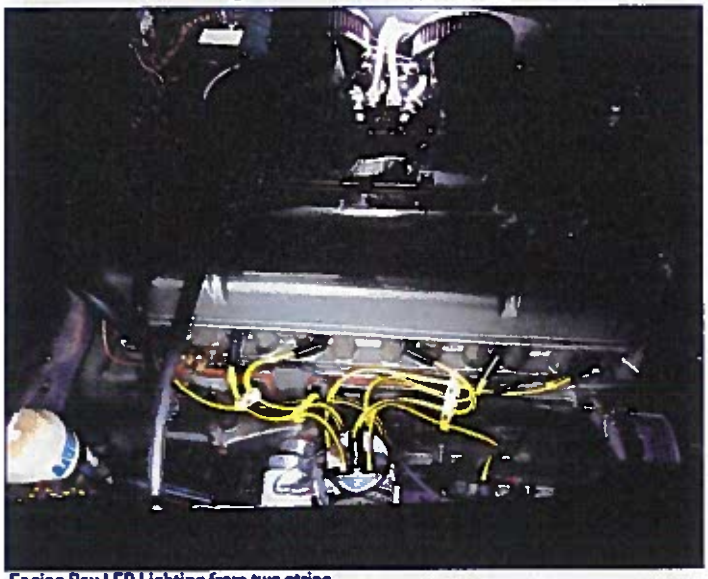
LED Lighting Strips are available that are self-adhering, waterproof and may be tucked into out-of-the-way locations to illuminate the cockpit, the boot, the engine bay and the glove box (BJ8 only).

***NOTE:* If your only goal is to convert the instrument lights to LEDs and not the other applications as listed below, you may purchase screw-type LED bulbs from Moss Motors for about $9 each (Part Number 170-970 for Negative Earth and 170-975 for Positive Earth). This will enable you to use the existing lamp sockets in your OE wiring harness and maintain your car in its original, Positive Earth configuration.**

Dim Healey Lights ... Some Things To Consider



Cockpit Lighting is produced by LED Strips located under the Dash Panel. All of the Interior LEDs are switched by means of the Panel Lighting toggle



Engine Bay LED Lighting from two strips

Boot Lighting generated from an LED strip

EXTERIOR LIGHTING

Parking Lamps are found as separate assemblies on the BJ8 Phase 2 models and appear as clear, plastic-globed units. They contain a single element, 5-watt #1156 bayonet-based incandescent bulb. The LED replacement will be accepted by the original Parking Lamp Receptacle, as it also is bayonet-based, but much brighter. These bulbs are available in either warm or cool white for the clear-lensed Parking Lamp Units.

Turn Signal Lamps* are separate amber lensed units, both front and rear, on BJ8 Phase 2 cars. The 21-watt #1156 (bayonet-based) incandescent OE bulbs would be replaced by a comparable amber LED bulb with a bayonet base (such as Super Bright # 1156-x24).

Turn Signal/Parking Lamps* are found on the front of all other Healey models, including the early BJ8 (Phase 1) cars. This OE clear glass-globed unit contained a single #1157 dual element (5/21-watt) incandescent bulb. The replacement for this OE bayonet-based lamp is a cool white, dual intensity LED lamp, such as the Super Bright #1157-x24.

Front Running Lights with LED bulbs (BJ8)

***NOTE:** All turn signal lamp conversions to LED bulbs, whether front or rear, MUST include the installation of a Flasher Relay (such as Super Bright FL3-RED) designed to accommodate the low current draw of the LED units in order for them to operate properly. This Flasher Relay will replace the OE Lucas relay.*

NOTE: in order to successfully use LED turn signals, an F3 Flasher Relay must be installed. This relay senses the low current draw output of LED lamps, thus allowing them to flash on-off, and cost about $13.

Rear Running Lights and License Plate Lamp powered by LED Bulbs

Brake Lights, which also serve as night time rear running lights on BJ8 Phase 2 cars, will easily convert to LED bulbs with a dual intensity, bayonet-based unit, such as Super Bright #1157-x24. Remember always to use an LED bulb of a color that matches the lighting unit globe color (in this case, RED, for the braking lights).

The rear lamps on all other Healey models, BN1 through BJ8 Phase 1, serve the dual purpose of turn signal lamps as well as braking lights. Bayonet-based, dual intensity LED lamps (Super Bright 1157-x24) in RED will successfully convert the rear lighting units of the car. Please refer to Photo 9 for an example of the LED conversion lighting of the car's rear end with brakes applied.

OE License Plate Lamp Unit came supplied with either one or two bayonet-based, 2.2 watt incandescent bulbs, depending upon what assembly was in the parts bin at the moment of the car's build. These may be replaced with a white LED bulb with a similar bayonet-style base.

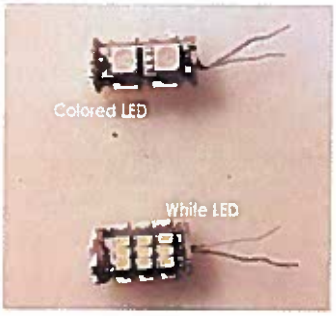
The conversion from the OE incandescent lamps to LEDs will result in a more efficient use of the electrical system in the car and provide a safer, brighter illumination. While this may run afoul of the strictest Concours d'Elegance judging, it is highly recommended for the daily driver and an occasional local car show, as it is very useful to be able to read your instrumentation and be seen after dark. Drive Safely!

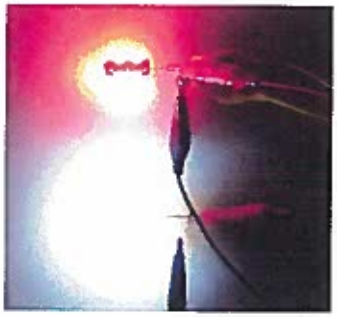
A Short Study on the Use of Non-white LED Bulbs Behind Colored Lenses

By Joe Parlanti

I had once heard that when using LEDs behind colored lenses it was advisable to use similarly colored LEDs. (see paragraph titled "Brake Light" in the left column). This seemed counterintuitive to me as the original incandescent bulbs are all white in color. I built a little test to verify this theory. Please keep in mind that the bulbs used in this test, which are those I had on hand, are similar to those sized for the E10 screw, T10 wedge, and BA9s bayonet bases and are not nearly as bright as would normally be used in tail lights. The bare bulbs are also of different type, the white one having 42, 1206 LEDs and the red one has 9, 5050 LEDs.

Here's a photo of them powered off and on. Notice how much brighter the white LED is:





Using a light meter placed 1.25" above each bulb, the readings were 4220 LUX for the white bulb and 550 for the red.

Now placing a red lens over each bulb yielded the following results:

White LED
300 LUX

Red LED
430 LUX

Not only was the red LED brighter but it produced a more "Red" color than the white LED which appears to the eye more of an orange color. In conclusion, lower output colored LEDs produce a higher output after passing through a similar colored lens.

SOME ADDITIONAL INFO ON LED LIGHT CONVERSIONS

By Steve Day

It's the hot buzzword for today: LED light bulbs, and, for good reason! Light emitting diodes, (LED`s), are better in almost every way: much brighter, lower power consumption, and the cycle of off-to-on is instant. They are widely available and reasonably priced, and now with the addition of positive ground LED`s for brake/taillight/turn signal, and screw base LED`s for the dash, it`s made it a little easier to convert to the LED system and benefit from the increased brightness they give.

Brightness that directly translates into safety for the car and us.

There are at least two choices when doing the brake/tail/turn signal upgrade. There are LED`s in bulb form, to directly replace the incandescent bulbs in our cars, and a circuit board with individual LED`s mounted on it, that goes in under the lens and replaces the bulb arrangement completely.

Each has it`s own distinct advantage. The bulb form is quick and cheap, the circuit board style is by far a brighter unit, with up to 60 LED`s, (depending on your model car), to light up on each board.

Suppliers I have used and been very happy with are: For the bulb style, www.superbrightleds.com, and for the circuit board style, www.classicautoleds.com .

Moss Motors also offers a line, and now has the screw in base LED`s for the dash.

Here are some general notes to keep in mind when considering this upgrade.

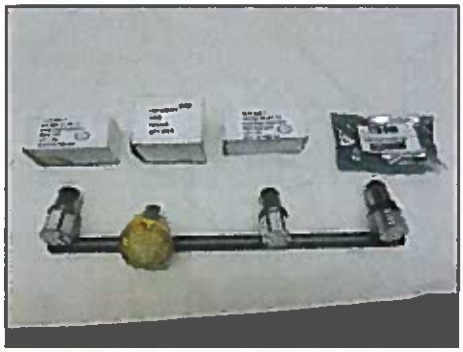
LED bulbs are polarity (ground), sensitive, so make sure you order the proper ground type for your car.

LED bulbs come in colors, clear, red, amber, blue, green. You select the bulb color to match the color of the lens it will shine through, red for a red lens, etc.

Led bulbs take 1/10th the current that the original incandescent bulbs do, which is good. They don`t tax the charging system, and they run cool. Drawing less current does present a couple of problems: One, the original turn signal flasher won't know the led is there, and won't flash. You must convert to an electronic flasher unit that is made for low wattage bulbs. Two, on some cars, the turn signal indicator circuit will allow that small amount of current to bleed back to the other side, and the turn signals will work on both sides at the same time! Moss Motors has a ballast resistor for this problem, part number 170-965. You need one on each side, for a total of two on the car.

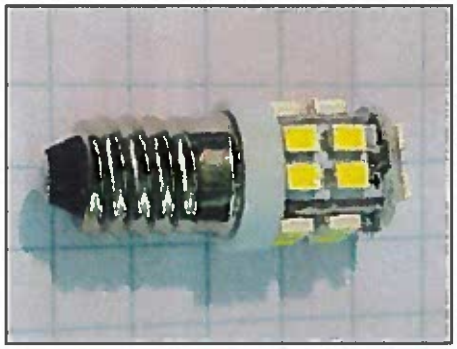
Additional considerations when replacing with the bulb style LED, are the bulb socket, gasket and rubber boot. Make sure you examine them carefully; most cars need them replaced after four decades of service!

Once again, when you are marrying modern technology to a 50-year-old car, it presents some unique challenges along the way. For instance, in considering which bulbs to buy, you must decide how many diodes will fit under the lens, which beam angle do you need, what relative intensity you desire.Teaming up with an experienced mechanic will help you sort this out, and help to make sure you finish with a safe and dependable job.



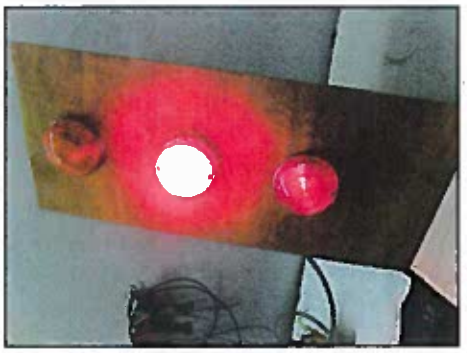
Bulb style choices for stop tail turn signal

Dash LED samples



A positive ground, screw-in dash LED

Circuit board LED for stop tail turn signals



Circuit board LED center, bulb style LED lower

Examples of electronic flashers

Testing and Repairing Directionals and Brake Lights

Part 1

By John Trifari
Golden Gate AHC

All Big Healeys up to Phase 2 BJ8s use integrated directional and brake lamps controlled by a DB-10 relay, an electro-mechanical device about the size of a cigarette box. It's found on the inner left-hand fender well of the engine bay.

The DB-10 relay is, essentially, a switch. It controls the flow of current between a brake lamp circuit that feeds power to both rear lamps when the brake pedal is depressed and to a directional circuit that feeds power to one or the other rear lamps, depending on which way the trafficator switch is thrown. The DB-10 relay permits the integrated brake lamps/directionals of a Big Healey to perform three different functions: they can be used solely as brake lights, one or the other can function as a directional only, or simultaneously, one can operate as a directional while the other serves as a brake lamp – an important consideration if you hit the brakes while entering a turn. Rear parking lights are separate circuits and are not related to either the directionals or the brake lights. Front directionals are a supplemental function as described below.

Here are some thoughts on how the brake lamp and directional circuits work, how the DB-10 relay works, how to check out brake lamp and directional circuits in cars equipped with this relay, and how to get in-op lights up and running.

Inside the DB-10 relay

Figures 1A and 1B show the right and left sides of the relay with the cover removed. Within each relay are two coils (A), each actuating a spring arm (B) that moves between a traverse bridge (C) connected to the brake lamp circuit and a traverse bridge (D) which is connected to the directional circuit. Each spring arm has contacts at the tip on the upper and lower sides. The position of a spring arm – whether touching either the upper traverse bridge (C) or the lower bridge (D – determines whether a given rear lamp will be used as a brake lamp or a directional. The front directionals get power when the spring arm comes in contact with a connector bar (E).

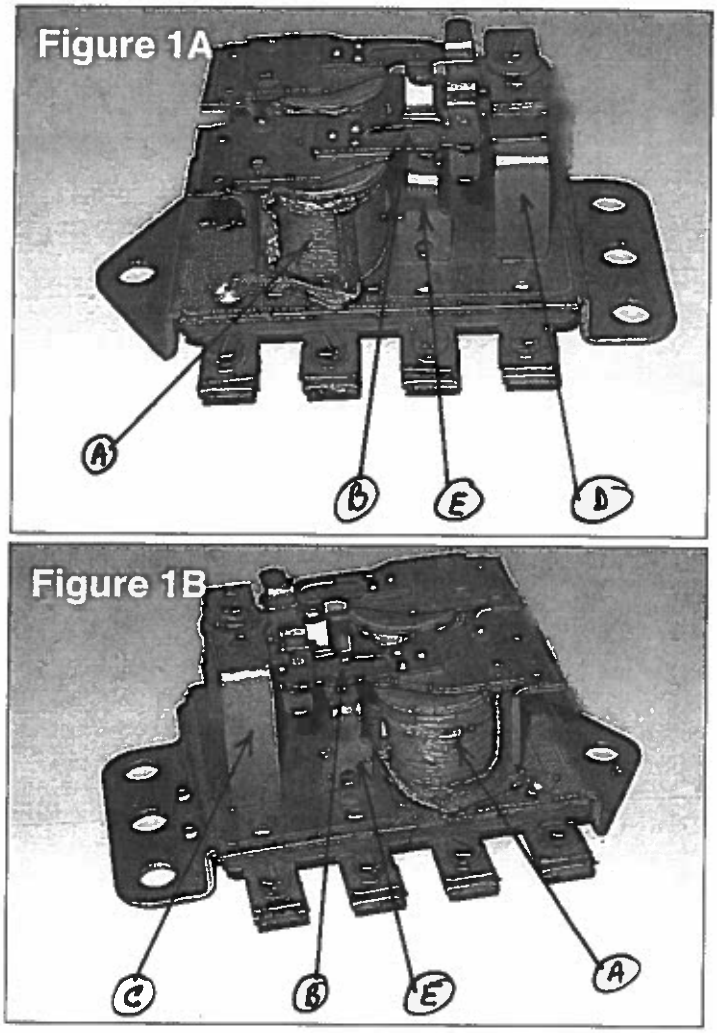
The relay has eight screw terminals, four per side. Terminals #1 through #4 are shown right to left in Figure 1A. Terminals #5 through #8 are shown left to right in Figure 1B. These terminals are used for the following:

#1: Power in from the flasher.
#2: Power out to right front directional.
#3: Power out to right rear directional.
#4: Power in from Trafficator Switch (right).
#5: Power in from the Stop Lamp Switch.
#6: Power out to left front directional.
#7: Power out to left rear directional.
#8: Power in from Trafficator Switch (left).

How the DB-10 relay operates

Brake lamps: In the DB-10 relay, both spring arms (B) are normally at rest with contacts on the upper edge of their tips, touching matching contacts on the lower side of the upper traverse bridge (C). When the brake pedal is depressed, fluid pressure closes the Stop Lamp Switch mounted off the right-hand frame rail below the generator, closing the brake lamp circuit. Power now runs from fuse terminal A4 to relay terminal #5 and up into the upper traverse bridge. It continues through the contacts, down both spring arms to the bases of the coils, and simultaneously out terminal #3 (right rear) and terminal #7 (left rear), illuminating both rear lamps. Figure 2 shows the brake lamp circuit on a Big Healey.

Directionals: The directional circuit is normally open due to



Figures 1A and 1B: Interior of the DB-10 Directional Relay. Each relay contains two coils (A), each actuating twin spring arms with upper and lower segments (B). Figure 1A shows the right-hand side. Figure 1B shows the left. Each upper spring arm segment has contacts on both the upper and lower sides at one end. Each lower segment has contacts on one end on the lower side only. These spring arms move between the upper and the lower traverse bridges (C, D). The front directionals get power via a connector bar (E). The DB-10 Directional Relay also has eight screw terminals, four per side.

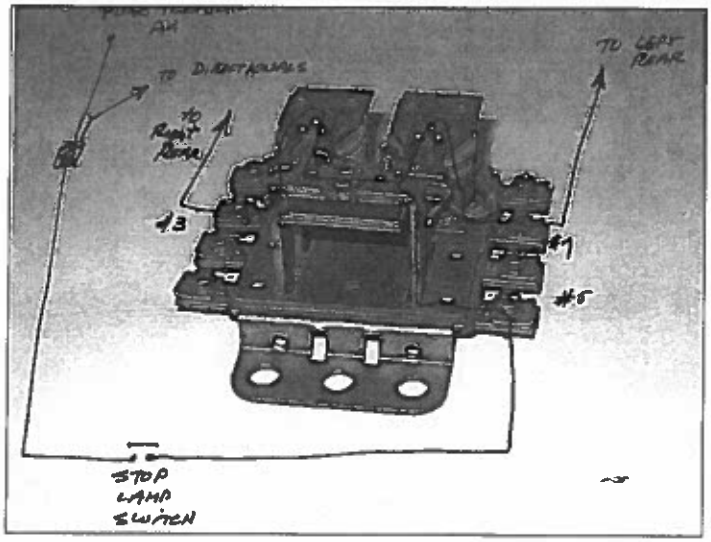


Figure 2: Generic brake lamp circuit. Power for the brake lamps is provided by fuse terminal A4/A5 (ignition fuse) via a pressure-activated stop-lamp switch. Power flows into terminal #5, through the two spring arms and out terminals #3 (right-hand rear) and terminal #7 (left-hand rear).

the position of the spring arms against the upper traverse bridge. This changes when the trafficator switch is positioned right or left. Throwing the trafficator to the right, for example, sends power to relay terminal #4, actuating the right-hand coil. This causes the right-hand spring arm to be pulled down, away from the upper traverse bridge and down against the contacts on the lower traverse bridge. Since the spring arms act as switches, this disconnects the brake lamp circuit on the right side, and closes the right-hand directional circuit. Power now flows from fuse terminal A4, through a flasher and into relay terminal #1, up to the lower traverse bridge, across the right-hand upper spring arm and out terminal #3 to the right-hand rear lamp. The left hand spring arm meanwhile, remains at rest against the upper traverse bridge. Thus if the brakes are applied while the right-hand directional is flashing, the left-hand rear light will continue to function as a brake lamp. Note that when the spring arm is pulled down, contacts on the lower side touch contacts on the connector bar (E – Figure 1A) linked to terminal #2, simultaneously providing output to the right front directional lamp.

Making the Directionals and Brake Lights work

Now that we know how these circuits work, lets see if we can get them operational.

Test Number 1:

Assume the neither the brake lights nor the directionals work when you hit the brake pedal or throw the trafficator. The first thing to do is make sure you've turned on the ignition and that the bulbs are good. Next, we want to check the integrity of the circuits between the relay and the lamps. To do this, you'll need a 4-foot wire lead with alligator clips on each end. For safety purposes, make sure one clip has a hood on it. For additional safety, connect that end of the lead to fuse terminal A4 (fused side of the ignition fuse). Turn on the ignition. Touch the other end of the test lead to relay terminals #2, #3, #6 and #7 in turn. (The numbers are stamped on the cover of the relay.) The right front, right rear, left front and left rear lamps should illuminate one after the other.

Remember that just above fuse terminal A4 are hot terminals A1/A2. These are hot even with the ignition *off*. Be careful clipping the lead to fuse A4. If you have difficulty attaching the test lead to the fuse bloc, disconnect the battery first so as not to inadvertently touch fuse A1 or A2. Also be careful not to accidentally touch the car body with the other end of the test lead wit the ignition *on*. Be sure to turn the ignition *off* or disconnect t lead from the fuse bloc when you are not using it.

This test by-passes the relay entirely. If one or two lamps fail to light up, you may have nothing more dramatic than a burned-out bulb(s). If no lamp illuminates, then you have four burned out bulbs, no power at the fuse bloc terminal A4 (bad fuse?), bad connections between the relay and the test lead (or dirty relay terminals), or worst of all, four badly grounded (or bad) sockets and/or four separate wiring problems between the relay and the lamps.

Let's assume the worst of all, starting with the front right directional.

1. Clip the test lead between fuse bloc terminal A4 and relay terminal #2.

2. Turn on the ignition and use a circuit tester to verify that you have power at terminal #2 and at the connection to the headlight pigtail under the front shroud on the right. Make sure the headlight switch is *off* so as to render the running lamps in-op.

3. If you have power at the pigtail connection, move on to the front-right lamp socket itself. It might help to take off the wheel. With the power off, use a continuity tester to check the connection between the socket and ground.

4. Finally use the circuit tester to check the contacts within the socket. There are two contacts – one for the running lights, the other for the directionals. If you have power at one (headlight switch *off*), but the lamps still do not light up (assuming the bulb is OK) then the bulb is not touching the contacts in the socket. The best thing to do is replace the socket.

5. If you have no power at any of the points between the rela terminal #2 and the right-hand front socket, you can guess th you've got some sort of wiring problem between the relay and the socket. You can verify this by clipping one end of a lead to relay terminal #2 and the other end to the socket input. Clip a second lead between relay terminal #2 and fuse terminal A4. Turn *on* the ignition. You should have a right front directional.

6. You can try to track down the problem, but my suggestion is simply to string a replacement wire from relay terminal #2 to the lamp in question. I have a few wires like that in my BN1 and I have them covered in shrink tubing and tied to the original harness with cable ties. If you don't get any light by applying power directly to the socket, you're at the end of the line. Go back and check things out again.

7. Repeat the test for the left-hand front directional using relay terminal #6.

8. Remember you may have more than one problem: e.g., you could have a bad socket and a bad connection.

Checking the rear lamps:

1. To check out the right rear directional, connect your test lead between fuse terminal A4 and relay terminal #3 (right-hand rear). Turn on the ignition. The right rear directional should light up.

2. If not, leave the test lead in place and check for power at the connection between the frame harness and the chassis harness. For the right-hand directional, this is the white/brown wire connected just behind the front crosspiece on the left-hand side (white/purple for the left-hand directional).

3. If power is there but still no light, go to the trunk and che for power at the white/brown connection between the chassis harness and the trunk harness.

4. If you have power at the frame harness as per #2 above, but

none at the trunk harness, you have a break in the white/brown wire running under the frame.

5. Run a test lead back into the trunk and verify that you can power the lights directly from the fuse bloc as described above. If this works, the socket is OK but you have confirmed a bad connection between the relay terminal and the lamp somewhere under the frame. Again, you can try tracking it down or you can string a new wire from the relay back through the cockpit to the trunk.

6. If you have power at the contacts within the sockets, but no light, you probably need a new socket.

7. Repeat this check for the left rear directional using relay terminal #7.

This kind of electrical detective work may take some time, but nothing is going to operate correctly unless you can get the front and rear lamps to light up by applying power directly to the relay terminals.

Test Number Two – Brake lights:

Assuming that all four lamps do light when power is applied to relay terminals #2, #3, #6 and #7 as described in Test 1 above, use the test lead connected to fuse terminal A4 to apply power to relay terminal #5.

1. In this case both rear lights should come on simultaneously.

2. If the rear lights *do not* come on when power is applied to terminal #5, but *do* come on when power is applied directly to terminals #3 and #7 as per Test Number One, you have a problem within the relay. Probably the contacts are not resting against the upper bridge. You will need to remove the relay and check it out as described below.

3. If both rear lamps *do* come on when power is applied to terminal #5 but *do not* come on when the brake pedal is depressed, you probably have a problem with the Stop Lamp Switch. You could also have a problem with the wiring between fuse terminal A4 and the switch, a problem between the switch and the relay, or any combination of these three.

4. To test the stop lamp switch, jump the two terminals on the switch. Turn on the ignition. The brake lamps should come on. If so, that means the switch is defective and your best recourse is to replace it.

5. To test the wiring between the power source and the switch, run a test lead from fuse terminal A4 to the input side of the switch. Hit the brake pedal. If both lights come on, you've isolated the problem – probably something wrong at the connector that joins the brake lamp and directional lines into a common link that runs to fuse terminal A4.

6. If still no brake lights, keep the switch terminals jumped and check for power at the output side of the switch. If you have power, run a test lead from the output side of the switch to terminal #5. If the lights now come on you have some sort of wiring problem between the switch and the relay. Again use a replacement wire to make a new connection.

Again, that this kind of detective work may be time consuming, but there's no point in moving on until you've isolated the problem and fixed things. Remember too, that it is possible for a circuit to be dead for more than one reason. You could have a bad switch, a bad connection and a problematic relay.

Test Number Three:

Assuming the lamps light up per Test Number One and that the Brake Lights operate as per Test #2, but the directionals still don't work when the trafficator switch is moved left or right.

1. First check the trafficator. Here's how: Use the test lead to apply power directly to terminal #4 (right-hand coil). Turn on the ignition. You should hear a "clack" as the coil actuates and pulls

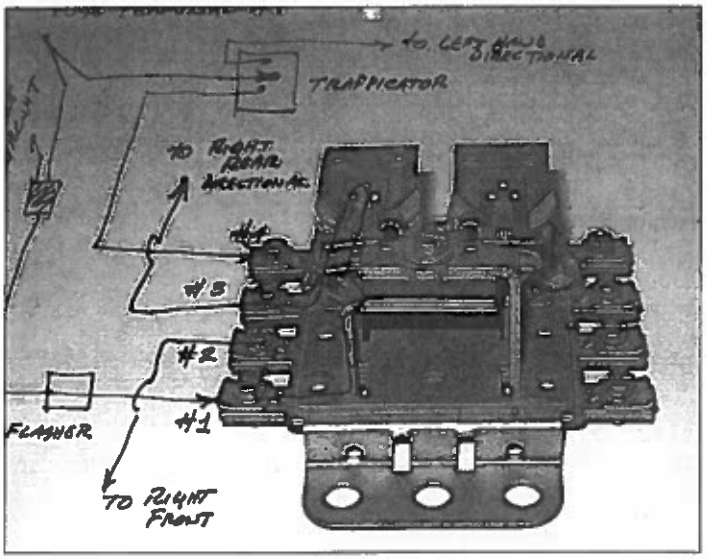


Figure 3: Generic directional circuit. This circuit is a bit more complex. When the trafficator is moved right or left, power flows from fuse terminal A3/A4 to either relay terminal #4 or terminal #8, actuating the corresponding coil, pulling down the spring arms on that side. The spring arms act as a switch between the brake lamps and the directionals, and normally are set so that the rear lamps function as brake lamps. When one spring arm is pulled down due to the action of the direction indicator switch and the corresponding coil, the brake lamp on that side is disconnected, and the lamp serves as a directional. The beauty of this little electro-mechanical control device is that it allows one lamp to serve as a directional while the other can continues to operate as a brake lamp. Note that while the brake lamp circuit and the directional circuit are functionally separate, power for the brake lamps and directionals is drawn from a common point, minimizing the number of connections at the fuse bloc.

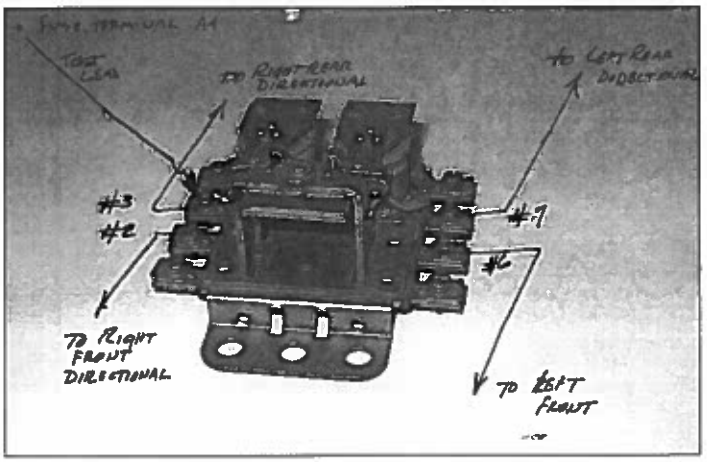


Figure 4: Lamp function check: Connect one end of a test lead to fuse terminal A4. Turn on the ignition. Touch the other end of the lead to relay terminals #2 (right front), #3 (right rear), #6 (left front) and #7 (left rear) and see if corresponding lamps can be illuminated. Drawing shows test lead connected to fuse terminal A4 and relay terminal #3. Fuse terminal A1 is a hot fuse, *so be careful. Disconnect battery if any difficulties in installing test lead to fuse bloc.*

Installing Four-Way Hazard Lights in a BJ8

By John Trifari

Golden Gate Austin Healey Club, Sunnyvale CA

A long time ago I came across a complete Lucas four-way hazard system – switch, flasher and casing (part #54006501) – and I installed it in our BN1. This system allowed all four turn signals to flash simultaneously. When we added the BJ8 to the family, I thought that this car should have four-way hazard lights too.

Installing these lights in the BJ8 was easy. Getting a four-way hazard switch was another matter. I could not seem to find a Lucas unit like the one I installed in the BN1 at a reasonable price. Moreover, the "universal" switches had long ago disappeared from the shelves of the local auto supply houses and for a very good reason – four-way hazard lights were no longer an "extra" on cars. Now they were built in and only Healey owners needed them.

At the Dixon (Calif.) Car Show every year there's always a swap meet. This year, after I parked the BN1 and raised the hood (no rain this year), I wandered the swap meet looking for whatever. What should my wandering eyes behold but a Lucas four-way hazard switch. It wasn't the complete assembly – the flasher and casing were missing – but the guts – the switch (part #30712) with wires attached, the knob (part #54329399), and the bulb (part #281) – were there.

Four-way hazard lights and the right and left turn signals all use the same lamps. Hazard lights have their own flasher though, and power comes directly off the battery so you can use them if the ignition is off (as opposed to the ignition for the turn signals). Both circuits also feed through a hazard switch like the one I picked up at Dixon.

Figure 1 shows how the two circuits work together through the hazard switch. When this switch is closed (and the hazard lamps not on) the turn signals operate normally. When you pull the hazard switch, however, the turn signals are automatically disconnected. Power from a separate source then feeds through the switch and directly to the four turn signal lamps, and all four lamps flash simultaneously. Power for the hazard circuit can be taken from any hot source – the battery, the starter solenoid, the regulator or fuse A2. I had added an auxiliary fuse block tapping power from the junction box I use for the alternator I installed in the BJ8 (See June 2004 *Healey Marque*).

Before installing these hazard lights remember two things:

1. Be sure all the wires coming into the cockpit – especially the power line – are well insulated. I covered all the wires with shrink tubing. Be sure too that you use grommets whenever a wire passes through the firewall.

2. Since you are dealing with a hot line, be sure the battery is disconnected before you start poking around.

The first decision is where to locate the hazard switch. Our BJ8 is a "rolling process" and one day we may go for a full ground-up paint job. At that point I will probably incorporate the hazard switch (along with a voltmeter and other switches) directly into the console. For the moment, the hazard switch is secured by temporary mounting screwed under the dash panels as shown in photo 1.

Now let's start wiring this thing up.

1. First, solder bullet connectors to ends of the wires coming off the hazard switch – power (brown or purple), ground (black), two lines for the turn signals (both green/brown), and two lines (green/white; green/red) for the hazard lights.

2. Locate the flasher for the turn signals and disconnect the green input line that runs from the ignition fuse/trafficator to terminal B on the flasher. Use a circuit tester if in doubt. Unscrew this wire from the flasher and clip off the ring connector at the end of the wire. Replace it with a bullet connector. Make up two lengths of 14-gauge wire each long enough to reach from the hazard switch, through the firewall and over to the turn signal flasher. Add three inches to both wires for luck. Cover these wires in shrink tubing, and solder bullet connectors to both ends of one wire. Solder a bullet connector to one end of the second wire, a ring connector to the other end.

3. Using single sleeve connectors connect one end of the first wire to one of the green/brown wires coming off the hazard switch; the other to the green power line that was formerly connected to the turn signal flasher. Connect the second wire to the other green/brown wire coming off the switch, the other end (with the ring connector) to the turn signal flasher terminal B where formerly the green wire had been attached. Don't forget a grommet where you bring the wires through the firewall.

4. What you have done is splice the hazard switch into the power line for the turn signals. Once everything is hooked up, verify that the turn signals work OK.

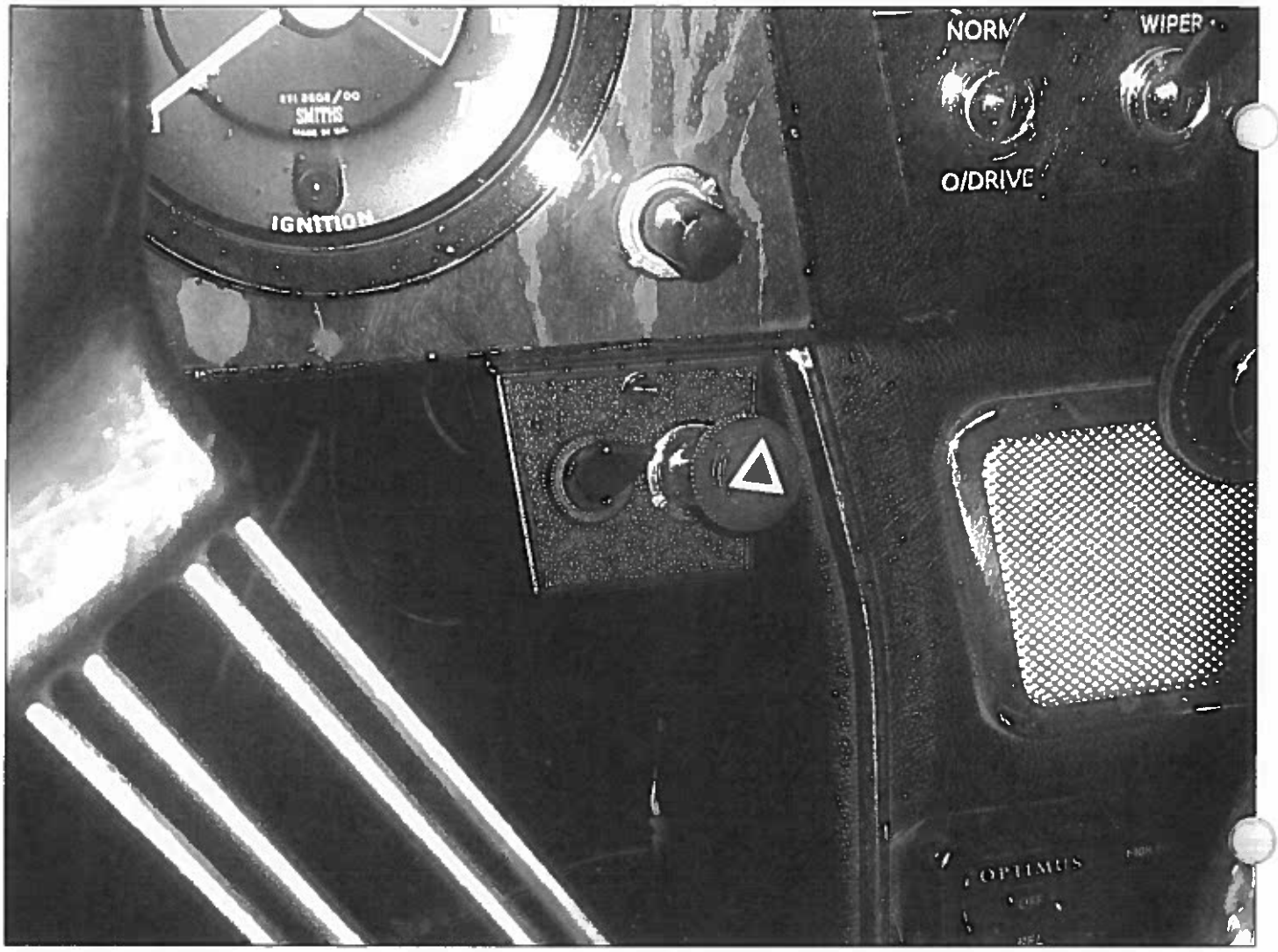
A) Make sure that the hazard switch is closed (knob is pushed in).

B) Turn on the ignition and move the trafficator left and right and verify that the turn signals are working OK.

C) Pull the hazard switch and the turn signals should cut out. Push the switch in and the turn signals will come back on.

If the turn signals don't work, go back and check all the connections. Be sure the turn signals are functioning properly through the hazard switch before moving on.

5. The lines from the trafficator to the turn signals run along the left-hand side of the firewall on the engine side, and branch off to the front and rear lights via two dual-sleeve connectors. These connectors are fairly easy to spot – one wire comes in to the connector and two wires go out. If you're lucky, you might even be able to see that the wire coming into one connector is green with blue and the lines leading out are green with red. These are the lines for the left-hand turn signals. The other connector (right-hand turn signals) has a green with yellow line in and two green with white lines out. It's important to know which is which. Use



a circuit tester if you can see any color-coding.

6. Cut two pieces of 14-gauge wire each long enough to reach from the two double connectors, through the firewall and to the location you have established for the hazard switch. Add three inches to each. Solder bullet connectors to the ends of both wires, and cover with shrink tubing. Run the wires through the firewall and connect the end of one wire to the green with white wire leading off the switch; the other to the double connector with the green with white wires (right-hand lamps) on the firewall. Connect the other wire between the green with red switch wire and the double sleeve connector with the green with red wires. Don't forget the grommet where the wires go through the firewall.

7. Disconnect the battery. Run a 12-gauge wire from your power source, through the firewall and into the cockpit. Connect it to an in-line fuse holder. Connect the other end of the fuse holder to a flasher. Connect the flasher to the brown power wire on the switch. Insert a 20-amp fuse. (Note – if you take power off fuse terminal A2, you will not need a fuse holder. In that case you can connect the power line directly to the hazard switch.)

However you connect the power line, remember that you will be connecting this wire to a hot source. So A), be sure the battery is disconnected before installing it, and B) be sure you cover the wire with good insulation (I use shrink tubing) and C) don't forget a grommet.

8. Finally connect the black wire to ground.

El momento de verdad: Pull the hazard switch (ignition on or off) and you should have instant four-way hazard lights. Push the switch in and the hazard lights should cut off. Turn on the ignition and throw the trafficator one way or the other and you should have a turn signal. Check the other way. Pull the hazard switch and the turn signal should cut out and the four-way hazard lights should come on. Now you have all the hazard lights you need. Hope you never have to use them.

Some final thoughts:

1. Before you start wiring anything up, I would verify that the hazard switch is working OK, especially if you pick it up at a swap meet like I did. To do this you'll need a test lamp, some test leads with alligator clips and a power source. I use a power supply I got from Radio Shack. A car battery is a good alternative, or the car itself can be used if there's nothing else available. To test the turn signals: connect the positive lead of the power supply to one of the green/brown wires coming off the switch. Connect the one lead of the test lamp to the second green/brown wire; the second lead to the

negative terminal. Turn on the power. The lamp should be on if the switch is closed (knob pushed in), and should cut off when the switch is pulled out. If so the turn signals are OK. Turn off the power supply and connect one lead off the test lamp to the green/white wire coming off the switch. Connect the other lead to the negative terminal. Connect a test lead between the power line off the switch (brown) and the L terminal of a flasher. Connect the positive terminal of the power supply to the B terminal of the flasher. Turn on the power supply. Pull out the switch knob. The test lamp should flash. If so, the right hand hazards are OK. Repeat the process using the green/red wire off the switch (left-hand hazards).

2. There is a small bulb (part #281) in the knob of the Lucas hazard switch. This lamp flashes in time with the four hazard lights. If the bulb is good but does not flash, make sure that it is making proper contact with the socket. A small spring is supposed to sit on top of the bulb to press it downwards. This spring may be missing. Don't try to get a better connection by over tightening the knob or by using a spacer.

Parts list:

One hazard switch. I used a Lucas #30712 with knob (part #54329399).

One mount: I used a universal mount from radio Shack.

One fuse holder with 20 amp fuse.

One two-terminal flasher.

15 feet of 14-guage wire for connections between turn signals and lamps and for ground line.

Three-four feet of 12-gauge wire for power.

About 10 feet of 3/8" shrink tubing.

9-12 bullet connectors.

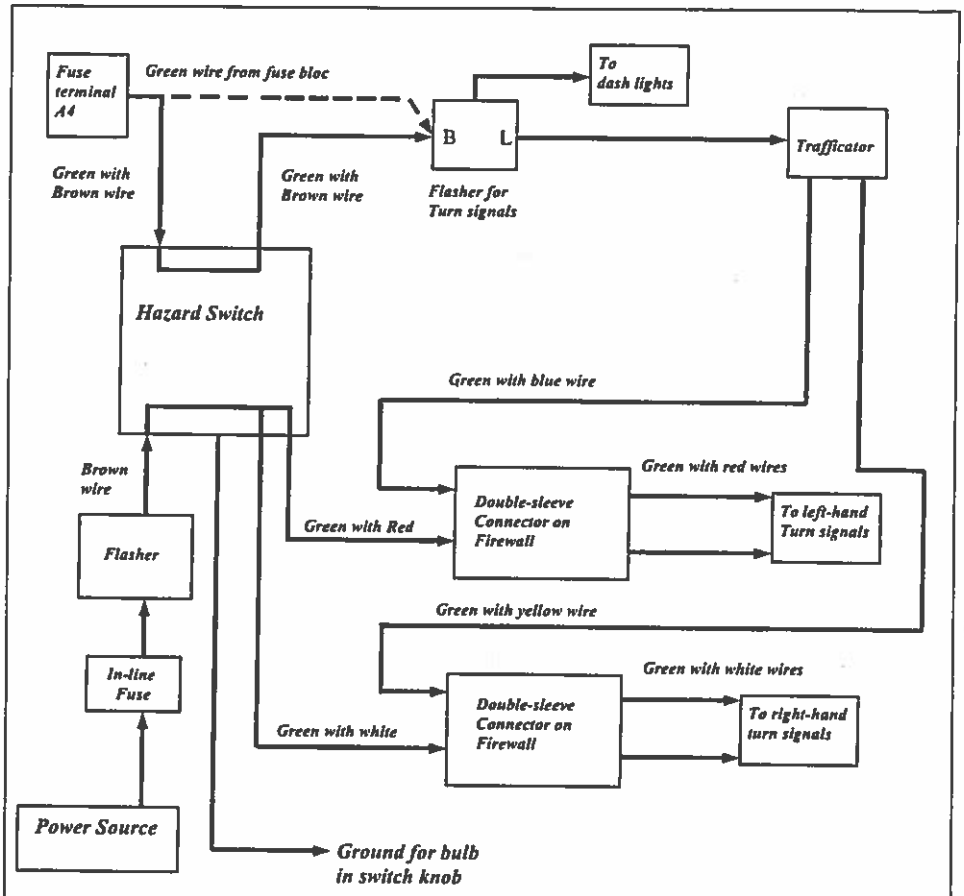


Figure 1: Hazard switch controls both hazard warning lights and turn signals. Dotted line indicates disconnected wire leading to turn signal flasher terminal B from ignition fuse A4. With four-way hazard lights installed, power for turn signals is re-directed through hazard switch then back to turn signals flasher. If hazard switch is OFF (pushed in), turn signals function normally If hazard switch is pulled out, turn signal circuit is cut off and turn signal lamps are illuminated in four-way hazard configuration using separate power source and separate flasher.

7 single sleeve connectors.

Caption for photo

Switch for hazard lights is mounted under dash on universal holder from Radio Shack. Bulb in knob flashes in synch with hazard lights. Switch to left and LED indicator are for soon-to-be-added auxiliary driving lights.

Installing Hazard Lights in a BN1

By John Trifari, Golden Gate AHC

At a swap meet some time ago, I picked up a Lucas Hazard Warning System (part number 5444006501), an after-market push/pull switch that gives a car four-way hazard lights. The switch comes with a self-contained flasher and mounting bracket and a knob that illuminates in sequence with the flashing lights. I wasn't planning to install a hazard warning light system on the car at the time, but the unit looked good, it was a Lucas unit after all and the price was right.

Last month, I decided to install hazard lights in my BN1. The task was a little more difficult than anticipated because of the design of the BN1 directional circuit. Anyway, here are some thoughts on the switch and how I made it work.

The Lucas hazard switch is fairly conventional: two leads from the switch (green with brown) are spliced into the regular directional circuit before the flasher; two others (green with red; green/white) feed into the right and left directional circuits themselves at points common to the front and rear lamps. There's a power line into the switch via the integral flasher, and a ground line for the switch lamp. When the hazard switch is in the OFF position (pushed in), power to the directionals passes through the switch to the regular flasher where it is routed to either the left or right directional, depending on which way the trafficator is thrown. When the switch is pulled out, the regular directional circuit is cut so the directionals can't function, power is routed into the switch's integral flasher unit, and power flows out simultaneously to the common points in the left and right hand directional circuits, providing a four-way flash.

Switch installation is easy enough on any car where the brake lamps and directions are on different circuits, and the front and rear directional circuits on each side can be tapped at a common point. On any pre-phase 2 BJ8 Healey, installation is more problematic. Reason: the rear brake lamps and the rear directional are on the same circuit; the front directionals are on separate circuits. There is no common point between the front and rear directionals that can be tapped by either the green/white or green/red lines from the switch.

Key to the installation of hazard warning lights on a pre-Phase 2 Healey is the relay, an 8-terminal electro-mechanical on the left-hand fender. The relay cuts off the brake lamp on the side used as a directional—if you signal for a right hand-turn, for example, the right-hand directional will flash while the left hand lamp will continue to serve as a brake lamp as you slow down and go into the turn. The relay also controls power to the front directionals, ensuring that they do not operate if all you do is hit the brake pedal. On the top of the relay are stamped numbers indicating the terminals. Terminal #1 is input from the directional flasher. Terminal #5 is input from the brake switch. Terminals #2 and #6 are output to the front directionals respectively; #3 and #7 output to the right and left rear directionals. Terminals #4 and #8 are linked to the trafficator switch and provide input to the relay.

If you lift open the top of the relay, you will see two coils and two spring-loaded arms with contacts on the tips. These rest against another set of contacts on the relay frame. There is a second set of contacts on the other side of the armature and a third set halfway down the length of the arm. The base of the right hand arm is connected to relay terminal #7 (left rear). The base of the right hand arm is connected to relay terminal #3 (right rear). When the relay is at rest, the first set of contacts rests against the contacts on the relay frame. When power from the stop lamp switch comes into terminal #5, it passes through these contacts, down both arms and out terminals #7 and #3 to both rear lamps. That's your brake lights.

When you move the lever on the trafficator, the relay configuration changes. Let's say you move the trafficator lever to the right. That connects the power line in the trafficator (green) to the right-hand input line (green with light green) which is linked to the right-hand coil (armature) of the relay via terminal #4. Energizing the coil pulls the right-hand set of contacts away from the "at rest" position and over to the outside set of contacts. That allows power to come through the flasher and into the relay via terminal #1, down the right-hand arm and out terminal #3 to the right-hand rear, converting the right-hand brake light into a flashing right-hand directional.

When the arm moves, the third set of contacts halfway down touch a set connected to terminal #2. That gives you a flashing light at the right front. Note that if you hit the brakes while the right hand directional is on, power still comes through the brake switch input terminal (#5), flows down the left-hand arm and out terminal #7, illuminating the left rear lamp, giving you a brake light on that side only. When the trafficator is returned to the "off" position, power to terminal #4 is cut, the coil is de-energized, and the relay returns to "at rest" position.

To add a hazard warning capability to the car I first needed a location to physically mount the hazard switch and the only place that made any sense was underneath the package shelf. Second, I needed power. The hazard lights are designed to run with the ignition off, so I needed a hot wire to the switch. So the first thing I recommend doing is to **disconnect the battery before proceeding.** I ran power in from an auxiliary fuse box I had installed just inboard of the air ventilation valve on the right hand side of the firewall. If you don't have an auxiliary fuse box, take power from terminal A1 of the regulator using length of 12-gauge wire or from fuser terminal A1. Be sure to install an in-line fuse.

Then I drilled a ½" hole through the top

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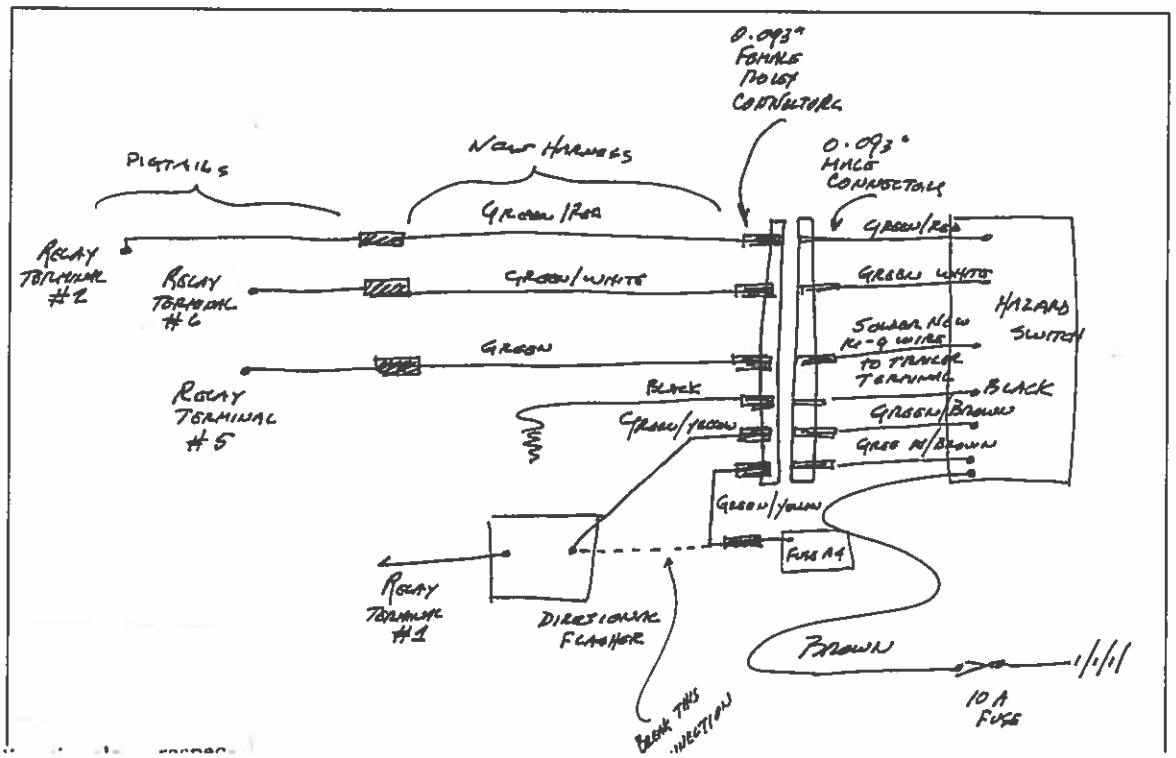

Mechanicals *(continued from page 7)*

of the passenger foot well, and made up the 5-wire harness. To measure for three of the five wires, I ran a piece of 16-gauge wire from the base of the shelf, up through the hole in the footwell up to the lip of the shroud, across the firewall to the left and down the felt-hand frame rail to the shroud support bracket. I cut two more pieces of 16-gauge wire to the same length. Then I ran a piece of 16-gauge wire from the same starting point over to the brake fluid can and added six inches, and cut another piece the same length. All five pieces of wire were green. I wrapped red tape around two ends of one of the longer pieces, white around another. The third had no tape. I wrapped yellow tape around the ends of the two shorter pieces (I didn't have any brown tape). I also cut a piece of black wire about 18 inches long. The wiring diagram is shown in Figure 1.

Back to the workbench. First, I soldered on 0.093" Molex connectors from Radio Shack onto one end and inserted them into a female casing. Tape all five green wires together at varying intervals and cover with shrink tubing. Leave about 9 inches of free wire at the end of the black wire, and make sure all the connectors are clean. Set the new harness aside for the moment and take the cover off the hazard switch.

First, check out the switch. Hook a power line to the brown input wire and connect the green/red wire to a test lamp in series. Ground the lamp, and pull out the switch. It should flash. Connect the black wire to the same ground, and the lamp in the knob should flash in sequence. If it doesn't, check out the lamp socket. Close the switch and the lamp should stop flashing. Check out the green/white wire the same way. There are two additional terminals on the switch for supplemental hazard lights used when someone tows a trailer. Solder a length of 16-gauge wire to one of the terminals, check it out as per above, and trim all other wire (except the brown input wire) to a constant length. Solder male 0.093" Molex connectors onto the ends of each, and insert the pins into a six-pin male connector casing, so that the wires match those inserted into the female casing on the wiring harness. Solder bullet connector to the end of one of the shorter green wires with yellow tape (it doesn't matter which) and to the ends of the three longer green wires.

Back to the BN1. Run the five green wires covered with shrink wrapping up through the hole in the passenger compartment and mount along the lip of the shroud the firewall side. Don't forget a grom-

Next splice the two green/yellow lines flasher. To do this, disconnect the wire leading to flasher terminal "B" (battery side), remove the tab connector and replace it with a bullet connector. Connect that wire to one of the green/yellow wires in the harness using a single snap terminal. Solder the tab connector you removed from the flasher input wire to the other green/yellow wire and connect it to the flasher. Reconnect the battery, turn on the ignition, and test left and right directionals. Make sure the hazard switch knob is pushed in. Pull the knob out and the directionals should stop working. Push in and the directionals work. OK so far? If not, make sure the bullet connections are solid and/or that the wires at the Molex connectors match.

Make up three 16-gauge pigtails two about 6 inches long; one about 9 inches. Put a piece of white tape on one of the shorter pieces; a length of red tape on the 9 inch piece. Solder a bullet connector to one end of each; a clip connector to the other. Use a ¾" length of shrink tubing to cover the joint between the clip connector and the wire tip. Get an idea of the size clip connector you'll need by looking at the clip connectors already on the directional relay. Loosen the screw holding down the wires attached to relay terminal #2 and slip on the clip connector of the longest pigtail (green/red). Connect the other end to the green wire with the red tape from the switch using a test lead. Attach the green/white pigtail to terminal #6 and connect the other end to the green wire with the white tape. Attach one end of the green pigtail wire to terminal #5; the other end to the green wire, again using test clips.

Here's what's happening: Since there is no common point in the directional circuits because of the relay, the green/red line from the hazard switch is attached directly to the line leading to the right front flasher (terminal #2). The green/white line leading from the switch is attached directly to the line leading to the left front flasher (terminal #6). The green line, leading from one of the trailer connections, is tied to the brake switch terminal (#5). Let's test the system. Make sure the test clip connections are insulated and not touching the body or engine at any point. Connect the power line running from regulator terminal A1 to the brown power line on the hazard switch. Connect the black ground line to a convenient location in the cockpit (I used one of the screws that mount down the package shelf). Connect the male and female Molex connectors, and switch on the battery.

With the switch closed, turn on the ignition and test the left and right directionals. Assuming all is OK, turn off the ignition and pull out the hazard switch knob. All four should the light in the knob. Turn off the hazards, turn on the ignition and turn the hazards back on again. If everything is working OK shut off the hazard lights and disconnect the battery. The last task is housecleaning—tie the wires down and neaten things up.

Things did not go that smoothly for me the first time, and I had to redo things a number of times before I got the reliability I wanted. The best way to trouble shoot the hazard circuit is to disconnect the test leads, then reconnect them one by one to each pigtail. You should get one light to come on after the other. Be careful not to short one of the leads against the car body. Check the pigtail connections to the relay. The connection to terminal #2 is fairly straightforward and clear. The connections to terminals #5 and 6, however, are more problematic due to the cramped space and the way the connectors must lie one atop the other. Be sure the shrink wrapping on the shoulders of the clip connectors is intact and is covering the area where the connector is soldered to the wire. Make sure the right wires from the switch are connected to the right pigtails. (I made that one.) Make sure that the wires are correctly linked at the Molex connector, and finally, be sure that the fuse is intact. Hope this all makes for hazard-free Healeying.

Installing Auxiliary Lights on a BJ8

By John Trifari
Golden Gate Austin-Healey Club
Sunnyvale CA

I like auxiliary driving lights and for the few times that I have driven along a deserted back road at night, they have proven to be very handy indeed. And besides, they really look good. Long ago I installed a set on the BN1, and when we got the BJ8, I put together a "to-do" list and put installation of driving lights close to the top of the list.

Physically mounting a set of driving or fog lamps is pretty straightforward. You have three choices: put in a badge bar, drill some holes in the front apron or pull the front bumper off and mount the lights on brackets. The BN1 has no front bumper and the driving lights are attached via some homemade brackets attached to the frame. The driving lights on the BJ8 are mounted through holes drilled in the apron. This article describes the circuit used to power the BJ8's driving lights and how I installed it, and how I put in the lights.

Getting started: Selecting a power source for the lights is the first issue. You can tap power from any number of sources – directly from the fuse bloc or starter solenoid, for example – but I thought that taking it off the high-beam side of the dip switch made the most sense. In that way, the driving lights can only be used if the high beams are on and, conversely, the driving lights will cut off automatically when you switch from high beams to low beams. Figure 1 shows the BJ8 circuit with the driving lights attached to the high-beam side of the dip switch.

Next I chose to use a relay to control the lights rather than and on-off-switch. On the BJ8 power for the lamps runs from the dip switch to a Lucas overdrive relay and out to the lamps. This relay has four terminals – C1 (contact 1) is power in to the relay. C2 (contact 2) is power out to the lamps. W1 (winding 1) is power to the relay's actuating coil and W2 (winding 2) is the coil ground. The on/off toggle switch that controls the relay is located in the ground line running off W2.

Wiring up the relay: First of all mark the location where you want to install the relay. On the BJ8 I mounted it inside the cockpit on the firewall to the right of the steering column with the terminals facing upwards. (See photo.) Once you position the relay, drill the mounting holes required. Given the tight spaces under the dash, though, I did not actually screw down the relay until I had the entire cockpit wiring in place.

Next measure out a length of 12-gauge wire long enough to run from relay terminal C1 to the dip switch, and subtract three inches. Cut the wire at that point and solder a bullet connector to one end. Strip about 1/2-inch off the other end and cover this wire in shrink tubing for added insulation. I then soldered a bullet connector to one end of an in-line fuse holder and connected the fuse holder to the wire with a single sleeve connector. At the other end of the fuse holder, I soldered on a female spade connector (with cover) and put in a 15-amp fuse. Bring the completed wire with attached fuse holder down to the dip switch.

Three wires are connected to the BJ8 dip switch by spade connectors. The thicker blue wire is power in from the light switch; the blue with white wire is power out to the high-beams; blue with red is power out to the low beams. I disconnected the blue with white (high-beam) wire from the dip switch and cut off the spade connector. Then I stripped about 1/2-inch off the end of the high-beam wire and twisted it together with the stripped end of the wire with the fuse holder. I soldered a 5/16-inch female spade connector onto the twisted wires, taped the two wires together for strain relief and covered the exposed connector and twisted wires with a piece of shrink tubing. Finally I re-connected the joined wires to the high-beam terminal on the dip switch. This all sounds simple, but working around the dip switch, especially with a soldering iron, can be the most aggravating part of this project. It's a back cruncher and is guaranteed to make you think that running driving lights off the dip switch has to be probably the stupidest idea I've had all week.

Wiring up the relay – continued: After installing the joined wires back onto the high-beam terminal at the dip switch, I used cable ties to secure the wire with the fuse holder to the headlight wires leading to the dip switch. Then to make sure this wire stayed out of the way of

Parts List

1. One pair of driving or fog lamps or one of each. Bar badge or mounting brackets for the lamps.
2. Relay (two relays required if one driving lamp and one fog lamp are installed).
3. About 15 feet of 12-gauge wire. About 15 feet of ¼-inch shrink tubing.
4. One in-line fuse holder; one 15-amp fuse. (You will need a second fuse holder if you have not already installed one in the parking lamp/panel lamp circuit.)
6. Ring connectors, bullet connectors, and 5/16-inch female spade connectors. Dual and single sleeve connectors.
7. On/Off switch (two switches required if one driving lamp and one fog lamp are installed).
8. Cable ties/cable loops as required. Sheet metal screws to mount relay.
9. Indicator light

my feet, I tucked it under the side panel, and secured it via a cable loop to one of the sheet metal screws holding the ventilation screen just above the clutch. Finally, I strung it over the steering column, so that the in-line fuse would be easily accessible and attached the spade connector end of the wire to terminal C1 of the relay. I like to check things as I go along, so I turned on the high beams and used a circuit tester to verify that I had power at C1.

I then made up a short (6-inch) 14-gauge jumper with two female spade connectors (with covers). You have to get power to relay terminal W1 so that the coil can actuate and close the contacts. You can use any power source, but I think stealing the power from C1 is the most efficient, neatest way to do this. And maybe Lucas agreed. They conveniently made C1 a terminal with two male spade connectors. Once you have the jumper wire prepared, connect terminals relay C1 and W1.

Next cut a two-foot length of 12-gauge wire, and solder a bullet connect to one end and a female spade connector to the other. Don't forget a cover for the spade connector. I also covered this wire in shrink tubing. Attach the spade-connector end of this wire to relay terminal C2 and place a dual-sleeve connector on the other end. Then I tucked this wire under the carpet covering the tunnel. After you have this wire in place, measure off about 8 feet of 12-gauge wire, cover it in shrink tubing and solder a bullet connector to one end. Run this wire through the firewall and into the cockpit, connecting it to the dual sleeve connector tucked under the carpet. Don't forget a grommet. Position this wire as necessary in the cockpit and secure it.

In the engine bay mount this wire to the frame rail using the cable loops that hold down the generator (in my case, alternator) wiring. When you have the wire secured to the frame rail, jack up the car and remove the right front wheel. Pass the wire under the generator (or alternator) and secure it to the brake lines and headlight pigtails using cable ties. Be sure that the wire is clear of the steering linkage and the front wheels and tie it down on the supporting strap inboard of the front directionals. Trim off any excess wire, solder a bullet connector onto the wire at this point and terminate it with a dual-sleeve connector.

Next install the on-off switch. I initially I planned to use a switch mounted in a holder and hung below the dash on the driver's side as a temporary expedient. Before actually starting this project, however, I was diverted by a problem with the lighting switch and had to pull the console. Once the console was out, I decided to recover it and install some switches, an indicator light for the driving lights and a voltmeter. The wiring will be the same though, irrespective of where you mount the switch: link one switch terminal to terminal W2 on the relay; link the other switch terminal to ground.

Indicator light: To install an indicator light that will come on when the driving lights are on, connect one lead of an indicator lamp to the dual-sleeve connector

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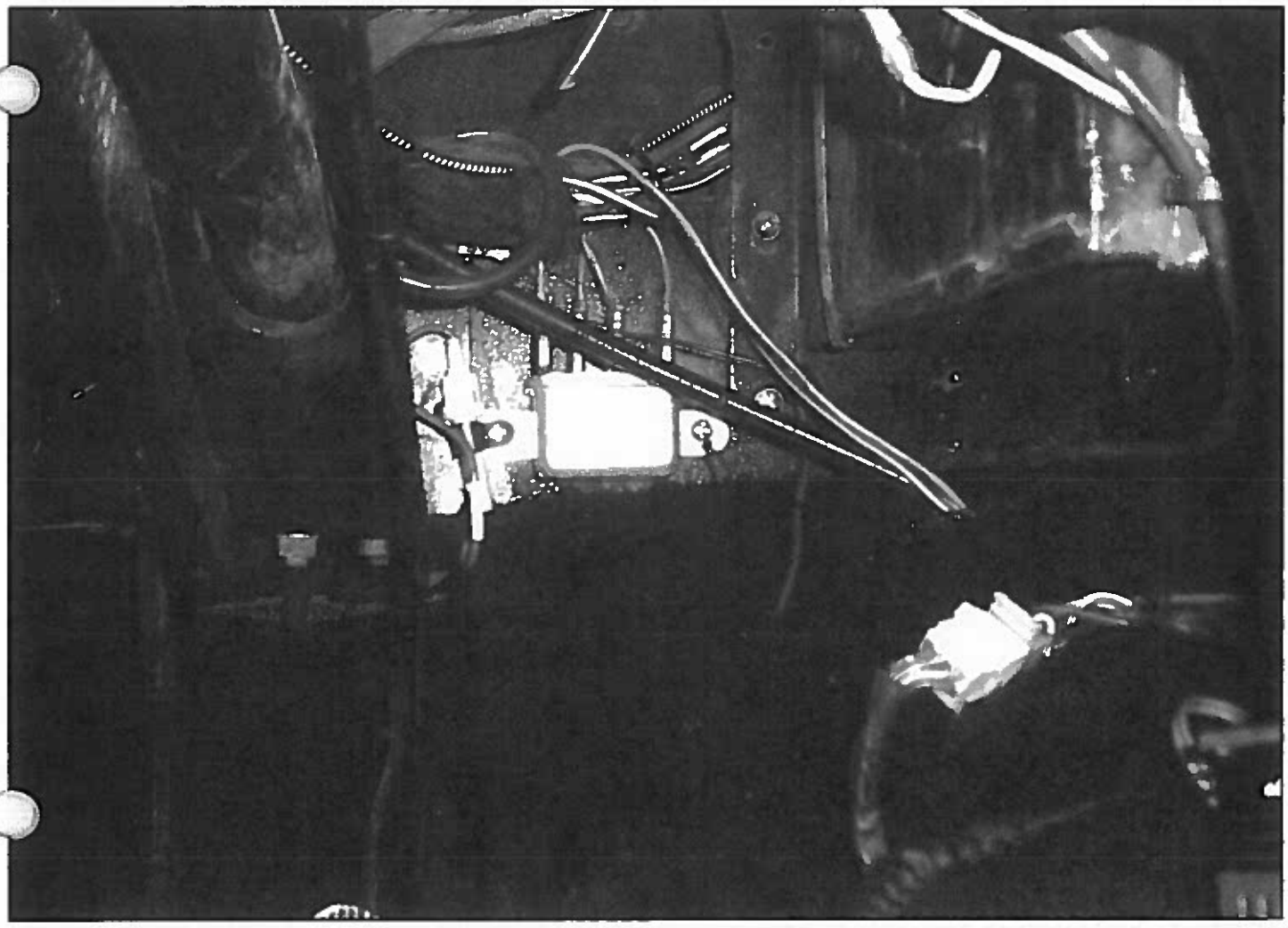
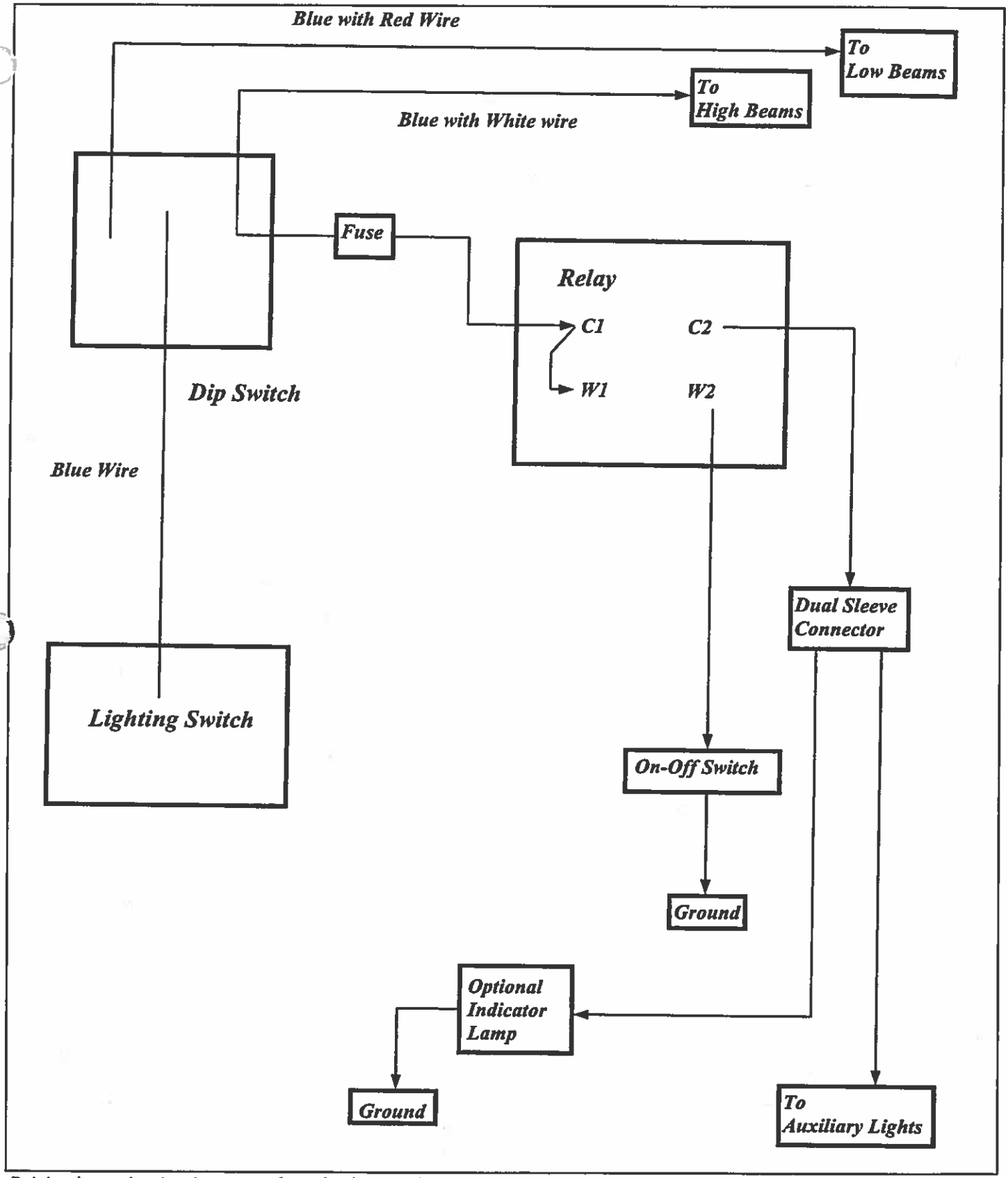


Installing Auxilliary Lights *(continued from page 15)*



Driving lamp circuit using power from the dip switch. Principal elements in the circuit are the Lighting Switch, the Dip Switch and the Relay. With this set-up, high current loads through the dash switch are avoided, and the driving light shut down automatically when the low beams are used. At the center of the system is a relay. I mounted the relay for the driving lamps up under the driver's footwell to the right of the steering column. Mounting screw on right is used to connect ground wires; screw on left supports

attached to the wire running off C2. Connect the other lamp terminal to ground. When I had the entire cockpit wiring in place I mounted down the relay and checked out what I had done so far. With the high beams on, I threw the driving lamp switch and heard the relay actuate. At the same time, the indicator lamp on the console came on indicating I had power up to the dual-sleeve connector tucked under the carpet. Finally I used a circuit tester to be sure I had power at the wire that terminated at the front end of the car. Hit the dip switch and put on the low beams. The indicator lamp should go off indicating no power through the relay.

Installing the lights: First check out the lights and make sure they are working OK. Next mount the lamp brackets. It's important to verify that you have a good ground between the driving lamp brackets and the car frame – or else the lights won't work. Attach one lead of an ohm meter to the ground terminal of the battery. Touch the mounting bolts on the brackets with the other lead in turn. You should have an indication of a complete circuit – either a buzzing sound or a deflection on the meter. After you verify that you have a good ground, wrap the power wires on each lamp in shrink tubing and soldered a bullet connector to each end. Solder a ring connector to the end of each ground wire. Install the lamps and attach each ground wires to the horizontal mounting bolts that secure the lamps to the mounting brackets.

Now wire up the right-hand lamp. You need to run the power wire behind the shroud so you can link it to the dual-sleeve connector at the end of the wire running down the frame rail from relay terminal C2. You can run the power wire from the lamp through the grill, under the shroud, along the bumper brackets, or drill ¼-inch holes in the shroud below the bumper. I chose the latter. Once you have the power wire from the right-hand lamp on the inside of the shroud, connect it to the dual-sleeve connector at the end of the wire coming out of the cockpit. Make sure everything is tied down and clears the wheel and linkage. Check out your work up to this point by turning on the high beams and throwing the driving light switch. If the light does not come on and if it was working and if you have power at the dual sleeve connector up front, make sure you have good connection and a good ground.

Install the left-hand lamp by preparing a 3-foot length of 12-gauge wire with bullet connectors at each end. Cover this wire with shrink tubing. Connect one end to the dual-sleeve connector attached to the line from C2 and the power line of the right-hand lamp. Run this wire in back of the lower lip of the shroud and through cable loops attached to the screws used to hold the shroud to the frame. Finally connect the unattached end to the power wire for the left-hand lamp using a single sleeve connector. Turn on the lights, switch on the high beams and flip the driving light switch. You now have driving lights. Hit the dip switch and make sure the driving lights go out when the low beams come on. Wait till dark and go find a nice deserted road and try them out.

Some final thoughts:

1. Make sure that the relay is working properly before attaching any wires to it. To check it out, attach one lead of a test lamp to C2 and a power lead to C1. Connect the ground side of the lamp to the ground side of the power source. Run a test lead between C1 and W1 to energize the coil. Finally attach another lead to W2. By touching the other end of the lead attached to W2 to the ground terminal of the power source causing current to flow through the relay windings, actuating the relay, closing the relay contacts and lighting the test lamp. (*Note: Relays are not sensitive to positive or negative ground.)* If the test lamp does not light up, check all the connections and be sure you have power going over to W1. If it still does not work, try another relay.

2. If you don't want to mount the on-off switch on the console and if you don't like plastic switch holders, another idea is to use the panel light switch to control the auxiliary driving lights. Here's how I'd do it: TURN OFF THE BATTERY. Pull the console and drop the panel switch. Pull the two wires from the switch and cut off the spade connectors. Replace the spade connectors with bullet connectors, and join the two wires using a sleeve connector. The panel lights will now go on whenever the head lights or running lights are turned on. Now make up a piece of wire with spade connectors on each end. Run this line between one terminal on the panel switch and relay contact W2. Run the second line between the other switch terminal and ground. The panel lamp switch can now be used to control the relay and turn the driving lights on an off.

3. If you have not installed an in-line fuse to protect the panel lamp/running light circuits do it now that you have the console out. (How many times have you seen fried wires under the dash? Chances are pretty good that the reason was a short in the panel lamp circuit). TURN OFF THE BATTERY. Drop the lighting switch and disconnect the red wire leading from the switch. Cut off the spade connector attached to this wire and solder on a bullet connector. Solder a bullet connector to one end of a fuse holder, a female spade connector (with cover) to the other. Insert a 15-amp fuse and connect the fuse holder between the switch and the red wire. Re-install the lighting switch. Turn on the battery.

4. If you don't have a Lucas relay, you can use a Bosch-type relay of the kind found in any auto supply store. Note, however, that these relays use different terminal codes: Terminal 30 (or 51) is equivalent to C1; terminal 87 is the same as C2; 85 is W1 and 86 is W2. These relays are nice and compact and they are readily available at lower-cost. The down side is that there is no dual-terminal C1. To jump power to W1 (i.e. terminal 87) you have to take the wire leading from the dip switch and either twist it together with the jumper to W1 and solder the twisted wires to a single spade connector, or use a female spade connector with an attached male adapter.

5. If you want to install fog lamps instead of driving lights, do everything as per above, but instead of drawing power from the high-beam connection at the dip switch, wire everything to the low-beam side (blue with red wire). The fog lamps can now come only if the low beams are on and will automatically cut off when the high beams are used. If you want to wire up one driving lamp and one fog lamp you will need two separate circuits – one connected to the high-beam side of the dip switch, the other to the low-beam side. You'll also need two relays, two wire harnesses and two switches. You'll probably also need twice as much time.

6. If you want the wiring to be Lucas-correct, use 12-gauge red with yellow to power the auxiliary lights. You can get this wire from British Wiring.

7. If you buy shrink tubing at a place like Radio Shack, you will pay a lot of money for relatively little tubing. I buy the stuff in 3-foot lengths at Fry's, a computer supply house. You can shrink the tubing down using a heat gun, a soldering iron or the kitchen stove. Whatever you use, keep the wire moving so you don't accidentally burn the insulation.