Shifting into Overdrive

Understanding and Trouble-shooting the Electrical Operation of the Austin-Healey Overdrive

By Gary Anderson, Roger Moment and Dave Russell

Of all the operating components of the Austin-Healey, the overdrive is the one that has always been most mysterious. The system is composed of an electrical circuit, an oil pump and valves, and a gear set that is separate from the main transmission. For those old enough to remember the old comic strip, the name "Rube Goldberg" comes to mind to describe the system.

Most mechanics will agree that the electrical circuitry is the source of many of the problems associated with the overdrive. Since electrical faults are ones that many owners can troubleshoot and they can even perform minor repairs on their own, we will explore this aspect of the overdrive system in more detail.

Note: This discussion applies to the circuitry as installed on the BN2 through BJ8. The BN1 has some slight differences, addressed in a separate sidebar.

Components of the Overdrive Electrical Circuit

The Laycock de Normanville overdrive used on all Austin-Healeys is engaged by physically sliding a gear assembly within the overdrive case from the normal position to the overdrive position. An internal clutch is used to lock the assembly in position, actuated with pistons moved by oil at 400 psi pressure. There is a ball valve that allows the oil to be diverted to the operating pistons, and this is controlled by a lever and linkage that is operated by an electric solenoid located on the overdrive unit itself.

This solenoid is the linking point between the electrical system and the mechanical system. If there is electric power to the solenoid, then overdrive will be engaged. If the electric power is interrupted, then the unit shifts back out of overdrive.

The overdrive wiring circuit is designed not only to operate the solenoid, but also to limit the conditions when it can be engaged or disengaged. The discussion that follows will describe how the various electrical components relate to each other to engage or disengage the overdrive. But more importantly, it should help you understand how the system works as the dash switch is turned on or off, as you operate the throttle, and as you shift gears. This understanding will make it easier for you to troubleshoot, should problems arise.

Though it might seem logical to start exploring the overdrive circuitry with the switch on the dashboard, in fact that component isn't always involved in determining whether the overdrive is engaged or disengaged, so we'll start from the other end with the overdrive solenoid.

Overdrive Solenoid – The solenoid is mounted on the side of the overdrive. The pictures on this page illustrate the solenoid on the overdrive unit. On many – including the late BN1s through the 100-Sixes – you can see the operating lever (upper photograph). Starting with the 3000 BN7/BT7 and continuing through the BJ8, this lever was enclosed in a box (lower photograph) that is cast as part of the overdrive side cover. All the operating components remained the same – they just were now enclosed. (Early 100s also had an enclosed design.) The change points for all these design variations are given in Service Parts Lists by overdrive unit numbers, not car chassis numbers, so it is hard to tell exactly where the changes occurred during car production.

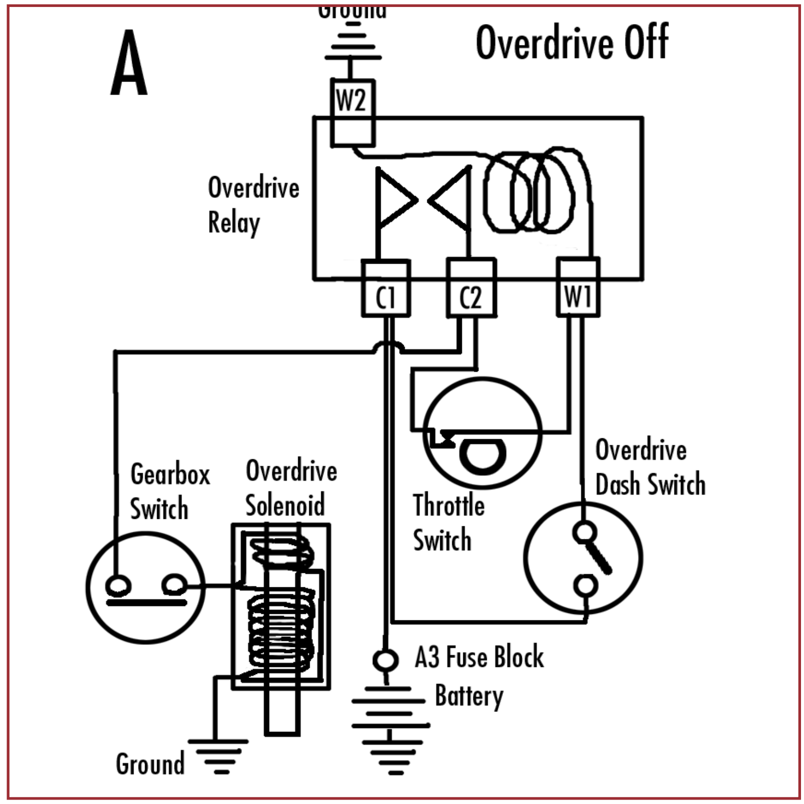
The overdrive solenoid with the exposed operating lever configuration. This first appeared during BN1 production and continued through the 100-Six models.

The overdrive solenoid on the 3000s, from BN7/BT7 through the end of production, was mounted with the operating lever enclosed in a case, which has to be opened in order to adjust the lever. This view of an early 3000 side-shift four-speed gearbox also shows the gearbox switch. While the switch is visually similar on all models, it was located in a different position on the earlier BN1 three-speed, and later four-speed, gearboxes.

The throttle switch (left) with the lever connected to the throttle linkage, and the overdrive relay (right) on the firewall of the 6-cylinder Healeys. On the BN2 the relay is located at a position just below that shown..

The throttle switch with the case opened. In this view, one can see how adjusting the thottle lever will determine when the throttle switch is engaged.

The overdrive relay, with the case open so we can see how the coil is wired and how it closes the points to connect the C1 and C2 posts. The exterior of the base plate from a second relay is shown at the right.



A schematic representation of the electrical circuit that controls the overdrive solenoid.

Inside the solenoid are wire coils that create a magnetic field that draws an iron plunger up and then holds it in place. As the plunger rises, the bottom end pulls up the lever underneath that, through a linkage inside the overdrive case, actuates the ball valve to divert oil, under high pressure, to the operating pistons.

Everything in the electrical circuitry is designed to eventually cause this lever to move up and down to coincide with the driver's desire to be in an overdrive gear, while at the same time safeguarding the mechanical components of the drive train.

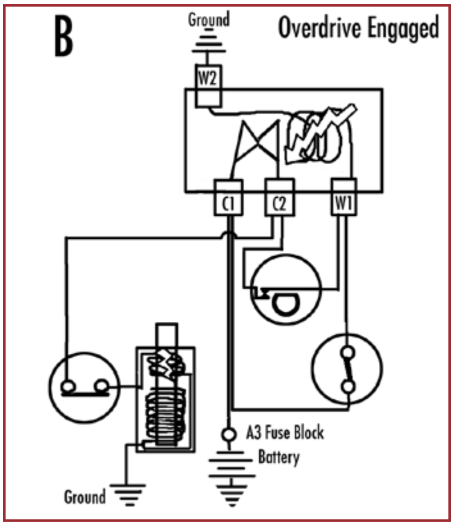
Since more force is required to draw the plunger up into the solenoid than to hold it there, the solenoid contains two internal coils. One has low resistance, about two ohms, (and draws a higher current) and this provides the strong actuating magnetic field. At the top of the solenoid cavity the plunger actuates a switch which disconnects the low resistance coil, leaving only the high-resistance – about 11 ohms (and thus drawing less current) – holding coil functioning, which creates a lesser, but sufficient, magnetic field to hold the plunger up.

The most frequent cause of solenoid failure occurs when the solenoid is improperly adjusted, and the low-resistance actuating coil doesn't disconnect, causing the solenoid to burn out. The Workshop Manual provides the procedure to adjust the lever to which the solenoid is connected. It is critical that you check that the coil resistance changes when the plunger is pressed to the top of its stroke and make sure that after removing the 3/16-inch setting dowel (as described in the shop manual) the lever is free to move upwards a bit more and thus is not restricting upward movement of the plunger.

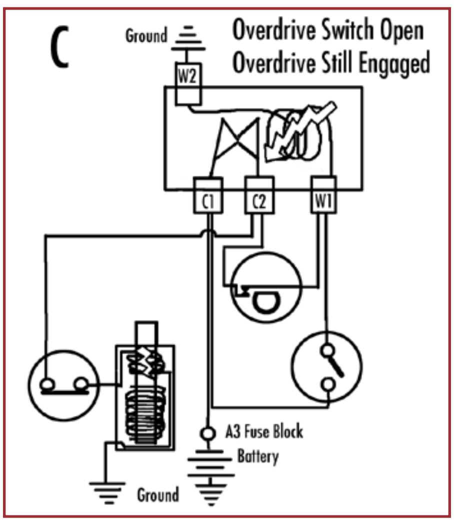
Gear Switch – The gear switch can be seen in the bottom picture on the opposite page, on the side of the gearbox housing. On 3-speed BN1 gearboxes it is located on the right side of the case, while on MkII and MkIII center-shift transmissions it is on the casting that supports the gear lever. Regardless of location, these switches are quite similar in appearance.

The purpose of this switch is to allow current to the overdrive solenoid only when the transmission is in the top two gears. In particular, it prevents the overdrive from being engaged when the transmission is in reverse, since some components of the overdrive are designed to operate in only one direction. Should this switch fail or be overridden, allowing the overdrive to remain engaged when the car is driven in reverse, catastrophic damage to the overdrive can result.

The gear switch closes when the gearshift is in the three-four slot on 4-speed gearboxes, and opens when the gearshift is moved over into the one-two or reverse slots. The electrical circuit connects the gear switch to the C2 post on the overdrive relay box.



B: Closing the dashboard overdrive switch sends power to the relay coil, closing the points and powering the solenoid coil through the gear switch.



C: Once the overdrive is engaged, and with the throttle closed, power will continue to flow through the throttle switch, keeping the relay coil energized and the relay points closed, and keeping the overdrive engaged.

Note: terminal identifying markings on the relay and throttle switch boxes are stamped into the brown insulating cover plate.

Throttle Switch – The throttle switch is contained in a box mounted on the firewall. The throttle switch ensures that, when the overdrive toggle switch on the dash is flipped from OVERDRIVE to NORMAL, the overdrive does not disengage while the driver's foot is off the throttle. This is important, because when the car is decelerating, the engine is providing what is called "compression braking" and power is being transmitted from the rear wheels forward through the drive train, so if the overdrive were to disengage, the consequent increase in engine rpm would cause the drivetrain to jerk and could cause harm to the engine.

The throttle switch is pretty simple in design and construction. Inside the case is a set of points that are closed when the throttle pedal is not depressed, creating a circuit that keeps the overdrive relay energized even if the dash switch has been flipped to NORMAL. As the throttle is pressed, a lever connected to the throttle linkage rotates a cam in the switch case that opens the points and breaks the circuit, de-energizing the overdrive relay. If the lever is properly adjusted, the points will remain closed at less than about quarter throttle, and open when the throttle pedal is pressed more than one-quarter.

Overdrive Relay – The overdrive relay mounted near the throttle switch from the BN2 - BJ8, connects electric power from the fuse block to the overdrive circuit. It is activated by flipping the dash switch which energizes a magnetic coil that closes the contact points between the two posts marked C1 and C2 on the bottom of the relay box.

At the same time, because C2 is connected through the throttle switch to the W1 post, a circuit is completed through the coil to ground at W2, which will keep it energized and electricity flowing to the gearbox switch, even if the overdrive dash switch is then opened.

Dashboard Overdrive Switch – The final component in overdrive circuitry is, of course, the dash-mounted toggle switch. While necessary to initiate operation of the overdrive, as we've just noted, depending on throttle position, the solenoid may remain engaged even if this switch is opened, and by the same token, the gear position will determine whether closing this switch will cause the solenoid to engage.

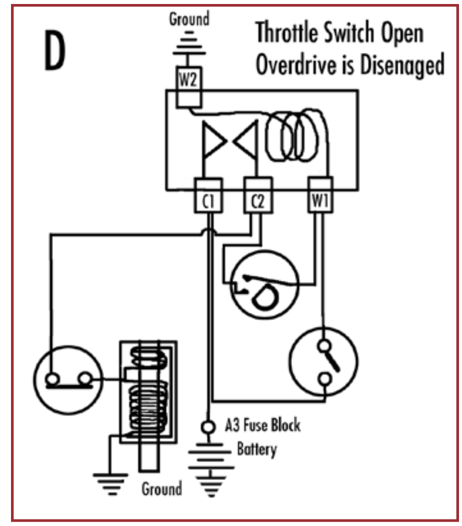
How all this works might best be understood by considering several different situations.

Operation and Basic Trouble-shooting

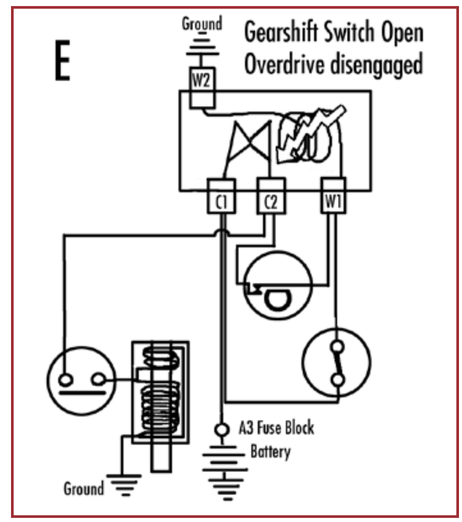
With some assistance from our schematic circuit diagram, we can examine how the overdrive electrical circuit looks under various scenarios. This is also a good procedure to use for checking operation of the electrical system in the event the overdrive isn't working.

As shown in Diagram B, with the ignition on, the engine not running, and the gear lever in third or fourth (second or third on BN1 3-speed gearboxes), when the dash switch is moved from NORMAL to OVERDRIVE, you should hear a distinct click from the overdrive as the solenoid is energized and the plunger is pulled up. If you don't hear the click, then some component of the electrical system is faulty, and you'll need to check each component in turn as discussed below. (Note: on 3-speed BN1s there is an additional component, the centrifugal switch, which prevents shifting into overdrive below about 40 mph. Because of this you cannot perform the above test on the BN1 cars.)

If you do hear the click, but the overdrive doesn't work when the car is driven, then the



D: As the throttle is pressed the throttle switch opens, releasing the contacts and cutting off power to the overdrive solenoid.



If the overdrive switch is left on, but the car is shifted down into second, first, or reverse, the overdrive will disenage, but will re-engage when the transmission is shifted back into third.

problem is in the overdrive itself, which will have to be checked by a qualified specialist.

Diagram C illustrates what happens when the dashboard switch is turned off while the throttle pedal is less than one-quarter pressed. The throttle switch points are closed, keeping the solenoid coil energized, maintaining contact between the points on C1 and C2 so that current continues to flow to the solenoid. The overdrive will stay engaged until such time as you depress the throttle pedal enough to open the throttle switch points, thus de-energizing the circuit – as shown in Diagram D.

You can use this feature to anticipate down-shifting out of overdrive. For example, if you are driving on fairly level ground, you can flip the dash switch to NORMAL and still maintain your speed using only a very light throttle. The overdrive will remain engaged. When you are ready to shift out of overdrive, merely depress the throttle about one-quarter and the transmission will immediately down-shift out of overdrive. This procedure can be handy when exiting a freeway, as it only takes a light "blip" of the throttle as you enter the off ramp to drop out of overdrive.

To check the throttle switch adjustment, with the engine off and the ignition turned on, flip the overdrive switch on. Then, with your foot off the throttle, flip the switch to NORMAL. Now flip the switch back on again. You should not hear the overdrive solenoid click, as it should not have been de-energized when the switch was flipped off. Next, repeat this above sequence, except this time depress the throttle about one-quarter before flipping the switch on for the second time. You should now hear the solenoid energize, as depressing the throttle should have opened the throttle switch points.

A more accurate and direct way to check the throttle switch setting is to disconnect the two wires and put an ohmmeter across the terminals. The reading should go from zero ohms (throttle less than one-quarter depressed – switch points closed) to infinite when the points open.

To adjust the throttle switch, loosen the clamp bolt on the lever arm. The throttle switch has an internal spring which helps in setting it. With the shaft free to be positioned by this spring, the cam should be oriented so that the points are closed.

You can check this by using a screwdriver to rotate the shaft by its slot. Turning an equal amount clockwise and then counterclockwise you should find a position in each direction where the resistance becomes infinite – the points are now open. Position the shaft about half way between these extremes, tighten the arm clamp, and use this as a starting point for adjustment. Observe the throttle position when the resistance changes from zero, and make adjustments to the shaft position until this occurs at about one-quarter throttle.

Diagram E illustrates what happens if the transmission is shifted down into second or first, as for example if you have to slow down on the highway in a traffic jam. In this case, there is still power flowing through relay coil and consequently through the C1 and C2 points but the overdrive solenoid circuit is open at the gear shift switch, preventing the power from getting to the solenoid coil. As soon as you shift back into third, the overdrive will re-engage.

Further Electrical Trouble-shooting

The gear shift switch operation can be checked as follows. Disconnect the ground wire from terminal W2 on the overdrive relay and connect a jumper wire (with alligator clips at both ends) from terminal A3 on the fuse block to C2 on the overdrive relay. Switch on the ignition (but do not start the engine) and move the gear shift lever back and forth from the three-four slot to the first-second slot. Each time the lever is moved over to the three-four position, you should hear the solenoid click as the plunger is pulled up. If you don't hear that click, then the throttle switch is faulty. Before continuing with the following additional tests remove the jumper wire and reconnect the ground wire to W2.

If the gear lever switch is working properly, to check the overdrive relay, turn on the ignition and shift the transmission into third or fourth gear. In the engine compartment, attach one end of a short jumper wire from terminal W1 of the relay and touch the other end to fuse post A3. If you don't hear the relay respond, the internal coil is bad. You can also sense operation of the relay by feeling the cover for vibration.

If you verify the relay is working, then go listen for the overdrive solenoid to click while someone else touches the jumper wire to the terminals. If the solenoid doesn't operate, then the relay points could be dirty or damaged and not making good electrical contact.

Once you have verified that all the other components are working properly, you can check the dash toggle switch. With the engine off, ignition turned on, gear lever in one of the top two gears, and throttle pedal released, flip the toggle to OVERDRIVE. You should hear the solenoid click. Flip the switch back to NORMAL and turn the ignition switch off (to de-energize the solenoid even if the throttle switch is not set correctly). Re-test by turning the ignition switch on followed by the toggle switch.

If the overdrive should stop operating while you're out on the road and you can determine that it's an electrical problem rather than a problem within the overdrive itself, it may be tempting to bypass the offending component(s). However, since these components are designed to protect the overdrive, this may not be a good idea, since it can be considerably more expensive to replace the overdrive should that fail as a consequence of one of the override switches not working.

Your engine can quite effectively handle highway speeds even without overdrive. Though the higher rpm may be a little wearing on driver and passenger, the car will get you to a place where you can trouble-shoot the system properly and properly replace a failed electrical component.

The BN1 Overdrive Electrical System

The first Austin-Healey, the BN1, had a three-speed gearbox (actually a four-speed with first gear blocked off) and the overdrive electrical control system was more complicated.

The system included a centrifugal switch, mounted at the rear of the overdrive case. This switch was in additon to, and placed in series with the toggle and gear lever switches, designed to close and allow the overdrive to be engaged only after the car reached a speed of about 40 mph.

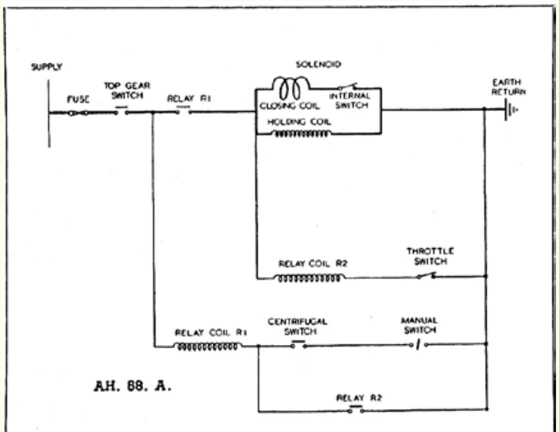
In addition, two relays were used instead of just one. They were located under the dash on the left side and are screwed to the face of the box that delivers fresh air to the cockpit (above the foot controls on LHD cars). The two relays served the same purpose as the single relay on the later cars.

The gearshift switch, of the same design as on the later cars, was designed so that the overdrive would operate only in the top two gears.

As a result of the differences, checking electrical operation is more complicated than on the later Healeys. Procedures for doing this are clearly described in the BN1 workshop manual. Still, a few straightforward operational tests can be performed with used of jumper wires and a volt-ohm meter.

The throttle switch can be easily set using an ohmmeter after disconnecting the two wires. Relays can be checked for operation by disconnecting all four wires from them and connecting jumper wires from the fuse block to terminal W1 and from ground to terminal W2. As the coil circuit is completed you should hear (or feel) the solenoid operate. Continuity through the internal contacts can be checked using an ohmmeter with the coil energized, since the contacts are electrically isolated from the winding terminals.

For additional electrical component tests, refer to the workshop manual. However, access to de-activate the centrifugal switch requires removal of the gearbox cover, which is a fairly involved process.



BN1 Workshop Manual Overdrive Wiring Diagram