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800-516-4461 info@vintageautogarage.com

Borg-Warner R-10 and R-11 Overdrive History and Operation

Thank you for requesting the Borg-Warner Overdrive history and operation guide. This guide is meant to assist owners with the operation and maintenance of the R-10 and R-11 overdrive transmissions.

History: The original Borg-Warner Corporation was formed in 1928 by the merger of Warner Gear, which itself was founded by Thomas Warner in 1901, and Borg & Beck, founded by Charles Borg and Marshall Beck in 1903. The company was best known as the supplier of its Warner Gear Overdrive units from 1930s into the 1970s, and as the developer of the Studebaker three-speed automatic transmission introduced in 1950. Ford took up development of the transmission in Studebaker's place in 1955. The early Ford automatics are derivatives from Borg-Warner.

The world-famous Borg-Warner Indy 500 trophy has been provided to the annual winner of the Indy 500 by the company since 1936.

As roads improved, and car speeds continued to increase, there was a need for a transmission that would allow the engine to turn slower at higher road speeds, yet still have the low-end torque needed for climbing hills. The Borg-Warner overdrive transmission was first introduced in the 1934 Chrysler and DeSoto lines, then later was used also by Ford, GM, Hudson, Kaiser-Frazier, Packard, Studebaker, and Willys. A total of 13 auto manufacturers used this transmission. Ford first used Borg-Warner overdrives in the Lincoln Zephyr in 1941. Then it became optional on Ford and Mercury cars from 1949; It then faded from use in their cars in the ‘60s. Ford pickup trucks continued to offer overdrive into the ‘70s.

The Borg-Warner R-10 and R-11 overdrives use a planetary gear set that fits in between the transmission and the tail shaft housing (or, in some cases, took the place of the tail shaft housing) and offered a 0.70:1 ratio on the R10 and 0.72:1 ratio on the R-11. Overdrive was available in second and third gear (i.e., whenever the vehicle was traveling at least 25-30 mph, which is difficult to do when the main transmission is in low/first gear), essentially offering five forward speeds.

These transmissions are electro-mechanical and require several electrical components to operate: Solenoid, Governor, Kick-Down Switch and Relay. Some models include a reverse safety lock-out switch as well. All electro-components were wired together via a dedicated wiring harness.

The R-10 has three pinion planetary gear sets and is adequate for most street applications. The R-11 has four pinion planetary gear sets and is overall a stronger transmission, used in heavy-duty trucks and military vehicles.

Operating the overdrive is simple. There is a manual T-handle control cable, mounted under the dash, which is used by the driver to manually engage and disengage the overdrive. Pulling the handle out takes the overdrive out of operation, which allows the transmission to operate like a conventional three speed.

Pushing the T-handle in engages the overdrive. In normal vehicle operation the handle is left in and then is only pulled out when parking, so that the vehicle does not roll away. It is not recommended to activate the handle while the vehicle is moving.

Driving a car with overdrive requires the driver to understand its operation and it may require some adjustment in driving style. With the overdrive T-handle in, the transmission will freewheel below the governor triggered road speed of 25-30 mph, depending on the car's rear-end gearing. This means that the engine will drive the wheels when power is applied via the accelerator pedal, but when the driver lifts off the accelerator pedal the car will coast, as there is no engine braking.

However, once the car is up to the required speed (25-30 mph) the governor contacts close the electrical circuit from the relay, which energizes the solenoid. Then – when the driver momentarily releases the accelerator pedal – the solenoid plunger extends fully and locks the sun gear of the planetary set. This causes the transmission to shift into overdrive. As a word of caution, this also means there is no braking from engine compression when you let off the gas (accelerator pedal).

Shifting out of overdrive happens in two ways. One way is by slowing down the vehicle to under the governor cut-in road speed (25-30 mph), which triggers the solenoid to release by cutting off its electrical power supply. A second way is to “floor” the accelerator pedal, which engages the kick-down switch. The kick-down switch does two things: First, it interrupts power to the overdrive solenoid and, second, it also momentarily interrupts power to the ignition circuit. (With power to the solenoid cut one might think it would instantly release the sun gear, and that the transmission would then revert to direct drive. However, with the transmission under load, the solenoid shaft pin (pawl) is trapped and cannot be released. By briefly shutting off the ignition system the engine power gets momentarily interrupted, which releases the load on both the transmission and solenoid shaft pin, which allows the shaft pin to retract, which releases the sun gear, which results in the transmission shifting to direct drive. The ignition system cut-off/cut-on operation happens quickly.)

The governor activates at around 25-30 mph road speed, which means that the overdrive cannot be activated below this speed. Driving around town while using overdrive is like having an automatic transmission, since the overdrive transmission shifts back and forth between direct and overdrive modes as the vehicle speed varies.

If cruising at regular highway speeds, with the main transmission in third gear and the overdrive engaged, the driver may want to activate a “downshift” out of overdrive to pass another car. To do this the driver simply presses hard on the accelerator pedal, which will activate the kick-

down switch, which causes an automatic downshift effect via taking the overdrive out of operation during the passing maneuver. When the driver has finished accelerating for the pass and lets up on the accelerator pedal, this releases the kick-down switch, which allows the overdrive to automatically re-engage.

When parking the vehicle, leaving the main transmission in gear and the overdrive T-handle in, there is no vehicle braking effect by the stopped engine, since the overdrive's overrunning clutch is still mechanically engaged (by the T-handle being in), which could cause a vehicle roll-away, particularly on uphill and downhill parking, if the vehicle's parking brake is not used or is not operating correctly. To prevent vehicle roll-away from happening, pull out the overdrive T-handle after parking to disengage the overdrive.

Reversing the vehicle with overdrive engaged will damage the internal gears and bearings inside the overdrive, which will be very costly to repair. **It is never recommended to bypass the reverse lock-out circuit or to install a dash switch to activate the overdrive solenoid. It is best to connect the overdrive electrical system, as it was designed, to avoid costly repairs and to ensure smooth, reliable operation.**

Overdrive Electrical System

It was mentioned earlier that 13 car manufacturers installed these Borg-Warner R-10/R-11 transmissions yet essentially all electrical operation is the same. However, different automakers used different colored wires, sometimes making it difficult to troubleshoot and change parts. Here is a simple-to-understand wring diagram, at this link. Click here .

The two most common components that wear out in the overdrive transmission control system are the Relay and the Solenoid, as they are utilized most frequently. 6-volt and 12-volt solenoids and relays are not interchangeable. If you need to replace one, you will need to order the one that matches your vehicle's electrical system voltage.

Kick-down switches are the next most common component to wear out but will work on both 6-volt or 12-volt systems. These can be installed under the gas pedal or on the carburetor linkage; either place works the same way. Click here to see kick-down switch.

Governor: This part seldom goes bad or needs replacing and will work on either 6-volt or 12-volt systems. In most cases they can be serviced locally by removing the cover and cleaning the points. The governor is a simple contact closure that provides a ground circuit to the relay. Some governors are internally grounded, and others have two connections thus requiring a separate ground wire. If the governor must be replaced, be aware that there were several different types and not all will fit every overdrive. Also, the gear that is driven off the tail shaft worm gear can be different.

Solenoid: The purpose of the solenoid is to engage the overdrive by extending the shaft (pawl) which locks the sun gear. The solenoid shaft (pawl) lengths typically measure about 1 inch. There are a few exceptions, e.g., some station wagons and convertibles had 1-1/2-inch-long shafts due to an extra cross member present on the frame, some Chevrolet pickups from the mid-to-late 1960s had 2 inch long shafts, and Lincolns used longer shaft solenoids. The image shows a solenoid with 1” shaft length.

There is a seal that fits inside the overdrive which prevents oil from seeping into the solenoid. Always change the seal when changing the solenoid, it’s cheap insurance.

Solenoid Wire Terminal Identification: To correctly identify the terminals on the solenoid hold it in-hand with the shaft facing away from you. The right-hand terminal is #4 and connects to the relay. The left-hand terminal is #6 and connects to the kick down switch. A few solenoids had a third wire, which was a ground, but in most solenoids the case itself is the ground.

A few solenoids had internal connections with wires coming out of the solenoid. Wiring connections for both are the same, you will just need to check which wire is the #4 and #6 by activating the solenoid with voltage and grounding the case.

Checking Solenoids for Operation: The best way to test a solenoid is to apply battery power directly to the #4 terminal and grounding the case with a set of jumper cables or test leads. When touching the ground, the solenoid shaft should snap out. You can do this while the solenoid is in the vehicle or on the bench. Either way should make the solenoid work. A 6-volt solenoid will operate on 12 volts for a while, but a 12-volt solenoid will not operate on 6 volts. Be careful when buying used solenoids in the open market. Click here to see all Borg Warner parts.

Solenoid Installation: First, always replace the seal in the transmission housing. If your seal is bad, oil will leak into the solenoid and damage the solenoid.

When you get ready to install the solenoid you want to line up the solenoid shaft, so the flat spot is oriented at 12 o'clock. Next, apply battery power to the number #4 terminal on the solenoid and ground the case of the solenoid which will extend the shaft out.

Next, carefully slide the solenoid shaft past the seal. You should apply a little white grease or Vaseline in the center of the seal and on the end of the solenoid shaft, which allows the shaft to slide in easier. Slide the shaft inward until the shaft engages into the pawl in the transmission. Once it is engaged turn the solenoid to secure the pawl into the grove of the solenoid and align the bolt holes.

Next, start the screws, loosely, to align the housing, then release the power and the solenoid shaft should retract. If the pawl is correctly in the groove at the end of the solenoid shaft, the solenoid itself will be pulled towards the transmission housing when the solenoid gets deenergized. Then tighten the screws. If you follow this procedure, you can be certain the solenoid is installed correctly.

This procedure works if the flat spot on the solenoid shaft is clocked at a different location than the original. The rule is that you want the flat spot on the shaft to be at 12 'clock position when you insert the shaft into the transmission. Once the pawl is in the groove rotate the solenoid as necessary to line up the mounting holes.

Wiring the Overdrive: The overdrive electrical components are interconnected with a wiring harness. Each auto manufacturer used their own color codes on the wires but the overdrive electrical systems were all wired essentially in the same way. When converting from 6 volts to 12 volts, and changing from positive to negative ground, there are no changes needed to the wiring harness. If a new wiring harness is needed, one can order this complete wiring harness.

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Overdrive Relay: There are 2 styles of relays. The first image below is a reproduction of the original style relay, which uses an external fuse. The second relay shown is a modern style with a self-resetting internal circuit breaker in a watertight case. Both work the same way, but we find the second relay is simpler to install with its well-marked screw terminals, and it is in a watertight case to prevent the relay points from corroding. These come in both 6- and 12-volt configurations. **Click here to see relay and other parts.**

The relay provides battery current directly to the solenoid when its coil is energized and the contacts are closed. The relay coil is energized when there is power from the battery, which happens only when all the following conditions are met: the governor contacts are closed, the lock-out switch is not engaged (if so equipped), and the kick-down switch is not engaged by the “floored” accelerator pedal.

Servicing and Cleaning the Overdrive Unit: If the overdrive has not been serviced properly and has 50-year-old lubricant, here is a simple way to clean it without tearing the overdrive apart. Drain the old fluid from the overdrive, replace the drain plug, then fill the overdrive with kerosene. Start the engine and run the transmission for about 5-10 minutes, then drain the dirty kerosene and refill with the correct overdrive transmission fluid. Use only API rated GL-1 oil. (Napa Part# NHF 65201)

Do not use any synthetic gear oils. The related additives in synthetic lubricants may damage the internal parts inside of the overdrive and can be too slippery for the overdrive to work correctly.

Most Borg-Warner manual overdrive transmissions require four pints of lubricant and share the same oil between the overdrive and main transmission. Dirty oil in the overdrive transmissions is a primary cause of poor operation. Before tearing apart the transmission do an internal cleaning as described above.

We hope this report answers questions you may have had.

Here is the link to all the overdrive electric parts.

Order the Borg Warner Original Service Manual here.

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