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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.

Here is some 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 Warner Gear Overdrive units from 1930's to the 1970's 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 BorgWarner Indy 500 trophy has been provided to the annual winner of the Indy 500 by the company since 1936.

As the 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 speeds and still have the low end torque for climbing hills. The Borg-Warner overdrive transmission was first introduced in the 1934 Chryslers and DeSoto then used by Ford, GM, Hudson, Kaiser-Frazier, Packard, Studebaker and Willys, all total 13 auto manufactures used this transmission. Ford first used Borg-Warner overdrive's in the Lincoln Zephyr in 1941. Then became optional on Ford and Mercury cars from 1949 and then faded from use in cars in the '60s. Ford pickups continued to offer overdrive into the '70s.

Borg-Warner R10 and R11 use a planetary gear set that fits in between the transmission and the tail shaft housing and offered a .70:1 ratio on the R10 and .72:1 on the R-11. Overdrive was available in second and third gear, essentially offering five forward speeds.

These transmissions are electro- mechanical and requires several electrical components to operate: Solenoid, Governor, Kick Down Switch, Relay, in some models a lock out switch and all wired together with a wiring harness.

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

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

Pushing the T handle in engages the overdrive. In normal operation the handle is left in and only pulled out when parking so the vehicle can use engine breaking, typically on downhill or uphill parking so vehicle does not roll away. Not recommended to activate the handle while vehicle is moving.

Driving a car with overdrive requires the driver to understand the operation and may require some adjustment in driving style. With the overdrive engaged handle in, the transmission will freewheel below governor speed 25-30 mph depending on the car's rear end gearing, which means the engine will drive the wheels but when you lift off the throttle the wheels won't spin the engine and 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 in the relay, then when the driver momentarily releases the throttle the solenoid plunger extends and locks the sun gear of the planetary set and the transmission shifts into overdrive which also means there will be compression braking when you let off the gas.

Shifting out of overdrive happens in two ways. Slowing down under the governor cut-in speed (25-30 MPH) causes the solenoid to release. Or, if the throttle is floored the kick-down switch is activated. This does two things, it interrupts power to the OD solenoid and also cuts voltage to the ignition circuit momentarily. With power to the solenoid cut you would think it would release the sun gear and the transmission would revert to direct drive. However, with the transmission under load the solenoid shaft pin is trapped and can not be released, by shutting off the ignition system briefly releases the load on the transmission and solenoid shaft pin and allows the solenoid to release the sun gear (which means the transmission is in direct drive) and the ignition system is back on and all this happens very fast.

The governor activates around (25-30 MPH), this means the overdrive can not be activated below this speed. Driving around town above the governor speed and in traffic using overdrive is like having an automatic as the transmission will shift back and forth between direct and overdrive as the speed varies.

On the highway and cruising in third gear the transmission is in overdrive. When you want to pass another car, the driver simply presses hard on the gas pedal and this will activate the kick down switch and causes a downshift taking the overdrive out of operation for passing. When releasing the kick down switch allows the OD to re-engage.

When parking and leaving the vehicle in overdrive (T handle in) there is no engine braking and could cause a roll-away partially on up and down hill parking. To prevent this from happing, pull out the T handle to disengage the OD.

Reversing the vehicle with OD engage will damage the internal gears and bearing in the OD and will be very costly. **It is never recommended bypassing the reverse lock out circuit or installing a dash switch to activate the OD solenoid. Best to connect as designed to avoid costly repairs and smooth operation.**

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Now that we covered overdrive basics, we will dig further into some specifics around the OD electrical system. We mentioned earlier that 13 car manufactures installed the BorgWarner R10-R11 transmissions and essentially all electrical operation is the same. However, all companies used different colored wires making it hard to troubleshoot and change parts. We have a simple to understand wring diagram, you can see here. Click here .

The purpose of the solenoid is to engage the overdrive by extending the shaft and locking the sun gear. Solenoid shaft lengths are mostly but not all measure about 1” in length. There are a few exceptions, station wagons and convertibles had 1 1/2 inch long shaft due to an extra cross member present on the frame and some Chevrolet pickups from the mid to late 1960's had a 2” long shafts and Lincoln’s also used longer shaft solenoids. The image shows solenoid with 1” shaft length. There is a seal that fits inside the OD that prevents oil seeping into the solenoid. Always change the seal when changing the solenoid. Cheap insurance.

The two most common components that wear out on a overdrive transmission is the Relay and the Solenoid, as they are used the most. The 6 volt and 12 volt solenoid and relay are not interchangeable. If you need to replace, you will need to order the one that matches your electrical system voltage.

Kick down switches are the next most common component to wear and will indeed work on both 6 volts or 12-volts. 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.

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Governors seldom go bad or need replacing and will work on either 6 volt or 12 volts and in most cases can be service locally by removing the cover and cleaning up 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 require a separate ground wire. If replacing the governor there were several different types and not all will fit every OD, and the gear that is driven off the tail shaft worm gears can be different. So not all governors will fit every OD.

Solenoid wire terminal locations: To correctly locate the terminal on the solenoid follow this: With the solenoid in hand and the shaft facing away from you, the right hand terminal is #4 and will connect to the relay. The left hand terminal #6 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.

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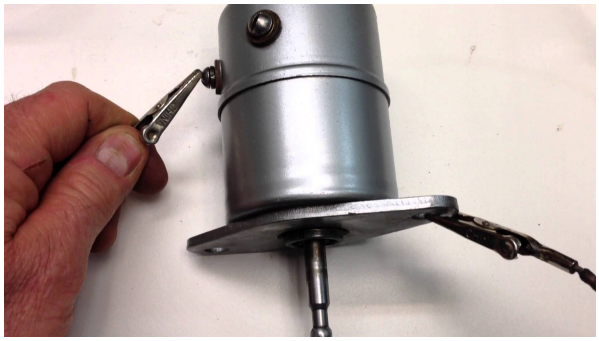
Checking Solenoids for operation: The best way to test a solenoid is to apply battery power directly to the #4 terminal and grounding the case with a set of jumper cables or test leads. When touching the ground, the solenoid shaft should snap out. You can do this while the solenoid is in the vehicle or on the bench. Either way should make the solenoid work. A 6 volt solenoid will operate on 12 volts, but this does not mean you have a 12 volt solenoid as the 6 volt coils will indeed work 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, you may not be buying a 12 volt solenoid and you may get a 6 volt solenoid and find that it fails after a short time on 12 volts.



Click here to see solenoids:

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 at the 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.

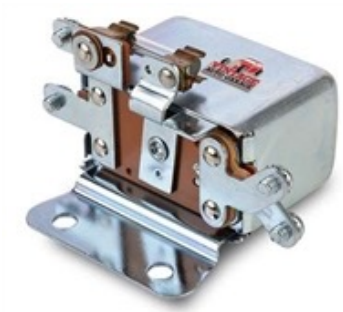
Next, carefully slide the solenoid shaft past the seal, you should apply a little white grease or Vaseline in the center of the seal and on the end of the solenoid shaft, this allows the shaft to slide in easier. Slide shaft in until the shaft engages into the pawl in the transmission. Once it is engaged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

Next start the bolts loosely to align to housing, now release the power and the solenoid shaft should retract, if you have the pawl into the groove at the end of the solenoid shaft correctly the solenoid itself will be pulled towards the transmission housing, then tighten the bolts. 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, 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 your overdrive: The OD electrical components are connected with a wiring harness. Each auto manufacture used their own color codes on the wires but they were all wired essentially the same way. When converting from 6 volts to 12 volts and changing from positive to negative ground, there is no changes needed to the wiring harness. If you need a new wiring harness recommend ordering this complete wiring harness

Overdrive relay: There are 2 styles of relays, first image below is reproduction of the original style relay with external fuse. The second relay uses a modern style relay with self setting internal circuit breaker in a water tight case. Both work the same way but we find the second relay is simpler to install with well marked screw terminals and in a watertight case to



prevent the relay points from corroding. These come in both 6 and 12 volts. **Click here to see relay and other parts**

Servicing and cleaning your overdrive: If your OD has not been service properly and has 50 year old lubricant, here is a simple way to clean without tearing the OD apart. Drain the fluid in the OD, replace the plug and fill the OD 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 OD to work correctly.

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

We hope this report answered questions you may have had.

Here is the link to all the OD electric parts:

Order the Borg Warner Original Service Manual here

Written by Jay Johnson

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