The Borg Warner Overdrive

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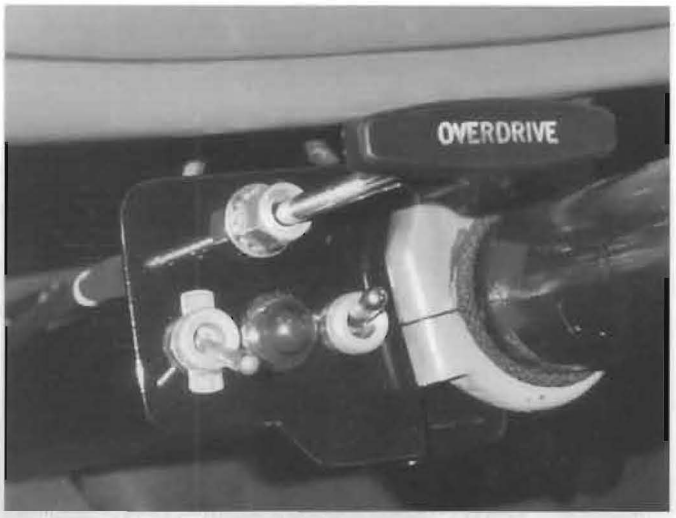


The one on the left, with the words on and off, is the power switch. The one on the right is the spring loaded over-ride switch. Pushing it down against the spring completes the circuit and over-rides the governor.

For the Model A Ford:

Over the last 30 years the addition of an overdrive to a Model A Ford drive train has become a popular and practical convenience. The very first to be used in the 1970's were the Borg Warner conversions. Cottage industries were developed to modify the Model A torque tube and drive shaft to utilize Borg Warner overdrives salvaged from the 1950's and 1960's Ford, Nash, Studebaker, and other cars. Today, there are companies such as the Mitchell Co. that produce a factory-built overdrive for the Model A Ford. While the trend is toward the factory-built overdrives, there are still many of the Borg Warner conversions around. Though somewhat misunderstood, they can still be a practical low cost addition to a Model A Ford.

Why An Overdrive:

When Model A Ford production began the nation's roads and highways were a far cry from what they are today. A speed of 45 mph was considered to be clipping along. The Model A was designed to run at a nominal 45 mph with the engine turning over at a nominal 2,000 rpm. You could run all day long at this speed without hurting the engine. You could also accelerate up to 65 mph, or even faster, if the car was capable of it. However, anything above the nominal 45 mph for any length of time was tough on the car. You would not want to sustain these speeds all day long. Not only would the engine not last long, the shaking and vibration of the whole car does not make for a smooth, pleasant ride for the occupants. As the nation's roads improved after the Model A went out of production, an after market ring and pinion gear with a higher gear ratio of 3.54:1 became available. This new ratio is higher than the standard Model A ring and pinion ratio of 3.78:1. The higher ratio allows the Model A to clip along at a little higher speed, but with the engine still turning over at the nominal 2,000 rpm. The drawback is that you will find yourself shifting into second gear more often when encountering hills. This trade off has to be considered when contemplating installation of the higher gear ratio. An overdrive, on the other hand, provides the capability of shifting back and forth from a low ratio to a high ratio. The thing to keep in mind about an overdrive is that it does not increase the top speed capability of the car. Whatever top speed your Model A is capable of achieving, the installation of an overdrive will not change that. What the overdrive allows you to do is clip along at a nominal 60 mph with the engine turning over at the desired nominal 2,000 rpm. This higher speed is obtained without strain to the engine, the ride is very smooth, and gas mileage does not suffer at the higher road speed.

How They Originally Worked:

The original "modern car" Borg Warner installations were almost an integral part of the standard three speed transmission. The overdrive had an open housing at the front end that bolted up to the rear of the transmission that had an open housing at the rear. The transmission and the overdrive shared the same oil volume. The overdrive unit has a planetary gear system that provides a two speed gear change. The overdrive has two controls, one is a "T" handle the driver pushes in to initiate the overdrive action. The second is an electrically operated solenoid that the driver did not directly control and was usually not aware it existed. The scenario usually went like this: the driver would be out on the highway and would desire to use the overdrive. He would push in the "T" handle. The overdrive planetary system would put the car into what is known as a "free wheeling" mode (more on that later). The car will not actually go into overdrive until it reaches a speed of about 35 mph. At that point the governor, which is a component of the overdrive, will close a switch that will electrically power the solenoid and the car will go into overdrive. Borg Warner overdrives have an overspeed ratio of 33.3%. When in overdrive the car will travel 33.3% faster for the same engine rpm. Should the driver want to pass a car ahead and desires to temporarily drop out of overdrive, a "kick-down" switch was provided right below the gas pedal. The driver momentarily pushed the gas pedal to the floor to actuate the switch. The switch will open the solenoid circuit and drop the car out of overdrive. The car will remain out of overdrive while the driver accelerates around the car he is passing. When the driver eases up on the gas pedal the solenoid is reactivated and the car goes back into overdrive. The solenoid circuit was controlled by an electrical relay. The kick down switch had an additional feature. A second set of contacts momentarily shorted out the ignition circuit. This caused the engine to quit firing for several revolutions

to allow the engine to spool down enough to release the overdrive gears.

Reverse Gear:
A Borg Warner overdrive will not operate in reverse gear because it has an over run clutch incorporated in the output shaft when it is shifted into overdrive. The free wheeling rollers in the over run clutch allow operation in only one direction - forward. When the standard modern car three speed transmission is shifted into reverse a horizontal shaft inside the transmission is pushed toward the rear engaging a mechanism inside the overdrive that pushes it out of overdrive. When a Borg Warner is converted for use in a Model A Ford it is mounted in the middle of the torque tube. It has no mechanical relationship to the Model A transmission. The overdrive is not automatically pushed out of overdrive when the Model A driver shifts into reverse in an attempt to back up. The Model A driver must manually take it out of overdrive by pulling the "T" handle out and deactivating the solenoid. If a Model A driver attempts to back up with both the "T" handle in and the solenoid powered, damage will occur to the overdrive gears. If a Model A driver attempts to back up with the "T" handle in, but the solenoid not powered, no damage will occur, but the car will not back up. As the clutch is engaged the car will just sit there and go nowhere. This is one of the major drawbacks of the Borg Warner overdrive when converted for use in a Model A Ford.

The Model A Conversion:
In past years there were a number of people with cottage industries offering the converted Model A Borg Warner overdrive. Some were excellent, some were marginally acceptable, some were not so great. Probably the best were those built by Bert Hiller of Vancouver, Washington. Bert built several thousand of them. His product was excellent because he understood the need for proper alignment. I spent part of a day at Bert's shop a number of years ago and he explained to me why alignment was so critical. In order to produce the Model A conversion a center section of the Model A torque tube and drive shaft must be cut away. The torque tube must have mounting flanges welded to the two sections, one to the rear of the front section, the other to the front of the rear section. The Borg Warner overdrive housing is then bolted into place between the two flanges. The overall length of the modified torque tube with the installed Borg Warner overdrive unit has to be exactly the same length as is the original Model A torque tube. Any variation of the length and you will not be able to slide the bolt into place that attaches the two rear radius rods to the front of the torque tube. This is a very critical dimension. Another critical dimension is the alignment of the two flanges. They must be perfectly perpendicular to the torque tube. If they are even slightly cocked it will throw off the alignment of the two drive shaft sections inside the torque tube. The stock Model A drive shaft also has to be modified by cutting away a center section to accommodate the overdrive unit. A spline has to be cut into the rear of the front section and another into the front of the rear section. The two splines make the attachment to the overdrive unit. The rear shaft section is referred to as the stub shaft. One end is splined into the overdrive and the other end is fitted into the pinion gear of the differential. If there is any misalignment of the torque tube flanges it will cause a side loading to the stub shaft and the front shaft. The side loading will increase the wear on the splines and eventually cause them to tear up. Side loading can also put a strain on the tapered end of the stub shaft where the pinion gear is mounted. This can cause the shaft to break right at the pinion gear key. The flanges that Bert Hiller used were more than an inch thick to give superior strength to the entire drive train. Bert also used a jig to provide proper alignment while welding everything into place.

Another consideration is the oil seal design. The oil inside the overdrive must be prevented from leaking out both the front and the rear. If oil should get past the front seal it will drip out on your garage floor right under the U-joint. If the oil gets past the rear seal, the only indication you will have is that the differential is manufacturing oil, caused by oil leaking past the seal, down the rear section of the torque tube, and into the banjo. Failure of the rear seal can cause oil starvation and failure of the overdrive, which will be masked by the fact the oil is accumulating in the banjo.

Bill Swigart:
Bert Hiller sold his business several years ago to Bill Swigart of Redding, California (530-221-1628). Although the market for Borg Warner conversions has diminished, Bill, however, is still in the business and does support the existing Bert Hiller overdrives in service and will build and sell a Borg Warner overdrive if ordered. One of the advantages of the Bert Hiller\Bill Swigart overdrive is that they are sold as a complete kit. This includes the "T" handle cable, a 6 or 12 volt solenoid, a governor, a power relay, the speedometer cable extension, and the wiring and installation instructions. Borg Warner overdrives were meant to utilize the governor. However, very few Model A hobbyist take advantage of the excellent feature the governor offers.

Typical Model A Use:
Most people who have a Borg Warner installed in their Model A have a very simple hookup. A small panel is attached to the side of the steering column with a muffler clamp. The panel accommodates the "T" handle and a simple on\off switch. An optional indicator light is sometimes included. Electrical power is applied through the switch to the solenoid. The optional indicator light lets you know when power is being applied. The Model A driver simply pushes in the "T" handle and flips the switch when he wants to use the overdrive. It is prudent to only use the overdrive when in high gear above 45 mph, or in second gear when climbing a hill, otherwise, it will cause the engine to "lug."

It is also prudent to take the car out of overdrive by turning power off to the solenoid and pulling out the "T" handle when coming down a hill. The free wheeling phenomenon explained earlier will allow the car to increase in speed as there is no engine braking when in the free wheeling mode. There are several distinct disadvantages to this simple hookup.

Damage To The Overdrive:
If the Model A is parked with the "T" handle pushed in while the solenoid is still powered and the driver forgets and leaves the switch on and later attempts to back up, damage will occur to the overdrive gears. If only the "T" handle was left pushed in, no damage will occur, you merely won't be able to back up until the "T" handle is pulled out.

A Dead Battery:

If the Model A is parked while the solenoid is still powered, and left that way overnight, the battery will be dead by morning. If you were to look inside a solenoid you will see two sets of contacts, one large, one small. When the solenoid is initially powered, it needs about 30 amps (on a six volt system) to mechanically actuate the solenoid. The large contacts provide this power to a separate coil. As the solenoid actuates, the small contacts close powering another separate holding coil and the large contacts open dropping out the first coil. The purpose of this arrangement is that once the solenoid is actuated it does not need 30 amps to hold it in, only a few amps for the holding coil are required. Those few amps, however, are enough to drain your battery overnight. Because of the initial 30 amps required to actuate the solenoid, it is a good idea to put the solenoid on its own fuse circuit separate from the car's electrical fuse circuit.

Use Of The Governor:

Just about every Model A Borg Warner overdrive in service has the governor installed, but few are hooked up to anything. Were the governor not installed, there would be a large hole in the top of the overdrive that would emit large quantities of oil unless the hole is somehow plugged off. Over the years I have owned three Model A's that I installed a Bert Hiller overdrive in. I still have one of them, a 1929 Coupe. All three utilized the governor and were controlled by a power relay. There are a number of advantages to utilizing the governor.

The Governor Hook Up:

There are several ways that a governor circuit can be connected. One such hookup is shown in schematic form at the end of this article. The governor is located on the top of the overdrive and is a circular looking device screwed into the overdrive housing. It has one single electrical connection point. Inside the governor there is a set of open contacts that are controlled by a fly-ball governor that is driven by a small gear in mesh with a worm gear on the overdrive output shaft. The fly-ball rotates and at a given speed will close the contacts. One of the contacts is grounded to the case, so when the contacts are closed it is providing a ground at the single electrical connection on the governor. This ground is applied to one side of the solenoid control relay. The fly-ball is set for a speed of about 35 mph. The Model A would be better served if the governor speed was 45 mph. However, I know of no way of adjusting the governor for a different speed. The overdrive circuit is hooked up such that the power relay does not close until it sees the ground from the governor switch. This means that even though you have placed the power switch to the on position, there is no power to the solenoid until the relay closes. The advantage of this is that you cannot go into overdrive until the car is above 35 mph and if the car is parked with the on\off switch in the on position the solenoid is not powered. This eliminates the possibility of backing up and damaging the overdrive gears, and prevents the possibility of running the battery down if left on overnight. The other advantage in using the governor, is that the overdrive acts like an automatic transmission. The driver does not have to continually switch the overdrive in and out. The governor will do that automatically. With the power switch turned on and the "T" handle pushed in, the car will go into overdrive automatically when it reaches 35 mph, will automatically drop out when below 35 mph and go back in when it again goes above 35 mph.

Second Gear Hill Climb:

The governor hookup described above will prevent you from using the overdrive to climb a hill in second gear because, more than likely, you will be below the governor speed of 35 mph. However, there is a way around it. An override switch can be added to the control panel attached to the steering column. This switch should be a spring loaded type of switch. When the switch is activated and held in the on position it will put the car in overdrive even when it is under the 35 mph governor speed. How it works is the switch, when activated, provides a ground to the relay the same as the governor would do. The spring load prevents the switch from being inadvertently left in the on position.

The Driving Scenario:

The Borg Warner in my 1929 Coupe is hooked up as described above, including the spring loaded override switch. The driving scenario usually goes like this: while driving around town on surface roads there is no need for use of the overdrive. The "T" handle is pulled out and the solenoid power switch is in the off position. When I am about to enter a (Southern California) freeway I push the "T" handle in and put the power switch to the on position. The car is not in overdrive at this time. As I accelerate down the on ramp and exceed 35 mph I will notice that the indicator light has come on. This tells me I have passed 35 mph, the governor switch has closed, and the solenoid is powered. As I continue accelerating, the car won't actually go into overdrive until I momentarily ease up on the gas pedal to allow the overdrive gears to engage. Once I do that, the car is in overdrive. I can continue down the freeway at speeds of 60 to 65 mph. If traffic begins to slow and I am forced to slow down below 35 mph, the governor switch will open, the solenoid will drop out, the indicator light will go out, and the car will be out of overdrive. When traffic resumes and I am able to travel above 35 mph, the car will automatically go back into overdrive as before. All of this will continue to happen without having to touch any of the controls. When I am off the freeway and I encounter a hill that is too steep to climb in high gear, but not steep enough for second gear, I can push in the "T" handle, close the power switch and actuate the spring loaded override switch and the car will go into second gear overdrive. The car will stay in overdrive even if I release the override switch as long as I keep the gas pedal down and not allow the overdrive gears to disengage.

Kick-down Switch:

A kick-down switch could also be incorporated in the Model A conversion. However, this is not really necessary since the Model A driver has access to the on\off switch, which serves the same purpose as a kick-down switch, as it will remove power from the solenoid. The "modern car" driver did not have this option and for that reason a kick-down switch was necessary. The idea of shorting out the Model A ignition, even momentarily, may not be prudent, as a Model A will have a tendency to backfire.

The Power Relay:

It is desirable to use a power relay to control power to the solenoid. The on\off switch applies battery power to one side of the relay coil. The governor or the override switch apply a ground to the other end of the coil to cause the relay to actuate.

The contacts of the relay actually provide the power to the solenoid. A 6 or 12 volt automobile headlight relay will work very well as a power relay for the overdrive circuit. Twelve volt headlight relays are still available at most auto parts stores. The six volt version is probably not available in stores, but can usually be found at swap meets. It is best to use a headlight relay and not a horn relay. Headlight relays are more robust and were designed for sustained use. A horn relay was designed for short bursts and will overheat if applied to sustained use. The headlight relay can easily be installed in the U-shaped frame cross member located just in front of the service brake cross shaft. There are unused holes in the cross member that a bracket can be attached to. The relay is then mounted to the bracket and is nicely tucked away out of sight in the "U" of the cross member.

The Model A Flywheel:

When a Model A is equipped with a Borg Warner overdrive it is a good idea to have about 10 lbs of weight removed from the flywheel. A Borg Warner overdrive does not immediately drop into overdrive when the solenoid is actuated. The driver has to momentarily ease off the gas pedal and allow the engine to "spool down" slightly to allow the overdrive gears to engage. With the flywheel slightly lightened the engine will spool down a little quicker and the time required to drop into overdrive is shortened.

Model A Do's, Don'ts and Can'ts:

The application of the Borg Warner overdrive in a "modern car" was designed to be fool proof so the driver could conveniently operate the overdrive and not do damage to it. Protection was provided through a combination of use of a governor and the reverse defeat shaft in the manual transmission. The installation of a Borg Warner in a Model A Ford creates some do's and don'ts that the Model A driver should be aware of.

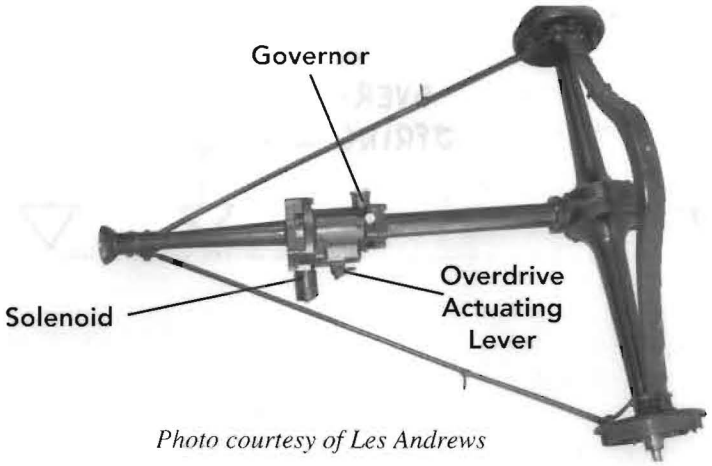


Photo courtesy of Les Andrews

Pertinent Facts:

Fact #1: While traveling down the highway, you can push the T-handle in without pushing in the clutch (solenoid not powered).

Fact #2: While traveling down the highway, you can pull the T-handle out without pushing in the clutch (solenoid not powered).

Fact #3: While traveling down the highway, you can push the T-handle in without pushing in the clutch while the solenoid is powered.

Fact #4: While traveling down the highway, you cannot pull out the T-handle while the solenoid is powered. Clutch in or not, the system just won't allow the handle to come out until the solenoid is de-powered.

Fact #5: While sitting still with the T-handle pushed in (solenoid not powered), you cannot back up in reverse. No damage to the overdrive will occur if you attempt it, the car simply will not move when you let the clutch out.

Fact #6: While sitting still with the T-handle pushed in and the solenoid powered, you should not attempt to back up in reverse as you will do damage to the overdrive.

Fact #7: When parking the car with the solenoid still powered, you will have a dead battery if you leave it that way long enough.

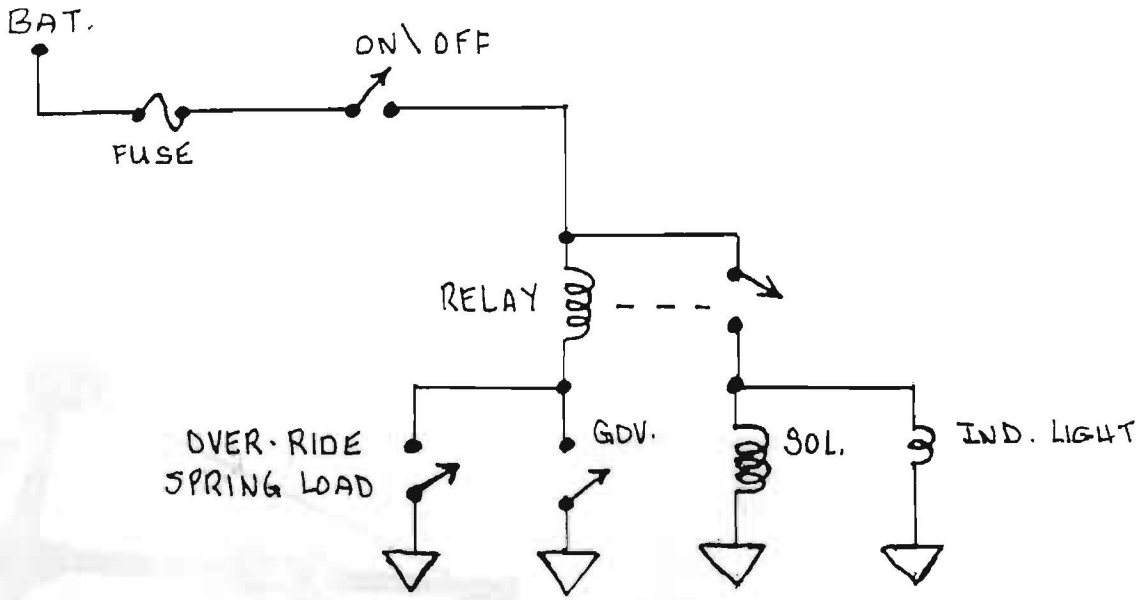
Fact #8: While traveling down the highway with the solenoid powered, but with the T-handle pulled out, the car will operate as normal as if there were no overdrive installed.

Fact #9: While traveling down the highway with the T-handle pushed in and the solenoid not powered, you will be in straight drive (not in overdrive), but the car will be in a "free wheeling" mode, in that the rear wheels can travel faster than the engine is driving them (as in going down a hill).

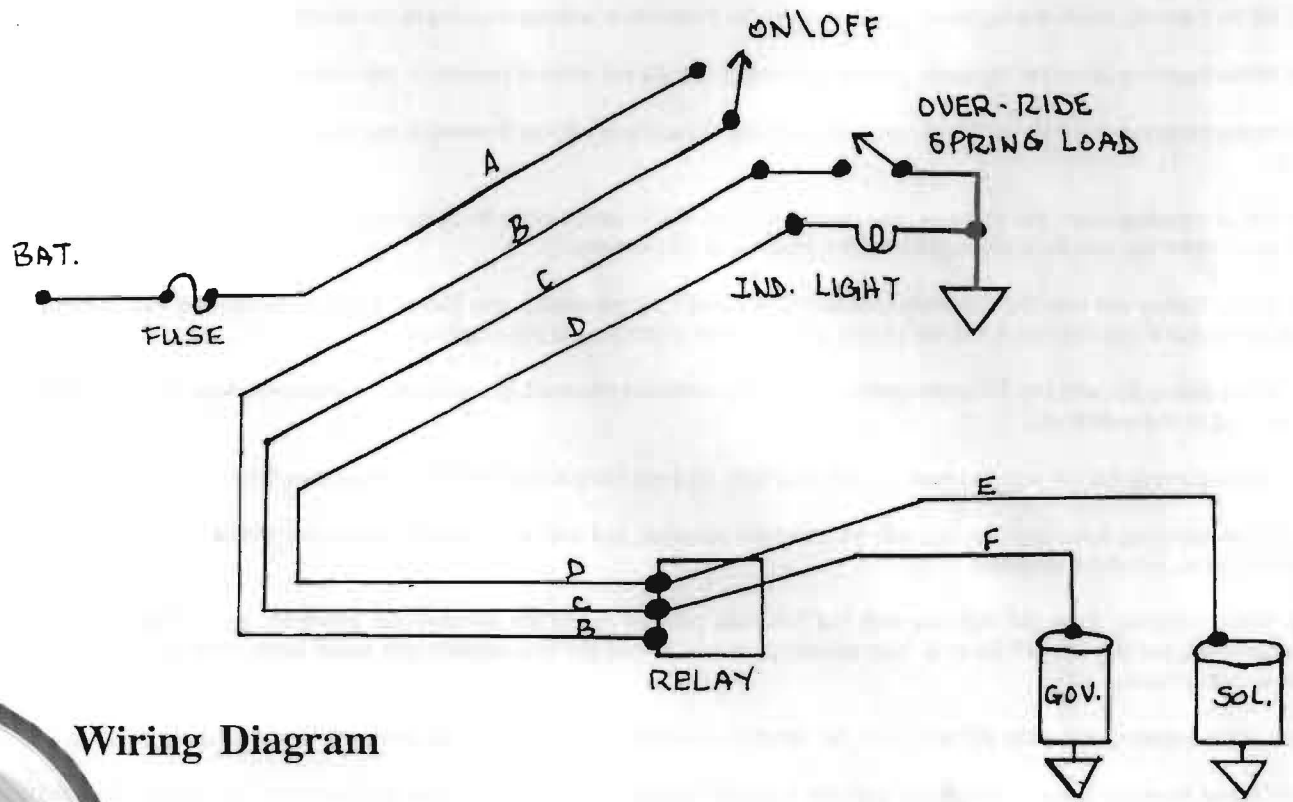
Fact #10: While traveling down the highway with the T-handle pushed in and the solenoid powered, you will be in overdrive.

Fact #11: While traveling down the highway with the T-handle pulled out and the solenoid not powered, you will be in straight drive as if there were no overdrive installed.

Borg - Warner Overdrive Circuit



Schematic Diagram



Wiring Diagram