"AUTOMATIC OVERDRIVE"
(Operation)

Prepared by
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THE BEST MECHANICS KNOW HOW A UNIT WORKS

If you stop to think about it, the best mechanics are the ones who know everything from A to Z about how a unit operates. When we understand what makes a unit tick the way it does, we’ve gone a long ways toward understanding how to properly maintain that unit.

The automatic overdrive unit is no exception to that rule. Sooner or later you fellows are going to be working on this overdrive unit. So the more information you have on how it operates, the better job you’re going to do. That’s why we’re going all out to give you that information. We’ve got other Tech sessions coming up on this automatic overdrive—how to test the electrical controls, and how to disassemble and repair the overdrive unit.

You’ll find this reference book on "Automatic Overdrive, Operation" a valuable addition to your Tech library. This reference book will give you complete information on how this unit operates. In addition, you’ll find the book jam-packed with additional information that will help you understand—but, wait a minute, this handy index will give you all that information:
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overdrive Control Handle</td>
<td>4</td>
</tr>
<tr>
<td>What is Overdrive?</td>
<td>6</td>
</tr>
<tr>
<td>How the Planetary Gear System Works</td>
<td>7</td>
</tr>
<tr>
<td>Mechanical Operation of the Automatic Overdrive</td>
<td>13</td>
</tr>
<tr>
<td>Electrical Controls of the Overdrive</td>
<td>15</td>
</tr>
<tr>
<td>Electrical Operation of the Overdrive</td>
<td>18</td>
</tr>
<tr>
<td>Shifting Into Reverse</td>
<td>20</td>
</tr>
<tr>
<td>Overdrive Unit Lubrication</td>
<td>21</td>
</tr>
</tbody>
</table>
OVERDRIVE CONTROL HANDLE

Before we get into the operation of the overdrive unit, we should understand just how the different positions of the overdrive control handle affect the operation of the automatic overdrive unit. The control handle is located on the instrument panel, just to the left of the steering column.

CONTROL HANDLE PUSHED IN—With the overdrive control handle pushed IN, the unit is in the overdrive position. The handle can be pushed in at any time—with the car moving or standing still. This means that the overdrive unit is ready to operate when two conditions are met:

1. When the car reaches a speed somewhere between twenty-four and twenty-seven miles per hour.

2. When torque is momentarily relieved by removing the pressure on the accelerator pedal.

CONTROL HANDLE PULLED OUT—With the overdrive control handle pulled OUT, the car will operate in conventional drive. In other words, by pulling out this control handle you completely cut the overdrive unit out of the power train, as far as operation is concerned.
HOW TO PULL OUT THE CONTROL HANDLE CORRECTLY—Of course, the overdrive control handle may be pulled out at any time the car is not in motion. But, there will be times when you’ll want to make the shift from overdrive to conventional drive when the car is in motion. Knowing just how to make the shift smoothly is important.

CAR TRAVELLING AT SPEEDS BELOW TWENTY MILES PER HOUR—The first condition under which you may want to shift out of overdrive is when the car is travelling at speeds below twenty miles per hour, and the unit has shifted back to direct drive. Here is how that is done.

1. Depress the accelerator slightly and,
2. Pull out the control handle.

CAR TRAVELLING IN OVERDRIVE AT SPEEDS ABOVE THE OVERDRIVE CUT-IN SPEED—The second condition under which you may want to shift out of overdrive is when the car is travelling in overdrive at speeds above the governor cut-in speed.

1. Fully depress the accelerator past the wide-open throttle position. This operates the “Kickdown” switch and kicks the unit down into the direct-drive, third-speed position.
2. Then pull out the control handle and the unit is shifted to conventional drive.

NOTE: Do not depress the clutch pedal when getting out of overdrive, as this will cause the engine to race unnecessarily.
WHAT IS OVERDRIVE?

Overdrive is a gear unit which increases the speed of the propeller shaft without increasing the speed of the engine.

What does this mean to you? Let's take a look at conventional drive—the type of drive which you have in a car not equipped with an overdrive unit—and see just what this means. It means that, when you have one thousand r.p.m. at the engine, you are also going to have one thousand r.p.m. at the propeller shaft, with the transmission in conventional third or "high" gear. In other words, there's an engine-propeller shaft ratio of one to one.

![Diagram of 1000 RPM and 1000 RPM]

Now let's look at a car equipped with an overdrive unit and assume the overdrive unit is in operation. With overdrive, the engine would have to operate at only seven hundred r.p.m. for you to get one thousand r.p.m. at the propeller shaft. In other words, there would be an engine-propeller shaft ratio of seven-tenths to one—an output gain of 30%.

![Diagram of 700 RPM + Overdrive = 1000 RPM]
HOW THE PLANETARY GEAR SYSTEM WORKS

Since the overdrive unit is basically a planetary gear set, in order for us to understand the Automatic Overdrive we must first understand how the planetary gear system works. Let's look first at a picture of the sun and the earth. You'll notice that the sun is in the center and that the earth revolves around it.

If you will keep this picture of the earth and the sun in mind, you will find it much easier to understand how the overdrive planetary gear system operates.

In the planetary gear system we have a sun gear, with three earths, called pinions, revolving around it. The sun gear, in the overdrive unit, is free-running on the transmission main shaft, and the three pinions are meshed with this sun gear.

Now, to hold these three pinions in place around the sun gear, we have a fixture which we call the pinion cage. This cage is splined to the main shaft, which means that the cage turns at the same speed as the transmission main shaft. That's how we get power into this planetary gear set.
An internal-tooth ring gear fits around the pinion cage and meshes with the pinions. This ring gear is splined to the housing which forms the outer race of the overrunning clutch. At the rear end of this housing is a shaft called the overdrive main shaft. This is also the output shaft for the overdrive unit.

What that means is this: The transmission main shaft is the input shaft, and the overdrive main shaft is the output shaft. As you can see, these two shafts must be connected if power is to be carried from one to the other.

That’s where the overrunning clutch enters the picture. The clutch is located directly behind the pinion cage, and is also splined to the transmission main shaft.

Now let’s see how we get power through this planetary gear set to get two types of drive—Overdrive and Direct drive. Suppose we look at overdrive first.

OVERDRIVE—In order to get overdrive, it is necessary for us to hold the sun gear, so that it cannot rotate. Remember—we are putting power into the gear set through the pinion cage, because the cage is splined to the transmission main shaft, which acts as a power input shaft. So, the cage will be turning at engine speed.
By keeping the sun gear from turning, we allow the cage to carry the pinions around this sun gear, which is being held from turning. This means that each pinion will have to rotate on its own axis as it rolls around the sun gear.

Let's stop right here for a moment and see just what this does. Suppose we think of the pinion as a lever. If we hold one end of a lever against a solid object, and push at the center of this same lever, the outer end will travel a greater distance than will the center.

Actually, this is exactly what we are doing with the pinions in this planetary gear set-up. One side of the pinion is held against the stationary sun gear, while power is being applied against the center of this pinion through its axle which is attached to the pinion cage. This means that the outer side of the pinion, which is meshed with the ring gear, will push the ring gear at a greater speed and a greater distance than the pinion cage is turning.

And that's the overdrive action we're talking about. When that ring-gear-and-overdrive-main shaft goes faster than the pinion cage which drives it, you have overdrive.
**POWER FLOW IN OVERDRIVE**—In overdrive operation, power comes into the overdrive unit through the transmission main shaft, goes into the pinion cage, to the pinions, to the ring gear and out through the overdrive main shaft.

**POWER FLOW IN CONVENTIONAL DRIVE**—Conventional drive is the same as having no overdrive at all. Of course we *do* have an overdrive unit, so that means that we’ll have to make the entire planetary gear set work as a single unit. In other words, all of the parts will have to be locked together. Here’s how we do that.

We lock all of the parts together by pulling OUT the overdrive control handle. When we pull out that control handle, we cause the sun gear to be moved so that its teeth will be in mesh with the internal teeth of the pinion cage.
This means that the sun gear will now turn with the pinion cage. So will the ring gear, because the pinions are in mesh with both the sun gear and the ring gear. So, in this position, the transmission main shaft will drive the pinion cage and, since the sun gear, the pinion cage and the ring gear are all locked together, the entire gear set revolves as a single unit.

Power flow, therefore, is through the transmission main shaft, to the pinion cage, through the pinions which are locked between the sun gear and the ring gear, to the ring gear and out through the overdrive main shaft.

POWER FLOW IN DIRECT DRIVE—Now, let’s suppose that the unit is in the overdrive position. That is, with the control handle pushed in, but with the car speed below overdrive cut-in speed.

In this position the sun gear is not held still, but is free to turn on the transmission main shaft. This means that when the pinion cage is rotated, the pinions have nothing to push against and, therefore, cannot drive the ring gear.
This brings in the overrunning clutch, which we mentioned earlier. The inner part, or cam of the overrunning clutch, is splined to the transmission main shaft. Therefore, the transmission main shaft turns the inner part, or cam, of the overrunning clutch. This action forces the rollers of the clutch to move up the ramps of the cam. By moving up, they become wedged between the cam and the outer race of the clutch, which is part of the ring-gear-and-overdrive-main shaft assembly.

Power flow during direct drive, then, is from the transmission main shaft, through the overrunning clutch, to the overdrive main shaft assembly, and out the propeller shaft.

A ONE-WAY DRIVE—While the overrunning clutch allows the engine to drive the rear wheels, it does not allow the rear wheels to drive the engine. When the rear wheels start to overrun the engine speed, they drive the outer race of the overrunning clutch faster than the clutch cam is being driven. This causes the rollers to move down off their ramps so that there is no power connection between the overdrive main shaft and the transmission main shaft.
Now that we’ve seen how the planetary gear set works, and how you can get power through it so that we have the same, or greater, speed from the output shaft, let’s see how this particular overdrive operates to get these conditions.

MECHANICAL OPERATION OF THE AUTOMATIC OVERDRIVE

CONTROL HANDLE “OUT”—With the overdrive control handle pulled out, the unit is in conventional drive, with all parts of the planetary gear set locked together. When you pull the control handle out, you have the same driving condition that you have when the car is not equipped with an overdrive unit.

CONTROL HANDLE “IN”—Suppose we take a look inside the overdrive unit with the control handle pushed in. Now we have an overdrive unit that is ready to operate as an overdrive when the driver calls for it. By moving this control handle IN, we have shifted the sun gear OUT of mesh with the pinion cage, so that the sun gear control plate can take over. This sun gear control plate is located in the adapter, which is between the overdrive housing and the transmission case, and is splined to the sun gear.
When the car speed reaches the overdrive cut-in speed—somewhere between twenty-four and twenty-seven miles per hour—and you take your foot off the accelerator pedal, a pawl is moved into one of the notches in this sun gear control plate by the action of a solenoid. This pawl holds the plate from turning, and also keeps the sun gear, which is meshed with the plate, from turning. This is important, because the sun gear must be kept from rotating in order for the gear set to work as an overdrive. From the moment the sun gear is held so it can’t rotate, the unit is in overdrive. The pinions are now driving the ring gear.

Now, when the car speed drops below the overdrive cut-out speed—around twenty miles per hour—the solenoid pulls the pawl out of the sun gear plate, allowing the gear to turn again. When that happens, you are back in direct drive.

Remember—when the control handle is pushed IN, the overdrive unit will operate as either direct drive or as overdrive, depending, of course, on whether the pawl is holding the sun gear or letting it turn freely.

**ACTION OF THE BALK RING**—In order for the pawl to successfully get into a notch in the sun gear control plate, it has to get past a part called the *balk ring*. You’ll find this balk ring mounted on the sun gear control plate. As its name
implies, it balks, or prevents, the pawl from entering the notch in the sun gear control plate until the plate stops turning and a notch in the plate is lined up with the pawl.

**ELECTRICAL CONTROLS OF THE OVERDRIVE**

In order to have a complete understanding of the operation of the overdrive unit, the part played by the units in the electrical circuit must be understood. Suppose we start out with the solenoid.
The solenoid is actually the “middleman” between the electrical circuit and the mechanical parts of this overdrive.

**Solenoid**—The solenoid is an electromagnet. When this solenoid is energized, a pawl rod and spring are loaded, ready to push the pawl into the sun gear control plate when the accelerator pedal is released.

**Governor**—The operation of the solenoid is controlled by another unit, called the governor, driven by a spiral gear on the overdrive main shaft. The governor is an automatic switch which opens and closes a set of contact points. By doing this, it completes or breaks the electrical control circuit through the relay. The governor is calibrated to complete the control circuit at between 24 and 27 miles per hour.

**Overdrive Relay**—This is an electrically operated switch which uses a small amount of current to close a set of points, thereby completing a circuit which carries a heavier current. Because a heavy initial pull is needed to operate the solenoid, we must have a heavy current to do the job. However, we don’t want to draw this heavy current through the ignition switch.
By using a relay, a smaller amount of current is used to close the points and complete the solenoid circuit without passing the heavy current through the ignition switch.

*KICKDOWN SWITCH*—The kickdown switch breaks the control circuit and interrupts the engine ignition to permit a shift out of overdrive and into direct drive without waiting for the car's speed to slow to governor cut-out speed—around twenty miles per hour. When the accelerator pedal is depressed beyond the wide-open throttle position, the throttle linkage operates the kickdown switch, which “kicks” the overdrive unit to what we call “direct drive.”

When this kickdown switch is actuated, two things happen:

1. The switch cuts the governor out of the circuit in order to de-energize the solenoid, and

2. It causes the engine ignition to be grounded just long enough for engine torque to be relieved so that the pawl can be pulled out of the sun gear control plate.

*RAIL LOCKOUT SWITCH*—The rail lockout switch makes or breaks the electrical circuit which operates the overdrive unit. It is operated by the control handle. When the overdrive control handle is pushed IN, the contacts in this switch are closed, bringing electricity into the overdrive circuit. When the control handle is pulled OUT, the switch points open, breaking the circuit.
ELECTRICAL OPERATION OF OVERDRIVE

SHIFTING INTO OVERDRIVE—The actual operation of shifting into overdrive is very easy to understand. Starting with the control handle pushed in, to place the overdrive unit in position to operate as an overdrive, the actual shift takes place automatically when the car speed is between twenty-four and twenty-seven miles per hour.

At that speed, the governor points have closed and the circuit to the solenoid has been completed. The solenoid is therefore energized, and the pawl rod and spring are loaded, ready to push the pawl into one of the notches in the sun gear control plate.

As soon as the driver lifts his foot from the accelerator pedal, bringing the engine to idle speed, the sun gear and the control plate slow down and come to a stop. As soon as this happens, and the notch in the control plate lines up with the pawl, the pawl is pushed into the notch. The control plate, then, as well as the sun gear, are held from turning. As soon as engine speed is increased, the overdrive unit will operate as an overdrive.

IT'S ALL DONE
SHIFTING OUT OF OVERDRIVE—In order to get the unit out of overdrive, we must break the overdrive electrical circuit and relieve engine torque on the gears. That is done in two ways.

First, when the car slows down below the overdrive cut-out speed, the governor points open. That action breaks the electrical circuit and de-energizes the solenoid. The pawl rod return spring pulls the pawl out of engagement with the sun gear control plate, and you’re out of overdrive.

Second, we can get out of overdrive at a speed above the overdrive cut-in speed—about twenty-four to twenty-seven miles per hour—by using the kickdown switch, as we have explained earlier. Just push the accelerator down past the wide-open throttle position to actuate the kickdown switch.
SHIFTING INTO REVERSE

So far, we have learned what happens within the overdrive unit during forward motion of the car. Now, let’s see what happens when shifting into reverse.

We’ll assume that the control handle is pushed in, placing the overdrive unit in the overdrive position. Now, we’ll shift the transmission to reverse gear by the normal movement of the shift lever beneath the steering wheel. Here’s what takes place inside the overdrive unit.

The transmission low-and-reverse gearshift rail is moved backward. When this rail moves backward, the rear end of the rail presses against the overdrive shift rail, moving it backward.

If the teeth of the sun gear are in alignment with the internal teeth of the pinion cage, the shift rail carries the shift fork and the sun gear back immediately, meshing the sun gear in the pinion cage.

However, if the teeth on the gear and cage are not in alignment, the movement of the shift rail momentarily compresses the fork spring. Further rotation of the pinion cage causes the teeth to line up and when this occurs, the fork spring causes the shift to take place.
In view of the fact that an additional load is placed on the transmission low-and-reverse shift rail, a little more effort is required to accomplish the manual shift to reverse. This is a normal action, and does not indicate difficulty in the overdrive unit or in the transmission.

When it is desired to drive forward again, and the gearshift lever is moved out of reverse, the overdrive shift rail retractor spring moves the rail and fork forward, disengaging the sun gear teeth from the pinion cage.

If the control handle is in the overdrive position, no resistance should be felt as the gearshift is moved out of reverse. However, if the control handle is pulled out, a little more effort is required to move the gearshift lever. This is due to the use of a heavier gearshift selector ball spring.

**OVERDRIVE UNIT LUBRICATION**

As the overdrive and transmission are connected by oil passages, the same lubricant is used in the overdrive that is used in the transmission of the car.

In filling the transmission and the overdrive, remove both filler plugs. Fill the overdrive housing first, until oil runs from the filler hole, and then install the plug. Then fill the transmission until oil runs from the filler hole, and install the transmission filler plug.

**NOTE:** Be sure that the transmission and overdrive oil level is checked on all new cars.
Keep in mind that the overdrive unit is basically a planetary gear set. If you understand how it is possible to transmit power through the gear set to get the same or greater speed at the output shaft, you should have no difficulty in understanding how the overdrive unit operates.
QUESTIONNAIRE
TEST YOURSELF
WITH THESE QUESTIONS!

1. The overdrive unit will operate as an overdrive when the control handle is (check one)
   IN □ OUT □

2. When the sun gear is locked to the pinion cage, the planetary gear set will operate as an overdrive unit.
   RIGHT □ WRONG □

3. The action of the solenoid unit is to move the control pawl into or out of engagement with the sun gear control plate.
   RIGHT □ WRONG □

4. When the sun gear is prevented from rotating because the pawl is holding the control plate, the planetary gear set will operate as an overdrive.
   RIGHT □ WRONG □

5. The governor points close at speeds above twenty-four to twenty-seven miles per hour.
   RIGHT □ WRONG □

6. The pinion cage is always being driven by the transmission main shaft because it is splined to the main shaft.
   RIGHT □ WRONG □

7. The rail lockout switch is operated by the overdrive control handle.
   RIGHT □ WRONG □

8. The sun gear is splined to the transmission main shaft.
   RIGHT □ WRONG □

9. When the pinions rotate on their own shafts and revolve around the stationary sun gear, the ring gear is being driven slower than the pinion cage.
   RIGHT □ WRONG □

10. The ring gear is splined and locked to the overrunning-clutch-outer-race-and-overdrive-main-shaft assembly.
    RIGHT □ WRONG □
SURE, I KNOW!

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