

Transmission:Manual, Clutch

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Maintenance and Operation:

Fluids and Fluid Change.

Fluid Type:

[Tip: Paul Seminara] The M46/M47 transmissions require Type F auto tranny fluid: NOT Dexron. It takes about 2.4 quarts if you can get it all out. I pumped in the new synthetic Type F ([Amsoil](#) Supershift Racing Transmission Fluid; product # ART.) . No wonder Volvo mandates type F. Shifts the best of any fluid I have tried. OD works flawlessly. [Editor: Redline [MTL](#) is also recommended as well as Redline [Type F](#) synthetic.] According to Duane Hoberg, I should stick with a product without friction modifiers, and of the type directly recommended. [Duane] Your trans needs Type F ATF ONLY. Northern locations and winter eliminate the 30W oil option since you regularly get below the 10 C low point for the oil option. Dexron or Mercon ATF is NOT usable in manual transmissions not designed for that fluid. It does not have the resistance to squeeze out or the cling necessary to stay between the gears as they mesh. You will end up with metal on metal as you drive, increasing wear and heat. The heat will eventually deteriorate the fluid so it no longer lubes well. After that point is reached, the tranny will go down hill fast. [Tony Hoffman] The M-47 takes 1.6 quarts. By jacking up the driver's side, you can insert all 2 quarts, overfilling slightly above the fill hole's normal line and ensure that fifth gear has more than adequate lubricant. [Ryan R.] The word on the street is that the M-47 fill hole is two low, so the 5th gear eventually wears out. The over fill with 2 quarts seems to work.

Drain and Filter Cleaning Procedures:

- **Fill and Drain Plugs.** [Jim Holst] *To check the oil level*, put the car on jack stands or ramps (safety first!!) Look at the driver's side of the tranny. There you'll see two plugs screwed into the side of the tranny. The lower is the drain plug, the upper is the fill plug. Clean the dirt away from the upper plug and unscrew the plug. NOTE: I recommend you use only a 6-point socket on this plug. Sometimes the plug will be frozen into the tranny and will be rounded off with a 12-point socket or, worse yet, a Crescent wrench. This is specially a problem with the aluminum case M47. If worse comes to worst, weld a 17mm bolt on to the plug. When you have the plug out, stick a finger into the opening and see if you can feel the oil. The oil should come up to the opening. Replace the fill plug after first placing antiseize on the threads. *Draining.* [Zee] **Before draining anything, make sure you can loosen and remove the FILL plug.** Yes, the FILL plug. Mine is frozen in and I already have drained the old juice out the drain plug below. Now I have to invent a method for filling the unit via the drain hole instead! [Shannon de Wolfe] It is possible to fill the transmission through the shifter hole if the fill plug is completely stuck.

- **Filling.** [Zee] Use a little hand pump affixed to the top of the quart oil bottle.
- **Gaskets and Overdrive Filters.** [Duane] The only gasket is the one for the Overdrive since it shares fluid with the trans. The only filter (actually a screen, up above a 3x5" rectangular cover on the bottom of the OD and easy to unscrew) is for the overdrive and needs a special wrench (homemade or from [IPD](#)) with two pins on it to remove the plug to access it once the OD pan is off. That filter is metal mesh and can be washed with mineral spirits or kerosene. [Tip from Mike Froebel] I've found you can remove it with two punches and a large adjustable wrench if you have 3 hands. Take the OD cover off to drain that....you'll need the gasket for this.Note the orientation of the cover so you can install it the same way.

Flushing Procedures:

[Paul Seminara] Get the overdrive access plate gasket from a Volvo source. First make sure fill plug comes out (see above). Drain tranny. You can easily see and access the planar screen. Clean well with an evaporating solvent. You'll need a special tool to open the lid to the cylindrical chamber with cylindrical OD screen. Clean this. Button up and fill with inexpensive petroleum type F (DON'T use Dexron), drive for 1000 miles or so. Drain and refill with Synthetic Type F, such as Amsoil Supershift. Go 10,000 miles drain and refill. Check filter screens again at this point if you are thorough; sometimes crud from unknown locations will be deposited on the cylindrical screen.

Manual Transmission Shifting Troubles.

[Inquiry:] My Volvo 745T has gradually been developing a shifting problem over the years and it has recently become a lot worse. I have the manual transmission and I find that I have trouble putting it into first gear and to a lesser degree second gear. These problems occur about every 4 out of 5 times I shift into those gears. They either go into those gears smoothly on the first try or completely refuse to go in (requiring a 3-2-1 shift maneuver). The other gears work fine and the car is generally in good mechanical shape. It has been suggested that this problem may be caused by shift cables or possibly the synchronizers on those gears.

Clutch Adjustments.

[Response 1: Jerry Andersch] I'd start by making sure the clutch cable is properly adjusted. There should be about 1/8" slack in it before it begins to pull the release arm. Adjustment is made under the car at the end of the clutch cable. Threading it in or out will produce the right amount of slack. If the cable is out of adjustment it may not fully disengage the clutch and as a result getting it in to first gear from a dead stop and shifting to other gears, may be difficult. Of course there could be other problems but I'd begin here with the easiest and virtually cost free potential solution. Hope this is the answer.

[Response: Rollie] I had similar problem after I replaced the clutch but it turned out to be an adjustment that I'd made on the shift linkage.

Worn Clutch. [Inquiry] My 740t 4sp w/od started having trouble getting into gear.

First didn't grind but I could not get it onto gear. If the car had been running a little while it would go into any gear just fine. Still a little rough on first and reverse. Master cylinder was bled; the clutch looks new.

[Response: Don Foster/Colin] Despite the apparently new clutch, it sounds as if the clutch is dragging. Often, this occurs with a worn clutch as the thin material bubbles, buckles, or tears and folds over, jamming between the pressure plate and flywheel -- even when the clutch is depressed. In your case, the clutch disc may be warped so that it remains in contact with the PP or flywheel. Another possibility is that the splines on the input shaft may be gunked, rusty, worn (having a notch), or damaged such that the clutch disc binds and can't move when the clutch is depressed. This could keep it in light contact with the flywheel. If your pressure plate springs or fingers look uneven, that suggests that when the t/o bearing pushes on them, the pressure plate lifts unevenly and won't fully disengage from the clutch disc. Sometimes that can happen from riding the clutch (or a misadjusted clutch) -- the friction from constant contact can heat and soften the fingers, causing several to bend slightly. It's also no good for the t/o bearing. Check the condition of the pilot bearing; if this is not totally free to turn it will cause the clutch to drag.

Fluid Change.

[Response: Robert Abel] I had this problem in my M46 (190,000 miles). In fact, it got so bad that I was locked out of gear in traffic once - that was a fun one. Changed the fluid to synthetic 10w30 motor oil. Ran the car for a week. Changed the fluid again. Problem fixed. Now shifts easily every time. The only thing I can figure is that the old fluid was not allowing the synchros to properly rotate. Once the new fluid had its chance, everything's good.

[Response: Ozzie] The guy I bought my car from at 129K was selling the beast because of the 1st, 2nd gear problem. I changed the fluid to find it a little better, then I changed to Redline MTL. This stuff works wonders, its a little expensive (8 or 9 bones a quart---you need two), but not near what a new/used tranny costs.

Shifting Technique.

[Ozzie:] A couple of tricks for you M47 owners with 1st gear problems: either shift into 2nd then 1st, or shift into 1st as you're coming to a stop. The synchros engage better. Another trick I learned a month ago, for those with a worn clutch and the grinding into reverse problem...put that puppy in first, then slide it into reverse--NO GRINDING--just another trick to put off replacing the clutch and surrounding pieces and parts (rear main seal,etc.)

Overall Diagnostics.

[Response: Gary DeFrancesco] Your problem sounds like the beginnings of what I experienced with my M46 tranny last year. In my case, the problem came on somewhat suddenly, then progressively got worse. After awhile, I no longer had 2nd gear at all. How many miles are on your tranny? Has the oil ever been changed? Unfortunately, many auto manufacturers do not consider changing the manual tranny oil a regular maintenance item. Hence, there are manual trannys out there with a lot of miles on the factory oil, and they sometimes fail. In my

case, I think the tranny oil was first changed at 164,000, which is shortly after I bought the car. At about 175,000, the shifting problems started. I think the wear was well underway when the oil was changed, by then the it was too late to prevent the long term problems. I tried Redline MTL in a desperate attempt to revive the tranny. It did not work. I ended up replacing the tranny with another one from wreck.

In your case, I would go ahead and change the oil. Look at the magnet in the drain plug. If there are a lot of metal filings, then there is some significant wear occurring. Maybe a good synthetic oil such as Redline MTL will help. I think your synchros are starting to go. Don't know what a set of synchros cost, but being a Volvo part... Such a repair will require a total tranny tear down, so you should also replace all the bearings and seals. Since your problem is mostly with 1st gear, you may have a problem with the 1st gear damper if you car is equipped with one. If this is the case, you may also need a 1st gear wheel which is obscenely expensive.

If an oil change does not help, and your clutch is working fine (if you get grinding into reverse, then your clutch is not releasing correctly which can cause your shifting problems), then you may want to look for another tranny from a wreck. Try to find one with some known history, relatively low mileage, and evidence of being maintained (ie., oil changes). Finding a M46 for a 745T can be very expensive. I was getting quotes of \$650 - \$950. Remember, a 740T with manual tranny is not a common configuration in the US. I ended up getting a M46 out of a 240. These trannys are much cheaper (\$300 - \$400 range) and are the SAME tranny as what goes into the 740. The only differences I could find was what was bolted to the gear box to make it mate to the different cars. Swap these few parts (shifting cage, selector rod, tranny mount, and maybe the drive shaft coupling and clutch fork), and the tranny is ready to go right into the car. No other changes need to be made.

Test Driving a Manual Transmission.

[Tips from Volvo TSB 890-43-4, 06/97, courtesy of Service Technicians' Society] Systematic testing and diagnosis continues to be a primary rule for technicians. Some problems, though, can only be confirmed while driving the car. Shifting and noise problems can be tricky without a standardized procedure within a particular shop. Volvo has outlined a manual transmission test drive procedure that would apply to most, if not all, manuals. The first step is preparation with checking the transmission oil level before test driving. Transmission warmup also is needed before the test drive. Volvo states that manual transmissions with an aluminum case should be driven for about 20 minutes to achieve normal operating temperature. With the car stationary, engine idling, clutch pedal depressed and shift lever in Neutral, release the clutch pedal and listen for mechanical noise. Note whether the noise occurs with the pedal depressed or released. Repeat this step 10 times to check for intermittent noise. With the car stationary and the engine idling, fully depress the clutch pedal and wait three seconds, put the lever into Reverse, then 1st gear, and then Reverse again. Move the lever to Neutral and release the clutch pedal. Repeat the procedure, but wait for 20 seconds instead of three. Note any changes: differences in noise or difficulty in selecting gears after the different wait time.

Check the point of clutch engagement, and whether the clutch sticks or causes noise when the pedal is depressed. Put the lever in Reverse and accelerate to about 2500 rpm, listening for any noise and noting any other problems. Next, drive the car on a highway with little traffic. Select 1st gear, and accelerate, shifting 1-2 and 2-3 at about 4000 rpm. Then shift 3-4 and 4-5 at as high an engine speed as can be done safely, but no higher than 4000 rpm. Engine brake the car, downshifting through all gears at about 3000 rpm. Note any difficulties selecting a gear, whether gears jump out of engagement, and whether there is any noise during any shift. Repeat the test, upshifting at 5000 rpm and downshifting at 3000 r

Drive the car in 4th gear at about 60 mph and begin 1 minute of constant acceleration, as traffic and speed limits allow. Upshift to 5th gear, release the clutch for a moment, depress the clutch and downshift back to 4th gear. Repeat six times, noting any problems. Whether you elect to use this procedure or develop a modified one of your own for local conditions, being able to repeat the sequence to demonstrate a problem is a plus. The test procedure also helps to confirm that the repair fixed the problem. A re-test need not repeat test steps that initially were satisfactory. However, there's always the slight possibility that another problem occurred as a result of the repair procedure. Become a creature of good, thorough habits when diagnosing. Unpredictable procedures will mislead you more often than not

M-46 and Overdrive:

Manual M-46 Laycock Overdrive Unit: Basic Operation.

Note that the Ohio Buckeye Triumph group maintains a superb website with detailed technical information on the J-Type Laycock de Normanville overdrive unit; this may be found at: <http://www.buckeyetriumphs.org/technical/technical.htm>

[Discussion and Analysis by [Duane Hoberg](#), from whom parts may be purchased]
The following describes the power flow and the fluid flow for control of the Laycock OD.

Refer to the [OD diagram](#) for the numbers.

- **Non-OD Operation.** Assume the output shaft from transmission through center of OD. During Non-OD operation, splines on end of trans shaft mesh with Sprague clutch cam (67) and internal of planetary carrier (70). Cone clutch (43) is pushed onto annulus /output case (55) by springs (51) through bearing (46) and its carrier (44).
- **Reverse and engine braking.** Trans output shaft turns the planetary carrier (70). Since planetary carrier gears (75) are in contact with the sun gear (78) and the annulus case (55), and the cone clutch (43) is in contact with output case (55), the complete system acts as a locked unit. The Sprague clutch freewheels allowing the case (55) to turn backwards.
- **Forward gears one through four.** As for reverse adding transmission output shaft drives Sprague cam (67) jamming rollers (66) against output case (55) eliminating slippage of cone clutch under higher torque and load conditions.

- **OD engagement.** At all times transmission output shaft is rotating, fluid is being pumped by pump (12) through check ball (18) through filter (30) to passages leading to the actuating pistons (49) and the solenoid (39). This fluid, under about 15 PSI, is always present behind the actuating pistons (49), at the top of the Pressure Relief Valve (between 22 & 23), and at the rear most port on the solenoid.
- **Non-OD fluid control and flow.** The solenoid not energized, blocks the fluid from reaching the area under the dashpot (just above 24). The pressure generated by the pump is sufficient to push the relief valve (between 25 & 27) down and the fluid is dumped through the side of the relief valve onto the trans output shaft just forward of the cam follower to bathe the cam (not shown inside 13) and the bearing (46). The 4 springs (51) have enough pressure to overcome this pressure and keep the cone clutch (43) pressed against the annulus case (55).
- **OD actuated.** Solenoid energized. Solenoid internal piston moves toward front of solenoid piston bore, opening path between the back port and the middle port on the solenoid bore. This action also blocks a port on the front of the solenoid bore plug.
- Fluid is now free to pass to a metered port between the solenoid housing and the bottom of the Pressure Control Valve Dashpot (above 24). Since this is a very small opening the pressure build up is slow to allow a slow buildup of pressure. Since the dashpot has a larger surface area than the top of the relief valve (between 25 & 27), the dashpot will push the relief valve up closing the relief port and increasing the pressure behind the actuating pistons (49) and the underside of the dashpot.
- As the pressure increases behind the actuating pistons, the pistons push on the bars (52) which then pulls the cone clutch (43) off the annulus case (55) and into the brake ring (42) which stops the cone clutch (43), bearing (46), and sun gear (78) from spinning. As the cone clutch unit slides on the trans output shaft, the planetary gear carrier (70) is still driven by the trans output shaft.
- When the sun gear stops spinning, The planetary gear carrier (70) still driven by the trans output shaft, spins the planetary gears (75) on the stationary sun gear (78), and cause the annulus case (55) to rotate faster than the output shaft of the transmission. The Sprague clutch (66 & 67) allows this by freewheeling since the output case (55) is still linked to the transmission output shaft splines. Engagement fluid pressure is maintained by the springs (below 25) inside the dashpot (above 24) pushing up on the relief valve (between 22 & 23) and fluid pushing down on the relief valve from above. Excess pressure is dumped through the side of the relief valve as in non OD operation.
- **OD disengagement.** Solenoid power is removed. Inner solenoid piston is returned to normal position by a spring between the plug on the end of the solenoid bore and the piston. Solenoid reverts to blocking the fluid from reaching the area under the dashpot. Pressure that is under the dashpot bleeds back through the metering port and passes from the middle port on the solenoid bore through the front plug hole and into the OD.
- As the fluid under the dashpot bleeds off, the Pressure Relief Valve (between 22 & 23) falls, reopening the side port dump. Pressure behind the actuating pistons falls allowing the springs to push the cone clutch back onto the

annulus case. Since the sun gear is now free to rotate, the drive reverts to through the Sprague clutch.

That is the operation of an OD in a LARGE nutshell.

Manual M-46 Overdrive Fails to Engage: Basic Diagnostics

[Inquiry:] 740T car has a 4 speed manual transmission plus overdrive. The overdrive is the push-button type on the end of the shifter. When the car is hot it will not shift into overdrive. I just changed the transmission fluid and cleaned the strainer but I still have the problem. Here are some basic conditions:

- It's not leaking.
- The light always comes on when I push the button.
- It never shifts by itself but it does occasionally slip out. This happens when it gets hot and I try to drive in OD at about 40-45 MPH.
- The relay has never been changed or worked on.
- It started happening suddenly. The problem seems to have started around the same time as the weather got warmer. I wonder if the problem may have actually started sometime over the winter but the cold weather delayed the effect. It is usually below zero here (Atlantic Canada) all winter.
- The oil & strainer looked fine. I was expecting the worse.
- It doesn't make any funny noises at all.

[Response 1: Duane Hoberg] In all the OD's that I have worked on (net included), electrical problems rank the highest. Second is bad seals on the solenoid piston allow fluid past and allowing a self-engage situation. Third is bad piston seals on units prior to 1985.

[Response 2: Basic Diagnostics by Paul Grimshaw]

- First check the fluid. Very important to have the correct fluid and level in an M46.
- Second check the OD switch and wiring. The former can die a painful death (causing intermittent problems) and the latter can be chaffed as it runs under the carpet and through the transmission tunnel.
- Third, check the oil pressure in 4th gear. Pressure is critical as it is used to engage/disengage the OD. Connect a pressure gauge to the port directly below the OD solenoid valve. Pressure should read 21 psig at 70 km/h or ~40 mph. On OD engagement, pressure should rise to 520-600 psig. If the pressure is not within this range (typically low) replace the solenoid valve.
- If all is correct and the OD still slips, remove/clean the relief valve located at the bottom of the OD unit. Note: you must replace the transmission cross member to do this. While you're doing this, replace the OD filter (located under a plug directly beside the relief valve).
- Next, replace the OD switch in the transmission case. If the unit still slips, there is a (big) problem in the OD clutch. Have the unit rebuilt.

Further O/D Functional Notes. [Abe Crombie] See Duane Hoberg's extensive M-46 [notes](#) above and the [OD exploded parts diagram](#)] The OD is engaged by closing a relief port with the od solenoid. The relief port is connected to the lower portion of the relief valve. When the relief valve is relaxed it regulates a pressure of about 1 bar (15psi+/-) and the apply pistons for od don't have enough pressure to lift

and engage cone clutch to cause od shift. When the solenoid closes the relief port the relief valve gets its spring compressed and now regulates a pressure of 30 bar (450 psi) and the pistons lift the cone clutch of the output shaft outer annulus and pull it into the brake ring which causes the planetary gears to increase output shaft----> overdrive. You may need to do more than to unscrew the relief valve plug and filter plugs and blow through the hole you will see in the relief valve bore just above the threads. When you back up if the od attempts to try to engage it will try to lift the cone clutch off the annulus and reverse will slip. The only power flow in reverse is by the cone clutch inner lining being pushed onto the annulus by the piston return coil springs.

Filters & Fluid. A frequent cause (not yours) is clogged filters inside the OD unit. Can be cleaned (with white spirit) without removing gearbox or OD. Also synthetic ATF (or redline MTL) will help. The reason it does not engage when the car is warm is that the gearbox oil is also hot - and thus thinner, so it's pressure drops. Synthetic oils do not change their properties (so much) when heated, this is one of their advantages.

O/D Relay. [Duane Hoberg] Relays for the manual trannies rarely fail, whereas the automatic tranny relays drop like flies after a frost. Manual transmission relays (blue) and automatic relays (white) are two different devices and ARE NOT interchangeable. To diagnose a suspected relay problem, watch the reaction of the dash light. If the dash light illuminates when you push the button on the shifter, the relay is OK and your OD not engaging is caused by something else. IF the dash light does not come on, you have either a blown fuse or a 4th gear switch that is not working. Plug your relay in and with the engine OFF, ignition ON, shifter in 4th, try to engage the OD. If the dash light comes on, does the solenoid by the OD unit click at the same time? If it clicks and still no OD, you need new actuating piston seals to get your OD working again. If the dash light does not come on, pull the shift lever further to the rear and right and holding it there try the button again. If the dash light comes on then goes out when you move the shift lever, the 4th gear switch is bad.

Bosch relays can have a habit of becoming intermittent and/or temperature sensitive due to solder cracks on the boards. See the FAQ file on [relay resoldering](#) if you need to do this.

Electrical Wiring to Solenoid. Check the wiring to (and connections at) the overdrive solenoid.

Basic O/D Electrical Diagnostics. There are a couple of good diagnostics and inspections that you or a willing mechanic can easily perform. Given that you changed the oil, at least you know where the OD is, so maybe you and/or a friend can dive right in.. Try these:

- Wire up an indicator light to the hot terminal on the solenoid, and confirm that there's 12 volts present when the OD engages -- and that the test light goes out when OD disengages.
- Then the question is, when you push the button but the OD fails to engage, did the light still come on? How is the condition of the ground lead at the solenoid, and is it solidly connected to ground?
- If the light fails to come on (when it should) then the problem is electrical and

not inside the OD. You can confirm this by feeding 12 volts to the solenoid directly -- note that you must only do this in forward gear (reverse OD is not healthy!).

- If appears that the solenoid is getting power but OD fails to engage, the next candidate is the solenoid itself. Sometimes a shop will have a known-good one to substitute (which is good, because they're not cheap). Sometimes an enterprising mechanic can disassemble, clean, and reclaim a solenoid -- but I wouldn't hang my hat on it (I've done a couple). If the problem is the solenoid, replace the OD solenoid NOW! My OD acted like this for a year and a half, then the overdrive turned into tiny bits and ate up the shaft from the transmission too

Rebuild. Finally, it may be time for an OD [rebuild](#). The OD uses the pressure of the oil in the tranny to engage. When the tranny is cold, the pressure is greater, so the OD works. When it gets hot, the pressure is less so the OD does not work. You really have two choices, find a reputable shop to rebuild your OD, or find a used OD. If you are playing around with extra boost in your car, you will want to have the OD rebuilt to handle the extra power.

Manual M-46 Overdrive Self-Engages. [Tip from Duane Hoberg:] If the clutch only slips in second gear and no other, and the OD does not appear to function, you have a problem with the solenoid on the overdrive allowing the OD function to self engage without input from you.

The solenoid in its OFF position acts as a stopper to keep fluid from an area that creates the pressure build up necessary to move parts internal to the OD and engage the fifth gear. When ON the solenoid valve moves only 1/8 to 3/16 of an inch and allows the fluid past. The seals internal to all this are two very small O-rings. There can be over time a small amount of leakage past the end O-ring and into the electrical area of the solenoid. If this leakage is great enough the valve cannot return to the OFF position and the OD then becomes self engaging. There are all sorts of causes for this to occur, age is one and poor electrical contact which causes heat which bakes the O-rings hard being another.

The solenoid has to be removed and shaken to test it. Yes, that is the test. It must rattle freely or it is bad.

In case anyone is wondering how this can be: Normal drive in the OD for gears 1 to 4 is via a Sprague clutch. (Only works in one direction and very very positive). OD is via planetary gearing which requires a stationary sun gear to accomplish. Hydraulics push the sun gear carrier (which almost everyone calls the cone clutch) into a brake ring which is part of the outside case of the OD. During the transition from Sprague clutch drive to planetary gear drive, the planetary gear drive is trying to make the output shaft move faster but cannot because the sun gear is not stationary and the Sprague clutch is just sitting there trying to drive but cannot. It is this in between area where slippage occurs.

The pump in the OD is a piston style driven off the output shaft of the transmission. The pressure necessary to move (not engage just move) the internal parts of the OD begins at around 15 mph and with good actuating piston seals is sufficient to maintain OD contact at about 25 mph. Second gear range in the M46.

After that, the OD is engaged and the OD doesn't work when the button is pushed. Only because it is already engaged. Change the OD solenoid.

Cleaning the OD Solenoid. [Duane Hoberg] If you have problems with the OD engaging and disengaging, clean out the OD solenoid. There is fluid inside which is preventing the solenoid from returning to the OFF position. Since the OD pump works constantly, if the solenoid is ON and enough pressure is being created, the OD will engage as you describe. Cure is remove the solenoid, then remove the small retaining clip from the barrel end. (NAPA tool 3150 or equivalent) DO NOT separate the brass barrel from the coil body. You may never get the same compression joint the factory achieves. Then remove the small plug with an O-ring pick or similar. There is a small spring just underneath the plug. The main piston requires patience and a little bit of luck. With repeated stabs toward a soft landing spot, the piston should work itself out. Once the piston is out, insert a small drift or stiff wire smaller than the piston. This has to be long enough to push an iron slug inside the main body clear of the end of the joint between the brass barrel and the coil case. Using an electrical contact cleaner with its extension spray tube, spray inside the barrel up past the drift or wire and clean out the inside of the coil area. The wire should keep the slug from acting like a sink stopper. When clean reassemble, preferably with new O-rings. Lube sparingly as you do not want any fluid getting into the coil area. A properly functioning solenoid should click very sharp when activated and released. When out and shaken it should sound like a baby's rattle. A solenoid O-ring kit from [Duane Hoberg](#) is \$5.20.

M-46 Overhaul and Rebuild Procedures. [Extensive Discussion courtesy of Duane Hoberg]

Tips on dismantling and overhauling the Laycock J type Overdrive. The identification plate is on the passenger's side of the overdrive unit. Numbers refer to parts as numbered on the attached [OD drawing](#). See the more detailed discussion at [Overdrive Rebuild: M-46 Transmission](#) which includes a parts list and another link to the diagram.

- After removing the OD from the vehicle, clean the outside well.
- Prior to separating the OD housing, remove the rear output flange (61) if necessary. A pipe wrench is suitable for holding the flange.
- Remove the nuts (53) holding the bars (52) over the actuating pistons and remove the bars.
- Remove the nuts and washers (82,83,84) holding valve body (2), clutch ring (42) and rear case (54) together gradually. Working your way around the case, loosen each nut a little at a time to release the tension from the springs (51) gradually. Note the two copper washers and possibly plastic sleeves on the upper pair of studs. These washers and sleeves will have to be replaced on the same two studs to prevent leakage after reassembly. With a soft (brass or plastic) drift, drive the brake ring (42) from whatever case it stuck to, working around the ring for even removal.
- With the rear case separated from the brake ring, remove the return springs (51), cone clutch (43), bearing and carrier (44 through 48), sun gear (78) and the planetary gear system (70 to 76) as a unit from the front of the annulus ring/output case (55). The cone clutch may stick a little but will release as the inside of the cone clutch has clutch material in contact with the output case.

The planetary system may decide to stay with the annulus case and is OK to remain with the case. If needed, to remove the annulus case from the rear case, put the nut (64) back on the output shaft and strike with a plastic mallet to drive the case from the bearing (59).

- Removal of the one way roller clutch (65 to 68) requires a special tool or lotsa patience and grease to reinstall. It is not recommended that this clutch be removed unless damaged. By inserting your thumb into the center of the clutch, it should turn one way and one way only. If using your left thumb inserted into the center, rotation counter clockwise should occur. Clockwise rotation should lock the bearing and try to turn the case.
- To remove the bearing (46) from the cone clutch (43), remove spring clip (48) and sun gear (78) from cone clutch. Spray a little penetrating lubricant of choice at the joint between the bearing and the cone clutch. Using two pry bars, place bars between cone clutch and the bearing carrier (44) at a point other than the flanges. Pry the bearing off the clutch. Remove the retaining clip (47), flip the carrier over, and drive the bearing out of the carrier with a drift or similar device.
- Reverse is the opposite of disassembly.

Warnings:

- The thrust bearing (46) can be driven into the carrier (44) by drift around the outer race if the carrier is on a flat stable surface. A press method is preferable but not necessary. The bearing (46) **MUST BE PRESSED** onto the cone clutch (43) with a vise and spacers or what ever. A socket on the back of the cone clutch with bolt through bearing and big washers that put pressure on inner race and the bearing boss of the cone clutch only. If bearing is driven on to cone clutch with an impact method or the pressure on the cone clutch is not directly under the inner bearing boss the cone clutch integrity will be compromised. **READ AS** guaranteed failure in many pieces with many dollars to repair OD unit.
- The thrust washer (56) under the roller clutch (65) fits into a mating recepticle in the annulus (55).
- The gaskets (80 & 81) are not interchangeable.
- The two copper washers (83) are installed on the upper two studs to prevent a possible leakage condition after reassembly. Some OD's had plastic seals around the studs instead of copper washers. Leave these in place or replace with eight to ten turns of Teflon tape. Just enough to contact the inside of the mating hole in the rear case. Tighten the case nuts (84) gradually and in a criss cross pattern to pull the cases together and load the springs (51) evenly.
- To reseal the annulus case into the rear bearing (59) (or bearing and annulus into the outer case), use a spacer of some sort to push against the inside of the rear case (54) to allow the flange nut (64) with a washer to pull everything into position.

M-46 Leaks. [Inquiry:] My M-46 overdrive leaks; does this require disassembly? [Response: Abe Crombie] The leakage is most likely from the upper two nuts/studs on the OD unit. These are sealed with cone shaped nylon pieces that get forced into threads. Clean it up and then drive a block and see if it leaking there. If so then you only need to remove nuts and clean the stud and case with brake cleaner

spray and then apply sealant (silicone, permatex, etc) to the studs liberally and then re-install nuts. If you have to remove OD then just before you lift car kill it in reverse so that the splines in OD will unbind from the trans output shaft. The OD will slide right off if this is done.

Manual Transmission Overdrive Solenoid and Switch.

Solenoid. I checked at a few volvo dealers for the cost of a volvo OD solenoid and the price was between \$195 and \$215. Then I ran into the Gear Vendors (World's largest supplier of Overdrive Auxiliary Transmissions) at the Los Angeles Roadster Show. Their price for new OD solenoids for the Volvo is \$100. I spoke to Homer Eubanks at 800/999-9555 (customer service rep) and he was very, very helpful diagnosing a problem I had with my OD when it would go off/on/off/on/off and finally off. He told me that the OD needs servicing and when that is done that I should have the screen cleaned and air blown through the small oil holes that go to the solenoid.

Relay. [Duane Hoberg] Manual transmission relays (blue) and automatic relays (white) are two different devices and ARE NOT interchangeable. For diagnostic tips, see [above](#).

Fourth Gear Switch Replacement. [Jim Holst] The OD would not stay in overdrive unless I held the gearshift lever hard down and to the right. This indicated a bad 4th gear switch on the transmission. All the manuals say to put a jack under the tranny, remove the bolts on the cross member where the tranny mounts, and lower the tranny to get room to put a crow'sfoot wrench on the 4th gear switch (top of tranny). The switch takes a 7/8" socket. Here's my short cut for replacement. I found that my oxygen sensor deep socket, the type with a slot in the side for the sensor wire, was a 7/8". Not only would it slip on the switch but the end of the sensor socket had a hex shape which would take a 1" open end wrench. I put the socket on the old switch, gave about a 1/3 turn with the 1" wrench and the switch came out the rest of the way with just my fingers. Reversed this to put the new switch in. Took about 10 minutes for the job once I realized the sensor socket would work. If you have this sensor socket remember it may work for this job too.

Manual Overdrive Clutch Slipping.

[Inquiry:] I posted a message about this problem a couple of weeks ago, or so, and one respondent suggested engine mounts, but after inspecting them, I doubt that they are the cause of this problem. The car is an '89 740 Turbo with M-46 plus P overdrive. When the car is good and hot, the overdrive clutch seems to slip. Starting out in 1st gear, I get a lurch, during which the engine revs slightly, then settles to normal. Sometimes, in any forward gear, in overrun, the engine drops back to idle, as if the overdrive was neither engaged nor disengaged and was freewheeling. In reverse gear, I get a loud gear whine, and the car proceeds at a clearly much lower ratio for 20 - 30 yards, then lurches into its normal ratio. At these times, the overdrive will not engage at all, but it doesn't feel like the direct drive has disengaged, because there is no freewheeling. In cool weather, or when the car is not stinking hot, the overdrive works perfectly. The electrics for the

overdrive all check out. The car is new to me, has 85,000 miles, and seems to have been very well cared for and driven lightly. Should I just assume that it has the wrong kind of oil (i.e. Dexron), or should I consider other things? Is Redline really the magic bullet for these units, or is Volvo's stuff better? The Volvo manual seems to suggest that Volvo's oil is only good where ambient temperatures remain above 10 degrees Fahrenheit, not a safe assumption here in the Boston area. If incorrect oil is the likely culprit, what should I do to clean out the old stuff?

[Response:] Try draining the trans and O/D. Clean both screens in the O/D. The one under the rectangular plate as well as the one on top of the big plug once you get the cover off. Type F will work fine for the trans./O/D. O/D's can slip both unengaged as well as engaged. They usually slip when engaged though. This is a first step and it's a lot easier to do them pulling a gearbox.

Manual Overdrive: New Pistons and Seals Needed.

If your M46/OD starts dropping out of overdrive in hot weather, the likely problem is worn overdrive actuating piston seals which allow leakage of hydraulic pressure. The original blue teflon seals are not available from Volvo or anyone else because according to TSB 43-14, new pistons and seals replace the two piece teflon/o-ring seal and piston. The new seals will not fit the old pistons due to differences in the grooves. See John Sargent's excellent illustrated [discussion](#) of how to replace these seals and pistons. Replacing these pistons will likely restore your O/D's ability to shift when hot.

M-47:

M47 5-Speed Noise in Gear: Bearings Bad

[Inquiry] Ever since I purchased the car in November, that M-47 transmission just moans and groans. 1st,2nd,3rd and 5th are the offenders. 4th appears to be OK. The car has 165,000 kms on it. Is this a common issue or is the result of poor maintenance in regards to the tranny oil? I recently changed the oil to find it a nice shade of silver. It's obvious the damage has been done. I'm just wondering if this is to be a continuing concern and if it is, are there any tricks to keep it from occurring any time soon.

[Response 1: Mike Froebel] I hate to say, but what you're seeing is bearing bits. One of the bearings is coming apart, probably on the countershaft. It's only going to get worse, I'm afraid. The reason you don't hear it in 4th is because that gear is not a gear at all, the trans just joins input to output shaft. This puts no load on your bad bearing. The trouble with a bad bearing is once the hard surface of the bearing parts has worn off, there is nothing to prevent rapid deterioration of what is left. In this type of transmission, then the gears don't mesh properly as the shaft with the bad bearing moves around. And of course, all the metal particles grinding everything else. Then instead of a small parts and large labour bill, you have a large parts and larger labour bill. I would have this fixed ASAP. As far as only working on one part of the transmission, I wouldn't recommend it, take the whole thing apart and see what is wrong. Or try to find a used one, rebuilding these takes time and patience, and not very many have any experience. [Response 2:

Paul] Mike is right, what you are hearing is noise from a bad countershaft bearing. Don't let this go on, because aside from damage to other bearings, the alignment between the gears on the Input/Mainshaft and the countershaft is changing, and those parts will add zeros to the parts bill in a hurry. Make sure this job is done by someone who has done Volvo tranny's before if you want it done right.

[Response 3: Henrik] If you see metal parts in the oil - don't replace just the bad bearing! Look for a used M47 instead. Just a few hours of labour (two actually if you are handy). The metal parts has probably made serious damage to other bearings in the gearbox. In Sweden, you can get a used M47 for about \$180 and it's not worth the money to rebuild the box and take the risk of making things worse and end up buying a used box.

M-47 Shift Linkage Causes Hard Shift.

[Tip from Art] M47 transmission, 294,000 km. It has always been hard to shift into 1st and sometimes 2nd gear. I replaced the fluid with Redline MTL this summer and it improved the shifting on the higher gears, but not 1st. After a particularly frustrating drive to work the other day (about 10 mi. of stop and go traffic jam) I had noticed that if I pushed HARD left on the stick, it would slide nicely into 1st, but if I pushed left then hard forward, no way. If I lifted the reverse knob and was careful, easy shift into 1st.

Chiltons says there is no adjustment of the linkage, Haynes has instructions for adjusting the reverse detent plate as part of shift lever removal. The detent plate prevents moving the lever so far left that you accidentally go into reverse instead of 1st. Mine apparently was preventing the lever moving left far enough to allow smooth shift into 1st.

Really easy job [notes apply to 240: 700 should be similar]. Lift the rubber boot from the carpet. The two bolts are right there. I adjusted mine by trial and error and the easiest shifting is when the detent plate is quite far to the left, more than the .06 inch clearance limit in the book. I'm a happy camper again, all gears shifting with two fingers pressure.

[Comment from Steve] The key indicator would be that worn synchros allow the gears to clash (crunch) as their job is to cause two shaft to match speeds. Silent gear changes that take a lot of effort are usually a clutch which does not fully disengage or as you found out, the shifter itself

Clutch:

Clutch Replacement

Clutch Replacement Tips. [Nigel Sheerwater]

A reasonably easy job if you follow Haynes: takes me about 4 hours start to finish on my own. Done it in 2.5 hrs with a mate which aint bad considering the garage time and we only use ramps. Some small hints....not in any order

- Put a supporting plank across the two strut tower tops and tie the back of the

- engine to it to support it so you don't smash the distributor against bulkhead.
- When car is on ground loosen (don't undo) the engine to gearbox / starter motor bolts and then retighten as they are pigs to get at if tight.
- I jack the car onto ramps but this is optional but can be done if clutch has gone. I also stick a couple of axle stands under other supporting bits. If things do go wrong then it's better that the car lands on these rather than you.
- You may have to undo the bolts holding the bellhousing to gearbox using a long extension rod to reach them.
- Use good quality allen wrenches if clutch is held on with allen bolts.
- Thoroughly clean new pressure plate to get rid of protective grease and wash your hands before you touch the plates on assembly.
- Don't cut corners...buy the full plate/bearing pressure plate kit.
- If gearbox is out check for leaks on real engine crank oil seal.
- You do need a jack and an alignment tool; a friend is handy.
- The slave cylinder can corrode in and the spring clip is a pig.
- If you split the driveshaft MAKE SURE YOU MARK IT as noted in [Driveline](#).
- After all is reassembled slacken the centre prop shaft bearing and let it settle.
- There is a reinforcing plate engine to gearbox. do the gearbox up first before fixing plate on.

Other Preventive Maintenance Needed When Changing the Clutch?

[Inquiry:] Our 88 740 Turbo Wagon is in need of a new clutch. Any suggestions as to other work to do while doing the clutch? Rear oil seal? Shifter bushing? Is it a given that the flywheel should be re-surfaced?

[Response: Gary DiFrancesco] While replacing the rear oil seal, pilot bearing, and throwout bearing, also look at the clutch fork. It is not unusual for the pivot point on the clutch fork to wear (clutch fork is about \$45 at the dealer.) When my '87 745T had a new clutch put in, the pivot point was worn so badly, you could see holes in the metal. If not replaced, the pivot point would have eventually failed and the clutch would have been useless. Also look at the pivot bolted to the bell housing. This rubs against the clutch fork pivot point and can get deformed. It should be smooth and round on top. If there is wear, replace it. It is easily removed with a socket (19mm I think), and the bell housing does not need to be removed to do it. When putting the clutch fork in, put some grease on the pivot point.

[Response: Dick Riess] By all means replace the rear seal. Also pilot, throwout and you may as well go for the clutch kit which includes a new pressure plate. To have a super smooth engagement you could have the flywheel resurfaced also.

[Response: Tom Frisardi] Only reface the flywheel if there's a problem. Usually there is, especially in the form of hairline cracks. Sometimes refacing won't cure this. A fresh flywheel face feels better, to me at least. Other things that I've had trouble with in the drivetrains of my 740's that you might want to look out for have been the center support bearing, the rear transmission mount and the flexible coupling on the output flange of the transmission.

[Inquiry] Is there something special I should request from the machine shop doing the flywheel resurfacing? So far I've heard two methods, using a lathe (like for turning brake rotors?) and using a surface grinder. I'm strongly leaning towards the

latter, as I've never had good luck getting rotors turned.

[Response: Don Foster] Use a surface grinder: it leaves a better, flatter surface. Check the teeth on the ring gear -- if some are obviously hammered, reinstall the flywheel so the worn teeth do not naturally stop in alignment with the starter.

Clutch Pedal Engagement.

[Inquiry] The clutch pedal on my 95 940 Turbo has to be pushed all the way to the floor to allow reasonable gear changes. Is this normal? Its very difficult to drive after being used to a cable clutch that disengages quite high up. I've tried bleeding it, and the original owner history also shows the dealer bled the clutch. Should I replace the slave / master?

[Response: Jerry Warren] The hydraulic system is supposed to be self adjusting. If it has leaked to the point that it go air in it then that could account for the action of the clutch. Unless the slave cylinder is leaking there is not reason to replace it. The same goes for the master cylinder. There might be an adjustment on the rod. If there is then you could use that to change the height of the pedal disengagement. More than likely the rod will be solid. Before you consider replacing either, if you determine that has to be done, look into rebuilding the units. Kits should be available. Be careful what fluid you use. My favorite is Castrol. I never had a problem using that fluid. I did when I use American brands.

Replacement, Conversion & Installation

Transmission Replacement Tips. [Phil]

Cost of Replacement. My M47 type II 5 speed developed the dreaded 5th gear syndrome exactly as described in the FAQ section of this site. I called local shops, but no one was overly enthusiastic about working on a manual transmission and a rebuilt transmission from Volvo was quoted as \$2023USD part only, no labor. After a few Internet inquiries, I finally located a replacement tranny from a 1991 240 and had it delivered. I spent \$550 for the tranny plus \$125 for shipping from CA to NY. I also replaced the rear mount while I was at it. Clutch was done 30K miles ago so I didn't touch it. All totaled I spent about \$725 USD.

Shifter Set Screw. Don Foster indicated that removing the M-47 shifter dowel pin set screw can be somewhat of an adventure. Well Don, you were correct! Soaking with PB Rustbustet didn't help and after rounding out the set screw allen head, I resorted to drilling it out, being careful to creep up in size and drill just large enough to be able to remove the interlocking dowel pin. Luckily, I have a set of metric taps and was able to retap the shifter eye. My Volvo dealer did not have a replacement set screw, but I was able to find a metric replacement from the local hardware store. I did have to grind a point on the new set screw to engage the dowel pin groove as the purchased set screw had a flat cup end and did not fit into the dowel machined cross groove.

Procedure. As for removing the transmission, I supported the car on 4 jack stands and fashioned a transmission cradle out of a scrap 2x12 with supports. This cradle

proved useful for sliding the tranny around on my garage floor and providing a flat surface from which to jack. [Editor: You can rent a tranny jack which is safer.] I used manual tools, 1/2 inch breaker bar and swivel, and a floor jack to support the tranny. Weight of the tranny is around 90 lbs. The breaker bar, swivel and extension worked like a charm to remove the dreaded top starter bolt. I also dropped the front exhaust pipe, to gain better side access and have room to move around between tranny and floor pan. The entire job took me several hours on Friday and most of Saturday. Other than having to tap the shifter set screw, nothing unplanned came up.

Replace Broken M-46 with Unit from 240 Car.

[Tips from John Sargent/Tom Fachetti] Volvo switched to a more robust Type P (from the earlier Type J) OD unit in 1987. These two overdrive units are not interchangeable. The M46 transmission with its OD in the 240 is a direct substitute for the M46 with OD in the 740 car. The 740 car will have the alloy case with P type OD, while the earlier M46 will have cast iron case and J type OD. The two OD types will not interchange since the transmission output shafts are different. I installed an M46 with J type OD in my wife's 745T. It functions perfectly. You do have to move the throwout arm ball stud, but the bell housings are the same. The output flange is different, but it is easy to change that too. The bell housings are identical, but have the ball stud in different locations. The throwout bearing arm is different, but all you have to do is use the one from your 740T.

[Tip from Gary DiFrancesco] Over the holiday break, I replaced the sick M46 tranny in my '87 745T. The sick M46 no longer would go into 2nd gear and repair costs were potentially out of this world. Many of the bone yards I contacted for a 740 ready M46 usually wanted big bucks for one, (\$650 to \$950). Yet, M46s for a 240 were relatively cheep, (\$250 to \$350). A few knowledgable yards confirmed my idea of using a M46 from a 240 and adapting it to a 740. I obtained a 240 M46 and intalled it over the holiday break. I can say with confidence (based on my experience) that a M46 from a 240 will easily fit into a 740!

These are the changes I needed to make to the 240 M46 in order for it to fit in a 740:

1. Swap the tranny mount and bracket, (2 to 4 bolts)
2. Swap shifting cage, (4 bolts)
3. Swap the selector rod, (1 pin)
4. Swap clutch fork and move fork pivot point, (240 clutch has a cable, 740 uses hydraulic)
5. Swap drive shaft couplings, (1 nut, My 740 uses a rubber coupling instead of a u-joint)

These changes are all easy and fast. Knowing what I know now, I can make these changes in maybe 20 minutes. Once done, the tranny installs into the 740 without difficulty or need for further modification.

In my situation, the 240 M46 I obtained is an earlier version that had the iron case. This is the version with the lower 1st gear ratio which is desirable. The later Al case M46s had a higher 1st gear ratio that could pull a house off its foundation.

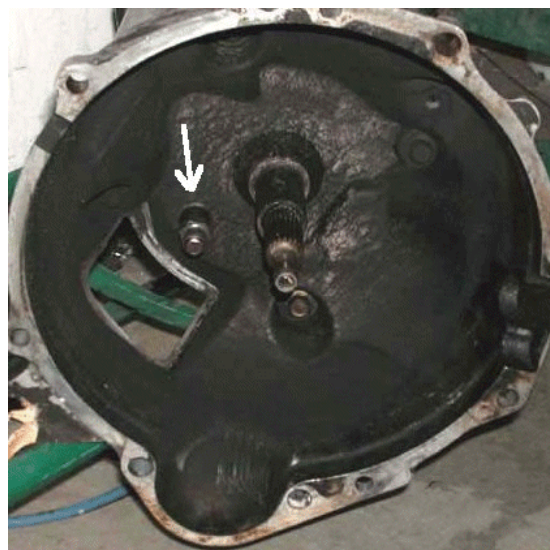
The 240 M46 came with a Type J OD unit. I was figuring on swapping it with the Type P OD from my sick M46 since I have a B230FT engine. Unfortunately this swap was not possible. The output shaft of the 240 M46 (with iron case) was about 3/16" longer than the shaft from the Al case M46. So the Type P OD would not go onto the iron case M46 all the way. Furthermore, I found the spline on the iron case M46 was shorter and slightly smaller in diameter than that of the Al case M46. I am not sure of the reason for the changes in the output shafts and OD units. Obviously there have been some design changes over the years that has caused some incompatibility with these parts. I put the Type J OD back onto the iron case M46 and am driving the car just fine. If anyone can shed some light on these design changes, it would be greatly appreciated. If a Type P OD can be obtained that will properly fit my iron case 240 M46, I would like to get one.

The Type P OD is stronger than the Type J OD, hence it is used on the Turbo cars. Can anyone tell me where the weakness of the Type J OD is. Is the weakness only an issue when the overdrive is engaged? Or is it an overall weakness that affects the OD unit whether it is engaged or not? Since I don't hot rod this car, am I correct in assuming that a Type J OD will be fine? After all, many 240 owners with Type J ODs tow boats and tent trailers which put a fair amount of stress on the OD even when not engaged. I don't hear anything about that being a problem. Since I don't tow with this car, running with a Type J OD seems to me to be okay if I don't hot rod. Any thoughts on this train of thought would also be greatly appreciated.

If nothing else, it is good to know that a 240 M46 can very easily be installed into a 740. This can be a real \$ saver for the few of us whose 740 M46 gets sick.

Replacing Turbo Manual Transmission with Non-Turbo Model. [Tips from John Sargent]

My son wrecked his 744T with manual transmission last summer. His replacement 1984 760T had an automatic, and he badly wanted a manual transmission in the car. The M46 with P type OD in his wrecked car had been giving some OD trouble, and I told Evan that we wouldn't replace a good automatic transmission with a bad manual transmission. I was able to buy a good 1987 M46 with J type OD very cheap. A P type OD is stronger, but J type is quite adequate for the job, and all Volvo did on the early turbo cars with J type was have the ECU disable injector number 2 when shifting into OD (or so the service manual says). I told Evan the J type would survive quite fine if he shifted sensibly in and out of OD. Turbo 700 series cars with manual transmission have a hydraulic clutch. Early Normally Aspirated cars have a mechanical cable clutch; later NA cars have the same hydraulic clutch as turbos. On turbo cars the ball stud for the throwout arm is between the throwout arm opening and the input shaft as pictured to the right.



On normally aspirated cars the ball stud for the throwout arm is on the opposite side of the input shaft as pictured left.



In order to use the NA transmission in the turbo car all you have to do is remove the NA ball stud, and then remove the turbo ball stud and screw it into the NA transmission bell housing. The bell housing has a hex socket cast into it with a threaded nut in it just waiting for you to use. The ball stud from the turbo transmission is internally threaded has a metric stud that screws into it and also fits the nut in the bell housing socket.

Converting an Automatic to Manual Transmission. While manual 740s may be found in the US, no 940 or 960 cars were ever sold here with manual transmissions. Elsewhere, the 940 non-turbo used the M47, as did non-turbo 740's and 240s. The 740T, 940T and older 240 used the M46. The 960 used a 5-speed called the M90. There is a great deal of info, and occasional imported parts collections being sold, regularly on Turbobricks.com. Some 740/940 cars have been converted from automatic to manual, but very few 960 cars have been converted in this country- the supply of conversion parts is small, and there aren't really a lot of 960s to begin with. In addition, the conversion will be rather expensive, with the cost of an imported M90 being probably close to \$2000 to get it to your doorstep. For a discussion of the techniques and parts needed to convert an AW-70/71 to manual, see the [file](#) discussing such a conversion.

[Volvo Maintenance FAQ for 7xx/9xx/90 Cars](#)
