Surgery of a Stick Inside a Manual Transmission

Inside A Manual Transmission

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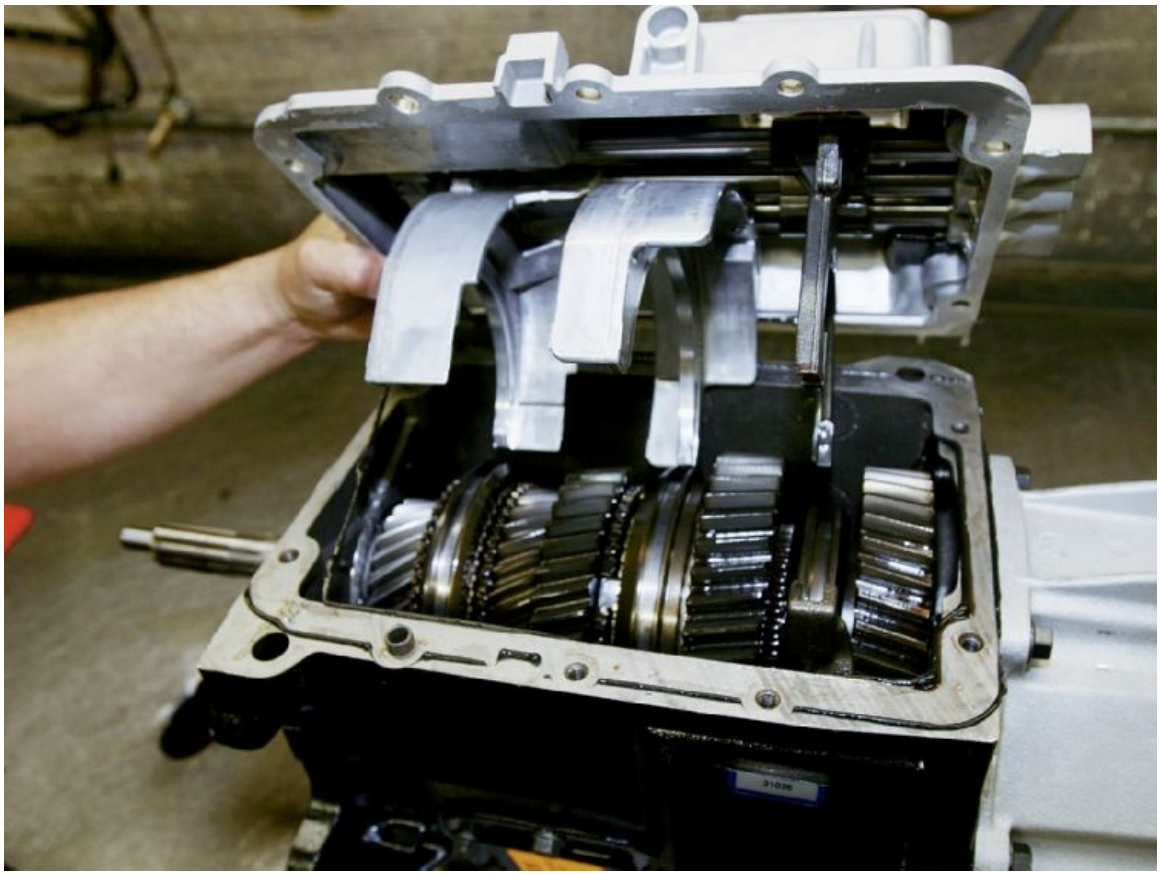
Photography by Fred Williams

Basics To Basic

The art of shifting gears is being lost. Every year more and more drivers are opting to have their gears shifted for them rather than doing it themselves. In fact you can probably count the number of new 4x4 models available with manual transmission on two hands. That's a sad state of affairs.

Maybe the problem is that drivers just don't understand how a manual transmission works. Maybe they just haven't looked inside one to know what's going on under that stick with the numbers and the "R" on the top. It's time for a look inside these strong reliable units that allow you to creep along, slam gears, or pick and choose exactly what you want from your transmission.

We recently took a freshly refurbished NV-4500 five-speed manual transmission from National Drivetrain to our local transmission shop, Transaction, and tore it apart just to see what's inside. National Drivetrain sell parts for axles, transfer cases, and transmissions as well as complete new and rebuilt units ready for installation, and National will deliver straight to your door. Transaction has been building transmissions in its Sun Valley, California, shop for ages and can remove and service your current box or help you upgrade to something stronger.



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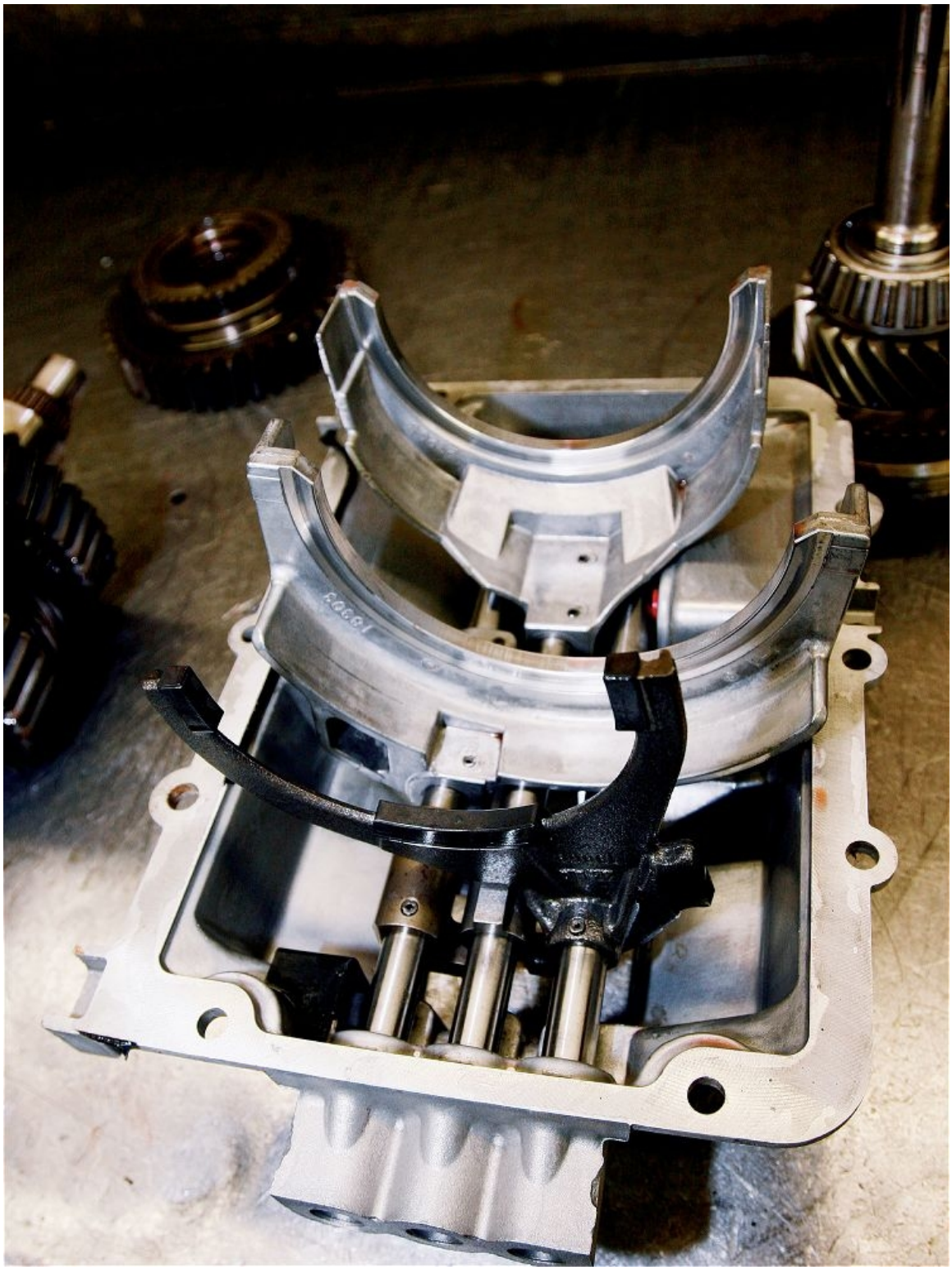
A manual transmission has four attributes visible on the exterior: (A) the input shaft that splines into your clutch and takes rotational power from your engine; (B) the output shaft that splines into your transfer case and delivers rotational power rearward; (C) the shift tower (top plate) that houses the shift rails; and (D) the case. The case is where all the gears are carried. Some transmissions, such as this NV-4500, also have a tailhousing for additional gear space.



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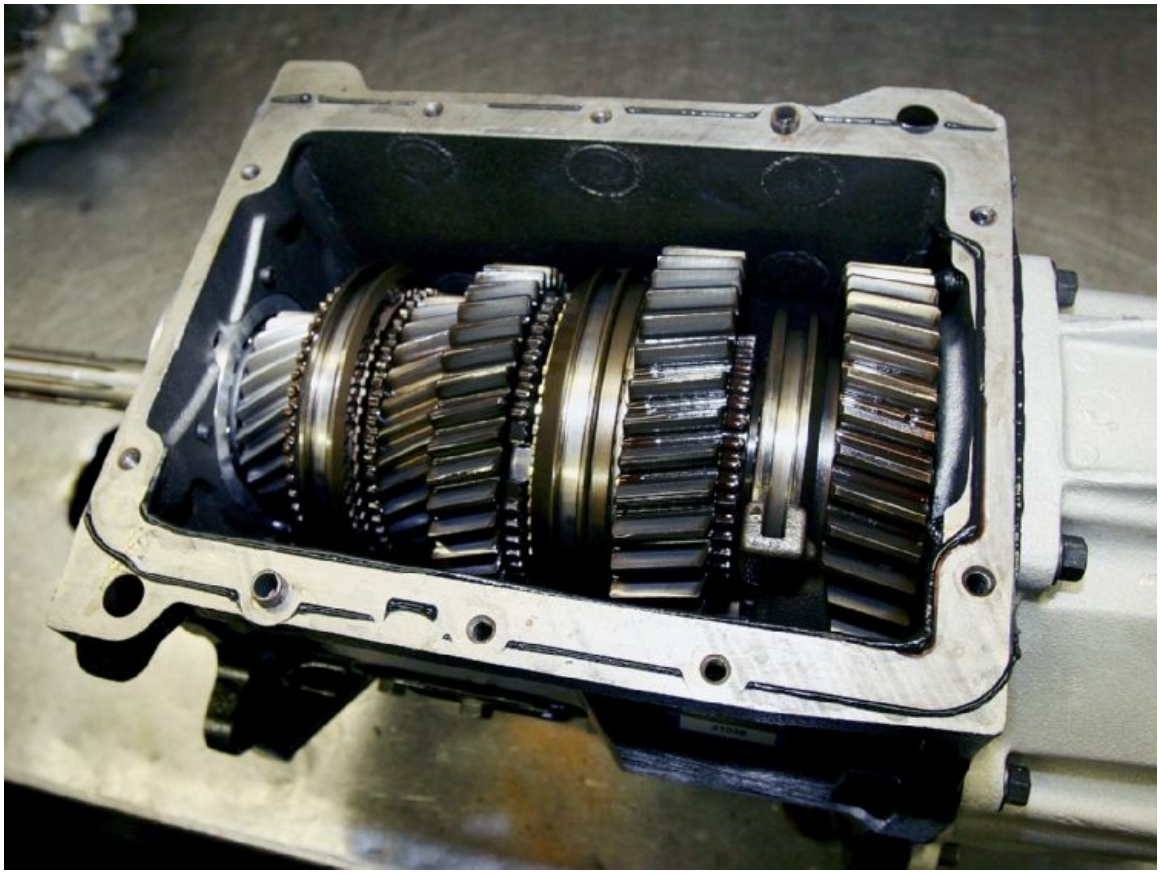
The bottom of the shift tower shows the shift rails and forks. The stick of the transmission enters the top and has a pivot point. As you move the stick from side to side it connects to different shift rails. As you move the stick forward and backward the selected shift rail slides back and forth. The shift rails have shift

forks attached that drop down into the transmission and engage the different gears



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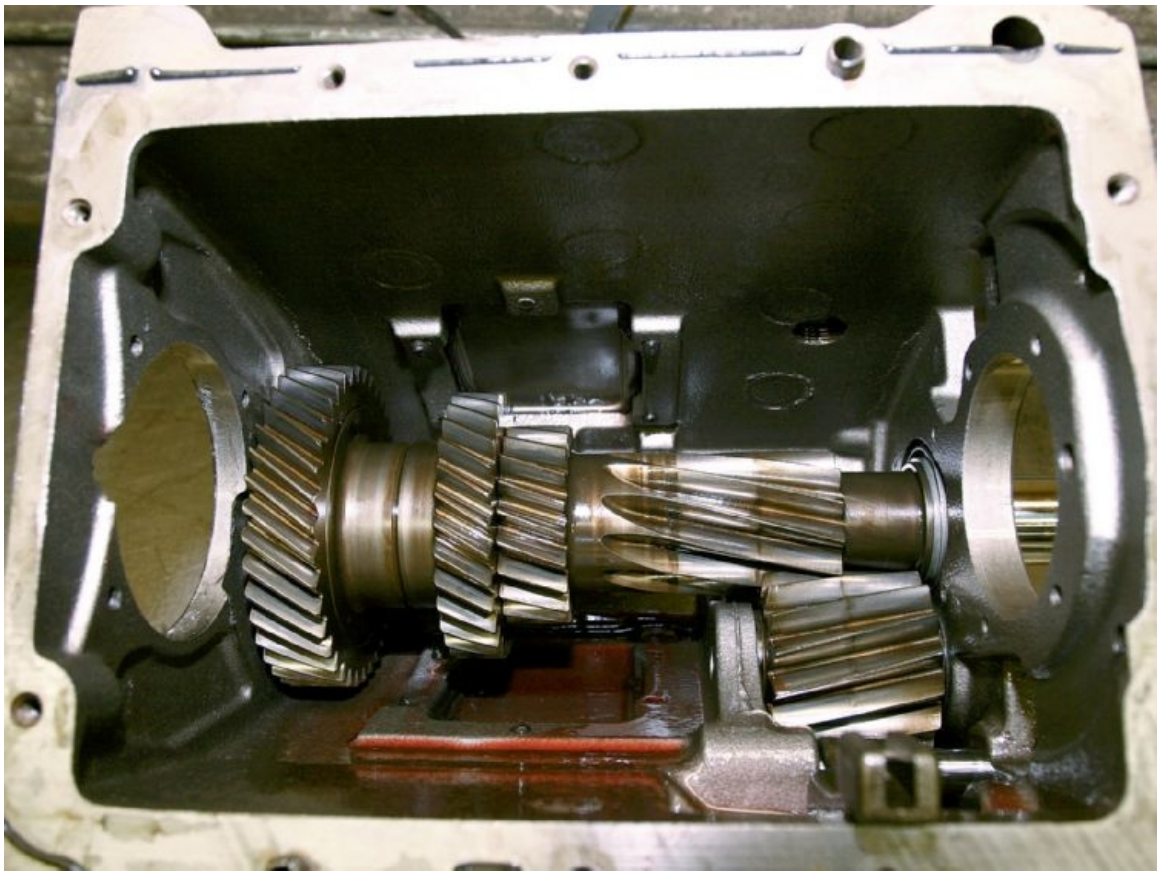
Inside the top of the transmission are many gears that ride on bearings on the mainshaft. When you are in Neutral, none of the gears are engaged to the main shaft, but gears are spinning on the main shaft from the corresponding gear on the countershaft. This is known as a constant mesh transmission



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Below the mainshaft are the countershaft and the reverse idler gear. The countershaft has the smaller of the gears for each gear engaged. For example, if the First gear ratio is 5.61:1 then the input shaft will turn 5.61 times for every rotation of the mainshaft when in First gear

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Contrary to popular belief, the input gear drives the countershaft, which then drives the main shaft for all the gears except Fourth in the NV-4500. For example, in First gear the input shaft gear (which is always engaged to the large gear on the input end of the countershaft) spins the first gear on the countershaft. This then spins the first gear (largest) on the main shaft. In Fourth gear (aka direct) the ratio is 1:1 and the input shaft is linked directly to the main shaft

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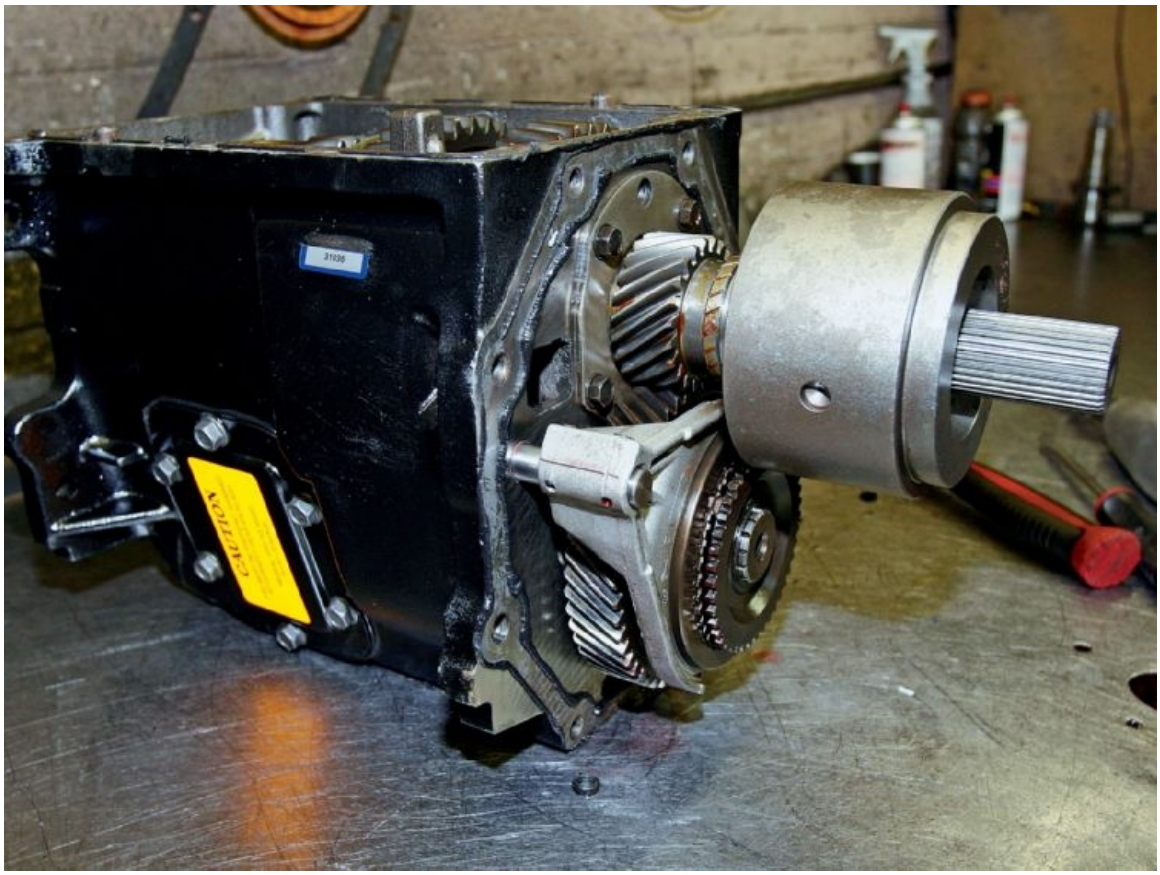
Beside each gear is a synchronizer hub that is attached to the mainshaft by internal splines. When you shift into a gear the shift fork slides a synchronizer sleeve or collar toward the selected gear and over the synchronizer ring and clutch. As you do this the synchronizer hub pushes onto a clutch, which then slows the spinning gear until it matches the speed of the spinning synchronizer hub. When the speeds match, dog gears on the hub and gear are aligned and the collar locks them both together, and power can now be transmitted through that gear to the main shaft. When the dog gears are not aligned they make the horrible noise known as grinding.



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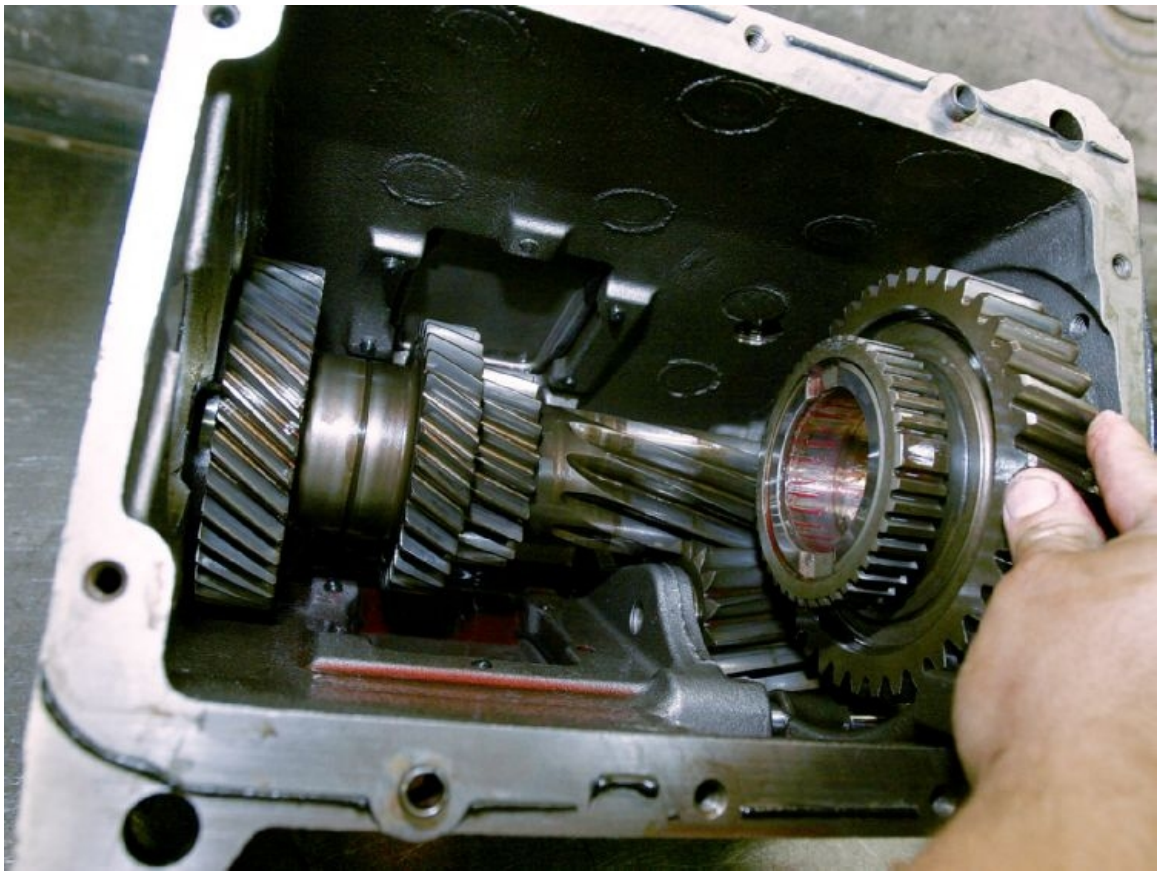
There are two gears left to discuss, reverse and overdrive. Overdrive is just like all the other gears except the countershaft gear is actually larger than the mainshaft gear. In an NV4500 the Fifth, or overdrive, gear resides in the tailhousing. When the synchro for the Fifth gear is engaged it actually locks the larger countershaft gear in place rather than the mainshaft gear, as the Fifth gear on the main shaft is a constant fixed gear. The massive cylinder on the end is a vibration damper, which many rebuilders dispose of.



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The reverse gear uses an idler gear between the countershaft and the main shaft gears to reverse the direction of the spinning. In this way the reverse gear on the mainshaft is always spinning backward; however, it is only locked into the mainshaft when reverse is chosen. Since reverse is not usually chosen under speed it doesn't have a synchromeshing shift collar. If you were to try to grab reverse while driving fast you would very likely strip the dog gears off the gear or collar and make a terrible noise as well as fill your transmission with small pieces of metal