



MANUAL TRANSMISSION SERVICE

Introduction

Internal combustion engines develop very little torque or power at low rpm. This is especially obvious when you try to start out in direct drive, 4th gear in a 4-speed or 5th gear in a 6-speed manual transmission -- the engine stalls because it is not producing enough torque to move the load.

Manual transmissions have long been used as a method for varying the relationship between the speed of the engine and the speed of the wheels. Varying gear ratios inside the transmission allow the correct amount of engine power to reach the drive wheels at different engine speeds. This enables engines to operate within their power band.

A transmission has a gearbox containing a set of gears, which act as torque multipliers to increase the twisting force on the driveshaft, creating a "mechanical advantage", which gets the vehicle moving.

From the basic 4 and 5-speed manual transmission used in early Nissan and Infiniti vehicles, to the state-of-the-art, high-tech six speed transmission used today, the principles of a manual gearbox are the same. The driver manually shifts from gear to gear, changing the mechanical advantage to meet the vehicles needs.



Nissan and Infiniti vehicles use the constant-mesh type manual transmission. This means the mainshaft gears are in constant mesh with the counter gears. This is possible because the gears on the mainshaft are not splined/locked to the shaft. They are free to rotate on the shaft. With a constant-mesh gearbox, the main drive gear, counter gear and all mainshaft gears are always turning, even when the transmission is in neutral.



Transmission Designation

Each transmission has its own unique designation. A front wheel drive designation always begins with **RS** and a rear wheel drive designation always begins with **FS**. Each designation goes as follows:

Front Wheel Drive RS6F51A or H

RS = Remote Shift

6 = 6 Forward gears

F = Front drive

51 = Model designation

A = Standard final drive

H = Helical type limited slip final drive

Rear Wheel Drive FS6R31A

FS = Fixed Shift

6 = 6 Forward gears

R = Rear drive

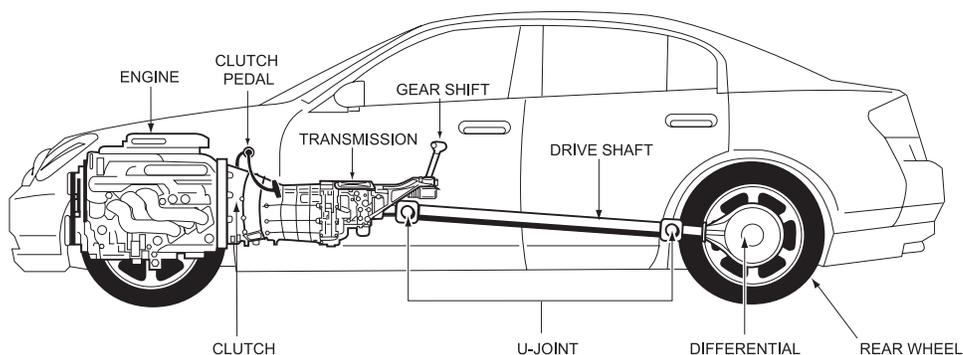
31 = Model designation

A = Version

Note: The letter V on some front drive transmissions indicates a viscous coupling, limited slip final drive.

Unit Operation

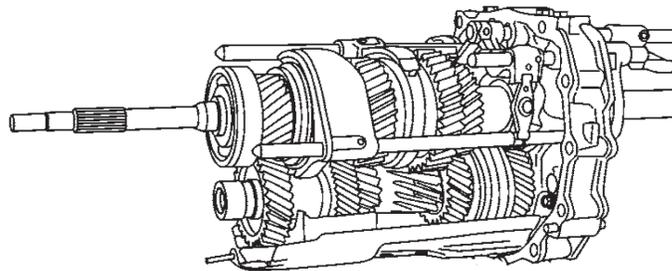
Engines have a maximum rpm value. The transmission allows the gear ratio between the engine and the drive wheels to change as the car speeds up and slows down. The driver shifts gears so the engine stays below the rpm band of its best performance.



Input Shaft, Counter Shaft and Output Shaft

The input shaft is in constant mesh with the clutch disc. In other words, the clutch disc drives the input shaft. When the clutch is engaged, the input shaft continually turns whether the car is moving or not. The input shaft in turn drives the counter shaft. Whenever the input shaft turns, the counter shaft rotates as well. When a gear is selected, the counter shaft then turns the output shaft, which is connected to the drive shaft or drive axle.

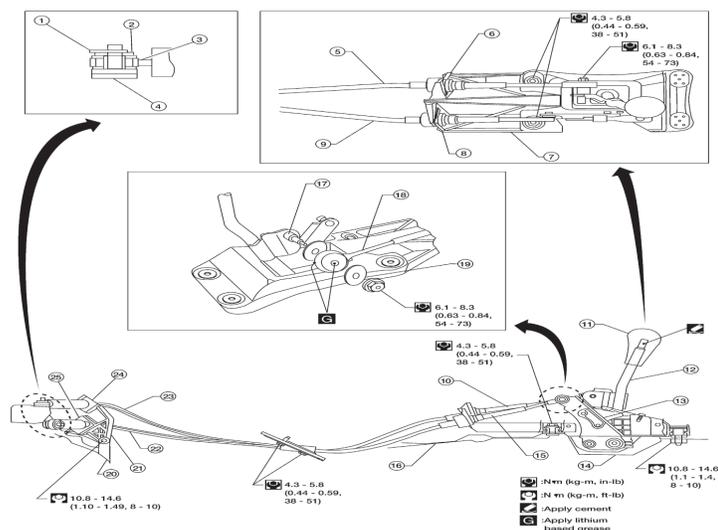
The output shaft only turns when the vehicle is moving.



Shift Lever

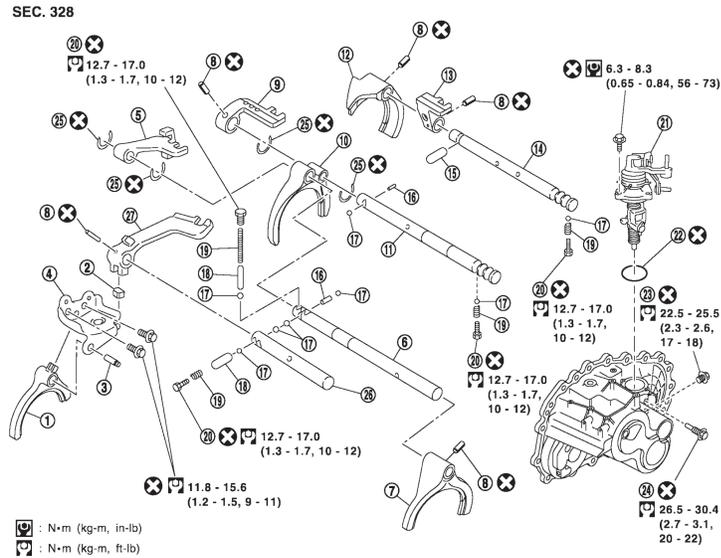
Using the gearshift, the driver selects the desired gear for the driving condition.

The gearshift or shift lever connects the transmission using either a shift rod or shift cables. The shift rod or cables move the internal shift rods.



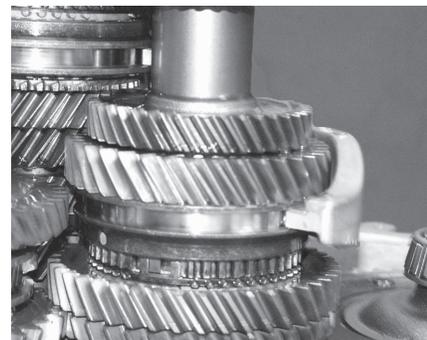


This slides the shift fork, which is attached to the coupling sleeve.



The shift fork could be compared to an oarlock on a rowboat. Moving the shift fork engages the selected gear.

Before a shift takes place it's necessary to synchronize the rotating speeds of the transmission elements.



Having the hub splined to the shaft and the coupling sleeve splined to the hub does this.





Forward Gears

The transmission changes the ratio of the engine speed and the wheels by connecting gears in various combinations.

For strength and quiet operation, all forward gears are helical cut. The helical cut distributes the force more evenly across the gear face.

Gear Ratio

Anytime rotational motion takes place, gears are used to maintain a rotational speed.

Gears are used to:

- Increase or decrease the speed of rotation
- Reverse the direction of rotation
- Keep the rotation of two axes synchronized
- Amplify torque



In the above figure, two gears rotate in opposite directions with the smaller gear rotating at two to three times the speed of the larger gear. The fact that one gear spins twice as fast as the other is due to the gear ratio.

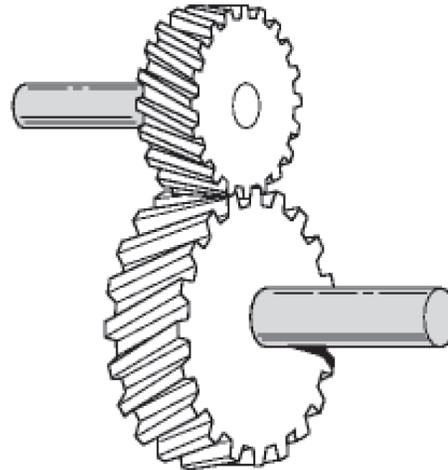
The diameter of the gear on the left is approximately three times that of the gear on the right. The gear ratio is therefore 3:1.

If both gears have the same diameter, they would rotate at the same speed (1 to 1) in opposite directions.



Transmission gears have teeth rather than smooth edges. The teeth have three advantages:

1. They prevent slippage between the gears.
2. They make it possible to determine exact gear ratios.



Counting the teeth in the gears and then dividing the number of teeth in the larger gear by the number of teeth in the smaller gear determines the gear ratio. One example of this would be 60 teeth on one gear and 20 on the other. The gear ratio when these two gears are connected together is 3:1.

3. The teeth make it so that slight imperfections in the actual diameter and circumference of two gears don't matter. The number of teeth control the gear ratios even if the diameters are a bit off.

Transmission gear ratios for each gear are determined by the need of the vehicle. Lower gears have higher gear ratios (6 to 1), which improve the performance off the line. Higher gears have lower ratios (2 to 1) for improved fuel economy at higher speeds.

Note: Gear ratios take into consideration the final drive when determining the total gear ratio.

Internal Components

Check Balls and Springs

The check balls and springs serve several purposes. First, they prevent the transmission from engaging two gears at one time. The detent or cutout in the shift rod blocks out any other rod once the shift rod begins moving. The check ball fits into the cutout or detent in the shift rod.

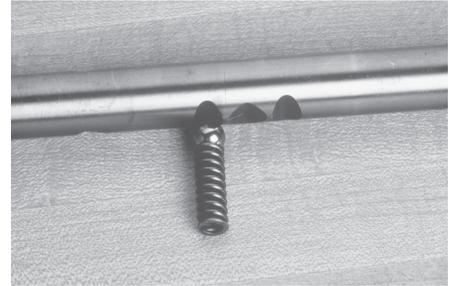




Second, they assist in keeping the transmission gear engaged once it's been selected.

Third, a straight, un-scored and properly aligned shift rod assists with smooth engagement of each gear.

The check ball and detent in the shift rod hold the shift rod in neutral or in gear because of spring pressure applied to the ball by the check spring.



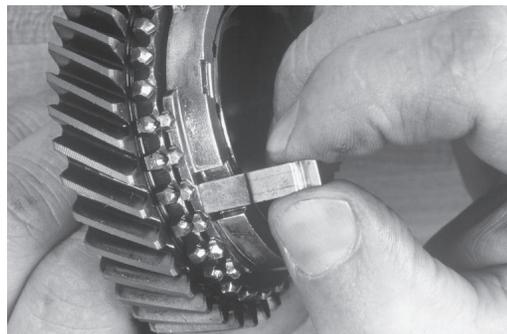
Synchronizer Hub, Coupling Sleeve, Shift Inserts, and Baulk Rings

Before a shift takes place, it is necessary to synchronize the rotating speeds of the transmission elements being joined. Where each gear on the mainshaft spins freely;

- The synchronizer hub is splined directly to the shaft and the coupling sleeve is splined to the synchronizer hub.



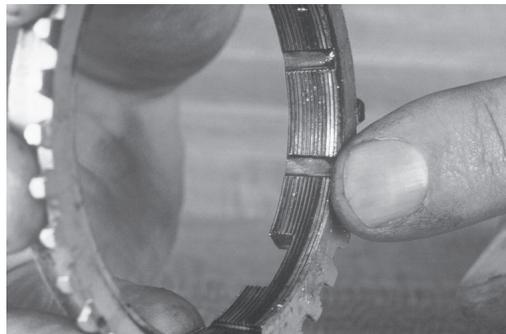
- The external splines on the hub provide a sliding surface for the coupling sleeve splines as well as lock the sleeve to the hub.
- When a shift is complete, the coupling sleeve is engaged to the gear beveled teeth. This locks the gear to the shaft through the synchronizer hub.





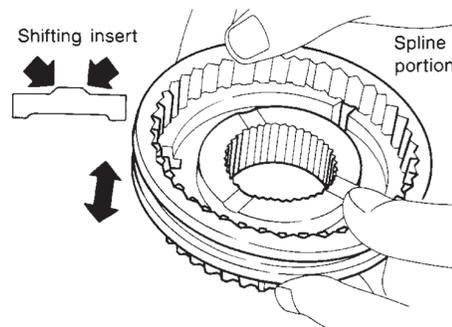
- Most synchronizer hubs, coupling sleeves and shift inserts serve a dual purpose. The coupling sleeve pushes against the shift insert, which pushes against the baulk ring. The baulk ring slows down or speeds up the spinning gear, which enables the coupling sleeve to lock the gear to the shaft. When shifting to the next gear, the driver moves the shift lever, which in turn moves the shift fork and coupling sleeve, unlocking one gear, then passing through a neutral position and locking another gear on the opposite side of the hub and coupling sleeve.

The baulk ring is made of a softer material such as brass or iron. It's designed to slow down or brake the selected gear during up-shifts and speed up the selected gear during down-shifts.



Each coupling sleeve has three shift inserts which are held in place with either a coil spring or a spread spring. During the shift;

- The insert presses the baulk ring up against the selected gear's braking surface.



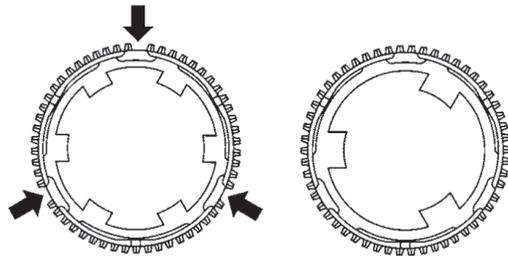
- This slows the gear down sufficiently so a smooth shift takes place. When down shifting, the insert presses the baulk ring against the selected gear, matching gear speed to output shaft speed.

Note: Coupling sleeves and hubs can be directional. Use the service manual and verify proper direction on reassembly.



Double and Triple Cone Baulk Rings

A double cone or triple cone synchronizer is utilized in cases where there are high demands for performance and/or reduction of gear shifting force. These are normally installed on 1st and 2nd gears. The double and triple cone synchronizers use two and three times the 'braking' surface of a normal baulk ring.

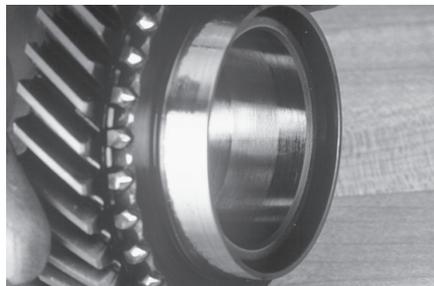


1st gear baulk ring

2nd gear baulk ring

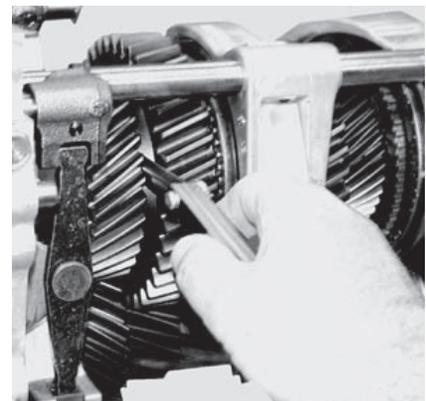
Main Gears

As mentioned earlier, transmission forward gears are a helical cut design. Not only are they helical cut, they have beveled teeth machined into the face of the gear. This enables the coupling sleeve a surface, which it can engage and readily lock onto.



Gear Endplay

Designed into each gear is a specified endplay. Endplay is defined as the clearance between the gear and the collar on the shaft or two gears. Endplay or clearance between the gears allows for lubrication of the two components.





Too much endplay could create unusual noises, difficulty in shifting, jumping out of gear, or difficulty in taking the transmission out of a particular gear.

Insufficient endplay could result in noise, wear or even binding. This could also create the effect of being in two gears at one time.

The gear endplay should be measured prior to disassembly and reassembly of a transmission.

Reverse Gears

The output shaft and counter shaft each contain a reverse gear. When a vehicle moves forward, the counter shaft and mainshaft spin in opposite directions. The shaft rotation speed depends on the engine rpm and selected gear.



When the vehicle is standing still and reverse is selected, the reverse gear on the output shaft engages the idler gear. This causes the output shaft to spin in the reverse direction, allowing the vehicle to back up.

Bearings

Bearings reduce friction by providing smooth metal balls or rollers, and a smooth inner and outer metal surface for the balls to roll against. These balls or rollers "bear" the load, allowing the device to spin smoothly.





The bearings used in the transmission support the input, countershaft and output shafts. On front wheel drive vehicles bearings also support the final drive.

Whether the transmission is front wheel drive or rear wheel drives determines which types of bearings are used. Rear wheel drive transmissions use primarily a caged ball bearing.

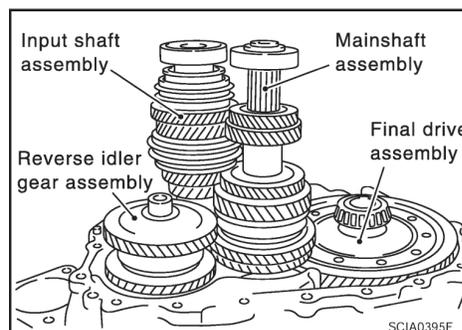
Front wheel drive manual transmissions use a combination of both the caged ball bearing and a tapered bearing. The tapered bearing is used so a preload can be added to the shaft during assembly and overhaul.



Tapered bearings have a calculated amount of tension or preload applied to them. Too much preload causes the bearing to overheat. Too little preload causes the bearing to wobble inside the bearing outer race. Both conditions cause premature bearing failure.

Front Wheel Drive Final Drive

Front wheel drive vehicles are completely self-contained. Within the transmission case is the differential or final drive. The transmission mainshaft is in constant mesh with the final drive ring gear. The output gear turns the ring gear and final drive assembly, thereby turning the drive axle shaft, which is attached to the wheels.

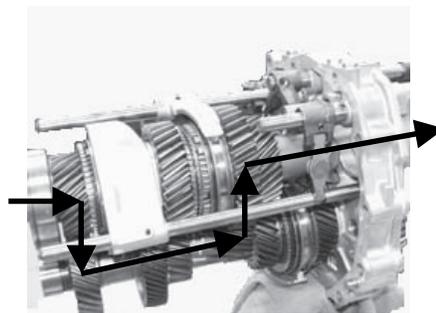




The final drive is a conventional arrangement of gears that divide the torque between the drive axle shafts. The final drive consists of a set of four gears. Two are called final drive side gears, and two are final drive pinion gears. Each side gear is splined to a drive axle shaft, which must turn when its side gear rotates.

Power Flow

The function of any transmission is to transfer power from the engine to the drive wheels. Lower gear ratios in the transmission serve as torque multipliers and assist the engine develop enough power to accelerate from a standstill. The input shaft drives the counter shaft. When the shift-coupling sleeve locks one gear to the mainshaft, then the output shaft spins at a rate equivalent to the ratio of the gearing.

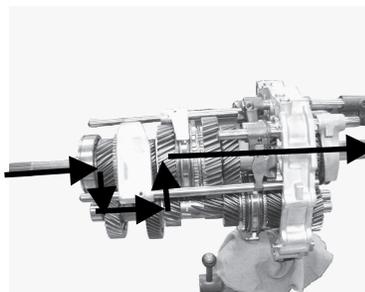


The torque multiplication comes into play when looking at the twisting force on the driveshaft to get the vehicle moving. For example, a first gear ratio of 3.794:1 and an engine which produces 274 lb.-ft. of torque will put around 1039 lb.-ft. of twisting force onto the driveshaft ($274 \text{ lb.-ft.} \times 3.794 = 1039.5 \text{ lb.-ft.}$). In first gear, the engine's torque is multiplied or increased 3.794 times.

The higher the ratio (6 to 1), the more torque; but the slower the drive wheels turn.

First gear connects the engine power to the drive wheels via a pair of reduction gear sets, which gives increased power and reduced wheel speed when the car begins moving.

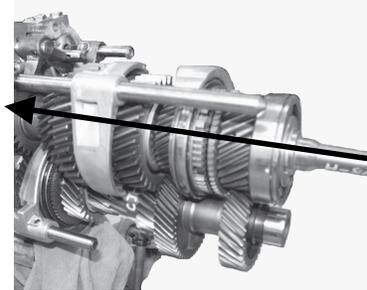
In 1st gear the engine turns at a much higher rpm than the transmission output shaft.





Conversely, the same thing occurs in each of the other gears. 2nd gear in a 6-speed rear wheel drive transmission multiplies the torque 2.324 times. Fifth gear has a gear ratio of 1.00:1. This means there is no torque multiplication. The output shaft turns at the exact same rpm as the input shaft.

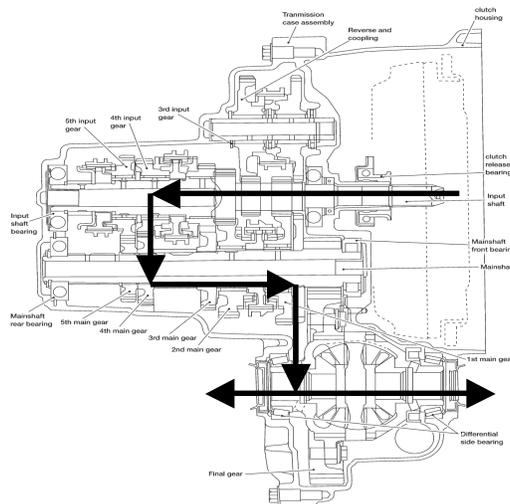
When sixth gear is selected the ratio is less than 1.00:1. In actuality, the output shaft turns at a higher rate of speed than the input shaft.



Note: When cruising at high speeds, torque multiplication isn't necessary. On a five-speed manual transmission, 4th gear is 1.00:1. Some FWD transmissions such as the 6-speed Sentra and Maxima don't use a 1.00:1 ratio in 4th or 5th gear.

Power Flow Front Wheel Drive

Power flow through a front wheel drive is almost the same as a rear wheel drive transmission. The exceptions are the layout of the main and countershafts along with the final drive housed with the transmission components. On front wheel drive transmissions, the mainshaft becomes the input shaft and the countershaft becomes the mainshaft. The illustration below shows the power flow through 4th gear on the RS5F51A transmission.

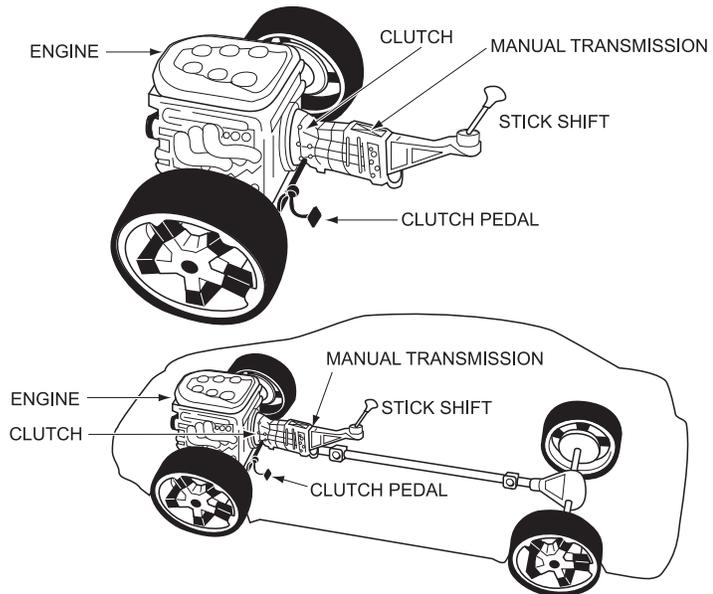




Clutch Operation and Assembly

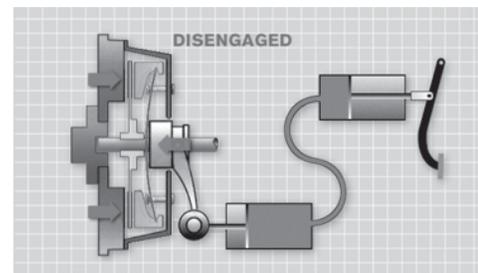
For ease of driving in all conditions and speeds, all manual transmissions require the use of some type of clutch. The clutch is used for disengaging the engine from the transmission.

Clutches are used in devices with two rotating shafts. In these devices, a motor or pulley typically drives one shaft, and the other shaft drives another device. In the case of the motor vehicle it is either a driveshaft, rear drive, or drive axle, front drive. The clutch connects the two shafts so that they can either be locked together and spin at the same speed, or be disconnected and spin at different speeds.

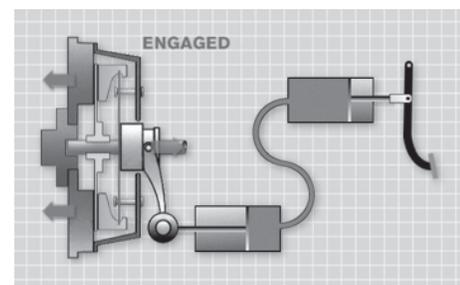


When the engine is running, the flywheel and clutch are constantly spinning, but the drive wheels aren't. In order for a car to come to a complete stop without stalling the engine, the wheels need to be disconnected from the engine. The clutch connects and disconnects the engine from the transmission during start up and shifting. The clutch allows a smooth engagement between a spinning engine and a non-spinning transmission.

The flywheel and clutch cover or pressure plate are both connected directly to the engine, while the clutch disc is connected to the transmission through the input shaft.



When the clutch pedal is pressed, a cable or hydraulic piston pushes on the release fork, which presses the throw-out bearing against the middle of the diaphragm spring. As the middle of the diaphragm spring is pushed in, a series of pins near the outside of the spring causes the spring to pull the pressure plate away from the clutch disc. This releases the clutch from the spinning engine.





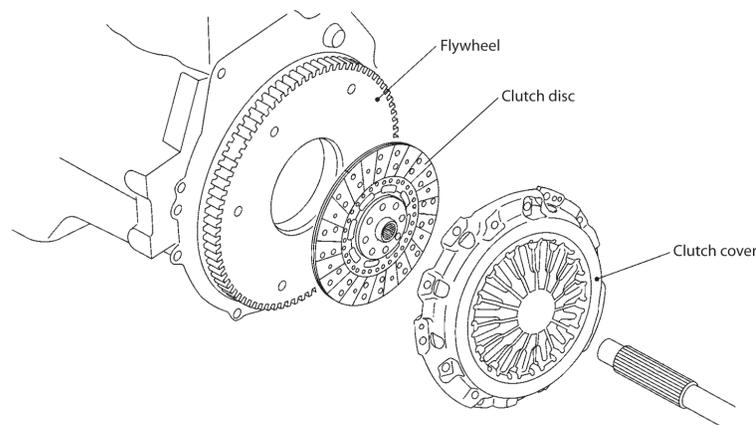
The clutch applies and removes engine torque from the input shaft.

When the clutch pedal is released, the springs push the pressure plate against the clutch disc, which in turn presses against the flywheel. This locks the engine to the transmission-input shaft, causing the engine and transmission input shaft to spin at the same speed.

Note the springs in the clutch disc; these springs help to isolate the transmission from the shock of the clutch engaging. The lines cut in the disc assist in breaking any vacuum that could cause the disc to stick to the flywheel or pressure plate.

Flywheel

The flywheel is a fairly large wheel that is attached to the crankshaft. It provides the momentum to keep the crankshaft turning between cylinder firings.



The flywheel is the base for the entire clutch attachment. The side of the flywheel where the clutch attaches is a smooth surface, which is used for friction between the flywheel and pressure plate. The clutch disc is sandwiched in between the pressure plate and flywheel. A bushing called the "pilot bushing" is installed in a hole in the center of the crankshaft. The bronze bushing is used to support the end of the input shaft on rear-wheel drive manual transmissions.

Around the flywheel is the ring gear, which the starter motor engages. The ring gear then mechanically turns the engine when the ignition key is turned to the start position.



Dual Mass Flywheel and Clutch

Starting in 2002, the QR25 and VQ35DE engines began using a newly designed "Dual Mass Flywheel." Design of the dual mass flywheel reduces drivetrain noise and vibrations.



PTN154

This flywheel design removes the dampening springs from the clutch disc and incorporates an arc spring directly into the flywheel.

When removing the dual mass flywheel from the QR25 motor, it's necessary to use the Torque Plus - T50 tool.

Note: Refer to the appropriate service manual and ASIST for the correct procedures associated with testing the flywheel rotation movement anytime the clutch is replaced or the flywheel is removed from the engine.

When reinstalling the flywheel on the VQ35 engine, pay close attention to the flywheel alignment dowel pin location. Incorrect flywheel installation will result in a no-start condition or a rough running engine. The crank position sensor identifies TDC from the flywheel and crank position sensor. (May/June 2002 Tech Talk pg. 13 and S.I.R. volume 102 contain additional information on flywheel indexing.)