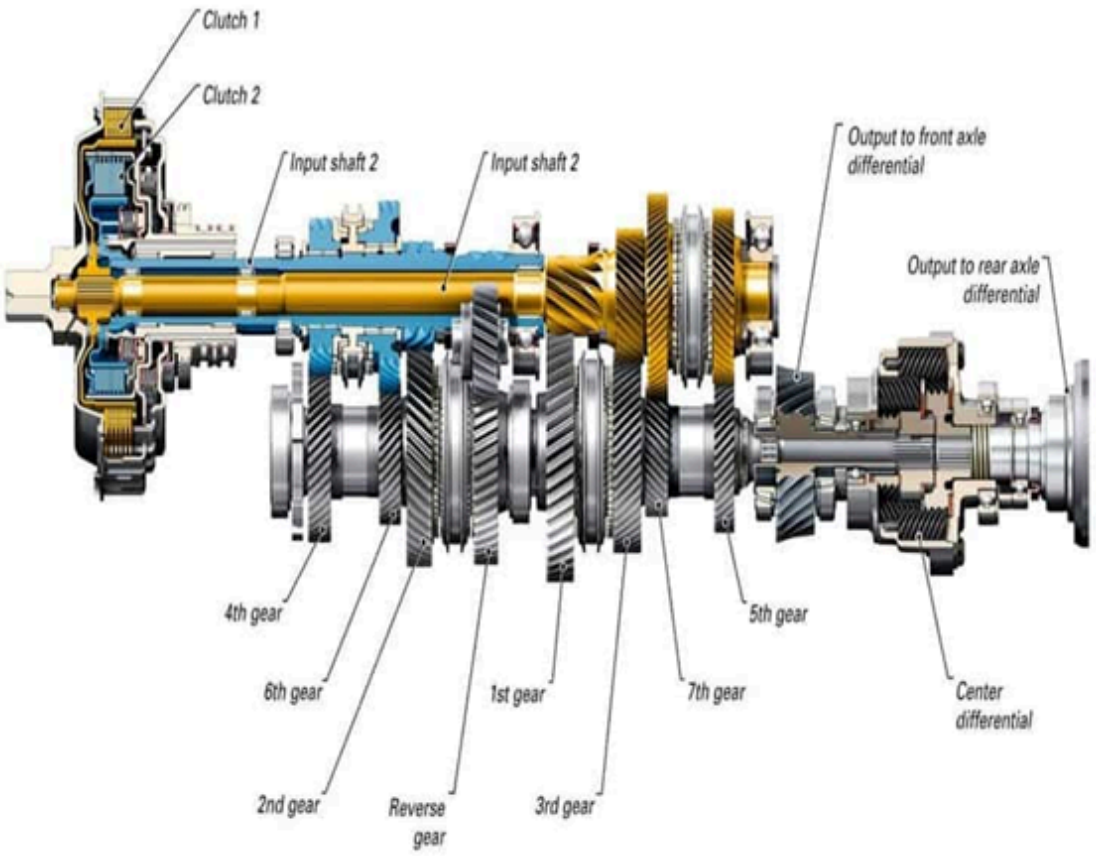
Manual & Dual Clutch Transmissions



Introduction

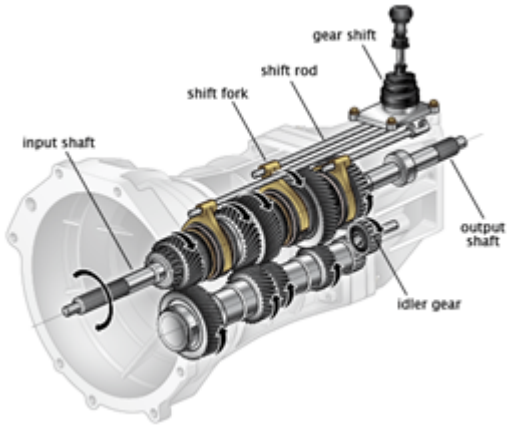
The focus of this chapter will be manual and dual clutch transmissions. Manual gear boxes have been around since the automobile's inception. As the name implies, manual transmissions & manual transaxles are shifted manually by means of a gear shift lever and a manually operated clutch. All shifting efforts are accomplished by the driver. Manual shifting takes skill, and some individuals never learn this skill nor have a desire to learn because the vast majority of vehicles in our society today shift automatically. The reason why automatic transmissions were invented was due to consumer demand. The first automatic transmissions were of planetary gear design, and this technology is still the basis of automatic transmissions today.

Dual-clutch transmissions are essentially a manual transmission that shifts automatically by means of electronically

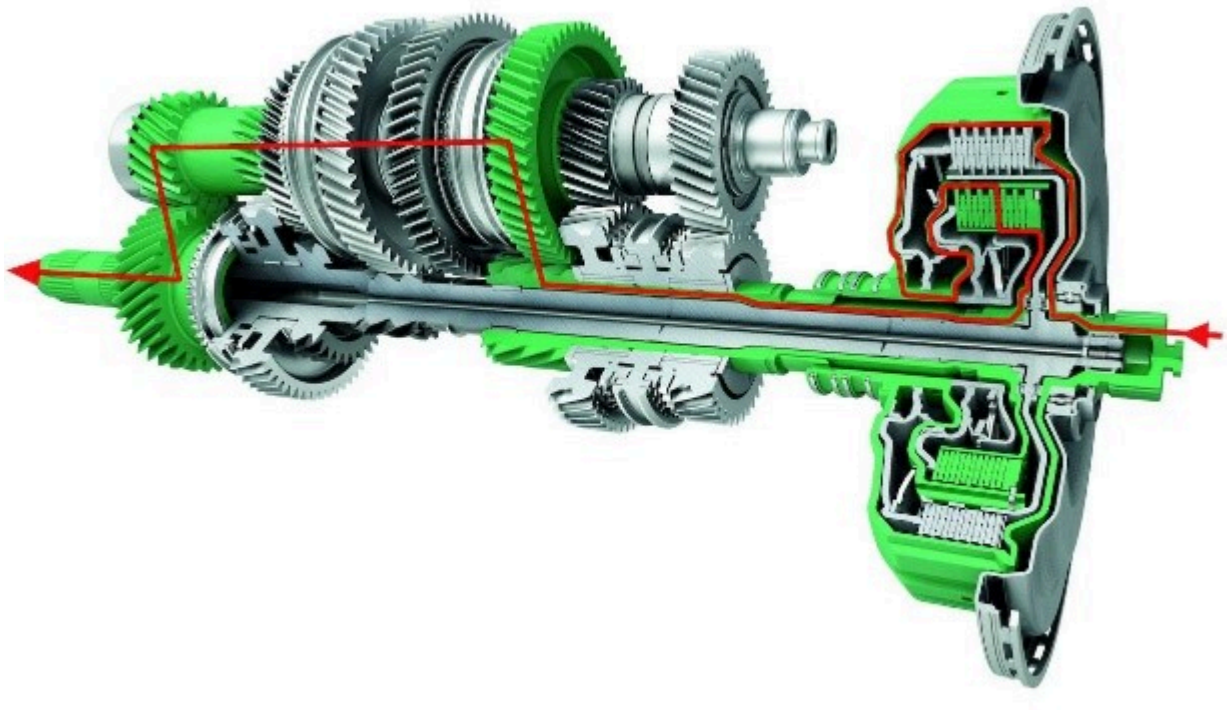
controlled mechanisms. Furthermore, there is no clutch pedal on these vehicles, they drive just like a traditional automatic transmission equipped vehicle. The shifting procedures in these transmissions occur so quickly that engine torque is essentially always available to the drive wheels, plus, engine rpms do not drop during shifting actions.

Dual-clutch transmissions, also known as Direct Shift Gearboxes or DSG's, have two clutch discs and two transmission input shafts, whereas manual transmissions have only one input shaft and one clutch disc.

Dual clutch and manual gearboxes have a number of similarities. Both designs use the same primary components such as helical cut gears, shift forks and shifting synchronizer assemblies. Where they differ is in how shifting movements are accomplished.



One of the goals of this chapter is to help the reader understand manual gearbox power flow. Mastering this will enable you to



easily understand dual clutch transmission power flow, since both transmission technologies utilize gears, shafts, synchronizer assemblies and clutch(es).

Here's some history as it relates to manual transmissions.

1. The earliest manual transmission is thought to have been invented by Louis-René Panhard and Émile Levassor in the **late 1800s**. It was one of the first transmissions produced and it offered three forward speeds and reverse.
2. Today, in the United States, a small number of manual transmission equipped vehicles are still available as new cars, but they are becoming more obsolete with each passing year. Additionally, for a number of years now, manual transmissions are only found on some muscle cars and a small number of ¾ and 1-ton pick-ups. Manual transmissions have not been offered in ½ ton pick-ups (Ford F-150, Chevrolet 1500, Dodge 1500) since 2012. Manual transmissions are becoming a thing of the past, at least in the United States, due to: (1) consumer preference and (2) vehicle emission standards.

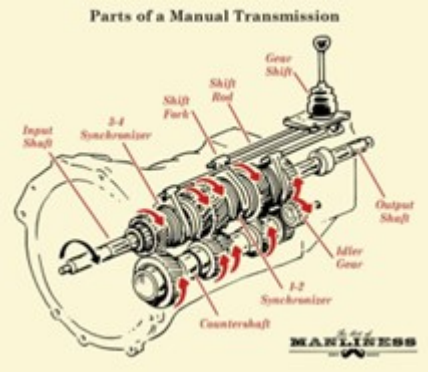


Figure 1: https://www.pinterest.com/pin/729512839614824889/

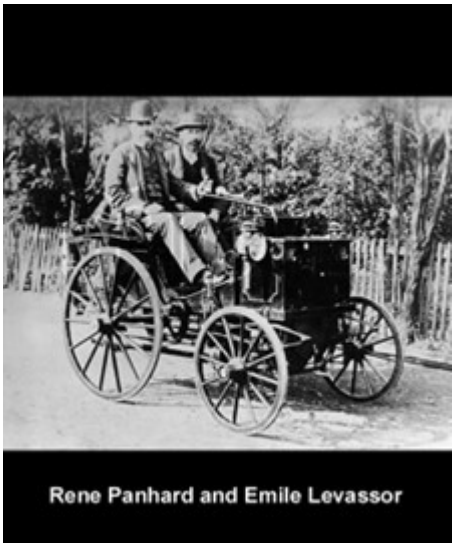


Figure 2: http://www.americanautohistory.com/Pioneers/Pioneer380.html

Direct Shift Gearboxes

In countries like South Africa, manual transmissions are found in 45% of their vehicles. In Europe, the number is 80%, while in the United States the percentage is **.9%**. These percentages reflect what various societies prefer in the vehicles they drive.

Dual clutch also known as 'automated manual' transmissions, have been marketed by a number of car manufacturers. Volkswagen Auto Group refers to their dual clutch as a Direkt-Schalt Getriebe (DSG) or a Direct Shift Gearbox. Between 2011 and 2016, Ford used a dual clutch unit, the DSP6, in both the Fiesta and Focus. Ford had its problems with the unit

and has discontinued its use. Transmission manufacturers that produce DSG's are: Borgwarner, Aisin Seiki, ZF, Getrag, Jatco, and Allison. DSG's have become quite popular in China and have seen some growth in Europe but the U.S. and Japan has not shown the interest that China and Europe have experienced. Dual-clutch technology has its roots in Europe and the largest market for their use is in compact cars not luxury models.

The purpose for development of DSG's are: (1) **no torque loss to the drive wheels** during upshifts, (2) improve **fuel economy** and (3) reduced tailpipe **emissions**. These transmissions shift extremely fast, 8 milliseconds or .008 seconds. Volkswagen/Audi dual-clutch units seem to be built better and their DQ500 and DL501 DSG's have become standard in some of their vehicles. In their beginning Volkswagen developed DSG's primarily for World Rallycross racing.

Shifting a traditional manual transmission creates extra emissions during each shifting event. Emissions occur when the throttle is released, the clutch pedal is pressed down, only to release the clutch and then accelerate. DSG's use electronically controlled **valve bodies**, electric motors as well as solenoids to move shift mechanisms to complete shifting actions inside the transmission.

Completing a shift manually takes a typical driver approximately .5 seconds. To put this into perspective, a human blink of an eye takes .3 -.4 seconds. If a dual clutch transmission shift time is .008 of a second this means they shift 62.5 times faster than shifting manually.

Dual-clutch housing

Read this document about how fast an eye blinks: http://www.madsci.org/posts/archives/1998-11/911697403.Me.r.html

Figure 3: http://www.allpar.com/corporate/auto-manual-transmission.html

Dual-Clutch Transmissions

Figure 4 below shows how dual-clutch transmission gears and clutches are grouped together. The **red** clutch drives the red input shaft, which in turn drives the **red** gear's whenever a particular gear is synchronized to engage. The red shaft operates the odd numbered gears, and the **green** clutch/shaft delivers torque to the even numbered gears.

This transmission design is compact. What is NOT shown in Figure 4 is the complex control mechanisms that operate or shift the transmission. Electronically controlled shift forks and synchronizers are used to engage each of the various gears when selected.

The two clutches, Clutch 1 and Clutch 2, alternate as to when one of the clutches is **engaged** while the other clutch is disengaged. This allows the next gear to be 'staged' or pre-selected before the clutch associated with the particular gear engages.

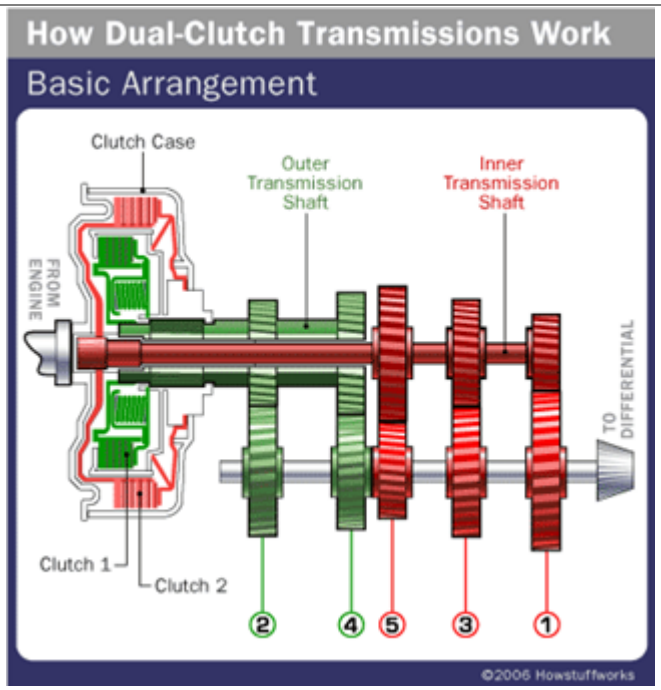


Figure 4:

http://inventorspot.com/articles/doubleclutch_double_fun_7679

Technical Service Bulletins and Dual-Clutch Transmissions

Pre-selecting a gear and when to engage and disengage each clutch is something that is precisely controlled through programming. Shift timing engagements cannot overlap with each other, or damage will occur to transmission components. Consequently, if shift timing engagements are timed too far apart or late, the driver will feel the impact of each clutch engagement. Either situation is inefficient, and it shortens the life of the transmission.

At times, transmission control modules, TCM's, have to be reprogrammed/'re-flashed' in order to correct shift-timing events due to wear and tear to the clutches. Whenever a dual clutch transmission is shifting abnormally or outside of parameters, a search for an appropriate TSB (Technical Service Bulletin) should be done. Common fixes found in TSBs for Ford DSP6 transmissions often include: (1) a TCM reflash procedure, (2) dual-clutch module replacement due to an oil leak at the transmission's input shaft. This type of leak allows oil to contaminate the clutch disc linings. When clutch linings become contaminated, it causes sudden or jerky clutch engagements. When this occurs, the clutch module and transmission front seal need replacing.

Other common TSBs are: (3) Replacement of both the clutch module and shifting forks. (4) The TCM itself may need to be replaced. TSBs are to be followed based upon diagnostic trouble codes retrieved and other symptoms as outlined in a TSB.

One tip that manufacturers of DSG transmissions give is that these vehicles should be driven a bit on the aggressive side. Driving them in a timid manner causes rapid clutch disc wear to the dual-clutch module.

Dual-clutch transmissions have not yet been perfected and some particular units have a history of problems. At this time point in time, dual clutch transmissions are gaining in popularity and are being refined. This technology is not going away as car manufacturers are always searching for ways to make improvements. They will continue to use various transmission types in vehicle applications where it makes the most sense. Additionally, consumer preference is

something that car makers are always trying to understand in hopes to improve the vehicles that they build in order to be profitable.

These two videos explain how a dual clutch or DSG transmissions work. Both videos are worth watching since they each point out different aspects of how these units operate.

Manual Transmission Components

Manual transmissions use manual clutches, which are single disc units. Understanding how a manual clutch works

makes it easy to see how a dual-clutch module operates.

It starts at the **flywheel.** Flywheels bolt directly to the engine's crankshaft and accomplish TWO things: (1) they provide a place for the clutch assembly to be fastened and (2) since they are made of heavy cast iron, the flywheel acts as an inertia wheel. This smoothens crankshaft pulsations it receives from each piston's power stroke. The flywheel and clutch assembly revolve with the engine's crankshaft whenever the engine is running.

The clutch **pressure plate assembly**, sometimes called the "clutch cover" houses the diaphragm spring, the release levers, and the plate. Diaphragm spring pressure is what compresses the clutch disc against the flywheel in order to transmit engine torque to the transmission.

Throw out fork/clutch fork. One end of the fork connects to the throw-out/clutch release bearing while the other end is operated by a cable or a hydraulic clutch slave cylinder. The fork is a lever that moves the release bearing against the pressure plate's levers whenever the clutch is disengaged.

Throw out/release bearing. This is the mechanism that presses against the pressure plate's release levers during clutch disengagement. Incidentally, this bearing is only in use during clutch disengagement. Incidentally, this bearing is only in use during clutch disengagement. When the clutch is engaged, the bearing is not in use.

Next is the **pilot bearing/ bushing.** It supports the transmission's input shaft. The only time this bearing actually spins or operates is when the clutch is disengaged.

A **clutch disk** is a component that gets compressed during clutch engagement. This connects engine power to the transmission. The disc is the clutch system member that transfers engine torque to the transmission when the clutch is engaged.

The disc has friction lining material much like the lining found on disc brake pads.

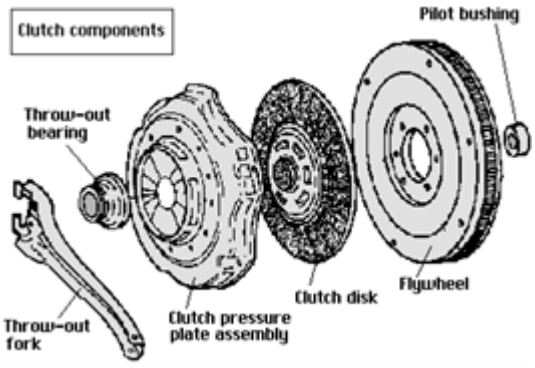


Figure 5:

http://www.precisionautosales.com/drivetrain.php

These two videos show clearly what is meant by clutch engagement and disengagement. All of the clutch components that have been described are displayed in these videos.

Youtube: "How Clutches Work"

Youtube: "HOW A CLUTCH WORKS NZ Automotive Distributors – NZAD – Clutches - Flywheels"

Flywheels

Flywheels are rather heavy and add smoothness to crankshaft rotation. To the naked eye, an engine spins smoothly. However, in reality, each time a power cycle occurs, it creates a rapid increase in crankshaft speed and then it slows down slightly until the next cylinder completes a power cycle. These repetitive speed fluctuations create a pulsating action as the crankshaft rotates. This is where the heavy flywheel acts as an inertia wheel, as it reduces these speeding up and slowing down actions.

For example, a four-cylinder engine will experience two power pulses each crankshaft revolution because with four-cycle engines, two complete crankshaft revolutions are required to fire all of the engine's cylinders once . For example, a V-8 engine experiences 4 power pulses per crankshaft revolution while 6-cylinder engines have 3 power pulses each crankshaft revolution.

The flywheel has a smooth finish on it for the clutch disc to engage against. This is why a flywheel is either resurfaced or replaced during clutch replacement service. A complete clutch service requires that all clutch components be replaced, and that the flywheel be replaced or resurfaced. This way, the new disc can be compressed between two ideal, flat surfaces: the flywheel and the pressure plate.

Flywheels are usually made of nodular cast iron which means the cast iron has some graphite in it. The graphite acts as a dry lubricant for the friction that occurs during clutch engagement.

Something to remember in regard to clutch operation is that both the flywheel and the pressure plate are the DRIVING members of the assembly, they essentially bolt directly to the crankshaft.

The clutch disc on the other hand, resides between the flywheel and the pressure plate and is the DRIVEN member of the assembly and is splined to the transmission's input shaft.

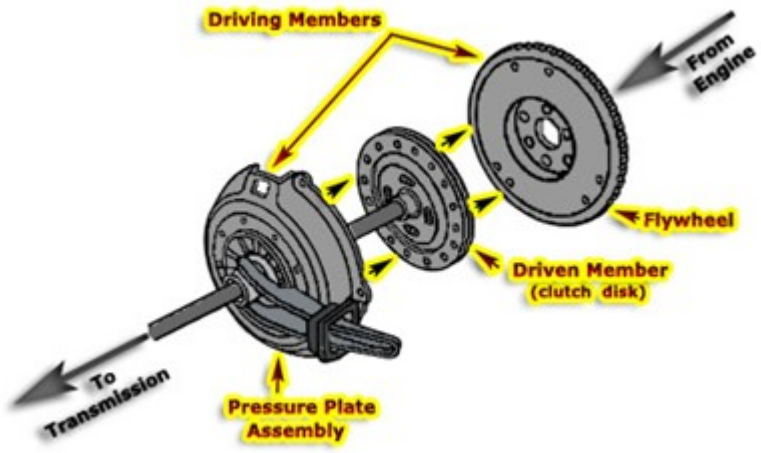


Figure 6: http://know-yourcar.com/Automotive-Clutches.html

Types of Flywheels

There are two types of flywheels: One-piece and dual-mass. One-piece flywheels are simply one solid piece of cast iron and are very common with non-turbo gasoline engines. Dual-mass flywheels are made up of two halves that are separated by some stiff springs. Many engines, diesel or gasoline that are turbo charged, utilize dual mass flywheels.

Dual-mass flywheels absorb engine vibrations. Clutch engagement minimizes harmonic noises in order to make for a smoother driving experience, as well as applies less stress to transmission components.

Dual-mass flywheels are typically replaced during clutch service. Quite often, the heavy springs that reside in between the two halves of the flywheel break. This eliminates their ability to absorb engine vibrations, to minimize harmonic noises, and makes for somewhat harsh clutch applications. Other symptoms of broken dual-mass flywheel springs are: rattling noises during engine idle and, at times, a squawk noise is heard when shifting gears.

The left video below shows how a solid flywheel gets resurfaced. The coolant used during the grinding process keeps the flywheel cool and flushes away particles during this process.

The video on the right explains what a dual-mass flywheel is.

Youtube: “Flywheel Resurfacing”

Youtube: “Dual-Mass Flywheel- Design & Operation”

Stepped Flywheels

Some one-piece flywheels are “stepped,” which means that the clutch pressure plate mounts to a different surface than where the clutch disc applies. Resurfacing a stepped flywheel requires the machine shop to grind both the surface that the pressure plate bolts to and the surface that the disc gets pressed against.

Figure 8, below, is of a stepped flywheel. It is being measured for run-out. This is a good task to perform during clutch service, especially whenever there is a clutch pedal pulsation concern. Run-out is a measurement to see if the flywheel is warped. Typically, flywheel run-out should not exceed .004”. If a flywheel tests good (flat) and there was a clutch pedal pulsation issue that was felt during clutch engagement, then either the pressure plate’s diaphragm spring or the clutch disc is warped.

Sometimes the machine shop will supply a .010” thick shim if the flywheel had to have .010 - .015” or more ground off. This shim is to be bolted between the flywheel and the crankshaft. Its purpose is to keep the flywheel’s clutch surface at the original location. This is necessary for hydraulic clutch release systems.

Think about it, when a flywheel gets resurfaced, the clutch surface actually moves slightly towards the engine. This may not seem like much of a change, but without a flywheel shim, the clutch fork and slave cylinder geometry can change enough to impact the stroke of the fork and release bearing, which may prevent complete clutch disengagement. See Figures 7 and 8 below for examples.

Flywheel Shim

Figure 7: http://www.8-lug.com/tech/1003_8l_ford_f350_transmission_swap/photo_21.html

Stepped Shim

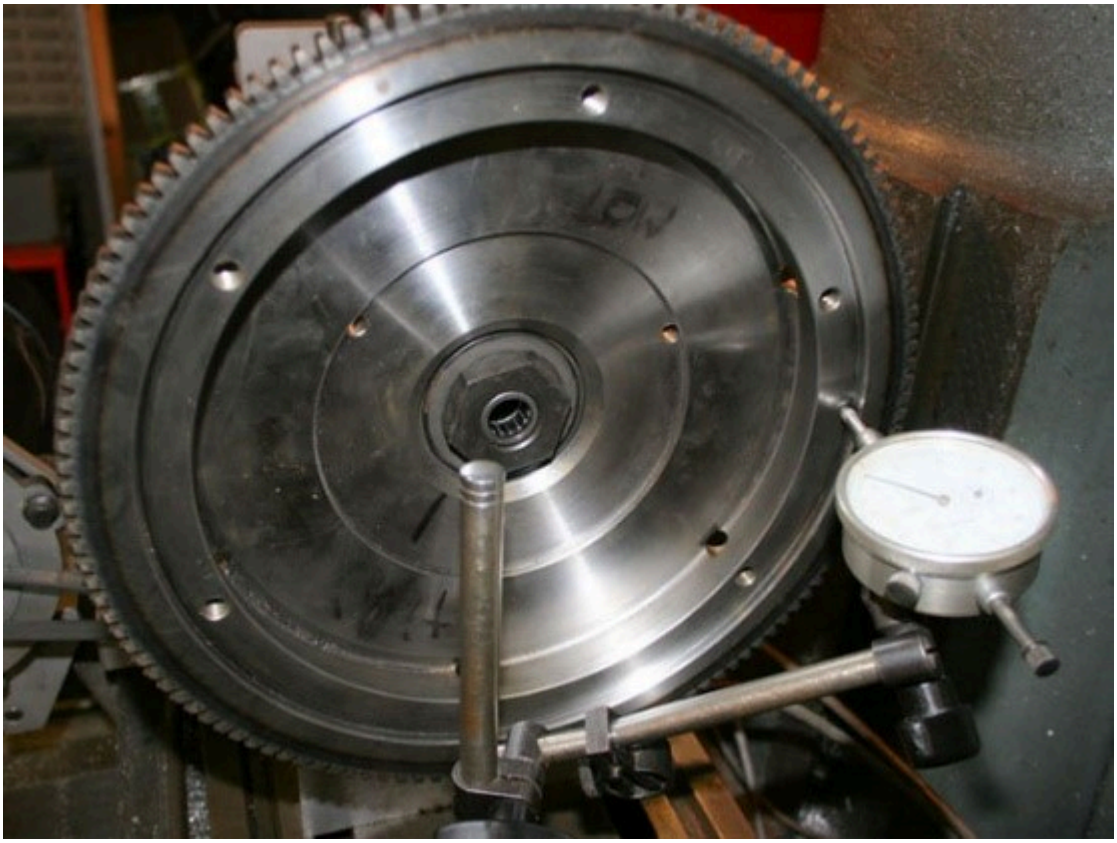


Figure 8: http://johnmaherracing.com/2013/01/project-2110-part-5-dynamic-balancing-continued/

Clutch Pedal Pulsation

As mentioned, sometimes manual clutch components become warped. A clutch member that is warped causes clutch pedal pulsation, a slight pumping motion that is felt while operating the clutch pedal.

This pulsation is an indicator that one of FOUR possible things has occurred:

1. The clutch disc has become warped.
2. The pressure plate release levers have become bent, broken or *uneven* somehow. (shown in both the top and middle pictures).
3. Clutch disc lining has become contaminated with engine oil due to a leaking rear main seal on the engine.
4. The flywheel is warped and needs to be replaced or resurfaced.

Clutch pedal operation should be smooth without pulsations. When a pressure plate diaphragm spring has become weak, the levers become uneven (see Figures 9 and 10). The levers are an extension of the diaphragm spring, they all need to be the same in levelness.

Figure 11 below depicts what happens when HARSH clutch engagements occur. This clutch disc shows evidence of uneven contact by the red arrows. Only the outer portion of the disc is making good contact.

At times, a clutch release system binds. One reason for binding is that clutch cable or the clutch master or slave cylinders have become sluggish in their travel. This is due to internal corrosion, and they do not operate smoothly. This will also impact how smooth the clutch applies when engaged/when the pedal is released.

This site gives some great troubleshooting tips in regard to manual clutches.

Trouble Shooting | EXEDY After Market (exedy-aftermarket.com)

Figure 9: http://www.6speedonline.com/forums/996/241073-clutch-dilemma.html

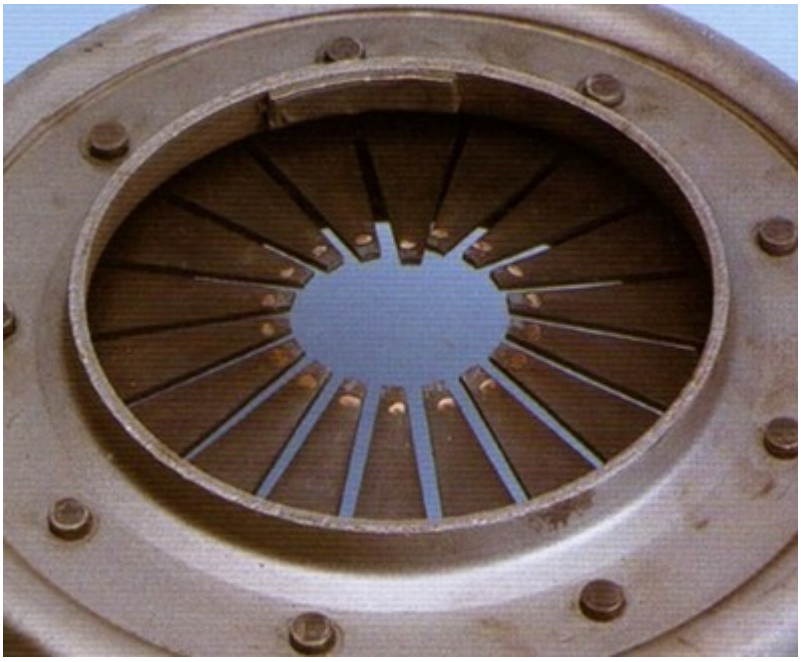


Figure 10

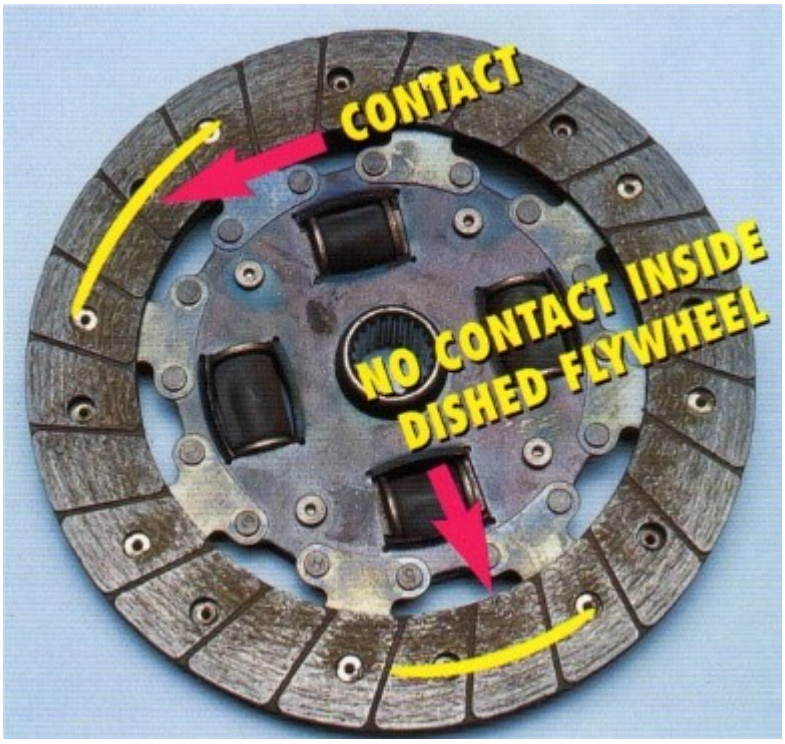


Figure 11: http://www.exedy-aftermarket.com/english/default/clutch/index/id/02-04/

New Clutch Kits

When it comes to clutch service, do not cut corners. Some individuals are tempted to not **resurface** or **replace** the flywheel. This is a poor decision because it most often results in having to repeat the clutch repair in the near future. A new clutch disc needs to operate against a perfectly flat surface in order to give it lasting service life.

Common reasons for clutch failure are: Clutch **over loading.** Pulling too heavy of a load causes clutch disc slip. **Low skill level of knowing how to operate a manual clutch. Aggressive shifting and clutch application.**	Additionally, always purchase a **new clutch kit**, not a **remanufactured clutch kit**. New kits include a new pressure plate. This is best, since a common reason for clutch system failure is that the old pressure plate diaphragm spring loses its ability to compress the clutch disc adequately. This causes clutch slip and heat which weakens the diaphragm spring.

Figure 12: http://www.speedcircuit.net/index.php/spec-super-twin-p-trim-clutch-kit-for-evo-x.html

This video is of a **twin-disc clutch** (not be confused with dual clutch. These are a solution for single disc clutch applications in order to improve clutch life. These are popular on diesel trucks that have had a performance enhancement.

Youtube: "South Bend Clutch – Twin Disc"

Clutch Replacement Kit Components

Pictured below are the items of what typically comes in a clutch replacement kit. One thing you may ask when working with a one-piece flywheel, when purchasing a clutch kit, is "Does it come with a flywheel?" Ask the parts specialist about the availability of a replacement flywheel when ordering a clutch kit. Sometimes they are available, and a replacement flywheel's cost is about the same as having the original flywheel resurfaced at a local machine shop. Buying a replacement flywheel is a great way to save some time.

As mentioned earlier, only purchase NEW, not remanufactured clutch kits. 'Reman' clutches are not made to the same specifications or quality as new clutches are.

One thing to note about this kit is, it is probably for a RWD vehicle. This is because it contains a pilot bearing. Many FWD clutch systems <u>do not</u> use a pilot bearing, therefore, a pilot bearing will not be part of the kit. So, depending on what vehicle you're servicing, you may or *may not be replacing* what is known as the *pilot bearing*.

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Insert Weird Image here

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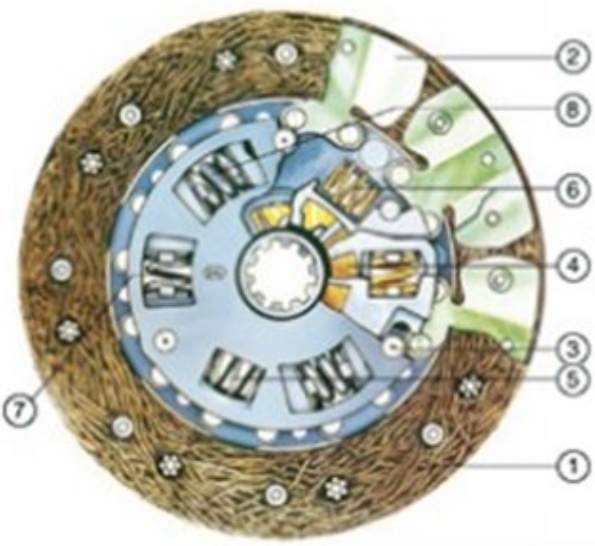
Clutch Disc Components

Figure 14 below points out 8 items that make up a clutch disc.

Today's clutch lining or friction material contains fiberglass, aramid compounds, powered iron, copper, graphite, and ceramic materials.

Please look at item No. 2: the Cushion segment. These segments are made of a thin spring type metal. The segments are not flat, they have a slight curve shape about them. Their purpose is to push the friction material “outward” for improved compression pression between the pressure plate and the flywheel, in order to minimize clutch disc slip.



(1) Friction material
(2) Cushion segment
(3) Stop pin
(4) Friction washer
(5) Idle damper spring (1st stage)
(6) Idle damper spring (2nd stage)
(7) Main damper spring (1st stage)
(8) Main damper spring (2nd stage)

Figure 14: http://www.schaeffler-aftermarket.us/content.schaeffler_as.us/us/services_luk_as/technicalinfo/clutchbasics/clutch_basics.jsp

A safety tip that car manufacturers would have you know is, **do not under any circumstances, blow off the old clutch assembly with compressed air during clutch service**. This makes the hazardous dust or old clutch fibers air-borne which allows them to be easily breathed into a person’s lungs.

The cushion springs (as mentioned on the previous page) on a clutch disc are also known as Marcel Springs (the red curved pieces). These springs flatten out to some degree during clutch engagement. They are made of spring steel, designed to **push** the lining material back **towards the clutch’s pressure plate** and flywheel in order to improve the discs’ grip.

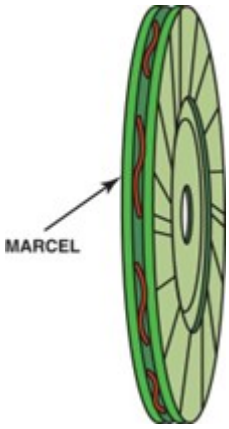


Figure 15:https://www.slideshare.net/mcfalltj/chap94

Torsional Springs

A clutch disc hub often has what are known as **torsional springs**. These springs absorb some of the torque that occurs during **initial** clutch engagement. Torsional springs simply provide a cushion effect during clutch application. The hub has a splined hole for the transmission’s input shaft. The hub of a clutch disc is independent of the clutch disc’s face segment. This is so it can rotate slightly and spring back to the center during clutch engagements. These springs soften

the initial shock of clutch engagement by allowing the hub section to twist slightly. To visualize this better, view about one minute of this video from where it starts. Also, view Figure 16.

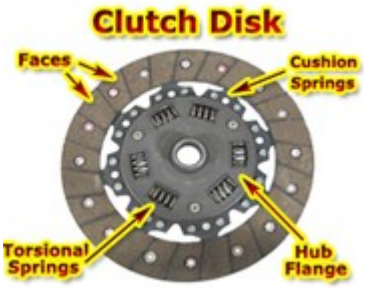


Figure 16: http://know-yourcar.com/Automotive-Clutches.html

Youtube: How a clutch works

Throw-out Bearing

A very common clutch complaint and wear item is the **throw-out bearing** (clutch-release bearing**.** To diagnose a worn **throw-out** bearing noise, think about when it operates. This bearing does not operate when the clutch is **engaged**, which is when your foot is not pressing down on the clutch pedal.

This bearing does operate whenever the clutch pedal is being pressed down, during clutch **disengagement.** This bearing pushes against the pressure plate's release levers. Consequently, the only time that this bearing can make noise is only when it operates. These bearings should operate quietly, without noise.

When this bearing is at rest during clutch engagement, a small air gap exists between it and the clutch plate's release levers. A small gap is necessary and is the reason why **clutch pedal free play** exists. It's good to have a small amount of pedal free play, this way the pressure plate is allowed to compress the clutch disc with its full potential against the flywheel.

This video below is of a noise due to a worn transmission input shaft bearing, **NOT** a throw-out bearing. People often confuse these two possible clutch pedal-related noises.

When a release bearing makes noise, it is because the rollers inside of it have become worn and they may be dry of grease. Usually, these bearings cannot be lubricated, but some throw-out bearings on large trucks are greaseable.

Here's the **diagnosis** for a worn throw-out bearing: it will make noise **all the while the clutch pedal is being pressed** downward, and the noise goes away when the pedal is released.

Clutch Pedal Free Play

Let's explain what **clutch pedal free play** is and the three things to know about it. First, some free play is necessary or normal. This allows the disc to be compressed between the pressure plate and flywheel as it should be during clutch engagement. Generally, the ideal amount of pedal free play is about **.5 inch or 13mm.** Free play is felt at the very beginning of a clutch pedal stroke. At first, there is no resistance as the pedal is pushed further resistance is felt. Free play ends just as resistance starts to occur because at this point the throw-out bearing is now pushing against the pressure plate's release levers. See the 'Clutch Pedal Freeplay' video below.

Second, having **too much** pedal free play is not good, since having too much 'resistance free' pedal stroke does not allow the clutch disc to be completely released when the clutch pedal is pushed all the way down. If the clutch disc is not able to completely disengage, it leads to "**gear clash**" because some of the engine's power is allowed to always be transmitted to the transmission. This is also known as **'torque drag'.** This can cause slight grinding in all gears. An early sign of too much pedal freeplay is when gear clash occurs when either FIRST gear or REVERSE are selected. This issue needs to be addressed early on in order to prevent damage to these transmission gears. The lesson here is, to avoid gear clash (torque drag), the clutch disc needs to be able to completely disengage.

This is a thrown-out or clutch release bearing.

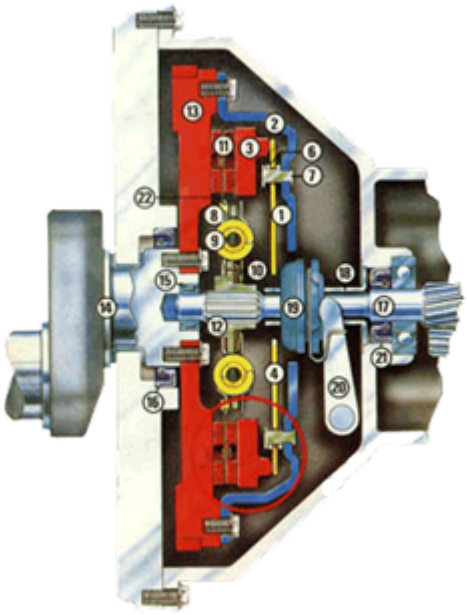
Figure 17: http://www.maximummotorsports.com/store/index.php?main_page=index&cPath=50_164

Third, when there is **no clutch pedal freeplay,** it means that there is no air gap between the throw-out bearing and pressure plate release levers. This can lead to accelerated clutch wear since the clutch pressure plate cannot be completely released.

In other words, the clutch disc cannot completely engage at full potential against the flywheel by the pressure plate.

This allows for clutch disc slip especially during hard acceleration or when towing. This generates heat at the disc. The throw-out bearing wear also accelerates, because it basically operates all of the time, not occasionally as it should. Clutch throw-out bearings are meant for short duration use, not continual.
Let's review the TWO problematic clutch pedal scenarios:

1. When there is **NO pedal freeplay,** it means that the release bearing is always in contact with the pressure plate's release levers. This may result in the pressure plate's inability to completely compress the clutch disc against the flywheel. This creates a chance for the disc to slip, overheating the pressure plate diaphragm spring. Overheated diaphragm springs lose their tension.
2. Whenever there is **TOO MUCH pedal freeplay,** the clutch disc will not be able to disengage completely, when the pedal is pressed all the way down. This leads to torque drag, which causes gear clash or grinding. An early sign of poor clutch disc release is when grinding occurs when trying to select FIRST gear and REVERSE. Too much clutch pedal freeplay can lead to wear and tear to some of the transmission's gears. When these symptoms occur, it is evidence that the clutch master and slave cylinders are not performing as they should.



Can you see the small amount of clearance or air gap between the yellow lever and the blue bearing? This is why pedal-free play exists.

Figure 18: http://www.clutch-shop.com/assemb3.htm

Pilot Bearings

Manual **transmissions** utilize a pilot bearing, whereas many manual **transaxles** do not. A pilot bearing is used to support the far end of a transmission's input shaft. Transaxle input shafts are much shorter and do not require such a bearing. A pilot bearing is located at the center of the clutch assembly. In actuality, the pilot bearing is located in the aft end of the crankshaft.

In the past, copper colored pilot bushings were used, but over time, bearings have become the standard. Bearings fit tighter on the input shaft's pilot area, this offers better support to the input shaft.

As with any bearing, both pilot and throw-out bearings become worn & make **noise.** A bearing in good condition operates quietly. Pilot bearings operate about the same time a throw-out bearing does with one difference. A worn pilot bearing will not make noise until the clutch is nearly or is completely **disengaged.** Worn throw-out bearings, on the other hand, make noise all the while the clutch pedal is being pressed down.

Here's another way to view this. With the engine running, a worn pilot bearing will only make noise when the transmission's input shaft and clutch disc are essentially stationary. The bearing now spins because the engine's crankshaft is rotating.

Throw-out bearings operate **all the while** the clutch pedal is being pressed down. This is when a faulty throw-out bearing will make noise because it is being pushed against the revolving pressure plate release levers.

So, how is it determined if a clutch pedal related noise is from a worn PILOT bearing or from a worn THROW-OUT bearing?

A worn pilot bearing will not make noise until the clutch pedal has been pressed nearly all the way down.

A worn THROW-OUT bearing will make noise during the entire time that the pedal is being pushed downward.

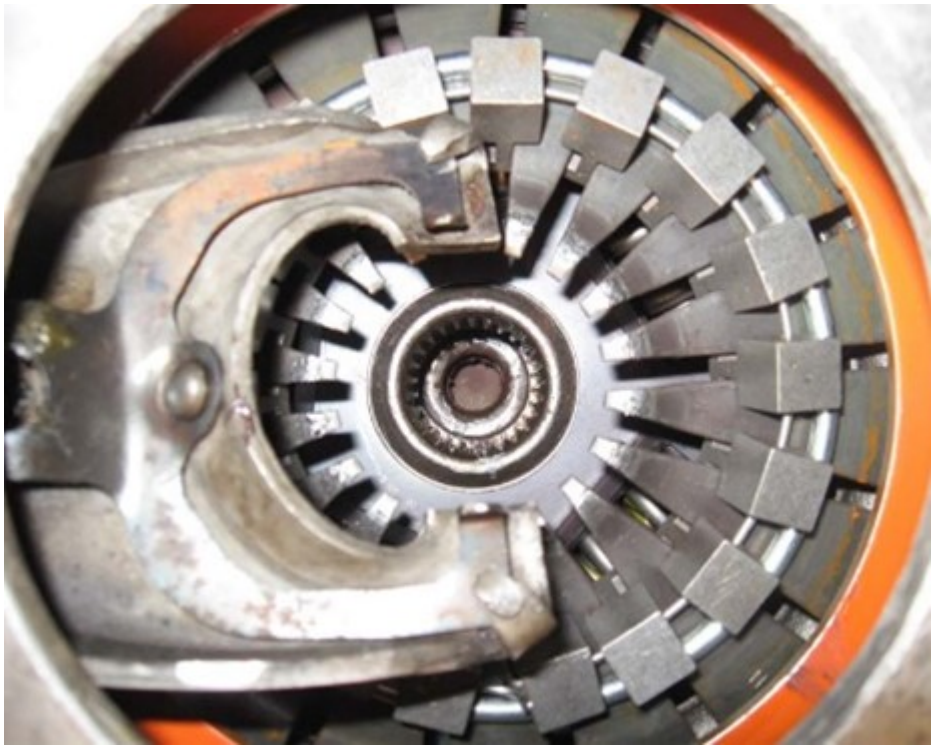


Figure 19: http://know-yourcar.com/Automotive-Clutches.html

Figure 20: http://www.chevelles.com/forums/showthread.php?t=356838

The picture below is of a transmission input shaft, throw-out bearing and release lever (fork). The red arrow is pointing to the pilot area of this input shaft. Note how this pilot area is smooth. This is what the pilot bearing rides on.

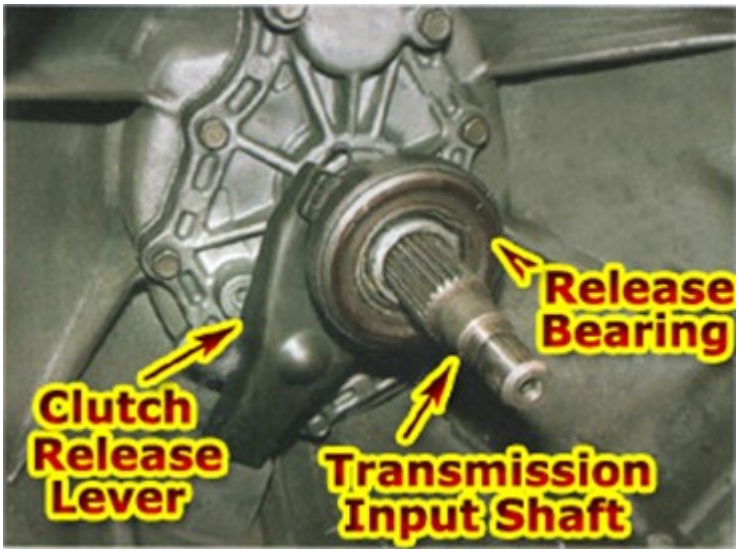


Figure 21: http://know-yourcar.com/Automotive-Clutches.html

The splines or teeth are for the clutch disc and are located just behind the pilot area. The pilot end of a transmission input shaft is what extends into a pilot bearing at the center of the flywheel. The pilot bearing supports this end of the transmission's input shaft. This is necessary, since engine torque gets applied to this shaft when engine power is delivered to the transmission via clutch engagement.

As stated earlier, many FWD transaxles do not use nor need a pilot bearing. Their input shafts are shorter in length and there is no pilot area on the input shaft.

More about Clutch Pedal Freeplay

1. Here is another reason for too little or no pedal freeplay. It is when a clutch disc has some wear and is getting thin. This causes reduced pedal freeplay, because as a clutch disc becomes thinner, the pressure plate release levers will push outwards towards the throw-out bearing, thus reducing the air gap between the throw-out bearing and the release levers. A reduction in pedal freeplay can be an indicator that the clutch assembly could be nearing the end of its service life. However, if the clutch passes a clutch disc slip test, then there is nothing to worry about for the time being.
2. When too much pedal freeplay exists, (which is the more common scenario), it often indicates that the clutch master and/or slave cylinders are getting old or weak and can't deliver the pressure they once did. This has already been explained in this chapter.
3. A **clutch disc slip test** is something that can be done on a test drive. To perform this test, drive the vehicle aggressively and shift rapidly in order to see if engine RPM's will rise ***abnormally*** after each clutch engagement. The objective is to see if engine torque reaches the wheels effectively or is there evidence of slip, a rise in engine rpm, after any of the transmission shifts?

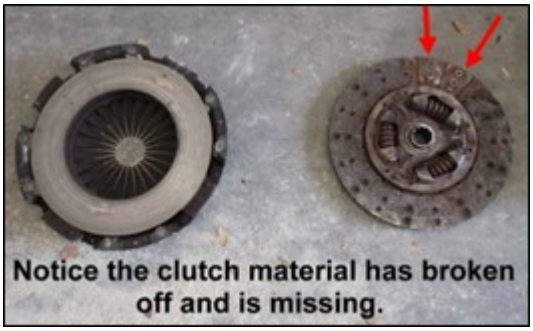


Figure 23: http://advancedautomotiverepair.us.com/pages/clutch_repairs_deland-fl.html

Common Complaint for Manual Clutches

Let's examine a common complaint as it relates to manual clutches.

1. "When the clutch is, pedal released with the transmission is in gear, the car doesn't move or barely moves." What's happening here is total clutch failure. Quite often, the pressure plate's diaphragm spring has lost its clamping ability altogether, which results in destroyed clutch disc lining. Disc lining materials can get so hot that it gets shredded off of the disc. This renders the clutch ineffective in transferring engine torque to the drive wheels.

Before a clutch fails altogether as just described, clutch slip can usually be detected in its early stages.

As described earlier, you may wish test for clutch 'slip' before the clutch fails leaving the driver stranded.

Here is another way to test for clutch slip:

1. Start the engine.
2. Push the clutch pedal to the floor and apply the parking brake firmly.
3. Select 2nd gear.
4. Let the clutch pedal out somewhat slowly.

This should stall or 'kill' the engine. If this doesn't kill the engine the clutch is slipping, clutch replacement service is necessary

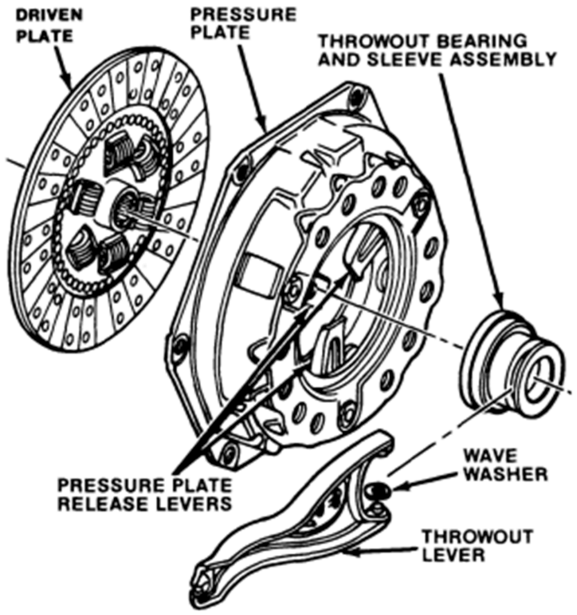


Figure 24:

http://www.benplace.com/vw_clutch.htm

Assessing Clutch Condition

When performing a test drive on a vehicle that has a manual transmission (or whenever there is a clutch concern), an experienced service technician will observe a few things while driving the vehicle: (1) Is clutch **pedal freeplay** close to normal and (2) is the clutch in good condition? Clutch condition can be assessed by performing a **clutch disc slip test.**

This video shows multiple ways to test a clutch for a slip problem. The basic idea of these tests has already been explained, but some similar methods are explained in this video, it is quite informative.

Often, when a clutch system seems to have a binding problem, the reason is that the sleeve that the throw-out bearing slides on has become damaged or corroded, (see Figure 25). Throw-out bearings need to slide easily on the **sleeve** it travels on. This sleeve is the transmission's **front bearing retainer**. The picture below compares a scratched-up bearing retaining sleeve to a new one.

Figure 25: http://www.lnkservices.co.uk/Clutch-Replacement.html

Figure 26 portrays someone installing a new release bearing onto a bearing retaining sleeve. The one problem with this picture is that this sleeve isn't clean but is rusty. A sleeve needs to be cleaned-up and lubricated as show in Figure 27. This sleeve is lubricated which will allow this throw-out bearing can glide back and forth smoothly.

*Figure 26: http://www.moparmusclemagazine.com/howto/mopp_0607_engine_bay_detailing/photo_*

Figure 27: https://www.rx7club.com/canadian-forum-42/throw-out-bearing-shaft-question-10054430/

Common lubricants used for throw-out bearings are: Anti-Seize, white lithium grease and chassis grease. Refer to figure 28.

Figure 28: http://www.etrailer.com/Tools/LubriMatic/L11350.html

Input Shaft Spline Wear

Figure 29 is an example of transmission **input shaft spline** wear. Input shaft teeth or splines need to be inspected whenever a transmission is removed. This type of wear is rare but when it happens it can impact how well the clutch disc is able to slide, the little amount that it does slide, on these teeth during clutch engagement and disengagement. These teeth are not quite worn enough to justify transmission replacement. Be certain to put some grease on these splines during clutch service.

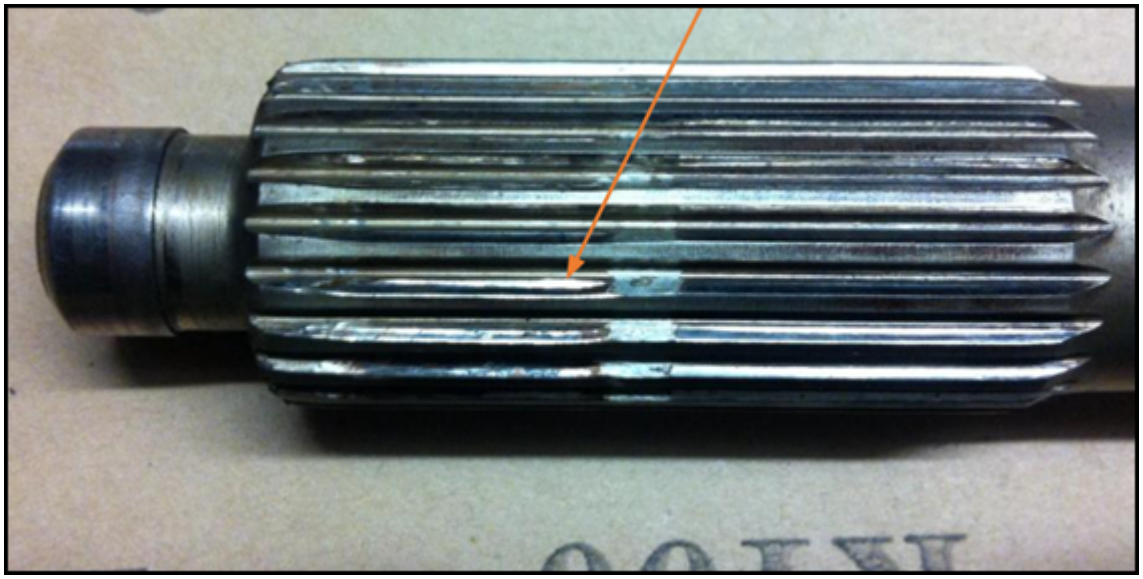


Figure 29: http://forums.rennlist.com/rennforums/928-forum/748811-more-clutch-wear-parts.html

Apply Bearings

Dual clutch transmissions have their own type of release bearing. For starters, they are two-stage or have two contact surfaces. Additionally, they are not referred to as release bearings but are more correctly called '**apply bearings**'. The apply bearing on a DSP6 Ford application is always pushing against one set of release levers on the dual clutch module. Clutch engagement for DSG's requires that the apply bearing push against the levers to engage the clutch, which is just the opposite of the single disc manual clutch operation.

Note that one of the apply-bearing forks (see arrows in Figure 30) has worn down. Additionally, the apply bearing came apart and this is what created much of the wear on this fork. A new set of forks, apply-bearing, clutch assembly module, and a new TCM computer is what was required to fix this car's shifting issues.

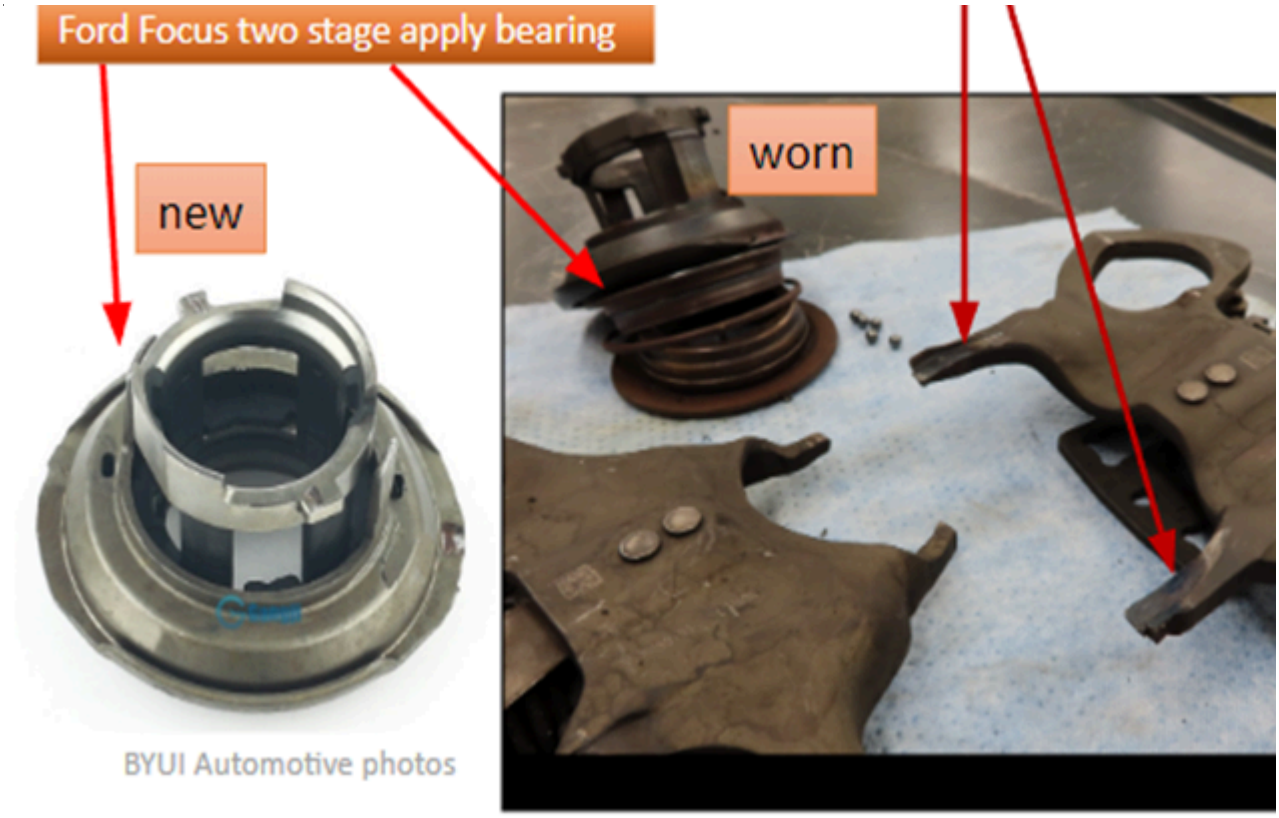


Figure 30 BYUI Automotive Photos

Don't forget to check the gear oil condition and its level. Some shifting concerns can be as simple as a lubrication problem.

The video below explains all of the components that make up a dual clutch module / clutch assembly for a Ford DSP6. Apply-bearing operation is also pointed out in this demonstration.

Synchronizer Assemblies

Something that was mentioned earlier is the problem of gear clash and how clutch release systems have an impact on this. Another possible reason for gear clash is due to **synchronizer** wear. There is a synchronizer assembly for each gear in both manual and DSG gear boxes. Their purpose is to prevent grinding or gear clash when shifting gears.

The role of the clutch release system, manual-clutch or dual-clutch style, is to completely disengage engine power to the transmission's input shaft during a shift/gear change. If engine power is not completely disengaged the synchronizer assembly can't slow down a gear's rotational speed in order for the selected gears to engage smoothly. The slowing down of a gear's speed is required for smooth shifting.

In other words, a synchronizer cannot perform its intended purpose if the clutch doesn't perform its job.

That being said, synchronizers can also be the problem of gear clash. At times a synchronizer ring/blocking ring can become worn and can't perform its job, which is to slow down gear rotating speeds once the clutch has disengaged engine torque from the transmission.

How can you determine whether it is a clutch release problem or a synchronizer issue?

Consider that if gear clash occurs when selecting any gear, or if it occurs while trying to select **1st** or **Reverse,** the problem is a clutch release system issue. This is because engine torque is still present at the transmission's input shaft.

When the clash problem is a worn synchronizer ring/blocking ring, gear clash will be particular to only one gear. For example, when a vehicle is driven all the gears inside the transmission are rotating and if a certain synchronizer ring can't slow down a particular gear's rotational speed adequately, grinding will occur.

Let's say that, while driving, a vehicle gear clash occurs only when 3rd gear is selected. In this case, the problem is likely that a **particular gear's synchronizer ring** or something associated only with that gear such as a synchronizer sleeve, the shift fork, or the gear's dog teeth.

You may initially try changing the transmission's gear oil in order to ensure that the synchronizer is properly lubricated but know that this is only an attempt and it may not be successful.

Quite often, the problem is either a worn synchronizer ring or a worn synchronizing 'cone.' The cone is part of a speed gear, and when they exhibit wear it means that a new synchronizer ring won't fix the issue. A new speed gear will be necessary and anymore these days such gears are difficult to come by. Basically, new gears are not available, only used gears.

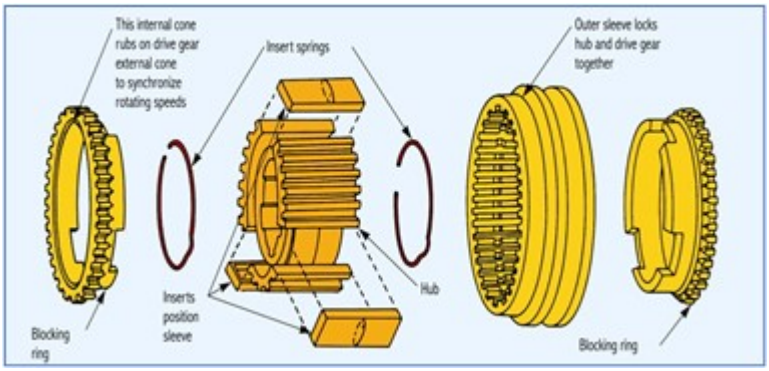


Figure 31: Synchronizer Assembly Breakdown

Figure 31 is a breakdown of a synchronizer assembly. This image does not show a speed gear, this is pictured to the right of the synchronizer image. The gray colored gear shows the cone, what the blocking ring rubs against in order to slow down the gears rotational speed when it is selected, and the dog teeth, the teeth that engage with the synchronizer sleeve when the speed gear is selected. Note the small almost triangle shaped teeth on this gear, these are the dog teeth and are the teeth that "grind" or "clash" due to a worn synchronizer ring.

Here is an explanation of each synchronizer assembly component:

Outer sleeve: The purpose of the sleeve, as stated in the diagram, is to connect a **gear** to the **hub**. When this connection is made, power is sent to the main shaft because the hub is splined to the main shaft.

Blocking Ring: This acts like a 'brake' to slow the gear down before the sleeve slides over it onto the speed gear connecting it to the hub.

Inserts or struts: These help to hold the sleeve in a particular gear or in neutral.

Insert spring: Insert springs push the keys outward against the sleeve so they keep the sleeve in neutral or in the engaged position with a gear.

Hub: This is central to all the other components of the synchronizer assembly. As mentioned, it is splined to the main shaft.

This 3:25 minute movie demonstrates all the details of how synchronizers work, including how the synchronizer ring rubs against a speed gear's cone.

Repairing Traditional Manual Transmissions

Having explained how synchronizers work, please understand that more and more manual transmissions **cannot be repaired** today because they are becoming obsolete. What this translates into is **part availability** and **technical skills.** Manual transmission parts are quite scarce. Simply buying and installing a set of synchronizer rings, which are often available, will not always cure a transmission's shifting issue. It's a popular philosophy, but in reality, when it comes to gears and synchronizers, it is usually discovered that there is more than one worn component inside the transmission once it has been disassembled.

Often, once a transmission has been disassembled other problems are discovered like chipped gear teeth, worn teeth, a worn shaft, or shift fork. Such parts are often not available. Today there are two options to fixing many manual transmissions, they are: Replace the transmission with a salvage yard unit (if a good one can be found) or send the original unit to a transmission shop who will likely send it to a nationwide rebuilding facility such as **Zumbrota** in Minnesota, **West Coast Standards** in California, **Jasper** Engines, or **Transmission** in Indiana. Before removing the transmission, make sure that the unit you wish to have repaired can be rebuilt. These nationwide rebuilders only rebuild certain transmission models. Manual transmission repair is something that many shops will not perform anymore.

In the case of **dual-clutch** transmissions, no one is rebuilding them. New car dealerships only sell remanufactured units which are available through car manufacturer resources.

Here is a tip that may **extend transmission life** in the event your manual transmission has a synchronizer problem: delay or take your time when shifting into the gear that has the gear clash problem. In other words, pause just before selecting the gear. This gives the synchronizer extra time to slow down the gear to produce a clash free shift.

In regard to clutch release systems, they are either cable or hydraulic type, hydraulic being the most common by far. Hydraulic systems are comprised of a clutch master cylinder and a clutch slave cylinder. The fluid used in hydraulic release system is **DOT 3** brake fluid.

Master and Slave Cylinders

As slave and master cylinders become worn with use, internal leaks can occur, which means the seal inside the cylinder starts to bypass fluid pressure whenever the clutch pedal is stroked. This cannot be seen externally. That being said,

clutch master and slave cylinders can also leak externally. When either type of leak occurs, hydraulic pressure cannot build up enough to adequately push the release bearing against the pressure plate's release levers in order to disengage the clutch disc properly. These hydraulic leaks cause excessive pedal free play.

When experiencing excessive clutch pedal free play inspect the **master cylinder's fluid** level. Whenever fluid is low check for a leak at both the **master cylinder** and **slave cylinder**. To inspect whether the clutch master cylinder is leaking, look inside the passenger compartment up under the dash. This is where the cylinder goes through the fire wall, which is near the clutch pedal's linkage. Any sign of fluid leakage at the clutch master cylinder means it is time to replace it.

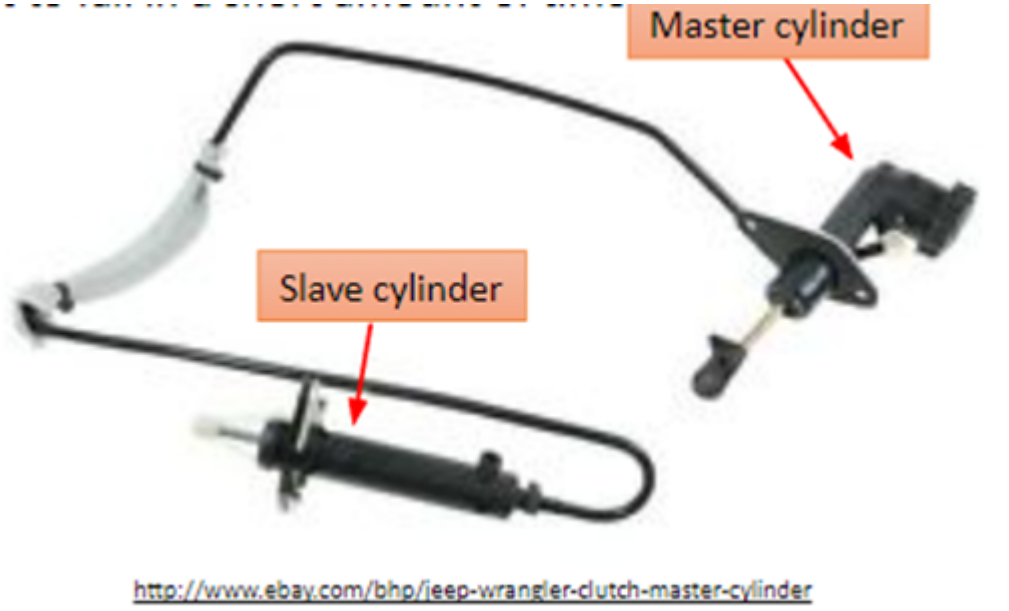


Figure 31: http://www.ebay.com/bhp/jeep-wrangler-clutch-master-cylinder

This image, Figure 31, is of a slave and master cylinder.

When inspecting slave cylinders for leaks look at or near the transmission's bell housing since this is where they are located. Once again, any amount of fluid leakage is not acceptable. Additionally, whenever **either of the two cylinders leak,** replace both of these components as a set. This is an industry standard and is not a dishonest approach. Whenever only one of the two cylinders is replaced, the new unit will build better pressure than the other, older unit, causing it to fail in the very near future.

Occasionally, the **hydraulic line** that connects the clutch and slave cylinder leaks. Visually inspect to see if the hydraulic line is leaking.

This next video demonstrates how a hydraulic clutch release system works. You only need to watch about 1:00 of this video (:30-1:30) from where it starts. This video also introduces what "concentric" slave cylinders are.

Bleeding Air from Hydraulic Components

When hydraulic components are replaced, "bleeding" air from them and the entire circuit will be necessary. The need for bleeding is because air compresses and fluids do not. Anytime a hydraulic circuit is opened or disconnected air enters the system and needs to be bled out.

A bleeder screw is usually located on the slave cylinder. A common approach to bleeding air from a hydraulic system is to bleed it **manually,** which means to:

1. Fill the system with DOT 3 brake fluid and leave the master cylinder lid off during the bleed process.

2. Pump the clutch pedal 40–60 times at a moderate speed. This allows much of the air to escape out the top into the master cylinder's reservoir.

3. Bleed more air out of the system by pumping the clutch pedal about 20 times and then hold the clutch pedal down for about 10 seconds. An assistant is needed to operate the pedal.

4. With the pedal held down, open the screw for only about 0.50 seconds, then close it.

Repeat the process a few more times, waiting about 10 seconds to open the bleeder after the pedal is held down. After each bleeding procedure, see if pedal resistance has increased. Repeat the process as necessary or try another type of bleeding method.

A second way to bleed is to **gravity bleed.** This is done by simply opening the bleeder and leaving it open, without operating the clutch pedal, with the system full of fluid. It usually takes a few minutes or more to see if fluid will push out air bubbles as fluid oozes out of the open bleeder. When using this method, follow it up with a manual bleeding procedure. Gravity bleeding won't work on every system. but it can, at times, speed up the bleeding process.

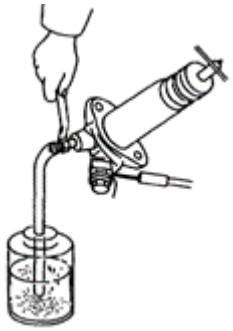


Figure 31: http://www.justanswer.com/car/1yodn-bleed-clutch-2000-daewoo-lanos.html

There are a few hydraulic clutch release systems, found on some GM S-10 pick-ups, that do not have a bleeder on the slave cylinder. This movie explains the best way to bleed these vehicles. The first four minutes will give you an idea of the procedure.

Below, Figure 32 is of a **concentric** slave cylinder. This one is one from an older Ford Ranger. These are unique for two reasons:

1. They are located inside the bell housing around the input shaft.

2. This type of cylinder includes the **release bearing.**

The cylinder and bearing are combined into one unit. The hydraulic line that operates these cylinders and the bleeder screw are both accessed through a side hole in the bell housing. The disadvantage to these cylinders is when they leak. When this type of slave cylinder fails the transmission will have to be removed in order to replace it. Concentric slave cylinders were used on both F-150s and Rangers.

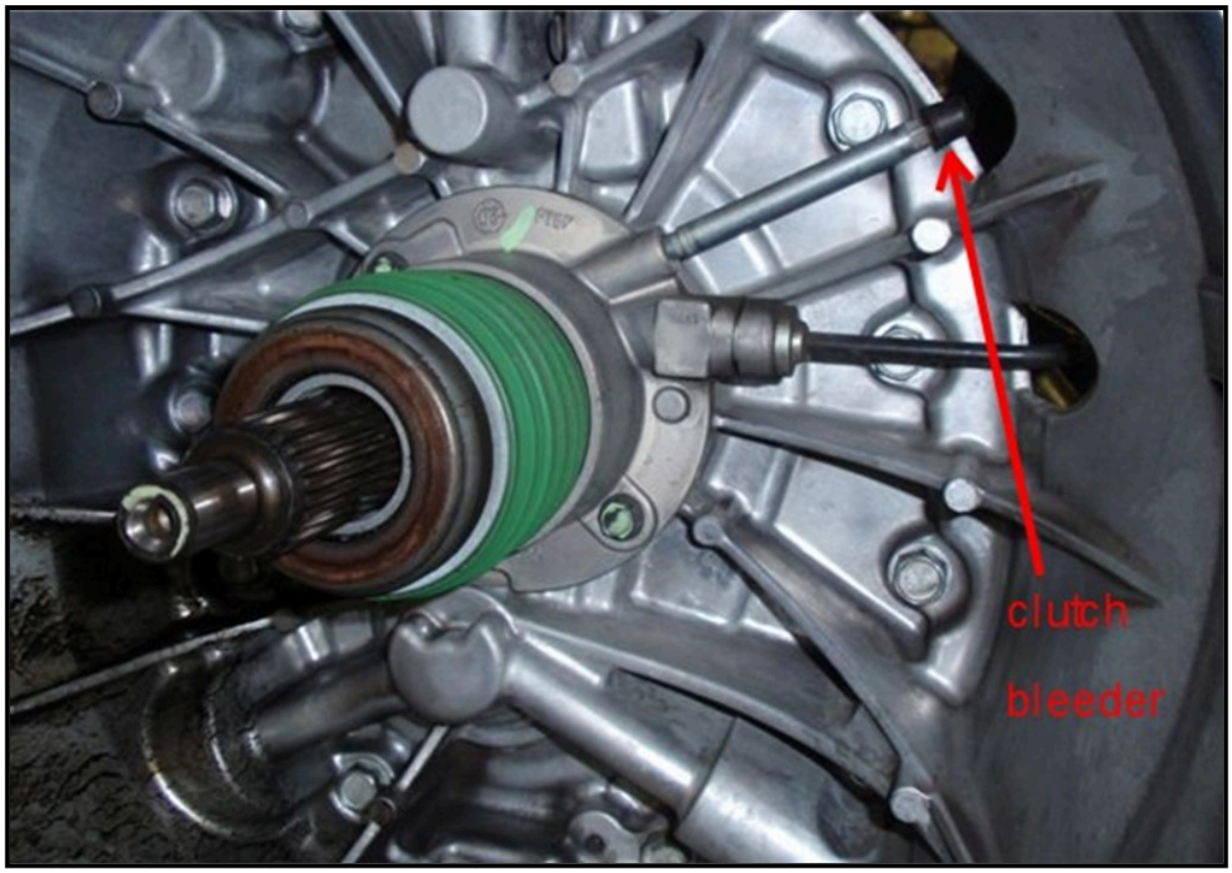


Figure32: http://www.camaro5.com/forums/showthread.php?t=72623

You can try bleeding these units by pumping the pedal 50+ times, then hold the pedal down for 10 seconds. After, have an assistant open and then quickly close the bleeder. However, there are times when these systems will not bleed easily.

Here is a video that describes how to bleed this application when they will not bleed successfully using the manual bleeding method.

Manual Transmission Power Flow and Operation

The last segment of this chapter is comprised of some videos that demonstrate manual transmission power flow and operation. Incidentally, these power flow and gear ratio explanations apply to both manual and direct-shift gear boxes.

This video "**Manual Transmission & Trans-axle operation & gear ratios**" is about 40 minutes in length. This video is more effective than reading text.

Segment 1: view 0:00 – 11:47 Parts and Power flow.

Segment 2: view 11:48 – 16:25 Synchronizers.

This next video "**Manual transmission InterLock operation - Ford 5 speed**" demonstrates shift linkage, what a transmission interlock linkage system is, and how they operate.

Segment 3: view full 2:29 video.

The following is the same movie that was used for Segments 1 & 2. This time however, you only need to view Segment 4. It demonstrates **gear ratios**.

Segment 4: view16:26 – end of video.

Five-Speed Transmission

Now that you have watched the transmission videos this graphic (Figure 32) should be easier to understand. This is a five-speed manual transmission.

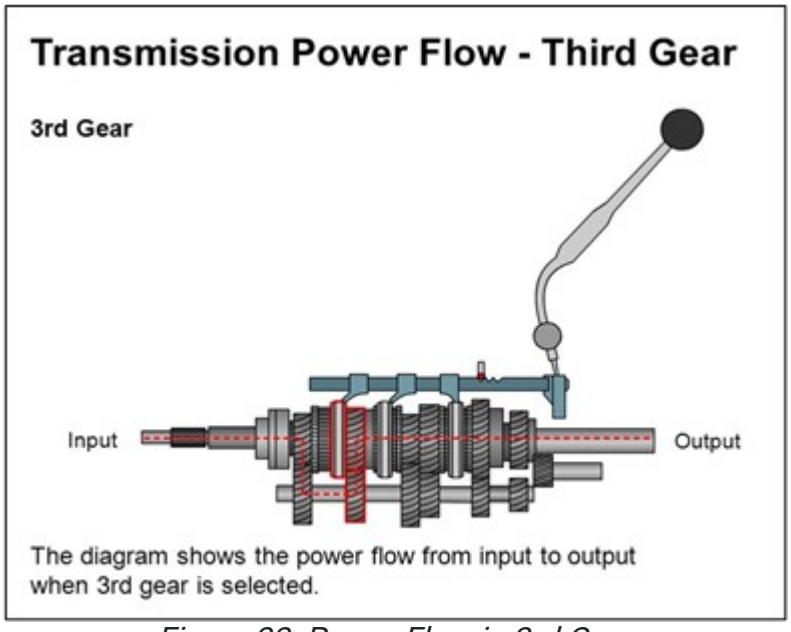


Figure 33: Power Flow in 3rd Gear

This graphic is a great illustration of transmission power flow of all five ranges and reverse. This illustration should be a review of what you have learned in the videos.

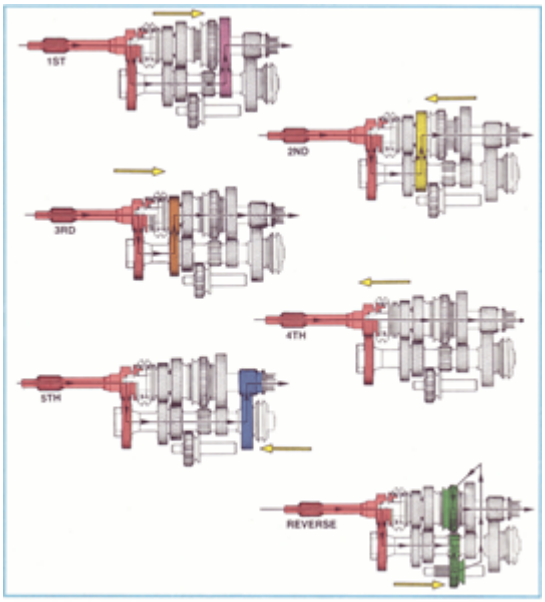


Figure 1-7, T5 Powerflow.

Figure34: https://www.germancarforum.com/threads/requesting

This is a diagram of the **three** shafts that make up a manual **transaxle**:

1. Reverse idler.
2. Input shaft.
3. Output shaft.

One thing that is not shown here is the **final drive ring gear**. The output gear meshes with the final drive's ring gear (see the **red arrow** in Figure 13).

The final drive gear is what sends power to the CV drive shafts.

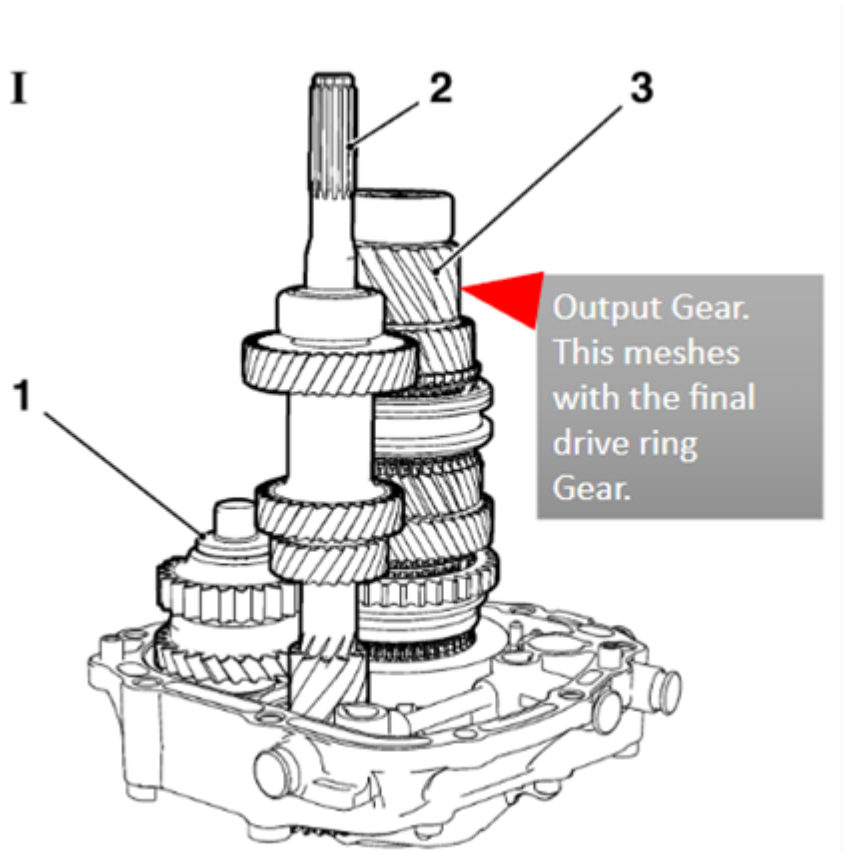


Figure 35: https://gm.oemdtc.com/4243/crunching-or-poor-selection-of-reverse-

These next two videos are here and will help you pass ASE exam questions. They describe power flow and some common noises that transmissions can make when various bearings become worn.

Power Flow: Introduction to Manual Trans Power Flow and Gear ID

Identifying Worn Bearings by Sound: Noises Associated with Manual Transmissions

Skip Shift Solenoid and Shift Blocking

One last item that ASE will test your knowledge of is what a **skip shift** solenoid is. This is a feature used on Tremec's TR6060 and other Tremec manual transmissions. The system had its beginnings on the T-56 six-speed manual. Tremec is a respected transmission manufacturer that makes both manual and dual-clutch gear boxes. Newer six-speed manual units are found in some Ford Mustangs, Chevrolet Corvettes, Camaros, as well as some Dodge Challengers and Vipers. Shift Blocking or Skip Shift technology is something that Tremec had to incorporate into their transmissions in order to meet emission standards.

Shift blocking is done by means of a solenoid. The idea behind this computer-controlled device is to improve fuel economy ratings in the Corporate Average Fuel Economy (CAFE) System by preventing the driver from shifting from 1st to 2nd and 3rd gear when shifting sequentially into higher gears. During light throttle driving the solenoid **activates** and prevents 2nd and 3rd gear shifts. This forces the driver to shift from 1st to 4th gear. This really is not a problem with the V-8s that power these cars.

This system turns off or **deactivates** when the vehicle is driven somewhat faster than city-type driving. The system will not activate at all during higher engine loads / throttle openings.

Under wider throttle openings the driver can shift through all the transmission's gears and use any desired shift pattern. This system is often deleted or eliminated by individuals who want full control of shifting.

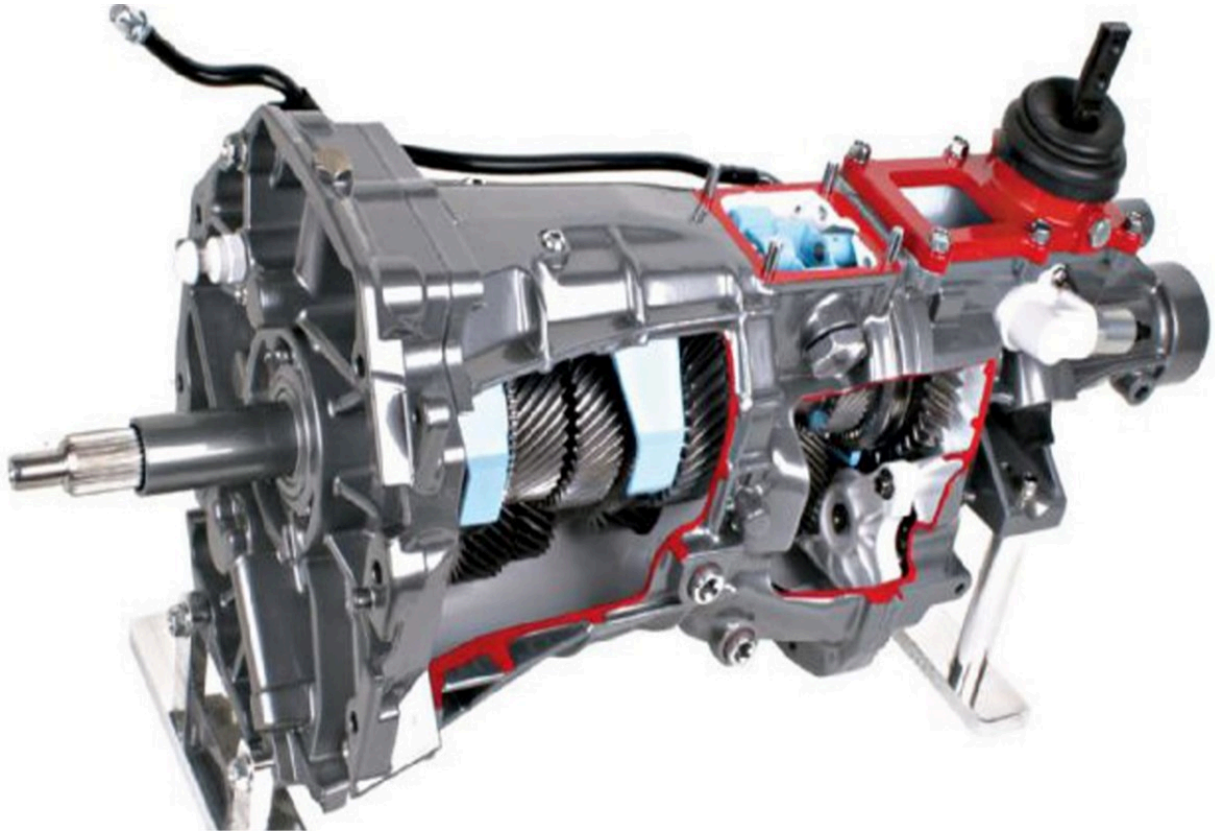


Figure 36: https://www.tickperformance.com/tick-performance-level-4-magnum-tr-6060-900rwtq-for-98-02-camaro-firebird/

Here are some videos that demonstrate what **Shift blocking** is.

Shift Blocking: Dodge Challenger Six-Speed Manual Skip Shift Demonstrated

Shift Blocking: 2008-2019 Challenger SR Performance Skip Shift Eliminator Review & Install

Some take-aways from these videos are:

- The solenoid **activates** at vehicle speeds between 18–22mph and less than 25% throttle. This forces a 1–4 manual shift.
- This system saves the number of times you need to shift the transmission during stop and go type traffic.
- The light on the dash will act normally even when the system is bypassed.

Here are two ASE practice Skip Shift-related questions:

1. A vehicle equipped with a six-speed manual transmission will not shift into 2nd or 3rdgears. While the vehicle is accelerating from a stop, scan tool data indicates that engine temperature is warm (good), throttle angle is 55%, and there are no DTCs.

- [ ] A mechanically stuck-ON skip shift solenoid.
- [ ] A short to ground in the TPS sensor wire.
- [ ] A restricted CAT converter.
- [ ] A worn shifter linkage bushing.

2. A vehicle with a manual six-speed transmission can be shifted only from 1st to 4th gear under light acceleration from a stop. Under heavy acceleration, the transmission can be shifted through every gear. Which of these could be the cause?

What is your question?

- [ ] A normal active, skip-shift system.
- [ ] Low transmission fluid level.
- [ ] A worn 1st gear shift gate.
- [ ] A worn the gear shift gate.

Conclusion

In conclusion, remember that the internal combustion engine is the power source of a vehicle and that a transmission alters the engine's power so that it can effectively and efficiently deliver torque to the drive wheels under a wide variety of conditions.

An engine's torque and horsepower increase as engine RPMs increase, but only to a certain point. Once engine RPMs exceed horsepower and torque peak output, power output starts to decrease. The principle is engineers try their best to match appropriate gear ratios to an engine's torque capability. They program optimum transmission shift timing events to achieve the best power delivery to the drive wheels.

Transmission gear ratios and final drive ratios are designed to match engine power to provide the most efficient torque to a vehicle's drive wheels. Low gears like 1st, 2nd, and 3rd, or high ratio numbers, allow the engine to deliver good torque to get the vehicle moving and to gain good speed from a stop. High gears, such as 4th, 5th, and 6th, or low ratio numbers, allow the engine to operate at lower RPMs, so the vehicle can be propelled efficiently during high speeds.

Figure 15: https://www.brakeandfrontend.com/dual-clutch-transmission-diagnostics/

Review Questions: Section 1

1. Manual and dual-clutch transmissions are similar in that they both use…
2. Which transmission type has two input shafts?
3. Reasons for DSG transmissions is to improve…
4. When a DSG shifts into 2nd gear, what else occurs?
5. If the clutch that controls the even numbered gears were to fail on a DSG, could the vehicle still move?
6. How quick does a dual-clutch transmission complete a shift?
7. When might a TCM re-flash be necessary on a dual clutch transmission?
8. Why drive a DSG a bit aggressively?
9. Some dual-clutch transmissions have a wet clutch, clutch module. What is the purpose of the oil inside the clutch assembly?
10. With the engine running, what manual clutch components operate or revolve during clutch is disengagement?
11. What clutch components quit spinning when the clutch is engaged?
12. What clutch component smoothens crankshaft rotation?
13. When the clutch pedal is released, it is said that the clutch is…
14. The driving members of a manual clutch system are…
15. The driven member of a manual clutch system is…
16. Which type of flywheel can be resurfaced?
17. Which type of flywheel has two members separated by stiff springs?
18. Dual-mass flywheels reduce…

19. What is the run-out specification limit in regard to flywheel warp?
20. Oil contaminated clutch discs can cause…

Answers: Section 1

1. Helical gears and synchronizer assemblies.
2. Dual-clutch or DSG's.
3. Fuel economy and to eliminate power loss to drive wheels during upshifts.
4. 1st gear is released, and 3rd is pre-selected.
5. Yes, it may only have 1st gear.
6. .008 seconds or less.
7. When shifts are not normal.
8. To prevent rapid clutch wear.
9. To apply the clutch, to cool it, and to lubricate it.
10. Flywheel, clutch cover/ pressure plate, the pilot bearing, and the throw-out bearing.
11. Throw out bearing and the pilot bearing.
12. The flywheel.
13. Engaged.
14. Flywheel and pressure plate.
15. Clutch disc.
16. One-piece flywheels.
17. Dual-mass.
18. Engine to transmission vibrations and their harmonic noises.
19. .004" maximum.
20. Irregular or pulsating clutch issues.

Review Questions: Section 2

1. True or False: A clutch is said to be disengaged when engine power is delivered to the transmission.
2. List at least three things that can cause clutch pedal pulsations…
3. Reasons for clutch failure include…
4. How much clutch pedal freeplay is normal, typically?
5. What is a primary reason for too much clutch pedal freeplay?
6. Hydraulic clutch master and slave cylinders can leak two different ways. List them.
7. What is the problem of having too little clutch pedal free play?

8. What bearing will make noise, when worn, anytime the clutch is engaged?

9. How much of a leak can a clutch master cylinder exhibit and still be considered in good condition?

10. What bearing will make noise, when worn, only when the clutch pedal is pressed completely down?

11. What transmission bearing will make noise only when the vehicle is moving?

12. What should occur when the parking brake is applied, the transmission is 2nd gear, and the clutch is released during relatively high RMPS?

13. What can cause manual clutch binding? To not fully release and apply?

14. Whenever gear clash is particular to one specific gear, what is often the problem?

15. Why is a dual clutch transmission's release type bearing more correctly called an 'apply bearing'?

16. Before removing a manual transmission for a rebuild what should you make sure can be done before removing it?

17. When bleeding a hydraulic clutch release system, how many pumps of the pedal should be done for each bleeding procedure?

18. After pumping the clutch pedal and then holding it down, during bleeding, how long should you wait to open the bleeder?

19. True or False: Manual transmission power flow through 4th gear goes down to the counter shaft and then up to the main shaft.

20. The skip shift feature, as used on modern manual transmissions, only operates under light engine loads at what vehicle speeds?

Answers: Section 2

1. False.

2. A warped clutch disc, oil contamination on the disc, and bent pressure plate levers. 4th, a warped flywheel.

3. Too heavy of towing, poor clutch operation skills, and aggressive driving.

4. ½ inch / 13mm approx.

5. Leaking slave and/or clutch master cylinders.

6. Internal and externally.

7. Grinding of gears during shifts and eventual damage to transmission gears.

8. Transmission input shaft bearing.

9. Pilot bearing.

10. None, no leakage is acceptable.

11. Transmission output shaft bearing.

12. Engine should stall out / die.

13. A rough or binding condition that exists between the release bearing and the sleeve it slides on.

14. Synchronizer wear for the particular gear.

15. It works the opposite of a manual clutches' throw-out bearing.

16. That parts or a reman unit are available.

17. 20 pumps.

18. 10 seconds.

19. False.

20. Speeds between 18-22 mph.

Sources:

https://mobilityforesights.com/product/dct-transmission-market/