

Clutches

By David Wolever

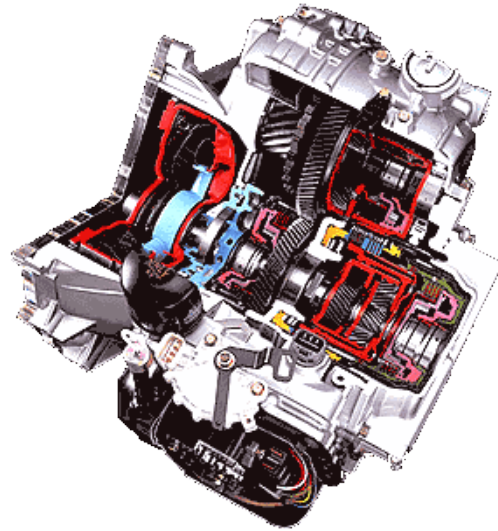
For M. Franzen

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With the increasing popularity of vehicles with automatic transmission, the number of people who know what a clutch is, let alone how one works, is slowly dropping. The reason for this may seem obvious at first – there is no clutch on automatic vehicles. This could not be farther from the truth. While there is not a clutch peddle in automatic vehicles, they – like everything else with a combustion engine – have one (actually, they have four, but more on that later). To fully understand why all combustion engines must have a clutch, one must understand how a combustion engine transmits power.

To transmit power efficiently, an engine must use a gearbox. A gearbox takes the high rpm, low torque output from the engine and produces an output low rpm (low being relative – an engine can rotate at thousands of rotations per minute and the gearbox may reduce this to hundreds) and higher torque. Some times, one gear ratio is all that is required, but in application such as motor vehicles, where the output must be high-torque some times, and high-rpm others, more than one gear ratio is required.



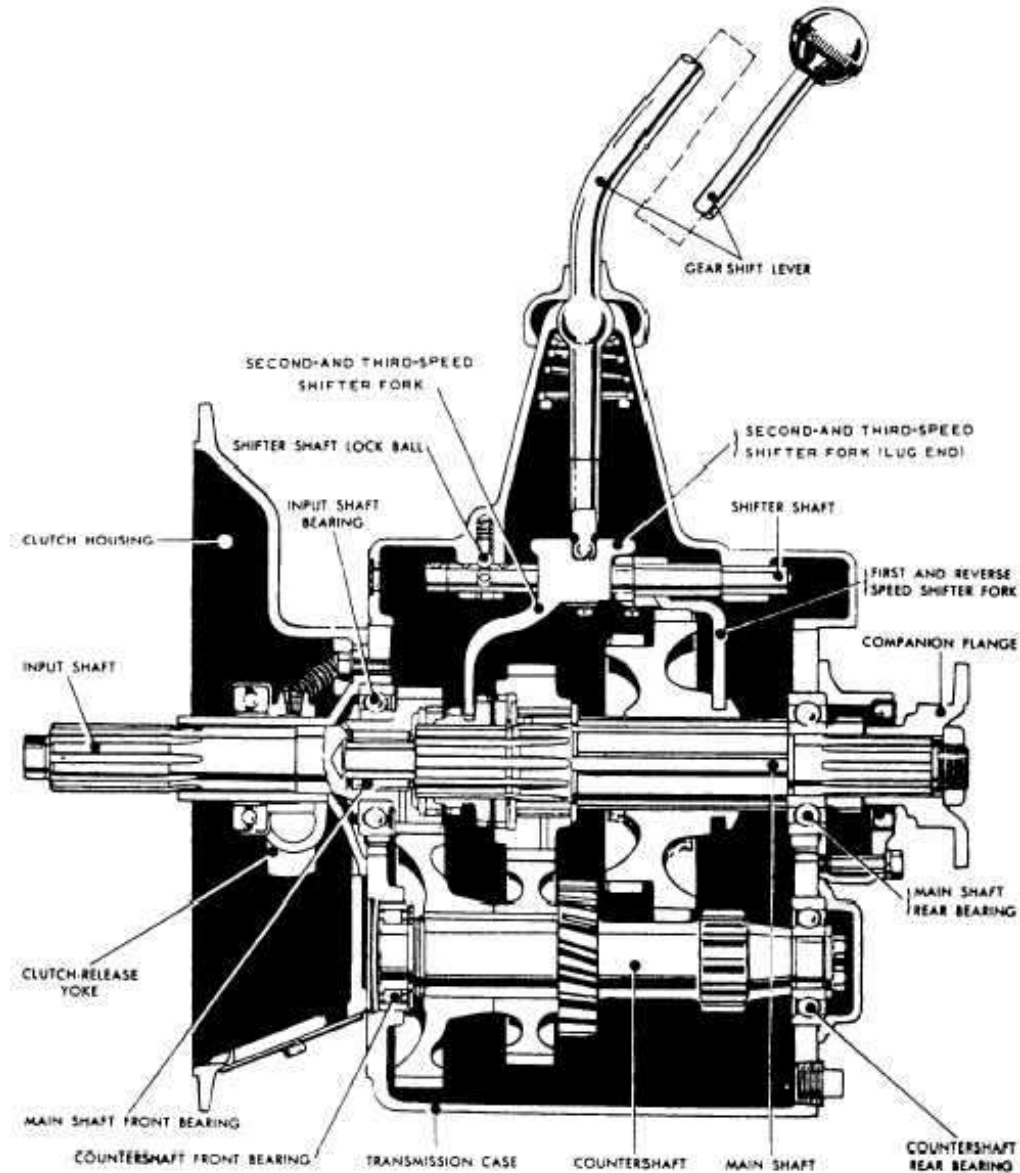
IVNECS-II automatic gearbox

http://www.mivec.co.uk/q_and_a/invecsiiiautogearbox.gif

When more than one gear ratio is required, there must be a system in place to temporarily disengage power from the engine to the gearbox while the gears change. This is so that the gears do not get worn down as they are moved in to place while spinning at very high speeds. The system responsible for this is the clutch.

In a normal car with manual transmission, there are two important parts. First, there is the gear shift lever. This

is how the driver selects which gear he or she wants to be in. When the driver moves it, it physically moves the



Typical manual shift transmission

http://www.tpub.com/content/engine/14081/img/14081_52_1.jpg

gears inside the transmission. The second part of the system is the clutch. This is the part which temporarily disengages power from the engine. This type of clutch works by pressing two disks together – one connected to the engine (the flywheel) and one connected to the gearbox (the clutch plate). When your foot is off the clutch peddle, springs (in the form of a diaphragm) push the pressure plate against clutch plate, which pushes against the



Clutch Plate

<http://www.profixauto.com.au/images/misc/clutch.jpg>

flywheel. When the clutch plate is being pushed against the flywheel, the friction between the two plates causes the power from the engine to be transmitted into the gearbox. When the clutch peddle is pressed, the diaphragm is pushed in, pulling the pressure plate away from the clutch plate, which in turn lets the flywheel spin independently of



Diaphragm and pressure plate (top)



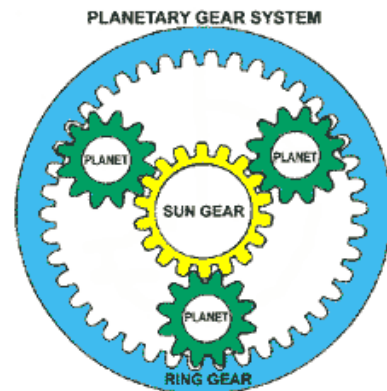
Diaphragm and pressure plate (bottom)

http://wac.addr.com/auto/obs/clutch/stock_pressure_plate_inside.jpg

the clutch plate. Note the springs on the clutch plate – these help reduce the shock when the clutch engages.

These are not the only types of clutches on a car, however. Things like the compressor for the air conditioner and engine-driven cooling fan use clutches to connect and disconnect from the engine's power. A car with automatic transmission has even more clutches! This is because of the way automatic gearboxes work.

Automatic gearboxes use a combination of planetary gear sets. A planetary gear system uses a combination of gears, any of which can be driven or fixed to produce different amounts of torque. For instance, if the "sun" (center) gear is being driven and the ring gear is fixed, the planet gears will be orbiting more slowly (increasing torque), or if the orbit of the



http://www.familycar.com/classroom/Images/Trans_Planetary.gif

planets is being driven and the sun is fixed, the ring will be moving faster (increasing rpm). Automatic engines have two of these "planetary systems" connected to each other, and clutches are used to control which part of the gearbox is stationary and which is moving.

In smaller engines, such as those powering go-karts, chain saws and weed whackers, a different type of clutch is used. For these applications, the clutch is used to allow the engine to idle at a low speed with out powering the output. The type of clutch used here is called a centrifugal clutch. Centrifugal clutches work slightly differently than those in cars, but still operate on the same principle of friction. Centrifugal



Centrifugal Clutch

<http://static.howstuffworks.com/gif/chainsaw5.jpg>
clutches have two, four, six or more friction pads (or shoes) held against the output shaft from the engine with springs. When the engine is running at low speeds, there is not enough centrifugal force to pull these pads out so they can not make contact with the outer drum, which is connected to the gearbox. When the speed of the engine increases, so does the centrifugal force acting on the shoes. Eventually the centrifugal force overcomes the force of the springs holding the shoes in and they are pulled out against the drum. The friction between the drum and the shoes then causes the drum to start spinning, transmitting power to the gearbox. Auto-



Yo-yo with a clutch

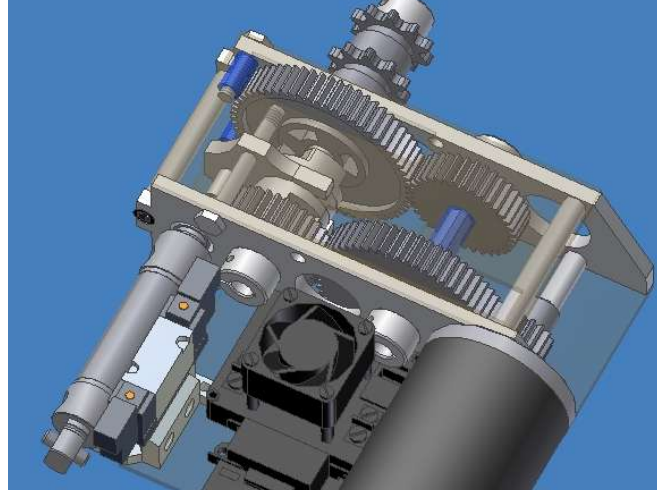
<http://fatpigeon.com/img/products/4754.gif>

return yo-yos have a similar mechanism, except the centrifugal force pulls small ball

bearings away from the axle, allowing the yo-yo to spin freely. When the yo-yo slows down, the ball bearings are pushed back in to place by springs, locking the axle and causing the yo-yo to return. Who knew something so much fun could also be so high-tech.

Robots are lots of fun too. Traditionally, they are driven with electric motors and single-speed gear boxes, but there is still the possibility of employing a multi-speed gear box.

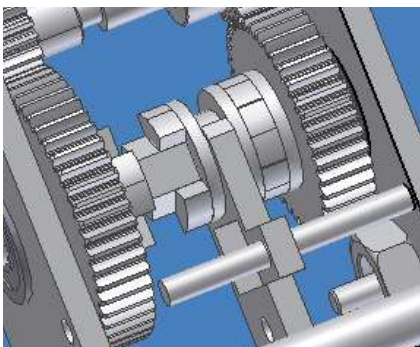
Multi-speed gearboxes on robots take many forms due to the great number of possibilities. The most common way to shift gears on a robot is by powering



Robot gear box

<http://www.chiefdelphi.com/pics/bin/109509702999.jpg>

a hexoginal shaft that has been rounded out at both ends. Along the center of the shaft is a cylinder with notched ends which is driven by the axle (hexoginal shaft). On either end of the axle there are free spinning gears who's sides are notched to match that of the shifting cylinder in the center. To change gears, the shifting cylinder is



Robot clutch

<http://www.chiefdelphi.com/pics/bin/109745257538.jpg>

moved to one side of the gearbox or the other, making contact with the notches on the gears. This drives the gears, which then drive the rest of the gearbox. While this is not the only way robots can shift gears, it is by far the most common.

Now you understand why clutches are everywhere and we wont be rid of them any time soon. It is a true travesty that more people do not understand them.

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General Clutch Information

ED & D Second Edition

Cecil Jenson

Pages 339, 340