Automatic Transmission Basics

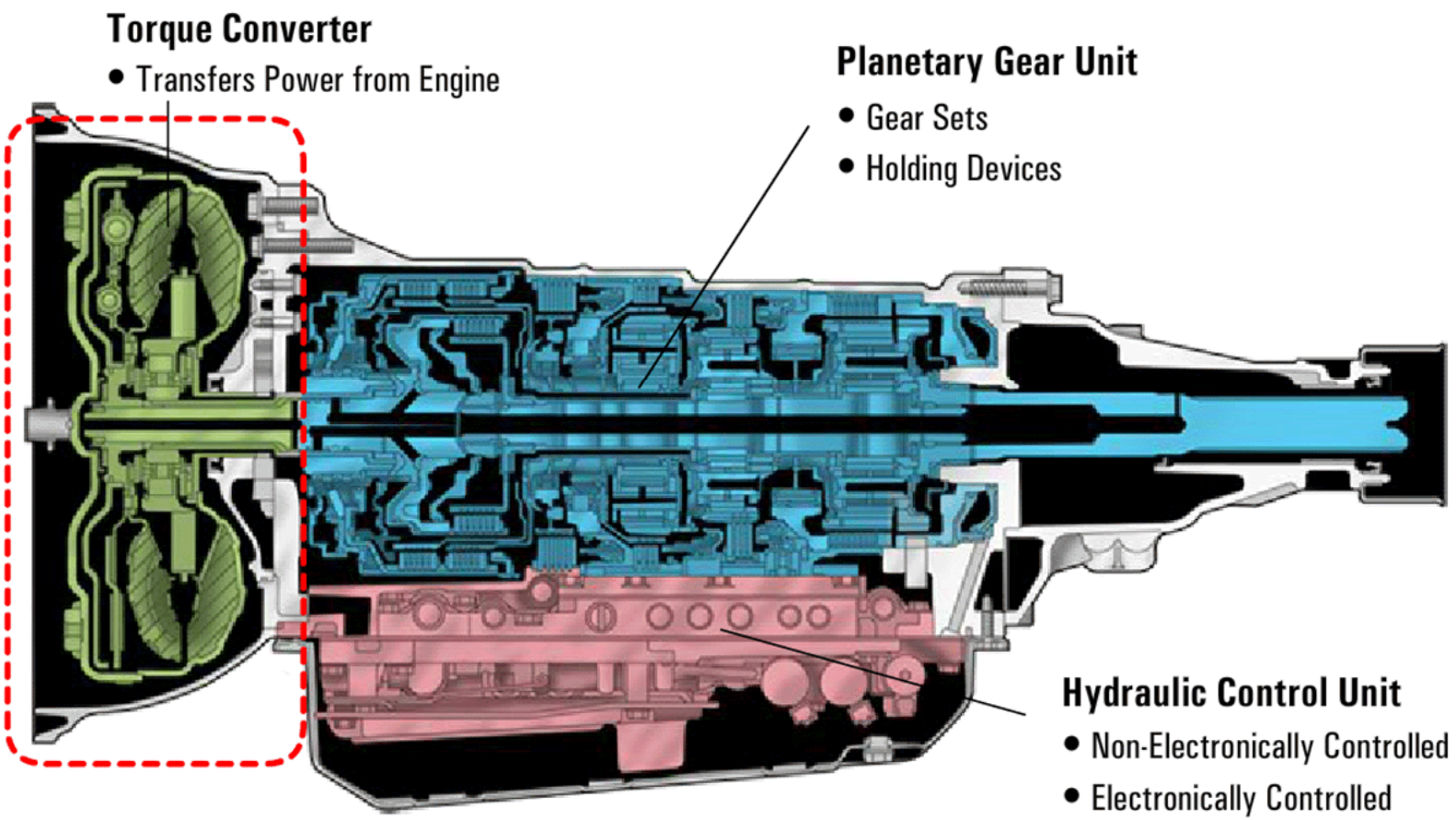
Automatic Transmissions/Transaxles contain
3 Major Components or Systems

1) Torque Converter

2) The Planetary Gears and holding devices

4) The Hydraulic Controls

Major Components



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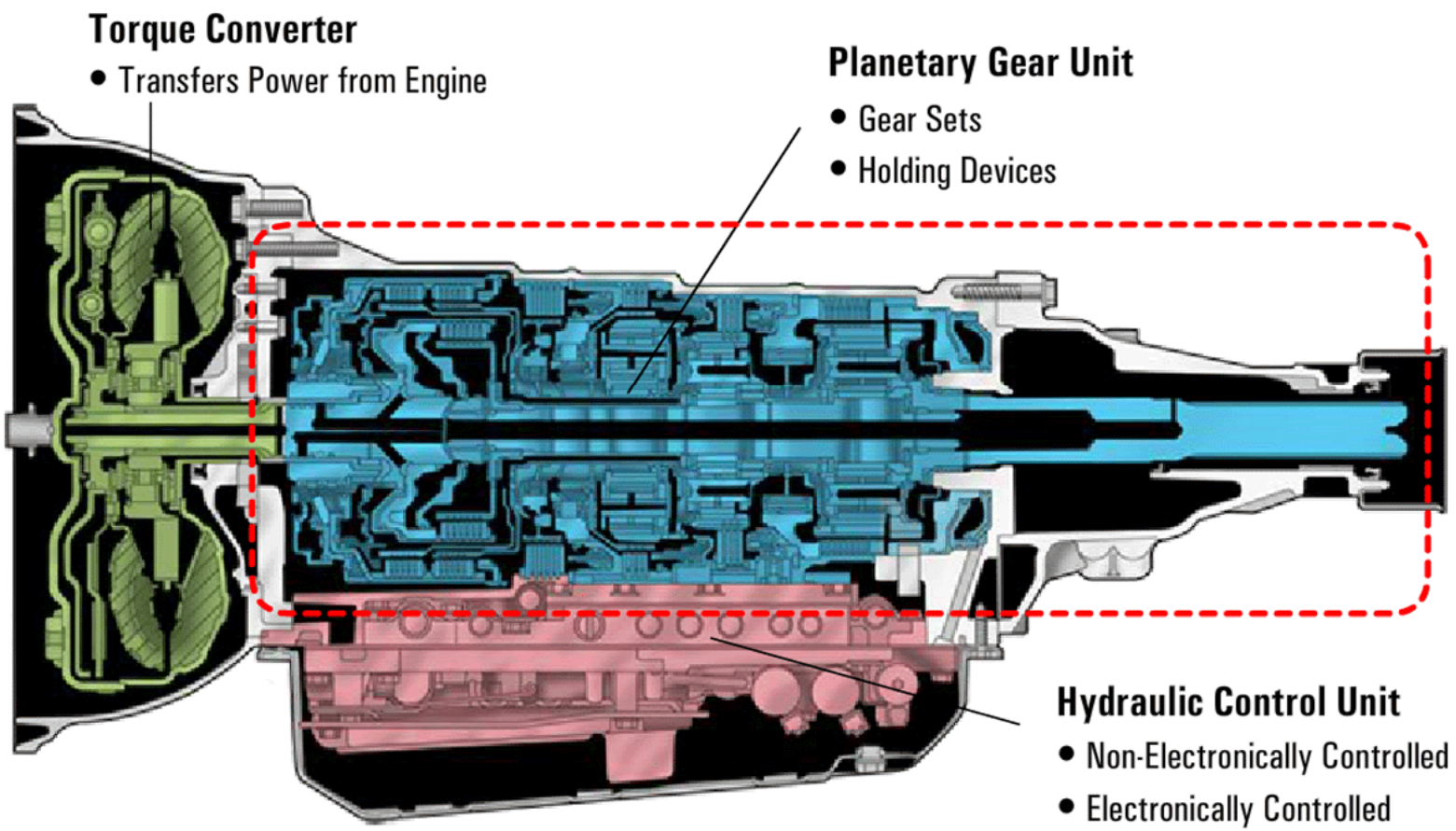

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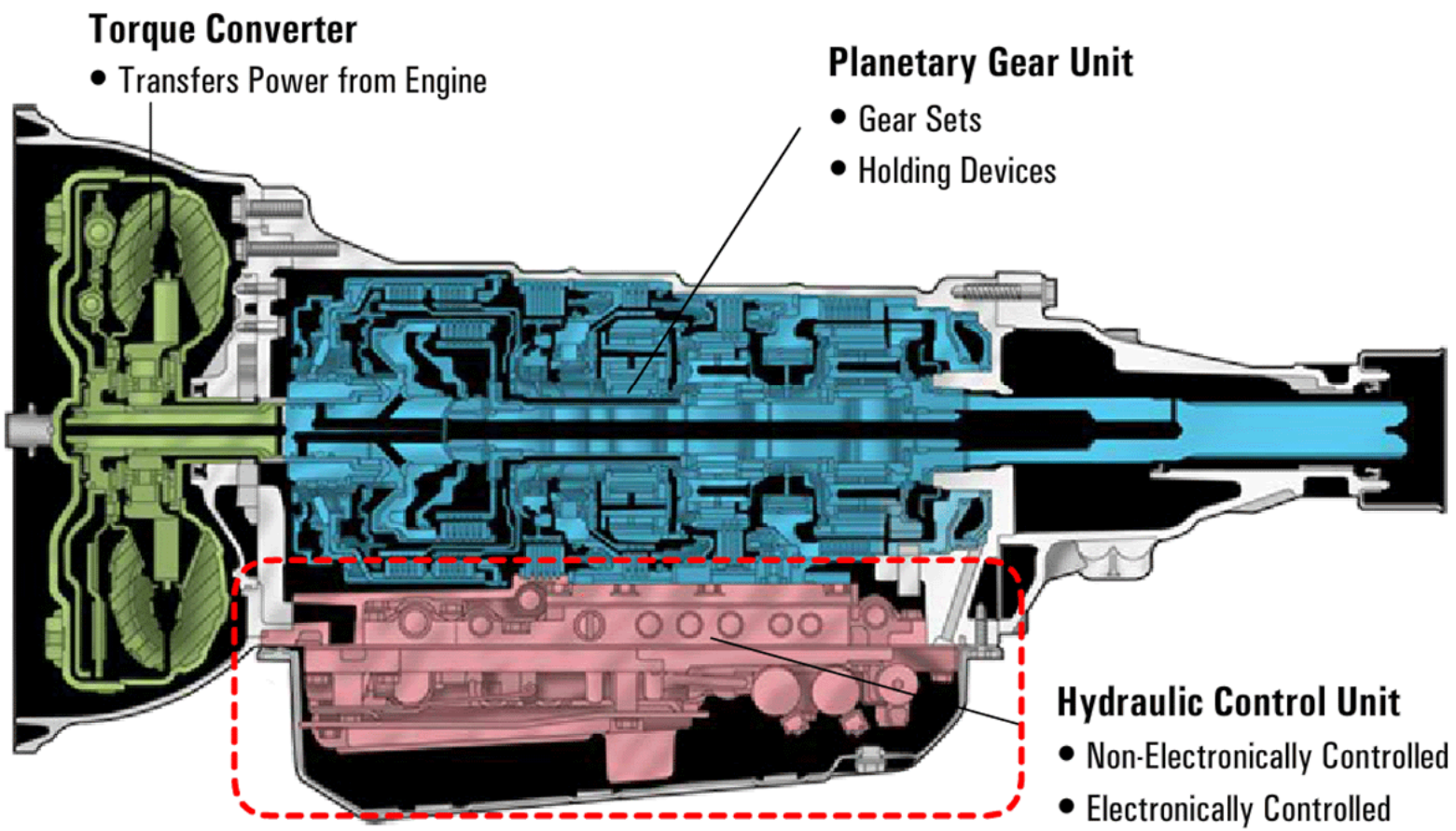


Selecting the Proper ATF is CRITICAL

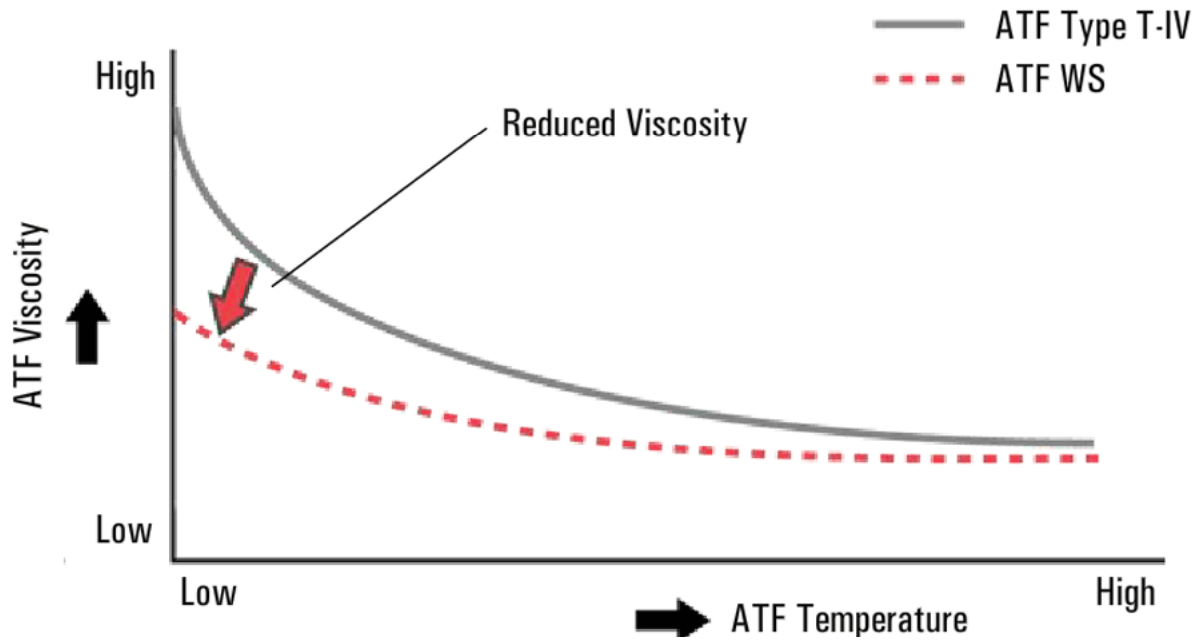
Mixing fluids can ruin a transmission

Always look up and use specified fluid

ATF

Transmission fluid has three major functions:

- Lubricate, clean, and cool
- Transmit torque
- Transmit pressure



Types of Toyota ATF

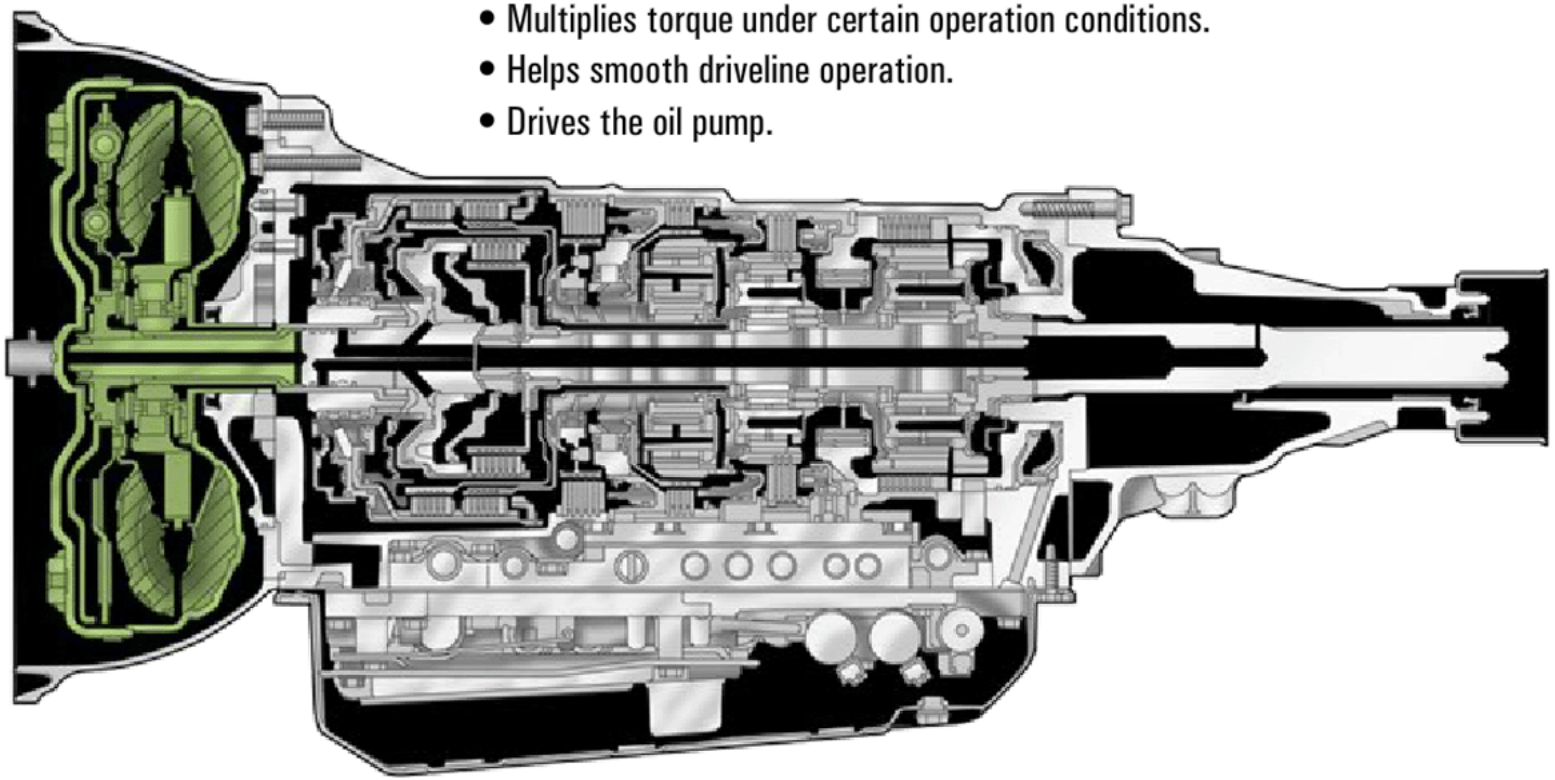
- WS (World Standard)
- Type T-IV
- Type T
- Dexron III
- Type F

It is vital to use the correct ATF. Fluid variations include:

- Viscosity
- Coefficient of friction
- Additives
- Compatibility with seals

Torque Converter

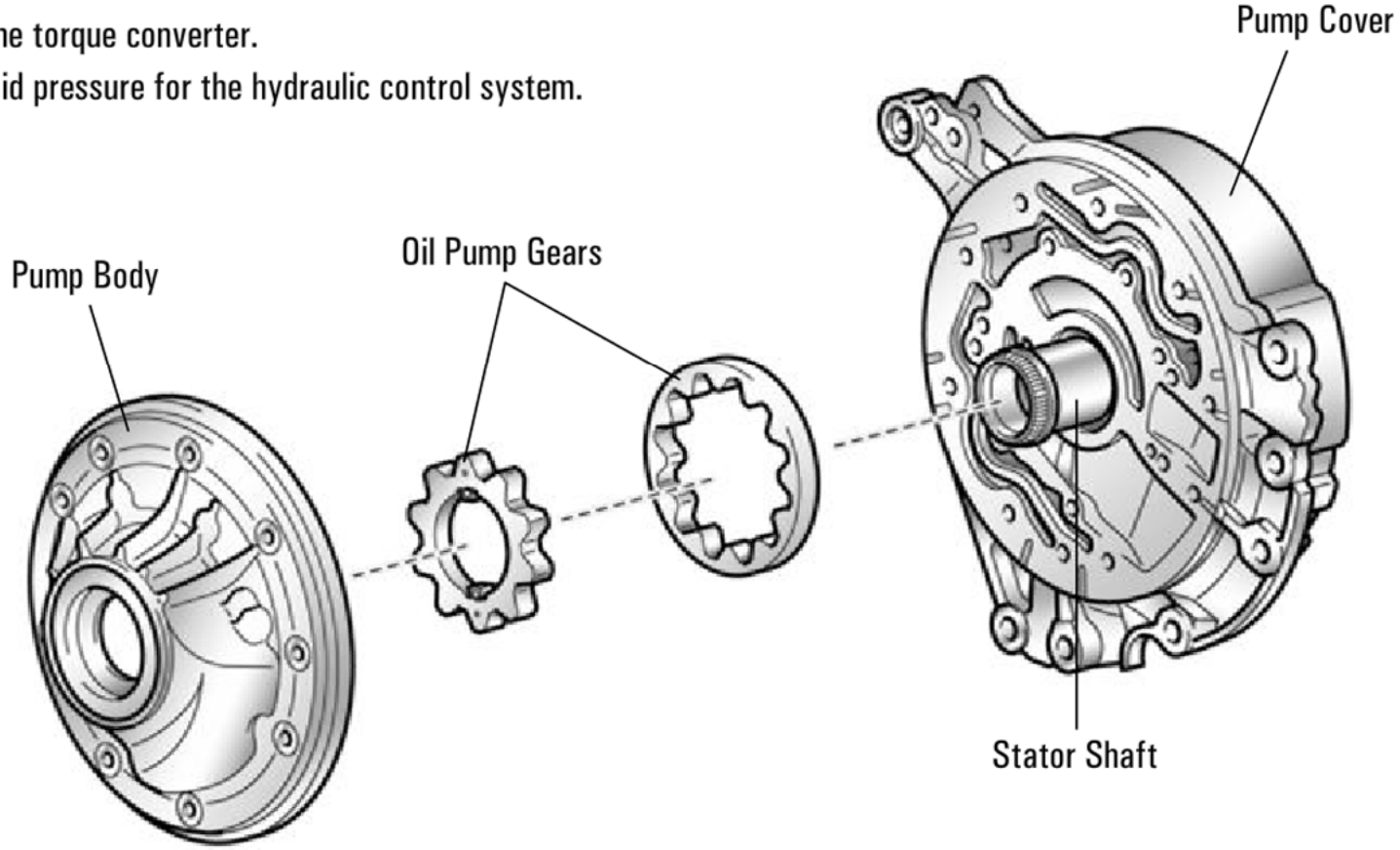
- Automatically transfers engine torque to the automatic transmission input shaft.
- Multiplies torque under certain operation conditions.
- Helps smooth driveline operation.
- Drives the oil pump.



Oil Pump

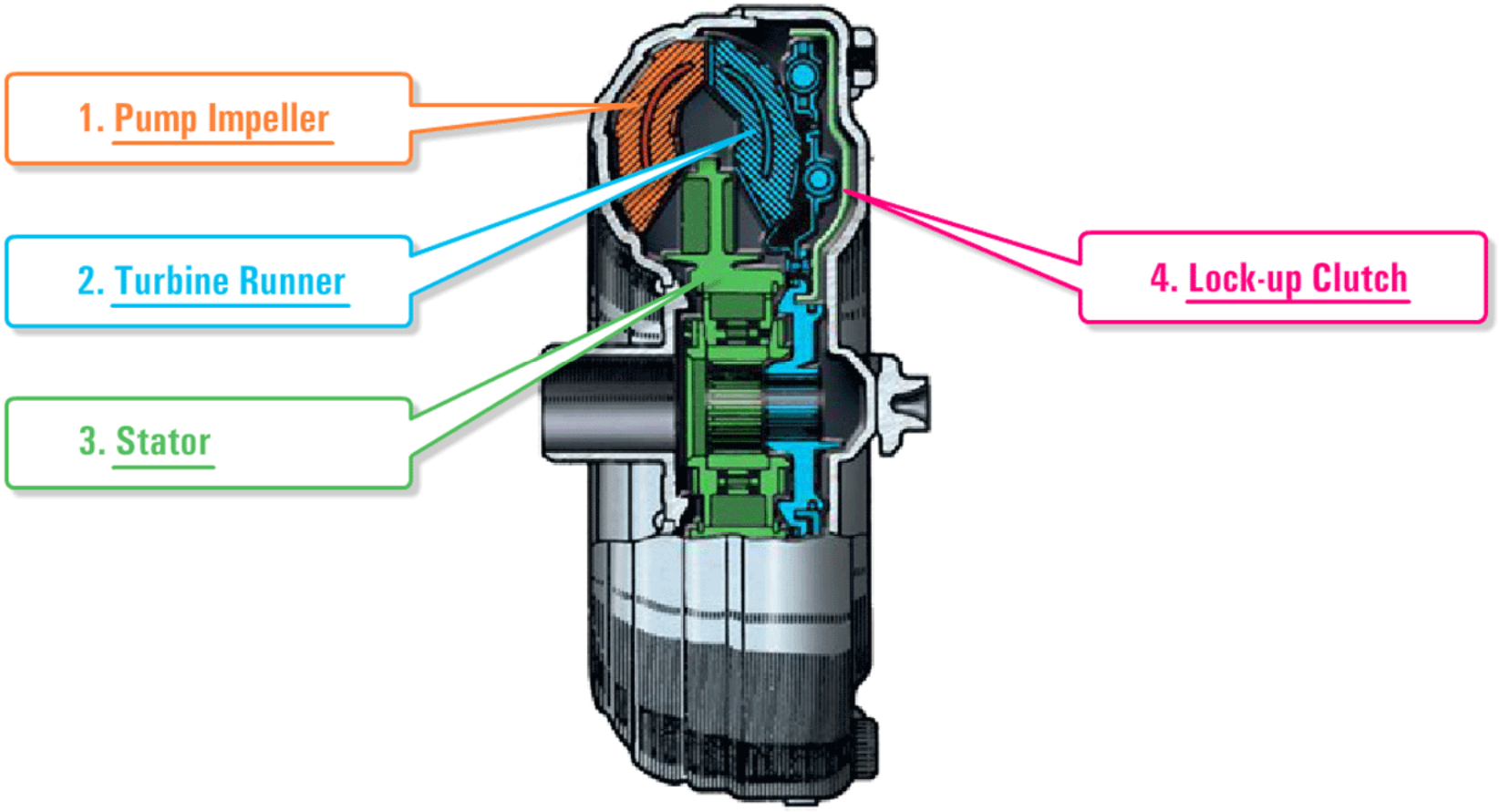
The oil pump is the “heart” of an automatic transmission.

- Driven by the torque converter.
- Supplies fluid pressure for the hydraulic control system.



Torque Converter

Components and Operation



Watch animation of Torque Converter at
https://www.youtube.com/watch?v=z5G2zQ_3xTc

Torque Converter

The **Impeller** is also called the Pump

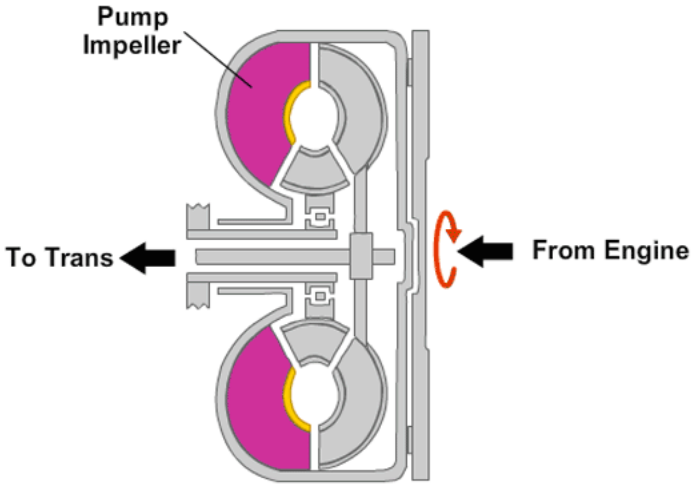
Impeller turns with the engine crankshaft

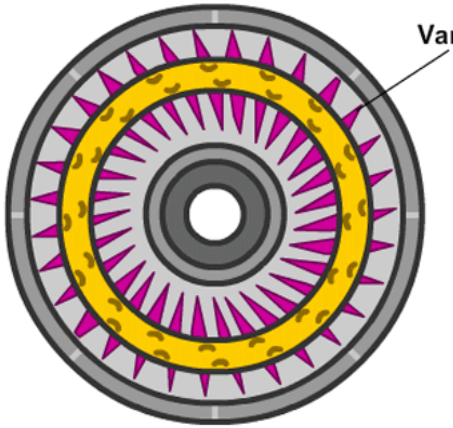
The **Turbine** is driven by the centrifugal force of the A.T.F.

The Turbine is splined to the transmission input shaft

When vehicle is stopped and in gear,
the impeller turns and the stator does not.

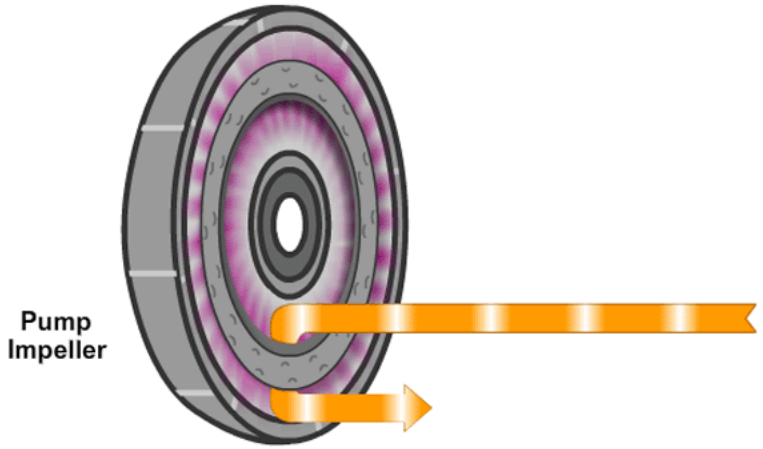
Torque Converter – Impeller or Pump



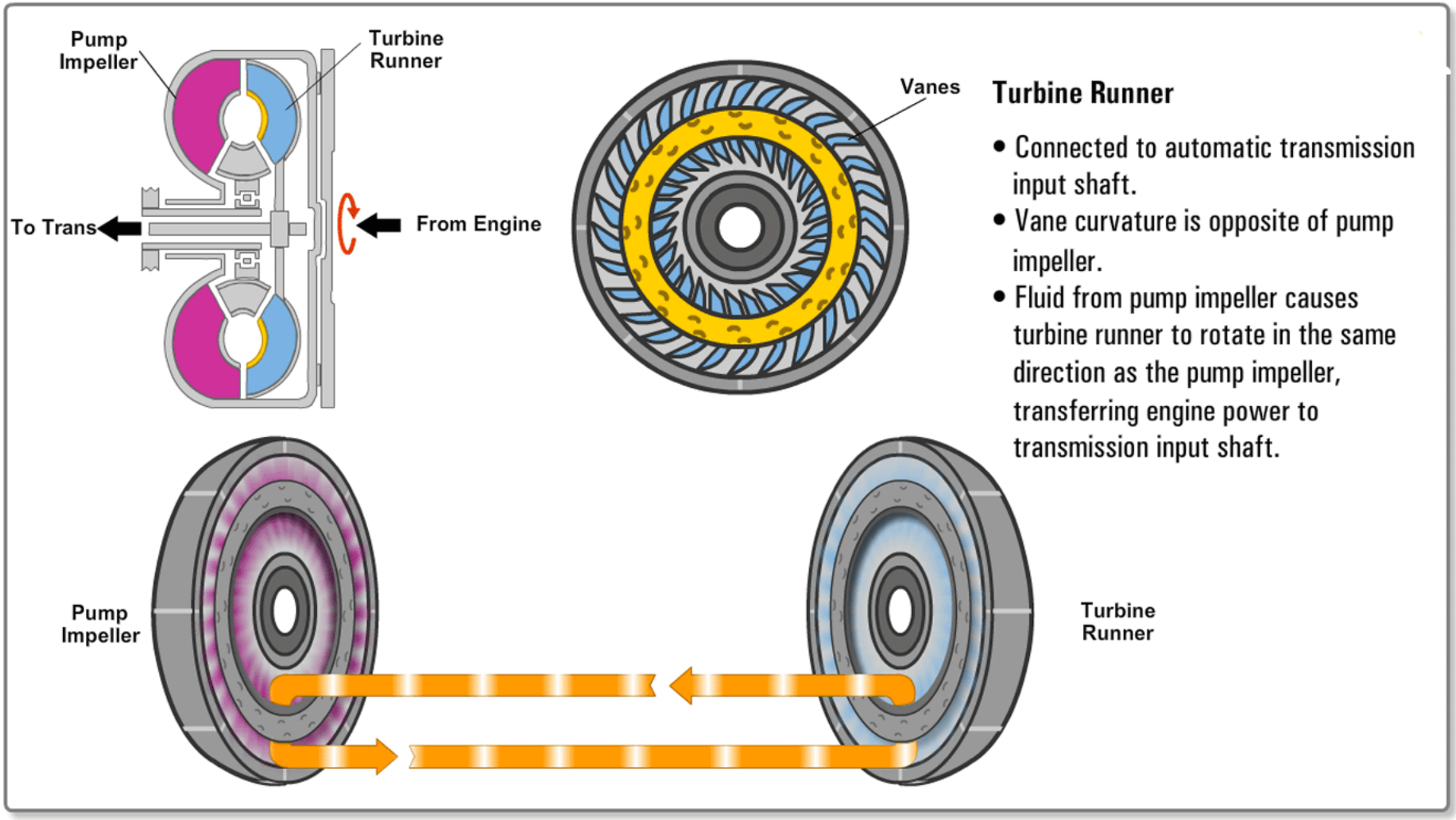


Pump Impeller

- Driven by the engine crankshaft.
- When impeller speed increases, centrifugal force causes fluid to flow to the turbine runner.



Torque Converter - Turbine



Stator Operation

The Stator provides Torque Multiplication

When the engine is running and the car is stopped, the stator will lock on the One Way Clutch

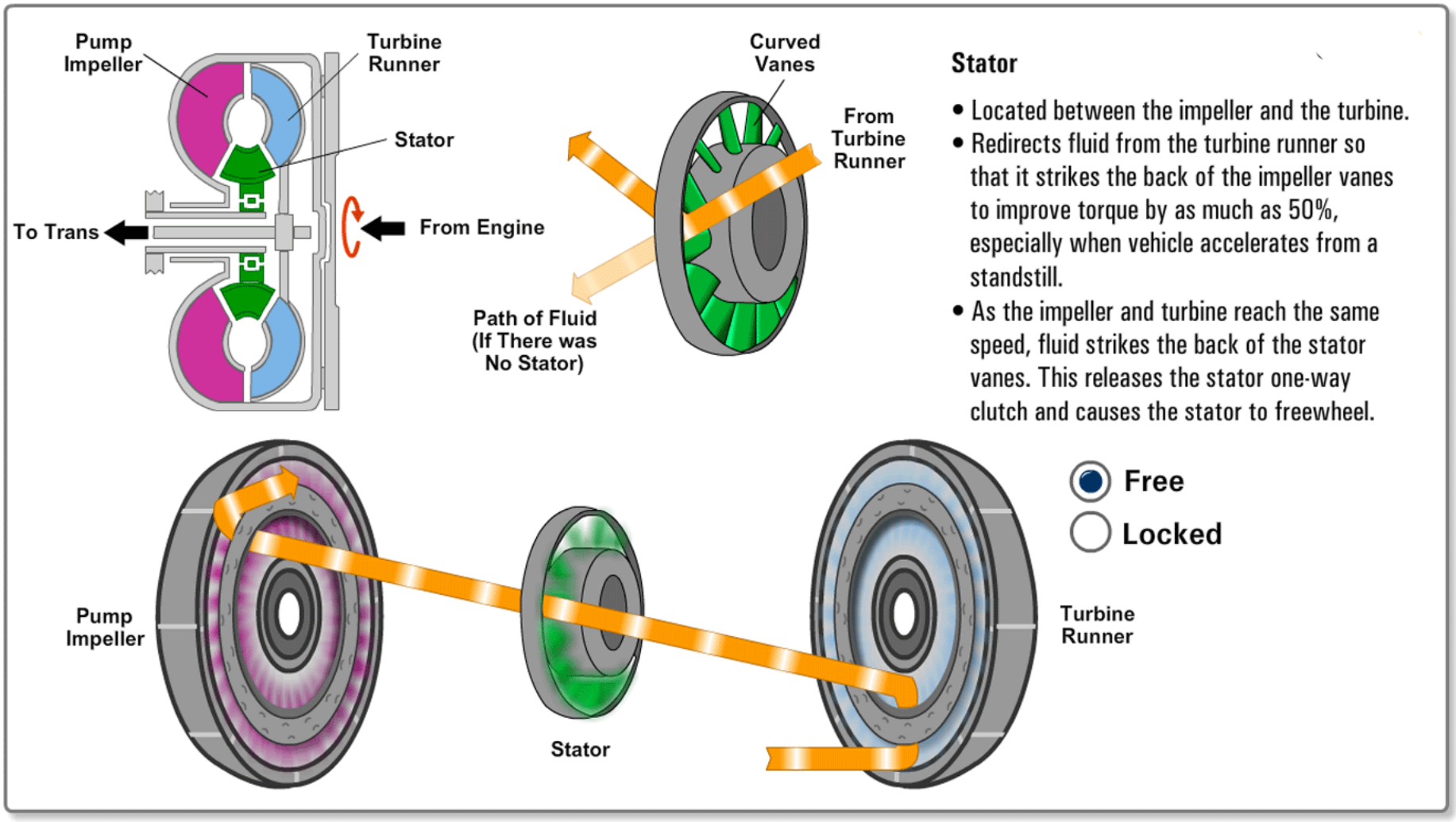
The one way clutch is splined to the transmission oil pump cover or stator shaft that does not rotate

This provides maximum torque multiplication

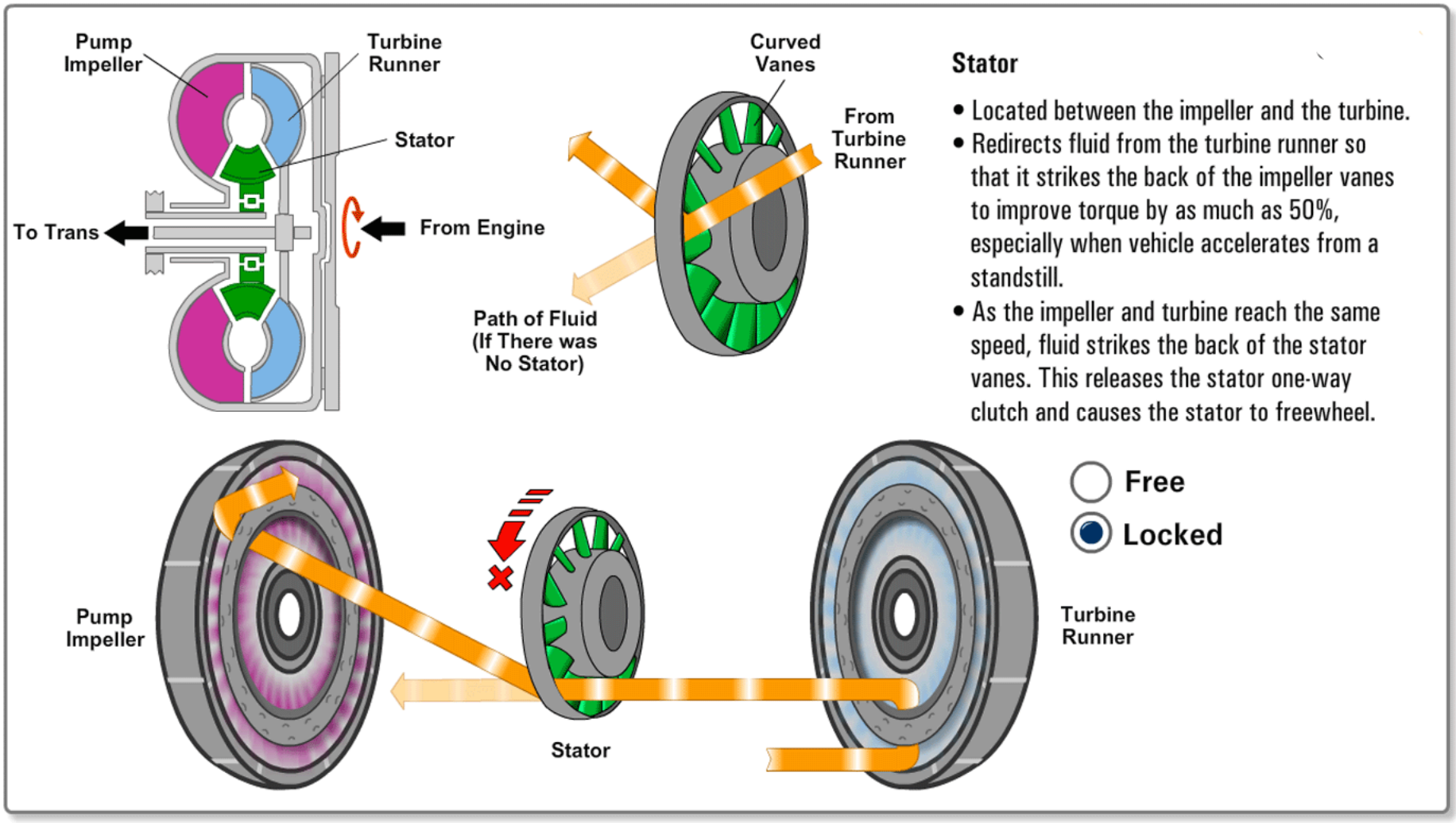
At “Coupling Speed” the stator will spin freely on the overrunning (one way) clutch

At coupling speed, about 10% of engine RPM is lost to ATF fluid slippage

Torque Converter - Stator



Torque Converter - Stator



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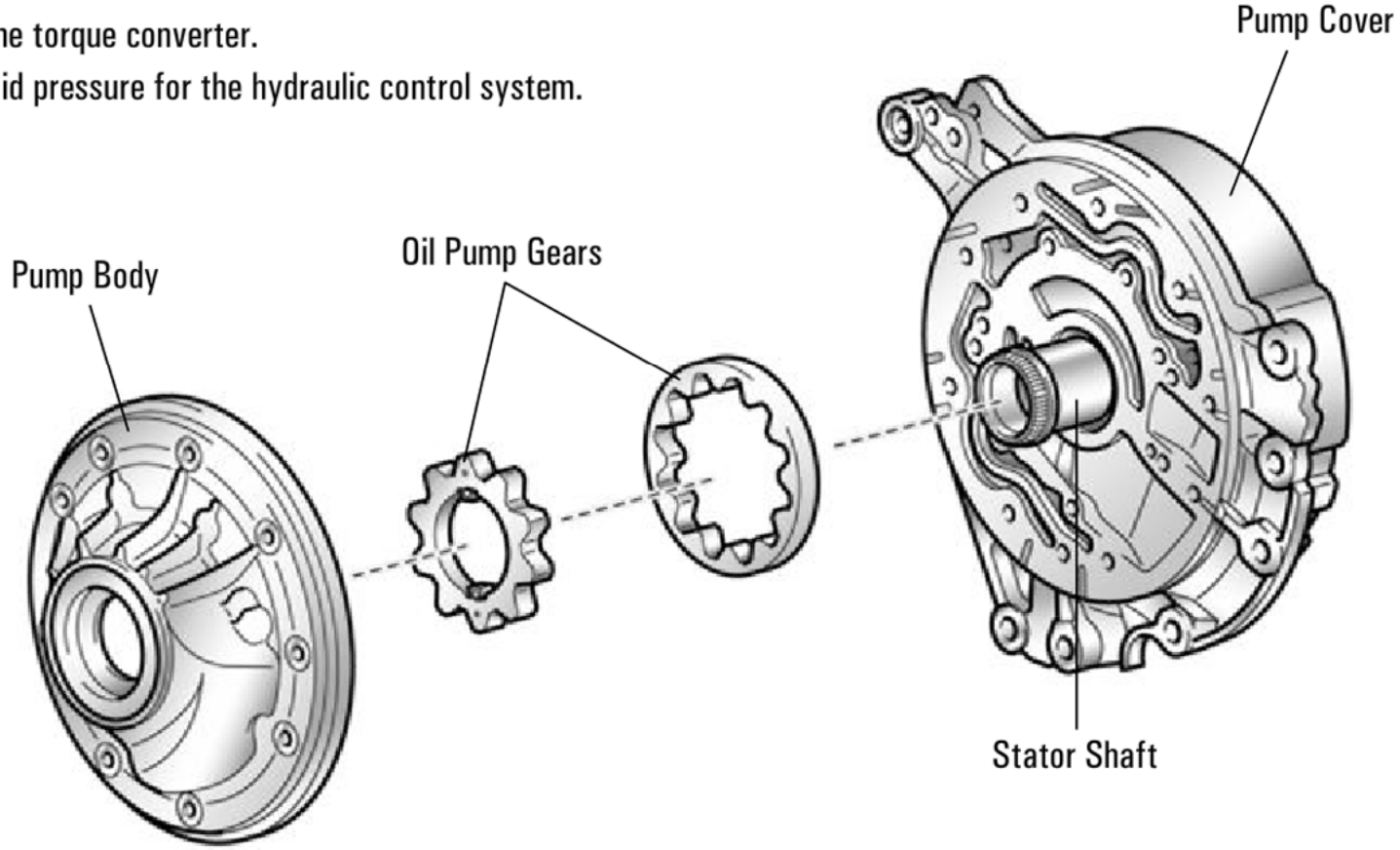
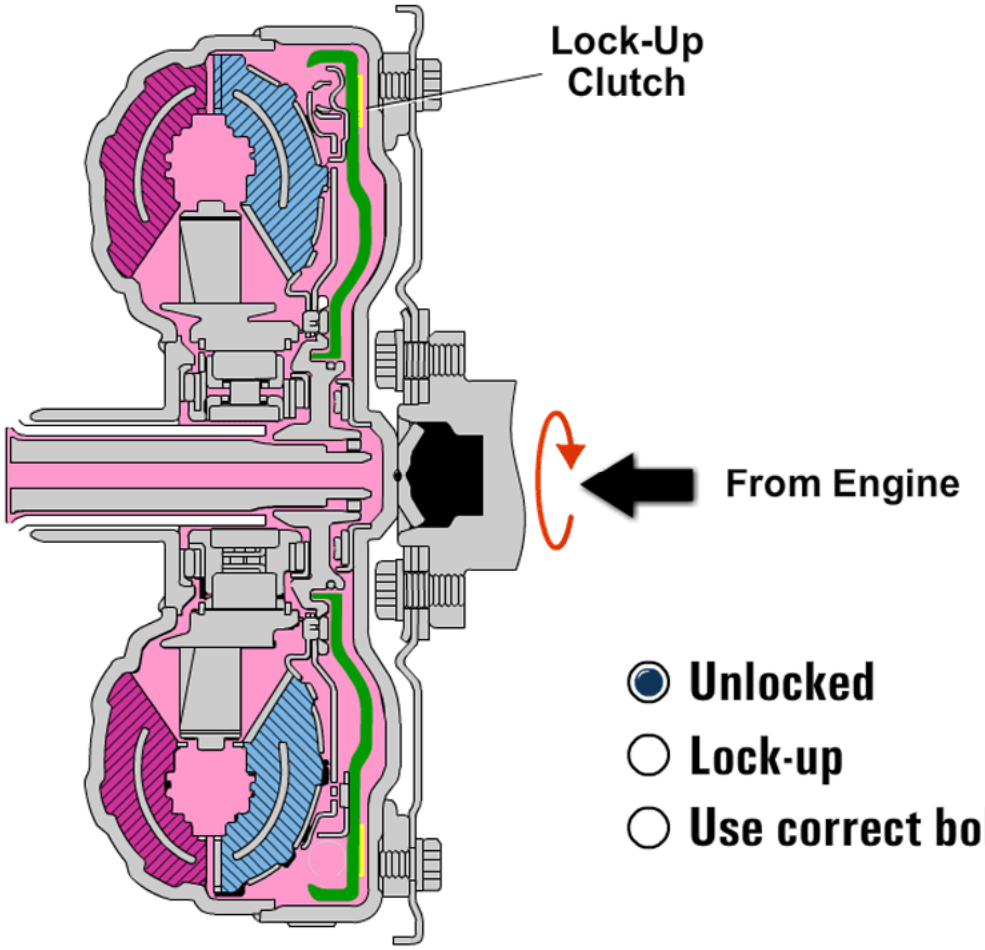


Locking Torque Converter

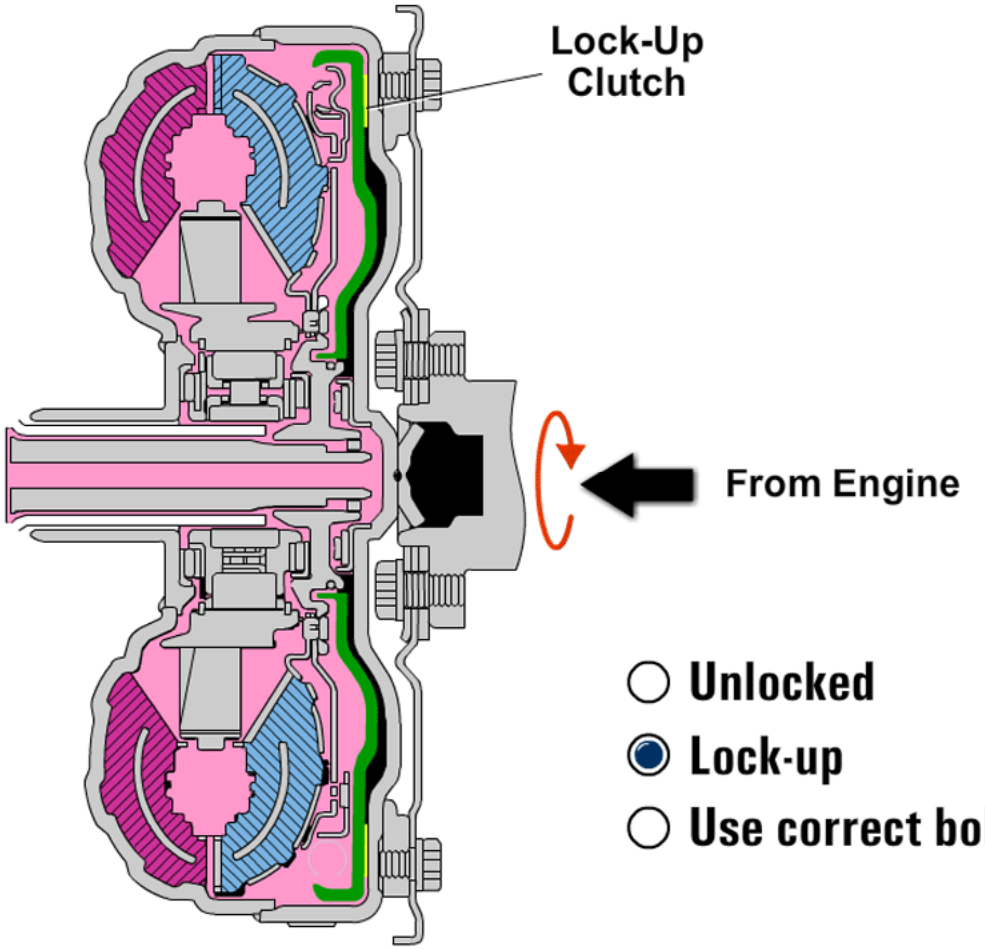


Lock-up Clutch

- Lock-up clutch provides overdrive at cruising speeds.
- Reduces energy loss and improves fuel economy by mechanically connecting the pump impeller and turbine runner.
- When lock-up clutch is fully engaged, 100% of engine power is transferred through the torque converter to the automatic transmission input shaft.
- Later designs provide variable levels of clutch application, known as “flex lock-up.”
- Use correct bolt length to install torque converter to avoid damaging the flex plate.

◉ **Unlocked**
○ **Lock-up**
○ **Use correct bolt length**

Locking Torque Converter



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◉ **Lock-up**
○ **Use correct bolt length**

Locking Torque Converter

The torque converter clutch is applied by hydraulic pressure

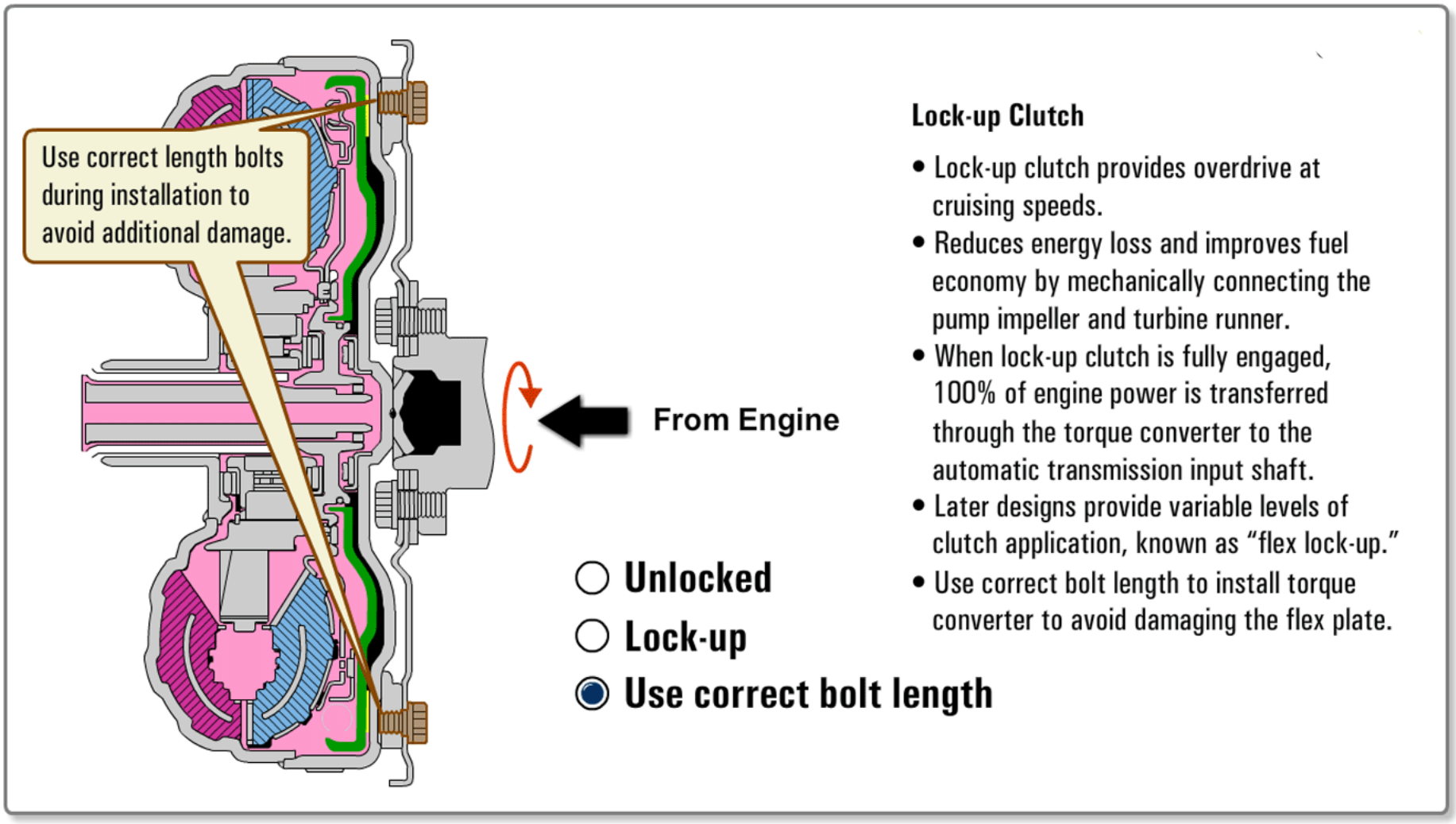
The PCM will control a Torque Converter Clutch (TCC) solenoid to send ATF under pressure to the lock-up clutch

Modern TCC solenoids are duty cycled to gradually apply

The TCC will only lock in higher gears

The TCC will unlock under acceleration (TPS input), high load (MAP or MAF) and when braking (Brake Switch)

Torque Converter mounting bolts are application specific. Using a substitute bolt(s) can cause damage to any torque converter

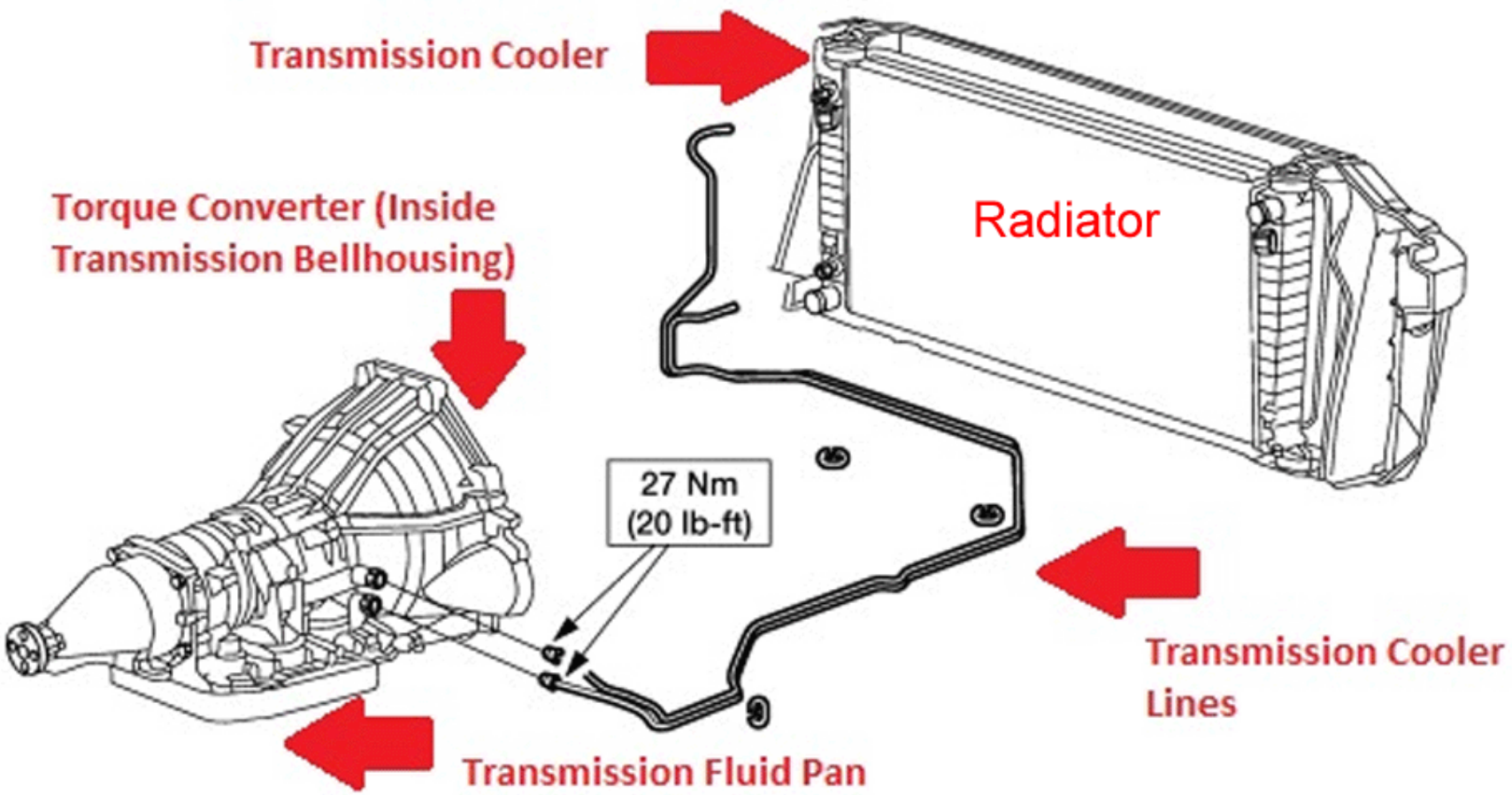


Torque converters generate a large amount of heat, especially under acceleration

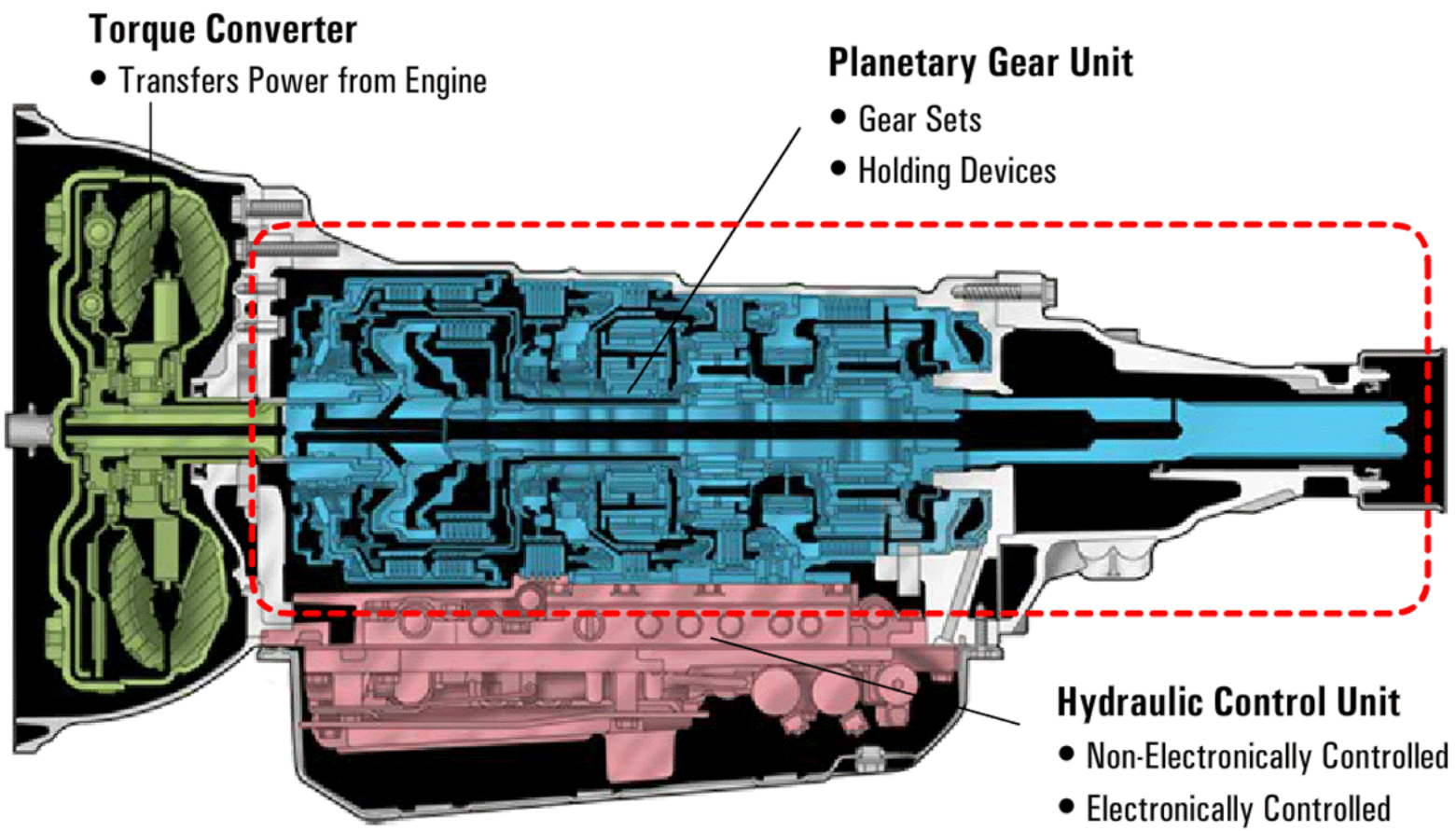
Most transmissions send ATF fluid to the transmission cooler after it leaves the torque converter

Most ATF coolers are located inside the radiator tank

Vehicles used to tow trailers often require an additional ATF cooler mounted in front of the radiator

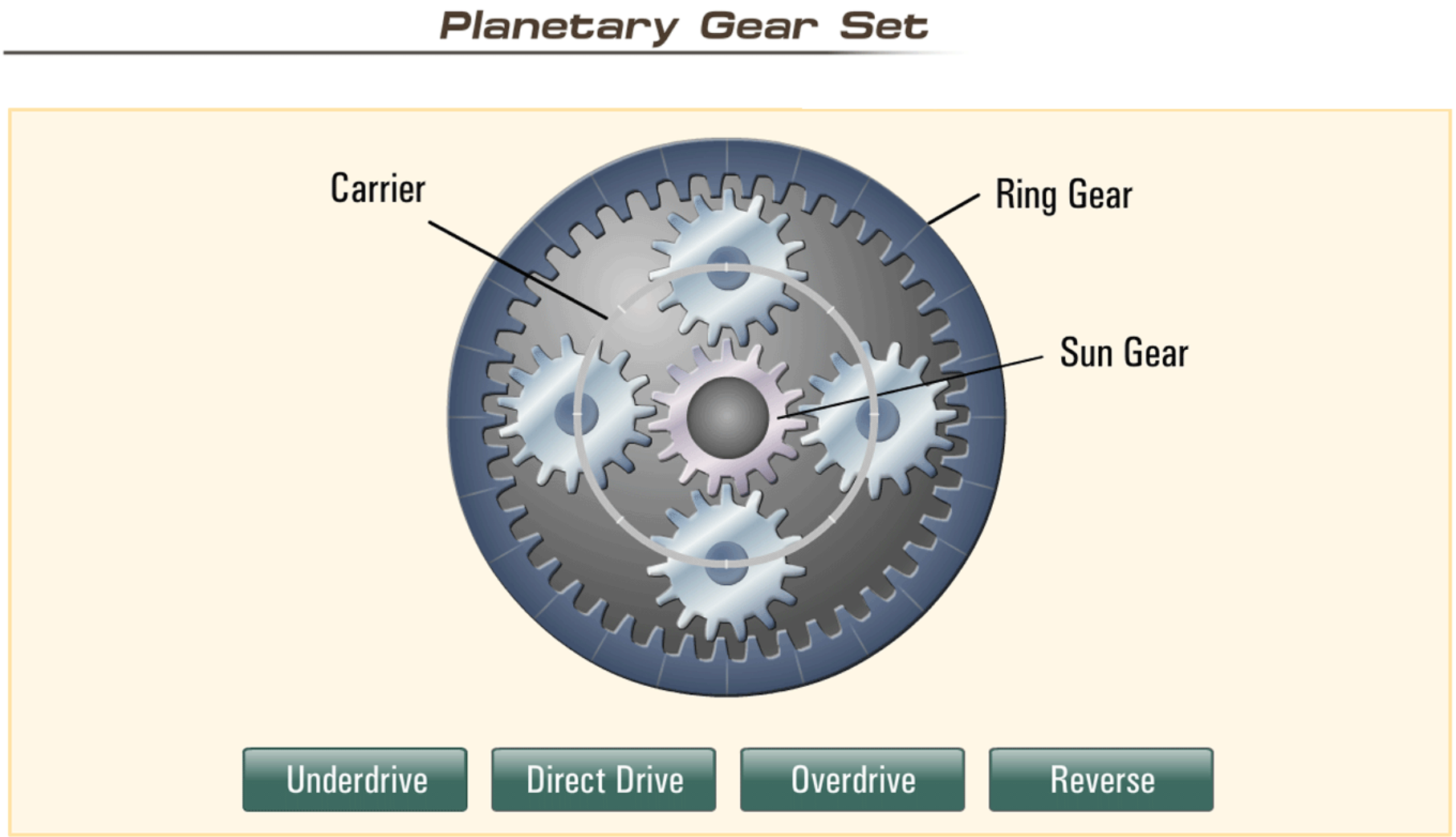

Transmission Cooler
Radiator
Torque Converter (Inside Transmission Bellhousing)
27 Nm (20 lb-ft)
Transmission Cooler Lines
Transmission Fluid Pan

Major Components

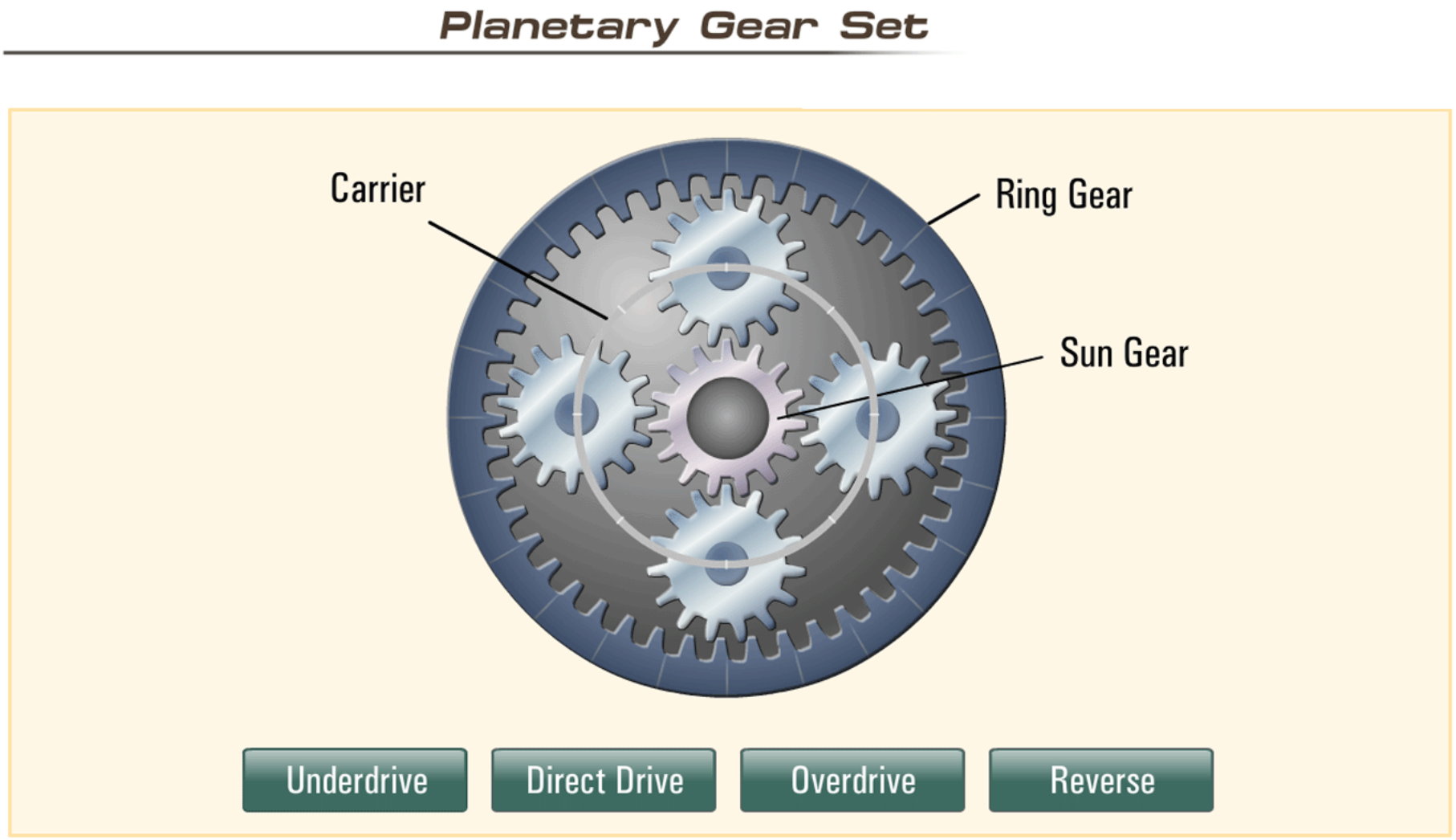


This link is an animation and explanation of Planetary gears

https://epxx.co/artigos/autogear.php



A Planetary gear can provide gear reduction (Underdrive) Direct Drive, Overdrive, or Reverse when you hold one part stationary, or lock two parts together.



Powerflow through the Planetary Gear Set

Mathmagically the Carrier is the largest gear in the planetary gear set.

Small gear driving large gear = Under Drive
Under Drive happens when Carrier is the Output

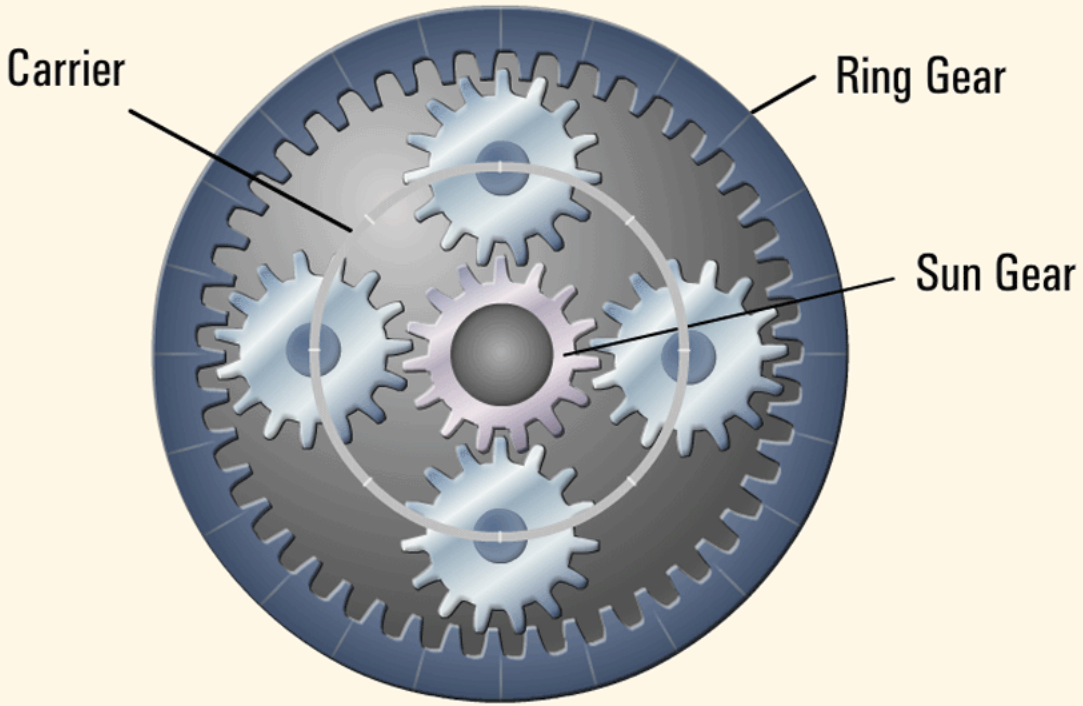
Under drive increases Torque – decreases Speed

Large Gear driving Smaller gear = Overdrive
Overdrive happens when the Carrier is the Input

If the Carrier is HELD, the Gear set goes to REVERSE

If you do not hold or lock any part, all gears will "Freewheel" and no power is transferred (neutral)

Planetary Gear Set

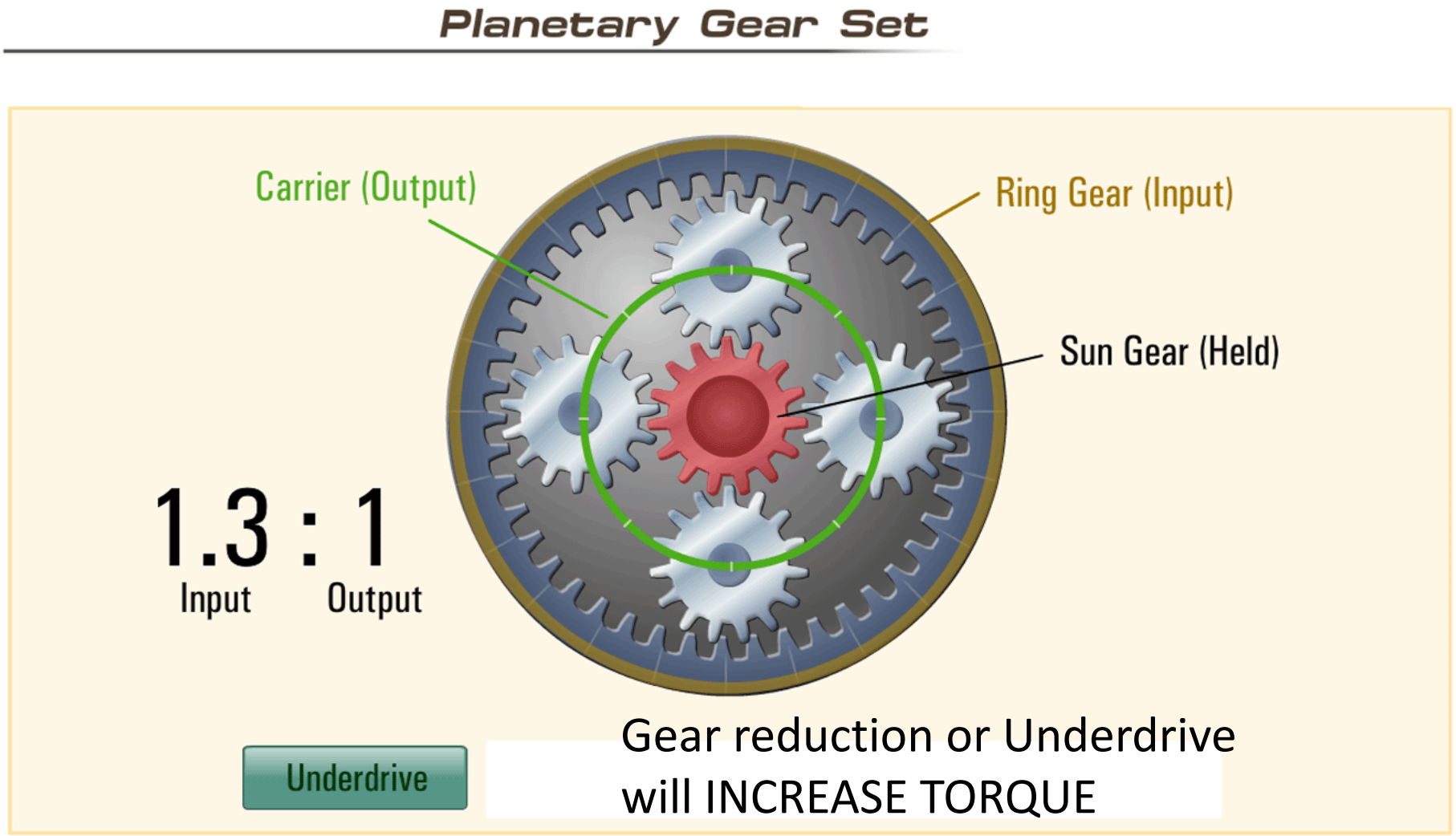


Underdrive | Direct Drive | Overdrive | Reverse

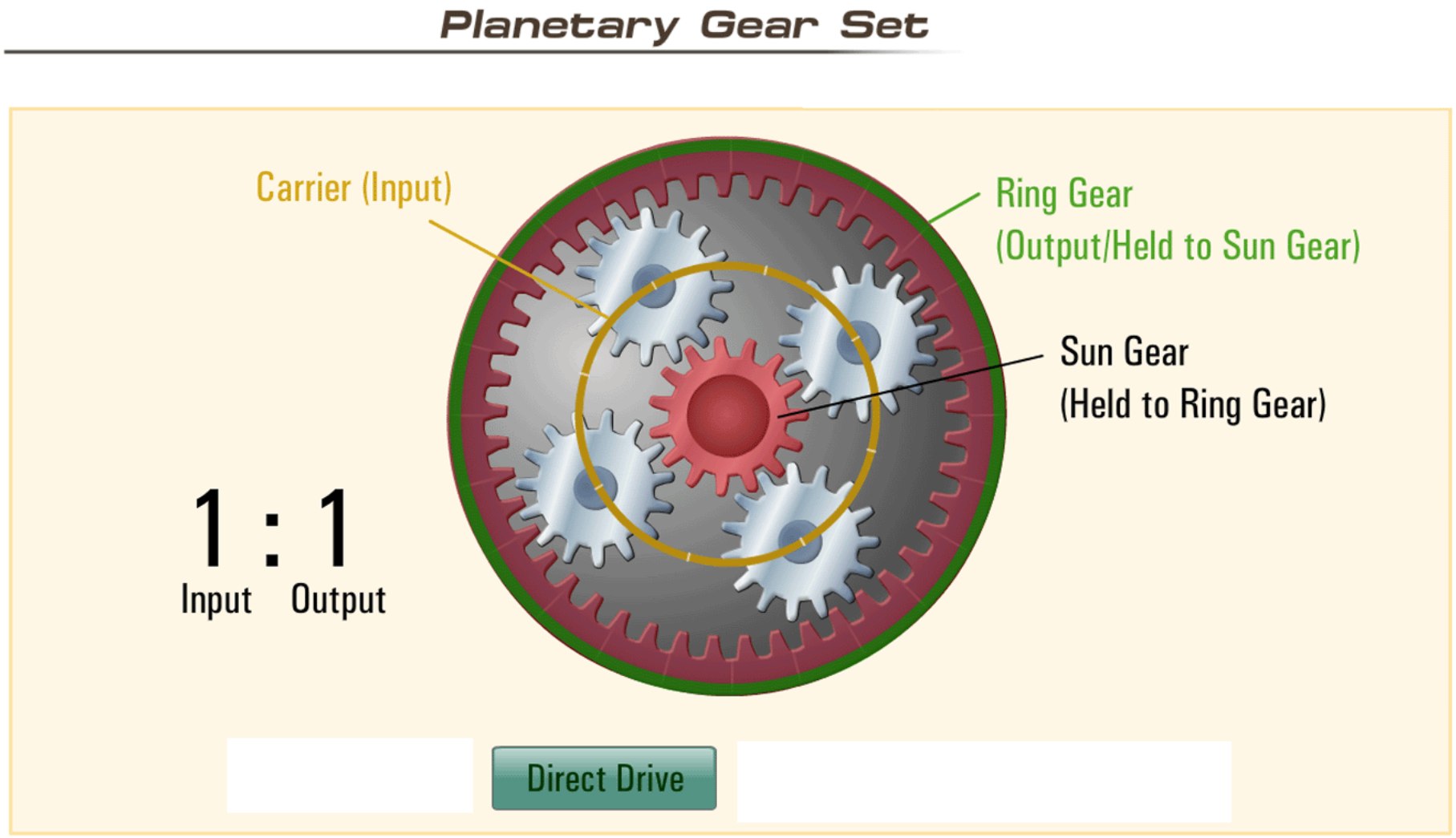
Underdrive is when Carrier is the Output.

Hold Ring for maximum reduction

Hold Sun for minimum reduction



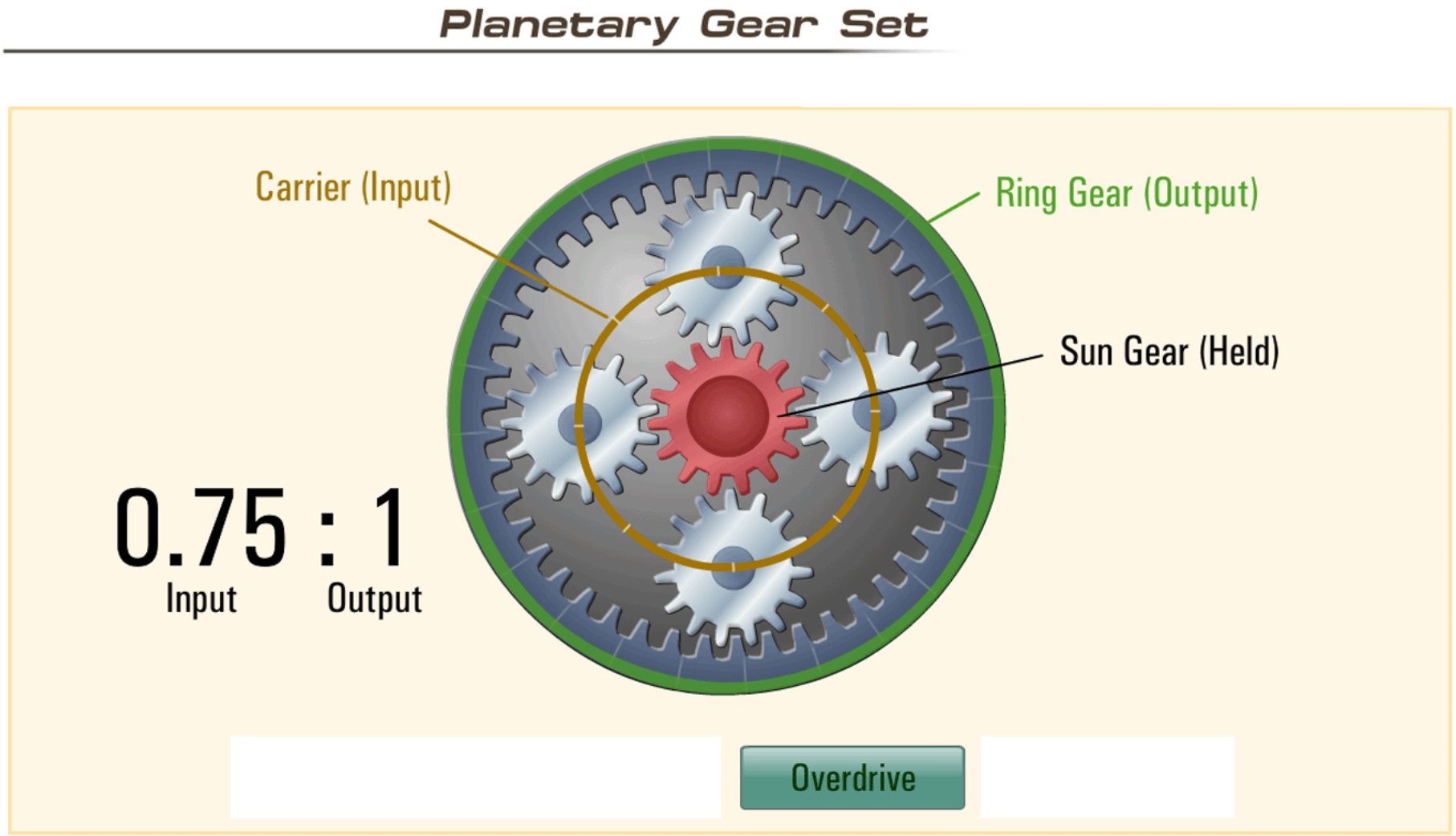
Direct Drive happens when ANY TWO components are locked together. This is done with multiple disc clutch packs



Overdrive is when Carrier is the Input.

Hold Ring for maximum overdrive

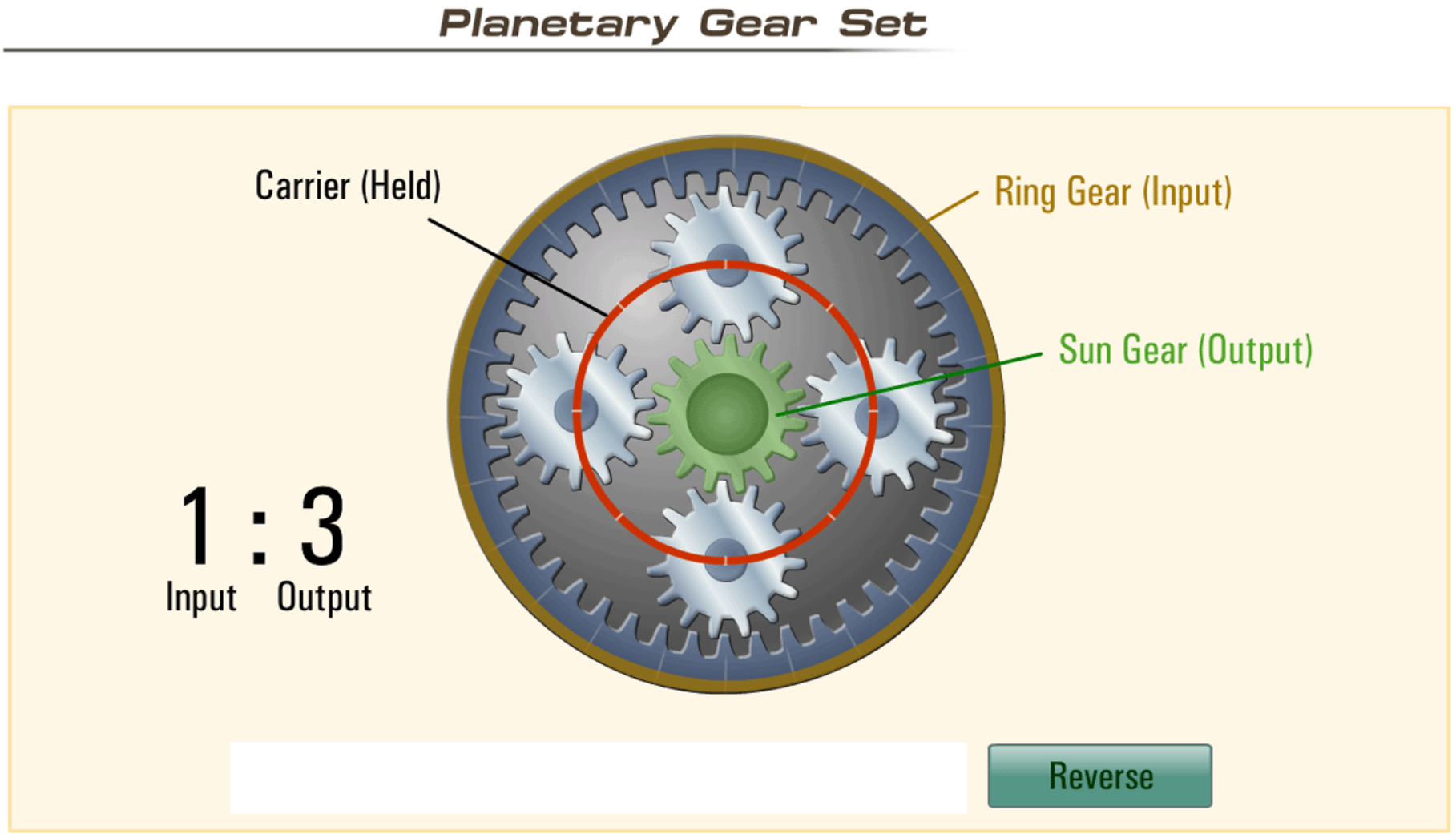
Hold Sun for minimum overdrive



Reverse is when Carrier is Held.

Input Ring for reverse overdrive

Input Sun for reverse underdrive



Automatic Transmissions use compound planetary gear sets to provide multiple gear ranges

Simpson Gear trains share a common Sun gear

Ravigneaux Gear trains share a common Ring Gear

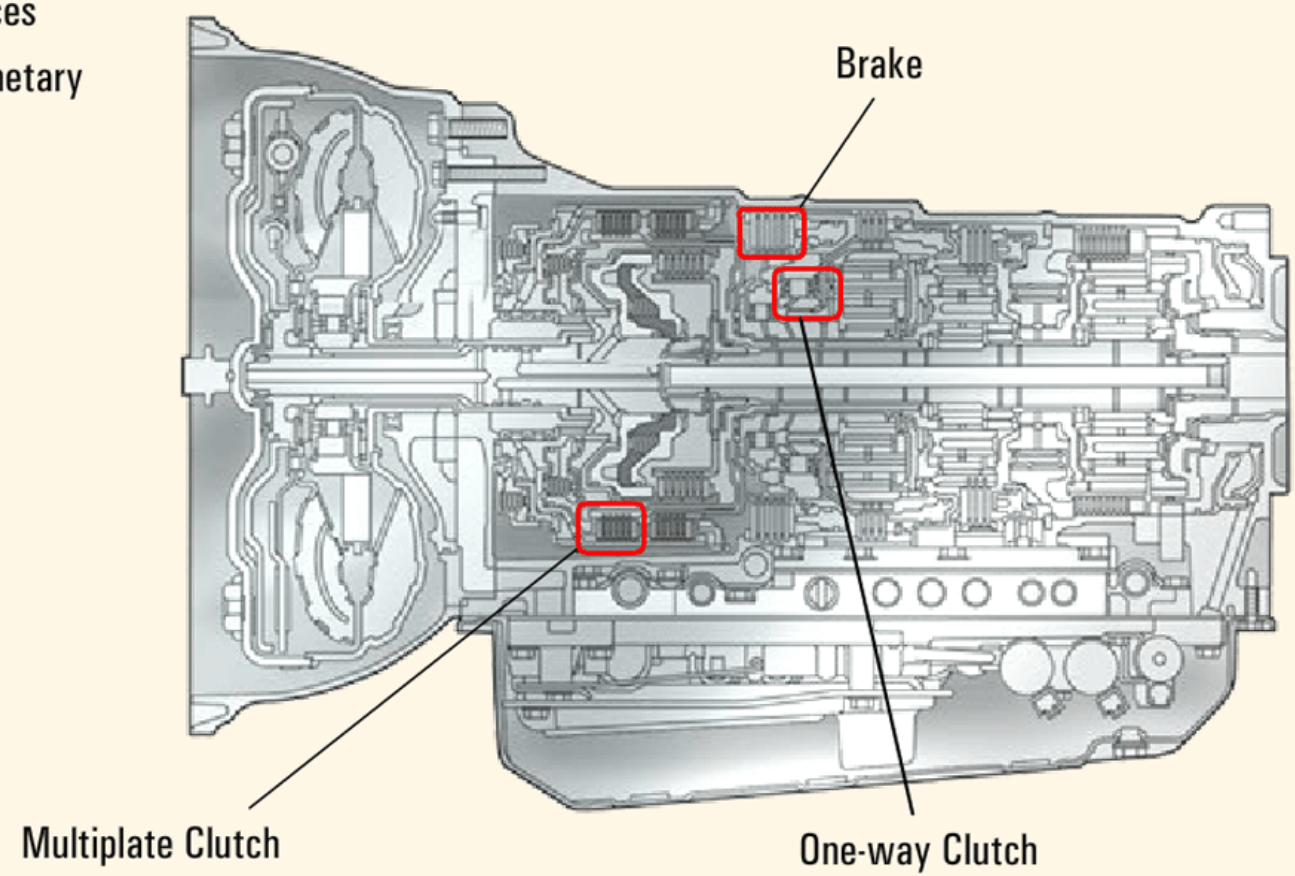
Many combinations are used

Output of one gear set becomes Input for other gear set allowing many gear ratios

There are three types of holding devices used to hold gears and carriers in planetary gear sets:

- Multiplate Clutches
- Brakes
- One-way Clutches

Each design has specific advantages.



Automatic Transmissions use compound planetary gear sets are controlled by:

Multiple Disc Clutches

Used to connect rotating components together

One-Way (overrunning) Clutches

Used to connect rotating components together in one direction and freewheel in the other

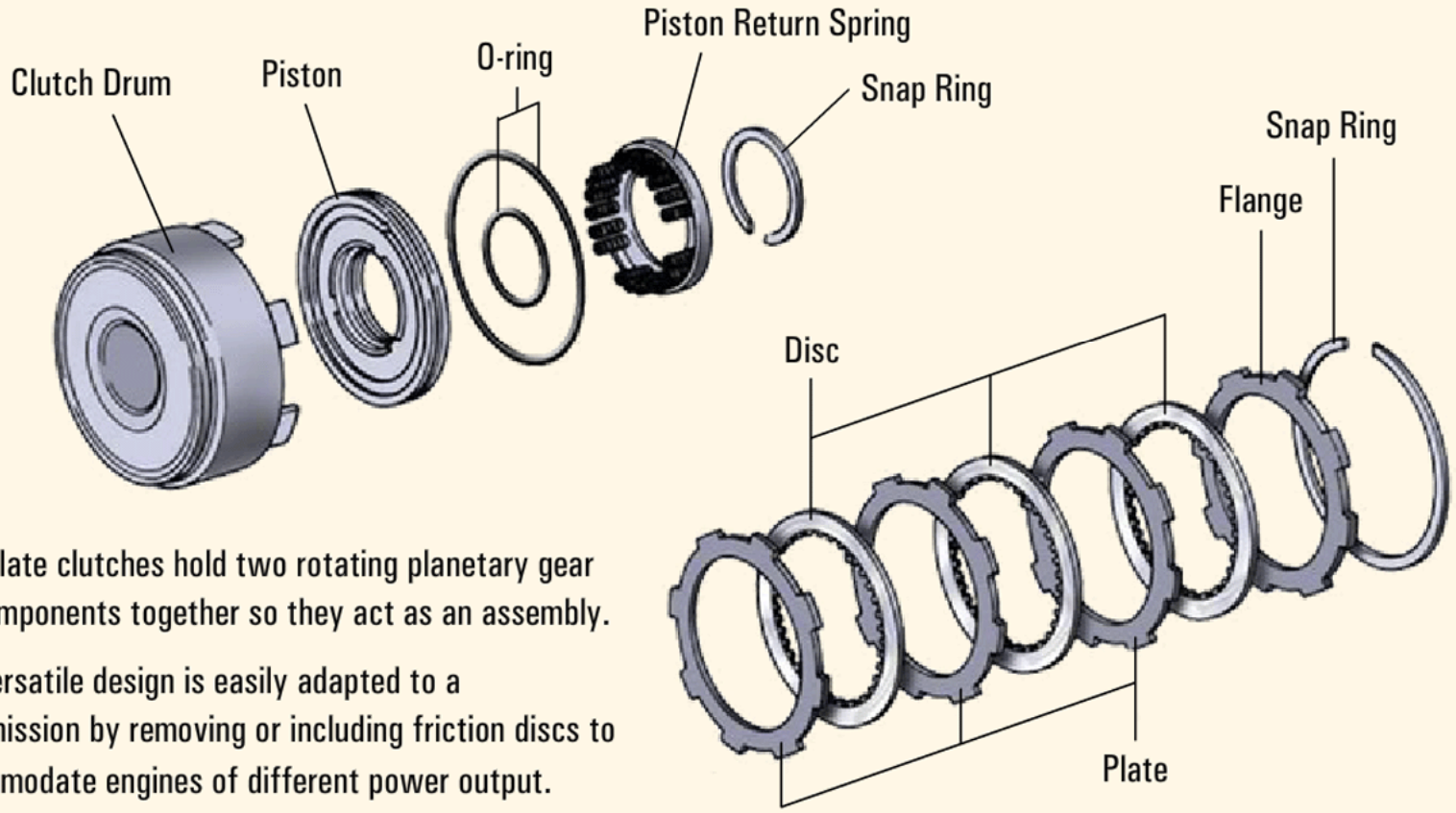
Multiplate brakes

used to stop or hold

Brake Bands also used to stop or hold

Multiple Disc Clutches
connect rotating components together

Holding Devices



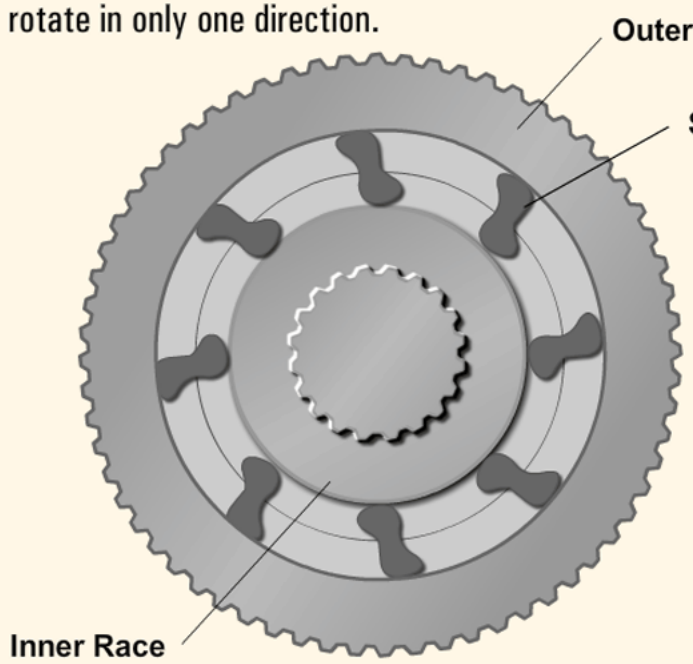
Multiplate clutches hold two rotating planetary gear set components together so they act as an assembly.

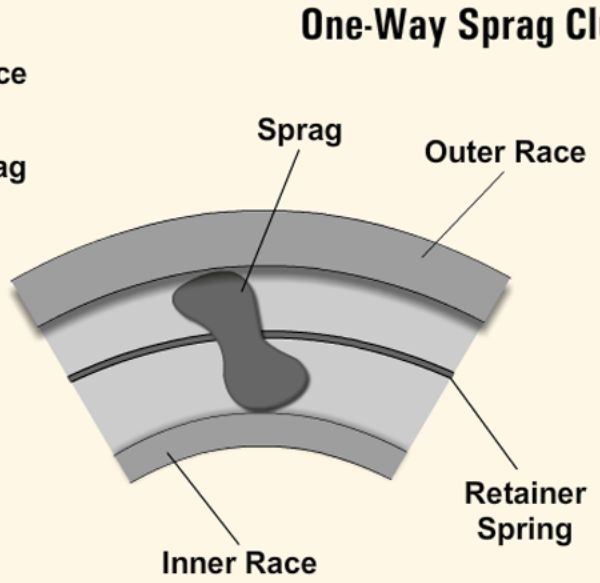
The versatile design is easily adapted to a transmission by removing or including friction discs to accommodate engines of different power output.

One-Way Clutches

Holding Devices

One-way clutches hold planetary gear set components so they can rotate in only one direction.





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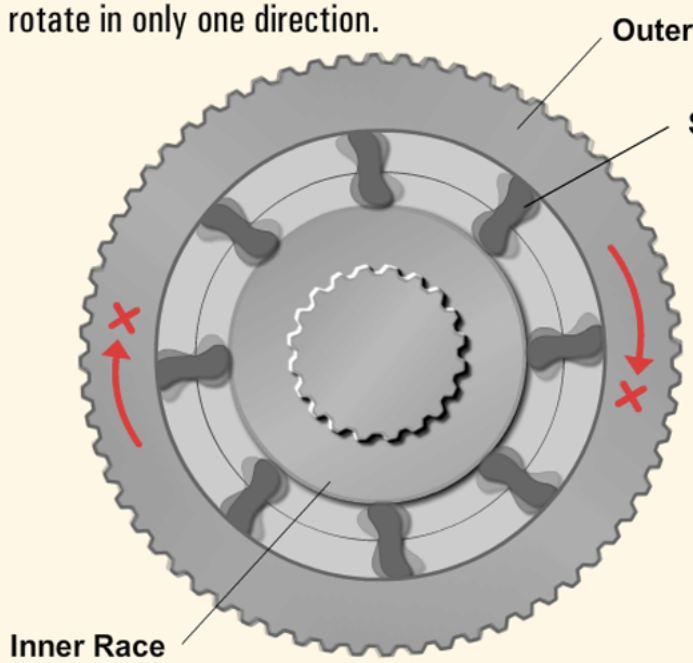
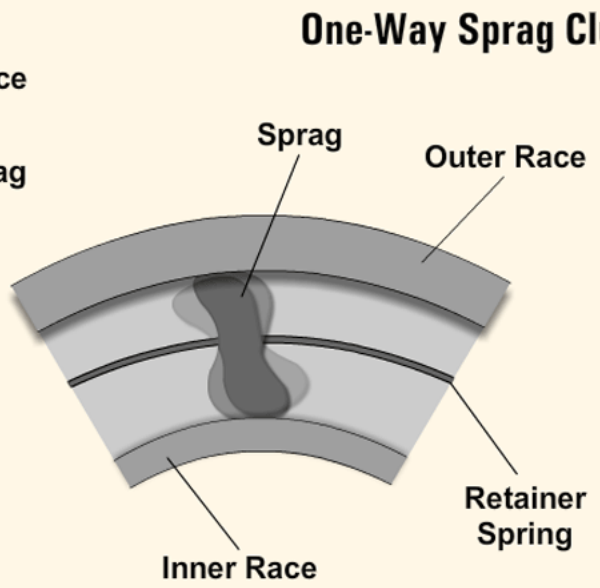
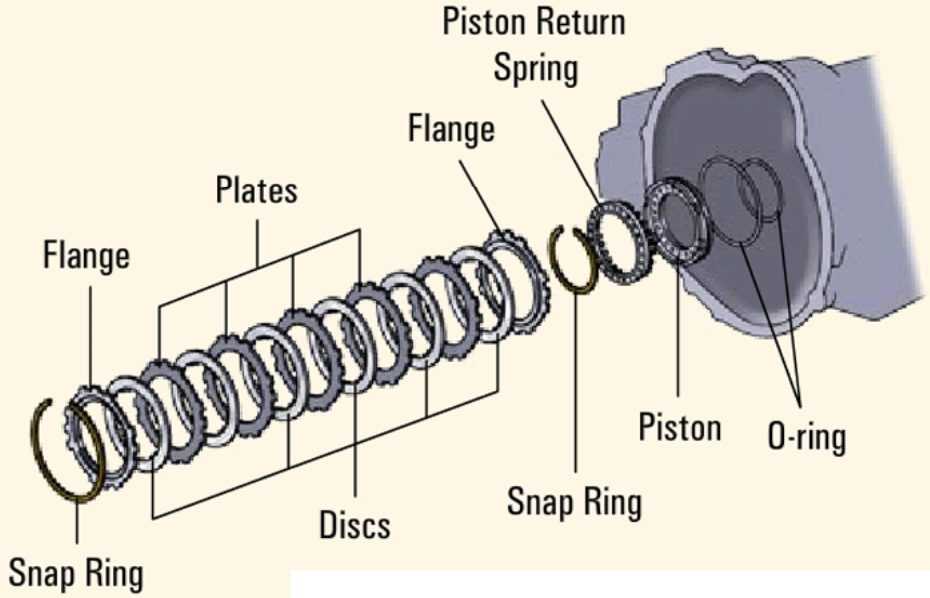




Multi-plate Brakes

Holding Devices

Brakes hold planetary components to the transmission case so they cannot turn in either direction.

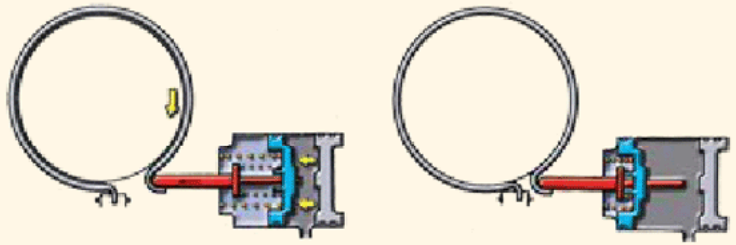


Along with multiplate clutches, multiplate brakes are among the most common holding devices. The versatile design is easily adapted to a transmission by removing or including friction discs to accommodate engines of different power output.

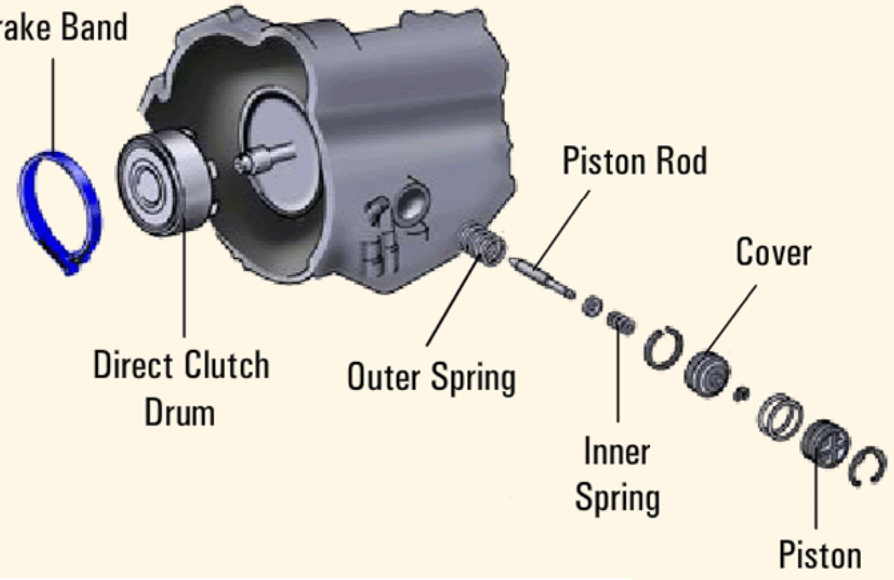
Brake Bands

Holding Devices

Brakes hold planetary components to the transmission case so they cannot turn in either direction.



Brake bands are less common than multiplate brakes. They are used to hold one-way clutches to provide an additional state of operation.



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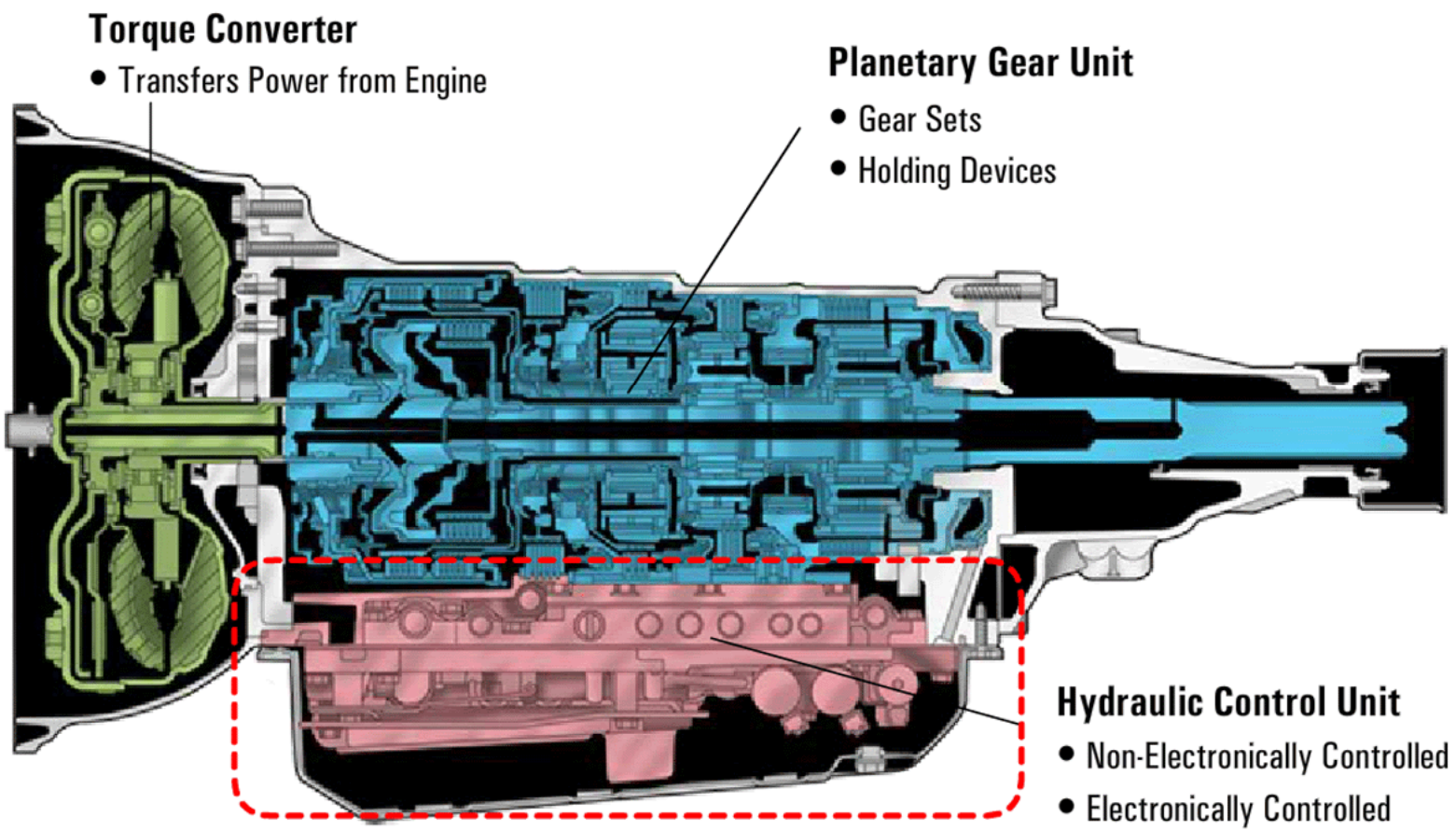
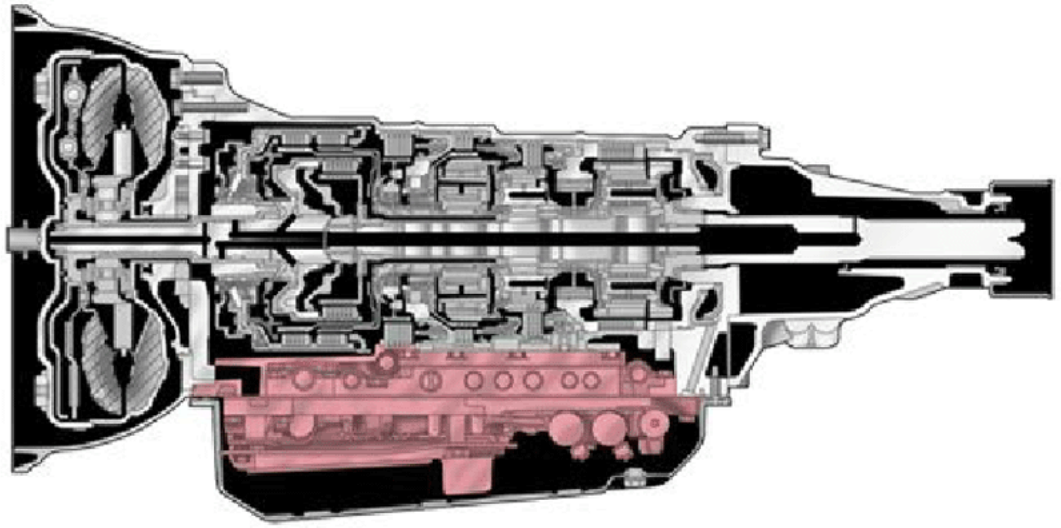
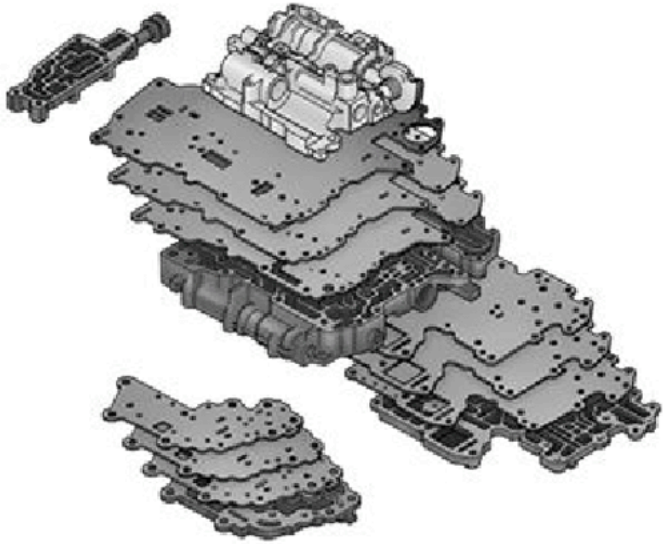
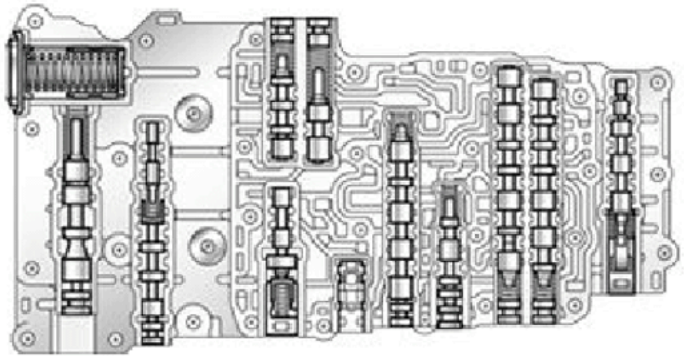


Hydraulic Valve Body



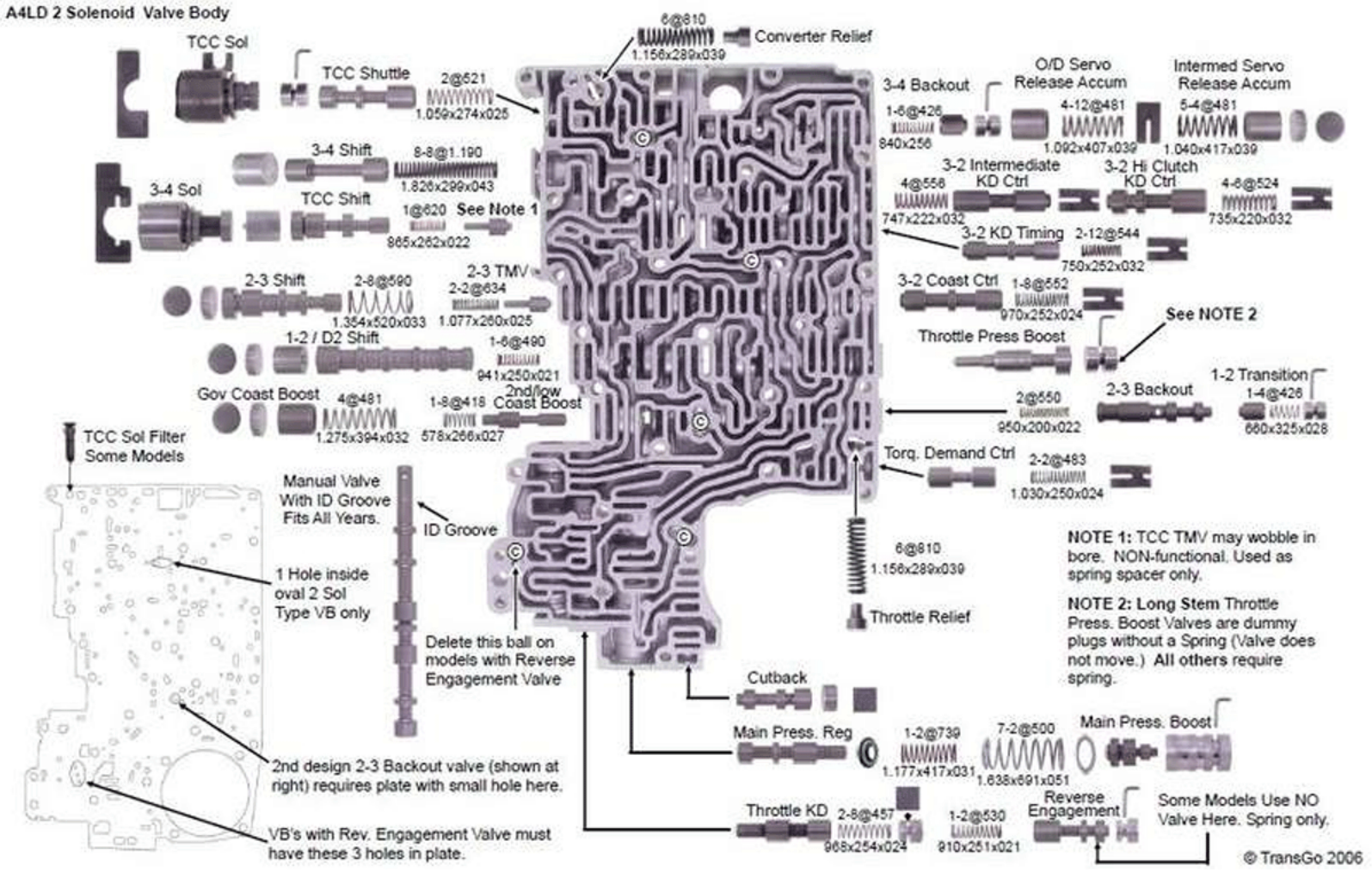




The **hydraulic control unit** has passages and valves that direct fluid flow to control:

- ATF pressure
- Gear selection (application of holding devices)
- Shift timing
- Shift quality

Valve bodies control shift timing, shift pressure, gear selection, fluid pressure



!Valve Body must be kept spotless clean!

Valve body needs clean ATF to stay trouble free.

DO NOT USE shop rags to clean oil pan.

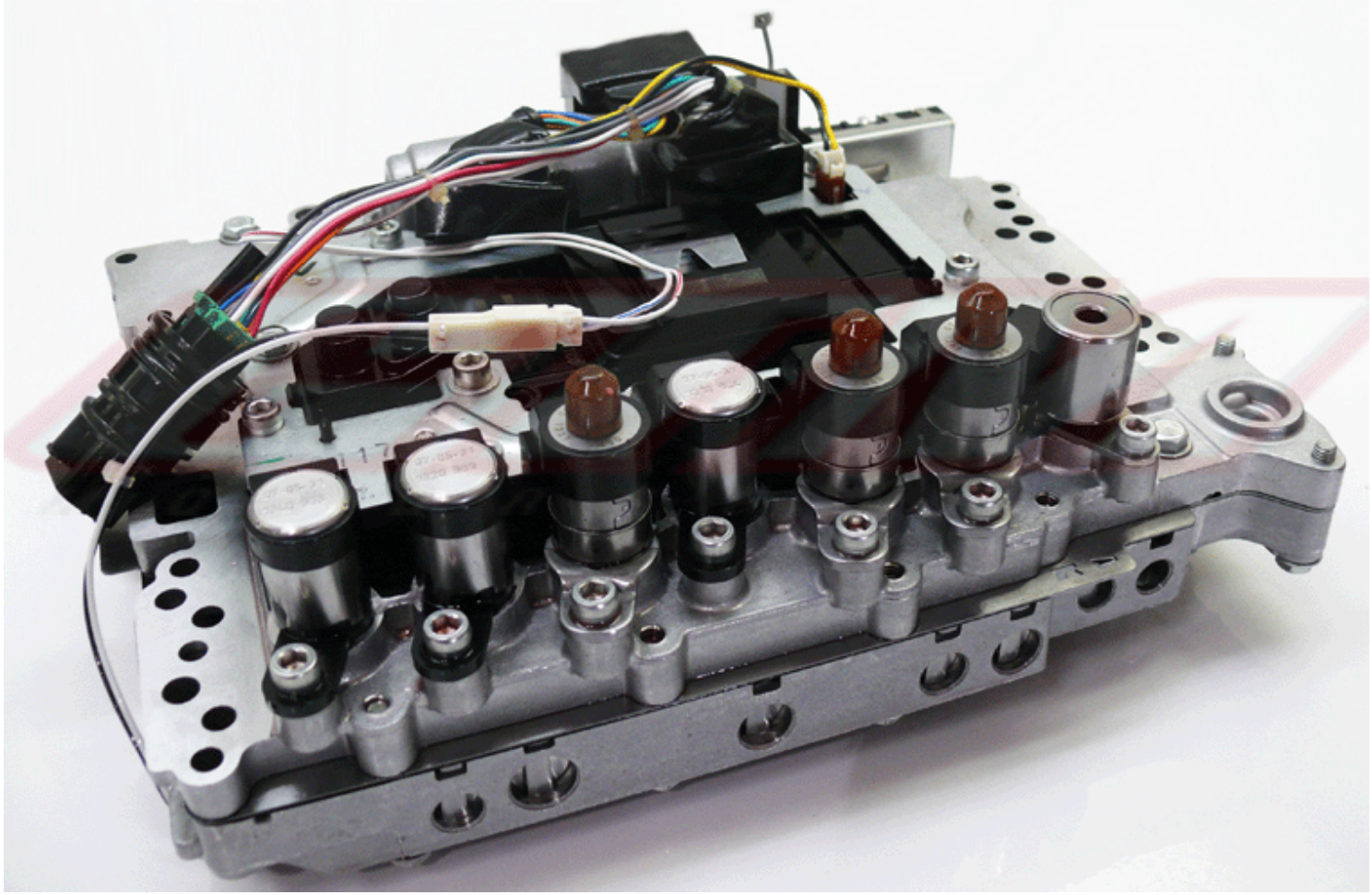
DO NOT allow shop rags to contact the valve body.

Rags will deposit lint that can block or jam shift valves, check balls, and hydraulic ports.

Only use lint free paper or cloth to protect and clean around the valve body or inside any part of the transmission.

!Valve Body must be kept spotless clean!

Shift pressures and shift points are controlled electronically using solenoids



Use ATF fluid level - Scan Tool – DVOM - and Labscope to diagnose shift problems