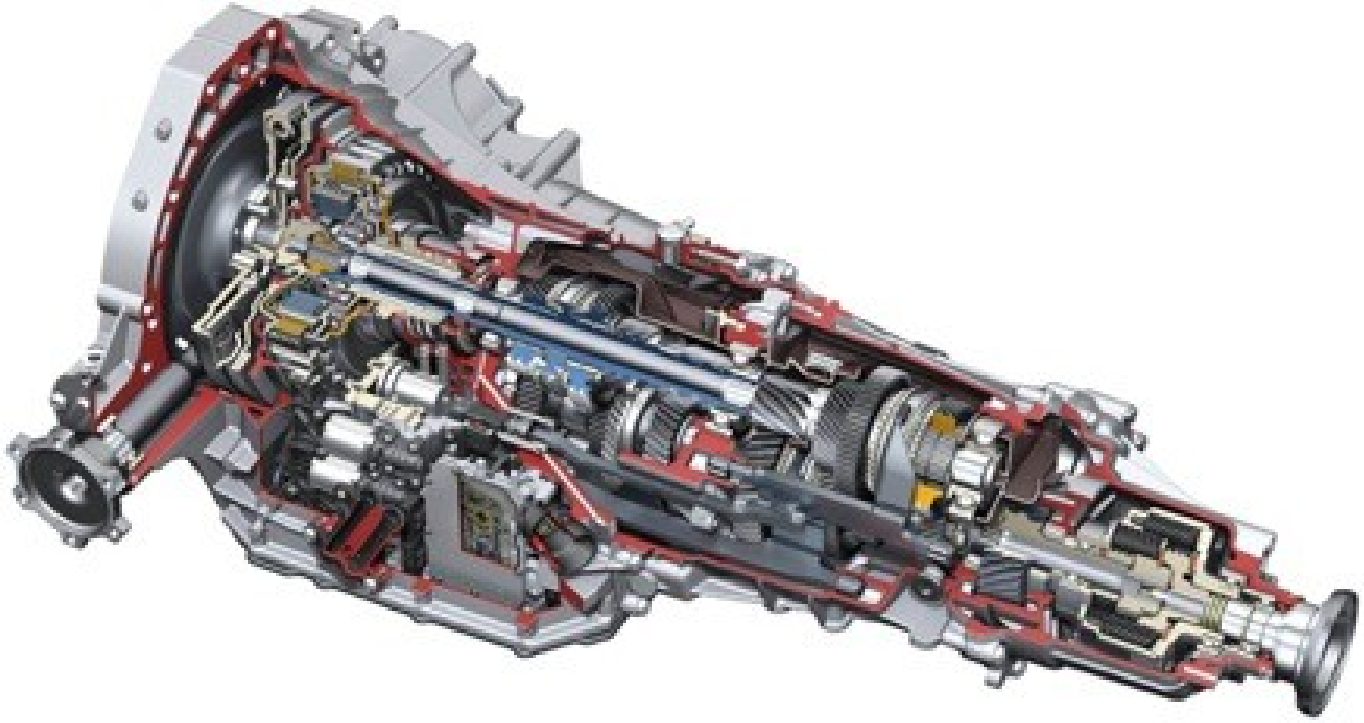


Automatic Transmission

AUTOMATIC TRANSMISSION

- Automatic transmission and transaxles have similar components. Three basic parts include:

1. ***Torque Converter.***
2. ***Gear train: planetary gear sets***
3. ***Hydraulic system***

- Torque converter connects to the crankshaft and transmits engine power to the gear train.
- Hydraulic pressure acting through the automatic-transmission fluid (ATF) in the transmission or transaxle produces the shifts.

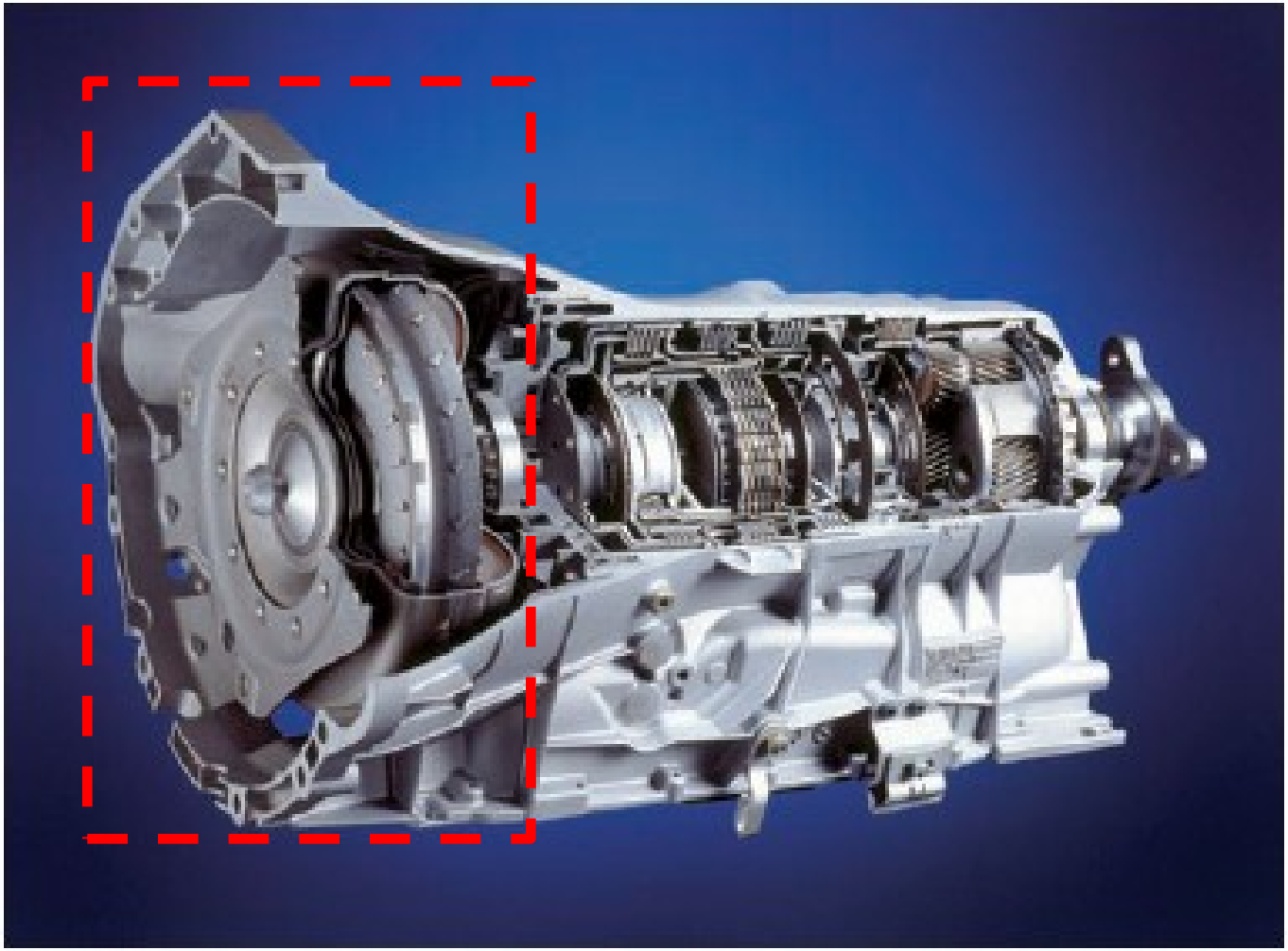


Figure 3-32 A cutaway of a six-speed automatic transmission shown with the torque converter in the housing. *Courtesy of BMW of North America, LLC*

Gear-Shift Mode

- **P** Locks drive wheels; engine should start; no torque transmitted to transmission
- **R** Allows vehicle to back up; engine should not start
- **N** Wheels free to turn; engine should start; no torque transmitted to transmission
- **D** Transmission automatically selects best available gear based on speed and load; engine no start
- **2** Two speed auto transmission, starts in 1st, mild engine braking in 2nd only; engine no start
- **L** Locked in low gear, strong engine braking, diagnostic gear position; engine no start

Automatic OPERATION

- Most A/T have 3 or four forward speed.
- They also have PARK, NEUTRAL, and REVERSE.
- 4^{th} speed is usually has overdrive ratio. Some others have fifth gear which is an overdrive.
- A typical A/T move the vehicle in 1^{st} gear. Then it shifts to 2^{nd}, 3^{rd} & 4^{th} without assistance from driver . They happen automatically as vehicle speed increases & the engine load or throttle opening decreases.

Automatic OPERATION

- To slow and stop the vehicle the driver only needs to release accelerator pedal or apply brake.
- The A/T disengages the torque converter clutch & automatically downshifts until 1st gear when the vehicle stops.
- Slippage in the torque converter allows the engine to idle with the transmission in gear.

TORQUE CONVERTER

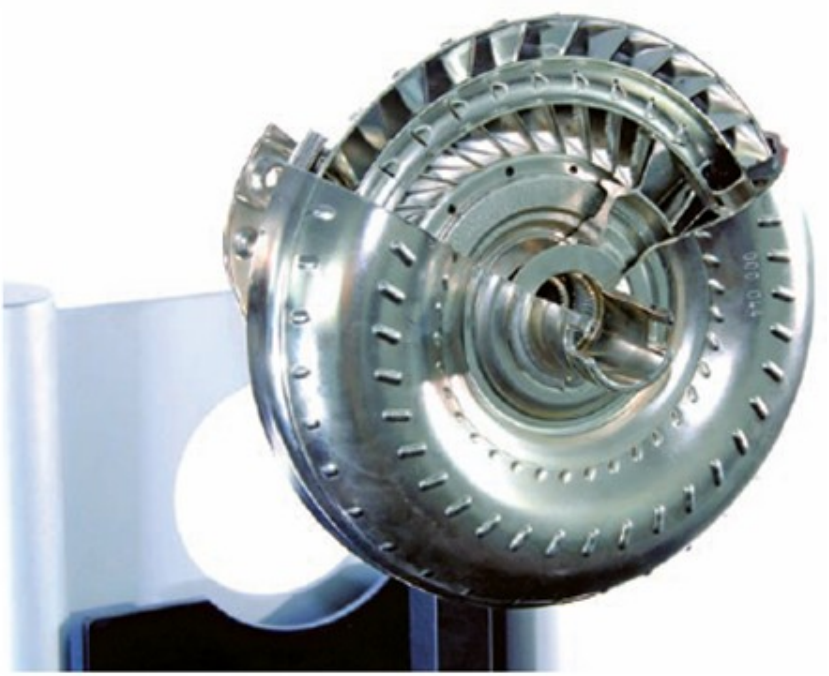
- Torque converter is a form of *fluid coupling*.
- It uses a fluid (such as ATF) and vaned rotors to transmit power between shafts. The torque converter is filled with ATF.
- When the engine runs, power flows from the crankshaft trough the fluid to the transmission input shaft.
- Torque converter can be divided into 3 main members:

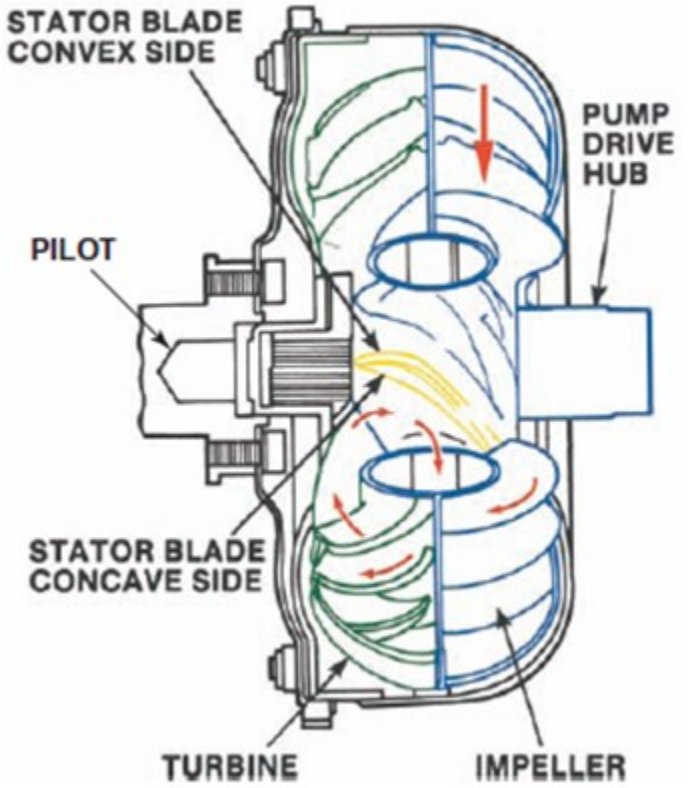
a. **Impeller:** The **impeller**, also known as the **pump**, is the driving member and rotates with the engine.

b. **Turbine:** The impeller vanes pick up fluid in the converter housing and direct it toward the **turbine**. Unless the torque converter is locked, the turbine is normally turns slower than the impeller.

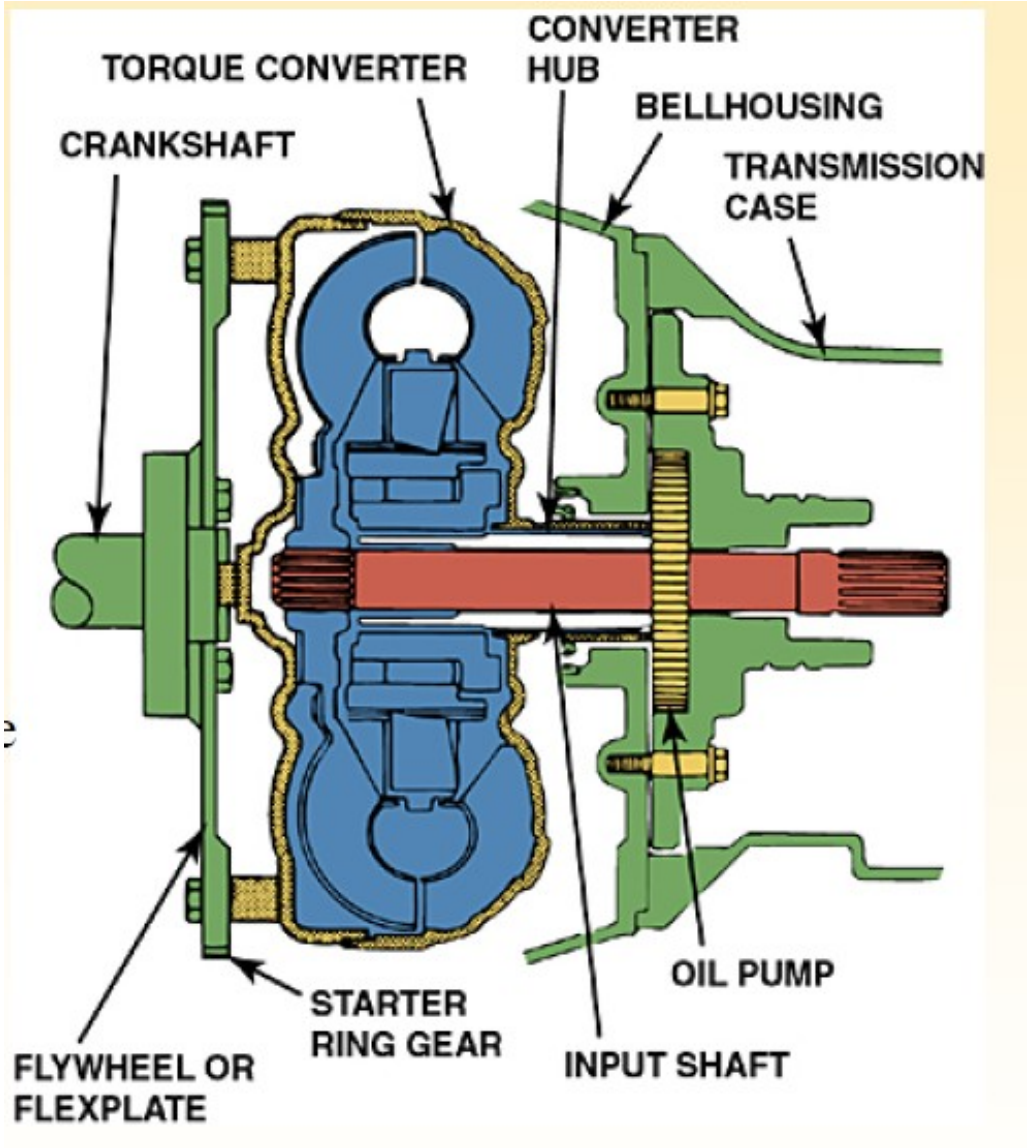
c. **Stator:** Fluid flow drives the turbine, and when the flow between the impeller and turbine is adequate, the turbine rotates and turns the transmission input shaft. A torque converter contains the **stator**, or reactor, a reaction member mounted on a one-way clutch.

- The vanes used in each of the three elements of a torque converter are curved to increase the diversion angle of the fluid. This also increases the force exerted by the fluid and improves the hydraulic advantage.





TORQUE CONVERTER

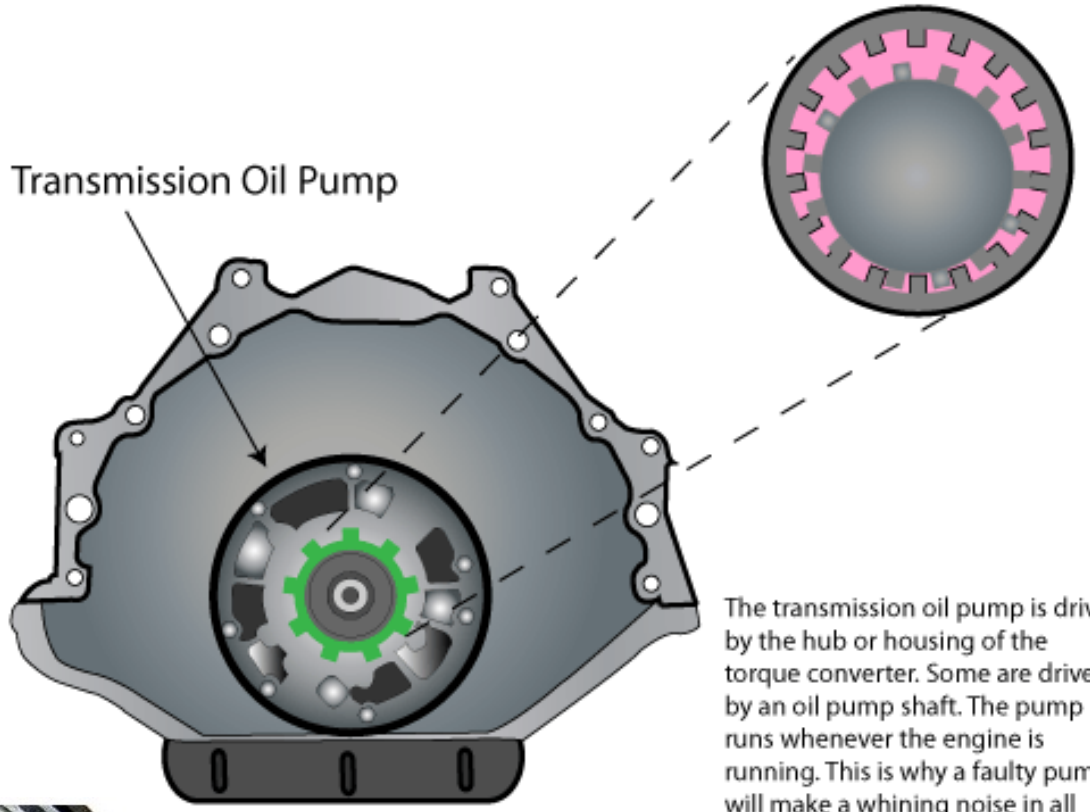


Torque Converter

- **The Pump**

  Automatic transmissions have a neat pump, called a **gear pump**. The pump is usually located in the cover of the transmission. It draws fluid from a sump in the bottom of the transmission and feeds it to the hydraulic system. It also feeds the transmission cooler and the torque converter.

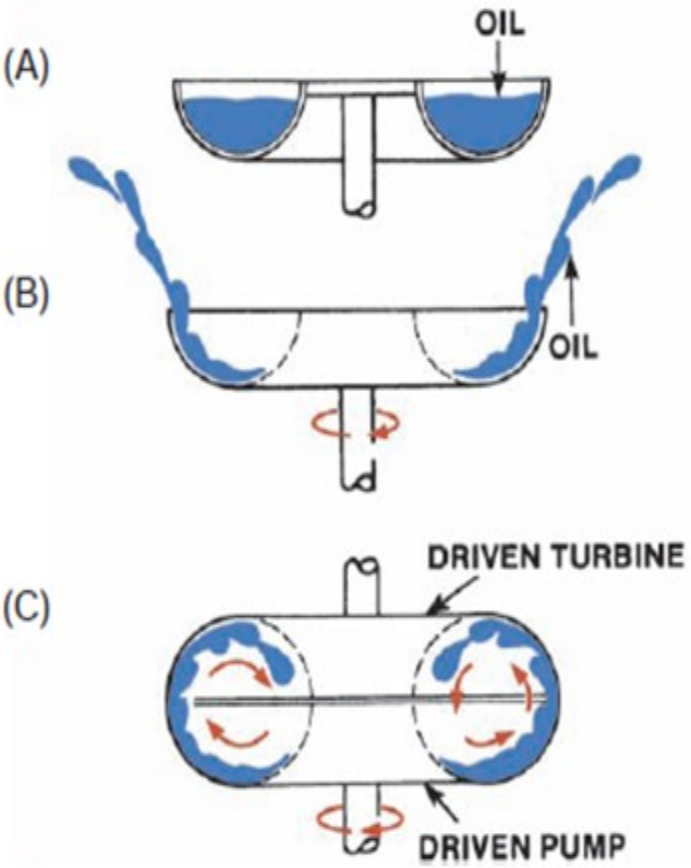
- The inner gear of the pump hooks up to the housing of the torque converter, so it spins at the same speed as the engine. The outer gear is turned by the inner gear, and as the gears rotate, fluid is drawn up from the sump on one side of the crescent and forced out into the hydraulic system on the other side.



The transmission oil pump is driven by the hub or housing of the torque converter. Some are driven by an oil pump shaft. The pump runs whenever the engine is running. This is why a faulty pump will make a whining noise in all gears including park and neutral.

Gear pump from an automatic transmission

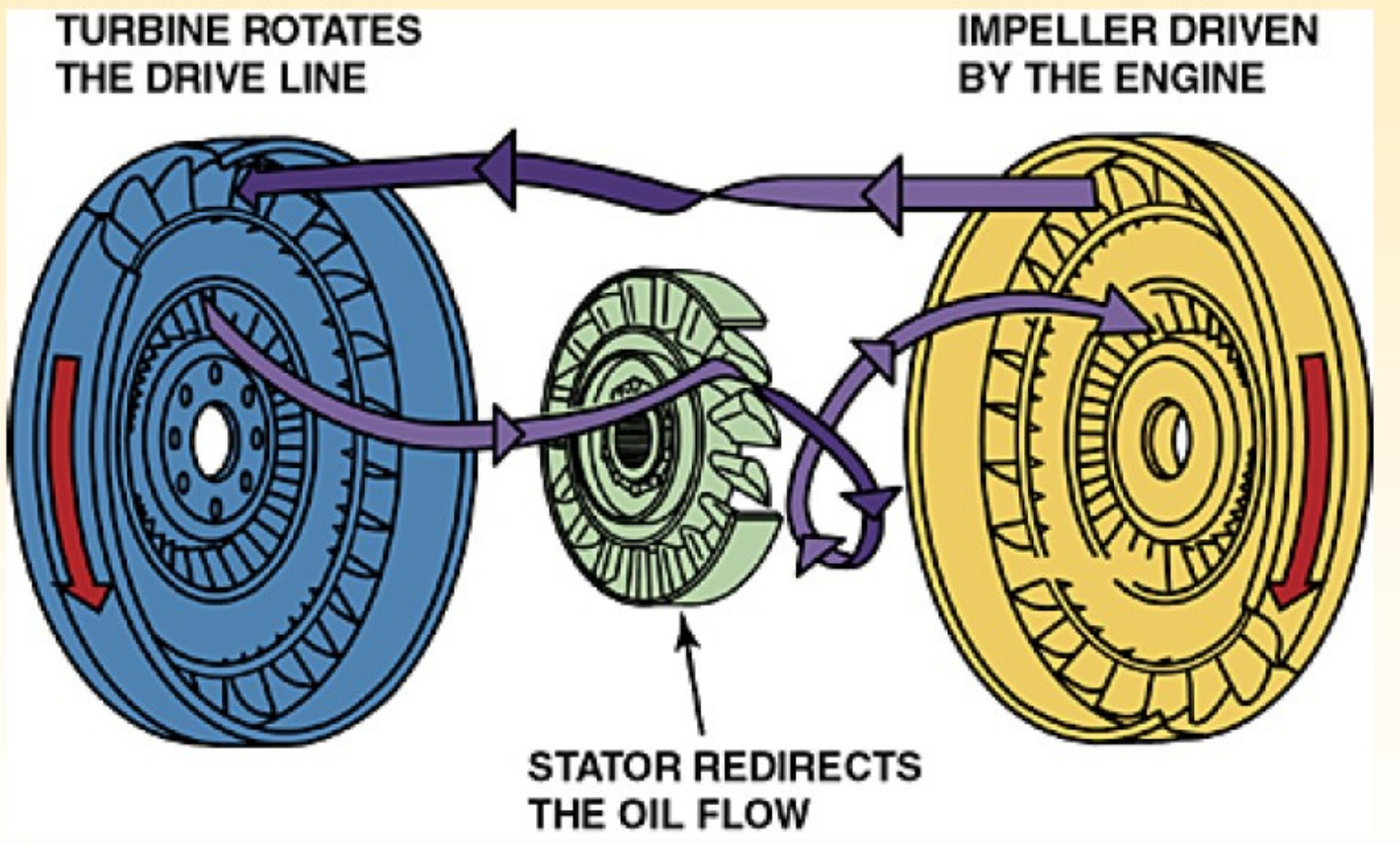
- When the engine runs, the fluid between the vanes in the impeller is thrown outward by the centrifugal force.
- The fluid strikes the turbine vanes. This action produce rotating force on the turbine and the transmission input shaft attached to it.
- The vanes then directs the fluid toward the centre of the turbine and back toward the centre of the impeller.

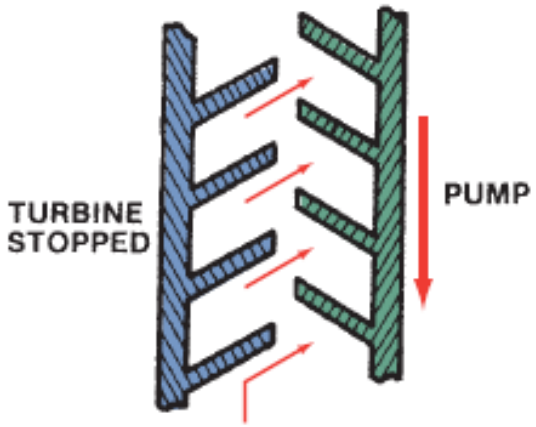


STATOR:

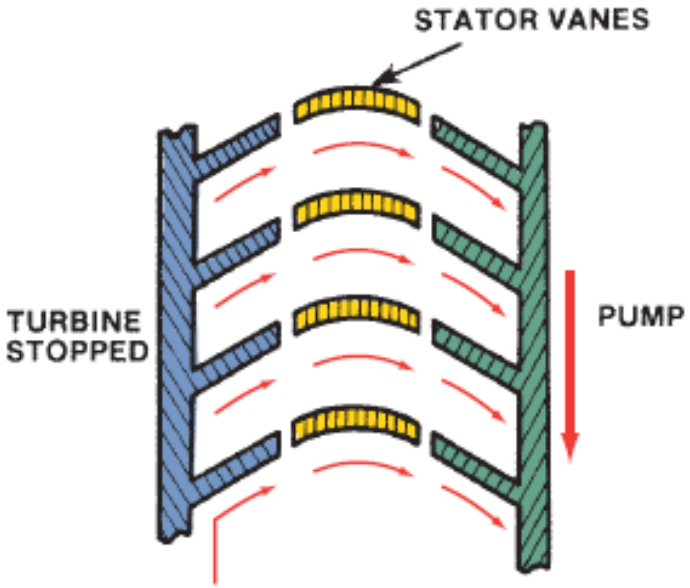
- To make the torque converter more efficient, a 3rd member or stationary reactor called stator is placed between the impeller & turbine.
- The stator have curve vanes that change the direction of the fluid after it leaves the turbine. This causes the fluid to pass trough the impeller & then push on the turbine vanes again with a helping force that aid rotation. The result is *torque multiplication* under certain condition.
- Torque multiplication: in many torque converter the torque is more than double.e.g, 1.35N.m of torque entering the impeller, the turbine delivers more than 2.7N.m of torque to the transmission input shaft. Torque multiplication occurs only when the impeller turns faster than the turbine.

Fluid flow within a torque converter. The stator redirects the fluid that is thrown out by the turbine, thereby improving efficiency.

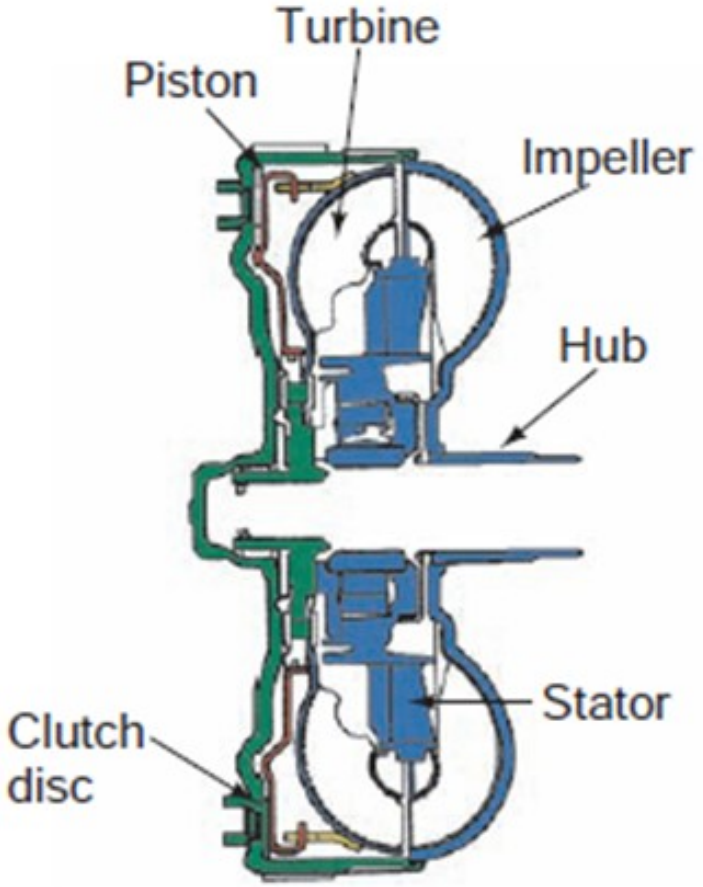




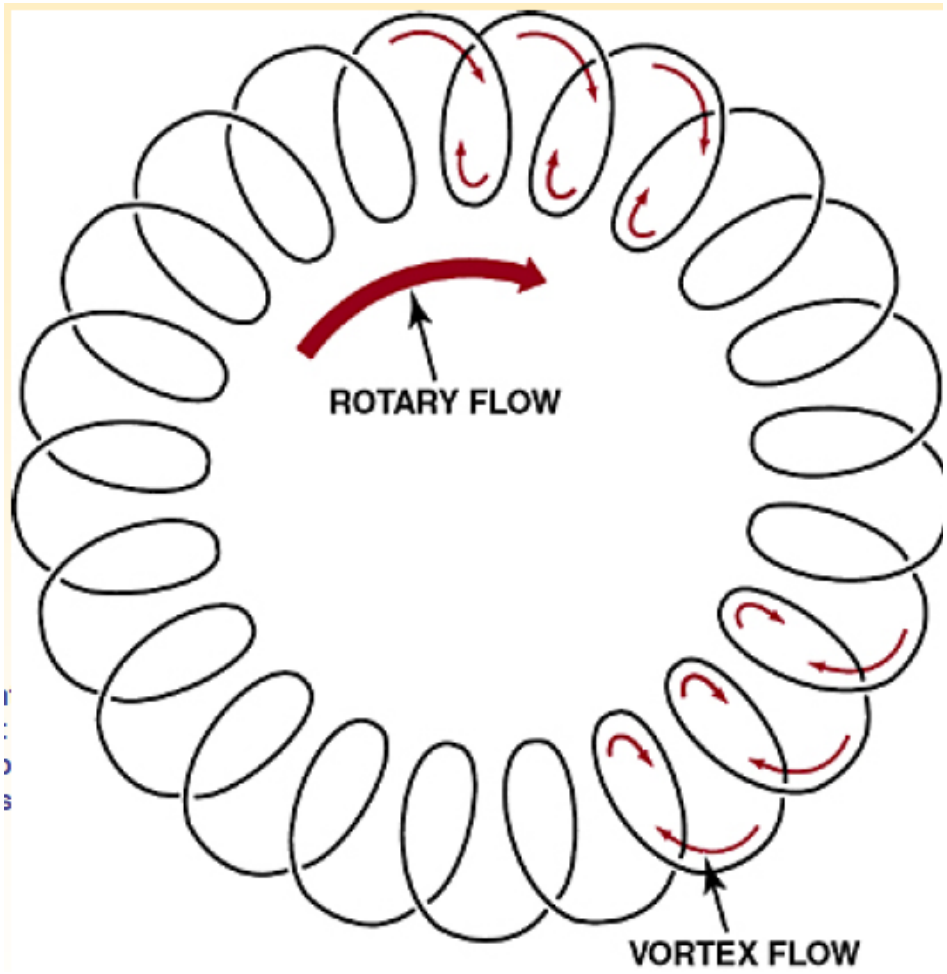
(A)



(B) OIL PATH IS CHANGED BY STATOR.



Fluid pumped into the turbine by the impeller not only creates rotary fluid flow but also vortex flow that increases the efficiency of the torque converter.



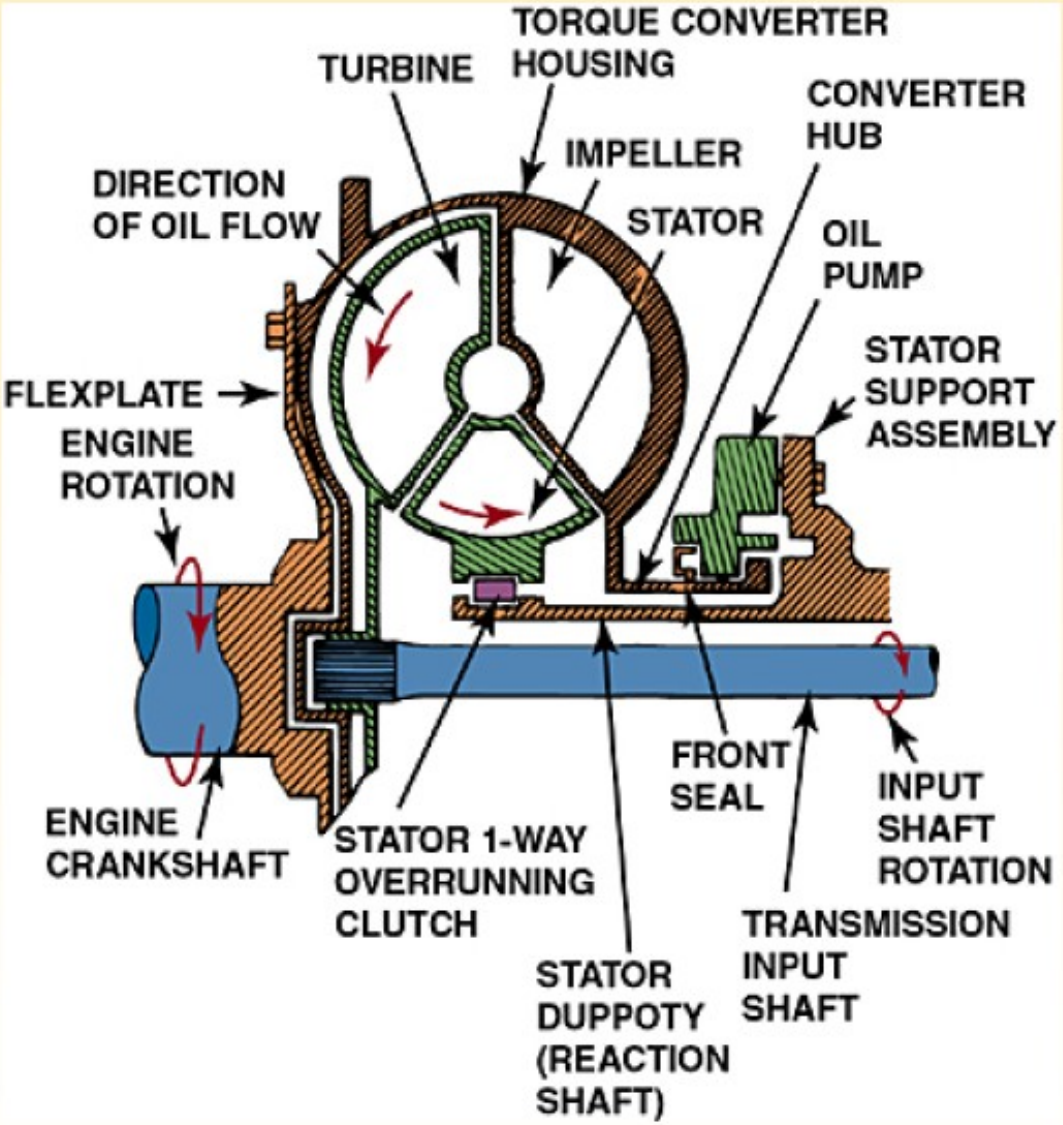
STATOR ONE- WAY CLUTCH

- As the vehicle approaches cruising speed, the turbine begins to catch up with the impeller (coupling point).
- The fluid leaving the turbine is moving at about the same speed as the impeller. This fluid could pass directly into the impeller without stator action. In fact, the stator vane are now in the way. The fluid is striking the back sides of the stator vanes.
- To allow the stator vanes to move out of the way, the stator mounts on a one- way clutch (overrunning clutch)

One- way Clutch

- A mechanical device that tranmits torque in one direction & permits free rotation in the opposite side.
- When the speed difference between the impeller & the turbine is large, the fluid from the turbine tries to spin the stator backward. This causes the one- way clutch to lock the stator to its shaft. When the speed difference is small, the clutch unlocks & allows the stator to freewheel. 2 types of one way clutch are *roller clutch & sprag type clutch.*

Figure 100–7
The transmission input shaft connects directly to the turbine through splines in most rear-wheel-drive transmissions.



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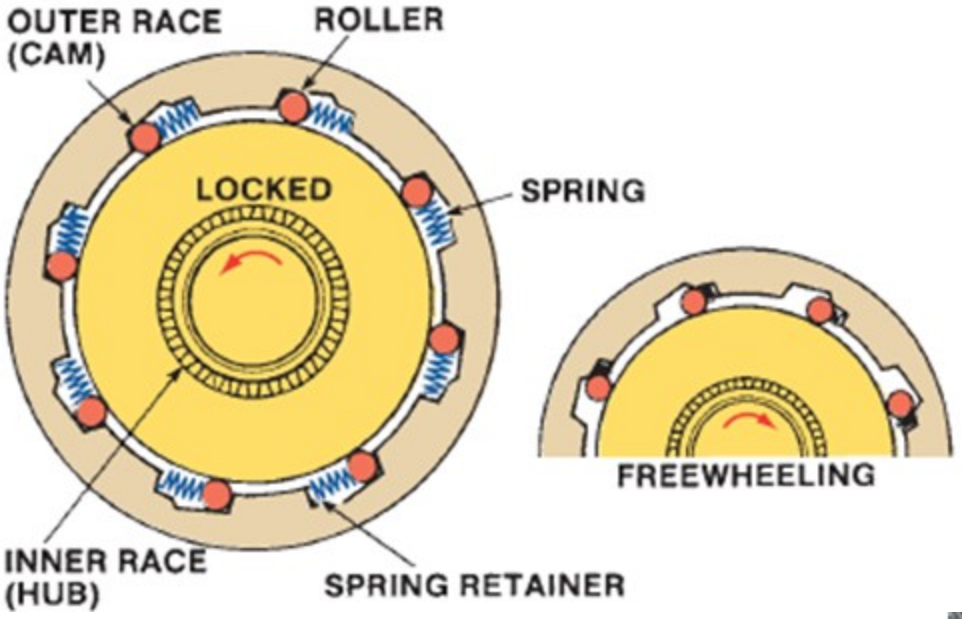
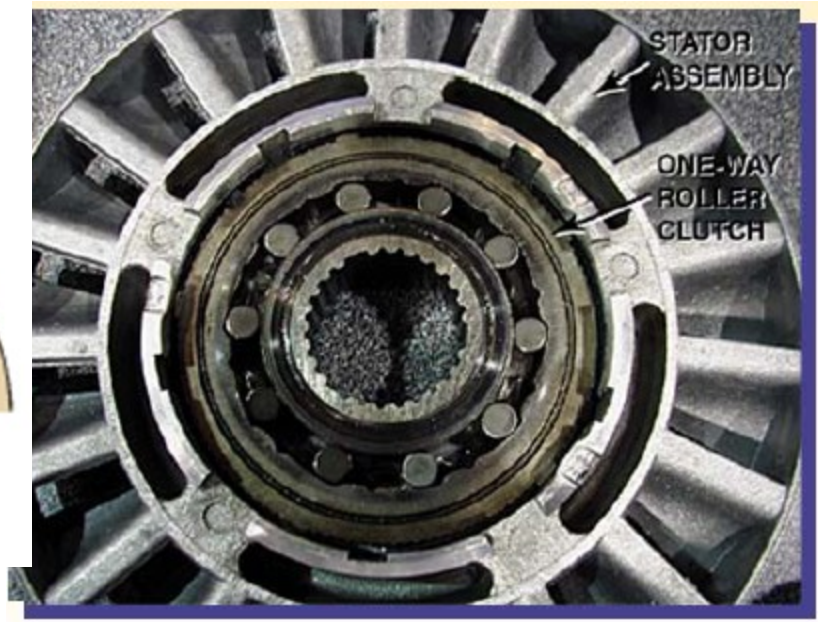
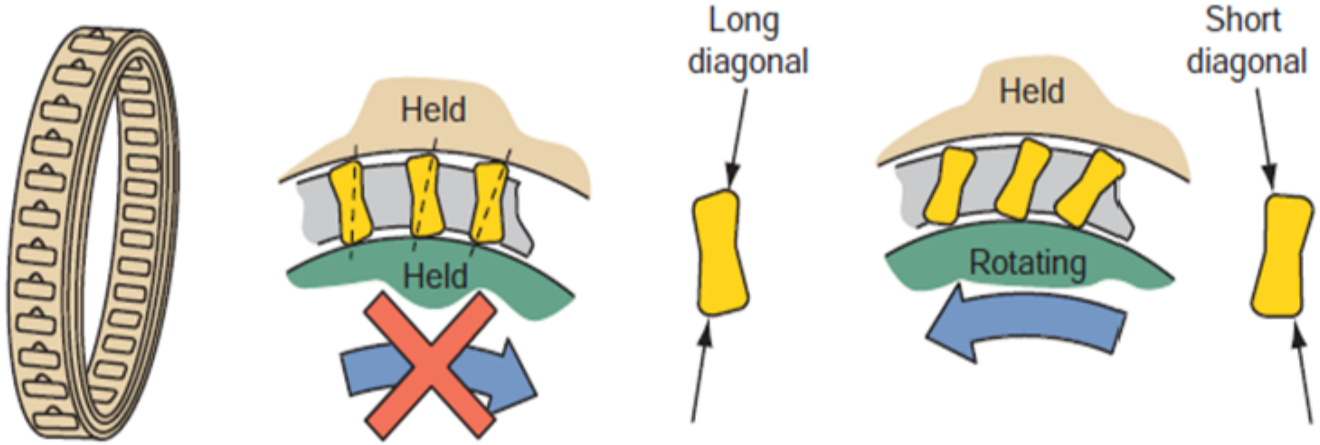






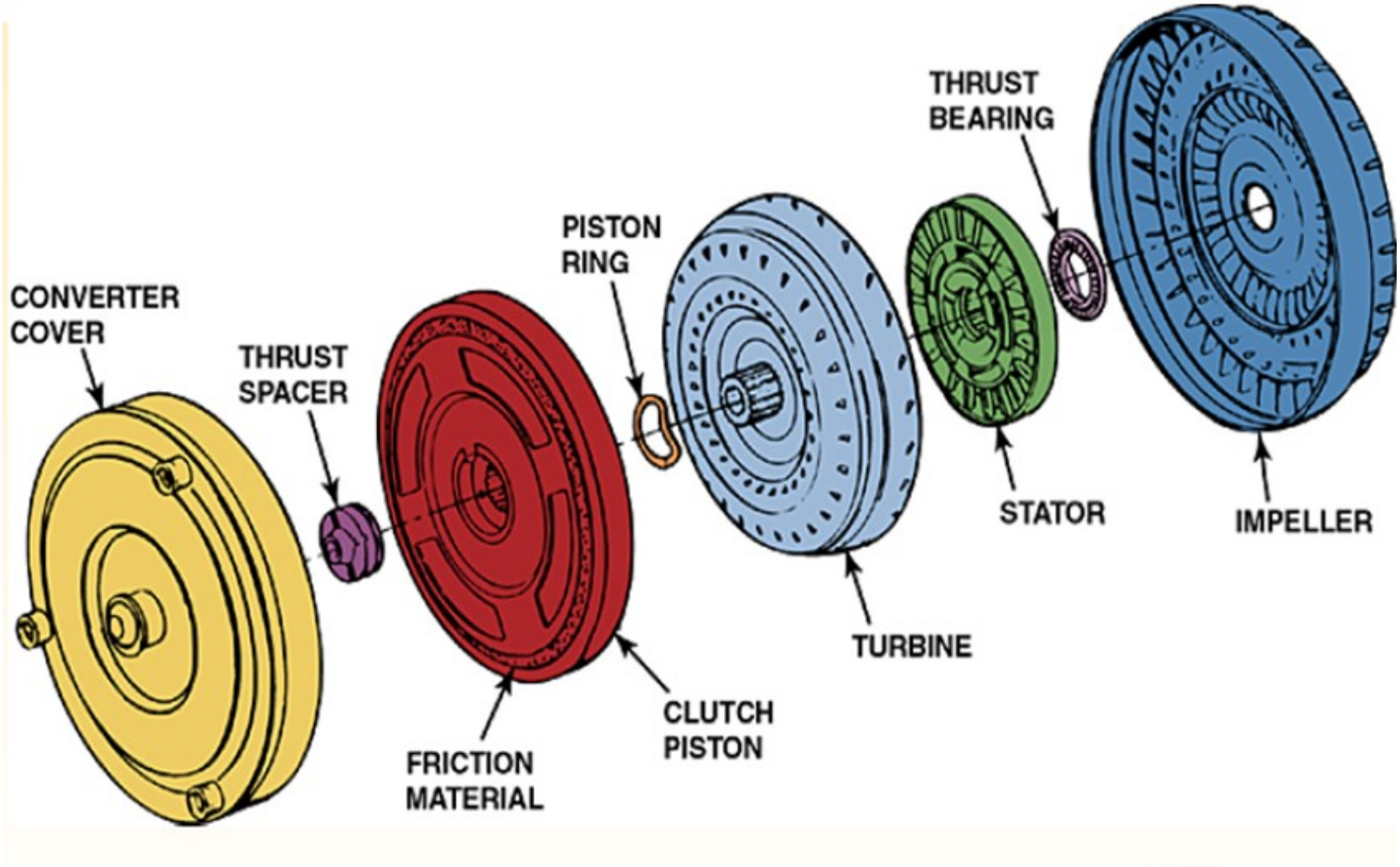
The action of a sprag-type one-way clutch.

TORQUE CONVERTER CLUTCH (TCC)

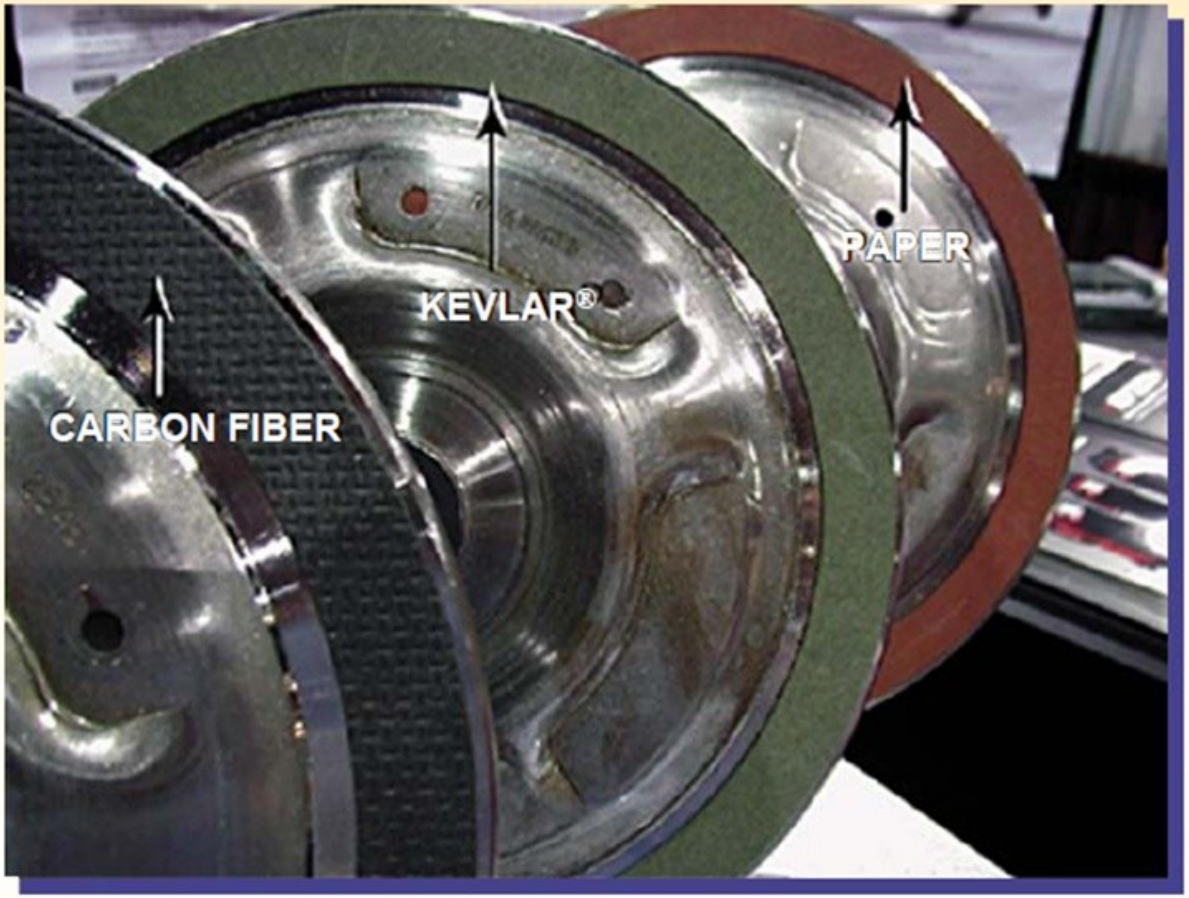
- Function:

A lockup torque converter eliminates the 10% slip that takes place between the impeller and turbine at the coupling stage. The engagement of a clutch between the impeller and the turbine assembly greatly improves fuel economy and reduces operational heat and engine speed.

An expanded view of a typical General Motors torque converter clutch (TCC).

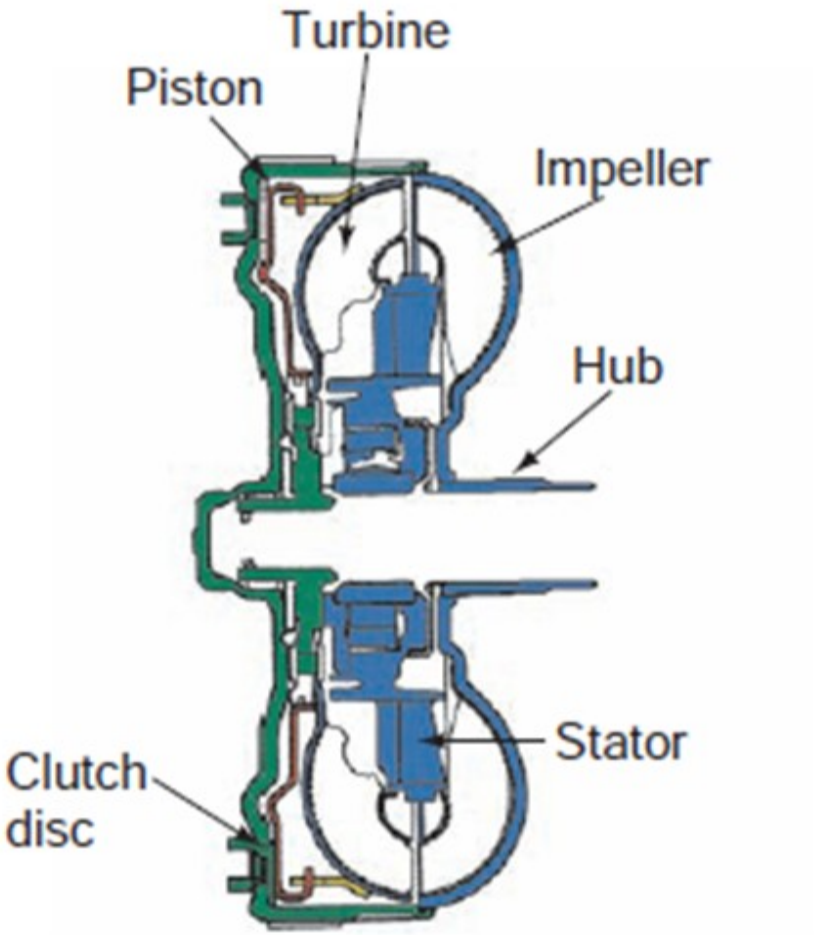


The type of torque converter clutch control determines the type of friction material that is used on a torque converter clutch. A paper friction material is usually used on clutches that are turned on or off, whereas Kevlar® or carbon fiber friction materials are used where the clutch is pulse-width modulated.



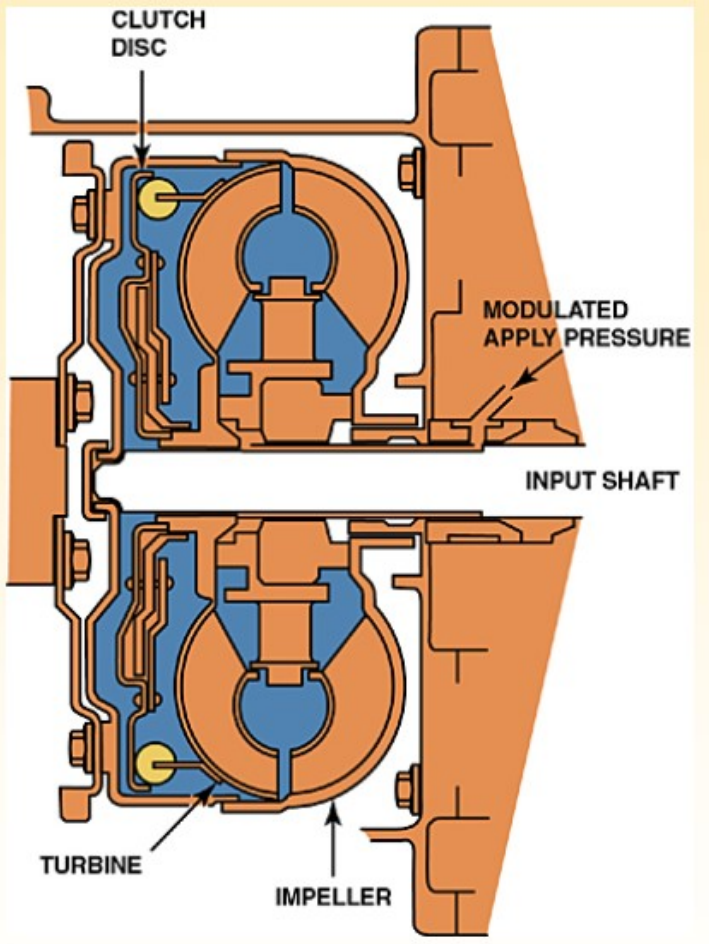
- The lock- up torque converter (TCC) has a lock-up or clutch piston with a lining of friction material.
- The piston or plate attaches to the turbine hub.
- Isolator springs helps dampen the shock of engagement as the torque converter locks. They also dampen out the power pulse from the engine while the torque converter is locked.

TCC operation



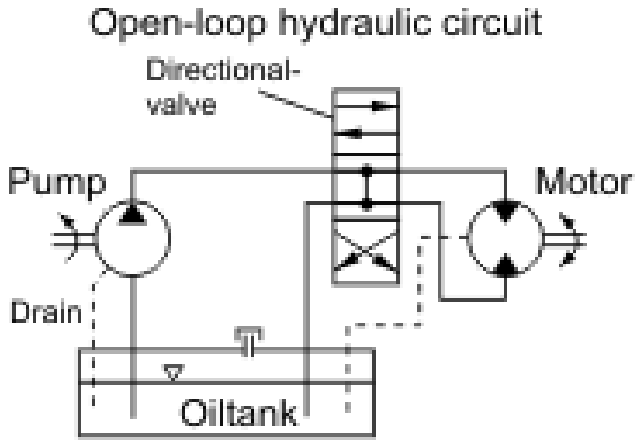
A piston-type converter lockup clutch assembly. *Courtesy of Chrysler LLC*

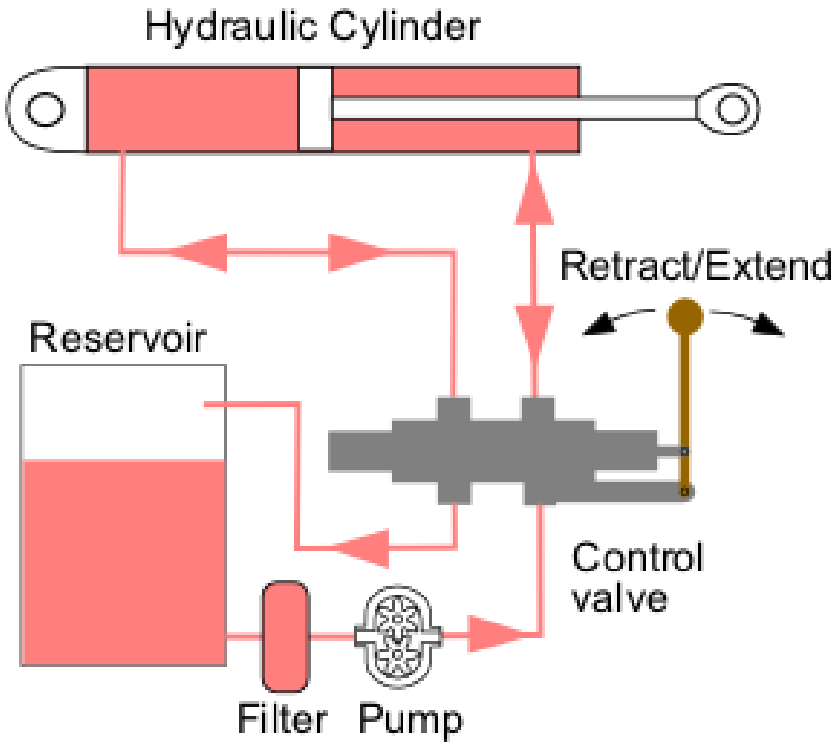
- The clutch is controlled by hydraulic valves, which are controlled by the PCM. The PCM monitors operating conditions and controls lockup according to those conditions.
- When the converter is not locked (clutch disengage), fluid enters the converter and moves to the front side of the piston, keeping it away from the shell or cover. Fluid flow continues around the piston to the rear side and exits between the neck of the torque converter and the stator support.
- During the lockup mode (clutch engage), the switch valve moves and reverses the fluid path. This causes the fluid to move to the rear of the piston, pushing it forward to apply the clutch to the shell and allowing for lockup. Fluid from the front side of the piston exits through the turbine shaft that is now vented at the switch valve.

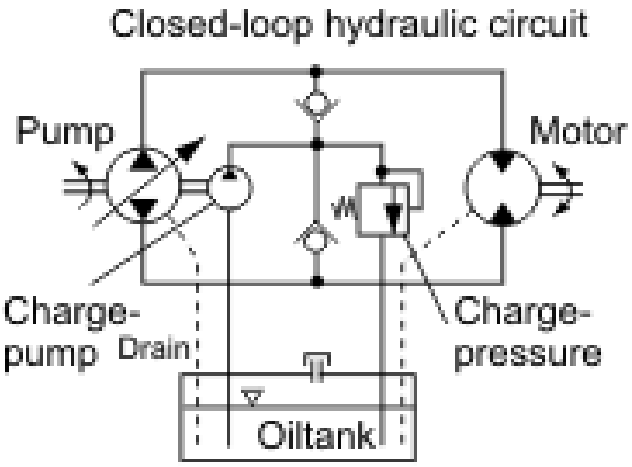


- Reduction in engine speed and the elimination of the normal slippage in the torque converter improves fuel economy.
- The torque converter clutch is released during rapid acceleration for maximum torque multiplication through the torque converter for best acceleration.

HYDRAULIC CIRCUIT







- Revise a basic hydraulic circuit components:-

a. Hydraulic pump

b. Control valves (directional control)

- **Pressure relief valves**
- **Pressure regulators**
- **Shuttle valves**
- **Check valves**

c. **Actuators(** Hydraulic cylinder, Swashplates, Hydraulic motor , hydrostatic transmission, Brakes)

d. Reservoir

e. Accumulators

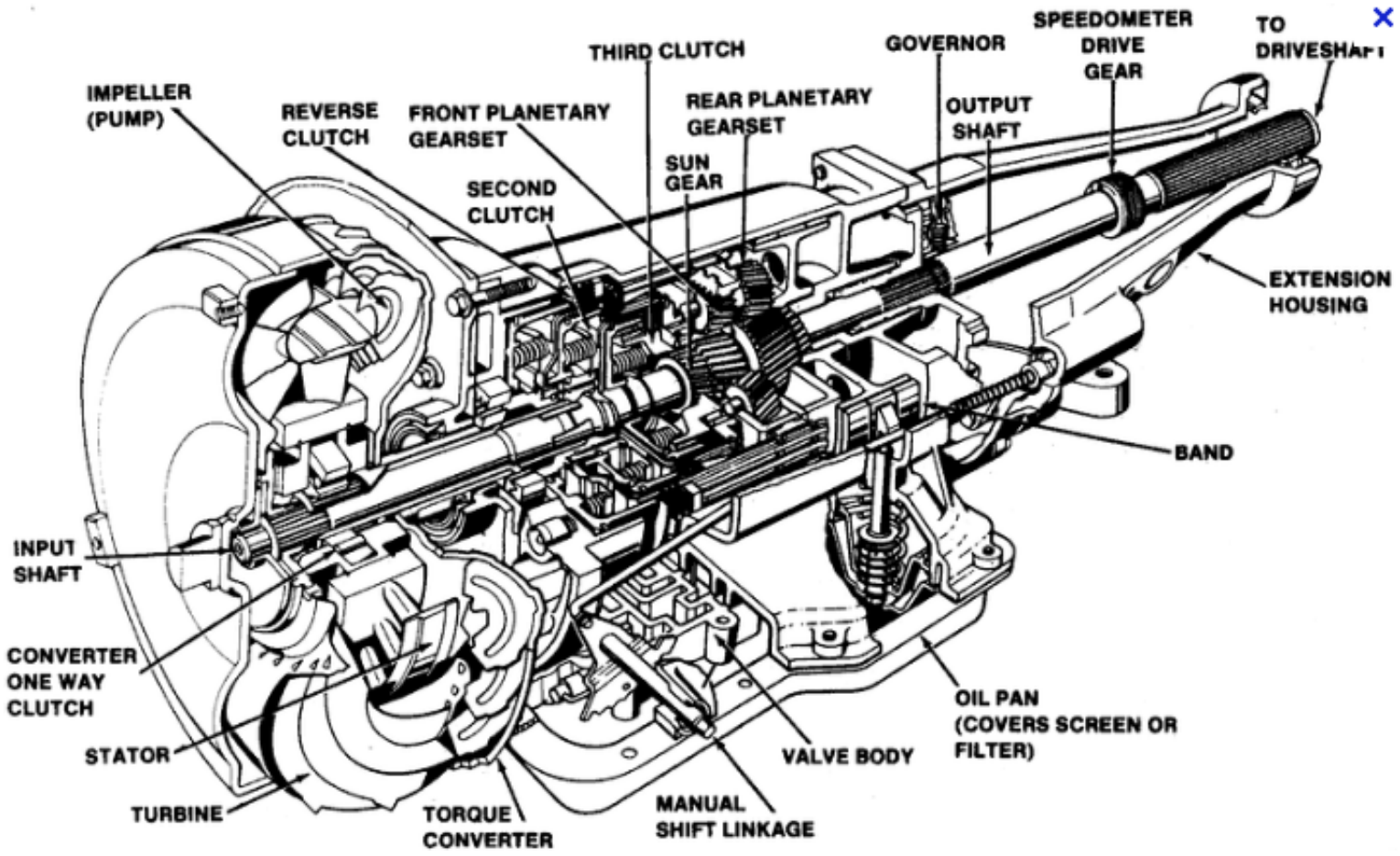
f. Hydraulic fluid

g. Filters

h. Tubes, pipes and hoses

i. Seals, fittings and connections

A/T GEAR- TRAIN



A/T GEAR- TRAIN

- Gear-train consist of the following:-

a. ***Planetary gearset*****:** A compound epicyclic planetary gearset, whose bands and clutches are actuated by hydraulic servos controlled by the valve body, providing two or more gear ratios.

b. ***Clutches and bands:*** to effect gear changes, one of two types of clutches or bands are used to hold a particular member of the planetary gearset motionless, while allowing another member to rotate, thereby transmitting torque and producing gear reductions or overdrive ratios. These clutches (overrunning clutch) are actuated by the valve body (see below), their sequence controlled by the transmission's internal programming.

***C. Valve body*:** hydraulic control center that receives pressurized fluid from the *main pump* operated by the fluid coupling/torque converter. The pressure coming from this pump is regulated and used to run a network of spring-loaded valves, check balls and servo pistons. The valves use the pump pressure and the pressure from a centrifugal governor on the output side (as well as hydraulic signals from the range selector valves and the *throttle valve* or *modulator*) to control which ratio is selected on the gearset; *as the vehicle and engine change speed, the difference between the pressures changes, causing different sets of valves to open and close.* The hydraulic pressure controlled by these valves drives the various clutch and brake band actuators, thereby controlling the operation of the planetary gearset to select the optimum gear ratio for the current operating conditions. However, in many modern automatic transmissions, the valves are controlled by electro-mechanical servos which are controlled by the electronic engine control unit (ECU) or a separate transmission control unit (TCU, also known as transmission control module (TCM).

a. PLANETARY GEARS

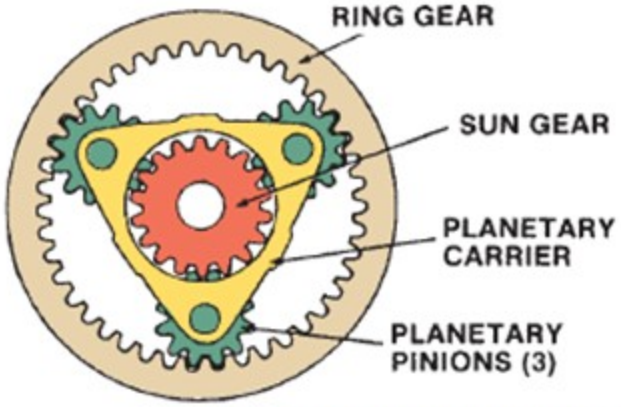
- Any planetary gear set has three main components:

a. The **sun gear**

b. The **planet gears** and the planet gears' **carrier**

c. The **ring gear**

- Each of these three components can be the input, the output or can be held stationary. Choosing which piece plays which role determines the gear ratio for the gearset.



Planetary gear configuration is similar to the solar system, with the sun gear surrounded by the planetary pinion gears. The ring gear surrounds the complete gear set.

From left to right: the ring gear, planet carrier, and two sun gears