GEARBOXES IN AUTOMOBILES

By

Sanket Chandrashekhar Totewar

AND

Shashank Maikhuri

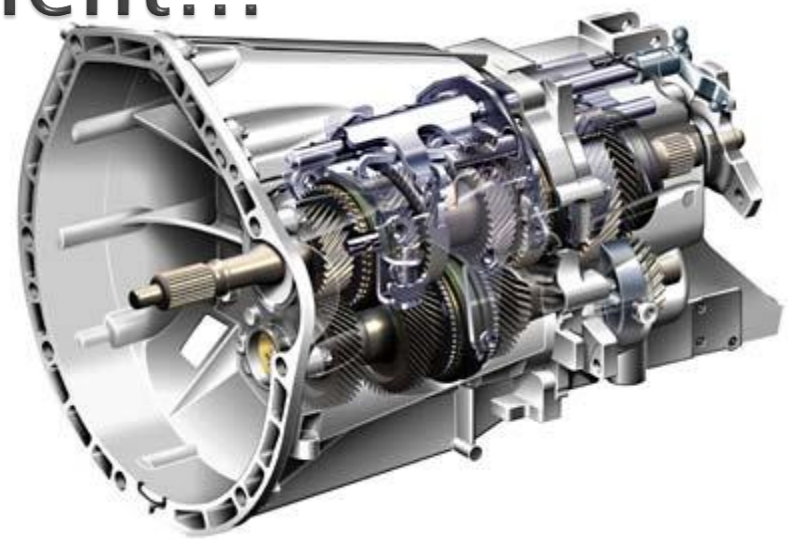
B.E. Mechanical Sandwich

Vishwakarma Institute of Technology, Pune – 37.

Introduction…

- A transmission or gearbox provides **speed** and **torque conversions** from a rotating power source to another device **using gear ratios**, including for a motor vehicle partly because of the limitations of internal combustion engines.
- Usually found near motors of some sort, gearboxes are used to **reduce** the **load** on the motor by using the motor's own momentum to keep it turning.
- Once a motor has reached a number of revolutions per minute, it is advisable for the operator to increase the gear, to drop the revolutions on the motor, yet still keep the same amount of power created.
- This **reduces wear** on the engine, allows **more control**, and allows **greater speeds**.

History and Development…



- Early transmissions included the right-angle drives and other gearing in **windmills**, horse-powered devices, and **steam engines**, in support of **pumping**, **milling**, and **hoisting**.
- Most modern gearboxes are used to increase torque while reducing the speed of a prime mover output shaft (e.g. a motor drive shaft).
- A gearbox can be setup to do the opposite and provide an increase in shaft speed with a reduction of torque.

History and Development…

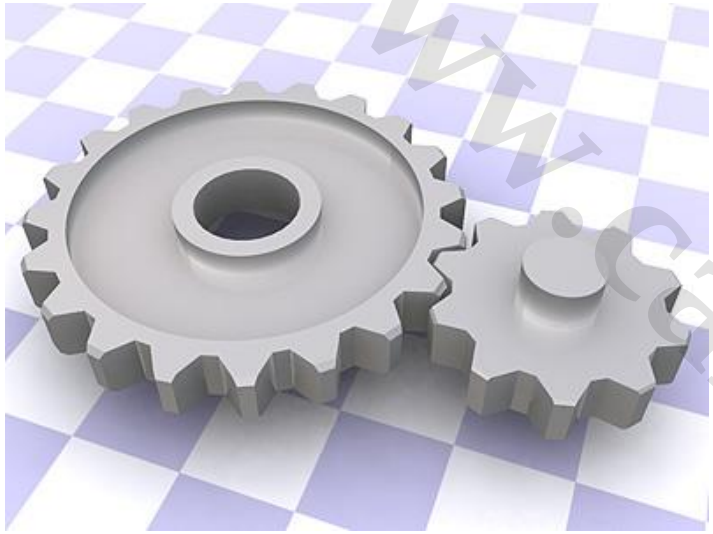
- As the output shaft of a gearbox rotates at slower rate than the input shaft, and this reduction in speed will produce a **mechanical advantage**, causing an increase in torque.
- Some of the simplest gearboxes merely change the physical direction in which power is transmitted.
- Many typical automobile transmissions include the ability to select one of several different gear ratios. In this case, most of the gear ratios (often simply called "gears") are used to slow down the output speed of the engine and increase torque.
- However, the highest gears may be "overdrive" types that increase the output speed.

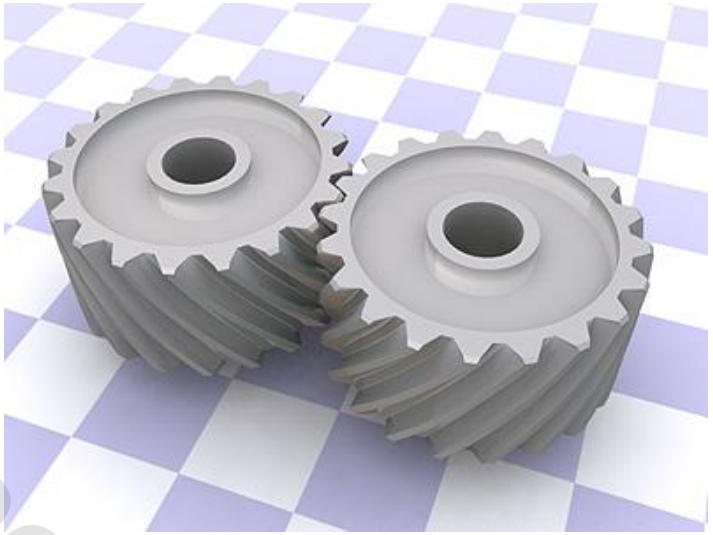
Function of a GearBox…

- In practice, the main use of a Gearbox is to act as a **reduction gear**. These can be variable or non-variable, depending on the application.
- This not only **decreases wear** on the motor, but also allows **greater acceleration** – in fact the larger the reduction ratio, the larger the acceleration.
- In other words, if when the motor is turning 2500 rpm the output shaft is turning 500, the gearbox is reducing the number of revolutions from input to output.
- Torque converters, hydraulics, electrical power and hybrid configurations may also be used for the same purpose.

Basic Principle…

- The gear (or cog, or sprocket) in its most basic form is a flat circular object that has teeth cut into the edge of it.





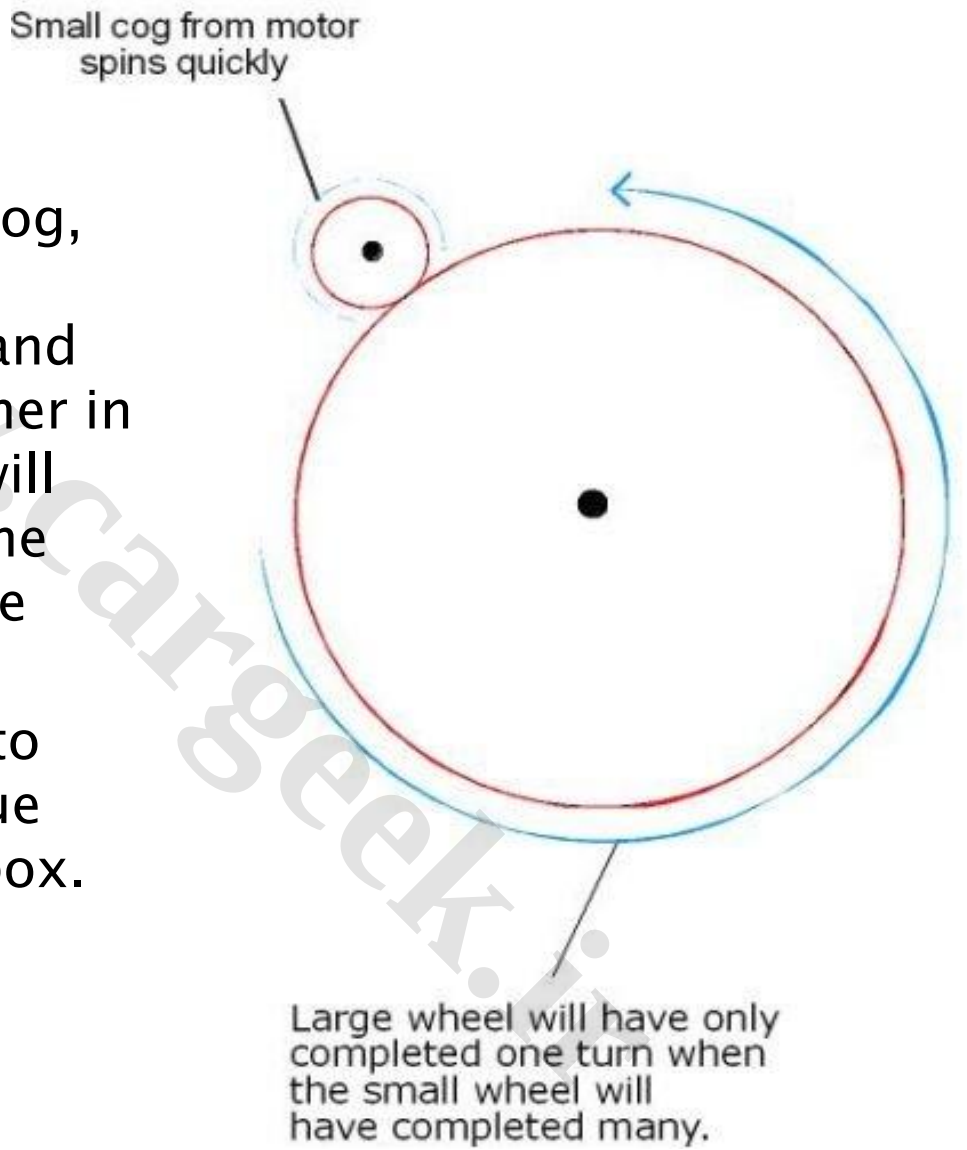
- The most basic type of gear is a spur gear, and it has straight-cut teeth, where the angle of the teeth is parallel to the axis of the gear.
- Wider gears and those that are cut for smoother meshing are often cut with the teeth at an angle, and these are called helical gears.

Basic Principle…

- Because of the angle of cut, helical gear teeth have a much more gradual engagement with each other, and as such they operate a lot more smoothly and quietly than spur gears.
- Gearboxes for cars and motorbikes almost always use helical gears because of this.
- A side effect of helical gears is that if the teeth are cut at the correct angle – 45 degrees – a pair of gears can be meshed together perpendicular to each other. This is a useful method of **changing** the **direction** of **movement or thrust** in a mechanical system.
- The number of teeth cut into the edge of a gear determines its scalar relative to other gears in a mechanical system.

Principle…

- If the input shaft is connected to a small cog, the output shaft is connected to a large, and two are meshed together in the gear box, then it will take several turns of the input shaft to make the output turn once.
- This principle is used to achieve speed or torque conversions in a gearbox.



Principle…

- Collections of helical gears in a gearbox are what give the gearing down of the speed of the engine crank to the final speed of the output shaft from the gearbox.

Gear	Ratio	RPM of gearbox output shaft when the engine is at 3000rpm
1st	3.166:1	947
2nd	1.882:1	1594
3rd	1.296:1	2314
4th	0.972:1	3086
5th	0.738:1	4065

- The table above shows some example gear ratios for a 5-speed manual gearbox (in this case a Subaru Impreza).

Applications…

- There are a number of things
- that use gearboxes, however for
- ease they are split up into 2 categories:

1. Motors
2. Engines

- **Motors** are generally speaking electrical based, and require a battery of some description to work, furthermore, they usually either have an automatic gearbox, or that the user can switch between a selected number of gears (mainly forward, neutral and reverse), with the gearbox filling in the rest.

- **Engines** are more likely to be run by a fuel, such as oil and are a lot larger, and more powerful, designed to be used for powering large systems.

Applications…

Motors:

- Items such as electric wheelchairs, milk floats and golf buggies use electric motors with a semi automatic gearbox.
- Pumps, winches and bowling alley machines use electric motors with an automatic gearbox.

Engines:

- Engines of motorcycles, cars, trucks and other heavy automobiles like dumpers, earth-movers, etc. employ gearboxes for transmission. Gearboxes are also used in generator sets.
- Most of them are manual, due to the range of conditions they need to use. As such, they are best used in things such as cars.

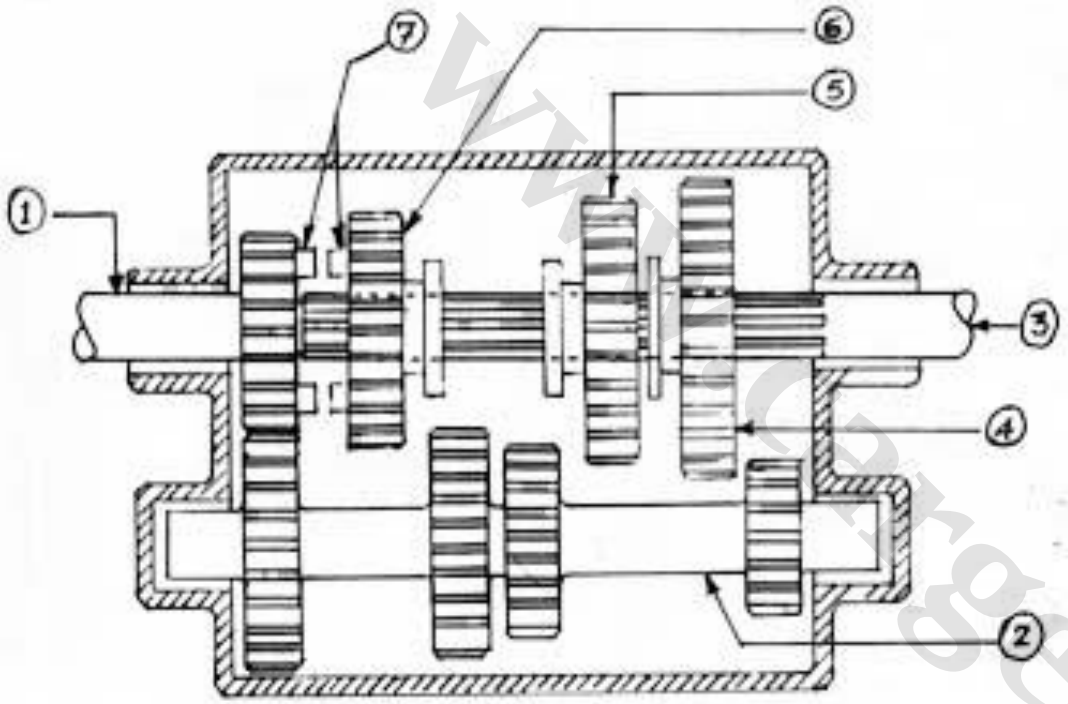
Types of Gearboxes

Types of Gearboxes:

- Sliding Mesh Gear box
- Constant Mesh Gear Box
- Synchromesh Gear Box
- Epicyclic Gear Box

An engine may consist of one or more gearbox.
There may be gearboxes which are a mixture of these types.

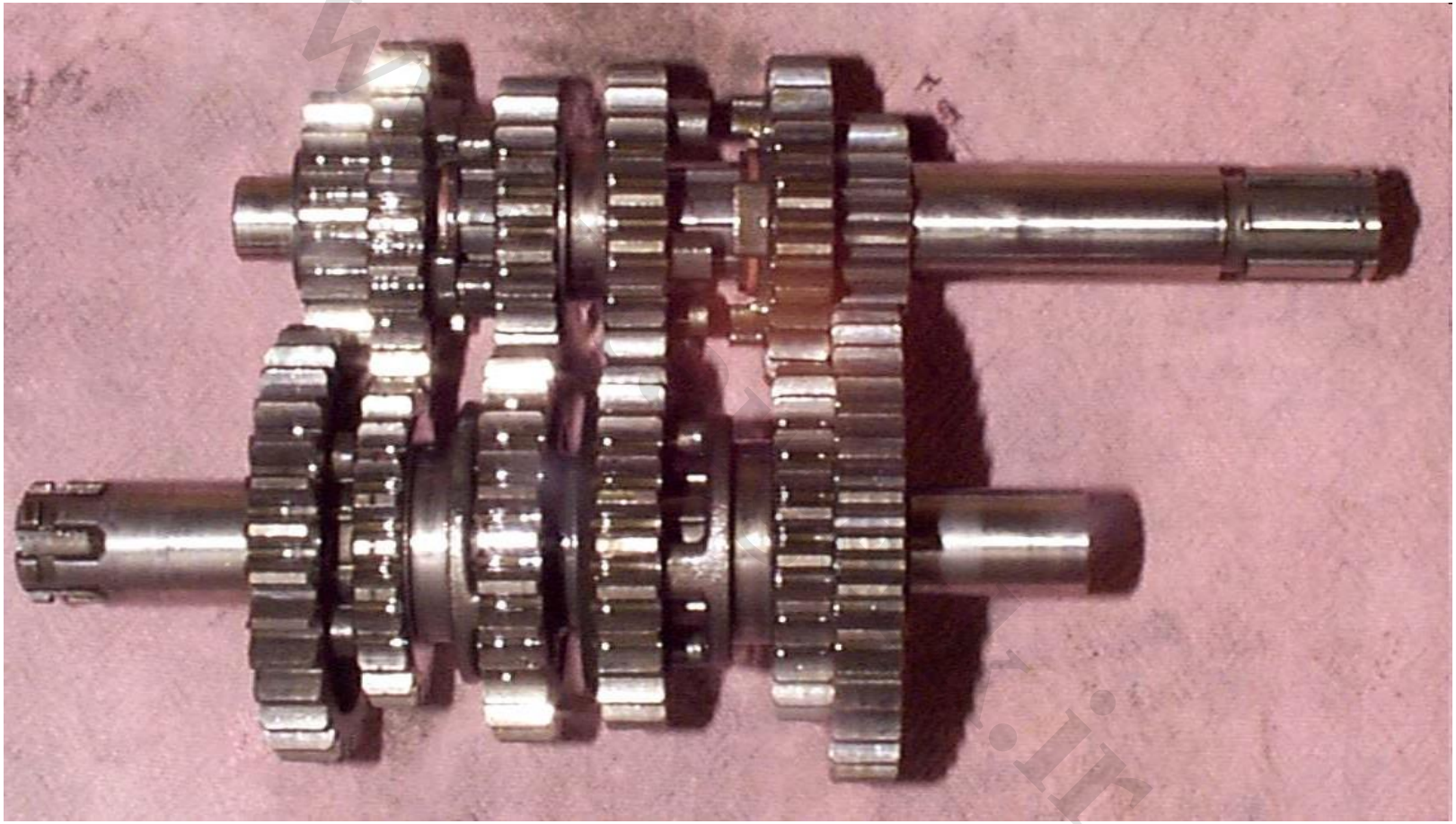
Sliding Mesh Gearbox



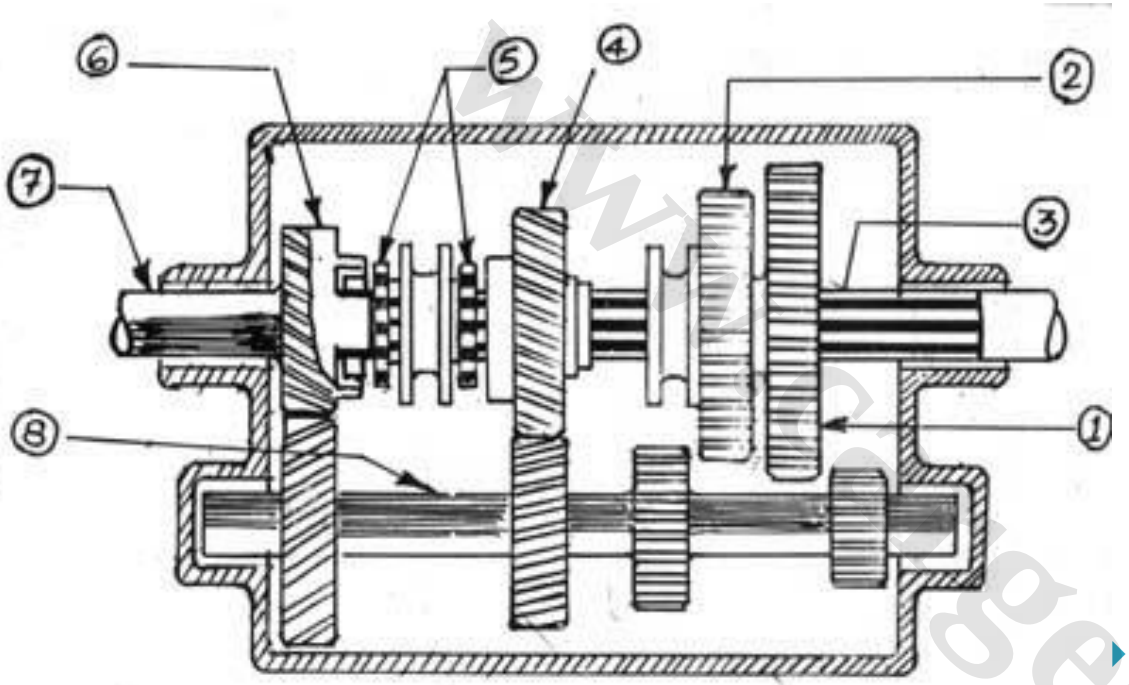
1.main drive gear
2.counter shaft
3.main shaft
4.I gear
5.II gear
6.III gear
7.top speed engaging dogs

- In this type of gear box, gears are engaged and disengaged by sliding of the gear wheels.
- Gear wheels on the main shaft engage with gear wheels on the lay shaft or counter shaft by sliding themselves.

Sliding Mesh Gearbox



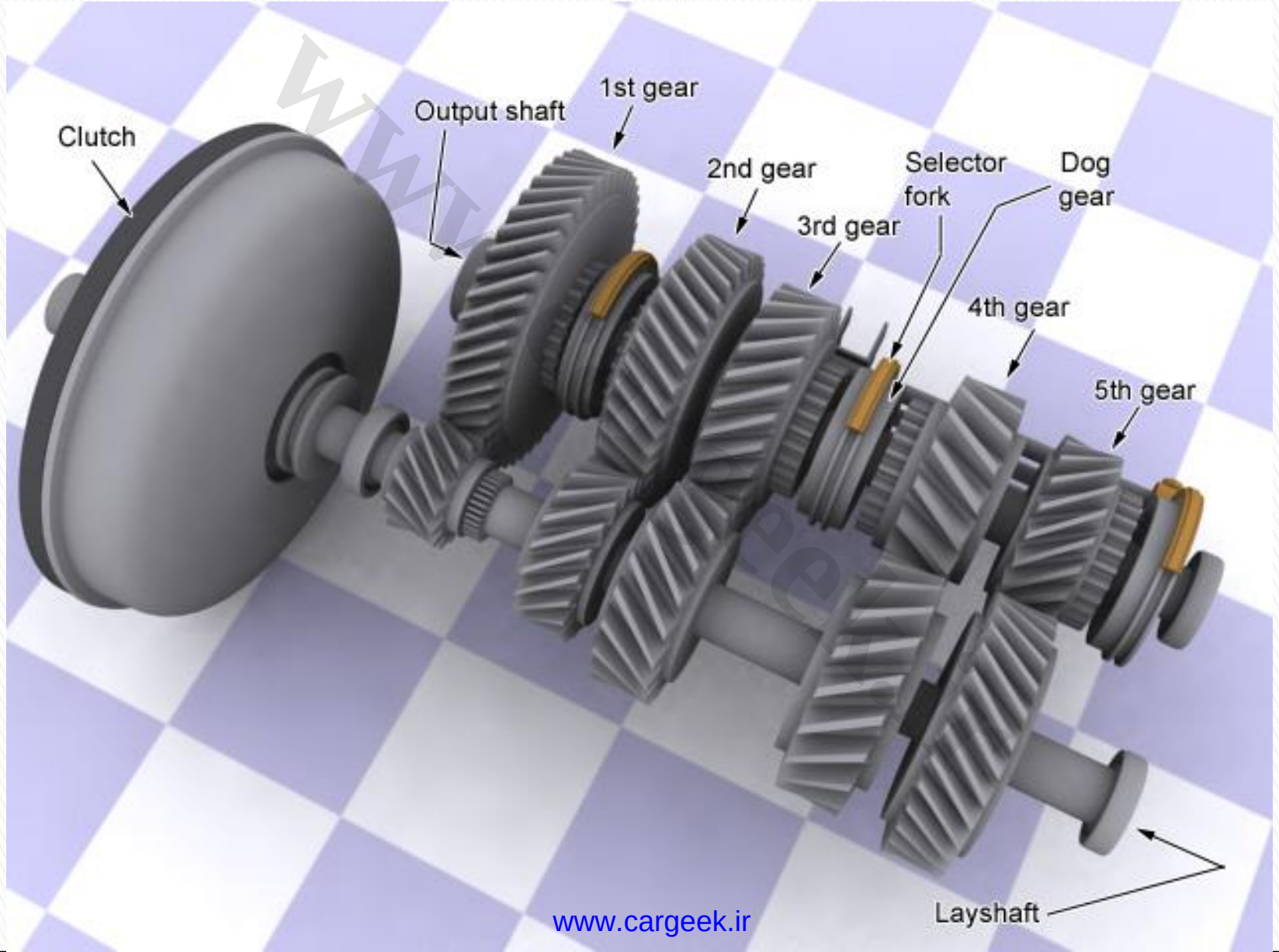
Constant Mesh Gearbox



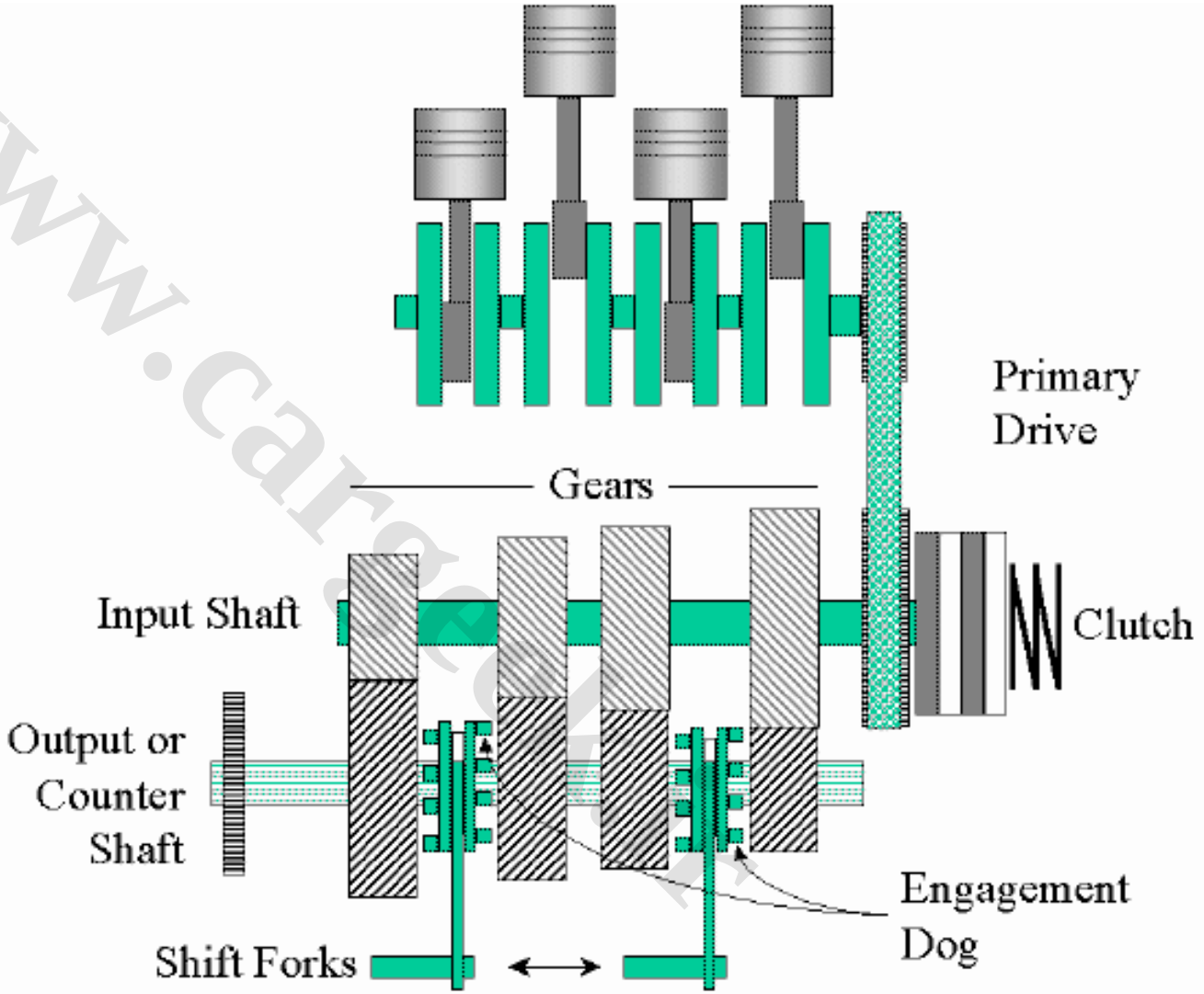
1.I speed gear
2.II speed gear
3.main shaft
4.III speed gear
5.top and III speed engaging dogs
6.top gear
7.primary shaft or main drive gear
8.counter shaft/cluster gear

- In this case, gear wheels on the main shaft and lay shafts are constantly engaged and the rotary motion is transmitted to the main shaft by engaging dog clutches.

Constant Mesh Gearbox



Constant Mesh Gearbox

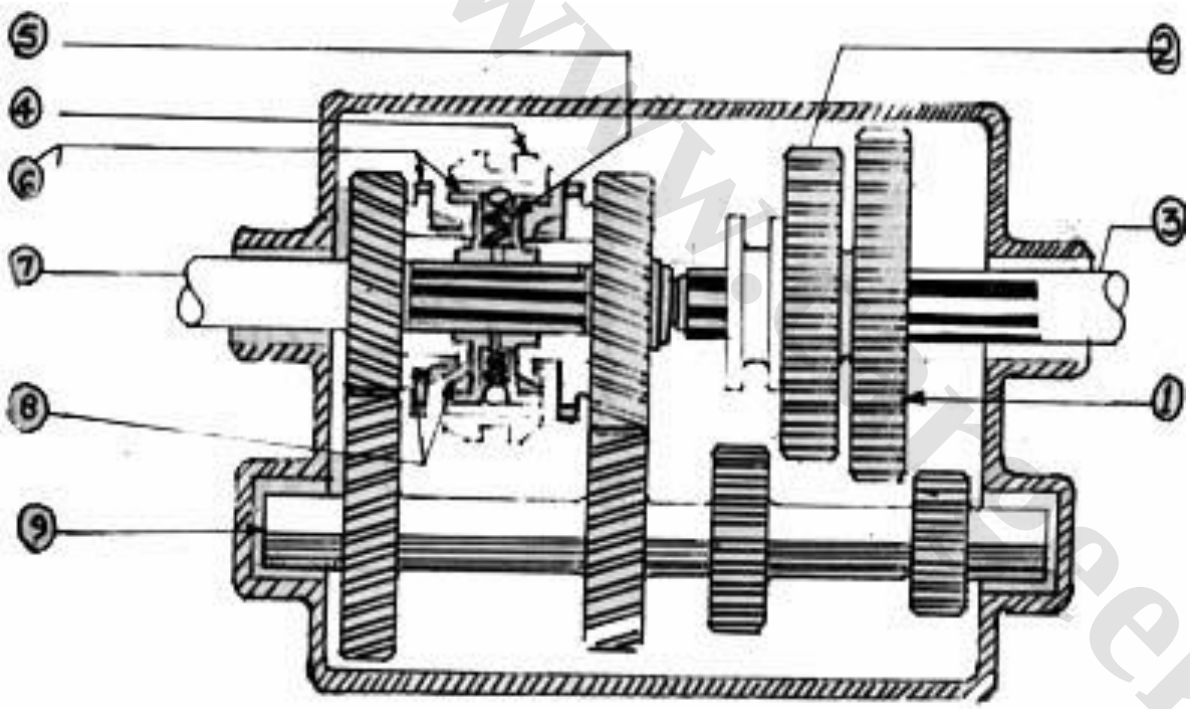


Constant Mesh Gearbox

Advantages of Constant mesh gearbox over Sliding mesh Gearbox:

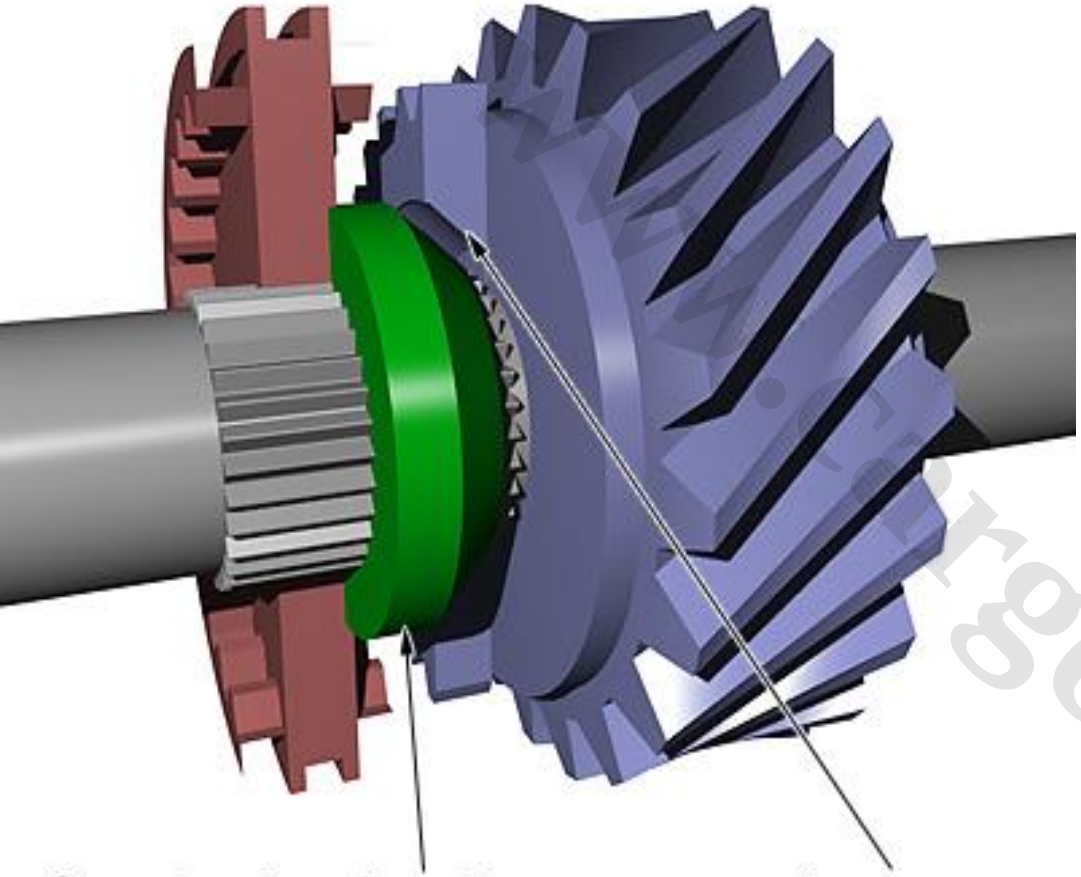
- Helical and herringbone gear can be employed in these gearboxes and, therefore, constant mesh gearboxes are quieter.
- Synchronizing devices can be easily incorporated.
- Since the gears are engaged by dog clutches, if any damage occurs while engaging the gears, the dog unit members get damaged and not the gear wheels.
- By suitably designing the dog clutch, the gear changing can be made easier.
- Damage to the dog clutch is less likely because all the teeth are engaged at a time.

Synchromesh Gearbox



1.I speed gear
2.II speed gear
3.main shaft
4.outer engaging unit
5.inner engaging unit
6.top gear engaging teeth
7.main drive gear
8.top gear synchronizing cones
9.counter shaft

Synchromesh Gearbox



Cone-shaped synchro collar engages cone-shaped recess in helical gear, bringing the dog gear up to speed.

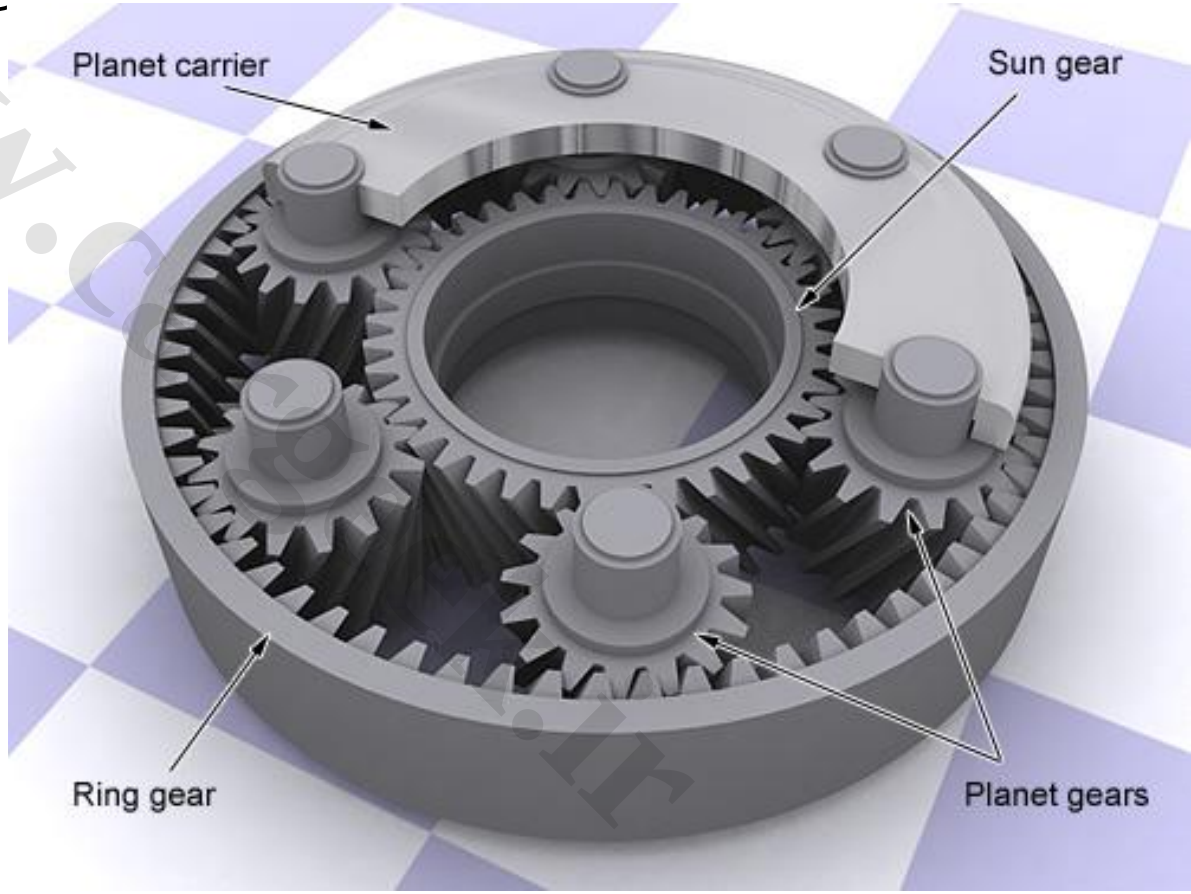
- The green cone-shaped area is the syncho collar. It's attached to the red dog gear and slides with it.
- As it approaches the helical gear, it makes friction contact with the conical hole.
- The more contact it makes, the more the speed of the output shaft and free-spinning helical gear are equalized before the teeth engage.

Synchromesh Gearbox

- If the car is moving, the output shaft is always turning (because ultimately it is connected to the wheels).
- The layshaft is *usually* connected to the engine, but it is free-spinning once the clutch has been operated.
- Because the gears are meshed all the time, the synchro brings the layshaft to the right speed for the dog gear to mesh.
- This means that the layshaft is now spinning at a different speed to the engine, the clutch gently equalises the speed of the engine and the layshaft, either bringing the engine to the same speed as the layshaft or vice versa depending on engine torque and vehicle speed.

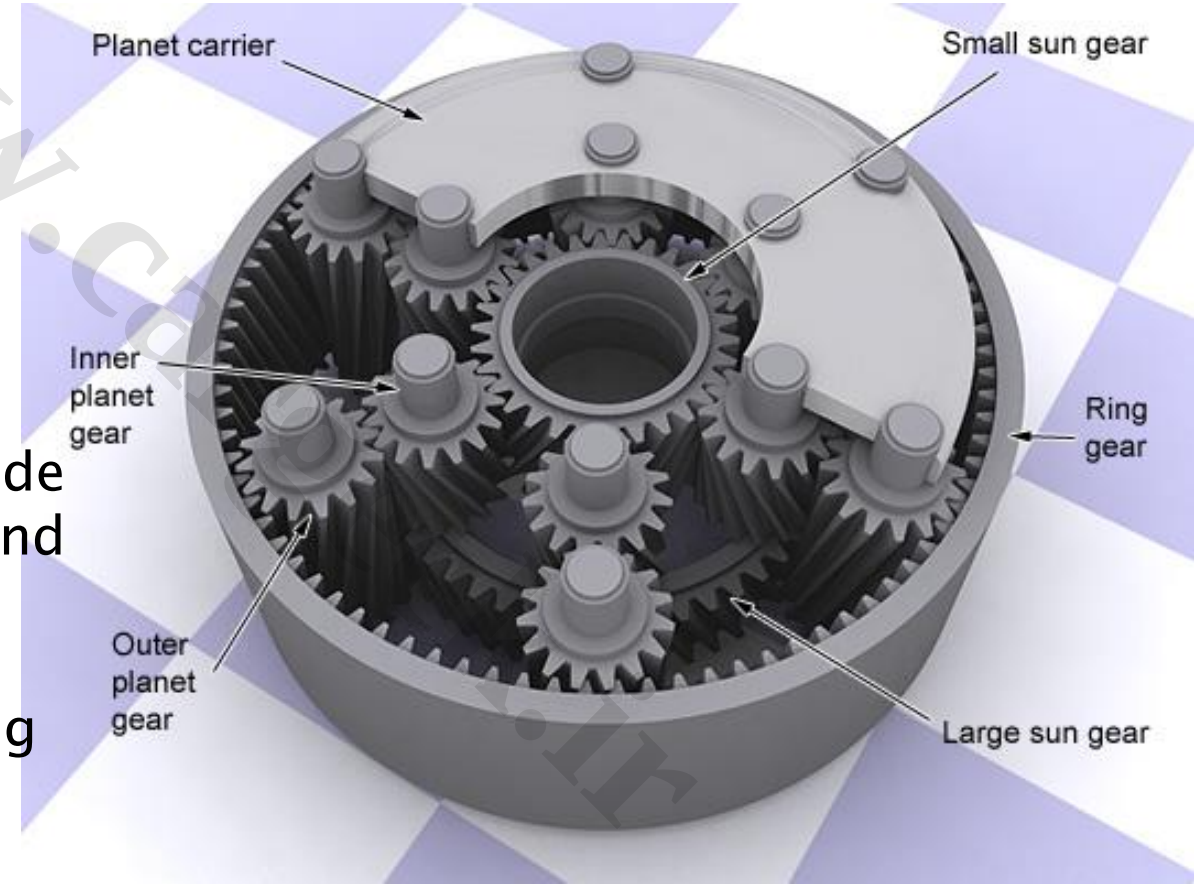
Epicyclic Gearbox

- In such gear boxes epicyclic gear trains are employed to get the various gear ratios.
- The characteristic feature of an epicyclic gearing is that at least one wheel not only rotates about its own axis but also rotates about some other axis.

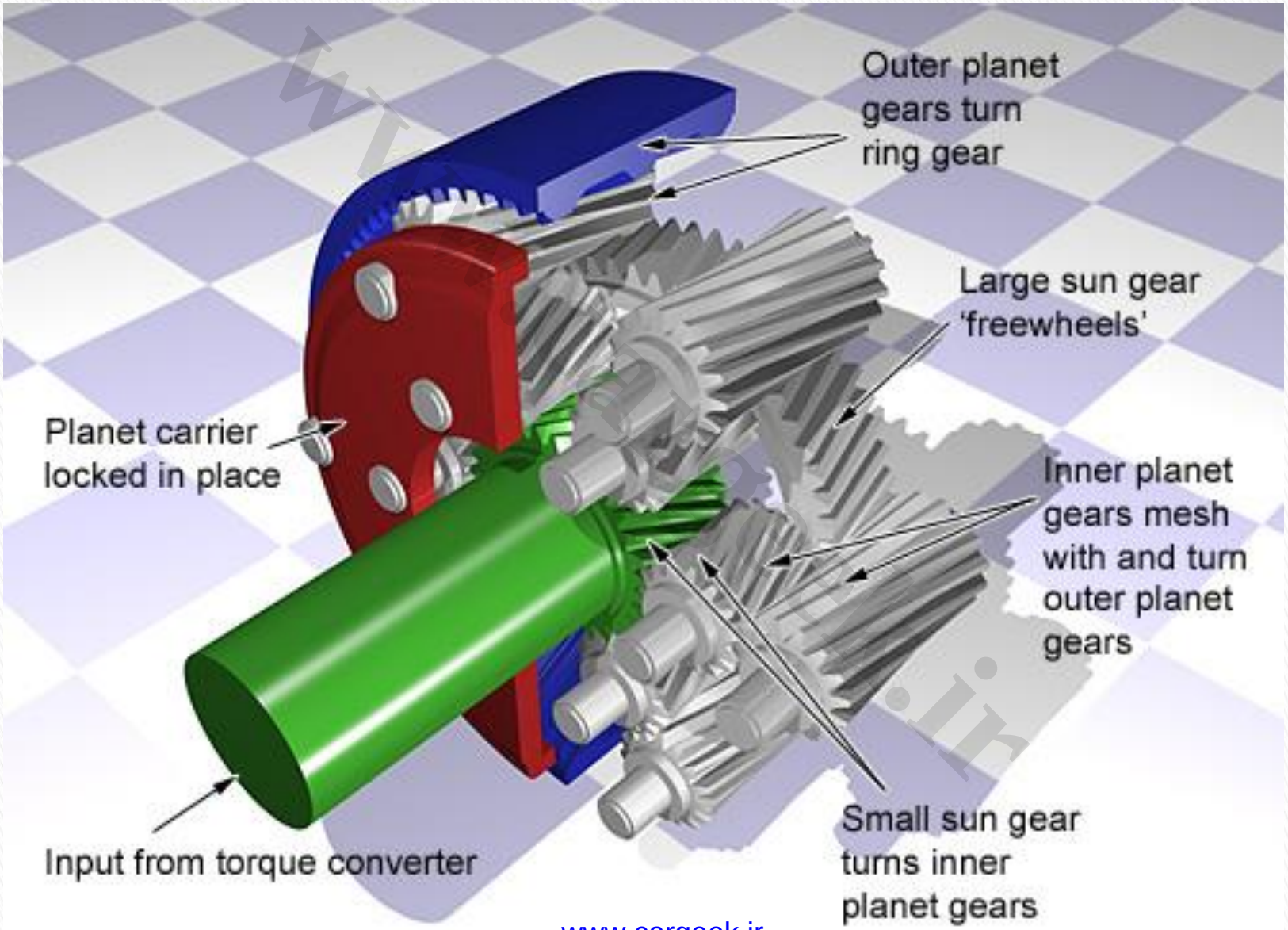


Epicyclic Gearbox

- Automatic gearboxes typically use one or more compound planetary gearsets instead of chaining regular gearsets together.
- They look just like a regular planetary gearset from the outside, but inside there are two sun gears and two sets of intermeshing planet gears.
- There is still only one ring gear though.



Epicyclic Gearbox



Overdrive…

- The overdrive consists of an electrically or hydraulically operated epicyclic gear train bolted behind the transmission unit.
- It can either transfer the input drive shaft directly to the output shaft, called a propshaft (1:1), or increase the propshaft speed so that it turns faster than the input shaft (1:1 + n). Thus, in overdrive the gear ratio is less than unity, i.e., propeller shaft rotates at a speed higher than the engine speed.
- Thus the propshaft may be "overdriven" relative to the input shaft.
- It is actuated by a knob or button, often incorporated into the gearshift knob, and does not require operation of the clutch.

Overdrive

3-synchro overdrive gearbox of an MGB Roadster 1968 model

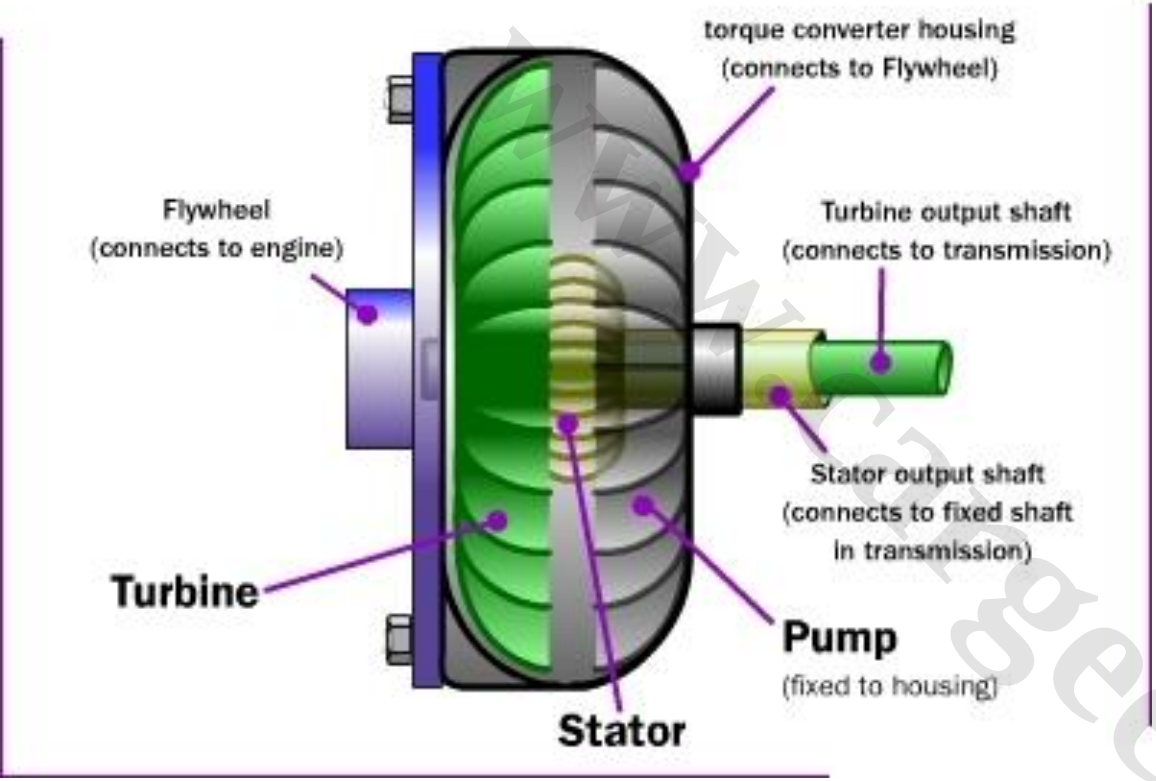
Overdrive…

- This gearbox is provided with two ratios, i.e., unity and less than unity and when second ratio is brought into action, this redcuces all the ratios of the main gearbox, making it suitable for all types of use.
- If the main gearbox is having four ratios, by bringing the auxillary box in connection with the main box another four ratios can be obtained. This is due to less than unity ratio of the auxilary gearbox.
- To maintain eight ratios a large gearbox would be required. While here, with the existing small gearbox, eight ratios can be obtained, by bringing overdrive into action in conjunction with the main box.The auxiliary box may be either a conventional one or the epicyclic type.
- To make gear changing easy, these are mostly the epicyclic type and are fitted behind the main box.

Torque Convertors…

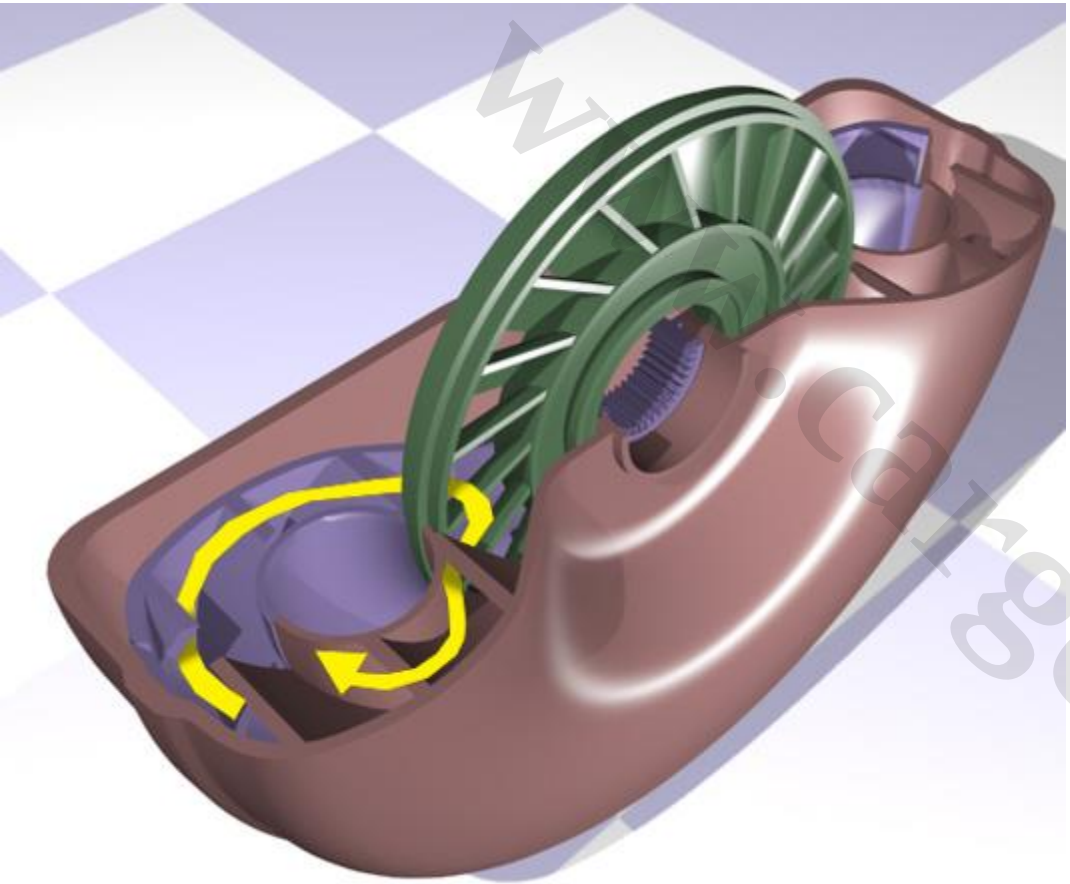
- To maintain eight ratios a large gearbox would be required. While here, with the existing small gearbox, eight ratios can be obtained, by bringing overdrive into action in conjunction with the main box. The auxiliary box may be either a conventional one or the epicyclic type.
- To make gear changing easy, these are mostly the epicyclic type and are fitted behind the main box.
- The blades of the turbine are curved. This means that the fluid, which enters the turbine from the outside, has to change direction before it exits the center of the turbine.
- It is this directional change that causes the turbine to spin. As the turbine causes the fluid to change direction, the fluid causes the turbine to spin.
- The turbine causes the transmission to spin, which basically moves the car.

Torque Convertors…



- The housing of the torque converter is bolted to the flywheel of the engine, so it turns at whatever speed the engine is running at.
- The fins that make up the pump of the torque converter are attached to the housing, so they also turn at the same speed as the engine.
- The cutaway below shows how everything is connected inside the torque converter.

Torque Convertors…



- The pump inside a torque converter is a type of centrifugal pump. As it spins, fluid is flung to the outside, much as the spin cycle of a washing machine flings water and clothes to the outside of the wash tub. As fluid is flung to the outside, a vacuum is created that draws more fluid in at the center.
- The fluid then enters the blades of the turbine, which is connected to the transmission.

Types of Transmissions

Common Types include:

- Manual Transmission
- Semi-Automatic Transmission
- Automatic Transmission

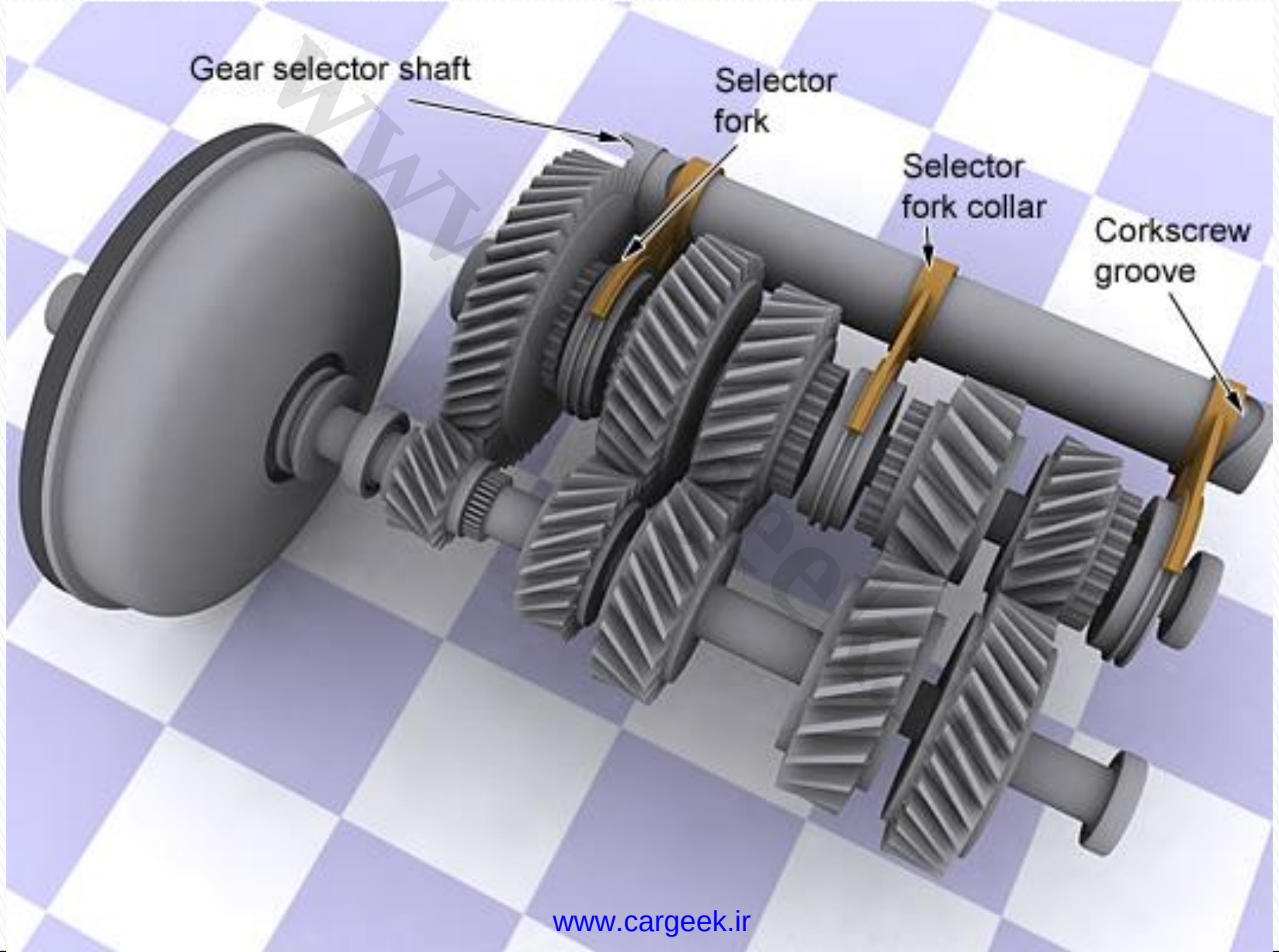
Uncommon Types include:

- Dual clutch transmission
- Continuously Variable Transmission [CVT]
- Infinitely Variable Transmission [IVT]
- Electric Variable Transmission [EVT]
- Hydrostatic
- Hydrodynamic
- Electric

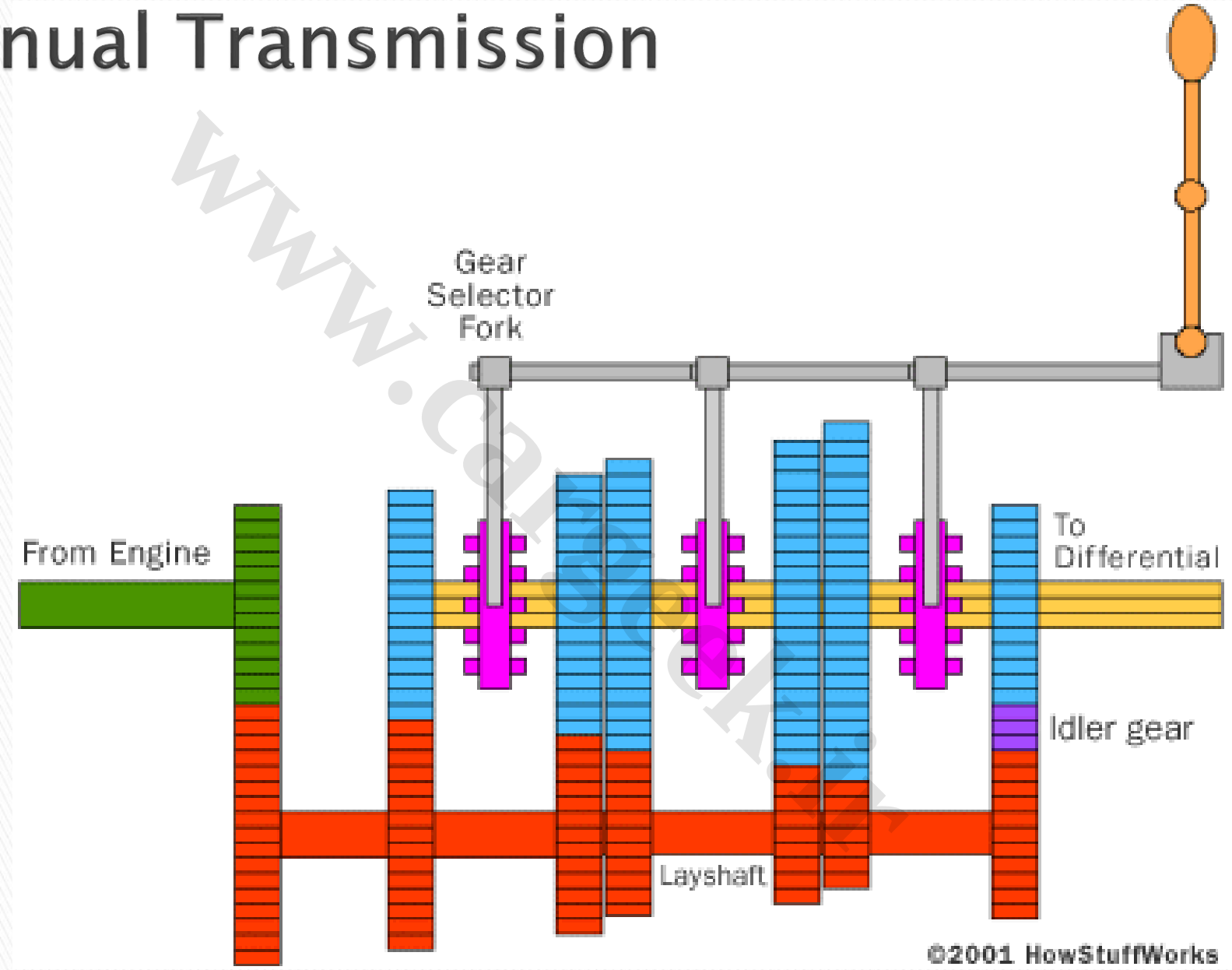
Manual Transmission

- A simple but rugged **sliding-mesh** or **unsynchronized / non-synchronous** system found in racing cars, older heavy-duty trucks, and some agricultural equipment.
- Here straight-cut spur gear sets are spinning freely, and must be synchronized by the operator matching engine revs to road speed, to avoid noisy and damaging "gear clash.
- When the driver engages the clutch, the sliding gear disengages from its existing position and can slide up and down the gearbox to re-engage in a higher or lower gear.
- And the now common **constant-mesh** gearboxes which can include **non-synchronous**, or **synchronized / synchromesh** systems . Here diagonal cut helical (and sometimes double-helical) gear sets are constantly "meshed" together, and a dog clutch is used for changing gears. On synchromesh boxes, friction cones or "synchro-rings" are used in addition to the dog clutch.

Manual Transmission



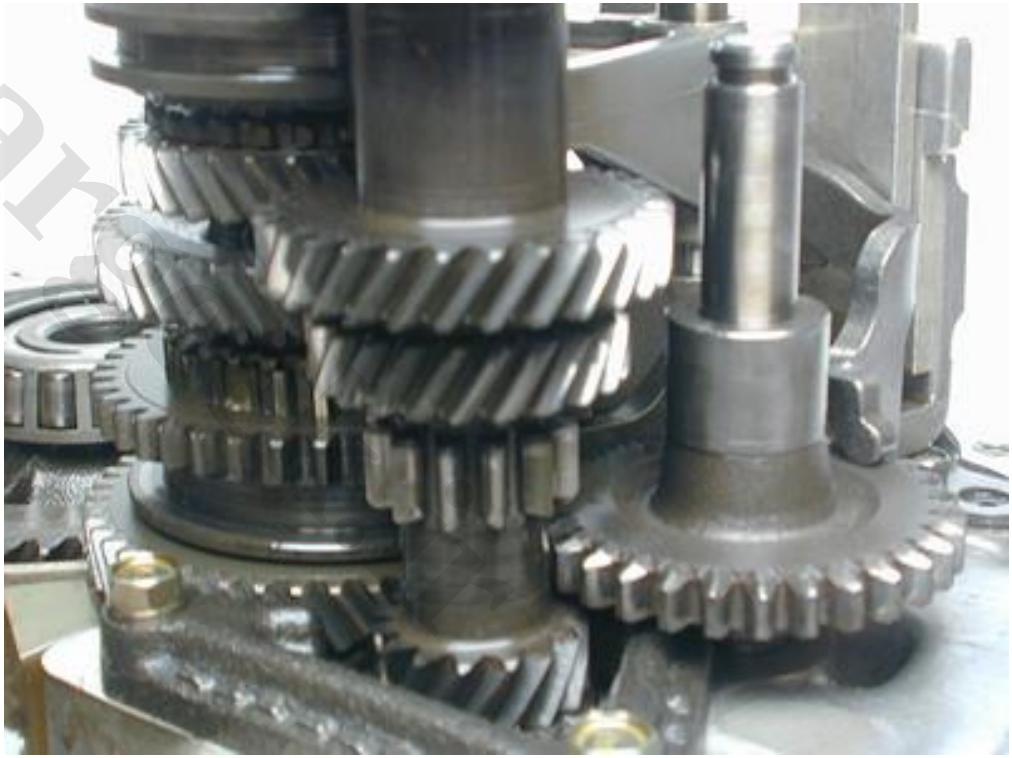
Manual Transmission



Manual Transmission

Manual transmission car make a loud whirring noise in reverse…

- Manual transmissions use mostly helical gears, but reverse are a special situation that requires a different type of gear – a spur gear.
- The gears that make up the forward gear ratios are all helical gears. Spur gears, which have straight teeth, slide into engagement much more easily than helical gears, so the three gears used for reverse are spur gears.



Manual Transmission

- On a manual transmission the forward gears stay engaged with each other at all times, and collars that are controlled by the shift stick lock different gears to the output shaft. The reverse gear on your manual transmission uses an idler gear, which has to slide into mesh with two other spur gears at the same time in order to reverse the direction of rotation.
- Each time a gear tooth engages on a spur gear, the teeth collide instead of gently sliding into contact as they do on helical gears. This impact makes a lot of noise and also increases the stresses on the gear teeth. When you hear a loud, whirring noise from your car in reverse, what you are hearing is the sound of the spur gear teeth clacking against one another.

Sequential Gearbox

Manual transmissions use the standard "H" pattern in the shifter. The manual transmission in a motorcycle is nothing like this.

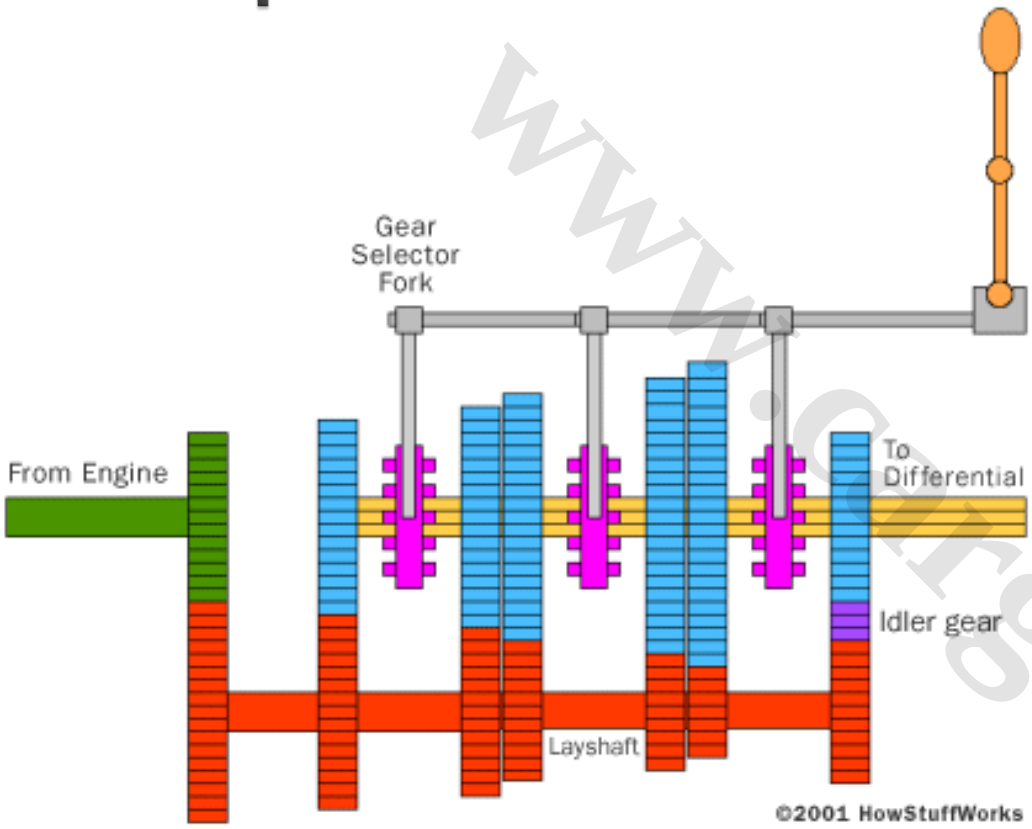
On a motorcycle, you shift gears by clicking a lever up or down with your toe. It is a much faster way to shift. This type of transmission is called a **sequential gearbox** or a **sequential manual transmission.**

It turns out that most race cars use sequential gearboxes as well

Sequential Gearbox

5-speed synchro box, ZF transaxle model 5DS-25-2. This gearbox has a custom-made sequential shifting mechanism that is pneumatically operated and computer controlled.

Sequential Gearbox



- There are three forks controlled by three rods that are engaged by the shift lever.
- There is still a set of **gear selector forks** that move collars that engage gears.
- The only difference is the way the control rods are manipulated.
- The "H" pattern is eliminated and replaced with a different motion.
- In a race car, the motion of the shift lever is either "push forward" to up-shift or "pull backward" to downshift.

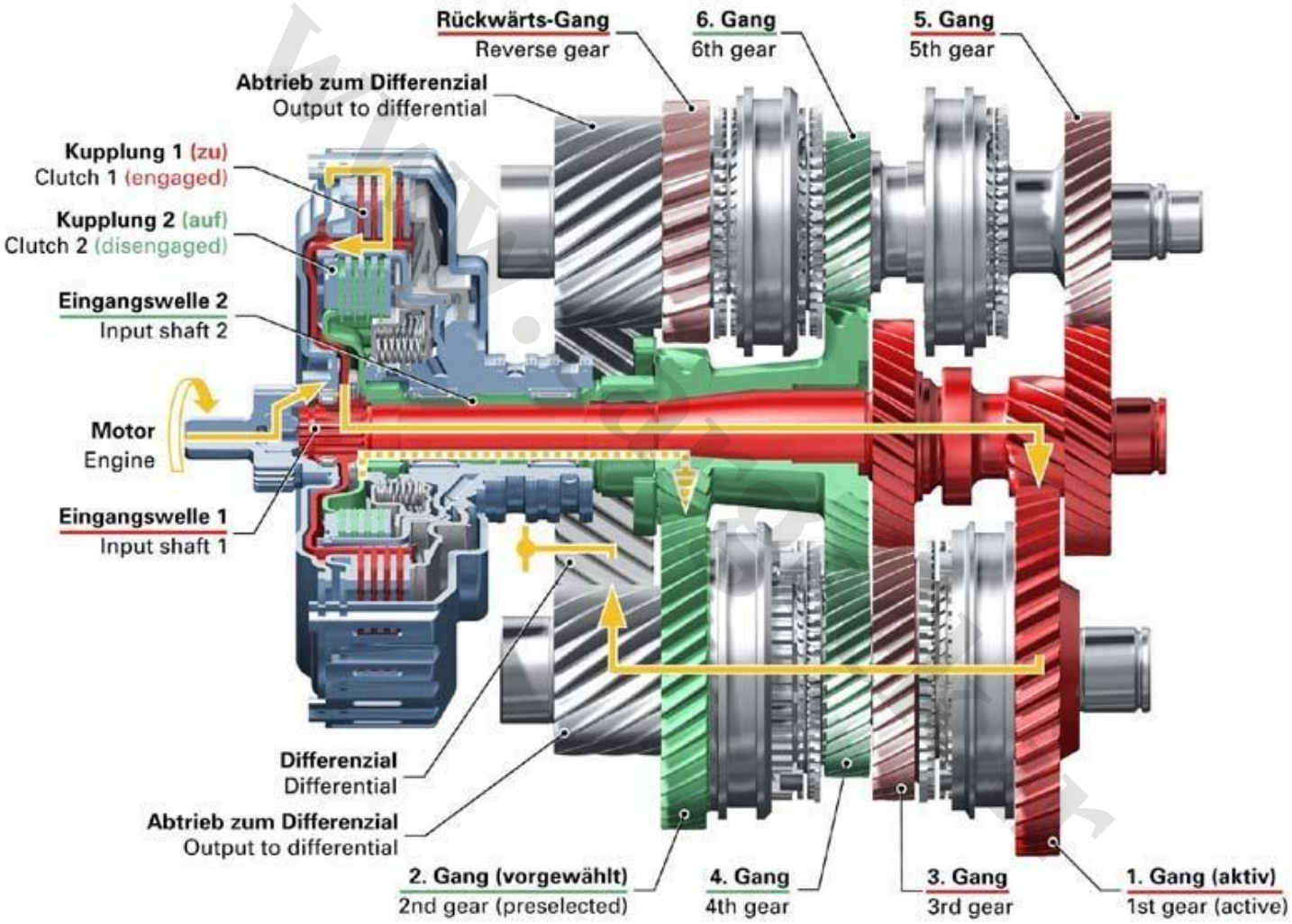
Semi-Automatic Transmission

- **Clutchless Manual** or **Automated Manual** Transmission is one where the car processor handles manipulation of the clutch automatically, but the driver can still select the gear manually if desired.

  They are generally designed using manual transmission internals, and when used in passenger cars, have synchromesh operated helical constant mesh gear sets. Specific type of this transmission includes **Easytronic** and **Geartronic**.
- A **Dual-Clutch** transmission uses two sets of internals which are alternately used, each with its own clutch, so that only the clutches are used during the actual gear change.

  Specific type of this transmission includes **Direct-Shift** Gearbox.
- There are also **Sequential** transmissions which use the rotation of a drum to switch gears.

Semi-Automatic Transmission



Automatic Transmission

Epicyclic Gearing or **Planetary** Gearing are as used in an automatic transmission. An Automatic transmission will select an appropriate gear ratio without any operator intervention.

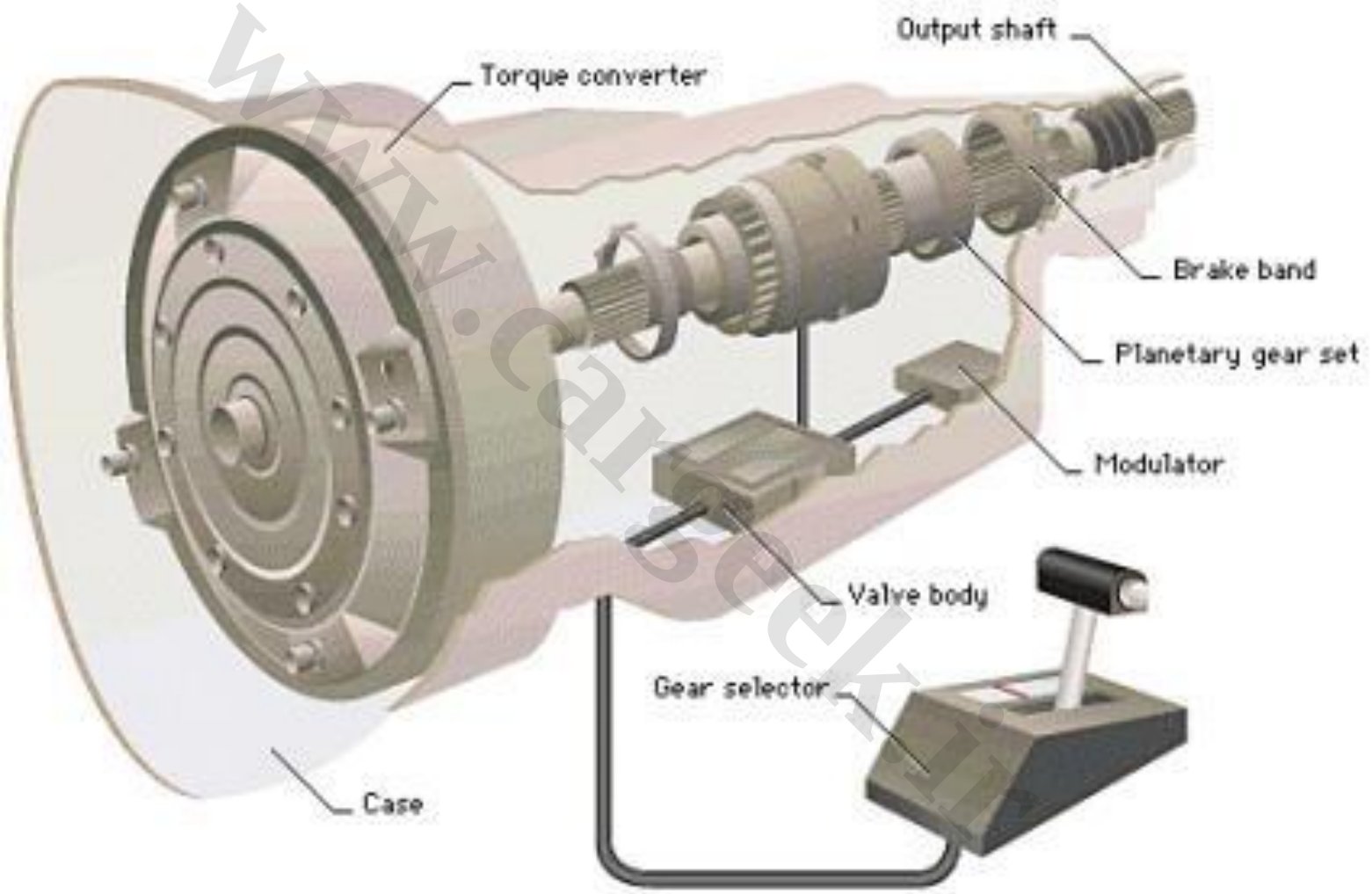
They primarily use hydraulics to select gears, depending on pressure exerted by fluid within the transmission assembly.

Rather than using a clutch to engage the transmission, a fluid flywheel, or torque converter is placed in between the engine and transmission.

It is possible for the driver to control the number of gears in use or select reverse, though precise control of which gear is in use may or may not be possible.

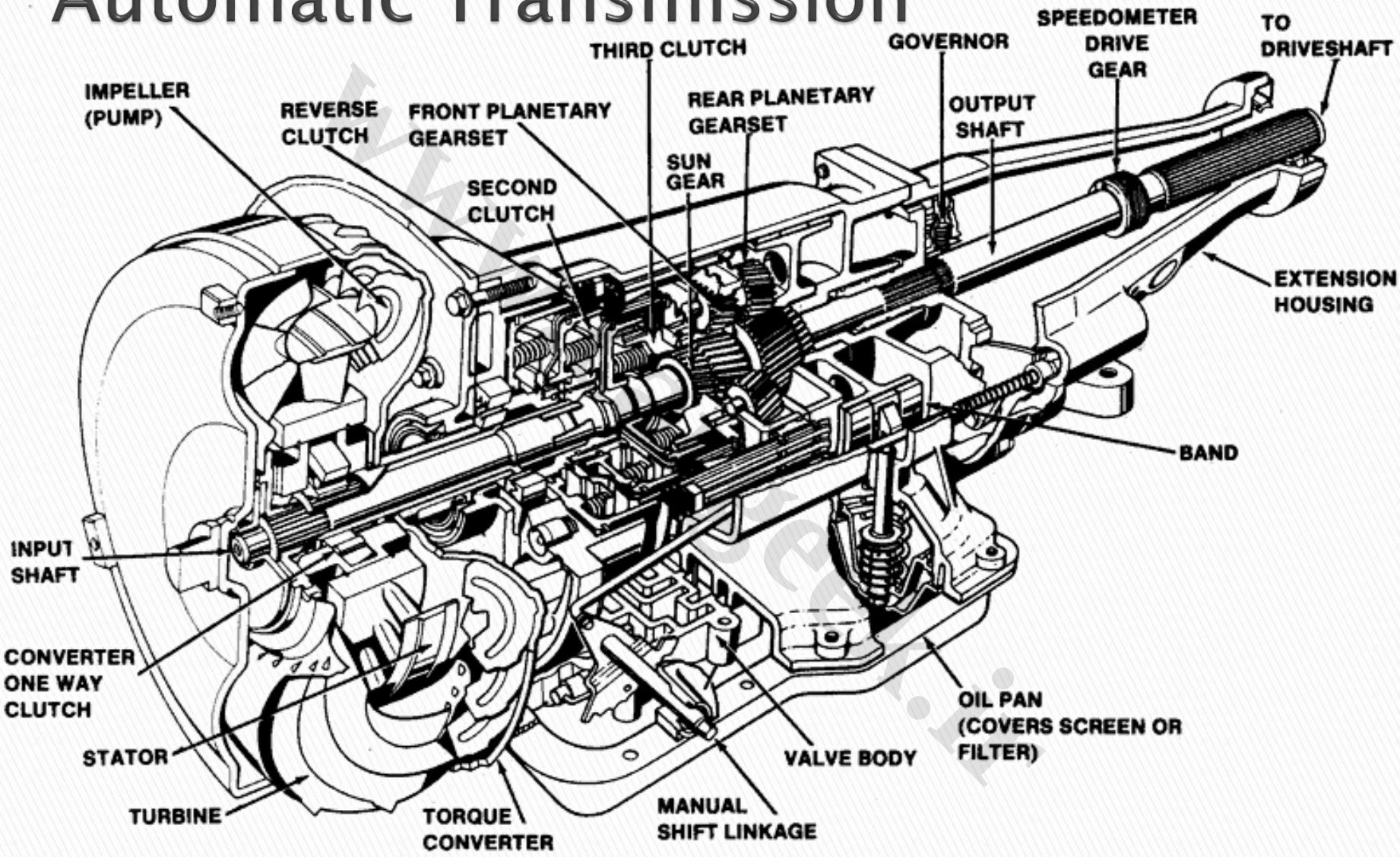
For certain applications, the slippage inherent in automatic transmissions can be advantageous; for instance, in drag racing, the automatic transmission allows the car to be stopped with the engine at a high rpm (the "stall speed") to allow for a very quick launch when the brakes are released

Automatic Transmission



Cutaway view of a typical 3-speed automatic transmission

Automatic Transmission



Cutaway view of a typical 3-speed automatic transmission

Advantages

Here are some of the features of an automatic transmission:

- If the car is in overdrive (on a four-speed transmission), the transmission will automatically select the gear based on vehicle speed and throttle pedal position.
- If you accelerate gently, shifts will occur at lower speeds than if you accelerate at full throttle.
- If you floor the gas pedal, the transmission will downshift to the next lower gear.
- If you move the shift selector to a lower gear, the transmission will downshift unless the car is going too fast for that gear. If the car is going too fast, it will wait until the car slows down and then downshift.
- If you put the transmission in second gear, it will never downshift or upshift out of second, even from a complete stop, unless you move the shift lever.

Advantages

Advantages of Automatic Transmission over Manual Transmission:

- Better fuel efficiency upto 15% increase.
- No loss of torque transmission from the engine to the driving wheels during gear shifts.
- Very smooth gear-shift operations
- Appeals to drivers due to overall fast shifts and rapid responses, along with the latest technology.

Disadvantages

Disadvantages of Automatic Transmission over Manual Transmission:

- Its mechanical efficiency is very less than that of a manual transmission type.
- Its requires a specialized transmission fluid/lubricants which is expensive and need to be changed regularly.
- Its expensive to manufacture.
- It is heavier than an conventional manual transmission gearbox.
- It has much higher rate of failure due to complexity.

Dual Clutch Transmission

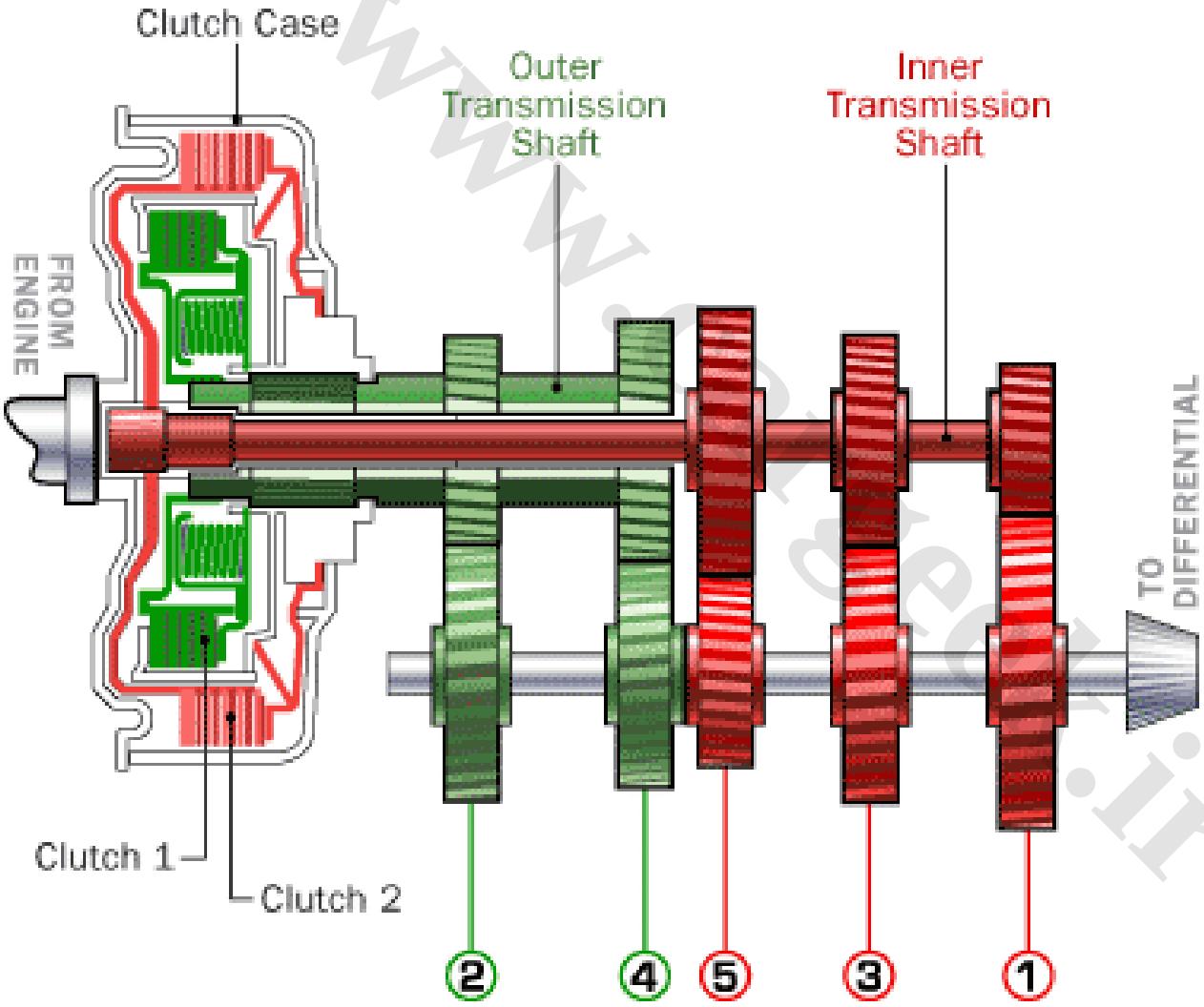
A dual clutch transmission [DCT] invented by Frenchman **Adolphe Kégresse** is also known as twin-clutch gearbox, double clutch transmission. It is a differing type of semi-automatic or automated manual automotive transmission.

It utilizes two separate clutches for **odd** + **reverse** and **even** gear sets. It can fundamentally be described as two separate manual transmissions (with their respective clutches) contained within one housing, and working as one unit. They are usually operated in a fully automatic mode, and many also have the ability to allow the driver to manually shift gears, albeit still carried out by the transmissions electro-hydraulics.

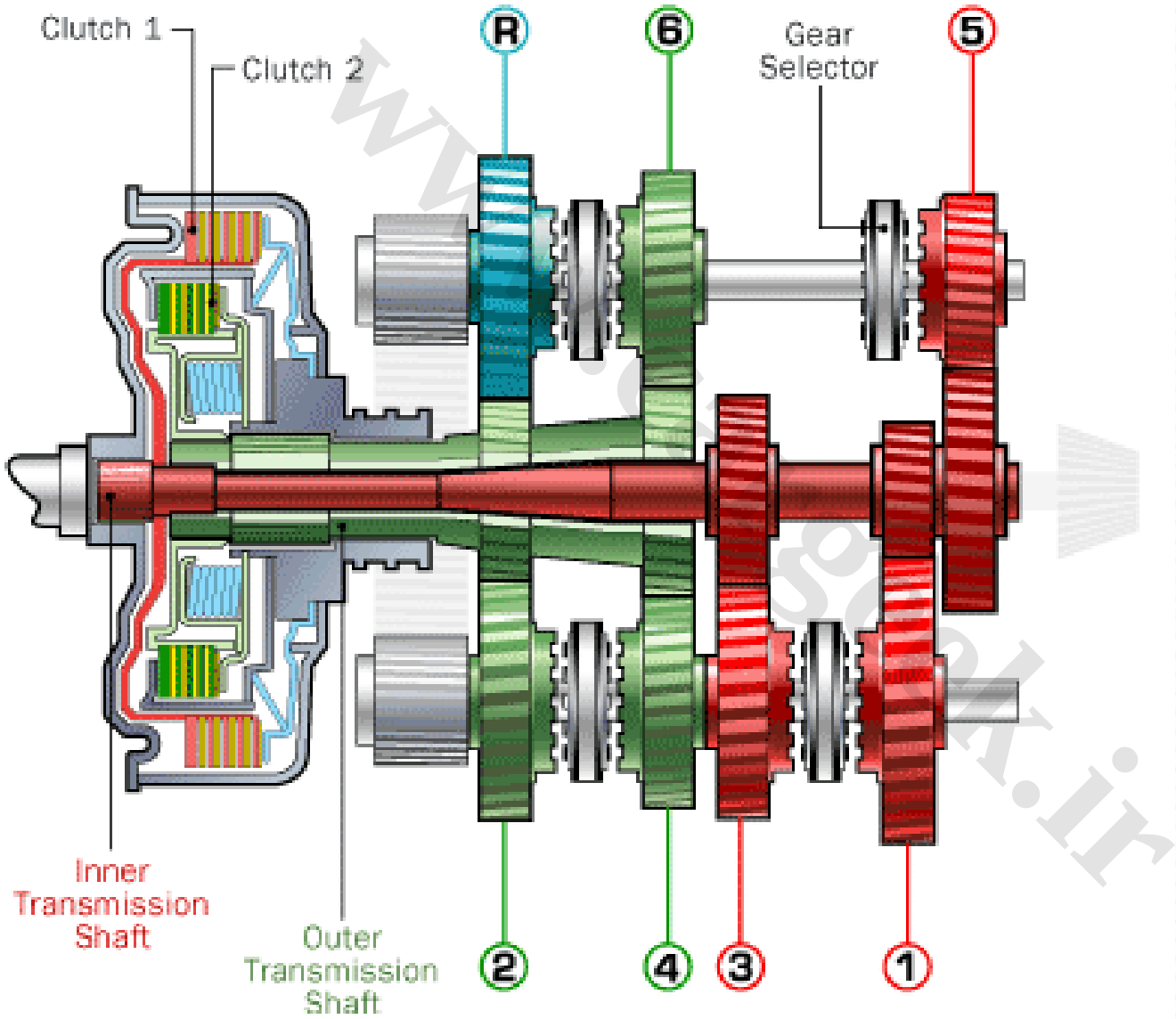
A dual clutch transmission **eliminates the torque converter** as used in conventional epicyclic geared automatic transmissions.

Instead, they primarily use two oil-bathed **wet multi-plate clutches**, similar to the clutches used in most motorcycles, though dry clutch versions are also available.

Dual Clutch Transmission

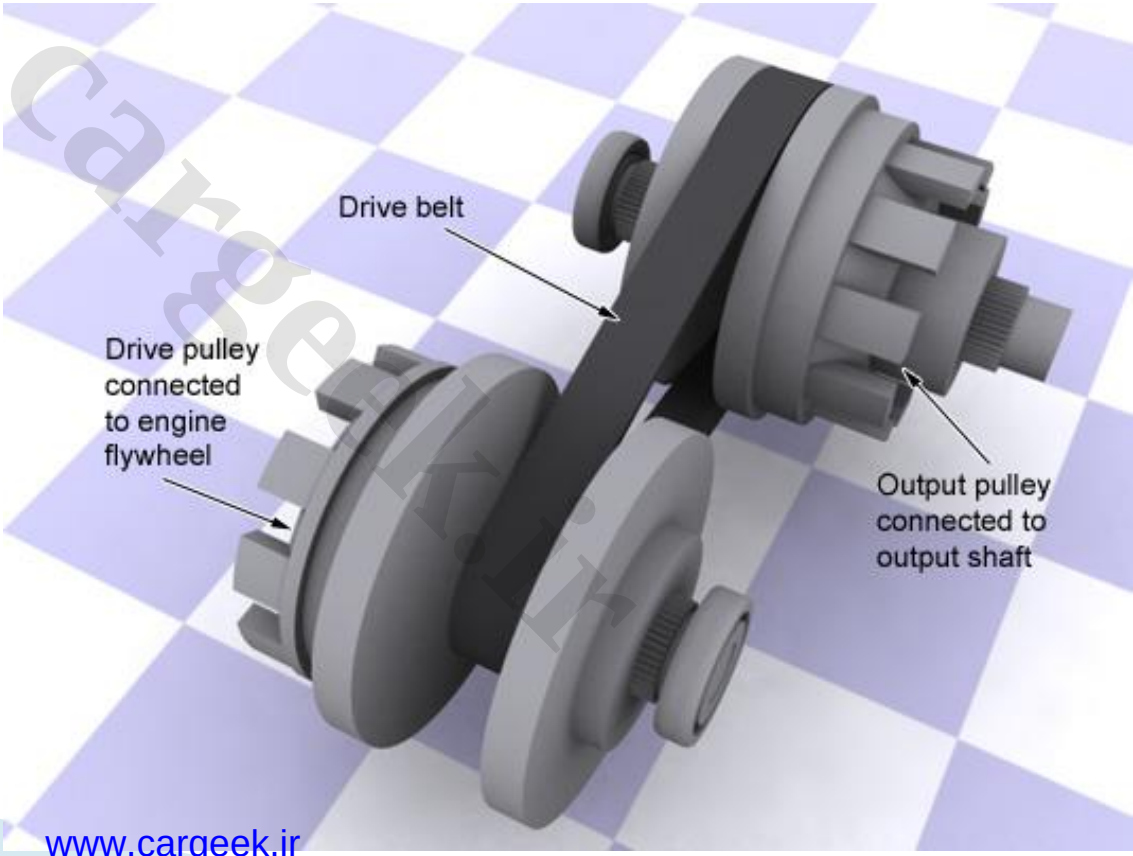


Dual Clutch Transmission



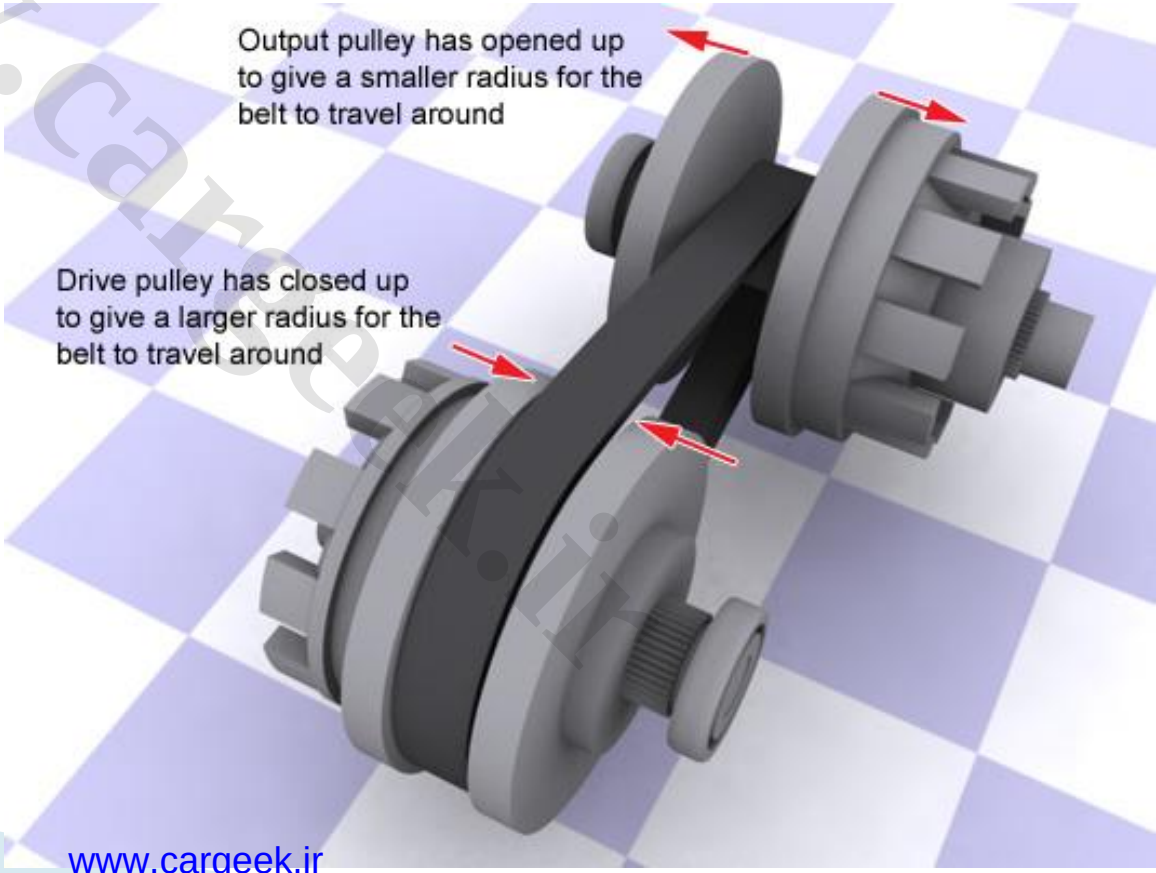
Continuously Variable Transmission

The Continuously Variable Transmission (CVT) is a transmission in which the ratio of the rotational speeds of two shafts, as the input shaft and output shaft of a vehicle or other machine, can be varied continuously within a given range, providing an infinite number of possible ratios.



Continuously Variable Transmission

The other mechanical transmissions described above only allow a few different gear ratios to be selected, but this type of transmission essentially has an infinite number of ratios available within a finite range.

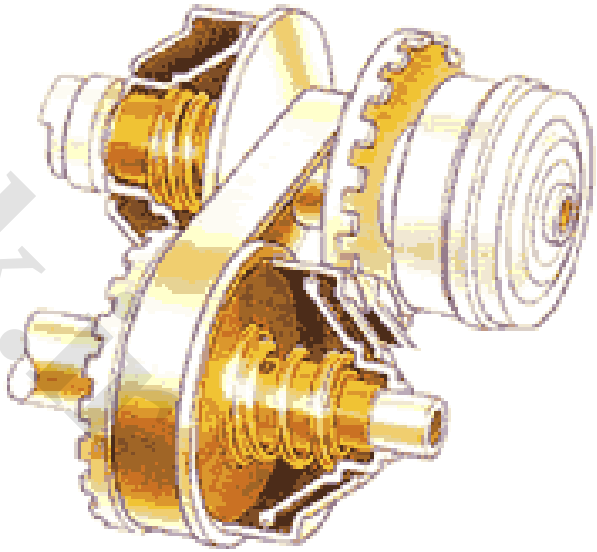


Continuously Variable Transmission

The continuously variable transmission allows the relationship between the speed of the engine and the speed of the wheels to be selected within a continuous range.

This can provide even better fuel economy if the engine is constantly running at a single speed.

The transmission is in theory capable of a better user experience, without the rise and fall in speed of an engine, and the jerk felt when changing gears.



Infinitely Variable Transmission

The IVT is a specific type of CVT that has an infinite range of input/output ratios in addition to its infinite number of possible ratios. Its range of ratios includes a zero output/input ratio that can be continuously approached from a defined 'higher' ratio. A zero output implies an infinite input, which can be continuously approached from a given finite input value with an IVT.

Most IVT's result from the combination of a CVT with an epicyclic gear system that facilitates the subtraction of one speed from another speed within the set of input and planetary gear rotations.

This subtraction only needs to result in a continuous range of values that includes a zero output; the maximum output/input ratio can be arbitrarily chosen from infinite practical possibilities through selection of extraneous input or output gear, pulley or sprocket sizes without affecting the zero output or the continuity of the whole system.

The IVT is always engaged, even during its zero output adjustment.

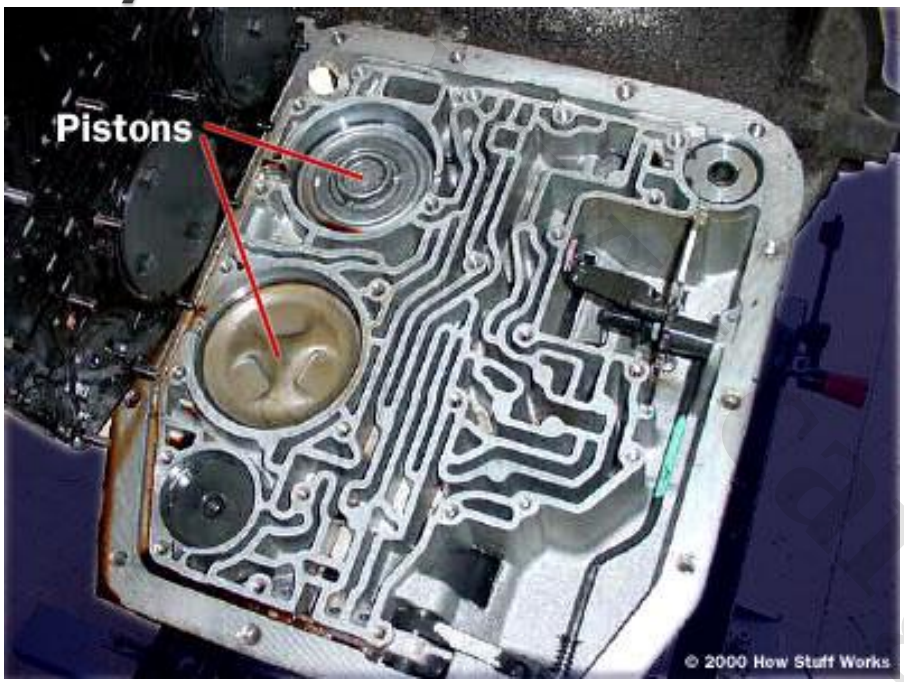
Electric Variable Transmission

The Electric Variable Transmission(EVT), also known as called a Power Split Transmission (PST), is a transmission that achieves CVT action and in addition can use separate power inputs to produce one output. An EVT usually is executed in design with an epicyclic differential gear system.

The epicyclic differential gearing performs a "power-split" function, directly connecting a portion of the mechanical power directly through the transmission and splitting off a portion for subsequent conversion to electrical power via a motor/generator. The remaining power travels down the EVT's "electrical path.

The EVT is the essential method for transmitting power in some hybrid vehicles, enabling an IC Engine to be used in conjunction with motor/generators for vehicle propulsion, and having the ability to control the portion of the mechanical power used directly for propelling the vehicle and the portion of mechanical power that is converted to electric power and recombined to drive the vehicle.

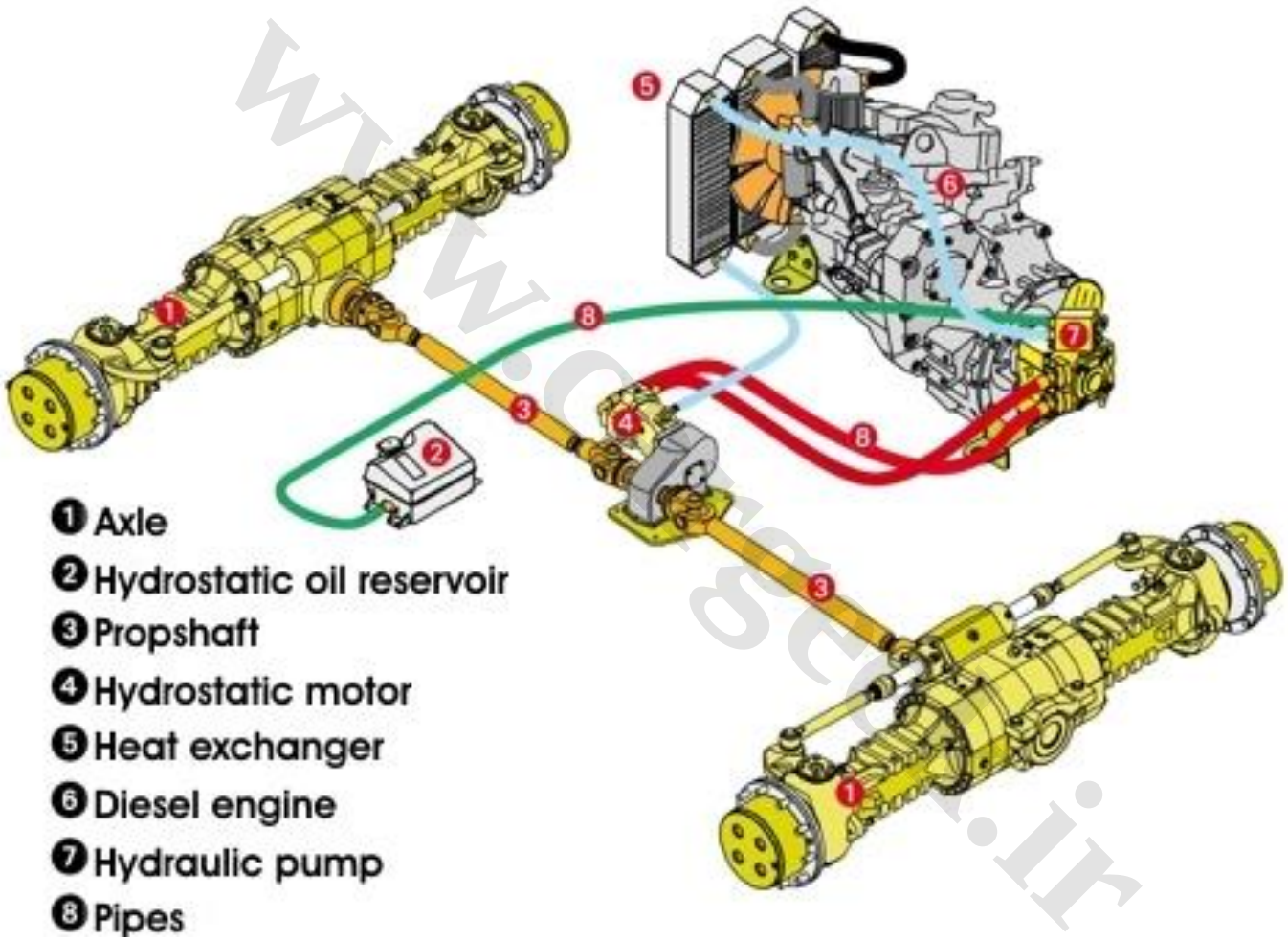
Hydrostatic Transmission



Hydrostatic transmissions transmit all power hydraulically, using the components of hydraulic machinery. There is no solid coupling of the input and output. One half of the transmission is a hydraulic pump and the other half is a hydraulic motor, or hydraulic cylinder. Hydrostatic drive systems are used on excavators, lawn tractors, forklifts, winch drive systems, heavy lift equipment, agricultural machinery, etc.

Hydraulic drive systems can be used as an extra transmission between motor and f.i. wheels.

Hydrostatic Transmission



Hydrodynamic Transmission

- If the hydraulic pump and/or hydraulic motor are not hydrostatic, but hydrodynamic, then the transmission can be called hydrodynamic. The pump and motor can consist of rotating vanes without seals. The pump and motor can be placed in reasonable proximity. The transmission ratio can be made to vary by means of additional rotating vanes, an effect similar to varying the pitch of an airplane propeller.
- The torque converter in most American cars is a hydrodynamic transmission, placed ahead of the automatic transmission.
- It was possible to drive the **Dynaflow** transmission without shifting the mechanical gears.
- Hydrodynamic transmissions tend to be inefficient due to energy losses in the fluid.

Electric Transmission

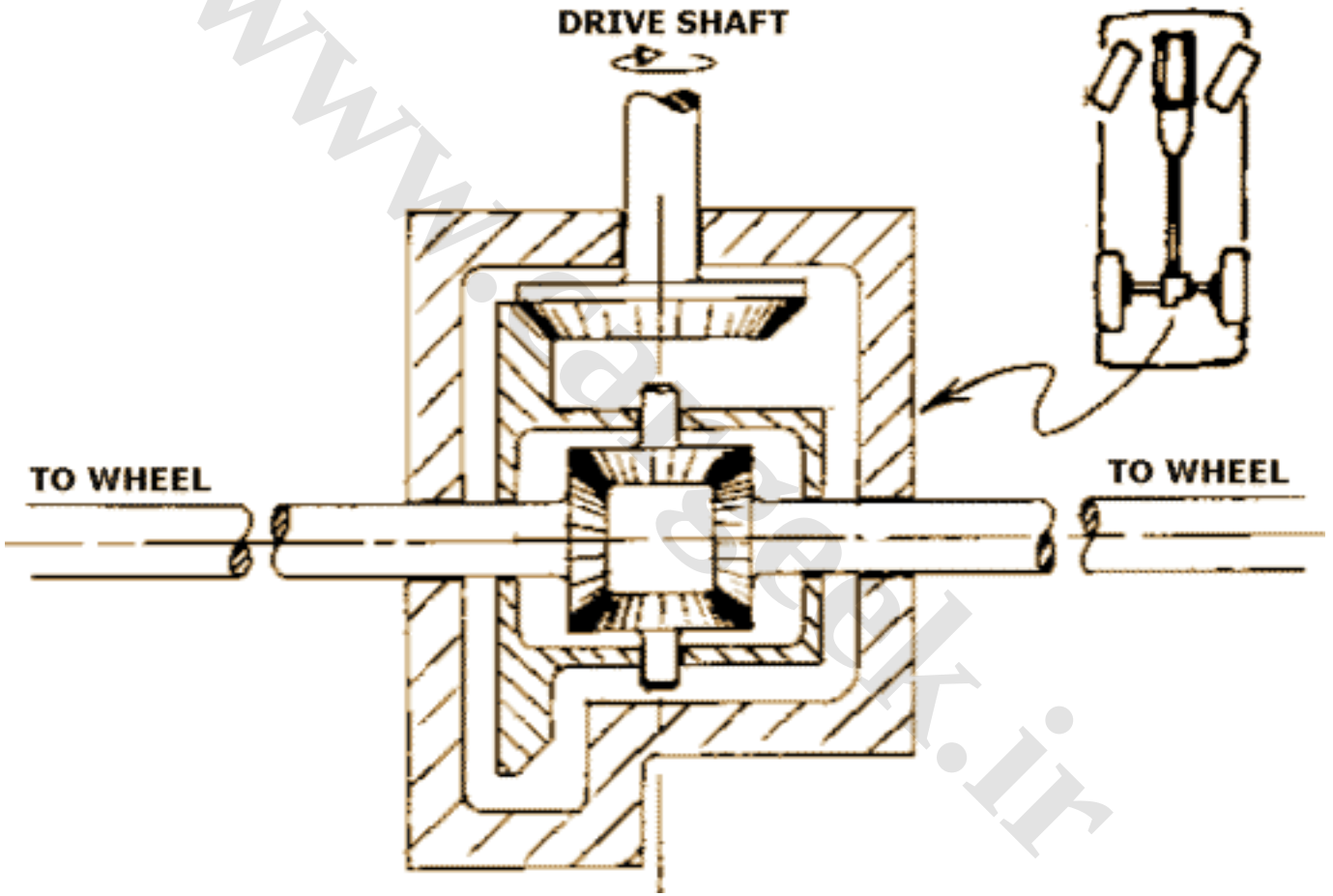
Electric transmissions convert the mechanical power of the engine(s) to electricity with electric generators and convert it back to mechanical power with electric motors.

Electrical or electronic adjustable-speed drive control systems are used to control the speed and torque of the motors.

If the generators are driven by turbines, such arrangements are called turbo-electric.

Likewise installations powered by diesel-engines are called diesel-electric. Diesel-electric arrangements are used on many railway locomotives, ships and large mining trucks.

Automobile Differential Gear Train



Automobile Differential Gear Train

- The above schematic diagram shows basically how the automobile differential works.
- It only comes into play when one wheel needs to rotate differentially with respect to its counterpart.
- When the car is moving in a straight line, the differential gears do not rotate with respect to their axes.
- When the car negotiates a turn, however, the differential allows the two wheels to rotate differentially with respect to each other.

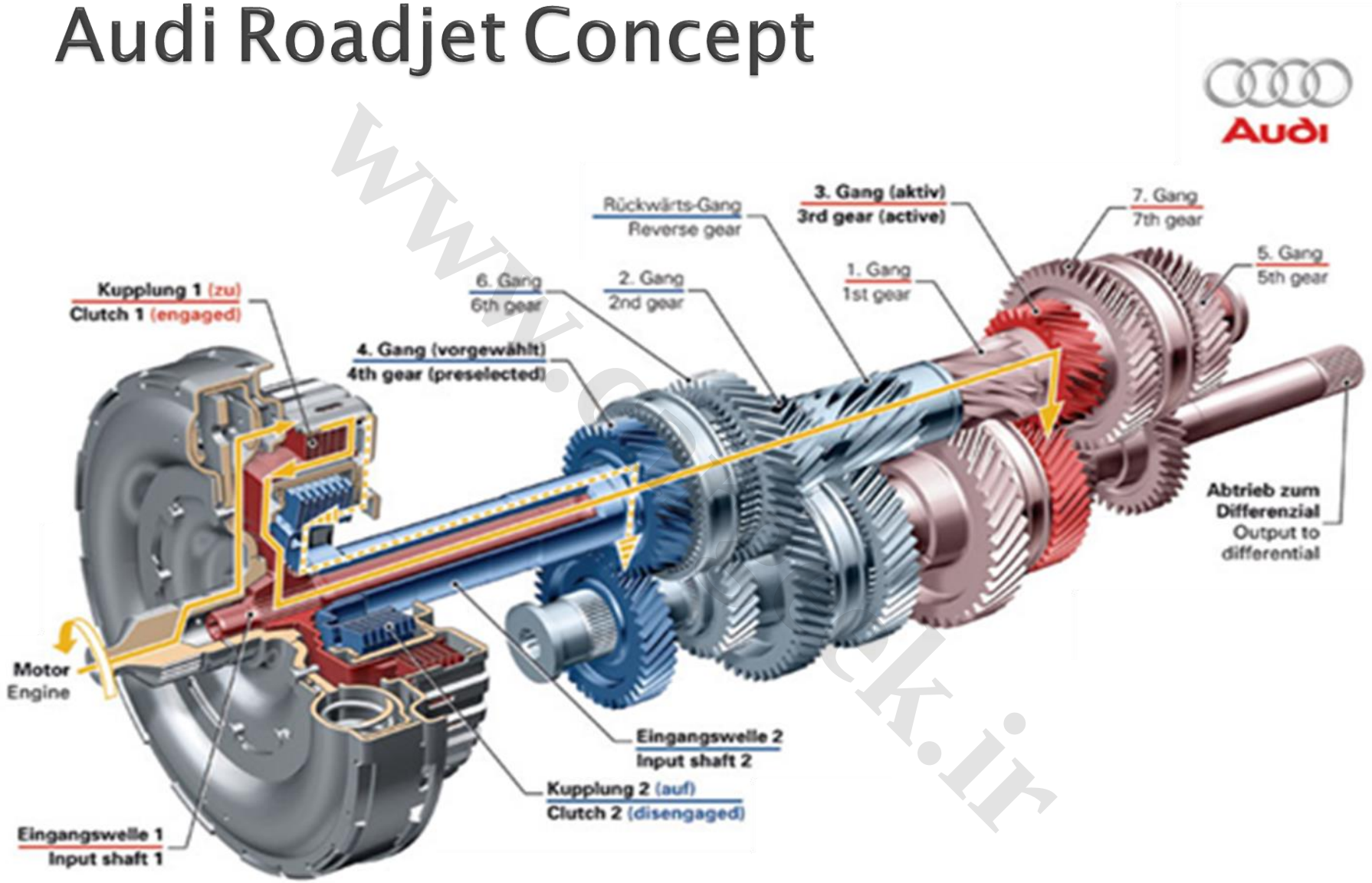
Automobile Differential Gear Train

- One problem with an automotive differential is that if one wheel is held stationary, the counterpart wheel turns at twice its normal speed as can be seen by examining the complete scheme of automobile differential.
- This can be problematic when one wheel does not have enough traction, such as when it is in snow or mud.
- The wheel without traction will spin without providing traction and the opposite wheel will stay still so that the car does not move.
- This is the reason for a device known as a "limited slip differential" or "traction control".

Recent Developments…

- Audi Roadjet Concept
- 10 speed gearbox by Eric Leppen
- Direct-Shift Gearbox by BorgWarner

Audi Roadjet Concept



Audi Longitudinal DSG

In late 2008, an all-new seven speed longitudinal S tronic version of the DSG transaxle went into series production lead by Audi transmission design engineer **Mario Schenker.**

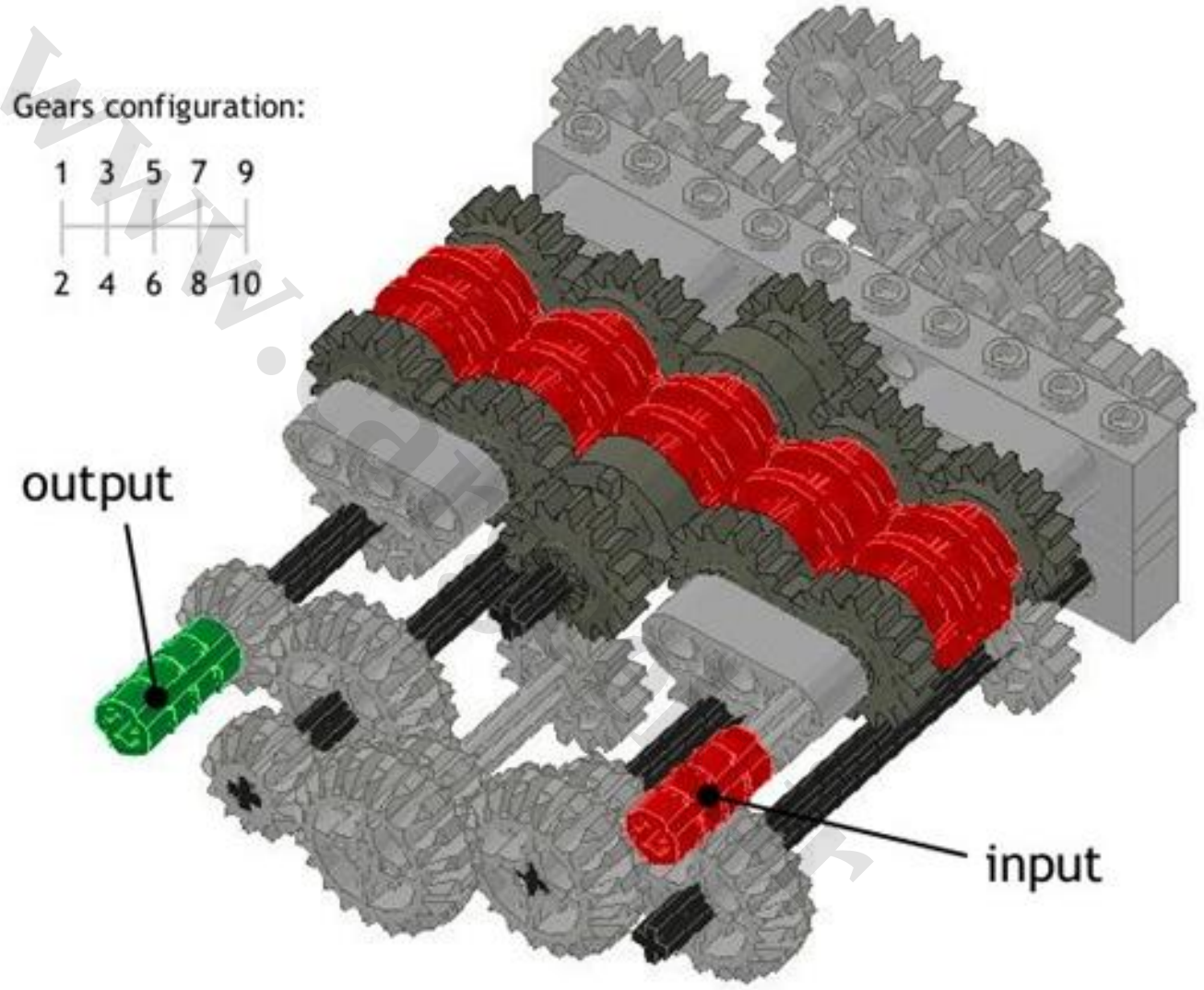
Like the original six-speed DSG, it features a concentric dual wet multi-plate clutch. However, this particular variant uses notably more plates - the larger outer clutch (for the odd-numbered gears) uses ten plates, whereas the smaller inner clutch (driving even-numbered gears and reverse) uses 12 plates.

It has a torque handling limit of up to 600 Newton Metres (443 ft·lbf), and engine power outputs of up to 330 kilowatts (449 PS; 443 bhp).

It has a total mass, including all lubricants and the dual-mass flywheel of 141.5 kilograms (312 lb).

This was initially available in their quattro four-wheel drive variants, and is very similar to the new ZF Friedrichshafen-supplied Porsche Doppel-Kupplung (PDK).

10 speed gearbox by Eric Leppen



contact: s.ariel@gazeta.pl

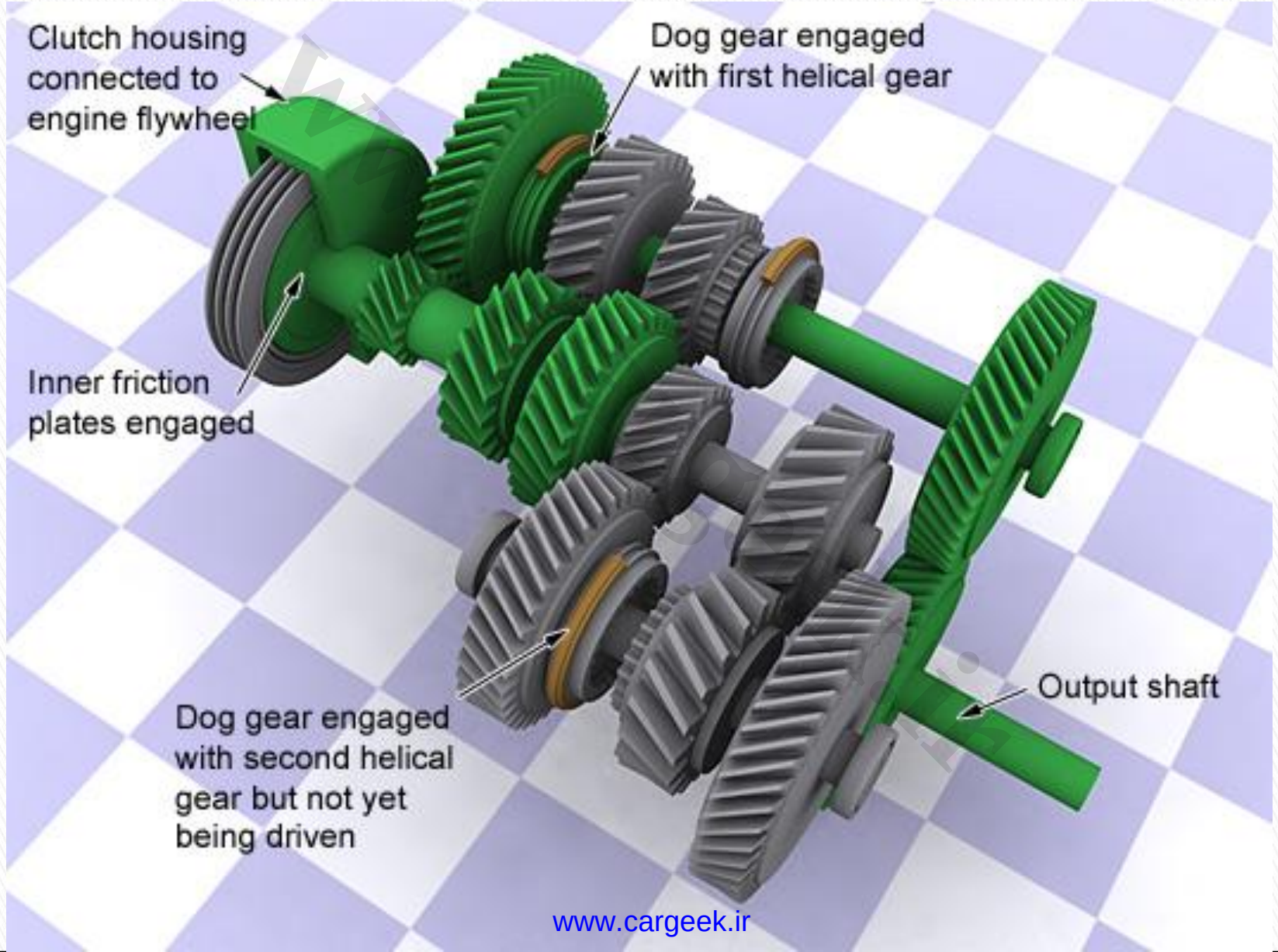
10 speed gearbox by Eric Leppen

- 10 speed gearbox is based on Eric Leppen's expanded idea for 4-speed gearbox.
- Plans to expand it to have 16 or more speeds, but it would generate high resistance and be ineffective.
- Transmission ratio changes considerably from 81:1 to 1:72.2 (input/output).
- This difference grows with the number of speeds - 12 speed gearbox would offer extremes from 243:1 to 1:12.86.

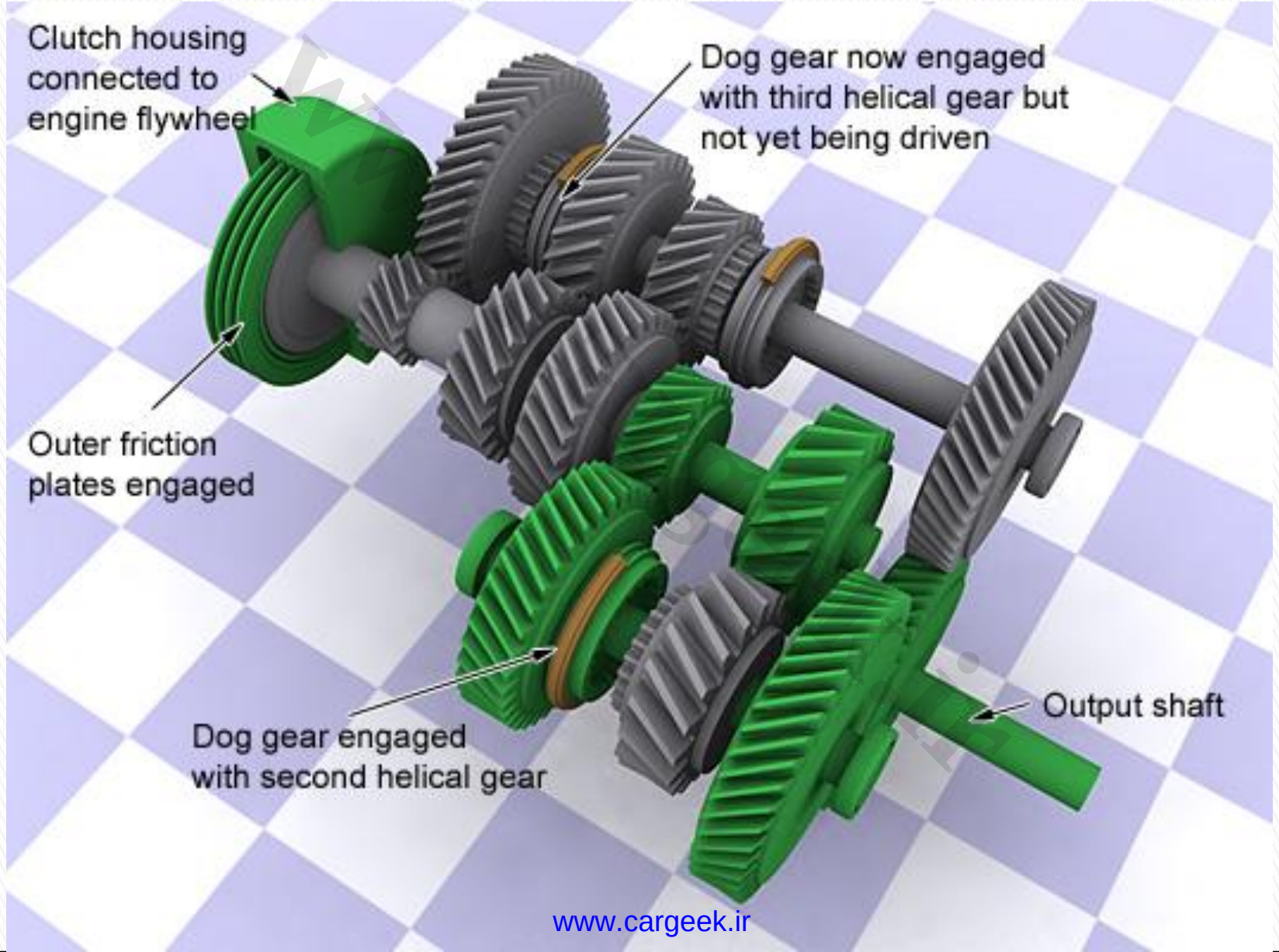
Direct-Shift Gearbox

- The Direct-Shift Gearbox [DSG] designed by **BorgWarner** is a Volkswagen Group developed electronically controlled dual clutch multiple-shaft manual gearbox, in a transaxle design – without a conventional clutch pedal, and with full automatic, or semi-manual control.
- It is two separate manual gearboxes (and clutches), contained within one housing, and working as one unit.
- By using two independent clutches, faster shift times can be achieved, and the traditional torque converter of a conventional epicyclic automatic transmission is eliminated.
- The seven-speed DSG transmission fitted in the 406 kilometres per hour (252 mph) Bugatti Veyron is a notable exception, its dual clutch transmission (DCT), capable of handling 1,250 newton metres (922 ft·lbf) was developed and produced by the English specialist consulting engineering company Ricardo plc.

Direct-Shift Gearbox



Direct-Shift Gearbox



Thank You