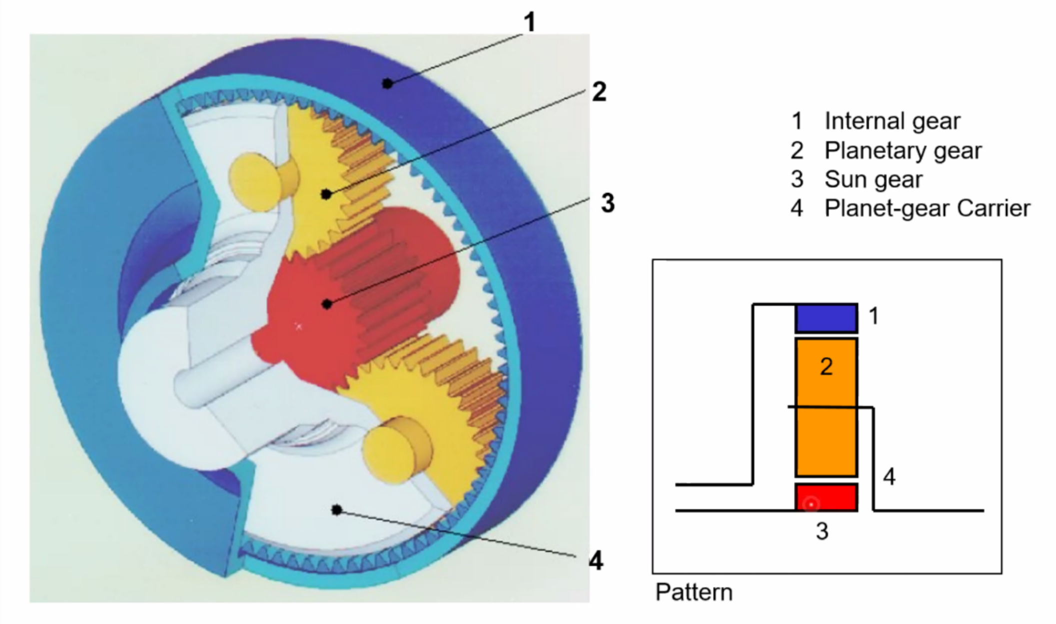
planetary transmission : Simple planetary gear



Components : Sun gear, ring gear, planetary gear and carrier

watch video : important

- ring gear Fixed
  or
- Sun gear Fixed
  or
- Carrier Fixed

Kinematics of a Simple Planetary Gear Transmission

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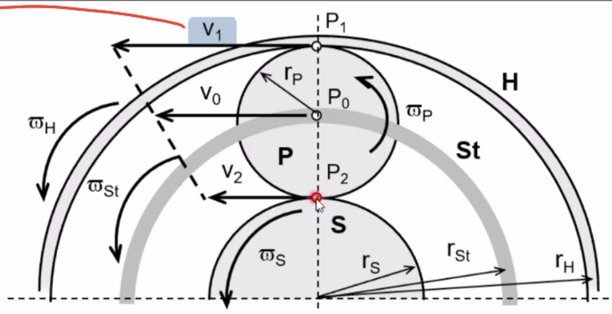
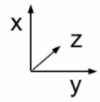
Constant





Stationary inertial system

Preliminary remarks:

- The simple planetary transmission possesses 2 degrees of freedom
- If the 3 angular velocities ϖ_H, ϖ_S and ϖ_{St} are introduced as general coordinates, there is a forced condition (kinematic bond) between them that leads to the basic equation of the planetary transmission

Derivation of the basic equation:

- Considering the absolute velocities of the points P_0, P_1 and P_2 within the inertial system, this results in: $v_1 = r_H \cdot \varpi_H$, $v_2 = r_S \cdot \varpi_S$ and $v_0 = r_{St} \cdot \varpi_{St}$
- The parallel velocity vectors v_1 and v_2 form a trapeze where the distance between v_1 and v_0 and between v_2 und v_0 equals the planetary radius r_P

Kinematics of a Simple Planetary Gear Transmission

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Thus, it is valid that

$$v_0 = \frac{v_1 + v_2}{2} \Rightarrow 2 \cdot v_0 = v_1 + v_2$$

$$\boxed{2 \cdot r_{St} \cdot \omega_{St} = r_H \cdot \omega_H + r_S \cdot \omega_S}$$

Furthermore:

$$r_{St} = r_H - r_P$$
$$r_{St} = r_S + r_P$$
$$2 \cdot r_{St} = r_H + r_S$$

$$(r_H + r_S) \cdot \omega_{St} = r_H \cdot \omega_H + r_S \cdot \omega_S$$

- If the equation above is divided by r_S and if the angle-of-rotation velocities ϖ_H, ϖ_S and ϖ_{St} are substituted by the speeds n_H, n_S and n_{St}, the basic equation results in

$$\boxed{\left(\frac{r_H}{r_S} + 1\right) \cdot n_{St} = \frac{r_H}{r_S} \cdot n_H + n_S}$$

- The ratio of the rolling-circuit radii r_H / r_S equals the (negative) transmission ratio of the planetary stationary transmission where the bar is retained ($n_{St}=0$).

$$n_{St} = 0 \Rightarrow \frac{r_H}{r_S} \cdot n_H + n_S = 0 \Rightarrow \frac{n_S}{n_H} = -\frac{r_H}{r_S}$$

With stationary transmission ratio: $i_0 = \frac{r_H}{r_S}$

$$\boxed{(i_0 + 1) \cdot n_{St} = i_0 \cdot n_H + n_S}$$

Stationary Gear ratio

Carrier

ring gear (internal gear)

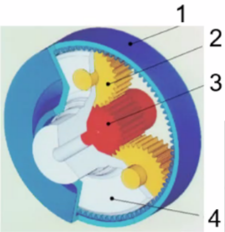
Sun gear

Planetry Transmission: Simple Planetary Gear Set

⇨ possible transmission ratios

$$(i_0 + 1) \cdot n_{St} = i_0 \cdot n_H + n_S$$

By clutches (Braked ⇒ $n_{st} = 0$)



1 Internal gear
2 Planetary gear
3 Sun gear
4 Bar (Planet-gear carrier)

Input	Output	Braked	Transmission i	Conventional transmissions i for $i_0 = 2 ⇔ 4$
Sun gear	Internal gear	Planet-g. carrier	$i = -i_0$	i = -4 ⇔ -2
Internal gear	Sun gear	Planet-g. carrier	$i = 1 / (-i_0)$	i = -0.5 ⇔ -0.25
Sun gear	Planet-g. carrier	Internal gear	$i = 1 + i_0$	i = 3 ⇔ 5
Planet-g. carrier	Sun gear	Internal gear	$i = 1 / (1 + i_0)$	i = 0.2 ⇔ 0.3
Internal gear	Planet-g. carrier	Sun gear	$i = 1 + (1/ i_0)$	i = 1.25 ⇔ 1.5
Planet-g. carrier	Internal gear	Sun gear	$i = i_0 / (1+i_0)$	i = 0.67 ⇔ 0.8

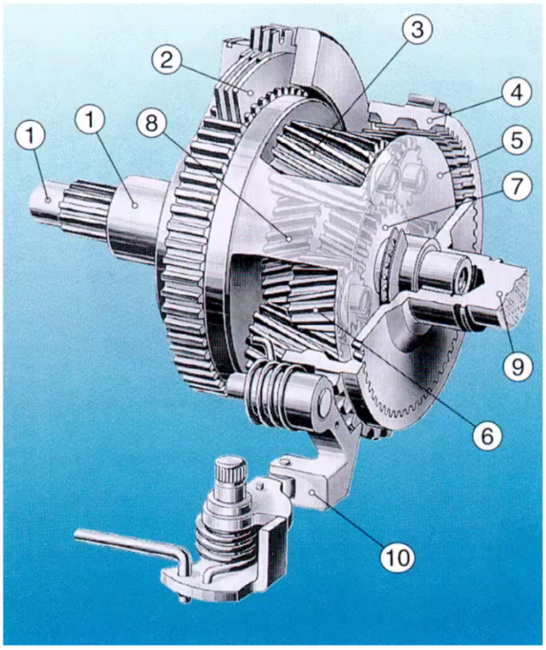
$i_0 = Radius_{Int.\ gear} / Radius_{Sun\ gear}$ = *stationary transmission ratio*

Degrees of freedom of the System : 2

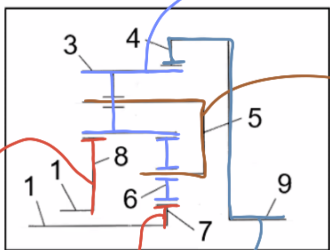
Simple planetary gear

Ravigneaux Planetary Gear Set

Two gear sets nested into each other joint by a planet gear carrier.



1 Drive shafts
2 Multidisc clutch
3 Broad planetary gear
4 Internal gear
5 Planet-gear carrier
6 Narrow planetary gear
7 Small sun gear
8 Big sun gear
9 Output
10 Parking lock



Pattern

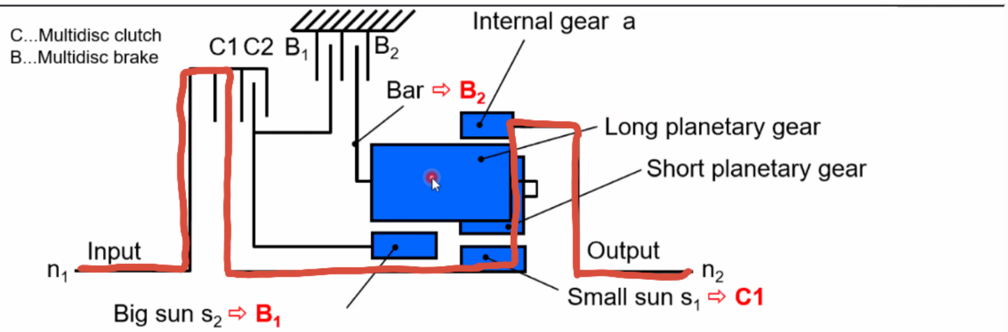
2 planetary gears

1 planetary gear carrier

2 Sun gears

1 internal gear

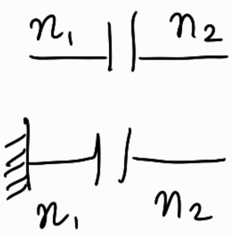
Ravigneaux Planetary Gear Set



Gear 1 عشان أحطها
لازم أعمل engagement لـ B2, C1

Combining the different clutches results in the following transmission possibilities:

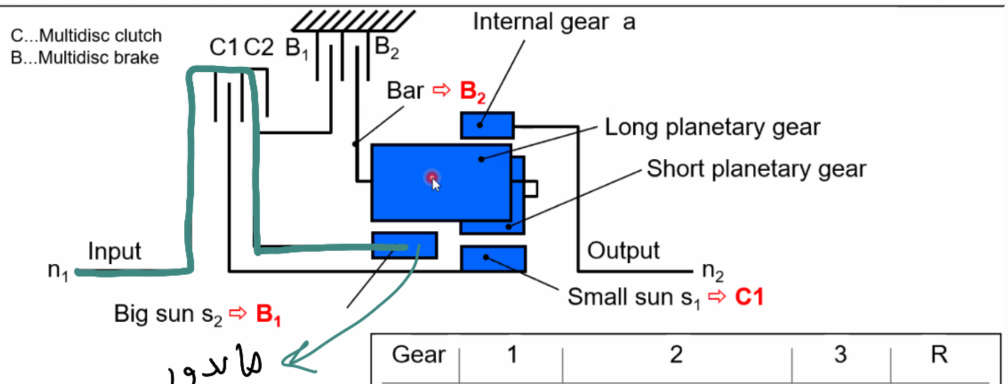
Gear	1	2	3	R
C1	●	●	●	
C2			●	●
B1		●		
B2	●			●
$i = n_1/n_2$	Z_a/Z_{S1}	$\frac{1+(Z_{S2}/Z_{S1})}{1+(Z_{S2}/Z_a)}$	1	$-Z_a/Z_{S2}$



$n_1 = n_2$ clutch
$n_1 \neq n_2$ Brake
} ارجعي للمحاضرة

Reverse gear → (فيديو) See Recording 50min

Ravigneaux Planetary Gear Set



Combining the different clutches results in the following transmission possibilities:

Gear	1	2	3	R
C1	●	●	●	
C2			●	●
B1		●		
B2	●			●
$i = n_1/n_2$	Z_a/Z_{S1}	$\frac{1+(Z_{S2}/Z_{S1})}{1+(Z_{S2}/Z_a)}$	1	$-Z_a/Z_{S2}$

Gear 5

6-Speed AT according to Leppeletier

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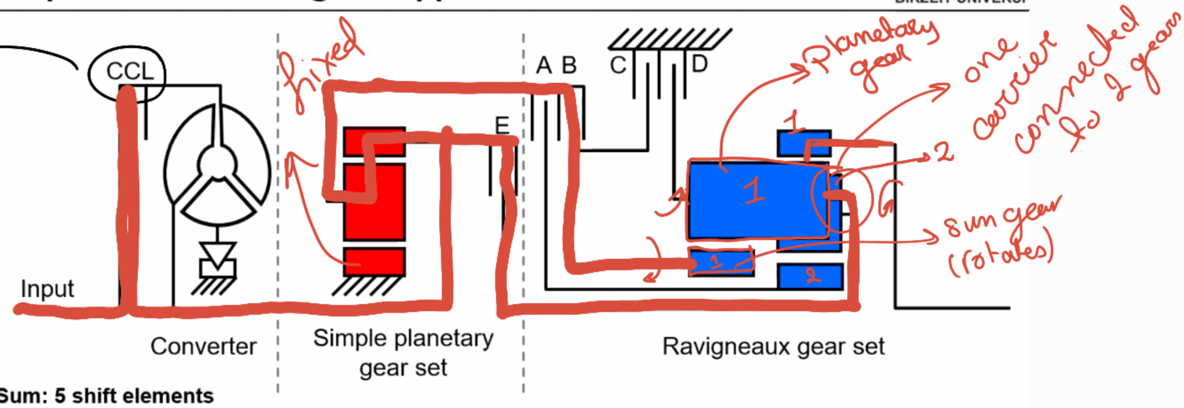
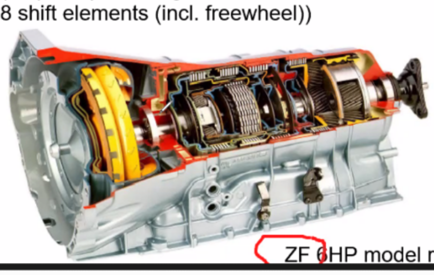
for speeds < 2000 rpm



Sum: 5 shift elements
(5-speed preceding transmission:
8 shift elements (incl. freewheel))

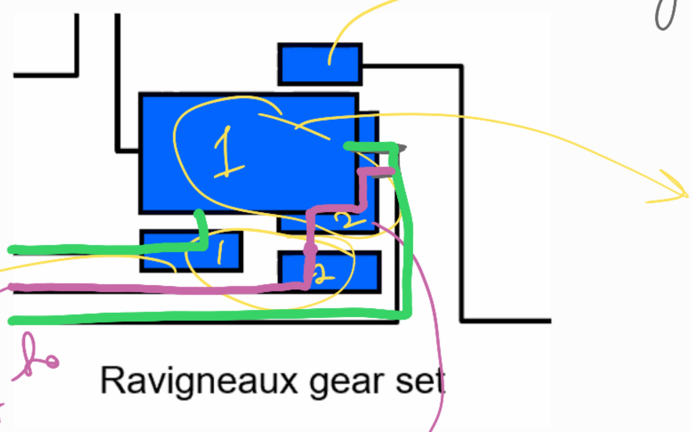


ZF 6HP model range

Shift matrix

Gear	Clutches			Brakes		Trans-mission
	A	B	E	C	D	
1	●				●	4.17
2	●			●		2.34
3	●	●				1.52
4	●		●			1.14
5		●	●			0.87
6			●	●		0.69
R		●			●	-3.40

There is two power flows



رح يدور
Torque بيصير ينقل
لأنه A مسكر

Gear 1

6-Speed AT according to Leppeletier

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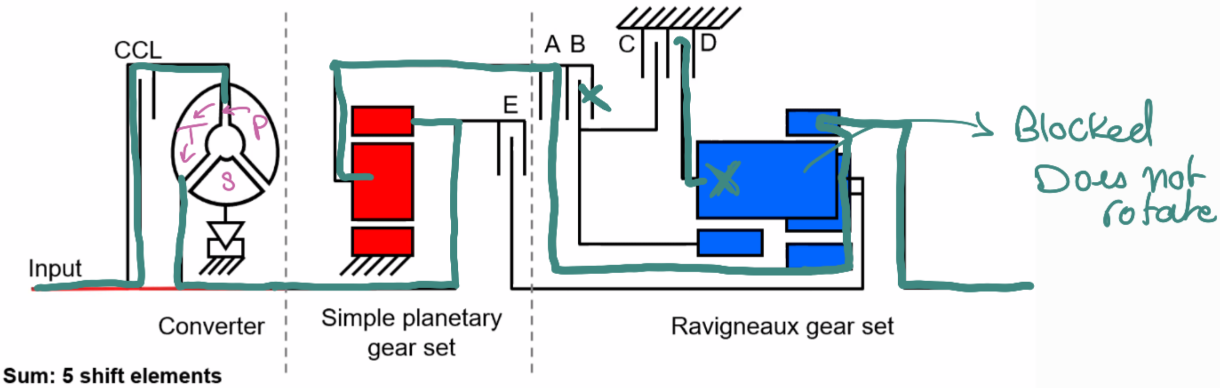
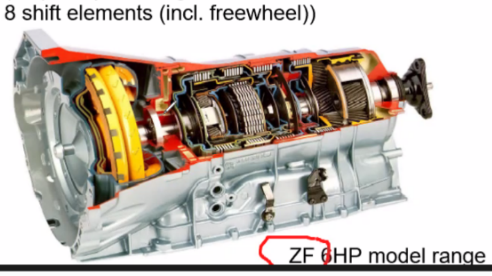


Sum: 5 shift elements
(5-speed preceding transmission:
8 shift elements (incl. freewheel))



ZF 6HP model range

Shift matrix

Gear	Clutches			Brakes		Trans-mission
	A	B	E	C	D	
1	•				•	4.17
2	•			•		2.34
3	•	•				1.52
4	•		•			1.14
5		•	•			0.87
6			•	•		0.69
R		•			•	-3.40

6-Speed AT according to Leppeletier

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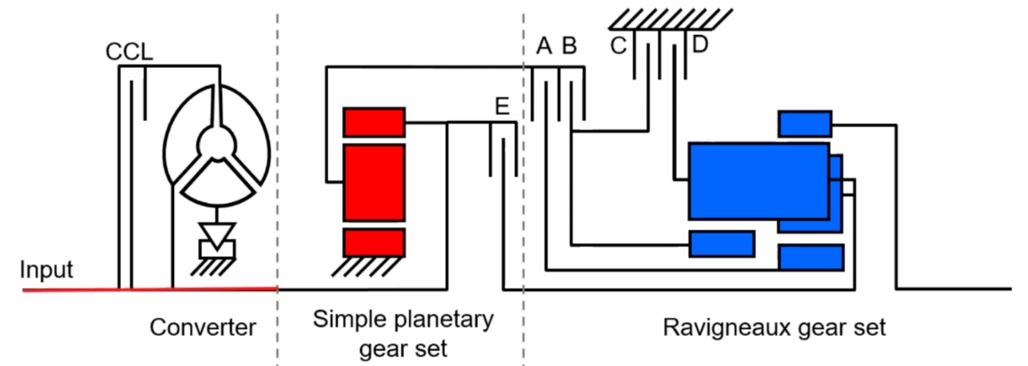
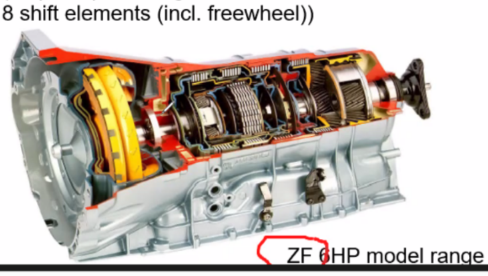


Sum: 5 shift elements
(5-speed preceding transmission:
8 shift elements (incl. freewheel))



ZF 6HP model range

Shift matrix

Gear	Clutches			Brakes		Trans-mission
	A	B	E	C	D	
1	•				•	4.17
2	•			•		2.34
3	•	•				1.52
4	•		•			1.14
5		•	•			0.87
6			•	•		0.69
R		•			•	-3.40

7-Speed AT according by DaimlerChrysler principle

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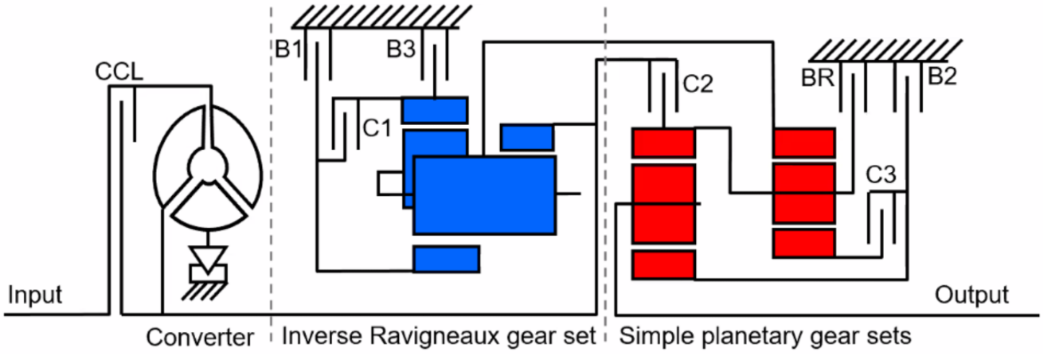
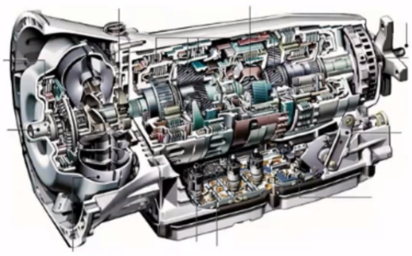


Sum: 7 shift elements



Shift matrix ● closed shift elemen

Gear	Clutches			Brakes			
	C1	C2	C3	B1	B2	B3	BR
1			●		●	●	
2			●	●	●		
3	●		●		●		
4	●	●			●		
5	●	●	●				
6		●	●	●			
7		●	●			●	
R1			●			●	●
R2			●	●			●

2 speeds for reverse

سرعة عالية زي [illegible] على طلعة

سرعة بسيطة

7-Speed AT according by DaimlerChrysler principle

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↳ 7 (5 clutches + 2 Brakes)

wet clutch