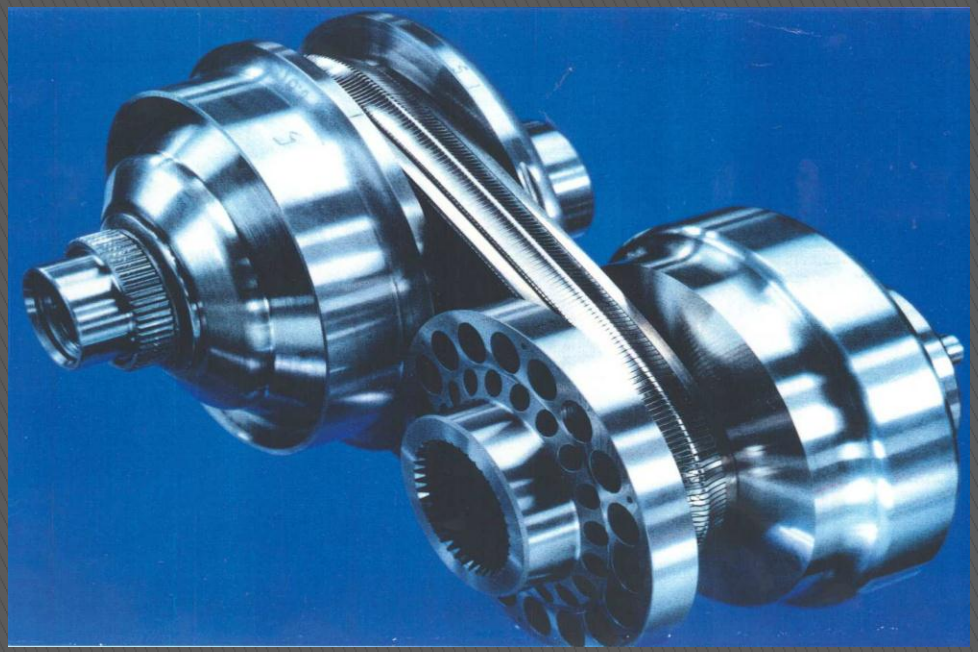
Design and fabrication of miniature of Continuously Variable Transmission



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Disadvantages of gearbox

- Produce jerk to vehicle during the change of gears.
- Considerable loss of power in the transmission system.
- Low starting acceleration.
- Considerable driving fatigue.

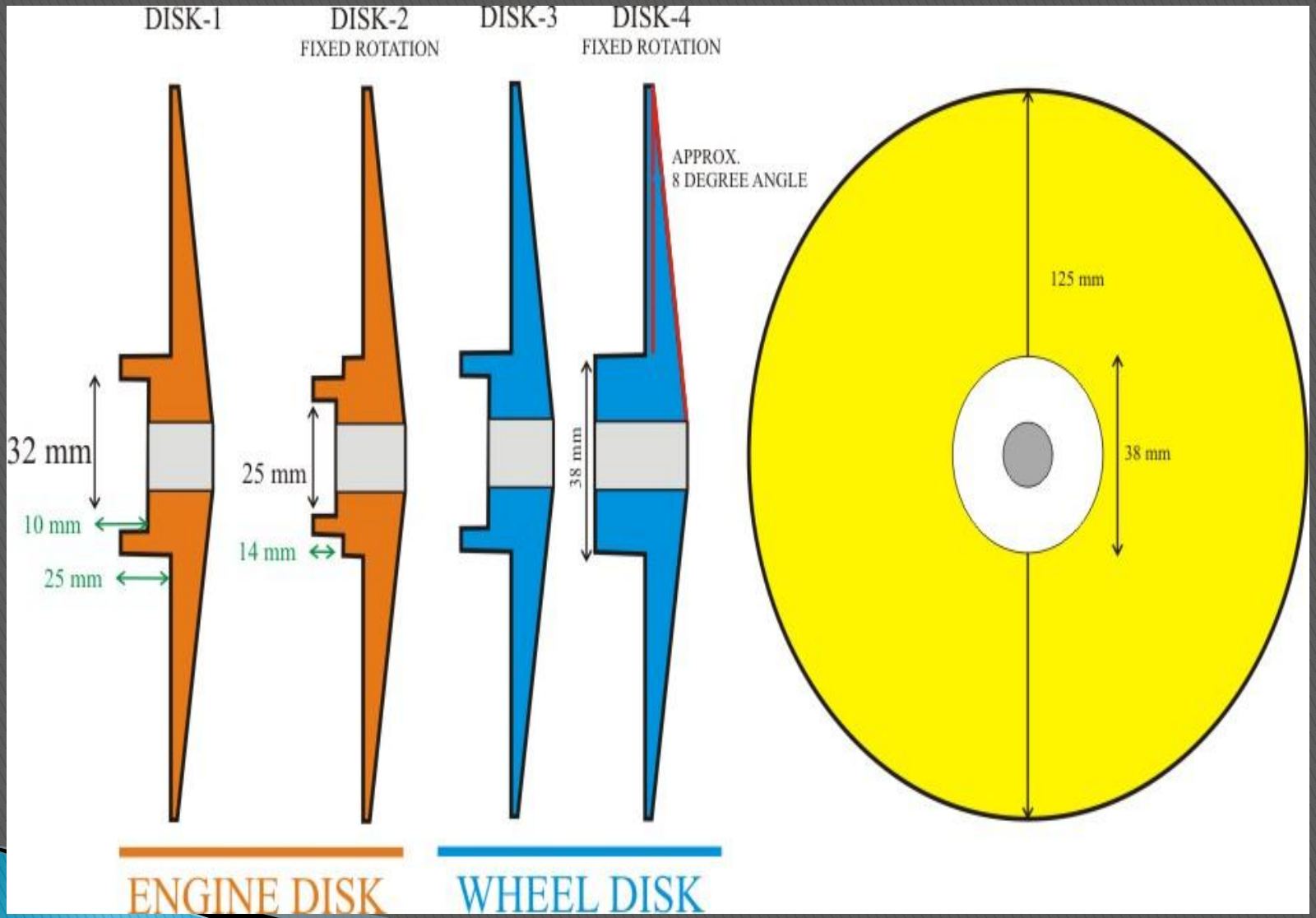
Cvt – an introduction

- This unique transmission does not have several set of gears like most transmissions, but rather have an infinite number of gear ratios.
- CVT does not strictly require the presence of a clutch, allowing the dismissal thereof.
- Seamless acceleration with a “direct” drive feel for enhanced driving pleasure.
- With fewer moving parts, CVT is simpler than AT in principle.
- CVT is emerging as a keystone technology that enables other innovations.

COMPONENTS

- Specially design discs (design on CNC machine).
- Motor.
- Bearing (608, 6801 and 6807).
- Sprocket and chain drive.
- Mild Steel rods or shafts.
- Threading nut and bolt.
- Wooden body frame.
- Rubber belt.

- The two variable pulleys are made up of a pair of tapered discs.



DESIGN OF SHAFT

Weight of disc = 8.8 N

Weight of pulley = 8.8*2 = 17.6 N

This weight of pulley acts as a point load on shaft.

Bending moment due to this point load $M = wl/4 = (17.6*0.470)/4$

$M = 2.07$ N m

Power of the motor used = 0.25 HP = 186.5 watt

Speed of the motor = 1400 rpm (approx.)

Torque produced by motor $T = (P*60)/(2\pi N) = (186.5*60)/(2\pi*1400)$

$T = 1.27$ Nm

Equivalent bending moment $M_e = [M+(M^2+T^2)^{1/2}]/2$

$M_e = 2.24$ Nm

For mild steel,

Allowable bending stess = 56 Mpa

Allowable shear stress = 42 Mpa

Factor of safety = 6

Now,

$$M_e = (\pi/32)*(\sigma_b/6) *d^3$$

$$2.24 = (\pi/32)*(56*10^6/6) *d^3$$

$$d = 14.44 \text{ mm}$$

Equivalent torque $T_e = (M^2+T^2)^{1/2}$

$$T_e = (2.07^2+1.27^2)^{1/2}$$

$$T_e = 2.43 \text{ Nm}$$

Now,

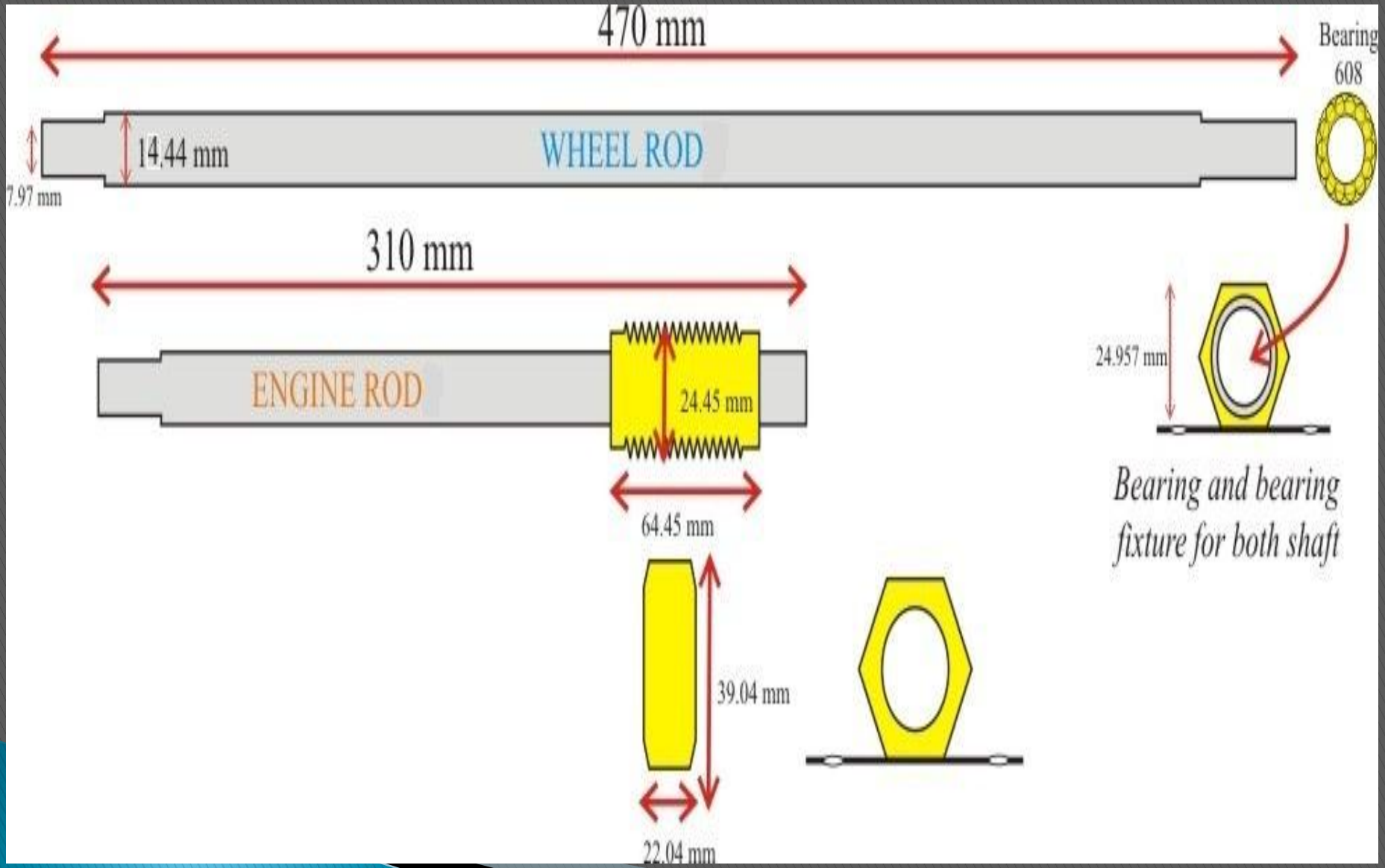
$$T_e = (\pi/16)*(\tau/6)*d^3$$

$$2.43 = (\pi/16)*(42*10^6/6)*d^3$$

$$d = 12.09 \text{ mm}$$

For the safe design of shafts, the larger diameter among the following is adopted i. e. d = 14.44 mm

DIMENSIONS OF SHAFT



DESIGN OF CHAIN AND SPROCKETS

It is assumed that,

Teeth on smaller sprocket $z_1 = 7$

Teeth on larger sprocket $z_2 = 44$

Velocity ratio = 44/7 = 6.285

For this velocity ratio(6 to 7) minimum centre distance $C_{min} = 1.5(d_1+d_2)/2+(30 \text{ to } 50)$

$C_{min} = 1.5(185+32)/2+40$

$C_{min} = 202.75$ mm

So it is adopted that C = 205 mm

Pitch of chain $P = C/(30 \text{ to } 60)$

$P = (205)/(30 \text{ to } 60) = 3.41 \text{ to } 6.83$

So it is adopted that P = 6.83 mm

No. of Links $m = (2C/P)+(z_1+z_2)/2+P(z_2-z_1)^2/(4\pi^2C)$

$m = 60.025+25.5+1.01$

$m = 86.03$

The nearest number is adopted -

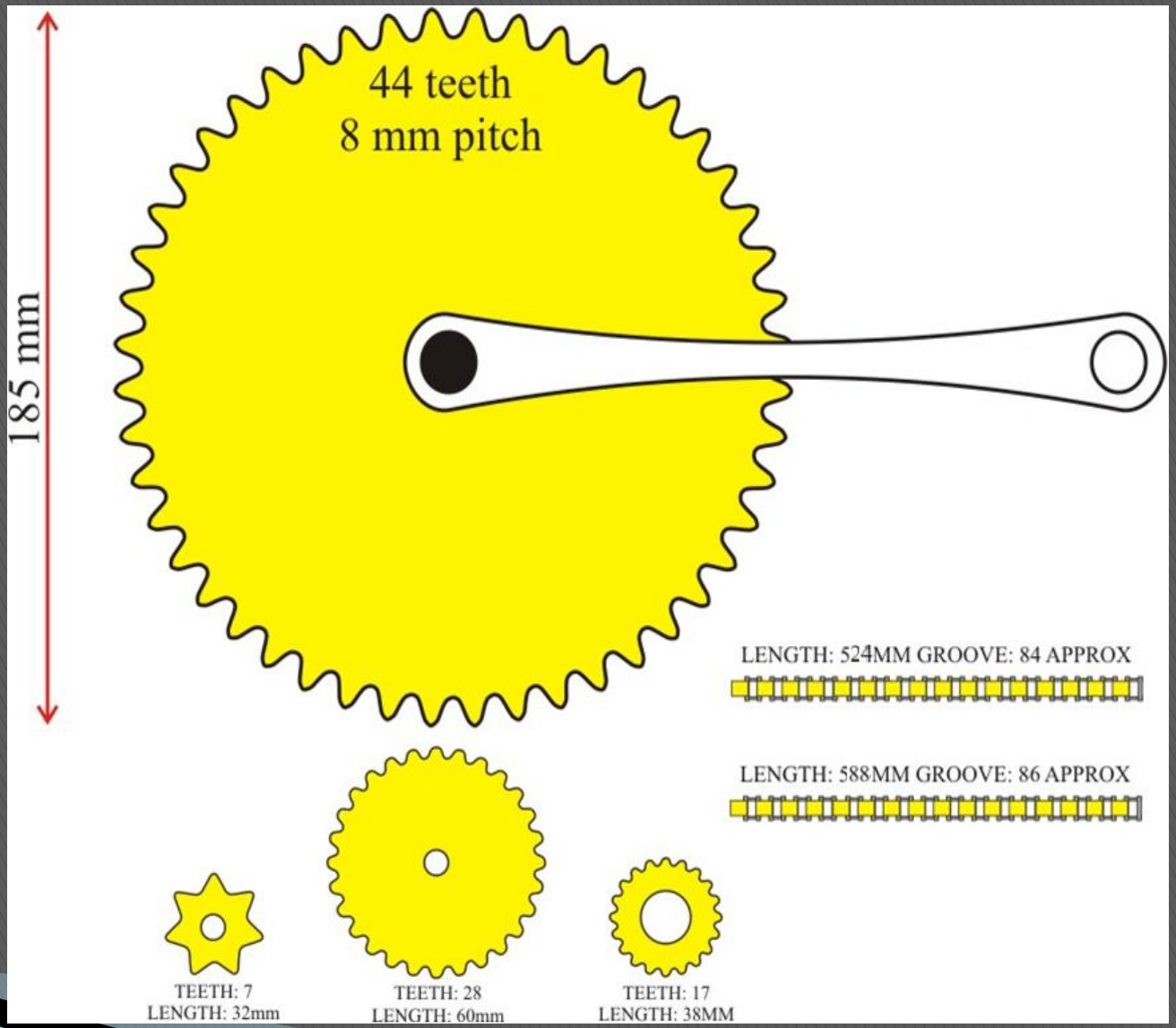
$m = 86$

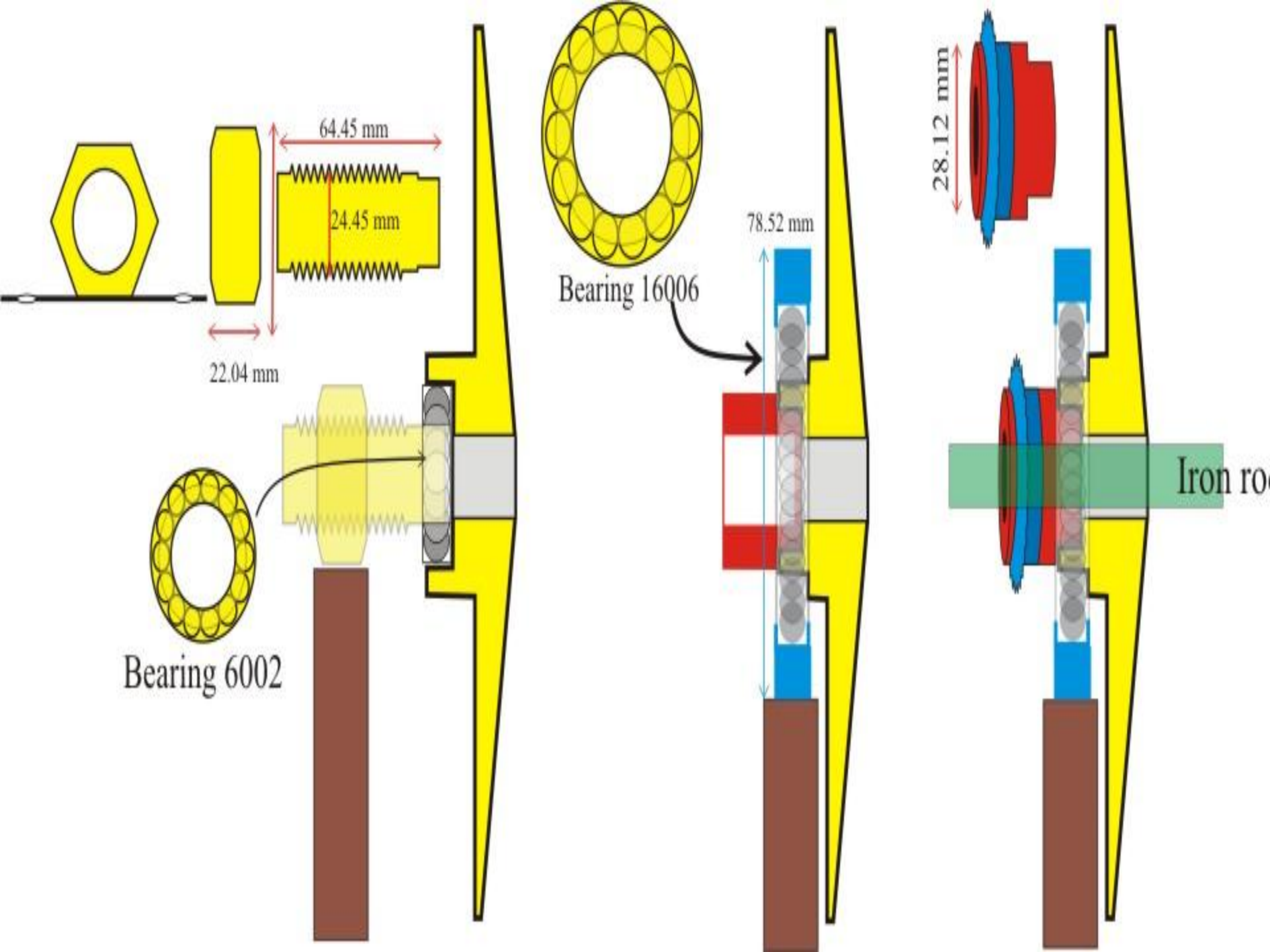
Length of chain $l = mP$

$l = 86*6.83 = 588$ mm(approx.)

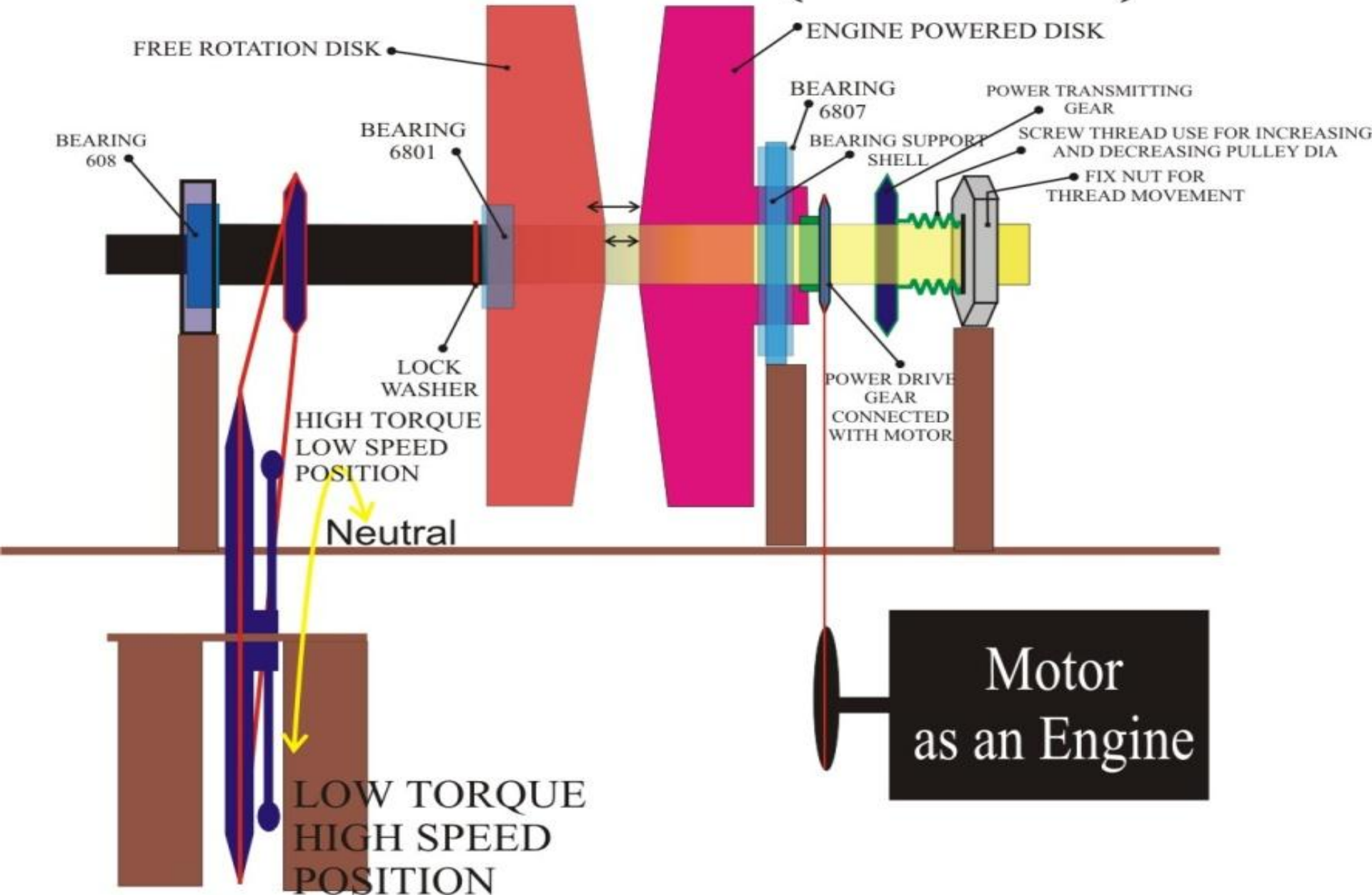
Design of chain drive

Dimensions:-
Length: 588mm
Groove: 86

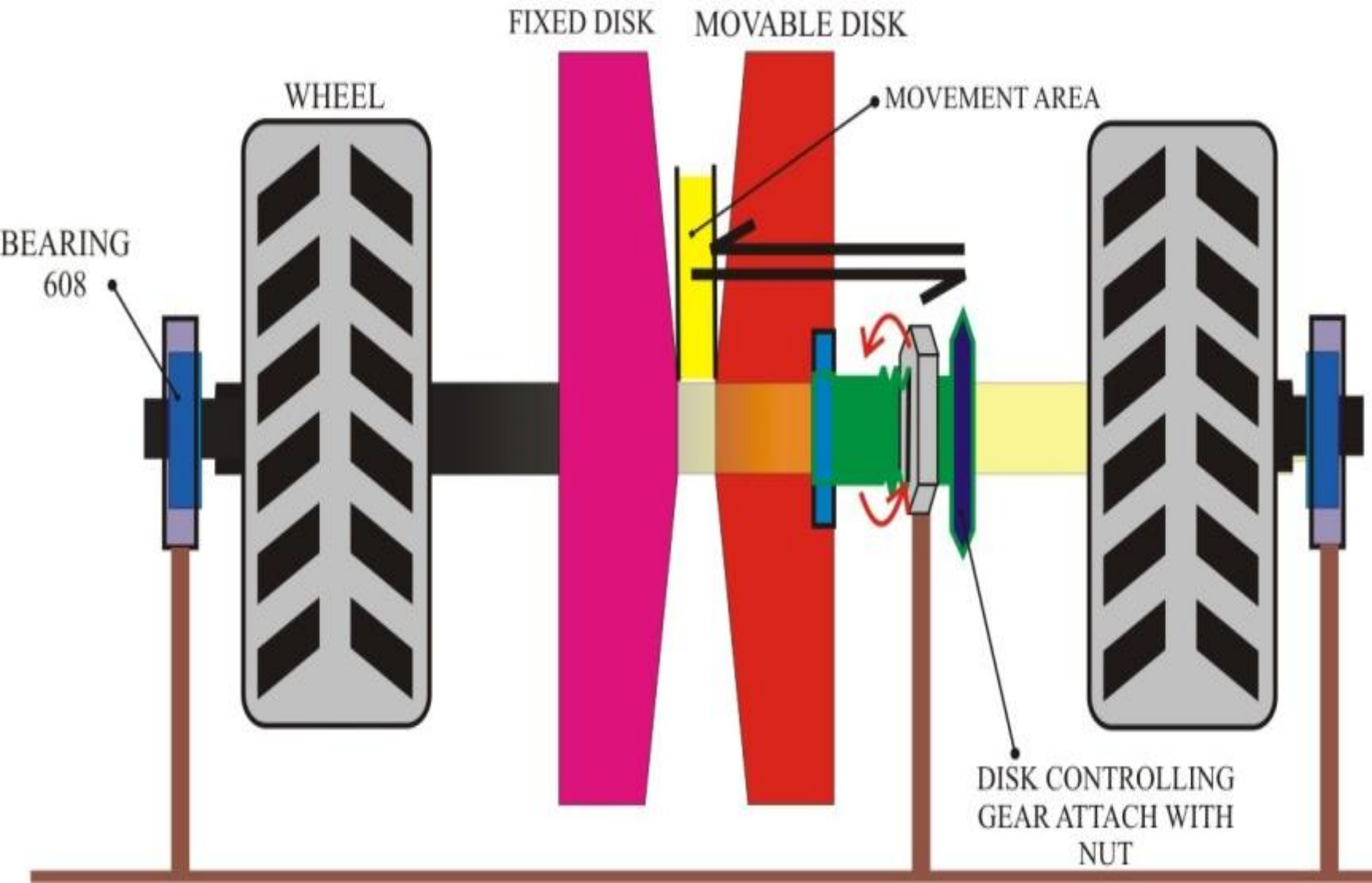



64.45 mm
24.45 mm
22.04 mm
Bearing 6002
Bearing 16006
78.52 mm
28.12 mm
Iron ro

SECTION-A
DRIVE PULLEY(ENGINE)

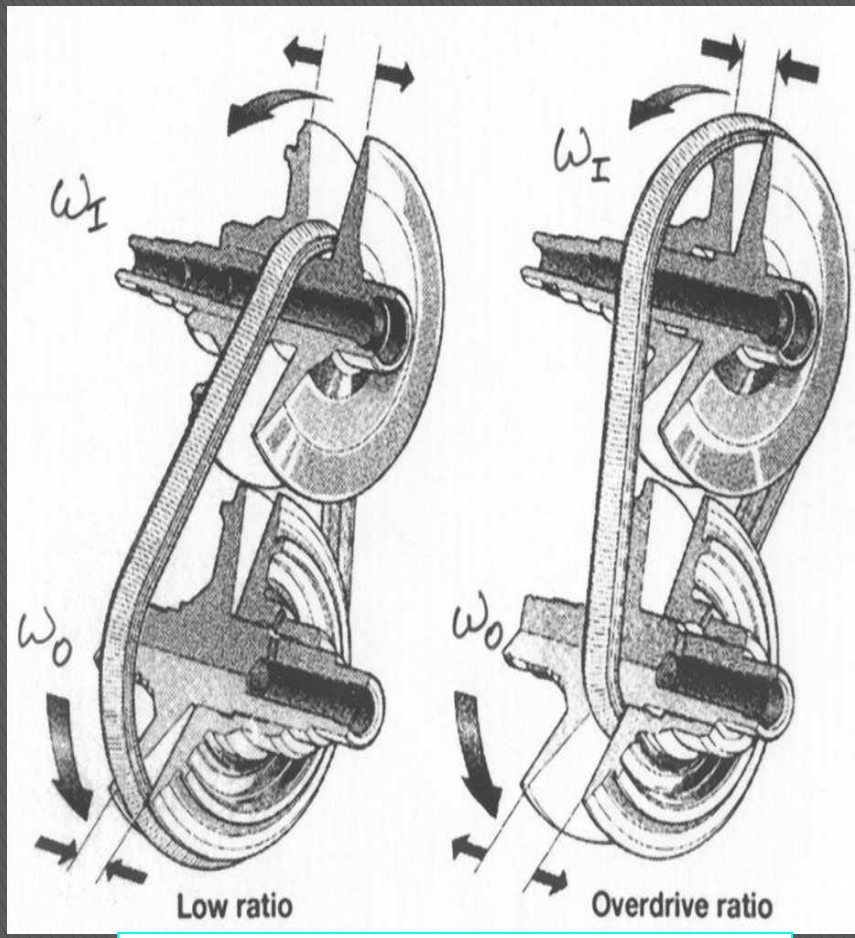


SECTION-B
WHEEL SHAFT PULLEY



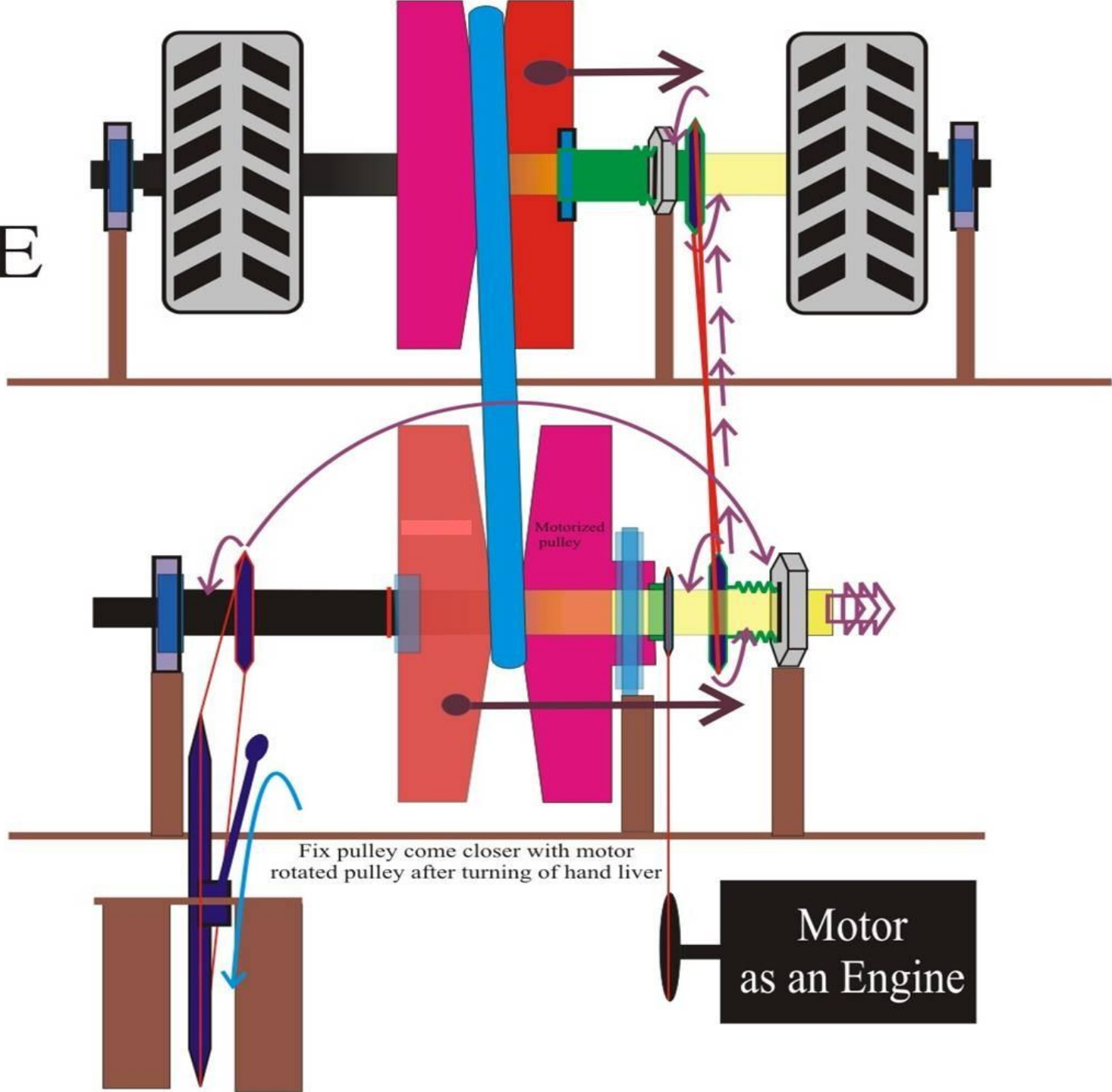
WORKING PRINCIPLE

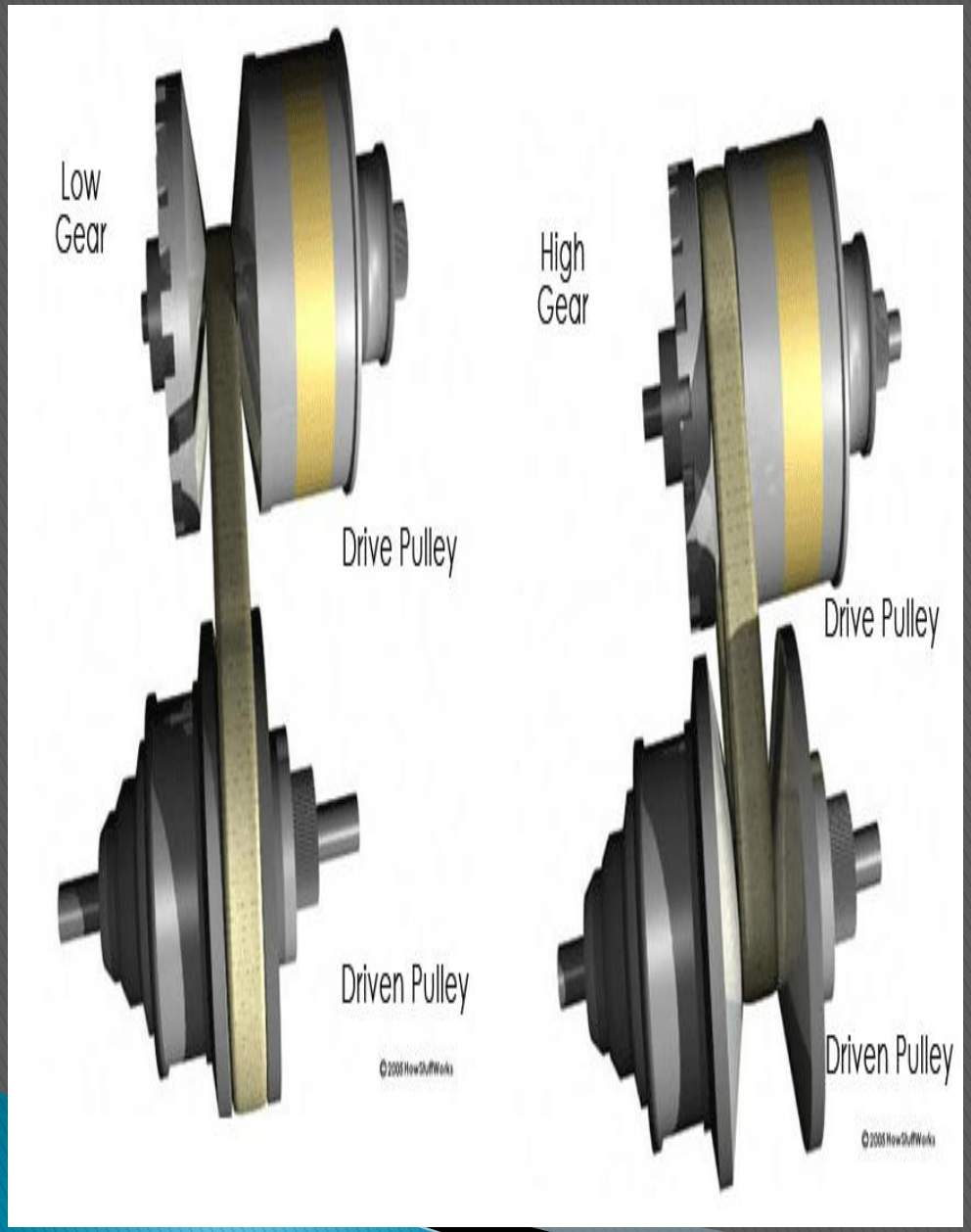
- The two variable pulleys are made up of tapered discs.
- The radius of the pulleys can be changed by changing the clearance between the discs.
- As the pulleys changes their radius relative to one another they creates infinite number of gear ratios between minimum to maximum and every thing in between.



$$Gear\_ratio = \frac{r_o}{r_i} = \frac{\omega_o}{\omega_i}$$

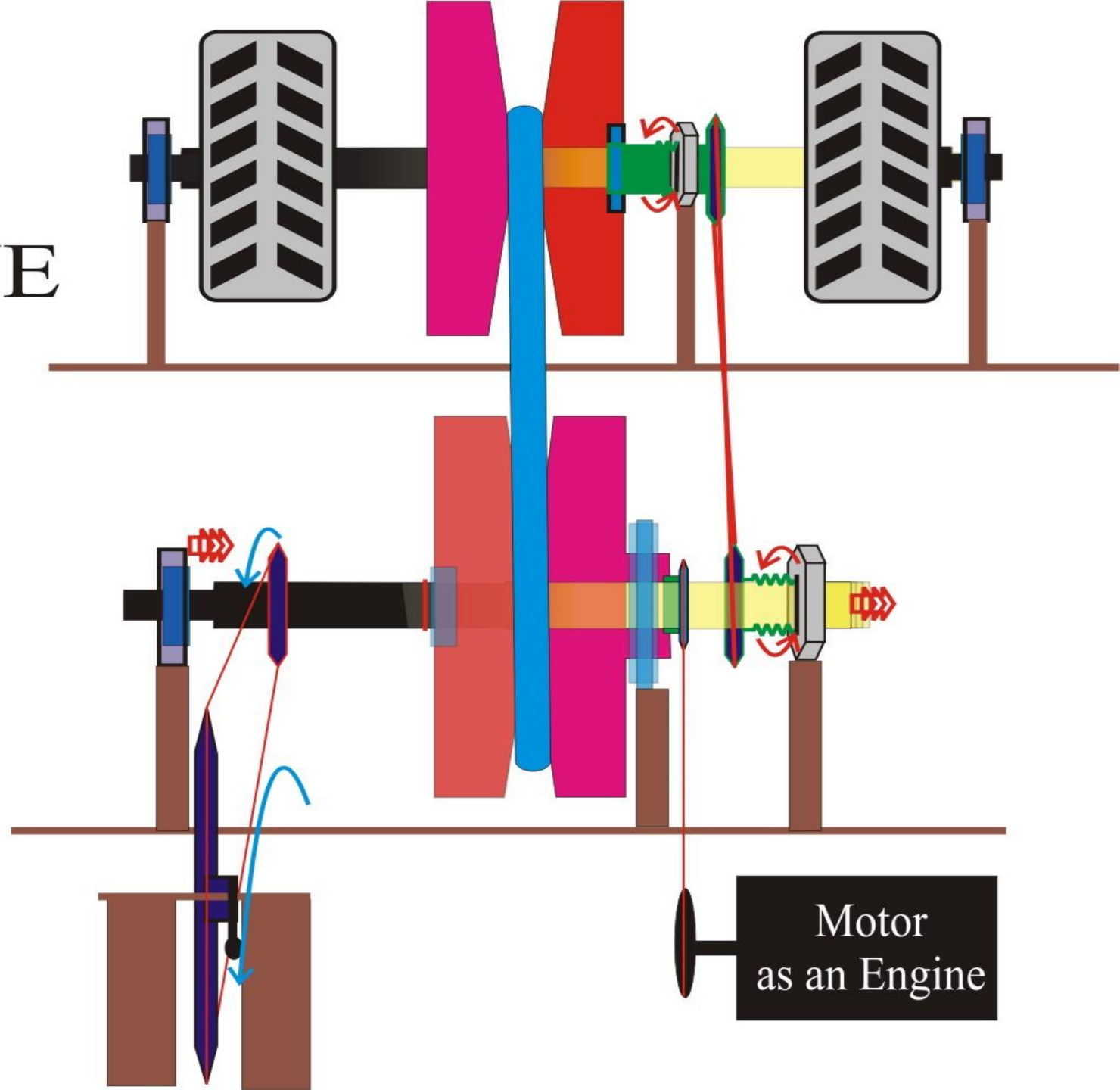
RPM
LOW
TORQUE
HIGH



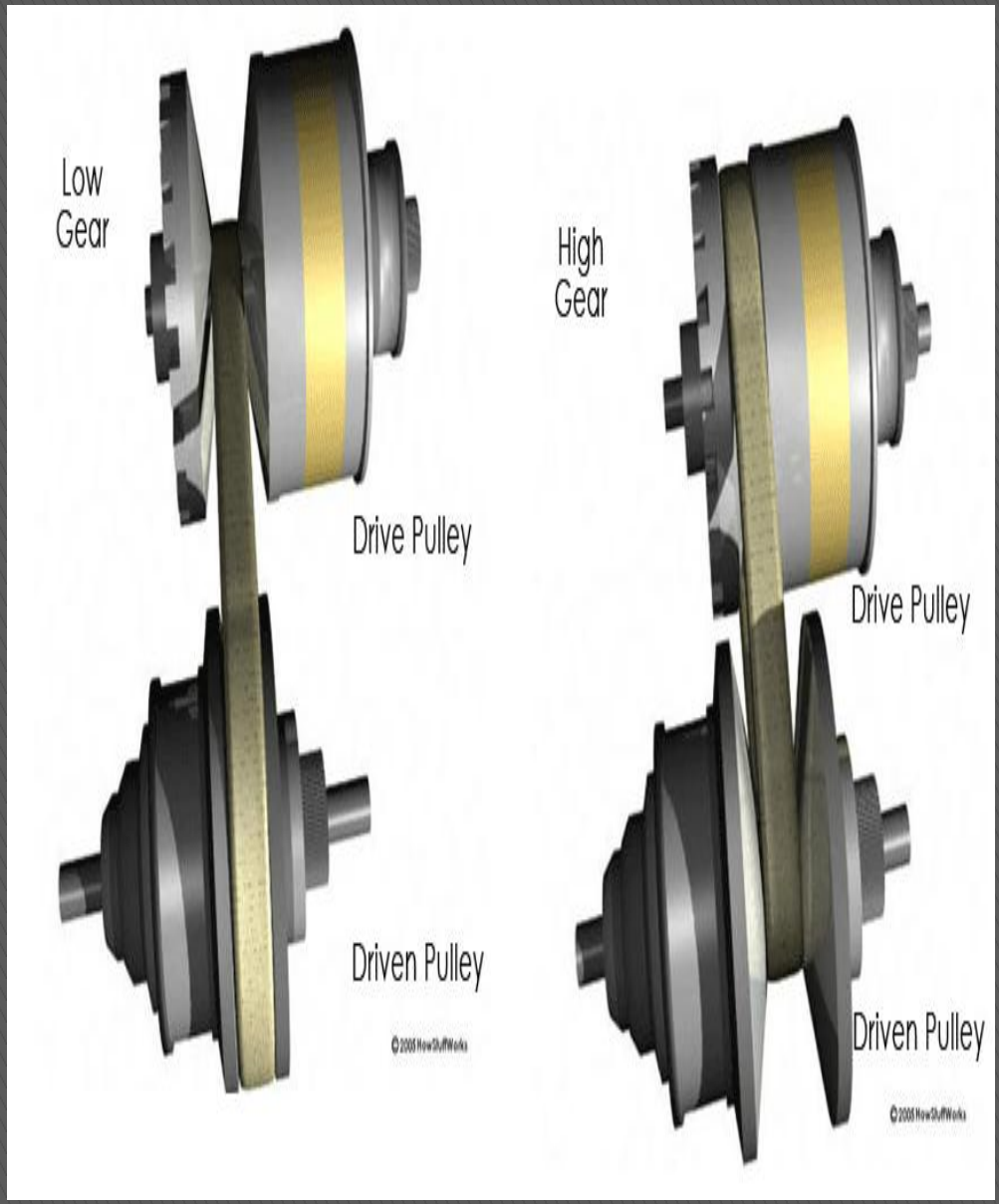


- On low gear situation the radius of drive pulley is smaller than the driven pulley.
- In low gear situation the Torque is high while the RPMs of driven pulley are low.

RPM
HIGH
TORQUE
LOW



- On high gear situation the radius of drive pulley is larger than the driven pulley.
- In low gear situation the Torque is low while the RPMs of driven pulley are high.



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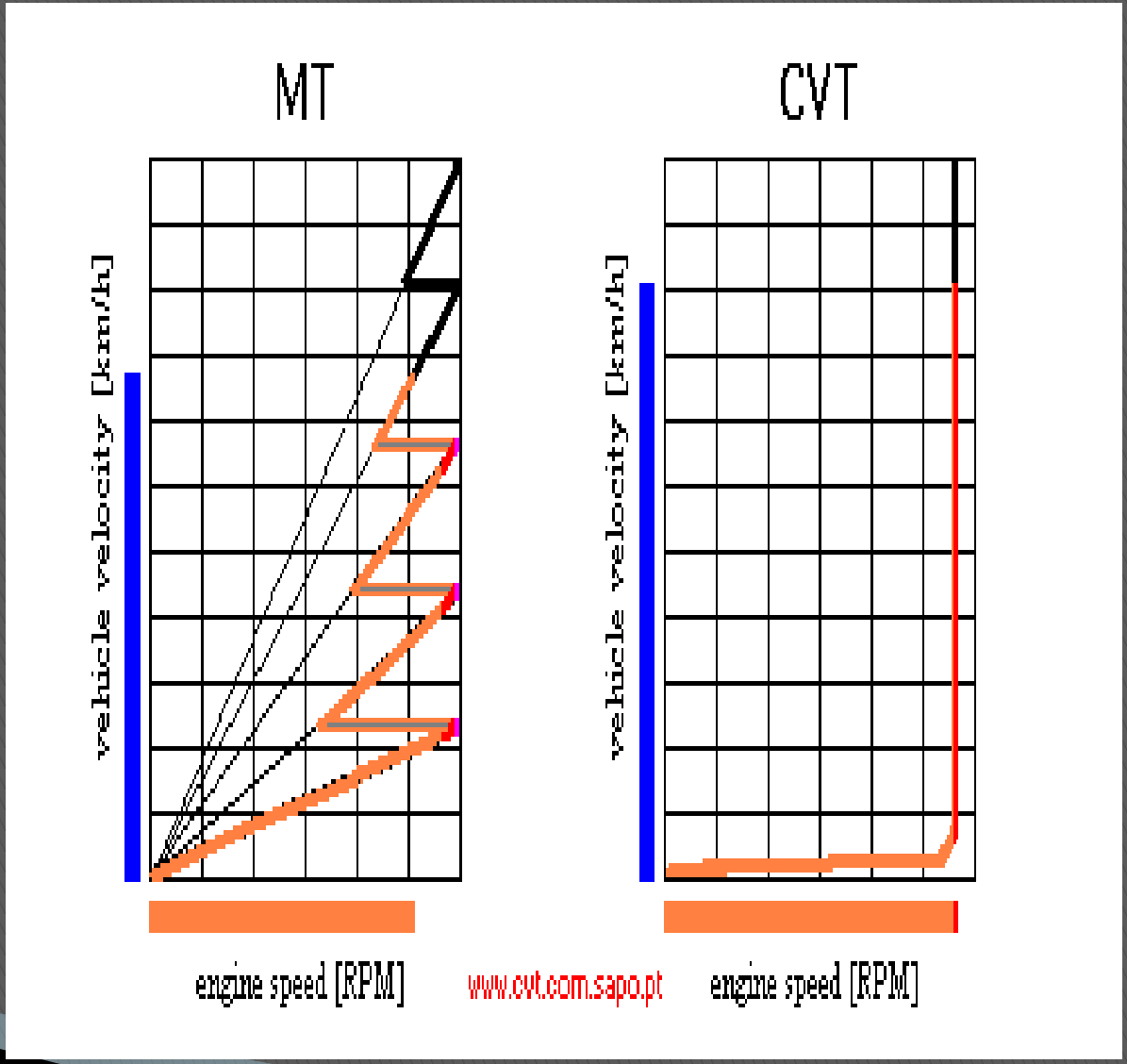
Advantages

- CVTs operate smoothly since there are no gear changes which cause sudden jerks.
- Constant, stepless acceleration.



Advantages

- The main advantage of CVTs is that they allow an engine to run at its ideal RPM regardless of the speed of the vehicle. This improves fuel economy and by effect, exhaust emissions.
- CVT equipped vehicles consumes 10% less fuel when compared with the automatic transmissions.

(from Nissan motor's journal)

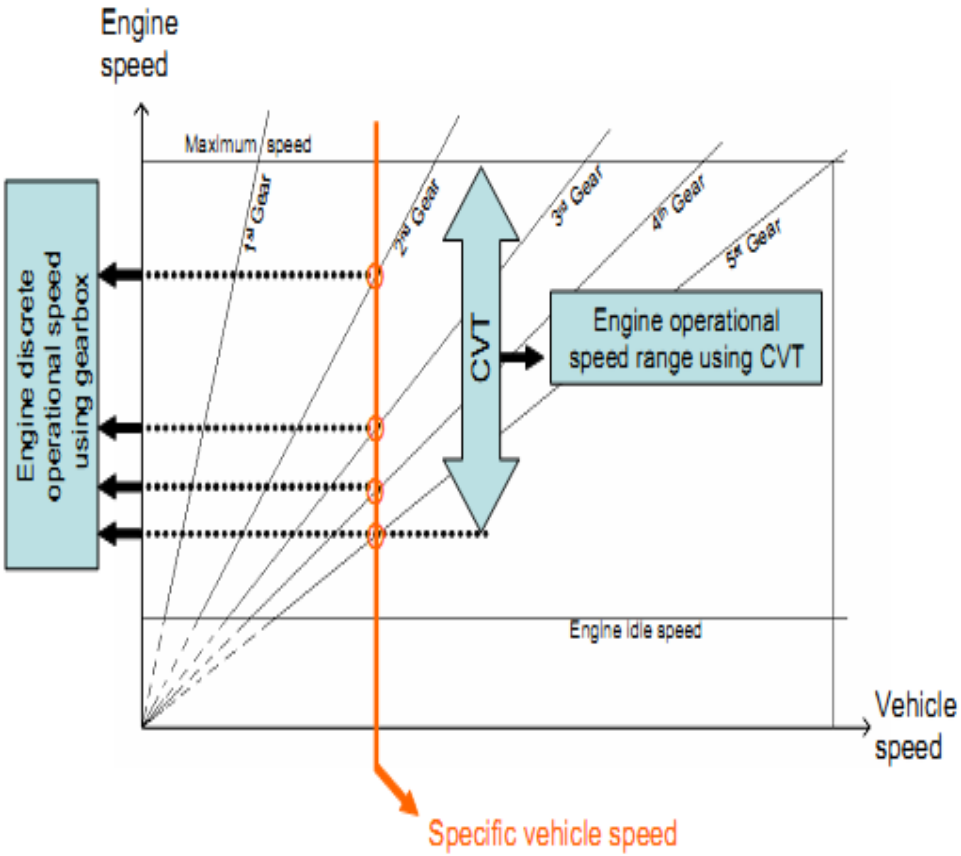
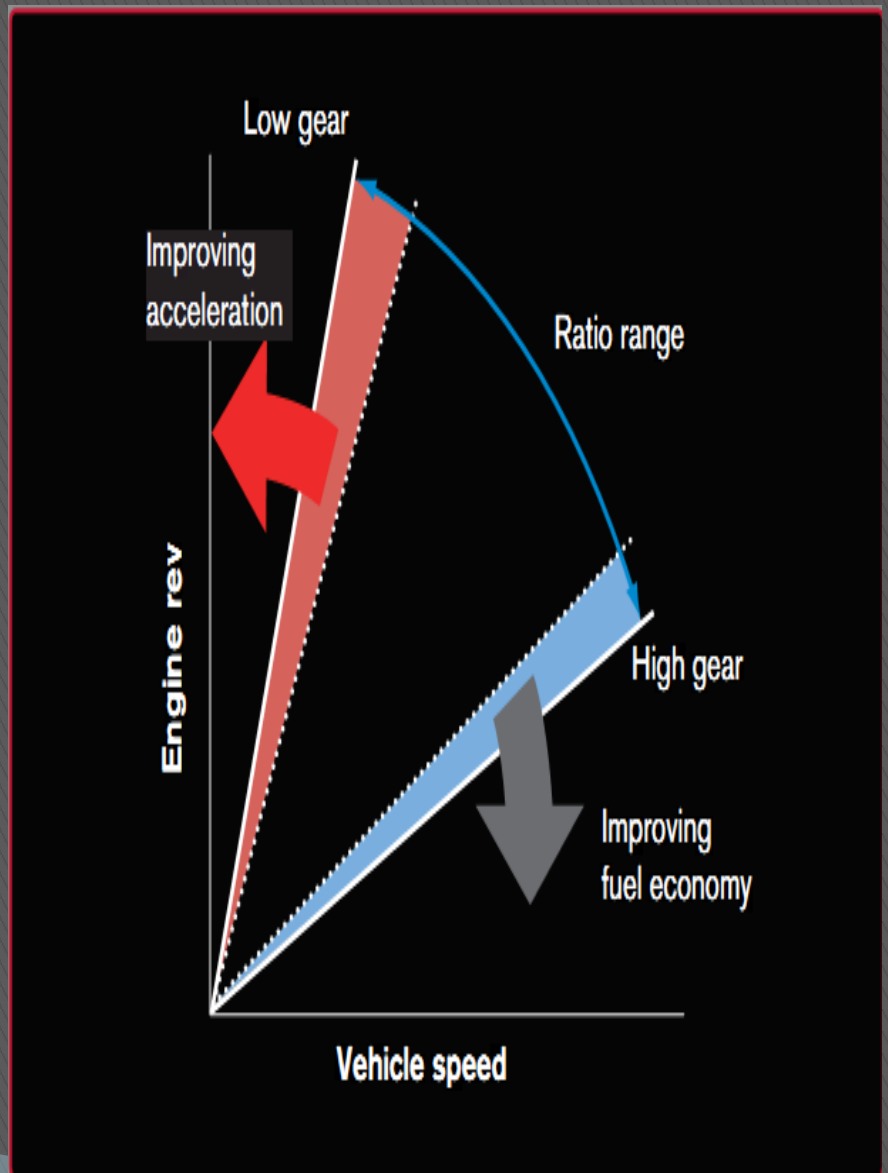


Figure 9: Continuously variable ratio compared with discrete ratio

Advantages

- Wider gear ratio range.
- In CVT, the gear ratio range from low to high gear is expanded, attaining a top-of-class final gear reduction ratio of about 6.
- The extended low end of the range to improve acceleration, and the high end to improve fuel economy.
- Flexibly tunable to match engine characteristics, thereby enabling optimization of the balance between combustion efficiency and acceleration.



Advantages

- There are 25% fewer moving parts to a CVT transmission.
- Less power loss in a CVT than a typical automatic transmission.
- Responds better to changing conditions, such as changes in throttle and speed.

APPLICATIONS

- Many small tractors for home and garden use simple rubber belt CVTs.
- All snowmobiles, old and new, and motor scooters use CVTs.
- Some combine harvesters have CVTs.
- CVTs have been used in aircraft electrical power generating systems and in Formula race cars.
- Some drill presses and milling machines contain a pulley-based CVT.

FUTURE PROSPECTIVES

- Much of the existing literature is quick to admit that the automotive industry lacks a broad knowledge base regarding CVTs. Whereas conventional transmissions have been continuously refined and improved since the very start of the 20th century, CVT development is only just beginning. As infrastructure is built up along with said knowledge base, CVTs will become ever-more prominent in the automotive landscape. Even today's CVTs, which represent first-generation designs at best, outperform conventional transmissions. Automakers who fail to develop CVTs now, while the field is still in its infancy, risk being left behind as CVT development and implementation continues its exponential growth. Moreover, CVTs are do not fall exclusively in the realm of IC engines.

CONCLUSION

- CVT is the most superior technology for power transmission
- And it would be the widely acceptable technology throughout the world.

THANK YOU