

T Level Resource Improvement Project

Teaching and learning resources for the vehicle occupational specialism, T Level Engineering and Manufacturing – steering systems

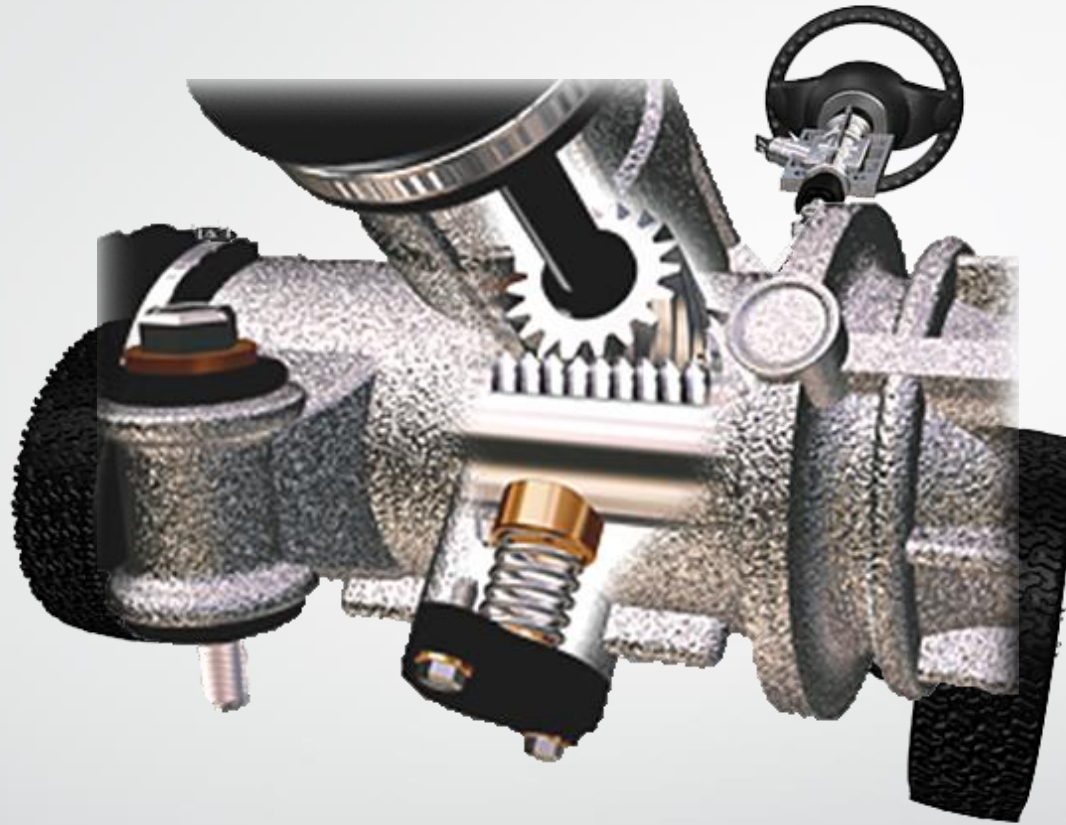
Education and Training Foundation



L1MV27

Steering systems

Steering Systems



In this presentation you will:

- identify the different types of steering systems used in modern vehicles

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Purpose of a Steering System

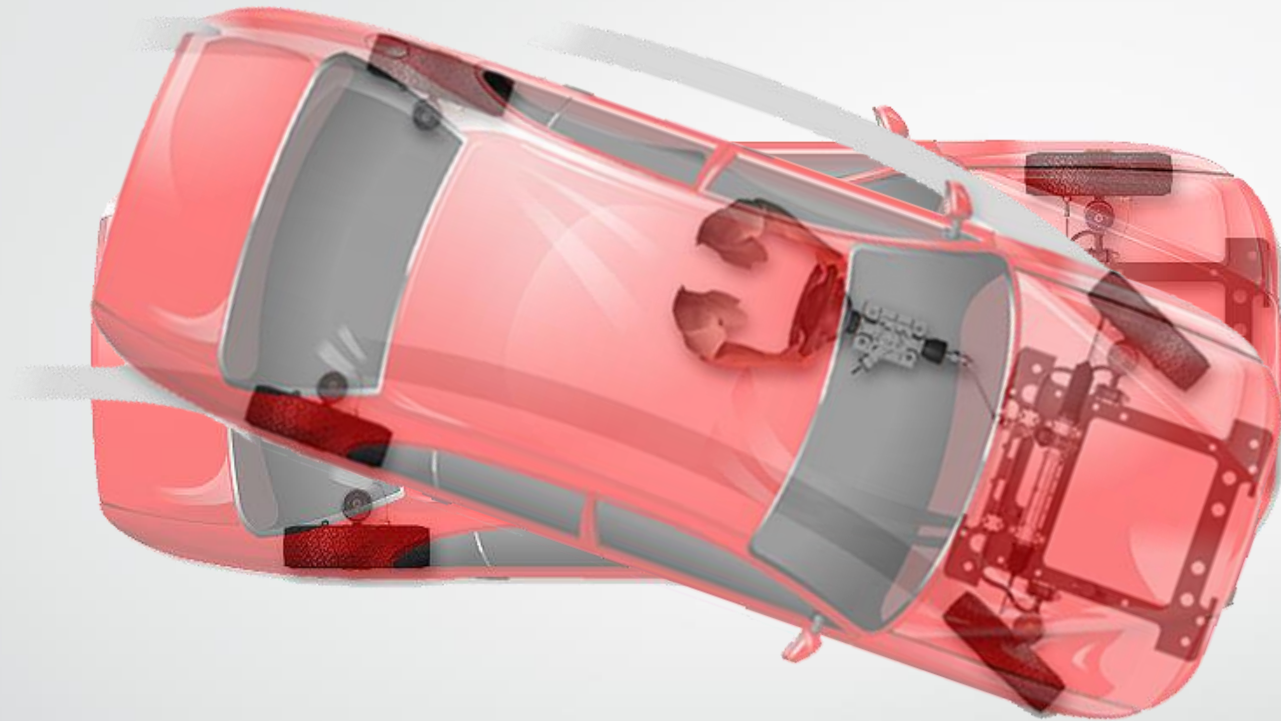
The purpose of the steering system is to allow the driver to control the direction of a vehicle when it is moving.

Early vehicles with steering wheels were fitted with linkage type steering systems.

Most modern vehicles are fitted with rack and pinion steering systems.



Turning a Corner



When turning a corner, the driver turns a steering wheel. This turning motion is transferred to the front road wheels.

The direction the front wheels point is the direction the car will travel, so long as the wheels do not lose grip.

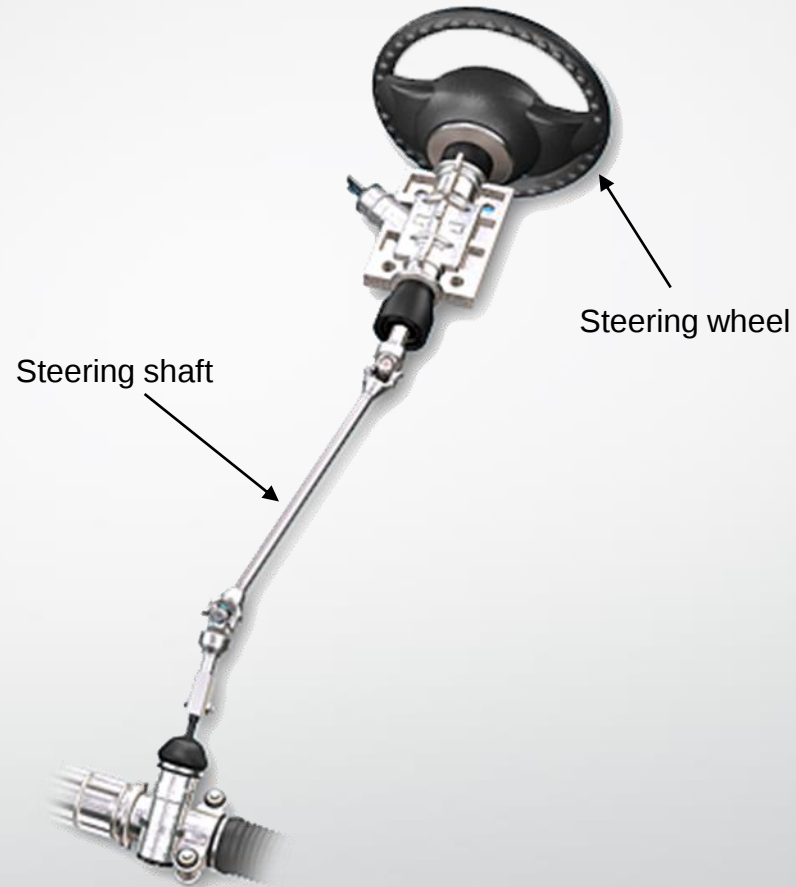
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Steering Columns

Steering systems use a steering column to link the driver to the steering components.

The driver turns a steering wheel to control the direction of the vehicle.

A steering shaft connects the steering wheel to the steering components.

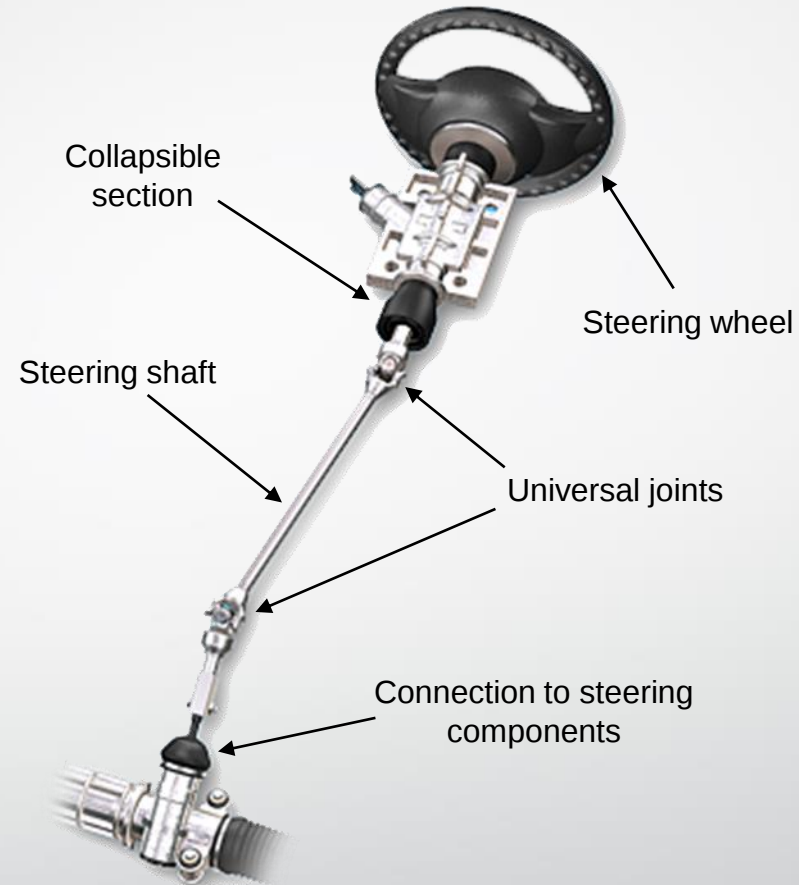


Steering Columns

Universal joints allow the steering shaft to change angles.

Most steering columns are designed with a collapsible section that helps prevent the forces generated in an accident being transferred to the driver.

The bottom of the steering shaft connects to the steering components (rack or box).



Question 1

Two technicians are discussing the driver's role in the steering system.

Technician A states that the driver controls the steering system by turning a steering wheel.

Technician B states that steering columns are designed to collapse in an accident to help protect the driver.

Who is correct?

- A) Only technician A
- B) Only technician B
- C) Both technician A and technician B
- D) Neither technician A nor technician B

Question 1

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Who is correct?

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D) Neither technician A nor technician B

Both of the technicians are correct. The driver does control the steering by using a steering wheel, and most steering columns are designed to collapse in the event of an accident.

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Steering Types

There are two main types of steering system:

- Rack-and-pinion
- Linkage

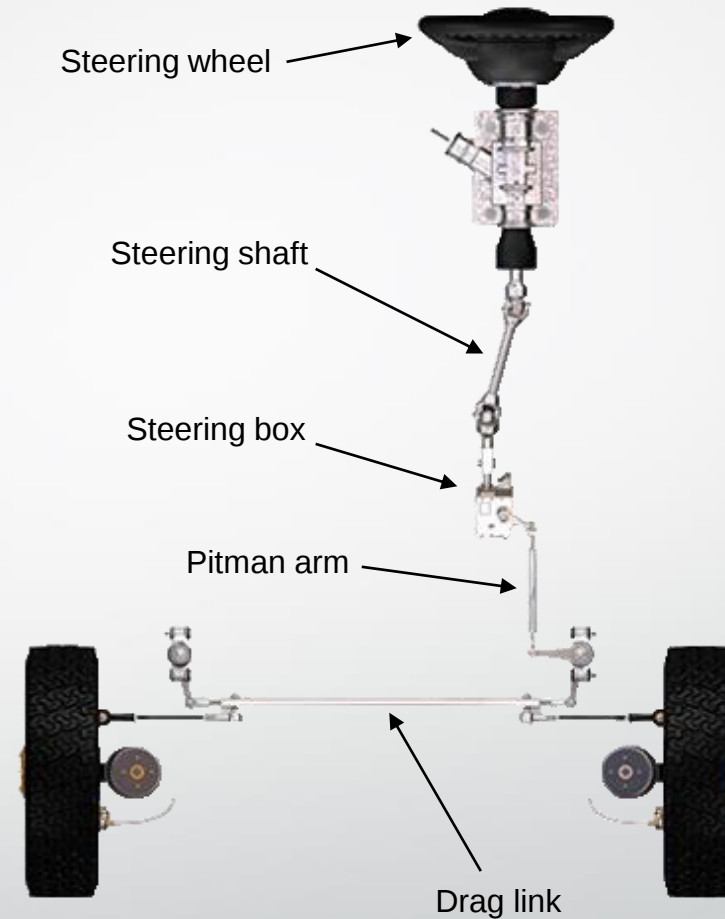


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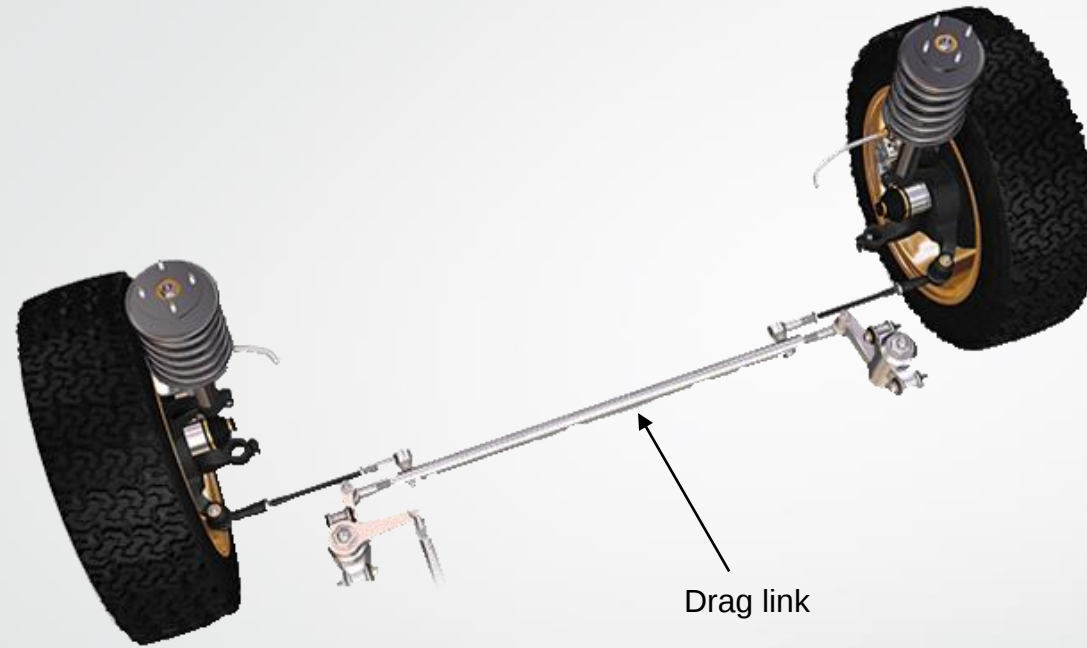
Linkage Steering System

The linkage steering system consists of several linked components, which are:

- Steering wheel - used by the driver to turn the steering components
- Steering shaft - used to connect the steering wheel to the steering components
- Steering box - converts rotary motion of the steering shaft into angular linear motion of the pitman arm
- Pitman arm - connects the steering box to the drag link



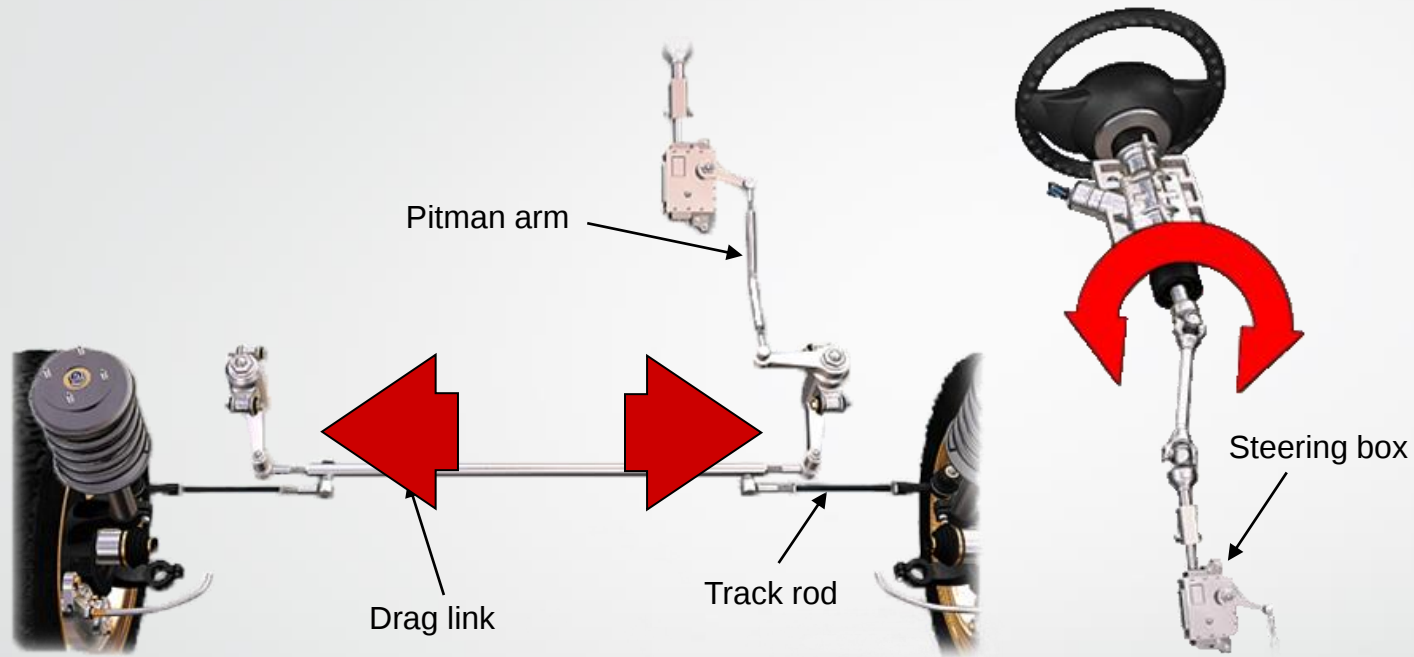
Linkage Steering System



The drag link joins the left and right sides of the steering system, causing them to move together.

The drag link is sometimes called a relay rod or track bar.

Linkage Steering System Operation



In a linkage steering system, the driver turns the steering wheel. Which in turn, through the steering box, swings the pitman arm.

The pitman arm moves the drag link in the required direction (left or right), and this movement is transferred to the track rods on each end of the drag link.

Question 2

Two technicians are comparing rack-and-pinion and linkage steering systems.

Technician A says rack-and-pinion steering systems provide a more direct route from the driver to the road wheels as there are fewer parts.

Technician B says linkage steering systems use a rack to create the linear movement that causes the wheel angle to change.

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A linkage steering system does not use a rack to create linear movement.



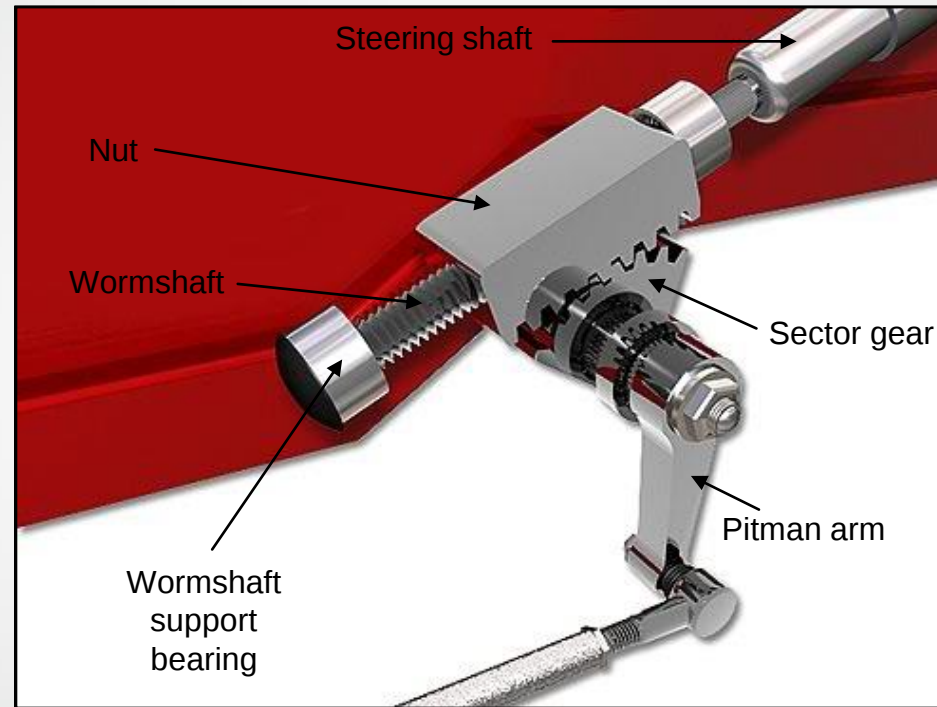
Steering Box

The steering box converts rotation of the steering shaft into angular movement of the 'Pitman arm'.

The box is partially filled with oil to lubricate the steering mechanism inside.

The steering shaft turns a wormshaft that runs through a threaded nut.

The nut has teeth that engage with the teeth on a sector gear.

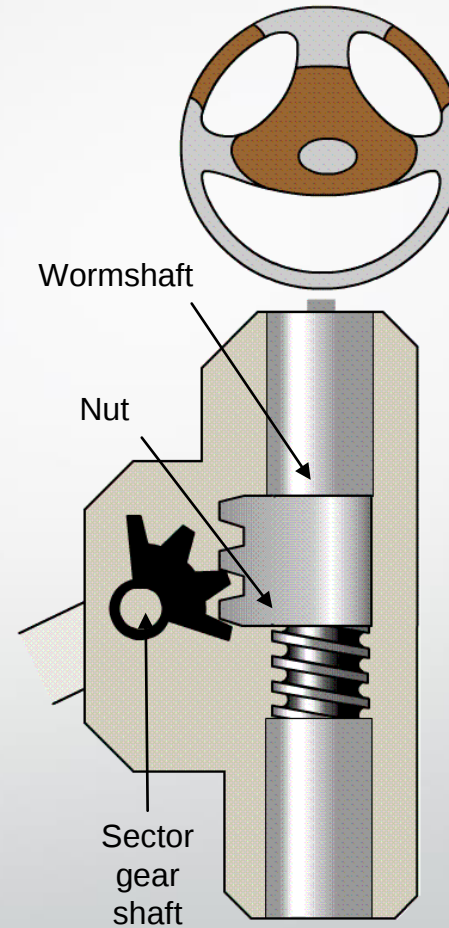


The Wormshaft

The driver turning the steering wheel makes the wormshaft turn.

The wormshaft acts as a screw, and the nut rides up and down as the screw turns.

This in turn rotates the sector gear shaft, because the teeth on the nut are meshed with the teeth on the sector gear.

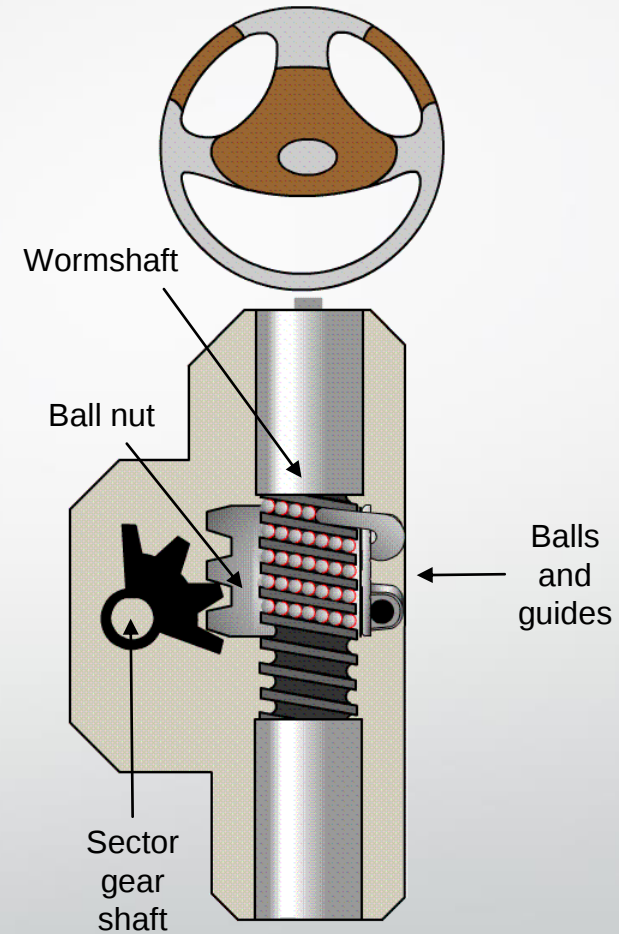


Recirculating Ball Steering Box

Some steering boxes use ball bearings between the wormshaft and the nut to reduce friction.

When the ball bearings exit one end of the nut, they travel through a guide or tube to re-enter at the other end.

This type is called a 're-circulating ball' steering box. The nut is called a 'ball nut'



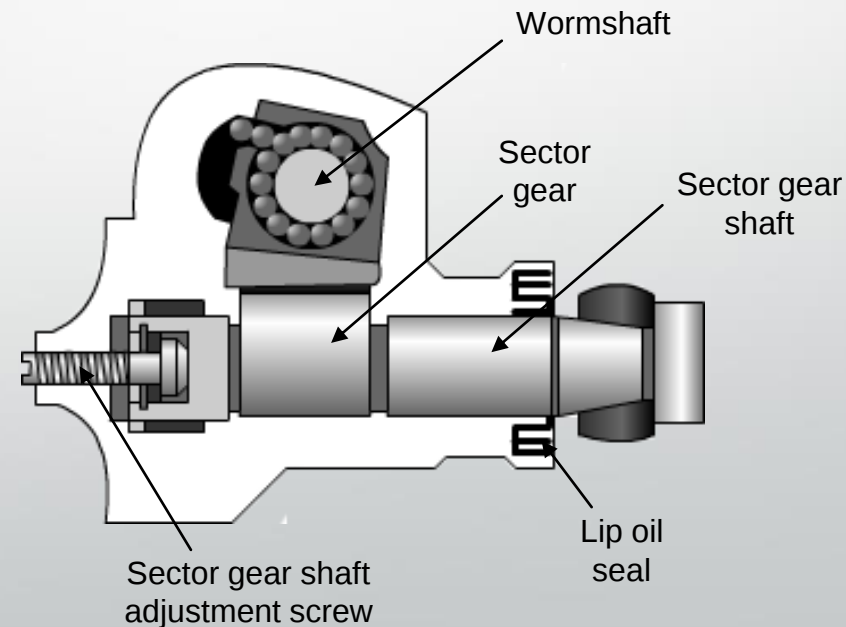
Worm Gear Adjuster

The adjuster sets the pre-load on the thrust bearings that locate the worm shaft.

The sector gear shaft has ball or roller bearings to reduce friction.

Worm gear preload is needed to prevent free play in the steering that would allow the vehicle to wander.

The lubricant for the steering gear is kept in place with seals.

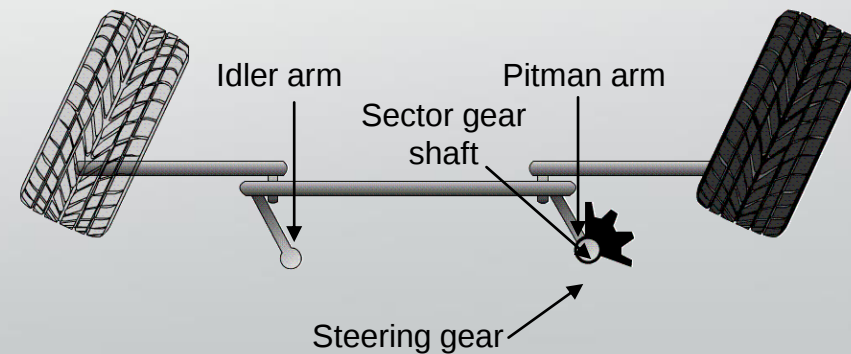
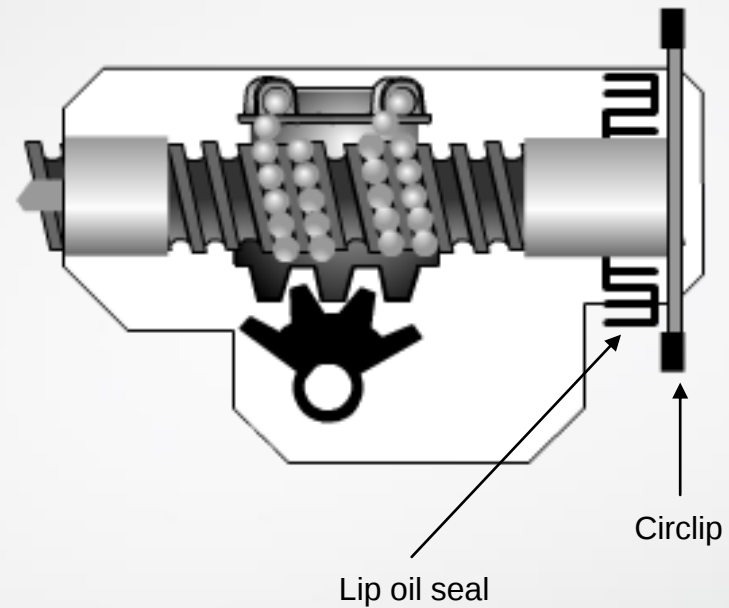


Seals

The seals on the input shaft and sector gear shaft prevent the lubricant leaking out.

Thrust washers and spacers provide proper clearance in the worm and sector gears.

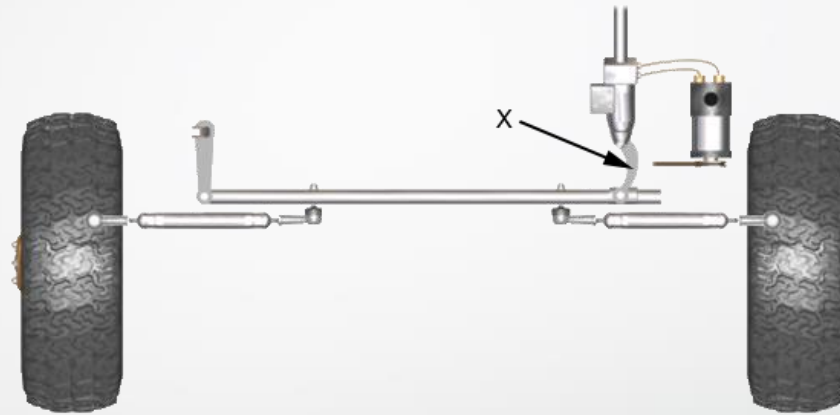
The lubrication reduces friction.



Question 2

What is the component labelled X in the diagram?

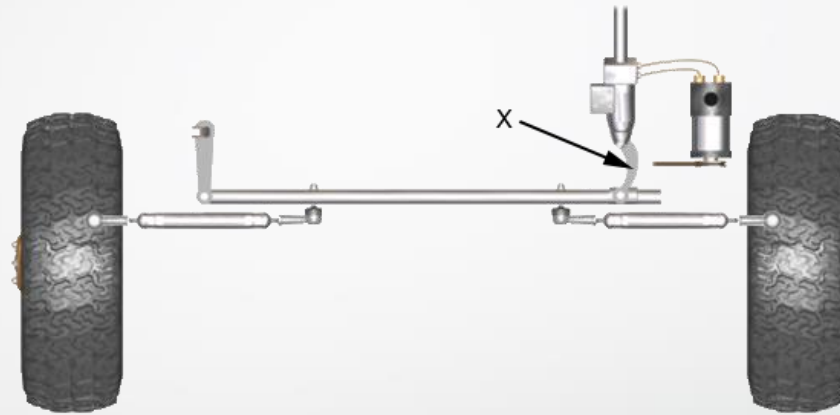
- A) Centre link
- B) Pitman arm
- C) Track rod
- D) Idler arm



Question 2

What is the component labeled X in the diagram?

- A) Centre link
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- C) Track rod
- D) Idler arm



This component connects the steering box to the centre link.

Summary

In this presentation you have seen:

- the arrangement and operation of conventional steering system components

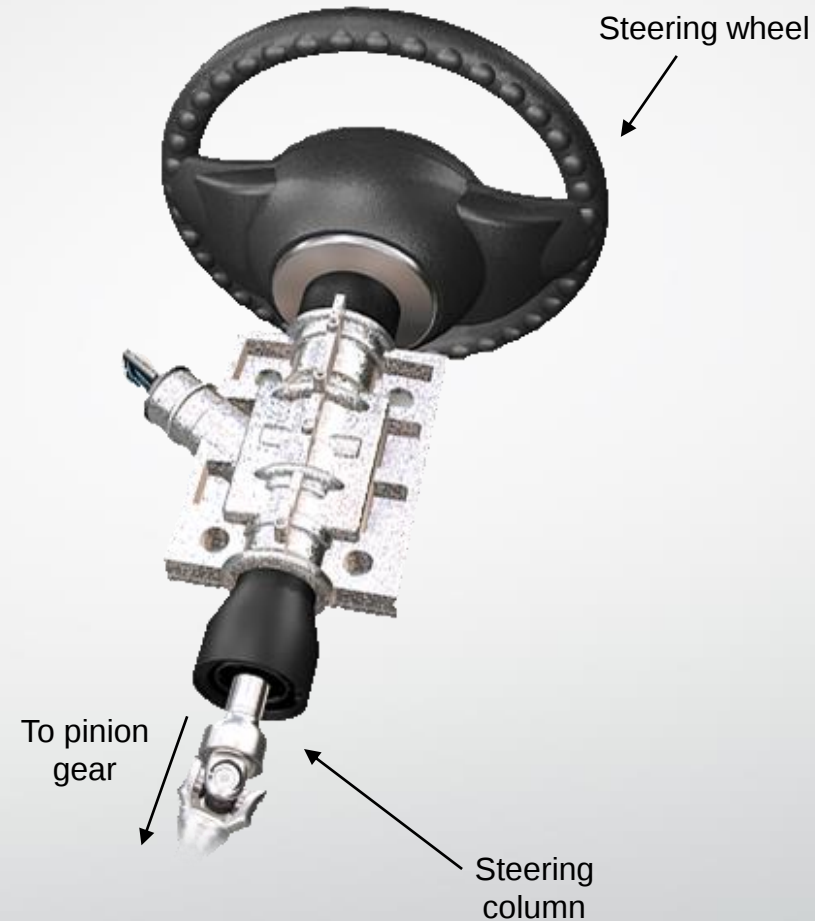
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Rack-and-Pinion Steering Systems

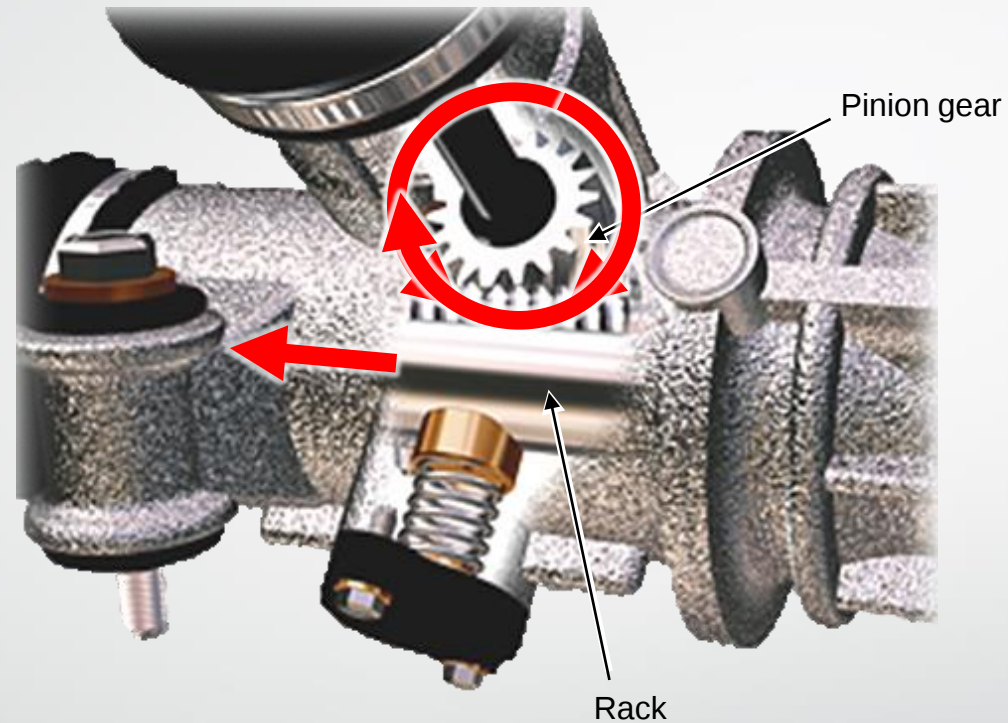
The rack-and-pinion steering is more compact and precise, as it uses fewer parts and has a more direct path to the wheels than the linkage type.

The steering wheel is used by the driver to turn the steering components.

The steering column with pinion gear on the end connects the steering wheel to the rack assembly.



Rack-and-Pinion Steering Systems



The steering rack assembly changes rotary motion of the pinion gear into linear motion.

As the pinion gear rotates, the steering rack is moved left and right.

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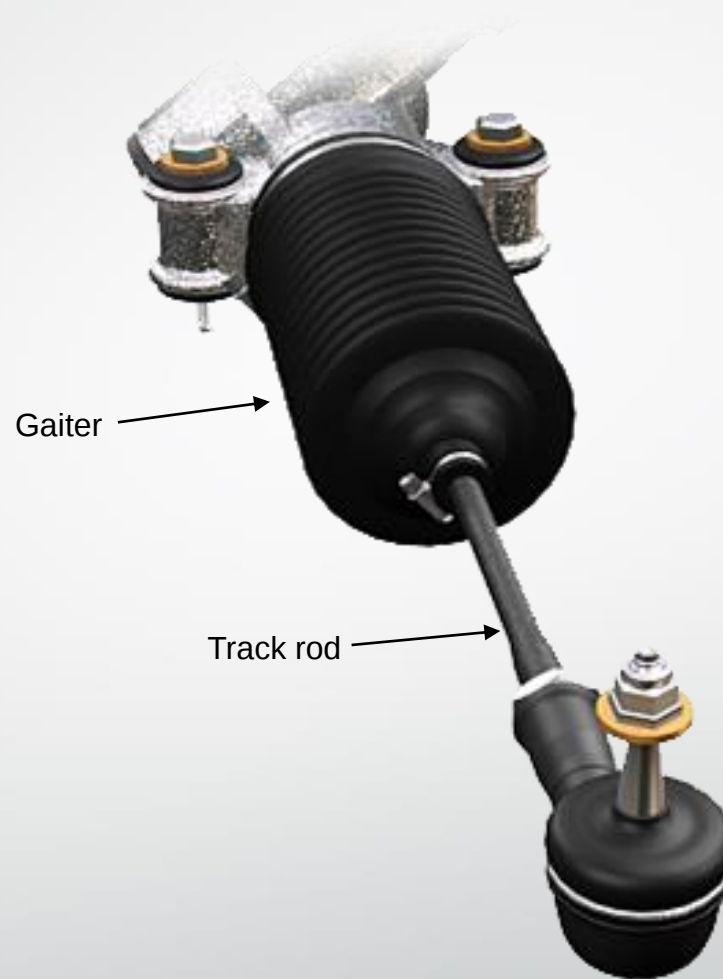
Rack-and-Pinion Steering Systems

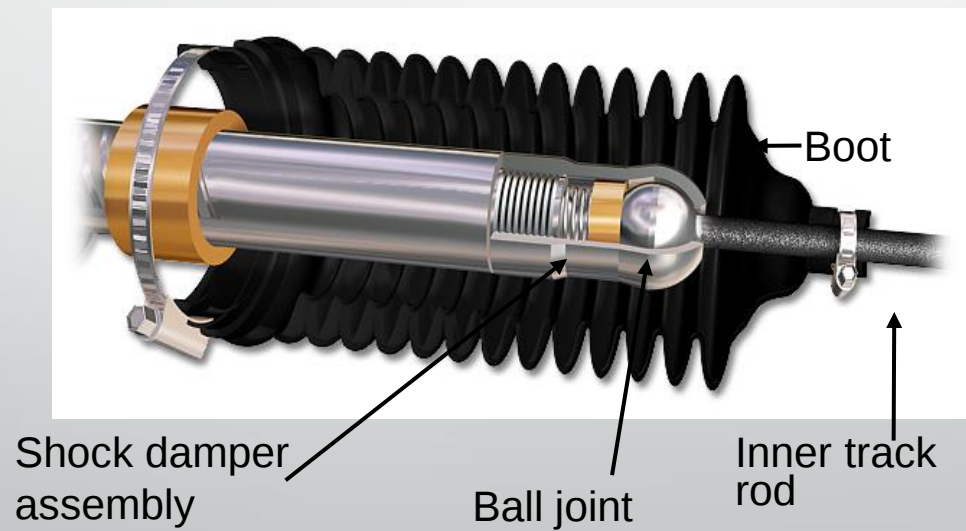
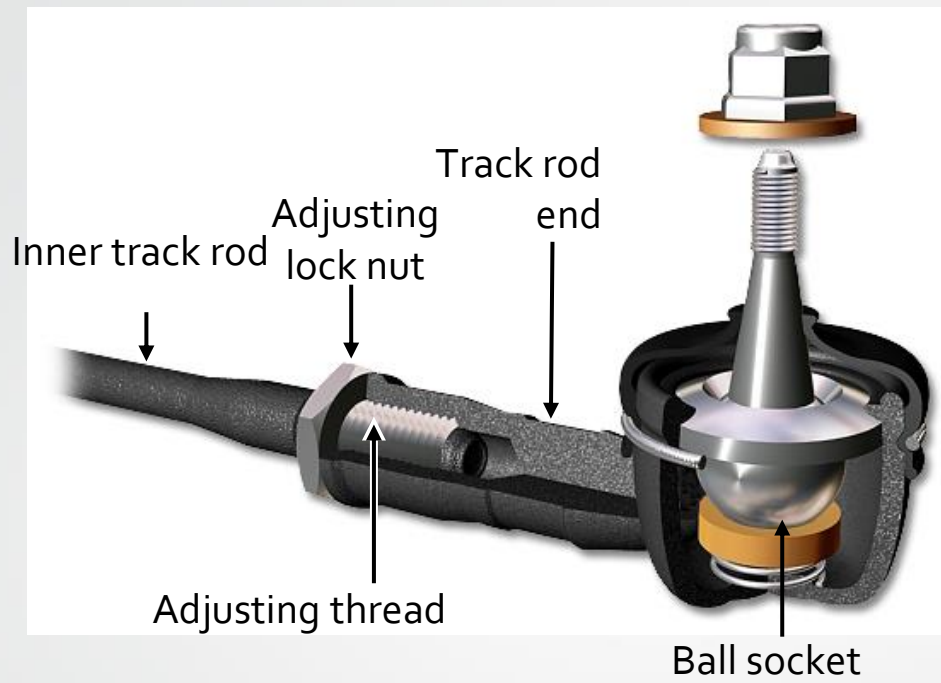
Track rods are attached to the ends of the rack.

They connect the rack to the hub carrier.

The gaiter, a flexible usually rubber tube, covers the joint between the rack and track rods to stop dust and dirt getting in the rack.

Gaiters are sometimes called boots.



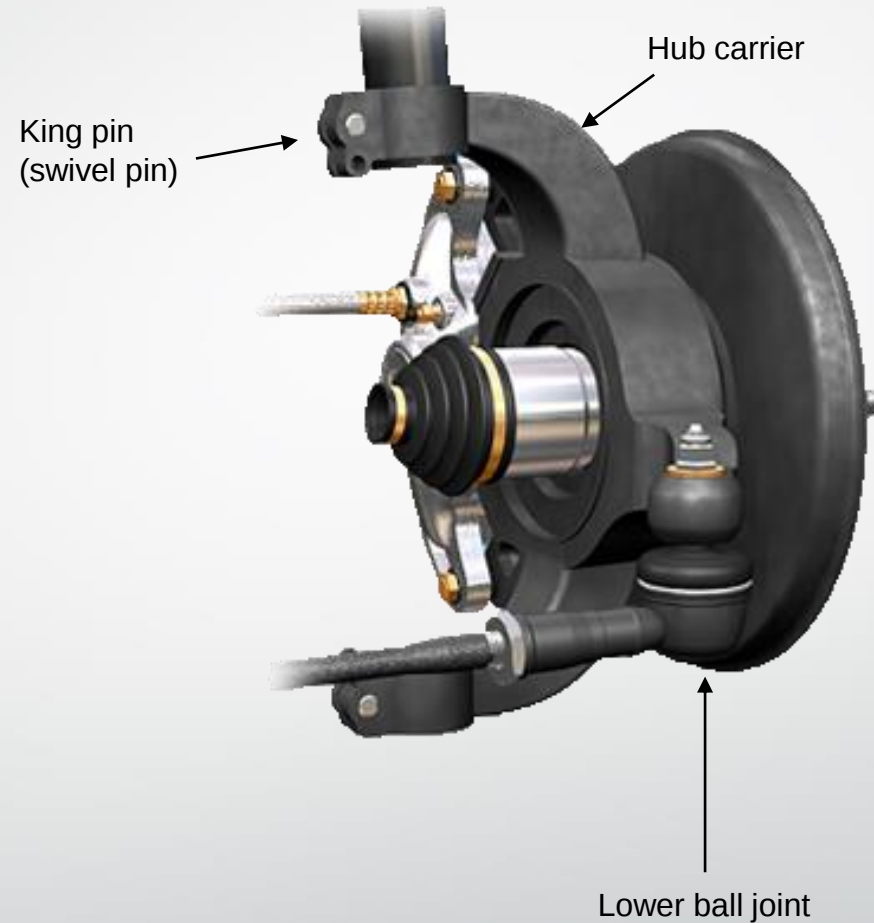


Rack-and-Pinion Steering Systems

The hub carrier transfers movement of the rack, via the track rods, into a change of wheel angle.

It rotates about an axis created by the king pin (swivel pin).

Track rods connect to the hub carrier via a lower ball joint.

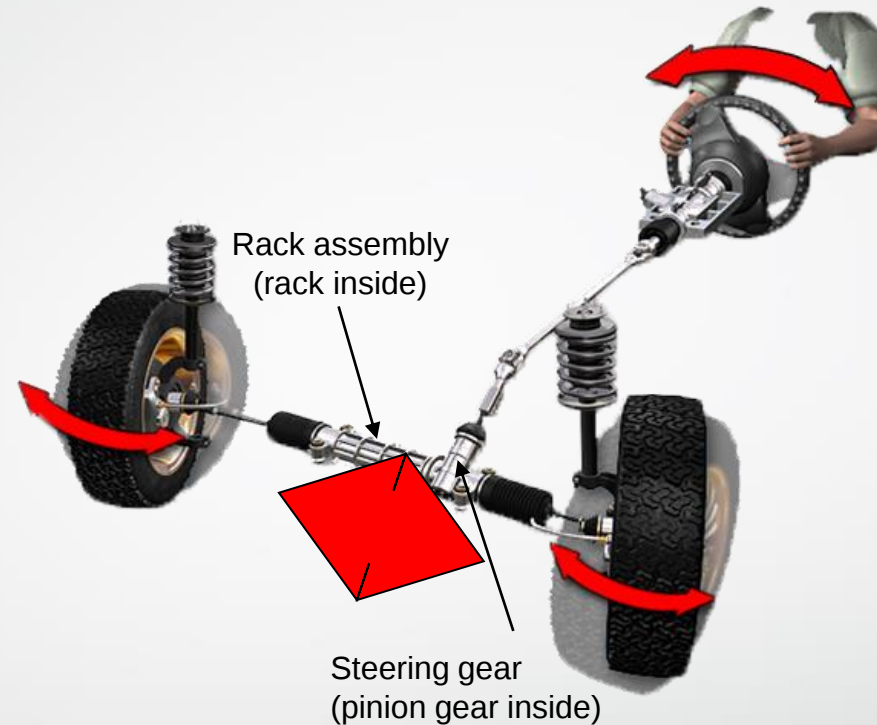


Rack-and-Pinion Steering Operation

To make the front wheels turn, a pinion gear, which is attached to the steering column shaft, rotates as the driver turns the steering wheel.

The pinion gear meshes with the rack, and as the pinion gear rotates the rack moves sideways.

This sideways movement is transferred to the wheels, via the track rods and hub carriers, causing them to change angle.

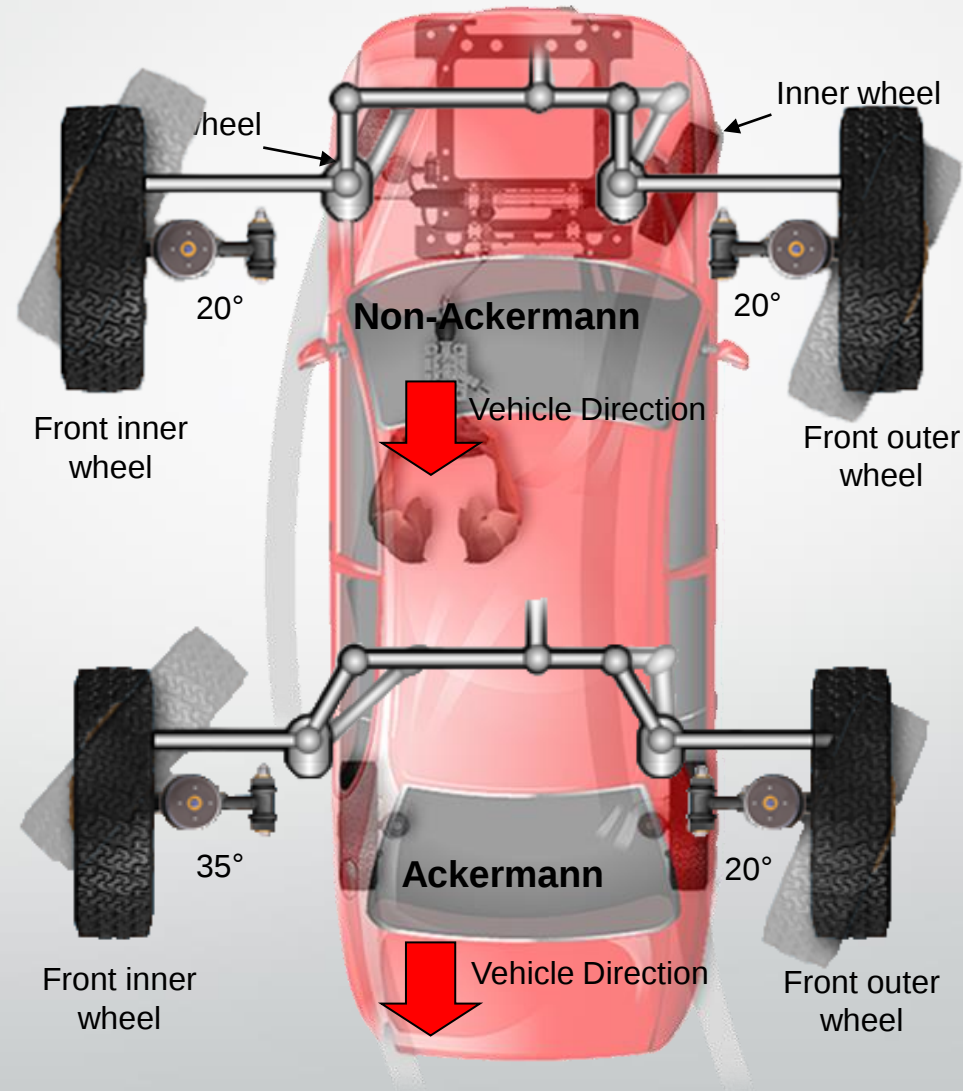


Steering Geometry

When a vehicle turns a corner, the outer wheel will travel a greater distance than the inner wheel.

The inner wheel needs to turn through a greater angle than the outer wheel so it does not slip.

The Ackermann steering geometry allows each front wheel to turn through a different angle.



Question 3

The Ackermann steering geometry causes what to happen when a vehicle turns a corner?

- A) The inner wheel is turned through a greater angle than the outer wheel
- B) Both the inner and outer wheels are turned through the same angle
- C) The outer wheel is turned through a greater angle than the inner wheel

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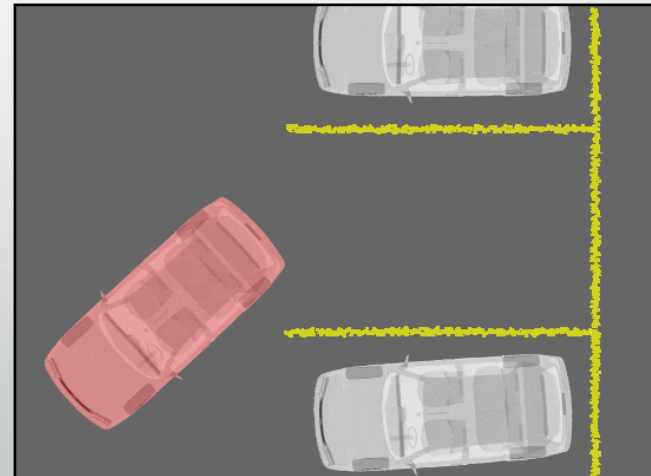
The Ackermann steering geometry turns the inner wheel through a greater angle than the outer wheel. This is needed because the inner wheel has a tighter radius to follow.

Power Steering

Power steering assists the driver by reducing the amount of effort needed to turn the steering wheel.

This is particularly useful when the vehicle is moving slowly.

The additional force applied to the steering can be generated hydraulically or electronically.

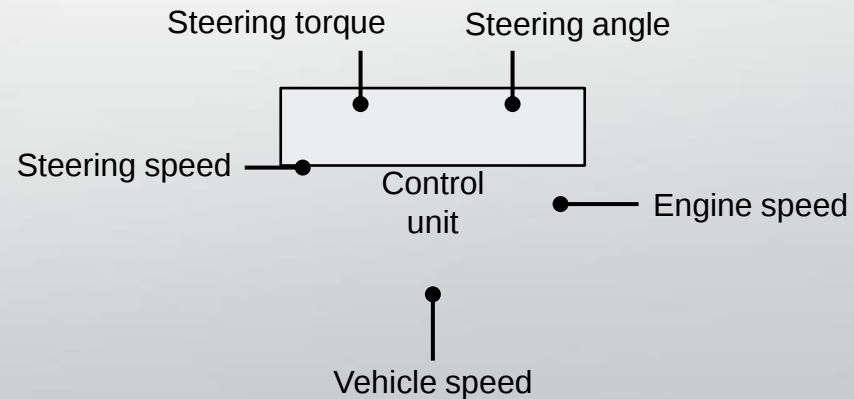
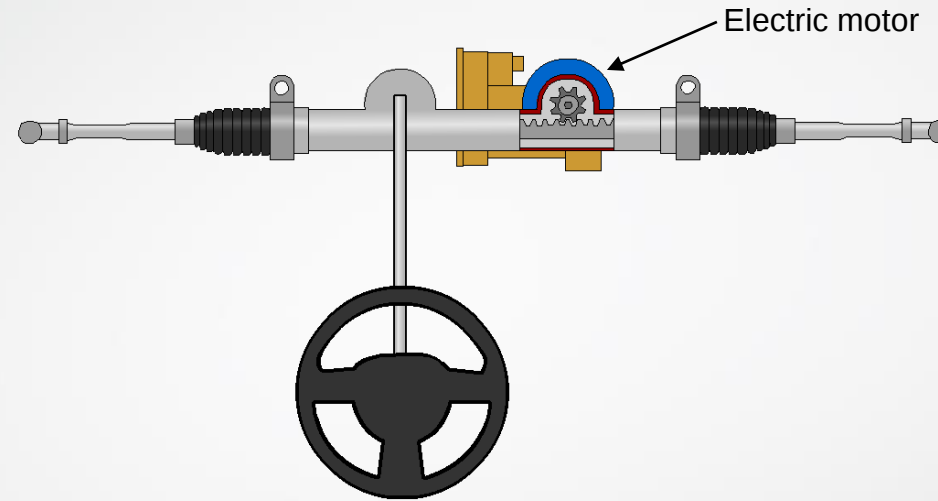


Electromechanical Power Steering - Servoelectric

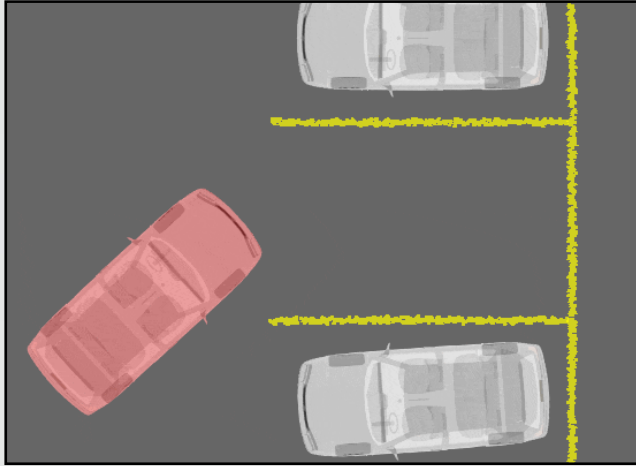
Steering assistance is provided by an electric motor directly connected to the rack.

This is a much simpler system as it removes the need for a pump, hosing, reservoir and hydraulic fluid.

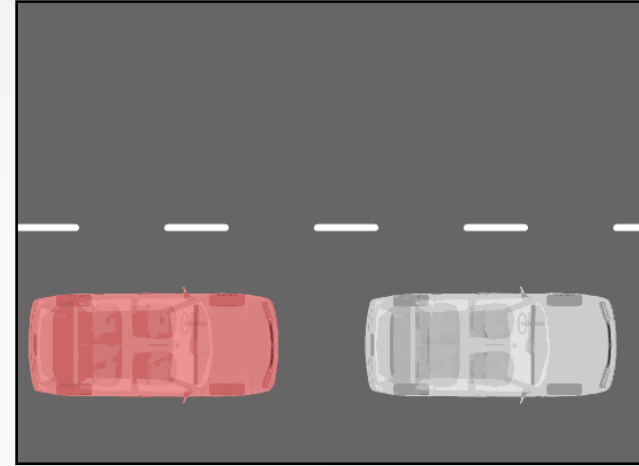
The control unit operates the motor by using sensory feedback on steering torque, vehicle speed, engine speed, steering angle and steering speed.



Power Steering - Servotronic



More power assistance



Less power assistance

Some systems dynamically change the amount of power assistance depending on vehicle speed.

If the vehicle is moving slowly, for example when parking, a large force is provided by the power assistance.

If the vehicle is moving quickly, for example changing lanes on a highway, less power assistance is provided.

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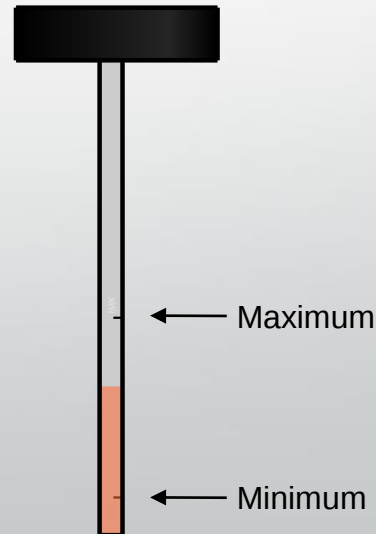
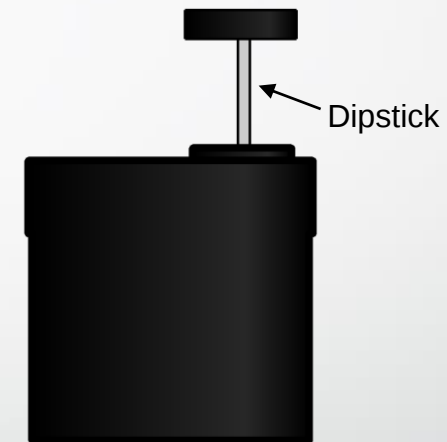
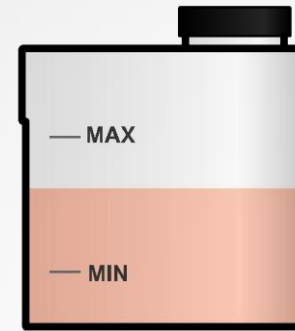
Power Steering Fluid Check and Top Up

Some vehicles have a clear reservoir where the power steering fluid can be seen.

The fluid level is checked against the markings on the side of the reservoir.

Alternatively, some reservoirs use a dipstick to indicate the fluid level.

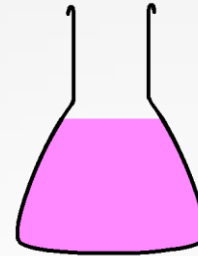
The level should be between the minimum and maximum indicated levels.



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Power Steering Fluid Check and Top Up

The colour of the power steering fluid can indicate if there is a problem.



The fluid should be either clear or pink, showing good condition.



It is common for power steering fluid to turn orange.

If it is very dark or has a burned smell then it will need replacing.



Summary

In this presentation you have seen:

- the need for a steering system
- rack-and-pinion steering components and operation
- linkage steering components and operation

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