GEAR SYSTEMS

SPUR GEARS - GEAR TRAINS - COMPOUND GEARS - IDLER GEARS - BEVEL GEARS - WORM GEARS

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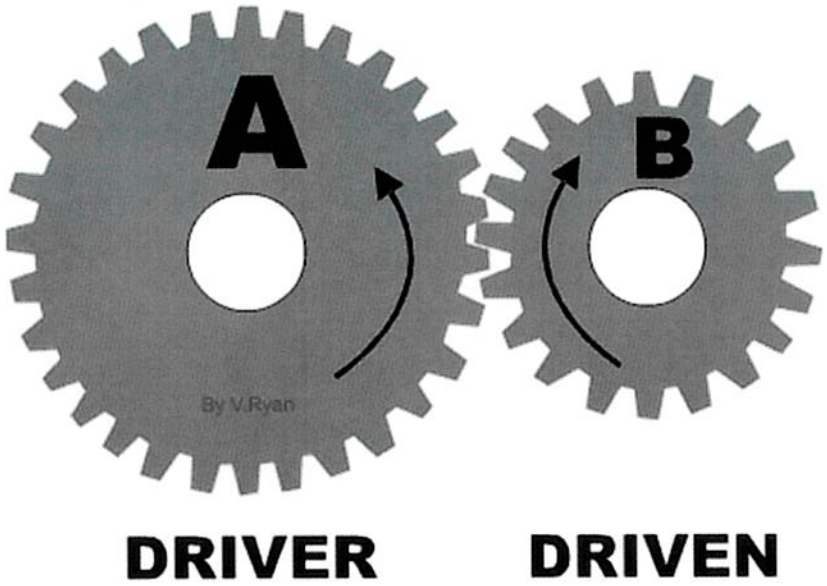
GEARS AND GEAR SYSTEMS

The gears shown below are called spur gears because they mesh together. Gear A is called the driver because this is turned by a motor. As gear A turns it meshes with gear B and it begins to turn as well. Gear B is called the driven gear.



Gear A has 30 teeth and gear B has 20 teeth. If gear A turns one revolution, how many times will gear B turn ?

$$\frac{\text{GEAR A = 30 TEETH}}{\text{GEAR A = 20 TEETH}} = \frac{30}{20} = \quad 1.5 \text{ (GEAR B)}$$

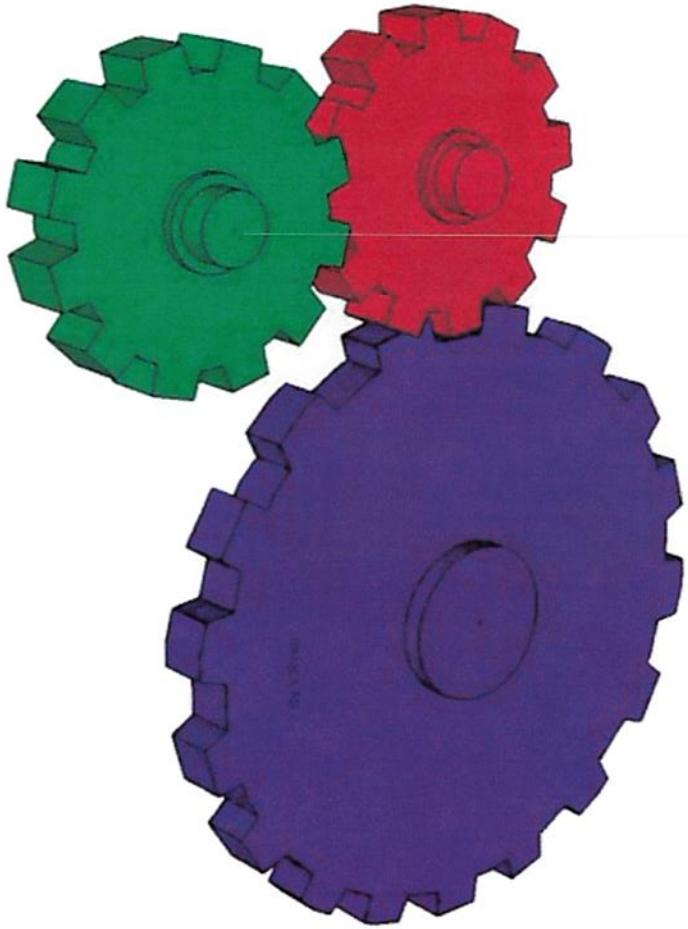
Which gear revolves the fastest ?

When gear 'A' completes one revolution gear 'B' turns 1.5 revolutions (1 times)

You should have also found the gear B revolves the fastest. A basic rule of gears is - if a large gear (gear A) turns a small gear (gear B) the speed increases.
On the other hand, if a small gear turns a large gear the opposite happens and the speed decreases.

GEAR TRAINS

A gear train is a mechanical system, composed of at least two gears. Gear trains can increase torque, reduce or increase speed and change the direction of rotation. They are used in machines and even power tools.

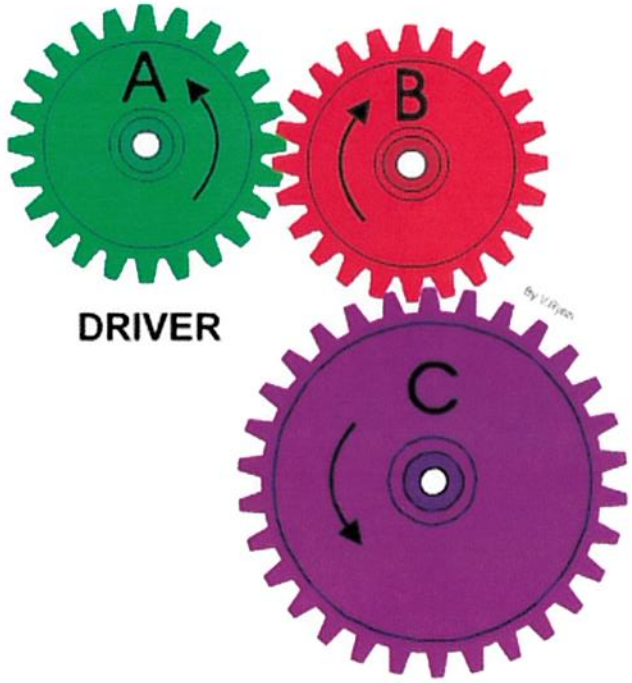


This is a good example of a gear train . A gear train is usually made up of two or more gears. The driver in this example is gear A . If a motor turns gear A in an anticlockwise direction;

Which direction does gear B turn ?

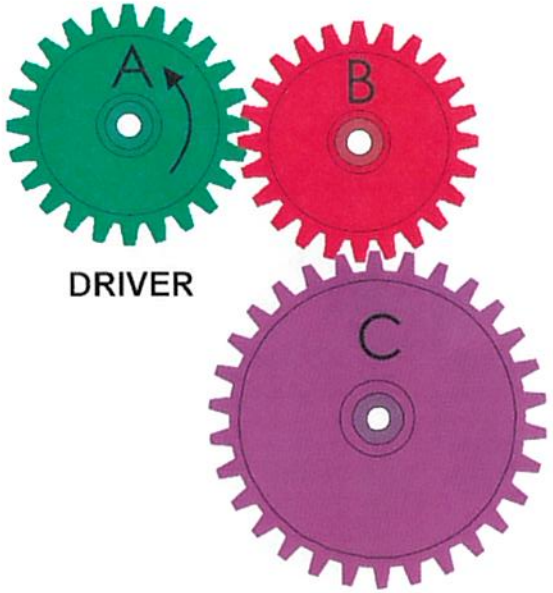
Which direction does gear C turn ?

Does gear C revolve faster or slower than gear A ? - explain your answer.



GEAR TRAINS

This is a good example of a 'gear train'. A gear train is usually made up of two or more gears. The driver in this example is gear 'A'. If a motor turns gear 'A' in an anticlockwise direction:

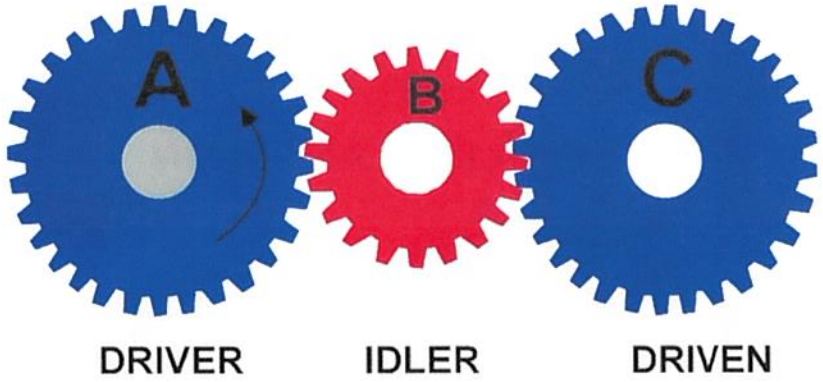


1. Which direction does gear 'B' turn ?

2. Which direction does gear 'C'' turn ?

3. Does gear 'C' revolve faster or slower than gear 'A ? Explain your answer.'

4. The gear train seen opposite is composed of three gear wheels. What is the purpose of the IDLER gear?



5. Gear 'A' rotates in an anticlockwise direction. What is the direction of rotation of the IDLER and the DRIVEN gears?

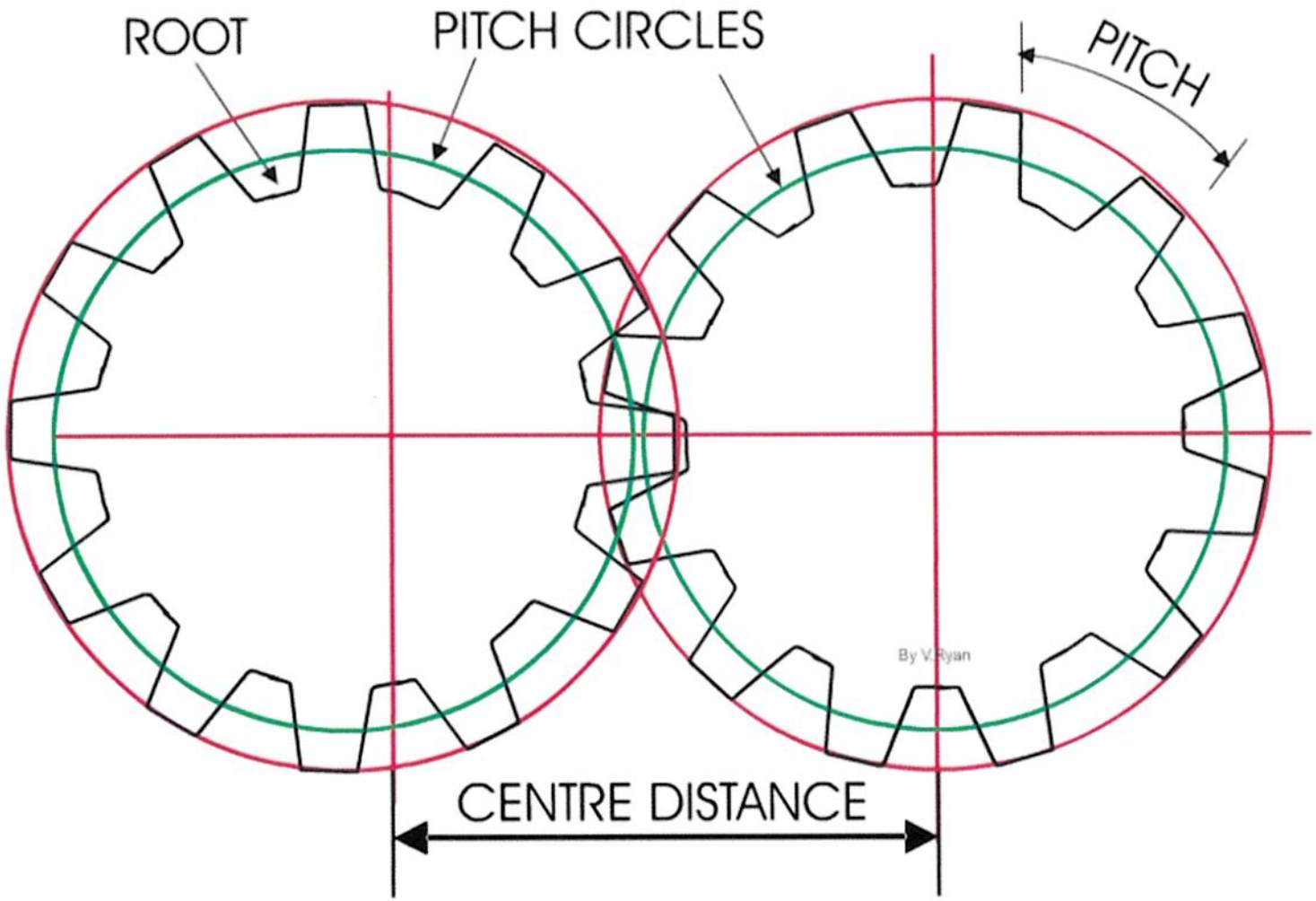
IDLER: _____ DRIVEN: _____

GEAR DETAILS

The gears opposite are known as spur gears. The circle marked in red shows the outer limit of the teeth whilst the green circles are known as the pitch circles. The pitch circle of a gear is very important as it is used by engineers to determine the shape of the teeth and the ratio between gears (ratios will be explained later).

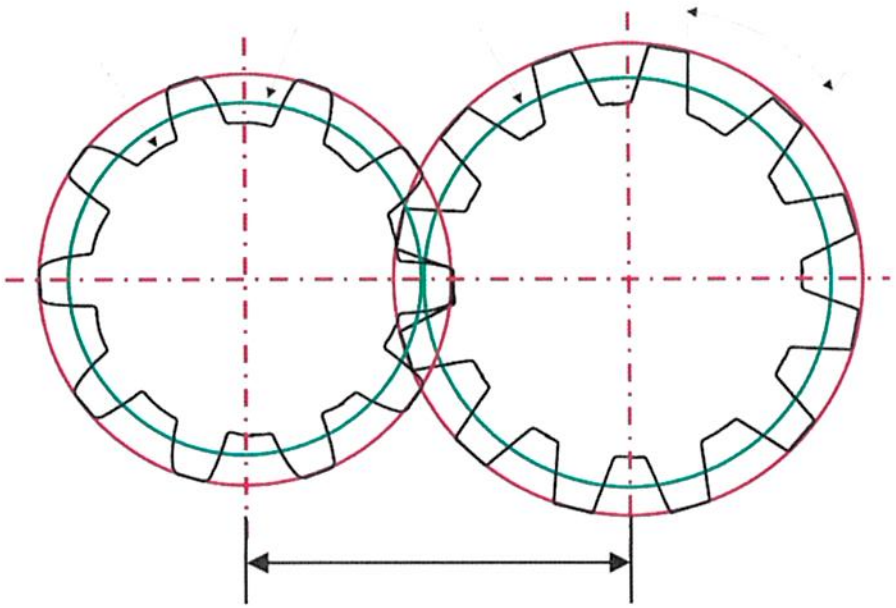
The pitch of a gear is the distance between any point on one tooth and the same point on the next tooth.

The root is the bottom part of a gear wheel.



GEAR DETAILS

1. Identify the ROOT, PITCH CIRCLE, PITCH AND CENTRE DISTANCE on the diagram drawn below.



2. Complete the paragraph by adding the following missing words/phrases:

PITCH CIRCLES RATIO ROOT SPUR GEARS PITCH SHAPE

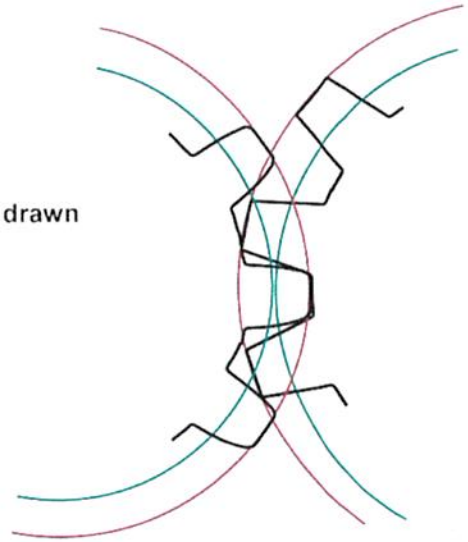
The gears above are known as _____ _____. The circle marked in red shows the outer limit of the teeth whilst the green circles are known as the _____ _____. The pitch circle of a gear is very important as it is used by engineers to determine the _____ of the teeth and the _____ between gears (ratios will be explained later).

The _____ of a gear is the distance between any point on one tooth and the same point on the next tooth.

The _____ is the bottom part of a gear wheel.

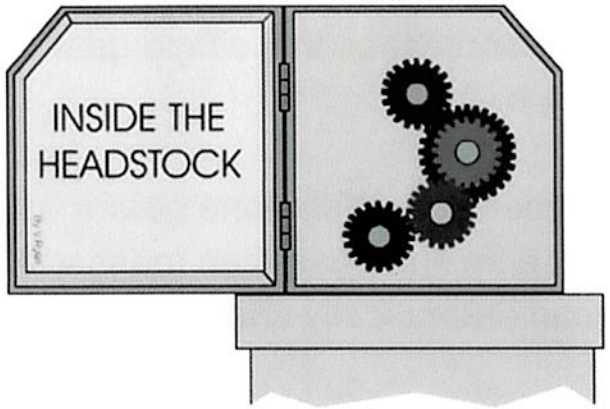
3. What is the PITCH POINT?

4. Mark the pitch point on the diagram drawn opposite.

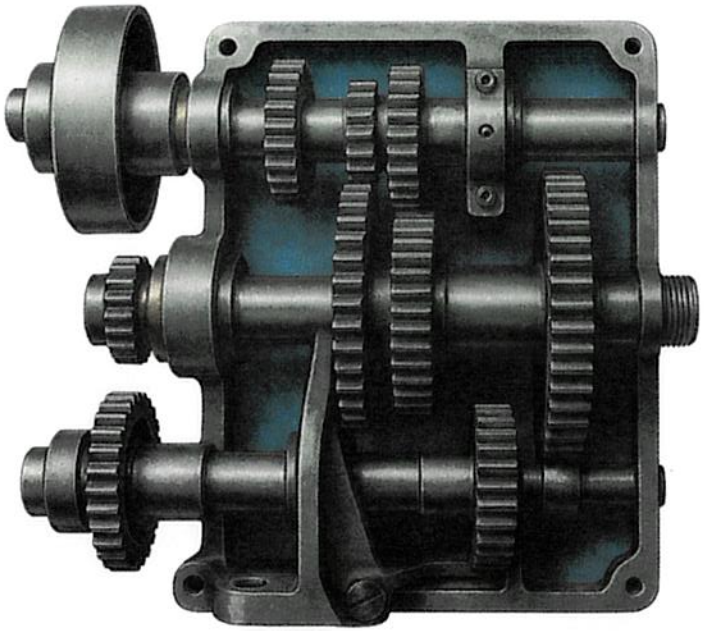


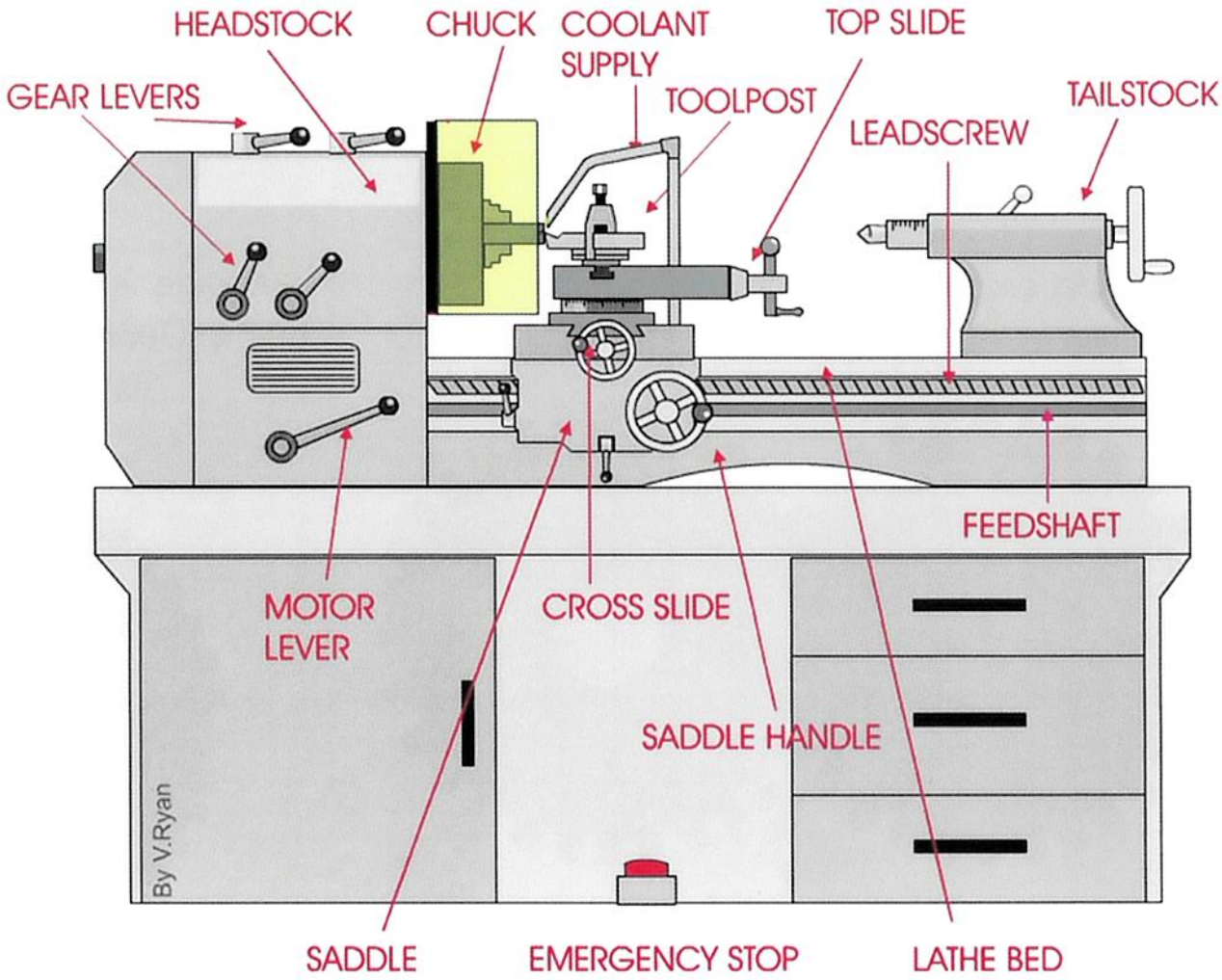
5. Draw two spur gears meshing together (Hint - do not draw all the teeth, simply draw the gears with two circles representing each gear wheel - see earlier example)

COMPOUND GEARS - CENTRE LATHE HEADSTOCK



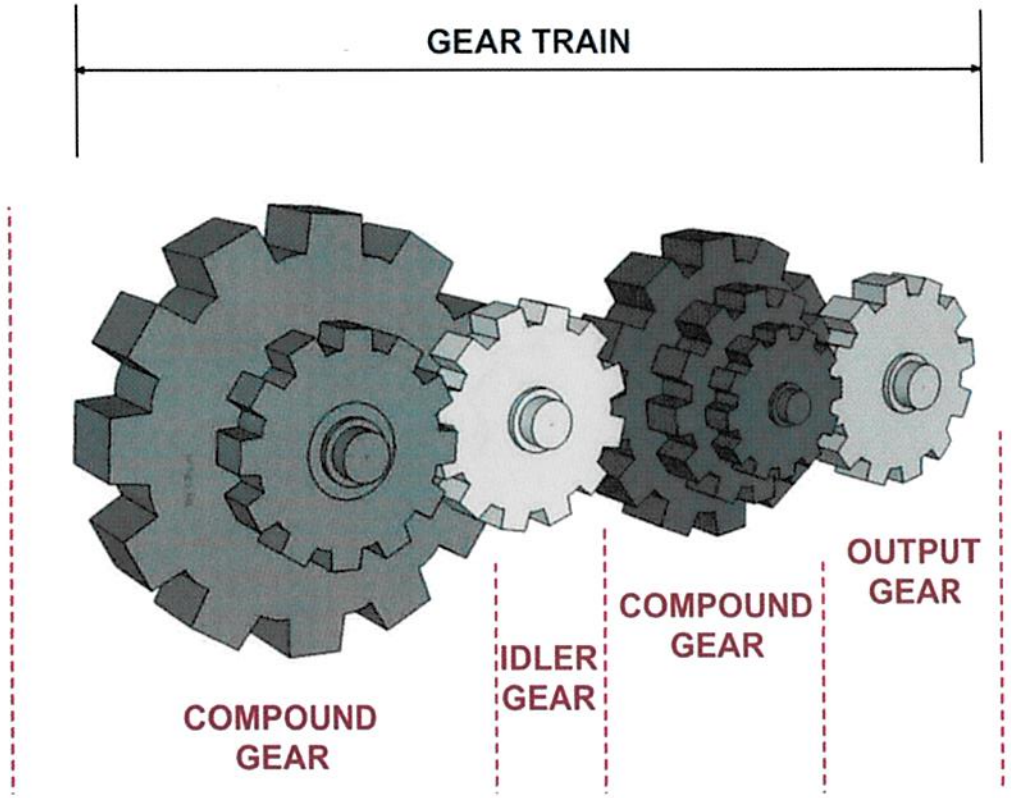
The headstock of a centre lathe contains a complex gear train and many of the individual gears are compound gears. This arrange allows the speed of the lathe to be adjusted so that the chuck of the lathe rotates at the correct speed for the metal being turned/machined.



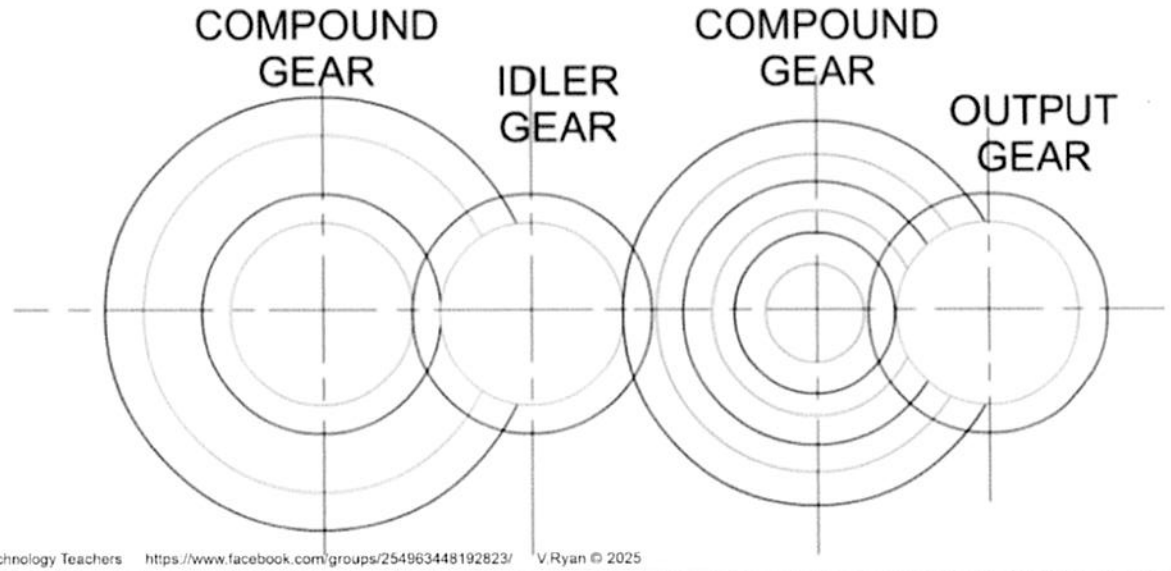


COMPOUND GEARS

The gear train below has an arrangement of gear wheels including two compound gears. Gear trains like this are often found inside machines such as centre lathes and milling machines. On a smaller scale, plastic gear trains are found inside DVD recorders. They ensure that the DVD disk spins at exactly the right speed (RPM Revolutions Per Minute).

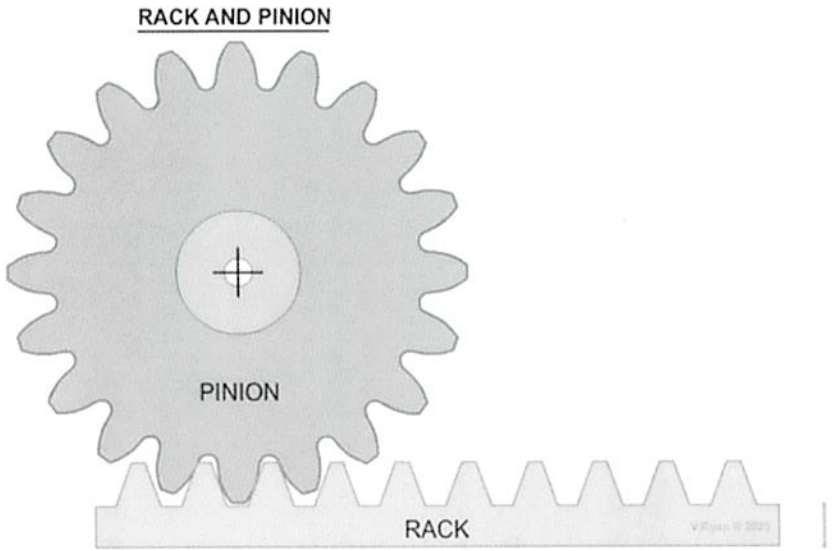


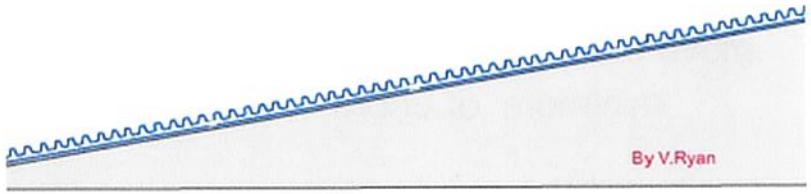
When drawing a gear train it is not necessary to draw all the individual teeth. Two concentric circles represent the gear wheel and teeth. The diagram below shows how the teeth mesh together.



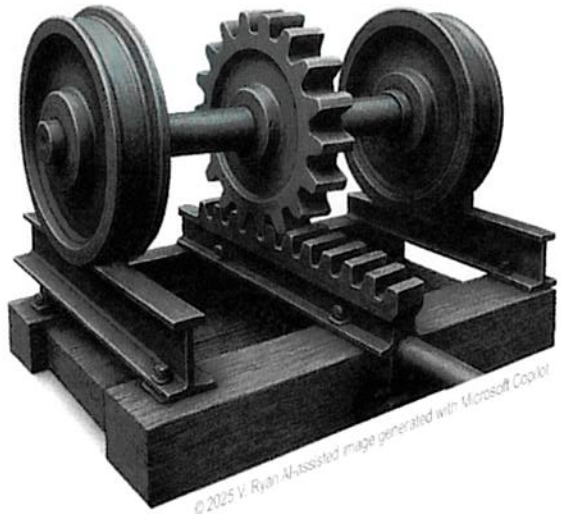
RACK AND PINION GEARS

A 'rack and pinion' gear system is composed of two gears. The 'pinion' is the round gear and the 'rack' is flat. The teeth machined into the'rack', mesh with the teeth of the pinion gear. A mountain railway uses this technology to pull a train up steep inclines.





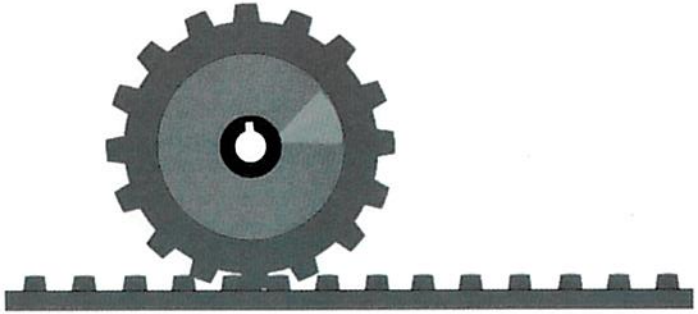
A good example of a rack and pinion train is seen in the Snowdonia National Park (North Wales). Mount Snowdon is the highest mountain in Wales and there are two ways to reach the top. The first is the walk and the second is to take the train. If you ever visit Mount Snowdon look at the train and the track, you will clearly see the rack



RACK AND PINION

1. A rack and pinion system is drawn opposite. Label the RACK and PINION.

Write a simple description of a rack and pinion gear system.



2. If the pinion revolves in an anticlockwise direction, in which direction does the rack move.

3. Why is a rack and pinion system applied to trains in mountainous areas.

4. Complete the diagram below by adding a rack and pinion gear system to the train/track. Label your diagram.

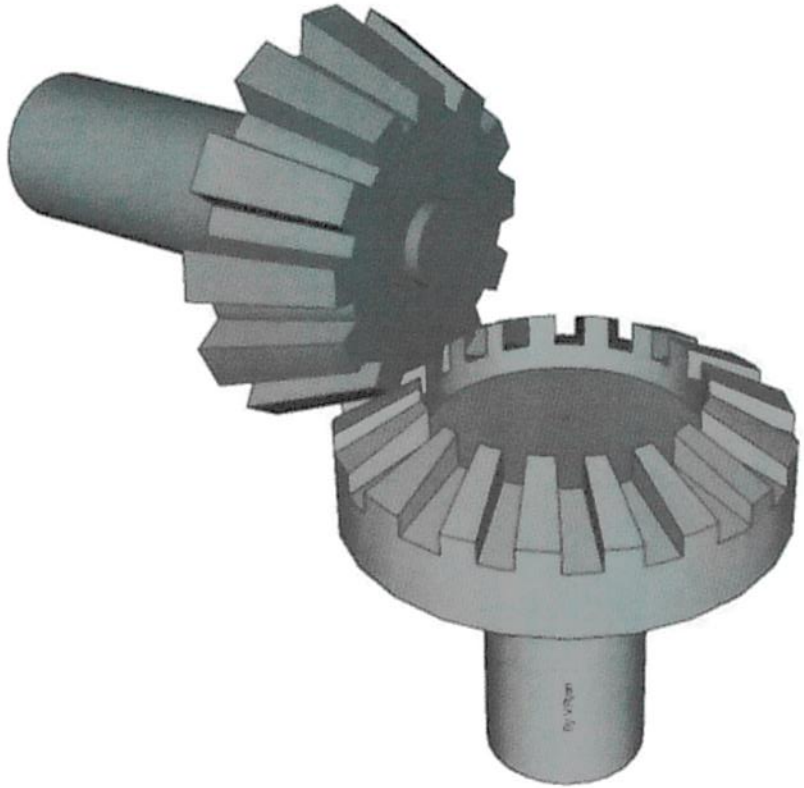
5. Using the internet as a research tool, find examples of the way rack and pinion gear systems are used in practical situations. Describe your findings. You may wish to include images/pictures.

IMAGES/PICTURES

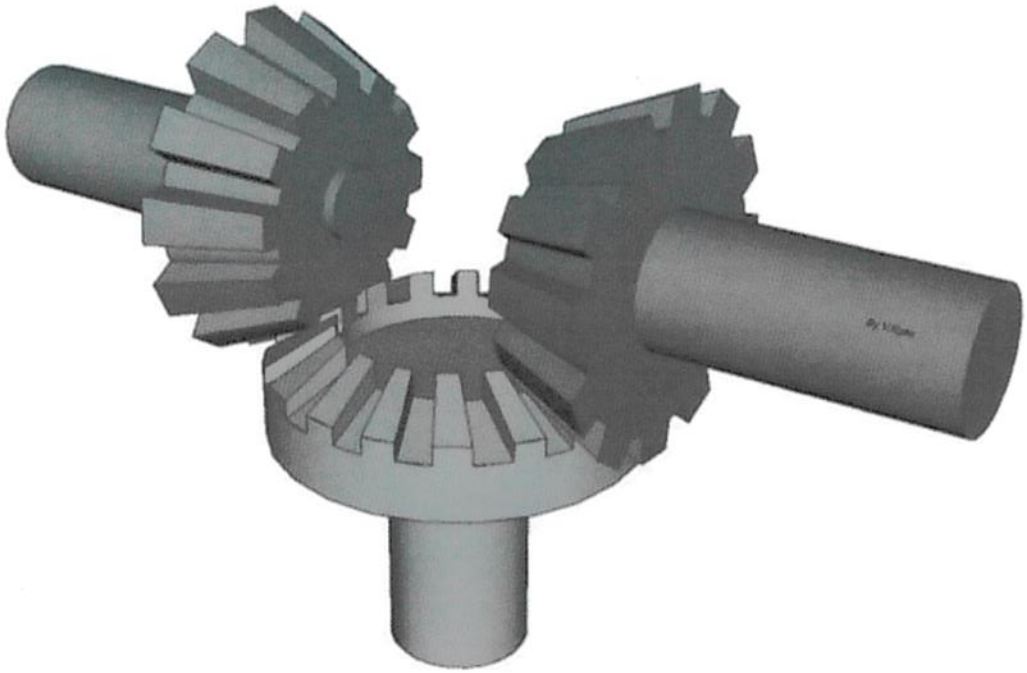
NOTES:

BEVEL GEARS

Bevel gears change the direction of drive in a gear system by 90 degrees. This set is made up of two bevel gears.



This set of bevel gears has three gears that mesh together.



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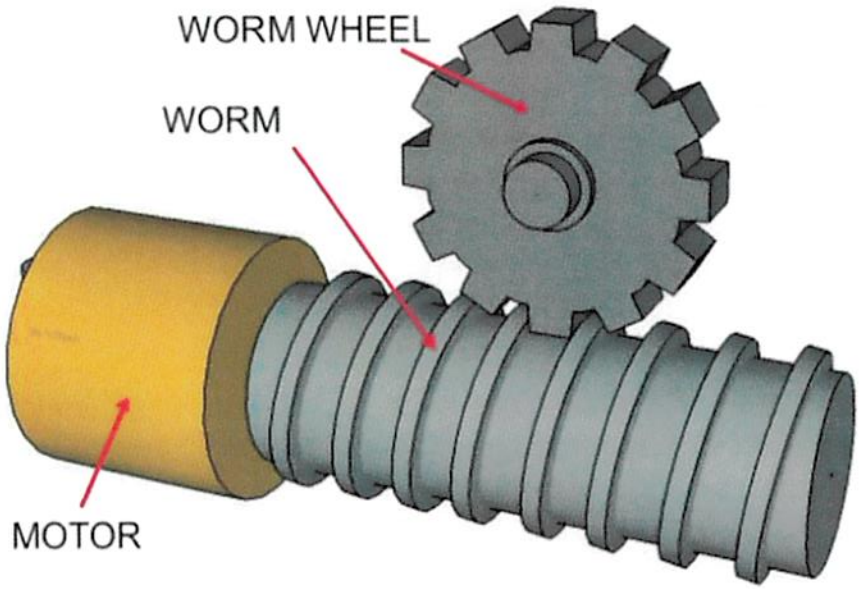
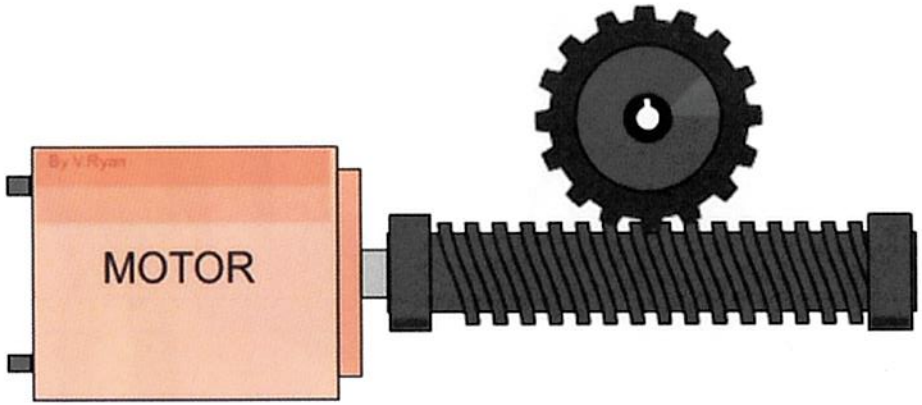
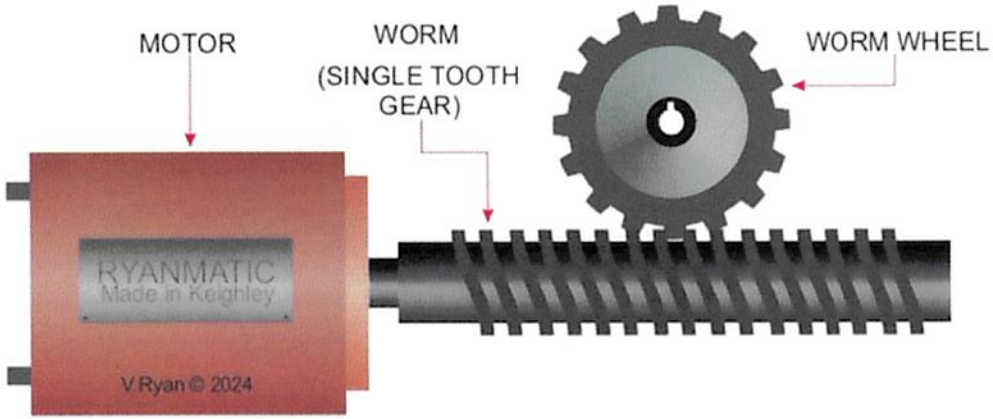
WORM GEARS



The arrangement of gears seen opposite and below, is called a worm and worm wheel. The worm has one helical tooth that looks like a screw thread. The worm wheel is a gear wheel with helical teeth, cut at an angle matching the worm. The worm always drives the worm wheel round, it is never the opposite way round, because the system tends to lock and jam

The worm, which in this example is brown in colour, only has one tooth but it is like a screw thread. The worm wheel, coloured yellow, is like a normal gear wheel or spur gear. The picture below show the typical set up of worm gear system, as seen in school projects. As the worm revolves the wormwheel (spur gear) also revolves, with motion is transmitted through a ninety degree angle.





HOW TO WORK OUT THE GEAR RATIO OF A WORM GEAR

The gear ratio of a worm gear is worked out through the following formula:

$$\frac{\text{number of teeth on wormwheel}}{\text{number of teeth on worm}}$$

The worm acts as a single toothed gear so the ratio is;

number of teeth on wormwheel = 1

EXAMPLE

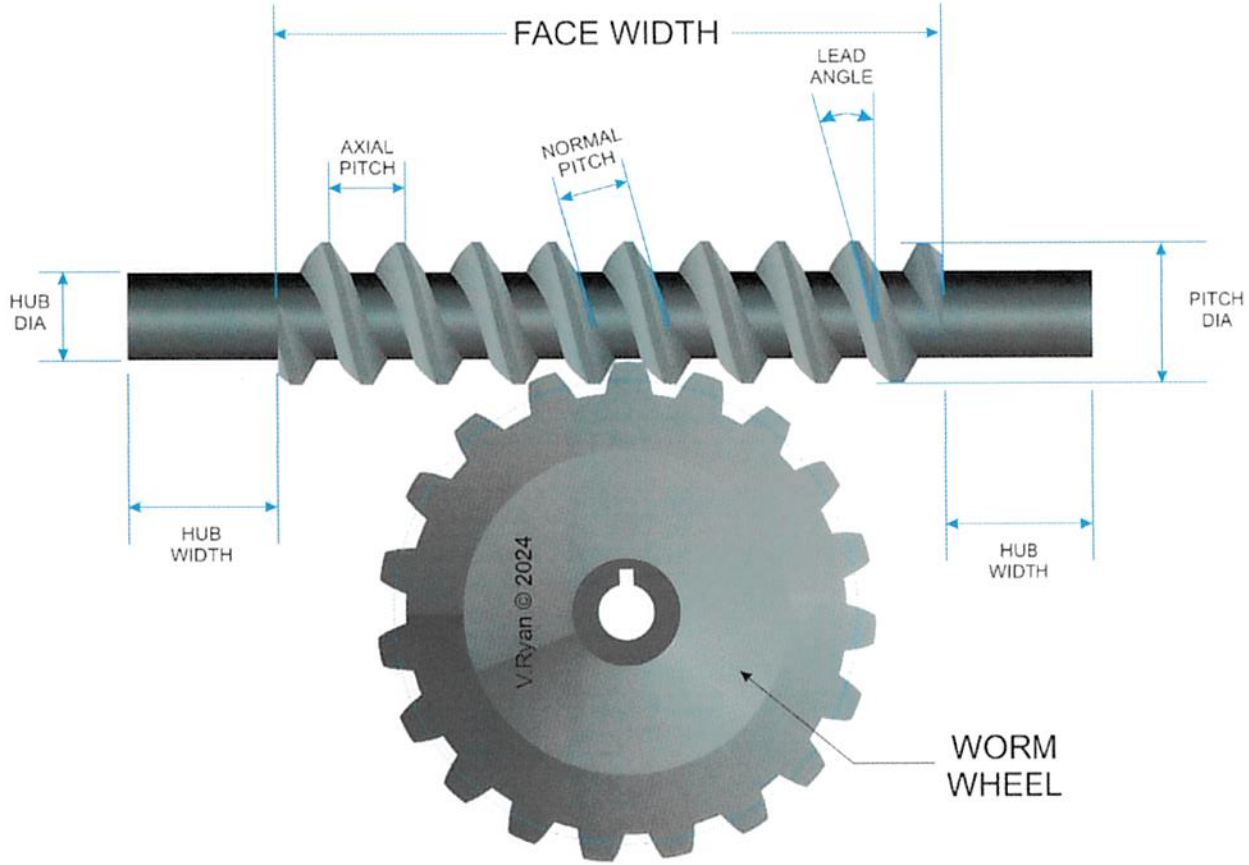
If the wormwheel has 60 teeth

$$\frac{60}{1}$$

Gear Ratio = 60:1

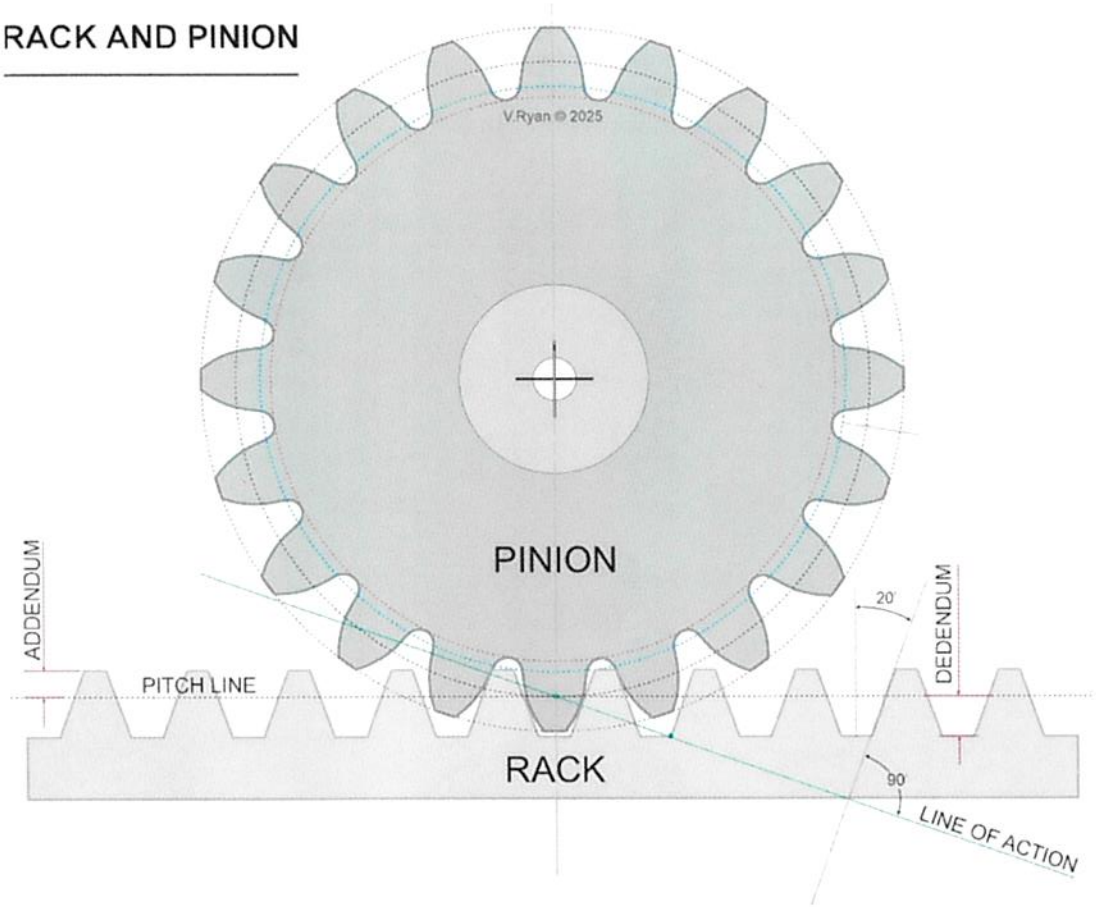
(Rotary velocity is also reduced by 60:1)

Quite simply, this means a worm gear reduces the speed of the spur gear by sixty times. If you need a gear system whereby the speed is reduced by a considerable amount, a worm and wormwheel are worth considering.



RACK AND PINION and SPUR GEARS

RACK AND PINION



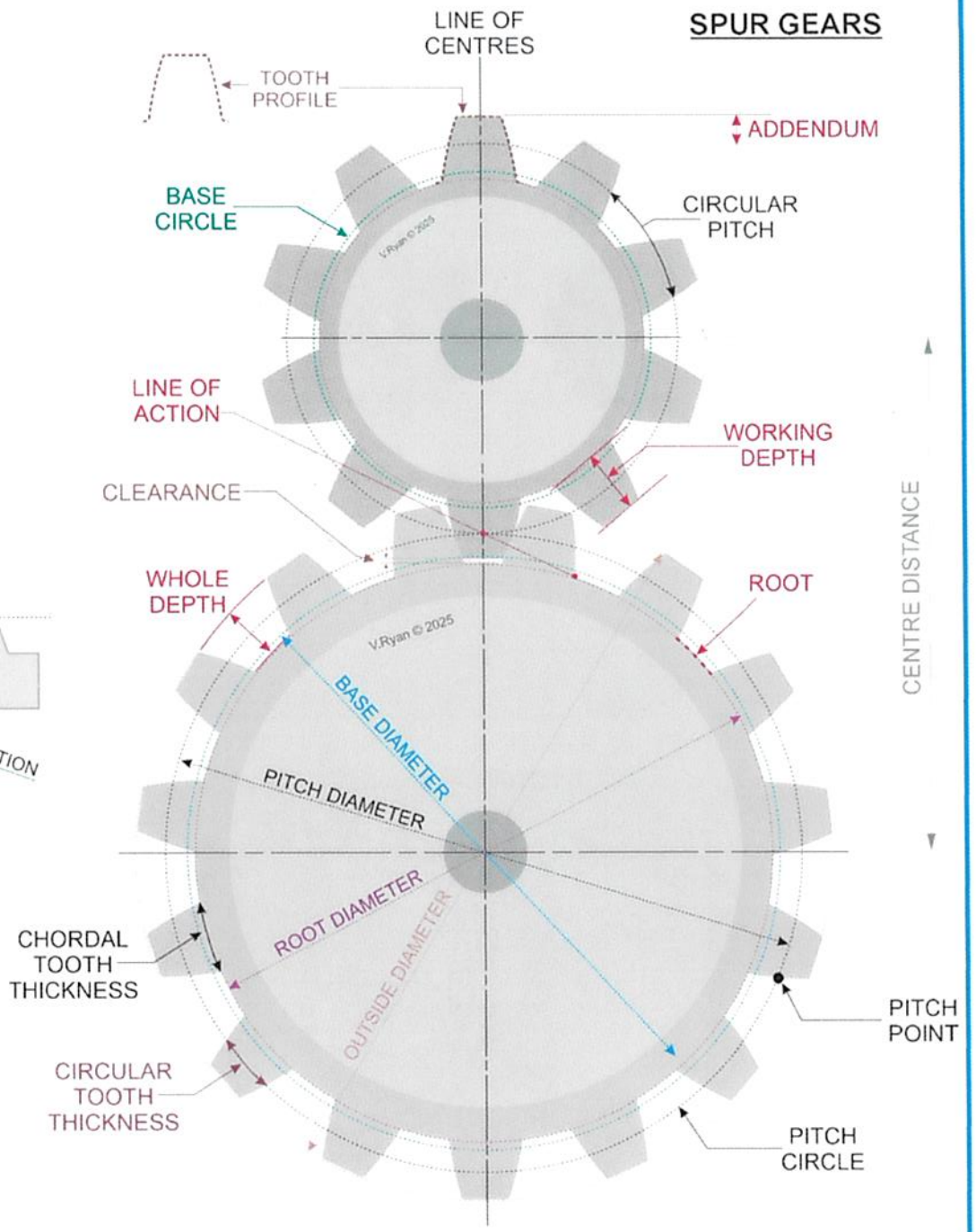
TOP CIRCLE

PITCH CIRCLE

BASE CIRCLE

ROOT CIRCLE

SPUR GEARS



GEARS AND GEAR SYSTEMS

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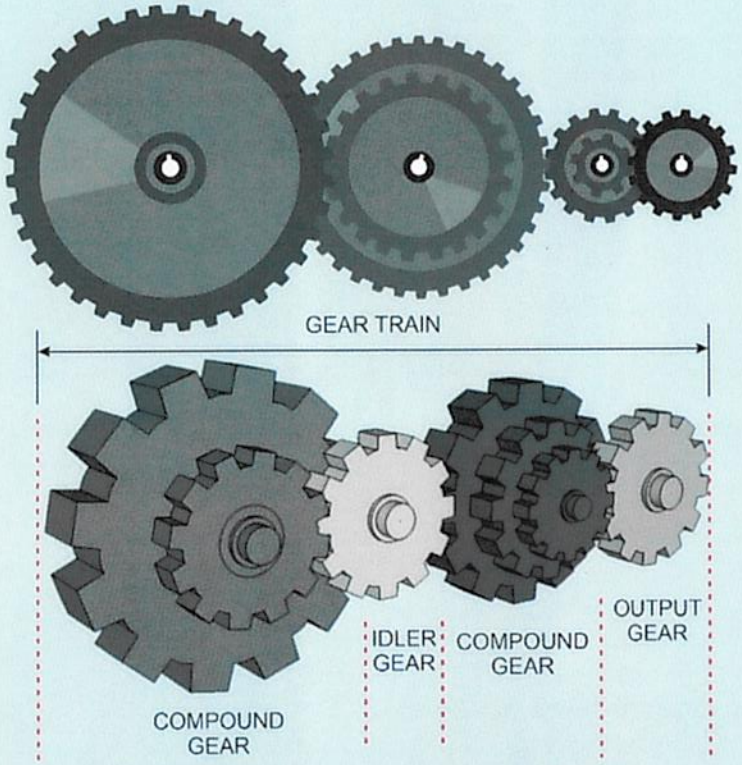
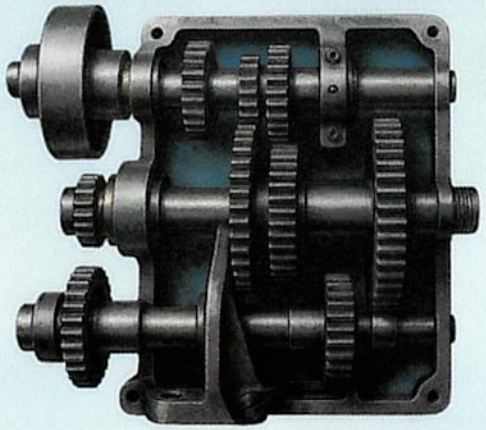
COMPOUND GEARS

Compound gears are multiple gears 'stacked' together, to achieve different gear ratios. They are used to transmit power and motion between different shafts. A good example is the gear system inside the headstock of a centre lathe



GEAR SYSTEM - CENTRE LATHE HEADSTOCK



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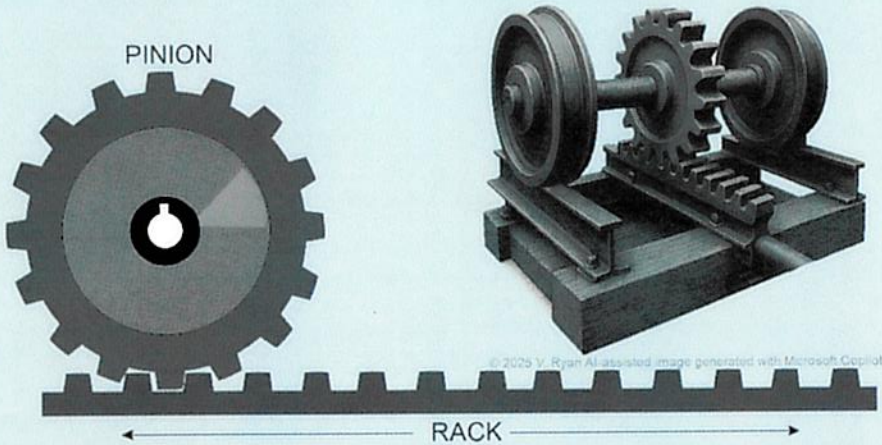

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