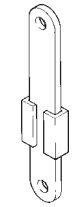
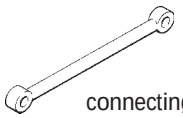
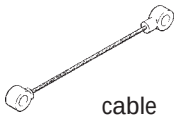
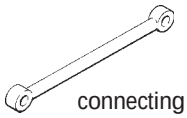
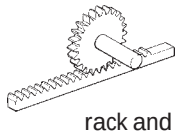
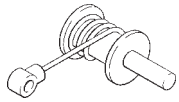
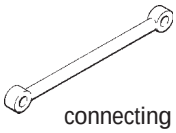
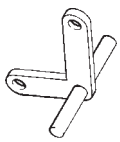
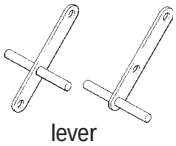
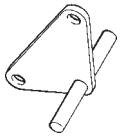
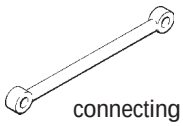
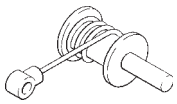
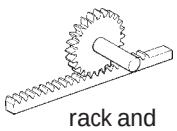
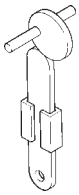
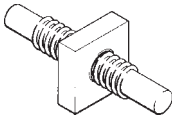
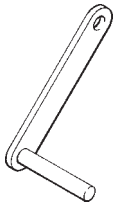
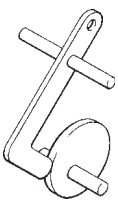
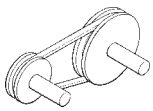
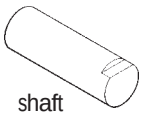
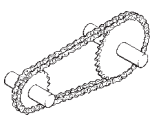
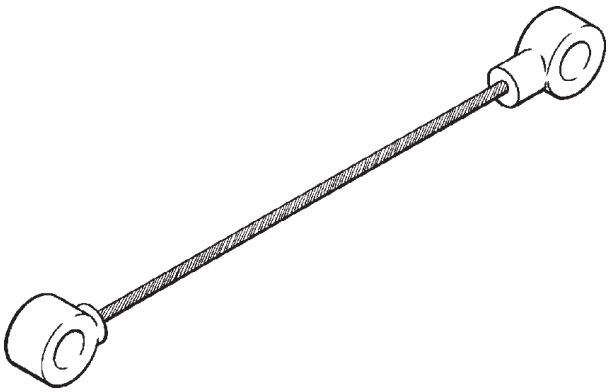
MECHANISMS SELECTION TABLE

To select a mechanism, decide first which type of input motion your device has - linear, arc or rotary. Select one of these from the left hand column labelled 'from'. Now select the type of output motion required from the top row of the table, again a choice of linear, arc or rotary. The most suitable mechanisms for your device are given where the selected row and column intersect.

FROM	TO: LINEAR	TO: ARC	TO: ROTARY
LINEAR	 slider  connecting rod  cable	 connecting rod	 rack and pinion  cable on drum
ARC	 connecting rod	  lever  bell crank  connecting rod	
ROTARY	 cable on drum  rack and pinion  cam and slider  screw	 crank  cam and lever	 pulleys and belt  shaft  gears  sprockets and chain  universal coupling

CABLE

Description
Cable, usually multistrand steel wire, that conveys a force between two items.

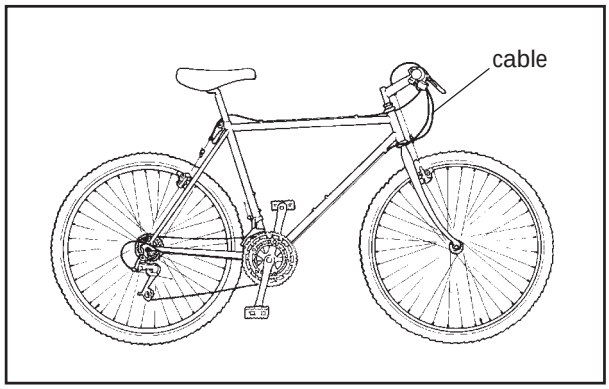


Function

- From linear motion to linear motion (not usually in the same straight line).
- From linear motion to arc motion.
- From arc motion to linear motion.
- From arc motion to arc motion.

Examples

- Bicycle brakes.
- Link between car bonnet catch and release lever under dashboard.



Why we use them

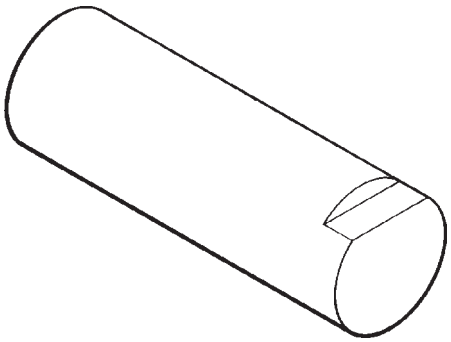
- Can convey motion around obstacles by passing over pulleys or through suitable tubing.
- Light, easy to make to any length and economical.

Things to watch out for

- Strong in tension but cannot exert any pushing force unless restrained within a sleeve.
- Usually must keep in tension by having a spring or weight at one end.
- Needs some way to connect to cable at each end - usually crimp or screw clamps.

SHAFT

Description
A straight rod or tube that rotates to convey rotary motion between two points.



Function

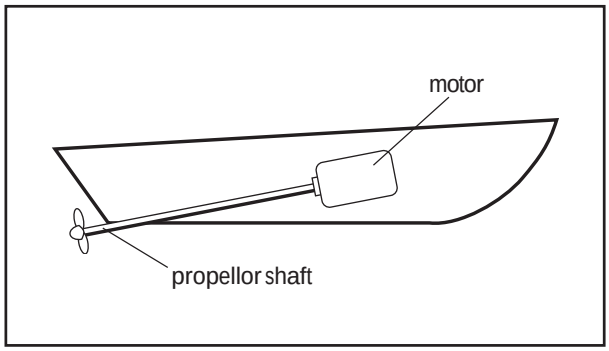
- From rotary motion to rotary motion.

Examples

- Shafts that drive vehicle wheels and boat propellors.

Why we use them

- Simple and cheap.
- Will not wear out like a belt or chain and is virtually silent.

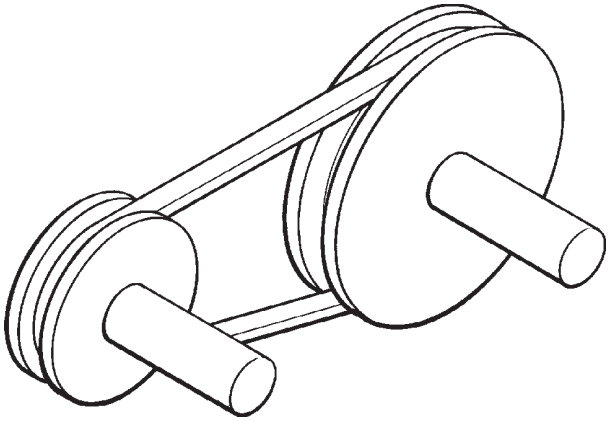


Things to watch out for

- Unlike belt and chain, cannot change rotational speed.
- Rotary motion at each end must be about the same axis.
- May be supported at one or more points with bearings.
- Usually something at each end to help fix the shaft to a pulley, sprocket, gear or other item e.g. keyway, flat, flange or spline.

PULLEYS AND BELTS

Description
Two pulley wheels connected by a belt.

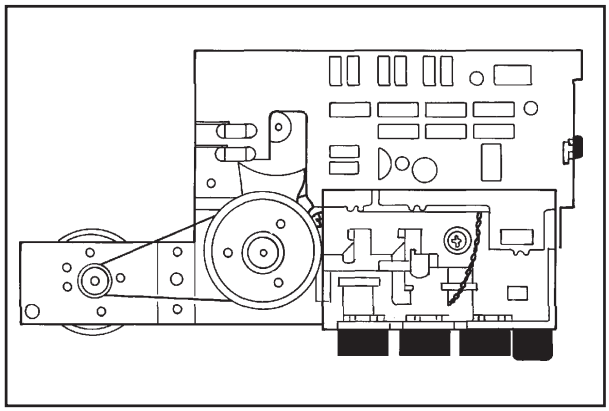


Function

- Rotary motion to rotary motion.

Examples

- Drive belts in an audio cassette recorder.
- Fan belt on a car.
- Washing machine - to transmit power from motor to main drum.



Why we use them

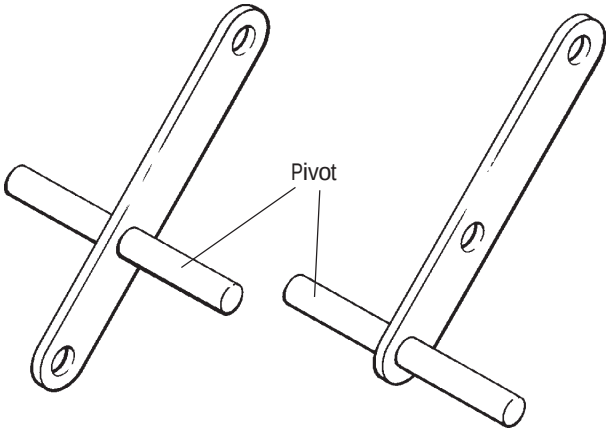
- Cheaper than gears or chain.
- Can convey motion over a much greater distance than the diameter of the pulleys.

Things to watch out for

- Shafts will rotate in the same direction unless belt crosses.
- The input and output pulleys do not have to be in exactly the same plane, but there are limitations.
- The belt may be passed over one or more jockey wheels to change its direction.
- The belt must be kept in tension - either by its own elasticity or by some other means, for example, by a spring-loaded jockey wheel.
- One belt may pass over more than two pulleys to drive more items.
- Some belts have teeth that engage in teeth on the pulleys to prevent slip.
- There are a number of different belt cross-sections.

LEVER LINKAGE

Description
A length of material which pivots and is coupled to two (or more) other mechanical members. The pivot does not move and the coupling points therefore have to move in arcs.

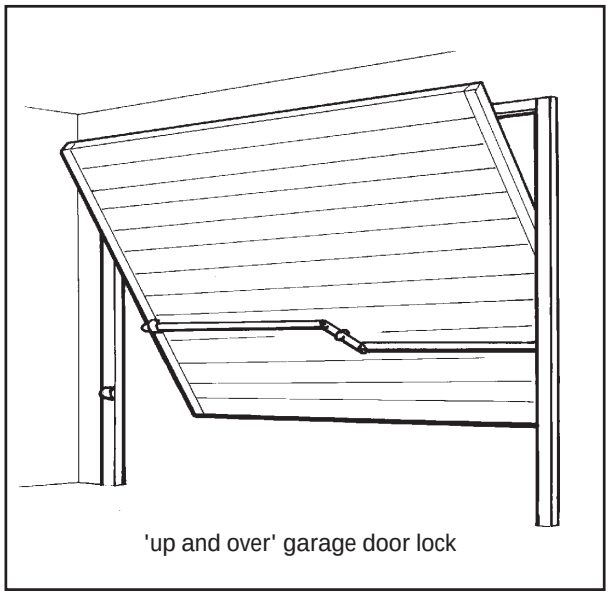


Function

- From arc motion to arc motion only.

Examples

- Toys - linkages transmit mechanical movements.
- Cassette recorders - part of the mechanism for ejecting tape.
- Locking mechanism for 'up and over' garage doors.


'up and over' garage door lock

Why we use them

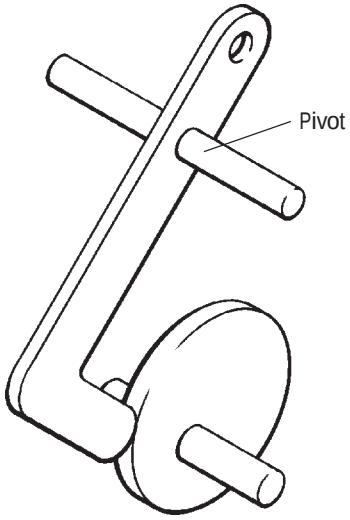
- Very simple way to increase a force at the expense of reducing the motion.
- May be used just to increase or decrease the motion.
- May also be used to convert a push into a pull, or a pull into a push.
- May be used to connect between two connecting rods or cables.

Things to watch out for

- The connecting rod or cable that supplies the operating force to the lever will become ineffective if it gets close to being in line with the lever.
- Levers can therefore usually only be used over a limited angle of swing - say up to about 60°.
- There will be a force on the pivot point, so the pivot needs to be firmly mounted.
- The pivot and connection points may need lubrication.
- A spring is quite often attached to a lever.

CAM AND LEVER

Description
A profiled shape mounted on a shaft that causes a lever to move. Cams can be pear shaped, snail shaped or circular with an off-centre hole.



Function

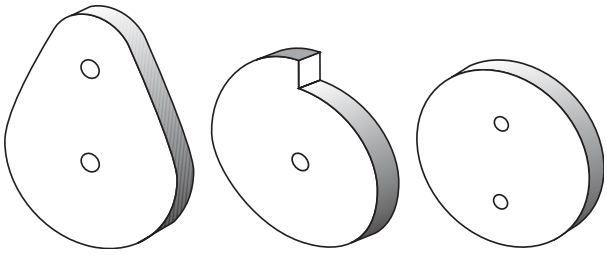
- Rotary motion to arc motion.
- Rotary motion to linear motion.

Examples

- Engine tappets.
- Toys

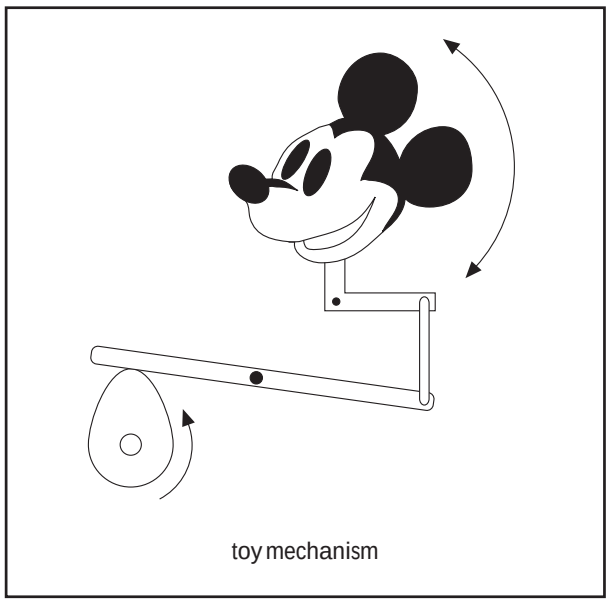
Why we use them

- The shape of the cam can be made to give the arc motion required.



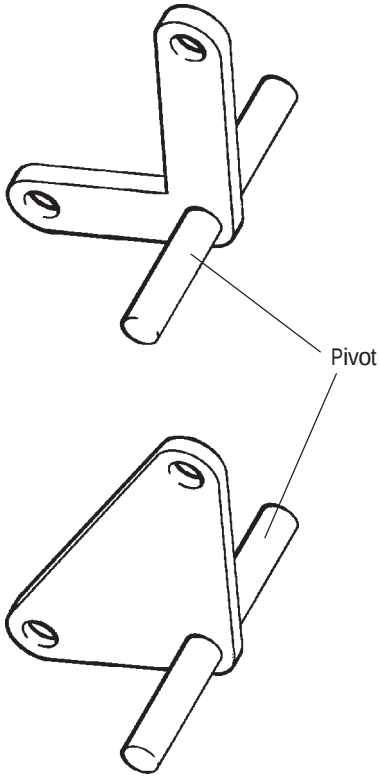
Things to watch out for

- The lever usually has to be kept in touch with the cam.
- The shape of the end of the lever can affect the arc motion.
- The sliding surfaces must be lubricated.



BELL CRANK

Description
A lever where the coupling points are close to 90° with respect to the pivot.



Function

- From arc motion to arc motion.

Examples

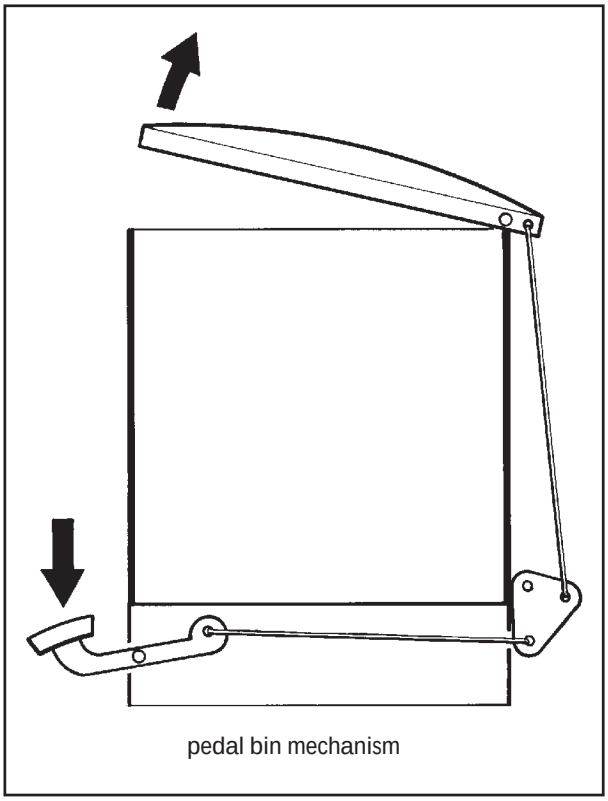
- Models - to connect a servo motor to a push rod.
- Pedal bin - to connect the floor pedal to the lid.

Why we use them

- To change the direction of force and movement by about 90°.

Things to watch out for

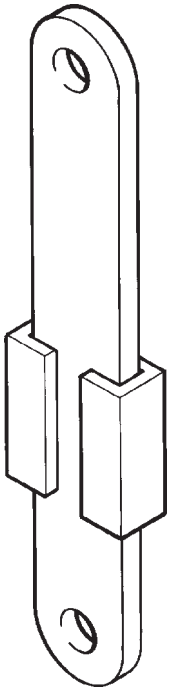
- The connecting rod or cable supplying the operating force to the bell crank will become ineffective if it gets close to being in line with the pivot.
- Bell cranks can therefore usually only be used over a limited angle of swing - say up to about 60°.
- There will be a force on the pivot point, so the pivot needs to be firmly mounted.
- The relative force and motion of the two coupling points depend on the relative distance of the connection points from the pivot.
- The pivot and coupling points may need lubrication.
- Not much use for circular motion.



pedal bin mechanism

SLIDER

Description
A length of material constrained so that it can only slide along its length. The cross-section may be round, rectangular, tube or more complex.



Function

- To convey linear motion along one straight line.

Examples

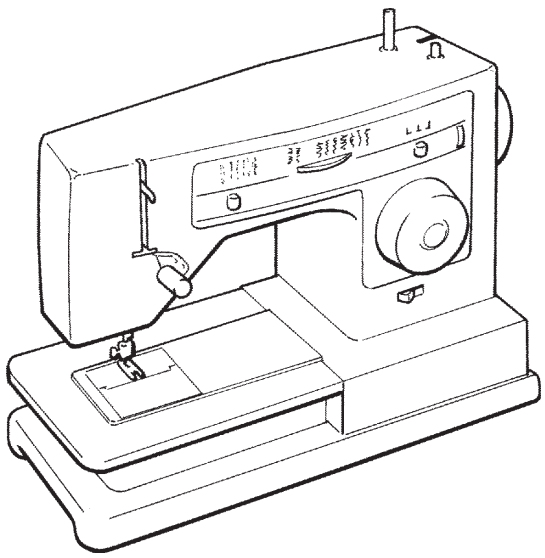
- The slider holding the needle on a sewing machine.

Why we use them

- When we need linear motion from arc (or circular) motion via a connecting rod or cable.
- May be used between two connecting rods.

Things to watch out for

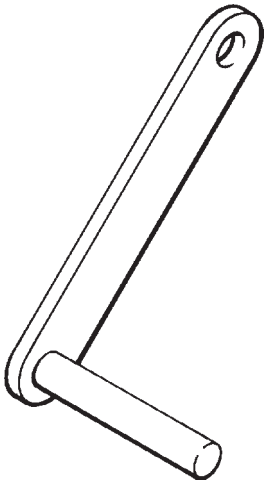
- Needs to be made well or it may wobble or jam.
- Likely to need some lubrication.
- Round sliders can convey rotary motion at the same time (e.g. some gearbox linkages).



needle held using slider mechanism

CRANK

Description
An arm connected to a shaft which has a coupling point for a connecting rod or cable near its end.



Function

- From rotary motion to arc motion.
- From arc motion to rotary motion.

Examples

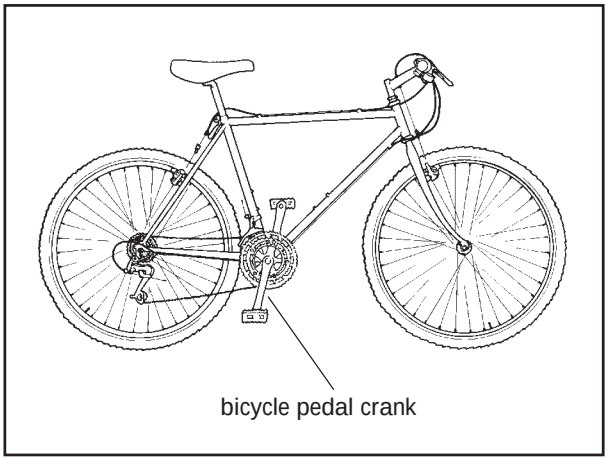
- Bicycle pedal cranks.

Why we use them

- Simplest way of converting from arc to rotary motion or vice versa.
- When linked via a connecting rod to a slider, produces oscillating linear motion from rotary motion.
- Used in converting the oscillating linear motion of a piston to rotary motion in engines.

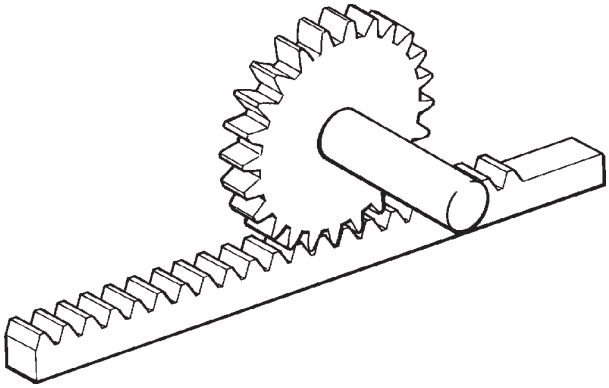
Things to watch out for

- There will be a sideways force on the shaft, so a bearing for the shaft will be required near the crank.



RACK AND PINION

Description
A straight rod with teeth that engage with a gear wheel. The gear wheel usually has a fairly small number of teeth and is therefore called a pinion.

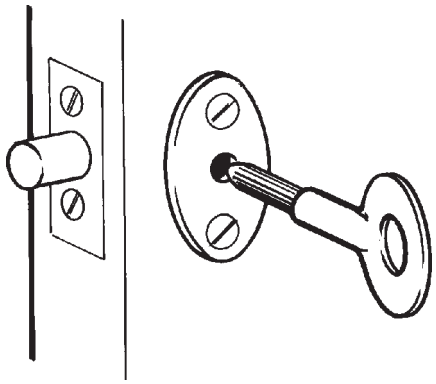


Function

- Rotary motion to linear motion.
- Linear motion to rotary motion.

Examples

- Door and window security bolts where the key forms the pinion.
- Car steering mechanism.



security bolt and key

Why we use them

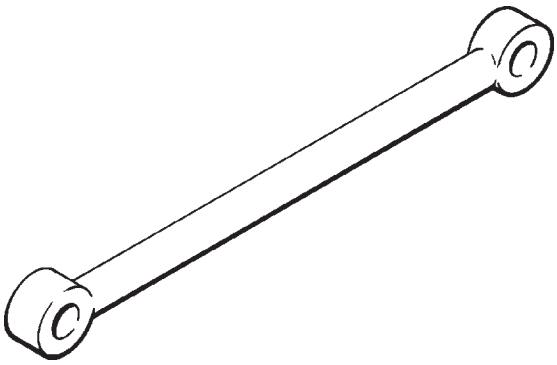
- Longer working life than cable on a drum.
- Rack can easily be quite long if required.
- Often a more practical solution than a cam and slider.

Things to watch out for

- The force on the teeth between the rack and the pinion will tend to push the rack away from the pinion, so adequate support must be provided.
- Lubrication will usually be required.

CONNECTING ROD

Description
A rod that conveys motion and force between two items but does not rotate. It is only held by the couplings at each end.



Function

- From linear motion to linear motion (not necessarily on the same straight line).
- From linear motion to arc motion.
- From arc motion to linear motion.
- From arc motion to arc motion.

  (The ends of a connecting rod can have more complex motion.)

Examples

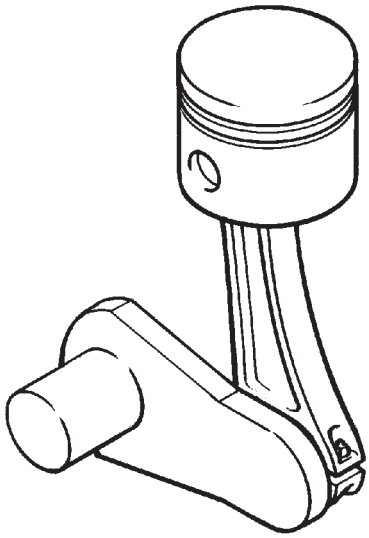
- Con rod in car engines - linear to circular motion.
- Toilet flush mechanism - arc to linear motion.

Why we use them

- Simple and cheap.

Things to watch out for

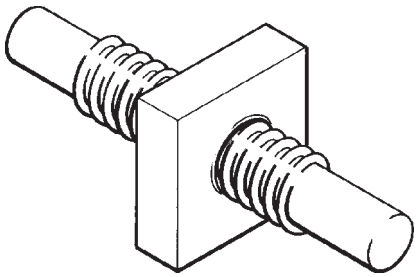
- Can buckle if it's not strong enough when used to push.
- If you connect one connecting rod to another, the force will generally not be transmitted. Connecting rods are therefore usually connected to sliders, levers, bell cranks and cranks.
- Need bearings at each end which may need lubrication.
- For complex situations, there can be ball joints at each end (e.g. some car throttle connecting rods).



connecting rod between crankshaft and piston

SCREW

Description
A screw that turns in a tapped hole so that either the screw moves or the item with the tapped hole moves. May be called a leadscrew.

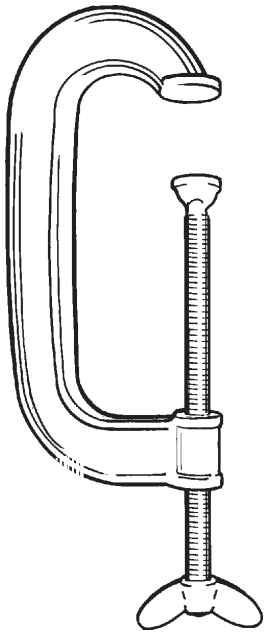


Function

- Rotary motion to linear motion.

Examples

- The lead screw on a lathe.
- G clamp.
- Water tap.
- Vice.



G clamp

Why we use them

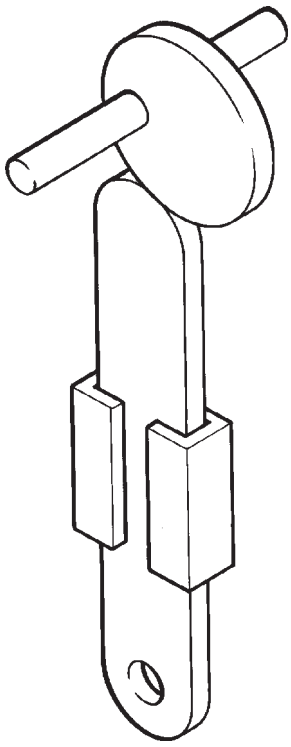
- As one turn causes quite a small linear motion, it is suitable for fine adjustment of linear position (as on a lathe).
- Unless the thread is very coarse or multi-start, a force in the direction of the linear motion will not cause the screw to rotate (as on a tap).
- High force may be produced in association with the linear motion.

Things to watch out for

- Lubrication will usually be needed.
- There usually has to be a bearing at one end, or possibly both ends, of the screw.

CAM AND SLIDER

Description
A shape mounted on a shaft that causes a slider to move.



Function

- Rotary to linear motion.

Examples

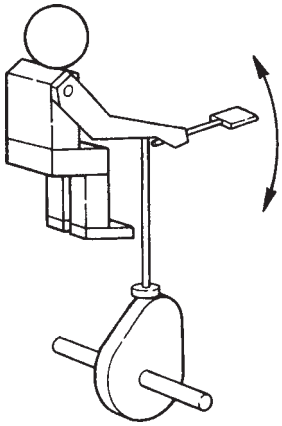
- Sewing machine foot (the manual lever rotates a cam that lifts the foot).
- Automata - for example, mechanical toys having at least one moving part.

Why we use them

- The shape of the cam can be made to give the linear motion required.

Things to watch out for

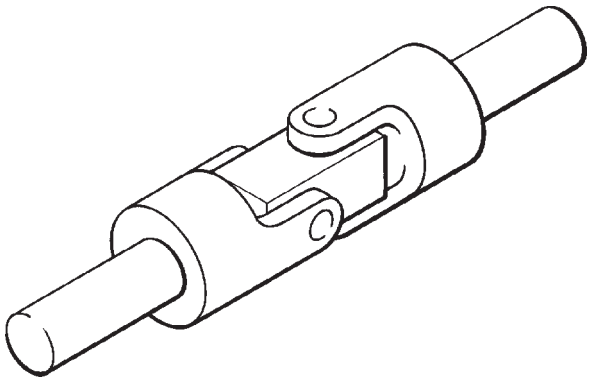
- The slider usually has to be kept in touch with the cam.
- The shape of the end of the slider can affect the linear motion.
- The sliding surfaces must be lubricated.



cam and slider mechanism for automata

UNIVERSAL COUPLING

Description
A device that allows connection between two shafts that are not in line.



Function

- From rotary motion to rotary motion.

Examples

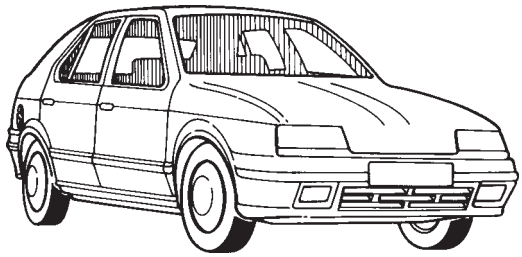
- On car drive shafts connecting the gearbox to the rear axle.

Why we use them

- The angle between shafts can change during use whereas gears have to be made for a fixed angle.

Things to watch out for

- Single universal couplings will not normally work well for angles greater than about 45°.
- The axes of the two shafts must intersect.
- A universal coupling must be carefully located at the intersection.



universal coupling used on propellor shafts of rear wheel drive cars

GEARS

Description
Toothed wheels that engage with each other.

Function

- From rotary motion to rotary motion.

Examples

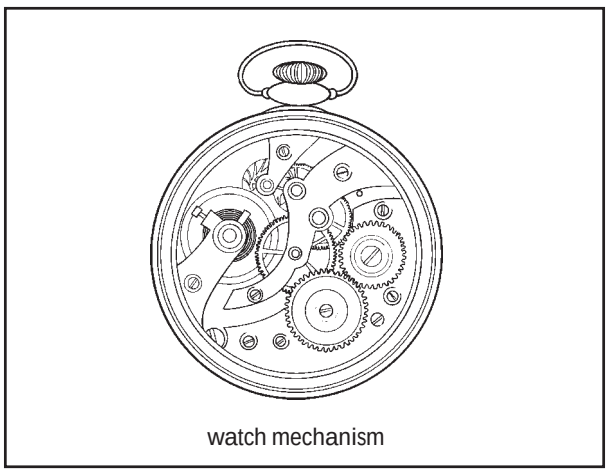
- Gears in a car gearbox.
- Gears in a watch or clock.

Why we use them

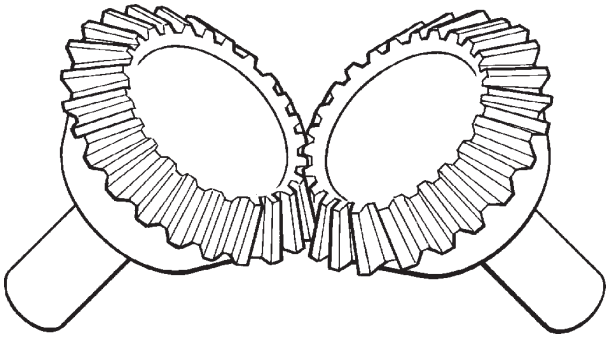
- Can change rotational speed.
- Can convey rotary motion to a parallel shaft.
- Can also convey rotary motion from one axis to another at any angle.

Things to watch out for

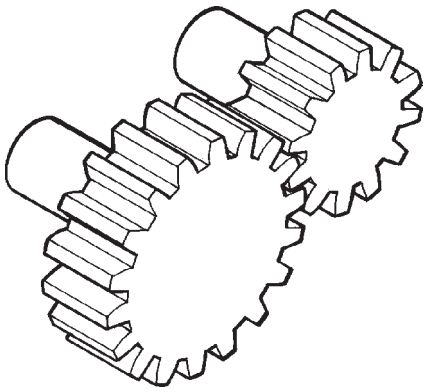
- Metal gears are fairly expensive because of precision machining needed.
- Gear teeth usually need lubrication.
- Often not particularly quiet in operation.
- Teeth must engage well for long life and smooth running, but must not engage too tightly.
- When in use, a gear exerts a force on its shaft; the shaft must therefore be firmly supported fairly close to the gear.



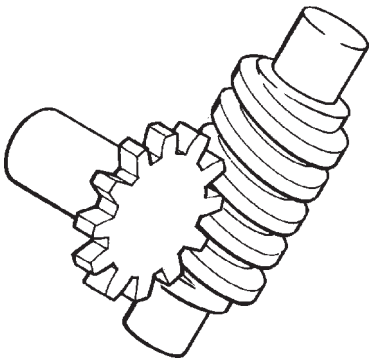
watch mechanism



bevel gears



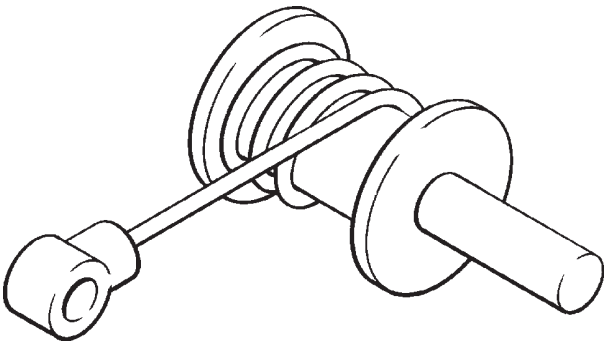
spur gears



worm and wheel

CABLE ON DRUM

Description
A drum to which one end of a cable is attached.

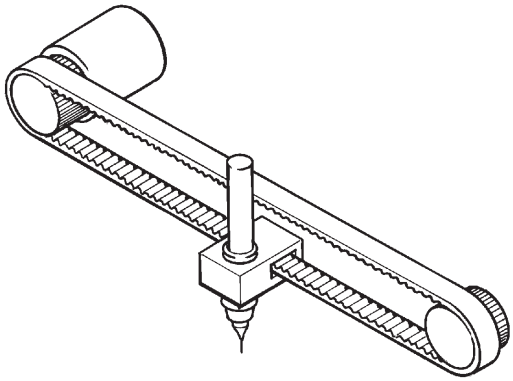


Function

- From linear motion to rotary motion.
- From rotary motion to linear motion.

Examples

- To move dot matrix or ink jet printing head across paper.
- Hoist mechanism.
- Starting pull cord on a lawn mower engine.



mechanism used to position plotter pen

Why we use them

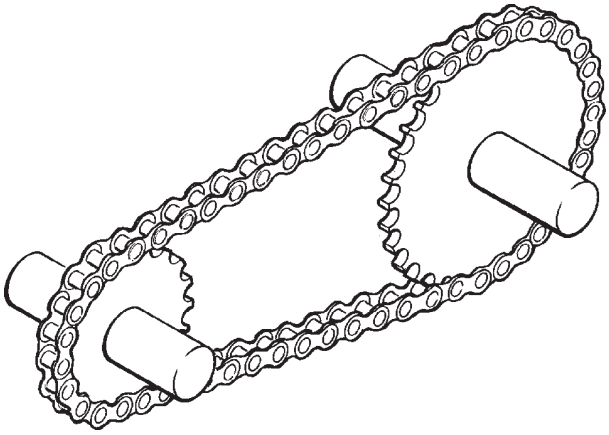
- Much easier to make and cheaper than a rack and pinion.
- Quiet in operation.
- Does not have as much backlash as a rack and pinion.
- Compared with a screw, there is more linear motion for every revolution.
- Cable can convey motion around obstacles by passing over pulleys or through suitable tubing.
- The linear motion is proportional to the rotary motion (providing the cable does not ride over itself on the drum and providing some cable remains in contact with the surface of the drum).
- Can get a relatively large amount of linear motion between the drum being fully wound and fully unwound.

Things to watch out for

- Cable must be kept in tension somehow at all times.
- Cable cannot exert a pushing force.
- Cable must be attached to the drum at some point.
- If rotary motion is less than 360°, only part of a drum is needed - usually called a quadrant.

SPROCKETS AND CHAIN

Description
Chain passing over toothed wheels.



Examples

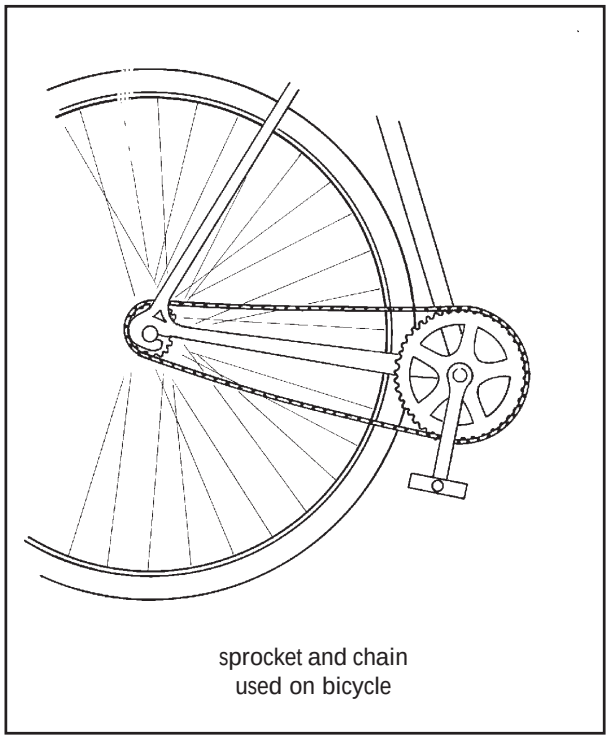
- Bicycle chain.

Why we use them

- Stronger than belts.
- Cannot slip (unless very loose).

Things to watch out for

- Shafts will rotate in the same direction.
- They will need lubrication.
- Chain links can be inserted or removed to get about the right length, but some adjustment of the spacing of the two sprockets may be needed.
- Chains tend to stretch with use due to wear.
- The two sprockets should lie in the same plane if possible, but some small misalignment will not matter.
- Chains can pass over more than two sprockets (e.g. on racing bicycles).



sprocket and chain
used on bicycle