

2 THEORY metalwork processes

Screw Threads

The screw thread is a very important detail in engineering. It is used to hold parts together. (e.g. bolt & nut) and to transmit power (e.g. vice screw).



Internal Screw Cutting

To achieve an internal screw thread, a hole has to be drilled first and then a tool called a TAP is used to cut a thread within the hole. TAPS are made from high speed steel (HSS). The top of the tap is square which enables the tap to be held securely in a TAP WRENCH, which can be seen below.



Taps are generally available in sets of three and are used in the following order:-

1. Taper Tap
2. Second Tap
3. Plug Tap

1



Taper

2



Intermediate

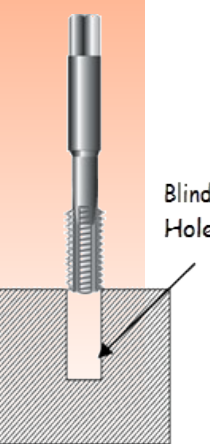
3



Plug

Blind Hole

A blind hole is a hole which has a bottom to it. If a blind hole is to be threaded it is very important to ensure that the depth of the hole is established before commencing to thread the hole. If this is not established it would be very easy to break the taps. A piece of tape attached to the tap indicating the depth is an ideal way of avoiding the tap from being broken by being forced into the bottom of the hole



THEORY metalwork processes

External Screw Cutting

To cut an external thread on a metal rod a tool called a DIE will be used.

Circular Split Die

The picture opposite shows a split die, this is the most common type of die used in the school workshop. These are used for cutting external threads. The die is made from high speed steel (HSS). To assist in starting the thread cut, the split die has a split which enables the die to be opened slightly thus cutting a shallower cut.



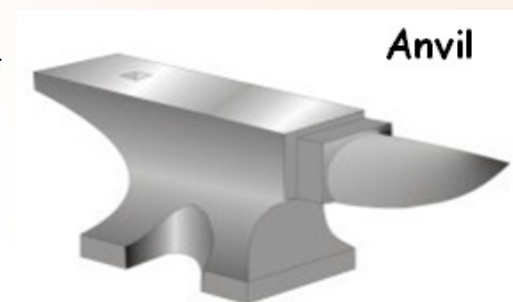
Die Holder or Stock

The circular split die fits into the die stock with the tapered side of the thread (shown by the writing on the die). The split in the die fits opposite the centre screw to allow the opening and closing of the die. The two screws at the side hold the die in the stock. To ensure the die can start to create a thread on the rod the rod must firstly be tapered at the end.



Heat Treatment of metals

When a metal is cold worked, i.e. when it is cut, beaten, hammered, bent, twisted or shaped, etc. at normal room temperature, tremendous internal forces are set up within its grain structure and the metal becomes extremely hard and liable to split. The term 'heat treatment' is applied to metals that undergo some form of heating process in order to change their properties. Generally, any heating process carried out on a solid metal is referred to as heat treatment. Heat treatments involve processes such as annealing, normalising, forging, hardening, tempering, etc.



Anvil

Malleability

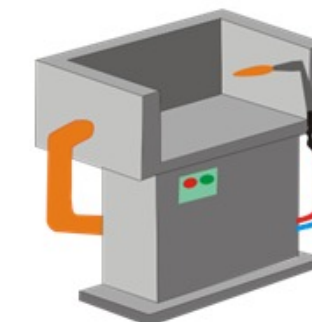
This is the ability of a material to withstand being hammered, rolled or bent without the material breaking.

Ductility

This is the ability of a material to withstand being stretched without the material breaking.

Toughness

This property of the material is the amount of energy it can absorb without breaking and measures its ability to withstand shocks. It is the opposite of brittleness.



Forge

2 THEORY metalwork processes

Work Hardened

If a material has been bent, hammered or twisted consistently over a period of time the metal will be Work Hardened. What is meant by this, is, the tiny molecules which make up the metal have been pushed and twisted out of their original positions thus making the metal very liable to breaking. This can be fixed by Annealing the metal.

Annealing

This process makes the metal as soft as possible to relieve the internal stresses, and make it easier to shape. The annealing process generally involves heating up to a certain temperature and allowing to cool, either in the air or in water depending on the material being annealed. If soap is applied to Aluminium prior to heating it will turn black when the correct temperature has been reached.

Tempering

This process involves heating the metal to various temperatures and then immediately quenching it in water. As the metal is being heated it changes colour starting with a pale straw to dark straw to reddish brown to purple then dark blue. Dependant on what properties are required of the steel being tempered will determines what heat it will be heated to. E.g. when it reaches a dark blue colour it is at 300° C. These colours are known as TEMPERING COLOURS.

Case Hardening

Mild steel cannot be hardened and tempered as its carbon content is too low. What can be done is to provide it with a hard outer case. In this process the metal is heated to a bright red heat and then rolled in a carbon rich powder. The carbon is absorbed into the skin of the metal thus making it very hard on the outer skin. This type of metal is ideal for components such as gear wheels which require to be hard wearing

Hardening

To enable carbon steel (i.e. tool steel) to be used for the wide variety of tools and articles that are necessary in the school workshop and in industry it must first be hardened, then tempered.

Taking a high carbon screwdriver blade for example, this is HARDENED by heating it slowly to a dull cherry colour and then quenching it in oil or tepid water. When this part of the process has been carried out, it is unusable. Although it is very hard and brittle (i.e. it can break very easily). To make the hardened steel usable it must now be TEMPERED, i.e. given properties such as toughness, elasticity, strength.

Twisting



As can be seen from the sketch below, the metal bar is heated until red hot, it is then twisted to the desired shape

Drawing Down



This involves the heating and re-heating of the metal bar and hammering it until a desired point is achieved.

Flattening

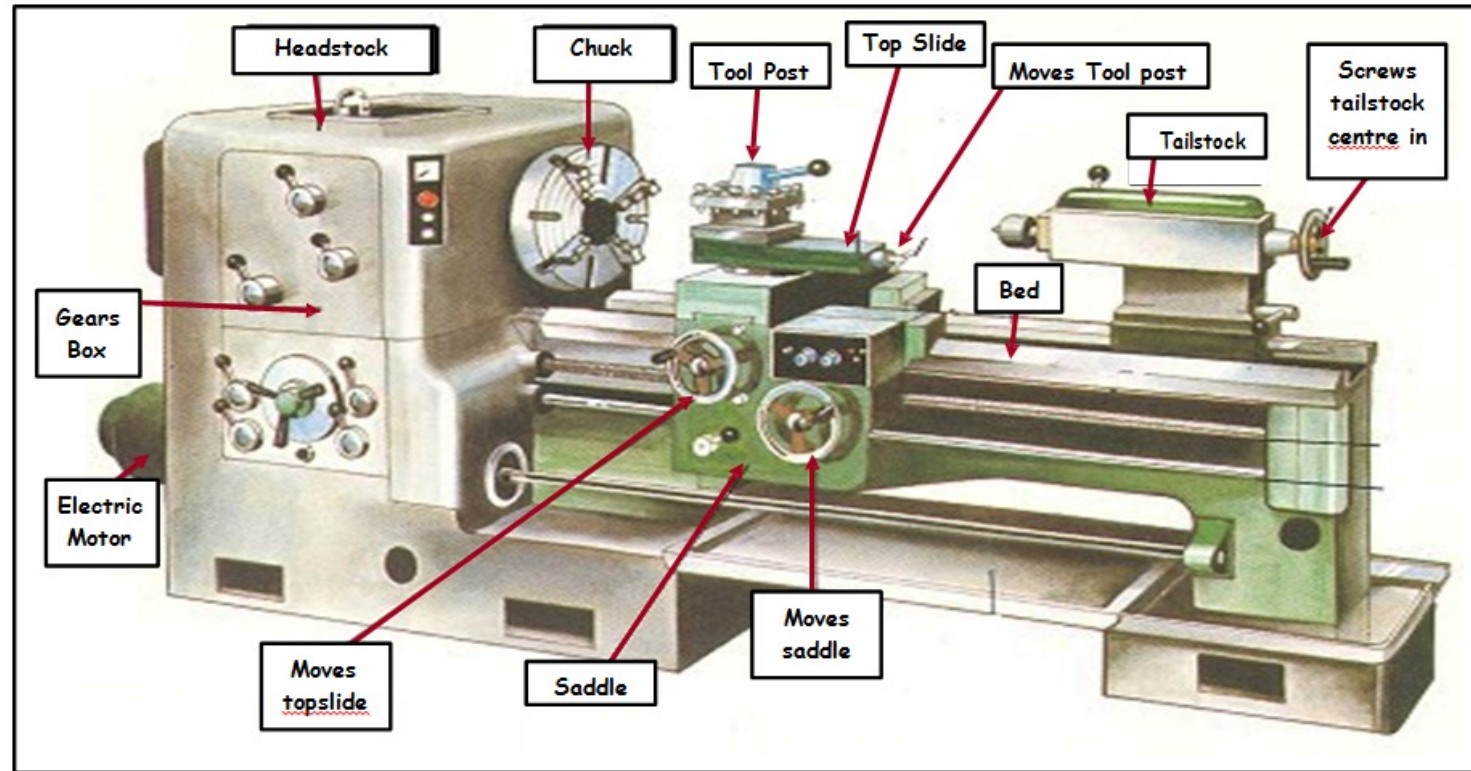


This involves the heating and re-heating of the metal bar and hammering it until the desired flatness is achieved.

THEORY metalwork processes

Metal turning

Metalwork Lathe/centre lathe

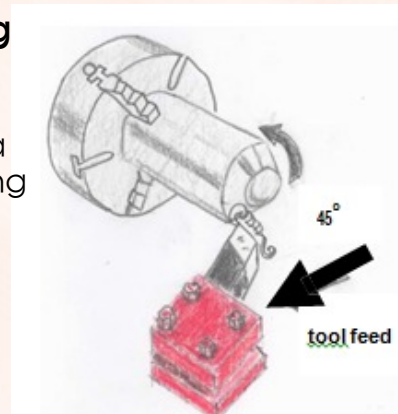


Facing off

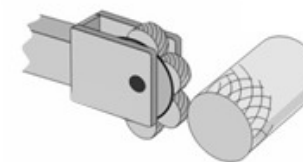


This means cutting across the end of a work piece. It is one of the first things normally done at the start of a new job. The process allows us to tidy up the face and ensure that it is flat

Chamfering



A chamfer is a slope on the edge of a piece of material. It is made by cutting at an angle on a job.

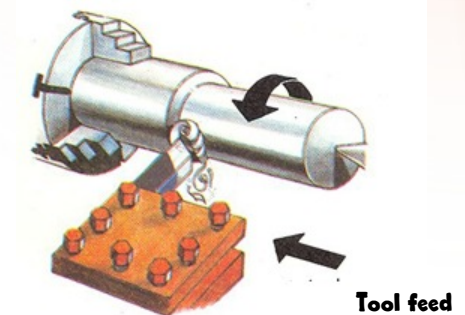


knurling

This process is used to engrave a diamond shape pattern onto the metal. This pattern acts as a grip for handles and screws.

Parallel Turning

This means cutting parallel to a job. The process allows you to turn the metal to

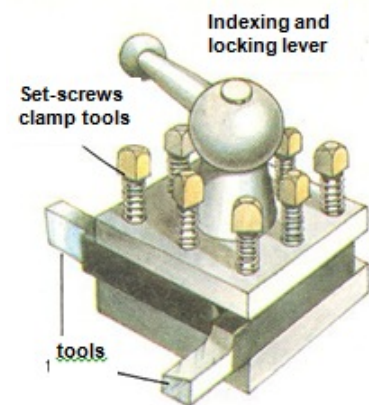


Revolving Centre

The revolving centre is secured in the tailstock. The bar to be turned is secured at one end by the chuck and held in place at the other end using the revolving centre. The revolving centre allows the bar to rotate freely allowing turning between centres.

Jacobs Chuck

This tool is placed in the tailstock of the centre lathe and is used to hold twist drills.



The tool post can be arranged to hold just one tool, or up to four. By loosening the screw-lever, the tool post can be rotated to each tool in turn.

Lathe Tools

1. Parting-Off.



2. Screw cutting.



3. Facing/parallel turning

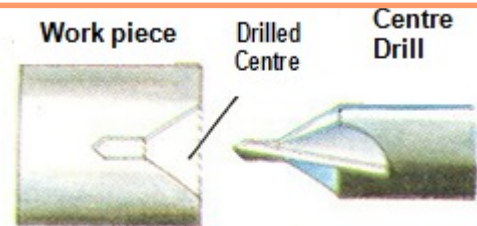


4. Roughing



Slocombe Drill/Centre Drill

This particular drill is used to drill a centre hole before you go ahead and drill the main hole. It is used with the tailstock



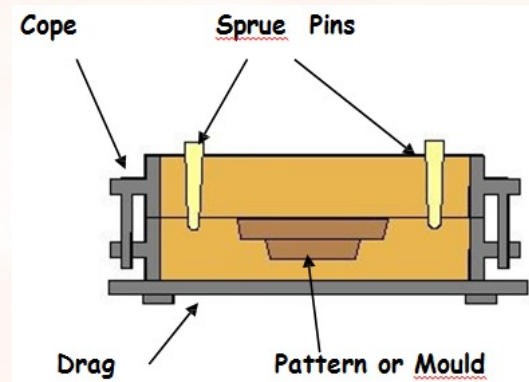
2 THEORY metalwork processes

Sand Casting (Moulding)

Sand casting is the process of making metal shapes (components) using pre-shaped objects and sand. A typical example of an object which has been cast is the Engineers vice which can be found on the workbench. This tool will have been cast in two separate castings. The bottom part of the casting unit which is called a DRAG because of the fact that the PATTERN is dragged from the sand. The top half of the casting unit is called the COPE.

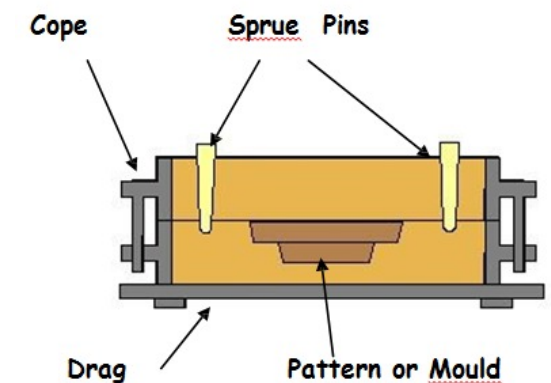
Stage 1

The COPE and DRAG are both filled with wet sand. The pattern (mould) is then pressed into the sand until flush with the surface. As can be seen from the drawing the cope is then placed on top of the drag. Sprue pins are then pushed through the sand to produce a RUNNER and a RISER. The runner will be the channel in which the molten metal will be poured into the mould.



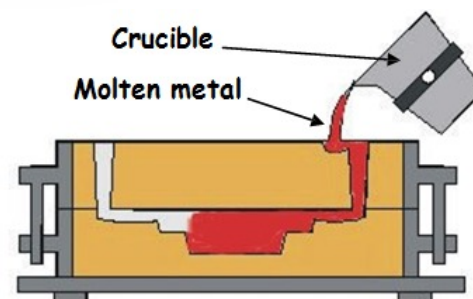
Stage 2

At this stage the wooden pattern has been removed and the riser and runner which were created by the sprue pins have been extended into the space left by the pattern. This will allow molten metal to flow through into the mould.



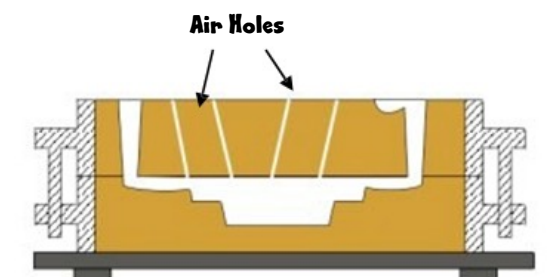
Stage 3

This shows a cross section (cut through the middle) of the pattern and runners. Very narrow holes can be seen, this allows excess gas and moisture to escape thus allowing the metal to fill fully all available space in the pattern



Stage 4

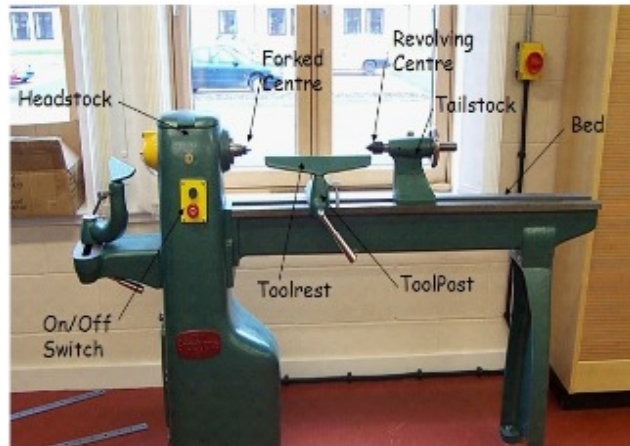
The final stage in the process is to pour the molten metal into the runner. The air which occupies the pattern space is forced out of the riser on the other side. The finished mould is then removed from the sand. The mould will also have extensions attached at this stage in the form of a runner and riser. These will simply be cut off and recycled.



THEORY woodwork processes

Mortise Machine

A mortise machine appears to drill a square hole in wood. The machine actually drills a round hole but because the drill bit is surrounded by a hollow square chisel, while the drill is creating the hole, the chisel is cutting the edges away from the hole leaving the mortise (square hole).



Turning Lathe

The wood lathe is a machine used to create cylindrical objects in wood, i.e. wooden bowls, table legs, etc. A piece of wood is secured between two points called the HEADSTOCK and the TAILSTOCK. The headstock has a motor enclosed and is therefore the end which actually turns the wood.

The surface finish of the wood being turned can be improved by increasing the speed of the lathe

Wood turning tools are used to shape the work piece. Depending on what shape is required will ultimately determine what type of tool will be used. The TOOL REST can be seen on the drawing on the previous page, this is used to support the tools while shaping is being carried out.



Revolving Centre - The Revolving Centre has bearings encompassed within the body of the tool. This allows the work piece to revolve without friction.

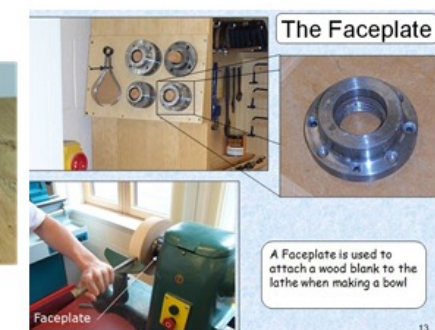


Dead Centre - The tailstock remains stationary while the work rotates. This causes friction and therefore the work piece has to be greased.



Centre Fork - The centre fork is secured in the revolving spindle (headstock). The fork is driven into the wood to be turned, the fork then turns the wood.

Face Plates - Face plates are secured to the headstock of the lathe and are used to hold blank pieces of wood which can then be turned into wooden bowls.



2 THEORY Woodwork processes

Wood turning

Wood Turning Tools

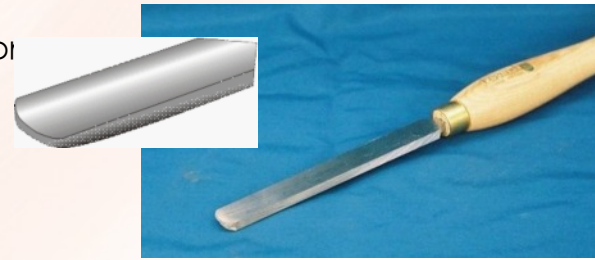
Parting Tool - The parting tool as its name implies is used to part off the "turned wood" from the Remaining wood at either end.



Spindle Gouge - This round nosed gouge takes over from the roughing-out gouge for general between-centres turning.



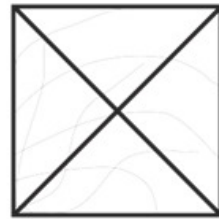
Round Scraper - These scrapers are used for working inside bowls and goblets.



Skew Chisel
This chisel is used to give a good surface finish. Stages in preparing a piece of wood for turning.

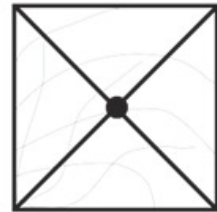


Stage 1



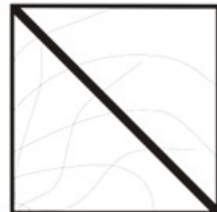
On both ends of wood mark a line from corner to corner to establish the centre.

Stage 2



On one end of the wood, using a centre punch, make a hole. The Cone Centre will locate here

Stage 3



On the other end cut a Kerf. The Centre Fork will locate here.

Stage 4



Now plane all four corners of the wood as can be seen from the sketch above.



THEORY plastic processes

Plastics Processes

Stages in finishing an edge of acrylic

When acrylic plastics are cut they tend to have very rough edges, this is due to the fact that it is a very brittle material. Brittle means that although it is very hard, it tends to break easily especially when sawing. To ensure the plastic is finished with a clean smooth edge it is essential that the edges are finished in the following sequence.

- 1 Cross file the edges to remove the majority of blemishes.
- 2 Draw file the edges to remove the marks left from cross filing.
- 3 Use wet and dry paper to get an overall smooth finish.
- 4 Use acrylic or metal polish (Brasso) to achieve the final finish.

Always finish the edges of the acrylic prior to any bending. Cross filing

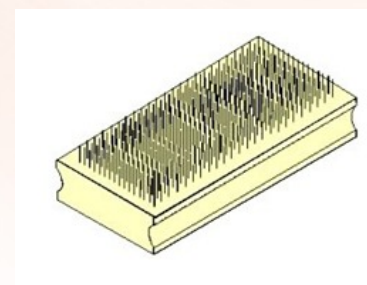
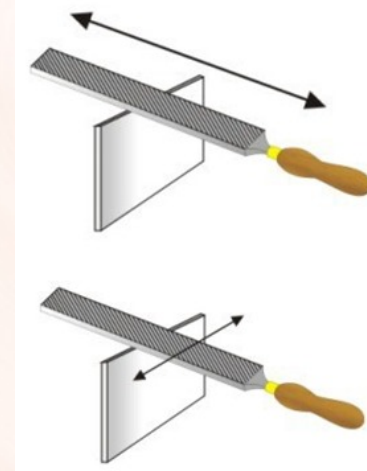
In this type of filing the file is moved across the work piece using the full length of the blade. This method of filing is used for removal of a lot of material with every stroke applied.

Draw filing

In this method of filing, the file is moved sideways along the work piece and is used to obtain a smooth finish after cross filing. This method does not remove much material.

Cleaning the files

Small pieces of plastic can get trapped in between the teeth of the file. This is called PINNING. A FILE CARD can be used to clear the file of the excess material. The file card looks very similar to a wire brush except the teeth are very short.

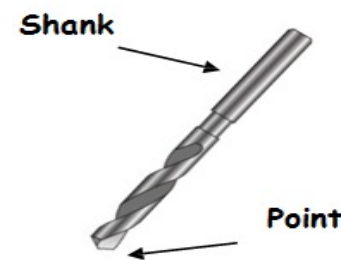


Drilling Holes

Holes can be drilled or cut in acrylic using standard drilling equipment, twist drills or hole saws. Prior to drilling it is very important to ensure the bottom of the acrylic is supported with a piece of wood. If it is not the most likely result will be the cracking of the acrylic. It is also essential that you drill into the acrylic slowly.

Twist Drill

Twist drills are generally made from a carbon steel and are used for drilling circular holes in metal, plastic or wood. Twist drills have three basic parts, a point, a parallel body and a shank which can be either parallel or tapered.



Hole Saw

This tool is used to drill big holes in wood or plastic and is generally fitted to an electric drill. The hole saw has a centre drill attached which is called the PILOT drill. It is called the pilot drill as it pilots the larger diameter cutter to exactly the right location.



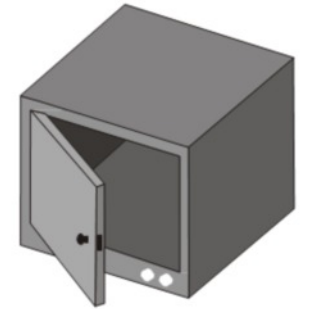
2 THEORY plastic processes

Bending and Forming Plastic

Acrylic becomes soft and pliable when heated to approximately 150 °C. In this state it can be easily bent and formed to shape. On cooling to room temperature the formed shape is retained. The most convenient method of heating, prior to bending and forming, is to use the oven or strip heater.

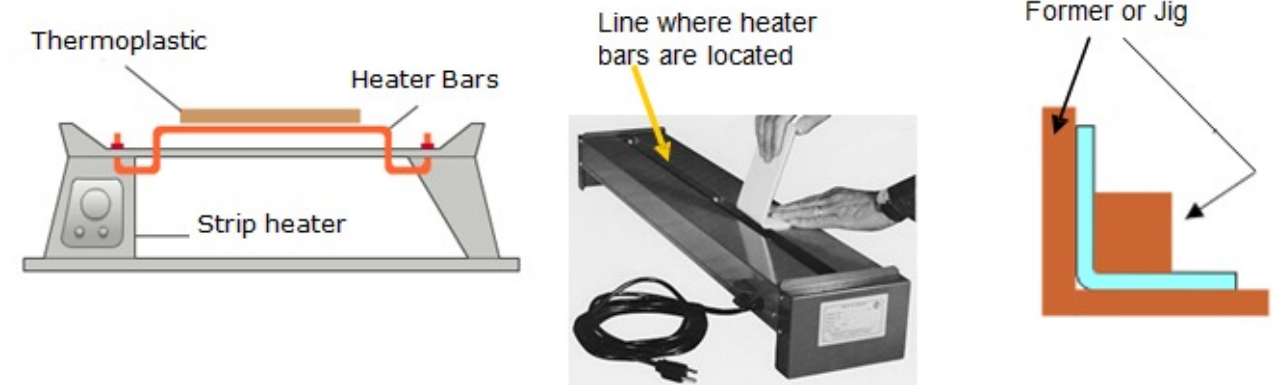
The Oven

Where more complex shaping of acrylic is required it is necessary to use an oven for heating. For a 3mm thick sheet of acrylic the oven should be set to a maximum temperature of 170°C and the sheet heated for about 15 - 20 minutes before forming to the required shape.

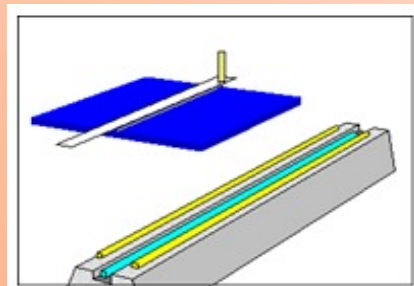


The Strip Heater

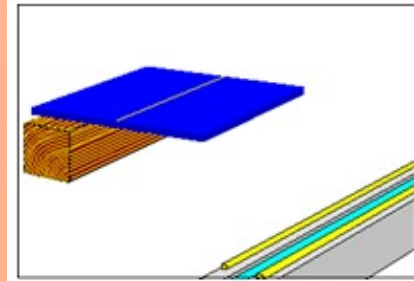
The purpose of the strip heater is to heat only a narrow strip of acrylic to allow local bending. Before bending the acrylic the protective coating is removed and then area to be bent is marked with a pen. After heating it sufficiently the acrylic can be shaped, preferably using a suitable former or jig.



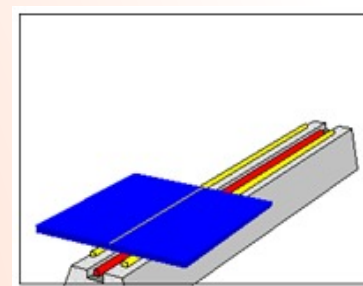
Stage 1
The first stage is to mark the line where the bending will take place



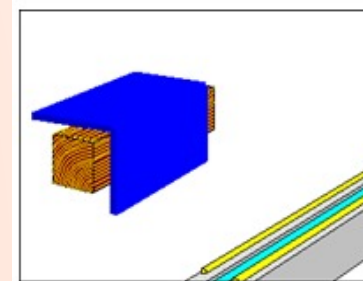
Stage 3
The third stage is to remove the soft heated acrylic and place it on a suitable JIG or FORMER



Stage 2
The second stage is to place the acrylic over the heating element, turning regularly to avoid burning.



Stage 4
The last stage is to bend the acrylic to the desired shape.



THEORY plastic processes

Vacuum Forming

In Vacuum Forming, a sheet of thermoplastic is held in a clamp and is heated until it is soft and flexible. Air is sucked out from underneath the sheet so that air pressure pulls the sheet down onto a specially made mould. This process enables thermoplastics to be formed into complicated shapes such as packaging, storage trays and seed trays.

Stage 1

The first stage of vacuum forming is to clamp the sheet across the top of the machine and heat it until the plastic is soft and flexible. This can be judged by watching the material, which will start to sag under its own weight when soft. If touched with a stick it will feel soft and rubbery.

Stage 2

The pattern is then raised up to meet the hot soft plastic.

Stage 3

At this stage the air has been sucked out from beneath the plastic pulling it onto the pattern.

Stage 4

The final stage is to remove the pattern from the plastic leaving the finished article.

The pattern tends to have sloping sides to allow it be removed from the cooled plastic easily. Also, the corners are rounded to prevent the plastic from tearing.

<http://www.youtube.com/watch?v=1t39xX6fjt0>

