FORGING – THE SKILLS OF THE BLACKSMITH

This mobile revision pdf is based on detailed work found in the 'EQUIPMENT AND PROCESSES' section.
Tap on the green link button below to go to the complete website section

Tap the blue button to view equipment / processes covered by this Revision PDF

FORGING – THE SKILLS OF THE BLACKSMITH

1. THE ANVIL, ANVIL STAND, SAFETY GEAR AND THE HEARTH

2. TONGS, METALS AND FORGING TEMPERATURES

3. HAMMERS, BENDING, UPSETTING AND SETTS

4. DRAWING DOWN, FLARES, SCROLLS, PUNCHING AND DRIFTING

5. FULLERING, SWAGES, SWAGE BLOCKS

6. FORGING AN EYE

7. CREATING A TWIST

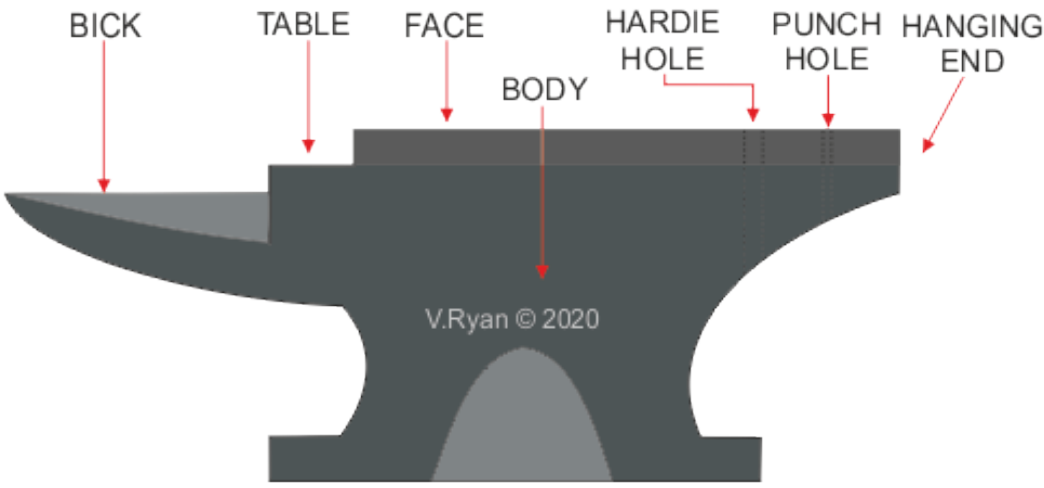
8. WELDING AND DROP FORGING

V.Ryan © www.technologystudent.com 2020

THE ANVIL

The anvil is a piece of equipment everyone recognises. The face is manufactured from high carbon steel, welded to the body. The 'table' is used for cutting. The 'body' is manufactured from wrought iron. The 'punch hole', is used for punching holes through 'yellow hot' steel. The 'hardie hole' is used to hold other Smith's tools and equipment. The 'bick' is the ideal shape/form and is used when shaping metal into 'rings' and other curved forms.

Tap the image for more information



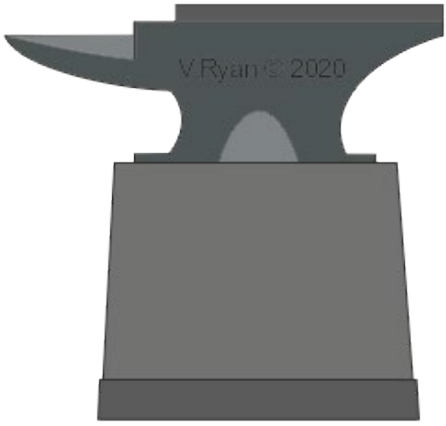
Tap the blue button for the next page.

Tap the red button to return to the Contents page

THE ANVIL STAND

An anvil should be set at a comfortable height for the user. It should be set on a cast steel anvil stand, or preferably a trunk of elm. The elm absorbs the force of each hammer blow, transmitted through the anvil to the stand. A cast steel stand does not absorb hammer blows, and tends to react / bounce.

Tap the image for more information



Tap the blue button for the next page.

Tap the red button to return to the Contents page

FORGING AND SAFETY

When forging, it is important that safety is the first priority. This begins with wearing the correct protective 'gear'. See below.

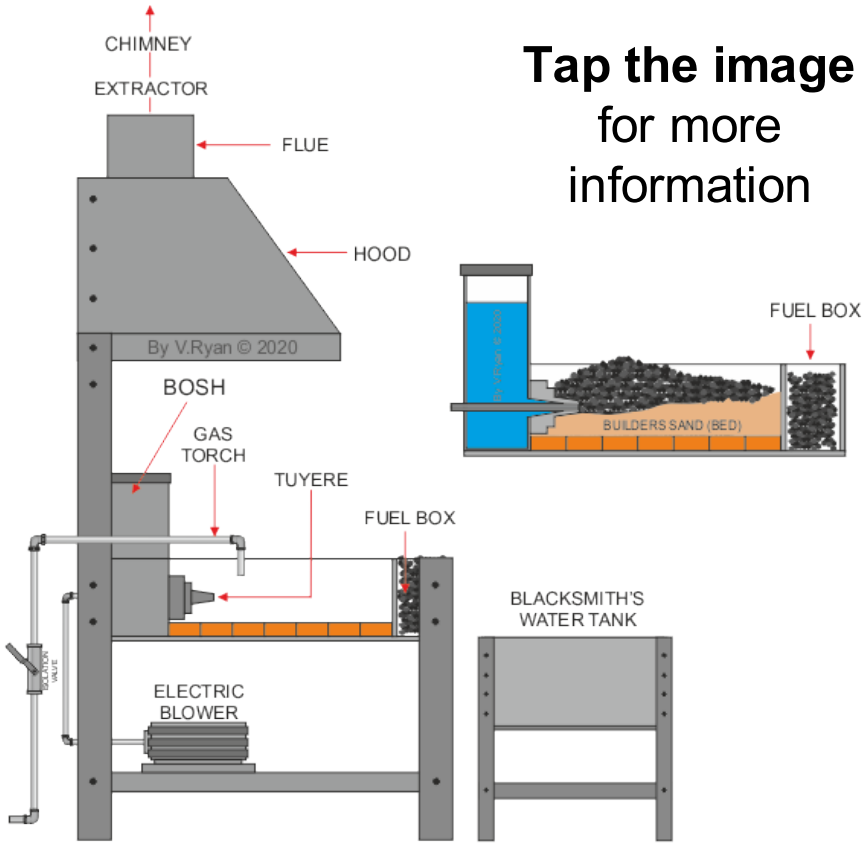
Tap the image for more information

Tap the blue button for the next page.

Tap the red button to return to the Contents page

THE TRADITIONAL BLACKSMITH'S HEARTH

Traditional hearths require a fire brick lining. Both types of hearth need a 'bed', built up from builders sand. The fuel is placed on top of the sand (Blacksmith's Breeze, sometimes referred to as 'Coke Beans' or Smithy Coal).



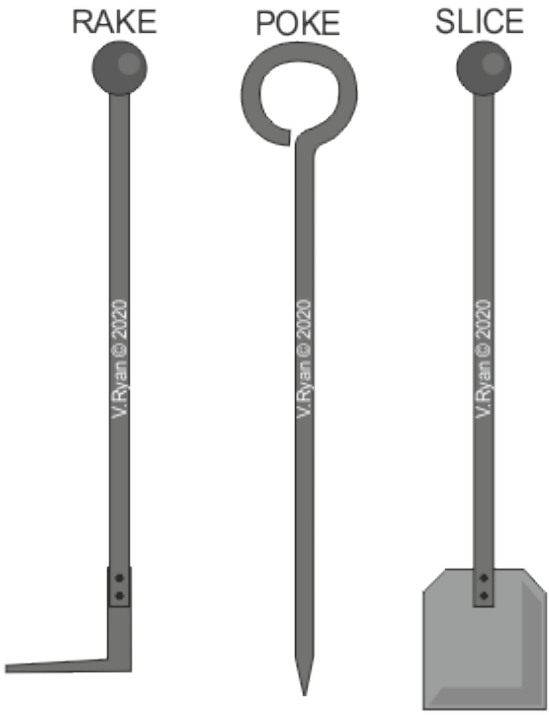
Tap the image for more information

Tap the blue button for the next page.

Tap the red button to return to the Contents page

BLACKSMITH'S FIRE TOOL

The Blacksmith needs three important tools, when controlling the hearth and the burning coke. They allow him/her to add more coke, to position it accurately and to rake away debris, allowing air to flow through the coke, enhancing the fire. Without these tools, the fire in the forge would eventually die or produce insufficient temperatures.



Tap the image for more information

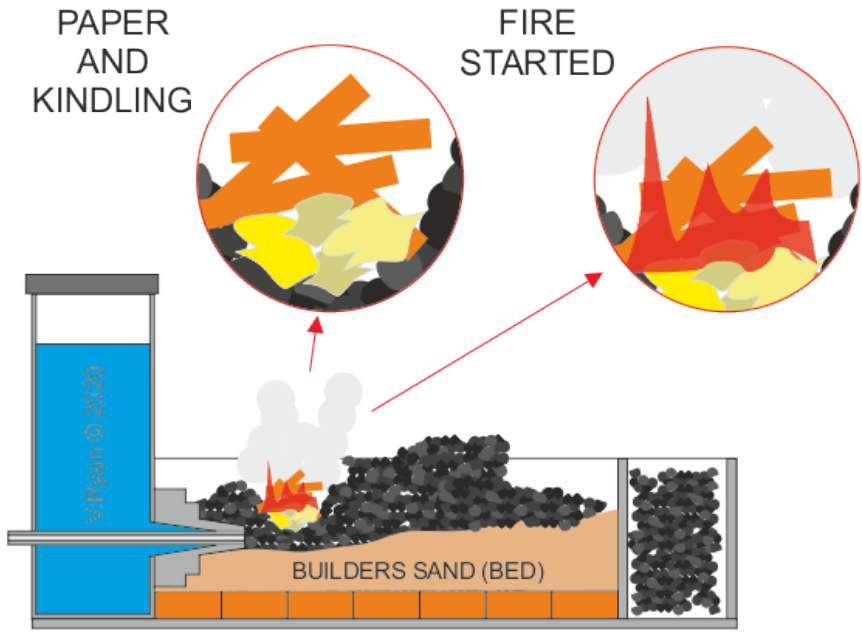
Tap the blue button for the next page.

Tap the red button to return to the Contents page

LIGHTING THE FORGE

A small hollow / depression is formed in the coke, in front of the tuyere. 'Rolled up' newspaper, with a few pieces of kindling (wood), are placed in the hollow and the paper set alight. As the fire takes hold and begins to 'grow' in intensity, a small amount of coke is added to the 'fire' and a gentle blast of air delivered through the tuyere.

Tap the image for more information



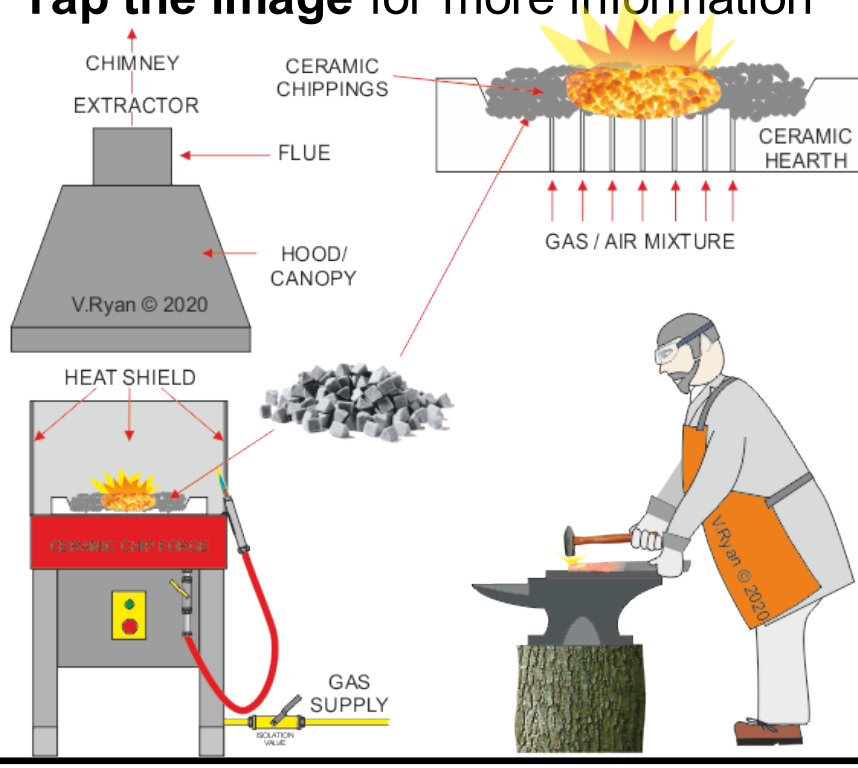
Tap the blue button for the next page.

Tap the red button to return to the Contents page

THE MODERN CERAMIC CHIP FORGE

A ceramic chip forge, is a good option for schools and colleges. The fuel is natural gas, which burns, heating up the ceramic chips, storing the heat. Heating of the metal to be forged, takes place in exactly the same way as with a traditional forge. It is placed in the heart of the fire, just below the surface of the heated ceramic chips.

Tap the image for more information



Tap the blue button for the next page.

Tap the red button to return to the Contents page

ADVANTAGES / DISADVANTAGES OF CHIP AND COKE FORGES

Ceramic chip forges have the advantage of being connected to a gas supply, which provides much of the heat. This means that the forge can be ready for work, in less than fifteen minutes. However, they tend to have a limited working area. The ceramic chips need replacing occasionally. Coke based forges reach higher working temperatures, an advantage to a professional blacksmith. They do not need a supply of gas or even electricity. Manual bellows can be used to provide the 'blast' of air. This type of forge, takes longer to light and requires a level of skill and practice to keep at a working temperature.

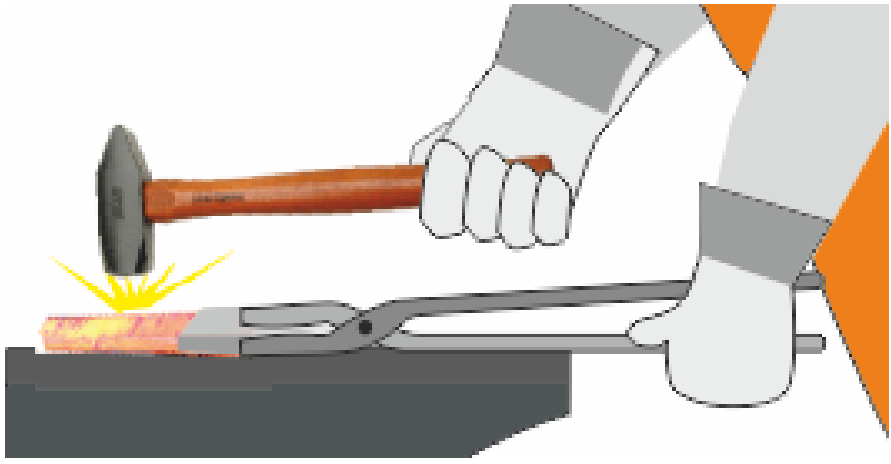
Tap the image for more information

Tap the red button to return to the Contents page

TONGS FOR FORGING

A range of tongs are available for forge work. They are used, when it is not practical or safe to hold the metal in the hand. Selecting the tongs to be used, depends on the nature of the work being carried out. They should hold the work comfortably and firmly. Tongs range in weight. For instance, lightweight tongs start at 900g and are ideal for school work and lighter forge work. Standard tongs range between 1300g to 1800g. Heavier tongs for substantial forge work, begin at 2kg.

Tap the image for more information

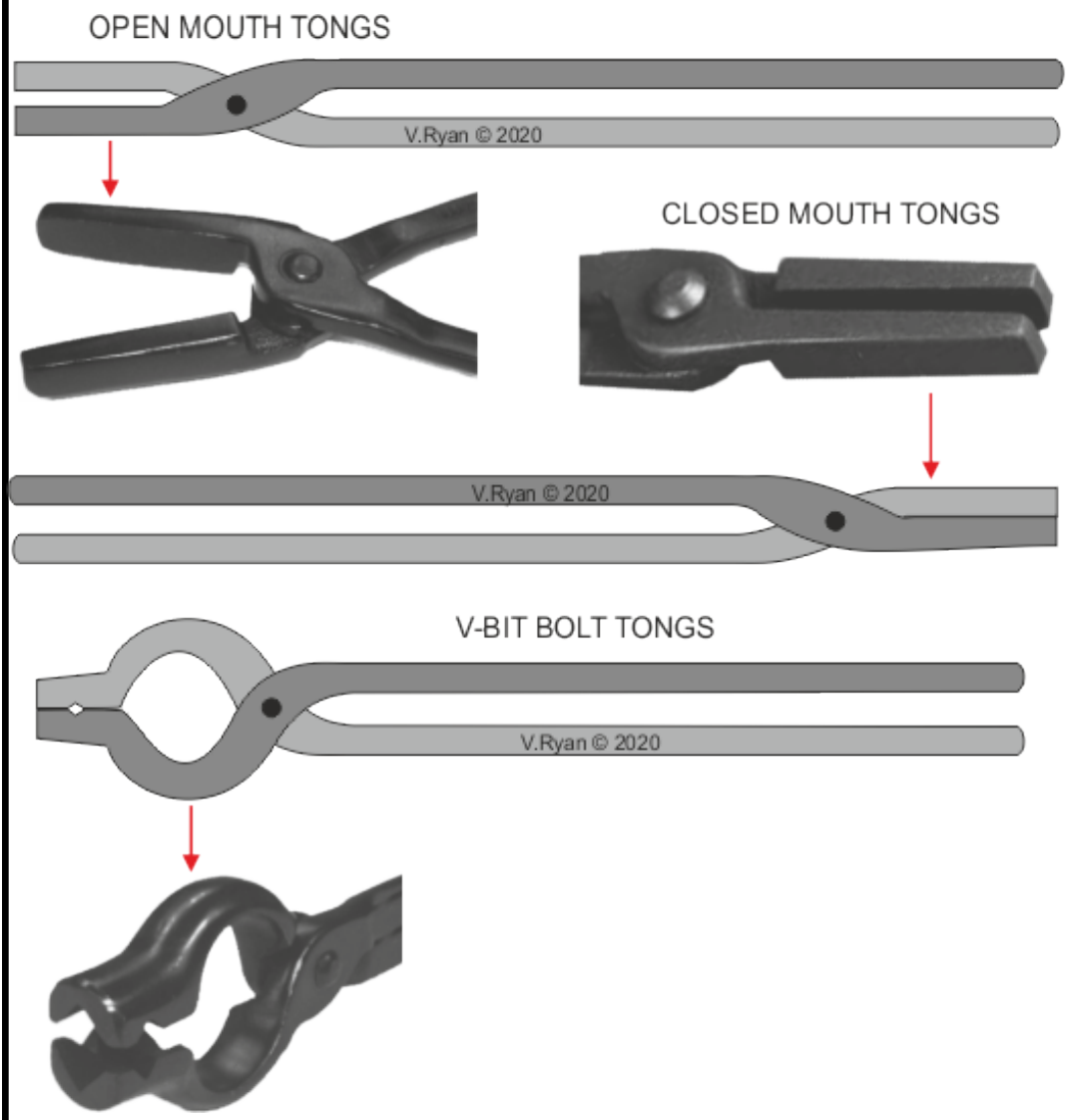


Tap the blue button for the next page.

Tap the red button to return to the Contents page

TONGS FOR FORGEWORK

Tap the image for more information

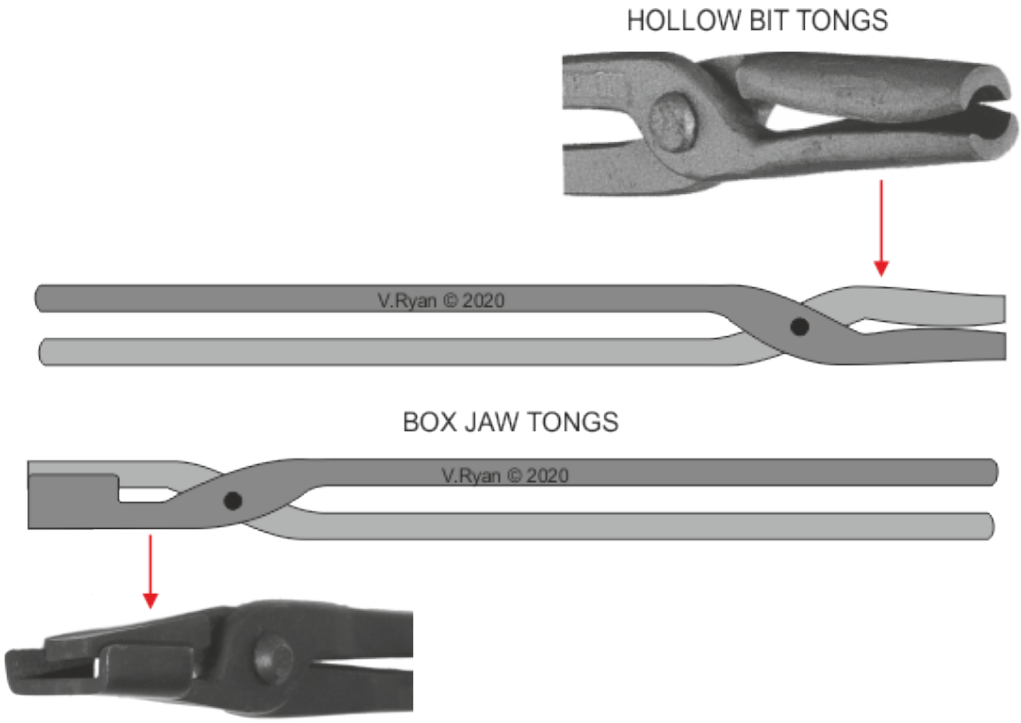


Tap the blue button for the next page.

Tap the red button to return to the Contents page

TONGS FOR FORGEWORK

Tap the image for more information

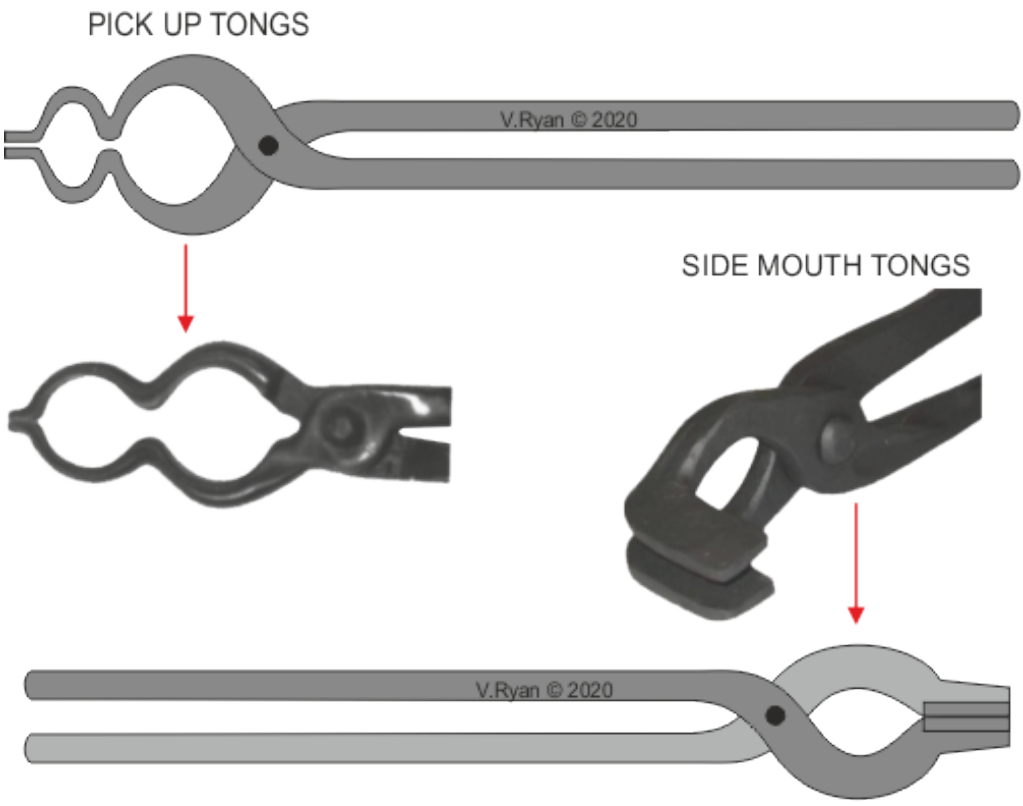


Tap the blue button for the next page.

Tap the red button to return to the Contents page

TONGS FOR FORGEWORK

Tap the image for more information



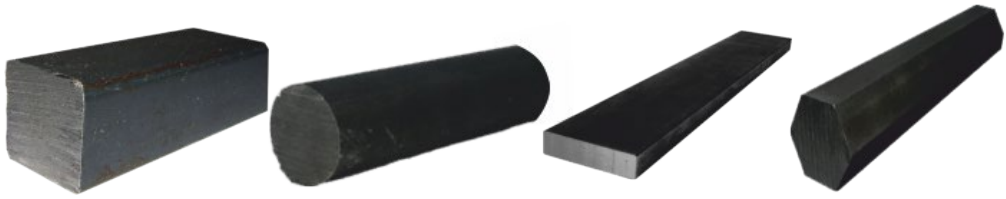
Tap the blue button for the next page.

Tap the red button to return to the Contents page

METALS FOR FORGING

Wrought iron is ideal for forgework. It has a low carbon content, less than 0.08 percent. It is ideal for forgework, because it is ductile and malleable, due to its fibrous structure..
As a replacement, medium carbon steels are used. They contain from 0.3 percent carbon to 0.7 percent. One such steel is called 'black mild steel'.
High carbon steels are sometimes used in forgework. The Blacksmith uses a variety of sections including: round, hexagonal square and a range of flat strips.

Tap the image for more information

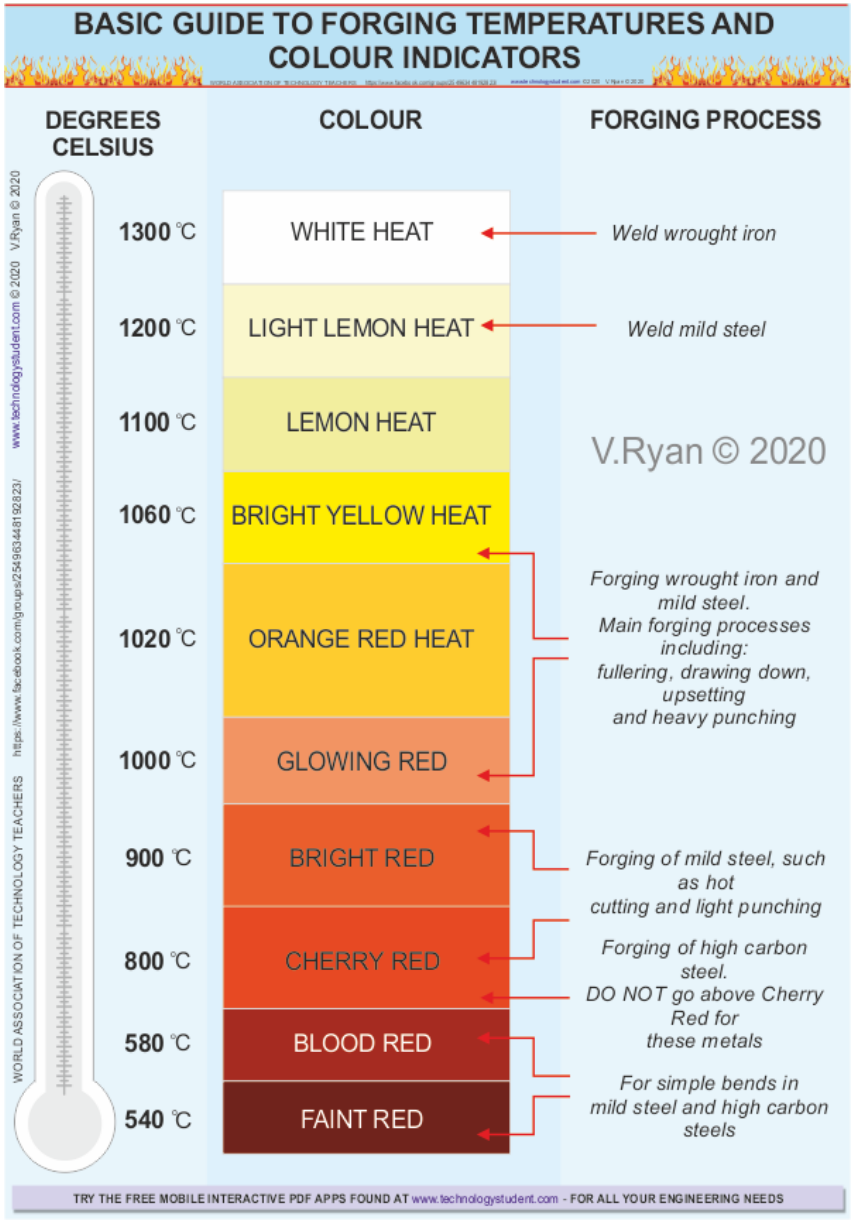


Tap the blue button for the next page.

Tap the red button to return to the Contents page

FORGING TEMPERATURES

Tap the image for more information



Tap the red button to return to the Contents page

HAMMERS FOR FORGEWORK

Tap the image for more information

Tap the blue button for the next page.

Tap the red button to return to the Contents page

HAMMERS FOR FORGEWORK

Tap the image for more information

DOUBLE FACE SLEDGE HAMMER
FIBREGLASS HANDLE

DOUBLE FACE SLEDGE HAMMER
HICKORY / ASH HANDLE

STRAIGHT PEIN SLEDGE

CROSS PEIN SLEDGE

Tap the blue button for the next page.

Tap the red button to return to the Contents page

HAMMERS FOR FORGEWORK

Here, the Blacksmith is positioning the 'Smith's hammer and the Striker (the Smith's Assisant) striking the hammer with a sledge. Two people are required for heavy forgework.

Tap the image for more information

Tap the blue button for the next page.

Tap the red button to return to the Contents page

HAMMERS FOR FORGEWORK

A Smith's hammer is used during the forging of metal. It is a general blacksmithing hammer, because it is heavy and well balanced. In trained hands, it is ideal for forming red / yellow hot steel and wrought iron, into numerous shapes and forms.

Tap the image for more information

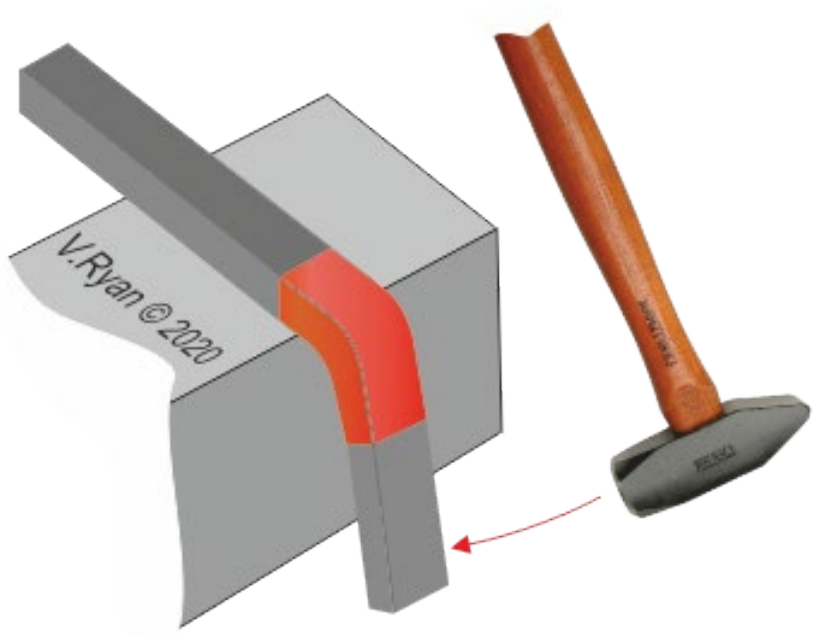
Tap the blue button for the next page.

Tap the red button to return to the Contents page

SIMPLE FORGING - 'BENDING' OF METAL

Basic bending / folding of steel, begins with heating the metal to ‘cherry red’. The metal is placed on the anvil and it is hammered to shape, as seen in the diagram. A chalk line should be drawn on the metal, before heating, which marks the point of the bend.

Tap the image for more information



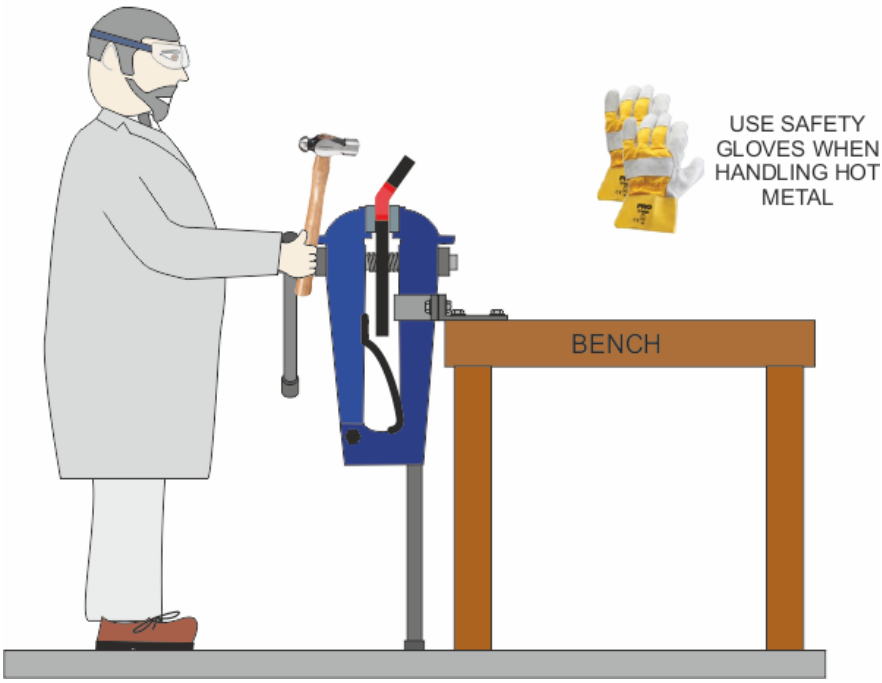
Tap the blue button for the next page.

Tap the red button to return to the Contents page

USING A LEG VICE TO HELP FORM A BEND

The leg vice is used here, to hold a substantial piece of steel, ready for forming to a 90 degree angle. The steel has been heated to ‘red heat’, on a brazing hearth or in a forge. The long piece of steel fits between the jaws of the leg vice, without interference from the bench, giving plenty of room

Tap the image for more information



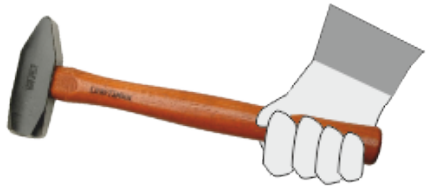
Tap the blue button for the next page.

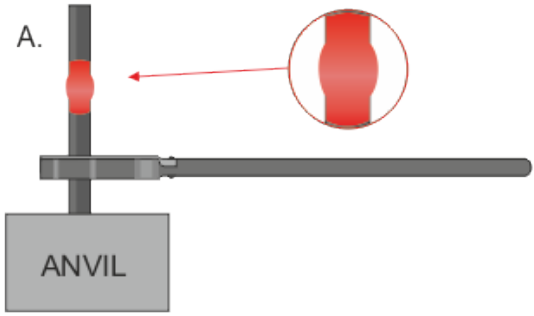
Tap the red button to return to the Contents page

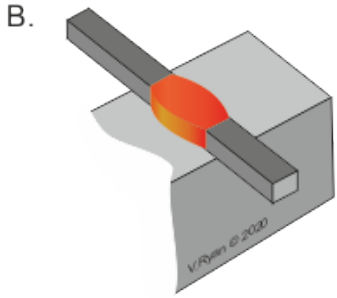
ACCURATE BENDING OF METAL

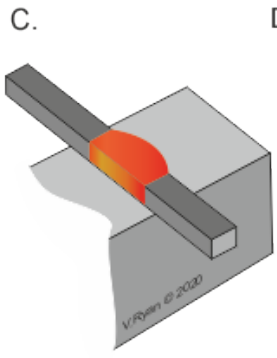
For an accurate 90 degree bend, there is a more detailed process.

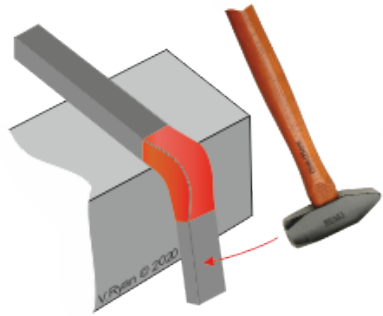
Tap the image for more information

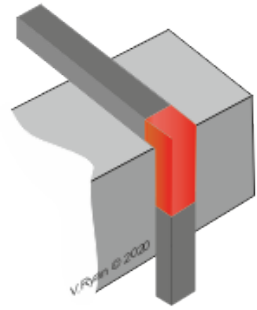












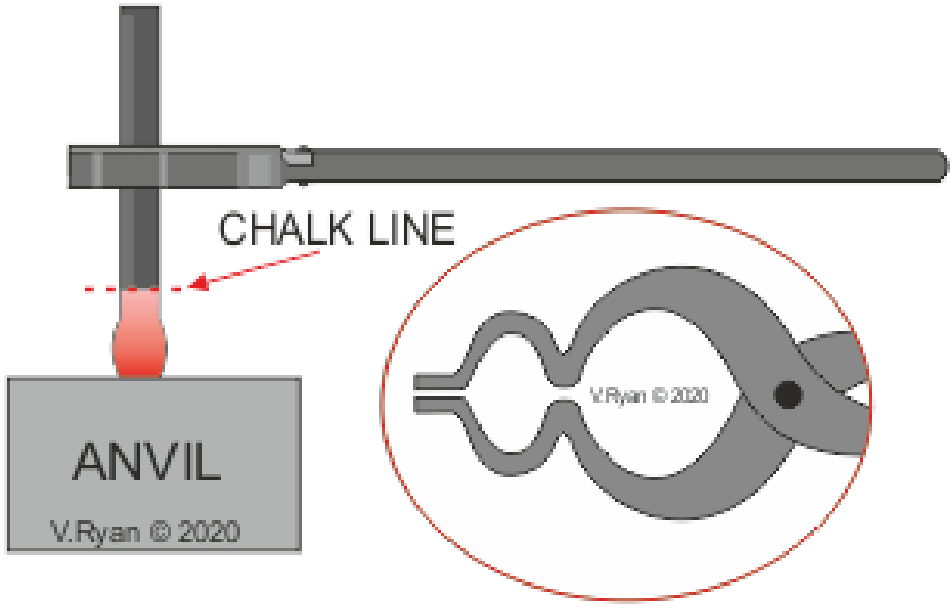
Tap the blue button for the next page.

Tap the red button to return to the Contents page

JUMPING UP / UPSETTING

This process involves 'thickening' a section of the metal being forged. The metal Is heated to 'yellow heat' in the area to be thickened. A chalk line can be drawn on the metal, which marks the limit of the thickening. Chalk will show up relatively clearly, even after heating the metal. It may be necessary to cool the rest of the metal.

Tap the image for more information



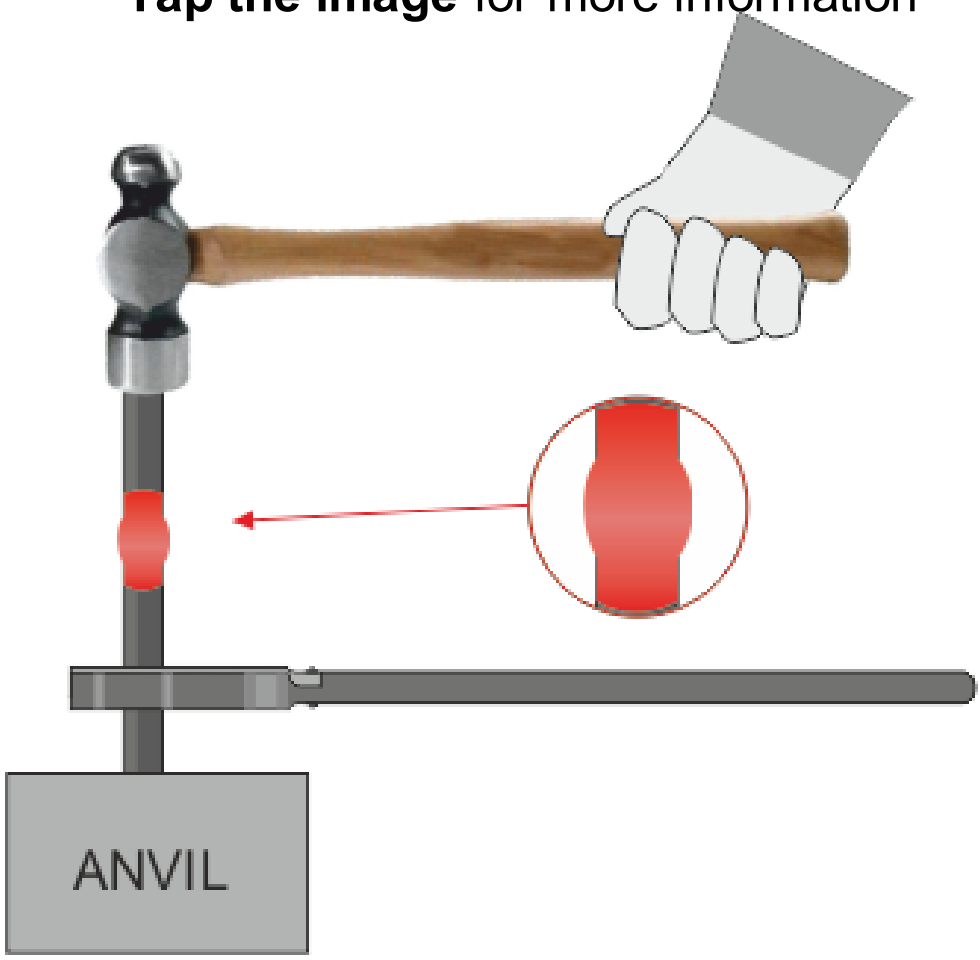
Tap the blue button for the next page.

Tap the red button to return to the Contents page

JUMPING UP / UPSETTING

Jumping / upsetting can be positioned away from the end of the metal. The area is heated, making it malleable.

Tap the image for more information



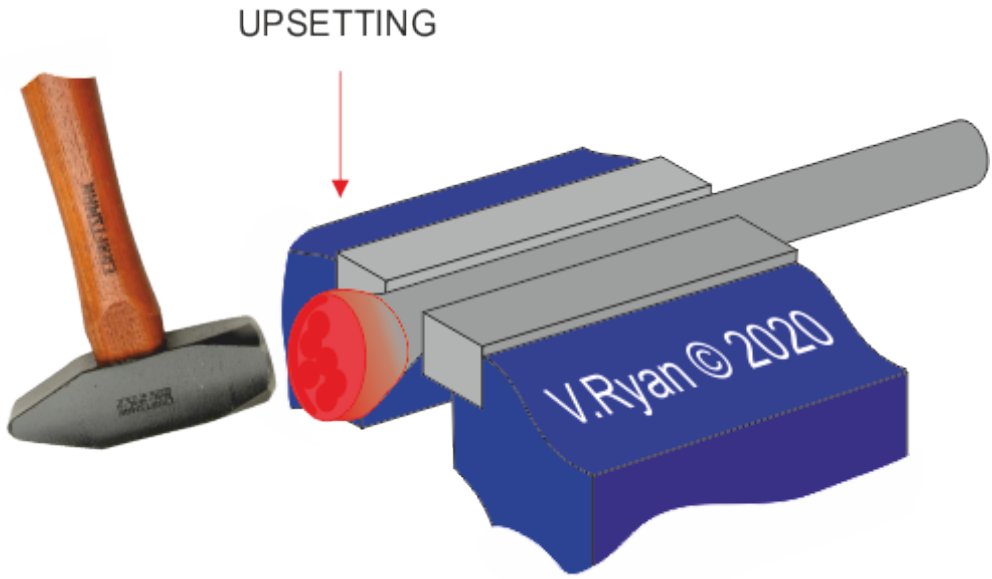
Tap the blue button for the next page.

Tap the red button to return to the Contents page

JUMPING UP / UPSETTING

Upsetting / jumping up, can be achieved with the aid of a vice and Blacksmith's hammer. A substantial engineers / fitters vice is seen below.

Tap the image for more information



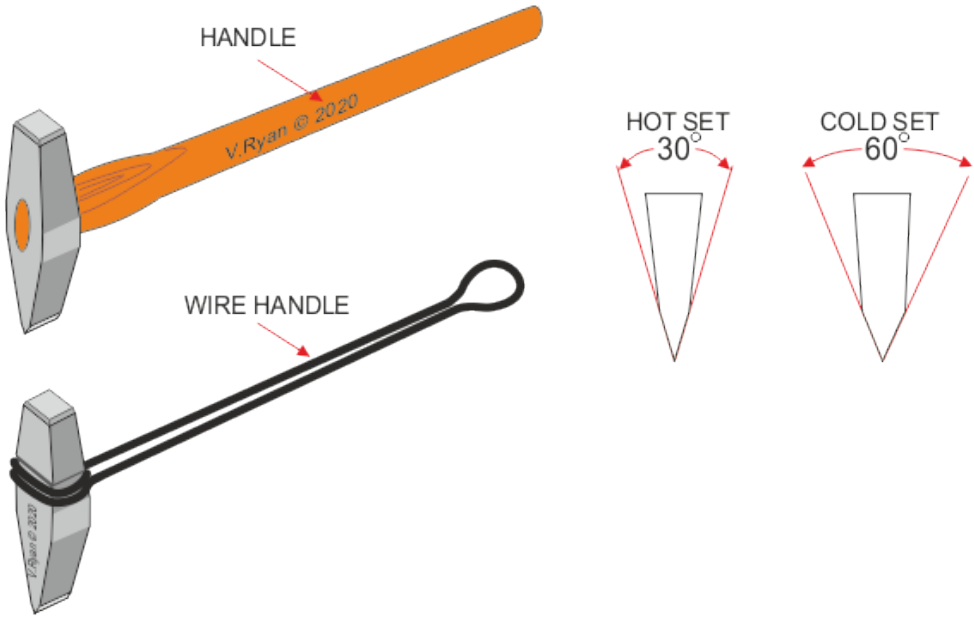
Tap the blue button for the next page.

Tap the red button to return to the Contents page

BLACKSMITH'S SETTS

A sett is a 'chisel' used by Blacksmiths. A sett will have either a wooden or wire handle, formed from steel (see opposite). They are normally used in conjunction with a 'hardie', which sits in the hardie hole of the anvil. Setts are in to forms, cold setts for cutting metal when it is cold and hot setts for use when cutting hot metal (as seen below).

Tap the image for more information



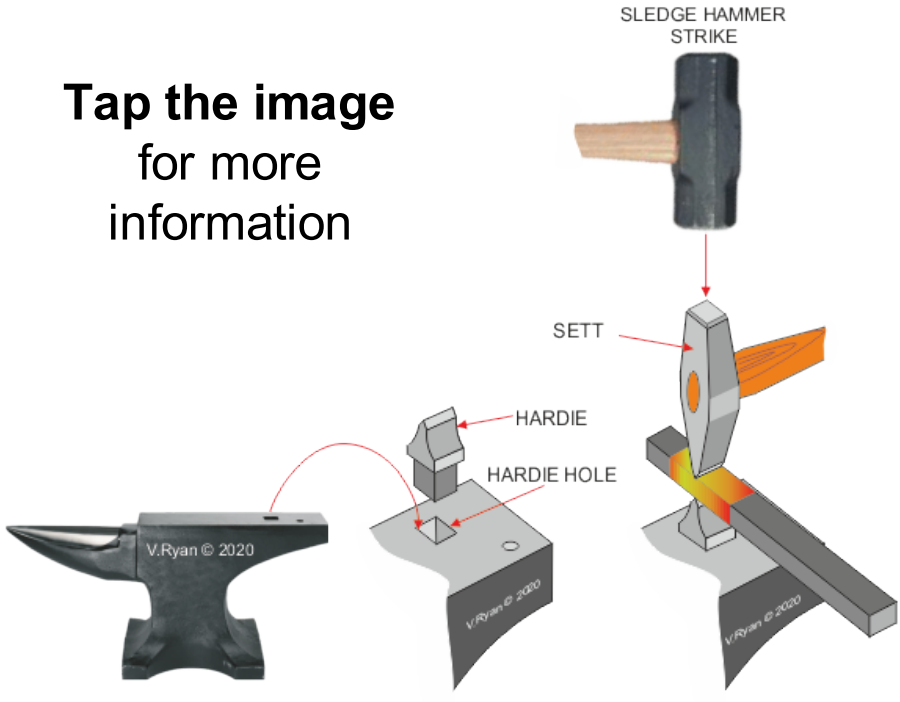
Tap the blue button for the next page.

Tap the red button to return to the Contents page

BLACKSMITH'S SETTS

The metal to be heated to 'yellow heat' and placed between the hardie and the sett. The Blacksmith's Assistant uses a sledge to strike the sett, creating a 'nick' in the top and bottom surfaces of the metal. The metal is then turned round, so that a 'nick' can be produced on the other two surfaces. This procedure continues until the steel can be broken apart.

Tap the image for more information

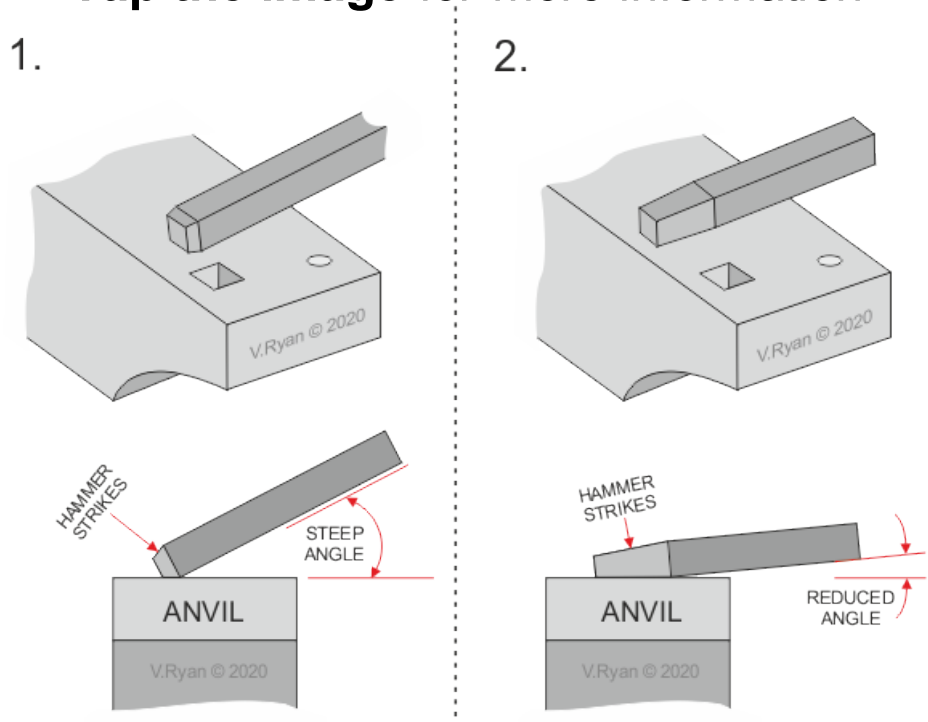


Tap the red button to return to the Contents page

DRAWING DOWN TO A TAPER

The techniques starts with heating the metal to an orange / yellow colour and placing it on the anvil face. A small chamfer is produced first, by striking all four edges of the bar, at the heated end. The metal is rotated to ensure all four edges are 'hammered'. The chamfer can be increased to produce a taper.

Tap the image for more information



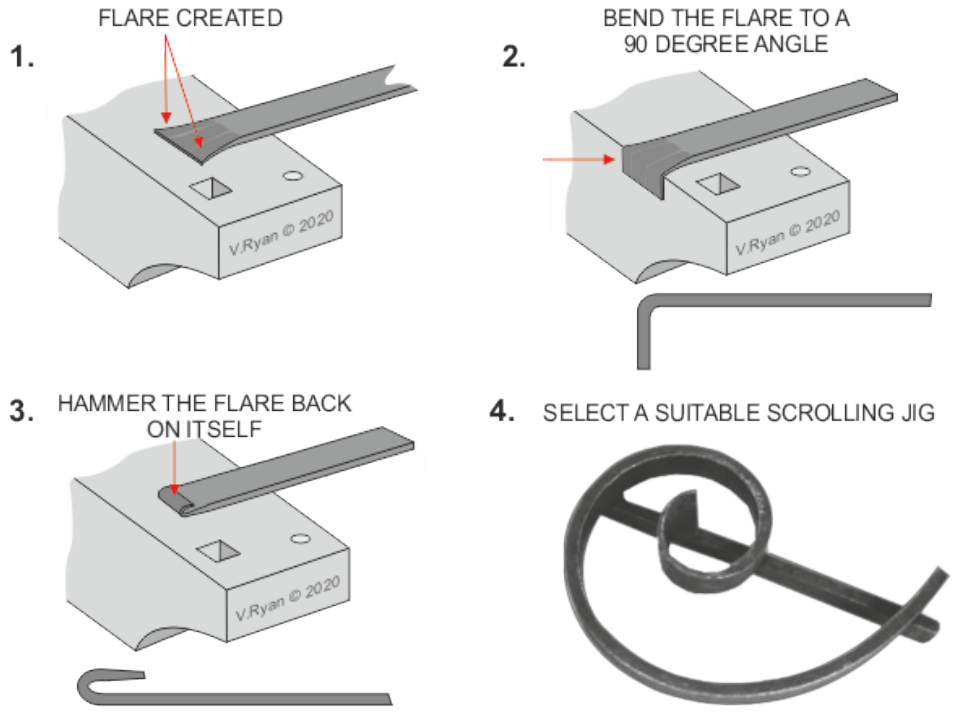
Tap the blue button for the next page.

Tap the red button to return to the Contents page

FORGING A FLARE AND A SIMPLE SCROLL

Flaring is a process whereby the end of the metal is drawn out, as seen in the diagram opposite. It is normally applied to flat metal strips and is often the first stage of creating decorative scroll work.

Tap the image for more information



Tap the blue button for the next page.

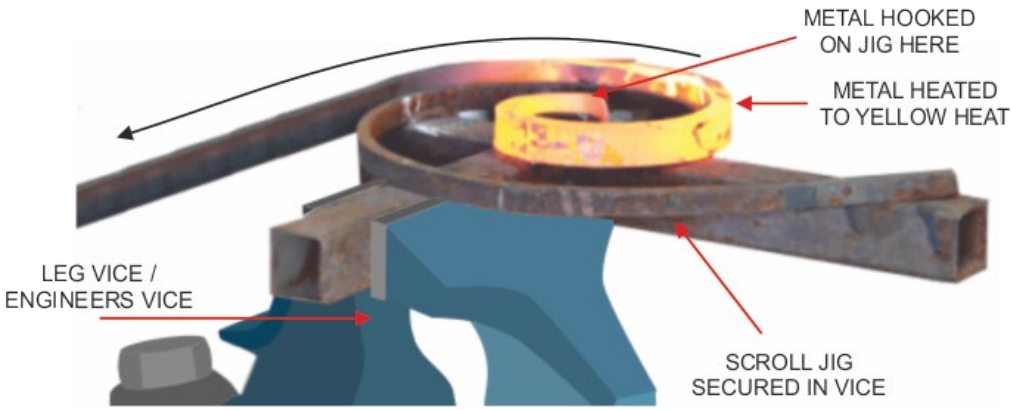
Tap the red button to return to the Contents page

FORGING A FLARE AND A SIMPLE SCROLL

5. SECURE THE SCROLLING JIG IN A VICE

The scrolling jig is placed in a vice. The 'hooked' area of the metal is heated in the forge and placed at the centre of the jig, on to which it 'hooks'. The Blacksmith pulls on the metal, pulling it round the jig.

Tap the image for more information



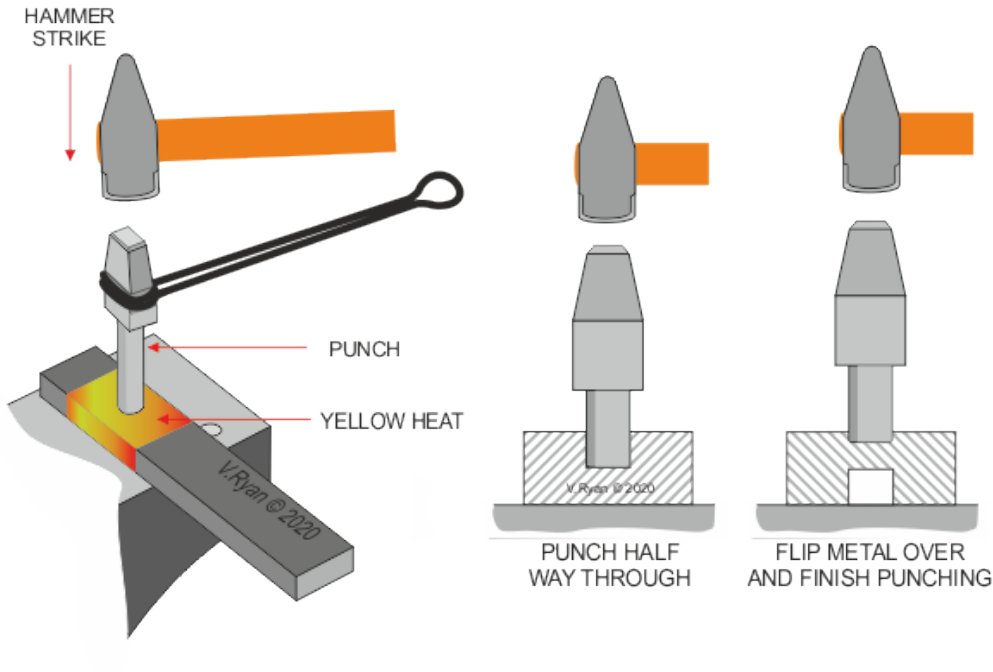
Tap the blue button for the next page.

Tap the red button to return to the Contents page

PUNCHING AND DRIFTING

Punches are used first to drive a hole through the metal being forged, followed by a drift, which smooths and is used to widen the 'hole'. The metal is heated to yellow heat, placed on the face of the anvil, and a punch is used to drive a hole, approximately half way through. The metal is flipped over and the metal is punched from the opposite side.

Tap the image for more information



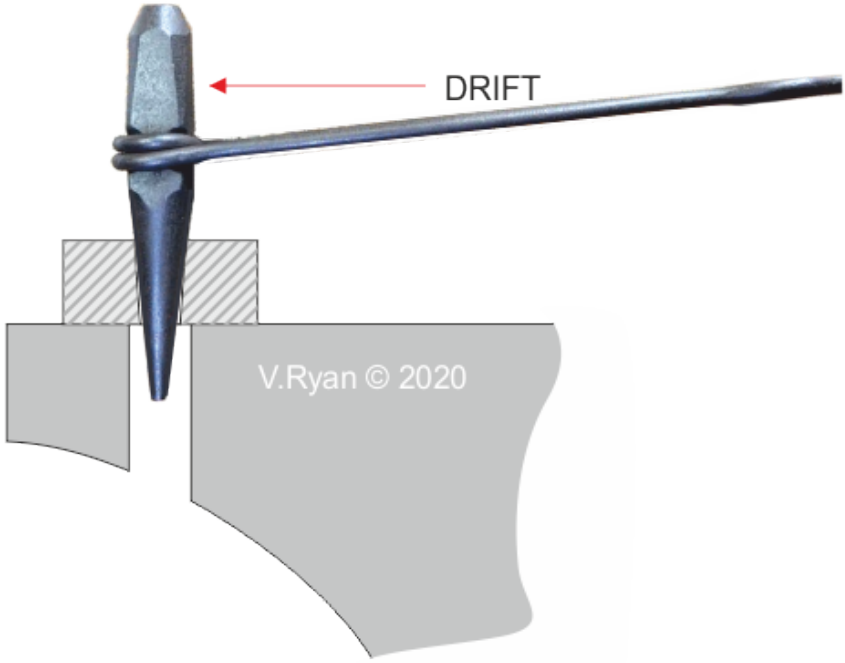
Tap the blue button for the next page.

Tap the red button to return to the Contents page

USING A DRIFT

The metal will need reheating, so that a drift can be used to widen the hole to the correct size. The drift will also produce a 'smooth' finish. Drifting' should be attempted over the punch hole of the anvil or using one of the holes through a swage block.

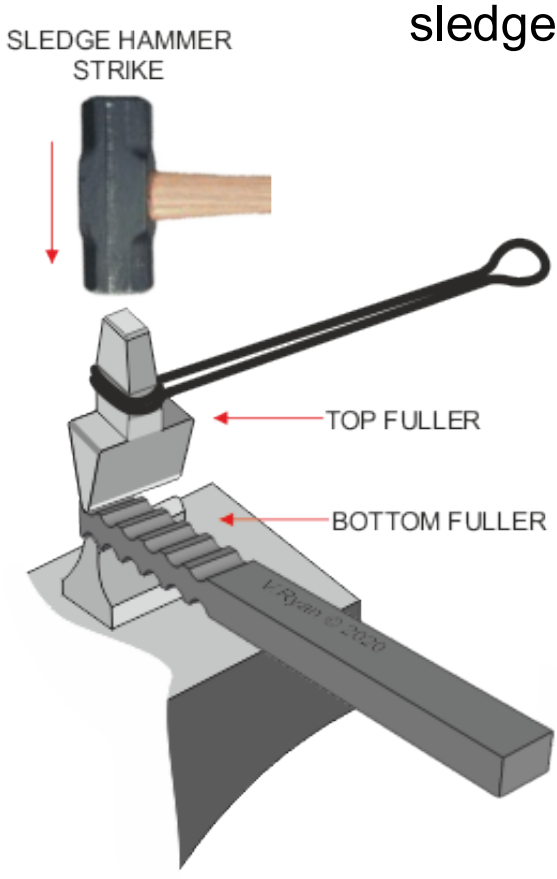
Tap the image for more information



Tap the red button to return to the Contents page

FULLERING

'Fullering' is the first stage of drawing down a section of steel. 'Drawing down' means, reducing the section size / thinning the section. This is normally a two person job. The bottom fuller fits in the hardie hole of the anvil and the top fuller receives strikes from a sledge.



Tap the image for more information

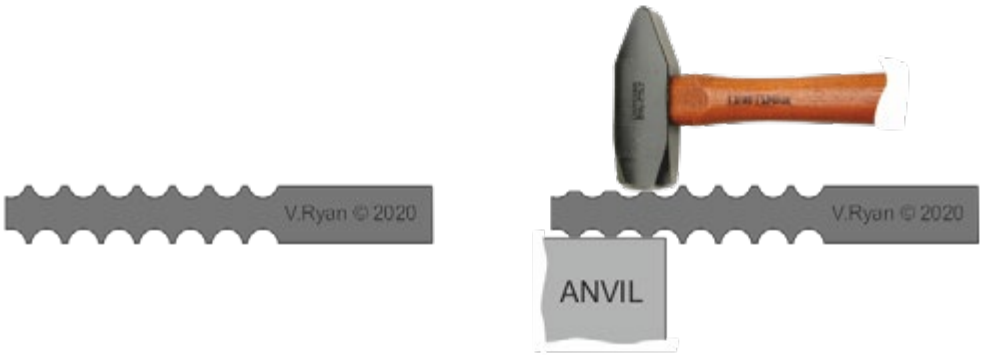
Tap the blue button for the next page.

Tap the red button to return to the Contents page

FLATTING (SETTING DOWN)

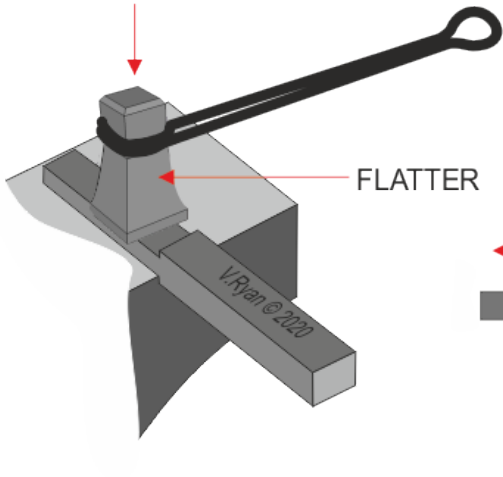
High spots hammered flat with a blacksmith's hammer, followed by the use of a flatter.

Tap the images for more information

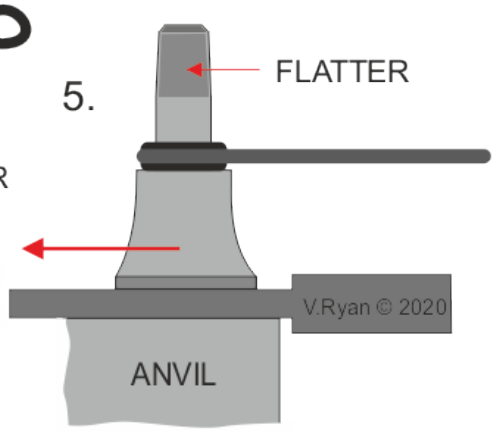


4.

Suitable 'flatter' used to complete the smooth finish.



5.



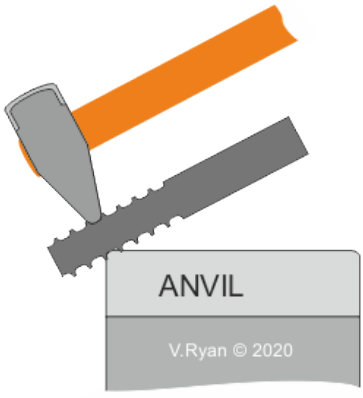
Tap the blue button for the next page.

Tap the red button to return to the Contents page

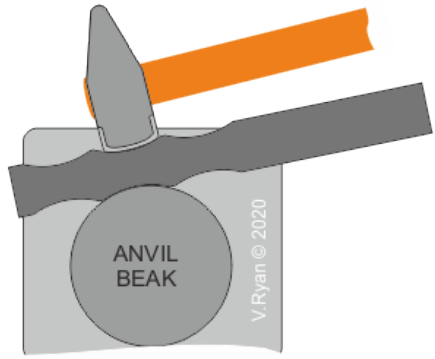
QUICK DRAWING DOWN

Drawing down can be achieved by one person, using the edge of the anvil (see diagram A).
The beak of the anvil can also be used (see diagram B).
In both cases shown here, a Blacksmith's hammer has been used.

Tap the image for more information



DIA. A



DIA. B

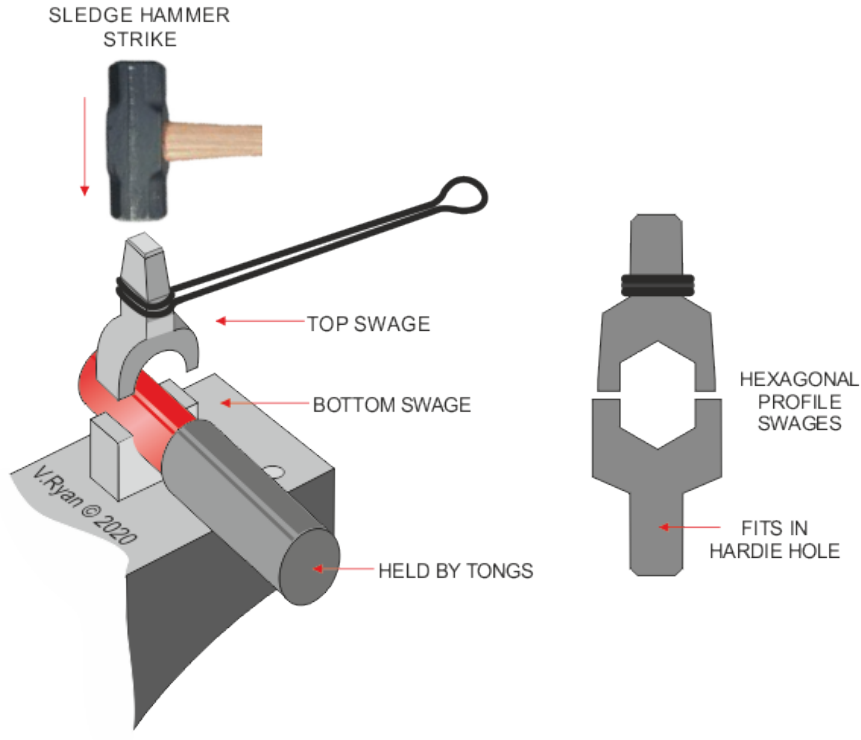
Tap the blue button for the next page.

Tap the red button to return to the Contents page

SWAGES

Round sections can be formed through the use of a set of swages. The pair shown below are capable of 'rounding' a section. Hexagonal sections can also be formed through the use of swages with an hexagonal profile. The bottom swage fits into the hardie hole of the anvil and the top swage, is hammered by a sledge.

Tap the image for more information



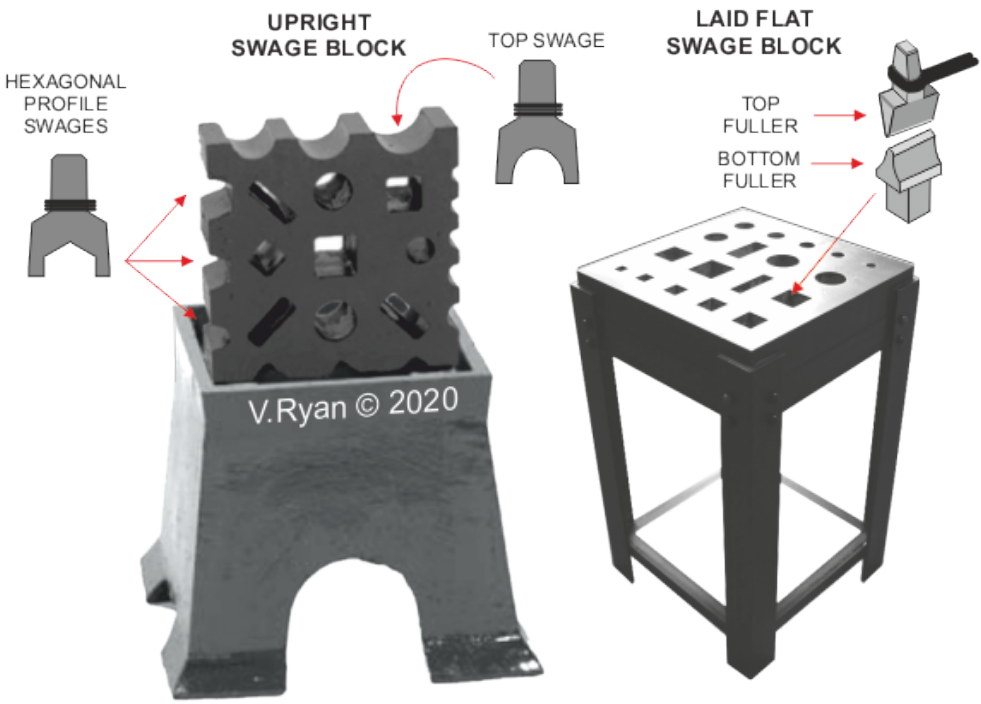
Tap the blue button for the next page.

Tap the red button to return to the Contents page

SWAGE BLOCKS

The edges of the swage block, have vee and half round notches and other profiles, and these are used to shape materials. When laid flat, a bottom fuller could be held in one of the square holes and a top fuller hammered from above. The holes are for holding lengths of various sections, whilst bending or deforming.

Tap the image for more information

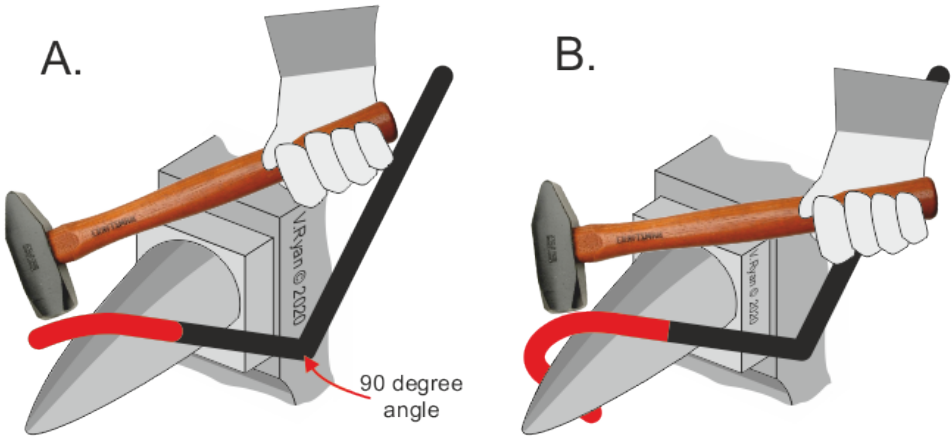


Tap the red button to return to the Contents page

FORGING AN EYE AND SIMPLE CURVES

Forming an ‘eye’ using the ‘bick’ of the anvil, is one of the first challenges, when learning the basics of forging. Round section steel (black mild steel or wrought iron), is being used to form an eye - see below. The same procedure is followed when forging square section steel.

Tap the image for more information

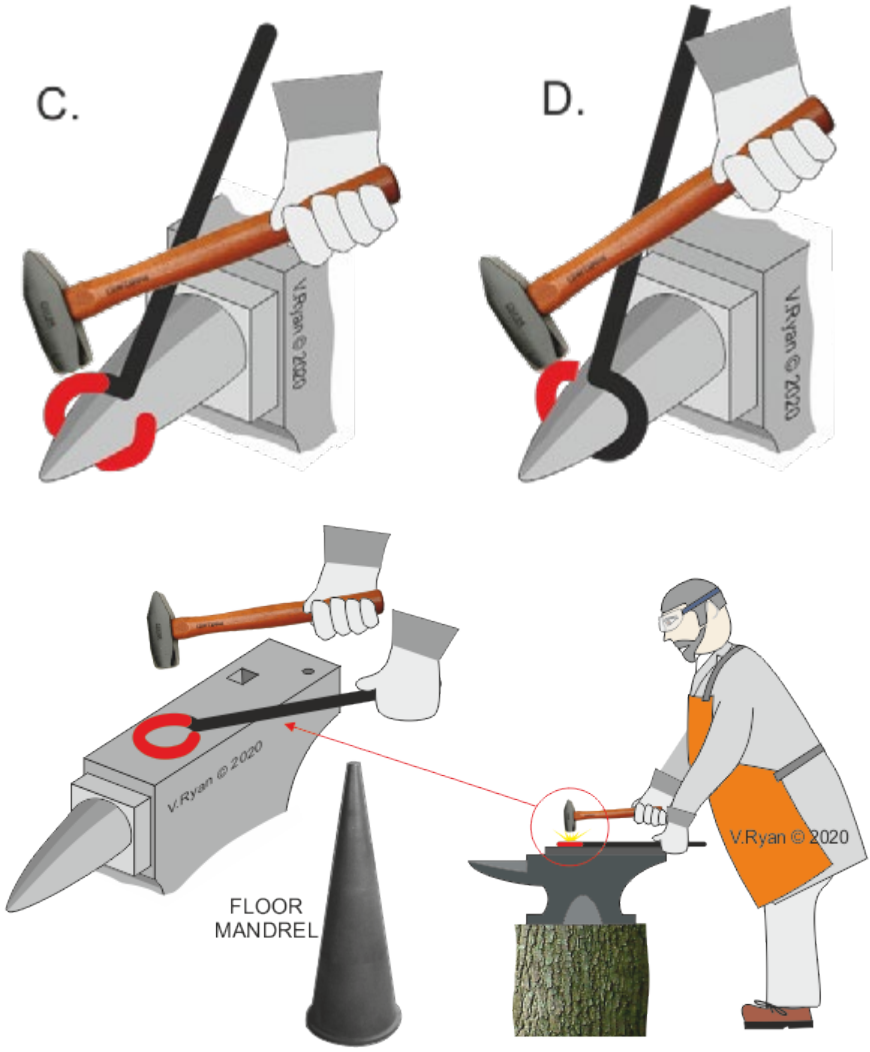


Tap the blue button for the next page.

Tap the red button to return to the Contents page

FORGING AN EYE AND SIMPLE CURVES

Tap the image for more information



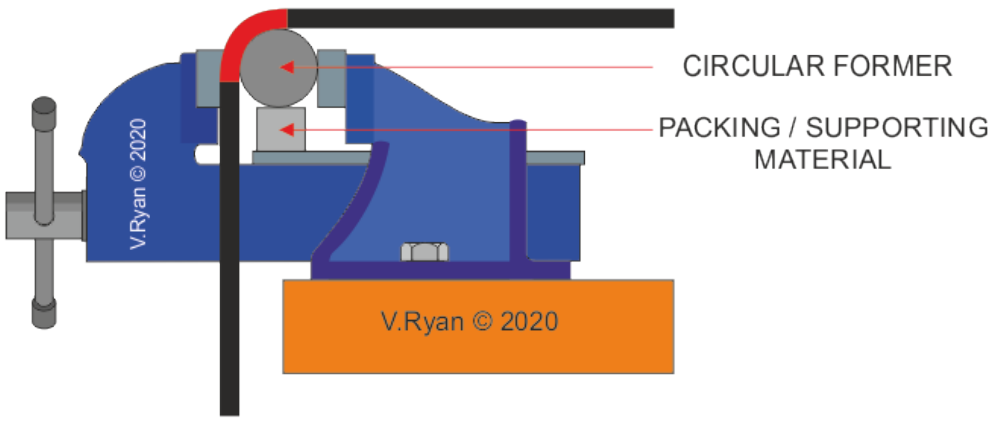
Tap the blue button for the next page.

Tap the red button to return to the Contents page

FORGING SIMPLE CURVES

Simple curves can be formed by heating the steel to red heat, in a forge or using a brazing hearth. The steel is then placed in a vice and forced round a circular former. Cold forming is possible when 'thinner' sections are being formed. A leg vice can be used for this process, if large sections of steel are being formed.

Tap the image for more information



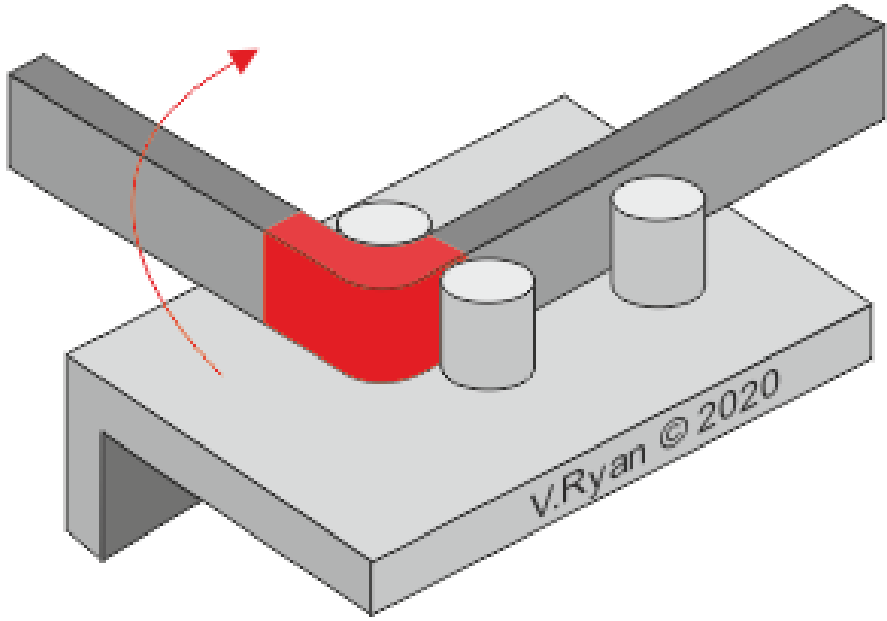
Tap the blue button for the next page.

Tap the red button to return to the Contents page

FORGING SIMPLE CURVES

This former / jig, manufactured from angle iron, is held securely in an engineer's vice. The steel to be formed is heated by a brazing hearth or in a forge. It is then transferred to the former and a little pressure applied, forming the 'bend'.

Tap the image for more information



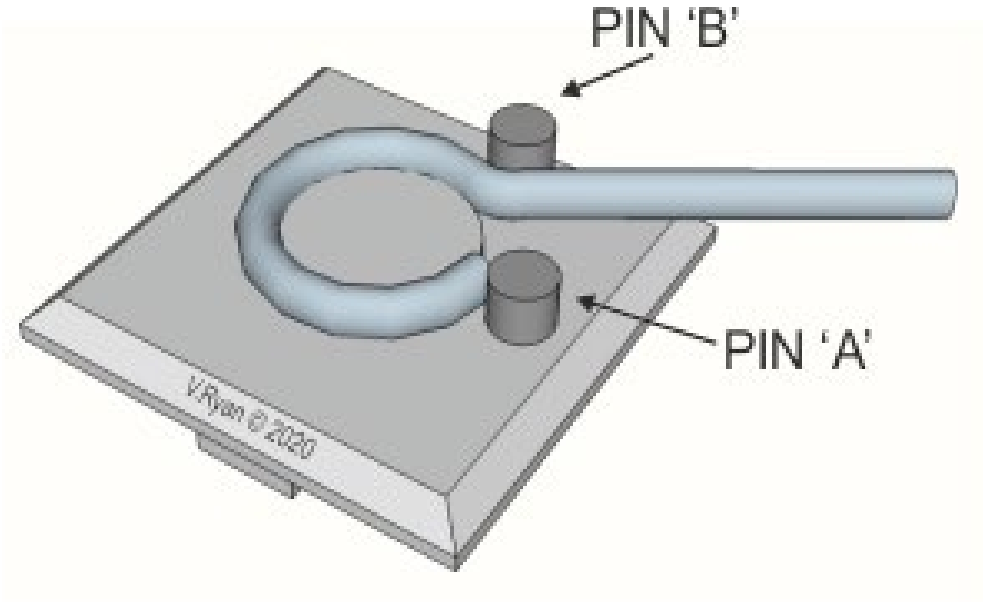
Tap the blue button for the next page.

Tap the red button to return to the Contents page

STAGES IN THE FORGING AN EYE USING A JIG / FORMER

To mass produce the same forged part, requiring an ‘eye’, would be time consuming. A simple but effective jig / former can be made, if there is a need to manufacture large numbers

Tap the image for more information



Tap the red button to return to the Contents page

CREATING A TWIST

Creating a twist in a length of steel, is a typical forging process, seen in many examples of Blacksmith's work, such as wrought iron gates and railings.

Thin sections can be twisted without the need to heat in a forge. However, larger sections need heating to red heat / yellow heat, and must be a uniform temperature, along the section to be twisted. The forge is the best way of ensuring a uniform temperature.

Tap the image for more information

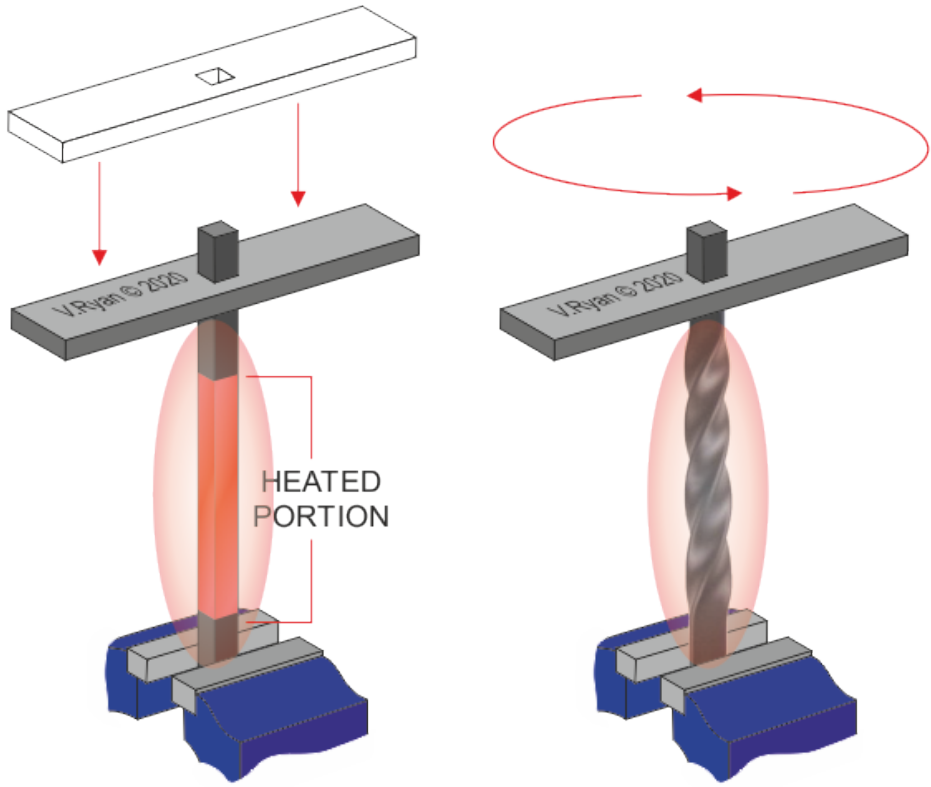
Tap the blue button for the next page.

Tap the red button to return to the Contents page

CREATING A TWIST

The steel is placed in a vice and a wrench slipped over the top. Homemade wrenches have a square hole, through which the steel fits. The wrench is then turned clockwise (or anticlockwise), usually one or two turns

Tap the image for more information



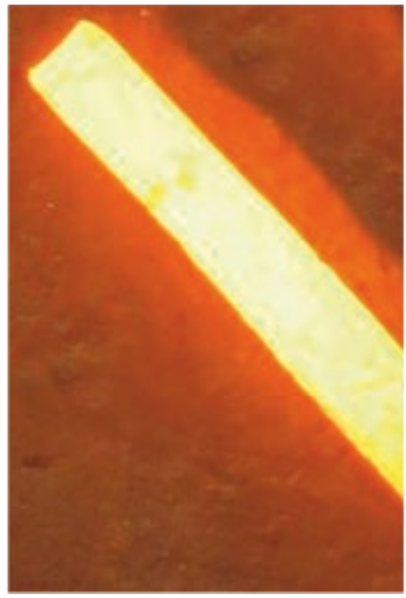
Tap the red button to return to the Contents page

WELDING THROUGH FORGING

Welding can be achieved through forging, by heating up both pieces to very high temperatures (white heat indicator colour) and then 'hammering' them together. Mild steel requires a slightly lower temperature, yellow heat approaching white heat. Getting the temperature right is very important.

Tap the image for more information

METAL A YELLOW / WHITE HEAT READY FOR WELDING



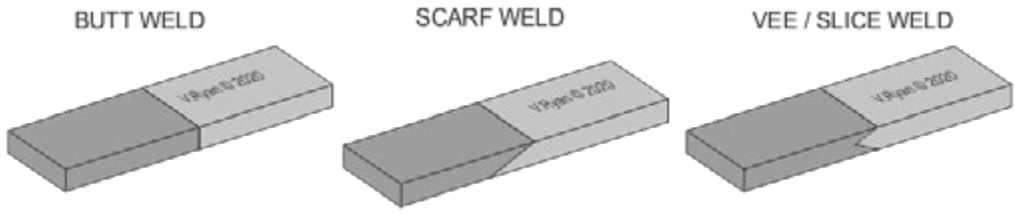
Tap the blue button for the next page.

Tap the red button to return to the Contents page

WELDING THROUGH FORGING

The welding process starts at the centre of the joint, with the Blacksmith working outwards. This displaces any slag / impurities. Working from the outside of the joint inwards, has the potential to lock in any impurities / slag, as hammering progresses. This could lead to poor and weak welded joint.

Tap the image for more information

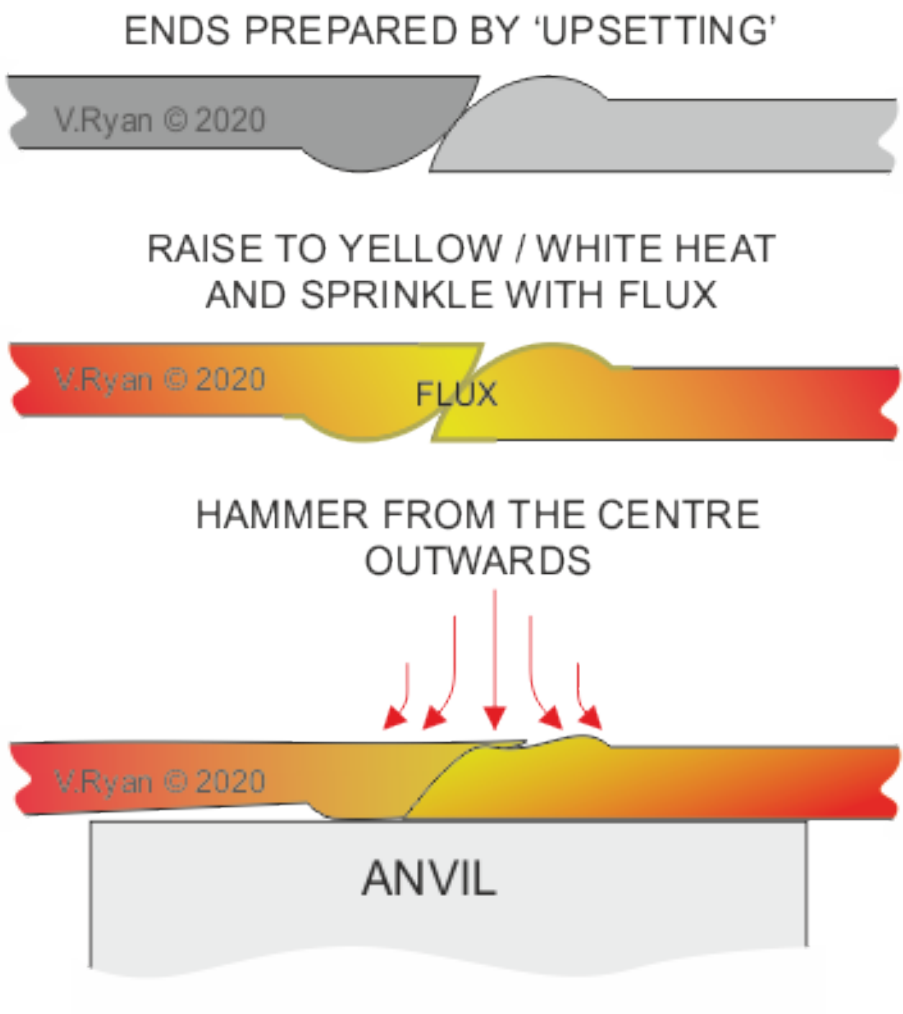


Tap the blue button for the next page.

Tap the red button to return to the Contents page

SCARF WELDING

Tap the image for more information



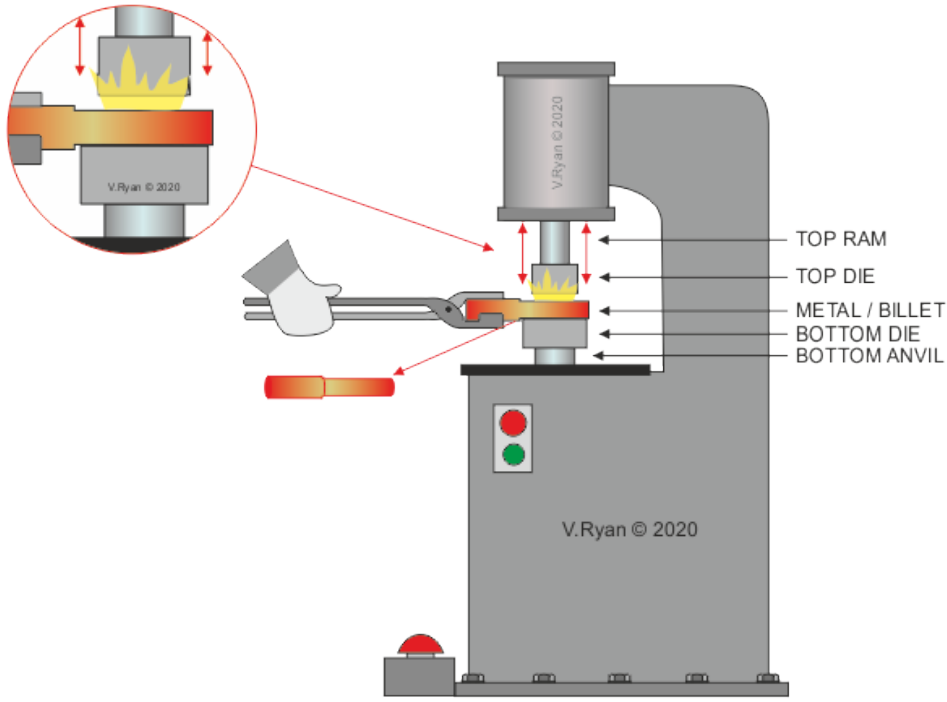
Tap the blue button for the next page.

Tap the red button to return to the Contents page

THE POWER HAMMER

The Blacksmith's Power Hammer, is extremely useful for repetitive processes such as drawing down, on larger pieces of work. The pneumatic hammer strikes the metal repeatedly, with force. The shapes of the top and bottom dies and the skill of the operator in manipulating the metal, determines the final shape of the metal.

Tap the image for more information



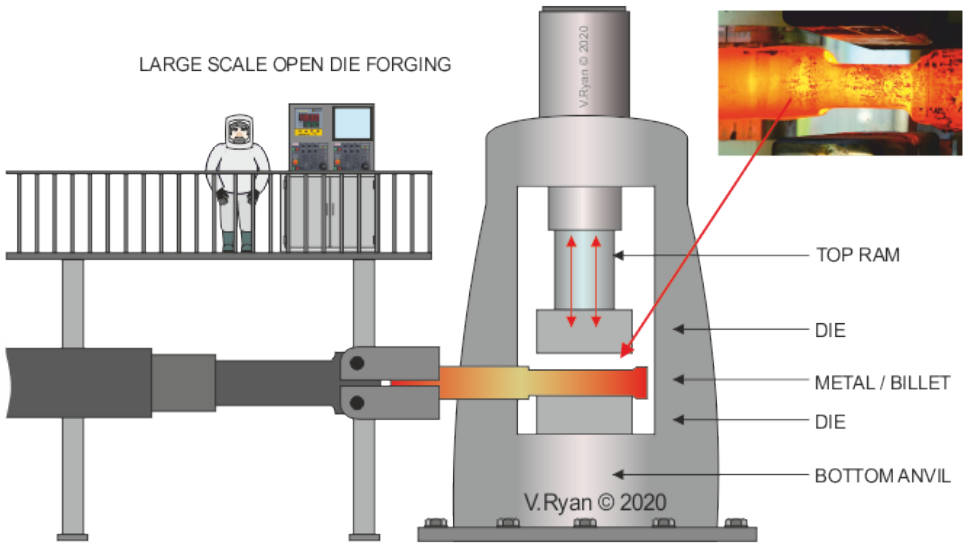
Tap the blue button for the next page.

Tap the red button to return to the Contents page

DROP FORGING OPEN DIE FORGING

Drop forging is a technique associated with the manufacture of cross-sections, shapes and forms. The metal is heated to 1000 - 1300 degrees centigrade. The work is shaped between the top ram and die AND the bottom anvil and die. As the top ram and die 'press' the metal against the bottom die.

Tap the image for more information



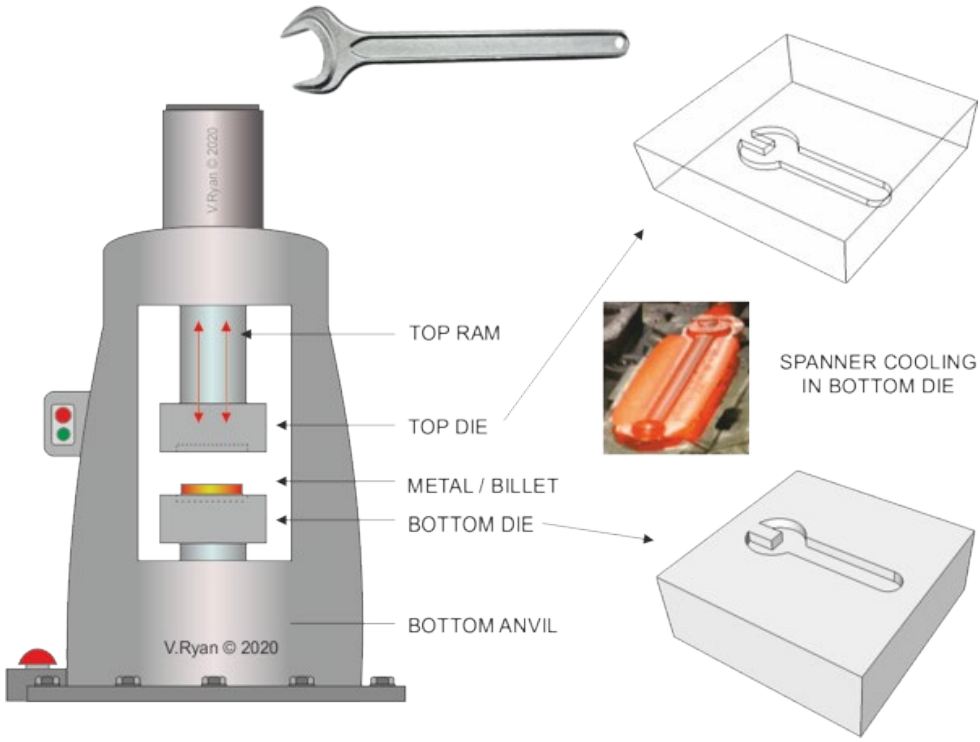
Tap the blue button for the next page.

Tap the red button to return to the Contents page

CLOSED DIE FORGING

The procedure starts with a metal billet being heated to yellow heat and placed in the bottom die. The ram of the drop forge then presses the top die directly over the bottom die, pressurising the billet. The billet takes the shape of the two dies.

Tap the image for more information



Tap the red button to return to the Contents page