Workshop Exercises Metal, Fundamental Skills, Part A

edited by H.N.C. Stam

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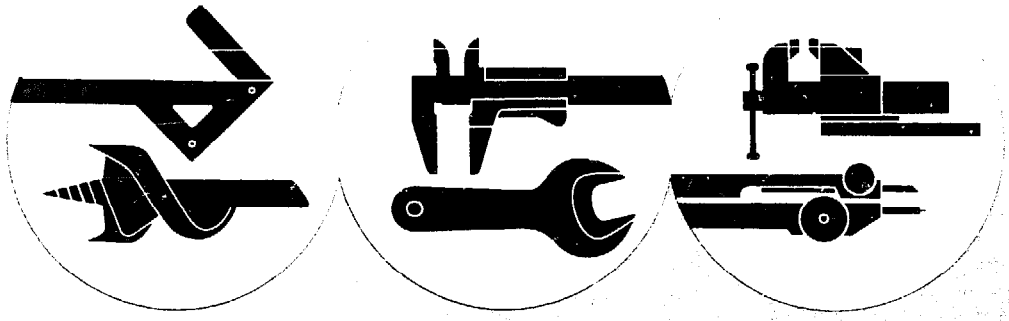

FUNDAMENTAL SKILLS

WORKSHOP EXERCISES METAL

PART A

INTEMS bv

inter-continental Technical Education, Materials & Services
The Netherlands

INTEMS PICTORIAL SYSTEM

WORKSHOP EXERCISES METAL

PART A

FUNDAMENTAL SKILLS

2nd edition

EDITOR-IN-CHIEF
ING. H.N.C. STAM

INTEMS bv

Inter-continental Technical Education, Materials & Services
The Netherlands

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INTRODUCTION

Intercontinental Educational Media B.V. was established in 1967 to meet the constantly growing demand for educational media suitable for use all over the world. The explosive development of technical education and modern teaching methods throughout the world has led to a rapid increase in the international exchange of learning approaches and educational media, especially books and other kinds of printed materials.

Technical and vocational education, in all its forms, will be progressively more important for balanced economic growth in all parts of the world. For many countries, industrialization is essential for a proper development of their manpower and natural resources.

Technical and vocational education is also an aspect of education that lends itself most readily to world-wide standardization. In general, tools and working methods are largely identical, despite the existence of special tools and techniques that may be peculiar to certain countries.
Experience in those industrially developing countries showing an increasing interest in technical education, and with a growing number of students, has made it clear that suitable learning aids, and in particular textbooks, are by no means easy to obtain.

Existing textbooks compiled for students in highly industrialized countries, are difficult to adapt to local circumstances and can seldom be fitted in with the programmes and curricula of other countries.

Collaboration in the field of international educational media was established with 'International Technical Education Media Services' (INTEMS), in order to develop adequate learning and teaching material for situations that differ in many respects from those in the industrialized world.

The Directorate of International Technical Assistance of the Netherlands Ministry of Foreign Affairs took a positive interest in this development and provided considerable financial support to the work.

The Technical Education Inspectorate of the Netherlands Ministry of Education and Science, in charge of technical assistance, especially in the field of technical education institutes collaborated closely on the editorial side of the material.

It is hoped that this new approach to teaching in Technical and Vocational Education will contribute to the expansion of his important aspect of economic and social development in many countries.

May 1975/October 1982

The editor-in-chief
H.N.C. Stam

SERIES TECHNOLOGY METAL

TECHNOLOGY METAL I

Part A: Fundamental skills
Part B: Workshop processes
Part C: Mechanisms, transmissions and fittings
Part D: Introduction to machine-tools
Part E: The workshop, organisation and maintenance

TECHNOLOGY METAL II

Part A: Hand and power tools for fitting
Part B: Limits and tolerances
Part C: Sheet-metal work
Part D: Machine tools
Part E: Soldering and welding
Part F: Forging
Part G: Pipe fitting and installation
Part H: Ferro materials

TECHNOLOGY METAL III

Part A: Turning
Part B: Milling
Part C: Shaping
Part D: Non-ferro materials

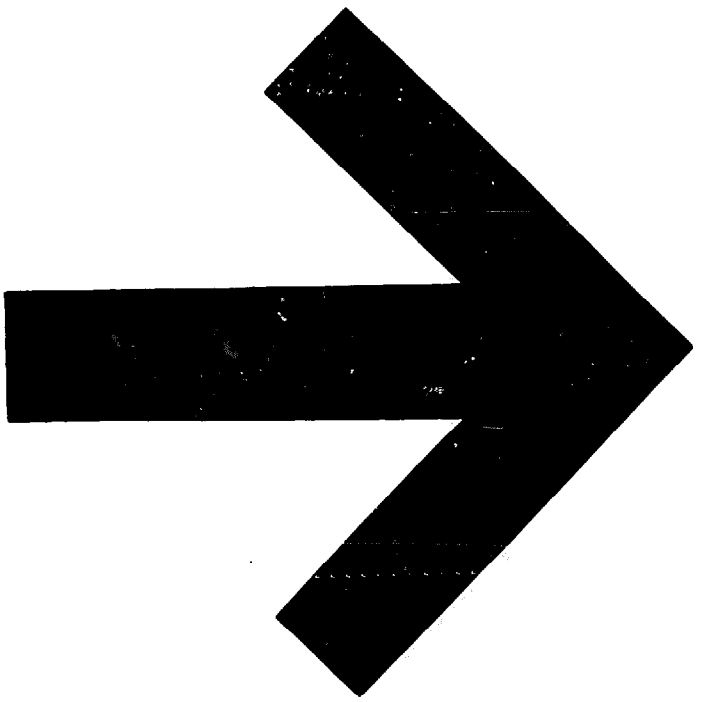
WORKSHOP EXERCISES METAL

Part A: Fundamental skills
Part B: Fitting
Part C: Sheet-metal work
Part D: Machining
Part E: Soldering and welding
Part F: Forging

OPERATION SHEETS METAL

OTHER VOLUMES OF ITEMS PICTORIAL SYSTEM

Automobile mechanics
Electricity
Technology wood
Workshop exercises wood
Safety
Technical drawing, blue-print reading and free-hand sketching
Workshop mathematics
Applied science and mathematics
Teaching outlines



WORKSHOP EXERCISES METAL

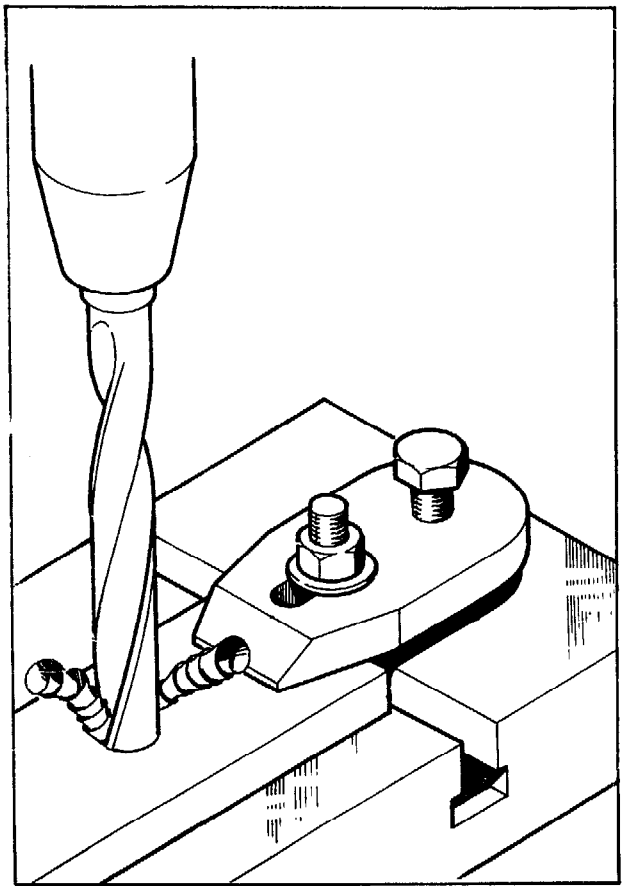
PART A: FUNDAMENTAL SKILLS

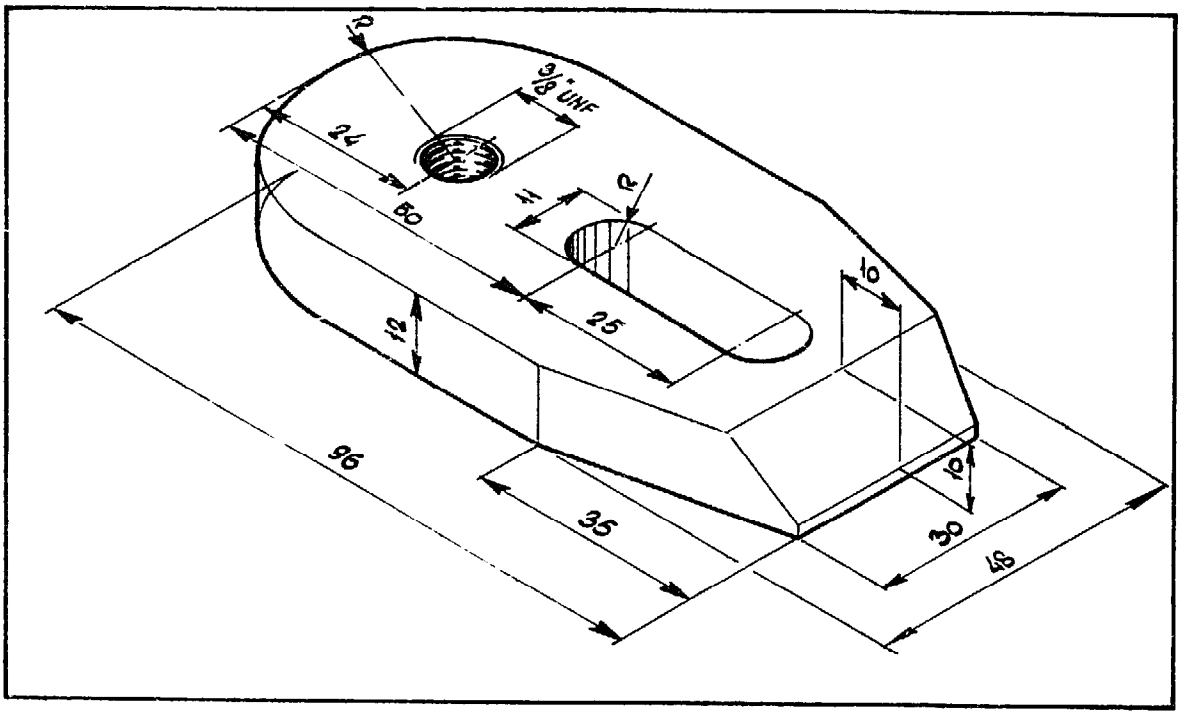
Contents

CLAMP

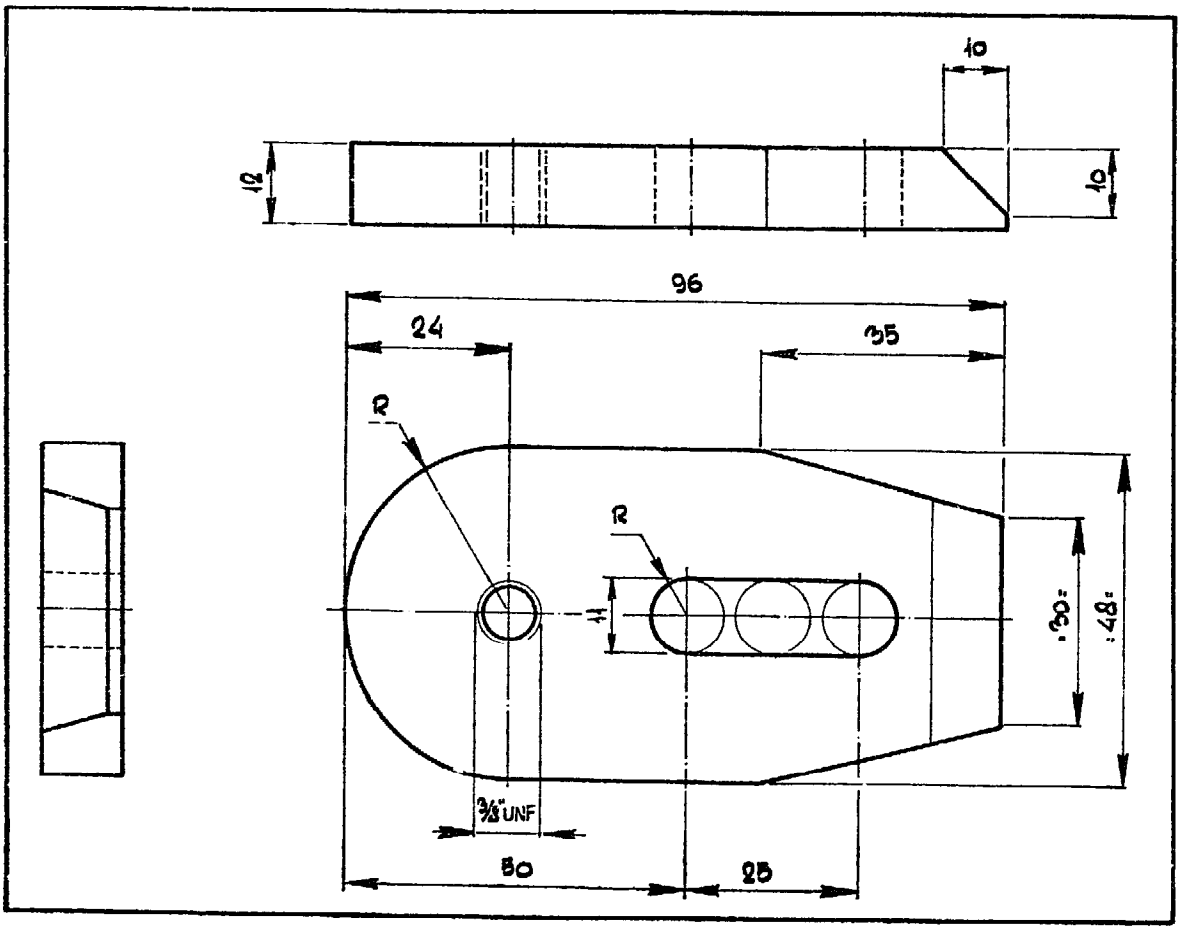
PICTOSTEPS

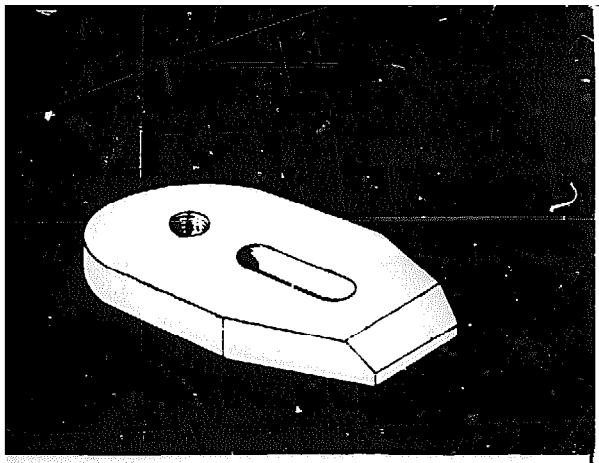
WORKSHOP INSTRUCTION METAL





NOTE : tolerance on all dimensions 0,5 mm





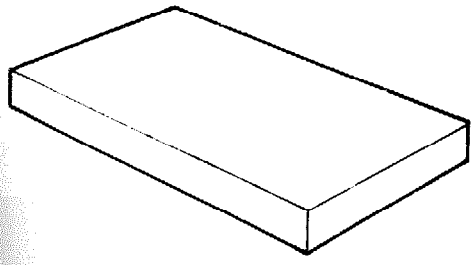
USE

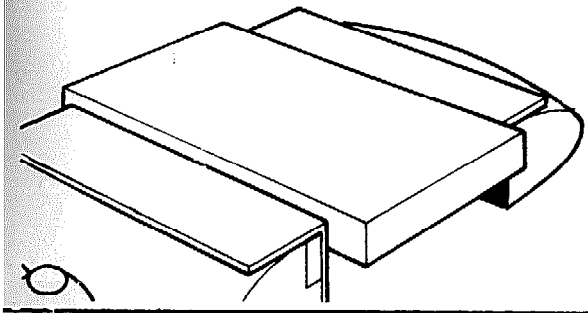
The clamp is used for holding the work on the table of a drilling or milling machine.

MATERIAL	DIMENSIONS
Mild steel	100 x 50 x 12.7 mm (4 x 2 x ½ in)

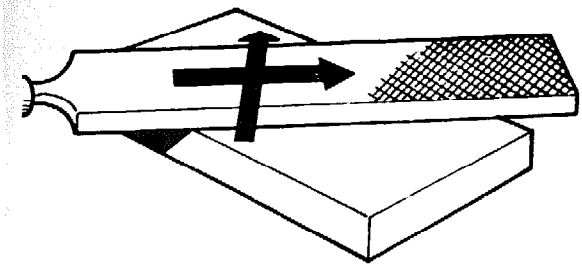
TOOLS

Blunt bastard file	Scriber
Try square	Rule
Outside callipers	Vice
Vernier callipers	Vice clamps
Steel straight edge	Chalk or varnish
Dividers	Stop block
Centre punch	Bevel
Engineers' hammer	Round file
Drilling machine	Saw frame
Threading tap	Saw blade
Tap wrench	Twist drill (8.5 mm)
	Twist drill (11 mm)

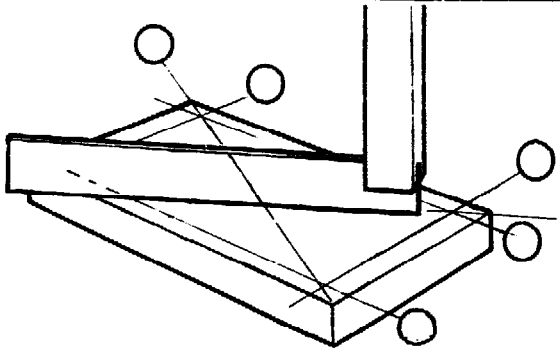




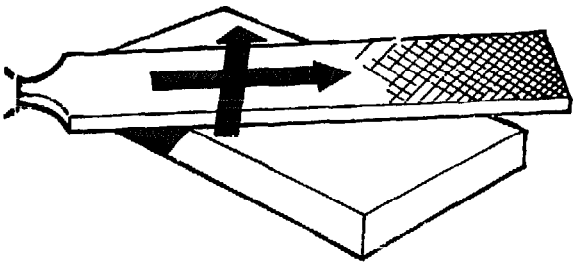
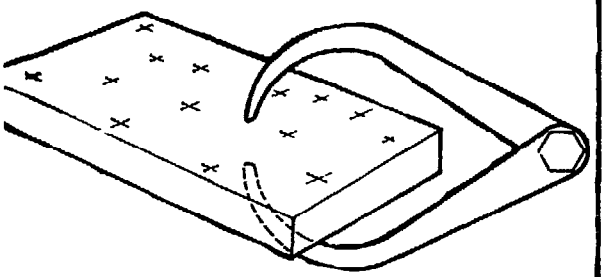
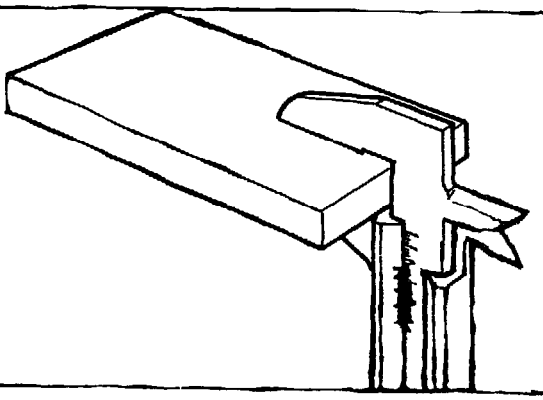
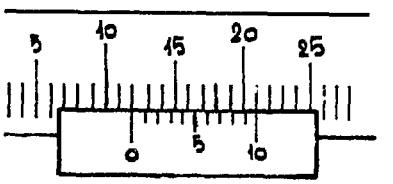
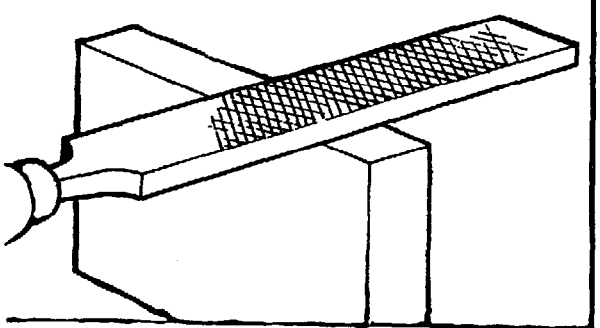
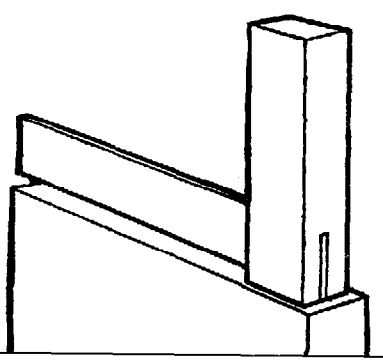
OPERATION	TOOLS
Holding.	Vice Vice clamps

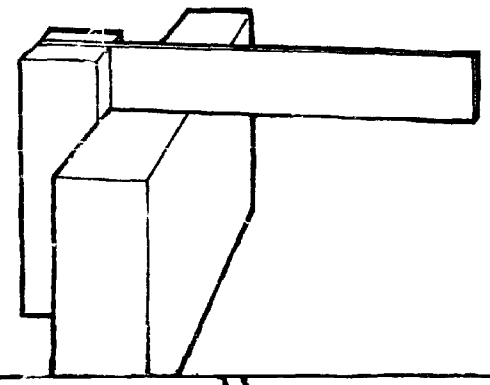
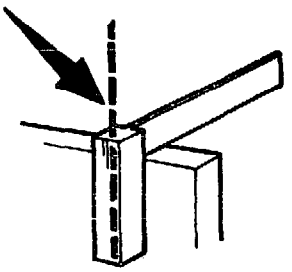
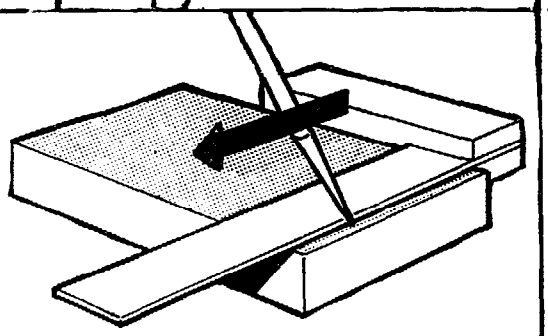
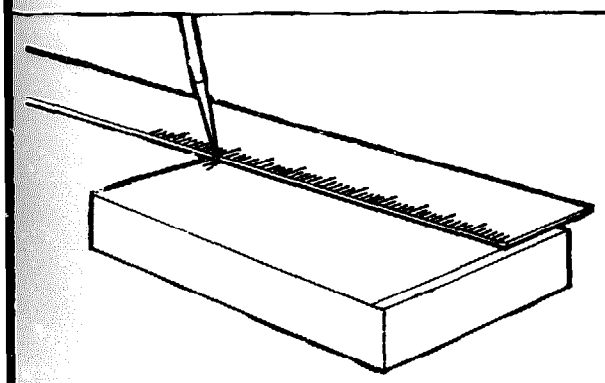
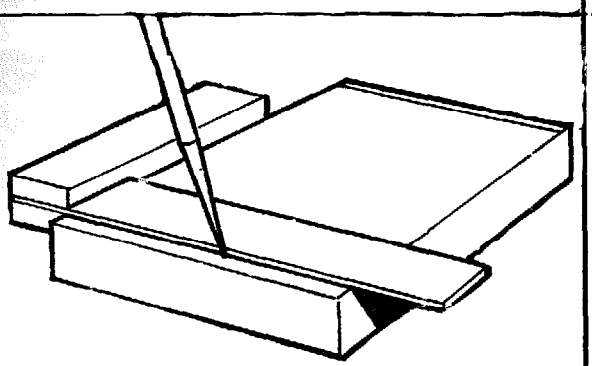
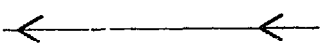
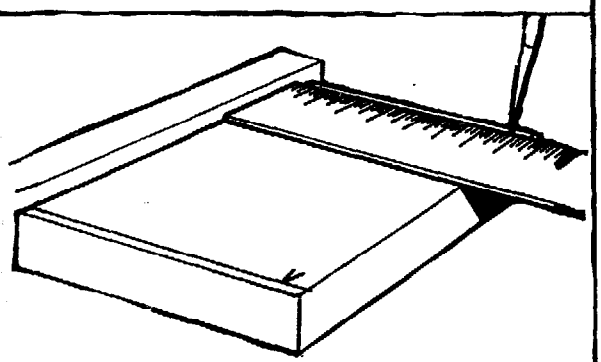


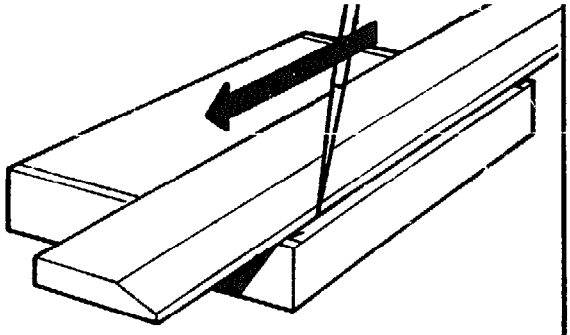
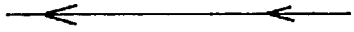
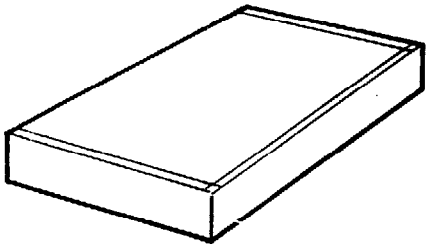
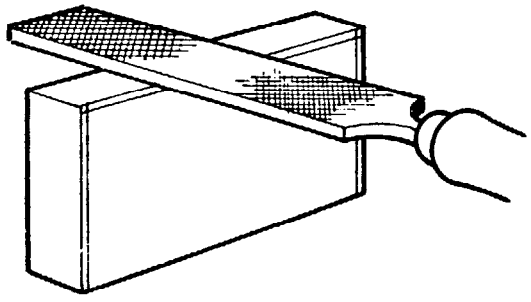
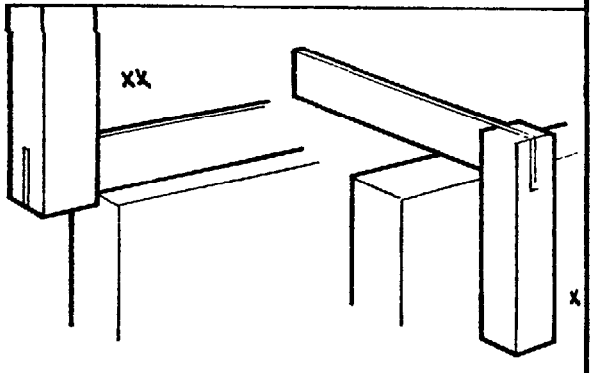
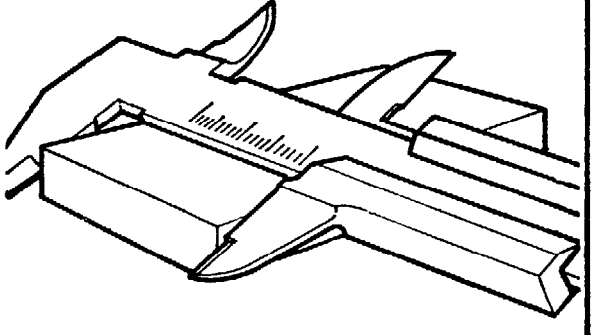
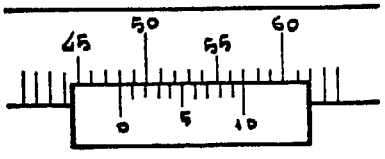
File flat and crosswise, i.e. after a few strokes in one direction reverse the action by filing in the other direction. Change directions regularly.	Blunt bastard file

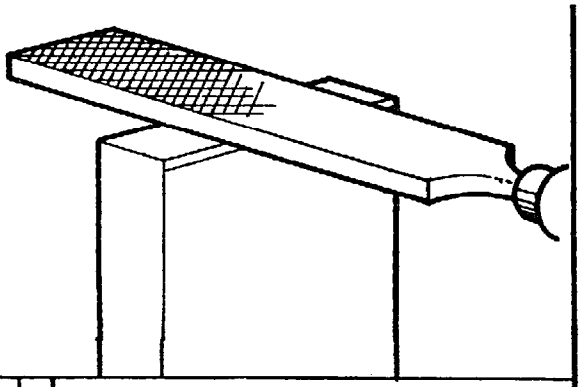


Test for flatness in every direction. Direction of testing.	Try square

	Turn work. File flat to 12 mm thickness. File crosswise. Change direction regularly.	Blunt bastard file.
	Test on even thickness all over surface.	Outside calipers.
	Test on correct thickness: 12 mm. *Reading:* 	Vernier calipers.
	File one long end flat, straight and square.	Blunt bastard file.
	Test flatness of this side.	Try square.

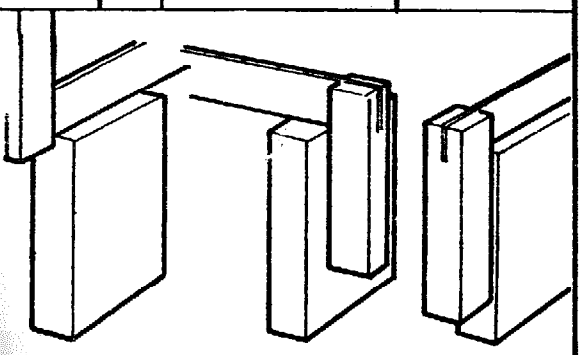
	Test this side on squareness. Keep try square at right angles to side. 	Try square.
	Apply chalk or varnish. Draw line at right angles to finished side nearest to edge.	Chalk or Varnish. Try square. Scriber.
	Mark a distance of 96 mm from scribed line. Place V-mark with point exactly at 96. 	Rule. Scriber.
	Square line across at distance marked. Draw line exactly through point of V-mark. 	Try square. Scriber.
	Mark distance of 48 mm on both lines. Place V-mark with point exactly at 48. 	Stop block. Rule. Scriber.

	Scribe line through both V-marks. Draw line exactly through points of V-mark. 	Steel straight edge. Scriber.
	Marked out result.	
	File long side to line. Remove any filings.	Blunt bastard file
	Test on squareness (x) and on flatness and straightness (xx).	Try square.
	Test width: 48 Reading: 	Vernier calipers.



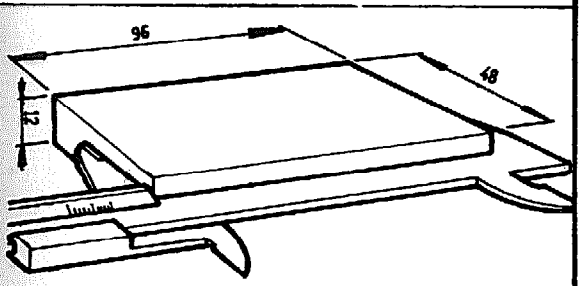
File the two short sides until they are truly flat, straight and parallel.

Blunt bastard file.



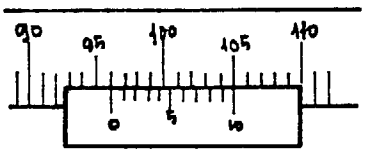
Test on squareness to other sides.

Try square.

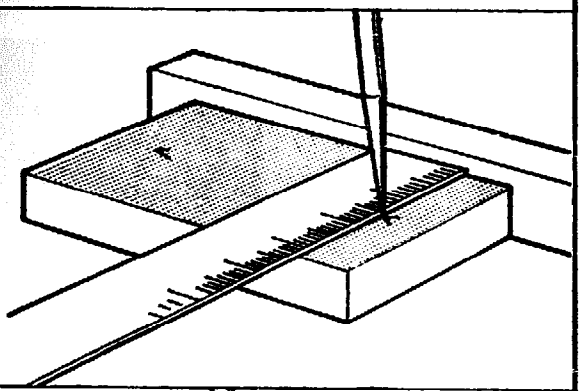


Result: total length = 96 mm

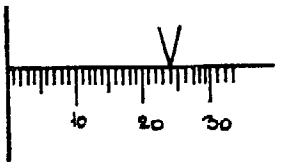
Reading:



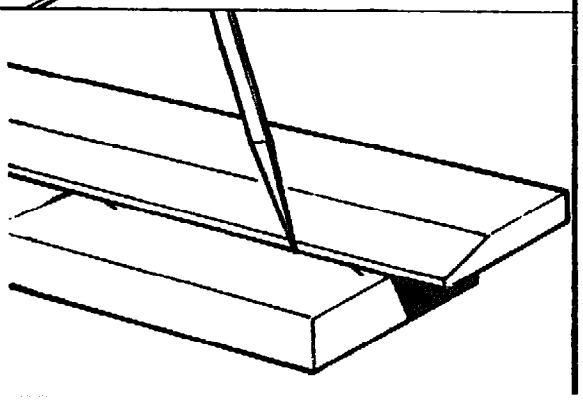
Vernier calipers.



Mark 24 mm from edge at two places.
Do not forget to chalk or varnish.
Put V-mark with point exactly at 24.

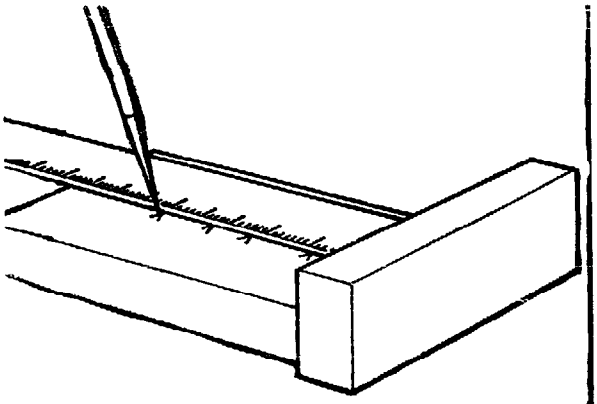


Stop block.
Rule.
Scriber.

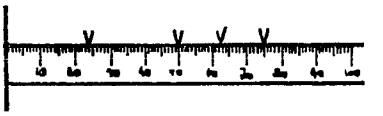


Draw line exactly through V-marks.
This is the centre line.
A centre line is sometimes also called: datum line.

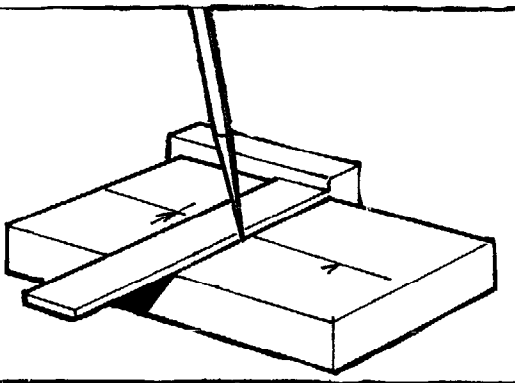
Steel straight edge.



Mark 4 V-marks on this line at distances of 24 mm, 50 mm, 62.5 mm and 75 mm from one short edge.

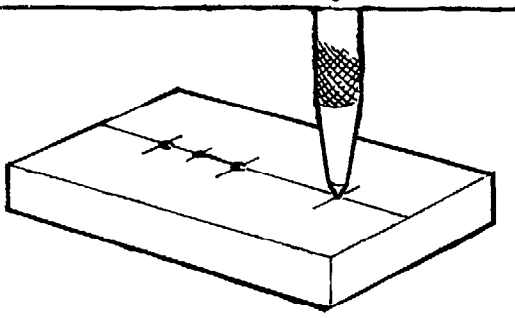


Stop block.
Rule.
Scriber.



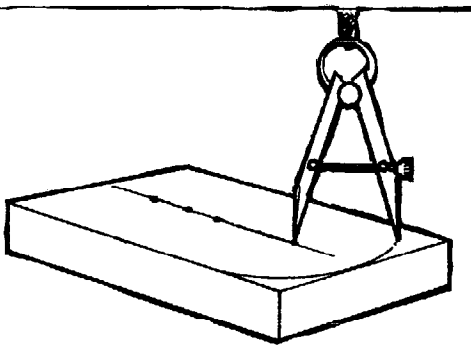
Scribe short lines through these four points.

Try square.
Scriber.



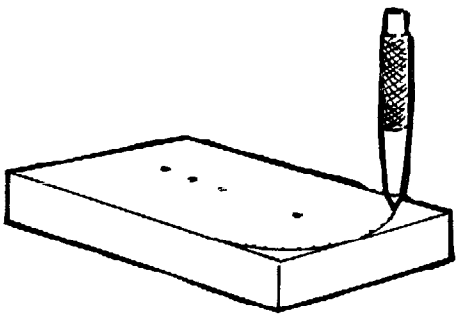
Centre punch at intersections.
Put centre punch at angle for finding exact positions.
Keep upright when hitting.

Centre punch.
Hammer.



Mark out half circle tangent to three edges.
Take 24 mm point for centre.

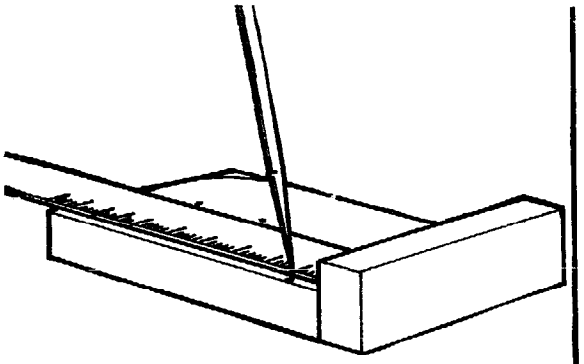
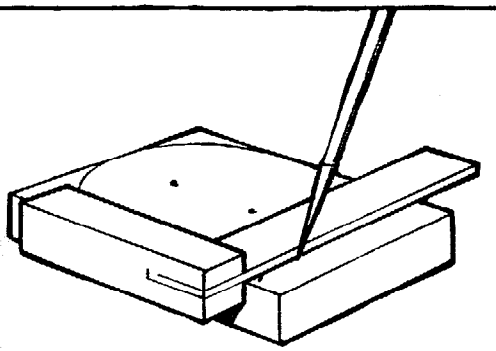
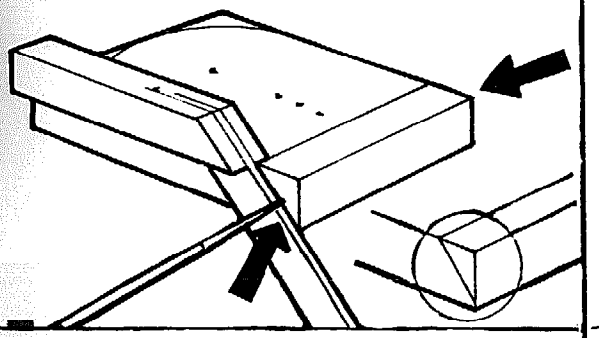
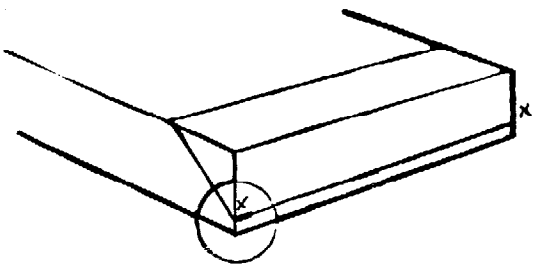
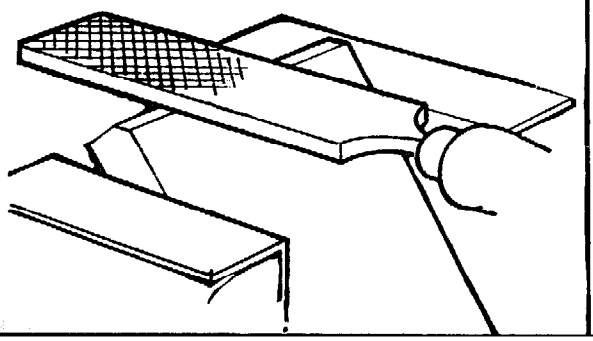
Dividers.

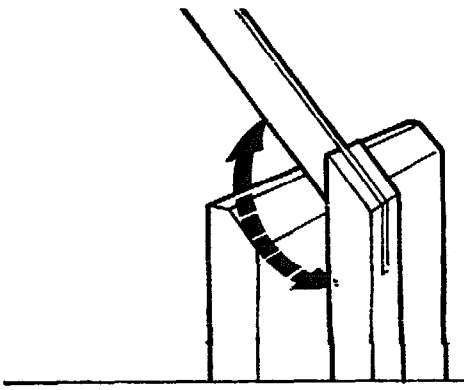
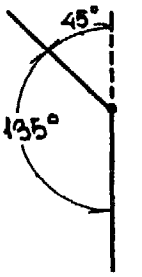
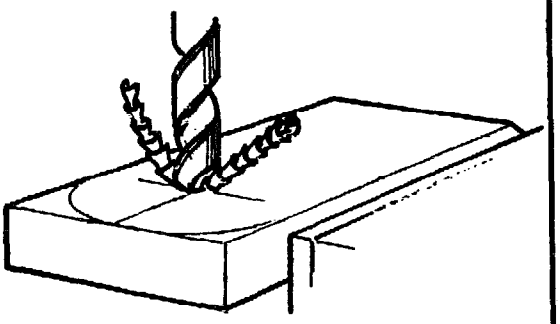
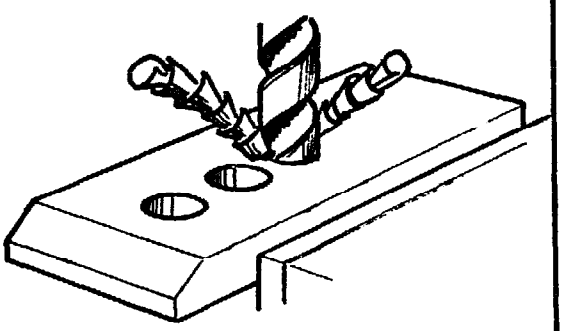
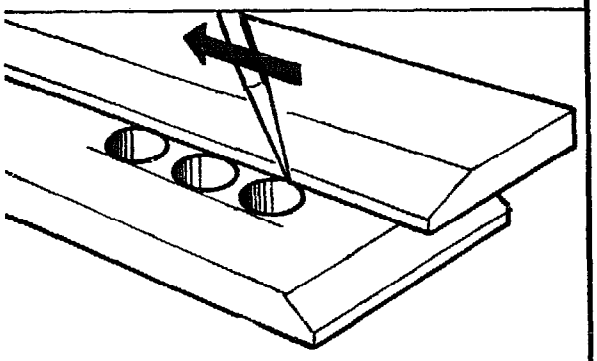
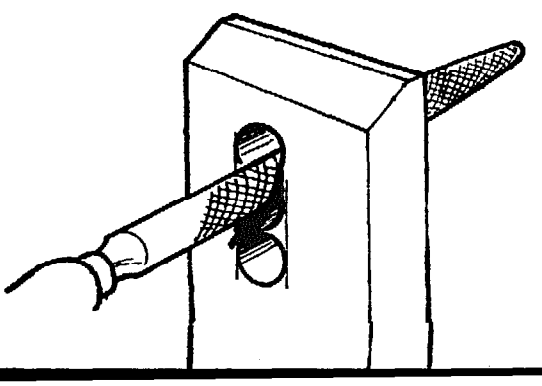


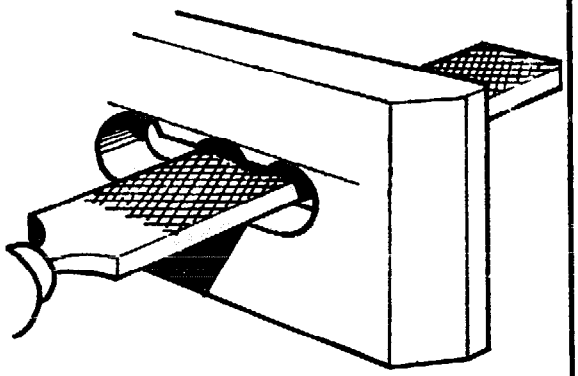
Dot-punch to make circle permanent.

Punched dots should be very light.

Centre punch.
Hammer.

	Mark distance of 10 mm from opposite edge. Marking: 	Stop block. Rule. Scriber.
	Square line across at this distance.	Try square. Scriber.
	Mark angle line on long sides using a 45 deg. bevel. Do this on both sides.	Bevel. Scriber.
	On short side scribe line connecting intersections of angle lines with edges.	Try square. Scriber.
	File to scribed line. (Work in vice held at angle).	Vice. Blunt bastard file.

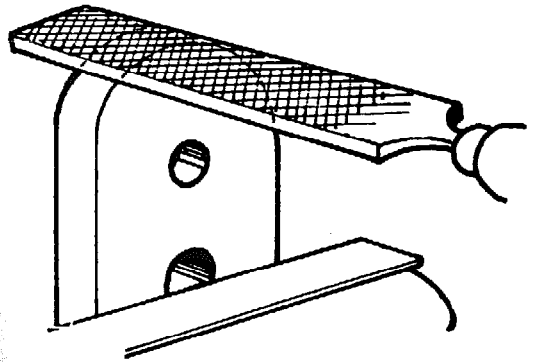
	Test angle. Angle 135°. 	Bevel.
	Drill 8.5 mm hole in centre of scribed line. Use cutting lubricant.	Drilling machine. 8.5 mm Twist drill. Vice clamp (machine vice).
	Drill three 11 mm holes in remaining drill centres.	Drilling machine. 11 mm Twist drill. Vice clamp (machine vice).
	Scribe two lines tangent to drilled holes.	Steel straight edge Scriber.
	File slot.	Round file.



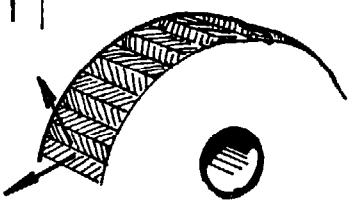
Finish slot.

Edges and arcs should connect accurately.

Blunt bastard file.

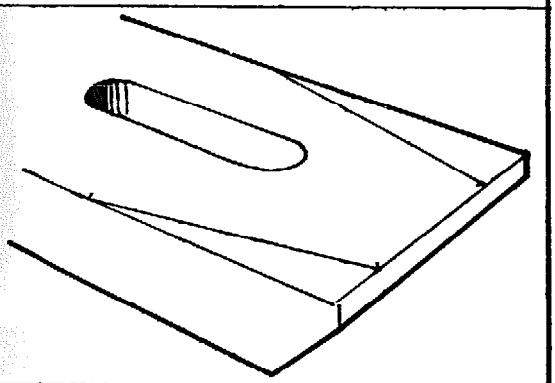


File to shape, rough shape first.

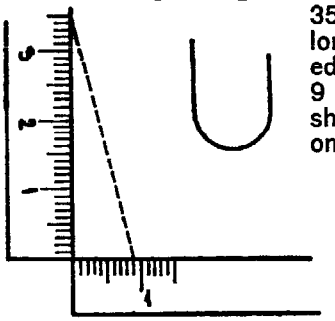


File flats in different directions.

Blunt bastard file.

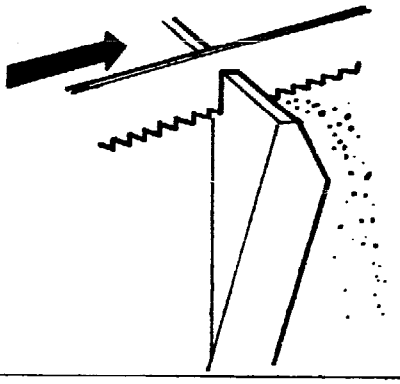


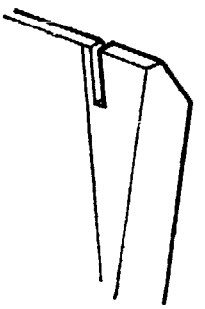
Mark out angled edges.



35 mm on long edges, 9 mm on short ones.

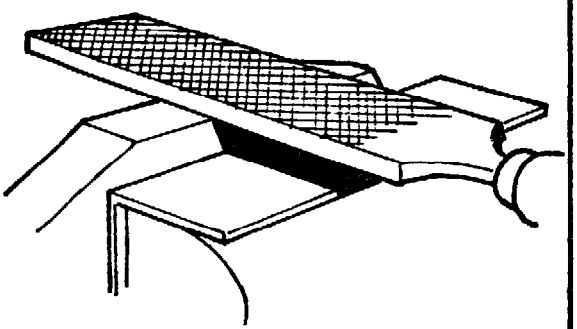
Rule.
Scriber.
Steel straight edge.





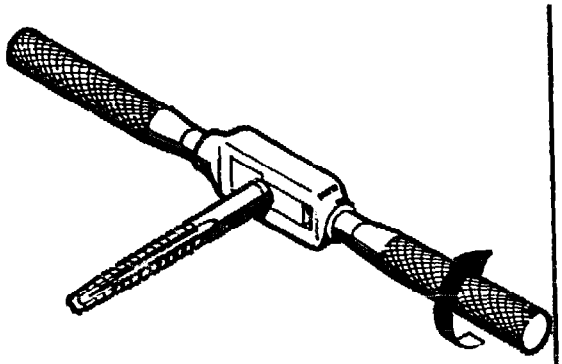
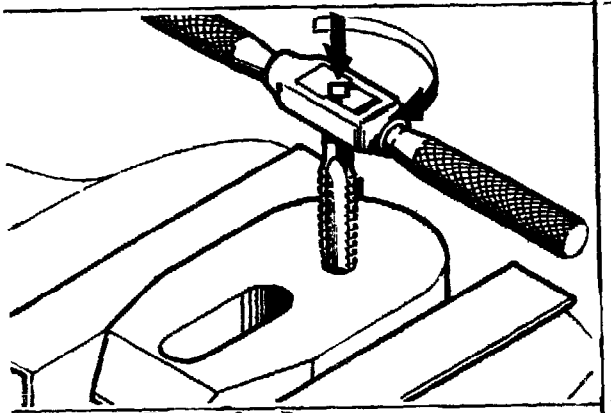
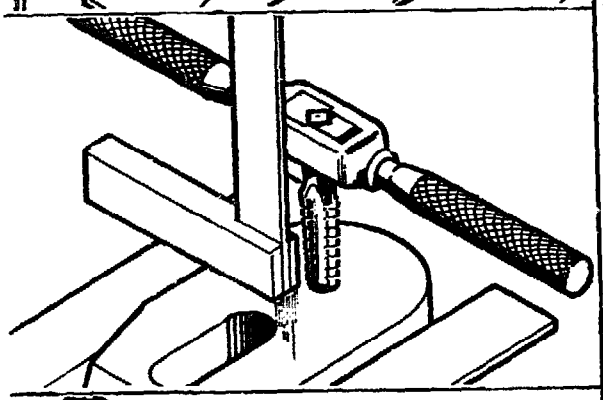
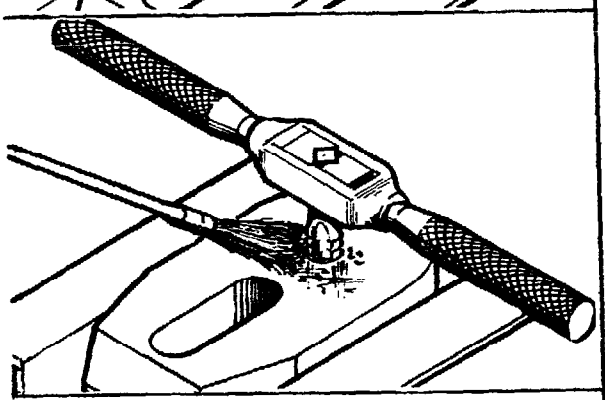
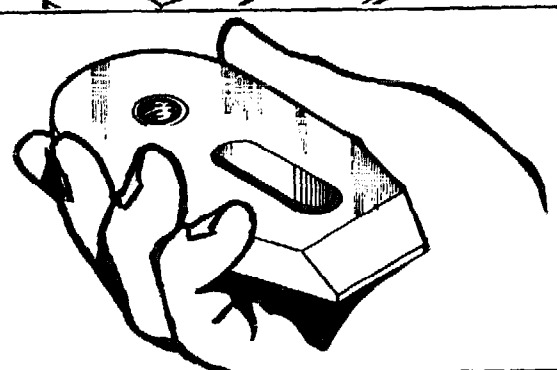
Saw off corners. Saw on outside line, leaving the latter on the work.

Saw frame.
Saw blade.



File to line.

Blunt bastard file.

	Put Nr. 1 tap in wrench. Tighten securely.	Nr. 1 Tap (3/8" UNF). Wrench.
	Start with a few turns in the hole. Turn clockwise, applying slight pressure.	Nr. 1 Tap. Wrench.
	Test tap on being accurately at right angles to work.	Nr. 1 Tap. Wrench. Try square.
	Tap through work. Apply the right cutting lubricant. If tap sticks turn slightly backward. Release pressure.	Nr. 1 Tap. Wrench. Brush.
	WORK IS FINISHED.	

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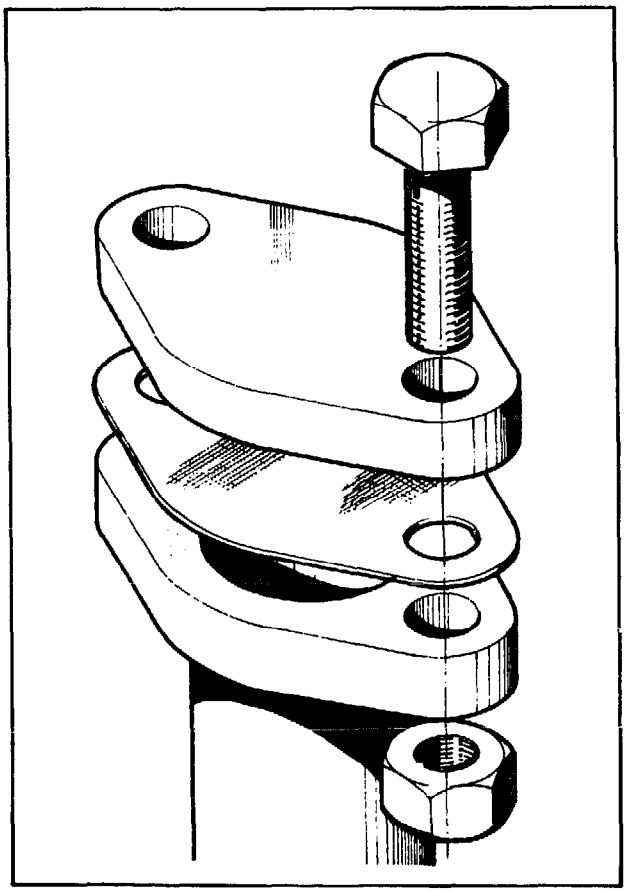
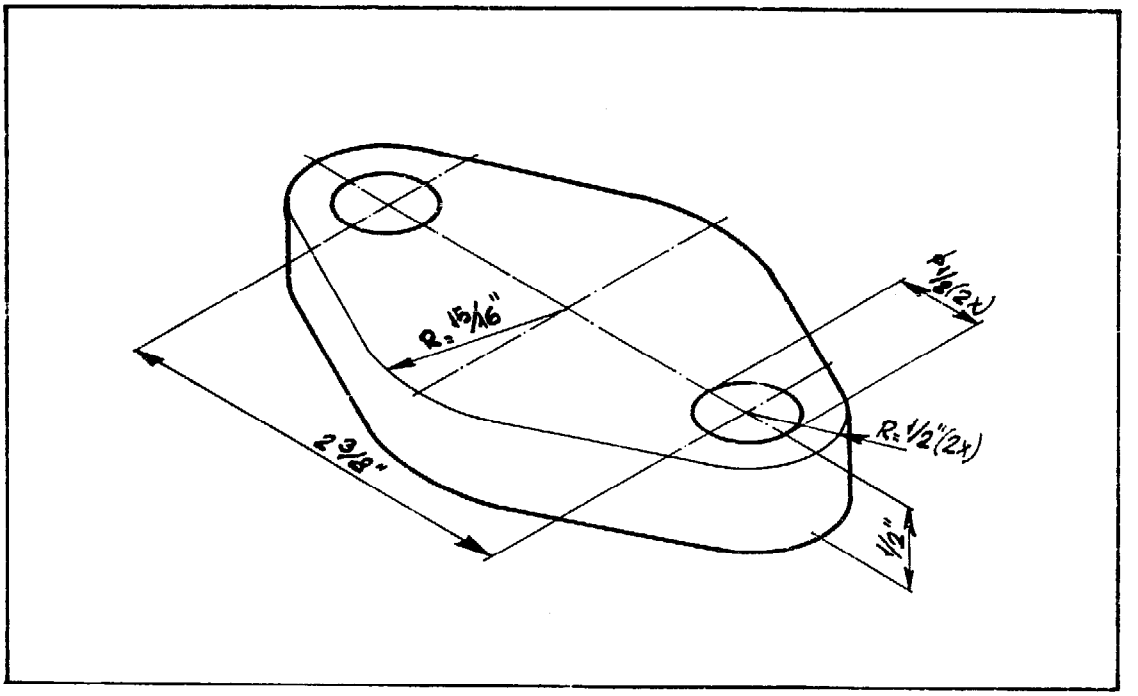
BLIND FLANGE

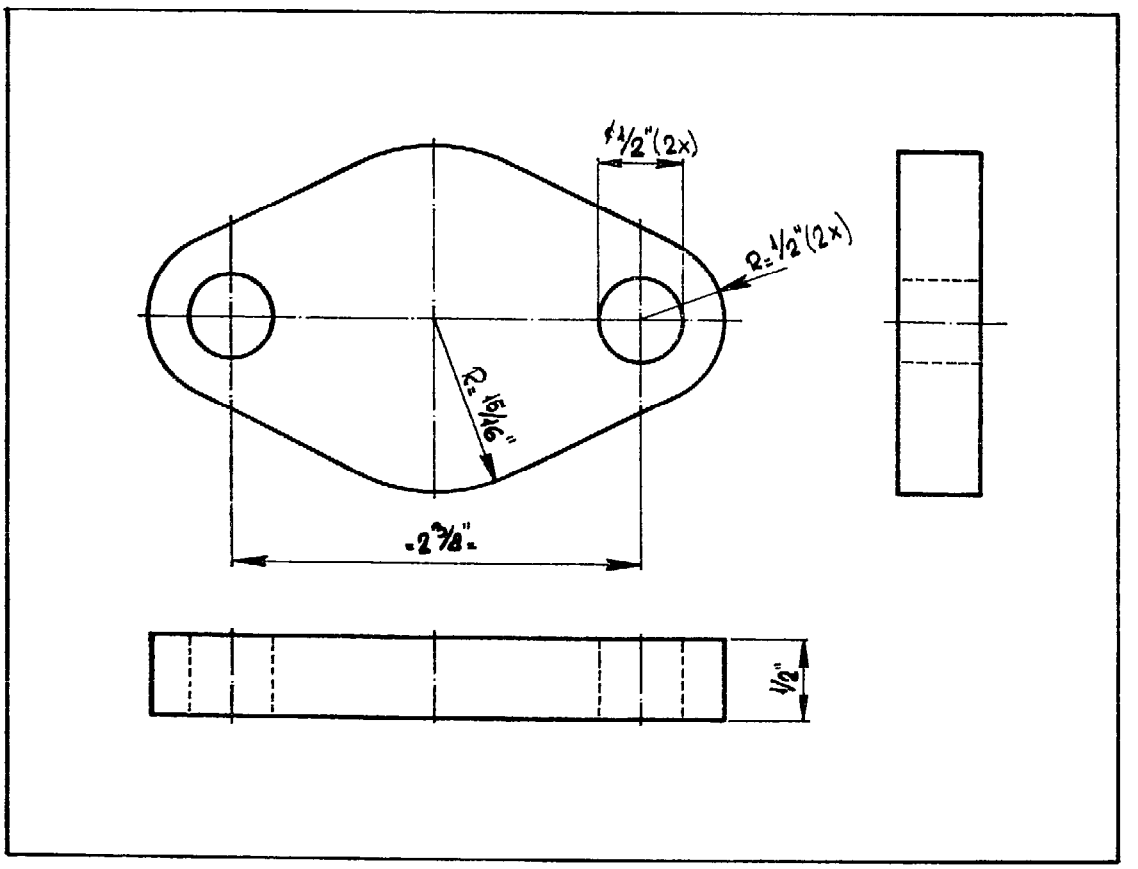
PICTOSTEPS

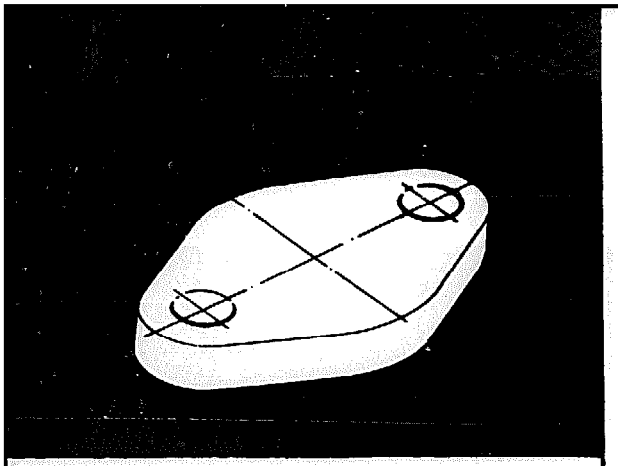
WORKSHOP INSTRUCTION METAL





NOTE : tolerance on all dimensions $\frac{1}{32}$"

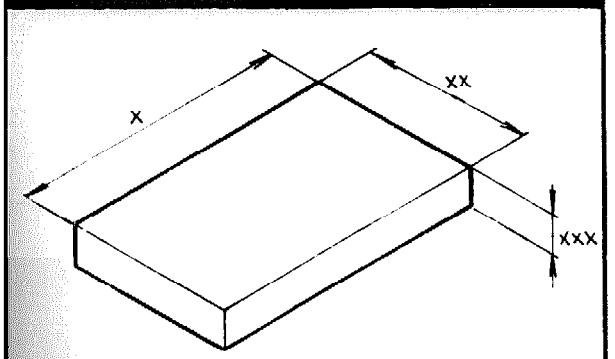




USE

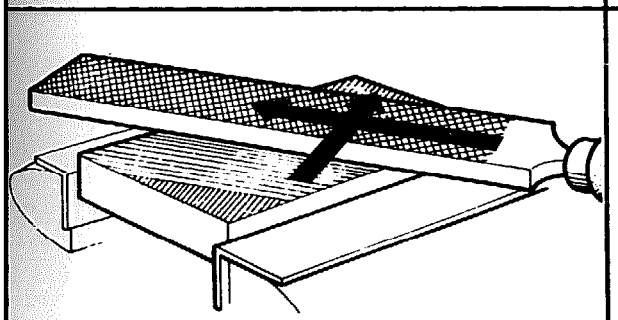
The blind flange may be used for sealing an opening normally provided with a flange of identical shape and size.

MATERIAL	DIMENSIONS
Mild steel, packing	Length : X 3½ in (89 mm)
	Width : XX 2 in (51 mm)
	Thickness: XXX 2½ in (63.5 mm)

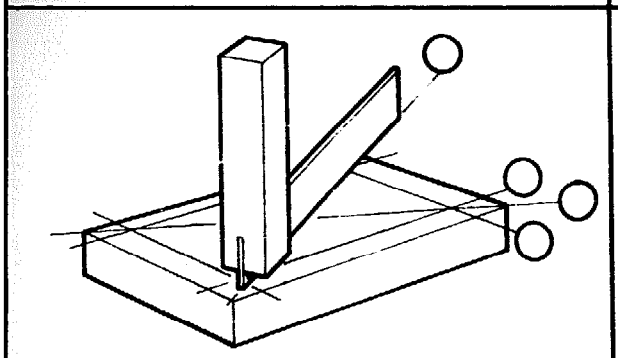


TOOLS

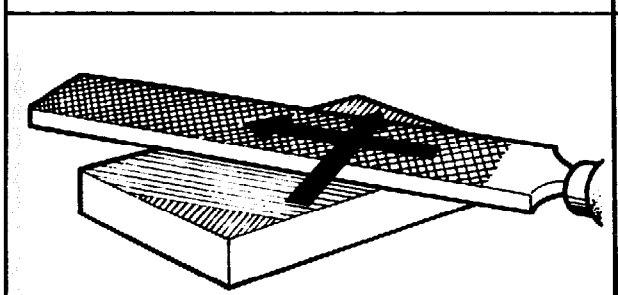
Blunt bastard file	Hack saw
Try square	Stop block
Outside callipers	Blunt smooth file
Vernier callipers	Packing shears
Scriber	Hollow punch (½ in)
Rule (inches)	Pencil
Spring compasses	Vice
Steel straight edge	Vice caps
Centre punch	Chalk
Engineers' hammer	Varnish
	Twist drill (¼ in)
	Twist drill (½ in)



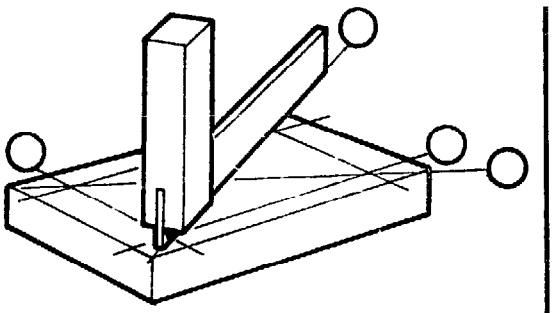
OPERATION	TOOLS
File flat and crosswise. Change direction of filing regularly. Use clean vice caps.	Vice Vice caps Blunt bastard file



Check flatness in all directions. ○ Check lines.	Try square



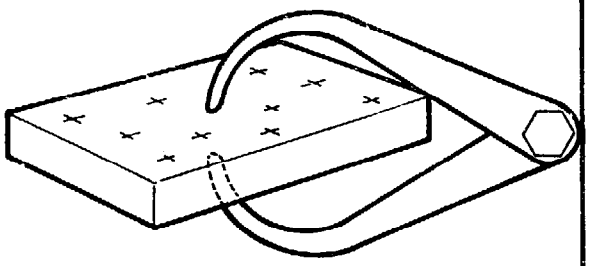
Turn work upside down, file flat to ½ in thickness. File crosswise. Change direction of filing regularly.	Vice Vice caps Blunt bastard file



Check flatness in all directions.

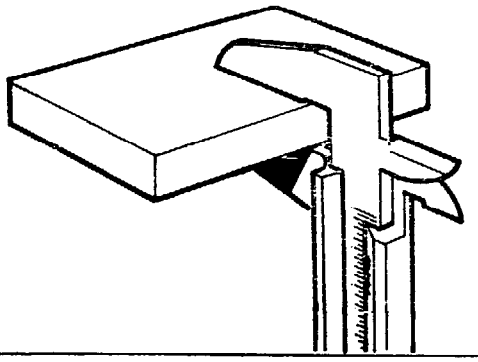
○ Check lines

Try square.



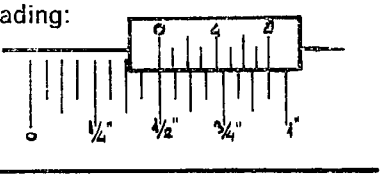
Regularly check work on equal thickness.
Check all over surface.

Outside calipers.

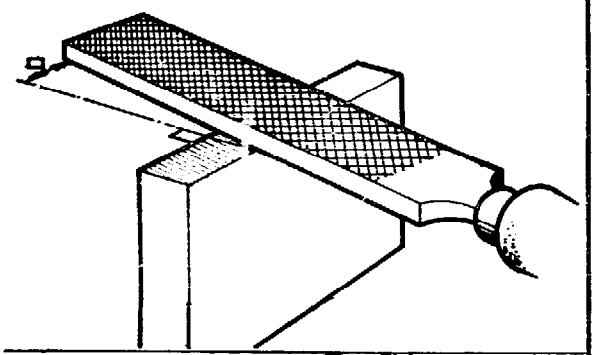


Test on correct thickness.

Reading:

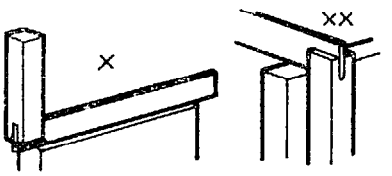


Vernier calipers.



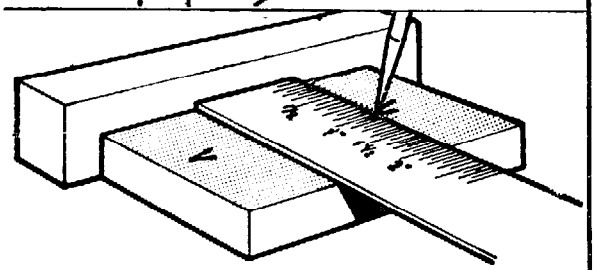
File one side flat and square.

▭ = 15 deg.

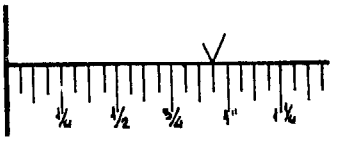


Check on flatness X and squareness XX.

Vice.
Vice caps.
Blunt bastard file.

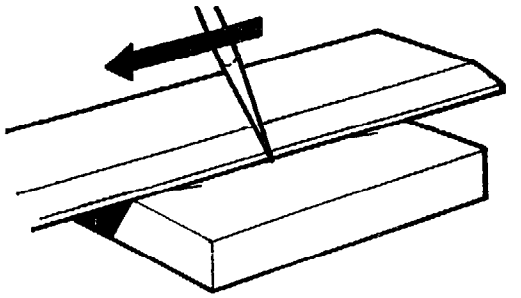


Apply chalk or varnish for marking out.
Put V-marks at two places 15/16" from finished side

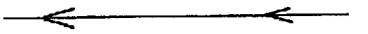


Use stop block.
Points of V-marks accurately at 15/16".

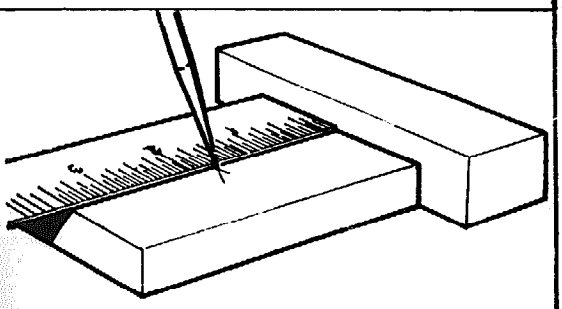
Rule.
Scriber.
Stop block.
Chalk or varnish



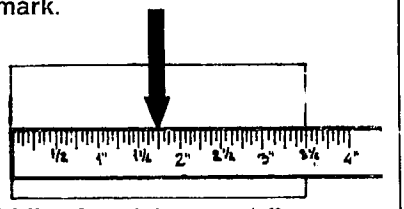
Scribe line exacly through points of V-marks.



Scriber.
Steel straight edge.

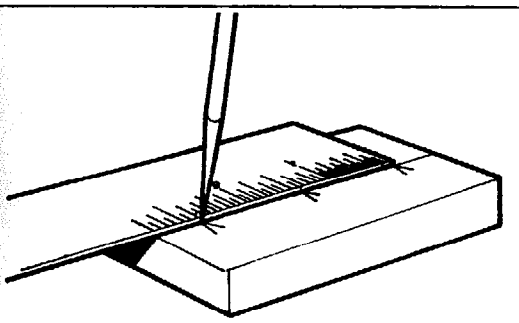


Accurately in middle of line put V-mark.

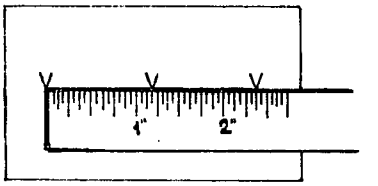


Middle of work is at 1 3/4" from side.

Rule.
Scriber.
Stop block.

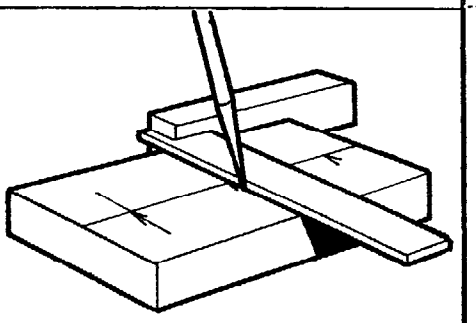


Mark 1 3/16" on either side of middle.



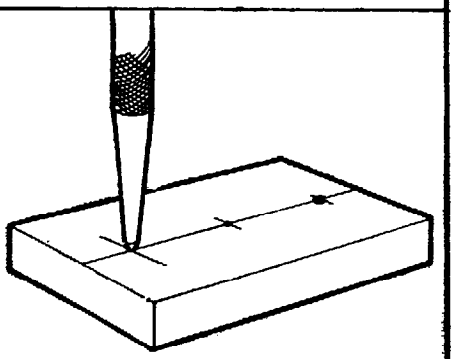
Put rule with 1 3/16" at midpoint. Scribe V-marks at 0 and 2 3/8".

Rule.
Scriber.



Scribe short crosslines through these three points.

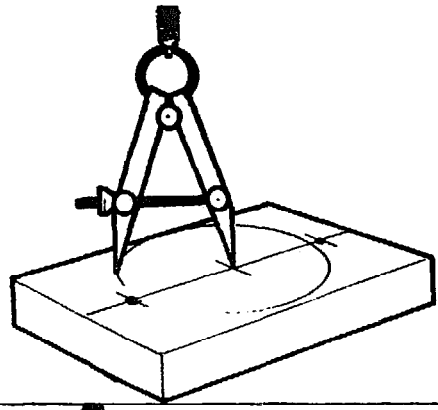
Try square.
Scribe.



Centre punch intersections.
Find exact point by tilting the punch.
Hold punch upright when striking it.

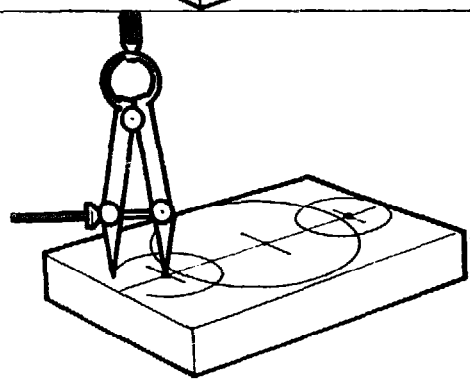
Middle centre shallow, outer centres deep.

Centre punch.
Hammer.

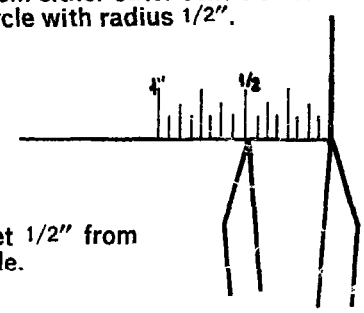


From midpoint of line scribe circle tangent to finished side.
Check circle on correct radius: diameter should be 1 7/8".

Spring compasses.
Rule.

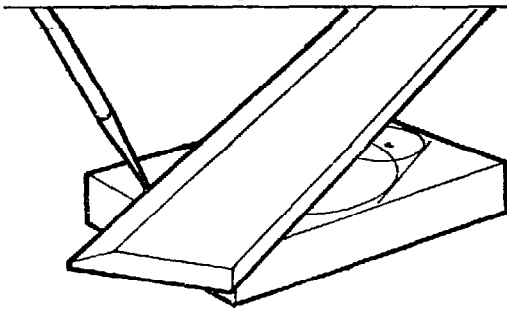


From either outer centre scribe circle with radius 1/2".

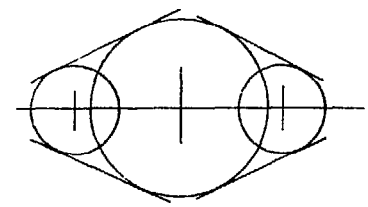


Set 1/2" from rule.

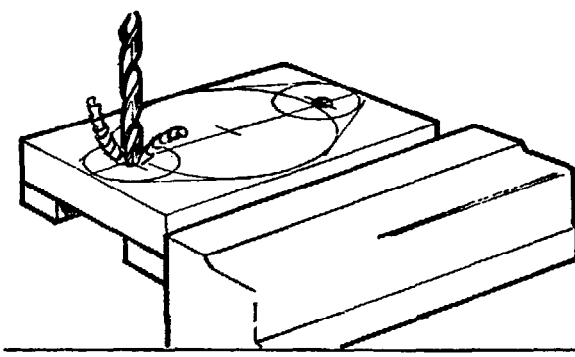
Spring compasses.
Rule.



Scribe 4 lines tangent to circles as shown:

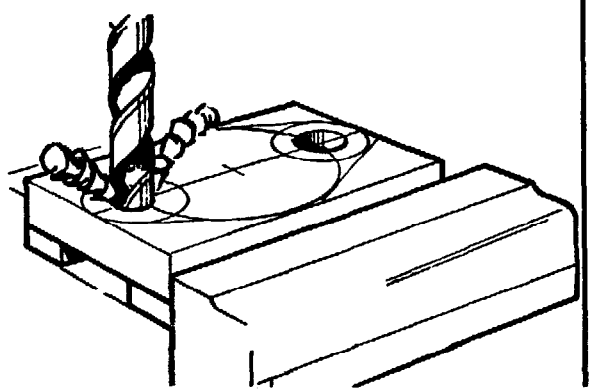


Steel straight edge.
Scriber.



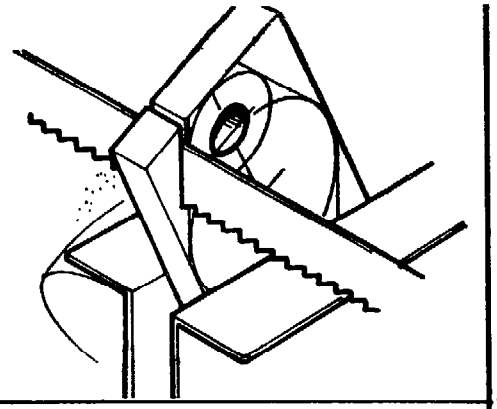
Drill two holes 1/4" dia.
Use cutting lubricant.

Drilling machine.
Twist drill 1/4"
Machine vice.
Packings.

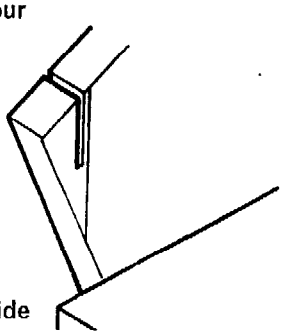


Enlarge holes to 1/2" dia.
Use cutting lubricant.

Drilling machine.
Twist drill 1/2"
Machine vice.
Packings.

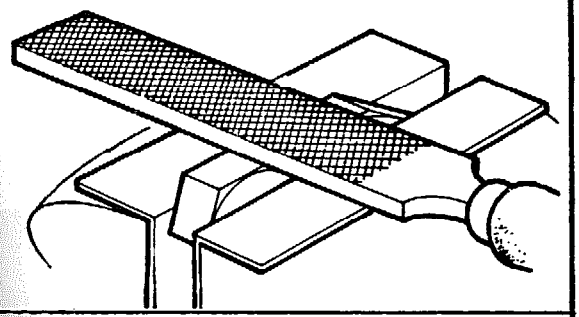


Saw off four corners.



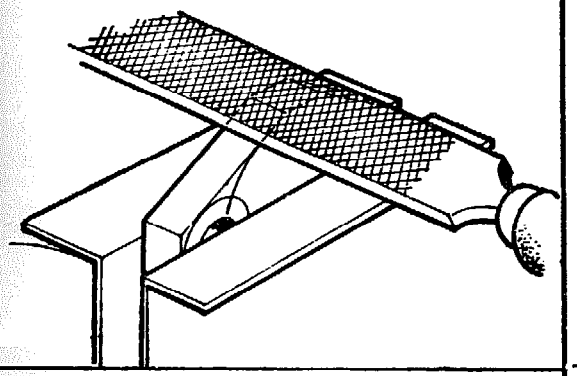
Stay outside lines.

Saw frame.
Saw blade.
Vice.
Vice caps.

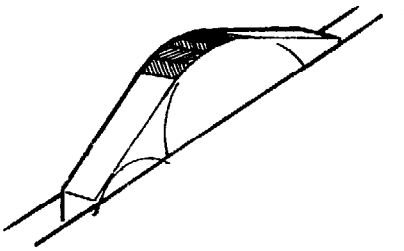


File flat and square to lines.

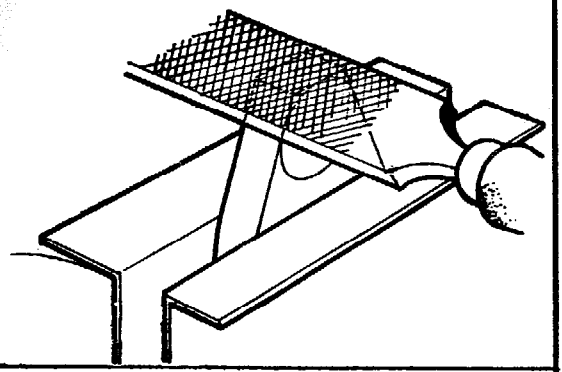
Blunt bastard file.
Vice.
Vice caps.



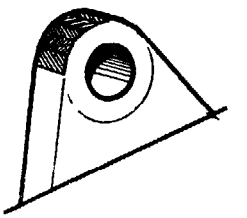
File round. First rough shape, file faces in various directons, then finish off.



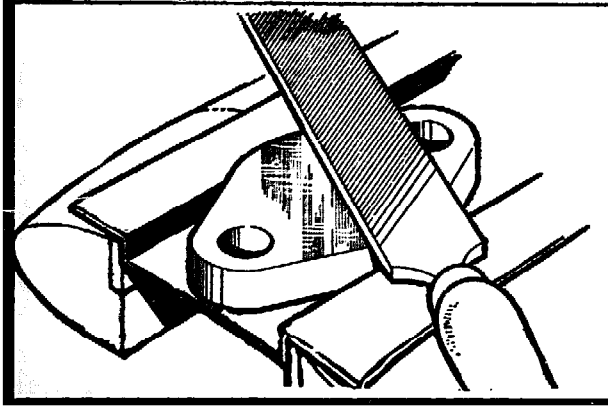
Vice.
Vice caps.
Blunt bastard file.



Round corners. First shape roughly by filing faces in various directions. Then finish off.

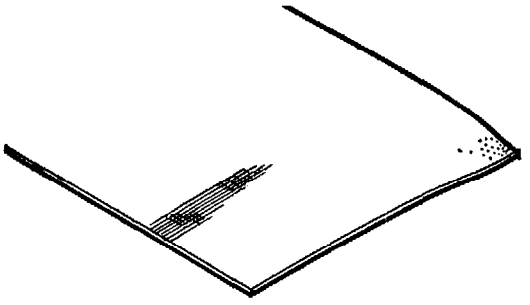


Vice.
Vice caps.
Blunt bastard file.

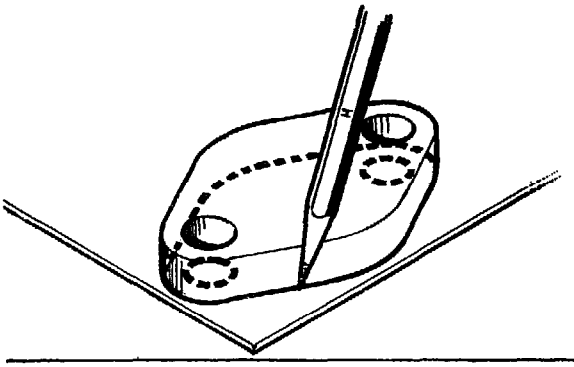


For the finishing touch use smooth file. A real polished sheen is obtained if the file is first just rubbed along a piece of chalk.

Vice.
Vice caps.
Blunt smooth file.
Piece of chalk.

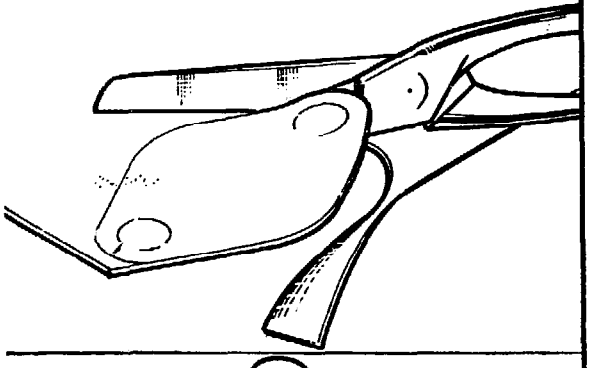


Now the gasket will be made.
Fetch a piece of packing material about the size of the flange and about 1/16" thick.



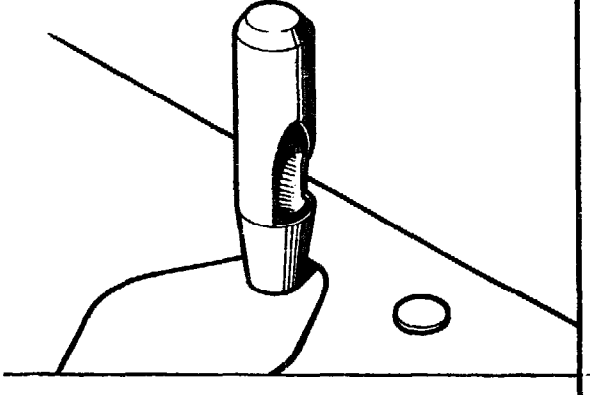
Mark out gasket by tracing along flange.
Do not forget the holes!

Pencil.



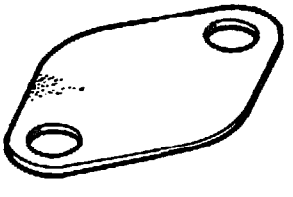
Cut out gasket along lines.

Packing shears.



Punch the holes.

Hollow punch.
Hammer.



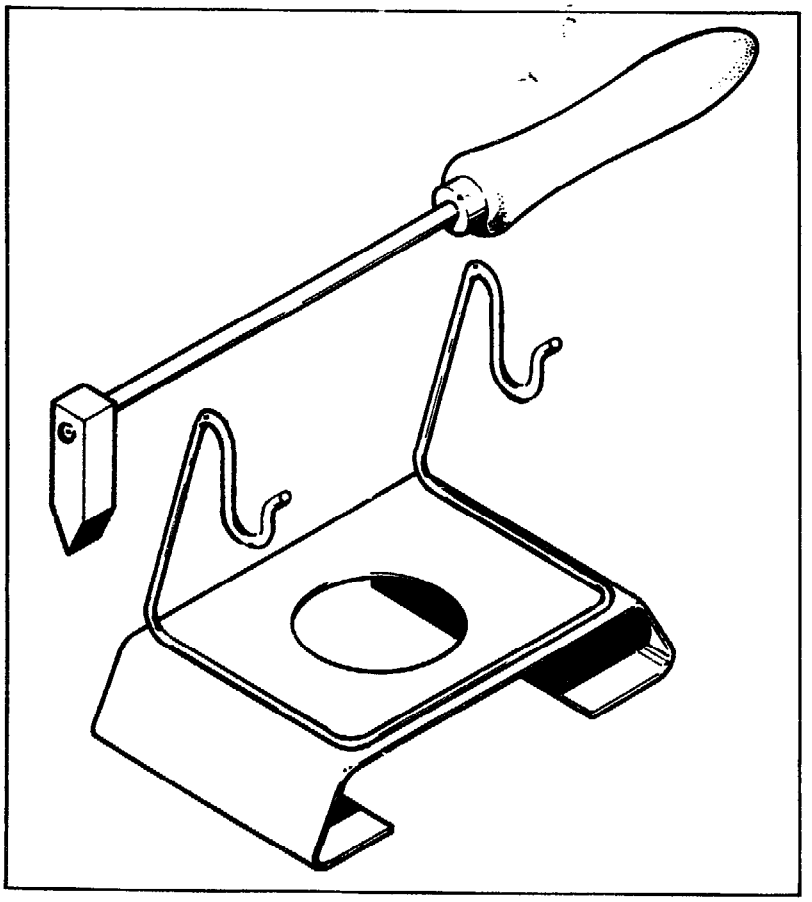
Gasket is ready.

Code 1002 - INTEMS B.V. - P.O.Box 262
4100 AG Culemborg - The Netherlands

SOLDERING IRON WITH STAND

PICTOSTEPS

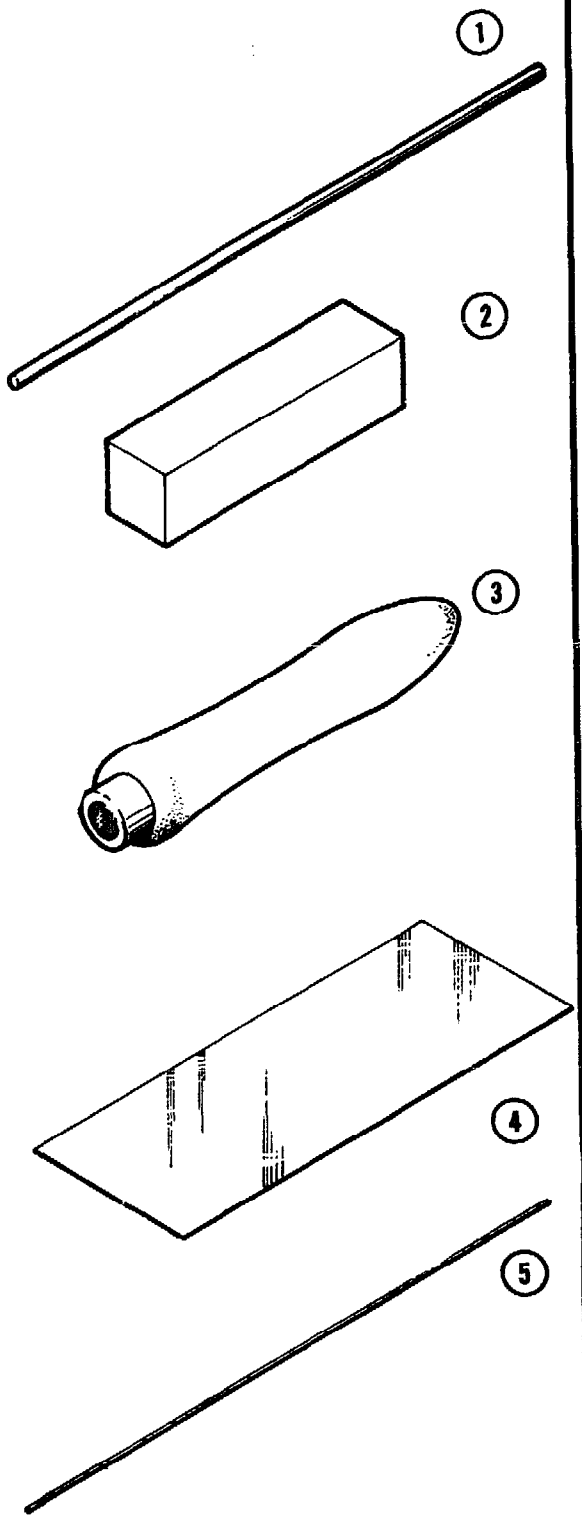
WORKSHOP INSTRUCTION METAL



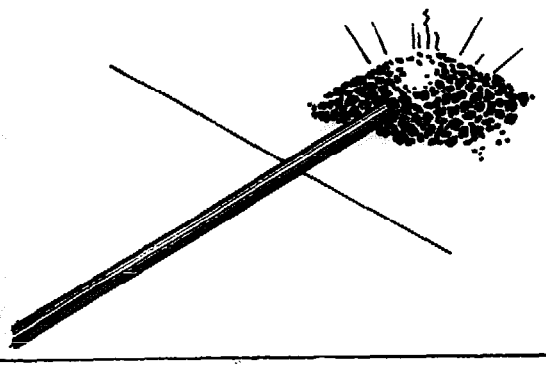
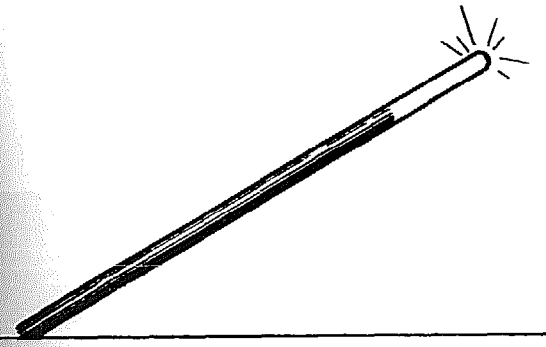
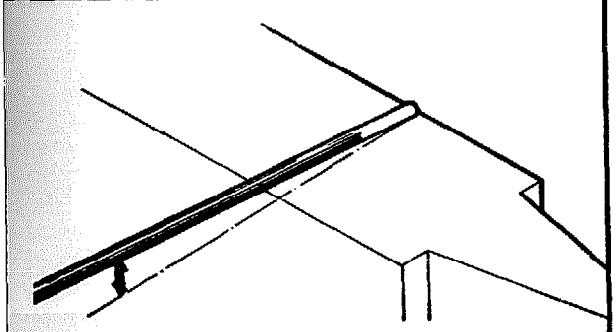
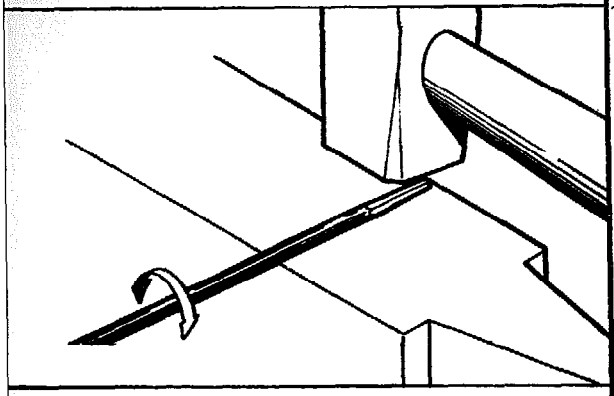
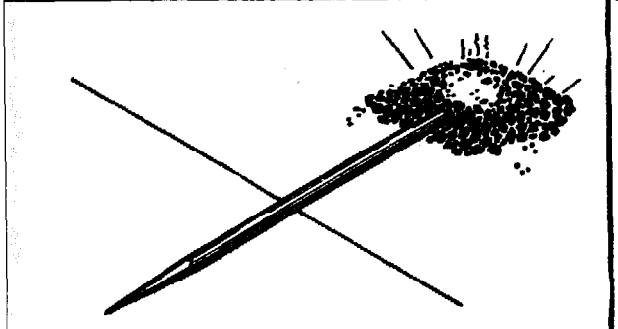
SOLDERING IRON AND STAND

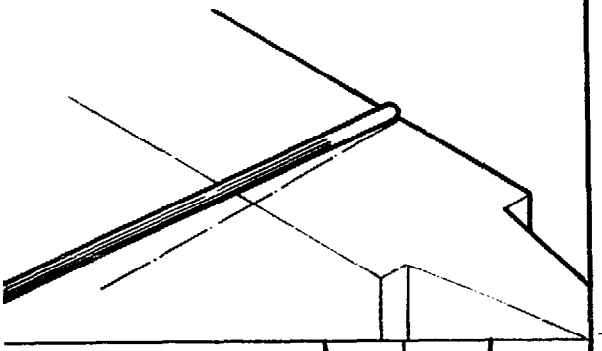
USE: The soldering iron is a tool used for soldering, that is joining metallic edges or surfaces by means of molten metal or alloy (solder). The hot soldering iron is rested on the stand.

TOOLS:
- Smith's fire.
- Smith's tongs.
- Anvil.
- Smith's hammer.
- Scriber.
- Rule.
- Try square.
- Centre punch.
- Hammer.
- Drilling machine.
- Vice.
- Bastard hand file.
- Smooth file.
- Wooden packing.
- Small square file.
- Ledge (50 cm length).
- Steel straight edge.
- Lever shears.
- Twist drill (3 mm).
- Boring tool.
- Rubber mallet.
- Pair of pliers.
- Soldering iron.
- Brush.
- Flux.
- Solder.
- Bevel protractor.
- Piece of wood (at least 10 x 21 cm).
- Panel pins.
- Vice clamps.
- Metal strip 15 x 3 mm.
- Short length of 10 mm dia. bar, (150 mm).
- Short length of 6 mm dia. bar, (150 mm).
- Emery paper.



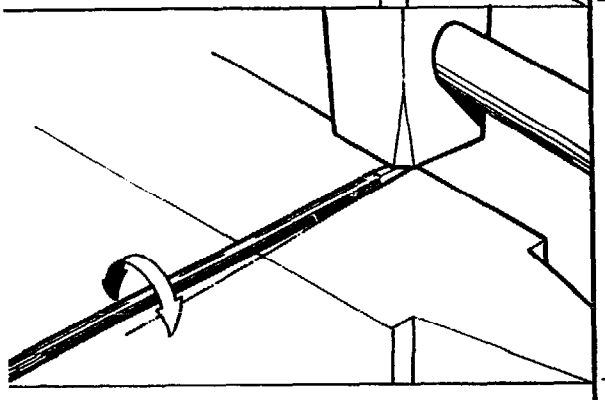
MATERIAL:	DIMENSIONS:
1. Mild steel.	Length 175 mm, dia. 5 mm.
2. Copper.	10 x 10 x 40 mm.
3. Wooden handle (from stock).	
4. Tinned steel sheet.	200 x 75 x 0.5 mm.
5. Copper-plated welding wire.	Length 450 mm, dia. 2 mm.

	OPERATION	TOOLS
	**Forging** We start by forging the shank. The drawing is on page 16. Heat bar over about 2 cm until white hot.	Smith's fire. Smith's tongs.
	Take bar from fire.	Smith's tongs.
	Rest bar on anvil at small angle.	Smith's tongs. Anvil.
	Hammer point 40 mm in length. Turn bar through 90° after each blow.	Smith's tongs. Anvil. Smith's hammer.
	Heat other end of bar over about 2 cm until white hot.	Smith's fire. Smith's tongs.



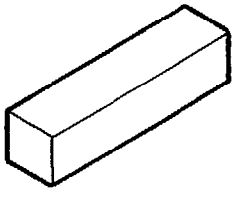
Take bar from fire and rest it on anvil at small angle.

Smith's tongs.
Anvil.

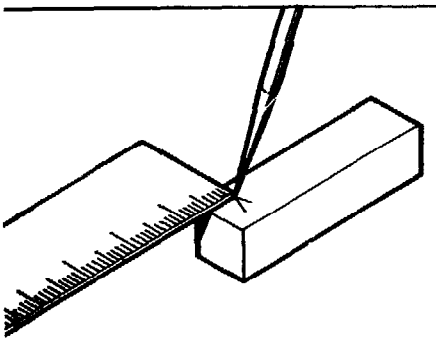


Hammer tip to a point 15 mm in length and square over 3 mm.

Anvil.
Smith's tongs.
Smith's hammer.

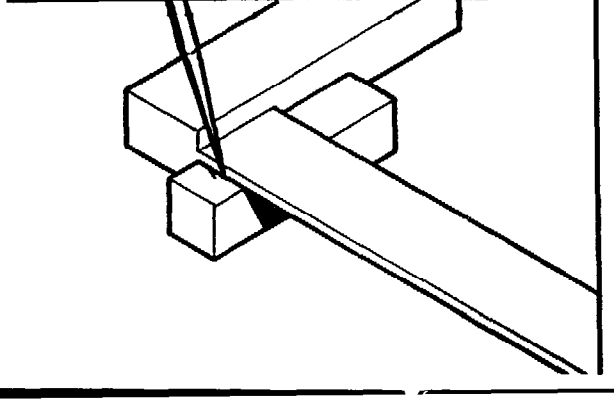


Now we start making the head or „bit" of the soldering iron.
It is made from the piece of copper.
The working drawing is on page 16.



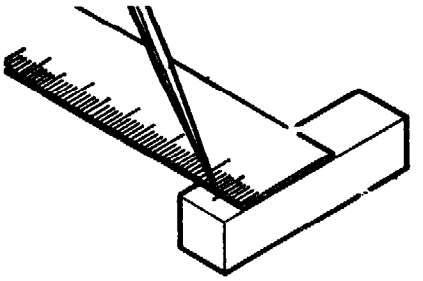
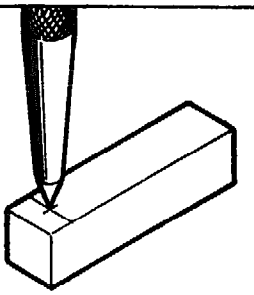
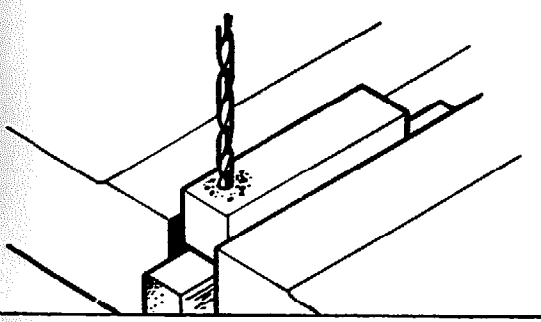
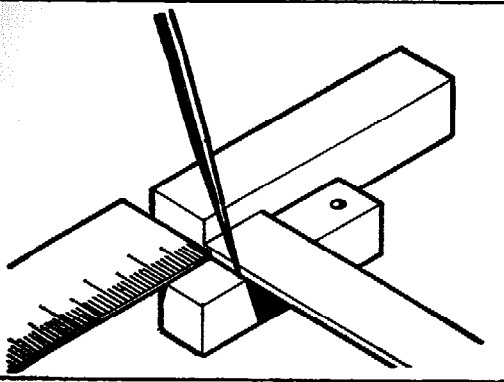
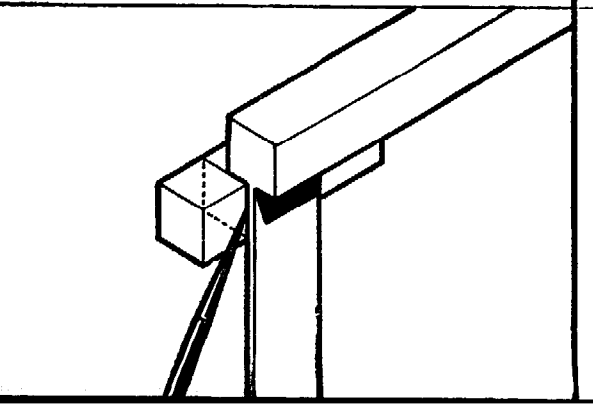
Scribe V-mark 5 mm from end.

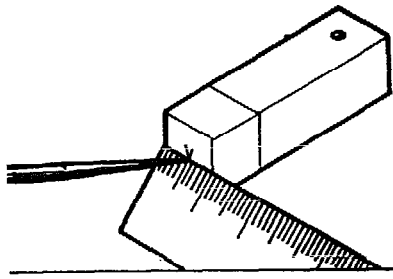
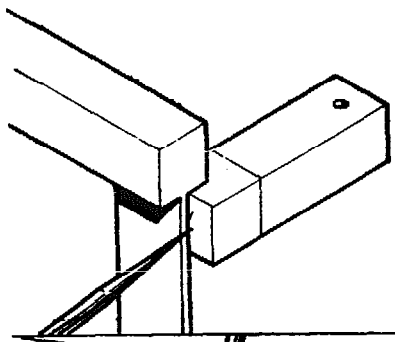
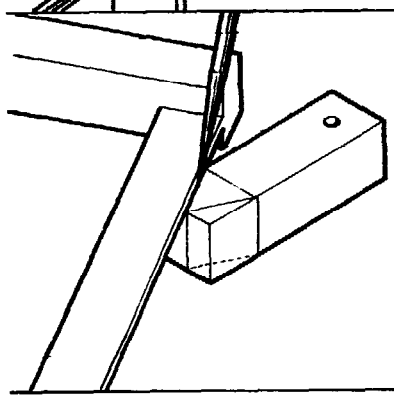
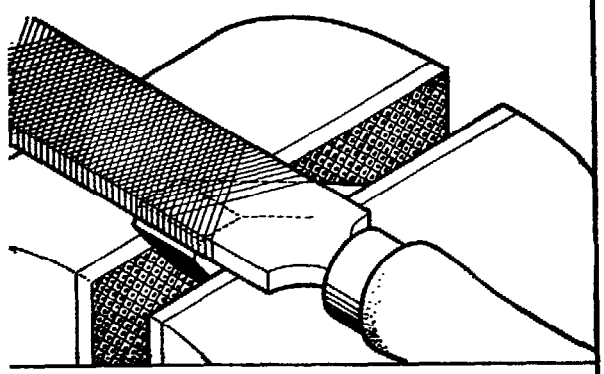
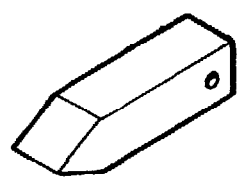
Scriber.
Rule.

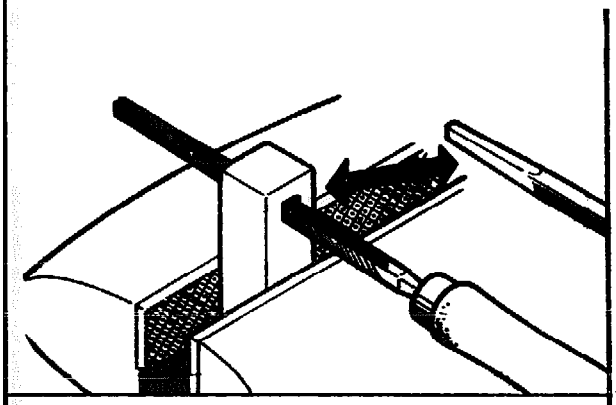


Scribe line through point of V-mark.

Scriber.
Square.

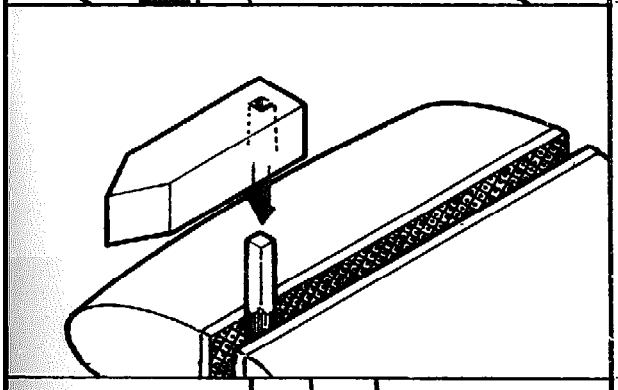
	Find midpoint of this line (5 mm from edge).	Scriber. Rule.
	Centre punch at this point.	Centre punch. Hammer.
	Drill hole 3 mm dia. Use wooden packing in vice.	Drilling machine. Twist drill 3 mm dia. Wooden packing.
	10 mm from other end scribe line square to side.	Scriber. Rule. Square.
	Scribe same distance on all surfaces around piece of metal.	Scriber. Square.

	Scribe V-mark at centre of front face (5 mm from edge).	Scriber. Rule.
	Scribe line through point of V-mark parallel to drilled hole.	Scriber. Square.
	Scribe four oblique lines as shown.	Scriber. Square.
	File off to oblique lines. Finish with smooth file.	Vice. Bastard file. Smooth file.
	At this stage the „bit" looks like this.	



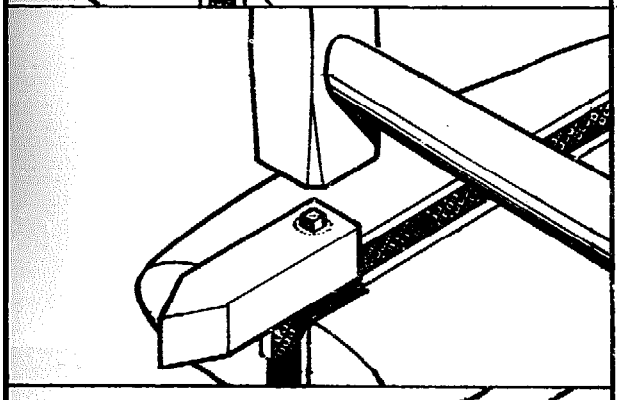
File square-section tapering hole to fit the end of the shank.
Point of shank should extend about 3 mm through bit.

Small square file.
Vice.

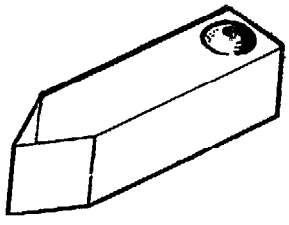


Clamp shank in vice, and place bit on it.

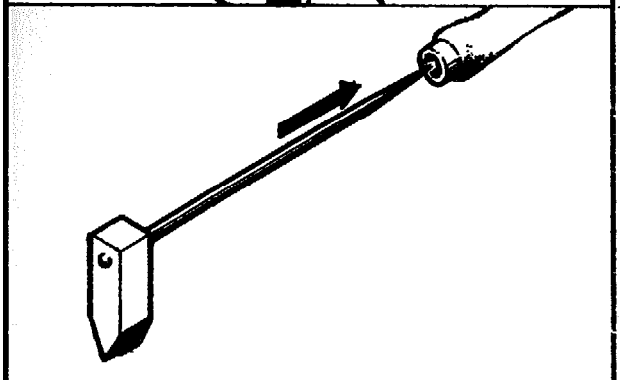
Vice.



Hammer round head on shank.

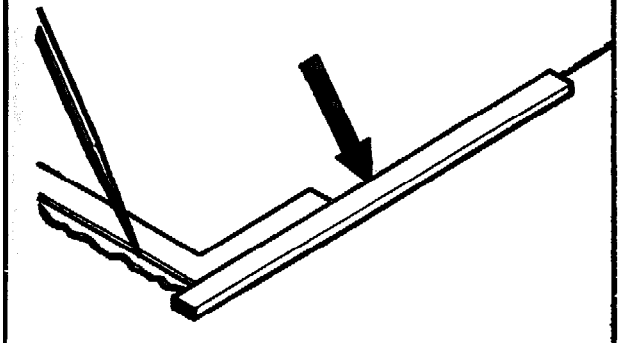


Vice.
Hammer.



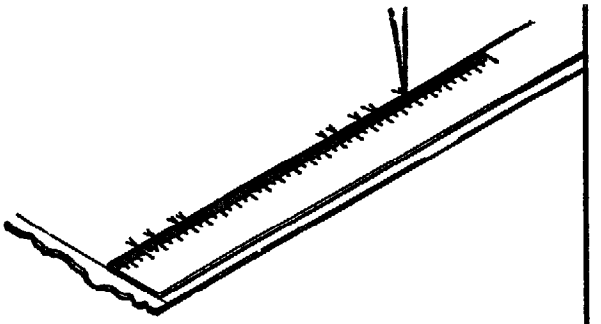
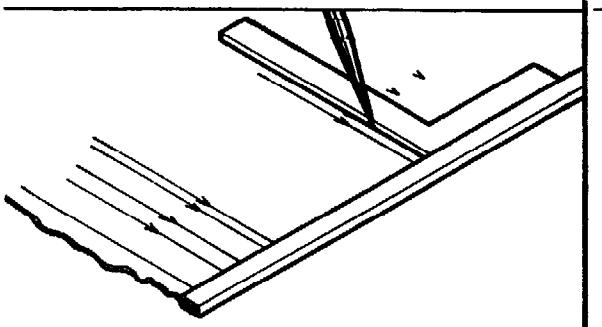
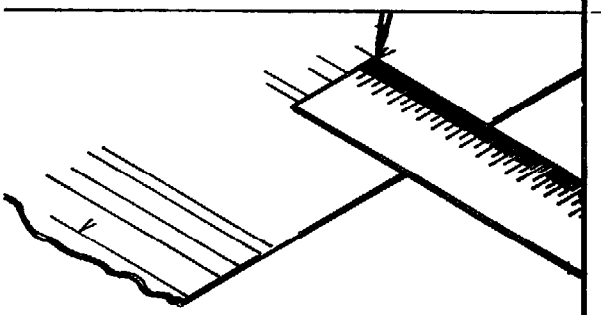
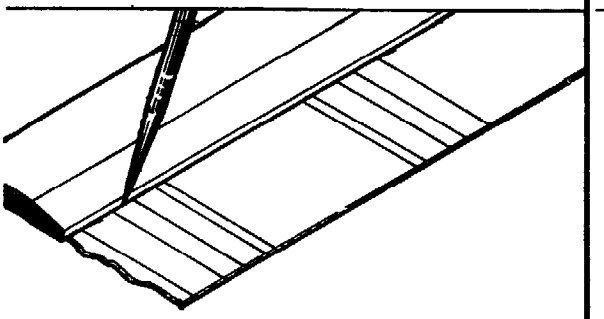
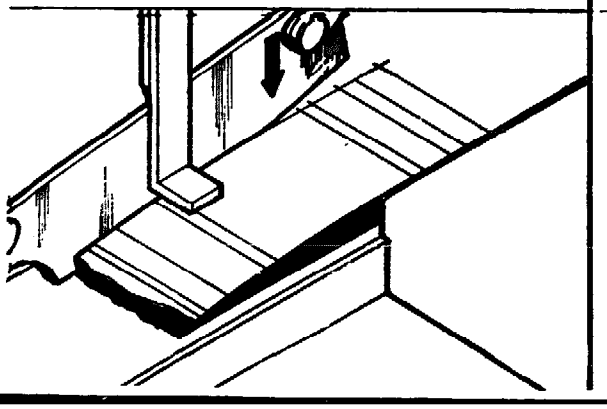
Fit handle to other end of shank.

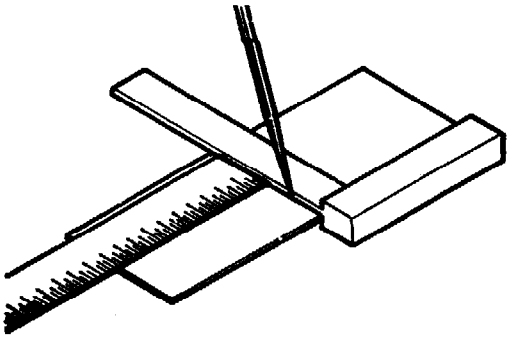
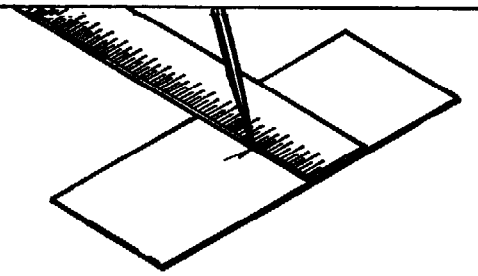
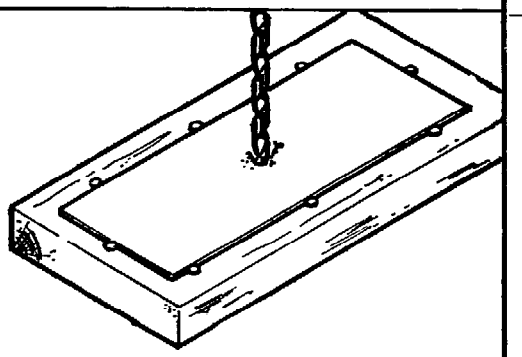
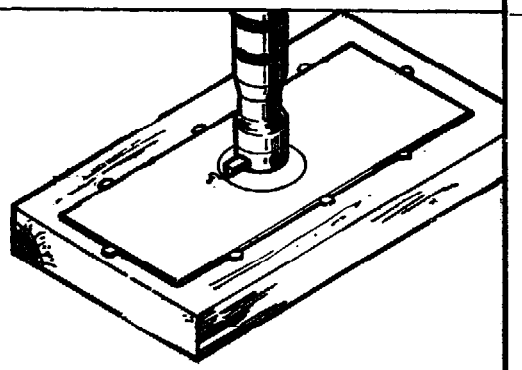
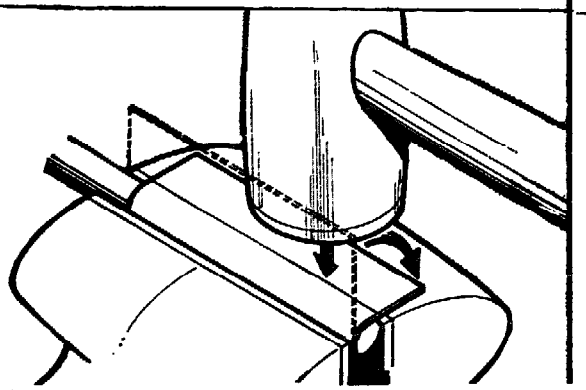
The soldering iron is now ready.

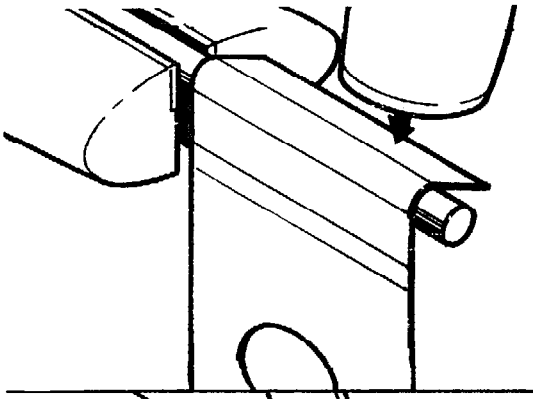
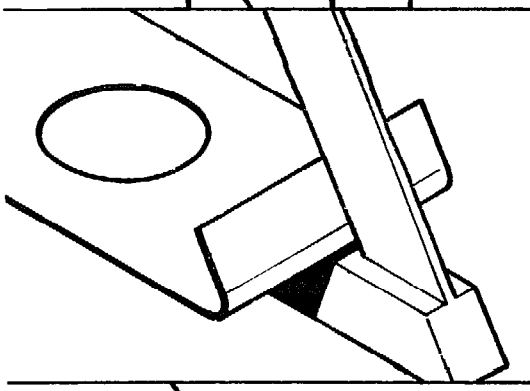
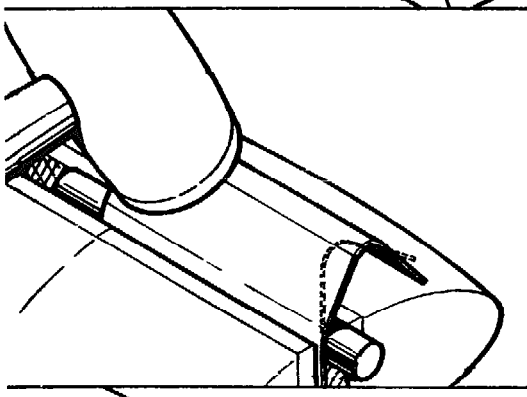
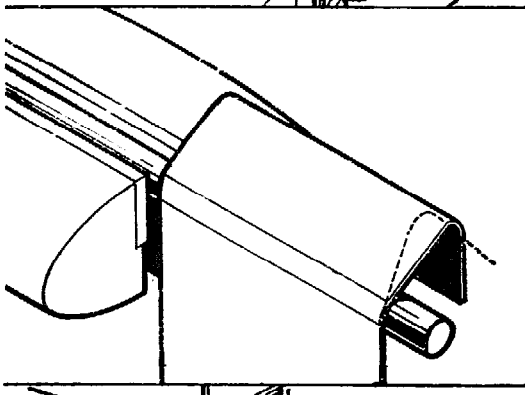
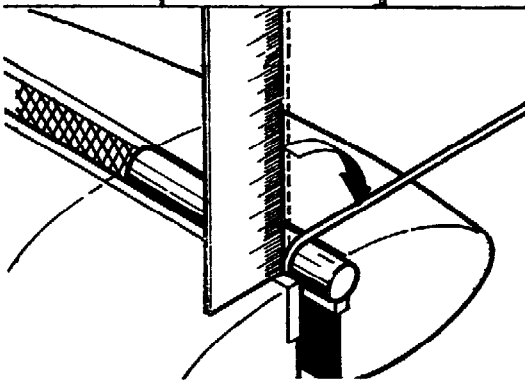
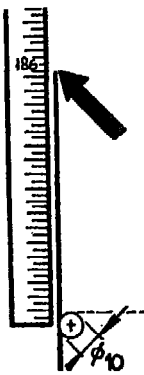


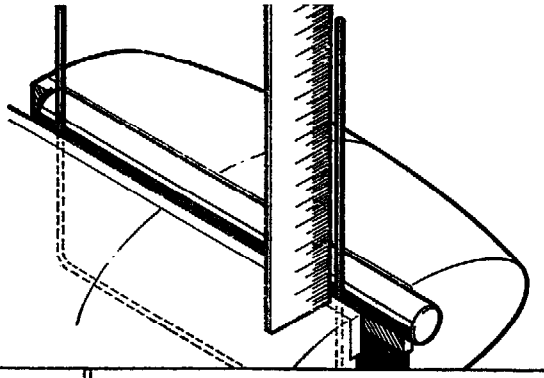
Now we are going to make the stand.
First the base. We start from one edge which is cut accurately straight. We will call this the bottom edge.
Scribe a line at right angles to this edge, as near the edge as possible.

Scriber.
Square.
Ledge.

	Scribe V-marks at distances of 20, 31, 47, 52.5, 147.5, 153, 169, 180 and 200 mm from this line.	Scriber. Rule.
	Scribe lines through these V-marks square to the bottom edge. These are the bending lines.	Scriber. Square. Ledge.
	Mark off distances of 75 mm on the outermost lines.	Scriber. Rule.
	Scribe lines through these V-marks.	Scriber. Steel straight edge.
	Cut off on outermost lines.	Lever shears, or hand shears.

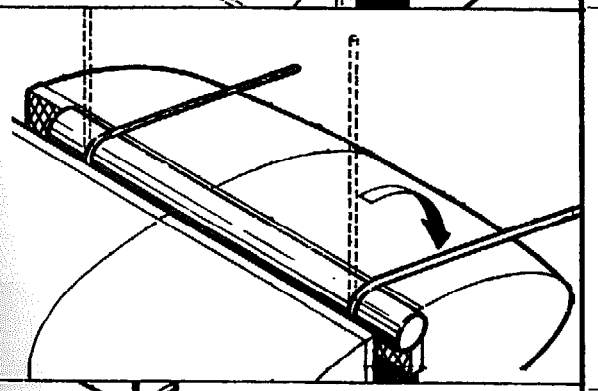
	At 100 mm from short edge scribe line.	Scriber. Rule. Square.
	Put V-mark at midpoint of this line (37.5 mm from edge). Centre punch at this point.	Scriber. Rule. Centre punch. Hammer.
	Fasten plate to piece of wood with panel pins. Drill hole 3 mm dia.	Drilling machine. Twist drill 3 mm dia.
	Set boring tool to 40 mm dia. Bore hole.	Drilling machine. Boring tool.
	Clamp plate together with 10 mm dia. bar in vice. The bending line second to last should be at same height as the centre line of bar. Bend to right angles.	Vice. Rubber mallet. 10 mm dia. bar.

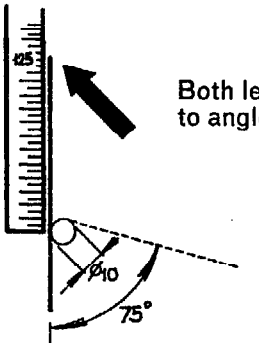
	Continue bending as shown.	Vice. Rubber mallet. 10 mm dia. bar.
	Check that angle is 60°. The three previous operations should be repeated on the other side of the base. (Bend to same direction)	60° bevel or bevel protractor.
	Clamp base together with 10 mm dia. bar in vice. The innermost bending line should be at same height as centre line of bar. Bend.	Vice. Rubber mallet. 10 mm dia. bar.
	Continue bending until upper and lower surfaces are parallel. Repeat the two previous operations on the other side of the base. The base is now finished.	Vice. Rubber mallet. 10 mm dia. bar.
	 Now we are going to make the wire rest. This is easily bent by hand from welding wire. Clamp wire with 10 mm dia. bar in vice. Wire extends 186 mm above centre line of bar. Bend to right angle. Repeat on other end of wire.	Vice. Rule. 10 mm dia. bar.



Wire is clamped as shown.
Both legs extend 125 mm above centre line of bar.

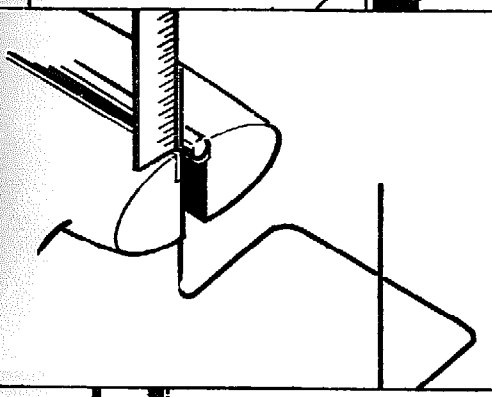
Vice.
Rule.
10 mm dia. bar.

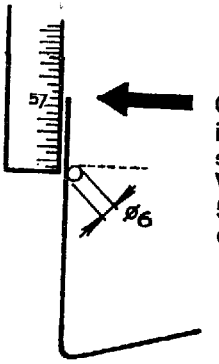




Both legs are bent to angles of 75°.

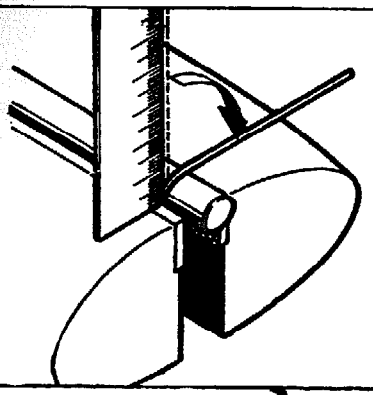
Vice.
Protactor.





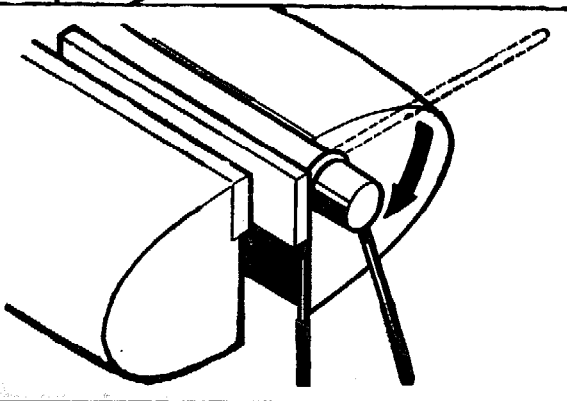
One end of wire is clamped as shown in figure.
Wire extends 57 mm above centre line of bar.

Vice.
Rule.
6 mm dia. bar.



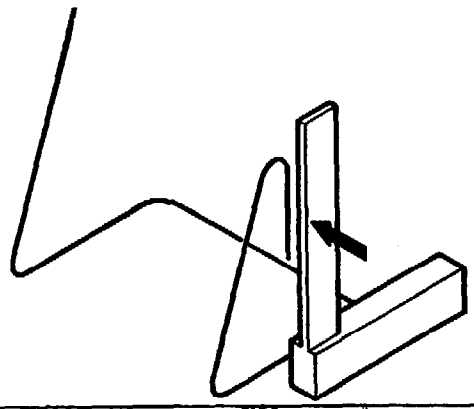
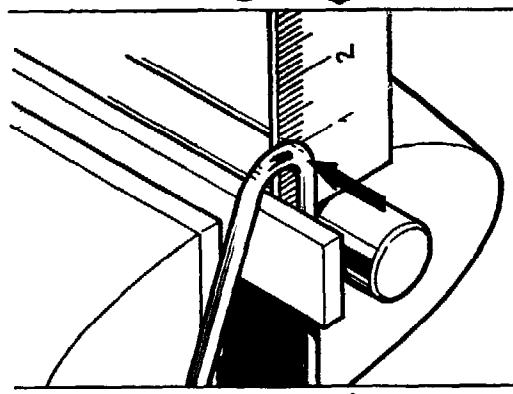
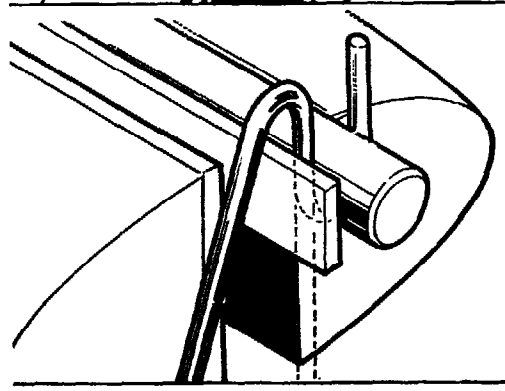
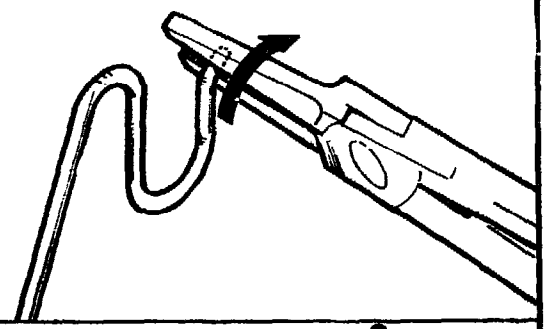
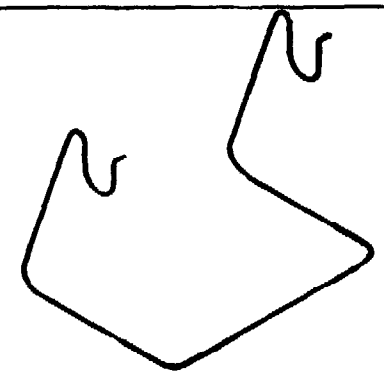
The wire is bent to right angles.

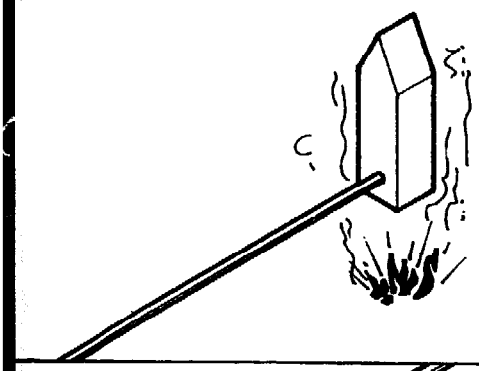
Vice.
6 mm dia. bar.



This same end is clamped in the vice as shown here.
The wire should be clamped by the strip.
Bend until the end is at right angles to bottom line.
See next page.

Vice.
10 mm dia. bar.
Metal strip 15 x 3 mm.

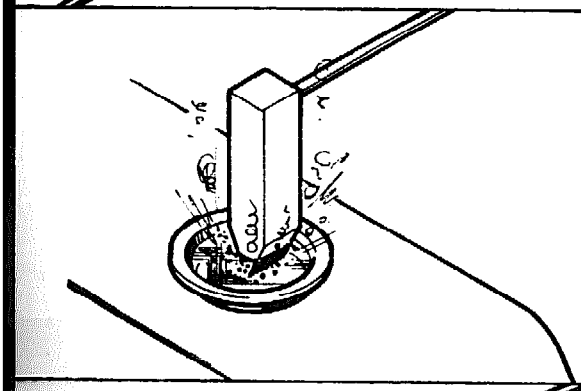
	Check that end of wire is at right angles to base.	Square.
	Clamp wire in vice as shown here. The wire should be firmly clamped by the strip. End of wire should extend 13 mm above centre bar.	Vice. Rule. 10 mm dia. bar. Metal strip 15 x 3 mm.
	End of wire is bent round bar as shown here.	Vice. 10 mm dia. bar. Metal strip 15 x 3 mm.
	Bend tip about 5 mm outward.	Pliers.
	Repeat the previous seven operations on other end of wire. The wire has now been bent to a rest shaped as shown here.	



Now the wire rest has to be soldered to the base.

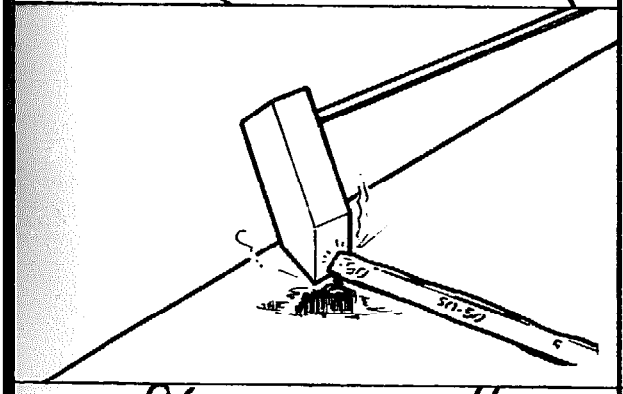
Heat copper of soldering iron until flame is bright green. Keep point of copper bit upward.

Soldering iron.

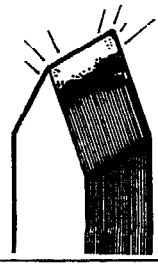


Dip point of bit in flux (soldering acid).

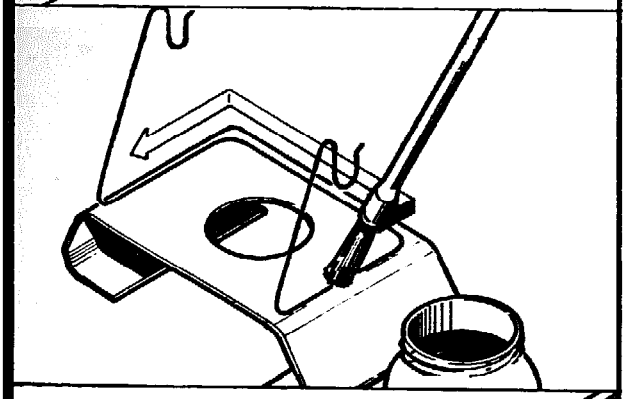
Soldering iron.
Flux.



The tip is tinned by rubbing it along the solder.

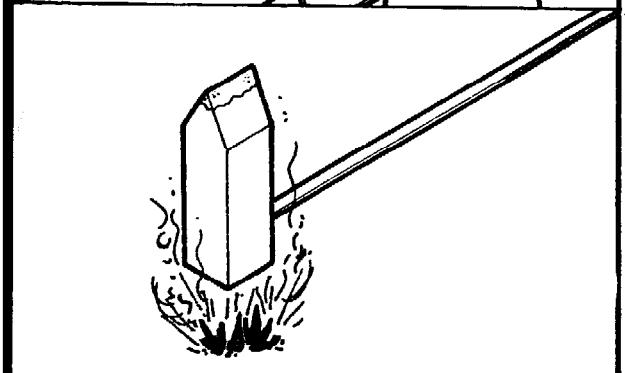


Soldering iron.
Solder.



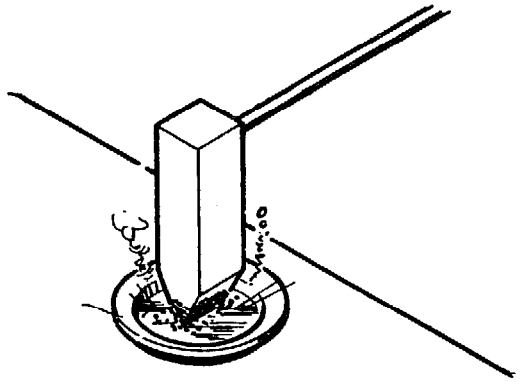
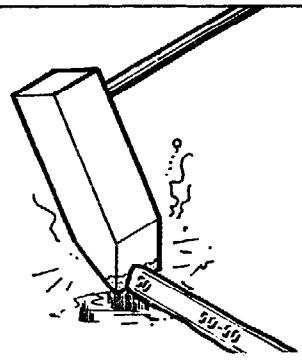
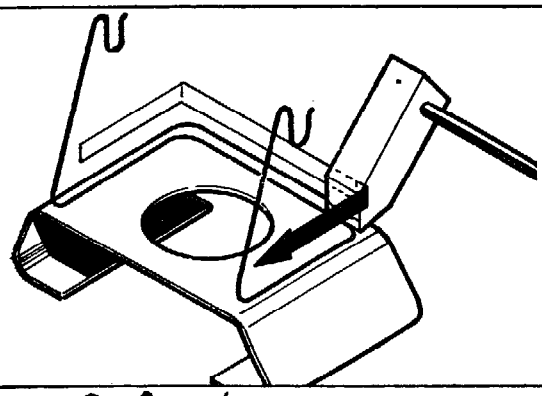
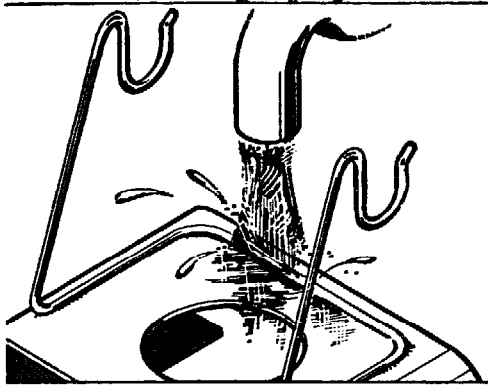
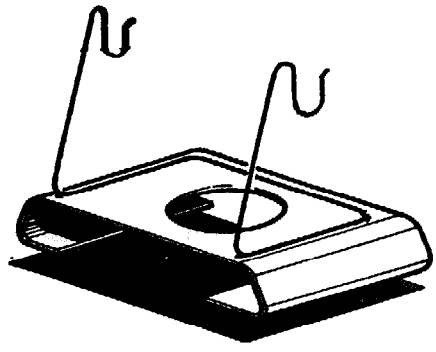
Clean the wire with emery paper and place the rest on the base in the position shown in the working drawing on page 15.
Put flux at the places where the wire rest touches the base.

Emery paper.
Flux.
Brush.



Heat soldering iron until flame is green. Keep tip of copper bit upwards.

Soldering iron.

	Dip point into flux.	Soldering iron. Flux.
	Apply solder to point.	Soldering. iron. Solder.
	Solder rest to base along the whole length in contact with it. Press wire down and take care that it does not move. When iron gets too cold, reheat.	Soldering iron.
	When soldering is completed any flux left is thoroughly rinsed away with water. Dry with cloth.	
	Now the whole stand is complete.	

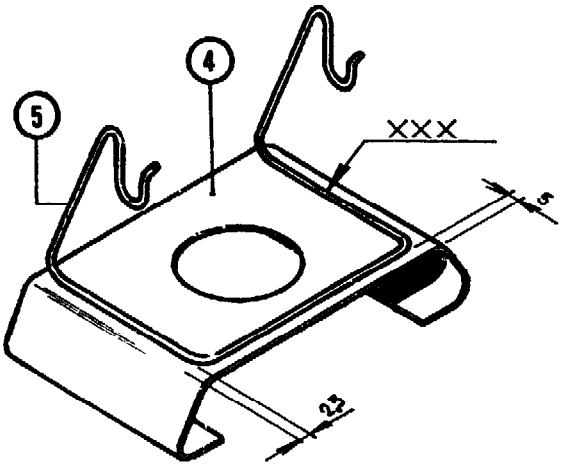
STAND

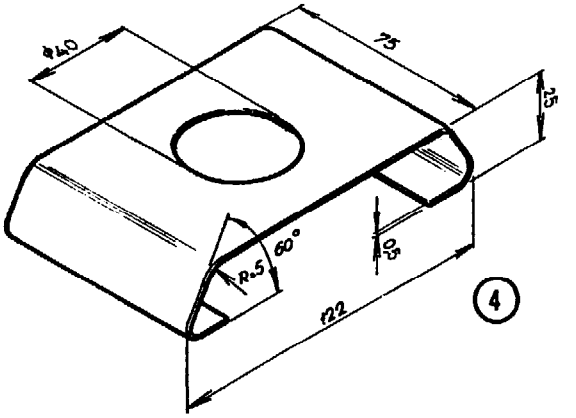
tolerance on all dimensions 1 mm

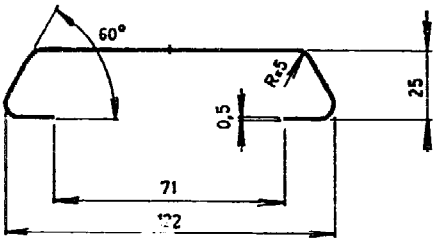
X = detail

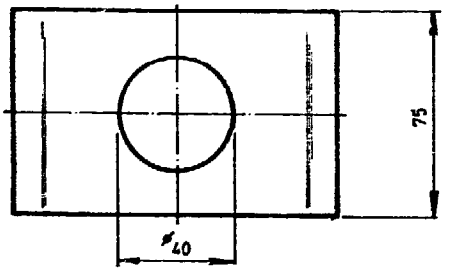
XX = development of base

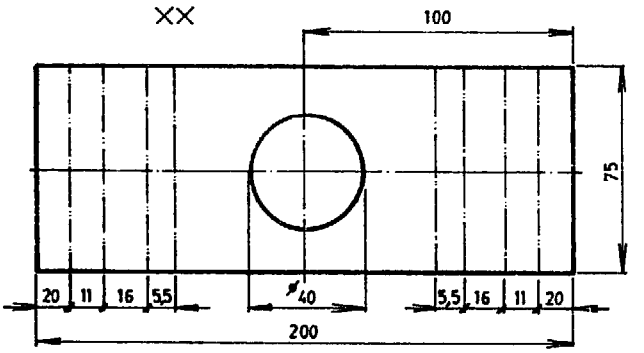
XXX = solder

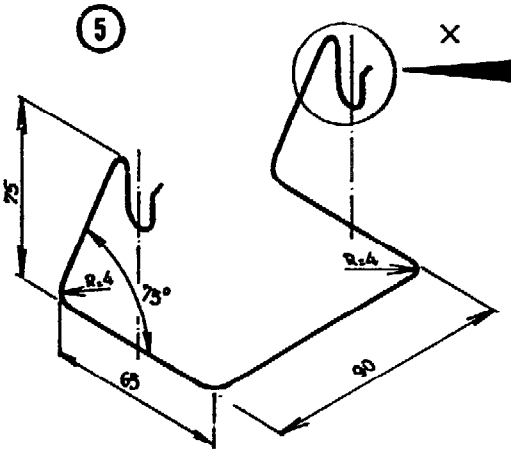


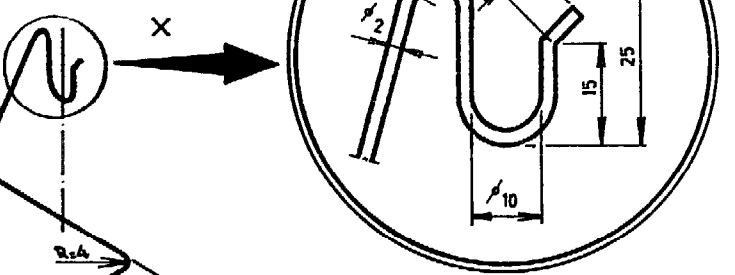










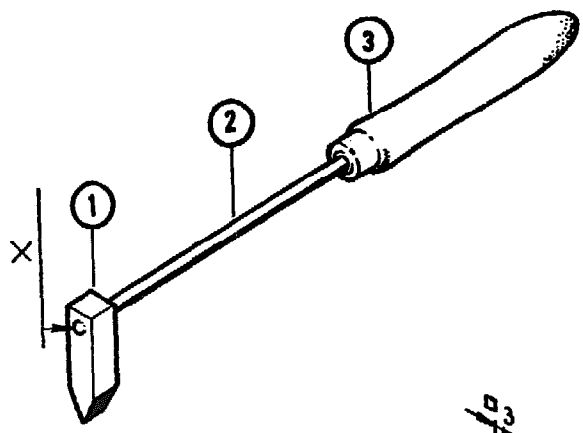


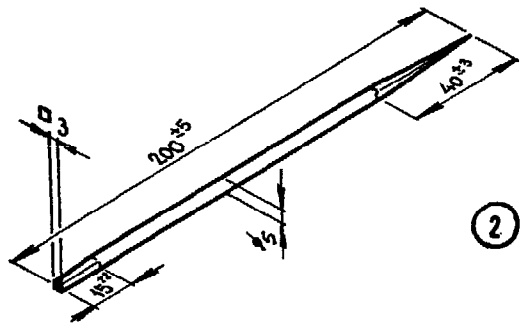
SOLDERING IRON

tolerance on all dimensions 0,5 mm
unless otherwise stated

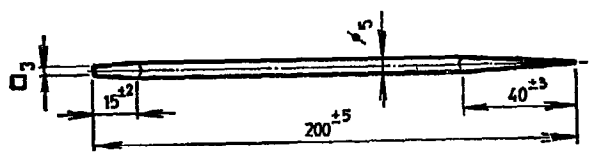
X = hammer

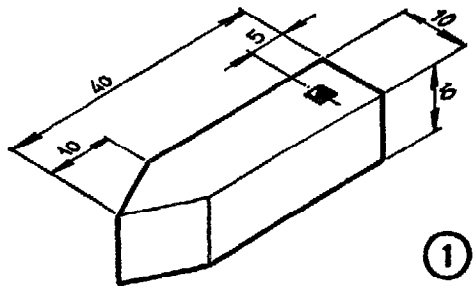
XX = fit to (2)



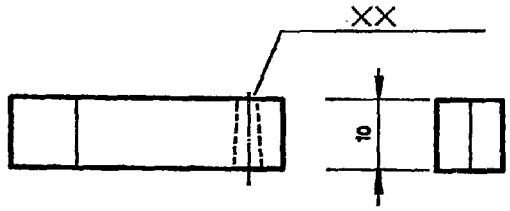


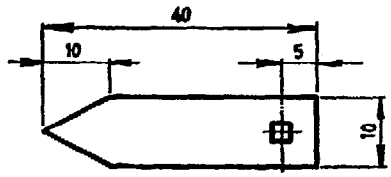
(2)





(1)

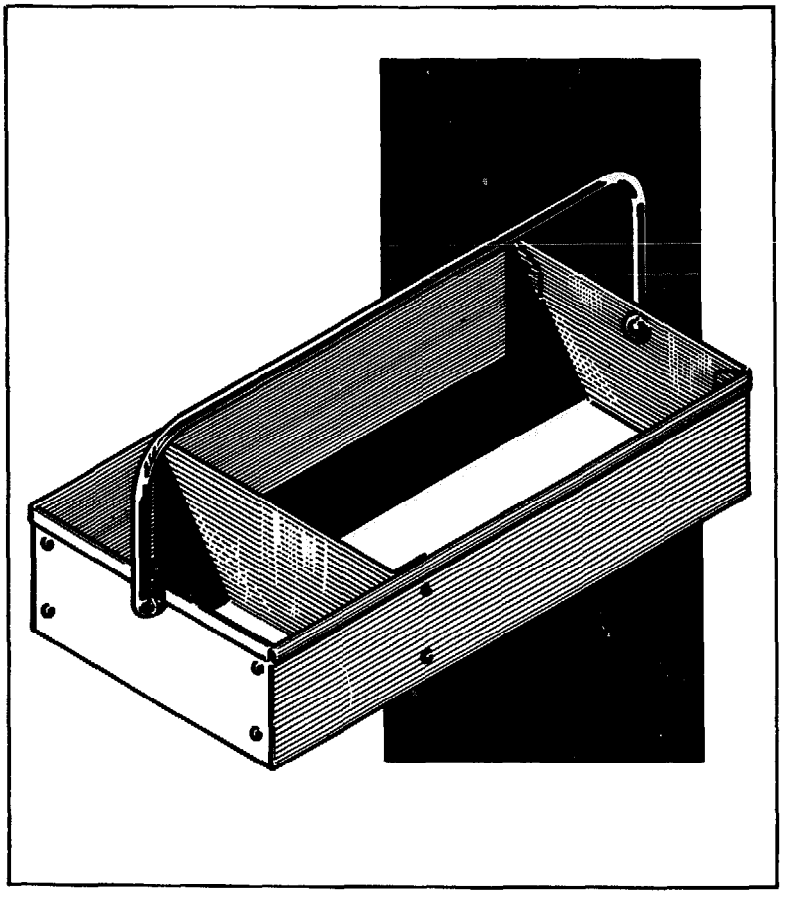


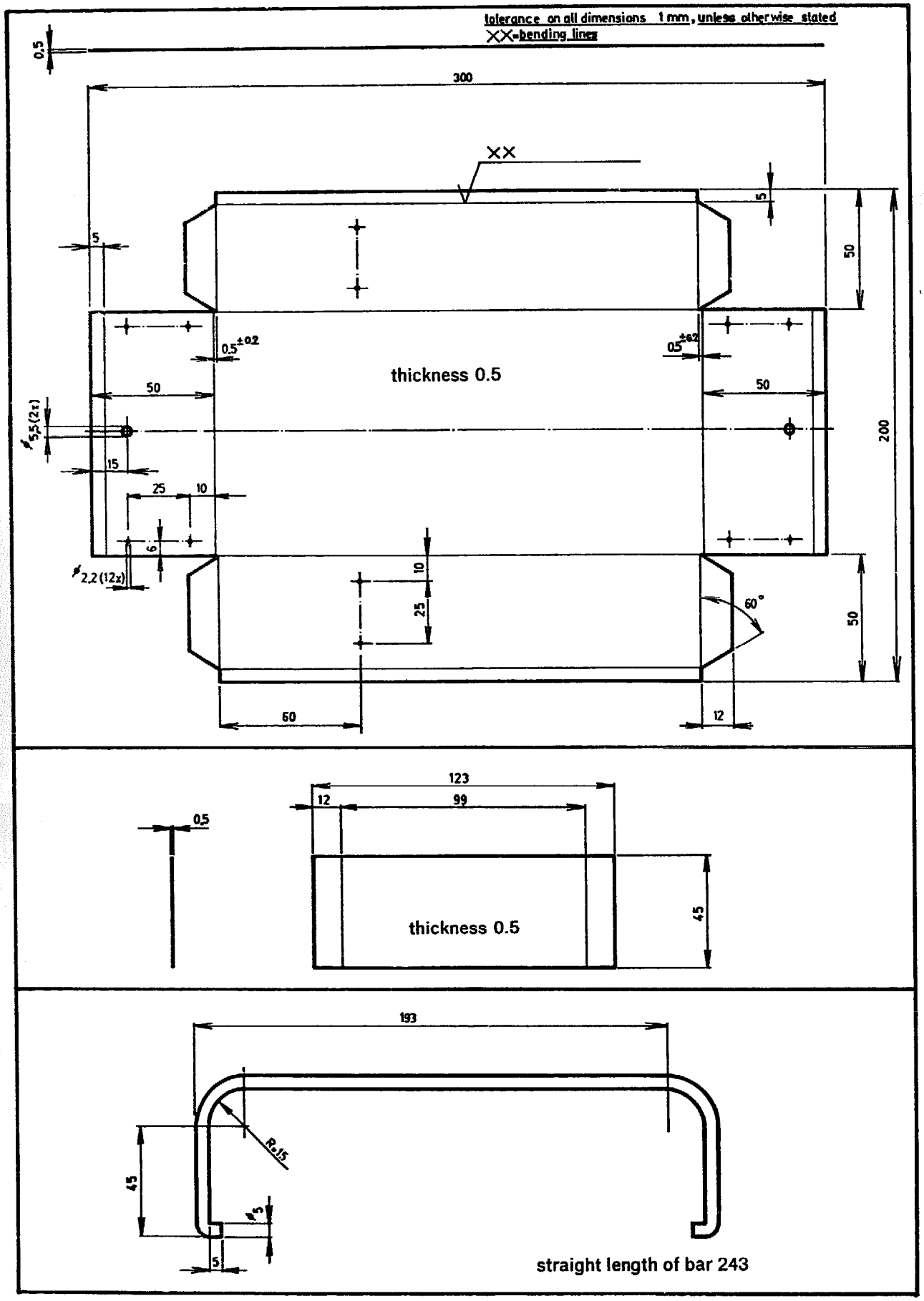


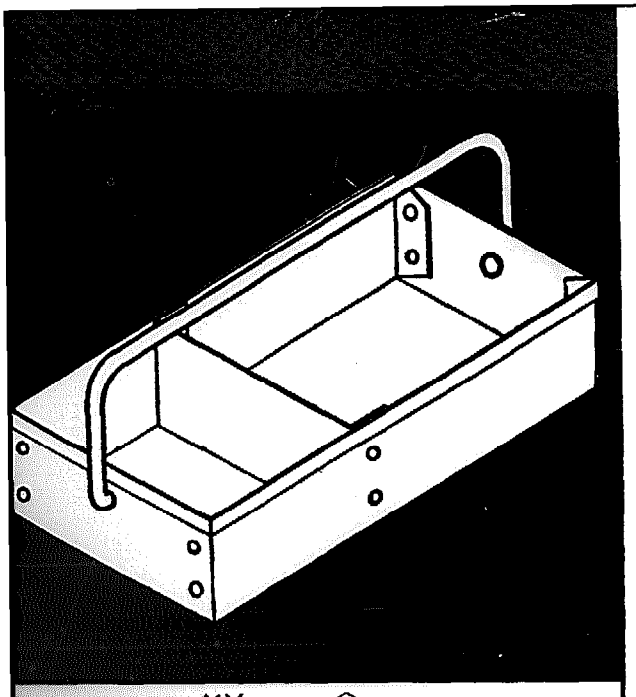
TOOL-BOX

PICTOSTEPS

WORKSHOP INSTRUCTION METAL




tolerance on all dimensions 1 mm, unless otherwise stated
XX=bending lines
0,5
300
XX
5
5
50
50
200
$0,5^{\pm 0,2}$
$0,5^{\pm 0,2}$
thickness 0.5
50
50
ϕ5,5(2x)
15
25
10
6
ϕ2,2(12x)
10
25
60°
50
60
12
0,5
123
12
99
thickness 0.5
45
193
R=15
45
ϕ5
5
straight length of bar 243



TOOL-BOX

USE: A tool-box is a box used for keeping and transporting different tools.

TOOLS:

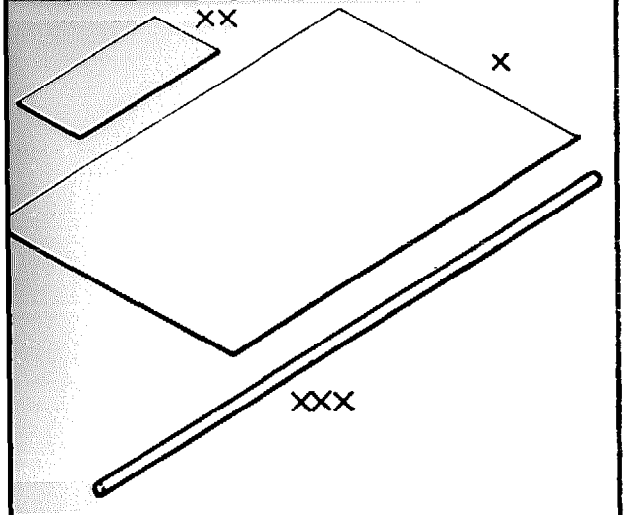
- Ledge
- Try square
- Scriber
- Rule
- Steelstraight edge
- Lever-operated sheer
- Protractor
- Centre punch
- Swage block
- Bar 30 mm dia.
- Smith's hammer
- Smith's fire
- Hammer
- Plate shears
- Hand drill
- Twist drills 2.2 and 5.5 mm
- Vice
- Folding bars
- G-cramp
- Wooden or plastic mallet
- 2 Stakes
- Rivet set
- Snap
- 12 Aluminium rivets 2 mm Ø—5 mm long

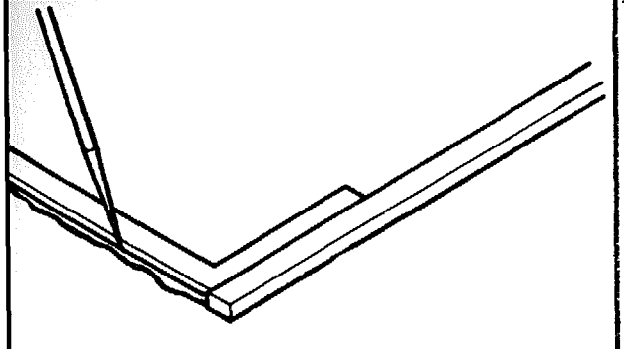
MATERIAL: Black sheet steel 0.5 mm thick

DIMENSIONS: 200 x 300 mm (x)
123 x 45 mm (xx)

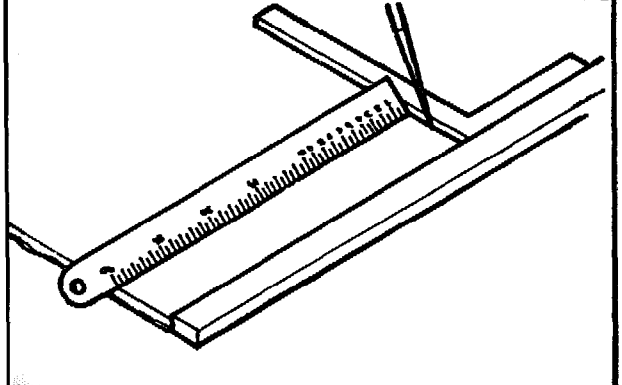
MATERIAL: Bar steel

DIMENSIONS: Diameter 5 mm
Length 243 mm (xxx)

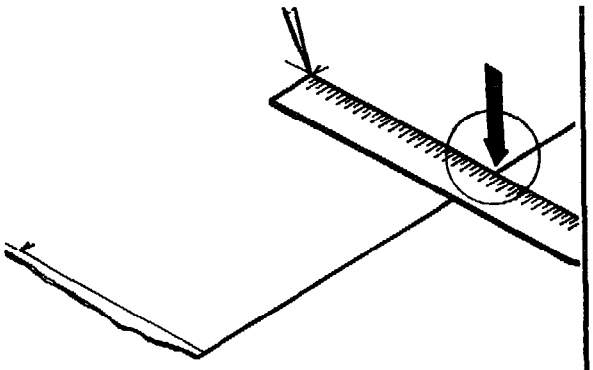




OPERATION	TOOLS
Put ledge along one side which has been cut quite straight. Then scribe perpendicular to ledge. Scribed line as near edge as possible. Use soft scriber (brass).	Ledge. Try square. Scriber.

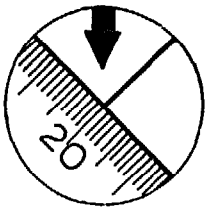


Keep ledge in place. Scribe perpendicular to it at 300 mm from first scribed line.	Ledge. Try square. Scriber. Rule.

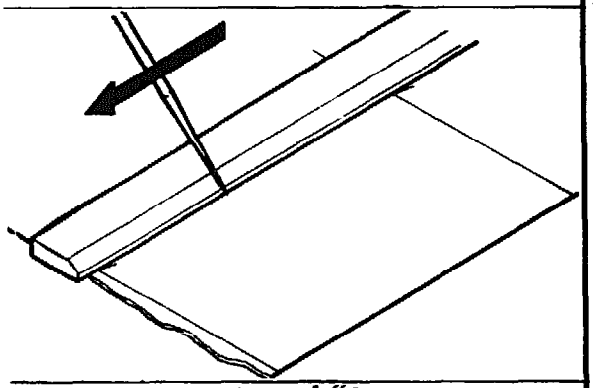


Set off distances of 200 mm on both lines.

Enlarged detail

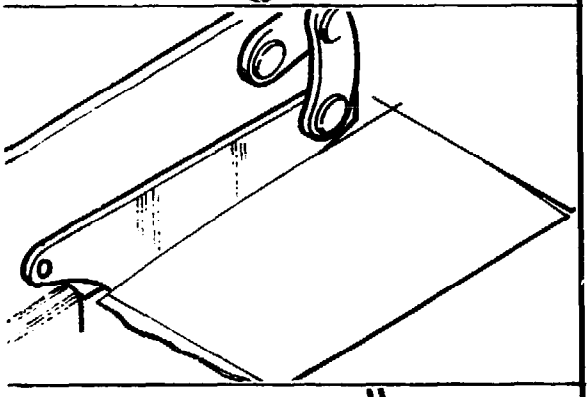


Rule.
Scriber.



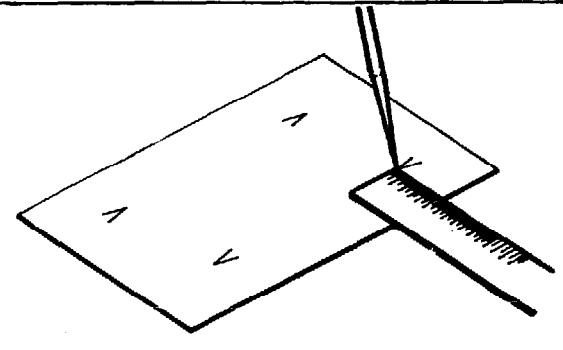
Draw line exactly through the points of the two V-marks marked off.

Steel straight edge.
Scriber.

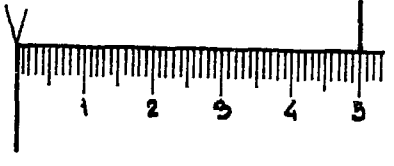


Cut out piece marked out.
Do this exactly on the lines.

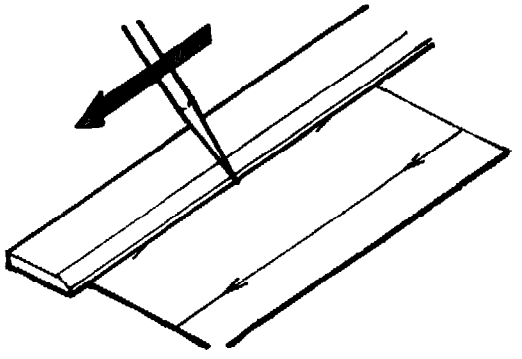
Lever-operated shear.



Mark off two V-marks at 50 mm from each long side

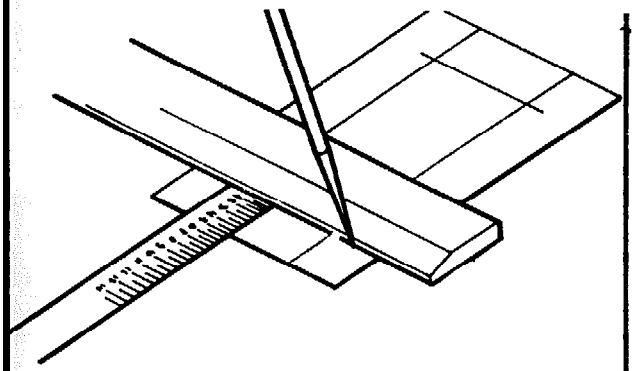


Rule.
Scriber.



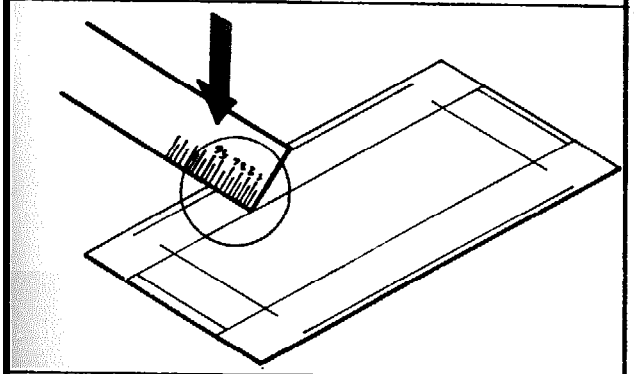
Scribe two lines through V-marks.

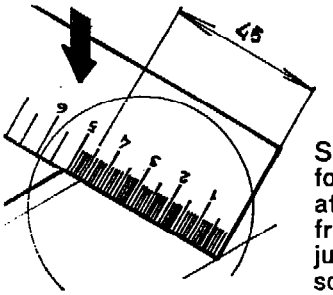
Steel straight edge.
Scriber.



Scribe two lines at 50 mm from short sides.

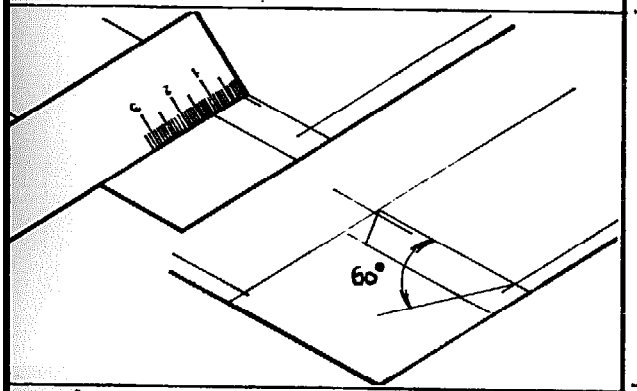
Rule.
Steel straight edge.
Scriber.

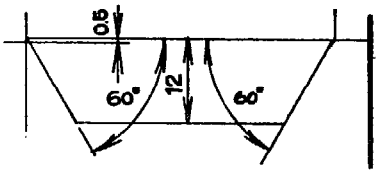




Scribe four lines at 45 mm from lines just scribed.

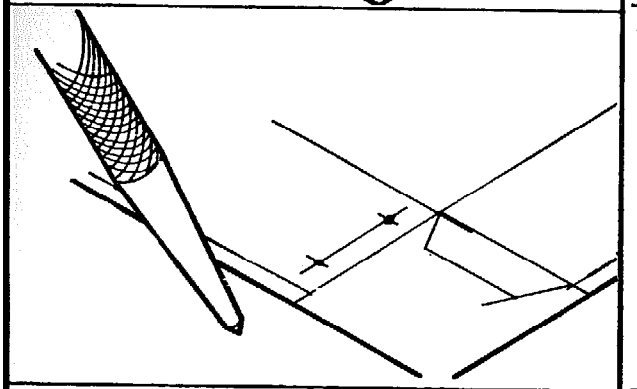
Rule.
Steel straight edge.
Scriber.

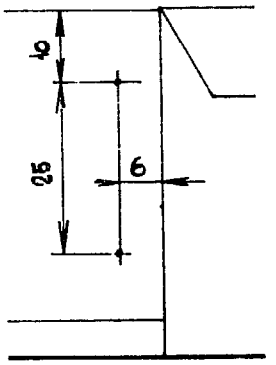




Mark off four corner lap joints as in sketch.
Bending line of lap joint is at 0.5 mm from bending line of side.

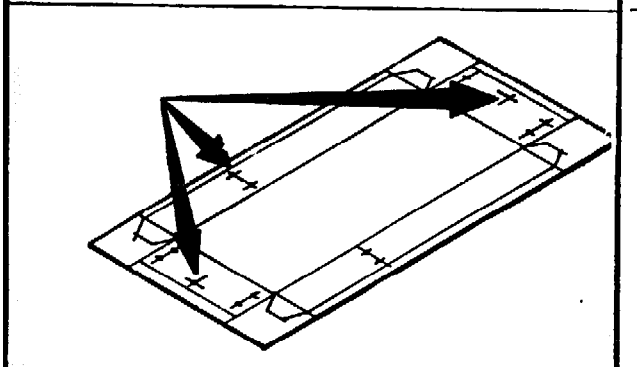
Rule.
Scriber.
Straight edge.



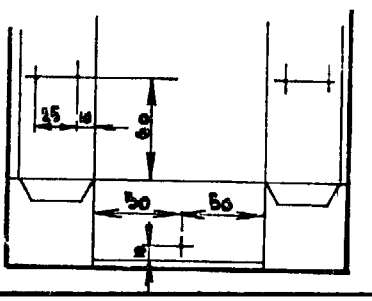


Centre punch eight holes as in sketch.

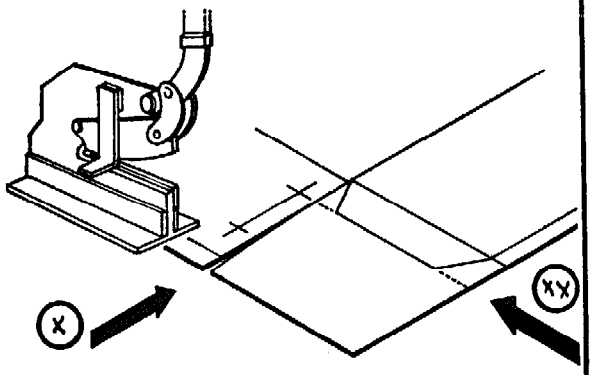
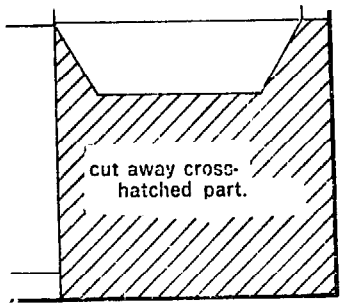
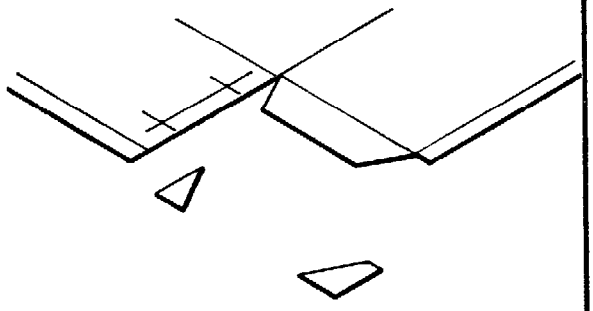
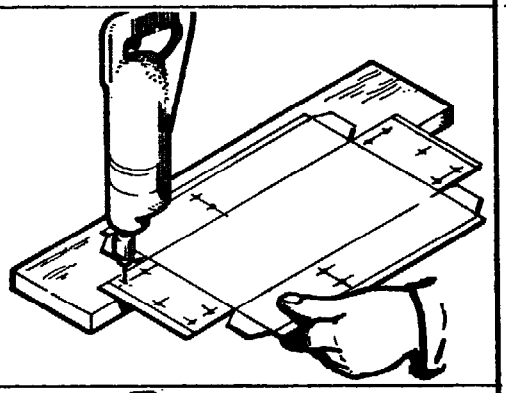
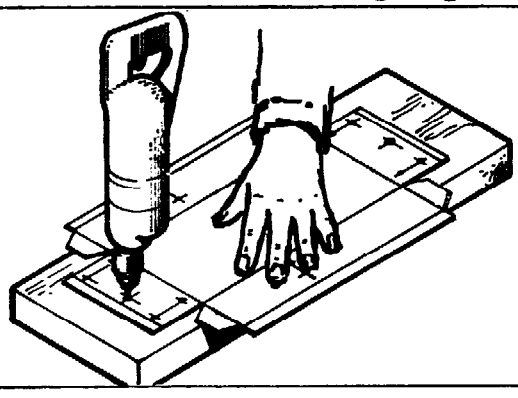
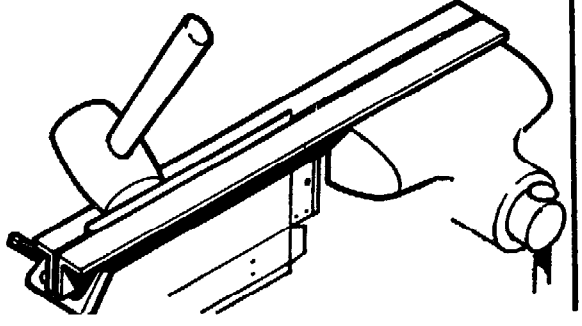
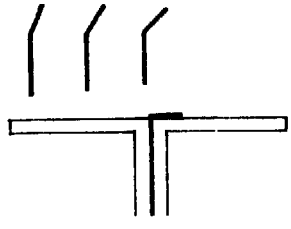
Rule.
Scriber.
Centre punch.
Hammer.

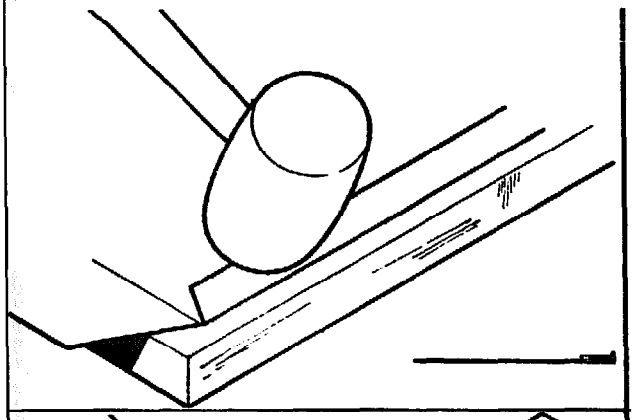
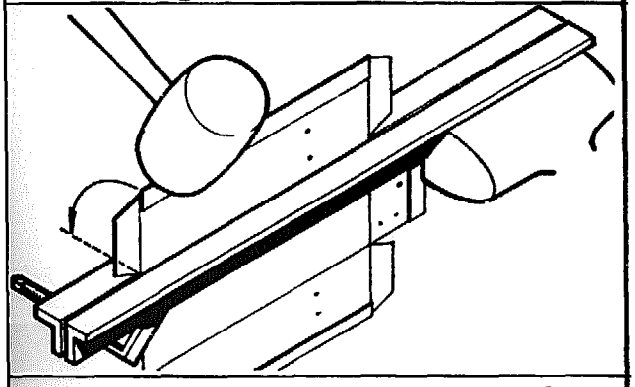
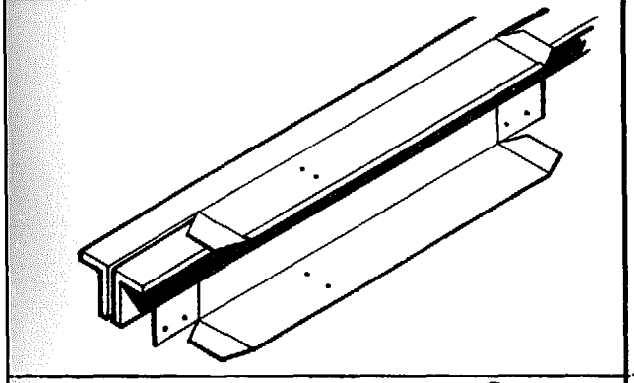
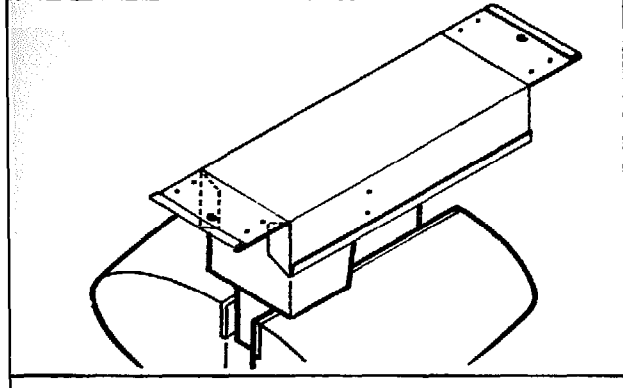
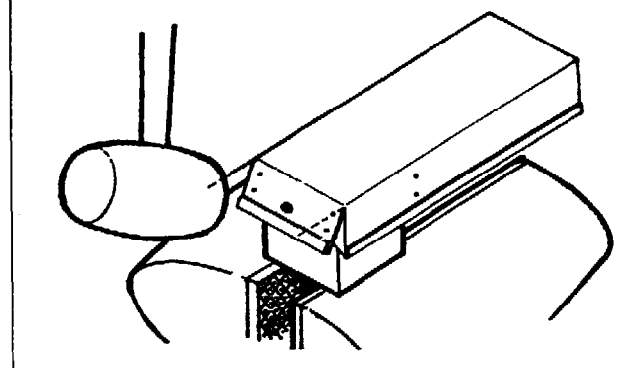


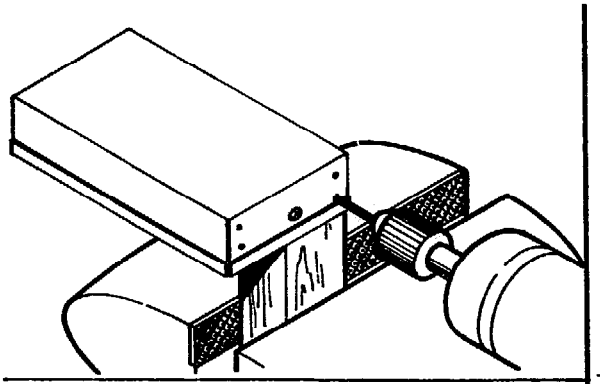
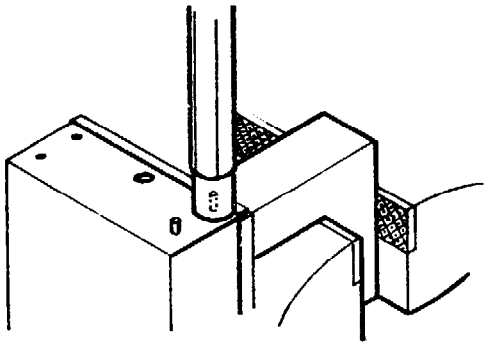
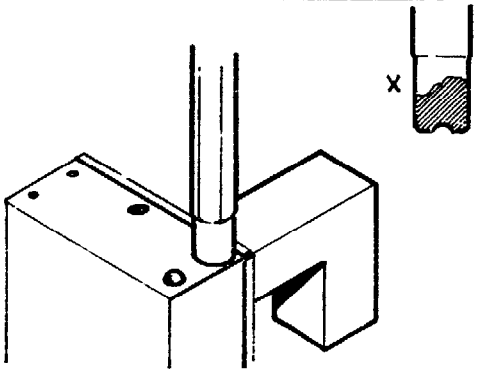
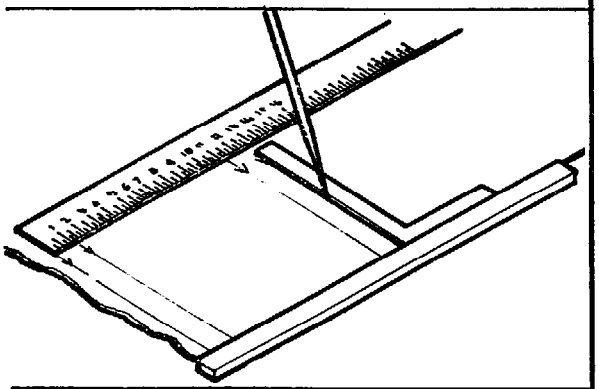
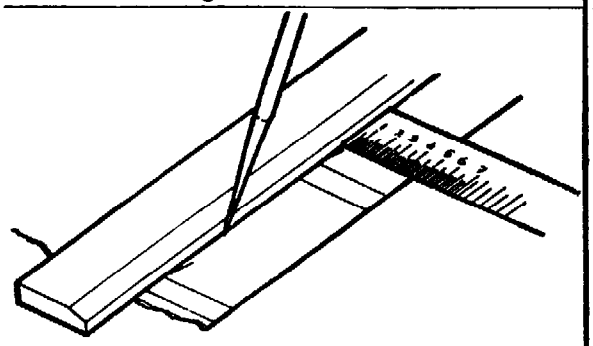
Mark off and centre punch 6 holes as in sketch.

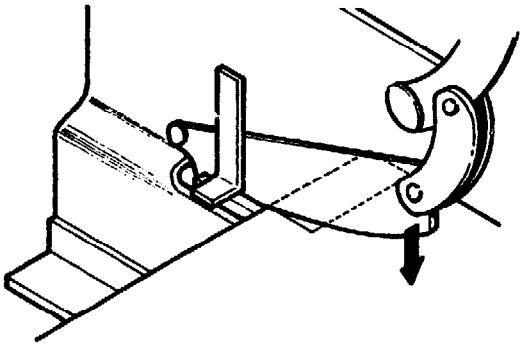
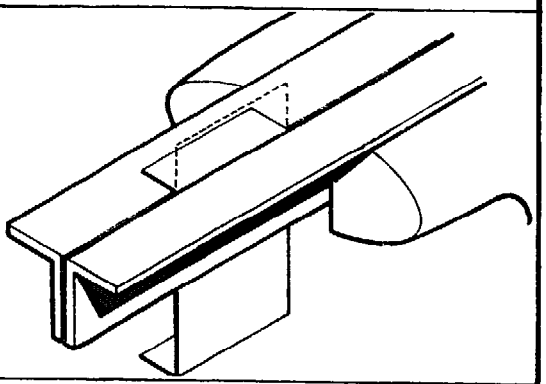
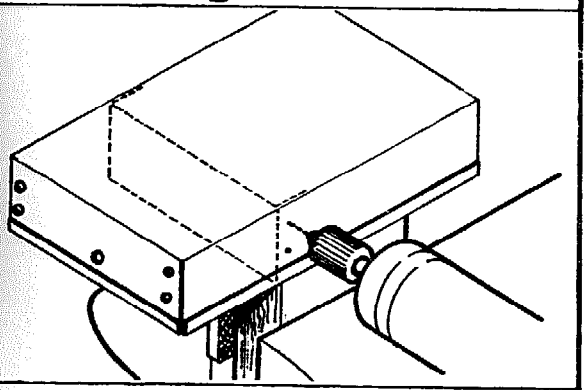
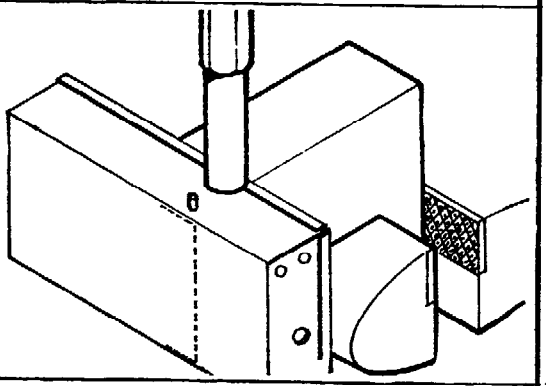
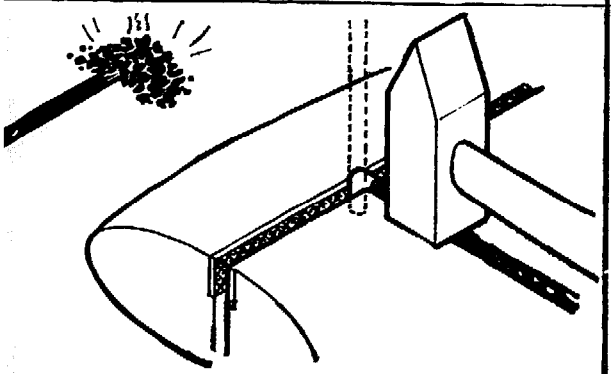
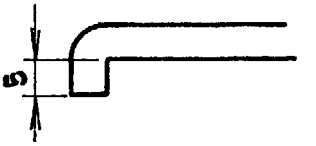


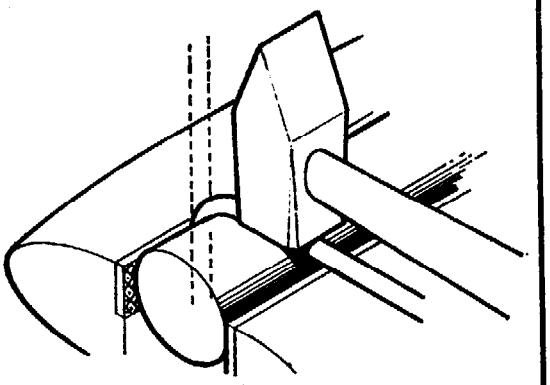
Rule.
Scriber.
Centre punch.
Hammer.

	Remove corners by cutting twice: at x and xx. 	Lever-operated shear.
	Cut away corners. Do likewise at all other corners.	Plate shears.
	Drill 14 holes. Use wooden base to prevent damage to drill.	Hand drill. Twist drill 2.2 mm. Wooden base.
	Drill 2 holes. Use wooden base.	Hand drill. Twist drill 5.5 mm. Wooden base.
	Bend edges on four sides at right angles. This is done in stages. 	Vice. Folding bars or 2 pieces of angle bar. G-cramp. Wooden or plastic mallet.

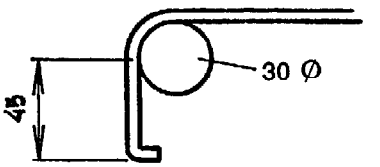
	Fold edges and flatten with mallet. This too is done in stages.	Hard base. Wooden or plastic mallet.
	Bend long side at right angles.	Vice. Folding bars or 2 pieces of angle bar. G-cramp. Wooden or plastic mallet.
	Bend other long side at right angles.	Vice. Folding bars or 2 pieces of angle bar. G-cramp. Wooden or plastic mallet.
	Bend four corner lap joints inward to right angles.	Vice. Stake. Wooden or plastic mallet.
	Bend short sides at right angles.	Vice. Stake. Wooden or plastic mallet.

	Drill holes through sides and lap joints.	Vice. Wooden packing. Hand drill. Twist drill 2.2 mm.
	Place and set rivets: First stick rivets through holes from inside and place on stake. Then put set over shank and press plates together by blow with hammer. Diameter of rivet shanks: 2 mm, length of rivet shanks: 5 mm.	Stake. Vice. Rivet set. Hammer.
	Snap rivet head by means of correct snap. The snap is uesd to give the right shape.	Stake. Vice. Round-head snap (x). Hammer.
	Now the partitions are made. First scribe four lines at right angles to side at 0, 12, 111 and 123 mm.	Ledge. Try square. Scriber. Rule.
	Place two V-marks at 45 mm from bottom line, and scribe line through them.	Rule. Scriber. Straight edge.

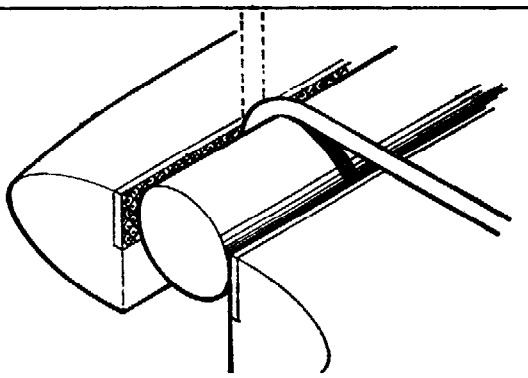
	Cut along outline.	Lever-operated shear.
	Bend along scribed lines.	Vice. Folding bars or 2 pieces of angle bar. G-cramp. Wooden or plastic mallet.
	Drill holes from outside box through partition.	Vice. Wooden packing. Hand drill. Twist drill 2.2 mm.
	Join with four rivets in way described before. Diameter of rivet shanks 2 mm, length of shanks 5 mm. The proper box is finished now.	Stake. Vice. Set. Round-head snap. Hammer.
	The handle is now made. First heat and bend 5 mm dia. bar at 5 mm from tip. Mind exact spot for striking. Be careful when clamping and striking. Bar should remain round. 	Smith's fire. Hammer. Vice or swage block.

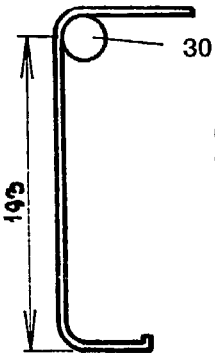


Clamp as shown in sketch (top of jaws a little above centre line of bar. Bent tip pointing in same direction).
Now cold bend at 15 mm radius.



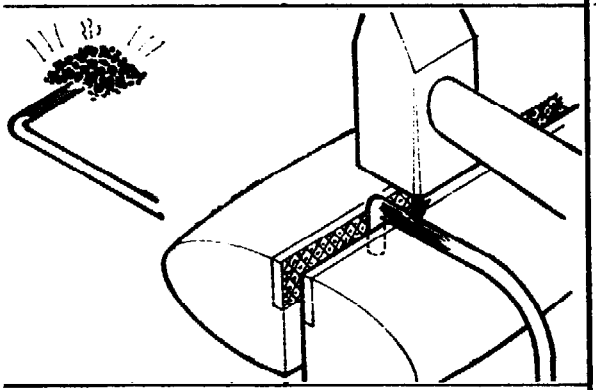
Vice.
30 dia. bar.
Hammer.





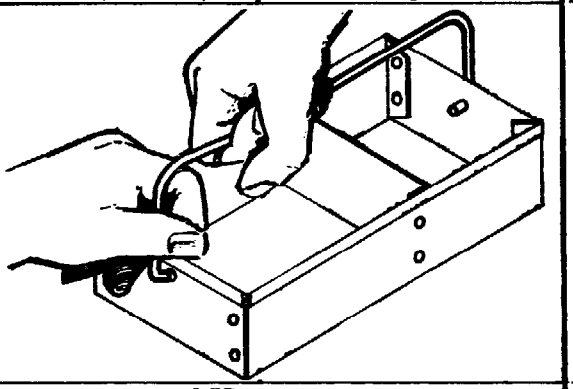
In same way cold bend other leg at 15 mm radius. Legs should be parallel.

Vice.
30 dia. bar.
Hammer.

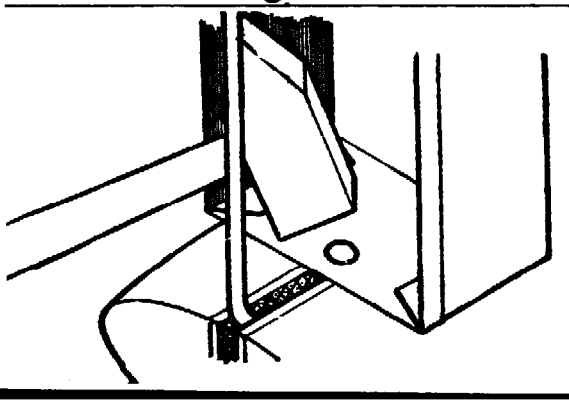


Heat second tip and bend.
Mind spot to be struck.
Be careful when clamping and striking. Bar should remain round.

Smith's fire.
Hammer.
Vice or swage block.



Mount handle by putting tips in drilled holes.



Set up tips to round heads on inside.

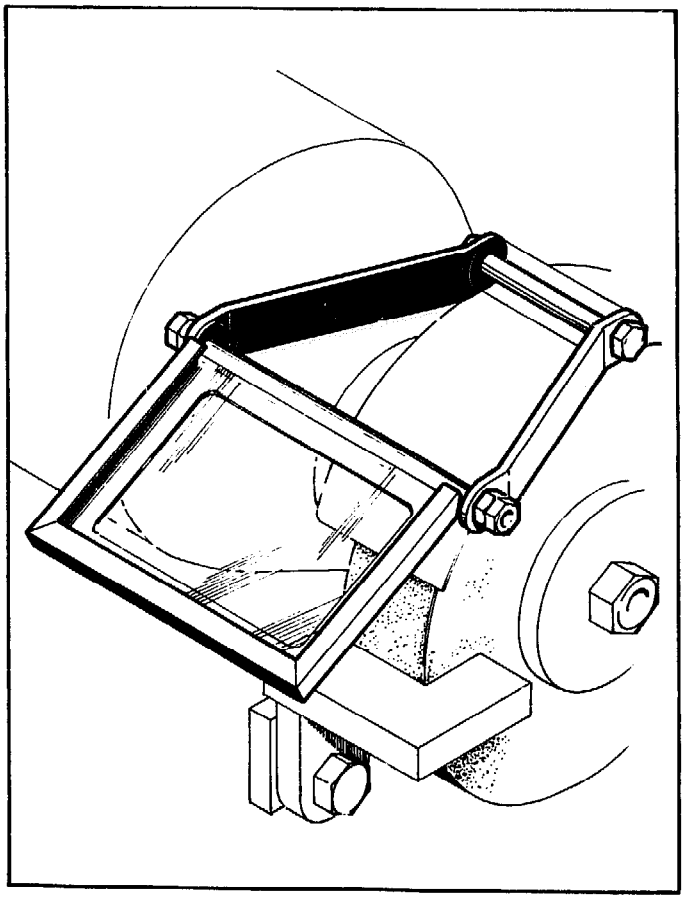
Vice.
Hammer.

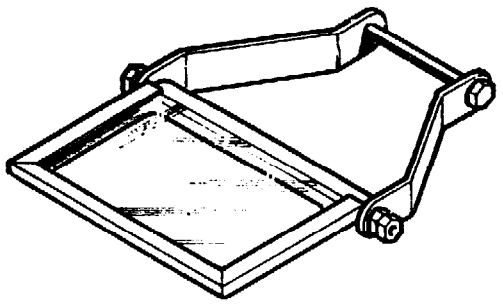
Code 1006 - INTEMS B.V. - P.O.Box 262
4100 AG Culemborg - The Netherlands

EYE SHIELD

PICTOSTEPS

WORKSHOP INSTRUCTION METAL



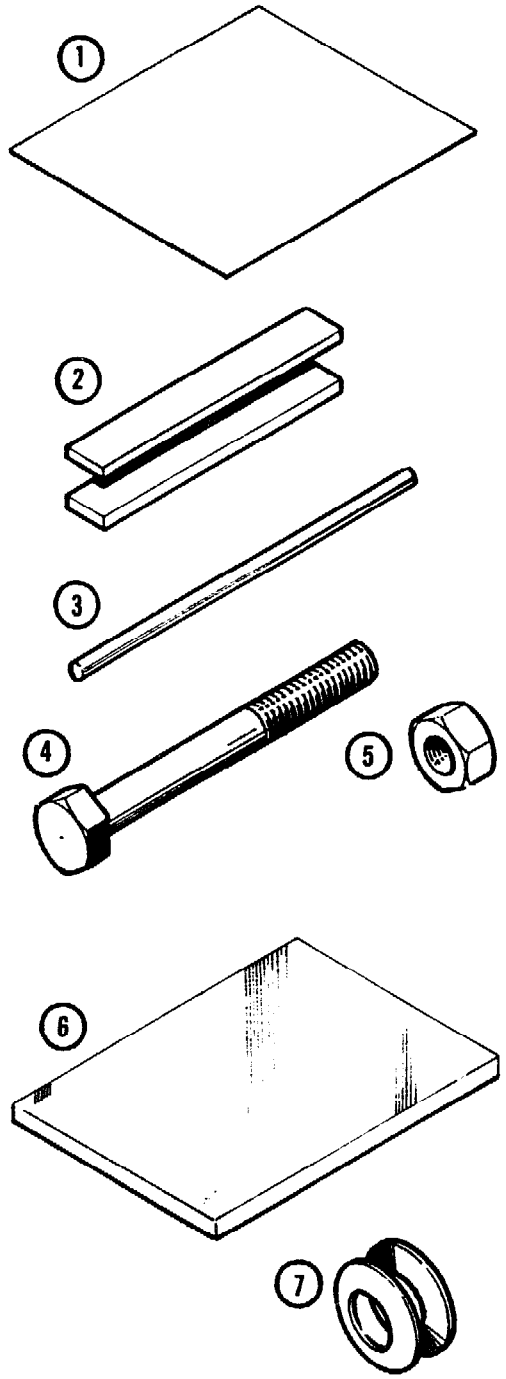


EYE SHIELD

USE:

This eye shield can be attached to a grinding machine to protect the eyes against flying sparks.

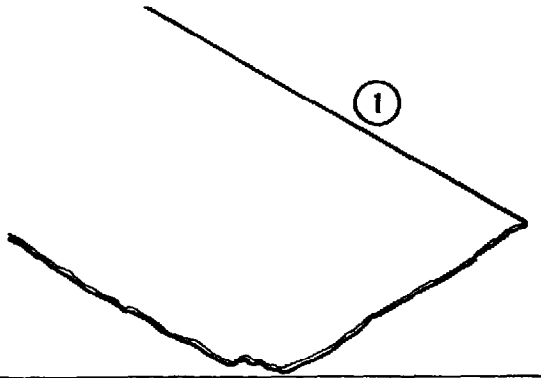
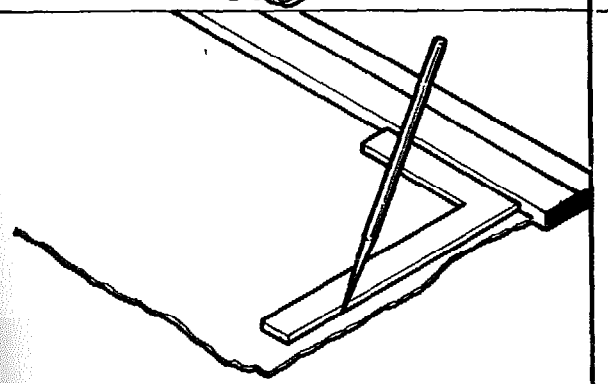
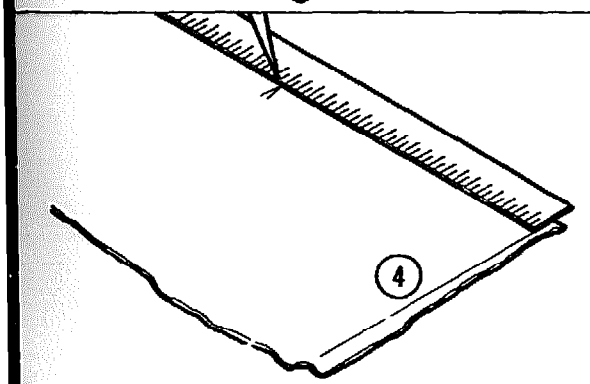
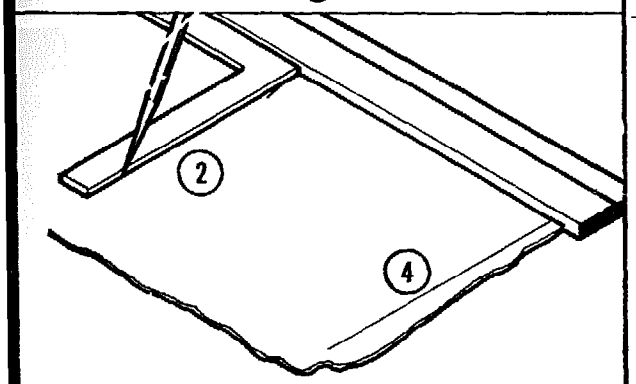
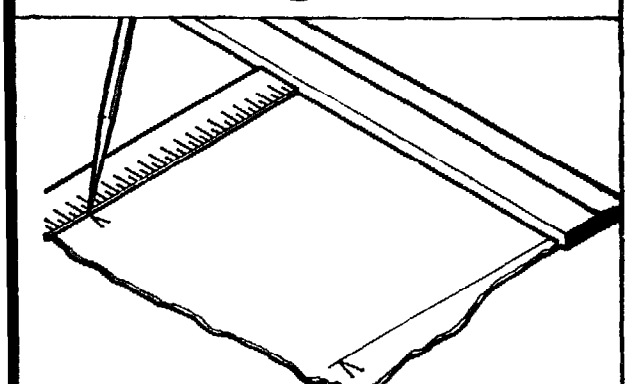
For the construction two auxililiary tools (folding jigs) are used which we are also going to make.

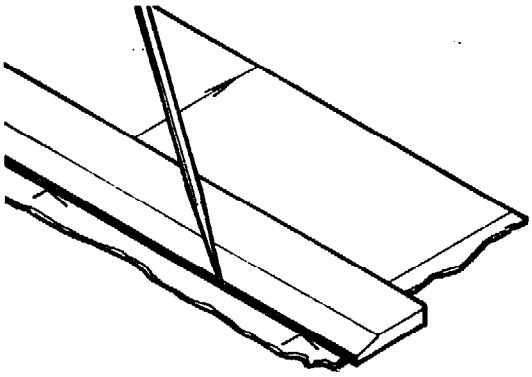
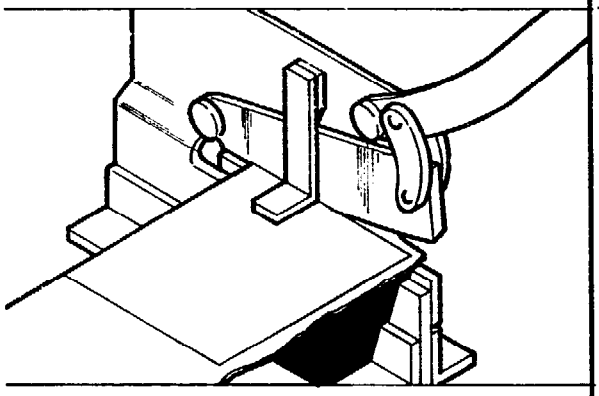
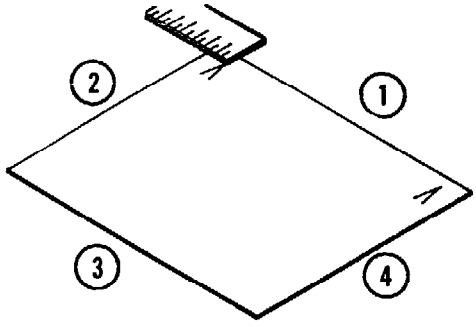
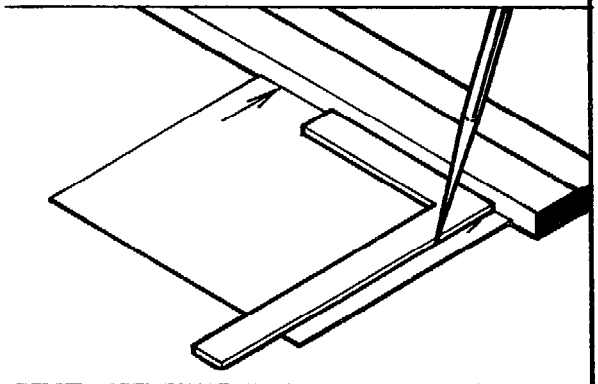
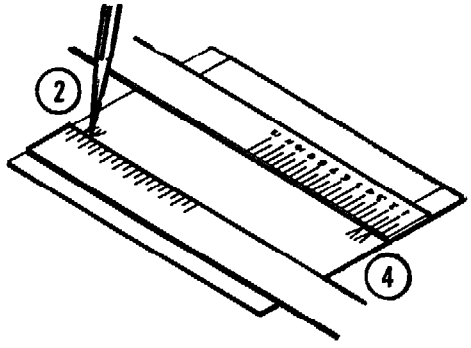


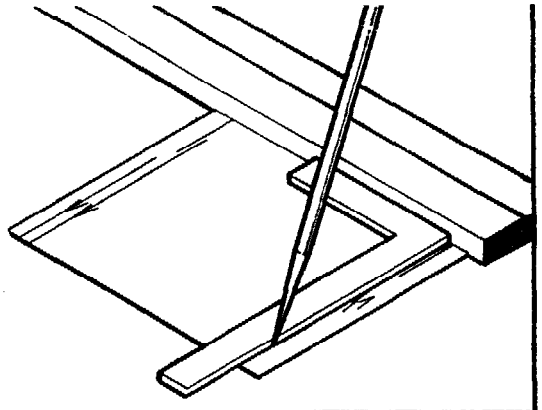
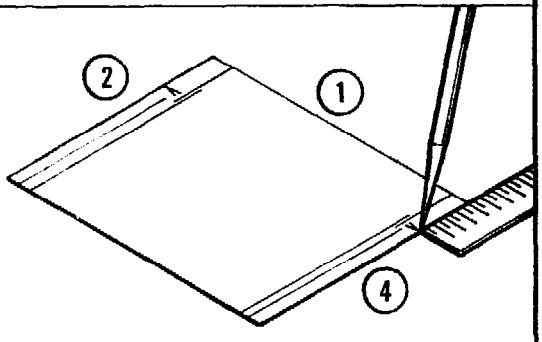
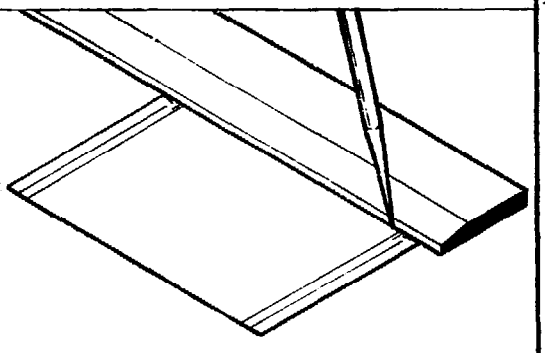
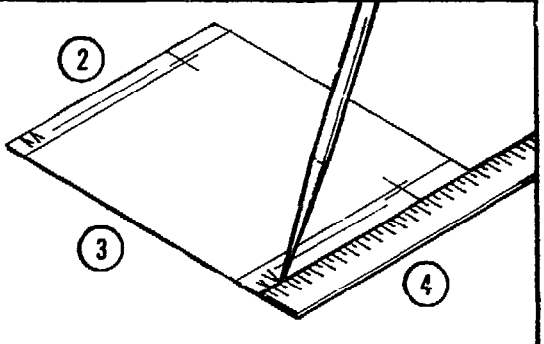
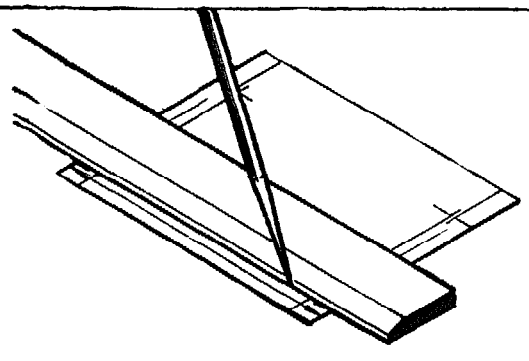
MATERIAL:		**DIMENSIONS:**
1	Black sheet steel	1.5 x 212 x 173 mm.
2	Mild steel	6 x 25 x 162 mm. (two pieces)
3	Mild steel	3/8" dia. 225 mm.
4	1 Bolt	3/8" UNF thr. 105 mm.
5	1 Nut	3/8" UNF
6	Glass plate	5 x 115 x 177 mm.
7	2 Spring washers	

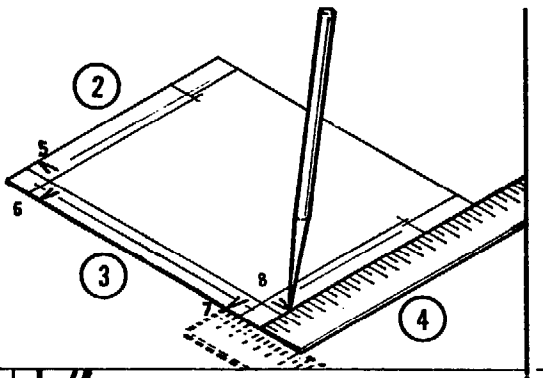
TOOLS:

Scriber.
Square.
Rule.
Steel straight edge.
Lever shears.
Centre punch.
Hammer.
Drilling machine.
Drilling vice.
Twist drill 3 mm.
Twist drill 10 mm.
Spring dividers.
Flat chisel.
Surface plate.
Wooden mallet.
Piece of wood 20 x 25 cm.
2 Angle sections:
30 x 30 x 5 — 350 mm long.
Second-cut hand file.
Bastard hand file.
Vice.
4 G-cramps.
Seam set.
Hack saw.
Try square.
Bevel protractor.
Screw stock and die 3/8" UNF.
3/8" spanners.
Iron support 1/2" x 1" x 7".
Cutting-out block.
Copper (vice clamps).
Panel pins.

	OPERATION	TOOLS
	The working drawing is on page 16. Also study the development on page 17. The letters and numbers are referred to in the following descriptions of operations. For the construction of the frame we start from a 1.5 mm thick sheet with one trued edge. This is side No. 1.	
	Scribe line square to trued edge and as near rough edge as possible. This is side No. 4. Use steel straight edge as support for square.	Scriber. Square. Steel straight edge.
	From this line mark off 212 mm on trued edge (side 1).	Scriber. Rule.
	Scribe line through this point square to trued edge. This is side No. 2. Use steel straight edge as support for square.	Scriber. Square. Steel straight edge.
	Mark off 173 mm on sides 2 and 4 measured from side 1. Use steel straight edge as support for rule.	Scriber. Rule. Steel straight edge.

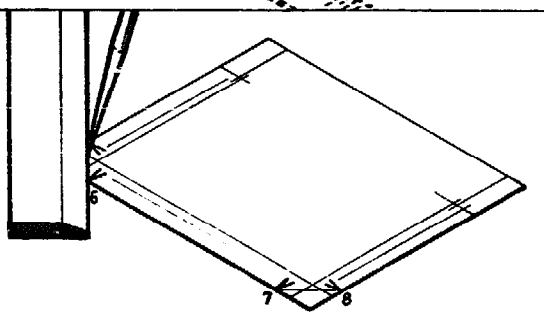
	Scribe line through the two points marked off. This is side No. 3.	Scriber. Steel straight edge.
	Cut out (shear) accurately on lines. The sheared work is 175 x 212 mm. Remove burr w th second-cut hand file.	Lever shears. Second-cut hand file.
	Mark off 16 mm from sides 2 and 4 as shown.	Scriber. Rule.
	Through these points scribe two short lines (A and B on page 17) square to long side. Use steel straight edge as support for square.	Scriber. Square. Steel straight edge.
	Mark off distances of 11.5 and 17.5 mm from sides 2 and 4 as shown.	Scriber. Rule.

	Through these four points scribe lines C, D, E and F (see p. 17) square to side 1. Use steel straight edge as support for square.	Scriber. Square. Steel straight edge.
	On sides 2 and 4 mark off 37 mm from side 1 as shown.	Scriber. Rule.
	Scribe short lines G and H (see p. 17) through these two points as shown in figure. These lines are scribed from the sides to just past lines D and E.	Scriber. Steel straight edge.
	On sides 2 and 4 mark off 11.5 and 17.5 mm from side 3 as shown.	Scriber. Rule.
	Scribe short lines I and J through these two points as shown in figure.	Scriber. Steel straight edge.



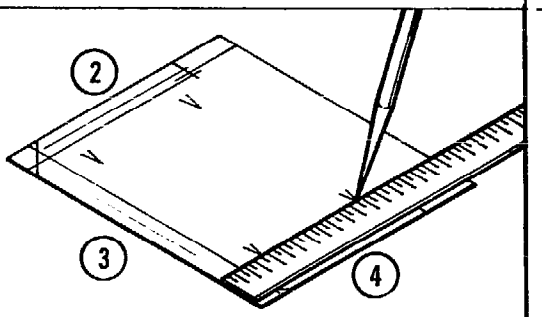
From the corners mark off 27.5 mm on sides 2, 3 and 4 as shown. The four points obtained are numbered 5, 6, 7 and 8.

Scriber.
Rule.



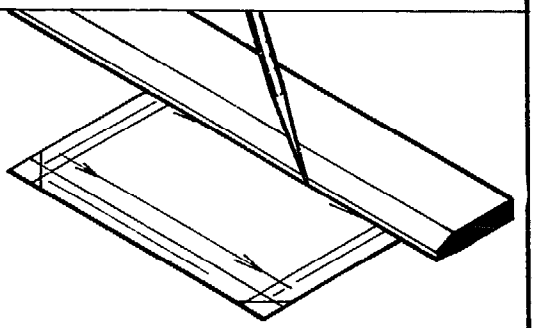
Scribe lines K and L as shown. Line K connects points 5 and 6. Line L connects points 7 and 8.

Scriber.
Steel straight edge.



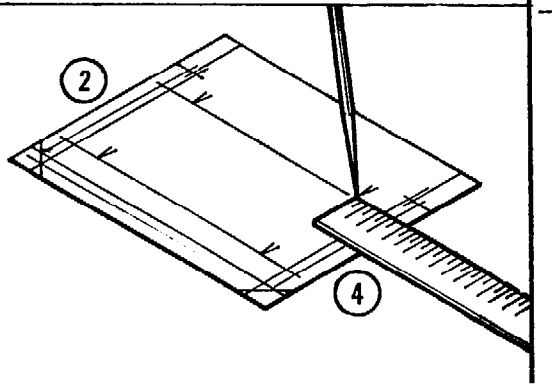
About 40 mm from sides 2 and 4 put V-marks at distances 38.5 and 118.5 mm from side 3.

Scriber.
Rule.



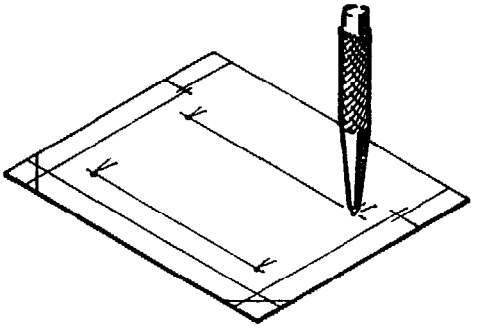
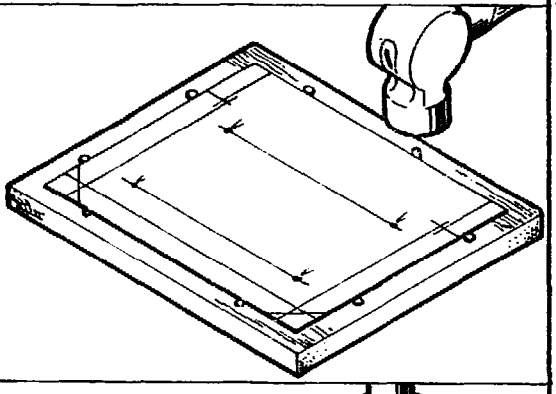
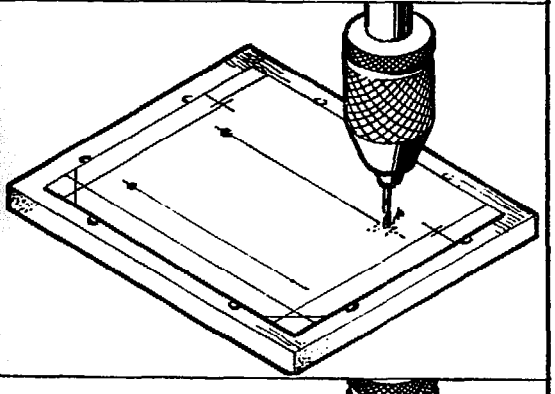
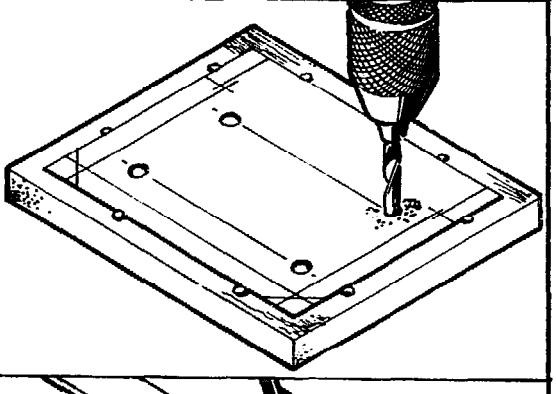
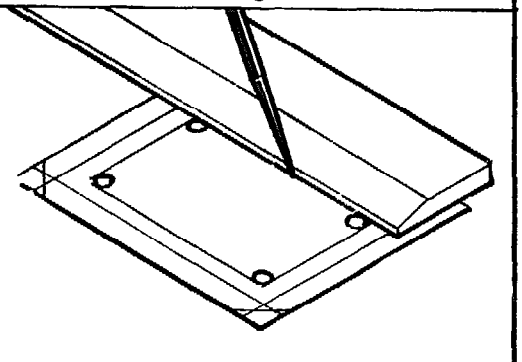
Scribe lines M and N through these V-marks as shown in figure.

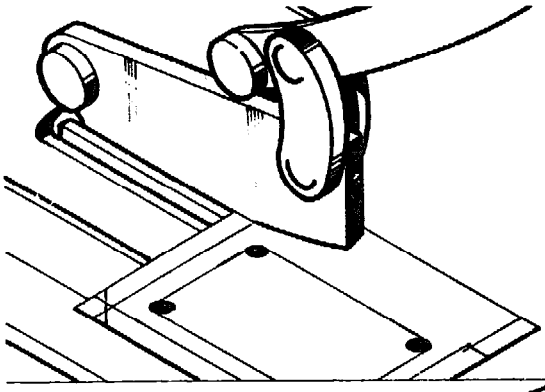
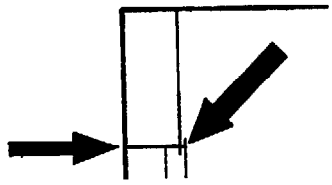
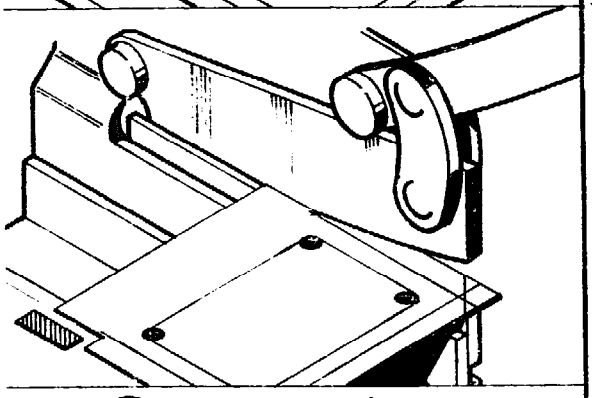
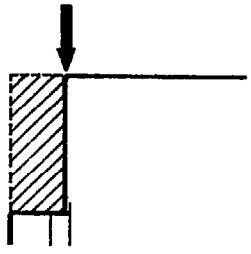
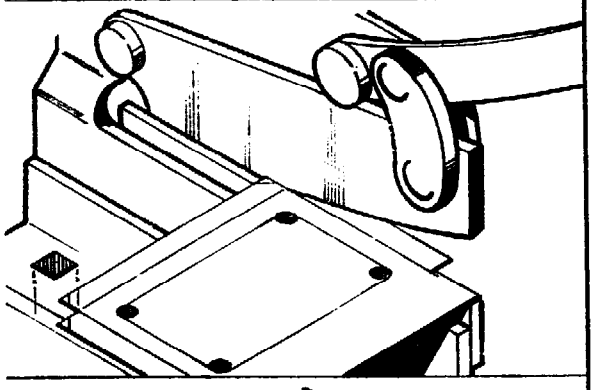
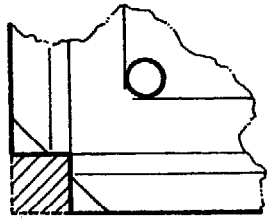
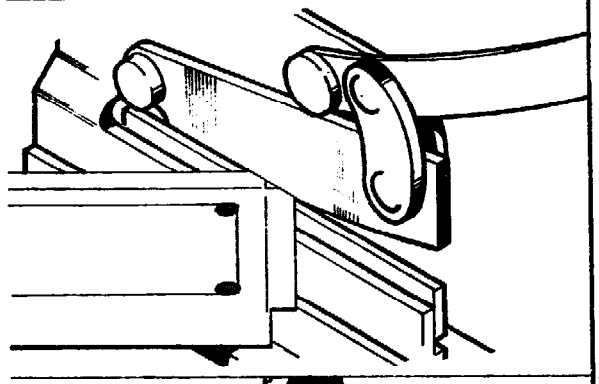
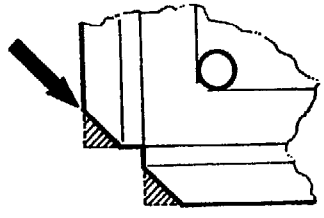
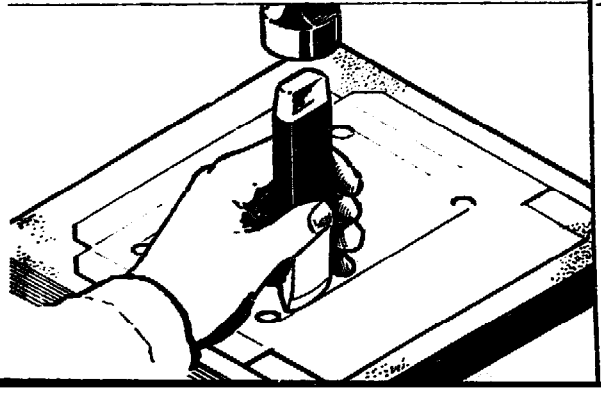
Scriber.
Steel straight edge.

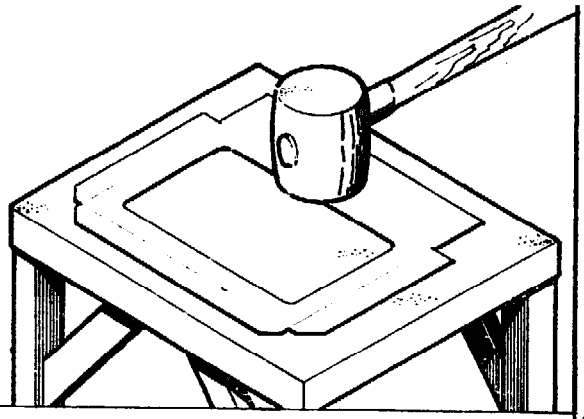


On both these lines M and N mark off 38.5 mm from side 2 and side 4. There are now two V-marks on both lines M and N.

Scriber.
Rule.

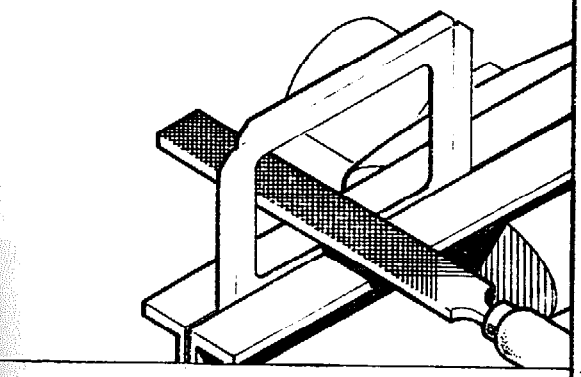
	Centre punch the four points found in this way.	Centre punch. Hammer.
	Fix work on piece of wood by means of panel pins around edge.	Piece of wood. 8 Panel pins. Hammer.
	Drill four holes 3 mm dia. through centres.	Drilling machine. Twist drill 3 mm.
	Enlarge holes to 10 mm dia.	Drilling machine. Twist drill 10 mm dia.
	Scribe four lines tangent to holes as shown in figure.	Scriber. Steel straight edge.

	Cut sheet at two places along lines G and H as shown in figure below. Cut up to innermost line. 	Lever shears.
	Remove corner pieces (hatched parts in figure below). Cut along lines A and B. 	Lever shears.
	Remove parts on opposite side indicated by hatching in figure below. 	Lever shears.
	Remove parts indicated by hatching in figure below (along lines K and L). 	Lever shears.
	Cut out window space with flat chisel. Stay some distance within scribed lines. Use cutting-out block of unhardened steel.	Flat chisel. Hammer. Cutting-out block.



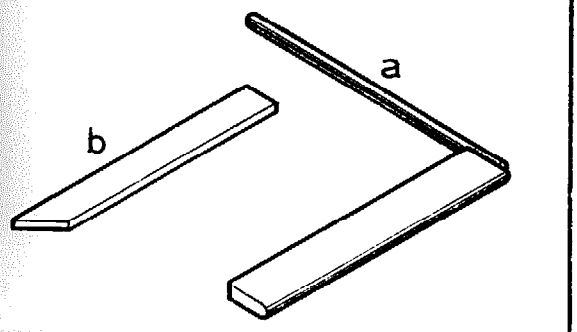
Flatten work with mallet on surface plate.

Surface plate.
Wooden mallet.

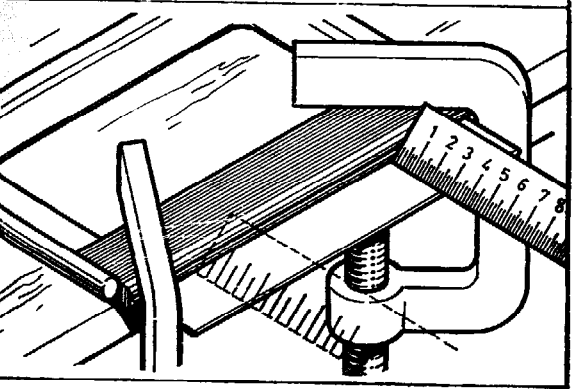


File window space to scribed lines. Clamp frame between two angle sections 30 x 30.5 mm.

2 angle sections 30x30.5 mm.
Second-cut hand file.
Vice.

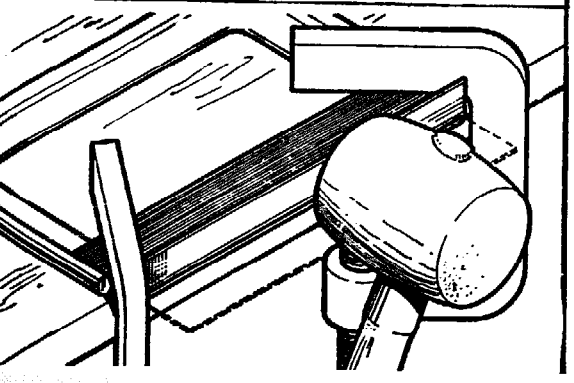


To give the work the required shape the two folding jigs **a** and **b** will be used.
How these jigs are made is described on pages 18 and 19.
The dimensioned drawings are on page 20.



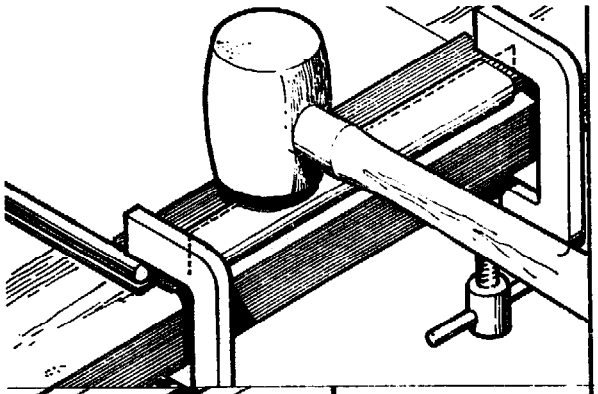
Clamp work, together with jig **a**, on edge of bench by means of two G-cramps as shown in figure. Side 1 of work extends 27 mm from jig **a**.

Jig **a**.
2 G-cramps.
Rule.



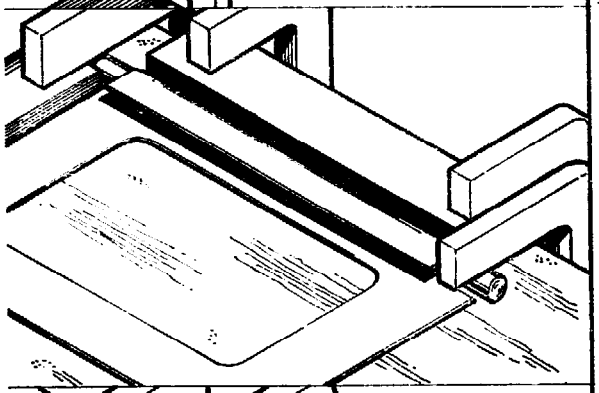
Bend projecting part round jig **a** to right angle, as shown in figure.

Jig **a**.
2 G-cramps.
Wooden or rubber mallet.



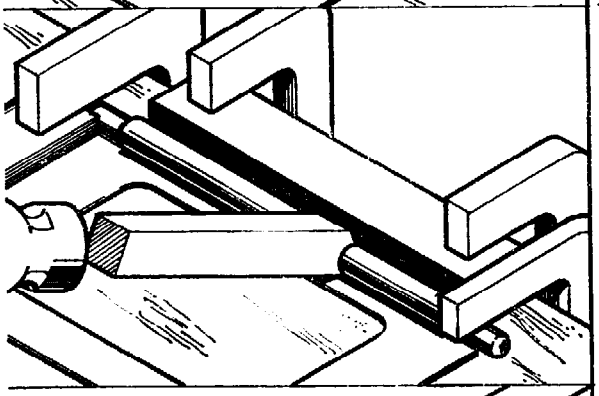
Continue bending until bent part is flat on jig **a**.

Jig **a**.
2 G-cramps.
Wooden or rubber mallet.



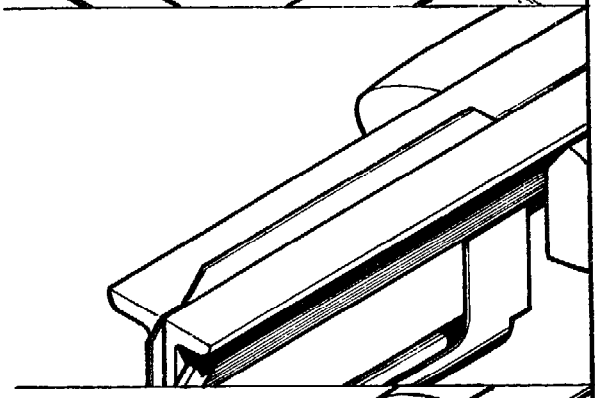
Clamp work jig **a** on bench as shown in figure.
Place support against rounded part.
The support is a piece of iron ½ " x 1" x 7".

Jig **a**.
4 G-cramps.
Support ½ " x 1" x 7".



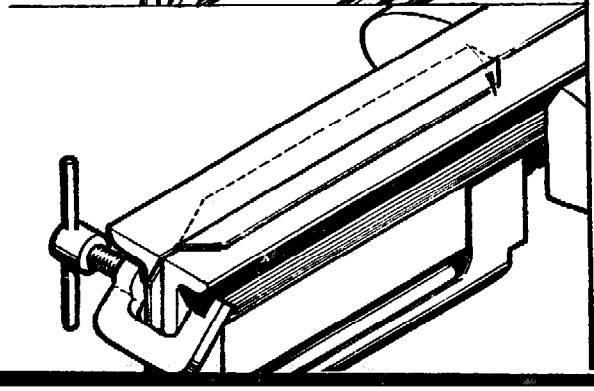
The beaded edge is finished by means of a steel seam set.
The support prevents the work from being knocked away.

Jig **a**.
4 G-cramps.
Support.
Seam set.
Hammer.



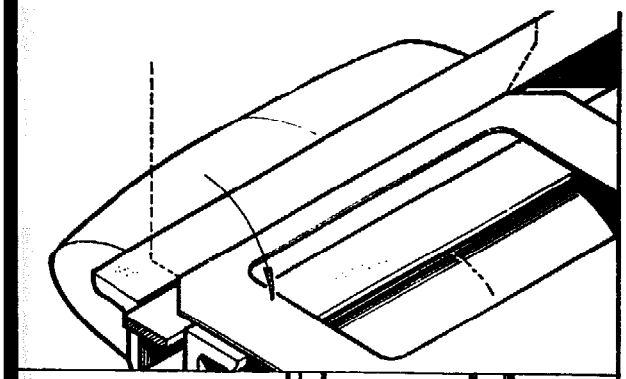
Clamp opposite side between two angle sections.
Line J coincides with top edge of sections.

Vice.
2 angle sections 30x30.5 mm.
G-cramp.

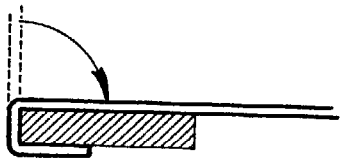


Bend projecting part to right angles.
Note position of beaded edge.
See figure.

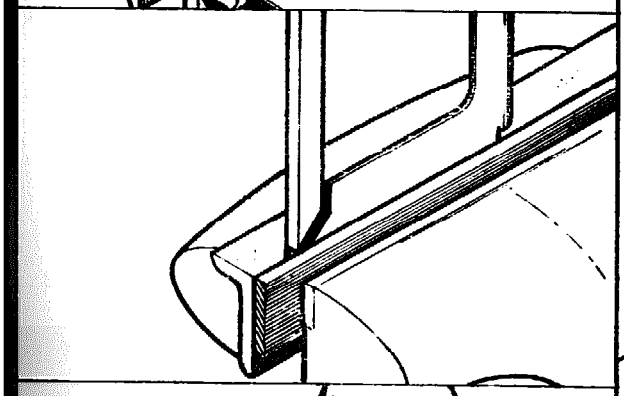
Vice.
2 angle sections 30x30.5 mm.
G-cramp.
Wooden or rubber mallet.



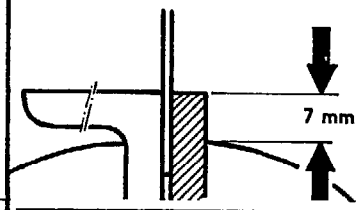
Clamp work together with jig **b** between the angle sections.
The bent part is under jig.
Bend to right angles.



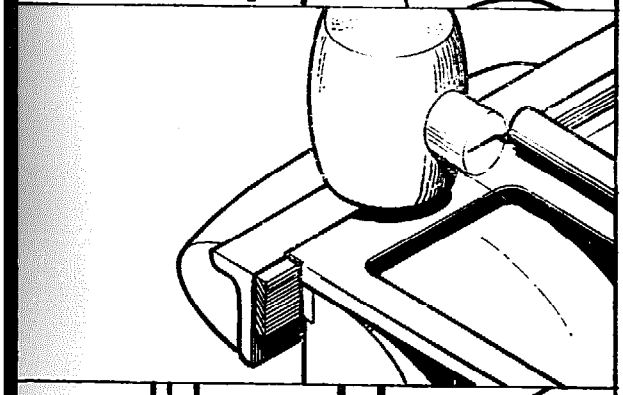
Vice.
2 angle sections 30x30.5 mm.
Jig **b**.
Wooden or rubber mallet.



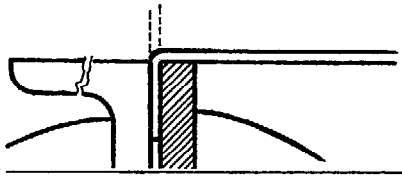
Clamp one of the sides between jig **b** and one angle section in vice.
Outermost bending line coincides with top edge of section.



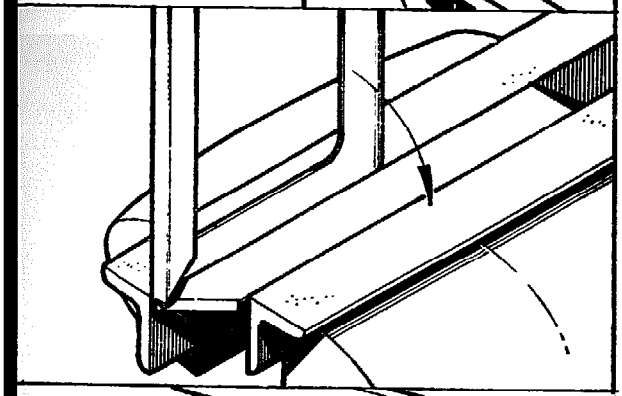
Vice.
Angle section 30x30.5 mm.
Jig **b**.



Bend to right angles as shown.

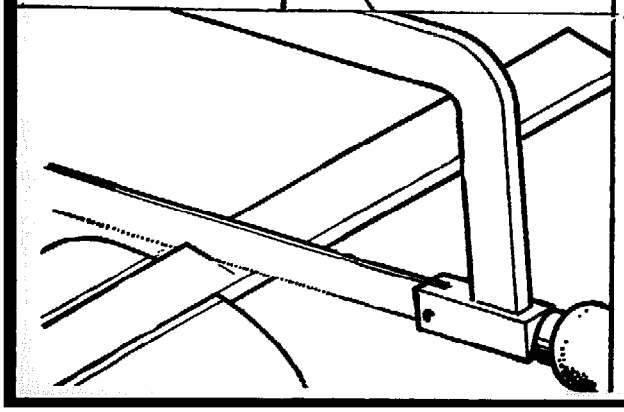


Vice.
Angle section 30x30.5 mm.
Jig **b**.
Wooden or rubber mallet.



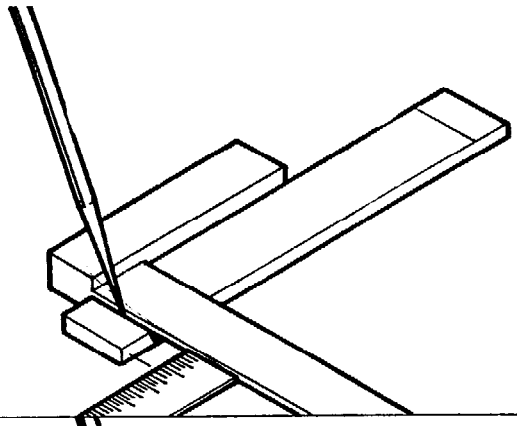
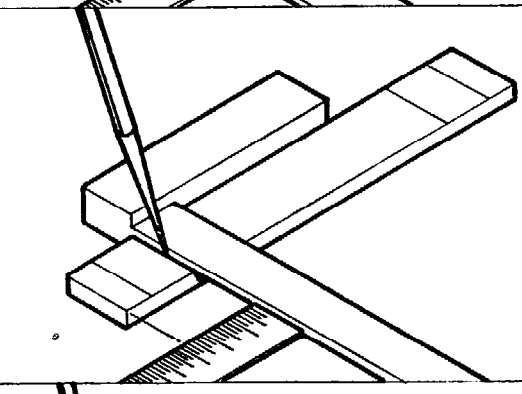
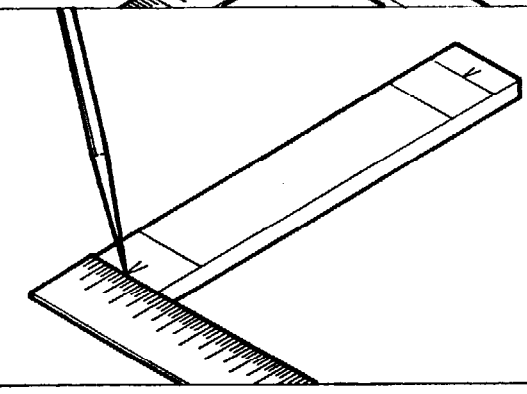
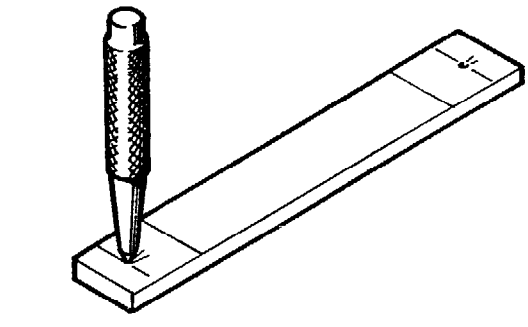
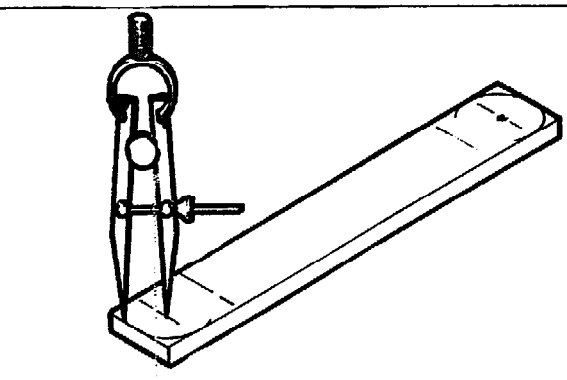
Clamp work with jig **b** as shown.
Bend to right angles.
Repeat whole operation on other side of work.

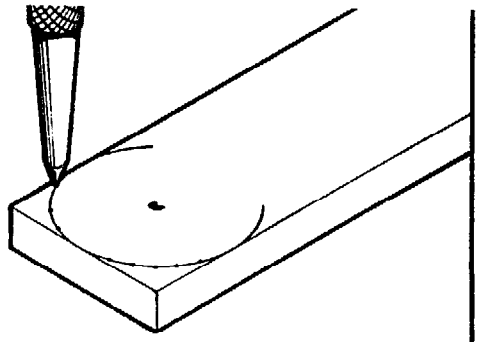
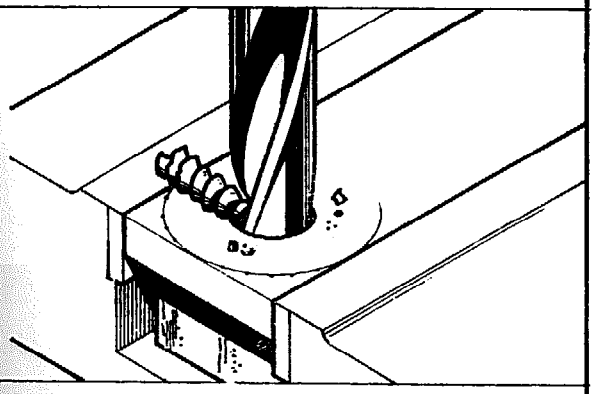
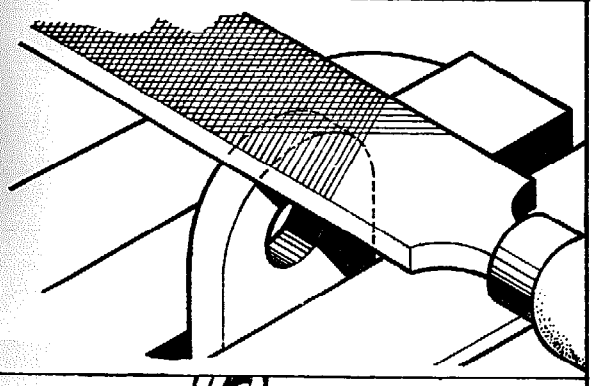
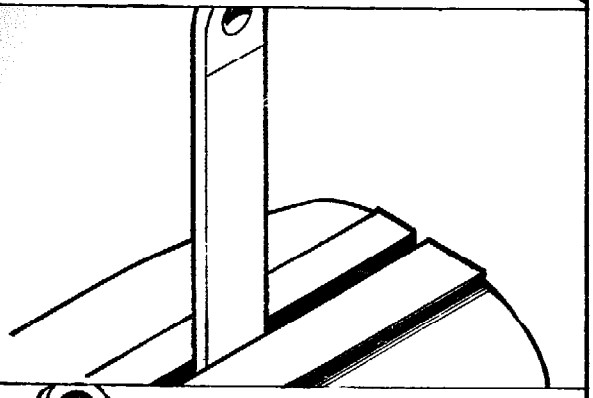
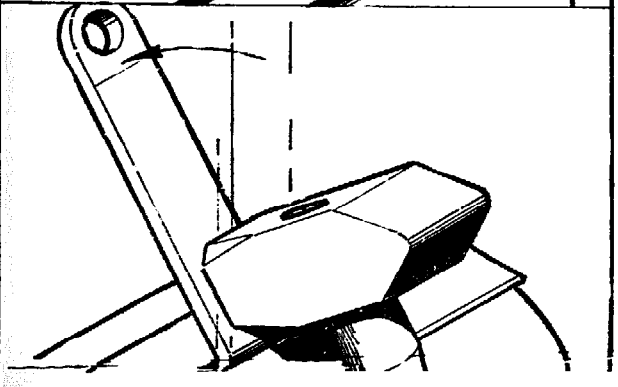
Vice.
2 angle sections 30x30.5 mm.
Jig **b**.
Wooden or rubber mallet.

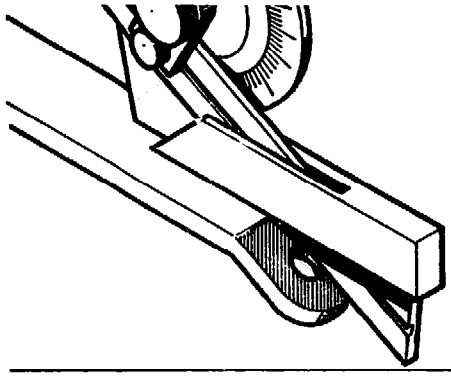
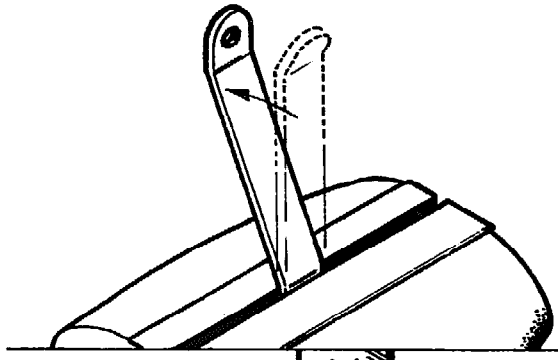
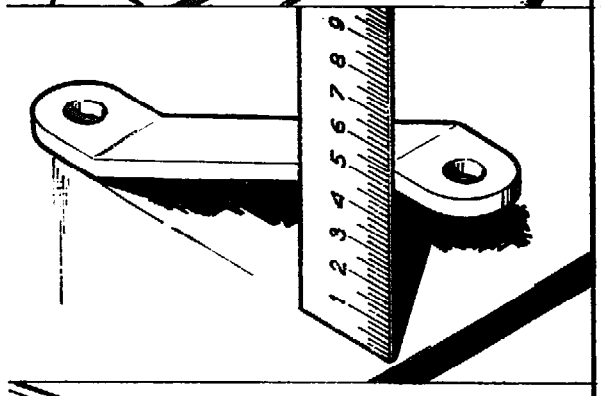
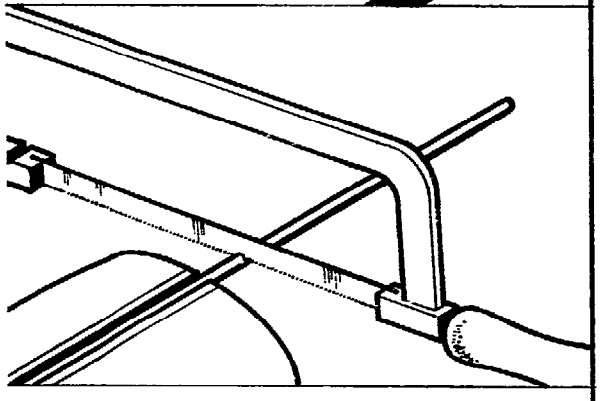
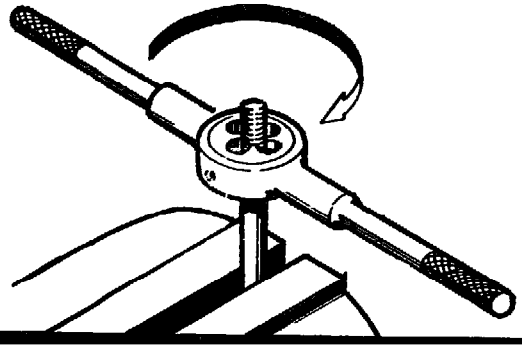


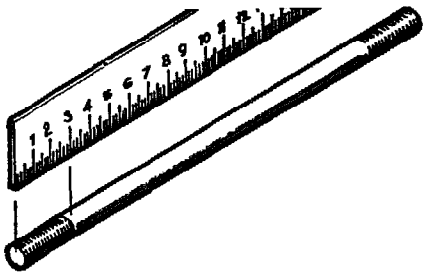
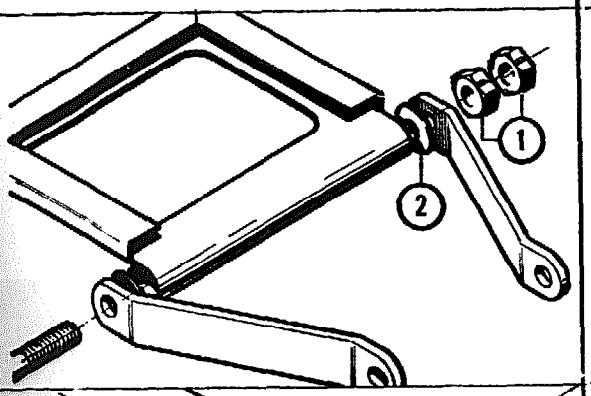
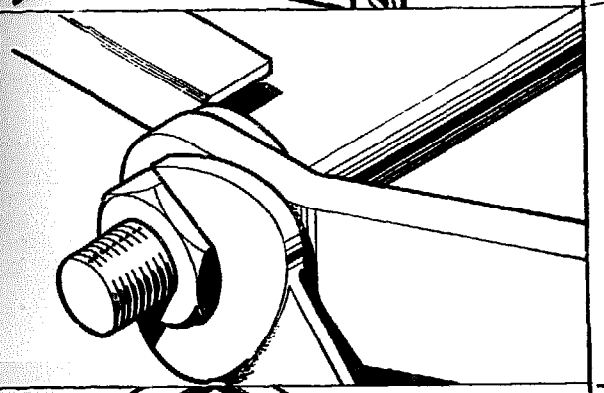
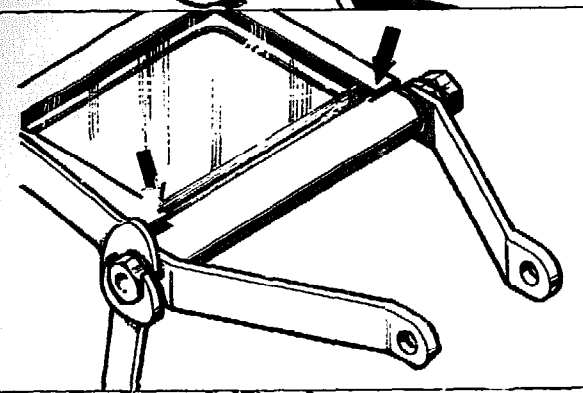
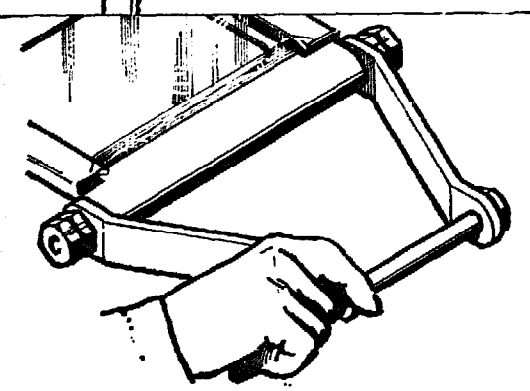
Now parts No. 2 are going to be made. For dimensions see drawing on page 16.
Saw two lengths of 162 mm off a 25 x 6 mm bar.

Vice.
Hack saw.

	Scribe two lines 12.5 mm from ends as shown.	Scriber. Rule. Square.
	Scribe two lines 27.5 mm from the ends as shown.	Scriber. Rule. Square.
	Put a V-mark at the midpoint of the outermost lines. As the width of the strip is 25 mm the midpoint is 12.5 mm from the side.	Scriber. Rule.
	Centre-punch these two points.	Centre punch. Hammer.
	Mark off two semicircles on the centres taking half the width of the strip as radius.	Dividers.

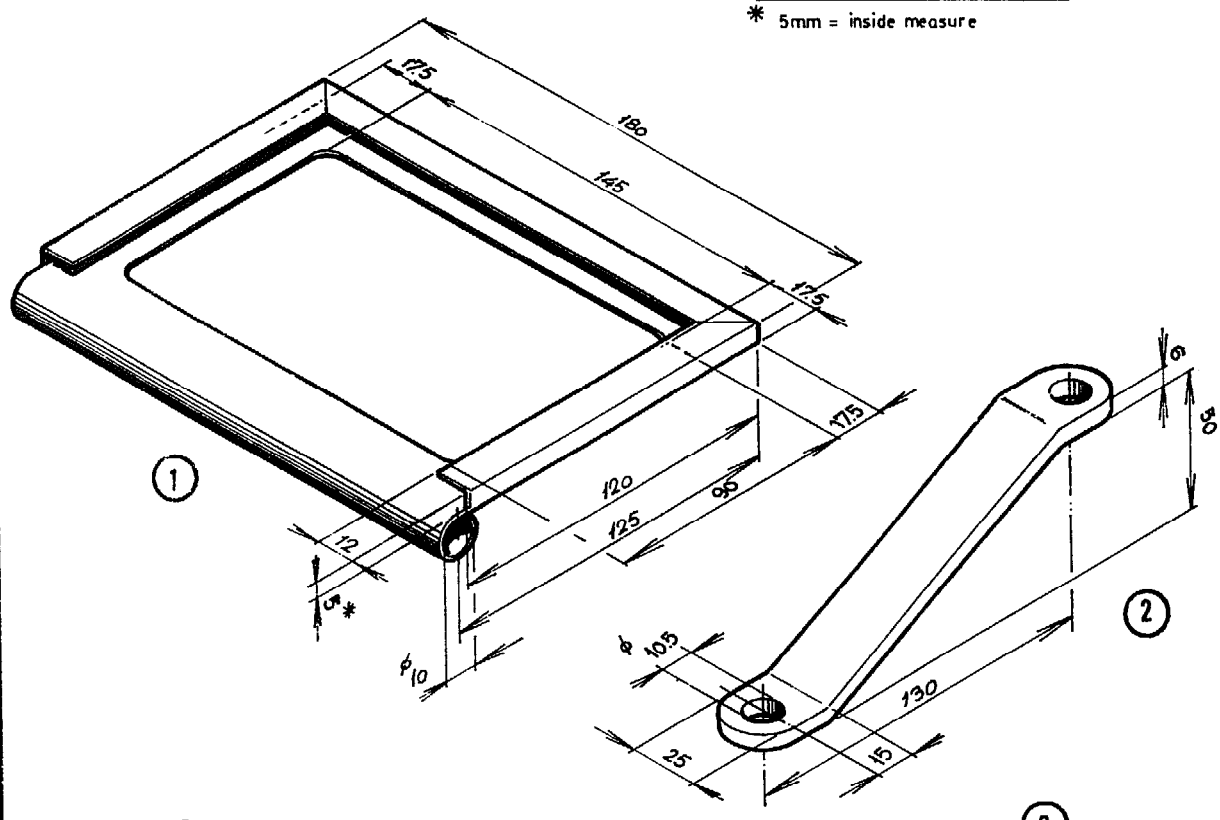
	Centre-dot to make circles permanent.	Centre punch. Hammer.
	Clamp work with wooden packing in drilling vice. Drill two 10 mm holes (use cutting fluid).	Drilling machine. Drilling vice. Wooden packing. Twist drill 10 mm dia.
	File round to scribed lines.	Vice. Vice clamps. Bastard hand file.
	Clamp strip in vice with vice clamps. The innermost scribed line should coincide with top edge of vice.	Vice. Vice clamps.
	Bend strip. Strike as close to bending line as possible.	Vice. Vice clamps. Hammer.

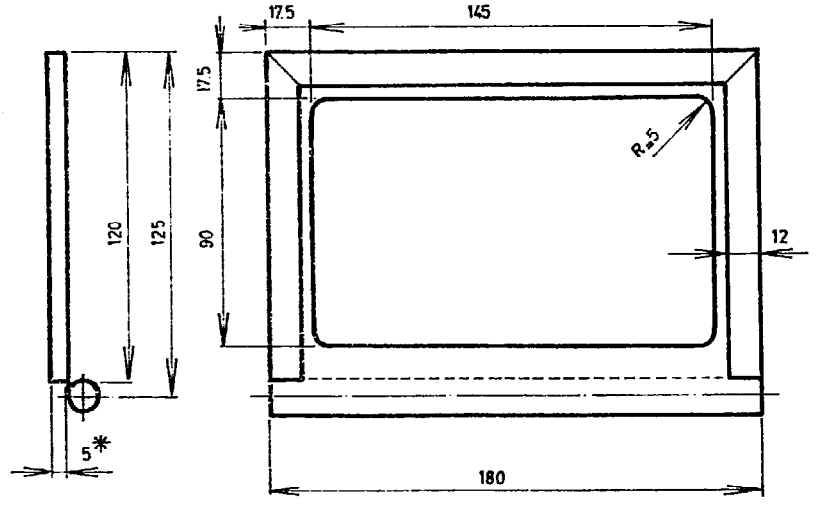
	Check that angle is 26°30′.	Protractor.
	Bend other end of strip in same way.	Vice. Vice clamps. Hammer.
	Check that shape of strip is exactly as shown in figure. Height as shown should be 50 mm. The second strip is made in the same way as the first one.	Rule. Surface plate.
	Saw a length of 225 mm off a 3/8″ dia. bar.	Vice. Hacksaw.
	Cut 3/8″ UNF thread on both ends over 30 mm. Use cutting fluid.	Vice. Copper jaw clamps. Die stock. 3/8″ threading die.

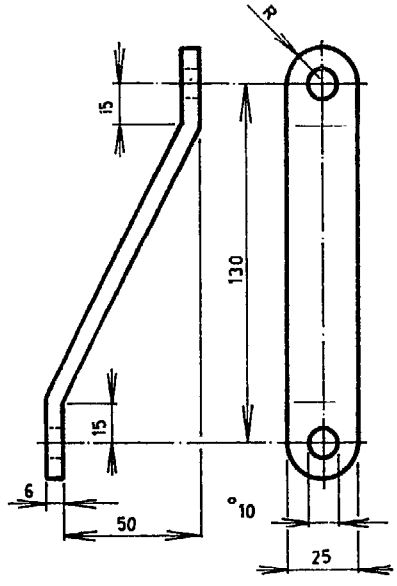
	Check that both threaded ends are 30 mm.	Rule.
	Assemble. Do this in the right order. 1 = nuts 2 = washer	
	Ligthly tighten the two inner nuts.	3/8" spanner.
	Firmly tighten the outer nuts. Use second spanner to hold the inner nuts in position. Place glass plate in frame and bend corners of glass channel inward to prevent plate from falling out. (See arrows).	Two 3/8" spanners. Hammer.
	Pass handle through holes and screw on nuts as shown. The eye shield is now complete.	

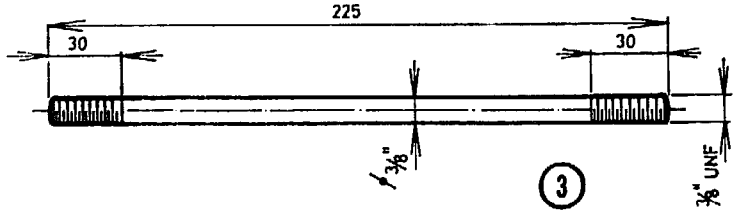
tolerance on all dimensions 0,5 mm

* 5mm = inside measure

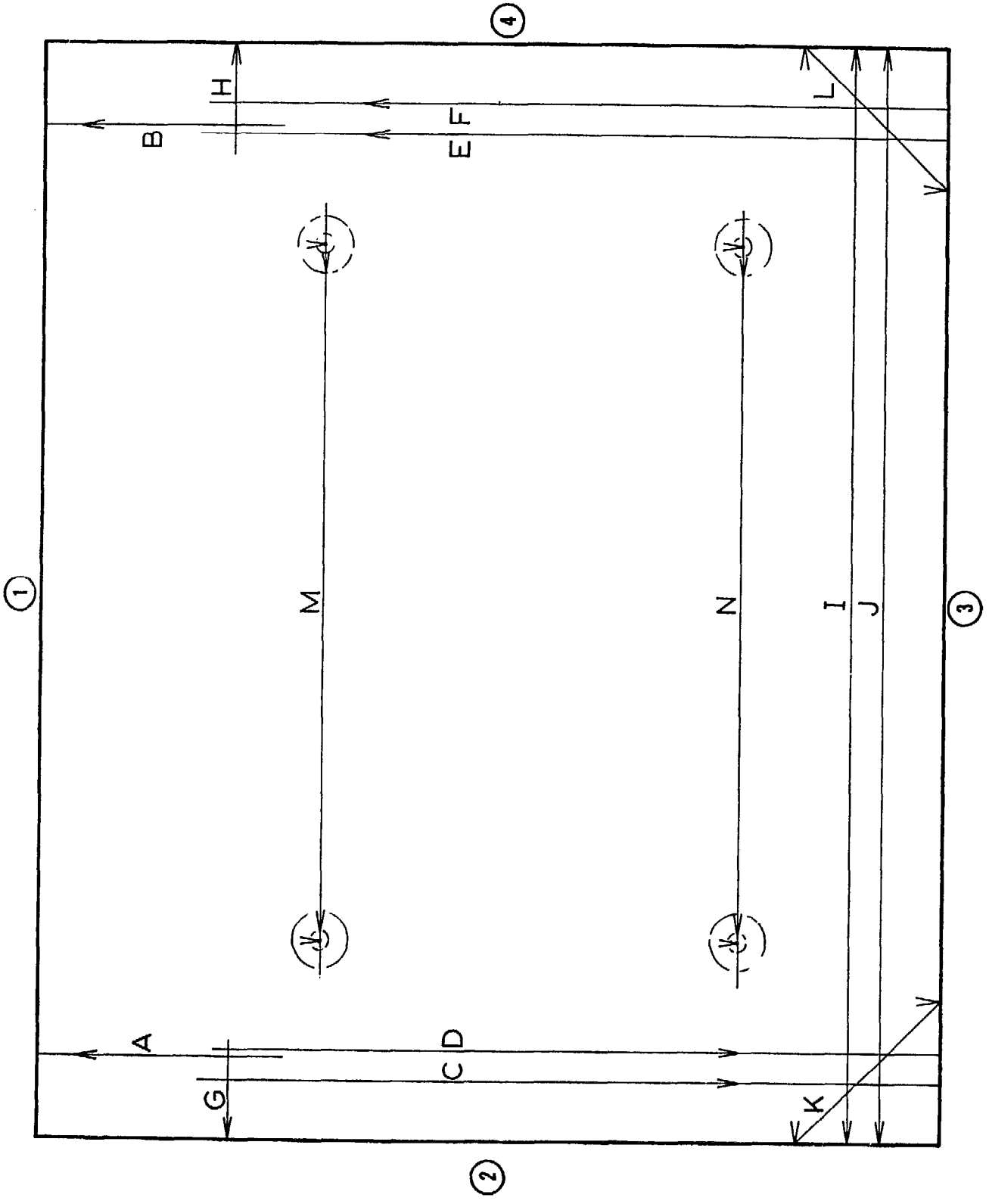




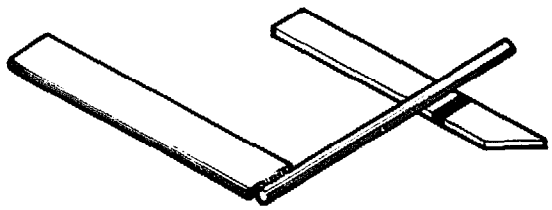




Development of frame of eye shield.

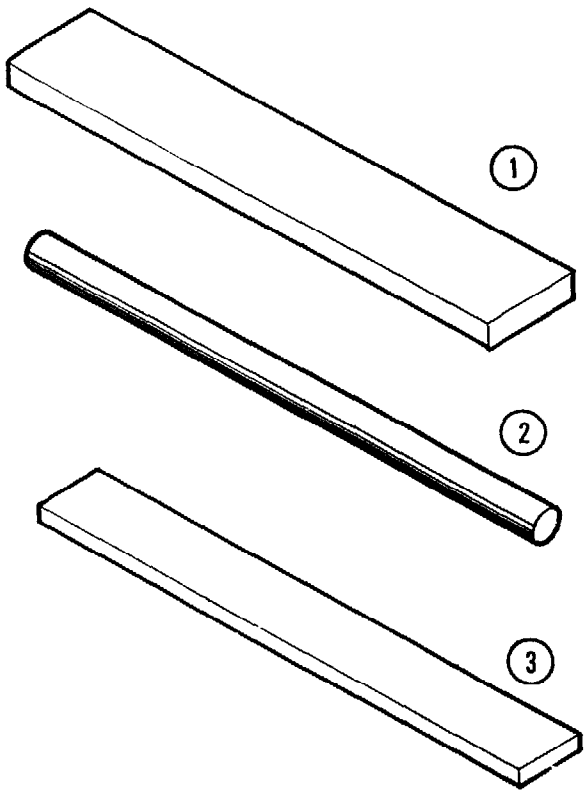


AUXILIARY TOOLS

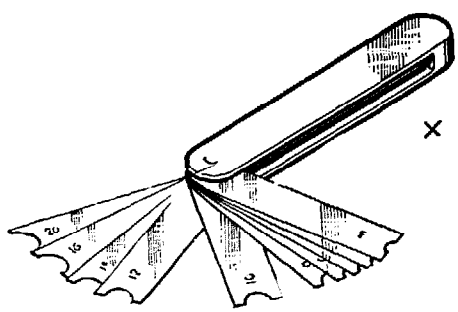


PURPOSE

These auxiliary tools are used as bending jigs for the construction of the shield.

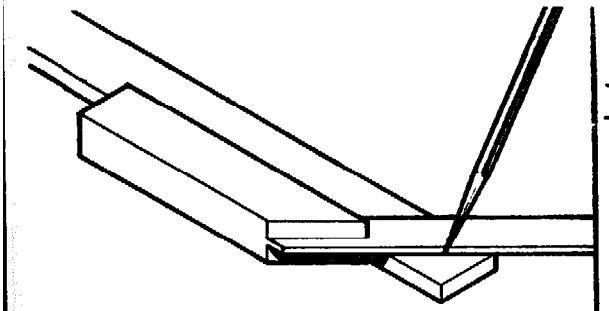
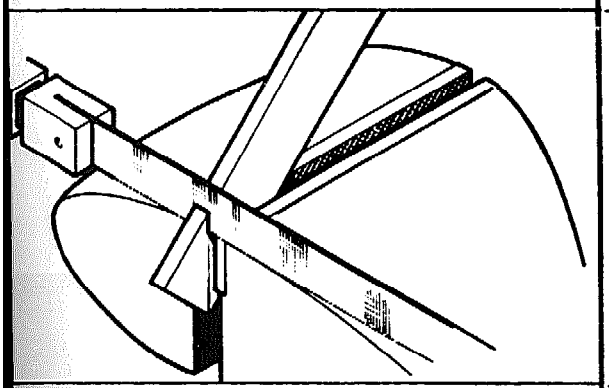
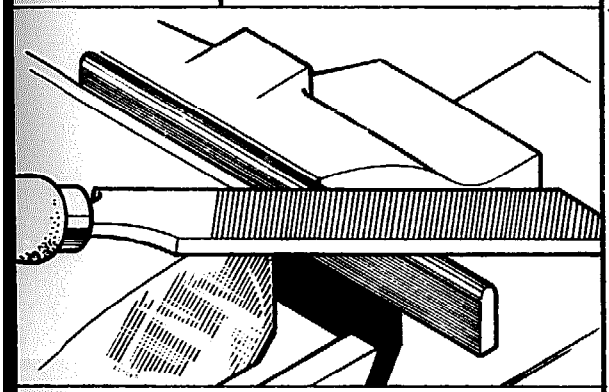
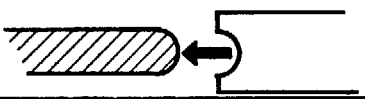
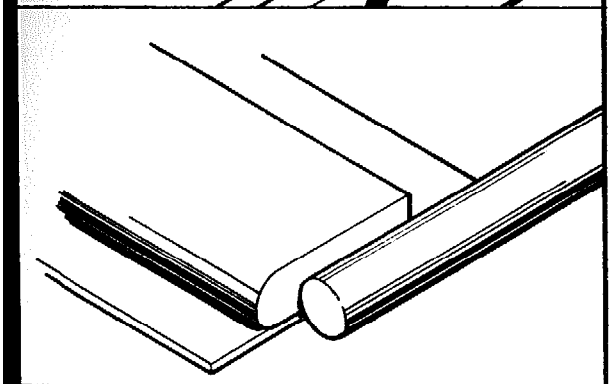
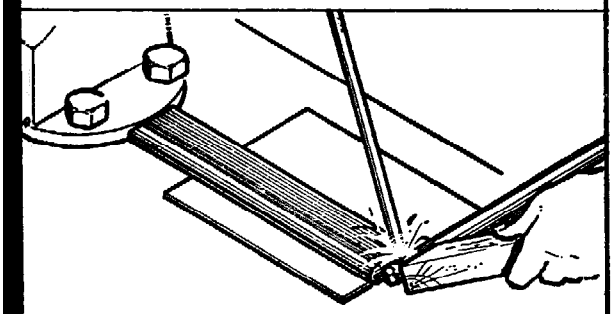


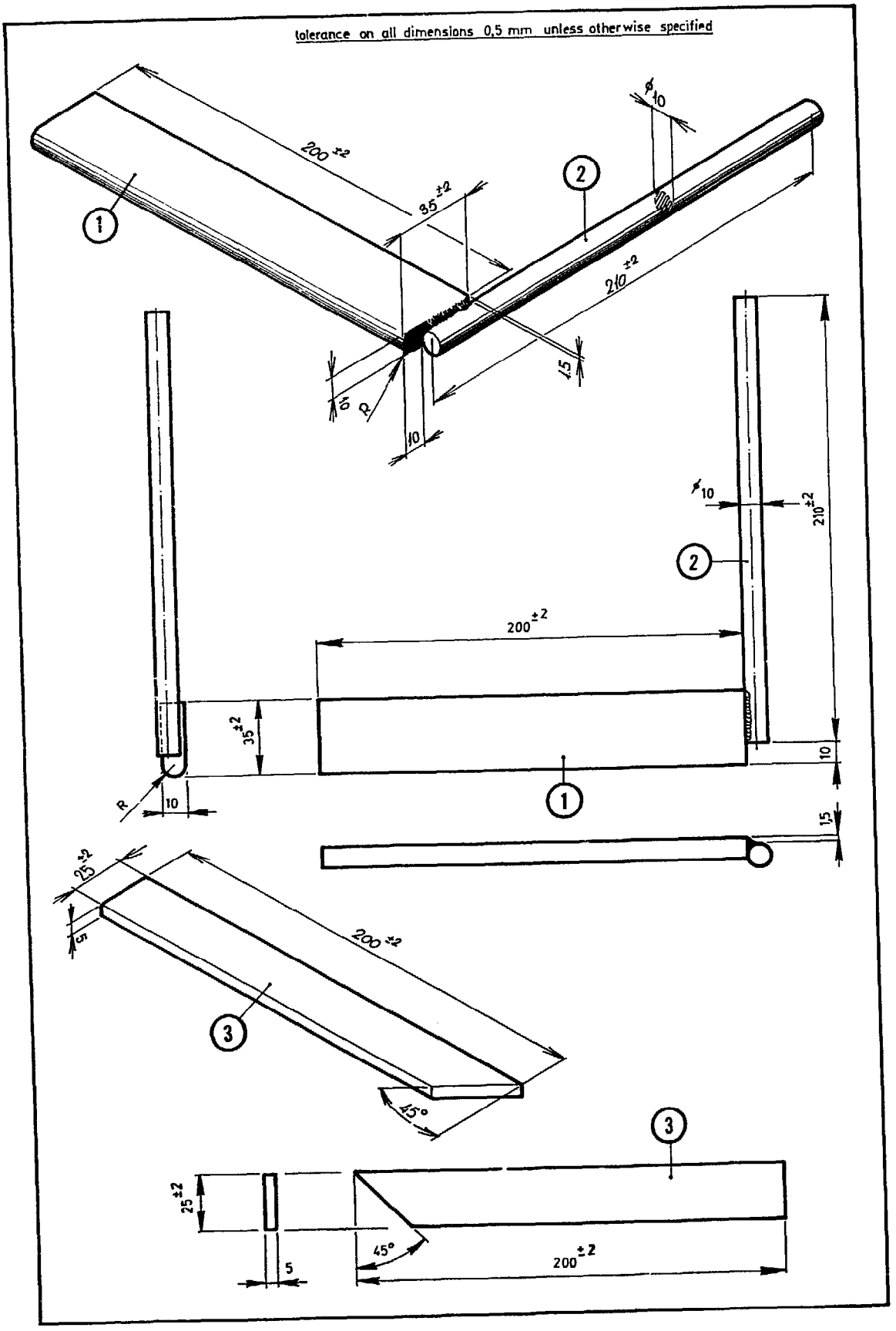
	MATERIAL	DIMENSIONS
1.	Mild steel.	35 x 10 x 200 mm
2.	Mild steel.	10 mm dia. 210 mm
3.	Mild steel.	25 x 5 x 200 mm



TOOLS

Scriber.
Bevel 135° (or bevel protractor).
Vice.
Hacksaw.
Bastard hand file.
Electric arc welding equipment.
Radius gauge. (See picture x).
Piece of metal 1.5 mm thick.
G-cramp.
Piece of wood.

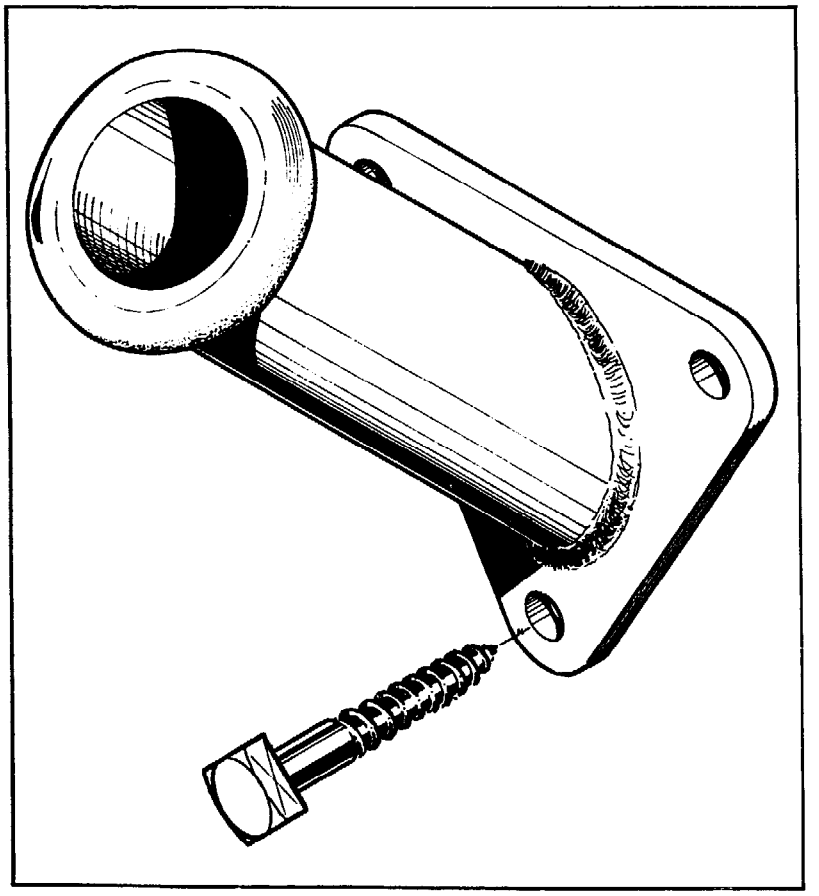
	OPERATION	TOOLS
	Take the strip listed on page 18 under materials No. 3. Scribe a line on it passing through one of the corners at 45° angle. See picture.	Scriber. 135° bevel or bevel protractor.
	Clamp strip in vice in such a way that the scribed line is vertical. Saw off corner. Remove burrs with file.	Vice. Jaw clamps. Hacksaw. Bastard hand file.
	Clamp strip (part number 1) in vice. File semicircular edge on it. Check correct rounding with radius gauge. 	Vice. Vice clamps. Bastard hand file. Radius gauge.
	Lay strip No. 1 and bar No. 2 on bench as shown. Put 1.5 mm piece of metal under strip. The strip is stopped by some device such as a vice, (see next picture), or it is clamped down with a G-cramp.	1.5 mm thick piece of metal. G-cramp.
	Weld the bar to the strip. Press bar against strip with piece of wood.	Arc welding equipment. Piece of wood.

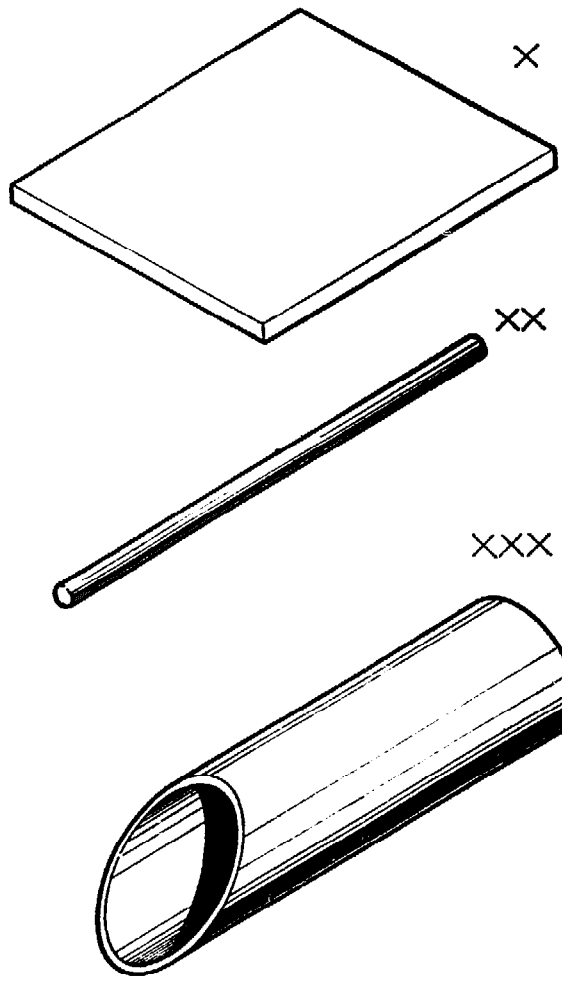

tolerance on all dimensions 0,5 mm unless otherwise specified
200 ±2
35 ±2
ø10
210 ±2
15
10
R
1
2
3
25 ±2
5
45°

STAFF HOLDER

PICTOSTEPS

WORKSHOP INSTRUCTION METAL





STAFF HOLDER

USE: A flag-staff holder is used for holding a staff and can be mounted on a wall.

MATERIAL:

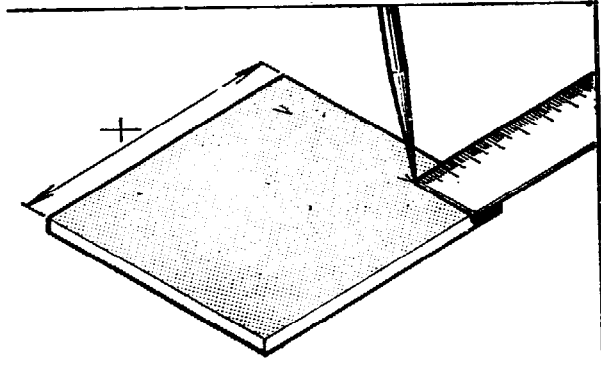
x Plate steel
xx Bar steel
xxx Gaspipe

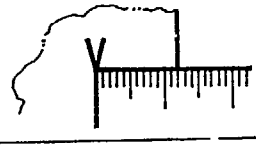
DIMENSIONS:

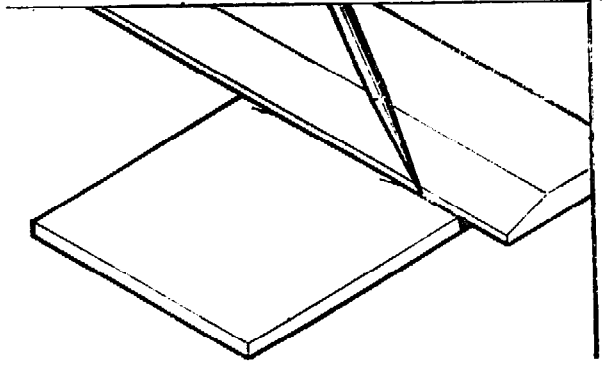
100 x 90 x 5 mm
Ø 6 — 153 mm long
1¼" BSP greatest length about 140 mm

TOOLS:

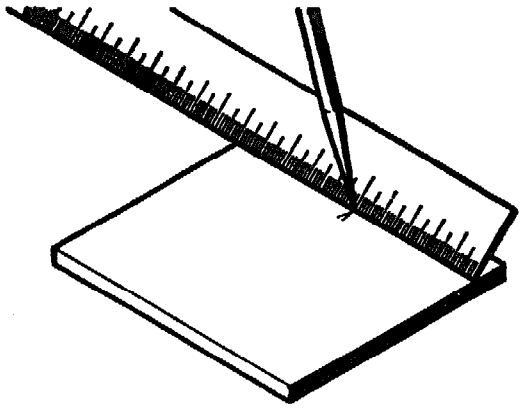
Chalk or varnish
Scriber
Measuring rule
Steel straight edge
Centre punch
Hammer
Dividers
Bow-spring dividers
Drilling machine
Twist drill Ø 8 mm
Cutting lubricant
Vice
Hacksaw frame
Hacksaw blade
Blunt bastard file
Smith's fire
Smith's tongs
Anvil
Smith's hammer
Sawing machine
Grinding machine
Gas-welding apparatus
Lighter
Welding goggles
Welding torch Nr. 3
4 mm welding wire
Wooden block
Arc-welding apparatus
Welding shield
Electrode
Scaling hammer
Scribing block (graduated)
Surface plate
V-blocks
Welding glove



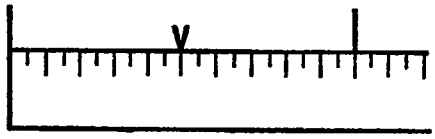
OPERATION	TOOLS
Apply chalk or varnish. Put V-marks at two places 12 mm from side. x = 90 mm. 	Chalk or varnish. Scriber. Measuring rule.



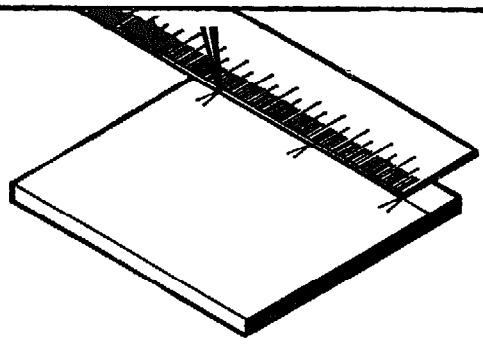
Draw line exactly through points of V-marks. 	Scriber. Steel straight edge.



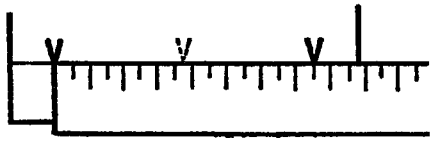
Find midpoint of this line in following way:



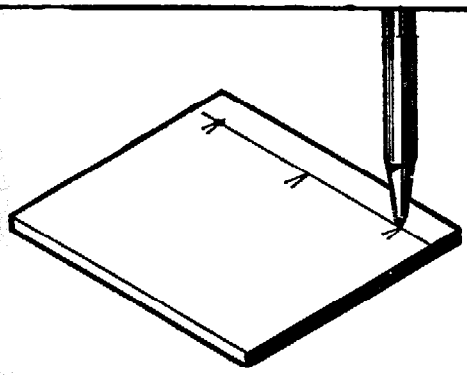
Scriber.
Measuring rule.



Put point 37.5 mm of measuring rule under V-mark and scribe V-mark at 0 and 75 mm.

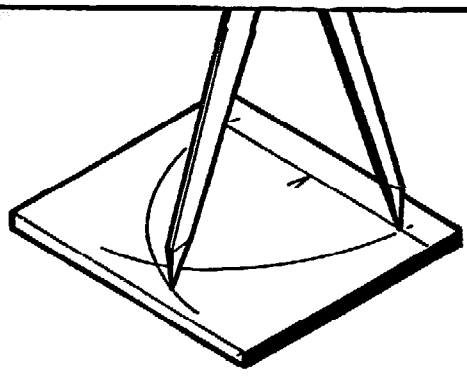


Scriber.
Measuring rule.



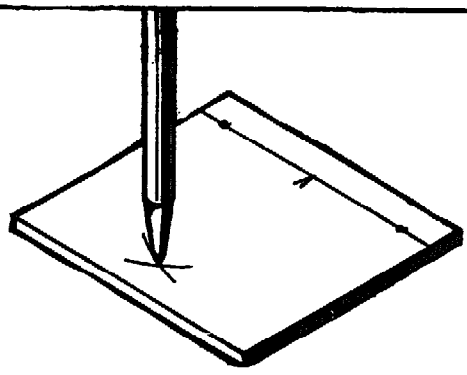
Centre-punch at outermost V-marks.

Centre punch.
Hammer.



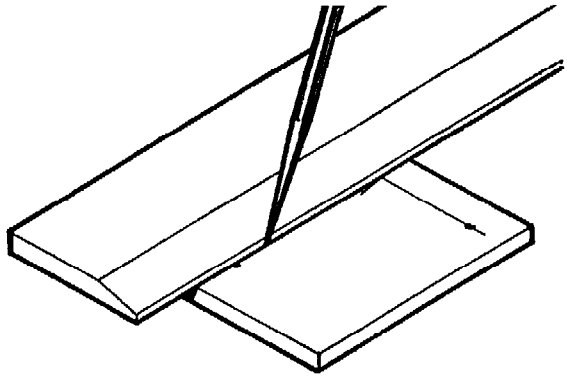
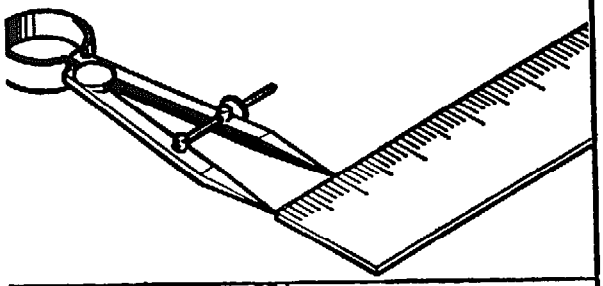
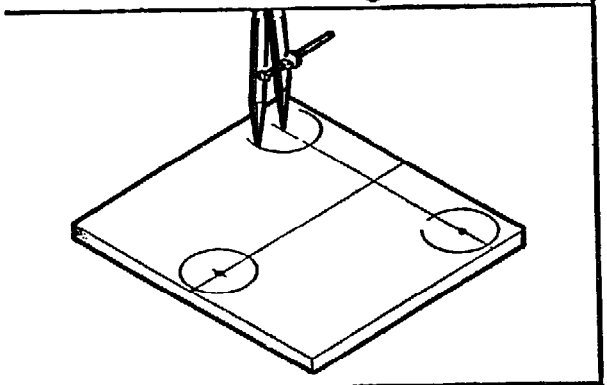
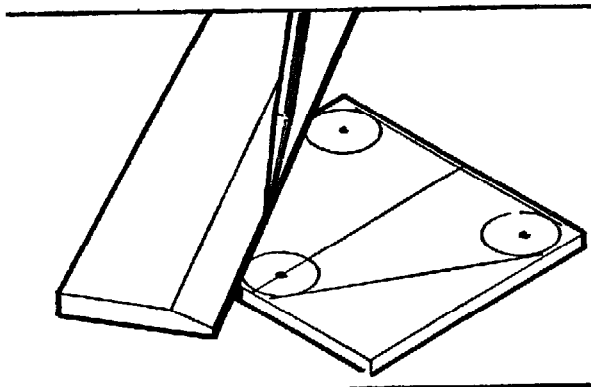
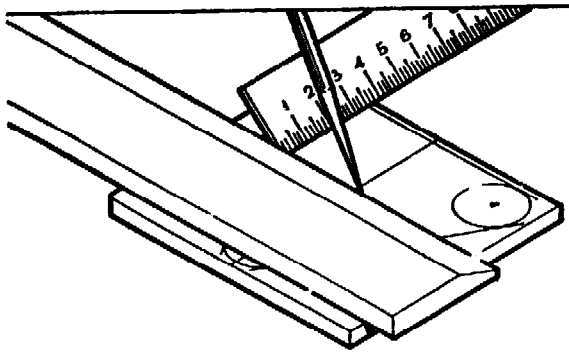
From centres mark off arcs with distance between centres for radius.

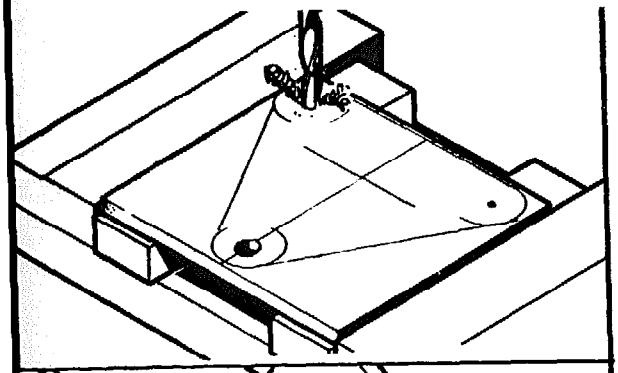
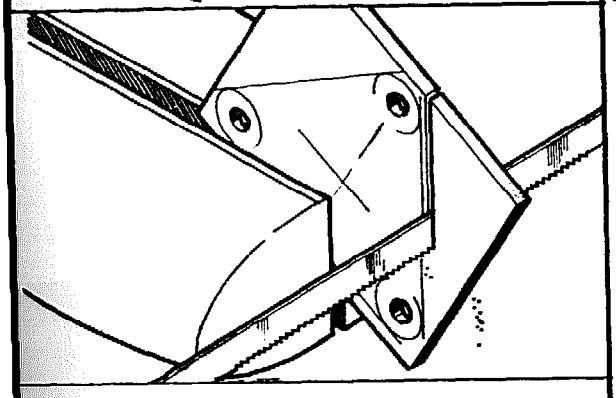
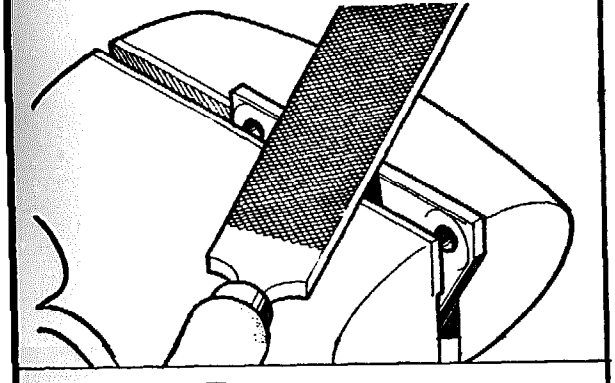
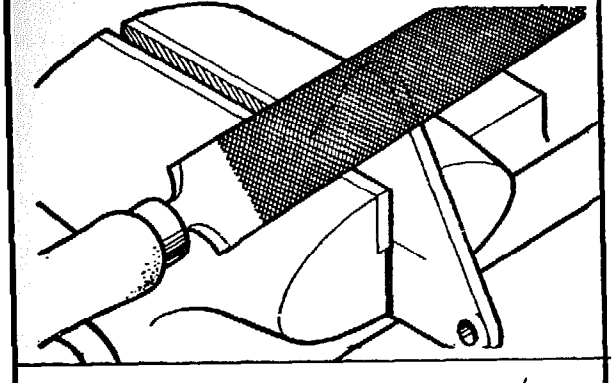
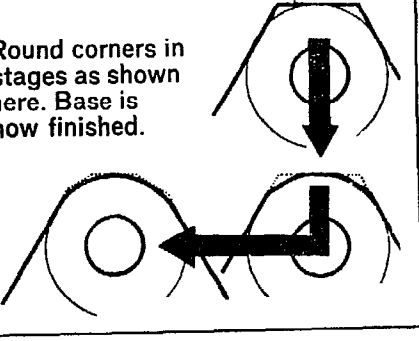
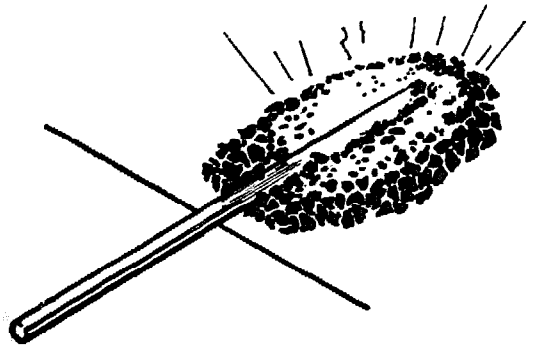
Dividers.

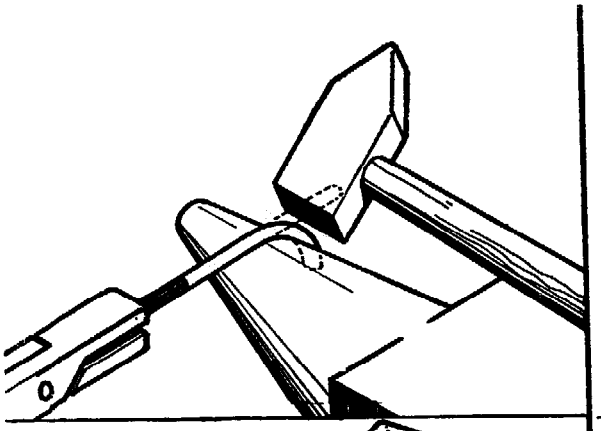


Centre-punch at intersection of arcs.

Centre punch.
Hammer.

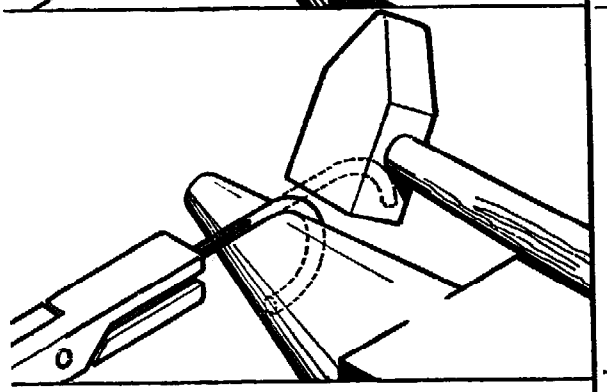
	Draw line through centre made in previous operation and V-mark at midpoint of first line. 	Scriber. Steel straight edge.
	Set bow-spring dividers at 10 mm.	Bow-spring dividers.
	With this distance for radius mark off circle in each of the three centres.	Bow-spring dividers.
	Draw three lines tangent to the circles.	Scriber. Steel straight edge.
	Now draw parallel line at 35 mm from the one tangent line that is parallel with side of workpiece, as shown in picture.	Scriber. Measuring rule. Steel straight edge.

	Drill three holes Ø 8 mm at centred points. **Use lubricant!**	Drilling machine. Twist drill Ø 8 mm. Cutting lubricant.
	Remove corners by sawing them off just outside tangent lines.	Vice. Hacksaw frame. Hacksaw blade.
	File off exactly to lines.	Vice. Blunt bastard file.
	Round corners in stages as shown here. Base is now finished. 	Vice. Blunt bastard file.
	**Forging the ring.** Half of the bar is heated to orange-yellow.	Smith's fire.



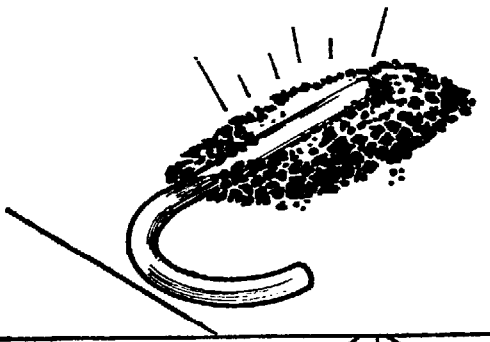
Take bar out of fire and bend end to ¼ circle.

Anvil.
Smith's tongs.
Smith's hammer.



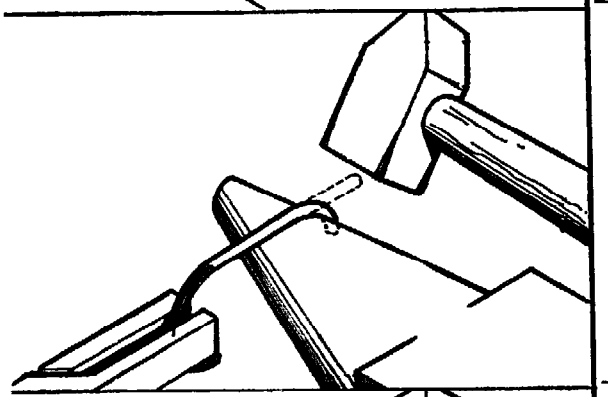
Go on bending end until half circle is made.

Anvil.
Smith's tongs.
Smith's hammer.



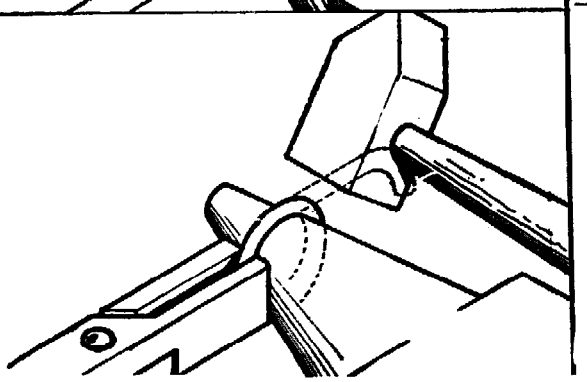
Heat second half of bar to orange-yellow.

Smith's fire.

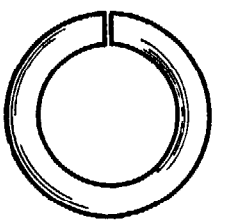


Forge round to ¼ circle.

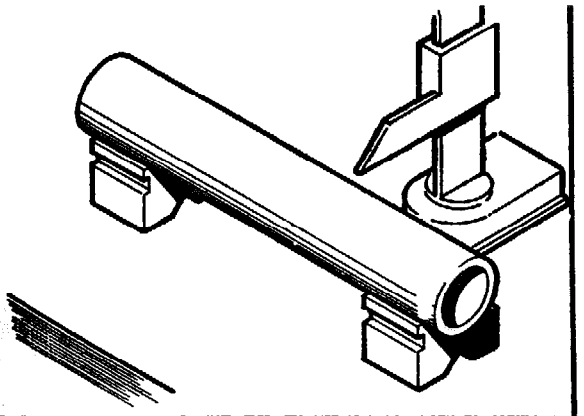
Anvil.
Smith's tongs.
Smith's hammer.



Finish circle.

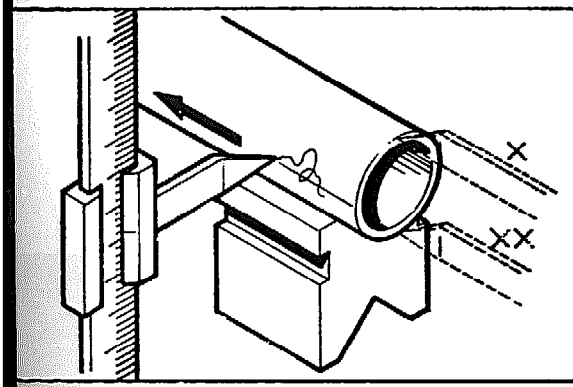


Anvil.
Smith's tongs.
Smith's hammer.



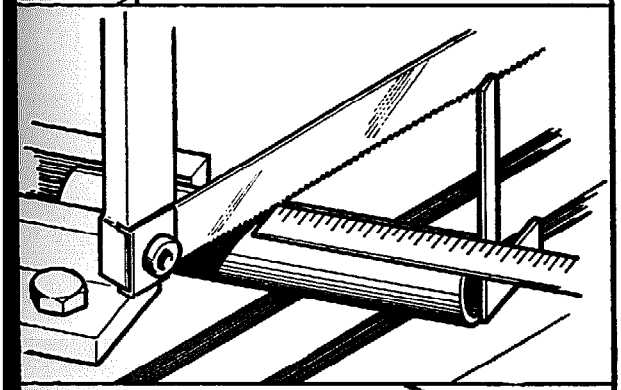
From a 1¼" gaspipe saw off a length of 240 mm.
(This is sufficient for two flag-staff holders).
Place pipe on two V-blocks on the surface plate.

2 V-blocks.
Surface plate.



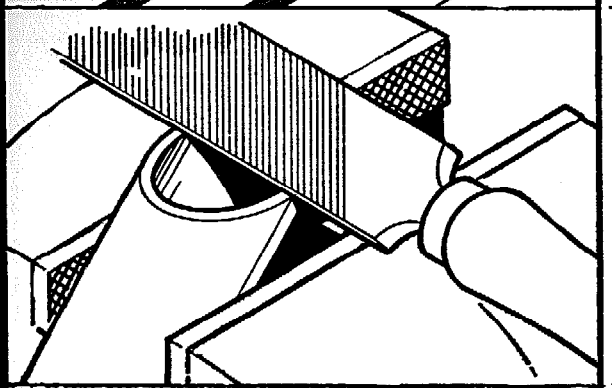
Find centre line of pipe.
This is sum of greatest height (x) and smallest height (xx) divided by 2.
Set scribing block and scribe two lines on both sides of pipe.

Graduated scribing block.

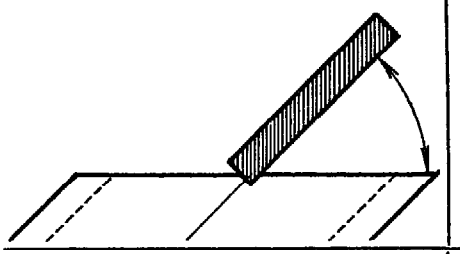


Clamp pipe in sawing machine at angle of 45°. The 2 lines should be right above each other — check with set square.
The saw blade should engage the pipe at 120 mm from the end, measured on upper line.

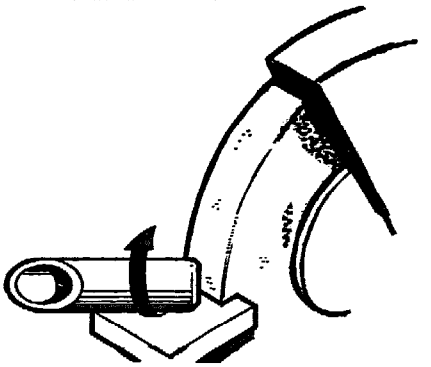
Sawing machine.
Set square.
Measuring rule.



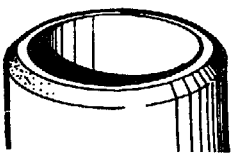
With file make two notches in pipe face at intersection of lines with face.



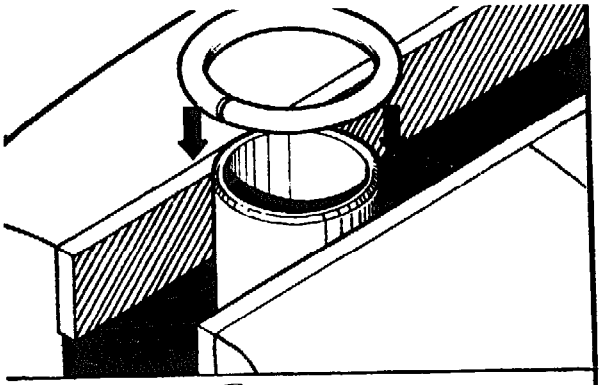
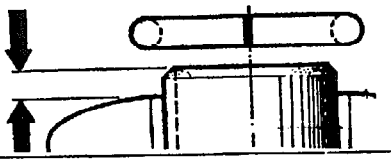
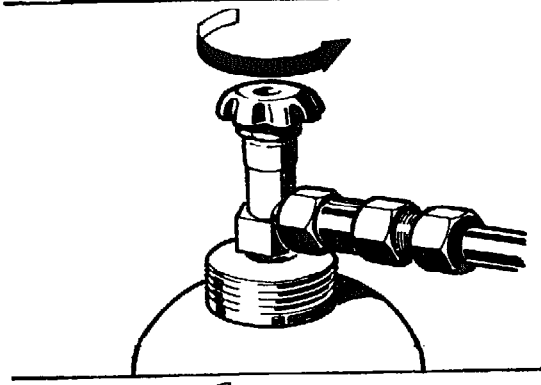
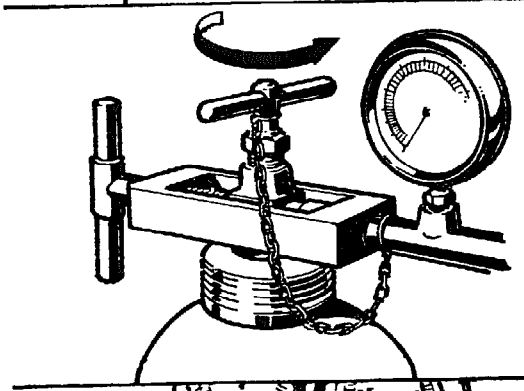
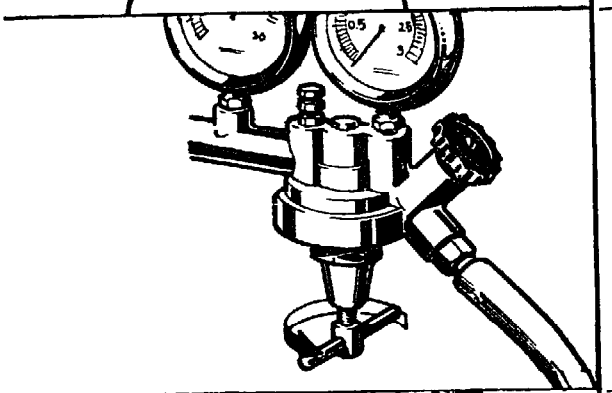
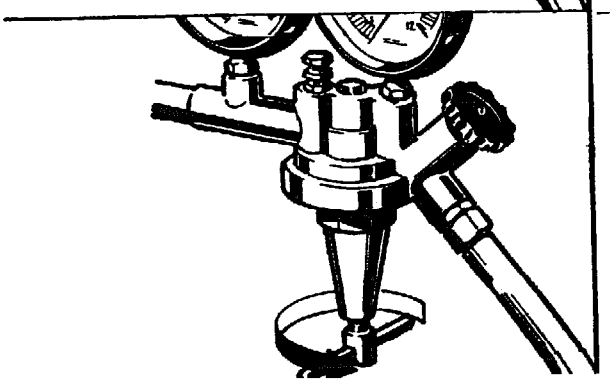
Vice.
Blunt bastard file.

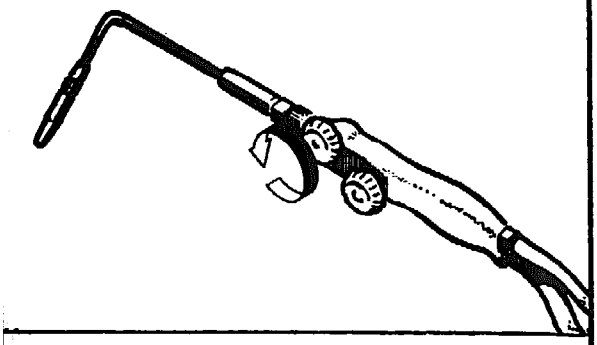
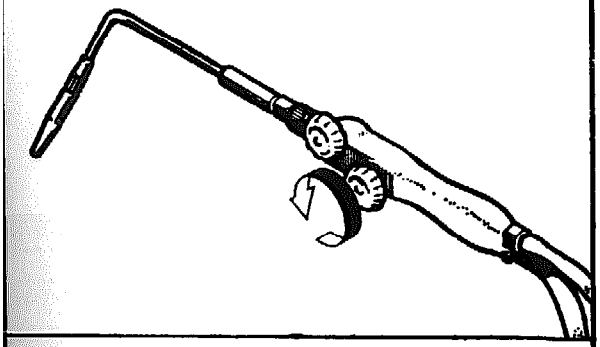
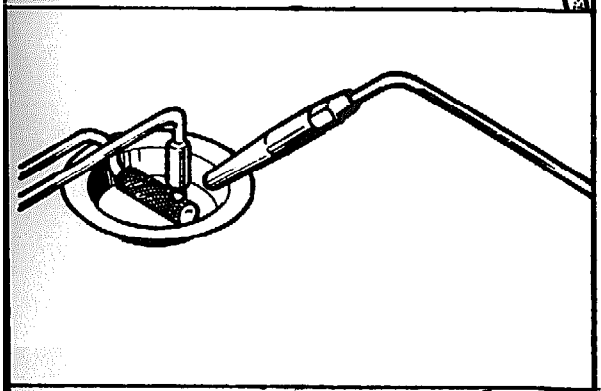
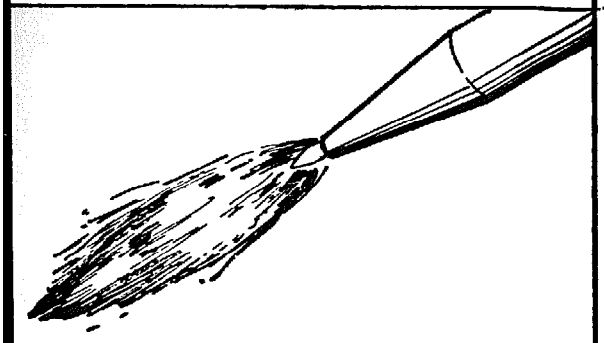
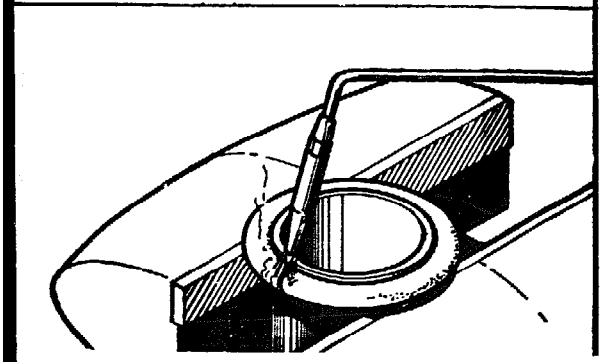


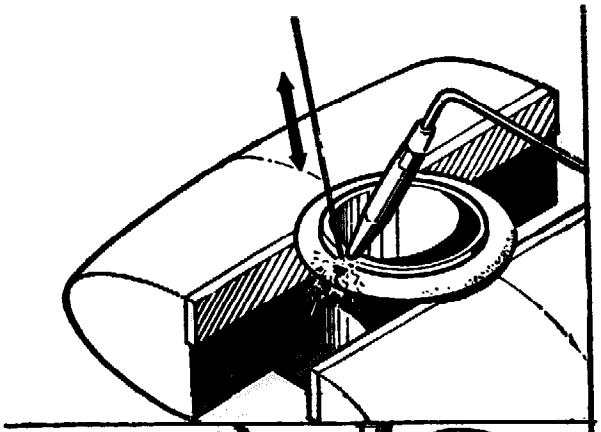
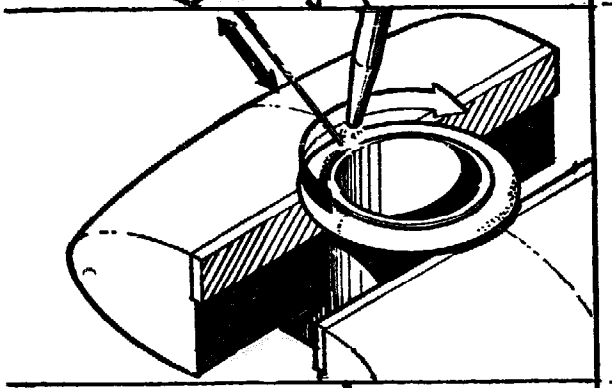
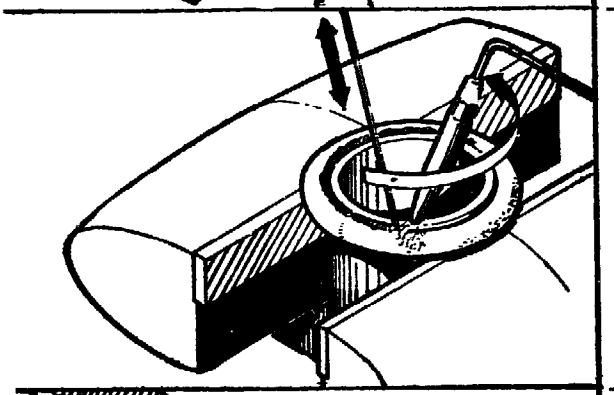
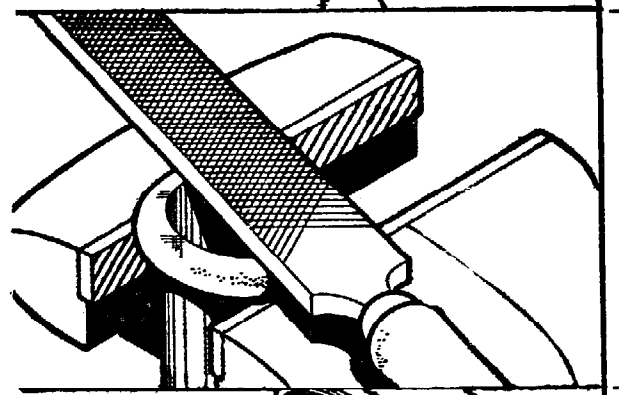
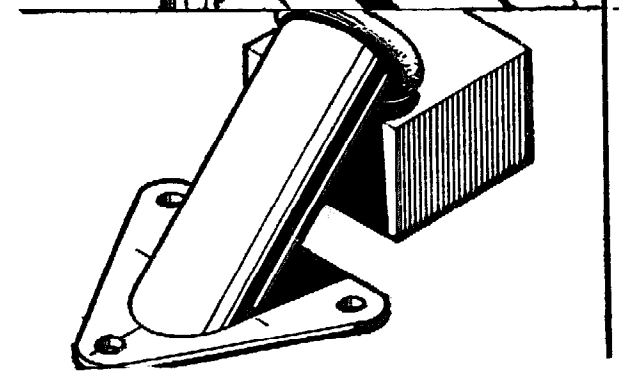
Grind beveled edge on straight end.

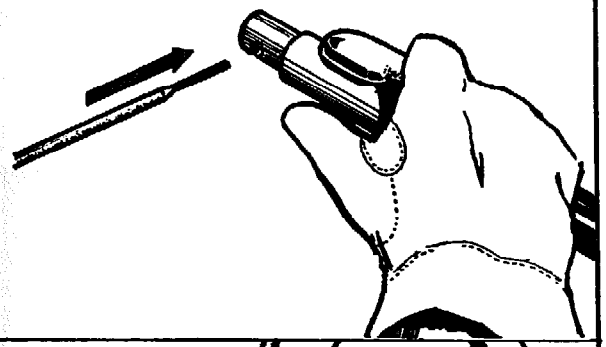
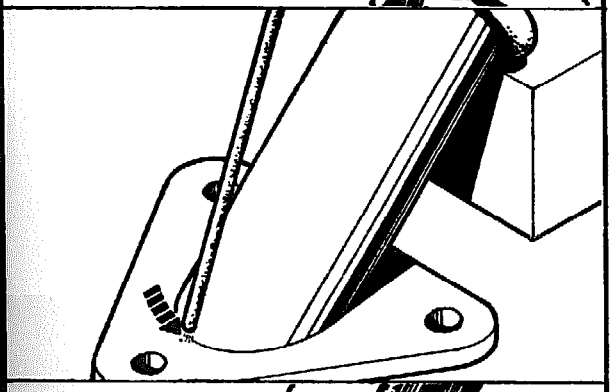
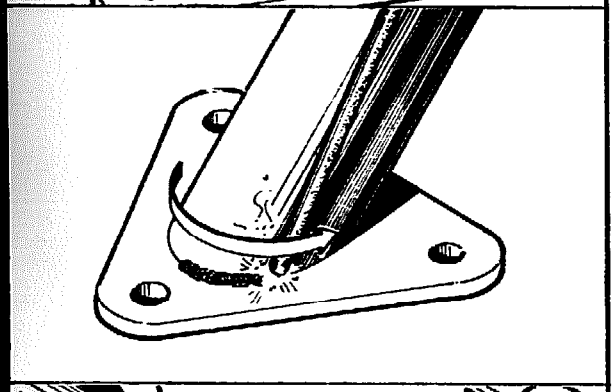
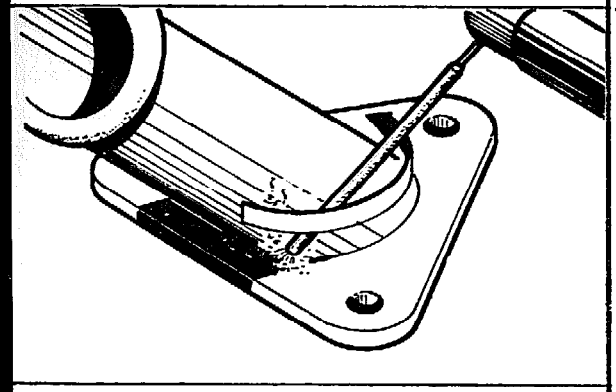
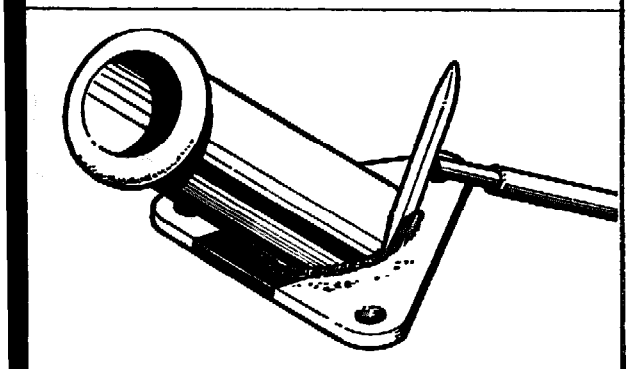


Grinding machine.

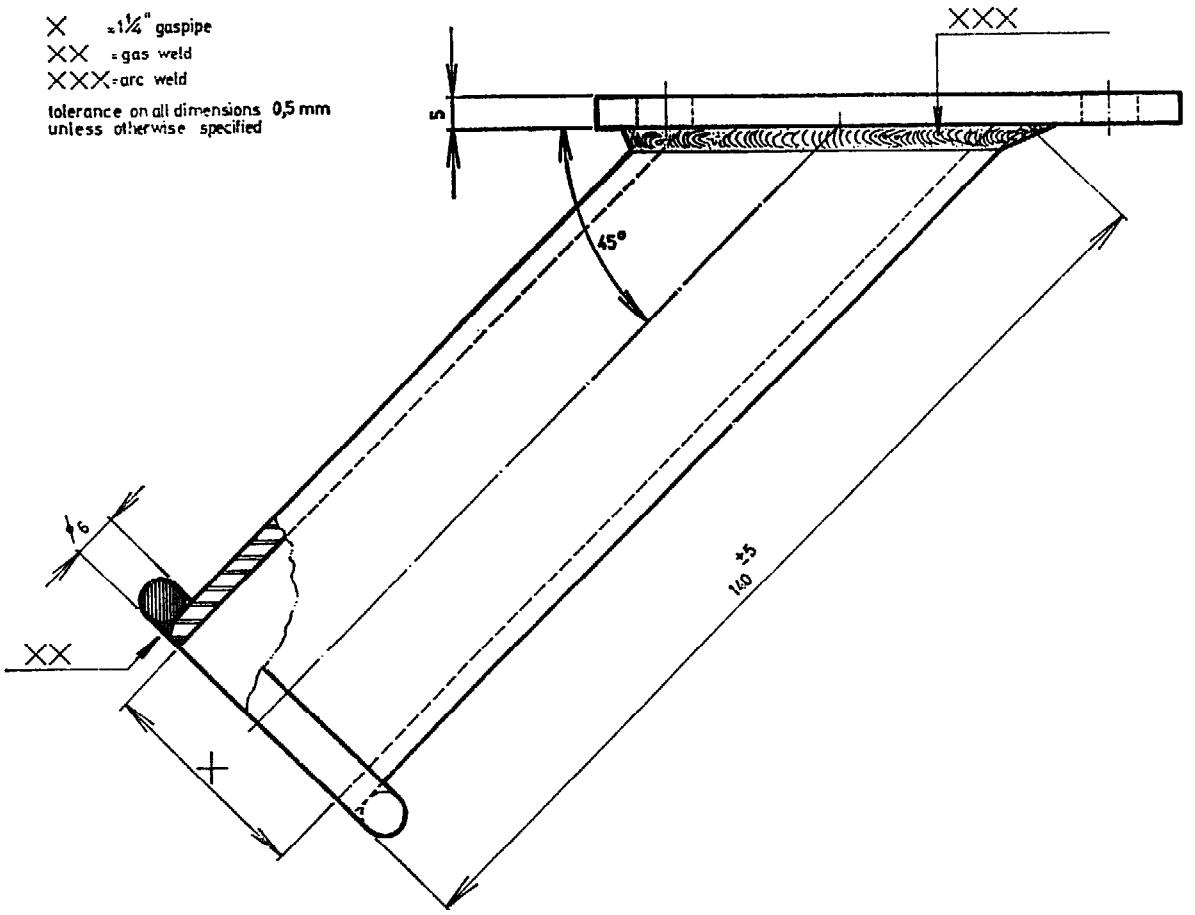
	Clamp pipe in such a way that top extends 6 mm above vice-jaws. Put forged ring on it. 	Vice.
	**Gas weld.** Open oxygen valve.	Gas welding apparatus.
	Open acetylene valve.	Gas welding apparatus.
	Adjust pressure of acetylene at 0.5 at. by means of regulator.	Gas welding apparatus.
	Adjust pressure of oxygen at 1.25 at.	Gas welding apparatus.

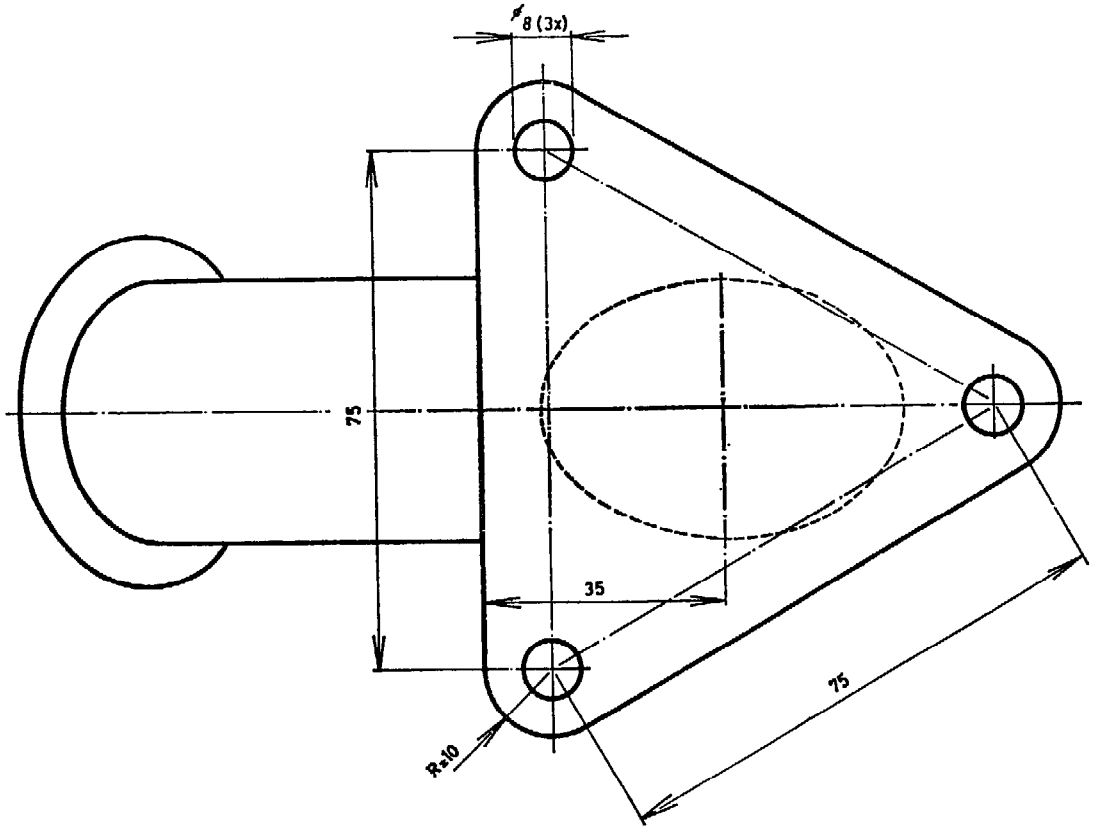
	Open oxygen valve.	Welding torch Nr. 3.
	Open acetylene valve.	Welding torch Nr. 3.
	Ignite flame.	Lighter.
	If necessary adjust flame until sharply defined clear cone is obtained. **Use goggles!**	Welding torch. Welding goggles.
	Point flame at point of work where ring is closed. Tip of flame must not touch material.	Welding torch.

	When work-material starts flowing add welding material. Make tipping movement with welding wire.	Welding torch. Welding wire 4 mm.
	Move to right while welding first half. Keep flame pointed at (thicker) ring.	Welding torch. 4 mm welding wire.
	Move to left while welding second half.	Welding torch. 4 mm welding wire.
	Smooth work after welding.	Vice. Blunt bastard file.
	Place pipe exactly on centre of base. The notches should coincide with scribed line. Support on piece of wood.	Piece of wood. (height 70 mm).

	**Arc-welding pipe to base.** Put electrode into holder. **Use a glove!**	Arc-welding apparatus. Glove. Electrode.
	Strike arc by scratching with electrode across material at place of weld. Make two tack welds.	Arc-welding equipment.
	Make weld moving to left.	Arc-welding equipment.
	Finish off weld.	Arc-welding equipment.
	Remove scale. Flag-staff holder finished!	Scaling hammer.

X = 1¼" gaspipe
XX = gas weld
XXX = arc weld
tolerance on all dimensions 0,5 mm
unless otherwise specified

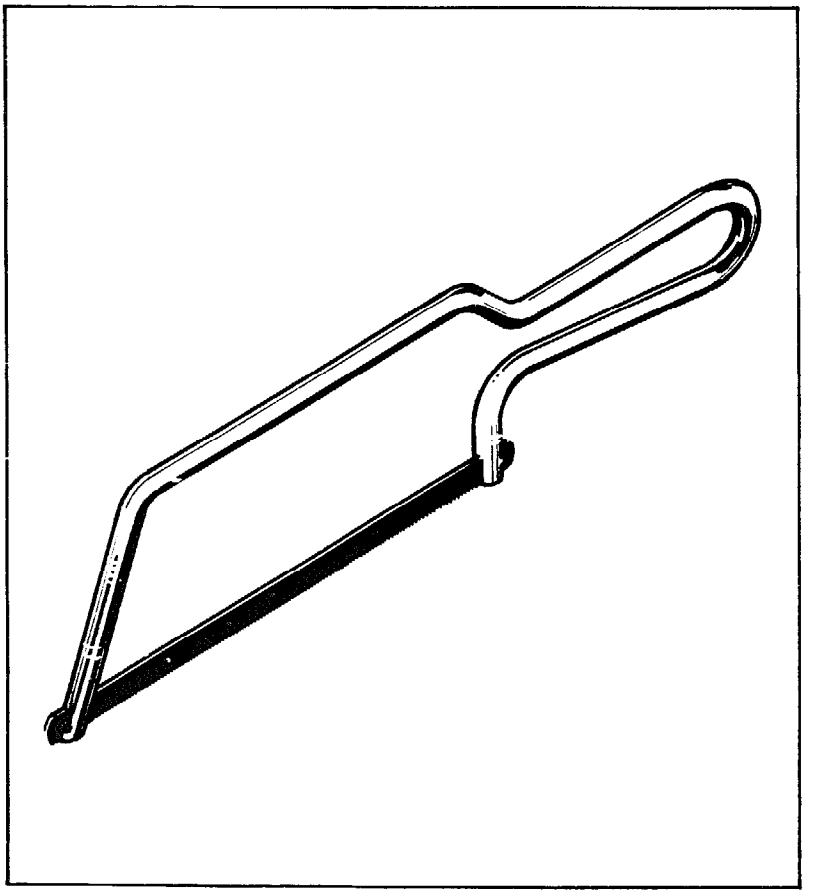


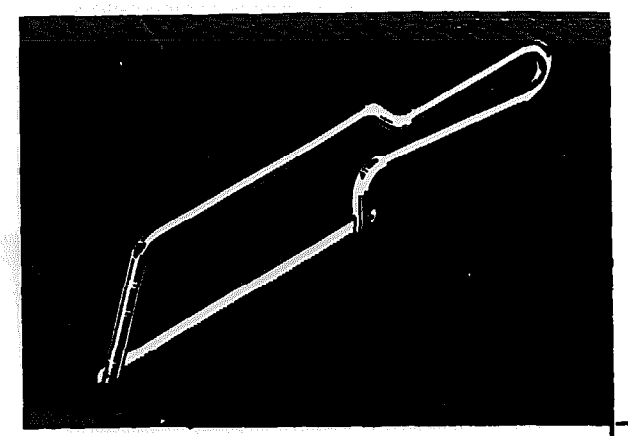


SAW FRAME

PICTOSTEPS

WORKSHOP INSTRUCTION METAL



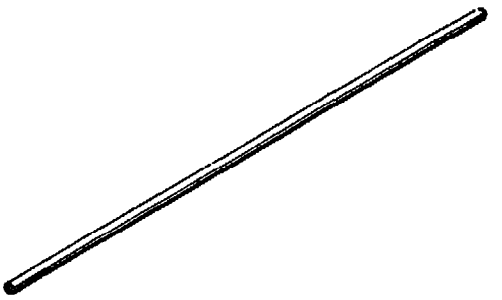


PICTOSTEPS

WORKSHOP INSTRUCTION METAL

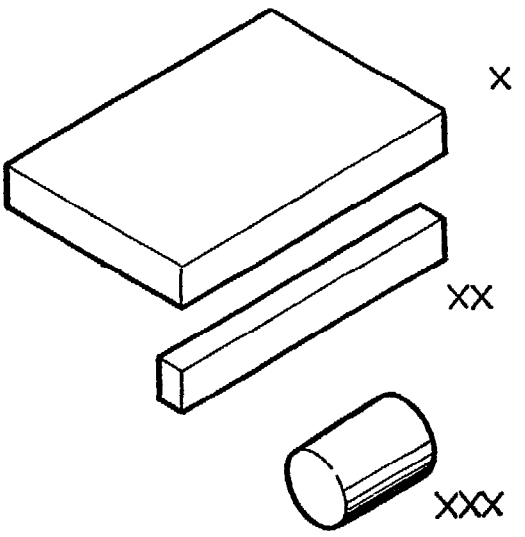
SAW FRAME

USE: The purpose of this saw is to cut material of small dimensions.
For the construction of this frame we use a former which is first made by ourselves.



For the saw frame is required:

MATERIAL:	**DIMENSIONS:**
White shaft steel 6 mm dia.	Length 402 mm.

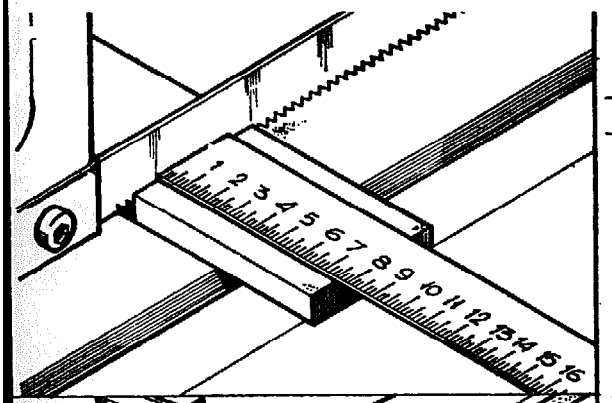


For the former is required:

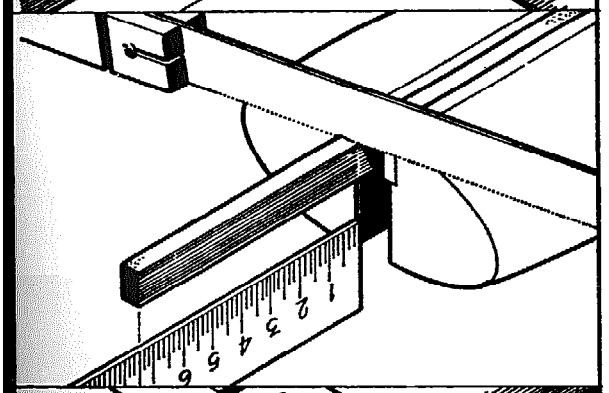
MATERIAL:	**DIMENSIONS:**
x Mild steel	10 x 50 x 75 mm
xx Mild steel	6 x 10 x 75 mm
xxx Mild steel	dia. 16 mm length 15 mm

TOOLS:

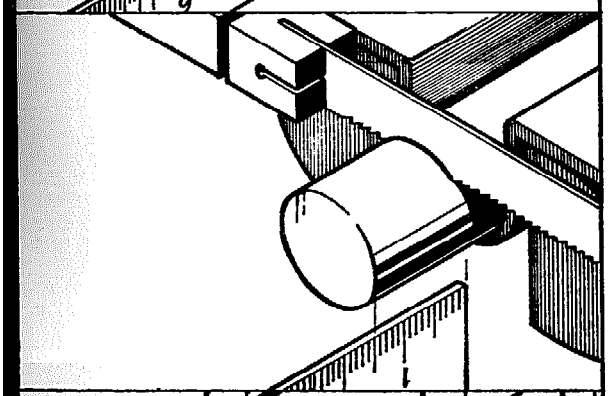
Rule.	Sawing machine.
Try square.	Drilling machine.
Scriber.	Machine vice.
Vernier calipers.	Twist drill dia. 6 mm.
Centre punch.	Twist drill dia. 16 mm.
Hammer.	Arc welding equipment.
Flat file.	Vice.
Hack saw.	Two G-cramps.
Vernier bevel protractor.	Goggles.



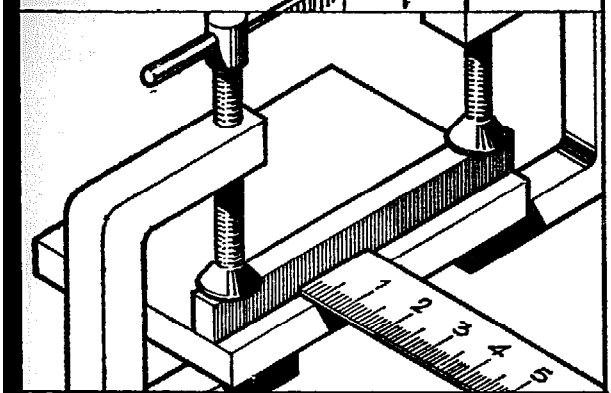
OPERATION	TOOLS
First the former is made. Saw 75 mm off a flat steel bar of 10 x 50 mm. This is the **base.**	Sawing machine. Rule.



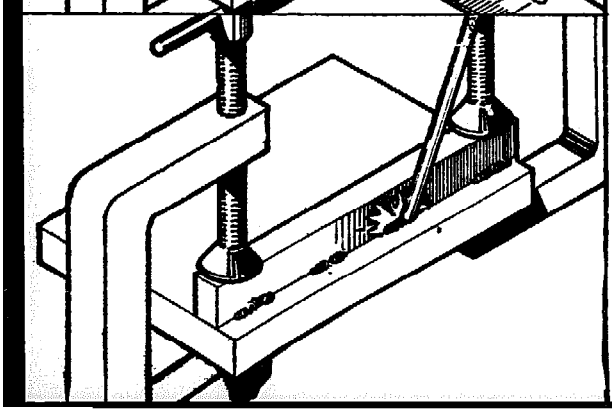
Saw 75 mm off a steel bar of 6 x 10 mm. This is the **strip.**	Vice. Rule. Hack saw.



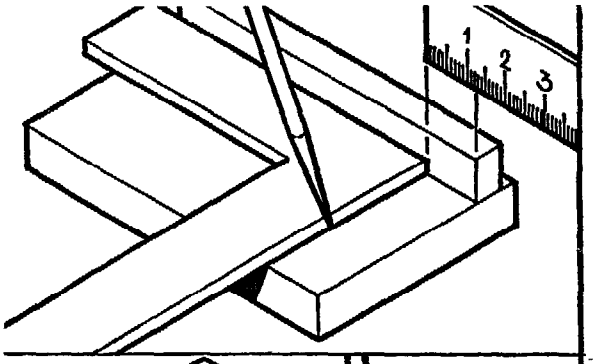
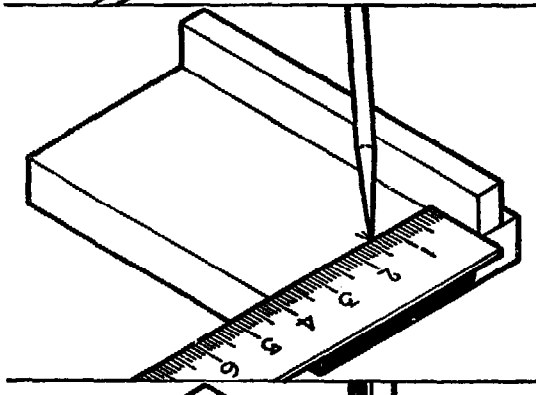
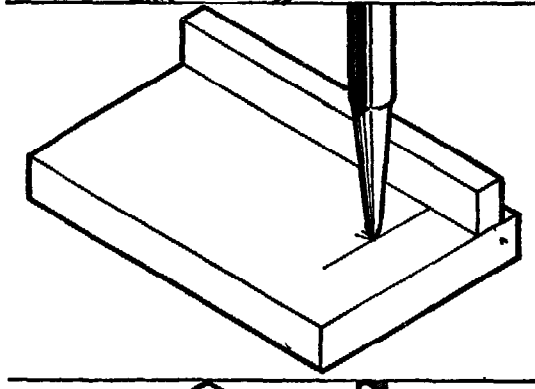
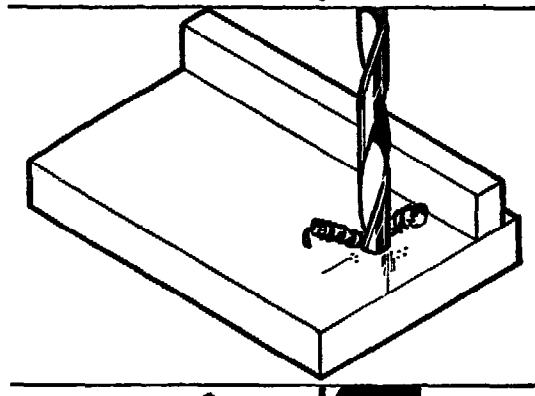
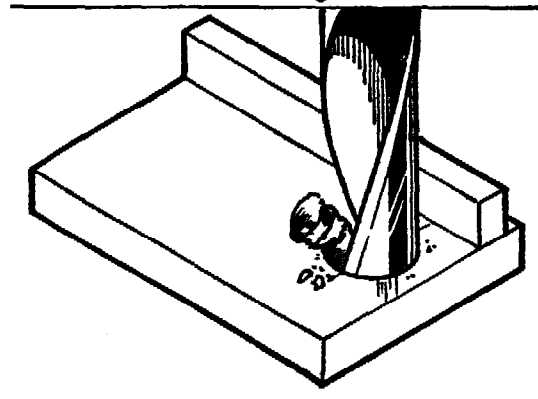
Saw 15 mm off a round steel bar dia. 16 mm. This is the **pin.**	Vice. Rule. Hack saw.

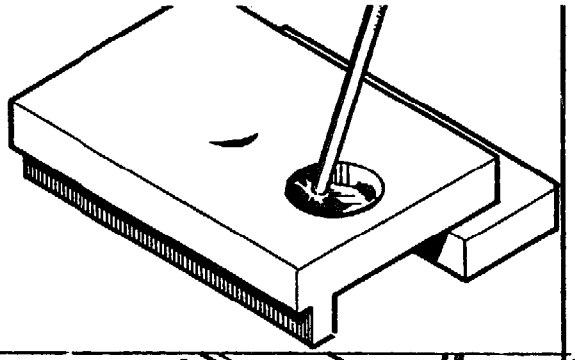


Clamp strip on base at 4 mm from edge.	Two G-cramps. Rule.



Tack weld strip on one side to base. First make outermost welds. (Thickness electrode 3¼ mm).	Arc welding equipment.

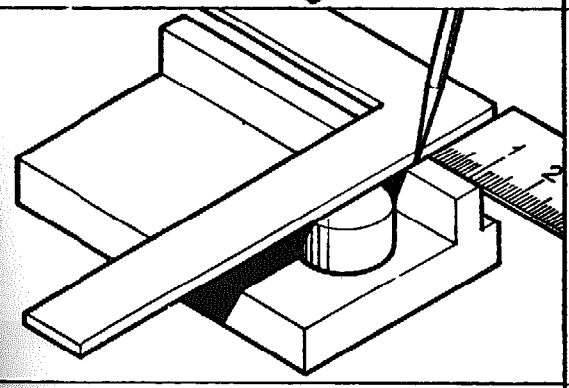
	Scribe line on base at 13 mm from side and at right angles to strip.	Try square. Rule. Scriber.
	Put V-mark on this line at 14.5 mm from strip.	Rule. Scriber.
	Centre punch at marked point.	Centre punch. Hammer.
	Drill hole at marked point. Use goggles!	Drilling machine. Machine vice. Twist drill 6 mm. Goggles.
	Enlarge hole to 16 mm dia.	Drilling machine. Machine vice. Twist drill 16 mm. Goggles.



Put base upside down on welding table with pin in hole.
Support with strip 10 mm thick.

Tack weld pin in hole.

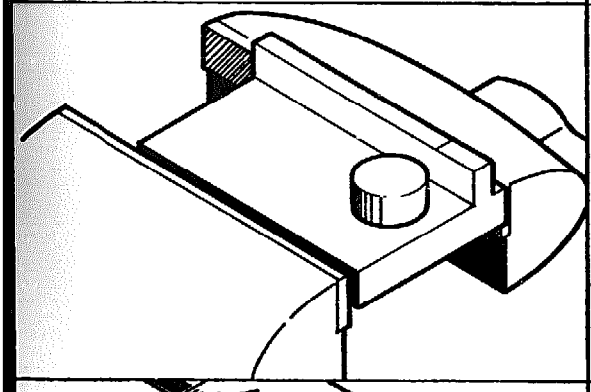
Arc welding equipment.



Scribe line on top surface of strip at 13 mm from side of base and parallel to it, as shown in figure. This is the datum line and it goes through the centre of the pin if lengthened.

Now the former is complete.

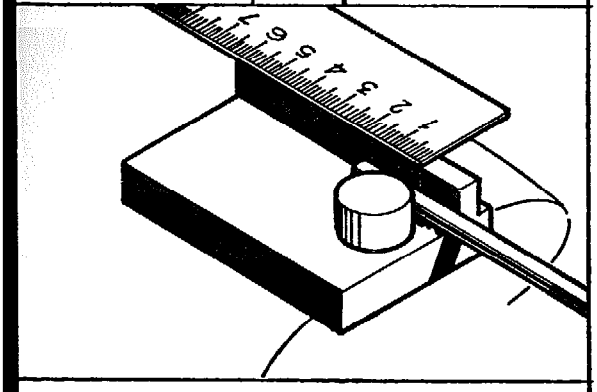
Try square.
Scriber.
Rule.



Now we are going to make the saw frame.

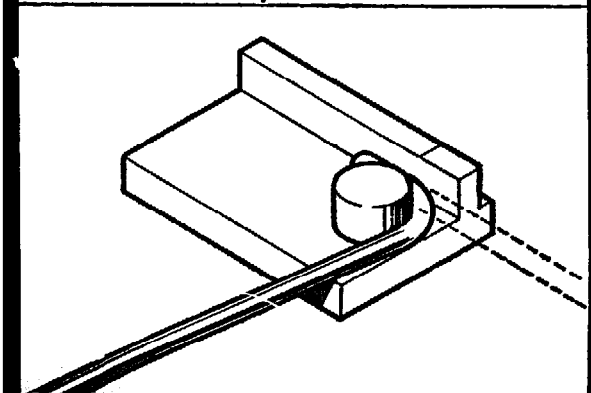
Clamp former in vice.

Vice.
Former.

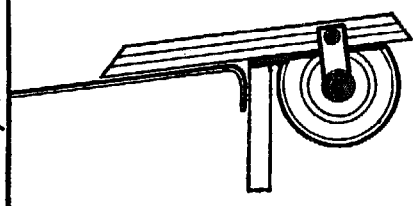


Put bar in former with end at distance 16 mm inside datum line, as shown.

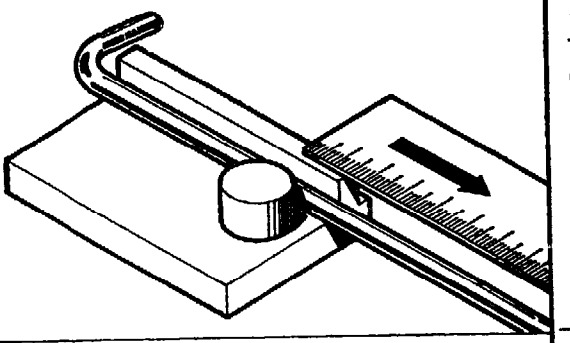
Vice.
Former.
Rule.



Bend to angle of 83 deg.
Check with vernier bevel protractor.

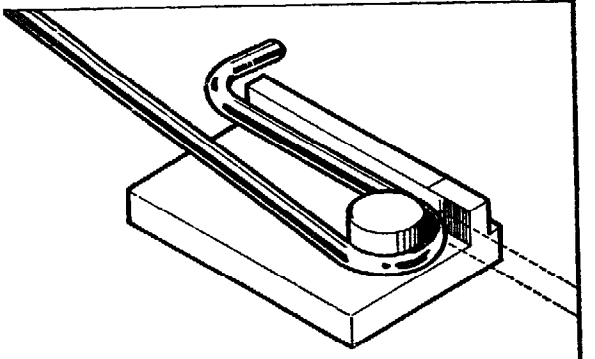


Vice.
Former.
Vernier bevel protractor.



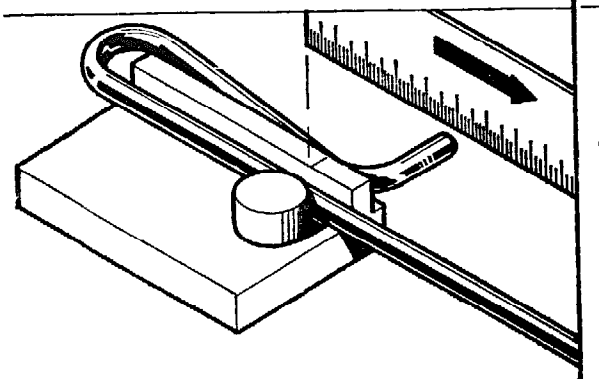
Put bar in former as shown.
The straight end extends 303 mm outside datum line.

Vice.
Former.
Rule.



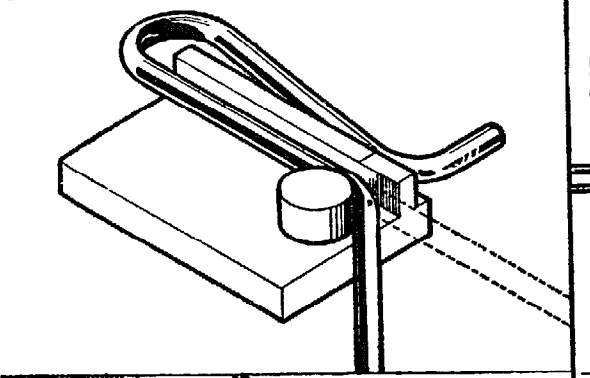
Bend until distance between first bend and straight part is 8 mm.

Vice.
Former.
Vernier calipers.

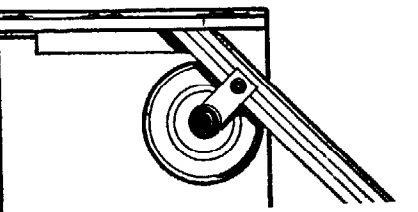


Put bar in former with straight end extending 202 mm outside datum line.

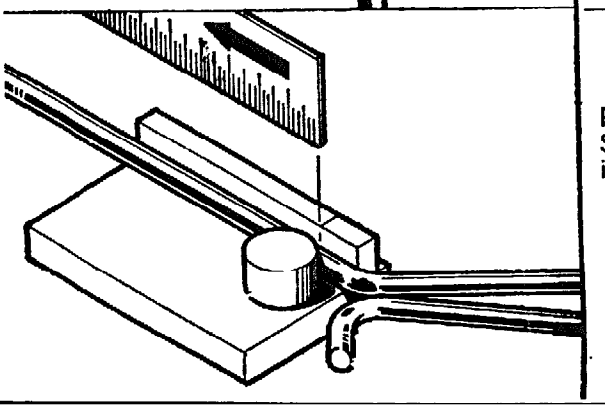
Vice.
Former.
Rule.



Bend to angle of 135 deg.
Check with bevel protractor.

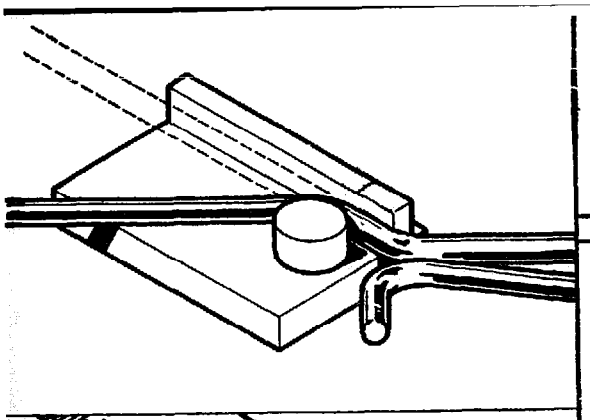


Vice.
Former.
Vernier bevel protractor.

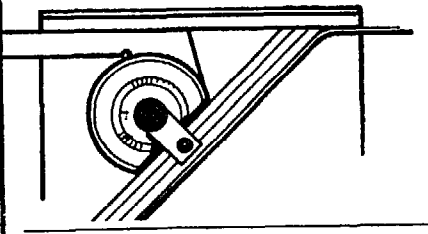


Put bar in former as shown.
Straight end extends 180 mm inside datum line.

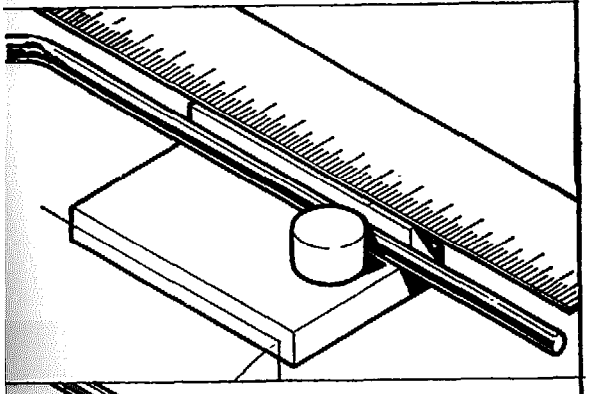
Vice.
Former.
Rule.



Bend to angle of 45 deg.
Check with bevel protractor.

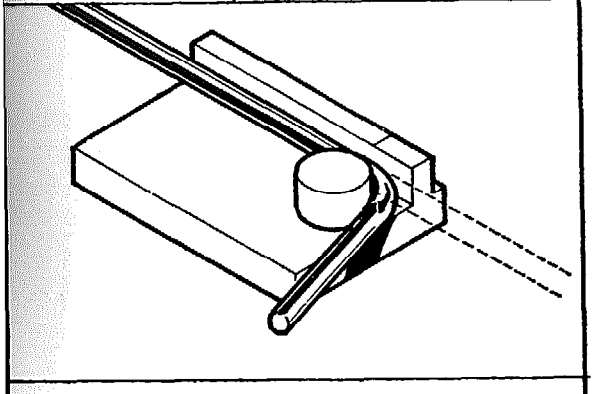


Vice.
Former.
Vernier bevel protractor.



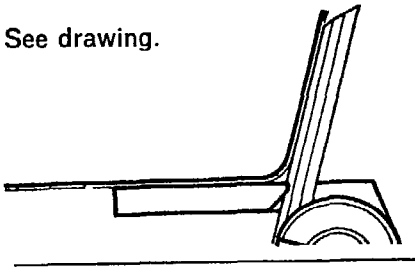
Put bar in former as shown.
Straight end extends 65 mm outside datum line.

Vice.
Former.
Rule.

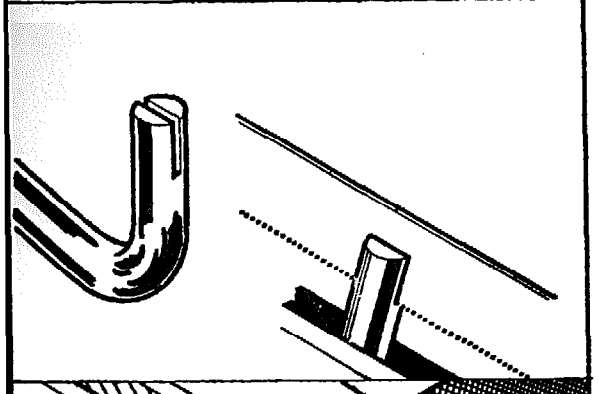


Bend to angle of 105 deg.
Check with bevel protractor.
Also check the 150 mm dimension.

See drawing.

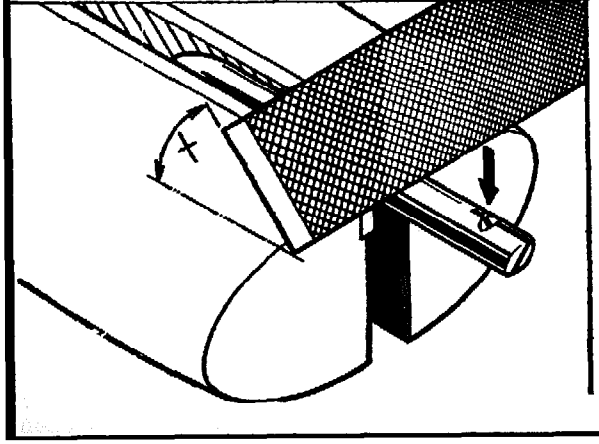


Vice.
Former.
Vernier bevel protractor.
Vernier calipers.



Saw slot of 8 mm depth in both legs.

Vice.
Saw frame.
Saw blade.



File notches on outside of tips as shown.
Keep file at angle of 45 deg. (x)
The exact place of these notches depends on blade to be used.

Vice.
Flat file.

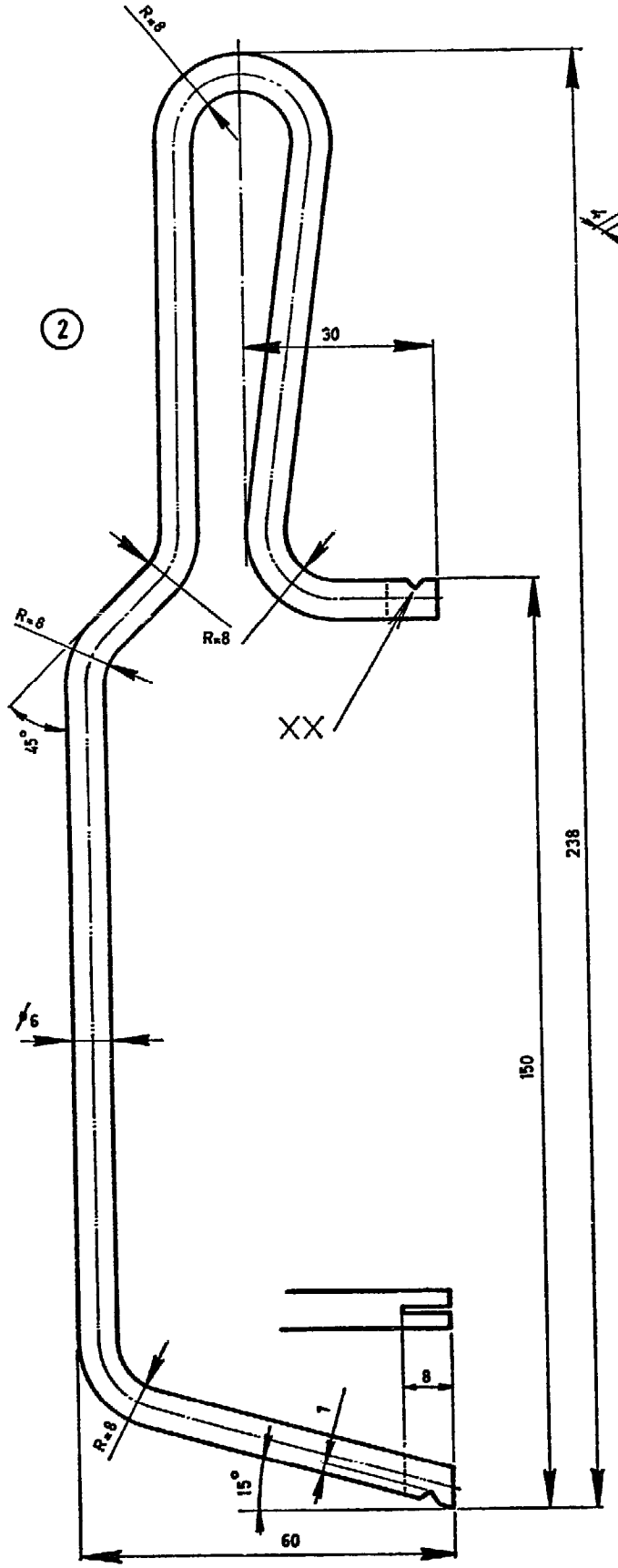
(1) = FORMER

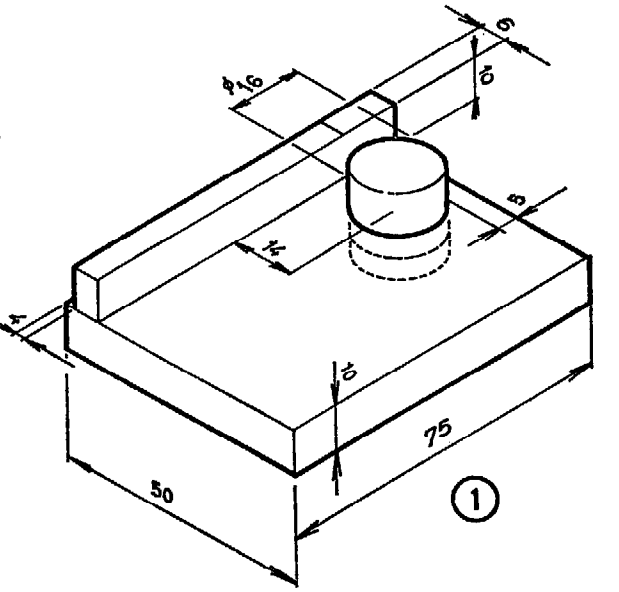
(2) = SAW FRAME

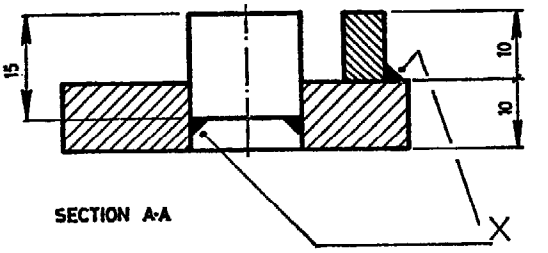
X = welded

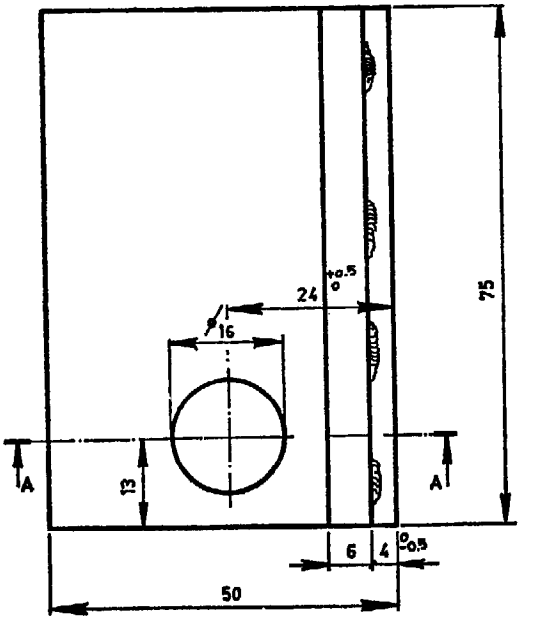
XX = exact place dependent on saw blade to be used

tolerance on all dimensions 1mm unless otherwise specified









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