TYPES, STRUCTURES OF WOOD AND PROCESSES

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First Edition

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"A Sincere Diplomat is like dry water or wooden iron"

Joseph Stalin

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DEDICATION

This work is dedication to Almighty God

ACKNOWLEDGEMENT

We owe thanks and deep gratitude to a lot of individuals for their immense contribution to the successful completion of this project. First, we wish to place on record, the enormous support and encouragement we received from professional colleagues.

In the course of writing this work, the author consulted a large body of existing related works in the area including published and unpublished works. Our gratitude goes to authors for the wealth of knowledge gained from their works.

Our deep and sincere appreciation and gratitude go to our families for their unflinching support and encouragement, and especially for their love, patience and understanding while we persevered to publish this work. The success of this work also owes much to circles of friends for their forbearance and enthusiasm during a long spell of this work. May God bless these and many more who in one way or the other contributed to the success of this work.

We also wish to extend our gratitude to Ibrahim Aliyu who spared enough time to read, make suggestions, guidance and pieces of advice which helped to make this work a huge success.

Finally, we give all praises, glory and honour to the Almighty God for his indispensable inspiration and magnificent gift of knowledge which guided us in putting this work together.

FOREWORD

Types, Structures of Wood and Processes revised edition book will be warmly welcomed by Vocational and Technical Education who have long felt the need of a suitably compiled text book on woodwork. The various chapters deal with History of Wood, workshop safety rules, common basic hand tools, woodworking power tools and methods, planning and squaring to dimensions, forestry, timber, cross sectional view of a tree, veneer and veneering, wood fasteners, ironmongery, design concept, timber finishes, glossary of technical terms and essay questions. The chief features of the principal styles of period furniture are dealt with at some length.

The excellent illustrations, of which there are many, have been specially drawn to elucidate the text. The book will be a useful guide to students preparing for the Examinations in Woodwork. It will be of assistance also to everyone who is interested in the craft of woodwork, we strongly recommend the book for students and teachers in technical education.

We congratulate the author on the arrangement and general treatment of the subject matter, and I wish his book every success.

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PREFACE

In keeping with its predecessor this second edition of Types, Structures of Wood and Processes has been revised and updated in order to satisfy the requirements of all who use it and to extend its appeal to an even wider readership.

Any person having an interest in the subject matter, whether it be to prepare for an NABTEB, or simply as a hobby will find something of value and interest in these pages. If used correctly, the book will provide a foundation from which access to the higher levels of craft competence can be gained.

We gratefully acknowledge the assistance of Aminu Jibril of National Examinations Council (NECO) in its preparation.

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Contents

ACKNOWLEDGEMENT vii
FOREWORD ix
PREFACE x
INTRODUCTION xvii

Chapter One 1
WOOD 1
The history of wood 1
Wood today 2
How a Tree Grows 3
Wood 5
Abridged list of timbers 6
Softwoods 6
Characteristics of some timber 9
Conversion of Timber (Cutting logs into boards and strips) 10
Natural seasoning in the open air. 13
Artificial – kiln drying 13
Moisture content 14
Timber Terms 15
Plywood 21
Non-Wood Manufactured boards 25
Useful chemicals 28

Chapter Two 42
WORKSHOP SAFETY AND TOOLS 42
Safety in the workshop 42
Personal wears 42
Tools 43
Machines 44
The Workbench 44

Holding devices on the bench 48
Cramps 48
Special note 49
The Rule 50
The Pencil and Marking Knife 51
Lines on wood 52
The Try Square 53
Straight edges 54
The Marking Gauge 55
Saws and Sawing 58
Saw design 58
Saw blades 60
Internal sawing 62
Bow saw 62
A smaller, lighter saw used for the same purpose. However, it can cut circles with a smaller radii and works better in thinner materials (fig. 2.23). 62
Pad or keyhole saw 63
Compass saw 64
Saws for straight cutting 64
The Tenon Saw 64
Rip saw 65
Crosscut saw 66
Rasps 67
Planes and Planing 69
planes 69
The Jack Plane 71
Special purpose planes 77
Block plane 80
Shoulder plane 81
Bull-nose plane 81
Spokeshave 82
Cleaning up 82
Chisels and Chiselling 83

The Firmer Chisel 84
Using The Chisel 86
The Mortise Gauge and Mortise chisel 87
The Mortise Chisel 89
Making a Mortise and Tenon Joint 90
Carving tools 92
The Mallet 93
The Hammer 94
The Nail Punch 96
The Pincers 97
The Bradawl 98
The Screwdriver 99
The G Cramp 101
The Brace 103
The Bits 104
The Twist Bit 104
The Countersink Bit 106
Bits in Less Common Use 107
Drills and drilling (fig. 2.63I) 110
Light machines 112
Circular saw 112
Bandsaw 112
Jig saw 113
Planer 113
Belt sander 114
Disc sander 114
Combination sander 114
Wood turning lathe 114
Circular saw data 115
Special saws 118
Transmission 120
Some Useful Definitions 132

Chapter Three 135
WOOD JIONTS 135
Framing Joints 135
Box Joints 136
Halving Joints 137
The Cross Halving Joint 138
The Housing Joint 140
The Mortise and Tenon Joint 142
Joint working 148
Methods of working 148
Butt joints 148
Cogged or tongue and grooved joints 149
Housing joints 150
Through housings 150
Another method 151
Stopped dovetail housings 151
Mortise and tenon joints 151
Dovetail joints 154
Cutting the tails 154
The door 155
The drawer 157

Chapter Four 162
ASSEMBLING, GLUING, FINISH AND FINISHING 162
Assembling, gluing and finishing 162
Planning 162
Preparation 162
Glues 162
Synthetic glues 163
Finishes 163
Staining 163
Water stain 163
Oil stain 164

Spirit stain..164
Polishing 164
French polish or shellac varnish..164
Cellulose finish 165
Acid-hardened catalyzed lacquer 165
Oil finish 165
Paints..165
Varnishes 166
Wax polishes 167
Stains, etc. 168
Strippers..169
Wood fillers 170
Polish revivers...171

Chapter Five 177
UPHOLSTERY 177
Upholstery Materials 177

Chapter Six 180
GLUES..180
Glues..180
Animal glue 180
Synthetic resin glue 182
Special glues 187
Gilding materials 188

Chapter Seven 190
IRONMONGERY 190
Nails...190
Screws 196
Screw hole sizes 198
Knock-down fittings 201

Chapter Eight 208
MAINTENANCE 208
Oilstones 208
Grindstones 209
Grinding wheels 210
Sharpening tools 210
Turning tools 213
Chisel..214

Chapter Nine 218
DEFECTS 218
Defect in timber during growth 218
Defects in timber after conversion 219
Defects in timber in use 220
Wood pests 221

Chapter Ten 225
FURNITURE..225
Period furniture 225
Jacobean period 1603-1660 225
Walnut period 1660-1720...226
Chippendale period 1745-1780..................................227
Hepplewhite period 1760-1790..................................229
Sheraton period 1790-1806 230

INSTITUTIONS CONNECTED WITH WOOD TECHNOLOGY
....233

AUTHORS BIOGRAPHY 234

INTRODUCTION

Woodwork Technology is a vital field within the broader scope of Building Technology, focusing on the design, construction, and finishing of wood-based structures and products. It combines the art and science of woodworking, emphasizing precision, craftsmanship, and the use of modern techniques to create functional and aesthetically pleasing items. From furniture making and cabinetry to structural wood components in building construction, woodwork technology plays a crucial role in both residential and commercial applications.

Historically, woodworking has been one of humanity's oldest crafts, evolving from basic hand tools to the advanced machinery and digital tools used today. This evolution has significantly expanded the scope of woodwork technology, incorporating new methods such as computer-aided design (CAD) and computer numerical control (CNC) machining, which have revolutionized the industry by improving accuracy, efficiency, and creativity.

The core of woodwork technology lies in understanding the properties of wood, the selection of appropriate materials, and mastering the various techniques required for cutting, shaping, joining, and finishing. Wood, as a versatile and renewable resource, offers unique characteristics that must be carefully considered during the design and construction processes. Factors such as grain patterns, moisture content, hardness, and durability influence the choice of wood and the techniques used in woodworking.

In tertiary institutions, the study of woodwork technology is designed to equip students with both theoretical knowledge and practical skills. The curriculum typically covers areas such as:

1. **Wood Properties and Selection**: Understanding different types of wood, their properties, and appropriate uses in various projects.
2. **Woodworking Tools and Equipment**: Familiarization with hand tools, power tools, and advanced machinery, including safety practices and maintenance.
3. **Joinery Techniques**: Learning different methods of joining wood pieces, including traditional joints like dovetail and mortise-and-tenon, as well as modern techniques using adhesives and mechanical fasteners.
4. **Furniture Design and Construction**: An introduction to the principles of designing and building furniture, considering factors like ergonomics, aesthetics, and structural integrity.
5. **Finishing and Surface Treatment**: Techniques for enhancing the appearance and durability of wood products through sanding, staining, painting, and varnishing.

The objectives of studying woodwork technology in tertiary institutions include developing problem-solving skills, creativity, and technical proficiency. Students gain hands-on experience through practical projects, enabling them to apply their knowledge in real-world scenarios. This foundation prepares graduates for careers in various sectors, such as carpentry, furniture making, cabinetry, and construction, or even entrepreneurial ventures in woodworking.

As the construction industry continues to prioritize sustainable practices, the role of woodwork technology is becoming increasingly significant. The use of engineered wood products, reclaimed wood, and eco-friendly finishes reflects the industry's shift towards more sustainable building practices. By understanding the fundamentals of woodwork technology, students are better prepared to contribute to this evolving field and meet the demands of modern construction and design.

Chapter One

WOOD

The history of wood

Wood has played an important part in the history of man. It provided primitive man with shelter, weapons and transport. His crude hut of saplings, covered with branches and skins, developed into homes of many kinds; log cabin, fortress, timber-framed cottage, half-timbered town house, chalet, bungalow, prefabricated building, even the caravan. Inside the dwelling, wood was used for chairs, tables and beds in many styles through many thousands of years. Among man's weapons, spears, shields, bows, catapults and battering rams and even warships and aeroplanes were made of wood; weapons which were used to shape history.

Primitive man used logs as rollers to move heavy loads, then followed the wheel and the use of wood in transport. It was used for carts and coaches, carriages and bicycles, galleons and barques, clippers and steamships, sleighs and skis, aeroplanes and gliders; the list is almost endless.

The hand tools for woodworking have developed side by side with the use of wood as a raw material. It is surprising to realise that the basic form of many tools has changed little through the ages. Many of the tools we use today are very similar to those used by our forefathers.

Every age has had its woodworkers; carpenters, joiners, cabinet makers, coopers, boat-builders and wheelwrights, patternmakers, sculptors, carvers and toymakers. Each new generation inherits the store of knowledge and skills of previous generations.

Wood today

In spite of the development of many new, 'man-made' synthetic materials, wood remains a very important raw material. Traditional uses in building and in the home are largely unchanged, but technical advances and the demands of modern mass-production have led to new methods of working in wood.

The development of machines capable of producing large quantities of manufactured boards such as plywood, blockboard, chipboard and hardboard has given designers and engineers wide scope to develop new ideas and techniques. Plywood can be used to make canoes and sailing dinghies of light weight but great strength. Plywood can also be moulded to form shells for chairs and TV cabinets. Chipboard and blockboard, veneered with wood or plastic laminates, are used to mass-produce good, inexpensive furniture and kitchen units.

Modern adhesives which give quick and immensely strong bonds have led to the development of the technique of lamination. Like plywood, laminating involves gluing layers of wood together to form shapes and sizes impossible to achieve in any other way. Massive portal frames for buildings, with exciting sweeps and curves and tremendous strength, can be constructed. Shapes for chair frames and table legs can also be laminated.

In furniture factories and elsewhere designers have developed a wide range of special woodworking machines, saws of all kinds, planers and sanders, spindle cutters and moulding machines, dowelling and dovetailing machines, hydraulic and pneumatic cramping devices and special heating equipment to speed the setting of glues.

The home craftsman engaged on "do-it-yourself" jobs about the house now has labour-saving power drills, saws and sanding machines.

How a Tree Grows

Trees are the tallest living things, some reaching heights of 400 feet. Some trees are hundreds of years old. Each year a tree forms new cells and the trunk expands in circumference. These annual rings of growth enable us to calculate fairly accurately the age of a felled tree. Many factors influence the growth of a tree; much depends upon the soil and the position in which it grows, the climate and the weather.

Most of the trunk is sapwood, cells of cellulose which are living and growing. As time passes, the cells in the centre stop growing and harden off to form the tough heartwood. This heartwood provides the most useful timber. The most active growth takes place in the cambium layer just beneath the protective outside bark. As the trunk expands, the bark cracks and splits giving the characteristic rough textured surface. Some trees, like the silver birch and plane, have a smooth bark that peels off in layers.

The juice-like sap rises through the tree to the leaves, where the action of the sunlight on the chlorophyll (the green matter of the leaves) combines with water and carbon dioxide to form elaborated sap. This processed sap travels back down the tree and is the 'food' upon which the tree lives. The medullary rays are thin tubes or ducts through which the elaborated sap travels into the heart of the trunk.

Typically, Food in the ground needed by the tree is soaked up by moisture in the earth. The fine root hairs (1) of the tree pick up this moisture. It is passed to the main roots (2) where it is made into crude (raw) sap. The crude sap climbs up the tree through the sapwood (3) and out to the leaves (4). Here, the green matter called chlorophyll, together with sunlight and with carbon dioxide from the air, change it into elaborated sap. Elaborated sap now passes down the tree through the bast (5) and into the tree along the medullary rays to 5a The Cambium Layer to grow. 5b The Sapwood to mature. 5c The Heartwood to store. Stored sap in the heartwood will be used by the tree to start a new growth next spring (fig.1.1).

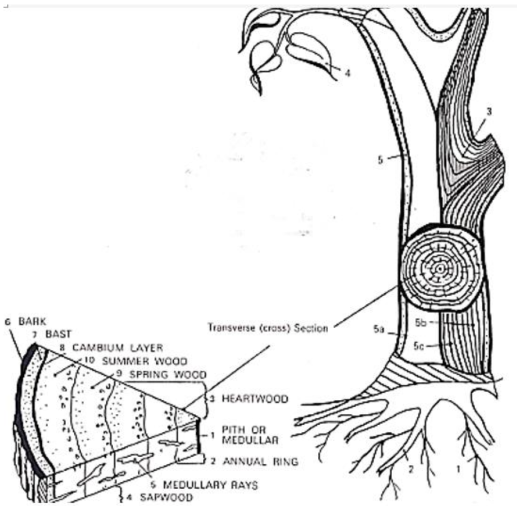


Fig. 1.1: Longitudinal section

Timber is divided into two main groups — hardwoods and softwoods. These classifications can be misleading because they are botanical and not necessarily anything to do with the working characteristics of the wood. Balsa, for example, is classed as a hardwood whilst some softwoods are very tough and difficult to work.

Wood

Wood is obtained from a tree. The type of wood will depend on the type of tree. Thus beech must come from a beech tree, box from a box tree. Deal, which is the name sometimes given to a softwood in general use, does not come from a deal tree. It comes from one of several types of pine tree.

The fibres which form the wood may be imagined as strands of string, all of which run up and down the trunk. Thus when the plank is cut out of the tree, the fibres will run along the plank. These fibres are called the 'grain' of the wood. When the fibres are cut across, the part cut is known as the end grain, because the ends of the fibres are exposed.

When a branch grows out of the trunk, the fibres (the grain) run along the branch but not in line with those in the trunk, imagine the fibres as string and you will remember better why the result is called a knot in the wood.

A plank is not always cut out of the tree in such a way that the fibres run straight down the plank. This may cause some trouble when you come to plane the wood. You may find you are planing 'against the grain' and the result may be better if the wood is planed in the opposite direction. Wood taken from the branches may have twisting grain which is difficult to plane smoothly from either direction. Not all trees provide timber suitable for Woodworking. Although there are many species, only a few are available commercially.

Abridged list of timbers

Trees are divided into two distinct families: (1) the coniferous or cone-bearing trees called softwoods, which have needle-pointed leaves; (2) the broad-leaved trees termed hardwoods, which in temperate climates stand bare during the winter. The terms have chiefly a botanical significance, the porous moisture-conducting deciduous trees being distinguished from the non-porous moisture-absorbing conifers. Hard does not imply strength or weight any more than "soft" suggests unreliability or lightness; but the terms have now been accepted universally as convenient for distinguishing the two main families of the timber realm.

Softwoods

Pine (Pinus sylvestris). Known alternatively as Scots pine, Scots fir, Red Baltic pine, Red pine, and Redwood. Sources: Scandinavia, the Baltic States, Northern U.S.S.R., and to a lesser extent Scotland. Colour, yellowish white. Weight, 26 lb. per cubic foot.

To us this is the most important timber of commerce. Moderately strong, easily worked, and obtainable in useful dimensions. The carpenter’s standard wood for roofing, joists, flooring, beams, partitions, window-frames, doors, fittings, kitchen furniture, and similar work. V

Yellow pine (Pine strobus). Known also as Canadian pine, Ottawa pine, White pine and (by agriculturalists) Weymouth pine. Sources: Canada and parts of U S A Colour pale yellowish white. Weight, 26 lb. Now very scarce.

Pitch pine (Pinus palustris). Source. U.S.A. Colour, similar to Scots pine but often with a strongly marked figure. Weight, 42-43 lb. Uses: a constructional wood for shipbuilding work, beams, piles, struts, church pews, spring mattresses, etc. The wood is highly resinous.

Parana pine (Araucana angustifolia). Source: South America. Colour, yellowish often with reddish streaks. Weight, 30-34 lb. Used for general indoor fitments but unsuitable for outdoor work. Has good working qualities and can be obtained almost free from knots

Douglas fir (Pseudotsuga taxifofia), commonly known also as British Columbian pine Oregon pine, Idaho pine, Red pine, Red fir, and yellow Fir. Source: British Columbia and parts of U.S.A. Colour, somewhat redder than pine. Weight, 32-34 lb.

Douglas fir yields timber for bridge construction, railway carriage wood, ship masts, spars and booms, telegraph and telephone poles, piles, sleepers, decking, flooring, agricultural implements, and carpentry and joinery. The timber is straight-grained and tough and is highly water-resistant.

Spruce (Picea abies), commonly designated Whitewood. Sources: Europe, including the Rosewood (Dalbergia, various). Sources: Brazil, Honduras, and East Indies. Colour, dark purple brown, banded with stripy markings. Weight, 53-63 lb. according to variety. Uses (almost wholly in veneer form): piano cases, cabinets, ornamental boxes, inlaying, etc. In this country the East Indian rosewood is now more widely used.

Sapele (Entandrophragma cylindricum). Source: East and West Africa. Colour, birch brown. Weight, 441b. Uses: interior furniture parts, veneering. The trees grow to a great height, many producing squared logs of six feet.

Satin walnut. (See Gum.)

Satinwood, East Indian (Chloroxylon swietenia). Sources: Ceylon, India, Burma. Colour, rich yellow. Weight, 59 lb.

Satinwood, West Indian (Fagara flava). Sources: Bahamas, Jamaica, San Domingo, and Puerto Rico. Weight, 51-52 lb. Uses: Employed chiefly in veneer form and for inlay stringing.

Sycamore (Acer pseudoplatanus). Sources: British Isles and Europe generally. Colour, nearly milk white, often richly mottled. Weight, 38-39 lb. Uses: flooring, textile trade work, rollers, cabinet work, ship-cabin fitments, dairy utensils, domestic goods, turnery.

The dyed grey wood fasionable for furniture (occasionally called "harewood") is produced from sycamore.

Teak (Tectona grandis). Sources: Burma, India, etc. Colour, brown, sometimes straw, but tending to darken on exposure. Weight, 45 lb. Uses: shipbuilding, railway work, building construction, high-class joinery, gates, garden furniture, etc.

One of the most valuable timbers of the world, teak has an enormous consumption, and being strongly fire-resistant and immune from the attack of the white ant, its uses cover almost every department of woodwork. Its resistance to crushing and transverse strain has earned for it the reputation of being the strongest timber available.

Walnut, European (Juglans regia). Sources: Great Britain, France, Italy, Black Sea area, etc. Weight, 40-46 lb. Purple-brown colour. Used for furniture but difficult to obtain in the solid. Often richly figured.

Walnut, American black (Juglans nigra). Source: Eastern U.S.A. Weight, 37-38 lb. A fine furniture wood.

Walnut, African (Lovoa Klaineana). Alternatively known as Nigerian walnut, tigerwood, congowood, etc. Source: West Africa. Weight, 31 lb.

Walnut, Japanese (Juglans sieboldiana). Source: chiefly Manchuria. Weight, 32 lb.

Willow (Salix alba, etc.). Sources: Europe, including British Isles; also (a different variety) U.S.A. Colour, pale greyish-yellow. Weight, 24-25 lb. Uses (according to species): cricket bats, basket work. The wood is strongly resistant to splitting.

Characteristics of some timber

Each timber has its own characteristics: colour, strength, weight, durability and so on. Some bend easily without snapping, some carve well, some are oily or resinous, some take paint well, others are water and weather resistant. Some woods have beautiful grain patterns. The first job of the woodworker is to select the most suitable timber for the job in hand. Some timbers in common use together with the purposes for which they are best suited are given below:

Ash: European hardwood. Very tough but springy. Used for cricket stumps, hammer handles and ladders.

Agba: West African hardwood, fine grained-and easy to work. Used for joinery and furniture.

Beech: From Central Europe. Very close grained. Clean and hygienic. Useful for breadboards, rolling pins, spoons, unpainted toys and kitchen chairs.

Birch: Scandinavian. White colour and close grained. Mainly used for plywood but also match sticks and match boxes.

Obeche: A hardwood but soft to work. Pale yellow colour free from knots. Often used in school craftwork.

Western Red Cedar: A softwood from Canada. Very weather resistant. Used for the external cladding of building and special roofing tiles called 'shingles'.

Conversion of Timber (Cutting logs into boards and strips)

About one-fifth of the earth's surface is forested and man is continually exploiting these forests. Because the supply is not inexhaustible, in recent years softwoods have been cultivated as a crop in many parts of the world.

Most trees are felled with motorised chainsaws. The branches are then stripped off and the trunk goes to the nearest sawmill or docks. In some parts of the world the logs are floated down rivers as great rafts (fig. 1.2). Elsewhere, giant elephants, giant tractors, Lorries or specially equipped trains are used. At sawmills, before or after export, the trunks are converted into useful sizes and shapes. Often a trunk is reduced to a square baulk; this removes a lot of the useless waste and makes the timber easier to handle.

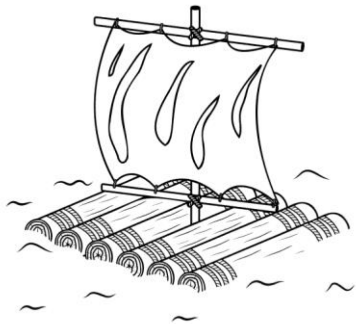


Fig. 1.2: Logs floating down river

A simple **“through and through”** cut is usual. An easy way to cut up softwood logs. It is quick and cheap. This results in very little waste but planks cut in this way are very prone to warping, creating problems later for the woodworker. Hardwoods which are used for furniture making and other decorative work are converted by **tangential sawing or quarter cut**. These two cuts produce a variety of sizes and show off the grain pattern (figure) to best effect; the wood is cut parallel to the medullary rays. These boards may shrink but do not warp. See figure 1.3 for the conversion methods

At the sawmill, the timber is carefully checked for defects such as splits along the grain, called 'shakes', and for decay caused by fungi or insect attack. After seasoning the timber is further converted into standard sizes, each cross section having a special name: plank, deal, board, batten, square, scantling and so on. Many of these are machine-planed before sale.

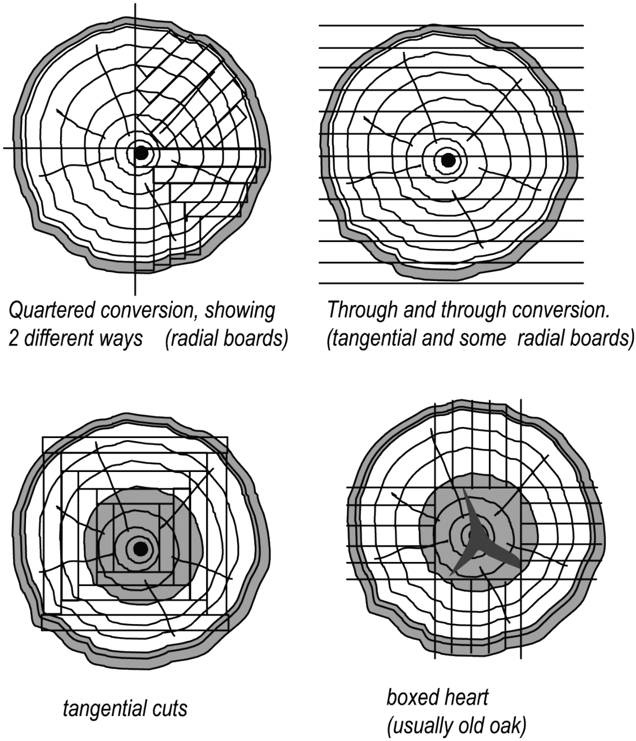


Fig. 1.3: Conversion methods

Seasoning (Lowering the amount of 'wetness' (sap) in the wood by drying)

Timber contains a great deal of moisture when felled. In this state the wood is called 'green'. The moisture content makes sawing difficult and planing almost impossible. Green wood also shrinks and splits. To overcome these problems timber undergoes controlled drying-out known as seasoning

Seasoning can be done in two different ways:

Natural seasoning in the open air.

A process taking several years. It gives the best results. The sticks between the boards let fresh air circulate freely. Boards stacked like this are said to be “in stick”. Slow drying stops splitting.

The boards are stacked carefully with 'sticks' (1"x1 725mm square) between them. This allows a good circulation of air. Each stick is placed directly above the one below, otherwise the boards sag under their own weight. The whole stack is supported off the ground on baulks or brick piers. A sloping roof keeps out rain and direct sun (fig. 1.4). Natural seasoning is very slow and can take many months, even years, to complete. To speed up the process, natural seasoning is sometimes combined with the second method - kiln seasoning.

Artificial – kiln drying

This takes place in a brick-built kiln. The boards are stacked, in 'stick', on trolleys. Inside the kiln, controlled amounts of steam and blown hot air gradually reduce the moisture content (fig. 1.5). The whole process takes only a few weeks.

Kiln dried timber is cheaper because it takes only hour instead of years.

There are two types of kilns:

1. Natural draught Hot air and steam are drawn through by tall HEATERS chimneys and flues.
2. Forced draught Hot air and steam are blown through by electric fans.

To keep the wood fairly stable, a small percentage of moisture is retained. Even carefully seasoned timber can cause the woodworker problems that have to be considered in the design and construction of jobs. Warping is the most serious defect in wide boards. Smaller sections twist along their length or curve and bow. Careful storage in cool but dry surroundings is best.

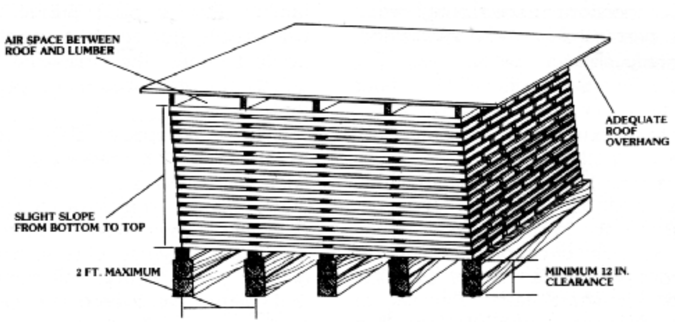


Fig. 1.4: Natural seasoning.

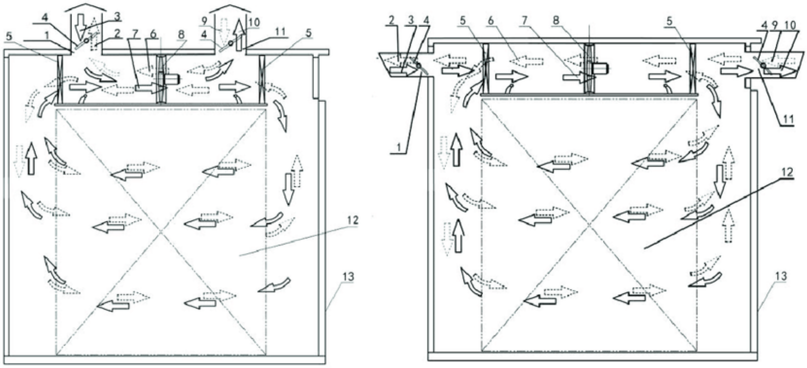


Fig. 1.5: kiln drying.

Moisture content

Cut timber is never bone dry except in exceptional circumstances. It loses or gains moisture in accordance with the surrounding atmosphere. Its moisture content should therefore be known, as otherwise there may be considerable movement owing to expansion or shrinkage, this depending upon the position in which the wood will be used eventually. It is thus clear that the content should vary in accordance with the use to which the timber will be put.

Moisture content is the weight of moisture expressed as a percentage of the dry weight of the timber. As an example in a piece of wood having, say, 20 per cent, moisture content there is 1 lb. of water for every 5 lb. of dry wood.

There are two ways of measuring the content; by using an electrical instrument which measures the electrical resistance; and by weighing a sample, drying it in an oven, and weighing again. The former calls for an expensive instrument; weighing is relatively simple. In this a small piece is sawn off the board and weighed. Assume that the sample weighs 8 oz. This is termed the "initial weight." It is then placed in an oven and dried at a temperature equivalent to boiling point until there is no further loss of weight. Assume then that when put on the scale for the "dry weight" it is 7 oz. —a difference of 1 oz. The moisture content is thus one-seventh of the dry weight, that is, 14.3 per cent.

The sample should be cut 200 mm. or more from the end of the board as the ends are often drier than the rest.

Timber Terms

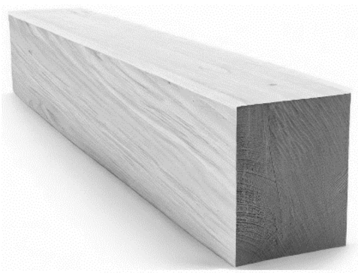
The following terms applied to imperial measurements are given in their nearest metric equivalents. As they are loosely applied to timber, and vary in different trades they cannot be regarded as binding. The sizes are nominal.

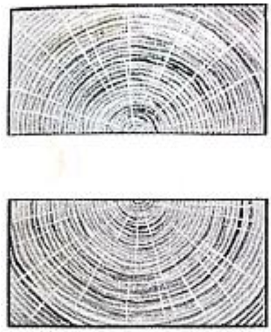
Baulk. Timber squared for further conversion and exceeding 115 mm. by 100 mm. Size is usually much larger (fig. 1.6).

Half-timber. A bulk cut in two along centre (fig. 1.7).

Flitch. Any large baulk or other timber squared for veneer-cutting or further conversion.

Wane-edged timber. Partially squared logs with corners not wholly cut out. The outer boards cut from such a timber would have waney edges (fig. 1.8).





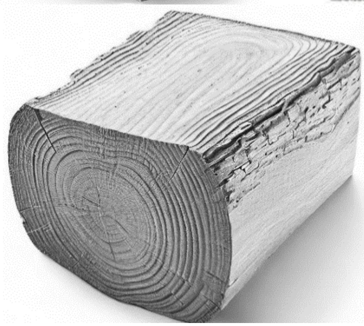


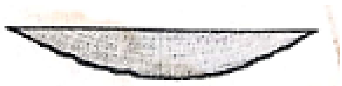
Fig. 1.6: Baulk Fig. 1.7: Half-timber

Fig.1.8: Wane-edge timber

Slab. The outside slice cut from a log which is being squared or cut into boards. One side rounded (fig. 1.9).

Plank. In softwood 200 mm. or more wide by 50-100 mm. thick. In hardwood 50 mm. or more thick (fig. 1.10).

Deal. Softwood from 225-280 mm. wide by 50-100 mm. thick (fig. 1.11).



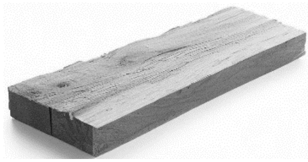


Fig. 1.9: Slab Fig. 1.10: Plank
Fig. 1.11: Deal

Board. In softwood 100 mm. or wider and under 50 mm. thick. In hardwood any width and up to 50 mm. thick (fig. 1.12).

Strip. Under 100 mm. wide and under 50 mm. thick (fig. 1.13).

Batten. Width is 100-200 mm. and thickness 50-100 mm. Term is applied to softwoods (fig. 1.14).

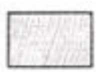


Fig.1.12: Board Fig. 1.3: Strip
Fig. 1.14: Batten

Square. Square-sectioned timber with sides from 25-150 mm (fig. 1.15).

Slating batten. (Also Tiling batten.) Up to 75 mm. wide by 16-32 mm. thick. Common size is 38 mm. or 50 mm. by 19 mm (fig. 1.16).

Scantling. Width 50-115 mm. and thickness 50—100 mm (fig. 1.17).

Fig. 1.15: Square Fig.1.16: Slating batten
Fig. 1.17: Scantling

Manufactured (man-made) boards

Veneers

Timbers sliced into thin sheets are called veneers. They are used for:

1 Making plywood and multi-ply.
2 Facing manufactured boards.
3 Using rarer, costlier and more highly decorative woods more economically.
4 Curved work not possible with solid wood.
5 Making matched patterns in veneered cabinet work.
6 A picture making craft called Marquetry.

Cutting veneers (fig. 1.18)

Saw cutting was first used to make veneers. It is still the best method. Today it is not much used. Knife cutting is quicker and can give thinner veneers.

Rotary cutting A rounded log is turned in a lathe. Whilst it is turning a sharp knife peels off the veneer. This passes over an Iron bench where it is cut up into lengths by a second knife called guillotine.

These veneers have poor grain quality and are mostly used in plywood making.

Knife cutting: A squad log is fastened to a machine bed. As the bed moves up and down, a sharp knife slices off the veneer. Veneers cut this way have interesting grain and figure pattern. They are used as face veneers.

Almost every figured hardwood is normally obtained in veneers. The finest wood, indeed is rarely on the market in any other form, and man/timbers are available only in veneers. The familiar classes of veneer are these:

A Saw-cut. These are the stoutest, but the most costly: because about 50 per cent of the log disappears m sawdust. They are not cut to-day because of this reason. Improvements m knife cutting has made the saw obsolete. By cabinet makers they are preferred, this on account of their greater reliability in laying and the avoidance of glue penetration.

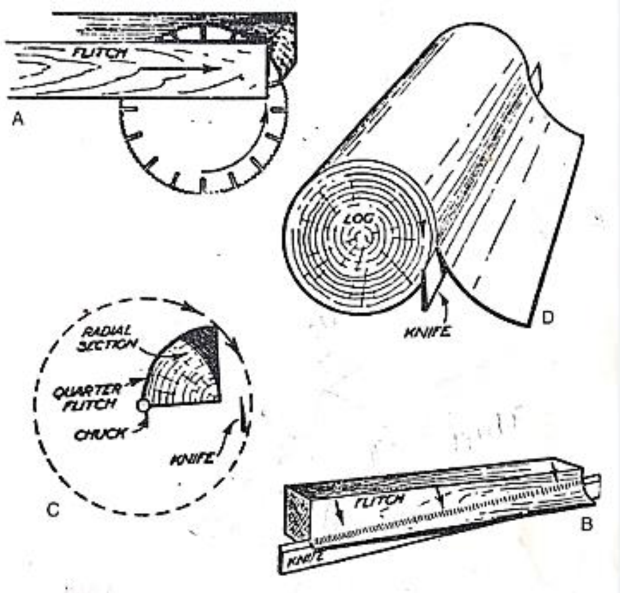


Fig. 1.18. Methods of cutting veneer

B. Flat knife cut. Like sawn veneers these are cut on the flat, the log being held stationary on a heavy bed while the knife is mounted upon a carriage which slides back and forth. In some cases the knife is stationary whilst the wood moves. The knife cuts across the grain at a slight angle, and the finest figured veneers are produced in this way. Except in cases where the colour might deteriorate (as in sycamore) the timber is steamed before cutting. \

C. Half rotary slicing. This method is used for woods which are largely dependent upon being cut on the quarter (that is, in line with the rays) to show good figure. The log is first quartered, and the quarter segments fixed in the machine with one of the corners nearest the sapwood at the centre. By revolving the segment about this centre the knife cuts a path which is approximately radial. In fact, the middle of each leaf is radial, the edges slightly diverging owing to the curved path of the cut.

D Rotary cut. This is quite a different method, although the veneers are again knife-cut. The logs, about 1-8 metres long, are mounted on a kind of mammoth lathe and a long knife is fed up to it which pares off the veneer. The knife is so held against the revolving log that a sheet of veneer is peeled off its entire length, and the "unrolling" is continued until the core of the log is reached. The grain of the resulting veneer is wild and unnatural, but for plywood these rota/y-cut veneers have been found excellent, and they can be produced at a much lower cost than by saw or flat-knife cutting.

A veneer should preferably be laid in the same relative position as when cut from the flitch, though this cannot always be done. For instance, in a quartered panel two of the pieces are bound to be reversed.

Man-made (Manufactured) Boards

Plywood

Planks and boards contain a certain amount of moisture even after seasoning. This can cause them to twist and warp as they dry out. Warping makes accurate work difficult.

If, for example, a wide piece of wood is needed to make a table top, several boards would have to be joined together edge to edge. To overcome this disadvantage, special kinds of manufactured boards are made, the most common of which is plywood. Plywood is made up of layers, or laminations, of wood glued together, the grain of each layer running in the opposite direction to the next. This is why plywood looks alternately light and dark on the edges. Gluing the layers in this way prevents the wood from twisting and warping; it makes the sheet stable. It also means that saw cuts can be made in any direction without the danger of splitting along the grain.

Plywood is made in large sheets, usually 8'x4' (2440X 1220mm), and in several thicknesses. The large sheets make edge jointing unnecessary. Sometimes the two outside layers have veneers of beautiful, rare and expensive timbers.

The ply layers are cut in one of two ways. In each the log is steamed first to soften it up. In the first method it is mounted on a giant, lathe-like machine where a large blade cuts and unrolls it rather like a reel of paper. In the second method, the log is squared-up and slices are taken from the top. After cutting, the layers are sorted, the best being used on the outside. Glue is applied by rollers and then the sheet is squeezed in a heated press until the glue sets (fig. 1.19).

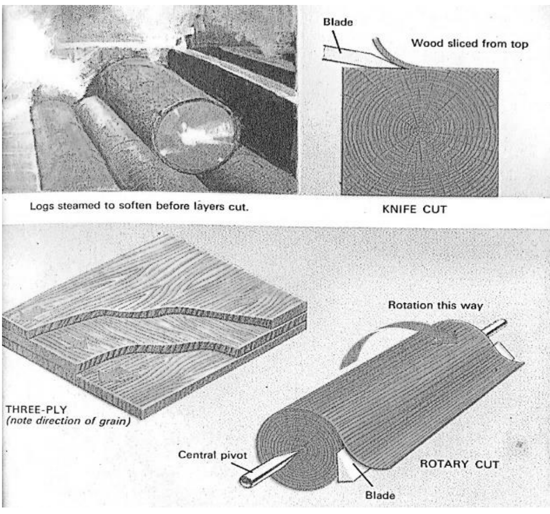


Fig. 1.19: Manufacturing plywood

Other manufactured boards (fig. 1.20)

Cheap plywood, such as those from which tea-chests are made have an extra thick centre layer known as stoutheart.

Multi-plys over $\frac{3^{\pi}}{4}$ (18mm) in thickness are expensive to produce and very heavy. Over this thickness, cheaper, lighter alternatives are used.

Laminboard has a core made of $\frac{3^{\pi}}{16}$ (7mm) wide strips of softwood between two facings of thick (3mm) veneers, the grain of which runs at right angles to the core. This produces a high quality, very stable board suitable for decorative veneering in furniture making.

Blockboard is also used in furniture making. It is very similar to laminboard but has wider (1 "/25mm) core strips.

Battenboard has even wider strips (over 3780mm). It is a low grade board used for flooring, shuttering and portable buildings.

Chipboard is a recently introduced material resulting from the development of new adhesives. Wood particles from waste, offcuts and small, otherwise useless trees are mixed with synthetic resins and compressed. This produces a strong, cheap board. Often extra-fine particles are used on the surfaces to give an improved finish. Chipboard is difficult to joint, but for table tops and simple furniture such as book-shelves, veneered chipboard is ideal. Like all other boards, the exposed edges must be veneered or lipped with a strip of wood.

Hardboard is a versatile, thin ($\frac{1}{5}$ to $\frac{1}{4}$ / 2-6mm), cheap sheet material. It is made from waste wood, chipped and shredded and pulped, mixed with resins then heated and compressed. Hardboard has one smooth face and one textured. For jobs that require painting, kitchen cabinets for example, special oil-tempered hardboard is best.

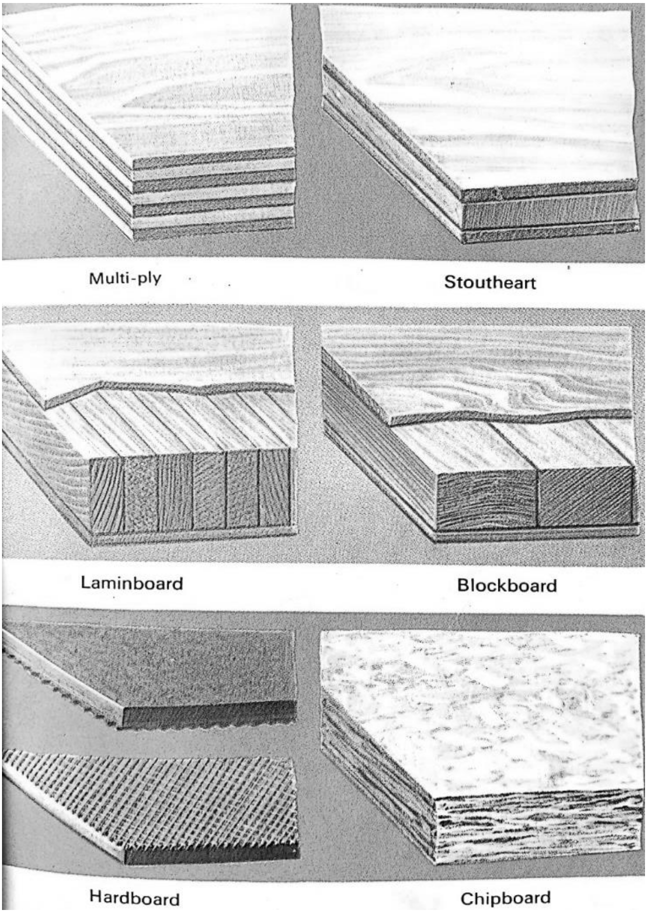


Fig. 1.20: Other manufactured boards

Non-Wood Manufactured boards

There is a wide range of proprietary boards made for various purposes, some of them being used nowadays as substitutes for solid wood for certain uses. The materials with which they are made varies with the uses for which they are intended, and should be considered when a selection is made. Some are intended for outdoor use, being able to resist most weather conditions, others are for indoor work only. The majority are not structural boards, but are meant mostly as filling panels for framework of solid wood or metal, and they should not be called upon to do work for which they are unsuited.

Asbestos-cement board. Suitable for outdoor use, it is made in flat sheets suitable for walls and partitions, and in corrugated form for roof work. It is somewhat brittle, however, and should therefore not be used in positions where it may be subjected to rough treatment. Rigid fixing is not advisable because any movement in the framing to which it is fixed may cause cracking. The better plan is to allow a 5 mm. gap between adjacent panels and cover with a wood fillet, the fixing nails passing through the gap. If nails through the sheet are essential holes rather larger than the nails should be drilled. Take care not to shatter the panel with the hammer, especially when the nail is nearly home. Corrugated sheets are fixed with 90 mm. galvanised screws driven through holes drilled through crown of the corrugations. (not the valleys) with special washers to keep out water. If possible the board should be used in the standard sizes as it is awkward stuff to cut. A small-toothed saw can be used but it is hard on tools. Sizes vary in different makes.

Asbestos fibre board. This has a high fibre content making it more easily workable than asbestos-cement board. Nails can be driven through it without previous drilling, and it can be sawn or cut by scribing with a knife along the line after which it will break. It can also be bent within certain limits. It is suitable for outhouses, poultry houses, garages, sheds, partitions, and so on. For roofs the corrugated type should be used. Sizes and thicknesses vary.

Fibre building board. Under this heading is a wide range of proprietary materials ranging from comparatively soft boards used largely for their insulation value to really hard boards suitable for van bodies, trailer caravans, etc. Various materials-wood, straw, cane, and other vegetable products-are used in its manufacture. They are not structural and require to be fixed to a rigid framework. Ordinary woodworking tools are used for cutting, though holes are best made with the Morse drill used for metal work. Sizes and thicknesses vary widely.

The chief headings under which they are classified are:

Insulating board. Density not exceeding 251b. per cubic foot and nominal thickness of not less than 12 mm.

Wall board. Density not exceeding 30 lb. per cubic foot and usually 4 mm. to 10 mm. thick.

Hardboard. Density between 30 and 50 lb. Thicknesses in common use are about 3 mm. and 5 mm, but thicker boards are also available. A specially compressed and impregnated variety is also available, this being suitable for outdoor work such as caravans, etc.

Embossed board is also made, this having a pattern such as reeding formed in the surface whilst under compression. Perforated board having small holes drilled at regular intervals is used widely for shop display work and so on.

Plastic laminate. Used for table and cabinet tops, wall panels, and so on. Mostly made from paper sheets heavily compressed and impregnated with resin. Many of them are highly resistant to heat so that a lighted cigarette could be laid on them without damage. This gives them a special value for table tops, etc. Some varieties are obtainable in colours and in special finishes such as linen, onyx, wood grain. Panel sizes and thickness (about 1 -5 mm. and upwards) vary according to make.

Most hardboards, chipboards, and so on can be assembled with animal or resin glue, the usual technique being followed. Plastic boards to be fixed to wood call for the use of contact adhesive or synthetic resin.

Glass. The type of glass used for glazing windows is known as sheet glass, and is normally obtainable in three grades: best (used for good quality work); seconds (for general average work); and thirds (often used in greenhouses, garden frames, etc.). Its thickness is known by the weight of glass in a square foot. Thus a piece of glass 24 in. by 12 in weighing 30 oz. is known as 15-oz. glass. The latter is used in the smallest work only, being liable to fracture if used in larger sizes. For the general run of windows 21 oz. is the thinnest practicable size, and this should be increased to 26 oz. in good work. For larger panes 32 oz. is desirable. As a general guide, 15-oz. glass is full T58 mm. thick; 18 oz.-2-1 mm.; 21 OZ.-2-5 mm. bare; 24 OZ.-2-5 mm. full; 26 oz.-3-2 mm.; 32 oz.-4-O mm.; 42 oz.-5-0 mm.

There are many other varieties of glass made for special purposes, such as reeded, cathedral, and figure rolled, which obscure the vision to a degree according to the type. Also wired glass made in varying meshes; toughened glass; tinted glass; glass slates and tiles; prismatic, and so on.

Sheet glass is inclined to distort objects seen through it, especially seconds and thirds, and for the best work plate glass is advisable. This is made of better materials, and is ground flat and polished. It is made in thicknesses from 5 mm. upwards.

Useful chemicals

P = poisonous; C = harmful to touch.

Acetic acid. 6% used in some furniture revivers. Vinegar is an impure form of acetic acid.

Alkanet root. Used chiefly for making red oil. The roots are 4-6 in. long and anything up to 5 in. thick. They are bruised and steeped in linseed oil. Difficult to obtain.

American potash is used for the weathering of oak. It turns the wood deep brown, causing the figure to become almost black. Subsequent treatment with chloride of lime turns it grey. It is now often known under the name of crude caustic potash. P.C.

Ammonia. Used chiefly for fuming oak, but is also useful for adding to water stain, as it helps to drive the latter into the grain. Obtain 0-880 (ask for “point eight-eighty” ammonia) and keep well corked, as it speedily loses its strength when exposed to the air. Rock ammonia is used for polish strippers. P.C.

Aniline dyes are obtainable in many colours and soluble in water, spirits, or oil. The kind required should be stated when ordering.

Black, blue, crimson, magenta, orange, red, yellow, bismarck brown, Vandyke brown, green, maroon, purple.

The dyes are used for making stains and for tinting polish. Colours can be blended, but water-, oil-, and spirit-soluble dyes cannot be mixed. P usually.

Asphalt see Liquid asphalt and pitch.

Benzoin or gum bertzoin. A resin used for making polisher's glaze. It is in the form of small pieces and looks like dried twigs compressed together in which are white specks. The more of the latter the better the quality.

Benzine. Sometimes used to remove excessive oil in varnishing. P.

Berlin black. A thick black liquid which dries out flat without shine.

Bichromate of potash. Pf. chased in crystal form of a deep orange shade. Used chiefly for darkening mahogany. Can also be used for oak. P

Bismarck brown. An aniline dye of fiery red colour. If used too strong it has a greenish blue. It is powerful and should be used cautiously. P

Bitumen powder, also called mineral pitch. Used for repeat designs for marquetry

Borax. Used in some strippers; also for water varnishes. Sometimes used to neutralise oxalic acid after bleaching.

Brown umber. A brown pigment which can be worked up in water or turpentine. Mixed with water and bound with glue size it makes a cheap water coating for inexpensive furniture backs.

Brunswick black. A thick black liquid drying with a shine. Used in woodwork for floor stains, for which purpose it is thinned out.

Burnt sienna. Pigment powder, light red-brown colour. Used much as brown umber.

Burnt umber. Similar to brown umber, but of deeper, stronger tone.

Butter of antimony. A dark brown liquid which has a slight hardening effect on polish. Used in making furniture revivers. P.C.

Camphor. Used in some furniture revivers. P.

Camphorated oil. A mixture of four parts olive oil and one part camphor. Used for the removal of heat and water marks. P.

Carbon tetrachloride. For degreasing some woods before gluing. It is used chiefly on teak, the greasy nature of which prevents glue from sticking well. P.C.

Carborundum powder. An abrasive obtainable in various grades. The fine grade is used in making the black coating for blackboards to give a bite to the chalk. Also used for rubbing down worn oilstones.

Caustic potash. Used as a stripper for polish, paint, etc. It tends to darken some woods and should be used with care. P.C.

China clay. Used for making paste wood filler.

Chloride of lime. Imparts a greyish tone to oak. Is used in the weathered finish.

Copal. A gum used in the manufacture of varnishes which have an oil basis. It comes from Africa and is a pale, yellowish resin, though some varieties are darker.

Copperas (green) (sulphate of iron). A chemical crystal which, dissolved in wafer, gives a pale blue shade. Used for killing the redness in mahogany when the latter has to imitate walnut. Also for staining oak a blue-grey colour. Turns sycamore a grey tone, thus producing grey wood or harewood. P.

Creosote. An oily liquid obtained from wood tar. Used as a preservative for wood.

Crocus powder. A fine abrasive used for dusting over a polished surface to dull it. Also used as a strop dressing for carving tools.

Dragon's blood. A red agent for colouring polishes. It has been largely superseded by aniline dyes.

Drop black. Obtained in the form of a thick paste which is 'hinned with turps. It is used sometimes in ebonising and in the preparation of blackboard.

Emery powder. An abrasive sometimes used in the preparation of blackboards. It gives a bite to the chalk. Also used for rubbing down varnished work. The fine grade mixed with lubricating oil makes an effective dressing for tool strops. Also sometimes used on oilstones which have lost their cut.

Eosin powder. A red powder dissolved in water and used to warm water stains. P.

Flake white. A white powder sometimes mixed with white polish for lightening the tone of the wood. Mixed with Scotch glue it turns the latter white, making it suitable for light woods. P.

French chalk. A finely powdered white chalk used in making the half-filling for oak to be French polished. Also sometimes used to lubricate surfaces which rub together.

Fuller's earth. Used in varnishing for removing oiliness.

Gas black. A preparation made by suspending a sheet of tin over a fishtail gas burner. Used chiefly in ebonising.

Glue size. Sometimes used as a partial filling on deal before the application of polish. Also used in the preparation of water coatings, in which it acts as a binder. It is also applied to softwoods to be veneered and to end grain.

Gold size. A quick-drying varnish normally used for the application of gold leaf and gold paint. It is also a useful binder for colours ground in turps. Sometimes used in making paste fillers.

Gum benzoin. See benzoin.

Hydrogen peroxide. Used for bleaching. 100 vol. is generally used, diluted with 2 parts water. Some chemists supply not less than 2 gallons. P.C.

Hyposulphite of soda. Sometimes useful for removing stains made by iodine.

Lamp black. A black powder used for water coating, also in ebonising.

Lime. Unslaked lime is used for the limed oak finish. Also used in the antique oak finish P.C.

Linseed oil is derived from the seed of the flax plant and can be obtained either raw or boiled. It takes up oxygen on exposure to the air and is thus a drying oil. Boiling the oil makes it dry more rapidly. It is used in the French polish process for killing the whiteness of filler, in lubricating the rubber, and for making red oil. It is also used in oil polishing and in the manufacture of putty. Paint makers use the raw oil for light shades, and boiled oil for darker tones. It makes an excellent lubricant for tools and can be applied with a wad of cottonwool.

Raw linseed oil is somewhat viscid, fairly clear, and is brownish-yellow in colour It is used for lubricating the rubber in polishing.

Boiled linseed oil is of a reddish-brown tinge and is rather more viscid than the raw It is used in oil polishing.

Liquid asphalt. For making brown stains. Thinned with turps.

Litharge. A pinkish powder used in colouring. P.

Logwood. The heartwood of a tree found in Central America which, when cut into chips, is soaked and boiled in water. It is used as a basis for stains, but discretion must be used, since its shade varies in accordance with other substances with which it comes into contact. It may vary from red, straw colour, purple, to black.

Mahogany crystals. Obtainable in crystal form and dissolved in warm water to make a reddish-brown stain. P.

Mastic. A resinous gum, pale yellow in colour when fresh and inclining to darken when kept. It is used in varnish making.

Methylated spirits. This is used mostly for making French polish and stains. It is alcohol with wood spirit, etc., added to make it undrinkable in which form it is sold free of duty. There are several kinds of mixtures produced for various purposes permitted by the Customs and Excise, and they are all subject to regulations French polish manufacturers use industrial methylated spirits, known as "I.M.S.", but this is not obtainable by the general public. That sold in oil shops is coloured and is made further unpalatable by the addition of wood spirit, mineral spirit, pyridine, and methyl violet dye French polish can be made with this successfully because the colouring effect is small and soon fades A better method, however, is to use "methylated finish." This is colourless, but contains three ounces of resin per gallon. This resin may be common rosin (this is the more usual as it is a cheaper substance) or it may be white lac. For the purpose of polish making "methylated spirit white lac" is more suitable, and can generally be obtained if specified. P.

Mineral oil. See white mineral oil.

Naphtha. Used sometimes in spirit varnishing to remove ridges. P.

Nigrosine crystals. Used for making a dark stain, particularly for oak. The crystals are dissolved in warm water. Colour is cold brown. P.

Nitric acid. A chemical sometimes used in the manufacture of stain and for removing ink marks. P.

Ox gall. Used in the acid finish for French polish.

Oxalic acid. Used chiefly for bleaching wood and for removing stains. It is bought in the form of small crystals, these being dissolved in warm water. Being a poison, care should be taken not to leave it about, and to avoid contact with the fingers. If this cannot be avoided wash well after using. P.

Paraffin, medicinal. Used as a lubricant for the polishing rubber on light woods.

Pearl ash. Sometimes used for stripping off old polish, varnish, etc.

Permanganate of potash. Obtained in the form of fine crystals. It is sometimes used for making a stain, producing a deep, rich brown, but it is not really satisfactory as the colour is fugitive. P.

Pitch. Asphalt in lump form, makes a brown stain.

Plaster of Paris. Used chiefly as a filler before polishing. The "super-fine” grade obtainable at most oil shops should be used. It must be kept in a dry place.

Poppy oil. Preferred by some workers as a lubricant for the polishing rubber.

Potash. See under American, caustic, bichromate, etc.

Powder colours. These are used chiefly for tinting plaster of parts when making wood filler, though they are also handy for water coatings. Useful colours are Vandyke brown umber, burnt umber, raw sienna, yellow ochre, Venetian red, red ochre, lamp black flake white.

Precipitated chalk. See note under Vienna chalk.

Pumice powder. A white powder obtainable in various grades. It is useful as a fine abrasive and is sometimes used in the polishing and varnishing processes for taking out the roughness of a surface. The usual plan in polishing is to use it in a pounce bag, this being dabbed on to the work leaving a fine deposit of powder which is taken up by the polishing rubber. The finest grade should be used.

Pyro-Gallic acid. Sometimes used in the fuming process, producing a warm tone.

Reckitt's blue. Used in the ebonising process to make the black polish a deeper and more intense black.

Red oil. See alkanet root.

Red sanders. The heartwood of an Indian tree. Small splinterings are used for dyeing the spirits used in making French polish, producing a blood-red shade.

Rose pink. A powder colour used for tinting plaster of Paris filling.

Rosin. The hard resin left after distilling off the oil of turpentine. Sometimes added to wax polish to give a harder finish. Also used in making stopping.

Rottenstone. A fine abrasive (finer than pumice powder) and sometimes used in the pounce bag (see Tripoli powder).

Russian tallow. Occasionally used as a filler, but it never hardens properly. Often used in polishing coffins.

Sandarac. A pale yellow resin used in making spirit varnish.

Shellac. This is the basis of all French polishes. Most of it comes from the Calcutta and Mirza-pore districts, and is derived from the exudation of the lac insect. It varies in colour considerably. White shellac is merely an orange shellac bleached with chemicals to lighten it and "pulled out" in a similar method to that used by the toffee maker, and looks rather like sticks or knots of thick white toffee. It should be kept under water or stored in damp sawdust, as it quickly becomes denatured if exposed to the air. The other shellacs are in the form of thin flakes. The following are the shellacs normally obtainable, given in the order of their colour: white, orange, button, garnet. The button shellac has the reputation for being rather harder than the others, but is inclined to make a somewhat cloudy polish.

Silex. A powder substance used in making paste filler.

Soda. Ordinary washing soda is useful for removing grease from a surface. It must not be used strong or it will strip off polish, and all traces must be washed off with clear water.

Sodium perborate. Can be used in the bleaching process.

Spirit black, chrysoidine, green, mahogany, walnut. Can be obtained in powder or liquid form. The former is dissolved in methylated spirit. Used for staining. A little French polish is added to fix the stain.

Spirits of camphor. Used in furniture revivers. Large dose may be P.

Sulphate of iron. See copperas.

Sulphuric acid. Used for the acid finish in French polishing. Add the acid drop by drop to water. P.C.

Tannic acid. Used sometimes in fuming oak.

Terebine. A drying agent sometimes used in correcting faults in varnished work. P.

Toppings. The clear liquid suspended above the stock solution of white French is strained off the polish and used as a finishing glaze.

Tripoli powder. A fine abrasive used to dull the extreme gloss of French polished work.

Turpentine. Used for making many oil stains and in making wax polish. Many substitutes are on the market owing to the high cost of pure turps, and many contain oils of the petroleum class which may act as a bleaching agent. Pure American turpentine is the best. See also white spirit.

Vandyke brown. A brown powder used for making stains and for water coatings. It will not mix directly with water. Add it to ammonia to form a paste and mix this with warm water* and glue size. A better stain is made with Vandyke crystals (q.v).

Vandyke crystals. Obtainable in fairly coarse crystals and makes a deep brown stain.

Venetian red. Used for mixing with plaster of Paris filler to tint to a reddish tone.

Vienna chalk. Used in conjunction with sulphuric acid in the acid finish for French polish. As a substitute use precipitated chalk.

Vinegar. Frequently used in furniture revivers. It helps to remove grease, oil, etc. See also acetic acid.

Walnut crystals. See Vandyke crystals.

Wax. Used in wax polishing. The chief kinds are: beeswax, bleached and unbleached; Japan wax; ozokerite wax; paraffin wax; and carnauba wax.

Beeswax. The unbleached wax is of a yellow to brown colour suitable for dark woods. For light woods bleached wax should be used. Beeswax is the basis of most wax polishes. Japan Wax. Sometimes mixed with beeswax in making wax polishes.

Ozokerite Wax. A natural earth wax also used with beeswax.

Paraffin Wax. A petroleum product of a whitish colour, used for light wax polishes. Carnauba Wax. A vegetable product used for making wax polish harder. In purified form it is of a pale yellowish shade. Polish made entirely with carnauba wax gives a very hard finish, but with repeated coats is inclined to flake. It is more satisfactory used with softer waxes. Wax is also used in making stopping.

White mineral oil. Used as a lubricant for the rubber when French polishing.

White spirit (turps substitute). Used in making some oil stains and for cleaning old woodwork. It should be as free of grease as possible. Test by soaking blotting paper and leave to dry. Good quality will dry out without residue. Greasy turps will leave a greasy deposit.

Whiting. Used in making putty and for some wood fillers. A superfine quality is also used in the manufacture of gesso.

Yellow ochre. A powder colour used in colouring wood fillers and for water coating.

Zinc white. A powder added to Scotch glue to whiten it for use on light-coloured woods. Can also be used with wax to form the deposit in the limed oak finish.

Polishes, lacquers, etc.

Modern proprietary finishes have largely replaced traditional polishes, though the last-named are still used in some trades, especially in repair and antique workshops. In all Proprietary finishes it is essential to follow the maker's instructions regarding stains, fillers, avoidance of oil, etc.

Polyurethane lacquer. A tough finish which resists water, spirit, and heat marking According to type it may be a two-can lacquer, the base and the hardener; or a one-can kind which is used straight from the can. There are varieties for spraying, brushing, or fadding. It is essential to use the recommended stains and fillers.

Polyester lacquer. A hard durable yet flexible finish, resistant to wear, liquid marking and heat. Up to the present its use has been confined to the factory owing to complications in its application.

Plastic coating. A finish based on synthetic rosin which dries by chemical reaction, it is resistant to bard usage, heat and liquid marking. It is brush-applied.

Cellulose lacquer. A tough finish which, according to type, may be spray-, brush-, or rubber applied.

French polish. A finish formerly widely used for furniture and still used by restorers and repairers, it is capable of an excellent finish but is neither heat- nor spirit-resistant. The main types are:

orange, a golden brown shade; button, yellowish and slightly opaque; garnet, deep brown colour; white, slightly milky-white for light woods; transparent, water-clear; black, tinted black for ebonising; red, orange polish tinted with spirit-soluble aniline dye; glaze, 6 oz. crushed gum benzoin in 1 pint methylated spirit.

Chapter Two

WORKSHOP SAFETY AND TOOLS

Safety in the workshop

Personal wears

i. Wear an apron to protect your clothes (fig. 2.1.1).
ii. Use goggles to protect your eyes when grinding or turning (fig. 2.1.2).
iii. Wear a mask over mouth and nose if you are using 'smelly' liquids like paint, spirits or synthetics (fig. 2.1.3).



Fig. 2.1.1: Apron Fig. 2.1.2: Goggles
Fig. 2.1.3: Mask

Hands protection (fig. 2.2)

A simple rule makes it impossible for you to cut yourself if the wood or the tool slips. *Always* keep *both* hands *behind* the cutting edge.

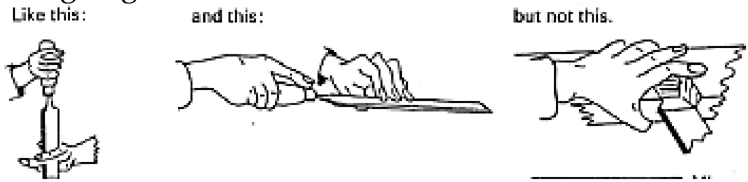


Fig. 2.2: Hand protection

Work protection (fig. 2.3)

Use every possible means to hold the work before starting to cut. By:

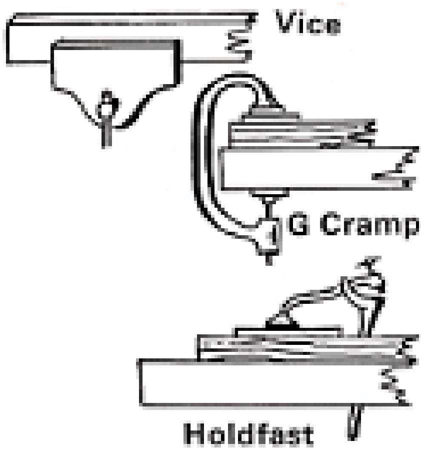


Fig. 2.3: work holding devices

Tools

Blunt tools are dangerous. The lazy worker who does not bother to resharpen his tools takes a great risk. Usually he tries extra force or some wrong method to make them cut.

This leads to *accidents.* Always use tools properly.

Machines

i. Know where to find the nearest emergency stop button.
ii. Check that the machine is running at the right and safe speed. Before starting the lathe, turn the work by hand to make sure nothing is fouled.
iii. Fasten work securely to the machine table.
iv. Forgotten chuck keys left in the chuck and loose hanging clothing like ties are very dangerous indeed.

Others

A workshop is not a play-room. Fooling about can cause serious accidents. Think for the safety of others and behave properly always.

Remember

A good workman is a tidy workman.

The Workbench

A good workbench is essential for anyone who wishes to do woodwork properly. Unfortunately, the workbench is often the most neglected part of the woodwork equipment. The benches provided for school woodwork are good solid benches, made of red beech. They should be looked after by all students with care.

Each side of the bench is fitted with a vice for holding wood. This is often of the quick release type. The jaws are lined with wood. The inside of these jaws should not be damaged by gripping metal objects. The wooden parts of the vice must not be planed, sawn or damaged in any way. A bench hook is held in the vice for sawing with the tenon saw.

An adjustable bench stop is provided for holding wood that is being planed on top of the bench. These stops are made for right handed people. However, many teachers put left-handed bench stops on some benches. The bench stop should always be lower than the wood being planed or it will be damaged. A little linseed oil helps it to move freely for adjustment.

The central part of the bench top is lower, this is called the well. Tools that are in use should be laid out in the well of the bench and not spread untidily all over the top of the bench. Tools not in use should be kept in the tool rack.

The good surface of the bench should be the concern of everyone who uses it. For example when sawing in the vice, a piece of waste wood should be placed on the bench under the saw. This will protect the bench from possible damage. Chiselling should not be done directly on to the bench top. A piece of waste wood should be underneath the work to protect the bench. When using paint, stain, or polish, the surface of the bench must be covered with a board or paper. When drilling or using nails care must be taken that holes are not made in the bench. Work bench is in different designs. Below are two examples (fig. 2.4 & 2.5):

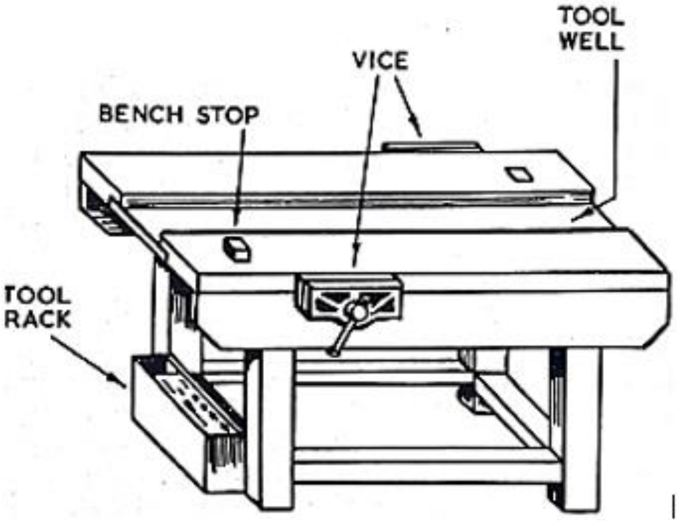


Fig. 2.4: A work bench

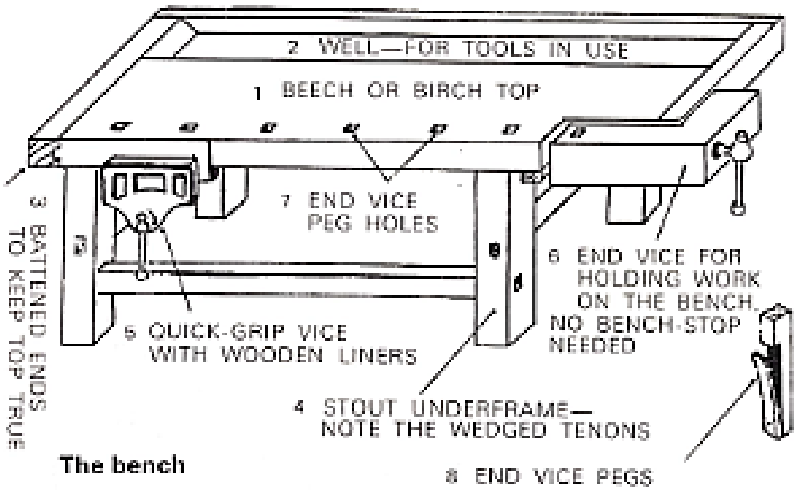


Fig. 2.5: A work bench

At the end of each work period, the bench should be swept down. The next person to use the bench should find it clean and with the tools in the correct place.

Chiselling board

A piece of hardwood planed flat and true and about 200mm by 150mm by 19mm. Used when chiselling on the bench to protect the top.

Supporting devices:

Figure 2.6. For working on the bench sawing ends.

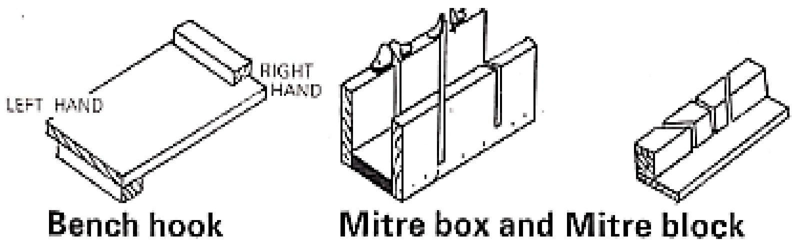


Fig. 2.6: Sawing supporting devices

Figure 2.7. For working on the bench-planing ends.

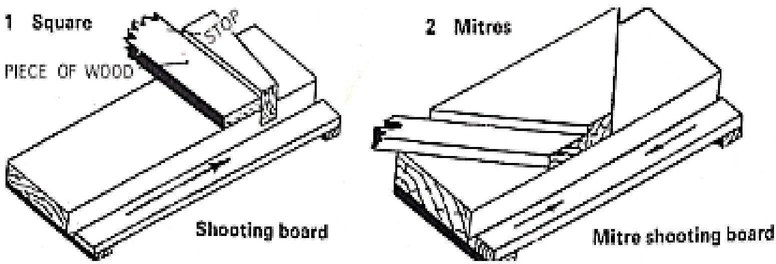


Fig. 2.7: Shooting boards

Lay a jack plane on its side. Push it in the direction of the arrows. It will plane, or shoot, the ends of the wood. The tapered stop of the shooting board allows its end to be re-squared. The mitre shooting board may be used either way.

Holding devices on the bench

Quick-grip vice. Tighten just enough to hold the work firmly. Over-tightening strains the working parts. Oil lightly, very occasionally (fig. 2.8 & 2.9)

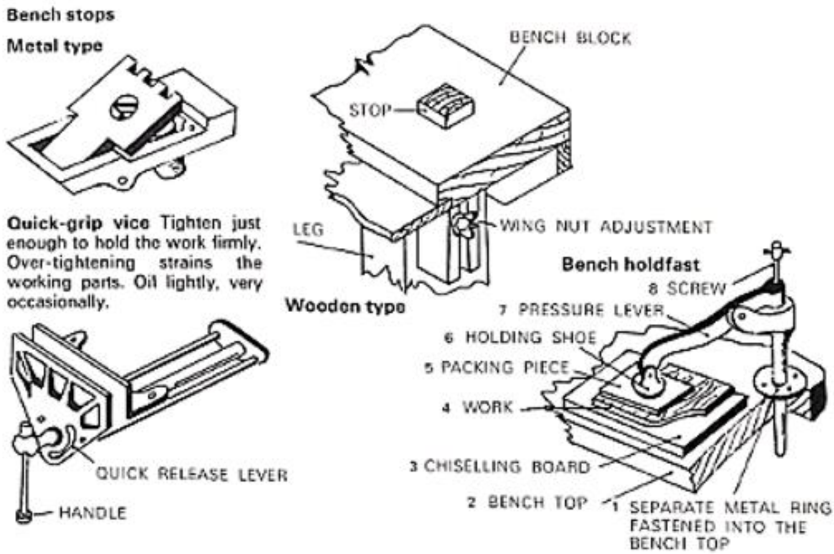


Fig. 2.8: Holding devices

Cramps

A. Sash cramp. 0-60 m.—1 -50 m. Also T sections, 0-60 m—2-10 m. Lengthening bars are obtainable for both.
B. G cramp. To take 50 mm.-305 mm.
C. Thumbscrew. 50mm.-100mm.
D. Carver cramp. 150 mm.-300 mm.
E. Spring cramp. Light cramping, specially repair work.
F. Joiner s dog. Holding edge joints while glue sets.

G. Handscrew. Wood chops, metal screws. Average 300 mm. chops.
H. Mitre cramp. Grips mitres while nailing, several patterns available.
I. Band cramp. For square or circular work.

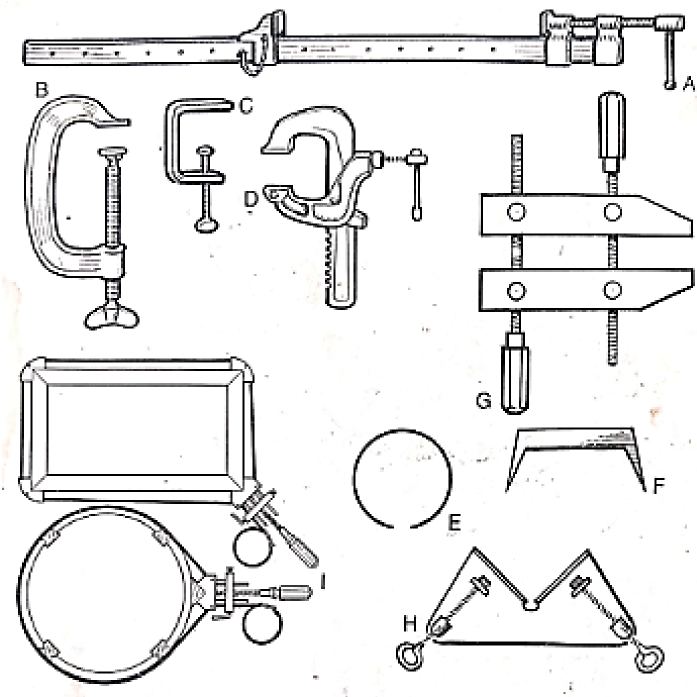


Fig. 2.9: Holding devices

Special note

When using any kind of steel cramps, put pieces of softer wood between the cramp shoes and the work. This stops the hard steel damaging the work.

The Rule

The rule is used for measuring. Measurement is often necessary in woodwork, and it is important that all measurement is very accurately performed. The student must therefore learn to use his rule with ease and precision.

Measurements on the rule are taken from the end. In this respect the rule used by woodworkers is not the same as the ruler in general use in the classroom.

The majority of rules provided for school workshops are of the 300 mm rustles steel type. Many carpenters prefer a wooden rule but as these break quite easily they are not very suitable for school use. In recent years white nylon rules have become very popular and they are much tougher than the wooden ones. For long measurement up to 2 or 3 metres a steel tape rule is very useful. A combined metre rule and straight edge is also a useful piece of equipment.

Readings on the rule are generally taken in millimetres but for very long measurements the metre unit is sometimes used. The centimetre unit is seldom used. Readings on the metric rule are very simple as there are ten millimetres in one centimetre and one hundred centimetres in one metre. There will thus be one thousand millimetres in one metre. The abbreviation for millimetre is mm, for centimetre cm and for metre m.

Several main types of rule divisions are shown on below. In figure 2.10, 1 shows a rule divided into centimetres and millimetres. No. 2 shows a rule divided into millimetres. The millimetre is a very small unit and it is quite easy to make an error in reading. The rule shown at No. 3 has divisions of different length and this makes it easier to read the number of millimetres required. In any case all millimetre rules are divided by a larger division into groups of five.

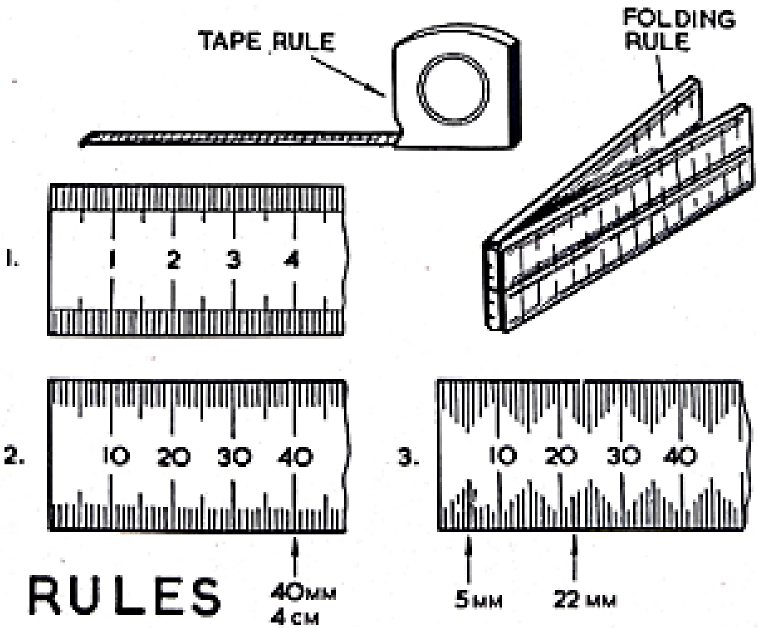


Fig. 2.10: Rule

The Pencil and Marking Knife

Two of the chief tools used for marking are the pencil and the marking knife. The pencil is in general use for much of the marking required. The knife is used for very accurate marking of joints which must fit tightly.

Pencils must be kept sharp. The degree of hardness of the pencil lead is stamped on one end of the pencil. An HB pencil is quite satisfactory, but many craftsmen prefer a 2H. This is harder and therefore gives a thinner line.

The marking knife consists of a short blade held in a wooden handle. Although it is used for marking joints, it must be used with care. Remember that a marking knife line will not rub off even with glass-paper. The appearance would be spoilt by marking knife lines showing on your finished work. Only those lines on which a cut is going to be made should be marked with a knife (fig. 2.1).

When using a pencil or marking knife to mark with the try-square the knife or pencil should be inclined at an angle of bout 60° (see drawing). In this way the line marked will be accurately aligned with the edge of the square.

The pencil is used to mark the face side and face edge to mark waste wood with a cross and to number joints. All unnecessary pencil marks should be avoided. Necessary marking should be neat. Remember these marks will probably have to be cleaned off when the work is finished.

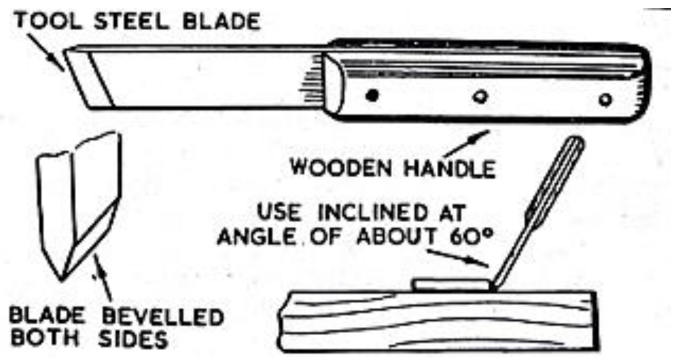


Fig. 2.11: Marking Knife

Lines on wood

Use a fine-pointed, hard lead pencil for all setting out lines. Take a sharp knife over all pencil lines that are going to form shoulders.

Ink is a stain so ball-point or other pen is never used.

These are sharp-edged knives for cutting-in shoulder lines. The point of the awl can be used as a scriber.

The Try Square

The try-square is used to mark lines at right angles to a true edge or side and for testing corners to see if these are square. The try-square consists of a steel blade set in either a wooden or a metal stock. The most important thing about the square is that the blade is set at exactly 90^{o} to the stock

In use, the stock of the try-square must always be held against a true or face edge or side. The stock must be held firmly against the wood while marking or testing is being done.

Try-squares are obtainable in various sizes. The size is indicated by the length of the blade, measuring along the inside edge.

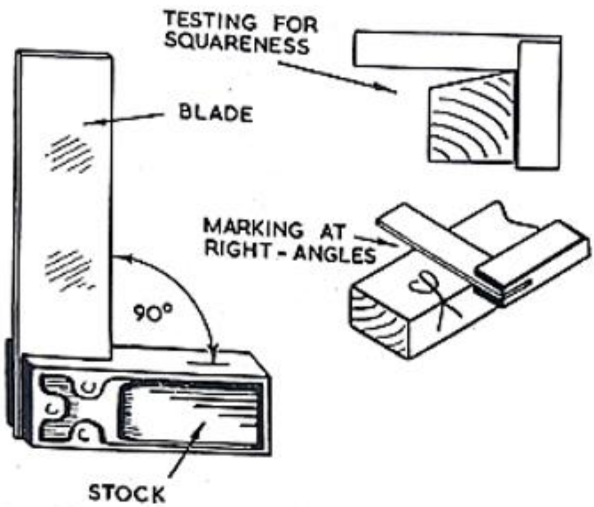


Fig. 2.12: Try square in use

A 150 mm square is suitable for most bench work. Most workshops have also a 300 mm square for marking across wide boards.

Care must be taken when using the square. It should not be dropped or damaged in any way or the blade may become out of ‘true’. The truth of the square may be tested by marking a line at right angles to a very accurate face edge. The square is then turned over and another line marked in the same place. If the square is true the two lines will be identical. If the square is not true, any inaccuracy will be doubled and would show by the two lines not being parallel (fig. 2.12).

Straight edges

Very important tools for checking flatness when long edges have to be planed.
They are made of carbon steel. Everyone is hardened so that it will have a long-wearing true edge. Straight edges are used also for large-scale setting-out (fig. 2.13).

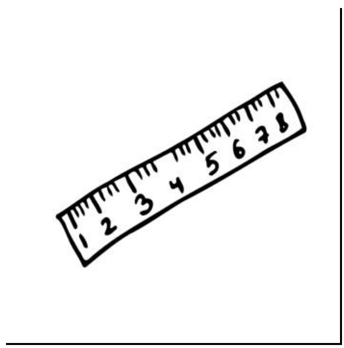


Fig. 2.13: Straight edge

The Marking Gauge

The marking gauge is used for marking lines parallel to a true edge or side. This is necessary when wood is being planed to width and thickness. It is also frequently necessary when marking out joints. The marking gauge is generally used along the grain of the wood. It may be used quite well on end grain but it tends to tear and scratch when used across the grain.

The marking gauge consists of four parts. The stock has a hole through the centre the stem is a sliding fit in this. The fit must be tight or the stem will wobble in use. Sometimes the stock contains brass bearing strips to reduce wear. The stem has a cast steel spur inserted near one end. This marks the wood and the point should not project more than 4 mm through the stem. The gauge is usually made of red beech with the exception of the thumbscrew which is made of boxwood or plastic.

To set the gauge first release the thumbscrew, then set the gauge placing the end of the rule against the stock (see drawing). It is usual to hold the stock and to tap the stem on the bench to move it to the required setting. When set correctly the thumbscrew is tightened and the setting checked before use.

The gauge is not a very easy tool for the beginner to use. But as it is such a useful tool, its correct use should be mastered. There are three points to remember when using the gauge. The stock must be pressed firmly against the face edge. The gauge should be pushed in a direction away from the operator. The spur should be allowed to trail, a slight pressure being applied. (The drawing below will illustrate this.) This spur should not be upright or it will tend to dig in. Several strokes may be needed to produce a clear line. It will sometimes be found helpful to hold the wood in the bench vice while it is being marked. This will leave both hands free to hold the gauge (fig. 2.14).

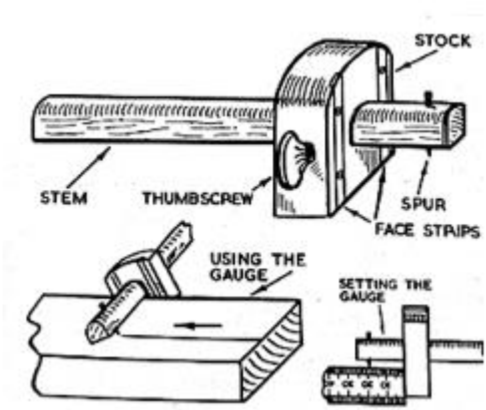


Fig. 2.14: Marking gauge

To use

1. Push the gauge.
2. Trail the point or spur.
3. Press lightly and repeat several times to get a good line.

Marking Out (fig. 2.15)

Accurate measuring and marking-Marking-Out out is essential. A most important tool is the rule There are three main kinds; the carpenter s “ding, boxwood rule; .he 'push and poll' metal tape in a compact case, and the steel rule. All woodwork rules have a zero end, where the dimensions start at the very end, a useful feature when checking internal dimensions.

When saw or chisel cuts are to be made across the grain of the wood, the surface fibre must first be cut with a marking knife. This ensures an accurate start for the chisel and a clean, splinter-free finish on the underside when sawing. Make only one clean cut with the marking knife, otherwise accuracy is lost.

Marking-out parallel to edges, and along the grain, requires a marking gauge. Beginners always find this a difficult tool. The secret is to push the stock hard up against the wood and then to trail or drag the spur lightly over the surface. This prevents the spur following the grain and producing a wavy line. A special gauge with two spurs is used for marking-out mortise and tenon joints.

A pencil is used where gauge or knife lines would spoil a finished surface. A soft pencil, HB or B, sharpened to a fine point is best.

Try squares are accurately set to right-angles (90°) and used in marking-out and for testing for squareness when planning and when assembling joints. When using a try-square with making knife, it is the best to cut along the outs.de edge of the try square blade. The mitre square is set to an angle of 45^{o} (135^{o}). A sliding bevel can be set up to any angle, the long slot in the blade making many possible. It is useful for copying angles and often used when marking-out dovetail joints.

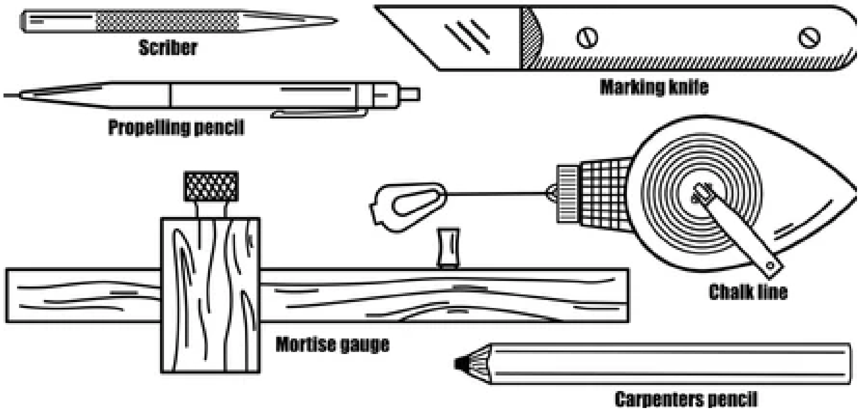


Fig. 2.15: Marking out tools

Saws and Sawing

Saw design

The teeth of saws are shaped, sloped, sharpened and set to be good cutting tools. The cut made by a saw is called the kerf. Saw teeth are 'set' to make this kerf wider than the saw blade is thick. In this way the sides of the saw blade do not rub against the wood. If they did they would cause friction and make the saw hard to use. This friction is called binding.

The handle is made a comfortable shape for the hand. It is placed and angled to direct the cutting effort of the sawyer along the cutting edge.

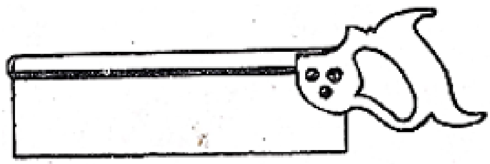
The effect of all this design is to make the saw cut easily and well if it is kept in good condition and properly used. Remember sawing needs motion and direction not force.

Nearly every woodwork begins with sawing. Most households have a woodwork saw of some kind. The most common saw is the **tenon saw** (fig. 2.16), often called a hacksaw because of the steel or brass strip along the top edge which stiffens-up the thin blade. Without this 'back' the blade would soon twist and buckle. The back prevents deep cuts being made and this indicates that the saw is best for cutting thin wood and joints.

A backsaw with between 12 and 16 teeth per inch (25mm) is a tenon saw; if it has as many as 20 teeth per inch it is a dovetail saw for very fine work (fig. 2.17).

A much larger saw without a back is **a panel saw** or **handsaw**. Used for heavy work it can make long, deep cuts. There are two kinds of handsaw, the **rip saw** which is used for cutting along the grain of the wood (fig. 2.18), and the **cross-cut saw** which is used mainly for cutting across the grain (fig. 2.19). The different kinds can be identified by carefully examining the shape of the teeth. A ripsaw has about five teeth per inch and the cross-cut up to ten.

Accurate sawing is essential in the production of good quality work. Like every other tool operation, skill and accuracy improve with practice.



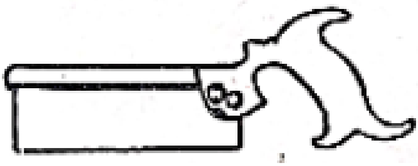


Fig. 2.16: Tenon saw Fig. 2.17: Dovetail saw

Fig. 2.18: Rip saw

Fig. 2.19: Cross-cut saw

Saw blades

Blades are made of cast steel or chrome vanadium steel. Recently a new way of coating saw blades with a black substance called 'Teflon S' has given them smoother cutting and better protection against rust.

Saws with very fine teeth have to be made of thinner metal. These saws have the backs of their blades stiffened. They are called Back Saws. Tenon and dovetail saws are back saws.

Teeth types and cutting actions for cutting along the grain

Rip Saw 660mm long. 3 ½ - 4 ½ points per 25mm (fig. 2.20).

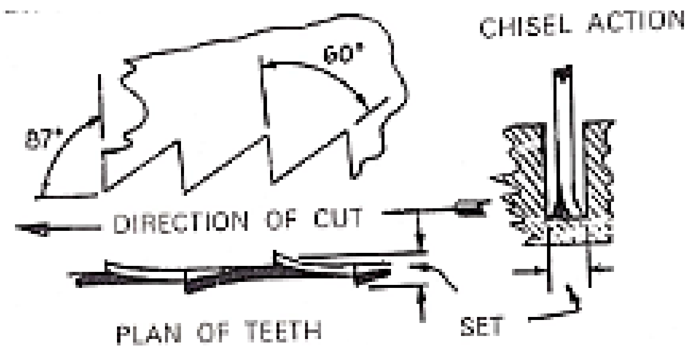


Fig. 2.20: Teeth for cutting along the grain

Teeth types and cutting actions for cutting across the grain (fig. 2.21)

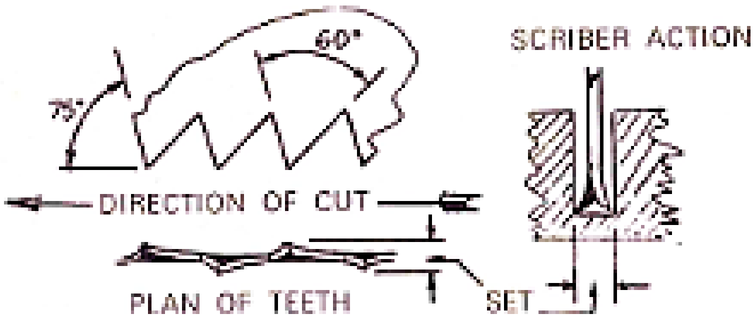


Fig. 2.21: Teeth for cutting across the grain

Crosscut saw 660mm long, 6—8 points per 25mm

Panel saw 550mm long, 10-12 points per 25mm

Tenon saw 300mm long, 14—16 points per 25mm

Dovetail saw 200mm long 18-22 points per 25mm

Bead or gents saw A very fine saw indeed with a small pad saw type of handle.

Saws for cutting curves

Internal sawing

These saws can be used for cutting openings inside the wood. First bore a hole inside the waste wood. Undo one end of the saw blade. Thread this loose end through the bored hole. Replace the blade end and retighten the saw. Try to keep the saw frame vertical always when cutting.

Bow saws and coping saws are held at the handle end only and with both hands. Holding the saws with one hand at each end of the blade will certainly lead to bad cutting. It can also break the blade.

Bow saw

This consists of an 'H' type frame. The cross-bar of the frame is loosely tenoned into the shaped uprights. Its coarse and replaceable blade is kept tight by a cord and key device called a tournique. Using the key to twist the cord shortens the length of the cord. This forces the handles outwards and tightens the blade.

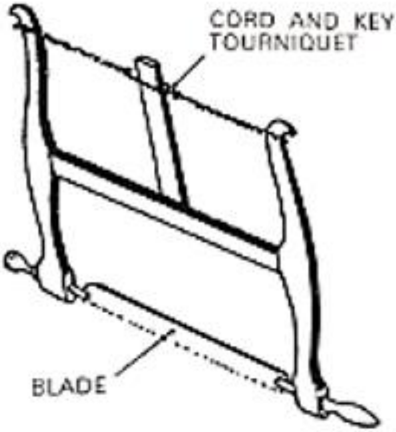
The angle of the blade can be altered by twisting the two handles at the same time and in the same direction.

The saw is used for cutting curves of larger radius in thicker material (fig. 2.22).

Coping saw

A smaller, lighter saw used for the same purpose. However, it can cut circles with a smaller radii and works better in thinner materials (fig. 2.23).

Screwing the handle up tight draws the two ends 'E' of the frame closer together. The frame pulls back against this and so the blade is made tight. The blade can be set at any angle by moving the two spigots. Make sure when doing this that the spigots stay in line. If they do not, then the blade will easily break. The blades are replaceable.



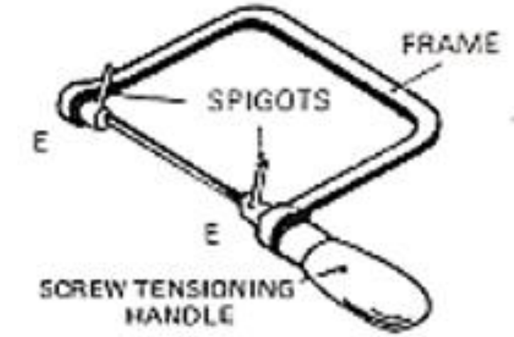


Fig. 2.22: Bow saw Fig. 2.23: Coping saw

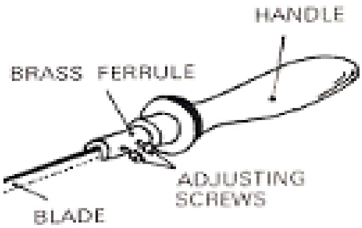
Pad or keyhole saw

Used to cut keyholes or holes of very small radii, especially where the coping saw cannot reach.

The blade can pass into the handle. This allows longer or shorter lengths of blade to be used. Two screws hold the blade tightly (fig. 2.24).

Compass saw

Used for large internal curves where coping and bow saws cannot reach (fig. 2.25). There are usually three different sizes of blade. They all fit the same handle.



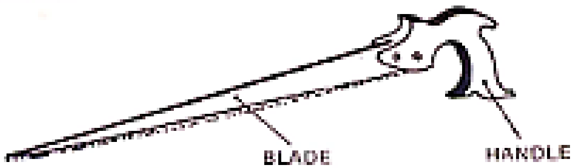


Fig. 2.24: Pad saw

Fig. 2.25: Compass saw

Saws for straight cutting

The Tenon Saw

The tenon saw is used for light bench work, for cutting wood of small section to length and for cutting joints. It is particularly well suited for cutting tenons hence its name (fig. 216).

The tenon saw has a stiffening rib along the length of the blade. This prevents the blade bending, it is therefore easier to make a straight cut. The stiffening rib is made either of brass or steel. The blade is made of high quality cast steel, hardened and tempered.

Tenon saws are obtainable in several different lengths. The shortest saws are 200 mm long, the longest are 400 mm. Tenon saws provided for school use are usually 300 mm long.

The size of the teeth on the tenon saw is important. The size of the teeth is indicated by the number of teeth per inch (T.P.I.). A fine toothed saw may have as many as 16 T.P.I. 12 or 14 T.P.I. is more usual.

The tenon saw must be treated with great care. The small teeth are easily damaged. Although the saw may be re-sharpened and set, this is not easily done. A damaged saw will not cut properly. The saw should not be left on the bench where it may strike metal tools. It is better to put it in the tool rack when not in use.

When using the saw the handle should be gripped firmly with the first finger along the length of the saw (see drawing) This gives increased control over the saw. When starting a saw cut it will be found helpful to draw the saw back two or three times first to mark the position of the cut. The cut should, of course, be made on the waste wood side of the line.

Rip saw

A **rip saw** is a type of hand saw that is designed to cut wood parallel to the direction of the wood grain. Rip saws have teeth that are angled backward and sharpened at right angles to the cutting plane, forming chisel-like cutting surfaces. Rip saws are used to cut wood into smaller pieces or to prepare wood for joinery. Rip saws typically have fewer and coarser teeth than crosscut saws, which are used to cut wood perpendicular to the grain (fig. 2.18).

Crosscut saw

A **crosscut saw** (thwart saw) is any saw designed for cutting wood perpendicular to (across) the wood grain with small teeth close together for fine work like woodworking or large for coarse work like log bucking. The cutting edge of each tooth is angled in an alternating pattern. This design allows each tooth to act like a knife edge and slice through the wood in contrast to a rip saw, which tears along the grain, acting like a miniature chisel. Some crosscut saws use special teeth called "rakers" designed to clean out the cut strips of wood from the kerf. Crosscut saws generally have smaller teeth than rip saws (fig. 2.19).

Sawing (fig. 2.26)

When handsawing, the wood is usually supported on a trestle, sometimes called a 'sawing horse'. The first problem is to get the saw started on the line; obviously a good start ensures a straight cut. A useful technique is to draw the saw lightly backwards first to produce a nick, then, keeping the blade at a shallow angle, make the first few careful strokes. Once 'on line' the saw handle can be raised until the most efficient cutting angle is found.

For tenon sawing, the wood must be firmly held either in a vice or held down with cramps. Often a simple sawing board (bench hook) is used. The technique of starting with a backward stroke, guiding the blade with the thumb, is also useful. All tenon saw cuts are made on the waste side of the gauge or marking knife lines.

When using any kind of saw, a handgrip with the forefinger pointing along the length of the saw will increase control and precision.

For some jobs special saws are required. Curved cuts can be made with bow saws, coping saws and fret saws. Generally the bow saw works best on thick wood and the coping saw and fret saw on plywood and hardboard. The coping saw is also useful when removing waste when cutting dovetail joints. With all frame saws it is important to keep the blade in line all the time. If it is allowed to twist it will jam in the cut and break. For small awkward holes a padsaw, sometimes called a keyhole saw, is useful.

Fig. 2.26: Sawing

Rasps

Rasps are available in a variety of Cuts Coarse, medium and smooth, in various length from 6 to 14 inches, and in several different shapes flats, half-round and rat-tail (round).

Rasps are used for rough shaping in awkward places a on tight curves inaccessible to other tools. Because the teeth are coarse they tend to tear at the grain of the wood and a very rough surface is produced. This requires more work with abrasive papers before a satisfactory finish is obtained. Rasps also tend to clog badly and need to be cleaned frequently with a wire brush. The disadvantages of the traditional rasp have led to the development of one of the few really new woodworking tools - the sharper or ‘'Surform' tool (fig. 2.27).

This new tool works rather like a cheese grater. The waste is shaved away by a perforated blade with many little plane-like cutting edges. This shaving action produces quite a smooth surface when used with the grain, and the 'shavings' pass through the blade so that clogging is eliminated. The shaper tool is available in the form of a file or plane; one variation, the 'planer file', has an adjustable two-position handle. The blades are flat, half-round or rat-tail and renewable. Used with care each blade has a long life. Soft metals and plastics can also be worked.

The shaper, together with coping saw, bowsaw and abrasives can be used to produce attractive sculptures in wood.

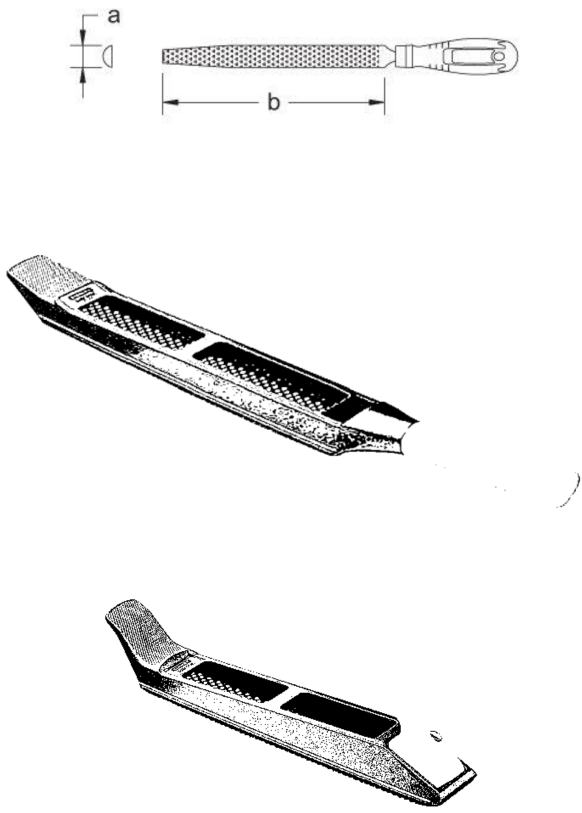


Fig. 2.27: Surfoam tools

Planes and Planing

planes

Planes reduce wood to required sizes by shaving away thin layers. Apart planing from the special planes, there are three main types of hand plane-the try plane, jack plane and smoothing plane. All three are similar' in appearance, only the length varies.

Try planes are between 18" and 24" long and used to 'true-up' large surfaces and long edges (fig. 2.28a). Jack planes are shorter (14"-17") and used for general purpose work (fig. 2.28b). The smoothing plane (9"-10") is for final finishing of surfaces, cleaning-up joints after glueing and working the hard end-grain (fig. 2.29).

Traditionally, planes were made of tough beech wood (fig. 2.30) but recently metal planes have become popular. The main advantage of the metal plane is the ease and speed with which the blade can be adjusted. The brass adjusting nut lifts or lowers the blade. A lever provides lateral (sideways) adjustment. Metal planes must be treated with care as their cast-iron bodies are brittle (fig. 2.31).

The cap iron is important to the cutting action of the plane. It stiffens the thin blade and lifts the shaving. Always set the cap iron close to the cutting edge; about $\frac{1^{\pi}}{10}$ (2mm) is usual.

When planing, the wood must be firmly held in a vice or flat on the bench top, pushed hard up to a bench stop. Both hands are used to grip the plane, and the body must be behind the plane so that it is driven forward with a kind of punching action with the right hand (fig. 2.32).

Sometimes shavings clog the mouth of plane. This indicate that the blade is incorrectly set. Never use a chisel or steel rule to unblock the plane; always dismantle the lever cap and remove the blade.

Fig. 2.28a: Try planes

Fig. 2.28b: Jack plane

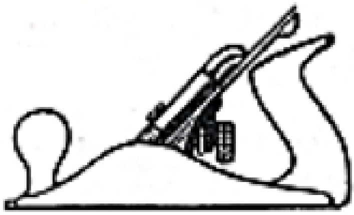


Fig. 2.29: Smooth plane

Fig. 2.30: Wooden Jack Plane

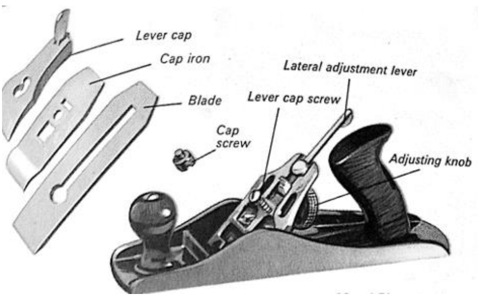


Fig. 2.31: Parts of a metal plane

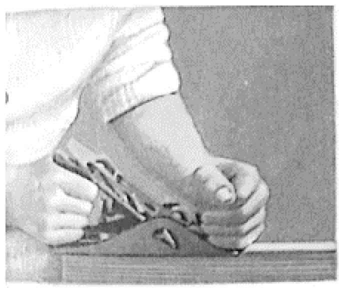


Fig. 2.32: How to hold plane in use

The Jack Plane

The jack plane (fig. 2.28) may be used for quite a variety of different planing jobs. It may be used for smoothing the surface of rough sawn wood, for planing an uneven surface straight and true, and for cutting away waste wood down to a finishing line.

Jack planes are of two main types: wooden jack planes and steel jack planes. The wooden jack plane is made of red beech and is frequently used in school workshops. It is a strong and efficient tool when correctly adjusted, However, some skill is required to adjust it correctly. This does not apply to the steel jack plane which is quickly and easily adjusted to suit all planing needs.

The blade and cap iron of a wooden jack plane are held in position by a wooden wedge. In order to adjust the cutting iron, this wedge must be loosened. The wedge is loosened by hitting the striking button with a mallet. The plane is held in the palm of the hand, the thumb being placed in the escapement to hold the cutting iron. When the cutting iron is set so that the cutting edge is just within the mouth of the plane the wedge is tapped down lightly to hold it. The plane is now turned upside-down and 'sighted' along the sole. The cutting edge should not be visible. The cutting iron is now gently tapped down with a hammer until the cutting edge is just visible as a thin black line. The wedge is given another tap to make sure that the cutting iron is set firmly and the plane is then tested. If a heavier cut is required, the cutting iron must be tapped down a little further with a hammer. If it is set too coarse, the whole process must be repeated.

By comparison, adjustment of the steel jack plane is extremely easy. An adjusting nut is situated behind the blade. When rotated this nut moves a lever which is fitted into the cap iron. If the nut is rotated clockwise the blade is moved down to make a coarser cut. If the nut is rotated anti-clockwise the blade is raised to make a finer cut. A lever which moves sideways is also situated behind the blade. This is used to move the cutting edge of the blade down on one side or the other. Complete control over the adjustment of the blade is therefore made easy.

Sometimes the mouth of the plane may become clogged with shavings. This is generally caused by having the cutting iron set to take too large a shaving, which then becomes jammed in the mouth of the plane. It is sometimes caused by an incorrectly set or faulty cap iron. Some woods tend to clog the plane more than others. If the mouth becomes clogged with shavings, the cutting iron must be removed and the mouth cleared. The mouth should never be cleared from the outside as this would damage the cutting edge of the blade.

Using The Jack Plane (fig. 2.33)

The jack plane cuts away the wood in the form of small shavings. Clearly care must be taken to remove shavings only where needed, otherwise the wood will not be finished to the required size. It is much easier to plane wood accurately if a few simple rules are followed.

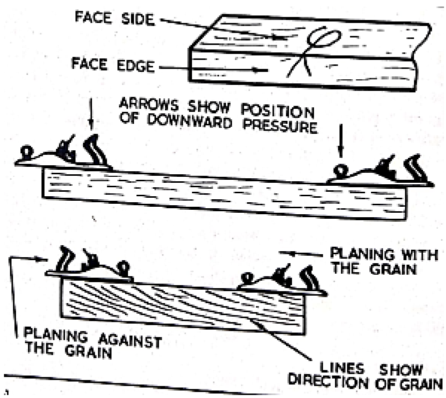


Fig. 2.33: Using a Jack plane

Let us imagine that we have a piece of sawn softwood 300 mm long, 50 mm wide and 25 mm thick. We require to plane this to finish to 46 mm x 21 mm.

The first thing we must do is to sight the plane to make sure the blade is correctly adjusted. It must not be set too coarse. The wider surface of the wood, called the side, is generally planed first, not the edge. The wood is placed flat on the bench; the end of the wood being set against the bench stop. We have first to prepare a true side which will be called the face side'. Face marks are shown on the sketch opposite.

Assuming that the operator is right handed, his right side should be against the bench. The plane is operated from behind in order to give plenty of punch. At the start of the cut, the main pressure should be on the forward part of the plane. During the latter part of the cut the main pressure should be at the back of the plane. Each stroke should, if possible, be taken through the full length of the piece of wood.

When planed, the surface must be tested for accuracy. This is done by placing the steel rule or straight edge on the wood. The two are then 'sighted' together to see whether the surface of the wood is true with the straight edge. When this surface is true it may be marked with a face side mark.

An adjacent edge must now be prepared in the same way to provide a face edge. This must not only be straight but it must also be square with the face side.

All marking or testing is done from the face side or face edge. These must, therefore, be accurate. It is not easy to prepare a face side and face edge true, but the student should not be satisfied with inaccurately prepared surfaces.

With surfaces accurately prepared the wood may now be marked to width. This is done with a marking gauge. The gauge must be used with the stock against the face edge. Care must be taken not to plane beyond the gauge line.

The wood is now marked to thickness, again using the gauge and the wood is then planed to the gauge line.

In this way all four sides of the wood are planed and the wood is true and finished to the correct size. If the wood is not accurately prepared this will be very obvious in any joints that are made with it later.

It frequently happens that wood planes better m one direction than the other. This is due to the direction of the gram. If a piece of wood tends to tear up, turn it round and try the other

The planing of end grain is rather more difficult. It should not be attempted at this stage without special instruction.

Great care should be taken of the cutting edge of the plane. Place the plane down on the bench sideways or over the well of the bench in order not to damage the cutting edge.

The Plane Cutting Irons (fig. 2.34)

The cutting iron fitted to the jack plane, try-plane, and smoothing plane, consists of two parts. The blade has the cutting edge at one end. This cuts the wood. The cap iron is attached to the blade. The main function of the cap iron is to break up the shavings and thus prevent the wood surface from tearing. It also guides the shavings through the plane and helps to prevent vibration of the blade.

Let us consider first the blade. The thin blade that is provided with steel planes is made of cast steel. The heavier blade provided with wooden planes has a piece of cast steel welded on to a mild steel body, the cast steel forming the cutting edge. The reason for this is two-fold. A thick cast steel blade would not be so easy to grind, and cast steel when repeatedly struck with a hammer would fracture.

The cutting edge of the blade is sharpened with two sharpening angles. Firstly the cutting edge is ground on a grindstone to an angle of about 25°. Secondly the cutting edge is sharpened on an oilstone to an angle of about 30° (see drawing). The blade requires sharpening frequently. It does not need grinding very often. It will be seen from the drawing, that by providing two angles, the whole thickness of the blade does not have to be sharpened on the oilstone.

Many craftsmen like to have the cutting edge very slightly rounded to form a convex cutting edge. It is also quite common practice to round off the corners so that these do not leave marks on the wood being planed.

The cutting iron has a ‘keyhole slot’ down the centre. A cheese head screw through this slot attaches the cap iron to the blade. The cap iron is made of mild steel. The lower edge is curved over in such a way that when tightened it will press down near the edge of the cutting iron. The cap iron must fit well on the blade or shavings will get between and clog the mouth of the

On jack planes the edge of the cap iron is set about 2 mm back from the cutting edge of the blade. On smoothing planes and try-planes the cap iron is set closer to the cutting edge. This helps to give a smoother finish to the wood being planed but « limits the degree of coarseness to which the plane may be set. When the cutting iron is placed in the plane, the cap iron should be uppermost and to the front.

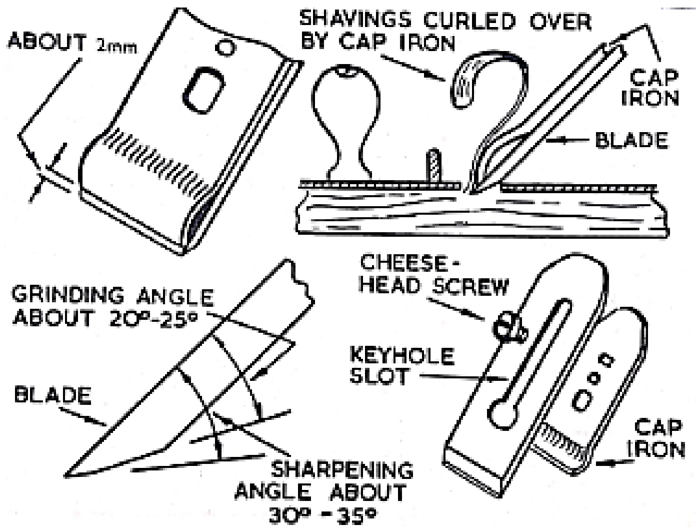
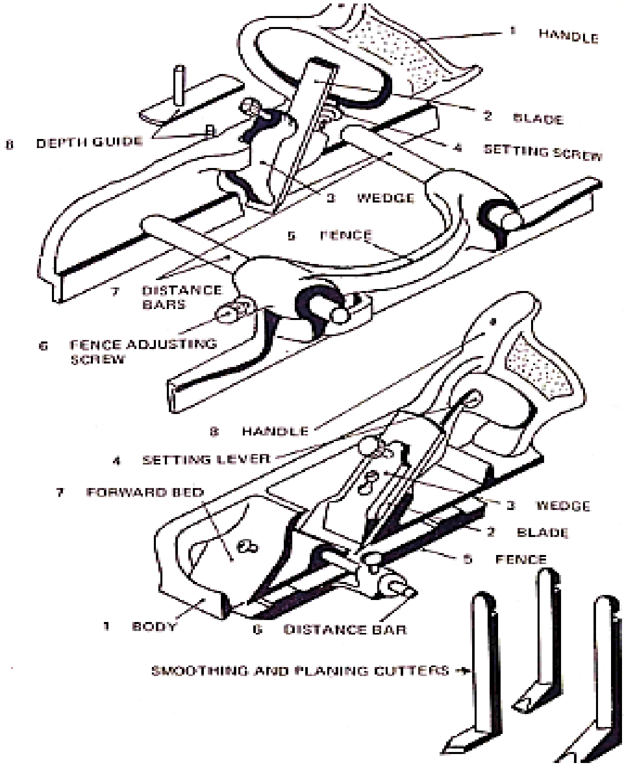


Fig. 2.34: Plane cutting irons

Special purpose planes

Plough (fig. 2.35 a & b)

A tool for ploughing or cutting grooves. The width of the groove is cut by one of its eight different size blades. Its depth is set on the depth gauge. There are two pairs of distance bars. These and the fence give the distance the groove is to be cut from the side or edge of the wood.



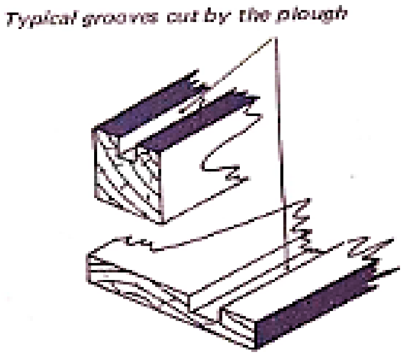
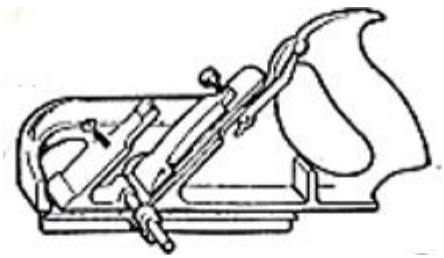


Fig. 2.35a: Plough plane Fig. 2.35b: Grooves cut by plough

Rebate plane (fig. 2.36a)

Cuts open-sided grooves called rebates (fig. 2.36b). The width of the rebate is set by a fence. The depth is set by its depth stop. This stop screws onto the outside of the body. It cannot be seen on the diagram.

When the blade and wedge are set into the forward bed position, stopped rebates may be cut close up to the stopped end.



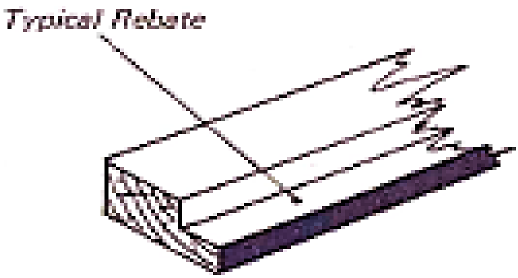


Fig. 2.36a: Rebate plane Fig. 2.36b: Rebate

Router (fig. 2.37)

Will plane the bottom of any sinking that is parallel to the surface of the wood, e.g. the sinkings for housing and for halving joints. The cutter can be set to any depth. A special fence may be screwed to the sole of the tool. With this fence work can be done parallel to straight or to curved edges.

Low angle planes

Made for working chiefly on end grain, these planes have a low bed angle of 20° (fig. 2.38). Their blades are put in with the grinding bevel upwards (not downwards as in ordinary planes). Because of this the blade needs no cap iron.

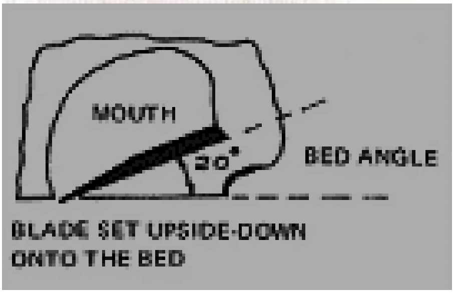


Fig. 2.37: Router plane

Fig. 2.38: Low angle plane

Block plane

This little plane is used to work end grain. It is used in one hand into which it fits easily. For this reason, it is an excellent little tool for truing and for cleaning mouldings, beads and chamfers (fig.2.39).

The tiny lever 'c' is for altering the size of the mouth. It is locked by a brass thumb screw.

Shoulder plane

Used for cleaning the shoulders of tenons. Also for the fine finishing of rebates (fig. 2.40). The size of the plane can differ in both length and width. To alter the size of its mouth first, slacken screw 'a'. Turn set screw 'b' to adjust the mouth. Now tighten screw 'a' again.

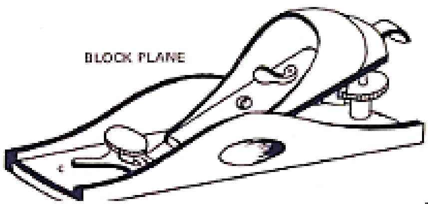


Fig. 2.39: Block plane

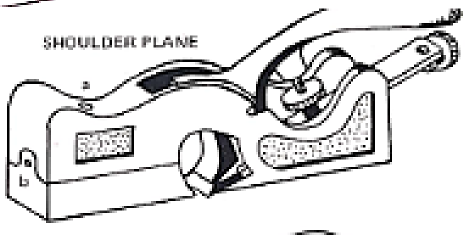


Fig. 2.40: Shoulder plane

Bull-nose plane

A smaller type of shoulder plane (fig. 2.41). It can be used in one hand. Its short bull-nose means it can be used close up to stopped rebates and stopped chamfers. If the nose is taken off it turns into a chisel plane. In this way it can work right up to stopped ends.

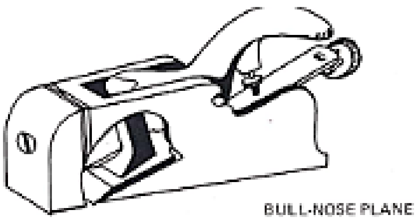


Fig. 2.41: Bull-nose plane

Spokeshave

This is a special tool for working a fine planed finish on curves and chamfers. If the surface curves outwards a flat-faced spokeshave must be used. When the surface curves inwards a round-faced spokeshave is needed. The tool gets its name from the time when it was used to shape the spokes of wagon and carriage wheels.

It is not an easy tool to use. Practice will be needed. Hold one handle in each hand. Put the thumbs on the special thumb rests 'T', and the first fingers on 'F'. Pushing forward firmly and easily will soon give good results (fig. 2.42).

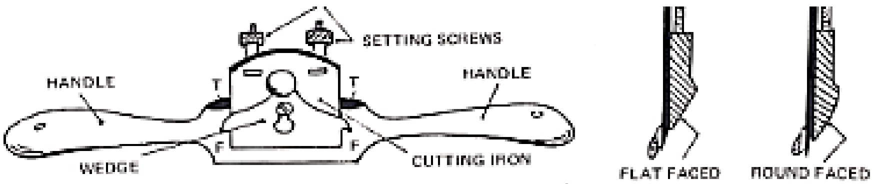


Fig. 2.42: Spokeshave

Cleaning up

This is done as late as possible but always before gluing up begins. Remove dirt, handling and setting out marks and prepare well-cut surfaces with a finely set smoothing plane. Rub with the finer grades of glasspaper ending with an old used paper. Finish with a soft cloth to burnish the surfaces.

Chisels and Chiselling

Chisels are available in many types and large range of sizes. Each type has a special use. All chisel blades made of high carbon steel which keeps a keen edge handles, traditionally made of boxwood or ash, are now frequently of tough, shatterproof plastic. The blade is usually fitted to the handle by a square, tapered tang (fig. 2.43).

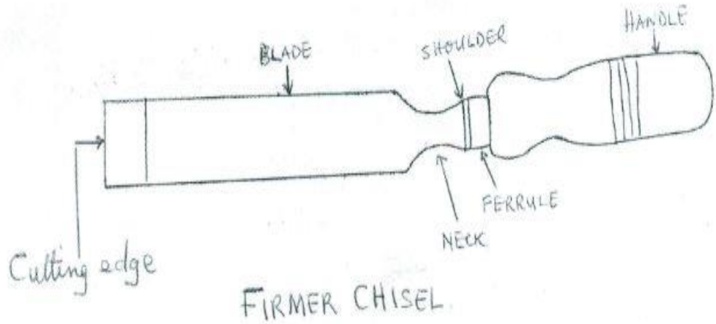


Fig. 2.43: sectional view of chisel

A general purpose firmer chisel has a square-edged blade. Lighter and less robust is the bevelled edged chisel: this is useful for working on acute angles such as dovetail joints. For cutting mortise joints a special, strong, mortise chisel is used. This has a tapered blade to give extra strength when leverage is applied and also to withstand blows from the mallet. Often mortise chisels have a leather washer between the shoulder boss and the ferrule which acts as a shock-absorber. Some mortise chisel handles have a metal band to prevent them splitting. Chisels with curved blades for carving and wood-turning are called gouges.

Chisels are highly dangerous tools and must be used with utmost care. Always keep both hands behind the cutting edge. Never chisel towards your body. If possible always fix down the work securely in a vice or with G-cramp. When chopping a through mortise, protect the bench with waste wood. Store your chisels carefully keep them sharp.

The Firmer Chisel

The chisel is one of the most important woodworking tools. It is used mainly for cutting joints, but it is also used for cutting out any required shapes in wood and for paring (fig. 2.44).

Chisels are obtainable in several different sizes, the size being the width of the blade. The smallest size is 3 mm wide. The largest chisel that is normally used in schools is 25 mm wide. However, chisels up to 38 mm wide are obtainable.

The blade of the chisel is made of cast steel, hardened and tempered. The blade has a pointed 'tang' which fits into the handle, with a shoulder to prevent it going too far into the handle and splitting it. The best chisel handles are made of boxwood, which is hard and close grained, though some quite good handles are made of red beech or ash. In recent years plastic handles have become popular.

The square edged firmer chisel is in general use for most bench work. When it is necessary to work with the chisel within an angle of less than 90° as, for example, when cutting a dovetail joint, the bevelled edge firmer chisel is used. The drawing opposite shows that a square edge chisel is not satisfactory for working in acute-angled corners.

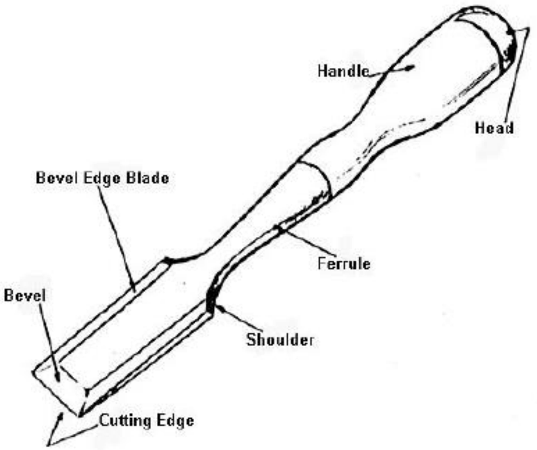


Fig. 2.44: Firmer chisel

The bevelled edge chisel is not as strong as the square edged chisel. It should not, therefore, be used for heavy chopping. It is generally reserved for lighter work (fig. 2.45).

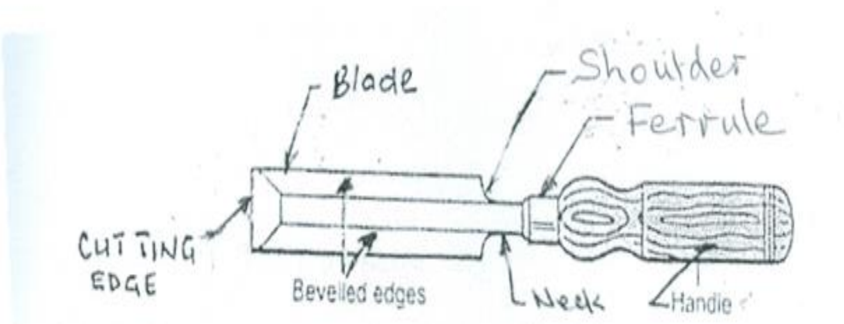


Fig. 2.45: Bevelled edge chisel

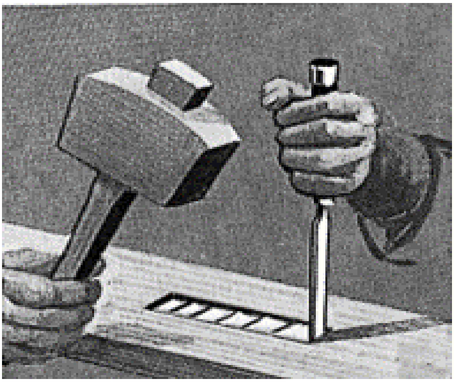
When using the chisel, great care must be taken to keep the hands, and indeed all parts of the body, behind the cutting edge of the chisel. This warning should not be taken lightly. The writer was acquainted with one man who died with a chisel in his stomach, and another who narrowly escaped death with a chisel in the artery of his wrist.

Using The Chisel

The woodwork performed with chisels may be divided into three main groups: chopping, paring, and shaping.

Chopping may be done across the grain of the wood, as when cutting out a mortise. It may also be done along the grain of the wood, as when cutting an angle halving joint. When chopping, the chisel is held in one hand only, the other hand using the mallet. The chisel must be firmly held and positioned with care. It should never be knocked sideways with the mallet, even if it becomes stuck in the wood, as this might break the fairly brittle blade of the chisel. Chopping along the grain of the wood is only possible if the wood has straight grain. The chisel follows the grain of the wood (fig. 2.46).

Paring is used for removing comparatively small quantities of wood. When paring, the flat side of the chisel is always next to the wood. The mallet is not used for paring, but the handle of the chisel is sometimes struck with the palm of the hand. The chisel is held in both hands, one holding the blade in order to give complete control over the chisel. The drawing opposite shows typical examples of paring (fig. 2.47).



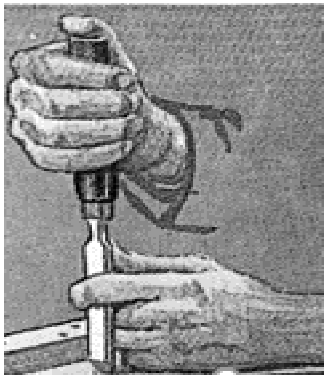


Fig. 2.46: Chopping Fig. 2.47: Paring

Sometimes it is necessary to cut wood out to a certain shape. When this is being done the bevel of the chisel is often used next to the wood. It is then possible to lever on the bevel, either to prevent the chisel cutting too deeply, or to lift the wood out as when cutting the wood from a mortice.

The chisel must always be used with great care, with the hands always behind the cutting edge. A sharp chisel is safer than a blunt one as the sharp chisel requires less pressure to cut.

The Mortise Gauge and Mortise chisel

The main difference between the mortise gauge and the marking gauge is that the mortise gauge has two spurs. It may therefore be used to mark two parallel lines at the same time. This is required particularly when marking mortise and tenon joints, but it is also useful on other occasions (fig. 2.48). For example, it may be used to mark tongues and grooves.

Before attempting to set the mortise gauge, the set screw must be released. When the set screw is unscrewed, the stock is free to slide on the stem and the thumbscrew may be turned to adjust the moveable spur.

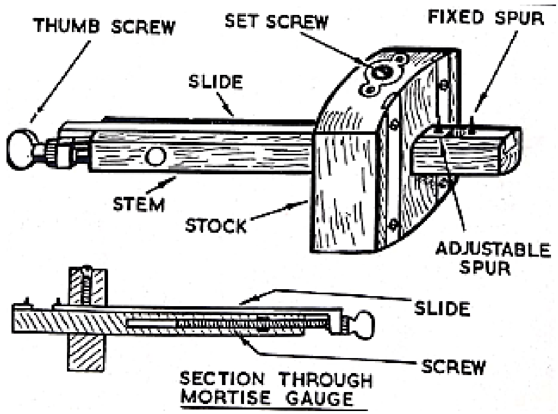


Fig. 2.48: Mortise gauge

When setting the mortise gauge, two settings are necessary. First the distance between the spurs is set; this will be the thickness of the tenon. The end spur is fixed, and the spur nearest the stock is adjusted by turning the thumbscrew. The second setting is the distance between the adjustable spur and the stock; this will be the space allowed between the edge of the mortise and the face side of the wood.

When the gauge is set, the set screw is tightened and the setting is checked.

The method of using the mortise gauge is the same as for the marking gauge. The stroke is made away from the operator. The stock is pressed firmly on the face edge of the wood and the' spurs are trailed.

The wooden parts of the mortise gauge are traditionally made of rosewood. This is hard and close grained. The metal parts are brass, with the exception of the spurs which are tool steel.

The Mortise Chisel

The mortise chisel is used only for chopping out mortises. The heavy work involved when chopping out a large mortise imposes great strain on the chisel. The mortise chisel is therefore made very strongly.

For very heavy work such as chopping out the mortise for an oak gate, a heavy duty mortise chisel would be used. The blade of this is very thick; it is fitted with a large sturdy handle. Heavy duty mortise chisels are not much used in school workshops.

The socket mortise chisel is a very efficient tool. Normally chisel blades have a tang which fits into the handle, the handle being fitted with a ferrule to stop it splitting. In the case of the socket chisel, the handle fits into a socket that is formed on the blade to receive it, which helps to prevent the handle splitting even with continual hard work.

The registered pattern chisel does not have such a thick blade as the two chisels mentioned above. The heavy duty and socket chisels are seldom obtained in widths of more than 13 mm, but the registered chisel is obtainable in widths up to 25 mm. The chief characteristic of the registered chisel is the steel ferrule on top of the handle. The great disadvantage of this is that it spoils the working face of the mallet (fig. 2.49).

A leather washer is placed between the blade and handle of mortise chisels. This helps to cushion the shock of heavy mallet blows.

The blade of the chisel is made of hardened and tempered cast steel. The handle is generally made of boxwood or plastic but red beech is occasionally used.

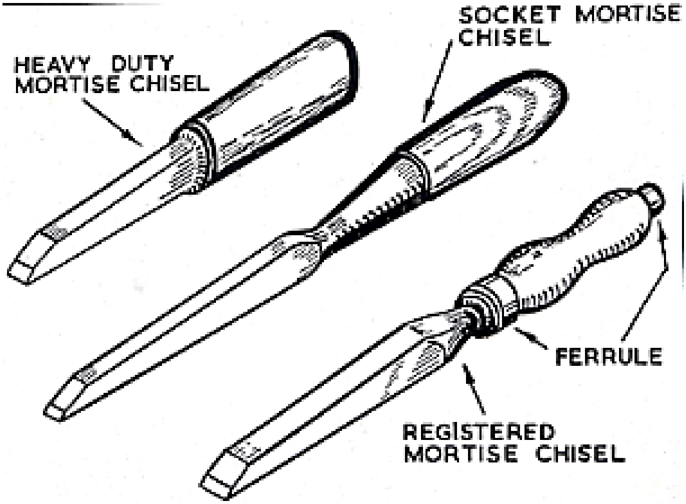


Fig. 2.49: Mortise chisels

Making a Mortise and Tenon Joint

The stages in making a simple two-shouldered mortise and tenon joint are shown in the sketches below (fig. 2.50).

The wood must be accurately prepared to width and thickness before making the joint.

1. Mark the shoulders of the tenon (piece A on the drawing). As the tenon in this joint is to pass right through the wood, the length of the tenon will be the same as the depth of the piece of wood in which the mortise is made. It is usual to add about 1-2 mm to the length of the tenon in order to allow a little to smooth off when the joint is finished.

2. Mark the position of the mortise (part B on the drawing). Square these marks round one side and two edges of the wood with a sharp pencil.
3. Set the mortise gauge. The distance between the spurs should be approximately the thickness of the wood. The spurs must be set to bring the mortise in the centre of the wood.
4. Use the gauge from the face side of both pieces of wood. Mark between the pencil lines of the mortise and right round the end of the tenon.
5. Cut the cheeks of the tenon using a tenon saw (see drawing). Take care to follow the gauge lines.
6. Cut the shoulders of the tenon. Use the tenon saw with the wood on the bench hook. Take care to saw in the waste wood beside the line.
7. Drill a series of holes to remove most of the waste wood from the mortise (some craftsmen prefer to drill only one hole). Use a brace fitted with a bit slightly smaller than the thickness of the mortise. Drill from either side to meet in the middle. The reason for these holes is to allow the waste to break away better when being cut.
8. Chop out the waste wood of the mortise. Work from both sides of the wood to meet in the middle. Keep the flat of the chisel towards the ends of the mortise all the time. Do not lever with the chisel on the ends of the mortise. The ends must be kept sharp and square.
9. It is not considered good practice to pare the sides of the tenon, but the inside faces of the mortise can be cleared until a smooth fit is obtained.

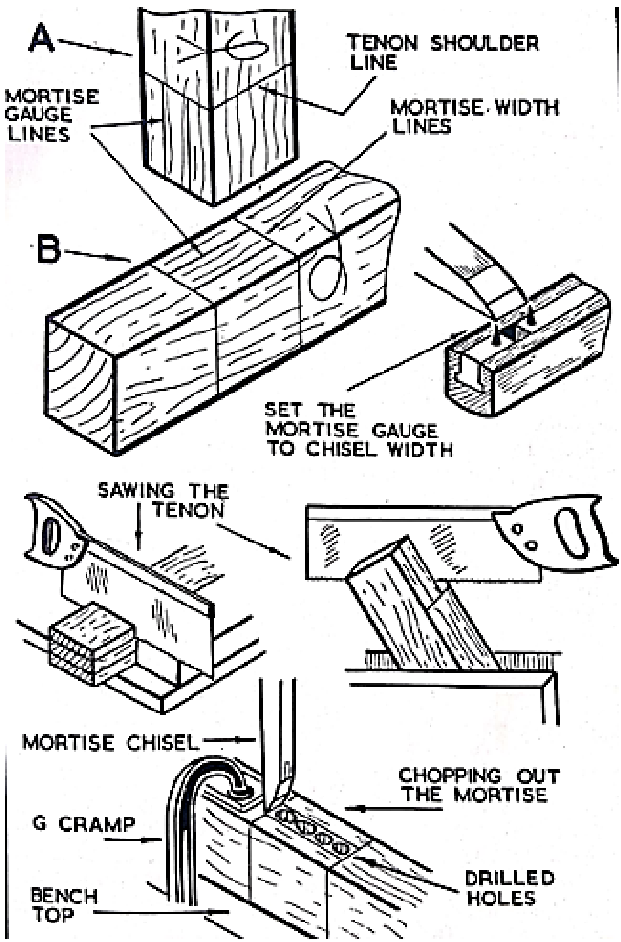
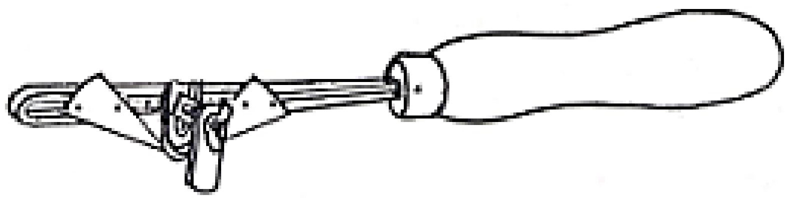


Fig. 2.50: Making a mortise and tenon joint

Carving tools

These are generally known by width of blade and a number which denotes the curvature, though the system varies with different makers. One common rule is that all tools of the same number have the same type of curve. Thus, all No. 9 tools are semi-circular in section regardless of width. Sizes range from ½ in. up to 1 in. and are obtainable with or without handles. Parting tools are available in varying angles ranging from about 40 degrees up to 90 degrees.



Tectool. For working either curved or straight grooves. Cuts in either direction to suit grain. Various cutter widths provided, but they can be staggered to cut extra wide grooves.

The Mallet

The mallet is mainly used for striking the wooden handles of chisels when these are being used to make fairly heavy cuts in wood. It is also used for knocking together or apart pieces of wood that are tightly joined. When being used for this latter purpose it is wise to use a piece of waste wood under the mallet to protect the work (fig.2.51).

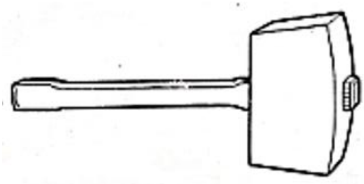


Fig. 2.51: Mallet

The mallet is nearly always made of red beech. This wood is hard enough to stand up to the heavy work and yet soft enough not to damage the chisel handles.

The handle of the mallet passes right through the head. As the handle is slightly tapered it becomes tighter with use. It cannot fly off. It will be seen from the drawing opposite that the striking faces of the mallet slope in slightly towards the bottom. The mallet in use moves through an arc of a circle, the point of rotation being the operator's elbow. The striking faces are sloped in order that they will fall flat on the work.

Mallets are made in several weights. The size generally provided for school use weighs about 500g.

A mallet should never be used to strike metal tools such as nail punches, as this would damage it. Similarly, wooden handles of chisels should not be hit with the hammer as this would damage the chisel handle. Mallets may be quite well made in the school workshop.

The Hammer

The hammer is used mainly for driving nails. It may also be used, for example, for driving in wooden wedges or for striking punches. The hammer should never be used to strike the handles of chisels or screwdrivers.

The type of hammer generally provided for school use is the Warrington pattern cross-pein hammer (fig. 2.52). This has a flat face at one side which is used for most of the work. At the other side is a wedge-shaped cross-pein that is used for starting small nails when they are held between the finger and thumb. Some carpenters prefer to have a claw hammer (fig.2.53), which has two claws which can be used to pull out nails. The hammer head is made of drop forged steel, the peins being hardened and tempered. The handle or shaft is generally made of ash or hickory, these are 'elastic' woods which cushion some of the shock from the blow. Metal handles with a rubber hand grip are becoming very popular. This type of handle is almost unbreakable.

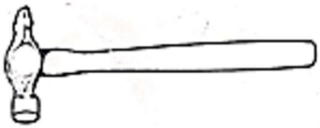


Fig. 2.52: Warrington Cross pein hammer

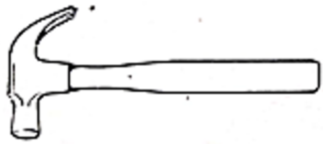


Fig. 2.53: Claw hammer

The wooden handle of the hammer is fixed to the head by means of a wedge. The hole through the head is shaped to allow the handle to spread when the wedge is driven in, thus making it almost impossible for the head to fly off.

Hammers with loose heads or broken handles should never be used. The head could fly off and might cause a serious injury.

Hammers are obtainable in several different weights. For small nails a 170g hammer is suitable; the hammer provided for general purpose bench work in schools generally weighs 340g; a heavy claw hammer may weigh as much as 680 g.

In use, the hammer should be held near the end of the handle and moved through an arc of a circle in order to bring the face down flat on the nail. Great care should be taken not to damage the surface of wood with the hammer. When removing nails with a claw hammer, a small strip of waste wood should be placed under the head to protect the work.

A common error when hammering is to grip too closely to the head. This means that the whole arm has to be swung whereas for most operations a grip at the end of the shaft and a wrist action are best. With practice, hammering can be very accurate and highly effective. Hammers are frequently used when fitting joints together. When doing this, use waste wood to prevent the surface of the work being bruised.

The Nail Punch

When nails are used, the appearance or efficiency of the finished job is often improved by driving the nails slightly below the surface of the wood. This is done with a nail punch (fig. 2.54). If, for example, a plywood base is fixed to a box, it is better to punch the nails in, or the nail heads would scratch any surface the box is put on. If also a plywood or hardboard panel is nailed on a door frame, the nails should be punched in. The small cavity thus made may then be filled.

Nail punches are made in several sizes. Always use a nail punch that fits the nail; too large a nail punch would make an unnecessarily large hole. Too small a nail punch would slip off the nail.

Nail punches are made with a hollow point which helps to prevent the punch slipping off the nail. This tends to become flattened and worn on an old punch.

Nail punches are made of cast steel, hardened and tempered at the point.

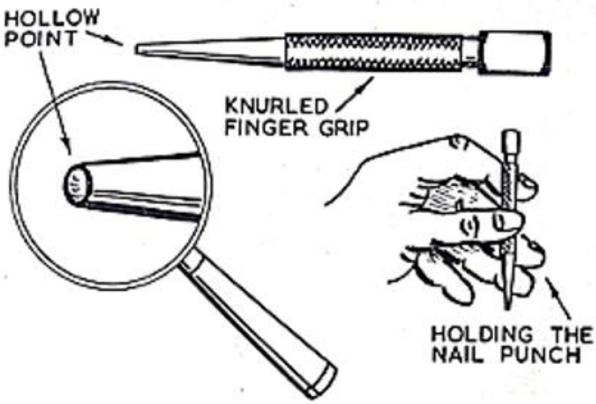


Fig. 2.54: Nail punch

The Pincers

Pincers are used for pulling out nails. If a nail is started at an angle so that there is a danger of its coming out of the side of the wood or splitting the wood then it is better to pull it out with the pincers and start again. If a nail bends over before it is driven right in, it is better pulled out and another used. Many woodworkers rely on second-hand wood for much of their work.

The pincers are used to pull out any nails already in the wood.

The method of using the pincers is important. The nail is gripped as low as possible, and the tool levered sideways (fig. 2.55). In order not to damage the wood, a piece of waste wood or a piece of metal should be placed under the pincers.

A claw is generally made on one leg of the pincers. Although this is not much use for pulling out nails, it is useful for lifting up nails that are bent over.

Pincers are made of drop forged steel.

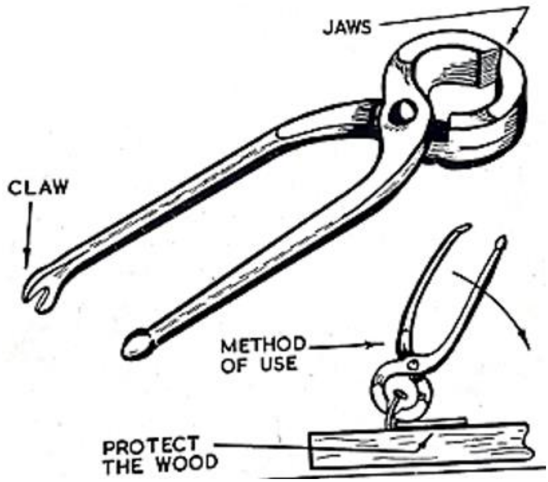


Fig. 2.55: Pincers

The Bradawl

The bradawl is used for making small holes in wood before using screws or nails. It is suitable for making holes only for small screws. The bradawl is also frequently used to mark the position of a hole that has to be drilled. For example, when hanging a door, the position of the screws is marked through the hinge with a bradawl. The hinge may then be taken away and the holes drilled.

Bradawls are obtainable in several different sizes. The smaller the size the thinner the blade. The handle of the bradawl is made of beech or ash with a ferrule to prevent it splitting. The blade is made of tool steel (fig. 2.56).

The end of the bradawl blade is sharpened on both sides to form a chisel point. When making a hole the chisel edge is placed across the grain in order to cut the fibres. The bradawl is pushed a little way into the wood and then given a twist.

It is then pushed in a little further and given another twist and so on.

The bradawl is also removed from the wood with a twisting action.

The blade of the bradawl can be broken easily. Care should be taken that it is not bent sideways in use. Spare blades are obtainable quite cheaply.

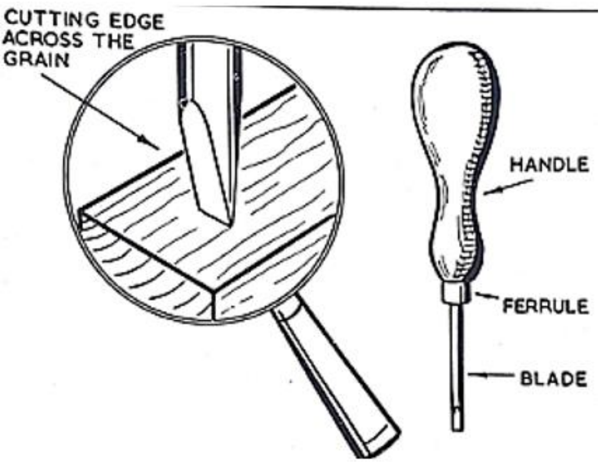


Fig. 2.56: Bradawl

The Screwdriver

The screwdriver is used, of course, mainly to turn wood screws. It is also used, for example, when adjusting a mortise gauge or for taking apart the cutting iron of a plane.

Screwdrivers are obtainable in several different sizes. The size is generally indicated by the length of the blade. The tip of the blade is made smaller and thinner in the shorter sizes. Screwdrivers with 150 mm or 200 mm blades are useful for general work. A 'dumpy' screwdriver with a very small overall length is useful for work in confined spaces.

The pattern of screwdriver generally provided for school workshops is the cabinet pattern (fig. 2.57). The wooden handle is oval in section. It is made of beech or box. The blade has a flat tang which fits through a slotted ferrule on the handle. The blade is thus securely held. Plastic handles have become popular in recent years.

Ratchet screwdrivers have a small ratchet fitted into the handle which allows the handle to be turned without turning the blade. A small button on the handle may be set to grip on the forward stroke only, on the return stroke only, or on both. Ratchet screwdrivers are not suitable for very heavy work.

The tip of the blade must fit the screw that is to be turned. The screw head will be one of two main types. It will have either a straight slotted head (the majority of screws are of this type) or it will have e.g. a Phillips recessed head. Phillips screwdrivers must be used to turn these recessed head screws. Not only must the screwdriver blade be the correct form for the screw, it must also be approximately the correct size. The tip of the blade should be quite a tight fit in the head, it should fit to the bottom of the slot in the screw head. If the screwdriver is too wide it will damage the wood round the screw. If it is too small an excessive strain is placed on the screwdriver tip and the screw head will be damaged.

The tip of the screwdriver should be examined from time to time to see if it has become worn. If worn it may be lightly trimmed on a grindstone, care being taken not to overheat the blade. The blade is made of cast steel hardened and tempered at the tip. If this were allowed to become hot the temper would be removed or drawn.

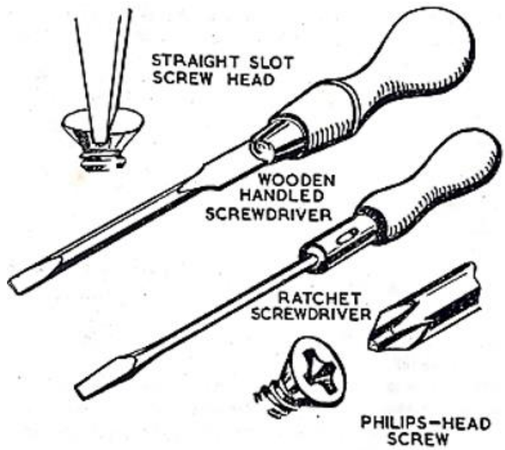


Fig. 2.57: Screw drivers

With regard to care of the screwdriver, three points should be borne in mind. The screwdriver should not be used as a lever, which might bend the blade and it would not then turn true. The handle should never be struck with a hammer, which would roughen the handle making it uncomfortable to hold. The rule followed when using a chisel, namely, that the hands are kept behind the cutting edge, applies also to the screwdriver. It must be said in favour of the recessed head screw that the screwdriver cannot slip out of the screw.

The G Cramp

The G cramp is so called because when viewed from the side it forms the letter G.

Often when it is required to hold two or more pieces of wood together for gluing, drilling or screwing, the G cramp is used. When a piece of wood is being worked on the bench top, the

G cramp is often used to hold it firmly in position. When parts of a structure are being assembled, the G cramp is sometimes used to hold them in position.

G cramps are made in several different sizes. The size is the distance between the jaws when fully open. 100 mm, 150 mm and 200 mm cramps are usually provided for school workshops.

The shoe on the end of the screw thread is made to swivel in order that it will always lie flat even when the surfaces being cramped are not parallel. In order to prevent damage to the wood surface, it is always advisable to use waste wood under the jaws of the cramp. A drop of oil on the screw thread and on the swivel shoe helps to keep these moving freely.

The main body of the cramp is made either of malleable cast iron or drop forged steel and the screw is of mild steel (fig. 2.58).

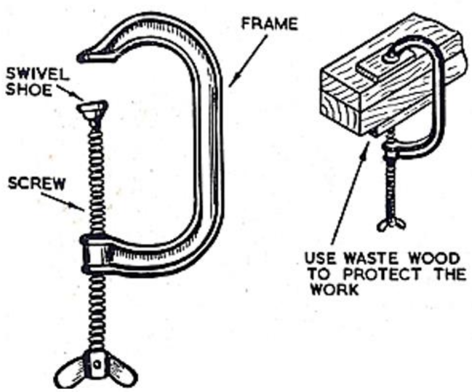


Fig. 2.58: G Cramp

The Brace

When boring holes in wood of more than 6 mm diameter, a brace and bit are used. The brace is used to hold and turn a bit of suitable type and size for the job in hand. A number of types and sizes of bit are obtainable.

Braces are of two main types: plain and ratchet. The ratchet brace has a strong ratchet built into the frame. This may be set to allow the bit to remain stationary either on the forward or return stroke as the brace is rotated. The ratchet is very useful when working in confined spaces that do not allow a full sweep of the brace. Most school workshops have at least one ratchet brace (fig. 2.59).

The size of the brace is indicated by the length of the sweep. The sweep is the diameter of the circle formed when turning the crank of the brace (see drawing). The sweep may vary from 125 mm to 300 mm. The brace provided for school use usually has a 200 mm sweep.

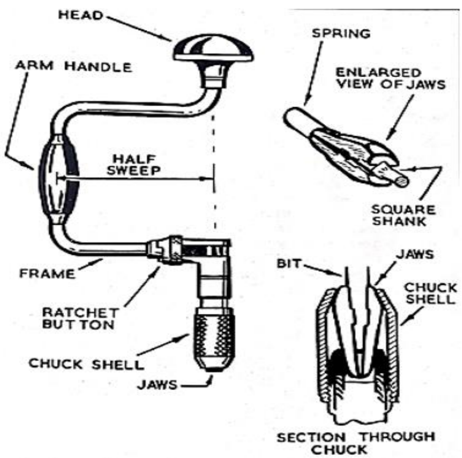


Fig. 2.59: Ratchet Brace

The bits are held in the brace in a two-jaw chuck. When the chuck shell is screwed up, the two jaws are tightened firmly on to the square taper shank of the bit. On most braces the jaws are designed to hold only square taper shank bits and not parallel shank drills. When fitting bits into the chuck it is important to make sure that the whole of the square taper shank is correctly fitted into the jaws (see drawing).

The jaws are held, together by a small spring clip. They fit into a slot in the chuck which allows them to open and close but prevents them turning round.

When using the brace and bits, great care must be taken to ensure that holes are not bored in the bench. Great care should also be taken of the delicate cutting edges of the bits.

The metal parts of the brace are made of steel. The wooden handles are made of some suitable hardwood such as beech or of plastic material.

The Bits

The Twist Bit

The type of bit that is probably used more than any other, when boring holes in wood, is the twist bit, sometimes called an auger bit. There are several types of twist bit. The most common type, which is also the one generally provided for school use, is the Jennings pattern twist bit. The details of this are shown in figure 2.60.

When using the twist bit to bore a hole, the centre of the hole should first be carefully marked. The point of the screw is accurately placed on this before starting to bore. If the hole is to be bored right through the wood, it is usual to work from both sides in order to prevent the wood splitting out at the back. The hole is bored through the wood until the screwed end of the bit appears on the other side. The wood is then turned round, the screwed end placed in the small centre hole, and the boring completed.

The majority of holes have to be bored square with the wood. The accuracy of the boring may be tested by placing the try-square on the wood. The blade of the square is then 'sighted' with the bit to see if the two are parallel.

It may be necessary to bore holes to a certain depth. This may be done using an adjustable depth stop attachment. Many workshops have one of these (see drawing). The stop is set to allow the required amount of bit to enter the wood. Simple depth stops may be made by boring a hole through a small piece of wood and slipping this onto the bit, so that only the required amount of bit is able to enter the work (see drawing).

Great care must be taken with the bits. Small diameter bits become bent easily and are thus spoiled. The screw, spurs, and cutters of a twist bit are very easily damaged if dropped or knocked °n metal tools. Bits can be sharpened, however, but this should be rarely necessary.

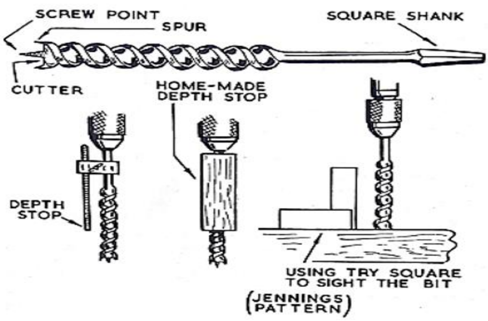


Fig. 2.60: Twist bit

The Countersink Bit

When screws are being used, a hole is drilled to take the screw. When countersunk head screws are being used, it is usual to make a small recess called a countersink at the mouth of the hole. This allows the head of the screw to sink just below the level of the surrounding wood. A neat and strong job is thus made.

Countersink bits are of two main types: rosehead bits and snailshorn bits. The main parts of these are shown below. The rosehead bit has a series of cutters, nine in all, that radiate from the centre point. These cutters do not look much like the petals of a rose, but the similarity is sufficient to give the bit its name. The snailshorn bit has two cutting edges which curve away from the point. The curve making it look a little like a snail's shell. The snailshorn bit, with its two cutters, cuts very much more quickly than the rosehead bit with its many cutters (fig. 2.61).

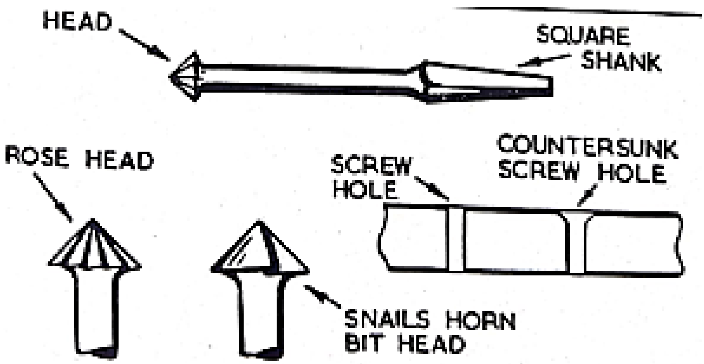


Fig. 2.61: Countersink bits

The rosehead bit may also be used for countersinking soft metals such as brass

The point angle of the countersink is 90°, this being the countersink angle of a screw head. The bit has a square taper shank to fit the two jaws of the brace.

Countersink bits are obtainable in several sizes. The size generally provided for school use is 13 mm maximum diameter. This may be used for all the screws in general use.

Bits in Less Common Use

The woodworker's brace is used to hold a number of types and sizes of bit. All of these have a square tapered shank which fits in the two jaws of the brace. The two types in most frequent use are the twist bit, sometimes called an auger bit, and the countersink bit. In addition to these there are several other types of bit that are used less frequently.

The Shell Bit. This is used for boring holes for screws or small dowels and so on. It is half round in shape and sharpened on the outside to form a cutting edge. It is rather slow cutting, but it forms a nice clean hole particularly when cutting into end grain. Shell bits are obtainable only in small sizes (fig. 2.62A).

Some shell bits have a small lip on the cutting edge to pull out the waste from the hole. This is very useful when boring a deep, blind hole.

The Gimlet Bit. This is also used for boring small holes for screws and so forth. It has a screw thread at the point which draws the bit into the wood, and this makes the work somewhat easier. But, as will be seen from the drawing, it has a tapered point and this tends to split the wood (fig. 2.62B).

Centre Bits. There are two types of centre bit. The older type has a plain point. The more modern type has a screw point, and has a rather better cutting action (fig. 2.62C).

Centre bits are quite easily sharpened and this is an advantage, but they have the rather serious disadvantage that they tend to wander sideways when used for boring deep holes. This is because there is hardly anybody of the drill behind the cutting edge to keep it in alignment.

When boring right through with a centre bit, the bit is taken through until the point appears. The hole is then finished from the reverse side, otherwise the hole will break out and split the wood.

The Screwdriver Bit. This has a tip exactly the same as a screwdriver. When a large number of screws have to be put in, it is sometimes quicker to use a screwdriver bit in the brace rather than a screwdriver. The brace provides a considerable leverage on the bit. This makes it suitable for removing screws that are very tight. Screwdriver bits, can be made quite well from old twist or centre bits, which can be cut down and drawn out to form a screwdriver tip (fig. 2.62D).

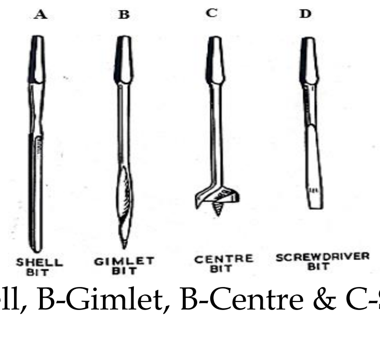


Fig. 2.62: A-Shell, B-Gimlet, B-Centre & C-Screwdriver bits

The Forstner Bit. The main feature of the forstner bit is that the centre spur is extremely small leaving the bottom of the hole unmarked. It is used mainly for boring shallow holes and particularly for decorative work where a hole is required with the centre unmarked (figure 2.63E).

The Expansion Bit. This may be adjusted to cut different sized holes. This is useful particularly in the larger sizes, as it saves the need of having a selection of large drills. The range of the drill is limited. Thus a small one may have a range of say 25 mm to 45 mm, and a large one may have a range of 35 mm to 75 mm (figure 2.63F).

The size of the hole that can be bored is really limited by the strength of the operator. Even with a brace of 250 mm sweep it is hard work to drill a hole of 75 mm diameter, even in softwood.

The Dowel Trimmer. This is used to take off the corners of the ends of a piece of dowel rod that is being used to make a dowel joint. The bit is obtainable in one size which is suitable for the diameters of dowel rod used for dowel joints (figure 2.63G).

The Extension Bit. This is used for boring holes in places that would be otherwise inaccessible. It consists of a two-jaw chuck, exactly the same as the two-jaw chuck of the brace. This is fixed to the end of an extension bar. The bar has a square taper shank which fits the jaws of the brace. The required bit is fitted into the chuck on the end of the extension bar and the brace is thus given a much longer reach (figure 2.63H).

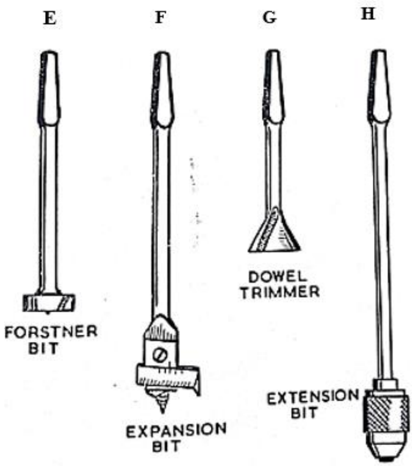


Fig. 2.63: E-H : Forstner, Expansion, Dowel & Extension bits

Drills and drilling (fig. 2.63I)

The brace and bit is for boring drills and drilling large holes. Many braces have a ratchet device which allows the tool to be used in confined spaces where a full sweep of the brace is impossible. The bits are held in the brace chuck by their square shanked ends. Always ensure that the bit is straight and secure before starting to bore. There is a great variety of bits, some of which have very special functions; the former bit, for example, makes flat bottomed 'blind' holes.

Centre bits are used for large shallow holes. The screw centre draws the bit into the wood whilst the circumference is scribed by one cutting edge; a second cutting edge removes the waste. When boring through, the bit is taken in until the tip of the screw appears on the reverse side. The wood is then turned round and the hole completed. This prevents splitting.

Twist bits are in common use, the Jennings pattern being the best known. A twist bit helps to ensure that deep holes are bored true. It is important that the bit enters the wood at right angles in two planes; some craftsmen stand a try-square alongside the bit as a guide.

Small holes ($\frac{5\pi}{16}$ 8mm and under) are best drilled with a hand drill, sometimes called a wheel brace. This is ideal for screw holes. Twist drills are available in sizes down to $\frac{5\pi}{16}$ (1.5mm). Two qualities are sold - H.S.S. (high speed steel) which are black in colour and expensive, or cheaper, shiny, C.S. (carbon steel). Wood sometimes clogs the flutes of a twist drill; it is sensible to clear this waste from time to time otherwise the drill may jam and break off-

Special counter-sinking drills open up the top of screw holes so that the screw head sets down flush with the surface.

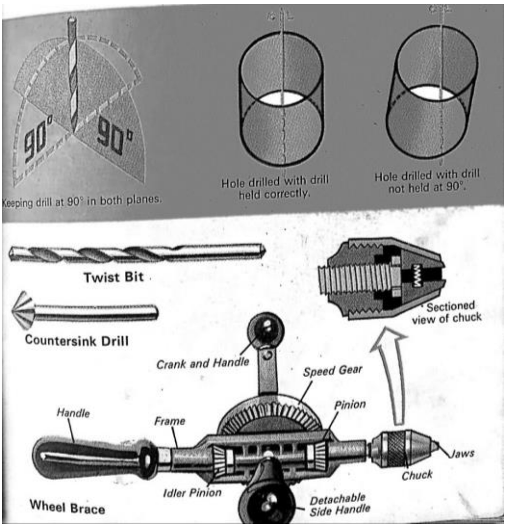


Fig. 2.63I: Drills and Drilling

Light machines

Circular saw

Obtainable both as a bench machine and on a stand. Generally known by largest size saw machine will take. For small workshop 170 mm to 250 mm most suitable. Either table or saw should have vertical adjustment to enable grooving and rebating to be done. Tilting table or saw also desirable for bevel cuts. A riving knife should be fitted to prevent wood from binding on the saw. Fence for ripping is needed, and table should have groove to take an adjustable mitre gauge for cross-cutting and mitring. Guard is also essential (fig. 2.64).

Bandsaw

Used chiefly for cutting external shapes. Can be used for straight cuts but is not so satisfactory as circular saw. May have either two or three wheels. Latter gives greater clearance for wood. Upper wheel must have tracking adjustment to keep saw in centre of rim; also vertical adjustment to enable saws of varying size to be fitted and to enable tension to be varied. Guides and thrust wheel should be fitted. Table should tilt, and have groove to take mitre block (fig. 2.65).

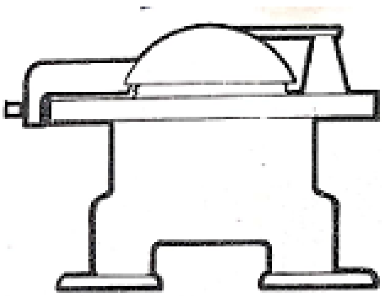


Fig. 2.64: Circular saw

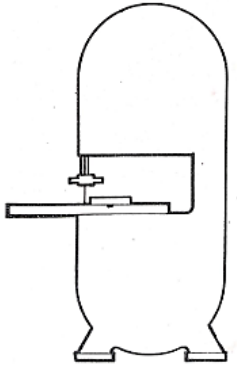


Fig. 2.65: Bandsaw

Jig saw

Used almost solely for internal cuts. Machine may be of rocker-arm type; the blade may be connected to a plastic band making the whole continuous, or it may be of the spring-return type. The latter type must be firmly bolted down because vibration is pronounced. Tilting table is an advantage. Hold-down foot is also useful (fig. 2.66).

Planer

Size of planer is reckoned by length of cutters, varying from 100 mm. up to 0-75 m. Tilting fence and guard should be fitted, and both tables adjustable. Rebating table is an advantage. Surfacer or jointer planes surface or edge straight and square (fig. 2.67).

Thicknesser brings wood to an even thickness, and any number of pieces can be brought to the same thickness. Many surfacers can now be fitted with a thicknessing attachment.

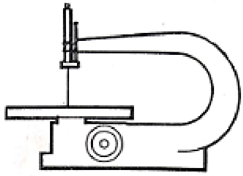


Fig. 2.66: Jig saw

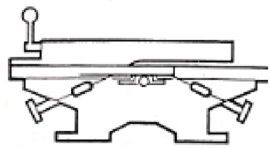


Fig. 2.67: Planer

Belt sander

Path of abrasive is straight, and can therefore be used for smoothing as well as trimming. Tracking adjustment is necessary to keep belt true (fig.2.68).

Disc sander

Size known by diameter of disc. Used chiefly for trimming rather than smoothing. Table should tilt and have groove to take mitre gauge (fig. 2.69).

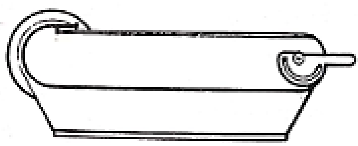


Fig. 2.68: Belt sander

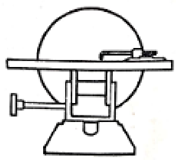


Fig. 2.69: Disc sander

Combination sander

Has disc, belt, and bobbin sanders, enabling small flat and bobbin sanders, enabling small flat and curved parts to be sanded (fig. 2.70).

Wood turning lathe

Size known by maximum distance between centres and height of centres above bed (4 in. lathe will turn work of just under 8 in. maximum diameter). Heavy headstock and bearings are desirable (2.71).

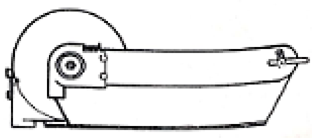


Fig. 2.70: Combination sander

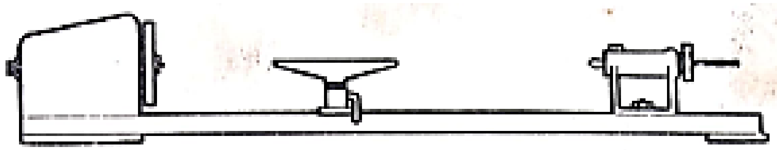


Fig. 271: Wood turning lathe

Circular saw data

Peripheral speed. The rate at which the teeth are moving. Theoretically this should be in the region of 3,000m per minute (but see note below).

Revolutions per minute of saw (r.p.m.). This should vary with the diameter of the saw, and is based on the peripheral speed (3,000 m. per minute). It is found thus

$$\frac{\text{Peripheral speed}}{\text{Diameter of saw x 3143}}$$

Example -Saw diameter, 0-30 m.

$$\frac{3{,}000}{0 - 30x3 - 143}$$
$$= \text{ say } 3{,}180 \text{ r.p.m.}$$

Note-The above can be accepted for saws of about -30 mm. diam. and upwards. Smaller saws seldom achieve the optimum, however, often because the bearings are not suitable for the high speed, and also because many machines have various attachments which require a lower speed. In practice, saws running at lower speeds cut perfectly well if kept sharp. As an example, the theoretical optimum speed of a 0-20 m. saw is about 4,770 r.p.m.

In fact, most saws of this size run somewhere between 2,000 and 2,500 r.p.m. They will cut quite well at 1,000 r.p.m. if sharp.

Theoretical optimum speeds are approx:

0-18 m. diam. 5,300 r.p.m. 0-30 m. diam. 3,180 r.p.m.

0-20 m. diam. 4,770 r.p.m. 0-35 m. diam. 2,700 r.p.m.

0-25 m. diam. 3,950 r.p.m. 0-40 m. diam. 2,380 r.p.m.

As noted above, the 0-18 m.-0-25 m. saws can run from 2,000-2,500 r.p.m.

Pulley sizes. When no pulleys are fitted to either saw or motor, the ratio between the speeds of the two must be found. The motor r.p.m. is usually marked on it.

Example – motor r.p.m. 1,450

Required Saw r.p.m 3,000

$$\frac{1{,}450}{3{,}000} = \frac{29}{60}\ say\ \frac{1}{2}$$

Therefore motor requires pulley twice size of saw pulley, giving sawspeed of 2,900 r.p.m (fig.2.72).

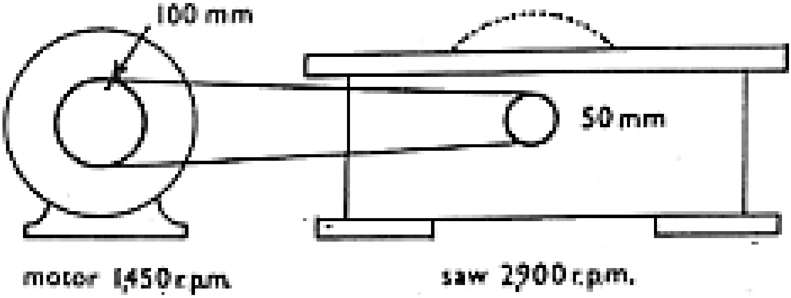


Fig. 2.72: Saw revolution

It is a help to remember that when the saw is required to have a higher r.p.m. than the motor it must have the smaller pulley.

To find size of saw (driven) pulley:

$$\frac{\text{r. p. m. motor x diameter motor pulley}}{\text{r. p. m. saw}}$$

Example —Motor r.p.m. 1,450; motor pulley 100 mm.; r.p.m. saw 2,500

$$\frac{1{,}450\text{x}100}{2{,}500}$$
$$say\ 60mm$$

To find size of motor (driving) pulley:

$$\frac{\text{Saw r. p. m. required x diameter saw pulley}}{\text{r. p. m. motor}}$$

Example-Saw r.p.m. 2,200; saw pulley 100 mm.; motor r.p.m. 1,500

$$\frac{2{,}200 \times 100}{1{,}500}$$

Say 150mm diam.

Power of motor. The motor should be powerful enough to drive the saw when cutting to maximum capacity. Except for the lightest work it should not be less than ½ h.p. the following are generally recommended (fig. 2.73):

Saw diam.	H.P. motor	Saw diam.	H.P. motor
0·18 m.	⅓–½	0·35 m.	2–3
0·20 m.	½–¾	0·40 m.	3–4½
0·23 m.	½–1	0·45 m.	5
0·25 m.	½–1	0·50 m.	7
0·30 m.	1½–2		

Fig. 2.73: Motor power & Saw diameter

The lower figure is for comparatively thin wood or softwood. For tough hardwood especially thick stuff, the more powerful motor should be used.

Saw gauges. This is thickness of the metal. The following are generally recommended (fig. 2.74):

Saw diam.	Stubbs Gauge	Saw diam.	Stubbs Gauge
0·15 m.	21	0·30 m.	18
0·20 m.	20	0·40 m.	17
0·25 m.	19	0·45 m.	16

Fig. 2.74: Saw gauges

Special saws

A. Hollow-ground, dimension, or planer saw. Plate is thinner at centre and teeth have no set. Teeth are usually peg type (see below). Saw cuts cleanly leaving finish almost equal to that of a planer.

B. Swage saw. Flat on one side, tapers towards rim on the other. Teeth have usually more set on tapered side than in the flat. Centre thickness stiffens the plate, and thin edge reduces saw kerf. Used generally for cutting narrow strips which bend away from saw without binding.
C. Ground-off saw. Gives very stiff plate but narrow kerf. Similar uses to the swage saws, but for still narrower pieces. For thin wood only.
D. Taper saw. Similar uses to swage and ground-off saws.

E. All these three saws (B, C, and D) should have minimum projection above saw table. Should not be used for general ripping or cross-cutting, but for special purposes only.

Fig. 2.75: Special saws

Saw teeth (fig. 2.75)

A. Peg teeth. Used for cross-cutting but now largely superseded by type **B**.

B. Cross-cut teeth. Front edges are radial to saw.
C. Cross-cut teeth. Note that front edges leans back slightly. The high back to the teeth makes for strength.
D. Rip-saw teeth for softwood. Note the pronounced hook formed by the angle of the front.
E. Rip-saw teeth for hardwood. Similar D to D but with less hook, making a stronger tooth.
F. Combination teeth. With mostly E cross-cut teeth, but with raker teeth at every fifth or seventh position.
G. Tungsten toothed saw. Widely used p today. Made in a wide variety of types and sizes and of particular value for abrasive materials such as chipboard.

Pitch of saw is distance between each point.

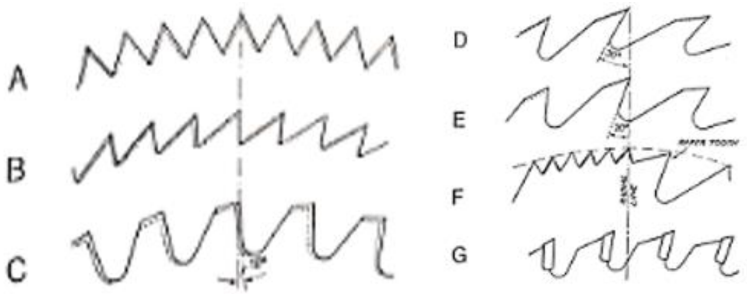


Fig. 2.75: Saw teeth

Transmission

The methods most suitable for small machines are the flat belt and the V belt. The former should have the driving side of the belt below so that the sag occurs at the top, thus increasing the arc of contact and lessening any liability to slip. The leather should be dressed monthly to keep it in good condition. Single ply flat belting will transmit the following loads approximately:

25 mm wide, up to 1 h.p.   65 mm wide, up to 3 h.p.

45 mm wide, up to 1-5 h.p. 90 mm. wide, up to 6 h.p.

V belts are specially useful when pulley centres are close. Arc of contact should be not less than 120 degrees to avoid slip. This generally means that ratio between pulleys should not be greater than 1:7. If a greater ratio is essential, a countershaft should be installed. A V belt should never need any dressing. A point to realize is that a belt at low speed will not transmit as much power as when at high speed. Fortunately, most woodworking machines run at fair speed.

Pulley calculations. When making any calculations it is useful to remember that: When the motor (driving) pulley is larger than the machine (driven) pulley the machine will run faster than the motor, and vice versa (fig. 2.76). Equal pulleys give same speed in both.

Thus, keep the following in mind:

Large motor pulley] Machine runs and [= faster than

Small machine pulley] motor

Small motor pulley] Machine runs and l = slower than

Large machine pulley] motor.

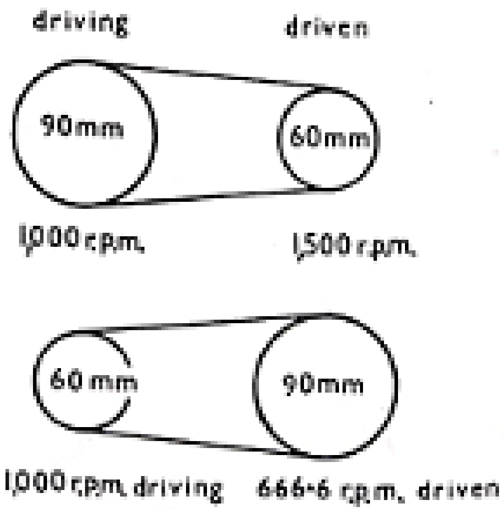


Fig. 2.76: Power transmission

When no pulleys are fitted. Find the ratio between the motor r.p.m. and the required machine r.p.m.

Example-Motor r.p.m. 1,500; Machine r.p.m. 2,000

1,500:2,000 = 3:4

As machine must run faster than motor it must have the smaller pulley, pulleys are in ratio, motor 4; machine 3

Note that any sizes giving same ratio could be used, as 00 mm : 60 mm, 120 mm 90 mm, 160 mm : 120 mm, 240 mm: 100 mm, etc.

To find motor pulley size

$$\frac{\text{Required machine r. p. m. x Diameter machine pulley}}{\text{R. p. m. motor}}$$

Example-Motor r.p.m. 1,500; required machine r.p.m. 4,000; machine pulley 50 mrn.

$$\frac{4{,}000\text{x } 50}{1{,}500}$$

133.3, say 130 mm. motor pulley.

To find machine pulley size

$$\frac{\text{R. p. m. motorx Diameter motor pulley}}{\text{Required r. p. m. machine}}$$

Example- Motor r.p.m. 3,000; required machine r.p.m. 2,000; motor pulley 100 mm.

$$\frac{3{,}000\text{x } 100}{2{,}000}$$

150 mm. = machine pulley.

V belt pulley calculations. As the speeds of woodworking machines are not usually critical it is usual to take the outside diameter of V pulleys when calculating speeds. This, however, does not give exact speeds, and when this is required it is necessary to ascertain the Pitch Circle Diameter of both pulleys to be used. This (known as P.C.D.) is found as follows:

P.C.D. = Outside diameter of V belt pulley, minus thickness of belt, plus 1.6 mm.

Example-100 mm. diam. V belt pulley 1,500 r.p.m. driving 200 mm. diam. V belt pulley. Thickness of belt 9-5 mm.

100 mm. —9-5 mm. + 1-6 mm. = 92-1 mm. P.C.D. of 100 mm. pulley

200 mm. -9-5 mm. + 1-6 mm. = 192-1 mm. P.C.D. of 200 mm. pulley

Now apply normal calculation:

$$\frac{1{,}500 \text{x} 92 - 1}{192 - 1}$$

= 719.15 approx., say 720 r.p.m.

If the outside diameter of the pulleys had been used the answer would have been 750 r.p.m.

Line and counter-shafts. These are often used as a matter of practical convenience, where more than one machine is driven from one motor, or when the ratio between driving and driven pulleys is very great.

When one-line shaft has to drive several machines, the individual speeds of which vary, it is sometimes convenient to fit pulleys of equal size to both motor and line shaft. In this case, since line shaft and motor revolve at equal speeds, all calculations for other pulleys can be made as for directly from motor to machine, each being calculated according to the speed required. If, however, all machines have to revolve at a speed well in excess of the motor, it is often convenient to step up the line shaft r.p.m. by fitting to it a smaller pulley than to the motor. A simple calculation gives the resulting line shaft r.p.m., and all pulley sizes for individual machines are worked out from this (fig. 2.77).

Example — A motor r.p.m. of 1,500 is required to drive a saw with 50 mm. pulley at 2,500 r.p.m.; a planer with 65 mm.

pulley at 4,000 r.p.m.; and a sander with 75 mm. pulley at 2,000 r.p.m.

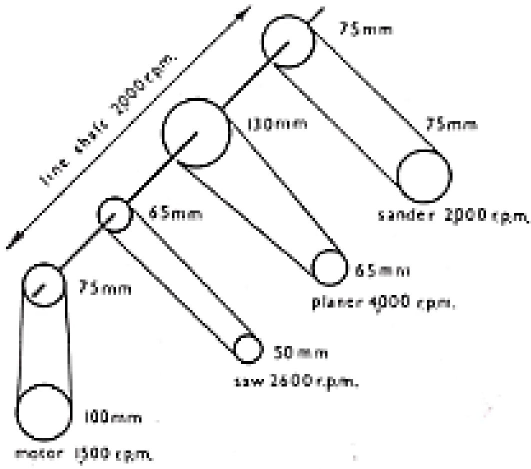


Fig. 2.77: One-line shaft driving several machines

The slowest machine is the sander and the line shaft might be stepped up to this speed. The ratio is:

Motor 1,500 = 3 Line shaft 2,000 = 4

As the line shaft has to turn the faster it has the smaller pulley

therefore motor pulley 100 mm.

line shaft pulley 75 mm.

$$\frac{1{,}500x100}{75} = 2{,}000\ r.p.m\ line\ shaft$$

Saw with 50 mm. pulley to revolve at 2,500 r.p.m.

$$\frac{\text{Saw r. p. m. x diameter saw pulley}}{R.p.m\ line\ shaft}$$

$$\frac{2,500x50}{2,000} = 62.5mm\ .say\ 65.0mm$$

Say 65mm. diam. Line shaft pulley to connect with saw, giving 2,600 r.p.m

Planer with 65mm. pulley to revolve at 4,000 r.p.m

$$\frac{4,000x65}{2,000}$$
$$= 130\ mm. diam. shaft\ pulley\ to\ connect\ with\ planer$$

Sander with 75 mm. pulley to revolve at 2,000 r.p.m.

Since both line shaft and sander have same r.p.m., no calculation is necessary. They have pulleys of equal size.

Example — Motor of 1,500 r.p.m. with 60 mm. pulley to drive grindstone at 100r.p.m. Ratio is 1:15

As this would give too small an arc of contact in the driving pulley a counter-shaft is used (fig. 2.78). The 15 can be substituted by any two numbers which, multiplied together, equal it. Thus 3 and 5.

As motor has 60 mm. pulley it should connect with 180 mm. counter-shaft driven pulley. Counter-shaft driving pulley can be 50 mm. connecting with 250 mm. grinder pulley, or any other sizes which have a ratio of 1:5. Resulting grinder speed is 100 r.p.m.

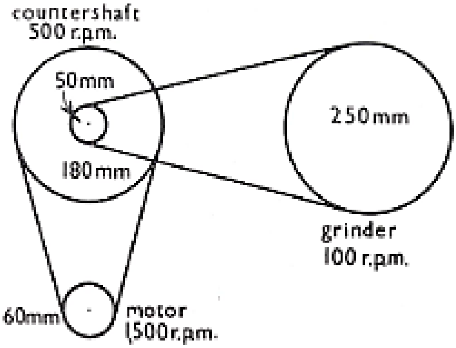


Fig. 2.78: Using counter-shaft

Machine speeds

Although optimum speeds have been found by experience and calculation, a wide variation is practicable for woodworking machines, providing they are sharp. The following are a guide showing the speeds at which to aim.

Circular saw. See notes under circular saw.

Band saw.	Diam. of wheel	R.p.m.
	300 mm.	950
	450 mm.	950
	600 mm.	800
	750 mm.	750

Many small band saws run at considerably lower speed than the optimum.

Jigsaw. 600-1,700 r.p.m. (one stroke per revolution).

Planer. Cutter block of 75 mm. and less, 4,000 - 6,000 r.p.m.

Lathe.

Diameter of wood being turned	R.p.m. of work	Diameter of wood being turned	R.p.m. of work
25 mm.	3,000	200 mm.	650
50 mm.	2,500	300 mm.	570
75 mm.	1,500	450 mm.	300
125 mm.	1,000	600 mm.	250

Spindle. 4,000 - 8,000 r.p.m. High speed gives best results, but small machines seldom achieve this

Sander. Disc type:

Diameter	R.p.m.
250 mm.	600-2,500
400 mm.	900-1,000
600 mm.	400-570
750 mm.	200-340

Small spindle type-2,000 r.p.m.

Drum type-900-1,500 r.p.m.

Belt type-300 m.-900 m. per minute (calculate according to size of cylinder). Drill. 650-3,500 r.p.m. (often variable). The larger the drill the slower the speed.

Mortising machine (hollow chisel and auger type). 2,500-3,000 r.p.m.

Router. 18,000-27,000 r.p.m.

Grinders. Dry type. Peripheral speed not more than 1,500 m. per minute.

Average speeds: 150 mm. wheel — 3,100 r.p.m.

200 mm. wheel —2,300 r.p.m.

250 mm. wheel —1,900 r.p.m.

Wet type. 450 mm. —95 r.p.m.

600 mm.-70 r.p.m.

Power of motor for machines

Circular saw. (See under circular saw.)

Bandsaw.	Diam. of wheel	H.P. motor
	300 mm.	0.33
	450 mm.	0.5
	600 mm.	1.5
	750 mm.	3.0

Jigsaw. Small machines-0-5 h.p.

Planer. Length of cutter block H.P. motor

100 mm.	0.33 - 0.5
150 mm.	0.5 - 1.0
225 mm.	1.0 - 1.5
300 mm.	2.0

Lathe. 100 mm. (height of centres above bed) – 0.33 – 0.5 h.p.

Spindle. Small machines 0.33 – 0.5 h.p., or for larger cutters 0-75-10 h.p

Sanders. Disc type:

Diameter	H.P. motor
250 mm.	0.5 – 1.0
400 mm.	1.0
600 mm.	3.0
750 mm.	4.0

Small spindle type 0.33 – 0.5 h.p.

Single drum type 150 mm. diam. 0.75 h.p.

250 mm. diam. 1.5 h.p.

Belt type 100 mm. width 0.33 – 0.5 h.p.

150 mm. width 0.5 – 0.75 h.p.

Drills. For boring up to 25 mm. holes 0.25 – 0.33 h.p.

Mortising machine. For chisels up to 12 mm. 0.33 h.p.

Router. 0.25 – 3.0 h.p. according to size.

Grinder. Dry stone- 150 - 200 mm. diam. – 0.25 – 0.5 h.p.

250 mm. diam. – 1.0 h.p.

Wet stone- 450 mm. diam. – 0.5 h.p.

600 mm. diam. – 0.66 h.p.

Portable machines (fig. 2.79)

A. Electric drill. Various attachments available; circular saw, jigsaw, orbital sander, disc sander, dovetailer, etc.
B. High speed electric router. For working grooves, recesses, mouldings, piercing, etc.
C. Jigsaw. For cutting curves and for internal cuts.
D. Circular saw. For ripping, cross-cutting, etc.
E. Power plane. Used mostly for the rapid reduction of wood.
F. Orbital sander. For the final smoothing of surfaces to be polished or lacquered.
G. Flexible disc sander. For the rough cleaning of surfaces.
H. Belt sander. Made in both bench and floor models.
I. Reciprocating sander. With two pads which move towards and away from each other.
J. Dovetailer. An attachment for fitting to an electric drill or router.

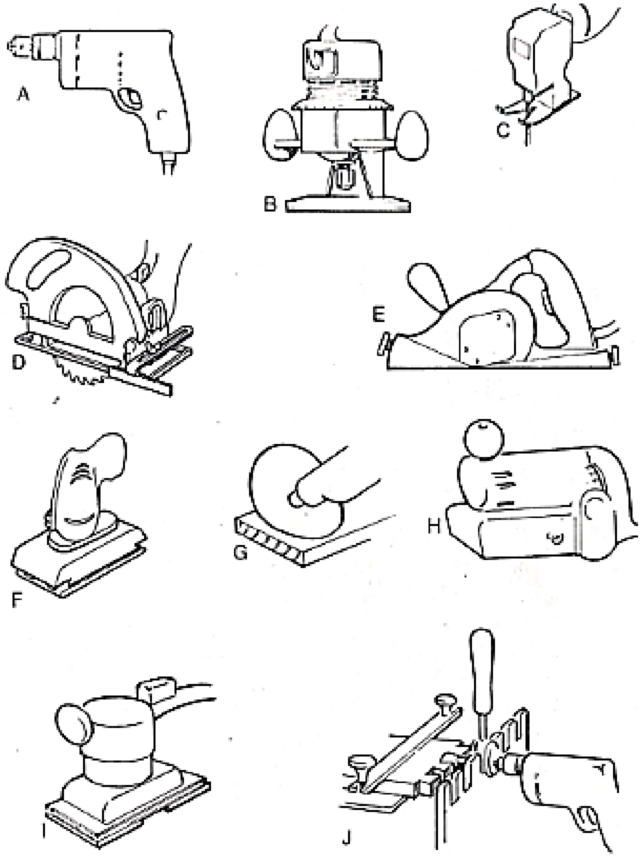


Fig. 2.79: Portable machines

Some Useful Definitions

A. Bench Hook: This is sometimes called a sawing board. It is used to support small pieces of wood on the bench that are being sawed with the tenon saw.
B. Bench Holdfast: This is a device that is used to hold a piece of wood securely on top of the bench. A hole must be drilled in the top of the bench to take the holdfast. It is not very much used in school

workshops. The G cramp is more often used to hold wood on the bench top.

C. Brass: A yellow metal used to make parts of tools, screws etc. It does not rust.

D. Cast Steel: Sometimes called tool steel or high carbon steel. This type of steel is used for making many tools and tool parts. The most important characteristic of this material is that' it can be hardened and tempered. It is then possible to produce a good cutting edge on it as, for example, on chisels or plane irons. It is also possible to produce a hard tough point as on nail punches and screwdrivers.

E. Ferrule: A metal ring is usually fitted to wooden handles. The purpose of this is to prevent the handle splitting. The ring is called a ferrule.

F. Galvanized: Steel nails and other steel objects are sometimes coated with zinc to prevent them rusting. This process is known as galvanizing.

G. Kerf: This is the name given to the amount of wood taken out by a saw cut. The teeth of a saw are set alternately from side to side. This makes the saw kerf wider than the saw. The saw should not then stick or rub in the kerf. A large toothed saw heavily set will make a much wider kerf than a small toothed saw.

H. Straight Edge: A straight edge is used to test the straightness of a piece of wood. For much of the small work a 300 mm steel rule makes a good straight edge. Most school work-shops have a metre steel straight edge. Larger straight edges are carefully prepared from reliable wood.

I. Screw Cup: This is shaped metal washer which is used under the head of a countersunk screw. Screw cups are used when there is a considerable strain on a screw and a danger of the head digging into the wood.

J. t.p.i.: This abbreviation means teeth per inch and it is used to indicate the size of saw teeth. 1 inch is 25-4 mm in length.

Chapter Three

WOOD JIONTS

Wood can be jointed together in a great variety of ways. Constructions in wood can be conveniently divided into two groups - frames (chairs, tables and windows) and boxes - (cabinets, drawers, bookcases and so on).

Framing Joints

The figures drawn below is a chair specially designed to include several frame joints (fig. 3.1).

The **cross-halving joint**. Half the thickness of each piece is cut away to form the cross. As in all joints, accurate marking-out, sawing and chiselling is vital if a well-fitting joint is to be obtained. This joint could also be used when making the framework for a shed or fitting divisions in a workbox.

The **mortise and tenon joint** has many variations. The mortise is the 'hole' part of the joint, the tenon is the close-fitting 'peg' part. The shoulders of the tenon must be very carefully sawn since this is the part of the joint which shows when the two parts are assembled. Large mortise and tenon joints are used on doors and window frames.

Dowel joints are often used as substitutes for mortise and tenons, especially in mass-production. If the holes are accurately positioned and carefully bored, a quick yet very strong joint results. Dowels can also be used to strengthen edge to edge joints in thick boards.

The **corner bridle joint** shown in the figure, and the **'T' bridle joint**, can also be used as alternatives to the mortise and tenon, especially in situations where angles other than right angles are required.

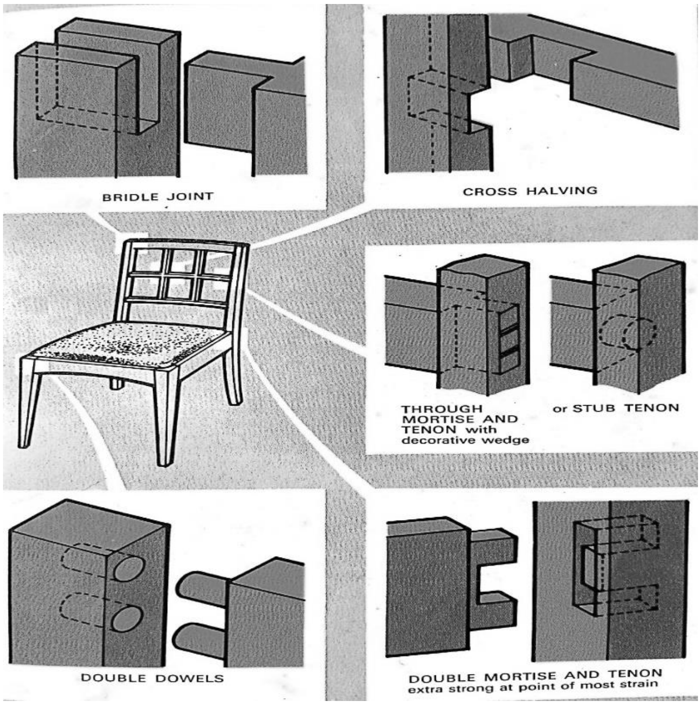


Fig. 3.1: Fame joints

Box Joints

A sideboard and a seed tray are examples of box constructions. It is obvious that the jointing used in each case has to be different. Some common corner joints are shown here. It is from these, and others, the most suitable joint for the work in hand must be selected.

The through dovetail, sometimes called the common dovetail, is a very strong joint. Cutting and fitting all the dovetail-type of joints demands skill and accuracy. Most beginners need to seek expert help at first. The 'tail' is sawn first and then the 'pins' and sockets are marked out from it. It is for this work that the special dovetail saw and the bevel-edged chisels are used. The lapped dovetail gives a joint on which the construction is only visible from one side; the drawer of a sideboard or dressing table is a good example to look at. In the secret mitre dovetail all of the construction is hidden except for the mitre on the edge. This joint is found only on fine cabinet work.

Housing joints are to be found in boxes with divisions, a cutlery drawer for example. The stopped housing joint would be used to fix a shelf in a bookcase. The 'stop' gives the front edge a neater look.

A simple corner joint is one with a tongue and groove. Accurately cut, carefully fitted and glued it can be quite strong and especially useful if the box is to be veneered later.

For making a simple job like a seed tray a butt joint, nail together, provides a quick and easy solution.

New materials, such as veneered chipboard and new, extra strong adhesives, make traditional joints inappropriate. New methods – dowels, fillets or patent fastenings – have to be used.

Halving Joints

Halving joints are used mainly for joining together the parts of a framework. They could be used, for example, to join the framework of a small door or cabinet. In addition to the cross halving joint, several other types of halving joint are in general use.

The halving joint used to join two pieces of wood to form a corner, is called either an angle halving, a corner halving or an L halving (fig. 3.2A). The method of marking out and cutting is similar to the method described for the cross halving.

The T halving is used to join the end of one piece of wood to the middle of another (fig. 3.2B). Sometimes the joint is stopped', that is to say it is not taken right across the wood (fig. 3.2C).

If the parts of a frame have to be made in such a way that they cannot pull apart, a dovetail T halving joint is used. These joints are sometimes sloped on one side only.

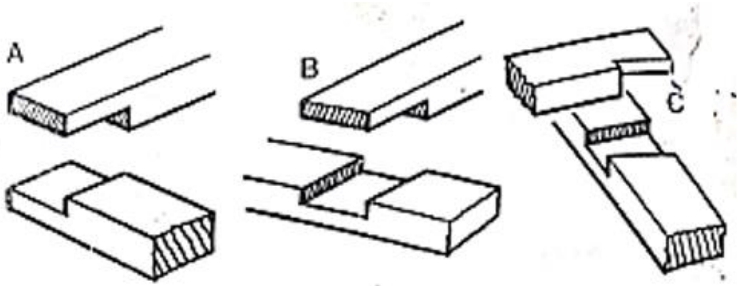


Fig. 3.2: Halving joints

The Cross Halving Joint

The cross halving joint is used when two pieces of wood have to be joined to form a cross. This is sometimes necessary. For example, the diagonal under-rails of tables are joined in this way. The joint may also be used to join the parts of a framework such as that of a shed, or to join the divisions of a box or drawer. As it is quite a simple joint it is used for early woodwork exercises (fig. 3.3).

Before starting to make the joint, the wood must be correctly planed to width and thickness. The stages in making the joint are as follows: —

1. Consider carefully the position of the joint. The joint will generally be in the centre of the pieces of wood. Consider also the angle between the two pieces of wood if this is not to be a right angle.
2. Mark on both pieces of wood, the width of the part that is to be cut out. This is best marked with a marking knife. If the joint is to form a right angle the knife will be used against the try-square. The width of the piece that is to be cut out will, of course, be the width of the piece that is to fit into it.
3. Set a marking gauge to half the thickness of the wood. Gauge both pieces using the gauge from the face side in each case.
4. Saw down to the gauge line with a tenon saw. The saw cut must be made in the waste wood or the joint will be loose. The bottom of the upper piece will be cut out, and the top of the lower piece. If the joint is a wide one it is helpful to make several saw cuts down to the gauge line in the waste wood of the joint.
5. Hold the wood in the vice and chisel out the waste wood. Work from both sides so as to meet in the middle. Use the chisel with the bevel uppermost and use as wide a chisel as possible.
6. The joint should, of course, fit straight away. If it is too loose nothing can be done about it. If it is too tight a little wood may be pared away until it fits correctly.

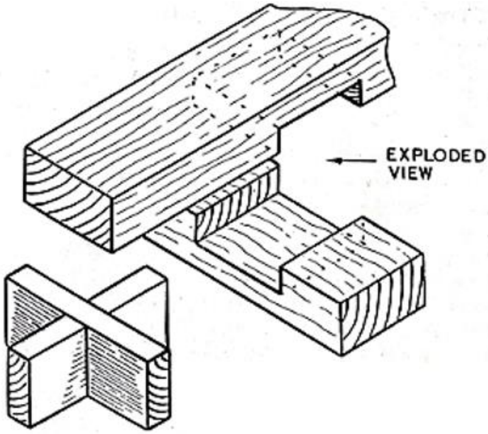


Fig. 3.3: Cross Halving Joint

The Housing Joint

The housing joint is used mainly for joining shelves to the upright supports. It is also used sometimes for joining divisions and partitions to the main structure. For example, a housing joint could be used when making bookshelves or a bedside cabinet. It could also be used to attach the central division of a small tool tray to the sides (fig. 3.4A).

Before starting to make the joint, the wood must be correctly prepared to width and thickness. The stages in making the joint to attach a shelf to a sidepiece are as follows: —

1. The piece that is to form the shelf (part A on the drawing) must be cut to length and the ends planed square. When cutting to length an allowance must be made for the depth of the joint, usually about 6 mm.
2. The position of the top face of the shelf is marked on the upright (drawing, part B). This is squared

across the wood on the inside face using a marking knife.

3. Place the end of the shelf with the top face on the knife line, and mark the thickness of the shelf on the upright piece. Square this mark across with the knife.
4. Square these knife lines round the edges of the upright using a sharp pencil
5. Set the gauge to the depth of the housing and gauge between the pencil lines. The gauge is. used from the inside face of the wood.
6. Saw down to the gauge line, making each saw cut up to the line but in the waste wood. If the board is a wide one, it may be helpful to make a chisel cut for the saw to run in
7. Chisel out the waste wood, working from each side of the board. Level the bottom of the housing by paring lightly.
8. If the marking has been accurately done and the work carefully performed, the joint should fit perfectly first time (figure 3.4B).

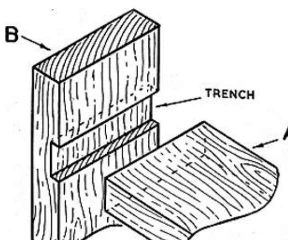


Fig. 3.4A: Housing joint

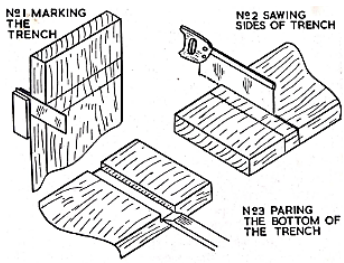


Fig. 3.4B: Housing joint construction

The Mortise and Tenon Joint

The mortise and tenon joint is used more frequently than any other joint in woodwork. It is used, for example, to join the rails to the legs of a table chair or stool. It is used to join parts of a strong framework such as a door or window frame. It is a very strong joint. There are very many types of mortise and tenon joint, each of which is designed to fulfil special requirements.

The mortise is the name given to the square hole which forms one part of the joint. The tenon is the name given to the part which is cut out to fit into the mortise. The joint relies for much of its strength on the tight fitting of the shoulders (fig. 3.5).

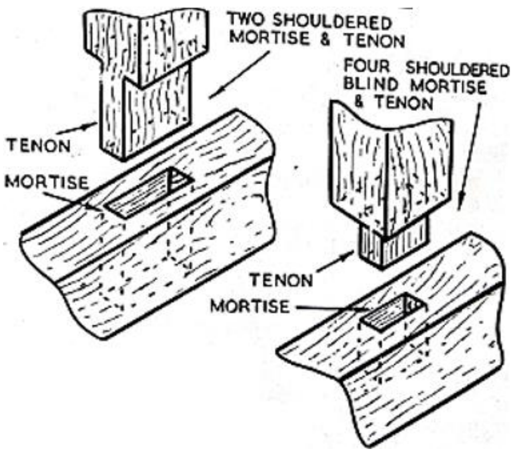


Fig. 3.5: Mortise and tenon joint

The tenon is generally made the thickness of the wood being used. This is not a hard and fast rule. The thickness of the mortise is partly controlled by the width of chisel available.

Several identical joints often have to be made on the same structure. When this is so, they would normally all be marked out at the same time to avoid the re-setting of tools.

When chopping out the mortise there is a tendency for the wood to split, particularly if the joint is near the end. This may be prevented by tightening a G cramp on the wood round the joint. When joints are to be chopped in several pieces of wood they may all be cramped together in this way. When chopping a mortise, the wood should be fixed on top of the bench and held either with a holdfast or a G cramp. The wood tends to slip if held in the vice.

The drawing on the left opposite shows a simple two-shouldered mortise and tenon joint. The tenon is made to go right through the wood. The drawing on the right shows a four-shouldered mortise and tenon joint that is 'blind', that is to say, it does not go right through.

Other types of mortise and tenon joints are shown in figure 3.6 and 3.7 below:

A. Stub mortise and tenon. Doorframes, etc. Haunch can be added.
B. Mortise and tenon for rebated frame. Note long and short shoulders. Haunch can be added.
C. Mortise and tenon for grooved framework. Haunch fills in end of groove.
D. Mortise and tenon for rebated and moulded frame. Haunch is optional.
E. Bare-faced mortise and tenon. Tenon is full thickness of rail.
F. Through mortise and tenon. Tenon is wedged at outside.

G. Double mortise and tenon. For wide rails.
H. Mortise and tenon for casement window also for sash window.
I. Bare-faced mortise and tenon. Rail is thinner than upright.
J. Through mortise and tenon. A framing joint.
K. Mortise and tenon for leg and rails. Mortises meet in thickness of wood. Note alternative haunches.
L. Twin tenons for drawer rail.
M. Twin tenons (right) for heavy framing.
N. Diminished dovetail housing. For shelvings, etc

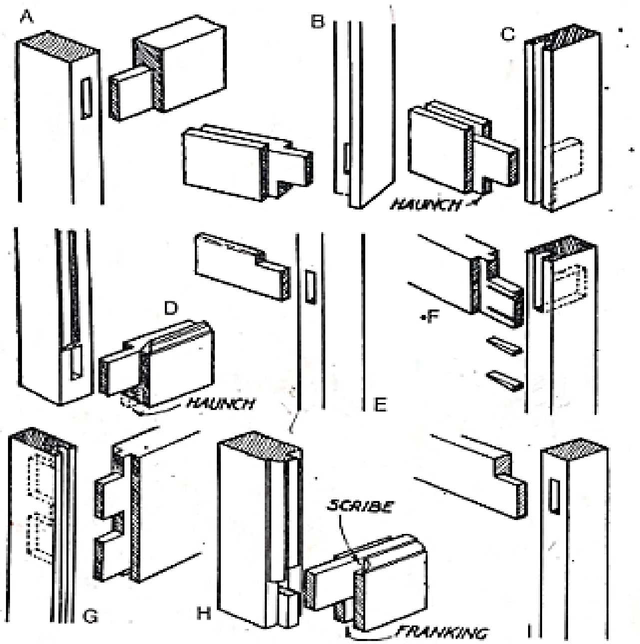


Fig. 3.6: Mortise and tenon joints

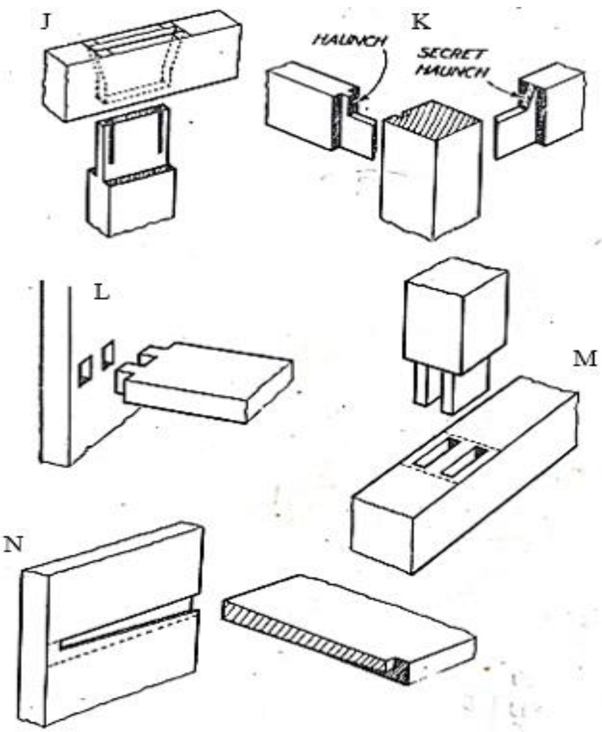


Fig. 3.7: Mortise and tenon joints

More woodworking joints (fig. 3.8)

A. Common housing.
B. Bare-faced dovetail housing. Both used for shelves, partitions, etc. The dovetail is easier to fit if tapered.
C. Simple mitre. Frames, mouldings, etc.
D. Tongued mitre. For strengthening plain mitres.
E. Veneer keyed mitre. Used for veneered boxes, etc.
F. Dowelled mitre. Alternative strengthening for plain mitre.
G. 'Pinning. For carcase partitions, etc.

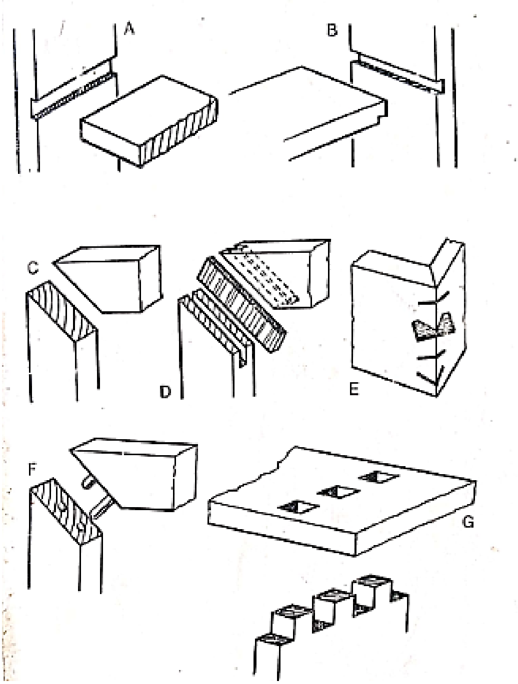


Fig. 3.8: Wood joins

Dovetails: Fig. 3.9 and 3.10 below:

A. Through dovetail. Boxes, carcases, etc.
B. Lapped dovetail. Carcases. Does not show at side.
C. Double lapped dovetail. Shows only end grain of lap.
D. Mitred secret dovetail. Joint entirely hidden.

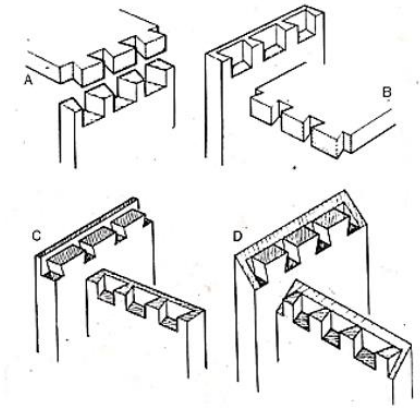


Fig. 3.9: Dovetails

E. Lapped dovetail for carcase. Rail has fly-piece and is cut around leg and end.

F. Lapped dovetail for carcase. Narrow dovetails prevent corners from curling.

G. Drawer dovetails. Also method of finding slope for dovetails. Some workers prefer dovetails with less slope.

H. Oblique dovetails. For general carcasing, special drawers, etc.

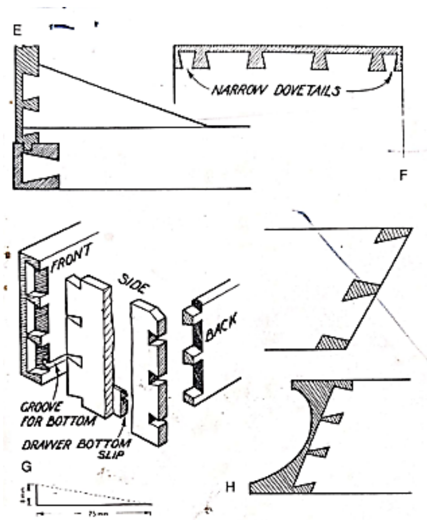


Fig. 3.10: Dovetail joints

Scarf for jointing timber in length. Resists both tension and compression. Extra tenons (dotted lines) help to resist side strain (fig. 3.11).

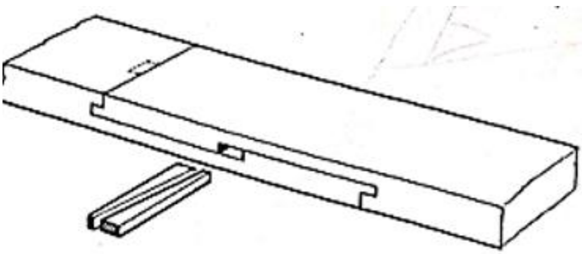


Fig. 3.11: Scarp joint

Joint working

Methods of working

Butt joints

The diagram above shows two ways of nailing, a Straight nailing — nail driven along the grain fibres, has no positive hold.

b Dovetail nailing — nail driven through the grain fibres forcing them to grip firmly. The alternate slopes of the nails dovetail fashion, increases this grip even more.

Nailing close to the end grain can easily cause splitting. This can be stopped by tapping the points of the nails with the hammer to blunt them slightly before driving them into the wood.

Cogged or tongue and grooved joints

An easy joint to make but the short grain in area 'a' can split very easily when the groove is being cut and even more easily when fitting the joint together.

The extra piece of wood called a horn is left on whilst cutting and fitting to stop this. It is cut off after the joint is finally glued, assembled and dried.

Note This same horn device may be used when nailing near end grain as another way of stopping splitting

Having joints (fig. 3.12a and 3.12b)

Set half distances (widths or thickness) by using the trial and error method shown below.

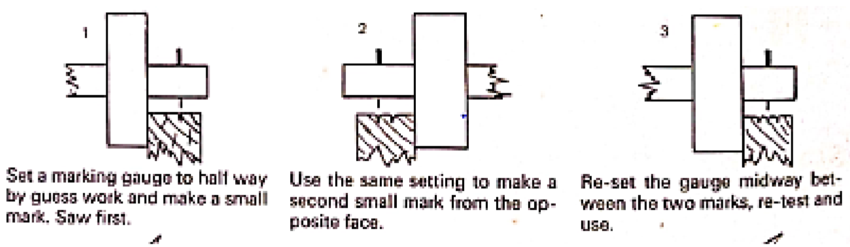


Fig. 3.12a: Marking halving joint

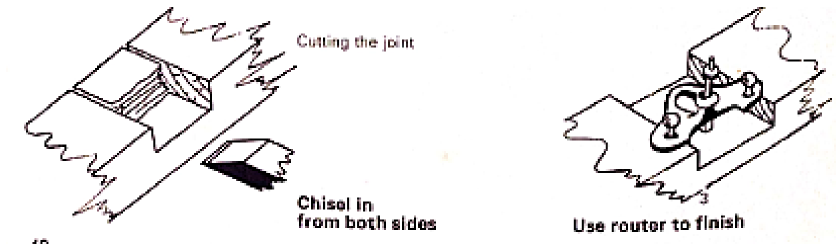


Fig. 3.12b: Cutting halving joint

Housing joints

Through housings

These are cut in the same way as halving joints

Stopped housings

Cut these in three stages.

1. Break up the waste wood at the stopped end with a wide chisel and lift it out to form a stub mortise hole as deep as the housing.
2. Using a wooden guide G cramped into the correct pos¬ition, saw into the stub mortise hole.
3. Remove the rest of the waste with a firmer chisel, finishing off to the correct depth with a router.

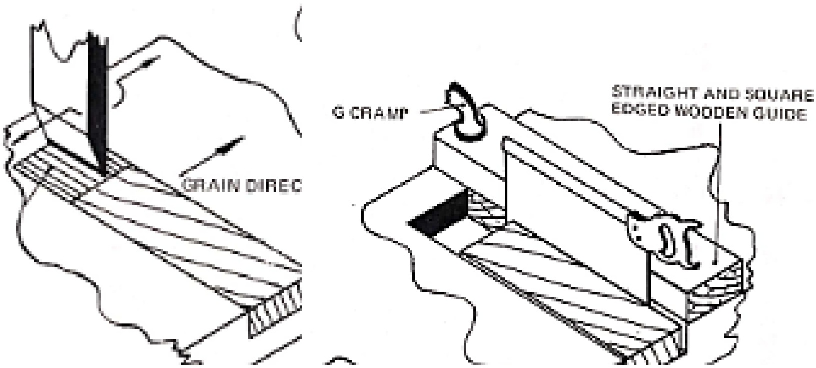


Fig. 3.13: Cutting housing joint

Another method

The waste in the stopped housing can be taken out by boring to depth with a Forstner bit and a brace, then finishing as before with firmer chisel and router.

Stopped dovetail housings

To make sure that the dovetailed end and the dovetail housing match exactly, make and use the shaped guides shown in the diagrams above. Before starting to saw or chisel be sure they are firmly clamped into position.

Mortise and tenon joints

In the mortise (mouth) and tenon (tongue) joint, the thickness of the tenon is usually one third of the thickness of the rail into which it is to be cut. However, this size is really decided by the nearest mortise chisel size to that third (fig. 3.14).

Where haunching is also done, the same one third principle is used.

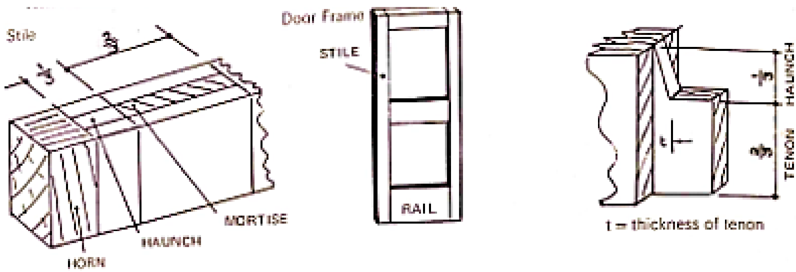


Fig. 3.14: Mortise and tenon joint

Note Setting the distance between the points of the spurs of the mortise gauge must be done with the mortise chisel to be used for cutting the joint (fig. 3.15). Use trial and error method to set the stock. Gauge both tenons and mortises at same time.

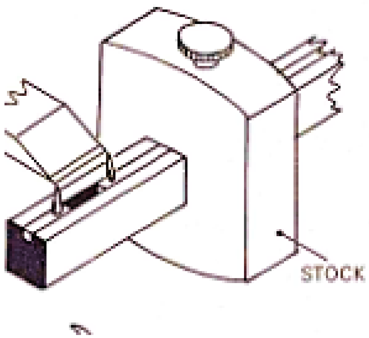


Fig. 3.15: Setting mortise gauge

Cutting a tenon (fig. 3.16)

1. Tighten the wood on the slope in the vice, - end grain pointing away from you. Start the saw by drawing it backwards from heel to toe and cut to the dotted line.
2. Turn the wood around and place upright in the vice, the sawn corner away from you. Saw to the

shoulder line by dropping the heel of the saw.

3 Cut the shoulder lines deep into the wood with a sharp knife and remove a little wood on the waste side to make a ledge to guide the saw. This is called Deepening a line and Nicking- In.

4 With the bench hook held firmly in the vice, cut the shoulders with a tenon saw. Use a dovetail saw if the tenons are small.

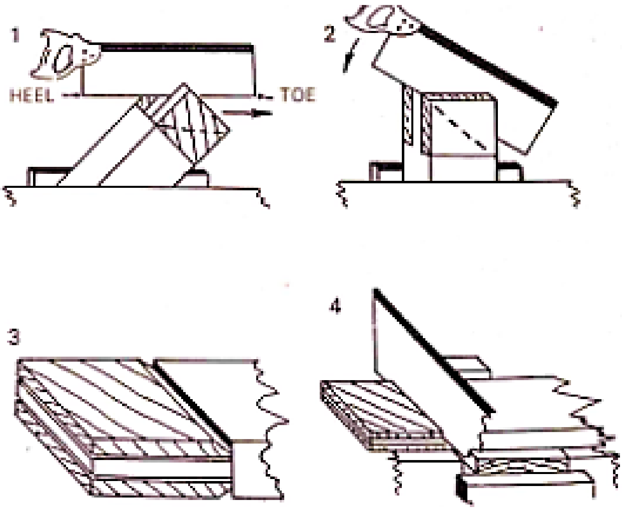


Fig. 3.16: Cutting tenon

Cutting the mortise. Imagine the front third of the stile taken away as the diagram shows. The through mortise is cut in three stages and from both edges (fig. 3.17).

1 Break up the waste wood by working outwards from the middle, towards each end in turn. Finish about 3mm short of the shoulder lines a a.

2 Cramp the stile to the bench. Use the mortise chisel

as a lever. Prise out the chopped-up waste wood.

3 When the mortise is through, clean back to the shoulder lines.

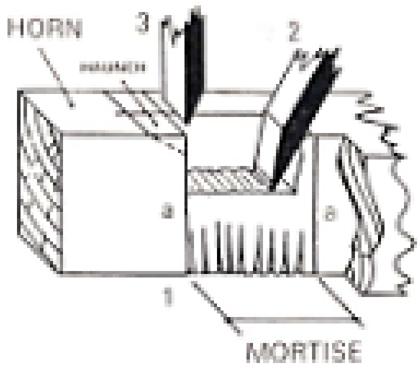


Fig. 3.17: Cutting mortise

Dovetail joints

The correct slope for cutting dovetails varies from:

1 in 6 where the strength of the joint is important to 1 in 8 where good holding with a good decorative quality is also needed.

Cutting the tails

1 Set slightly sideways into the vice to be able to saw vertically. Turn to cut other slopes.

2 Saw just off each line on the waste wood side, yet close en¬ough to just rub against it. Cut the shoulder lines with a sharp knife. Remove waste with bevel- edged chisel. Work off the line to remove the bulk then take a finishing cut on the shoulder line.

Cutting the pins Place the tails exactly where they are going to fit.

Check that the shoulder lines meet properly, that the face marks are in the right place and the joint markings are the same.

Now use a fine pointed awl to mark out the pins around them. Shade the waste wood part.

Cut the pins in the same way as for the tails.

The door

Framed style (fig. 3.18 and 3.19)

The construction of the frame in these doors is decided by the type of panels they use. There are two types of panel.

1. Permanent unbreakable, grooved into the frame and built in when the door is glued and assembled. Once again the panel is not glued in as it must be able to 'breathe'. The frame is square haunch mortise and tenoned at the corners.
2. Semi-permanent breakable, rebated frame and fitted after the door has been put together. The panel is fastened in with thin wooden strips called fillets which are screwed into place. They can be taken out easily if the panel should get broken. The frame joints are long- and short-shouldered mortise and tenons.

Note permanent panels may be:

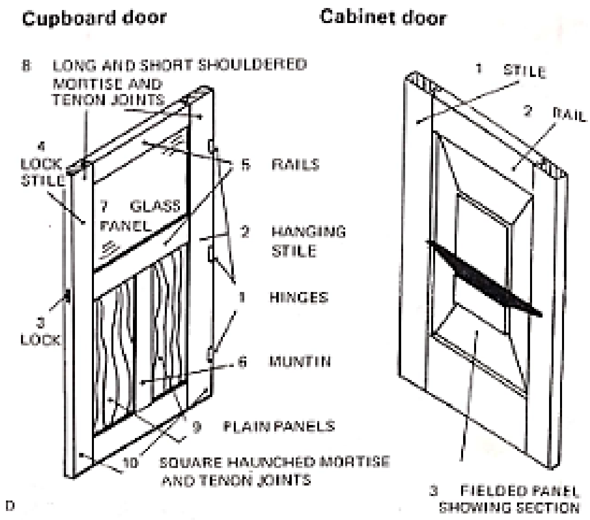


Fig. 3.18: Framed style

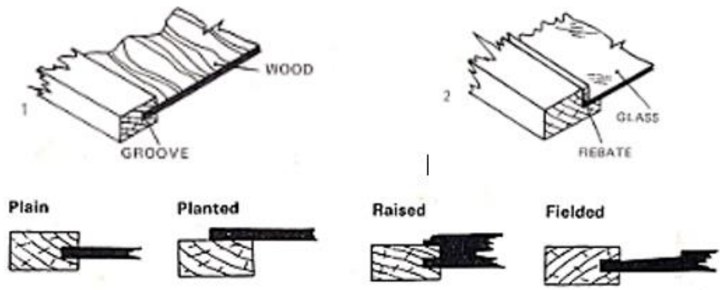


Fig. 3.19: Method of construction

These are flat wooden frames of softwood, jointed or dowelled at the corners. Each side is covered with a planted panel. The door edges are finished with mitred fillets.

Large doors will need to have their planted panels supported on the inside (fig. 3.20). These inside pieces are housed into the frame and cross halved over each other.

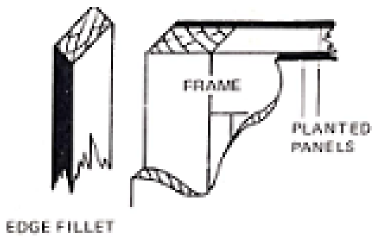


Fig. 3.20: Planted panel

The drawer

Traditional type (fig. 3.21)

The front corners are lap dovetailed together. The back corners are through dovetailed to each other.

The bottom fits into grooves ploughed into the inside of the front and two sides. It is run into position from behind and below the bottom of the back. Then it is screwed up into that edge.

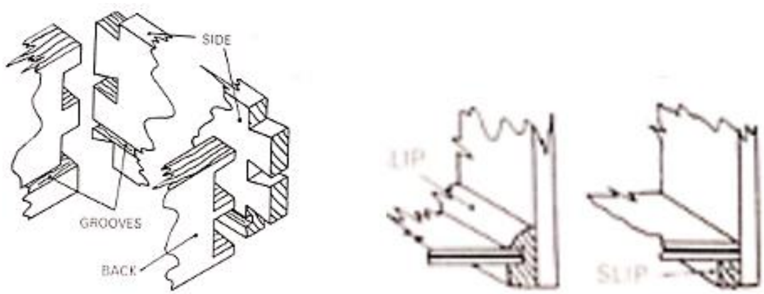


Fig. 3.21: Traditional drawer construction

Sometimes the sides of the drawers cannot be grooved because they are too thin in this case drawer slips are fitted (see diagrams above) Drawer slips stiffen the drawer sides and also increase their running areas.

Fitting a Drawer to get a drawer to move with a smooth and easy glide is not easy Each drawer must Ire fitted separately and with great cate Several faces must fit and work smoothly against each other:

1 The lower drawer rail and the runner against the under edges of the drawer

2 The faces of the guides against the outsides of the drawer, stopping any sideways movement.

3 The upper drawer rail and the kicker against the top edges of the drawer The kicker stops the front of the drawer dropping as it is opened and so falling right out of the table or cabinet.

Both these types run on hardwood slip rails screwed to the cabinet carcase or under the table top.

Modern types (fig. 3.22)

Types run on hardwood slip rails screwed to the cabinet carcase or under the table top.

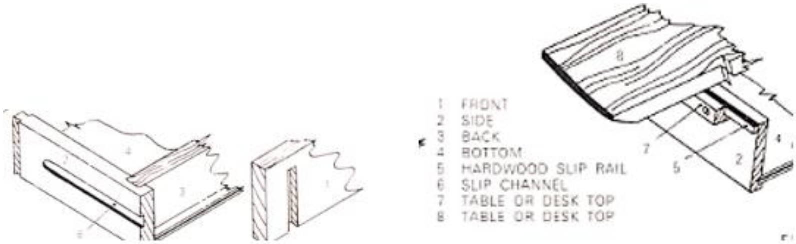


Fig. 3.22: Modern drawer runners

The plinth (fig. 3.23)

A plinth is used to lift the bottom of a cabinet above the floor so that its corners will not get damaged. Also to give more clearance for drawers and the swing of doors.

Plinths which are outset give the best corner protection. Inset plinths make it more easy to stand close against the unit e.g. a desk or a kitchen unit.

It is a simple squared structure. The front corners AA, can be jointed with secret mitred dovetails, for the best work, through dovetails, rebate and butt, or plain well-cut mitres. The last two kinds of corner joints should be stiffened by glue-blocks.

The same kinds of joints including lap dovetails can also be used for the rear corners BB. If the back rail is set forward a little way, it can then be housed into position. This is much simpler and a method used quite often, (note position CC above).

A large plinth for a large cabinet may need a tie rail DD. This would be dovetail housed into both front and back rails.

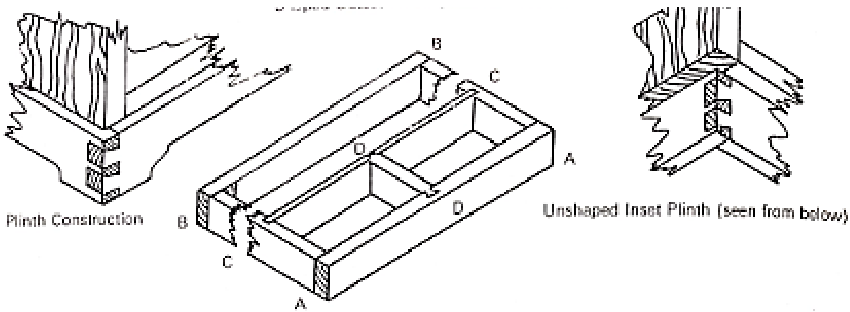


Fig. 3.23: Plinth

Attaching tops to tables and stools and plinths to carcases (fig. 3.24)

Fitting wide cabinet bases to plinths and fitting solid stool and table tops to their frames have to face the same problem. The problem is that the fixing must be firm but not rigid. All wooden boards, especially wide ones are liable to 'move'. If they cannot do so because they are held tightly to a base frame they will certainly split. Diagram **'a'** below shows a firm but flexible kind of fixing called Buttoning whilst **'b'** shows another called Plate Fixing.

Tops made of manufactured boards are not affected by 'movement' these can be fastened by Pocket Screwing **'c'** or Counter boring **'d'**.

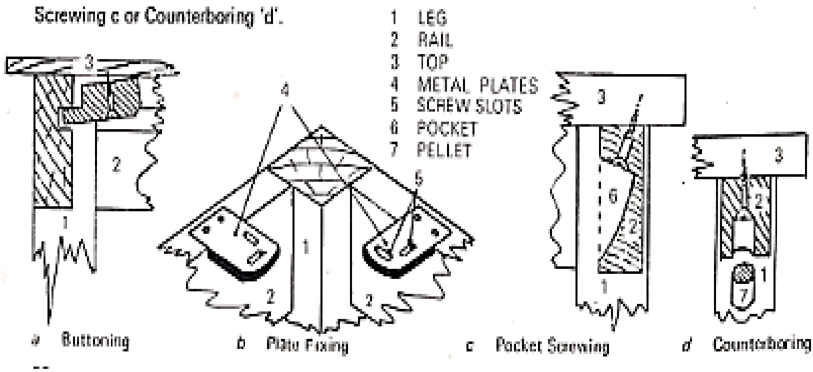


Fig. 3.24: Attaching tops to tables, stools and plinths

Floor boards (fig. 3.25)

Floor boards vary in width from 100 mm. upwards, 150 mm. being a common size. Thickness, unplaned, except for cheap work, is 25 mm. Boards may be plain-edged (termed P E), rebated (R.), or rebated and beaded (R.B.). There is also a special rebated section for secret nailing (see X). The nails holding one board are driven in a slant as indicated, the tongue of the next board covering the head. For superior hardwood flooring the section shown at Z is sometimes used. Boards are also grooved.

Matchboarding also varies in width and thickness from 75 mm. by 16 mm. upwards. Different sections include tongued-and-grooved (T.G.); tongued, grooved, and beaded (T.G.B., the bead being on one or on both sides); tongued, grooved, and V-jointed (T.G.V.J.).

Weatherboarding also varies in width, thickness, and section. The types shown are plain weatherboards (W.B.), rebated (R.W.B.), plain feather-edged (a, Fig. 2), shiplap (b), logsiding (c), planed and moulded (d).

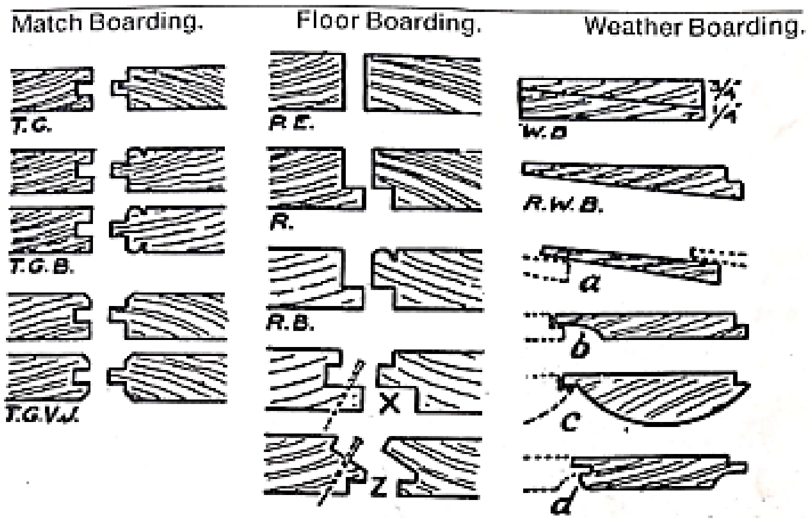


Fig. 3.25: Floor boards

There is also a wide variety of special machined sections for window sashes, door frames, mouldings, and so on.

Chapter Four

ASSEMBLING, GLUING, FINISH AND FINISHING

Assembling, gluing and finishing

Plan and prepare this part of the work very carefully.

Planning

Think out the best order in which to put the pieces together before starting to glue. In cases like the stool it is often better to glue only parts of the job together at first. In this way it is easier to control squareness and wind. The parts can be put together later to assemble the complete model.

Preparation

Have all the tools and equipment needed laid out before starting to glue. The cramps, set to size, the softwood cramping pieces, hammer, screwdriver, try-square, squaring rod etc. Immediately afterwards wipe away all the glue squeezed out of the joints before it sets.

The final cleaning up of the outside of the work with smoothing plane, glasspaper and soft cloth.

Glues

Animal glue Made from the skins and bones of animals. Can be got in the form of cakes, pearls or grains. Has great strength. It has a long shelf life. Is ideal for veneering. Is used hot and needs 12 hours to harden. It does not stain the wood.

Fish glue Is good for small jobs especially repairs and piano repairs.

Casein glue Made from the protein of milk. It stains some woods. Mix in glass or earthenware but never metal container. Cramps must be used for it is not naturally sticky. Leave 24 hours before cleaning.

Synthetic glues

Polyvinyl acetate (PVA) An excellent glue. Ready mixed. It has a long shelf life. Has great strength. Does not stain the wood.

Urea formaldehyde. A two-part glue obtainable in two forms.

1 A syrup + a liquid hardener.

2 A powder (to make into a syrup by mixing with water) + a liquid hardener. The hardeners have different setting times. Fast-5mins, medium -10mins, slow-15mins. The syrup is put on one piece, the hardener on the other. No setting takes place until the two pieces are put together. Pieces cannot be separated.

Finishes

Staining

This is done to show up the grain and figure of the wood, to colour it, or match it to other furniture. There are three types of stain.

Water stain

Easy to make and use but the water in the stain will raise the grain of the wood. First apply clear, cold water to the job and let it dry. Rub down the raised grain with fine glasspaper and dust off. Do this about three times until the water does not raise the grain again. Now use the water stain.

Oil stain

The easiest way to use but takes longer to dry. It can 'deaden' the natural beauty of the grain.

Spirit stain

Can be difficult to spread evenly as it dries so fast. It must be applied quickly. Spirit stains in cream form are far easier to use because speed is not so important.

Polishing

This is done to resist heat, light, scratching and the spilling of liquids. It can give either a matt, satin or gloss finish to the surface. The quality of this finish depends entirely upon the quality of the surface upon which it is put. The final cleaning of the work is, therefore, most important. Some open-grained timbers like Opepe and Edinam need to have their grains filled. If these woods are to be stained also, the stain to be used must be added to the filler before it is applied. Work the filler across the grain and wipe off along the grain.

Note Follow the maker's instructions at all times when using stains and polishes.

French polish or shellac varnish

This is shellac dissolved in methylated spirits. It is put on thinly with a fine, squirrel hair mop. After 24 hours drying it is very, very, very lightly rubbed down and dusted and the process repeated. This goes on until a sufficient thickness of polish is laid. 'Spiriting off' with a rubber will bring it to a high gloss finish.

Cellulose finish

(Lacquer), must be applied quickly and evenly by brush, then left to dry and harden, and rubbed down lightly with 000 grade wire wool. Build up the lacquer by repeating this and then a final burnishing will leave a matt to satin finish. Burnishing cream will make this into a high gloss finish if needed.

Acid-hardened catalyzed lacquer

Use an air-tight glass jar to mix the resin and the hardener quickly and well. Keep to the maker's proportions exactly. Put on three or four coats. Rub each one down carefully with 'wet and dry' paper before putting on the next one. Burnish for a high gloss finish or use steel wool and wax for a matt or satin finish.

Oil finish

Can be used on all timbers but is specially good on teak. It shows up the grain and protects against weather. It must be re-done each year. It is not proof against the spilling of liquids.

Paints

Paints are an excellent finish and protection for both internal and external woodwork. Colours and colour combinations are endless. They also finish matt, satin or gloss. Any knots must be coated with knotting to stop them weeping. Put a primer on first, follow with two coats of undercoat and then the final gloss. Recently these oil-based paints have been improved and now contain polyurethane or silthane and these are harder wearing.

Varnishes

The old type oil-based and copal varnishes are still in common use. Newer polyurethane-based types are slowly taking their place. They are best applied in thin coats, rubbed down lightly after each one except the last.

Finishing (fig. 4.1)

Almost every woodwork job requires a finish of some kind to protect the surface from dirt, stains and moisture. Finishes seal the grain, reducing the likelihood of warping. Finishes enhance the appearance of a job by bringing out the full 'figure' (grain pattern) and colour of the wood. Every job and each wood has a finish most suitable for it.

Creosote is made of coal tar and is ideal for garden fences and similar jobs. It prevents rotting, and is cheap and easy to apply with a brush. For a teak garden seat raw linseed oil, or one of the specially formulated oils with synthetic resins, is best. In the damp steamy atmosphere of the bathroom, paint is best for cabinets and stools of softwood. Painting looks easy but each step - priming, filling, undercoating and final top coating - must be carried out with great care. Enamels give a bright and durable finish to children's toys.

A tea tray of hardwood needs a hard, heat resistant finish. Catalysed lacquers are specially made for this kind of work. The lacquer is bought in a two-part pack, lacquer and acid-based hardener. The two are mixed before use and brushed on. Usually fast drying, after rubbing down more coats can be added. Wax polish produces a fine sheen on all furniture. The wood is first sealed with a brush polish (a mixture of shellac and methylated spirits). After several coats, rubbing down between each, wax polishes are applied. Silicone waxes make the surface fairly resistant to water spills.

Varnish is oil-based and ideal for canoes and boats of marine plywood. A recently developed finish for the same type of work is polyurethane based.

Sometimes no finish is used at all for hygienic reasons. Wooden spoons, chopping boards and rolling pins of beech or teak are good examples.

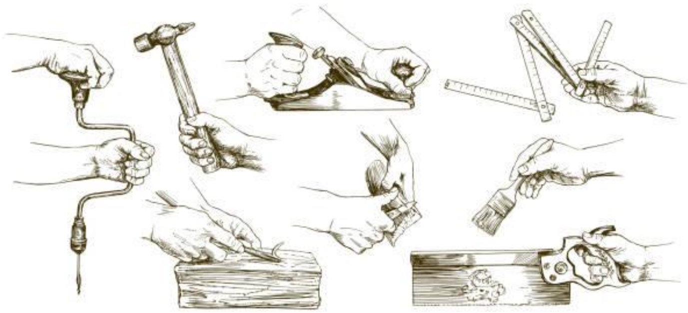


Fig. 4.1: Finishing

Wax polishes

There are man- excellent proprietary wax polishes but for those who prefer to make their own the following are given. Note that in all cases time should be allowed after application for the turps to evaporate as no shine can be built up until this has occurred.

When waxing over oil stain, fix the latter first with one or two rubbers of French polish or use sealer. Otherwise the stain may be lifted in patches.

Light polish. Shred bleached beeswax. Dissolve in turpentine (best American) to form thin paste (like butter in summer-time).

Normal polish. Substitute unbleached beeswax in the above.

Brown polish. Shred unbleached beeswax. Dissolve in turpentine, making thin paste. Add raw or burnt umber powder, and stir thoroughly.

Antique (black) polish. Shred unbleached beeswax. Dissolve in turpentine, forming thin paste. Add lamp black powder and stir thoroughly.

The dissolving of the wax in any of the above recipes can be speeded by warming the mixture in a jar of hot water. Keep it away from a naked flame.

Any of the polishes above can be hardened by the addition of carnauba wax. The proportion could be one carnauba wax to three or four beeswax.

Another way of hardening polish is to add a small amount of powdered rosin dissolved with the wax.

Petrol (as used in lighters) is sometimes added to wax polish to speed up evaporation.

Stains, etc.

Although ready-made stains are widely used nowadays owing to their reliability and to the wide range available, the following still hold their own, partly because they are in wet gives a good gloss. Hold the lump wax against the revolving wood and move slowly across the work. Make a hard cloth rubber by tying a knot in fluflles cloth, press against the work, and more slowly along to spread wax evenly and burnish.

French polish. A special lathe polish can be obtained. It is thicker than normal polish and is applied with the lathe running at slow*speed. It requires knack, as there is otherwise tendency to pull off polish and to form ribs. Two or three applications are needed Finish with saliva from the mouth applied with a rag.

Varnish. This should be brush applied with the wood stationary. Use a rubbing variety and when thoroughly hard burnish with a motor-car polish applied with a rag, the work revolving at slowest speed.

Strippers

Proprietary strippers are generally used: The type should be selected according to the finish to be removed. A caustic type should be avoided when it is essential that the wood is not darkened.

Home strippers are:

1. Dissolve caustic potash in water and apply with rag on stick or a grass-hair brush. Leave surface coated. Scrape off old polish or paint, and wash down with clean water. Wipe over with vinegar. This stripper is inclined to darken oak, mahogany, and other hardwoods.
2. 0-880 ammonia will strip old polish and varnish. Use scraper. Scrubbing brush is useful for carving. Wash down afterwards. Ammonia darkens most hardwoods, however. Avoid contact with the fingers as it is painful.

3. Household soda dissolved in hot water and used strong. Wash down afterwards. This will remove French polish. It has a slight darkening tendency.

4. Methylated spirits will soften French polish after a while, enabling it to be scraped off, but it takes a long time on very hard polish.

1 5. ½ lb. rock ammonia. 1 lb. washing soda,
a. ½ lb. crude soft soap. 1-gallon hot water.

Leave to soak then scrape off. A scrubbing brush fed with pumice powder is sometimes useful. Wash down afterwards.

All traces of caustic or alkaline strippers must be removed as they may attack finishes subsequently applied.

Wood fillers

Most polish manufacturers supply fillers to suit their products. It is essential to use a filler compatible with the particular finish.

Other fillers are:

Plaster. Plaster of Paris damped with water is rubbed into the grain. It is coloured with Vandyke brown powder when used for dark oak or walnut, and with red ochre for monogamy. To apply dip a damp rag into the plaster and rub across the grain, wiping off the surplus. When thoroughly dry wipe over with raw linseed oil. This will kill the whiteness and enable any filler left on the surface to be wiped off in the form of a thick scum. Give two coats of French polish and allow to dry before applying filler.

Paste filler. To 1 lb. of crushed whiting add powder colour to take off the whiteness, red ochre for mahogany, and

Vandyke brown for walnut and dark oak. Add turpentine to bring to a paste. Add 1 tablespoonful of gold size as a binder.

Another recipe is:

1 quart boiled linseed oil, 1-pint gold size or brown japan, 1 gill turpentine.

Mix together and add china clay or silex, little at a time, to form a stiff paste. Allow to stand twenty-four hours and thin with turpentine as required. It will not keep for much over a week.

Polish revivers

1. 1-part linseed oil.

   1-part vinegar.

   1 part methylated spirits.

2. Dissolve 1 oz. camphor in ½ pint methylated spirits. Add 5 pint vinegar, 1 oz. linseed oil, 5 oz. butter of antimony.

3. 4 parts linseed oil.

   1 part terebine.

   12 parts vinegar.

Abrasives (fig. 4.2)

After using a smoothing plane but before applying a finish, abrasives are used to finally smooth the surface of the wood. Confusion is often caused because this is frequently called 'sanding' and the abrasive is referred to as 'sandpaper, the reason being that the early abrasives were made from sand glued to paper. Today the most common abrasives are glass papers. Crushed bottle glass is sieved to produce various grits to make papers in a range of coarseness. The grade is printed on the back of each sheet either in the English system (00, 0, 1, 1 ½, F2 etc.), the European system (220, 150,120, 100, 80 etc.) or both.

Abrasives of garnet, aluminium oxide, silicon carbide and tungsten carbide, in 'open' or 'close' coatings on a variety of backings - paper, cloth, fibre and metal - are available. Special discs and belts for power tools are produced.

When working on large flat surfaces, wrap the abrasive tightly round a cork block. This increases the area rubbed and ensures flatness. On complicated parts it is sometimes necessary to make up a specially shaped block. Rubbing strokes should always be along the grain. Never use a scrubbing action as this covers the surface with unsightly scratches. Excessive use of abrasives can spoil a piece of work. If edges are rounded off, the crisp appearance of the work will be lost. If joints are rubbed-down, they will become ill fitting.

Abrasives are often used to cut back polished or painted surfaces in between coats; special wet and dry papers can be used for this purpose. In the final stages of brush polishing in preparation for a wax finish, steel wool can be used as an abrasive. This has an advantage over papers in that it does not clog.

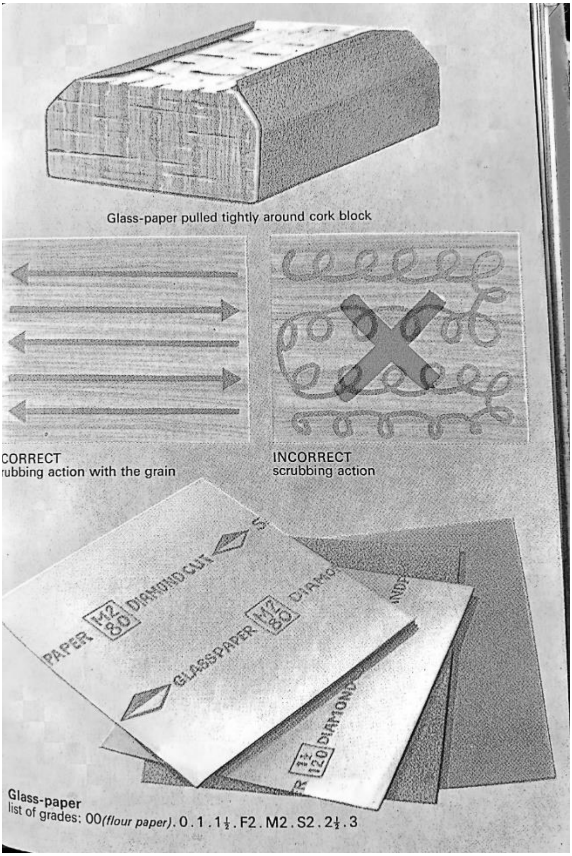


Fig. 4.2: Abrasive and method of application

Abrasive papers and cloths (fig.4.3)

There are many kinds and grades of abrasives used in various trades, and below are given those chiefly in use. It should be realised that the grading systems vary according to the abrasive, and, in order that a quick comparison can be made, we give in Chart A the comparative grades. Thus, taking No. 1 ½ glasspaper, the equivalent grade in garnet is 2/0, and 100 in aluminium oxide. We are indebted to English

Abrasives Ltd., for much of the information contained on this and the following pages.

Glasspaper. Used chiefly for the hand smoothing of wood. Abrasive grains are of crushed glass. Supplied in sheets 11 in. by 9 in.

Grades: 2/0 or Flour, 0, 1, 1 ½, F2, M2, S2, 2 ½, 3.

As general guide use M2 for preliminary smoothing followed by No. 1 or 1 ½ . For delicate woods use No. 0, and when rotary movement is needed on fine woods (as in burr walnut) use Flourto finish.

Made in close coat only. *

Glass cloth. This is preferred in some trades. Grades are as in glasspaper, and size of sheets is 11 in. by 9 in.

Made in close coat only. *

Garnet paper. Used for both hand and machine sanding. Supplied in sheets 11 in. by 9 in., and in rolls, belts, discs. The abrasive grains are the natural crushed garnet stone. Grades (in sheets): 8/0, 7/0, 6/0, 5/0, 4/0, 3/0, 2/0, 0, ½, 1, 1 ½, 2.

Grades (in rolls): 5/0, 4/0, 3/0, 2/0, 0, ½, 1, 1 ½, 2, 2 ½, 3, 3 ½.

As a comparison 2 is of same coarseness as 1 ½ glasspaper.

Made in both open and close coat. *

Aluminium oxide paper. Used chiefly for machine sanding, but can also be obtained in sheets size 11 in. by 9 in. for hand work. The grit is very hard. Aluminium oxide (derived from bauxite) is the abrasive used.

Grades: 9/0, 8/0, 7/0, 6/0, 5/0, 4/0, 3/0, 2/0, 0, ½, 1, 1 ½, 2, 2 ½, 3.

Made in both open and close coat. *

2/0 aluminium oxide corresponds with 1 ½ glasspaper.

Aluminium oxide cloth. Made only in rolls and discs for machine work.

Grades: 400 (very fine) up to 24.

Made in both open and close coat. *

Flint paper. This has only a limited use in woodwork. Flint is a natural product and is not so hard as garnet, aluminium oxide, or glass. One or two woodworking trades use it, but generally it is used more in other industries. Flint paper is made in sheets 11 in. by 9 in. Grades: 150 up to 3-24 coarse.

As a comparison 100 Flint corresponds with Tl glasspaper.

Made in close coat only. *

Silicon carbide paper. This is seldom used for machine sanding except sometimes in floor surfacing. But chief users are the leather and metal-working industries. It is made in sheets 11 in. by 9 in. and in rolls and discs. The grit is exceptionally hard and durable.

Silicon carbide cloth. Made in sheets 11 in. by 9 in. and in rolls, close coat only. Grades (in sheets and rolls): 320, 280, 240, 220,180,150,120,100, 80, 60, 50, 40, 36, 30, 24.

Chart A.—Comparative grades of abrasive papers and cloth

Glass-paper Glass cloth	Garnet Aluminium oxide (woodworking)	Flint paper sheets	Aluminium oxide Silicon carbide (metal-working)	Emery cloth
			400	
	9/0		320	
	8/0		280	
	7/0		240	
	6/0			
00 or Flour			220	0
0	5/0			
1	3/0	120	180	
1½	2/0	100	120	F
F2			100	
M2				1½
–	–	–	60	2
S2			–	
2½	1½	1½		2½
3	2	2	40	3
–	2½	2½	36	½
–	3	3	30	4
			24	4½

Fig. 4.3: Abrasive paper grades

Waterproof silicon carbide sheets. In sheets 11 in. by 9 in.

Grades: 400, 320, 280, 240, 220, 180, 150, 120,100, 80, 60.

The grades of these waterproof papers are the same as the corresponding gluebond

*Open and close coat. These terms refer to the spacing of grains on the paper. In the 'open' there are spaces between the grains, making the paper less liable to choke. It is therefore used more on softwoods and resinous woods and surfaces liable to cause choking. In the "close" the grains are close together, making them suitable for hardwoods.

Chapter Five

UPHOLSTERY

Upholstery Materials

Coil springs. Majority are copper-covered steel wire, but are sometimes black japanned or galvanised. Sizes range from 100 mm. to 250 mm. and in gauges 8 to 13. The lower the gauge number the stouter the wire.

Tension springs. Made in 12 mm. diameter (for seats) and 9 mm. diameter for backs. They are fixed at a tension of 40-50 mm on a 450 mm length. Made in several lengths.

Foamed latex rubber. This has largely replaced traditional stuffings and spring interiors.

It is made in a wide variety of sizes and specially moulded shapes; also in sheets which can be cut to size. In addition, there are chemical foams of the polyether and polyester groups. These are slower in regaining shape but are cheaper than foamed latex.

Spring units. Single, double, and triple spring units were originally made in various sizes and shapes.

Pocketed interiors. Used for cushion interiors. The coil springs are enclosed in calico or hessian. Both these and spring units have largely been replaced by chemical foams and latex rubber.

Webbing. Best grade is black and white twill weave of flax. Second qualities are mixtures of jute and cotton, or hemp. Cheaper grades are brown and are of jute. Usual width is 50 mm., but certain types are also available 53 mm. and 56 mm. The black and white grades are usually in 18 yard rolls and the brown jute qualities are put up in 33 m. pieces. Quality of the jute webbing is governed by weight: 10-11-12 or more lb. to the gross yardage.

Rubber webbing. This is highly resilient and has largely replaced twill. It is made in widths of 56 mm., 50 mm., 38 mm., and 19 mm. It is fixed either with tacks or special clips.

Hessian. Made in many weights and widths. Usual upholstery width is 1-82m. Best quality is known as tarpaulin and is used mostly for covering over springs. Scrim is a more open type of hessian and the threads are rounded in section. It is used mostly for covering the first stuffing.

Stuffings. Horsehair is the most satisfactory of traditional stuffings. It is in various grades, the cheaper kinds consisting of short hair, or a mixture of horsehair and hog hair. Of the 34 vegetable fibres coco fibre (brown in colour) is used for first stuffing, but has a tendency to become brittle and break up in time. Algerian fibre is either black or green, and of the two the former is more satisfactory. Both hair and the fibres can be obtained woven on to hessian to form stuffing pads. Latex rubber has largely replaced traditional stuffings.

Other stuffings include linsey wool (black wool) manufactured from rags, rugging which is similar but is made from jute rags and has not so much resiliency, and cotton flock which is a waste product from cotton.

Cotton waste or linters, felted together to form a type of wadding, and wadding, either sheet or pound, are used over hair or fibre stuffings before covering.

For cushions and bedding both feathers and kapok are used. The latter is a vegetable down from Java and the Dutch East Indies.

Twines. For sewing to webbing a fairly thick hemp twine is needed, but for stitching rolls and edges, running through, etc., a finer but equally strong twine is needed, known as stitching twine. Both kinds are usually put up in i lb. balls. For lashing the tops of springs together laid cord is used. The quality in all cases may vary in both materials and manufacture. A cheap twine may weigh heavier and so give less yardage to the ball.

Tacks. Sizes of tacks vary from 10 0 mm. to 16 mm. Improved tacks are of stouter build with larger heads, and these are used in 16 mm. size for webbing, and '10-0 mm. and 13 mm. for hessian. Fine tacks in the smaller sizes are used for various covers. Black japanned gimp pins are used for fixing gimps and trimmings, also covers in inconspicuous places such as the outside backs of chairs.

Chapter Six

GLUES

Glues

The following are the chief types. Those marked with an asterisk are used in special industries and are not normally available.

1. Animal - Fish	Casein	Cellulose
2. Resin - Polyvinylacetate		Rubber based
3. Vegetable - Oilseed residue		Blood albumin

Most modern glues are derived from one or other of these sources, and some are formed from combinations of them. Proprietary glues are given in italics under the various headings.

Animal glue

Under this heading is Scotch glue, which is obtained from the skins and bones of animals. It is obtainable in cakes which need to be broken up, though some makers supply it in powdered form, which quickens the preparation and enables the exact consistency to be more accurately judged. In its best form the skins of animals are used, when it is sometimes known as Salisbury glue. Prepared glues ready for immediate use can be obtained in tubes and tins which, according to grade, are applied hot or cold.

Croid Aero, Croid Universal, Fortil, Adams, Cox's, Calbar.

When properly used Scotch glue is extremely strong and in normal circumstances is durable. Furthermore, it is not liable to stain wood. As against this it is neither heat nor water proof, and it must be used hot. This last point means that arrangements have to be made to prevent the glue from chilling when it is applied to the wood. Cold application glue needs no heat except in Winter time when slight warming is necessary.

To make Scotch glue, break up the cakes and steep in water. Heat in a proper glue-pot (never with naked flame) and stir until thoroughly mixed. Make hot, but do not boil. Remove any scum from surface and test consistency by raising brush a few inches above pot. It should flow down freely without lumpiness yet without breaking up into drops. Heat the work to be glued. For light woods add zinc white powder to the glue to prevent a dark glue line from showing.

Fish glue. In its best form this is made from isinglass, which is extracted from the bladder of the sturgeon. In lower quality glues the heads, skins, and cartilage of fish are used. It is handy for small jobs, but not for large woodwork because of its high cost. It has a somewhat objectionable smell. Usually sold in tubes. Its water resistance varies according to make.

Seccotine, Lepage's Liquid.

Casein glue. Skimmed milk is the basis of this glue. It is precipitated by the addition of a weak acid, and is marketed in the form of light-coloured powder. There are many proprietary forms of the glue and most of them are put up in small quantities so that it is suitable for home use. Casein is extremely strong and has the great advantage of being used cold (though hot-setting caseins are available). It is considerably more water-resistant than animal glue. A disadvantage is its liability to stain hardwoods, such as oak, mahogany, and other woods containing acid. Non-stavning glues are available, but not all these are free from the trouble, and they are less water-resistant. One point to note is that joints must be cramped. They cannot be rubbed, since the glue is not sticky.

Casco, Croid Insol, Certus.

Cellulose-based glue. Put up in tubes and used for fixing plastics, metal inlay, ivory, etc., to wood. It is highly water-resistant and is free from staining. It is used cold.

Durofix.

Synthetic resin glue

This modern development is essentially the product of the chemist, and it has most of the advantages of other glues and is free from many of the snags. A drawback from the point of view of the small user is that some makes are liable to become rubbery if kept unused for more than three or four months, and are then useless.

To make a broad distinction, there are two general classes of glues: phenol-formaldehyde and urea-formaldehyde. Of these, some varieties of the former requires hot pressing in a thermostatically-controlled press. They are thus unsuitable for the small workshop, in which the available cramping apparatus is comparatively primitive. Cold setting phenol-formaldehyde glues are widely used, but are critical in application and are therefore unsuitable also. Urea-formaldehydes, on the other hand, can be obtained for both hot and cold pressing, and it is the latter which will appeal to the small user, since it is used at normal temperature and needs no special apparatus.

These urea glues are put up in various forms, but generally they are in two parts: the glue proper and the hardener. The glue may be in the form of a treacle-like syrup or it may be a powder which requires to be mixed with water. The hardener is a transparent or coloured liquid, and has no adhesive value in itself; it is required purely for the reaction which takes place when it is brought into contact with the glue, causing the latter to solidify, quickly or slowly in accordance with its special type. Thus the glue, if used alone, can remain for a considerable time with little or no change, but when brought into contact with the hardener begins to react, with the result that it sets.

One method—which lends itself well to home workshop use-is the separate application system. The glue is applied to the one joining surface and the hardener to the other. The two are then brought together, when the process of hardening begins straightaway. In some brands the hardener must be still moist at the time of assembly. In other makes it is recommended that the hardener is allowed to dry out first. Sometimes it is permissible to apply both to the one piece. Generally the hardener is put on first. Another alternative with some makes and using a slow hardener is to mix the glue with the hardener and thus apply both together.

To overcome the drawback of the short life of the syrup form of glue, some makes are prepared as a powder which keeps indefinitely if kept sealed. This is mixed with water, when or all practical purposes. It is the same as the syrup. The hardener is the same.

There are generally at least three hardeners to each kind of glue, and the difference between them is in the speed with which they cause the glue to set. Large work with many joints needs a slow hardener, whilst a job which has to be worked on soon is assembled with a quick hardener. For normal work a medium hardener is used. A point to be remembered is that heat speeds the setting. Yet another form of resin glue, also in powder form, has the hardener incorporated. It requires only to be mixed with water to be ready for immediate use.

Cascamite waterproof glue, Aerolite 300, Aerolite 306.

Polyvinyl acetate. A cold-setting resin glue in the form of a white and fairly thick liquid. It is used as it is from the container without a hardener. Many substances can be glued with it: wood, plastics, hardboard, fabrics, tiles, lino, rubber, etc. Joints can be rubbed or cramped, and the glue is free from staining, though glue may turn dark if used on some woods such as oak. The glue will keep for many months but should not be stored in a cold place. Generally the glue is liable to creep, that is, a heavy panel glued vertically may tend to slide slowly downwards.

Uni-bond, Casco P.V.A., Polystik, Lepage's, Bondfast, Redi-bond, Resin Wone-way wet, Timbabond, Croid Fabrex.

Rubber-based adhesives. These are not generally used in ordinary wood assembling — in fact for some jobs they are impracticable. They have their uses for special work, however, and in bonding other materials to wood. In use the adhesive is applied to both surfaces and allowed to dry for 15-20 minutes. The two are then brought into contact when the bond is immediate. It follows then that great care has to be taken to position the work exactly because it is impossible to shift once the two are pressed home. Furniture repairers sometimes use it for items which would be difficult to cramp. By coating the surfaces and allowing to dry it is only necessary to press the two parts together when the bond is immediate. Of necessity it ieaves a glue line because an appreciable glue thickness is bound to be left.

Its chief use, however, is in fixing plastic sheeting to wood frames or chipboard. No cramping is necessary but care has to be taken not to trap air in the middle of the panel, and to position exactly.

Evo Stik, Bostic C, Casco Super Contact, Unistik,

Vegetable glue. This glue is not of direct use to the ordinary woodworker, because it is not normally obtainable, its use being largely restricted to the manufacture of plywood. We include it here as a matter of interest, however. It is made from starch and has been in use from earliest times. It is a cheap glue and has the advantage that it can be used cold; furthermore, it remains in good working condition for a long period. On the other hand it has low water resistance, is slow setting, and is liable to stain certain woods.

Oilseed residue glue. In a sense this comes under the heading of vegetable glues, but it is usually classed separately as it is derived from soya beans, peanuts, or cotton seeds, and has come into use only within recent years. It is more in the nature of a casein glue. Like vegetable glue, it is not used in ordinary woodwork. It is in the manufacture of plywood that it is chiefly employed. Curiously enough it has not proved a success for hardwoods, plies made from Douglas fir and pine being its chief application. As its successful use requires the addition of alkali it is liable to stain hardwoods of an acid nature. An advantage is that it is water-resistant though not waterproof. It is not normally available.

Blood albumin glue. Here again is a glue which is used almost entirely in the plywood manufacturing trade and does not come into normal woodwork. It is derived from animal blood obtained from abattoirs. Used generally in conjunction with casein, it produces a water-resisting glue, but is liable to cause staining in some hardwoods. Heat is necessary in the pressing- stage, this causing the albumin to coagulate, an essential feature of the process. It is not obtainable ready-made.

Properties of glues

	Water resistance	Drying property	Hot or cold working	Micro-organism resistance	Staining liability
*Animal glue	Low	Slow	Hot	Low	Quite free
Fish glue	Low	Slow	Cold	Low	Quite free
Vegetable glue	Low	Slow	Cold	Low	Stains hardwoods
Oil-seed residue glue	Good	Medium	Cold	Low	Stains hardwoods
Blood albumin glue	Good	Rapid	Hot	Low	Stains hardwoods
Casein glue	Good	Medium	Cold (Hot also obtainable)	Medium	Stains hardwoods
Casein glue (non-stain)	Medium	Medium	Cold	Medium	Some brands free
Synthetic resin glue	High	Rapid or slow according to hardener	Hot or cold according to type	Complete	Generally free
Cellulose	High	Rapid	Cold	High	Free
Polyvinyl acetate	Low	Medium to fairly rapid	Cold	High	Free, though glue itself may be liable to darken on some woods
Rubber-based	Good	Rapid	Cold		Free

Fig. 6.1: Properties of glues

'Prepared forms of animal glue give varying degrees of water and heat resistance and w of drying speed according to brand and grade.

Special glues

Brass inlay. Add a little plaster of Paris to freshly-made Scotch glue- or add a table - spoonful of Venice turpentine to a pint of Scotch glue. Keep well stirred when heating. A little garlic added to Scotch glue increases its strength for gluing metal inlays, and helps ^ to keep it fresh. Araldite epoxy glue can be used.

Celluloid and ivory. Coat with paste made from celluloid dissolved in ether. Then use Scotch glue or Araldite epoxy glue.

Tortoiseshell. Use synthetic resin glue if possible. Failing this Salisbury glue is best, scotch glue if used must be made up fresh for the job. Glue which has been repeatedly neated is useless. If a light colour is wanted add flake white to the glue when a warm tone is needed mix, rouge Powder instead. This shows right through the transparent portions. Score the back with a fine file to give the glue a grip. For curved work steam the tortoiseshell to make it bend. Imitation tortoiseshell can be made pliable with acetic acid.

Baize and leather. Wallpaper Paste made UP to double strength. Cut baize ½ in. full all round to allow for shrinkage, and trim after twenty-four hours. Leather can be cut within

Rubber to wood. Use a rubber-based contact adhesive.

Plastics to wood. Use a rubber-based contact adhesive or one of the synthetic resins. Generally the surface of the plastic should be sanded to give a key to the glue.

Gilding materials

Gesso. Used in building up the foundation when water gilding. Also used in lacquer work. Cut up oddments of parchment, cover with water, and leave overnight. Gently simmer for several hours in a container with water jacket (glue-pot fashion). The water must never boil. Allow to chill when a thin jelly will be formed. If too thick the gesso will be brittle; too thin a jelly has no strength. As a test shake the jar (when cold). The jelly should fracture. Heat again and add superfine gilder's whiting until a creamy mixture is formed. A spot of linseed oil or tallow makes the gesso more manageable.

Gold leaf. Obtainable in books of 20 leaves. Two kinds are available: loose leaf and transfer. The former is used in water gilding. Transfer leaf is backed with thin paper and is used in oil gilding.

Gold size. A specially high grade is used for gilding. Two kinds are available: 2-4 hour and 18 hour. When there is time the slower is the more satisfactory. It is painted on with a small brush and allowed to become tacky before the gold leaf is applied.

Gilder's clay. Applied after gesso before the gold leaf is used when water gilding. It is moistened with water and painted on. Various colours such as brown, blue, and yellow are available.

Chapter Seven

IRONMONGERY

Nails

Nails are used as a quick and easy method of joining pieces of wood. Nails alone do not make a very strong joint. Several things can be done to make the joint stronger Glue is often used in conjunction with the nails. In this case the mam function of nails is to hold the wood while the glue sets. For outdoor work where appearance is not of first importance, the nails may ranched' over (see drawing). It is nearly always advisable to 'dovetail' the nails (see drawing). The nails then pull against each other when an attempt is made to separate the two pieces of wood thus joined.

When nailing two pieces of wood of unequal thickness* the nails should be driven through the thin piece into the thick piece.

When using large nails in hardwood, it is often necessary to make a hole first to prevent the wood splitting.

When buying nails three things must be stated, the type o nail; the length of nail; the material or finish of the nail. For example, the nail may be of steel, brass, or galvanized.

There are dozens of different kinds of nails made for special purposes, and their names vary not only with particular trades but also in different localities. Those shown here (fig. 7.1 and 7.2) are generally representative, but there are additional nails made for special purposes. Nails are mostly sold by weight. All the illustrations are in full size so that the relative stoutness of the types can be judged. At the time of going to press it is uncertain whether nails will be altered to exact metric lengths. We have therefore retained Imperial measurements. To find the metric equivalents turn to the conversion tables on page 125.

A. Lost-Head wire nail. Joinery head makes only shall hole, easily punched in. sizes 1 ½ - 4 in. (2-in, shown)
   Finishes: bright mild steel, galvanised.
B. Oval wire nail. Joinery. Not so liable to split grain as round nails.
   Sizes ½ -6 in. (2-in. shown).
   Finishes: Bright mild steel, galvanised.
C. French or wire nail. Carpentry, casemaking, etc.
   Sizes ½ - 6'in. (2-in. shown).
   Finishes: Bright mild steel,galvanised.
D. Cut floor brad. Fixing floorboards. Not liable to split grain.
   Sizes ½ -3 in. (2-in. shown).
   Finish: Black iron.
   Cut joiner's brad. Same shape, but slightly lighter.
   Sizes ½-3 in.
   Finish: Black iron.
E. Cut clasp nail. General-purpose carpentry nail. Grips strongly.
   Sizes ½ -8 in. (2-in. shown).
   Finish: Black iron.

F. Panel pin. Cabinet work, joinery, etc. Fine gauge, small head.

Sizes ½ -2 in. (1 ½ -in. shown).

Finishes: Bright mild steel, brass, coppered.

G. Veneer pin. Veneers, small mouldings, etc.

Sizes ½ - 1 ½ in. (½ -in. shown).

Finish: Bright mild steel.-Finishing pin. Similar, but finer.

Sizes ½ - ½ in.

Finish: Bright mild steel.

H. Cuttack. Upholstery, etc.

Sizes ½ -1 ½ in. (½ -in. shown).

Finishes: Blued or black iron, tinned, galvanised, copper.

Improved tack. As above, but with larger head.

I. Wire clout nail. Roofing felt, chair webbing, canvas, etc.

Sizes ½ -3 in. (1-in. shown).

Finishes: Brig-ht mild steel, galvanised.

Cut clout nail. Sharp point stays in when pressed with fingers.

Sizes ½ -3 in.

Finish: Black iron.

J. wire tack. Upholstery, etc.

Sizes ½-1 in. (|-in. shown).

K. Covered tack or stud. Fixing gimp. .

Sizes ½-½ (½-in. shown).

Finishes: Leather and leather cloth covered.

L. Sprig. Picture backs, lino, etc.

Sizes -½-½ in. (½-in. shown).

Finish: Black iron.

M. Wire lath nail. Laths for plaster work. Fine shank, large head.

Sizes ½-1½ in. (1-in. shown).

Finishes: Galvanised.

Cut lath nail. As above but square section.

Sizes ½-1½- in.

Finish: Black.

N. Brass pin. Fixing fittings.

Sizes ½-1½ in. (½-in. shown).

Finish: Brass.

O. Brass chair nail. Decorative upholstery work.

Sizes (of head) ½-5 in. (½-in. shown).

Finishes: Brass, antique (dull), black iron.

P. Drugget nail. Carpets, etc.

Sizes, head 1-5 in.; pin5-2 in. (5-in. shown).

Finish: Brass.

Q. Square nail and rove. Boat building.

Sizes ½-6 in. (2-in. shown).

Finishes: Copper, mild steel, galvanised.

R. Roofing nail. Corrugated iron roofs.

Sizes: 2½ in

Finish: Mild steel.

S. Stack pipe nail. Fixing pipes to brickwork, etc.

Sizes 2-6 in. (2½. shown).

Finish: Iron.

T. Deck head nail. Shipbuilding.

Sizes 1½-8 in. (2-in. shown).

Finishes: Galvanised iron, copper.

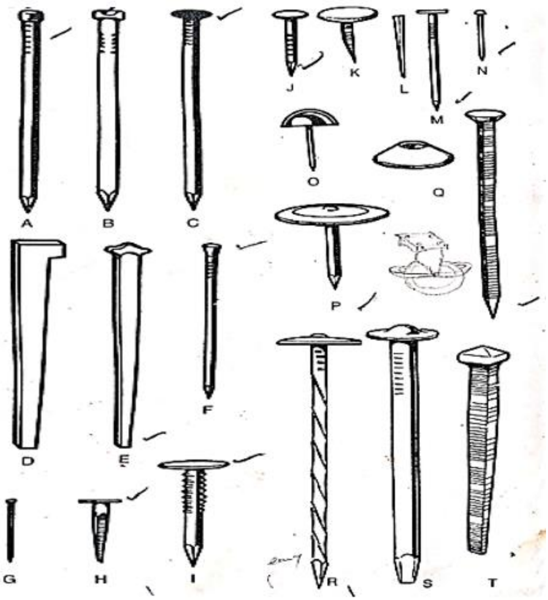


Fig. 7.1: Nails

U. Needle point. Veneers, small mouldings, etc. Headless and tempered.

Sizes 1½-1½ in. (1½-in. shown)

Finish: Bright steel.

V. Wire gimp pin. Upholstery.

Sizes ½-½ in. (5-in. shown).

Finish: Brass and blacked.

Cut gimp pin. As above but square section. Long, thin, sharp point.

Finish: Black iron.

W. Corrugated fastener. Crude joints in cheap work.

Sizes, depth ½-½ in.; length ½-1jin. (1½. by ½ in. shown).

Finish: Bright steel.

X. Staple. Upholstery springs, wire, etc.

Sizes ½-4 in. (1-in. shown).

Finishes: Bright mild steel, galvanised, coppered.

Y. Escutcheon pin. Metal fittings to wood.

Sizes ½—1½ in. (½ in.-shown).

Finishes: Brass, bright iron.

Z. Screw nail. Sheet metal to wood. Heads, flat, countersunk, or round.

Sizes ½-2 in. (½-in. shown).

Finishes: Bright steel, plated.

Diamond point. Generally sherardised. For fixing hardboard. Common size is ½ in.

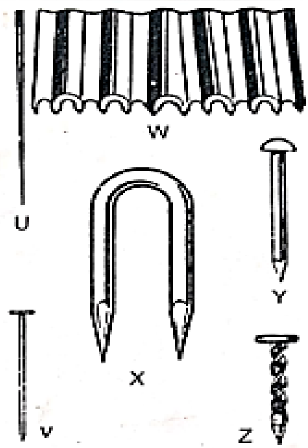


Fig. 7.2: Nails

Screws

Screws are used by the woodworker for many different purposes. For example, they may be used to join parts of a wooden structure. They may be used to attach fitments such as hinges, door bolts or handles to wood. They are also used sometimes to join parts in such a way that they may be easily removed or shifted by loosening the screws.

When buying screws four things must be stated: the type of screw, the length of screw, the thickness or gauge of screw and the material or surface coating of the screw. For example, a screw may be ordered as follows: -

8-gauge x 38 mm steel countersunk.

The gauge or thickness of the screw is indicated by a number.

The larger the number, the thicker the screw. Thus a 12g. x 38 mm is thicker than an 8g. X 38 mm. Some useful sizes are as follows: — 4g. x 13 mm, 6g. x 19mm, 8g. X 25 mm, l0g. X 38 mm, 12g. x 50 mm.

It is necessary to drill holes in the wood to receive all but the smallest screws. The hole for the shank of the screw should be a clearance hole, i.e. slightly larger than the shank. The hole for the threaded part should be half the size used for the shank.

When using brass screws in hardwood it is advisable to put in a steel screw first, since brass screws break off very easily. A little soap on the thread helps the screw to be driven into the wood easily,

Screws do not grip very well when used in end grain. For this reason, they are seldom used for this purpose.

The main types of screw head are illustrated in figure 7.3. Countersunk head screws are in general use for all woodwork. Round head screws are used for fixing metal fittings that are not countersunk. Raised head screws combine the advantages of both the countersunk and round head screws and are neater than both in appearance. Coach screws are used where a bolt would be more desirable, but for some reason cannot be used.

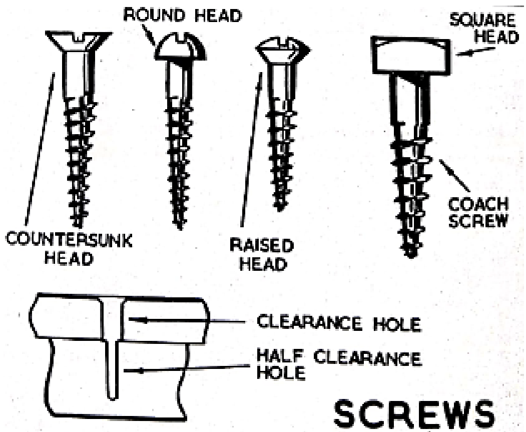


Fig. 7.3: Screws

Steel countersunk head screws are always in a packet with a green label. Brass screws have a yellow label and black japanned screws have a blue label.

When choosing the type and size of screw for a particular job, common sense must be the main guide. The screw must be long enough to hold, but not unnecessarily long. If there is any danger of the wood splitting, thin screws should be used.

Screw hole sizes

Two distinct sizes of holes are needed when screwing - a thread and a clearance hole. The former is the hole into which the screw bites its way, and should be smaller than the over-all diameter of the shank. The clearance hole should be a trifle fuller than the shank diameter.

Finding the gauge of a screw. If you are uncertain of the gauge of a screw this simple method will give the exact answer in a few moments. Measure across the head of the screw, counting the measurement in sixteenths of an inch; double this number and subtract two. This is the gauge.

For example: a No. 10 screw (independent of length) will measure ½ in. or ½ in. This multiplied by two is $\frac{12}{16}$ in.; less two is $\frac{100}{14}$, or No. 10.

Exact drill sizes need not be followed closely, and in any case are variable in accordance with the kind of wood being screwed. Hard woods generally need a larger thread hole than a soft wood.

At the time of going to press it is uncertain how screws may be classified under the metric system. It is quite possible that existing gauges will be retained and lengths given eventually in mm.

Metals. The chief kinds arc mild steel (iron) and brass, but in addition screws are made in copper, gunmetal, aluminium, and in a variety of finishes, such as Berlin blacked, galvanised, tinned, nickel-plated, electro-brassed, antique brassed, antique copper, electro-coppered, copper-oxydised, electro-silvered, and blued. The range of sizes is not so great •in these fancy finishes.

Castors (fig. 7.4)

A. Minicastor. Rubber tyred ball castor. Screw-plate fixing.
B. Hooded wheel castor. With wide wheel covered by plastic hood.
C. Spring-loaded piano castor. For heavy items.
D. Swivel castor with brake. For heavy duty. Wheel can be fixed by foot brake.
E. Wheel castor, plate fixing. Ball hearing swivelling.
F. Spring castor, peg and socket fixing. For wagons, etc. for easy movement over carpets, etc.
G. Wheel castor, peg and socket fixing. General-purpose castor.
H. Wheel castor, screw plate. General-purpose castor.
I. Spring wagon castor. Large wheel travels easily over carpets.
J. Round socket castor. For table and chair legs.
K. Square socket castor. Fixing over square legs.
L. Ball castor. With screw or plate fixing.
M. Floor glide. Spreads load over wide area.
N. Slipper glide. A glide which also swivels for easy movement.
O. Glide. For chairs, tables, etc. glides easily over the floor.

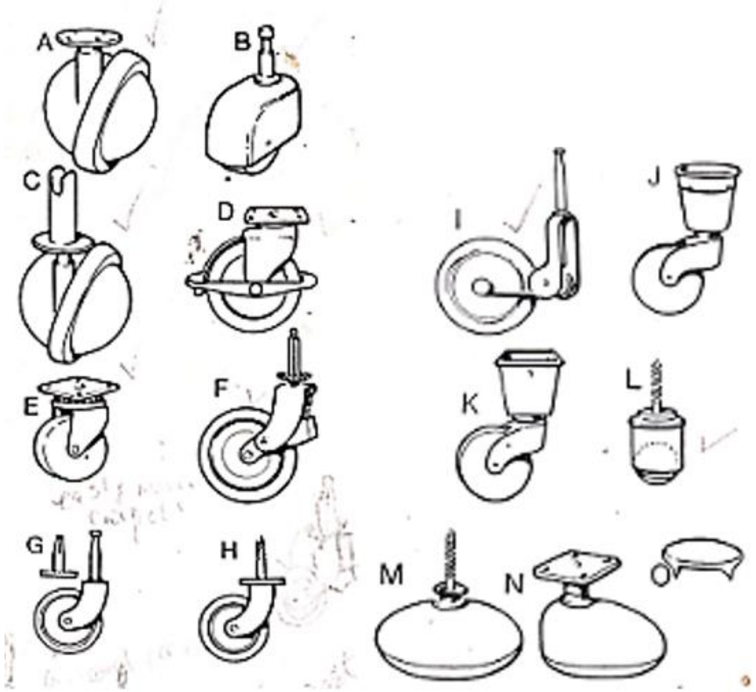


Fig. 7.4: Castors

Stays (fig. 7.5)

A. Wardrobe stay. To limit opening of a door.
B. Casement stay. To hold casement in various positions.
C. Pneumatic stay. Primarily for record players. Lid can be dropped and will close silently.
D. Cocktail cabinet stay. Opens fall and lid simultaneously.
E. Friction stay. Holds lid in a required position.
F. Door stay. Holds door open in any position.
G. Bureau hinge and stay. Supports fall in down position.

H. Quadrant stay. For lid for which straight stay would be impracticable.
I. Rule-joint stay. Used for lids and hinged seats. Made right- and left-hand.

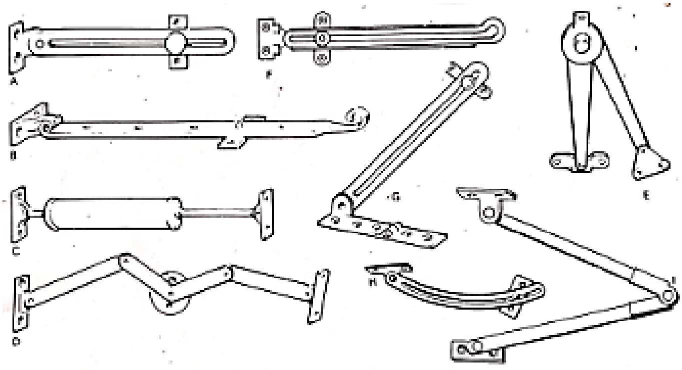


Fig. 7.5: Stays

Knock-down fittings

There are many types of fittings, some of them made especially for and used only by manufacturers. Below are some of the fittings commonly available (fig. 7.6).

A. Corner plates. For drawing pieces together at right angles. Made right- and left-hand.
B. Screw plate. For pulling together parts in same plane.
C. Single fixing plate. Acts in same way as slot screw.
D. Self-locking fittings. Parts have simply to slide one within the other.
E. Leg fitting. One part fixed beneath top, other engages in slots in leg. Insertion of metal wedges locks parts.
F. Bolt and plate. Slotted screw engages with plate. Bolt tightened with tommy bar.
G. Table-leg plate. Legs are screwed in at correct slope.

H. Cam action. Turning slot draws parts together by cam or hook action.

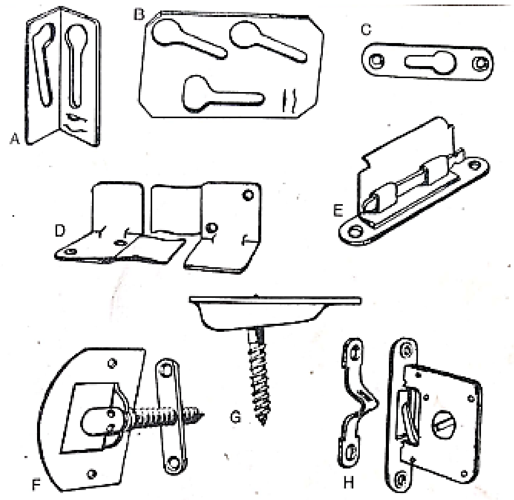


Fig. 7.6: Knock-down fittings

Metal fittings Hinges (fig. 7.7 and 7.8)

A. Butt hinges. For cupboard .and room doors, boxes, etc. Require letting equally into both door and carcase, or wholly into either.
B. Rising butts. For lifting room door clear of carpet. Made right- and left-hand. To tell hand required stand outside door. If hinges are to the right-hand hinges are required, and vice versa.
C. Screen hinges. Enable folds of screen to hinge both ways. To be let into both joining edges. Distance between pin centres must equal or be not less than timber thickness.
D. Centre hinges. For letting into top and bottom of door. Plates let into both door and cabinet. Lower hinge should have raised seating or washer around pin to

prevent binding. Made straight as shown, or cranked to throw door clear of cabinet.

E. Back flap hinges. Used chiefly for bureau falls. To be let into both joining parts.

F. Table leaf hinges. For leaf tables having rule joint. Countersunk on reverse side so that knuckle is recessed into wood. One flap is longer to bridge across joint. Short side is fixed to top, and long side to leaf.

G. Counter hinges. Double-jointed hinge enabling entire hinge to be flush without projecting knuckle. Let into face of counter and flap.

H. Card table hinges. Double-jointed hinge leaving a flush surface when opened. Let into face of top and flap. Type for letting into edges is also available.

I. Butterfly hinges. Decorative hinge screwed straight to face of door and framing.

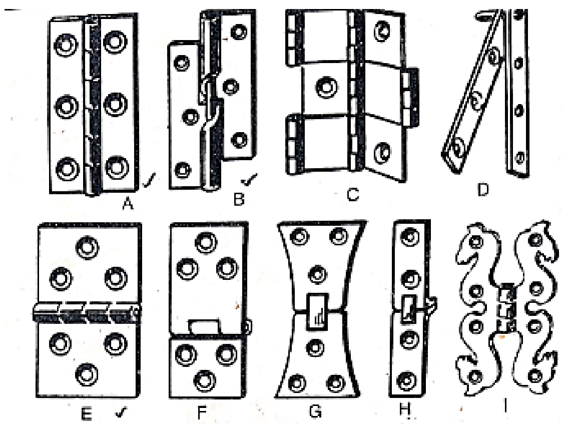


Fig. 7.7: Metal fittings hinges

J. Cross-garnet hinges. For ledged doors, etc. Screwed on face.

K. Soss hinges. Let into the edge of the door. Are entirely concealed when door is closed.

L. Parliament hinge. For a room door to fold back flat to the wall to clear architrave, skirting, etc. Knuckle projects from door face slightly more than half the greatest projection of the architrave.

M. Lift-off hinge. Door pivoted from outer corner enabling it to fold back flat through 270 deg.

N. Pivot hinge. When opened through 90 deg. the throw-off action keeps the door in line with the cabinet side.

O. Onyx invisible hinge. Fitted in various ways and invisible from outside.

P. Clock-case hinge. Used when door stands out from face of case, hence one wide flange.

Q. Strap hinge. Used when hinge has to be fixed to a narrow edge.

R. Piano strip hinge. Fixed to wide falls similar to lid of piano.

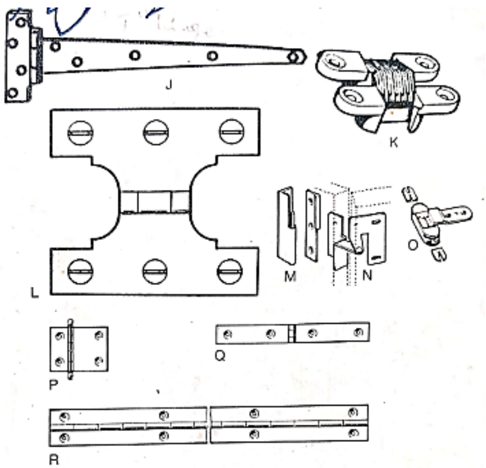


Fig. 7.8: Metal fittings hinges

Locks (fig. 7.9)

A. Straight cupboard lock. For door fitting between ends. Requires no letting in. Bolt shoots both ways.
B. Cut cupboard lock. For door fitting between ends. Needs cutting into door. Made R- and L-hand.
C. Cut drawer lock. Recessed inside drawer front.
D. Sliding door lock. To be recessed into edge of door.
E. Link-plate lock. For door closing over face of ends. Bolt shoots R- or L-hand.
F. Cut box lock. Lock is cut into box and plate into lid.
G. Wardrobe push latch. Screwed to rear of door, button projecting through hole.
H. Roller mortise latch. Let into edge of door. Opened from outside with key, and by" revolving knob at inside.
I. Rim lock. Screwed inside door. End plate is recessed; also box staple. May be R- or L-hand, or reversible.
J. Mortise lock. Recessed entirely into edge of door. The latch may be reversible.
K. Cylinder latch. Key cylinder requires to be recessed. Usually with locking device on bolt.

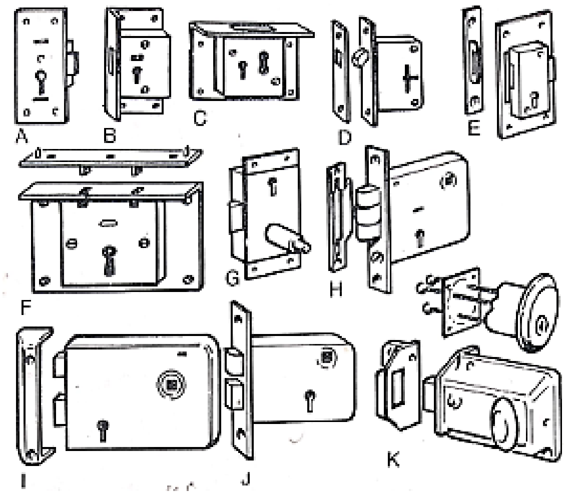


Fig. 7.9: Locks

Fixings (fig. 7.10)

A. Rawlplug. A fibre tube for inserting into a hole drilled in brick or similar wall.
B. Expandet screw anchor and wooden wall plug. A rubber plastic tube to be instead into a hole.
C. Alex screwplug. An aluminium plug for inserting in a hole.
D. Rawlanchor. For thin walls. When the bolt is tightened the flexible arms bend outwards.
E. Rawlplug gravity toggle. For a cavity or thin wall. The arm drops down after being passed through the wall.
F. Recco wall plug. For brick and similar walls using a Whitworth bolt rather than a wood screw.
G. Rawlplug spring toggle. For thin or cavity walls. After being passed through a hole in the wall the sprung arms fly outwards.

H. Philplug Taylor nut and rawlnut. A hard rubber bush with metal insert threaded for metal bolt. Suitable for walls liable to crumble.
I. Rawlbolt and Philplug expandabolt. Suitable for fixing into concrete.

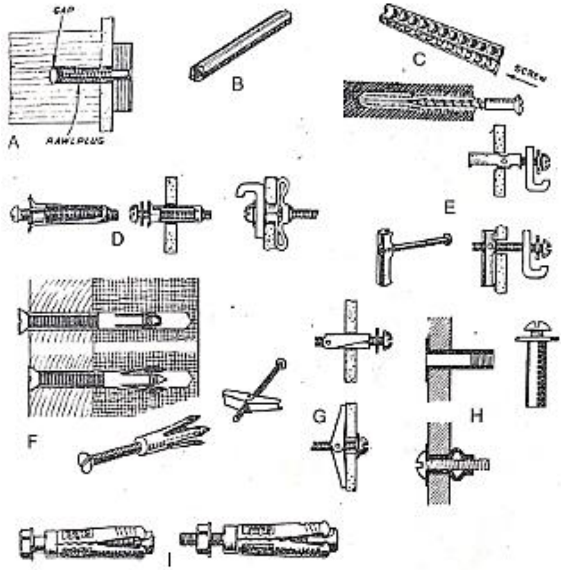


Fig. 7.10: Fixings

Chapter Eight

MAINTENANCE

Oilstones

Two main kinds, natural and artificial.

Natural stones – **Washita** - cuts well and gives good finish. Occasionally stones go hard and lose their cut.

Arkansas - High quality stone giving superfine edge but expensive. Used chiefly by wood carvers, dental mechanics, and so on. There are other types but these are the most popular.

Turkey stone - Gives good quality edge for finishing.

Artificial stones – These have advantage of constant quality. Are made in three grades: coarse, medium, and fine, also combination coarse and fine. Well-known makes are: India, Carborundum, Aloxite, Unirundum, etc. All the above are made in various sizes-125 mm. by 50 mm., 150 mm. by 50 mm., 200 mm. by 50 mm., 250 mm. by 50 mm., 200 mm. by 45 mm. Also in various sectioned slips.

Cleaning a gummed stone. If an unsuitable oil is used on a stone it is liable to become gummed, thus choking the pores and robbing it of its cut. A method of cleaning which is usually effective is to scrub it with a stiff brush dipped in kerosene oil. or petrol. This will remove the old oil and dirt. If it does not yield rapidly to this, soak it for twenty-four hours or so in petrol, then brush it. If this fails, the only alternative is to send it to the makers for a refinishing operation.

It is seldom that the woodworker finds a stone cut too rapidly, but the cut of an artificial stone can be retarded by soaking in a pan of hot Vaseline.

Resurfacing a stone. If a natural stone becomes out of shape it can be levelled by rubbing on a flat piece of marble or paving stone, using silver sand and water to give a bite. Artificial stones are usually too hard for this treatment, and carborundum powder should be used instead of sand. Some workers prefer to rub down on a flat piece of close-grained hardwood, this being dressed with a mixture of lubricating oil and paraffin with some carborundum powder sprinkled on the surface. Use a fine-grade powder for fine stones.

Grindstones

York stone and Yorkshire Blue Grit as generally used: latter is slightly harder Should be used wet, but not allowed to stand in water. Does not draw temper of steel Various sizes from about 150 mm. diam. by 37-9 mm. up to 0-90 m. by 100 mm

Grinding wheels

Made in various grits-emery, aluminous oxide, and corundum under different trade names. Sizes range from 50mm by 6-3mm. to about 300mm. by 37-0mm. used dry. Care needed for woodworking tools owing to liability to draw temper.

Horizontal grinding wheels are taking the place of grindstones. They are easier to use and work quickly, cleanly and accurately. Thin oil from a reservoir washes the wheel and cools the tool. This oil passes through the wheel. Then it is collected, cleaned and sent back to the reservoir, for re-use.

Sharpening tools

Planes. A trying-plane cutter should be only very slightly curved, and have a really pronounced curve for a roughing plane. Shoulder bullnose and rebate plane cutters must be both straight and square.

The grinding angle of cutters is in the region of 25 degrees, and the honing angle 30 degrees. An exception is the cabinet-maker's plane, which has a high pitch of about 50 degrees. This usually needs to have its cutter honed at about 35 degrees, as otherwise it is liable to chatter. The cutter is held with the bevel flat on the stone (Fig. 8a), the hands raised a trifle so that only the edge touches the stone, and worked back and forth. This rubbing turns up a burr at the back, which can be detected by drawing the thumb across the edge. This is an indication that it is sharp, though it does not reveal the quality of the edge or whether it is free from gashes. To detect the latter, look at the edge in a good light-gashes will show up as little spots of light.

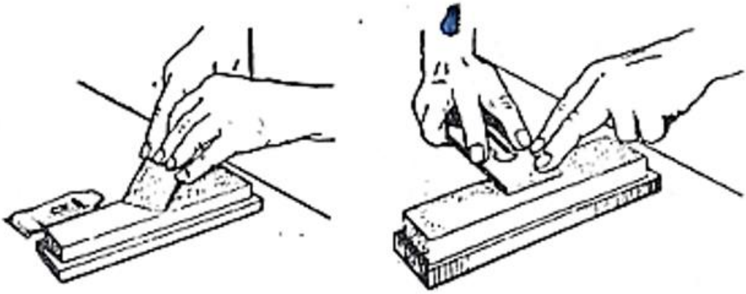


Fig. 8.1a Fig. 8.1b

Fig. 8.1: Sharpening plane cutter

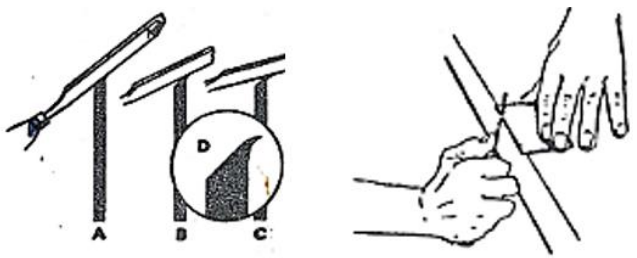
Turn back the burr by reversing the cutter flat on the stone and rubbing once or twice as in Fig. 8.1b. To get rid of the burr draw the edge across the corner of a block of wood. A slight roughness will be left, but this can be got rid of by stropping on a piece of leather dressed with fine emery and oil. When the honed bevel becomes wide the cutter should be reground.

Scraper plane. After initial grinding and honing a keen edge at about 45 deg. turn the edge with a ticketer or gouge. Fix cutter edge uppermost in vice and place ticketer flat on bevel raise the handle slightly-and rub along the edge with fair pressure. Increase tilt and make another stroke. Finally bring ticketer to within 15 deg. of the horizontal and again rub down.

Toothing plane cutter is sharpened similarly to bench plane cutter, except that edge is straight and no attempt is made to remove the burr.

Scraper. This tool cuts by virtue of an edge which is turned back. A ticketer or a gouge is used for turning the edge, which must be really sharp and square to start with.

Hold the scraper in the vice, and rub edges down with a flat file until square and sharp. Finish off on the oilstone. Afterwards rub each side flat on the stone. The edges have now to be turned. Place scraper flat on bench, its edge standing in a short way from the edges, and hold down with the fingers. Moisten the ticketer or gouge in the mouth and draw it along flat on the scraper once or twice in each direction, as in Fig. 8.2. If the gouge is used, make sure that it clears the fingers of the left hand.



Sharpening scraper plane cutter.

Turning the edge.

Fig. 8.2: Sharpening of a scraper

Now hold the scraper so that it overhangs the edge of the bench about sin. Holding the ticketer at a slight angle, draw it along the edge once in each direction with film pressure. Treat all four edges alike. The angle at which the ticketer is held is about 80 deg. As the edges become dulled they can be restored two or three times by flatting, as in Fig. 8.2, and turning back afresh. When this ceases to be effective it is necessary to file and hone afresh.

Generally, there are two main ways to sharpen a tool:

1. Keep angle 'a' steady, do not wave up and down. To stop uneven wear, use the full width of the stone. Use a thin machine oil or a 50/50 oil paraffin mixture on the stone. This is to wash the stone and stop it clogging. When a stone clog, it will not work properly. Go on rubbing the tool on the stone until there is a fine 'wire edge' or 'burr' on the back of the blade.
2. Lay the back of the blade on the stone. Hold it with fingers on both edges. Press on the top to keep the blade absolutely flat on the stone. Rub sideways to remove the burr. This is called back off.

Turning tools

Gouges

Gouge stones and slip stones are used to sharpen gouges and moulding plane irons (fig. 8.3).

There are no separate grinding and honing angles. For bowl turning this should be not less than 45 deg., and edge should be straight, as at (D), Fig. 8.2. For work between centres, angle can be less and a nose given to the tool (B).

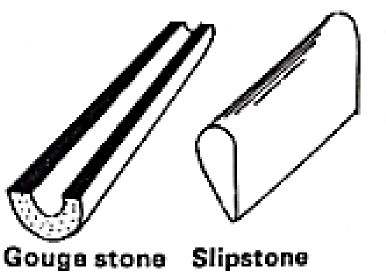


Fig. 8.3: Gouge and slip stones

Chisel

This should have equal flat bevels at both sides, combined angle about 43 deg. If chisel is long-cornered, angle measured across side should be about 60-70 deg.

Scraper tools (fig. 8.4). Worn-out files ground to shape. Serrations are ground off on one side and the edge ground at about 75 deg. For some woods grinding is at lower angle, and after honing the edge is turned with ticketer.

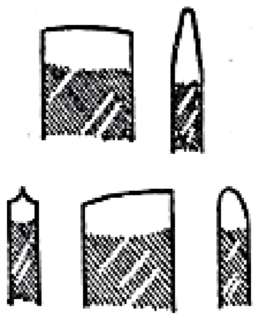


Fig. 8.4: various shapes of scraping tools

Chisels. These are ground at about 20-25deg. But honing angle is in the region of 30 deg. For paring chisels. Those for chopping might be sharpened at about 35 deg. This honing makes a second bevel, and when this becomes wide it is necessary to have chisel ground afresh.

Hold chisel with bevel flat on the stone and raise the hands slightly. This gives an angle of 30 deg. Rub back and forth as in Fig. 8.5, varying the position on the stone. This turns up a burr which can be detected by drawing the thumb across the edge at the back. Reverse the chisel flat on the stone and rub once or twice, so bending back the burr (Fig. 8.6). Get rid of burr by drawing the edge across the corner of a waste piece of wood. Finish by stropping on leather dressed with fine emery and oil.

Gouges. Sharpen firmer gouge on oilstone with rocking movement, and finish inside with slip held flat. Scribing gouges are sharpened inside with slip and finished outside on oilstone. Tool is held flat and given a rocking movement.

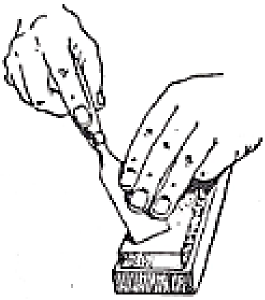


Fig. 8.5: Sharpening chisel

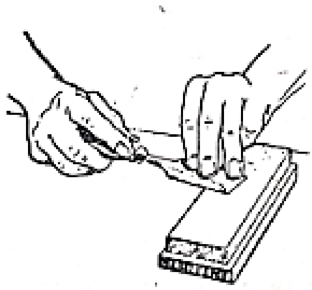


Fig. 8.6: Turning back burr

Carving tools. These are sharpened with a bevel on both sides, that on the inside being about one quarter of that outside. Use a fine-grade stone. For the outside bevel use a rocking movement as Fig. 8.7. For the inside bevel an oilstone slip of slightly less curvature than the gouge is needed, Fig. 8.8. Finish by stropping both sides.

Fig. 8.7: Rubbing outside bevel on oil stone

Fig. 8.8: Sharpening inside bevel

For the V tool, use oilstone slip of triangular section. It will be found that a sort of hook is formed at the apex. To remove this, rub the outside corner of the bevel on the stone.

Strops can be made of wood covered with leather and dressed with oil and crocus powder.

Centre bit (fig. 8.9). Nicker is filed at the inside only. It should have greater protection than the cutter, but less than the centre point. It should either be rounded or sloped so that it cuts, not scratches. The cutter is filed as shown, and underside should have slight clearance.

Twist bits. Use file with safe edge to avoid damaging thread. Sharpen nickers on the on the inside only.

Half-twist bits. Use rat-tail file in alignment with line of the twist. It is obvious which side of the hollow cuts the wood and has to be kept sharp.

Spoon and shell bits. Cutting end is of spoon form which limits the number of times it can be sharpened. Rub with a rocking movement on an oilstone.

Shell bit is similar but end is not spooned. Either a fine file Bevel is flat, but the centre is higher than the sides.

Countersinks. Snail type touched up with flat file or oilstone slip rubbed in the hollow.

Forstner bits. Sharpen flange at inside with edge of a three-cornered file having its serrations ground away. Remove the burr by rubbing flat on the oilstone.

Expansion bit. Use fine file or oilstone for both cutters, retaining bevel.

Bradawl. Round type is filed and finished on oilstone. Square section type has usually 4 to be ground.

Spokeshave. Metal spokeshave cutter is gripped in holder, as Fig. 8.10. This is simply a block of wood with a kerf in it. Sharpen as plane iron. Wood spokeshave cutter has projecting tangs. It is gripped in a handscrew, as in Fig. 8.11, or in the vice, and oilstone slip rubbed across the bevel. Do not remove the burr at the front as this helps the tool in its cut.

Draw knife. It is held so that its edge slightly overhangs the edge of the bench, and the oilstone is taken across it at slight angle. Retain existing bevel. Turn back burr by rubbing stone flat on reverse side.

Axe and adze. Hold axe so that edge overhangs bench, and work oilstone across bevel with a slight tendency towards edge.

Sharpen adze with oilstone, holding tool on bench so that edge just overhangs. Hold stone flat on the bevel and press rather towards the edge.

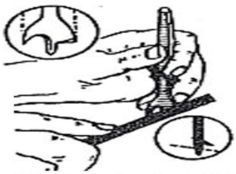


Fig. 8.9: Sharpening Centre Bit

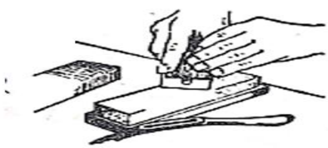


Fig. 8.10: Sharpening Metal Spokeshave Cutter

Fig. 8.11: How wood Spokeshave Cutter is held

Chapter Nine

DEFECTS

Defect in timber during growth

Heart shake. A split outward from the centre of the tree and along the medullary rays. It is caused by old age. When several heart shakes come together they form a **Star shake**. **Cup shake** is when a young tree bends too much in very high winds, the annual rings may come apart. When this happens a cup shake is made. Too much heat can cause this to happen also. Where a cup shake runs completely round the tree it is called **Ring shake**. **Radial shake** is one starting at the outside of a log and running inwards radially. **Shell shake** is part of a ring shake. In a board it results in a loose rounded section. **Compound shake** is a combination of two or more shakes. Felling shake is the one caused during the process of felling. (see fig. 9.1)

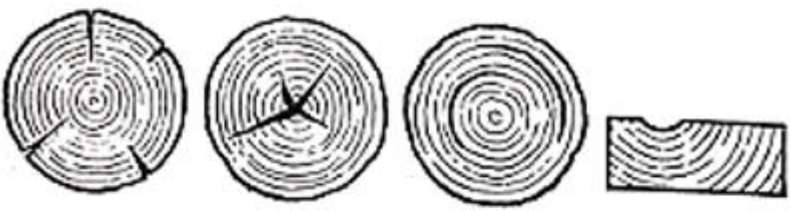


Fig. 9.1: Shakes

Knots (fig. 9.2)

A. Edge knot. Round or oval knot occurring at the edge of a board.

B. Face knot. As above but on the face rather than the edge.

C. Arris knot. One occurring at the arris or sharp corner of timber.

D. Knot cluster. Several small knots in a group and having the wood fibres flowing around the whole.

E. Splay or spike knot. One which is exposed by a cut parallel with its length.

F. Margin knot. A knot cut parallel with its length and showing at the arris as part of a circle.

G. Loose knot. One which is not tightly held in place and may be pushed out. A tight or sound knot is firm.

H. Pin knot. One no more than 0-65 mm. diam.

I. Dead knot. One not joined throughout its length to the surrounding wood.

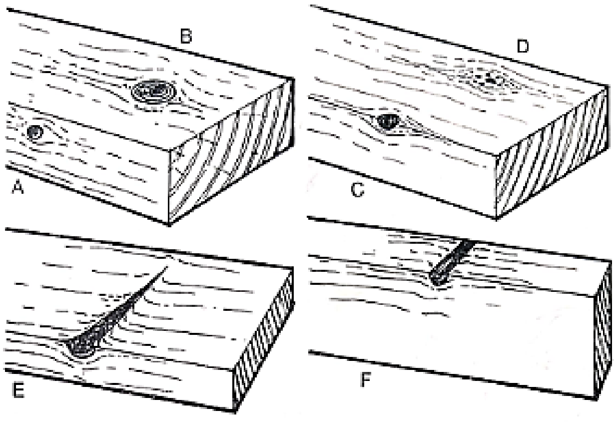


Fig. 9.2: Knots

Defects in timber after conversion

Warping: Boards which do not stay flat and straight are said to 'move'. This movement is called warping. The four different kinds of warping are shown and named in the figure 9.3 below.

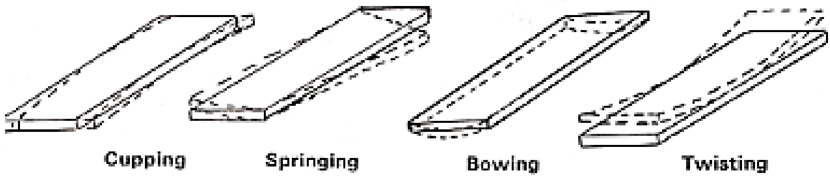


Fig. 9.3: Warpings

Shrinking: Freshly cut timber open to the air, contracts along its annual rings (see arrows below). This is called Shrinking. It distorts the wood as the diagrams show (fig. 9.4).

Fig. 94: Shrinkage

Defects in timber in use

Decay: The woody material of which timber is made includes two substances called Cellulose and Lignin.

1 White rot attacks both the cellulose and the lignin. It leaves a white powdery ash. Happening mostly out-doors. It is also called wet-rot.

2 Brown rot. An indoor type, sometimes called dry rot. It attacks only the cellulose leaving the wood looking brown and 'charred'.

Pests: These include the Powder Post, the Death Watch and the Common Furniture Beetles. Eggs are laid by the female beetles in splits in dry wood. Six weeks later these hatch out as white grubs called Larvae. They bore through the wood to feed on the starch in it. After two years they turn into Pupa near the surface. In about two more weeks they become fully grown beetles. They make little round holes in the wood as they eat their way out. Now the life cycle starts again.

Termites are often called White Ants. They are not ants. They are related to the cockroaches. When they attack the timbers of buildings they work havoc and are a serious problem in all tropical countries.

Wood pests

Furniture beetle or woodworm. Once the presence of the woodworm has been detected, treatment should be begun at once. Affected wood may be half eaten away by the pest or it may show nothing more than one or two holes about 1-5 mm. in diameter, but the insidious nature of the trouble is that the interior may be in a very bad state leaving a surface shell of sound wood. The holes are the points from which the beetle emerges, not the point of entry.

The cycle of events is this. The beetles may be introduced in other furniture or they may enter through an open window, since they live in a natural state in the dead branches of trees. They are very small and the average man would probably not connect them with woodworm. The female beetle lays her eggs in crevices in the wood, then dies. Small white grubs hatch out from the eggs and begin to burrow into the wood. They work on in this way for perhaps a year or two years leaving behind them in the tunnel a light, fine powder. Finally, the grub drives a tunnel towards the surface of the wood where it bores a chamber in which it lies up and turns into a chrysalis. After a few weeks it develops into a beetle with wings, legs, and so on, and bites its way through to the surface and emerges. The male and female beetles mate and the whole thing starts again. It is during June, July, and August that this exodus takes place, though it may be as early as May.

The most usual treatment is the application of a proprietary insecticide made specially for the purpose. The powder should be removed from the holes as far as possible to enable the liquid to penetrate. A pricker can be used or a vacuum cleaner is sometimes useful. The liquid is fed into the holes with a small brush or a fountain pen filler. If the area is large the liquid will have to be brushed in.

One treatment may not effect a cure, since individual beetles may escape. A watch should therefore be kept on the furniture. A good plan is to lightly ring treated holes so that fresh ones may be recognised. When treating the wood rub the insecticide into all crevices whether near the holes or not.

Another method of treatment, which, however, involves sending the infected furniture to a firm with the necessary equipment, is that of fumigation. The furniture is placed in a special chamber, which is then filled with a poisonous gas.

When examining old furniture in which the beetle is suspected, look out for a light fine powder which may lie on the surface or have dropped to the floor.

Death-watch beetle. This pest is larger than the furniture beetle and generally attacks large pieces of timber-roofs, beams, and so on. The beetles emerge in April, May, and June, and lay their eggs in crevices or old exit holes. After hatching out the grub burrows into the wood for two years or so, then changes into a chrysalis, and eventually bores its way out to begin another cycle of events. The holes are about

3-0 mm. diameter. As the beetles are able to fly the pest can spread easily to all parts of the building.

All dust and really rotten wood should be removed and the whole given a thorough treatment with a special insecticide. If necessary, any paint or varnish should be scraped off to help penetration, and in some cases it is an advantage to bore holes into which the liquid can be poured, enabling it to reach otherwise inaccessible parts. When it is feasible to take joints apart it is an advantage to do so to enable the inner surface to be reached.

Dry rot. This term is somewhat misleading, for, although the wood after attack has a cracked and dry appearance, the trouble always occurs in a damp, badly ventilated position. It is caused by a fungus which feeds upon the timber, gradually eating away the fibres and producing a sort of cubical, cracked effect. The fungus itself is a white growth, often with patches of yellow, and it sends out lace-like strands to attack sound timber in the locality. Timber with a moisture content of less than 20 per cent, is seldom attacked. Floors are subject to dry rot when there is an absence of air bricks beneath or if the latter have become stopped up. Trouble may also be due to the lack of honeycomb openings in sleeper walls. The lack of a dampcourse is also a possible cause.

The commonest of the fungi is the Merulius lacrymans. It thrives chiefly upon the sap-wood of softwoods, but will also attack the heartwood. Hardwoods too are subject to it, though to a lesser extent. It can be introduced on many ways. The spores can be carried in by the wind, they can be present in a sack of coals or they even penetrate through mortar; and if they lodge on a piece of damp timber and the conditions are right, they begin to germinate.

A second fungus is the Coniophora cerebella, which is found often in damp cellars. Very wet timbers are attacked, and it may therefore be suspected in the locality of leaking pipes and other damp positions.

Timber which has the dry rot has an unmistakable appearance, cracks developing both across and with the grain so that the wood looks as though it has been broken up into irregular cubes. In the case of structural timbers there will probably be collapse, as affected wood entirely loses its strength. It is possible, however, for painted woodwork to be affected at the back (where it cannot be seen) leaving a normal appearance at the front. Symptoms of the complaint are an offensive, musty smell, the presence of fine red powder (the spores of the fungus), and surface cracks. Bad warping may also be a sign. Tap the timber to see whether it has a healthy ring or a dead sound. If also a sharp tool such as a bradawl can be pressed in easily, it is a sign of trouble.

Cutting out and burning affected timber is generally the only solution, but before replacing with fresh it is necessary to correct the conditions giving rise to the trouble This may involve the clearing of air bricks or their introduction if there are not any the removal of bricks in a sleeper wall to ensure a through draught; and the removal of the causes of damp. Cut away the affected timber well beyond the last sign of rot. Go over all exposed surfaces of both timber and adjoining brickwork with a blowlamp to sterilise it and qive the whole a thorough treatment with a proprietary wood preservative or a good quality creosote. Any new replacement timber must also be thoroughly brushed with a preservative. The old affected timber which has been cut away should be burnt.

Chapter Ten

FURNITURE

Period furniture

The division of the periods from 1500 to 1800 into the ages of the Carpenter, Cabinet Maker, and Designer is convenient because these terms suggest the type of furniture being produced. In the earliest period furniture was made by the carpenter, who regarded furniture-making as incidental to his general work, and it therefore bore the characteristics of a craftsman used to large joinery work. Soon after 1660 some woodworkers began to specialise in furniture, and so came the age of the cabinet maker. Lastly, at about the middle of the eighteenth century, furniture began to be associated with the names or individual designers and craftsmen, hence the term Age of the Designer.

Jacobean period 1603-1660

Jacobean mouldings as applied to furniture were a free and somewhat coarse rendering of the classical (fig. 10.1).

Nos. 1 to 4 and No. 13 are cornice mouldings.

Nos. 5 to 7 are surbase mouldings.

Nos. 8 and 9 are table or chest top sections.

Nos. 10to 12,16and 17 are suitable for bases.

No. 14 shows panel mouldings and No. 15 a channelling.

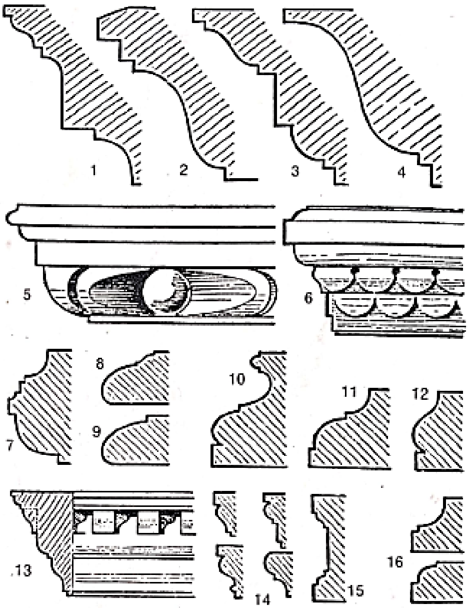


Fig. 10.1: Jacobean mouldings

Walnut period 1660-1720

Walnut period mouldings, founded upon the classic, were invariably cross-grained. They were built up of a layer of thin cross-grained walnut upon a pine groundwork (fig. 10.2). Straight members were often veneered.

Nos. 1 to 9 are cornice mouldings. Nos. 10 to 21 are various table-top and surbase sections. Nos. 22 to 24 are base mouldings. No. 25 shows small beads used for barred doors, drawer edges, etc. Nos. 26 to 28 are mirror-frame sections. Nos. 29 and 30 are frieze contours.

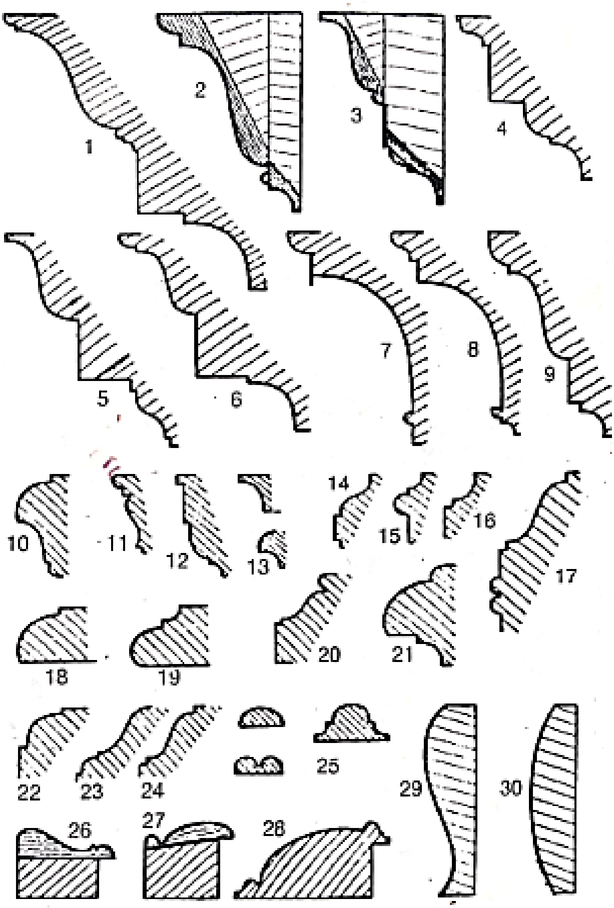


Fig. 10.2: Walnut period mouldings

Chippendale period 1745-1780

Mouldings of this period were mostly founded upon classical examples. The sections were frequently carved in the better class work (fig. 10.3a and 10.3b).

Nos. 1 to 14 cornice mouldings, Nos. 4. 5, 11, and 12 being suitable for a low height level.

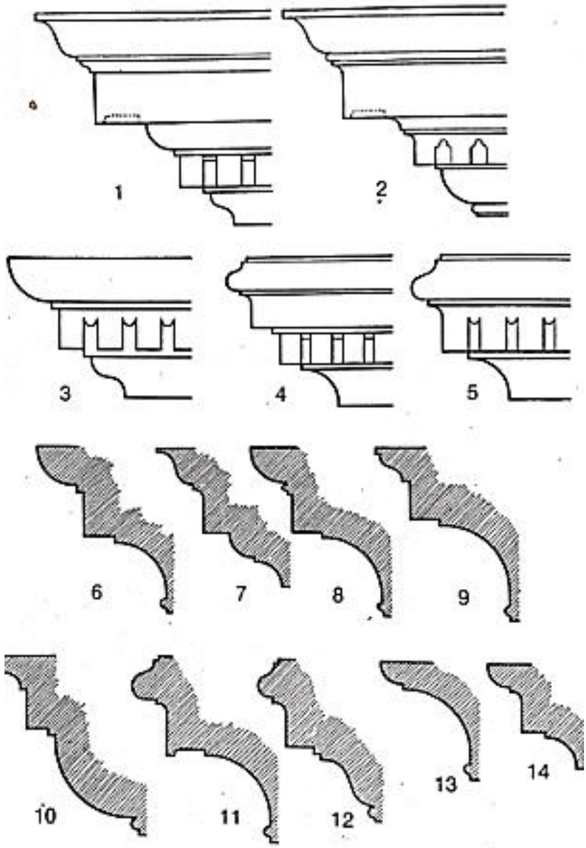


Fig. 10.3a: Chippendale mouldings

Table sections with frieze rails are given in Nos. 15 to 18.

Nos. 19 to 22 are for tables or low cabinet tops.

Surbase mouldings are shown in Nos. 23 to 26.

Nos. 27 to 33 are base mouldings.

Nos. 34 to 36 are suitable for panels.

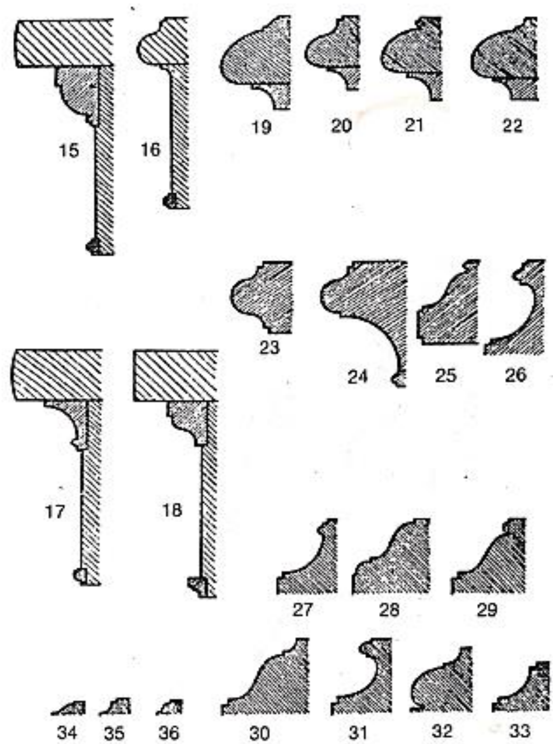


Fig. 10.3b: Chippendale mouldings

The mouldings are taken partly from old furniture and partly from the "Gentleman and Cabinet Maker's Director."

Hepplewhite period 1760-1790

Mouldings of this style were founded upon the classical, but the sections were simplified to make them suitable for the comparatively small size required for furniture (fig. 10.4). A restrained form of carving was frequently introduced.

Nos. 1 to 13 are cornice mouldings.

Nos. 14 to 20 are surbase sections.

Nos. 21 to 26 are plinth mouldings.

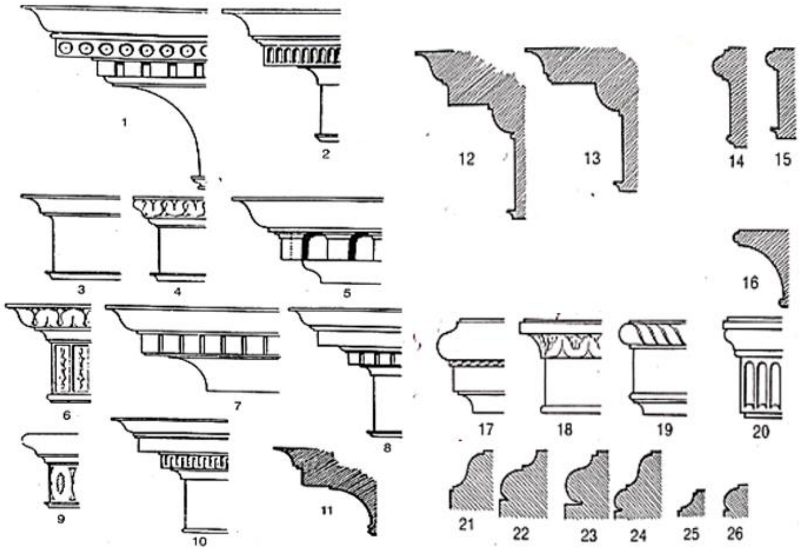


Fig. 10.4: Hepplewhite mouldings

Some Hepplewhile mouldings were decorated with inlay rather than carving. This usually took the form of ebony or satinwood lines or cross-banding. Occasionally the flutted effect shown in 2 was inlaid rather than carved, a recessed appearance being obtained by the use of veneer immersed in hot sand to give a shaded effect.

Sheraton period 1790-1806

Sheraton mouldings were generally finer than those of the Chippendale period. Frequently they took the form merely of square fillets, often with inlaid lines or bandings. Larger cornice mouldings were invariably backed with pine for economy (fig. 10.5a and 10.5b).

Nos. 1 to 13 are cornice mouldings. For a low cornice at about eye level Nos. 6, 8, and 12 are specially suitable.

Surbase mouldings are given in Nos. 14to 17.

Those from 18 to 21 belong to table tops. Sections for bases are Nos. 22 to 25.

Nos. 26 to 28 are barred door mouldings. No. 29 is a shelf mould.

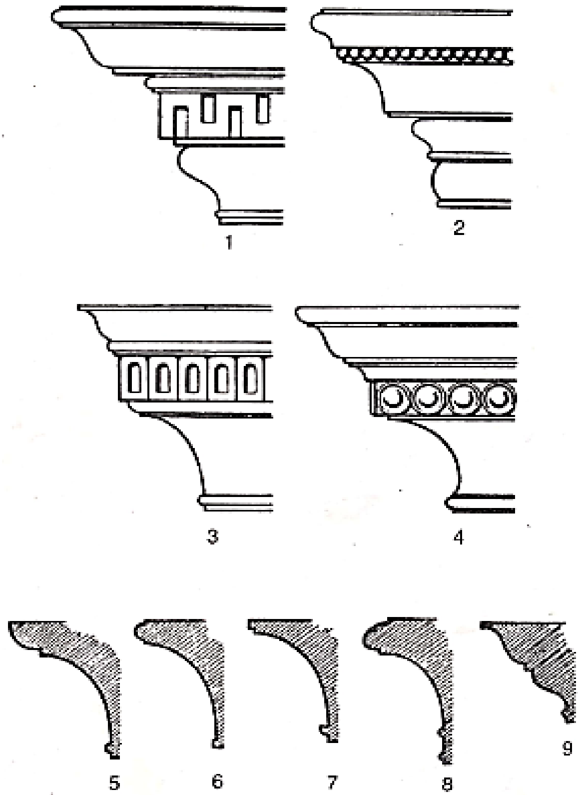


Fig. 10.5a: Sheraton mouldings

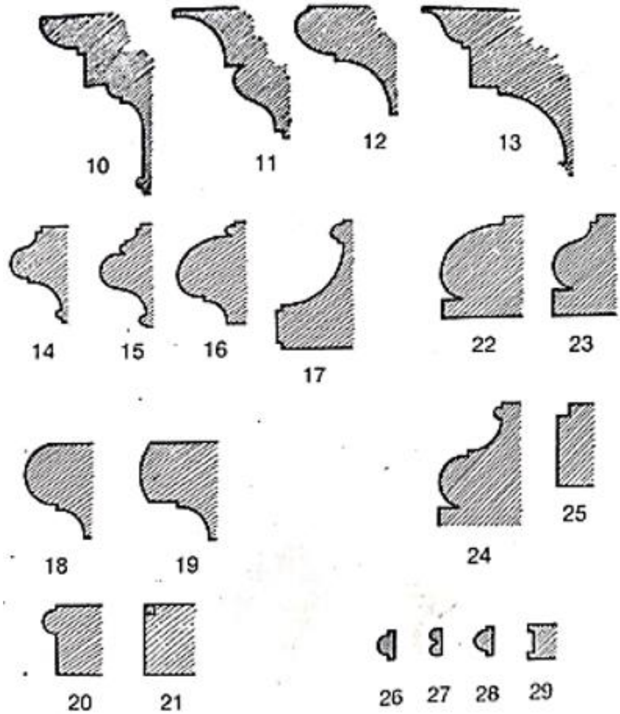


Fig. 10.5b: Sheraton mouldings

In the case of mouldings decorated with carving the detail was sometimes applied as a strip glued on to a flat surface. Thus the dentil pattern in 1 and the repeat device in 3 was frequently carved separately and added later, though in good quality work it might be carved in the solid.

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Prof. Hassan Abdullahi Muhammad received his training in Industrial and Technology Education from Ahmadu Bello University, Zaria; Federal University of Technology, Minna; and University of Nigeria, Nsukka; where he obtained Bachelors and Masters Degrees, as well as Doctor of Philosophy (Ph.D) respectively. He is a Lecturer in the Department of Industrial and Technology Education, Federal University of Technology, Minna. He has written textbooks such as Fundamentals of Furniture Making, Introduction to Research Methodology, Challenge based & activity based learning on technical college student, A Guide to Effective Micro/Teaching Practice, Modern Woodwork Technology and Quality Assurance in Technical Teacher Preparation for Effective School Administration and published many articles in reputable journals and has attended many conferences, seminars and workshops. He is happily married with children.

Dr. Mrs. Franca Nwankwo is a distinguished scholar and educator with a profound dedication to fostering sustainable development, environmental justice, and educational excellence across a variety of sectors. With a career that bridges academic, technical, and community-oriented realms, Dr. Mrs. Nwankwo has consistently demonstrated a commitment to using education as a tool for social change, particularly in the fields of industrial and technology education, wood waste management, and youth empowerment.

Born into a milieu that values knowledge and service, Dr. Mrs. Nwankwo's academic journey is marked by an early passion for education and a drive to contribute meaningfully to society. This journey led to obtaining a Bachelor of Technology in Vocational and Technical Education specializing in Woodwork Technology from Abubakar Tafawa Balewa University, Nigeria, and furthering her studies with a Master of Technology and a Ph.D. in Industrial and Technology Education specializing in Woodwork Technology from the Federal University of Technology Minna, Nigeria. She is currently advancing her expertise with a Ph.D. in Higher Education Administration at Morgan State University, Baltimore, Maryland, USA.

Dr. Mrs. Nwankwo's professional career is as diverse as it is impactful. As a Lecturer of Industrial and Technology Education (Specialized in Woodwork Technology) at the

Federal University of Technology Minna, Nigeria, she nurtured the next generation of educators and innovators, emphasizing practical skills in Woodwork Technology, and the importance of sustainability in technology. Her role extended beyond the classroom, engaging in research that pushes the boundaries of knowledge in wood waste management and advocating for environmental safety and sustainability.

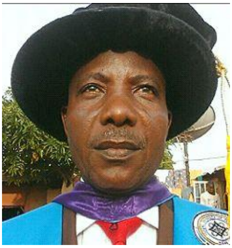
In the United States, Dr. Mrs. Nwankwo continued her advocacy and research as a Research Assistant with the Environmental Justice Thriving Communities Technical Assistance Centers, where she played a crucial role in promoting environmental justice through education and community engagement in the Mid-Atlantic region.

Simultaneously, Dr. Mrs. Nwankwo is holding a significant position as the Director of the Global Essay Project for the STAR Global Network. In this role, she oversees the meticulous process of selecting, reviewing, and editing essays, ensuring that they reflect the thematic focus of the project while maintaining the highest standards of quality. This position highlights her dedication to global education, cross-cultural understanding, and the empowerment of diverse voices in academic discourse.

Dr. Mrs. Nwankwo is a prolific writer and researcher, with numerous publications to her name that address critical issues ranging from wood waste management practices to gender dynamics in Industrial and Technology Education, and Sports. Her work not only advances academic knowledge but also provides practical insights into improving environmental practices, educational methodologies, and community engagement.

An active member of professional organizations such as the Association for Career and Technical Education(ACTE) USA, Technology Education Practitioners of Nigeria (TEPAN), Teachers Registration Council of Nigeria (TRCN). Dr. Mrs. Nwankwo is deeply committed to the advancement of her field. Her roles as a reviewer and guest editor for several international journals further attest to her standing in the academic community and her dedication to ensuring the integrity and relevance of research in her fields of interest.

Outside her professional endeavors, Dr. Nwankwo enjoys Taekwondo, chess, scrabble, and music, activities that reflect her diverse interests and her belief in the importance of lifelong learning and personal growth.



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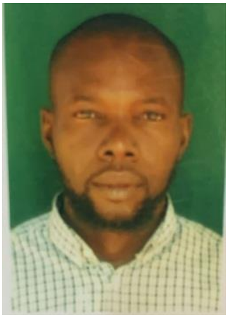

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