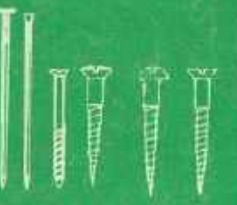
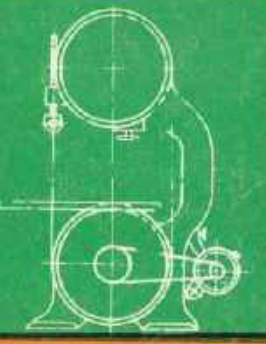
PRINCIPLES OF WOOD TECHNOLOGY

J. ULLRICH





DEVELOPMENT CELL
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PRINCIPLES OF
WOOD TECHNOLOGY

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PREFACE

This book has been written to satisfy the needs of those who require, in one volume, sufficient information to gain actual and basic experience in professional woodworking. This profession and its products are intimately connected with our daily lives and present an important factor in every nation's economy.

The woodworking industries and handicraft manufacturing have now reached a position of commercial and economic importance incomparable to any previous century. Not only because they employ thousands of skilled workmen, but also because the end product is not only useful and a practical object, but a thing of beauty and a work of art.

Fundamental tools and machine processes, common to all woodworking trades have been compiled and set down here in connected groups, whereas especially cabinet-making has been emphasized throughout the book. However, even though this book is an attempt to give, in a limited space, the maximum of information supported by illustrations, it should be stressed that no book can take the place of actual experience.

There is only one real way to learn how to handle machines and tools and that is to use them, only one real way to understand the properties of wood and that is to work with it and only one real way to learn how to construct things of use and beauty and that is to do it yourself.

J. Ullrich

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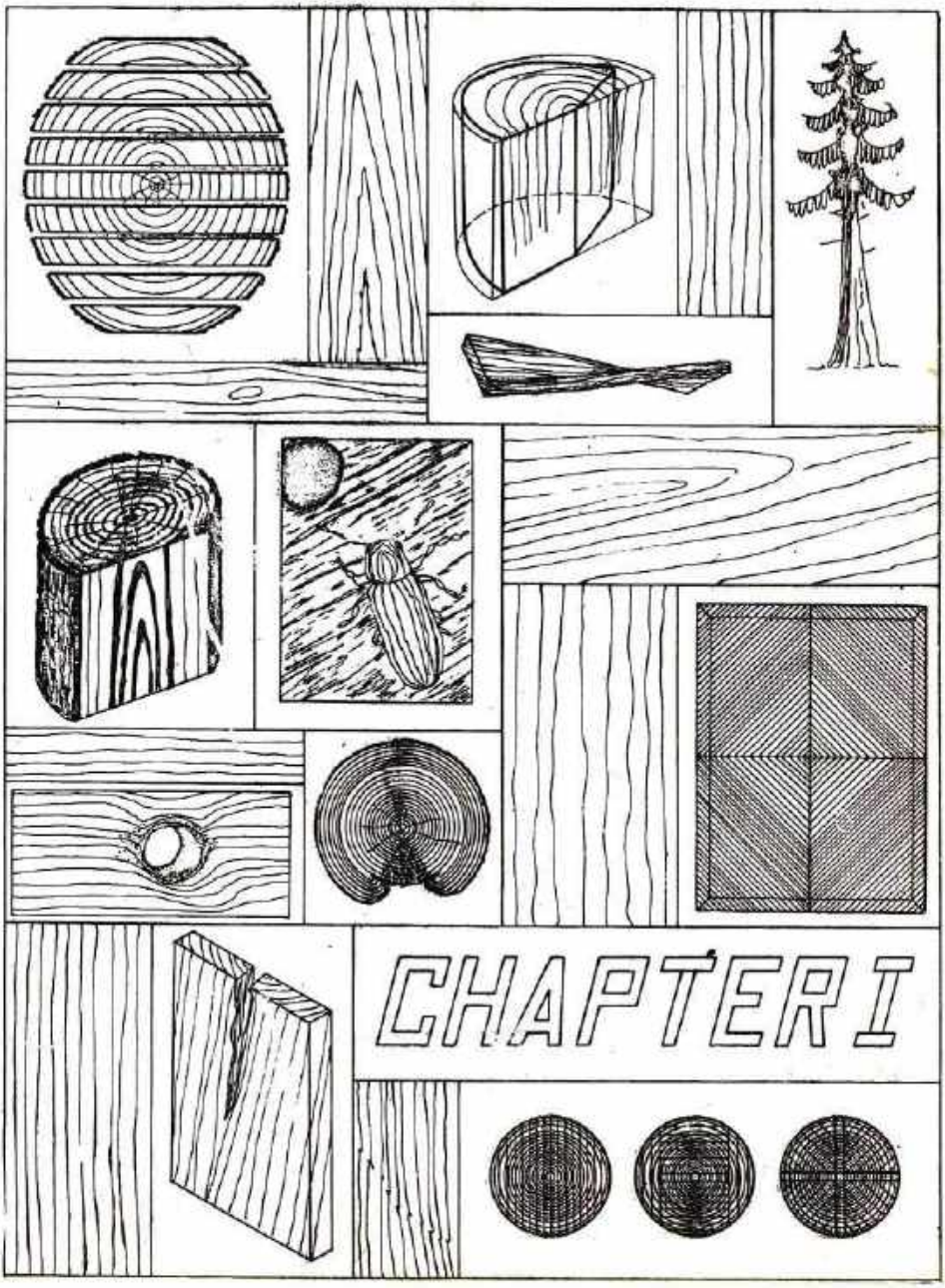
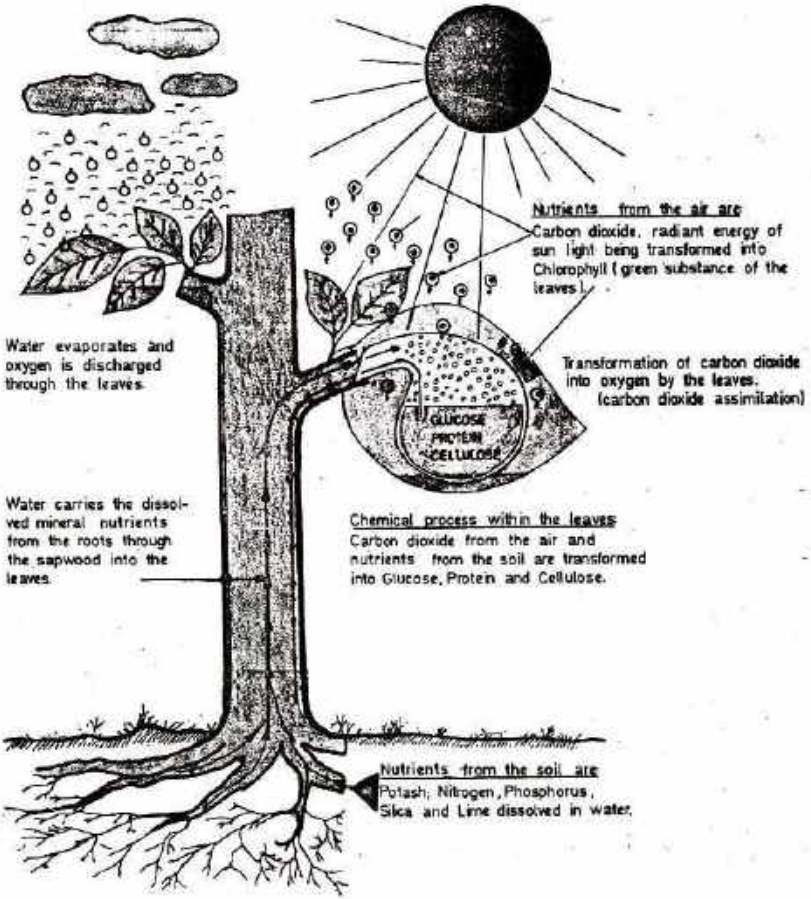

CHAPTER I

THE VEGETATIVE STRUCTURE OF THE TREE



THE CHARACTERISTICS, STRUCTURE AND GROWTH OF A TREE

CHARACTERISTICS AND CLASSIFICATION OF TREES

The classification and characteristics of trees should be understood to appreciate the technology of wood-working. The knowledge of structure, durability, strength, beauty, working qualities, its uses and sources of supply is also of major importance in the manufacturing process.

CLASSIFICATION OF TREES

Trees are divided into two general categories

1. ENDOGENS
2. EXOGENS

Endogens (inward growing) trees have no commercial value. Most of their growth takes place inwardly in a hollow trunk, as in bamboo and palm trees. Fig.1,A,B.

Exogenous trees are outward-growing. Building layers of growth (annual rings) around the trunk and branches and indicating the age of the tree. In moderate climates, one ring is added each year. When nutrient and water are abundant, the tree grows more and the rings are wide. The rings are narrow when there are adverse conditions of drought and lack of food. The light band of an annual ring is spring growth, the dark one is formed in the autumn.

BROADLEAF TREE HARDWOOD Fig.2

The valuble, lumber-producing exogens are divided into two classes. The BROADLEAF deciduous hardwood tree and the CONIFER (evergreen) softwood tree. The broadleaf trees are often also fruit producing trees. Hardwood is a common term, but it is not always precise in relation to density weight or texture. For example, basswood and poplar two hardwood trees, are softer than yellow pins and chir which are classified as softwood.

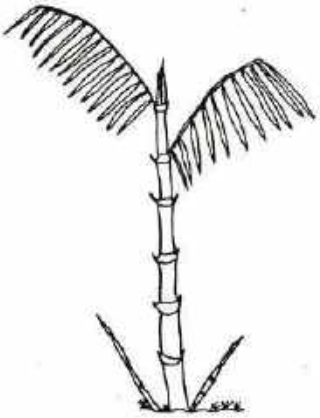


Fig1(A) BAMBOO TREE (ENDOGEN)

Fig1(B) PALM TREE(ENDOGEN)

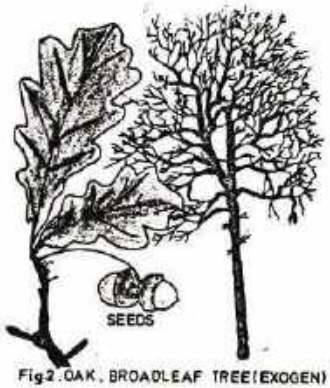


Fig2.OAK, BROADLEAF TREE(EXOGEN)

CONIFER OR EVERGREENS Fig.3

Conifers are classified as softwoods. They have needle-like or scalelike leaves. Softwood or evergreens are common names for conifers, but they are somewhat misleading. It was mentioned that some softwoods are harder in texture than are some hardwoods. There are also evergreens, such as larch and bald cypress which shed their leaves annually. Most lumber for building construction is cut from the softwood. Included in this group are cedar, bald cypress, fir, hemlock, larch, pine a. l redwood. Most common softwoo.s are deodar, partal, chir and .ail.

Fig.3. CONIFER OR EVERGREEN TREE (EXOGEN)

OUTER TREE STRUCTURE

The three main parts of a tree are the ROOTS, the TRUNK, and the CROWN.


Fig.4. SEEDLING


Fig.5. SEED

THE ROOTS Fig 4,5,6,7

In the root structure, the TAP-ROOT grows deepest. This growth begins as the seed sprouts. It continues to develop through the seedling and the sapling stages to maturity. Broadly, there are two types of root systems. Some trees have a stout TAPROOT which penetrates deeply into the soil, while others have a FASCICULATE ROOT system of several main roots which grow obliquely downwards. The root hairs, which are living CELLS, absorb water from the earth and dissolve the minerals and nitrogen necessary to make food. Roots also help to hold soil against EROSION. A layer of growth cells at the root lips makes new root tissue during the growing season.

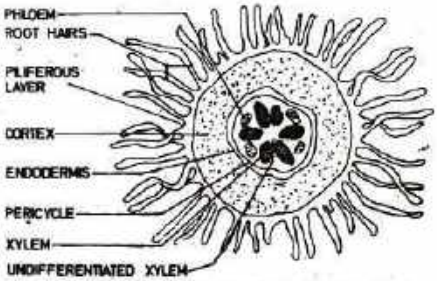


Fig.6. CROSS SECTION OF A YOUNG ROOT


Fig.7. TAP ROOT SYSTEM

THE TRUNK Fig.8

The trunk or main stem of a tree is the part that is of greatest commercial value. It supports the crown and produces the most useful wood. Some trees have a short thick trunk which divides into several parts according to its length, shape and diameter.

THE CROWN AND THE LEAVES Fig.9

The crown of a tree is formed by the branches and leaves. Leaves have been called the most important chemical factories in the world. Millions of green microscopic bodies called CHLOROPLASTS manufacture inside each leaf. The green pigments in leave are called CHLOROPHYLL. Power is generated by combining radiant energy from sunlight with water from the soil through the roots and CARBON DIOXIDE is obtained from the air. Water vapor is discharged from living plants through PORES on the undersides of leaves.
See page 3.

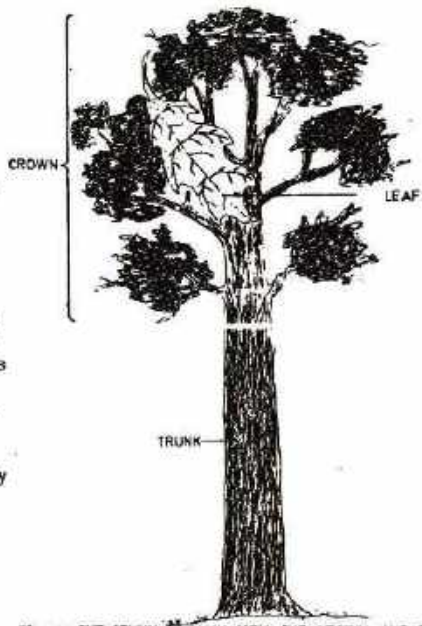


Fig.8&9. THE TRUNK OR MAIN STEM, THE CROWN AND THE LEAVES

INNER TREE STRUCTURE Fig.10, 11

The thin layer of cells between the bark and the wood is called CAMBIUM. This layer is where growth in diameter occurs. The cells are capable of dividing and forming new ones in the part toward the SAPWOOD and BAST cells situated near the inner BARK. SAPWOOD contains nutrients cells which store and conduct nutrients vertically. The nutrients are carried from the roots to the leaves through tiny openings, or cells called VESSELS. Hardwood was once sapwood; it is composed of strong fibers which give the tree strength. Softwood FIBERS are two to four times greater than the fibers of hardwood. Softwood has no open-end cell structure so it is NONPOROUS. Hardwood being POROUS has open end cells. Hardwood is called OPEN and CLOSE-GRAIN wood. Walnut, shisham and oak have larger open-end cells

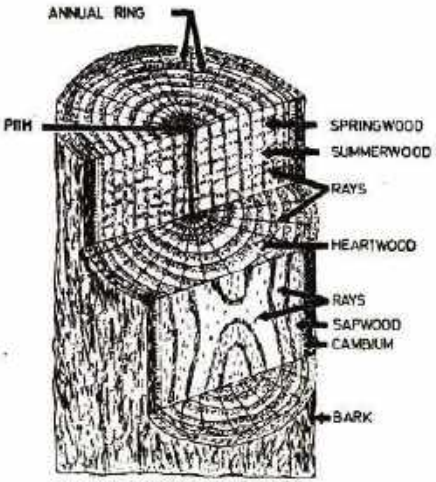


Fig.10. THE STRUCTURE OF A LOG

Air in the cells of dry wood allows most wood to float when placed in water. The dry weight of different wood varies because of these hollow cells. Balsa wood is exceptionally light, but rose wood and ebony wood is almost solid wood. They sink in water because there are only a relatively few air-filled cell cavities.

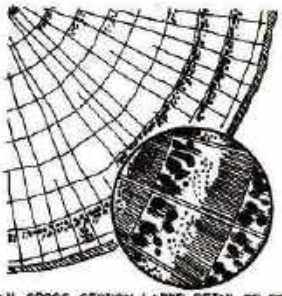


Fig.11. CROSS SECTION, LARGE DETAIL OF POROUS END CELLS IN HARDWOOD

MEDULLARY RAYS Fig.12

The lines or rays, running from the PITH to the bark in all exogenous trees are called MEDULLARY RAYS. These rays store and conduct nutrients horizontally. Medullary rays add beauty to some wood and are important when drying lumber. The larger the rays, the more they tend to affect the process of drying lumber by shrinking and cracking. This accounts for the difficulty in drying hardwood as compared to softwood. The size and arrangement of cells along with colour pigments add to the beauty of the wood by enhancing the figure or GRAIN.

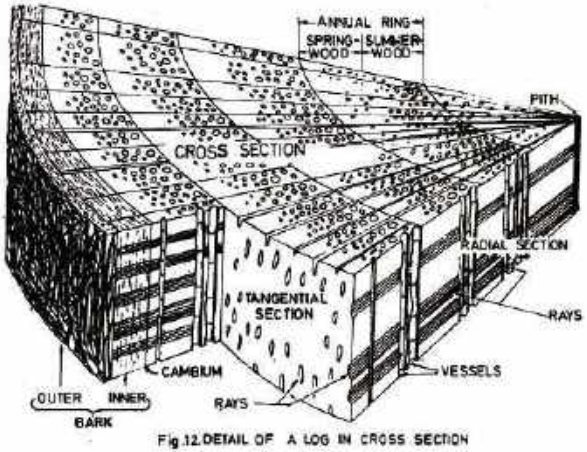


Fig.12.DETAIL OF A LOG IN CROSS SECTION

THE CELLS Fig.13

A tree trunk is composed of millions of individual CELLS. These cells differ in size and shape, depending upon their physiological role in the tree, most of them being many times longer than broad. They are arranged in recognizable patterns of distribution within the wood. The long cells which are arranged longitudinally make up the bulk of the wood and provide "GRAIN to the material.

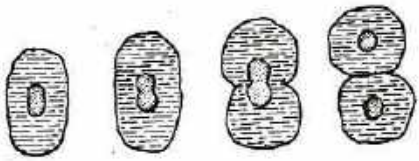
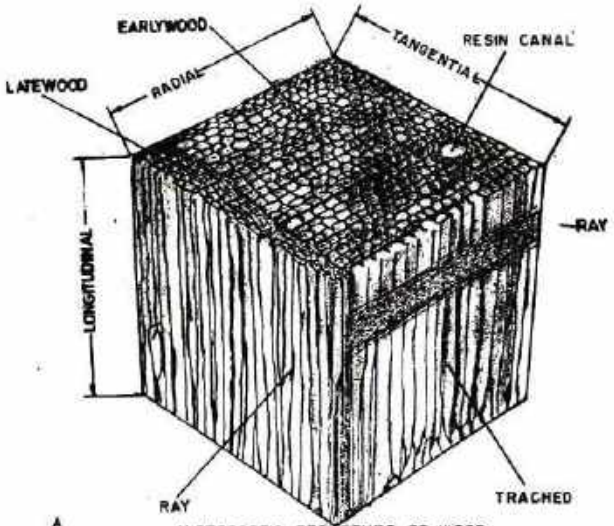
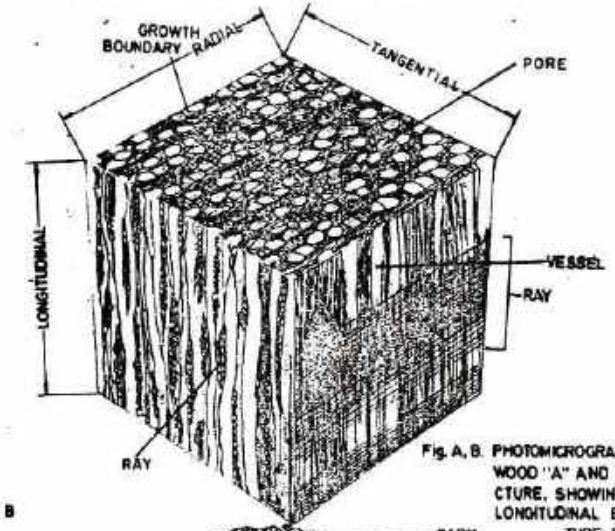


Fig.13. GROWTH AND DIVISION OF CELLS

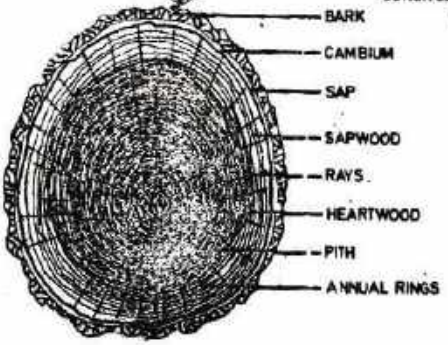


A MICROSCOPIC STRUCTURE OF WOOD



B

Fig. A, B. PHOTOMICROGRAPHIC MODEL OF SOFTWOOD "A" AND HARDWOOD "B" STRUCTURE, SHOWING GROWTH INCREMENTS, LONGITUDINAL ELEMENTS, RAY STRUCTURE, RESIN CANAL



CROSS SECTION OF HARDWOOD STEM WITH DARK COLOURED HEARTWOOD AT CENTRE, LIGHTER COLOURED SAPWOOD SURROUNDING THE CORE AND ON THE OUTSIDE

The walls of wood cells are composed of structural substances. The framework substance is CELLULOSE which occurs in the form of MICROFIBRILS. The multiplication of cells occurs by splitting of the individual cell.

SAPWOOD AND HEARTWOOD Fig.14

The sapwood-heartwood pattern is one of the most obvious features that can be observed on the cross or radial section of a mature tree trunk. Most trees have an inner core of dark coloured wood, heartwood and an outer shell of light coloured tissue called sapwood. This contrast in colour has physiological significance in a general way, but it is not strictly correct to designate the CORE as heartwood only, on the basis of its darker colour. For commercial purposes, however, colour is the determining factor used for the separation of sapwood from heartwood.

Fig. 14. SAPWOOD AND HEARTWOOD

DEFECTS AND ABNORMALITIES OF WOOD

NATURAL DEFECTS

KNOTS Fig.15,16

The most common natural defects is one over which foresters have limited control, KNOTS.
A knot is a branch that is included in the wood of a tree stem by growth around its base. As long as the branch is living, the cambium of the stem and branch are continuous and the resulting knot is INTERGROWN or TIGHT. Once the branch has died, the continuity of the cambium is interrupted and the knot produced is ENCASED or LOOSE. The appearance of a knot in a piece of lumber depends upon the direction of cut through the included branch. When the cut is made along the axis of the original branch, the knot appears as a spear knot on the surface of the wood. When a transverse cut is made through the branch, the knot appears round or oval. If a branch is pruned naturally after dying, or if a living branch is artificially pruned, the branch end is grown over and any wood produced subsequently

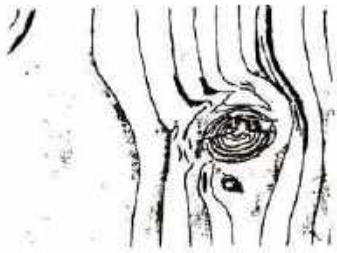


Fig.15. TIGHT KNOT

in this area of the stem will be knot free. When the lower branches are pruned early in the life of a tree there is a larger proportion of clear wood produced than if they are allowed to remain for a longer period.
The market value of lumber is, of course, related to lumber grade, clear wood bringing the highest price. Lumber containing large and numerous knots is normally graded quite low.

Fig 16. SPIKE KNOT

TENSION WOOD Fig.17

TENSION WOOD occurs on the upper side of living trees and branches of high wind pressure. The presence of tension wood can be indicated by eccentric growth as seen on the end of a log, wide rings occuring in the region containing tension wood. Tension wood tested of its tensile in the green condition is particularly low, when air dried, however its tensile strength is higher than of normal wood (nail hard).

Fig 17. TENSION WOOD ECCENTRIC PORTION OF STEM CROSS SECTION

VARIATION IN LOG FORM Fig.18

Logs from trees having abnormal butt swell, crook, sweep or excessive taper can yield lumber of lower grade due to so-called short grain or cross grain defect. When logs with butt swell are sawn there is, of course, considerable wood loss in the form of slabs, the bark and other portion of wood cut from the log.

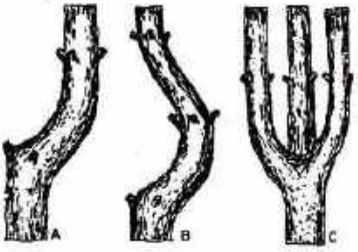


Fig.18. (A) CROOK TREE (B) KNEE TREE (C) FORK TREE

EXCESSIVE TAPER AND SPIRAL GROWN TREE Fig.19,20

Excessive taper in a log also leads to greater waste than a normal straight grown tree. It leads as well to cross grain or diagonal grain defects unless taper sawing can be done, that means, sawing parallel to the bark. Lumber produced from SPIRAL GRAIN, CROOK or

Fig.19. SPIRAL GRAIN

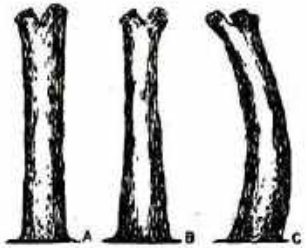


Fig.20. (A) STRAIGHT GROWN TREE (B) EXCESSIVE TAPER TREE (C) CONCAVE TREE

SWEEP also contains cross grain. Furthermore, short material and waste result from cutting logs having such abnormal form.

SHAKE

Shake is a defect which is classified as natural because it occurs in the standing tree. The splitting and complete separation of portions due to differential stresses of various origins.

FROST CRACK-SHAKE Fig.21

Frost shake is caused as the name indicates by frost. The wind causing the tree trunks to sway. With contraction of the outer portion of the stem followed by expansion upon warming, the trunk cracks along the grain.

Fig. 21. FROST CRACK SHAKE

HEART OR STAR SHAKES Fig.22

This is a crack in the heartwood near the centre of the tree, extending towards the outer layer. It may be due to faulty seasoning, or more frequently, to decay in a fully matured tree.

Fig. 22. HEART OR STAR SHAKE

DRYING CRACKS Fig.23

This name is given to a crack starting usually from the outer layer of the log and extending towards the center generally along the line of the medullary rays. The fault is due to the shrinking of the outside of the log from the effect of uneven or too rapid seasoning, exposure to strong sun and winds, or to severe frost, damaging the outside of the tree during growth.

Fig. 23. DRYING CRACKS

CUP SHAKES AND RING SHAKES Fig.24

A crack which follows the lines of the annual rings, and which is caused by the separation of these rings owing to loss of adhesion between the layers. The fault is generally produced

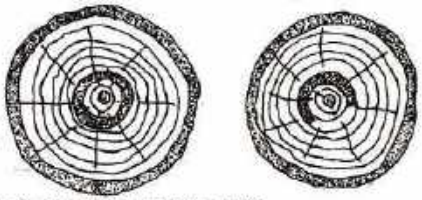


Fig. 24. CUP SHAKE AND RING SHAKE

by a check in the growth of the tree, or by the excessive bending or twisting of the tree by high winds.

THUNDER SHAKE OR UPSET Fig.25

Both these names describe a rupture of the fibres across the grain, this can rarely be detected until the timber is planed. It seriously weakens the timber as sometimes the fibres are completely broken across the grain. It is caused by thunder or by faulty felling.

Fig. 25 THUNDER SHAKE

WET ROT Fig.26

This is a form of timber decay which results from pools of water lying stagnant in hollows in the living tree. The wood rots to a brown powdery mass. The term is also applied to decay in outdoor timber, where it is subjected to alternate wet and dry conditions particularly at ground level in posts. The latter defect can be prevented to a large degree by the use of preservatives on the timber before it is placed in position.

Fig 26. WET ROT

DRY ROT Fig.27, 28

This is caused by the decay of timber due to the action of fungus, a soft spongy plant growth, which grows strongly when the timber is in a moist, warm condition around which the air cannot circulate freely. The wood becomes completely destroyed and crumbles at the touch, and it is difficult to get rid of the fungus completely. On exposure to the sun or to freely moving air-currents the fungus will be destroyed. All infected timber should be burned and all surrounding masonry, soil and sound timber be given a thorough coating with creosote, boiling tar, hot lime, copper sulphate solution, kerosine, or any other preservative.

Fig.27. DRY ROT

Fig.28. TYPICAL CUBICAL PATTERN OF CROSS-CHECKS IN BROWN-ROTTED WOOD

Burning with a blowlamp helps to kill the fungus pores. Arrangements must be made for thorough ventilation of the area, otherwise the trouble will occur again.

TERMITES Fig.29

These important wood-boring insects, often called WHITE ANTS are found in virtually all parts of the world with the exception of the arctic and antarctic regions. In the tropical regions, members of the Termitidae are very common inhabitants of decaying wood. White ants generally affect those timbers which are directly in contact with the earth. Ants eat the timber and leave clay on the surface of the wood.

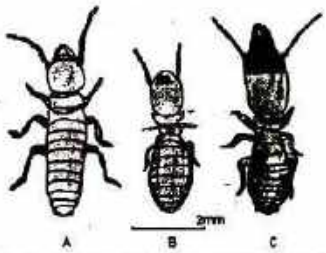


Fig.29. TERMITE CASTES (A) SECONDARY REPRODUCTIVE (B) WORKER (C) SOLDIER

CONTROL

The best approach to prevent termite infestation is to carry out certain safety precautions on the healthy wood. All wood used during layout work, in the construction of forms and scraps should be removed from the side before filling around the foundation. Such materials left under porches or steps invite termite attack. The soil under a building should be poisoned and then covered with heavy tar paper. Where possible, the wood of the building should be treated with preservatives like coal tar oil, chlor naphthalenes, metalic naphthenates, copper and chrome arsenates etc.

WOOD-BORING INSECTS POWDER-POST BEETLES Fig.30,31

The term powder-post is often used in describing the damage done by beetles. Insects from this broad group are widely distributed throughout the world and are the source of great damage to articles and structures made of wood. Adult beetles are reddish to

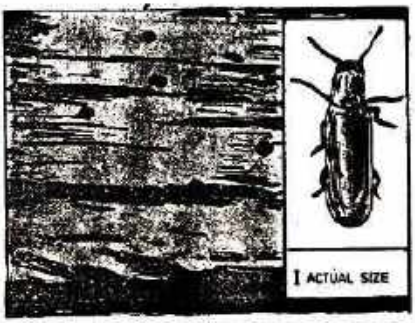


Fig. 30. EXIT HOLES OF LYCTUS POWDERPOST BEETLES IN HARDWOOD TABLE LEGS

brownish in colour and from 2 to 7 mm in length, depending on species. The wood attacked by LYCTUS beetles is generally restricted to the sapwood of seasoned or partly seasoned hardwoods. Coniferous woods are not attacked by lyctus beetles. The LARVAE, which are responsible for the damage caused, cannot digest cellulose, but require sugar or starch as a major constituent of their diet. Boring is, therefore, limited to the sapwood which is richer in starch than heartwood. Eggs and larvae develop in moist conditions ranging from 10 to 28%.

Fig.31. LYCTUS POWDERPOST WORK IN HARDWOOD LUMBER VERTICAL SECTION

WOOD-FEEDING ANOBIIDAE Fig.32,33

Representatives of the family Anobiidae can be found in most parts of the world. They are important pests of wood products and structures, causing great damage all over the world. In Europe attacks by the DEATH WATCH BEETLE and the FURNITURE BEETLE are wide spread. Death-watch beetle, typical of the anobiidae wood feeders, differs from the lyctus beetle in its food preference. It has been found in both, softwood and hardwood, heartwood and sapwood. It prefers old seasoned timber such as furniture, flooring and similar wood work. The less specialised feeding habits of this group are related to the insect's digestive abilities. They can digest cellulose and do not need so much sugar and starch. They develop in four distinct stages; EGG, LARVAE, PUPA, and ADULT. Eggs are deposited in cracks in woods rather than being limited to vessel openings.

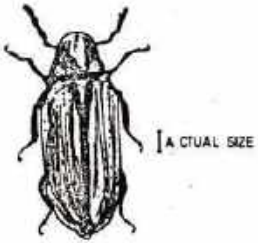


Fig.32 DEATH WATCH BEETLE

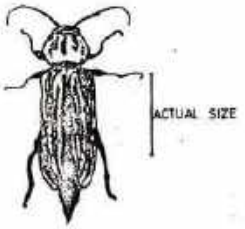


Fig.33 FURNITURE BEETLE

The larvae does not bore along the grain as the powder-post larvae do. The duration of a life cycle is from one to several years for the anobiidae and a few months for lyctus beetles, depending upon temperature.

WOOD PRESERVATION

Wood preservation means treating wood with solutions which make i. poisonous to fungies, insects and marine borers. A wide range of methods for preservative treatment has been developed during the long history of wood preservation practices. If the wood preservation is to provide protection to all parts of the wood susceptible to attack or deterioration, it must be distributed in sufficient concentration through out the vulnerable areas. Many methods of preservative application have been developed. Some of them are mentioned and explained.

METHODS OF APPLICATION PRESSURE Fig.34,35

This method is used for most timbers and sapwood of all kind. The timber is placed in a metal cylinder and the preservative forced into the timber under pressure. This method permits control over the amount of preservative absorbed which ensures complete penetration of sapwood and good penetration into heartwood.

HOT AND COLD OPEN-TANK TREATMENT Fig.36,37

This treatment is used for timbers and sapwood of all kind. The timber is placed in a tank of preservative which is heated. The timber is kept in the preservative while it cools, or is removed and placed into a tank of cold preservative.

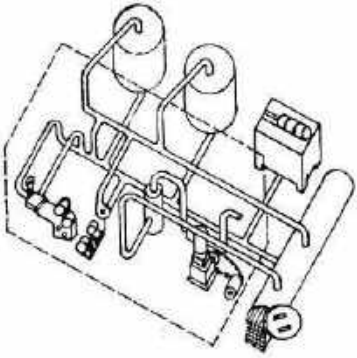


Fig 34 METHOD OF APPLICATION PRESSURE

Fig.35 COMPLETE PENETRATION OF SAPWOOD AND GOOD PENETRATION INTO HEARTWOOD

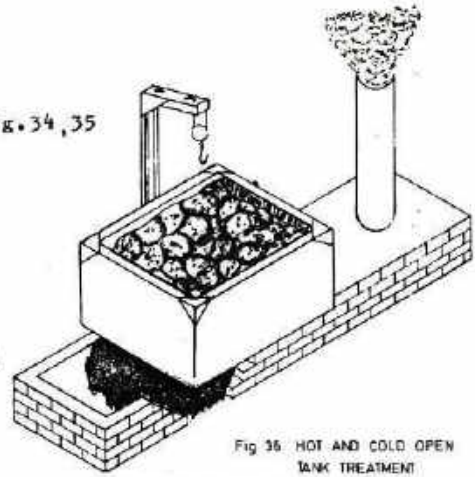


Fig 36 HOT AND COLD OPEN TANK TREATMENT

Fig 37 DEEP SAPWOOD PENETRATION AND SOME PENETRATION INTO HEARTWOOD

Deep sapwood penetration and some penetration into heartwood.

COLD DIPPING AND STEEPING Fig.38,39

The lumber is immersed in cold preservative. The longer the period of immersion the more effective the treatment, particularly with oils.

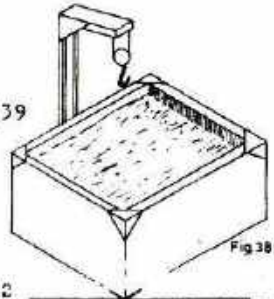


Fig.38 COLD DIPPING AND STEEPING

Fig.39 PENETRATION DEPENDING ON IMMERSION TIME, PERMEABILITY, MOISTURE CONTENT OF THE TIMBER AND TYPE OF PRESERVATIV USED

BRUSHING AND SPRAYING Fig.40,41,42

This treatment is particularly suitable for lumbers used for interior work. Not normally used if deep penetration is necessary.

Fig.40 BRUSHING

Fig.41 SPRAYING

Fig.42 SURFACE PROTECTION WITH VARIABLE PENETRATION INTO SAPWOOD

DIFFUSION Fig.43,44

This method is carried out at the sawmill only with lumber freshly felled and miled. The lumber is completely immersed in the preservative and then close-piled to allow the preservative to diffuse through the wood. Softwood lumbers not exceeding 3 inches in thickness to be used under the protection of a roof, or the surface sealed by the application of a coating such as oil, based-paint wood protect by this method, is not intended for use where there is direct contact with the ground or used where continuous contact with water are involved.

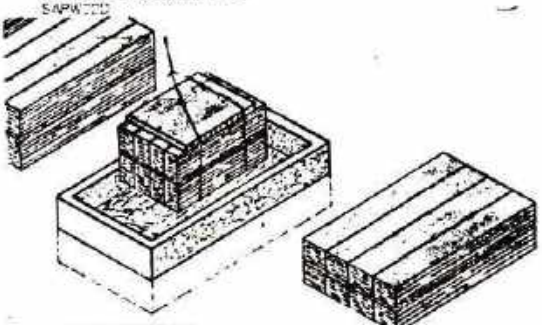


Fig.43 DIFFUSION

LUMBER QUALITY CONTROL

Wood being used in furniture production shall be declared with its correct name. This applies to solid wood as well as to veneers. Generally lumber is GRADED into two classes: Hardwoods and Softwood, which is again graded into 1,2,3 or A,B,C classes.

Fig.44. ALMOST COMPLETE PENETRATION

Grade 1 or A: is straight grown wood with or without very small knots, not affected by decay, rot or fungi. It should have its natural colour, no checks or splits.

Grade 2 or B: is common healthy wood a number of blemishes or defects, perhaps knotted but without holes. It can have a slight decay and the colour must be resonably natural.

Grade 3 or C: is wood with defects of all kinds but not to the extent of impracticality.

GRADE 2 OR B: HEALTHY KNOTS CAN MAKE THE WOOD MORE BEAUTIFUL

KNOTS WHICH CAUSE HOLES DECREASE THE VALUE OF THE WOOD

SAWING AND DRYING LUMBER.

METHODS OF SAWING Fig.45

The product of sawmills is LUMBER of various kinds obtained by ripping of the logs. LOGS are the different parts of a tree trunk, like fire wood, pulpwood, construction wood and industrial wood. In respect to the nature of processing, it is necessary to distinguish and to name all different parts after having been sawn on a LOG BAND SAW or FRAME SAW. The different names are:

1. half round wood,
2. dull-edged timber,
3. squared timber,
4. sleeper,
5. slab,
6. edging,
7. unedged board,
8. dull edged board,
9. partly dull edged board,
10. square board,
11. cylindrical stave,
12. quarter beam

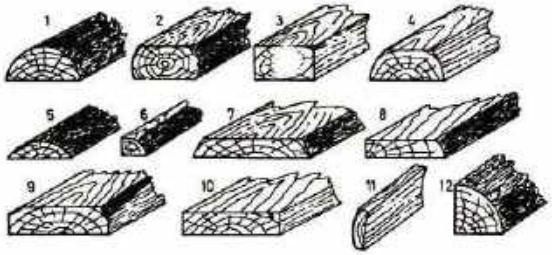


Fig 45. MAIN KINDS OF LUMBER

The two general methods of sawing lumber are PLAINSAWING, often also called COMMON or SLASH sawing. The second method is called QUARTERSAWING, of which there are four methods.

PLAINSAWING Fig.46

A slab is the first cut in plainsawing. The log is slabbed on either two or four sides to form a CANT, from which other plainsawed lumber is cut. Plainsawn lumber has several advantages over quartersawn lumber. More material is recovered when grain and figure are not needed to be considered and it is cheaper to cut.

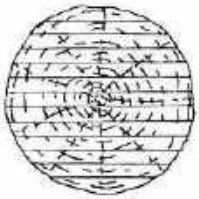


Fig 46. COMMON, FLAT OR SLASH SAWING: "SLABSAWING"

QUARTERSAWING Fig.47

Quartersawing can be done by any one of the four methods. RADIAL, TANGENTIAL, COMBINED radial, tangential and QUARTER-TANGENTIAL. The log is quartered and then cut radially from the bark to the centre. This is perpendicular to the annual rings. Quartersawing has the following advantages over plainsawing:

1. The wood does not twist and it warps less.
2. There is less shrinkage in width.
3. The wood lasts longer and wears more evenly when used for such purposes as flooring.
4. It does not crack as easily during seasoning.

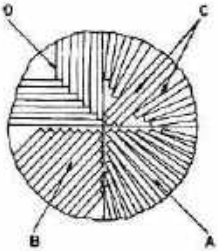


Fig 47 FOUR METHODS OF QUARTER SAWING (A) RADIAL (B) TANGENTIAL (C) COMBINED RADIAL AND TANGENTIAL (D) QUARTERTANGENTIAL

SEASONING OR DRYING

PROCESS OF DRYING LUMBER Fig.48,49

Seasoning lumber is the removal of moisture (water) until a specified dryness is obtained. Correctly seasoned wood has more strength, is more stable in use and is more resistant to decay than unseasoned wood. In seasoning, the MOISTURE CONTENT (MC) is expressed as a percentage (%). For example, wood under 10% MC is immune to decay. The lower the percentage figure, the drier the wood. Wood has an EQUILIBRIUM moisture content (EMC) when the moisture in the wood equals the humidity in the surrounding air so that it

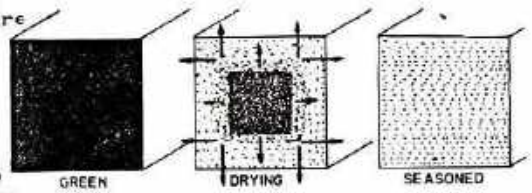


Fig 48. HOW WOOD LOSES MOISTURE

neither gains nor loses moisture. When wood is dried to the correct EMC it is more stable and shrinks or swells less. Damp wood in dry air shrinks, dry wood in damp air swells. The MC is only slightly affected by temperature, but it is considerably influenced by humidity. The EMC varies under different weather conditions. For example, if lumber is too dry, doors and drawers of side board swell and fit too tightly.

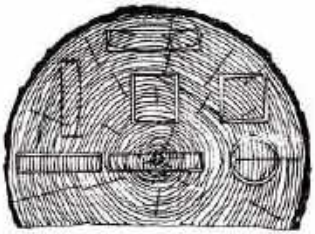


Fig 49. CHARACTERISTIC SHRINKAGE AND DISTORTION OF FLATS, SQUARES, AND ROUNDS AS AFFECTED BY THE DIRECTION OF THE ANNUAL RINGS.

METHODS OF DRYING Fig.50

Wood may be AIR-DRIED (AD), KILN-DRIED (KD) or both. Several days or weeks of kiln drying equal several years of air drying. The method of drying, the loss of moisture, and the time required for drying, affect shrinkage of wood during seasoning. Softwood can usually be dried faster than hardwoods, by either method. With thin boards (25 mm or less) and rather green stock, the stickers should be spaced 45 cm to 50 cm apart. With air-seasoned stock from 30 mm or more in thickness the space between the stickers should be 60 cm to 75 cm and in some cases up to 90 cm and 120 cm, as the thickness of the boards increases.

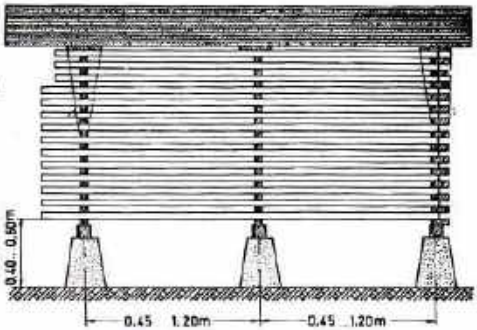


Fig 50 THE PROPER METHOD OF STACKING LUMBER FOR AIR DRYING OR SEASONING

PROGRESSIVE KILN

PROGRESSIVE KILN is similar to an assembly line. A car load of wood enters the kiln and goes through each of several drying compartments or stages of drying. The most modern kilns scientifically control heat, moisture, and air circulation, using special instruments. As the drying procedure continues, this condition is gradually reversed. Moisture is decreased and the heat is increased until the correct moisture content of the wood is secured. The wood is allowed to cool before removal

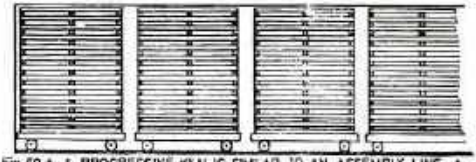


Fig 50 A A PROGRESSIVE KILN IS SIMILAR TO AN ASSEMBLY LINE. A CARLOAD OF LUMBE ENTERS THE KILN AND GOES THROUGH EACH OF SEVERAL DRYING COMPARTMENTS, STAGES OF DRYING

to the area where it is stored until it is used.

DETERMINATION OF MOISTURE CONTENT Fig.51,52

Moisture content of wood can be determined by using an ELECTRIC MOISTURE CONTENT METER, or perform an MC experiment by observing the following procedures.
Select a board from the wood to be tested. About 60 cm from the end of the board, saw off a piece 8 to 15 mm long. Weigh the sample as accurately as possible, and record the weight. Place the sample in an electric oven. Heat it up and dry it for about 30 minutes. Weigh the sample, record its weight and return it to the oven for approximatly 15 minutes. Continue weighing the sample periodically until the weight is constant. The MC can be calculated by using the following formula.

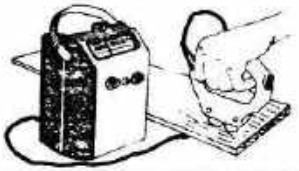


Fig 51 DETERMINING THE MOISTURE CONTENT OF LUMBER WITH AN ELECTRICAL MOISTURE CONTENT METER

$$MC = \frac{W-D}{D} \times 100 = \%$$

MC = percentage of moisture (moisture content)

W = Wet wood

D = Dry wood

Example:- $\frac{21g-18g}{18g} = \frac{3}{18} \times 100 = 16.7\ \%$

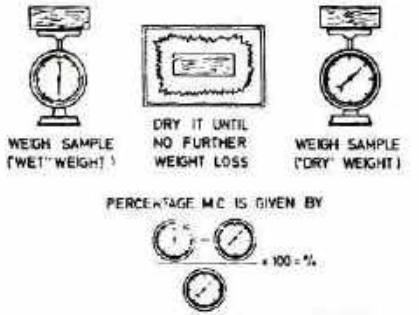


Fig.52 PICTORIAL FORMULA AND PROCEDURE FOR DETERMINING THE MOISTURE CONTENT OF LUMBER

AIR-DRYING Fig.53,54

Air-drying reduces the moisture content of lumber to a minimum of 15 percent. Wood is often stacked for air drying when it is to be used for exterior purposes. It may be air-dried and then sent to a kiln. In both air and kiln drying, space is left between layers of wood for proper air circulation. It consists of piling the boards or planks carefully in the open air by putting STICKERS

Fig.53 DETAIL OF STACKING LUMBER FOR AIR DRYING

crosswise between each layer of boards. The stack must be roofed to protect it from sun and rain. One of the most important and effective measures for wood protection is seasoning. Seasoning starts immediately after the cutting of green trees. At first liquid or free water (in practice commonly called "Sap") is removed or it evaporates. However, the disadvantage of shrinkage in the course of seasoning is more off-set (balanced or compensated) by a remarkable number of advantages, increase in resistance to blue stain and wood-destroying fungi, reduction in being attacked by same types of insects, reduction of warping, twisting, splitting and bending, reduction in weight (reducing transport costs), increase in stiffness, mechanical strength and hardness. Seasoning is therefore of the utmost importance for the economical utilization of wood.

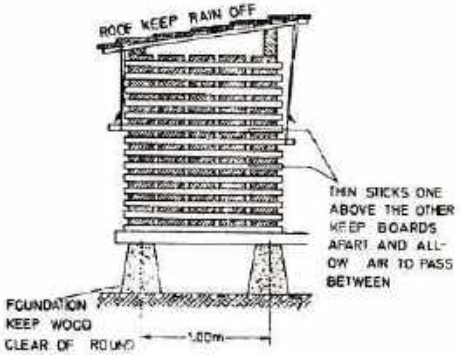


Fig 54 THE PROPER METHOD OF STACKING LUMBER FOR AIR DRYING

KILN SEASONING OR KILN DRYING

COMPARTMENT KILN Fig.55

Dry kilns are of two types, compartment and progressive kiln. After lumber is sawn, it is usually seasoned (dried) in kilns. It is stacked or piled and enters the COMPARTMENT KILN. In this type of kiln it usually remains in one location until it is dry. Generally flat piling is used in dry kilns and, as a rule, the boards are piled length-wise. The stickers can be made of any kind of dried lumber. They should be planed to an uniform thickness about 22 mm to 25 mm. The stickers should be spaced carefully to prevent warping.

The first treatment in the dry kiln is STEAMING. Steaming at about 95% relative humidity is the usual practice at the start of kiln drying. This process heats the lumber and relieves it of any stresses set up by CASEHARDENING during air-seasoning.

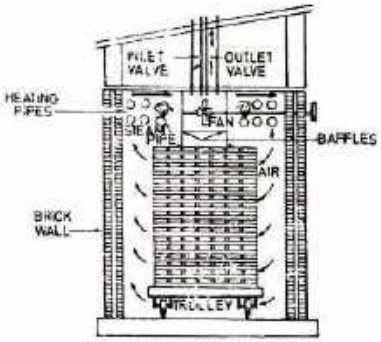


Fig 55. CROSS SECTION OF DRY KILN.

If green or very moist wood is steamed, drying takes place at first. The liquid water evaporates under the influence of the temperature of the steam. On the other hand very dry wood absorbs moisture from the steam. After the steaming has been finished, the drying process begins. The steam sprays are closed and steam is led into the heating coils. If electrical heated, instead of steam the electric heaters are set in function. The control of temperature is either by hand or automatically operated. The dampers are closed during steaming periods and opened by degrees as the drying proceeds.

SHRINKAGE OR DRYING DEFECTS
Fig.56,57,58,59

Shrinkage of millions of little cells causes tremendous stresses in lumber which is drying. If not properly relieved by adding moisture, the wood will split or crack in various ways. Some of the most common drying defects are "HONEYCOMBING" and "CASEHARDENING". Honeycombing means a series of checks or cracks either on the surface or in the center of the board. Casehardening means the drying of the outside layers of cells before the inside ones have had an opportunity to do so. The surface of a board, however, cannot shrink properly until the center has shrunk, thus causing this surface to become set when expanded. When the inside layers of cells become dry and are ready to shrink the wood becomes stressed.

Fig 56 CROSS SECTION OF A BADLY DRIED OAK-WOOD POST WITH GREAT INTERNAL CHECKS

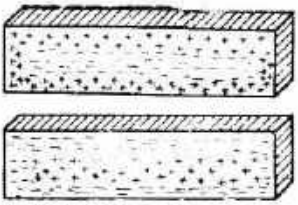


Fig 57 STRESS CONDITIONS IN DRYING WOOD LEADING TO CASE HARDENING DEFECT

Fig 58 DRYING CRACK AS SEEN IN CROSS SECTION

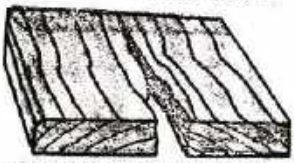


Fig 59 CRACKED BOARD DUE TO RAPID DRYING

SHRINKAGE AND SWELLING OF WOOD
Fig.60,61,62,63

How does wood shrink?
To answer this question we have to discover some of the fundamentals regarding wood's behaviour. It is good to know that a board warps, but it is much more important to know "Why"?
Wood has got a maximum value with its stiffness, strength and flexibility, but it has also one great inherent fault for almost every purpose for which it is used. It is HYGROSCOPIC. That means it will shrink and swell. Swelling means that water is absorbed by the FIBERS until the fibers are completely swollen. Shrinkage means that water evaporates from the cells and fibers until complete dryness. Shrinkage and swelling is not the same in the different grain direction. The greatest dimensional change occurs in a direction TANGENTIAL to the annual rings. Shrinkage from the pith outwards or RADIALLY is considerably less than the tangential shrinkage, while shrinkage along the grain or LONGITUDINALLY is so slight that it can nearly always be neglected. That means wood shrinks in three directions.

TANGENTIALLY, or along the circumference 10 % approx.

RADIALLY, or along the diameter 5 % approx.

LONGITUDINALLY, or lengthwise 0,1 to 0,3 approx.

Lumber which are abnormally light in weight shrink more along the grain longitudinally than heavier lumber.

Fig.60. PANELS WHERE TOO DRY

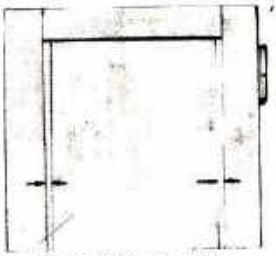


Fig.61. PANEL TOO WET

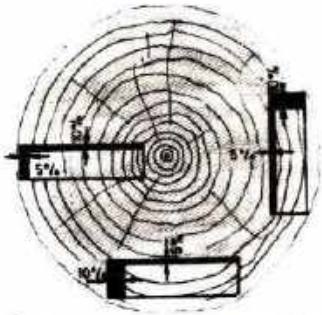


Fig.62 CHARACTERISTICS OF SHRINKAGE

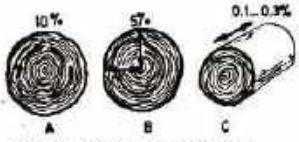


Fig.63 DIRECTION OF SHRINKAGE

TWISTING AND WARPING OF WOOD Fig.64,65,66,67

Board sawn through the center or quarter-sawn boards are practically straight, because they are sawn at right angles to the annual rings. These annual rings are short and, therefore, cannot pull in a circular direction. These boards are the most valuable because they do not twist and warp. On the other boards, however, the annual rings are longer on one side than on the other side. The pull is, therefore, greater on one side. Thus the pull will be greater on the outside-LEFTSIDE-than inside, heartside-RIGHTSIDE and the boards bend away from the heart of the stem.

Fig 64 THIS SHRINKAGE AND WARPING ALWAYS OCCURS AGAINST THE ANNUAL RINGS THE BOARD WARPS FROM RIGHT TO LEFT

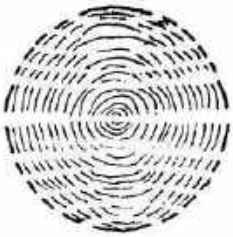


Fig.65 A CROSS SECTION OF A TREE AFTER BEING CUT INTO BOARDS SEE THE EFFECT OF SHRINKAGE ON OUTER BOARDS

VENEER

The production and use of veneer can be traced back to the earliest days of civilization. In the modern world, the improvement in the appearance and quality of veneer has been a result of three developments.

1. Machinery for cutting has been improved.
2. New methods of cutting have been developed.
3. More kinds of lumber is being used for veneer production.

METHODS OF CUTTING VENEER

ROTARY CUTTING Fig.68

This is the most economical cut. The FLITCH (log) is prepared and fixed into place on a lathe. It is turned against a sharp steel knife.

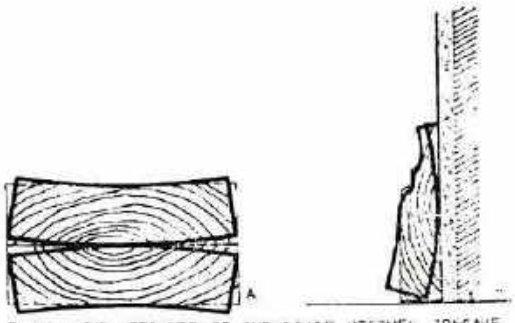


Fig 66 (A) THE LEFT SIDE OF THE BOARD BECOMES CONCAVE AND THE RIGHT SIDE BECOMES CONVEX (B) A PRACTICAL EXAMPLE WHAT WILL HAPPEN IF A SKIRTING IS USED INCORRECT

Fig.67 A BOARD FROM A TWISTED GROWTH OR SPIRAL GRAIN GROWN TREE AFTER SEASONING

This produces a continuous sheet of veneer somewhat like unwinding a roll of paper.

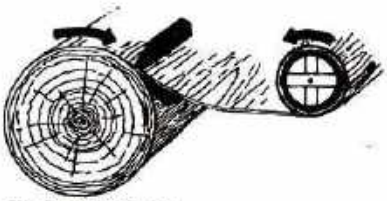


Fig.68. ROTARY CUTTING

SAWING Fig.69

Sawing is the oldest method, but produces only a small percentage of veneer stock. Band saws and special circular saws cut plain or quarter sawn veneers. This method is used for veneer comparatively thick which may be used for the plywood core.

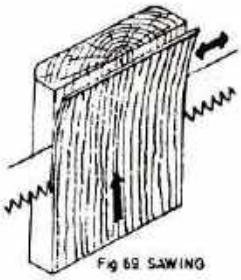


Fig 69 SAWING

SLICING Fig.70

Slicing is used to obtain special grain effects, particularly for face veneers. Different patterns and figure variations of wood-GRAIN structure are obtained by slicing. In slicing, the flitch is mounted on a stationary table and a movable knife slices a thin layer of the flitch, called veneer. There are five ways of slicing.

1. Flat slicing (most common)
2. Quarter slicing
3. Half round slicing
4. Block slicing
5. Rift slicing

Veneers are cut from 0,5 to 3,5 mm thickness.

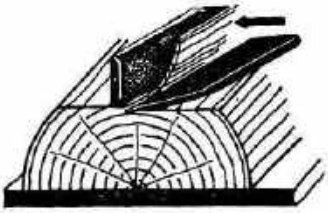


Fig.70. SLICING

VENEER DRYING

Veneers are usually dried in progressive type dryers specially designed for this purpose. These are somewhat costly and only firms dealing with large quantities of veneers, such as plywood manufacturers, install them. The veneer is fed slowly into dryers which operate on heat and steam.

PLYWOOD Fig.71,72

The name is used to designate wood panels of 3,5,7 and more layers of cross banded wood. The centre layer of plywood is sometimes thicker than other layers; it is called the CORE. Cross bands are glued to the core with the grain running at right angles to each other. This gives the plywood maximum strength with the least weight. Most veneer for plywood is rotary cut, but high quality plywood has sliced FACEVENEER on its right side. The backs of plywood are made of a less expensive wood that has similar characteristics to the face veneer. Exterior plywood is manufactured with a completely waterproof glue. Many hardwood plywood products are used in homes and in offices. Veneers and plywood for sports equipment have practically unlimited uses. Tennis rackets, bowling pins, hockey sticks, boats and hunting bows are a few of the thousands of items made of plywood. (Laminated construction)

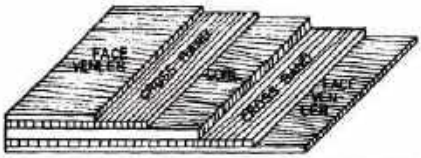


Fig. 71. FIVE-PLY PANELS PLYWOOD SHOWING DIRECTION OF GRAIN AND METHOD OF LAMINATION

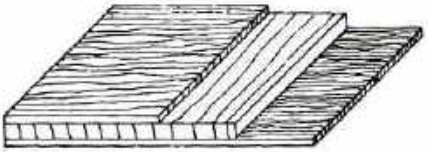


Fig. 72. THREE PLY PANELS

HARDBOARD Fig.73

Hardboard is a board, panel, or sheet manufactured from tiny wood FIBERS. Hardboard fibers have been arranged during manufacture to form a hard panel. Other types of wood sheets use various synthetic glues to hold the chips or the thin wood fibers together. Interior quality of wood or parts of a tree with big knots are used for hardboard production. Practically any form of wood can be the raw material for hardboard manufacture.

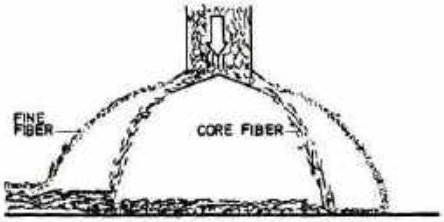


Fig.73 SCATTERING OF CHIPS AND FIBERS

Fig.73.A. CHIPBOARD WITH BEADINGS

PARTICLE BOARD OR CHIPBOARD Fig.73A

Particle board or chipboard is a board panel, or sheet that is made in various shapes and sizes form wood particles. These particles

include flakes, splinters, chips and shavings. They are banded together with various synthetic RESINS. All commercial hardwoods and softwoods can be used in making chipboard. Common softwoods used for chipboard are hemlock, fir, pine, cedar and redwood. The most important of the conditional additives are PARAFFIN. It is needed to lower the fairly great hygroscopity of the boards. PARAFFIN emulsion is usually mixed with the glue, in amounts ranging between 0,5 to 1,5 % of the dry weight of the chips. The most important other additives are:-

a. Preservatives against insects (the same substances are used in impregnating wood, the amount approx from 1 to 2 %).

b. Fire preservative substances (ammonium phosphate).

c. Colour substances

d. Substances to improve and prevent the chip mat from sticking to the press.

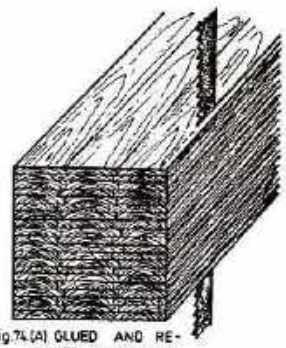


Fig.74 (A) GLUED AND RE-SAWED BLOCK CORE

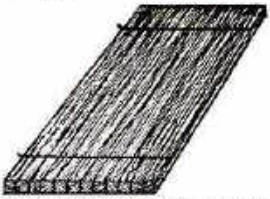


Fig.74 (B) CORE JOINT WITH A CORD

LAMINATED BOARDS Fig.74 A,B,C

Laminated boards are used for veneered furniture. They are built up with an inner core made of numerous narrow strips glued to each other. Both surfaces being faced with a 2 to 3 mm ply which grain lies at right angles to the core. The strips forming the core should not be wider than 7 mm. The aim and purpose of laminated boards is to obtain a strong and light board which does not warp and twist and can be used for high class furniture production.

Fig.74 (C) LAMINATED BOARD

BLOCK-BOARD Fig.75

The process of manufacture of block-board is closely related to the one of laminated boards. The strips forming the core are approx 20 mm wide. Blockboard is made in different thicknesses 13, 16, 19, 22, 25, 28, 32, 38 and 45 mm. It is less favoured for high class furniture.

Fig.75 (A) BLOCK BOARD

INSULATION BOARD

In the preparation of the pulp for insulation boards, the material passes through much the same stages as the continuous sheet of hardboard up to the rollers which extract most of the moisture from the board. From here the continuous sheet of insulation board is cut into various sizes and then passes through into a kiln or drying chamber. The sheets enter at one end and are continuously moving towards the other end from which they emerge at the correct moisture content. The insulation boards have excellent heat and sound insulation properties and they can be used for such work as roof insulation, ceilings, partitions, etc. They can be obtained in various sizes from 3.648 m (12 ft.) down to 1.824 m (6 ft.) in length and 1.216 m (4 ft.) in width and 12.7 mm (½ in.) thick.

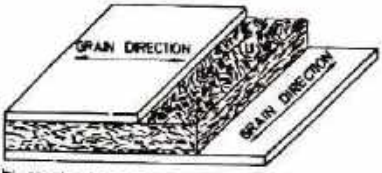


Fig.75(B) INCORRECT DIRECTION OF FACE VENEER THE BOARD WILL WARP

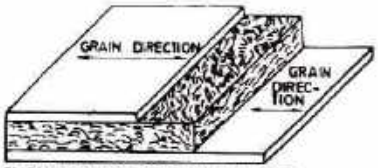


Fig.75(C) CORRECT DIRECTION OF FACE VENEER

LAMINATED PLASTICS (FORMICA) Fig.76, 76A

Laminated plastics consist of impregnated papers. The production of these papers, or films (bas film, decorative film, overlay film) is a complicated process, requiring extensive equipment. The impregnated papers are then cut and pressed together. There after the sheets are sawn to size and polished. Laminated plastics have proved to be the ideal answer to the increased demand for service free surfaces in homes, offices, and elsewhere. The material is resistant to heat, cold, grease, oils, cigarette burns, etc. Laminated plastics have since many years been used in the interior of kitchens and bathrooms as well as in the furniture industry for covering tables, cupboards, laboratory trolleys, etc.


Fig. 76 LAYERS OF COMPRESSED IMPREGNATED PAPER HAVING METAL-LIKE STRENGTH

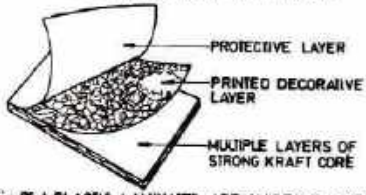


Fig.76 A.PLASTIC LAMINATES ARE MADE OF LAYERS OF STRONG KRAFT PAPER, A DECORATIVE SHEET AND PROTECTIVE TOP SHEET

The material has lately found new markets as wall linings in shops, schools, industrial premises, boats, buses, etc.

GLUING AND JOINING SMALL BOARDS TO A PANEL

EDGE JOINTS Fig.77

In order to obtain a unit of considerable width various methods of joining strips edgewise are common. The width of a PANEL will depend upon the number of strips from which it is made and the width of each strip. A wide strip however, is more liable to warping than a narrow one. For this reason strips should be taken with the smallest possible width to obtain a panel with a stable shape. Beside, the stability of the panel shape depend upon the arrangement of the growth rings of each strip.

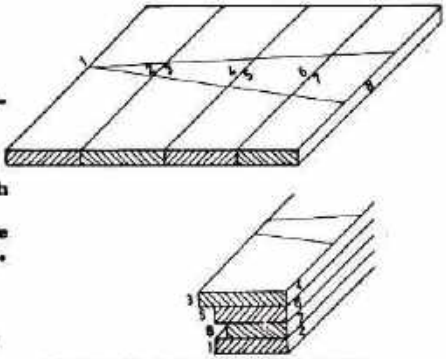


Fig 77 PROPER ARRANGEMENT AND MARKING OF BOARDS FOR EDGE GLUING

a. When making up panels of slashsawn strips with the growth rings arranged in one direction, the result will be greatly warped panels, but with a smooth surface. Fig.78

Fig.78 PANELS OF SLASH SAWN STRIPS WITH GROWTH RINGS IN ONE DIRECTION

b. When the arrangements of the growth rings are made in one LEFT, one RIGHT direction, the resulting panels have obtained only a small degree of warping, but having a wavy surface Fig.79

Fig 79 PANELS OF STRIPS, WITH GROWTH RINGS ALTERNATING IN DIFFERENT DIRECTION

The right side of a board is always towards the pith, (centre of the tree). The left side is always towards the bark.

c. When arranging the growth rings at right angles to the surface, a straighter panel will be obtained, with a smooth surface. Fig.80

Fig.80 PANELS OF STRIPS WITH GROWTH RINGS AT RIGHT ANGLES TO FACE OF PANEL

d. The best practice is to arrange the strips with similar edges joined together, SAPWOOD to SAPWOOD and HEARTWOOD to HEARTWOOD, the strips on the surface must be arranged left-right left-right. Fig.81

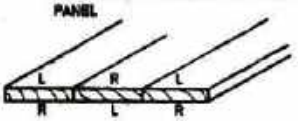
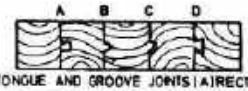
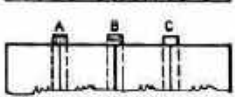


Fig.81 PANELS MADE BY CONNECTING SIMILAR EDGES OF ADJACENT STRIPS

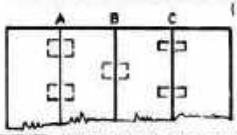
The edges of the strips can be glued together using butt joints, tongue and groove, splined and doweled joints. Fig.82



TONGUE AND GROOVE JOINTS (A) RECTANGULAR (B) TRIANGULAR (C) OVAL (D) DOVETAIL



SPLINED JOINTS (A) LONGITUDINAL SPLINE (B) CROSS SPLINE (C) PLYWOOD SPLINE



DOWELED JOINTS (A&B) FLAT DOWEL (C) ROUND DOWEL

Fig.82 EDGE JOINTS OF PANELS

VENEER JOINING AND GLUING Fig.83, 84 A,B,C,D

Veneering is the art of covering a plain board with a thin sheet of very thin veneer slice. A good veneered job is as strong and durable as a solid piece of wood. There are several good reasons for veneering.

a. The veneer adds strength, and offers a certain amount of protection to the boards to be veneered.

b. Rare woods are too costly and scarce to be used solid. Their beauty and richness would, therefore, be denied to most people were they not used as veneer.

c. Many woods of pleasing appearance have such curly grain that they are not strong enough for constructional use. Others have twisted or short grains which make them equally unsuitable. Curly grains of rare hardwoods are, however, suitable for veneer slicing because of their beautiful grain appearance.

d. The grain and figure of woods may be used with the advantage to produce beautiful and decorative effects.

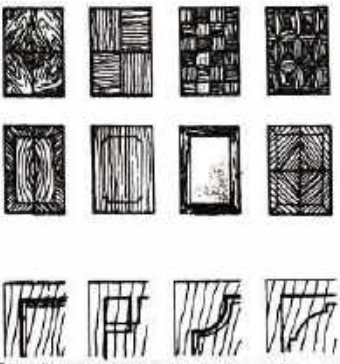


Fig.83 DIFFERENT POSSIBILITIES FOR SURFACE DECORATION AND DIFFERENT TYPES OF INLAY WORK

For cutting veneers a fine saw is used called VENEER SAW. The veneer is laid flat on a board for support, and the saw used with a straight edged board to guarantee straight cut. How to join veneer by hand? **Cut the veneer into size with a veneer saw. Clamp the pieces of veneer between two boards that have straight edges. See that the edges of the veneer barely project beyond the edges of the boards. Plane the edges with a sharp trying plane to form a perfect joint. To obtain a beautiful figure the veneer sheets have to be joined left-right left-right together.**

Fig.84 (A) CUTTING VENEER WITH VENEER SAW PLANING VENEER EDGE FOR MATCHING

Take a gummed paper tape and moisten the gummed side. Press the veneer joint together and glue a few short tape pieces across the joint. Glue another long piece over the full length of the joint. Some veneers are so badly warped that they are difficult to handle and to cut. They are straightened by being pressed between two flat, heated boards or in a press, after they have been moistened on both sides, and left for some hours to dry.

PREPARATION OF SURFACES TO BE VENEERED.

The type and condition of the surface preparation is most important for successful veneering. In most furniture factories laminated boards and chipboard are extensively used for veneering because of its non-shrinking character. Of these built-up boards, laminboard is the most suitable, because the narrow core strips have little or no tendency to warp and shrink. The surface to be veneered, therefore, remains perfectly flat which is a basic requirement in all veneering jobs. A trying plane is the tool for this work and if the surface is planed across the grain and in all directions, as well as along the grain, the surface will be fairly true. A true surface is the aim at this stage, and not a smooth finish. In some cases the toothing plane will be used to roughen the surface to provide a good key for the glue. Chipboard is sanded in big drum sanders to exact thickness and the surface is ready for veneering. When using PROTEIN GLUES (animal glue) for veneering the process of veneering will be different from processes with a synthetic glue.

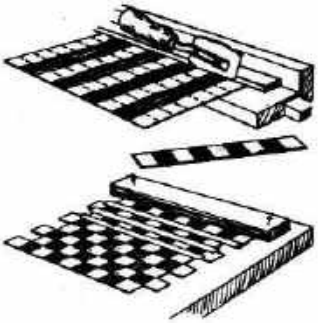


Fig 84(B) HOW TO JOIN VENEER FOR A CHESSBOARD

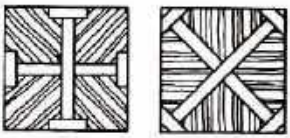


Fig. 84(C) HOW TO JOIN VENEER OF A CROSS JOINT

Fig. 84(D) FAULTS WHICH ARISE WHEN THE GUM-TAPE IS EITHER TOO WET OR NOT SUFFICIENT PRESSURE IS APPLIED ON THE GUM-TAPE

HAND OR HAMMER VENEERING Fig.85,86

In the process of veneering edges the veneer is pressed into close contact with the surface to be veneered by the action of the veneer hammer, which is not a hammer in the familiar sense, but a squeezing tool. Careful preparation is necessary for good veneering. The surface to be veneered is coated evenly and quickly with hot glue using a large brush. The veneer is placed in position and smoothed down on the surface. Starting from the centre towards either end along the grain and squeeze out all the surplus glue. Blisters may occur in the veneer occasionally, they have to be cut with a sharp knife along the grain, inserting a little glue and rubbing down again with the hammer. It may be necessary to cover the place with a piece of paper and clamp a hot block of wood or a sheet of zinc over it.

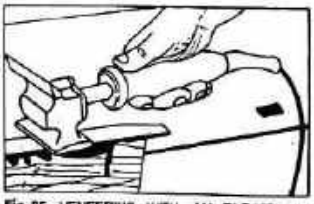


Fig.85. VENEERING WITH AN ELECTRIC VENEER HAMMER

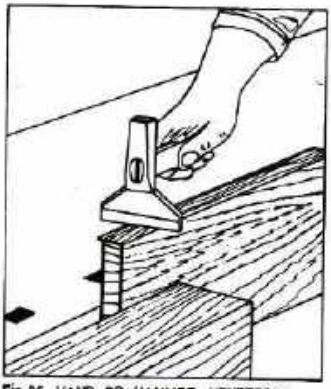


Fig.86. HAND OR HAMMER VENEERING

VENEERING WITH SPINDLE, STEAM AND ELECTRIC PRESS. Fig.87,88, 89,90

A SPINDLE press is a useful pressure device for small veneering jobs. When using protein glues a hot zinc sheet is placed between each board to be veneered, to heat up and melt the glue which has become slightly stiff while operating. The pressure to the veneered surface is applied by a hand wheel tightening the screws, squeezing the boards between a base or bed table and the upper pressure plate. Cold veneering is another

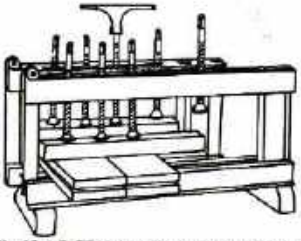


Fig.87. VENEERING WITH A HAND SPINDLE PRESS

method but it needs more time and the veneered board must be carefully re-dried after the setting of the glue. There are many types of HOT PLATE presses, mainly massive machines. They consist of a heavy structural head supported by four or more columns and a press table. When the press is open, there are spaces between the plates, known as DAYLIGHT'S. Pressure is applied by raising hydraulically the press table which in turn lifts the hot-plates. Heat is supplied to the plates by steam or hot water. Most of the presses reach a temperature of 110°C. Pressure is produced by rotary or piston pumps operated on hydraulic oil. The application of glue by hand has to be carried out quickly and utmost care has to be taken that the glue is spread even all over the surface. Every spot which is not covered with glue will result in blisters which are every difficult to repair.
Pressure which can be produced on different veneer presses differ from 2 to 25 kg/cm^2. Only specially built high pressure presses can produce a pressure of up to 300 kg/cm^2. (300 kilogram per square centimeter). In almost all board producing factories the application of glue is carried out with a glue spreading machine. In small workshops the brush or a teethed-glue spatula are still common.

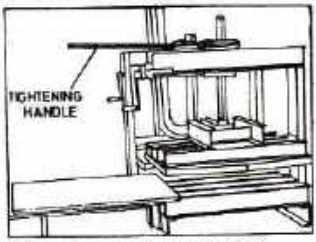


Fig.88. A TWO TABLE HAND PRESS

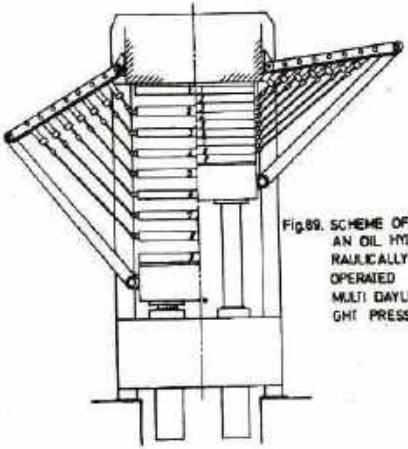


Fig.89. SCHEME OF AN OIL HYDRAULICALLY OPERATED MULTI DAYLIGHT PRESS

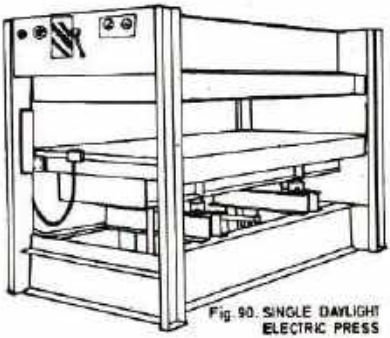


Fig.90. SINGLE DAYLIGHT ELECTRIC PRESS

GLUES

In the beginning of the 20th century, synthetic materials made their appearance. During the 1930's several such glues were brought on the market and variations are still being discovered even today. Glues can be classified on the basis of many criteria. The two main groups are:

1. NATURAL GLUES
2. SYNTHETIC GLUES

The former group is further divided into two sub-groups.

a. Vegetable glues
b. Protein glues

The latter can also be divided into three sub-groups:

a. Thermosetting glues (Duro-plast).
b. Thermoplastic glues (Thermo-plast).
c. Elastomer glues.

NATURAL GLUES

This class of glue has become less important during the last 20 or 30 years. One can say that certain natural glues are still important as such as in combination with plastic glues.

VEGETABLE GLUES

This group comprises of VEGETABLE PROTEINS and water soluble glues containing lignin. They are used for easy-gluing operations of modest requirements: Raw materials for STARCH GLUE are:

Potatoes, wheat, rice, maize etc. Tapioca starch, which is obtained from cassava grown in Java.

PROTEIN GLUES

Protein glues are usually made from ANIMAL RESIDUES (hides, leather, bones, fish residues). The protein contained in these residues decomposes into GLUE-TINE on applying heat. It is easily dissolved in hot water. Glutine glue is suitable for indoor use; main field of application is furniture. This glue is elastic, chemically inactive, it sets very quickly and is easy to apply.

CASEIN GLUES

Casein is a MILK PROTEIN which is made from milk by means of enzymes or acids. The latter kind, acid casein, is the actual raw material for glues. Casein is dissolved in alkaline water. The pot life of this glue is very short but it can be lengthened by means of chemicals (phosphates, fluorioles etc). Casein can be stored for many years in air tight packages. The casein glue is simply to be mixed with cold water.

ALBUMINE GLUE

Albumine is a constituent of BLOOD. Alubmine-based glue has formaly been used widely in the plywood industry. Today, albumine only can be found in certain combination with phenol (Fenalb glues). Certain oily plant seeds yield an extract residue containing proteins which can be used for glue. The best known of these seeds are SOYABEAN. Soyabean glue is much used in Japan and in the U.S.A. All protein glues can be combined with varying mixtures of ratios, also with certain plastic glues like (phecarbamine).

PLASTIC GLUE

This is the most important group of glues due to its advantage of:-

1. Good resistance to water, even boiling.
2. Good resistance to chemicals and micro-organisms.
3. The setting process can be made very rapid.

Plastic glues have opened up many new possibilities of application and are still in a state of rapid development. Plastic glues can be divided into two groups:-

1. Phenol-formaldehyde resin, phenolic resins, resoreinol resin.
2. Carbamide resin, amino resins, melamine resin.

PHENOL GLUE

Phenol is a reddish substance mixed with carbolic acid. It is manufactured from COAL TAR and BENZENE by means of distillation. It is easily dissolved in hot water of + 65°C = 150°F. Phenol reacts easily with formaldehyde. The main use of phenol is hot gluing. The powder is dissolved in water so that the content of dry substance is 40-50 per cent. The glue sets by means of a hardener under pressure and heat. Phenol is resistant to water (even boiling) and is more heat resistant than wood.

RESOREINOL GLUE

This glue is a close relative of phenol. It is also made from BENZENE which is sulphurated with sulphuric acid. Resoreinol reacts very well with formaldehyde. This glue can be used in such exacting jobs as aeroplane construction, boat buildings, glued girders etc.

CARBAMIDE GLUE

This glue belongs to the amino compounds. It is made by a relatively simple process from CARBON DIOXIDE and AMMONIA and therefore, can be produced at a low price. Carbamide reacts with formaldehyde, it is a white crystalline substanc and soluble in water. It sets under heat or acid hardeners. Carbamide can be used in cold or hot gluing. The properties of carbamide glue can be considerably improved by adding melamine but this increases the price. Carbamide glue is widely used for instance in all kinds of board manufacture.

MELAMINE GLUE

Melamine is also an amino glue and belongs to the amino compounds. It is manufactured from LIMESTONE, CARBON and NITROGEN in a many staged process, resulting is a high priced product. Melamine is also a colourless crystalline powder. The glue is strong, elastic and water resistant, most suitable for high frequency gluing. Its advantage is the possibility of drying the surface after spreading glue.

MOWILITH GLUE

To provide carpenters and the wood working industry in Pakistan with a durable, ready for use glue, the HOECHEST.PAKISTAN LIMITED, KARACHI returned to the use of a plastic glue. That is distinguished by its exceptional adhesive powers on practically every kind of surface. The registered tradename is MOWILITH and POLYVINYL ACETATE (PVA) is its basic raw material. It is manufactured from acetylene and acetic acid. The polymerization process is uncomplicated. So it can be produced at a reasonably low price. No need of hardnener, easy to spread, easy to clean, rapid setting, low pressures needed, very elastic and it can be made thinner by adding only water. The glue is suitable for assembly gluing of furniture. The dry strength is very good. Hot gluing is also possible but in this case cooling must be done under pressure.

MOWILITH IN PRACTICE

General: In wood working industries for use in carpentry, this glue has been used since 1945. It glues wood based surfaces of all kinds, like plywood, chipboard, fiber board, plastic sheets and paper. Mowilith can be used at temperature above 18°C. Mowilith DLR can be used at 10°C. At higher temperature the "open assembly time" will be shorter because the water evaporation is higher. The different types of Mowilith can be mixed with each other, with the result of flexible "open assembly times".

STORAGE Fig.91

Mowilith can be easily stored. It remains durable for a very long time, if measures are taken to prevent the evaporation of water. Therefore, plastic or paraffin wax containers are suitable. Mowilith remains fluid even at low temperatures, also high temperatures do not effect the glue if it is protected carefully and is not exposed to the open air.

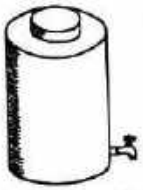


Fig.91. PLASTIC OR PARAFFIN WAX CONTAINER WITH A HERMETIC SEAL

HOW TO APPLY GLUE Fig.92,93,94,95

Mowilith may be applied with all the usual tools, brush, spatula, glue spreaders or other instruments. If the glue dries transparent the temperature is right. If it dries chalky white, then the temperature of wood, glue or workshop is too low. Pressure is required to bring pieces to be glued into the closest possible contact and to keep them in this position until the completion of the setting process.

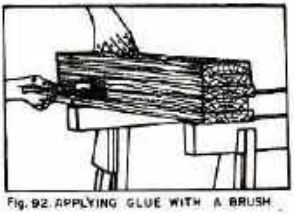


Fig. 92 APPLYING GLUE WITH A BRUSH

CLEANING OF EQUIPMENT Fig.96,97

Brushes, machinery, glue pots etc, may be easily cleaned with water so long as the glue is still wet. All equipment should therefore be washed immediately after completion of work. Glue pots that have become encrusted gradually soften in water and glue may be removed. Cloths are first soaked in water for 2-5 days by which time the dried glue should have softened and the cloths can be washed.

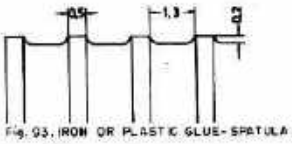


Fig. 93. IRON OR PLASTIC GLUE-SPATULA

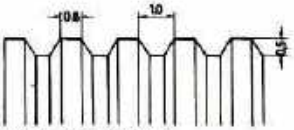


Fig. 94. RUBBER SATULA

FIELDS OF APPLICATION

1) Block gluing.
2) Edge jointing
3) Gluing of tenon and dowels.
4) Knot holes filling with wooden plugs.
5) Plywood gluing.
6) Gluing of cores.
7) Veneering.
8) Veneer jointing.

In these and many more fields of application setting time at 20°C (68°F) is about 1-1½ hours. While gluing tenons or dowels, their fitting should be exact and the glue should be applied on both sides of the mortise and tenon. After pressing, it is advisable to leave the parts stand for some hours before handling them further.

Fig.95. APPLYING GLUE WITH A SPATULAR

Fig. 96. GLUE BRUSHES

SPATULA WORK

A filler for cracks, etc. may be prepared from Mowilith as follows:

100 parts by weight Mowilith

250-300 parts by weight water.

100 parts by weight wood flour

300 parts by weight chalk.

PRESSING TIMES FOR VENEERING AND PLYWOOD GLUING

The pressing time depends on the temperature and the thickness of the plies or veneers to be glued:

1mm	176°F	80°C	=	3 minutes	approx
1mm	149°F	65°C	=	5 "	"
1mm	122°F	50°C	=	9 "	"
2mm	176°F	80°C	=	6 "	"
2mm	149°F	65°C	=	10 "	"
2mm	122°F	50°C	=	18 "	"

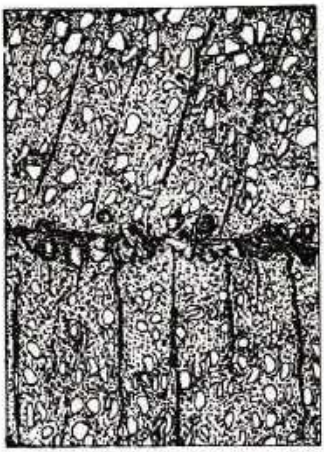
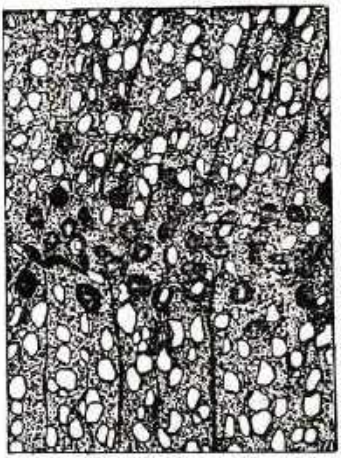


Fig 97. CORRECT. JOINT IS PROPERLY GLUED



INCORRECT. GLUE IS TO THIN IF PENETRATS TOO DEEPS INTO THE PORES

SELECTION AND DESCRIPTION OF TIMBER AND ITS USES

CHIR WOOD (Conifer) Fig.98,99,100

Botanical name : Pinus longifolia
Local name : Chil or Chir
Weight : 38 lbs. per cu.ft. air dry.

Description

The sapwood is yellowish white. The heartwood is yellowish. The wood has a characteristic resinous odour. It is usually straight grained but sometimes the fibers are twisted. The texture varies from fine to coarse. It frequently has large knots.

Seasoning

Chir is an easy wood to season if properly stacked in piles, sufficiently shed, protected from direct sun rays, hot and moist air, rains and fungi attacks, as it has a tendency to split and warp.

Strength

This wood is fairly strong as far as elasticity and shock resistance is concerned.

Durability

Chir is not a very durable wood but if preservatives are added, durability is increased. Sapwood of Chir can be readily treated, but heartwood varies in this respect. Sometimes complete penetration is obtained while at other times penetration is very poor.

Working qualities

Chir is an easy timber to saw and work. It is commonly used in all wood workshops, but it is more suitable for paint and enamel than for polish work.

Fig 98. SEED

SEED WITH A PRIMARY ROOT

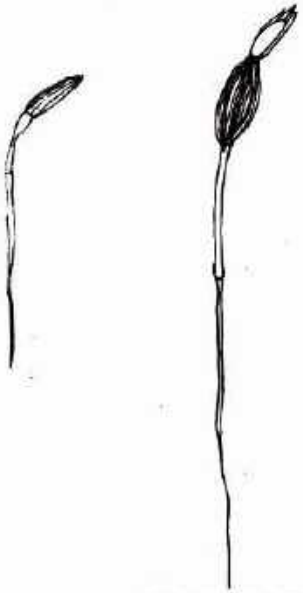


Fig 99. SEEDS WITH PRIMARY ROOTS AND SHOOTS

Uses

Chir is a popular building timber and is useful for railway sleepers after proper treatment. It is often used for beams and rafters, for constructional purposes, packing boxes, ordinary furniture, shingles and cores for laminated board.

Sources of Supply

Chir is available in the form of sleepers and logs from Punjab, N.W.F.P. and Azad Kashmir.

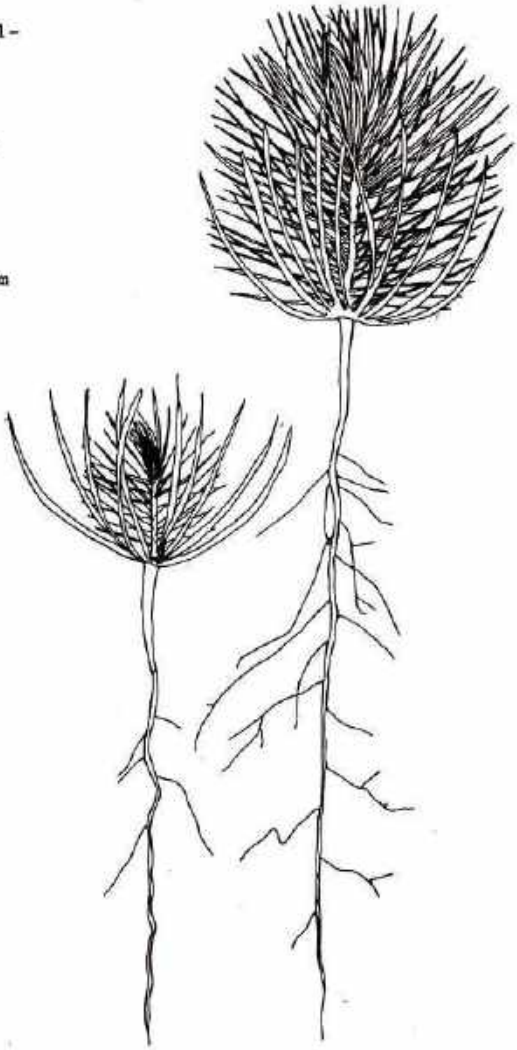


Fig 100. SEEDLING

DEODAR WOOD (Conifer)
Fig.101, 102, 103, 104

Botanical name : Cedrus deodara
Local name : Paludar, Diar, Devidar
Weight : About 35 lbs. per cu.ft. air dry.

Fig 101. SEED

SEED WITH A PRIMARY ROOT

Description

The wood is light yellow-brown in colour and contains volatile oil with a characteristic odour. It is a steady wood, usually evengrained. The timber is durable, with medium fine texture, but due to large knots, it is not suitable for veneer peeling.

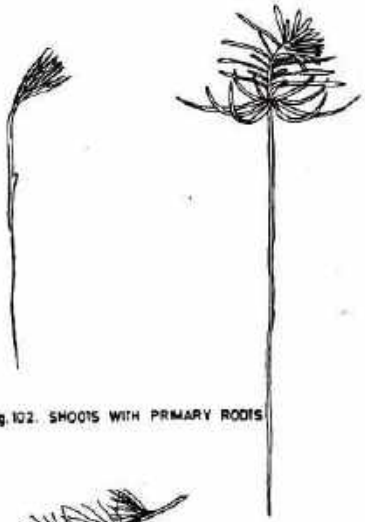


Fig. 102. SHOOTS WITH PRIMARY ROOTS

Seasoning

Deodar can be easily air-seasoned. It may suffer a little in seasoning from surface cracks and some splitting if dried too quickly. It is best seasoned under cover, but on the whole, Deodar gives very little trouble. It can also be kiln-seasoned without degrading in quality. The wood contains a volatile oil (from 3% to 10% of the weight of the dry wood) and this effects moisture content readings by the ordinary even-drying method. A moisture content reading may show for example, 18% water and 8% Deodar oil.

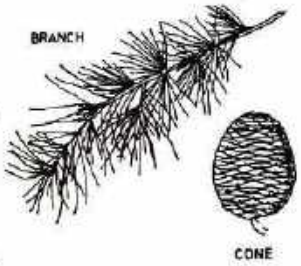


Fig.103

Strength

Deodar is the strongest of the Pakistani conifers. Its weight is 20% less than Teak and its strength is also about 20% less. Weight by weight therefore, it has about the same strength as Teak.

Durability

The seasoned heartwood of Deodar is durable, but it is by no means unknown for Deodar

heartwood to be destroyed by termites and fungi. It gives excellent results, if treated against these parasites. Generally, preservation liquids are absorbed well.

Working qualities

Deodar can be easily sawn and worked to a smooth finish. It is not, however, a suitable wood for polish or paint work, as the oil in the wood and the knots always penetrate through such finishes. The presence of knots also makes Deodar unsuitable for veneer peeling.

Uses

The primary use of Deodar at present is for railway sleepers and constructional work. It is sold mainly in sleeper form and is further converted into scantlings and boards for house building furniture, shingles and other purposes. It is an excellent pattern wood, being very steady when well seasoned.

Sources of Supply

Deodar is available in block and log form, chiefly from the N.W.F.P. and Azad Kashmir.

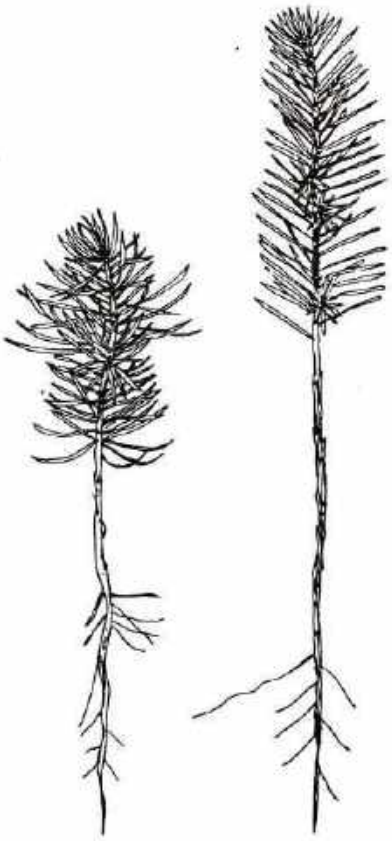


Fig. 104. SEEDLING

KAIL WOOD (Conifer) Fig.105,106

Botanical name : Pinus excelsa
Trade name : Blue pine
Weight : 32 lbs. per cu.ft. air dry.

Description

The heartwood is reddish buff, the sapwood is yellowish white. The wood has a characteristic resinous odour. It is a straight grained timber, usually with an excess of knots.

Fig. 105

Seasoning

Kail can also be easily seasoned. If it is stacked in well ventilated open piles preferably under cover or in shade, it will dry without any difficulties arising. If stacked out unprotected in the sun Kail tends to crack and split heavily. If close-piled in a damp atmosphere fungus attacks result. It can be kiln-dried without difficulty.

Strength

It is lighter in weight than Teak and reasonably strong for its weight.


Fig 106. SEEDLING

Durability .

It is not a durable wood for sleepers or for other outdoor work. It should be treated with a good preservative liquid, which does not penetrate into the wood easily.

Working qualities

Kail can also be easily sawn and worked and usually is a very popular wood in any workshop. It can be given a fine smooth surface but it is more suitable for paint and enamel finishes than for polish work.

Uses

Kail wood is a useful joinery wood and very suitable for the manufacture of drawing boards due to its softness of grains. It is mostly used for packing cases, constructional work and light furniture. It is also a suitable wood for pattern making and for cores of plywood.

Sources of Supply

Kail is growing around Murree and the Patriata Hills of the Punjab, the N.W.F.P. and Azad Kashmir River transported timbers can be obtained from the Jehlum Depot.

PARTAL WOOD (Conifer)
Fig. 107, 108, 109, 110, 111

Botanical names : Abies pindow or Picea morinda
Trade names : Fir or Spruce
Local names : Ravi, or Badar, Rewar, Tos, etc.
Weight : 30-33 lbs. per cu.ft. air dry.

Description

The colour of heartwood as well as sapwood is creamy white to light buff. It is inclined to be knotty. Clear timber in good lengths is rare.

Seasoning

Partal is also easily air-seasoned, but very prone to fungus attack if wet and should, therefore, be dried quickly after conversion. It can be stacked in the open but should preferably be protected with sheds against the sun and rain. It can be kiln-seasoned without any difficulty.

Strength

Partal wood is similar to Chir wood in strength, not as strong as Deodar but stronger than Kail.

Durability

Partal is not a durable wood and it is very prone to fungus and white ant attack, especially if laid on the ground. If used for railway sleepers or in exposed positions, the wood should always be treated with a good preservative but it should be noted that it is difficult to obtain a good penetration of the preservative liquid.

Working qualities

Partal is fairly soft and therefore, easy to saw and process.

Fig 107. SEED

SEED WITH A PRIMARY ROOT

Fig 108. SEED WITH A PRIMARY ROOT AND SHOOT

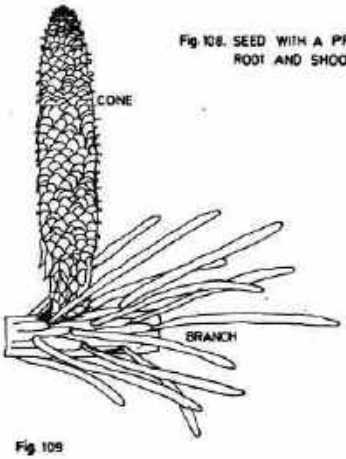


Fig 109

Uses

Partal is suitable for all types of packing cases, containers and fruit crates. It does well for cheap furniture and other purposes where strength combined with lightness should be considered. It is one of the few Pakistani woods suitable for aircraft work. If treated with good preservatives it is suitable for railway sleepers and shingles. It can be peeled on a veneer lathe but the often knotty wood makes peeling difficult. It is also suitable for paper pulp, but not very suitable for matches.

Sources of Supply

Fir and Spruce are available in the form of sleepers from N.W.F.P. and Azad Kashmir.

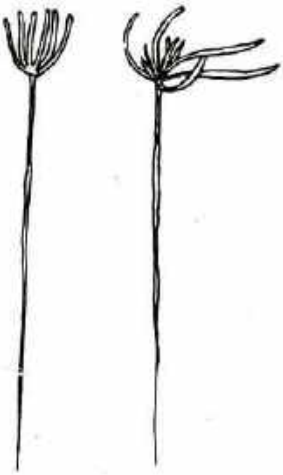


Fig. IID. SHOOTS WITH PRIMARY ROOTS

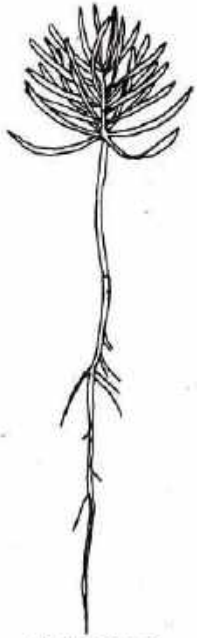


Fig. III. SEEDLING

BABUL WOOD Fig.112, 113, 114, 115

Botanical name : Acacia arabica
Local name : Kikar, Babur etc.
Weight : About 52-54 lbs. per cu.ft. air dry.

Fig.112. SEED SEED WITH A PRIMARY ROOT

Description

The sapwood is usually yellowish white. The heartwood when freshly cut is pinkish or old rose, but it darkens on exposure to a dull red or reddish brown. It is often mottled with darker streaks. The wood has straight or slightly twisted grains.

Strength

Babul is an extremely strong, hard and tough wood. It is nearly twice as hard as Teak and it is very shock resistant.

Seasoning

Babul is a wood which, if care is taken, can be air-seasoned with fairly good results. Preferably, it should be converted and stacked for seasoning during or just after the rains. If seasoning is started in the dry season, the wood should be stacked in sheds closed on all sides to slow down the drying. Excessive cracking may otherwise result. The wood can be kiln-seasoned without difficulty.

Fig.113

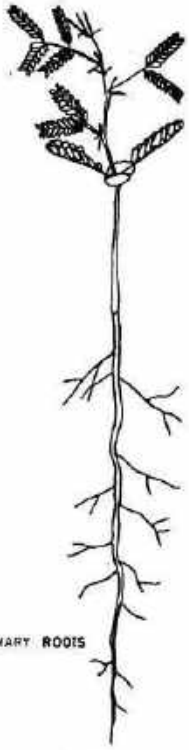


Fig.113&114. SEEDS WITH PRIMARY ROOTS AND SHOOTS

Fig. 114

Durability

The sapwood is not durable. The heartwood is durable in most situations but not to the same degree as Teak and Sal. It is usually used untreated, but it is advisable to treat it, if the wood is to be subjected to excessive wood destroying agents.

Working qualities

An easy wood to convert and to saw when green. Babul becomes harder and tougher when seasoned and is

easy to process with hand and machine tools. To achieve a proper finish, filling is required before polishing.

Uses

Babul is a very popular and useful fuel wood and very large quantities are consumed annually for this purpose. It is very popular for manufacturing agricultural implements. It is useful for certain tool handles and for tent pegs. The Railway uses it in fairly large quantities for anvil and brake blocks. It can be described as one of the best utility woods where hardness and toughness are required.

Sources of Supply

Babul is usually available in small logs only, but in some districts bigger logs are available. It is found throughout the drier regions of West Pakistan, the best sources being Sindh and Punjab.

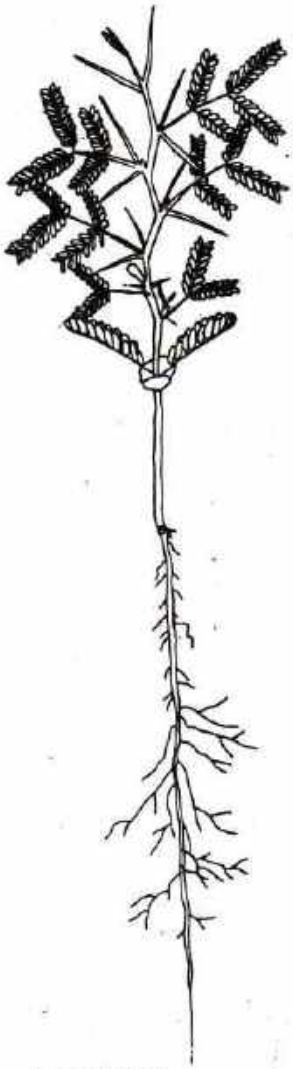


Fig. 115. SEEDLING

KAO WOOD Fig.116

Botanical name : Olea cuspidata
Trade name : Olive
Local name : Kao
Weight : 60-70 lbs. per cu.ft. air dry.

Description

The sapwood of Kao is pinkish or greyish white. The heartwood varies but is usually brown with a greenish or even pinkish tinge.

Seasoning

Care should be taken to protect from too rapid drying if cracks are to be prevented. This wood can be kiln dried, but mild conditions are necessary.

Strength

Kao wood is hard, strong, tough, elastic and is very shock resistant.

Durability

Kao has a good natural durability.

Working qualities

Kao is fairly easy to saw and process. It can be turned and finished to a beautiful surface and takes a high class polish.

Uses

This wood is especially suitable for tool handles, table work, walking sticks, toys and carving. Being ornamental, it can be used for inlay work.

Sources of Supply

Kao is available in the Salt Range, Kala Chitta and Jehlum Hills.

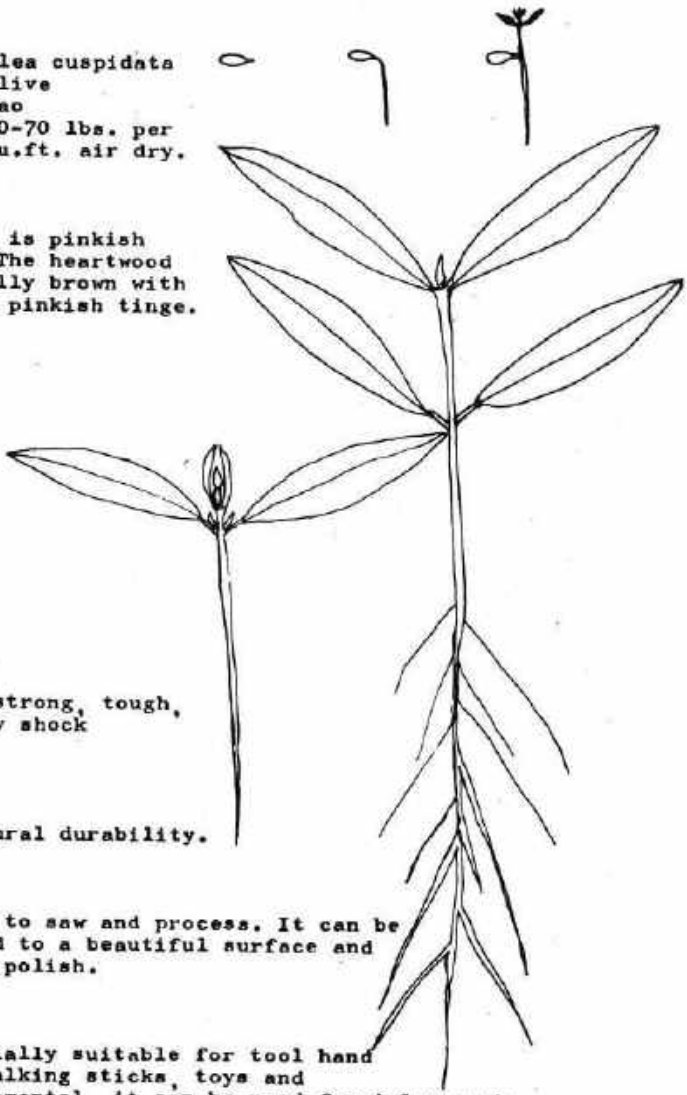


Fig.116. SEED SEED WITH A PRIMARY ROOT
, SEEDS WITH PRIMARY ROOTS AND SHOOTS

MANGO WOOD Fig. 117, 118, 119

Botanical name : Manifora indica
Trade name : Mango
Local name : Aam
Weight : 38-43 lbs. per cu.ft. air dry.

Description

Mango is a grey and greyish brown wood without any strong characteristic feature.

Seasoning

Mango is an easy to be seasoned. It usually dries out quickly with little deterioration. It is however, a wood which is rather prone to fungal stains and sometimes to decay, but with immediate drying these dangers can be avoided. It can be kiln-seasoned without any trouble.

Strength

Mango is slightly lighter than Teak. Shock resistance and wear are equal or slightly better than Teak.

Durability

Mango is not a very durable wood in exposed positions.

Working qualities

Mango presents no difficulties in so far as sawing and working are concerned. It can be easily finished to a clean surface and with proper filling it takes a good polish. Mango is also suitable for veneer peeling and slicing.

Uses

Mango is chiefly used for furniture, planking, floor and ceiling boards, boat building, agricultural implements, parts of carts, tonga-hood frames and plywood manufacturing. It is also used for shoe's heels.

Sources of Supply

Mango is available from Sindh, Punjab.

Fig. 117. SEED SEED WITH A PRIMARY ROOT

Fig. 118. SEED WITH A PRIMARY ROOT AND SHOOT

Fig. 119. SEEDLING

MULBERRY WOOD Fig.120

Botanical name : Morus alba
Trade name : Mulberry
Local name : Tut
Weight : 38-42 lbs. per cu.ft. air dry.

Description

The sapwood of Mulberry is white and contrasts sharply from the heartwood which is a bright yellowish brown when freshly cut. The colour of the heartwood quickly tones down to a duller brown on exposure. The wood is straight grained and of rather open, medium-coarse texture.

Fig-120 LEAVES AND FRUIT OF MULBERRY TREE

Seasoning

Mulberry is not a difficult wood to season, but it has a tendency to warp. The best results can be obtained by storing the quartered log for some months before final conversion. Mulberry can not be kiln-seasoned without difficulty.

Strength

Mulberry has approximately the same weight as Teak. As regards shock resistance and hardness, it is considerably stronger than Teak.

Durability

Mulberry is a fairly durable wood and is not prone to fungus attacks.

Working qualities

Mulberry is an easy wood to saw and process to a clean finish by hand or by machine. It can be turned to a smooth surface. It is an excellent wood for steam-bending. It can take a right angle bend without any signs of cracking. It is also suitable for veneer slicing.

Uses

The primary use for Mulberry is for sports goods, carriage building and for upholstered furniture. It is also useful in plywood manufacture.

Sources of Supply

The main source of supply of Mulberry is from the irrigated plantations and near the rivers in the Punjab.

SHISHAM WOOD Fig.121, 122, 123, 124

Botanical name : Dalbergia sissoo
Trade name : Shisham Sissoo
Local name : Tahli, Satisal
Weight : About 50-55 lbs. per cu.ft. air dry.

Description

The Shisham heartwood is usually of a golden-brown to dark brown colour. The sapwood is greyish and yellowish. It is as extremely handsome wood, often with rich grain figuring and if well seasoned, it is a durable wood of the first quality.

Seasoning

Shisham can be air-seasoned and kiln-seasoned without difficulty. Green conversion and careful stocking in open piles, preferably under cover will give good results in air-seasoning, as it dries out very readily. During very hot and dry weather, protection against too rapid drying is advisable as to avoid end cracking. Kiln-drying produces equally quick and satisfactory results and with the drying conditions under complete control it is possible to kiln-seasoned the wood with practically no deterioration. Heart centres are, however, a frequent cause of trouble. They often contain a white, calcarous deposit and it is advisable to box the heart centres separately when converting this wood.

Strength

Shisham is a fairly strong timber with average elasticity.

Durability

The heartwood of this timber is above average in natural durability and, under cover, will last for

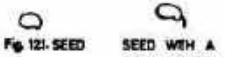


Fig. 121. SEED


Fig. 122. SEEDS WITH PRIMARY ROOTS AND SHOOT


Fig. 123. SHELL

a very long time. The sapwood, however, is very perishable and is quickly attacked by fungi. If sapwood is to be used, it should be treated with preservative liquid.

Working qualities

Although Shisham is hard, it is not difficult to saw and work to a beautifully smooth finish. In some exceptional cases, however, excessive inter-locking fibers make surfacing to a smooth finish difficult. Shisham can be used for veneer slicing.

Uses

Shisham ranks among Pakistan's finest furniture woods. It is also very good for constructional works and is frequently employed for house building and floorings. In rural areas it is commonly used for farm implements. It is also used for gun butts, carriage wheels, wagon parts and other similar purposes. The railway uses it for floor boards.

Sources of Supply

Shisham is obtainable chiefly from the Punjab with limited supplies from Sindh and N.W.F.P. Shisham logs and squares vary in different localities. Plantation supplies are usually straight and of good length. Riverside of roadside trees are usually shorter and stouter. The best timber can be had from Chahanga Manga and Lahore District.

Fig. 124. SEEDLING

WALNUT WOOD Fig.125,126,127

Botanical name : Juglans regia
Trade name : Walnut
Local name : Akhrot
Weight : About 36 lbs. per cu.ft. air dry.

Description

Walnut varies considerably in colour. Some are dull grey, while other woods may be dark brown with even darker markings.

Fig125 SEED

Seasoning

Walnut wood seasons slowly and shrinks considerably while drying out, therefore, very careful seasoning is required.

Strength

Walnut is relatively strong wood for its weight. It is about 80% the weight of Teak and its shock resistance is about equal to Teak.

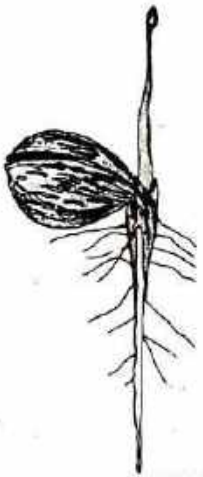


Fig.126. SEED WITH PRIMARY ROOTS AND SHOOT

Durability

Walnut is not a very durable wood and it does not offer much resistance to white ant and fungus attack.

Working qualities

Walnut is very easy to process with hand machine tools. Polished it gives a fine finish, very suitable for carving, for which it is used extensively in Kashmir. It is a well known veneer and plywood timber.

Uses

Walnut is very suitable for high class furniture production, tool handles, production of

rifle butts and high class sliced veneers. It can be carved very easily. (Kashmiri carvings on sofa sets, mirror frames etc).

Sources of Supply

The main supplies of Walnut in Pakistan are from Azad Kashmir. Smaller quantities can be obtained from the hill divisions of the Punjab, N.W.F.P. and Baluchistan.

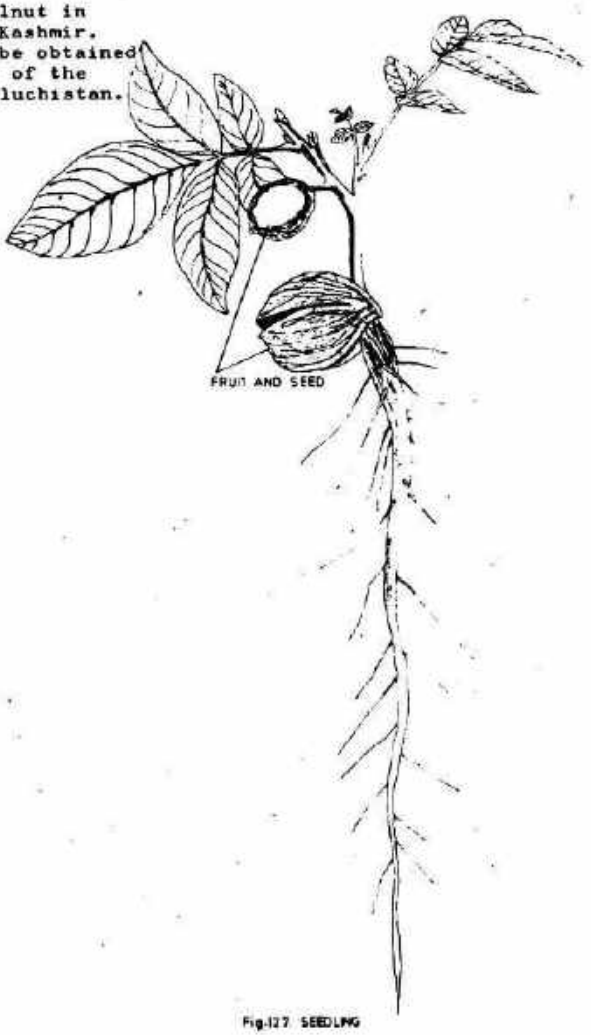


Fig.127 SEEDLING

SAL WOOD Fig.128, 129, 130

Botanical name : Shorea robusta
Trade name : Sal
Local name : Sal
Weight : About 55 lbs. per cu.ft. air dry.

Fig 128 SEED

SEED WITH A PRIMARY ROOT

Description

Sal is a reddish brown wood of medium texture with interlocking fibers.

Strength

Sal is a very hard, strong and tough wood. In hardness and shock resistance it is about 50% higher than Teak and about 20-30% higher in other strength characteristics.

Seasoning

Sal seasons very slowly and is prone to develop surface cracks and checks, therefore, careful seasoning is required.

Durability

Heartwood of sal is very durable, but sapwood is perishable and should not be used untreated. Sapwood treats readily but heartwood is not penetrated easily by a preservative liquid.

Working qualities

Dried Sal is not an easy wood to saw and process. It is very hard which makes it difficult for processing.

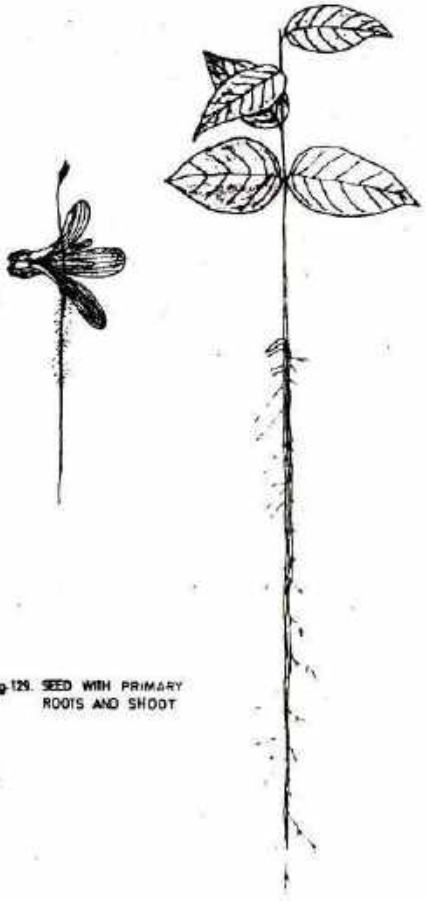


Fig.129. SEED WITH PRIMARY ROOTS AND SHOOT

Uses

Sal is very good constructional wood and is well suited for railway sleepers, beams, wagons and tool handles.

Sources of Supply

Dacca and Mymensingh (Bungla Desh)

Fig. 130. SEEDLING

SIMUL WOOD Fig.131,132,133

Botanical name : Bombax malabaricum
Trade name : Simul
Local name : Simul
Weight : 23 lbs. per cu.ft. air dry.

Fig. 131. SEED

Fig.132. SEEDS WITH PRIMARY ROOTS

Description

Simul is a very soft, creamy-white or pale pink timber, very light in weight and with large open pores.

Seasoning

Kiln-seasoning is the surest and best method of drying Simul without deterioration.

Strength

Simul is very soft. It can not stand wear as furniture industries demand.

Durability

Simul is a highly perishable wood. It is attacked within a few days of conversion by insects and fungi and is especially prone to blue staining. If Simul is treated, however, and does not get wet, it can last for many years.

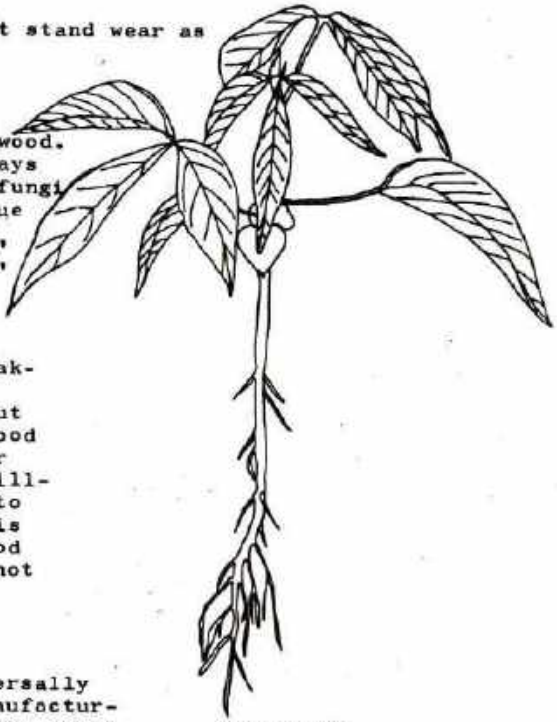


Fig. 133. SEEDLING

Working qualities

Simul is one of the easiest Pakistani woods to saw and work. It planes to a good surface but the large open pores of the wood prevent it from being used for polished work. With careful filling it can, however, be used to advantage for paint work. It is very suitable for light plywood containers where strength is not of great importance.

Uses

Simul is one of the most universally used timbers for match box manufacturing. It is also used for packing cases, suitable for veneer peeling.

Sources of Supply

Chittagong, Chittagong Hill Tracts and Sylhet.

TEAK WOOD Fig.134,135,136,137

Botanical name : Tectona grandi
Trade name : Teak
Local name : Sagoon or Sagoan
Weight : About 38-43 lbs. per cu.ft. air dry.

Description

Teak is one of the most outstanding timbers in the world because of its many invaluable properties, such as durability, strength, moderate weight, working quality, general appearance etc. Usually, the colour of Teak is golden brown which darkens on exposure. It is sometimes figured with dark markings. Timbers from Burma are somewhat straight-grained. Other available Teaks have irregular grains which increase the beauty of the wood.

Seasoning

It takes much care to kiln-season Teak. Sometimes the colour changes while seasoning, but a very good characteristic is that the colour changes uniformly.

Strength

Teak is a hard, strong wood and resistant to damage from impact loading.

Durability

Teak is a very durable wood, but the timber is liable to attack by the bee-hole borer, which can be prevented by treatment with wood preservative liquid.

Working qualities

Most pieces of Teak are easy to work with, however, the

Fig.134. SEED SEED WITH A PRIMARY ROOT

Fig.135. SEEDS WITH PRIMARY ROOTS AND SHOOT

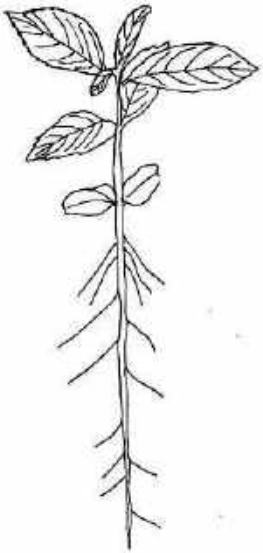


Fig.136 SEEDLING

dulling effect of Teak on the tools is quite considerable. A good finish can be obtained, therefore, only if the tools are sharp. While planing or cutting the end grain, care should be taken to avoid splitting, as the wood is brittle. It can be varnished or polished effectively.

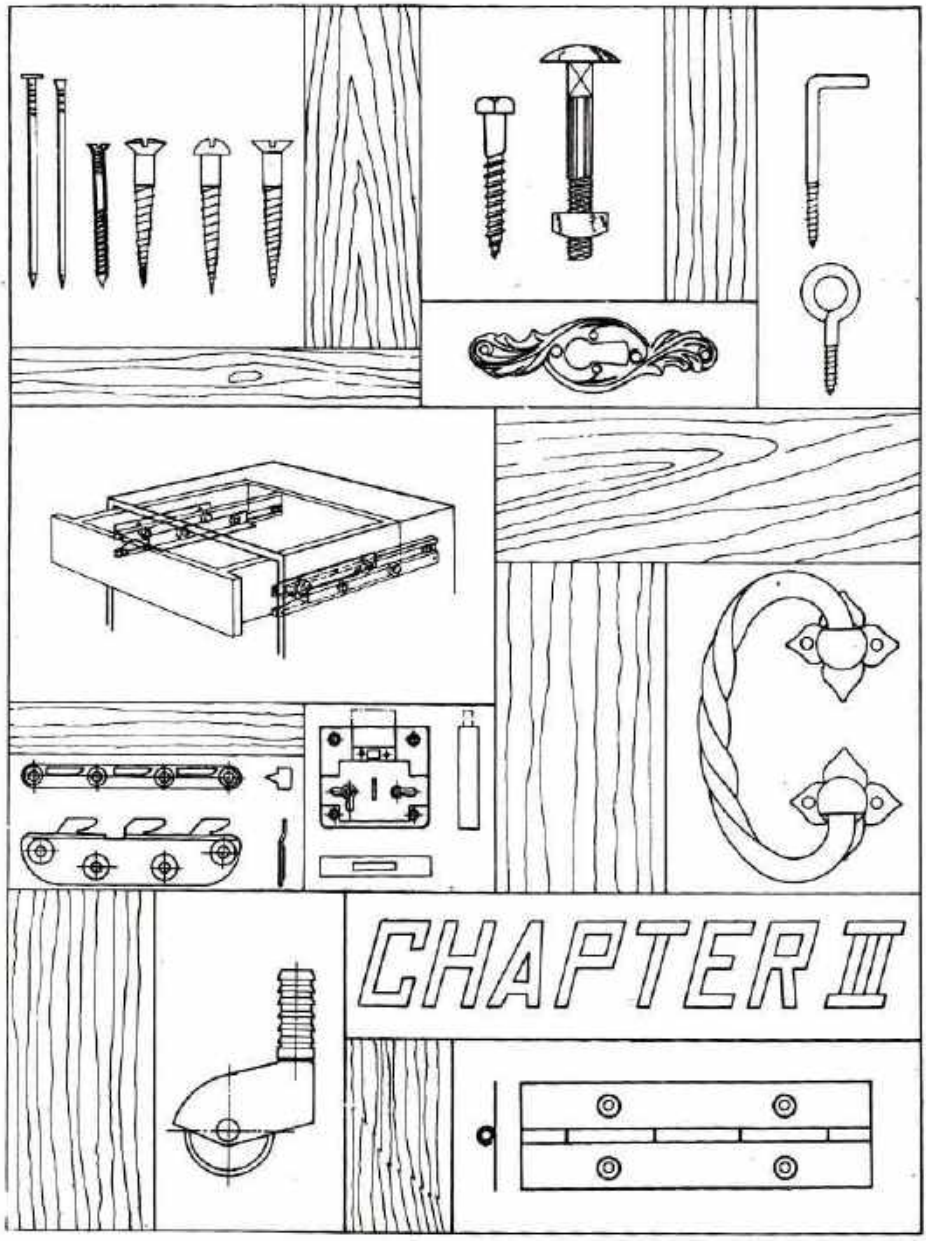
Uses

Teak has a large variety of uses, due to its stability and durability. It is used as the most suitable timber in ship building and is widely used in construction work and in furniture making. Teak is very suitable for high class veneers.

Sources of Supply

The best quality of Teak is obtained from Burma. Other sources are Chittagong in Bungla Desh, some parts of India, Indonesia and Africa.

Fig 137 SEEDLING


CHAPTER III

HARDWARE

NAILS

Although wood very frequently is joined together with glue, it can also be joined with nails, screws and bolts. Different kinds of hardware as hinges, locks, bolts, catches, casters, drawer pulls and knobs, are used in cabinet making. Nails are used in house framing, roofing, interior trim, box making, upholstery and for many other purposes. They are, therefore, made in many shapes and of different materials such as steel wire, iron, brass, copper etc. Some of the most common nails used in the woodworking industry are wire nails, box nails, casing nails, finishing nails and tacks.

COMMON WIRE NAILS Fig.138,139

Common wire nails are made with a large, flat head in lengths from 12 mm (½ inch). to 152 mm (6 inches). They are made by machines in large quantities from round wire and sharpened to a point at one end. The head is roughened to reduce the possibility of the hammer slipping off when striking. The upper part of the nail is similarly treated to assist grip. These nails are mainly used where the large heads are not an objection, such as in the manufacture or packing boxes, crates and general purposes in joinery.

BOX NAILS

Box nails are made like common wire nails, but are thinner than wire nails of the same length. Box nails have also a flat-head.

CASING NAILS

Casing nails have the same wire gauge as box nails. They are used for interior trim and can

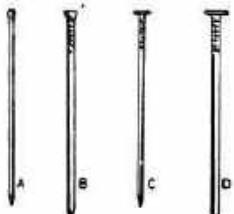


Fig.138. (A) FINISHING NAIL (B) CASING NAIL (C) BOX NAIL (D) COMMON WIRE NAIL

Fig.139. NAILS HASPS AND CLINCHERS FOR AIR DRIVEN NAIL STAPLE

be set below the surface of the wood, because they have a small head.

Fig.140.(A,B) FINISHING NAILS (C) TACK NAIL

BRADS OR FINISHING NAILS Fig.140

Brads or finishing nails are small nails used mainly for finishing process. They vary in length from 12 mm (½ inch). to 30 mm (1¼ inch). and are used to nail thin stock together, like fine picture frames or to fix glass in doors and windows.

TACKS

Tacks are also made of iron. They have a sharp point and a large head. They are used primarily in upholstery work and are made in lengths from 10 mm (0.39 inch). to 25 mm (1 inch).

BRASS, COPPER AND GALVANIZED IRON NAILS

Brass, copper and galvanized iron nails are used on work which is exposed to the weather and, therefore, likely to be damaged by rust. They are also used for decoration purposes.

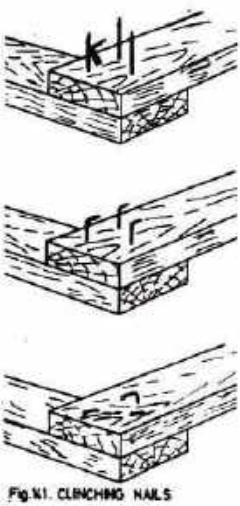


Fig.141. CLINCHING NAILS

RULES FOR DRIVING NAILS
Fig. 142, 143, 144

a) Glue, grease, or dirt on the face of a hammer will cause it to glance off when striking a nail. Clean it with a piece of fine sandpaper.

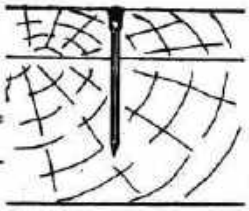


Fig.142. COVERING A NAIL HEAD

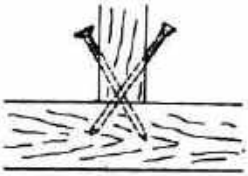


Fig.143. TOENAILING

b) When driving thin nails in hardwood, it is recommended first to bore holes for them.

c) Always clinch a nail with the grain, because its point can then be driven in between the wood fibers. This can not be done if the nail is bent across the grain. Fig.141

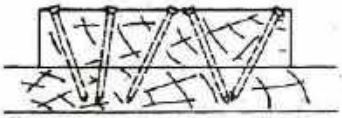


Fig.144. DRIVING NAILS AT AN ANGLE TO INCREASE HOLDING POWER

d) If the point of a nail comes outside the surface, drive it

back with a nail set until its head projects enough above the wood to be pulled out with a hammer or pincer.

e) A nail has a tendency to follow the grain of the wood. Blunting its point with a hammer helps to drive it in a straight line. Fig. 145

f) Place a block under the head of a claw hammer or pincer to protect the surface of the wood when pulling a nail. Fig. 146

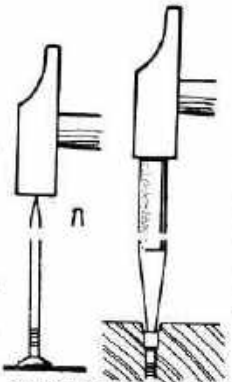


Fig 145. BLUNTING AND SETTING OF A NAIL

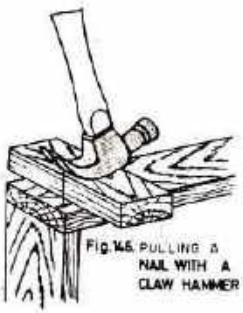


Fig 146. PULLING A NAIL WITH A CLAW HAMMER

AIR DRIVE NAIL STAPLE Fig. 147

A staple gun is a new invention and is operated by air pressure. It works like a gun and it can be used for various sorts of nails without resetting of the gun being necessary. Air-driven staples speed-up-construction and have more holding power.

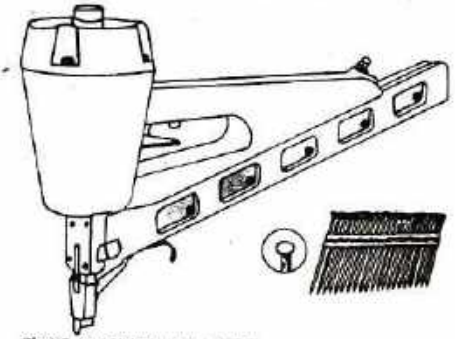


Fig. 147 AIR DRIVEN NAIL STAPLE

SCREWS Fig. 148, 149, 150

Screws are superior to nails, because they hold better, look better and can be removed easily without damage to the wood. Like nails, screws are made in many different shapes and sizes and of different materials such as brass, soft steel and iron. Screws are also bress or nickel plated, or galvanized iron. The most common screws are: flathead, roundhead, oval-countersunk head, phillips head, lag screws or wrench bolt, drive or nail screws, screw eyes, screw hooks and cup hooks. Screws are made in lengths from 6 mm (¼ inch). to 120 mm (5 inch). and in screw gauges from 0 to 30. THE HIGHER THE NUMBER, THE THICKER THE SCREW. For example No. 5 is about 3 mm (1/8 inch) thick and No. 12 is almost 6.5 mm (¼ inch) thick. Screws are packed in carboard boxes which hold one GROSS, 144 screws, each or 100 Nos each.

Fig 148. SCREWS IN mm

Fig 149. SCREWS IN INCHES AND GAUGES

Gauge No of Screw approx. in mm	2,5	3	3,5	4	4,5	5	5,5	6	6,5
Dia of First Hole approx. in mm	3	3	4	4	5	5	5	5,5	5,5
Dia of Second Hole approx. in mm	2	2	3	3	4	4	4	4	4

Fig 150 TABLE SHOWING SIZE OF HOLES IN mm TO BE BORED TO SCREWS OF VARIOUS SIZES

The length and screw gauge are marked on the box as for instance 1¼ by 9. The different parts of a screw are: head, shank and thread. Fig.151

Fig 151. NAME OF SCREW PARTS

FLATHEAD Fig.152 screws are most commonly used. Flathead steel screws are mainly used for internal structure. In places where screws might rust, brass, brass-plated, nickel plated or galvanized-iron screws are used.

OVALHEAD screws are used where the screw head remains visible for decorative purposes. They are also used for metal fittings.

ROUNDHEAD screws are not countersunk headed screws and therefore the head remains always on the surface. They are used for metal or wood fittings.

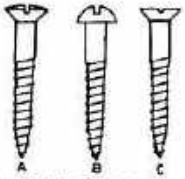


Fig 152 (A) FLAT HEAD SCREW
(B) ROUND HEAD SCREW
(C) OVAL HEAD SCREW

PHILLIPS HEAD Fig.153 screws have a flat oval or roundhead with two slots at right angles to each other, but not extending to the edge of the screw head. They can be driven only with a special screw-driver but faster and easier than ordinary screws and with less possibility of the screw-driver slipping off the screws slot.

NAIL screws have a very steep thread and can, therefore, be driven with a hammer instead of a screw-driver. They are commonly used for flooring, roofing and framing of rough work. Fig.154


Fig 153 PHILLIPS HEAD SCREW AND SCREW DRIVER


Fig 154. NAIL SCREW

SCREW EYES, SCREW HOOKS, SQUARE SCREW, HOOKS AND CUP HOOKS are made in many sizes. They are made from steel, brass or of galvanized iron and are used for special purposes, such as for hanging pictures, curtains, kitchen utensils, keys etc. Fig.155

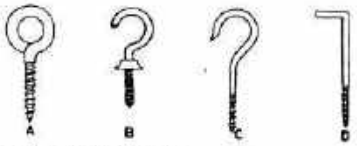


Fig 155. (A) EYE SCREW (B) CUP HOOK (C) SCREW HOOK (E) SQUARE SCREW

LARGE SCREWS OR WRENCH BOLTS Fig.156 are used for heavy joinery work and where greater holding power is needed. A wrench is used to drive these into a pilot hole that has been drilled into the wood.

Fig.156 WRENCH BOLT

RULES FOR DRIVING SCREWS Fig.157, 158

When two boards are to be fastened together with screws, a hole of the same diameter as the shank of the screw must be bored through one and a smaller hole, equal to the root diameter of the screw. In hardwoods the small hole or PILOT hole must be bored as deep as the screw enters; in softwood it may be bored to half this depth. The large shank hole must be big enough to permit the screw to be pushed through with the fingers. The screw head must be countersunk when flat-head or ovalhead screws are used. Soap, grease or wax rubbed on the threads of screw reduces friction and makes it much easier to drive. It also reduces the danger of "twisting off" the screw. Too tight going screws do often break at the point where the thread begins. Such broken parts are very difficult to remove. As brass screws are softer than steel screws, they twist off more easily. It is most important to use a screw-driver that fits the the slot in the screw and whose sides are flat. A screw-driver that is too thin or has rounded edges constantly slips out of the slot and damages it, so that the screw becomes difficult to drive and ruins its appearance.

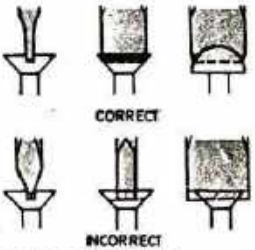


Fig.157 SCREW DRIVING

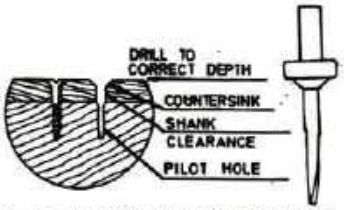


Fig.158. THE COMBINATION COUNTERSINK BIT BORING ALL NECESSARY HOLES IN ONE OPERATION

CARRIAGE BOLTS Fig.159

They have a large rounded head with a square part just below the head. They are specially useful for wood because when they are driven into the holes the square part will dig into the wood and prevent the bolt from turning. Carriage bolts have square, hexagon or wing nuts.

Fig.159. CARRIAGE BOLT

HINGES

Hinges are mechanical devices used in furniture making and carpentry. They are, therefore, made in many different shapes, designs and of different materials such as iron, galvanized iron, brass, brass plated and nickel plated.

BUTT HINGE Fig.160

The butt hinge is the type most frequently used. It is made in different lengths and widths and has either a riveted pin (fast-joint) or a removable pin (loose-pin). A butt hinge always has two rectangular leaves joined together with a pin. The width of butt hinges are measured across both leaves in the open position. Butt hinges are used on doors, boxes, folding tables etc.

Fig.160. BUTT HINGE

LOOSE PIN BUTT OR LIFT OFF BUTT HINGE Fig.161

These hinges are used where it is necessary to remove the door occasionally. The door can be removed by simply taking out the pins. The flaps with the pin of lift off butt hinges are recessed (fixed) into the body or carcass and the flaps with the hole are recessed into the door stiles. Hinges are always fitted on the door first before attaching the door to the door frame.

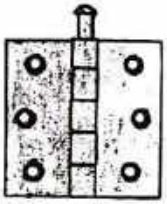


Fig.161. LOOSE PIN BUTT HINGE

CRANKED OR OFF SET HINGES Fig.162 A,B,C,D

These hinges are specially designed for overlapping doors and have different cranks (off sets). The most common ones are: A,B,C and D cranks. The set off distance of a D crank hinge is 5,7,5 and 10 mm and they have an angle of 90 degrees. They are used for different overlappings. When using cranked hinges care has to be taken for left and right side hinges.

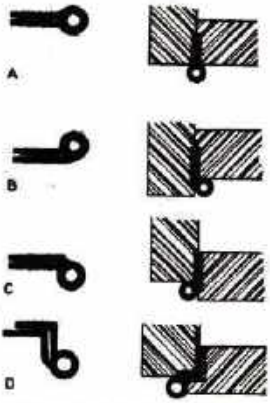


Fig.162. A STRAIGHT HINGE (B,C) CRANK LEFT DOOR (D) CRANK

CONTINUOUS OR PIANO HINGE Fig.163

The construction of a piano hinge is similar to a butt hinge but upto 3500 mm length (11 ft. 8 inch). They are cut to desired lengths and used for different purposes like piano lids, cabinet doors etc.

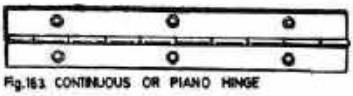


Fig.163 CONTINUOUS OR PIANO HINGE

PARLIAMENT HINGES Fig.164,A,B,C

These hinges are used where it is necessary to open the door at 180° or where projecting sides of articles interfere or for folding mirrors. They are designed in different shapes and of different finishes.

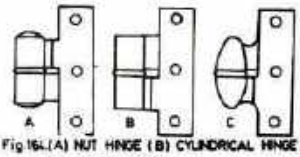


Fig.164.(A) NUT HINGE (B) CYLINDRICAL HINGE
(C) ACORN HINGE

INVISIBLE OR VICI HINGE AND INVISIBLE SOSS HINGE Fig.165

The vici hinges are generally used on small cabinet doors. They are mounted or mortised into the stile of the door and the side of the cabinet. Soss hinges are named after the inventor (US Patent) and are also used principally on cabinet doors. They are quite easy to apply but are not very strong because they are cast.

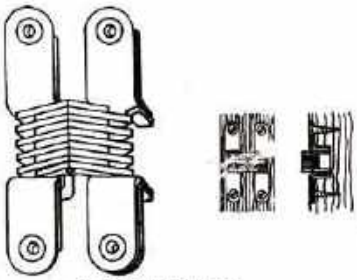


Fig. 165. INVISIBLE HINGE

PIVOT OR PIN HINGE Fig.166,167

The pivot or pin hinge consists of two flat, narrow, rectangular pieces of iron. One of them has a pin which fits into a hole in the other. The part having the pin is screwed into the ends of the door, and the other part into the frame. Pin or pivot hinges are of different designs, invisible, cranked, or with a visible knuckle.

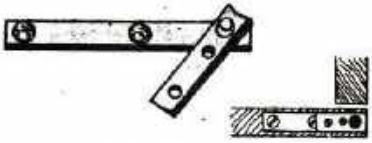


Fig.166. PIVOT HINGE

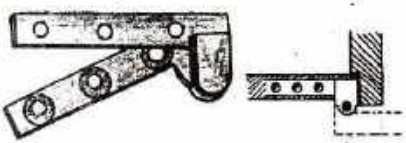


Fig.167. CRANKED PIN HINGE

FOLDING TABLE HINGE Fig.168

These are narrow brass or iron hinges riveted together. They are set into the edges of the two leaves of the folding table tops and the flaps are screwed underneath the table top. This special design permits a gapless and flush mounting. They are easily and economically to be fixed.

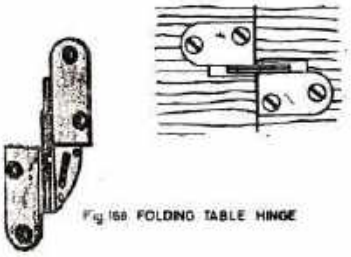


Fig.168 FOLDING TABLE HINGE

SURFACE HINGES Fig.169

They are available in a variety of sizes and patterns. They are used for decorative purposes, fastened on the surface and entirely visible.

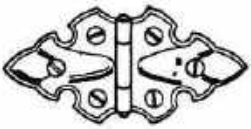


Fig 169 SURFACE HINGE

DRILL-IN-HINGES Fig.170,A,B

This hinge has gained such wide popularity because it is easy to mount. Both parts of this design have a fine thread on both pins and the end of the pin is slightly tapered for easy fitting into the ready drilled holes. In principle a drill-in steel hinge requires only two basic steps:
Firstly to place the drilling jig in proper position and pre-drill the hole, secondly, driving in the hinge and screwing it into place with the screwing crank. The holes can be drilled into the frame door or window at the same time without moving the drilling jig.

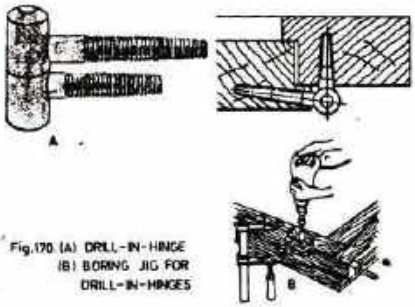


Fig.170 (A) DRILL-IN-HINGE (B) BORING JIG FOR DRILL-IN-HINGES

2 D HINGES Fig.171,A,B,C,D

The 2 D hinge is the first completely concealed hinge for face mounted doors, which offers the possibility for lateral and vertical adjustment. It is well functioning and economical to mount. Many different designs and shapes for different fitting systems are available. The 2 D hinge is made from steel or plastic and the adjustable plates are made of zinc die-cast or of plastic or a combination of both materials.

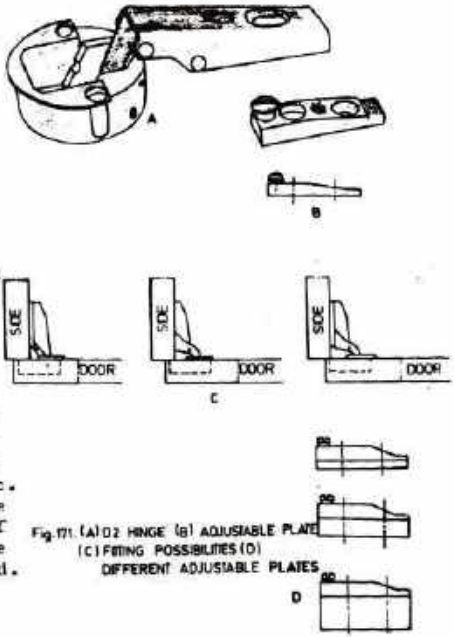


Fig.171 (A) D2 HINGE (B) ADJUSTABLE PLATE (C) FITTING POSSIBILITIES (D) DIFFERENT ADJUSTABLE PLATES

LOCKS

Locks are used on drawers, doors, desks, chests and boxes. They are made in several different types and sizes and are either of brass or iron or partly iron and plastic. When sizes of locks are given, the distance from the SELVAGE (edge of the lock) to the key pin or centre of the cylinder is always included. Some locks are furnished with a metal plate, called the STRIKE.

which corresponds in size and sh to the SELVAGE and is fastened t the frame or partition of the cabinet. It adds to the security of the lock, because it protects the wood from wearing out.

MORTISE LOCK Fig.172

The mortise lock is completely set into the wood and is fixed with two screws on its selvage. Most of the modern mortise locks can be used for left and right side doors and for drawers. They are made from steel, iron and many lock cases are made from plastics.

Fig.172 MORTISE LOCK

RIM LOCK Fig.173

Some rim locks have no selvage and are screwed to the wood without cutting any recess. Others have to be recessed both for lock box and selvage.

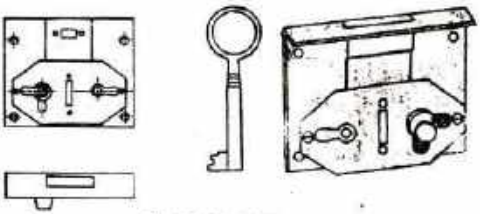


Fig.173. RIM LOCK

SCREW-ON-LOCK Fig.174

The screw-on lock is the most economical lock because it can be used for left and right hand side doors and for drawers. It is very easy to mount with 3 or 4 screws at the back of the door. They are supplied in different sizes and materials. Common sizes are 20, 25, 30, 35, 40, 45 and 50 mm. The size indicates the distance from the selvage to the key pin or the centre of the cylinder.

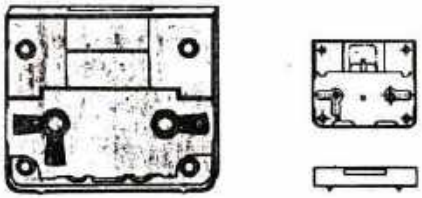


Fig.174 SCREW-ON LOCK

MORTISE ROLL-BLINDLOCK OR SLIDING DOOR LOCK Fig.175

These locks are constructed to withstand an upward pull. The bolts on such locks, therefore, have hooklike projections, which are forced out by a spring and engage the strike when in the locked position. Some have bolts which move sideways and engage pinhooks on a strike which enters the lock.

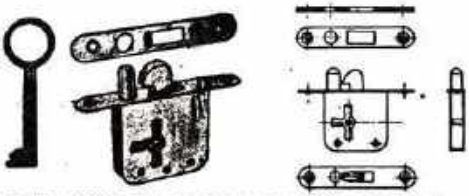


Fig.175 MORTISE ROLL-BLINDLOCK OR SLIDING DOOR LOCK

CENTURY LOCK Fig.176, 177

The century lock has a new feature: the centre bolt. It pulls the door tightly against the body in the centre and at the top and bottom. The catch hooks are operated by a pivoting movement. This enables safe closing, even if the door does not contact at the top or bottom, or if it is warped. This lock also functions easily and safely on extra high cabinet doors. The different parts of the century lock are:-

a) lock casing

b) keys

c) profile rods

d) catch hooks

e) angle striking plates

f) locking bolts

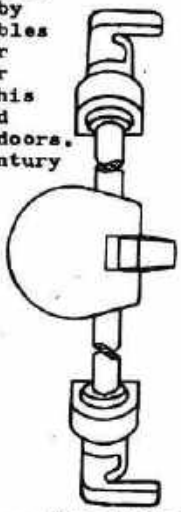


Fig.176. CENTURY LOCK

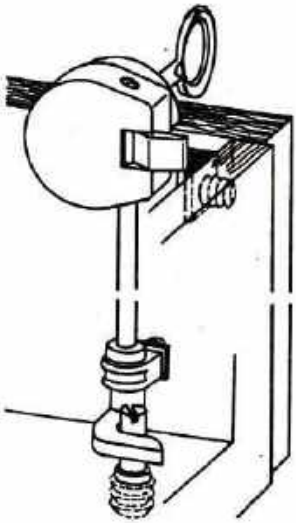


Fig.177 FITTING POSSIBILITIES

MORTISE DOOR LOCK Fig.178

This lock is also completely set into the edge of the door and fixed with two screws on its selvage. This lock serves two purposes: latching and locking of the door. A square spindle in the bush operates the latch and a key both. The spindle is controlled by a pair of handles.

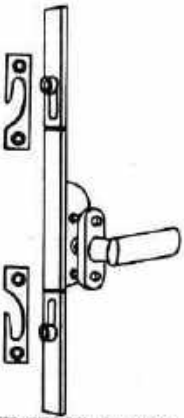


Fig.179. WINDOW LOCK WITH TWO STRIKING PLATES

TWO PIN MORTISE WINDOW LOCK Fig.179

The window lock has a large flat iron bar and two roll-pins operated in an up and down action. The roll pins are centrally operated by the lock case and the window handle. A square spindle in the bush moves the roll-pins up or down by turning it. When closing the window the roll-pins catch behind the strikes which are recessed in the frame and pull the window tightly against the window frame.

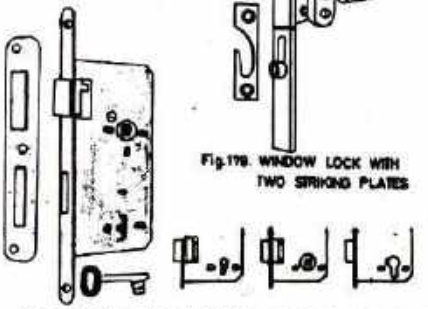


Fig 178 MORTISE LOCK WITH THREE DIFFERENT LOCKING POSSIBILITIES

MAGNETIC CATCHES Fig.180,181

These magnetic catches have a casing, made of high quality impact resistant plastic. They have slot holes for fine adjustment of mounting. The high quality magnets guarantee soft closing and opening. The spring loaded strikers adjust themselves. The magnetic catch is probably the easiest catch to fit, it is noiseless and a very practical way of keeping cabinet doors closed where a lock is not needed. They are available in a large variety of shapes and sizes of different materials.

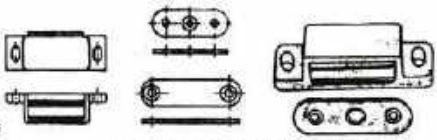


Fig.180. SCREW-ON MAGNETIC CATCH

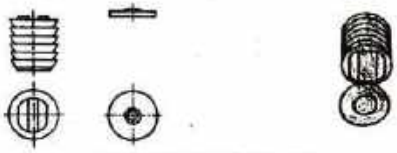


Fig.181. RECESSED MAGNETIC CATCH

BALL CATCH, ROLLER CATCH, SPRING WEDGED CATCH AND FRICTION CATCH. Fig.182,A,B,C,D

All these catches are closing devices for doors which need not to be locked. They are used in such places where a lock is not needed. Ball or friction catches consist of small brass or iron cylinders with a steel spring pressing a steel ball against the cylinder rim. When mounting a ball catch it is necessary to bore a hole of the proper diameter in the edge of the door and press in the catch. The strike, which is bevelled on one edge, is set into the frame flush with the surface. The other types of catches are simply screwed to the underside of the top or centre shelf and the back of the door. They are made of iron, steel, brass and plastic.

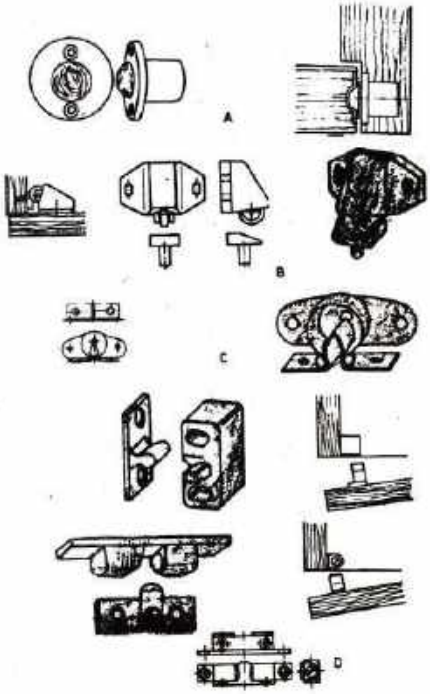


Fig.182. (A) BALL CATCH (B) ROLLER CATCH (C) SPRING WEDGED CATCH (D) FRICTION CATCH

DOOR BOLTS Fig.183,184

Bolts are screwed to the inside of the left-hand wardrobes or cupboard doors near the top and bottom of the door, so that the bolt locks into the frame around the doors. For short doors only one bolt can be used, but for larger door two bolts are necessary.

Most of the bolts are fitted out with a steel spring, which automatically keeps the bolt in the locked position. They are usually furnished with a strike plate. A hole must be chiseled or bored in the frame to set the strike plate which locks the door. Bolts are manufactured of different materials like white steel, nickel plated, brass, plastic etc.

Fig.181 CRANKED CABINET BOLT

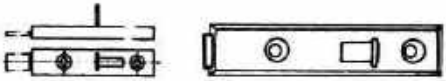


Fig.184 STRAIGHT CABINET BOLT

FLAP BRAKES OR FLAP STAYS
Fig.185

Flap brakes or stays are meant to keep flap doors, after opening, in horizontal positions. In the case of a flap brake the braking action is adjustable by means of a screw, according to the flap weight. They are available with an angle fixing plate or with a dowel fixing plate. The flap stays are manufactured with a slotted guide in the centre joint and function for right or left side use. Flap stays and brakes are available in white steel, nickel plated, brass, brass plated, bronzed and plastics.

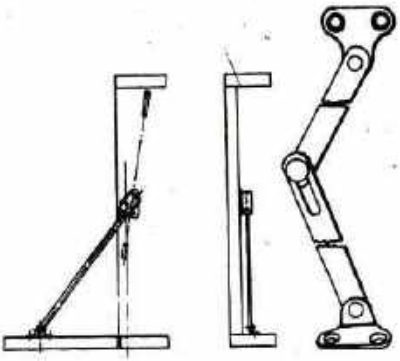


Fig.185 FLAP BRAKES OR FLAP STAYS

BED FITTINGS Fig.186

BED HOOKS are used where bed sides, bed heads and foot ends have to be fitted tightly together, but detachable. The bed hooks can be used for left and right bed sides and have a wedge locking effect. The hook plate is fitted in a slot in the centre of the bedside end and tightened with 3 or 4 screws. The strikes are recessed in the bed head and foot end. It is also tightened with 3 screws. The bed hooks are available in steel or galvanized steel.

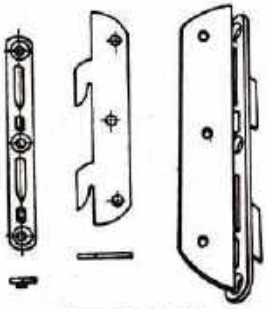


Fig.186 BED HOOKS

SLIDING DOOR TRACKS AND GLIDES Fig.187, 188, 189, 190

Plastic offers many advantages especially in the design of upper and lower slide elements on sliding doors. In addition to being economical, plastic tracks and glides are characterized by their frictionless, silent operation and are also warp resistant. The wide range of profiles allow many combinations. Tracks can also be made of wood. The tracks are glued into the groove of the bottom. A different design is needed for heavy glass sliding doors. These fittings are made of solid aluminium, with built-in roller units of steel with precision bearings. The solid aluminium tracks in conjunction with the grooved rollers give this fitting extra-ordinary sliding characteristics. Another method is to have two grooves in the top and bottom in which the glass doors run.

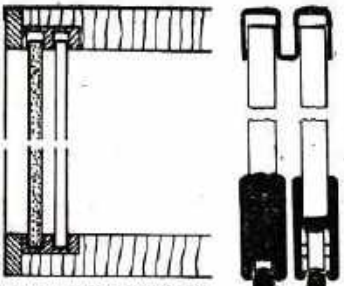


Fig.187. GLASS DOORS SLIDING IN GROOVES

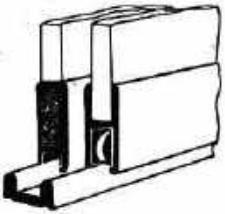


Fig.188. SLIDING DOORS WITH BUILT-IN ROLLER UNITS ON PRECISION BEARINGS

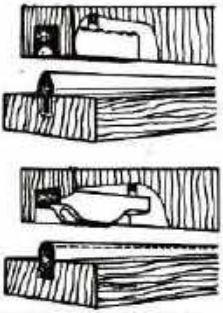


Fig.189 TRACKS AND GLIDES

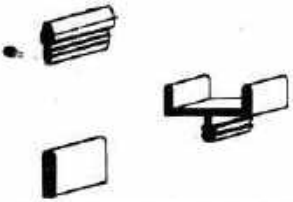
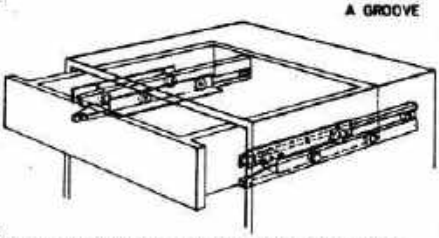


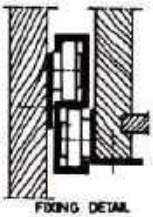
Fig. 190 TRACK WITH DEPTH LIMITATION

TWIN TRACK FOR DRIVING INTO A GROOVE

DRAWER GLIDES Fig.191, 192, 193

Drawers can normally be pulled out approx.2/3rds of their depth without tipping. In special cases, however, it is desired to be able to pull out the entire drawer. On Fig 191 you can see metal drawer glides which fulfil all the requirements placed upon modern furniture. The drawer glides are available in different size and design. The most common ones are ball glides and roll or ball bearing glides. They have an





FIXING DETAIL

Fig.191. PRECISION DRAWER GLIDES FOR BOTTOM FIXING

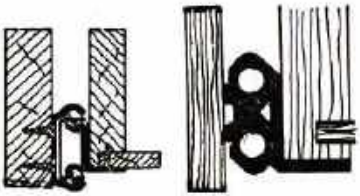


Fig.192. TWO DIFFERENT DRAWER GLIDES DETAIL

extremely high load capacity and can be rolled very easily. The stable parts of the drawer glides are mounted on the body, cabinet sides, or partitions, the movable parts on the lower drawer edge.

EDGING PROFILES Fig.194, 195, 196

Plastic profiles are common in the production of kitchen furniture, mainly for the protection of edges. The main rawmaterial for this product is POLY-VINYL CHLORIDE (PVC). The new matal-plastic combination is not manufactured by galvanishing, but it is covered with a hard coate of PVC. The solid PVC profiles and the combination profiles are more impact and liquid resistant than wooden beading. The decorative effect in one or several colours is also possible. Mounting examples are shown in Fig

FURNITURE CASTORS Fig.197, 198.

Furniture castors are a new development for upholstered and office furniture. Well designed castors with a wide running surface have a remarkably smooth run, even under the highest load (maximum load 250 kg). The castors can be fixed either by a drive-in-screw sleeve, with screw-on plate, with stem and sleeve or with a threaded bolt and nut. They are economical to mount because no extra fitting is needed. Castors are available in many different designs and of different materials such as

Fig.193 PVC GUIDE TRACK FOR DRIVING INTO A CASING GROOVE

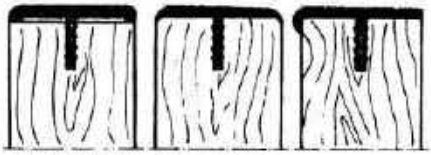


Fig.194 ALUMINUM EDGING PROFILES

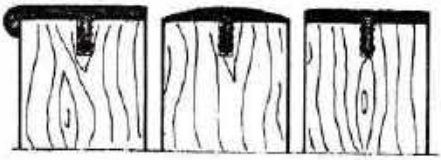


Fig.195 PVC PLASTIC EDGING PROFILES

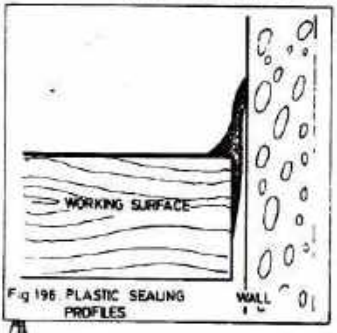


Fig.196 PLASTIC SEALING PROFILES

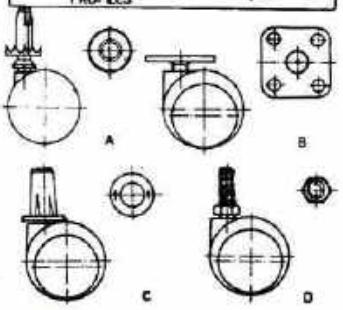


Fig.198 (A) DRIVE IN SCREW SLEEVE (B) SCREW ON PLATE (C) STEM AND SLEEVE (D) THREADED BOLT AND NUT

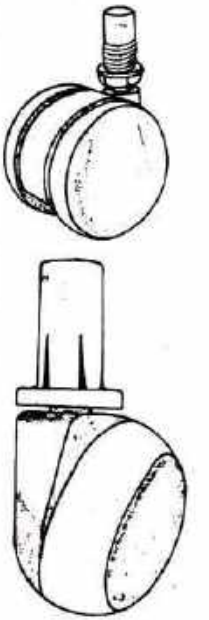


Fig.197 FURNITURE CASTORS

aluminium, steel chrome plated and nylon-steel combination.

PLASTIC WALL DOWELS Fig.199

Plastic dowels are very useful for quick, simple and secure mounting of door frames, window frames, shelves, boards, or similar articles. The advantage of the plastic dowel is that a wooden screw can be used and an absolutely tight fit in hard materials is achieved. However, it has to be made sure that the hole drilled into the wall should not be bigger than the diameter of the dowel. Plastic dowels are available in diameters of 6,8,10,12,14,16 mm etc.

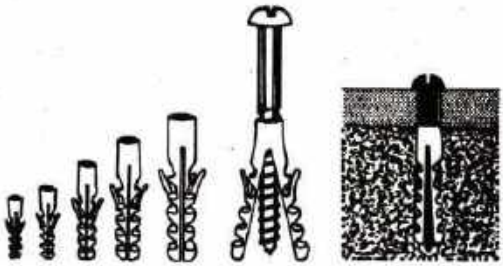


Fig.199. PLASTIC WALL DOWELS

SHELF SUPPORTS Fig.200,A,B,C,D

Shelf supports are small metal or plastic pins of different design. They are used for removable shelves. The most common ones are pin support, drive-in support, spoon support and inserting support with socket.

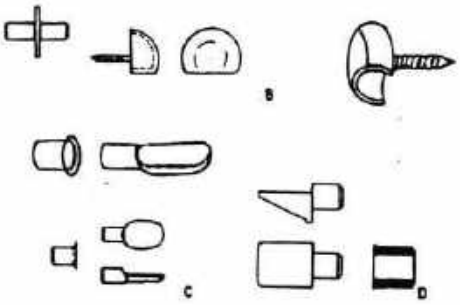


Fig.200.(A) SUPPORT PIN (B) DRIVE-IN SUPPORT (C) SPOON SUPPORT (D) INSERTING SUPPORT WITH SOCKET

GLASS FASTENERS Fig.201

Glass fasteners are used where a sheet of glass has to be mounted on a table top, picture board mirror frame etc. Glass fasteners are small cranked metal plates with two holes for screws. They are available in steel nickel plated, brass, or brass plated.

Fig.201. GLASS FASTENERS

Fig. 202. BEADING HANDLES

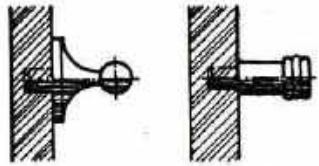


Fig. 203. KNOB HANDELS

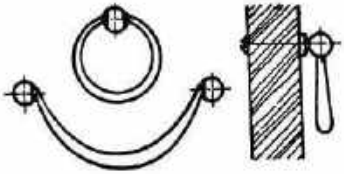


Fig. 204. RING HANDLES

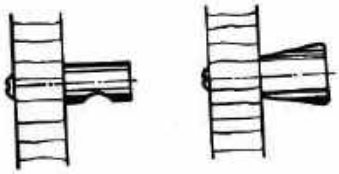


Fig. 205. PLASTIC OR METAL HANDLES

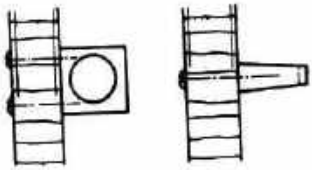


Fig. 206. METAL HANDLES

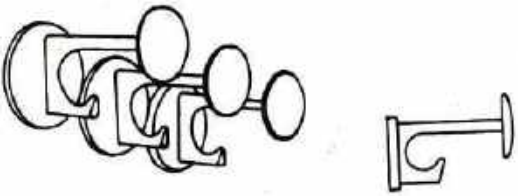


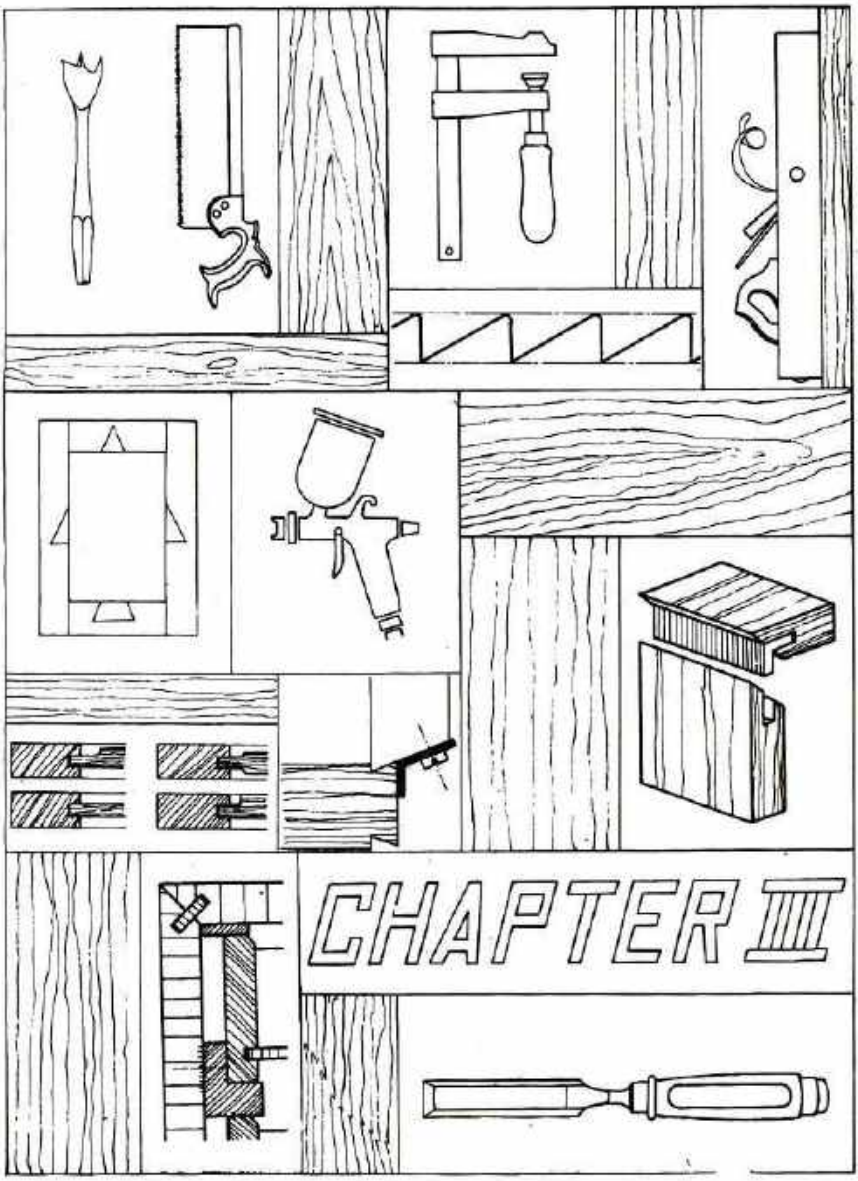
Fig. 207. HAT AND COAT HOOKS

Fig. 208 HAT AND COAT HOOKS

Fig. 209. DECORATIVE HOOKS

Fig. 210 FOLDING BENCH HOOKS

Fig. 211. TWIN COAT HOOKS


CHAPTER III

THE PRINCIPLES OF WOOD WORK HAND TOOLS AND THEIR USE

The woodworker uses a large variety of hand tools. Every workman should be familiar with the tools he uses. He should know their proper names, the purpose for which each is needed and how they are sharpened and kept in good condition.

WORK BENCH

The work bench is a tool or device of the utmost importance to the woodworker. The best type of bench has a top that is constructed of narrow strips of hardwood, glued and bolted together. In this way warping is prevented. It usually has a tool box or trough in which tools may be placed while working. The top is doweled to the frame consisting of four legs, four foot rails and two links, which are either bolted or key-wedge jointed to the legs. The parts of a French work bench are: Fig.212, 213, 214.

1. Bench table
2. Tool box or trough
3. Front chop jaw or vise
4. Pressure plank
5. Front chop spindle
6. Rear chop
7. Rear chop spindle
8. Chop key
9. Front cramp iron
10. Rear cramp iron
11. Front touch ledge
12. Rear touch ledge
13. Drawer
14. Cramp iron hole
15. Front trestle foot
16. Rear trestle foot
17. Link
18. Trestle-tension bolt

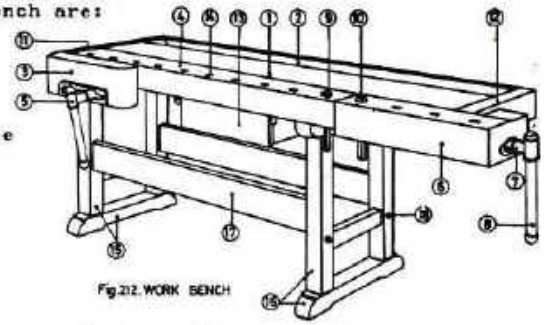


Fig.212. WORK BENCH

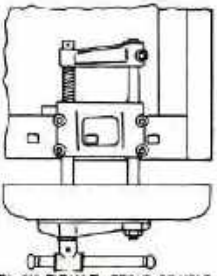


Fig.213. PARALLEL FRONT SPINDLE

Fig.214. FRONT AND REAR CRAMP IRON

The Maintenance of a work bench

Always remove glue remainders from the bench table and oil it. Plane it annually with the trying plane and oil the steel spindles. While boring, cutting and chiselling, use always a support or a bench hook. Control tension screw or wedge and tighten it firmly. When adjusting the bench cramp iron, never use the hammer head but the hammer handle.

SUPPORT STOCK OR SUPPORT VISE Fig.215

The function of the bench support stock is to support large and long boards or rails when planing, sanding or during other operations. The support stock is adjustable in height by a teethed stock in which a stop block can be positioned. A long board being tight on one side in the front chop jaw, can be supported on the other side with the support stock.

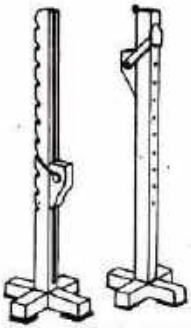


Fig.215. TWO DIFFERENT DESIGN OF SUPPORT STOCK

POINTED BENCH CRAMP Fig.216

The pointed bench cramp is a tool or device which is fixed to the front touch ledge and its teethed bar is adjustable. It is used when planing and sanding boards without tightening them between the front and back cramp. The end grain wood of the board is pushed against the teethed cramp thus keeping the board in position.

Fig.216. POINTED BENCH CRAMP

BENCH HOOK

The bench hook is a block of hardwood with a support fixed at each end and on opposite sides. (See Fig.217). It is used when sawing small pieces, which are then held firmly against the support with the free hand. The bench hook can be 200-250 mm long and 150-180 mm wide.

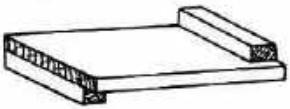


Fig.217. BENCH HOOK

FIXING AND HOLDING DEVICES

CLAMPS

The assembly of jointed woodwork usually involves the use of clamps, particularly in gluing together and joinery work. Clamps are also used to hold down work when both hands are occupied.

Fig.218 BAR CLAMP WITH A FIXED HANDLE

SASH OR STEEL BAR CLAMP Fig.218,219

Sash clamps are generally used in pairs, for gluing purposes. The bar of the clamp may be of rectangular or 'T' shape. 'T'-bar clamps are heavier and more expensive, but they are more reliable, as extra pressure can be applied to the work without destroying the bar or the sliding shoes. The sash-clamp has two sliding shoes, one which is attached to the screw whilst the other is fixed where necessary along the bar by a steel pin. The screw of the clamp has a strong square thread, capable of being used to apply a great deal of pressure. Sash-clamp are used mainly for clamping up wide work such as jointed boards, carcases and large frames.

Fig.219 BAR CLAMP WITH A LOOSE HANDLE

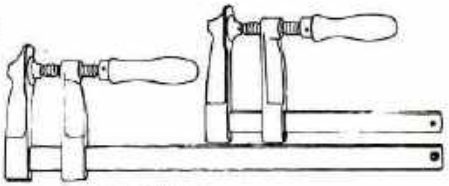


Fig.220 G CLAMPS

'G' AND 'C' CLAMP Fig.220,221

These clamps are frequently used in the workshop and have a variety of uses besides those of clamping together glued work and holding down work on the bench when both hands are employed. Both clamps have a body of a 'H' section iron, which resists any tendency to distortion. The screw has a strong square thread and a round shoe on a ball which is socked joints. 'G' clamps are available in sizes of 160 mm clamping capacity to 2500 mm.

Fig.221 C CLAMP

Fig.222 HAND SCREW

HAND SCREW Fig.222

The hand screw is a clamp consisting of a pair of chops operated on the lever principle

by two metal hand screws. Metal inserts are fixed into the wooden chops to receive the metal screws. The hand screw seems to be an old fashion clamp when compared to the 'C' clamp, but the long jaws can reach where the 'C' clamp cannot and pressure is spread over a larger area. Hand screws are used largely in veneering and for holding stock in various positions for convenience and security.

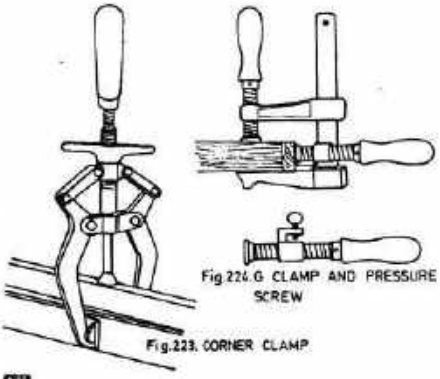


Fig.224.G CLAMP AND PRESSURE SCREW

Fig.223. CORNER CLAMP

CORNER CLAMP Fig.223, 224

The corner clamp is a specially designed clamp and can be only used for gluing edges and beadings on large boards. The pressure which is applied by the hand screw on to the shoe, presses automatically the two side jaws against the board. The jaws which are usually slightly serrated, guarantee a good grip

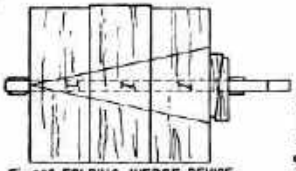


Fig.225. FOLDING WEDGE DEVICE

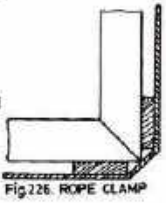


Fig.226. ROPE CLAMP

IMPROVISED CLAMPS

Metal clamps are not always available and there are several methods of improvising clamps to apply pressure, which are often more convenient and efficient than metal clamps and less expensive. The different types of improvised clamps are:

1. Folding wedge device Fig.225
2. Rope clamps Fig.226
3. Flexible-band clamps Fig.227
4. Miter jig Fig.228
5. Wooden gluing device Fig.229

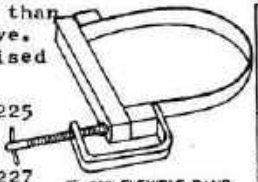


Fig.227. FLEXIBLE-BAND CLAMP

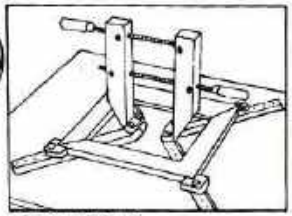


Fig.228. MITER JIG

MEASURING TOOLS Fig.230, 231, 232

A rule, is generally the first tool used by the trainee. Rules are made in different lengths, materials and designs. Those used in woodworking are usually of the folding type. The most common ones are: The folding rule, an extension zigzag rule, a flexible steel tape Wooden and steel bench rules are generally marked off on both sides in inches or metric divisions.

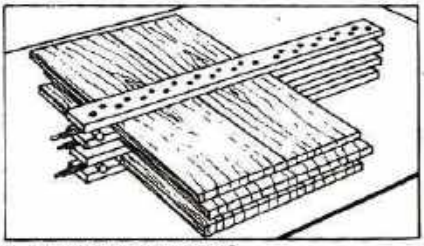
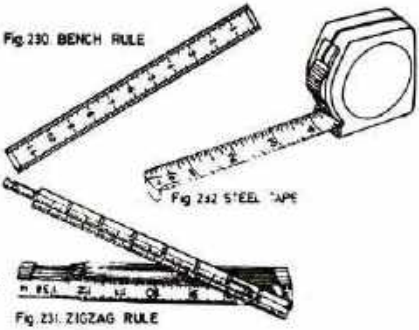
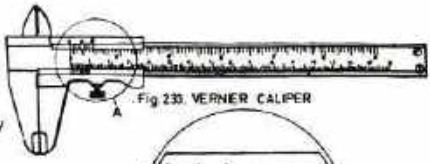


Fig.229. WOODEN GLUING DEVICE

CALIPERS Fig.233, 234

Inside and outside calipers are constructed like dividers, but are used for measuring inside and outside diameters. With calipers dimensions can be transfered from a work piece to a measuring instrument. They are also used to test the uniformity in size and shape of several work pieces. The VERNIER CALIPER is in wood-work considered as a precision measuring instrument. It is therefore only used for exact measuring when fractions of a millimeter is to be determined





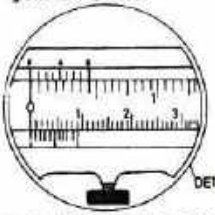


Fig.234 VERNIER SCALE ENLARGED

MARKING AND SETTING TOOLS

DIVIDER Fig.235, 236

The divider is a layout tool used by both wood and metal workers. It consists of two steel bars or legs sharpened to a fine point and held together at one end either by a movable joint or a spring. They are made in different sizes and are used to scribe a circle on a surface and for stepping out equal distance on timber. If the surface should remain unscratched a pencil holder may be attached to one of the legs.

Fig.235 DIVIDER

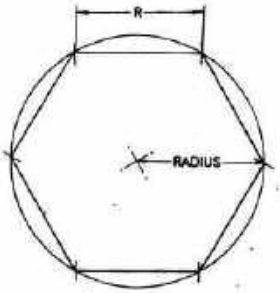


Fig.236 HEXAGON

Laying out a Hexagon

1. Set the dividers or compass to the length you want for one side of the hexagon.
2. Draw a circle, using the radius set in step 1.
3. Mark off distances on the circumference with the dividers set to the radius length Fig.236
4. Connect the intersecting (crossing) points on the circumference with straight lines. This forms the hexagon.

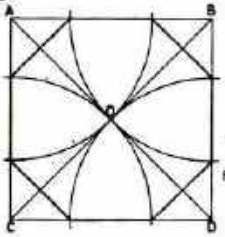


Fig.237 OCTAGON

Laying out an Octagon

1. Draw a square the size of the octagon.
2. Draw diagonal lines AD and BC. See Fig.237.

3. Set the dividers to the distance of A to O. Scribe arcs intersecting the sides of the square. Use the corners as centers

4. Connect the intersecting points of the square with straight lines. This is an octagon.

Laying out an Ellipse

1. Draw a rectangle with the sides representing the width and length of the desired ellipse (oval). See Fig.238

2. Divide the rectangle with a horizontal line AB and a vertical line CD.

3. Use C and D as centers. Draw arcs with the dividers set for a radius of XB. The arcs will intersect line AB at E and F.

4. Fasten a string at points E and F so that it will reach to C. This will form triangle CEF.

5. Place a pencil against the string, starting at point C. Draw half the ellipse ACB. Repeat this for the other half.

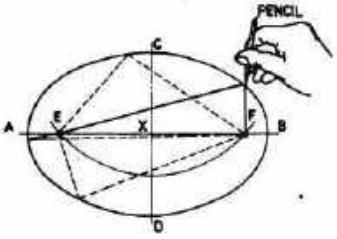


Fig.238 ELLIPSE

TRY SQUARE Fig.239

Try squares are used for testing the squareness of lumber and in checking the squareness of work being assembled. Try squares consist of two parts, the stock and the blade, which are firmly fastened together at right angles. The stock is thick and s made of wood or iron. The blade, which is thin, is made of steel and has sometimes an inch or metric scale stamped on it. Try squares are made in different sizes and measure from the end of the blade to the stock. The try square can only be used for marking and checking 90 degrees (90°) angles.

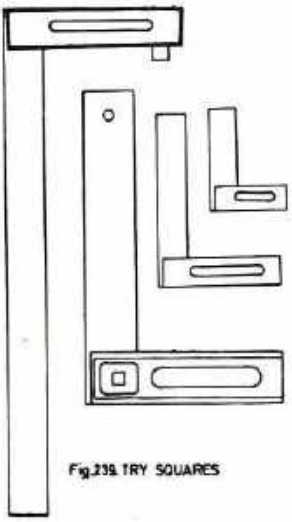


Fig.239 TRY SQUARES

SQUARING RODS Fig.240

A squaring rod is used for testing frames and carcases for its exact square. The rod is made of either hardwood or softwood, sharpened at one end to a chisel edge so that it

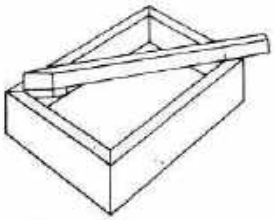


Fig.240 SQUARING ROD

fits closely into the corner of the work. The rod is used diagonally, from corner to corner and marked for each diagonal. The true measurement is mid way between the two marks, provided that the two sides and the two ends of the frame or carcase are exactly parallel. Squaring with a rod is more reliable than with a try square.

Testing squares Fig.241

When using a square, the stock must always be held tightly against the face of the work. A square can be tested for truth by squaring from a straight edge and then reversing the stock. The blade should fit the line exactly. Any deviation can be corrected by carefully fitting the edge of the blade not by trying to adjust it in the stock fitting.

MITER SQUARE Fig.242

A miter square is a tool for setting out and testing angles of 45 and 135 degrees. It also consists of a wooden or iron blade and stock. The blade is riveted into the stock at 45 degrees. Its size is determined by the length of the blade.

SLIDING T BEVEL Fig.243, 244, 245

A sliding T bevel is used to test and transfer angles other than right angles. The bevel is called sliding bevel because it has an adjustable sliding blade, which is locked into position by means of a setscrew. The required angle is set from a streight edge and the degrees are measured against a PROTRACTOR. The sliding bevel is commonly used for laying out dovetails, side rails for chairs, chamfers bevels and for transfering angles from a drawing to the work piece.

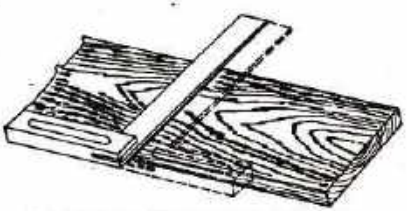


Fig 241. TESTING A TRY SQUARE ON A TRUE BOARD

Fig 242. MITER SQUARE

Fig 243. WOODEN SLIDING T BEVEL

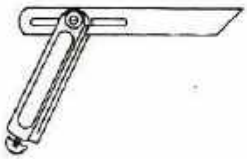


Fig 244. IRON SLIDING T BEVEL

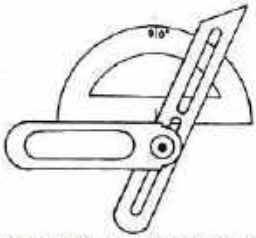


Fig 245. ADJUSTING A SLIDING BEVEL ON A PROTRACTOR

MARKING GAUGE Fig.246

A marking gauge can be made of wood or steel. The most commonly used consists of a square, wooden bar or beam on which a wooden block or head slides. This block can be fastened at any point of the bar by means of a brass setscrew bearing against a brass shoe. The block, on the better grade of gauges, is protected from wear by a piece of brass set flush with its surface. The bar is graduated in inches or millimeters and provided with a steel point or spur fastened in the bar near the end. As the spur may be easily bent out of place, it is advisable to measure the distance from the spur to the face of the block with an ordinary rule.

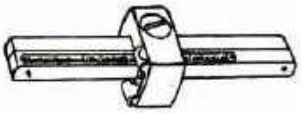


Fig.246 MARKING GAUGE

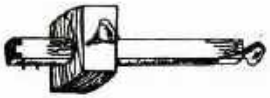


Fig.247 MORTISE GAUGE

MORTISE GAUGE Fig.247

A mortise gauge is a marking gauge with two spurs, which can be spaced at different distance and mark two parallel lines at the same time. One type is made of hardwood and has an adjusting screw in the end of the beam, which moves one of the points up or down as desired. The other side of the beam is fitted with a single point as on the ordinary marking gauge. This gauge is used chiefly for laying out mortises and tenons. Other types are made entirely of metal and have two bars.

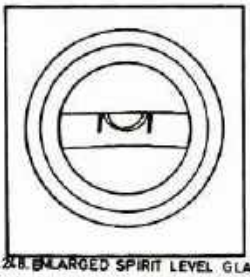


Fig.248 ENLARGED SPIRIT LEVEL GLASS

SPIRIT LEVEL Fig.248,249

A spirit level is used principally by the carpenter. It consists of a piece of wood (a very common wood for spirit levels is Teak wood) or aluminum into which a spirit level glass is fastened horizontally and vertically. As the glass tube is not quite filled, a bubble always remains. When this bubble is in the centre of the glass, indicated by lines marked on it, the structure on which the level rests is absolutely horizontal or vertical.

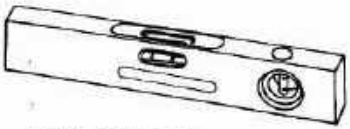


Fig.249 SPIRIT LEVEL

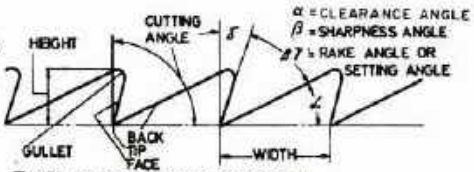


Fig.250 NAMES AND ANGLES OF TEETH

HAND-SAWS

After measuring and laying out, the portion of a board or plank required has to be cut to the desired size, by a saw. The term 'hand-saw' generally applies to all saws, which are used for woodworking and are not run on electric power. It includes rip-saws, cross-cut saws and panel saws. These differ in size and the number of teeth, but are similar in design, having a thin, hardened steel blade fixed into a shaped hardwood handle. Apart from the general shape and size, the most important factor in the design of a saw are the teeth. These differ both in size and shape, according to the work they have to do. In most saws the shape of the tooth is triangular and all the teeth are set. The points of the teeth of a set saw should be wider than the thickness of the saw blade, which allows the saw to pass through the wood easily. The angle of the tooth, between the back and face edges is 60 degrees, whether the tooth is pitched forward or upright. The size and number of teeth in a saw depends on the type of saw. Fig.250,251,252,253

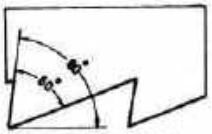


Fig.251. RIP SAW TEETH.

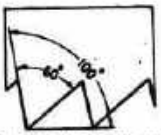
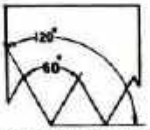


Fig.252. CROSS CUT SAW TEETH

Fig.253 RIP AND CROSS CUT SAW TEETH



CROSS CUT SAW TEETH

SETTING AND SHARPENING SAWS

SAW-CLAMP Fig.254,255

For the sharpening of saws a saw clamp is necessary, holding the saw tightly between two jaws. A quick action metal saw-clamp is used for this purpose, which is fixed in the vise and is operated by an eccentric lever. The saw may be fixed in a bench-vise to be sharpened, gripped between a pair of hardwood jaws, long enough to accommodate the saw. The jaws of the saw-clamp should grip the saw 2-3 mm below the gullet of the teeth.

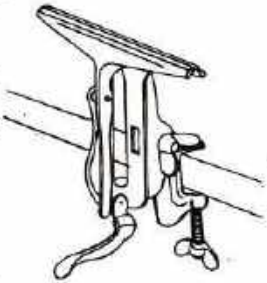


Fig.254. IRON SAW CLAM


Fig. 255. WOODEN SAW CLAMP

TOPPING OR JOINTING OF SAW TEETH Fig.256

The teeth of a saw often become uneven through wear or misuse and

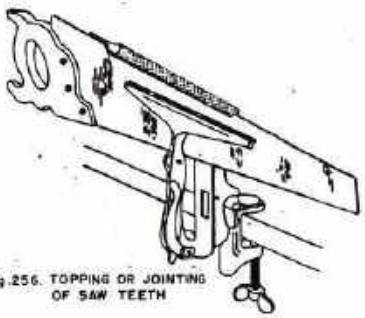


Fig.256. TOPPING OR JOINTING OF SAW TEETH

only a portion of them do the work. To correct this, the saw teeth have to be jointed, which means to level all the teeth by running a fine flat file along the length of the saw teeth. The file must be kept flat and passed lightly over the tops of the teeth until the smallest has been slightly touched.

RE-SHAPING Fig.257

The next process is to file all the teeth to their correct shape and size with a triangular saw file. The file is pressed firmly into each gullet and held square across the blade. The same grip should be maintained throughout the filing and care should be taken to make all the teeth the same shape. Each gullet is filed in turn, until the tooth on the finished side has a point and half the flat on the next tooth is filed away. The next gullet is then filed, the previous tooth being finished off to a point. If the teeth are unevenly spaced, the file should be pressed heavily against the tooth with the longest flat, until the centre is reached. At the end of the re-shaping process, the teeth should all be level and the same shape.

SETTING Fig.258,259,260,261,262,263

Setting a saw is to bend the teeth alternately to left and right, so that the kerf is wider than the thickness of the saw-blade, which will then pass through easily without binding. One method of setting saw teeth is done with a flat piece of steel containing a number of slots, one of which is fitted over the tooth to bend it over, but with this tool a considerable amount of experience is necessary to bend over each tooth to the same degree. The most popular method of setting a saw is with the plier-saw set. These pliers grip the blade with the first pressure and then bends the tooth over, on to a graduated

Fig.252 RE SHARPENING OF A SAW

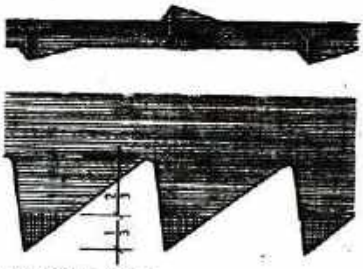


Fig.258. CORRECT SETTING

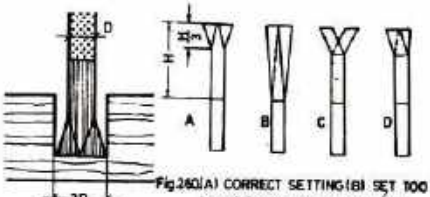


Fig.259. CORRECT SETTING

Fig.260(A) CORRECT SETTING(B) SET TOO LONG(C) SET TOO WIDE(D) ONE SIDE SET

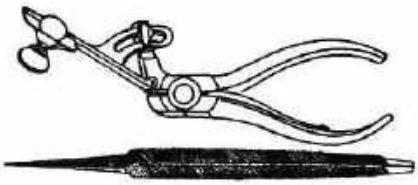


Fig.261. SAW SETTING PLIER AND TRIANGULAR FILE

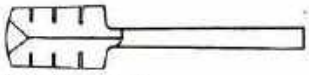


Fig.262. SETTING STEEL

Fig.263.TRISECTION OF SAW TEETH

circular bevel, which can be adjusted to suit all size of teeth. It is important, when setting, that the whole of the tooth is not bent over. Only one third (1/3) of the tooth should be set. Completely bent over teeth lead to distortion of the blade and cracks in the gullets. When setting has been completed, the saw should be sighted from an end to make sure that all the teeth are set to the same degree. A tooth out of line is easily detected.

SHARPENING OF SAWS Fig.264, 265, 266, 267, 268

A tapered triangular saw file with slightly round corners is used for sharpening. The file should be more than big enough to cover the face, back and gullet. For the actual sharpening the saws should be as low in the clamps as possible. (Approximately 2-3 mm below the gullets). The firmer the blade is held, the better will be the file cut. Sharpening usually starts at the beginning of the saw, to get the burr, which is left by the file on the tooth point, pointing in the teeth direction. One method of keeping the teeth in the same size is to count the number of strokes per tooth. It has to be made sure that the file should be held at 90 degrees in both ways horizontally and vertically from the saw-blade.

RIP-SAW Fig.269A, 269B

The rip-saw is used for cutting along the grain. The teeth of a rip-saw vary in size according to the fineness of the work to be done. Their size is indicated by the number of "points" to the inch or a metric division indicates the size of a tooth. The teeth of a rip-saw are shaped like chisel points and their forward edges are at right angles to the length of the blade. The action of these teeth are like that of a series of small chisels, each cutting small shavings to the width of the tooth. The cutting angle of a rip-saw tooth is either 90 degrees or less.

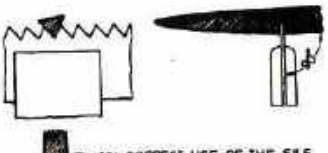


Fig.264. CORRECT USE OF THE FILE

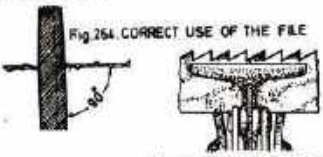


Fig.265. CLAMPING THE SAW BLADE

Fig.266. DIRECTION OF SHARPENING

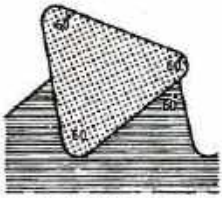


Fig.267 CONDITION OF THE FILE

Fig.268 INCORRECT HOLDING OF THE FILE

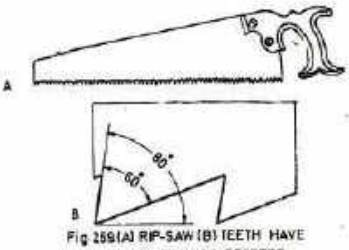


Fig.269(A) RIP-SAW (B) TEETH HAVE LESS THAN 90 DEGREES

CROSS-CUT SAW Fig.270

The cross-cut saw has smaller teeth for cutting across the grain. All fibers must be severed across the grain and this demands teeth of different shape from those of the rip saw. Teeth pitched forward would dig into the wood when cutting across the grain and a saw with big teeth would merely rip up the fibers. Cross cut teeth are, therefore, pitched more up right. The cutting angle of a cross-cut saw tooth is always more than 90 degrees

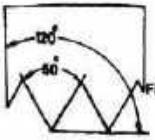


Fig.270. TEETH HAVE MORE THAN 90 DEGREES

BACKSAWS Fig.271,272

The two main types are the TENON SAW and the smaller DOVETAIL SAW, both are used for bench work. The tenon saw is from 250 to 400 mm long, while the dovetail saw is only 200 to 250 mm long. The blade of a backsaw is parallel and has a strong metal back fitted to the top edge to act as a stiffener. The dovetail saws are very light saws for fine work and they usually have a round handle like a chisel handle. As indicated by its name this saw is mainly used for cutting dovetails and similar work.

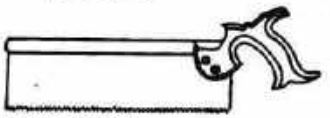


Fig.271. BACKSAW

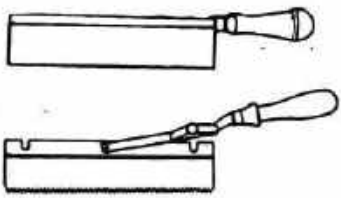


Fig.272. DOVETAIL SAWS

BOW OR TURNING SAW Fig.273

This saw has a hardwood frame and its blade has lengths of 600 to 1000 mm. The blade is held in tension either by a twisted cord or by a steel stainer on the opposite side of the frame to the blade. It has a middle rail to balance the side bars when tightening the saw. The handles at each end of the blade can be turned to alter the course of the cut or to avoid the projecting wood. It is important that both are turned to the same degree, otherwise the blade becomes twisted. A strong grip is needed to control the weight of the frame. These saws are available in different sizes for different saw blades.

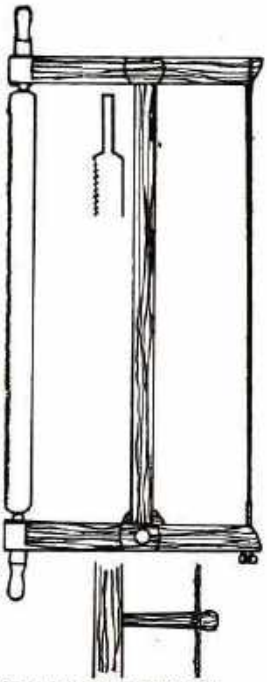


Fig.273. BOW OR TURNING SAW

COMPASS AND KEYHOLE SAW Fig.274

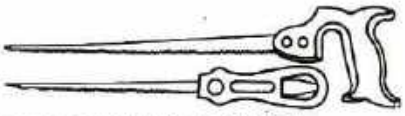


Fig.274. COMPASS AND KEYHOLE SAW

The compass saw teeth are sharpened to a point and its narrow blade is ground off to the back edge and therefore it need not to be set. It is useful in cutting a section from within a board or panel. A hole is bored near the line to be cut and the pointed end of the saw is inserted in this hole. The keyhole saw has also a very narrow and tapered blade, which runs in a slot right through the handle. The blade is softer than a normal saw blade, which allows it to be straightened easily when buckled. The keyhole saw is convenient to use for small internal curves and for cutting out such shapes as keyholes.

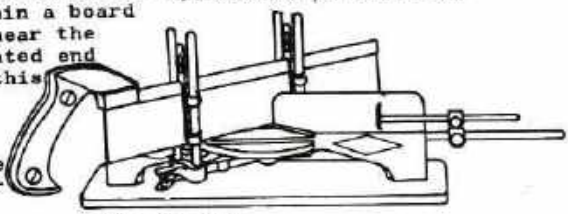


Fig.275. MITER SAW

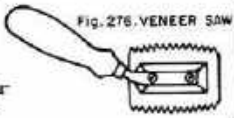


Fig.276. VENEER SAW

MITER SAW Fig.275

A miter box is made of either iron or wood. The iron miter box consists of a cast-iron frame fitted with a large backsaw which is held perpendicularly to the work by metal guides. It can be adjusted to cut at any angle and is used chiefly for mitering moldings and in picture frame work. It is also very useful for cutting small pieces of wood at right angles. The teeth of the miter saw are small (similar to the backsaw) so that a very clean cut can be made.

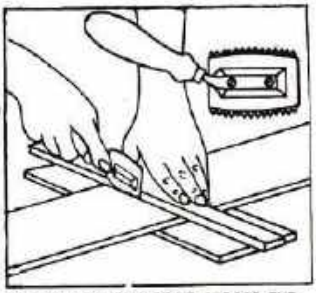


Fig.277. VENEER CUTTING ACROSS THE GRAIN

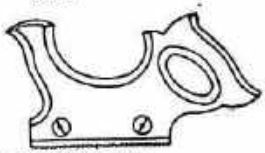


Fig 278 GROOVE SAW

VENEER SAW Fig.276,277

The veneer saw is short and has a curved cutting edge with very fine teeth and little or no set. The handle is fixed like on the dovetail saw. The blade is teethed on both sides and can be interchanged if one side is dull.

GROOVE SAW Fig.278,279

The groove saw is used to cut grooves when making dovetail and groove joints. This saw is very short (150 mm), it has two handles and its saw blade has very fine teeth. Some groove saws have adjustable saw blades so that the depth of the cut can be adjusted.

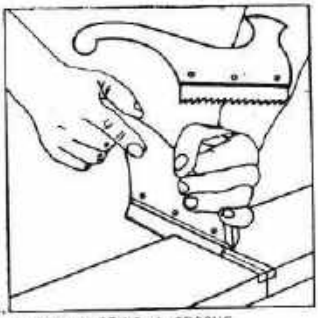


Fig.279. CUTTING A GROOVE

The direction of the cut is towards the body and not like the other saws away from the body.

USING THE HANDSAW
Fig.280, 281, 282, 283, 284

Both ripping and cross-cutting can be done on sawing-rack benches or in the bench-vise, whichever may be more convenient. Longer lengths of timber are best cut on sawing-racks. They are held firmly with one knee, leaving one hand free to hold the unsupported piece of the wood. The saw is started fairly low down to establish the line of cut and the thumb or knuckle is used as a guide. Once the cut has been started, the saw is brought up to an angle of about 45 degrees. Nearly the whole length of the saw should be used and the saw, wrist elbow and shoulder should all be in line. The sighting eye should also be directly above the saw. The saw can be tested for its vertical line with a square. It may be necessary, when ripping down, to wedge open the two pieces, which tend to tighten and pinch the saw. When cutting across the grain, the free hand is brought across to hold the cut piece and care must be taken to avoid splintering the wood as the cut is completed. A few short careful strokes at the end will prevent this.
Tenon and Dovetail saws are used in a similar way to handsaws, but for more accurate benchwork. Tenons and dovetails should, with practice be fitted straight from the saw. For cutting tenons, the wood should be fixed as low as possible in the vise and fixed firmly. The cut is started at the far corner of the tenon and gradually brought down the line to the nearer bottom corner. In this way the line can be followed accurately. The other cut can be made whilst the wood is in position and then it is reversed in the vise and both cuts finished off. Wide, deep tenons are often cut with a panel saw. Where a cut has to be made across the grain,

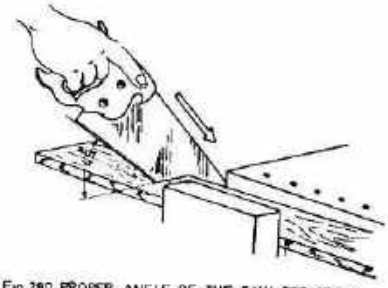


Fig 280. PROPER ANGLE OF THE SAW FOR CROSS CUTTING

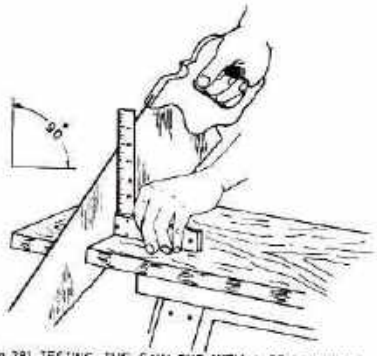


Fig 281 TESTING THE SAW CUT WITH A TRY SQUARE

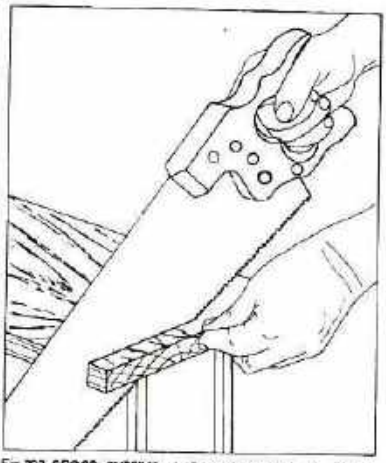


Fig 282 CROSS CUTTING A BOARD WHICH IS HELD IN BENCH VISE

such as shoulders and halvings, the wood is either gripped in the vise, or is held against the bench-hook, which is fixed in the bench-vise for further rigidity. The golden rule to follow in all saw-cutting is to cut on the waste side of the line and it is wise, when marking out, to shade in the waste with a pencil, as one wrong cut can spoil a great deal of work and where there is a multiplicity of lines, as in dovetails, confusion is likely to arise.

PLANES Fig.285A, 285B

Planes are used to make the surface of the wood true and smooth. They are made in both wood and metal, in various sizes and types for particular jobs. The body of the plane carries a cutting-iron, a back-iron, or stiffener and a wedge to fix the irons in position, though some special planes have only a single iron. Most woodworkers use both wooden and metal planes, finding that each does a particular job better than the other. The metal plane, now in wide use, permits a fine and easy adjustment of the blade and the mouth of the plane can also be altered readily by an adjustable frog, the part which carries the irons. The plane-sole is accurately machined and keeps its shape without perceptible wear. The cutting-irons are quickly and easily released by a locking cap-iron. Metal planes are, however, expensive to buy and heavier than wooden planes to use. They are also more liable to fracture if dropped, being made of cast-iron. The wooden plane may be less expensive than a metal one and lighter to use, especially in the longer types, but is not so convenient to adjust. The sole needs truing up periodically through wear as it is the mouth of the plane, which in time needs a new insert. Re-mouthing need not be done too frequently, however

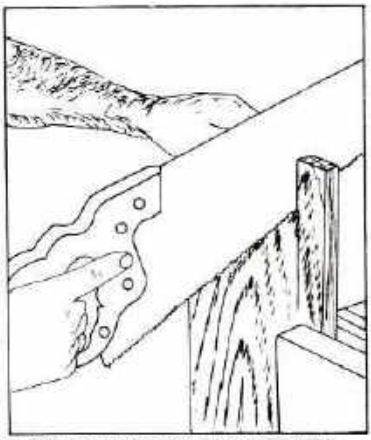


Fig 283. BOARD HELD IN A BENCH VISE WITH RIPPING

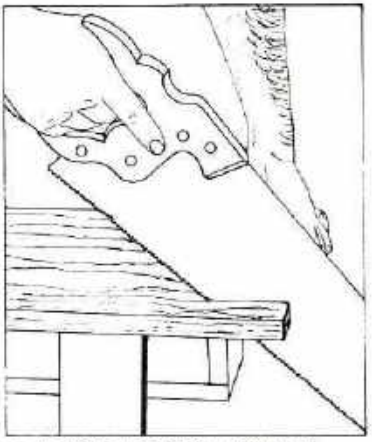


Fig 284 RIPPING A BOARD ON A SAWHORSE

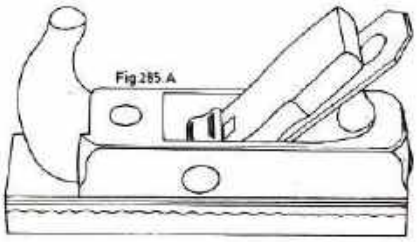


Fig 285 A WOODEN PLANE

and the smooth running of a well maintained wooden plane is preferred by many experienced woodworkers to the greater resistance of a metal plane. Metal planes can be obtained with a 'corrugated' sole, to lessen the friction, but this makes it more difficult to use as an all round tool.

GRINDING AND SHARPENING Fig.286

When a plane iron, chisel, gauge or spokeshave blade has been whetted on the oilstone so often that its bevel has become short or convex, it is necessary to grind it on a grindstone or emery wheel. A cutting iron may be whetted a few times before it needs regrinding.

How to grind a plane iron?

1. Adjust the tool rest to the required angle and grind the bevel until it is true, straight and at right angles to the side of the iron. Move the iron back and forth across the face of the stone while grinding. Make sure the blade is frequently cooled down in a small water container which must be fixed to the grinder. Fig.287
2. It is important that the bevel is ground flat or slightly concave and that the iron is not burned while grinding. Burning means that the edge turns to a blue-black colour. When this happens, the temper of the steel is drawn or lost and the edge will not stay sharp. Fig.288
3. The length of the bevel should be about twice the thickness of the blade. This gives a grinding angle of 25 degrees which is used for most cutting operations. A 20 degrees bevel can be used on softwood, but it crumbles when used on hardwood. Fig.289

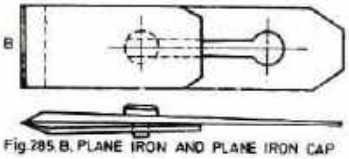


Fig.285.B. PLANE IRON AND PLANE IRON CAP

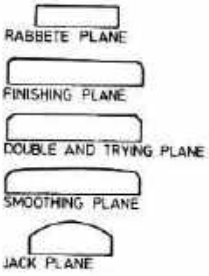


Fig.286 GRINDING AND SHARPENING

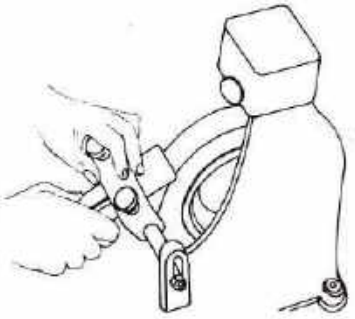


Fig.287 GRINDER

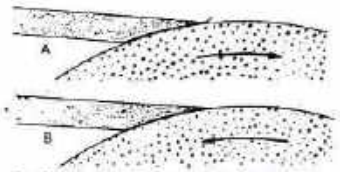


Fig.288.(A) GRINDER WHEEL IS RUNNING WRONG (B) GRINDER WHEEL IS RUNNING CORRECT

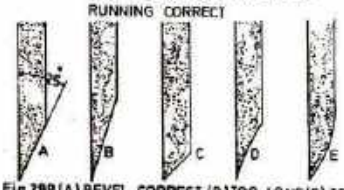


Fig.289 (A) BEVEL CORRECT (B) TOO LONG (C) TOO SHORT (D) TOO CONCAVE (E) TOO CONVEX

4. When whetting the plane iron we place the bevel flat on the oilstone, raise the iron a little and move it back and orth, pressing on it with the left hand. Use the whole surface of the stone to wear it down evenly. Reverse the iron and place it flat on the oilstone, bevel side up. Press on it with the left hand and move it back and forth a few times. Be careful to hold it absolutely flat. Repeat the process until the wire edge (or burr) has been removed. Finish the whetting by drawing the iron over the edge of a piece of hardwood. Chisels and spokeshaves are sharpened in the same way. Fig.290,291,292,293,294

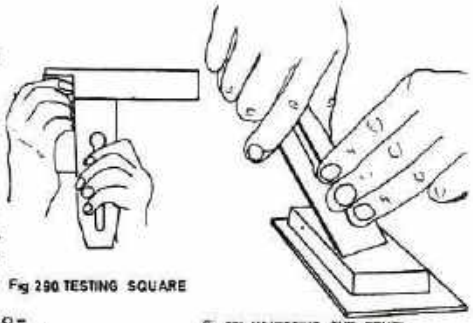


Fig 290 TESTING SQUARE

Fig291. WHETTING THE BEVEL

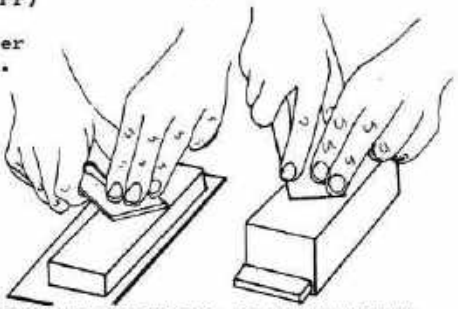


Fig.292. WHETTING THE FACE

Fig 293. FINAL WHETTING

TRUING THE SOLE OF A PLANE Fig.295 A,B,C,D.

From time to time the sole of a wooden plane, (through wear) will need to be trued. The plane is of little use unless the sole is true. Truing is done on a straight board covered with sandpaper on which the plane is sanded until the sole of the plane is trued. A good straight surface for truing the plane, is the front or rear table of the jointer, or any other machine table.

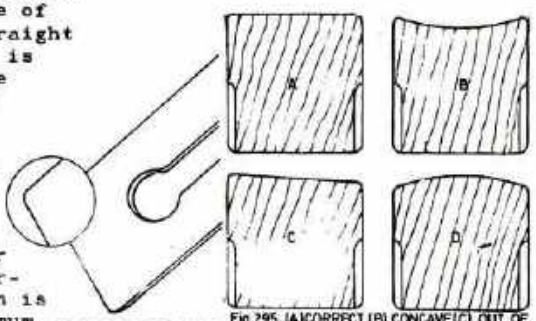


Fig 294. CORNER SLIGHTLY ROUND

Fig 295. (A)CORRECT (B) CONCAVE(C) OUT OF SQUARE (D) CONVEX

THE CUTTING ACTION OF A PLANE Fig.296,297,298,A,B,C,D

For a properly maintained efficiency in work and greater accuracy in planing, the understanding of the cutting action is necessary. Obtaining the maximum accuracy from a plane depends mainly on the maintenance of four things: a true sole, a small enough mouth, a well-fitting back-iron and a sharp blade. Common faults causing bad results in planing are: bluntness and choking. Bluntness can be avoided by frequent sharpening as already described. Choking is caused by the lack of a free passage for the shavings, which become tightly wedged in the mouth

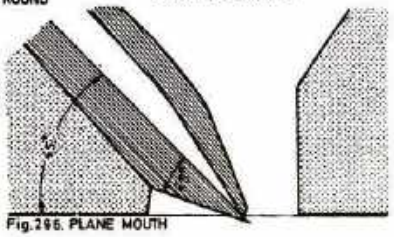


Fig.296. PLANE MOUTH

of the plane. One cause may be; a badly fitting back-iron, as shavings will find its way into the slightest gap between the back-iron and the cutting-iron, blocking the passage of the shavings following after and preventing the back-iron from doing its proper work. Should this be the cause of choking, the back-iron must be trued. The angle of the cutting-iron in most planes is 45 degrees, which has been found to be the most efficient angle for general work. The size of the plane-mouth is also important in the cutting action of a plane; if it is too large, the shavings are not held down directly in front of the cutting edge of the blade and is torn up too far ahead. Here lies a need for remouthing.

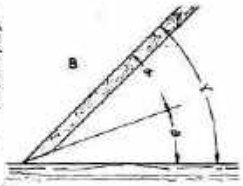


Fig.297(A) CUTTING ANGLE (B) PRESSURE POINT

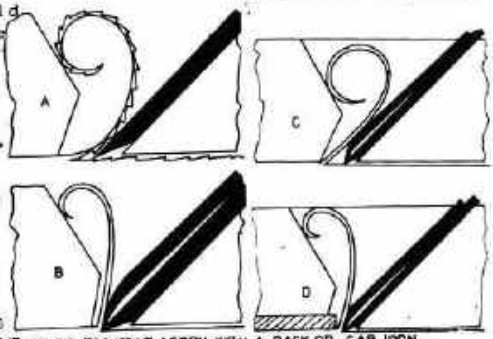


Fig.298(A) CUTTING AGAINST THE GRAINS (B) CUTTING ACTION WITH A BACK OR CAP IRON (C) BEFORE RE-MOUTHING (D) AFTER RE-MOUTHING

THE PLANE IN USE Fig.299, 300

When planing, a comfortable working position should be adopted, with the feet apart and the body well over the work, the arms being free to maintain the full stroke. A common fault in planing is to plane the work round by letting the plane tip at each end. This tendency should be resisted, by putting weight on the front of the plane as the stroke begins and transferring it to the rear as the stroke ends. There is little danger of planing the work hollow with a large plane, but it is very easy to make the surface twisted (winding), therefore, the work should be tested before and during planing with the winding strips. Fig.301. The flat surfaces of the work are planed on the bench-top, clamped between the front and rear cramp irons. Edges are planed with the work piece clamped in the front chop jaw or vise and a slightly different grip is employed. A guide piece of wood is kept against the board and the plane sole by the left hand, acting as a guide to keep

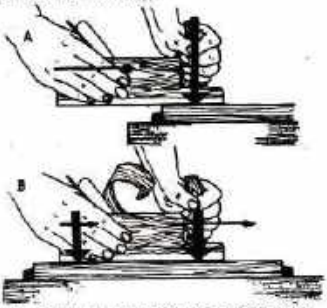


Fig.299 (A) PRESSURE ON THE FRONT HAND (B) PRESSURE ON BOTH HANDS

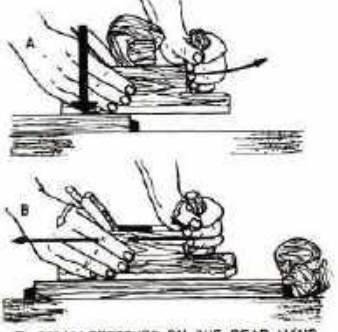


Fig.300 (A) PRESSURE ON THE REAR HAND (B) WHEN PULLING BACK TILT THE PLANE

the centre of the plane on the edge of the work. Fig.302. Planing must be done with the grain to avoid tearing the surface of the wood. It is necessary to plane one side and one edge of a piece of wood first, so that these are true to be used as a guide for the other sides. They should be marked clearly with a face side and a face edge mark, Fig.303 to avoid subsequent confusion in marking-out and assembly. From these faces the wood is marked with a marking gauge for width and thickness and then planed down. The end-grain of a piece of wood is planed with a sharp and fine adjusted finishing plane. There is a danger when planing end-grain, of splitting off the farthest corner of the wood. This can be avoided in several ways. If the planing is done in the bench vise, a waste piece of wood may be clamped on for support. Another method is to chisel off the corner and plane the end-grain before planing the width, but the best and surest way of avoiding damage is to plane from both edges towards the centre. Fig.304, 305, 306

Fig.301

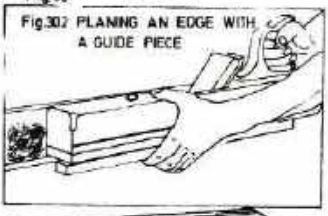


Fig.304 PLANING END GRAIN BY CHAMFERING A CORNER
Fig.305 PLANING END GRAIN BY ADDING A PIECE OF SCRAP STOCK

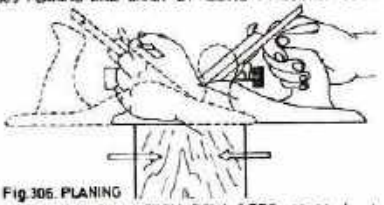


Fig.306. PLANING END GRAIN FROM BOTH SIDES

TYPES OF PLANE

JACK-PLANE Fig.307

This plane is used for getting the work quickly down to size and approximately true. The size of the jack-plane is 240 mm long and the body is 66 x 47 mm wide. The angle of the cutting iron is 45 degrees and the cutting edge is sharpened in a curve, (concave), its width is 30 to 33 mm wide. The mouth of this plane should be fairly big to accommodate thick shavings, as the blade projects further than in other planes. This plane has no cap or back iron.

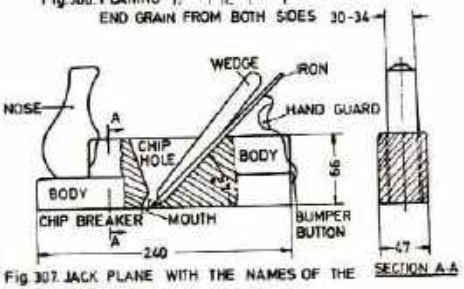


Fig.307 JACK PLANE WITH THE NAMES OF THE PLANE PARTS

SMOOTHING-PLANE Fig.308

The smoothing-plane is used when the surface has already been trued and it is also essential if a rough board has to be smoothed without regard to the truth of the surface.

The size of a smoothing-plane is 240 mm long the body is 66 x 65 mm wide and the cutting iron is 48 mm wide. The cutting edge is sharpened square across the iron. The angle of the cutting iron is 45 degrees. This plane has also no cap or back-iron.

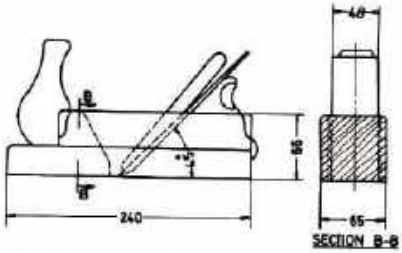


Fig. 308 SMOOTHING PLANE

DOUBLE-PLANE Fig.309

The size of this plane and the angle of the cutting-iron is the same as of the smoothing-plane, but it has a cap-iron. Its main function however, is to plane surfaces smooth and true but it is generally used for many different operations which makes it an all round tool. The mouth of the double-plane must be small to guarantee a clean and fine cut.

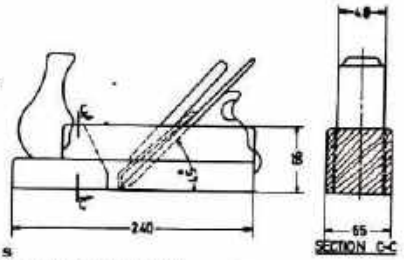


Fig. 309. DOUBLE PLANE

FINISHING-PLANE Fig.310

The size of the finishing-plane is slightly smaller than the smoothing or double plane. Its cutting angle, however, is 49 or 50 degrees which prevents the wood from tearing and a good finish can be obtained. The mouth of a finishing-plane is always very small and some modern planes have an adjustable mouth by which one can move the whole frog backwards or forwards. These finishing-planes are also called **Reform-Finishing-Planes.**
The soles of all the planes mentioned so far are made of Pockwood (Lignum Vitae)

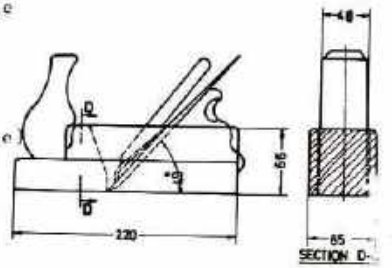


Fig 310 FINISHING PLANE

TRYING-PLANE Fig.311

A trying-plane is needed for greater accuracy in planing a true surface, to cover a larger area and for jointing perfectly straight edges. A common size of a trying plane is 600 mm long and its body is 78 x 78 mm wide, with a cutting iron of 57 mm and 60 mm wide. The cutting iron is adjusted at an angle of 45 degrees and the cutting edge of the iron is sharpened square across the iron.

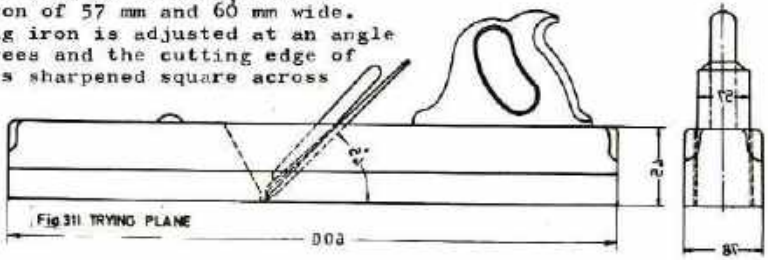


Fig.311 TRYING PLANE

The extreme length of the trying plane is needed for producing a true and straight surface.

TOOTHING-PLANE Fig.312

The toothing-plane is similar in size and shape to the finishing plane and its main purpose is to prepare a rough gluing surface. The cutting angle is different from all other planes because it is set at 75 to 80 degrees having a scraping action and has no back-iron. The cutting edge is a series of teeth, formed like a 'V' on the face of the blade and is sharpened like a normal plane iron, but with no sharpening on the face of the iron. The plane is used diagonally across the work in both directions and then along the grain.

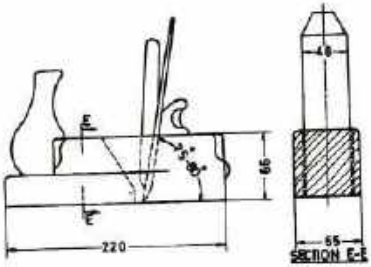


Fig. 312. TOOTHING PLANE

SPECIAL-PLANES

RABBET-PLANE Fig.313,314,A

The rabbet-plane is used for planing rabbets on the edges of a board or frame. Common sizes are 240 mm to 270 mm long, 21 mm to 30 mm wide and 70 mm to 90 mm high. Its cutting iron is adjusted to an angle of 48 degrees and the edge of the cutting iron has either a square or a "skewed" shape. Some designs of rabbet planes have an adjustable front sole and a back iron, with the adjustable sole a very fine setting can be achieved which is needed when fitting doors or windows. The skewed-iron rabbets-plane is used with the leading point of the cutter in the corner of the rabbet, which tends to draw the plane into the corner. The disadvantage of this is that it may have to be used against the grain, causing tearing of the wood.

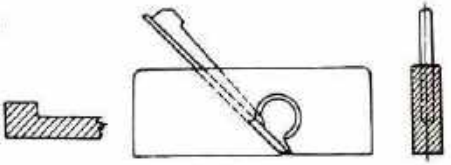


Fig. 313. RABBET PLANE

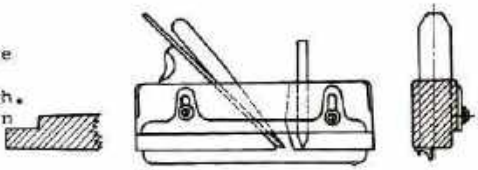


Fig. 314. RABBET PLANE

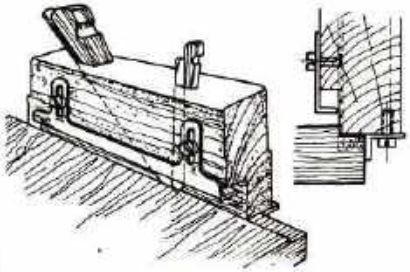


Fig. 314.A. CUTTING A RABBET WITH THE ADJUSTABLE RABBET PLANE

FILLISTER OR DOVETAIL-PLANE Fig.315

This is a more complicated tool, used for cutting dovetail end ledges on boards across the grain.

The sole and the cutting iron of this plane has a bevel of 75 to 80 degrees to fit the shoulder of a dovetail joint. In front of the main cutting iron a taper die counterblade is mounted to cut the fibers ahead of the main cutting iron and to trim the corners. An adjustable guide is used to limit the depth of the cut. Fig.315A

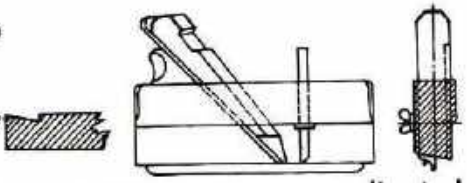


Fig.315. FILLISTER OR DOVETAL PLANE

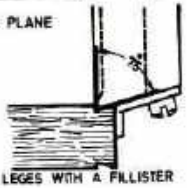


Fig.315.A. TRIMMING DOVETAL LEGES WITH A FILLISTER PLANE

PLOUGH PLANE Fig.316

This plane is used to form grooves parallel with the grain. The cutting irons are available in various sizes from 3 to 16 mm wide. The iron has no back-iron and is fixed into position by a wedge. The depth of the groove can be adjusted by a gauge which is fixed to the body of the plane and operated by a thumb-screw. A second guide parallel to the plane controls the distance of the groove from the edge of the board.

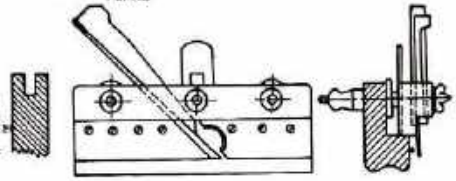


Fig. 316. PLOUGH PLANE

ROUTER-PLANE Fig.317

The router plane is used to clean out and level grooves and recesses. It is used mainly across the grain. The router has a scraping action and the single blade is pitched high in the stock, which is made of BEECH-WOOD like most of the planes mentioned before. The cutting iron is lowered after each cut until the required depth is reached. An alternative is to remove the bulk of the waste with a chisel and finish with the router-plane.

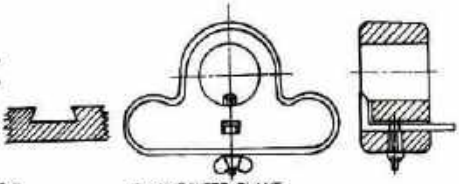


Fig.317. ROUTER PLANE

COMPASS OR CIRCULAR-PLANE Fig.318,A,B

The compass plane is often called a circular plane. It is used for planing large curved work, either concave or convex. The cutting iron, back-iron and cap-irons are similar to those of an ordinary steel plane, but they are held in a metal device. The sole of the plane is flexible and the main adjustment to form the curve is made by raising or lowering both ends of the sole by means of a

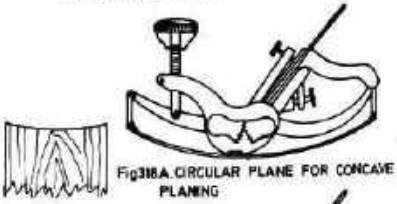


Fig318.A CIRCULAR PLANE FOR CONCAVE PLANING

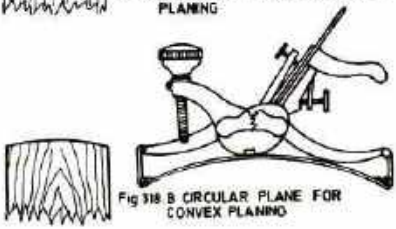


Fig 318.B CIRCULAR PLANE FOR CONVEX PLANING

threaded knob. The cutting iron should be set whilst the sole is straight and the tension on the sole should be released when the plane is not in use.

SPOKESHAVE Fig.319,A,B

Spokeshaves are used for finishing curved surfaces, they have a blade and cap-iron similar to a steel plane and some types are fitted with two adjusting screws for setting the blade. These types of sole or face are made.

1. The FLAT-FACE spokeshave is used for outside curves. Fig.320
2. The ROUND-FACE for inside curves. Fig.321
3. The HOLLOW-FACE for work curved in both directions. Fig.322

The blade is sharpened in the same way as the plane-iron, but being short it is not easy to hold. It is advisable to use either a small metal hand-vise or a piece of hardwood slotted to fit over the blade. Fig.323. The use of the spokeshave is shown in Fig.319AB. It is gripped by the handles, but if the thumbs are placed behind the blade and the forefingers on the front part of the stock move control can be exercised over the cutting action. The wrists then do most of the guiding. The direction of the cut must always be with the grain, not against it and this may mean working from both direction on a piece of curved work.

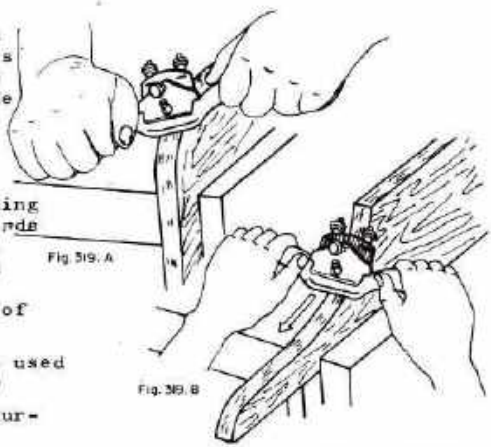


Fig. 319. A & B SMOOTHING A CORVED EDGE WITH THE SPOKESHAVE

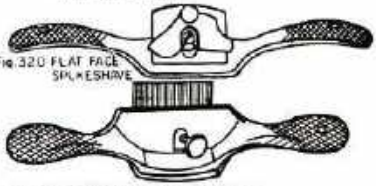


Fig. 320 FLAT FACE SPOKESHAVE

Fig 321. ROUND FACE SPOKESHAVE


Fig. 322 HOLLOW FACE SPOKESHAVE


Fig. 323. SLOTTED PIECE OF HARD WOOD FOR HOLDING WHEN GRINDING SPOKESHAVE BLADES

THE SCRAPER Fig.324,A,B,325,A,B, 326,A,B,C

In spite of its name, the scraper is a definite cutting tool and should remove shavings, not dust. It is a flat tempered steel, either rectangular in shape or curved to suit different operations. The cutting edges are first carefully flat filed then ground smooth on the oilstone. The scraper is then laid flat on the bench to raise the edges by drawing a burnisher or (scraper steel) along the edge common of the scraper. This makes a


Fig. 324 A. RECTANGULAR SCRAPER Fig. 324 B CURVED SCRAPER

Fig. 325 A. FILING ON THE SCRAPER
Fig. 325 B. SMOOTHING THE SCRAPER WITH AN OIL STONE

clean, sharp cutting edge, by holding the scraper-steel at a slight angle to the square edge and making full length strokes from end to end. All four long edges should be treated in this way. The scraper can be also clamped vertically in vise with the same jaw protection for turning the edges, when greater pressure is needed, but the hands should be protected with a piece of cloth, to avoid nasty cuts. A good cutting-edge can be felt with the finger or thumb and can be renewed several times without filing until the edge becomes too round. Fig.327 shows a specially designed scraper sharpening device which makes work much more easy to handle. The scraper is used mainly on hardwood and veneered surfaces, where there is sufficient resistance to make the tool effective. It is also used on edges and on articles with difficult grain. The thumbs are placed in the centre of the blade and kept at an angle until the edge 'bites' and then pushed away from the body. A scraper-plane can be also used for this work, which acts similarly to a spokeshave. The blade in the plane is set at an angle of 70 degrees, but it is pushed with the blade angle not against it. Fig.328.

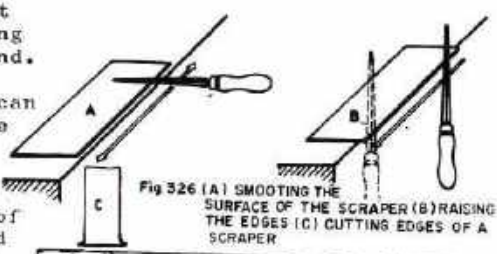


Fig 326 (A) SMOOTING THE SURFACE OF THE SCRAPER (B) RAISING THE EDGES (C) CUTTING EDGES OF A SCRAPER

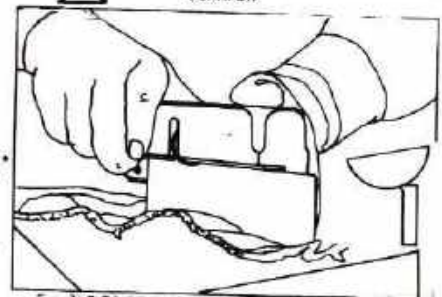


Fig 327 RAISING EDGES WITH A SCRAPER SHARPENING DEVICE

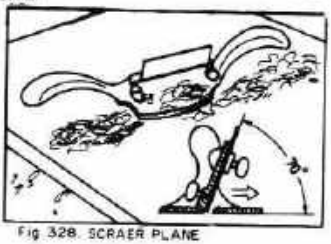


Fig 328. SCRAER PLANE

CHISELS AND GOUGES Fig.329,330

Chisels and gouges are the simplest of the cutting tools and vary in strength according to the work they are designed to do from the FIRMER chisel with its long thin blade, the TANG chisel, for general work, to the strong, heavy mortise chisel. The blade of a chisel or gouge is made from high-grade forged tool-steel fitted into a shaped handle of Ash, Beech or Boxwood. The grinding angle is the same as that for plane-irons 25 degrees and sharpening is done in a similar manner. The grinding angle of 25 degrees is sufficiently strong to withstand normal use and acute enough to cut the material instead of splitting it.

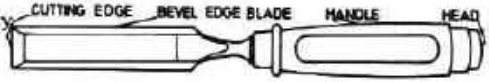


Fig329 NAMES OF CHISEL PARTS

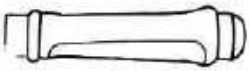
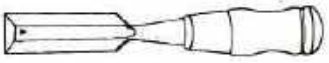


Fig330 HANDLE OF A CHISEL

SOCKET FIRMER AND TANG BUTT CHISEL
Fig.331,332

The chisels are used for cutting, trimming, fitting and shaping. They range in sizes from 2 mm to 40 mm in width. Common sizes are 6,8,10,12,14,16,18,20 and 26 mm in width. The blade is fitted into the handle by a tang, which has a shoulder to butt up against the end of the handle. A brass or iron ferrule on both ends prevents the handle from splitting. The blade is bevel-edged and increases in thickness towards the handle for greater strength. The shape of the handle is a matter of the manufacturers preference, but the plastic ones are getting more and more common because of their strength.



TANG BUTTCHISEL

SOCKET FIRMER CHISEL

Fig331

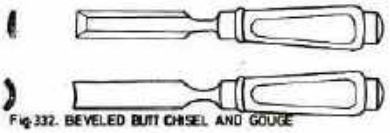


Fig.332. BEVELED BUTT CHISEL AND GOUGE

MORTISE CHISEL Fig.333,334

The mortise chisel is designed to withstand hard, rough wear and the thickness of the blade permits the leverage necessary to clear the mortise and keep the blade true. It has a strong handle and the blade is fitted into it by a tang as with the socket and tang chisel. Common sizes of mortise chisels are 4,5,6,8,10,12,14,16,20 mm in width. The chisel blade is ground slightly taper from the face towards the back and from the cutting-edge towards the handle to avoid friction.

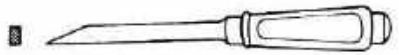


Fig.333. MORTISE CHISEL

Fig.334. MORTISE CHISEL BLADE

GOUGES Fig.335,336,337

The gouge is a chisel with a curved cutting edge. The size is measured straight across from one edge to the other. They range from 4 to 40 mm in width, but common sizes in use are: 6,8,10,12 16 and 20 mm wide. The gouge is used for hollowing, for cleaning round moldings and for inserting round-edge hardware. It is sharpened on the oilstone in a similar way to the chisel, except that it is rolled from side to side so that the whole of the cutting edge

Fig.335. OUTSIDE BEVEL GOUGE

Fig.336. INSIDE BEVEL GOUGE

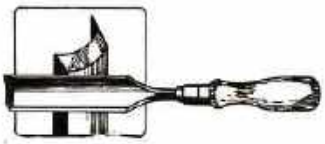


Fig337. DETAIL OF THE CUTTING EDGE

is sharpened. The wire-edge (or burr) is removed from the inside with a curved slip-stone.

THE USE OF A CHISEL Fig.338,A,B,C, 339,340,341,342

Woodworking depends so much on the correct use of the chisel that it is essential to master the use of this tool completely. That means the chisel should be always well ground and sharpened to retain control over the cutting edge. It is indispensable in the construction of most joints made by hand. Most work with the chisel is done paring, either vertically or horizontally, that means it is used with both hands and the work piece is held firmly in the vise or it is clamped to the work bench. In straight grained wood it may be possible to remove a thick piece of the waste with mallet and chisel without the danger of splitting off the far edge (cross-lap joint), but better and safer practice is to remove the waste in the form of thin shavings, working from both sides of the joint. The chisel is held horizontally in one hand and guided with the other. When the chisel is used for chopping, for example the waste between dovetails, the work must be clamped down solidly, if possible above the leg of the bench. With end-grain paring, only a little should be taken off at a time. When the chisel is used vertically the left hand should never be in front of the cutting edge, to avoid nasty cuts.

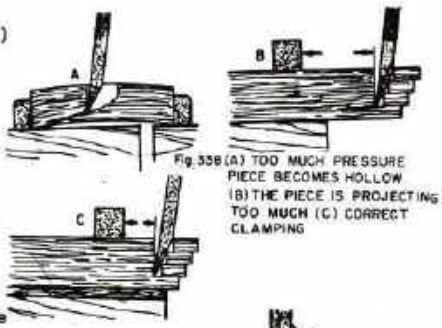


Fig.338 (A) TOO MUCH PRESSURE PIECE BECOMES HOLLOW (B) THE PIECE IS PROJECTING TOO MUCH (C) CORRECT CLAMPING

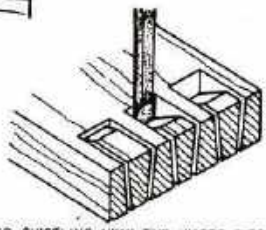


Fig.339. CHISELING AWAY THE WASTE PIECES

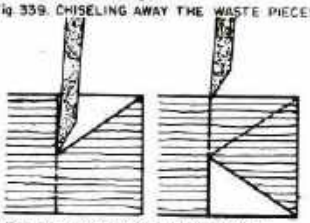


Fig.340 CHISELING OUT A MORTISE

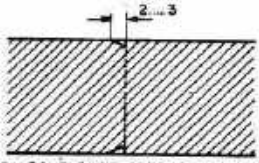


Fig.341 SLOPING GROOVE TO SHART A SAW OR CHISEL CUT

BORING TOOLS

TWIST-BIT Fig.343,344

The woodworking and metal trades distinguish sharply between bits and drills, between boring and drilling. In the woodworking trade we never say that a hole is drilled into the wood, we use the term bored instead. Twist drills are shaped like twist bits, but their cutting edges are not ground as steeply as

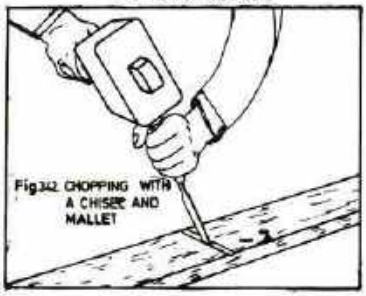


Fig.342 CHOPPING WITH A CHISEL AND MALLET

on a twist bit. As the name implies, they are made for drilling in metal, but can also be used for wood. Twist drills used by machinists have only a round shank. Twist bits used by woodworkers have a square shank like most of the other bits.

Fig.343. SHORT SHANK TWIST BIT

Fig.344. LONG SHANK TWIST BIT

THE DOUBLE SPUR TWIST BIT Fig.345,346

This bit has its cutters in the form of rounded wings or ears also called (nibs) and a sharp point called 'spur'. It is preferred for boring end grain wood, as there is less or no tendency to follow the grain and it is by far the best bit for clean and accurate boring. It has two horizontal cutting edges called the routers, besides the two 'lips'. The sharpening is always done from inside.

Fig.345.DOUBLE SPUR TWIST BIT

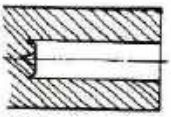


Fig.346. DOWEL HOLE

AUGER-BIT Fig.347,348

The auger bits are screw-shaped tools consisting of two main parts, the twist and the shank. The twist ends in two sharp points, the nibs and two cutting edges, the lips, which remove the shavings from within the scored circle or boring. A small screw point, in the centre of the cutting end, centres the bit and draws it into the wood. The shank ends in a square-tapered tang, which is held by the chuck of the brace. The sizes of auger bits vary in size from 1 mm to 16 mm and by 2 mm to 30 mm in diameter and are 185 mm to 250 mm long. The most common ones in use are: 4,5,6,8,10,12,15,18 and 22 mm.

Fig.347. AUGER BIT

Fig.348.DETAIL OF THE CUTTING EDGES

CENTRE-BIT Fig.349,350

The centre-bit has little or no twist and is generally used on thinner work, but can be used on any thickness of wood. If they are used for deep boring, they are liable to follow the grain. The centre-bit has a single nicker on the opposite side to the router and the point is sharpened to cut also. When boring a hole the nicker is cutting first to obtain a clean hole.

Fig. 349. CENTRE BIT

Fig.350. DETAIL OF THE CUTTING EDGES

The disadvantage of this bit is, that it is not drawn into the wood and it does not clear the waste from the hole. They are available from 6 to 40 mm in diameter.

EXPANSIVE-BIT Fig.351,352

This is an expansive tool, extremely useful for boring holes of odd sizes. It is similar to the centre bit, but has an extending wing cutter. This bit has also a small screw point in the centre of the cutting end which centers the bit and draws it into the wood. The fixed centre cutter removes most of the waste. The wing cutter can be adjusted at any point from 14 to 78 mm in diameter and is fixed with a jaw-screw clamping plate.

Fig.351. EXPANSIVE BIT

Fig.352. DETAIL OF THE CUTTING EDGES

FOERSTNER BIT **Fig.353**

The foerstner bit has no twist nor screw. They cut with a sharp circular steel rim with two lips within this rim and has also a centre point or spur. They bore very accurately and are used for decorative holes or boring out knots, to be replaced by a plug. Moreover, when boring near the end of a piece of stock, a foerstner bit is less likely to split the wood than an auger bit. They are available in sizes from 6 to 80 mm in diameter.

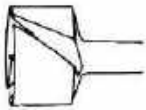


Fig.353. FOERSTNE BIT AND DETAIL OF CUTTING EDGES

GIMLET OR SNAIL BIT **Fig.354**

Gimlet bits are used for boring holes of small diameters such as are needed when inserting screws in hardwood. They are easy to handle because of their very steep pitched points and their cutting edge. They are available in sizes from 2 to 10 mm in diameter.

Fig.354. GIMLET OR SNAIL BIT

Fig.355. ROSE COUNTER SINK

Fig.356. SNAIL COUNTER SINK

COUNTERSINK BIT Fig.355,356,357

Three types, are commonly used in woodwork. The snail countersink is best for hardwood, having a

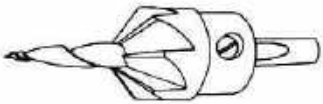


Fig.357. ADJUSTABLE COUNTER SINK

cutting edge which is liable to cut. The rose countersink has several scraping edges and can be used also on soft metals. The adjustable countersink bit has the advantage of being able to be fixed at any point on another bit which has the same diameter as the hole of the countersink head. Therefore it bores and countersinks at the same time.

DOWEL SHARPENER OR TRIMMER Fig.358,359

This bit saves a great deal of time if a lot of dowelling is to be done. It has a funnel-shaped end with a cutter, which chamfers the end of the dowel for easy entry into the hole and provides a space for some of the residue of the glue.

BRADAWL Fig.360

The bradawl has the appearance of a small screw driver, but it is sharpened to a point. It is used for marking and pointing work, but not for making holes as it has no sharp edges to cut, it forces the wood fibers apart and the wood splits.

REAMING BIT Fig.361

The reaming bit is also a sort of a boring tool and its appearance is like an aid, but it is sharpened square to a point and has one handle. It is used to make holes by forcing the reamer into the wood with a twisting motion. If carefully handles it does not force the wood fibers apart, because it has a cutting action.

RATCHET BRACE Fig.362,363,364

The ratchet brace is used for holding bits, screw bits and screw driver blades, with a square shaped tang. One end of the brace has a two-jawed chuck (some have four jaws) which holds the bit. The chuck has a ratchet gear for convenience in boring holes where there is no room

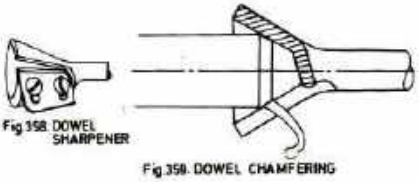


Fig.358. DOWEL SHARPENER

Fig.359. DOWEL CHAMFERING

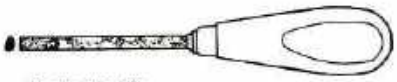


Fig.360. BRADAWL


Fig.361. REAMING BIT

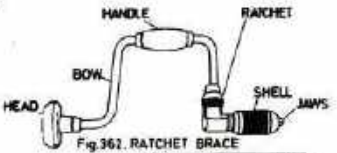


Fig.362. RATCHET BRACE

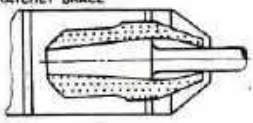


Fig.363. CHUCK OF A RATCHET BRACE .

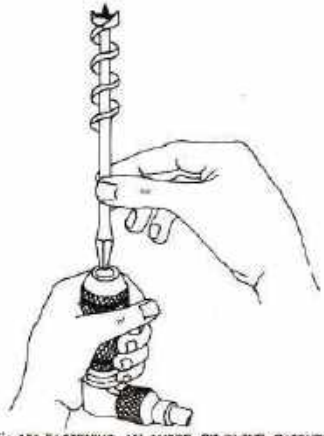


Fig.364. FASTENING AN AUGER BIT IN THE RATCHET BRACE CHUCK

for the full swing of the crank. On the other end a knob is fitted, which runs on a ball-bearing for guiding the brace and bit. The handle in the centre of the crank which has also a twisting guide is used for turning the brace in both directions.

THE BRACE AND BIT IN USE
Fig.365,366,367,368,369,370

The brace can be used equally well horizontally or vertically with bits having a screw-point, but boring with bits requiring pressure to cut, should be arranged so that the weight of the body can be brought to bear on the brace. True boring is difficult until sufficient practice develops the judgement, especially where two holes are to coincide, or deep boring where there is danger of splitting out the side. Various aids may be enlisted to assist true boring. The bit may be sighted for the vertical when boring out a mortise or similar hole. The bit can be sighted this way by an assistant if necessary. A large square placed alongside the work will also help true boring, or a piece of wood as a guide clamped on the work. For boring holes at a particular angle a jig can be made, which is a piece of waste wood, bored through with the bit to be used and then cut at the angle wanted. This is clamped on the work to guide the bit. A further method is to draw a pencil line on the side of the work in the direction of the bore and sight the brace and bit with the line. There are two methods of avoiding splintering when boring through wood. The first is to clamp a piece of waste wood behind the work and bore well into it. The second is to reverse the work immediately, the point penetrates the far side and bore until the nicker of the bit has made a deep cut. The wood is then turned back to the original side and the hole bored through. The disc of wood will fall out, leaving a clean hole.

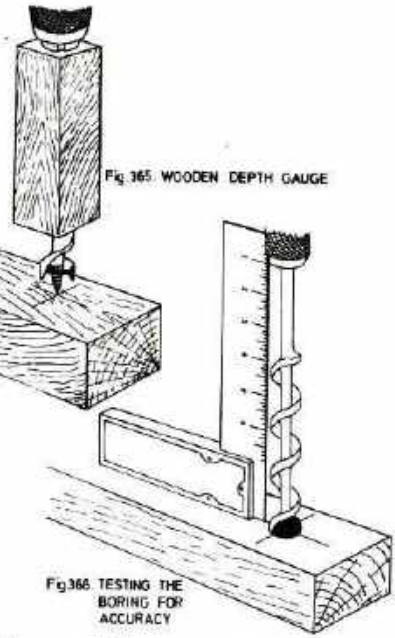


Fig.365. WOODEN DEPTH GAUGE

Fig.366. TESTING THE BORING FOR ACCURACY

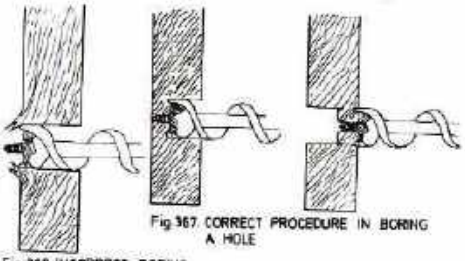


Fig.367. CORRECT PROCEDURE IN BORING A HOLE

Fig.368. INCORRECT BORING OF A HOLE

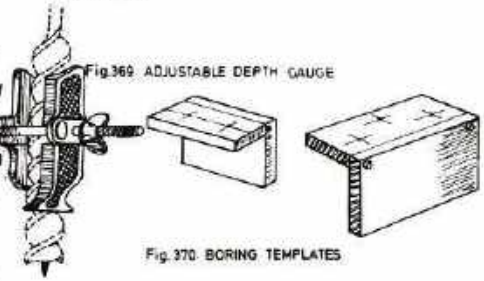


Fig.369. ADJUSTABLE DEPTH GAUGE

Fig.370. BORING TEMPLATES

SHARPENING THE BIT Fig.371,372,373,A,B

A fine file, followed by an oilstone slip if necessary, is used to sharpen bits. The nickers, or vertical cutters, are sharpened on the inside only, so that the true diameter of the bit is not impaired. The horizontal cutters, the routers, are sharpened on the underside to keep the cutting edge high and the bit is best held upside down in the vise to do this. A file with a plain or 'safe' edge helps to avoid damage to the other edges, but a small three-cornered saw-file is more easily controlled. Other bits, such as the snail countersink, need a fine 'rat-tail' file to reach the inside of the cutter. Generally, if the cutting-action of the tool is thoroughly appreciated, the method of sharpening is clear.

Fig.371 SHARPENING A FOERSTNER BIT

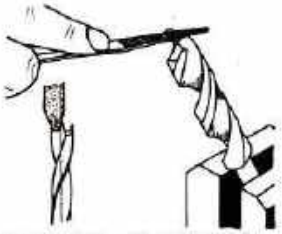


Fig.372 SHARPENING A DOUBLE SPUR BIT

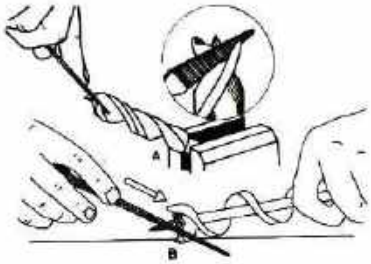


Fig.373 A & B SHARPENING AN AUGER BIT

MALLET Fig.374,375

Where the use of a hammer would damage tools or material, the wooden mallet is used. Besides avoiding damage, the mallet is also effective in use with chisels, gouges, dowels, etc, having more striking area and weight. The carpenter's mallet has a rectangular head of BEECH-WOOD. The striking faces are tapered off towards the bottom so that they give movement of the tool as it is swung. A head 110 mm long 80 mm wide and 60 mm thick is a suitable size for most purposes. The handle is driven in from the top and is tapered in its width so that it tightens up as it is driven in. If the mallet is held upside-down and dropped once or twice on the bench the weight of the head will tighten it on the handle.

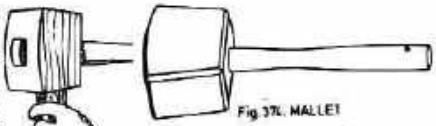


Fig.374. MALLET

Fig.375 USING A MALLET

CLAW AND WOODWORK HAMMERS Fig.376

This hammer is generally used by carpenters. It has two parts, the head and the handle. The end of the head, used for striking blows, is called the face, the other end is the peen. The peen of this hammer is

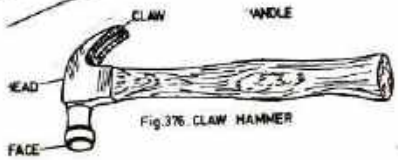


Fig.376 CLAW HAMMER

bent and shaped so that it can be used for pulling nails. Hammers used in woodwork have peens of different shapes, like shown on Fig.377,378. The faces of these hammers are always slightly convex so that they will not mark the surface of the wood after striking the last blow on the head of the nail. It is important to keep the face of the hammer clean and free from grease or glue, so that it will not glance off the head of a nail and bend it. It can be cleaned by rubbing over the face with a piece of sandpaper. The size of a hammer is indicated by weight of the head in grams or ounces.


Fig.377 WARRINGTON HAMMER

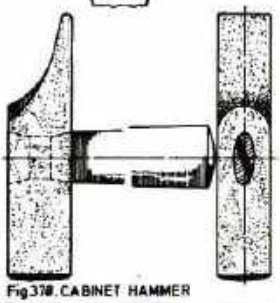


Fig.378 CABINET HAMMER

PINCERS Fig.379,380

This tool is chiefly used for extracting nails and tacks which have become bent in driving. When in use, care should be taken to prevent the jaw from marring the surface of the job by protecting it with a small piece of waste board.

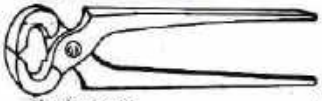


Fig.379. PINCER

NAIL PUNCH Fig.381

This tool is also called 'Nail set' and is used for punching nail heads below the surface. The nail punch is a small steel bar about 100 mm in length and 10 to 12 mm in diameter. It has a cup-shaped point and the size of the point varies with the size of the nail to be set.

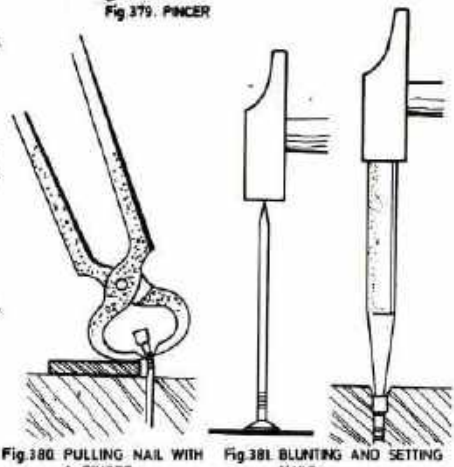


Fig.380 PULLING NAIL WITH A PINCER

Fig.381 BLUNTING AND SETTING NAILS

SCREWDRIVERS Fig.382,383

The plain screwdrivers are made with blades in many different widths and lengths. The blade of a screwdriver is fitted into the handle, either wood or plastic, by a tang and the shoulder is slotted or pined into the ferrule for further strength. The shape of the tip of the screwdriver is important for good work and a little consideration of this matter will avoid much irritation and spoilt work resulting from the screwdriver slipping out of the


Fig.382 COMMON SCREWDRIVER BLADE


Fig.383 PHILLIPS SCREWDRIVER BLADE

screw-slot. A tip too thin will break under hard use and when too wide will tear up the work around the screw-head. The tip should be square and straight and the taper from the point, should be as gradual as possible Fig.384. The tip should fit the slot of the screw exactly and there should be no taper on the tip until it is clear of the screw-head, so that all the power of the driver is available for turning the screw.

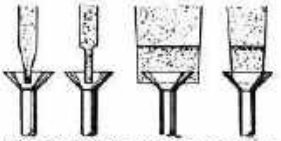


Fig.384. SCREWDRIVING


Fig.385 SPIRAL RATCHET SCREWDRIVER

SPIRAL RATCHET SCREWDRIVER Fig.385

The Spiral Ratchet screwdriver is further development in the rapid driving of screws. It is used more in industry than in general woodworking, for it is an expensive tool with limited scope. Different sizes of bits can be used with the spiral ratchet screwdriver and they are inserted in a chuck, which has a loose collar to be held with the free hand when driving in screws. A further collar on the body of the screwdriver locks it in either the open or closed position and a similar button to that on the ratchet screwdriver reverses or locks the ratchet. The spiral ratchet screwdriver is very effective for rapidly driving screws into softwood but where there is any resistance, sufficient downward pressure cannot be applied to prevent the bit from slipping out of the screw slot.

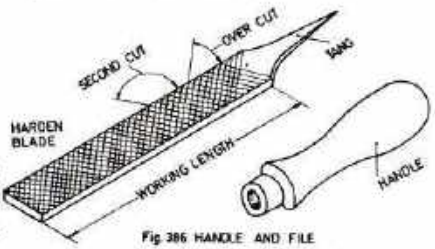


Fig.386 HANDLE AND FILE

FILES Fig.386,387,388,389,390, 391,392

Files are used in many different trades and many different purposes. They are classified according to the shape of their cross section for instance square, round, triangular, flat, half round, etc. and according to the manner in which the serrations or teeth are cut, as single cut or double cut. Single cut means, single parallel lines across the surface and double cut means, two sets of parallel lines crossing each other

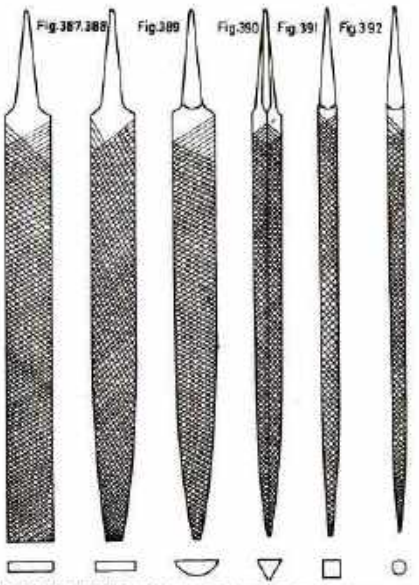


Fig.387,388.FLAT FILES, 389. HALF ROUND FILE. 390. TRIANGULAR FILE. 391. SQUARE FILE AND 392. ROUND FILE.

obliquely. Triangular files with pointed corners are made for sharpening hand saws. The second type with slightly round corners are for sharpening hand saws.

FILES FOR WOOD

Files for wood are made in several cuts, sizes and shapes and the teeth are pitched more forward than those of a metal-working file, giving a sharper cut. Half round files are the most useful in the workshop.

RASPS Fig.393,394,395

Rasps are very coarse-cutting tools, similar to files, but differing in that the teeth are individually raised instead of being formed by cuts right across the tool, as are those of the file. Rasps are used for quickly removing waste wood where cleaner cutting tools cannot reach. They tend to split of the edges of the wood and cause more work than they are worth unless used carefully. Rasps are made in various grades, the coarser ones being used for rough carpentry the finer ones for shaping curved surfaces and edges. They also differ in shapes. The most common ones are: round, half round and flat.

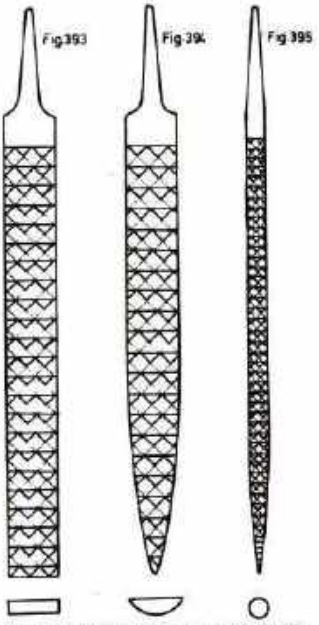


Fig.393. FLAT WOOD FILE, 394. HALF ROUND WOOD FILE, 395. ROUND WOOD FILE

OILSTONES Fig.396,397,398,399

There are two main types of oilstones, natural and artificial, each obtainable in various grades. Of the natural stones the 'Arkansas, or American stone and the 'Belgium Rock' are perhapes the most popular ones. The Arkansas stone, is a very hard and fine cutting stone and mainly used to produce on extremely keen edge (woodcarving tools). This stone is used with a kerosene oil mixture but the Belgium Rock is only used with water. Artificial stones are usually made in three grades, coarse, medium and fine. They are made from Carborundum or Corundum


Fig.396. ARTIFICIAL OILSTONE


Fig.397. BELGIUM ROCK


Fig.398. OILSTONE IN A CASE


Fig.399. SLIPS FOR CURVED TOOLS

and should be fitted into a wooden case if they are not bought ready cased, both for protection of the stones, which are fairly brittle and for convenience in sharpening. Oilstones become uneven with wear and it becomes difficult to maintain a straight edge when sharpening. Re-truing the face can be done by rubbing the stone on a sheet of coarse emery cloth fixed on a flat surface. Stones worn too much for re-facing may be split and sharped into slips for sharpening curved tools.

EMERY WHEELS

Emery wheels are artificial stones, made usually of either emery or carborundum abrasive and graded from soft to hard by letters, from fine to coarse by numbers. For tool grinding the emery wheel should have a medium grit and not too hard.

SAFETY WITH HAND TOOLS

The proper care of the tools is as important as their proper handling. Therefore, utmost care should be taken in the maintenance as well as the use of the different kinds of tools. The tools should be kept in a convenient place which is safe and the same time handy. Tools placed on slippery surfaces or projecting objects is hazardous to the trainee and may result in the damaging of the tool itself. Fig.400,A,B,C.

1. Test the sharpness of cutting tools on wood or paper, not on your hand.
2. Be careful when you use your thumb as a guide during cross cutting and ripping. Fig.401
3. Always direct the cutting action of chisels and other operating cutting tools away from your body and hands. Fig.402
4. Wear an overcoat or shop apron when you work with wood. Fig.403
5. Place tools in an orderly manner, on the bench, or in your tool cupboard. Point the cutting edges away from you. Do not let them rub against each other. Fig.404
6. Keep screw-drivers properly shaped to prevent injuries to hands, wood fiber and screw-heads. Fig.405
7. Keep handles firmly fastened on hammers, mallets, chisels and files. Fig.406
8. Use all tools properly and only for their intended purpose.
9. Always fasten or hold wood properly in a vise, use clamps or hold it firmly in a bench-hook. Fig.407
10. Put waste and short pieces of lumber in a storage rack. Do not throw them on the floor where they may cause an accident. Fig.408

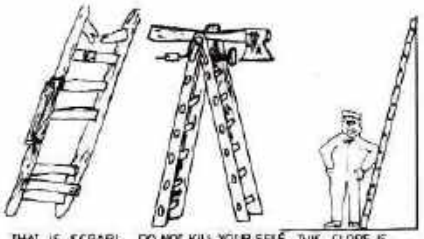


Fig.400

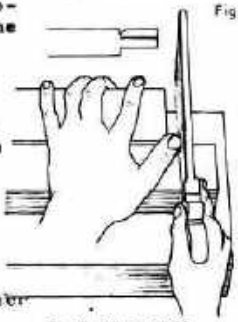


Fig.401 THUMB GUIDE


Fig.402 CORRECT PASSING ON A CHISEL


Fig.403 DO NOT PUT TOOLS INTO YOUR POCKET!

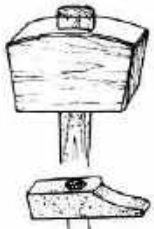


Fig.406 HAMMERS HANDLES MUST BE FIXED PROPERLY


Fig.404 TOOLS MUST BE KEPT IN SAFE PLACE

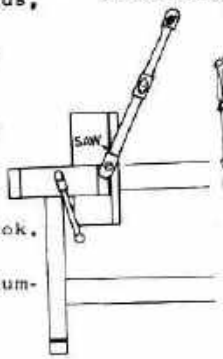


Fig.407 PROPERLY CLAMPING IN THE BENCH VICE


Fig.405 DO NOT USE SCREW DRIVERS INSTEAD OF CHISEL


Fig.408 THAT BELONGS INTO THE WASTE BOX

11. Report any type of accident immediately so that first aid can be given.

12. Co-operate with fellow trainees and workers to help prevent accidents. Be aware of the movement of others. Think ahead. Accident prevention must become the full time-task of all trainees and workers in the shop. "An hour of prevention is worth a second of cure." Fig.409

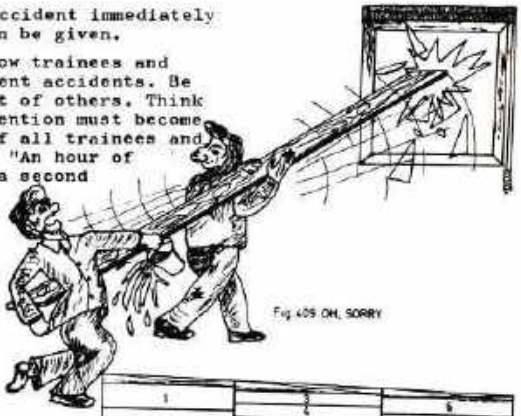


Fig.409 OH, SORRY

MARKING TIMBER
Fig.410,411,412

Time spent for selecting timber properly before marking out and cutting is well spent. It is advisable, if timber is in plank form, to mark out as much as possible of the work at once. There are several reasons for this. The fullest advantage can be taken of the grain, which is most important and the timber can be cut economically. Sapwood or other faulty timber like knots and checks can be avoided. As already mentioned in the chapter 'Plane in uses' boards should be marked clearly with a 'face side and face edge mark', after they have been planed, to avoid confusion in marking out and assembly. In chapter 'Edge joints Fig.77' we have explained how to mark boards for edge gluing. Another way of marking out all frame constructions is the triangle marking system. Rails and stiles are marked with a triangle which indicates the face side, the face edge as well as top and bottom. Rail and stiles used for frame construction jointed by a slip-joint, miter-joint or mortise and tenon-joint are always 'trisectioned' that means they are divided into three equal parts.

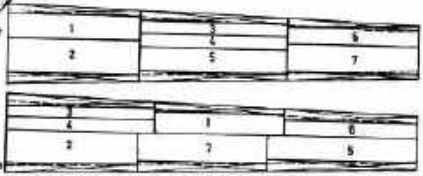


Fig.410 MARKING OUT A BOARD BEFORE CUTTING

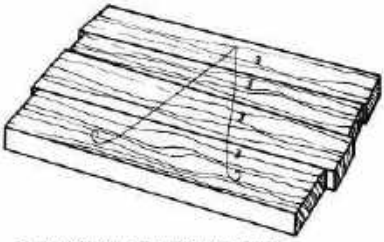


Fig.411 MARKING BOARDS FOR EDGE GLUING

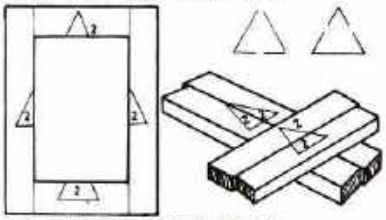


Fig.412 MARKING A FRAME WITH TRIANGLES

LAYING OUT LUMBER

Laying out lengths Fig.413

1. Select a board which has no checks or knots.

2. Square a line across the end of the board at a place which will avoid end checks or knots. Place the blade of the try square firmly against the edge of the board. Mark the line against the tongue of the try square on the board surface. The mark will be at a 90 degree angle with the edge.

3. Lay out the length you want with a measuring rule and mark it with a sharp pencil. Square the line on the surface of an edge and cut it off with a cross-cut saw. Fig.414

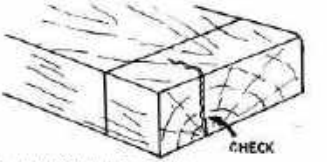


Fig 413. MARKING THE LENGTH

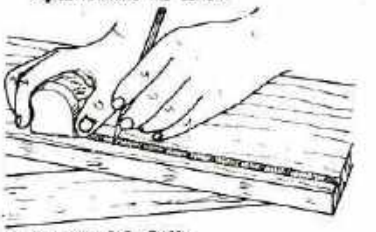


Fig 414. LAYING OUT LENGTH

Laying Out Widths

1. Measure and mark the width you want with any of the measuring tools. Divide and mark a board into any number of equal widths. Lay the rule edgewise across the board in a diagonal position, as shown in Fig.415

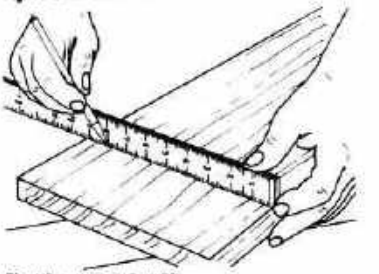


Fig 415. LAYING OUT WIDTH

END AND CROSS LAP JOINT Fig.416, 417

This joint is used as the simplest method of joining the corners of a flat frame and is strong enough if the frame is to be faced with plywood. The shoulders, if cut carefully, keep the frame fairly rigid and square. The frame should be laid out when marking out with the face side up and the face edges inwards. To cut off half of the joint is also called 'halving'.


Fig 416 CORRECT CHISELING OF A LAP

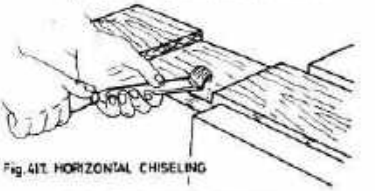


Fig 417. HORIZONTAL CHISELING

To make an end or cross-lap joint Fig.418

1. Make and square up to the given dimensions, the pieces that are to be joined.

2. Place the two pieces in their proper positions. Mark the locations of the cross-lap joint.

3. Square lines across the surfaces of both pieces. Use a sharp pencil and a try square. Fig.418A

4. Extend the marked lines on the edges of both pieces.

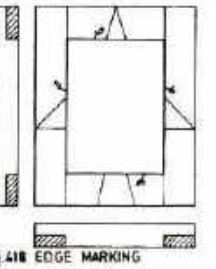


Fig 418 EDGE MARKING

5. Mark the depth of the joint with the marking gauge. Fig.419, 419A. The depth should be one half the thickness of the pieces, because the surfaces are to be flushed when together. Fig.420. When marking end-lap joints cut the shoulder and the two laps off with a saw.

6. Saw just inside the lines marked on the surface of both pieces, to the proper depth, with a backsaw. Fig.421.

7. Make a few extra saw cuts inside the marked lines to approximately the same depth. This will make chiseling easier.

8. Cut away the waste stock with a chisel. Fig.422.

9. Fit the two pieces for trial assembly. If the joint is too tight, pare the edges of the piece carefully with a sharp chisel. The pieces should fit snugly, but without being driven.

Fig.418.A. MARKING A LAP

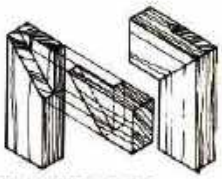


Fig.423. MITER LAP JOINT

Fig.419. GAUGING A LAP

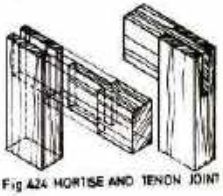


Fig 424 MORTISE AND TENON JOINT

Fig.419.A. CHISELING A SLOPING GROOVE TO FORM CHANNEL FOR SAW

Fig.420. READY MEMBERS

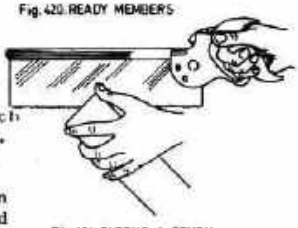


Fig.421. CUTTING A TENON

MITER LAP JOINT Fig.423

Miter lap joint is a simple method of running the grain of the wood round the corner for a better appearance. The joint is similar to the end lap joint only that the right side surface is jointed in miter. This joint is used for big flat frames like decorative door frames or frames which are glued or screwed to another body. The joint may be glued and carefully screwed from the back. It is not so strong as a mitered mortise and tenon joint, but is more simple to make and strong enough for these particular jobs.

MORTISE AND TENON JOINT

The mortise and tenon is probably the most familiar and most widely used joint in woodworking. It is extensively employed in every class of construction from rough carpentry to cabinet making and various forms are used to suit particular jobs. The mortise is a slot cut out in one member and the tenon or tongue cut on the other member to fit into the slot.

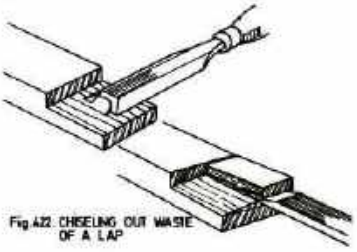


Fig.422. CHISELING OUT WASTE OF A LAP

Marking out is done on most joints with the try square, pencil and mortise-gauge. Where the faces of both members are to be made flush, it is best to mark out both mortise and tenon with the same setting of the gauge. The tenon is cut with either tenon or dovetail saw. The mortise is chopped out with a mallet and a mortise chisel. The tenon is usually about one third of the thickness of the stock.

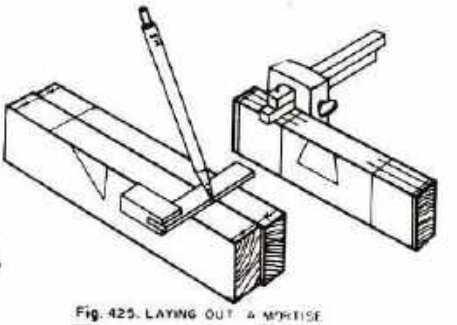


Fig. 425. LAYING OUT A MORTISE

To make a mortise

1. Mark and square up to the given dimensions, the pieces that are to be joined. Fig.425
2. Study your working drawing. Determine the thickness and width of the mortise.
3. You may need to mark identical mortise, as in marking the legs for a stool or table. Mark all the legs together. The legs must be perfectly square to do this accurately.
4. Fasten the piece to be mortised, with a clamp on the bench top.
5. Do not chisel the mortise at once to the marking lines. Keep 1 or 2 mm distance from the marked lines until the mortise has its desired depth. Then chisel and trim the sides and the ends of the mortise to its proper width and length. Fig.426, A,B,C, 427
6. Another method is to bore a series of holes to the depth necessary with an auger bit slightly smaller than the thickness of the mortise and clear the surplus waste with a chisel. Fig.428, 429.

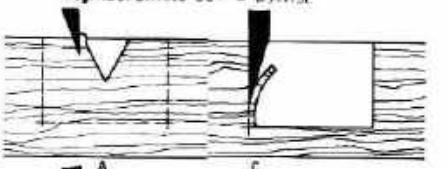


Fig.426. A,B,C CORRECT CHISELING

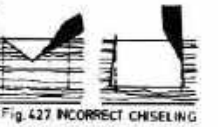


Fig.427 INCORRECT CHISELING

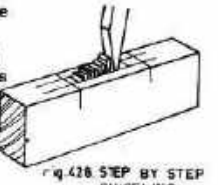


Fig.428 STEP BY STEP CHISELING

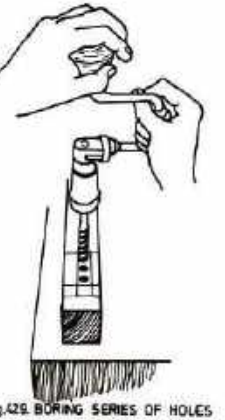


Fig.429. BORING SERIES OF HOLES FOR MORTISE

To make a tenon

1. Layout the tenon on the rail according to the dimensions of the working drawing.
2. Fasten the rail vertically in the bench vise.

3. Cut the tenon with a backsaw. The saw cut should be barely outside the gauge line. Fig.430, 431, 432

4. Place the rail horizontally in a vise or bench hook. Cut on the waste side of the marked line to remove the surplus stock. Fit the mortise-and-tenon pieces for a trial assembly. The pieces should fit rigidly without being driven. See Fig.401

Fig.430 CUTTING A TENON WITH BACK

THE MORTISE AND TENON MITER JOINT
Fig.433, 434, 435, 436, 437, 438, 439

In this method the joint is mitered at both sides, back and front and the end grain is shown on one side only. A stronger method is the miter joint where the front is mitered and the back shoulder is not cut in miter, but remains rectangular. It offers a greater fixing surface but is not so neat in appearance. It is set and marked with a try square and mortise gauge as for a plane mortise and tenon slip-joint. The miter is then set out on the face of each piece and the parts to be cut away clearly marked on both faces and edges. Cutting may then be done with a back-saw or dovetail saw on the waste side of the lines and the shoulders, miters carefully trimmed to fit the joint.

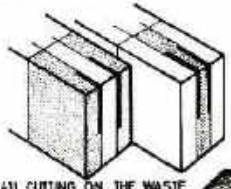


Fig.431 CUTTING ON THE WASTE SIDE

Fig.432. INCORRECT CUTTING OF A TENON

TWIN TENONS Fig.440, 441

Extra thick rails need twin tenons to guarantee the durability of the joint. If a single tenon is used on thick rails and stiles, the sides of the mortise tend to warp and twist for lack of support. The twin tenons avoid this difficulty and make the joint much stronger. The procedure for making this joint is much the same as on the single mortise-and-tenon joint.

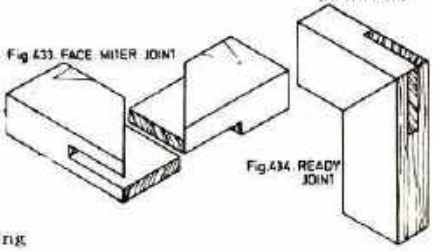


Fig.433. FACE MITER JOINT

Fig.434. READY JOINT

WEDGED THROUGH TENON Fig.442

When a joint has to be fairly strong it is advisable to make the tenon

Fig. 435. LAYING OUT OF A FACE MITER JOINT

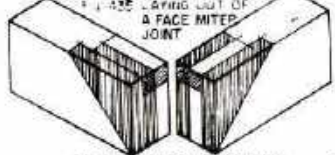


Fig. 436. MITER JOINT WITH A RABBET

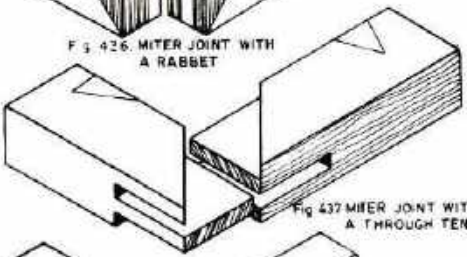


Fig. 437 MITER JOINT WITH A THROUGH TENON

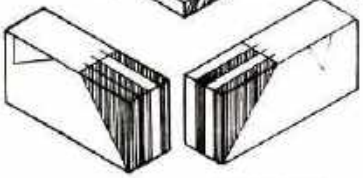


Fig. 438. LAYING OUT THE JOINT

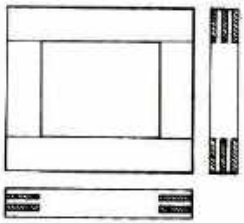


Fig. 440 WINDOW FRAME WITH TWIN TENONS

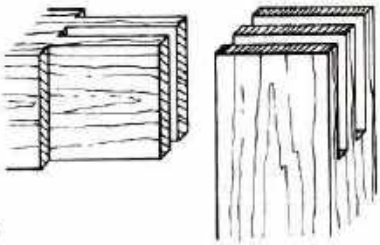


Fig. 441 TWIN TENON

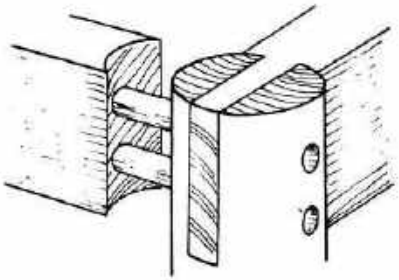


Fig. 439. TENON DOWEL LOCKING JOINT

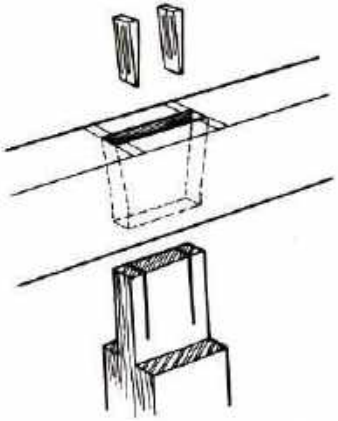


Fig. 442. WEDGED THROUGH TENON

right through and wedge it. The general procedure is similar to a stop mortise, (that means that the tenon is not made through), but the mortise have to be squared round to the opposite face. When chopping out, the mortise is cut bigger on the outside to allow the tenon to expand when the wedges are driven in. Saw cuts are made in the tenon for the wedges to be inserted.

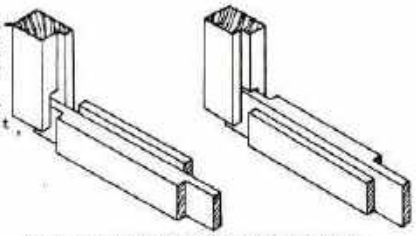


Fig.443. TENON WITH LONG AND SHORT SHOULDERS

TENON WITH LONG AND SHORT SHOULDERS FOR DOOR AND WINDOWS WITH RABBETED FRAME WORK

When a door or similar framework has to be fitted with a rabbeted-in panel or glass, the tenon has larger shoulders in front and shorter at the back and the depth of the rabbet must be subtracted from the depth of the mortise. This is because the rabbet plane must be pushed right through at both ends of the stiles and rails Fig.443. Note that in all framing work of this kind the mortise will be made on the stiles and the tenon on the rails.

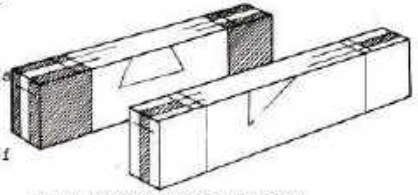


Fig.444. LAYING OUT MORTISE AND TENON

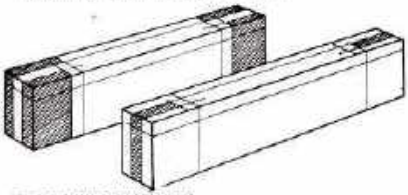


Fig.445. LAYING OUT RABBET

Marking stiles

1. Plane them to the finished over-all size and mark with a gauge the width of rabbet along the face edge. Then the depth of the rabbet is also marked on the back of the stile. Fig.444, 445

2. Clamp them together temporarily with the face sides touching each other and the face edges upwards. Mark the over-all height of the door and square lines across both stiles. Note that a waste allowance is made on both ends to minimise any tendency for the wood to split when being mortised. Fig.446

3. Now mark the over-all rail width and a second line for the rabbet depth, that is the distance by which the tenon is set in. It remains only to separate the stiles and gauge in the mortise. Fig.447, 448.

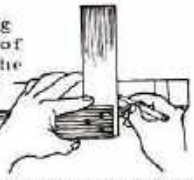


Fig.446 SQUARING THE MORTISE LINE

INCORRECT RABBET DEPTH

CORRECT DEPTH

Fig.447

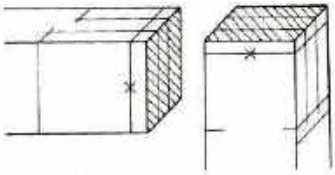


Fig.448. THE CORRECT LENGTH WILL BE OUT AFTER JOINTING

Marking the rails

Once again the parts should be clamped together temporary after the rabbet has been gauged. Mark first the over-all door width, then the width of the stiles and the depth of the rabbet and square across the face-edges. The front shoulder will be cut off longer and the back shoulder shorter. Fig.444

Cutting the tenons (See Fig.430,431)

Make the saw cut on the waste side and be careful not to cut past the shoulder line. One side will obviously be deeper than the other. The shoulders are cut off on the bench hook with a very slight bevel towards the shoulder.
Window frames may be counter-doweled. See Fig.449,450

Fig.449. INCORRECT COUNTER PINNING

Fig.450. CORRECT COUNTER PINNING

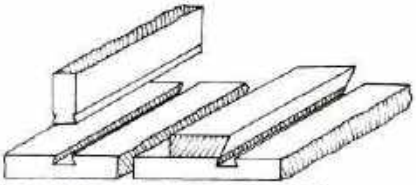


Fig.451. DOVETAIL GROOVE

Fig.452 GUIDE FOR CUTTING

THE THROUGH DOVETAIL GROOVE JOINT
Fig.451,452,453,454,455

This is the simplest form of dovetail grooving, which runs right through from edge to edge of the board. The position of the shelf or partition should be marked on both pieces to be joined together. The width of the groove should be slightly less than the thickness of the shelf. The depth of the groove is gauged on both edges. The cutting is done with a grooving saw or if not available with a tenon saw. A guide for the saw is quickly made by planing the edge of a spare piece of wood to the dovetail angle and clamped across the work exactly on the groove line. It is a good practice to ensure that the joint is slightly tapered and does not tighten up until the shelf is nearly in position. A too tightly fitting joint is difficult to assemble because of the friction. After the groove is ready the dovetail end ledges on the shelf are made with a fillister plane. Fig.456

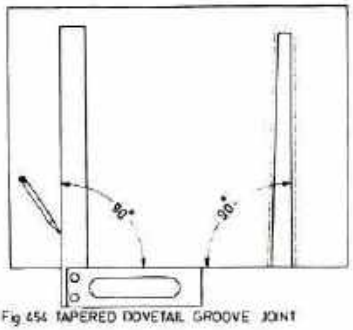


Fig.454 TAPERED DOVETAIL GROOVE JOINT

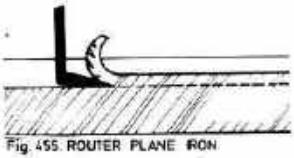


Fig.455 ROUTER PLANE IRON

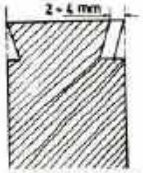


Fig.453 TAPERED END LEDGES

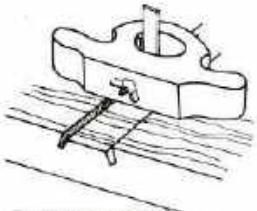


Fig.456 CLEANING THE GROOVE WITH A ROUTER PLANE

DOVETAIL LEDGE AND CLAMP JOINTS
Fig.457

Wide boards have a tendency to warp and twist and often need strengthening across the grain. A piece of wood fixed to the underside of the boards and running across the grain, is called a ledge or batten. Dovetail ledges a superior to screwed on ledges, but involve much more work and skill. There are two types of dovetail ledges, the flat one and the upright one Fig.458. They are made of well seasoned hardwood and care should be taken that the grain is always upright like shown in Fig.459. If the grain is flat or horizontal it shrinks and becomes loose in the joint. Gluing of dovetail ledges is done only on one side, as there may be some shrinkage or swelling across the grain.

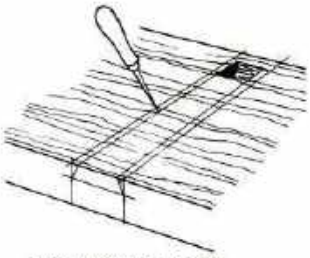
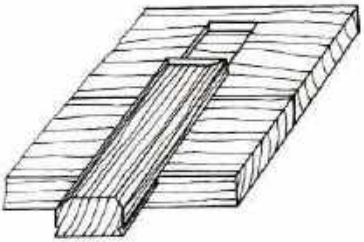
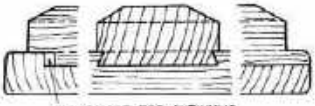


Fig.458 MARKING THE GROOVE





CLEARANCE FOR SHRINKING

Fig.459 FLAT DOVETAIL LEDGE JOINT

CLAMP JOINT Fig.460,461,462, 463,464

'Clamps' are pieces of wood jointed to the ends of wide boards with the grain running in the opposite direction. They serve the same purpose as ledges, but are used where the work requires to be kept flat. Clamps may be fixed by the tongue, groove, loose tongue, dowel, or mortise and tenon methods and are only glued in the centre or at the tenon or dowel joint. The clamping-piece, for most purposes, may run right across the end grain of the board and can be left longer at the ends to be cut off when the glue has set. In cabinet work however, the objection to plain clamping is that the end grain of the clamp shows on the edges and may project if there is any shrinkage in the width of the boards.

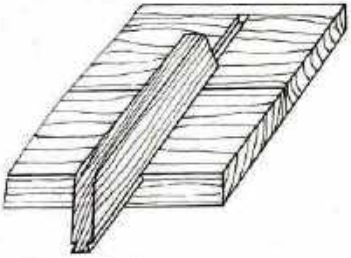


Fig.457 CUTTING LEDGE WITH A FILLISTER PLANE

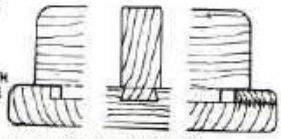


Fig.460 UPRIGHT LEDGE JOINT

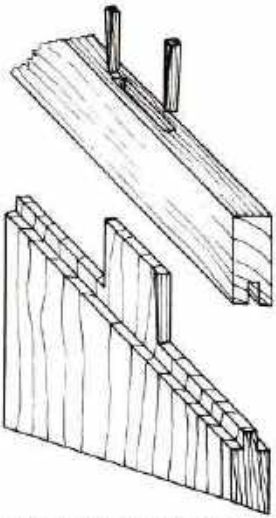


Fig. 461. CLAMP JOINT WITH CENTRE TENON AND GROOVE

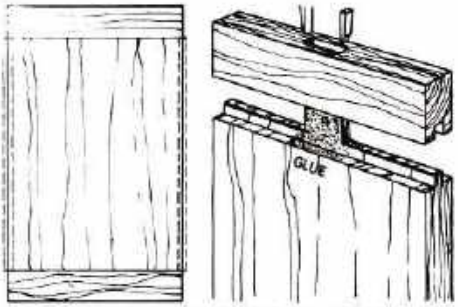


Fig. 462 POSSIBILITIES OF SHRINKING AND SWELLING

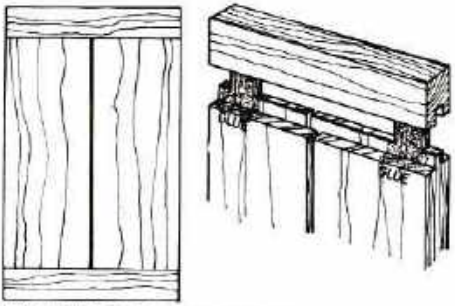


Fig. 463. TWO BOARDS CLAMP JOINTED

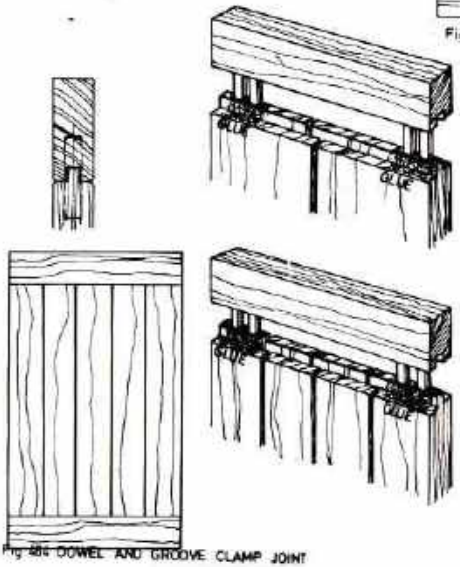


Fig. 464 DOWEL AND GROOVE CLAMP JOINT

TONGUE AND GROOVED ANGLE JOINT
Fig.465,466,467,468,469

This joint is more satisfactory than either the lapped or the butt joint. In one piece a groove is cut as deep and wide as half the thickness of the board. In the other piece a rabbet is cut of the same dimensions, though these dimensions may vary for different jobs. A different method is the loose tongue joint. Here a groove is ploughed in both pieces to be jointed with a plywood or a cross-grained feather. Tonguing and grooving is also used in board joining, flooring and paneling.

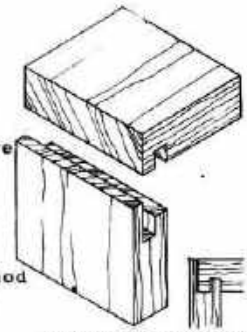


Fig.465 RABBET AND TONGUE JOINT

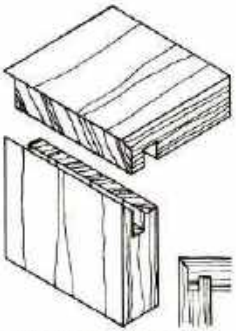


Fig.466 MITER RABBET AND TONGUE JOINT

KEY MORTISE-AND TENON JOINT
Fig.470,471

This joint differs from the other mortise-and-tenon joints in that it can be taken apart. It can also be tightened by driving in the key, which is not glued. It is used on benches, tables and other heavy wood construction. The keyed joint is a through mortise and tenon joint with a tenon at least twice as long as the mortise.

1. Make the through mortise and tenon joint as explained in Article 'Mortise-and-Tenon' and when that fits, lay out a through mortise on the projecting end of the tenon.

2. This mortise should be rectangular in shape. The end shoulder of the key mortise must be cut slightly in bevel toward the underside, but the opposite or inner end shoulder should be cut at a right angle and cut back at least 2 to 3 mm beyond the face of the large mortise member. When the mortise has been cut, the upper edge of the rectangular hole in the tenon should, therefore, be a little longer than the lower edge.

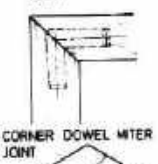


Fig.467 CORNER DOWEL MITER JOINT

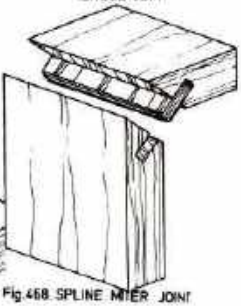


Fig.468 SPLINE MITER JOINT

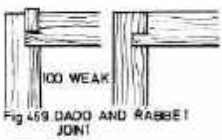


Fig.469 DADO AND RABBET JOINT

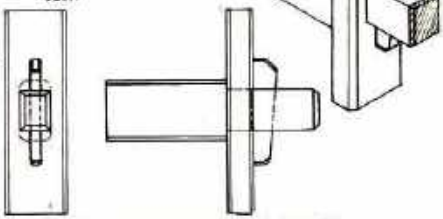


Fig.471 KEY MORTISE AND TENON JOINT

3. A key is now made to fit this mortise. The rear edge of the key is square to the two ends, but its front edge is tapered to fit the mortise.

4. When this key has been driven into the mortise, its rear edge bears against the face of the mortise member drawing the joint tight. If the mortise, made through the tenon, has not been cut back 2 or 3 mm the joint could never be tightened, because the wedge could not press the second member against the shoulders of the rail.

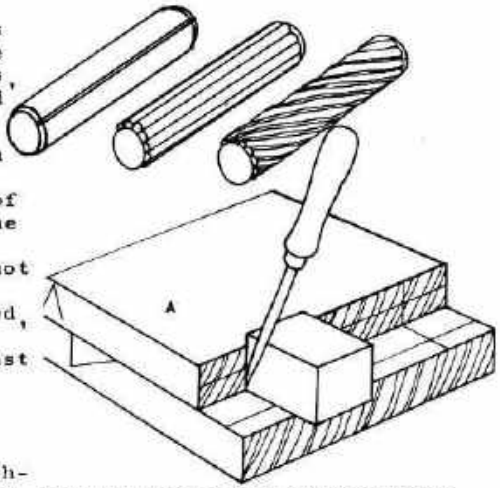


Fig.472,472 A GROOVED PROFILE AND SPIRAL DOWELS

DOWELLED JOINTS Fig.472,472A

This is another method of strengthening an edge joint and is used as a substitute for the mortise and tenon. Hardwood dowels (Mulberry) are inserted at intervals at right angles to the joint edge, giving extra gluing surface and keeping the two parts securely in position. Fig.473. The dowel joint needs to be carefully positioned and the dowel hole must be bored at right angles to the surface. For dowels straight-grained lumber should be used. The dowel may be driven through a dowel plate to bring it to the exact size. Fig.474. When the dowels have been cut to length the ends should be trimmed, that means the sharp corners taken off, with a dowel trimmer. Fig.475. The dowel also needs a groove to allow air and surplus glue to be squeezed out. If it cannot drain away, it will simply burst open the wood, as shown in Fig.476. When marking out the edges for boring, the two boards are placed together, face sides outwards and held either in the vise or by clamps. The distance between dowels will vary, according to the kind of work and strength required. The centre of the dowel is squared across both boards or stiles. The longitudinal centre lines are made with a marking gauge, set to half the thickness

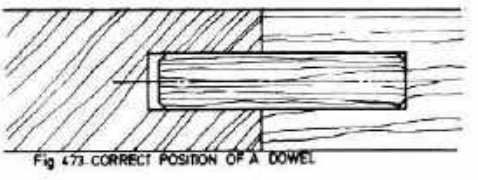


Fig 473 CORRECT POSITION OF A DOWEL

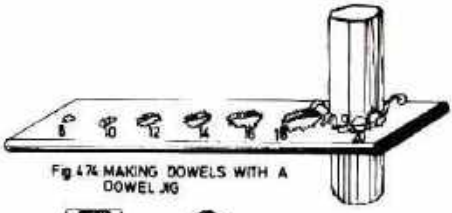
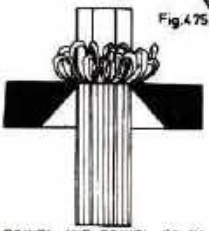


Fig 474 MAKING DOWELS WITH A DOWEL JIG

Fig.475 CHAMFERING THE DOWEL END



DOWEL AND DOWEL JIG IN SECTION

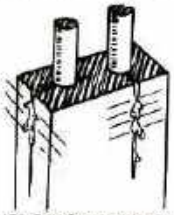


Fig.476. DOWELS WITHOUT GROOVES DO NOT DRAIN THE GLUE AND SPLIT THE WOOD

of the boards and used from the face side of each board. Where these lines intersect the squared lines are the centre of the dowel hole. Fig.477,478. A twist-bit with a spur or an auger bit is the best types for boring dowel holes. The spur or point is placed on the intersections of the lines and it may be useful to make a hole first with an awl. A depth gauge must be used for uniformity of depth when boring and it is important to keep the bit perfectly upright. Fig.479. The holes are countersunk slightly to avoid rough edges keeping the joint apart. The dowels and the dowel holes on one joint are glued first. The surplus glue should be cleaned off if the joint is not glued together immediately. The dowelled joint depends entirely upon the pressure applied for the removal of surplus glue. There are many varieties of the dowelled joint besides the edge joint. Dowels are often used in place of the mortise and tenon to join rails to legs, in framing doors and similar construction. Cutting off dowels to equal length can also be done as shown in Fig.480.

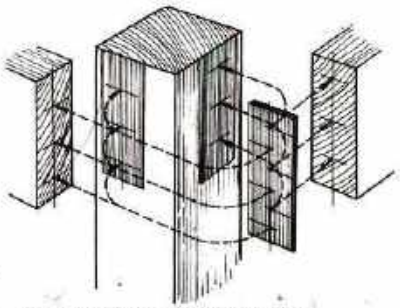


Fig.477. LAYING OUT FOR OFFSET DOWELING

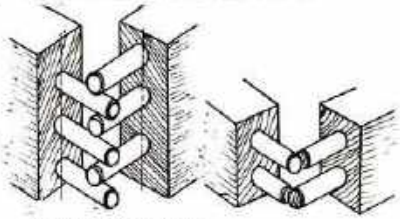


Fig. 478. OFFSET DOWELING

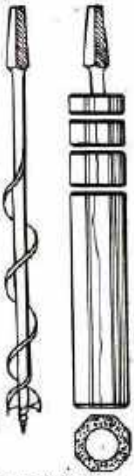


Fig.480. CUTTING DOWELS AFTER SETTING

Fig.481. BUT JOINT

Fig.482. DOVETAIL TONGUE BUT JOINT

Fig.479. WOODEN DEPTH GAUGE

Fig.483. SCARF WEDGE JOINT

END JOINTS

It is well known that a most difficult problem in woodworking is to obtain long rails or squared timbers. Since the presence in wood of natural defects is a very great obstacle, boards and rails of high-quality and long dimensions must be joined. In this respect the joining of small pieces of wood into lengths is sometimes very important. This can be done in many ways. Common methods are shown in Fig.481,482,483,484,485,486.

THE FRENCH JOINT Fig.487

This joint is not very difficult to make and it is the strongest of its kind. When marking the two pieces to be joined the thickness of the wood should be divided in three

equal parts and gauged with the marking gauge. Fig.488. Then mark the lengths of the tenons to the given dimensions. Fig.489. The two parts to be joined receive the same marking because they are of the same size. Fig.490. Cut the tenons with a back or dovetail saw. The slot for the end tenon must be chiseled out. The two shoulders of the centre wedge hole are cut slightly shorter and in bevel towards one edge. Fig.491. The width of the wedge must, of course, be slightly larger than the bevel of the wedge hole, otherwise the joint could not be fixed tightly at the visible outside shoulder joints. Fig.492

Fig.484. SIMPLE SCARF JOINT

Fig.485. MORTISE AND TENON JOINT WITH SCARFED SHOULDERS

Fig.486. FRENCH WEDGE JOINT

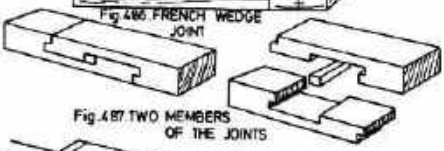


Fig.487. TWO MEMBERS OF THE JOINTS

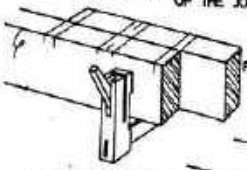


Fig.489. LAYING OUT EDGES

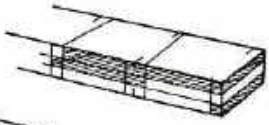


Fig.488. MARKING THE MEMBERS

Fig.490. CUTTING THE MEMBERS

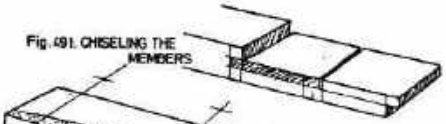


Fig.491. CHISELING THE MEMBERS

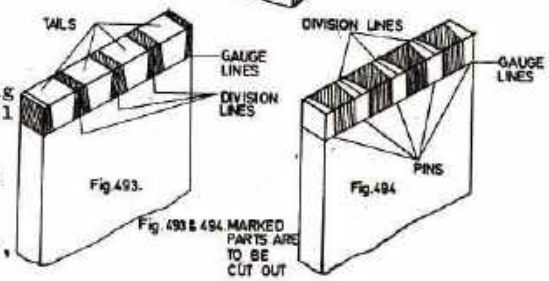
Fig.492. CUTTING WEDGES

DOVETAIL JOINTS Fig.493, 494

A well made dovetail joint is one of the strongest in woodwork, but much more difficult to make than other joints. The 'dovetails' so named because of their shape, are cut on the end of one member and the 'pins' on the other. The pins are set out and cut first and the tails are marked from them. The four chief methods of dovetailing are: the 'Through' or 'Common' dovetails, 'Lapped', 'Mitered' 'Bevel' or 'Funnel' shaped dovetails.

Spacing out the dovetails

Setting out dovetails often causes confusion and most doubts occur on the number and proportion of them. The strongest form of dovetailing is that in which the dovetail and pins are the same size and are used where strength is of utmost importance. The joint has a much better appearance if the dovetails are made wider than the pins, perhaps twice the width of



the pins. How to find the number of tails and pins see Fig.495.

$$\frac{\text{Number of tails} = \text{width of wood}}{3 \times \text{half the thickness of wood}}$$

Sample:

$$\frac{100}{3 \times 9} = 3.7 = 3 \text{ or } 4 \text{ tail pins}$$

Number of pins = Number of tails + 1

Setting out a Through-Dovetail

The members to be dovetailed together are cut to size leaving about 1 mm in length and width for trimming off. The members are marked on the face edge with a triangular mark to make sure which of the four members fit together. Fig.496. For example concerning the construction of drawers, the front and back pieces receive the pins and the side pieces, the dovetails. It is advisable to plane the end grain so that a clean surface is provided on which the lines will be clearly visible. At a distance from each end equal to the thickness of the boards plus 0,5 mm, a line is squared on all faces. There are several methods of marking the dovetails and pins, but the most precise method is to make a template. Fig.497. This can be done by the method explained in Fig.495,498. A simple method is to lay out the angle of the dovetails as follows:
Square a line across a board and step off six spaces with a divider Fig.499. At the sixth point make a line parallel to the edge of the board. Lay out one space on the parallel line and draw a line from this point to the edge of the board where the first line begins. This will give you the correct bevel for a dovetail. Note, never set the dovetail in a too steep bevel because the tail corners will break off. Fig.500. Now the two end pins are set out to begin with. The number of pins must be estimated and marked on the end grain. Each pin mark is squared down to the

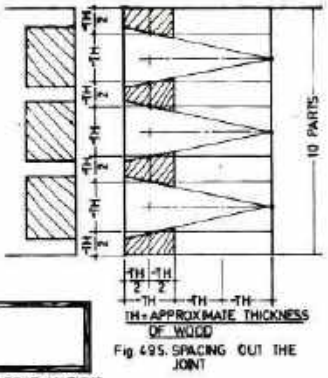


Fig.495. SPACING OUT THE JOINT

Fig.496 EDGE MARKING

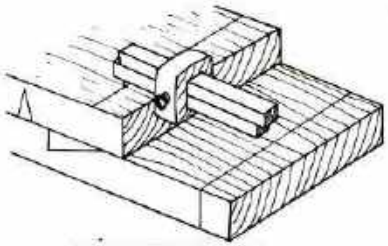


Fig.497 MARKING THE DEPTH

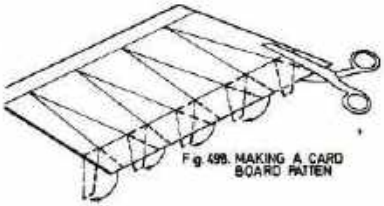
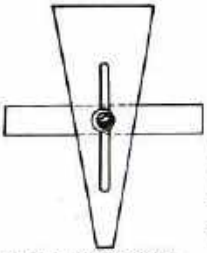


Fig.498. MAKING A CARD BOARD PATTEN


DOVETAIL MARKING BEVEL

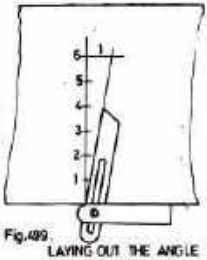


Fig.499. LAYING OUT THE ANGLE OF THE DOVETAILS

shoulder line. Fig.501. Before cutting the pins it is wise to shade the waste pieces with a pencil to avoid cutting the wrong pieces. The dovetail saw is used to cut the pins down to the shoulder line and the inner sockets are removed by chopping them out with a mallet and chisel from both sides. Fig.502. Care should be taken to cut always on the waste side of the line. When the pieces are cut out, the other board is placed on the bench top and the pins are placed on it exactly in position and then marked by scribing with an awl or sharp pencil around the pins. Fig.503. When assembling, the dovetails are tapped in evenly with a hammer and a piece of waste wood and should not be finally driven down until they are glued up.

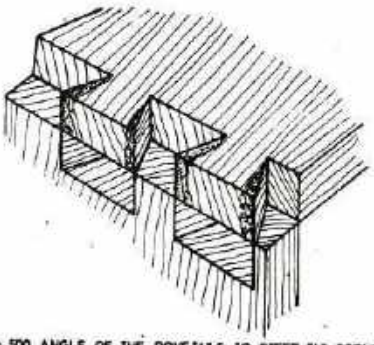


Fig. 500. ANGLE OF THE DOVETAILS TO STEEP TAIL CORNERS WILL BREK

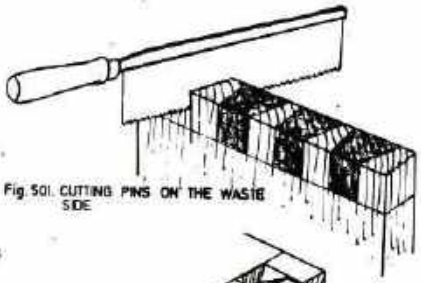


Fig. 501. CUTTING PINS ON THE WASTE SIDE

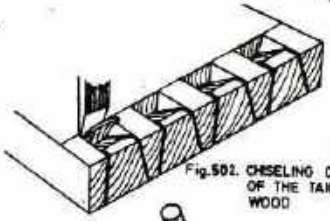


Fig. 502. CHISELING OUT HALF OF THE TAIL WASTE WOOD

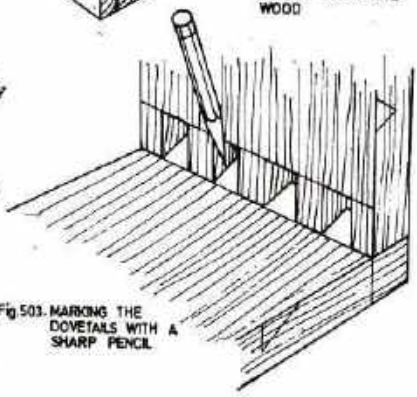


Fig. 503. MARKING THE DOVETAILS WITH A SHARP PENCIL

LAPPED DOVETAILS Fig.504,505,506

In the lapped dovetail the joint shows only on one side of the work instead of on both sides as in the through dovetail joint. It is commonly used in drawer constructions and case work. The boards to be dovetailed are cut exactly to length and width, subtracting the 'laps'. The laps should normally have 1/3 to 1/4 of the thickness of the drawer front or a better method is to mark the length of the dovetail with the same gauge setting as used for marking sides and back. Laying out dovetails and pins is done in the same way as in through dovetailing. The joint is cut in the same way as the through dovetail, except that the pins cannot be sawn right through. They are cut as far as possible and then chopped out with a mallet and chisel. Fig.507,508

MITERED DOVETAIL

This joint is used in high-class cabinet making in all positions in which it is necessary to conceal the dovetails completely. It is used in box construction where there are no projecting tops for example, certain rails solid cabinet

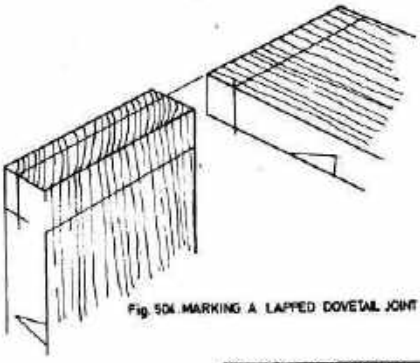


Fig. 504. MARKING A LAPPED DOVETAIL JOINT

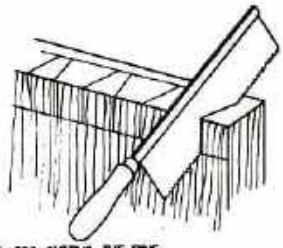


Fig. 505. CUTTING THE PINS

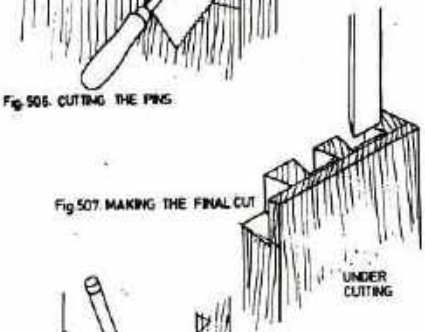


Fig. 507. MAKING THE FINAL CUT

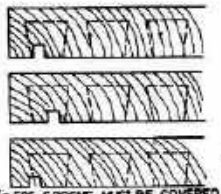


Fig. 506. GROOVE MUST BE COVERED WITH THE TAILS

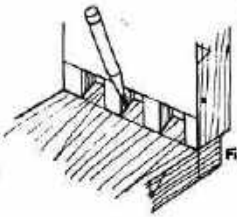


Fig. 508. MARKING THE TAILS

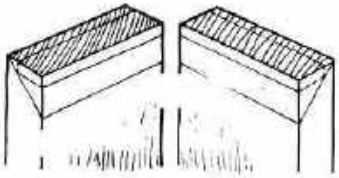


Fig. 509. LAY OUT FOR A MITER JOINT

Fig. 511. MARKING THE PINS WITH A BEVEL PATTERN

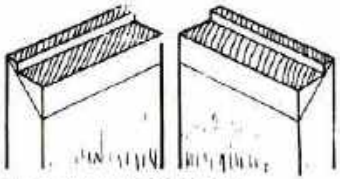
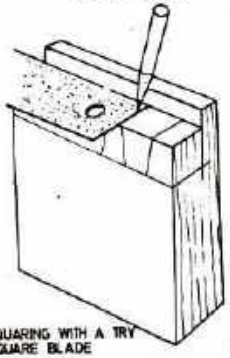


Fig. 510. CUTTING THE RABBET FIRST



SQUARING WITH A TRY SQUARE BLADE

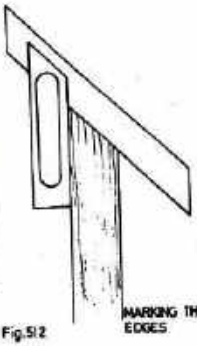


Fig. 512 MARKING THE EDGES

carcases etc. With this joint it is absolutely necessary to mark out from the pins. It is impossible to do it the other way round.

Marking out a Miter Dovetail Joint

Cut the boards to be joined to the correct dimensions. A marking gauge is set to the thickness of the boards and the inside surface of both pieces are marked as shown in Fig.509. From the projecting laps a rabbet has to be cut out at the end of each board. Fig.510. Now the same method of marking out pins can be used as on lapped dovetail joints. It is a good plan to cut a template from a piece of cardboard, with which the pins are marked out. Fig.511,512.

Cutting the pins

Cut the pins with a dovetail saw to the shoulder line. It does not matter if the lap is touched by the saw (providing the outer corner is not reached), because the saw marks are removed later when the miter is cut. The outer miter shoulders can be removed with the saw. Fig.513,514. The miter along the lap can be mainly cut with a sharp chisel as in Fig.515. It is finally trimmed with a rabbet plane, the board being either clamped down on the bench or fixed in the vise. To make certain of the exact angle fix a block of wood behind the board, the end of which is planed at exactly 45 degrees. Fig.516,517.

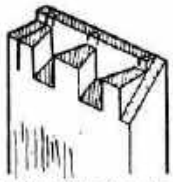


Fig.513. CUTTING THE EDGE MITER

Fig.514. CUTTING THE TAILS

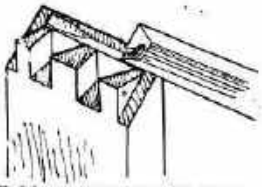


Fig.515. CUTTING ROUGHLY THE WASTE FROM EACH SIDE

Fig.516. MITER CHISELLED THEN PLANED

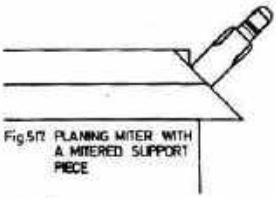


Fig.517. PLANING MITER WITH A MITERED SUPPORT PIECE

THROUGH DOVETAIL WITH THE FRONT SHOULDER MITERED

Another method is to make a dovetail joint where the front or top edge is cut in a miter. This is of special value when there is a rabbet or if it needs a neat finish. It also enables the edges to be rounded or to be moulded. Fig.518. When cutting the miter, hold the saw on the waste side so that the line is

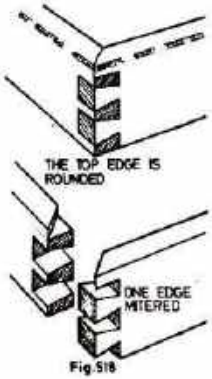


Fig.518

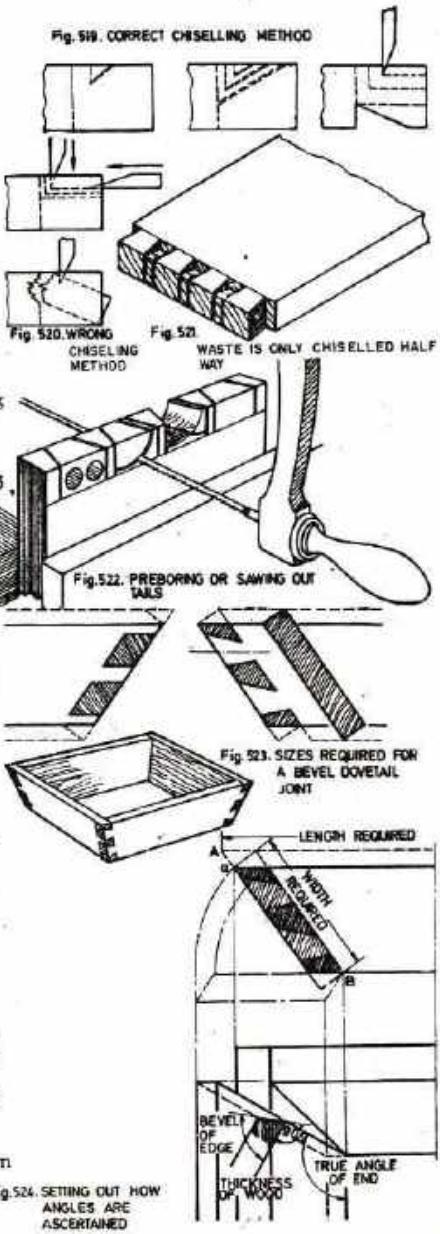
left visible. The marking and cutting of the dovetail and pins is done in the same method as in normal through dovetailing. Fig.519, 520, 521 and 522 shows how to cut out wastage on both joints.

BEVEL DOVETAILS

This joint is used for such items as waste-paper boxes, flower pots and decorative boxes of all kinds. Before the joint can be dealt with it is necessary to decide upon the proper shape and size of the side pieces and also the bevel at which the ends are cut. Neither can be measured directly from either the plan or the elevation. When cutting the pieces you must take care that the wood is cut wider and longer that seems necessary at first glance. The dotted lines at Fig.523, make this clear, whilst the shaded section shows the size needed.

Drawing

A drawing must be prepared from which all bevels and sizes can be obtained. Draw an elevation and immediately below it a plan, as in Fig.524. In the elevation put in the thickness of the board and draw the edges square. This will give the width of the board required. To find the length continue the slope upwards until it intersects a horizontal line A-A which passes through the inner corner of the board. The distance A-A is the true length required. This is an important point. Most people would pick on a-a as the correct length, but this does not take into account the fact that the edge is bevelled in its thickness and is longer when measured on the inside than on the outside. To find the true angle of the ends it is necessary to pivot the side down so that it is placed in a horizontal position. The section of the side is shown shaded. Allow the side to drop down as shown by the arrows until it lies flat. (See dotted lines).



Seen in the plan, the side would then appear as shown below and the true angle can be measured. Trim the boards to the over-all width and set on an adjustable sliding bevel to the true angle of your drawing. The board can then be marked out as in Fig.525, the length being marked on the edge by using the sliding bevel. By working this way timber can be saved. Plane all four pieces to the same size and angle. One should be completed and the other three tested against it in turn. Now you take the bevel of the side edges from the drawing, by the help of a sliding bevel, mark the end grain of each side and plane the edges down to this mark line.

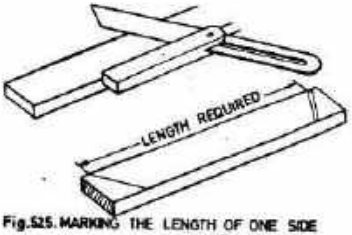


Fig.525. MARKING THE LENGTH OF ONE SIDE

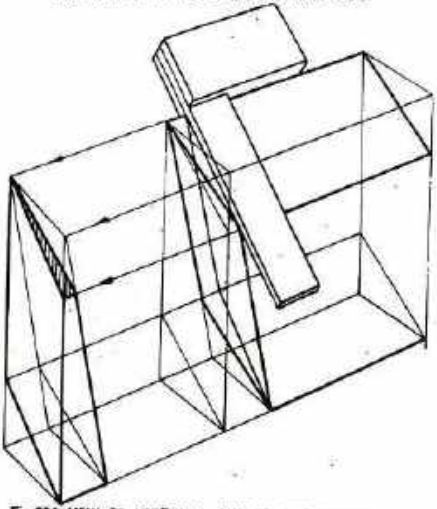


Fig.526. HOW TO APPROACH ANGLES AND BEVELS

Bevel of the ends

At this stage the ends are square in their thickness and the correct bevel has now to be worked out. Revert to the plane. Fig.524, which gives the true angle of the end. The dotted lines show the outer corner of the end grain and the thick solid line, the inner corner. Draw a line at right angles to the solid line and at a distance from it, equal to the thickness of the board. Draw a second line parallel to it. By drawing a line from corner to corner the bevel of the edge is given. What you have done is drawn a section through the side of this point. This angle is marked on the top edge on each side and planed down to the marked line. Fig.526

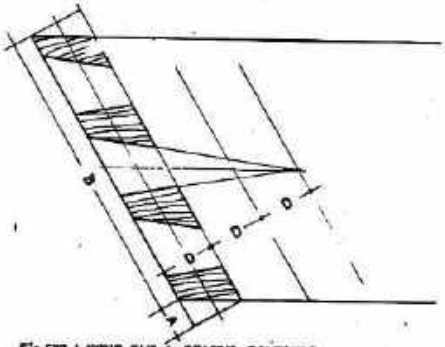


Fig.527 LAYING OUT A SPACING DOVETAILS

Marking the dovetails

You cannot use the gauge for marking out. Instead measure in the depth and mark with pencil and sliding bevel. Now the dovetail and pins are marked as shown in Fig.527,528.

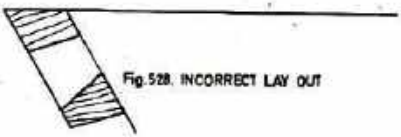


Fig.528. INCORRECT LAY OUT

MITERED INTERSECTION JOINT

CROSS BAR JOINT Fig.529

Cross bar joints are usually made by joiners in window construction. The bars are planed or cut into the over-all size and then set out. Mark and square, to the given dimensions, the pieces that are to be joined. Place the two pieces in their proper positions and mark the locations of the cross joint. Square lines across the four surfaces so that you get the thickness of the bar marked on each surface. Now divide the thickness of the bar into three equal parts inside the two lines marked before as well as along the grain where the joint will be made. Fig.530. On the surface of the bar a line is marked along the grain on both sides indicating the depth of the lap joint. The depth should be one-half the thickness of the bar, because the surfaces should be flush when together. The depth and width of the rabbet must be one third of the thickness and width planed from each underside of the bar. Fig.530,531. First the laps should be cut, one from the top, the other from the underneath. The cut should be done on the waste side, down to the centre line. The miters are cut either with a dovetail saw or on the miter trimmer. Fig.532,533. Fig.534 shows the mortise and tenon joint of the bar with the stile.

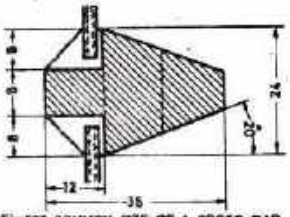


Fig.529. COMMON SIZE OF A CROSS BAR

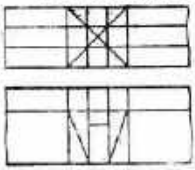


Fig.530. LAYING OUT A CROSS BAR

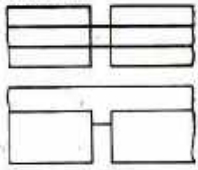


Fig.531 LAP CUTTING

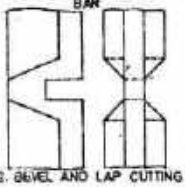


Fig.532. BEVEL AND LAP CUTTING


Fig.533. BAR AND STILE JOINT

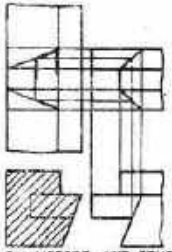


Fig.534. MORTISE AND TENON FOR BAR STILE JOINT


Fig.536. ALTERNATIVE METHOD OF ARRANGING TENON ENDS(HALVED)

DIFFERENT CONSTRUCTIONS

LEG-RAIL CONSTRUCTION

The simplest form of table or stool construction is that in which four legs are fastened together by rails, usually by means of mortise and tenon joints. The haunched mortise and tenon is necessary for giving sufficient strength at the top of the leg and the ends of the two tenons, where they meet inside the leg, are either mitered or halved. Fig.535,536. The rails may be set

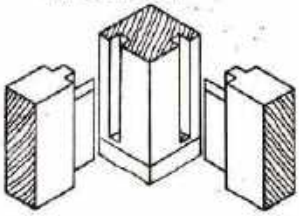


Fig.535. CORNER LEG AND RAIL JOINT TENON ENDS ARE CUT IN MITER

in slightly from the face of the leg, or finish flush. The further the tenon is set in however, the shorter it becomes and the holding strength will be decreased. When doweling table legs and rails good methods are shown in Fig.477 and 478, (dowel joint) as well in Fig.537,538,539. A simple and effective method of lightening the legs is to taper them. Tapering is generally carried out after the joints have been cut but before they are glued together and starts at the point where the lower edge of the rail meets the leg, in order to keep the shoulders square. Fig.540. The bottom edges of the legs are always chamfered to avoid splitting as the table is moved about. Fig.541. Before the marking out is started, the parts of the table or stool should be laid out and identified so that the best possible use is made of the grain. The marking sign as shown in Fig.542, indicates the side edges of the legs and the top end. Legs, particularly the front legs should be matched for colour and characteristics and the grain should be straight. If there are curves in the grain they should run outwards towards the bottom. Curved grain in the rails should be arranged so that it drops towards each end. All these points make a considerable difference to the finished appearance of the job. When the joints have been cut and fitted, the aim is to glue and assemble the two ends as separate frames. Legs can be glued with bar or G clamps, but it is easier to press the joint together between the bench front and back cramp iron. A table top made from prefabricated boards (chipboard or laminated boards) is generally glued upon the rails, but if it is a solid top of any width no gluing is permitted. (See chapter 1 Shrinkage and Swelling of Wood) Fig.60,61,62,63. Different methods are used for fixing solid tops. A common one is, wooden buttons fitted into grooves in the rails,

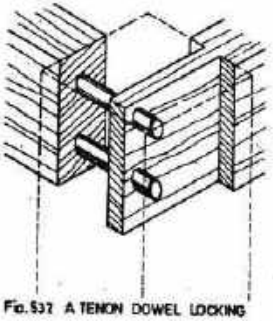


Fig.537 A TENON DOWEL LOCKING

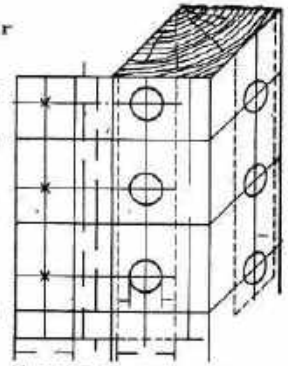


Fig.538. OFFSET CORNER JOINT

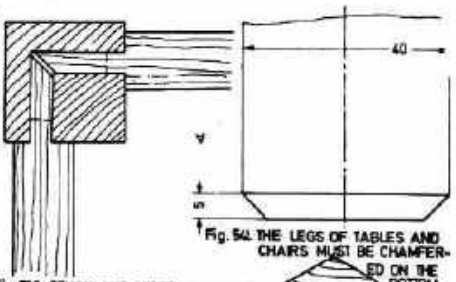


Fig. 541 THE LEGS OF TABLES AND CHAIRS MUST BE CHAMFERED ON THE BOTTOM

Fig.539 TENON AND MITER NEEDS A LITTLE CLEARANCE

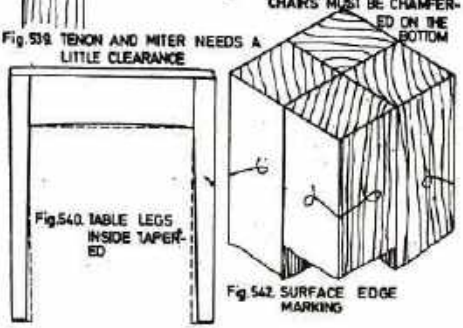


Fig.540. TABLE LEGS INSIDE TAPERED

Fig.542 SURFACE EDGE MARKING

which are long enough to allow the button to move with the top and provision must be made for movement across the grain. Fig.543,544. Four more methods are shown in Fig.545,546,547,548.

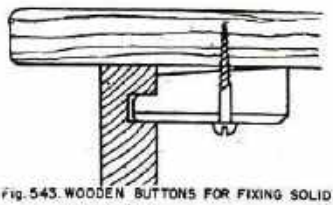


Fig.543. WOODEN BUTTONS FOR FIXING SOLID TABLE TOP

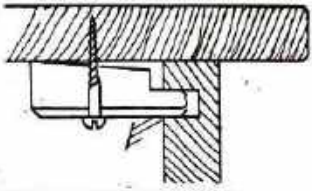


Fig.544. CLEARANCE FOR SHRINKING

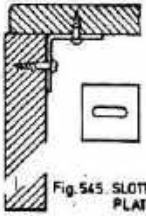


Fig.545. SLOTTED METAL PLATES

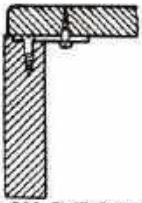


Fig.546. FLAT SLOTTED METAL PLATE

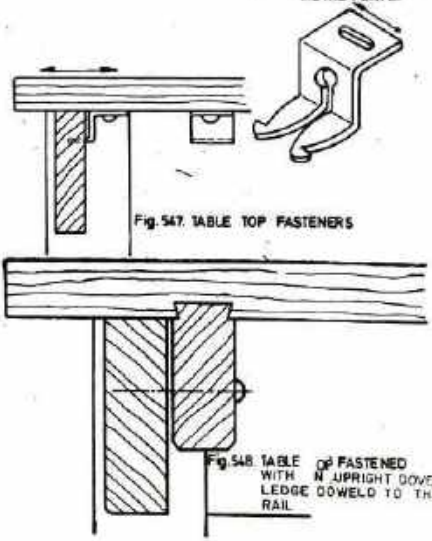


Fig.547. TABLE TOP FASTENERS

Fig.548. TABLE TOP FASTENED WITH UPRIGHT DOVETAILED LEDGE DOWELED TO THE RAIL

DOORS

LEDGED AND BRACED DOORS Fig.549

This simplest form of doors is known as 'ledged' door, which is a number of boards, usually tongued and grooved, nailed or screwed to horizontal battens or ledges. The nails are clenched over on the inside of the door. (See Fig.141 Chapter 2). For small doors two ledges fixed approximately 150 to 200 mm from the top and bottom are sufficient, but for full-size doors three ledges are needed. Ledged doors tend to twist and to drop on the unsupported side. For this reason sloping 'braces' are added which increase the strength of the door and transfer the weight of the unsupported side to the hanging side. The bottom of the brace has therefore to be on the hanging side. The braces are notched into the ledges and the appearance is improved by chamfering or bevelling exposed edges. Fig.550. Different methods are used for joining boards for this purpose. Fig.551,552,553, 554.

FRAMES AND PANELS

Frames and panels are used to counter the effects of movement in solid timber and to lighten the work. They had to a large extent, governed the techniques of cabinet making until the production of good quality laminated boards was explored, but they are still used for doors, room panelings and a variety of other purpose. The framing is usually mortised and tenoned together and the panel set in either a groove or a rabbet. Fig.555. The thickness of the groove should correspond with the thickness of the mortise, which is usually one-third the thickness of

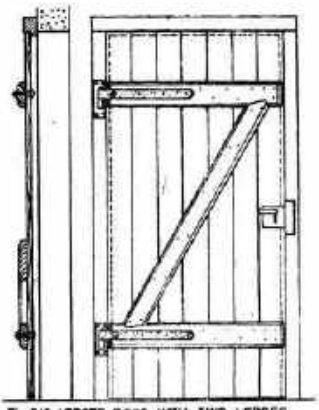


Fig.549. LEDGED DOOR WITH TWO LEDGES AND ONE BRACE

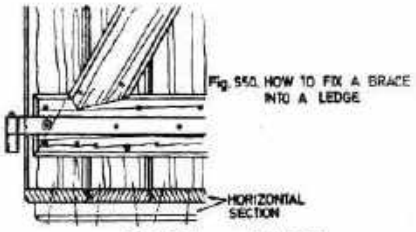


Fig. 550. HOW TO FIX A BRACE INTO A LEDGE

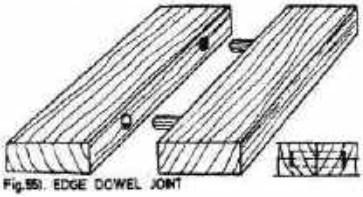


Fig.551. EDGE DOWEL JOINT

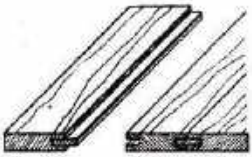


Fig.552. GROOVE AND FEATHER JOINT

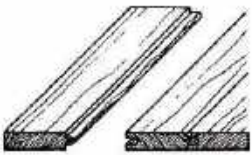


Fig.553. TONGUE AND GROOVE JOINT

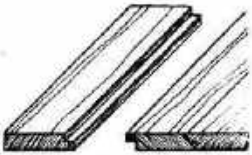


Fig. 554. RABBET LAP JOINT

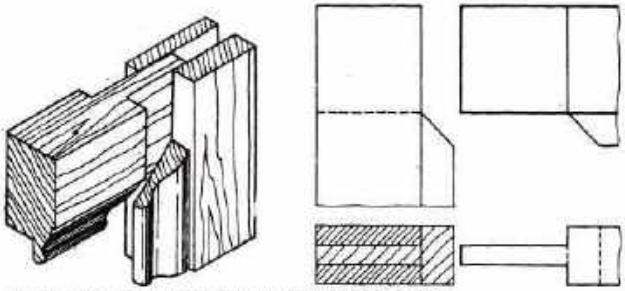


Fig.555. FRAME FOR A LOOSE PANEL WITH A PROFILED RABBET

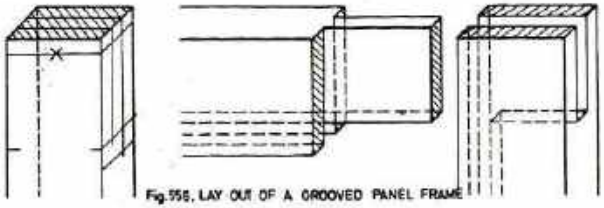


Fig.556. LAY OUT OF A GROOVED PANEL FRAME

the frame. Fig.556. This is more convenient for working, as the groove can be taken right through, the ends being used to accommodate the haunch on the tenon. The proportions of the panels need some consideration on some jobs, these may be governed by the need for economy and arranged to suit the size of the object, but on good class work the proportions of the panels are usually arranged to harmonize with the work. The simplest type of panel is a plain flat panel of the same thickness as the groove. Plywood is often used because of its non-shrinking qualities and large areas. Fig.557. Plain solid panels often have to be joined to make the width and are usually chosen for their fine grain pattern to provide interest. The sharp edges of the framing are taken off either by moulding or by chamfering. Where the panel is shaped off towards the edges and the middle left stronger is called 'fielded' Fig.558. This is normally done with a shoulder or rabbet plane. For all the solid panels allowance be made for shrinking and swelling. A raised panel projects over the face of the frame and avoids showing a gap through shrinkage. Fig.559. In a rabbeted frame the panel is fixed from the back with a small neat bead into the angle. The bead is nailed or screwed, but never glued. Fig.560. If the panel is fixed from both sides with a bead then the front one may be glued. Fig.561.

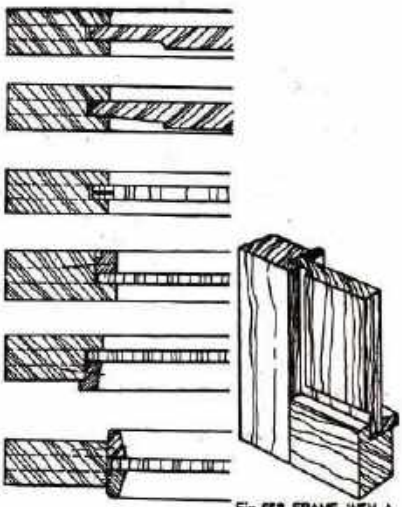


Fig. 558. FRAME WITH A FIELDED PANEL

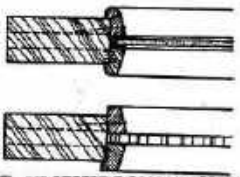


Fig. 557. DIFFERENT POSSIBILITIES FOR FIXING PANELS

Fig.559. PANELS WITH A GLUED AND A LOOSE BEAD AND A RAISED PANEL

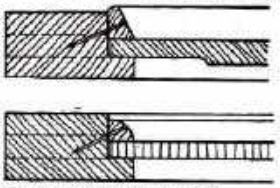


Fig.560. HOW TO NAIL A BEAD

Fig. 561. GLUED DECORATION BEAD

DRAWER CONSTRUCTION

The back, front and sides of a drawer are joined together with a lap dovetailed or a through dovetail joint. When lap-dovetailing only the front board is joined that way. The timber for drawers should be well seasoned and where a set of drawer is being made, the fronts should be matched up with each other and with the body. The fronts are made of thicker boards than the sides, common sizes are: 20 mm for the fronts and 12 to 14 mm for the sides. Only for very large drawers do the sides have

15 mm or more. The bottom of small drawers is grooved into the front and sides and screwed or nailed into the back, as it is slid in when the box has been glued-up. Fig.562. On large drawers, however, a stronger method is to groove the bottom higher and increase the strength of the bottom. Drawers are made of hardwood for harder ware. When the wood has been prepared it is cut into size and marked. It is important that all the edges are perfectly square. The drawers should also be numbered if there is more than one of the same size in order to avoid confusion. Allowance must be made for the side top and bottom runners in between which the drawer is fitted. Fig.563. After the drawer box is joined and glued the final fitting of the drawer into the opening is adjusted with the runners. Clamps may be necessary to tighten up the joints but they need not be left on if the joints fit well. The grain of the drawer bottom should run always across the drawer from left to right. Fig.564. Care should be taken when cutting the groove for the drawer bottom. Fig.565. It also may run past the back a little, the back is reaching the edge of the groove and is as well 6 to 8 mm shorter on top. Fig.562. Drawers in some constructions are suspended in order not to slide on their runners. A common method used is that a stopped groove is cut on the outside of the drawer side and the runners are fitted to the inner sides of the body to correspond with the grooves and the drawer runs on these. Fig.566, 567, 568. To stop the drawer small pieces of wood are glued to the runners and the side of the body, but not against the back. Fig.569, 570.

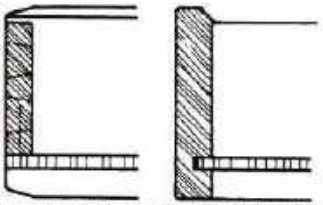


Fig. 562. SECTION OF A DRAWER BACK AND SIDE

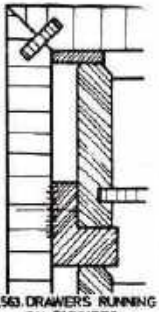


Fig. 563. DRAWERS RUNNING ON RUNNERS

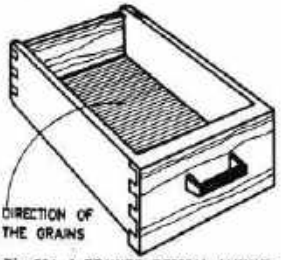


Fig. 564. A DRAWER BOTTOM ALWAYS RUNS ACROSS THE DRAWER AS SHOWN

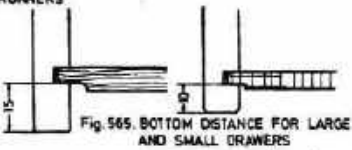


Fig. 565. BOTTOM DISTANCE FOR LARGE AND SMALL DRAWERS

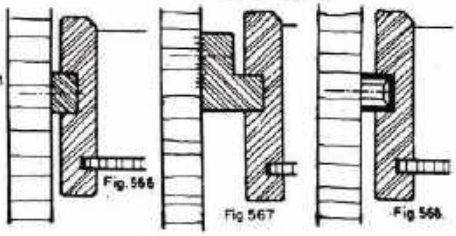


Fig. 566. DRAWER SCREWED ON RUNNER
Fig. 567. DRAWER GLUED ON RUNNER
Fig. 568. DRAWER ON PLASTIC RUNNER

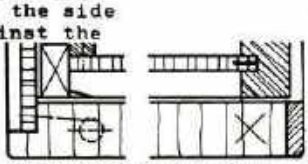


Fig. 569. STOPPER BEHIND A DRAWER

Fig. 570. DRAWERS SHOULD NEVER RUN AGAINST THE SIDE OF THE BODY

WOOD FINISHING

Wood finishing is the last step in the completion of a piece of furniture and a very important one. It was formerly a parr of the cabinet-makers trade, but now requires so much skill and knowledge that it has developed into a distinct trade. Wood finishes are either transparent or opaque. The finishing processes of the first type, with which we are principally concerned, fall into three main divisions: staining, filling and polishing. Opaque finishes are produced by paints, coloured lacquers, or metal lic leaf or powders.

Procedure for preparing the surface

While the different parts of a piece of furniture should be prepared for finishing during the process of construction, especially those that are inaccessible after gluing, it is, nevertheless, of the utmost importance to give the piece a thorough inspection when all the tool-work has been completed, so that any little damage or defect may be repaired. Check the following points:

1. See that every trace of glue is removed from around the joints, because stain does not penetrate through glue. Any speck of glue therefore, leaves a light mark on the stained surface. Use the blade of a cabinet scraper or a chisel, with the edge bent over, to remove glue from corners that are not easily accessible.

2. Inspect the surfaces thoroughly for any dent or bruise. A dent in the wood often may be removed by the application of a small pad of cotton waste soaked in hot water. Leave the pad on the bruise for a few minutes and repeat. The water will fill the cells in the wood near the surface and cause them to swell, thus bringing the bruise to the level of the surrounding surface.

3. A quicker way of taking out dents is to use steam. This may be done by placing a small pad of wet cotton waste over the dent and then applying a hot soldering iron to it. The steam generated will enter the pores and cause them to swell more rapidly than if only water had been applied. If a soldering iron is not available, an ordinary flat-iron, placed on several layers of wet paper, will serve the purpose.

4. Look for any marks left by the cabinet scraper or any scratches caused by sanding across the grain. Nothing shows up more prominently and is more unsightly when the finish is applied than scratches across the grain. It is usually necessary to use a scraper to remove them entirely and then resand the surface.

5. See that there are no spots of oil or grease on the surface, because they will prevent the stain from penetrating. They should be removed by rubbing with naphtha or benzine.

6. Any holes, or other defects should be filled with crack filler, which is also known as wood cement or stick

shellac. It is sold in sticks of different colours and is composed largely of shellac and resin. It is melted into the hole to be filled like sealing wax, or by holding a heated iron against it until the drops off fill the crevice to above the level of the surface. Work it in with the hot iron. It hardens in a moment and should then be cut down almost to the level of the paper until the surface is perfectly level and smooth.

7. Give the piece of furniture to be stained a final but through sanding, using No.2/0 = 100 grit sandpaper. Hold the work towards the light and see that no imperfections remain on the surfaces. If water stain is to be used, wet the work before this final sanding, because water raises the grain of the wood and makes the surface rough.

8. Wood is composed of millions of little cells, the great majority of which run lengthwise. When the surface is planed, a great many of these cells are cut through and their fine, hairlike edges are bent down by the pressure of the tool. Fig.571.

Fig.571. PORES CUT THROUGH AND FINE EDGES BENT DOWN BY PLANE OR SCRAPER

9. When water is applied to the surface, the hairlike edges of the cells bend upward by capillary attraction and this makes the surface rough to the touch. See Fig.572.

10. When dry the surface is given its final sanding with No.2/0 = 100 grit or 3/0 = 120 grit sandpaper. The aim of the sanding is to cut the hairs off and make the surface smooth. Use a piece of new, sharp sandpaper and rub very lightly at first. Then fold the paper around a cork sanding block and using both hands, apply plenty of pressure. End grain is sanded smooth, by moving the sanding block in one direction only. In this way, the wood fibers are flattened down and the surface can be made as smooth as that of length grain wood.

Fig.572. EDGES OF PORES BENT UPWARD AFTER STAINING WITH WATER STAIN

11. When the hairs are cut off, the wood looks like C in Fig.573 under the microscope. When water is again applied a second time less hairs will bend up and the surface will therefore not be so rough. Too much care cannot be given to this final preparation and inspection for, contrary to the popular belief, imperfections in the surface are

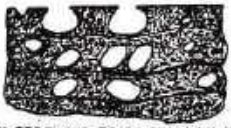


Fig.573. PROJECTING EDGES CUT AWAY WITH FINE SANDPAPER

not covered by the finish, rather they appear as if magnified. An extra hour spent in preparing the surface is, therefore, well spent and often save many hours of tedious refinishing.

Sandpaper

Comparison of natural (garnet) grit numbers and artificial (aluminum oxide and silicon carbide) sizes of grits:

3	=	24 grit	2/0	=	100 grit
2½	=	30 grit	3/0	=	120 grit
1½	=	40 grit	4/0	=	150 grit
1	=	50 grit	5/0	=	180 grit
½	=	60 grit	6/0	=	220 grit
1/0	=	80 grit	8/0	=	280 grit
China made		0	= 3/0	=	120 grit
		00	= 4/0	=	150 grit

Production and Manufacture of Shellac

Shellac is produced by an insect called Tachardia Lacca (the lac bug, Fig.574), which is native to the southern part of India. This insect lives on the sap of a few species of acacia trees which are now cultivated in plantations. After being host to a colony of lac bugs, a tree needs several years of rest and care to recuperate. The lac bug sucks up the sap through a needlelike elongated mouth which it inserts under the tender bark of young twigs. Through the bug's digestive processes, the sap is changed into shellac which is exuded through numerous pores in its skin. Pretty soon the insect, which is about the size of an apple seeds, is covered with shellac. As more shellac is exuded, it runs together with that produced by the hundreds of other insects sitting on the same twig. Fig.575. Finally the twig and all the insects are completely encased in shellac, but before that happens the females lay thousands of eggs. When the larvae are hatched from the eggs, they first live off the dead bodies of their parents.

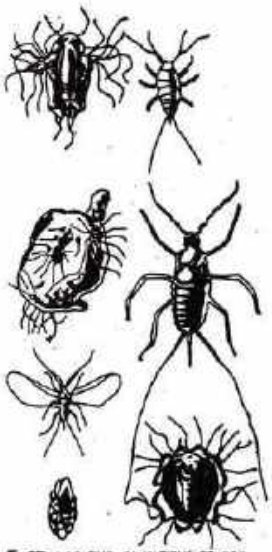


Fig.574. LAC BUG IN VARIOUS STAGES

Fig.575. STICKLACK SHOWING ENCRUSTATION ON TWIGS

Later on they bore their way through the shellac. When this is about to happen, the native workmen break the shellac covered twigs off and hang them on another tree which is strong and healthy enough to support another colony of lac bugs. Once the lac bugs have inserted their needlelike mouth into a tree, they never move until they die. When the new generation of lac bugs have begun their life cycle, the shellac-covered twigs, from which they came, are collected and broken up into small pieces, either by hand or by machinery. The crushed shellac is washed in a large, circular vessel filled with water. Bits of wood and remnants of the dead insects float to the top and are skimmed off, after which the shellac pellets are spread out and dried in the sun. Shellac in this stage is called "seed-lac."
The seed-lac is put into a cheesecloth bag several feet long, but only about 50 mm (approx. 2 inches) in diameter. Two men hold the bag in front of an open fire. The heat melts the shellac, which drops down upon a marble slab while the men are twisting or wringing the bag. Another man then picks up the sticky molten mass and lays it on a large porcelain cylinder filled with hot water, thereby producing a sheet of lac about 6 mm (¼ inch) thick and 610 mm (2 ft.) square. He then takes this sheet and its four corners with his hands and toes, while standing in front of the fire, stretches it to four times its size or about 1220 mm (4 ft.) square. The temperature is so high that it would burn the hands and feet of anyone not trained to do this work. These sheets are then laid on the floor and later are broken into small pieces, cooled and packed. Shellac of the lightest colour is the finest. Garnet lac and button lac is shellac of darker colout and inferior quality. Shellac is dissolved in alcohol only. It is sold according to the number of pounds of shellac which are dissolved in one gallon of alcohol. A 4-lbs. cut, for example, means that four pounds of shellac have been dissolved in one gallon of alcohol. The natural colour of shellac is orange. White shellac is bleached from orange shellac.

FINISHING MATERIALS

A fine finish on furniture and cabinet-work improves the appearance and increases the value. It is therefore important to study the different kinds of finishing materials and woods. You must also know how to select them. Before a finish can be applied, however, all exposed surfaces, edges and ends of the wood must be smoothly scraped and sanded. Equipment and materials used for finishing surfaces are: brushes, spraying equipment, sandpaper, linseed oil, turpentine, alcohol, steel wool, pumice stone, rubbing oil, lacquer, thinner, wax, stains, bleaches, wood fillers, shellac varnish, sealer, paint and enamel.

BRUSHES

Use a good brush to get a high-quality finish. A 50 mm (2 inch) wide brush of the best quality will hold paint or varnish better than a cheap one. When brushes are not in use,

keep them in a solvent which is a thinner for the finish being applied. Alcohol is a solvent for shellac, turpentine for enamel or varnish, linseed oil for exterior paint and nitro thinner for nitro sealer or lacquer. The bristles of a brush should be kept from bending. When the brush is not to be used for a period of time, clean it in the same solvent or thinner used for the finish you have applied.

LINSEED OIL

This is a product of flaxseed. It may be used to bring out the rich colour of the wood. When using it to bring out the colour of different woods, mix two-thirds linseed oil with one-third turpentine. Apply it with a cloth or brush. Linseed oil mixed and applied in this manner will penetrate deep into the wood. This application may take the place of stain.

TURPENTINE

Turpentine comes from the sap of the pine tree or coal. After much processing it is refined to an inflammable liquid. It is used as a thinner in paints, enamel and varnishes and can be used for cleaning brushes.

ALCOHOL

Alcohol or spirit is made from sugar and starch substances in a chemical process. The spirit is denatured by adding chemicals which make it poisonous and it is very highly inflammable. It is used for dissolving shellac and cleaning brushes and polishing equipment.

STEEL WOOL

Steel wool is available in rolls or pads. Grades vary from No.000 (very fine) to No.3 (Coarse). It is sometimes used instead of sandpaper for rubbing down between coats of finish.

PUMICE STONE

Pumice stone is a light-coloured powdered substance made from lava. It is used when polishing a surface with shellac for rubbing it into the pores or grain. It is applied by mixing it with rubbing or paraffin oil.

RUBBING OIL

Rubbing oil may be either a petroleum or a paraffin oil. The latter type is preferred for shellac polish and gives a much better finish.

STAINS

A stain is used to change the colour of a surface and it often emphasizes the beauty and grain of the wood. It is the first

step in the finishing operation after finishing the wood for surface treatment. Many woodworkers prefer the natural tones of hard and softwood, but very often the careful use of stains will improve even more the natural beauty of the wood. They are also used when one piece of work is to be matched with another. Wherever possible a particular stain should always be tried out on a piece of wood taken from the actual job in hand, to judge the effect accurately and should also be examined in daylight.

WATER STAIN

Water stain comes in concentrated powder form. Water-soluble colours (usually aniline dyes) are dissolved in hot water. It should be mixed in a glass or plastic container to avoid rusting. Water stain penetrates deeply and gives great transparency. It does raise the grain, therefore watering of the surface should be done before staining. Staining is done with a brush, but it can be also applied with a spray-gun or in mass production the dipping method is used.

OIL STAINS

Oil stains are usually classified as pigmented, wiping or penetrating stains soluble in benzol, naphtha, or turpenting. They are available either in powder or in ready-mixed forms. Penetrating oil stains are often used to colour wood filler. Oil stains do not raise wood grain and are easy to apply to a uniform colour. All excess stain should be removed because it bleeds. Apply a coat of boiled oil to all exposed end grain before staining. This produces a uniform colour when the stain is put on.

SPIRIT STAINS

Spirit stains are made from 'aniline' colours, but the solvent used is alcohol. They dry so rapidly that it is difficult to cover a large surface without showing laps except when they are applied with a spray gun. They are used chiefly for shading and for refinishing old work, because they penetrate more readily than water or oil stains. They are however, liable to fade when exposed to the light.

ACID STAINS OR STAINS DUE TO CHEMICAL ACTION

Acid stains are not used so much as the method of applying it is quite complicated. In this method the colour of the wood is not changed by application of a coat of coloured liquid which penetrates into the wood, but due to a reaction of two different acids brought together. For example Oak and Mahogany contain 'Tannic Acid' which reacts with the 'Bichromate of potassium or other acids. Some of the most common acid stains are: Bichromate of potassium, permanganate of potash, ammonia and quick lime. Permanganate of potash dissolved in hot water produces a brown colour on Oak. A strong solution of ammonia allowed to evaporate in a small closed room or box produces a rich

brown colour on Oak called 'fumed Oak'. When working with acid stains care should be taken because they are dangerous.

BLEACHING

Dark spots and natural wood colouring are removed by bleaching. However, it is sometimes difficult to remove the colour without causing injury to the wood fibers. Bleaches are often composed of strong chemicals. They require protection of the skin and utmost safety in use. Be careful when you apply bleaching material. Wear rubber gloves, protect your eyes with goggles and wear a rubber apron. Bleaching should be done only when necessary to obtain a uniformly light colour. The most satisfactory bleaches are commercial two-solution liquids. These are mostly applied separately. Read thoroughly the instructions given on the containers.

APPLYING OIL AND WAX FINISHES

Wax that is used as a finish or to polish and protect other finishes must be renewed periodically to keep a shining surface. It cannot withstand water, acid, alcohol or excessive heat. However, a wax finish is one of the lowest qualities of all polish materials. 'Carnauba' (Brazilian) wax is the most important natural polishing agent. It is obtained from a palm tree growing in Brazil and is the hardest of the natural waxes. Carnauba wax is usually mixed with other waxes, such as bees wax (a fairly hard wax produced by honey bees), kerosene (a hard hydrocarbon wax), or paraffin (a soft wax obtained from petroleum), to make it softer and easier to use.

How to apply wax

1. Before a surface is ready for waxing, it must be given a sealing coat of shellac, varnish, or lacquer. If a sealing coat is not given, the wax penetrates into the wood, leaving a dull, uneven finish.
2. Apply the wax, either paste or liquid, with a soft cloth. Do not put too much on at a time, as it is likely to make the surface greasy and consequently difficult to polish.
3. Allow the wax to dry for about 20 minutes and then rub properly with a soft cloth and finish rubbing with the grain.
4. A second coat may be applied after an interval of 1 or 2 hours.
5. A wax finish is easy to produce, but is not durable. Any liquid spilled on a waxed surface makes a dull spot. In most cases, however, this will disappear if rubbed over with a soft cloth.

OIL FINISH

1. Dust the wood surface and other parts thoroughly.
2. Very carefully heat a mixture of two parts boiled linseed oil and one part of turpentine. Heat in a double boiler, because both are highly inflammable.

3. Apply the heated mixture with a soft cloth tied to a piece of wood. Use enough oil to soak readily into the wood and wipe off the surplus oil.
4. Allow the oil coat to dry about 15 minutes.
5. Rub the surface with a dry cloth until the surface shines brightly.

SHELLAC FINISH

Shellac finish or French polishing is a lengthy process, requiring a fair amount of skill, patience and good working conditions. The result is usually in proportion to the degree to which these factors are favourably combined. French polishing must be done either well or not at all. In the commercial production of furniture, however, a cellulose polish, applied by spray guns, has largely taken the place of shellac finishes, over which it has certain advantages. Good shellac polish can be bought ready for use, or it may be prepared by dissolving shellac in methylated spirit. The process of french polishing is to apply a good coat, or body, of shellac to the work by means of a pad of cotton, wrapped in clean soft linen, using the pad in which the polish has been gradually displaced by methylated spirit. Filling-in the grain is necessary on most work to form a reasonable surface. Fillers like pumice powder or special filling pastes are rubbed in across the grain with a piece of clean pad and allowed to dry. The work may be rubbed over with linseed oil before the filling is applied. This brings out the grain of the wood. Any holes or cracks in the surface should be filled in with hard fillers. Fadding is the process of covering the work with polish with a pad. This pad is soaked in polish and covered with a piece of soft linen. The fadding is carried out by applying the polish through the pad to the surface of the work, using long strokes with the grain until the whole has been covered. This is done several times and then allowed to dry for at least a day. Next day it may be dusted with very fine sandpaper (180-220). The room in which the polishing is done should be kept at a moderate and even temperature and as free as possible from dust. Bodying, as the name suggests, is the precess of applying body (polish) evenly to the surface. In this process the work is given a reasonable polish by adding a touch of linseed oil to its face, but as little as possible should be used, because the oil must be completely removed before the process is complete. The actual bodying is carried out by working the pad methodically over the whole surface of the work in a series of overlapping circles, taking care that every spot is covered and that an even pressure is maintained throughout the movement. When the polish becomes difficult to work, it is left to dry and the process repeated five to six times. Sipiriting-off is the final stage. The same pad is used as before, but the quantity of polish in it is gradually reduced and at the same time spirit is gradually introduced, so that by the time the process is completed, the pad will contain almost clean spirit. Of course the pad must not be made too wet with spirit, for the danger that the shellac will be dissolved and washed off.

VARNISH

Varnish has the excellent qualities of transparent depth, durability and hardness. It dries slowly when produced with oil bases, but it dries very quickly if nitrocellulose is its basic raw material. Materials in varnish include resinous gums are the solid portion or varnish, giving the firm hardness and luster. They vary in hardness and are blended for each particular kind of varnish. Originally, all good varnihses used fossilized gums. Recent developments have produced varnishes based on synthetic (man-made) resins that dry more quickly.

NITROCELLULOSE LACQUERS

Nitrolacquers are the most wide spread wood finishes at present. The ordinary grades of nitrocellulose lacquers are solutions of cellulose nitrate (collodion cotton), resins and plasticisers in a mixture of complicated organic solvents, the esters of acetic acid (acetates alcohol and thinners (aromatic hydrocarbons). The contents of film-forming substances in modern grades of nitrolacquers ranges from 10-37 percent. Nitrolacquer films due to the presence of resins are durable, elastic and are easily sanded, smoothed and polished and harden rapidly due to evaporation of the solvents. A disadvantage of the nitrolacquers is the inflammable and explosive nature of the solvents. Various grades of nitrolacquers are employed for finishing wood. The most wide spread use is made of cold or normal spray nitrolacquers with a reduced evaporation solvent and a solid content of 25 percent. Nitrolacquers are very difficult to apply by brush because of the rapid hardening process. They are applied either with a spray gun or with a lacquer pouring machine.

Note:

A good ventilation must be provided when spraying. Remember that nitrolacquers are highly inflammable, therefore they must be stored inclosed containers.

POLYESTER

Polyester varnishes occupy a special place among the resin varnishes. They are prepared with a base of unsaturated polyester resins that are products of condensation of polybasic acids and polyalcohols. To ensure its hardening, special hardeners are introduced to it before use. Once the hardeners are mixed with the varnish the 'pot-time' is 30-40 minutes (that means the varnish) is good for use over this period of time and then it hardens and becomes useless). It should be understood then that only the amount of varnish needed should be mixed with hardener, otherwise the remaining varnish goes to waste. To get a higher content of polyester (up to 96-97 percent) paraffin is added. The high solid content makes it possible to apply the varnish in one coat with a thickness of up to 600 g per m^2. In this case the varnish does not sink into the pores of the wood. A drawback polyester varnishes containing paraffin is their short spreading life after introduction of the hardener and the impossibility of applying them to vertical surfaces due to the paraffin running down them.

DD-VARNISH

A very good finish is obtained with varnishes based on epoxy and polyurethane synthetic resins. The name DD comes from the basic raw material Desmondur and Desmophen. These two compounds are mixed 1:1 and special hardener is added to harden the varnish. The ready mixed DD-varnish has a part-life of 24 hours. The application of this varnish can be done with a pad, brush, spray gun or a lacquer pouring machine. For sealing a surface with a priming coat, 50% of thinner must be added to get a good penetration, but only a special DD thinner can be used. After the first coat has dried (4 to 6 hours) a second and third may be applied with a thickness of up to 120 g per m^2. DD-varnish has excellent qualities of transparent depth, durability and is acid, alcohol and waterproof.

PAINTS

Paints and enamels are used on less expensive woods. They cover, protect and beautify woods when natural, clear finishes are not desirable. Paint is used on both exterior and interior surfaces. Vegetable oils made possible the oil resin and latex emulsion paints. 'Latex' once referred only to a substance extracted from the rubber plant, but it now refers to a variety of synthetic resins. Oil-base paints are extremely popular. They consist mainly of either white or coloured pigments and certain vehicles or liquids. A good paint should contain at least 65 percent pigment, the remaining 35 percent is composed of the vehicle. Linseed oil is the most important of all drying oils. Other drying oils are: castor, fish, hemp seed and soya, they give different characteristics to a particular paint. Basic carbonate or sulfate of lead is widely used as a hiding pigment and the vegetable, animal or mineral colour pigments are added.

How to apply paint

1. Clean all surface thoroughly. Read and follow the manufacturers directions on the can for mixing, thinning and applying. A primer coat may be needed to seal wood pores before other coats are applied.
2. Shake the can properly to mix all ingredients thoroughly. If the paint is not completely mixed, pour some of the top solution into another container.
3. Stir the base mixture in the can until it is smooth. Gradually blend in the top solution. A drill press with a stirring device in the chuck is useful in mixing paint.
4. Select a good brush of suitable size. Dip about one-third of the bristle length into the paint. Strike (press) off excess paint.
5. Apply the paint with long, smooth strokes. Start at the top and work down on vertical surfaces. Paint the inside areas first and then exterior sides, front and top. Start painting across the grain and finish brushing with the grain. Do not allow the material to run, but keep sufficient paint on the brush to cover smoothly and evenly.

6. Allow the coat to dry according to the directions. Sand lightly between coats, but do not sand the final coat.

SPRAY GUN Fig.576,577

The most widespread method of applying surface coating is the spraying method. A surface coating material can be sprayed faster, cleaner, more economically (time) and the quality of the finished surface is more satisfactory than a hand finished surface. A suction-feed gun is probably the most widely used gun. It usually has an adjustable external-mix type of nozzle and tip. That is, the air and finish are mixed just as each comes from the gun. The gun is attached to an air hose, (tube) in addition to a container that has a special air-vent cap. This vent (small hole) must be kept open at all times to allow air to come through to create a suction. The suction-feed gun operates as air passes through the gun. A variety of sizes of spray heads, nozzles and fluid needles can be used. Fig.577A.

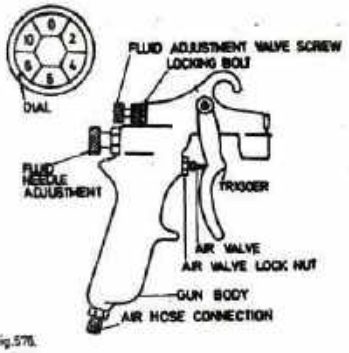


Fig.576

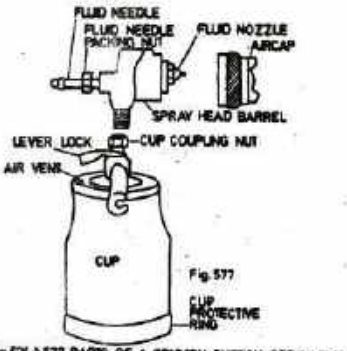


Fig.577 Fig.576 & 577 PARTS OF A COMMON SUCTION SPRAY GUN

Using a Suction-Feed Spray Gun

1. Finishing materials should be sprayed at room temperatures of more than 20°C (69°F). Finishes work best at a specified consistency, called their 'viscosity'. A cupful of properly thinned material should flow through a spray gun in a designated number of seconds.

2. Let the finish flow into the container through fine cloth or very fine window screen if there is any possibility of particles in the liquid. These particles will otherwise block the gun. They are often found in cans of finish which have been opened for previous use.

3. Spray finishing should be done in a special dust-free area. A spray hood with exhaust makes an ideal location. Fig.578. Air should enter the area through a filler. It should be cleaned properly by exhaust fans designed for that purpose.

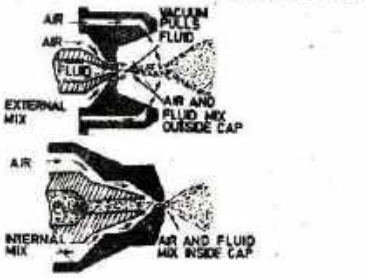


Fig.577A DETAIL OF TWO DIFFERENT DESIGNS OF FLUID NOZZLES

4. Start the compressor and let the air pressure increase. Open the air line to the regulator. Check the regulator to see that the pressure is somewhat greater than that needed at the gun. There will be an air loss that must be adjusted. The longer the air hose and the smaller the inside diameter, the greater the loss of pressure, regardless of the volume of compressed air generated by the system. The regulator must allow sufficient passage of air.

5. Adjust the regulator on the gun air-hose line for the pressure needed. Air pressure for spraying are given in Fig.579

6. Regulate the fluid-adjustment screw on the rear of the gun. The fluid adjustment screw controls the amount of finishing material which leaves the gun.

7. Adjust the air cap to the proper externally mixed spray pattern. This could be either a spot or an elongated (elliptical) pattern. Fig.580

8. Test on scrap paper and perform steps 5, 6 and 7 until the paper spray is obtained.

9. Hold the spray gun 150 to 200 mm (6 to 8 inches) from the surface to be sprayed. Fig.581. Pull the trigger and make the spray stroke a continuous movement parallel to the surface. Fig.582. Runs result when the gun is held too close, is moved too slowly, or is delivering too much fluid for the operator to control. When the spray-gun nozzle is held too far from the surface, the material atomizes too much mist is lost. This results in waste and leaves a cloudy, sandy finish that must be done over. A deliberate, steady pass which leaves a full, wet coat is desired. Arching and tilting

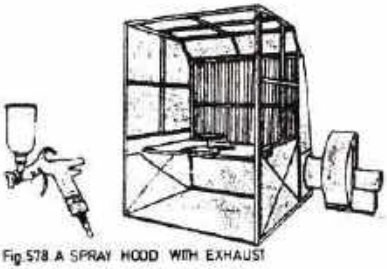


Fig.578 A SPRAY HOOD WITH EXHAUST

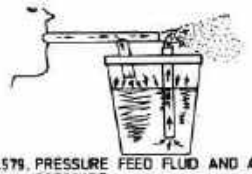


Fig.579. PRESSURE FEED FLUID AND AIR PRESSURE

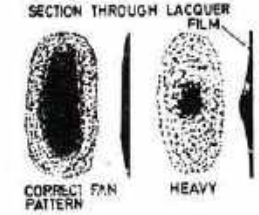


Fig.580. CORRECT AND FAULTY SPRAY PATTERNS

Fig.581. GUN MUST BE AT A PROPER DISTANCE FROM SURFACE FOR BEST RESULTS

the gun are the two common faults which result in a streaky effect.

10. Corners of projects should be sprayed first. Turn the project so that the gun is always perpendicular to the surface being sprayed. Tilting allows finish to spill from the air vent and eventually will close it. This stopping up prevents operation until the opening is clear.

11. Move the gun to the corner of the project to be sprayed. As it reaches the leading corner or edge, pull the trigger and release it near the end. Pull it for the next stroke and release it at the end. This will prevent over-spraying. Leave flat surfaces to be done last.

12. Use a round spray pattern for table legs and similar round surfaces. When spraying curved surfaces, hold the gun the same way and at the same distance from the work. Follow the curvature of the surface.

13. Study each project or object before spraying it. Decide what procedure will be the simplest, easiest and require the fewest passes of the gun. Use a round spray pattern on a narrow object or piece; a wide (elliptical) one on larger surfaces. Fig.583

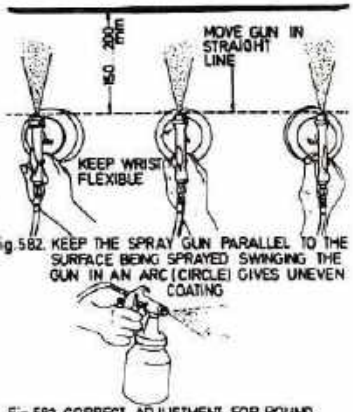
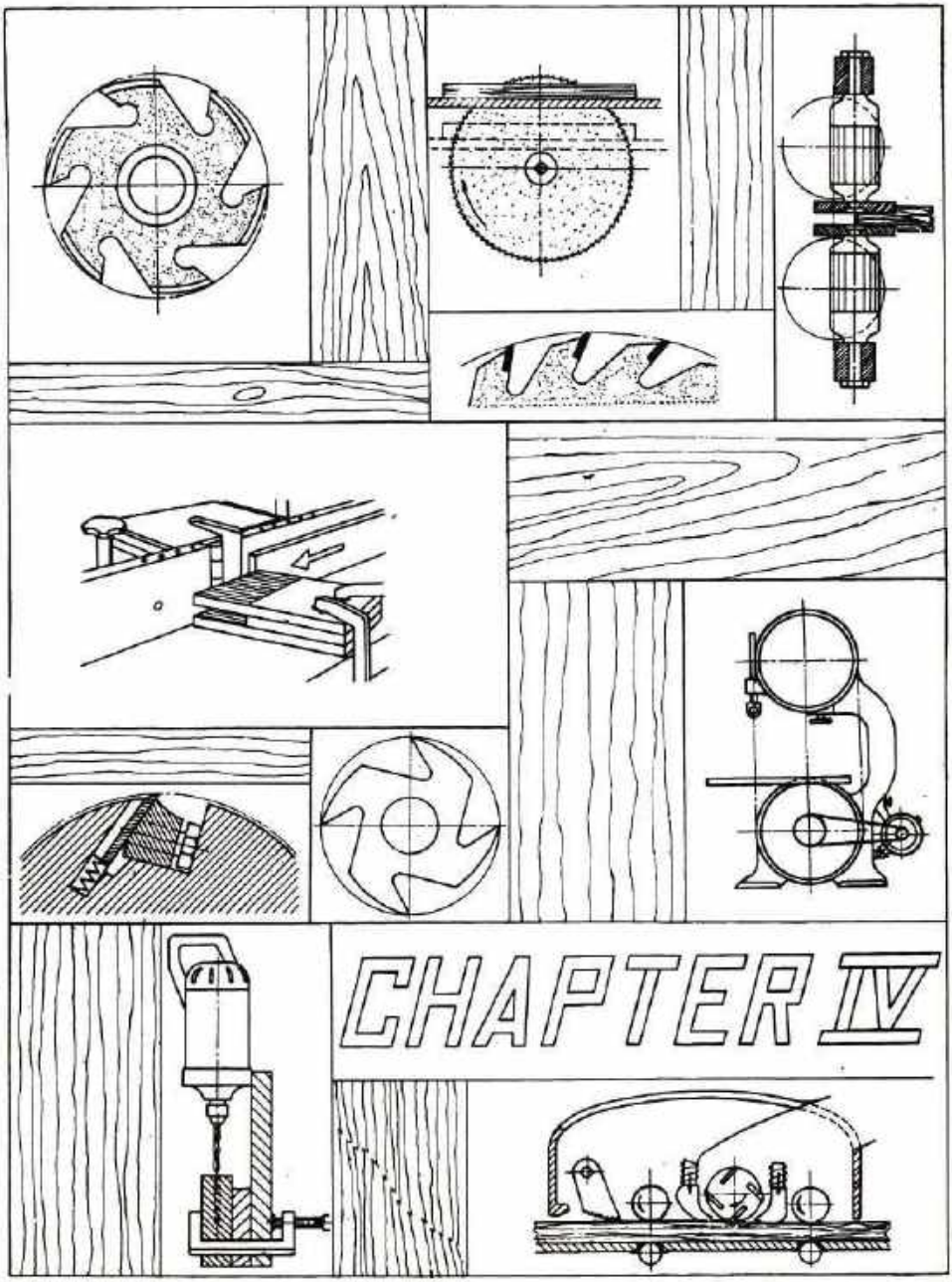


Fig.582. KEEP THE SPRAY GUN PARALLEL TO THE SURFACE BEING SPRAYED SWINGING THE GUN IN AN ARC (CIRCLE) GIVES UNEVEN COATING

Fig.583. CORRECT ADJUSTMENT FOR ROUND PATTERNS


CHAPTER IV

WOOD-WORKING MACHINES

During recent years there has been considerable progress in the field of woodworking machinery. Particular attention has been given to greater safety for the operator and to convenience and ease in both the setting up and the operation of the machinery. Old types of production machines have been improved and new types have been invented. Moreover, numerous types of bench and portable machines have been developed.
Since woodworking machinery is very dangerous to operate, improvements and inventions that will safeguard the operator are of the greatest importance. Some of the most notable advances have been cylindrical heads on planing machines, safety switches, improved guarding devices and the elimination of fast-moving belts through direct motor drives. It is necessary for anyone who would use a machine to understand thoroughly how it works, how its different parts are inter related, how they may be set and adjusted to perform certain operations and how jigs and fixtures may be made and used on a machine for special jobs.
Machine tool maintenance is a day-to-day process. As a person learns to perform various operations on a certain machine, he also should learn as soon as possible how to take care of it.

The machines can be divided into groups for different purposes:

1. Machines for cutting
2. Machines for planing
3. Machines for boring
4. Machines for shaping
5. Machines for sanding
6. Machines for wood turning
7. Machines for grinding
8. Miscellaneous machines.

Precautionary Measures

Approximately 22 accidents per 100 workers occur yearly in the woodworking industry, i.e. almost twice as much as in the commercial and industrial life in general. Machines simlipy the work but also require a great deal of attention and maintenance. On an average, every fifth worker in the wood-working industry receives injury during the year. Generally speaking the high rate of accidents in the woodworking industry depends on the great many risks which are involved in this kind of work. The speed of the machines being very high, causes great strain on the machines and on rotating tools. If the cutters are not properly fixed in the machines or their static properties are too weak these may either break or get loose and would be thrown out of the machines with great force.

As an example can be mentioned:

The centrifugal force of a knife weighing about 1 kg. which is 100 mm from the centre of the shaft and moves with a periphery speed of 40 meters per second is equal to approxi-mately 1770 kg. This force tends to break away the bolt which holds the knife and in case it would happen, the knife

would be thrown with such great force that it could pass through a 50 mm (approx. 2 inches) thick wooden wall. To facilitate accessibility the means of protection of the rotating tools and work spindles are generally rather defective. Feeding of work pieces into the machine is usually done manually and the hands of the worker thus come very close to the cutting tools. Moreover, the material will often be found difficult to handle. It may be thrown back towards the operator etc. Unless the worker is aware of such events and knows how to tackle such a situation, an accident can easily happen. The most common reason for accidents generally lies in the fact that the workers are not skilled enough in their work to handle such complicated machines. With regard to the great risks involved in wood working it is obvious that a responsible operator must be on his guard. If he is to succeed in his efforts to prevent accidents he must also be familiar with other important factors and what is expected of him.

Some may be mentioned here:

1. He should have a thorough knowledge of the functions of the machine.
2. He should be fully aware of the most common causes of accidents and also know how these are avoided.
3. He should utilize available safety devices wherever possible and if necessary be able to make such himself.
4. He must be able to select the most suitable working method and how to use his hands and the position of his body according to the kind of work and different operations.

Safety and common sense

The risk of accident in the use of woodworking machines can be very high when sensible precautions are not used. Accidents can occur if regulations are not studied. It is most important that an apprentice studies these regulations carefully and frequently. The precaution and safeguards set out are compulsory to keep danger to a minimum. Apart from any law breaking, it is foolish to run risks that can bring suffering and life long handicaps. Concentration can play the most important part in avoiding injury. Accidents rarely happen on jobs that may be considered dangerous because the operator knows its danger. The every day or common operations often lull the operator into carelessness or to disregard the possible danger. One of the major causes of accidents is testing the setting of a machine for the first cut without placing a guard in position. Chips and shavings will make a floor slippery, small pieces of wood and off-cuts can be tripped over, badly stacked timber or work parts can fall. A clean and tidy working space around a machine is essential for safety. All guards that are necessary for safety must be used and fixed in position correctly before the machine is started, whether this is for a very short or long run. When setting a machine of any kind many parts may be moved or

loosened. Each must be checked before starting the machine. This, if one starts doing it from the beginning, soon becomes a habit that will never be lost. An operator has a responsibility to others who may well be placed in danger through loose parts, cutters and stock being kicked back. Danger is considerably increased by the use of dull cutters and saws. During the time a machine is in operation there is added danger when spanners and loose pieces of wood are lying on the machine tables, this is especially so with circular sawing machines where a small off-cut can be thrown back at the operator with terrific force.

GENERAL SAFETY RULES ON SAWS

1. Request permission from the instructor before you start to operate the machine.
2. Do not wear loose clothing or hanging neckties. Button or roll up your sleeves.
3. If you wear a ring take it off. It could catch in splinters and cause injury to your hand or finger.
4. Stand to one side of the machine. If the board kicks back, it will not hit you. Always stand firmly on the floor.

Fig.584. SETTING OF THE SAW FOR RIPPING

5. Keep always the tools properly sharp.
6. Be sure that the saw blade molding head and other cutters are pointing towards you as you stand on the operator's side of the machine.
7. Make certain that the safety guard is properly fixed in place and ready to use.

   Keep your hands away from moving parts of the machine. Alway use a safety guard if the saw teeth extend above the stock being cut.

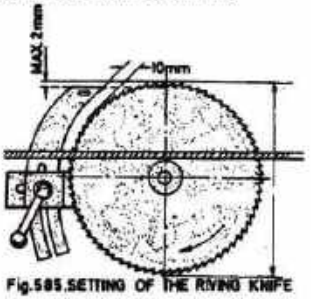
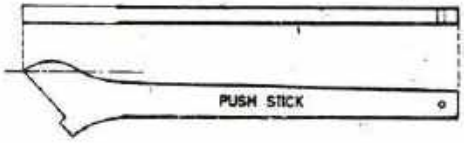


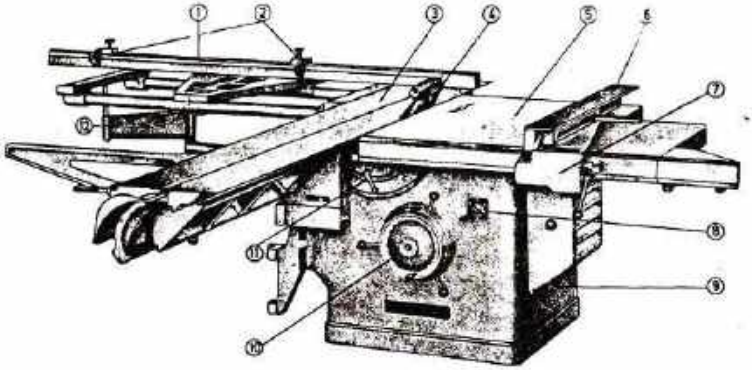
Fig.585.SETTING OF THE RIVING KNIFE

9. When ripping, set the saw blade that it does not extend more than 5 to 8 mm approximately above the stock to be cut. Fig.584.
10. Whenever possible, especially in ripping, use the riving knife which is fixed 10 mm behind the saw blade and in height equal with the gullets of the saw blade. Fig.585.


Fig.586. HOW TO USE A PUSH STICK

11. Use a push stick when you rip narrow stock. Fig.586.





1 CROSS CUTTING GUIDE
2 CUT-OFF GUIDE
3 SLIDING TABLE
4 SAW AND SAFETY GUARD
5 TABLE
6 RIP FENCE
7 FENCE LOCKING DEVICE
8 SWITCH
9 BODY
10 HAND WHEEL FOR RAISING, LOWERING AND TILTING
11 SAW TILT SCALE AND LOCKING SCREW
12 TABLE SUPPORT

THE CIRCULAR SAW

The circular saw is, no doubt, the most useful and indispensable of woodworking machines. Besides the regular ripping (cutting along the grain) and cross-cutting (cutting across the grain) operations, for which this machine is specially built, many other operations such as cutting of grooves, rabbets, tenons, miters tapers etc., may be performed on the circular saw. A circular saw consists of a heavy casting to which an iron table with a smooth machined surface is fastened. All sawing machines have the facility to raise or lower the saw. The variety saw is generally a smaller machine and is sometimes equipped with a mortising and boring attachment. The older circular saws were belt driven, but the newer ones are 'direct-driven' which means that the saw arbor (shaft) is the rotor of the motor. Its projecting end has a left screw thread for the nut which clamps the saw blade between two large collars, one fixed to the arbor, the other is loose. Fig.587. On older circular saws the table can be tilted toward the left to an angle of 45 degrees. On the latest types the saw blade and, therefore, the whole motor is tilted while the table is fixed in a horizontal position. A circular saw is equipped with three types of fences or gauges for ripping, cross-cutting and mitering. A ripping fence is a rectangular casting, which is fastened to the right side of the table. It is fastened parallel to the line of the saw and is generally fitted with a very accurate micrometer adjustment. The ripping fence is used for any lengthwise

Fig.587. SAW BLADE FIXED BETWEE COLLARS

cutting such as ordinary ripping, grooving, rabbeting or tapering. The miter cut off gauge is used for cross cutting or mitering boards. It runs in a shallow groove cut in the face of the table parallel to the saw blade. It can be set to any angle from 30 to 135 degrees by means of a graduated scale marked on the gauge. Fig.588. Most of the modern circular saw machines have a movable extension table on the left side of the saw. Its lengthwise movement past the saw is for the purpose of cross-cutting wide boards. The table is mounted on roller bearings running on a metal runner fixed to the body of the machine, but the left side of the extension table rests on a flexible arm which moves with the table. Fig.589.

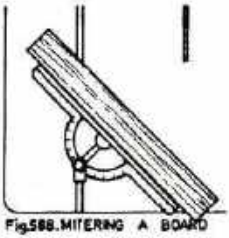


Fig.588.MITERING A BOARD

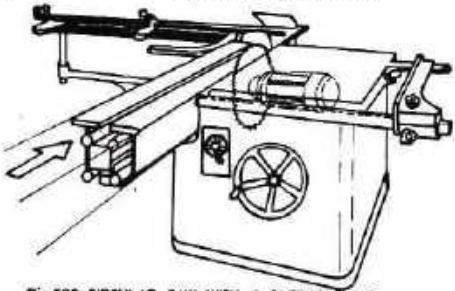


Fig.589.CIRCULAR SAW WITH A SLIDING TABLE

CIRCULAR SAW BLADES

It is now generally admitted that where saws are sharpened by hand, even by experts, there is difficulty in maintaining the correct shape and spacing of the teeth. The work of preserving a proper gullet is difficult and is consequently neglected, always resulting in an unsatisfactory cutting action of the saw. Consequently, most furniture factories have installed automatic saw grinding machines which grinds gullets, shapes, spaces and top teeth in one operation. Since TCT (Tools With Carbide Tip) tools are in use sharpening by hand is no longer possible. Special diamond or silicon carbide grinding discs are necessary to grind this TCT tools.

CLASSIFICATION OF CIRCULAR SAW BLADES

CROSS-CUT SAWS

The general classes of circular saw blades are: circular saw blades for cross-cutting and circular saw blades for ripping. The cross-cut saw blades are made for both rough and smooth cutting. Some of the various types of cross-cut teeth are shown in Fig.590. True 'rim travel', proper setting and taper grinding give the smoothness of the cut desired. More efficient cuts are made with tapered and hollow face shaped carbide-tip teeth. Fig.591. The teeth of a cross cut saw have always a cutting angle

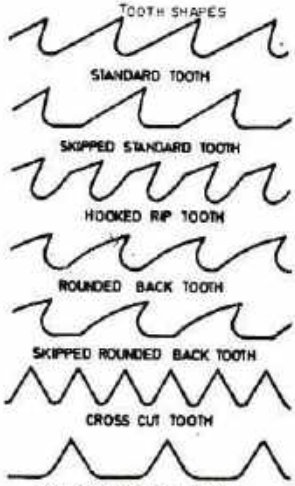


Fig.590.DIFFERENT SHAPES OF CIRCULAR

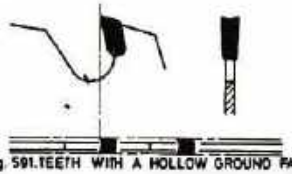


Fig.591.TEETH WITH A HOLLOW GROUND FACE

of 90 degrees or more. Only specially shaped carbide tip saw blades used on high-speed circular saw machines can be used for cross-cutting with a cutting angle below 90 degrees Fig.592,593. The planer saw blade is another saw blade which does not require setting, because the blade is ground hollow. It has very small teeth and should be used only for cross cutting. As the name indicates, it makes an excellently clean and smooth cut. Fig.594.

Fig.592. CARBIDE TIPPED SAW BLADE FOR CROSS CUTTING AND RIPPING

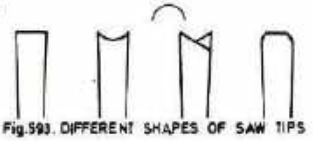


Fig.593. DIFFERENT SHAPES OF SAW TIPS

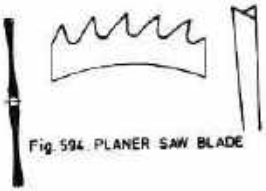


Fig. 594. PLANER SAW BLADE

RIP-SAWS

The teeth of ripsaws are shaped like a group of small wood chisels. The saw is used to cut wood in the direction of the grain. The cutting angle of the teeth has always more than 90 degrees and there are many different shapes of teeth for various purposes. A newly designed saw blade is called KBS. (kick back safety) or kick proof saw blade. This ripsaw blade has a chip limiting detachment, that means one tooth can only cut a shaving of 0,8 mm at a time and so prevent the stock from being kicked back. Fig.595, 596,597,598. All carbide-tip saw blades do not require setting because the carbide tip projects on both sides of the blade to clear the cut sufficiently. See Fig.596.

Fig.595. SAFETY RIP SAW BLADE

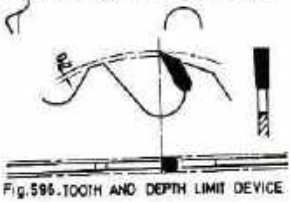


Fig.596. TOOTH AND DEPTH LIMIT DEVICE

Saw-setting

Set is necessary in order to make clearance for the saw blade in its passage through the timber. Lack of this clearance will cause the saw to rub on the wood and the friction will generate considerable heat, causing the saw to bend. It is very important that the set is equal on both sides of the saw, where the set is unequal, the saw will pull towards the side having the most set. The teeth are generally set to 1/1000 mm of the saw blade diameter. For example a saw with a diameter of 400 mm should be set 0,4 mm to each side.

Saw diameter. 300 = 0,3
Saw diameter. 500 = 0,5

$\frac{400}{1000} = 0,4$

Fig. 597. SKIPPED TEETH

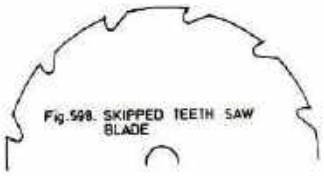


Fig.598. SKIPPED TEETH SAW BLADE

All teeth should be set 1/3 of their length. Fig.599. The setting can be done with a setting machine, setting plier or setting steel.
Setting of saw blades of any kind must be done before sharpening.

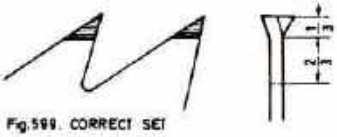


Fig.599. CORRECT SET

How to remove Circular Saw Blades

1. Swing the saw guard out of the way. Remove it if necessary.
2. Remove the throat cover.
3. Engage the arbor with a wrench or pin or stop the movement of the blade by placing a piece of wood against the teeth. Apply force on the wrench clockwise till the nut is loose.
4. Unscrew the nut and remove the blade.

How to mount Circular Saw Blades

1. Select the type of saw blade desired.
2. Grasp the blade, turn it so that the teeth of the blade are turned toward the front as it is held against the open end of the arbor.
3. Place the blade on the arbor, likewise the collar.
4. Hold the nut against the end of the arbor and turn it anti-clockwise.

Note

Ripping is cutting timber lengthwise along the grain. Deep cutting is when the timber is on its edge.
Flat cutting is when the timber is on its face.

Procedure for Setting and Operating a Circular Saw

1. Raise the saw guard and if practicable, swing it out of the way while setting.
2. Set the fence at the distance desired from the saw by measuring from the fence to the point of a tooth which is bent towards the fence.
3. Tighten the clamping screws that hold the fence in position. Then test the setting by remeasuring the distance.
4. Raise the saw blade to the position desired by turning the hand wheel that raises or lowers the saw table or saw arbor.
5. Remember that the saw blade should project not more than 5 mm above the thickness of the stock to be cut.
6. Swing the guard back in position.
7. Start the machine and make a trial cut on a piece of scrap wood.
8. Stop the machine and make adjustments if necessary.

9. Examine the stock to be ripped. If it is concave, place it on the saw table with the concave side down. If the piece has been jointed, turn the jointed edge towards the fence and the jointed face towards the table.

10. Place the hands on the work with the left hand forward. Stand slightly to the left of the saw blade. Then, holding the piece firmly down on the table, push it towards the saw.

11. Use a push stick or shoe when cutting narrow beadings. Fig.600

12. Keep the piece moving forward as rapidly as the saw will cut without slowing down. At the conclusion of the cut allow the piece to fall off the rear end of the table or draw it back to the right of the fence.

13. Make all similar cuts before resetting the saw for a different operation.

14. When the operation is completed, stop the machine.

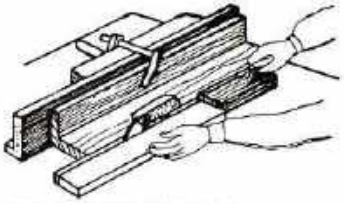


Fig 600 RIPPING WIT.. A PUSH SHOE

Procedure for Squaring and Trimming Ends Fig.601,602

1. Slide the ripping fence out of the way. If necessary remove it from the saw table.

2. Place the cut-off guide in position on the saw table.

3. Set the saw for the depth of cut to be taken, but do not raise the saw blade higher than 5 mm above the board to be cut.

4. Start the saw, then holding a piece of scrap stock firmly against the cut-off guide with the left hand, push both guide and stock forward with the right hand.

5. At the end of the cut, hold the remaining stock firmly against the guide and draw both guide and stock back to the starting point.

6. Test for squareness. Adjust the guide if necessary.

.. Place the stock to be cut on the saw table with the jointed face

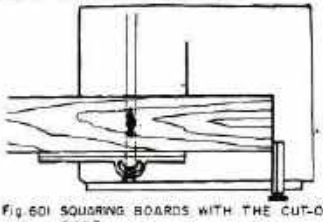


Fig 601 SQUARING BOARDS WITH THE CUT-OFF GUIDE

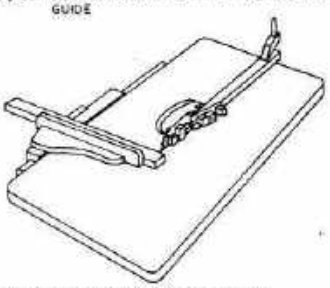


Fig 602. KICK BACK SAFE TRIMMING

down and the jointed edge against the guide. Allow the waste stock to remain on the table. If necessary to remove trimmings while the saw is running, use a piece of scrap wood. Do not use the hand.

Procedure for cutting to length

1. Square one end as mentioned before.
2. Square a line across the edge of the stock where the cut is to be made.
3. Place the stock on the guide and adjust it so that the cut will be made at the point desired with saw kerf in the waste stock.

Procedure for cutting Short Pieces Fig.603.

1. Trim one end of each piece as described before.
2. Place clearance block against the fence.
3. Set the distance from the clearance block to the saw blade according to the desired length of the piece.
4. Move the clearance block back so that it clears the front edge of the saw blade and clamp to the fence.
5. Make the cut holding the piece firmly against the cut-off guide.
6. Check the length and adjust the fence if required.

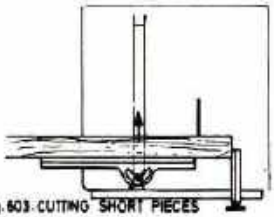


Fig.603. CUTTING SHORT PIECES

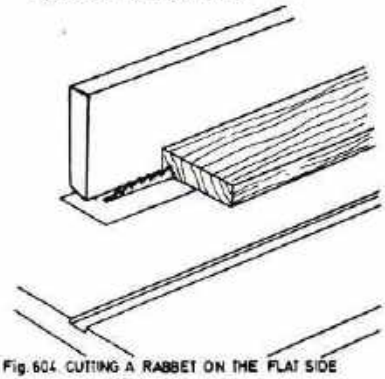


Fig.604 CUTTING A RABBET ON THE FLAT SIDE

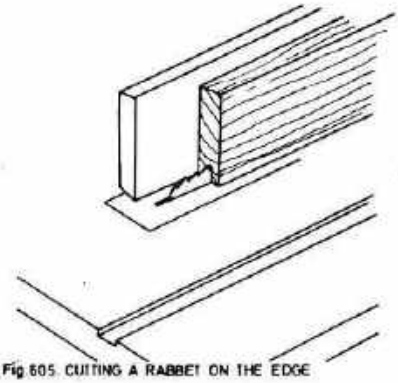


Fig.605 CUTTING A RABBET ON THE EDGE

How to Cut a Rabbet Fig.604, 605

1. Square and reduce the stock to the required dimensions.
2. Lay out the shape and size of the rabbet on the end of the stock.
3. Set the fence to the correct distance.
4. Set the depth of cut.
5. Test the setting on a piece of waste stock. Adjust if necessary.

How to Cut a Groove Fig.606

1. Locate and lay out the size and shape of the groove on the end of the stock, on that part which will first come into contact with the saw.
2. Adjust the saw for the depth of cut desired.
3. Set the saw to make the cut on the left side of the groove.
4. Test for accuracy, then make the cut.
5. Set the saw to make the cut on the right side of the groove.
6. Repeat as frequently as necessary to remove all waste stock completely.
7. Do not make the outer saw cuts by putting both faces against the fence. If the stock is slightly different in thickness the groove will also become irregular. Fig.607 and 608 shows two operations which are very dangerous and, therefore, must be avoided.

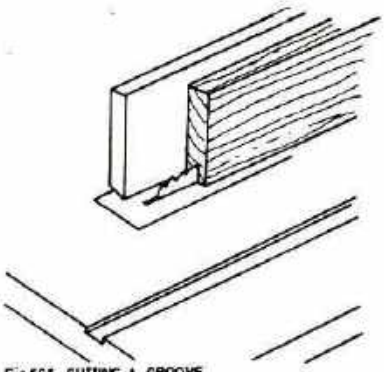


Fig.606. CUTTING A GROOVE

Fig.607. GROOVE CUTTER

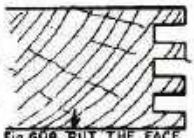


Fig.608. PUT THE FACE ALWAYS ON THE TAB

THIS WAY, YOU ARE BOUND TO LOOSE YOUR HAND AND THAT WAY YOUR THUMB

How to Cut a Tenon Fig.609

1. Place the cut-off guide in position for cutting-off. Then square one end of the member.
2. Mark off the length of the tenon by squaring a line at the required distance from the end of the member.
3. Lay out the thickness of the tenon with a marking gauge.
4. Place the ripping fence in position, keeping the right distance.
5. Adjust the saw according to the length of the tenon.
6. Place the stock exactly vertically on the table and slide it towards the fence. Use for this operation an accurate squared off pushing shoe.

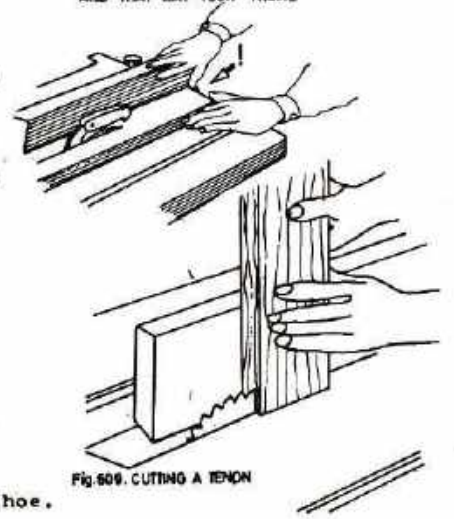


Fig.609. CUTTING A TENON

7. Check the accuracy and repeat the same operation after proper adjustment of the fence for the outer side of the tenon.
8. Place the cut-off guide in position.
9. Set the depth of cut.
10. Use clearance block while cutting the shoulders.
11. Complete all similar cuts before resetting the machine. When ripping long boards it must be done with a support or the help of a second person. Fig.610,611.

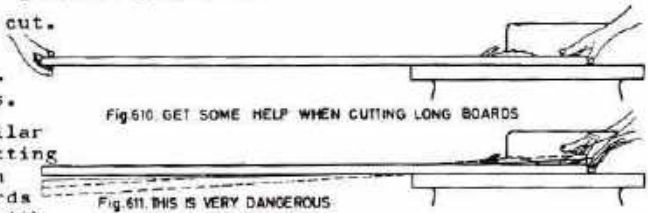
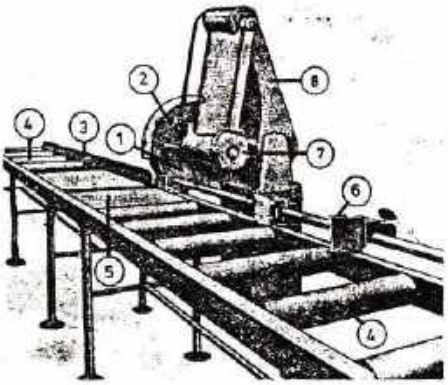


Fig.610. GET SOME HELP WHEN CUTTING LONG BOARDS

Fig.611. THIS IS VERY DANGEROUS



1 SAW BLADE AND SAW GUARD
2 SAW GUARD
3 FENCE
4 ROLLERS
5 TABLE
6 DIMENSION STOP
7 MOTOR
8 PENDULUM BODY

Fig.613. ACTION OF THE SAW

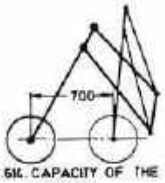


Fig.614. CAPACITY OF THE MACHINE

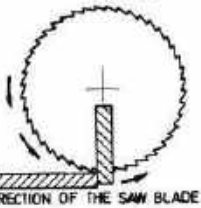


Fig.615. DIRECTION OF THE SAW BLADE

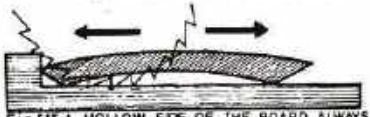


Fig.615.A. HOLLOW SIDE OF THE BOARD ALWAYS ON THE TABLE

PENDULUM CROSS CUT SAW OR TRENCHING MACHINE Fig.612

Cross cutting machines are made in various forms and sizes. The large production cross-cutting machines have a casted body like a normal circular saw whilst the pendulum cross cut saw has no stand or body and is generally fixed to the wall. The saw is direct driven that means the saw blade is fixed directly to the arbor of the motor. A work table is needed for this machine which runs at right angles to the saw and is supported on legs. Roller-feed tables are made for fast repetative work and the saw is pulled towards the operator. Fig.613,614,615. Care must be taken when trimming boards, that the boards are placed with the round side

against the fence and not with the hollow side or choking will be the result. Fig.616,617.

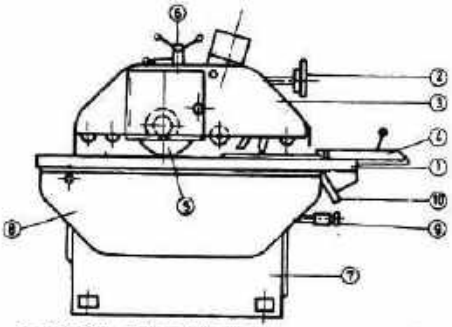
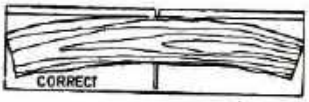


Fig.618.FRONT VIEW OF THE RIP SAW



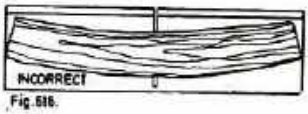


Fig.616.

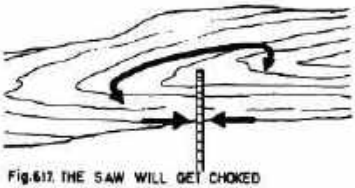


Fig.617. THE SAW WILL GET CHOKED

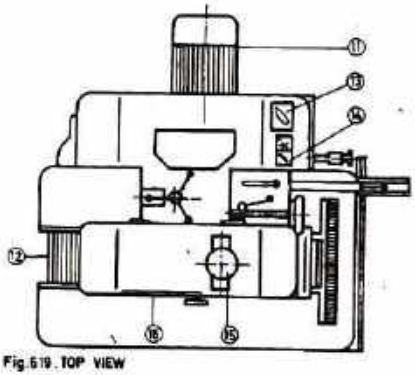


Fig.619. TOP VIEW

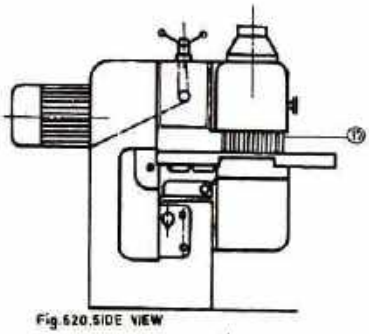


Fig.620.SIDE VIEW

1 TABLE
2 HAND WHEEL FOR RAISING AND LOWERING THE PRESSURE SUPPORT
3 PRESSURE SUPPORT
4 FENCE
5 SAW BLADE
6 STAR KNOB FOR RAISING AND LOWERING THE SAW
7 BODY
8 CHAIN HOUSING
9 CHAIN FEED SPEED CHANGER
10 FENCE CLAMPING DEVICE
11 MOTOR
12 CHAIN
13 MOTOR SWITCH
14 CHAIN FEED SWITCH
15 EXHAUST PIPE
16 DOOR TO THE SAW
17 ANTI-KICKBACK-DEVICE

MULTIPLE RIPSAW Fig.618,619,620

A travelling chain or belt and pressure rollers carry the wood over the table in a perfectly straight line. The machine is used for straightening the edges of stock and cutting straight board or rails in a single cut or multiple cut. This means that more saw blades can be fixed at one time, which produce several rails in one action.

This type of machine has the motor, on which arbor the saws are directly fixed, in the uper part of the body and the travelling chain or belt is in the lower part of the body. The saw arbor is adjusted in height by turning the star knob at the top of the machine. The pressure support and the travelling chain is adjusted to the thickness of the wood to be cut by turning the handwheel near the height scale. Rollers must have an elasticity of approx. 8 mm (5/16 inch) when the wood is fed through the machine. This machine has two different feed speeds. At switch position 1 the feed is 5-15 m min. and at switch position 2 the feed is 15-30 m min. A special feeding speed device is attached to the machine by which the speed can be regulated from 5 m min to 15 m min. and from 15 m min to 30 m min. To replace the saw blade use the socket wrench to bolt the arbor nut and with the hook wrench loosen the small grooved nut. Then take out the bushing that carries the saw blade. Open the second grooved nut with the hook wrench and the blade with spacers can be removed. The main motor is switched on by a star-delta starter. The feed motor can be switched only if the saw motor is switched in "Delta" position. Before using the machine make sure that the anti-kick back device is put in position

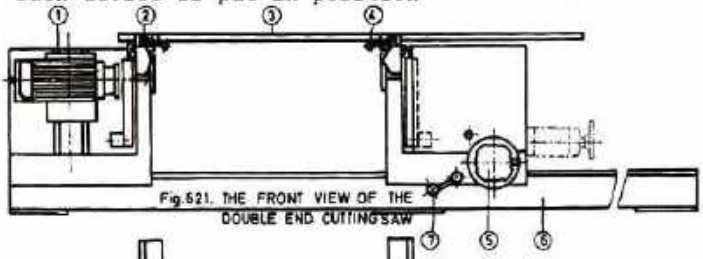


Fig.621. THE FRONT VIEW OF THE DOUBLE END CUTTING SAW

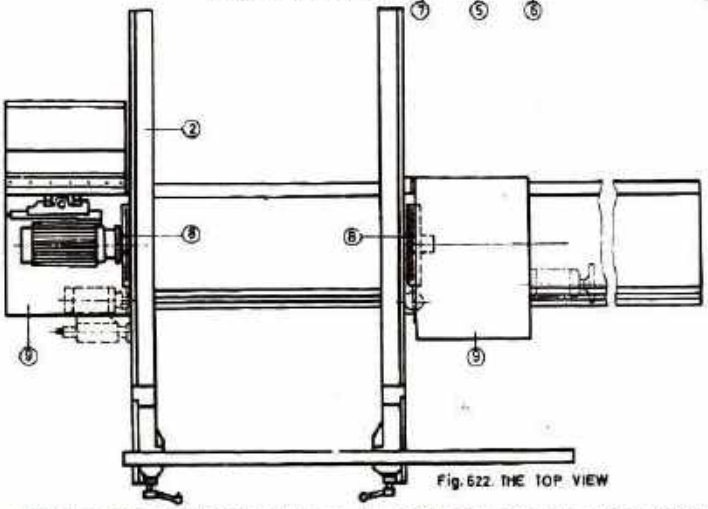
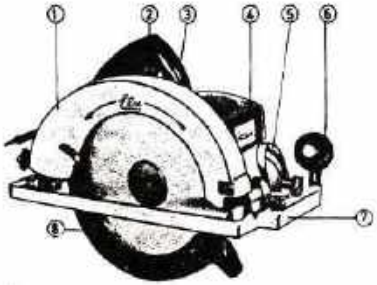


Fig.622. THE TOP VIEW

DOUBLE END CUTTING SAW OR DIMENSION SAW Fig.621,622

The double end saw is a heavy production machine for cutting

large boards to the desired size. The saw cuts the board off on two ends at the same time and can be used for ripping and cross-cutting. The cutting is done on a movable table which consists of two large metal rails running on ball bearings, passing the saw blades on the inner side. The correct squareness is adjusted by the two wooden ram-blocks on the end of the table rails. The dimension adjustment is done by a hand wheel which moves the right hand cutting device, either to the left or to the right. If it is moved to the left the dimensions will be decreased and if it is moved to the right the dimensions will be increased.



1 SAW GUARD
2 SWITCH
3 HANDLE
4 MOTOR
5 TILTING ADJUSTMENT
6 HOLD KNOB
7 BASE
8 MOVABLE SAW GUARD

PORTABLE ELECTRIC HANDSAW

The portable electric handsaw Fig.623 is sometimes called an electric circular handsaw. It is used extensively in building construction and it is especially convenient in that it can be carried to the work. This power tool has been improved with the development of a built-in blade brake. This is a good safety factor and also saves time by stopping the blade quickly so that either adjustment or succeeding cuts can be made. Other safety devices include a kickproof clutch and telescoping guard. It is also useful for cutting grooves, dadoes and rabbets.

Operating Adjustments and Maintenance

The various adjustments on the portable electric handsaw make possible several different blade positions. It is possible, for example, to change the depth of cut and also to make different bevel cuts. It is a relatively simple matter to change blades. The motor will give maximum wear if its carbon brushes are inspected often.

Changing a Blade

1. Disconnect the electric cord from the power source.
2. Set the portable electric handsaw on blocks of wood sufficiently high to clear the retractable guard.
3. Loosen the retaining screw by turning it counterclockwise (to the left). Use the wrench that comes with the saw Fig.624.

Hold the blade securely with the front block. This keeps it from turning. Some saws have a built in blade lock which holds the shaft stationary while the screw is loosened.

4. Push back the retractable guard so that you can lift off the blade and slide it down through the bottom opening.

5. Clean the surfaces of the collars. Make certain that you remember to add a thin film of grease.

6. Place the new or sharpened blade on the arbor. Tighten the retaining screw by turning it clockwise, or to the right. Make it secure with the wrench. The teeth of the blade should point up, toward the front of the saw.

7. Return the retractable blade guard to its proper position.

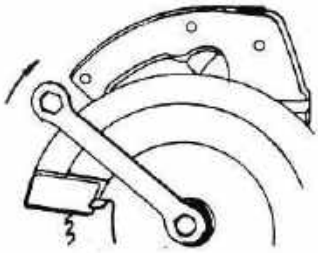


Fig. 624. TIGHTENING THE SAW BLADE

Adjusting for Depth of Cut

1. Loosen the large, round depth-lock knob on the front of the saw by turning it counterclockwise about three-fourths of a turn. See Fig. 625. This unlocks the slide.

2. Raise or lower the slide until the blade extends the desired dis ance below the base plate.

3. Tighten the depth lock knob by turning it clockwise until it is secure. Each manufacturer has specific instructions for making very slight depth adjustments.

Adjusting for Bevel Cuts

1. Loosen slightly the tilt-lock-knob on the front of the portable electric handsaw. See Fig. 625

2. Swing the body of the saw until the desired angle is obtained.

3. Tighten the tilt-lock-knob to hold the base in the selected position.

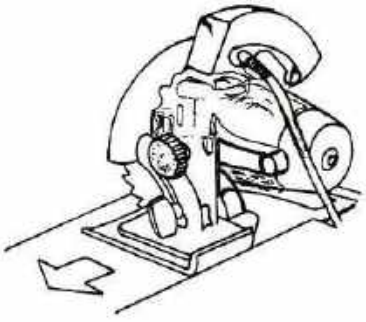


Fig. 625. A STRAIGHT EDGE IS CLAMPED TO THE BOARD TO SERVE AS A GUIDE FOR RIPPING

Motor Brush Inspection

1. Remove one brush with a screw driver.
2. Withdraw (pull out) the spring and the brush. If the carbon is worn to less than 6 mm (1/4 inch) in length, it should be replaced.
3. If the old carbon is not worn too much and the spring is not damaged, broken, or burned, you may re-install it to its former position. Do not however, turn it over.
4. Be sure to fasten the brush holder securely.
5. Check the opposite brush the same way.

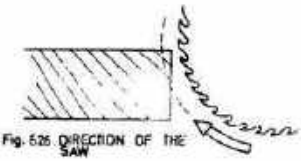


Fig. 626. DIRECTION OF THE SAW

Cross-cutting and Ripping

The portable electric handsaw is designed to be used with the right hand. The left hand holds the work on saw-horses or on other rigid supports and the right hand guides the saw across or with the work. Keep in mind that the saw teeth cut from the bottom of the board to the top, the reverse of the manual saw operation. See Fig.626. Cross-cutting and ripping are done very much the same way; however, ripping is a little more difficult, especially when the saw is operated freehand.

Fig.627. CORRECT SUPPORT FOR CROSS CUTTING

Cross-cutting

1. Adjust the depth of the cut so that the blade just saws through the board. Fig.626.
2. Lay out or mark the board. Put the hollow face of the board on the table. Fig.627,628
3. Plug the cord into an outlet.
4. Put the front of the base plate squarely on the edge of the board. Move the saw forward until the blade just touches the wood at the marked line for the cut. The alignment is made with the cut-line guide, or notch.

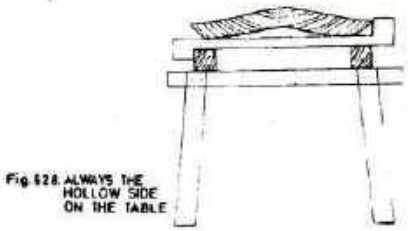


Fig.628. ALWAYS THE HOLLOW SIDE ON THE TABLE

5. Back the saw slightly away from the work. Start the motor with the trigger switch.
6. When the saw has reached full speed, move the blade steadily forward through the board. Do not force the motor. Move the saw only fast enough to keep it cutting.
7. Cut off the power with the trigger switch when the cutting is completed.
8. Stop the blade by pressing down on the blade brake button if the tool is equipped with a brake stop. The brake stops the blade rapidly so that the tool can be laid down or adjustment can be made immediately.

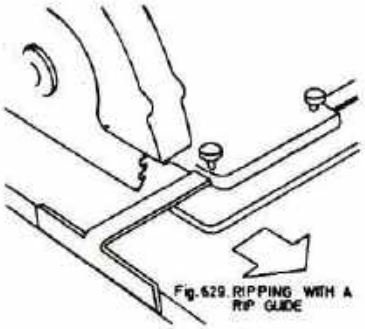


Fig.629. RIPPING WITH A RIP GUIDE

Ripping

1. Follow steps 1 to 8 as in cross cutting with this exception: in step 4 the base p ate should be put squa. l. on the end of the board or ripping. It is quit possible to rip free-hand while following a straight line but the use of a guide is recommended for greater accuracy.
2. Attach the rip guide and set it to the desired widt i of the cut. This guide is pa icularly useful in making narrow rip cuts. Fig.629.
3. In order to make wider cuts, use a wooden guide strip. It can be clamped or tacked (nailed) to the board far enough back from the line to serve as a fence to guide the base plate. Fig.630

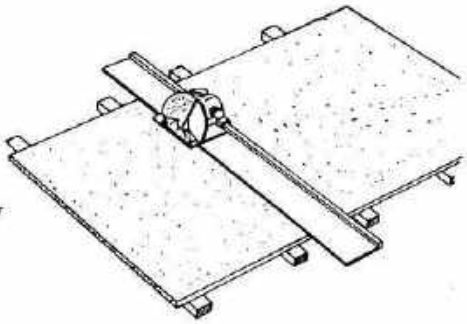
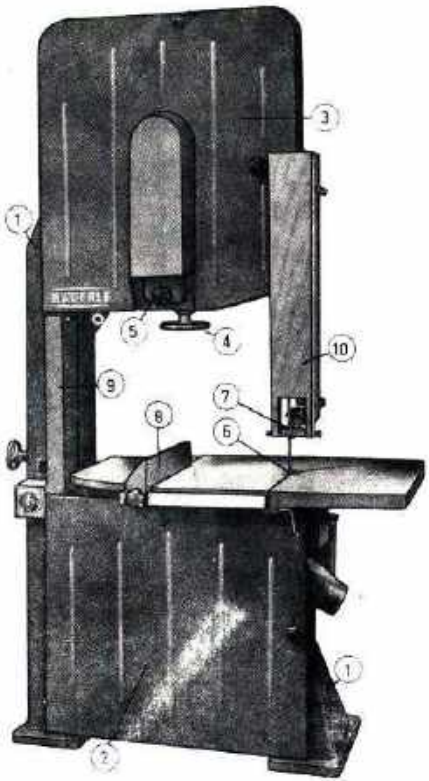
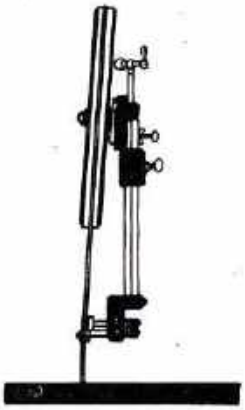


Fig.630. CUTTING LARGE BOARDS WITH A WOODEN GUIDE



1 COLUM OR FRAME
2 LOWER WHEEL GUARD
3 UPPER WHEEL GUARD
4 HAND WHEEL FOR RAISING OR LOWERING THE UPPER WHEEL
5 GUARD LOCKING SCREW
6 BLADE
7 BLADE GUIDES
8 RIP FENCE
9 BLADE GUARD
10 BLADE GUARD

Fig.632. EXCESSIVE TILT, PRESSURE GUIDE WHEEL TOO MUCH IN FRONT



THE BANDSAW Fig.631

The band saw is one of the oldest and most indispensable woodworking machines. They are made in many sizes from a large heavy duty production or a medium large bandsaw to a little bench saw. The most common in use is a medium size with a wheel diameter of 800 mm (approx.32 in.) The most important parts of a band saw are the continuous flexible-steel saw blade, from which it has got its name, the two wheels on which this saw blade revolves, a heavy cast-iron frame and a steel table. The wheels are fastened to shafts, which are

mounted on rollers or ball bearings on the frame. These wheels are all of the same size and one is stationed directly above the other. The upper one is supported by a curved arm of the casting called the 'gooseneck' It can be moved up or down for the purpose of giving tension to the saw and to accommadate saw blades which have become shorter due to breakage and resoldering. It can also be tilted forward or backward so that the saw can be made to run on every part of the rim. This is called 'tracking'. Fig.632. The lower wheel is not adjustable. The wheels usually are made of cast iron or steel and their rims are covered with rubber bands or tyres which protect the teeth and prevent the saw from slipping. The table is fastened to the casting directly above the lower wheel. It can be tilted in most cases to an angle of 45 degrees to one side and 10 degrees to the other side. It is slotted, for the saw, from the centre of one edge and is furnished with a soft-metal or wood throat plate. A ripping fence is also furnished with most band saws. Some designs have a grooved top for a miter and cross-cutting gauge. In order to keep the saw blade running straight and true and prevent it from being pushed off the wheels when sawing two guides are used one above the table and one below. Fig.633. In some cases the guides are made of two hardwood or steel jaws, Fig.634 but the more advance machines have two little wheels on ball bearings between which the blade runs and a guide wheel which spins around when the back of the saw is forced against it, Fig.635,636. The upper guide is fastened to the guide post, which is a steel bar that can be moved up or down as the thickness of the stock being cut demands. Fig.637. The 'guards' on a band saw are two metal doors enclosing the wheels and a channel shaped piece of steel or wood, which is fastened to the guide post, slides up and down with it so that only the cutting part

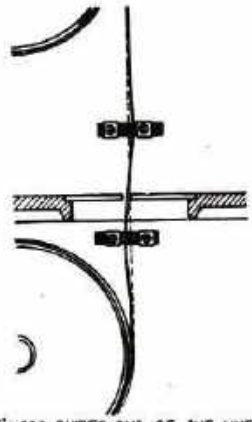


Fig.633. GUIDES OUT OF THE LINE

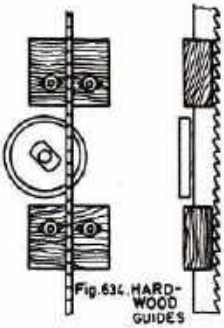


Fig.634. HARD-WOOD GUIDES

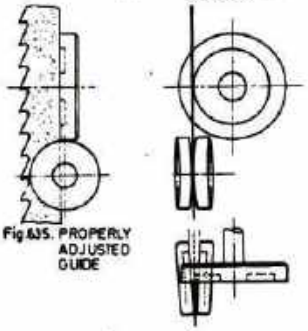


Fig.635. PROPERLY ADJUSTED GUIDE

of the saw is exposed. A fixed guard covers the other side of the saw between the wheels. Band saws are usually driven by individual motors. The latest models are however direct driven by which the lower shaft is the rotor of the motor.

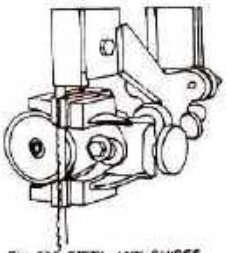


Fig. 636. STEEL JAW GUIDES

BAND SAW BLADES

The blade is made of high quality steel and soldered on both ends to a continuous belt. Length width and thickness depends on the diameter of the wheel. The thickness must be 1/1000 mm of the wheel diameter. For example: if the diameter has 800 mm, the thickness of the blade should be 0,8 mm. The shape of the teeth depend on the type of wood to be cut. For ripping, the rake angle should not have more than 20 degrees and for cross-cutting approximately 0 degrees. Fig.638. The band saw teeth should be set to 1½ times of the blade thickness. For example: if the blade is 1 mm thick the teeth must be set 0,25 mm to each side. Fig.639. The saw cut will be 1½ mm wide. As explained before, the tooth is set 1/3 of its height. See Fig.599.

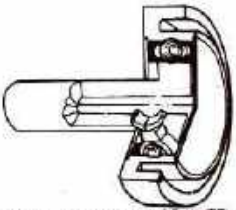


Fig.637. PRESSURE GUIDE WHEEL

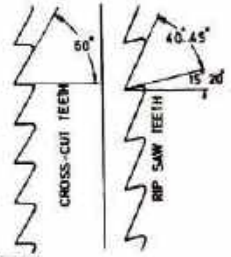


Fig. 638.

Fig.639. CORRECT SET

Important Rules for the Band Saw

1. Make all adjustments with the power switch off.
2. Check the tension of the blade, following the manufacture's specifications.
3. Keep safety guards fastened firmly.
4. Examine the blade frequently to make sure it is in good condition. There should be no cracks in it. A rhythmic click sometimes indicates that the blade is cracked.
5. Check the blade for lead. The guides may not be correctly set or the blade itself may

have an incorrect setting. This can cause it to pull to one side and the saw must be reset.

6. It is important that you keep the blade in use on the band saw sharp at all times.

7. Use the correct size of blades for your cutting. A narrow blade is best for cutting sharp curves, a wider one, for larger circular and straight cutting.

8. Check carefully to see that the saw table is square with the saw blade.

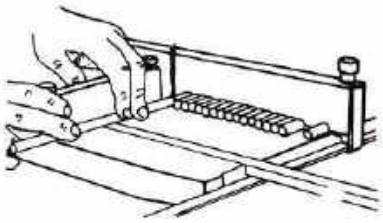


Fig.640. CUTTING SHORT PIECES WITH CROSS-CUT GAUGE

Straight Sawing and Resawing

The band saw can be used for straight sawing as well as for cutting curved pieces. Most band saws are fitted with a rip fence and a miter-gauge cut off. Fig.640. The widest band saw blade available should be used for both straight sawing and resawing (Resawing is cutting stock to a narrower thickness). Resawing is a job that the band saw does better than any other machine. Fig.641

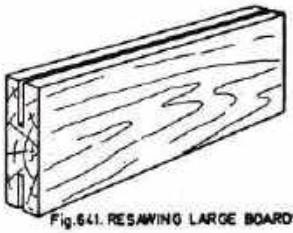


Fig.641. RESAWING LARGE BOARDS

Straight Freehand Sawing

1. Raise the upper blade guide to clear the lumber being cut. The guide should clear the stock by approximately 12 mm (½ inch).

2. Mark the board.

3. Turn on the switch. Make certain that you allow the blade to come to full speed.

4. Now feed the lumber slowly through the saw. Guide it gently with one hand; push it with the other. Fig.642. Saw slightly on the waste side of the marked line.

Fig.642. RIPPING TO A STRAIGHT LINE

Ripping

1. Repeat the first two steps of freehand sawing.
2. Attach the rip fence to the band saw table. Set it to the desired width of the cut to be made.
3. Turn on the switch and allow the blade to come to full speed.
4. Feed the piece into the saw. Hold it firmly against the fence while pushing it into the saw blade.
5. A square piece of wood can be split or ripped in two diagonally. Tilt the table to 45 degrees; push the stock along the rip fence Fig.643.
6. The band saw is excellent for removing corners of turning squares Fig.644.
7. Diagonal cuts can be made on the ends of turning squares to mark the centre for lathe turning. Fig.645. Make a V block jig for this purpose. Fasten it to the table, or place it against the rip fence.

Cross-cutting

1. Repeat the first two steps of freehand sawing.
2. Place the cut-off guide on the table in the groove. If the band saw does not have a groove, the cutting may be done freehand. Fig.646,647.
3. Turn on the switch and allow the blade to come to full speed.
4. Hold the stock firmly against the cut-off guide and feed it slowly into the band saw blade. Fig.648,649.
5. Cross-cut wide boards by reversing the cut-off guide. Fig.650.
6. Make dowel pins uniform using the rip fence as a guide.

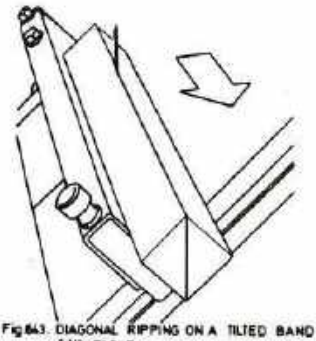


Fig.643. DIAGONAL RIPPING ON A TILTED BAND SAW TABLE

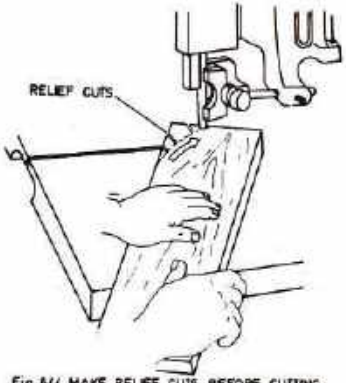


Fig. 644. MAKE RELIEF CUTS BEFORE CUTTING THE MARKED CURVE

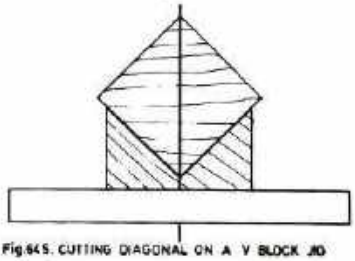


Fig.645. CUTTING DIAGONAL ON A V BLOCK JIG

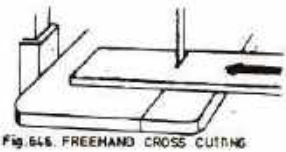
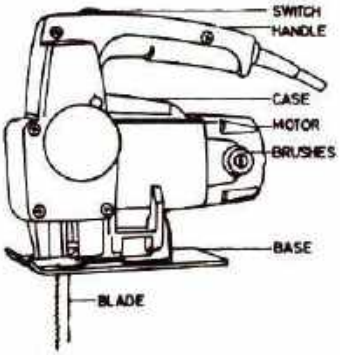


Fig.646. FREEHAND CROSS CUTTING



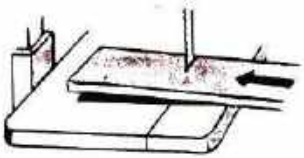
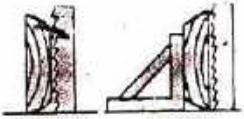


Fig 647 DO NOT LIFT UP THE BOARD THE SAW BLADE MIGHT BREAK

THE PORTABLE ELECTRIC JIG SAW
Fig.651

The portable jig saw is a very competent machine tool for cutting wood, composition boards, veneer materials, plastics, thin metal, cardboard and even leather. This broad range of possibilities make it an ideal portable electric saw for use in cabinet shops, furniture factories and the building trade. It is a safe tool for every one to use and even an inexperienced trainee can obtain excellent results with only a few minutes of practice. The general appearance of the jig saws would seem to indicate that all are the same size. The difference, however, lies in construction, cutting ability and motor power. They are designed to operate on normal 110 or 220 volts. The cutting speed is approximately 4200 'strokes' per minute (spm). A stroke is a straight up-and-down motion of the saw blade. The blade cuts only on the up-stroke, backing away on the return stroke. Some jig saws are equipped with a guide to aid straight ripping or cross-cutting.



INCORRECT Fig 648. CORRECT Fig 649.

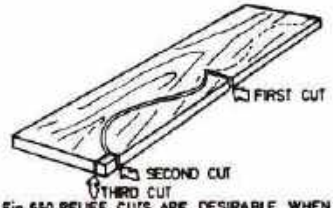


Fig.650.RELIEF CUTS ARE DESIRABLE WHEN SAWING SHARP CURVES

Ripping and Cross-cutting with a Guide

1. Fasten the correct blade on the saw. Select it for the material to be cut.
2. For ripping or cross-cutting narrow stock, fasten the guide in place and adjust it to the desired width. See Fig.652. If the piece to be cut off is wider than the guide permits, clamp a wooden fence (guide) on the board.
3. Hold the board so that the blade can cut through freely.
4. Start the motor. Slowly saw the board. Keep the guide firmly against the edge or the end of the stock, or keep the portable saw against the wooden fence or guide.

Sawing Circles

1. Place the board securely in same position, such as on saw horses, that allows space underneath for the blade.
2. Lay out the circumference of the circle. Use a compass or dividers.
3. Drill a starting hole through the board. This should touch the circle line on the waste side.
4. Fasten the correct blade in the saw for the material to be cut.
5. Drive the circle guide pin into the board at the centre of the circle. Fig.653.
6. Turn the rip guide over and fasten it to the saw to the radius desired
7. Start the motor with the saw in place. Slowly push the saw as it makes the circular cut.

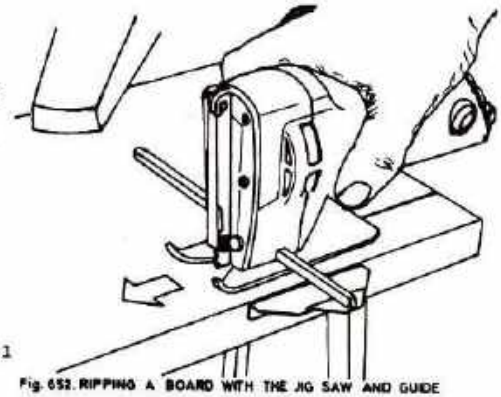


Fig.652. RIPPING A BOARD WITH THE JIG SAW AND GUIDE

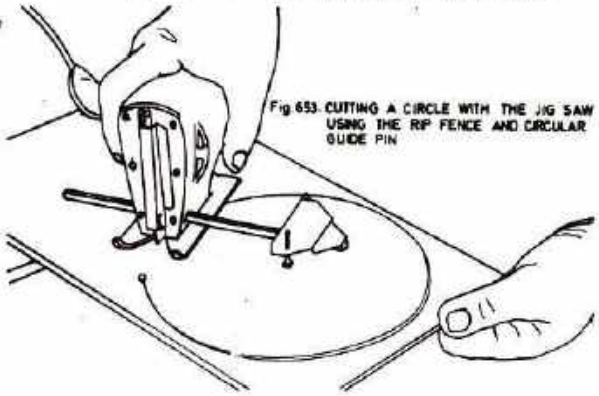
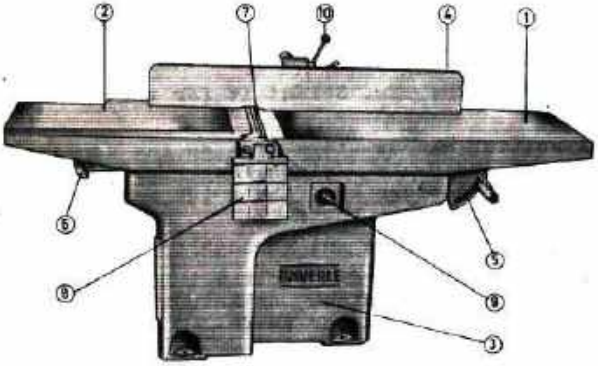


Fig.653. CUTTING A CIRCLE WITH THE JIG SAW USING THE RIP FENCE AND CIRCULAR GUIDE PIN



1 FRONT TABLE (IN SIDE)
2 REAR TABLE (OUT SIDE)
3 BODY
4 FENCE
5 FRONT TABLE ADJUSTMENT
6 REAR TABLE ADJUSTMENT
7 CUTTER HEAD
8 CUTTER GUARD
9 SWITCH
10 FENCE CLAMPING DEVICE

THE JOINTER Fig.654

The jointer is, next to the circular saw, the most necessary and useful machine in woodworking. It takes the place of the hand plane and is particularly useful in straightening the surfaces of boards or planks and for jointing edges of boards. It can also be used to plane tapers, chamfers and bevels. On specially designed jointers, rabbeting can also be performed. Fig.654A. The capacity (size) of the jointer is usually determined by the length of the knives. Common jointer sizes are 250 mm (10 inch) 400 mm (16 inch) 630 mm (25 inch), but there are also jointers available in sizes of 100 mm (40 inch) and 900 mm (36 inch). The table of the jointer consists of two parts: the front, or 'infeed' and the rear or 'outfeed'. Tables are adjustable for levelness and cutting height. The surface of the rear table must be level (even with the cutting edges of the knives). If it is higher or lower, the planed edge or surface will not be straight and accurate. The front table is easily adjusted by means of handwheels. Instead of cutting long, narrow shavings like a hand plane, the jointer cuts wide and extremely short shavings. As each knife strikes the wood, it makes small hollows across the entire width of the surface as the wood is pushed along. A series of small ridges are therefore formed between these hollows. This is called 'rotary cutting.

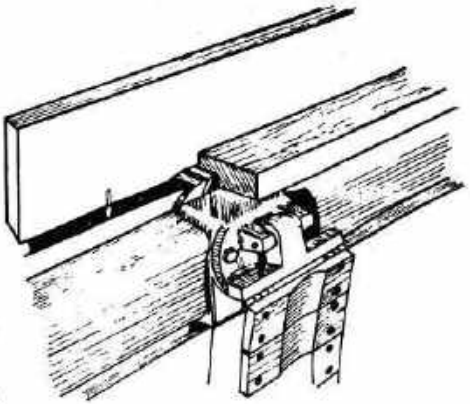


Fig. 654.A A JOINTER WHICH IS DESIGNED TO CUT RABBEDS

Parts and Uses

The main parts of the jointer are the cutter head, front and rear table adjustments and the base.

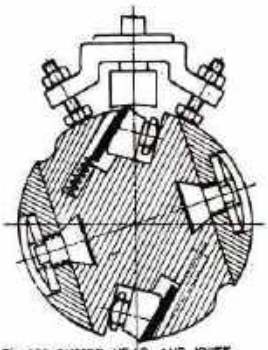


Fig. 655. CUTTER HEAD AND KNIFE ADJUSTMENT DEVICE

Cutter head

The cutter head Fig.655, has two knives, but sometimes a cutter head may also have four knives. A levelling device to set the knives is also shown in this illustration.

Front table

This is the infeed table, which is easily adjusted to the depth of the cut. It supports the board, which is fed into the knives.

Rear table

The rear table is also adjustable. For most cuts, it should be even with the cutting edges of the knives. It supports the board after it is planed.

Fence

The fence is used as a guide. It is usually set at a 90 degrees angle to the table to get edges planed at right angles to the face. It can be set at an angle to produce a chamfer or a bevel. Fig.656.

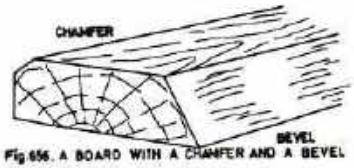


Fig. 656. A BOARD WITH A CHAMFER AND A BEVEL

Guard

The guard covers the cutting knives. It swings out as the board is planed, thereby protecting the operator. On some jointers there is a back guard which adjusts behind the fence. This is particularly useful when the fence is adjusted to cut rabbets because it covers the cutter head behind the fence.


Fig. 657. SCHEME OF THE JOINTER TABLES ADJUSTMENTS

Table adjusters

These are conveniently located under or to one side of the front and the rear tables. They raise or lower the tables, according to the type of cut desired. Fig.657.

Base

The base is the stand, or support, which holds the jointer.

PLANING FINISH

The factory fixed knife cutter head is the only one that gives a true flat surface. Ordinary cutters leave a circular shaped cut on the wood with each turn of the block. These merge into each other as the wood is pushed past the cutter block and can be seen when magnified, as a fine drawing of waves, where the cutters enter and leave the wood. Fig.658. It should then be appreciated that the slower the feed the greater the number of marks or times the cutters will touch the wood over a given space. To slow the feed means a rise in the cost of planing. There is another factor, if the wood is being fed to the cutters too slowly the later will be cutting too long in the same place and so start to rub and scrape and quickly lose their cutting edge. By increasing the number of cutters on the block, an increase of feed speed can be obtained still with a control on the number of cutter marks. The ultimate planing finish required determines the number of cutter marks per inch, for example if the work is constructional, painted work, furniture and polished work, or if it is to be cleaned up by hand or by sanding machines.

Cutter Marking Calculation

Fig.658. CUTTER MARKING ON THE SURFACE

It is obvious that too widely spaced marks mean a rough finish which needs more time in the final cleaning up of the surface. For softwood, however, 10 to 12 cutter marks per cm(or 24 to 48 per inch) are required. For example, with a two knife cutter block at a speed of 4000 r.p.m., if the knives are properly set, makes 8000 cuts per minute. If we plane a board with a 'feed speed' of 16 m per minute (or 16000 mm per minute) then the hollows of the cuts will be 2 mm. 16000 : 8000 = 2 mm Suppose a cutter head has got three knives and 4000 r.p.m. and the feed speed is 16 m per minute then the hollows of the cuts will be 1.33 mm
16000 : 12000 = 1.33 mm.

SAFETY FOR THE JOINTER

1. Make certain the jointer blades are sharp.
2. Always check the fence adjustment before planing.
3. Make no adjustments of any kind while the jointer is in operation. Follow the instructions for adjustments.
4. Keep the safety guard in place and ready to use at all times.
5. Use a push block when surfacing (planing) short boards on the jointer.
6. Always hold the board firmly against the fence or on the table of the jointer.

7. Surface the concave (hollow) side of a warped board first.
8. Do not attempt to plane or joint the end grain of boards less than 200 mm (approx. 8 inches) wide.
9. Always try to plane with the grain.

Planing a surface

1. Adjust the front (infeed) table for a cut of about 2 mm (1/16 inch).
2. Check to see that the guard is in place and is working properly.
3. Check the surface of the board for a warp or a wind (slight twist). The concave (hollow) face should be placed down and planed first. Fig.659.
4. Push the stock forward firmly with both hands. Fig.660. When about 300 mm (approx. 12 inches) has been planed, move your left hand forward slightly beyond the cutter head. Stand at the left of the front table as you plane. Plane in the direction of the grain. Use a push block for planing surfaces of a narrow, shorter board. Fig.661.

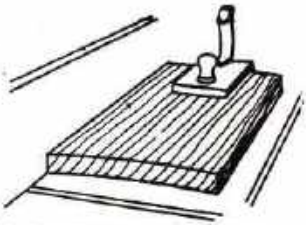


Fig. 659. PLANING A HOLLOW BOARD WITH A PUSH SHOE

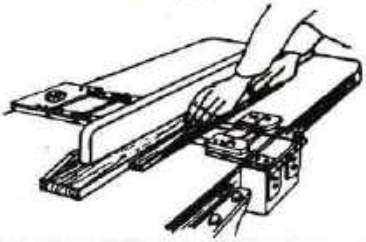


Fig. 660. PLANING A NARROW PIECE WITH A EXTENSION BOARD

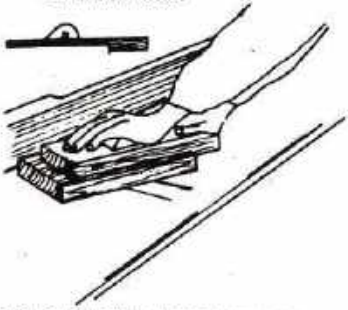


Fig. 661. PLANING SHORT STOCK WITH A PUSH SHOE

Jointing an Edge

1. Check the fence with a try square to make certain it is set at right angles to the table.
2. Select the best edge of the board to be planed. This should be the one having the fewest irregularities and the one that is the straightest.
3. Adjust the depth of the cut. This is done by lowering the front table.
4. Place the board on the front table with the best surface (face side) against the fence. Make certain that you plane with the grain. Fig.662
5. Hold the board against the fence firmly with both hands and slowly push it over the cutter head. Fig.663

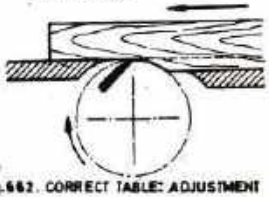


Fig. 662. CORRECT TABLE ADJUSTMENT

Jointing an End

1. Check the end of the board with a try square or a framing square.
2. Adjust the depth of the cut by raising or lowering the front table. The depth of the cut should be very shallow.
3. Place the end of the board on the front table with the best face against the fence. Remember: never plane end grain on the jointer if the board is less than 200 mm (8 inches) wide.
4. Hold the board firmly with both hands; slowly push it forward over the cutter head. Jointing completely across the end of a board is satisfactory when squaring up stock, as shown in Fig.664
5. Another method of jointing an end is first to make a short cut of about 25 mm (1 inch) along one end.
6. Reverse the board and joint the end to blend with the cut made in step 6 Fig.665.

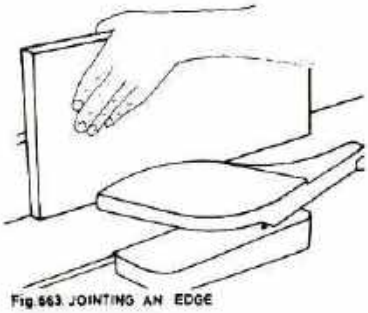


Fig.663 JOINTING AN EDGE

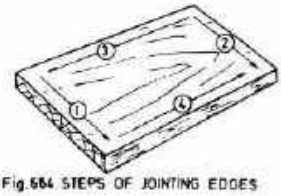


Fig.664 STEPS OF JOINTING EDGES

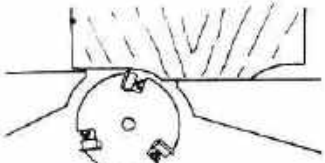


Fig.665 JOINTING AN END GRAIN

Planing a Chamfer or a Bevel

1. Set a sliding T bevel to the desired angle for the chamfer or bevel. An angle of 45 degree is often used for chamfers.
2. Adjust the fence to fit the angle of the sliding T bevel Fig.666. The fence can be tilted out backwards or forwards.
3. Adjust the depth of the cut by either raising or lowering the front (infeed) table.
4. Make a trial run on a piece of scrap wood; test the angle with the sliding T bevel. Make adjustments if necessary. Hold the stock much as you would in jointing the edge of a board. Fig.667,668,669 show what happens if the jointer rear table is incorrectly adjusted. Fig.670 and 671 shows incorrect holding positions.

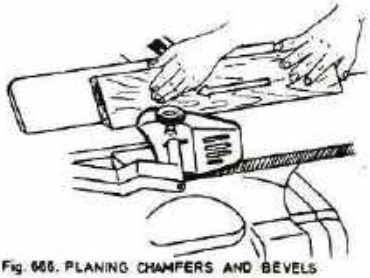


Fig. 666. PLANING CHAMFERS AND BEVELS

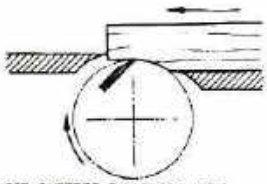
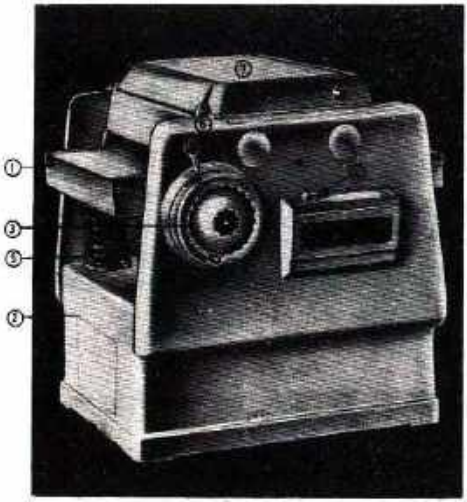


Fig.667. OUTFEED TABLE TOO HIGH



1 TABLE
2 BASE
3 HAND WHEEL FOR RAISING AND LOWERING THE TABLE
4 SWITCH
5 TABLE SUPPORT
6 FEED SPEED CHANGER
7 HOUSING

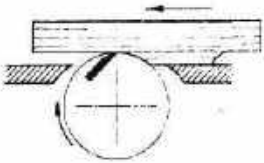


Fig.668. OUTFEED TABLE TOO LOW

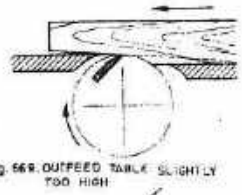


Fig. 669. OUTFEED TABLE SLIGHTLY TOO HIGH

THE THICKNESS PLANER Fig.672

The thickness planer is also called the surfacer. It is a single purpose woodworking machine used for making a smooth planed surface on a board. The thickness planer planes the surface to an even thickness. Planers are either double or single, that means they have one or both surfaces at the time. The size is determined and listed by the maximum thickness and width of board it can handle. The single planer is the most frequently used type in furniture industries. Common sizes in furniture factories and workshops are 600 mm to 200 mm in width and 250 mm in thickness. Most cutter heads have two knives, but modern designs four knives. Great care has to be taken

Fig.670. THIS CAN COST YOUR FINGERS

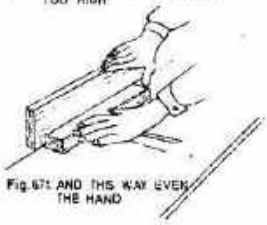


Fig.671. AND THIS WAY EVEN THE HAND

when setting a four knife cutter head to make sure that all four knives project precisely the same distance to form a true circle. If this is not taken care of, it might happen that only one knife is cutting and the four-knife cutter head fails in its purpose. Successive cuts are made as the corrugated infeed roll pushes the board through the planer head. The outfeed roll holds the board through the planer head and holds the board against the table and the table rolls as it moves forward. The infeed rolls can be switched to two different feeding speeds. For the first rough cut the fast feed speed may be used because the quality of the surface is not important as it is followed by a second cut. The final cut must be made on low feed speed as a smooth surface is desired. If the machine is overloaded the feed can be switched on neutral gear, to enable the cutter head to obtain its full r.p.m. The planer has an anti-kick-back device above the infeed roll to protect the operator from boards being rejected. (kicked back) Fig.673. Very accurate true surfacing of stock on a planer can be done if one side (face) of the board has first been planed on the jointer. This is especially desirable if the board is warped or twisted.

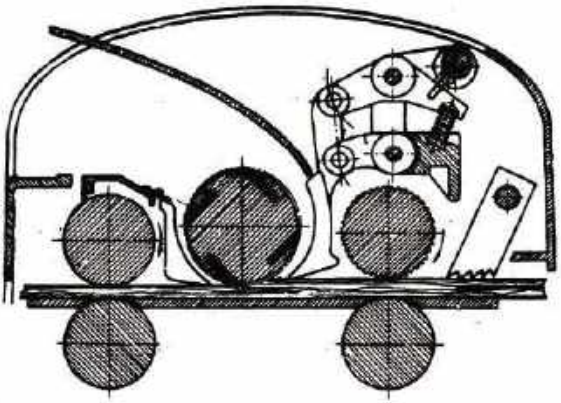


Fig.673. DETAIL OF THE CUTTER HEAD AND ROLLS ON THE THICKNESS PLANER

A warped board should have the cupped (warped) face planed first. A board having a wind should have one face planed flat before it is surfaced. Boards can be edge-glued together and surfaced to uniform thickness. The width must, of course, be within the capacity of the machine. Lumber that is less than 300 mm (12 inches) in length or 5 mm in thickness should not be planed in the surfacer. The board should be sufficiently long that the outfeed roll starts pulling it before the infeed roll releases it.

Inspect boards to make certain that they are clean and free from nails, screws or other metals enclosures.

PORTABLE ELECTRIC POWER PLANE Fig.674

A recent introduction is an adaptation of the circular cutter block type of planing machine, working from the top called the electric power plane machine. It is pushed along in the manner of a handplane, depth of cut being adjustable. The inverted table (now the sole of the plane) is arranged in two parts. The cutterblock is set in motion by means of a trigger-switch

in the handle. The cutters used in most machines are the same as in jointers and thickness planers, where the knives are removable, however, some are also made of a solid body with two spiral cutting edges. For sharpening the whole cutter head has to be taken out. The capacity of a power planer varies from 50 mm to 280 mm in width and up to 2HP.

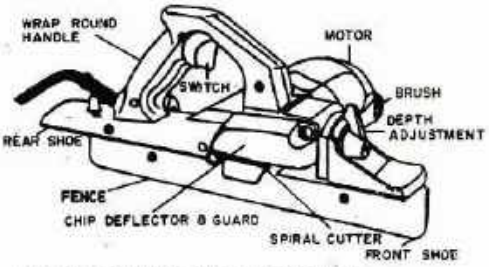


Fig.674. PORTABLE ELECTRIC POWER PLANE

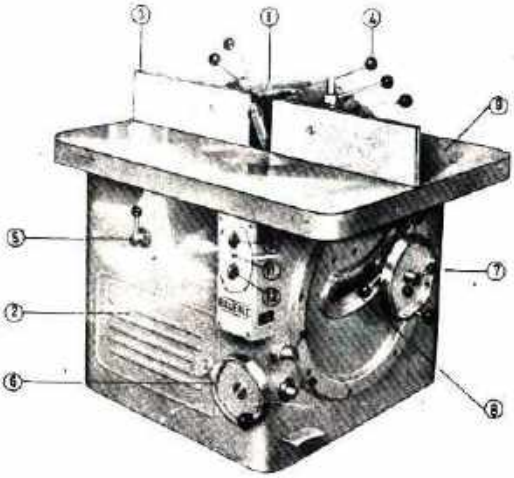
Planing with the portable electric power plane requires a stance (position of standing) similar to that used with regular hand planing. The difference, however, is that the electric power plane must be properly handled and advanced steadily and evenly along the work. Because the operation of this plane is similar to a jointer, it is rather like operating a small inverted (upside down) jointer by hand.

Procedure for Planing

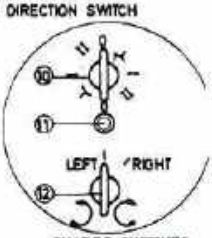
1. Adjust he depth for making the cut.
2. Plug the electric cord into a power outlet. The cord should be grounded for safety.
3. Grasp the plane as shown in Fig.675. The right hand should be on the handle and the forefinger should be free to control the switch.


Fig. 675. PLANING AN EDGE

4. Place the plane on the board with the cutter slightly back from the edge of the wood. Make certain that the electric cord cannot interfere with the planing process.
5. Turn on the switch. Push the plane to make the cut. Keep more pressure on the front shoe with the left hand on the rear shoe with the right hand.
6. Continue planing. Maintain an even pressure with both hands until you have almost completed the cut.
7. To complete the cut, keep a greater pressure on the rear shoe on the front one.
8. A bevel can be cut by adjusting the fence to the desired angle marking. The procedure for planing a bevel is the same as for straight planing.



1 SPINDLE
2 BASE
3 FENCE
4 LEVERS FOR FENCE ADJUSTMENT
5 SPINDLE LOCK
6 HAND WHEEL FOR RAISING AND LOWERING THE SPINDLE
7 HANDLE FOR TILTING THE SPINDLE
8 SCALE
9 TABLE
10 MAIN MOTOR SWITCH
11 FREQUENCY CHANGER
12 SPINDLE DIRECTION SWITCH



SHAPER SWITCHES

THE SHAPER OR SPINDLE MOULDER
Fig.676

The shaper is probably one of the most useful, but also one of the most dangerous woodworking machines. It is used for grooving and shaping on straight or curved edges, for making almost limitless combination of decorative cuts. Shaping is done with guides, collars and patterns and with the use of forms, jigs and different safety devices. Like other woodworking machines, shapers are made in many different sizes and shapes. From the large double spindle production machine to the small bench shaper. Many shapes have reversible motors to provide rotation in two directions. This permits additional combinations of shapes from the cutters because they can be turned over. The reversing mechanism is usually controlled by a reversing switch. Many shapers have hollow vertical shafts which allow interchange of spindles. Interchanging permits use of a wider variety of shaper cutters. Each spindle is fitted with a tie rod that is threaded in the centre and on one end. One end is fitted to the spindle, the opposite end is capped with a nut after it passes through the hollow main spindle. The shank of each spindle is tapered which fits tightly to the tapered spindle chuck and tightened with a left threaded nut, which prevents the spindle from slipping or turning. When the spindle is in place it can be fitted with various collars and cutters.

Common detachable spindles and their uses Fig.677

1. Cylindrical with nut is used for round and square heads and solid circular cutters.

2. French or slot spindle is used for profile cutters.
3. Chuck for end cutters is used for dovetailing and moulding bits.
4. Boring chuck is used for all kinds of bits.
5. Flush top spindle is used for flat profiled cutters.
6. Slotted collar or ring spindle is used for straight or profiled cutters.

One of the chief advantage of a shaper is that it is possible to tilt the spindle. Modern design have made it possible to tilt the spindle itself to 45 degrees which help adjusting and using cutters for odd and difficult operations. Some modern designed shapers are provided with a sliding table. They are mounted on the side of the shaper and run on iron bars by means of two ball bearing wheels and a support device. Fig.678. With a clamping device the stock is clamped on the table while it is being shaped on one end. A sliding table is very useful for making tenons or cutting different rabbets or grooves on end grains. A sliding table has a great advantage for smaller work shops where a special mortise and tenon machine is uneconomical. When using a slotting disc of a large diameter for tenoning work a spindle support must be used. See Fig.678. Some cutter heads have depth cutting limit safety devices which are kick back safe. Fig.679.

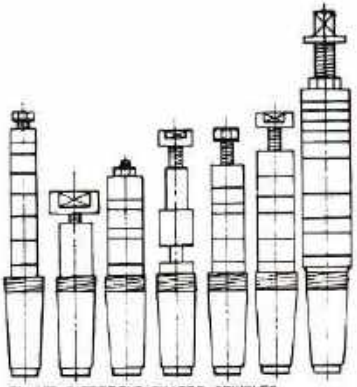


Fig.677. DIFFERENT SHAPER SPINDLES

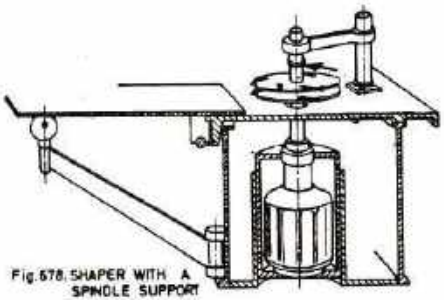


Fig.678. SHAPER WITH A SPINDLE SUPPORT

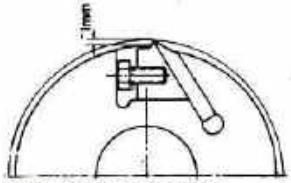


Fig.679. SAFETY CUTTER HEAD

SAFETY CLAMPS AND DEVICES

Most shapers are equipped with 'hold-down devices' (spring-type clamps) which provide safety as well as tension against the stock being shaped. Fig.679A

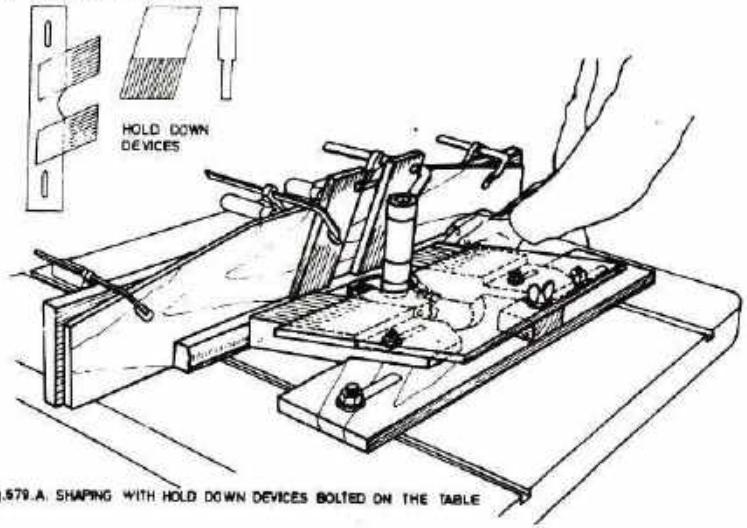


Fig.679.A. SHAPING WITH HOLD DOWN DEVICES BOLTED ON THE TABLE

When the rub collar serves as a fence guide during the shaping of irregular edges, use a circular fiber or wooden ring guard for safety. Fig.680.

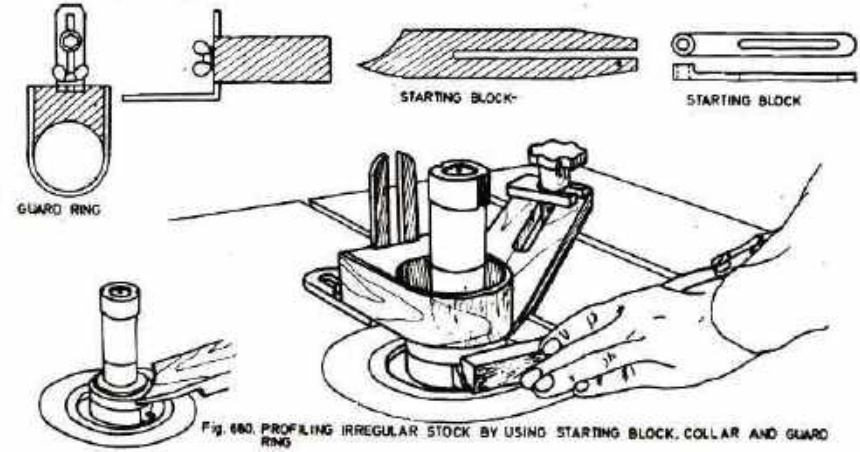


Fig. 680. PROFILING IRREGULAR STOCK BY USING STARTING BLOCK, COLLAR AND GUARD RING

Other safety clamps and devices are shown in Fig.681,682,683, 684,685,686.

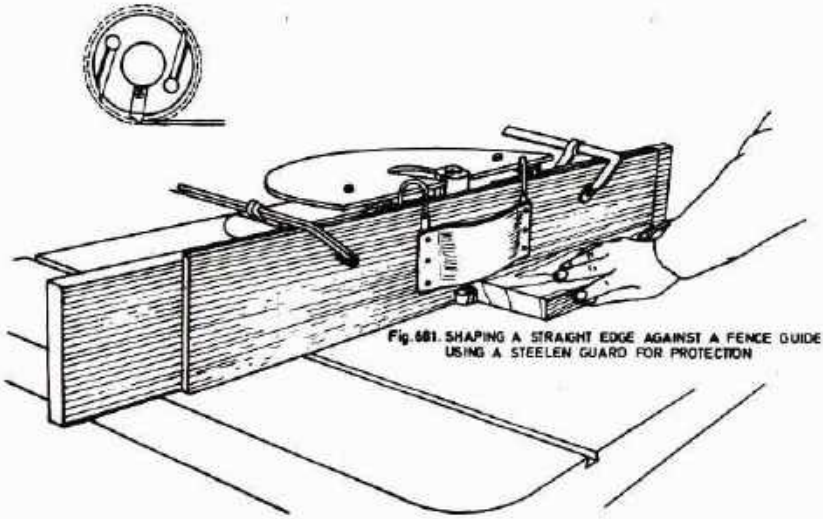


Fig.681. SHAPING A STRAIGHT EDGE AGAINST A FENCE GUIDE USING A STEELEN GUARD FOR PROTECTION

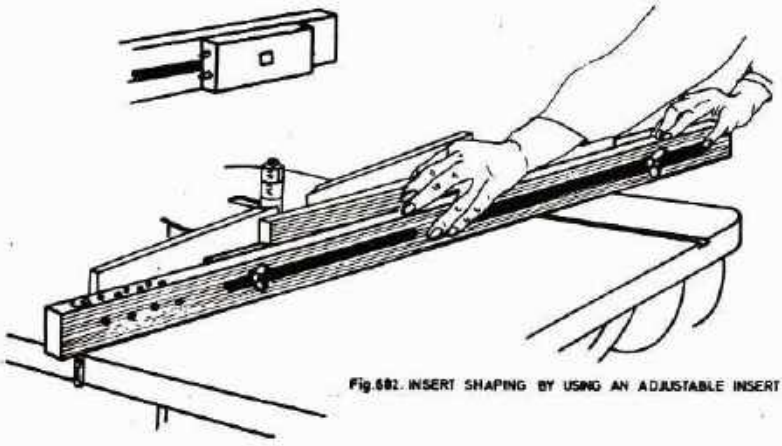


Fig.682. INSERT SHAPING BY USING AN ADJUSTABLE INSERT DIVICE

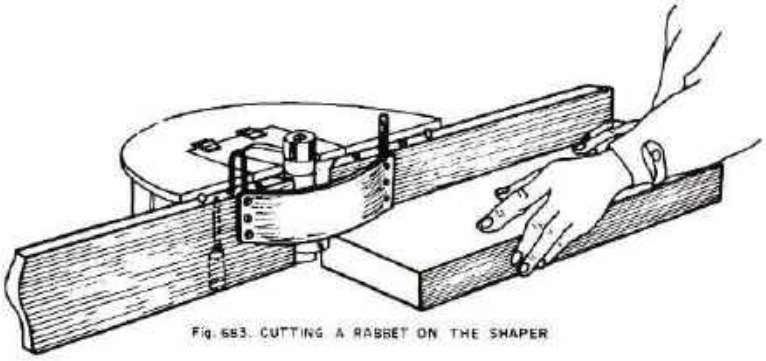


Fig. 683. CUTTING A RABBET ON THE SHAPER

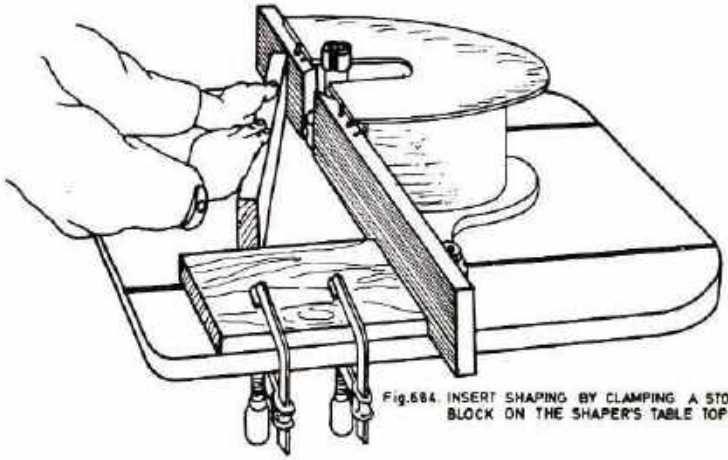


Fig.684. INSERT SHAPING BY CLAMPING A STOP BLOCK ON THE SHAPER'S TABLE TOP

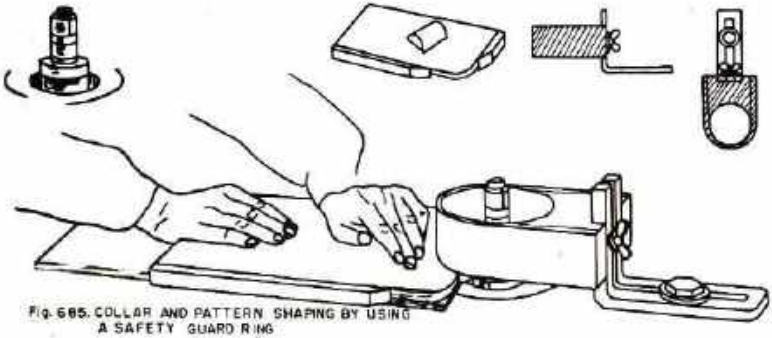


Fig. 685. COLLAR AND PATTERN SHAPING BY USING A SAFETY GUARD RING

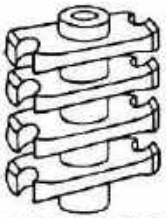
SAFETY FOR THE SHAPER

1. Make all adjustments with the power shut off. Check that all adjustments are tight at all times.
2. Keep the safety guard and hold-down devices in place at all times when it is possible to do so.
3. Make sure that the cutters are sharp. See that the cutter knives or the cutters are fastened securely before you use the shaper.
4. When using separate cutter knives, check to see that both knives are of the same size and weight.
5. Remove all wrenches and special tools used in setting up the shaper before you turn on the power.
6. After the cutter head has been fixed to the spindle, see that the spindle turns freely before turning on the power.
7. Arrange the cutter head on the spindle so that the unused portion of the cutters or knives are below the table. This is usually possible if the machine is equipped with a reversing switch.
8. If the shaper has a reversing switch, make certain that the direction of feed will oppose the direction of rotation. Always feed into the cutting edge.
9. Maintain a well-balanced position on both feet when operating the shaper.
10. Direct plenty of shadow free light on the work.
11. Hold the board firmly against the fence and the table for straight work. Hold it firmly against the rub collar on the spindle for irregular pieces. Always feed the stock slowly into the cutter at an even pressure and speed.
12. Make certain that the starting pin is securely in place on the table when shaping against the rub collar.
13. When using the rub collar for a guide, start the cut away from any corner. This is especially true when shaping around the entire edge of a board.
14. Boards less than 250-300 mm wide should not be shaped on the end unless proper safety precautions are taken.
15. Shut off the power. Do not leave the shaper until the motor has come to a complete stop.

CUTTER AND CUTTING EDGES

The grinding angle of a cutter is also its clearance angle because the back of the cutter is ground away to give clearance during and after cutting. The degree of angle also determines the keenness (sharpness) of the cutting edge and its ability to stand up to the work required.

Fig.687 shows cutting angles for solid wood. Fig.688 shows cutting angles for chipboard. Fig.689 shows cutting angles for plastic Other cutting edges and angles for saws and hand tools are discussed in the preceding chapters.



MULTIPLE GROOVE CUTTER

CUTTING SPEED

Cutting speed is the distance covered by a given point of a tool within a given period of time, which is expressed in meters per second. Fig.691 Technically it is possible to obtain high revolutions, but some of the tools used cannot stand such high revolutions. Old-fashioned cutters or saw blades, for instance are a great danger being used at too high revolutions. On most modern cutters the revolutions are mentioned in revolutions per minute. (r.p.m.) Fig.690 Cutting speed is most important for quality results. There are recommendations for every machine which give best result in cutting and smoothness of the surface.

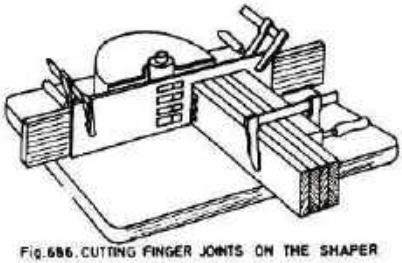


Fig.686. CUTTING FINGER JOINTS ON THE SHAPER

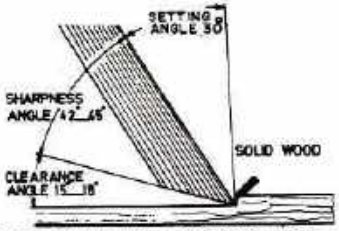


Fig.687. CUTTING ANGLE FOR SOLID WOOD

Recommended cutting speeds are:

Band saw	20-30 m per second
Circular saw	40-65 m per second (Tool Steel)
	60-70 m per second (HSS. High-Speed Steel)
	70-90 m per second (Carbide tipped tools)

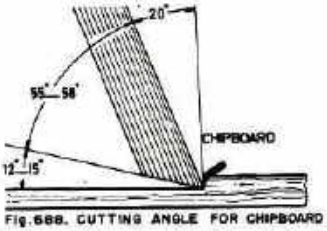


Fig.688. CUTTING ANGLE FOR CHIPBOARD

The highest stability (true run) for a circular saw blade is reached at about 60 m per second.

Jointer and thickness planer 30-45 m per second.

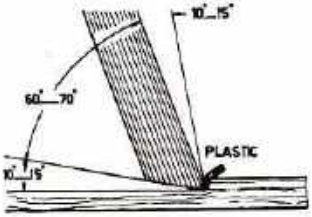


Fig. 689. CUTTING ANGLE FOR PLASTIC (FORMICA)

Shaper: 30-45 m per sec. (HSS)
45-60 m per sec. (Carbide tipped tools)

Besides these recommendations, special care has to be taken of the different kinds of tools to be used. Generally there are three kinds of tools.

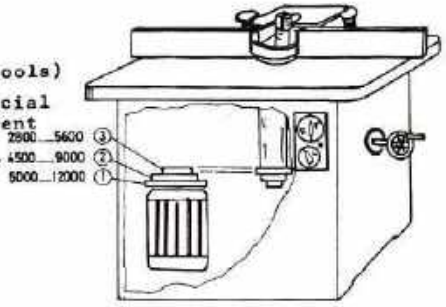


Fig.690. DIFFERENT R.P.M.

1. Set of cutter heads Fig.692
2. Solid cutters Fig.693
3. Carbide tipped tools Fig.694

As mentioned previously, the revolution of modern tools are shown on the cutters. Tools on which the revolutions are not the recommendations mentioned above. (Cutting speed)

Belt sander 16-22 m per second.
Chain mortise 4- 8 m per second.
Drilling machine 3- 5 m per second.

Recommended feeding speeds are generally 1/1000 (one thousand of the revolution).

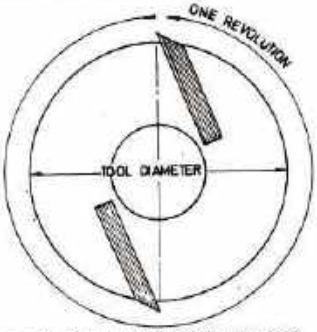


Fig.691. REVOLUTION ACCORDING TO MOTOR (DRIVING) SPEED

Formula for cutting speed

V = Cutting speed
d = diameter of the tool
= constant factor to calculate the circumference of a circle
n = revolution per minute (r.p.m.)

$$V = \frac{d \times 3{,}14 \times n}{60}$$

dividing by 60 in order to get seconds.


Fig.692. SET OF CUTTER HEAD

Example 1.

What is the cutting speed of a circular saw with a diameter of 320 mm?

Speed of the spindle or motor is 4500 r.p.m.


Fig.693 SOLID CUTTER HEAD

d = 320

n = 4500 r.p.m.

= 3,14

V = ?

$$V = \frac{320 \times 3,14 \times 4500}{60}$$

Fig.694. CARBIDE TIPPED TOOL

For calculating cutting speed the diameter to be converted into meters.

$$V = \frac{0,32 \times 3,14 \times 4500}{60} = 75 \text{ m per second.}$$

Example 2.

What is the cutting speed of a cutter head with a diameter of 120 mm?

Speed of the spindle or motor 6000 r.p.m.

$$V = \frac{0,12 \times 3,14 \times 6000}{60} = 27,68 \text{ m per second} = 38 \text{ m per second.}$$

A common formula, but not so precise may be used as well:

Half of the tool diameter multiplied by one thousand of the revolution.

Half of the tool diameter = 6 (in cm.)

1/1000 of the revolution = 6

Example:

d = 120 mm

n = 6000 r.p.m.

V = ?

$$V = \frac{6 \text{ cm} \times 6000}{1000} = 36 \text{ m per second.}$$

$6 \times 6 = 36$ m per second.

The difference of 1,68 m between the two calculation is due to the simplification of the formula, but it is permissible to use.

The illustration shows a modern shaper with adjustable speeds by means of changing V belts on to different pulleys. Fig.690

1. Motor with a large and spindle with a small pulley means high speed (approx.6000-12000 r.p.m.)
2. Motor with a medium and spindle with a medium pulley means medium speed (approx.4500-9000 r.p.m.)
3. Motor with a small and spindle with a large pulley means low speed (approx.2800-5600 r.p.m.) In order to double the speed of a motor the frequency (in electricity, number of complete cycles per second of alternating electric current) has to be switched higher by a special switch mounted on the machine.

Calculation of revolutions

In case the revolutions of a motor or machine are unknown they can be calculated with the following formulas:

d_1 = diameter of the driving pulley (motor)

n_1 = r.p.m. of the motor.

d_2 = diameter of the driven pulley (spindle)

n_2 = r.p.m. of the spindle.

Example

The revolutions per minute of the spindle or cutter are unknown

Formula:

$$d_1 \times n_1 = d_2 \times n_2$$

This formula can be revised in any form in order to find one unknown Figure.

See Fig.695 the unknown figue is n_2

The formula will be:

$$n_2 = \frac{d_1 \times n_1}{d_2} = 2 \times 2880 = 5760 \text{ r.p.m.}$$

$$n_2 = \frac{16 \times 2880}{8} = 2 \times 2880 = 5760 \text{ r.p.m.}$$

In case d_2 is unknown the next example show us the correct result.

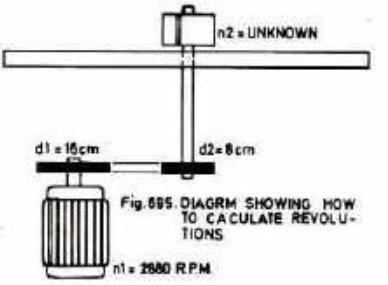


Fig.695. DIAGRM SHOWING HOW TO CACULATE REVOLUTIONS

$$d_2 = \frac{16 \times 2880}{5760} = \frac{2880}{360} = 8 \text{ cm}$$

In Fig.695 the $d_2 = 8$ cm

If the unknown is d_1 the formula will be:

$$d_1 = \frac{d_2 \times n_2}{n_1}$$

If the unknown is n_1 the formula will be:

$$n_1 = \frac{d_2 \times n_2}{d_1}$$

Most woodworking machine motors have a fixed revolution per minute which usually is shown by a label on the motor.

The most common ones are:

Circular saw	2850-4600	r.p.m.
Band saw	900-	r.p.m.
Jointer	4000=6000	r.p.m.
Thickness planer	4000-6000	r.p.m.
Belt sander	1400	r.p.m.
Edge sander	1400	r.p.m.

Procedure for shaping straight edges.

1. Select the cutter, cutter head, or knife assembly. Fasten it securely on to the spindle.
2. Sketch the planned cut on the end or the edge of the wood.
3. Adjust the fence guide and fasten it securely. Make sure the two parts of the fence are in alignment. Check this with a straight board. Fig.696.
4. Adjust the cutting height of the spindle for the planned cut.
5. Place hold-down clamps for safety and tension. Adjust these to the work on the table. Fig.679.
6. Turn on the power. Allow the shaper to come to full speed.
7. Make a trial run on a piece of scrap wood. Hold it firmly in position against the fence. Feed it into the cutter head from right to left. Fig.697. Occasionally the shaper cuts may be such that the motor should be reversed through the switch, the cutter head inverted (turned upside down) and the piece fed from left to right.
8. Shape the edge if the trial cut is accurate.
9. When shaping all four straight edges on a board, follow the sequence of cuts shown in Fig.698.

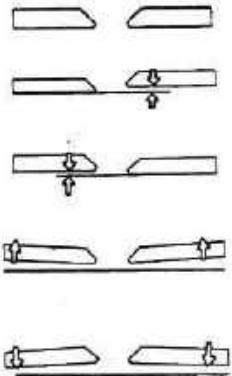


Fig.696. BOTH FENCE MUST BE IN ALIGNMENT

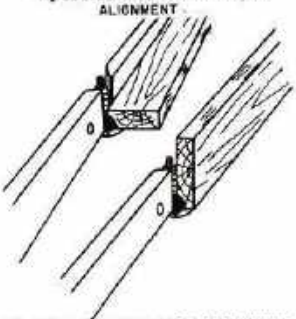


Fig.697. TWO POSSIBILITIES FOR MAKING A MOLDING

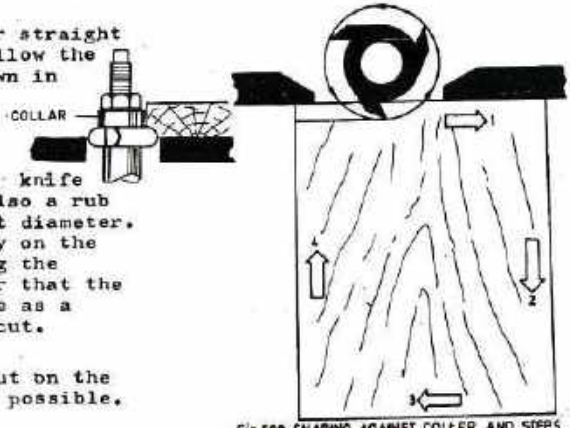


Fig.698. SHAPING AGAINST COLLER AND STEPS HOW TO SHAPE ALL FOUR EDGES OF A BOARD

Shaping Irregular Edges

1. Select the cutter or knife blade assembly and also a rub collar of the correct diameter. Fasten these securely on the spindle. In selecting the collar size, remember that the rub collar will serve as a depth gauge for the cut. See Fig.698.
2. Sketch the planned cut on the end of the board, if possible.

3. Adjust the cutting height of the spindle so that the shaper cuts will be made where they were planned. Adjust the circular ring guard so that it barely clears the work. See Fig.699. This may not be on all shapers, but it is a good safety precaution.

4. Fasten the starting pin or board securely on the table.

   Turn on the power and allow the shaper to come to full speed.

6. Make a trial cut on a scrap piece of wood. Place the piece to be shaped firmly in position against the starting pin. Gradually, but firmly, push the wood into the revolving cutter head so that it makes contact with the rub collar. After making full contact with the starting pin and the rub collar, gradually move the board so that you will move away from the starting pin.

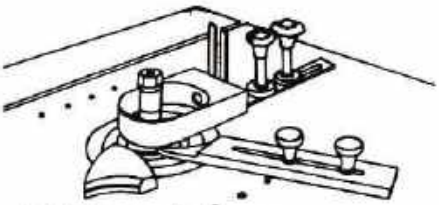


Fig.699 SHAPING SMALL PIECES ON A STARTING BLOCK COLLAR

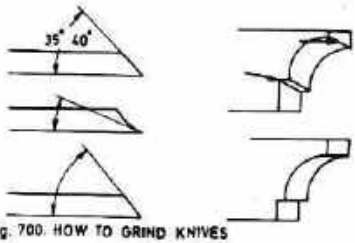


Fig. 700. HOW TO GRIND KNIVES

SHAPER TOOLS AND CUTTERS

As mentioned before there are three different kinds of shaper cutters in common in use.

1. Set of cutters
2. Solid cutters
3. Carbide tipped cutters.

A set of cutters is made up of two or more different cutters, either of various solid cutters fitted together or the open knife slotted cutter heads. Open knives which fit slotted cutter heads are available for the craftsman who desires to make moldings of his own design. The edges of the knives have been ground (bevelled) to the required angle and profile Fig.700,700A. These knives have a projection limit according to their thickness Fig.701.

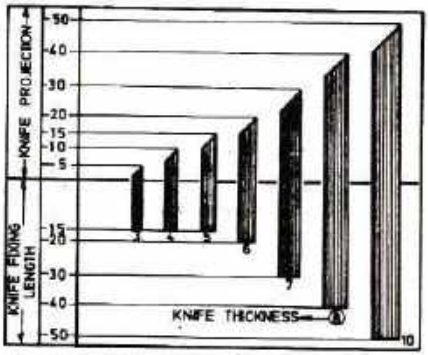


Fig. 701. SETTING OF CUTTER HEAD KNIVES

A knife should never be ground on both sides, Fig.702, however, it might slip out of the slot and injure or kill a person. The new force locking cutter head and the "form-closed" or "form locking" cutter head are much safer., Fig.703 and Fig.704.

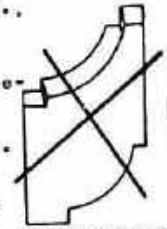


Fig.702. DANGEROUS

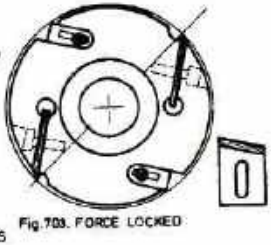


Fig.703. FORCE LOCKED

The Wobbling Saw is an extremely useful tool for grooving. It consists of a circular saw mounted between taper-collars upon a screwed sleeve. Wobbling-saws with a diameter more than 200 mm should be used with 2800 r.p.m. If the diameter is less than 200 mm it can be used with 4500 r.p.m.

HSS Grooving Cutter for making grooves and small rabbets, are available from 2 mm to 40 mm. These cutters are only sharpened on the face, gullet and back. Never sharpen them from the outside. Fig.706, 707.

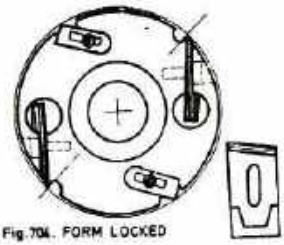


Fig.704. FORM LOCKED

HSS Solid Square Edge Cutters are used for cutting edges at a right angle. They are also sharpened on the face side only. Fig.708.

HSS Solid Edge Profile Cutters are used for special cutting of profiles on edges to increase the strength of the joint. Fig.709.

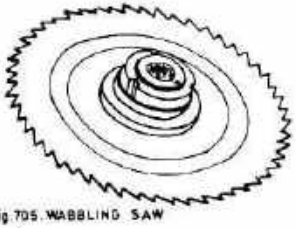


Fig.705. WABBLING SAW

HSS Solid Profile Cutters are used for shaping a profile on edges of different boards. They are only sharpened on the face of the cutter. If revolutions are not shown on the cutter the cutting speed should be maximum 40 m per second. and not more than 4500 r.p.m. Fig.710.

Fig.706. GROOVE CUTTER

Fig.707. CUTTER GROOVE

Carbite tipped Cutters are the latest design and usually have a depth cutting limit safety device. They prevent rejection of the stock and are, therefore, called 'anti-kick-back tools'. The r.p.m. are always mentioned on these tools. Fig.711.

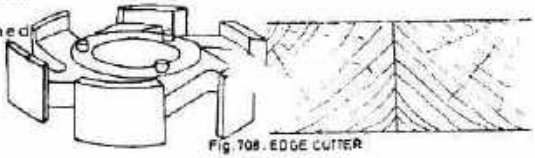


Fig.708. EDGE CUTTER

A new Set of Cutter Heads is a model with throw away knives. The knives can be used on both sides and the 'preshaves' (square knives on top of the cutter head) on four sides. The setting of the knives is done with the setting screws. The knives project approx. 0,8 mm to 1 mm out from the cutter head, which guarantees a depth limit cut and is kick back safe. This cutter head is most safe, easy to handle and gives best results. Knives are cheap and available in HSS and carbide tipped. R.p.m. are shown on the cutter head. Fig.712.

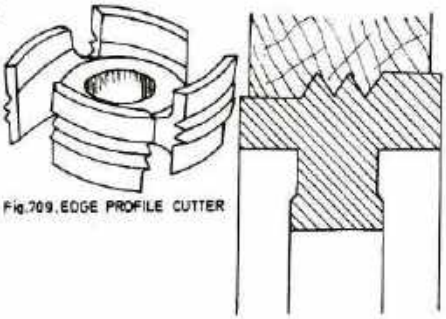


Fig.709. EDGE PROFILE CUTTER

A Set of Cutter Heads is a common tool with replacable knives and preshaves which can be sharpened many times and then replaced. Adjustment of these knives requires much care to get the cutting edges to one true circle. Safety while in use is ensured by a locking system. R.p.m. is again according to the cutter head indication. If they are not mentioned then 4500 r.p.m. and cutting speed of max. 40 m per second should be used. Fig.713.

Fig.710. SOLIDC PROFILE CUTTER

Fig.711. CARBIDE TIPPED CUTTER

Fig.712 SET OF CUTTER WITH THROW AWAY KNIVES

The knives of Adjustable Bevel and Chamfer Cutter Head can be adjusted to 45 degrees in both directions, up or down without removing them. It has also a depth cutting limit device of 0,8 mm 1 mm. R.p.m. are given on the cutter head. Fig.714.

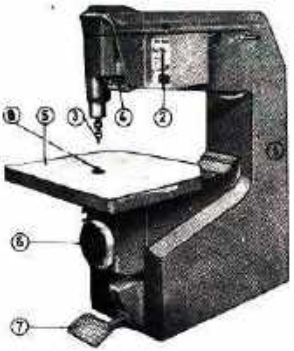
Fig.713 SET OF CUTTER HEAD

Fig.714. BEVEL AND CHAMFER CUTTER HEAD

This most commonly used of Cutter Heads can be used with a large number of profiled knives. Different ready ground profile knives available with the head or square knives can be ground to the profile required. This cutter head should never be used above 4500 r.p.m. and with a maximum cutting speed of 40 m per second. Higher speeds may be only used with the recommendation of the manufactures. Fig.715

Fig.715. SET OF CUTTER HEAD Fig.716. PROFILE KNIVES FOR STRAIGHT AND PROFILE KNIVES

Box with a set of profiled knives and a set of cutter head. Fig.716.



1 COLUMN OR BODY
2 SWITCH
3 CHUCK
4 MOTOR
5 TABLE
6 HAND WHEEL FOR RAISING AND LOWERING THE TABLE
7 FOOT PADLE FOR RAISING THE MOTOR
8 PIN

HIGH SPEED ROUTER Fig.717

Routing and shaping can easily be done on the high speed router when the proper bits and cutters are used. The very high speed required for this work makes it necessary to use a frequency changer mentioned earlier. Material is always fed from left to right. This means that the work must be against the rotation of the cutter. The thrust (push or drive) of the cutter should press the piece against the fence. In the table directly below the motor or cutter, provision is made for a guide pin against which the pattern is pushed during operation. Fig.718,719. The pins are of different diameters and are locked into position by means of a screw knob below the table. The motor has usually from 2 to 4 HP, it is totally enclosed, shell or air cooled. The vertical depth position of the motor can be adjusted by means of a multiple stop with 8 different depth adjustments. The motor is risen by a foot pedal and locked with a locking screw. The operator has thus his hands always free to handle the work. In order to be able to carry out

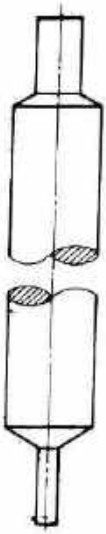


Fig 718 GUIDE PIN

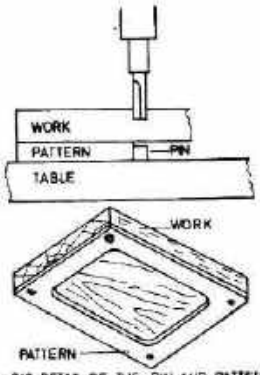


Fig 719 DETAIL OF THE PIN AND PATTERN METHOD OF ROUTING

How to adjust a cutter for the high-speed router.

For example:

Cutting dia = 20 mm = Cutter dia. 15 mm Chuck No 3, setting angle 40°

Cutting dia.mm	Cutter dia.mm	Chuck No.	Setting angle.	Cutting dia.mm	Cutter dia.mm	Chuck No.	Setting angle.
3,5	3	0,75	45°	4,5	3,5	0,75	45°
5	4	0,75	45°	5,5	4,5	0,75	45°
6	5	0,75	45°	6,5	5	1	48°
7	5,5	1	48°	7,5	6	1	47°
8	6,5	1	47°	8,5	7	1	46°
9,5	8	1	46°	10	8	1,25	42°
10,5	8,5	1,5	39°	11	8,5	1,5	40°
11,5	9	1,5	38°	12	9,5	1,5	40°
12,5	10	1,5	37°	13	10,5	1,5	40°
13,5	11	2	38°	14	11	2	48°
14,5	11	2	33°	15	12	2	47°
15,5	12	2	34°	16	13	2	47°
16,5	13	2	34°	17	13	2,5	43°
17,5	14	2,5	53°	18	14	2,5	43°
18,5	15	2,5	52°	19	15	2,5	42°
19,5	15	3	48°	20	15	3	40°
20,5	16	3	48°	21	16	3	39°
21,5	17	3	52°	22	17	3,5	52°
22,5	17	3,5	45°	23	18	3,5	51°
23,5	18	3,5	45°	24	18	4	49°
24,5	18	4	42°	25	19	4	49°
25,5	19	4	42°	26	19	4,5	47°
26,5	19	4,5	40°	27	20	4,5	46°
27,5	20	5	50°	28	20	5	45°
28,5	20	5	36°	29	20	5	30°
29,5	22	5	49°	30	22	5	45°
30,5	22	5,5	48°	31	22	5,5	43°
31,5	22	5,5	36°	32	24	5,5	51°
32,5	24	5,5	47°	33	24	6	50°
33,5	24	6	46°	34	24	6	36°
34,5	24	6	32°	35	26	6	49°
35,5	26	6	45°	36	26	6	38°

moldings at any angle the motor can be tilted either way and locked into the desired position. Scales are provided for all the different degrees to which the motor may be set. A most important part of the high speed router is the eccentrically bored chuck. Fig.720, 721. The advantage of this chuck is that a bit can be used within certain limits for different cutting diameters. Fig.722. This is done very simply by turning the bit in the chuck to the left then the cut will be increased, by turning to the right the cut will be decreased. To compensate for the lack of balance resulting from the eccentrical fastening of the tool the chucks are fitted with a dovetail groove round the periphery with two balancing weights. Fig.723. Having adjusted these weights they are locked, each with its locking screw. Both chuck and tool are guarded to protect the operator's hands.

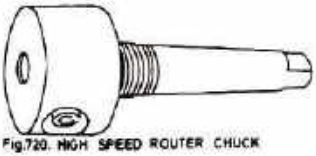


Fig.720. HIGH SPEED ROUTER CHUCK

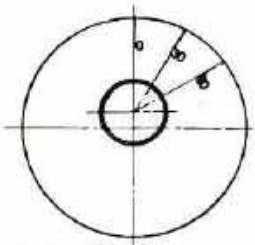


Fig.721. ECCENTRICALLY BORED CHUCK

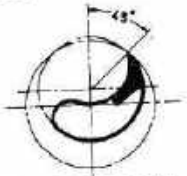


Fig.722. POSITION OF THE CUTTER

Some common router cutters are shown in
Fig.724 Straight, or Groove Cutter.
Fig.725 Dovetail Cutter
Fig.726 Concave Cutter
Fig.727 Different Shape Groove Cutters
Fig.728 Double Rabbet Cutters.
Fig.729 Expansive Dovetail Cutter.
Fig.730 Grinding Attachment.

Routing with a pattern. (See Fig.719)

1. Lay out and cut a full size template from plywood.
2. Fasten a suitable router bit into the chuck.
3. Set the guide pin which should be of the same diameter as that of the router bit.
4. Fasten the plywood pattern to the underneath side of the piece to be routed.
5. Adjust the depth of the cut.
6. Place the work on the table. Turn on the power. Follow the template design to rout the surface piece.

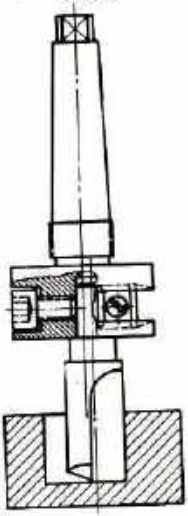


Fig.723. DETAIL OF THE CUTTER CHUCK AND BALANCING WEIGHTS

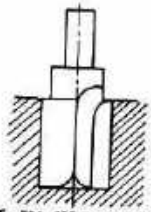


Fig. 724. STRAIGHT OR GROOVE CUTTER

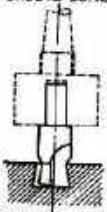


Fig. 725. DOVETAIL CUTTER

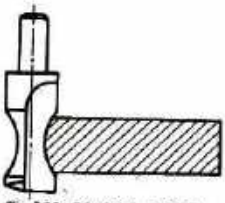


Fig. 726. CONCAVE CUTTER

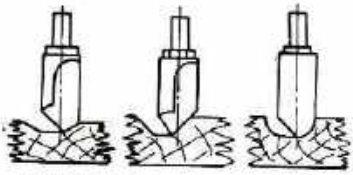


Fig. 727. DIFFERENT SHAPE GROOVE CUTTERS

Fig. 728. DOUBLE RABBET CUTTER

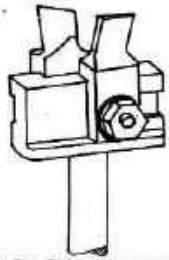


Fig. 729. EXPANSIVE DOVETAIL CUTTER

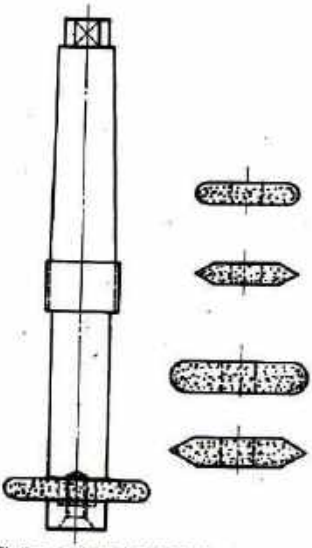


Fig. 730. GRINDING ATTACHMENT

1 R.P.M. ADJUSTMENT
2 HANDLE(KNOB)
3 LOCKING DEVICE
4 GUIDE BARS
5 SPINDLE AND CHUCK
6 CHUCK EXTENSION
7 BIT
8 CORD
9 SWITCH
10 BASE

PORTABLE ELECTRIC ROUTER

The portable electric router is a precision build machine and can be used in work-shops and in the building trade. This machine works on the same principle as the high speed router. Available router accessories make it possible to complete a large number of operations and decorative cuts. It can also be used to shape edges, cut recesses for all kind of hardware and it can even be used to make dovetail joints. Portable electric routers are available in different designs, sizes and capacities. A heavy duty portable electric router can be converted into a table router by means of fixing it into the bench vise or with the cutter facing upwards and use the bench top as a table. A straight wooden rail can be used as a fence attached to the bench top. The most common router cutter are shown in Fig.731, 732, 733, 734, 735, 736.


Fig.731. RABBET CUTTER


Fig. 732. STRAIGHT OR GROOVE CUTTER


Fig.733 CONVEX CUTTER


Fig.734. PROFILE CUTTER


Fig.735 BEVEL CUTTER


Fig. 736. DOVETAIL CUTTER

Shaping an Edge

1. Select the right cutter and insert the cutter into the chuck at least 12 mm (½ inch.) and tighten it.
2. Adjust the router for the depth of the cut.
3. Make a test cut on a piece of scrap wood.
4. Fasten the board on to the object firmly.
5. Place the router back on to the board with the cutter or the bit sticking over the edge.
6. Turn on the switch. Push or pull the router against the edge of the board until it hits the bit or the cutter collar.

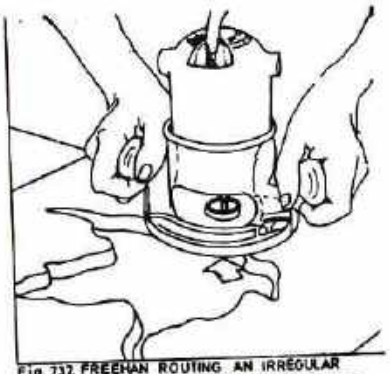


Fig.737. FREEHAN ROUTING AN IRREGULAR PATTERN USING A WOODEN TEMPLATE

Freehand Routing

There are a number of routing operations that can be performed by the freehand method. One example is routing (cutting) letters or patterns directly into the surface of a board. Another is cutting out stock from the surface of wood, following a penciled layout. An example of freehand routing is cutting a groove or dado by simply guiding the router base along a straight piece of wood. On the other hand, one can use a wooden template to cut out the contour of the design and then work the router cutter collar against the template.

Freehand Routing with a Template

1. A dado can be routed freehand by guiding the router base along a straight piece of wood which has been clamped on to the board.
2. An irregular pattern or design can be cut into a surface with the router by using a pre-cut wooden template as a guide Fig.737 This could involve cutting a vein (grooved) outline of the design or cutting out (recessing) the entire background to a given depth by using bits and cutters.

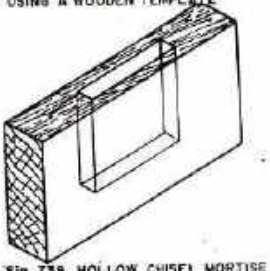


Fig.738. HOLLOW CHISEL MORTISE

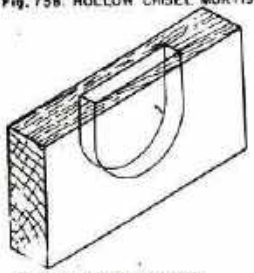


Fig 739. CHAIN MORTISE

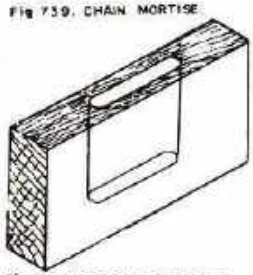
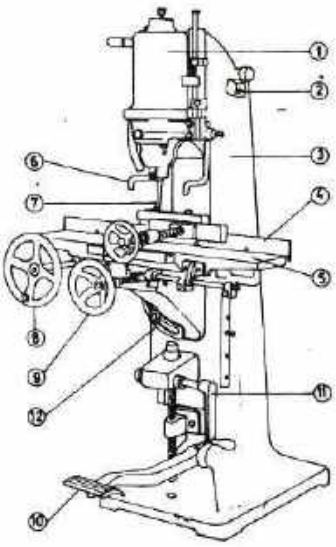


Fig.740. SLOT BORING MORTISE

MORTISING MACHINES

Mortising machines are made in three types, each operating on a different mechanical principle.

1. The hollow-chisel mortiser Fig.738.
2. The chain mortiser Fig.739.
3. The horizontal slot boring machine Fig.74



1 MOTOR
2 SWITCH
3 BODY
4 FENCE
5 TABLE
6 HOLDING DOWN CLAMP
7 CHISEL AND BIT
8 TABLE MOVING HAND WHEEL
9 TABLE RAISING ADJUSTMENT
10 FOOT PEDAL
11 HANDLE FOR RAISING AND LOWERING THE TABLE
12 TILTING DEVICE

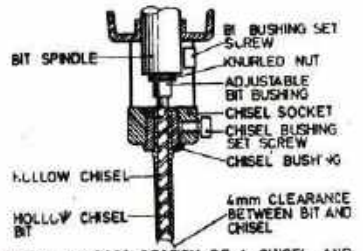


Fig. 742. A CROSS SECTION OF A CHISEL AND BIT ASSEMBLY

THE HOLLOW-CHISEL MORTISER Fig.741

The hollow-chisel mortiser has an auger bit which revolves inside a square hollow chisel. It is used for all-round work and makes a mortise with square sides, ends and bottom. The hollow-chisel mortiser has a cast-iron column, on which a horizontal table is mounted about midway up the column. The mortising head or ram is belt driven and carries the bit spindle, which is mounted directly on to the motor. Below this bit chuck is a similar chuck mounted on to the motor housing, independent of the spindle and bit chuck. This lower chuck holds the square hollow chisel, inside of which the bits revolve. When putting a bit int the machine, fasten the hollow chisel first and then insert the bit from below and fasten it into the spindle chuck. A little clearance should be allowed at the end of the chisel so that the bit revolves freely. Fig.742,743,744.

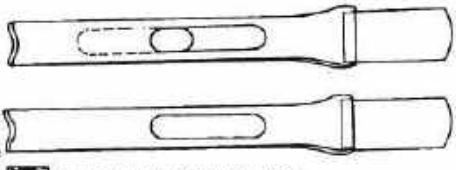


Fig. 743 HOLLOW MORTISING CHISEL

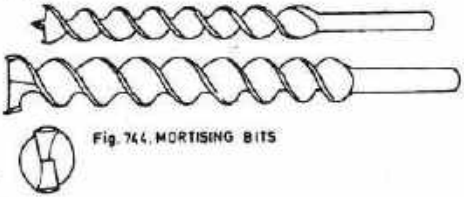
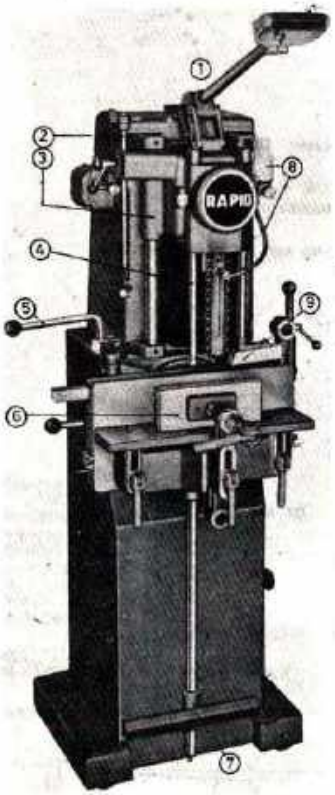


Fig. 744. MORTISING BITS



1 HAND LEVER FOR RAISING AND LOWERING THE CUTTING DEVICE
2 DEPTH GUIDE (STOP)
3 GUIDE BAR
4 PRESSURE BAR
5 SIDE MOVEMENT LEVER
6 CLAMPING DEVICE
7 SUPPORT FOR LARGE DOORS
8 LUBRICATION PIPE
9 CHIP BREAKER

CHAIN MORTISER Fig.745

The chain mortiser and slot boring machines are the ones most frequently used for cutting and boring mortises and holes. The body of a chain mortise is similar to the hollow-chisel mortiser. This mortiser has an endless chain with saw shaped teeth, Fig.746, which revolves around a steel bar guide with a sprocket wheel on its lower end. Fig.747. The sprocket wheel runs on ball-bearings and must be very well lubricated to make sure it does not over-heat. The chain mortiser is the fastest mortising machine and is used principally in door and window industries. It makes a mortise with a rounded bottom. Fig.739. The size or width of the mortise is limited by the dimension of the chain and the chain guide. They are available from 6 mm (¼ inch) to 40 mm (1¾ inches approx.) in width. The chain must be tightened with a tightening device right above the chain guide, but care has to be taken that the chain is not tightened too much. The following basic rules must be observed when working on a chain mortiser.

1. The chain should be fed in smoothly, with uniform pressure. While the chain moves deeper into the mortise the feed speed should be reduced.

2. When cutting long mortises the chain should be driven into the stock first at the extreme left hand position.

3. During one pass it is not advisable to cut to a depth exceeding 60-70 mm because you might choke the chain and break it.
The table can be moved up or down on the column to allow for work of different heights. It has a crosswise movement for centering the stock to be mortised directly under chain and a clamp for holding it firmly in place. It also has a sidewise movement for making successive cuts to complete a mortise without opening the clamp and shifting the stock. When a number of pieces have to be similarly cut the sidewise movement of the table may be controlled by iron rods and stops. The table can be tilted into different degrees. The chain mortiser is direct-driven that means the chain pulley is mounted on to the motor arbor.

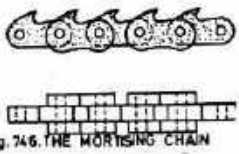


Fig.746. THE MORTISING CHAIN

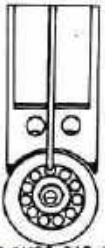
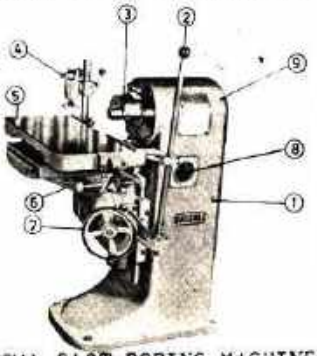


Fig.747. GUIDE BAR AND SPROCKET WHEEL

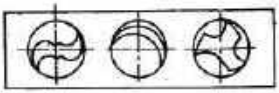


HORIZONTAL SLOT BORING MACHINE Fig.748

Small mortises and holes are cut with a slot boring machine using slot mortise bits with chip breakers. Fig.749,750. Slot boring machines have a horizontal spindle on which at one

end a chuck is mounted. A table designed for clamping the stock with two clamping devices is located in front of the motor in a horizontal position. It has vertical and horizontal movement that ensures positioning of the stock in height and transverse feeding on to the bit. Slot boring machines are in use both with a hand mechanical feed. Hand feeding is performed by the operator by means of a hand lever on the table and another one on the motor. The lever on the table is for the horizontal movement while the lever on the motor feeds the bit into the stock. How the bit should be fed into the stock is shown in Fig.751, from which it can be seen that first the extreme left hand hole is bored and then the right hand one and only after this is the waste between the two holes cut out. When a number of pieces have to be similarly mortised, the sidewise movement of the table may be controlled by iron rods and stops as on the chain mortiser. The horizontal slot boring machine is also an excellent doweling or single hole machine. It can be done in two ways.
First method: lay out the holes on the stock with a pencil and try square and second: set the machine with iron rods and stops. The first method is faster if a small number of pieces with different adjustments have to be dowelled, but if a larger number of pieces with identical holes have to be made the second method is more economical. For doweling, a bit with a spur must be usde to prevent the bit from following the grain.

Fig 749.MORTISE BIT



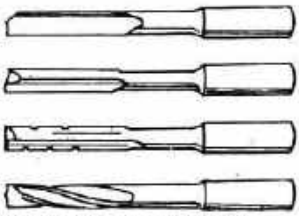


Fig.750. DIFFERENT MORTISE BITS

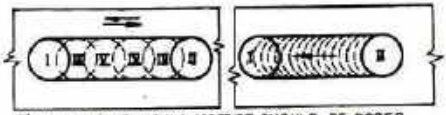


Fig.751. SCHEME, HOW A MORTISE SHOULD BE BORED

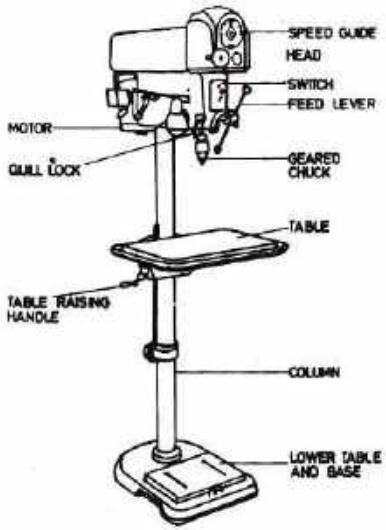


Fig 753. PLUG CUTTER

Fig 754. CUTTING EDGE

Fig 755. QUICK CUT HOLE SAW

Fig 756 FORSTER KNOT BIT

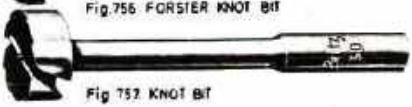


Fig 757 KNOT BIT

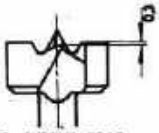


Fig 758. CUTTING EDGE

Fig 759. COUNTER BORE BIT

DRILL PRESS Fig.752

The drill press was originally designed for the metal work trade, but it has been adapted to wood-working. It is one of the most practical machines. Drill presses are made in bench and floor models. The only difference between the models is the length of the upright column. The more practical sizes of drill presses vary from 300 mm (12 inches) 550 mm (20 inches). The size is determined by the distance from the centre of the chuck to the front of the vertical column. The speed of this machine varies from approximately 300 to 6000 r.p.m. On most drill presses, the speed is controlled by shifting the drive belt, or belts, on a set of cone or V pulleys located in the head. Slow speeds are used for metal working, faster ones are for woodworking. The numerous jobs the drill press can do depend upon the many types of bits, cutters and accessories which are available. All bits mentioned in chapter 3

which have a round shank can be used in the drill press chuck.
Additional bits for a drill press are plug cutters. Fig.753,754. A plug cutter is used for making dowel pins to replace knots ir boards. A quick-cut hole saw and knot hole bits Fig.755,756,757,758. These saws are mostly used for cutting larger holes, like a hole for as electrical switch in a wall panel. Counterbore bits are used for cutting holes for screws and a larger one to insert the screw head at the same time. Fig.759.

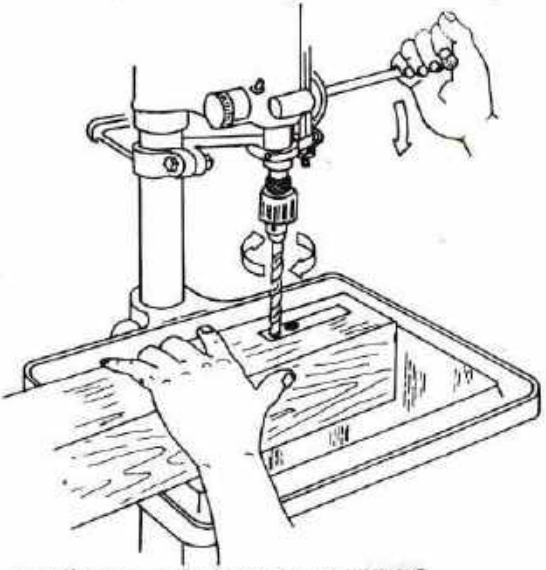


Fig.760 BORING A SERIES OF HOLES FOR A MORTISE

Boring a Hole

1. Lay out and mark the centre of the hole. Use an awl.
2. Select the bit of the correct size. Fasten into the chuck. Make sure it does not wobble.
3. Place the board on the table of the drill press. Put a piece of scrap wood underneath the board.
4. Adjust the table to the correct height and tilt angle. The tilt, of course, depends on the angle at which the hole is to be bored.
5. Adjust for depth of boring Fig.760. This is especially necessary when the hole is to be bored to a specified depth and is not to go through the board.

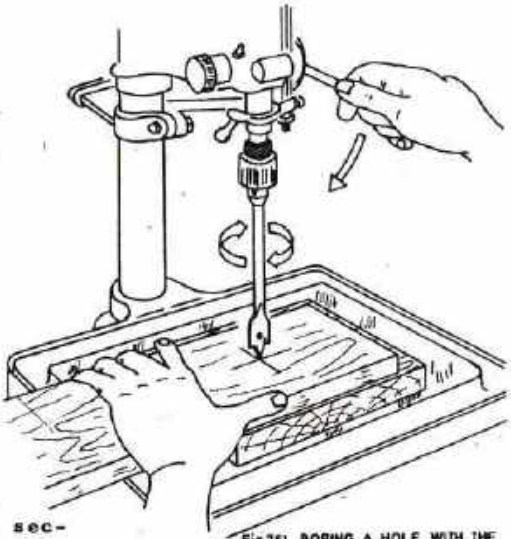


Fig.761. BORING A HOLE WITH THE CENTRE BIT

6. Hold the board, or stock, securely by hand (or with clamps, if necessary). Apply an even pressure in feeding the bit into the wood slowly. Fig.761. If the wood smokes, ease the pressure on the bit until the smoking stops and then proceed slowly.

1 MOTOR
2 HANDLE WITH TRIGGER SWITCH
3 HANDLE
4 CHUCK
5 KEY
6 KEY LESS CHUCK
7 BIT

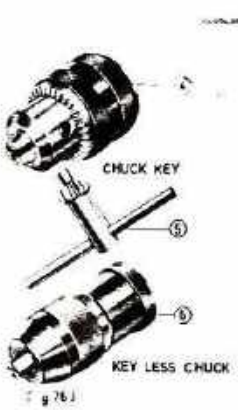


Fig.762

THE PORTABLE ELECTRIC HAND DRILL
Fig.762,763

The portable electric hand drill is one of the most popular and useful of all portable power tools. It is manufactured in a variety of types, sizes and capacities. This handy electric tool is used extensively by nearly all trades. This tool is equipped with an electric motor which operates on normal 220 or 110 volts like most of the other portable electric hand tools. It is of the utmost importance, however, that portable electric tools are used only where they can be earthed. This eliminates the possibility of getting an electric shock. Most electrical connections have a third conductor (wire) in the power supply cord for earthing. It is also very important that all electrical connections (plugs) are always in perfect conditons.

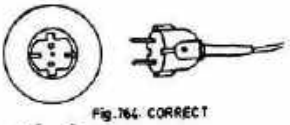


Fig.764. CORRECT

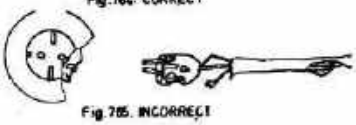
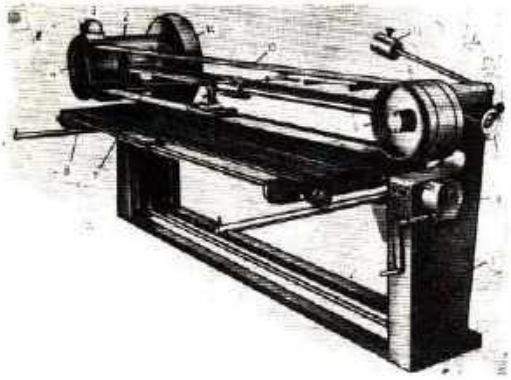


Fig.765. INCORRECT

Fig.766. PORTABLE HAND DRILL WITH A SCREW DRIVER BLADE

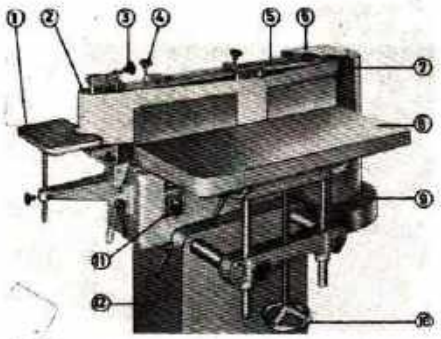
Fig.764,765. The chuck sizes are measured by the sizes of the drill bits they can handle. Portable electric hand drills use either key or keyless chucks. The three jaw key chuck is designed to centre the bit exactly. The jaws are opened by turning the sleeve anti-clockwise (as seen from bit end). A keyless chuck works in much the same way as the key chuck, but the bit is tightened firmly in the chuck by hand. A most common chuck is the 12 mm (½ inch) chuck. Most instructions and methods of operations are discussed in chapter 3. 'Hand Tools'.
Most bits with a round shank, discussed previously, can be used in this machine. When drilling a hole, care has to be taken that the maching is kept absolutely straight as no changing of the boring position can be tolerated while the bit is still in the hole, because it will break.
Fig.766 shows a drilling machine used with a screw-driver.



1 BASE
2 MOTOR
3 SWITCH
4 PULLEY GUARD
5 PULLEY
6 PULLEY GUARD
7 SANDING ATTACHMENT
8 TABLE
9 ATTACHMENT FOR RAISING AND LOWERING THE TABLE
10 BELT
11 BELT TIGHTENING ATTACHMENT
12 HAND WHEEL FOR ADJUSTING THE PULLEY
13 COUNTERWEIGHT
14 FAN GUARD

MACHINES FOR SANDING. BELT-SANDER Fig.767

The sanding machine is one of the more recent developments within the field of woodworking machinery. In the past when people had more time and competition was less keen, all sanding operations were done by hand. Sanding, however, is a slow, tedious and laborious process, which after all can be done much better and a great deal faster on a machine. With the general speeding up of production methods, sanding machines have been so developed that they can do practically any type of sanding operation formerly done by hand. Sanding machines are made in six general types: the belt sander, edge sander, the disc sander, the spindle sander, the drum sander and the frame sander.
These machines are made in a variety of sizes and forms. On a belt sander, sanding is accomplished either by the belt travelling across the face of the work which is held stationary, or by holding the work on to the travelling belt. The belt sander is useful for sanding flat work, such as table tops, flush doors, panels, etc. as well as for sanding straight mouldings and concave surfaces. The belt sander shown in Fig.767 has an endless belt running over two pulleys mounted on



1 TABLE FOR SANDING CURVED EDGE
2 WHEEL
3 BELT ADJUSTMENT SCREW
4 FENCE ADJUSTMENT SCREW
5 BELT
6 DUST HOOD
7 PULLEY
8 TABLE
9 MOTOR
10 HAND WHEEL FOR RAISING AND LOWERING THE TABLE
11 SWITCH
12 BASE

ball bearings. The right-hand pulley is adjustable along the axis of the belt, which makes possible a certain variation in the length of the belt. There is also a counterweight tension device which keeps the belt under the correct tension and also facilitates replacement of the belt. The frame is cast in two pieces which stand seperately. At the bottom the frame members are connected by a channel and at the top by two bars and a rear support. Since the frame has a gap for the table it is possible to sand practically any length of work up to 2500 mm. The table which has double vertical slides, is raised and lowered by a hand wheel and crank placed on the right-hand frame member. With a flip of the hand the table can be locked to the desired height. Horizontally the table, which runs on rollers mounted on ball bearings, is readily moved by hand. In sanding, the work is placed on the table and sanding is done by pressing the belt against the work with a self-balancing sanding shoe. The shoe can be moved along the axis of the belt and is balanced by a counterweight. This causes the shoe to be lifted automatically when no sanding is being done. The motor is usually connected directly to the pulley and runs with a speed of 1400 r.p.m. Due to the resulting fine dust thrown off while sanding is in process, all sanding machines should have a dust deflector or a dust bag. The dust deflector is a metal housing that covers one of the pulleys. It sucks the dust away from the work. The deflector is designed to be connected to a dustcollecting system. Working on sanding machines with a dust collecting system, no material should be sanded which cause sparks, otherwise an explosion resulting in extensive damage, might occur.

EDGE SANDER Fig.767A

The edge sanding machine is similar to the belt sander, but it is mainly used for sanding edges. The operations are carried out on the table which is mounted in front of the belt Fig.767A. The belt runs horizontally, upright and it is supported from the back with a fence. The table can be tilted for sanding bevels and chamfers. Some edge sander have an additional table which can be fixed next to the pulley for sanding curved stock.

This attachment serves the purpose of a spindle sander. Both tables can be raised and lowered by means of a hand wheel or setting screw, so that the full width of the belt can be utilized. The edge sander is a direct driven machine and runs 1400 r.p.m. A special attachment is fixed on the main fence for sanding veneered edges.

DISK SANDER Fig.768

The disk sander is used to sand straight and convex (outwardly curved edges). The disk diameters range from 200 mm (8 inch) 600 mm (24 inches). A disk sander is usually a small machine which can not serve large production operations because the surface of the disk is not very large and the sandpaper wears out very fast. The table on most sanding machines can be tilted to sand bevelled edges. A miter gauge makes it possible to hold stock at various angles. The sandpaper is fastened to the disk either with a special abrasive disk cement or with a clamping ring tilted in a groove. Fig.769.

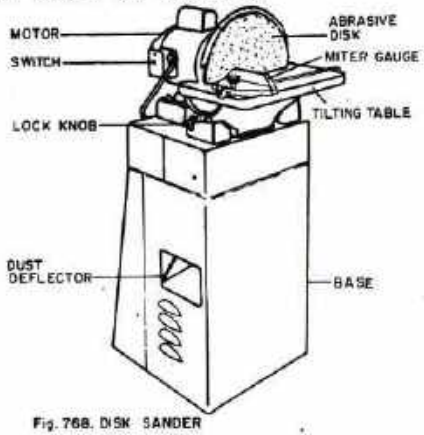


Fig.768. DISK SANDER

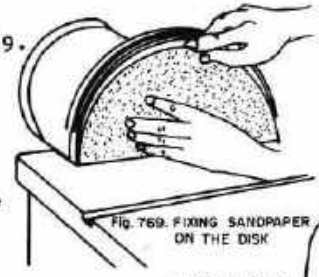


Fig.769. FIXING SANDPAPER ON THE DISK

PORTABLE BELT SANDER Fig.770

The portable belt sander has a sandpaper belt which runs continuously over pulleys at both ends. The average portable sander weighs between 5 and 10 kg (11 to 22 pounds). Its size is usually determined by the size of the belt. Most of these machines have a dust bag which collects all the fine dust produced while sanding. The housing is usually made of cast aluminum to reduce the weight of the machine. The traction wheel is the rear pulley, which drives the belt. The front wheel or pulley provides tension on the sanding belt. The handle is usually made of plastic material (shockproof), and contains the trigger switch.

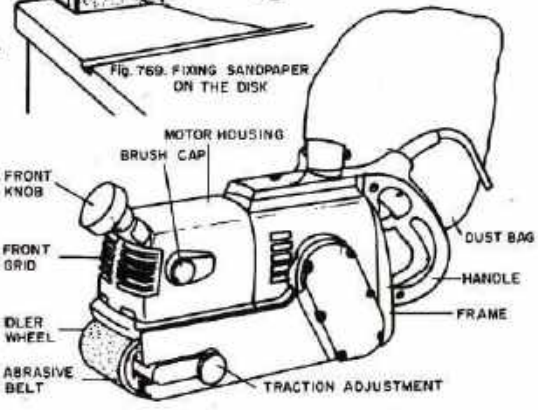


Fig.770. PORTABLE BELT SANDER

A ball knob or a front handle is also mounted because operation of the sander requires use of both hands. The shoe or base is a metal plate over which the back of the belt moves. Belts are available ready made in many grits (rough to fine) to fit portable electric belt sanders of different sizes.

ORBITAL SANDER Fig.771

The orbital finishing sanders are either orbital (circular) or oscillating (back and forth vibrating) in motion. Both types look practically alike. The designation 'finishing sander' means that this machine is used for fine sanding. It is at the same time used to obtain a finer surface finish after applying the first coat of sealer or a coat of paint. This sander is not causing much dust. The abrasive sheets are fastened and locked to the pad plate, with a clamp at each end which holds the abrasive sheet.

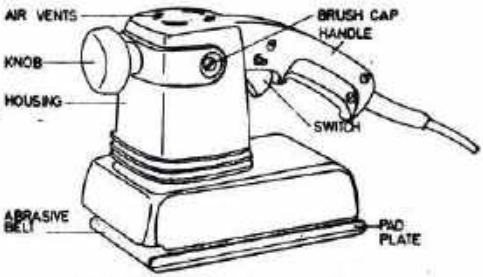
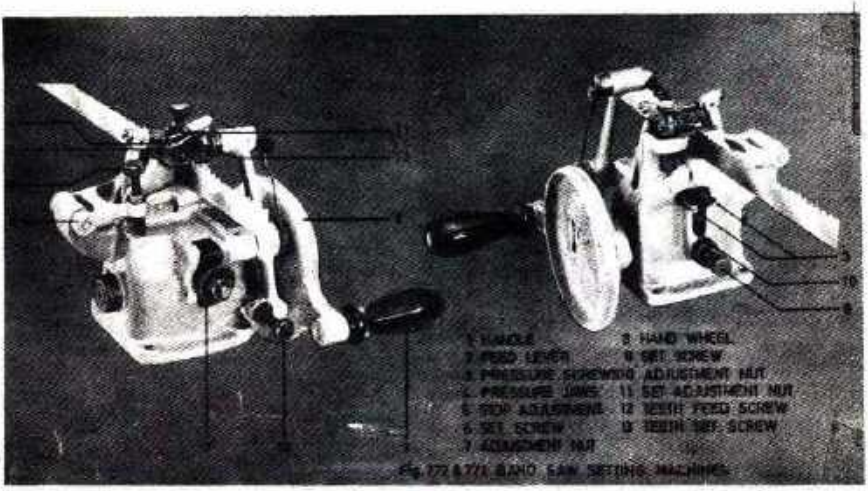


Fig. 771. ORBITAL SANDER

BAND SAW SETTING MACHINE

The setting machine Fig.772,773 is hand operated and suitable for hand saws only (width 5-45 mm, thickness max.0,9 mm). Accurate setting is achieved and adjustment of transport is regulated by a spring activated regulator. Uniform setting is easily and speedily carried out. Only proper setting makes a band saw blade a valuable tool with precise performance possibilities.



BAND-AND CIRCULAR SAW SHARPENING AND SETTING MACHINE

Accuracy is one of the main demands in band-and circular saw sharpening and setting. Fully up to the mark is this model shown in Fig.774. The saw blade is clamped firmly between the jaws which permits exact grinding of the teeth. The built in setting apparatus, also motor driven is synchronoised with the speed of the grinding operation. Accuracy, speed and uncomplicated adjustments are the prominent features of this model.

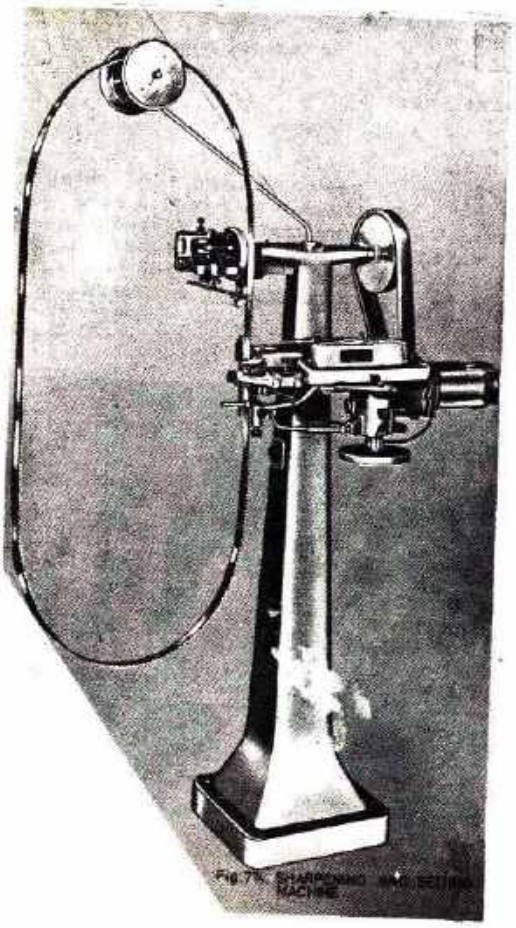
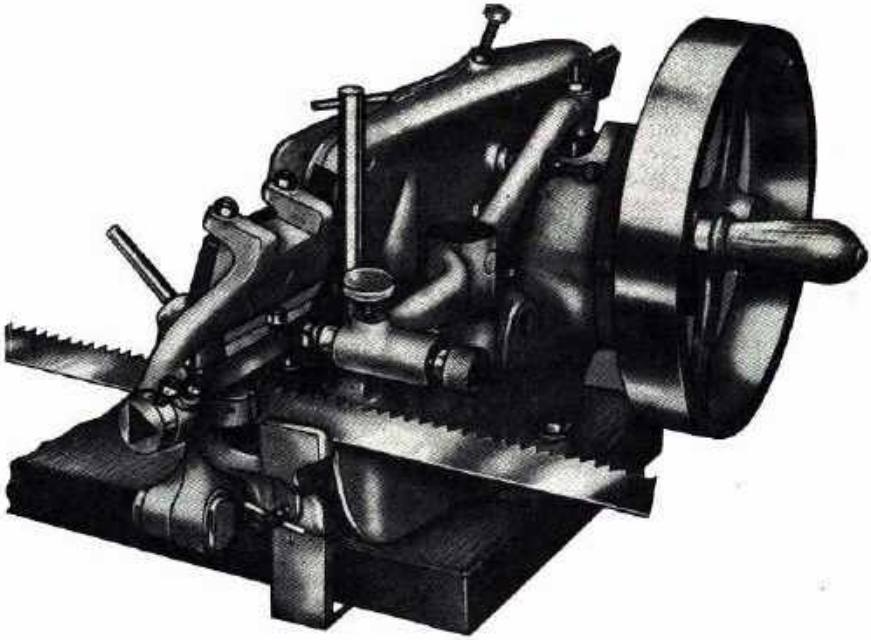


Fig.774 SHARPENING AND SETTING MACHINE



BAND SAW-CIRCULAR SAW SHARPENING MACHINE Fig.775

This handy and inexpensive operated sharpening machine, Fig.775, is fully suitable for small and medium size workshops. Sharpening capacity for circular saws ranges from 80 mm - 400 mm. dia, for band saw blades from 5 mm - 50 mm width, length unlimited. The file can be changed according to shape of teeth, the machine gives accurate and speedy performance which makes properly prepared saw blades readily available any time.

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INDEX