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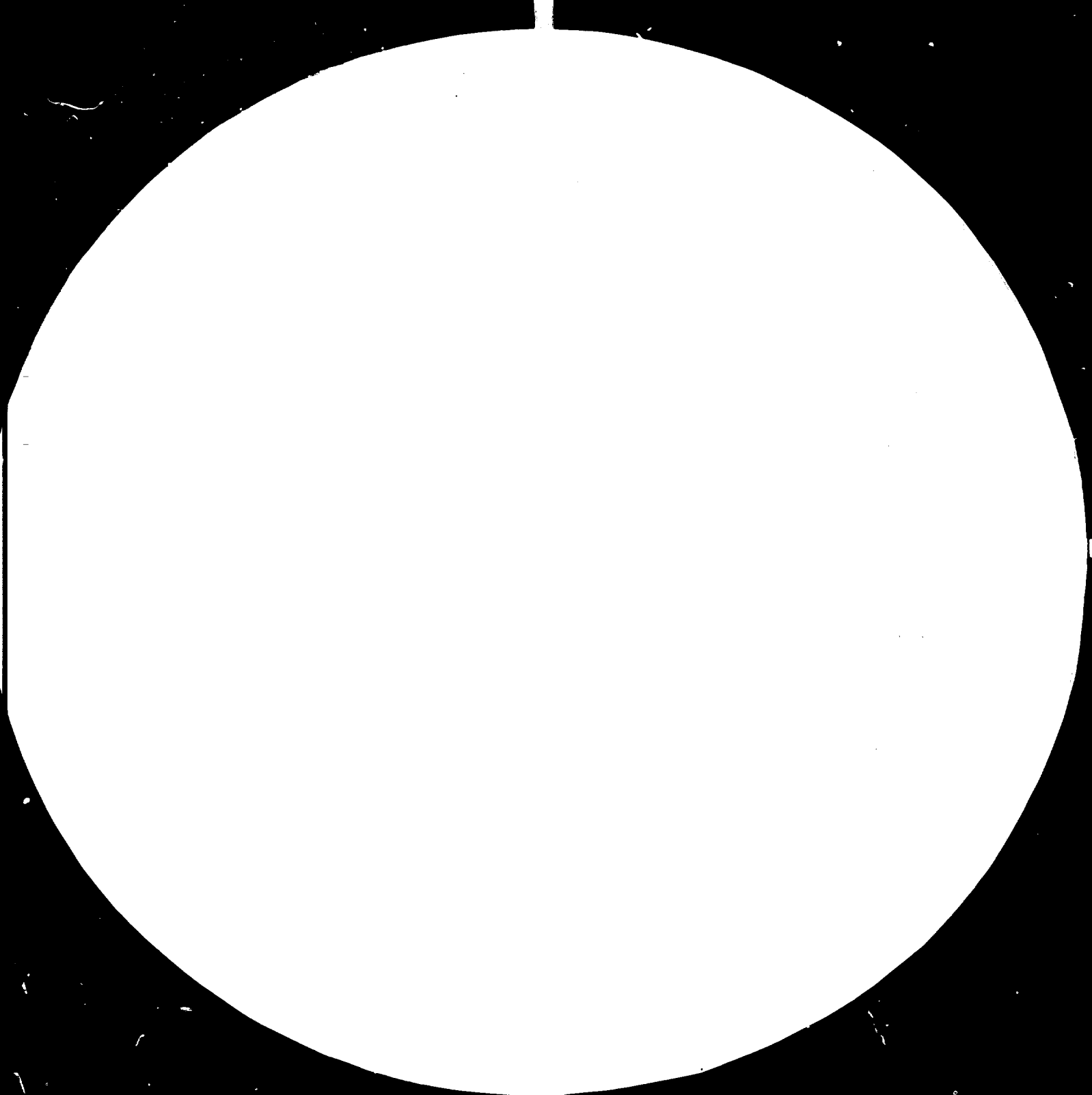

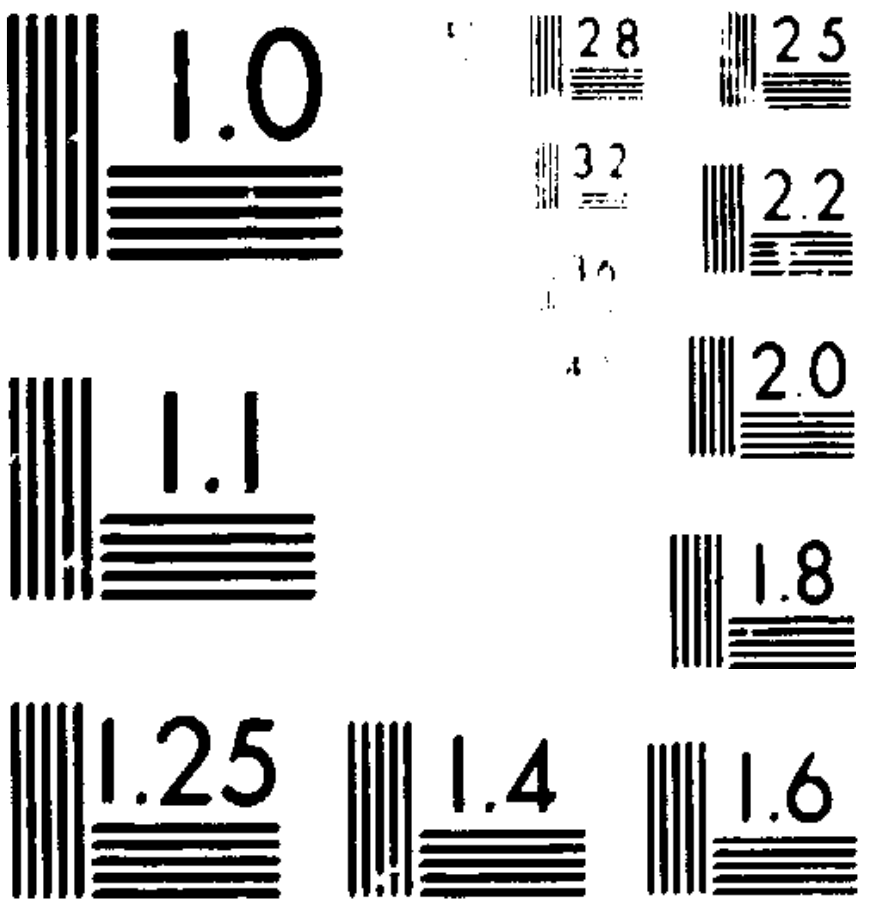

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

MANUAL ON JIGS FOR THE FURNITURE INDUSTRY

P. J. Paavola
K. Ilonen

UNITED NATIONS

with
10853

ERRATA

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October 1981
New York

MANUAL ON JIGS FOR THE FURNITURE INDUSTRY

Erratum

Preface, last paragraph

The second sentence should read

It was compiled by Pekka J. Paavola, Head of the Wood Technology Department at the Lahti Institute of Technology, and Kaarlo Ilonen, Lecturer at the School for Small-Scale Industry and Teachers Training at Lahti, Finland.

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MANUAL ON JIGS FOR THE FURNITURE INDUSTRY

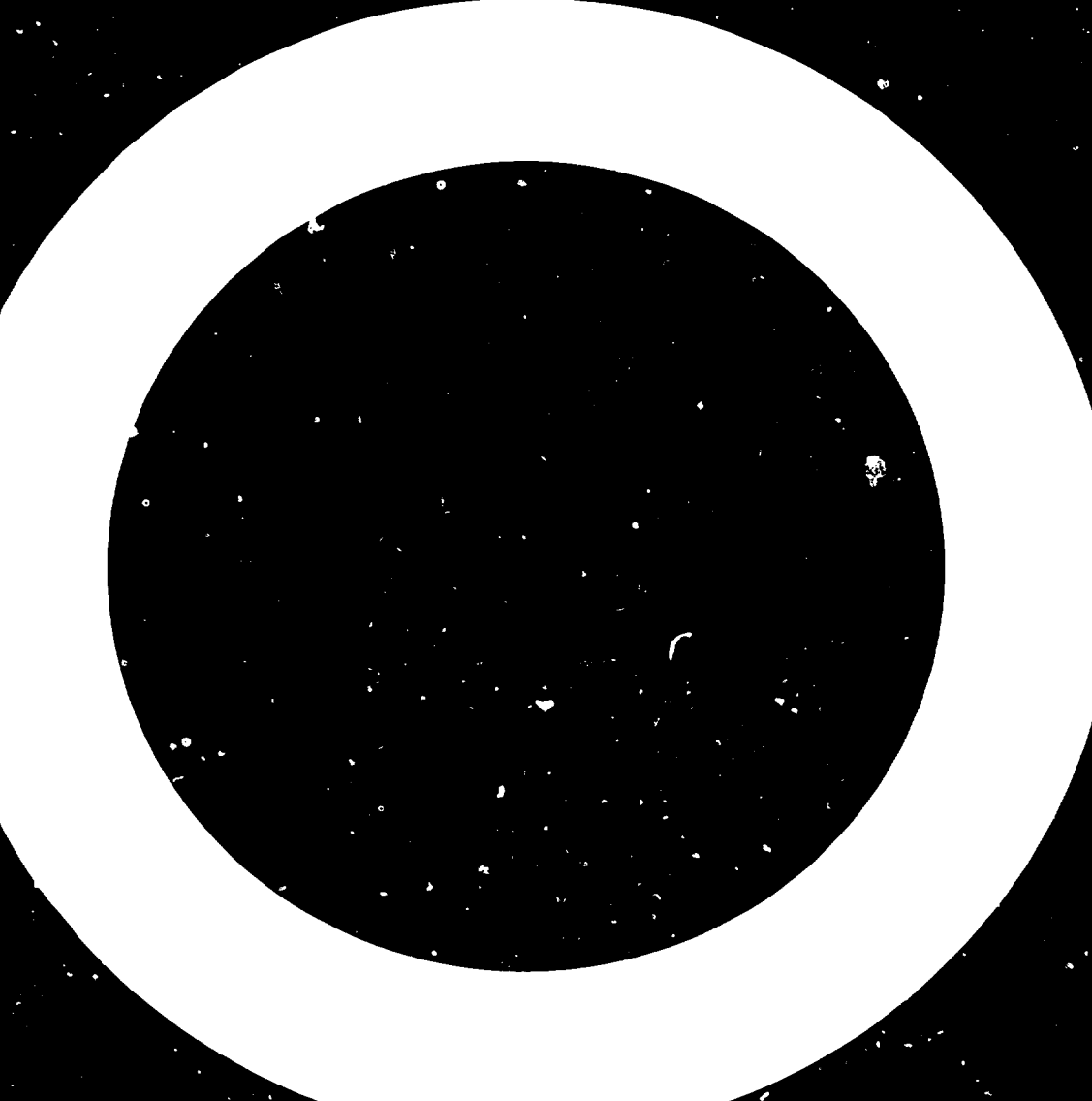
UNITED NATIONS
New York, 1981

Preface

One of the most pressing problems of the furniture industry in developing countries is to increase productivity and profitability in their move from craft to industrial-type operations.

Furniture is produced at a craft level in all societies at all stages of development, irrespective of whether or not they are endowed with forest resources. The industrial production of furniture, however, calls for serial production, a rational division of labour in the factory and interchangeable components. The latter in its turn implies accurate machining, which not only requires precise machines, but also jigs. Moreover, simple jigs can greatly increase the productivity of basic woodworking machines, still common in many developing countries, and the accuracy of the components machined on them. The machines, if properly maintained, are sturdy and need not be replaced by more specialized and sophisticated pieces of equipment because of the relatively small markets of developing countries, on the one hand, and the comparatively low cost of labour, on the other. Provided the necessary know-how is available, properly working jigs can be constructed at practically no cost, thus making possible serial production and rising productivity.

The object of this manual is to familiarize technical personnel of small furniture plants in developing countries with the basic requirements in the design of jigs and give some examples of jigs for use on basic woodworking machines. It was compiled by Pekka J. Paavola, Head of the Wood Processing Industries Department at the Lahti Institute of Technology, and Kaarlo Ilonen, a teacher at the Vocational Training School in Lahti, Finland. The views and opinions expressed herein are theirs and do not necessarily reflect those of the secretariat of the United Nations Industrial Development Organization.



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Introduction

The objective of this manual is to describe the design, construction, and use of jigs for machining and assembly purposes in the furniture industry. The term jig usually means a self-constructed appliance which facilitates production, lowers labour cost and improves product quality (figures 1 and 2).

Figure 1

Machining jig for spindle-moulding the edges of chair legs

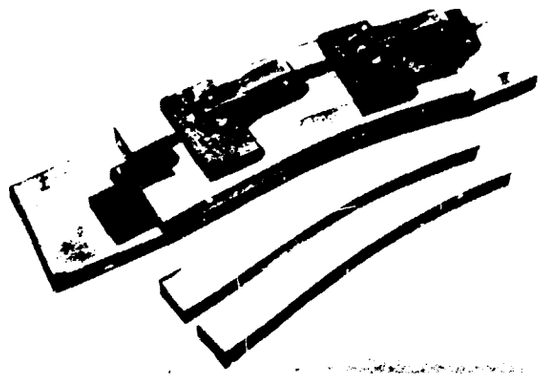
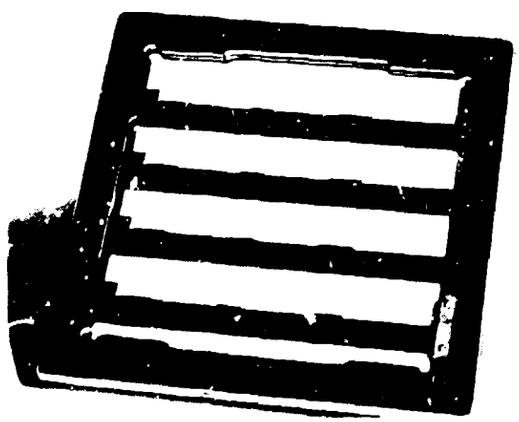


Figure 2

Assembly jig for fixing drawer supporting slides on cabinet side panels by nailing or stapling



The use of jigs also makes it possible to produce interchangeable parts and avoid manual adaptations in the assembly. The jigs introduced in the following text and illustrations are of basic type and therefore easy to modify and adapt to the particular purposes of any furniture factory.

Development from craft level to industry

The development of the furniture industry in industrialized countries has been very fast during the past two decades. The most advanced factories now operate according to the same production principles as, for example, the metalworking industries.

The present level of development has been achieved by a gradual, step-by-step process. The main development stages from the craft level to highly mechanized and automated mass production are outlined below.

Level 1: manual or craft level; only hand tools; manufacture according to individual orders; no standard products.

Level 2: semi-mechanized level; simple machines used for rough cutting of material; finishing stages with hand tools; manufacture principally according to individual orders, eventually small batches of certain standard designs.

Level 3: mechanized level; most working stages done using basic woodworking machinery and equipment; simple jigs used in machining and assembly; manual adaptations necessary in assembly; standard models in small batches but products not systematically designed.

Level 4: advanced mechanized level; machinery consists of basic and multi-purpose machines using sophisticated jigs and low-cost automation in machining and assembly when applicable; systematic quality control at decisive points of the process makes possible the production of interchangeable parts; each part or component considered as a final product and the assembly as a stage where the components are combined; systematic process control; no manual adaptations in the assembly; standard products in large batches designed according to internal standards (standardized materials, sizes, joints and working methods), taking into account machinery and equipment requirements already at the design stage.

Level 5: automated mass production level; machining lines to produce standard components in large quantities; machining heads programmed to produce the desired shapes instead of using jigs; production very capital-intensive; highly specialized product range; microprocessor technology to be applied to a large extent in the future development of the process; robots partly to replace manpower.

The above classification is very schematic, because most existing factories have a certain overlapping of the various stages. Since the objective of this manual is to describe the design, construction, and use of jigs in furniture production, it will principally deal with levels three and four, which still predominate in most furniture factories in both developing and developed countries.

Definition and importance of jigs

A characteristic of manual production is to work according to pencil markings when making parts and in certain assembly fixing operations. The markings are usually made with either a tape ruler or a plywood template for their correct location. The markings are no longer necessary when jigs are used, since the guiding elements of the jigs control the workpieces in machining and assembly. In general, all production jigs in the furniture industry can be divided into machining and assembly jigs. The definitions of the two types of jigs are as follows:

(a) Machining jigs are appliances used in a machine shop for accurately guiding and locating tools or workpieces during the operations involved in producing interchangeable parts;

(b) Assembly jigs are appliances used in an assembly shop for accurately guiding and locating interchangeable parts in joint glueing, fixing and other assembly operations controlling the parts to be handled or the angularity of the product.

I. Economic aspects of jig design

Cost of jig

The cost of a machining or assembly jig covers the following major items: designing (drawing-board stage, sometimes requiring experimentation); materials (wood, wood-based panels, various sheet materials); supplies and ready-made parts (bolts, nuts, springs, hinges, eccentrics, pneumatic components, etc.); construction; testing and adjusting prior to use for serial production. The proportion of the jig cost in the production cost of one part or final product decreases when the batch size increases. The product development policy of a furniture factory should therefore favour mass production with as long a product live as possible to minimize the jig cost per product. Contracts may be concluded involving the design and construction of jigs for a certain definite number of products without any continuity of production. Even a small batch may justify making a jig if the reduction in labour costs is large enough.

Minimum economic batch size

The minimum economic batch size which justifies the contruction of a jig can be calculated from the following formula:

$$n_{min} = \frac{A}{B - C}$$

A = total cost of jig
B = labour cost per unit without jig
C = labour cost per unit with jig
B - C = saving in labour cost per unit

Suppose, for example, that a certain assembly stage without a jig lasts an average of 0.25 hours per product. If a special jig is constructed for the purpose, the duration of the same working stage is estimated to be only 0.05 hours. Wages are $1.20 per hour in both cases. The jig cost covers the following items:

Designing (10h at $2.00 per hour)	$20.00
Materials and supplies	$14.00
Construction (8h at $1.50 per hour)	$12.00
Testing and adjusting (2h at $1.50 per hour)	$ 3.00
Total cost of jig (A)	$49.00

Labour cost per product without jig: B = $0.25 x 1.20 = $0.30

Labour cost per product with jig: C = $0.05 x 1.20 = $0.06

Saving in labour cost per product: B - C = $0.30 - $0.06 = $0.24

The minimum batch size justifying the jig is as follows:

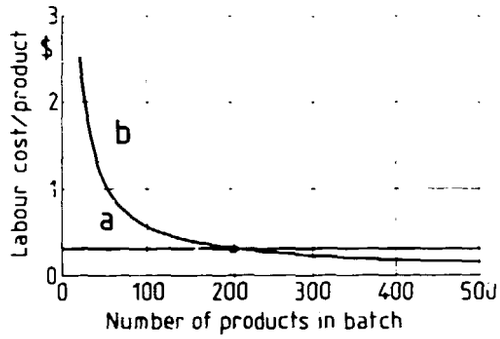
$$n_{min} = \frac{A}{B - C} = \frac{\$49.00}{\$\ 0.24} = 205 \text{ pieces}$$

The break-even point is presented graphically in figure 3.

The curve is calculated according to the cost figures of the above example. The intersection point of the curves gives the break-even point which justifies the making of a jig.

Figure 3

Labour cost per product manufactured against number of products in batch (a) without a jig and (b) using a jig



Increasing the productive capacity of the equipment installed

The time saved by the use of jigs varies so much from case to case that even average figures for the amount saved are difficult to estimate. In that connection, however, the following point should be noted:

(a) Certain woodworking operations may be performed by machine with or without a jig (for example, boring or mortising a row of holes either according to pencil markings or by using a special jig to control the location of holes);

(b) Certain woodworking operations must be done either wholely by hand tools on the basis of pencil markings or with a machine and a special jig (for example, safe and accurate spindle moulding of the curved edges of a chair leg is possible only with a jig);

(c) Most assembly operations can be carried out with or without a jig. It is not uncommon that the use of efficient jigs may increase capacity by up to 50 times the results achieved without a jig, depending on the circumstances.

Quality improvements

The above method of calculation does not, however, take quality improvements (finishing, regularity of shape, accuracy of assembly) into account, but is based on production cost only. In fact, the use of a jig may also be justified in certain cases below the calculated minimum batch size if the improved quality has a positive effect on the marketing of the product.

Savings in raw-material consumption

One further positive consequence of the use of jigs is the decrease in raw-material consumption as a result of the smaller number of faulty parts or products. That is naturally related to the improved manufacturing accuracy made possible by the use of jigs. The typical faults causing material and labour wastage are as follows:

(a) A part may be inaccurately worked or machined (for example, faulty dimensions or shape, wrongly located joint details, incorrect angularity);

(b) An assembled product includes faulty parts or the assembly is incorrectly done (for example, the product is not rectangular, clearances are not even, movable parts do not move properly), causing the rejection of the whole finished product.

Manpower skills

Manual or semi-manual furniture production sets high requirements on the skills of the workers since the quality of the product depends directly on the work of the carpenter. In more advanced production involving the use of jigs, the manpower must be well-trained, but not to the same high level of skills as in the case of manual production. That further reduces labour and production costs.

Safety considerations

One of the advantages of the use of jigs from the human point of view is the fact that jigs function as effective safety devices, particularly in machining. Most machining jigs can be provided with special handles for safe machine feeding. Splinter guards are to be recommended in certain jigs. A machining jig usually makes a solid base for the part to be machined, so that the hands of the machine operator can be quite far away from the cutting tool during the feed. The safety aspects are reflected in the jig illustrations presented later in this manual.

II. Technical aspects in design of jigs

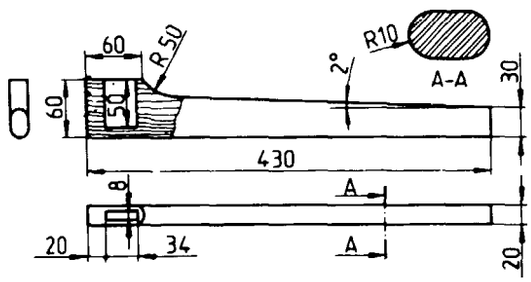
Design according to working drawings and prototypes

In modern furniture production the manufacturing stages are based on drawings that also provide the necessary information on jig design. The drawings are usually classified as follows:

Parts drawings. Such drawings include all measurements and other information needed on machines, jig design and quality control of machining (figure 4).

Figure 4

Dimensioned part drawing for a furniture component

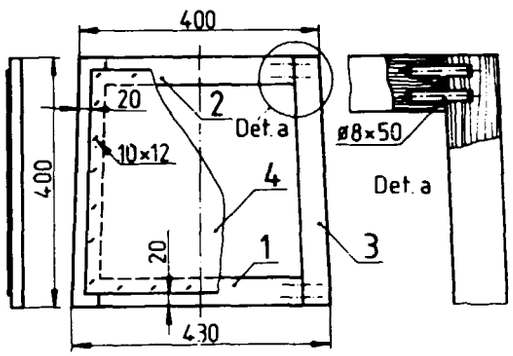


Assembly drawings. This group is further divided into subparts assembly drawings (figure 5) and final assembly drawings (figure 6).

The former includes drawings for the assembly of parts such as frames, drawers and bases, which will be combined with other furniture parts in the final assembly. Assembly drawings contain all measurements and other information required for assembly, jig design and quality control in assembly (figures 5 and 6).

Figure 5

Dimensioned assembly drawing for sub-assembly



The prototype of a new product can be used to facilitate the machining jig design for components with complicated shapes, such as curved chair parts.

Primary and complementary measurements

The construction measurements of a furniture part or of an assembled piece of furniture may be generally classified as primary measurements, which are decisive for manufacturing accuracy, and complementary measurements, which are less crucial product dimensions (figures 7 and 8).

Some product measurements concern decorative details affecting the appearance alone but not the construction. Greater inaccuracies may sometimes be tolerated in such details than in the construction measurements. Typical examples are shown in figure 9.

Figure 6

Dimensioned final assembly drawing for a simple piece of furniture

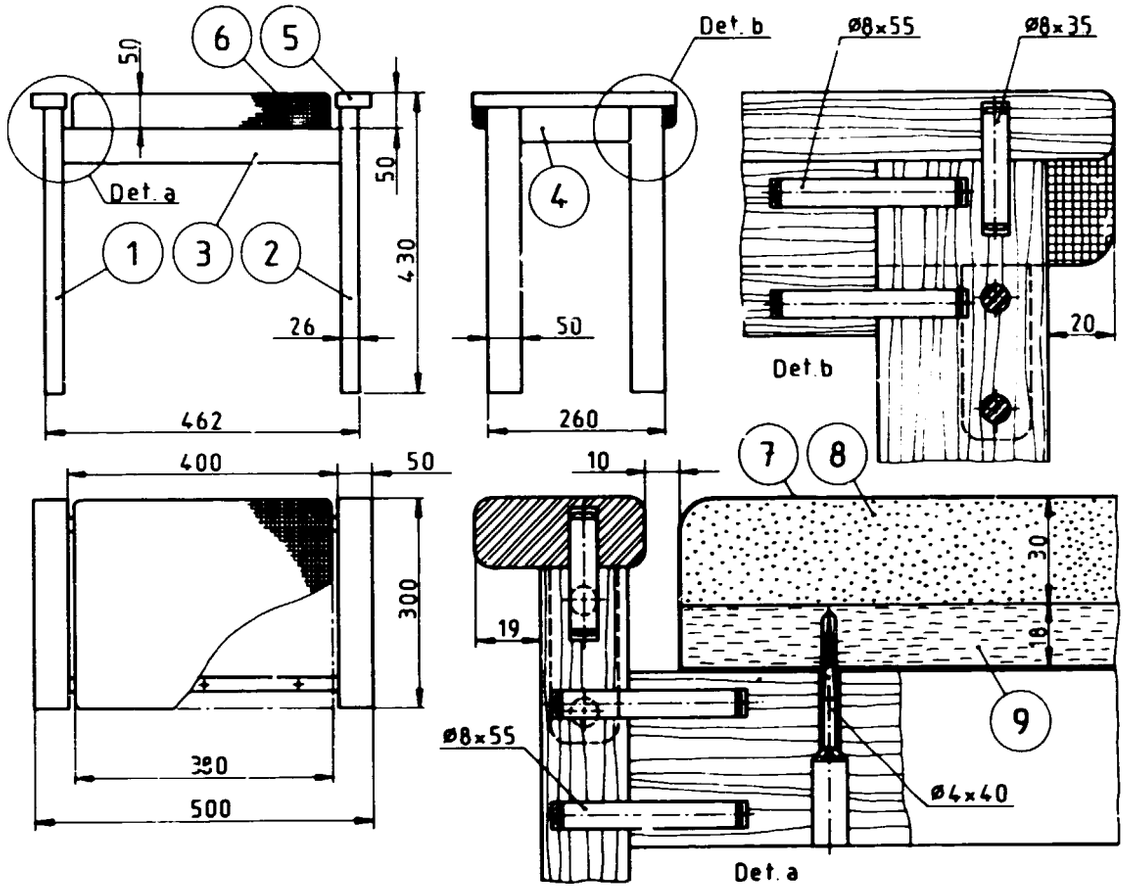


Figure 7

Assembly drawing of a table showing primary (p) and complementary (c) measurements. The primary dimensions are decisive for the accuracy of the joint

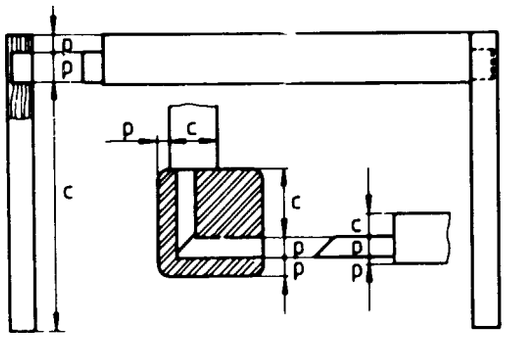


Figure 8

Cabinet side with drawer supporting slides showing primary (p) and complementary (c) measurements. The levels of the upper edges of the slides and the end-to-edge distances are decisive for the proper location of the drawers and therefore are primary (p) measurements. The other measurements given are complementary (c)

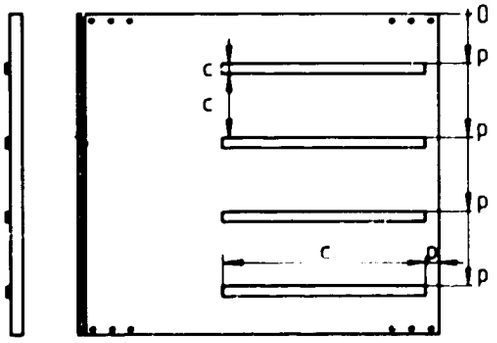


Figure 9

Curved furniture components with decorative details

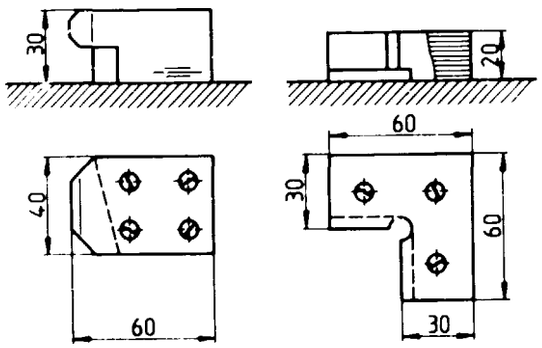
Position and construction of stoppers

Special stoppers are needed for the accurate positioning of workpieces in both machining and assembly jigs. Their design should be based on the following rules:

(a) The stoppers must hold the workpiece at specific points and not over long lengths, so as to prevent small particles such as wood chips and dust from supporting the part at the wrong places. Extra space should be available for splinters that may become lodged in the corners of the workpiece (figure 10);

Figure 10

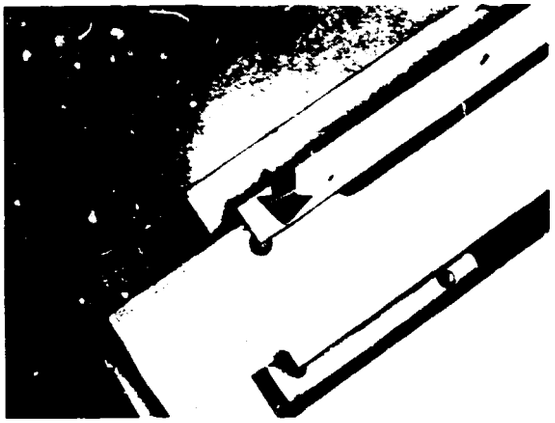
Wooden stoppers



(b) The location of the stoppers must correspond to the primary measurements whenever possible (figure 11);

Figure 11

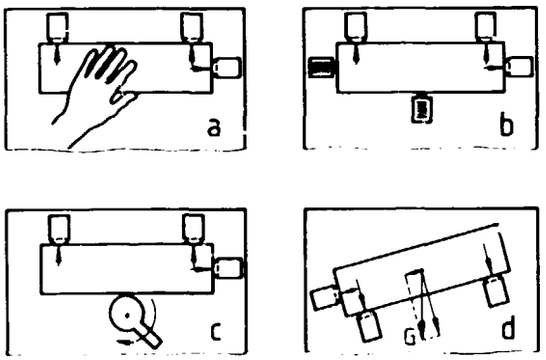
Location of stoppers. The panel (see figure 8) is upside down in the jig



(c) The workpiece can be pushed against the stoppers by hand, using rubber or steel springs, eccentrics or some other mechanical means, or by gravity (figure 12);

Figure 12

Alternative methods of holding the workpiece against the stoppers:

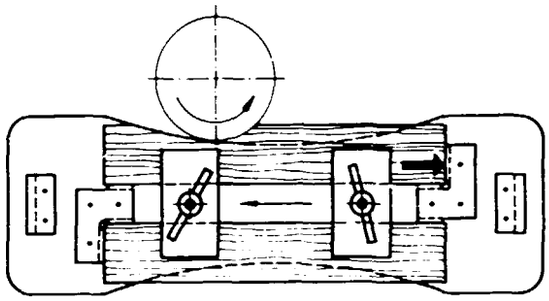


Key: a. Pushing by hand
b. Spring
c. Eccentric
d. Gravity

(d) In machining jigs the stoppers in the direction of the feed should be positioned against the cutting force (figure 13);

Figure 13

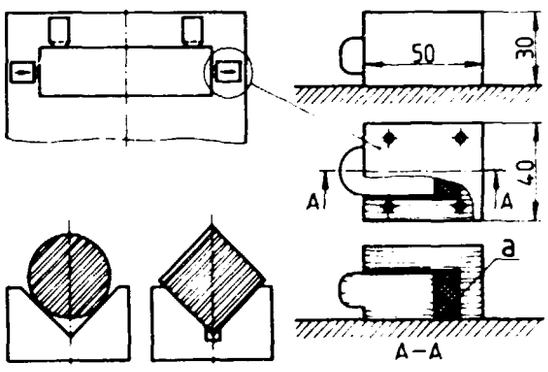
Spindle-moulding jig for a curved furniture component. The cutting force pushes the workpiece against the stoppers



(e) If the workpiece must be held symmetrically between two stoppers, both should be provided with similar springs. For workpieces with a circular or square cross-section, special holders shcuild be constructed (figure 14).

Figure 14

Stoppers for holding the workpiece symmetrically with respect to the jig. A piece of medium-hard rubber (a) acts as spring in the wooden stopper



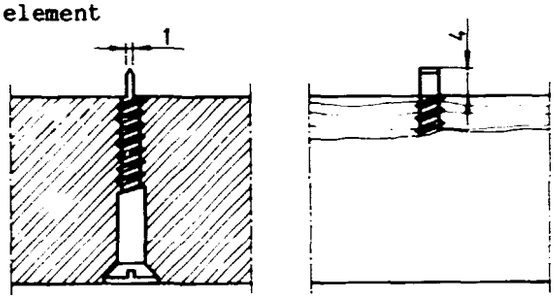
Fixing elements

The workpiece must be tightly secured in the machining jigs. Certain assembly jigs also require good fixing of the workpiece. The commonly used fixing elements are listed below.

1. Thin steel pins sharpened like a chisel. The sharp edge must penetrate into wood in the direction of the grain to avoid cutting the fibres. Such pins are often used in jigs for band-sawing, spindle-moulding, and routing (figure 15).

Figure 15

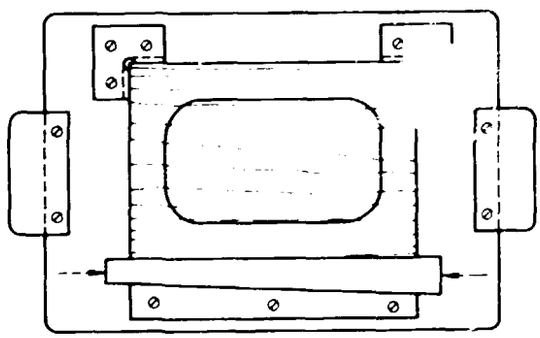
Sharpened steel pin used as fixing element



2. *Wedges, usually made of wood or* plywood, are common in spindle-moulding and routing jigs (figure 16).

Figure 16

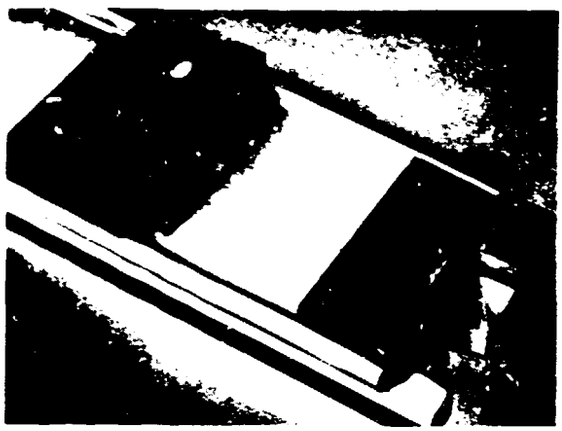
Routing jig with a wooden wedge for fixing the workpiece. A hammer is used to tighten and loosen the wedge



3. Screws, which were formerly very common in all kinds of machining jig (figure 17), are being superceded by eccentrics, which may be tightened more rapidly.

Figure 17

Spindle moulding jig with a screw-type clamp for fixing the workpiece



4. Eccentrics, often used both in machining and assembly jigs. The material may be wood, plywood, or metal. Car engine valve springs can be used to return the pressure shoes when opening the eccentrics (figures 18 and 19).

5. Fire-hose clamps, used particularly in assembly jigs (figures 20 and 21). The fire hose must have a plastic lining on its inner face.

Figure 18

Spindle-moulding jig with eccentrics as fixing elements. Sandpaper is glued on top of the jig base to increase the friction

Figure 19

Eccentric with pressure plate (a) for fixing the workpiece

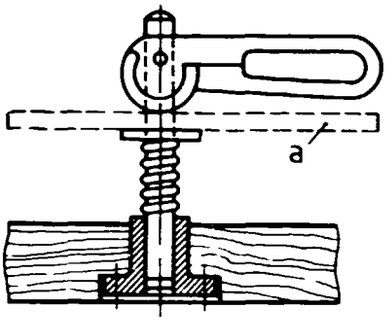


Figure 20

Principle of a fire-hose clamp

(a) With no pneumatic pressure applied
(b) With pressure applied

Rubber bands around the clamp work as return springs

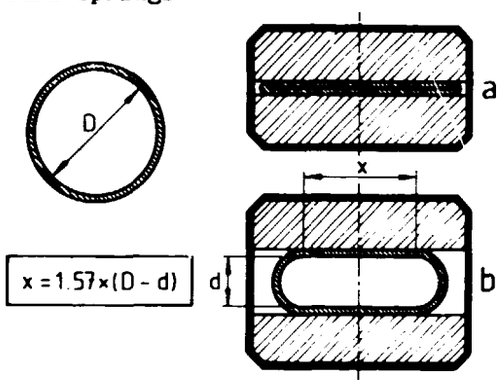
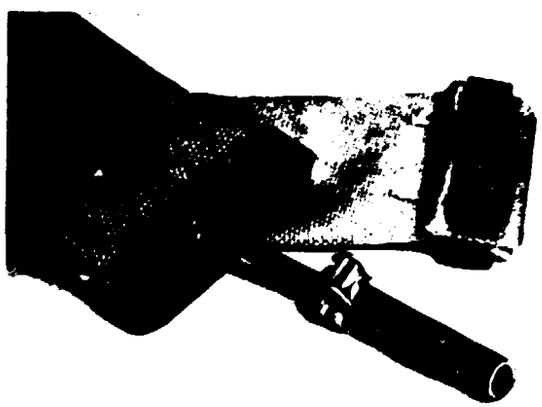


Figure 21

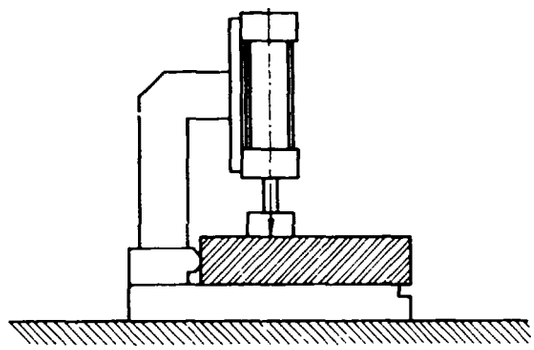
Construction of a fire-hose unit. The ends of the hose are sealed by riveting



6. Pneumatic cylinders and suction cups, used in advanced jigs for both machining and assembly (figure 22).

Figure 22

Pneumatic cylinder for fixing a workpiece on a jig



The friction between the workpiece and the jig can be easily increased by glueing a piece of sand-paper or abrasive cloth on the base panel of the jig (figure 18).

Single and multi-purpose jigs

Jigs may be classified as single- and multi-purpose according to their uses. The first type of jig is designed to serve one definite purpose, whereas the latter may be adjusted for various purposes. Most spindle-moulding and routing jigs are constructed for a certain component and specific machining operation and will be rejected when the production of the component is finished. Good examples of multi-purpose jigs are the adjustable jigs for the band-sawing of circular pieces with unequal radius from various panels, and those assembly jigs in which the guiding and clamping elements can be readjusted within certain limits.

Accuracy of jigs

Machining jigs

The accuracy of the working heads of woodworking machines is at most ± 0.05 mm when the bearings are in good condition. Studies made in furniture and joinery industries have shown, however, that the actual maximum accuracy with which parts and their details can be machined is ± 0.1 mm to ± 0.3 mm, taking into account the changes in dimensions resulting from variations in moisture content of wood during the manufacturing process. The accuracy with which small details such as joints can be machined is usually higher than the accuracy with which larger parts can be manufactured.

The measurements in the above-mentioned studies were taken from workpieces in the machining of which the standard guiding elements of the machine have been used (straight fences and feed tables and chains) for feed control.

When machining with jigs, the standard guiding elements are replaced by the guiding surfaces of the appliances, with a special attachment in the machine, but the machining principle itself remains the same. For example, when spindle-moulding a longitudinal groove into a furniture component, it is fed along the straight fence of the machine, but in the spindle-moulding of a curved chair leg, the guiding edge of the jig is fed along a collar around the spindle opening in the machine table, keeping the jig tightly in contact with the collar. If the stoppers, which control the positioning of the workpiece within the jig, are properly designed, the machining accuracy should not differ very much from the standard method, provided the following conditions are met:

(a) The guiding collar is precisely circular and fits tightly into the spindle opening;

(b) There are no chips or dust between the jig stoppers and the workpiece;

(c) The workpiece is carefully secured in the jig.

Various experiments have shown that the machining accuracy of spindle-moulding jigs falls within the limits of overall machining accuracy stated earlier. The same may be expected to apply to most machining jigs.

Assembly jigs

The dimensional accuracy of an assembled furniture detail or a finished product depends on the accuracy with which the manufacture of parts is carried out and on the precision of the assembly stage itself. If the parts are interchangeable and the proper jigs available, the assembly can be done very accurately and efficiently. The main functions of the assembly jigs are as follows:

(a) One or more parts have to be fixed to another part by glueing, nailing, stapling, or screwing according to the primary measurements (figure 8), without any machined joints (known as surface fixing);

(b) Parts with machined joints must be glued to each other. The jig must take care of the clamping and proper angularity of parts, so that manual corrections before the setting of the glue will not be necessary (figure 23);

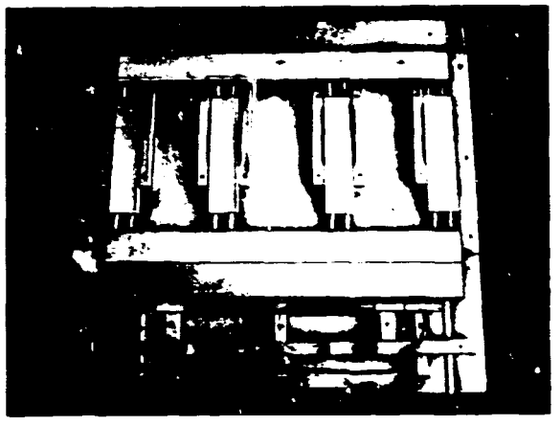
(c) The jig must ensure correct clearances at proper points when assembling moving parts.

The assembly jigs have so many different uses that any generally applicable figures about their precision cannot be given. Experiments carried out by the expert have shown that the accuracy with which a part can be located within another part in surface fixing corresponds to the average machining accuracy of about ± 0.2 mm to ± 0.3 mm.

The nominal clearance between two sliding parts must be chosen according to the size of the detail in question. Usually the clearances vary between 0.5 mm and 3 mm. For example, the

Figure 23

Frame assembly jig with pneumatic cylinders. The jig also ensures the rectangularity of the frame

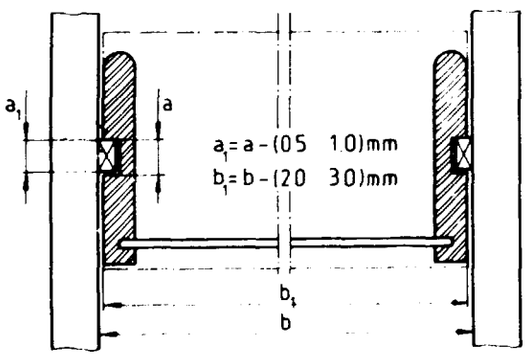


nominal clearance between the sliding groove of the drawer side and the supporting wood strip should be about 0.5-1 mm in the width of the groove, whereas the outer width of the same drawer, when assembled, should be 2-3 mm less than the inner width of the cabinet (figure 24).

Particular attention must be paid to the supporting principle of the drawer in the foregoing example. It is easy to show that the distances of the upper edges of the supporting strips from the cabinet top are decisive for the

Figure 24

Cross-section detail of a portion of a cabinet with a drawer showing nominal clearances necessary for the proper moving of the drawer



proper location of the drawer or a set of drawers, if there are several of them on top of each other. The distances will therefore be primary measurements for the jig designed for nailing or stapling the strips.

Jig materials

The properties of the materials used for the jig body (base, frame etc.) and the guiding elements are decisive for the precise functioning and manufacturing accuracy of the jigs. The general material requirements are as follows: good resistance to wear (hardness); good moisture stability, that is, low tendency to warp, shrink or swell under moisture variations; rigidity, smoothness and easy working with machines and hand tools.

The traditional material, solid wood, is well suited for many jig details such as stoppers, pressure shoes, eccentrics and handles, but not recommended for the material of the guiding elements of high precision jigs because of the shrinking and swelling of wood under moisture content variations. The best-suited wood-based materials are of cross-laminated structure and include the following: cross-laminated solid wood, plywood, blockboard, hard fibre board and particle board.

For the guiding elements very high-quality material can be made of the above-mentioned panels by glueing a sheet of rigid plastic laminate (Formica-type) on each side. The surface and edges of the combined panel are very resistent to wear. Easy sliding, affecting the accuracy of the jig and the quality of finish, particularly in spindle-moulding and routing, can be ensured by rubbing solid paraffin as a lubricant on the surfaces. Plastic laminates are also among the best materials for machining jig bottoms, because they ensure easy sliding.

Before being used, all wood-based jig materials should have a moisture content in equilibrium with the relative humidity of air inside the factory, so as to avoid inaccuracies caused by later deformations. If several panel or sheet materials are combined by glueing, the construction should always be symmetrical to avoid warping and curving. When a particularly long service life is required, aluminium sheet can be used to make the guiding parts, particularly in routing jigs.

Rigid frames are necessary in certain assembly jigs. They can eventually be constructed of wood or wood-based panels, but very often steel or aluminium profiles are also used because of better strength and stiffness. If the weight is not decisive, steel is more practical because it can be easily welded in any factory maintenance workshop.

Quality and price of jigs

High quality in a jig does not necessarily mean a high jig cost but is more related to proper design and material selection. In fact the material cost of the majority of machining and assembly jigs is very low, and in many cases one can literally pick up the material from the factory floor. If complicated assembly jigs with pneumatic components are overlooked, the following rules apply to most ordinary production jigs:

(a) The design stage of a jig seldom takes more than a few hours to complete, provided proper working drawings or an accurately made prototype of the new product are available;

(b) The cost of materials and supplies for a jig can sometimes be disregarded because of the use of waste pieces. Even in the case of big jigs, the material consumption is rarely more than that of an average piece of furniture produced by the factory. Certain jig components such as eccentrics, screws and springs can be recycled after a jig has become useless;

(c) The construction, if proper jig drawings are available, seldom takes more than a few hours.

III. Jig storage and identification

Planning of storage areas

Jigs designed and built for serial production of furniture form an important part of production facilities and should therefore be carefully stored. The following storage requirements should be met:

(a) Storage should be close to the tool maintenance workshop. In large factories it is advisable to keep assembly jigs in a special storage area in the assembly shop;

(b) The storage area must be a special room separated from the actual production workshop to avoid chips and dust on the stored material;

(c) The relative humidity in the storage area should be the same as in the factory in general. A jig should never be exposed to water (rain, pipe leakages);

(d) The most practical means of storing smaller jigs is by hanging them from special racks fixed to the walls. Shelves can be constructed for large and heavy jigs.

(e) The jigs must be provided with an identification number or code and stored accordingly.

Identification of jigs

The standard models produced serially in furniture factories usually carry a type number or code for easy identification. A factory may choose the following type of coding system:

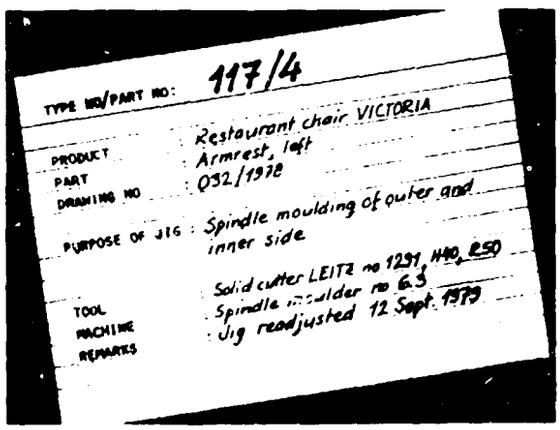
Chairs	100 ... 199
Tables	200 ... 299
Cabinets	300 ... 399
Bookcases	400 ... 499
Beds	500 ... 599

The first number of the three-digit codes indicates the product group. The code number can serve as the general storage number of all the jigs used to make the product in question. The different jigs of the set are further identified by the part number in the working drawing. Similarly, the jig numbers should be used in the drawings as references to the part in question or in the column of remarks in the list of parts.

A good practice is to complete a filing card for each jig in storage, including all information necessary for the use of the jig. An example of such a filing card is shown in figure 25.

Figure 25

Filing card used for the identification of jigs



IV. Examples of jigs for use in machining of furniture parts

The selection of machining jigs to be introduced in the following examples consists of a variety of appliances, principally made of wood or wood-based panels, which are intended for use on basic woodworking machines. The main purpose of presenting the examples is to show how different types of jigs can be designed and constructed and how they work. All materials and supplies needed are cheap and easily available. They enable considerable working time to be saved in production, thus helping to achieve improved productivity together with improved quality of finish, dimensional accuracy and safety.

The examples of jigs are grouped according to the types of machine on which they are designed to be used, the main emphasis being placed on the principles involved and not on the measurements, which in practice will vary from case to case.

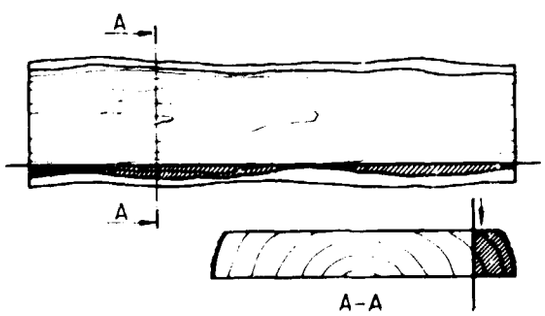
Jigs for use on band-saws

Edge-sawing attachment

The attachment or jig is used to saw the first straight edge on an unedged board (figure 26), so that a pencil marking is not necessary. The attachment consists of a base panel, fixed on the band-saw table, and a feed slide (figure 27).

Figure 26

Band-sawing of an unedged board



The board is manually secured on top of the feed slide with sharp steel pins. The function of the attachment is illustrated in figures 28, 29 and 30. The attachment can be fixed on the machine table, for example with steel pins which penetrate through the fixing rails (figure 27, (e)) into holes bored on the edges of the table. Such a method makes it possible to position the attachment properly each time it is used, without further adjustments.

Jig for sawing wedge-shaped pieces

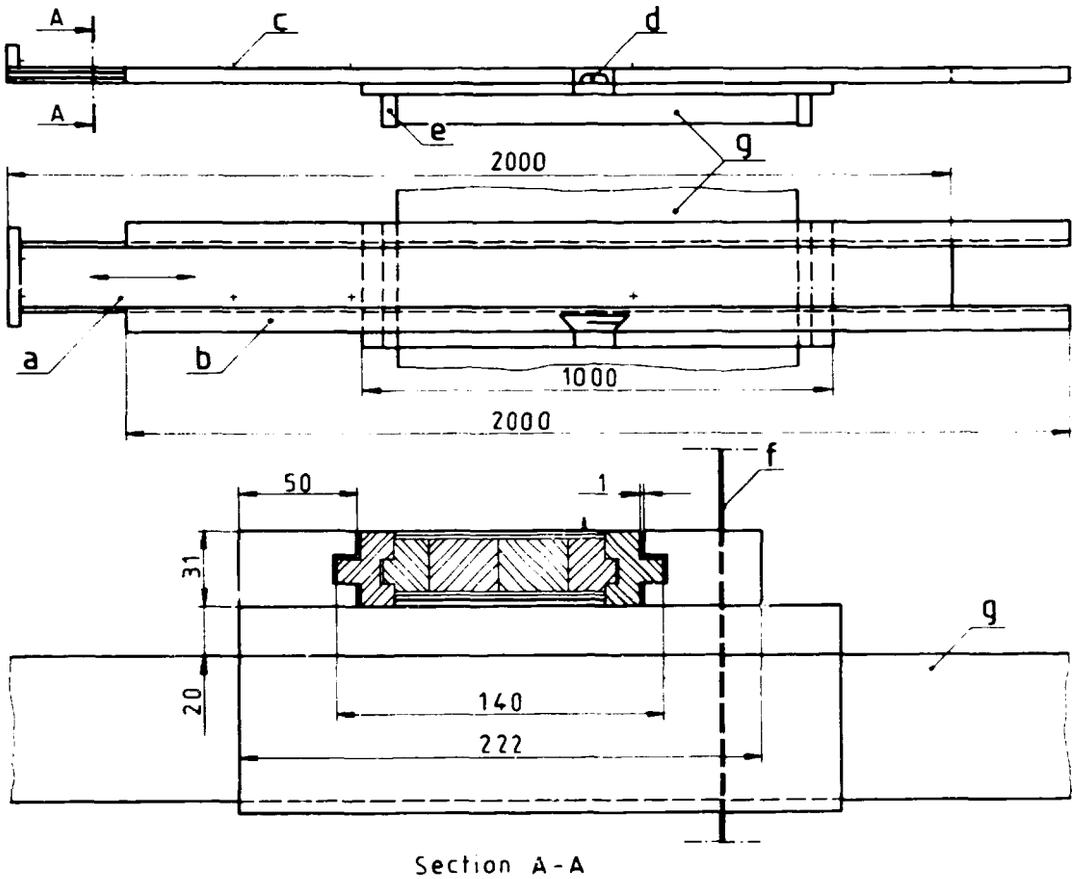
Various types of wedge can be easily sawn from solid wood by using a wooden feed-block or jig with a wedge-shaped incision, as shown in figures 31 and 32.
If a large number of wedges is needed, the material should first be cut into larger pieces with the same measurement in the direction of the grain as a desired wedge length. When the material is turned upside down after each successive cut, a series of similar wedges is easily obtained without any unnecessary wastage of wood. The same method can be applied to the sawing of wedge-shaped parts from particle board and other wood-based panels, as reflected in figure 33. The jig is guided against the adjustable band-saw fence.

Jig for trimming edges of surfaced panels

The purpose of the appliance is to remove the protruding margin of surfacing material on panel edges. The

Figure 27

Edge-sawing attachment for band-saw



Section A-A

Key:
a. Feed slide with steel pins
b. Guiding rail
c. Steel pin
d. Removable hardwood block with slit for band-saw blade
e. Fixing rail
f. Band-saw blade
g. Machine table

Figure 28

Edge-sawing attachment seen in direction of feed

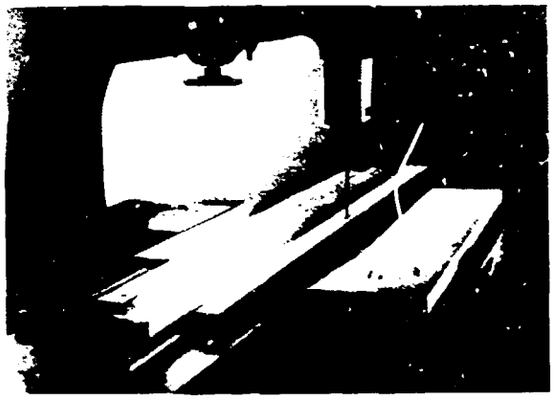


Figure 29

Edge-sawing attachment in operation

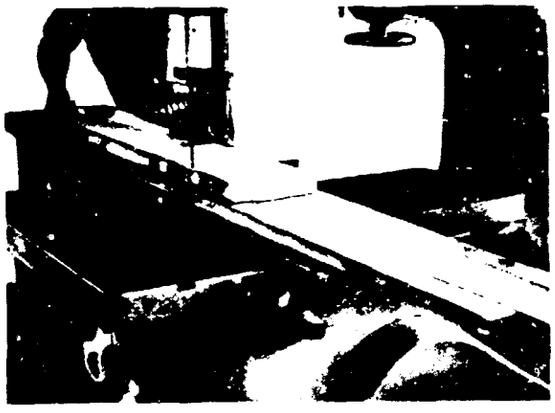


Figure 30

Edge-sawing attachment seen from the rear

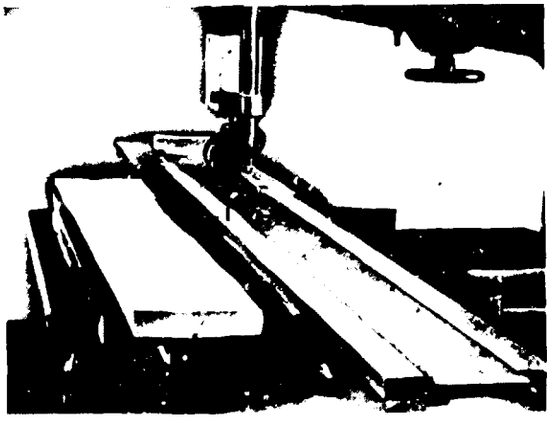


Figure 31

Wedge-sawing jig in operation

Figure 32

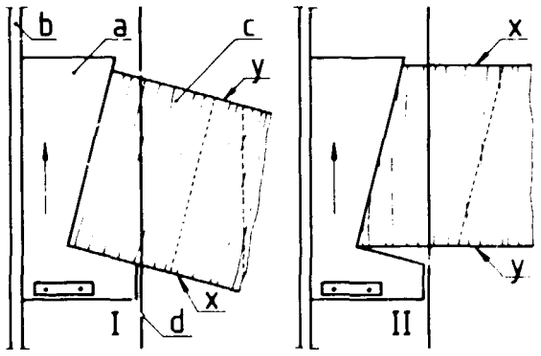
Working principle of wedge-sawing jig

Figure 33

Jig for sawing wedge-shaped parts from wood-based panels

I. First cut

II. Second cut, after reversing the panel

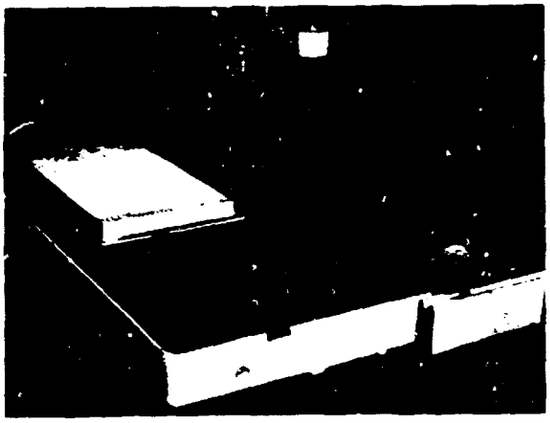


Key: a. Jig
b. Machine fence
c. Work piece
d. Sawing line
X and Y are panel edges (to show reversing)

jig consists of a straight adjustable plywood guide, with an incision for the band-saw blade, slightly raised from the top surface of the machine table (figure 34).

Figure 34

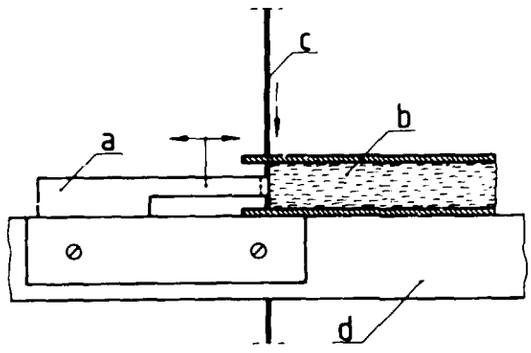
Panel edge trimming jig for removal of protruding excess of surfacing material



If the band-saw has a metal fence the guide should be fixed to the fence. The edge of the core panel is fed along the guide as shown in figure 35.

Figure 35

Cross-section of edge trimming jig seen in direction of feed

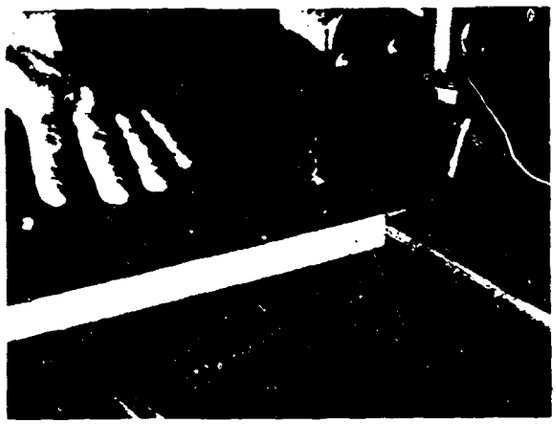


Key: a. Adjustable guide
b. Workpiece
c. Band-saw blade
d. Machine table

The sawing depth can be controlled by adjusting the distance of the guiding edge from the sawblade. The end blocks of the attachment can be fixed to the machine table directly with screws or small screw clamps, depending on the construction of the table. Figure 36 shows the appliance in operation.

Figure 36

Edge trimming jig in operation



Jig for sawing octagonal profiles

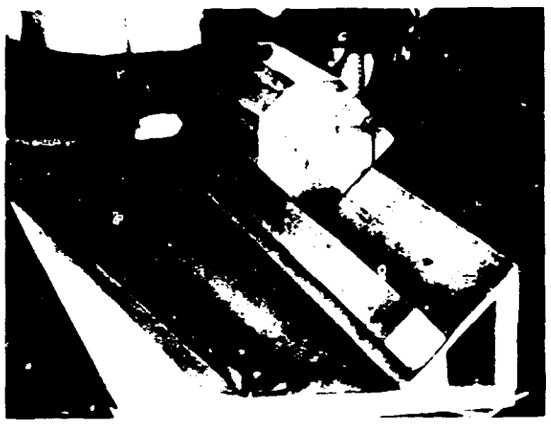
The design and construction of the jig are clearly reflected in figures 37 and 38.

Figure 37

Jig for sawing octagonal profiles, first feed

Figure 38

Jig for sawing octagonal profiles, third feed



The small wooden strip, fixed on the jig bottom, fits into the groove of the band-saw table and ensures its proper positioning. The jig is secured on the machine table with a screw clamp.

The workpiece with a square cross-section is fed along the inclined guiding surfaces of the jig. By fitting wooden slats of different thicknesses between the guiding surface and the workpiece, different sizes of octagonal profiles are obtained. The corresponding sizes are given in the following table (see figures 39, 40 and 41).

Dimensioning of jig for band-sawing octagonal profiles on the basis of figure 42

a (mm)	x (mm)	t (mm)
100	70.7	0
90	63.6	7.1
80	56.6	14.1
70	49.5	21.2
60	42.4	28.3
50	35.4	35.3
40	28.3	42.4

Note: t = thickness of slat used for spacer

Figure 39

Fitting wooden slat for spacer. The jig is slightly lifted from the table to show the wooden slide fitting into the table guide groove.

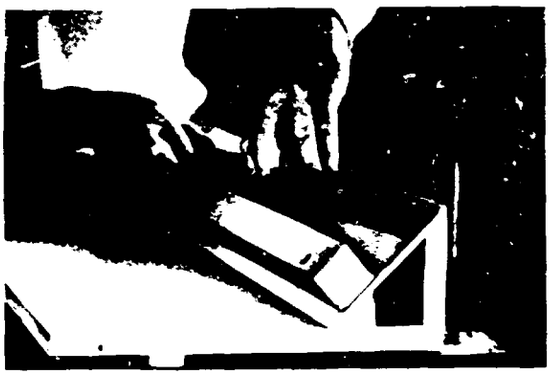
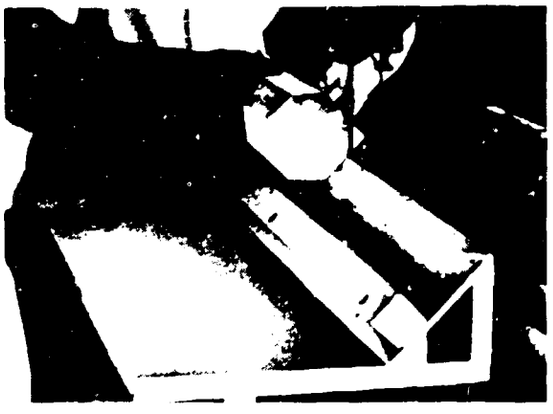


Figure 40

First feed using spacer

Figure 41

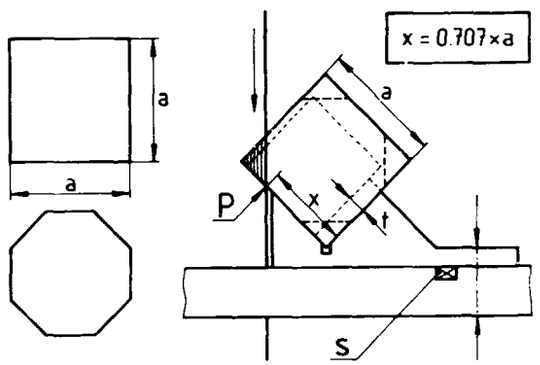
Fourth feed using spacer



The use of wooden dowels is a practical method of securing the slats on the jig. To facilitate the proposed changes, slats should be made with standard thicknesses corresponding to the standard sizes of the profiles to be produced. The principles governing the establishment of the jig dimensions are reflected in figure 42.

Figure 42

Dimensioning principle of jig for band-sawing regular octagonal profiles. The position of point P is independent of the size of the square profile. S is the guiding wooden slat placed in the guide groove of the machine table



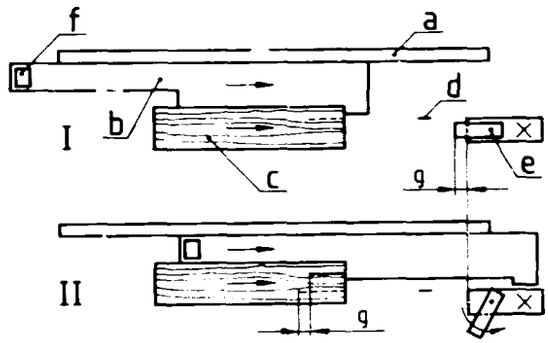
Jigs for tenoning

The standard method of tenoning with a band-saw is to saw first the tenon sides and then the shoulders. A simple jig which makes it easy to saw the parallel sides of a straight tenon is shown in figures 43 and 44.

The two-step wooden feed block or jig maintains the tenon thickness constant. The height of the step is the same as the desired tenon thickness plus the width of the kerf. The sawing depth, that is, the length of the tenon, is controlled by a stopper. If the sides of the tenon should be of different length, a swivel-type double-acting stopper is used. This type of jig permits the production of tenons placed asymmetrically. The function of the jig and stopper is shown in figures 45 and 46.

Figure 43

Jig for sawing sides of straight tenons



Key:
a. Band-saw fence
b. Two-step sliding jig
c. Workpiece
d. Saw blade
e. Swivel-type stopper
f. Returning handle
g. Difference in length of tenon sides

Figure 44

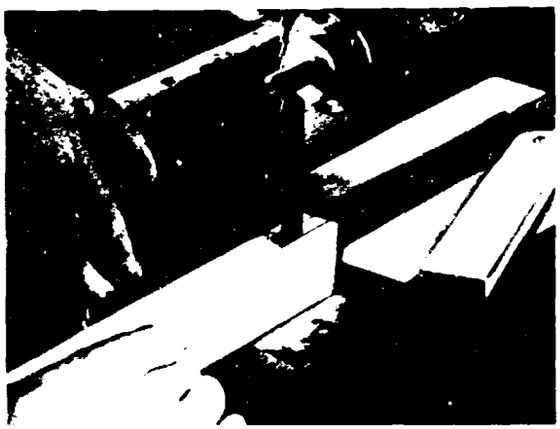
Jig, double-acting stopper and finished tenon

Figure 45

Sawing of shorter side of tenon

Figure 46

Sawing of longer side of tenon. The swiveling stopper is turned aside



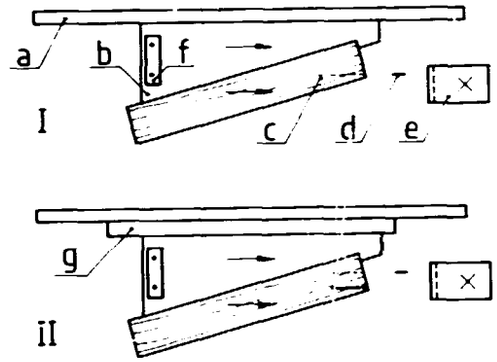
A jig or feedblock for inclined tenons is illustrated in figure 47.

For the second sawing a wooden slat is used as a spacer to control the tenon thickness. Here again the thickness of the slat is the same as the desired tenon thickness plus the width of the kerf. The two working stages are shown in figures 48 and 49.

In figure 47 the workpiece, guided by the jig, is fed until the end to be tenoned meets the stopper, whereas in

Figure 47

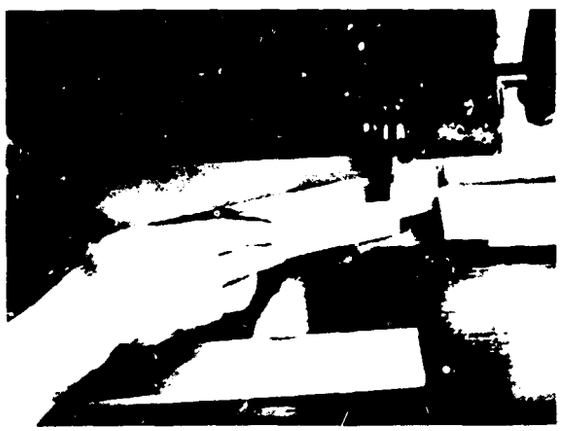
Jig for sawing sides of inclined tenons



Key:
a. Band-saw fence
b. Sliding jig
c. Workpiece
d. Saw blade
e. Stopper
f. Returning handle
g. Slat for spacer

Figure 48

Sawing of right side of tenon



figures 48 and 49 the movement of the jig is limited by the stopper. Both alternatives are feasible.

The principle of cutting the shoulders of the tenon is illustrated in figure 50.

The necessary cutting jigs are shown in figures 51, 52, 53, 54 and 55.

Figure 49

Sawing of left side of tenon using wooden slat as spacer

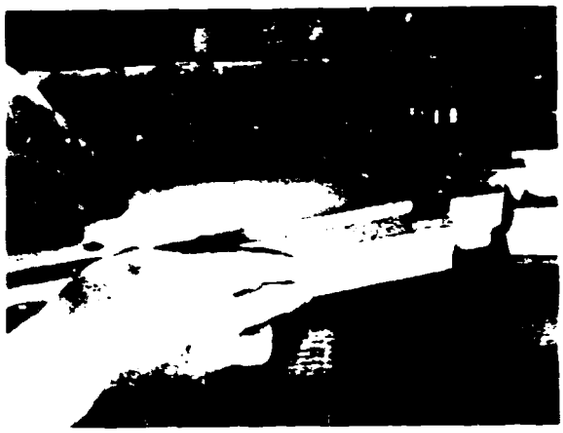


Figure 50

Principle of cutting tenon shoulders, top view

(a) Straight tenon with one perpendicular and one inclined shoulder

(b) Inclined tenon, shoulders perpendicular to tenon sides

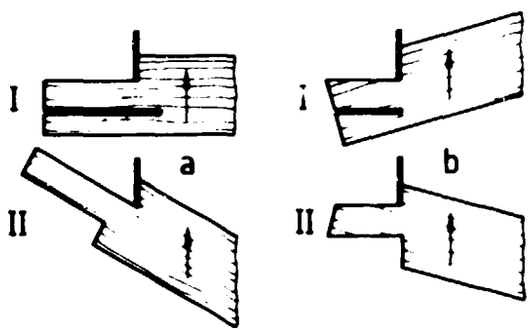


Figure 51

Cutting of perpendicular shoulder of straight tenon

Figure 52

Cutting of inclined shoulder of straight tenon

Figure 53

Cutting of shoulder of inclined tenon, first operation

Figure 54

Cutting of shoulder of inclined tenon, second operation

Figure 55

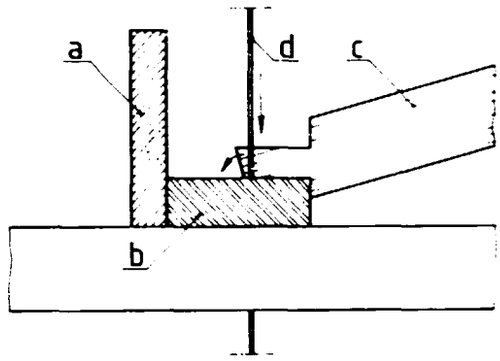
Cutting jig and a finished workpiece

The cutting depth is controlled by hand in the illustrations. A stopper can also be used for this purpose, particularly in serial production. The standard angular feed-guide of the machine is used to move the jig block.

The inclined end of tenons can be trimmed perpendicularly, if desired, according to figure 56.

Figure 56

Trimming of end of inclined tenon



Key: a. Band-saw fence
b. Slat
c. Workpiece
d. Band-saw blade

Jigs for sawing circular shapes

The critical factors in all form-sawing with a band-saw are the width of the saw-blade and the dimensions of the set of teeth, which together determine the minimum radius (r_{min}) of curvature obtainable. The latter can be calculated from the following formula:

$$r_{min} = \frac{b^2}{2H}$$

b = width of the saw-blade
H = measurement of set, usually 0.3 mm (to left and right)

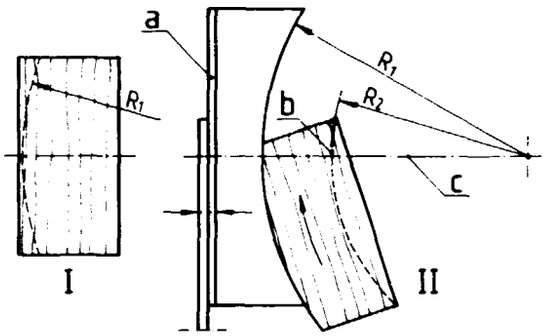
The following figures are calculated according to the above formula for a set measurement of 0.3 mm:

Width of saw-blade b (mm)	Minimum sawing radius r_{min} (mm)
6	60
8	107
10	167
12	240
15	380
20	670
25	1040
30	1500

The principle of a simple jig for band-sawing pieces with two circular edges, having the same centre (part of a circular ring), is shown in figure 57. The set-up should be done in such a way that the tooth bottom of the saw-blade falls on the centre line (c). The first sawing is done on a drafted line. The jig itself can be used as a drafting template before fixing it to the machine as shown in figure 58.

Figure 57

Principle of sawing pieces with two circular edges having the same centre. The first sawing is done on a drafted line (I) and the second with a jig (II). Top view



Key: a. Circular jig
b. Saw blade
c. Centre line

R_1 and R_2 are the outer and inner radii of the sawing lines

After having drafted the first sawing line on all pieces of the batch in question, the sawing is carried out according to the pencil markings (figure 59).

For the second sawing operation the jig is fixed to the band-saw fence with a carpentry clamp. The second sawing with the jig is shown in figure 60.

To separate pieces in which both edges have the same radius, a jig with a fixed circular guide and a rotating feed slide is necessary (figure 61).

Figure 58

Drafting of the first sawing line using the jig as a template

Figure 59

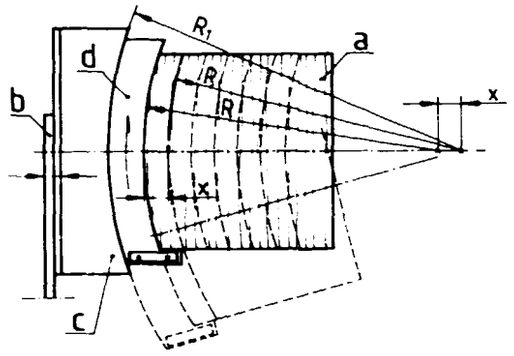
First sawing according to pencil marking

Figure 60

Second sawing with jig

Figure 61

Jig with a fixed and moving guide to separate pieces having the same radius at both edges



Key: a. Workpiece
b. Band-saw fence
c. Fixed circular guide
d. Moving circular guide or feed slide

The first sawing of each panel in the batch must be done on a drafted line as above, whereas all successive sawings are done one after another without any extra drafting or wastage of material. The moving feed slide can be used as the drafting template (figure 62) for the first sawing line. Particular attention should be paid to the geometry of the jig when designing it. According to figure 61, the fixed guide and the sawing line must have the same centre of curvature but different radii (R_1 and R), whereas the left edge of the feed slide has the desired sawing radius (R) but a different centre of rotation. The distance between the two centres (x) is the same as the width of the desired component measured at its middle. The working stages with the jig are shown in figures 63, 64 and 65.

If both edges of the pieces must have the same centre (but different radii), they can be resawn by using a fixed jig as shown earlier in figure 57.

Figure 62

Drafting of the first sawing line using moving feed slide as template

Figure 63

Hand-controlled sawing along the drafted line

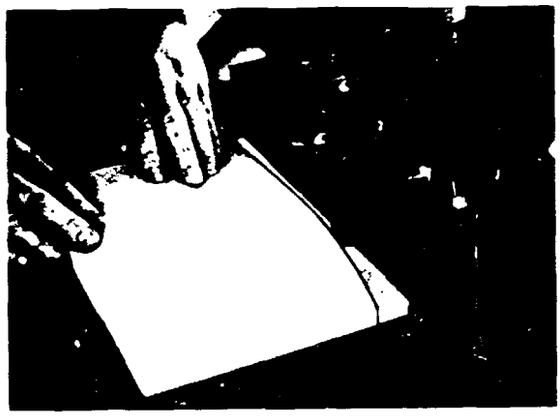


Figure 64

Successive sawings with jig by using the feed slide. View from rear of the band-saw

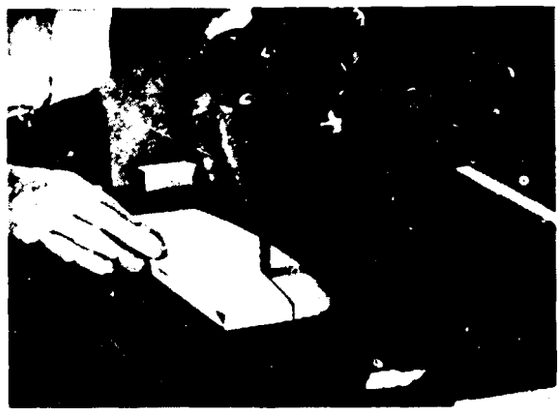
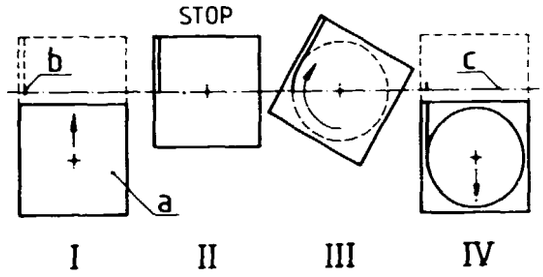


Figure 65

Use of jig seen from the side of the operator

Figure 66

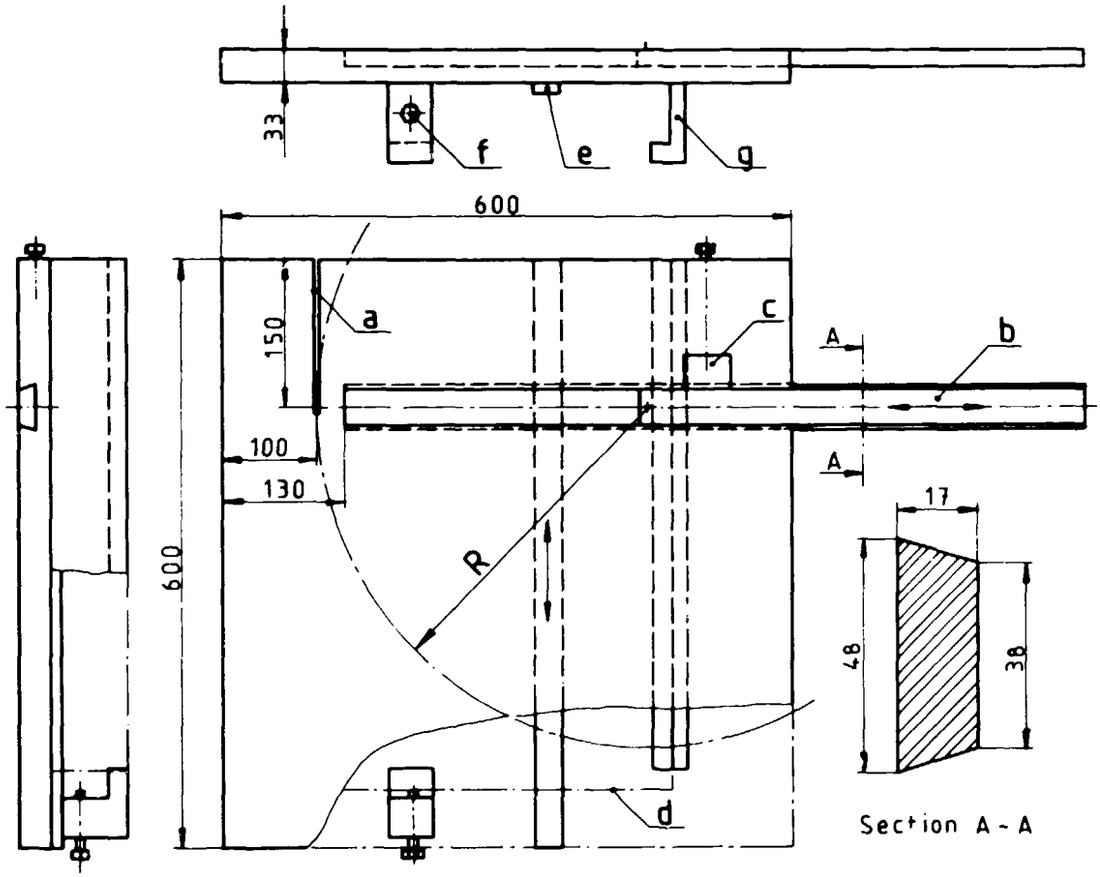
Principle of band-sawing circular discs



Key: a. Square-shaped workpiece (panel)
b. Band-saw blade
c. Centre line

Figure 67

Jig for band-sawing circular discs



Key:
a. Slit for saw blade
b. Adjustable rail holding centre pin
c. Rail fixing block
d. Edge line of band-saw table
e. Slide
f. Stopper bolt
g. Side guide

Jig for sawing circular discs

The method of sawing circular discs is illustrated in figure 66.

The square-shaped panel to be sawn is fixed centrally onto a centre pin with sharpened point (I), then fed linearly towards the band-saw blade until the root of the blade teeth meets the centre line (II). Now the panel is turned around (III) and finally withdrawn to its starting position (IV).

A jig is shown in figure 67.

The sliding strip (e) on the reverse side of the jig base slides in the groove of the machine table and thus controls the linear feed. The feed stops when the stopper bolt (f) meets the edge of the machine table. The centre pin is fixed into an adjustable rail (b) which for large sawing diameters can be turned so that the centre falls outside the jig base. The constructive details of the jig are shown in figures 68, 69 and 70.

If the discs to be separated are small it is advisable to cut the panel material into bigger squares to make four discs out of each as shwon in figures 71, 72, 73, 74 and 75.

The corner markings shown in figure 71 should be done on removable masking tape strips.

Figure 68

Detail of jig base showing slit for saw blade and adjustable centre pin

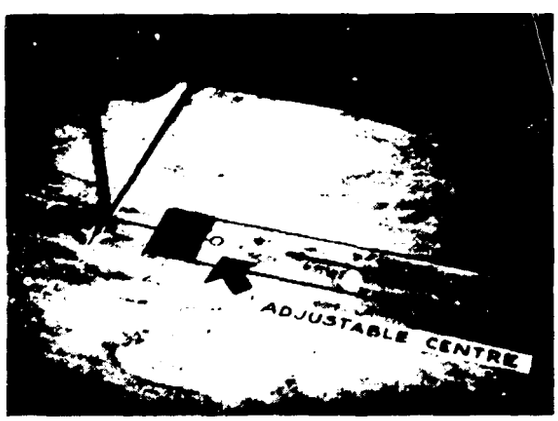


Figure 69

Adjustable rail accommodating centre pin taken apart. The screw and plywood block for fixing the rail may be seen

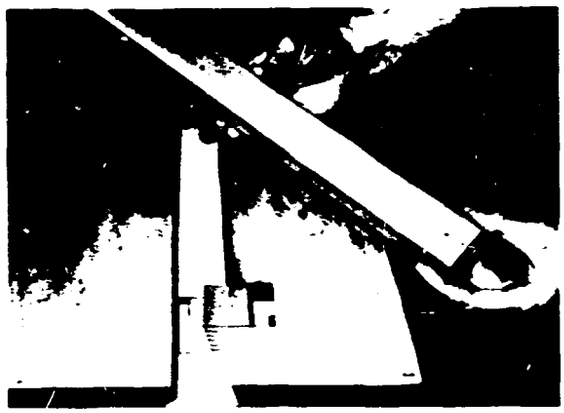


Figure 70

Reverse side of jig. The slide is seen in the middle of the jig base

Figure 71

Fixing workpiece on top of jig using the fist as a hammer. Markings facilitate proper positioning of panel

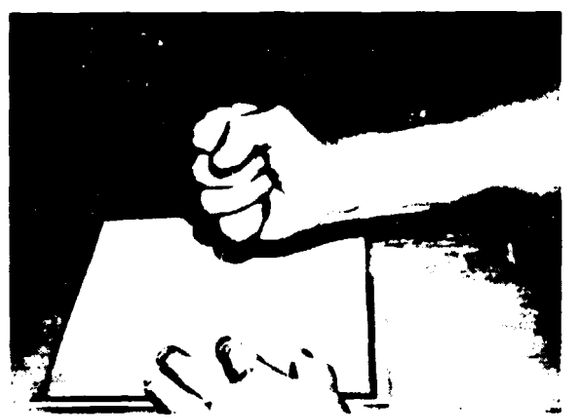


Figure 72

Linear feed towards saw blade

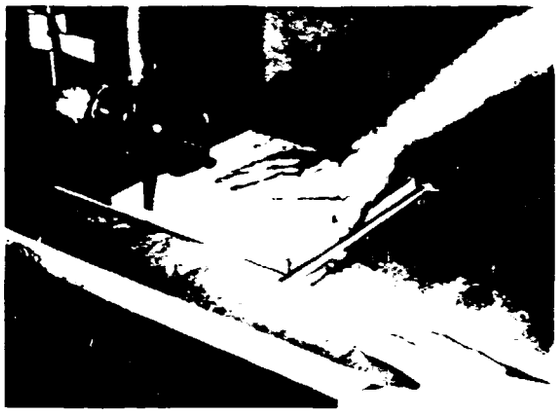


Figure 73

Turning workpiece to saw the first disc

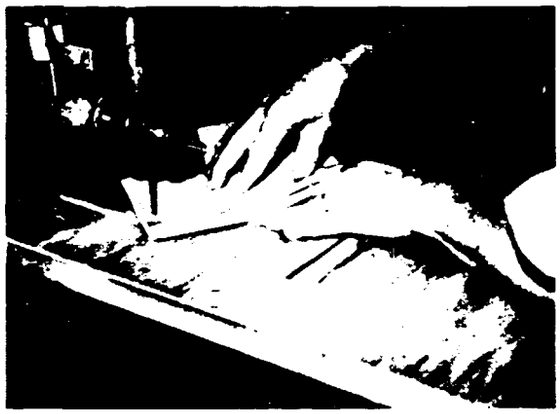


Figure 74

Linear feed towards the saw blade to saw the fourth disc

Figure 75

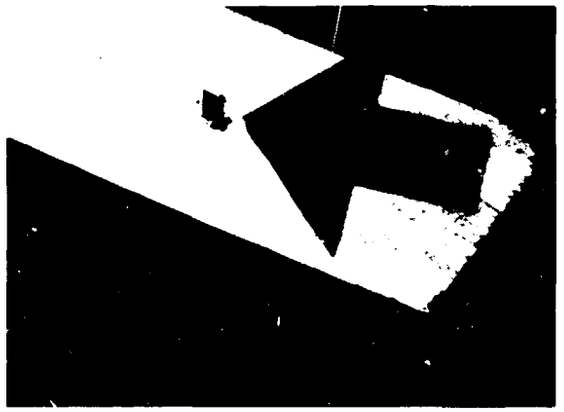
Turning the workpiece to saw the fourth disc

Jig for sawing curved parts with variable or constant radii

The jig is a piece of wood similar to the components to be separated but provided with sharpened steel pins to secure it on the planed board to be sawn. A detail photograph is shown in figures 76 and 15.

Figure 76

Sharpened steel pin on reverse side of jig



Two alternative jig guides, along which the jig is fed, are shown in figure 77 and the respective set-ups in figures 78 and 79.

Figure 77

Two alternative guide constructions. The wooden guide in front has an open incision for the saw blade, whereas the metal-headed guide has a slit for the blade between the metal part and the wooden body

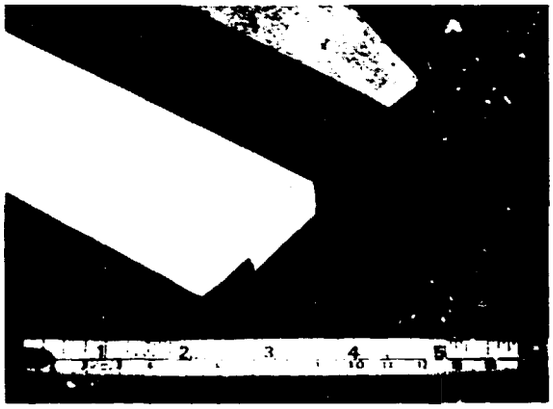


Figure 78

Set-up for wooden guide

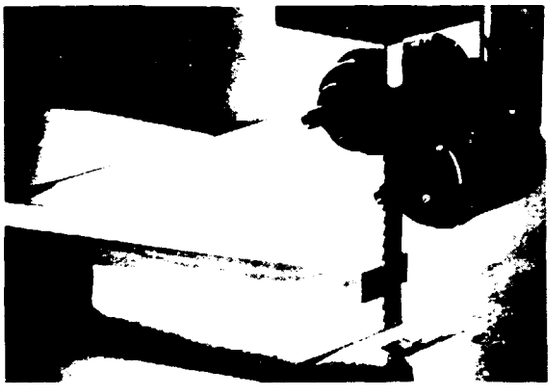
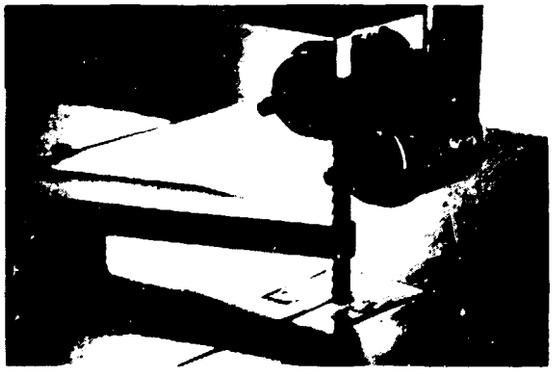


Figure 79

Set-up for metal-headed guide



The head of the guide, wooden or metal, must be dimensioned so that the distance of the kerf from the jig edge is the same as the desired working margin necessary for later machinings. The function of the jig is illustrated in figures 80, 81, 82, 83, 84 and 85.

The quality of the sawing finish in the case of the circular disc in figure 85 is much better than in sawing along a drafted line, but does not meet the standard obtainable with the jig shown in figure 67.

Figure 80

Sawing with jig using wooden guide

Figure 81

Separating jig from ready-sawn workpiece

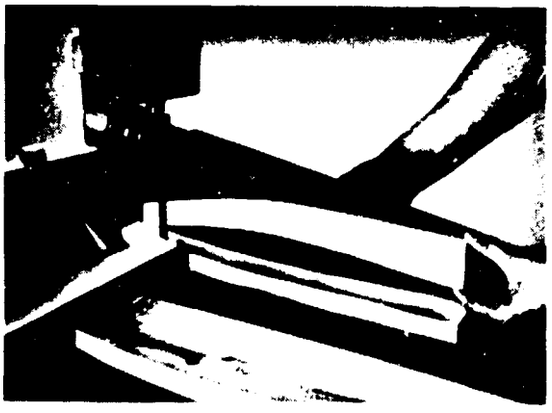


Figure 82

Sawing with jig using metal-headed guide

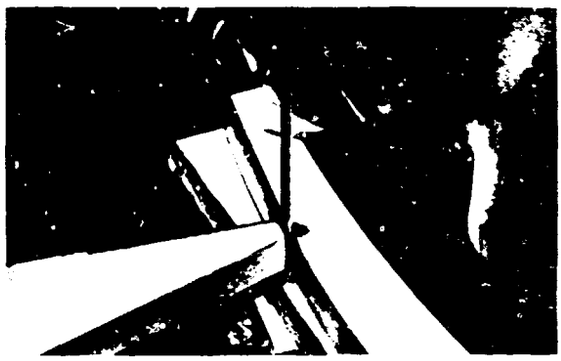


Figure 83

Sawing with jig using metal-headed guide. The board is unedged, with planed surface and thickness

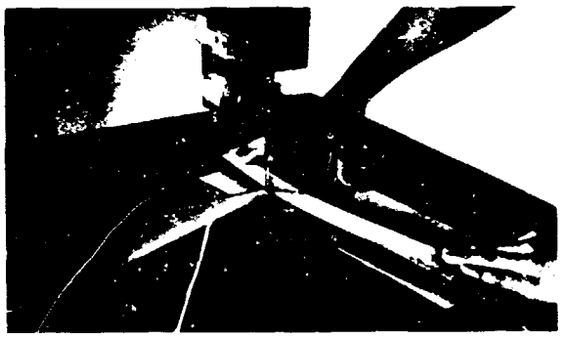


Figure 84

Sawing of circular disc by using circular jig on top of panel. The arrow points the guiding head of the wooden guide

Figure 85

Separation of jig from finished disc

Jigs for use on circular saws

Edge-sawing attachment

This attachment or jig is used, like the band-sawing jig in figure 27, to saw the first straight edge into an unedged board. The jig consists of a base panel with sharpened steel pins on which to secure the board to be sawn, and of a steel slide with dovetail-cross-section. The slide fits into the dovetail-shaped groove in the machine table. The use and construction of the jig is shown in figures 86 and 87.

Figure 86

Edge-sawing attachment in operation, seen from the rear of the machine

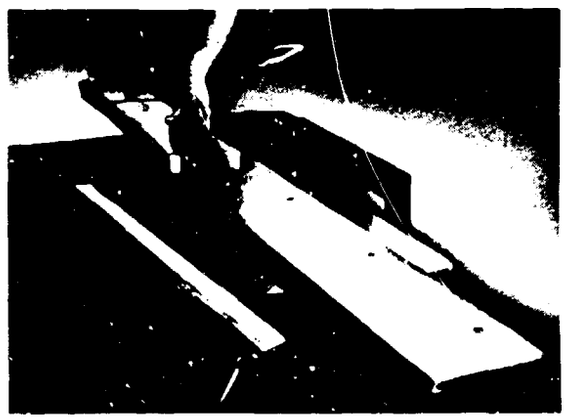


Figure 87

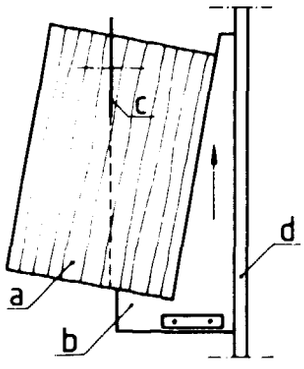
Base panel of edge-sawing attachment seen upside down and showing the dovetail-shaped steel slide. Both edges are sawn off the workpiece on the table

Jig for sawing wedge-shaped pieces

The jig, illustrated in figure 88, is usually made of some type of wood-based panel and used, for example, to cut a rectangular panel into two wedge-shaped pieces. The standard fence of the machine is used as a guide.

Figure 88

Jig for sawing wedge-shaped pieces, top view



Key: a. Workpiece, usually panel
b. Jig, functioning as feed slide
c. Circular saw blade
d. Fence

Attachment for trimming to final length according to sample

The arrangement in question is practical in cases when a smaller number of short pieces have occasionally to be trim-sawn by interrupting serial production at a circular saw which already has a set-up for a longer length. To avoid changing the set-up the following steps must be taken:

(a) The sample is set against the fixed stopper, adjusted for serial working, of the feed table and a piece of waste material against the right end of the sample when seen in the direction of the feed (figure 89).

(b) The sample plus the waste material are fed to the saw and a piece of the waste material is separated.

(c) The remaining piece is moved against the fixed stopper of the feed table to function as a spacer (figure 90).

The right end of the spacer is then used as a new stopper when cutting the profile to the required length. The pieces separated with successive feeds have the same length as the sample (figure 91).

Figure 89

Cutting a spacer. The sample is against the stopper

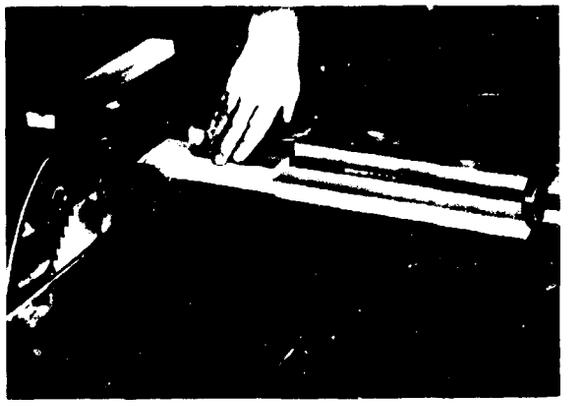


Figure 90

Spacer moved against the stopper to control the trimming length

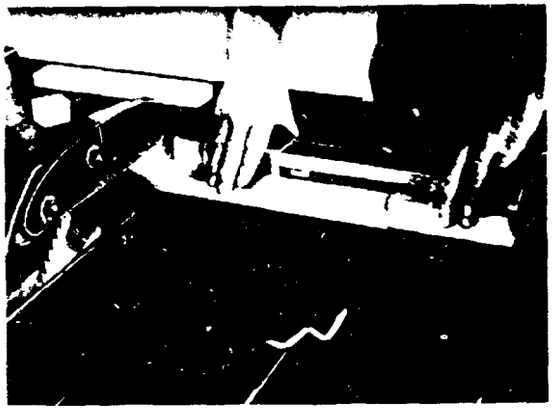


Figure 91

Pieces separated having the same length as the sample

For sawing accuracy it is very important that the profile ends, pushed against the stopper, are always trimmed perpendicularly.

Jig for tenoning

The sides of straight tenons can be easily sawn with a circular saw by using a two-step feed block as jig (figures 92, 93 and 94).

Figure 92

Two-step feed block for tenoning

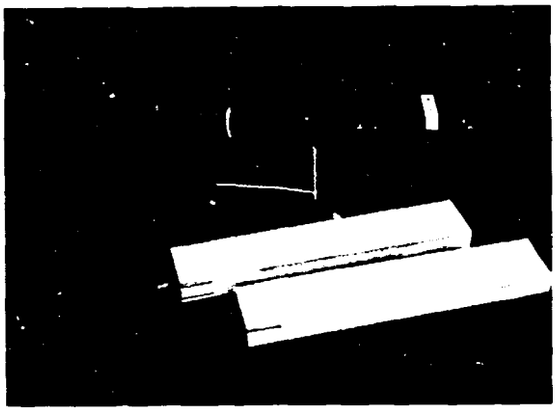


Figure 93

First sawing

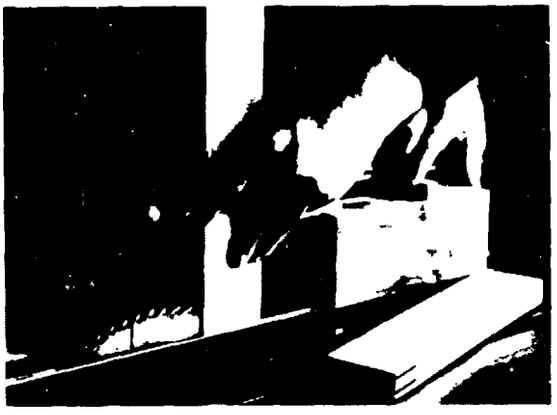
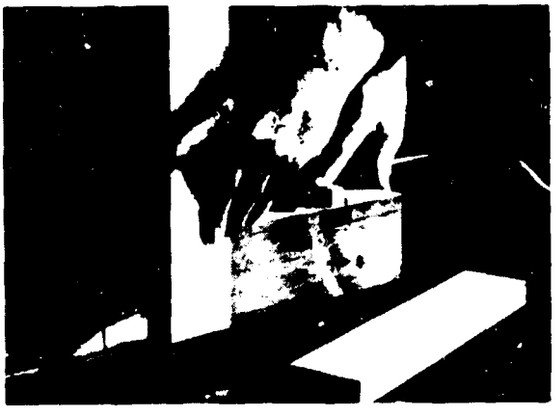


Figure 94

Second sawing



The measurement of the step is the same as the desired tenon thickness plus the width of the kerf. The shoulders can be cut afterwards with either the same machine or a band-saw, as previously shown.

Attachment for elliptic grooves

A groove, which is a part of an ellipse in profile, can be machined with a bench saw by replacing the standard fence of the machine with a straight wooden or plywood guide fixed into inclined position on the machine table according to figure 95.

Figure 95

Guide for machining an elliptic groove, inclined in the direction of the blade

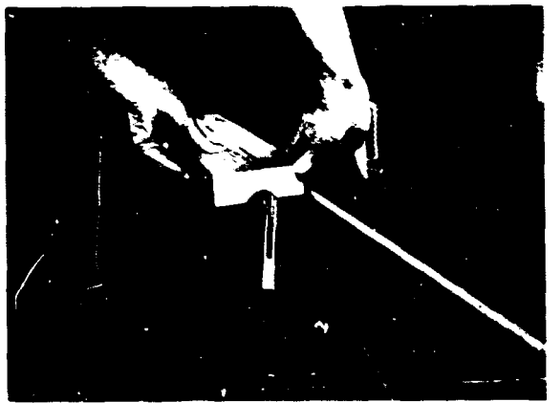
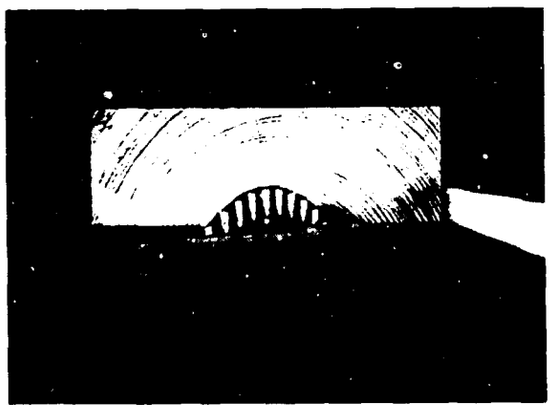


Figure 96

Elliptic groove seen in direction of feed



The profile of the groove (figure 96) depends on the angle of inclination of the guide with respect to the blade and the cutting height of the saw-blade.

Deep and wide grooves require several successive feeds. The saw-blade is lifted after every feed until the desired groove profile has been obtained. In serial work the whole batch in question must be fed through the machine with the same blade adjustment before lifting the blade for the next deeper cut.

Jigs for use on surface planers

Jig for tapering

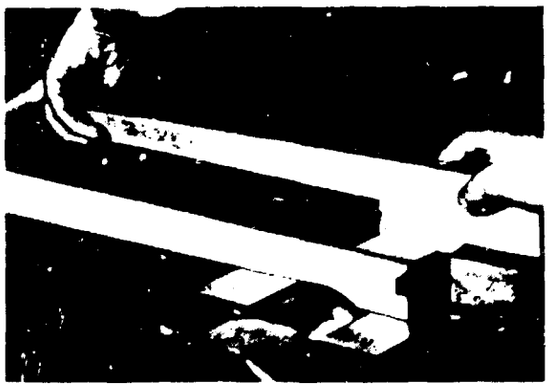
A simple wooden jig for tapering items such as furniture legs is shown in operation in figures 97 and 98.

Figure 97

Tapering jig at surface planer. Start of feed

Figure 98

Tapering almost finished



The workpiece can be tapered on its whole length or only partly, depending on the amount it projects from the jig base (figure 99).

A wooden wedge is used to secure the workpiece on the jig (figure 100).

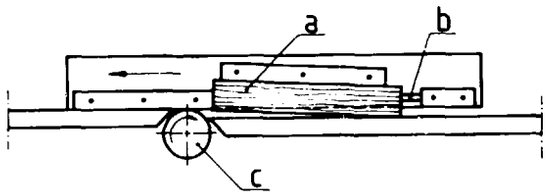
The wedge can be closed and opened easily with a knock of a light hammer.

Jig for machining circular edges

The attachment is used to smoothen the rough band-saw finish in circular edges. The jig consists of two parts as shown in figures 101, 102 and 103, which are clamped to the standard fence of the surface planer.

Figure 99

Principle of tapering jig



Key: a. Workpiece
b. Wedge
c. Cutter

Figure 100

Securing wedge seen from above

Figure 101

Setting up a jig for machining circular edges. Pendulum-type safety attachment on the planer in foreground

Figure 102

Jig with workpiece

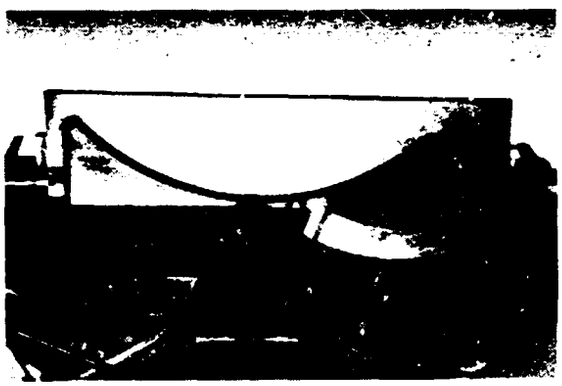


Figure 103

Jig in operation

Both tables of the machine are lowered to the same level according to figure 102. Each different radius of curvature calls for an individual jig. The jig must be so designed that the common centre of curvature of both guiding surfaces falls on the vertical line running through the cutter centre. The guiding surface of the part of the jig behind the cutter has the desired radius of curvature and is tangential to the cutting circle, whereas the radius at the front part of the jig is bigger by the amount of the desired depth of cut.

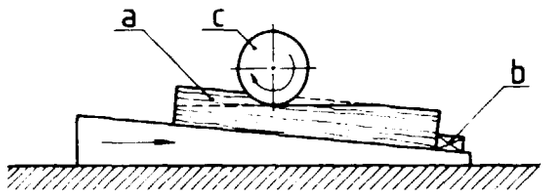
Jigs for use on thickness planers

Jigs for tapering

A simple tapering jig consists of a wedge-shaped wooden base with a stopper (figures 104 and 105).

Figure 104

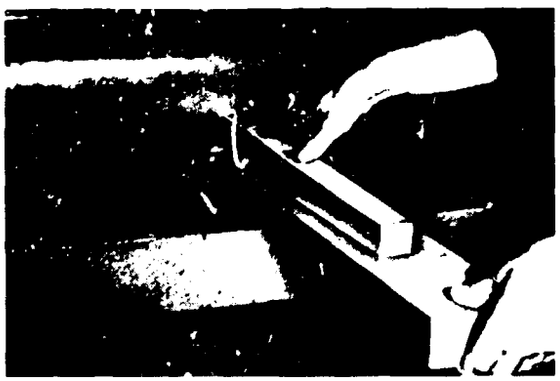
Principle of tapering jig



Key: a. Workpiece
b. Stopper
c. Cutter

Figure 105

Feeding of tapering jig with workpiece into thickness planer



The feed rollers and pressure shoes of the feedwork hold the workpiece, together with the base, against the machine table during the feed. The workpiece can be tapered over its whole length or only partly, depending on the height adjustment of the table.

A piece gradually tapering towards both ends can be easily produced with a thickness planer by making a wooden base which is thinner at the middle and becomes thicker towards the ends (figures 106, 107 and 108).

Figure 106

Jig for tapering both ends is fed into thickness planer

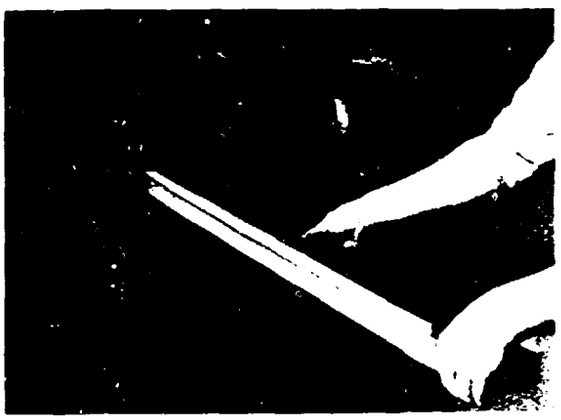
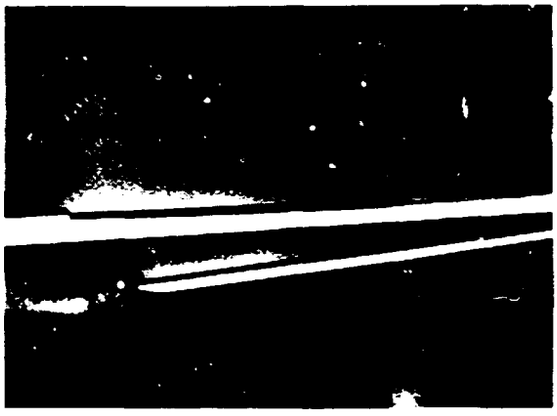


Figure 107

Receiving jig with finished workpiece behind the machine

Figure 108

Separating finished workpiece from the jig



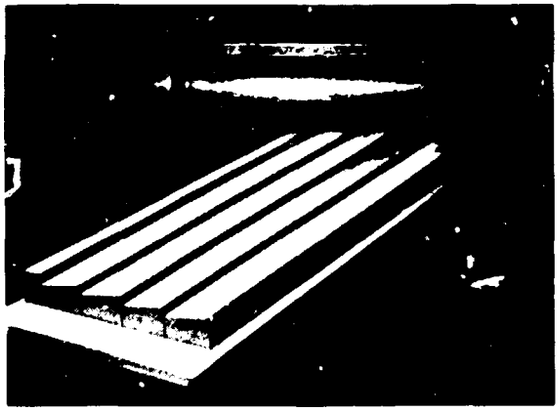
The feedwork of the thickness planer forces the originally straight workpiece to bend according to the shape of the base. The method is limited only to thin and flexible pieces.

Jig for making trapezium-shaped profiles

The jig consists of a baseboard and guiding profiles glued on top of it (figure 109).

Figure 109

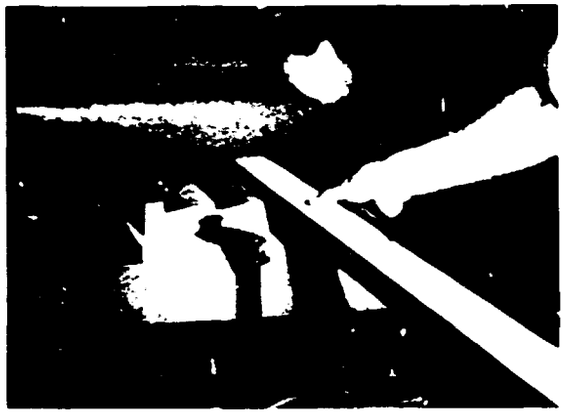
Planing jig for trapezium-shaped profiles. Jig is not yet fixed



The jig is fixed on the machine table with ordinary carpentry clamps (figure 110).

Figure 110

Feeding of a rectangular profile into the machine



When pieces with a rectangular profile are fed into the planer they come out trapezium-shaped (figure 111).

Figure 111

Finished trapezium profile coming out of the machine

Because of the construction of the jig several pieces can be machined at the same time.

Jigs for use on mortising machines

Attachment for machining a series of mortises

A series of several linearly located mortises with constant or variable distances can be easily and accurately machined with a chisel mortising machine when provided with a wooden step-type stopper (figures 112, 113 and 114).

The spring, also made of wood, pushes the stopper against the workpiece. The machining is started by using the first step of the stopper at the left. The horizontal length of the mortise is controlled in the normal way by the left-right movement of the machine table.

Figure 112

Chisel mortising machine with step-type stopper. Start of machining

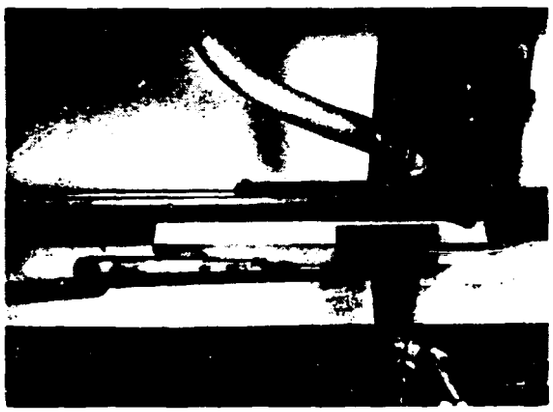


Figure 113

A series of three mortises

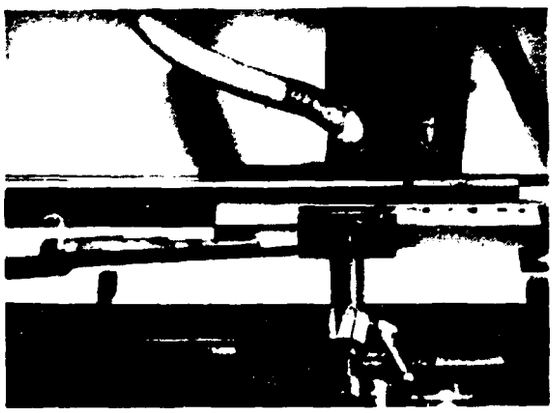
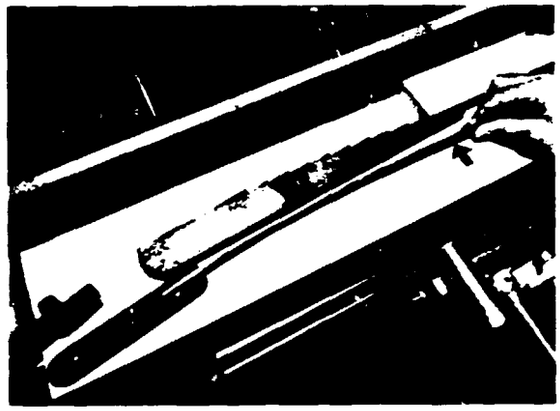


Figure 114

Entirely wooden step-type stopper. Arrow indicates working direction of spring



Set-up for two adjacent mortises

The machining of two adjacent mortises, by using a wood block as spacer is shown in figures 115, 116 and 117.

Figure 115

Set-up for two adjacent mortises. The first machining is done with spacer between workpiece and machine fence. End stopper fixed with hand clamp

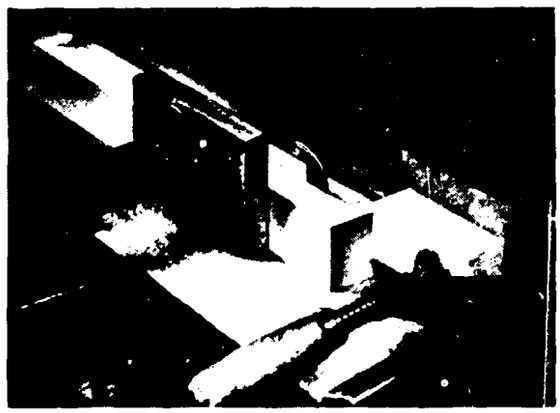
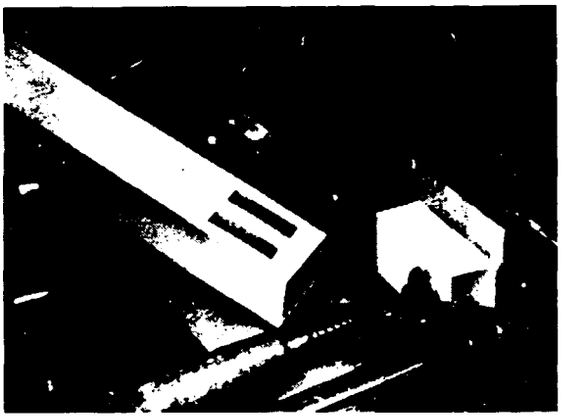


Figure 116

Second machining with spacer between pressure shoe and workpiece

Figure 117

Finished workpiece with two adjacent mortises



The thickness of the spacer must be the same as the desired distance between the two mortises plus the thickness of the hollow chisel.

Attachment for inclined mortises

The machining of inclined mortises by using a wedge-shaped base (figure 118) produces a hole in which the bottom is inclined to the surface of the workpiece (figure 119).

In case the machine table is tilted (figure 120), a mortise with the bottom parallel to the surface is obtained (figure 121).

Figure 118

Mortising by using a wedge-shaped base

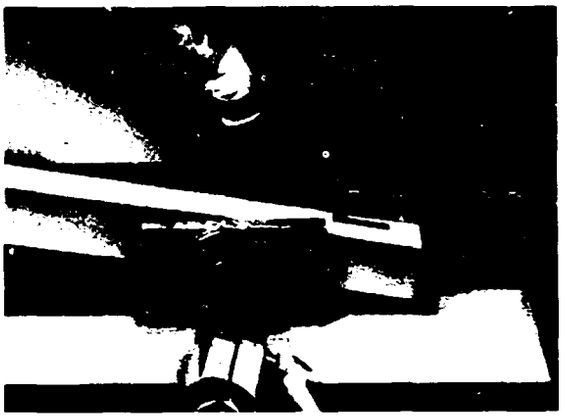


Figure 119

Mortise botton inclined to surface of workpiece

Figure 120

Mortising by using inclined machine table

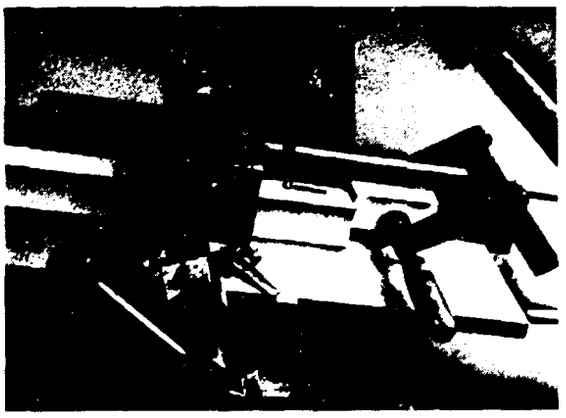
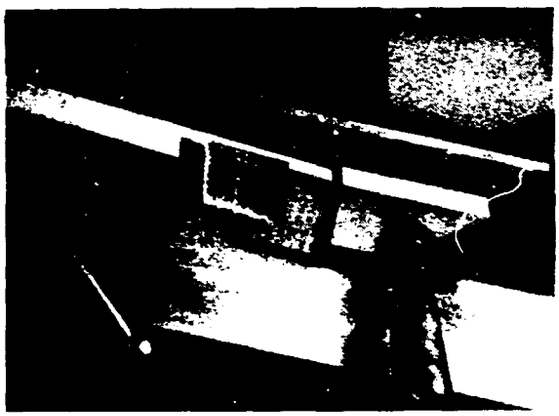


Figure 121

Mortise bottom parallel to surface of workpiece



In both cases the length of the mortise is controlled by the standard adjustment system for the transversal movement of the machine table.

Jigs for use on single-spindle boring machines

Jig for boring a series of holes according to pencil markings

The attachment consists of a wooden slide with stoppers to hold the workpiece at both ends, and of a longer straight piece of wood to function as a guiding fence for the slide (figures 122, 123 and 124).

Figure 122

Marking of zero point on guide

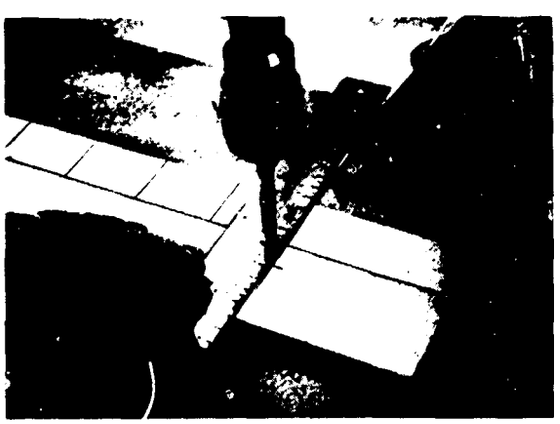


Figure 123

First boring

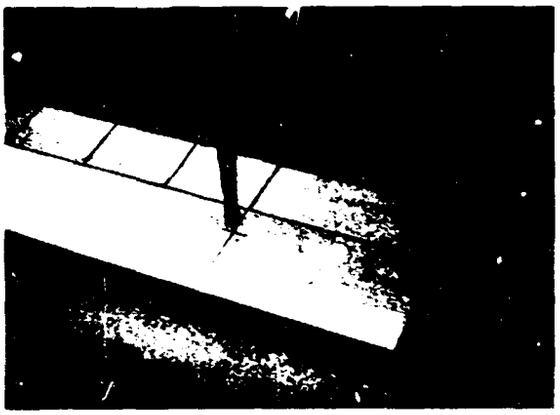
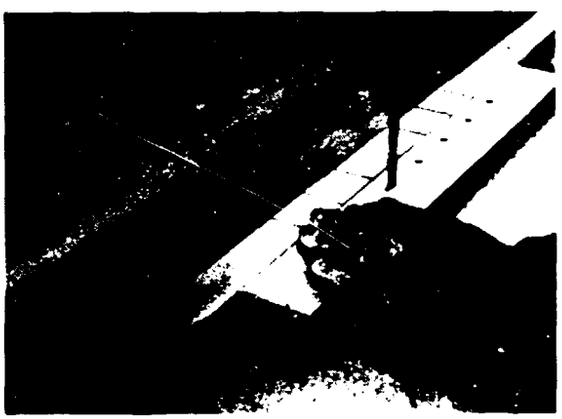


Figure 124

Boring jig in operation. Both end stoppers of slide are visible



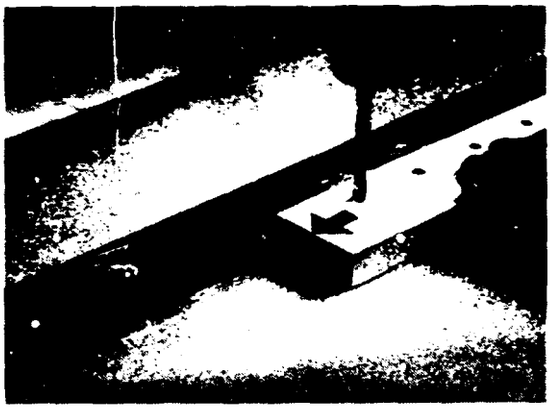
The boring points are marked on the slide. The first stage is to move the slide, holding the workpiece, so that the borer is precisely on top of the first boring point. On top of the guide behind the borer is a pencil marking which acts as the zero-point and is shown with an arrow in the figures. The slide is moved step by step from left to right until the desired number of borings is obtained. The hole-to-hole distances may be either constant or variable. The method is well suited to small-scale production in response to special orders.

Step-type stoppers for a series of holes

The stopper attachment in figure 125 consists of a straight wooden guide with cut-outs for steel springs.

Figure 125

Step-type stopper attachment with steel springs



In the example the springs are made of pieces of a rejected band-saw blade. The ends of the springs project from the surface of the guide functioning as stoppers. The workpiece is moved in steps from left to right after each boring in the direction of the springs. During the boring the workpiece must be held firmly against the projecting spring end (shown with an arrow in figure 125) and the guide to obtain precisely located holes.

The entirely wooden stopper arrangement in figures 114 and 126 has been introduced earlier in connection with chisel mortising jigs.

Jig for boring a pair of holes

The jig, intended for horizontal boring machines, consists of a base-board and slide for the workpiece (figures 127, 128, 129 and 130).

Figure 126

Workpiece is held against stopper (arrow) and machine table fence during boring

Figure 127

Jig for boring a pair of holes. Slide moved against the left stopper for first boring

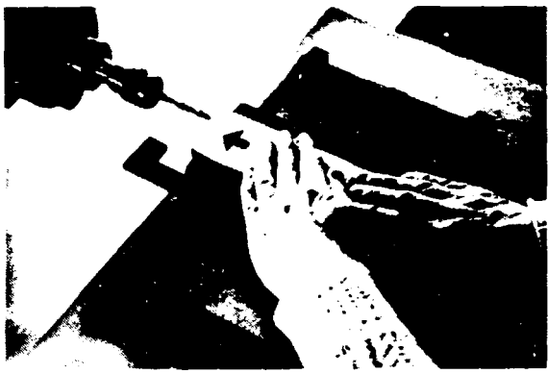


Figure 128

First feed finished. Workpiece fed until end-stopper is reached

Figure 129

Slide moved against the right stopper

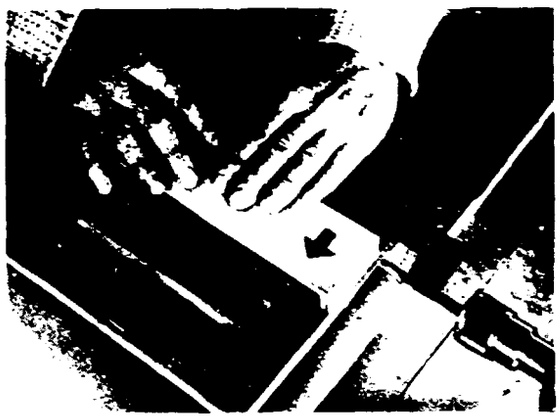


Figure 130

Second feed

The slide movement within the base-board is across the boring direction and controlled by a stopper at both left and right. The length of the slide movement is the same as the desired centre-to-center distance of the holes to be bored to the workpiece end. The slide is also provided with two guides for the workpiece in the direction of the boring feed and with an end-stopper to control the boring depth.

Jig for hand-held electric power borer

The borer is guided by predrilled steel bolts (figure 131) fixed on a piece of plywood in the boring jig (figures 132 and 133).

Figure 131

Pre-drilled guiding bolt for hand-held electric power borer

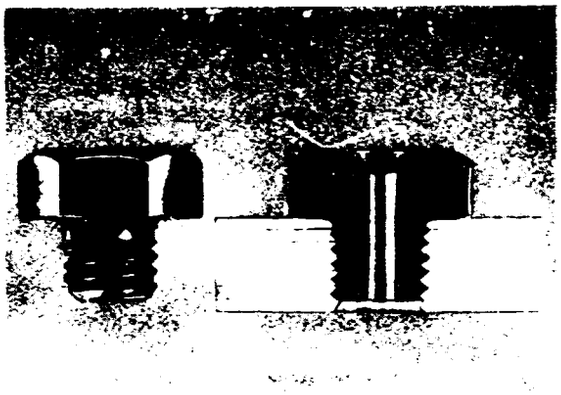


Figure 132

Inserting workpiece into vertical boring jig

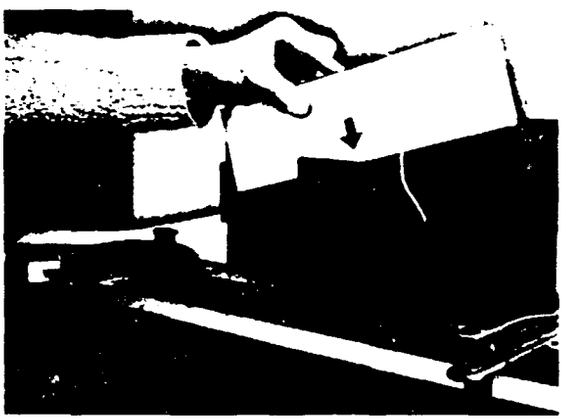
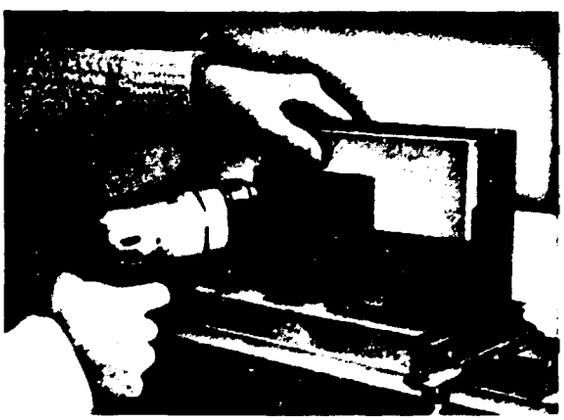


Figure 133

Hand-held electric power borer guided by pre-drilled steel bolts



The workpiece is held by two stoppers within the jig. The outer ends of the guiding holes of the steel bolts are bevelled to function like a funnel. The nominal diameter of the through-going hole is the same as the desired hole diameter in the workpiece. The vertical jig illustrated is well-suited for boring holes for drawer handles.

Jig for boring circular groups of holes

The jig (figures 134 and 135) consists of a baseboard, fixed on the boring machine table, with a sharp steel pin in the centre and circular pencil markings for proper placing of the workpiece. The circles drafted are divided into sectors according to the desired number of holes to be bored.

Before the boring is begun the edge of each workpiece is marked to function as a zero-point. The proper boring points are then easily found by turning the workpiece according to the markings after each boring operation.

A more advanced jig can be developed from the above-mentioned type by adding a revolving turntable with click-stops to the attachment to control the angle of turning. In that case the turntable must be provided with at least two sharp steel pins to prevent the work-piece from slipping on top of its surface.

Figure 134

Jig for boring circular groups of holes. Boring of first hole according to zero marking on workpiece edge

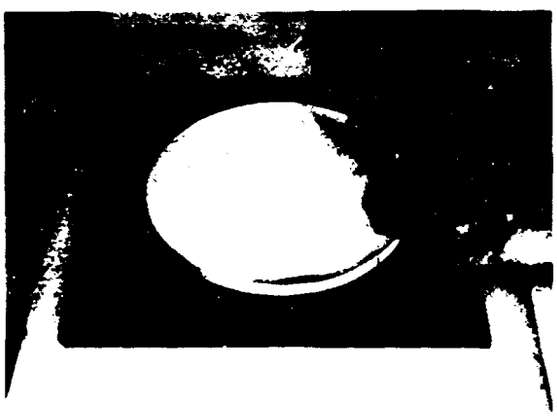


Figure 135

Boring last hole of the group

Jigs for use on spindle moulding machines

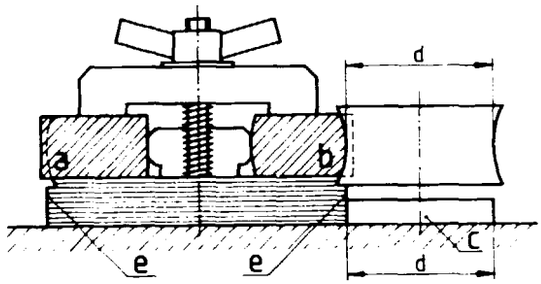
The spindle moulding machine is one of the most versatile basic woodworking machines, especially when properly designed jigs are available. A typical objective of use of a spindle moulding jig is to produce a curved shape on the edge of a workpiece. The profile of the edge may be a straight line or a combination of straight lines or curves. In the case of flat workpieces with a straight edge profile, it is often possible to design a jig to accommodate several workpieces in a stack, for example two or three chair legs on top of each other. Sometimes, when seen along its length, the edge of the workpiece to be machined is straight before spindle moulding and will be curved only afterwards, whereas certain workpieces are roughly shaped already before spindle moulding by separating them from a larger piece of lumber with a band-saw. In the latter case the purpose of spindle moulding with a jig is to finish the rough edges and to give a precise final shape to the component in question. The band-sawing is normally done if it saves raw material or reduces the amount of wood to be chipped in the spindle moulding stage.

The most usual guiding device, to control the feed movement when machining with a jig, is the guiding collar fitted into the spindle opening of the machine table. To facilitate the design and construction of jigs, the diameter of the collar should be the same as that of the cutting circle corresponding to the cutting diameter of the outermost point of the machined edge (figure 136).

If a standard collar with the proper diameter is not available, one can be easily made by turning a thick piece of plywood (figure 137). Several basic types of spindle moulding jig are described below.

Figure 136

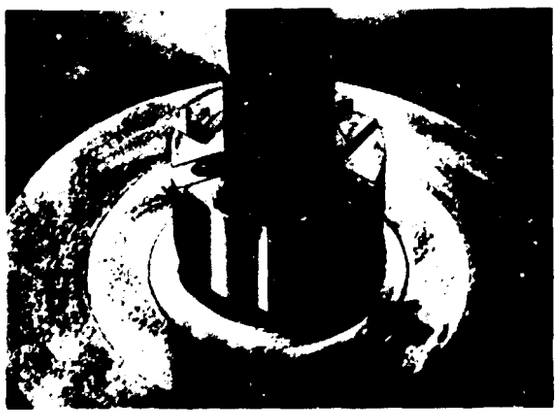
Cross-section of a jig accommodating two components on a spindle moulding machine



Key:
a. Roughly sawn workpiece
b. Workpiece being machined
c. Collar
d. Minimum diameter of cutting circle and of collar
e. Guiding edge of jig

Figure 137

Guiding collar made of thick plywood

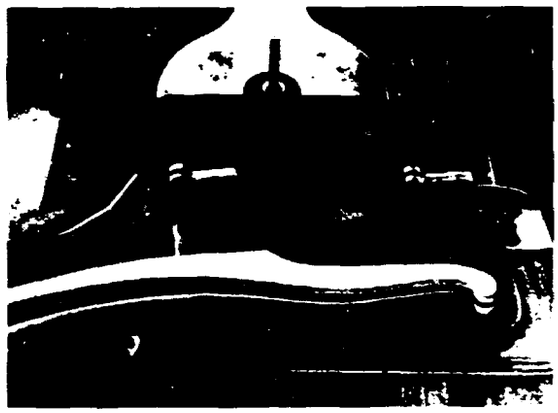


Jigs for machining edges of chair legs

A typical double jig, that is, one taking two components, is shown in figure 138.

Figure 138

Open double jig with workpieces



The jig is designed for spindle moulding both the front and back edges of a curved rear leg of a solid wood chair. The jig base is made of a solid wood panel 26 mm thick composed of narrow boards glued into a panel. The stoppers and pressure pads are of solid wood. The sanding paper is glued onto the base board in the places where the workpieces are fitted to increase friction. The eccentrics, seen in their open position in the figure, are made of cast bronze. The sides of the jig are marked I and II. The workpiece to be placed on side I for machining the front edge of the leg has been roughly sawn on a band-saw. The side stoppers, controlling the location of the workpiece within the jig, must take the excess dimensions into account. The width of the workpiece per edge to be machined should be 1-3 mm wider than the final size, depending on the accuracy of the band-sawing. The leg to be placed on side II for machining of its back edge

is moved there from side I, thus providing a finished front edge which must also be taken into account when positioning the side stoppers. After machining sides I and II the jig is opened and the finished workpiece is removed from side II, the semi-finished from side I to side II, and a roughly sawn workpiece is placed on side I. The jig is seen in operation in figures 139, 140 and 141.

A jig similar in principle and designed for the front legs of a chair is shown in figure 142.

In that case, however, the straight edge profile would make it possible to construct the jig in such a way that it could hold a stack of two or three legs on top of each other on both sides.

Figure 139

Spindle moulding of side I

Figure 140

Spindle moulding of side II

Figure 141

Detail of side II showing relative position of cutter with respect to the guiding collar and the workpiece

Figure 142

Spindle moulding straight edge profile with a jig

Jig for rounding chair back rails

The jig illustrated in figures 143, 144, 145 and 146 is designed for the rounding of curved back rails of a rocking chair. The rails are flat in the middle but taper towards both ends, the cross-section of which must be circular for assembly into circular holes. The pressure pads of the jig work with screw clamps and a special nail-like end-holder, also fitted with a screw, is added to the jig because the small cross-section of the work-piece offers the possibility of movement during machining.

Figure 143

Jig for rounding back rails of a rocking chair

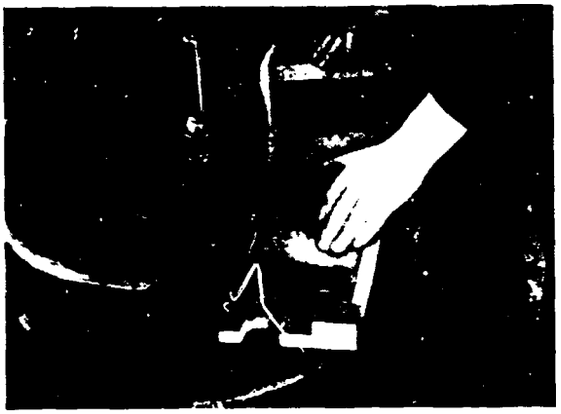


Figure 144

Detail of jig showing profile of cutter and end holder

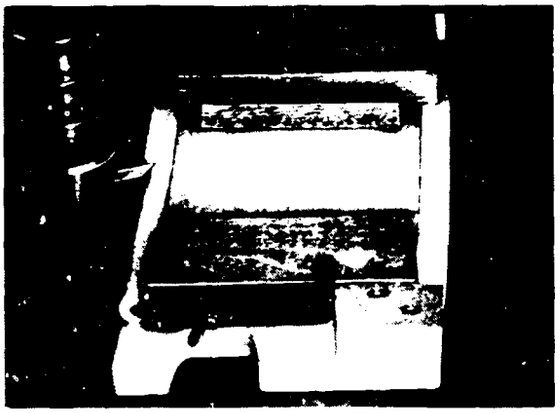


Figure 145

Detail of jig showing the guiding edge

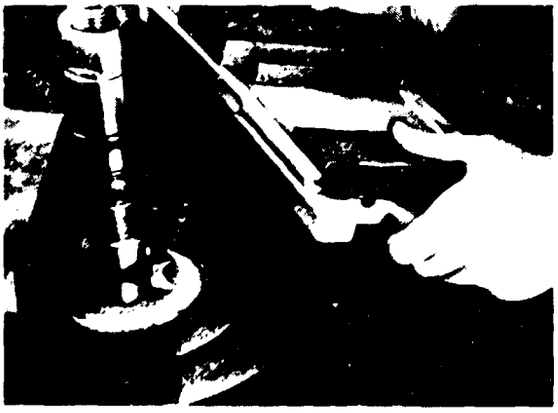
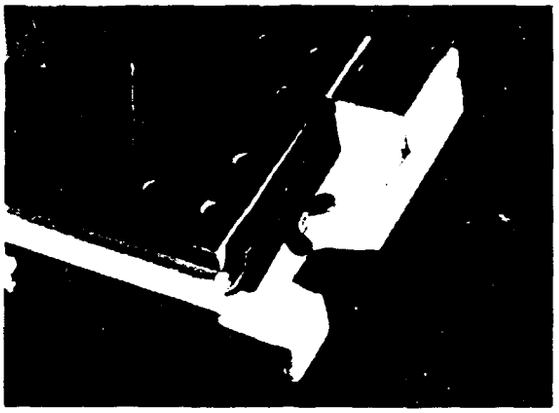


Figure 146

Detail of end holder of the workpiece



Jigs for spindle moulding the entire periphery of a workpiece

The jig in figures 147 and 148 is designed for machining the periphery of a solid wood panel into a chair seat.

The jig is simply a wooden frame with sharp steel pins at the corners to secure the workpiece on top of the jig. The guiding collar controls the machining in the normal way.

A jig for rounding the edges of a curved plywood back panel of a chair is shown in figures 149, 150 and 151.

Figure 147

Machining the periphery of a chair seat. The jig underneath the workpiece is guided by the collar

Figure 148

Partly machined seat lifted from the frame-like jig to show the sharp steel pins (arrow)

Figure 149

Curved base of edge rounding jig. Band-sawn workpiece fixed on top of jig

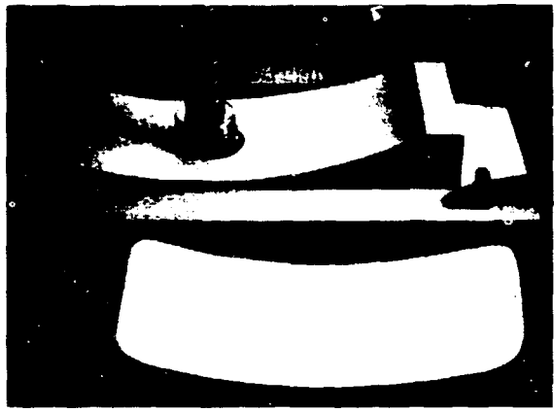


Figure 150

Machining of corner

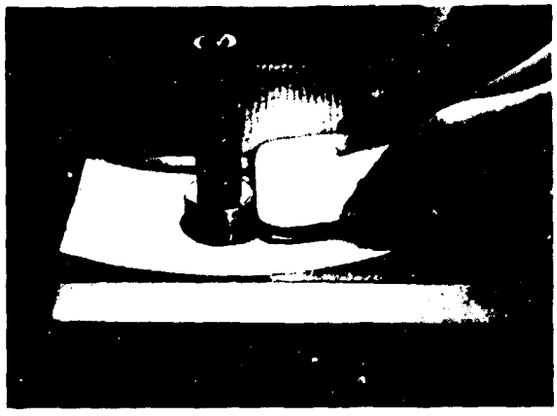
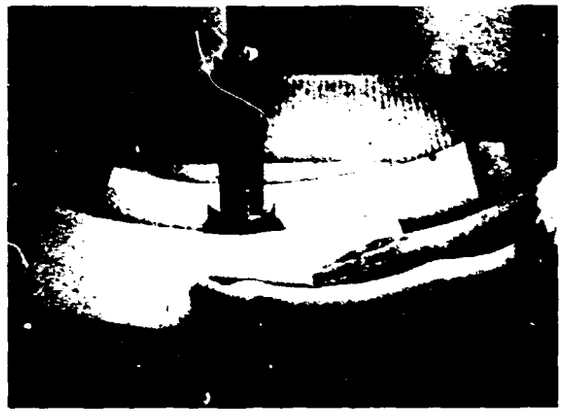


Figure 151

Machining of side



In that case the collars are slotted to hold the knives, the bottom one serving as the guiding collar. The moving part of the jig underneath the workpiece is similar in shape to a finished part but provided with sharp steel pins to hold the panel to be machined. The position of the pins coincide with the points of the screw holes in the finished component and can help to locate the centres for subsequent boring without a further jig or marking. The curved guiding base of the jig is made of solid wood and fixed to the machine table with ordinary carpentry hand clamps. Its curvature is identical to that of the plywood component to ensure continuous contact between the jig and the guiding base.

Jig for grooving mitre joints

The construction of the jig is illustrated in figures 152 and 153.

The workpiece is secured on the jig with a wooden wedge which is closed and opened by hammering on its ends. The jig is guided normally by feeding it along the standard fence of the machine, but a guiding collar can also be used instead of the fence. By fixing a stopper to the fence as in figure 154 a groove is obtained with one closed end. If none of the groove ends should be visible, the feed movement must be limited by using a similar stopper both before and after the cutter.

Figure 152

Jig for grooving mitre joints

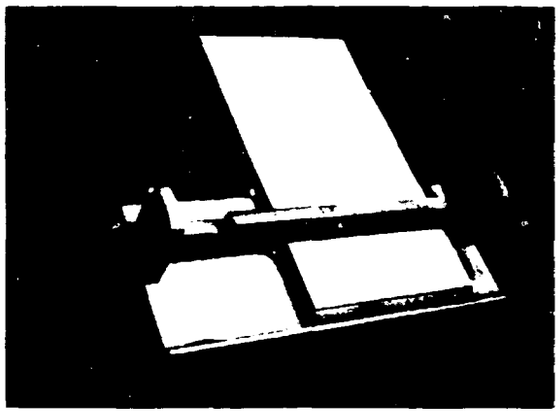


Figure 153

Detail of jig showing guiding edge and machined groove

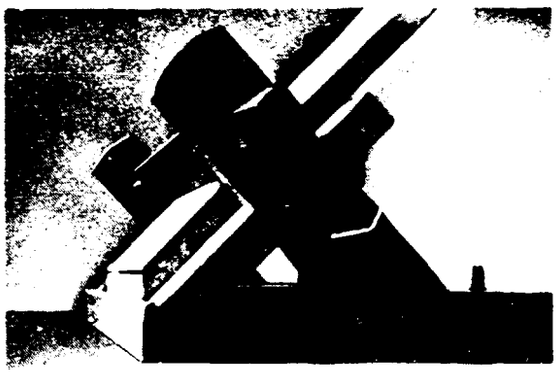
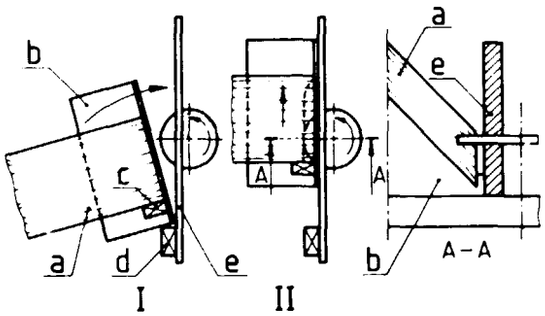


Figure 154

Set-up for machining a groove with one end closed



Key:
a. Workpiece
b. Jig
c. Stopper on jig base for precise location of workpiece
d. Stopper on fence
e. Fence

Adjustable jig for limiting the length of a groove

The attachment (figures 155, 156 and 157), made of wood has an adjustable working length.

Its movement on the spindle moulder table is limited by two vertical end-stoppers protruding downwards below the surface of the machine table. During the feed the workpiece is held between two adjustable stopper blocks. The third stopper block shown in figure 155 is designed to accommodate the second screw of the extension

Figure 155

Adjustable grooving jig, turned on side, and a finished workpiece

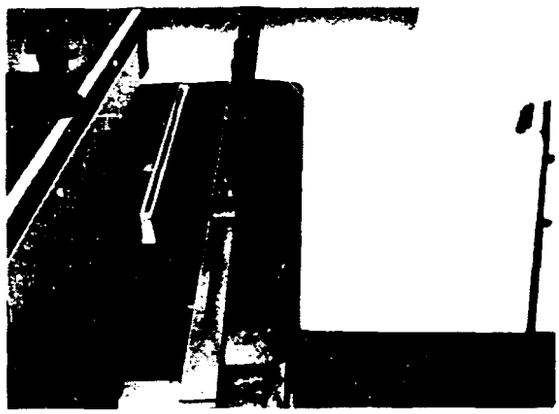


Figure 156

Workpiece placed between stoppers before feed

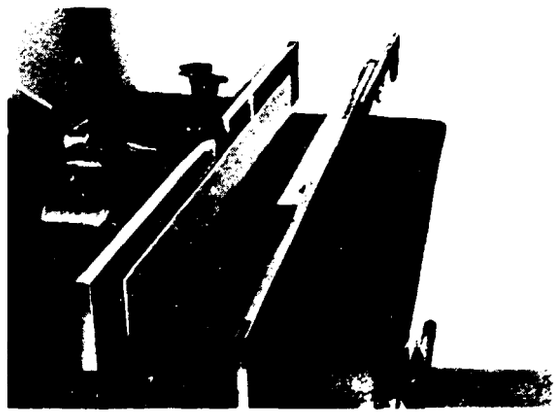
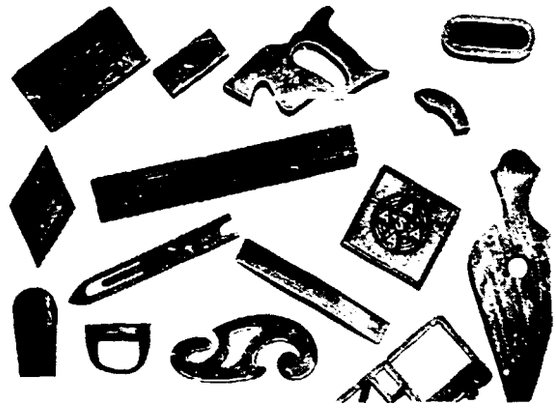


Figure 157

Start of feed with front end stopper against the edge of machine table

Figure 158

Typical components produced on a router



system. The limited lengthwise movement of the workpiece makes it possible to obtain grooves with both ends closed.

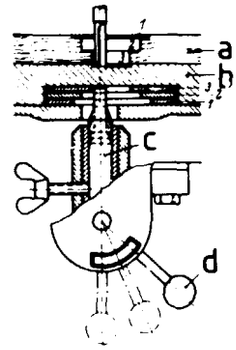
Jigs for use on routers

The router, like the spindle moulder, is also among the most versatile woodworking machines. To take fullest advantage of it, however, the technical personnel of the furniture factory in question must be able to design and construct all the jigs required for the numerous, often complicated, range of machining possibilities offered by such equipment. Although a router can in many cases be used alternatively with a spindle moulder for profiling straight edges, grooving, rebating etc., the most specialized function of the machine, is the routing of complicated and often small details consisting of curved shapes, holes, slots, openings, cut-outs etc., which cannot be produced with any other standard woodworking machine. Factories producing solid wood furniture with decorative details are among the most frequent users of routers and routing jigs. Typical examples of details machined with a router are shown in figure 158.

The working of a routing jig is controlled by two devices on the machine, namely the former pin protruding from the machine table centre and the revolver located in the upper part of the machine body. The function of the former pin is the same as that of the guiding collar in a spindle moulder. The working height of the pin is adjustable in steps, (figure 159) each representing normally a height-difference of 5 mm.

Figure 159

Function of former pin in steps



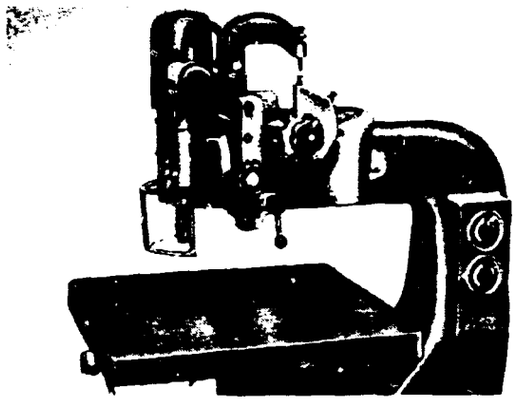
Key:
- a. Workpiece
- b. Jig base
- c. Former pin
- d. Lever for adjustment of height of pin

The steps (1, 2, 3), the heights of which vary on the revolver, correspond to adjustments of the former pin and positions on the jig and the machined component

The step adjustment is necessary in case the same jig must control routing at different depths. The revolver controls the actual cutting depth of the routing tool. The axis of rotation of the revolver is either horizontal (figure 160) or vertical, depending on the machine manufacturer.

Figure 160

Detail of router showing position of revolver for adjusting the cutting height



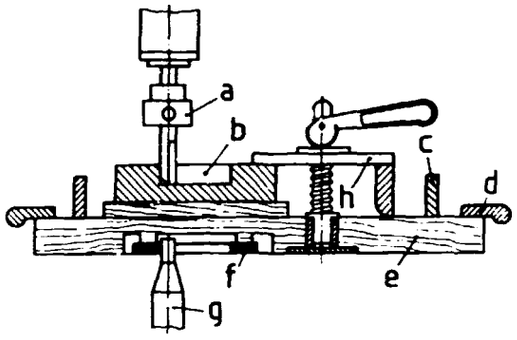
In the latter case the revolver body is spiral-like. The height of the stopper bolts at the revolver are adjustable. The steps between different cutting depths are adjusted according to the working drawing of the component to be machined, whereas the height adjustment of the former pin functions only as a selector of machining stages, each corresponding to a different machining depth. Each successive cutting depth calls for selecting a corresponding step both on the former pin and on the revolver. Because the steps of the former pin adjustment are constant, the guiding contour of the jig base can be made of a stack of plywood sheets, in which each layer is provided with a contour of appropriate shape for guiding the workpiece past the bit of the router. The thickness of the plywood must correspond to the height of the step at the former pin. To facilitate the design of the jig, the cutting circle of the routing tool and the former pin should have the same diameter. If that is not the case, the difference must be taken into account when dimensioning the guiding contours of the plywood sheets on the jig base.

Jigs for routing holes

The cross-section of a simple jig is shown in figure 161.

Figure 161

Cross-section of simple routing jig



Key:
- a. Cutter head with tool
- b. Workpiece
- c. Guard
- d. Handle
- e. Base of jig
- f. Plywood sheet with guiding contour on the bottom of the jig base
- g. Former pin
- h. Pressure pad

The jig base with handles, guards and stoppers for the workpiece is made of solid wood. The jig bottom is provided with a routed hole to accommodate the plywood sheet with the guiding contour. In small jigs in particular, the sheet may be of the same size as the jig base to make the construction simpler. The workpiece is secured on top of the jig with a steel pressure pad and eccentric. Various types of pressure pads are shown in figure 162.

Screw clamps may also be used for fixing purposes (figures 163, 164 and 165).

Figure 162

Steel pressure pads for routing jigs. The symmetric pressure pad on the left is for holding two workpieces simultaneously

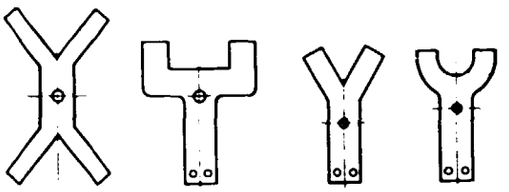


Figure 163

Screw clamps holding workpiece by pressing on top surface

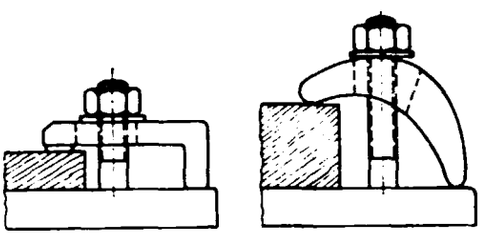


Figure 164

Screw clamp holding workpiece by pressing on edge

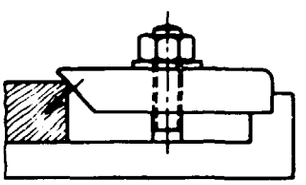
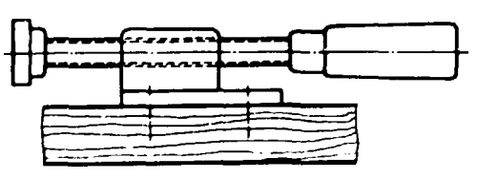


Figure 165

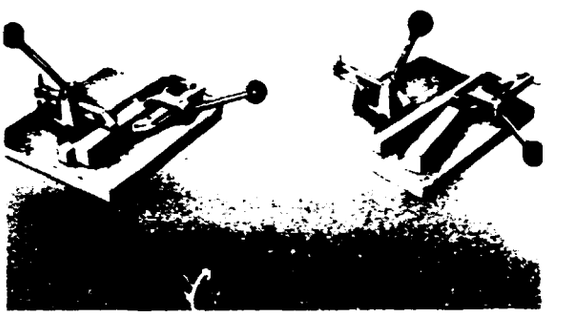
Screw clamp holding workpiece by pressing on side (workpiece not shown)



The closing and opening of the jig become much faster if the ordinary nuts illustrated are replaced with wing nuts or nuts with a welded lever. A more sophisticated lever clamp is shown in figure 166.

Figure 166

Lever-clamps for fixing workpieces on machines



The fixing methods introduced above are generally applicable to most types of routing jigs. The selection of the actual type used depends to a large extent on the shape and size of the workpiece. Small components such as furniture handles are sometimes quite problematic with regard to fixing because the space available for that purpose is very limited.

The routing jig in figure 167 is designed for machining a two-step hole on a solid wood component.

The three workpieces shown in the figure represent the successive routing stages. The component is pressed against the stoppers by a wooden eccentric, the pressure of which is transmitted to the workpiece through a wooden spring. The inside of the spring is covered with sandpaper to increase friction. The jig bottom accommodates the two necessary plywood sheets with the guiding openings (figure 168). The jig is seen in operation in figure 169.

Figure 167

Routing jig for machining a two-step hole. The workpieces represent different routing stages

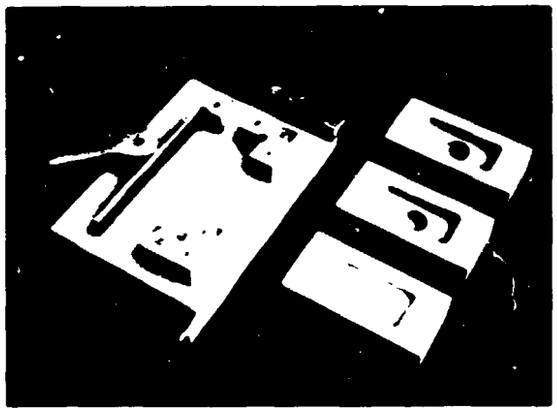


Figure 168

Guiding contours on jig bottom

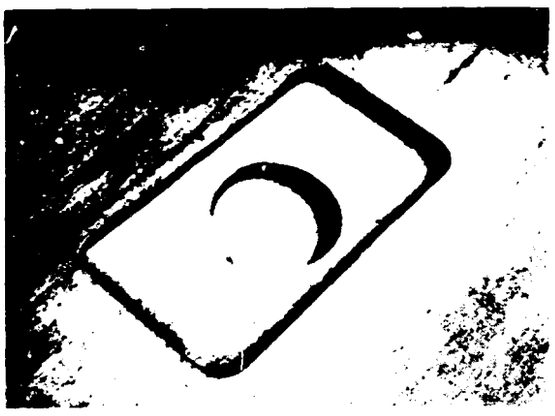
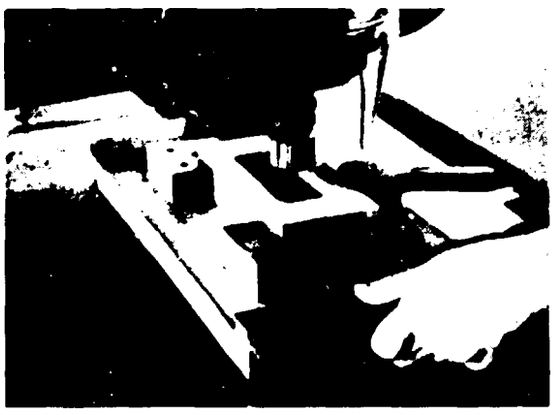


Figure 169

Jig in operation. Routing of the second step



A two-step routing jig for a more complicated workpiece (figure 170) is shown in figures 171 and 172.

When machining with soft types of wood direct clamping of the workpiece with an eccentric should be avoided because of the risk of depressions which would lower the quality of the component.

The routing of a cut-out is shown in figure 173.

The diameter of the former pin should be the same as the smallest cutting circle of the routing tool. Because of the rounded shape of the cutting profile both the axial feed into the

Figure 170

Complicated workpiece with holes at different routing depths

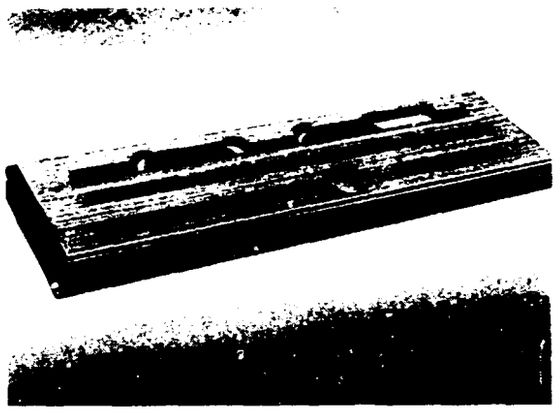


Figure 171

Jig in operation

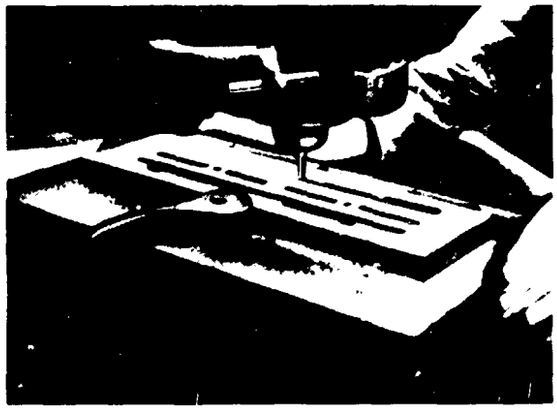


Figure 172

Jig bottom with two-step guiding contours

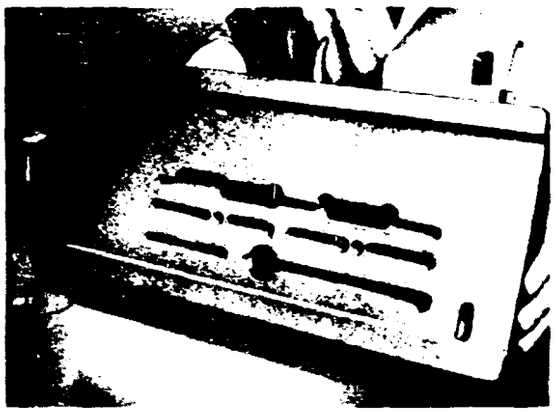


Figure 173

Routing a cut-out hole

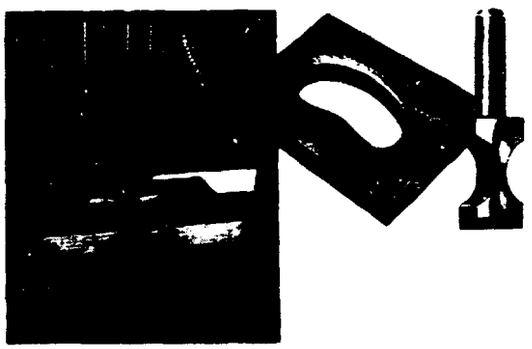


Figure 174

Jig for decorative grooving. Feed towards machine operator

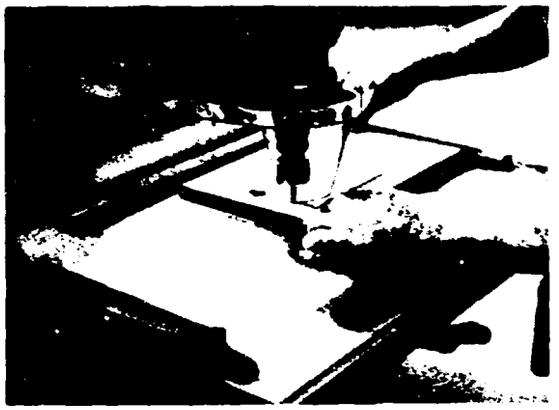
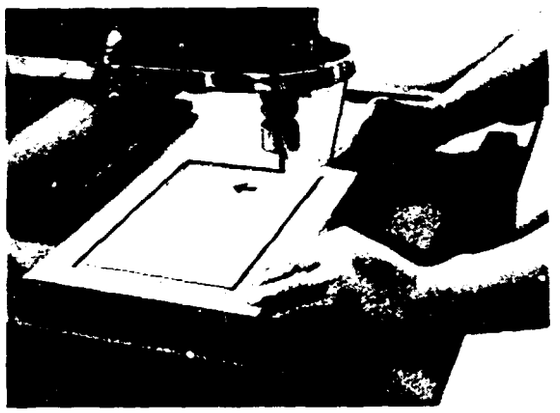


Figure 175

Feed towards machine. Routing almost finished



workpiece and the return of the tool must take place in the middle of the hole.

Jig for decorative grooving of solid wood panels

The jig (figures 174 and 175) consists of a rectangular particle board base with a straight wooden guide at each side.

The base is clamped on the router table. The open spaces between the ends of the guides are necessary for the hands of the machine operator. The workpiece is fed around the inside faces of the guides by keeping it constantly in contact with one of the four guides. The outer corners of the groove being routed are rounded, having the radius of the cutting circle, whereas the inner corners are sharp. The same jig construction can be used to cut a rectangular opening, with rounded corners, into a rectangular panel. In that case the bottom of the router tool must be below the surface of the jig base to be able to cut out completely a piece of the panel.

Jigs for routing edges

The jig in figure 176 accommodates two similar workpieces. The curved shape is roughly band-sawn into the components before the routing to diminish unnecessary chipping. The router operates in the same way as a spindle moulder in such an arrangement. Instead of a normal former pin a large-diameter cylindrical guide is fitted on the machine table.

Figure 177 illustrates a standard routing jig for machining solid wood handels on both sides by using a rounding cutter. The pair of workpieces is secured with a screw clamp on the jig. The space the cutter has worked on the jig base is clearly visible. The feed is controlled by the former pin in the normal way. The first stage is on the left.

A set of two different jigs to shape a handsaw handle in two stages is shown in figures 178, 179, 180 and 181.

The original rectangular-shaped workpiece is routed in two stages. The guiding part on the bottom is made of bakelite sheet to resist the wearing caused by large-scale production. The fixing method in the first stage is an eccentric with a pressure pad. A screw

Figure 176

Edge routing jig accommodating two workpieces. Guiding cylinder replacing the former pin

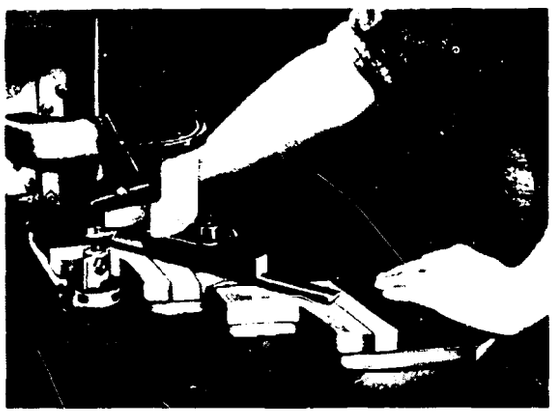


Figure 177

Double jig for shaping a handle

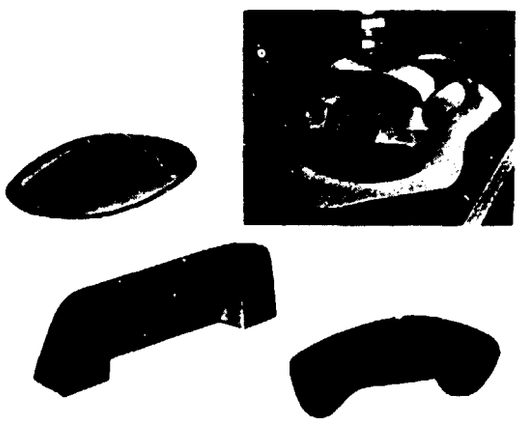


Figure 178

Routing jig for hand-saw handle. First stage. Original workpiece marked with a dotted line

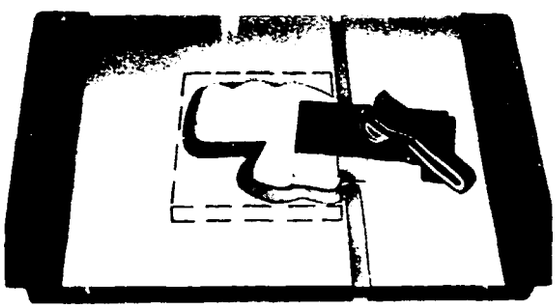


Figure 179

Underside of jig, the same as in figure 178, showing the guiding form

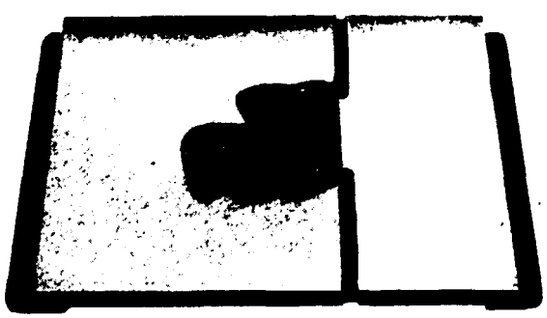


Figure 180

Jig for the second stage of machining

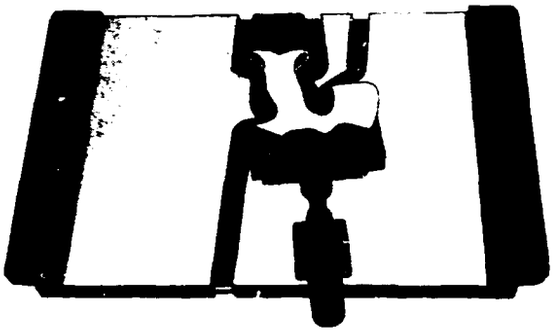


Figure 181

Underside of the same jig as in figure 180

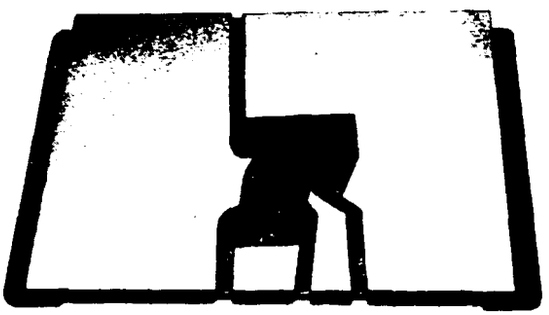


Figure 182

Double-purpose jig for stages I (left) and II (right)

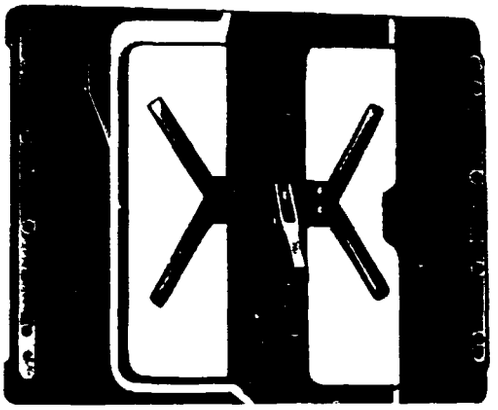
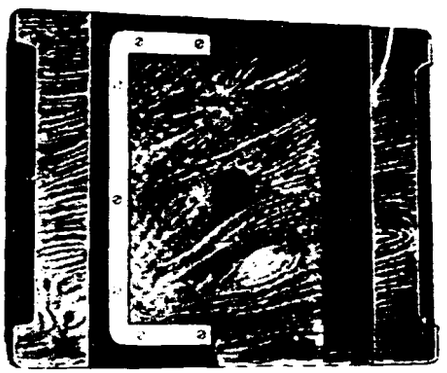


Figure 183

Underside of jig, the same as in figure 182, showing guiding details



clamp with a shaped pressure pad is used in the second stage. The grooves for feeding the router into the workpiece can be seen in the figures.

The jig in figures 182 and 183 is intended for routing a workpiece around in two stages.

The left side in the figure is for the first stage and the right one for the second stage. The machining must be arranged in the same way as in spindle moulding of chair legs with a double jig. The same applies also to the operation of the jig in figure 177 above.

The jigs shown in figures 184 and 185 are for two successive routing operations.

The workpiece is rectangular in the beginning. A spacer underneath the workpiece raises it above the jig base to provide space for the routing tool permitting the use of a cutter with a rounded profile.

Figure 184

Jig for the first stage. Workpiece lifted from jig base by a spacer

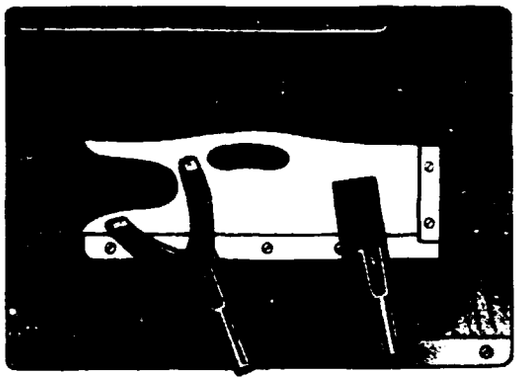
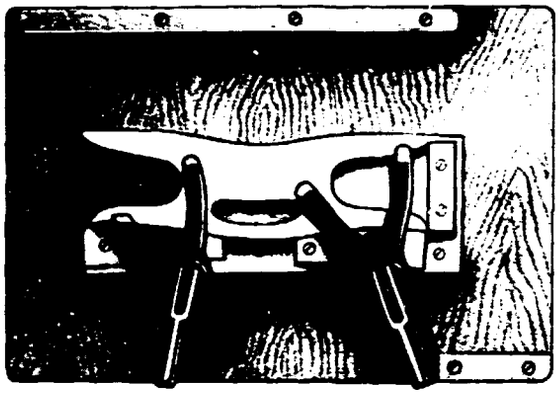


Figure 185

Jig for the second stage. Workpiece lifted from jig base by a spacer



V. Examples of jigs used in furniture assembly

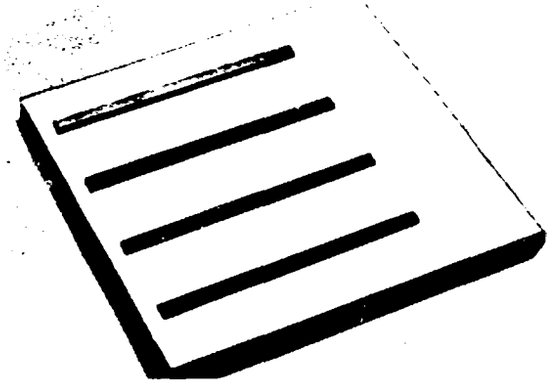
The amount of assembly work in furniture industry is substantial and varied owing to the different types of products, machines and facilities available, batch sizes and quality levels. The jigs used for that stage of production, can therefore be introduced only by giving examples of typical designs and constructions. The types of jig described below are, however, generally applicable.

Jigs for fixing drawer slides

The proper and easy sliding of drawers within a cabinet, chest-of-drawers, or office desk drawer unit, without any manual fitting in the assembly stage, is a prerequisite of industrial furniture production which is based on interchangeability of parts. The accuracy at which the slides, usually of wood or plywood, are fixed on the cabinet sides and the manufacturing accuracy of the drawer parts are decisive for the proper functioning of the drawers. As previously stated, the levels of the upper edges of the slides are critical because they determine the places of the drawers in a finished cabinet. The distances of those levels from the top edges of the panel are primary measurements for the assembly (figure 8). The slides must always be fixed before assembling the cabinet body. A finished cabinet side with fixed slides is seen in figure 186.

Figure 186

Cabinet side with slides for drawers



Frame-type jig without base

A jig of the above type is shown in figures 187 and 188.

The rigid stoppers on the frame are in contact with the primary surfaces (edges) of the side panel, whereas the stoppers on the opposite side of the frame are fitted with springs. The springs are made of a piece of elastic rubber and covered with a steel sheet profile. Such a construction enables the jig always to locate itself automatically into a correct position in relation to the side panels of the

Figure 187

Frame-type jig for fixing the slides

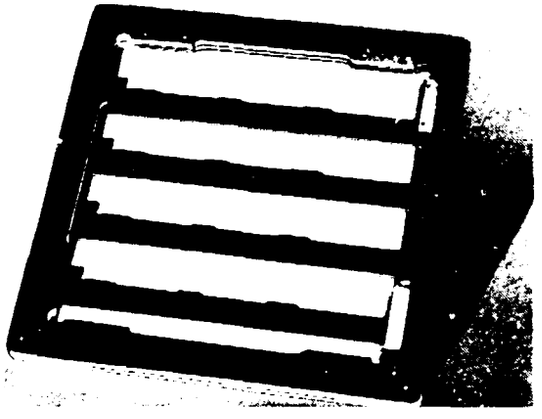
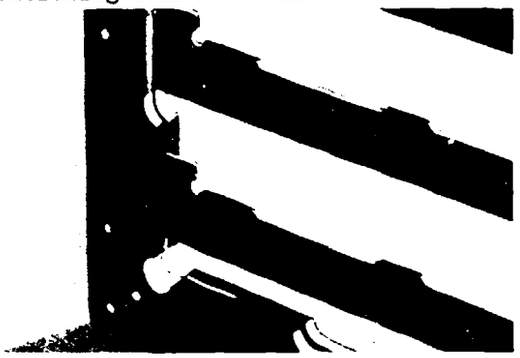


Figure 188

Detail of jig showing stoppers for positioning frame and slides



cabinet in question. The guiding parts position the slides only at certain points for maximum accuracy. The jig shown in working position in figure 187 is guiding the slides of the right cabinet side. By using the reverse side, the jig is used for the left side because of its symmetric construction. The panel is placed in the jig with its top edge at the bottom. The jig is constructed from film-coated plywood used for concrete shuttering.

Frame-type jig with base

The force of gravity positions both the panel and the slide strips against the stoppers in the jig shown in figure 189.
For that reason the jig is tilted backwards and the hinged frame unit with the guides can be revolved either to the left or to the right. The direction is determined by the eventual position of the cabinet side (right-hand or left-hand). The end-positions are provided with click stops. Because of the construction described above, the panel inside the jig always lies tightly against both the jig base and the edge stoppers, pulled by gravity. The same holds true in the case of the slides, which automatically fall into position against the corresponding stoppers. Because of the effects of the principle of gravity, the top edge of the panel must be placed in the bottom of the jig (figures 190 and 191).

Figure 189

Revolving stapling jig for drawer slide fixing. Workpieces are pulled against stoppers by gravity

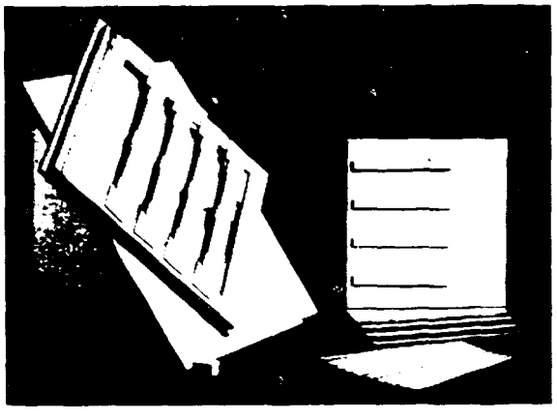
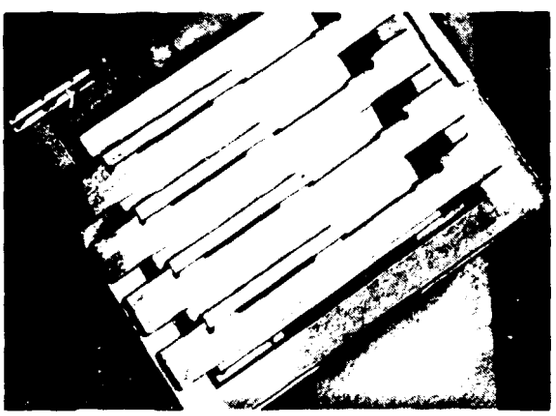


Figure 190

Jig opened showing stoppers for panel

Figure 191

Detail showing stoppers for slides

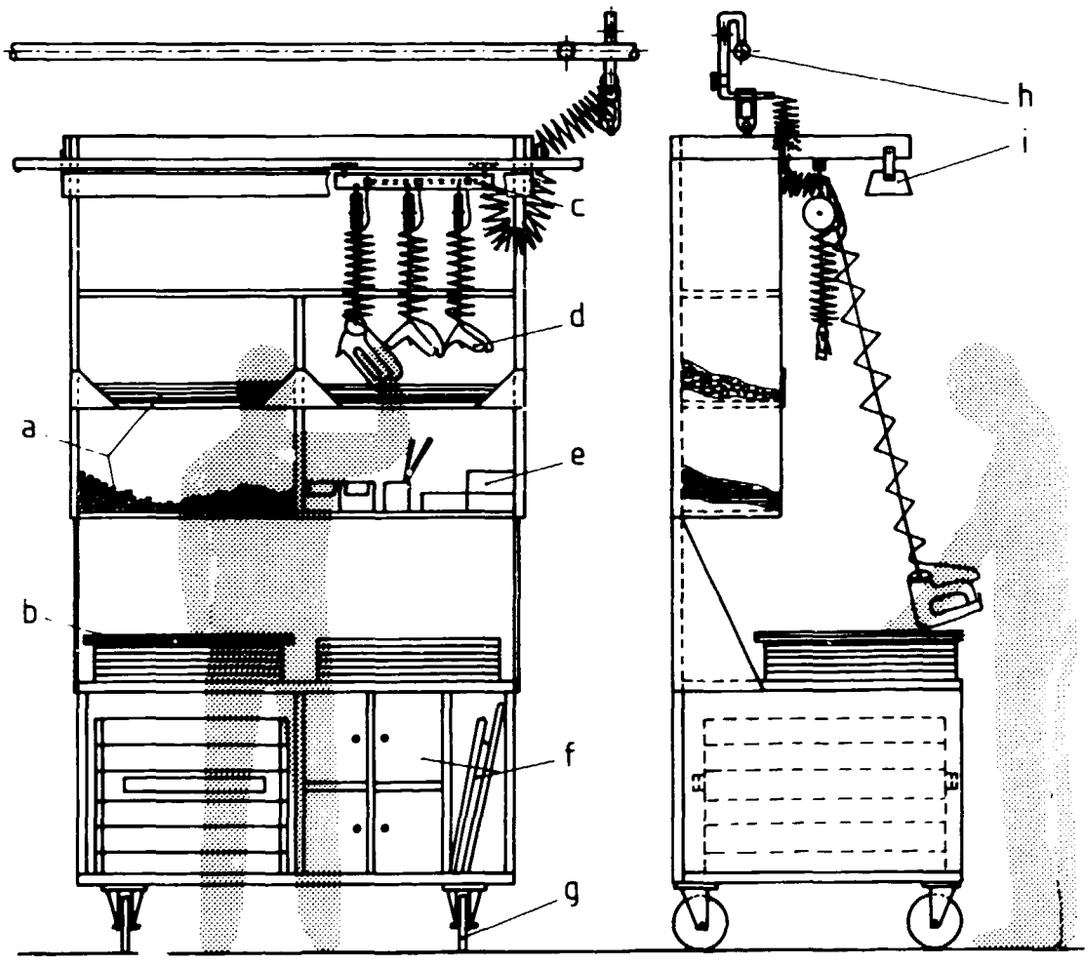


The panel rests on spacers in the jig, which makes it possible to fix the slides on both sides of the panel if desired. The guiding frame is provided with a piano-type hinge which has proved to be well suited for use in jigs.

An efficient working station, designed primarily for slide stapling purposes, is shown in figure 192.

Figure 192

Working station for slide stapling using jig



(a) Compartments for wood and metal slides
(b) Stapling jig
(c) Sliding holder for compressed air tools
(d) Pneumatic stapling and boring tools
(e) Compartment for staples
(f) Compartments for jigs and supplies
(g) Swivel wheels for easy moving
(h) Pipeline for compressed air
(i) Fluorescent lamp

The frame-type jig (figure 187) is placed directly on top of the stack of panels to be handled.

If it is not essential to place the components to be stapled in a stack, the working table should be inclined at 15° to improve the reach of the worker.

Jig for boring and fixing hinges

The versatile jig for left- and right-hand cabinet doors, shown in figures 193, 194, 195 and 196, designed to bore holes for handles, to position magnetic locks, and to fix hinges.

It can accommodate two standard door sizes. The positions of the holes for two alternative door widths are marked with letters A and B. The stoppers guiding the workpiece are shown in the figures. The side stoppers to the left and right also function as guides for the hinges to be fixed. The boring guides are symmetric by construction and made of perforated steel bolts, as shown in the figures in connection with boring jigs. The jig material is film-coated plywood.

Figure 193

Jig for boring and fixing of hinges. Stoppers are visible in figure

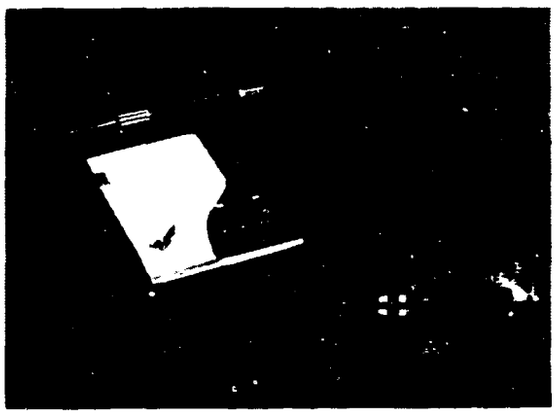


Figure 194

Detail showing boring guides for fixing handles and magnetic locks

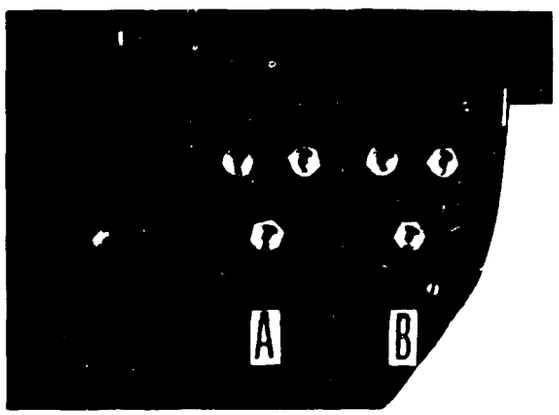


Figure 195

Boring guide on right side of jig. Hinges are already fixed by screws

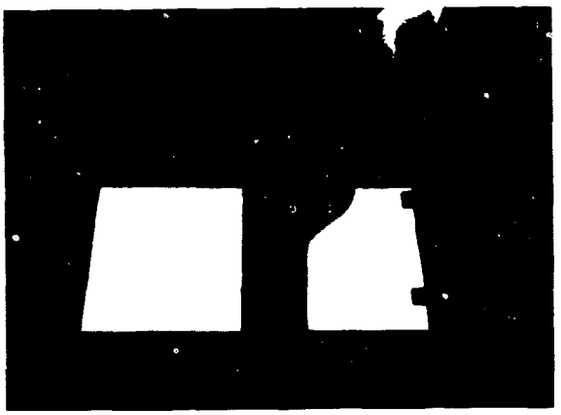
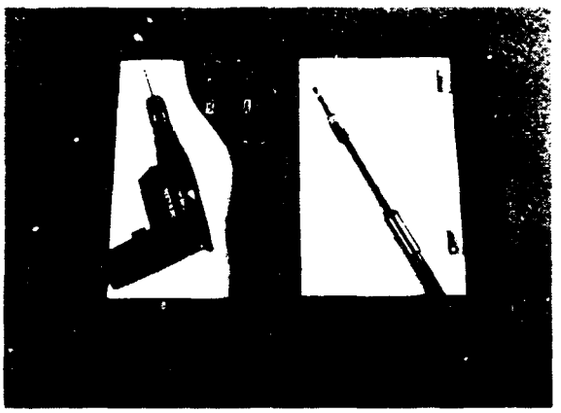


Figure 196

Boring guide on left side of jig



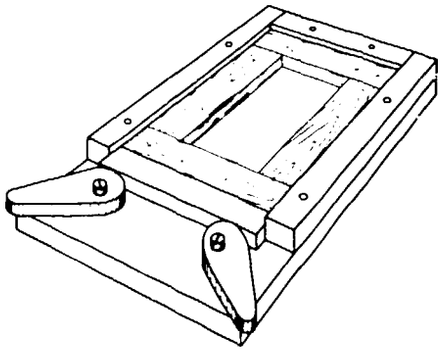
Jigs for frame assembly

Different kinds of frame and frame-like constructions are widely used as sub-components for furniture. The correctness of all angular measurements is of great importance. To avoid manual adaptations in assembly, special jigs should be designed both for pressing and for controlling the accuracy of the frame shape.

A simple frame assembly jig is shown in figure 197. All parts of the jig are made of wood.

Figure 197

Simple frame assembly jig



A more advanced jig, for assembly of the frame in figure 198, is shown in figures 199 and 200.

Figure 198

Wooden frame construction

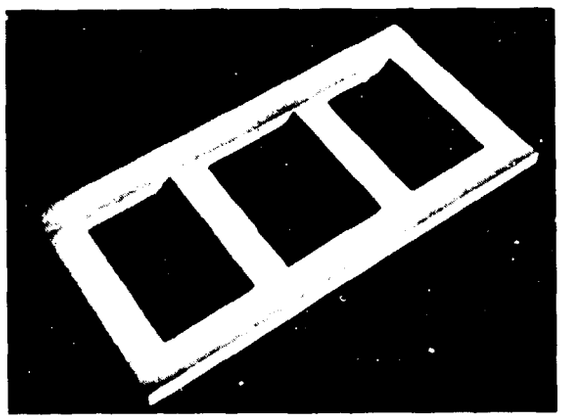


Figure 199

Pneumatic frame assembly jig or clamp with guides for components

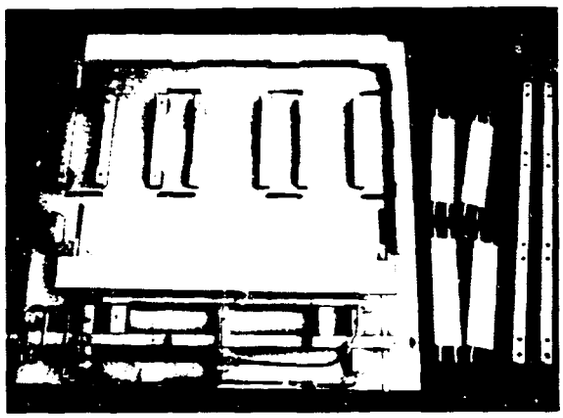
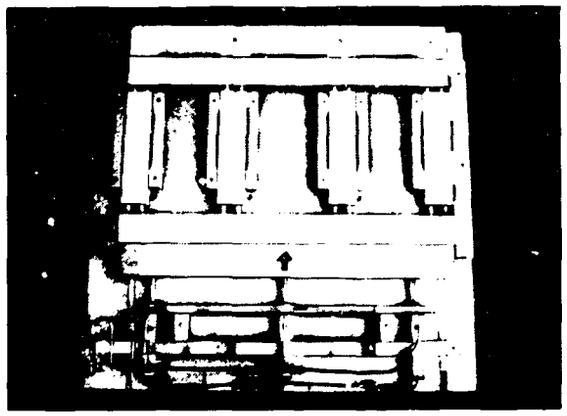


Figure 200

Jig in operation



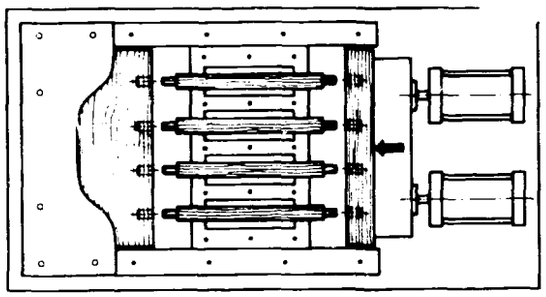
The jig operates with three pneumatic cylinders and is provided with accurate guides for positioning the components to be assembled. Dowels are used for jointing. The longer side components of the frame, with glue applied into the dowel holes, are pushed against the end-stoppers on the right by rubber springs to ensure that they are properly located. The shorter pieces, with dowels at the ends, are placed between the guides on the jig base. After the valve for compressed air is operated, the pressure bar of the jig closes all joints simultaneously,

thus ensuring the rectangularity of the frame. The small slots on the base underneath the joints are intended to hold any excessive glue oozing out of the joints.

The same jig concept is used in the construction of the jig shown in figure 201 for assembling chair backs with vertical rails.

Figure 201

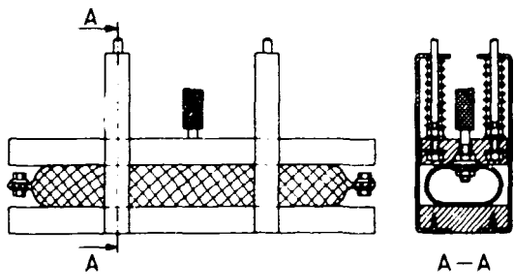
Assembly jig for chair backs several rails



A fire-hose pressure unit (figures 202, 20 and 21) can be used instead of the pneumatic cylinders, provided the tenons are not long (for example, when using groove joints).

Figure 202

Fire-hose pressure unit for assembly



Jigs for chair assembly

A clamp for assembling large series of chairs is shown in figures 203 and 204.

Figure 203

Chair assembly clamp

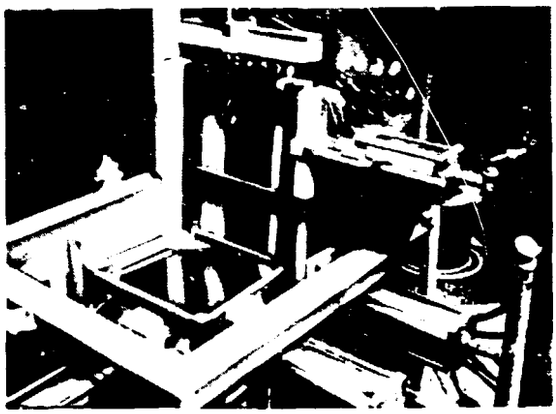
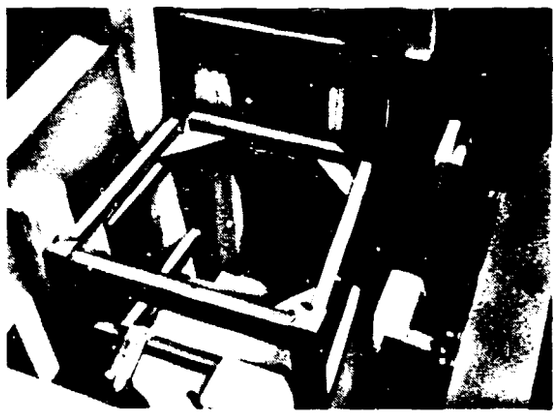


Figure 204

Chair assembly clamp



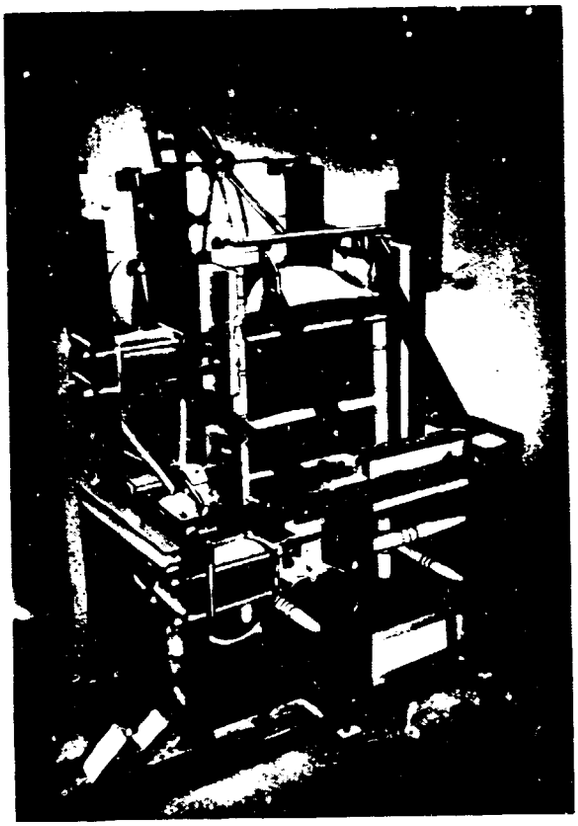
The part of the clamp which can be called a jig is the same as the wooden structures inside the press. Such details control the shape of the assembled chair.

A complicated assembly clamp with several functions is shown in figure 205.

The chair to be handled is first assembled outside the clamp or jig by using a rubber hammer and a simple pneumatic clamp to close the glued joints. Only at the next stage is the chair placed into the clamp to be pressed into its correct shape. The clamp is adjustable for different chair models.

Figure 205

Complicated clamp or jig for chair assembly



The following studies on various uses of wood have been prepared by the United Nations Industrial Development Organization and some have been issued as United Nations sales publications:

ID/10	Production Techniques for the Use of Wood in Housing under Conditions prevailing in Developing Countries. Report of Study Group, Vienna, 17-21 November 1969 United Nations publication, Sales No. 70.11.B.32
ID/61	Production of Prefabricated Wooden Houses Keijo N.E. Tiusanen United Nations publication, Sales No. 71.11.B.13
ID/72	Wood as a Packaging Material in the Developing Countries B. Hochart United Nations publication, Sales No. 72.11.B.12
ID/79	Production of Panels from Agricultural Residues. Report of an Expert Working Group Meeting, Vienna, 14-18 December 1970. United Nations publication, Sales No. 72.11.B.4
ID/133	Selection of Woodworking Machinery. Report of a Technical Meeting, Vienna, 19-23 November 1973
ID/154	Low-cost Automation for the Furniture and Joinery Industry
ID/180	Wood Processing for Developing Countries. Report of a Workshop, Vienna, 3-7 November 1975
UNIDO/LIB/SER.D/4	UNIDO Guides to Information Sources No.4: Information Sources on the Furniture and Joinery Industry
UNIDO/LIB/SER.D/6	UNIDO Guides to Information Sources No.6: Information Sources on Industrial Quality Control
UNIDO/LIB/SER.D/9	UNIDO Guides to Information Sources No.9: Information Sources on Building Boards from Wood and other Fibrous Materials
ID/214 (UNIDO/LIB/SER.D/31)	UNIDO Guides to Information Sources No.31: Information Sources on Woodworking Machinery
ID/265	Manual on Jigs for the Furniture Industry
*	Manual on Upholstery Production in Developing Countries

* Forthcoming.

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