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ASSISTANCE TO THE FURNITURE AND JOINERY INDUSTRY

SI/TON/86/873

KINGDOM OF TONGA

Technical report: Assistance to the furniture and joinery industry *

Prepared for the Government of the Kingdom of Tonga
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Karl Fuchs, expert in furniture and joinery production

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Vienna

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BACKGROUND AND OBJECTIVES OF PROJECT SI/TON/86/873

Karl Fuchs, a UNIDO expert in furniture and joinery production has been assigned for a three months mission (14 January - 13 April 1987) to the Kingdom of Tonga, in order to up-grade the furniture and joinery industries through the use of improved design and production facilities and the processing and use of coconut wood.

The main purpose of his work was to give assistance to 15 furniture and joinery manufacturers and enterprises.

INTRODUCTION

Many developing countries are fortunate in owning good reserves of timber.
All require some sort of housing and home furnishings.
Even if a country should lack sufficient timber to meet its demands, a strong wood processing industry based on imported raw material may still prove an important asset.
Such an industry could provide the framework for supplying the requirements for housing and home furnishings and could create employment, thus leading to improved living standards.

Developing countries have a near monopoly in the tropical woods that are in increasing demand by developed countries for fine furniture and joinery work.

In nearly all developing countries, the furniture and joinery industries are still at a handicraft or "mechanized craftsman" stage, that is, large scale production

is unknown. Because wood is a raw material that has been used for centuries in a great many ways, a basic number of skilled furniture makers and other wood workers often exists. They use basic machines and produce items more or less on an individual basis.
As the production of furniture is not a difficult manufacturing process involving complex training programmes, many existing small-scale factories can, with circumspect planning, be up-graded to industrial enterprises through assistance in production planning, quality control, design for larger production series, selection of equipment for modernizing their workshops and more efficient organization of work.

The requirements for manufacturing furniture and its components for the export market, however, are more stringent than those for the home market.

The situation found in the Kingdom of Tonga was - as anticipated - the same as described above. Although the presentation referred to a woodworking and furniture industry, the nomenclature is too grandiose. Most of the establishments are in reality small-scale workshops, and the woodworking equipment is merely basic. A high number of the machines are rather to be described as for "hobby" and not "industrial" production. The skills and techniques observed are still at a handicraft stage.

However, there exists a deep sense for the utilisation of their traditional raw materials. Taking this into consideration and adding their congenital handicraft skills, with improved production methods, a certain financial input and the utilisation of local materials, there is nothing against the development of a well-functioning woodworking industry.

ASSESSMENT OF THE WORK DONE BY THE PROJECT

A) RAW MATERIALS

Solid wood, or timber, was traditionally the basic raw material for the furniture and joinery industries. The properties required of the wood used in furniture and joinery products vary greatly. Dissimilar properties may be needed for different parts of a given product. Therefore, the choice of appropriate raw materials is of prime importance. Properties that should be taken into consideration in the choice of timber are:

Strength, together with toughness, rigidity and hardness;
Grain structure, with homogeneity, colour shade and variations;
Drying properties, such as shrinkage, swelling and twisting;
Suitability for glueing;
Finishing qualities;
Bending qualities (reaction to treatment by steam and ammonia);
Workability;
Resistance to weathering and to insect damage;
Density.

The properties of each kind of wood are quite specific; certain species are better suited to some purpose than others. Conversely, no one wood is ideal for all purposes.

Coconut wood: Most of the technical properties of coconut timber are excellent; its grain structure and colour shade are beautiful, but it dulls woodworking tools rapidly, it needs proper sanding equipment and a thorough technical knowledge, in order to obtain a smooth surface.

In Tonga the coconut timber is at present exclusively provided by the Mataliku sawmill for furniture and joindery production it has to be graded in two classes. The first plank obtained(from the bark side) generally consists of first quality high-density timber. The colour is dark brown, snd it shows a nice grain structure.

The second and the following planks sawn mostly consist of second and third-grade quality, low-density timber (inner part of the log). The colour varies from middle to light brown and it shows a porous grain structure.

Coconut timber suitable for furniture making should always only consist of first-grade quality. Lower quality coconut timber should only be used for certain joinery products and as a construction material for specific non structural uses.

In view of the hardness and toughness of this material, the manufacturer, who considers its use for serial production has to take into consideration that all cutting be carbide tipped, since, when used for this purpose normal machine tools have only a very limited tool life and wear out rapidly.

For sanding, a special technique has to be applied, in order to obtain a smooth surface. For the first sanding process a sanding belt with grit size 100 has to be used, and the timber should be sanded across the grain. The second sanding process has to be carried out with grit size 120 or even finer and should be repeated for at least two times; one process alone and the second process, across the grain.

In general, it can be said, that, although the material is difficult to manufacture, it has the advantage of a very short natural seasoning process (only six to ten weeks, for two inches properly stacked) and the finished products show finally a very attractive appearance.

Other raw materials : Raw materials, such as Canadian Pine which always arrive in a seasoned condition have to be stored properly under cover or rather under roof.

In order to obtain high quality products, it is important to use only well seasoned timber.

B) TECHNICAL DESIGN / SERIAL PRODUCTION

The introduction of industry into a country without industrial traditions always stimulates new demand. The more one branch of industry is developed and the more its product is sold to retail consumers, the greater the need is for good design. As export markets become more necessary, the role played by good design becomes greater.

There is high interest in good design among producers in many developing countries, but the services of capable designers are difficult to obtain.

Mass-produced furniture is always cheaper than custom-made pieces, but in most developing countries furniture is still produced on an individual basis. However, local people will probably come to accept mass-produced furniture in the same way as they accepted automobiles, radios and other everyday, obviously mass-produced items.

In both mass-produced and individually produced furniture, design plays an important role in developing the furniture industry of a developing country.

Technical product design is the planning and design of a product and its parts in such a way that its serial production is as rational as possible **and that it is done at the lowest possible cost.**

Serial production is a manufacturing process in which a large number of one item is fabricated in a single batch by performing each operation for each member of the series at the same stage. The number of pieces fabricated in one batch depends greatly on the nature of the product and hence on the demand.

Modern serial production techniques usually require the following characteristics of a product:

1. The product must be suitable for the manufacturing process of the plant in question and permit the efficient use of the machinery.

2. Less manual work should be included and jigs for machine operation and assembly have to be used.

3. Sanding and surface finishing of parts should be done, whenever possible, before assembly.

4. Quality controls have to be undertaken continuously during the whole production process.

C) JIGS FOR MACHINE OPERATION AND ASSEMBLY

One of the most urging problems of the "furniture industry" in the Kingdom of Tonga is to increase productivity and profitability in the move from craft to industrial-type operations.

Furniture is produced at a craft level in all societes at all stages of development. 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, and the accuracy of the components operated on them.

Provided, the necessary know-how is available, proper working jigs can be constructed at very low cost, though render possible serial production and increasing productivity.

During the expert's assistance to the furniture and joinery industry, the UNIDO manual on "Jigs for the Furniture Industry", Document ID/265 served as a helpful support material, and the following descriptions and detailed informations were used:

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:

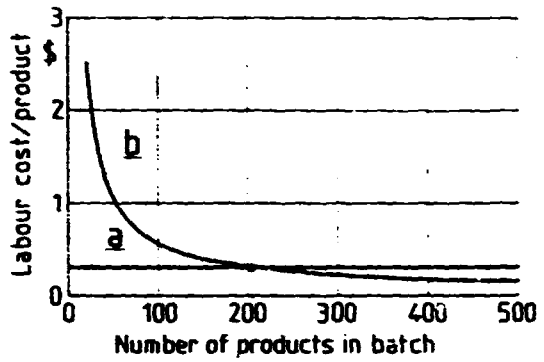
$$n_{min} = \frac{A}{B - C} = \frac{\$49.00}{\$\ 0.24} = 205 \text{ pieces}$$

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 th 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.

II. Technical aspects in design of jigs

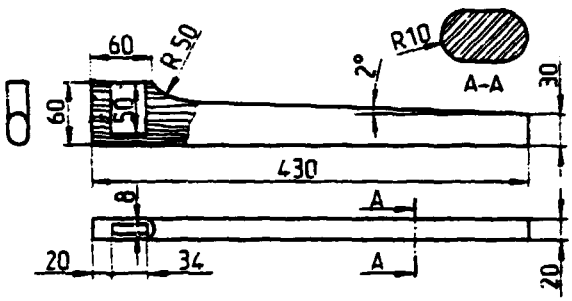
Design according to working drawings and prototypes

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

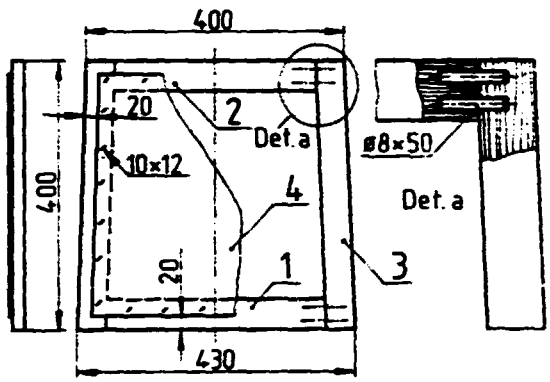


Assembly drawings. This group is further divided into subparts assembly drawings (figure 5) and final assembly drawings (figure 6).

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

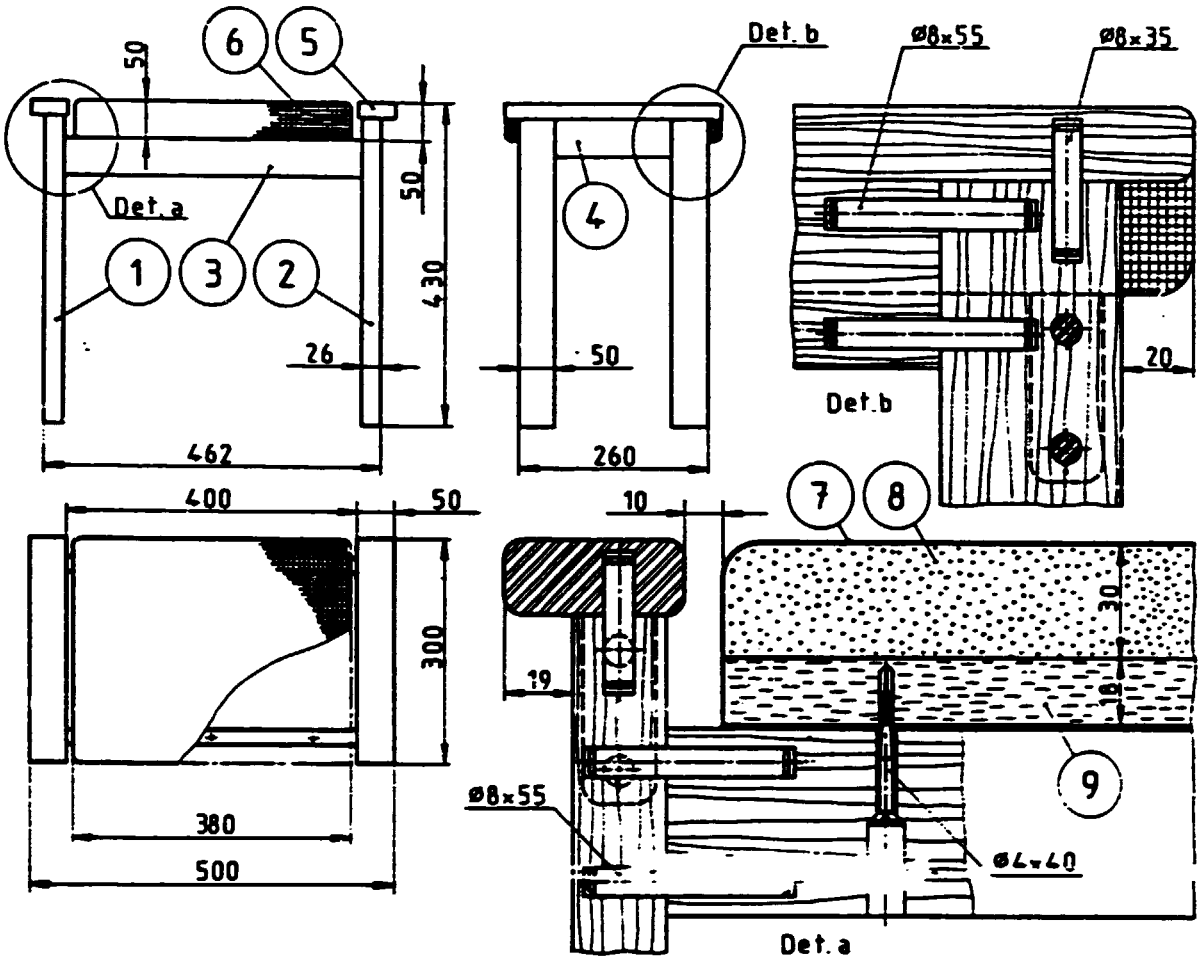


Figure 7

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

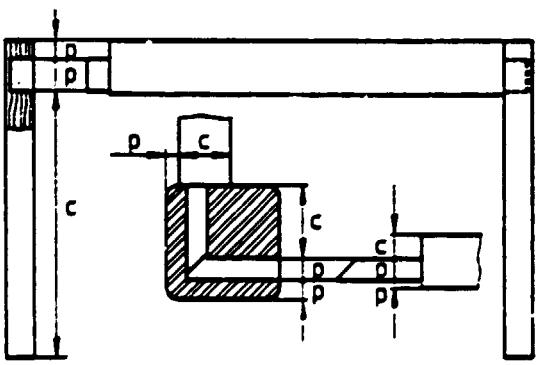


Figure 8

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)

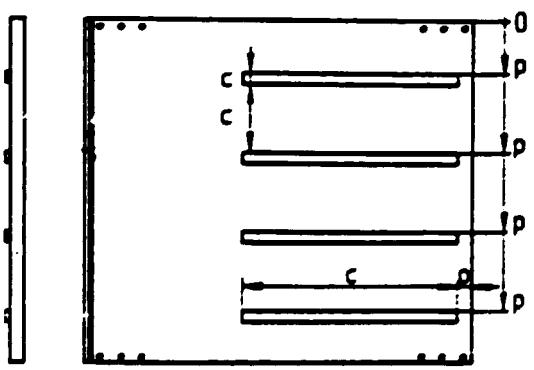
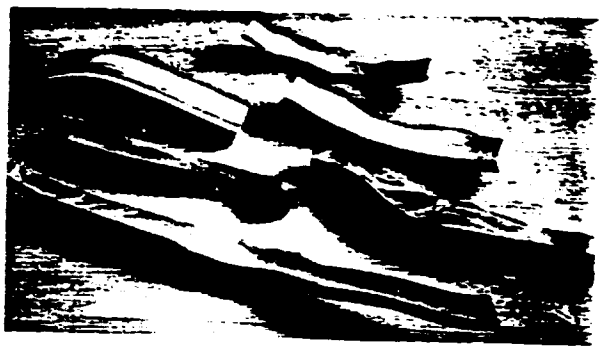


Figure 9

Curved furniture components with decorative details



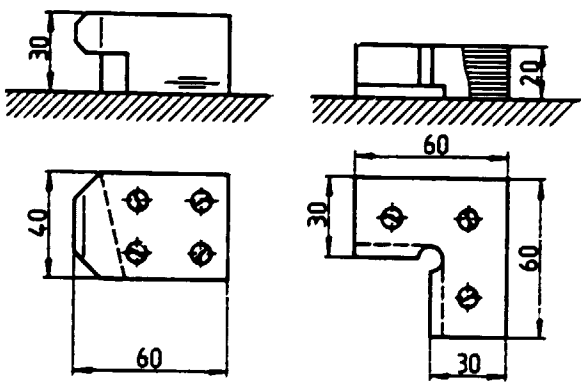
Position and construction of stoppers

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

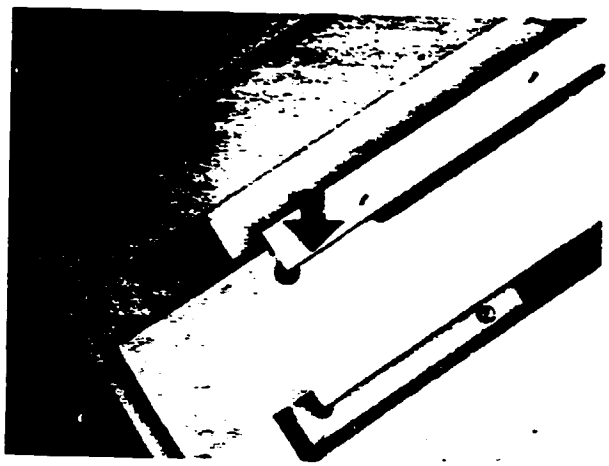
Wooden stoppers



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

Figure 11

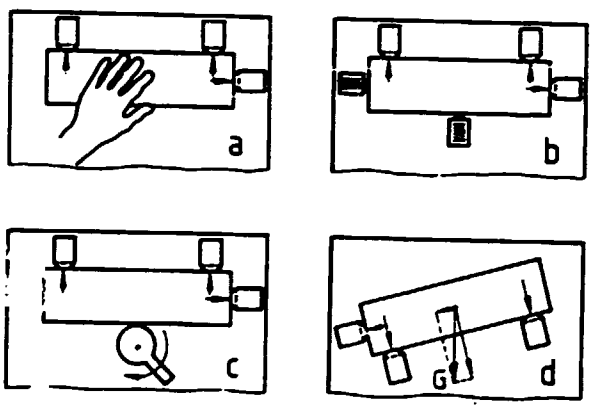
Location of stoppers. The panel (see figure 8) is upside down in the jig



(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:

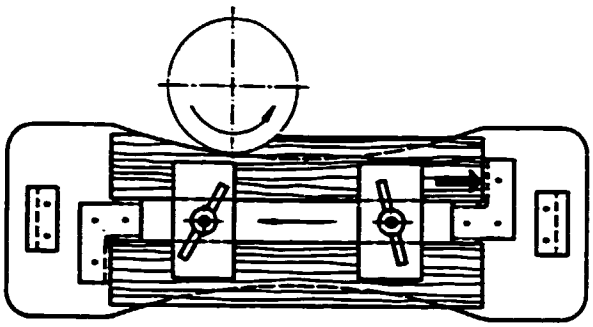


Key: a. Pushing by hand
b. Spring
c. Eccentric
d. Gravity

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

Figure 13

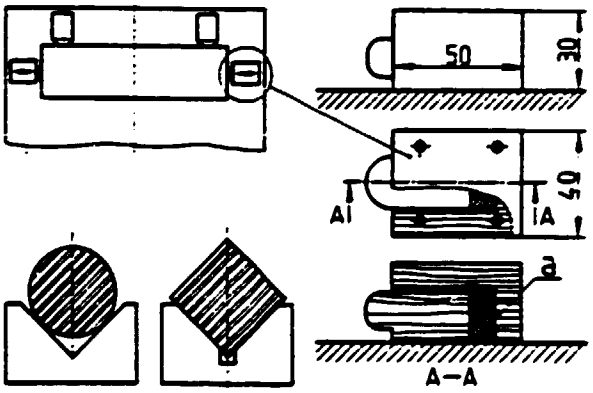
Spindle-moulding jig for a curved furniture component. The cutting force pushes the workpiece against the stoppers



(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 should 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



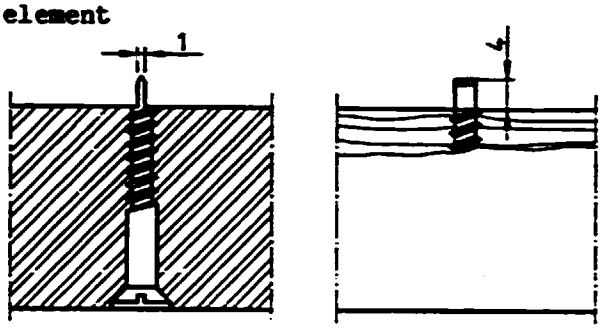
Fixing elements

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

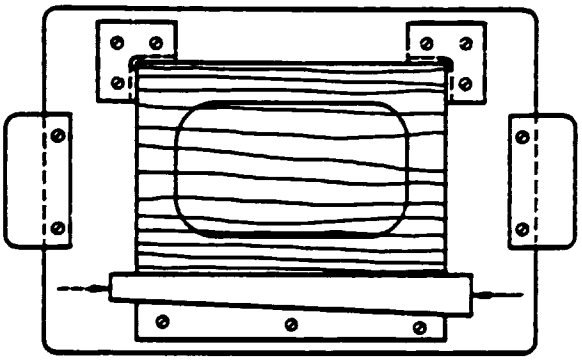
Sharpened steel pin used as fixing element



2. Wedges, usually made of wood or plywood, are [illegible] spindle-moulding and routing [illegible]

Figure 16

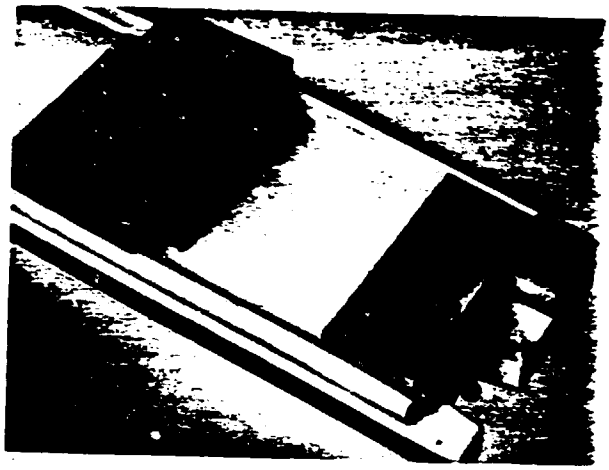
Routing jig with a wooden wedge for fixing the workpiece. A hammer is used to tighten and loosen the wedge



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

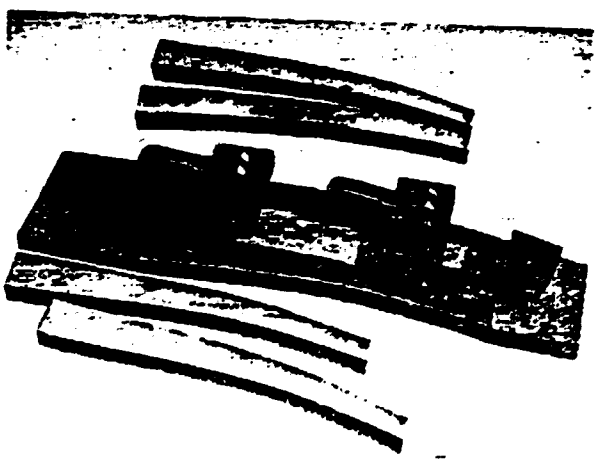


Figure 19

Eccentric with pressure plate (a) for fixing the workpiece

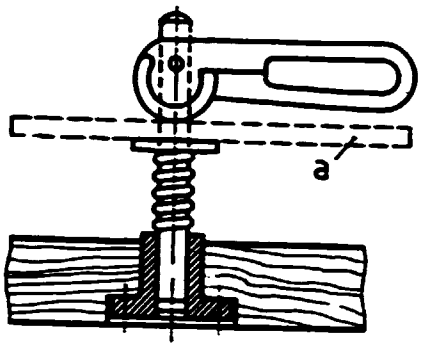


Figure 20

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

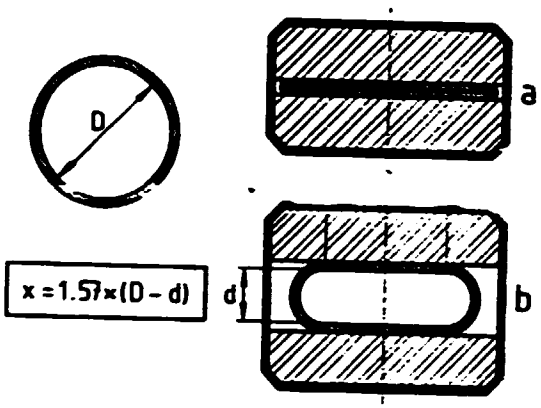
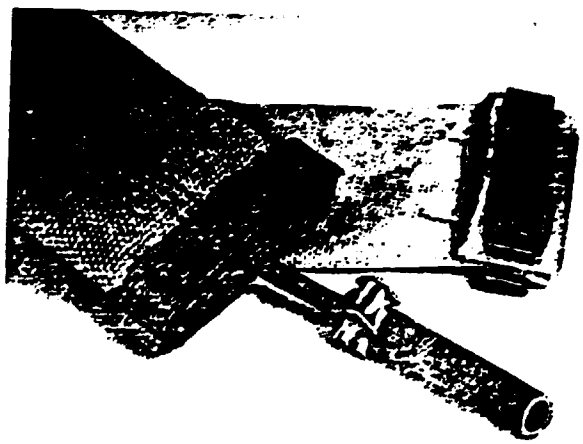


Figure 21

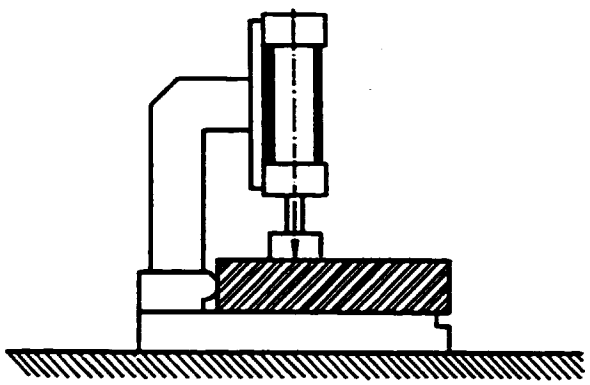
Construction of a fire-hose unit. The ends of the hose are sealed by riveting



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 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), ...ly 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

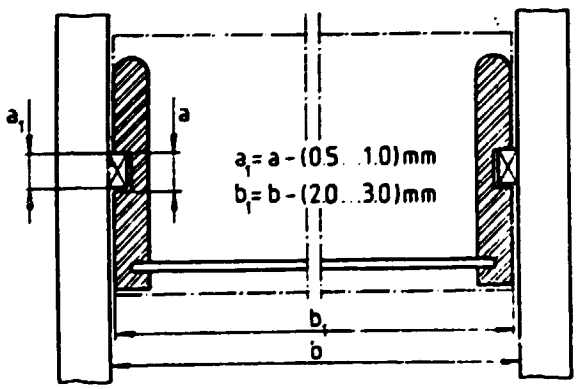
Frame assembly jig with pneumatic cylinders. The jig also ensures the rectangularity of the frame

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 [illegible] 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.

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 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.

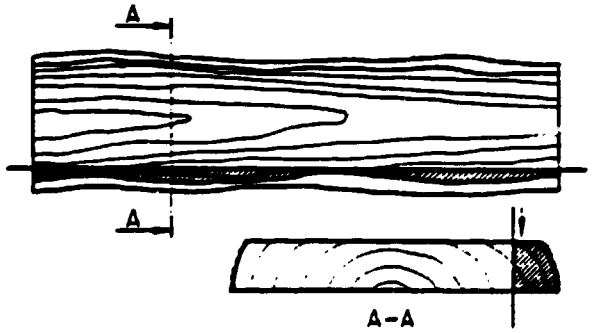
Jigs for use on band-saws

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

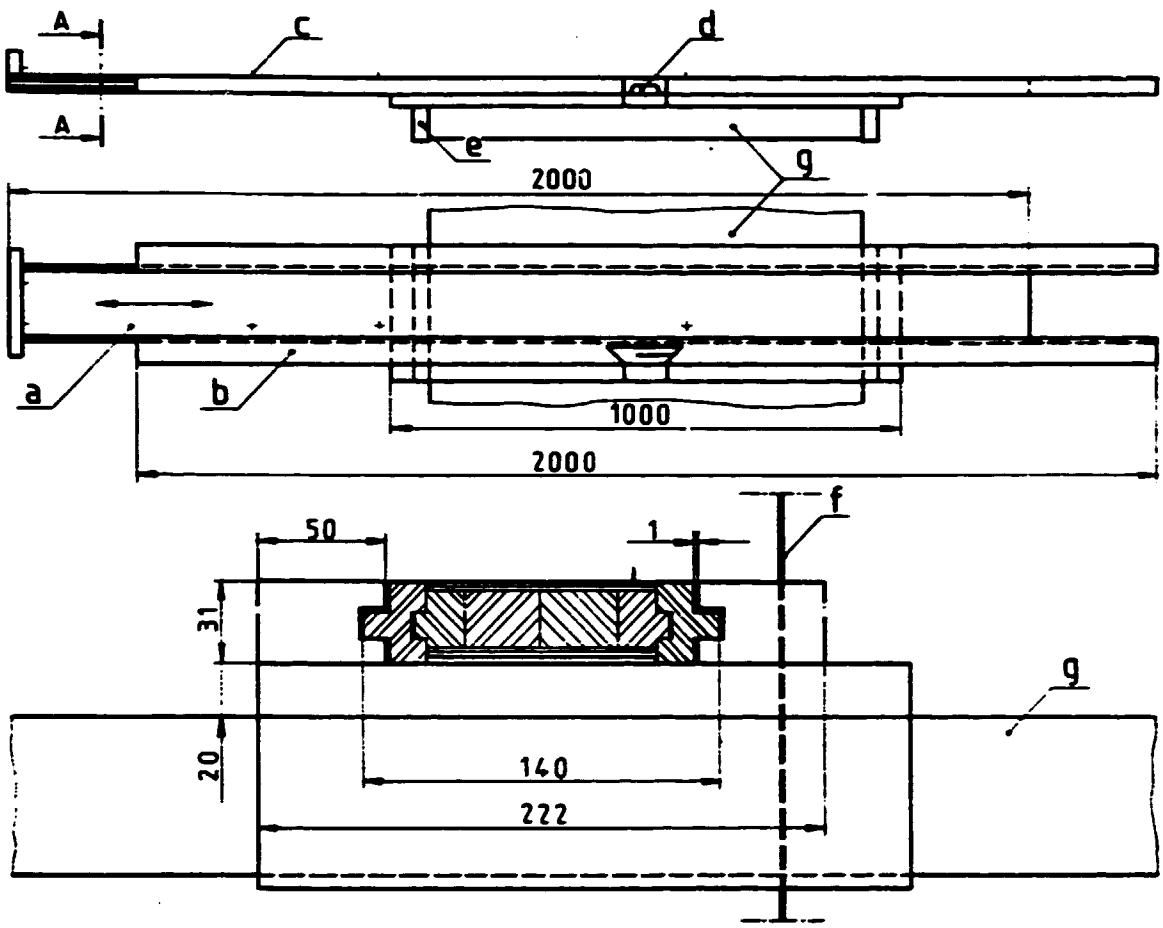
Various types of wedge can be easily sawn from solid wood by using a wooden feed-block or jig with a wedge-shaped incision, as shown in figures 31 and 32.
If a large number of wedges is needed, the material should first be cut into larger pieces with the same measurement in the direction of the grain 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

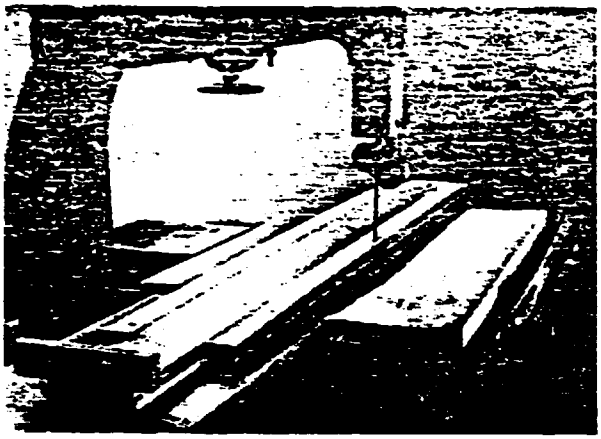


Figure 29

Edge-sawing attachment in operation

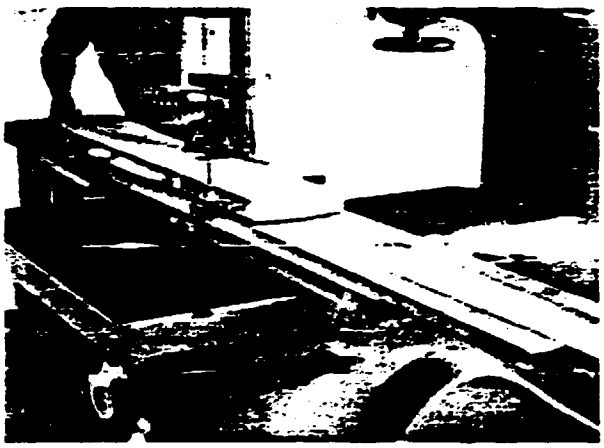


Figure 30

Edge-sawing attachment seen from the rear

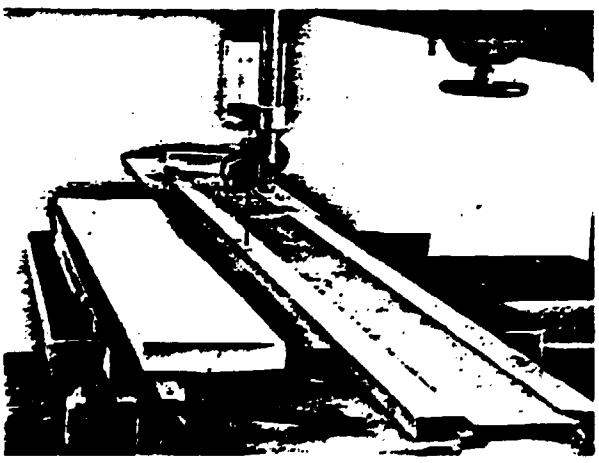


Figure 31

Wedge-sawing jig in operation

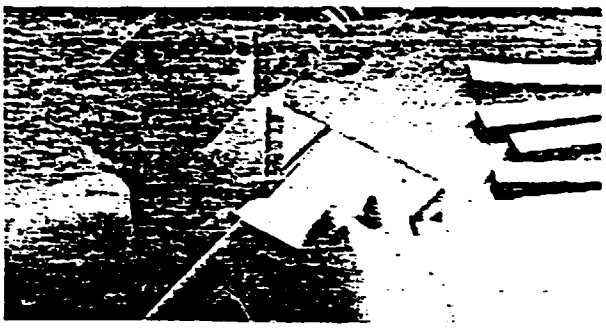


Figure 32

Working principle of wedge-sawing jig

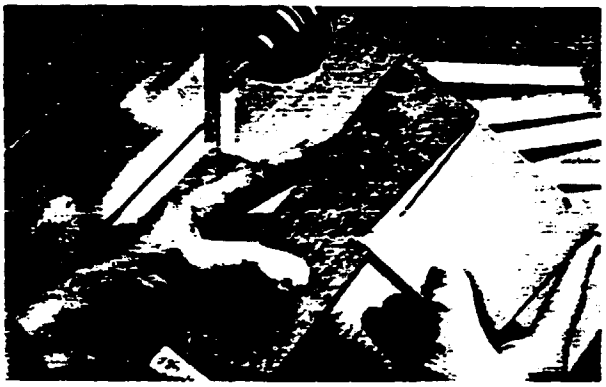
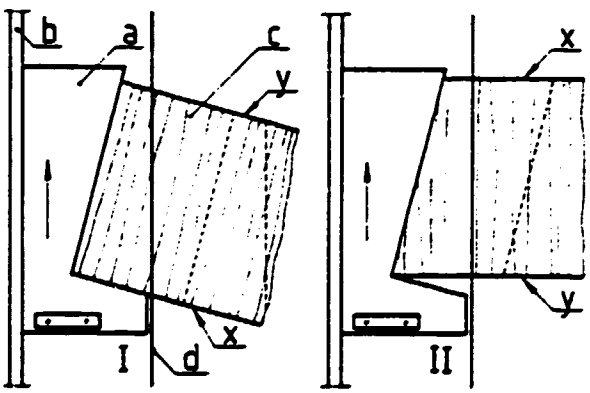


Figure 33

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

I. First cut

II. Second cut, after reversing the panel

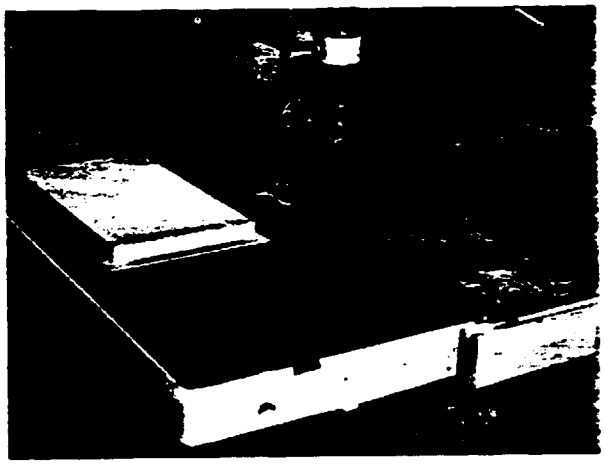


Key:
a. Jig
b. Machine fence
c. Work piece
d. Sawing line
X and Y are panel edges (to show reversing)

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

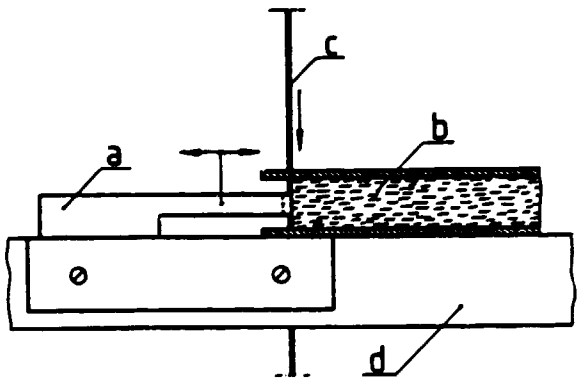
Panel edge trimming jig for removal of protruding excess of surfacing material



If the band-saw has a metal ..... 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

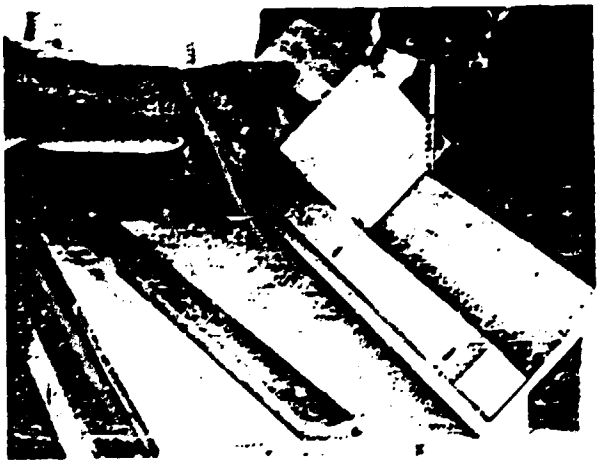
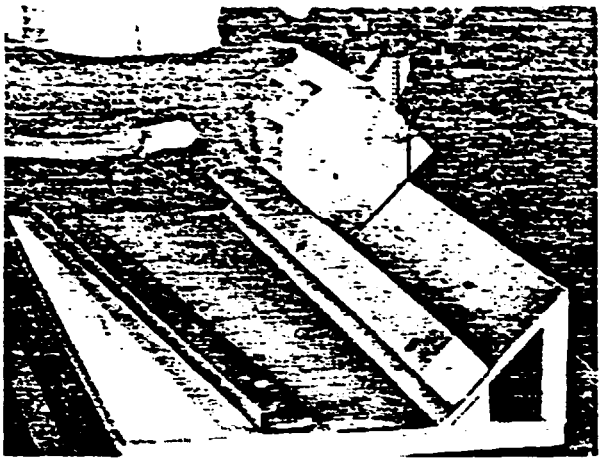


Figure 38

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.

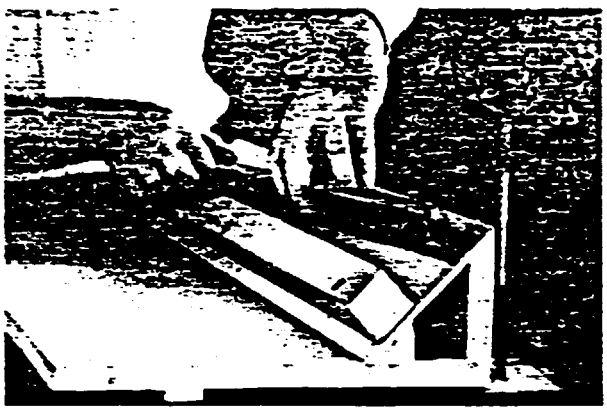


Figure 40

First feed using spacer

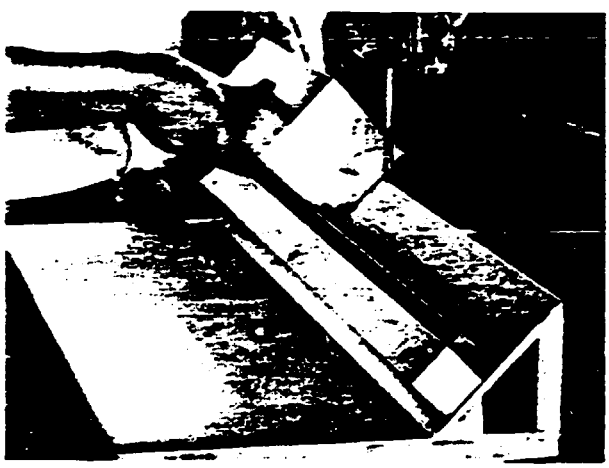


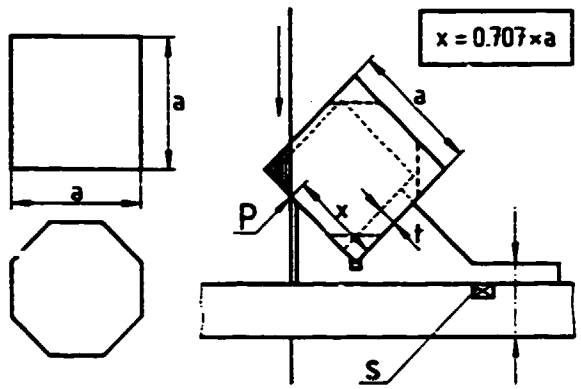
Figure 41

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



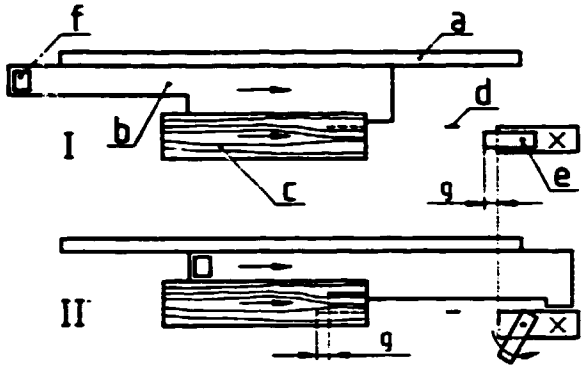
Jigs for tenoning

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

Figure 43

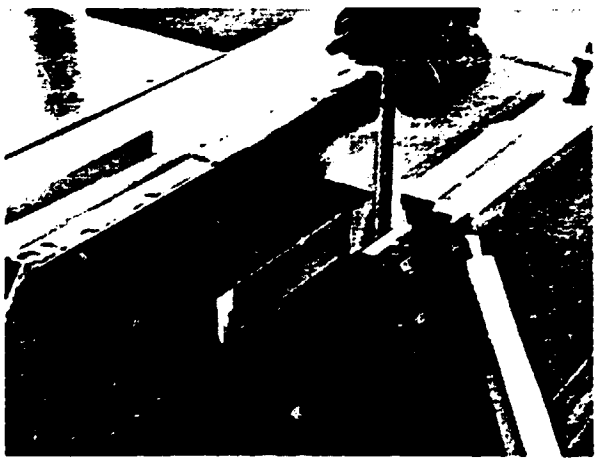
Jig for sawing sides of straight tenons



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



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.

D) BASIC WOODWORKING MACHINERY

At present there exist in the Kingdom of Tonga only avery limited number of woodworking machines. The machinery is rather old in terms of function and design and partly size for "hobby" and not "industrial" production. Due to these facts and minimal maintenance, let alone proper servicing, machinery malfunction and breakdowns are common.

In order to seize the idea of manufacturing on a serial basis, at least a certain number of well functioning basic machinery has to be available.

The process of manufacturing mass products means, that one machine serves the next and all together act like a production chain. Malfunction or breakdown of only one machine is equivalent to damage of one link in a chain, which means that the entire production flow would collapse.

Basic woodworking machinery for furniture production:

TABLE CIRCULAR SAW

Main purpose:	Edge sawing Splitting Tenoning Panel sizing Rebating Grooving
Accessoires:	Sliding table Edge-sawing device First saw speed 3000 to 3500 rpm (sawing of solid timber) Second saw speed 5000 to 6000 rpm (sawing of panels e. g. chipboards) Motor has to be tropical insulated

BAND SAW

Main purpose: Hand controlled curve sawing
Tenoning
Sawing curved pieces

Accessoires: Tropical insulated motor

SURFACE PLANER

Main purpose: Planing of surfaces
Planing to rectangular shapes
Insert planing
Beveling

Accessoires: Knife setting device
Tropical insulated motor

THICKNESSER

Main purpose: Planing to final sizes.
Planing to wedge shapes
Planing to trapezium shapes

Accessoires: Knife setting device
Tropical insulated motor

SPINDLE MOULDER

The spindle moulding machine is one of the most versatile basic woodworking machines.

Main purpose: Rebating
Grooving
Profile cutting
Insert cutting
Glue joint cutting

SPINDLE MOULDER/ (continuation)

Main purpose:
- Multiple dowel cutting
- Edge planing
- Tenoning
- Edge sanding

Accessoires:
- Automatic feeding roller
- Sliding table
- First spindle speed 3000 rpm (milling of soft wood, tenoning),
- Second spindle speed 5000 to 6000 rpm (milling of hard wood, plywood, particle boards)
- Tropical insulated motor

CHISEL MORTISING MACHINE, AND/OR CHAIN MORTISER

Main purpose:
- Mortising for joints
- Slots for fittings (door lock)

Accessoires:
- Tropical insulated motor

BELT SANDING MACHINE

Main purpose:
- Sanding of surfaces
- Sanding of edges
- Sanding of profiled workpaits
- Intermediate lacquer sanding

Accessoires:
- First belt speed 600 to 800 rpm (lacquer sanding)
- Second belt speed 1800 to 2200 rpm (wood sanding)

Saw Doctoring Equipment:

In addition to woodworking machines, saw doctoring equipment and its proper utilisation plays an important role, since quality work can be achieved only with well conditioned machine tools.

UNIVERSAL SAW BLADE GRINDER

Main purpose:
- Sharpening of carbide tipped saw blades
- Sharpening of profile cutters
- Sharpening of drill bits

Accessoires:
- Diamond and silicon carbide grinding wheels
- Grinding device for profile knives
- Grinding device for drill bits
- Tropical insulated motor

UNIVERSAL KNIFE GRINDER

Main purpose:
- Sharpening of planer knives
- Sharpening of thicknesser knives
- Sharpening of spindle cutter knives
- Sharpening of hand planer knives

Accessoires:
- Diamond and silicon carbide grinding wheels
- Grinding device for insert knives and spurs
- Tropical insulated motor

BANDSAW GRINDER

Main purpose:
- Sharpening of bandsaw blades
- Setting of bandsaw blades

Accessoires:
- Silicon carbide grinding wheels
- Saw blade set attachment
- Tropical insulated motor

Energy Resources:

Electricity for supply within the Kingdom is still produced with Diesel generators. Therefore, its utilisation is extremely expensive.

One way to increase productivity is the use of air-powered hand machines.

The capacity of a compressor has to be adapted to the size and demand of a workshop and possible expansion of the plant in the future has to be calculated.

COMPRESSOR

The type of compressor most commonly used in furniture plants is the reciprocating type, which can produce pressure up to 10 bar. Pressure, lower than 5 bar may not be sufficient for some requirements.

Compressor capacity is generally given as the number of cubic feet per minute (cfm) or cubic metres per minute (m^3/min) of free air delivery (FAD).

Occasionally, compressor capacity may be rated in terms of the volume of free air displaced, in which case this displacement must be multiplied by the efficiency of the compressor, in order to obtain the FAD volume.

COMPRESSOR/continuation

Sample problem:

A compressor is rated at 500 cfm (14 m^3/min)
free air displaced.
The efficiency of the compressor is 88 per cent.
Find its FAD volume!

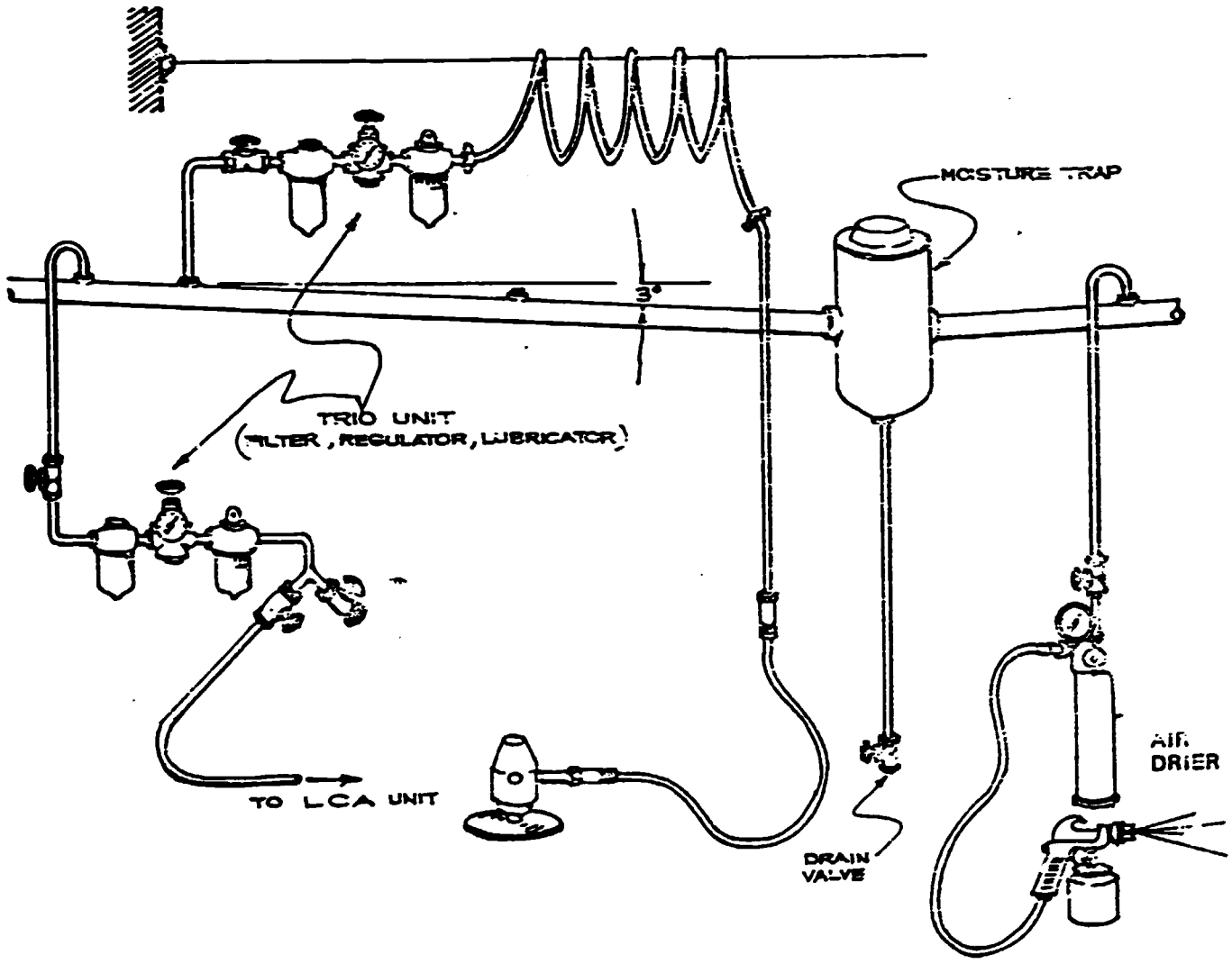
Solution:

FAD = (Free air displaced) x (Efficiency of compressor)
= 500 x 88/100
= 440 cfm (12,46 m^3/min)

A compressed air supply system installed throughout the entire workshop offers the advantage to use compressed air. everywhere needed.

For a sample airline system - see overleaf.

The airline system should also serve the surface treatment department, which must be located in a dustfree area within the workshop.



Air-line system

Equipment for Surface Finishing:

It is a matter of fact that only a carefully tre ted surface gives the finishing touch to the end product.

Already on designing the layout of a factory, care should be taken to separate the production- and especially the sanding operations from spraying and drying. A good partition between the machine department, the sanding room and the spraying room should be foreseen.

It is recommended that in this section all electrical installations and electric powered machines have to be of the explosion-proof type, since there is always an increased risk of fire in a spraying room.

Summary of basic equipment:

SPRAY PISTOL, with different spray nozzles
SPRAY STAND
INTERMEDIATE-SANDING-TABLES
EVAPORATING RACKS
EXHAUST FANS

Dust Extraction System

When carrying out serail production, it is nearly indispensable to use saw -and sanding-dust exhausts for the entire woodworking machinery.

Priority should be given to the following basic machines: (In order of priority)

1. Thicknesser
2. Planer
3. Belt Sander (separate silo for sanding dust/risk of fire !)
4. Circular Saw
5. Band Saw
6. Cross Cut Saw

Various systems are possible:

1. A generalized extraction system for the entire machinery
2. Portable exhaust units for single machines
3. Smaller units for certain groups of machines (this would avoid running the entire exhaust system, when only one or few machines are in operation).

In addition to the extraction system, wooden boxes should be placed especially next to machines producing off-cut material in operation such as:

Cross cut saw

Circular saw

Band saw

in order to collect the accrued waste.

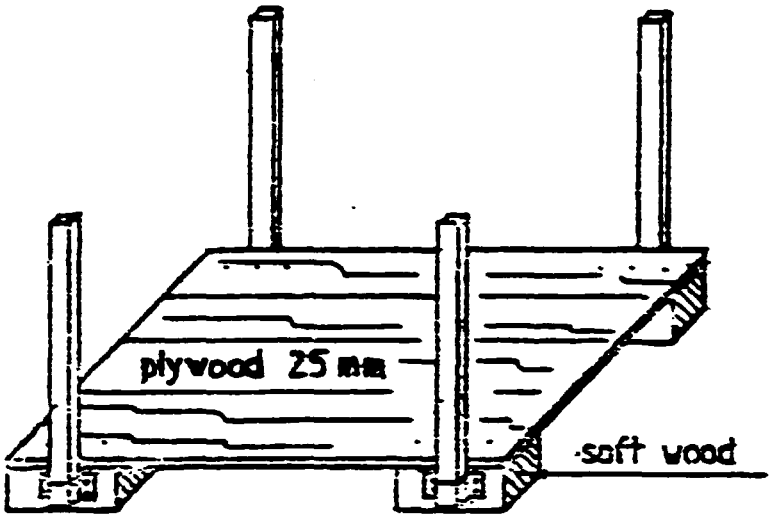
The result of following this advice would be a clean workshop and thus, and uninterrupted production flow would be achieved.

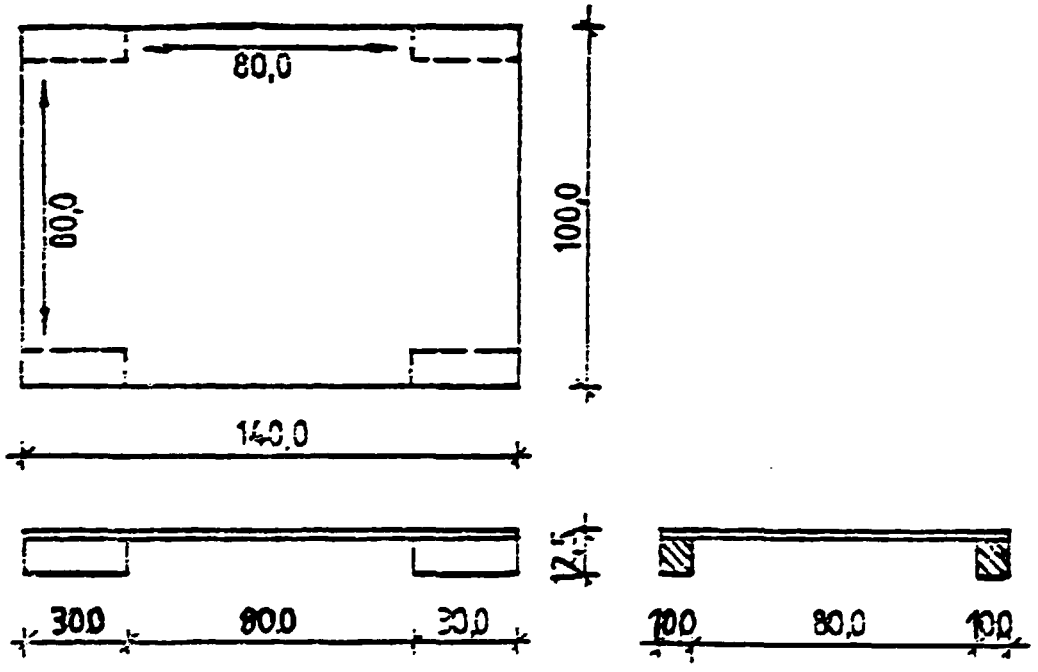
Internal Transport:

More value should be added, within the serial production process, to the moving of work pieces from the space next to one machine to the space next to the following machine.

The most suitable system for the type of operation in small scale industries are simple wooden pallets carried with hand-operated hydraulic pallet transporters (hand fork lift transporter).

See sample of a wooden pallet overleaf.





PRODUCT – palett PART –	SCALE – 1:20
DESCRIPTION –	DRAWING NO,
PAY ATTENTION TO INSIDE DIMENSION!	DRAWN – fuchs 3.85
	CHECK –
SI/TOM/86/275 UMUDO 3.87 K. FUCHS	CHANGE –

SELECTION OF CUTTING TOOLS :

The function and suitability of woodworking machines is depending on the variety of well-conditioned auxiliary equipment at hand.

Cutting tools should always be available in duplicate, so as to ensure that one set be any time at hand in a sharpened and adjusted condition.

Recommended basic range of cutting tools :

Cross cut saw:	Cross cut saw blade (coconut/hard and soft wood) - Annex I
Circular saw:	Rip saw blade (coconut/hard wood) Annex II Trim saw blade (coconut/hard and soft wood) Annex III Panel saw blade (plywood/chipboard) Annex IV
Band saw:	Band saw blade, 1 inch wide (hand controlled sawing, coconut/hard and soft wood) Band saw blade, o,5 inch wide (hand controlled sawing of narrow curves, hard and soft wood)
Surface planer:	Planer knives (coconut/hard and soft wood) Annex V
Thicknesser:	Planer knives (coconut/hard and soft wood) Annex V

Spindle moulder:

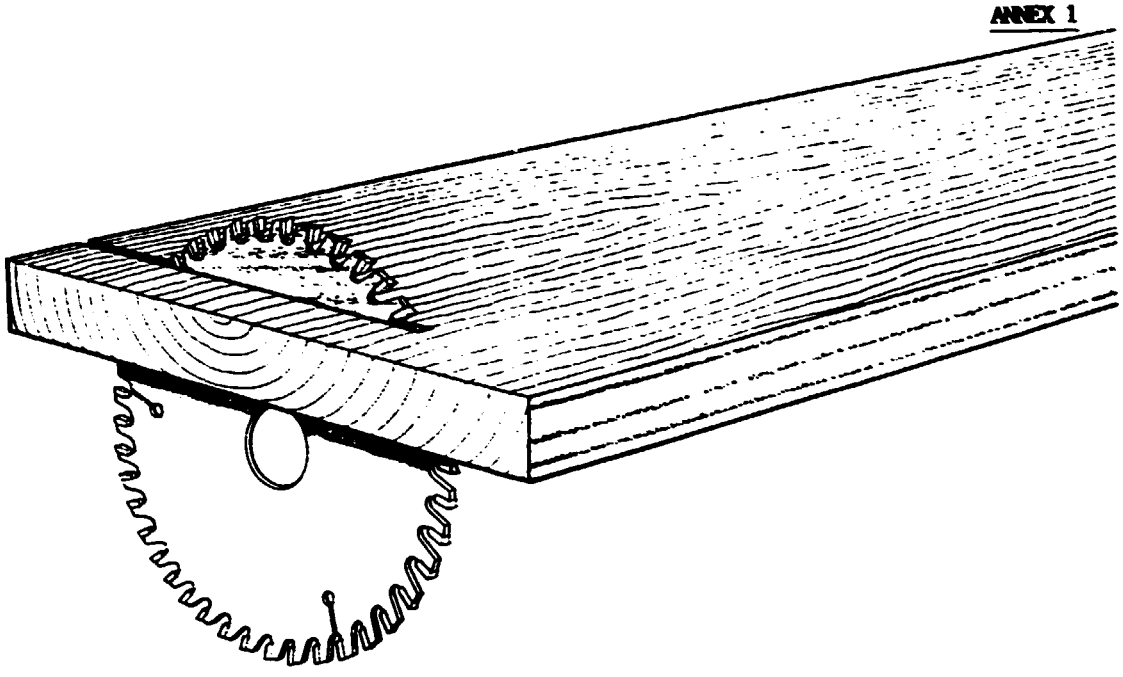
Adjustable grooving cutter - Annex VI
Rebating cutter with spurs - Annex VII
Vari-angle cutterhead - Annex VIII
Panel raising cutterhead - Annex IX
Profile cutter combination - Annex X
Coffering cutterblock - Annex XI
Reversile mitre joint cutterblock - Annex XII
Multiple dowel cutters - Annex XIII
Wedge type planer head - Annex XIV

In case of placing an order for cutters, saw blades, etc, it is essential to know all given technical data of the respective machine, such as:

1. Spindle and bore diameter
2. Minimum and maximum rpm
3. Configuration of tools (HSS, carbide tipped)
4. Direction of rotation of the machine spindles
5. Direction of work, such as with, or across the grain
6. Manual or machine feeding.

Crosscutting and trimming

ANNEX 1

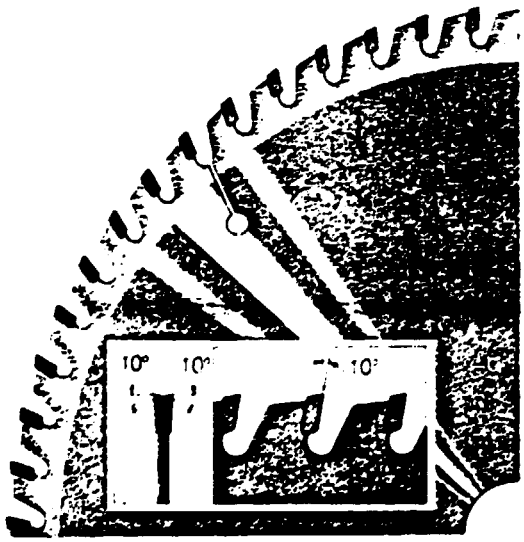


Sandvik 10BA16E

Normal kerf. Low-sound blade. Limited chip space.

Crosscutting and trimming saw blade for trimmer, crosscutters, high-speed cut-off saws and parallel cut-off saws. Also suitable for plaster board, veneered fibre building board and particle board.

Diam. mm	Kerf width mm	Plate thickness mm	C-hole mm	Number of teeth	Pitch mm
150	2,8	1,9	20	30	15,7
180	2,8	1,9	20	36	15,7
200	2,8	1,9	30	40	15,7
225	3,2	2,2	30	44	16,1
250	3,2	2,2	30	48	16,4
300	3,2	2,2	30	60	15,7
350	3,6	2,6	30 35	72	15,3
400	3,6	2,6	30 35	80	15,7
430	4,4	3,0	30	90	15,0
450	4,4	3,0	30	90	15,7

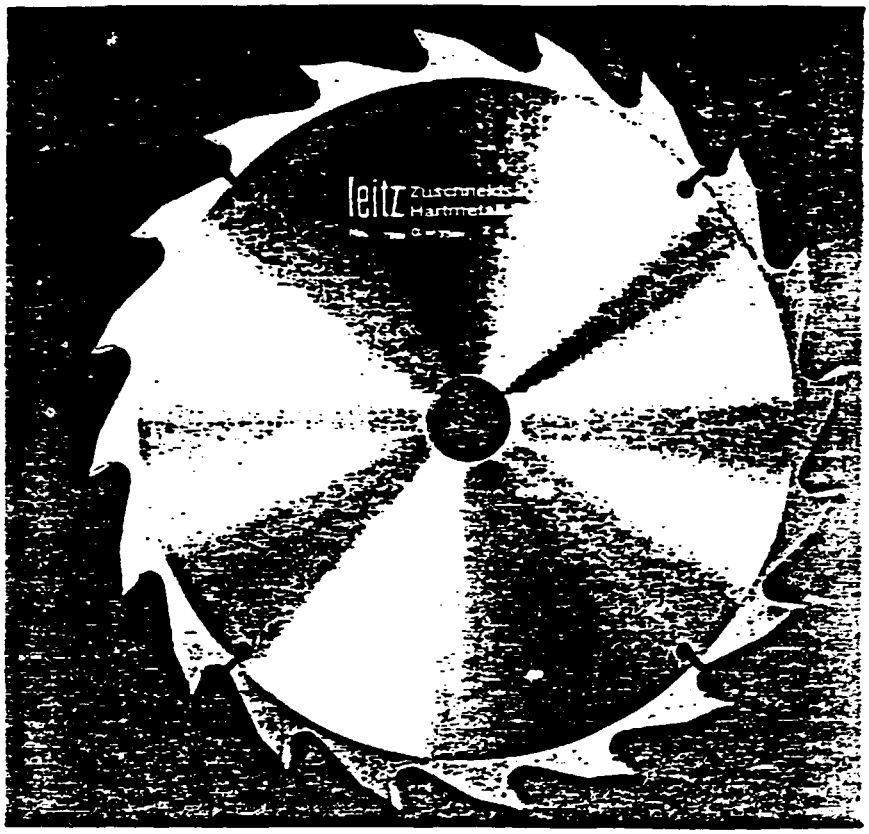


ANNEX 2

780

Heavy duty rip saw Square tooth

Carbide-tipped

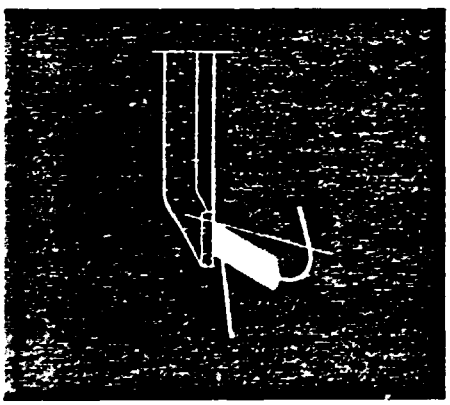


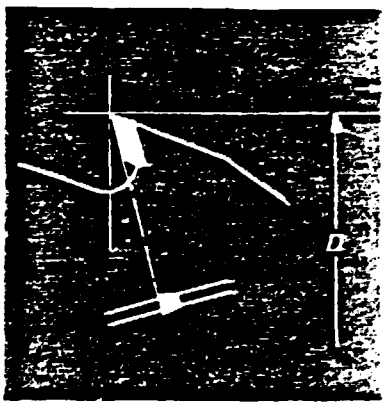
Technical details

With square carbide teeth. Enlarged chip clearance area for easy chipflow. Blade in heavy gauge, therefore exceptionally stable.
For splitting cuts in solid wood, mainly exotic hardwood. Cuts timber up to 120 mm thick.

Maintenance

Grinding on automatic machines on top of tooth. Soft steel backing to be reduced behind tip 0.5 – 0.8 mm to allow for back clearance.





Dimensions

Diameter	D = mm	300	350	400	450
Max. R. P. M.		6500	5500	5000	4000
Kerf	B = mm	4.0	4.4	4.4	4.4
Standard bore	d = mm	30	30	30	30
Number of teeth	Z =	20	20	24	28

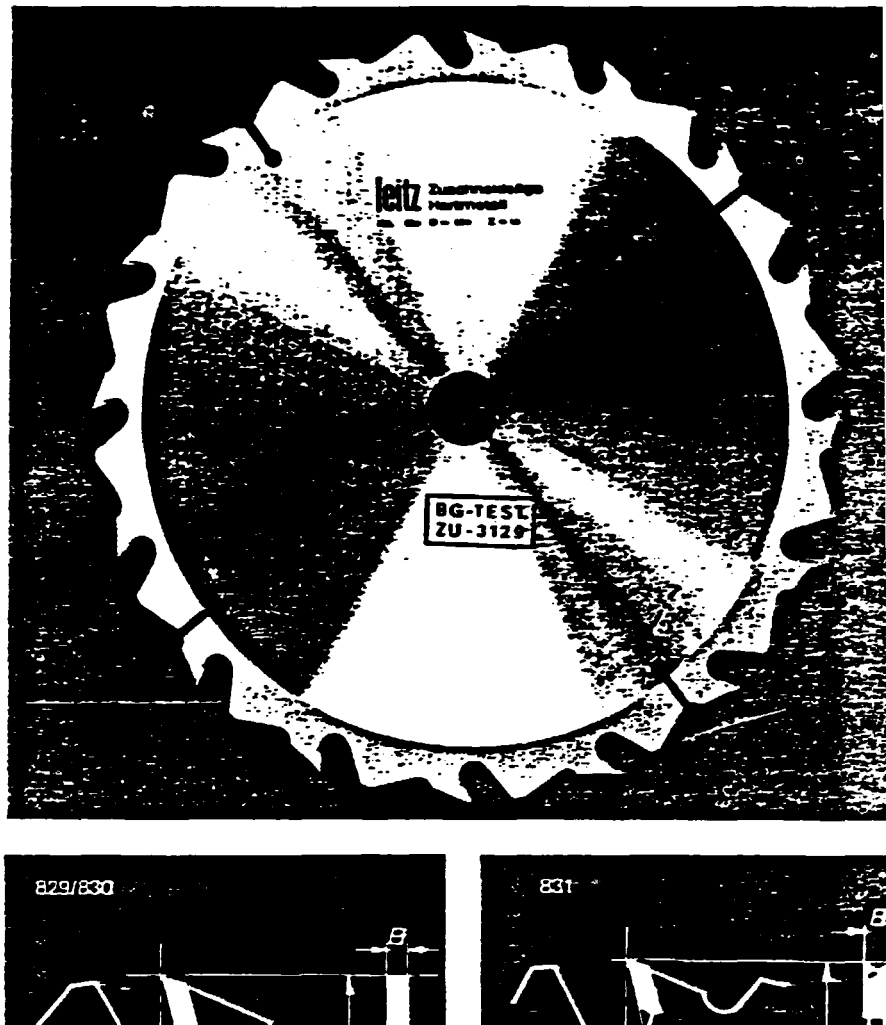
All available with 1¼" bore

829
830
831

Carbide-tipped

Trim and rip saws

Square- or alternate top bevel tooth

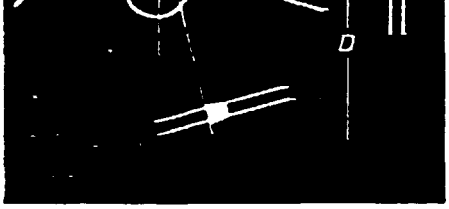


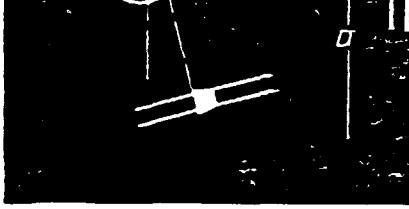
Technical details

Types 829/830 with square carbide teeth, type 831 with alternate top bevel teeth. With chip thickness limitation butts, therefore reduced kickback.

Maintenance

Grinding on automatic machines on top of tooth. Set machine on swivelling action to grind alternately bevelled top. Soft steel backing to be reduced behind tip 0.5 – 0.8 mm to allow for back clearance. Chip thickness limitation butts must be kept 0.8 mm below cutting circle.





829/830
Ripping in softwood and hardwood along and cross grain up to 60 mm thick, diameters above 350 mm cut timber up to 100 mm thick. Max. rate of feed 10 m/min. Sizing cuts in furniture boards without veneer or plastic laminates. Also sizing cuts in light building materials such as plaster type boards, etc.

831
Ripping and sizing in softwood or hardwood along grain up to 60 mm thick, cross grain up to 100 mm thick. Plywood and furniture boards without veneer or laminating. Manual feeding only.

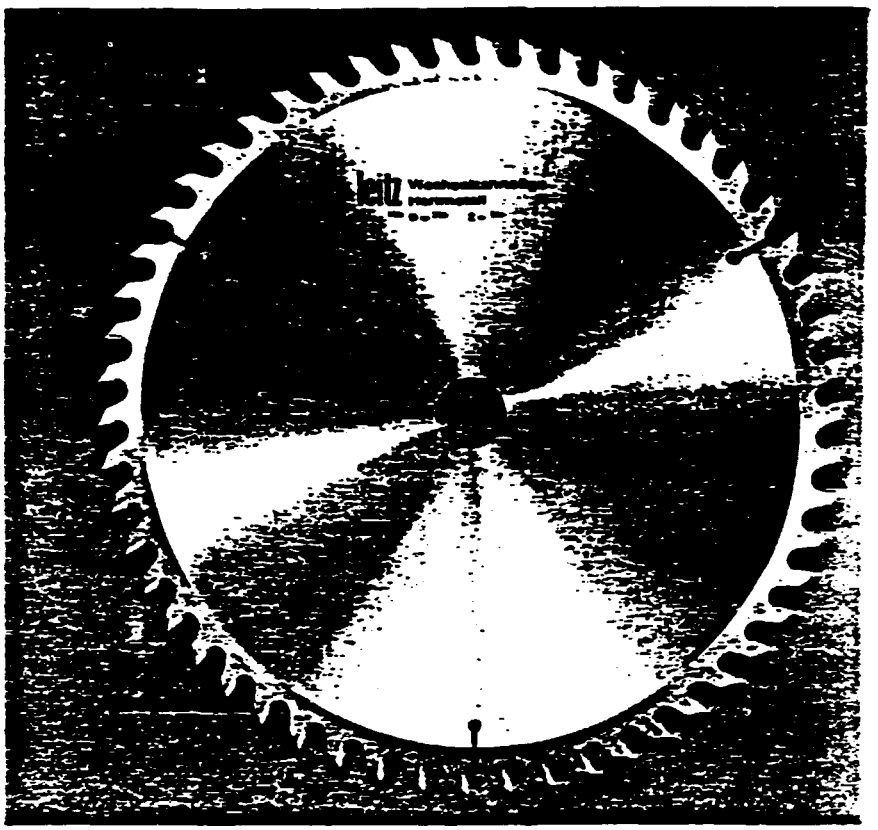
Diameter	D = mm	250	300	350	400	450	500
Max. R. P. M.		8000	6500	5500	5000	4000	4000
Kerf	B = mm	3.2	3.2	3.5	4.0	4.0	4.4
Standard bore	d = mm	30	30	30	30	30	30
829	Z =		14	16	18		
830	Z =	18	20	24	28	34	36
All available with 1¼ inch bore							
Diameter	D = mm	190	190	250	300	350	400
Max. R. P. M.		9000	9000	8000	6500	5500	5000
Kerf	B = mm	3.4	3.4	3.2	3.2	3.2	4.0
Standard bore	d = mm	30/60	40 DKN	30	30	30	30
831	Z =	20	20	24	28	32	36
All available with 1¼ inch bore, at 250 and 300 mm dia. with 5/8, 3/4 and 1 inch bore.							

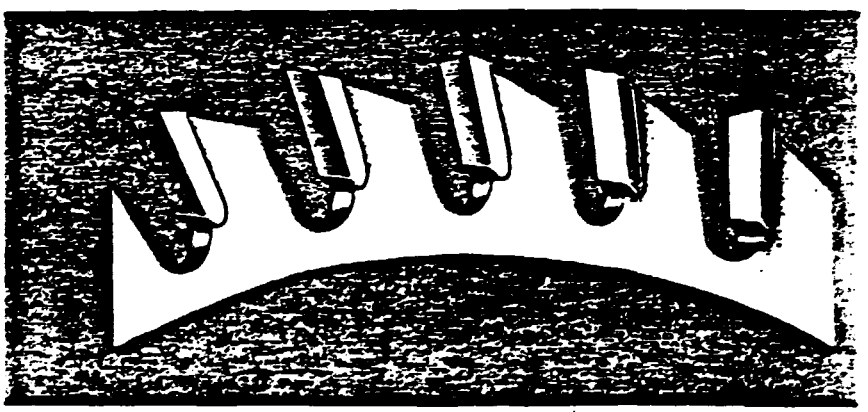
790
799
792
791

Carbide-tipped

Trimming and parting saws

alternate top bevel tooth



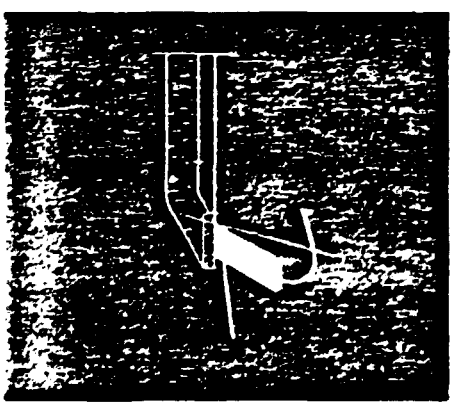


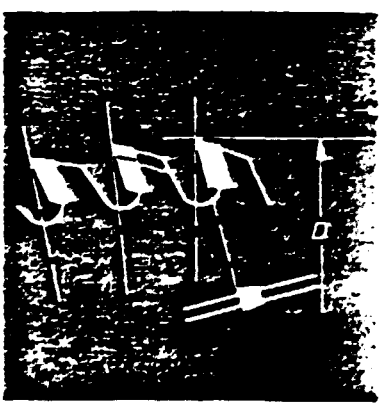
Technical details

With alternately top bevelled carbide teeth. Type 790/791 at 150 and 180 mm dia. with wide kerf may be used as scoring saws.

Maintenance

Grinding on automatic machines on top of tooth in swivelling action. Soft steel backing to be reduced behind tips 0.5 – 0.8 mm to allow for back clearance.



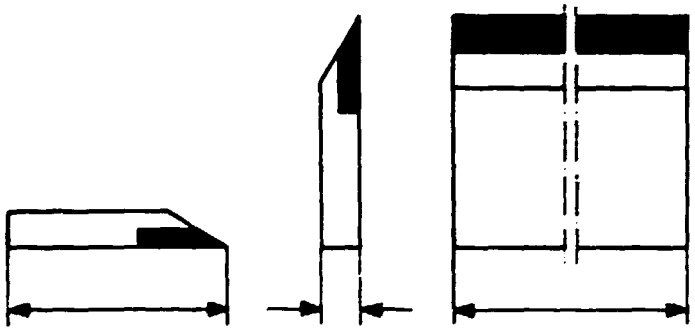


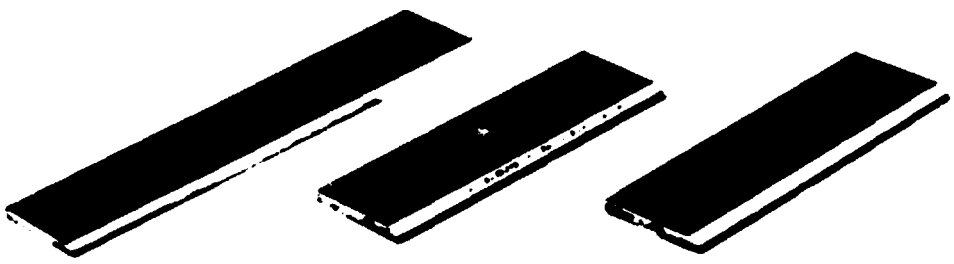
Sandvik 2856.

Carbide tipped thin planer knives.

Code number	Width	Thickness	Length
2856-30-3- 40	30	3	40
2856-30-3- 50	30	3	50
2856-30-3- 60	30	3	60
2856-30-3- 80	30	3	80
2856-30-3-100	30	3	100
2856-30-3-110	30	3	110
2856-30-3-125	30	3	125
2856-30-3-150	30	3	150
2856-30-3-180	30	3	180
2856-30-3-210	30	3	210
2856-30-3-230	30	3	230
2856-30-3-310	30	3	310
2856-30-3-320	30	3	320
2856-30-3-330	30	3	330
2856-30-3-400	30	3	400
2856-30-3-410	30	3	410
2856-30-3-450	30	3	450
2856-30-3-460	30	3	460
2856-30-3-500	30	3	500
2856-30-3-510	30	3	510
2856-30-3-600	30	3	600
2856-30-3-610	30	3	610
2856-30-3-700	30	3	700
2856-30-3-710	30	3	710
2856-30-3-800	30	3	800
2856-30-3-810	30	3	810

Code number	Width	Thickness	Length
2856-35-3- 40	35	3	40
2856-35-3- 50	35	3	50
2856-35-3- 60	35	3	60
2856-35-3- 80	35	3	80
2856-35-3-100	35	3	100
2856-35-3-110	35	3	110
2856-35-3-125	35	3	125
2856-35-3-150	35	3	150
2856-35-3-180	35	3	180
2856-35-3-210	35	3	210
2856-35-3-230	35	3	230
2856-35-3-310	35	3	310
2856-35-3-320	35	3	320
2856-35-3-330	35	3	330
2856-35-3-400	35	3	400
2856-35-3-410	35	3	410
2856-35-3-450	35	3	450
2856-35-3-460	35	3	460
2856-35-3-500	35	3	500
2856-35-3-510	35	3	510
2856-35-3-600	35	3	600
2856-35-3-610	35	3	610
2856-35-3-700	35	3	700
2856-35-3-710	35	3	710
2856-35-3-800	35	3	800
2856-35-3-810	35	3	810

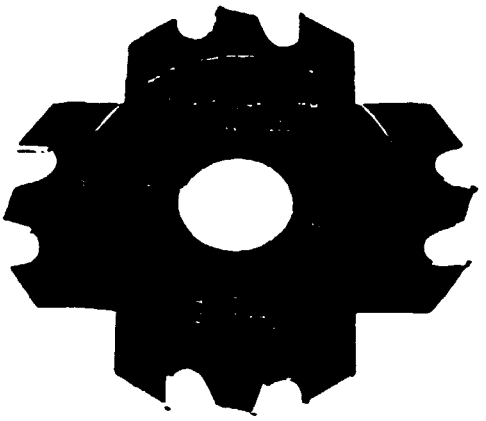


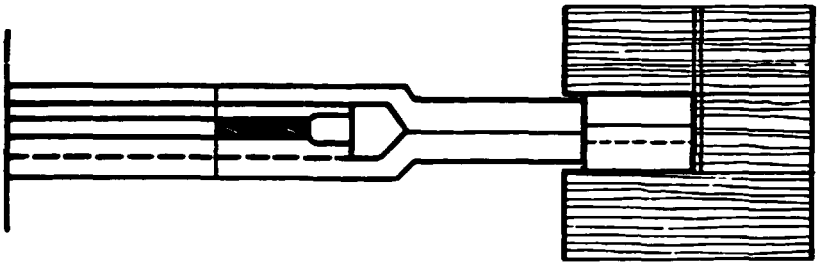


Sandvik 2500.

Adjustable grooving cutter with spurs. Carbide tipped.
Adjustable with rings. BG-TEST.
For hardwood, plywood and particle board.

Code number	Ø mm	Cutting width	No. of edges	Bore mm	Depth of cut mm
2500-120-2.2- 4 -30	120	2.2- 4.0	4+4	30	15
2500-140-1.8- 3.4-30	140	1.8- 3.4	4+4	30	20
2500-150-4 - 7.5-30	150	4.0- 7.5	4+4	30	25
2500-150-4 - 7.5-50	150	4.0- 7.5	4+4	50	20
2500-150-7.5-14.5-30	150	7.5-14.5	4+4	30	25
2500-150-7.5-14.5-50	150	7.5-14.5	4+4	50	20

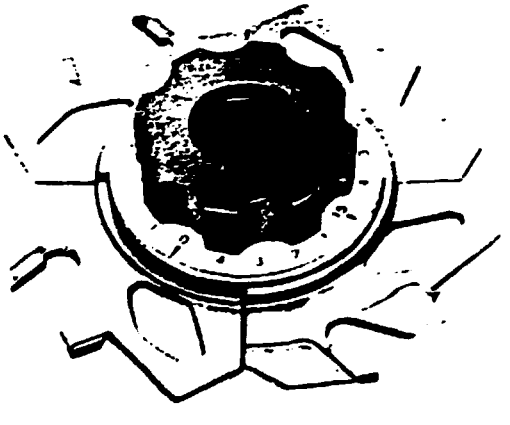


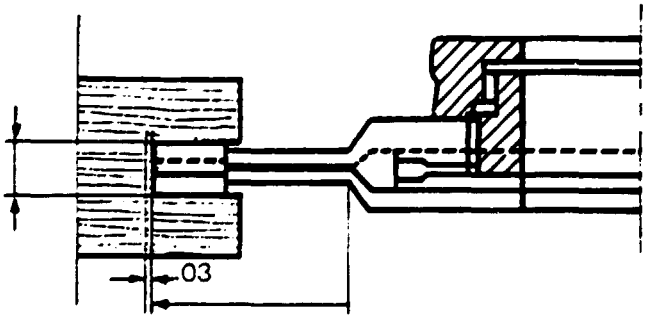


Sandvik 2501.

Adjustable grooving cutter with threaded bush.
According to scale. Carbide tipped.
For hardwood, plywood and particle board.

Code number	Ø mm	Cutting width	No. of edges	Bore mm	Depth of cut mm
2501-150-4- 7.5-30	150	4.0- 7.5	4+4	30	44
2501-150-4- 7.5-30	150	4.0- 7.5	4+4	50	39
2501-150-8-15.5-30	150	8.0-15.5	4+4	30	44
2501-150-8-15.5-50	150	8.0-15.5	4+4	50	39

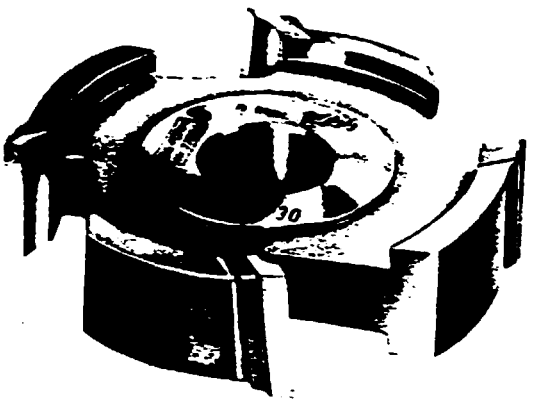


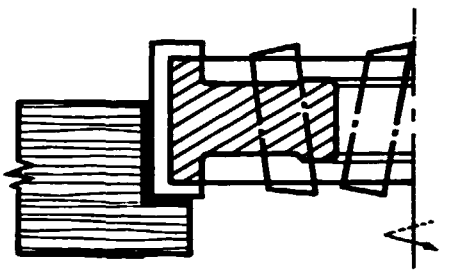


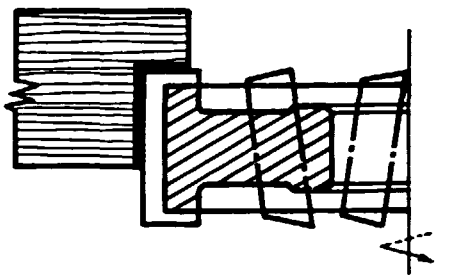
Sandvik 2634.

Jointing and rebating cutter. Without spurs with drawing cuts. Carbide tipped. BG-FORM.

For jointing, rebating and grooving hard wood, plywood and particle board.







Cutting diameter: 120 mm.

Code number	Ø mm	Cutting width	No. of edges	Bore mm
2634-120-10-30-4	120	10	4	30
2634-120-15-30-4	120	15	4	30
2634-120-20-30-4	120	20	4	30
2634-120-25-30-4	120	25	4	30
2634-120-30-30-4	120	30	4	30
2634-120-35-30-4	120	35	4	30
2634-120-40-30-4	120	40	4	30
2634-120-45-30-4	120	45	4	30
2634-120-50-30-4	120	50	4	30

Cutting diameter: 140 mm.

Code number	Ø mm	Cutting width	No. of edges	Bore mm
2634-140-10-30-4	140	10	4	30
2634-140-10-50-4	140	10	4	50
2634-140-15-30-4	140	15	4	30
2634-140-15-50-4	140	15	4	50
2634-140-20-30-4	140	20	4	30
2634-140-20-50-4	140	20	4	50
2634-140-25-30-4	140	25	4	30
2634-140-25-50-4	140	25	4	50
2634-140-30-30-4	140	30	4	30
2634-140-30-50-4	140	30	4	50
2634-140-35-30-4	140	35	4	30
2634-140-35-50-4	140	35	4	50
2634-140-40-30-4	140	40	4	30
2634-140-40-50-4	140	40	4	50
2634-140-45-30-4	140	45	4	30
2634-140-45-50-4	140	45	4	50
2634-140-50-30-4	140	50	4	30
2634-140-50-50-4	140	50	4	50

Cutting diameter: 160 mm.

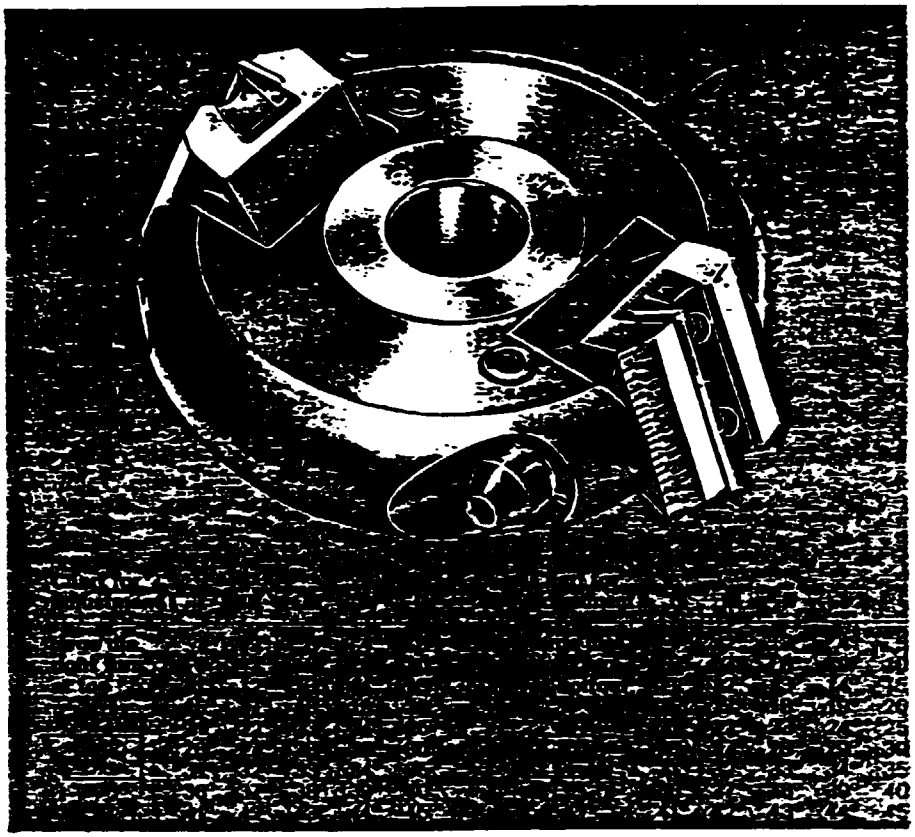
Code number	Ø mm	Cutting width	No. of edges	Bore mm
2634-160-10-30-4	160	10	4	30
2634-160-10-50-4	160	10	4	50
2634-160-15-30-4	160	15	4	30
2634-160-15-50-4	160	15	4	50
2634-160-20-30-4	160	20	4	30
2634-160-20-50-4	160	20	4	50
2634-160-25-30-4	160	25	4	30
2634-160-25-50-4	160	25	4	50
2634-160-30-30-4	160	30	4	30
2634-160-30-50-4	160	30	4	50

Cutting diameter: 180 mm.

Code number	Ø mm	Cutting width	No. of edges	Bore mm
2634-180-10-30-4	180	10	4	30
2634-180-10-50-4	180	10	4	50
2634-180-15-30-4	180	15	4	30
2634-180-15-50-4	180	15	4	50
2634-180-20-30-4	180	20	4	30
2634-180-20-50-4	180	20	4	50
2634-180-25-30-4	180	25	4	30
2634-180-25-50-4	180	25	4	50
2634-180-30-30-4	180	30	4	30
2634-180-30-50-4	180	30	4	50
2634-180-35-30-4	180	35	4	30
2634-180-35-50-4	180	35	4	50
2634-180-40-30-4	180	40	4	30
2634-180-40-50-4	180	40	4	50
2634-180-45-30-4	180	45	4	30
2634-180-45-50-4	180	45	4	50
2634-180-50-30-4	180	50	4	30
2634-180-50-50-4	180	50	4	50

1194

Vari-angle cutterhead
With 2 disposable tips



Technical details

Body and clamping segments of tempered steel; 2 exchangeable cutting elements with chip thickness limitation for reduced kickback. Precision ground knife seatings, preset knives for constant cutting circle. 2 disposable tips, each with 2 cutting edges of solid tungsten carbide. Adjustable through 60 degrees up or down. Adjustment by 1 degree intervals as instructed on selection charts provided with every tool.

Handling

Replacement or turning of tips as per description article No. 1666 (page 66).

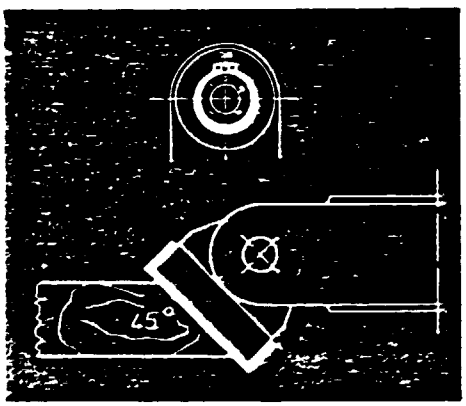
Adjustment to angle required

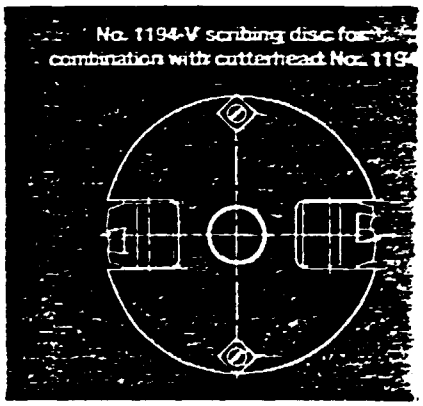
For adjustment in steps of 5°
select position 0 on chart and proceed as follows:

1. **Slacken covering nut and press to release cutting element thus enabling adjustment to either side.**
2. **Select degree of angle on scale and locate element into corrugation. Fasten nut again.**

Adjustment in steps of 1°
Example: 14°, large diameter at top

1. **Determine whether chart I or chart II is to be used.**
2. **Select position on chart; say 14° with large diameter at top = IV. Release the covering nut and press to release the cutting element for adjustment.**
3. **Remove pin screw on side of head.**
4. **Locate the cutting element into corrugation again and turn clamping ring into position IV against "0" on body.**
5. **Replace and fasten pin screw again. Cutting element may now be adjusted to 9 different degrees of bevel on corrugation: 4, 9, 14, 19, etc., as per selection IV on chart.**
6. **Locate cutting element at 14°, i.e. near to 15° on scale.**
7. **Tighten covering nut again.**

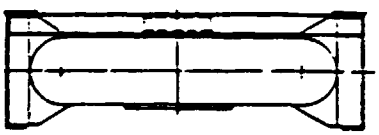




No. 1194-V scribing disc for combination with cutterhead No. 119

Dimensions

1194				
Cutting circle	D = mm	150	170	
Cutting circle at 45° adjustment	D = mm	169	189	
Max. R.P.M.		6000	6000	
Cutting width	B = mm	50	50	
Standard bore	d = mm	30/35	50	
		1 1/4"		
1194-V				
Diameter	D = mm	150	170	
Standard bore	d = mm	30/35	50	
		1 1/4"		

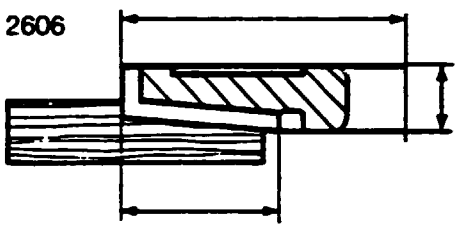


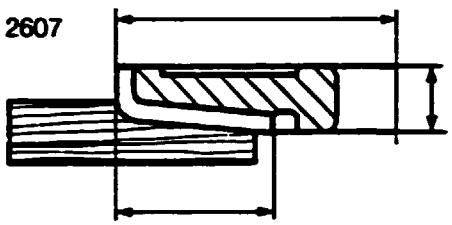
Disc with 2 carbide spurs, each with cutting edges. Seating of the tips on or bottom to allow for application on either side of cutterhead. This combination (No. 1194 + 1194-V) provides for rebating at 90°. Side adjustment o knives on cutterhead against gauge included.

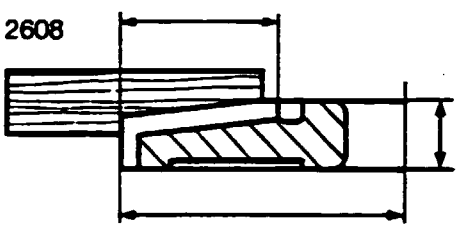
Sandvik 2606, 2607, 2608 and 2609.

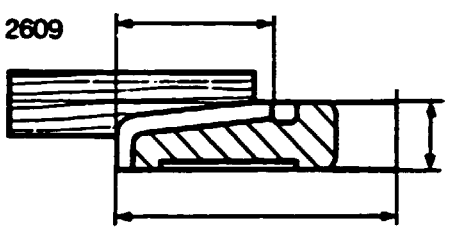
Cutters for raised panel. HSS. BG-TEST.
Production of raised panels for furniture doors, roomdoors and kitchen-doors, preferably for manual infeed of solid wood.

Code number	Ø mm	Cutting width	No. of edges	Bore mm
2606-200-20-40-2÷2	200	20	2÷2	40
2607-200-20-30-2÷2	200	20	2÷2	30
2608-200-20-40-2÷2	200	20	2÷2	40
2609-200-20-30-2÷2	200	20	2÷2	30





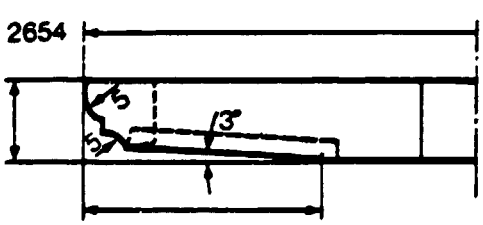


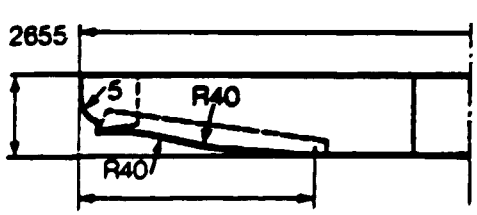


Sandvik 2654, 2655.

Cutters for raising panel. HSS. BG-TEST.
Production of raised panels for furniture doors, roomdoors and kitchen-doors, preferably for manual infeed of solid wood.

Code number	Ø mm	Cutting width	No. of edges	Bore mm
2654-200-20-40-2÷2	200	20	2÷2	40
2655-200-20-30-2÷2	200	20	2÷2	30

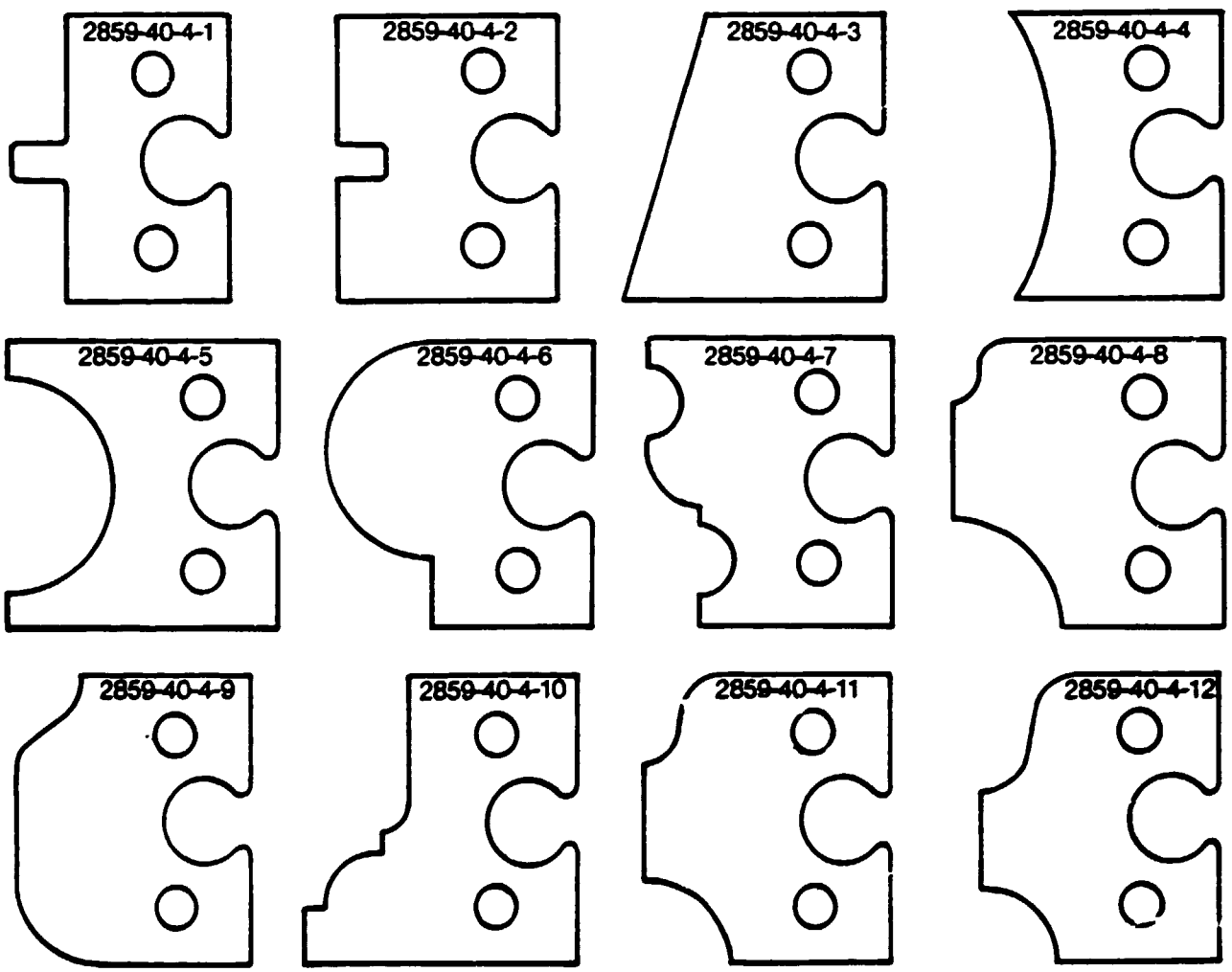


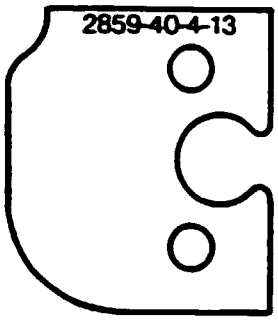


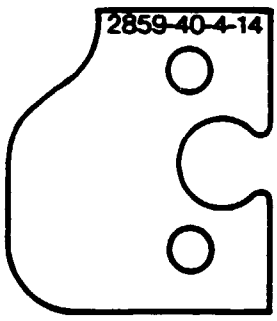
Sandvik 2610.

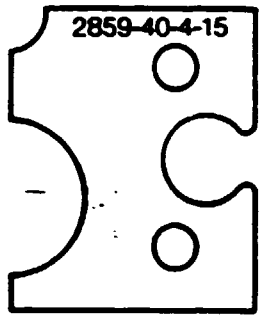
Universal cutterhead with profile knives.
BG-TEST.

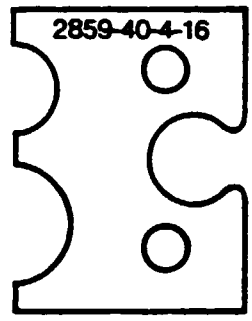
Code number.
2610-100-40-20-2
(only cutterhead with 2 planer knives
2611-100-40-30-2
(only cutterhead with 2 planer knives).
2612-125-40-30-2
(only cutterhead with 2 planer knives).
2613-125-40-50-2
(only cutterhead with 2 planer knives).
2612-125-40-30-2-A
(with 10 pairs of profile knives).
2613-125-40-50-2-A
(with 10 pairs of profile knives).
2612-125-40-30-2-B
(with 20 pairs of profile knives).
2859-40-4-31-1
(spare knives).

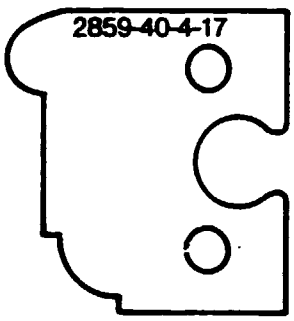


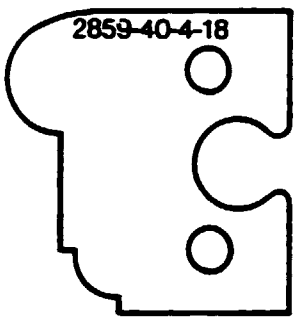

2859-40-4-13

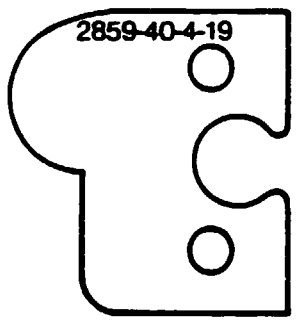

2859-40-4-14

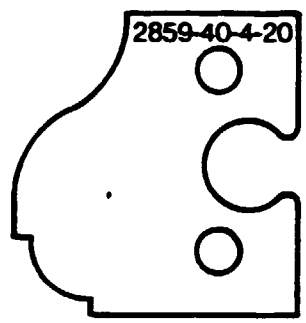

2859-40-4-15

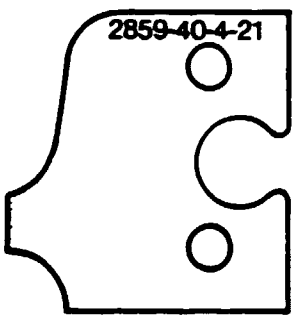

2859-40-4-16

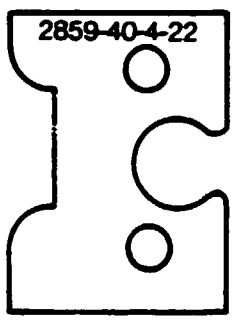

2859-40-4-17

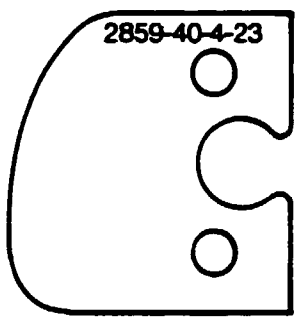

2859-40-4-18

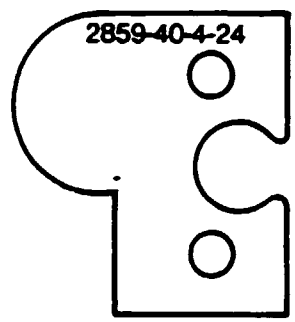

2859-40-4-19

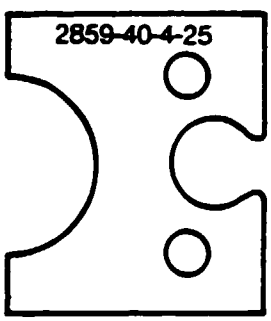

2859-40-4-20

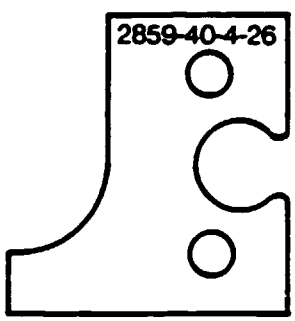

2859-40-4-21

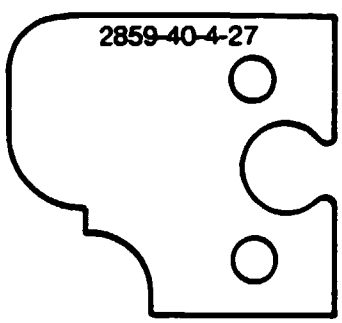

2859-40-4-22

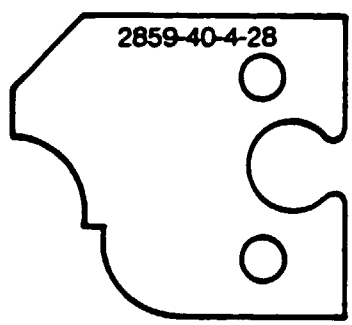

2859-40-4-23

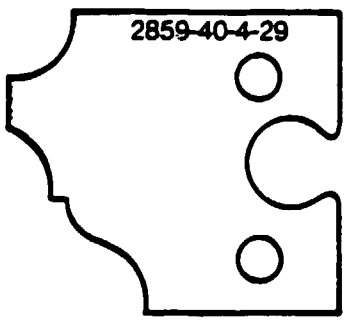

2859-40-4-24

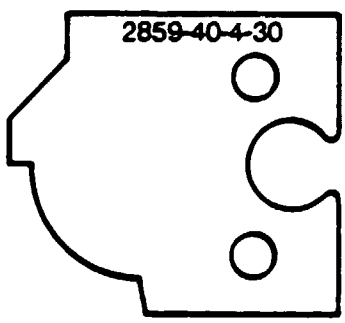

2859-40-4-25

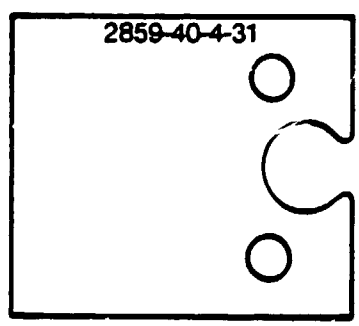

2859-40-4-26


2859-40-4-27


2859-40-4-28


2859-40-4-29

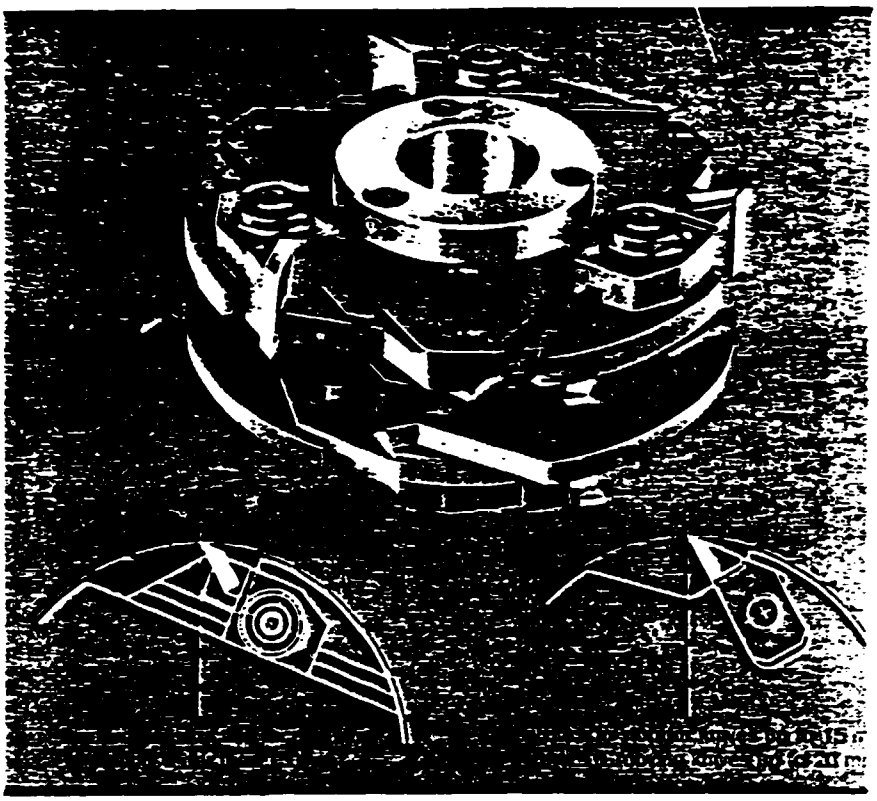

2859-40-4-30


2859-40-4-31

801

"Dufix" cutterblock
3 knives or 3 knives + 3 spurs

HSS- or carbide-tipped knives

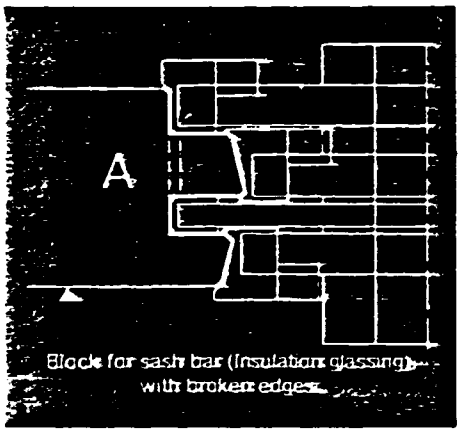


Technical details

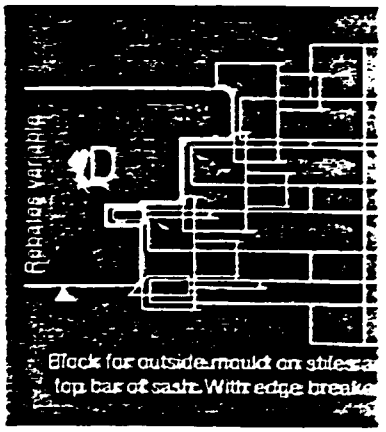
Cutterblock designed for absolutely constant cutting circle. Body made of highly durable material, with 3 precision machined knife seatings and guiding grooves. Face of knife resting firmly against stop on body. This provides for constant cutting circle. Available with 4 knife seatings on request. No deviations of profile after regrinding. Reduced down times. Blocks for rebating will be provided with disposable spur cutters (each with 4 edges) for constant height of rebate and splinter free edges.

Illustrations show a few examples of application of "Dufix" blocks.

Grooving blocks can be designed to cut 4 mm wide at minimum (To insert insulating strips) as per ill. D.
To produce non adjustable heights of rebates on mouldings (Ill. A) edge breakers are included in shape of knives. When rebates vary, edge breakers will be designed as per ill. D. Edges may be required to be bevelled or radiused.



Block for sash bar (insulation glassing) with broken edges



Block for outside mould on stile and top bar of sash. With edge breaker

Handling

After regrinding, mount "Dufix" knives into guiding grooves on disc, put in and fasten clamping screw after pushing knife with face firmly against stop. Use no extension on key.
This simple procedure sets knives precisely to cutting circle and eliminates the use of gauges. Place fully assembled block on spindle and resume production.

Maintenance

Thoroughly described on page 172.

Dimensions

Cutting circle	mm	104–125	126–180	181–200
Max. bore	d = mm	40	50	50
Max. R.P.M. up to	B = 40	9000	9000	6000
Max. R.P.M. up to	B = 48	9000	6000	6000
Cutting widths:	4 – 48 mm			

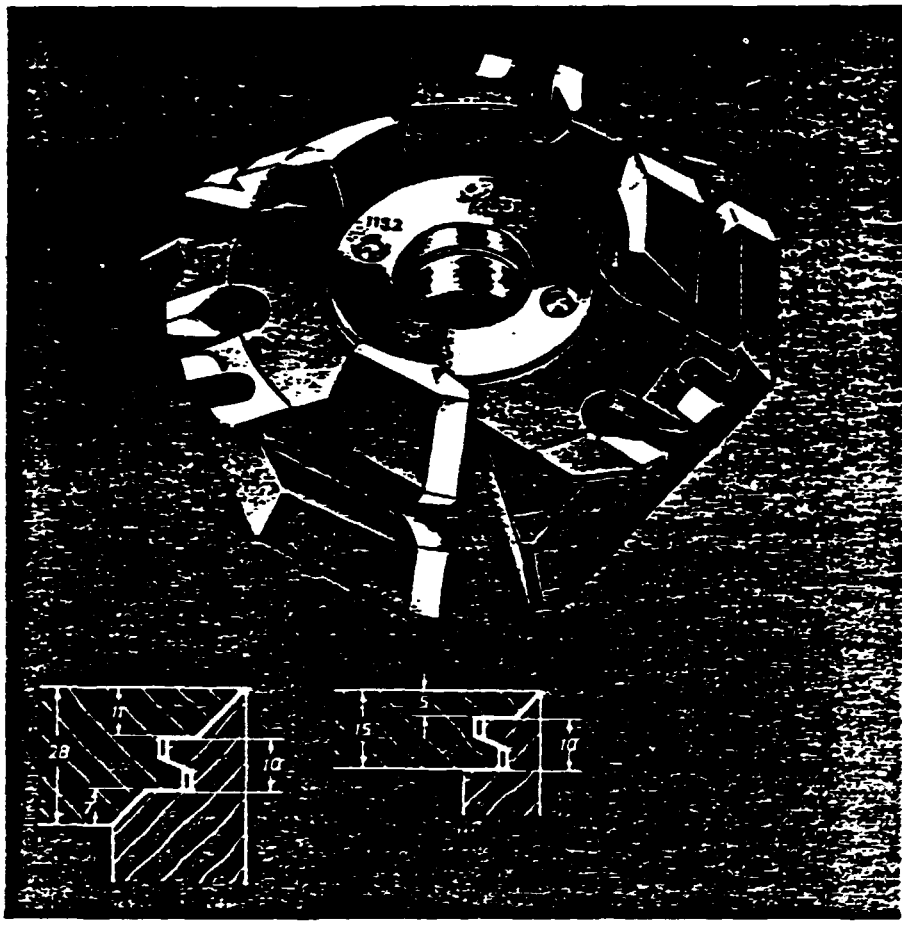
ANNEX 12

1152

Reversible mitre joint cutterset

3 wings

Carbide-tipped

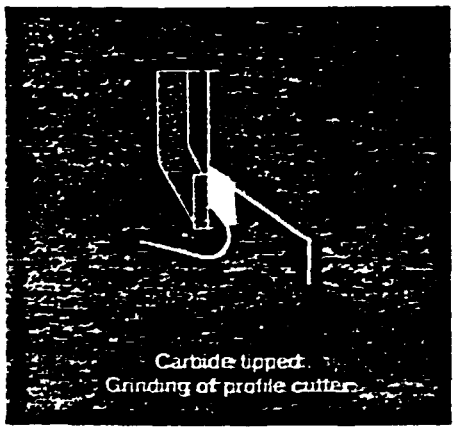


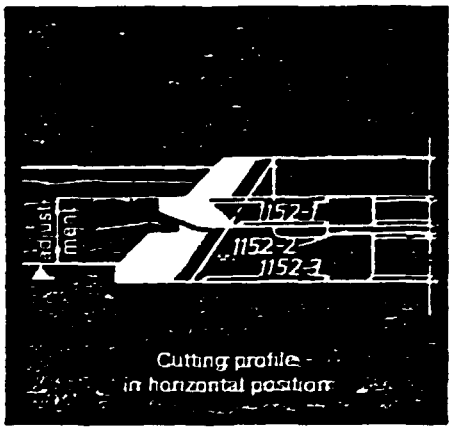
Technical details

Set consists of profile cutter and grooving cutter pinned together. Adjustable, by spacers and shims supplied, according to requirement of joint.
With chip thickness limitation for reduced kickback.
Self-clamping mitre joints for furniture components of chipboard, plywood and blockboard as well as hardwood.

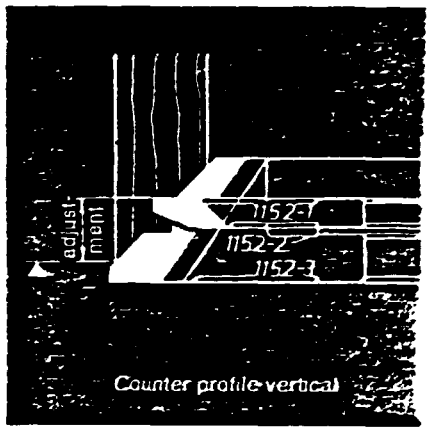
Maintenance

Grinding parallel to face only. After several regrinds chip thickness limitation butt must be reduced in diameter.


Carbide tipped.
Grinding of profile cutter



Cutting profile
in horizontal position



Counter profile vertical

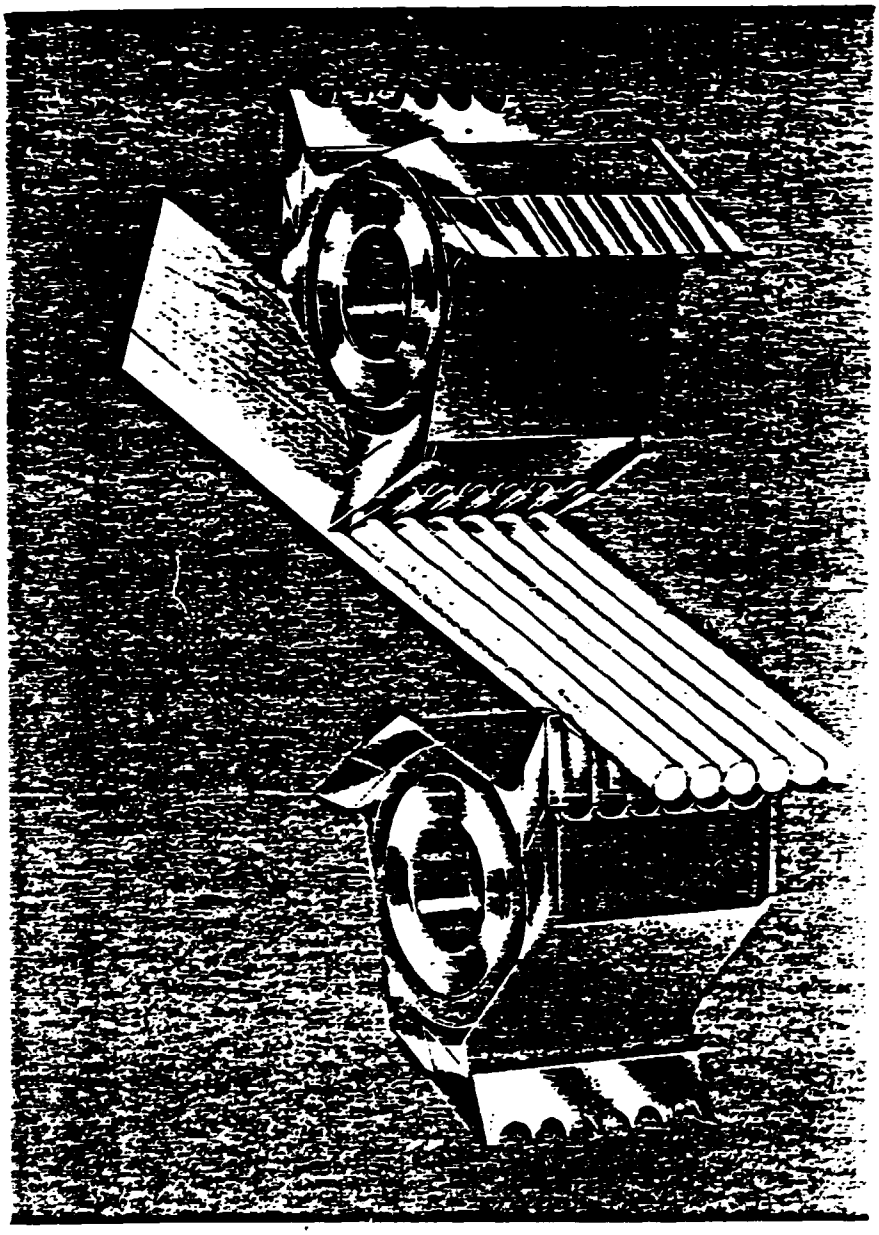
Dimensions

Wood thickness	mm	15–28	15–28
Standard bore	mm	30/35/1¼"	50
Max. bore	mm	35	50
Max. R.P.M.		9 000	8 000
1152-1 Profile groover	mm	137 x 8	157 x 8
1152-2 Set of spacers			
1152-3 Profile cutter	mm	160 x 35.5	180 x 35.5

398 2 wings
399 3 wings

HSS- and carbide-tipped

Multiple dowel cutters
2 or 3 wings



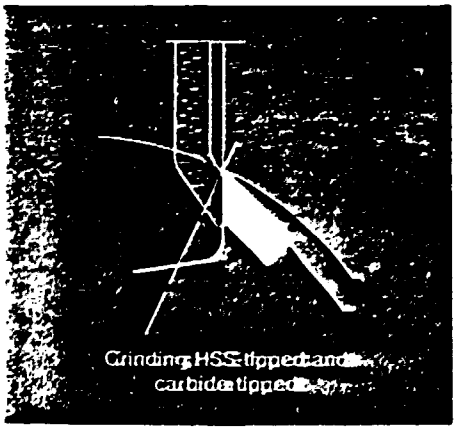
Technical details

With 2 (type 398) or 3 (type 399) straight wings, cutting on periphery only.
To produce rods or dowels in multiples, with circular shape or serration. Cutters work in pairs to produce full profile.

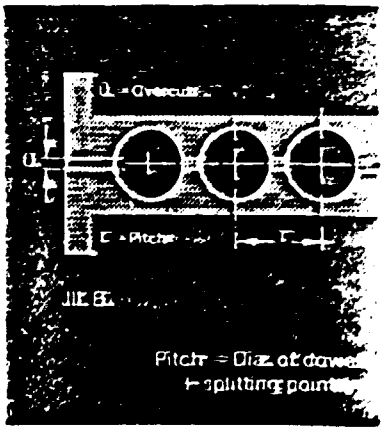
To achieve best surface quality and maximum performance timber should be thicknessed and surfaced properly.
When setting tools on machine, idling on wood should be avoided to prevent blunting of cutting edges.

Maintenance

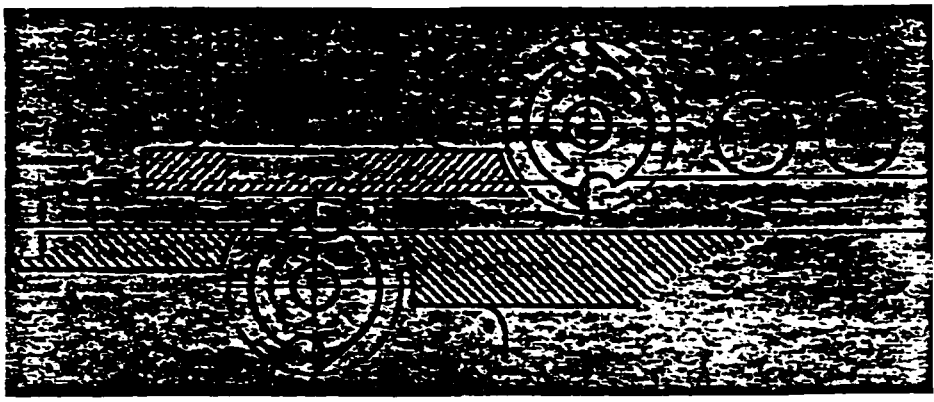
Grinding parallel to face only.

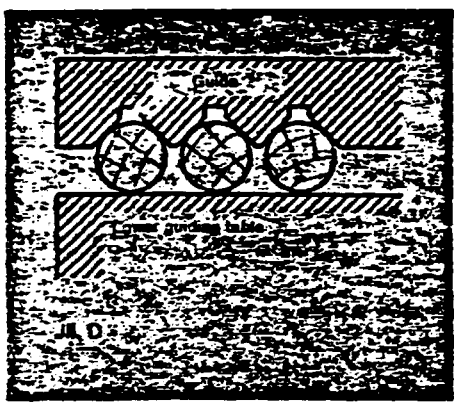


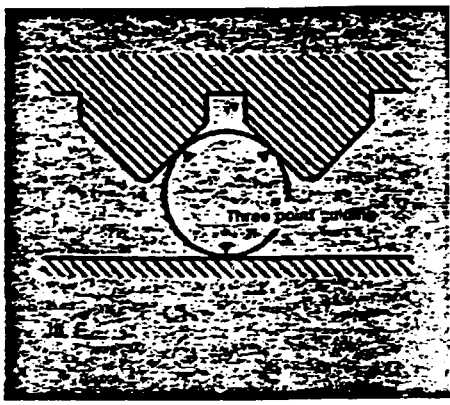
Grinding HSS-tipped and carbide-tipped



Operation and setting of cutters 398/399







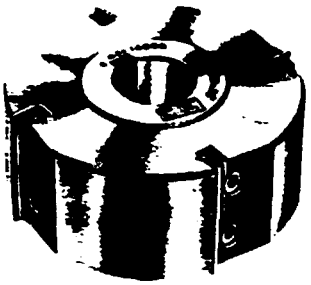
Dia.of Dowel	mm	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Splitting point	mm	1	1	1	1	1	1	1	1	1.5	1.5	1.5	1.5	1.5	1.5
Pitch	mm	4	5	6	7	8	9	10	11	12.5	13.5	14.5	15.5	16.5	17.5
Square end	mm	4	4	4	4	4	4	4	5	5	5	5	5	5	5
Splitter dia.min.	mm	120	120	120	120	120	120	120	120	120	120	120	120	120	140
R.P.M. max.		10000	10000	10000	10000	10000	=	=	=	=	=	=	=	10000	9000
Splitting width mm	1	11	12	13	14	15	16	17	20	21	22	23	23	25	26
Number of dowels	2	15	17	19	21	23	25	27	31	33.5	35.5	37.5	39.5	41.5	43.5
	3	19	22	25	28	31	34	37	42	46	49	52	55	58	61
	4	23	27	31	35	39	43	47	53	58.5	62.5	66.5	70.5	74.5	78.5
	5	27	32	37	42	47	52	57	64	71	76	81	86	91	96
	6	31	37	43	49	55	61	67	75	83.5	89.5	95.5	101.5	107.5	113.5
	7	35	42	49	56	63	70	77	86	96	103	110	117	124	131
	8	39	47	55	63	71	79	87	97	108.5	116.5	124.5	132.5	140.5	148.5
	9	43	52	61	70	79	88	97	108	121	130	139	148		
	10	47	57	67	77	87	97	107	119	133.5	143.5				
	11	51	62	73	84	95	106	117	130	146					

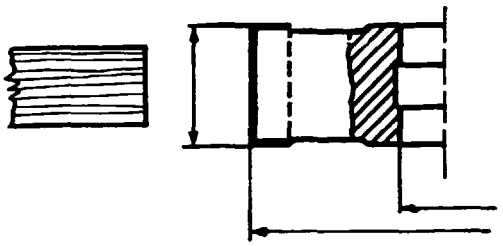
Dia.of Dowel	mm	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Splitting point	mm	1.5	1.5	1.5	2	2	2	2	2	2	2	2	2	2	2
Pitch	mm	18.5	19.5	20.5	22	23	24	25	26	27	28	29	30	31	32
Square end	mm	5	5	5	5	7	7	7	7	7	7	7	7	7	7
Splitter dia.min.	mm	140	140	140	140	140	140	140	140	160	160	160	160	160	160
R.P.M. max.		9000	=	=	=	=	=	=	9000	8000	=	=	=	=	8000
Splitting width mm	1	27	28	29	30	35	36	37	38	39	40	41	42	43	44
Number of dowels	2	45.5	47.5	49.5	52	58	60	62	64	66	68	70	72	74	76
	3	64	67	70	74	81	84	87	90	93	96	99	102	105	108
	4	82.5	86.5	90.5	96	104	108	112	116	120	124	128	132	136	140
	5	101	106	111	118	127	132	137	142	147					
	6	119.5	125.5	131.5	140										

Sandvik 2203.

Jointing and planing cutter head with turnover knives. BG-TEST.
For jointing and planing all types of wood materials.
High-alloy light metal with hardepoxy.

Code number	Ø mm	Cutting width	No.of edges	Bore mm
2203-100- 30-50-2	100	30	2	50*
2203-100- 30-30-2	100	30	2	30
2203-125- 30-50-2	125	30	2	50*
2203-125- 30-30-2	125	30	2	30
2203-125- 30-50-4	125	30	4	50*
2203-125- 30-30-4	125	30	4	30
2203-125- 50-50-2	125	50	2	50*
2203-125- 50-30-2	125	50	2	30
2203-125- 50-50-4	125	50	4	50*
2203-125- 50-30-4	125	50	4	30
2203-125- 80-50-2	125	80	2	50*
2203-125- 80-30-2	125	80	2	30
2203-125- 80-50-4	125	80	4	50*
2203-125- 80-30-4	125	80	4	30
2203-125-100-50-2	125	100	2	50*
2203-125-100-30-2	125	100	2	30
2203-125-100-50-4	125	100	4	50*
2203-125-100-30-4	125	100	4	30
2203-125-120-50-2	125	120	2	50*
2203-125-120-30-2	125	120	2	30
2203-125-120-50-4	125	120	4	50*
2203-125-120-30-4	125	120	4	30
2203-128- 30-50-4	128	30	4	50*
2203-128- 50-50-4	128	50	4	50*
2203-128- 60-50-4	128	60	4	50*
2203-150- 50-50-2	150	50	2	50*
2203-150- 50-30-2	150	50	2	30
2203-150- 50-50-4	150	50	4	50*
2203-150- 50-30-4	150	50	4	30
2203-150- 80-50-2	150	80	2	50*
2203-150- 80-30-2	150	80	2	30
2203-150- 80-50-4	150	80	4	50*
2203-150- 80-30-4	150	80	4	30
2203-150-100-50-2	150	100	2	50*





Code number	Ø mm	Cutting width	No. of edges	Bore mm
2203-150-100-50-4	150	100	4	50*
2203-150-120-50-2	150	120	2	50*
2203-150-120-50-4	150	120	4	50*
2203-180- 30-50-4	180	30	4	50*
2203-180- 30-50-6	180	30	6	50*
2203-180- 50-50-2	180	50	2	50*
2203-180- 50-50-4	180	50	4	50*
2203-180- 50-50-6	180	50	6	50*
2203-180- 50-50-8	180	50	8	50*
2203-180- 60-50-4	180	60	4	50*
2203-180- 60-50-6	180	60	6	50*
2203-180- 80-50-4	180	80	4	50*
2203-180- 80-50-6	180	80	6	50*
2203-180-100-50-4	180	100	4	50*
2203-180-120-50-4	180	120	4	50*

*More accuracy with Sandvik ETP Hydro-grip System.