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Technical Meeting on the Selection of Woodworking Machinery

Vienna, 19-23 November 1973

BORING AND MORTISING: TECHNOLOGY AND EQUIPMENT 1/

by

Heinz Eldag
Consultant
Vienna, Austria

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BORING AND MORTISING: TECHNOLOGY AND EQUIPMENT[1/]

by

Heinz Eldag
Consultant
Vienna, Austria

SUMMARY

Hollow places or cavities can be made in wood with rotating, continuous or oscillating tools. The most common machine boring units are the auger and twist-drill types, which are derived from craftsman's tools. Boring tools advance into the wood in a direction parallel to the axis of rotation and cut on their forward end only. The stem of the auger bit is fluted to permit chip release and is narrower at the top (chuck) and in order to prevent friction in deep holes. The main parts of a bit or drill are the spur, lips, point and flute.

The common tools used with drill presses are: twist drill, auger bit, spur machine drill, multi-spur machine bit, plug cutter, adjustable countersink, solid centre bit, expansion bit, hole cutter, hole saw, router bit, dovetail cutter, countersink, counterbore with centre pilot, hollow chisel. These are illustrated in the document.

The mortising operation is more difficult to define, since it can combine several basic cutting actions. When a routing bit oscillates as well as rotates, the operation is called slot mortising. The term "routising" is used when a slot mortiser is tooled with a router turning at a much higher speed than a drill.

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ESPAÑOL
Original: INGLES

Organización de las Naciones Unidas para el Desarrollo Industrial

Reunión técnica sobre selección de maquinaria para trabajar la madera
Viena, 19 - 23 noviembre 1973

TALADRADO Y ESCOPLEADO: TECNOLOGIA Y EQUIPO 1/

por

Heinz Eldag
Consultor
Viena (Austria)

RESUMEN

Para hacer muescas, rebajes o entalladuras en la madera se emplean herramientas giratorias, de acción continua y de acción oscilante. Las máquinas perforadoras más comunes son las de tipo barrena y las de tipo taladro helicoidal, que se derivan de los modelos artesanales. Las herramientas perforadoras penetran en la madera en una dirección paralela al eje de rotación, produciendo el extremo anterior de la herramienta el efecto cortante. El vástago de la barrena de rosca es acanalado para permitir la salida de las astillas y más angosto en el extremo superior (insertable en el portabrocas) para evitar la fricción cuando se trata de agujeros profundos. Las partes principales de un taladro o broca son las siguientes: los gavilanes o dientes, los filos, la punta y la acanaladura o espiral.

Las herramientas que se suelen emplear con los taladros de banco o prensas taladradoras son las siguientes: broca salomónica o helicoidal, barrena de rosca, taladradora mecánica de tulipa, broca mecánica multitulipa, fresa de cuña, avellanador regulable, broca sólida, broca ajustable, fresa de barrenar, sierra de agujeros circulares, broca ranuradora, fresa para colas de milano, avellanador, escariador con piloto central, formón hueco. En la memoria figuran ilustraciones de todos estos accesorios.

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Joint designs [illegible] machines. Mortise and tenon joints are usually done on a chain and chisel mortiser and, since they require two different operations, normally require two different machines (tenoner and mortiser). Recently the ease and simplicity of boring machines have brought about a strong trend to replace the various mortise and tenon joints by dowel joints. The latter have been shown to be the strongest in most applications, but since they always require glue, can be less appropriate [illegible] not commonly used.

The many requirements of the furniture industry have led to a wide variety of hole-boring machines for single- and double-end boring, in vertical or horizontal designs. Multi-spindle bars can be used with 20 - and even up to 48 - bits. Special boring machines for deep holes, with flexible shafts and with automatic controls have been developed.

Mortising machines have followed this trend with many specifically designed combination units, i.e. for recessing square plated furniture locks, a combined slot mortiser, recesser and keyhole mortiser machine has been developed. Another special slot mortiser has been developed for making louver shutter slots. Also a multiple mortiser with small routing motors mounted on movable units controlled by pneumatics and guided by templates has been designed to do a variety of jobs at a high rate, automatically.

El escopleado es más difícil de definir ya que puede combinar varias operaciones básicas de corte. Cuando la broca ranuradora oscila y gira al mismo tiempo, la operación se denomina escopleado de ranuras. El término "ranurado" se emplea cuando se equipa la escopleadora de ranuras con una fresa de ranurar que gira a una velocidad mucho más elevada que la de un taladro.

La construcción de juntas requiere a menudo determinadas operaciones y, por lo tanto, máquinas especiales. Las ensambladuras de caja y espiga suelen hacerse con una escopleadora de cincel o mortajadora en cadena, y, como ese trabajo exige dos operaciones diferentes, es necesario emplear generalmente dos máquinas distintas (una espigadora y una escopleadora). Ultimamente, debido al fácil y sencillo manejo de las máquinas perforadoras, se registra una marcada tendencia a sustituir las diversas ensambladuras de caja y espiga por ensambladuras de clavija. Estas han demostrado ser más fuertes para la mayor parte de las aplicaciones, pero como siempre requieren encolado pueden resultar menos apropiadas en los casos en que no se suelen emplear materias adhesivas.

Las muchas y diversas necesidades de la industria del mueble han dado como resultado la aparición de una gran variedad de máquinas perforadoras de acción sencilla o doble y funcionamiento vertical u horizontal. Se pueden emplear vástagos múltiples que accionan 20 y hasta 48 brocas. Existen máquinas perforadoras especiales para agujeros profundos, con ejes flexibles y controles automáticos.

Las máquinas escopleadoras han seguido esta tendencia, existiendo muchos modelos en las que se combinan distintas funciones; por ejemplo, para preparar las entalladuras en que encajan las cerraduras de forma cuadrada se ha diseñado una máquina en que actúan combinadamente una escopleadora de ranuras, una embutidora y una escopleadora para el agujero de la llave. También se ha ideado otra escopleadora especial para hacer las ranuras necesarias para las tablillas de persiana. También se ha ideado una escopleadora múltiple con pequeños motores acanaladores montados en unidades móviles controladas neumáticamente y dirigidas mediante plantillas o patrones; este tipo de máquina ejecuta automáticamente gran variedad de trabajos a alta velocidad.

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Original : ANGLAIS

Organisation des Nations Unies pour le développement industriel

Réunion technique sur le choix des machines
dans l'industrie du bois
Vienne, 19-23 novembre 1973

PERCAGE ET MORTAISAGE ; TECHNOLOGIE ET MATERIEL[1/]

par

Heins Eldag, consultant
Vienne (Autriche

RESUME

Pour faire des creux ou des cavités dans le bois, on peut utiliser des outils rotatifs, des outils à mouvement de révolution ou des outils oscillants. Les outils de perçage les plus couramment utilisés sur les machines sont les mèches et les forets hélicoïdaux qui dérivent d'outils de menuisier. Les outils de perçage avancent dans le bois suivant une direction parallèle à leur axe de rotation et ne coupent qu'avec leur extrémité antérieure. La tige de la mèche cuiller est cannelée pour permettre le dégagement des copeaux et elle est plus étroite au sommet, c'est-à-dire du côté du mandrin, pour éviter les frictions dans les trous profonds. Les principales parties d'une mèche ou d'un foret sont le couteau-traçoir, les lèvres, la pointe et la cannelure.

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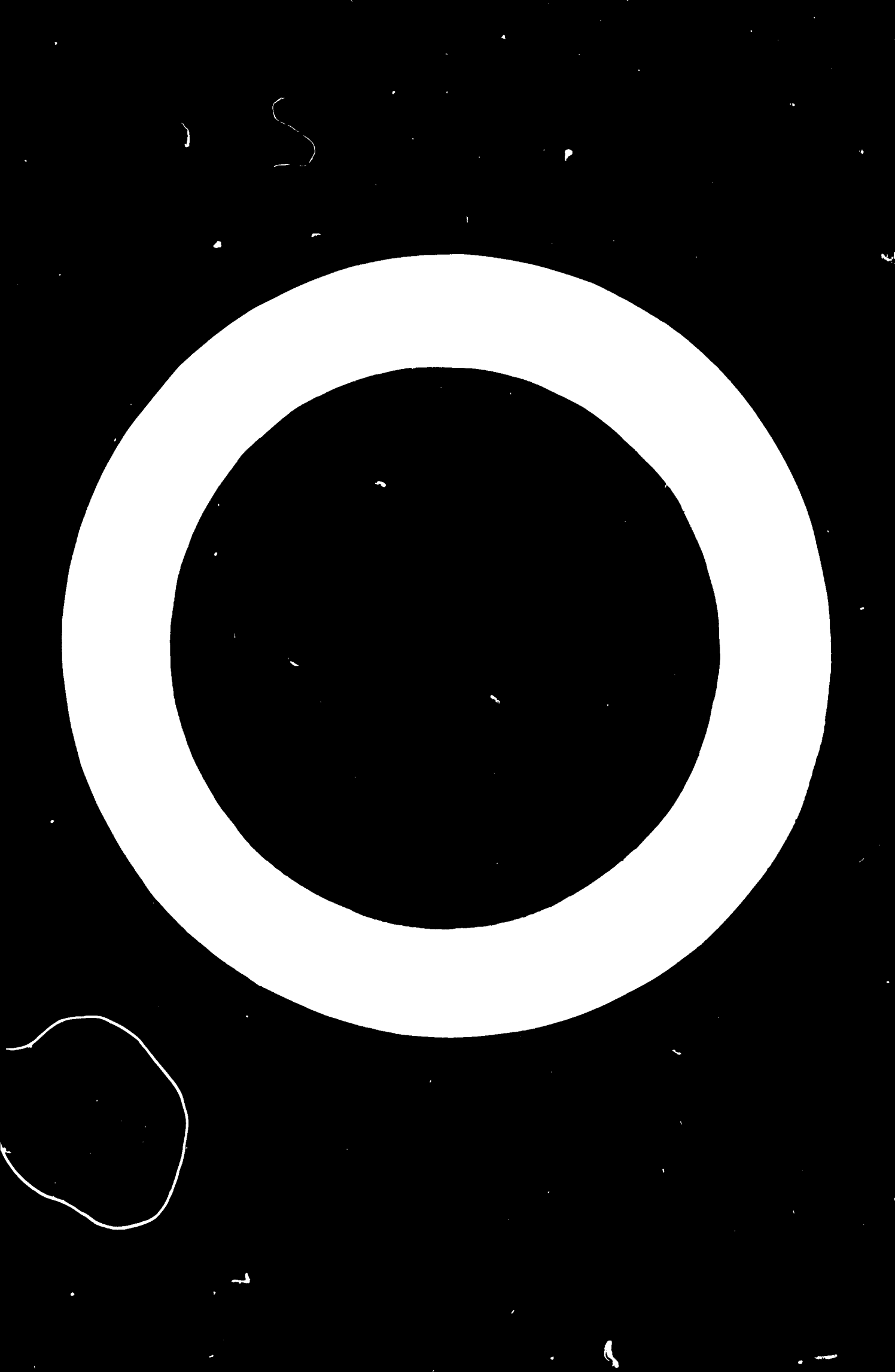


Les outils les plus communément utilisés sur les perceuses sont les suivants : foret hélicoïdal, mèche cuiller, mèche torse à traçoir, mèche à traçoirs multiples, mèche de bouchonnage, mèche-fraise réglable, mèche à centre monobloc, mèche extensible, découpeur, scie rotative, mèche à défoncer, fraise pour queues d'aronde, mèche-fraise (ou fraise conique), fraise à chambrer avec pilote, bédane creux. Ces outils sont représentés dans le document.

L'opération de mortaisage est plus difficile à définir parce qu'elle peut combiner plusieurs opérations élémentaires de coupe. Dans les mortaiseuses à mèche, l'outil oscille et tourne en même temps. On utilise le mot "routising" (défonçage-mortaisage) lorsque l'on adapte sur une mortaiseuse à mèche un outil de défonçage dont la vitesse de rotation est beaucoup plus élevée que celle d'un foret.

Les assemblages exigent souvent des opérations spéciales et par conséquent des machines spéciales. Les assemblages à mortaise et tenon exigent deux opérations différentes et sont donc exécutés normalement sur deux machines différentes : tenonneuse et mortaiseuse; la mortaiseuse utilisée est généralement du type à chaîne et bédane creux. En raison de la facilité d'emploi et de la simplicité des perceuses, on a tendance depuis quelque temps à remplacer les divers assemblages à mortaise et à tenon par des assemblages à cheville. On a constaté que, dans la plupart des cas, les assemblages à cheville étaient plus solides mais, étant donné qu'ils exigent toujours de la colle, ils peuvent être moins appropriés dans les pays où les adhésifs ne sont pas d'emploi courant.

En raison de la grande variété des opérations effectuées dans l'industrie du meuble, on a mis au point un grand nombre de perceuses verticales ou horizontales, de type simple ou double. Les barres d'alésage à broches multiples peuvent être utilisées avec un grand nombre de mèches : 20 à 48. On a également mis au point des foreuses à mèche pour trous profonds, à arbre flexible et commande automatique.

Les mortaiseuses ont suivi la même évolution et peuvent comporter une grande variété d'unités combinées conçues pour un usage déterminé; c'est ainsi que, pour faire les entailles pour le logement des serrures à platine carrée, on a mis au point

une machine qui combine les opérations d'une mortaiseuse à mèche, d'une machine à rainurer et d'une mortaiseuse pour trou de clé. Il existe également une machine spéciale à faire les entailles pour le logement des lames de persienne. Autre innovation récente : une mortaiseuse multiple munie de petite moteurs à forer montés sur des unités mobiles à commande pneumatique guidées par des gabarits; cette machine à grande vitesse exécute automatiquement un grand nombre d'opérations.

- - - - -

INTRODUCTION

Hollow places - cavities - machined in wood can be made with rotating, continuous or oscillating tools.

Drills or boring units generate by rotating a cylindrical hole.

Routing bits, mortising chains and chisels generate by combined movements non-cylindrical holes.

I MACHINE BORING AND MORTISING TOOLS

The most common machine boring units are the auger and twist-drill types which are derived from craftsman's tools. See figures 1 and 2.

An auger bit has a central screw (bit points) which draws it into the wood, two spurs which score the circle and two cutters which cut the shavings. The screw point may have a double or single thread or a brad point.

Some auger bits have a solid centre which makes the tool stiffer, but the bore surface is not as smooth as machined with normally twisted flute bit.

Larger diameter holes are bored with centre bits, plug cutters or hole saws.

Spur bits are used especially for boring into cross-grained wood.

Router bits have sharp wings to cut in a direction 90^{0} of the bit.

For making screw holes counterboring bits will be used.

Boring tools will be used on a single or multi-spindle drill press. See figure 3.a.

Any boring tool advances into the wood in a direction parallel to the axis of its rotation and cuts on its forward end only. In order to remove the accumulating chips, the stem of the auger bit or twist-drill is provided with flutes to facilitate the release of the chips. The diameter of the tool body toward the chuck end is slightly less than the lead end, to prevent friction as the tool advances into the wood.

The main parts of a bit or drill are:

Spur: for smooth cutting of the hole periphery. Twist-drills do not have spurs.

Lips: for lifting and separating the successive layers of the central wood when boring into side wood and to sever the fibres in that area when boring into end wood. Auger bits accomplish this with a chisel-like action, while twist-drills develop a shearing process.

Point: for centering the drill and preventing its initial wobbling. The thread generates a drawing action which is more essential in hand boring operations.

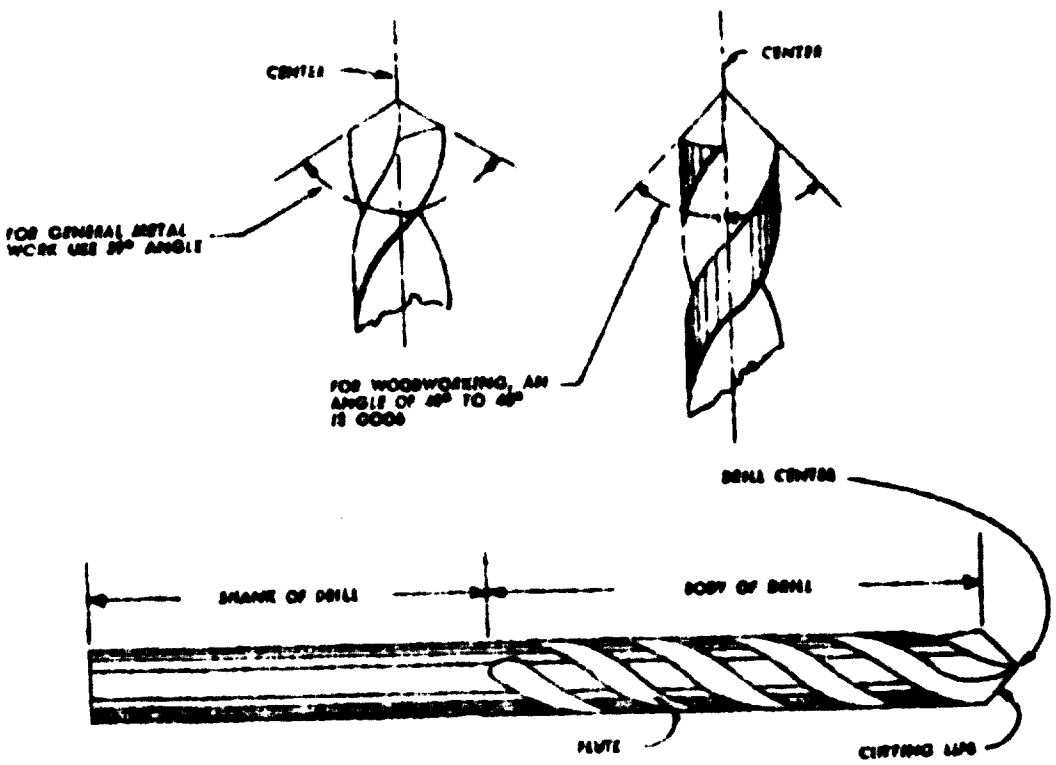
Flute: for removing the chip waste in a spiral way. For shallow holes, as in plywood, such flutes may not be necessary.

See figure 1.

FIGURE 1

Boring Tool Terminology

Twist drill



Spur bits

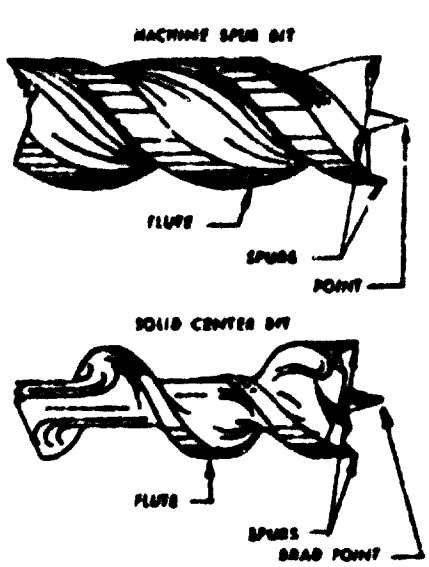
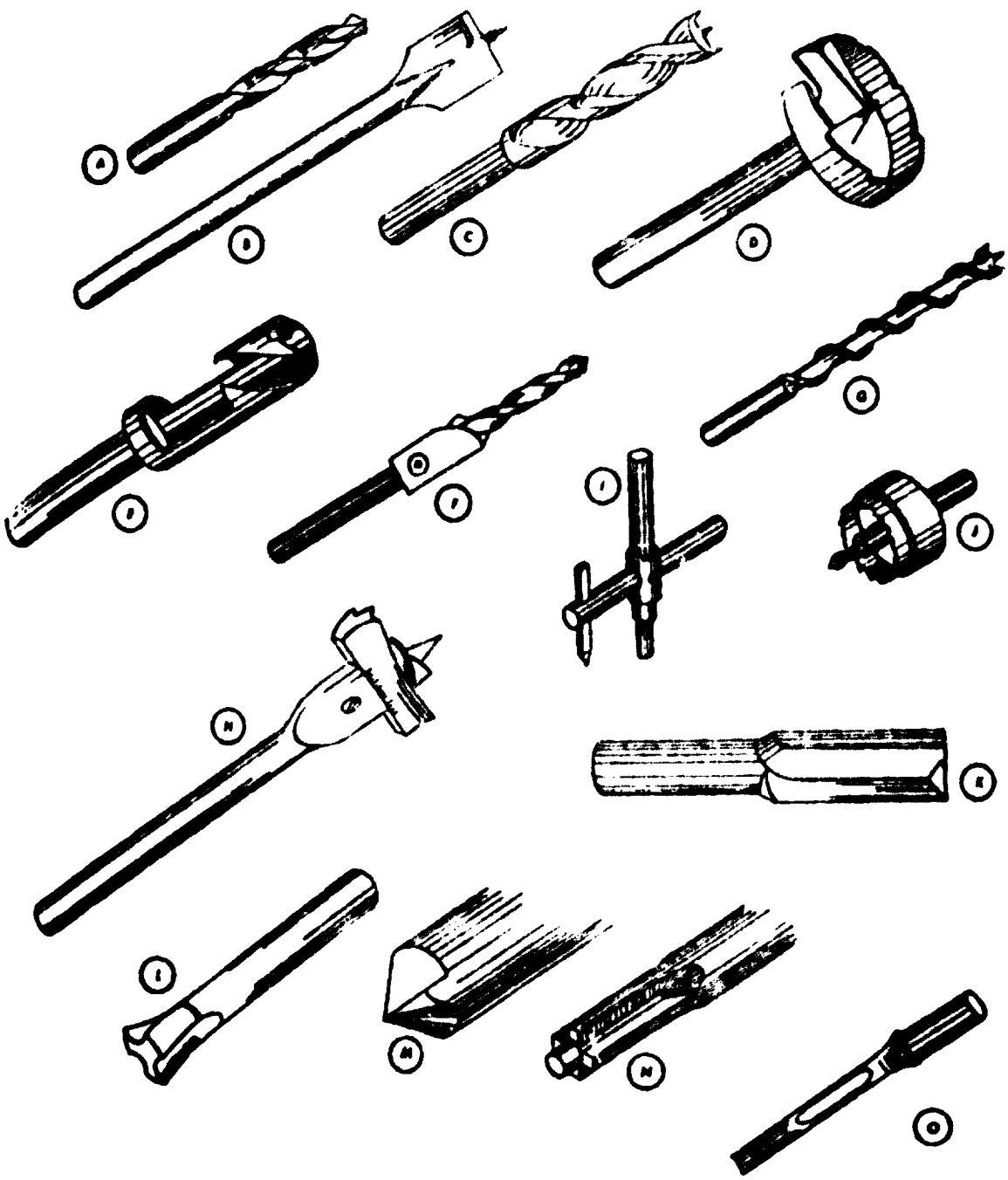


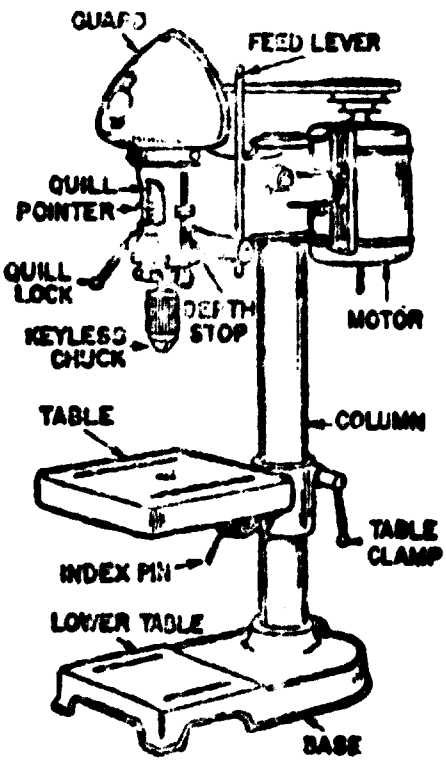
FIGURE 2

Common tools for use on drill presses

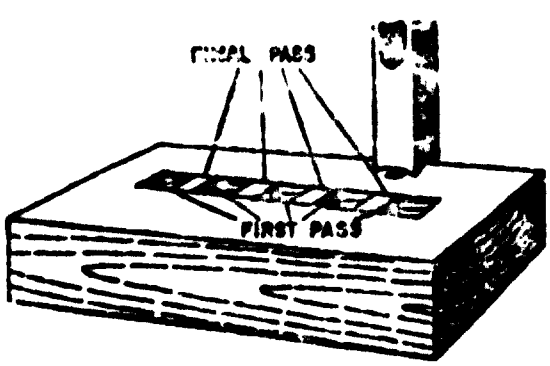


A. Twist drill
B. Auger bit
C. Spur machine drill
D. Multi spur machine bit
E. Plug cutter
F. Adjustable countersink
G. Solid center bit
H. Expansion bit
I. Hole cutter
J. Hole saw
K. Router bit
L. Dovetail cutter
M. Countersink
N. Counterbore with center pilot
O. Hollow chisel

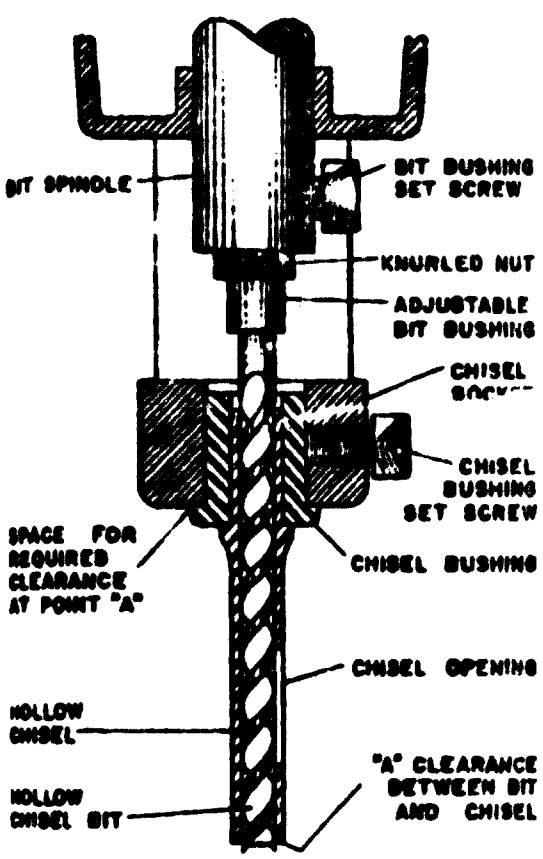
FIGURE 3 DRILL PRESS AND COMPONENTS



a. Drill press



b. Square holes made with a hollow chisel



c. Hollow chisel assembly

Plug cutters with serrated or saw tooth spurs in the form of short cylinders are widely used to upgrade construction plywood by removing knots and defects which are replaced by sound plugs.

For machining square and rectangular holes, the combined auger bit and square chisel will be used. If non-rotating square shell is attached to the rotating auger bit, a square hole will be generated. The hollow chisel bit with its lead end broaches out the corners with a chisel-like action. See figure 3.b.

This combined tool leads to the design of the hollow chisel mortiser. The same rectangular hole can be machined with a rapid oscillating chisel. The hole is exactly rectangular with all adjacent surfaces of the hole. See figure 3.c.

However, when a routing bit oscillates in addition to its rotating action, the operation is then called slot mortising. See figure 4. The machined hole has two parallel surfaces which are connected by half round ends.

Another mortising operation is chain mortising. It is a rough but fast operation, especially where large holes are machined. Most of the chain-cut holes are rectangular, but the bottom is slightly round. To avoid this feature, some of the chain mortising machines are additionally equipped with a hollow chisel attachment.

When comparing all the different mortising operations, it is difficult to define exactly the cutting action.

The slot mortiser is tooled with a router, which means that the r.p.m. of the bit is much higher than of a drill. So in some machine developments where high speed routing bits are chucked for mortising operations, the term "routising" is applied.

II JOINT DESIGNS DETERMINING THE OPERATION See figure 5

In many cases a joint design requires a specific operation and in consequence the machine to be applied will vary.

The mortise and tenon joints can be done on a chain and chisel mortiser.

The exploded table view gives details of a very strong design, but the haunched tenons could easily be replaced by a twin dowel joint, hence much stiffer than the mortise-tenon joint. See figure 6.

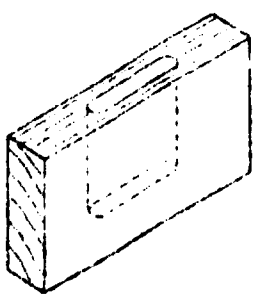
The mortise-tenon joints require two different operations and two different machines, viz: the tenoner and the mortiser.

When changing the dowel joint, both adjacent parts can be bored by the same machine with the same boring tools. The pitch of the bore axis is fixed so that a boring jig which locates the two parts is necessary only.

But what about the strength of the mortise-tenon joint compared with the dowel joint? Strength tests on door frame corner joints had the following results: all frame parts measured 90mm width and 40mm thickness; different tenon sizes and dowel sizes had to stand this test using two different kinds of adhesive; the winner of the test is in any case the dowel joint, which had 150% to 200% richer strength than the mortise-tenon joint. The reason for this strength is the size of the glue coated surfaces. A tenon of 30mm width, 16mm thickness and 90mm length and two dowels 10mm in diameter and 65mm in length have 64,8 cm2 and 65,3 cm2. The relation of the end grain surface is 28 cm2 : 32 cm2.

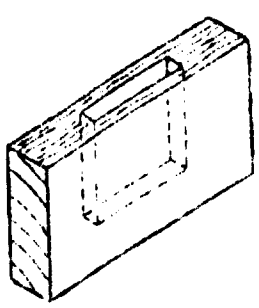
Figure 2

Comparison of cavities machined with different mortising tools



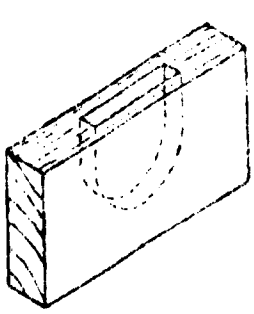
Slot mortise

machined with oscillating router bit



Hollow chisel mortise

machined with combined boring bit and hollow chisel



Chain mortise

machined with mortise chain

FIGURE 5 JOINT DESIGNS

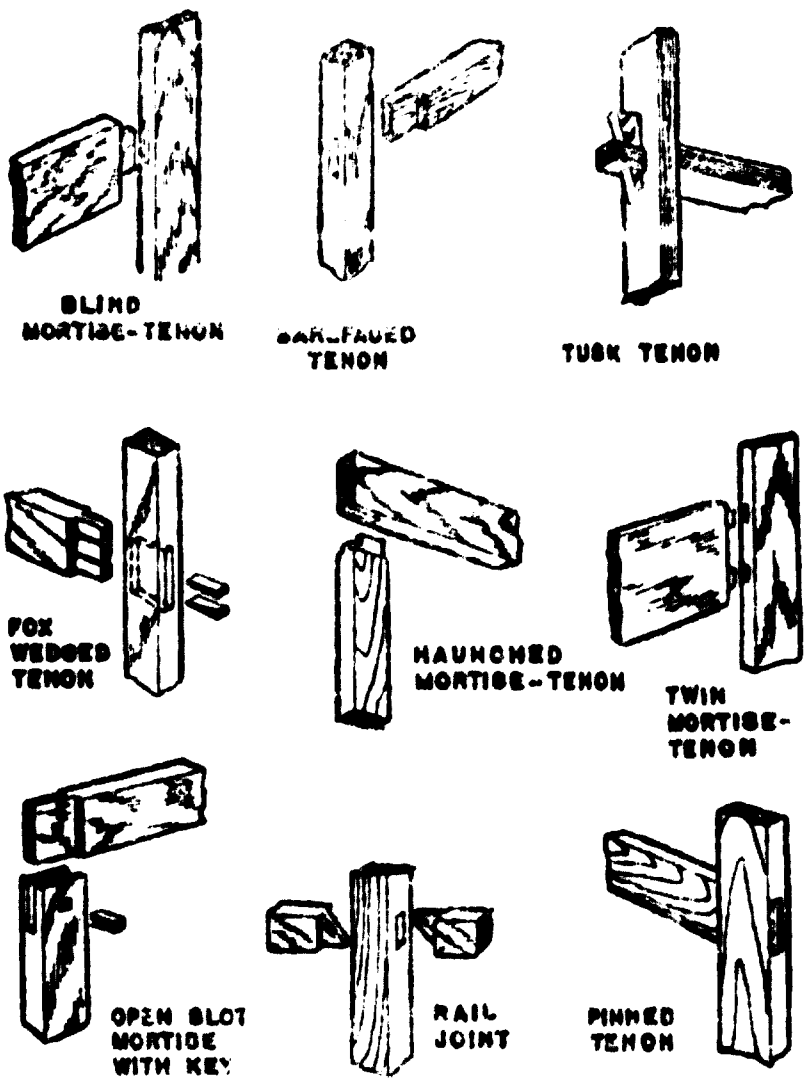
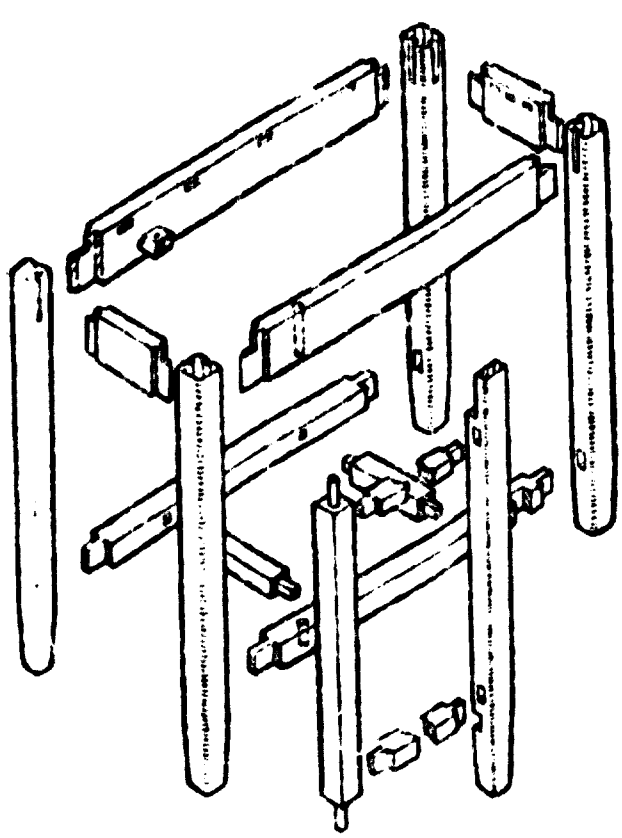
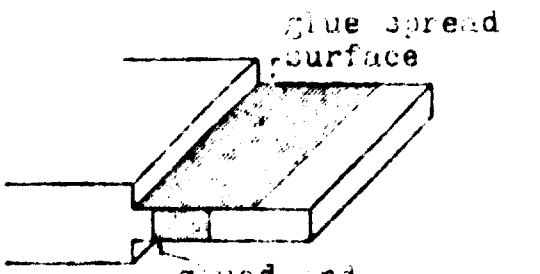
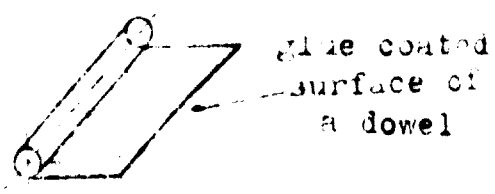


FIGURE 6 EXPLODED VIEW OF A STRONG TABLE DESIGN







glue coated [illegible]
on the [illegible]
(end grain surface)

Tol 72 19 732

As jointing in furniture production is a time-consuming operation, many manufacturers have switched to boring operations instead of mortising. Despite of the joints, new developments of hardware, e.g. hinges, are shaped to adopt the boring operation instead of mortising.

It might be stated here that most of the new developments of boring equipment are in those countries where hardwares have been designed for automated production.

A comparison of boring machines between U.S., British and Continental manufacturers will give an idea of the development stages in the woodworking industry of those countries.

However, boring operations are also combined with other machines where the sequence of operation is required. Examples are given in section III.

A widespread field of combined operations for boring:

glue spreading
dowel driving
hinge mounting
screw driving
plugging
hardware setting
brush stud driving/nailing
chucking (dowel)
ring reinforcing

and for boring:

routing (recessing)
hardware setting

III TYPES OF MACHINES

A. Boring Machines

A vertical drill press is the most universal type used in the woodworking trade. The horizontal slot boring machine is wrongly termed because a slot cannot be bored. The manufacturers should rather term it "slot mortiser". It is a machine used for boring operations when either the twist drill or the workpiece moves parallel to the drill axis. When chucking a router bit and the workpiece moves to and fro for a limited distance, the result will be a "slotted mortise". Many workshop cabinet makers are using this machine for boring operations on furniture parts. This machine was the basic idea for designing modern "slot mortisers" with single- or double-side action.

The many requirements from the furniture industry lead to many dowel hole boring machines for single- or double-end boring, in vertical or horizontal design.

A special feature is the multi-spindle boring bar. In fixed positions up to 20 threaded chucks are lined in a bar. Any bore pattern can be adjusted. Cabinet side boards can be bored for knock-down hardware or position pins, shelf pin holes, key holes and so on. Bore patterns with 48 holes are even used. However, most of the bores with this equipment are lined up because of the bore bars.

More different boring patterns are required for the production of chairs. End-grain boring and side-grain boring on single- or double-end boring machines are often used in the chair industry.

A very special machine is the commercial gear hole drill for drilling wooden musical instruments, which is a component of operating machine which will drill in one pass very fine holes for both end-grain ends.

As requirements grew to such an extent, some machine manufacturers started to build boring units for custom-sized machinery. Standardised motor-units with couplings for single or multiple boring heads are available for individual purposes. Those units are built with combined feed drive and are known as "Feeddrills", pneumatically controlled.

When bores have to be machined under different angles, multi-spindles machines with cardan shaft or flexible shaft will be used.

The development of automatic boring machines did not stop with the built-in pneumatic controls, or sequence control of different operations, but includes tape control to cover the demand of industrialized woodworking industries.

B. Mortising Machines

The change in the design of mortising machines is similar to the development of boring machines. Mortising machines include chisel and chain mortising operations as well as oscillating chisel and slot routising.

As may woodworkers still have in mind that they are trained craftsmen for solid designs, it is not an easy task to convince them of better solutions. The design of new mortising machines rendered possible a good cooperation between woodworkers, machine manufacturers, tool manufacturers and hardware manufacturers. Just remember the old furniture locks with square plates! According to the router bit diameter, these plate ends are round, so that after recessing the lock can be flush mounted. A combined slot mortiser, recesser and keyhole mortiser machines in one pass the plate recess, the lock body mortise and the keyhole - an ingenious idea of a prototype which is now available in many variations. Despite the highly developed equipment, many conservative designs of chisel mortisers and chain mortisers are in action and there is still demand for them.

Very special is the louver shutter slot mortiser for cutting the slots to which the louver boards are fitted. It is a twin-acting machine with a high rate of machining cycles. Other chain mortising machines are available to do the same job with a special shape of the chain. The mortising head can be swivelled to cut the angled mortise for the lower boards.

A new development is the multiple mortiser which has small routing motors mounted to movable units which are controlled by pneumatics and guided on templates. Any recess, bore, or mortise will be machined. This is a high production machine which may also be controlled by tape.

IV HOW TO SELECT THE MACHINE FOR THE JOB

An analysis of all operations which should be done will give the best view for choosing the machine. The operation analysis could also be the base to change the design and operation of existing machines or to decide on a high production machine.

The mortise-tenon contra-dowelling operation mentioned under section II should further be discussed here. The dowel joint is the better construction. There is a saving in wood of 10%. The boring cycle for chair frame parts is 10 seconds. 50 frame parts = 400 frame corners.

400 x 10 seconds = 4000 seconds or 1 hour 6 minutes 40 seconds

A trained operator can make those bores in 59 minutes 30 seconds.
There is no tenoning equipment available doing this job in a comparable time.

Boring equipment is often cheaper than tenoning and mortising machines. Flexibility in resetting the boring units will reduce "down time" of a machine.

Highly mechanized boring and mortising equipment is often pneumatically controlled.

One must first check the product:

furniture
acoustic tiles
sports goods (e.g. tennis rackets)
brushes and brooms
doors and windows
indoor-outdoor goods
railroad ties (sleepers)

then choose the equipment:

stationary machines or manually operated machines (e.g. power drills)
boring or mortising
single spindle or multiple spindle
combined or convertible equipment
modular boring systems

and finally compare the price and the possibility of tool maintenance of different machines.

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