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TOOLS AND TOOL MAINTENANCE[1]

by

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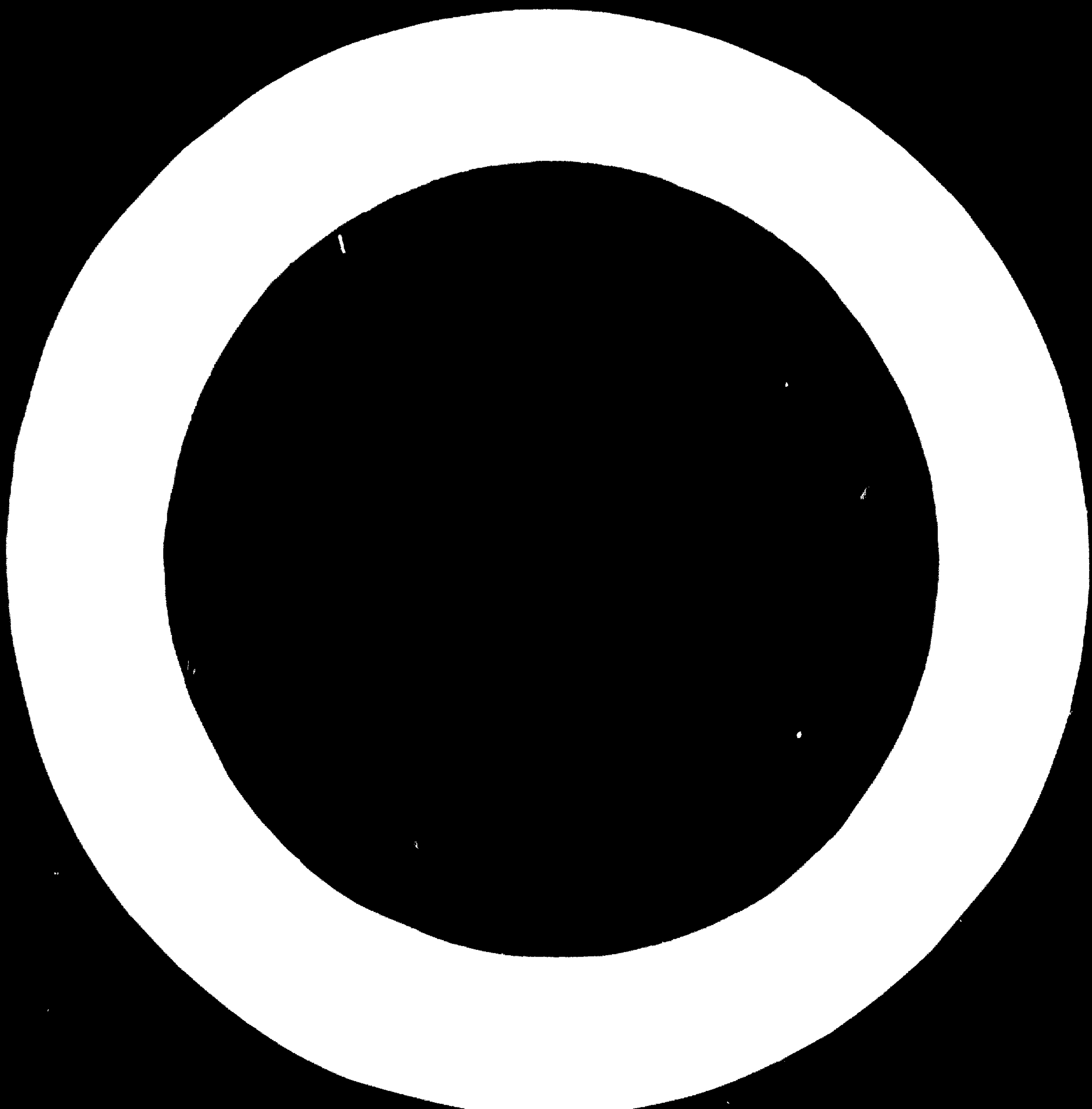

When cutting wood three different directions can be specified with respect to the grain (Fig. 22.1).

CIRCULAR SAW BLADES

The saws can be obtained with tooth shapes suitable for either ripping or cross cutting. The standard toothforms and angles are given in Fig. 22.2.

The saw must be well balanced when running and, in order to secure its satisfactory and steady rotation, the centre portion must be hammered in advance so that it receives an extension corresponding to that produced in the saw rim when running at full speed.

The saws are prepared in a correct way during the manufacture but due to the cutting conditions the saws will lose the tension, which must therefore be renewed by experienced personnel.

Normally the periphery speed is approximately 50 m/sec. Higher or lower rim speed than normal means that the tension must be adjusted. Higher speed requires a "looser" tension.

It is very important when rotating that these are absolutely flat and even and do not deviate more than a couple of tenths of a mm from the straight groove. Hence the importance of tensioning.

Both steel qualities have an even hardness approximately 46 RxC with no sizeable deviations. For the saw blades to do good work it is necessary that they be filed and set in a correct way and that correct tooth shape with suitable angles be maintained by the saw filer.

The saw blade is mounted to a shaft which exactly fits to the centre hole of the blade. The shaft is usually driven by pulley drive but also direct drive by the motor shaft is used on smaller machines.

When sawing logs, the log is fed towards the saw blade on a separate table or log carriage. Also manual feed is used in primitive saw mills.

In joinery shops and similar industries manual feed is common, but rolls or bands are also used. Sawing of logs at saw mills with circular saws is cheap as regards machine costs. However, the exactness of the sawn timber is often not so good due to the difficulty in supporting the saw blade mechanically. Correct tensioning and levelling of the saw blade is here very important.

No sorting of the working material is necessary except that too big logs are sorted out. In certain countries so called twin saws are used for sawing big logs. This twin saw consists of two saw blades, one placed above the other and in a way that the saw curves meet in the kerf.

Circular saw blades are not economic as much material is lost in the form of saw dust. Therefore these machines are disappearing more and more especially for log sawing. Instead band saws and carbide tipped circular saws will take over more and more of the market share held by conventional smaller circular saw blades.

CARBIDE TIPPED CIRCULAR SAWS.

Carbide-tipped circular saw blades are gaining steadily in popularity. The introduction of more stable machines - designed especially with carbide-tipped saw blades in mind - and better understanding of the use and care of these blades have resulted in increasingly improved economy.

The wood products industry in Sweden has undergone thorough reorganization in recent years and efficiency measures have been widely adopted. Increasingly stiff competition has forced most companies to try to concentrate their efforts on a limited range of products, with long runs as a result. In the course of this development the previously used universal machines have lost ground in favour of specialized machines of great precision and capacity.

When acquiring these frequently expensive specialised machines it is necessary, however, to see that tools used with them permit the full exploitation of the machines' potential. Carbide-tipped circular saw blades play an important role in this context. Because of their high durability it has been possible to raise output and reduce manufacturing costs per unit.

The optimum performance of carbide-tipped blades will be enjoyed only under certain definite operating conditions.

Cutting speed.

As a rule, machines of older types used in the wood products industry are not adjustable for different speeds. They frequently have a speed which, with ordinary blades, gives a cutting speed of approx. 47 m/sec. (155 fps). When a switch is made to carbide-tipped blades a smaller diameter can be employed, because with such blades the diameter reduction will amount to no more than about 5/8" (15 mm) during the life of the saw; in other words, much less than for an ordinary blade. Given these circumstances, a carbide-tipped blade in an older-type machine will give a much lower cutting speed than the conventionel blade, which means in many cases that it cannot be used in the most economical way.

Table 22.1 gives recommended cutting speeds for various types of material. The cutting speed for each group can be given only within relatively broad limits, because of the familiar differences in workability between one kind of wood or product and another. At the upper limits, it is necessary for the machine to be stable enough to ensure vibration-free blade running.

If the feed per tooth is too low, no proper chip will be formed, the tooth edge merely acting abrasively on the material, with excessive wear as a result. To reduce wear it is best to employ large feed per tooth, since edge wear is principally dependent upon the course of the tooth through the material. If excessive feed speed is used the cutting forces may become so large that the sintered carbide in the cutting edge is broken down. Of course, the required finish of the section will always be an important factor in selecting feed rate.

<u>Feed speed</u>

The feed per tooth should be between 0,002 - 0,012" (0,05 - 0,30 mm), according to the material being worked and the standard of finish required. It can be calculated using the formula:

$$= \frac{s \times 1000}{n \times z}$$

where = feed/tooth in mm.

s = total feed in m/min.

n = r.p.m.

z = no. of teeth working on the section in question

<u>Height of blade over work</u>

The hook angle of standard catalogued carbide-tipped blades is usually designed for a blade height over the work of 3/8 - 5/8" (10 - 15 mm).

The drawing here (Figure 22.4) shows how the angle of attack of the tooth against the material varies as the height of blade is changed. In other words, by varying the overhang it is possible to influence the finish of the section to some extent. This is especially true of materials faced with plastic laminates or veneers. The optimum height of blade must be established by trial and error in each case.

Generally speaking, the greater the overhang the worse will be the break-through at the underside of the material, while the top face will be better. Reduced overhang, on the other hand, results in break-through on the top side but a fault-free underside. The former situation gives a shorter cutting path through the material, meaning less feed force and, in theory, reduced edge wear. The latter case, however, results in smoother blade running and therefore a better finish in the cut.

<u>Angles</u> (see Figure 22.5)

The clearance angle is kept between 10 - 12°. Thorough studies have shown that increasing the angle above this range will not lead to reduced cutting forces, but may well weaken the edge.

The tooth point angle should not be less than 45°, for the sake of strength.

The hook is determined by the specific cutting properties, workability and hardness of the work. Normal values lie between 0° and 30°, the largest angles being employed for ripping softwoods and the smallest for crosscutting and adjusting.

In ripping work the wood tends to separate in advance of the saw, which reduces the cutting forces. It is therefore possible to increase the hook without any risk of overloading the edge. Increased hook results in lower feed forces.

The tangential clearance angle is normally between 3° and 4°.

The radial clearance angle is kept between 1.5° and 2°. If blade tends to pick up deposits, however, this angle should be increased to 3°.

Front bevel is used on ordinary carbon steel blades with tooth shapes F and G, this being about 15° (Fig. 22.2). On carbide-tipped blades front bevel is employed for mitre cutting and also for plywood and veneered boards where a clean cut is required. In these cases it is never greater than 5° in order not to weaken the edge.

Back bevel is nowadays featured on most carbide-tipped blades. Compared with a blade having straight teeth, a blade with back bevel requires less power and less feed force. The angle is between 5° and 15°.

As a rule, alternate teeth have left-hand bevel and alternate teeth right-hand bevel. This applies to both front and back bevel. This practice results in smoother blade running than if all teeth were bevelled alike, though this would be desirable in some cases for the sake of a good finish in the cut.

Dimensions

Swedish standards governing the dimensions of circular saw blades with carbide tips have recently been established. SMS 2370 contains a dimension schedule comprising diameter series, three tooth width series and tooth-number series for pitches of 75, 49, 30, 19, 14 and 10 mm. SMS 2371 sets forth data for crosscutting circular saw blades and SMS 2372 for ripping saw blades.

The thickness of the blade itself has not been standardized. Normally it is about 1/32 - 3/64" (1 mm) less than the width of the cutting edge. In other words, the blade has a clearance of about 0.02" (0.5 mm).

Blades having extra-narrow cutting edges are sometimes made with a clearance of only 0.01 2" (0.3 mm). It is therefore necessary to pay extra attention to the setting-up of such blades and be more careful in sawing.

The thickness of blades for carbide tips is usually somewhat greater than that normal for ordinary carbon steel blades for the sake of steady running and to provide a good brazing attachment for the carbide tip.

In order to release the stresses which arise in the periphery of the blade, due mainly to the heat generated in sawing, carbide-tipped blades feature expansion slits and pinholes, as seen in Fig. 22.6.

These slits are found on all close-pitch blades and on those used for continuous sawing.

Grades of sintered carbide

Since 1959 sintered carbides have been described by ISO designations with regard to chip-forming machining operations. There are three main groups, as shown in Fig. 22.7. The arrows indicate the directions in which durability and toughness, respectively, increase.

In woodworking, sintered carbides reveal an abrasive wear picture as shown in Fig. 22.8. This type of wear is known as flank wear.

The grades of sintered carbide falling within Group K are particularly resistant to flank wear and are therefore employed in circular saw blades.

The grade used depends on the design of the blade itself and the material to be worked. It is important that the sintered carbide should be sufficiently tough to resist breaking down of the edge during sawing.

Toughness and strength are mainly related to the kind of carbide, the cobalt and the grain structure. Thus an increase in the cobalt content and a coarser grain structure result in greater toughness but less durability.

Grinding

A frequent error is to regrind a carbide-tipped blade less frequently than is necessary to secure optimum results. Flank wear should be studied as a guide to the most economical time at which to regrind. The wear should not exceed 0.008" (0.2mm) - See Fig. 22.9. The simplest way to check this wear is with a measuring magnifier.

When regrinding, for which a diamond wheel should be used, grind the leading edge first and then the back. As will be seen in the picture, wear arises quite a long way down at the working corner, despite the radial clearance angle. If grinding is confined to the back only, a relatively large amount of the carbide tip must be removed to restore the edge to full satisfaction.

For coarse grinding a 150-grain wheel is recommended, and for finishing a 400-grain wheel. The grinding machine must be stable and the blade securely fixed, preferably with a support close to the point of grinding.

Summary

The use of carbide-tipped blades is increasing steadily. The introduction of more stable machines - specially designed with the use of carbide-tipped blades in mind - and better understanding of the use and care of carbide-tipped blades have resulted in increasingly improved economy. New patterns and new grades of sintered carbide, suitably composed for various sawing conditions, will increase still further the potentialities of the carbide-tipped blades. It is, of course, desirable that the standards governing dimensions should be observed and applied as far as possible.

BAND SAW BLADES

Band saw blades are normally toothed on one side only but a limited number of blades are also toothed on both sides. The distance between tooth points varies depending upon blade dimension and use. The size and type of material to be cut also affects the tooth pitch. Band saw blades are exclusively used for ripping. Wider dimensions are used at saw mills and narrow dimensions at joineries and similar wood industries.

Generally said saw blades up to 70 mm are considered as narrow and blades wider than 70 mm as wide band saw blades. Band saw blades for cutting logs are usually more than 150 mm in width.

The band saw machine is normally working in a vertical position. Horizontal machines are gaining ground, especially in smaller saw mills. The machine consists of two fly-wheels held together by a rather steady body. The bottom wheel is driven by a motor and the top wheel by the saw blade which acts like a transmission belt. The band saw blade always cuts in a downward direction in a vertical machine and all teeth are working

The purpose of tensioning, i.e. elongation of the middle of the blade by rolling, is to make the blade fit to the band wheels properly over its entire width during sawing - with normal friction and heating and with suitable strain in the machine. It is very important that the toothed edge is sufficiently stretched during sawing. Otherwise the blade will not cut straight. The stretching of the blade is done by pressing the upper wheel upwards. This stretching should not be mixed up with tensioning of the saw blade centre, which is something entirely different.

The blades are joined together by welding which is the most efficient way. At saw mills both welding and soldering from saw blades bought in coils is usual.

A complete machine consists of two fly-wheels on a steady body. Furthermore a log carriage for log cutting machines is used but also other forms of log feeding are usual for example a table feed machine is supplied with a steering equipment above and below the work piece. The upper one can be moved vertically and adjusted as close to the work piece as possible which makes it easier to cut straight.

The rims of the band wheels are higher in the middle than at the edges in order to prevent the blade from wandering back and forward on them,provided the blade is correctly tensioned. Big machines with wide blades for instance in the US have flat wheels as the large surface contact is considered to give sufficient contact support without any extra measures.

Band sawing gives the smallest possible saw dust losses and sorting of logs is not necessary. The band saws of various types are considered as the most economical machines for splitting up wood into smaller sizes. This is due to low thickness of blade and that logs can be treated according to dimensions and quality without too much time wasted by handling. Band sawing is becoming more and more popular all over the world.

The servicing of band saw blades is more complicated than the servicing for other machine driven blades. The necessity of using good maintenance machines is more noticeable in the band saw mills than in other wood industries.

MACHINE KNIVES

Main Groups of Machine Knives.

Most machine knives carry out either reciprocating or rotary motion on discs, drums, shafts, etc.

Other knives remain stationary in the machine and the stock (work-piece) performs the necessary reciprocating or rotary motion.

There are single knives and knives that shear in conjunction with another.

Machine knives can be classified by cutting action as follows:

a) Rotating units, such as revolving cutters and chipper knives.
b) Stationary units, such as veneer knives and surface scrapers.

Rotary Cutters (Fig. 22.10)

The individual cutter knife in its simpliest form cuts principally along its face (cutting edge). Its function is to remove the surface, flat or curved, rather than to reduce the larger board into smaller units, which is the function of the saw.

Stationary Knives (Fig. 22.11)

In many instances knives for cutting wood are relatively stationary. The wood either revolves against the knife, as in a veneer lathe, or reciprocates across the knife, as in a veneer slicer. Another example is the surface scraper, where the wood is fed across a rigid knife, with a slightly turned edge to remove a thin (abt. .006" = abt. 0,15 mm) shaving.

CHIPPER KNIVES

Sandvik has used the case-hardened technique. The raw material has a low carbon content (around 0,10 %) and is consequently not hardenable. The carbon content in that part of the knife which is to be hardened is increased to a suitable percentage by a carburization process penetrating to the required depth. During subsequent hardening only the carburized section becomes fully hardened. The toughness of the low carbon steel is retained in the body of the knife. The transition from hard to soft material is progressive, with no sharply defined limits that could be stress raisers under certain conditions.

Today we only use high chromium material for chipper knives. This is because modern chippers operate at very high speeds and production and can give the knife edge a temperature of 450°C. For these machines it is therefore necessary to have knife-material with a high anealing temperature. Thin knives are all hardened but the thicker ones are high-frequency hardened. The hardness configuration is practically identical to that obtained with case-hardening.

HOG KNIVES

Hog machines are used primarily for reducing waste wood and bark into pieces of small size suitable for boiler fuel, and are employed for this purpose by nearly all veneer mills and many other woodworking plants. Also, Hog machines for converting bark to fuel are used by many saw mills having a debarker and steam plant, and by a number of pulp mills. Other applications include the processing of pitch-pine stumps for production of turpentine; chipping oak for tanning in extract plants, and the preparation of fertilizing material in packing plants.

Machines now in use include a large variety of models from twenty or more manufacturers. Between 10 and 36 knives normally are required for a set. Other machines of this general type, known as "Hammer Hogs" and 'Pulverisers" do not use knives.

Since there is hardly any "quality" requirement on the product from most hog machine applications, and plant procedures on handling waste frequently permit metallic and other foreign materials to go through the hog, the knives regularly receive much more abuse and careless maintenance than knives of other types. Thus, it is a common belief that the cheapest knives obtainable probably are adequate for the purpose and most economical in the long run.

This theory can be valid only within certain limits, of course. Knives which will stay in use longer during normal use, before regrinding becomes essential, and which have equal or superior resistance to damage from "tramp metal", must offer worthwhile extra value in reduction of knife consumption and maintenance costs.

Other hog knives are made of very low alloy steel with carbon content to permit hardness in the range of about 47 to 54 Rockwell C. Cheap grades of ordinary commercial steel are used to permit lowest possible prices (to satisfy the prevailing theory of buyers). Since the knives are fully hardened by conventional methods, and properties of the low-grade steel can provide only moderate toughness, the hardness must be kept relatively low to avoid excessive breakage during use.

VENEER KNIVES

During the years, Sandviken has manufactured a case hardened veneer knife. The knife is zone hardened, which means that only a part of the knife (the cutting edge) has full hardness (59-60 HRC).

The knife's performance has proved to be very satisfactory in softwood and in hardwood as well.

About two years ago we introduced a new quality veneer knife. It is a "low alloy steel knife", high-frequency hardened. The knife's construction is identical to the old case-hardened type - zone hardened. Hardness 59-61 HRC.

Edge holding ability of this knife is very good. It stays sharp very long. In case of minor edge damages, caused by rocks, nails, hard knots etc., the edge can easily be maintained in the lathe.

In case of a bend, the edge can be straightened by using a hammer and then touched up by honing, if there is a nick, it can be maintained by filing and honing.

PRESSURE BAR

A pressure bar is used on both veneer lathes and veneer slicers.

On lathes you can find a roller bar or a solid pressure bar.

The most common pressure bar is manufactured with a stellite-edge, whioh gives good edge holding and wear properties.

However maintenance of this bar is expensive, if it is damaged by a foreign item, for instance a nail of steel. In many cases the bar must be sent to a special shop for repair.

When certain species of wood are peeled or sliced, particularly oak, staining is a problem, as all stained veneer is waste.

In order to avoid such difficulties, the bar must be removed quite frequently and cleaned together with the bar holder.

Experiments have been performed by painting the bar, but with no greater success.

With the pressure bar in high chromium steel the staining problem seems to be solved.

Furthermore the customers are able to maintain the bar themselves, and in certain cases the edge holding and wear properties are just about the same as in a stellite bar.

RESHARPENING MACHINE KNIVES

Careful resharpening results in improved cutting properties, longer life, and a corresponding reduction of costs.

Rather often, the sharpness of a reground knife is inferior and of shorter duration to that of a new one. In many cases, the reason for this is to be found in faulty regrinding, which has often given rise to unjustified complaints and may be prejudicial to the good-will built up between the manufacturer and the customer.

Knives should be changed and reground before the cutting edge has become too blunt. If this precaution is taken, it is only necessary to remove very little material when regrinding, which reduces the time and costs for this operation and lengthens the life of the knife.

A correctly ground cutting edge should be clean and straight along its whole length and free from burrs, burnt spots, and grinding cracks.

Factors when sharpening.

The quality attained when sharpening machine knives is dependent upon the following main factors:

.) The grinding machine
.) The grinding wheel
.) The grinding method and
.) The grinding performance

THE GRINDING MACHINE

In most cases the machines used for grinding straight machine knives are surface grinders with horizontal spindles and reciprocating tables, fitted with cup or cylinder type grinding wheels.

Small machine knives are frequently ground on surface grinders with vertical spindles and cup wheels.

Generally speaking, the machine knife is fixed by a magnetic chuck or by clamping it to the reciprocating table of the grinder which reciprocates in front of the stationary spindle carrying the rotating grinding wheel.

The quality of the grinding machine is of the greatest importance for the results obtained in grinding. It must be vibrationless and in good condition to ensure a uniform bevel and a clean, sharp cutting edge, that is to say precision work. In machines that are less rigid, particularly where no coolant is employed, grinding must be done with the greatest precaution.

THE GRINDING WHEEL

THE PROPER GRINDING WHEEL FOR EACH TYPE OF MACHINE KNIFE

It is extremely important to select a wheel of the proper grade and grain-size.

Grade (Hardness)

The degree of hardness calls for special attention. A wheel that is too soft will not retain its size, particularly at the roughing cut. Owing to its quick loss of shape its life will also be unduly shortened.

On the other hand, a wheel that is very hard will give unsatisfactory working results. Such a wheel will rapidly become glazed and dull and requires repeated dressing. A glazed and dull wheel tends to burn and ruin the knife.

The grade of the wheel should be selected in accordance with the composition and hardness of the knife material. The type and condition of the grinder, the shape and speed of the wheel as well as the cooling are also very important. It is preferable to try out a wheel that is on the soft side first, and then proceed gradually to a harder and more economical wheel.

Grain.

Wheels with a finer grain have come more and more into use for machine knives, in certain instances a No. 60 up to No. 80 grit is employed, these being correspondingly softer. The finer grains, being smaller and sharper, will penetrate the hard surface of the knife more readily than will the coarser grains. A finer grit wheel will therefore cut with less pressure and less risk of burning, and in addition, will produce a better surface.

Grinding Wheel Recommendation.

The general rules applying to the selection of hardness and grain-size are as follows:

Hard Wheels.

Wheels of harder composition are used for soft material, small contact surfaces, greater depths of cut and with grinders that are not completely rigid.

Soft Wheels.

Wheels of looser composition are selected for hard material, larger contact surfaces, smaller cuts and very stable machines.

Roughing, Finishing.

For roughing large grain wheels are used, whilst for finishing wheels with a small grain should be employed.

Standardized Symbols

The system of symbols used for grinding wheels is internationally standardized and a grinding wheel designation contains all the data relating to the quality of the wheel

Wheels for Machine Knives.

For grinding machine knives of tool steel, high chrome alloyed steel, or high speed steel alundum vitrified wheels are generally used.

The grain sizes, grades and structure of wheels for grinding machine knives are underlined in the table below.

As a rule only a vitrified bonding agent is used in wheels for knife grinding.

The following qualities of grinding wheels are recommended for grinding the most commonly used types of machine knives (Table 22.2).

The conbinations in table 22.2 apply to stable and vibrationless grinders. For machines that are less rigid, wheels having one or two more degrees of hardness should be selected. Similarly, lower peripheral speed needs harder wheels and a higher speed needs softer wheels than that recommended above.

Segmental Wheels.

Where a segmental wheel can be used in place of a solid one (particularly of larger sizes), this should be done, as the air circulating around the segments during rotation contributes towards more rapid and cooled grinding. In addition, the removal of chips is more effective and the working capacity greater than with the solid wheel.

Truing and Dressing of Wheel.

If the grinding wheel exhibits a tendency to burn, it must be dressed immediately. A newly mounted wheel must always be trued in order to get the grinding surface running evenly. The wheel must also be dressed from time to time to keep the cutting face clean, sharp and free cutting, thereby minimizing the danger of burning the edge of the knife.

A special dresser for sharpening by hand, which is supported against the table and clamping plate, is recommended both for truing and dressing. A diamond tool may also be used but not an abrasive stone (a piece of a grinding wheel, for instance) as it is difficult to hold it sufficiently steady. An abrasive stone is also unsuitable on account of the fact that it is apt to produce a glazed surface instead of cleaning the wheel face and rendering it sharp and free cutting.

THE GRINDING PROCEDURE.

Partially Hardened Knives.

The grinding of selective hardened machine knives (eg high frequency hardened, or compound steel) must be regarded as a very delicate job, as the grinding wheel has to work on soft and hard material simultaneously. The soft material easily tends to stick to the wheel which is then very apt to become glazed and to burn the material.

Firm Holding of Knife.

The machine knife must be firmly held by a magnetic chuck or clamped to the table (it must never be held by hand). It is very important that the contact surfaces are free from projecting burrs, dirt or the like. The chuck should be rotatable to enable different angles of the cutting-edge to be obtained according to the type of knife.

Where no suitable clamping device in available, the knife should be placed on an adjustable table with a stop against the rear edge of the knife.

Direction of Rotation of Wheel.

Machine knives should always be ground <u>towards</u> the cutting edge (Fig. [illegible].1[illegible]). By grinding towards the edge, the wheel retains its sharpness and the danger of overheating the edge is reduced.

When grinding in the opposite direction, the wheel draws the softer material of the bevel towards the cutting edge which causes the wheel to become glazed and lose its sharpness.

Grinding is, however, sometimes carried out against the periphery of a cylindrical wheel. A hollow ground bevel can be obtained by this method which may be an advantage in certain cases. It is advisable here not to employ a wheel with too small a diameter which will produce too deep a hollow and thus weaken the edge.

Coolant on before Grinding.

Before grinding is begun, the coolant should be turned on, after which the wheel is set in rotation, a small feed being maintained.

Grinding Finish.

Grinding is finished with a die-out cut, that is to say, the wheel should be allowed to cut without any further feed until sparking ceases. In this way a bevel with a smoother surface is obtained and honing is simplified.

Grinding speed.

The speed prescribed for different wheels should be carefully observed as the maximum cut will be obtained at this speed. If the speed is too low, the wear on the wheel will be excessive. On the other hand, a speed that is too high will produce such a heavy grinding effect that the cutting edge will be burned and ruined. As mentioned earlier, however, a deviating peripheral speed can be counteracted by selecting a suitable wheel hardness.

Maximum Speed.

It should be noted that for safety's sake, the maximum speed given for every grinding wheel should not be exceeded.

Generally speaking, the speed of the feeding table should be 26-78 ft/min (18-24 m/min.).

Feed.

The feed must be small and should not exceed 0.002"/stroke (0.05 mm/stroke). This also applies to roughing. If the feed and speed of the table are too great, the knives may easily be ruined. The best results are obtained by taking a light cut with a moderately rapid table feed.

Detrimental Heating of Knife.

Heating at the point of contact between the grinding wheel and knife may exercise a detrimental effect on the properties of the steel. If the original tempering temperature for the knife is exceeded the steel will be annealed with a consequent loss of hardness. If the temperature rises high enough, the cutting edge will be ruined by unsuitable hardening, as it will become brittle.

An infallible indication of detrimental heating of the knife is the appearance of the tempering colours. As long as no colours are visible, no conversion of the steel has taken place.

Tempering begins
with straw (yellow) colour (at 250-300°C = 480-570°F)
and increases over blue (" 300-350°C = 570-660°F)
to blue-grey and grey (" 350-400°C = 660-750°F)

At the latter temperature the cutting edge is ruined, so that the damaged part must be entirely ground off.

Cooling GRIND WET.

Machine knives of any kind should preferably be ground wet. The flow of coolant should be directed at the point of contact between the wheel and the knife or close above, in order to prevent burning of the knife. A certain cleaning of the wheel is obtained at the same time. The tank for the circulation coolant in a cooling system should be large enough to allow a minimum circulation time of 10 minutes, which calls for a capacity of 43 gallons (200 litres). The use of a filter in the cooling system is a great advantage, as it prevents steel chips and fragments broken off the wheel from reaching the grinding point, where impurities of this kind may cause damage in the form of scratches on the bevel or edge of the knife.

Too little or intermittent cooling is worse than none at all. To direct the coolant against the knife when it becomes hot is a sure means of damaging or even entirely ruining the knife.

Coolant.

Clear water may be emplcyed as coolant, in which case plenty of coolant must be used, i.e. about 4½ gallons per minute (20 litres per minute) or more.

Rust-preventing Coolant.

The coolant must not cause rusting of the knife or machine. When using water a rust-preventing agent should be added. This may be sodium carbonate, in proportion of 8.8 lb per 22 gallons (4 kg per 100 litres). A large number of oil emulsions also available on the market are very suitable as coolants, as they generally possess the excellent property of facilitating the production of perfect surface.

Honing.

After grinding is completed, the cutting edge must be honed before the knife is ready for use. Not even the best grinding wheels are capable of producing a ground surface which is smooth enough for an entirely satisfactory knife edge. Scratches are always formed resulting in a rough and uneven cutting edge will, however, soon become dull due to the fact that the tops between the scratches on the edge are rapidly worn down. In order to obtain a satisfactory cutting edge that will retain its sharpness over a long period and permit the knife to work accurately, the wire or feather edge invariably left on the steel side by the grinding wheel must be honed away completely. Thorough honing has a direct influence on the life of the knife, the quality of its cut, and on the operating economy.

Honing Guide.

The following description may serve as a guide for honing edges of machine knives.

1. Support the knife in a vice or on a bench at a convenient height and with sufficient light on the edge.

2. The oilstone must be perfectly even and should be applied against the bevel with a light pressure over the whole bevel and steel side (see Figure 22.15) to prevent the formation of a rounded edge.

3. Honing of the steel side of the knife should be stopped when the wire edge has disappeared or been straightened.

4. Honing should not be forced and should be carried out with a sort of rotary motion along the bevel. It can be carried out quickest and best by first rough honing the edge with a coarse oilstone. Use a thin machine oil on the stone and reduce the pressure gradually.

5. Then continue honing in the same way with a finer oilstone.

6. Finish honing with a fine-grain hard oilstone on both sides of the cutting edge. For this purpose the stone should be tipped up slightly about 1/16" (2 mm) from the heel of the bevel.

7. Examine the edge with a magnifying glass (ten-power, for instance) to ensure that it is free from all burrs and nicks.

Checking of Proper Honing.

One way to tell if a knife has been honed properly is to draw a piece of writing paper along the edge. It will cut the paper easily but any uneven spots will inevitably cause slight but clearly perceptible vibrations of the paper. Such spots must be marked for further honing. - After honing, the knife should be carefully wiped.

CUTTER 2100.

The Cutter 2100 is a new tool intended for planing and milling, and is based on earlier designs used in the wood industry, but has made use of and further developed the metal industry's advanced technique for mechanically clamped indexable inserts.

The letters and numbers refer to the attached outline drawing(Fig. 22.16)

The new tool is constructed on the changeable insert principle with the intention that the insert should be thrown away instead of being reground after wear.

The miller body (cutter-head) is 25 mm in thickness (1) and is available in five standard forms with cutting diameters of 100, 120, 140, 160 and 180 mm. The corresponding number of inserts are 3, 4, 4, 4 and 6.

The Cutter 2100 can be used in all types of multi-cutting, table-milling (spindle-moulder) and tenon-cutting machines. In the former type several millers can be joined to form a wide cutter (2), whilst in the latter two types the Cutter 2100 can be used either as a single-tool or a multi-tool unit. (1 and 2).

The purpose of the clamping system (3) is to locate and firmly hold the inserts, and consists of a flat bearing surface (4) and a cylindrical seat. (5).

The shape of the insert is a half-circle (6) with the cutting edges 26 mm long (7).

Each insert has thus 2 cutting edges. The ends of the inserts (8) can also be used for cutting purposes in rabbeting and grooving applications.

The inserts are clamped by a steel ball (9) and a screw (10) at right angles to the insert (screw-thread M8). The ball thrusts the insert against the seating and there clamps it firmly. The chip-break (12) in front of the insert breaks up and guides the chips away from the cutting zone.

The recesses (13) in the circumference of the miller-body facilitate the adjustment or change of inserts when the tool is used as a multi-unit cutter (2). In order that the inserts of a multi-tool unit can be changed an aperture is provided on the body lying alongside to permit access to the clamping system. Precise relative location is ensured by pin and hole in each miller-body. One advantage of this mounting system is that the inserts take a spiral form, which can be very useful from many points of view. (see figure 2).

In order to prevent the occurance of length-wise ridges in the material when utilising a multi-tool layout (2) the inserts have been made 1 mm longer than the milling cutter's breadth. This always creates the necessary overlapping to overcome this problem.

The steel used for the miller-body is SIS 1672, apart from the component, which forms the chip-breaker. In order to reduce wear which chip-removal creates, steel quality SIS 2140 is utilized for this latter component. By this means it is possible to supply the miller-body without the necessity of special hardening processes.

The range is today as follows:

Outside Diameter (D) mm	Centre Hole (d) mm	Number of Inserts (z)
100	40	3
120	60	4
140	60	4
160	60	4
180	60	6

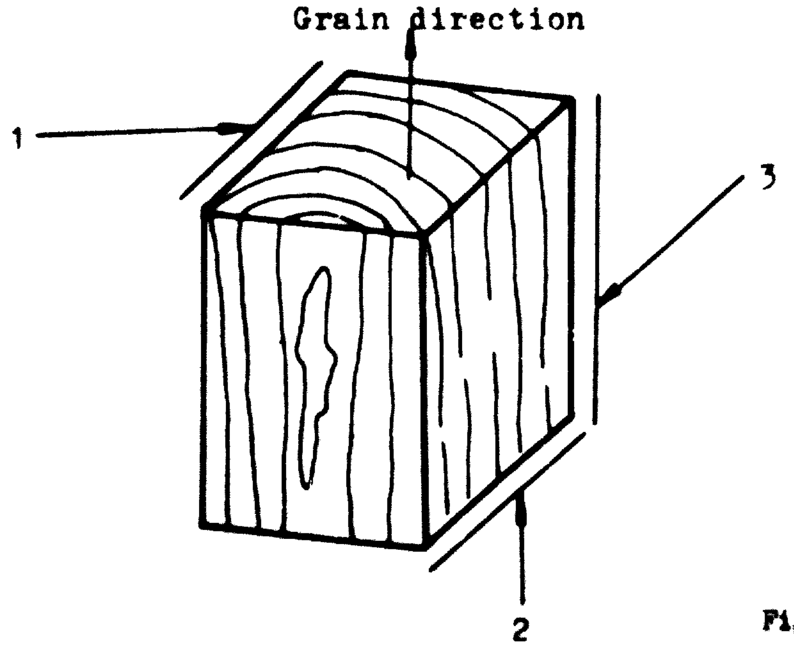

Fig. 22.1

Specifications for directions with respect to the grain:

1. Cutting surface perpendicular to the grain
2. Cutting surface and movement parallel to the grain
3. Cutting surface parallel to the grain but the movement perpendicular to the grain

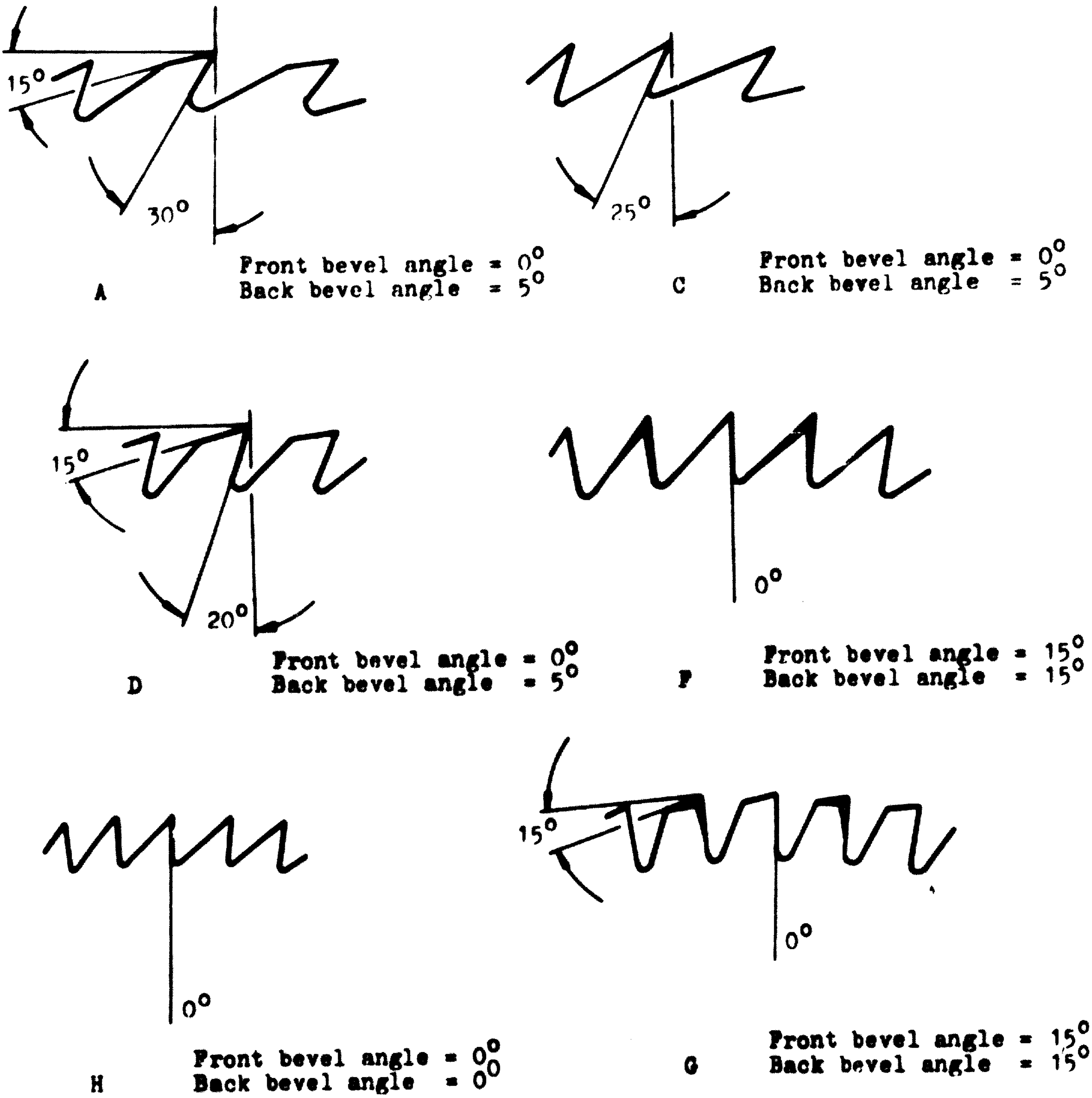

Fig. 22.2

Standard tooth forms and angles of circular saw blades

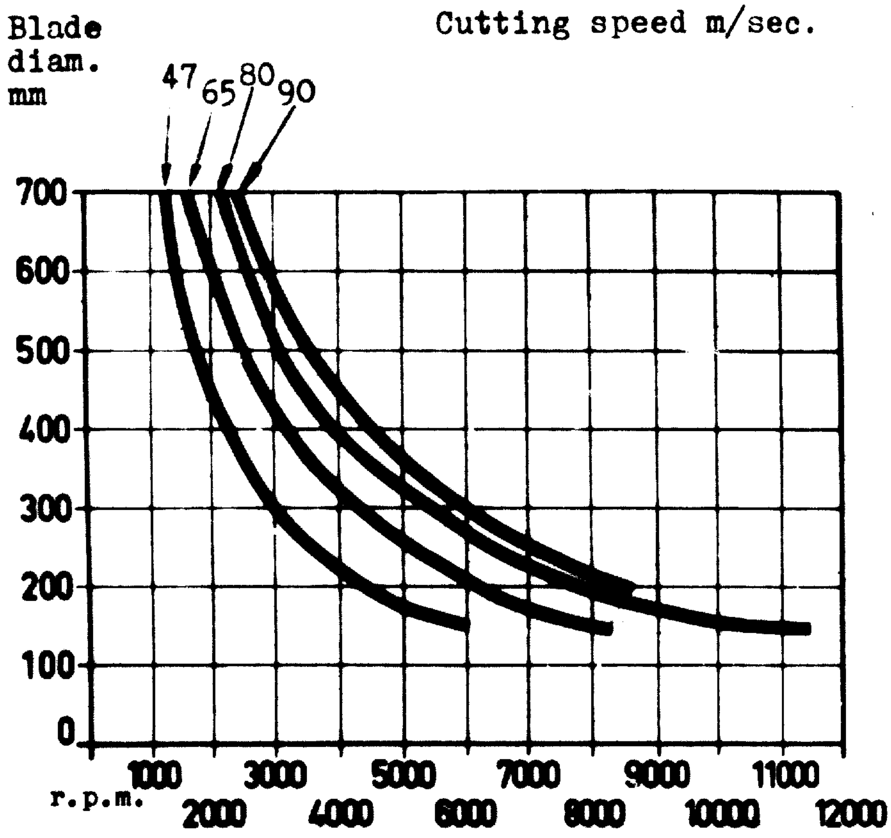

Fig. 22.3 Cutting speed as a function of r.p.m.

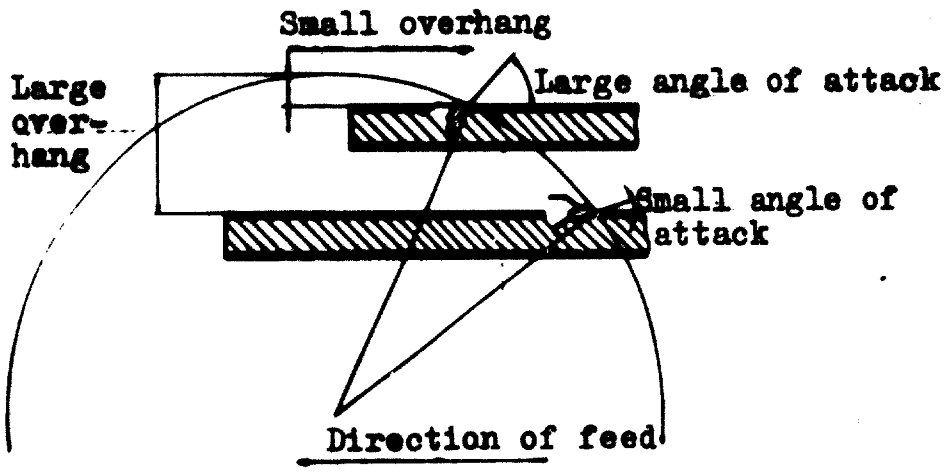

Fig. 22.4 The variation of the angle of attack of the tooth against the material

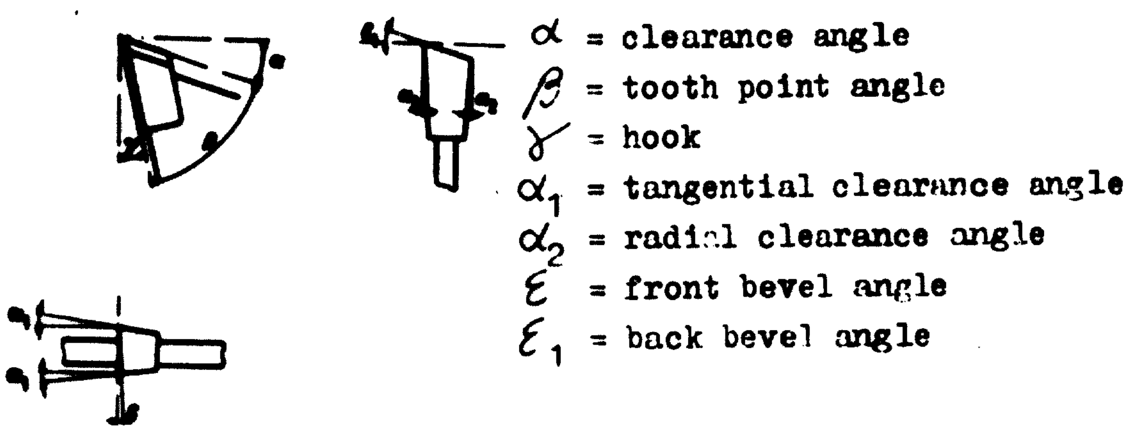

Fig. 22.5 The accepted angle designations for carbid-tipped circular saw blades in Sweden

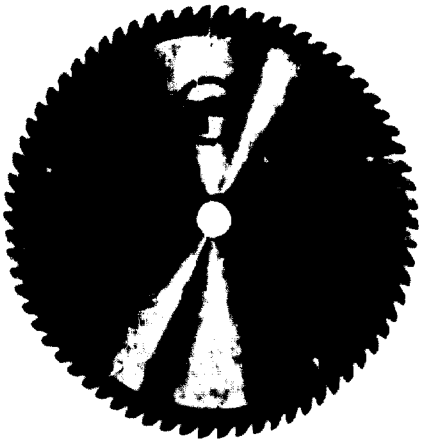

Fig. 22.6 Expansion slits and pinholes of carbide tipped blades

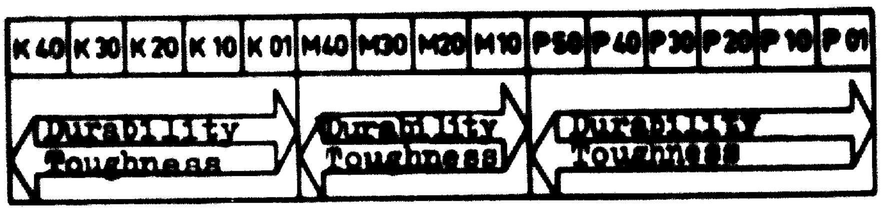

Fig. 22.7 Grades of sintered carbide

Fig. 22.8 Typical abrasive wear picture of sintered carbide tool in woodworking

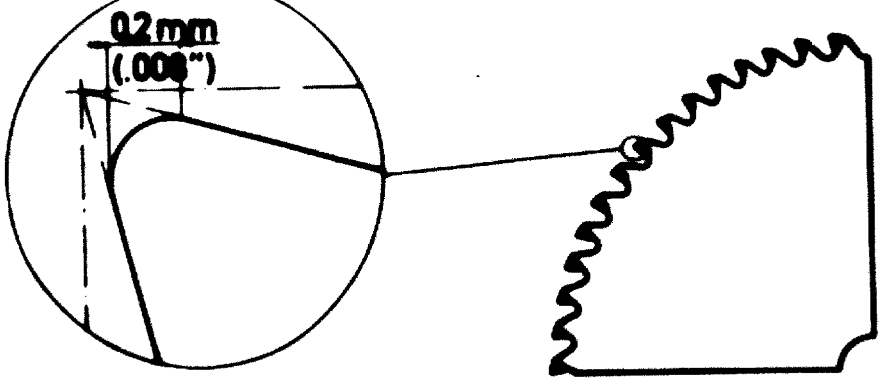

Fig. 22.9 Frank wear of a carbide tipped blade

Fig. 22.10 **Rotary cutter action.**

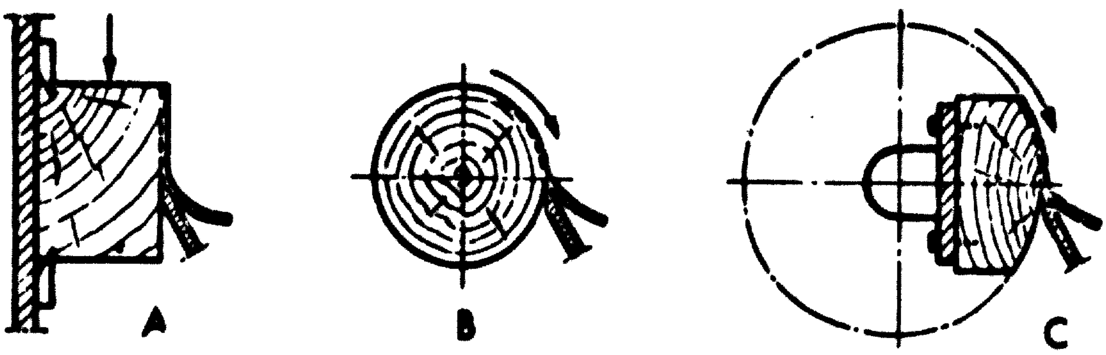

Fig. 22.11 **Cutting veneer with stationary knives.**

A. Slicing veneer from flitch; B. Rotary cutting veneer from log; C. Half-round cutting, in lathe, from flitch.

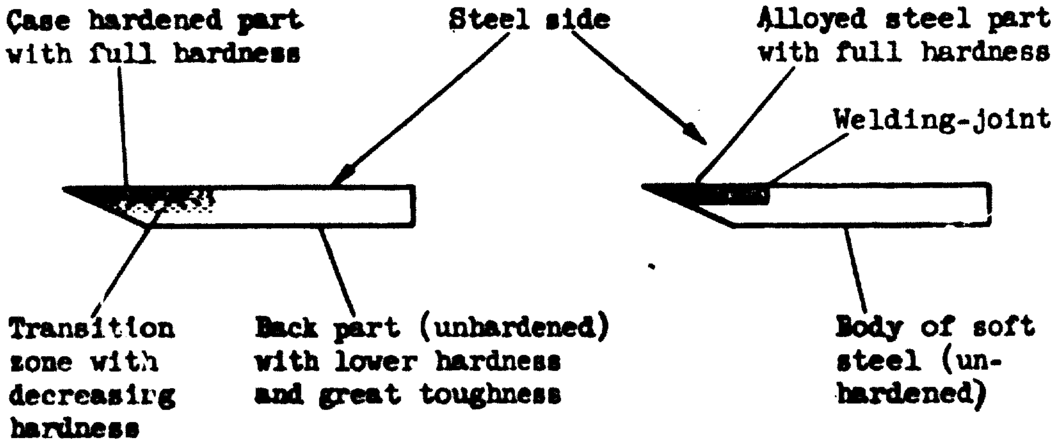

Fig. 22.12 Chipper knives

A. CASE HARDENED KNIFE. B. COMPOUND STEEL KNIFE.

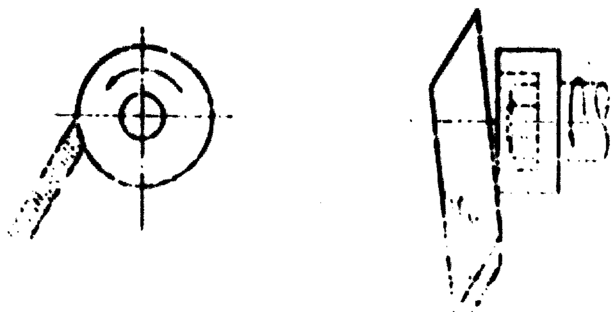

Fig. 22.13 Correct method of grinding, the grinding running towards the hardened cutting edge

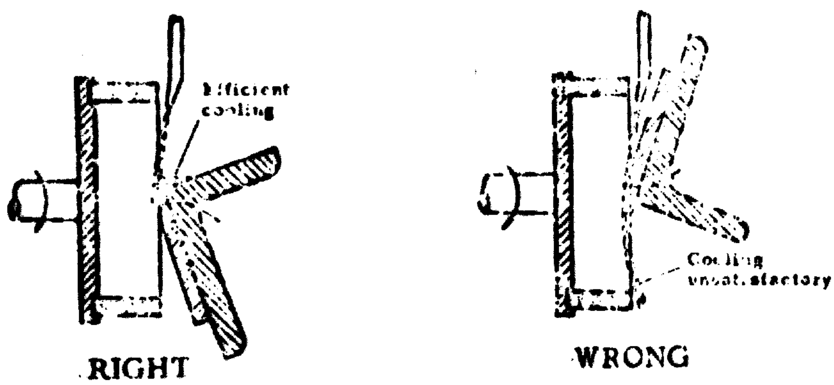

Fig. 22.14 Clamping of knife for grinding

Fig. 22.15 Correct application of the oil stone on the hardened side (steel side) and the bevel

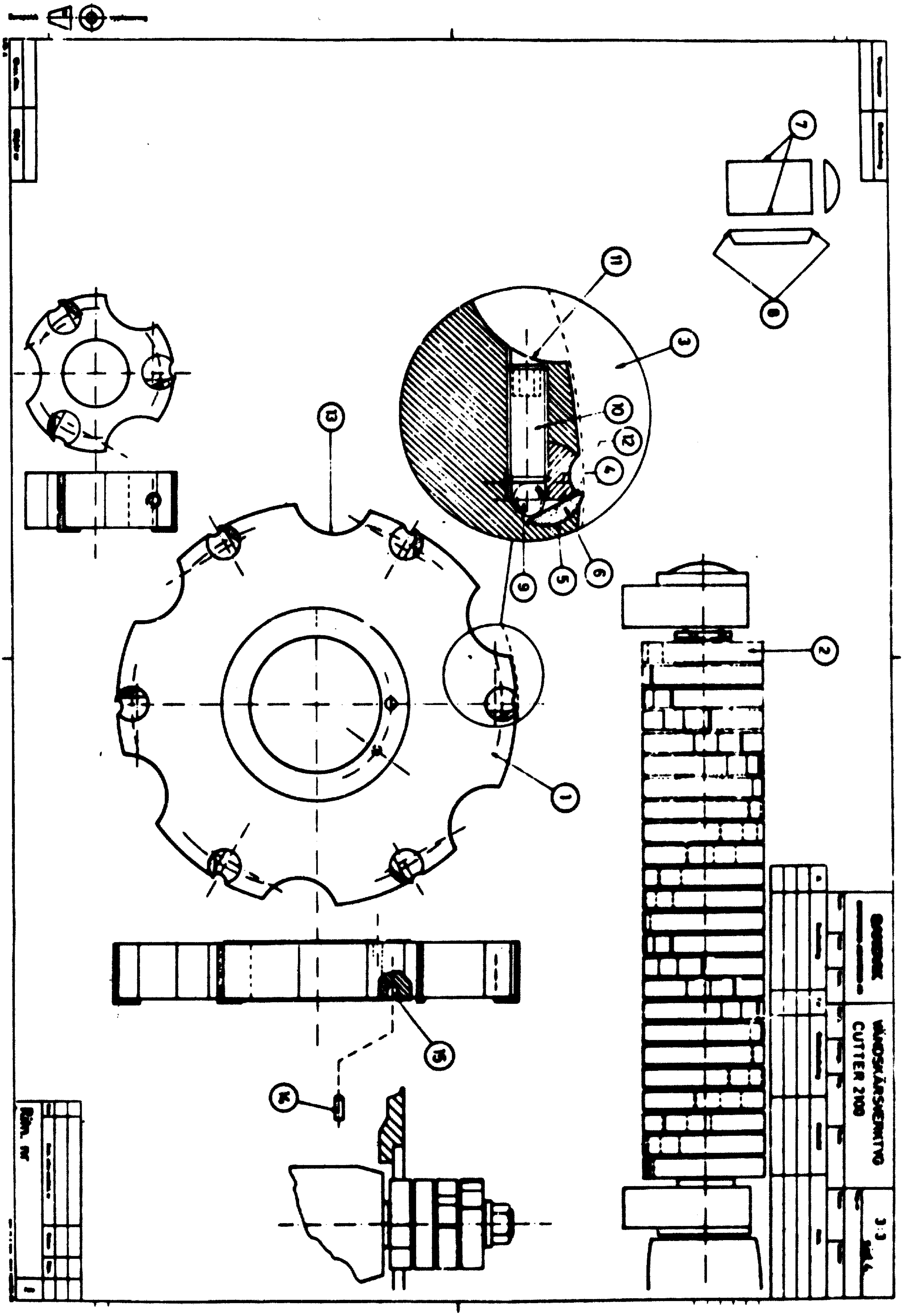

Fig. 22.16 Cutter 2100 (Sandviken)

Material	Cutting speed ft/sec. (m/sec.)	
Softwood	200 - 300	60 - 90
Hardwood	160 - 230	50 - 70
Plywood	200 - 260	60 - 80
Hardboard	230 - 300	70 - 90
Chipboard	200 - 260	60 - 80
Veneered board	200 - 300	60 - 90

Table 22.1 Cutting speeds in different materials

Type of knife	Grain size	Hard-ness	Struc-ture	Wheel shape	Peripheral speed, ft./sec.
Veneer knives	46	H	8	cup	59-75
Chipper knives	46	H	8	cup	59-75
Planer knives (high speed steel)	60	J	8	cup	66-82

Table 22.2

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