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Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
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Technical Meeting on the
Selection of Woodworking Machinery

Vienna, 19-23 November 1973

WOODWORKING TOOL MAINTENANCE AND SELECTION OF TOOL ROOM EQUIPMENT 1/

by

O. Stier
Vollmer Werke Maschinenfabrik GmbH
Biberach an der Riss, Federal Republic of Germany

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WOODWORKING TOOL MAINTENANCE AND SELECTION OF TOOL ROOM EQUIPMENT[1/]

by

O. Stier
Vollmer Werke Maschinenfabrik GmbH
Biberach an der Riss, Federal Republic of Germany

SUMMARY

Despite the great variety of woods from developing countries, their hardness and structure of fibres is similiar to European species and so permits the use of conventional cutting tools. Exceptions are the very hard and abrasive species such as Bongossi, jacaranda wood, pockwood, Donka, Bubinga and Grenadill. Circular saws, bandsaws, milling cutters and knives all share common features and their maintenance can be treated accordingly.

The different evolutionary patterns in Europe and the USA for sawblades and sawing methods caused fundamental differences in the equipment developed to sharpen and maintain them.

Formerly universal machinery was adequate, but now, specialized equipment is needed to achieve the accuracy standards of today. American practice is to use "plunge grinding" whereby the wheel is lowered down into the tooth while imobile. Europeans have leaned towards "tooth form" grinding whereby the grinding wheel follows the profile of the tooth and thus avoids momentary heat build-ups and tedious dressing of the wheel.

Features of grinding equipment that promote accuracy are: straight line lifting and dropping (versus lever lifting); a vertically adjustable mounting device to ensure compatible and rigid mounting of blade and wheel; choice of tooth shape cam to allow switching from straight to bevel grinding; infinite regulation of working speed; rough and fine adjustment for grinding the tooth face; and an incorporated dust exhaust.

Swaging and equalizing equipment can be either hand or machine operated

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

RESUME

ENTRETIEN DES OUTILS A BOIS ET CHOIX DE L'EQUIPEMENT DE L'ATELIER DE L'OUTILLAGE[1/]

par
O. Stier
Vollmer Werke Maschinenfabrik GmbH
Biberach an der Riss (République fédérale d'Allemagne)

Les bois des pays en voie de développement sont très variés, mais leur dureté et la structure de leurs fibres sont semblables à celles des espèces européennes et permettent donc l'emploi d'outils de coupe classiques. Des bois très durs et très abrasifs tels que l'azobé, le jacaranda, le gaïac, le Donka, le Bubinga et la grenadille constituent des exceptions. Les scies circulaires, les scies à rubans, les fraises et les fers présentent des caractéristiques communes et peuvent être entretenus de la même façon.

Les lames de scie et les méthodes de sciage ont évolué de manière différente en Europe et aux Etats-Unis d'Amérique, ce qui a entraîné des différences fondamentales dans la conception du matériel d'affûtage et d'entretien.

Autrefois, des machines universelles suffisaient, mais aujourd'hui il faut un équipement spécialisé pour satisfaire aux normes de précision. En Amérique, la méthode la plus couramment employée est celle de "l'affûtage par plongée" qui comporte

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1/ Les opinions exprimées dans le présent document sont celles de l'auteur et ne reflètent pas nécessairement les vues du Secrétariat de l'ONUDI.

id.74-339

or fully automatic. The accuracy of hand devices has been improved by incorporating compressed air control cylinders to reduce operator fatigue. "Warm swaging" has recently come to the attention of manufacturers and electric resistance (low voltage, high amperage) equipment is now available.

Tensioning, straightening and levelling are also important operations to be done on saw blades for which an array of equipment is available. Hammering is still the basis of these and, although automatic straightening machines are offered, they do not yet come up to the requirements.

Hardening of toothpoints can be either short- or long-time. Long-time hardening includes flame-hardening, bath tempering and resistance hardening, while short-time hardening can be done by high frequency, plasma current, ionic and laser beams. Resistance and high frequency hardening are most used.

Stellite and carbide tipping of teeth considerably increases service life of tools, but requires special equipment and great care in selecting the grinding wheel.

Milling cutters require wheels with hardness not above K with grain size 46. A Borazon wheel has been developed for special high alloyed tool steels. Carbide tipping requires diamond wheels.

l'abaissement de la meule dans la dent, la lame restant immobile. En Europe, la méthode d'affûtage la plus courante est celle de la "forme de la dent", dans laquelle la meule suit le profil de la dent et évite donc les échauffements momentanés ainsi que les opérations fastidieuses de dressage de la meule.

Le matériel pour l'affûtage de précision présentera les caractéristiques suivantes : levage et abaissement vertical (qui remplacent le levage par levier); dispositif de fixation réglable verticalement permettant un alignement correct et sans jeu de la meule par rapport à la lame; choix de l'angle de la dent permettant le passage de l'affûtage vertical à l'affûtage en biais; réglage variable de la vitesse; réglage approximatif et fin pour l'affûtage de la face de la dent; un aspirateur de poussière incorporé.

Les machines à écraser et à égaliser les dents peuvent être manuelles, mécaniques ou entièrement automatiques. La précision des affûteuses à main a pu être améliorée grâce à des dispositifs de commande à air comprimé qui rendent le travail moins fatigant. Une méthode "d'écrasement thermique" a récemment été proposée aux industriels, et on trouve aujourd'hui sur le marché du matériel à résistance électrique (courant de forte intensité sous faible tension).

La tension, le dressage et le planage sont également des opérations importantes à faire sur les lames de scies et pour lesquelles on dispose de nombreuses machines. Ces opérations se font encore essentiellement par martelage et les machines à dresser automatiques qui existent maintenant sur le marché ne donnent pas encore entière satisfaction.

Le durcissement des pointes des dents peut être rapide ou lent. Parmi les procédés de durcissement lent, citons le durcissement au chalumeau, la trempe et le durcissement par résistance, alors que le durcissement rapide peut se faire par induction d'un courant électrique à haute fréquence, par jet de plasma, par faisceau d'ions et par rayons laser. Les procédés de durcissement par résistance et à haute fréquence sont les plus couramment utilisés.

L'utilisation de stellite et de carbure pour les dents augmente considérablement la durée utile des outils mais nécessite un matériel spécial et un soin particulier pour le choix de la meule.

Les meules à affûter les fraises doivent avoir une dureté maximum K et un grain de 46. Pour les aciers à outils spéciaux fortement alliés, on a mis au point une meule au Borazon. Les dents à pointe de carbure rapportée nécessitent l'emploi de meules diamant.

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Reunión técnica sobre selección de maquinaria para trabajar la madera

Viena, 19 - 23 noviembre 1973

MANTENIMIENTO DE LAS HERRAMIENTAS PARA TRABAJAR LA MADERA Y SELECCION DE EQUIPO PARA EL TALLER DE UTILLAJE[1]

por

O. Stier
Vollmer Werke Maschinenfabrik GmbH
Biberach an der Riss, República Federal de Alemania

RESUMEN

Las maderas existentes en los países en desarrollo, si bien son muy variadas, se asemejan, en cuanto a dureza y a estructura de sus fibras a las especies europeas y, por lo tanto, se pueden trabajar con las herramientas de corte corrientes. Se exceptúan las especies de madera muy dura y abrasiva, como por ejemplo bongossi, jacaranda, guayacán, duka, bubinga y granadilla. Las sierras circulares, sierras sin fin, fresadoras y cuchillas tienen todas ellas características comunes y por lo tanto su mantenimiento es similar.

La evolución de las sierras y de los métodos de aserrar ha sido diferente en Europa y en los Estados Unidos, lo que ha producido diferencias fundamentales en el desarrollo del equipo para afilar y mantener dichas herramientas.

Antiguamente, bastaba con maquinaria universal, pero las normas de precisión actuales obligan a emplear equipo especializado. En los Estados Unidos se practica el "rectificado por hueco", en el que la muela baja para ponerse en contacto con el diente de la sierra, que permanece inmóvil. En Europa se tiende más al método de afilado de "conformación del diente", en que la muela de afilar sigue el perfil del diente, con lo que se evita los recalentamientos momentáneos y el tedioso reavivado de la muela resulta casi innecesario.

Las características del equipo de afilar que facilitan la precisión son las siguientes: subida y bajada de la muela en perpendicular (en lugar de hacerse por medio de una palanca lateral); un dispositivo de montaje ajustable verticalmente,

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1/ El presente resumen ha sido preparado por la Secretaría de la ONUDI. Las opiniones expresadas en el documento original son las de su autor y no reflejan necesariamente las de la Secretaría.

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WOODWORKING TOOL MAINTENANCE AND SELECTION OF TOOL ROOM EQUIPMENT

by

O. Stier
Vollmer Werke Maschinenfabrik
Biberach an der Riss
Federal Republic of Germany

ADDENDUM

Page 38

Insert at the end of the first paragraph under the photo (ending with ...."to use these tools") the following text:

"Comparison of Service Life

When cutting very hard and abrasive woods the service life of stellite tipped saw blades (see chapter VI) is approximately 8 times and of carbide tipped saw blades up to 20 times the service life of a standard saw blade.

When cutting soft and medium hard wood species, the service life of a hardened saw blade(see chapter IV) is increased by approximately 2.5 to 4 times, and of a carbide tipped saw blade up to 40 times that of a standard saw blade."

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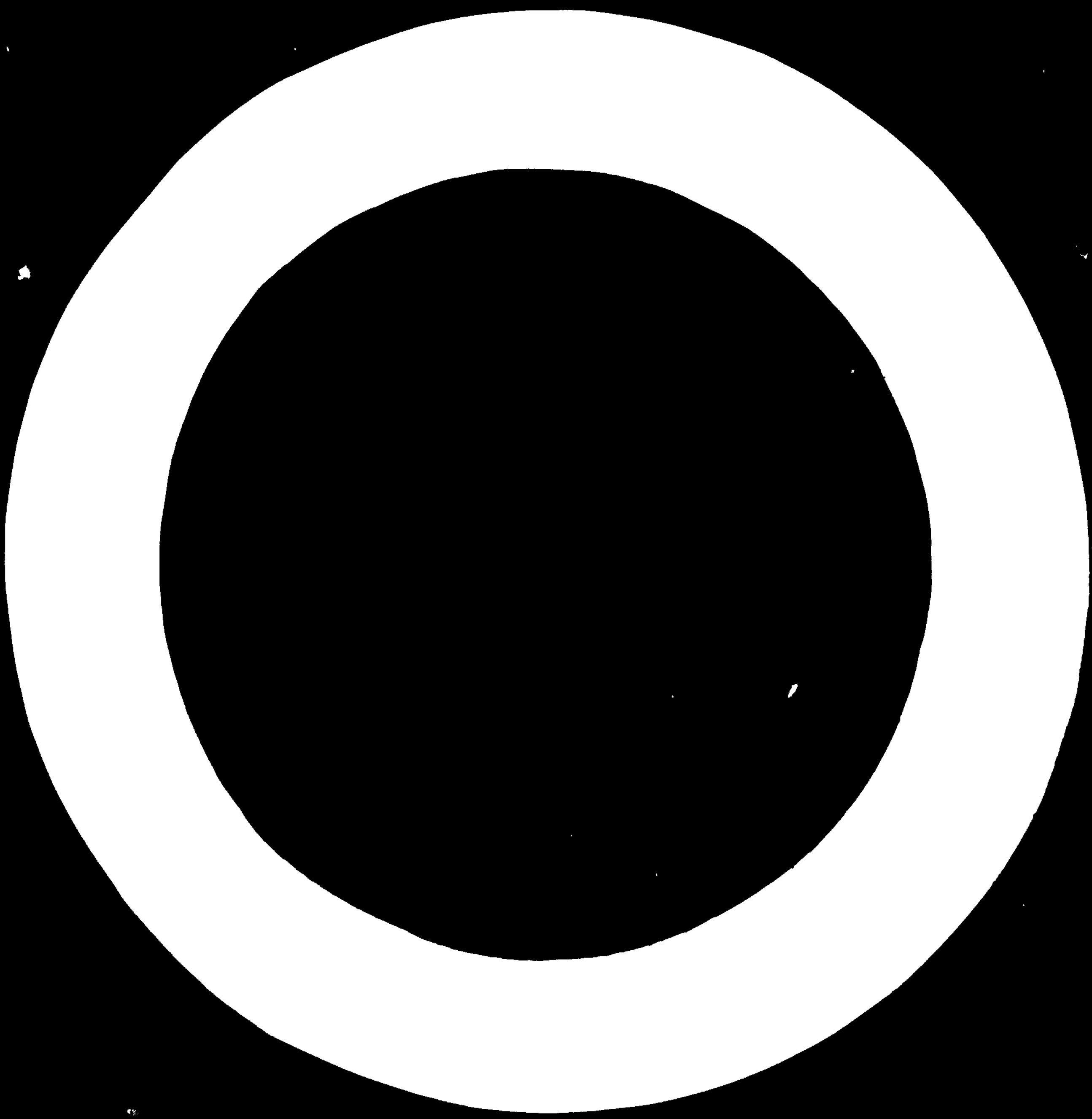


para conseguir un montaje rígido y compatible con la hoja y la muela, un dispositivo para elegir la leva de forma del diente, para poder cambiar de afilado recto a biselado, una regulación de la velocidad de trabajo infinitamente variable, un dispositivo de ajuste para afilado basto y fino de la superficie del diente, y un sistema incorporado de eliminación del polvo

Los equipos para triscar o igualar pueden ser manuales o mecánicos o completamente automáticos. Se ha aumentado la precisión de los aparatos manuales incorporándoles cilindros de control de aire comprimido a fin de reducir la fatiga del operario. Recientemente los fabricantes han prestado atención al procedimiento de "triscado en caliente" y actualmente se dispone de equipo para este proceso de resistencia (de voltaje bajo y amperaje alto).

Tensar, enderezar e igualar son también operaciones importantes a que se han de someter las hojas de sierra, y para las que se dispone de diversos tipos de equipo. La base de estas operaciones sigue siendo el martilleo, y aunque existen máquinas automáticas para enderezar éstas no son aún lo bastante buenas para satisfacer las exigencias que esa operación plantea.

El temple de las puntas de los dientes puede ser de corta o larga duración. El temple de larga duración puede consistir en temple por flameo, temple por baño y temple por resistencia; el temple de corta duración se puede realizar por los sistemas de alta frecuencia, corrientes de plasma, rayos iónicos y rayos láser. Los más usados son los sistemas de temple por resistencia y por alta frecuencia.

Cubriendo la punta de los dientes con carburo o estellita se aumenta considerablemente la vida de la herramienta, pero este procedimiento requiere un equipo especial y una selección muy cuidadosa de la muela de afilar.

Las herramientas de corte para trabajos especiales se han de afilar con muelas cuya dureza no pase de K, y tamaño de grano 46. Se ha desarrollado una muela de borazon para aceros de herramientas muy aleados. Las puntas de carburo requieren muelas de diamante.

CONTENTS

INTRODUCTION

1. The working of wooden materials and their derivatives is performed to nearly 100 % by chip removing tools. A great variety of different woods is offered from the developing countries. Nevertheless we can compare most of them with European woods with regard to their hardness and structure of fibers which means that similar techniques can be applied. Excepted are the very hard and abrasive woods such as Bongossi, jacaranda wood, pockwood, Donka, Bubinga, Grenadill and similar which are for the moment excluded.

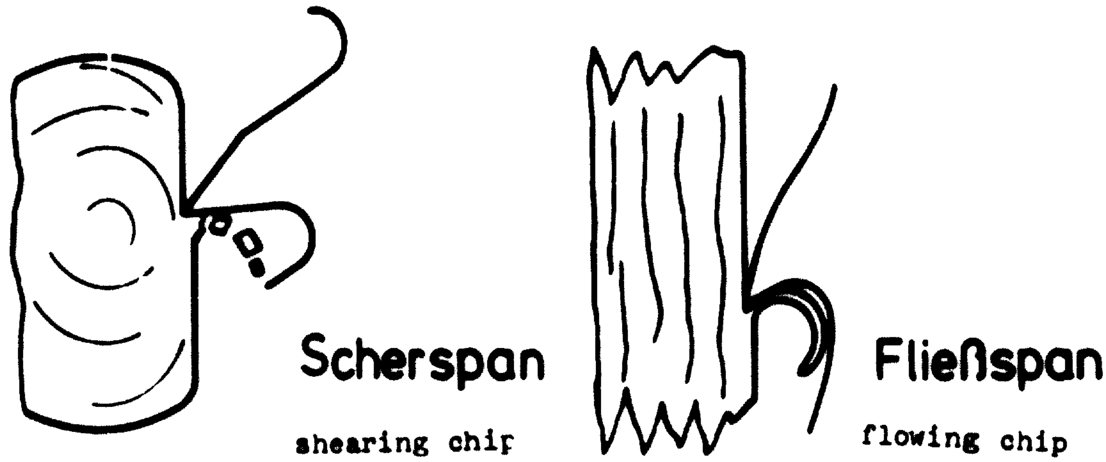
Although the machines on which the wood working tools are employed are quite different from a technological point of view as for instance circular saws, band or frame saws or milling cutters and knives, all tools have one thing in common, i.e. they all have cutting edges similar in action and shape for the cutting process. The class and condition of wood as well as the direction of working require certain minor modifications with regard to the cutting edge geometry, the woodworking machine however implies more important differences as to the carrier of the cutting edges and consequently to the tooth shapes.

In spite of the extremely high standard of the cutting tools it is quite obvious that due to the cutting process the edges get blunt after a certain service. This is not only disavantageous with regard to the cutting performance and quality but also to the absorbed power and changing of tools means loss of time.

It is therefore proved that a successful enterprise owes a lot to the performance of tne cutting edges.

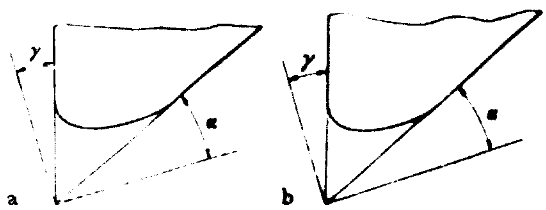
This lecture tries to explain, in the scope of the actually applied techniques, the troublefree methods of tool maintenance which are suited for the developing countries so that they can there maintain the tools for their work, for investment in expensive machinery (as band mills or frame saws) is useless without an efficient tool.

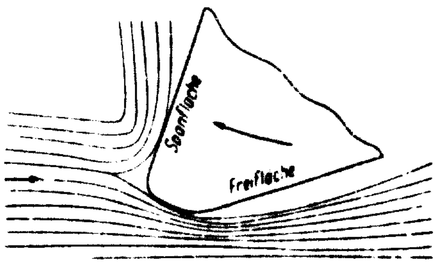
When paying attention to good and troublefree maintenance for the tools, even with a relatively small investment in tool maintenance machinery, success will be guaranteed also with rather simple wood working machines, when the following points are observed, although we know from experience that particularly in developing countries this point is often neglected.


Scherspan
shearing chip
Fließspan
flowing chip

The cutting edge of a tool should work in such a way that the heel produces according to the class of tool either flowing or shearing chips which depend in their size on the feed per tooth.
In case that the cutting edge is working with a too small chip thickness it is rather scraping the wood than cutting which means an enormous wear on the cutting edge. In this case no chip can be formed and only wood powder and dust are produced. The service life of a tool employed in such a way is reduced considerably in spite of low feed rates and the cutting performance decreases to zero. The proper selection of the wood working tool is decisive, but shall not be discussed within this study.

I MAINTENANCE AND CARE OF WORN DOWN CUTTING EDGES





The wear on the cutting edge is generally greater on the so-called clearance surface whèreas the face shows a minor erosion depending on the material and on the tool. Considering a saw blade as the main tool in the wood working industry it is equally important to maintain the lateral clearance of the cutting edges so that the tool cuts freely. When treating a band saw or a frame saw the internal stress has to be checked and if necessary corrected.
As the maintenance of saw blades is different compared to the maintenance of cutters and knives, these tools will be discussed later.

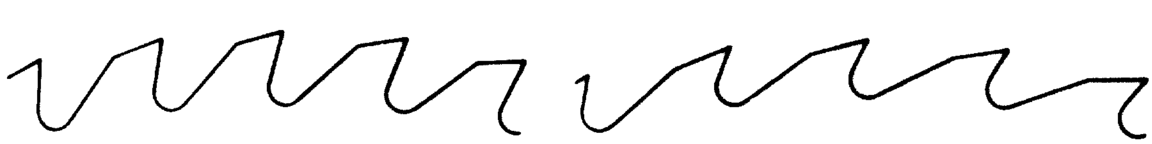
II KINDS OF SAW BLADES

a) Circular saws

This kind of saw is rather universal; it can be used for ripping and cross cutting. In the saw mills it is used for breakdown, for scantlings, beams, etc. and also in the furniture industry, for door and window frames, flooring etc.

New developments show that very good results can be obtained with circular saws in saw mills for breakdown. So for instance in Sweden, a "classical" frame saw country where thick saw blades as well as conical blades (tapered to reduce the loss of wood) are employed in circular log saws with 2 or 3 blades on one shaft or arranged in one oblique line. These circular blades are mostly swaged with a lateral projection for cutting in summer of about 0,45 mm and for winter of about 0,35 mm.

In recent times new developments took place, for instance the Minibell saw in Scandinavia and the Strob-Saw in the USA, where due to the changing of the complete saw shaft the machine can continue the cutting operation after only 10 minutes interruption.

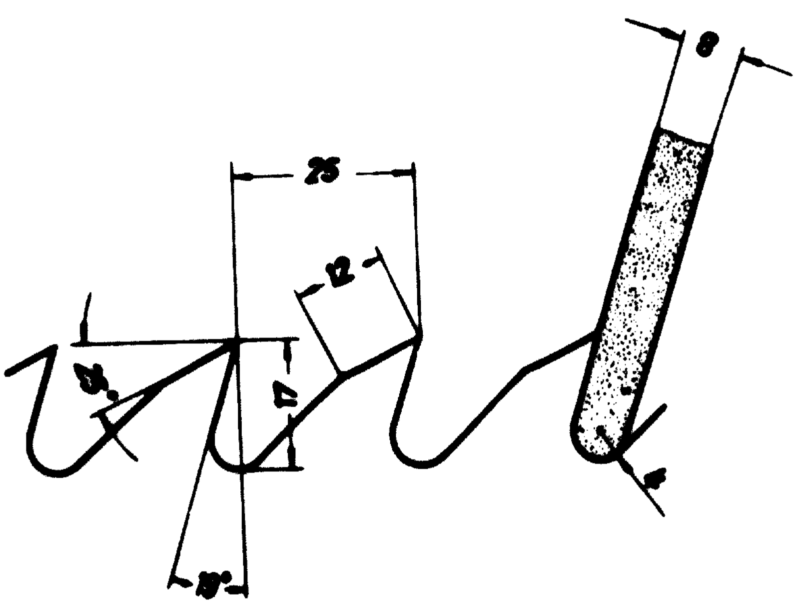


cross cutting — Querschnitt

ripping — Längsschnitt

b) frame saws

The order of succession of the listed saws does not indicate anything about their importance. There are horizontal frame saws, blades with expansion slots, blades with teeth on both edges etc.
Spring set saw blades with standard tooth shape are losing importance as the swaging of frame saws becomes more and more popular. Swaged saw blades bring an increase in capacity of about 30 % and even more.

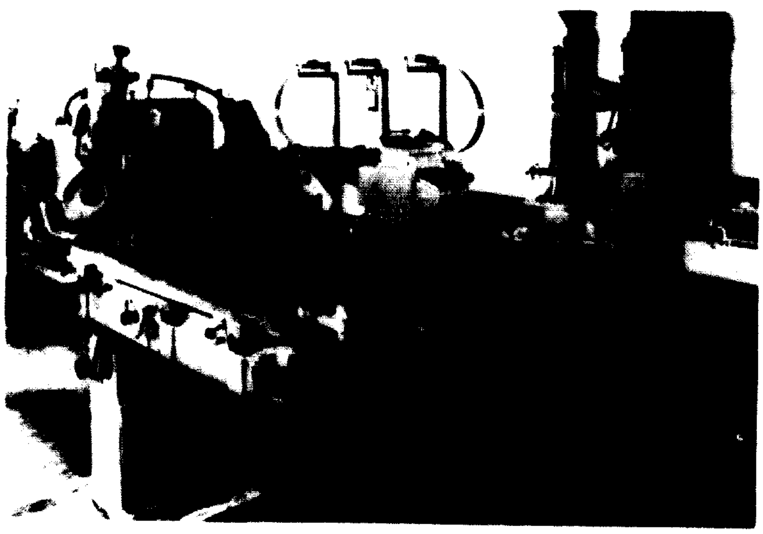


The most suitable tooth shape is the so-called hooked rip tooth with tooth pitches between 25 and 30 mm and a cutting width from 3,6 to 4,4mm having a blade thickness between 2 and 2.4 mm (14 and 13 gauge). The saw blade material contains about 2 to 3 % nickel and has a Rockwell hardness of 46 to 48 degrees.
During manufacture these blades have a certain internal stress which gets lost in the cutting process. The back of the blade tends to a concave shape.

A saw blade deformed in such a way can only bring its maximum performance when it is tensioned and the back straightened after being used 3 or 4 times.

Tension of a saw blade means the internal partition of material which gives a certain rigidity to the saw blade for better resistance to large feed rates and to avoid deviations of the blade during the cutting operation. Each saw blade heats up during the cutting process, elongates and tends to deviate. For this reason the centre zone of the saw blade should be longer so that the main tension is in the tooth and back zone while cutting.

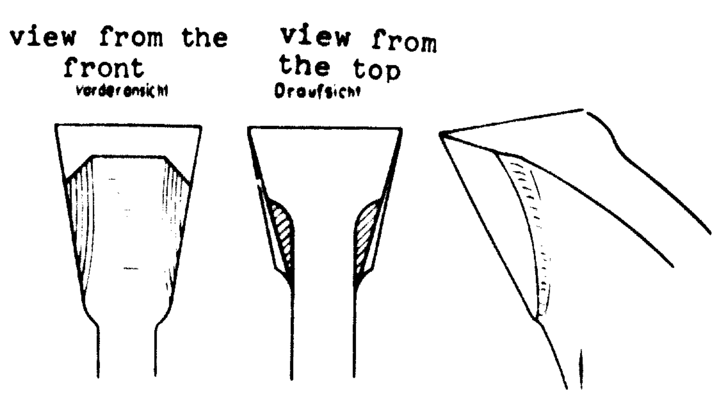
It is particularly important that saw doctors or filers be well trained.



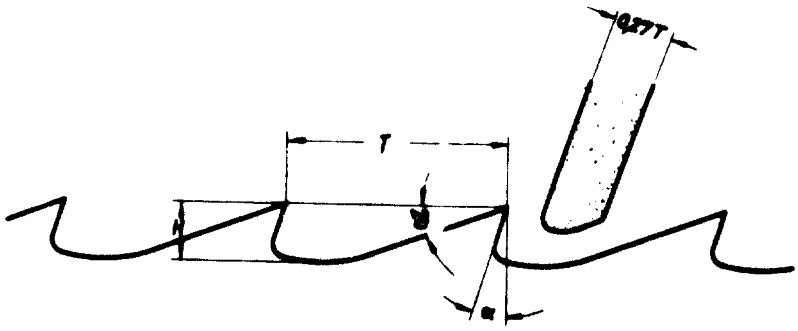
c) Band saws

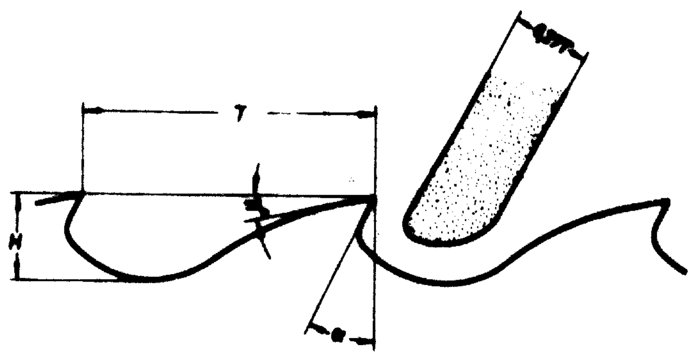
The maintenance of resaws and log band saws with a blade width between 80 and 410 mm is considerably more difficult than the maintenance of frame saws. According to our opinion a special training of the filer is required for only a proper tension and a maximum sharpening of the blade make the band mill an efficiently working machine.

Band saw blades of this size are swaged and in relation to the kind and condition of wood to be cut the shape of swage and the cutting edge geometry vary, but these variations cannot be explained in detail in the scope of this lecture.



The tooth shapes of log band saws have changed quite considerably in the course of time and due to the different grinding principles in Europe and the USA this development shows essential differences which I shall explain in the following paragraph.





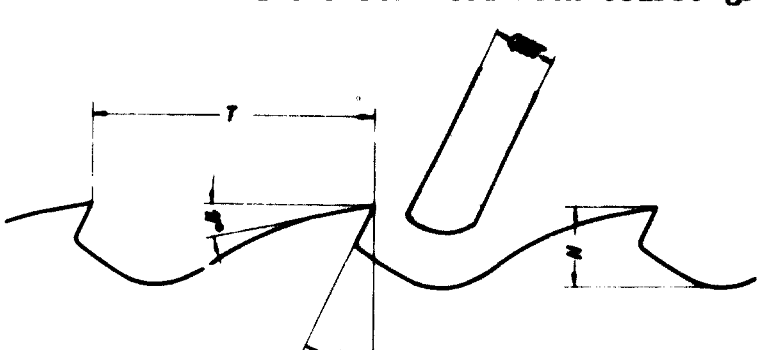
Nowadays the important tooth shapes are the so-called skipped tooth and the rounded back tooth which aim:

a) to keep the deepest point of the tooth gullet as far as possible away from the main stress on the tooth face and
b) to keep the radius of the round gullet as large as possible in order to avoid a surcharge by scoring
c) to avoid marks, scratches, burr and burnt patches as consequence of a heating up by the grinding wheel

The proper selection of the sharpening machine therefore is of decisive importance.

The development in France proved that in practice 2 tooth shapes for these band saws are sufficient:

1. the skipped tooth shown above for wood with coarse grain and long fibres



and

2. the PCP-tooth with chip deflector and the tooth gullet rather far from the face with relatively large rounding in the gullet, with shape of swage and cutting edge geometry varying according to the kind and condition of wood

The hardness of log band saws is about 42 to 46 degrees Rockwell, the material composition 0,7% to 0,75% C, 0,2% Si, 0,3% to 0,6% Mn, and partially 0,2% to 0,25% Ni. This material is well adapted for swaging with a very high tenacity and tensile stress of more than 140 kg/mm^2.

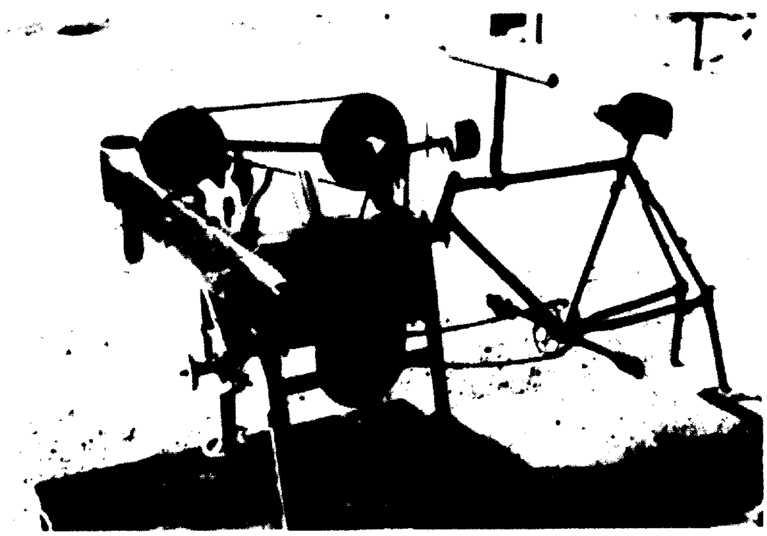
When equipping the filing room for band saws, attention has to be paid whether the band mill is running in right-hand or left-hand execution. According to the US-standard a socalled right-hand band saw corresponds with a left-hand band saw of European standard and vice-versa. We therefore recommend when defining the sharpening equipment not to use these standard definitions, but rather determine whether the saw blade shall be fed from the right-hand towards the grinding wheel or from the left-hand towards the grinding wheel when the saw is fitted in the sharpening machine. (see illustration above)

III MACHINES FOR THE MAINTENANCE OF SAW BLADES

Under this heading we want to compare different practices and explain the technical knowledge which we can judge after more than 60 years of experience in this field.

When in former times universal machinery and apparatuses were quite adequate, nowadays special equipment is required in order to meet the demands of the development and the high standard although we cannot neglect the demand that particularly for developing countries machines with easy handling together with a spare parts service throughout the world are of main importance.

The operating instructions should correspond with the symbols on the machines which are easy to understand and the use of special colouring on control parts can simplify the work for the filer.
The following illustration shows how a filing room should not be, according to our opinion. The photograph was taken in South-East Asia:

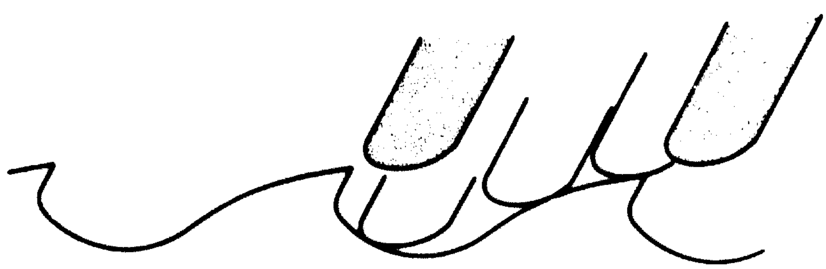


There is an essential difference between the grinding principle as used in Europe and Asia, the so-called tooth form grinding, and the plunge grinding as applied in the USA. With plunge grinding the grinding wheel is lowered down into the tooth gullet while the saw blade is not moving, the grinding wheel stays there and moves upwards when the feed motion starts.

Einstechschliff
plunge grinding

The throat is produced only by the grinding wheel profile and variation is not possible. Every tooth shape therefore shows this characteristic rounded profile. The grinding wheel is used one-sided on that Particular point which produces the tooth back.

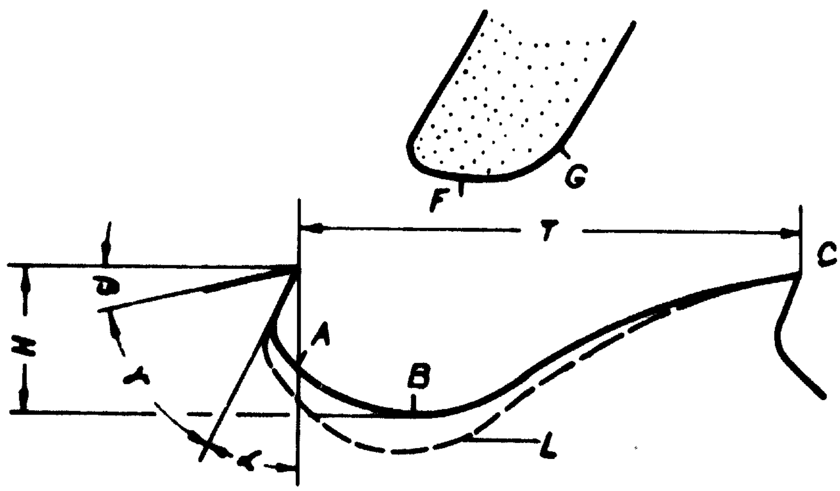
The rounded profile therefore has to be re-profiled constantly with grinding wheel thickness up to 1 1/2". The tooth gullet is rather deep which is disavantageous for the lateral stability of the tooth, for in the States also the trend is to reduce the loss of wood by using small cutting width.
Another disadvantage of the plunge grinding from a technical point of view is that on account of the short moment the grinding wheel stays in the gullet this part is heated up to more than 800 degrees C. The surface of the gullet has a hardened zone which favours the risk of cracks.
With the tooth form grinding the movement of the grinding wheel and the feed motion of the saw blade can be varied in such a way that the sequence of the motion corresponds with those tooth shapes which render the maximum cutting results according to the research of well-known Technical Institutes.



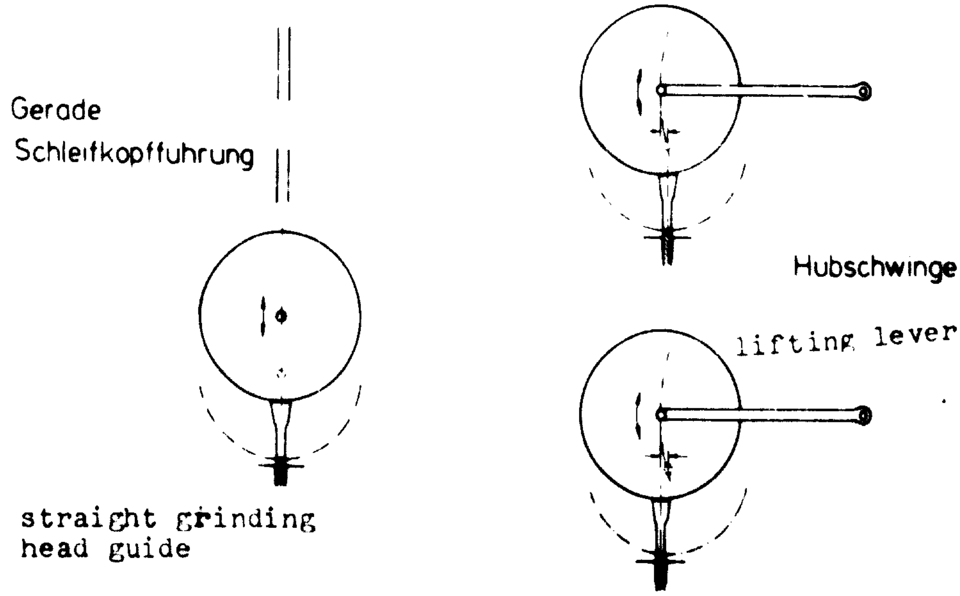
Nachformschliff
tooth form grinding

The tooth form grinding offers the advantages, from a tecnnical point of view, as follows: The movement of the grinding wheel along the tooth face is controlled in such a way that approx. 1/3 of the grinding movement is used for the finish grinding of the point of the tooth face. Due to the positive inclination of the grinding wheel scratches and marks are avoided on the face. The movement of the grinding wheel along the tooth gullet and the back is accelerated so that no structural transformation can take place and consequently the formation of heat cracks is avoided. When grinding the tooth back in the cutting edge zone the feeding speed is reduced considerably so that here again similar as on the tooth face a finish grinding is attained. When passing the grinding wheel from tooth point to tooth point as described a regular wear on the grinding wheel profile can be obtained with a corresponding tooth shape so that the tedious dressing of the grinding wheel is almost unnecessary.

The throat room is calculated for American tooth shapes according to D.S. Jones, B.C.E., A.M.I.E. Australia according to the formula T x H x 0,571. The tooth shape factor is 0,6 with the above tooth shape. Taking also into consideration the better chip ejection with A (acc. to the CTB, Paris) the tooth height H can be chosen considerably lower than with the American tooth shapes even with equal cutting height.
The tooth gullet B should be as far as possible away from the tooth face as the main stress of the saw blade with pull plus bend is in the zone of the tooth face.
According to Jones B.C.E., Australia the maximum tension in the tooth gullet is 2 to 2,5 times the average expansion tension which he has determined by means of strain gauge (photoelastic) studies.
We however are of the opinion that with a long tooth gullet B the maximum tension is less and has a value of smaller than 2. (Exact studies are at the moment executed by the Office of material testing, Stuttgart).
The profile of the grinding wheel shows that it is submitted to stress in the zone of the tooth face to B and from B to the tooth point C nearly equally, which means that the grinding wheel shape is produced by the natural wear and consequently the tedious dressing is nearly avoided. As in this case the radius between F and G on the grinding wheel is larger than on the circular shaped grinding wheel profile for the plunge grinding a finer grinding finish is obtained in the zone of the tooth point C. The advantages of the tooth form grinding are obvious.



A further difference in the sharpening machines is the construction for the lifting movement of the grinding wheel.



The right illustration shows a straight-lined, nearly vertical guide of the grinding head, the rotation axis of the grinding wheel during the liftin movement being exactly in the mathematical centre of the saw blade thickness, the socalled "zero-position". By this method, even with wear of the grinding wheel, the tooth gullet as well as the cutting edge are exactly in right angle to the saw blade plane.

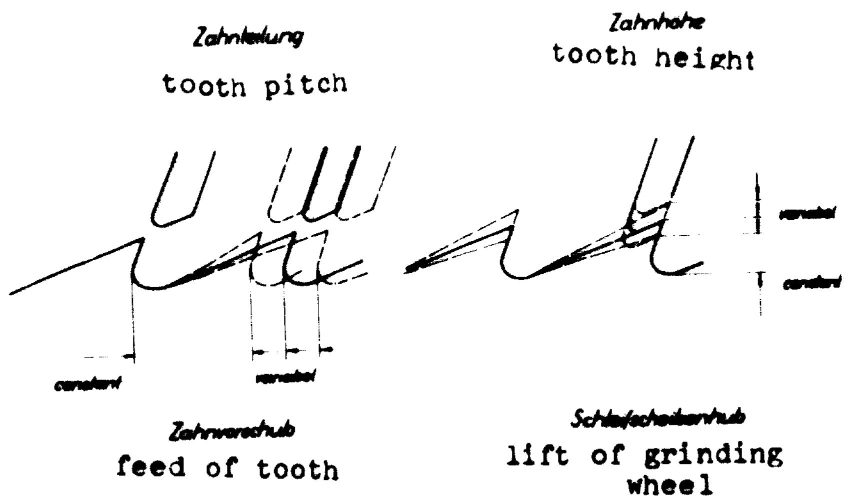
The left illustration shows the system of the lifting lever which does not permit, even with a very precise adjustment of the blade thickness, the tooth gullet or the cutting edge being straight but inclined to the saw blade plane.

An inclined cutting edge brings the following disadvantages:

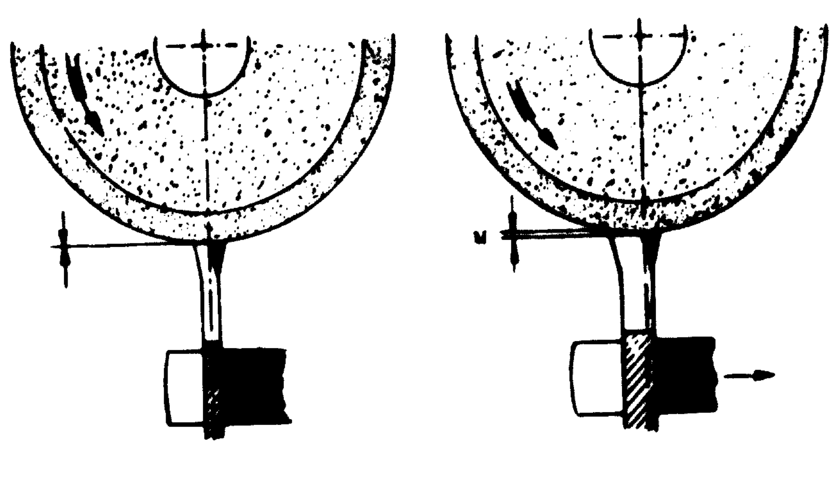
1. During the cutting process the saw blade is submitted to asymmetric forces which as a consequence result in a curved cut as the saw blad deviates.
2. When reswaging the lateral projection will be uneven with the same disadvantageous consequences as mentioned at point 1. Sometimes it is attempted to bend the swaged tooth point (similar to spring set) in order to align the main cutting edge symmetrical to the blade which means compensating one mistake by the other. This additional work is time-wasting as tooth by tooth has to be checked which requires a lot of time and an enormous attention from the filer.

The inclined tooth gullet has the disadvantage that it increases the scratches and grinding marks and favours the formation of blade cracks. It is quite right that the inclination gets smaller the more the centre of rotation of the lifting lever is away from the grinding wheel. But at the same time the lateral instability of the lifting movement is increased which results in an inferior grinding quality at the tooth.

With the straight-lined guide of the grinding head which normally is arranged near behind or above the grinding wheel such difficulties do not exist, the advantage of the straight-lined grinding head guide is obvious.
Tooth pitch and tooth shape are two main measurements of a tooth shape to which the feed and the grinding wheel lift have to be adapted.



Sharpening machines where both adjustments can be made while the machine is running and where no further adjustments have to be corrected by the filer, as for instance the amount of tooth face or back grinding, are designed in such a way that the foremost position of the feed pawl and the deepest position of the grinding wheel remain constant even when the pitch and the tooth height are altered. Sharpening machines with this constructional feature simplify considerably the work of the filer.
A further important setting is the adjustment of the saw blade thickness which enables to set the "zero-position" of the saw blade exactly under the rotation axis of the grinding wheel. In case that this blade thickness adjustment is missing the same disadvantages result as mentioned under 1. when using the construction of the lifting lever.

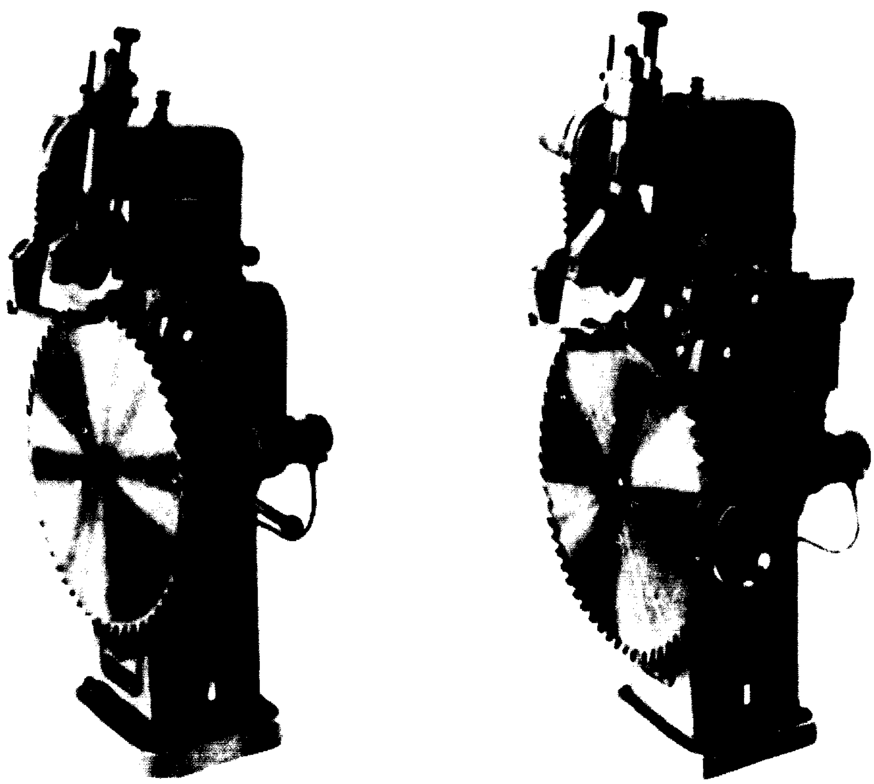


In order to obtain an exact sharpening of the saw blade a vertically adjustable mounting device is required which should be rigid against distortion on account of flat guides and which guarantees that the "zero-position" of the saw blade is maintained exactly in straight line with the movement of the lifting mechanism when adjusting the diameter of a circular saw or the blade width of a band or frame saw.
Furthermore it is required that the hook angle can be adjusted exactly according to scale by inclining the lifting mecanism.
Further constructional features of a good sharpening machine are devices which do not influence the proper sharpening but which facilitate the job of the filer:

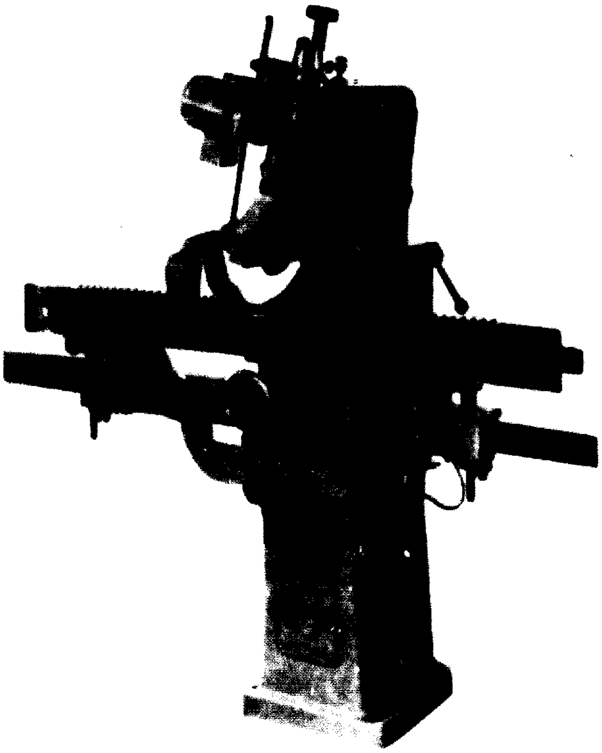
1. choice of tooth shape can by means of a lever, switching over from straight to bevel grinding in similar way
2. regulation of the working speed by means of a gear mecanism or an infinitely variable gear
3. rough and fine adjustment for grinding the tooth face
4. incorporated dust exhaust

Attention should also be paid, beside these constructional features, that the machine meets the requirements of enclosed design, stability vibrationfree construction which will contribute to a long life of the machine.

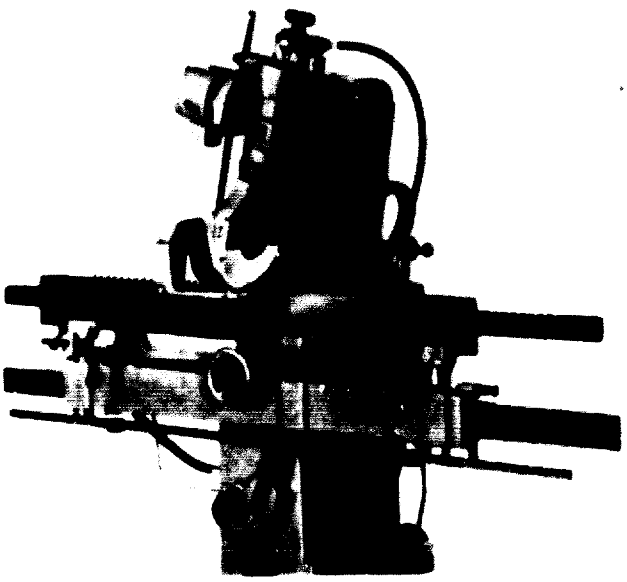
The illustration below shows two machines for the sharpening of circular saws of different size and capacity.



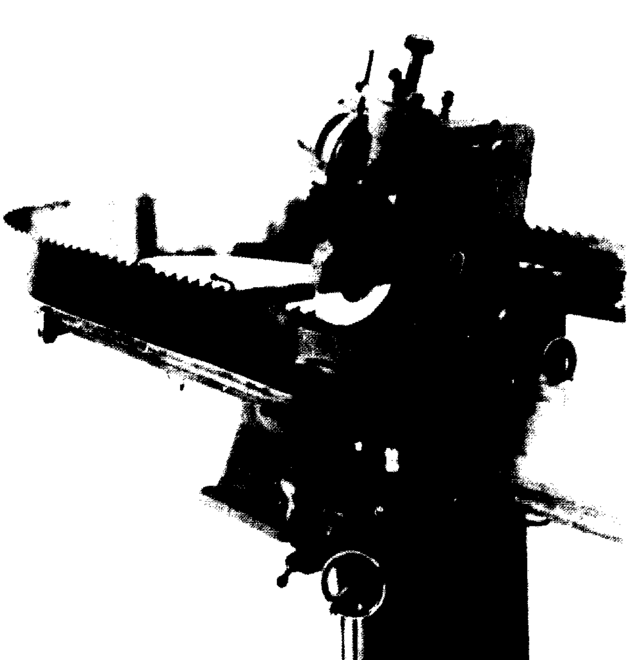
The figure below shows the larger machine with special equipment for the sharpening of frame saws using for the saw blade feed an index bar. This method of grinding guarantees highest precision, an exactly straight tooth line and precise cutting width, even on saw blades which are nearly used up.



Hereunder is shown a fully automatic machine for frame saws with automatic operation of the return movement of the saw blade, automatic infeed of the grinding wheel with 2 polishing grinding passes and automatic switching off of the machine after the preset number of grinding passes.



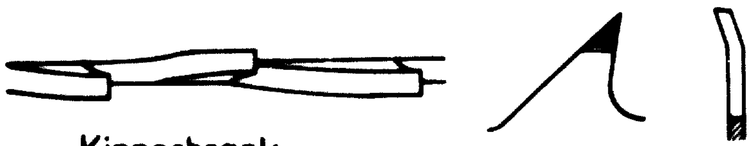
Below is shown a sharpening machine for wide band saws with back feed arrangement and straight-lined feed movement which is very favourab- for band saws as the feed pawl pushes the saw blade in the upper part of the tooth face without changing its position. Only by this an impeccable and true tooth shape resharpening is possible whereas feed pawls which push in the tooth gullet will bring no exact tooth face grinding which means uneven cutting widths in case of swaged saw blades. The illustration shows a machine with right-hand feed towards the grinding wheel, but this machine can also be supplied in left-hand execution with feed from left towards the grinding wheel so that it is not necessary to turn the wide band saws, whether right-hand or left-hand execution or to mount these blades in front of the machine without a back feed arrangement.
In place of the back feed arrangement there could be connected a high frequency hardening machine or an equalizing machine and due to the synchronous drive by the sharpener the hardening of the tooth cutting edges or the side grinding of stellite tipped tooth points can be executed at the same time while the sharpening machine is grinding the tooth form.



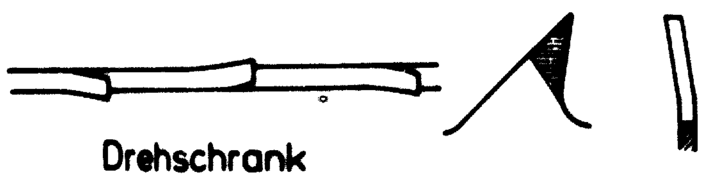
Machines of this type are employed everywhere where high requirements are set for the sharpening of band saw blades.

Spring setting

The purpose of the setting of saw blades is well known. When setting circular saws and frame saws the tooth is bent in the upper third of the top either to the right or to the left. Another method is not only bending but twisting the tooth point at the same time which gives a better clearance angle at the sides of the teeth. This applies to frame and circular saws, but it absolutely necessary for band saws in order to reduce the heating up of the saw blade during the cutting process. The difference between simply bending or bending and twisting is shown in the illustration below.



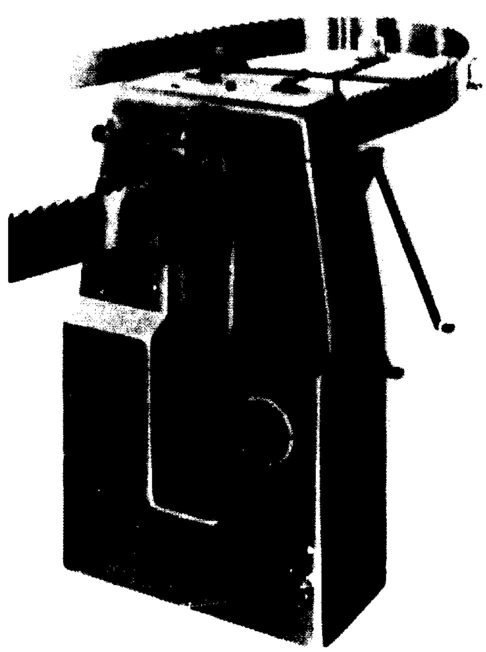
Kippschrank
bending



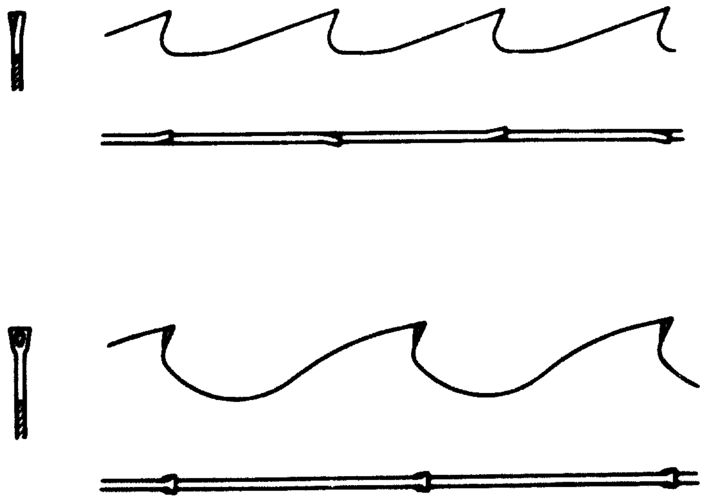
Drehschrank
bending and twisting

The amount of set depends on the kind and condition of wood to be cut. Soft and green wood requires more set than hard and dry wood. If the width of set is too small friction is caused during the cutting and burnt patches are the result.
A raker tooth on a set saw blade means that either every 3rd, 5th or 7th tooth is left straight in order to improve the guide of the saw blade when cutting, if for instance with frame saws the cutting height is bigger than the lift up movement of the saw blade, or in order to avoid the "wash-board" effect on soft and green woods when working with a rather large set. In such a case the raker tooth serves as vibration dampener. It is recommended to use a setting machine. This machine for circular saws, frame and band saws can be either hand operated or with electrical drive. A machine which is sufficient for most cases is shown on the next page. All adjustments are made according to scale. The machine can take saw blades with up to 4 mm (8 gauge) blade thickness.

If a very high standard is set to the cutting quality the tracer controlled automatic setting machine is better suited. This machine is equipped with an automatic re-setting device correcting immediately the amount of set. It works with a precision of ± 0,o2 mm and switches off automatically after the complete pass of the saw blade.
In the course of the last years the setting has lost in importance as for ripping mainly swaged circular saws, frame and band saws are used.

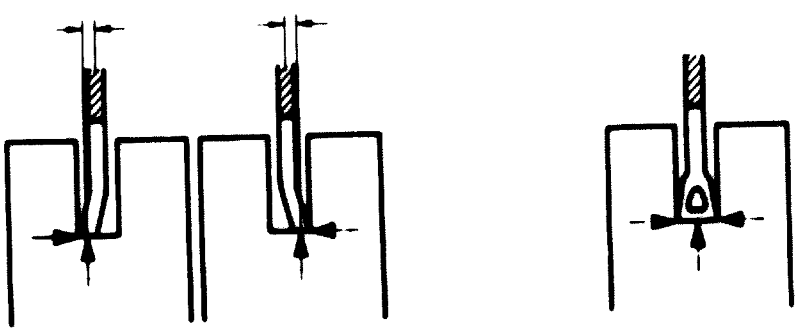


aging



lthough the principle of a set and a swaged saw can be supposed to be nown the advantages and disadvantages of both methods shall be discussed n detail.

setting the tooth points are bent alternatively to the outside hile for swaging the tooth point is enlarged on both sides. The set saw lade requires at least two teeth to produce the kerf.

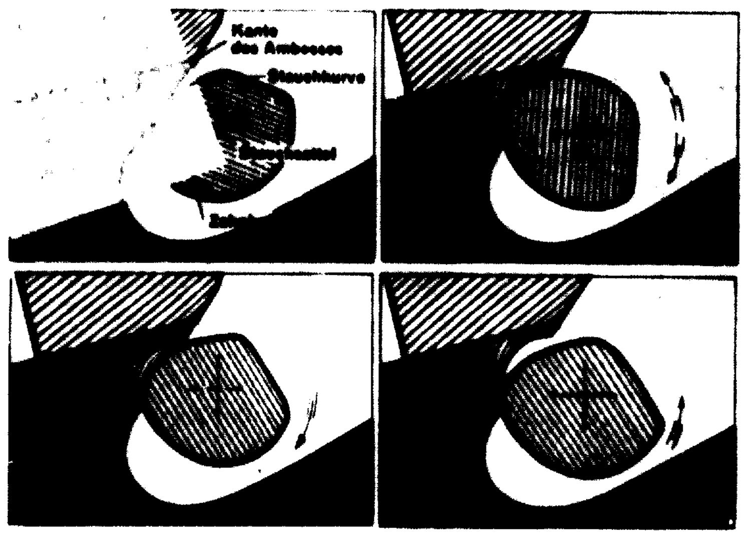


he set tooth is exposed to the force components resulting from the main utting pressure, the feed and the lateral cutting pressure. The force omponents of the main cutting pressure and the feed attack the set tooth t a point slightly offset to the saw centre. In this way the set tooth hen cutting hard annual or timber rings, knots or the like is forced utwardly so that the kerf is slightly enlarged. As a result of lateral

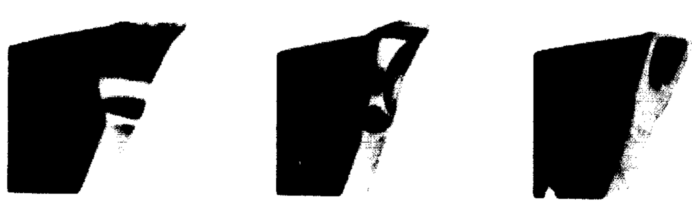
ng pressure the set tooth has the tendency to evade inwardly. This
u... to-and-fro motion of the set teeth produces a noisy running
... of the saw blade. The result is that the teeth rapidly become
nd the cutting quality gets worse.

area to the set tooth, the swaged tooth offers considerable
. It is enlarged on both sides and has from the tooth point a
... in rearward direction and another in downward direction,
...tting and in the feeding direction, and these characteristics
fect cutting free of tooth points, and the force components
m the lateral cutting pressure are largely compensated by each
the figure on the previous page).

h is above all charged by the force components of the main
and the feed. Both attack exactly the blade centre so that
has no tendency to evade towards the side, i.e. it remains in
i in spite of increased feeding speeds, the cutting quality
is deviations of the swaged saw blade are considerably reduced
as knots are separated neatly and no depression appears in
comp surrounding surface.



When producing the swaged tooth, the eccentric die turns to the tooth face of the tooth to be swaged in the direction of the tooth point, while the tooth back is in contact with the anvil. During this swaging operation, the material is displaced towards the sides and towards the point.

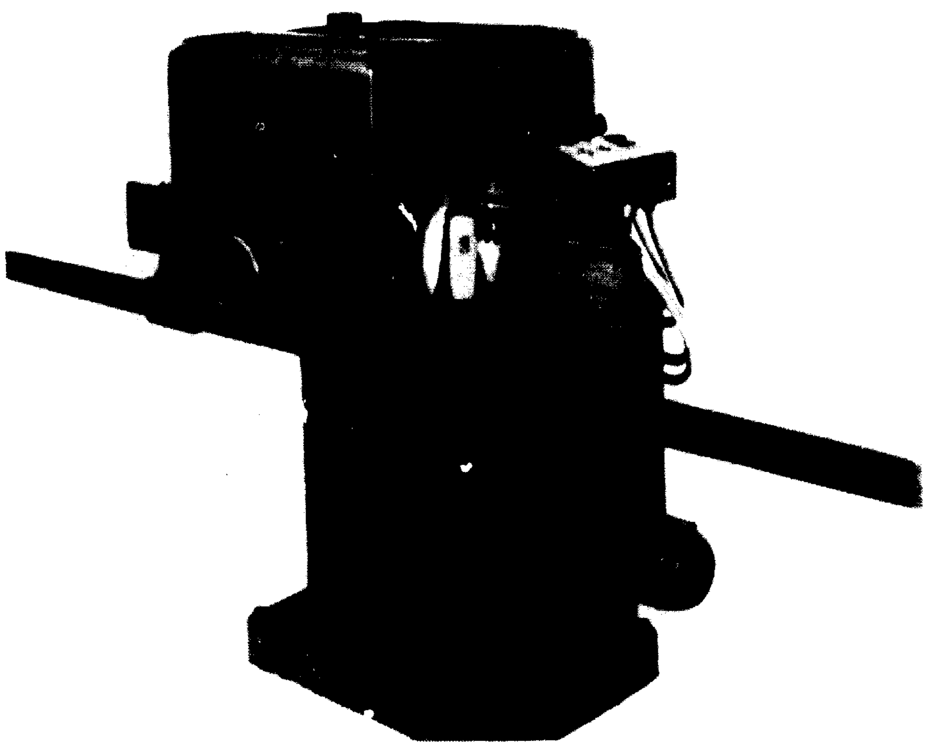


a b c

From illustration a. it becomes clear that with the tooth swaged this way it is not possible to work since the broadest portion is not at the tooth point, but slightly below same. The swaged tooth must first of all be equalized i.e. the material displaced to the two sides must be compressed from either side to a certain measure, so that the tooth has its greatest width in its upper portion and is narrowed backwards and downwards (illustration b.). After grinding of tooth face and tooth back the saw blade is ready for cutting (illustration c.).
Owing to the cold shaping of the tooth point there results an increase of material strength of 2 to 5 Rc so that the swaged tooth point has a higher strength than the blade body resulting in a longer service life.
A further and rather considerable increase of service life can be obtained by high frequency hardening which will be discussed in detail in a special paragraph.
For the production of swaged and equalized tooth points there exist hand operated devices, swaging machines and fully automatic machines which will be explained in detail.

The oldest and best known equipment are the hand-operated swaging unit and the hand operated equalizing unit. There are different sizes and capacities with various diameters of the eccentric dies. In spite of this it is for the most part necessary to swage the same tooth two or even more times in order to obtain the required material deformation.
The accuracy of teeth swaged and equalized this way is not always satisfactory since it depends greatly on the care of the operator, as the swaging and equalizing by hand is expensive and troublesome. For this reason hand controlled units have been developed where part of the tiresome hand work is carried out by compressed-air control cylinders.

A further disadvantage of the hand swaging apparatus is the damage of the blade body by the clamping bolts having cutting rings at the clamping faces which penetrate into the blade body.
These disadvantages had the effect that machines have been developed for swaging and equalizing of saw teeth and are now available on the market. They are all working according to the principle of slide swaging. The swaging process is separated from the equalizing process. While most machines demand a separate operation for the equalizing there are also automatic machines executing the swaging and equalizing in one single pass of the saw blade.



Here again exist two methods. In one case the eccentric die and the equalizing jaws are separate tools whilst in the other case a combined swaging and equalizing tool is employed. This last method has the disadvantage that for this combined tool a special tooth geometry is given, with the other method however all tooth shapes can be swaged and equalized and the higher material strength at the tooth point results in a higher service life of the saw blade.
A further product in this field is the so-called warm-swaging. Already the first tests 25 years ago offered considerable problems which still exist today. Nevertheless a machine is offered since a few years which is working according to the electric resistance process where during the deformation the glowing tooth point is enlarged toomuch and then bent towards the front by an "equalizing fork".

This equalizing does not offer sufficient accuracy and in a further working process - equalizing by grinding is required.
This resistance process working with low voltage and high amperage belong to the processes of long time hardening which means that beside the through-hardening of the tooth point also a coarser material structure is formed than is the result of short-time hardening which I shall discuss later. The tooth point becomes brittle and there is the risk that the tooth points tend to break and it also happens that in one saw blade there are hard and soft teeth.
Whilst in our countries in Central Europe for a long time only band saws have been swaged in the Scandinavian countries, mainly in Sweden and Finland also frame saws are exclusively swaged already for some years. This trend towards the swaged frame saw is clearly discernible in other countries in the last two years.
The use of swaged and high frequency hardened frame saws offers the following advantages compared with spring set hard chrome plated saw blades:

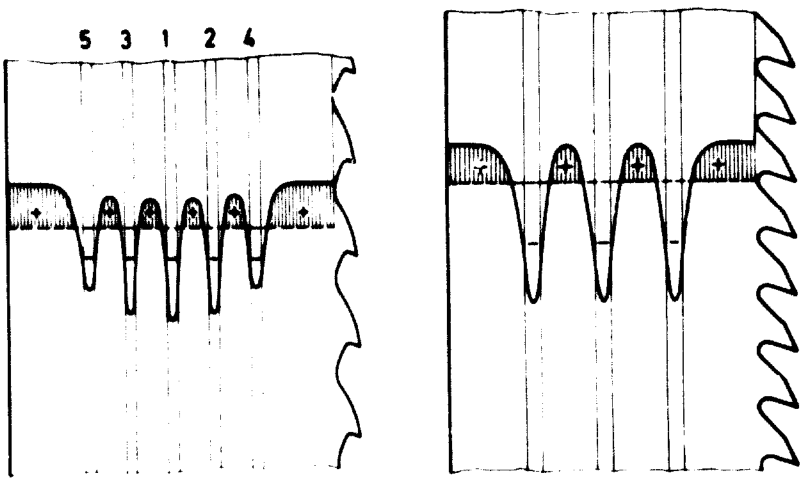
1. due to higher feeding speed better cutting performance and more than 30 % more output in the same time
2. service life increased by 40 % and more, therefore less changing of saw blades and less work in the filing room
3. less power consumption with regard to the cutting performance
4. better cutting quality and less deviation of the saw blade in spite of higher feeding speeds.

Tensioning, straightening and levelling

Tensioning, straightening and levelling are methods to give a saw blade an internal tension and a geometrical shape which are required for an unobjectionable working of the saw.
This internal tension and the geometrical shape get lost little by little again through the strain of the saw during the cutting operation. The reason therefore is the heating, the jamming, the stress in the machine and through the overhang of the gang saw out of the saw centre.
For the tensioning and straightening of the saw blade a roll saw stretcher on a tensioning bench is required and the straightening can partially be completed by hammering.
Levelling of a saw blade is done on principle by hammering both sides of a saw blade using a special anvil fitted in the tensioning bench. Automatic straightening machines are offerd, but up to this date they do not come up to the requirements.
The tension of the saw blade is constantly checked during the operation. For this purpose a special tension gauge is used showing a light gap in

the centre of the curved blade surface which can vary slightly according to the width of the blade between 0,3 and 2,5 mm .

Special instructions can be gathered from technical books for the filer but we recommend to train the filer at least 2 to 3 weeks to get to know the problems and difficulties under the supervision of a skilled expert.



- = Druckspannung
+ = Zugspannung

- = Druckspannung compressive strain
+ = Zugspannung tensile stress

After the tensioning of the saw blade the straight back has to be checked and to be corrected so that the back is slightly convex with approx. 0,4 to 0,8 mm on the length of a straight edge 1,5 m long.
The levelling of the saw blade is the last step and should be executed from both sides using, according to the blade thickness, special hammers with a weight varying from 0,7 to 1,8 kg with a ball peen. For checking the plane surface of the saw blade a tension gauge of at least the width of the saw blade should be used.

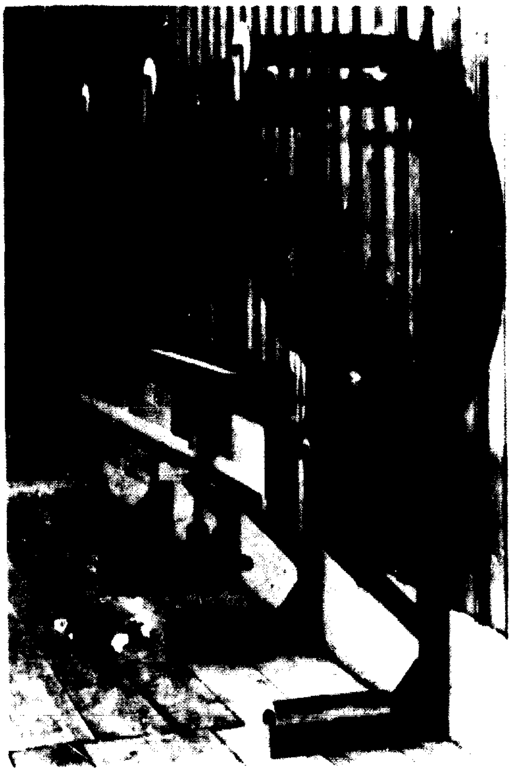
With regard to the roll saw stretcher observe the following points that:

1. both rollers are driven
2. the upper part of the machine can be lifted up
3. the rollers are easy to exchange
4. the construction is short in order to save space
5. the adjustment of the guide rollers can easily be done according to scale.
6. the pressure of the rollers is adjustable according to scale
7. if possible two rolling speeds are available
8. in case of blade width over 8" (800 mm) both rollers are axially movable so that the heavy saw blade has not got to be moved in relation to the rollers.

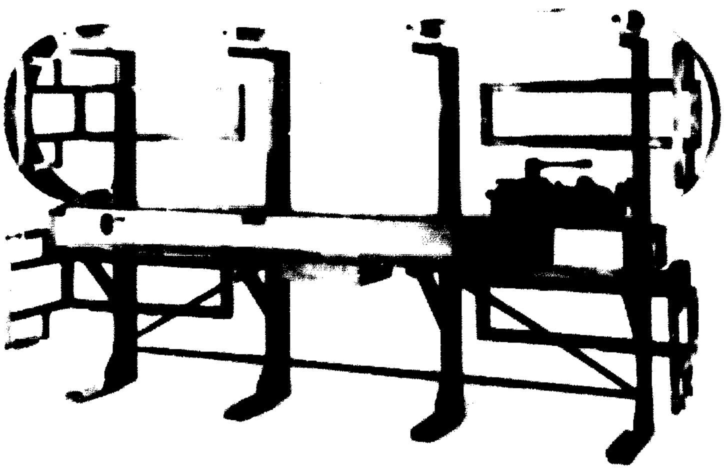
The anvil plate should be of such a size that the saw blade can-not only be checked but also hammered at the same spot. To move the saw blade to a special anvil and back again for checking is time-consuming and trouble-some.

Return and guide rollers for band saw blades of different lengths are absolutely necessary, particularly for wide and heavy log band saws.

A practical execution of a complete tensioning and straightening installation is shown in the figure below for blade widths up to 8" (200mm),

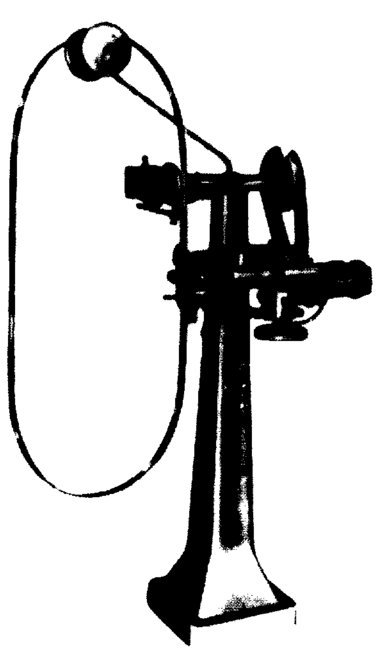


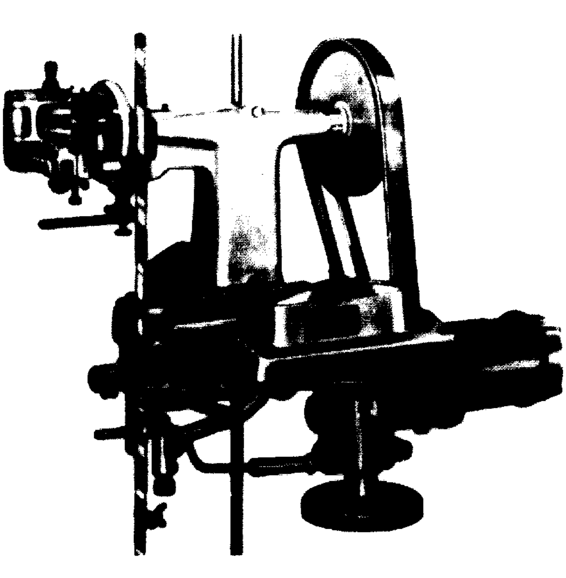
and in the figure below for blade widths up to 14¼" (360mm).



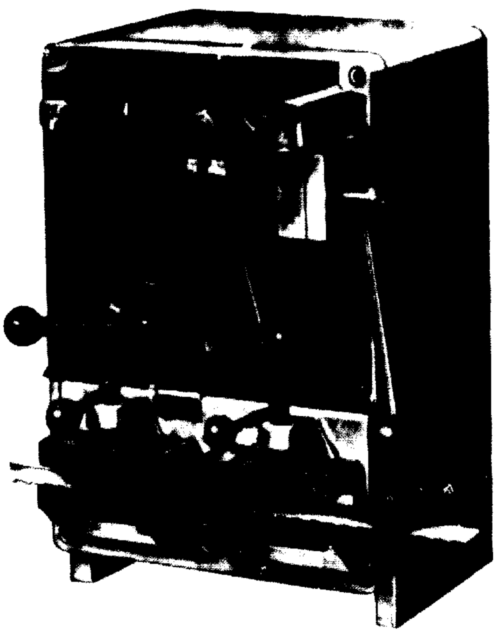
Joiner band saw

Up to now we have not discussed a machine which should be in every wood working shop. It is the so-called joiner band saw with a blade width up to 1 9/16" (40 mm). In opposition to resaws and log band saws the treatment and maintenance of these saw blades offers no problems.
Up to this day the filing of these small and thin band saw blades has proved better compared to the sharpening by means of a grinding wheel as the cutting capacity of filed saw blades is superior to that of blades sharpened by a grinding wheel.
For the maintenance of these blades a space saving combination of filing and setting machine is fitted on the wall.





The consumer can buy the band steel already toothed and set per running meter and weld it together himself. For this purpose a semi-automatic butt-welding machine which is easy to handle and which can be connected to the supply line may be used.



IV. IMPROVEMENT OF THE SERVICE LIFE BY HARDENING

In the following paragraph I should like to discuss briefly the tooth point hardening by high frequency.

In the first place I want to explain the hardening process from a metallurgical point. Unalloyed and low-alloyed steel with a carbon content of more than 0,3 % can be hardened. Saw blades for the wood working such as band saws, frame and circular saws are made from steel with a carbon content from 0,6 up to 1,1 % and can be hardened.

The hardening of the tooth points can be divided into two main groups:

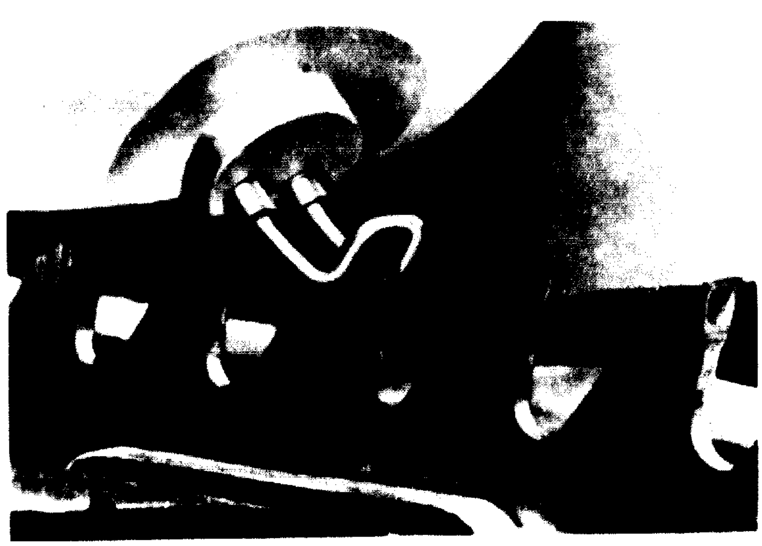
1. long -time hardening
2. short-time hardening

The conventional processes such as flame hardening, bath tempering and resistance hardening belong to the group of long -time hardening.

Hardening by high frequency, by plasma current, by ionic beam and Laser beam belong to the short-time hardening group.

Of the aforementioned processes for tooth point hardening at the moment for long-time hardening the resistance hardening is employed and for short-time hardening the process of high frequency.
The resistance hardening operates as already explained in connection with the warm-swaging, with low voltage and high amperage, the two electrodes fitted to the tooth point and to the saw blade body. A conductive connection has to be established from one electrode to the other through the saw blade so that the heating up can take place. As a result of this method, a through-hardened tooth point with a relatively coarse structure is produced which is very brittle and the risk exists for it to break.
With the high frequency hardening for tooth points the high frequency current is applied only for a short period and only the boundary layer of the cutting edge is heated up. Quenching takes place immediately by the cold of the core material that has not been heated. By this procedure a hard surface is obtained and it is ensured that the tough core is maintained. The influence of the high frequency occurs intermittently from tooth point to tooth point.

A further advantage with the high frequency hardening is the no-contact transmission of the electrical energy so that damage to the tooth point is avoided.



The hardness obtained by this surface hardening is about [illegible] to [illegible] degrees Rockwell, which means a wear-resisting tooth point with a soft tough core.

On this occasion I should like to quote from an article by Prof. Ettenreich on the short-time hardening by high frequency. This method is also an intermittent, but indeed extremely short-timed influence of the high frequency on the tooth point:

Due to the exceptional properties of work pieces which have been surface hardened in such a way, such cutting tools for example have an extremely long service life. As a result of keeping sufficient elasticity they do not require to be tempered after the hardening. The surface hardening can be accomplished at the finished work piece, for instance after the swaging of the saw. In doing so there is no alteration in shape or any decrease in quality in spite of the heating which reaches nearly the melting point. This is due to the rapidity at which the whole thermal process develops.

The practical advantages like the great resistance to wear, the long service life, the great resistance to corrosion, the avoiding of the annealing and hardening of the finished work piece without any subsequent mechanical treatment, depend exclusively on the fine-grained structure that has been obtained with this hardening procedure.

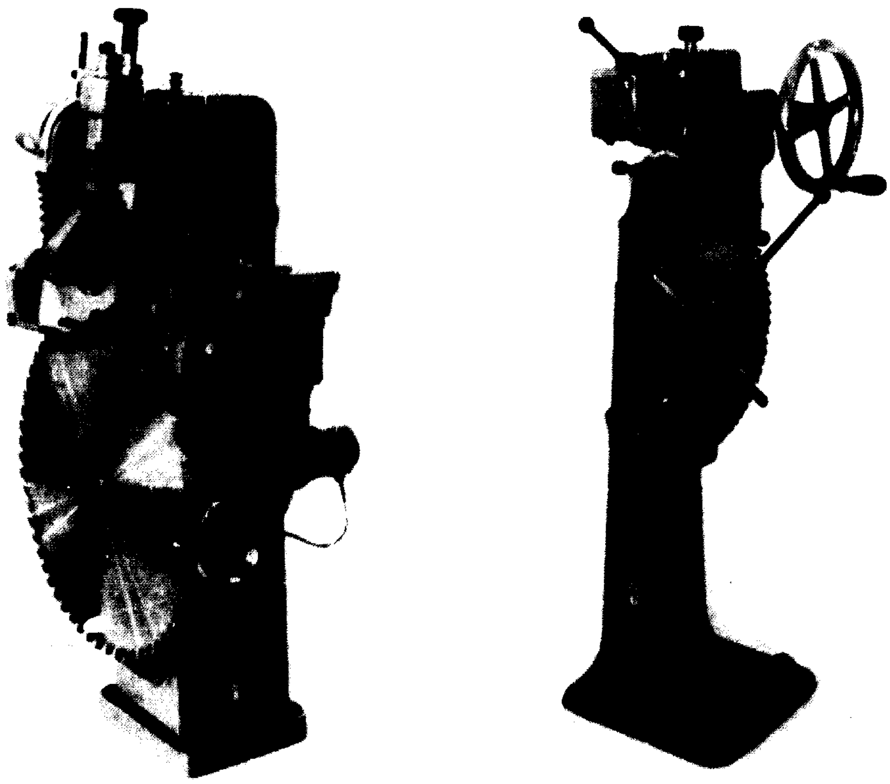
A material shows so much better properties of strength, all the more fine-grained its structure is with regard to eleasticity. These characteristics explain why with this surface hardening procedure besides particularly good properties of strength also sufficient elastic properties are assured. Only when the structure is extremely fine-grained, as happens with this hardening process, great values of strength can be expected whereby the elastic properties are maintained.

To obtain such a fine-grained structure is especially important for the hardening of tools, particularly of cutting tools, because in this case the resistance to wear and a long service life is decisive.

So far the explanations of Prof. Ettenreich.

How differs the hardened saw from the unhardened saw with regard to performance and service life? With the unhardened saw the degree of bluntness increases rapidly so that after a certain time the feeding speed has to be reduced in order to avoid untrue cutting of the blade. For the high frequency hardened saw the descent of the feed graph is by far less steep so that apart from the service life extension which is always obtained also an increase in cutting performance is achieved.

The descent of the feeding speed is shown in the diagrams 1 to 3 where the rate of feed has been plotted as a function of time.



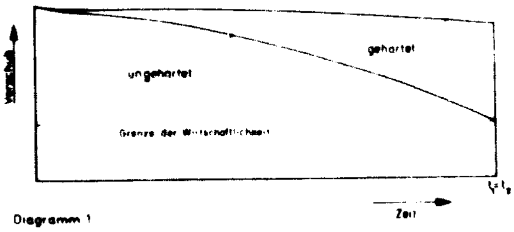


Diagramm 1

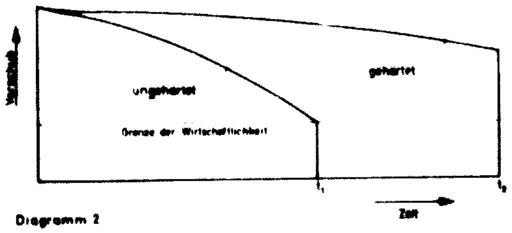


Diagramm 2

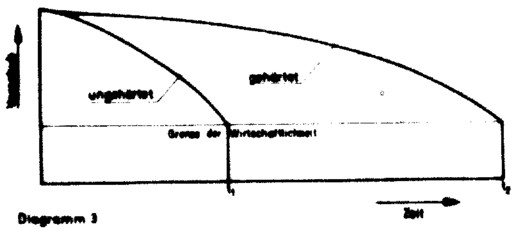


Diagramm 3

V. EXAMPLE FOR INVESTMENT

At the beginning of this lecture I had pointed out that the maintenance of circular saws is easy and offers no problems.

In countries where industrialization is lacking and where investment is very limited, we feel that according to our opinion other measures should be applied in order to obtain at least from the beginning a positive result.

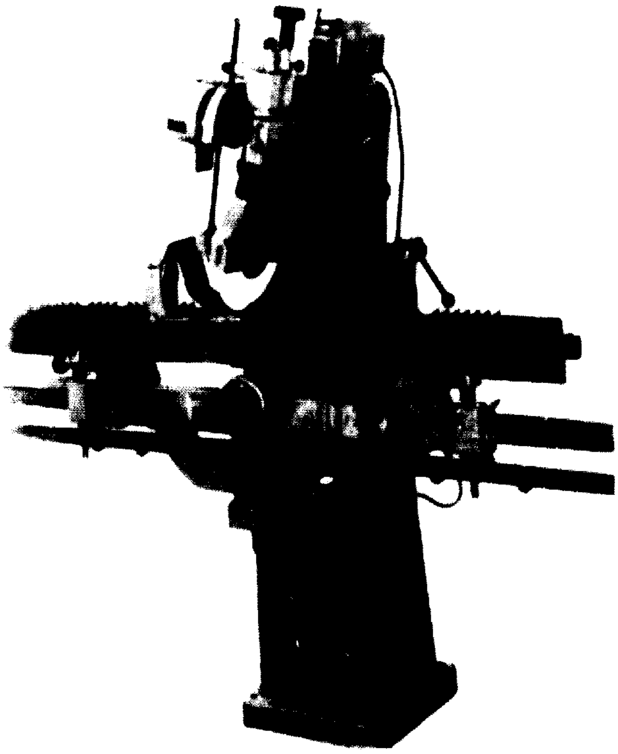
The following example will show the possibilities of a simple equipment for a saw mill:

1. Breakdown up to 16" Ø (40 cm) with a twin log circular saw, possibly a second log circular saw in tandem arrangement according to the dimensions of the standard cut wood, possibly resawing with a multiple circular saw and cross cutting by means of a single blade circular saw.

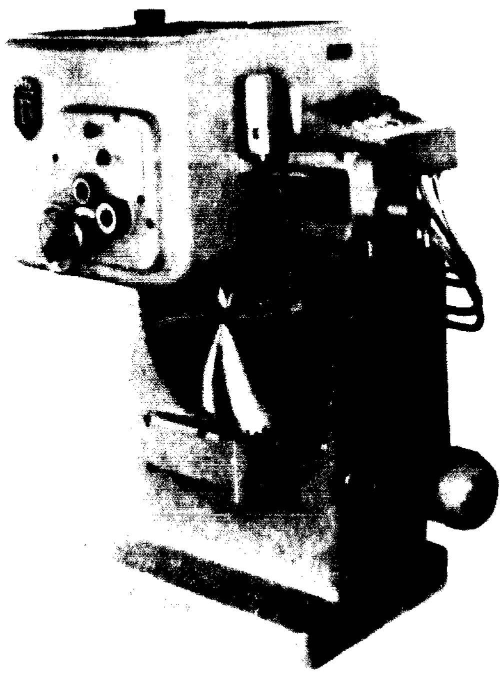
For the maintenance of the tools of the above mentioned machinery a sharpening machine for circular saws with straight and bevel grinding is required as well as a setting machine, according to the illustration on the opposite page.

[illegible].Breakdown of more than [illegible]" Ø (40 cm).

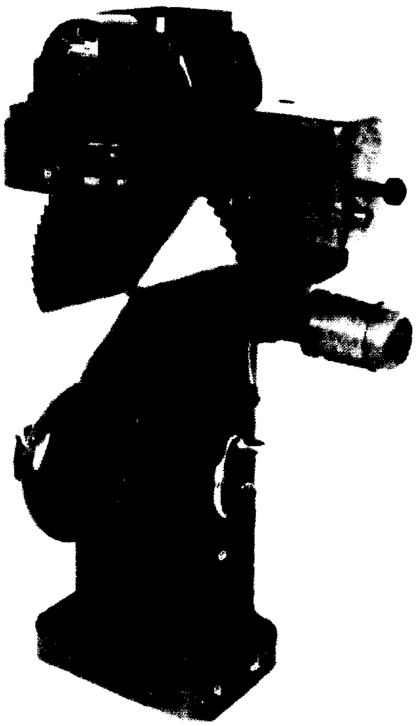
Cutting the raw wood with a horizontal frame saw for further processing is as the preceeding. For the maintenance of all tools there is only a mounting device for horizontal frame saws required in addition to the aforementioned machines.



The capacity of the above-mentioned installations, i.e. the quantity of wood cut per time unit, can be increased when using swaged saws instead of set saws. The increase is about 30%.
The investment in the sharpening room then requires a sharpening machine and a swaging machine and attention must be paid that swageable saw blades are used.



Further to the increase in capacity the service life of the saw blades can be extended by more than 40 % by means of high frequency hardening of the swaged saw blades. The hardening of the tooth points of all kinds of saw blades can be executed on one machine as per illustration.



In case that attention is paid, when acquiring the log circular saw, that the complete saw shaft can be exchanged, the saw machine will be ready for work again after an interruption of 10 to 15 minutes which is an advantage, because the main argument against the use of circular saw machines was the loss of time caused during the interchanging of the saw blades.

When giving this example I do not want to argue against other and possibly more efficient wood working machinery. However this example shows that even with a rather limited investment capacity in the saw milling sector there exists the possibility to start industrialization in the wood working industry.

VI. STELLITE TIPPING OF BAND SAWS

This method is used with best results above all if hard and abrasive woods, which we excluded in the beginning of this lecture, shall be cut.

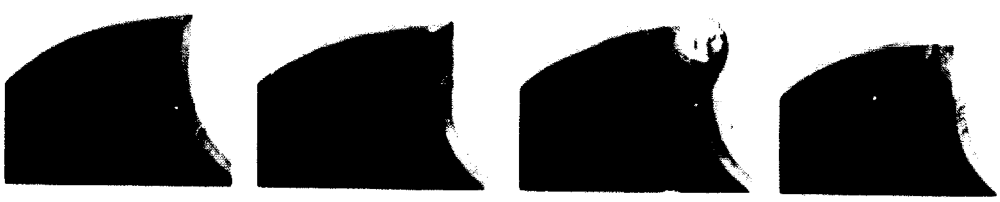
The saw machines themselves could without difficulty give a higher output. Consequently it must be tried to improve the tool. Cutting of certain tropical woods, particularly those with mineral inclusions,

result in such a rapid wear that a convincing solution is to cover the tooth points with especially wear-resistant materials. For this reason today the stellite tipping method is used with the very best results. Stellite tipped band saws have a considerably increased cutting capacity and service life and can be sharpened irreproachably.
Apart from tensioning and straightening, swaging is one of the main steps for saw blade preparation, in order to make possible deep embedding of the stellite into the base material.
For this purpose swaging machines are required as discussed in detail in the paragraph "Swaging".
Then the stellite must be applied, either on every tooth or on every second tooth as often done in practice in order to avoid the removal of the remaining stellite before retipping. This operation is the most delicate one, for it requires skill and care.
The mixture of oxygen and acetylene must be controlled in such a manner that the flame cone has a length about 3 times that of the inner white flame. The white flame must touch the tooth edges slightly below the rear portion of the recess formed by swaging. The stellite rod should have a diameter of 2,4 or 3,2 mm (0.09 or 0.12").
The stellite tipping equipment comprises a light high-pressure oxyacetylene welding torch having a tip with a nozzle of 0,5 to 1 mm (0,03 to 0,04"), an oxygen cylinder with a reducing valve and a pressure gauge and a similarly equipped acetylene cylinder. In order to be able to work in a comfortable and exact manner it is recommended to use very supple connection hoses. Apart from this the band saw should be passed over guide rollers and through a feeding mechanism. In this way the blade can be fed step by step whilst the operator is sitting and actuates the foot switch. The working conditions are very favourable since neither the welding electrode nor the torch must be laid aside. The illustration shows a tensioning bench with the guide rollers for the band saw and the attached feeding device.

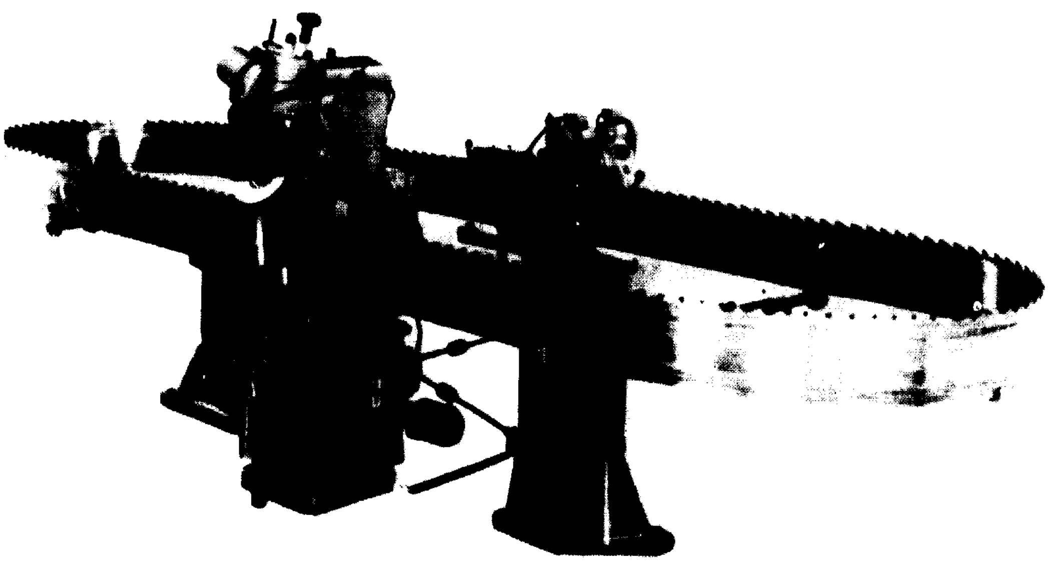
The two most important preliminary conditions for this work are: (1) to heat the steel of the tooth up to the correct temperature and (2) to form stellite drops of the proper size. If the steel temperature is too low, difficulties will arise with respect to the spreading of the stellite, which will stick in the swaged recess in a lumpy manner rather than spreading over the recess. If, however, the temperature is too high, the steel will melt and the tooth point will be destroyed. A too large stellite drop will cause unnecessary consumption of stellite and grinding off the excess stellite will require much more time. The required stellite quantity per tooth is approximately 0,23 to 0,27 grams. If the drop is too small it will not be sufficient for grinding a complete tooth cutting edge. Care must also be taken that the stellite is deposited symmetrically.

The material stresses produced during the stellite tipping must be eliminated by heating up the transition zone to about 450°C. For checking, there are special design temperature crayons that change colour according to the action of heat. A skilled operator can carry out this work by his feeling only.

Following the stress relieving, the saw tooth points will be given their sharp cutting edge on the automatic sharpeners for tootn form and side grinding. The sequence of work is illustrated below.

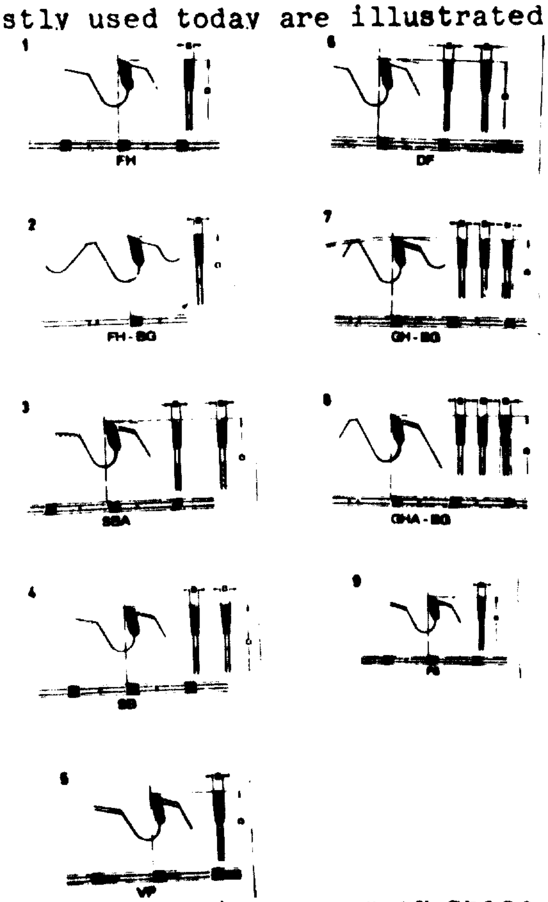


This combination of synchronously working sharpening and equalising machine guarantees high precision of the cutting edge geometry. (see below)

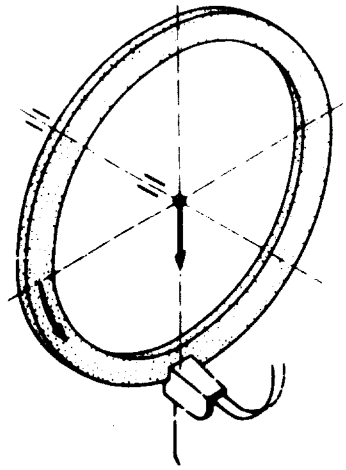


VII CARBIDE TIPPED CIRCULAR SAW BLADES

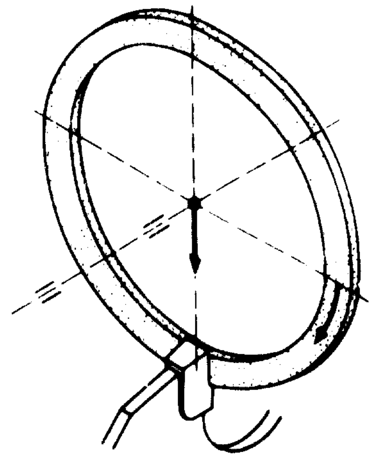
The use of carbide tipped tools in the wood working industry has gained considerable importance in the course of the past years.
Above all carbide tipped circular saw blades are employed throughout the world nowadays and the development in the last years showed that these blades can be used today for work that had been reserved for the conventional chrom-vanadium saw blades some years ago.
Although the acquisition of these tools requires a considerably greater investment the demand is constantly increasing, as the attainable performance and consequently the efficiency justify their use. It should however be assured that not only the new tools correspond with these requirements, but it is also necessary that the resharpening in a quality and standard, as practised by the manufacturers of such tools, can be executed as near as possible to the place of employment of the tools.
The tooth shapes mostly used today are illustrated in the folllowing picture.



For the manufacture and the resharpening of these teeth special machines are required which differ completely from the commonly used sharpening machines with regard to construction, grinding principle and stability free from vibrations. Particularly the deep grinding technique applied everywhere nowadays resulted in a grinding method which permits to execute the resharpening in such a manner that the resharpened tools are absolutely equivalent to new tools. Nearly all new constructions of these special sharpening machines are designed to execute the socalled "grinding in guide ways" which permits the diamond grinding wheel to execute the resharpening of tooth face and tooth back on the shortest possible way.

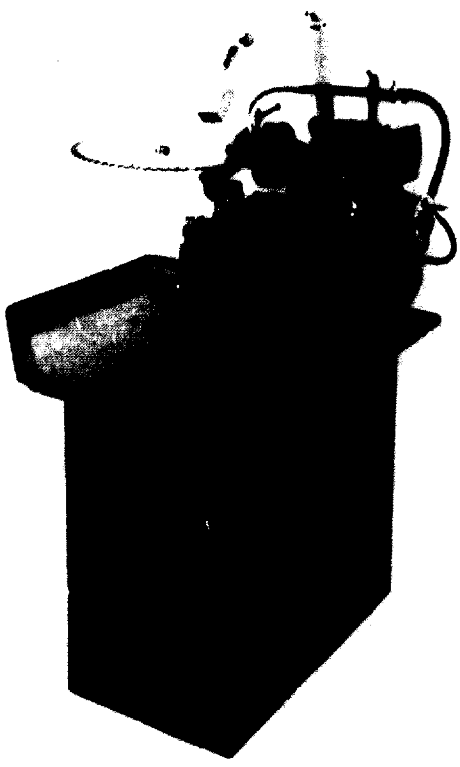


back grinding
Ruckenschliff



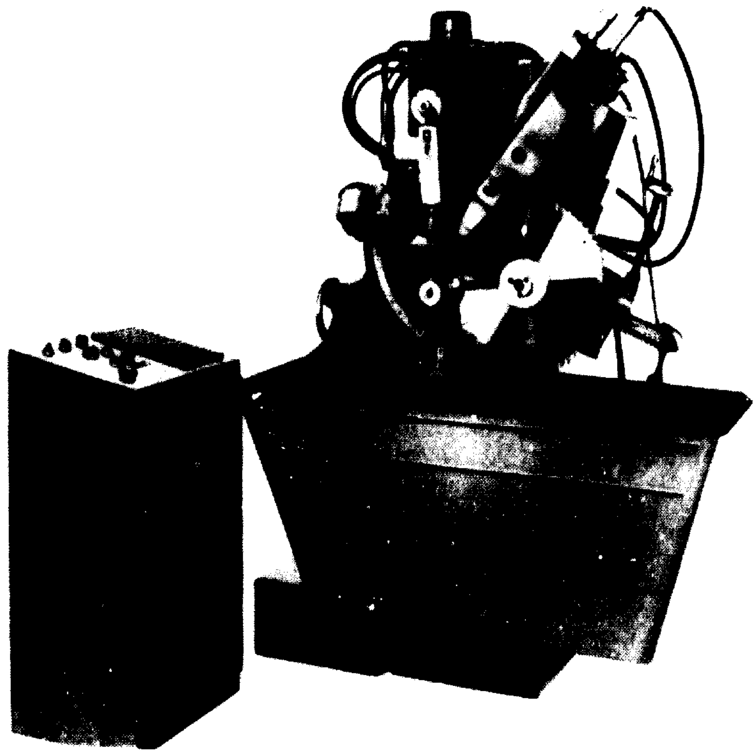
face grinding
Brustschliff

A simple hand operated machine for the sharpening of all tooth shapes shown above, up to a saw blade diameter of 24" (600 mm), is shown below.



With corresponding additional equipment this machine can also be used for the sharpening of groove and profile cutters as well as surface milling cutters and dowel bits.

A very efficient fully automatic sharpening machine with a construction nearly free from vibrations, easy to operate according to scales even by untrained workers, and equipped with a very practically placed wet-cooling system is shown below.



To discuss further details of these special sharpening machines, the kind of diamond wheels and the correct shaping of the cutting edge geometry of the carbide tip exceed the scope of this lecture. I should like to recommend however that the competent manager asks the advice of an expert before employing these tools, and the resharpening is today no problem which could influence in an unfavourable manner the decision to use these tools.

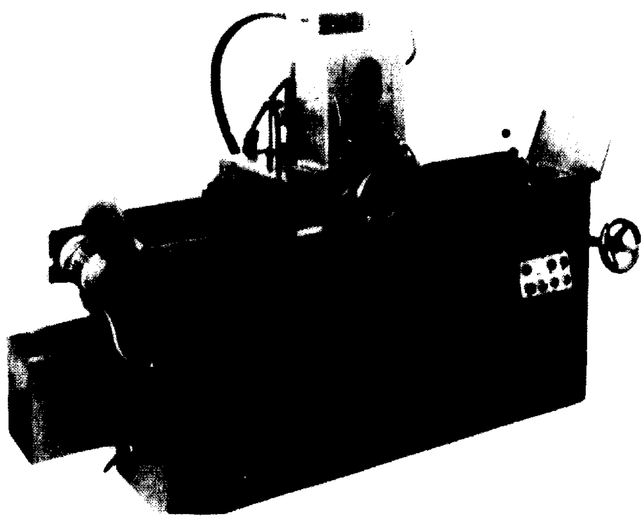
The tools used for further treatment of the so far discussed sawn wood can be divided, in spite of the many variations regarding shape and use, in two groups: knives and milling cutters. As for the maintenance, each group can be discussed separately.

VIII <u>KNIVES</u>

Chipping, chopping, peeling, planing and cutting are the works which are executed with machine knives for the wood. These works require different knife thicknesses, knife angles and material for the cutting edges.

Machine knives are tools which are submitted to an enormous stress and therefore they are manufactured from high quality materials. Thin knives are produced from high speed cutting steel with the main components chromium, vanadium and (up to 18%) tungsten. The hardness is between [illegible] and 62 Rc. Thicker knives are made from composite steel, i.e. the knife body is manufactured from low-alloyed steel and only the cutting edge is made from high alloyed tool steel.

In order to sharpen these knives efficiently, great importance must be placed on the selection of the grinding wheel. Attention must not only be paid to the size of the grains and to their hardness, but also to the suitable abrasive as well as to bond and porosity. Another point requiring attention is the circumferential speed of the vitrified grinding wheel of approximately 30 m/sec, which means that the grinding motor with direct drive to a 200 mm Ø grinding wheel should rotate at 2.800 r.p.m. In case of wet grinding, the coolant must be applied in sufficient quanitities directly onto the grinding spot; the most suitable manner to do this is through the grinding motor shaft. Only in so doing can a clean grinding wheel and the best cooling effect be attained.

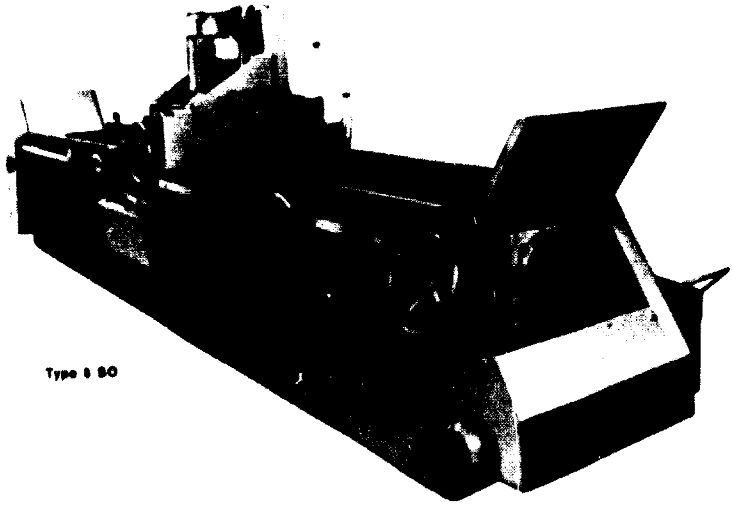


In the modern universal knife grinding machines the grinding support moves across the mechanical or magnetic clamping device which holds the knife. The grinding support, moving on antifriction bearings, is sliding on interchangeable steel bands with different feeding speeds according to the kind of material.

In view of the great number of knives with different thicknesses and tooth point angles, a time-saving adjustment is a necessity. Due to the enclosed construction of the machine base a maximum rigidity against distortion has been obtained. These machines are available for different grinding lengths.

The grinding capacity is increased maintaining the highest precision.

(See figure overleaf)

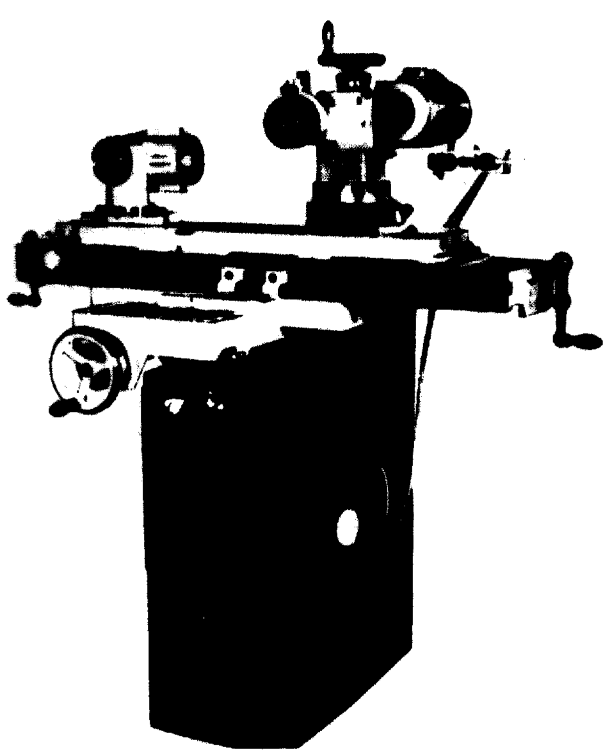


IX MILLING CUTTERS

Groove, jointing, notching and profile cutters, tenoning cutters and router bits, as well as dowel bits, are tools which are submitted to an enormous stress just like the knives and they too are manufactured from various high quality steel types. In the course of the last few years the use of carbide tipped cutters has increased, mainly for purposes where the tool steel failed. For the sharpening of milling cutters, the selection of the proper grinding wheels is equally important with regard to shape and composition. The grinding wheel must not be too hard - the maximum hardness being K with grain size 46.

For special high-alloyed tool steels, the abrasives industry has developed a completely new grinding wheel, the so-called Borazon wheel. Tools with a hardness of more than 60 degrees Rockwell can be sharpened perfectly with a Borazon wheel. For carbide tipped tools nowadays only diamond grinding wheels are employed.

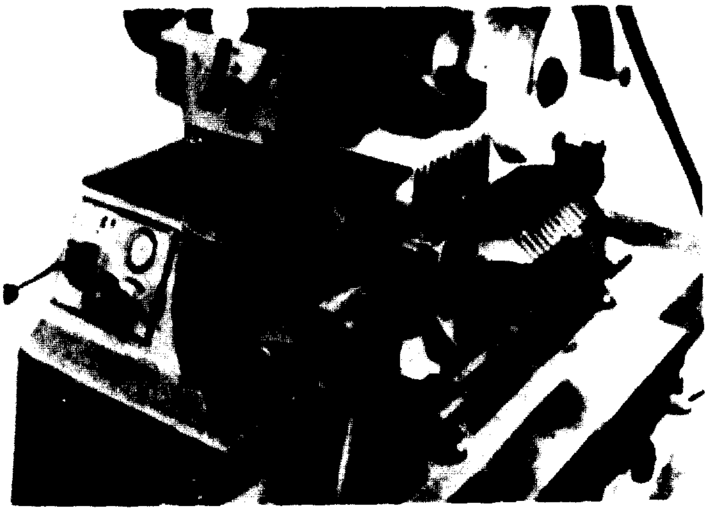
In order to enable the sharpening of the great variety of milling cutters with the aforementioned grinding wheels, a very stable universal machine with wet grinding equipment and various additional equipment is a preliminary condition.



With the indexing head that is revolving and swivelling with a translation 1 : 72 respectively indexing disks groove and profile cutter can be sharpened.

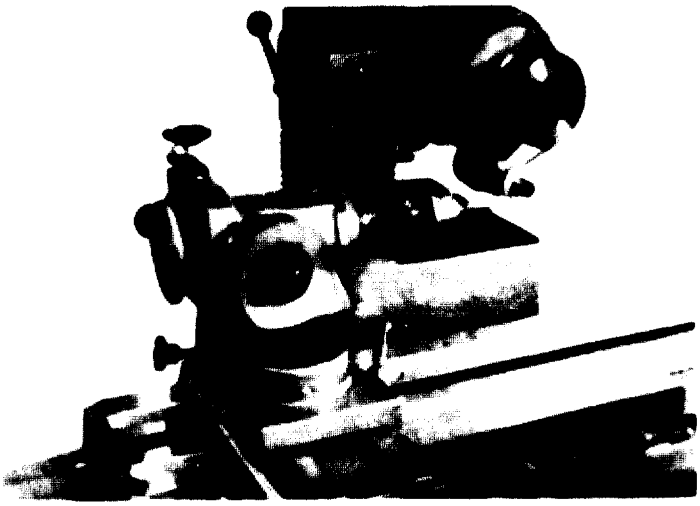
It is very important with groove cutters to maintain the clearance angle, as only the back will be resharpened. The same is valid for the jointing, notching and profile cutters with regard to the hook angle as these cutters are sharpened only at the tooth face. The work of the filer can be considerably facilitated by the use of special gauges for the proper adjustment of the cutting edges in relation to the grinding wheel.

The resharpening of tenoning cutters is executed only at the tooth face similar to profile cutters, but with regard to the size of the work piece it is important to pay attention that the work piece is not only supported in the indexing head but also supported from the other end by means of a tailstock.

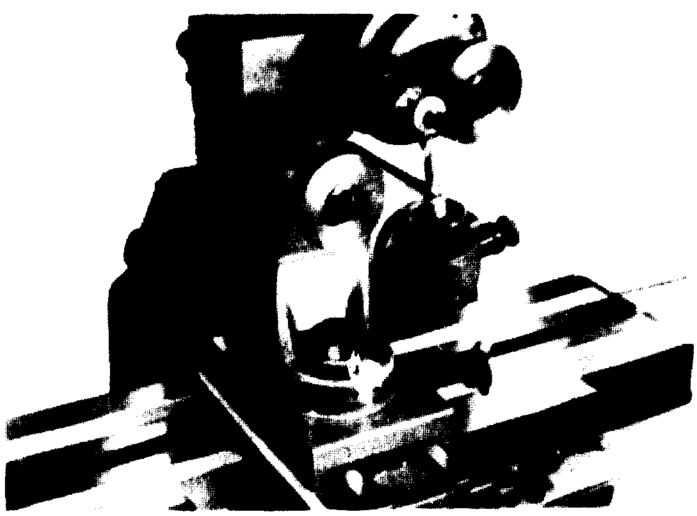


These cutters should be sharpened only in sets in order to maintain the diameter and the geometrical shape of the single cutting edges for the use in sets.

The centrical router bits for eccentrical clamping chuck will be sharpened only at the true rake with a profiled grinding wheel.



Dowel bits are clamped in a special device and sharpened with a profiled grinding wheel with smaller diameter.



In order to maintain the circumferential speed of the grinding wheel a special reduction gear will be used.

It is not necessary to discuss in detail in the scope of this lecture the grinding method for the great variety of tools that can be sharpened on a universal cutter grinder as the various adjustments as angles, feeding speed, grinding speed, grinding wheel etc. can be gathered from every good operation instruction.

X SAFETY MEASURES

We learned from experience that in developing countries very often the auxiliary machines and equipment do not correspond in the least with the requirements which are necessary for the prevention of accidents and for the health of the personnel.

We are however of the opinion that no problems will arise with industrialization as long as the machinery and equipment correspond with the regulations of highly industrialized countries.

When acquiring such machinery it is therefore important to check, whether

1. the electrical equipment corresponds with the valid regulations of CSA and VDE (Canadian Standards Association and Association of German Electrical Engineers),
2. the mechanical and hydraulic equipment of the installation correspond with the law covering technical working facilities,
3. the existing regulations for security and protection according to the employers' liability association and the controlling authorities are at hand,
4. the test specification has been complied with (for instance DIN 8447 and DIN 8448).

The machinery and equipment explained during this lecture correspond completely with the aforementioned regulations.

74.09.13