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SELECTION AND MAINTENANCE OF CUTTING TOOLS FOR THE WOODWORKING INDUSTRY 1/

by

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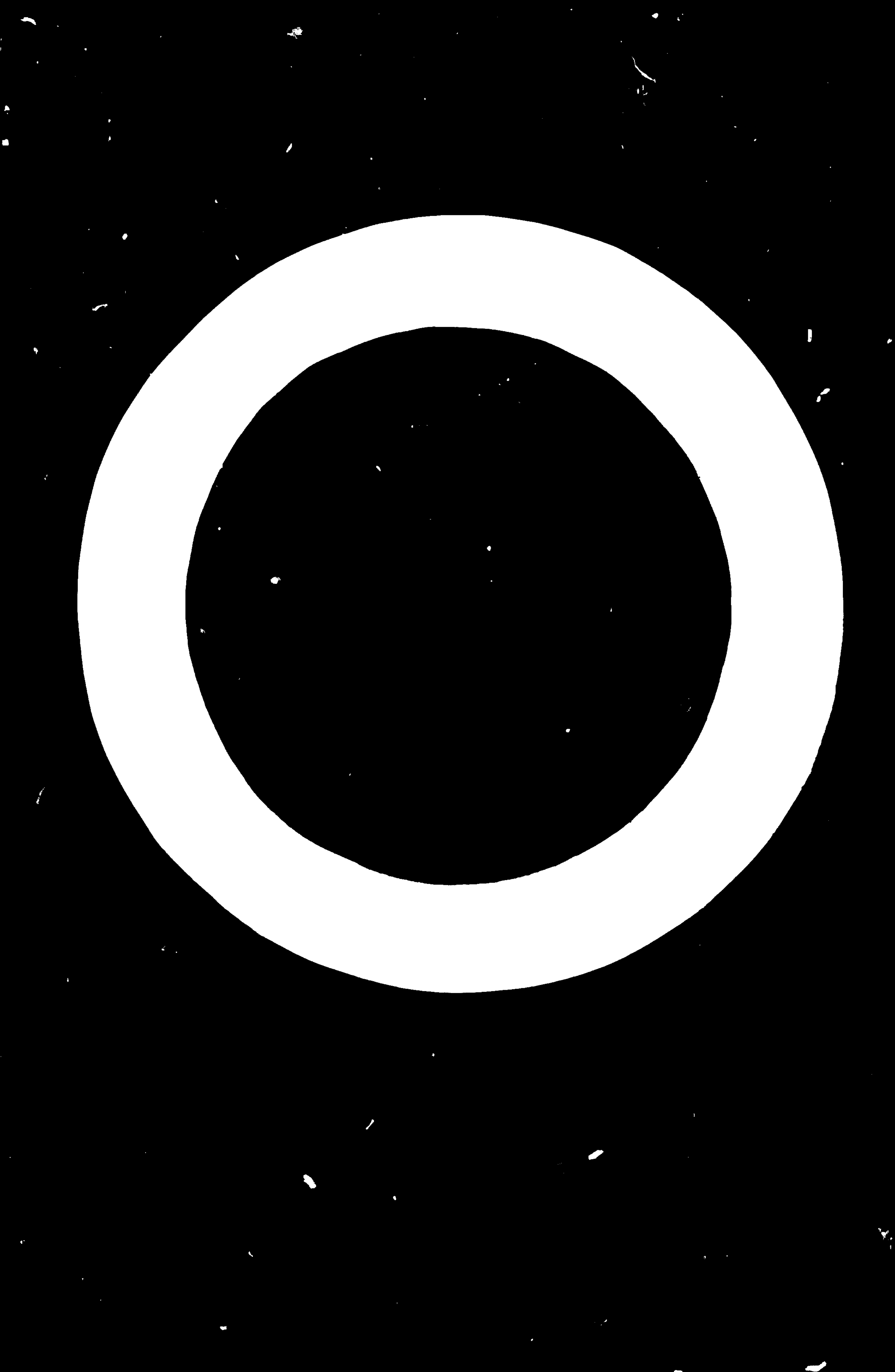

INTRODUCTION

1. The topic of selection of cutting tools is a complicated one. It is complicated because of the vast number of variables which must always be considered when selecting cutting tools for any cutting application. Such things as the hardness and density of the material being cut, whether or not the material will contain any foreign objects or loose knots, whether the material is solid stock such as lumber or laminated stock such as plywood or veneered paneling will all effect the decision as to what style and type of cutting tool is applied. That, of course, sounds complicated; yet it only deals with the material itself. Other things such as feed rates and the type of cutting machine must also be considered.

2. Many tooling manufacturers try to apply standard design tools to applications which vary widely in their tool requirements. This makes things easier for the tool maker, but at best it produces only marginal results for the woodworker. This is not, however, to say that some standardization cannot exist in the tooling industry. Such standardization should not be applied to cutting application where the requirements call for specially designed tools.

3. Because of the wide variety of different applications, this paper does not attempt to describe tool selection in detail. The basic approach to tool selection is made from a general point of view. In many cases, broad generalizations would hold true and should, therefore, be used as a guide to tool selection. Where specific and specialized applications are to be made, however, it is best for the woodworkers to contact a reputable tool maker.

4. If the tool manufacturer is knowledgeable about his products he will be of great assistance in guiding the woodworker to the proper tool selection for each application. In order to do this, it is important to specify several basic pieces of information:

A. What material is being cut.

- Is the material wet (over 15% moisture content)
- Is the material dry (under 15% moisture content)

B. What type of cutting machine is being used.

C. What is the RPM (revolutions per minute of the cutting tool.

D. What is the feed rate at which the material will be fed into the machine (either in feet per minute or decimeters per minute).

With this type of information, the tool maker will be able to recommend the proper tool to do the job.

5. Tool selection is difficult, yet cutting tools and their maintenance are one of the most expensive costs of a woodworking operation. Proper tool selection and maintenance can save tremendous amounts of money. Therefore, this aspect of the woodworking operation should be looked at as critical to the success of the venture.

I. CUTTING TOOLS AVAILABLE

1.1. Types of Tools

1.1.1. High Speed Steel Tools

6. Prior to 1945 selecting cutting tools for wood cutting operations was much less complicated than it is today. In the years before the end of World War II, the only type of cutting tool being successfully applied in wood and wood products industries were those made of high speed steel.[1] High speed steel tools were being applied to all the various cutting operations in wood fabricating plants throughout world woodworking markets. Tool selection, at that time, simply centered around the proper tool design to perform the task at hand. Because all tools were made entirely from steel, and various steel alloys, the only difference in the cutting longevity between one tool and another centered around what steel alloy the tool was made from, the tool design, and what material was being cut. Naturally, the harder the materials being cut, the shorter the productive cutting life of the tool. Also, the softer the steel alloy, the shorter the tool life.

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[1] These tools were made of various types of steel, i.e., high carbon steels, spring steels, high nickle steels, and various other alloys which gave them resistance to wear. Many of these alloy steels are commonly referred to as tool steels and high speed steels. Because of the wide use of the term in industry, this paper will refer to all tools which are not either carbide or stelite tipped as high speed steel tools.

1.1.2. Carbide Tipped Tools

7. Tool design was very important in expanding productive cutting life of high speed steel tools just as it is today important in the cutting life of carbide tipped[2] cutting tools.

8. Although the characteristics of the hardness of the material, the hardness of the cutting tool, and the tool design come into effect when selecting any type of cutting tool; the tool selection process prior to 1945 was somewhat simplified because there was only one material from which wood cutting tools were made--steel. In the early 1940's, tool engineers began to experiment with carbide tipping various cutting tools. Carbide tipped tools had been in use for some time in the ferrous metals industries in both Europe and the United States. The application of carbide to woodworking tools had not been seriously pursued, however, until after the Second World War. This lag in development was no doubt due to the ease of machineability of wood materials as compared to hard metals. It was also due to the fact that wood cuts could be finish sized by sanding or through inexpensive secondary cutting operations. Metals, on the other hand, had to be finish cut exactly to size and secondary cutting operations are extremely expensive in the metal working field.

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[2]Throughout this paper, the term "carbide" or "carbide tipped" will refer to tungsten carbide materials and to the grades of tungsten carbide commonly and successfully used in the woodworking industries. See appendix A for common woodworking carbide grades.

9. The introduction of carbide tipped cutting tools has somewhat complicated the tool selection process because it added a completely new dimension to wood cutting tools. It increased tool longevity by as much as 1000% in many cases. Because carbide tools are designed differently, they cut smoother than their steel counterparts and, therefore, require less finish operations. Whereas HSS tools can be sharpened with common hand files, carbide tipped tools require sharpening with expensive diamond impregnated grinding wheels and precision grinding machinery. In addition to these troublesome complications, the woodworker also finds the price of a comparable carbide tool may be as much as ten times the price of a high speed steel tool. Carbide tipped cutting tools are also more difficult to maintain simply because they have brazed in cutting teeth; and, if these teeth come lose, they must be replaced with new ones. A high speed steel tool, on the other hand, has no brazed in teeth to lose and, therefore, maintenance is simply a matter of keeping the teeth sharp with a hand file.

10. In spite of all these complications, carbide tipped cutting tools perform so much better in the vast majority of applications than do HSS tools that they are here to stay. As a matter of fact, in both the developed and developing nations, carbide tipped tools are replacing high speed steel at a very rapid rate.

1.1.3. Stelite Tools

11. During the 1950's several American and European companies began experimenting with the application of a relatively new steel alloy called stelite on wood cutting tools. Here again, as in the case of carbide, stelite was developed by and for the ferrous metals industry. Stelite is an alloy steel much harder than regular high speed steel. It is so hard, in most instances, it is not economical to machine stelite with conventional carbide lath tools and milling cutters, but rather it must be ground to shape using hard grit grinding wheels.

12. At first stelite was often applied to the teeth of high speed cutting tools by being melted onto the teeth as an electronic welding rod is melted onto a piece of steel. Today, however, stelite is produced in small tips, as is carbide, and is brazed to the tool in the same manner as carbide is brazed.

13. Whereas carbide will normally increase the cutting life of a tool from 500% to 1000% between sharpening over high speed steel; stelite will normally increase the cutting life from 200% to 600% over high speed steel.

Therefore, today there are three major materials to be considered when selecting cutting tools, i.e., high speed steel, carbide, and stelite.

1.1.4. Ceramic Tools

14. Actually, there is a fourth material now in the experimental stage. That material is ceramic tipped tools.

Ceramics are much more wear resistant than any of the presently used cutting materials. They are, however, extremely delicate and, at this tim , are not very well perfected. Therefore, this paper will not consider ceramic tipped tools as possible selection alternatives.

1.2 Technical Differences Between Solid Steel and Tipped Tools.

15. In describing high speed steel tools, carbide tipped tools and stelite tipped tools, the carbide and stelite tools are always referred to as tipped tools. This is because of the design and construction characteristics of carbide and stelite tools versus high speed steel tools.

1.2.1. Tool Design

16. In a high speed steel tool, the cutting teeth or cutting edges are made from the same material as is the tool's body. In the case of a carbide or stelite tool, the cutting teeth or cutting edges are made from carbide or stelite while the body of the tool is made from steel. (See description: Drawing A) To persons famili r with these various cutting tools, this observation is elementary. This characteristic, however, plays an extremely important part in the cutting results obtained from a high speed steel tool versus a tipped tool.

1.2.2. Clearance Angles

17. All cutting tools regardless of their construction must have cutting clearances built into the cutting teeth.

If these cutting clearances do not exist, the tool will burn the material rather than cut it. In other words, a cutting tool such as a saw blade must cut slightly wider than its body thickness; otherwise, the body will rub on the material causing friction and severe heating of both the material and the saw blade. (See descriptive Drawing B)

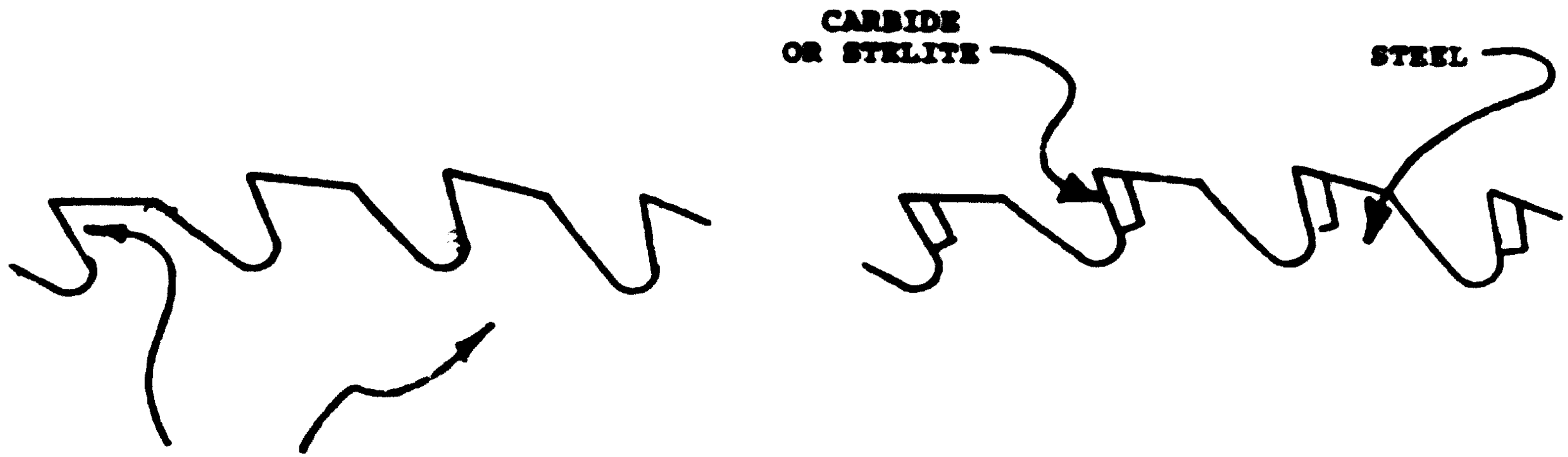
18. In the case of the saw blade shown in the top drawing, the cutting teeth have been properly "swagged" (bent) to provide the necessary cutting clearances. The saw shown in the lower picture has all of its teeth running in line and does not provide cutting clearance and, therefore, will burn the material.

19. Because the cutting teeth on a high speed steel saw blade are made of the same material as the body, they wind up being the same thickness as the body. Therefore, they must be "swagged" or bent in order to provide the necessary cutting clearance. A brazed on tip such as carbide or stelite, however, can be ground larger than the steel body and, therefore, can provide the cutting clearance. (See descriptive Drawing C)

1.2.3. Cutting Characteristics

20. Because the teeth in a high speed steel tool must be bent or "swagged" in order to provide clearance, they seldom

DRAWING A

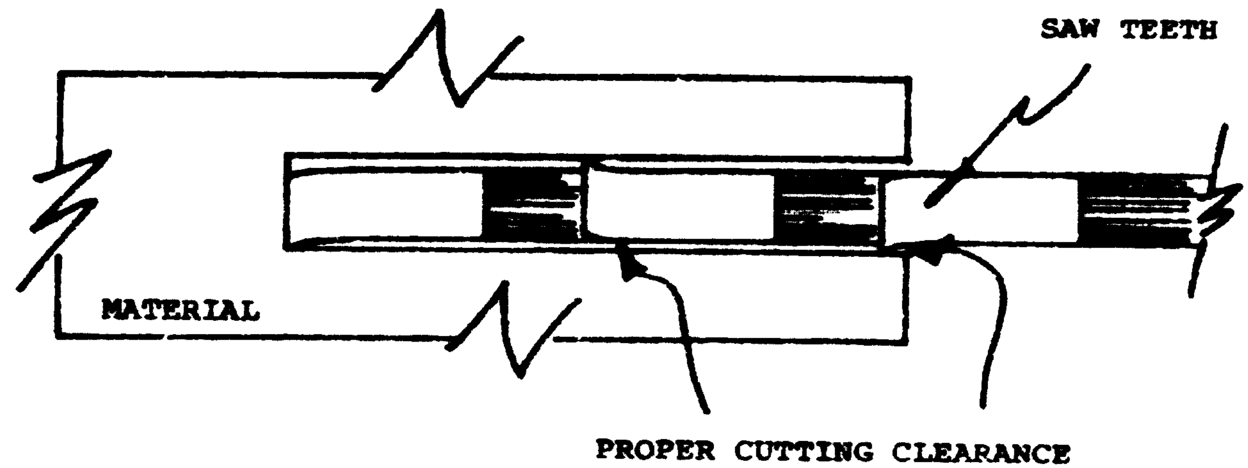


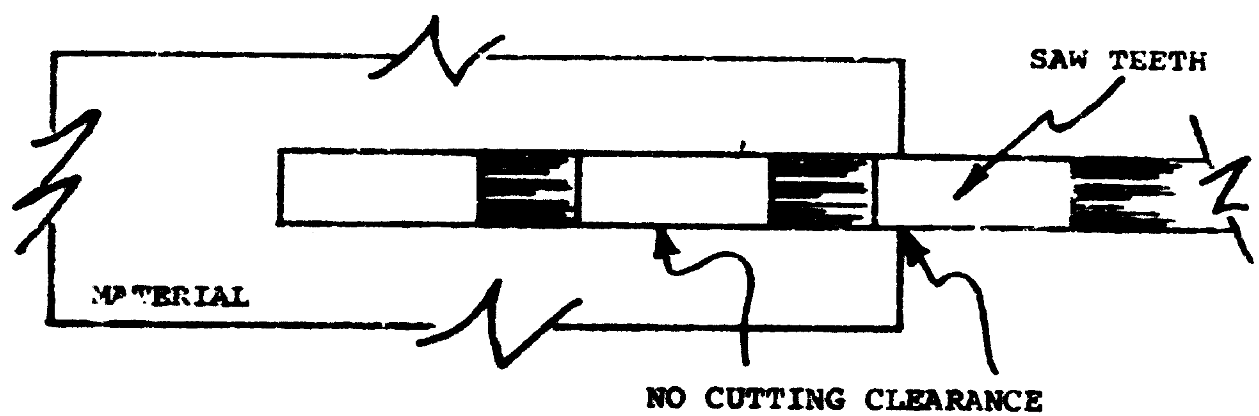
CUTTING TEETH AND TOOL BODY ALL MADE OF STEEL.

CUTTING TEETH MADE OF CARBIDE OR STELITE. TOOL BODY MADE OF STEEL.

DRAWING B

TOP VIEW LOOKING DOWN ON THE SAW BLADE





give as smooth a cut as the tipped tool. This is because the tipped tool's clearances are ground onto the tips and, therefore, the tips are much more aligned one to the other than are the bent steel teeth. Often a high speed steel saw will produce cutting lines whereas the tipped tool will not. (See descriptive Drawing D)

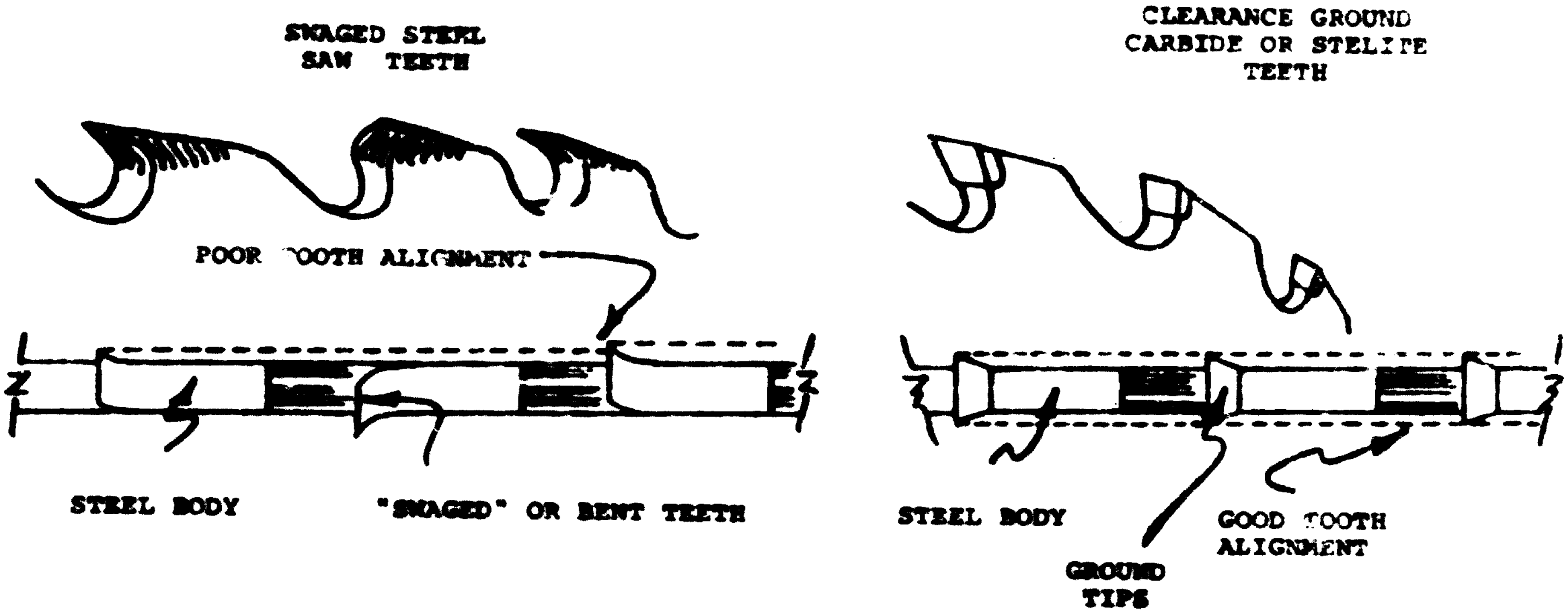
21. Clearly, it is obvious a ground surface will produce a smoother cut than a bent surface. This is, however, an important consideration when selection of cutting tools involves a choice between steel saw blades and tipped saw blades. Though the initial cost of the tipped tools may be greater, they will provide finish surfaces at the cutting station, thus, eliminating what may be very expensive finishing operations.

22. Generally speaking, this rough cut condition is centered around high speed steel saw blades. Other high speed steel tools such as planner knives, moulder heads, shaper heads, etc. will not necessarily leave cutting marks on the material. The offsetting factors in these tools, however, centers around their relatively short cutting life as compared with the hard metal tipped tools.

1.3. Summary

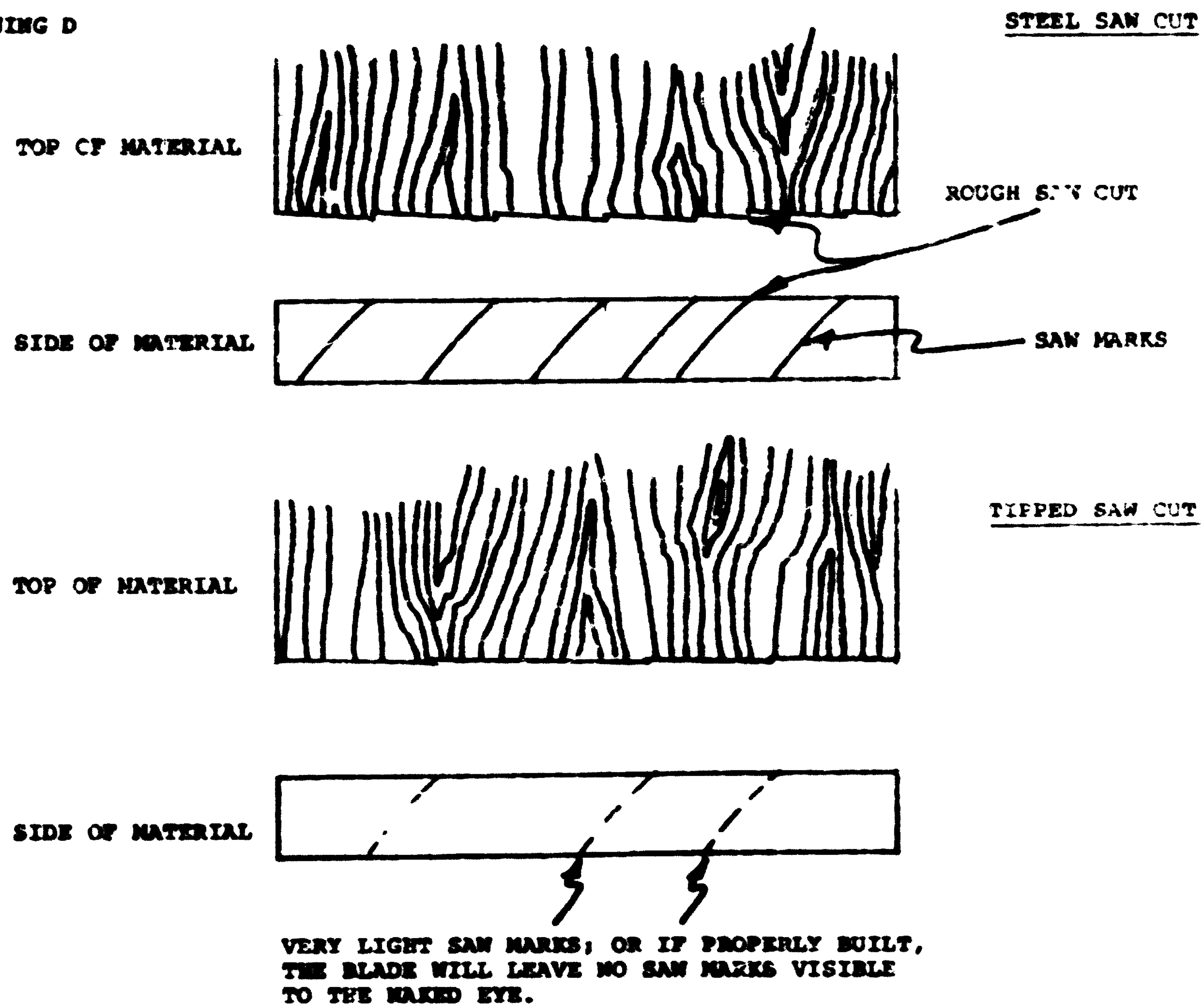
23. This chapter has dealt with the basic differences in the design, construction, and general cutting characteristics of high speed steel, carbide tipped, and stelite tipped

DRAWING C



SWAGED STEEL
SAW TEETH
POOR TOOTH ALIGNMENT
STEEL BODY
"SWAGED" OR BENT TEETH
CLEARANCE GROUND
CARBIDE OR STELITE
TEETH
STEEL BODY
GROUND
TIPS
GOOD TOOTH
ALIGNMENT

DRAWING D


STEEL SAW CUT
TOP OF MATERIAL
ROUGH SAW CUT
SIDE OF MATERIAL
SAW MARKS
TIPPED SAW CUT
TOP OF MATERIAL
SIDE OF MATERIAL
VERY LIGHT SAW MARKS; OR IF PROPERLY BUILT, THE BLADE WILL LEAVE NO SAW MARKS VISIBLE TO THE NAKED EYE.

cutting tools. Some of the differing characteristics described here are quite basic, such as the differences between the steel cutting edge and the brazed in tip. Also, anyone familiar with cutting tools may find the description of clearance angles quite elementary.

24. It is important to appreciate these basic differences, however, and to realize that proper tool evaluation and tool selection cannot be accomplished without such an appreciation. There are, of course, various other considerations such as the material being cut, the material feed rate, the tool RPM (revolutions per minute) and the finish cut required which must play important parts in tool selection. These aspects will be dealt with in succeeding chapters.

II PERFORMANCE CHARACTERISTICS OF HIGH SPEED STEEL, CARBIDE TIPPED, AND STELLITE TIPPED CUTTING

2.1 Major Considerations In Tool Design

2.1.1. Tool Life

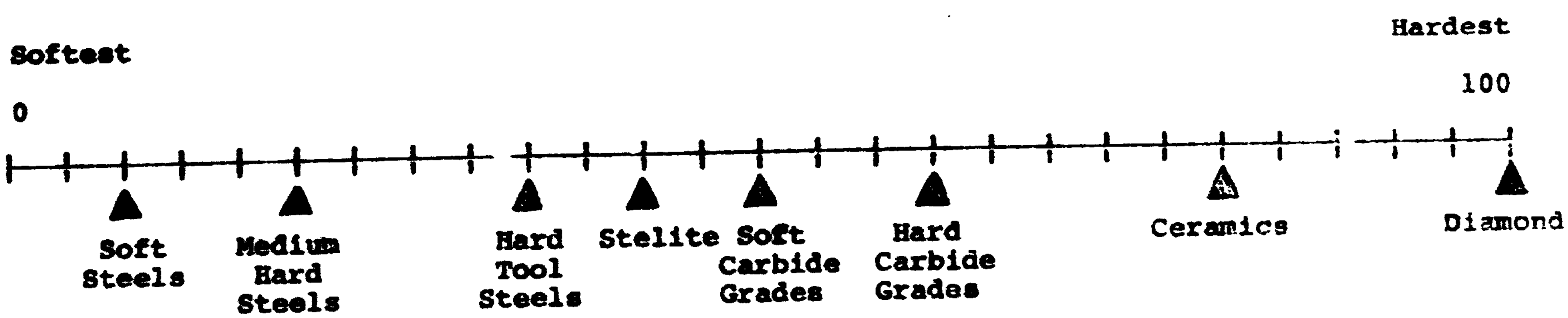
25. Tool life (the length of productive cutting time between sharpenings) is one of the major aspects of successful tool selection. If tools are selected which will provide maximum tool life, vast savings will result from reduced cutting machine down time and reduced maintenance costs.

26. The degree of wear resistance of the cutting tool employed has the major effect on tool life. In order to appreciate the various degrees of wear resistance, various materials have been graphed on a continuum chart (See Chart 1). This chart is not intended to compare actual hardnesses of the various materials but rather give some indication of the hardness relationship one to the other.

2.1.2. Tooth Design

27. Regardless of the type of material selected for the cutting edge, the design characteristics of the cutting tool will have a great deal of effect on the cutting life of tools. For instance, a more massively designed tooth shape will, of course, last longer than one of delicate design. (See descriptive Drawing E)

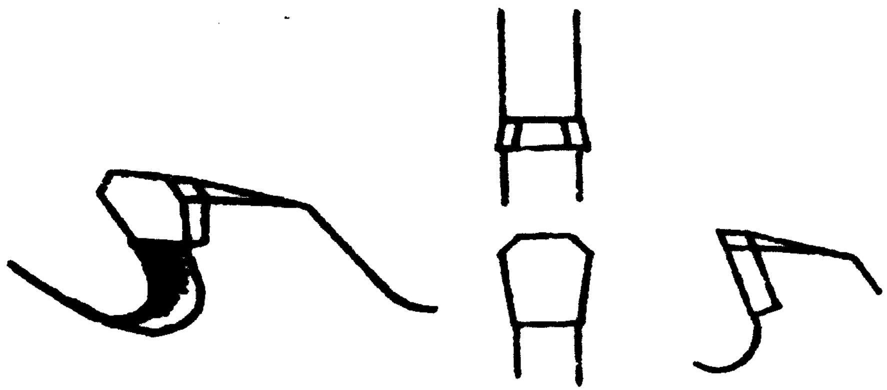
CHART I



On a general continuum ranging from "0" to "100", the above stated materials will fall approximately in their designated positions. The "0" reading representing the softest (least wear resistant) material and the "100" reading representing the hardest (most wear resistant).

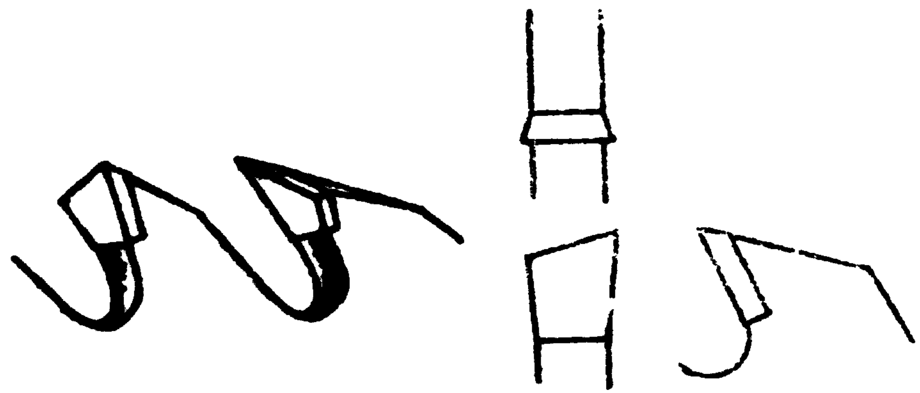
This chart was compiled from statistical information as published in the Machinery Handbook-16th edition. ERIK OBERG AND F. D. JONES, The Industrial Press, and from the 1972 Material Selector Periodical, published by Material Engineering Magazine, A Reinhold Publication, Connecticut, U. S. A.

DRAWING E



MASSIVE DESIGN TOOTH CONSTRUCTION

LONGEST TOOL LIFE



DELICATE DESIGN TOOTH CONSTRUCTION

SHORTEST TOOL LIFE

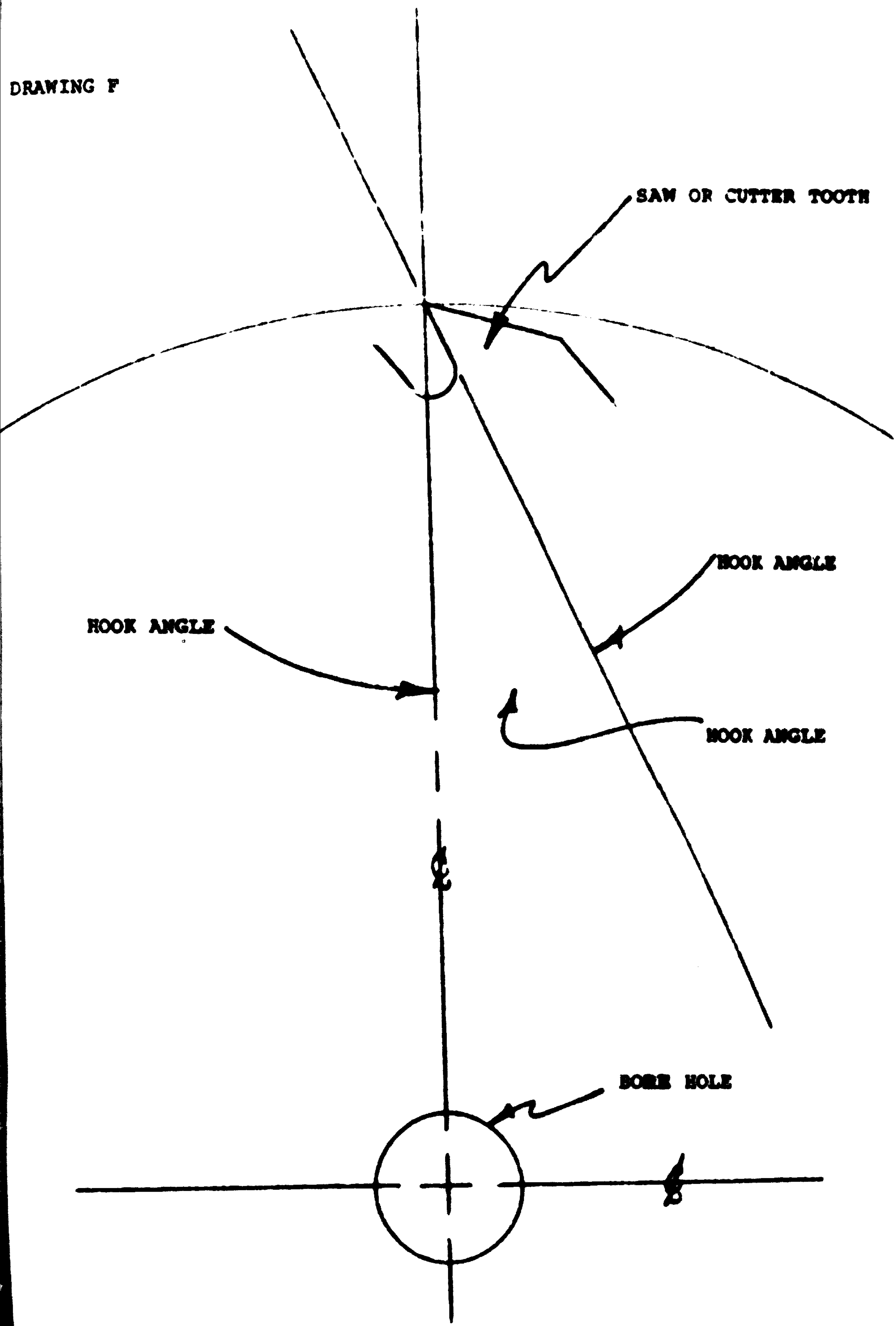
28. The immediate question which comes to mind when tooth construction is discussed is, why not always use the massive design and, thereby, maximize tool life? This could be a feasible decision if the smoothness of the cut is overlooked. Because of its massive design, this tooth form does not have the ability to sharply "clip" material fibers as does the delicate design. Therefore, it will not produce a smooth enough cut in all cases. This is especially true in soft fibrous materials such as plywood, pine, and balsa. It is also true in very hard brittle materials such as plastic laminate.

2.1.3. Hook Angles

29. Another factor in tool life is the degree of hook angle designed into the saw or cutter head. (See descriptive Drawing F) If the hook angle is made very steep, the cutting edge will have a sharper edge and will again be better able to "clip" the fibers in the materials being cut. The edge will, however, be more delicate and again will result in lower productive tool life between sharpening. (See descriptive Drawing G)

30. Generally, reputable tooling manufacturers will design the proper clearance and hook angles into cutting tools to produce maximum tool life while giving the quality of cut desired. It is important, however, to be aware of the importance of tool design when selecting cutting tools. Improperly

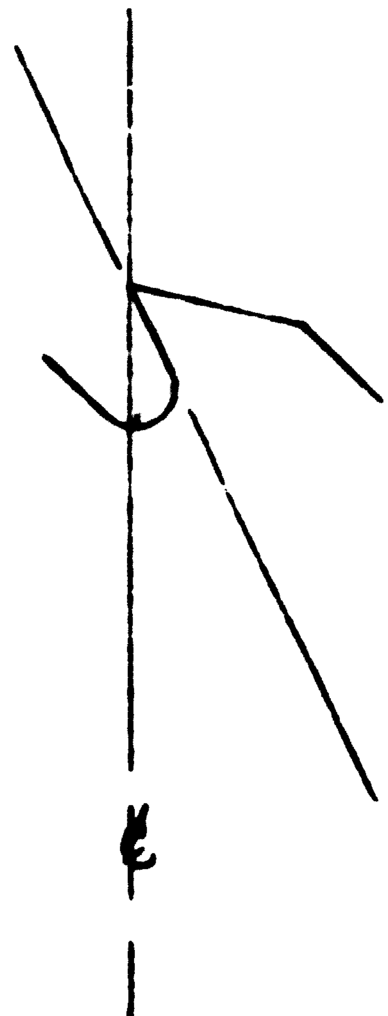
DRAWING F


SAW OR CUTTER TOOTH
HOOK ANGLE
HOOK ANGLE
HOOK ANGLE
BORE HOLE

DRAWING G

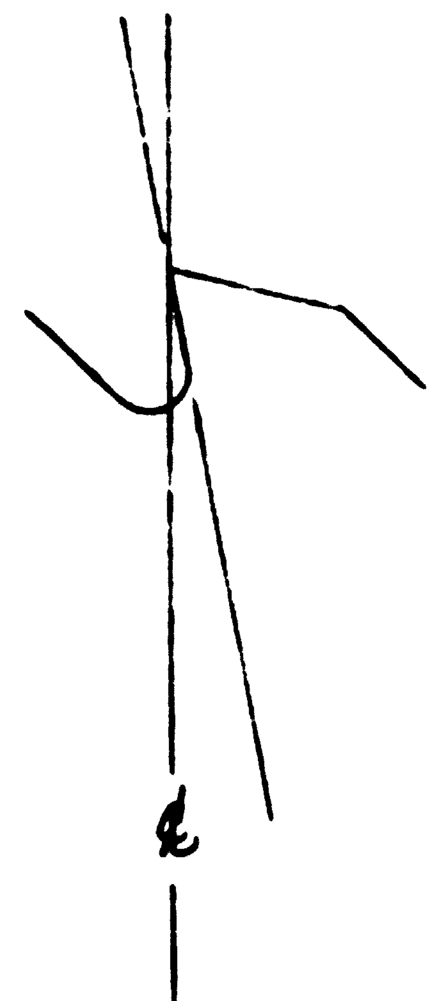
HIGH HOOK ANGLE

SMOOTHER CUT PRODUCED
BUT SHORTEST TOOL LIFE



LOW HOOK ANGLE

ROUGHER CUT PRODUCED
BUT LONGEST TOOL LIFE



designed cutting tools can result in very high production costs.

2.2. Tool Selection Relative to the Type of Material Being Machined

31. Though there are several thousand species and varieties of woods and wood component materials which must be machined on the world market, they basically fall into three main catagories, i.e., hard, medium, and soft. Because of the vast numbers of such species and component materials and the brevity of this paper, tool selection relative to materials will be dealt with on a broad scale. (See appendix A for Wood Classification Breakdowns)

2.2.1. Hard Woods and High Density Component Wood Materials

32. The relative hardness or softness of any material is a factor of the material's specific gravity and, of course, specific gravity is nothing more than a factor of the material's density. Naturally, the more compact a material is, the higher its specific gravity and the higher its hardness. Clearly, these same principles hold true for wood as they do for other materials.

33. Selecting tools for machining high density hard woods generally will center around two basic considerations, i.e., tool life and smoothness of the cut required. Cutting hard woods, high density particleboards, hard boards, or stacked hard laminated plastics require strong tooth design in order to withstand the tremendous impact of the tooth with the material and the severe abrassiveness of the resistant fibers.

34. Additionally, high density woods and component materials will generally produce a better degree of machineability than will softer low density materials. This is because the fibers in high density materials are so tightly compact they resist being torn away from the parent material as the cutting edge penetrates them. This resistance to tearing allows the sharp edge of the tool to "clip" the fibers sharply at the point of impact producing a sharp, clean cut through the material. Due to the high density of the material, it also resists compaction. This characteristic holds the wood fibers firmly in place allowing the cutting edge to shear the fibers cleanly.

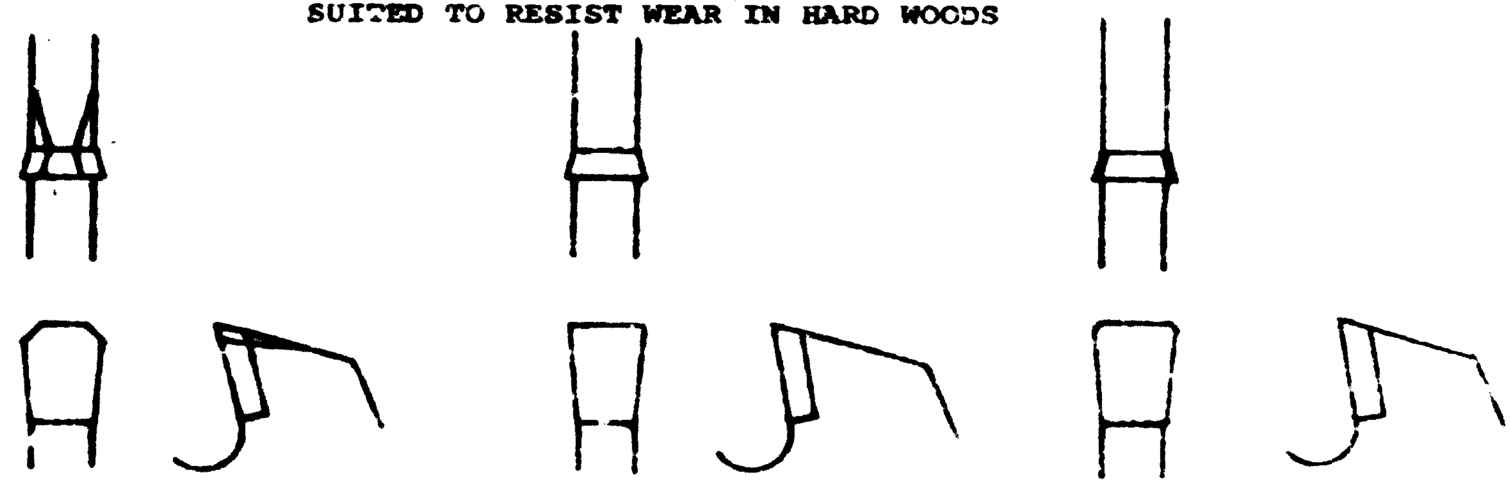
35. This concept can be demonstrated by holding a hand full of straw loosely in the hand and then trying to cut through the straw with a sharp knife. It will be found the straws will push away from the knife blade as pressures build up prior to the knife edge penetrating the material. Conversely, if the straws are held tightly and compacted together as much as possible, they will not yield nearly so much before the knife edge penetrates; and they will be cut much smoother.

36. Because of the high resistance to tearing out of fibers in hard woods, the massive tooth styles can be used in most cases with excellent results. This is important because the massive tooth designs have the highest resistance to wear and, therefore, will produce satisfactory cutting life in the hard woods.

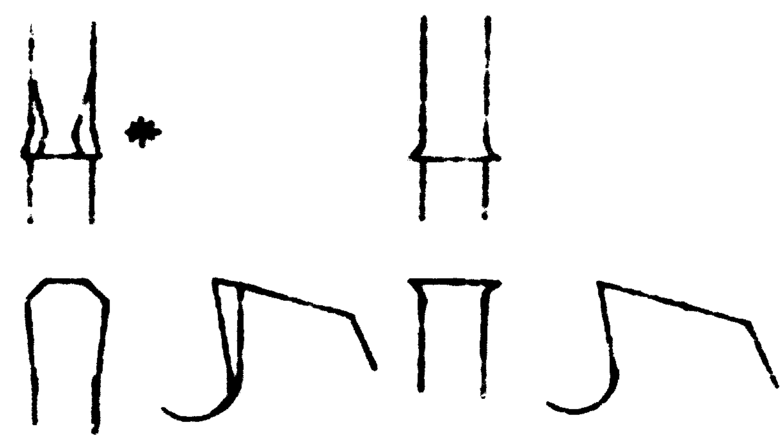
37. As a general rule, it should be remembered that the more "blocky" the tooth construction, the longer the tool life will

DRAWING H

THESE STYLES OF SAW TEETH ARE BEST SUITED TO RESIST WEAR IN HARD WOODS



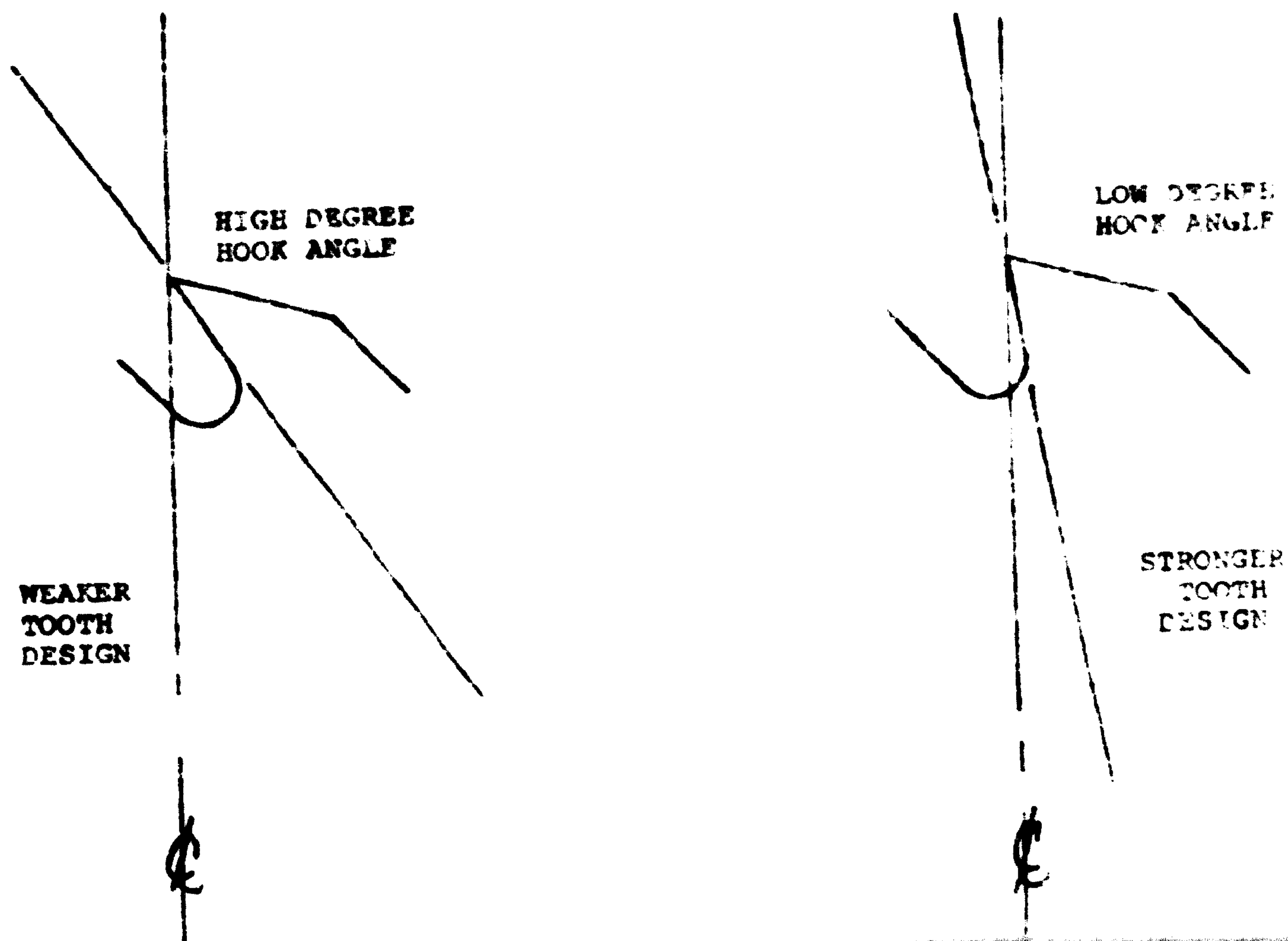
MASSIVE TOOTH DESIGNS IN TIPPED TOOLS



MASSIVE TOOTH DESIGNS IN STEEL TOOLS

* IT IS QUITE RARE TO FIND THIS PARTICULAR TOOTH DESIGN. IT IS OFTEN FOUND IN STEEL SAWING OPERATIONS BUT THE EXPENSE OF ITS CONSTRUCTION MAKES THE TIPPED TOOL MORE PRACTICAL IN WOODWORKING APPLICATIONS.

DRAWING I


HIGH DEGREE
HOOK ANGLE
WEAKER
TOOTH
DESIGN
STRONGER
TOOTH
DESIGN

be. This is because the square tooth construction provides stronger support to the cutting edge, thus, protecting it from rapid breakdown and dulling. (See descriptive Drawing H)

38. The wider variety of massive tooth designs available in tipped tools allows a greater degree of flexibility in selection. This results in selecting a tool which will produce both a high quality cut and a maximum tool life.

39. It is important to remember, however, that the more delicate tooth designs can be used in hard woods and will produce excellent cuts. This is true for both steel and tipped tools. The only adverse result will be extremely short tool life. Sometimes where circumstances demand unusual application of tooling, the delicate tooth designs must be applied to high density materials and, in such cases, the demands of the application will warrant the shortness of productive tool life.

40. In hard woods, the hook angles can be reduced slightly. This will serve to further strengthen the tooth construction (See descriptive Drawing O)

41. The main problem of using a massive tooth design and a low hook angle is the difficulty of feeding the material into the saw blade or cutter head. Cutting tools with low hook angles resist materials being fed into them. This resistance makes it difficult for the machine operator to feed the materials and the harder the materials are, the more resistance

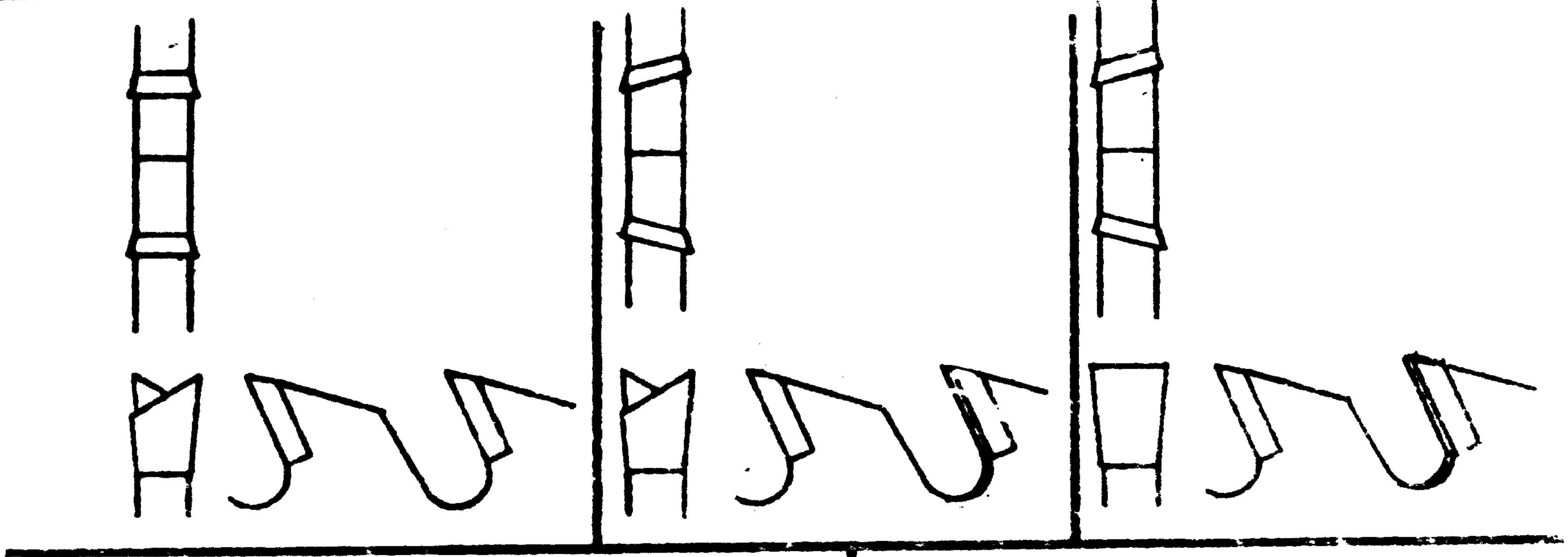
the tool sets up. Therefore, where materials are hand fed into the cutting tool, the degree of hook must be kept relatively high in order to avert rapid operator fatique. In automatic feed machines, the problems are much less of a concern although the feed rate may have to be slowed down slightly.

2.2.2. Soft Woods and Low Density Component Materials

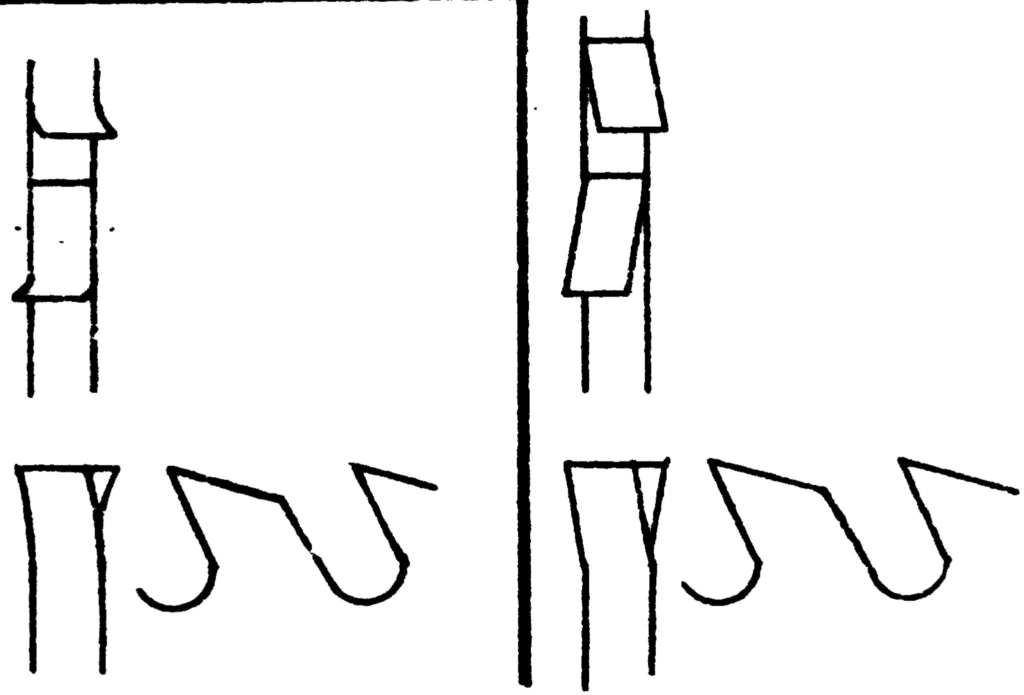
42. Low density or soft materials are those having a lesser specific gravity than hard materials. Their fibers are not nearly so closely compact as the hard materials. In the case of wood materials, the fibers may be so loosely held together there is actually an appreciable amount of air space between them. Balsa wood and low density chip core represent good examples.

43. It also becomes obvious, using balsa wood as an example, that the low density materials have a much lower resistance to compaction when they are impacted by a cutting tool than do the hard woods. Balsa can be crushed by an improperly applied cutting tool. The fibers in balsa would be torn and frayed if they were cut by the massive tooth designs because they do not have the strength to resist the tremendous pressures of the cutting impact.

44. The soft woods require very sharp cutting edges which will "clip" their fibers with the least amount of pressure possible. This means that tooth designs for soft materials should have their cutting edges drawn to the sharpest point possible. Due to the softness of the materials, there is less



THESE STYLES OF SAW TEETH ARE BEST SUITED TO "CLIP" THE FIBERS IN SOFT WOODS PRODUC-ING THE SMOOTHEST CUTS.



DELICATE TOOTH DESIGNS IN STEEL TOOLS

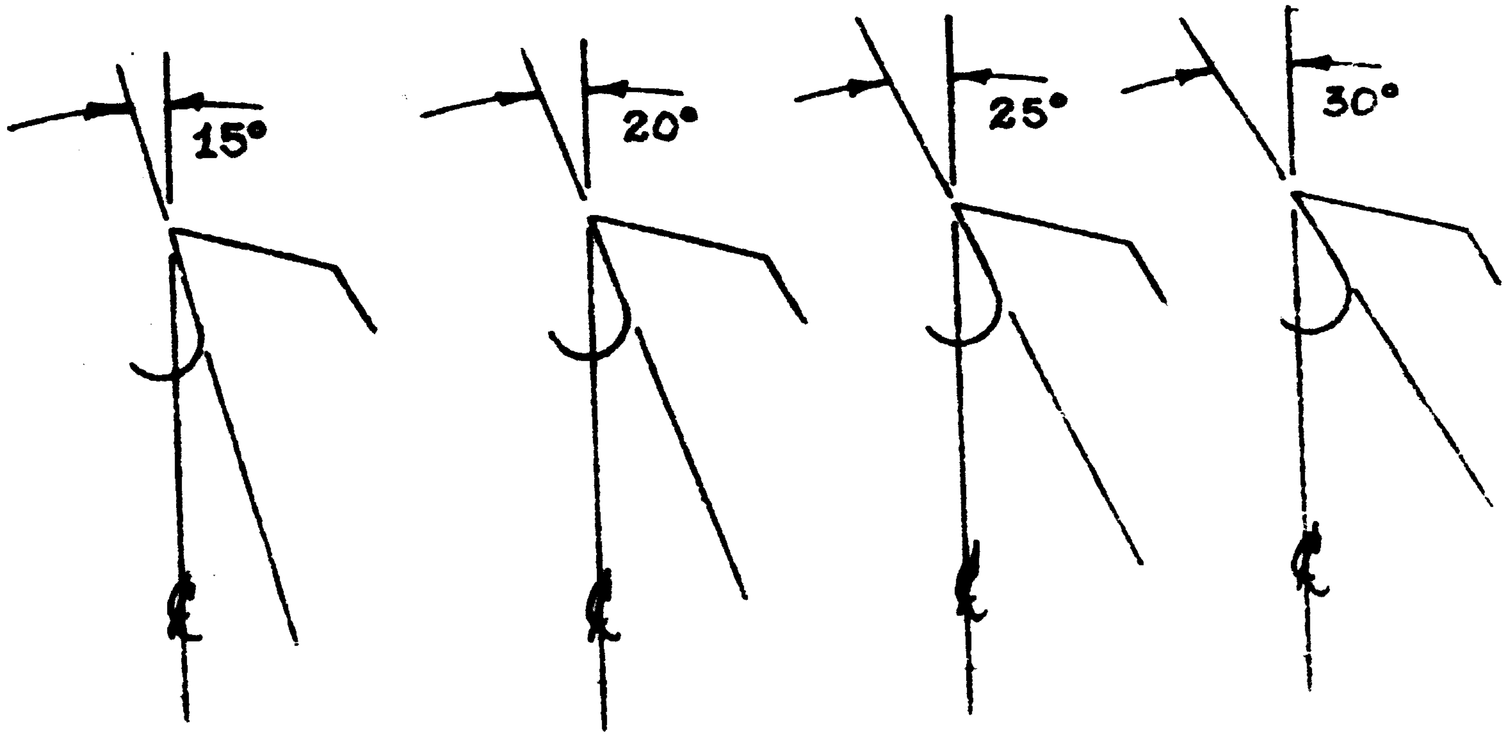
resistance to the cutting edge and, therefore, there is less abrasion to the teeth resulting in the more delicate edges being able to produce acceptable levels of productive tool life.

45. Generally speaking, the tooth designs for soft woods will have higher angles in all cases. These higher angles produce sharper cutting edges with sharp points which serve to "clip" soft fibers. (See descriptive Drawing J)

46. There are several other tooth designs used in soft woods but the ones shown in Drawing J serve to represent those most commonly found. Because of the softer materials, tool life is probably not as critical a factor in tool selection here as it is in hard woods. The softness of the woods does, however, make it more difficult to obtain a smooth finish cut and, therefore, the major emphasis shifts to the quality of the cut desired. As stated before, the tipped tools will produce a smoother cut in the vast majority of cases because their teeth are more evenly aligned than are the teeth of high speed steel tools.

47. Here again, there is no clear line indicating the point at which to switch from massive construction to delicate construction. Massive tooth styles can be used on soft woods and will produce extremely long tool life. They will not in the majority of instances, however, produce smooth cuts. In some instances, it is wise to obtain this very long tool

DRAWING J



HIGH HOOK ANGLES HELP "CLIP" SOFT
WOOD FIBERS HOOK ANGLES OFTEN FOUND
IN DELICATE TOOTH CONSTRUCTION

life. This would be especially true of any cutting operation where the quality of the cut is not important because secondary cutting or finishing operations will occur.

48. As in the case of all of the other angles in the delicate tooth designs, the hook angles can be made quite steep without appreciable loss of tool life. (See descriptive Drawing K)

49. The higher the degree of hook angle, the easier material will be able to be fed into the cutting tool. At the same time however, the tools having higher hook angles will become dull much faster than those with lower hook angles.

2.2.3. Medium Woods and Medium Density Component Materials

50. Tool Selection for the medium density material is somewhat simplified because both the massive and delicate tooth construction will produce acceptable results. The materials found in this catagory, for the most part, possess some of the characteristics of both the high density and low density materials. Therefore, cutting quality and tool life become almost an even trade-off against each other.

51. The same principles of cutting quality versus tool life apply to the medium density materials just as they do to the others.

2.2.4. Summary of Materials

52. The main thing to remember in tool selection is it is a process of trade-offs. If a high quality, smooth cut is demanded, some tool life will be lost to accomplish this. If

maximum tool life is demanded, something will be sacrificed in the quality of the cut produced. If the machine operator wants a tool which will easily accept the material he is feeding into the machine, a high hook angle on the tool will accomplish this. Such a tool will not last as long between sharpenings as will one which has a lower hook.

53. Tools with fewer teeth will not cost as much as those with many teeth. They also will not produce as smooth as finished cut as tools with many teeth.

54. It becomes obvious that wherever something is to be attained in tool selection, something else is sacrificed. The objective of good tool selection is to choose tool designs which maximize the desired results; while at the same time, hold the undesirable results within acceptable tolerances.

2.3 Miscellaneous Problems

2.3.1. Silica in Woods

55. Silica is most often found to a higher degree in soft fast growing woods. This wood grows at such a rapid pace, it takes portions of sand and stone into the cells of the tree as it grows. Much of the soft pine grown in the southern United States contains a very high silica content.

56. Silica is a very hard material ranking on the hardness continuum with glass and being just below hardened steel. Because of its hardness, silica produces extreme abrasiveness in woods where it is deposited in large quantities. This abrasiveness is very hard on cutting tools and can reduce

their productive cutting life by as much as 50% to 75%.

57. Tool makers can compensate for materials having a high silica content by using more wear resistant grades of carbide. In the case of high speed steel tools and stellite tipped tools there is little which can be done to increase tool life in silica impregnated woods.

58. In most cases, the harder more wear resistant grades of carbide used do not cost the tool maker any more than the normal grades and, therefore, should not cost the buyer any more. The buyer must, however, tell the tool maker that the material he is cutting is high in silica so the tool maker will understand the harder grade carbide is to be used.

2.3.2. Foreign Object in Woods

59. Any time a cutting tool hits a hard object in a piece of wood, there is a strong possibility the tool will be damaged. Foreign objects such as fence wire, bullets, rocks, pieces of steel, and glass are commonly found in woods grown throughout the world. Normally, by the time wood is processed to the point where it is fabricated into furniture, or plywood, or particleboard, it no longer contains a lot of foreign objects. In the primary lumbering operations, however, where logs are being sized into lumber, there is a high probability tools will be damaged by hitting foreign objects.

60. For many years there has been a strong argument whether or not to use metal detectors in order to stop machines in order to avoid hitting foreign objects. The decision whether

or not to invest in such equipment must rest with each individual business manager. His decision must be based on economic consideration. He must ask himself: Is it cheaper to replace the tool in the event it is damaged by hitting a foreign object or is it cheaper to shut down the whole operation when the metal detector finds a foreign object.

61. The main problem with metal detectors is they cannot decide between pieces of metal which will damage a tool and those which will not. Many metals such as lead and aluminum will not damage tooling in most instances. In many cases, a tool can hit several pieces of metal before it has to be taken off the machine and be repaired. The metal detector will cause the machine to be shut down each time a piece of metal is detected. This may not be economical.

2.3.3. <u>Wet Woods (High Moisture Content)</u>

62. If wood contains a lot of moisture cutting tool designs must be changed in order to properly perform. The main changes are their clearance angles must be increased and fewer number of teeth should be used.

63. Dry woods, i.e., those not needing specially designed clearance angles, contain 12% to 15% moisture content or less. Moisture contents of greater than 15% of the material's total volume can cause tooling problems. The most noticeable problem would be over heating of the tool. Especially in saw blades, this type of over heating can turn a saw blade black within minutes of starting up the cutting operation. Such

high heat will quickly destroy the cutting tool.

64. To avoid such problems, the buyer should simply tell the tool maker he is cutting material with greater than 12% to 15% moisture content. The tool maker* will then compensate for this condition.

2.3.4. High Resin Content in Particle Board

65. Studies performed by the Gulf Abrasives Corporation of Landsdale, Pennsylvania, U.S.A., have shown that resins in particle board can have a very great effect on tool life. When cutting particle board, it is almost always most practical to use carbide tipped cutting tools. Both high speed steel tools and even stelite tipped tools break down quickly under the abrasiveness of the resins found in particle boards.

66. Even where carbide tipped tools are used, there is a great difference in tool life depending upon how much resins the board contains. The study shows, "...that increasing the percent of resin solids content from five to eight percent had no appreciable effect on board abrasiveness but that at the nine to eleven percent level the abrasiveness was almost double that observed at the five to eight percent level."[1]

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*Whenever it is stated the buyer simply must tell the tool maker and the tool maker will adjust his design to correct the problem it is assumed the tool maker will be a large reputable company with the technical knowledge and willingness to make such adjustments. Generally, these companies are the larger tool companies in Japan, Western Europe, and the United States.

[1]A Quantities Study of Some Factors Affecting the Abrasiveness of Particle Board, Robert P. Briges, as published in Forest Products Journal, Vol. 21, No. 11, November 1971 issue.

67. Wherever resins are cut, there will be a more rapid dulling of cutting edges. Carbides will extend the cutting life, but even their productive cutting life is drastically reduced by high resins.

III TYPES OF TOOLS AND HOW TO SELECT TOOLS FOR VARIOUS CUTTING OPERATIONS

3.1 Saw Blades

68. There are two basic types of cutting done with saw blades, i.e.

. Rip Cutting - Cutting with the grain

. Cross Cutting - Cutting across the grain

(See descriptive Drawing L)

69. Selection of saw blades must center around the operation to be performed; either rip cutting or cross cutting.

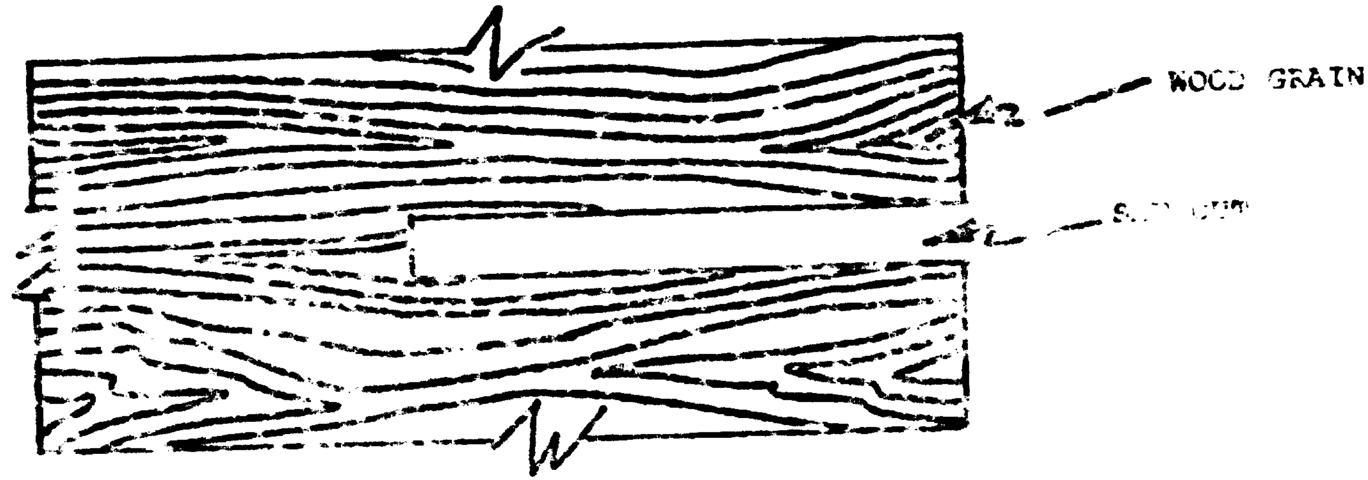
3.1.1. Rip Cutting (See Appendix B for Tool Selection Guide)

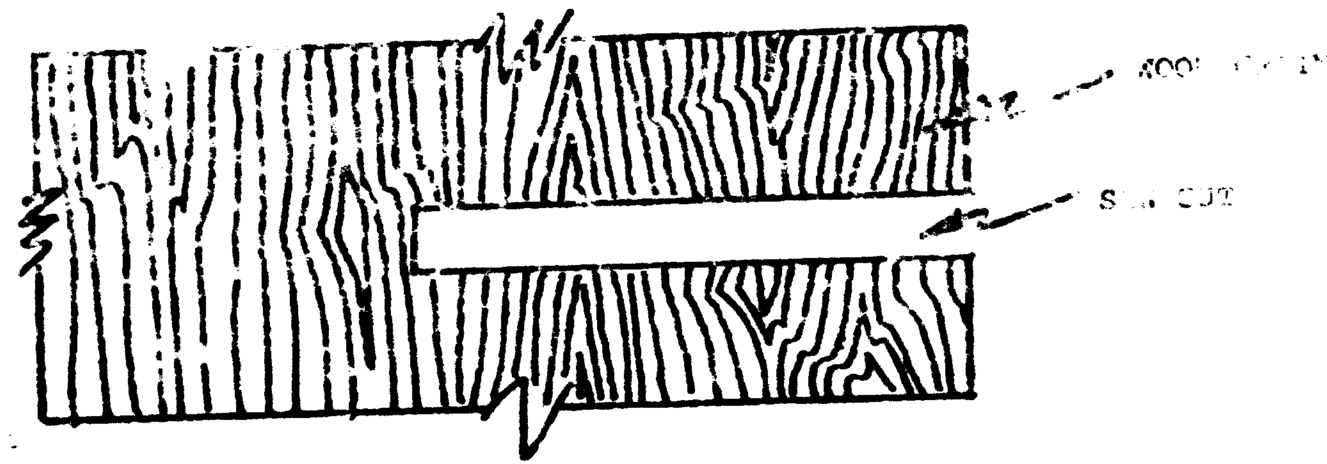
70. Generally, the massive tooth styles are applied to rip cutting regardless of the hardness and density of the material. The very soft woods such as balsa would be exceptions to this rule. Those exceptions would be rip cut with the delicate tool forms more successfully than with the massive tooth forms. The most common tooth forms used in rip cutting are shown in descriptive Drawing M.

71. Often in rip cutting, the material is glued back together after its bad sections are cut out. In order to achieve good glue joints which will not pull apart as the wood and glues age, the saw cuts must be very smooth in order to properly bond together. Wide gaps left by saw marks will cause the materials to split apart or may cause the glue to stain the

DRAWING L

RIP CUT

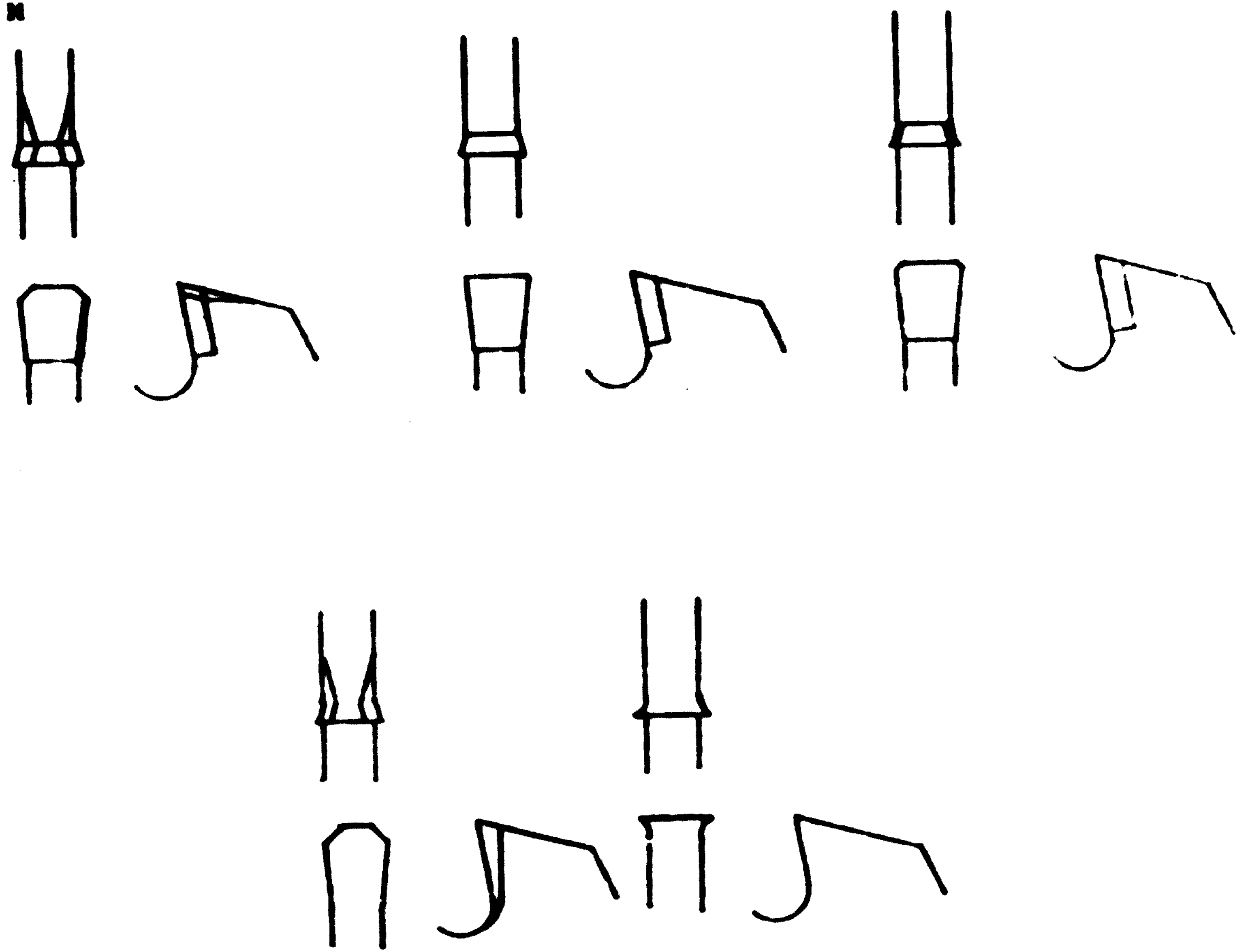




CROSS CUT

BASIC TYPES OF CUTTING

DRAWING N



COMMON TOOTH FORMS USED IN RIPPING

material where it seeps to the surface. (See descriptive Drawing N).

72. In ripping operations which are automatically fed, the feed rates can be much higher than in crosscutting operations. Feed rates of 90 feet per minute (274.32 meters) to 180 feet per minute (548.64 meters) are common on automatically fed rip saw machines. If the saw blades running on these machines are properly designed; and if the machines are well maintained, glue joint smooth rip cuts will be obtained.

73. In most cases it is wise to allow rip saw blades to be manufactured somewhat thicker than the crosscut blades. This additional thickness in the blades gives them more strength and will assist in obtaining smoother rip cuts.

74. It can be seen in Appendix B that rip saws for the most part have fewer teeth than do crosscut saws. There are two main reasons for this. First, in the majority of cases, rip saws are fed at a much faster feed rate than are crosscut saws.* If a saw blade with many teeth was applied to such a high feed rate operation, it would burn the material and the blade. Second, fewer numbers of teeth can be used because the cutting edges are "clipping" the material fibers on the top edge of the teeth rather than on the sides of the teeth

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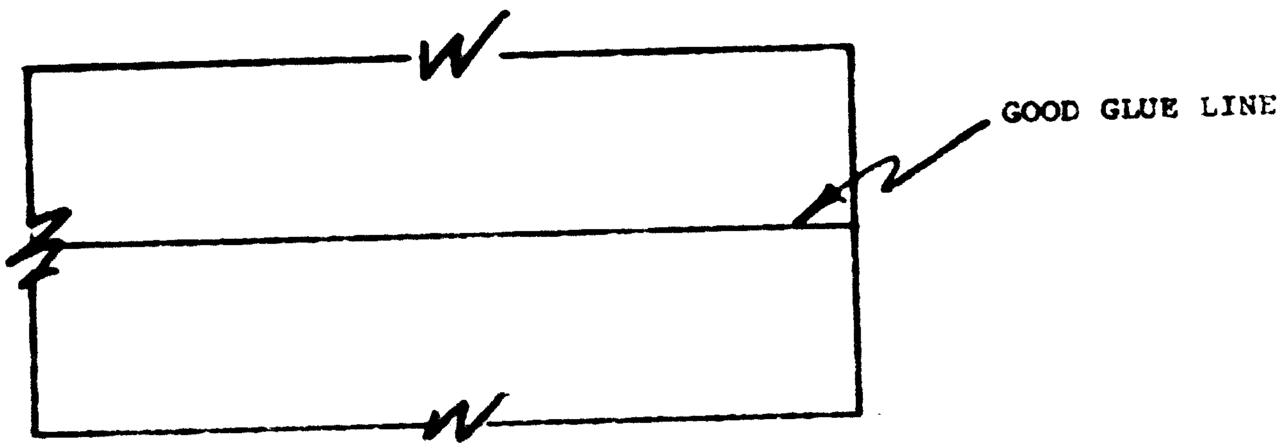
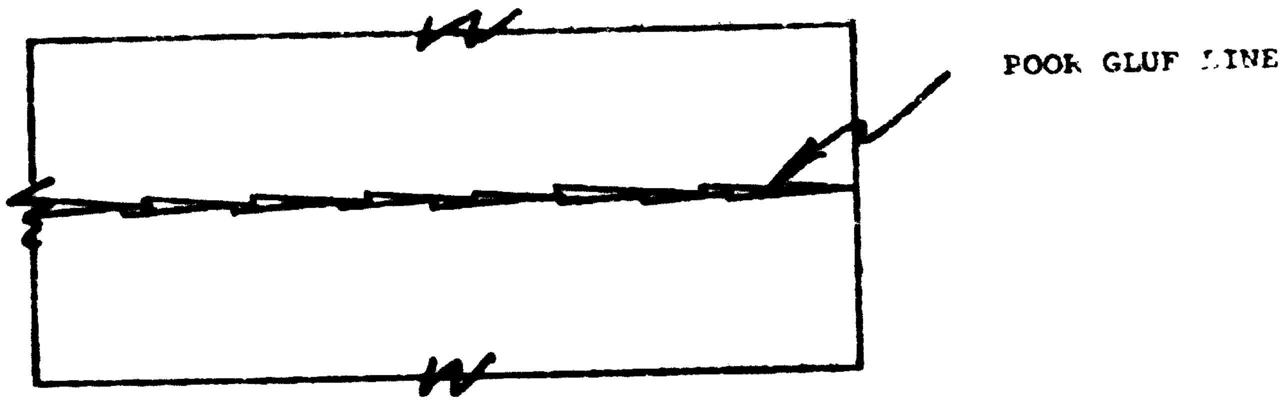
*This statement is not true if all the saw machines are hand fed. In hand fed operations, even though the feed rates are the same in both rip sawing and crosscut sawing, different blades should still be applied to the different operations in order to obtain best results.

DRAWING N

A GOOD GLUE LINE IS SMOOTH AND FORMS A TIGHT SMOOTH LINE BETWEEN THE BOARDS WHICH ARE GLUED TOGETHER.



A POOR GLUE LINE IS ROUGH FROM THE SAW CUTS LEAVING SPACES WHERE THE GLUE CAN RUN OUT AND STAIN THE MATERIAL. THIS GLUE JOINT WILL NOT HOLD AS WELL AS THE SMOOTH LINE.



as in crosscutting. (See descriptive Drawing O)

3.1.1.1. Summary-Rip Cutting

75. There are several rules which hold true in the majority of cases concerning the proper selection of rip saw blades:

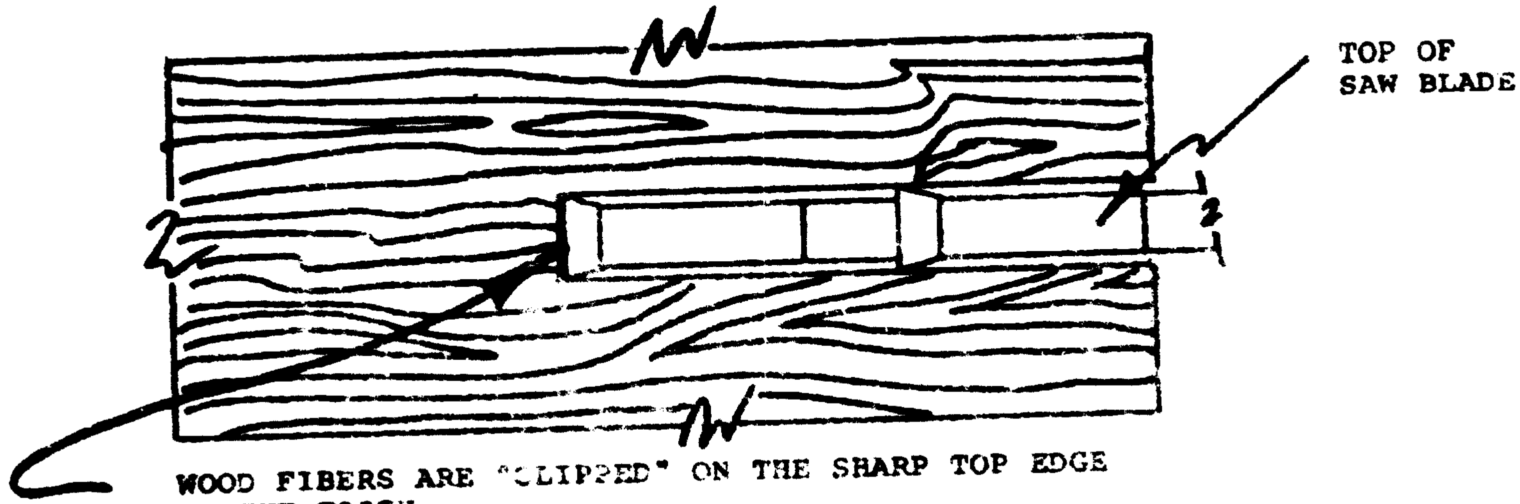
1. Rip cutting is usually most successful with saws containing low numbers of teeth.
2. The massive tooth styles will normally do a better job of rip sawing than will the delicate styles. This is particularly true where automatic feed rip machines are in operation.
3. It is usually better to allow the tool maker the ability to make rip saws slightly thicker than crosscut saws.
4. In general, it would be wise to use high speed steel saws for rough cuts where the quality of the cut is not so important and tipped tools in cutting operations where smooth cuts are desired.

3.1.2. Crosscut Saw Blades (See Appendix B for Tool Selection)

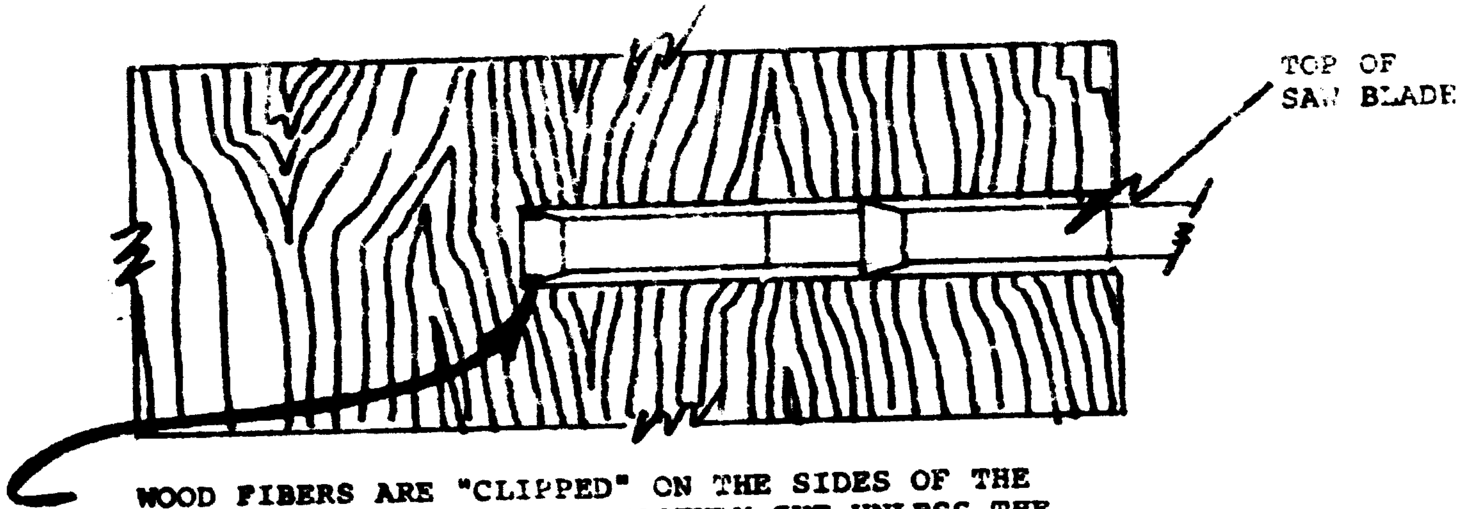
76. As in the case of the rip saws, the discussion of crosscut saw blades is made in general terms. It is meant to be a broad guide and to instruct the reader on the main things to be aware of in selecting crosscut tools.

77. The tooth designs usually applied to crosscutting operations are the delicate designs. (See descriptive Drawing P)

DRAWING O



WOOD FIBERS ARE "CLIPPED" ON THE SHARP TOP EDGE OF THE TOOTH.



WOOD FIBERS ARE "CLIPPED" ON THE SIDES OF THE MATERIAL AND CANNOT BE SMOOTHLY CUT UNLESS THE PRESSURES ARE REDUCED ON THE MATERIALS BY USING MORE TEETH.

The massive construction in tooth design may be successfully applied where very hard woods and high and medium density particle boards are being cut. In any operations where the material switches from hard woods to soft woods on a fairly consistant basis, it would be wise to use the delicate tool form blades on crosscutting at all times. This will save time in changing saw blades each time the material changes.

78. The reason the delicate tooth forms are applied to cross-cutting operation is the fact that their sharp points help them "clip" the cross grains with very light cutting pressures. In crosscutting, it is important to remember that the lighter the cutting pressures, the better the cut produced.

79. In addition to producing lighter cutting pressures, the delicate tooth forms generally have higher clearance angles. This is important due to the Flow Back Theory. The Flow Back Theory hypothecates that "...in all cases where materials are cut, regardless of their hardness and resistance to compressibility, there is compression of the material being cut. This compression takes place at the point where the cutting tooth initially impacts the material and is not relieved until the cutting tooth leaves the material. When the tooth leaves the material and the compressive forces are relieved, the material at the point of stress moves to a position close to its original position prior to impact causing a flow back wave."[2]

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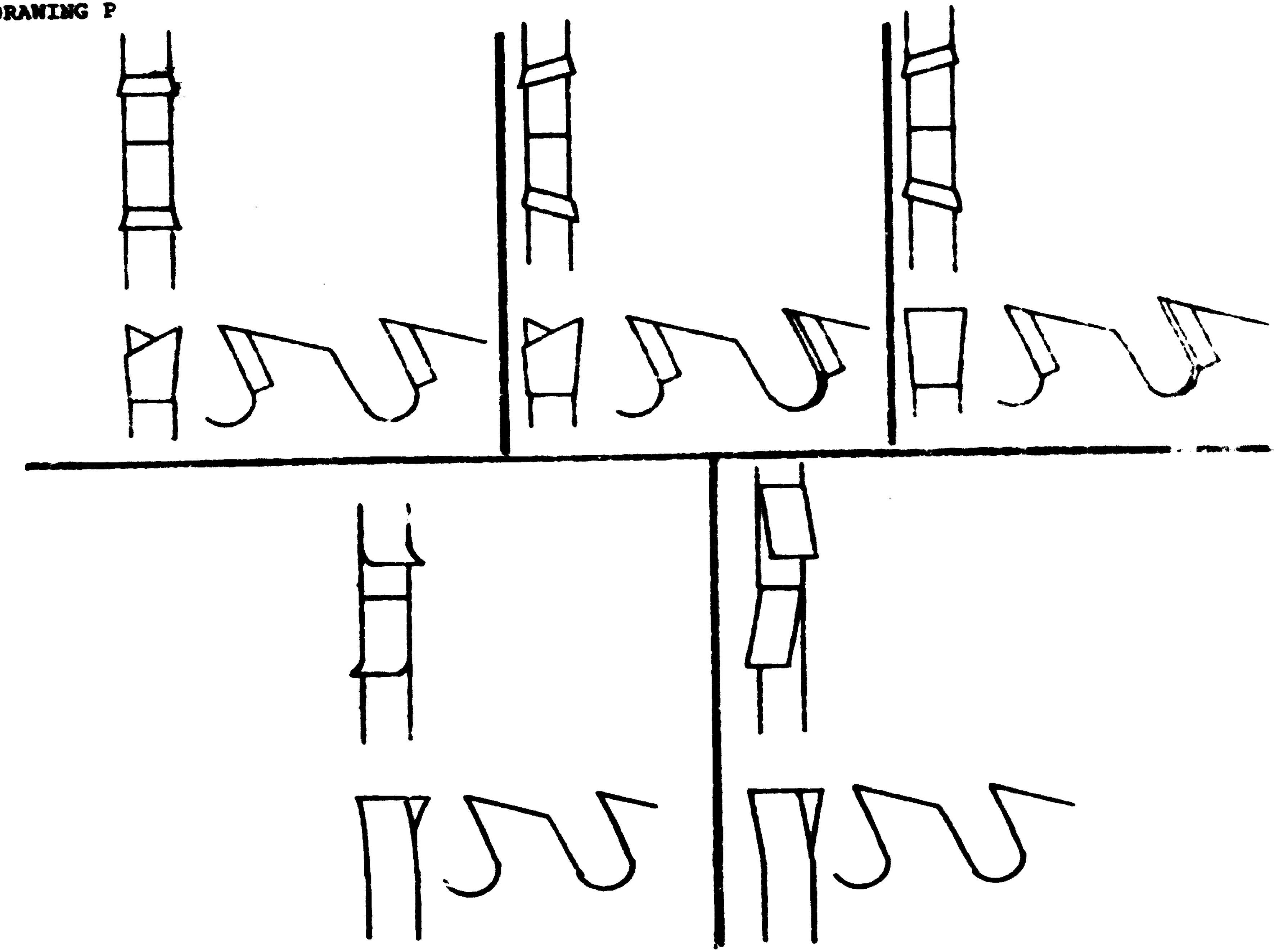
[2] The Flow Back Theory as first hypothecated by Arthur Robert Segal, North American Products Corp., private company papers, 1947.

DRAWING P



80. Simply stated, this theory means there will be a flow back wave directly behind a cutting tooth and the clearance angles of the tooth must be great enough to compensate for this flow back wave. (See descriptive Drawing Q)

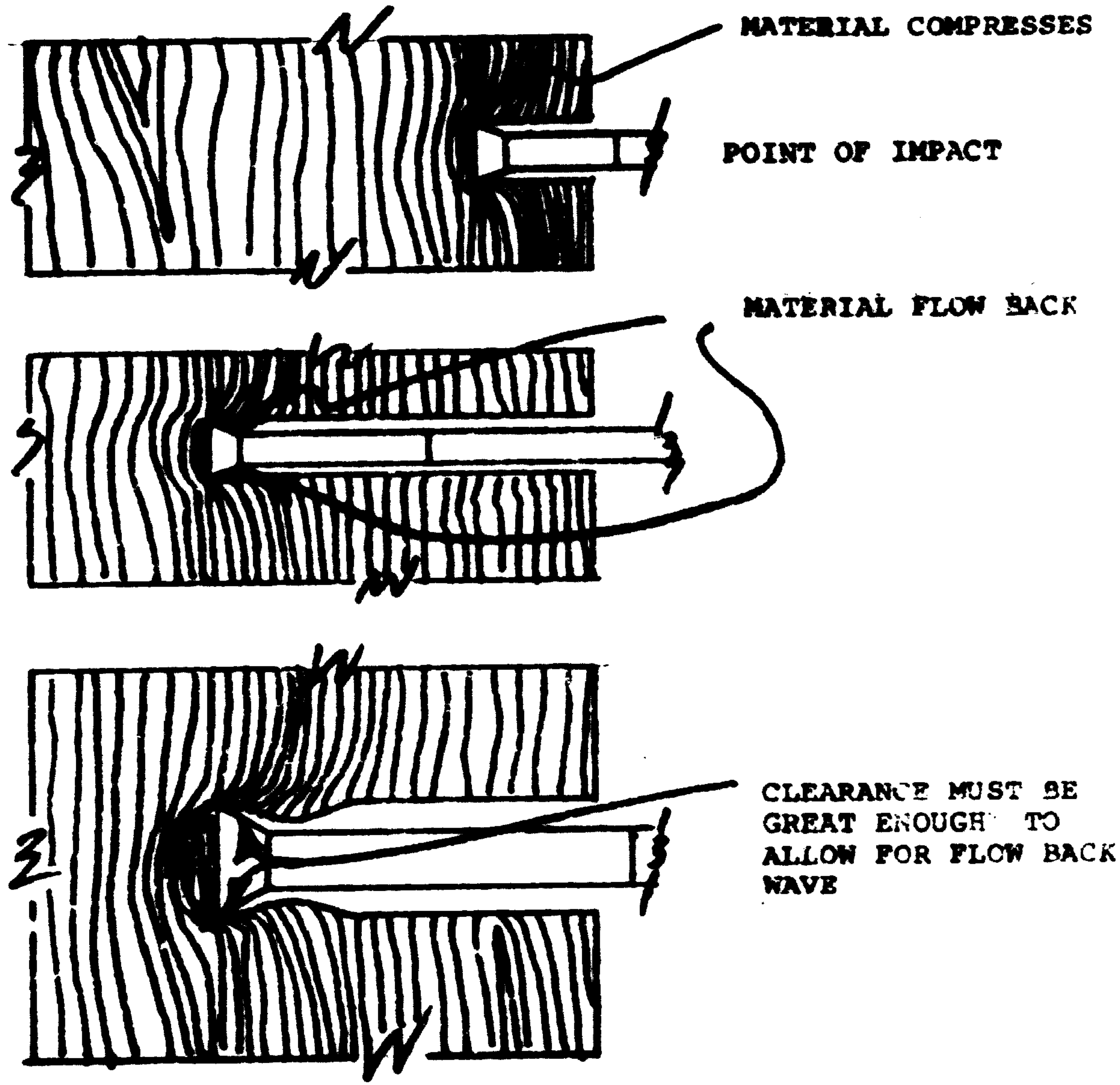
81. The Flow Back Theory further hypothecates that flow back waves will be greater in crosscutting operations than in ripping operations and greater in soft materials than in hard materials. Therefore, the clearance angles on the crosscut (delicate) tooth designs are generally greater than on the massive tooth designs.

82. Because there are lighter side pressures, crosscut blades can be made thinner than the rip blades. (See descriptive Drawing R)

83. One good tool design uses what is termed as "thin rim" body as shown in Drawing R. This body style provides the maximum amount of strength while at the same time producing the benefits of a very thin saw blade.

84. The crosscut saw blades will usually have more teeth than the rip cut saw blades for two main reasons. First, and most important, cutting pressures must be kept as light as possible in crosscutting. The more teeth a saw has the lighter bite each tooth takes and the lighter the cutting pressures are. Secondly, the feed rates are usually slower thus allowing more teeth to do a proper job of cutting.

DRAWING Q


MATERIAL COMPRESSES
POINT OF IMPACT
MATERIAL FLOW BACK
CLEARANCE MUST BE GREAT ENOUGH TO ALLOW FOR FLOW BACK WAVE

3.1.2.1. Summary

85. There are several main things which can be said about crosscut saws in summary:

1. The delicate tooth designs are usually better for crosscutting applications.
2. Generally, thin saws will perform better in crosscutting operations than in rip cutting.
3. Clearance angles usually have to be greater on crosscut blades than they do on rip blades.

3.1.3. Cutter Heads and Planer Heads

86. Selection of cutter heads* must also consider rip and cross cut applications but the general rules are not so complexed. The main thing to remember when selecting a cutter head for a crosscut application is to keep the hook angle as high as possible. It would be recommended that the hook angle should be between 15° to 25°. In some cases where very soft material is being cut, a hook angle of 30° is used.

87. The second major point in cutter head selection centers around the number of teeth the cutter should have. The general rule is; the more teeth the cutter has the smoother the cut will be. It would be wise to always specify at least three teeth in cutters larger than 4 in. diameter (10.16 centimeters). This will reduce the number of knife marks per inch (knife marks per centimeter) and will produce a smoother surface. (See

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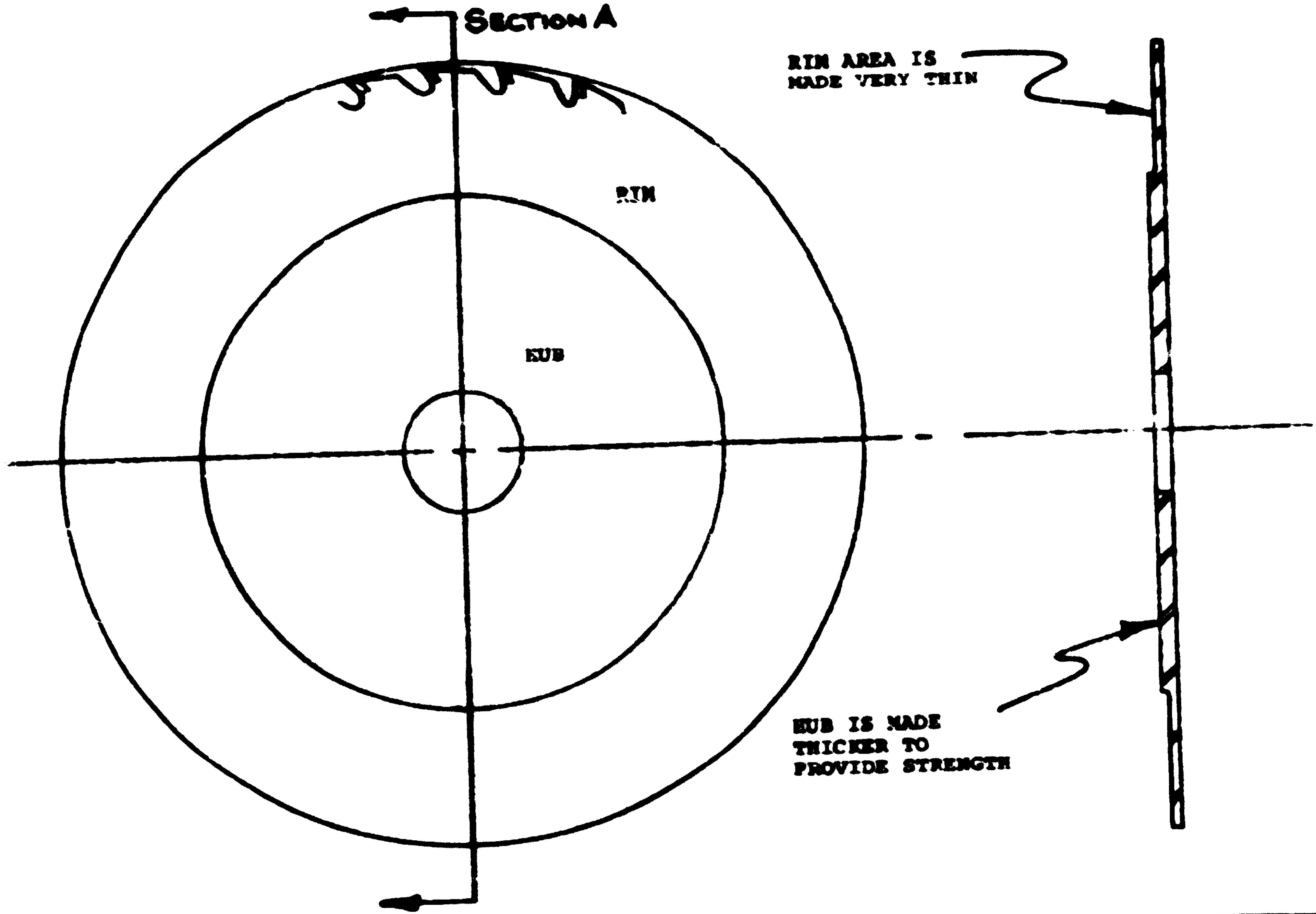
*Note: Whever the term cutter heads is used, it implies both cutter heads and planer heads.

DRAWING R


SECTION A
RIM
HUB
RIM AREA IS MADE VERY THIN
HUB IS MADE THICKER TO PROVIDE STRENGTH

descriptive Drawing 8)

88. Assuming the cutter is designed properly, there are three way of obtaining a smoother cut:

1. Increase the number of teeth in the cutter
2. Decrease the feed rate
3. Increase the revolutions per minute of the cutter.

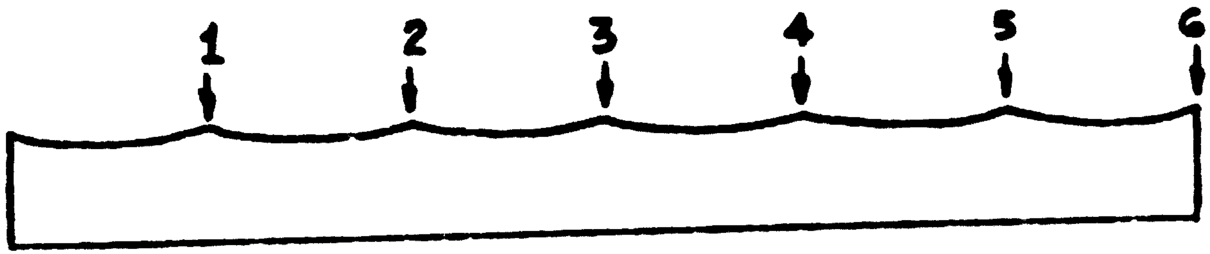
89. Anyone of these or a combination of them will produce smoother cuts. Conversely, doing the opposite in any or all three areas will, of course, produce a rougher cut.

3.1.3.1. Summary

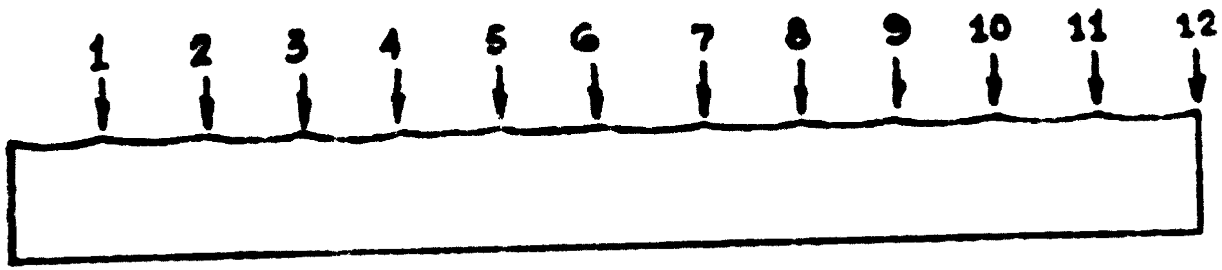
90. The two main points to watch in cutter head selection are the hook angles and the number of teeth in the cutter. Where cutters will be doing crosscut work, the hook angles should be kept high (15° to 30°). This is especially true in soft woods. The number of teeth, the motor RPM, and the feed rate all affect the smoothness of the cut.

91. These basic rules hold true for all cutter heads and planner heads.

DRAWING 8



AT A FEED RATE OF 137 METERS PER MINUTE AND TURNING AT 3600 RPM, A THREE TOOTH HEAD WILL LEAVE SIX KNIFE MARKS PER 2.54 CENTIMETERS. THIS WILL BE A FAIRLY ROUGH FINISH.



AT THE SAME FEED RATE (137 meters per minute) AND THE SAME RPM (3600), A SIX TOOTH CUTTER WILL LEAVE TWELVE KNIFE MARKS. THIS WILL BE A MUCH SMOOTHER SURFACE.

4. MAINTENANCE OF CUTTING TOOLS

91. The average cost of maintenance equipment and supplies available from Europe and the United States today [illegible] range in price from thousands of dollars to just a few hundred dollars. The selection of maintenance equipment runs from machines which automatically load themselves, grind the tool to preset dimensions, and then unload themselves to the hand operated grinders.

92. When speaking of service equipment, this paper will discuss only the manually operated equipment and will be centered on the equipment of better than average quality.

93. It is also impossible for this paper to make equipment recommendations and, therefore, no trade names or company names will be used in description of such equipment.

4.1. Maintenance Versus Throw Away

94. There is always the question of whether to maintain tools or simply throw them away after use. This is particularly true in developing nations where good maintenance service is virtually non-existant.

95. In the case of some of the cheaper high speed steel tools, it may be economical to throw them away when they become dull rather than resharpen them. This action is questionable at best; and in the case of expensive carbide and stelite tools, there can be no justification for discarding good tools simply because they are in need of sharpening. Wherever possible, tools should be sharpened as many times as possible before they are destroyed.

3. 9. 74

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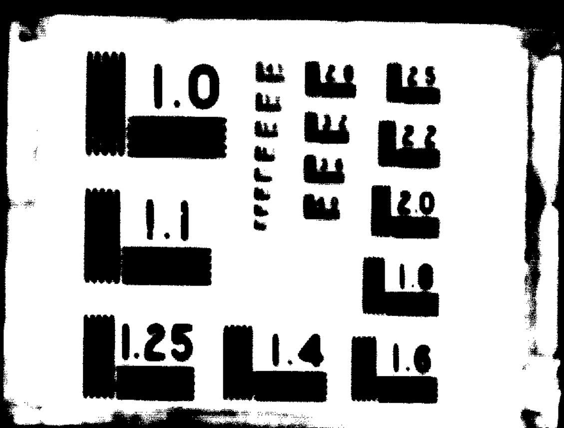


4.2. The Service System

96. The best way to achieve maximum tool life is to set up a service facility on the location where the tools are being used and then coordinate this "in house" service with a reputable outside service company.

97. This is the way such a system can work:

1. Each tool should be purchased in quadruplicate. There should be four of each kind of saw, four of each kind of cutter head, etc.
2. One set of tools should be on the cutting machinery, doing the cutting jobs.
3. The second and third set of tools should be in storage in sharp condition and waiting to be placed on to the cutting machinery.
4. The fourth set of tools should be in the service shop being sharpened.
5. Every fifth or sixth time a tool comes in for sharpening, it should be shipped out to a reputable large service company which will completely reservice the tool. Such a company may be located within the country or may be located in another country. The important thing is that it is a large well equipped service company and one which will provide all of the service needed. If this outside service source is carefully selected, it will keep the tools in good repair and the "in house" service station will be able to do the daily repairs.

This method can keep maintenace costs down while the cutting quality is kept high. It is a vast improvement over the throw away concept now in practice in some countries.

98. Using the service system where tools are sent out, every fifth or sixth time for complete servicing and where tool stocks are large enough to back up requirements, the woodworker can maximize his tooling investment. In order to make this system work, two things must be found.

1. A good outside service source (many exist in Japan. Europe, and the United States).
2. Good service equipment for the "in house" service station.

4.3 Description of Equipment Needed

99. The equipment which is described in this section is mainly designed for saw blades and cutter heads ranging in size from 15 to 63 centimeters in diameter. Most of the equipment on the market is designed to be operated in dry in-door conditions using electrical power which is reliable and steady. These, however, may not be the conditions where the equipment is to be installed. If these are not the conditions the machinery manufacturer should be told of the prevailing conditions so he can make adjustments in the machine designs. Equipment needed to set up a limited service station is:

4.3.1. Facing Machine (manual operation)

100. This machine can be quite light in design but must have

a good wheel arbor.

- Two to four diamond wheels (75 concentration, 150 grit)
- A set of saw plates - These are heavy plates between which the saws are clamped when being faced. Each equipment manufacturer uses a different clamping technique but some sort of clamping is necessary.
- A set of ground and hardened bushings - These bushings will allow saws and cutters with different bore (center hole) sizes to be face ground. It is important these bushings are accurate and are kept in good shape. There should be one or two bushings for each bore (center hole) size used.
- A fixture to hold cutter heads on the machine - This fixture will have to be designed according to the buyers requirements and can be worked out with the equipment manufacturer.

4.3.2. <u>O. D. (Outer Diameter) Grinding Machine (manual operation)</u>

101. This machine should be of heavier construction than the facing machine and must have a good arbor and a good traverse table.

- Two to four diamond wheels (100 concentration, 220 grit)
- A set of saw plates - The same recommendations hold true for this machine as for the facing machine.
- A set of ground and hardened bushings - The same recommendations hold true for these bushings as for those on the fac- machine.
- A fixture to hold cutter heads on the machine - It is recommended that only straight heads are O. D. ground. All form or shape heads should only be faced at this service station.

They should be [illegible] ground only [illegible] to the outside service station.

4.3.3. A Gullet Polisher (manual type [illegible])

102. This machine is used to clean out the gullets of saw blades and is not used on cutter heads. It is, however, an important piece of equipment and should be used each time the saws are sharpened.

4.3.4. Cleaning Tubs

103. Two large galvanized wash tabs in which dirty tools are soaked prior to sharpening.

1. One tub is filled with soapy water (hot water if possible); the second tub is filled with clear water.
2. Prior to sharpening, soak the dirty tools in the soapy water for about 30 to 60 minutes. Then, rinse them in the clear water. This process will losen all the pitch and dirt and make sharpening easier.

4.3.5. Supply of Protective Paraffine Base Oil (5 to 10 Gallons)

104. To coat the tools with after the soaking in order to keep them from rusting.

4.3.6. Steel Straight Edge

105. To check if saws are bent. This check should be made each time a saw is sharpened. If the saw is bent, it should immediately be sent to the outside service station for straightening.

4.3.7. Checking Arbor and Dial Indicator

106. Used to check tooth alignment in both saws and cutters.

107. The above equipment will provide all that is necessary to do the intermediate sharpening on most cutting tools. Those which cannot be serviced by this type of equipment would be large and small lengths band saws, large diameter saw blades (those above 63 centimeters).

108. In order to sharpen large saws both bands and circular saws various different equipment manufacturers should be contacted who manufacturer this equipment

109. If a larger service station is desired which has the capacity to replace tips and do its own straightening of saw blades, then the following equipment is recommended. It is not, however, recommended that tips be replaced and blade straightening take place unless experienced people are employed in the service station. These two operations require a lot of skill: and if not properly done, can do more damage to the tools than they do good.

4.4. Additional Equipment to be Installed if Tip Replacement and Saw Straightening Is to be Done

4.4.1. Body Polisher

110. Body polishers are used to polish up the saw bodies (mostly for appearance).

4.4.2. Torch

An acetylene brazing torch and gas tanks are used to heat up the tip for brazing. NOTE: Be sure to get a torch made for brazing. Welding torches are too large and may damage the tool.

4.4.3. Carbide and Stelite Tips

A supply of tips for all tipped tools are needed so tips can be replaced.

4.4.4. Side Grinder (manual operation)

Side grinders are used to grind the sides of the tips.

4.4.5. Seating Machine (manual operation)

Seating machines are used to cut the seats into the steel tools which will seat the tips.

4.4.6. Hammering Equipment

Hammers (specially designed) anvils and straight edges are used to straighten bent saw blades and to retension saws.

4.4.7. Miscellaneous

Various work heads are used for dividing heads for proper indexing of cutter heads. Indexing plate for saw blade indexing. Work head with collets for sharpening shank type tools.

4.5. Training of Personnel

111. Regardless of what kind of an intermediate service station is set up, the training of the personnel is critical to success. In most cases, the companies which manufacturer the equipment which is to be used in the servicing operation have training programs. It would be wise to send personnel who will be responsible for the service work to these training schools.

If tools are serviced by people who do not know what they are doing, the tools will be badly damaged. If, on the other hand, tools are serviced by qualified people and are periodically sent out to a well equipped shop tool life can be extended to the point where the investment in service equipment is quickly returned.

APPENDIX A

[illegible]

HARD	MEDIUM	SOFT
White Ash	Black Ash	Basswood
Beech	Cherry +	White Pine
Birch -	Fir	Yellow Pine +
Rock Elm	Soft Elm	Yellow Poplar (cores)
Hickory +	Red Gum (Furniture)	Redwood
Hard Maple	Black Gum (Tupelo)	Balsam Fir
Soft Maple	Cypress	Aspen
White Oak +	Red Maple	Boxelder
Red Oak	Magnolia	Cottonwood
Sycamore	Ebony	Hackberry
Walnut	Teak	Fir (Douglas)
Mahogany	Tanbark	Hemlock
Red Alder (Furniture)	Butternut	Spruce +
Chestnut	Holly (tough)	Balsa -
Pecan	Prima Vera	Larch
Locust	Cedar	Red Maple
Lignum Vitae	Dogwood (tough)	Myrtle
Persimmon	Rosewood	Sassafras (brittle)
Apitong		
Lemonwood		

NOTE: There is no distinct line between groups. + indicates high hardness for group, - indicates low hardness compared to others in group. Hard, medium, and soft are not particularly related to classifications of hardwood, medium hardwood, and soft wood.

APPENDIX 7

(Continued)

CARBIDE GRADES FOR WOODWORKING APPLICATIONS

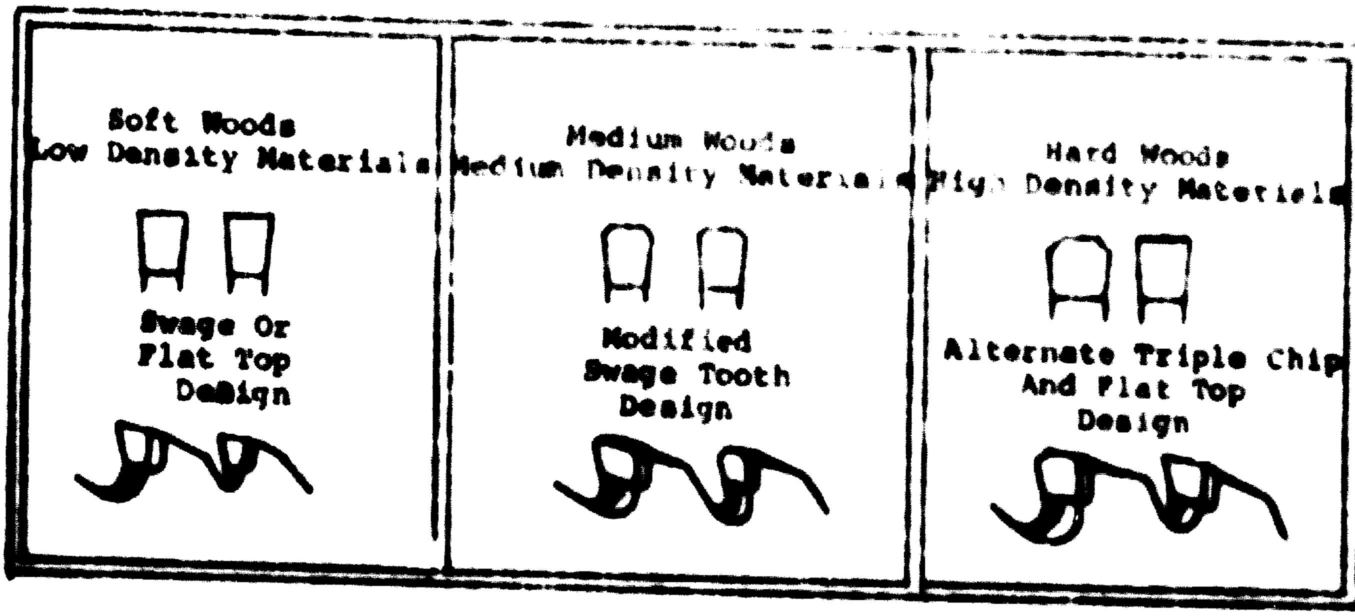
- General Application Grade
  - Carboloy* Grade 883
- High Density (High Resin) Particle Board and High Silica Content Wood Grade
  - Carboloy* Grade 905
- Shaper Knife and Shaper Head Grade
  - Carboloy* Grade 44A

* Carboloy
Metallurgical Products Dept.
Box 237-General Post Office
Detroit, Michigan 48232 U.S.A.

NOTE: There are many different and reliable manufacturers of carbide located throughout world industrial markets. This paper has used the Carboloy grades of General Electric Corp. as an example. Most manufacturers of carbide can convert the carboloy grades into comparable grades of their own manufacture.

APPENDIX [illegible]

Types of Saw Blades Generally Recommended For RIP CUTTING



Recommended Numbers of Teeth For Rip Cutting

Rate At Which Material Is Fed Into The Cutting Machine

Saw Blade Diameter	Manual Feed	61 To 122 Decimeters Per Minute	122.1 To 183 Decimeters Per Minute	183.1 To 274 Decimeters Per Minute
25 Centimeters	18 Teeth			
30 Centimeters	24 Teeth	24 Teeth	30 Teeth	36 Teeth
36 Centimeters	30 Teeth	30 Teeth	36 Teeth	42 Teeth
41 Centimeters	36 Teeth	36 Teeth	42 Teeth	42 Teeth

APPENDIX [illegible]
(Continued)

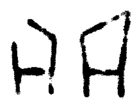
Types of Saw Blades Generally Recommended For

CROSS CUTTING

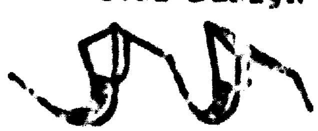
Types of Materials and Recommended Tooth Designs

Soft Woods

Low Density Materials

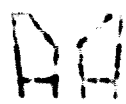


Alternate Top Bevel Design

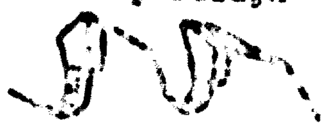


Medium Woods

Medium Density Materials

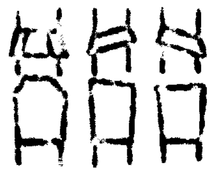


Modified Triple Chip Design



Hard Woods

High Density Materials



Modified Alternate Top Bevel Design

Recommended Numbers Of Teeth For Cross Cutting

Rate At Which Material Is Fed Into The Cutting Machine

Saw Blade Diameter	Manual Feed	51 To 122 Decimeters Per Minute	122.1 To 183 Decimeters Per Minute	183.1 To 274 Decimeters Per Minute
25 Centimeters	40 Teeth	50 Teeth	60 Teeth	
30 Centimeters	40 Teeth	50 Teeth	60 Teeth	72 Teeth
36 Centimeters	45 Teeth	55 Teeth	65 Teeth	72 Teeth
41 Centimeters	45 Teeth	55 Teeth	65 Teeth	96 Teeth

APPENDIX C

Additional helpful reading material (English) by Mr. Arthur R. Segal

What is Carbide - Bulletin Number 2-69

Carbide's Performance and Economy - Bulletin Number 1-69

What You Should know about Carbide Tipped Saws

Analysing the Problem - Form Number T-2

Engineering Tools for Particle Board

APPENDIX D

WORKABILITY OF TROPICAL WOODS

HARD	MEDIUM	EASY
Ipil	Ramin	Jelutong
Merbau	Dao	Tiama
Kwila	Teak	Edinam
Kerving	Indian Rosewood	White Seraya
Apitong	Brazilian Rosewood	Peroba De Campos
Yang	Jacaranda	Afrormosia
Gurjun	Mersawan	Kokrodua
Phillipine Mahogany	Lavan	Imbuia
Mersawa	Lumbayau	Carribbean Pine
Krabak	Mengkulang	Ocote Pine
Palosapis	Kapur	Cativo
African Ebony	Bagtikan	Muninga
East Indian Ebony	Kasai	Narra
Kempas	Malugai	African Padauk
East Indian Satinwood	Niangon	African Mahogany
West Indian Satinwood	Whismore	Menkulang
Ayan	Acapu	Lumbayau
Movinqui		Limba
Oriental Wood		Gola
Sapele		Makore
Sipo Utile		Obeche
Karri		Wawa
Jarrah		Samba
		Avodire
		Banak

* Refer to Appendix E for Types of Sawblades generally recommended for rip cutting and crosscutting Tropical Woods.

APPENDIX E

Types of Saw Blades Generally Recommended For

Rip Cutting

Tropical Woods

EASY

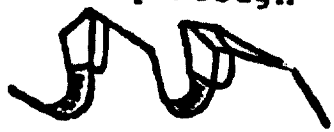
Low Density Materials

Alternate Top Bevel Design

MEDIUM

Medium Density Materials

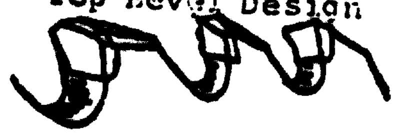
Modified Triple Chip Design



HARD

High Density Materials

Modified Alternate Top Bevel Design



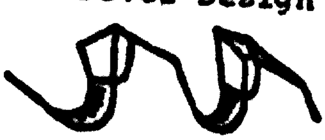
Cross Cutting

Tropical Woods

EASY

Low Density Materials

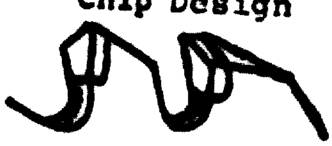
Alternate Top Bevel Design



MEDIUM

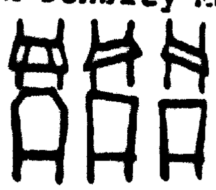
Medium Density Materials

Modified Triple Chip Design



HARD

High Density Materials



Modified Alternate Top Bevel Design

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Technical Meeting on the Selection of Woodworking Machinery

Vienna, 19 - 23 November 1973

SELECTION AND MAINTENANCE OF CUTTING TOOLS for THE WOODWORKING INDUSTRY 1/

by

Steven A. Segal, President
North American Products Corp.

SUMMARY

The selection of cutting tools is complicated by the vast number of variables involved, including the hardness and density of material being cut, its moisture content whether or not it is solid stock, laminated or a composite product, and also machine parameters such as feed rates and machine type.

High speed steel tools, made of high carbon steel, spring steels, high nickel steels and various alloys, were the first step towards reducing wear. Next came carbide tipped tools (in the 1940's) which tremendously increased service life; but posed extra maintenance problems. Stelite tools appeared in the 1950's and are similiar to the former but do not last as long.

Technical differences between solid and tipped tools mainly relate to tooth angles and cutting characteristics.

Major considerations regarding performances in tool design are tool life, teeth design and tooth angles. Strong teeth are required for dense woods, high density particleboards, fibreboards or stacked hard laminated plastics. "Blocky" teeth will generally wear better than delicate teeth. Feeding requires more force the higher the tool angle, but the surface is better. Soft woods require better attention to be paid to clipping the fibres, and should therefore have their cutting edges drawn to the sharpest possible point.

The presence of silica in fast growing woods requires a higher resistent grade of carbide; foreign objects should be detected if tool costs are high. High resin content in particleboard drastically reduces tool life.

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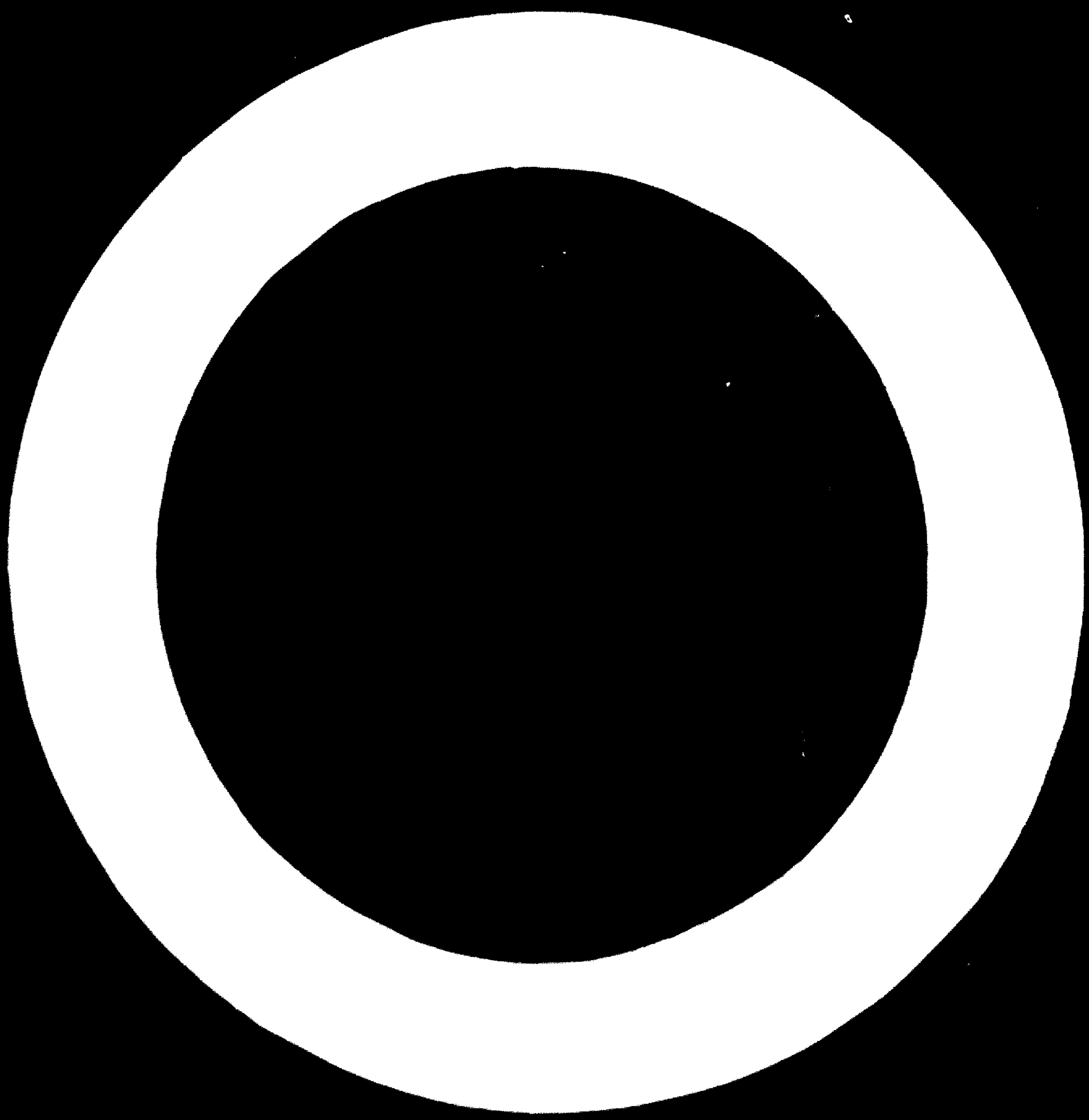

The two [illegible] types of cutters [illegible] ripping and cross-cutting require different angles. Generally, [illegible], fewer number are used for ripping, and [illegible] teeth [illegible] with high clearance angles are used for cross-cutting.

Cutters for hardwood and [illegible] wood should have hook angles of 15° to 25°, but very soft wood can have up to 30°. In general, the more teeth the smoother the cut will be.

The question of maintenance or throwing away used or dull tools can arise, especially in developing countries where maintenance facilities are often lacking. The best way is to set up a service facility on location and coordinate this with a reputable outside service company. Two sets of each tool should be kept.

The equipment normally required for saw blades and cutterheads ranging in size from 15 - [illegible] cm. in diameter are:

- Facing machine (manual operation) with ancillary equipment;
- Outer Diameter grinding machine (manual);
- Gullet polisher;
- Cleaning tubs;
- Paraffine base oil (5 - 10 gallons);
- Steel straight edge;
- Checking arbor and dial indicator;

Additional equipment for tip replacement and saw straightening is:

- Body Polisher;
- Torch (acetylene brazing torch);
- Carbide and Stelite tips;
- Side grinder;
- Seating machine;
- Hammering equipment;

plus various work heads for indexing.

Personnel must of cource must be trained in the proper use of this equipment.

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