BANDSAWS,
Wide Blade and Narrow Blade types

...in sawmilling and remanufacture
...in cabinet and furniture manufacture
...in history

by
CHANDLER JONES

A summary of bandsaw types, their tooling and its maintenance, cutting principles, production rates, plus history and dictionary of terms.
BANDSAWS,
Wide Blade and Narrow Blade types

...in sawmilling and remanufacture
...in cabinet and furniture manufacture
...in history

CHANDLER JONES, author
2716 West Hayes Street
Seattle, Washington 98199
Phone (206) 284 3135

First Edition 1992 ©
Library of Congress Catalog
Card Number: 91-090705
## CONTENTS

### PART I. THE HISTORY AND PRINCIPLES OF SAW DEVELOPMENT  <<<<<<<<<<<<<< 1


### PART II. THE ABC'S OF WIDE BANDSAW TOOLING  <<<<<<<<<<<<<< 47


### PART III. WIDE BANDSaw MACHINES  <<<<<<<<<<<<<< 68

Horsepower requirements. Bandsaw sizes and configurations. Mechanical features: types of strain, centrifugal force, guides, saw alignment, deflecting waste, blade lubrication, wheel bearings.

### PART IV. HOW WIDE BANDSaws ARE USED IN SAW MILLS AND REMANUFACTURING  <<<<<< 83


### PART V. THE NARROW BLADE BANDSaw  <<<<<<<<<<<<<< 105


### PART VI. VOCABULARY AND TABLES FOR BANDSAWs  <<<<<<<<<<<<<< 124

INTRODUCTION

Certainly, woodworking is not...and can never be... as exact a science as metal working. Every tree upon this earth is different from every other one, and each tree...or part of a tree...must be treated differentially. But, there are basic principles which guide us. It is therefore surprising that there is so much more printed matter on metal working than on woodworking, which is one of the most wide-spread industries in the world.

There is a considerable section of this book devoted to the history of saws, and it is hoped it will be of interest to historians as well as woodworkers. Descriptions of the logical transitions in saw development through frame saws and circular saws will contrast with band saws, thus giving readers a better grasp of the principles of the band saw, as well as its complexities.

At first glance the band saw seems to be so utterly simple, but in the case of the wide band more skill and attention to detail is required than in almost any machine in the woodworking world.

There are three basic types of bandsaws, each designed for the particular job to be done; they are discussed and illustrated in this text. These types are:

1. Band mills for log and cant breakdown.
2. Remanufacturing saws for converting dried lumber to such uses as beveled siding, molding stock, sash and door material and similar items.
3. Narrow blade band saws for furniture plants, cabinet shops and other specialized operations producing both irregular shaped and straight pieces.

The bandsaw blade, its servicing and its inter-connection with machine design is covered in a special section of the book.

SAFETY

Because there are many designs and variations of band machines, safe operating instructions must be developed by plant management for each machine...taking into account individual plant conditions, information available from machine and tooling manufacturers, plus national and local codes. The band saw and its blade pose special safety problems not found in other woodworking machines, and must be treated accordingly.
Part I
THE HISTORY AND PRINCIPLES
OF SAW DEVELOPMENT

Wood has presented us with an easily available and readily renewable resource to satisfy a host of our daily needs... too many to list. This has been true throughout history and is true today.

We are a busy generation, and many believe it is a waste of time to delve into history. But, it is impossible to separate the past from the present. The principles upon which nearly all of the woodworking machines we use are at least 100 to 200 years old. So it is educational to look at the successes and failures which pushed development in the right direction, creating the machines of today.

BASIC PROBLEMS IN CUTTING WOOD

As wood use progressed over thousands of years it was apparent that, though it was readily available, it was not always easy to machine. This prompted men to study wood with the thought that if they knew the detail of its composition, they could devise better machines and tools for working it. Today, most of the things we need to know about wood in order to do a good machining job have been discovered. But getting that information into the hands of the people who supervise and operate the machines has been a terribly slow process... much of it simply by word of mouth. Wood is complex because we use most of it in a non-homogenous way... we just saw the tree into pieces that suit us for size and shape. So, most of our problems are caused by the basic nature of the tree:

Knot size, shape and condition
Grain structure...fine, coarse, tapered, straight, flat, vertical, or multi-directional
Moisture content... from saturated to bone dry
Chemical content... some attack the cutters in our tools
Combinations of all of the above
Our job of wood machining is philosophically different from that of the woodworkers who make paper or particle board, or the machinists in a metalworking shop. They work homogenous material; we do not. We accept the whims of nature, work with them and even charge extra when we can present them in an attractive way in a piece of furniture or on the dash board of a luxury automobile.

Although the first woodworking machine was the lathe (patterned after the quern or potter's wheel), it has been stated by a number of writers that the three most important woodworking machine inventions in the world have been the frame saw, the circular saw and the band saw. It is easy to agree with that conclusion; probably the fourth most important invention was the planer-matcher and its kin...the molder. Number five...how about the tenoner?

THE FRAME SAW

Saws, in crude hand tool form, have been in use for many thousands of years, even pre-dating the use of metals. With the arrival of the Bronze Age (approx. 4000-2000 B.C.) more efficient blades were possible, and it wasn't too long before the two-man "over and under" system came into play. Figure #1. Hiram Hallock's presentation, "Sawmilling Roots", at the 1979 Sawmilling Clinic in Portland, Oregon offers an interesting chronology on this and describes the later transition into the use of iron and steel.

The application of mechanical power to the two-man saw occurred in Germany as early as the 1300's using water wheels as a power source, according to the Disston publication in 1934, "The saw in History". Figure #2. This was followed by windmill-powered machines in Holland, and horsepowered machines in other countries. See Figure #3. Despite vigorous opposition by carpenters guilds, it was not long before the powered frame saw was widely used. This basic reciprocating gang saw, later powered by steam or electricity, was important in sawmills up to World War II and immediately thereafter. Many continue in operation today, though most newly constructed mills use other types
of saws...notably band saws, singly or in multiples.

Gang saws made very good lumber, but production was slow. In 1910, Clint Prescott, founder of Prescott Company in Menominee, Michigan (manufacturers of bandmills and edgers) wrote the following anecdote, reflecting on earlier times:

"In passing it may be of interest to state that the old Sash Saw was usually run by undershot water wheels, and a man would start a cut in the morning and then go to plowing out in his field. By noon, that cut being finished, he would set over the log for another board, go home to dinner, after which he would resume plowing, and by evening the second cut would be completed; so that by close attention to business a man could get two boards a day."

Prescott went on to reinforce his point with this amusing yarn:

"A sawyer on one of these mills once told the writer that he could sit on a log that was being sawed and go to sleep. When the log had moved far enough the saw would scratch him when it came down and he had plenty of time when the saw went up to wake up and get off the log before the saw came down again."

---

**Figure #1.** The "over and under" sawing system is an ancient one. This drawing from HISTORY OF TECHNOLOGY shows how things were done in the 15th century. Two men are operating a frame saw while others do a variety of woodworking chores with adzes, chisels, borers, etc. Saw horses are holding the cant in this scene, but pit-sawing was another common way of doing it, where the cant or log was at ground level and the bottom sawyer stood in a pit. Scenes of this kind occurred in America during the early years of the country's development.
Figure #2. This basic, water-powered gang saw was shown in a 1661 London publication, according to Joshua Oldham's 1887 saw catalog. Sash saws were powered by horse, wind, water, and by hand. Above, an undershot water wheel drives a crank arm mechanism to stroke the sash containing the three saw blades. Two weights (A & B), connected by cables to the carriage, maintain pressure to move the cant into the saw blades. The possible number of saws depended upon available water power. In more sophisticated machines, the carriage was driven by rack and pinion, actuated by the up-and-down motion of the saw frame. Courtesy of Smithsonian Institution.
Prescott was a bandsaw manufacturer and, for competitive reasons down-played the sash saw, but it should be noted that the gang saw blade is in effect just a small section of what later became a bandsaw blade. In fact, the servicing of the band blade...e.g., swaging, shaping and sharpening...requires nearly identical tools. But, the dynamics of the bandsaw with its repetitive, high speed bending as it passes over the wheels introduced problems. Also, feeding forces are continually trying to force the blade off the wheels. Therefore, to get first class performance, greater skill and attention to detail are needed to service the machine and its blade.

THE FRAME SAW FOR RIPPING AND RESAWING

Considerable effort went into developing a resaw with a single reciprocating blade, combined with roller feeding devices. Figures #4 and #5. Note also the special shipyard saw in Figure #6. But, as circular and band saws became practical and power was available to run them, these types of saws were obsoleted.

A number of special variations of the sash saw were developed. For example, one type of problem tree is the one which grows with a crook or sweep due to prevailing wind direction or other causes. In the conventional mill these logs are cut back to 8' or 10' lengths before sawing. Some sash gangs use a carriage with a steering mechanism so that the sawing follows the sweep or curve in the log. This produces more valuable long lengths without loss of yield in volume.

Another type sash saw is the cant gang, and these may have large openings that will permit sawing two or more cants stacked on top of each other...a way of increasing production. Some sash gangs had as many as 50 blades !!
Figure #3. Many mechanical cross-cut saws were devised in the 1800's for felling timber, bucking logs to length and for cutting firewood. This interesting machine used a circular saw for cutting off small diameter logs and brush cradled in the arms at point B; for larger logs, the drive mechanism engages to operate the reciprocating cutoff saw. Developers claimed that one man and one horse could operate this rig and saw 20 to 30 cords of wood per day. This machine was described in Scientific American May 27, 1865.

Figure #4. This manually operated shop saw was patented in 1860 and offered to smaller plants which had no steam or water power available. Claims were made as follows: "...will do as much work as three men will do with the ordinary hand saw in the same time... even a boy fifteen years old will operate it." The saw blade was held under tension by long, upper and lower arms, forming a parallelogram which pivoted in unison as the operator moved the mechanism up and down. With each cycle the bottom feed roll was ratcheted ahead to advance the board into the saw. From Scientific American, 1860.
Figure # 5. Here is a reciprocating-blade type of vertical resaw by J.A. Fay & Co., in the 1860's. With every stroke of the blade, the feedworks ratcheted ahead as indicated by the arrow.
Figure #6—Here is an 1869 Shipyard Saw with reciprocating blade which can be rotated 270 degrees in order to shape timbers, planking, knees, etc. on faces, edges or ends. Note the incoming and outgoing tracks which can also be adjusted on radial tracks to any desired position for producing irregular pieces. This was indeed “high tech” at that time. It was stated, "With the aid of two attendants it will do the work of 40 men...".

With the development of the narrow band saw, similar equipment was built using a band blade instead of the reciprocating blade. Throughout the life of the wooden ship industry, band saws, otherwise similar to this engraving, were widely used. World War I saw many Ship Saws manufactured. Some were even made for the wooden minesweeper program during World War II. Illustration from Scientific American February 6, 1869.
Much effort also went into developing a jig saw, used for cutting out the interesting and complicated shapes that were popular in furniture of the 1800's. In John Richards' 1872 book, Construction & Operation of Woodworking Machines, he states, "No other machine in the whole range of woodworking tools, has been produced under so many modifications as the scroll saw...it would be impossible to describe the endless devices that have, from time to time been introduced...scroll saws, as a rule shake every thing that is near them...". Figure #7 shows one of the more novel ideas put forth. In correction of the problems, the band was an ideal solution, and Figure #8 shows an 1880's unit which was unique in its simplicity.

Fig. #7. A heavy duty jigsaw of the 1870's. This French-made machine used leaf-springs to increase tension on the blade during the cut, and to facilitate the return of the blade to the upward position after each stroke.

The term "gig" has been used in the woodworking industry in connection with stroke cuts, such as on a saumill carriage. Somewhere along the line the term has been popularized into the "jig" saw instead of a "gig" saw.

Illustration courtesy of Smithsonian Institution.

GIG, OR FEET, SAW.
For general and decorated scenery.--With spring tension.
F. ARBEE, PATR, FEB. 1872.
NEW HAND POWER BAND SAW.

The engraving shows a new hand power band saw made by Frank & Co., of Buffalo, N. Y., and designed to be used in shops where there is no power and where a larger machine would be useless. It is calculated to meet the wants of a large class of mechanics, including carpenters and builders, cabinet makers, and wagon makers. It is capable of sawing stuff six inches thick, and has a clear space of thirty inches between the saw and the frame. The upper wheel is adjusted by a screw pressing against a rubber spring which compensates for the expansion and contraction of the saw.

Figure #8. From Scientific American
December 19, 1880.
Figure # BA. As shown here, the J.A. Fay Company saw efficiently produced elaborate bric-a-brac for furniture manufacturers. Such machines obsoleted the "jig saw" (Fig #7), except where required to make cuts that could not be made from the outside of the piece.

Scroll saws produced objectionable shaking, and they were slow because they cut only on the downward stroke, whereas the bandsaw cut continuously and without vibration.

The arrow points to a weighted strain arm which maintained tension on the blade. This type of strain was standard for most of a century on sawmill bandsaws, but it was much more than needed for shop-type machines, and a simple spring tension device was adopted by most manufacturers of these lighter machines.

The unit shown here shows four different patent dates, the earliest believed to be June 18, 1868. Engraving from M.Powis Bale's Woodworking Machinery, Its Rise, Progress and Construction, published in 1880. Material courtesy of Smithsonian Institution.
THE CIRCULAR SAW

The invention of the circular saw preceded the band saw and leap-frogged all earlier techniques. These saws were revolutionary because they cut by continuous rotary action, and did not have the non-cutting return stroke inherent in the gang saw. The first patent (#1150) on such a saw was issued in London, England in 1777 to Samuel Miller. Circular saws were in use at the Royal Navy yards by 1781, and their use spread rapidly thereafter. It has been alleged that circular saws were in use in Holland in the 1600's.

Reference is made to Norman Ball's well-documented 1975 presentation to the Association of Preservation Technology, titled "Circular Saws and the History of Technology". Ball shows that Samuel Miller's patent actually covers a machine powered by a windmill and containing "a square bar of iron that received saws which are a circular figure". The remainder of the patent does not describe the saw blade at all nor show any drawings of it; it only covers various mechanisms to power and operate the machine.

Ball goes on to state that the use of rotary cutters "clearly predates Miller by at least a century and perhaps 240 years. These early applications of rotary cutters were for cutting gears for clocks and scientific instruments". Apparently history gets a little dim in this area. In any event, it can safely be said that the circular wood-cutting saw came into well-documented use at the end of the 1700's.

ADVANTAGES & DISADVANTAGES OF CIRCULAR SAWs

The circular saw vastly increased production rates, with corresponding decrease in manpower, but there were some minuses along with the pluses. When used on saw mill headrigs very large diameter blades were needed to saw the big logs, as it is not practical to saw to a depth of more than about 1/3 the diameter of the blade. So, plate
thickness was increased to provide the rigidity necessary to keep
the saw from wandering or buckling under heavy load. To saw the large
logs it was often necessary to add a top saw. See Figure 9.
Regardless, frequently 25% (or more) of a log became sawdust!

Circular saws tended to be noisy...with harmonic problems which some
times caused "screaming". Blade imbalance, incorrect tension,
meating, critical speeds or bearing problems were all encountered.
But these were not inherent defects...they were the result of imperfect
knowledge.

INVENTION OF THE INSERTED TOOTH SAW

The inserted tooth solved two major problems. Figure 10.

1. No loss of blade diameter by sharpening.
2. The metal of the insert tooth is specially
   selected for long cutting life, while the
   metal of the saw body is chosen for the job
   it has to do.

Inserted teeth have not proved satisfactory in band saws, so a single
metallurgy had to be used until recent developments made application
of hard tips practical. More on this later.

The inserted tooth concept had its beginnings in the 1840's according
to Ball's report, but it was not successful until a style using a
curved socket was devised by a Californian named Spaulding. (Perhaps
in 1846; perhaps in 1859 per Ball). R. Hoe & Co. in 1866 laid claim
to production of the first "successful chisel tooth saw insert".
Figure #9. Called “The Lane & Bodley Mammoth Sawmill”, this machine was patented in 1872. The engraving shows the climb-milling top saw which came into play when processing large diameter logs. Also of interest is the complexity of pulleys and gears to traverse the wood-framed carriage through its forward and reverse movements. Note rack and pinion carriage drive and detail of set works for carriage knees. Heavy mills of this type sawed lots of lumber, but suffered kerfs up to ¼"! Another 20 to 30 years of development were needed before band mills could saw straight and at the same time get acceptable production. See Figure #11 for an indication of later circular sawmill capabilities. Courtesy of Smithsonian Institution.
The principal disadvantage of the inserted tooth saw is that it requires a thick body in order to hold the teeth securely. This results in heavy kerf. Their use today is mostly on circular saw headrigs and cutoff saws. Their use in edgers and other rip operations is diminishing, being replaced by carbide tipped or stellite tipped solid blades.

**SOME EARLY CIRCULAR SAW MACHINES**

Figures #11 through #16 provide a good overview of early circular saw headrigs and carriages. They point up the very high production rates achieved well before 1900.

The band saw was an obvious next step in sawing technology, but we shall see that the obvious is not always easy to achieve.

---

Figure #10 In 1874 R. Hoe & Co. were issued a patent covering the inserted saw tooth shown here. At the right is shown the method for inserting or removing the teeth. The shank is shown, jaws released, ready to receive the bit, and with the tightening wrench in place. When the bit is inserted, the shank is rotated to the position shown on the left, at which point the jaws of the shank have been compressed to hold the tooth securely. From *Scientific American.*
Figure #11. Sawmillers always want to speed up their carriages and also minimize labor cost. It was no different in 1861, when this improvement was patented by Dennis Lane of Plainfield, VT. One man controlled both setting and movement of the carriage without leaving his control station. The operator actuated the arm and ratchet device to set the log forward for the cut and also to back away from the saw blade as the carriage returned. Similar devices with more functions are shown in Figure #12. From Scientific American, September 28, 1861.

Figure #12. Frick Company offered this portable rig in 1883. Frick started business in 1848 manufacturing agricultural machinery and steam engines. The first engine was a 2HP unit. Their operation was in Waynesboro, PA, and by 1883 their factory had 100,000 square feet of floor space. Their sawmills and their grain threshing machines tied in well with the engine business. From Scientific American 1883.
Figure #13. This circular sawmill was designed to take a cut on both the forward and reverse strokes of the carriage. The belting arrangement caused the two bottom saws to rotate in opposite directions. The shafts carrying the bottom saws were movable longitudinally in their bearings by hand lever to bring the saws alternately into cutting position...one on the forward movement of the carriage...the other on the return. The top saw did not shift, but stayed always in the line of cut. Thus it made climb cuts or power cuts, depending upon the direction of carriage travel. It is not believed that the industry received this equipment enthusiastically. From Scientific American June 5, 1886.

Figure #14. One of Five Distan Floats in Philadelphia Industrial Parade. From Woodworker 1908
Figure #15. This 1869 news item sheds light on the capability of circular saw headrigs at that time. 60" saws on both top and bottom were needed to tackle the large diameter logs which were then available. We can only speculate about the kerf, but it was likely 3/6" to 1/2"! The cumbersome nature of the double saw circular rigs, plus their heavy kerf, encouraged the use of band-saws even though they required more skillful fillers and sawyers. The Seattle fire on June 6, 1889 completely gutted the down-town district. Substantial remnants of that fire remain today, and may be inspected in a tour of the pioneer section of the city.

Puget Sound Lumber Industry.

The Port Blakely Mill is the largest mill on Puget Sound. It can cut logs of any length up to 130 ft., and has a capacity of 300,000 ft. every ten hours. The mill is a modern one, having been rebuilt after the fire of 1888, and has more power in proportion to its size than any other mill on the coast. It is furnished with two double circulars with sixty inch saws on both upper and lower arbors, two ponyrotaries or resaws, and a large gang, besides the smaller machinery. This mill ships nearly all of its product by water to California and foreign ports. During the twelve months ending November 30, 1889, they shipped eighty-eight cargoes of lumber, of which fifty-five were sent to foreign ports, chiefly to Australia, and thirty-three to domestic ports, chiefly to California. Twenty-seven going to San Francisco, and only one to an Atlantic port—Boston—and that laden chiefly with spars and shingles. The total amount of lumber shipped was 49,450,310 ft., board measure. In addition there were 9,444,650 lath, 635,138 pickets, 949,350 shingles, 177 spars containing 181,363 ft., and 8,662 piles containing 230,961 lineal ft. Besides this there was a large quantity of lumber sent over to Seattle from this mill after the fire, amounting to between twenty and thirty million, with other local sales.—Pacific Lumberman.

Figure #16. In 1870, this circular veneer saw with an 8' diameter cutter was offered by Allen Ransome & Co. of London, England. The cutter was composed of a series of saw segments, each approximately 1' long, and secured to the periphery of a large wheel made of wood and steel. A carriage traversed by rack and pinion moved the veneer flitch past the cutter. It is not difficult to imagine the mechanical and kerf problems such a machine must have had, and the development of a veneer slicer must have been welcomed with enthusiasm. Illustration courtesy of Smithsonian Institution.
INVENTION OF THE BAND SAW

This invention had a very slow start after its beginning in 1808. William Newbury is generally credited with inventing the band saw which was covered by his British patent #3105. Figure # 17. Early band saw machines and their blades were plagued with every imaginable problem and many which could not be imagined. The blade steel itself was difficult in those times and then it was difficult to get a good weld to join the band together. Some even tried to forge a continuous steel band so as to avoid the weld.

The blade requirements are somewhat of a paradox. They must be flexible and soft enough enough to pass around and conform to the wheels without breaking because of bending fatigue; yet they must be hard enough to receive and maintain keen cutting teeth. With each sharpening the blade narrows, requiring expert attention by the filer in order to maintain good performance.

These difficulties were finally overcome, however it was almost 1900 before sawmillers began to feel comfortable with bandsaws. From then on it was a continuous contest to see who could build the biggest, the best and the most productive bandsaw.

A story in THE WOODWORKER in 1908 shows the band mill and carriage at Hoquiam Lumber and Shingle Co. (state of Washington). The specifications on the blade were: 20" width, 65' long, 11 gage, 3" tooth spacing. This was claimed to be the largest band saw blade ever made. Blade supplier was Joshua Oldham Co. See Figure #19.

The largest diameter wheel ever used on a band mill is believed to be 12'. See Figures #20 and #21.
Figure #17 Newberry's patent model shown here was certainly clear in principle, but it did not take into account many features needed to make it work. Before success, a large number of machines were made over a long period of time. All of them failed in one way or another. The earliest successes were machines using narrow blades, replacing the reciprocating blade coping saw. Illustration from GRIMSHAW ON SAWS.

Original Band Saw of 1808.

Figure #18 With the circular saw the cutting angle and the shape of the cut change continually as the blade proceeds through the cut. This sawing action can adversely affect appearance and quality of the board surface as compared to the nearly 90 degree cut of the band saw. Also, when internal stress is present, the wood may spring inward after the cut. In this case the circular saw teeth can damage the already sawn surface. Illustration from GRIMSHAW ON SAWS.
Figure #19 These two photos and text from THE WOODWORKER in 1908 illustrated the huge size of west coast logs at that time and the consequent need for huge band mills. Examples of such large trees exist today in preservation areas, the largest in Washington state being 48' in circumference. Oldham & Sons said they could make saws up to 24" wide, but it is not known if blades this wide were ever actually made. The band mill shown here is likely a 12-footer.

**Largest Band Saws Ever Made.**

The illustration is an interior view in the plant of the Hoquiam Lumber and Shingle Co., Hoquiam, Wash. This company was the first to use band saws 26-in. wide, 65 ft. long, 11-ease, teeth spaced 3-in.—said to be the largest ever made—a pair of such saws having been made to the company's order by J. H. Oldham & Sons, New York City. Chas. Beall is the fiber and Frank Hall the sawyer. The great element of success in the use of extra-wide blades is the vigilance of the fiber in examining them after every run for the development of "fast" places, as only by this means may the saw be kept in perfect condition, for if left until poor work is shown, such is the extent of substance in the blade that it may get beyond control. To get big results from such a big saw is worthy the fiber's skill and care, and should be his pride.

*Calling a tree: 30½ ft. circumference, 100 ft. to first limb.*

*The largest band saw ever made. Ready for business.*
Figure #20. In 1917 big logs required huge band mills. This excerpt from the Clark Bros. ad in The Timberman tells about it. 120" wheels were fairly common in the larger west coast mills... 144" diameter wheels were the exception, and the 12' unit by Clark Bros. gave them a chance to toot their horn loudly.
For Pacific Coast Work—

This 10-foot band mill is unexcelled for handling large logs. It is of the surrounding base type, the base measuring 11x15 feet.
The saw straining device is very sensitive and the guides of the most improved type, the one at the bottom being quick opening.
The top guide is steam operated when required. Everything is very simple and accessible.

Heaviest Band Mill

The machine weighs 50,000 pounds and is arranged to carry saws 12 to 18 inches.
The maximum distance between guides is 7 feet and 3 inches; minimum, 24 inches.
The maximum length of saw is 61 feet; minimum, 58 feet and 4 inches.
The distance from saw to column measures 5 feet.
We also build a 9-foot mill of this same general design for Pacific Coast work, either in single or double cut.
We build a full line of sawmill machinery.

Figure 21 The 10' band mill was quite usual in Pacific Coast mills cutting original growth timber. This 1916 picture and specifications for a Prescott mill is typical.
Figure #21a. E.C. Atkins & Company were proud of their double-cutting blades as shown in this picture excerpted from their ad in The Timberman for July 1916. The double-cutting circular saw shown in Figure #13 never became popular, but the double-cutting bandsaw was found in sawmills early in the century and is still used to this day.
In the 75 years it took to develop the know-how to make the wide band saw practical the changes were frequent, but gradual. But, the band saw certainly expanded upon the "continuous cutting action" which made the circular saw so successful. These were some of the advantages achieved:

1. The long saw blade creates a time interval for cooling, so blade heating is less of a problem. Only a small percentage of the saw is cutting at any moment.

2. The band blade cuts essentially in a straight line, just slightly inclined from the perpendicular. Figure #18. So, it saws always at the same cutting angle. This compares with the circular saw thick cuts in a longer, sweeping and curved path.

3. The downward cutting force of the band saw holds the material snugly:
   ... onto the carriage knees in the case of the sawmill
   ... onto the bed rollers in the case of the linebar resaw
   ... onto the table top in the case of the shop saw.
Thus, the tendency for kickbacks as experienced with circular saw does not occur.

4. Thinner blades make less sawdust and solid wood yield is greater.

5. Less power is required for a band saw than a circular saw.

6. The band mill with its large throat opening is ideal for milling large diameter logs.

7. Narrow band saw blades as used in the furniture industry cut intricate shapes very economically.
Figure #22. These two drawings showed the advantage of using bandsaws instead of early-day circular saw edgers when producing edge-grained flooring strips. Courtesy HANCHETT MANUFACTURING.

Figure #23. This picture was shown in Allis-Chalmers literature of the 1920's, showing direct connection of a synchronous motor to the bottom wheel arbor of one of their band mills. Power factor improvement was important in many earlier mills where electric plants were overloaded or local public power was limited and expensive. From the Smithsonian archives.
Converting to the use of bandsaws instead of circular saws was specially attractive when producing 1" lumber. See figure 22. And, until recent years, nearly every substantial sawmill produced 1" T&G flooring, 1" shiplap or T&G for sub-floors, walls and ceilings...as well as wall paneling. Furthermore, many mills had box factories on the premises, producing large quantities of box material only about ¼" thick. Since World War II, a majority of the market for 1" construction lumber in North America has been replaced by plywood, particle board and flake board; and fruit boxes are usually made of corrugated cardboard or plastic material instead of wood.

* * * * *
PROBLEMS WHICH SLOWED BANDSAW DEVELOPMENT

The band saw would seem to be a simple application of the belt and pulley principle. But it was that and much more...witness the length of time it took to make it a reliable and practical machine.

1. The blade.

Getting good blades was difficult and frequent reference is made in early publications to the band saw blades made by M.Perin of Paris as the leading source in the world for band blades. In 1892, H.H.Supplee in Cassiers magazine states, "The blades for early machines were imported from Paris, but the interruption which occurred in 1870-71, during the siege of Paris, led to the development of the industry in America, and American blades are now used in all large mills". (The siege of Paris was the culmination of the Franco-German War of 1870-71 in which Napoleon III was defeated, marking the end of Napoleons as a force in French politics. But old enmities remained, eventually causing WWI, WWII and crises persisting to this day. It is interesting to note that President Theodore Roosevelt appointed Charles Joseph Bonaparte as secretary of Navy in 1905 and Attorney General from 1907 to 1909).

In these times reliable information on blades and their maintenance was almost non-existent, causing John Richards in 1872 to write,"...little has been given where much is required..."

American manufacturers such as Disston, Simonds and others were prominent in the manufacture of saw steel, but since WWII the trend has reversed, and today wide band saw steel is all imported from Europe or Japan.

2. Saw deflection in the cut.

In addition to blade problems there were serious machine problems
which were not solved until the 1890's. Prescott's 1910 dissertation went on to state that pioneer versions of the band saw, under pressure for high production, would invariably cut snaky, crooked lumber. Even when operating at modest speeds, each end of a board would have a crook, indicating that the saw was deflecting when entering and leaving the cut.

The problem was that the band blade...same as a belt...has a slack side and a tight side...the tight side being where the cutting takes place. If for any reason the saw blade slips on the lower wheel or the lower wheel slows down under load, then the momentum of the top wheel carries the slack over to the cutting side and a crooked cut occurs. Irregular cutting may also occur when making a cut in wood with sloping grain, as the blade will try to follow the grain. Adequate strain and guiding devices were finally developed toward the end of the 1800's, and thereafter band mills had more ready acceptance.

3. Traction between the blade and the wheels.

It had long been thought that, in order to have enough traction and to avoid damage to saw teeth, the surface of the wheels should be coated with an anti-slip, resilient material. A number of things were tried...wood, leather, rubber, and various composites. All of these coverings wore excessively and attracted pitch accumulations, which in turn created balance and blade difficulties. In about 1890, machine manufacturers began the use of wheels with cast iron rims which had no coverings. The blade was run directly...metal-to-metal...on the wheel, with the teeth projecting over the edge of the wheel. This was a major breakthrough, and it made the band saw a practical machine for the high production saw mill.

The narrow blade band saws (3" and less) became very successful several decades earlier, using coated wheels, a practice which continues today.
4. Maintaining constant speed on the wheels.

Constantly repeated surge loads on the saw have been a problem from the beginning. Flat belt drives were subject to slippage between the pulleys. Finally more efficient "V" belt drives came on the market, and the arrival of electric motors helped. But we were well into the 20th century before electric power was widely used.

AC squirrel cage motors have a slippage ranging roughly from 2% to 8% depending upon motor design, plus they have a low power factor when not fully loaded. Taking into account both slippage and power factor, in the 1920's some band mills were powered by synchronous motors, directly coupled to the bottom wheel. Figure #23. The synchronous motor has the characteristic that it will not slip or get out of step under a sustainable load. Also low RPM, highly efficient units are available, eliminating the need for a belt drive. There are merits to the idea, but it was an overkill for most jobs and was not widely used.

Today, a heavy duty band saw performs a job that, on the face of it, seems impossible. A 50' long piece of steel weighing over 150 pounds is welded together to form a continuous band, perhaps 12" wide x 3/32" thick. It is tensioned over a pair of metal wheels under 20,000 pounds of strain, and the wheels drive the blade at 10,000 linear feet per minute. The log, on its carriage is propelled into the band blade at 500 feet per minute. As the blade cuts, it must not vibrate nor waver, as any such movement will make a rough, crooked surface on the board. The saw essentially must not lose speed upon entering the cut, nor can it slip on the surface of the wheels...no wonder the birth of the band saw resulted in so many abortions and false labors during the early years of its development.

The following series of illustrations show various transitions of the wide band saw from its early beginnings.
To increase mill production, and to rework edged lumber and miscuts, most sawmills needed a resaw. As early as 1870 band resaws began to replace circular resaws, evidenced by the machines also shown in the illustrations.

Developments were also taking place in equipment to service wide bandsaws. Early practice included the simple procedure of filing the teeth of the blade by hand for sharpening, and to this date, those who service bandsaws are called "filers", even though nearly all bandsaw sharpening is done by machine. The job of leveling and tensioning was done with hammers, but according to Spear & Jackson's "Story of the Saw", in the 1860's, "the tensioning or spreading of the centre of the band by rolling and hammering" took place. The name of the inventor of the stretcher-roll machine did not appear in this study. But, by 1900, most sizable sawmills used the roller stretcher in the filing room as well as some form of grinding machine for tooth sharpening and gulleting.

But, even after band saws were able to cut straight lumber, the techniques for servicing the blades were a mystery to most people, and filers were often secretive about their skills. For interesting background on this subject read "The Saga of the Saw Filer" published by Armstrong Manufacturing Company.

Figure #24. This 1870 band saw was constructed with heavy wooden posts to support the machine...a practice which was soon obsoleted by use of cast iron columns. Arrow points to the weighted lever strain mechanism which was used in principle on most wide band saws up to approximately 1970. From "The American Band-Saw Mill" published by Cassiers in 1892. From Smithsonian Institution.
Figure #25. In 1873 this installation at J.J. Van Pelt's plant in New York city was called "...probably the most extensive experiment in log cutting ever undertaken and carried out..." The saw was designed by Van Pelt and manufactured by Richards, London & Kelley in Philadelphia, PA. The wheels were 75" in diameter and the rims were covered by pine lagging to which was glued a coating of harness leather. The 55' long X 6" wide blades (16 gauge) came from Perin & Company of Paris, France at a cost of $100 each. 1/8" kerf was reported. Production rates were 30 to 60 FPM. The details of the machine construction are not all visible, but it appears that the saw was a combination of machine parts combined with heavy timbered support structure. The weighted cable and spool device to the right of Mr. Van Pelt is believed to be the strain which the article says ranged from "one to four tons". Two planers (?) appear in the background. This was a brave venture, but ultimately was not very successful according to later reports. This material from Scientific American, March 23, 1873.
RESAWING BAND SAW.

The capacity of the machine, shown in the engraving, the manufacturers state, is from 12,000 to 16,000 feet of lumber per day. The height of the machine is 10 feet; the wheels are 5 feet in diameter; the weight is between 4,000 and 5,000 lbs. The saw kerf made is from $\frac{1}{8}$ to $\frac{3}{8}$ inch thick, and its sawing space is 80 inches, taking an timber 18 inches thick.

As lumber has become costly, it will be seen that it is of great advantage to use a thin blade; the saving of power is also considerable. On hard lumber, the saving amounts to more than the sawing costs. The general construction will be readily understood from the engraving.

Figure 26. Here is a portion of an 1873 report in Scientific American describing what was at that time a heavy duty vertical resaw, and which had already found a number of users. It appears that both the inboard and outboard feed rolls were powered. The gear drive in the center of the feed rolls is unusual. Such a machine served as an auxiliary to the sawmill headrig, or for use in a large planing mill or remanufacturing plant. These machines were manufactured by First & Prybil in New York City.
Figure #27. Here is a lighter duty resaw in the 1870's, having only one powered feed roll. J.A.Fay & Co. were proud of their side guide rollers (two per side), used both above and below the work piece. Arrows point to these rollers which were made of hardened steel and ran in sleeved bearings. The backup guide is likely a hardwood block. Reprinted from GRIMSHAW ON SAWS and obtained from Smithsonian Institution.
Figure #28. This 1880 sawmill featured two 6' bandmills...one right hand and one left hand. Wheels were wood-rimmed with resilient covers to provide blade traction and to avoid damage to saw teeth. The top and bottom saw guides had "...a wheel to receive the back thrust of the saw", and lateral supporting guides or packing plates to suit the thickness of the saw". Very slow feed rates were necessary to prevent cutting snaky lumber, and the setter-man seen here could likely serve both carriages. This twin mill was proposed in the place of a single circular mill on the basis of kerf-saving when sawing valuable Black Walnut or other expensive lumber. From August 13, 1881 Scientific American.
Figure #29. This 8' bandmill was DIRECTLY driven by a single piston steam engine to avoid slippage problems common to flat-belt drives when a surge load occurred. The engine operated at 300 RPM and powered both the saw and the variable speed carriage drive (from the gear indicated by the arrow). Operator deck was located adjacent to the steam engine, but is not shown in the engraving so that we can see detail of the mechanism. The man at the left loads logs onto the carriage and does setting. Note overhead cable which connects to a counterweight (not seen) to facilitate quick setting of the top saw guide. A 50' long, 17 gauge blade was used. Band wheels were covered with wood and resilient, anti-friction material to avoid saw tooth damage. From Scientific American, October 4, 1884.
Figure #30. This is one of the more exotic bits of band mill history. But, it does point up how desperate the industry was to produce a successful wide band saw. Arrows point to the centrifugal governor and the blade tightener pulley which was controlled by the governor in an unsuccessful effort to maintain a constant strain on the blade. Reproduced from Clint Prescott's band saw dissertation.

Febry. 14, 1885. The Northwestern Lumberman caused a shiver to run through the mechanical world by publishing an account of "A New Entry," and showing two illustrations of a Band Mill for sawing logs invented by Mr. Benjamin of the firm of Benjamin & Fischer of Chicago, Ill. It was extensively advertised, and really was an ingenious mill. It was intended to correct the defects existing in other mills which had made such crooked lumber, cracked saws, and performed all sorts of mischief, which they really had, and there was no doubt about it.

Apart from the fact that the lower wheel was much larger in diameter than the top wheel, the main distinguishing feature in the Benjamin mill was the application of a tail centrifugal governor to automatically adjust a tightener pulley impinging on the back side of the saw to instantly take up and prevent a slack from going over to the tight side and thereby making shaky, crooked lumber.

One of these mills was erected at Chicago. A car of logs was brought there and many prominent mill men were invited to see the mill at work. A large number attended, but the mill did not satisfy any of them. There was just one thing Mr. Benjamin did not take into account, namely, a governor cannot act until there is a perceptible increase or diminution in the speed of an engine or a machine; consequently in a band mill it got in its work too late to stop the mischief. The mill never went into general service. Its wheels were of wood with rubber face.
Figure 5.31. A combination Bandsaw and Circular mill in 1885, by E.P. Allis Co. of Milwaukee, Wisconsin. Several companies offered this type of machine for those mill men who did not wish to be totally at the mercy of a band mill.

But, the Allis machine had some features which no other company offered. Below, is the explanation which was copied from Clint Prescott's widely circulated dissertation.

But the amusing feature in the mill of E. P. Allis & Co. is shown in the effort to keep the slack slide of the saw on the back side of the mill where it belongs, and thus prevent making snakey or dishy lumber. The overhanging wheels, nine feet in diameter for eight-inch saws, are shown. The top wheel was almost entirely of wood, and the spokes were flat and wide, the object being to obtain an atmospheric resistance continually as a pull back on the cutting side of the saw. A tightener pulley was also applied to the saw on the rear side.

This sounded good and they sold a lot of mills on the strength of it; but the wind that came from them would blow the sawyer out of the mill unless the wheel was boxed in.
Figure #32. This turn-of-the-century ALLIS bandmill and carriage was titled: "The Double Cutting Telescopic Band Mill". To cut small diameter logs and to make finishing cuts on large logs, the whole saw lowered to the position shown in the large picture. When sawing large logs, the machine was raised to the position shown in the small picture. Arrow points to the combination steam-oil device which quickly adjusted the machine to the desired cutting position. Note cable and counterweight arrangement to facilitate elevation of the machine. Later development of efficient adjustable top saw guides made this elaborate mechanical arrangement unnecessary. Illustration from undated company literature, courtesy of Smithsonian Institution.
Figure 33. This Swiss-designed (British-built) 5' horizontal mill was supported by two spiralled, vertical columns which were rotated in unison to vary the height of the saw. Carriage travel varied from 40 to 200 FPM during the cut, but returned at a brisk 600 FPM. All-metal wheels were used with saw teeth projecting over the wheel edge to protect the teeth. This information is from THE ENGINEER, July 5, 1895. This information and illustration courtesy of Smithsonian Institution.
The bed of the machine is adjustable so as to conform to the height of any planer and matcher, and the wheels are likewise adjustable, both simultaneously, for straight sawing, and independently for bevel sawing, as for the making of bevel siding, etc.

The saw is guided by patented ball-bearing crowding wheels, the advantages claimed for these being that they support and stiffen the saw and cannot clog with sawdust. The machine is also supplied with the latest spring-balance straining device, steel locomotive rim wheels, hammercd crucible steel arbors, with self-adjusting and self-oiling journal boxes.

Figure #34 This horizontal resaw for planers was introduced in 1912 and described in THE WOODWORKER magazine. It could handle stock up to 15" wide x 4" thick. Arrows point to the roller pressure guides, referred to as "ball bearing crowding rolls" in the text. The saw could handle up to 200 feet per minute on narrow, soft textured material. This unit was a valuable add-on for plants running a large volume of beveled siding and other patterns machined double in the planer-matcher. Today, resawing of planed lumber is usually done on a separate vertical band resaw, which is then available to do other types of resawing without slowing down a high speed planer. A flow plan incorporating a planing mill resaw is shown later.
All of the blame for making poor lumber could not be assigned to the saw. A great amount of energy went into designing a heavy duty head saw made of cast iron and steel, while wood-framed carriages remained standard. See Figure #35. These were adequate for low production rates and light duty, but the demand for precision cutting and more production soon focused attention to the carriage. Carriages framed in steel and cross-girted to stabilize them under stress of receiving and cutting heavy logs were developed.

By the 1880's steam was a common source of power in the larger mills, making it possible to power and control many devices in the plant without having to rely on cumbersome overhead lineshafts and their maze of belts and pulleys. The term STEAM SAWMILL was often incorporated into company names to indicate to prospective customers that this was indeed a productive and substantial lumber source. Later, instead of the slow, high maintenance rack and pinion driven carriage, the "shotgun" carriage became important in high production mills. This unit was traversed by a long steam-operated cylinder, which could stroke through the cut at a controlled rate and return at breakneck speed in preparation for the next cut. Read the text in Figure #36.

Development of high speed, accurate setting devices for the carriage knees, tongs, etc. became a priority so as to increase time in the cut. In fact over 300 patents were issued even before 1850 for improvements in saws and sawmills, according to Frank Camparato in his book Chronicles of Genius and Polly, describing the history of R. Hoe Company. And the pace of new sawmill invention continued for another 50 years as a perusal of publications of the period reveal.

THE SETTER RIDES THE CARRIAGE

In many high production mills the setter actually rode on the carriage during the cut, so that the next set after the cut could be made without
lost time. To overcome the noise of the mill, sawyers used hand signals to tell the setter what adjustments should be made for the next cut. In fact, a well-developed hand signal system was published and used by sawyers in most high production West Coast mills. The following quotation comes from "This Was Sawmilling" by Ralph Andrews in 1957:

An index finger asks for a 1" cut. Add a thumb and you get 6/4—six quarter inches or a 1½" cut. All five fingers tell the man with the log to come forward 5". Until saws get silencers, sawyers will be using fingers and are thankful "the old man don't know I got toes."

**THE RIDERLESS CARRIAGE**

Many attempts were made to develop Sawyer-controlled setworks, thereby to eliminate the setter and to improve accuracy. All of the early efforts either only partially did the job or were outright failures. It was not until well after WWII that the many problems...electrical, pneumatic, hydraulic and mechanical were solved. Of equal importance was a system that was simple enough that a sawyer could do a good job without loss of production and miscuts. The sawyer-controlled setworks did in fact require extensive retraining of sawyers, retirement of some, and development of a new crop of sawyers not committed to the "old ways".

Lionel Pease's setworks of the late 1950's (manufactured by Mill Equipment Inc. in Seattle) was the first unit to receive wide acceptance in the United States. Today the remotely controlled carriage is universal in the larger mills.
Figure #35. The powered carriage setworks speeded up the job and also increased accuracy. This led to setters riding the carriage, as above; but with demand for increased speed on the carriage, setters were provided with a seat as shown to the left. These illustrations are from 1910 Allis-Chalmers literature, courtesy of Smithsonian Institute.
Armstrong Saw Engineer

We used 60-inch circular saws with 80 teeth in them. The saw was 7 gauge and ran 900 r. p. m., a Prescott gun shot feed and Hill nigger were used, and a sawyer we had was a Mr. Charley Green, and I never saw a better one. He could also file saws, but did not like it, he said, but he would rather saw than eat.

After his crew got used to his quick actions, he would saw hours at a time and never stop the carriage. That is, he would have a power of steam in either one end of the feed cylinder or the other all the time so the carriage would slam from one end to the other just as fast as the feed would drive it. And when he ran the last piece out past the saw to be taken off onto the live rolls he would cushion the steam in the cylinder for a quick come-back just the same as between cuts, so the carriage men had to undog and kick off the last piece at just the right time or there would be a smash-up by pulling the last piece back on to the saw and it (the piece) be shot over the saw.

It was the same way at the other end. When he came back after a log he cushioned the steam just the same and the log had to be kicked on to the carriage on the fly followed up with the nigger against the knees and dogged and right slam onto the saw it went all in the wink of an eye. The setter had to judge the size of the log and let the blocks open just so the first slab would be O. K. from the log with no puttering at setting out for the first s"a... -

The sawyer, the setter, the dogger and the off-bearer all were just like part of the machine, and they and the machine worked just like clockwork. Every man did his little act just in the nick of time and drove the feed wide open all the time.

Many on this West Coast may not believe it when I say, in running 2 x 10's from a cant it was common for them to feed the 60-inch saw 20-inch at each revolution and with the saw turning 900 a minute it meant that the carriage was running at the rate of 1500 feet per minute.

Twenty-inch feed with 80 teeth is just over 1/4" each tooth had to cut and the pine that we were sawing did not seem to tax the saw much in a 10" cut.

Figure #36 Here the operation of the "steam shotgun" carriage and its control by a skilled sawyer is described by E.P. Armstrong from his 1892 experience as a filer in the State of Michigan. Riding the carriage was not for those with a weak stomach! On today's carriages, the dogging and setting functions are controlled remotely by the sawyer, usually with the aid of electronic equipment to establish the best setting to maximize yield. The "steam shotgun" was common in large mills before WWII, after which most new carriages were equipped with high performance DC electric drives. This text was excerpted from the writings of the founder of ARMSTRONG MANUFACTURING COMPANY.

P.S. His mathematics checks out: 900 x 80 x .25 divided by 12 = 1500FPM.
Figure #36A. This 1920's photo in the State of Washington shows dancers on the stump of a giant fir tree. A talented musician, this young lady was extracting dance music from a shovel. Many pictures of early-day logging scenes were made to expand upon the Paul Bunyan theme, in an attempt to see who could tell the tallest tale. Trees of the kind shown here were called "Washington Toothpicks" on postcards sent home to Eastern relatives. The bandsaw was important for milling big diameter logs...then as now...because of its large throat clearance.
Part II
THE ABC'S OF WIDE BANDSAW TOOLING

Before discussing modern bandsaw machines, it is worthwhile to
cover the tooling, because this has such an important bearing upon
machine design.

BLADE STEEL COMPOSITION

Band blade steel must have very high elastic limits because it
withstands both tensile and bending stresses, flexing hundreds
of times per minute going around the wheels. (Example: 10,000 SFPM
wheel speed divided by 50' long blade x 2 wheels = 400 bends per
minute)

In addition, the steel must be hard enough to be a practical cutting
tool and be adaptable to swaging or spring setting to provide cutting
clearance between the tooth and the body of the blade.

There are only about ½ dozen manufacturers in the world for this
steel...all in Europe or Japan. The specifications among the
various manufacturers are nearly identical: steel alloyed with
carbon, silicon, manganese, phosphorous, sulphur and nickel.(Nickel
is the predominant alloy at about 2% while the other alloys are
only a fraction of 1%.) The final material has a Rockwell hardness
of 42 to 44; and teeth attain an extra 3 to 4 points of hardness
where cold-formed by swaging.

EFFECTS OF BENDING STRESSES ON THE BLADE

The wide bandsaw blade is held under strain between the top and
bottom wheels, but a totally flat blade will not adequately grip
the wheels. A flat, untensioned blade under strain would be loose
on both edges and stiff in the middle due to anticlastic curvature... i.e. convex on the wheel or bottom side; concave on the opposite face. See Figure 37. This would cause erratic cutting, if in fact it could be run at all.

Figure 37. Bending stress on the saw as it goes around the wheels is one of the many factors affecting saw maintenance and performance. The adjoining drawings show the principle. In section A-A, the top side is under tension, which causes it to decrease in width creating a slight concave surface. The bottom side is in compression, causing it to increase in width and assume a slightly convex surface. You can demonstrate this for yourself by bending a rubber eraser and observing the change in shape when it is bent. From the article, "High Strain/Thin Kerf" by Ed Allen of Letson & Burpee.

GUIDE LINES FOR BLADE SELECTION

Because of the repeated bending of the blade, it can not be too thick relative to wheel diameter. But, too thin a blade will not stand the stress of high feed rates. Figure 38 provides suggestions for blade thickness.

HOW TO DETERMINE PROPER THICKNESS

<table>
<thead>
<tr>
<th>Size of wheel</th>
<th>Thickness of Saw</th>
</tr>
</thead>
<tbody>
<tr>
<td>11'</td>
<td>11 gauge</td>
</tr>
<tr>
<td>10'</td>
<td>12 gauge</td>
</tr>
<tr>
<td>9'</td>
<td>13 gauge</td>
</tr>
<tr>
<td>8'</td>
<td>13 or 14 gauge</td>
</tr>
<tr>
<td>7'</td>
<td>14 or 15 gauge</td>
</tr>
<tr>
<td>6'</td>
<td>15 or 16 gauge</td>
</tr>
<tr>
<td>5'</td>
<td>17 gauge</td>
</tr>
<tr>
<td>4'</td>
<td>18 gauge</td>
</tr>
<tr>
<td>3'</td>
<td>20 gauge</td>
</tr>
<tr>
<td>2½'</td>
<td>22 gauge</td>
</tr>
</tbody>
</table>

Choose a band saw of the proper thickness for the size of the wheel, or there will be serious trouble with cracking. The following table shows the thickness of saw considered standard for different size wheels.

An easy rule to remember is the diameter of the wheel should be 1,000 times the thickness of the saw.

Figure 38 A simple guide. A blade too thick for the wheel diameter will be damaged by excessive bending stress. Too thin a blade will buckle or develop cracks from feeding and cutting pressures. Table and text courtesy of PACIFIC/HOC.
Following are the usual jobs the filer does when servicing saw blades: leveling, tensioning, back gauging, swaging, shaping and sharpening. These procedures will be discussed in the order mentioned.

**THE LEVELING PROCESS**

During normal handling, operation and maintenance of the saw, localized lumps or hollows in the blade will occur. The process of detecting and eliminating these irregularities is called "leveling"; and it is normally done before tensioning. The filer detects these visually using a LEVEL GAUGE. This gauge is a short straight-edge as shown in Figure #39. When detected, the areas are marked and can be eliminated in the stretcher rolls, or filers may elect to hammer out minor lumps.

![Leveling gauge diagram](image)

**Figure #39.** Use of the Level Gauge to detect bumpy areas, and how corrections are made. The filer sees light under the straight edge where there is a lump (bad place). He chalks the lumpy area, and proceeds as follows:

1. This crosswise lump is best handled by light blows with a hammer.

2. This longitudinal lump may be eliminated by a single pass with the stretcher (or hammering) in the middle of the out-of-level area. Or, if working only the center of the lump doesn't correct the problem, more work on each side of the middle should get the job done.

3. WARNING: Do not hammer or stretch outside of the marked area. To do so will cause distortions in other parts of the blade.
THE TENSIONING PROCESS

The primary objective of the tensioning process is to stretch the center portion of the blade, thus tightening both the tooth and back sides. TENSION is a term saw filers use to describe the result of using the stretcher rolls...it does not refer to tension put on the blade to hold it on the wheels. In wide band saw parlance that is called strain.

STRETCHER ROLLS: WHY AND HOW USED

Actually, the blade grips the wheels only on the two tire areas...near the tooth side of the blade and at the back side of the blade. The center of the band should not bear upon the wheels. Here, we discuss how that is accomplished. To produce quality work the blade must not waver nor vibrate during the cut. This is of primary importance in the tooth area, where all of the work is done. The forces of cutting as well as the heat generated tend to stretch the blade more on the tooth side than on the back side.

Therefore, it is necessary that the tooth side of the blade be just slightly shorter than the back side to allow for stretch, but still permitting tire contact on the back edge of the blade.

In the original manufacture of the wide band saw blade, both ends of the strip of steel are cut at 90 degrees and at a location to coincide with the midpoint of a tooth...important so that the saw can be sharpened on an automatic grinder. Then the weld is precision-ground to the exact thickness of the rest of the blade. At this point, both the tooth edge and the back edge will be the same length. Then the saw will be tensioned, using a BANDSAW STRETCHER. See Figures #40 and #41. The rollers in the stretcher machine are very precisely made out of high grade tool steel, and the steel of the saw blade actually becomes reformed in the cold-rolling process.
Figure 40. A MOVABLE ROLL BAND SAW STRETCHING MACHINE. The insert shows detail in the roller area. Note that both the top and bottom rollers are powered. These rollers can be positioned at desired locations along the roll shafts to suit the width of saw being worked. The large handwheel is a roll positioner. Three machine models are offered for 12", 14" or 16" maximum saw widths. The feed rate is about 40 feet per minute, driven by a 1 1/2 HP reversible motor. Courtesy of Armstrong Manufacturing.

Figure 41. FIXED ROLL BAND RESAW STRETCHER for blades up to 8" wide x 17 gauge or thinner. A 3/4HP direct connected gear motor powers both stretcher rolls. A similar unit is also made for saws up to 12" wide. Illustration courtesy of Hanchett Manufacturing.
The next sketch shows the use of stretcher rolls to tension a blade. The operator can vary the pressure on the rolls, and general practice is to apply more pressure on the first pass near the center of the blade, and progressively less pressure as stretch lines are made alternately toward each edge. Figure #42.

Figure #42 This sketch shows in principle 5 stretcher lines in the central portion of a saw. Note that the operator begins with heavy roller pressure in the middle of the blade, alternating with progressively lighter pressures out to the tire areas. As many stretcher lines as needed are made at more-or-less 1/2" intervals, depending upon saw width, thickness and the filer's good judgement. (NOTE: The two tire areas are smooth. The dotted areas in the sketch are for illustration only).

USE OF THE TENSION GAUGE

TENSION in wide band saws is a term filers of wide band saws have used over the years and is defined as the amount the center of the saw is stretched greater than the edges. To simplify the concept, filers visualize the center or stretched section of the blade as an arc upon a huge circle...the wider the saw the larger the circle. Figure #43.
Then, a steel gauge having a curved edge conforming to that circle is used to check the tension, thus telling the filer when he has stretched the saw correctly. The curvature in the center of the blade must match the tension gauge uniformly. The test is visual; if no light appears anywhere between the blade and the gauge, the tension is right.

During several shifts of operation, the tensioning is overcome and gradually disappears, so that stretching must be redone.

Figure #43 This diagram shows the tension gauge in position to test the blade. Note that two narrow flat areas (tires) have been reserved during the benching process. These tire areas bear upon the wheels, transmitting power from the wheels to the blade.

TYPICAL TENSION CIRCLES

Note: The tension circle is not the radius of the crown on the wheels. The tension circle is a theoretical one, developed after many years of experience by filers, and universally used in the trade. It is worth mentioning, though, that when crowned wheels are used, a larger tension circle is necessary than when wheel surfaces are flat. See Figure #44 for typical tension circles.
<table>
<thead>
<tr>
<th>Width &amp; Gauge of Saw</th>
<th>Tension</th>
</tr>
</thead>
<tbody>
<tr>
<td>16&quot; x 12</td>
<td>50'</td>
</tr>
<tr>
<td>15&quot; x 12</td>
<td>45'</td>
</tr>
<tr>
<td>14&quot; x 13</td>
<td>45'</td>
</tr>
<tr>
<td>13&quot; x 14</td>
<td>45'</td>
</tr>
<tr>
<td>12&quot; x 13</td>
<td>40'</td>
</tr>
<tr>
<td>11&quot; x 14</td>
<td>40'</td>
</tr>
<tr>
<td>10&quot; x 16</td>
<td>35' or 40'</td>
</tr>
<tr>
<td>9&quot; x 16</td>
<td>35'</td>
</tr>
<tr>
<td>8&quot; x 17</td>
<td>35'</td>
</tr>
<tr>
<td>7&quot; x 17</td>
<td>30' or 35'</td>
</tr>
<tr>
<td>6&quot; x 17</td>
<td>30'</td>
</tr>
<tr>
<td>5&quot; x 18</td>
<td>30'</td>
</tr>
<tr>
<td>4&quot; x 19 &amp; 20</td>
<td>25'</td>
</tr>
</tbody>
</table>

**Figure #44.** Condensed summary of tension circles (in feet) for various widths and gauges of saws. Table and text are used courtesy of PACIFIC/HOE.

Best results will be obtained by putting no more tension in a saw than is needed to allow it to lay perfectly level on the leveling block. Excess tension is one of the contributing factors causing body cracks to develop in the saw. For every gauge lighter than specified above, add 5' tension.

Example: For a 16" wide saw that is 13 ga. add 5' tension to 55' tension.

---

**BACK EDGE CURVATURE**

By making additional stretcher passes toward the back of the blade, the back edge will stretch and become slightly longer than the tooth edge, forming a crown.

A commonly used amount of crown (back edge curvature) is 1/64" in 5' feet of blade length. This is measured with a BACK GAUGE as shown in Figure #45. Too much crown may cause cracks in the tooth area and some pushing back of the saw on the wheel during the cut. Too little crown causes looseness in the tooth area and produces rough saw work.

---

**USE OF THE SWAGE**

The SWAGE is a tool which widens the cutting edge of the saw tooth in order to provide clearance between the saw tooth and the body of the blade. This is necessary because wood compresses during the cut, but immediately recovers, reducing the clearance between the blade and the kerf. Also, slight blade and tooth irregularities plus vibration contribute to the clearance problem.
Figure #45 The top drawing shows the BACK GAUGE in place on the back edge of a saw which has the correct 1/64" crown. The three sketches show in exaggerated form some problems which may be detected with back gauge. The lined areas show where hammering or stretcher lines should be used to make corrections.

1. This shows a section of the back with a hollow, and indicates where localized hammering (or stretching) are needed.

2. This shows a hump on the back edge and shows where attention is needed on the tooth side of the blade to eliminate the hump.

3. The difficulty here is not two hollow places, but one hump. The back gauge should be moved only half the gauge length each time to avoid a false indication such as this. If hammering is done at a and a', the problem will be worse. Work at point b is the correct solution.

The swage applies heavy cold-forming pressure to the tooth area of the saw brought about by movement of an eccentric die against an unyielding anvil. Figure #46. This spreads the steel evenly on each side, and must be done with care to avoid fracturing the steel...taking more than one pull on the swage handle, as needed.

THE SHAPER

The SHAPER refines the edges of the swaged area to end up with the precise width desired. Also shown in Figure #46. Shaping is important because it insures perfect clearance and sharp cutting
corners on all teeth. Actually the shaper is quite similar in operation and appearance to the swage, but uses two side dies to shape both sides of the tooth. Identical cutting points on all teeth of the blade will result if the job is carefully done.

**SPRING SETTING**

SPRING SETTING of wide band blades is occasionally seen, but was quite common in earlier times. Spring setting takes the place of swaging. Alternate teeth are sprung outward to provide clearance to the body of the saw. Inexpensive devices for offsetting the teeth are available, ranging from a simple wrench, to hammer & anvil devices, to fully automatic machines. Most narrow band blades (below 4" wide) are spring-set. For further explanation see Figures #47 and #48.
Figure #47 SWAGED TEETH on the left and SPRING-SET on the right. These sketches compare the two types of teeth. Note that each of the swaged teeth cuts full kerf width, but each spring-set tooth cuts half the width of the kerf. Sketch is courtesy of Eric Stephenson, co-author of "Circular Saws".

Motor Drive Setter

Figure #48 Automatic BANDSAW SETTER for blades up to 3" wide. The closeup view shows the saw feeding arm on the left and the tooth setting hammer on the right. This machine is powered by a 1/4 HP motor and can set 130 teeth per minute. Hand operated models are also available. Photos courtesy of HANCHETT MANUFACTURING COMPANY.

THE SAW SHARPENER

The BAND SAW GRINDER sharpens the saw teeth, automatically advancing the blade a tooth at a time until all teeth have been ground sharp. Control of tooth shape is important and this is accomplished by use of grinding wheels which are formed to match the shape of the tooth gullet. Figures #49 & 50. Also the raising and stroking of the wheel is actuated by a rotating cam. Various shapes of cams are available and the one selected is chosen for producing the desired tooth shape.
Figure #49. A bandsaw sharpening machine (Gummer) and associated support stand system. Roller type stands are illustrated. Arrow points to the saw filing clamp which guides and provides lateral support for the blade. The unit guides the saw, but not tight enough to prevent easy movement as sharpening proceeds. Also, a major use of the clamp is to securely hold the blade during swaging and shaping. The other arrow indicates the direction of saw travel. Right hand machine shown. Photo by HANCHETT MANUFACTURING COMPANY.

Figure #50. This sketch shows the grinding wheel at the instant of sharpening the face of the tooth, and the guiliet at its maximum depth. The wheel travels into the guiliet in an eccentric fashion by cam action, so that it grinds the whole guiliet from tooth tip to tooth tip. In the process the guiliet shape and depth, rake angle (hook) and back clearance are automatically formed. Sketch by HANCHETT MFG.
The two basic types of back-feeders are shown here. Figure # 51 shows an air-operated unit, which is electrically actuated in unison with the sharpener feed. Figure # 52 shows a back-feeder which is mechanically powered by the feed unit on the sharpener. Both types work well, but the air-operated one is generally preferred for these reasons:

1. There is less mechanical stress on the sharpener.
2. Access area around the back side of the sharpener is increased.
3. Maintenance and adjustment as required for the mechanical linkages is eliminated.

Illustrations from ARMSTRONG MANUFACTURING COMPANY
Automatic saw support units are necessary to support the blade and keep it level as it proceeds through sharpening. This picture shows an optional automatic unit. It raises or lowers in unison with the saw width adjustment in the sharpener. Note elevating gear. The unit shown is lined with durable plastic to handle double-cut or sliver-tooth blades without damaging the teeth. Illustration by ARMSTRONG MANUFACTURING COMPANY.

Automatic sharpeners may grind as many as 30 teeth per minute, so the labor saving is obvious. Also, the accuracy of such a unit is nearly impossible to duplicate by hand filing...as was done for many decades before invention of the machine.

* * * * *

A device which many filers use is the Proctor Roll. This attachment for the sharpener smooths the edges of the gullet and removes burrs which develop during grinding...and thus reduces chances for gullet cracking. But, this device is not a substitute for doing a careful grinding job. The sharpener must be adjusted to take a light grind, to minimize burrs and case-hardening of the gullet. Several passes should be taken as necessary. Figure #54 describes the process further.
In form the Proctor Roll is a U-shaped clamp containing a pair of rollers 3/4-inch wide and 1 1/2 inches in diameter, with a crowned face. The clamp is hinged and is provided with a clamping screw similar to a vise, having a spring to keep the pressure uniform. The Roll is easily attached to any band saw grinder and does its work automatically. The saw is fed through the roll by the feed finger of the grinder after the saw has been ground. Pressure is applied to the spring clamp when the Roll is in the position as shown in the illustration. The bottom edges of the rollers are set 3/4-inch below the extreme bottom of the gullet of the tooth. The pressure brought to bear on the rollers on each side of the saw has a smoothing or crimping action on the burred edge of the gullet left by the grinding wheel.
THE SAW BENCH

We have discussed the basic operations and tools that are employed in maintaining a wide bandsaw blade. The bench man needs an efficient combination of these elements so as to maximize results from his efforts. The cost of a good bench can be quite modest in smaller operations, without leaving out needed features.

As with buying any equipment, there are usually options. For example, the most basic way to test a blade for tension is to give it the manual lift-bend test...lifting with one hand and gauging with the other hand. Figure #55. But most bench men will want a mechanical lift because a more careful gauging job can be done this way.

Machine manufacturers offer saw benches in various forms, depending upon the blades to be handled and the volume of work to be done. The following Figures #56, #57 and #58 show the features offered in benches for all sizes of mills.

Figure #55. When a blade is correctly leveled and tensioned, it can be made to lie flat on the leveling slab, the same as it is when the saw is actually cutting wood in the bandsaw. Lifting the saw as shown here brings out the tension curve, and may highlight lumpy areas. Inspection at this point is with the tension gauge and/or straight edge. When the bench is equipped with an air-lift, this frees both of the filler's hands for gauging work. Sketch courtesy of HANCHETT MANUFACTURING.
Figure # 56 Here is a basic bench for working smaller band saw blades. Shown are the stretcher, leveling block and rubber covered rollers to support the saw without damaging the teeth. To do a complete job, the filer must work both surfaces of the blade; so, the saw may be positioned either above the bench (as shown) or below the bench to give access to both sides of the blade. Photo is by courtesy of ARMSTRONG MANUFACTURING.

Figure # 57 Large bandsaw blades are quite heavy and cumbersome to handle. The double block bench avoids having to lift the blade to the upper position, and it also eliminates the double handling required with a single block bench. To access the lower leveling block, the filer opens a trap door in the floor, and steps down to address problem spots on the reverse surface of the blade. Note the air lift to raise the saw for checking the tension, instead of doing it manually as shown in Figure #55. A welding clamp may also be built into the bench, which is shown here. Photo by ARMSTRONG MANUFACTURING COMPANY.
Figure # 58. This elevation drawing shows a bandsaw bench which makes use of a large diameter wheel at each end of the unit. The wheel on the left is mounted on a telescoping assembly. Arrow B points to an 18" stroke air cylinder which is used to strain the blade during leveling. The wheels are crowned to insure that the blade moves in a straight line across the leveling slabs. The long stroke of the cylinder makes it possible to accommodate some variations in blade lengths, and longer cylinders are available for different length saws.

During the stretcher operation the large wheels are not under strain, and the slack side of the blade rides on the UHMW idler rolls which are adjustable so that the blade is steered accurately during the tensioning operation, along with help from the roller on the tip of the inspection lift assembly.


The ability of this bench to put the blade under strain causes the saw to lie flat on the leveling slab. For plants using extra-thin saws, with their smaller tension circles, this feature is desirable.
Before tensioning the blade, leveling must be done...

i.e. eliminate lumps. Many can be corrected with the stretcher, but hammering is still needed to do a complete job. Three basic types of hammers are used: the Cross-face, the Twist face and the Dog head. Figure #59.

The first two have elliptical shaped faces and are used for leveling (lump removal). The one used will be determined by the direction of the lump and convenience in holding the hammer at the right angle to address the problem.

The dog head hammer, which has a round face, is used to correct tension problems not handled by the stretcher, particularly work in weld areas.

The hammers are usually the personal tools of the filer. He maintains their striking faces, so that a uniform impact occurs between the hammer head and the blade surface to minimize the creation of dents. In general:

1. Use light weight hammers for thin saws.
2. Use heavier hammers for thick saws.
3. It is better to apply a heavier hammer lightly than a light hammer heavily. Too heavy a hammer hand damages blades. How the hammer is used reflects the craftsman's understanding and concern for his profession.


Figure #59. Illustration from the book, CIRCULAR SAW by Stephenson and Plank.
Summary of
EQUIPMENT NEEDED FOR A BANDSAW FILING ROOM

Most companies using wide bandsaws on a daily basis find it desirable to set up an in-plant filing room, and to hire a skilled filer to service the blades. A minimum list of equipment is listed below.

1. SAW BENCH incorporating stretcher rolls and leveling block or blocks. Figures # 56-7-8 and #40.

2. BACK GAUGE (concave) to check crown on back edge of blade. Figure # 45.

3. TENSION GAUGES (concave) to check that blade tension conforms to the circle associated with the saw being serviced. Figure #43.

4. LEVELING GAUGE (straight) to identify bumps and hollows. Figure # 39.

5. SWAGE to expand and form the cutting portion of the saw teeth. Figure # 46.

6. SWAGE TOOTH SHAPER to refine the tooth shape after swaging.

7. SHARPENER to sharpen saw teeth and maintain gullet and hook geometry as the blade is worn from use. Figures # 49 thru 53.

8. BRAZER or WELDER to repair accidental tooth or blade damage. Figures # 57 & 58 show location of welding clamps.

9. HAMMERS to help eliminate problems detected in the leveling and tensioning process and for finishing welds. Specifications to suit blade thickness and filer preference.

10. Bench grinders, wrenches, feeler gauges and normal assortment of machinist hand tools.

In addition, large mills will consider stellite tooth tipping and shaping equipment and an automatic leveling machine. Some operators may prefer heat tensioning to roller tensioning. See next page.
HEAT TENSIONING

This method is not widely used, but a goodly number of filers prefer it and are successful with it. In this procedure, instead of stretching the center of the saw, as is done with the roller stretcher, the edges of the blade are heat shrunk. This makes both edges of the blade shorter than the center, thus accomplishing essentially what the roller stretcher does. An oxy-acetylene flame or a heat induction generator is used to get the job done. Advocates of heat tensioning state that it is less stressful to the steel of the blade than cold-rolling the center of the blade.

* * * * *

"Well, that's a beauty!"

Will some of our filer readers tell me if the saw is worth fixing? It is 21-ft. 8-in. long, 2¾-in. wide, 20-gage, space 1½-in., and has been in use part of the time for one and one-half years, without a crack. It was doing fine work till it hit the knot.

E. A. SOULES.

Figure #60 above. Filer E.A.Soules sent in this photo to the WOODWORKER magazine in 1912, outlining his struggles with the saw and asking the question reproduced here. Reader comments were a popular feature in the WOODWORKER, which was a good source of education for wood machinists...much needed then, as now!
BIBLICAL ADVICE TO WOODWORKERS... updated.

ECCLESIASTES: Chapter 10. (written in 799 B.C.)

Verse 9: Whoso removeth stones shall be hurt therewith; and he that cleaveth wood shall be endangered thereby.

1992 Update: Machining wood can be dangerous; work carefully.

Verse 10: If the iron be blunt, and he does not whet the edge, then must he put to more strength; but wisdom is profitable to direct.

1992 Update: Keep tools sharp...they consume less horsepower that way. Seek knowledge.
Part III
WIDE BANDSAW MACHINES

As pointed out earlier, the band saw went through a long and tortuous development period. Today, however, a majority of large and medium-sized sawmills and remanufacturing plants use them. Band saws produce smoothly sawn lumber at good production rates. They do it with minimum kerf...less than most circular saws. Kerf-saving and surface quality have been the driving forces favoring the bandsaw.

Bandsaws are designated by their wheel diameters, commonly sized as follows: 3', 3½', 4', 4½', 5', 6', 7', 8', 9', and 10'. Sizes smaller than 5' are usually found in remanufacturing plants, and these machines often have a tilting feedworks or a tilting bandsaw unit, to do bevel sawing in addition to vertical resawing. The larger machines are used for log and cant breakdown.

HORSEPOWER REQUIREMENTS.

There are many variables which determine how much power a bandsaw will consume...so many that it is difficult to come up with a meaningful horsepower formula. These variables include:

1. Wheel diameter and weight.
2. Wheel speed.
3. Saw gauge and kerf.
4. Tooth spacing.
5. Gullet capacity.
6. Rake angle of teeth.
7. Sharpness of teeth.
8. Cut depth.
9. Feed rate.
10. Stock density.
11. Stock moisture content.
12. Climate extremes (frozen timber).

However, some educated observations of trade practice give us ballpark figures. See Figure #63.

BANDSAW CONFIGURATIONS

Most mills are the vertical type...i.e. a top wheel is directly over a bottom wheel, the bottom wheel being driven by an electric motor sized and belted to suit production requirements. Figure #61 shows a double column unit; Figure #62 shows a single column machine.

Horizontal mills are less frequently used, but are specially effective
Figure #61. A heavy-duty, double-column bandmill, without guards.
1. Upper one-piece wheel with tightening holes cast-in.
2. Upper wheel non-rotating, eccentric arbor, which pivots by air cylinder to produce desired strain.
3. Motorized top guide adjusting mechanism.
4. Upper wheel elevating post.
5. Upper wheel supporting steps.
6. Strain pressure gauge.
7. Motorized elevating device for top wheel.
8. Top pressure guide (cartridge type) with pivoting breakaway mounting.
9. Top wheel tilting adjustment.
10. Bottom pressure guide (cartridge type) and outer sliver shear.
11. Slat bed off-bearing table and drive.

Photo courtesy of McDonough Manufacturing Company.
Figure #62 Upper section of a sturdily-built SINGLE COLUMN BANDSAW, available with 5' or 6' diameter wheels. Machines are used in single, twin or quad applications for log breakdown or resawing. Horizontal and slant models are also offered.

1. Top and bottom wheels are cast, ductile iron. Top wheel rotates in cartridge-mounted roller bearings, mounted on a dead arbor.

2. The strain unit is a simple compressible rubber element requiring no air, gas or hydraulics. Maximum operating strain 25,000 pounds, monitored by a digital readout.

3. Arbor adjusting screw.

4. Handwheel adjustment for wheel tilt (motorized available).

5. Wheel elevating motor.

6. Wheel assembly pivot point.

7. Top guide support arm.

Photo courtesy of CAE MACHINERY LTD.
<table>
<thead>
<tr>
<th>WHEEL DIAMETER</th>
<th>HORSEPOWER</th>
<th>WHEEL DIAMETER</th>
<th>HORSEPOWER</th>
</tr>
</thead>
<tbody>
<tr>
<td>36&quot;</td>
<td>20-30</td>
<td>60&quot;</td>
<td>100-150</td>
</tr>
<tr>
<td>42&quot;</td>
<td>30-50</td>
<td>72&quot;</td>
<td>150-200</td>
</tr>
<tr>
<td>48&quot;</td>
<td>40-75</td>
<td>84&quot;</td>
<td>200-250</td>
</tr>
<tr>
<td>54&quot;</td>
<td>75-125</td>
<td>96&quot;</td>
<td>250-300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>108&quot;</td>
<td>300-350</td>
</tr>
</tbody>
</table>

Figure 63. This table shows a range of motor sizes needed to power the blades on bandsaws with various wheel diameters. Power recommendations are taken from specification sheets furnished by a representative group of North American machine manufacturers, covering commonly used wheel diameters. The smaller units on the left are used mostly in remanufacturing operations; those on the right in sawmills as headrigs or for heavy duty resaws.

for reworking rough slabs coming from the sawmill headrig, gaining an extra saw line without an extra operator. Figure 64.

Band saws are frequently used in multiples...i.e. twin, triple or quad. The multiple saw machines are used most frequently for small-log breakdown, and will be discussed later.

MECHANICAL FEATURES OF WIDE BANDSAWS

Sawmillers always look for heavy, rigid construction in their machines because of the severe shock loads they must handle and because these machines are the key elements in the mill. Double column mills are normal for mills with wheels over 6' in diameter. Double column mills have a separate bearing support for each end of the saw arbor compared to a single column machine without an outboard bearing on the spindle. Single column construction eases blade changing and makes possible the close-coupling of band units in the case of a quad-mill. In double column design, the added rigidity is a key point, and the larger machines are built that way.

Regardless of individual requirements, there are certain elements common to all vertical band mills. The bottom wheel is always the one which is powered, and it is much heavier than the top wheel. The flywheel effect of the heavier wheel minimizes potential slowdown of the wheel when the log or cant engages the saw blade.
The top wheel acts as a tensioner on the blade. In contrast to the bottom wheel, it is LIGHT in weight so as to have lower inertia. This makes it easier to respond to any slowdown of speed of the bottom wheel due to sudden load changes. It reduces the tendency of the top wheel, when the bottom wheel slows, to transfer slack to the cutting side of the blade, thus creating looseness at the cutting area. Having a lighter weight top wheel also reduces the amount of upward pressure needed to overcome the weight of the wheel when applying strain.

![Figure #64. A top-mounted Horizontal Resaw (right hand). The lower feedworks is a slat-bed type. Arrow points to upper feedworks which is a "slab" type...i.e. it is composed of a number of narrow roll sections, each of which is tensioned, but yields separately to conform to slab irregularities. Note that there are two sections of these slab rolls...one before the cut and one after the cut. Illustration by Kockums Cancar.](image)

**THE STRAIN**

The top wheel is driven by the saw blade itself. It operates under a continuous upward pressure which automatically maintains blade tension to meet variations in the sawing load. The strain contends with forces in two planes:

1. The power which drives the blade.
2. The feeding forces which tend to push the blade off the wheel.

The strain adjustment is critical to good saw performance. The generally accepted method of strain was for many decades the counter-weight system (Figure #65), or a simple coiled spring. The object was to provide instantaneous response to load changes which occur: 1. at the beginning of the cut, 2. during the cut, or 3. at the completion of the cut. The weighted strain (or springs on smaller machines) did a reasonably acceptable job of this, but not perfectly so.
Many thought that damping and response times were too slow, particularly with the weighted strain. Figure #66. If damping time could be reduced, there would be less blade oscillation, and therefore less deviation in lumber size. During the past 20 years there has been a proliferation of new mechanisms designed to do a better job. There are two basic types of strain...those which are cylinder operated, and those which make use of spring action. A summary of strain types is shown in Figures #67, #68, and #69, which follow.

Spring-type strains have the advantage of basic simplicity...essentially no moving parts to maintain, low friction and they are fail safe. To set the strain, the top wheel is raised until the strain unit is compressed under load to the required tension. A load cell can give strain readout on a display. But, smaller, remanufacturing machines often use only a mechanical pointer to show the level of strain.

Cylinder type strains are more readily adjustable, and usually can cover a wider range of pressures.
SECOND ORDER SYSTEM RESPONSE

Figure #66. An illustration of the unfavorable damping period with the weighted strain system. Courtesy of CAE MACHINERY LIMITED.

Figure #67. An air conversion kit for an existing bandsaw with weighted strain. The unit has a direct reading strain gauge. This conversion greatly improves the damping problem shown in Figure #65, but maintenance of the strain pivot points is still required. Drawing courtesy of SALEM EQUIPMENT INC.
Figure 68. CYLINDER-ACTUATED STRAINS. On the left is an AIR cylinder unit, which applies strain through an eccentric dead-arbor arrangement which pivots in anti-friction bearings. On the right is a HYDRAULIC cylinder strain system, which is cushioned by an accumulator. Sketches courtesy of CAE MACHINERY LTD.

Figure 69. SPRING TYPE STRAINS. On the left is illustrated the "aeon" rubber spring, which is formed internally and externally to allow compression under strain. The rubber spring is directly under the arbor of the top wheel. On the right is an air spring in the form of an air bag. In this sketch the air bag is located off-center of the arbor, though manufacturers offer it both ways. Readers can also visualize a steel spring in place of the rubber or air springs shown above. Adapted from sketches courtesy of CAE MACHINERY Ltd.
CENTRIFUGAL FORCE

Centrifugal force resulting from blade travel around the wheels is a consideration because it tends to stretch the blade. But operators are not usually concerned about this...the amount of stretch is very small and whatever does occur is offset by the strain and guide system. Refer to Figure #70.

What is of greater concern is the ability to transmit torque to the blade, and the strain system certainly enables this. But the strain system still needs some help in maintaining rigidity in the cutting area of the saw, and this leads to the subject of guides.

Figure #70. The object of the strain, in combination with the pressure guides, is to insure that no slack or vibration occurs in the cutting area of the saw, and that power is transmitted to the blade without slippage. Centrifugal force also acts upon the blade as it goes around the wheels, but these effects are considered small, and they are neutralized by the strain and guide systems.

WIDE BANDSAW GUIDES.

The purpose of the guide is to insure STIFFNESS of the blade right at the area where cutting takes place. Guides must reinforce and aid the action of the strain. The blade has two guides...a bottom fixed unit just below the lower edge of the cut and a top guide which is adjusted vertically to suit the depth of cut. On high production mills, this adjustment is remotely done, but is done manually on small machines.
The ability to remotely set the top guide makes it possible to set instantly when cut thickness changes; thus the blade is always cutting with maximum stiffness.

The guides were historically blocks of hardwood (lignum vitae or rock maple), mounted in a "U"-shaped holder straddling the blade, and adjusted so that the wooden blocks just barely made contact with both sides of the blade. This was done to prevent blade deviation in either direction during the cut...such as tending to follow a cross-grain, or deflection for whatever reason. Again, this was a feature that worked reasonably well over the years, but improvement was needed.

PRESSURE GUIDES.

To overcome the short-comings of the old style guides, pressure guides were developed. The pressure guides actually exert a force on the back side of the blade. This increases tautness between the top and bottom guides, and thus improves sawing. This is an additional mechanical factor for the machine, but the increased accuracy is deemed well worth it.

This led naturally to the "cartridge" type quick-change guide blocks. The blocks are made of composite materials, impervious to swelling caused by moisture. These cartridges are taken to the filing room and placed in a truing unit which machines the guide pieces to same-as-new accuracy. Spare cartridges permit this to be done without lost production time. Figure #71 shows a modern pressure guide unit.

A recent innovation is an electronic saw deviation detector mounted in the upper guide area...adjacent to but not touching the blade. It makes the test results instantly visible on a panel at the sawyer's station and/or the filing room. Excessive deviation will alert personnel to check for problems such as guide wear, slivers in the guide, bent saw teeth, saw cracks, or insufficient strain.
BASIC SAW ALIGNMENT

Each machine manufacturer provides detailed procedures, but essentially the following must be done:

a. The top and bottom wheels should be plumb...i.e. directly opposite each other.

b. Wheels must also align crosswise...i.e. the rim edges of the top and bottom wheels should be in line with each other. To check, place a straight-edge between the top and bottom wheels and manually rotate them to see if there is overlap more on one wheel than on the other. Another possibility is the use of piano wires stretched across wheel rim edges. See Figure #72. If space will not permit these procedures, plumb-bobs suspended from wooden pieces attached to the top wheel may provide a reference from which to measure alignment.

c. The saw must be square with the carriage in the case of the headrig, or with the feedworks in the case of the resaw.

Figure #71. The elements of a quick-change pressure guide system:
1. The upper guide block and holder.
2. The lower guide block and holder.

Guide blocks are precision-machined within .001" in the filing room and can be quickly put into place in the bandsaw. Photo courtesy of PACIFIC/HOE.
DEFLECTING WASTE.

It is necessary that there be no buildup of pitch or other material on the faces of the wheels and that splinters, knots, etc. not enter between the blade and the wheels.

Typically two wheel scrapers, made of brass or steel, will be used...one for the top wheel and one for the bottom wheel.

In addition, a closely-fitted, adjustable shear deflects sawdust, knots, splinters, etc. away from the space between the blade and the bottom wheel.

While discussing waste deflection, mention should be made of the SLIVER TOOTH BLADE which is often used on sawmill headrigs. This is a single
cutting blade, but has shallow teeth on the back edge. The function of these teeth is not to saw lumber, but upon return of the carriage after a cut, these teeth break up any splinters or debris which developed during the cut and extended into the path of the saw...material which could cause saw damage or endanger operators. In some cases sliver tooth saws make it possible to eliminate use of the offset on the carriage return. Because the side of the blade with the sliver teeth does very little cutting, sliver teeth are only occasionally sharpened.

![SLIVER TOOTH](image)

This specially shaped shallow tooth is sometimes put on the back of log bands. It is not swaged or fitted. It is used instead of an offset on the carriage.

**Figure 73.** Drawing of a SLIVER TOOTH on the back (non-cutting) edge of a blade for a large sawmill headrig. Courtesy of PACIFIC/HOE.

**BLADE LUBRICATION**

As an aid to the scrapers, and to reduce friction between the guides and the blade, water may be sprayed to the blades when cutting green lumber. Also, special lubricating compounds may be applied by wick, felt pad or by atomized spray when resawing dry lumber, or where freezing temperatures require it.

**WHEEL BEARINGS.**

In the sawmills, bandsaws run day-in and day-out...often two shifts...as the prime production machines in the plant. So, it's never wise to skimp on bearings, failure of which can cripple production. Not only do these machines operate continuously, but the wheels run under high tension; on 10' foot mills the strain may be as much as 60,000 pounds.
Bandsaw manufacturers recognize the heavy-duty requirement, so cartridge type roller bearings are typical...with extra-heavy duty ratings...often based upon bearing specifications for railroad cars.

Bearings with predictable operating life (depending upon load) of 40,000 to 60,000 hours are used.

* * * *

Every rework of the blade weakens the steel. Every sharpening narrows the blade and decreases beam strength. The strain system and the guides are fighting a continual battle to maintain a stable cutting situation to offset these conditions, plus other hazards of the sawmill. So, the life of a blade is hard to predict.

* * * *

Additional Bond
THE CONVENTIONAL MILL

The traditional sawmill is set up to handle large and medium-sized logs in such a way that they can be selectively sawn to any configuration that produces the best grade and yield. The cutting decisions are under the control of the sawyer, but in larger modern mills he is assisted by electronic scanning which enables much more accuracy than is possible with human judgement and "eye-balling" decisions. The bandsaw, however, is the key to kerf reduction, as well as control of sawing deviation.

Figure #74 is a basic flow plan for a sawmill using a bandsaw/carryage combination for headrig and a linebar resaw for further breakdown of the log. It is noted that a BAND resaw is used for SELECTIVE sawing of cants coming from the headrig, but that a CIRCULAR SAW edger is used. Because edger cuts are usually not deep, kerf is not excessive, and capital costs are much lower, circular saw edgers find a place in most mills of this type. Gang edgers, shifting-saw edgers, or combination machines are chosen to suit the cutting program.

In working out the flow in the mill, the choice of resaw machines involves many options and configurations. See Figures #75, 76 and 77.

SMALL LOG SAWMILLS.

A high percentage of lumber production comes from logs 6" to 20" in diameter, because such logs can be grown quickly... in only 25 to 50 year cycles. But, to get high production in a sawmill a very large number of logs must be processed...often in the range of 2000 to 5000 logs per 8-hour shift. This has forced the development in the last 25 years of a complete generation of new sawmilling machines.

A key to most of the new era small log systems has been the use of chipping heads to machine reference faces for further breakdown of the log by band saws. A 3-head unit which chips the bottom and two sides
Figure 74. BASIC FUNCTIONS AND FLOW in a mid-sized conventional sawmill with bandmill/carriage headrig. Log lengths 8' to 16'. Building 200' long x 70' wide.
A. Debarked logs pass through metal detector to log infeed deck. Logs containing metal or other unacceptable defects are kicked out after the metal detector.
B. The sawyer is located in a cab where he can observe incoming logs and remotely control their movement onto the carriage. He also can view the operation of the bandsaw, where logs are selectively sawn piece-by-piece. By remote control (and perhaps with the help of an electronic scanner) the sawyer sets and turns the log on the carriage so that the most favorable cuts are made. He then routes the pieces to: 1. the trimmer infeed chains...or 2. the resaw...or 3. the edger.
C. The linebar resawyer, from his cab, controls the breakdown of cants or double-thick pieces. The circular shaped "run-around" returns pieces requiring further breakdown to the resawyer. This return system makes use of double-flex chains, so a single transfer gets the job done.
D. The edger receives lumber from both the headrig and the resaw. The operator selectively edges off wane and other defects, and may also activate one or more splitter saws.
E. All lumber passes through the multiple saw trimmer for defect and length trim, continuing then to the sorting area.
Figure #75. TERMINOLOGY FOR SINGLE SAW AND MULTIPLE SAW LINEBARS.
A. Right hand mill - left hand fence  B. Right hand mill - right hand fence  C. Left hand mill - left hand fence  D. Left hand mill - right hand fence  E. Twin band mill - left hand fence;  F. Twin band mill - right hand fence.

Illustrations courtesy of McDonough Manufacturing Company.

Figure #76. A PRODUCTION LINE FOR CANT BREAKDOWN. This arrangement is aimed at resawing for best grade recovery and the reworking of slabs and defective pieces to increase solid wood yield. The drawing shows the resawyer either working next to the resaw, or at the tail end of the resaw feed table. Choice of operator location depends upon lumber lengths, mill arrangement and operator preference. Illustration courtesy of McDonough Manufacturing Company.
Figure 77. THE LINEBAR RESAW. Here is a double column bandsaw, combined with a basic linebar feeder. Significant points are numbered above:

1. The linebar is positioned by a hydraulic setworks so that pieces of desired dimensions can be sawn from the cant.
2. Operator console for the setworks and electrical controls.
3. The powered vertical press-rolls pivot open to admit a cant and are then actuated by foot button to hold the stock to the fence.
4. The spiral horizontal feed rolls also urge the stock to the fence.
   A variable speed motor powers the vertical and horizontal rolls.
5. A disc splitter separates the pieces after the cut so they can be directed to the next work station as follows:

<table>
<thead>
<tr>
<th>One piece to Edger</th>
<th>One piece to Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>One piece to Trimmer</td>
<td>One piece to Return</td>
</tr>
<tr>
<td>One piece to Edger</td>
<td>One piece to Trimmer</td>
</tr>
<tr>
<td>One piece to Edger</td>
<td>One piece to Waste</td>
</tr>
<tr>
<td>One piece to Trimmer</td>
<td>One piece to Waste</td>
</tr>
</tbody>
</table>

Both pieces to Edger
Both pieces to Trimmer
Both pieces to Return

McDONOUGH MANUFACTURING photo.
of the log may be used when the log is fed by an overhead end-dogging carriage. Only two chipper heads can be used when a bed-line, sharp chain feeder is used. Arrangements of this type provide accurate faces for feeding the cants to the bandsaws, and reduce the problem of slab disposal, which always has been costly and bothersome.

Two basic approaches have been used in combining chippers with bandsaws. One is the COUPLING of chippers and bandsaws on a common base; the other is the DE-COUPLING of the chippers and bandsaws by a feed-roll arrangement with a linebar for accurate control of the cant as it goes into the bandsaws. See Figure #78.

The coupled arrangement reduces capital costs and space needed in the sawmill, because an intermediate feeder is needed in the de-coupled unit, and that feeder system must be longer than the longest log to be processed.

The de-coupled unit has the potential to reduce cycle time between logs. The chipping units can be fed at much higher speed than the bandsaws. The chipped cant can then be discharged to a slowdown feeder operating at the lower bandsaw feed-speeds. The chipper area is then free to accept the next log sooner than when its feed speed is the same as the bandsaw. Overall production of the line is thus increased. A further advantage of de-coupling is that the forces and vibration from chipping are isolated from the bandsaw base. Also access for maintenance is improved.

Figure #78. THE TWO BASIC COMBINATIONS of bandsaws with chipping heads. Drawing is by courtesy of COE MANUFACTURING COMPANY.
Feeding systems for small log breakdown by bandsaws

Feeding the log to the chipping/sawing unit seems like a simple problem, but if not done correctly, it can badly affect yield and production. Several basic feeding methods are used.

**The Sharp Chain Systems.**

In this arrangement, the log is placed on top of a chain having numerous sharp-toothed lugs, and force is applied to engage the teeth with the log. So, it is fed in a stable manner through the chipping heads and twin or quad bandsaws. The chipping heads and the saws are mounted on slideways. They are traversed by setworks on a log-by-log basis to the required setting for greatest yield. Refer to Figures #79 and #80.

*Figure #79. Here is a close-up view of the Sharp Chain Log Feeder. As the log enters the feeder, it is rotated to best cutting position. Then, it is impaled by press rolls upon the spiked tips of the chain lugs. In this case, the log is being sawn by a twin bandsaw, without any chipping heads. The slabs will be resawn... or be chipped if no salvageable lumber remains. Feed rates are variable up to 350 lineal feet per minute. Photo courtesy of Kockums Cancar.*
Figure #80. A CLOSE-COUPLED CHIPPER/QUAD BAND UNIT...this is the heart of a small-log processing line using the sharp-chain feeding system. Arrow points to the log feed chain. The flow is illustrated by the drawing: A. The operator. B. Log loading and turning. C. Log guiding infeed unit. D. Two-head side chipping unit. E. Twin or quad bandsaws. F. Pinch roll outfeed. G. Side board tipples. The center cant exits to further breakdown machines. Using a scanner and quad saws overall length of the system is about 85' for 16' logs; 100' for 24' logs. Illustrations courtesy of KOCKUMS CANCAR.
THE END-DOGGING SYSTEMS.

In this arrangement, traveling overhead dogging units secure the log on each end and feed it through the saws or chipping/sawing combinations. Because the end-doggers are overhead, it becomes practical to use a 3-head chipping unit. Thus slab-chipping cuts are made on the bottom as well as on the two sides of the log.

One very high production system uses two end-dogging units...one mounted on either side of a common overhead frame. The object of the dual system is to have one set of end-doggers moving a log through the cut while the other set of end-doggers returns to receive the next log. This reduces "dead time" between logs. Proponents of the system report processing as many as 15 logs per minute, working with 16' pieces! The working principle of this dual system is shown in Figures # 81 and #82.

Some end-dogging systems use only bandsaws, without chipping heads. So, slabs are then handled down-stream by various arrangements of resawing and chipping. Rotary end-dogging units are also offered as an option, so that the log can be turned 90 degrees. This makes it possible to saw slab cuts on all 4 sides of the log.

It should be noted that overhead dogging is well suited to either two or three-dimensional scanning. With a scanner it is possible to determine the required amount of skew, vertical placement and offset to get best solid wood yield from the log.

Most two-plane scanners are based upon the assumption that logs are true truncated cones...which, as a generality, is true. So, sawing solutions based upon this are helpful, but often leave unsolved problems. They don't fully evaluate log shape variations, so considerable increased yield is missed. Refer to Figure # 83.
Figure #81. Flow plan for a DE-COUPLED OVERHEAD END-DOGGING SYSTEM with dual carriages. The log enters the charging area where it is end-dogged and fed through the 3-head chipping canter at 600FPM. The emerging cant is slowed down in the transfer section to 350FPM, the desired bandmill feed rate. Side boards are diverted to the edger and the center cant proceeds to the next machining station. Drawing by THE COE MANUFACTURING COMPANY.

Figure #82. DETAIL OF THE DUAL CARRIAGE END DOGGING SYSTEM. Above a log is shown dogged and ready for machining. Arrows point to the retracted end-dogs which are returning to the charging station. The dog return and charging of the next log are begun while the first log is being machined. This greatly reduces idle cutting time. Note in the smaller drawing that the dogging arms are eccentrically shaped so that both the right hand and the left hand modules always dog the log in the center-line of the machine. Drawings courtesy of THE COE MANUFACTURING COMPANY.
Figure 83. A comparison of two-plane scanning and complete profile scanning.

A. The log is elevated through a group of sensors, which gage the true profile of the log.

B. As a result of the “full profile” scan, the log is skewed up, down, and sidewise by the charging apparatus to move it in accordance with the best sawing determination from the computer. At this point end-dogging occurs.

C. Potential higher yield from a log with irregular shape is illustrated...in this case an additional board was developed from the full-profile scan. Illustration by CUE MANUFACTURING COMPANY.

This discussion covers very briefly the basic uses of vertical bandsaws in primary log breakdown. But, mill plans have numerous variations in detail, necessary to suit a particular plant. These variations take into account work area available, numbers of logs to process per shift, log sizes, log quality, desired lumber sizes, grade sawing possibilities, and production machine capabilities.

Some times, a horizontal bandsaw is best suited to a particular production need, so horizontal bandsaws will be discussed next.
In large sawmills, the horizontal bandsaw is often used as an auxiliary to the head saw, in tandem with it. It is specially useful when working cull logs with rough, irregular surfaces. Cuts from these logs often produce pieces which a vertical band resaw would find difficult or impossible to feed. On the horizontal rig, the piece lies flat on its sawn surface, so it can be fed through the saw in a controlled manner. The feedworks of the horizontal machine can be furnished to work rough slabs for recovery, or to gain one line for the headrig, or both.

Such machines have a dual feedworks...upper and lower. The lower feedworks may be a roller type with sharp teeth, or a slat bed with its broad contact on the bottom surface of the piece. The top feedworks may be composed of multiple, narrow powered feed rolls, which yield separately conforming to surface irregularities. This will accomodate slabs. Figure #64. If the mill uses a chipping slabber on the headrig, then simple, full-width top feed rolls are used.

On most horizontal mills, the saw raises or lowers by setworks to determine the depth of cut to be made, and this may be tied into the headrig control system...so an operator is not needed for the horizontal rig. Another less practical method is to raise or lower the feed bed to establish thickness, but this doesn't fit too well into most conveyor systems, because of the varying bed-line.

A few horizontal bandsaws are used as twin, over and under units. Figure #84. Another twin variation is the tandem unit (one behind the other).

Some horizontal bandsaws have been used in-line with a planer-matcher or molder to resaw planed lumber into beveled siding or to saw pieces planed double thickness. The lumber then can be used with either the planed or sawn surface exposed. Refer back to Figure #34.
Figure #84. Here is a Twin Horizontal Bandsaw using a top mounted unit opposite a bed level saw (both left hand units). Visible at the infeed end of the machine are the full-width "cant" type feed rolls instead of "slab" type. Coleman rolls or rolls having knurled and chromed surface may be used. This illustration from KOCKUMS CANCAR.

Large, traversing type horizontal saws are used at some saw mills to cope with occasional extra-large diameter logs which the headrig can't handle. Often, such logs would be quarter or half-sawn and then reworked to realize maximum grade...either by sawing or slicing for veneers. Some machines can handle logs up to 6½' in diameter. On these machines the saw is not cantilevered, but is supported on both ends by a carriage which straddles the log, as drawn in Figure #85.

Figure #85. Drawing shows a carriage-mounted horizontal bandsaw, which adjusts vertically to desired depth of cut. The unit straddles the log and traverses the saw through the cut to a maximum feed of 100FPM. A 60HP diesel engine powers this unit. FORESTOR illustration.
There are a number of portable bandsaws for use as "bush" type rigs. These machines are powered by gasoline or diesel engines, and in effect bring the mill to the trees rather than the trees to the mill. Figure #86. The typical unit has a stationary log deck with dogging and positioning mechanisms to secure the log during the cut. The saw unit then traverses over the log when making a cut.

Figure #86. This "Tom Sawyer" horizontal portable mill is easily towed from place to place. The saw unit pivots 90 degrees for travel, to meet road width restrictions. Upon arrival at a new destination, two men can set up the rig in less than half an hour. Double arrows point to the track upon which the cantilevered saw travels as it cuts the log. Single arrow points to operator. A hydraulic unit raises or lowers the saw to establish depth of cut, and to clear the top of the log for the saw return after completing the cut. A 30HP engine powers the machine, which has 36" diameter wheels, suitable for a 4" wide tensioned blade. Saw traverse speed is variable to 148FPM; usual blade speed is 5900FPM. Illustration by FORESTOR.
Many high production saw mills use a double cutting headrig...i.e. the bandsaw blade has teeth on both edges,(Figure #21a) and the machine cuts on both the forward and reverse strokes of the carriage. This increases production, but it also increases the demand for careful attention to both the servicing of the blade and maintenance and alignment of the bandsaw and the carriage.

Regarding the blade, the tooling fundamentals discussed earlier are extremely critical:

1. The teeth must be straight.
2. The blade must be level.
3. The tension must be correct.
4. But, the major difference is that the blade must be tensioned so that both edges are straight...i.e. no back crown.

Regarding the machine, the crown on the wheels is centered and the wheels must be accurately aligned with each other.

The carriage must track very accurately, and excessive wear in carriage parts can cause erratic cutting, even more noticeable than on a single cutting band mill. Most important is the alignment of the saw and the carriage. This can be checked by taking a cut on a log and then
slowly making the return without advancing the log for another cut. The saw should barely touch the log on the return. If there is a space between the saw and the log or the saw rubs the log heavily on the return, there is an alignment problem which must be corrected.

To quote Bob Chaves from his 1984 presentation: "A double-cut mill is, in effect, two mills...a right hand and a left hand, with the interesting phenomena that both mills use the same pair of wheels. If the double-cut mill is making thick and thin lumber, one hand is aligned into the log, the other hand is aligned out of the log." Expert opinions vary on the comparative efficiency between single-cutting and double-cutting rigs. It seems to boil down to two things:

1. The double-cutter is in the cut a higher percentage of the time, per log sawn. This is measurable.
2. The required higher standard of machine and tooling maintenance enforces best sawing practices, which in the end improves profits. This factor is important, but difficult to measure.

In any event, one expert offers the opinion that a double cutter properly maintained and operated, on average, increases production about 30%.

* * * * *

REMANUFACTURING BANDSAWS.

Secondary manufacture, after the sawmill, also has some interesting variations.

Readers will recall the coupling of the horizontal bandsaw to the planer for production of beveled siding, double T & G and similar items. Figure #34. This is still a viable procedure, but the high production rates of most modern planer-matchers go beyond bandsaw capabilities. Still, a number of planing mills need resaws in their programs, and by installing the resaw near the planer, it may be possible to avoid rehandling resawn lumber. Stifling of planer production by the resaw is avoided by an installation such as shown in Figure #88.
Figure 88  The basic planer line with resaw added. Tilting unloader hoist feeds to the resaw, and a reloader hoist accumulates lumber after resawing, without affecting planer operation. Also, resaw may feed directly into the planer flow—or feed into the trimmer and sorting line without passing through the planer.

The high grade, high cost lumber that goes into moldings and many wooden parts has encouraged the use of THIN-KERF machines. These units usually have 36" to 42" diameter wheels, and use blades as thin as 18 to 21 gage, making it possible to have a kerf of only about 1/16". In addition, these machines also can do bevel-sawing, so very large savings in material can often be realized. See Figures #89, 90 & 91.

In remanufacture we are usually concerned with the special problems of machining dry lumber, instead of green. The machine basics are similar, but the blades and blade lubrication must be adapted to suit the material.
Figure #89. A 36" BAND RESAW WITH TILTING FEEDWORKS so that beveled sawing can be done. Four powered feed rolls are used, or opposed belt conveyors "on edge", instead of feed rolls. The photo shows the feedworks tilted to 45 degrees, machining a square piece into two triangular shaped corner blocks. The sketch points up stock saving when bevel-sawing molding stock. The wheels are cast aluminum alloy, with rubber covered rims. Tensioning recommendations range from 1 3/4" wide expendable blades to 2 1/2" wide re-sharpenable saws. A 20HP motor powers the wheels; a 1 1/2 HP variable speed motor operates the feedworks. Top wheel strain is by spring or optional hydraulic tensioning. Photo courtesy of TYLER MACHINERY COMPANY INC.
Figure #90. 42" TILTING TWIN BAND RESAW with feedworks tilted outward. Right and left hand single column saw units are mounted on a common base. The feedworks tilts up to 50 degrees inward and 30 degrees outward. In addition, the machine is adjustable to saw two cuts beveled in opposite directions...so three beveled molding blanks may be produced in a single pass. See Figure #91. Multiple roller holds keep material snugly to the fence and table top throughout the cut. This avoids sniping, and sawing accuracy is within .003".

18 to 21 gage blades are used, so kerf as small as 1/16" is possible. This heavy duty machine feeds from 70 to 400 lineal FPM, and handles stock from 1/2" x 1/2" to 10" x 10". Photo courtesy of KIMWOOD CORPORATION.
Figure #91. These illustrations show various types of resawing that may be done using a machine with tilt capabilities. Both single saw and twin-saw cuts are shown.

A. A 45 degree diagonal cut produces corner blocks from a square.
B. A diagonal cut produces two molding blanks, while maximizing value from the raw material.
C. Two perpendicular cuts by a twin-saw make three strips.
D. One bevel cut and one perpendicular cut by a twin-saw produce two bevel-cut strips, plus one perpendicular cut strip.
E. Two beveled cuts produce three beveled molding blanks.
F. Two pieces of material are fed simultaneously through a twin-saw to produce four beveled molding blanks.

Illustrations courtesy of KIMWOOD CORPORATION.
MATCHING THE MACHINE AND SAW BLADE WITH PRODUCTION TARGETS.

There are a few simple "rules-of-thumb" which help to understand the theory of matching tooling to machine performance. These are stated capably by Stanford Lunstrom and Phil Quelch in separate writings by each of them. In summary these guides are:

1. For every square inch of saw tooth gullet only about 7/10 of a square inch of solid wood (converted to sawdust) can be efficiently carried in the gullet. Stated another way, the gullet area must be about 1 1/2 times that of the maximum tooth bite.

2. The minimum tooth bite should not be less than the clearance on one side of the blade. Otherwise the sawdust will spill out the side of the gullet and fill the area between the body of the saw and the wood. Then, erratic cutting results, heat will develop and blade damage may occur. A saw bite of less than .010" actually becomes wood flour rather than clean-cut sawdust.

3. To calculate gullet area, a quick and reasonably correct formula is:

\[
\text{Gullet Area} = \text{Tooth Space} \times \text{Gullet Depth divided by 1.75}
\]

Quelch's book "Sawmill Feeds & Speeds" contains extensive tables and commentary on this subject.

4. Depth of cut, tooth pitch, tooth speed and bite per tooth all relate directly to each other. See the formula and drawing by Stan Lunstrom, shown in Figure #92.

DETERMINING BLADE WIDTH.

The larger the wheel, the wider the face on the wheel. This
is necessary to accommodate wider blades which will have the beam strength to withstand heavy cutting programs. A general rule:

\[ \text{BLADE WIDTH} = \text{WHEEL FACE WIDTH} + \text{GULLET DEPTH} + \frac{1}{4} \]

**BLADE THICKNESS.**

Along with the wider blade, a thicker gauge is also used. Phil Qualch states in his SAW FILER'S HANDBOOK, "A rough rule of thumb for saw gauge is .001" thickness for each inch of wheel diameter, with large mills running slightly heavier and small mills slightly thinner."

Example: 10' mill 120" x .001 = .120" or 11 gauge.

Those who advocate higher strain sawing will use thinner blades in the interests of kerf-saving, and thinner than those shown in Figure #38.

---

**Figure #92. BANDSAW TEETH IN THE CUT.** This side view of the blade shows four teeth chambering sawdust at various stages as they saw through the wood. The target "bite per tooth" can be determined using the formula below; and this is vital because:

1. It affects surface quality on the board.
2. It enables you to avoid the overloading or underloading of saw gullets and the problems caused by same.
3. It enables you to set correct machine feed rates, directly affecting plant output.
4. It is a major factor in specifying the correct blade for your bandsaw.

Illustration and formula from the 1985 USDA publication, "Balanced Saw Performance" by Stanford J. Lunstrom.

\[ D = \text{Depth of Cut} \]
\[ P = \text{Tooth Pitch} \]
\[ F = \text{Feedspeed} \]
\[ C = \text{Toothspeed} \]
\[ t = \text{Bite per Tooth} \]

\[ t = \frac{P \cdot F}{C} \]
SURFACE QUALITY

The finish of sawn lumber is directly affected by a number of factors:

A. The first step in producing a fine surface is to take small bites...this avoids breakage of knots and tearing of wood surface. There are three ways to lower bite size:
   1. Decrease feed rate.
   2. Increase surface speed of band blade(greater wheel RPM). Don't exceed manufacturer's RPM specifications.
   3. Use a blade with more teeth (closer tooth spacing).

B. Saw teeth must be sharp and uniform in shape and height.

C. The tooth rake angle must be compatible with wood density...big angle for soft woods...small angle for hard woods.

D. Tooth gullets can not be over-loaded, nor should the bite be so small that it produces fine dust that spills out of the gullet.

E. All elements of the machine must function correctly...the strain, guides, wheels, etc.

F. The blade must be of good quality and be correctly tensioned and fitted.

In many molding and remanufacturing plants, the smallest practical bite size is a target. Saws as thin as 20 or 21 gauge are often used, with tooth spacing as small as 3/16", bite .035" and kerf of only 1/16". In contrast, large log sawmills fed at rates 500RPM or more have used blades thick as 11 gauge, with 3" tooth spacing, \( \frac{1}{4} \)" kerf and .150" bite.
Part V

THE NARROW-BLADE BANDSAW

Machines which use blades in widths from 1/16" to less than 2½" occupy a special place in secondary woodworking. These machines can do a wide variety of jobs, sawing thick or thin lumber, wide lumber, or narrow lumber. They can saw with the grain, across the grain or in complex curves (scroll work). Stacks of pieces can also be sawn.

A narrow blade bandsaw can be defined as one which uses blades so narrow that they do not go through the arduous benching operations described earlier for the larger machines. In fact, throw-away blades are often used...i.e. blades are disposed of when dull, or go through a limited number of resharpenings. Typically the blade runs on a rubber covered wheel to provide traction and to avoid damage to blade teeth.

THE MACHINES

Narrow bandsaws are usually less sophisticated in design than the wide band machines, and much lighter in weight. In commercial operations, wheel diameters generally range from 14" to 36". They are available in left or right hand configurations, but the most common unit is the right hand machine (i.e. looking in the direction of feed, the cutting area of the blade is on the right). However, those who are accustomed to feeding ripsaws and resaws usually prefer the opposite hand for straight-line work. Plant production lines may demand one hand or the other to meet flow requirements or convenience in maintenance, so the right/left hand choice is necessary.

One key dimension is the throat opening, i.e. blade to column distance, which determines the widest piece that can be sawn. Some machines are made with three wheels to accommodate extra-wide material. The principle is illustrated on an old machine, Figure #8. The other key dimension is the maximum space under the top guide. This determines the thickest material which can be processed.
Most machines are hand-fed, so they depend upon the skill of the operator to control feed rates, to operate safely and to accurately make the desired cut. But, automatic cutting to follow a template... or even computer controlled cutting is possible.

Some of the aids which expand bandsaw usage are:

A. Jigs for cutting circles.
B. Templates for accurate guiding of pattern cuts.
C. Powered feeders...roll-fed or belt-fed...for straight-line work only.
D. Mitre guides, to make accurate angled cuts.
E. The 45 degree tilting table top...in some cases up to 45 degrees right and 15 degrees left as well:
   1. To make beveled cuts.
   2. To make circles (or other shapes) in beveled or conical configurations.
   3. To make compound mitre cuts.
   4. To make three-sided corner blocks from squares.
F. Variable angle fences or jigs for cutting tapers.
G. Rip fence for making straight cuts.
H. Use of twisted blade guides to use the bandsaw for cross-cutting (described later).

The ingenuity of bandsaw enthusiasts is boundless, with some even making dovetails, tenons, dowels, marquetry (inlaid work), and various mosaics.

Some times, a choice must be made to cut a profile on a shaper or to do it on a bandsaw. Depending upon the pattern, it may be possible to get two finished pieces by sawing, instead of only one piece with the shaper, thus cutting material cost in half. Also, when cutting profiles, it is possible to use the "waste" from the first cut as a template for making subsequent identical parts, or as raw material for other cuttings.

**EXTREME CAUTION** is necessary when feeding bandsaws, as hands often are close to the blade. If shop-made jigs and fixtures are used,
they should be checked by experts to be sure that they are not conducive to accidental cuts or injury from broken blades.

Those interested in pursuing the details of special narrow bandsaw techniques will find good reading in Mark Duginske's 319 page book, BAND SAW HAND BOOK, 1989 by Sterling Publishing Company.

Figure #9.3. A modern, intermediate-sized bandsaw, equipped with 20" diameter wheels, having rubber tires vulcanized to the rims, and crowned for tracking purposes. A 2HP motor is typical. This manufacturer also makes bandsaws with wheels ranging from 14" to 36" in diameter. Blade widths up to 3/4". Courtesy of POWERMATIC.
Figure 94. A 36" MBD bandsaw, with guard doors opened. This heavy duty machine features aluminum alloy wheels, dynamically balanced, and with press-on tires which are steel reinforced and precision ground. The standard motor for this model is 7½ HP for manual-fed units, but up to 25 HP is used on automated units. Illustrations courtesy of TYLER MACHINERY COMPANY, Inc.

Above: Closeup of top guide area with guard swung open for inspection. Note large diameter back-thrust wheel and two side guides of composite material.
BANDSAW ASSEMBLIES

Basic parts of the narrow bandsaw closely parallel the machines developed well over 100 years ago, as illustrated in Figures #8 and #8A, but the change to welded steel construction and addition of extensive improvements in detail, machine options and safe guarding has made a big difference in machine function and appearance. See Figures #93 and 94.

Following are descriptions of the machine components common to most narrow bandsaws, and their functions:

1. The main frames of today's machines are basically "C" shaped and formed from reinforced welded steel, annealed to avoid distortion.
2. The top wheel mounting assembly not only includes the top wheel arbor and bearings (ball or roller bearing type), but also an adjustable straining device to keep tension on the blade during the cut. The strain may be accomplished by spring, by air cylinder, or by hydraulic cylinder. The strain unit applies upward pressure to the top wheel and arbor, moving it on a vertical slide, or alternatively by a pivot arrangement. In addition, means is provided to make the top wheel align with the bottom wheel.
3. The bottom wheel mounting assembly is located directly below the top wheel, and is driven by a motor/"V" belt combination. The motor is usually a single speed unit. However, some users may choose a variable speed motor or step pulleys to increase or decrease blade speed to suit different densities and thicknesses of material.
4. Wheel brakes are incorporated into wheel assemblies to rapidly stop wheel rotation when power is secured, or in case of blade breakage. Braking is accomplished electro-magnetically or by use of a foot-operated friction brake, electrically interlocked to de-energize the drive motor.
5. The top and bottom wheels on narrow band saws are usually identical, in contrast with the wide bandsaws which use a heavy bottom wheel and a light weight top wheel. Narrow bandsaw wheels are made of cast aluminum, cast iron with lightening holes, or from pressed steel
having stiffening flutes pressed into the wheel body. Tires are made of rubber, either vulcanized to the wheel rim or demountable types are also commonly used. Wheels should be dynamically balanced.

6. The work support table is typically cast-iron, ground to a precision smooth surface, and including provision for using a rip fence, mitre attachments, etc. Tables usually can be tilted for making beveled cuts...either to right or to left.

7. Top and bottom guides provide blade rigidity in the cutting area. The top guide adjusts vertically, and should be set close as practical to the surface of the work piece...for safety and to minimize blade deflection during the cut. All narrow bandsaw guides have three basic parts: The back thrust wheel and two side units, which may be either anti-friction rollers or rubbing blocks. See Figure #95. These are described as follows:

   A. The thrust wheel limits the back movement of the blade when work is pushed into the saw. The thrust wheel rotates in ball bearings, providing an anti-friction backup. It is set so that it does not rotate when no work is being done, but rotates freely whenever feeding pressure causes the blade to move back slightly from its true vertical alignment.

   B. The two side guide-blocks are used to prevent twisting or side movement of the blade in the cutting area. Side blocks are set to provide an easy sliding fit on both sides of the blade, with only about .003" to .005" clearance. They must also be set so that the saw teeth project in front of the guides to avoid damaging the set on the saw teeth. Guide blocks are made of many materials including wood, teflon, various composites and laminates, some of which are impregnated with a dry lubricant, or even sintered metals. Guide block requirements vary according to the type of material being sawn...as well as strong operator preference in many cases.

   C. Guide wheels are also available, to minimize friction between the blade and the side guides, and are recommended when sawing wood which does not contaminate the blade.

Guide blocks instead of rolls are necessary when sawing material which leaves a residue on the blade. The blocks tend to strip this
material off the blade, often in conjunction with a blade lubricator. A lubricator may be a simple oil-saturated pad, or a pressurized system using vaporized water or various chemical compounds.

The importance of correct guide adjustment cannot be overstated.

Although the top and bottom guides are identical in function, and similar in vital parts, the top guide mounts on a vertical slide, so that it can be set to suit the thickness of material being sawn.

8. Guards. A good number of safety guards are used, to suit the various machine designs. Wheel covers and belt guards are standard on all modern machines. Blade guards mounted on the top guide slide assembly are usual on the manual-fed saws. Check manufacturer, federal and state requirements, and your plant safety rules before a machine is put into service.

Figure #95. Here are shown three basic models of narrow bandsaw guides:
A. A three wheel unit which takes thrust against the periphery of the backup wheel.
B. A section of a guide similar to "A", but with two side blocks and a backup wheel which also takes thrust against its periphery.
C. A guide with two side blocks and a backup wheel which takes the thrust against the flat face of the wheel, near the rim. This arrangement permits nesting the the guide blocks within the arc of the backup wheel, very close to the surface of the wood being cut, and is therefore recommended for complex contour sawing, where extreme accuracy is a requirement.
Illustrations courtesy of CARTER PRODUCTS CO., INC.
INNOVATIONS TO INCREASE VOLUME AND WORK QUALITY WHEN CUTTING PROFILES.

The demand for more production and more precise cuts has led to three basic systems which take the place of "free-hand" feeding for pattern cuts:

A. Template, with manual feed.
B. Template, with automatic feed.
C. Programmable machine using Computer Numeric Control (CNC) & Programmable Logic Control (PLC).

Following is a discussion of each type. In all cases either one-piece at-a-time or stacks of material can be sawn, depending upon machine capability and production need. A heavy 36" machine can handle stacks (or pieces) up to 14" thick, so very high production rates are achieved.

A. Template control, with manual feed.

A common practice in smaller shops is to make a template out of plastic, plywood or hardboard. The template is secured to the top of the work piece by taping. Then, a special top guide having auxiliary steel template pins is used. These pins project downward and close to the blade and are positioned so that they can bear upon the edge of the template. The operator sees to it that template contact is maintained as the stock is fed, and thus pieces are shaped to conform to pattern. See Figure #96.

Because the template pins can not coincide precisely with the saw teeth, the template must be made smaller (perhaps 3/16") to compensate. Alternatively, if an exact size template is used, a router or shaper with flush cutting bit and guide bearing can be used, after sawing, to machine the edge to a precise dimension; and this machined finish requires little or no sanding.

A multitude of jigs and fixtures have been devised to suit particular profiles, ranging from rub blocks for simple curves to complex units
used to produce beveled curves, cones, etc. As always, special fixtures must be carefully chosen and used safely.

**Template Pin Jaw Blocks** — All Carter Micro-Precision guides may be fitted with a special version of the jaw blocks having a small pin projecting down from the bottom edge near the front. When doing repetitive cutting of complex contoured parts, this pin can be used to follow a pattern of the part which is attached to the top surface of the material being cut. This insures better consistency, speeds production, and eliminates the need to individually mark each piece.

*Figure #96.* A Template Pin Guide simplifies production of multiple identical pieces. The white line points to the pin. Text and photo courtesy of CARTER PRODUCTS CO., INC.

B. Template with automatic feed.

A mechanically fed unit uses a hydraulically controlled X Y carriage to feed material through the saw. Individual pieces or stacks are clamped to the carriage. Immediately below the work-piece (or stack) is a metal template (preferably lined with stainless steel), and this template is engaged by two styluses which actuate a hydraulic cylinder to position the carriage in and out as the stock is fed longitudinally into the cut.

C. CNC/PLC controlled bandsaws.

These machines also make use of a work-piece carriage with an X and Y axis movement. The control system is programmed to produce a particular profile without mechanical templates and sensors. See Figure #97. Figure #98 illustrates one type of high production work which can be done on these machines.
Figure 27. CNC-controlled automatic bandsaw system by MBO MACHINES DIVISION. The machine will saw material into a desired profile under direct computer numeric control. The unit shown has 48" of carriage travel in both X and Y axes. Other sizes of the machine are available with up to 154" of X travel and 66" of Y travel.
An important feature on these saws is the automatic twisting of the saw blade between the guides (90 degrees right or left) so that the feed direction of the material is always directly into the teeth of the saw. The amount of twist constantly varies during the carriage travel to coincide with the profile being sawn. See Figure #99. Production rates are shown in Figure #100. Typical saw speeds range from 6000 to 8000 Feet per minute. Typical blade widths are also shown on the table. Figure #101 is a radius table to indicate turn limitations for various patterns.
Figure #100. Estimated feed rates of CNC controlled bandsaw, in inches per minute, for various stack heights and blade widths. Feed speeds may vary up to 25%, depending upon stock density, quality of material and blade type. Tyler Machinery Company graph.

<table>
<thead>
<tr>
<th>BLADE WIDTH (INCH)</th>
<th>.025 (.059 SET)</th>
<th>.035 (.089 SET)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.38</td>
<td>1.43 R</td>
<td>N/A</td>
</tr>
<tr>
<td>.50</td>
<td>2.50 R</td>
<td>2.00 R</td>
</tr>
<tr>
<td>.75</td>
<td>5.49 R</td>
<td>3.12 R</td>
</tr>
<tr>
<td>1.00</td>
<td>7.50 R</td>
<td>5.00 R</td>
</tr>
<tr>
<td>1.25</td>
<td>12.00 R</td>
<td>9.50 R</td>
</tr>
</tbody>
</table>

Figure #101. Minimum radius table for typical blade widths and thicknesses, to be used on CNC controlled machine. Tyler Machinery Company data.
The Scroll Saw.

The origin of the term "scroll" goes back to historical times when writings were formed into a roll for storage and for convenience in reading. As the reciprocating (or stroke) saw developed, it was discovered that by using a thin, ribbon-like blade, cuts could be made in spiral or involute paths, which suggested the appearance of a rolled manuscript. By this process many elaborately sawn shapes were possible for making ornamentation, fancy furniture, marquetry, toys...and even jigsaw puzzles. Today, most so-called scroll work is done on bandsaws.

The reciprocating type is still made however, and is common in hobby shop work...and for extremely thin, delicate cuts, as required in marquetry. Whereas a 1/16" (.067") wide blade .025" thick is about the smallest used on band saws, the thickness of reciprocating scroll saws will usually be only .010" to .025".

When it is necessary to form an irregular shape in the central portion of a piece of wood, the reciprocating scroll saw blade can be inserted in a pilot hole without cutting through the rest of the work piece. To duplicate this on a bandsaw requires inserting the blade material into the pilot hole and then welding the blade together. A bandsaw such as the Doall (widely used in metal work), has a blade welder and a grinding device built into the machine to handle the "blind-hole" problem.

It should be noted, however, that in wood, the access cut for an interior pattern can often be disguised simply by applying glue (or a mix of glue and sawdust) to the sawn cut and clamping it together until the glue dries.

Scroll work on complex patterns with sharp changes in direction is restricted to use of very narrow blades...some only 1/16" wide. With such a minute blade, cut depth is limited.
TOOLING FOR NARROW BANDSAWS

We have, by definition, said that narrow bandsaw blades range in width from 1/16" to 2¼". Also, the wheel diameters of these saws range from 14" to 36". Furthermore, the wheels of narrow bandsaws for industrial use make use of rubber tires, rather than running the blade directly on the metal of the wheel rim.

These parameters, then, simplify blade selection. Blade material is produced in coils, usually in 100', 250' or 500' lengths. Large users buy the coiled material, cut it and weld it in-plant to lengths suitable for their machines: smaller plants order blades welded-to-length by their tooling supplier.

10 factors to consider when choosing blades:

1. Small diameter wheels need thin blades to avoid breakage from flexing as they go around the wheels.

2. Larger diameter wheels may use thin blades, but a heavy duty job will require both a thicker and a wider blade to provide necessary "beam strength" to resist feeding and cutting forces.

3. Tooth velocity. Bandsaws usually are not powered by variable speed motors. A wide range of wheel speeds is specified by the different machine manufacturers...some with blade speeds as low as 3000 surface feet per minute; some as high as 8000SFPM. This must be considered when buying a new machine, and must be coped with when choosing blades for an existing machine, because the blade specification will determine maximum feed rates and affect the quality of the sawn surface. For safety reasons, don't use drive pulleys which produce a wheel RPM exceeding the manufacturer's design.

4. Cutting profiles. There is a limitation on blade choice, relating directly to the size of the radius of the pattern being sawn. Two things determine how much the work-piece can be rotated during the cut without binding the blade:
   A. Blade width
   B. Thickness of the kerf cut (a combination of saw gage + amount of tooth set)
When the blade binds because of too sharp a contour, both the back corner and the middle of a wide blade (in direction of rotation) may rub in the kerf. Because of variations in saw specifications by blade manufacturers, a universal radius table cannot be established. Contour limitations by one manufacturer are illustrated in Figure 102.

![Blade width vs. Min. radius table](image)

For straight cuts, always use the widest blade the machine can accommodate.

For contour cuts, use the widest width that will cut the smallest radius required.

5. **Blade steel.** Carbon alloy blades are commonly used on woodworking bandsaws. Various treatments of these blades are used to increase blade life and improve cutting efficiency. Teeth are hardened by heat treating; and the back edge of the blade is often tempered so that it can accept greater strain (tension) and thus survive heavier feeding conditions. Bi-metal blades are also available, using heat-treated, high speed steel welded to the tooth edge of the blade. These blades can stand high temperatures, and they wear longer. They are much more costly than standard blades, but may be considered for difficult jobs.

6. **Tooth shape** is important to cutting performance, and has to do with sawdust capacity of the gullets as well as suitable cutting angles. Figure 103 illustrates this.

7. **Tooth spacing** is available with 2 to 32 teeth per inch, to suit thickness and density of material to be cut, as well as required quality of sawn finish. At least 3 teeth should be in the cut for the thinnest material to be sawn.
Figure #103. BASIC TOOTH SHAPE VARIATIONS.

A. Here standard shaped teeth are closely spaced to produce the best quality of sawn surface.
B. This is a standard tooth shape, but with "skip" tooth spacing, i.e. alternate teeth removed. The skip tooth arrangement has a much greater area for sawdust removal; so it is desirable when sawing thick material or for higher feed rates on thinner stock. The zero rake angle is desirable when cutting dense materials.
C. Here is a skip-tooth design with a 10 degree rake angle and a deeper gullet, which permits more aggressive feed rates. A positive hook angle is preferred for soft woods.

Commonly available rake angles are 0, 5, 7½ and 10 degrees.

8. **Set.** All band saw blades are made to cut a kerf wider than the thickness of the blade. In narrow bandsaws, this is made possible by spring-setting the teeth. The tooth set provides side clearance for straight-line cutting, as well as side and back clearance when sawing contours. Thus, the blade will cut freely without rubbing or pinching. The set is the tilt or angle at which the tooth is bent to provide clearance. Several types of tooth setting are available:

A. **Every tooth set.** All teeth are set, alternately right and left.

B. **Raker set.** In the most common raker arrangement, one tooth is set right, one tooth set left, and the third tooth, called a raker, is straight, i.e. unset. Some times a raker is used every 5th or 7th tooth.
C. Wavy set. This system consists of groups of teeth positioned alternately right and left throughout the blade, creating a wavy appearance. Greater chip clearance and minimum vibration is claimed for this type of blade.

The above three basic types of tooth setting are shown in Figure #104. See a description of saw setting machinery in the wide bandsaw section.

![Diagram of Alternate Set, Raker Set, and Wavy Set](image)

Figure #104. TYPES OF TOOTH SET

A. Every tooth set, alternating right and left. This is a standard arrangement for simple sawing requirements.

B. Raker set. Every third tooth is a raker, i.e. a tooth which has no set; so it cuts full thickness of the blade. This increases cutting capacity.

C. Wavy set. This design makes use of varying set angles to create a wave shape. In addition to additional chip clearance this type of set reduces cutting strain on individual teeth. This may reduce tooth breakage which sometimes occurs when sawing very dense material. Not often used on woodworking jobs, but widely used in metal working.

Illustrations courtesy of MILFORD PRODUCTS CORPORATION.

Some tooling suppliers offer special "combination" blades which make use of multiple tooth sets as well as multiple tooth and gullet shapes all in one blade. Such "specials", as a rule, should be avoided, and are not necessary if a standard blade does a good job.

9. Blade length. Machine manufacturers usually specify blade lengths for their machines. But, if you don’t know how long your blade should be, it can be calculated, using this formula:

\[
\text{LENGTH} = \text{wheel diameter} \times 3.1416 + 2 \times \text{the distance between the center points of the two wheels.}
\]
10. Blade sharpening. Most blades are quite narrow and the cost of resharpening is usually more than the cost of a new blade. Some will touch up a dull blade by filing, but that is a tedious job which most operators will find unproductive.

TOOTH TIPPING

Because of high density, chemical content or glue content in composite materials, rapid dulling of teeth may occur. Use of stellite tips is common on wide bandsaws, as described earlier, but they are not frequently encountered on narrow blade machines. On blades from about \( \frac{1}{4} \)" wide to \( 2\frac{1}{2} \)" wide, carbide or stellite tipping is available, and this takes the place of either spring-setting or swaging. Some tooling manufacturers even offer triple-chip cutting teeth where extremely smooth cutting, without surface tearing, is a requirement.

Tipped blades will of course be re-sharpened in order to justify their cost, and a precision sharpening machine is necessary.

* * * * *

On the next page is Figure \#105, which lists various ways to eliminate narrow bandsaw difficulties. A sharp tool is the most basic requirement for success in any woodworking operation. So, when you're trying to isolate a sawing problem, start out your search using a new, sharp blade.
50+ WAYS TO CORRECT COMMON BANDSAW PROBLEMS.

1. PREMATURE BLADE BREAKAGE.
   * Blade too thick for wheel diameter.
   * Blade too thin for heavy sawing job.
   * Tooth pitch too wide for feed rate. 
     a. decrease feed rate
   b. use blade with finer tooth pitch.
   * Excessive strain (tension) on the blade.
     Ease the strain.
   * Brittle weld on blade. Check welding procedures.
   * Improper thrust wheel and/or side guide settings. Make sure that both top and bottom thrust bearings rotate equally.
   * Pitch buildup on wheels. Scraper/blade lubricant problem.
   * Damaged tire surface.

2. EXCESSIVE TOOTH WEAR.
   * Feed rate may be too slow; when too many teeth are cutting, teeth overheat.
   * Use blade with wider tooth spacing.
   * Use blade with more hook on the teeth.
   * Increase blade speed.
   * Check for insufficient blade lubrication.

3. TOOTH BREAKAGE.
   * Reduce feed rate; teeth may be taking too big a bite.
   * Decrease blade speed to reduce bite size.
   * Use blade with closer tooth spacing.
   * Check for blade interference with work table insert.
   * Teeth may be rubbing on side guides.
   * Check for teeth running in wrong direction. Turn blade inside out to get correct tooth direction.

4. BLADE VIBRATION.
   * Unbalanced wheels.
   * Increase strain (tension) on blade.
   * Teeth too coarse; use finer tooth blade.
   * Use blade with less tooth hook when running dense material.
   * Blade too thin; use a thicker blade to improve 'beam strength' for a heavy job.
   * Check guide settings; should be close as practical to wood surface.

5. BLADE MAKES BOWED CUT.
   * Increase strain.
   * Adjust guides closer to work piece.
   * Use blade with more teeth per inch.
   * Use a wider and/or thicker blade to increase 'beam strength'. Doubling blade width increases beam strength 8 times; doubling blade thickness increases beam strength 2 times.
   * Decrease feed rate.
   * Check blade for sharpness.

6. EXCESSIVE WEAR ON BACK EDGE OF BLADE.
   * Feed at lower rate or use coarser pitch blade.
   * Thrust bearing is too close to blade or needs replacement.
   * Increase strain on blade.
   * Band wheels not properly aligned.
   * Band weld out-of-square.

7. ROUGH FINISH ON SAWN SURFACE.
   * Use a fine tooth blade.
   * Decrease feed rate.
   * Increase blade speed.

8. EXCESSIVE GULLET LOADING.
   * Reduce feed rate.
   * Use blade with larger gullets or a skip-tooth saw.
   * Use blade with wider set on teeth.

9. SIDE WEAR OR GROOVING ON BLADE.
   * Check guide inserts for wear or incorrect setting.
   * Check blade tracking.

10. BAND DEVELOPS A TWIST.
    * Too wide a blade for radius being cut.
    * Band wheels need alignment.

11. PREMATURE SET LOSS.
    * Blade too wide for radius being cut.
    * Tooth too fine for feed rate. Use a blade with larger gullet area.
    * Check coolant to reduce heat on teeth.

12. BLADE MANDERS OR LEADS.
    * Check straightness of blade. A crooked blade will appear to wander.
    * Check band wheel alignment.
    * Adjust tracking.
    * Uneven tooth sharpening or uneven tooth shaping.

13. SAM CUT IS NOT PERPENDICULAR.
    * Top and bottom guides not aligned with each other.
    * Work table is tilted.

14. BLADE DOESN'T BEAR EVENLY AGAINST TOP AND BOTTOM THRUST BEARINGS.
    * Check blade tracking.
    * Blade not straight.
    * Damaged back-thrust wheel assembly.
    * Misaligned blade weld. Reweld blade.
Part VI
VOCABULARY AND TABLES
FOR BANDSAWS

It is important that operators, fillers and maintenance people understand terminology common to bandsaws. This section lists and defines many of these terms, and includes some illustrations for further clarification.

Figure #106. WIDE BANDSAW TOOTH NOMENCLATURE. Adapted from USDA publication Utilization of Hardwoods on Southern Pine Sites by Peter Koch.
THE HAND OF BANDSAWS
(Viewed from Infeed End)

Vertical Bandsaws

TOP WHEEL
(COUNTER-CLOCKWISE)

Left Hand Machine

TOP WHEEL
(CLOCKWISE)

Right Hand Machine

Horizontal Bandsaws

(OVER BED SAW MOUNT)

Left Hand Saw

Right Hand Saw

(BED LEVEL SAW MOUNT)

Left Hand Machine

Right Hand Machine

When you view the infeed end of any bandsaw...wide or narrow, vertical or horizontal...the hand is determined by the direction of saw movement in the cutting area. The left hand saw travels counter-clockwise; the right hand saw clockwise. Adapted from Quelch's Saw Filler's Handbook, published by ARMSTRONG MANUFACTURING CO.
### SAW GAUGE EQUIVALENTS

<table>
<thead>
<tr>
<th>GAUGE of blade</th>
<th>FRACTION of inch</th>
<th>DECIMAL measurement of *</th>
<th>MILLI-</th>
<th>meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>11/32 scant</td>
<td>0.340</td>
<td>8.63</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>5/16 scant</td>
<td>0.300</td>
<td>7.62</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>9/32</td>
<td>0.284</td>
<td>7.21</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1/4 full</td>
<td>0.259</td>
<td>6.57</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>15/64</td>
<td>0.238</td>
<td>6.04</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>7/32</td>
<td>0.220</td>
<td>5.59</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>13/64</td>
<td>0.203</td>
<td>5.18</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>3/16 scant</td>
<td>0.180</td>
<td>4.57</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>5/32 full</td>
<td>0.165</td>
<td>4.19</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>5/32 scant</td>
<td>0.148</td>
<td>3.76</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1/8 full</td>
<td>0.134</td>
<td>3.40</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>1/8 scant</td>
<td>0.120</td>
<td>3.05</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>7/64</td>
<td>0.109</td>
<td>2.77</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>3/32</td>
<td>0.095</td>
<td>2.41</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>5/64 full</td>
<td>0.083</td>
<td>2.10</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>5/64 scant</td>
<td>0.072</td>
<td>1.82</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>1/16 full</td>
<td>0.065</td>
<td>1.65</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>1/16 scant</td>
<td>0.058</td>
<td>1.47</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>3/64</td>
<td>0.049</td>
<td>1.24</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
<td>0.042</td>
<td>1.06</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>0.035</td>
<td>0.89</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>1/32</td>
<td>0.032</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td></td>
<td>0.028</td>
<td>0.71</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td></td>
<td>0.025</td>
<td>0.64</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td></td>
<td>0.022</td>
<td>0.56</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>0.020</td>
<td>0.51</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td></td>
<td>0.018</td>
<td>0.46</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>1/64</td>
<td>0.016</td>
<td>0.41</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td></td>
<td>0.014</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td></td>
<td>0.013</td>
<td>0.33</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>0.012</td>
<td>0.30</td>
<td></td>
</tr>
</tbody>
</table>

### CONVERSION TABLE

**Length**

- Inch = 0.0254 meter
- Foot = 0.3048 meter
- Yard = 0.9144 meter
- Millimeter = 0.03937 inch
- Centimeter = 0.3937 inch
- Meter = 39.37 inches

**Volume**

- Cubic foot = 0.02832 cubic meter
- M board foot = 2.36 cubic meters
- *Standard = 4.67 cubic meters
- Cubic meter = 0.214 *Standard
- Cubic meter = 35.315 cubic feet

- Cubic meter = 423.78 board feet
- M board feet = 83.33 cubic feet
- *Standard = 1980 board feet
- *Standard = 165 cubic feet
- M board feet = 0.505 *Standard

* European Standard (Petrograd)

American and metric conversions for units of measurement used in lumber and woodworking.
ANVIL (saw): A block of steel, usually mounted in the saw bench, and used in leveling and tensioning procedures.

ANVIL (swage): On a swage, the fixed steel part which rests on the top of the saw tooth being compressed by the swage die.

ARBOR: The shaft or mandrel upon which a bandsaw wheel is mounted.

BACK: The edge of the blade opposite the teeth.

BACK CLEARANCE: A decline in the shape of the saw tooth angle immediately behind the cutting tip to avoid rubbing behind the cut. Also known as clearance angle.

BACK CRACK: A crack in a blade which extends from the back edge toward the inner body of the saw.

BACK FEEDER: An auxiliary device which is used to insure smooth feeding of the blade through the sharpening machine.

BADGER HOLE: The pit in which the bench man works to level or work the inside of the blade. It is covered by a trap door when not in use.

BACK GAUGE: A long steel gauge with one concave edge making use of a 3-point system for checking the shape and uniformity of the back edges of bandsaw blades. Some incorporate a dial indicator at the center point as added help for the filer.

BEAM STRENGTH: The ability of a blade to withstand the forces of feeding and cutting without deflecting or breaking.

BENCHING: The work of straightening, leveling and tensioning a bandsaw blade, using a specially equipped bench.

BITE: The distance the work piece moves forward during the cut of a saw tooth... the amount of wood chambered in the gullet during the cut.

BUTT WELD: The weld that joins the two ends of a strip of saw steel together, forming a continuous band.

BURR: Bits of metal which may cling to the edge of a gullet during sharpening, where the grinding wheel exits the cut. Sometimes called "wire edge".

CAMBER: A slight convex curve on the rim of a bandsaw wheel... same as crown.

CANT: See flitch.

CARRIAGE: A device to feed logs through a bandsaw. The carriage holds the log during the cut, and advances and adjusts the log for subsequent cuts.

CHIP LOAD: The amount of wood removed by the saw tooth during its complete cut.

CLEARANCE ANGLE: Same as back clearance.

COLEMAN ROLL: A feed roll having notched knives inserted across its periphery to insure positive movement of the material through the machine.

COLUMN: In a wide bandsaw, the support for the top wheel... may be a single column or a double column.

CROSS FACE HAMMER: A saw leveling hammer which is used to work across the width of the blade... leaves a pattern in that direction.

CROSS LINE: The horizontal and parallel alignment of the top and bottom wheel shafts with each other.

CROWNED WHEEL: Same as camber.

DIE (swage): the movable steel part which compresses the cutting edge of the saw tooth against the anvil to widen the cutting tip of the tooth.

DISHED: Describes the hollow formed in the saw blade by tensioning. Also used to describe a grinding wheel which is made with one side convex and one side concave.
DOG BOARD: The last board remaining from a log being sawn on a conventional headrig or a cant resaw...often a piece that is off-size because of cumulative errors in set decisions, wear of carriage parts, etc.

DOG HEAD HAMMER: Description of a particularly long-headed, round-faced hammer used for tensioning wide bandsaw blades.

DOGS: The parts of the carriage which hold the log while it is being sawn.

DOUBLE-CUT SAW: A bandmill which cuts on both the forward and reverse strokes of the carriage, using a blade with teeth on both edges.

FAST SAW: Looseness...a situation in which the lengths of both edges of a wide bandsaw blade approximate or equal the length of the blade in its center area. Requires center stretching for correction.

FENCE: A straightedge to guide the lumber through the saw. Some feeding devices, coupled to bandsaws, have fences adjustable by setworks. This combination is referred to as a 'linebar resaw'.

FILING CLAMP: A device used to hold the blade during swaging and shaping of the teeth.

FITTER: In a filing room with several employees, those helping the head filer may be called fitters.

FITTING: All filing room activities involved in maintaining a blade: such as swaging, shaping, gauging, straightening, leveling, sharpening.

FLITCH: A section of a log sawn on two or more sides, intended for remanufacture into lumber. Also referred to as a cant.

FORGING HAMMER: A special hammer used to forge and flatten the bead of a weld on a bandsaw.

FRONT: The edge of the blade where the teeth are.

FROST NOTCH: A notch ground near the bottom of the tooth face. This notch becomes a small auxiliary tooth which enables increased feed rates when sawing frozen timber.

GAGE or GAUGE: Unit of measurement for blade thickness, based upon "Birmingham" standard for measurement of wire, rifle bores and thickness of metals. When used as a verb...to measure very accurately.

GUIDES (wide band): Devices located immediately above and below the cut to restrain the saw from lateral movement and vibration due to stresses of cutting.

GUIDES (narrow band): Similar to above, but includes in addition a 'backup thrust bearing' to limit rearward movement of the blade due to feeding pressure.

GUIDE BLOCKS: The replaceable wear parts which bear upon the edges of the blade to stabilize it.

GULLET: The area between the saw teeth where sawdust is chambered during the cut.

GULLET CRACK: A crack which occurs in the gullet area of the tooth profile and extends toward the inner portion of the blade.

GUMMING: Refers to the action of the sharpening machine, which deepens and shapes the gullet as it sharpens the saw tooth.

HAMMERING: The process of manually hammering the blade to remove lumps and assist in the leveling of the blade.

HAND (right or left): To define the machine configuration...i.e. looking in the direction of lumber travel, a right hand machine is one on which the blade travels clockwise in the cutting area. Conversely, (looking in direction of feed) if the blade travels counter-clockwise it is a left hand machine,
HEAD FILER: The person in charge of the saw filing room with two or more persons in the crew. He is responsible for the work performed and the associated equipment to get the job done.

HEADRIG: The machine used for initial breakdown of the log.

HEAD BLOCKS: Assemblies on a sawmill carriage which support and secure the log during the cut. Each assembly consists of a frame, an "L" shaped part called the knee, means of advancing or retracting the log for depth of cut and/or taper, and 'dogs' which bite into the log to hold it.


HOOK: The angle at which the face of the tooth engages the wood. Also called rake.

HORIZONTAL BANDSAW: A machine on which the wheels are horizontal to each other rather than one wheel above the other.

KERF: The width of the cut made by the saw. In theory the kerf width is the swage or set width, but in fact it is slightly wider because of blade or tooth irregularities, misalignment and vibration which can never be totally eliminated.

KICKER: Device on a carriage which "kicks" the remaining piece off the carriage after the final cut on the log, thus clearing the carriage to receive the next log.

KNEE: See head block.

LEVELING: The process of bringing a wide bandsaw blade into a uniformly flat condition...part of the benching procedure.

LEVELING SLAB: The part of the saw bench on which leveling is checked. It may also serve as an anvil for hammering. The slab is usually made of mild steel, precision surface ground.

LINEBAR RESAW: See fence.

LOOSE SAW: See fast saw.

LUBRICATORS: Devices which apply a lubricant to the blade to cool it and keep it free of pitch, gums and resins. Types of lubricants range from plain water to various compounds used separately or combined with water, and applied in sprayed or aerated condition. On some small machines, a simple, oil-soaked pad does the job.

LUMPS: Refers to localized uneven places on a blade, caused by foreign material getting between the blade and the wheel, reaction of the saw to cutting stresses, or from forcing the saw after it is dull and/or needs re-tensioning.

NARROW BANDSAW: A machine which uses blades from 1/16" to 2½" wide (saws which are usually not tensioned).

PITCH (tooth): The distance between tooth points. In wide bandsaws, measured in inches and fractions of an inch; in narrow bandsaws, measured in number of teeth per inch (TPI). Also in narrow saws, may be expressed as "points per inch".

PONY RIG: An additional machine following the headrig in a big log sawmill for further breakdown of large cants.

PRESSURE GUIDES: Guides which bear directly upon the inner portion of the blade with a force which insures the rigidity of the blade in the cutting area. See guides.

QUARTER CRACK: A crack appearing in the body of the blade, but not reaching either edge.

RAKE ANGLE: Same as hook.

RAKER SET BLADE: A narrow saw containing some 'unset' teeth intermixed with teeth which are set. The most common arrangement is with one tooth set to the right, one tooth to the left, while the third is straight (a raker).
RESAWING MACHINE: A bandsaw built for further processing of lumber or cants coming from the headrig. Resaws are also frequently used in planing mills or other secondary manufacturing plants not necessarily located at the sawmill site.

ROLLER STRETCHER: A machine with two opposed, hardened, powered rollers which are used to tension a wide bandsaw blade by cold rolling the center portion of it under variable pressure.

ROUGH LUMBER: Lumber as it comes from the saw, un-planed.

SAW DOCTOR: See saw filer.

SAW FILER: A person who maintains, straightens, levels, tensions and sharpens bandsaw blades. The title originated when saws were sharpened by hand with files. The title of 'Filer' is common in North America even though little hand filing is done today.

SAWDUST INTERFERENCE: Overloading when the saw gullet capacity and clearance is too small to accept the volume of sawdust being cut; or alternatively when sawdust particles are so fine that they go into the side clearance area of the blade and cling there.

SAW ROD: The material used as filler material in the weld of a bandsaw. It is the same material as the saw blade.

SAW SHARPENER: An automatic machine which sequentially sharpens saw teeth and maintains gullet shape, using a grinding wheel the stroke of which is controlled by cams corresponding to the gullet shape.

SCRAPER: On a bandsaw, thin metal or plastic pieces which bear lightly on the rims of the wheels to assist in removal of pitch and resin.

SCROLL SAW: A term originally applied to a reciprocating blade saw (a jigsaw or fret saw) to produce intricate pattern work. However, today most scroll work is done on bandsaws.

SET: Refers to the amount the teeth are bent or offset from center on a spring-set saw blade.

SHAPER: A tool for refining the shape of the swaged portion of a saw tooth to insure uniformity of width and shape.

SHARPNESS ANGLE: The angle between the back clearance angle and the rake angle. Some times called tooth angle. See diagram at the beginning of this section.

SHEAR BOARD: A protective device used to shear off knots, splinters and debris to prevent same from going between the blade and the bottom wheel.

SHIM: A thin, defective piece of lumber, usually wedge-shaped, that develops during the breakdown of the log, or in a resawing operation, due to incorrect sawing decisions or cumulative errors caused by equipment wear.

SIDE CLEARANCE: The distance between the widest portion of the saw tooth and the body of the blade.

SIDE GAUGE: A tool used to check for uniform sidewise projection of all teeth on a band, so that any bent-out-of-line teeth can be corrected.

SIDE GRINDING: Shaping the sides of a stellite or carbide tipped saw tooth, using a special machine designed for this purpose. Also occasionally used on swaged teeth.

SKIPTOOTH BLADE: A narrow saw with widely spaced teeth (alternate teeth are omitted). This blade provides additional chip capacity for thicker cuts.

SPRING-SET: Band blades which have teeth sprung alternately in opposite directions to provide side clearance during the cut.

 STELLITE: Trade name of a metallic compound used to tip saw teeth in order to increase wear time between sharpening, and to extend blade life.
STRAIN: The means for putting the top wheel under tension to avoid slippage of the blade under varying load conditions.

STRETCHER: See roller stretcher.

SWAGE: A device making use of an eccentric die working against an anvil by which the front section of the saw tooth is widened under pressure...to provide side clearance when sawing.

TEETH: The formed and sharpened portions of the blade which do the cutting.

TENSION: A term used to describe the condition created in a wide bandsaw blade when the center has been stretched; using the roller stretcher. Narrow bandsaw users often use the term "tension" to mean "strain", but wide band sawyers prefer the term "strain" to avoid confusion between the two.

TENSION GAUGE: A hand tool with a convex surface which corresponds to the tension circle of a correctly tensioned wide bandsaw blade. It is used to determine that a correct stretching job has been done.

THROAT: Same as gullet.

THROAT WIDTH: On a bandsaw machine, the distance between the blade and the column supporting the top wheel.

TOP CLEARANCE: See back clearance.

TIRE: The narrow areas of a wide bandsaw blade on each side of the tension curvature. These tires bear upon the wheels and provide traction for powering the blade. In narrow bandsaws "tire" refers to the rubber tire vulcanized or clamped to the wheels. The body and the teeth of the narrow bandsaw blade bear upon the tire, which is resilient enough to avoid tooth damage.

TILT: Adjustment of the top wheel to improve tracking of the blade.

TOOTH PITCH: The distance between tooth points.

TOOTH BITE: Same as bite.

TOOTH ANGLE: A term some times used to designate sharpness angle.

TRACKING: An adjustment to cause the blade to position itself correctly on the face of the wheels. Usually accomplished by tilting the top wheel.

TWIST-FACE HAMMER: A saw leveling hammer which is used to correct lumps which occur at an angle across the blade.

WAVY SET: A saw tooth pattern used on narrow bandsaw blades where groups of teeth are set alternately to the right and to the left, giving the appearance of a wave.

WELDING CLAMP: A device for holding the blade securely when making blade repairs or for butt welding.

WIDE BANDSAWS: Machines using blades 3" wide and wider.

WIDTH OF BLADE: Measurement from the tip of the teeth to the back of the blade.

WIRE EDGE: See burr.
BANDSAW SAFETY

Operators and maintenance people work intimately with the bandsaw when setting up, while it is under power, and during down-time periods. To prevent injury and health problems, it is essential that these people are familiar with details of the saw, and that positive safety and work procedures are established.

The set up or operation of the machine, or performance of maintenance on it, requires instruction and knowledge of correct procedures. Instructions from the machine manufacturer should be understood and followed. Plant safety committees will also include in their procedures regulations by federal and local governments.

Normal power tool safety rules contain many common-sense precautions for woodworkers to follow...items which should also be incorporated into safety programs. Figure #107 is one such listing.

SAFETY = KNOWLEDGE + DEDICATION
SOME GENERAL SAFETY INSTRUCTIONS.

READ ALL INSTRUCTIONS
1. KNOW YOUR POWER TOOL
   For your own safety, read the owner's manual carefully. Learn its application and limitations as well as the specific potential hazards pertinent to this tool.
2. GUARD AGAINST ELECTRICAL SHOCK BY PREVENTING BODY CONTACT WITH GROUNDED SURFACES.
   For example: Pipes, radiators, ranges, refrigerator enclosures.
3. KEEP GUARDS IN PLACE and in working order.
4. REMOVE ADJUSTING KEYS AND WRENCHES
   Form habit of checking to see that keys and adjusting wrenches are removed from tool before turning on tool.
5. KEEP WORK AREA CLEAN
   Cluttered areas and benches invite accidents.
6. DON'T USE IN DANGEROUS ENVIRONMENT
   Don't use power tools in damp or wet locations, or expose them to rain. Keep work area well illuminated.
7. KEEP CHILDREN AWAY
   All visitors should be kept a safe distance from work area.
8. MAKE WORKSHOP KID PROOF
   With padlocks, master switches, or by removing starter keys.
9. DON'T FORCE TOOL
   It will do the job better and be safer at the rate for which it was designed.
10. USE RIGHT TOOL
    Don't force tool or attachment to do a job for which it was not designed.
11. WEAR PROPER APPAREL
    No loose clothing, gloves, neckties, rings or jewelry to get caught in moving parts. Non-slip footwear is recommended. Wear protective hair covering to contain long hair.
12. ALWAYS USE SAFETY GLASSES
    Also use face or dust mask if cutting operation is dusty. Everyday eyeglasses only have impact-resistant lenses. They are NOT safety glasses.
13. SECURE WORK
    Use clamps or a vise to hold work when practical. It's safer than using your hand and frees both hands to operate.
14. DON'T OVERREACH
    Keep your proper footing and balance at all times.
15. MAINTAIN TOOLS IN TOP CONDITION
    Keep tools sharp and clean for best and safest performance. Follow instructions for lubricating and changing accessories.
16. DISCONNECT TOOLS FROM POWER SOURCE
    Before servicing and when changing accessories such as blades, bits, cutters, or when mounting and re-mounting motor.
17. AVOID ACCIDENTAL STARTING
    Make sure switch is in "OFF" position before plugging in cord.
18. USE RECOMMENDED ACCESSORIES
    CONSULT THE OWNER'S manual for recommended accessories. Use of improper accessories may be hazardous.
19. NEVER STAND ON TOOL
    Serious injury could occur if the tool is tipped or if the cutting tool is unintentionally contacted.
20. CHECK DAMAGED PARTS
    Before further use of the tool, a guard of other part that is damaged should be carefully checked to ensure that it will operate properly and perform its intended function - check for alignment of moving parts, binding of moving parts, breakage of parts, mounting, and any other conditions that may affect its operation. A guard or other part that is damaged should be properly repaired or replaced.
21. DIRECTION OF FEED
    Feed work into a blade or cutter against the direction of rotation of the blade or cutter only.
22. NEVER LEAVE TOOL RUNNING UNATTENDED. TURN POWER OFF.
    Don't leave tool until it comes to a complete stop.

Figure #107. Following these instructions will reduce possibilities for accidents when working around woodworking and mill machinery. This list must be supplemented with instructions from machinery manufacturers.
ACKNOWLEDGEMENTS.

Here is a partial list of individuals who provided input and encouragement for the preparation of this book. Machinery manufacturers, industry groups and forest industry manufacturers were all extremely cooperative. My notes do not list all who were helpful; but noted or not, thanks goes to each one.

Harry Bell       Elmer Briggs       Chip Corley       John Ekwall
Gerry Hague      Noel Jenkins       Phil Judson       Bill Jungers
Erich Kaufman    Len Larsen         Dennis Lentz      Dan Macomber
Ralph Manting    Don Mason          Stan Niemiec      Bob Palmer
Peter Perez      Derek Phillips      Ray Quenel       Bob Rozman
Bill Sairy       Dave Tyler          Clark Williams    Con Williams

*     *     *     *
EPilogue

Writing a book about bandsaws is more challenging than one might believe at first glance...in fact much more so.

For example, one industry friend provided a 24-page computerized bibliography on sawing technology...it contained 199 entries! A number of these writings contain gems of bandsaw knowledge, for which the author is grateful. Most have great detail on specific limited areas of interest, and an effort was made to extract the gist of these writings for this publication...the goal of which is to be a 'reader's digest' of bandsaw information.

Some other writings exceed this writer's scientific background. But, because the goal is to cover bandsaw basics, this is not considered to be a fatal obstacle. Cooperation from those in the industry is enthusiastic, and it would have been impossible to do a creditable job without them.

It is hoped that this book will become a reference for those working with wood and that it will inform those starting a woodworking or sawmilling career, those pursuing woodworking machinery jobs, those engaged in vocational training, and non-engineer supervisors who need an overview of the subject.

As a followup to a 33-year job of marketing woodworking and sawmill machinery, writing this book has been personally satisfying. It is an opportunity to record information accumulated over the years, plus it has answered questions which this writer wondered about but never pursued because of time limitations. Such a digest on bandsaws would certainly have been welcome at the beginning of a career that started in 1947, rather than after its completion.

So, friends, if you have read this far, you have indeed been charitable to the author... many thanks for that!

May 20, 1992

THE END.