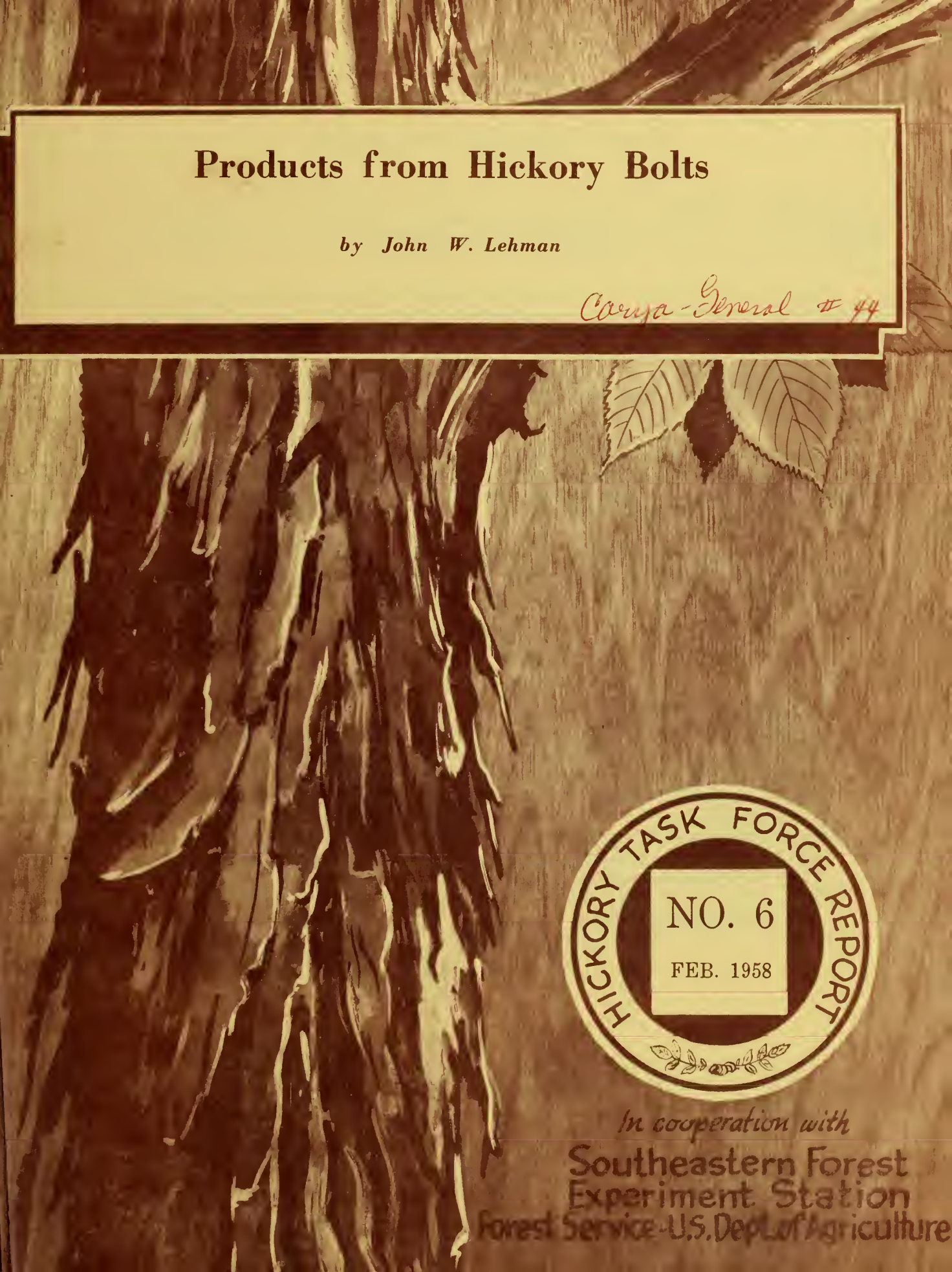
Products from Hickory Bolts

by John W. Lehman

Carya - General # 44



HICKORY TASK FORCE REPORT

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In cooperation with

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FOREWORD

Hickory (Carya spp.) has earned the reputation of being one of the world's toughest woods. In shock resistance it has no equal. The reputation earned by hickory is based on the performance of high quality material in products requiring a high degree of strength and toughness.

Today, a limited quantity of high-grade hickory is available and its value and scarcity are well recognized by the wood-using industries. There is, however, a large volume of low-grade hickory that was bypassed when loggers cut our hardwood forests, and many land managers are troubled by the increasing amount of growing space occupied by it. Although this low-grade hickory does not possess the quality or properties required in many products, it is a potentially valuable wood for many uses.

A conference of federal, state, university, and industrial representatives was held in Clemson, S. C., in April 1953, and the Hickory Task Force was organized to promote the utilization of hickory. Accomplishment of this objective will be reached through research and publication of known information.

The Southeastern Forest Experiment Station has assumed the responsibility to edit, publish, and distribute reports containing information which will be developed under this program.

Full acknowledgment is due the many cooperating agencies and individuals who are making the project possible. Subject Matter Committee Chairmen are:

John Drow, Forest Products Laboratory, Madison, Wis., Growth and Properties of Hickory.
Roger Anderson, Duke University, Durham, N. C., Enemies of Hickory.
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Richard D. Lane, Central States Forest Experiment Station, Carbondale, Ill., Marketing of Hickory.

Walton R. Smith, Chairman
Hickory Task Force

See the inside back cover for a list of hickory reports planned.

Photos in this report are from
Marion Handle Mills, Inc., Marion, Virginia
and
Tennessee Valley Authority, Norris, Tennessee

PRODUCTS FROM HICKORY BOLTS

by

John W. Lehman, Chief
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SUMMARY

This report presents information on the size, quality, and grade requirements of hickory bolts in use today. Specifications for a number of bolt products and comments on manufacturing methods are also included.

Approximately half of the hickory used in the manufacture of small products comes to the plant in the form of bolts. These products include handles, ladder and chair rungs, veneer for street brooms, archery equipment, singletrees, baseball bats, picker sticks, pitman rods, textile loom parts, and wagon spokes. Handles are by far the most important of these products and make up over four-fifths of the bolt volume used.

Because of the great variety of products, specifications for hickory bolts are not standard except within wide ranges.

INTRODUCTION

Hickory products are manufactured from saw logs, veneer logs, and bolts. This report is confined to the products manufactured from bolts, involving about 38 million board-feet in 1948, the latest year from which data are available. These bolts are produced from all the commercial species of hickory, but most of them come from three species of true hickory, namely, shagbark, pignut, and mockernut.

Reports show that total hickory used in manufacture has declined from 389,604 MBF in 1912 to 76,530 MBF in 1948 (1, 7). [1] Changing times and use of metal have practically eliminated hickory in a number of items. For example, the amount of hickory used in nonmotor vehicles (principally wagons) decreased from 239,492 MBF in 1912 to 1,541 MBF in 1948. The amount of hickory used in the manufacture of automobiles and trucks declined from 49,522 MBF in 1928 to 1,350 MBF in 1948. Steel has largely replaced hickory in golf club shafts. At least three manufacturers are fitting hammers and hatchets with metal handles. Use of hickory in agricultural implements decreased from 4,263 MBF in 1928 to 2,741 MBF in 1948 (1, 7).

This fine American wood is holding its own, however, in many instances. Because of its high strength-weight ratio and toughness, hickory is still in strong demand for striking tool handles, picker sticks, and athletic equipment. Plastics and fiber glass have recently found some favor as handles, and compreg and staypak (compressed wood) have replaced hickory in certain specialized types of picker sticks, but some of the staypak itself is made from hickory.

One would expect the downward trend in total demand for hickory to be strongly reflected in supply of hickory bolts. This is not so; the fact is that high-quality hickory bolts are becoming increasingly hard to find.

CHARACTERISTICS OF HICKORY FOR BOLT PRODUCTS

Hickory's combination of toughness, hardness, strength, and shock resistance are unequaled by any other commercial species (9, 10, 11). A comparison of these factors for hickory, pecan, oak, elm, and ash is shown in table 1. These comparisons show why hickory is used almost universally for handles. It has twice the shock resistance of white oak, and ranks well above the other species in bending strength, compressive strength, and stiffness.

Table 1.--Comparative values for hickory and several other species (14)

Species	Specific gravity [1]	Comparative values [2]				
		Volumetric shrinkage [3]	Bending strength	Compressive strength	Stiffness	Shock resistance
Shagbark hickory	0.64	100	100	100	100	100
Pecan hickory	.60	81	83	85	87	61
White oak	.60	90	77	80	83	49
Amer. elm	.46	84	64	61	70	49
White ash	.54	76	84	86	90	57

[1] Based on volume when green, and weight when ovendry.

[2] Calculated from ratios of comparative figures presented in (14), with shagbark hickory taken as 100.

[3] Shrinkage from green to ovendry condition based on dimensions when green.

[1] Underlined numbers in parentheses refer to literature cited.

For other uses, however, hickory has properties that may limit its use. Because it is a high-density hardwood, its shrinkage from green to dry is greater than in most woods; thus, it is more apt to give problems in swelling and shrinking that might cause warp and open glue joints (5). This increased density also makes hickory harder to machine than softer woods when ordinary steel cutting tools are used, but this difficulty is eliminated by the use of the newer carbon-tipped saws and knives. Back in 1935 (6), hickory was listed as difficult to kiln dry and difficult to glue, but recent research in kiln drying has eliminated the drying problem (4), and the development of synthetic resin glues has resulted in many glued hickory products on the market that are standing up excellently. The hardness of hickory makes nailing and screwing more difficult, but the nail-holding and screw-holding ability of this wood exceeds most others.

There has been and continues to be considerable controversy over the relative quality of red (heartwood) and white (sapwood) hickory. Specifications frequently call for all white, and much good red hickory is left in the woods or thrown on the scrap pile at the mill. Tests by the Forest Products Laboratory (13) show conclusively that weight for weight, red, white, and mixed red-and-white sound hickory all have the same strength, toughness, and resistance to shock. Why then the continued discrimination against red hickory?

The answer is not too difficult. The red hickory is the heartwood and is in the inner part of the tree stem. On the older trees, this wood is often a hundred or more years old and was formed under virgin forest conditions which generally produced slow growth. Slow growth in hickory produces low density, lower strength wood. As the forests were cut, and many of these trees released, the growth rate increased and the white sapwood in the outer portions was denser and stronger than the red heartwood. Also, the center of the tree contains more knots, whereas the exterior sapwood is usually clear material. These factors have been most important in perpetuating the desire for hickory sapwood or white hickory.

Now that much of the virgin old-growth hickory has been cut and the hickory in managed forests is growing at a fairly rapid rate, the heartwood and sapwood should not vary appreciably in density. Therefore, the red hickory will generally be as strong as the white hickory, and specifications and utilization practices should be changed to recognize this situation. Already, government specifications for hickory handles have no color limitations, and many industries are accepting red as well as white hickory. Perhaps the biggest job ahead is to educate the consumer regarding color in hickory.

There is less controversy with regard to variation in properties among species, especially between the true hickories and pecan hickories. The biggest species differences are in shrinkage and shock resistance. True hickories on the whole have higher shrinkage factors, but tend to have greater shock resistance than the pecan hickories (14).

REQUIREMENTS FOR HICKORY BOLTS

Because no standard grading specifications for hickory bolts have been agreed upon by the trade as a whole, there is considerable variation among companies in their hickory bolt requirements. Differences are due partly to product requirements and partly to customer preference. Many buyers relax their specifications when they encounter difficulty in finding enough bolts to sustain their operation. For these reasons, research is needed to develop hickory bolt grades that will be satisfactory to both buyer and seller. After such grades are accepted, the specifications should remain constant, with the prices changing on a basis of changing demand for bolts.

This report covers products that are sawn from lengths of less than 8 feet (fig. 1). In the absence of generally accepted standard bolt specifications, the following requirements and specifications are given as an indication of present practices:

Size.--Many companies specify that bolts be cut in multiples of 38 inches. Some specify 40 inches, some 45 inches, others 6 feet, and still others 7 feet. Diameters range from 8 inches up, with a seeming preference for 12 to 18 inches.

Quality and grades.--Generally, the specifications call for heavy growth,[2/] tough-textured, straight-grained, and reasonably clear bolts. Many firms specify that the higher-quality bolts have white wood for a depth of at least $3\frac{1}{2}$ to 4 inches under the bark. They should be free of birdpeck, mineral streak, shake, and rot. Some knots are permitted, especially if they are near the end and concentrated on one face. However, bolts with knots are placed in the lower grades.

Some companies purchase bolts by grade; others simply specify that the bolts be of high quality and reduce the volume in proportion to defect. Suggested grades will be covered in another report in this series entitled, "Grading and Measuring Hickory Trees, Logs, and Products."

Many firms use these three grades (10):

1. Strictly clear young growth with at least 4 inches of white wood under the bark.

2. Good clear hickory with less than a 4-inch ring of white wood.

3. Reasonably good hickory that misses Grade 2 because of light weight, defects, or knots.

2/ The term heavy growth is used by industry to mean fast growth. It is well known that fast-growth hickory has a higher density than slow-growth. Generally, any hickory with 27 rings per inch or more is rejected for handles. Preferable growth is 17 rings per inch or less.

The following grades are also used sometimes:

1. Clear butt cuts free of imperfections, at least $3\frac{1}{2}$ inches of white wood, heavy weight, and good growth.

2. Clean bolts with more than $2\frac{1}{2}$ inches of white wood.

3. Clean bolts with blemishes or less than $2\frac{1}{2}$ inches of white wood.

Figure 1.--Hickory bolts in yard.

DESCRIPTION OF SOME COMMON DEFECTS IN HICKORY BOLTS

Some companies adhere closely to defect specifications, while others use them only as a general guide. Following are some of the more common defects as they affect grade:

Knots.--Top grades do not permit any knots; the lower ones permit a few. Any blank that has open knots larger than 3/4 inch in diameter is rejected.

Bird peck.--None is permitted in the top grades; the lower ones permit some. If bird peck is visible to any extent on end of bolt, the bolt is generally rejected.

Mineral streak.--A small amount of streak is permitted in the top grades. However, extensive streak is cause for reject.

Cross grain.--If grain deviates to any extent from the parallel, the bolt is rejected.

Brashness.--This is generally light-weight wood with more than 27 rings per inch (usually old-growth hickory). Here the slow growth in the outer portion of the tree is apt to be brashy, making it too brittle for use. Such wood breaks easily across the grain and lacks toughness. No brashy hickory is acceptable.

Rot.--Some rot is permitted if there is enough usable sound wood in the bolt. Some companies specify that at least 2/3 of the bolt be clean, sound wood. Others specify that a bolt must have a minimum 4-inch ring of sound wood.

Internal stresses.--This causes such defects as end split. Another report in this series, "Stresses in Living Hickory and Their Importance," will cover internal stresses in more detail.

Wind shake.--While this is not a common defect, it does occur--most frequently in older trees and those growing on upland sites. Bolts with any sign of wind shake are rejected.

METHODS OF PURCHASING BOLTS

Hickory bolts are commonly bought by the cord (128 cubic feet) but sometimes by the board-foot, which is measured either by the Doyle or Doyle-Scribner log rule. For 40-inch bolts, a rick 4 feet high and 9-2/3 feet long constitutes a cord. For 38-inch bolts, the rick is 4 feet high and 10 feet long.

One thousand board-feet of 40-inch bolts (Doyle) will yield approximately 650 forty-inch blanks and 250 fourteen- to twenty-inch blanks. These short blanks are the result of trimming for defects. According to one company, a standard cord is expected to yield about 275 long blanks. The yield of 40-inch blanks is in various sizes depending on the quality and color. One size used for axe handles is 3-5/8 inches x 1-1/4 inches at the small end and 3-5/8 inches x 2-1/4 inches at the other. The red wood is usually sawed into railroad

pick handle blanks which are 3-5/8 inches x 2-5/8 inches at one end and 2-1/4 inches x 2 inches at the other. Sledge handle blanks are 2 inches x 2 inches. The shorter blanks are also 2 x 2.

Some companies buy bolts on the basis of the number of handles the bolts will produce (table 2).

Table 2.--Yield table used by one company for 38-inch bolts

Bolt diameter	Handles
Inches	Number
8	4
10	7
12	10
14	14
16	18
18	23
20	28
22	34
24	40

Hickory is also purchased as split billets. These are usually 2 inches x 2 inches and in lengths of 16, 18, 20, 26, 34, and 40 inches. Four grades are generally used--extra, 1, 2, and 3. Billets used for railroad pick handles are 40 inches long, 2 inches x 2 inches at small end and $2\frac{1}{2}$ inches x $3\frac{1}{2}$ inches at the large end.

PRODUCTS MANUFACTURED FROM BOLTS

Handles are by far the major item produced, but a wide variety of other products are also made, ranging from picker sticks, ladder rungs, and pitman rods to wagon spokes, singletrees, baseball bats, billiard cues, and veneer for street brooms (3, 7).

Handles

There are three general handle categories: striking tools, lifting and pulling tools, and other hand tools (11).

Striking tools include such tools as axe (fig. 2), adze, pick, mattock, maul, sledge, hammer, and hatchet. Striking tool handle blanks are generally graded extra, No. 1, No. 2, or No. 3. The extra and No. 1 grades are the same for axe, pick, and sledge handle blanks, but the other grades vary some. The following are typical specifications for striking tool handle blanks:

Extra: Must be all white, heavy timber, free from all defects, perfect, full size, and straight grain.

No. 1: Must be good weight timber, permitting 1/3 red wood the entire length of the blank. All white blanks of good weight not sufficiently heavy for extra grade. Two light hair streaks running full length, or their equivalent in shorter streaks permitted. Must be full size, straight grained and free from defects.

No. 2: Must be fair weight timber permitting red, white, or mixed red-and-white wood (for axe handle blanks not more than 2/3 red permitted). Light streaks permitted. All white blanks can have not more than three small pin knots not to exceed 1/8 inch in diameter. Reasonably straight grain required.

No. 3: Includes blanks that will produce serviceable handles but are not admissible to the higher grades because of defects.

Reject: Blanks containing open knots greater than 3/8 inch in diameter, worm holes or windshake, or ones that are brashy and not admissible to any grade.

The size of handle blanks varies by the handles to be produced (table 3).

Figure 2.--Single-bit axe handles.

Table 3.--Common handles and size specifications, dry size

Blank	Length	Cross section	
		Head end	Eye end
	Inches	Inches	Inches
Axe	33-36 and 40	3-1/2 x 2-1/8	3-1/2 x 1-1/8
Axe	29-32	3-1/8 x 2	3-1/8 x 1
RR pick	40	2 x 1-3/4	3-1/2 x 2-1/2
Coal pick	40	2 x 1-3/4	3-1/2 x 1-3/4
Hatchet	19-28	2-7/8 x 1-3/4	2-7/8 x 1
Sledge	29-32, 33-36 and 40	1-5/8 x 1-3/4	1-5/8 x 1-3/4
Hammer	15-28	1-5/8 x 1-3/4	1-5/8 x 1-3/4

Most companies use standard grade specifications for striking tool handles. Listed below are handle grades taken from standard practice recommendation No. R77-45, U. S. Department of Commerce, November 1, 1945 (10):

SIMPLIFIED PRACTICE RECOMMENDATION, HICKORY HANDLES

(The grading of handles is based on visual inspection of each handle and on the judgment of the grader. It is not expected that the grader will determine the weight per cubic foot or number of rings per inch for each handle. In case of question, however, one or both of these characters may be measured for conformance with the requirements given in this table for each grade.)

Grade symbol 1/	Color of wood	Number of annual rings per inch of radius	Weight in pounds per cubic foot 2/	Admissible blemishes 3/	Admissible defects 4/
AAW	All white	Not more than 17	Over 55 (heavy)	None	None
AW	All white	Not more than 22	Over 46 to 55 (medium)	Not exceeding 2 small streaks or their equivalent in shorter streaks	None
AR	Red or red-and-white	Not more than 22	Over 46 to 55 (medium)	Medium streaks	None
BW	White except for red extending from the eye end not more than 2 inches beyond the shoulder, or 3 inches from the grip end, or both.	Not more than 27	Over 46 to 55 (medium)	Not exceeding 4 medium streaks or their equivalent in shorter streaks. Light stain.	One or 2 bird pecks, or tight, sound knots the sum of whose average diameter does not exceed $\frac{1}{4}$ inch in the eye end or first third of the grasp end. Slight dip grain.
BR	Red or red-and-white	Not more than 27	Over 46 to 55 (medium)	Medium streaks Light stain	One or 2 bird pecks, or tight sound knots the sum of whose average diameter does not exceed $\frac{1}{4}$ inch. Slight dip grain.
C	Red or red-and-white	No requirement	38 to 46 (fair)	No requirement	Any or all those listed in footnote 4, provided none of them seriously impairs the serviceability of the handle.

1/ Grade marking: If handles are grade marked it is recommended that the grade symbol be impressed in the wood.

2/ These weights are based on a moisture content not exceeding 12 percent.

3/ Blemishes include: Small streaks, threadlike discoloration extending not more than 1/3 the length of the handle; medium streaks, discoloration extending more than 1/3 the length of the handle, but not over 1/32-inch in width; mismanufacture which does not impair the serviceability; and light stain, slight difference in color which will not seriously impair the appearance of the handle.

4/ Defects include: Knots, bird pecks, splits, holes, decay, stain, cross grain--deviation of the fibre out of parallel with the axis of the handle in excess of 1 in 20; abrupt dip grain--deviation of the fibre out of parallel with the axis of the handle in excess of 1/8 the minimum diameter of the handle at the point where the dip grain occurs; slight dip grain--deviation of the fibre out of parallel with the axis of the handle not in excess of 1/8 of the minimum diameter of the handle at the point where the dip grain occurs; heavy stain--discoloration of the wood occurring in specks, spots, streaks or patches of varying intensities of color (generally bluish black); and large streaks--discoloration more than 1/32 inch in width.

Lifting and pulling tools include hoes, digging forks, rakes, spades, shovels, etc. (fig. 3). Handles for these tools do not have to meet such rigid requirements as do those for striking tools. One of the main requirements is toughness. While ash is preferred for these handles, hickory is still used to some extent.

Others include cant hooks, peavies, scythes, crosscut saws, chisels, etc. The main requirements for these tool handles are toughness and stiffness. This is especially true for cant hooks and peavies, which are subject to sudden stresses. Specifications are not as rigid as for striking tool handles. The top-grade cant hook and peavy handles are red or red-and-white, medium weight (46 to 55 pounds) wood. They can have up to 27 rings per inch, and some blemishes and defects are allowed. The grade symbol BW, or in some cases AR, represents top grade for these handles.

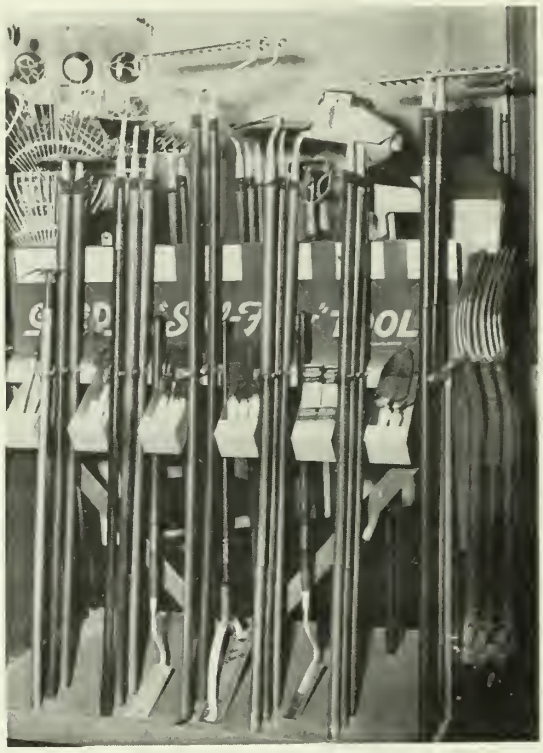

Figure 3.--Some typical lifting and pulling tools.

Industrial Products

The industrial uses of hickory include such products as picker sticks, ladder rungs, dowels, and shunt poles. Picker sticks used in the textile industry provide a good example. These sticks must be all clear, white, free from any defects, and straight grained. They are produced from blanks 1-1/4 inches x 2-1/8 inches and 1 inch x 2-1/8 inches, in lengths of 34, 36, 38, 40, and 42 inches (fig. 4). Some producers prefer to use No. 2 grade bolts for picker sticks. The size of the blanks permits them to cut around defects, and red wood can be used for other products in which color is not a factor. The textile industry is quite dependent on hickory for loom parts. Lug connectors, lug straps, pitman arms, and sweep sticks are also made from hickory.

Ladder rungs are often byproducts of other operations. In one plant, rungs are made from material that is left over from plow handles. Blanks 1-1/4 inches square are run through a dowelling machine to produce a round piece 1-1/8 inches in diameter. These rounds are cut into lengths ranging from 14 to 28 inches. They must be all clear, straight grained, and free of defects and blemishes. Red or red-and-white wood is permitted.

Dowels are used as ladder and chair rungs, tent poles, some types of handles, tamping sticks, archery material, for furniture joints, and a variety of miscellaneous round products. Many companies run material that is not suited for other products through dowelling machines. This assures good utilization and a variety of sizes for different markets.

Figure 4.--Storage of hickory picker stick blanks.

Agricultural Products

Hickory has always been widely used in agriculture. It has the right properties for pitman rods, plow handles, singletrees, wagon spokes, and wagon axles. Specifications for pitman rods call for straight grained, all clear, heavy material. Color is no problem. One blank size is 1-7/16 x 1-15/16 x 32 inches; another is 1-1/4 x 1-3/4 x 37 inches. Plow handles are made from blanks 1-1/4 x 2 inches square and 4-1/2 to 5 feet long. These blanks should be reasonably straight grained. Some defects and blemishes are permitted. For example, a few sound knots not to exceed 1/4 inch are allowed, and color is not a factor. Singletrees are produced from several size blanks. They include 2-1/4 x 2-3/4 inches and 2-1/2 x 3-1/4 inches. Lengths run 20, 28, 36, and 42 inches. The smallest size is used on tobacco

cultivators and is produced in the greatest number. Singletrees have to be clear and reasonably straight grained (some dip grain permitted). A few blemishes and defects such as bird peck are allowed. Color is not a defect.

Wagon spokes are made in a wide range of sizes. Lengths run from 22 to 36 inches. Widths and thicknesses are 1-1/2 x 2; 1-1/2 x 2-1/4; 1-1/2 x 2-3/8; and 1-3/4 x 2-1/2. There are three grades--A, B, and C. Color is not a factor. Grain must be reasonably straight. A few blemishes such as sound knots and bird peck are permitted.

Wagon axle blanks are produced from 6-foot bolts in various sizes. Some of the more common sizes are 2-1/2 x 3-1/2, 2-3/4 x 3-3/4, 3 x 4, 3-1/4 x 4-1/4, 3-1/2 x 4-1/2, 3-3/4 x 4-1/2, 3-3/4 x 4-3/4, and 4 x 5. There are two grades--No. 1 and No. 2. Specifications for these grades are listed under wagonstock in the NHLA grading rule book.

Sporting, Athletic, and Playground Equipment

The use of hickory for these items has declined considerably, as indicated by the following annual reports: 1912, 5044 MBF; 1928, 1423 MBF; 1933, 566 MBF; 1940, 2581 MBF; 1948, 1908 MBF. Some of the items still made of hickory are gym bars, golf shafts, baseball bats, archery bows, and billiard cues.[3/] However, at least one company is now producing laminated bats that are accepted in the major leagues. Hickory is used in this laminated bat along with beech and birch. This hickory lumber 1-3/8 inches thick and 3-1/4 inches wide is sawed from bolts 4 and 7 feet long. There are no established grades for this material, but it must be of high quality. The dimension is flat sawed so that the grain is parallel with length.

Miscellaneous Products

These include lawn furniture, woodenware, novelties, turnery, dimension, meat smoking blocks, skewers, poultry crates, wedges, and street brooms.

MANUFACTURING METHODS

Hickory bolts are usually sawed into blanks by bolting saws or short-carriage sawmills. The bolting saw is most commonly used to produce handle blanks.

Bolting Saw

This is a stationary circular saw generally 50 to 58 inches in diameter (9-10 gage) coupled with a movable table (fig. 5). The bolt is placed on the table and pushed into the saw. Most of these table tops are operated manually, but a few have mechanical feed. Methods of sawing vary by product

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3/ Although ski blanks are important products from hickory, they are produced from hickory logs rather than bolts because of their length.

and plant. One method commonly used by handle companies is to halve the bolt, then quarter it, and then saw out tapered blanks like those required for axe handles. Red-colored heartwood of hickory usually goes into railroad pick blanks. The smaller pieces are salvaged for sledge and hammer handle blanks. The operators of these bolting saws must be highly skilled, for the way they saw a bolt is a prime factor in determining the quality of material produced. Some handle plant superintendents say the man at the bolting saw can mean the difference between profit and loss in the whole operation.

Figure 5.--Bolting saw.

Small Sawmill

These are generally short-carriage, 8-foot mills with a 54-inch circular saw (fig. 6). Bolts are sawed into flitches of different thicknesses depending on the product. These flitches are then ripped to desired width on a rip saw. Small sawmills are commonly used in producing blanks for picker sticks, pitman rods, garden tool and broom handles, laminated baseball bats, ladder rungs, and dimension.

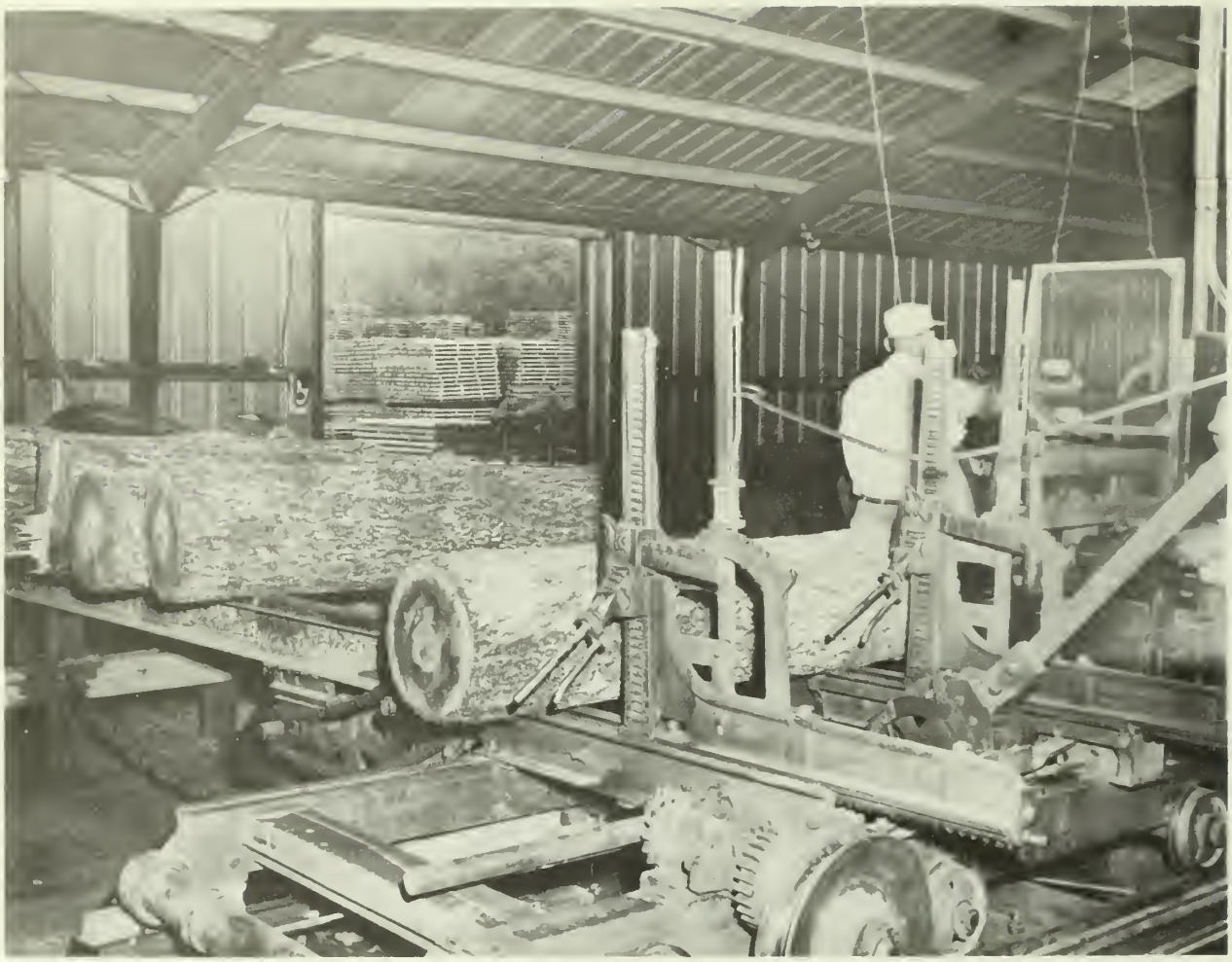

Figure 6.--Short-carriage sawmill.

Production Operation

Machines and methods vary with the product to be made. In a typical setup for handle manufacture (8), handles are kiln dried to about 12-percent moisture content. Some companies kiln dry small handle blanks before turning, large handles after turning. Others turn all handles before kiln drying. Details on schedules, control of pinking, storage, etc., are given in Hickory Task Force Report No. 4, "Seasoning Hickory Lumber and Handle Blanks."

Machining.--Rough blocking or shaping is usually done on a circular saw. The shaped blanks are then turned on a lathe. Irregularly shaped handles such as those for a single-bit axe are turned on a copying lathe (fig. 7). A pattern of the handle automatically controls the depth of cut . Such lathes are usually equipped with saws that have long, coarse, thick teeth. Regular-shaped handles for sledge, maul, and some garden tools are turned on a knife lathe.

Trimming reduces rough handles to the proper length. Straight handles and picker sticks are usually trimmed by a pair of circular saws (fig. 8). Curved handles are trimmed in two separate operations.

Figure 7.--Copying lathe turning double-bit axe handle.

Throating is the first grinding operation on handles with deep concave bends. The throat of a single-bit axe handle, for example, must be smoothed prior to grinding. Next the rough handles are ground on a coarse abrasive belt, after which they are polished. This operation is the same as grinding, except that the abrasive belt is finer.

Finishing.--Handles are given a fine smooth finish on finishing belts of fine sandpaper (fig. 9), and then they are coated. Buyers have different specifications for final coating. These include wax, stain, lacquer, and paint. Waxing is done on a belt or in tumblers, and lacquering is accomplished by dipping. Clear lacquer is frequently used. Some handles are stained to improve their appearance. Painting is usually limited to low-grade, cheap handles.

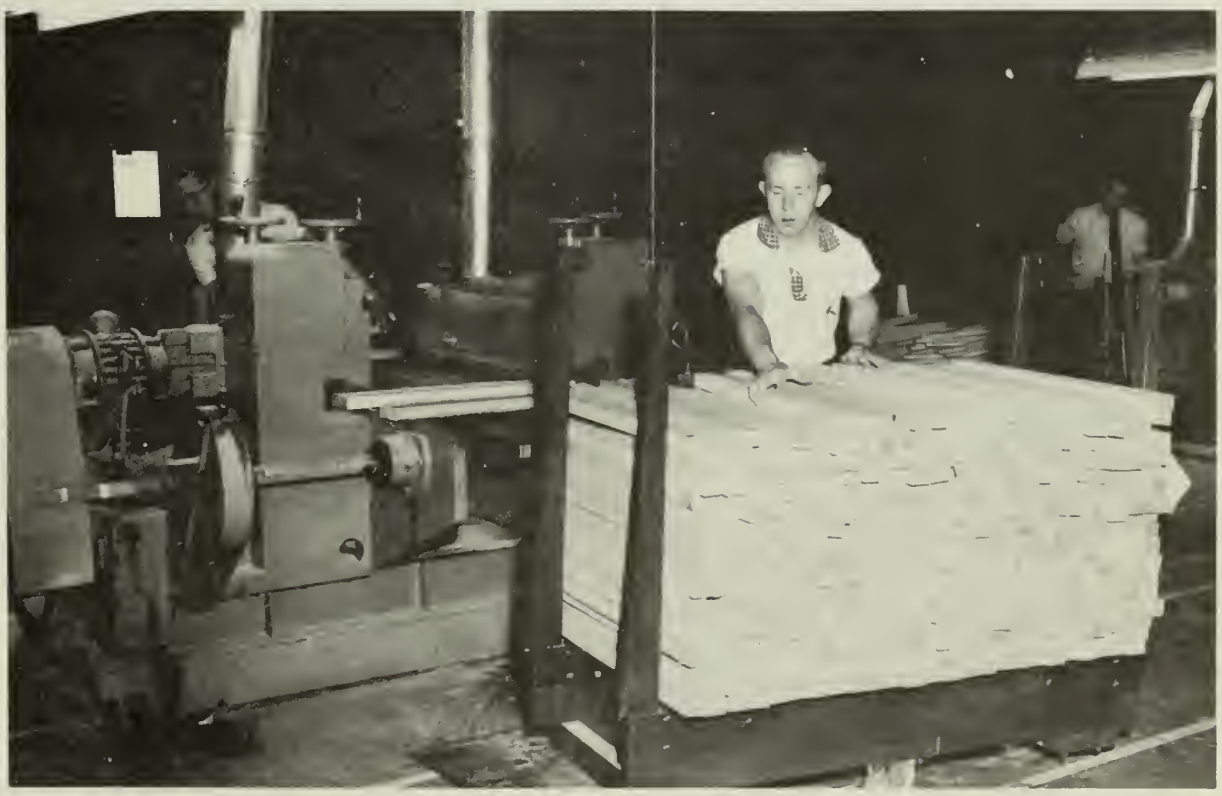

Figure 8.--A double-end trimmer trimming hickory picker stick blanks.

Figure 9.--Sanding axe handles.

As one of the last operations, handles are usually labeled or stamped (sometimes both) with the name of the manufacturer and the trade name.

Equipment used to manufacture other products generally includes all or part of the following:

Sawmill, usually 8-foot carriage
Bolting saw
Wood lathe
Single rip edger
Gang rip saw
Dry kiln
Dowelling machine
Shaping machine (figures 10 and 11).
Chucking machine
Sanding machine
Paint shop equipment
Labeling and stamping equipment

INSECTS IN HICKORY PRODUCTS

The most serious insect damage to hickory products is caused by powder-post beetles, which attack the sapwood as it begins to season. Eggs are laid in pores of the wood. The eggs hatch into larvae which burrow through the wood making tunnels about 1/16 inch in diameter. This type of damage is indicated by small holes in the wood and by piles of fine powder. Well seasoned sapwood, usually below 15 percent moisture content, is most susceptible to attack. Heartwood is not attacked (2).

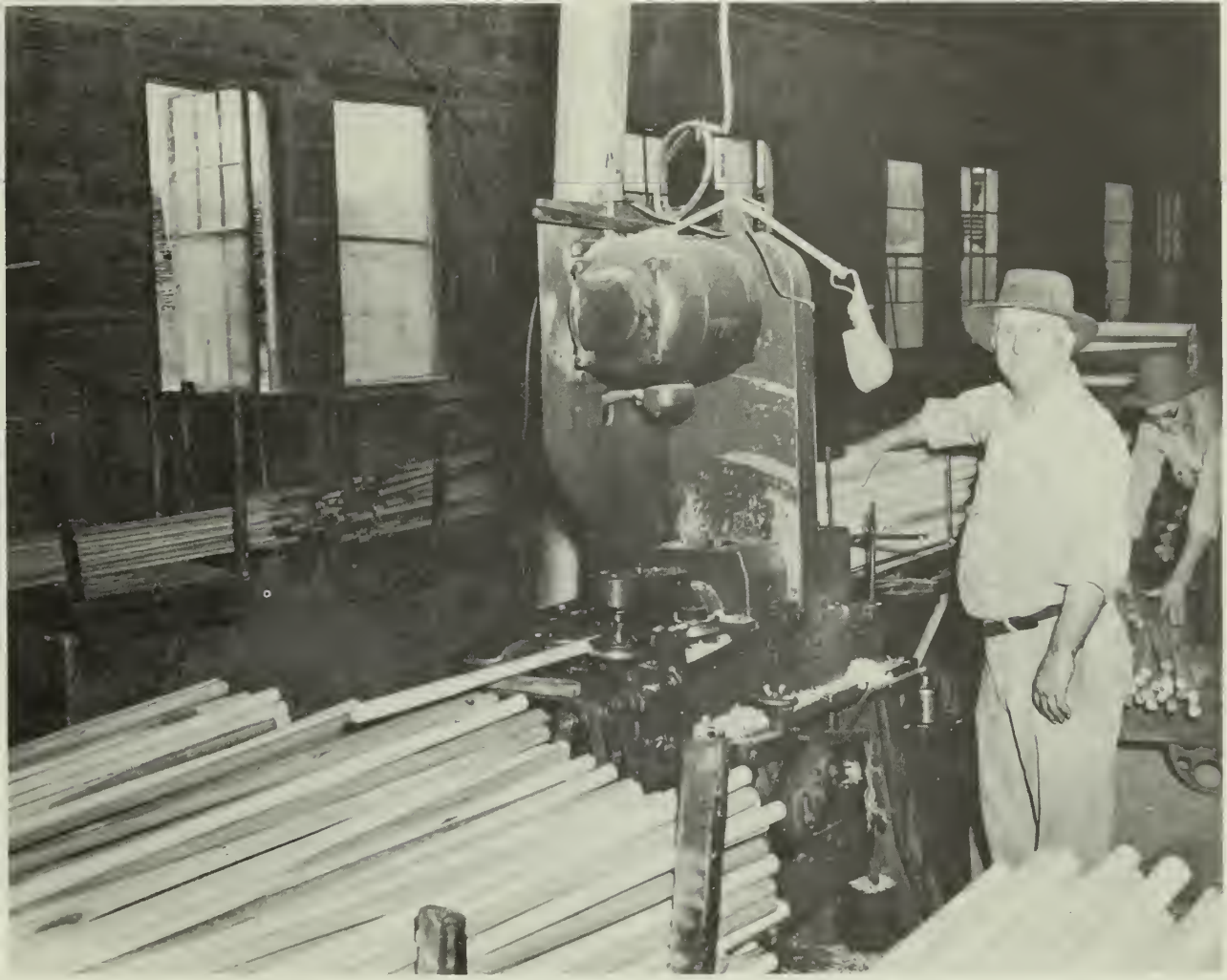

Figure 10.--Shaping hoe handles.

Since the beetles lay their eggs in the open pores, many plants prevent infestation by covering the surface of the wood with linseed oil, paraffins, or some other finish that will fill the pores. Another method for known or suspected infestation involves sterilization with steam (130 to 180 degrees, depending on moisture content) for about 2 hours for 1-inch lumber and longer for thicker material. These methods do not prevent the possibility of later attack and damage if the finish is removed with use or if parts of the stock have no finish. More lasting protection can be obtained by soaking in a petroleum oil solution of 5 percent pentachlorophenol, 5 percent DDT, or 1 percent lindane (12).

Important insects that attack unseasoned wood include ambrosia beetles (Platypus spp.), red-headed ash borer (Neoclytus acuminatus), and red-shouldered shothole borer (Xylobiops basilaris). The best safeguard is to stack green lumber so that it will dry as rapidly as possible without checking. Damage in freshly sawed material can be prevented by dipping in a water emulsion of 0.2 percent gamma benzene hexachloride (2).

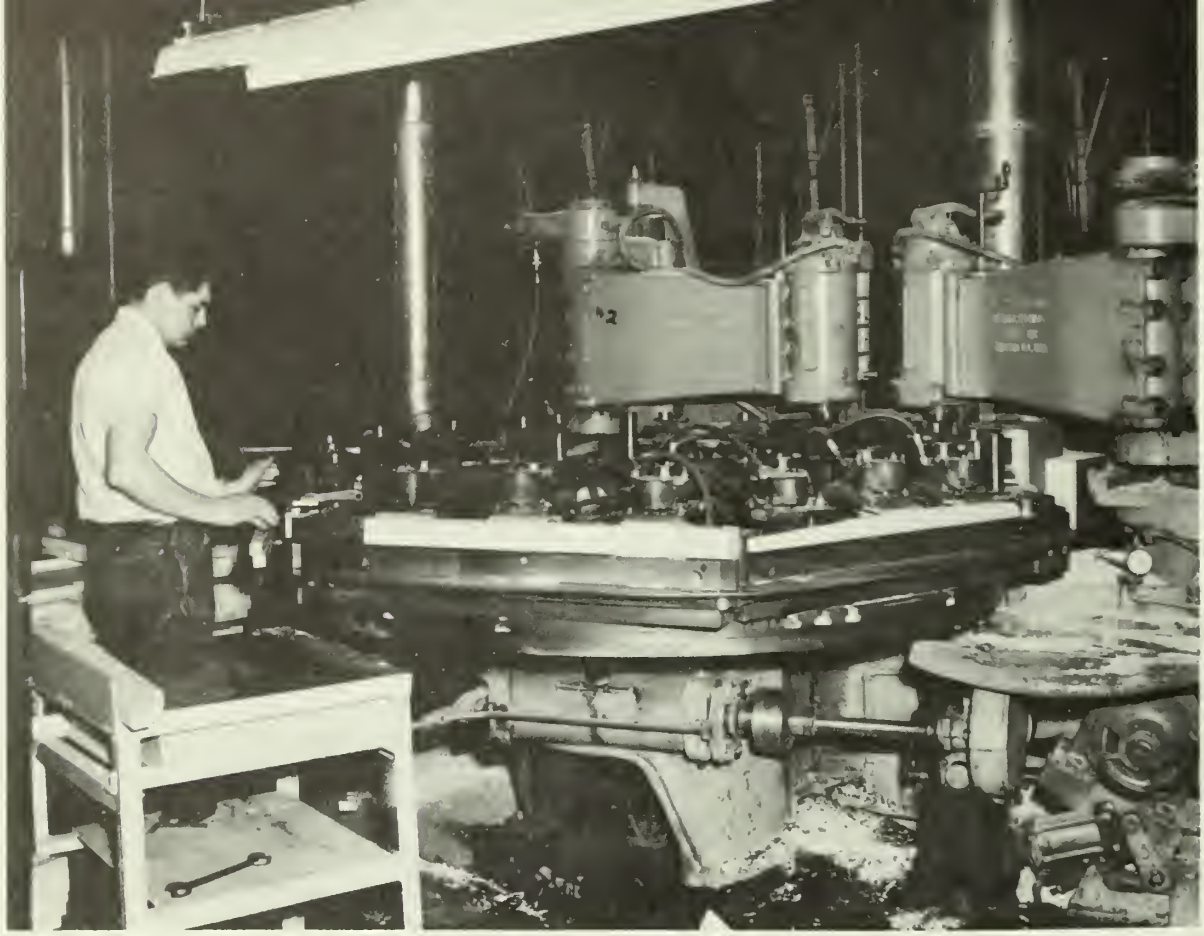

Figure 11.--Automatic shaper used to rough out picker sticks from clear, straight-grained hickory blanks.

ECONOMIC IMPORTANCE OF HICKORY BOLT PRODUCTS

A survey of wood used in wooden products during 1948 (latest data available) reveals 76,532,000 board-feet of hickory was used (7). Approximately 51 percent of this volume was produced from hickory bolts. About 88 percent of the material produced from hickory bolts was manufactured into handles; other proportions are indicated in the following tabulation:

Product	Percent of total volume
Conduits, pumps, and woodpipe	2
Dowels, skewers, and wedges	1
Handles	88
Shuttles, spools, and bobbins	5
Sporting, athletic, and playground equipment	1
Woodenware, novelties, and miscellaneous	3
	100

The value of products from hickory bolts is estimated at $10,000,000 per year. According to one manufacturer, 80 percent of this value is in handles.

Costs of material and labor vary with the products made. One handle manufacturer estimates that his manufacturing costs run about 20 percent for bolts and 25 percent for labor. Another estimates that labor accounts for about one-third of his production costs, and material another third. In products where higher grade material is required, the proportionate cost of bolts may go as high as 30 to 35 percent.

All in all, hickory has desirable strength properties for bolt products that are unequaled by any other species in the United States and probably in the world. American hickory is sought by all foreign countries, since it is grown only on this continent. The main detriment to the hickory bolt industry has been the continuous creaming of the best hickory trees, with no attention to forestry practices that could assure quality hickory for the future. An awakening of interest in hickory by foresters and landowners should improve this situation.

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