CIRCULAR 533

MEASURING FARM TIMBER

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CONTENTS

MEASURING FARM TIMBER

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The volume of timber products in the farm wood-land is often an unknown quantity, yet it is of great importance for purposes of inventory, management plans, investment evaluation, and timber sales.

I. - UNITS OF MEASURE

All products are measured by some unit. For farm woodland products there are many common units of measure. These are described in the following paragraphs. A thorough understanding of the unit to be used in the sale of any product is of extreme importance. It may mean a greater financial return as well as minimizing the chances of a misunderstanding of the terms of a sale agreement.

A. - Piece

The piece is the simplest unit of measure, yet there are usually certain specifications involved which should be thoroughly understood before any timber cutting is started. Such specifications cover acceptable diameters, lengths, species, defects, and other variables which may set up several grades of a product. Poles, piling, fence posts, railroad ties, and in many cases, mine props, are sold by the piece. Sample specifications for Southern Pine Poles are shown in Appendix A. Specifications for other piece products may be more or less detailed; however, in general the same factors are involved.

B. - Tight Cooperage Units

Some variation of methods may be found in measurement of the tree or bolts which are considered for cooperage products. Only trees of the white oak group are suitable for this use. White oak is preferred; however, bur oak, swamp white oak, swamp chestnut oak, overcup oak, and chinkapin oak are commonly accepted.

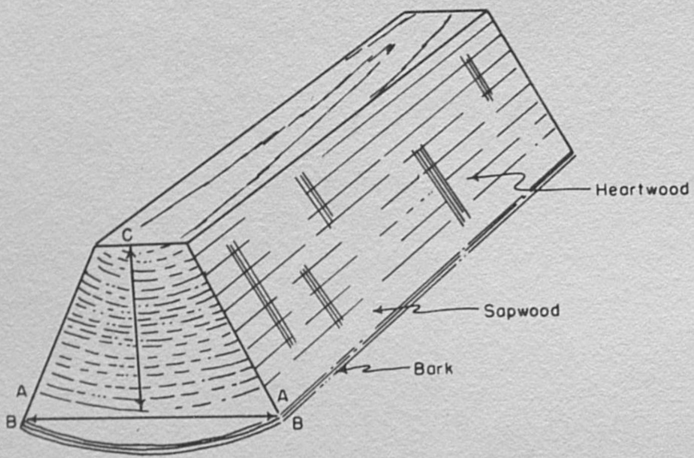


Fig. 1- The Stave Bolt

The stave bolt (Fig. 1) is usually the basic rough product. The bolt is split from a section of the tree trunk which has been cut approximately 39 inches in length. Measurement is taken from outer corner of sapwood to the opposite outer corner of sapwood (B-B). Thus a bolt measuring 12 inches across from outer corner to the opposite outer corner of sapwood would contain 1 bolt foot. Smaller bolts would contain proportionately less and larger ones more. Sample specifications for stave and heading bolts are given in Appendix B. In general, stave bolts measuring 12 inches across the outside are preferred with a range of from 6 inches to 16 inches accepted. Bolts must also have a certain range of radial or heartwood thickness (C-C). Some buyers set this measurement as ranging from 5 to 8 inches.

There appears to be some variation in regional practice in measuring by the bolt-foot as to whether the measurement is made from outer corner of sapwood to opposite outer corner of sapwood (B-B), or from outer corner of heartwood to the opposite outer corner of heartwood (A-A).

Stave bolts are graded as suitable for bourbon or oil staves. Bourbon-grade bolts must have clear, straight-grained heartwood. No defects such as worm holes, dote, or shake are allowed unless the location of the defect is such that it would be removed in the end-trimming, edging, or jointing of the staves. Oil-grade bolts allow a few small defects, such as one or two tight pin knots, a slight waviness of the grain, and more sapwood. A minimum heartwood thickness of 4 to 5 inches is usually allowable in this grade.

Heading bolts follow the same pattern in grades and sizes except that the bolt length is 24 inches. Trees larger than 24 inches in diameter should be worked up into such bolts. Many stave companies do not advocate cutting trees less than 12 inches in diameter for either stave or heading bolts.

A variation from using the bolt-foot measure as previously described is found in the practice of estimating the board foot contents of the portion of the tree suitable for stave bolts. In this case a thousand board-foot log or tree scale is assumed the equivalent of 100 bolt feet, or a quantity of staves that would make 10 barrels.

E. - Cord Measure

This unit is useful in determining the measure of a stack or pile of wood, particularly when the value of the individual piece is not large enough to justify measurement of it. By custom, when this form of measurement is used, all sticks in the pile are cut to approximately the same length, and a face measurement of 4 feet in height and 8 feet in length of the pile is a cord.

The standard cord is set as a unit equivalent to a pile of wood 4 feet in height, 8 feet in length and 4 feet in depth, having a displacement of 128 cubic feet (Fig. 2).

Fire wood is usually cut in 16 or 18 inch lengths and is sold in pile units of 4 feet in height and 8 feet in length. This so-called firewood cord is actually only a third of a standard cord.

Pulpwood and acid wood (chestnut) sticks are cut 5 feet and 5 1/2 feet respectively in length, and the "cord" has the same face measurement, 4 x 8 feet. Displacement of the pulpwood cord is therefore 4 x 8 x 5 feet or 160 cubic feet, and the acid wood cord is 4 x 8 x 5 1/2 feet or 176 cubic feet.

The actual solid wood content of any pile of wood is dependent on care in piling and surface irregularities of the individual sticks. The solid cubic contents of a standard cord vary from 60 cubic feet for limb wood, tops, and small diameter material to 100 cubic feet for large, smooth, straight, and regular logs and bolts.

F. - Board Foot

The board foot is the most commonly used unit of measure for standing trees, logs and lumber. It is a unit 1 inch thick, 12 inches wide and 1 foot in length. For purposes of determining the number of board feet in any rectangular piece of wood the formula is:

Board feet = The quantity thickness in inches times width in inches, divided by 12, times the length in feet.

1" x 8" - 16' would therefore be figured:

$$\text{Bd. ft.} = \frac{1 \times 8}{12} \times 16 = \frac{2}{3} \times 16 = 10\ 2/3$$

In general, rough lumber less than 1 inch thick is figured as an inch. Rough lumber more than 1 inch thick is figured to the nearest full quarter inch. Thus a board 1 3/8 inches thick would be figured as 5/4 inch. Widths are usually taken

Table 1. - Board Foot Contents of Lumber

Thickness and width	Board length in feet						
	8	10	12	14	16	18	20
Inches	Board foot content						
1 x 2	1 1/3	1 2/3	2	2 1/3	2 2/3	3	3 1/3
1 x 3	2	2 1/2	3	3 1/2	4	4 1/2	5
1 x 4	2 2/3	3 1/2	4	4 2/3	5 1/3	6	6 2/3
1 x 5	3 1/3	4 1/6	5	5 5/6	5 2/3	7 1/2	8 1/3
1 x 6	4	5	6	7	8	9	10
1 x 7	4 2/3	5 5/6	7	8 1/6	9 1/3	10 1/2	11 2/3
1 x 8	5 1/3	6 2/3	8	9 1/3	10 2/3	12	13 1/3
1 x 10	6 2/3	8 1/3	10	11 2/3	13 1/3	15	16 2/3
1 x 12	8	10	12	14	16	18	20
1 1/4 x 4	3 1/3	4 1/6	5	5 5/6	6 2/3	7 1/2	8 1/3
1 1/4 x 6	5	6 1/4	7 1/2	8 3/4	10	11 1/4	12 1/2
1 1/4 x 8	6 2/3	8 1/3	10	11 2/3	13 1/3	15	16 2/3
1 1/2 x 4	4	5	6	7	8	9	10
1 1/2 x 6	6	7 1/2	9	10 1/2	12	13 1/2	15
1 1/2 x 8	8	10	12	14	16	18	20
2 x 4	5 1/3	6 2/3	8	9 1/3	10 2/3	12	13 1/3
2 x 6	8	10	12	14	16	18	20
2 x 8	10 2/3	11 1/3	16	18 2/3	21 1/3	24	26 2/3
2 x 10	13 1/3	16 2/3	20	23 1/3	26 2/3	30	33 1/3
2 x 12	16	20	24	28	32	36	40
2 1/2 x 12	20	25	30	35	40	45	50
3 x 6	12	15	18	21	24	27	30
3 x 8	16	20	24	28	32	36	40
3 x 10	20	25	30	35	40	45	50
3 x 12	24	30	36	42	48	54	60
4 x 4	10 2/3	13 1/3	16	18 2/3	21 1/3	24	26 2/3
6 x 6	24	30	36	42	48	54	60

to the nearest full inch. Some slight variations in thickness and widths by size classes are allowed in grading but are beyond the scope of this discussion. Likewise, the finished sizes in thickness and width are not covered. The board foot content in various common sizes of lumber is given in Table 1. For sizes not listed, use combinations of given sizes. Thus a 4x6 inch piece is the same as two 2x6's.

The volume of a log in terms of board feet is determined by a log rule. A log rule is merely a tabulation of the board foot volume in logs of var-

Table 2. - International Log Rule. 1/4" Saw Kerf.

Log diameter at small end inches	Log lengths in feet				
	8	10	12	14	16
	Volume in board feet				
8	15	20	25	35	40
9	20	30	35	45	50
10	30	35	45	55	65
11	35	45	55	70	80
12	45	55	70	85	95
13	55	70	85	100	115
14	65	80	100	115	135
15	75	95	115	135	160
16	85	110	130	155	180
17	95	125	150	180	205
18	110	140	170	200	230
19	125	155	190	225	260
20	135	175	210	250	290
21	155	195	235	280	320
22	170	215	260	305	355
23	185	235	285	335	390
24	205	255	310	370	425
25	220	280	340	400	460
26	240	305	370	435	500
27	260	330	400	470	540
28	280	355	430	510	585
29	305	385	465	545	630
30	325	410	495	585	675
32	375	470	570	670	770
34	425	535	645	760	875
36	475	600	725	855	980
38	535	670	810	955	1095
40	595	750	900	1060	1220

(Values rounded off to the nearest 5)

ious diameters and lengths (Table 2). The log rule seeks to give the volume of sawed lumber that could be cut from a log after allowing for milling losses in sawdust and slabs and edgings. Log rules have been based on use of a mathematical formula, diagrams, and by actual mill tallies. Since different people have different ideas on how the slab and edging and sawdust deduction should be handled, there have been many different log rules constructed and used in various sections of the country. The International log rule, based on a 1/4-inch saw kerf is considered as the one that gives values consistently closest to the actual sawed contents of the sound, straight logs of all sizes. The values given in Table 2 are based on one-inch lumber.

For a "rule of thumb," the formula $(D-1)^2 \times \frac{L}{20}$ will give fairly close results with D equaling the small-end diameter of the log in inches and L equaling the length of the log in feet. Thus the board foot volume of a log with a small-end diameter of 14 inches and a length of 12 feet would be:

$$(14-1)^2 \times \frac{12}{20} = 13^2 \times .6 = 169 \times .6 = 101.4 \text{ bd. ft.}$$

When measuring the small-end diameter of a log, the average diameter inside bark should be taken to the nearest full inch. Length is measured in feet and is to the nearest full foot plus about 4 inches for trimming allowance. Thus a 12-foot log length must measure at least 12 feet, 4 inches, and so forth for other lengths.

Defects

Any condition that will cause a reduction in the quantity of lumber that might otherwise be cut out of a log is considered a defect. Thus rot, cracks, or splits, crook or sweep, and similar conditions which cause an actual reduction in the scaled contents of a tree or log, are defects. Conditions that cause a lowering of grade only, such as stain, are not considered defects in log-scaling practice.

To warrant a deduction, the defect must penetrate into the central cylinder as determined by the small-end diameter (inside bark) less one inch, extended the length of the log. Thus a surface defect at the butt or large end of the log must be deep enough to penetrate into the central cylinder, and only the depth of penetration into the cylinder is considered as the depth of the defect. Defects can be classified as (1) end and surface, (2) center, (3) crook and sweep, (4) uniform surface, (5) cracks and splits, and (6) shake.

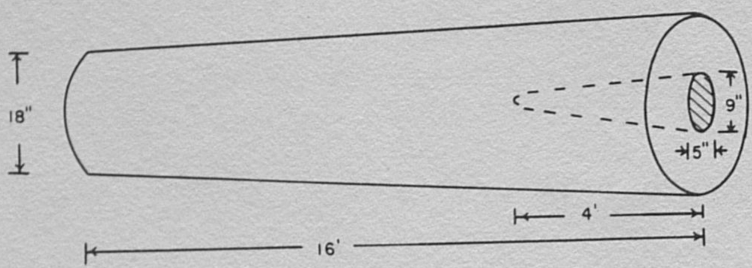
The method most commonly used, and described in textbooks treating with timber measurements, boxes in the defective area and determines its volume in board feet by use of the formula:

$$\text{Deduction} = \frac{D \times W \times L}{15}$$

In this formula, D equals the depth or thickness in inches, W equals the width in inches, and L equals the length in feet of the defect.

Examples of the various kinds of defects together with sample calculations are shown in the following cases:

Case 1. - Butt rot in a log 18 inches in diameter and 16 feet long.



Case 1

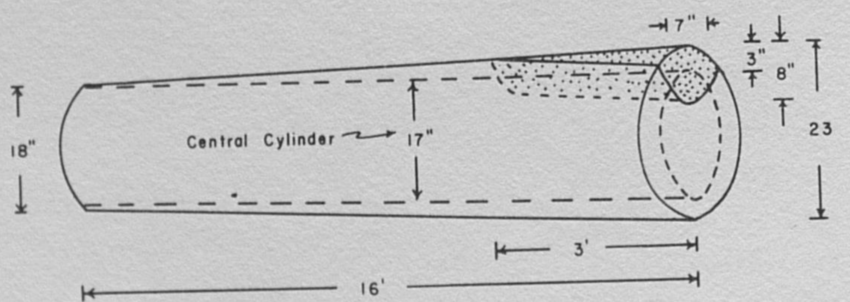
The dimensions of the defect as shown are 5 inches in thickness by 9 inches in width by 4 feet in length. In all cases involving a rotten area, 1 inch is added to the thickness and width measurement to make sure the defective area is enclosed. Use of the formula would then give:

Deduction =

$$\frac{(5 + 1) \times (9 + 1) \times 4}{15} = \frac{6 \times 10 \times 4}{15} = 16 \text{ bd. ft.}$$

With a gross scale of 230 board feet as found in Table 2, the net scale of the log is 230-16 or 214 board feet.

Case 2. - Surface defect in a log 18 inches in diameter at the small end, 23 inches in diameter at the large end and 16 feet in length.



Case 2

$$\frac{(5+1)+(8+1)}{2} = \frac{15}{2} = 7.5'' \text{ average diameter of}$$

defect

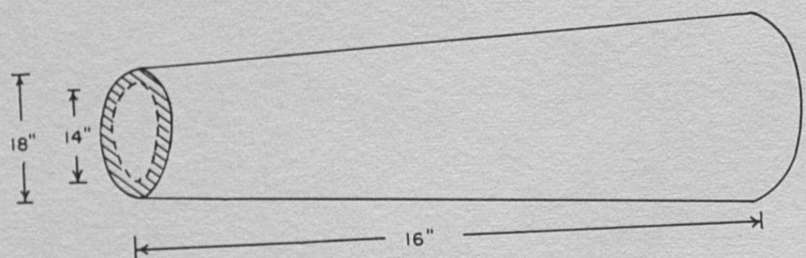
$$\text{Deduction} = \frac{7.5 \times 7.5 \times 16}{15} = 60 \text{ bd. ft.}$$

The net scale of this log would be 230-60 or 170 board feet.

Case 4. - Sweep in a log 18 inches in diameter and 16 feet in length. (See solution given for Case 4-a on page 22.)

Case 4' - Crook in a log of the same size as Case 4. (See Case 4-b, Page 22.)

Case 5. - Rotten sapwood or any condition which is surface in nature and can be confined to a collar of uniform thickness.

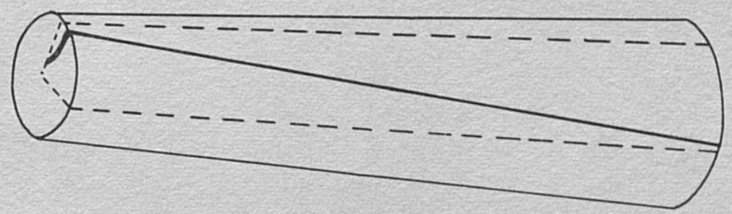


Case 5

In the above example, the defective portion of the log is estimated to be 2 inches thick. The log is 18 inches in diameter at the small end. Procedure in this case is to reduce the diameter by twice the average thickness of the defective sheath and scale as a 14-inch diameter log. The net scale would thus be 135 board feet.

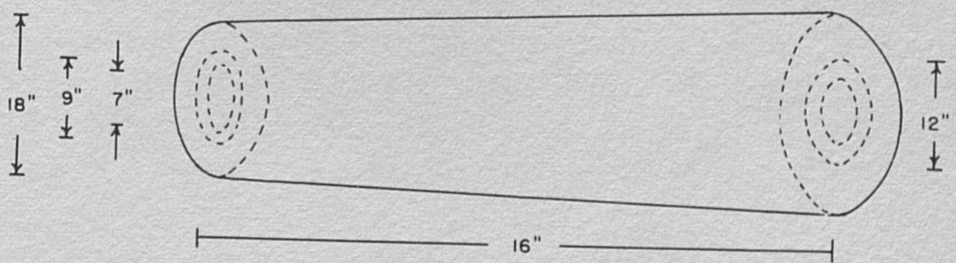
Case 6. - Crack or Splits.

If the log is straight-grained, the defect can be enclosed in an area having thickness, width, and length, and the standard procedure followed. If, however, the log has spiral grain, the defect is best enclosed in a sector of the log.



Case 6

In the above sketch, a crack spirals along the length of the log, and extends in approximately to the log center. The sector which encloses the defect is equivalent to one-fourth of the log volume, or a 25-percent deduction from the gross scale.



Case 7

Case 7. - Shake

Shake is a term used to identify a condition where one or more growth rings are loose from adjacent wood. It may extend entirely around the ring or extend only for a few inches. Areas having only a limited amount of shake can be considered as a center defect, and standard procedure followed. In some cases, however, where the shake extends completely around the ring, and where there is still a sizeable core of wood in the center of 6 inches or more in diameter as illustrated in sketch, the procedure is modified to allow salvage of the sound center.

The above example shows an 18 inch diameter log of 16 feet in length, with a shake zone extending completely around the annual rings and about 1 inch in thickness. The outside dimensions of the shake zone average 9 inches at the small end of the log, and 12 inches at the butt end. There is a sound core of 7 inches in diameter (small end). Computations would be as follows:

$$\frac{(9+1)+(12+1)}{2} = \frac{23}{2} = 11.5 \text{ average diameter}$$

of shake

$$\text{Deduction} = \frac{11.5 \times 11.5 \times 16}{15} = \frac{2116}{15} = 141$$

bd. ft., if the entire center were shaky. In this case, however, there is a 7 inch sound core which is equivalent to a 7 inch log, 16 feet long. The scale of such a log, using the rule of thumb, $(D-1)^2 \frac{L}{20}$, is $6^2 \times \frac{16}{20}$, or 29 board feet. Thus, the deduction for the case in question would be 141-29 or 112 board feet. The net scale would then be 230-112 or 118 board feet. Except for the log of a valuable species, a deduction such as this of approximately 50-percent would cause the log to be a cull.

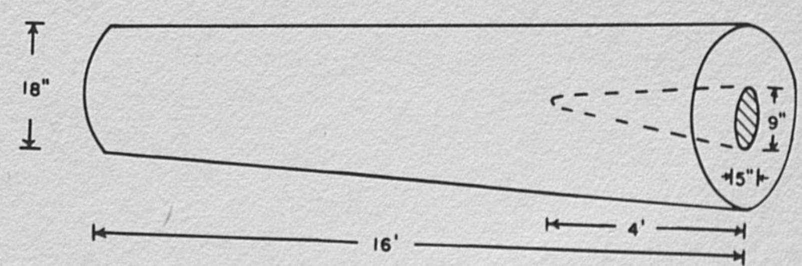
An alternate method of computing deduction for defects has been recently outlined by L. R. Grosenbaugh of the U.S. Forest Service (Southern Forest Experiment Station Occasional Paper

#126, pp. 14-15) in which a percent deduction from the gross scale is computed. In general, the deductions by this method are less than those in similar cases as computed by the formula $\frac{D \times W \times L.}{15}$ Since this formula admittedly imposes a heavy penalty for defective portions, the alternate method should have merit in localities where a high standard of utilization of the log contents is possible.

Procedure for calculating deduction for end or surface defects is given as follows:

1. Enclose the defect cross-section in an ellipse.
2. Measure the short and long dimension of the ellipse. Add 1 inch to each.
3. Determine the ratio of each increased dimension to the log diameter less 1 inch. Round off to the nearest tenth. (Table 3 p. 18.)
4. Estimate the length of the defect and determine the ratio of defect length to the log length. Round off to the nearest tenth. (Table 3).
5. Multiply the three ratios together. The result is the proportion to be deducted from the gross scale for the defect.

Examples of the various kinds of defects to-



Case Ia

Table 3. - Ratio of Defect Dimension to Log Dimension

Log Dimension	Defect Dimension 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
8	.1	.25	.4	.5												
9	.1	.2	.3	.4	.6											
10	.1	.2	.3	.4	.5											
11	.1	.2	.3	.4	.5	.5										
12	.1	.2	.25	.3	.4	.5										
13	.1	.2	.2	.3	.4	.5										
14	.1	.1	.2	.3	.4	.4	.5	.6								
15	.1	.1	.2	.3	.3	.4	.5	.5								
16	.1	.1	.2	.25	.3	.4	.4	.5	.6							
17	.1	.1	.2	.3	.3	.4	.4	.5	.5							
18	.1	.1	.2	.2	.3	.3	.4	.4	.5	.6						
19		.1	.2	.2	.3	.3	.4	.4	.5	.5	.6					
20		.1	.15	.2	.25	.3	.35	.4	.45	.5	.55					
21		.1	.1	.2	.2	.3	.3	.4	.4	.5	.5	.6				
22		.1	.1	.2	.2	.3	.3	.4	.4	.5	.5	.5				
23		.1	.1	2	.2	.3	.3	.3	.4	.4	.5	.5	.6			
24		.1	.1	.2	.2	.25	.3	.3	.4	.4	.5	.5	.5			
25		.1	.1	.2	.2	.2	.3	.3	.4	.4	.4	.5	.5	.6		
26		.1	.1	.2	.2	.2	.3	.3	.3	.4	.4	.5	.5	.5		
27		.1	.1	.1	.2	.2	.3	.3	.3	.4	.4	.4	.5	.5	.6	
28		.1	.1	.1	.2	.2	.25	.3	.3	.4	.4	.4	.5	.5	.5	
29		.1	.1	.1	.2	.2	.2	.3	.3	.3	.4	.4	.4	.5	.5	.6
30		.1	.1	.1	.2	.2	.2	.3	.3	.3	.4	.4	.4	.5	.5	.5

gether with sample computations are shown in the following:

Case 1-a. - Butt rot in a log 18 inches in diameter and 16 feet long.

As Step 1, the cross section of the defect can be enclosed in an ellipse. Following through with Step 2, the short and long dimensions are 5 inches and 9 inches respectively; adding 1 inch to each, and dividing by the log diameter - 1 (Step 3) we get:

$$\frac{5+1}{18-1} = \frac{6}{17} = .3$$

$$\frac{9+1}{18-1} = \frac{10}{17} = .6$$

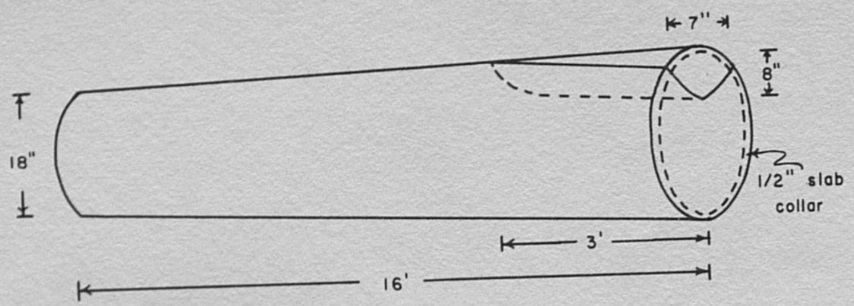
In Step 4, we note that the length of the defect is 4 inches. This expressed as a ratio of the length is $\frac{4}{16}$ or .25.

Step 5 consists of multiplying the three ratios together (.3 x .6 x .25), giving .045, which to the nearest unit percent is 5.

This is the proportionate deduction for the defect from the gross scale of the log, or .05 x 230 = 11.5 or 12 bd. ft. The net scale thus is 230-12 or 218 bd. ft.

Case 2-a. -Surface defect in a log 18 inches in diameter at the small end, 23 inches in diameter at the large end, and 16 feet in length.

Again the defect cross-section and length can be estimated. In this case the defect is at the butt of the log and all of the defective area is deductable except that occurring in the peripheral half-inch which is the slab-collar. Depth of the



Case 2a

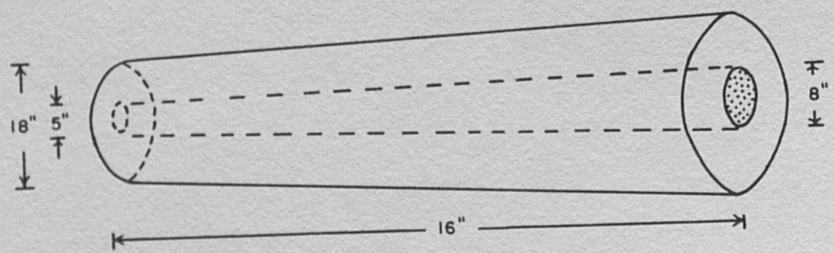
defect as illustrated in the sketch is 8 inches, width is 7 inches, and the length is 3 feet.

Computations would then be:

$$\frac{(7-1/2+1)}{17} = .5; \quad \frac{7+1}{17} = .5; \text{ and } \frac{3}{16} = .2$$

Proportionate deduction for the defect would then be .5 x .5 x .2 or .05. Five percent of 320 is 16 board feet. The net scale of the log would then be 320-16 or 304 board feet.

Case 3-a. - Center or heart rot in a log 18 inches in diameter and 16 feet in length.



Case 3a

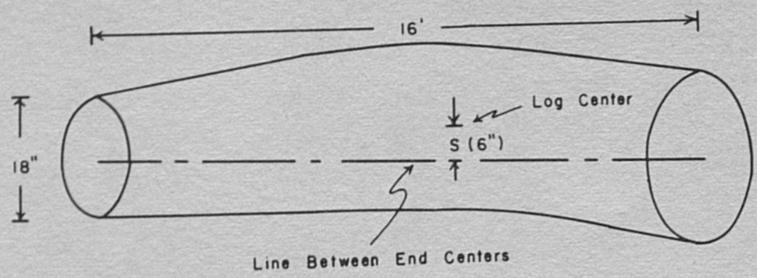
Procedure in this case is slightly different, but involves the same principles as in cases 1-a and 2-a. The rot in this case is almost circular in cross section. Long and short dimensions are thus the same. The deduction percentage is computed for each half length of the log to compensate for change in dimension of the defect. For the butt half of the log, the cross section dimensions of the defect are 8 inches and 8 inches. These, in terms of a percentage of the small-end diameter less one inch, are $\frac{9}{17}$ and $\frac{9}{17}$ or .5 and .5. The length of 8 feet is 50-percent of the log length, or .5.

Deduction for defect in the butt half of the log is thus .5 x .5 x .5 or 13-percent. Procedurefor the other half of the log is the same except that the defect cross section is 5 inches. Computations for this half of the log (.4 x .4 x .5) give 8-percent as the deduction. Adding the two deductions gives 21-percentas the total deduction from the gross scale; .21 x 230 = 48.3 bd. ft. The gross scale would then be 230-48, or 182 board feet.

A short cut in the computations involved would be to (1) square the defect cross section percentages for large and small ends of the log, (2) add results, and (3) divide by 2. Thus (1) .5 x .5 = .25 and .4 x .4 =.16 (2) .25 and .16 added together equals .41 (3) $\frac{.41}{2}$ = .21 or 21-percent. In effect, this is following the same procedure as given in the more detailed computation.

Case 4-a. - Sweep in a log 18 inches in diameter and 16 feet in length.

When the sweep occurs in one plane, the actual deviation of the log center from a line connect-

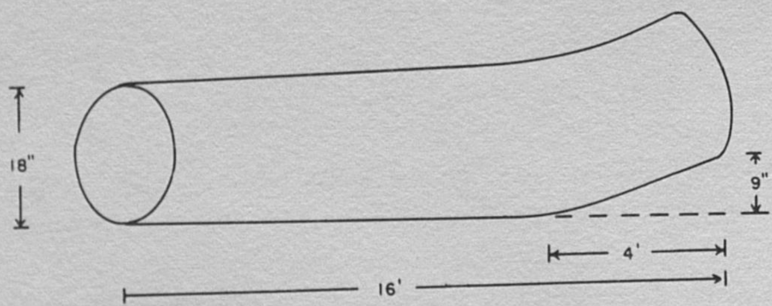


Case 4a

ing the center point at each end is considered the measurement of the sweep(s). Deduction percentage for sweep is obtained by use of the formula:

$$\text{Proportion deducted} = \frac{s - 2}{\text{Scaling diameter of log}}$$

In case of a sweep of 6 inches in the log diagramed above, the deduction percentage would be computed as $\frac{6-2}{18}$ or $\frac{4}{18}$ or 22-percent. In terms of board feet this would be .22 x 230 or 51, and the net scale 230-51 or 179 bd. ft.



4b

Case 4-b. - Crook in a log 18 inches in diameter and 16 feet in length.

Crook is a sharp bend in a log as differentiated from the rather uniform curvature of sweep along the log length. Measurements of the magnitude of the crook are taken as indicated in the above sketch. The deduction is then computed by the rule:

Proportion deducted =

$$\frac{\text{sideways measurement of crook}}{\text{scaling diameter of log}} \times \frac{\text{Length of log effected}}{\text{log length}}$$

Computation of deduction in Case 4-b would be

$$\text{Proportion deducted} = \left(\frac{9}{18}\right) \times \left(\frac{4}{16}\right) = 1/2 \times 1/4 = 1/8 \text{ or } 12\text{-}1/2 \text{ percent.}$$

12.5-percent of 230 is 29 bd. ft. The net scale for this case is then 230-29 or 201 bd. ft.

Case 5-a. - Shake

Shake is a term used to identify a condition where one or more growth rings are loose from adjacent wood. It may extend entirely around the ring or extend only for a few inches. Areas having only a limited amount of shake can be considered as a center defect and standard procedure followed. In some cases, however, where the shake extends completely around the ring and where there is still a sizeable core of wood in the center of 6 inches or more in diameter as illustrated in sketch, the procedure is modified to allow salvage of the sound center.

small-end diameter (inside bark) and of the length. A common yardstick or any scale graduated in inches can be used. When measuring the diameter, care should be exercised that the average measurement is obtained, since many logs are not exactly round. Length is measured in feet to the nearest full foot plus about 4 inches for trimming allowance. With a diameter and a length measurement, the volume of the log in board feet can be obtained by consulting a log rule. (Table 2, p. 8.)

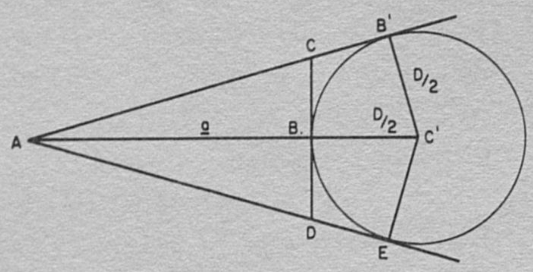
B. Standing Trees - Diameter Measurements.

Measurement is customarily made of tree diameter (outside bark) at D. B. H. (Diameter at Breast Height). This point is standardized at 4-1/2 feet above ground level.

Perhaps the simplest and most consistently accurate method of measuring the diameter of a standing tree is to measure the circumference by stretching a tape measure around the tree, and then divide the reading by 3. To be strictly accurate, the reading should be divided by 3.1416, however, the approximate diameter obtained by dividing by 3 is within the standards of accuracy usually required.

Calipers and the Biltmore scale can also be used if available. The principle of the Biltmore scale is shown as follows:

The lines AB' and AE represent diverging lines of sight when a person looks at the side of a tree. B'C; or $\frac{D}{2}$ is a radius of the circle (tree diameter). CD is the proportionate measurement that would be included on a stick held hor-



Biltmore Scale

izontally against the tree. AB or a would represent the distance the stick was held from the eye. Angles ABC and AB'C' are right angles and thus triangles ABC and AB'C' are similar. From this relationship, an initial proportion can be set up -

$$\frac{CB}{AB} = \frac{C'B'}{AB'}$$

Simplifying this proportion in terms of a and D (reach and diameter) we can derive the following formula:

$$s = \sqrt{\frac{a\ D^2}{a\ \ D}}$$

In the above formula, a equals the reach, which for the average person will be 25 inches, and D represents a particular diameter. S is then the scale measurement (line CD) for the particular diameter used.

For example, the graduation, (s) for a 10 inch diameter and a 25 inch reach (a) would be computed as follows:

$$s = \sqrt{\frac{25 \times 10^2}{25 + 10}} = \sqrt{\frac{2500}{35}} = \sqrt{71.46+} = 8.74+''$$

Graduations for other diameters can be computed in a similar fashion. In case of a longer or shorter reach than the standard 25 inches, the value of a in the formula can be changed to whatever is considered a normal reach. A table of graduations for a 25 inch reach is given on following page:

To make a Biltmore stick, take a piece of lath, lattice, or a yard stick and plane or sand one face clean and smooth. Next measure the indicated scale for the smallest diameter reading (for example 8 inches) from the left end of the stick, and mark it on the face of the stick in a suitable manner. This then is the 8 inch graduation of the Biltmore scale. Repeat for other diameters.

To use the stick, hold it horizontally against the tree at D. B. H.; line up the left upper corner of the stick with your line of sight, cutting the left side of the tree trunk. Then without moving the head, swivel your line of sight to the right side of the tree trunk and read tree-diameter on the Biltmore scale. Remember that the scale was graduated on the basis of a specified reach. Accuracy in use of the scale depends on how closely the correct reach (a) is maintained. Also, be sure that an average of the largest reading and the smallest reading is obtained, since many trees are oval in cross section.

C. Standing Trees - Heights.

Measurement of the height of the point on the tree trunk where the last cut will normally be made requires some training; however, the procedure and equipment can be relatively simple. The length of the useable section of the

Table 4. - Biltmore Scale Graduations
(25 inch reach.)

Diameter	Scale graduation to the nearest $\frac{1}{10}$ of an inch
inches	
8	7.0
10	8.5
12	9.8
14	11.2
16	12.5
18	13.7
20	14.9
22	16.1
24	17.1
26	18.2
28	19.2
30	20.2
32	21.2
34	22.1
36	23.0

tree trunk is influenced by (1) the taper of the tree trunk, and (2) the breaking up of the central trunk into large branches. In the latter case, the top limit of useable trunk length is just below the fork, and is easy to determine. However, in the first case, a point on the tree trunk must be chosen where the minimum useable diameter (usually 8-inches inside bark) is estimated to occur. If bark is estimated to be about one-half inch thick at the 8-inch diameter point, the outside dimension would thus be 9-inches. Determining the point on the tree trunk at which it would measure 9-inches outside the bark is at best an approximation. If the DBH is known, it can be used as a comparative measure.

Some estimators use the formula:

> (Circumference in inches at DBH x .28) -2" equals diameter inside bark at the top of the first 16 foot-log. For each 16-foot additional length, deduct 2 inches to secure the diameter inside bark at the top end of the log in question.

Thus a 20-inch DBH tree would give the following:

> (63" x .28) -2 = 17.6 -2 = 15.6" diameter inside bark at the top of the first 16-foot log length. At 32 feet the diameter (i.b.) would be 13.6 inches, and at 48 feet, 11.6 inches.
>
> The above example assumes that the tree trunk tapers gradually and extends up at least 48 feet before any large branches occur. For thick-barked trees, use the factor .27 instead of .28.

Having estimated the point on the tree trunk that is the limit of useable trunk length for logs, there remains the problem of determining how high that point is above stump height. Stump height can usually be standardized at about 1 foot above ground for this purpose.

There are many methods of measuring height that require special and sometimes expensive equipment; however, the two methods to be described are just as accurate and employ quite simple equipment.

Method 1. -(Based on Similar Isosceles Triangles)

Grasp one end of a straight stick that is just a little longer than your arm. Stretch your arm full length in front of you, with your hand (in which the stick is held) about level with your eyes. Holding your arm in that position, point the stick toward your face and adjust your grip on it so that the free end touches your closed eye or your eyebrow. Then, without changing your grip on the stick, raise it to an upright position. Holding the stick upright, walk away from or toward the tree (keeping as nearly as you can on the same level as the tree) until you find a place where you can sight over your hand and see the point on the tree that will be the height of the stump, and without moving your head, you can sight over the top of the upright stick and see the point that will be the top of the last log. Measure the distance from where you are standing to the base of the tree. This distance will be the same as the height from the stump to the top of the last log. See following sketch for geometric principle.

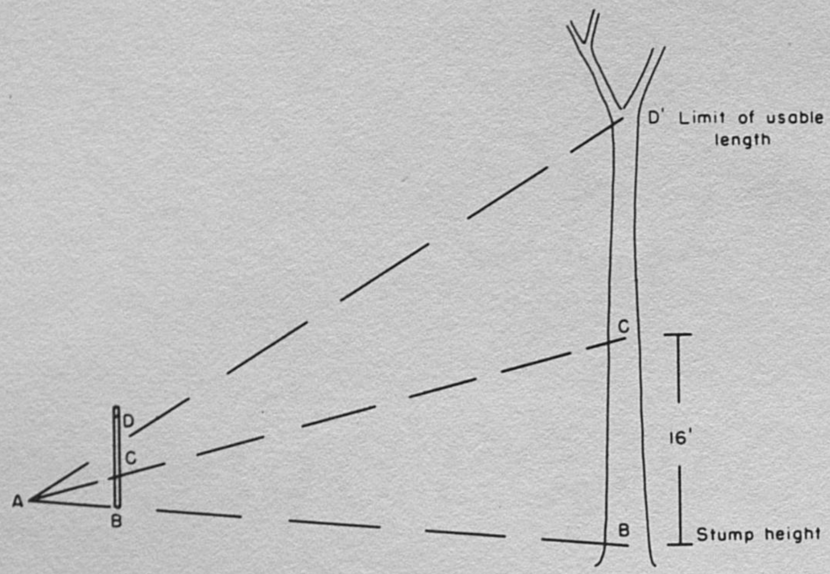


Fig. 4

that one must stand away from the tree (66 feet); C'B' is a set height unit (16 feet), and BC is the interval or scale graduation that the lines of sight would cover on the measure stick. The following relationship of sides can now be set down:

$$\frac{BC}{AB} = \frac{C'B'}{AB'}$$

Substituting values as used in above explanation:

$$\frac{BC}{24''\ (\text{or } 2')} = \frac{16'}{66'}$$

$$BC = \frac{2' \times 16'}{66'} = \frac{32'}{66'} = .48' \text{ or } 5.76''$$

A scale unit of 5.76 inches on the stick will cover 16 feet on the tree with the 24 inch reach and 66 foot distance factor. Multiples of this unit can be marked on the stick. Thus when one is 66 feet from a tree with the stick held 24 inches from the eye, and the lower line of sight to the stump height cuts the bottom of the stick, the upper line of sight to the point of height-measurement can be read on the scale in terms of 16 foot units. (As in method 1, a slight error is involved; however, results are within limits of accuracy of this type of measurement).

To suit the convenience of the person using the stick, it can be calibrated for any reach, height unit, and/or distance by substituting these in the formula in place of the values used.

Still another method is often favored in which a pole of known length, say 10 feet, is leaned against the tree and used as an occular yard stick in estimating the number of 10-foot units in the useable part of the tree bole.

III. - ESTIMATING THE BOARD-FOOT CONTENT OF A STANDING TREE.

A. - By Use of a Volume Table.

A volume table (Table 5) is a tabulation of the average volume in trees by D. B. H. and height classes. Thus, all that is needed to determine the volume in any tree of normal form is a measurement of the D. B. H. (outside bark) and a measurement of the useable length of the tree. The methods of obtaining these measurements are explained in the previous section. A tree that is determined to be 14 inches at D. B. H., and to have 1 1/2 - 16 foot units (from 20-27 feet) of useable trunk length, will contain 100 board feet. This is found in Table 5 by reading at the intersection of the 14-inch D. B. H. and the 1-1/2 log

Table 5. - O. B. - Form Class Volume Table
Board Feet International 1/4" Log Rule
O. B. - Form Class 85

DBH	Number of 16.3 foot logs							
	1/2	1	1 1/2	2	2 1/2	3	3 1/2	4
Inches	Gross volume in board feet							
10	21	34	46	57	67	77		
11	26	43	58	71	84	96	107	
12	32	52	70	87	102	117	131	144
13	38	63	85	104	123	140	157	173
14	45	75	100	124	146	167	186	206
15	53	88	118	145	171	195	219	241
16	61	102	137	169	199	226	254	279
17	70	117	157	194	228	261	292	321
18	81	133	180	221	261	297	333	366
19	91	151	203	251	295	337	377	416
20	103	170	229	282	332	379	425	468
21	115	190	256	316	372	425	474	524
22	128	212	285	352	413	472	528	582
23	142	234	316	389	458	524	586	646
24	156	259	348	430	506	577	646	711
25	171	284	383	472	555	634	710	782
26	188	311	419	516	608	695	776	857
27	205	340	457	564	665	759	847	935
28	223	370	497	612	721	824	923	1016
29		401	538	664	782	893	1000	1102
30		434	582	718	845	966	1081	1191
31		468	628	774	912	1042	1167	1285
32		502	676	834	982	1119	1253	1384
33		540	726	895	1052	1202	1346	1483
34		578	778	959	1130	1288	1442	1589
35		618	832	1026	1208	1377	1542	1698
36		659	887	1094	1288	1472	1644	1816
37		703	994	1164	1371	1567	1754	1932
38			1005	1239	1459	1667	1862	2056
39			1067	1315	1549	1770	1982	2183
40			1130	1396	1641	1875	2099	2312

columns. The volume for any normal tree of a size within the D. B. H. and height range of the volume table can be determined in a similar fashion.

Since volume tables are necessarily based on average volumes of a large number of trees, and the height is treated by half-log or 8-foot units, the volume given for any individual tree may be slightly greater or less than the actual volume in the tree, depending on how closely the tree approximates the average of that particular size class. In general, volume tables are most useable for trees with a central bole or stem that (1) tapers gradually to the inside bark diameter that is determined to be the limit of merchantability, and (2) does not have any very large limbs or forks within this useable bole length. Table 5 is based on an 8-inch (inside bark) top diameter. Volume tables are also based on Form Class, which is the relationship of the diameter (inside bark) at the top of the first 16-foot log to the D. B. H. (outside bark). Table 5 is based on a Form Class of 85, which is about right for trees on average sites in Kentucky.

The principal utility of the volume table is that it requires but two measurements (D. B. H. and useable height). When used with large numbers of trees, the individual errors tend to balance out and the end estimate is within the limits of error permissable for this type of work.

Deduction for defect may be handled in the manner described for logs (page 10) and the defect calculated and noted for each tree. An alternate method is to estimate the percentage of the gross scale that may be defective and make deduction on a percentage basis. Either method is at best a guess when dealing with standing timber, and considerable experience is required to become proficient.

Several forms of tally sheets may be used for tallying the number of trees of different sizes and species. A sample sheet that will fulfill most requirements is shown in Fig. 5. Changes can be made in size ranges and species groups to fit conditions at hand. Individual trees are tallied in the appropriate space by making a short line or a dot. If care is taken, a large number of any one-size trees can be tallied in the space provided. Also, if the stand is composed of predominately smaller-tree sizes, the spaces allocated for these sizes can be tailored to fit the need. Additional tally sheets can always be used if more space is required. After the field work has been completed, a count of the lines or dots in each space will indicate the number of trees in each D. B. H. and height-class by species groups. By consulting the volume table, the volume of an average tree for each D. B. H. and height-class can be found. Multiplying each average-volume by the number of trees tallied in its size-class will give the volume in board feet for the individual size classes. Total volume for all the trees tallied is then a simple matter of adding up all of the volumes determined for the various size classes.

B. - By Use of a Log Rule

As noted in an earlier section, a log rule is a tabulation of the estimated volume in logs of various small-end diameters and length classes.

Fig. 5. - Field Tally Sheet

Location ______________________

Owner ______________________

Sheet No. ________

D. B. H.	Pine							Yellow Poplar				
	1/2 Log	1 Log	1 1/2 Log	2 Log	2 1/2 Log	3 Log	1/2 Log	1 Log	1 1/2 Log	2 Log	2 1/2 Log	3 Log
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												

Thus, if the sizes of the logs that could be cut from a standing tree could be determined or estimated, the volume of each log could be found by the log rule and the sum of the volumes of the logs in a tree would represent the board-foot content of the tree. This method requires more work than the "Volume Table Method" and a little more skill; however, it is more accurate in the case of short, thick-boled trees, and for any one individual tree since the actual log sizes that could be cut from the tree are computed exactly as they would be if the tree were felled and bucked into logs. The difficulty lies in estimating the correct small-end diameters and lengths of the logs as they appear in a standing tree. Any standard of comparison, such as a 10-or 12-foot pole with a yardstick fastened across its top and leaned against the tree, is a great help to the beginner.

A form of tally sheet that can be modified to suit local requirements is shown in Fig. 6. In the case of the form shown, spaces have been provided for identifying the individual tree by a number and by species, for noting the diameter and length of as many as four separate logs, and for the tree volume after it has been computed.

IV. - ESTIMATING THE BOARD-FOOT VOLUME IN A TRACT OF TIMBER.

The two previous sections have indicated how tree diameters and heights can be determined, and how these measurements can be used to determine the volume in a tree.

In small tracts of timber up to 10 or 15 acres in extent, it is best to measure diameter and height of every tree that is above minimum size for the inventory or sale. When only large, mature trees are being considered, then only the trees in this category are measured and tallied.

In larger tracts, the same procedure can be followed with considerable expenditure of time and effort; however, it is more practical to limit the work to sample areas in the form of parallel strips or lines of plots running across the area. The strips or lines of plots should be aligned so as to obtain a proportionate coverage of variations in size and density of the timber. When there are ridges and valleys involved, the strips or lines of plots should cross the main ridges and valley at approximately right angles in order that sparser ridge timber is obtained as well as the larger and denser timber on the lower slopes and in the valleys.

One side of the tract can be used as a baseline and the spacing of the strips or lines of plots laid off along it. A staff or pocket compass can be used to maintain strip alignment. A tape or chain should be used to determine distances.

The strips can be of any set width; however, a narrow strip of one-half chain width (33 feet) is easier to stay within, as are small circular plots of 1/5 acre (52 feet radius) or 1/10-acre plots of 37 feet radius. The distance traveled along the strips must be measured so that the area cruised can be determined. Thus, a strip of 1/2 chain (33 feet) width and 20 chains,(1320 feet) in length covers 10 square chains, or 1 acre. Likewise, in lines of 1/5-acre plots spaced at a set distance from center to center, the number of plots taken times 5 gives the acreage of the sample. In order to eliminate personal choice of sample areas, the spacing of the strip or line-of-plots-intervals should be mechanical, and carried out according to a predetermined pattern.

The number of strips or lines of plots to be run should be determined by the percentage of estimate that will satisfy the requirements of accuracy. Usually the smaller the tract, the larger the sample should be. Thus, for tracts of 20 to 100 acres, a 20-percent estimate should give a fair standard of accuracy. If the timber is fairly uniform, a 10-percent estimate may do. On larger tracts, a 10-percent estimate is usually satisfactory, or even a 5-percent may do in some timber. With the percentage of estimate, determined that will be satisfactory, the spacing between strips or lines of plots can be computed. If 1/2-chain-width strips are used, a spacing of 5 chains between strip centers will give an approximate 10-percent cover-

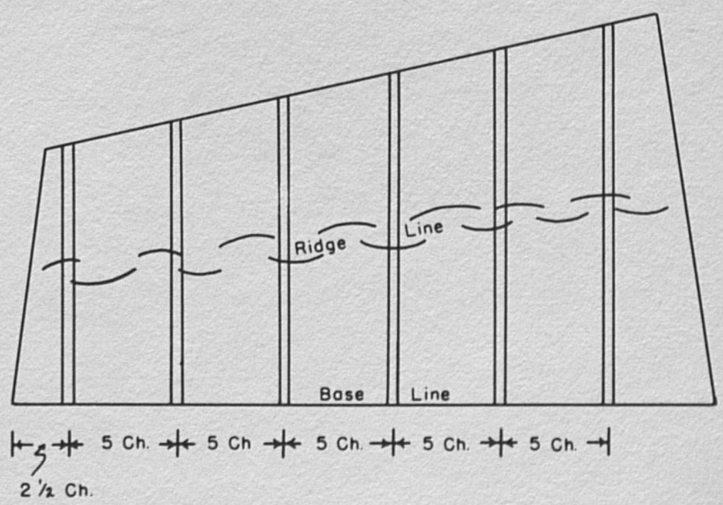


Fig. 7 - Showing use of one side of tract as a Base Line, and parallel strips spaced five chains center to center. Also note that the strips cross the ridge line at approximately right angles.

age of the tract. In the case of 1/5-acre plots, a spacing of plots in the line at 4-chain center distance and 5 chains between lines of plots will also give an approximate 10-percent estimate. Strips or lines of plots should be one half of the strip or line of plots spacing interval inside of the timber edge. Fig. 7 and 8 illustrate most of the details explained is this section.

When using the strip method, it is suggested that one tally sheet be used for each 5 or 10 chains of strip covered. Individual tally sheets may be numbered or otherwise identified by strip number and distance interval such as Strip #1, Distance 0-10 chains. Likewise, separate tally sheets for each circular plot help to keep the records straight and each should be identified as to line and plot number.

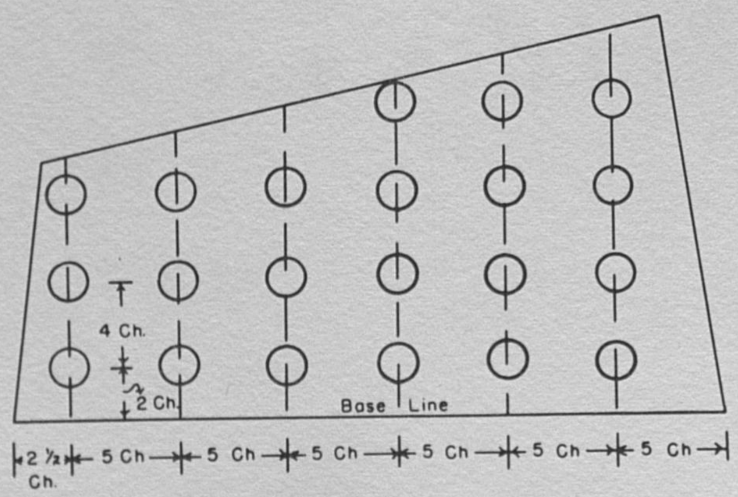


Fig. 8 - Showing parallel lines of plots spaced five chains apart and four chains center to center distance in the lines. (10 percent estimate)

Table 6. - Circumference Specifications for the Various Classes of Creosoted Southern Pine Poles

Length of pole	Distance of ground line from butt [1/]	Pole Class 1	2	3	4	5	6	7	8	9	10
		Minimum top circumference (inches)									
		27	25	23	21	19	17	15	18	15	12
Feet	Feet	Minimum circumference six foot from butt (inches)									
16	3.5					21.5	19.5	18.0	No butt requirement		
18	3.5			26.5	24.5	22.5	21.0	19.0			
20	4.0	31.5	29.5	27.5	25.5	23.5	22.0	20.0			
22	4.0	33.0	31.0	29.0	26.5	24.5	23.0	21.0			
25	5.0	34.5	32.5	30.0	28.0	26.0	24.0	22.0			
30	5.5	37.5	35.0	32.5	30.0	28.0	26.0	24.0			
35	6.0	40.0	37.5	35.0	32.0	30.0	27.5	25.5			
40	6.0	42.0	39.5	37.0	34.0	31.5	29.6	27.0			
45	6.5	44.0	41.5	38.5	36.0	33.0	30.5	28.5			
50	7.0	46.0	43.0	40.0	37.5	34.5	32.0	29.5			
55	7.5	47.5	44.5	41.5	39.0	36.0	33.5				
60	8.0	49.5	46.0	43.0	40.0	37.0	34.5				
65	8.5	51.0	47.5	44.5	41.5	38.5					
70	9.0	52.5	49.0	46.0	42.5	39.5					
75	9.5	54.0	50.5	47.0	44.0						
80	10.0	55.0	51.5	48.5	45.0						
85	10.5	56.5	53.0	49.5							
90	11.0	57.5	54.0	50.5							

1/ For use in applying specifications which require a definition of "ground line."

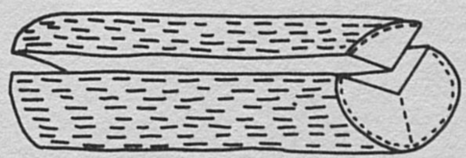
Table 7. - Diameter Specifications for the Various Classes of Creosoted Southern Pine Poles 1/

Length of pole	Pole Class 1	2	3	4	5	6	7	8	9	10
	Minimum top diameter (inches)									
	8.6	8.0	7.3	6.7	6.0	5.4	4.8	5.7	4.8	3.8
Feet	Minimum diameter six feet from butt (inches)									
16					6.8	6.2	5.7	No butt requirement		
18			8.4	7.8	7.2	6.7	6.0			
20	10.0	9.4	8.8	8.1	7.5	7.0	6.4			
22	10.5	9.9	9.2	8.4	7.8	7.3	6.7			
25	11.0	10.3	9.5	8.9	8.3	7.6	7.0			
30	11.9	11.1	10.3	9.5	8.9	8.3	7.6			
35	12.7	11.9	11.1	10.2	9.5	8.8	8.1			
40	13.4	12.6	11.8	10.8	10.0	9.2	8.6			
45	14.0	13.2	12.3	11.5	10.5	9.7	9.1			
50	14.6	13.7	12.7	11.9	11.0	10.2	9.4			
55	15.1	14.2	13.2	12.4	11.5	10.7				
60	15.8	14.6	13.7	12.7	11.8	11.0				
65	16.2	15.1	14.2	13.2	12.3					
70	16.7	15.6	14.6	13.5	12.6					
75	17.2	16.1	15.0	14.0						
80	17.5	16.4	15.4	14.3						
85	18.0	16.9	15.8							
90	18.3	17.2	16.1							

* Diameters to the nearest one-tenth inch obtained by converting circumference specifications, assuming all poles to be round.

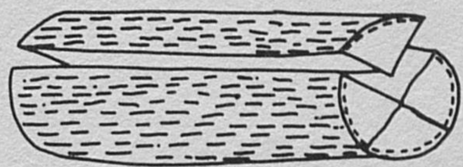
SUGGESTIONS
FOR MAKING STAVE BOLTS

12"-16" diameter:



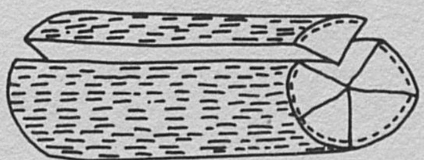
Three regular bolts.

17"-20" diameter:



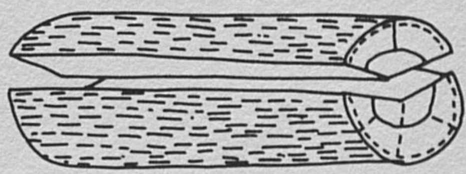
Four regular bolts.

21"-24" diameter:



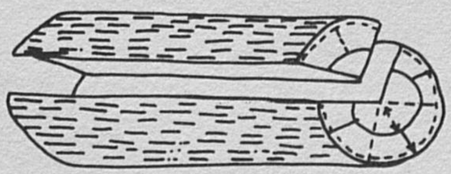
Five regular bolts.

24"-29" diameter:



Six to seven regular bolts and three heart bolts.

30"-36" diameter:



Eight regular bolts and four heart bolts.

All bolts:

Any knot over two inches in diameter should be removed.

When the field work is completed, the volume of the trees on the strips or lines of plots can be computed as given in the section dealing with "Estimating the Board Foot Content in a Standing Tree." The area of the strips or plots can also be determined. The relationship of the measured sample area and its volume to the tract area and tract volume can be expressed by the proportion:

$$\frac{V}{v} = \frac{A}{a} \text{ or } V = \frac{vA}{a}$$

In the above proportion, V equals the volume of timber on the tract; v equals the volume of timber in the sample area; A equals the area of the tract in acres, and a equals the area in acres of the sample area.

V. - EVALUATING TIMBER VOLUME ON A TRACT BY SPECIES GROUPS AND SIZES.

The total volume of timber on a tract is of extreme value for purposes of inventory or sale. An average value per 1,000 board feet can be set and total value thus easily computed. It is better business, however, to be able to compute volume and value by species groups and sizes when such variation in the timber occurs. This can be done easily if species groups are separated in making the tally during the estimating procedure as advocated in Section III. The sample tally sheets proposed in this section are likewise designed to allow such separation. Thus, the estimated value of the species groups, such as White Oak, Red Oak, Beech, and Hickory or Yellow Poplar, and their diameter ranges (for example: 8"-12", 12"-16", 17"-20", etc.) can be determined and computed separately. This is more satisfactory than attempting to set an average for all species and all sizes.

APPENDIX A

SPECIFICATIONS FOR SOUTHERN PINE POLES

(From "American Standard Specifications and Dimensions for Southern Pine Poles." American Standards Association, 05.4-1941.)

These specifications cover southern pine poles which are to be given a preservative treatment. Poles are to be classified in accordance with the table of dimensions.

The length and class of poles wanted and full details of the framing desired shall be stated in the orders.

The details of any marking, including length and class marks, to be placed on the poles shall be in accordance with instructions from the purchaser.

Complete detailed instructions shall be given the supplier in all cases where modifications are to be made in these specifications to meet special requirements.

MATERIAL REQUIREMENTS

SPECIES

All poles shall be cut from live southern pine timber. Longleaf Pine (Pinus palustris), Shortleaf Pine (Pinus schinata), Loblolly Pine (Pinus taeda), Slash Pine (Pinus caribaea), and Pond Pine (Pinus rigida serotina).

PROHIBITED DEFECTS

All poles shall be free from decay, red heart, cracks, plugged holes, and bird holes. Nails, spikes, and other metal shall not be present in the poles unless specifically authorized by the purchaser.

PERMITTED DEFECTS

Blue Sap Stain. Blue sap stain that is not accompanied by softening or other disintegration of the wood (decay) is permitted under these specifications.

Hollow Pith Centers. Hollow pith center in the tops or butts of poles and in knots are permitted.

LIMITED DEFECTS

Checks. The top and side surfaces of poles shall be free from injurious checks.

Shakes. Shakes in the butt surface, extending over not more than one-quarter of the circumference, are permitted, provided they are at least 1 inch distant from the edge of the butt. Shakes extending over more than one-quarter of the circumference are permitted when they are inside of a circle whose center corresponds to the center of the butt surface and whose diameter equals one-half of the average butt diameter.

Shakes in the top surface, whose width does not exceed 1/16th of an inch, are permitted provided they do not extend over more than one-half of the top circumference.

Splits. Splits are prohibited in the top surfaces of poles. Splits in butt surfaces are permitted provided that their height from the butt along the side surfaces does not exceed 2 feet.

Grain. No pole shall have more than one complete twist of grain in any 20 feet of length.

Insect Damage. Insect damage consisting of holes less than 1/16th of an inch in diameter is permitted.

Knots. The diameter of any single knot or knot cavity, or the sum of the diameters of all knots and knot cavities in any one foot section shall not exceed the limits set up in the following table. Knots and knot cavities 1/2 inch or under in diameter shall be ignored in applying the limitations for sum of diameters.

LIMITATIONS OF KNOT SIZE

	Maximum Sizes Permitted, Inches		
	Diameter of any single knot or knot cavity		Sum of Diameters of all knots and knot cavities in any 1 foot section
Length of Pole	Classes 1-3	Classes 4-10	All Classes
45' and under	4 in.	3 in.	8 in.
50' and over	5 in.	5 in.	10 in.

Knots 1 inch or over in diameter, showing discoloration or softness of fiber indicating possible decay, shall be neatly gouged to a depth of not more than one-fifth of the diameter of the pole at the point where the knot is located, to permit determination of the character and extent of decay. The gouging shall be done without unnecessary removal of sound wood, and in such a manner as to insure drainage of water from the hole when the pole is set. Where such gouging does not completely remove the decay (heart rot), the pole shall be rejected.

Knots under 1 inch in diameter need not be gouged unless after trimming the presence of decay is revealed and, upon further examination, the decay is found to extend to a depth of more than 2 inches.

When more than one cavity is present in a pole, the sum of the depths of all cavities in the same 6-inch longitudinal section of the pole shall not exceed one-third of the mean diameter of that section.

Scars. No pole shall have a turpentine face or other scar located within 2 feet of the ground line. "Ground line" points for each length poles are given in Table 1. In other sections of the pole, scars which have been smoothly trimmed so as to remove all bark and all surrounding or overhanging wood that is not completely intergrown with the wood of the body of the pole, are permitted, provided:

(a) That such trimming does not result in abrupt changes in the contour of the pole surface and that the trimmed scar does not have a depth of more than 1 inch, except that where the diameter of the pole at the location of the scar is more than 10 inches, the depth may be one-tenth of the diameter; and

(b) That the circumference of the pole at any point on trimmed surfaces located between the butt and a point 2 feet below the ground line is not less than the circumference of the pole at the ground line.

Shape. Poles shall be free from short crooks (Fig. 1).

A pole may have sweep subject to the following limitations:

(a) Where sweep is in one plane and one direc-rection only, a straight line joining the surface of the pole at the ground line and the edge of the pole at the top shall not be distant from the surface of the pole at any point by an amount greater than 1 inch for each 6 feet of length between these points.

(b) Where sweep is in two planes (double sweep) or in two directions in one plane (reverse sweep) a straight line connecting the mid-point at the ground line with the mid-point at the top shall not at any intermediate point pass through the external surface of the pole.

DIMENSIONS

LENGTH

Poles under 50 feet in length shall not be over 3 inches shorter or 6 inches longer than nominal length. Poles 50 feet or over in length shall not be over 6 inches shorter nor 12 inches longer than nominal length.

Length shall be measured between the extreme ends of the pole.

CIRCUMFERENCE

Poles shall be classified in accordance with the dimensions given in Table 6 p. 43. Minimum allowable circumference at 6 feet from the butt, (except for classes 8, 9, and 10), and at the top, for each length and class of pole listed, are shown in this table. Poles having circumferences which are greater at the same points of measurement than those shown for the length and class desired, shall be acceptable, provided that the 6-foot length from butt circumference is less than the minimum given for the second larger class pole of the same length. The top dimensional requirement shall apply at a point corresponding to the minimum length permitted for the pole.

MANUFACTURING REQUIREMENTS

BARK REMOVAL

Outer bark shall be completely removed from all poles. No patch of inner bark left on the pole surface shall be more than 1/4 inch in width or more than 4 inches long.

SAWING

All poles shall be neatly sawed at the butt along a plane which shall not be out of square with the axis of the pole by more than 2 inches per foot of diameter of the sawed surface. Beveling at the edge of the sawed butt surface not more than one-twelfth of the butt diameter in width, nor an equivalent area unsymmetrically located, is permitted.

TRIMMING

Branch stubs, partially overgrown knots, and completely overgrown knots rising more than 1 inch above the pole surface shall be trimmed close. Completely over-grown knots less than 1 inch high need not be trimmed.

FRAMING

TIMBER DEFECTS

Checks. - Checks are lengthwise separations of the wood in a generally radial direction. Heart checks which extend from the pith-center of the pole toward, but not to, the periphery of the pole.

Cracks. - Cracks are breaks or fractures across the grain of the wood.

Scars. - Scars or cat faces are depressions in the surface of the pole, generally elliptical in shape, resulting from wounds where healing has not re-established the normal cross section of the pole.

Shakes. - Shakes are separations of the wood, generally parallel with the annual rings.

Splits. - Splits are separations between the fibers of the wood extending from surface to surface through the pole.

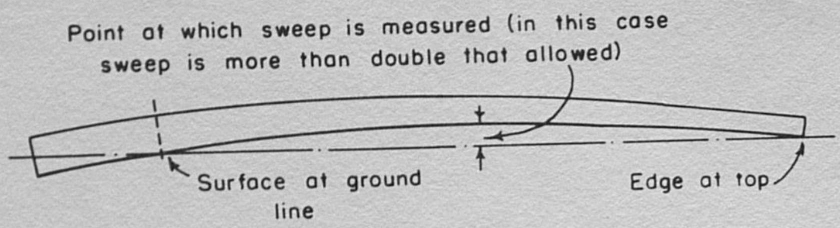
SHAPE

Short Crook. - A short crook is a localized deviation from straightness which, within any section of 5 feet or less in length, is more than one-half the mean diameter of the crooked section. (See Diagram 3 of the subsidiary drawing entitled, "Measurement of Sweep and Short Crook in Poles.")

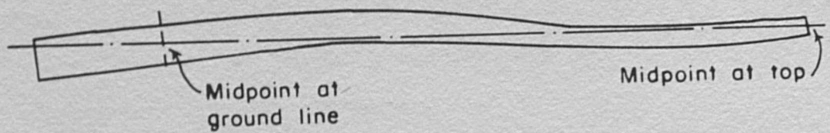
Sweep. - Sweep is the deviation of a pole from straightness. (See Diagram 1 and 2 of the subsidiary drawing entitled, "Measurement of Sweep and Short Crook in Poles.")

MEASUREMENT OF SWEEP AND SHORT CROOK IN POLES

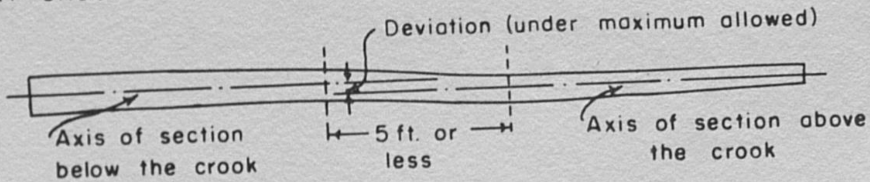
SWEEP IN ONE PLANE AND ONE DIRECTION



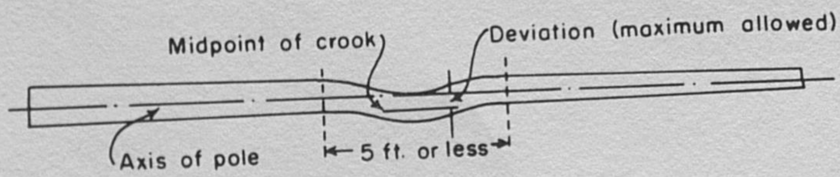
SWEEP IN TWO PLANES (DOUBLE SWEEP) OR IN TWO DIRECTIONS IN ONE PLANE (REVERSE SWEEP)



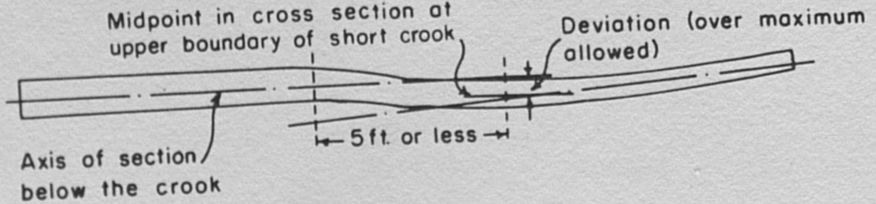
SHORT CROOK WITH REFERENCE AXES APPROXIMATELY PARALLEL



SHORT CROOK WITH REFERENCE AXES COINCIDENT OR PRACTICALLY SO



SHORT CROOK WITH REFERENCE AXES NEITHER COINCIDENT NOR PARALLEL



MISCELLANEOUS

Knot Diameter. - The diameter of a knot is its diameter on the surface of the pole measured in a direction at right angles to the lengthwise axis of the pole.

Live Timber. - Live timber is that cut from a tree which was standing and living at the time of cutting.

APPENDIX B.

GRADING BOURBON STAVE AND HEADING BOLTS

All bolts must be split from live, sound, straight-grained White Oak timber (preferably 16 to 20 inches in diameter) and must be free of all defects, such as knots, heart checks, bird pecks, streaks, shake, cat faces, worm holes, water soak, bows or crooks.

Requirements for stave bolts.

No. 1 stave bolts must square up 5 inches of heartwood and measure 39 inches in length.

No. 2 stave bolts; all bolts not squaring 5 inches of redwood and with a minimum of 5-1/2 inches of redwood from sap to apex.

Requirements for heading bolts.

No. 1 heading bolts must be 15 to 18 inches from corner to corner, and 8 inches deep from heart to sap.

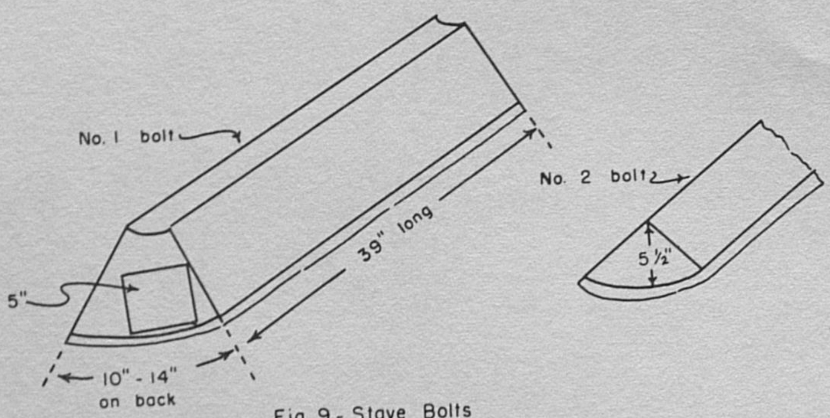


Fig. 9 - Stave Bolts

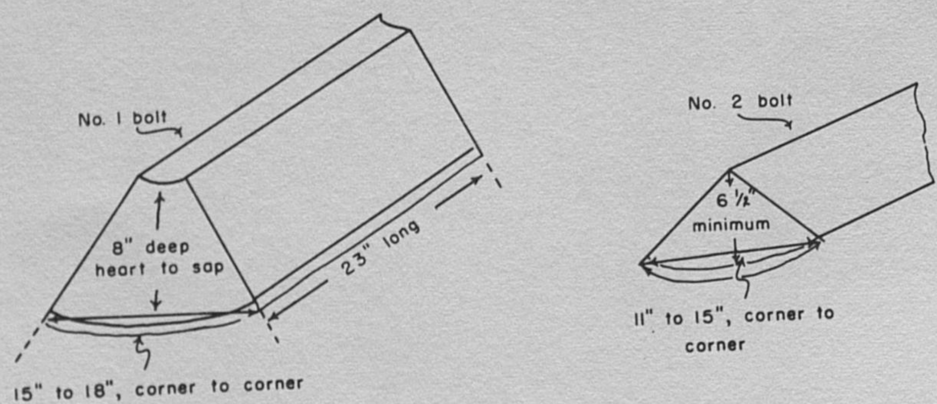


Fig. 10 - Heading Bolts

No. 2 heading bolts must be 11 to 15 inches from corner to corner, and a minimum of 6-1/2 inches from heart to sap.

RULES FOR INSPECTION OF BOURBON STAVE BOLTS

Bolts must be split from sound straight-grained White Oak timber 16 inches to 20 inches, and must be free from all defects, such as knots, heart checks, bird pecks, streaks, shake, cat faces, worm holes, water soak, bows or crooks.

The following dimensions are for green bolts; 39 inches long, 5 inches to 8 inches wide from heart to sap.

Bolts must average 6 inches deep and can be 5 inches to 8 inches deep clear of sap.

Bolts will be measured in ricks 4 feet high and 8 feet long.

RULES FOR INSPECTION OF BOURBON HEADING BOLTS

Bolts must be split from sound, straight-grained White Oak timber 20 inches and up, and must be free from all defects, such as knots, heart checks, bird pecks, streaks, shake, cat faces, worm holes, water soak, bows or crooks.

The following dimensions are for green bolts; 23 inches long, 6 inches and wider from heart to sap.

Bolts must average 8 inches deep, and can be 6 inches and deeper clear of sap.

Bolts will be measured in ricks 4 feet high and 8 feet long.

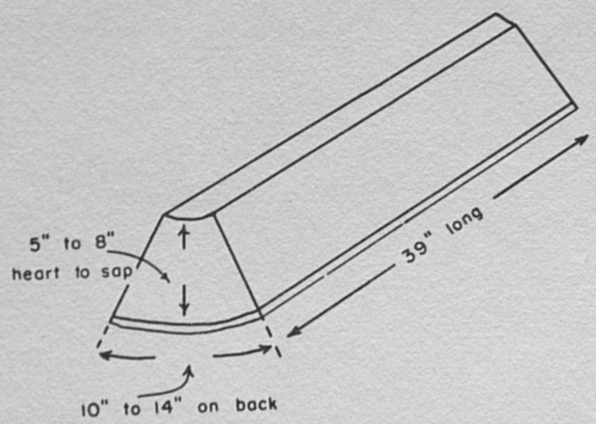


Fig. 11 - Bourbon Stave Bolts

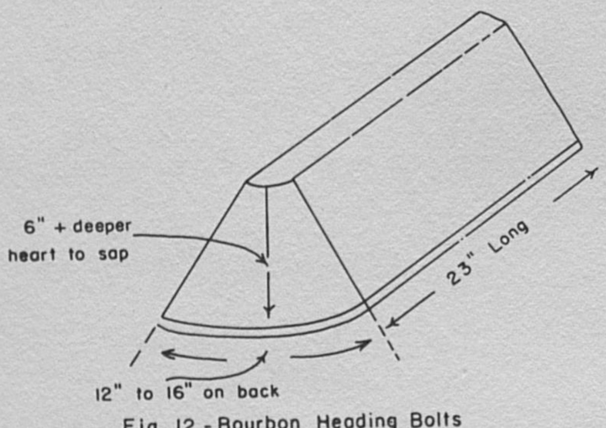


Fig. 12 - Bourbon Heading Bolts