FELLING, SAWING AND SEASONING TIMBER.

By E. E. SCHNEIDER, Wood Expert, Bureau of Forestry.

IN ORDER to avoid or to surmount the difficulties encountered in converting the trunk of a tree into timber that shall be serviceable and of pleasing appearance it is well to understand the causes of the phenomena that take place during the processes of cutting and drying the raw material; and to understand these causes it is necessary to acquaint one's self with the structure and qualities of that very complex substance, wood. Before entering, therefore, into the methods of conversion, the most essential properties of our material will be discussed.

PROPERTIES OF WOOD.

Some mention has been made in a previous article[1] of the most conspicuous elements in the minute structure of wood as seen in the cross section. Little attention will be given to these details in the present discussion, except to mention certain elements whose relative size, abundance, etc., may affect the behavior of wood in seasoning or under the tools used for working it. Rather, it is desired to consider here the occurrence and behavior of these elements in great masses.

Wood is composed primarily of numerous longitudinal fibers which lie, broadly speaking, parallel to the axis of the tree. Beside these, there is a set of radial fibers which lie horizontally, at right angles to the axis. The former constitute the bulk of the wood and their thickness, arrangement, color, etc., determine the appearance of the "grain" of the wood. The latter, which form very thin, flat bundles, the pithrays, are not generally conspicuous in any but a radial, or nearly radial, section, where they form the broad, irregular stripes known as "silver grain" and "flake grain," as for instance in Oak, Catmon, and Agoho. In species where the pithrays are both large and numerous, they may form as much as one-fourth of the total bulk of the wood, but in most species they amount to much less than this. It is unnecessary to discuss here the several different kinds of fibers. It is enough to state that they are hollow and that in living wood they are largely filled with water and in perfectly dry wood contain air in their cavities.

[1] Methods of Identification of Philippine Woods, THE PHILIPPINE CRAFTSMAN, December, 1912.

The varying weights and densities of different woods when dry do not depend on any quality of the wood substance itself, but on the thickness of the walls of the fibers. The substance of the wood weighs about 1.6 times as much as water. Light woods float because of the air contained in the fibers. If soaked until the water enters into the cavities of the cells and drives out all or most of the air, the lightest wood will sink. If the escape of the air and entrance of the water are made easier by breaking the fibers, the wood will sink sooner. Sawdust will sink very soon, because most of the fibers in it are crushed or torn. A very fine shaving taken across the grain with a sharp plane will sink almost as soon as it gets wet, because almost all of the cell cavities in it are cut across.

Trees grow in thickness only by adding successive layers of wood to the outside, just under the bark. The wood of very young trees is generally light colored and soft. In some species the color of the wood changes little or scarcely at all as the tree grows older, as for instance in Lanete. Of such trees we say that they have no distinct sapwood and heartwood. In the great majority of trees, however, there begins at a certain age the formation of heartwood, which is caused by the infiltration of various substances into the cell walls and, in some kinds, also into the pores and cell cavities. This process begins at the center and, once begun, keeps about even pace with the growth of the tree, so that the surrounding layer of sapwood forms a ring of practically the same thickness at all future stages of growth. The heartwood is darker, harder, heavier, and stronger than the sapwood; in trees possessing a peculiar odor, or colored deposits in the pores, or other peculiarities, all such qualities are more pronounced in the heartwood. Also, the heartwood is generally more durable than the sapwood. In trees having no distinction of color between heartwood and sapwood, there is generally very little difference between these in strength and durability; in those where the color of the heartwood merges gradually into that of the sapwood, the difference in quality is not great; while in those where the dark heartwood is sharply distinguished from the light sapwood, the latter is generally much inferior to the former, especially as regards durability.

It must be remembered that all the foregoing statements about heartwood and sapwood are only broad general rules. There is hardly one of them without some exceptions. One notable exception is so common that it should be mentioned. It often occurs that the inner portion of the heartwood of large trees is distinctly lighter and softer than the outer, newer part. This is due to the fact that, when young, many trees grow very rapidly, forming a light, porous wood, and later grow more slowly, when they form denser wood. This is common, for instance, in woods of such widely different characters as Red Lauan and Molave. In such trees, when fungi or insects gain access to the interior through wounds in the bark, rotten knots, fire scars at the base of the tree, etc., they naturally penetrate the soft inner wood more rapidly than the hard shell surrounding it. This is the commonest cause of worm eaten and of "brash," "punky," or "doty" heart.

The successive layers of growth have a considerable influence both on the appearance and behavior of wood. When the fibers in the successive layers are all parallel, the wood is "straight-grained" and is generally easy to split in any direction and easy to plane along any straight section. But often the fibers of the layers, instead of being parallel, twist spirally around the

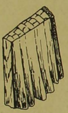

Fig. 1.

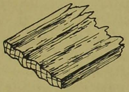

Fig. 2.

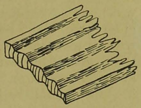

Fig. 3.

trunk in opposite directions. Such wood may split quite easily between the layers, that is tangentially, but radially it will split in the manner shown in figure 1. This fact is of little importance in the sawmill, as lumber is sawn, not split, but two other difficulties are caused by this peculiar structure. Boards sawn radially from very cross-grained woods often warp and shrink in a wavy shape in the manner shown in figure 2,[2] which reduces their effective thickness and causes additional work in finishing. The other difficulty is that such boards are very hard to plane; as the grain runs alternately "up" and "down," planing the wood in either direction leaves a series of alternate rough and smooth stripes. Once well surfaced, however, this feature gives the much admired "ribbon grain."

The growth rings also vary in color, hardness and density. Generally, where any differences exist, the inner part of each ring is softer, lighter colored, and more porous than the outer

[2] It must be understood, of course, that this and fig. 3 are exaggerated both as to the depth and the regularity of the corrugations.

part. The difference in hardness and density will cause a radially sawn board to shrink as shown in figure 3, with the same resulting loss of material and labor as in the previous case. Of course, in boards sawn otherwise than radially, these two peculiarities of structure will cause all sorts of irregular shrinking and warping.

So far, the fact of shrinking has been assumed without considering why it takes place or how it acts on a piece of timber as a whole. Shrinkage of timber is due almost wholly to the evaporation of the water in the wood. Water forms over nine-tenths of the contents of the living cells in the tree; it saturates the walls of the cells, both the living cells in the sapwood and the dead cells in the heartwood; and finally, it partly fills these last. There is more water in the sapwood than in the heartwood. Soft woods contain more water than hard.

Wood begins to lose water as soon as the tree is felled, or killed by girdling. At first, the loss is very rapid, but after a few days or weeks, it goes on very slowly, so that a large log will not become dry inside for years. Thin boards dry much more rapidly than heavy pieces. Ultimately, any piece of timber will reach a state of equilibrium, when it will lose or absorb slight quantities of moisture according to the condition of the atmosphere. Such lumber is called "air dry." If this is heated in a kiln to a little above the boiling point of water, it again loses moisture until, after some days, no further loss of weight is observed. Then it is called "kiln dry." [3] Suppose now that a piece of green wood weighing 200 pounds has lost 100 pounds in drying; then we say that it contained 100 per cent of water, that is, the weight of moisture is expressed as a percentage of the weight of the dry wood. As yet no accurate data are available on the moisture content of Philippine woods. It is probable, however, that there is no very great difference in this respect between the woods of the tropics and of the temperate zone. The following extract [4] shows the extreme variations in different woods and in heartwood and sapwood of the same kind:

Pounds of water lost in drying 100 pounds of green wood in the kiln.

	Sapwood.	Heartwood.
Pines, cedars, etc	45–65	16–25
Poplar, cottonwood, basswood (soft, light woods)	60–65	40–60
Oak, beech, etc. (hard, heavy woods)	40–50	30–40

[3] Most kiln drying is done at temperatures rather lower than the boiling point.

[4] From "Timber" by Filibert Roth, Bull. 10, U. S. Dept. of Agr., Div. of Forestry, 1895.

The very low moisture content of the heartwood of pine is due to its being almost completely filled with resin; except the two pines (Benguet Pine and Tapulao) there are no Philippine woods that can be well compared with the American pines. The woods in the second line may be compared with Calantas, White Lauan, White Nato, etc., and those in the last line with Tindalo, Molave, Acle, and others. The highest figure in the table, 65 lbs., is equivalent to 185.7 per cent of the weight of the resulting kiln-dry wood; the lowest figure (excluding the special case of heartwood of pine) to 42.8 per cent. It is possible that some of the densest Philippine woods, such as Mancono or Camuning, may contain even less than the latter figure, or such as Taluto and Dapdap, more than the former.

Careful tests of thoroughly air-dried timber, both in America and here, show that it contains from 7 to 15 per cent or more of moisture, the average being between 11 and 12 per cent. Kiln-dried timber reabsorbs moisture almost to the same amount.

As wood dries, it shrinks. If it were a homogeneous substance, this would affect only its size and not its form. A pressed brick, made of well-ground and tempered clay, shrinks evenly without any distortion. But wood is far from being homogeneous. So it shrinks unevenly, and to this are due, excepting decay and destruction by insects, all the evils wood is subject to in seasoning. For warping, splitting, twisting, and checking are all results of unequal shrinkage.

It is well known that lengthwise wood shrinks hardly at all. A fact that is not so commonly known is that in a tangential direction it shrinks from two to three times as much as radially. This is due principally to the fact that the pithrays resist being compressed longitudinally and this fact is the cause of most of the splitting and warping both of heavy pieces and thin planks.

The amount of shrinkage varies greatly in different woods. Experiments made in America show that green boards, air dried, will shrink in width about as follows: light, soft pines, about 3 per cent; hard pines and wood of old oaks, 4 per cent; various other woods, some hard and some soft, 5 to 6 per cent; hickory (a very tough and hard wood) and wood of young oaks, up to 10 per cent.[5]

[5] A fresh-sawn Guijo plank donated to the museum of the Philippine Bureau of Forestry in February, 1911, was exactly 48 inches wide; exposed to the air under an open shed, it shrunk to a little over 45 inches by August, 1911; during the extraordinary dry weather of the spring of 1912, it went down to exactly 45 inches, a total shrinkage in width of 6¼ per cent; since then it has reabsorbed some moisture and now (February, 1913) measures 45¼ inches.

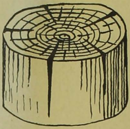

Fig. 4.

It is commonly believed that all soft woods shrink more than do hard ones. This impression is probably due to the fact that they shrink more rapidly, so that the shrinkage is more noticeable, and also to their being often used very green for cheap and temporary work, while the harder woods are generally at least partly seasoned and so do not open up so much after finishing.

Figure 4 shows the effect on a round log of the excess of tangential over radial shrinkage. From the same cause, the boards on either side of the heart of a log tend to warp outward as shown in figure 5. In figure 6 are shown the various ways in which squares cut from different parts of the log will act. (The hollowing of the faces is partly due to another cause, which will be explained further on.) The square (*a*) will check on all faces; (*b*), which has the growth rings and pithrays running diagonally across it, will be distorted into a parallelogram; (*c*), which has them at right angles to its faces, will not be distorted, but will become narrower one way than the other; and (*d*), which is part sapwood and part heartwood, will shrink more in the outer than in the inner half. It is the exception, of course, that any one of these causes acts alone on a given piece; two or more of them acting together may produce all sorts of distortions and checks.

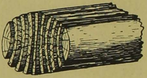

Fig. 5.

When a timber is exposed to the atmosphere or to artificial heat, the water evaporates first from the surface. A thin outer layer may be almost perfectly dry, while the inside is still wet. Let us suppose a heavy timber to be dried approximately as far as the dotted line in figure 7. This outer shell cannot, of course, shrink except within its own thickness, for, to contract as a whole, it would have to compress the whole wet core. But being partly dry, it hardens or "sets" in the form and size determined by its own shrinkage and by the resistance of the core. This is called

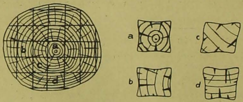

Fig 6

"casehardening." Generally, the shell cracks more or less deeply from the surface inward. Straight-grained woods that split easily check deep and wide in a few places; cross-grained woods become covered with a network of fine "superficial season checks." When the interior of the piece begins to dry, it shrinks in its turn and tries to pull the shell with it. If the wood is one of a loose structure, that does not become very hard and stiff in drying, the shell follows the core and the superficial checks close, sometimes so completely as to show only as fine lines. Since the four corners of the shell are stiffer than the flat sides, they shrink less and the four faces become more or less hollow, as shown in figure 6. If, however, the wood is one that "sets" very hard and stiff, the shell refuses to follow the core, and the latter, trying to shrink and restrained by the stiff shell, has to split internally, as shown in figure 7. This is called "honeycombing." Sometimes all three of these things, more or less deep surface checking, hollowing of the faces, and honeycombing, take place in a single piece of timber. Honeycombing occurs most easily in woods having very broad pithrays, like the oaks, and in large dimension timbers, but one very severe case of it is reported in some 2-inch planks of Calantas at the Philippine School of Arts and Trades.

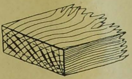

Fig. 7.

The more rapidly timber is dried, the more pronounced is the casehardening. It is worst in steam or fire heated dry-air kilns. In kilns where steam is admitted, the wood hardly casehardens at all. Most woods dried in the open air, but not exposed directly to the sun, will not caseharden enough to do any harm; but if a large timber is dried, even slowly, and then sawn into boards, the outer boards will warp as shown in figure 8, on account of the fresh, soft surface shrinking more than the old, hard one.

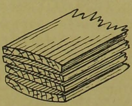

Fig. 8.

A certain but very small amount of casehardening takes place under almost any circumstances. It is probably due to this that even seasoned boards, if replaned, again shrink a little. The hardened outer surface being removed, the fresh surface perhaps loses a very small additional percentage of moisture, and being released from the restraint of a part of the "shell," shrinks a little more.[6]

So far there has been considered in connection with the structural peculiarities of wood only the mechanical effects of moisture, or rather the removal of moisture from the wood. Before discussing the methods of conversion, we should consider another very different, but also most important, effect of moisture on wood. Wood cannot decay except in the presence of moisture—that is, wood does not rot of itself. All forms of decay in wood are caused by bacteria or by fungi. Seasoning wood, provided it is done early and rapidly enough, absolutely prevents decay and even incipient decay is stopped by subsequent drying. Fungi are plants whose soil is vegetable or animal matter, but they cannot grow without oxygen and water, though many of them do not require light. Completely and permanently submerged in water or buried so deep as to prevent the access of air, wood does not rot because the fungi are deprived of oxygen; exposed to the air, but protected from water, it does not rot because the fungi can obtain no moisture.

Different kinds of decay are popularly known as "bluing," "wet rot" and "dry rot." Bluing, which is common in the sapwood of pines, in Cupang and other white woods of the Narra family, in the white woods of the Lanete family, in White Nato, etc., is caused by certain bacteria. These apparently attack only the contents of the cells, but not the cell walls, so bluing affects the appearance of the wood, but has very little, if any, effect on its strength. Wet rot is that which takes place where the presence of moisture is evident to the eye. The fungi that grow in the wood attack and in time completely destroy the cell walls. Dry rot is not essentially different from wet rot; many fungi can live and grow with only the small amount of moisture present in apparently dry wood.

Besides increasing the durability of wood by preventing decay, seasoning also makes many woods much less liable to the attacks of wood-destroying insects.

Rapid seasoning is desirable for woods much subject to bluing, rot, or insect attacks. In all other respects, except as a matter of economy of time, it is undesirable, for the more rapid the drying, the worse are all the mechanical defects caused by shrinkage, casehardening, etc.

---

[6] The fact is well known to woodworkers. A lumberman in Manila reports a case of a wide Molave plank 21 years old which, on being replaned on both sides, shrunk a few millimeters in width.

All the advantages of seasoning wood before using it may now be enumerated:

(1) It prevents decay, if the wood is not subsequently subjected to moisture; and even under the most severe conditions, a well-seasoned piece will decay more slowly than one put into place green.

(2) It lessens liability to insect attacks.

(3) It decreases the weight, which is almost always an advantage, as great weight is desirable in wood only for certain special uses.

(4) It makes wood harder, stronger, and stiffer.

(5) It lessens the liability to shrinking, splitting, checking, and warping.

(6) It increases the capability for receiving and retaining a fine and permanent finish.

FELLING.

Opinions vary widely as to the influence of the time of year on the process of manufacture. Most producers and consumers state that timber seasons better at certain periods of the year than at others, but as some connect this with the rainy or dry seasons, others with the hotter or cooler seasons, and still others favor certain months of the year with no apparent regard to humidity and temperature, it is impossible to draw any conclusions from such conflicting testimony. One of the most experienced lumbermen in Manila states that a Spanish forest officer first called his attention to the fact that the logs felled from November to January sawed and seasoned best and that this was confirmed by experience with logs from Cagayan, Mindoro, southern Tayabas, and Mindoro. This would seem to indicate, as including logs from such widely separated regions, that our trees probably contain the least moisture during the coolest season of the year, irrespective of the rainy season. Nevertheless, it would seem extremely probable that in regions having a long and strongly pronounced dry season, this must have a stronger influence on the moisture content of a tree than would the temperature.

In one case certainly, namely, if logs must remain some time in the forest, it is better to fell them during the dry season, as the rapid drying out of bark and sapwood will make them less liable to decay and insect attacks.

Practically all lumbermen are agreed that there is no advantage in seasoning in the log. The slight amount of drying that takes place in no way compensates for the severe surface checking, splitting at ends, and damage done by insects and fungi. This refers, of course, to logs lying in the forest or piled in the mill yard. With logs rafted to their destination and left in the water until ready to be sawn, the case is different. Logs submerged in water not only suffer no loss from insects, but little or none from rot, while practically all manufacturers are agreed that they saw more easily and that the lumber sawn from them seasons more evenly and, it is said, even more rapidly.

Summing up, then, the following seem to be the best rules for felling:

(1) Trees should be felled either during the coolest or the driest season of the year; in most cases, the latter rather than the former.

(2) Logs should be left in the forest as short a time as possible; if it is necessary to leave them for any length of time, the bark should be peeled off; in case of very valuable individual logs, they should be raised a little off the ground; the ends should be covered with tar, very thick paint, or a paste of carabao dung and stiff clay, to prevent too rapid drying and consequent splitting of the ends. If the logs are to be rafted, they should be taken from the stump to the water as soon as possible and, on arrival at their destination, left in the water until ready to be sawn. To this last procedure, there are two important exceptions: one in the case of timbers known to stain badly in water and the other in the case of teredo-infested waters; in both of which cases, the logs should, of course, remain in the water as short a time as possible.

SAWING.

It is easily seen from figures 5 and 6 that the boards least liable to warp are those sawn radially from the log; also, it is known from mechanical tests that such pieces are generally stronger and stiffer than those sawn tangentially; moreover, they season more rapidly, for water evaporates twice as fast from a radial as from a tangential section; and finally such boards have, in many woods, a more beautiful grain than the others, such as the "silver grain" in Oak and the "ribbon grain" in cross-grained woods. Wood sawn radially is called "rift-sawn" and "quarter-sawn;" that sawn tangentially, "flat," "slash," or "bastard." In America and Europe many methods have been tried to produce the maximum amount of rift lumber from a given log.

Three of these are shown in figure 9; from the first of these, in which the log is first quartered and these quarters sawn up diagonally, came the term "quarter-sawn." All methods of quarter-sawing involve more handling of the timber and also more waste in "edging" the product to uniform widths, but the improvement in stability, strength and appearance pays for this additional expense. In the Philippines, quarter-sawing is at present unknown, and if introduced, it will probably be only for certain woods and for special purposes. In such woods as Narra and Tindalo, which warp very little, it will probably never be used to any great extent. Moreover, the element of the appearance of the much admired "silver grain" does not enter into the question to the same extent here as in America, as the majority of our hard woods have only rather inconspicuous pithrays. In woods of very homogeneous structure there is little difference in appearance between rift and slash sawn boards. Such are:

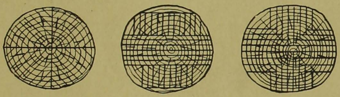

Fig. 9.

Amuguis, Aranga, Bancal, Bansalaguin, Calamansanay, Dungon, Ebony, Lanete, Malacadios, Baticulin, Mangachapuy, Pagatpat, etc. Except Amuguis and Bansalaguin, which are liable to warp rather badly, the above named are all woods that behave pretty well in this respect. Ring-porous woods, and those that have conspicuous regular or irregular rings of color, generally show a more wavy and florid figure when cut tangentially than radially. Such are: Banuyo, Batitinan, Benguet Pine, Calantas, Dao, Narra, Palo Maria, Supa, Teak, Tindalo, and others. Among these, Batitinan, Dao, Palo Maria, Supa, and probably Pine, are liable to warp badly if not very carefully seasoned. It will be seen that here taste sometimes conflicts with practical considerations; many people prefer the florid figure of slash-sawn boards to the straight "ribbon grain" of rift-sawn stuff. There is no doubt, though, that for such purposes as flooring, siding, ceiling, or broad flat surfaces in furniture, the practical side should be considered first and rift-sawn boards selected for these uses.

As there is no selected quarter-sawn stuff on the market in the Philippines, the consumer must do his own selecting. Provided the ends of the boards are neither dirty nor very rough, this is not a difficult matter except in woods of extremely homogeneous structure. All boards that have the rings running approximately square across from face to face are quarter-sawn. In the American lumber trade, specifications for quarter-sawn pine flooring generally admit all pieces in which the rings form any angle from 90 to 45° with the face, those pieces in which the divergence of the rings from the perpendicular is more than 45° being rejected. These conditions are shown in figure 10; (*a*) and (*b*) are rift, (*c*) slash or flat grain.

In ordering lumber from merchants (or, in the case of trade schools, generally from the Bureau of Supply) the purchaser has little or no choice as to the method of sawing. He can only stipulate that the lumber be of certain kinds and sizes and be free from certain defects. In obtaining lumber from local sources

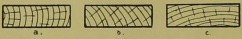

Fig. 10.

of supply, however, as is often done by provincial trade schools, the purchaser can frequently exercise considerable control over the methods of conversion.[7] Large logs can generally be sawn both economically and with an improvement of the product by using some adaptation of the methods shown in figure 9, cutting them first into large cants or flitches[8] to be marked and sawn into boards or small dimension timber. Such pieces, however, should be sawn as soon as possible into approximately the dimensions in which the wood is to be used. Not only will the smaller pieces season more rapidly and thoroughly, but the

[7] In this connection attention should be called to the waste involved in the almost universal practice of squaring logs in the forest. The waste in squaring a cylinder is about four-elevenths of the volume (36.34 per cent). There is afterwards no choice as to the direction in which the log is to be sawn. If, as often happens, one or more heart cracks run diagonally through the log, every board they reach will be split, whereas in the round log the sawing can often be done parallel to the biggest crack. Quarter-sawing is out of the question, as the resulting waste would be two or three times as great as in the original round log.

[8] Terms used in lumbering for large pieces intended for resawing.

danger of casehardening and subsequent warping (as shown in figure 8) is avoided.

SEASONING.

Since the invention and development of kiln-drying, it has sometimes been stated that it is impossible to season wood naturally as well as it can be done in the kiln. Given time enough, as has already been said above, wood will dry out so far that it no longer shrinks or swells except to the very slight extent caused by changes of the atmosphere. Kiln-drying reduces to a very slight extent the capacity of wood for absorbing moisture from the air, that is, a piece of kiln-dried timber will reabsorb less water than it contained when thoroughly air-dried, but the difference is very slight. One of the largest manufacturers of dry-kilns in the United States says in his prospectus that kiln-drying is only a rapid way of doing what nature does better though at the expense of more time. This statement, however, refers only to certain woods that are particularly difficult to season; with all woods that season easily and well, kiln-drying gives results as good, and sometimes better, than air-drying.

To dry sawn timber properly by natural means, two things only are essential: protection against sun and rain, and ventilation. Green lumber exposed to the sun warps, checks, and splits more than it does under cover, and alternate wetting and drying intensify all these defects, besides increasing the danger of decay. Lumber piled in solid piles, or in a closed storage place, dries out slowly or not all and, unless of an extremely durable species, rots before it dries.

The prime requisite then for storing fresh or only partly seasoned timber is a roof; of what kind is of little importance as long as it is large enough and tight enough to keep sun and rain from the lumber pile. Second, the lumber should not lie on the earth, or on the floor of the building. Stone, cement, or wooden cross sills should be provided to hold the pile 6 to 12 inches above the ground. Third (and this is by no means the least important item), no two pieces should be piled on top of each other; thin cross sticks (one-half to 1 inch) must be put between every two layers and, if the timber consists of dimension pieces more than two inches in thickness, narrow spaces should be left between the sides, so that the air can circulate about all four faces of every piece. The cross sills for boards one inch or less in thickness should not be less than one meter apart. If the tops of the cross sills are broad, a stick should be laid on each one under the bottom board of the pile.

Heavier timber, such as 2-inch or 3-inch plank and large squares, may be laid on fewer cross sills, but no ordinary dimension timbers should have less than three points of support, except perhaps very short heavy pieces, such as, for example, a 10 by 10-inch by 8-foot piece.

The sticks should be of uniform thickness and no wider than necessary. They must be carefully laid in vertical rows above the cross sills, and the two end rows should be as close as possible to the ends of the lumber in the pile. If the pile is broad, so that a number of boards lie side by side, it is well to provide sticks long enough to reach clear across the pile, as in this way they help to keep the whole pile straight and level. To prevent the uppermost boards in a pile from warping, cross sticks should be put on them and weighted down with other lumber.

Too much care cannot be taken in the first piling of green lumber, especially anything thinner than 2-inch planks. Green boards lose the greater part of their moisture in the first few weeks and careless piling may cause them to take twists that no subsequent and more careful piling will ever remove.

If no roof, permanent or temporary, be available for storing lumber, a sloping cover of any material available should be put on the pile; a few sticks of wood or bamboo with some nipa shingles, a half dozen sheets of roofing iron, some slabs or old lumber will do better than nothing.

When it is necessary to enclose a shed to prevent loss of lumber by theft, a siding of strong bamboo slats or of narrow strips of wood is better than a solid wall. If a solid wall is put on, as of galvanized iron, for instance, ventilating openings should be provided at top and bottom.

Machine sawn lumber is often covered with a thick layer of the paste formed by the sawdust with the water used on the saw. If a supply of water is convenient to the yard or shed, it is advisable to wash this off. The wood will dry more rapidly for having the pores freed of the paste that chokes them; it will be much easier to select the pieces afterwards for special uses; and it is hardly necessary to tell any woodworker that planing a clean board does not require as much whetting of the plane bit as does planing a dirty one. There need be no fear of retarding the seasoning or encouraging decay (except in very perishable wood) by wetting it; the little water that soaks into the surface of the boards will, in ordinary weather, evaporate in a day and, as to decay, there is much more likely to be a million fungus spores on the wood than a thousand in the water used for washing it.

Whether in the open or in a shed with an earthen or other floor, the ground around and under the piles should be kept clear of litter, such as sawdust, bark and chips, nor should weeds be allowed to grow up around the piles, as all of these furnish food and breeding places for insects and fungi. In any permanent yard, it is a good plan to cover the ground with sand, gravel, or cinders. It is perhaps unnecessary to say that if the yard is in a damp place, or one subject to flooding from heavy rains, the whole ground, or at least the cross sills, must be raised well above the danger line. If a shed is to be built purposely for storing in any but the very driest situation, it is best to raise it some feet above the ground on posts. In such a shed the most thorough ventilation can be secured by constructing the floor of narrow boards with half-inch spaces between them and providing windows, louvres, or a clear story immediately under or in the roof.

CARE OF SPECIAL PIECES.

In all the above directions, it has been assumed that a number of pieces of lumber of ordinary dimensions were to be treated; it often happens that trade school or other "crafts" shops have to take care of special pieces which have to be kept for some time before they are fit for working up. In such cases a little precaution and a small expenditure of labor will often prevent serious deterioration of a piece or a considerable amount of work in surfacing it.

It is a common practice to nail strips across the ends of planks to prevent them from splitting in transportation or while seasoning. While this is no doubt an excellent precaution for the first reason, there can be no greater mistake than to leave such a strip in position on a green board for any length of time. It should be remembered that green boards shrink from 3 to 10 per cent in width in drying, that is, a board three feet wide will shrink at least one inch and perhaps three and a half. Even a board of a wood not naturally disposed to split simply has to split when it shrinks if it has a stick nailed across the ends. The proper thing to do with such a piece is to put on

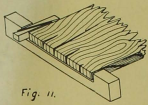
Fig. 11.

each end a clamp, as shown in figure 11, with a wedge or pair of wedges at the edge of the board. While the board is still very green, that is, for the first few weeks, the wedges should be inspected every day or two. Later, a tap of the hammer once a week or so will keep them tight. It is, of course, impossible absolutely to prevent a board from splitting at the ends, but to a very large extent the split ends can be prevented from spreading and the split from becoming longer. If the wood is one in which warping as well as splitting is to be feared, the clamps should be made double, with cleats nailed across them as shown in figure 12. With such clamps wedges can also be used, if needed, though they are not shown in the sketch.

Round table tops often warp badly after they are "roughed out" from the buttress roots of which they are generally made. By putting on them two or three clamps of the second kind not only can the piece be prevented from warping, but a warped piece can even be partially straightened if it is not already too dry. For this purpose the clamps must be pretty heavy, say, 2 by 4 inches at least for a 5-foot table, and of stiff wood, such as Guijo, Apitong, Yacal, or Ipil. The 10-foot Dao table in the Forestry Museum was badly warped when it was received. By putting on three clamps of 6 by 8 inch timber, wetting the table thoroughly morning and evening and driving hard wedges under the clamps, in the course of a few weeks about 3 inches of warp were taken out of it.

Single-piece table tops and similar large pieces are generally more or less casehardened when received at the shop. To make them season at once more rapidly and more evenly, it is advisable to surface them roughly with the adze or even the jack-plane before putting on the clamps. If a piece is much thicker than necessary, it is well to do the dressing down in several stages at considerable intervals of time. In this way the case-hardening becomes less severe after each successive surfacing and the danger of checking deeply is correspondingly lessened.

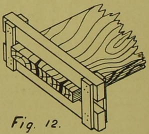
Fig. 12.

TIME REQUIRED FOR SEASONING.

The time necessary for thoroughly air-drying woods varies very considerably in different species. As a general rule, soft, light, porous woods season very much more rapidly than hard, heavy, and dense ones. Rift-sawn boards season more rapidly than slash-sawn. Thin pieces season more rapidly than thicker ones; a 1-inch board dries out more than four times as fast as a 4-inch plank and more than twenty times as fast as a 10-inch timber.

A very large part of the moisture in wood evaporates during the first few weeks. Figures and diagrams of tests made by the United States Bureau of Forestry in 1902 show that green pine railroad ties piled in open piles out of doors lost moisture with great rapidity the first three to six weeks, then came a period of a few weeks when the rate of drying diminished rapidly, after which it became again steady but extremely slow. A typical case is the following: First three weeks, loss of weight of green wood over 30 per cent; end of next two weeks about 36 per cent; end of following six weeks, nearly 40 per cent. These tests were made during the hottest and driest months, June to September. Now the significant fact here is not the rapidity of evaporation in the beginning, but its extreme slowness during the last six weeks. During the following weeks and months it would certainly become still slower. Probably from one-half to two-thirds of the original weight of these ties (see table on p. 674) was water, so that, having lost two-fifths only (40 per cent) of their weight in eleven weeks and the rate of loss being now less than 4 per cent in six weeks, it is easy to see that it would take many months to reduce them even to an approximately dry condition.[9] Although there are no exact data on the seasoning of Philippine woods, it is reasonable to believe that it will take place very much in the same way, and this is confirmed by the experience of woodworkers. For ordinary work, where only a fair degree of freedom from shrinking and warping is required, 1-inch boards of such woods as soft Narra, Calantas, Tanguile, and the Lauans can be used when a few months old, but for good flooring and inside finish and for fine furniture and cabinet work, they should be air-dried for not less than a year. Harder and denser woods such as Molave, Tindalo, Acle, Palo Maria, and, above all, Ebony and Camagon, require a still longer period. One-piece table tops, which are generally upward of 1½ inches thick, should never be made up unless known to be at

[9] The shrinkage of the Guijo plank mentioned above was over one inch during the first month or so; after that it shrunk so slowly that sometimes scarcely any difference was noticeable from one week to another; but it continued shrinking for considerably over a year until the total shrinkage amounted to 3 inches.

least a year old, and then only after repeatedly dressing down as described above. And after all this, it is still advisable to make the screw holes in the battens a little bigger than the screws that are to go into them, so that the screws can give a little in case the top still persists in shrinking an eighth of an inch after the table is finished.

To those who may think these precautions excessive it should be remarked that, unless it is just out of the dry-kiln, one can never be absolutely sure that a piece of wood is even "air-dry", that one of the greatest virtues of fine wood-work is its permanence and that the appreciation of good quality outlasts the memory of the cost.

The *Journal of Education* for August 22 has an article by William H. Adams on "The Failure of Fundamental Education in Industrial Communities," in which the author points out the fact that too many of the lower schools are organized and conducted on the presumption that all pupils will continue on through the high school and perhaps some higher institution, whereas the training should have been suited to the hard facts and limiting conditions governing their pupils' lives. "It is true," says the author, "that we put our theories into cold storage and begin an overhauling of our schools in line with facts as they exist."

The same publication in its number for August 29 has an article on "Vocational Education," written by Dr. Frank W. Gunsaulus in his customary solid and elegant style. He cites the wonderful success of the continuation schools of Europe and says that "the industries and crafts of any district in our American land cannot be more healthfully related to public authority, than by the knowledge upon the part of workingmen and their children that society believes there is a special place for every one in the life and progress of the race and that every school, from the great central institution down to the remotest night school, proposes to make of each of its citizens something valuable and unique in the social organism."