CHARACTERISTICS AND PROPERTIES OF WOOD.

ALTHOUGH wood has been universally in use for a great number of years, there is still said to exist a lack of knowledge by architects, lumbermen and woodworkers regarding its characteristics and properties. We print herewith some abstracts from Bulletin No. 10 of the Department of Agriculture of the United States, which contains some useful and valuable information regarding the nature of the various woods. The work is compiled by Mr. Filbert Roth, Special Agent in Timber Physics, under the direction of Mr. B. E. Fernow, Chief of the Division of Forestry.

METHOD OF SAWING TIMBER.

The manner in which the stick is sawed from the tree has a remarkable influence upon its qualities and behavior, and it should, therefore, either be specially sawed or selected with a view to its character and to the purpose for which it is used. This is a matter fully appreciated among only a few wood users, like the wheelwrights, piano makers, etc., but it needs to be observed much more than it is, even in building. Quarter or rift sawing, i. e., cutting sticks or boards out of the log in such a manner that the annual rings are cut through as nearly as possible radially, has lately been practised largely for the sake of the beauty of the even grain thus obtained, and also for flooring on account of the better wear which the even exposure of the grain (hard bands of summer wood on edge) secures; but it should be much more widely applied to secure greater strength and more uniform seasoning and thus to reduce to some extent the one drawback to wood as a material of construction, that is, its liability to "working" (shrinking and swelling). The reason for the superiority of quarter sawed pieces, as well as the general fact that the manner of sawing out a stick affects the general character and behavior of the same, will appear from the following considerations:

A square column or beam cut so as to contain the heart or pith of the tree in its centre—which, by the way, is the weakest part on account of

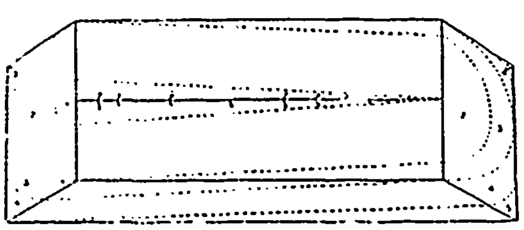

FIG. 1.—A piece of sawn timber cut through along the pith, illustrating its structural aggregates

the many knots which it invariably and necessarily contains—consists in the main of five structural aggregates (see fig. 1), namely: (1) In the centre a cone of wood fibers with the base in the butt end and the apex in the top end, the base representing the rings of as many years as it took the tree to attain the height of the column; none of the fibers belonging to these rings appear in the top section excepting those of the last ring which forms the apex of the cone; (2) a hollow cylinder of material surrounding the cone, all fibers of which are found in both sections and continuously through the whole length of the column; all the entire rings at the bottom belong in this cylinder, and undoubtedly form the strongest part of the column, (3) surrounding this cylinder a partial cylindrical envelope of wood fibers, all of which are represented in the top section, but only a part appear at the corners of the bottom; most of them, therefore, do not run through the whole length, but are cut through at varying lengths, thereby presenting the "bastard faces" on the sides of the column; (4) a partial envelope whose radial extent is limited by the corners of the basal section, imperfect at both ends; (5) the corners at the top, three-sided pyramids with the base in the top section, the fibers running out at varying lengths.

Now, it will be readily admitted that each of these "structural aggregates" has a different value in the combined strength of the whole. If the stick be cut with the center or pith in one side (see fig. 2) all these aggregates will be halved; if the stick be cut out differently, for instance, with the heart entirely out, or if it be made longer or shorter, or rectangular instead of

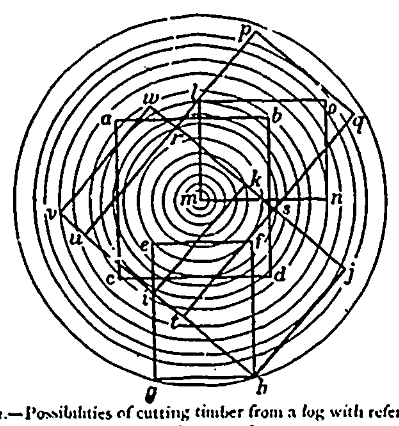

FIG. 2.—Possibilities of cutting timber from a log with reference to position of grain.

square, in each case the proportion of each of the aggregates changes, and hence it stands to reason that the strength of the column, or beam, or stick, changes according to the manner in which it is cut from the tree. This most evident and important fact has, it seems, escaped our best engineers and experimenters, who have tested beams without taking account of this disturbing element, and it is certainly overlooked most generally by builders and carpenters in their selection of material.

While it may perhaps not be expected that the sawing at the mill will be done with more care so as to secure the best results in application, or that the special advantage of quarter sawing will soon be sufficiently appreciated so as to extend its use in such a manner that the greater efficiency of the quarter-sawed material will compensate for the greater expense of the operation, wood users may at least be expected to make their selections from the sawed material in the yard, and shape it for their particular use with greater care.

WEIGHT OF WOOD.

A small cross section of wood, as in fig. 3, dropped into water, sinks, showing that the substance of which wood fiber or wood is built up is heavier than water. By immersing the wood successively in heavier liquids, until we find a liquid in which it does not sink, and comparing the weight of the same with water, we find that wood substance is about 1.6 times as heavy as water, and that this is as true of poplar as of oak or pine.

Separating a single cell, as shown in fig. 4, a, drying and then dropping it into the water, it floats. The air-filled cell cavity or interior reduces its weight, and, like a corked empty bottle, it weighs less than the water. Soon, however, water soaks into the cell, when it fills up and sinks.

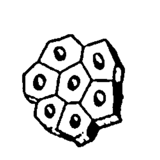

FIG. 3.—Cross section of a group of wood fibers.

Many such cells grown together, as in a block of wood, sink when all or most of them are filled with water, but will float as long as the majority are empty or only partly filled. This is why a green, sappy pine pole soon sinks in "driving" (floating). Its cells are largely filled before it is thrown in, and but little additional water suffices to make its weight greater than that of the water.

In a good-sized white pine log, composed chiefly of empty cells (heartwood), the water requires a very long time to fill up the cells (five years would not suffice to fill them all), and therefore the log may float for many months. When the wall of the wood fiber is very thick (five-eighths or more of the volume), as in fig. 4, b, the fiber sinks whether empty or filled. This applies to most of the fibers of the dark summerwood bands in pines, and to the compact fibers of oak or hickory, and many, especially tropical woods, have such thick-walled cells and so little empty or air space that they never float.

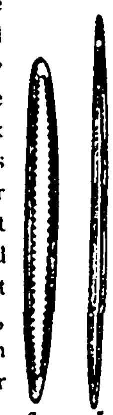

FIG. 4.—Isolated fibers

Here, then, are the two main factors of weight in wood: The amount of cell wall, or wood substance, constant for any given piece, and the amount of water contained in the wood, variable even in the standing tree, and only in part eliminated in drying.

In general, it may be said that none of the native woods in common use in this country are, when dry, as heavy as water, i. e., 62 pounds to the cubic foot. Few exceed 50 pounds, while most of them fall below 40 pounds, and much of the pine and other coniferous wood weighs less than 30 pounds per cubic foot.

WEIGHT OF KILN-DRIED WOOD OF DIFFERENT SPECIES.

	Approximate.		
	Specific weight.	Weight of 1 cubic foot.	Weight of 1,000 feet of lumber.
(a) Very heavy woods: Hickory, oak, persimmon, osage orange, black locust, hackberry, blue beech best of elm, and ash	0.70-0.80	Pounds. 42-48	Pounds. 3,700
(b) Heavy woods: Ash, elm, cherry, birch, maple, beech, walnut, sour gum, coffee tree, honey locust, best of Southern pine, and tamarack	.60-.70	36-42	3,200
(c) Woods of medium weight: Southern pine, pitch pine, tamarack, Douglas spruce, western hemlock, sweet gum, soft maple, sycamore, sassafras, mulberry, light grades of birch and cherry	.50-.60	30-36	2,700
(d) Light woods: Norway and bull pine, red cedar, cypress, hemlock, the heavier spruce and fir, redwood, basswood, chestnut, butternut, tulip, catalpa, buckeye, heavier grades of poplar	.40-.50	24-30	2,200
(e) Very light woods: White pine, spruce, fir, white cedar, poplar	.30-.40	18-24	1,800

The weight of the wood is, in itself, an important quality. Weight assists in distinguishing maple from poplar. Lightness, coupled with great strength and stiffness, recommends wood for a thousand different uses. To a large extent weight predicates the strength of the wood, at