HOW LUMBER SHRINKS.

A STORY is told by the "Arkansaw Traveller," about the manner in which lumber was "hauled" across the mountains down in his country. "Why?" said he, "they saw it green, leave it in the sun, and off it starts. I have seen a board turn three summersaults in less than a minute, and get to the other side of the mountain before sunset." "What," asked a by-stander, would be the result if it was attacked in its wild career by a shower of rain, would it come back?" Here was a poser, but the traveller was equal to the occasion and replied: "No, it would turn on the other side and continue its course."

The subject of the contraction of lumber is an interesting one to wood-workers, and the doors and shutters in many of our mushroom cities are said to come off the hinges in retaliation of the persistent disobedience of the natural law of shrinkage. An examination of the end of an oak or beech tree will show the arrangement of its structure. It consists of a mass of longitudinal fibrous tubes, arranged in irregular circles that are bound together by means of radial strings or shoots, which have been variously named: they are the "silver grains" of the carpenter, or the "medullary rays" of the botanist, and are in reality, the same as end wood, and have to be considered as such, just as much as the longitudinal woody fibre, in order to understand its action. From this it will be seen that the lateral contraction or collapsing of the longitudinal, porous, or tubular part of the structure, cannot take place without first crushing the medullary rays, hence the effect of the shrinking finds relief by splitting in another direction, namely in radial lines from the centre, parallel with the medullary rays, thereby enabling the tree to maintain its full diameter, as shown in Fig. 1.

Fig. 1

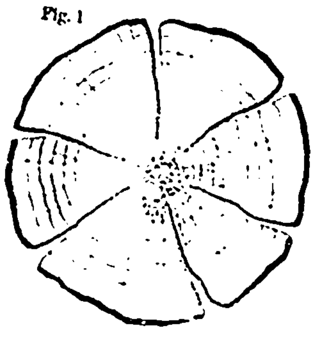
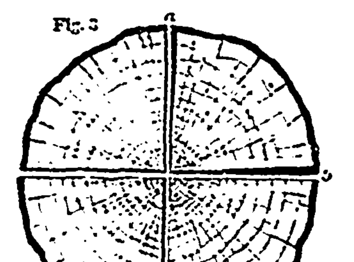


Fig. 2

If the entire tubular fibre composing the tree were to contract bodily, then the medullary rays would of necessity have to be crushed in the radial direction to enable it to take place, and the timber would thus be as much injured in proportion as would be the case in crushing the wood in the longitudinal direction. If such an oak or beech tree is cut into four quarters, by passing the saw twice through the centre at right angles, before the contracting and splitting have commenced, the lines *a c*, and *c b*, in Fig. 2 would be of the same length, and at right angles to each other, or, in the technical language of the workshop, they would be square, but, after being stored in a dry place, say for a year, it would then be seen that a great change had taken place both in the form and in some of the dimensions, the lines *c a*, *c b*, would be the same length as before but it would have contracted from *a* to *b* very considerably, and the two *c a*, and *c b*, would not be at right angles to each other by the portion here shown in black in Fig. 3. The medullary rays are thus brought closer by the collapsing of the vertical fibre.

Fig. 3



But supposing that six parallel saw cuts are passed through the tree so as to form it into seven planks, as shown in Fig. 4, let us see what would be the behaviour of the several planks. Take the centre plank first. After due seasoning and contracting, it would then be found that the middle of the board would still retain the original thickness, from the resistance of the medullary rays, while it would be gradually reduced in thickness toward the edges for want of support, and the entire breadth of the plank would be the same as it was at first, for the foregoing reasons, and as shown in Fig. 5. Then, taking the planks at each side of the center, by the same law their change and behaviour would be quite different; they would still retain their original thickness at the centre, but would be a little reduced on each edge throughout, but the side next to the heart of the tree would be the reverse, or hollow, and the plank would be considerably narrower throughout its entire length, more especially on the face of the hollow side, all due to the want of support. Selecting the next two planks, they would be found to have lost none of their thickness at the centre, and very little of their thickness at the edges, but very much of their breadth as planks, and would be curved round on the heart side, and made hollow on the outside.

Fig. 4

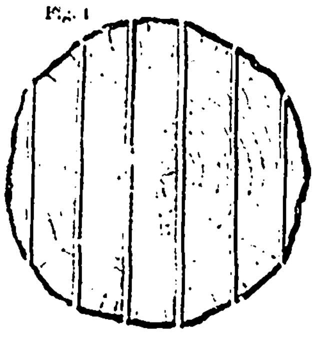
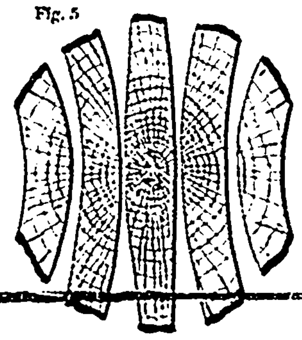


Fig. 5



Supposing some of these planks to be cut up into squares when in the green state, the shape that these squares would assume, after a period of seasoning, would entirely depend on the part of the tree to which they belonged; the greatest alteration would be parallel with the medullary rays. Thus if the square was near the outside the effect would be as shown in Fig. 6, namely, to contract in the direction from *a* to *b*, and after a year or two it would be thus, as seen in Fig. 7, the distance between *c* and *a* being nearly the same as they were before, but the other two are brought by the amount of their contraction closer together. By understanding this natural law, it is comparatively easy to know the future behaviour of a board or plank by carefully examining the end of the wood, in order to ascertain the part of the log from which it has been cut, as the angle of the ring grows and the medullary rays will show as in Fig. 8.

Fig. 6

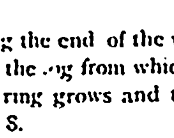
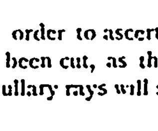


Fig. 7

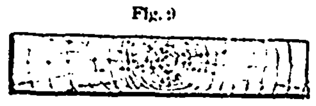


A plank that has it will evidently show to have been cut from the outside, and for many years it will gradually shrink all to the breadth. While the next plank shown in Fig. 9, clearly points to the centre or heart of the tree, where it will not shrink to the breadth, but to the varying thickness with the full dimensions in the middle, but tapering to the edges, and the planks on the right and left will give a mean, but with the centre sides curved round, and the outside still more hollow. These remarks apply more especially to the stronger exogenous woods, such as beech, oak, and the stronger firs. The softer woods, such as yellow pine, are governed by the same law, but in virtue of their softness another law comes into force, which to some degree affects their behaviour, as the contracting power of the tubular wood has sufficient strength to crush the softer medullary rays to some extent, and hence the primary law is so far modified. But even with the softer woods, such as are commonly used in the construction of houses, if the law is carefully obeyed, the greater part of the shrinking, which we are all too familiar with, would be obviated, as the following anecdote will serve to show: It was resolved to build four houses, all of the best class, but one of the four to be pre-eminently good, as the future residence of the proprietor. The timber was purchased for the entire lot, and the best portions were selected for house No. 1, but by one who did not know the law, and to make certain of success this portion of the wood had an extra twelve months' seasoning after it was cut up. The remainder of the wood was then handed over to a contractor for the other three houses, who had an intelligent young foreman, who knew the structure of wood as well as how to obey the law, and who, therefore, had the wood for the three houses cut up in accordance therewith. The fourth house was built the following year by another man; but long before ten years had passed to the great surprise and annoyance of the proprietor it was found that his extra good house had gone in the usual manner, while the other three houses were without a shrinkage from top to bottom.

Fig. 8

A similar want of correct knowledge of the natural figure and properties of the structure of wood, such as the oak, is constantly shown by the imperfect painting to resemble that wood, as exhibited on doors and shutters of many houses. If we can afford to have genuine wainscot doors, as in France and other countries, but yet desire to have an imitation, it would surely be worth the trouble to have a block cut from the quarter of an oak tree, and to have each of its six sides planed and polished, in order to make plain their several features. The house painter would then see who nature really is, and thus save us from the ridicule of other nations, when we mix up "silver grains" and all the other natural features upon one side of a board or panel. This is a subject that should interest all wood-workers and builders and a great deal of attention should be given to the structure of the various woods. It is almost as necessary for a wood-worker to understand the anatomy of his tree, so to speak, as a surgeon to understand the anatomy before he commences to operate. The importance of the subject is therefore obvious.

Fig. 9



A SCALE OF HARDNESS FOR METALS.

The author describes a scale of hardness in use in the laboratory of the Technical High School at Prague, composed of the following eighteen metallic substances, arranged in ascending order, from the softest to the hardest:

1. Pure soft lead.
2. Pure tin.
3. Pure hard lead.
4. Pure annealed copper.
5. Cast fine copper.
6. Soft bearing copper (copper. 85; tin, 10; zinc, 5).
7. Cast iron annealed.
8. Fibrous wrought iron.
9. Fine-grained light-grey cast iron.
10. Strengthened cast iron (melted with 10 per cent. of wrought turnings).
11. Soft ingot iron, with 15.00 per cent. carbon (will not harden).
12. Steel, with 0.56 per cent. carbon (not hardened).
13. Steel, with 0.96 per cent. carbon (not hardened).
14. Crucible cast-steel, hardened and tempered blue.
15. Crucible steel, hardened and tempered, violet to orange yellow.
16. Crucible steel, hardened and tempered straw yellow.
17. Hard-bearing metal, copper, 83; zinc, 17.
18. Crucible steel, glass hard.

The test is made by drawing a cylindrical piece with a conical point along a polished surface of the metal to be tested. In the case described, that of a bronze used for the crosshead guide of a locomotive, the point, when with 5 kilograms, was drawn six times through a distance of 3 centimetres. Under these conditions the points of the number below 5 in the scale were blunted without marking the surface; with Nos. 5 and 6 neither point nor surface was abraded; but with No. 7, while being slightly worn on the point, began to scratch the surface. The hardness was, therefore, that of pure copper or soft bronze. The absolute tensils resistance was found to be 2,051.7 kilograms per square centimetre, while that of copper is 1,920 kilograms per square centimetre, and that of the bronze, No. 7, is 2,300 per square centimetre, thus showing an intimate relation between the strength and hardness of similar metallic compounds,