STRAIGHTENING SAWS.

(See page 173.)

In the manufacture of saws, the straightening forms a large proportion of the manipulative processes. The cutting of the teeth, the grinding, the polishing, the tempering, and the finishing: each of these processes is accompanied by a straightening operation; for in insuring an equal amount of tension at all parts of the blades lies one of the principal elements necessary to the production of a good saw, and a blade can hardly have any mechanical operation performed upon it without affecting its tension and straightness. In the use of saws, it is found that band and frame saws are, under ordinary conditions, comparatively easily kept true and straight; whereas hand and circular saws are readily affected by several causes, among which the most prominent is the setting of the teeth. The blades of circular saws, moreover, frequently become hot, and the heating of a blade is almost certain to impair its straightness, and hence the equilibrium of its tension.

The set of a saw tooth should all be given to the tooth itself, and in no case should it extend below the bottom of the tooth into the solid blade; because in that case it affects the straightness of the same and renders it liable to break. The harder any cutting tool is, the more cutting duty it will perform without becoming dull. On the other hand, the strength depends upon the degree of hardness or temper. In a saw, the temper is made to conform to the requirements of strength and elasticity, the latter element including its resistance to becoming bent or taking a permanent set, if bent much out of the straight line; and this degree of temper (which is shown by a blue color) is found to be the highest which it is practicable to give to the saw teeth: which, being formed out of the plate itself, are necessarily of the same temper as the plate. Furthermoie, the blue shows the highest temper which it is practicable to give to the teeth, and still allow them the capability of being bent to obtain the set. Indeed, it is only from the fact of their being weakened by the spaces between them that they will permit of being set without becoming broken; for were we to attempt to set the solid edge of a plate or blade, it would break, if properly tempered. If then, in setting saw teeth, we allow the setting to extend below the tooth, the strength of the latter is destroyed, and the straightness of the plate or blade is impaired.

What is commonly called a buckle or a bend in a saw plate is known to the trade as a tight or a loose place, meaning that the want of straightness is produced by parts of the blade being unduly contracted or expanded; and all the efforts of the straightener are directed to the end of removing the contraction or of accommodating the expansion, so that, the unequal tension or strain being removed, the plate will be true and straight. If we take a saw plate that is quite true, and lay it upon a truly planed iron plate and allow it to become first heated and then cooled thereon, we shall find that it has become warped by the process, and it is apparent that the warping has been produced by the expansion and contraction of the plate, and possibly mainly from irregular heating and cooling; for it is impossible to insure that the heat can be imparted to and extracted from the plate equally in all parts. The varying widths, the extra exposure of the teeth due to their partial isolation (and hence their increased susceptibility to heat and cold), and other elements, would all cause inequalities in heating, against which it would be impossible to provide. The circular saw affords the best example of the vicissitudes caused by unequal tension, as well as the most striking instance of the minuteness and skill in mechanical detail required in the saw straightener's art.

Suppose, for example, that we have a circular saw of three feet diameter, and that it is made straight and true, and with an equal degree of tension existing all over it. Let its circumference travel at a speed of 2,500 feet per minute: it is obvious that the centrifugal force generated by the motion will tend (and actually does, to a slight extent) to expand the saw plate, and it is equally obvious that this expansion decreases in amount as the center of the saw is approached. The equality of the tension on the plate is destroyed; and though stiff and true when in a state of rest, the saw is loose on the outside (or, in other words, center-bound) when rotated, the looseness of the plate decreasing from the circumference towards the center as the radius shortens. As a consequence the extreme edge will, when in motion, flop over from one side to the other, according to the side on which the duty offers the most resistance; and this resistance will vary, from the curves in the grain in the wood, from knots, and from a variety of more minute causes. It follows, then, that the sawing cannot bs smooth, and that, as the saw bends or flops over on one side, the opposite side of the blade will come into close contact with the work, entailing friction and, as a result, heating; the latter will cause the saw to dish, and to remain permanently dished.

The method employed by the saw straightener to compensate for the expansion due to the centrifugal motion is to place upon the saw a tension insufficient to dish the saw when at rest, and yet sufficient to accommodate the expansion due to the centrifugal force. This he does by the delivery of blows upon the plate, the effect of which will be to create a tension sufficient to tend to enlarge the plate without overcoming the resistance to enlargement offered by the plate itself until such time as the centrifugal force diminishes this resistance: when the tension follows up the advantage afforded by the centrifugal force, and holds the plate from becoming loose on its outer circumference. If from an error of judgment the tension is insufficient to accommodate the centrifugal force, the saw becomes loose in the middle, or, in other words, it becomes rim-bound when in motion; and the result is that it dishes, as shown in Fig. 1. So that one side contacts with the work; and if the saw teeth meet with different resistances on its two sides (which may occur from the waves in the grain of the timber, or from other causes), the dish will jump from one side to the other of the saw, because, from being rim-bound, it is impossible that it remain straight. And as soon as it is forced over the straight line, it springs to the dished form, which is the only one capable of accommodating the tension. Now when it is remembered that cutting out the metal to form the teeth weakens the saw, rendering it more susceptible to expansion from the centrifugal force, and that the number and the depth of the teeth, and the temper, thickness, and size of the saw, as well as the speed at which it rotates, are all elements tending to vary the force and effect of the centrifugal motion, it will be readily perceived that it requires unusual judgment and skillful manipulation to enable the workman to give to a saw the exact amount of tension called for by the particular circumstances under which it is to operate. Yet so skillful are some of the straighteners that they have been known to remedy a defect in a saw from the delivery of a single light blow.

The blows delivered are in no case quick ones, nor are they sufficient to leave an indentation or impression upon the saw blade or plate. Each is given with a view either to create or remove tension, and not to give to the metal a permanent set; and although in explaining the method of manipulation it will be necessary to show, in the illustrations, the hammer marks, it is to be understood that those marks are not visible upon the work, and are only employed to denote where the blows were delivered.

In Figs. 2 and 3 are shown the hammers used by the saw straighteners. The first is called a "doghead." Its weight is about 3 lbs., its diameter is about 1⅝ inches, and its length is about 5½ inches. Its handle which is about 14 inches long, stands at an angle of 85° to the body of the hammer. Its face is rounding, and of an even sweep. That shown in Fig. 3 is called a blocking hammer; the face at A is slightly rounded. In Figs. 4 and 5 are presented the straightening blocks; that shown in Fig. 4 is of iron faced with steel. The face is bright, smooth, and slightly rounded. Fig. 5 represents a wooden block upon which the straightening of the finished saws is performed.

The doghead hammer, Fig. 2, is used mainly for stretching, that is, for removing a tension. The reason for its handle being at an angle is that by this means the handle of the hammer stands, when the blow is delivered, in the line of the hammer's motion; hence the blow delivered is a dead one, that is to say, it has as little spring or rebound as possible. By this means the effect produced by the blow is kept at a maximum; and the speed of the hammer being comparatively slow, it does not leave hammer sinks or marks upon the saw plate or blade.

The part of the saw plate being operated upon must always be kept flat upon the anvil, so that the blows will be received on a solid; otherwise they would distort the blade by bending it instead of stretching it. The motion of the doghead hammer, shown in Fig. 2, is sometimes such that it strikes the plate or blade fair, so that its effects extend equally in all directions, as shown in Fig. 6, at A, in which the dark center shows where the hammer fell, and the radiating lines denote the stretching effects of the blow. At other times, the direction in which the hammer falls is aslant, as shown in Fig 6, at B, in which the hammer, while failing, travels also in the direction denoted by the arrow, C, the stretching effects of the blow being denoted by the radial lines around the center, at B. The motion of the hammer, however, is never varied so as to travel towards, but always away