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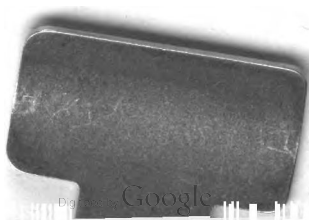
GRIMSHAW

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Saw-Filing and **Management of Saws**

A PRACTICAL TREATISE ON FILING, GUMMING, SWAGING, HAMMERING, AND THE BRAZING OF BAND SAWS, THE SPEED, WORK AND POWER TO RUN CIRCULAR SAWS, ETC., ETC. A HANDY VOLUME FOR ALL WHO HAVE CHARGE OF SAWS, AS IT DEALS WITH THE PROPER SHAPE AND PITCHES OF SAW TEETH OF ALL KINDS AND GIVES MANY USEFUL HINTS AND RULES FOR GUMMING, SETTING AND FILING.

By **ROBERT GRIMSHAW, M.E.**

Author of "Steam Engine Catechism," "Engine Runner's Catechism," "Locomotive Catechism," etc.

New Edition, Revised and Enlarged

Illustrated

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PREFACE.

THIS book is designed as a practical aid to those who use saws for any purpose. While, as its title implies, it treats principally of saw-filing, it also goes into the questions of gumming, spring-setting, and swaging. The author has tried to bring it up to present successful usage, and will be glad to receive from practical sawyers and others for future editions, questions, suggestions, and information bearing on the subject.

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INTRODUCTION.

THERE is no more sense in using a dull saw than in shaving with a dull razor.

It is a great deal easier to keep a saw sharp by frequent light file-touches, than to let it get so dull as to need a long-continued filing down, after it gets so dulled as to refuse to work.


The saving in power, by using a sharp saw, is very great. It has never yet been measured in power-saws, and is hardly measurable in hand-saws ; but it is without doubt considerable.

By using sharp saws, thinner blades may be used than where the teeth are dull ; because the duller the saw the more power required to drive it through the wood, and the more strain on each tooth separately, and on the blade as a whole.

For the same reason, longer teeth may be used where they are sharp, than where they are dull.

The advantage of using sharp teeth is greatest in those saws in which the strain of cutting tends to deform the blade—as in all “push-cut” straight saws and in circulars.

SAW-FILING.

Classification of Saws.—There are four general classes of saws—reciprocating, circular, band, and cylinder ; * and four classes of teeth—the V or cross-cut, the  or ripping tooth, the M or W, and the hook ; with their variations and combinations.

Each of these requires special treatment, as distinguished from the others, and particular adaptation to conditions of saw, speed, thickness, and character of material and work, etc.

Saws for use in fibrous materials, such as wood, act in two ways—for ripping, or cutting with the grain, and for cross-cutting or dividing at right angles (or thereabouts) to the fiber.

In ripping fibrous material, each fiber is severed by each tooth only once at a stroke, but many times in successive strokes ; while in cross-cutting, each fiber is cut off in two places at a stroke, and never again cut off in that line.

* For fuller classification of saw-blades, see “Grimshaw on Saws,” page 12.

Rip-Saws.—The rip-saw, having for its duty severing each fiber once at a time in its length, is generally given acute teeth, well raked, and as it can act more like a mortising chisel than can the cross-cut, it is given more gullet, because it will take greater feed per tooth.

The hand rip-saw is longer and stouter than the hand cross-cut, being from 28" to 30" long as against 26" for the cross-cut, and having only 3 to 5 teeth to the inch through the greater part of its length, as against 5 to 12.*

The sash-saw for ripping, † (mill-saw) is about the most abused tool that man uses, getting the worst shaped teeth, and being allowed to get the dullest, because the operator does not feel that it runs hard; nor does he see if it is wrongly toothed, as the mulay, the circular, or the band, would clearly show by running crooked. The teeth have seldom enough "rake" or front pitch, nor enough gullet; they are, too, frequently given excessive and irregular set.

The mulay rip-saw ‡ gets better care than the sash. The teeth are about the same.

* For various forms and styles of hand-saws and handles therefor, see "Grimshaw on Saws," pages 18, 30, 33 to 35.

† See same work, pages 21 to 23 and 33.

‡ See same work, page 20.

The circular rip-saw responds better than any other to skill in toothing and mounting, and to ease in running. Its teeth should be widely spaced and very hooking, with plenty of gullet to take out the chips (not dust) which it should make.

The band-saw * is never used for cross-cutting, except when cutting scroll-work, and may generally be treated as a rip-saw. It requires special regularity in shape and set of teeth to prevent it from breaking and from running into the work.

The Cross-Cut Saw † has for its duty severing each fiber crosswise ; and in order to prevent pinching or binding, it divides each fiber in two places at once, leaving a path or "kerf" for the blade to run in and the material to fall out through.

If you undertook to divide a board in two, crosswise, by successive knife-cuts, you would soon find the necessity for having a groove at least as wide as the thickness of the blade ; and this could be accomplished only by severing each fiber twice ; making two parallel cuts

* "Grimshaw on Saws," page 83.

† For various styles of cross-cuts saws and of handles therefor, see same work, pages 37 to 48 of 2d edition.

between which the material was removed to leave the "kerf."

The action of the cross-cut saw is analogous—it makes two parallel sawings, and removes the short lengths between them.

Ordinarily, every other tooth is beveled to right and to left, so as to help make the right hand or the left hand score. The front view of a rightly filed straight cross-cut, with teeth beveled to right and left alternately, should be as in Fig. 1, and the filing should be so accurate that a needle could be slid along the groove left between or formed by the beveled tooth edges. But instead of making a kerf having a bottom of ridged section, the result is the crumbling out of the material as fast as the scoring progresses, and the kerf is left square bottomed.

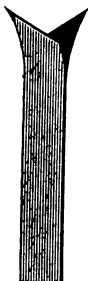


Fig. 1.

It is the outside edge of each tooth that does the cutting.

The Elements of a Saw Tooth * are its face, point, back, and gullet.

Teeth vary in length, thickness, spacing, rake, amount and kind of set, fleam, outline and direction, and in depth and outline of throat or "gullet."

* See "Grimshaw on Saws," pages 12 to 23.

They have for offices cutting, cleaning, and planing.

They are either solid (in one piece with the plate of the saw), or inserted.

The cutting edge of a saw may have all teeth of a kind, or several kinds in regular order.

Teeth may be simple or compound.*

The gullet may be angular, notched, or rounded.

Whatever be the style of saw or of tooth, it is imperative that all teeth of a kind shall be of uniform outline and dimensions—except in those cases (as “increment toothed saws”) where the teeth purposely vary in size in regular progression.†

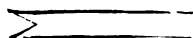
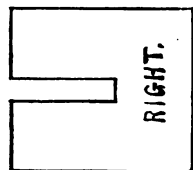
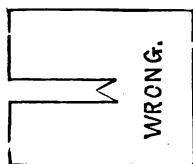
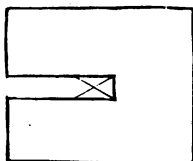


Fig. 2.—Action of a Cross-Cut.

* Various styles of compound and special teeth are shown and described in the author's work on Saws, pages 12 to 20, 28, 38 to 48, 57 to 61, 64, 71, 73 to 81, 87, 109 to 119, 128, 138, 157, 170 to 177, and 204.

† Grimshaw on Saws, pages 20 to 23, 28, 34, and 59.

Tooth Length.—The softer the material

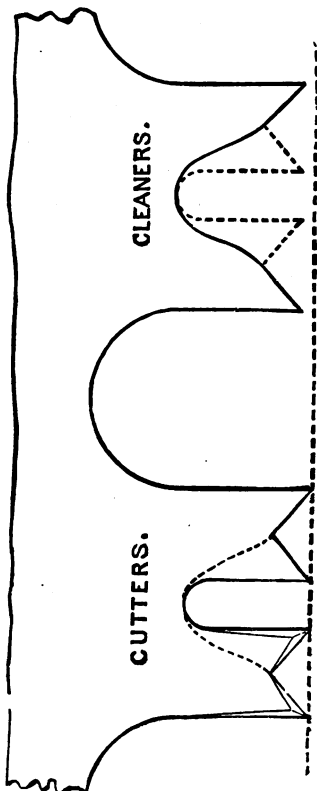


Fig. 3.

the greater the length of tooth among materials of the same general class. Long teeth give plenty of clearance for sawdust; hence are good for soft, wet, or fibrous woods.

The length of cleaner teeth may be regulated by a gauge such as that shown in Fig. 58.

When a cross-cut needs more cleaners, they may be made by filing down cutting teeth, as shown in Fig. 3, taking care to

bring them below the cutting line.

The thinner and longer the teeth, the greater the importance of having even, and not excessive, set ; because a thick or a short tooth will, more readily than a thin or a long one, withstand a tendency to spring into the cut.

The difficulty of springing into the cut is met with only in sawing fibrous (although perhaps we may add granular) materials. It is greater with teeth having excessive rake and "fleam," (or side angle) than with those of straight pitch, filed square across.

Tooth Space.—The following table gives lengths, sizes, and spaces of teeth of hand-saws :

	NAME.	LENGTH.	GAUGE.	POINTS TO INCH.
Taper and Unbacked.	Hand.....	26"	19	5 to 12
	Rip... ..	28" to 30"	18	{ Heel, 3 to 5
	Panel	14" to 24"	22 to 20	{ Point, 6 to 8
	Compass.*..	10" to 20"	16	8 to 12
	Keyhole.*..	7" to 9"	12	—
Straight and Backed.	Tenon.....	6" to 18"	22 to 20	11 to 15
	Miter.	20" to 30"	20 to 19	10 to 11

Hand rip-saws may have coarser teeth at the heel than at the point, so that fine teeth commence and coarse ones finish the cut.

* Narrow blades for curve-sawing.

For soft wood, band-saws should have a tooth-space one-half the blade width, and depth one-fifth. For hard wood, space one-third, and depth one-fifth.

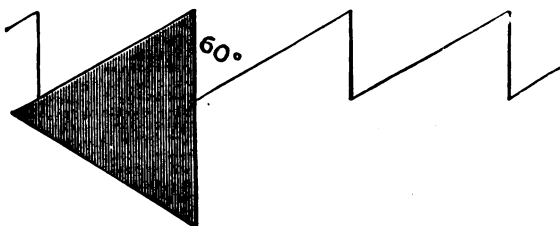


Fig. 4.

Angle and Rake.—The generic angle of saw-teeth is 60° . Teeth of any other angle cannot be filed well without a special file, as can those shown in Figs. 4, 5, in which, although

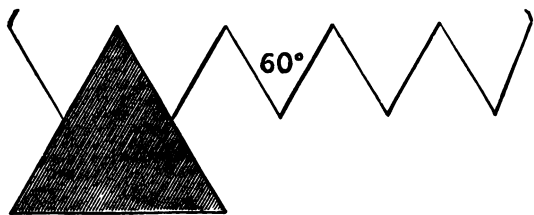


Fig. 5.

the rake is different, the angle is the same.

The rake of a rip-saw is in front; that of a cross-cut at the side.

Rip-saws take more inclination than cross-cuts.

Teeth with great front rake tend to spring in, especially in hard wood.*

More rake can be put on a circular than on a rectilinear saw, partly because it runs faster, hence can stand it.

The harder the wood the less rake there should be.

For soft wood, teeth as at *A*, Fig. 6, are

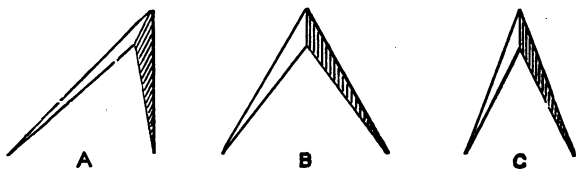


Fig. 6.

good ; for hard and knotty stuff, *B* (60° equally pitched front and back). For varied work *C* (40° equally divided).

The teeth shown in Fig. 7 have excessive front rake, and, while keen cutting, tend to dig in. Fig. 8 shows various degrees of rake, and the arrows show the direction of the strain put upon them by the work. In Fig. 9, the points of the teeth have considerable rake ; but

* See "Saws," pages 14 to 16.

the main portions are so formed as to resist the strain of work.

Side Angle or Fleam.—Referring to Figs.

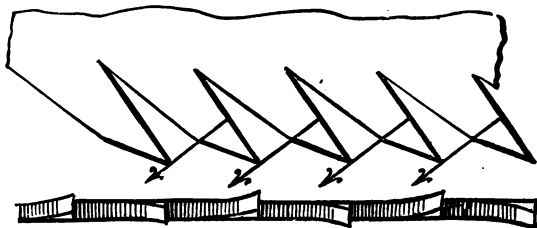


Fig. 7.—Great Front Rake.

10 to 44 :—for metal saws, the file is held 90° in both vertical and horizontal angles ; for hard

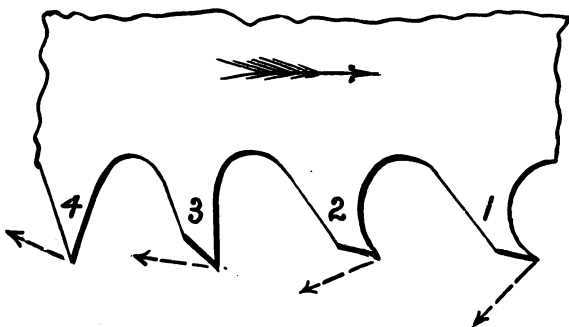


Fig. 8.—Various Degrees of Rake.

woods, 90° to 80° horizontally ; for soft woods, 70° to 60° and less horizontally ; 35° to 30° vertically.

Shingle saws should be filed square across.

Fleam or side angle is better for soft woods and those free from knots than for hemlock or spruce.

Fig. 10 shows, greatly magnified, the teeth of a hand rip-saw which has both bent-set, and fleam or side angle. The arrows show the

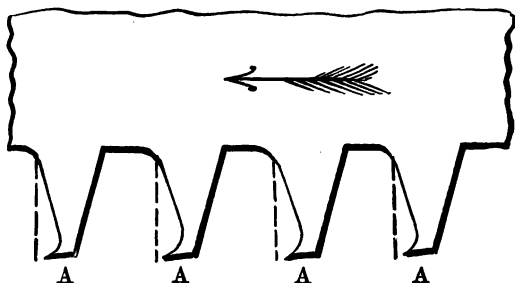


Fig. 9.—Strong Teeth, with very Raking Points.

direction in which the strain of work comes upon the teeth set and fleamed to the right side, and those bent and fleamed to the left. As this is at right angles to the cutting edge of the tooth, it will be seen that the greater the fleam the greater the tendency to spring in to the work ; and as the tendency to spring in is also increased by bent set, the two should not be given together.

Choice of Teeth.—With the choice of teeth

for special purposes, this work will have little to do ; this matter being treated in special detail in the author's work on Saws.*

Circular-saw teeth are generally more distant and more inclined, and have more set, than rectilinear.

Pruning-saws may have half-moon or briar teeth.

The more valuable the material and the

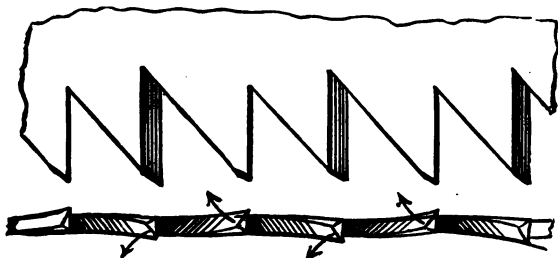


Fig. 10.—Spring Set and Side Angle.

greater the cost of power, the thinner the teeth and the less the set should be ; although in general the harder the material, the thicker the teeth, to stand the greater strain.

The softer the material, the more depth, "fleam," "hook," and "rake," may be given.

The more fibrous and porous the material,

* See pages 12, 18, 65, 234, of 2d edition of that work.

the greater may be the spacing, and the greater the necessity of deep throat or gullet.

Gumming may be done with punches, rotating steel cutters, or emery-wheels.

In Fig. 11, the dotted line *B* shows where the point first wears; *CCC*, how it should be filed back; but too often, on account of the long surface, and the sharp corner at *I*, the fil-

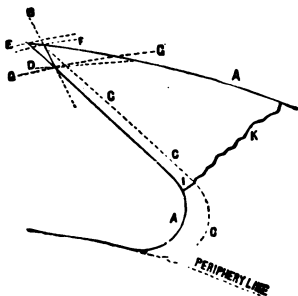


Fig. 11.—Tooth Wear and Gumming.

ing is done on the top. Filing back in the line *CCC*, the diameter is diminished only to *F*, while from the top you work it down to *D*.

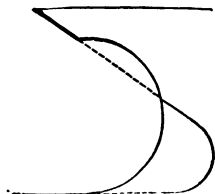


Fig. 12.—Machine Gumming.

In Fig. 12, the same tooth is shown, gummed by a machine, and leaving but little underfiling.

The higher the speed, the greater necessity for rounding the gullet.

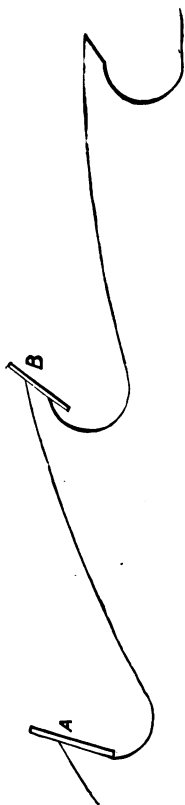
Band-saws particularly require rounded gullets.

In Fig. 13, tooth *A* is shown to need gulletting ; tooth *B* is all right.

Fig. 15 shows a very bad job of gumming.

Reversible Blade Gummer. — A gummer for circulars, with the blades reversible and detachable, as shown in Fig. 14,* has the advantage that both cutting edges of the blades may be sharpened at once, and when one edge is dulled the other may be turned ; besides which the gummer cuts practically the same sized circle all the time.

Fig. 13.—Testing for Need of Gumming.



Mixer's Rotary Gummer. — The same firm makes Mixer's gumming machine, to use these cutters. (See Fig. 16.)

Kind of Set.—Set is of two kinds—"spring" or

* R. L. Orr & Co., Pittsburg.

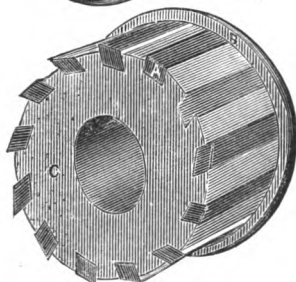
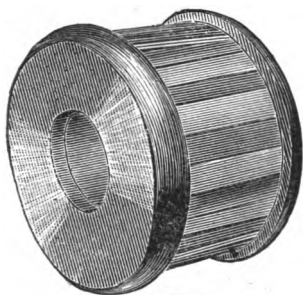
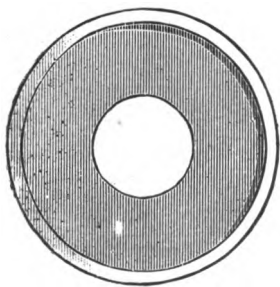


Fig. 14.



“ bent ” set, and “ swaged ” or “ spread ” set.

Bent set teeth cut upon only one side; spread set teeth cut upon both sides, unless they are either bent or “ sheared ” as well as swaged.

Each method of setting has its advantages and disadvantages, according to the conditions.

Of course, bent set teeth have more of this

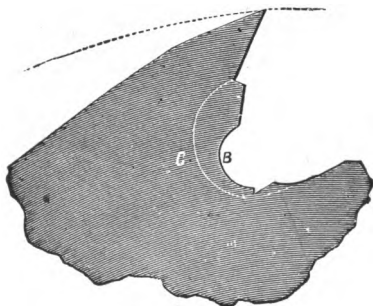


Fig. 15.—Very Bad Gumming.

tendency than swaged ones, and the greater the bend, the more tendency to spring in.

A swaged tooth, being supported on both sides, is less subject to side strains than one which is bent for set.

Bending for Set may be done by blows or by leverage—the latter including bending by cams. Either may be accomplished by a machine or by simple hand tools.

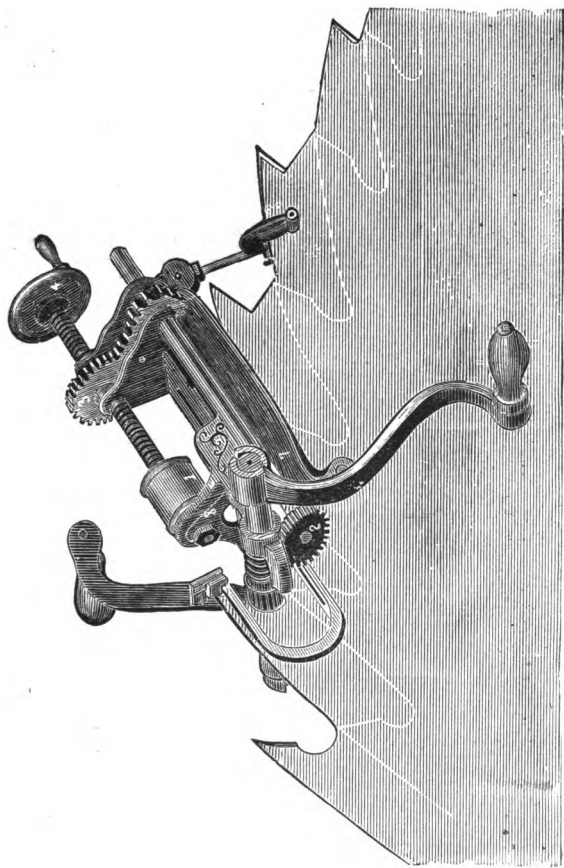


Fig. 16. — Mixer's Gummer.

To set by blows, without a machine, the blade must be gripped close to the ends of the teeth, and the blow struck quickly with a light hammer—the blows being as uniform in force as possible, in order to bend all teeth alike.

Avoid either too short or too long set ; the former causing too sharp bending of the tooth near the point, and the latter (the less evil of the two) requiring more force to effect.

Where bent set is effected by hammer blows, it is by many thought best to slightly overset, and then lightly correct the excess by gentle taps, in the case of large saws, noting the exact and proper amount of projection by means of a simple sheet-steel set-gauge.

For large teeth, there may be used special set levers, having two set screws—one to accommodate the instrument to various thicknesses of saw plate, and the other to regulate, as a stop, the amount of bending.

Small teeth may readily be bent for set by a simple notch in the end of a file.

Cam sets produce a bent set that is necessarily the same for all the teeth of each saw.

Figs. 19 and 20 show cam sets for circular and band saws, devised by C. E. Grandy, of South Barton, Vt.

Spread Set may be effected by direct hammer blows on the teeth, or by "crotch punches" or dies applied to the tooth ends and struck by a hammer.

Large mill-saw teeth may be upset by blows of a flat-faced hammer, using the firmly-held butt of an axe as an anvil or counter; but this method is crude, and at best unsatisfactory. The operation may be shortened and facilitated, and the work made more perfect and uniform, by having a die of suitable outline and faces, into which the metal of the tooth-point is spread by smart hammer blows on the instrument.

Usually, these upsets have two notches, one merely to spread the tooth-point, and the other to limit

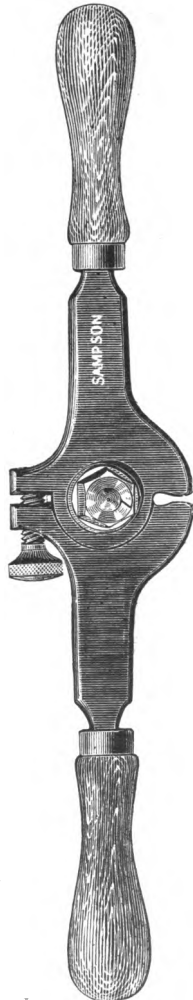


Fig. 17. — Hand Set.

its side dimensions and give the cutting edge, when desired, a slightly concave form.



Fig. 18. — Combined Saw File and Set.

There being some difficulty in properly hardening the angles of single-piece crotch punches, so as to preserve the original straight form,* they are now best made with a saw-cut in the angle, the metal being kept to size and form by means of a strong steel band, which drives the walls of the crotch hard together, and gives a straight line, which may be renewed when worn by taking off the band, dressing out the cut, and driving the walls together again.

In swaging or upsetting teeth, care should be taken not to make the corners too sharp. There should be enough metal back of them to hold them out firm without breaking off; and this in no wise affects the sharpness of the front of the tooth, which is the chisel-edge that does the work,

* The hardening fluid does not always reach into the angle, where the greatest hardness is required.

and which may be straight, convex or concave, at the option of the sawyer.

The ideal swaged tooth, looking only at the question of strength of corners, would be

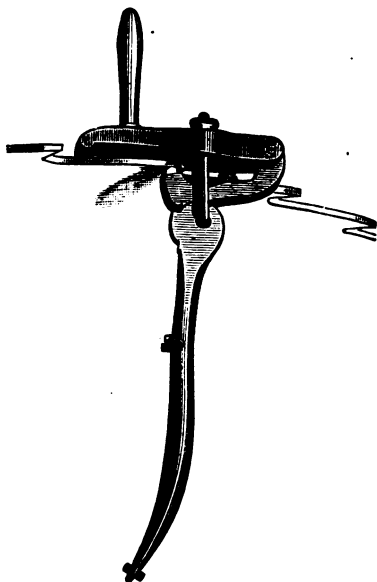


Fig. 19.—Cam Set for Circulars.

somewhat like Fig. 21; but as it would be impossible to swage cold-tempered steel by hand into such an outline, the form shown in Fig. 22, which is a possible one, should be

aimed at. The form shown in Fig. 23 has extremely weak corners, and if one of them crumbles off, the other gets all the work, and is liable to go too. If both go, then the tooth

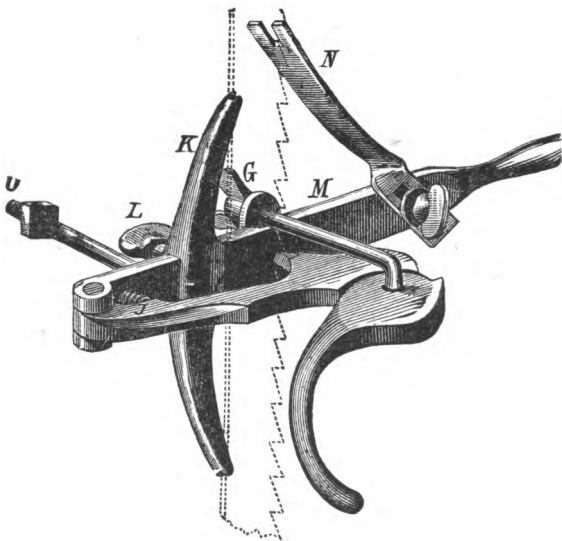


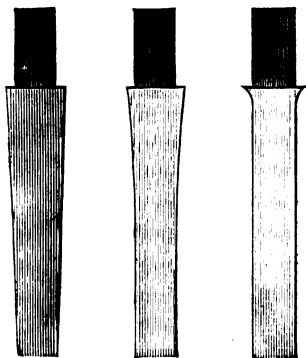
Fig. 20.—Cam Set for Bands.

behind has an extra load thrown upon it, and so on. The finer the feed, the greater the *proportion* of work thrown on the tooth corners, as compared with the front face. With very coarse feed, the action of the tooth is

more like ~~that~~ of a mortising chisel, getting a full cut all across its face; so that if the corners were gone, the chisel would tear through anyhow, leaving to the next tooth behind the duty of trimming square the ragged edges of the cut.

If it were practicable to swage and file teeth into such a shape as is indicated in Fig. 24, in which there is a cutting edge at each side as well as in front, the greatest possible smoothness of cut would be attained.

Such a tooth would have a strong corner, well sup-



Figs. 21, 22, 23.

ported from behind, and from this there might be a taper, as in Fig. 21, or else the plate behind might be of even thickness, with a slight sweep as a strengthening curve.

The Gridley tooth has both spring and spread set and "shear." (See Fig. 25.)

Various devices for spreading and bending teeth are shown in "Saws," pages 127, 180, 258, &c.

In swaging, the “upset” tool should be so held as to deliver the blow in a line with the face of the tooth. If inclined, so that the blow comes in the direction of the back of the tooth, or further out, there is danger of a crack starting in the gullet, especially in frosty weather.

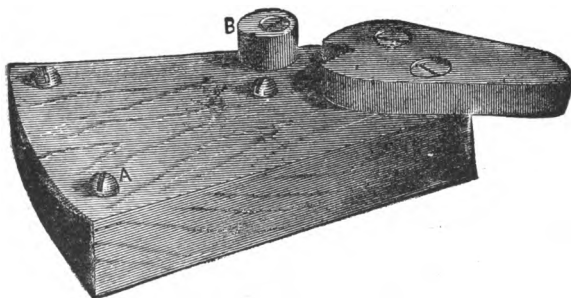


Fig. 26.—Leslie Swage.

Fig. 26 shows the Leslie “solid swage,” made by R. L. Orr, of Pittsburg, and which is claimed to be able to equalize the lugs of such a tooth as Fig. 23, by drawing the metal over to the desired side. This swage has what is called a “three-fold convex surface,” and is provided with guides for regulating its exact position on the saw, and hence the shape of the point which it gives the tooth. The “three-fold convex” surface is formed by the

intersection of two right cylinders, its property being to spread the metal of the tooth in both directions from the center, at right angles from the body of the saw, leaving the tooth curved on the face, back, and edge. A light file touch is then used to bring the edge straight if desired.



Fig. 24.

In drawing over a tooth to change the lead of a saw, with this swage, the screws provided for the purpose are set out so as to cant the swage on the saw, with the result of making the blow come on one side of the tooth, and crowd the metal towards the other.

Amount of Set.—Circular saws require more set than rectilinear, because they run faster and are apt to wobble.

Ice-saws should have excessive set, to prevent clogging.

There should be very little set to veneer saws, by reason of the great cost of the material.

The more gummy the material, the greater the need of "set" or side clearance.



Fig. 25.—Gridley Tooth.

Small, narrow blades of jig-saws should be

eased off with the file, a gauge or so in thickness, if not already made so.

Band and jig saws require more set for short curves than for those of long radius.

A tapered jig-saw blade is shown in Fig. 27. Such a blade needs neither spread nor spring set to its teeth, but will keep cool in hard

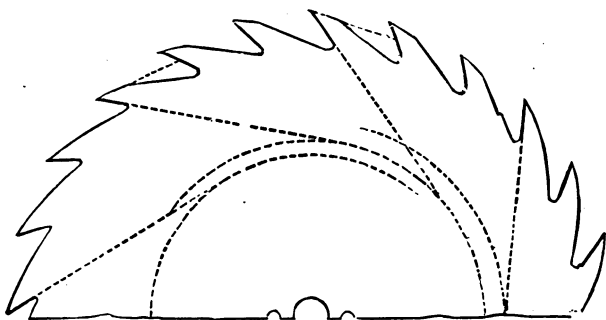


Fig. 28.—Forms of Circular Saw Teeth.

wood, and cut short curves without binding.

Leading in or out of the log is very often caused by giving more fleam or more set on one side than on the other.

Gullet, or Throat.—The greater the feed, the greater the gullet needed.

Spaulding's rule for throat room of circulars is to double the number of cubic inches of

wood removed at one revolution, and divide by the number of teeth, to get the required number of square inches of gullet per tooth.

Insufficient gullet, throat or chamber, causes the saw to choke and heat, the rim to become too large, and the plate to run "snaky."

The gullet should be rounding, as in Figs. 29 and 30, and not angular, as in Figs. 31 and 32, in which case cracks may start ; and in any instance sharp corners are the hardest on files.

"Top Jointing" (also called "rounding" when applied to circular saws) is bringing the points of all the teeth down to the same line, so that no one tooth shall project lengthwise beyond the others, and thereby receive undue strain. It is generally performed with a flat or "mill" file ; although it may be done by a plane rubber of emery or corundum, or a whet-stone. It is best effected with the saw mounted in a special but simple jointing frame, or its equivalent.* It is a very necessary operation.

Side Jointing not only gives each tooth its exact share of work, but prevents scratching



Fig. 27.—Tapered Web-Saw Blade.

* "Saws," page 248.

of the lumber caused by too great side projection of a tooth, and what is about as unsightly, "ridging," caused by a tooth not cutting out to full kerf width, and hence

leaving a ridge on the lumber; although ridging is often largely effaced by the action of the following teeth.

"Side jointing" is a corrective of irregular setting, and prevents undue side-projection of any tooth or teeth beyond the rest. It is more effective with swaged teeth than with those bent for set.

The "side file" (Fig. 33) may be adjusted by the set screws to any set desired.

Fig. 29.—Round Gullets.



Choice of a Saw.—A hand-saw must be springy and elastic, with almost a "Toledo blade" temper. There is no economy in buying a soft saw; it costs more in a year for files and filing than

a hard one does, dulls sooner and drives harder, and does not last as long.

Frequency of Filing.—Saw teeth should be filed, set, and jointed frequently, and gummed at regular and not widely distant

times. The keener and more regular the teeth, the cleaner and easier they will work.

Hand vs. Machine Filing and Setting.—Hand filing generally has the advantage of convenience in time and place.

Machine filing has the advantage of greater regularity, ease, speed, and cheapness of work.

Hand filing may be rendered more regular by the use of file-guides.*

The same remarks may be made concerning the relative merits and demerits of hand and machine setting, as in reference to hand and machine filing. †

Fig. 34 is an adjustable filing guide for circular or straight saws. It will file

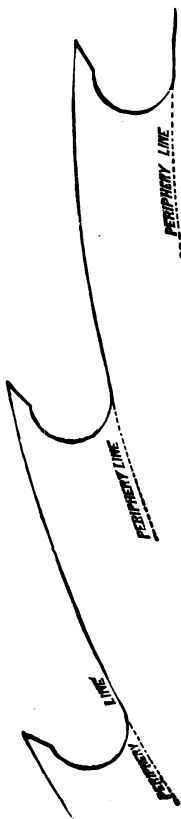


Fig. 30.—Round Gullet.

* See "Grimshaw on Saws," second edition, page 123.

† For various machine saw-sets, see same work, pages 126, 127, 181.

a tooth square top and bottom, or bevel point and square back, or square point and bevel back ; and will file either from right to left, or the reverse.

Fig. 35 shows a filing guide, having a grad-

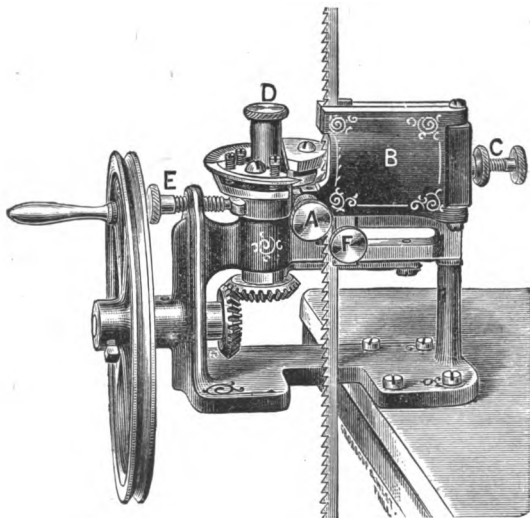


Fig. 36.—Amesbury's Band-Saw Filing Machine.

uated circle numbered from its center each way, giving bevels for each side of the saw.

Other machines for this purpose are shown in the larger work on Saws.

Fig. 36 shows an automatic band-saw filing machine,* which employs a spiral file in two sections—one to cut the faces and to feed the blade on, and the other to file the backs.



Fig. 31.—Angular Gullets.

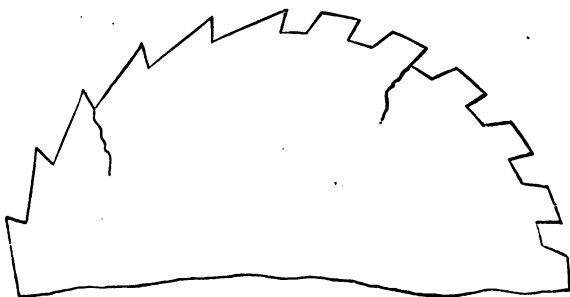


Fig. 32.—Angular Gullets.

Filing Clamps. — The screeching of saw-filing is proverbial, and yet unnecessary. A saw properly clamped and rightly filed need

* Made by G. W. Amesbury & Co., Philadelphia.

not “screech” under the operation. The blade must be firmly held close to the bottoms of teeth, and the file held firmly against the teeth.

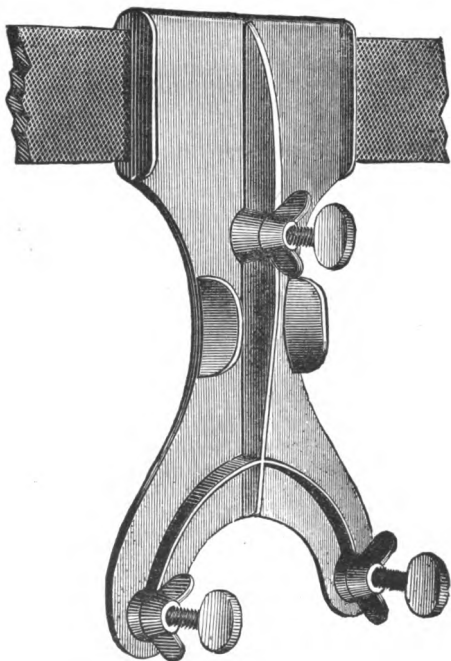


Fig. 33.—Side File.

Rubber, leather, or even soft, thick paste-board between the blade and the jaws of the

clamp will absorb most of the vibrations, and render the operation more nearly noiseless.

If a saw shake and jar while being filed, it will strip the file ; hence it ought to be kept close down to the edges of the clamps.



Fig. 34.—File Guide.

Fig. 37 shows a convenient form of saw-filing clamp.

Files.—The files used are triangular, flat or mill, round or gulleting, and special.

There are many sizes of saw-files and many grades of coarseness of cut.*

* These are more fully illustrated than the limits of this hand-book permit, in the larger work on Saws.

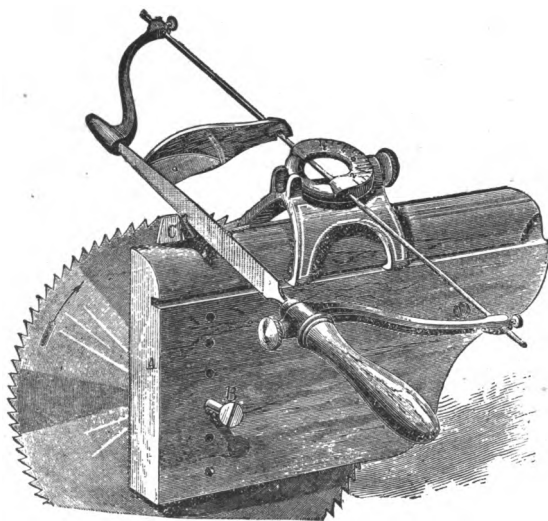


Fig. 35.—Filing Guide.

Many styles of special teeth are best sharpened with files of special section, made on purpose for them ; and some cannot be sharpened with any other than special files.

The face of the file should be double as wide as the length of the tooth-face. (See Figs. 4, 5). In Fig. 38 the file is somewhat too narrow.

A saw file cannot well be too hard, nor too sharply cut. To preserve its cutting powers, it should not be so held and used as to strip the teeth against the edges of the saw tooth. It should not be thrown down carelessly, nor knocked about among other files or tools. The corners are particularly liable to be stripped in the angles between the teeth.

“Increment cut” files, or those in which the distance between the teeth increases from point to heel, are claimed to work cleaner and easier than those in which the spacing is regular.

Hand-cut files are claimed to work better than any machine-cut, except the “increment” toothed.

In some cases the file is so shaped and held as to sharpen the back of one tooth and the face of the one behind it. This frequently occurs with such small teeth as have no curved

outlines, and is especially handy where the angle of the gullet is 60° , as is generally the case where the throat is sharp-cornered.

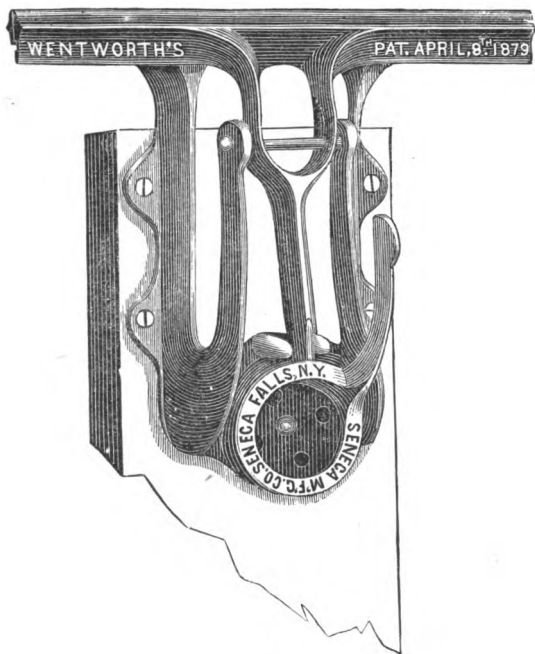


Fig. 37.—Saw-Filing Clamp.

Saw files should be “float” or single cut.
The ordinary triangular saw file is double

tapered—a contour not to be recommended on the score of either clean work or economy.

Since, however, a taper saw file will continue to be demanded, it is well that it be offered in the best possible modification.

One important improvement is the formation of a knob or button at the top, affording firmer hold for the thumb and forefinger, and not making them sore where filing is infrequent. Double taper files are also made

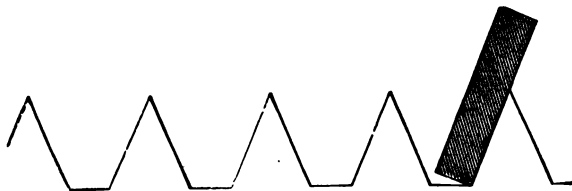


Fig. 38.

“double ended” or “reversible,” and these too are sometimes “knob-ended.”

Band-saw files must have rounded angles so as to insure round throats to the teeth. (See Fig. 39.)

System.—Saw filing, to be effected regularly, neatly and rapidly, and with minimum wear of files, must be gone about in a systematic manner, in order that no tooth may be omitted nor gone over twice.

For instance : the faces of every other tooth may be gone over in regular succession ; then either the backs of those teeth, or the faces of the intermediates, and so on.

The following cuts and descriptions will illustrate systematic filing of various types of hand saws.

Fig. 40 is for metal frame saws.

Fig. 41 is a peg tooth, with plenty of fleam. Mill saws and M teeth are sharpened about the same as this. File sides 1, 5, 9 (the left of alternate teeth), at horizontal angle, h ; then opposite sides of same teeth, 2, 6, 10, with reverse angle h' .

Then take the other teeth, and file from the other side of the blade, 12, 8, 4 ; then 11, 7, 3.

In Fig. 42, the file cuts a front and a back at once. "Top" the teeth, then file 1, 5, 9, on alternate teeth, clear back to the center of each tooth left by topping. Then take sides 2 and 3, 6 and 7, 10 and 11 of the notches, and file them forward to meet the line a . This finishes faces 3, 7, 11. Then change the saw end for end, and finish backs 4, 8, 12.

Fig. 30.—Band Saw File.

Fig. 43 shows a pruning saw for green wood, ground thin at the back, and having no

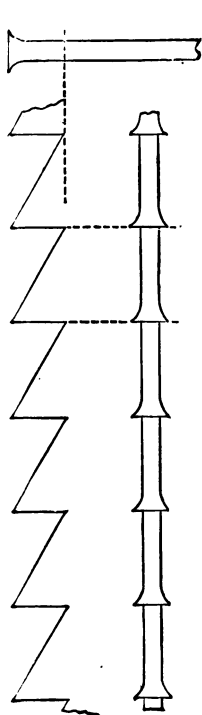


Fig. 40.—Metal Frame Saw.

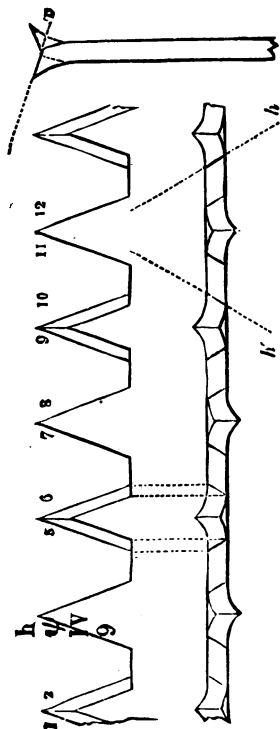


Fig. 41.—Peg Tooth.

set. It has great amount of bevel, and cuts “sweetly.”

Fig. 44 is done with a pit saw-file smaller

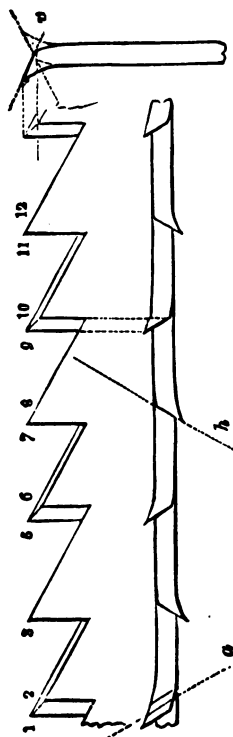


Fig. 42.

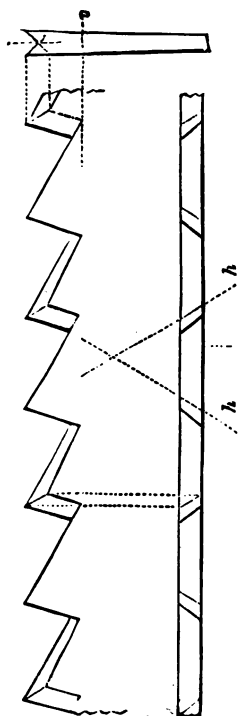


Fig. 43. —Pruner for Green Wood.

than the gullet. First make gullets 3, 7, 11, very obliquely in the vertical plane ; first fil-

ing the face of one tooth, and then the back of the other. Then file the backs of teeth 4, 8, 12, with flat side of file, at an angle 5° to 40° with the edge, and 80° to 60° with the side of the blade (the 5° and 80° being for the hardest woods, and the 40° and 60° for the softest).

One common rule given is as follows : File the faces or fronts before the backs. Where the teeth are to be square, file in regular succession, 1, 2, 3, 4.

Where there is "fleam," file 1, 3, 5, 7 to right ; 2, 4, 6, 8 to left, etc.

File the fronts of all teeth set from you, and the backs of those set towards you.

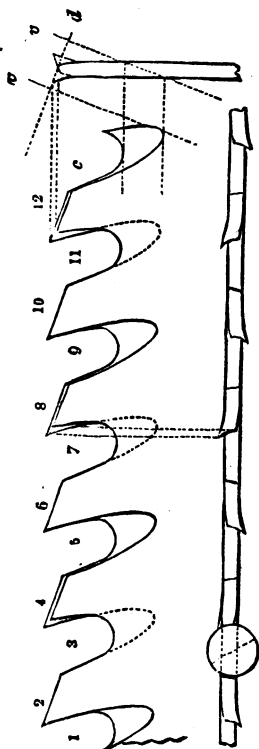


Fig. 44.

Circular Saw Teeth should be filed on the *under* side.

Hints.—The first six or eight inches at the point of a hand rip-saw may be given “cross-cut” pitch, with which you can cut through knots without changing saws.

The last teeth of cross-cuts may be rounded at the points to prevent tearing on entering and leaving.

A sheet-steel gauge (Fig. 45) will show if a circular saw tooth is exactly to shape.

A templet for making all the teeth of a circular saw of the same outline, distance between points, and distance from the saw center, may be made of saw plate or sheet zinc,

and used on a radial arm, as shown in Fig. 46, while the saw is on the arbor.

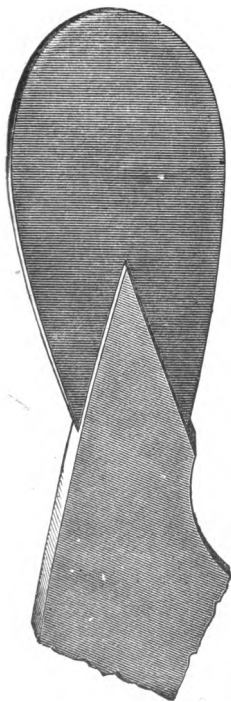


Fig. 45.—Gauge for Circular Saw Teeth.

Where a tooth is only slightly broken off, it

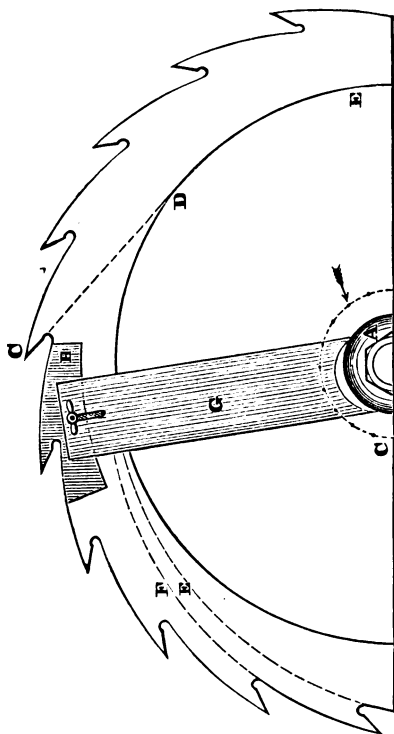


Fig. 46.—Templet for Circular Saw Teeth.

may be brought up by a crotch swage, as shown in Figs. 48 and 49.

A small U gullet in the angle of teeth, as in

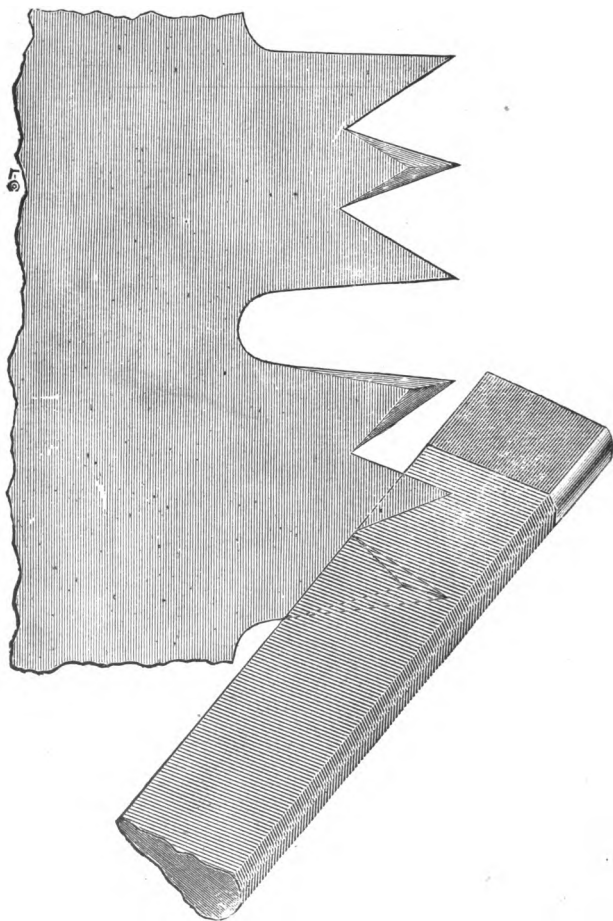


Fig. 47.

Fig. 29, page 36, tends to save the file from stripping.

Better file all along in three light filings, than do the whole of each edge at one cut.

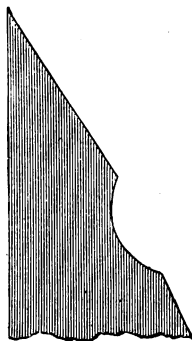
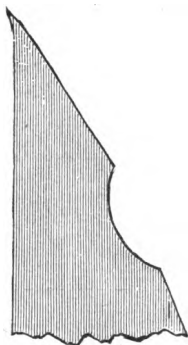
In sharpening an undercut or a parallel tooth, there is danger lest the original shapes and sizes get perverted, as in Figs. 51, 52.

An M tooth should have slightly flaring sides, and then it may be kept in size and shape easily with a special file, cutting side and gullet at one operation.

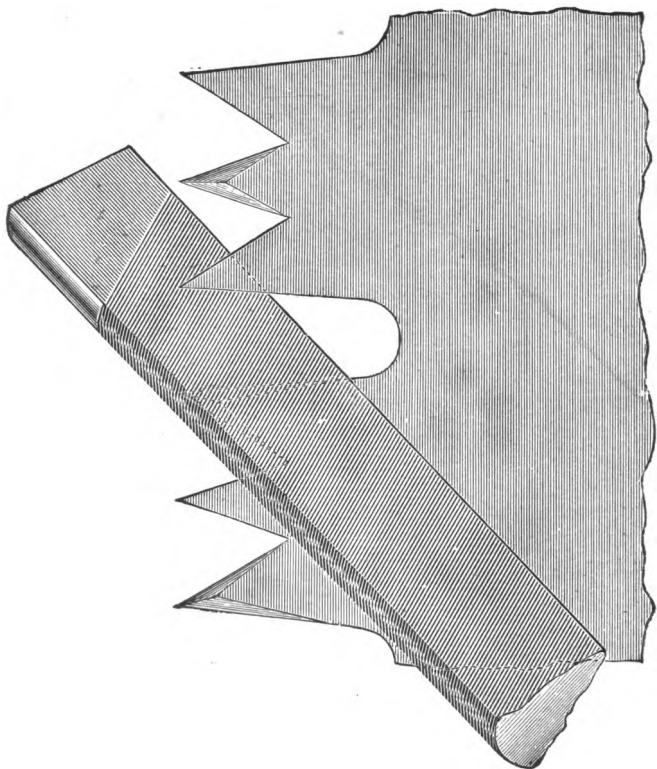
Figs. 47, 50, 53, show the manner of filing a "Great American" cross-cut with a special file.

When one tooth of a circular saw is too short, it may be brought out to line by using the swage as a lever while hammering upon it. (See Figs. 48 and 49.)

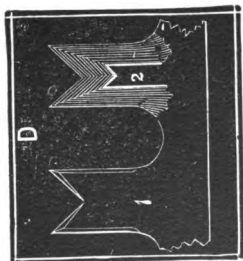
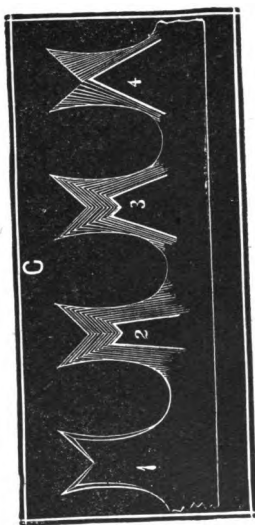
Referring to Fig. 54, which shows five differ-



Figs. 48 and 49.—Bringing Out a Short Point.

**Fig. 50.**

ent conditions of teeth of circular rip-saw—that shown at A has nearly all the swaged portion broken or worn off one side. This can be remedied without swaging, by squaring and filing so that both sides are alike. Tooth B has the cutting edge almost square, but the corners are unequal. In this case the file should be used to make both corners alike, as at C, and then the swage will bring out the points as at D, condensing the metal well into the corners; but if the wood is very hard, such an outline as either side of E is preferable.



Figs. 51 and 52.—Wrong Filing.

In removing a circular saw from the arbor, when hot at the eye, it should not be leaned

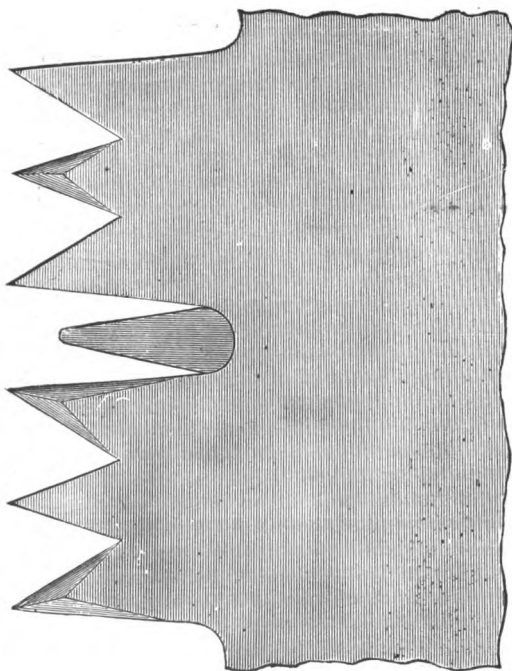


Fig. 53.

up against any thing, else it will very likely get dished. Before taking a saw from the

mandrel, it should be cooled by letting it run a few minutes, out of the cut. (*Simonds.*)

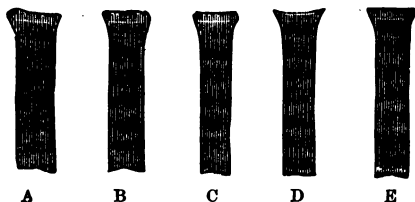


Fig. 54.

The harder the emery wheel used for gulleting and sharpening, the more apt it is to glaze a saw.

Glazing, by reason of use of too hard emery wheels, is apt to cause checking and splitting of the teeth in swaging.

Styles of Circular Saw Teeth.—Refer-

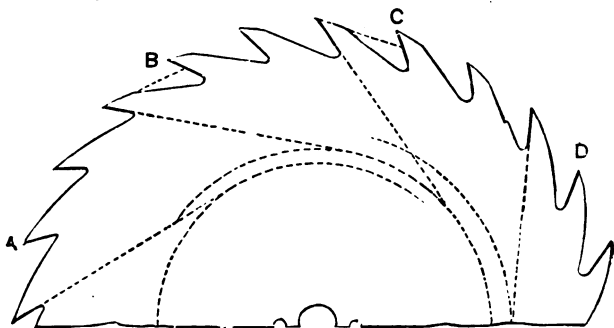


Fig. 55.

ring to Figs. 55, 56, 57, we find the teeth A

at the left of Fig. 55 raking to a circle rather more than half the saw diameter ; and the next two sets, B, C, to a circle $\frac{3}{4}$ the saw diameter. The softer the wood, the more rake the teeth may have. In two of these sets, B, C, the back has a separate rake rendering the teeth less acute than if the back was in one line.

In Fig. 56, the rake of the left hand and middle sets is to a circle not quite half the saw diameter.

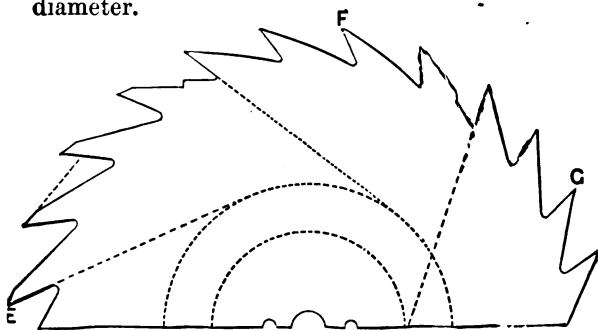


Fig. 56.

Calling these styles A to G inclusive, as lettered in the illustrations, Grandy would use class E for ripping hard wood in the winter, and C for hard wood in the summer, working G in the summer on every class of wood. Styles B, C, and F would be used for harder wood than if the back had no rake.

Style F (better with a rounder gullet) would be used, say 2 inches long for soft wood and $1\frac{3}{4}$ inches long for hard ; in the first case getting $\frac{3}{4}$ pitch and in the second $\frac{1}{2}$ pitch. For small power and light feed a shorter tooth is used than when sufficiency of power enables heavier feed.

Styles H to N inclusive, Fig 57, are nearly all, except M, forms of ripping teeth but little

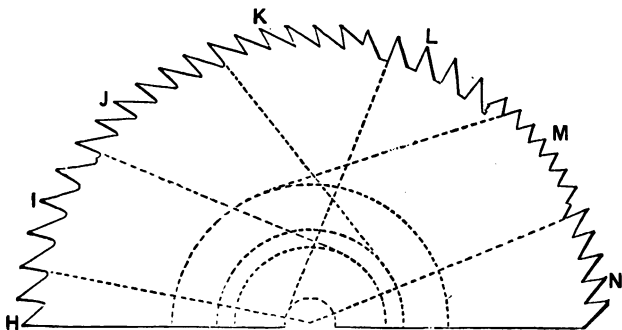


Fig. 57.

used in soft wood ; and M is properly a cross-cutting tooth. L is a shape very common in England and France ; being produced entirely with a mill-file. M "goes" quickly in frosty weather, particularly when it strikes a knot.

SET.—Set the tooth and not the plate of the saw (when bending for set). This will prevent the distortion and springing of the blade,

and the frequent cracking natural in fine full-tempered cast steel blades when carelessly or wrongly spring-set.

For glue-joints it is best to use a saw without set ; and a good workman will run a winter saw with little or none, the back holding the blade stiff and square, and keeping it from springing. In this, its comparatively short length assists.

It requires a first-class workman to use a hand-saw without set ; and, conversely, a man who can drive a saw surely and straight, without twist or buckle, tremble or varying pressure, can run it with little or no set, except in very gummy or very hard wood.

Spring vs. Spread Set.—The C. N. Nelson Lumber Co., Cloquet, Minn., say : “ A spring set with a slightly shearing tooth unquestionably cuts the easiest, but as it is only the corner of the tooth that cuts, you will require twice as many teeth in a spring set as you will in a full swaged saw ; and as power is a secondary consideration in a saw-mill where fuel costs nothing, the full swage is generally preferred as being easier taken care of.”

We must, however, take particular exception to the statement that “ power is a secondary consideration in a saw-mill, where fuel costs nothing.”

There are other items of expense in producing power ; the principal ones being interest, wear and tear, lubrication, insurance, firemen's wages, "boiler compound," etc. So that if a given amount of work can be done with 200 horse power, there is no use in paying for these items in a 250 horse "plant."

In order to make a cross-cut fast-cutting, it must have deep teeth, so as to give plenty of throat room to carry out the sawdust.

One advantage in blunt end saw-files is, that their sides are less tapered than "sharp-enders."

Cleaner Gauge.—Fig. 58 shows the cleaner gauge referred to on page 14, for keeping the cleaver teeth of a cross-cut shorter than the cutters, and all of a uniform length.

Gummers.—One point of advantage of a rotating steel-cutter gummer over an emery wheel is that, whereas an inexperienced hand can ruin a saw by case-hardening with an emery wheel, such cannot be done with a steel-cutter, or "burr gummer." Most of the emery gummers for circulars require that the saw shall be taken off its arbor to be gummed ; all burr gummers work with the saw in position.

Crotch Swages.—In the manufacture of crotch swages, it is found that the tempering is a difficult matter, a good many being lost in this operation. The jaws have to be tempered very hard ; but if this hard temper run back too far there is a tendency for them to split. Just around the notch they must be very hard, and the rest must be soft and tough.

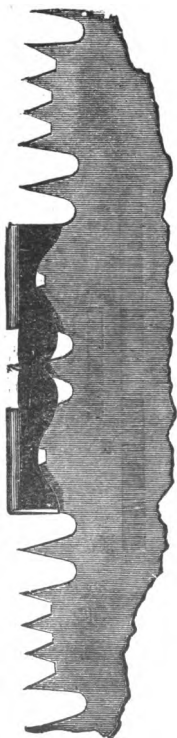


Fig. 58.—Cleaner Gauge.

It is best that crotch swages be fitted with a side guard to prevent the hand of the operator being injured by the swage slipping off the tooth. This guide may be made to serve also as an attachment to keep the swage central, or to throw it over so as to give the saw more lead on one side than on the other.

The Simonds Manufacturing Company makes a swage that is claimed to act on the teeth back from the cutting edge as

well as at the edge, spreading them to the required width without materially reducing their length. This, if accomplished as claimed, would leave the rate of reduction of saw diameter and increase the life of the saw.

It is claimed to give strong substantial shoulders to the teeth, thus making them stand hard work without dropping corners, and to spread them about the saw on the face as on the top, causing the saw to cut easy, and clear well, and steadying it in the cut.

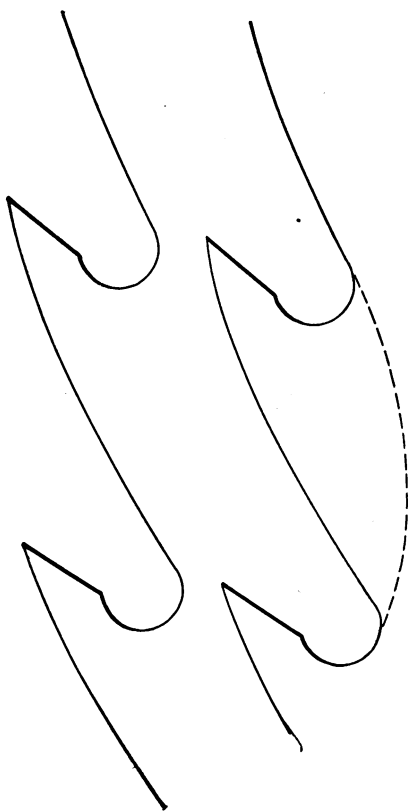
In the collar are depressions serving as guides to keep the teeth in proper shape, by there being a sharp angle for summer sawing, and a more obtuse one for winter work.

The question was asked in a recent issue of "*The Mechanical Engineer*" of New York :

"Suppose we have a circular saw, with teeth spaced as shown in Fig. 59. Will it make the cut easier or harder (keeping the feed *per revolution* the same) to cut out every other tooth, as in Fig. 60 ?"

To this the author made substantially the following reply :

"EDITORS MECHANICAL ENGINEER :—In the matter of number, or distance apart, of circular saw teeth, referred to by your correspondent 'Michigan,' in your last issue, page 40,



Figs. 59 and 60.—Spacing of Circular Saw Teeth.

the enclosed sketches show the effect of wide spacing by giving increased throat-room, not only per tooth; but in the whole saw. In Figure 61 are shown parts of three properly formed teeth; and the dotted rim-line gives the outer boundary of the throat-space. Now cutting out the middle tooth, as in reducing by one-half the number of teeth in the saw each tooth has to take double depth of cut, if the feed per revolution remains the same; tooth *A* will have as throat-room not only the space *a*, which it had before, and the space, *b*, which tooth *B* had before being cut out, but the space occupied by tooth *B* is also added to the throat-room of *A*. Thus, while it has double the cut,

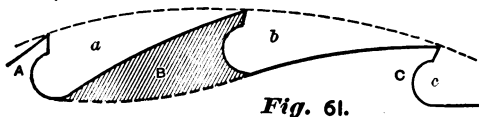


Fig. 61.

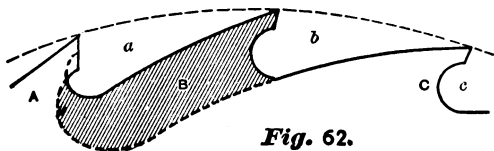


Fig. 62.

and hence removes double the kerf, it has three times the space to hold the sawdust, or rather cuttings; for a rip-saw should *mortise*

its way through a log, and not make fine dust.

“So, within certain limits, we are gainers by removing every other tooth ; for instead of having to cut through the fibers twice, with a given feed per revolution, they are cut only once. That is, if the saw is 56 inches diameter and has 56 teeth, and the feed is 7 inches per revolution, each tooth will mortise $\frac{1}{2}$ ” deep at a cut ; whereas, with only 28 teeth, each tooth will, if the feed remains 7 inches per revolution, cut in $\frac{1}{4}$ inch, and have more than double the space to hold the cuttings.

“If, then, the saw is heated and bound because of insufficient throat-room, it will be less liable than before to do so.

“But there is another thing to look at. While we have lessened by one-half the amount of power expended in cutting through the fibers, we have more than doubled the strain on the teeth, in crumbling down and wedging out the cuttings ; and this strain tends to break out the teeth-points. There would be cases where it would be advisable to strengthen the tooth-point by deepening the gullet ; gradually working it down at each successive gumming, until the outline was as shown in *A*, Fig. 62. This gives even greater gullet than the outline shown

in Fig. 61 ; the back and face of the tooth have the same rake as before, but the points are stronger.

“The question of few or many teeth in a rip-saw depends almost entirely upon the character of lumber being ripped ; and the feed per revolution should be made dependent upon the strength of the teeth to resist breaking, and the capacity of the gullet to hold the cuttings.

In a cross-cut the conditions are different.”

To Straighten a Circular Saw.—Get a hard-wood block 12x12", bed it, on end, on the ground (not on the floor). Round the top off with, say $\frac{1}{4}$ inch rise. Nail up a joist at the back of the block, for the saw to rest on ; let its face be an inch below the top of the block. *Do not use an iron anvil.*

Use a 3 or 4 lb. blacksmith's hammer for saws over 50 inches ; a lighter one for smaller and thinner disks.

For large saws the straight edge should be about $\frac{1}{16}$ " thick :—say 20" long, $3\frac{1}{2}$ wide in center, 1" at end ; the edge of the straight side chamfered or rounded off.

Balance the saw on a mandrel, and apply the straight edge. Mark the high places with chalk.

Have a helper to hold the saw on the block, and hammer on the humps, testing frequently.

By this means a saw may be changed from right to left handed, or *vice versa*.

If the saw is rim-bound, or center-bound, it should be nailed between two circular boards each an inch larger than the disk, and sent to a good saw maker (preferably the one who made it) to be straightened and given the proper tension for the speed at which it is to be run.

High places may be taken out of straight saws in the same way.

Choice of a Hand-Saw.—A good hand-saw should spring regularly in proportion to its width and gauge; that is, the point should spring more than the heel, and the curve hence not be a perfectly circular arc.

If the blade is too thick for the size of the teeth, the saw will work stiffly.

If the blade is not well, evenly and smoothly ground, it will drive hard and tend to spring. The thinner the gauge and narrower the blade, the more need for perfectly uniform and smooth grinding; and, *per contra*, the smoother and more uniform the grinding, the thinner and narrower a saw you can use.

The cutting edge is very often made on a convex curve or with a "crown" or "breast," to adapt it to the natural rocking motion of the hand and arm.

By holding the blade in a good light, and tapping it, you can see if there are imperfections in grinding or in hammering.

Before buying a saw, test it on about the same grade of work as it is intended to be put to.

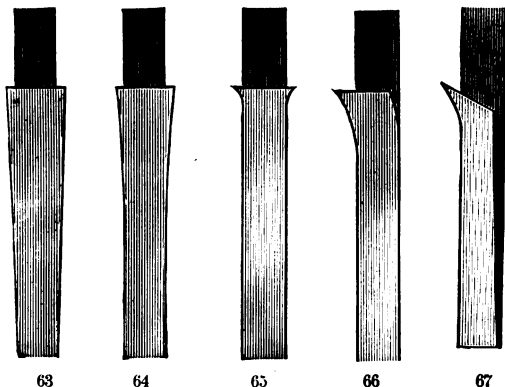
It is a mistake to suppose that a saw that is easily filed and set is the best for use. Quite the reverse is true. A saw that will take a few more minutes and a little harder work to sharpen, will keep its edge and set longer than one that can be put in order quickly ; and will work better in knots and hard wood.

Comparison of Circular Saw Teeth.—Referring to the line of cuts showing various styles of teeth for circular rip-saws :—

Style 63 cuts a smooth surface, and the duller the smoother, as a rule ; but takes considerably more power to do a given amount of work, on account of the friction at the sides. The corners wearing off, would leave a tooth worn like 69, which, on swaging, would be like 70, requiring considerable side-filing. This would cause the saw to wear “stunted” or obtuse, faster than some other styles—notably that shown at 68, with concave front edge and sides.

Style 64, with long curving taper, is a modification of 63, and approaches nearer to 68 ; con-

sequently would be somewhat better than 63 in the matter of power, swaging, etc. Both styles can be produced only as inserted teeth, and are practicable only in clear, hard wood, and with plenty of power.

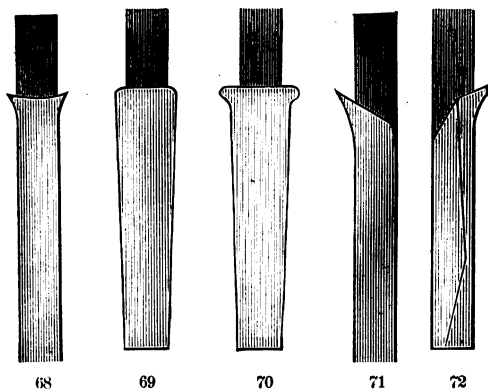


Style 65, with straight front edge and very short curved sides, is the most practicable form of swaged teeth, and is easily reproduced with a few blows of the swage, requiring but very little side-filing to keep a sharp corner, and giving the best possible side clearance.

Style 66, in which the tooth has both bent and spread set, takes less power than any other style, wears the plate less, and will shift from any kind of timber to another.

Style 67, in which there is bent set and considerable "shear," is practicable only on soft pine, as second growth pasture pine. Where the timber grows with the limbs low down, and is as near one way of grain as another, this style will cut less fuzz, and consequently take less power, where the tooth has stock enough to resist the tendency to spread sideways, or "make set," as termed by sawyers.

Style 68, with concave front edge and short



side curves, is about like 65 ; their capacity being about the same, giving 65 the preference.

Style 71, with a "double bevel shear," is totally impracticable, except in very soft water-

soaked pine, or hemlock. Of course, where the plate is thick enough to give strength, it takes less power than a tooth of style A on the same plate. It is better fitted for a cut-off saw than for splitting. It is used by some sawyers mostly for hemlock taken from the pond in summer time.



72 The double bevel 71 answers for plain triangular teeth with considerable hook, but for teeth like 73, (which have the same outline, but are "rights and lefts,") F. H. Stevens recommends such a bevel as is shown at 72, in which the beveled sides, as well as the back of the tooth, have clearance.

Emery Wheel vs. Grindstone. — The emery wheel has the advantage over the grindstone that it can be made thinner to run with safety, and can be run at higher speed. The principal objection urged against it is its heating the saw. This may be obviated by using a water-proof wheel and running a stream of water directly into the cut. "But $\frac{22}{100}$ of all the emery wheels used for this purpose" (says Mr.

T. Duncan Paret) “are used dry ; there being but one make of wheel in the United States on which the use of water is recommended.” The same intelligent inventor and manufacturer writes the author as follows, as to the methods of running wheels :

How to use Emery Wheels.—“ The simplest method by which solid emery wheels can be applied for saw gumming is by placing them on the spindle of the circular saw. The saw to be gummed can then be laid on the saw table, or supported in any convenient way. A simple way is to pass the end of a rope with a small cross stick on it through the eye of the saw, and thus suspend the saw so that it swings evenly balanced just in front of the emery wheel. The weight being thus carried, the operator only has to use his hands to guide the saw against the wheel. In the south and south-west, where expensive machinery is scanty, and where people are slow to introduce the latest improvements, there is a steady demand for saw gumming wheels all the way from 14 to 24 inches in diameter. In the north-west, where the latest improvements are quickly added, regardless of price, nearly all the emery wheels used for saw-gumming are from 12 inches in diameter to 8 inches, none of the machines spe-

cially designed for saw gumming being intended to carry anything above a 12-inch wheel."

Sizes and Shapes of Emery Wheels.—

Saw gumming wheels are used with the edge (or face) square, round, or beveled.

The principal sizes are :

$8 \times \frac{1}{4}$	} $\frac{3}{4}$ in. hole.	$10 \times \frac{1}{4}$	} $\frac{3}{4}$ in. hole.	$12 \times \frac{1}{4}$	} Holes, $\frac{3}{4}$, $\frac{7}{8}$ and 1 inch.
$8 \times \frac{3}{8}$		$10 \times \frac{3}{8}$		$12 \times \frac{3}{8}$	
$8 \times \frac{1}{2}$		$10 \times \frac{1}{2}$		$12 \times \frac{1}{2}$	
		$10 \times \frac{3}{4}$		$12 \times \frac{3}{4}$	
				$12 \times \frac{7}{8}$	
				12×1	

Probably more wheels $12 \times \frac{3}{8}$, $12 \times \frac{1}{2}$, and $12 \times \frac{3}{4}$ are used, than all the other sizes together. Saw gumming wheels are used, however, of all sizes up to $24 \times 1\frac{1}{2}$.

While the variety of sizes as well as of shapes is largely dependent on the variety of saws, it is also greatly influenced by individual taste and opinion. The general preference is for beveled wheels, and probably $\frac{2}{3}$ of all sold for saw gumming purposes are this shape.

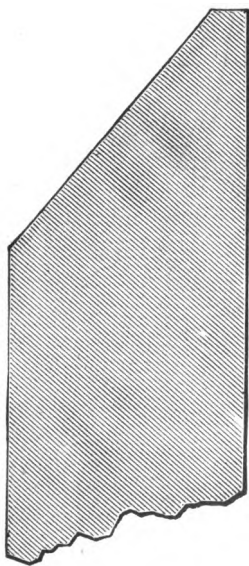
In this connection the gentleman last quoted says: "It seems questionable whether this choice is wise. On page 226, 2d edition 'Grimshaw on Saws,' it is stated that 'Sawdust packs in the side of the log and board, sometimes on account of the shape of the gullet.' Now where a beveled wheel is used, there is too little

room at the bottom of the gullet to hold any sawdust, and it is forced between the saw and the wood. Where a round faced wheel is used, and a large, full, round gullet left, there is space for the sawdust to be accumulated and carried round with the saw till it leaves the log and drops the dust. I am therefore inclined to think that round faced wheels are preferable."

We show herewith, in actual thickness, the largest and smallest usual sizes of saw gumming wheels made by the Tanite Co.:



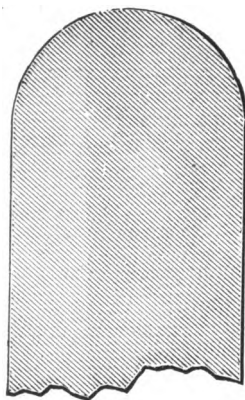
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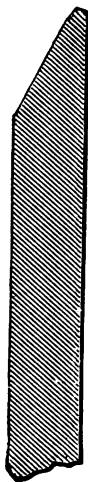
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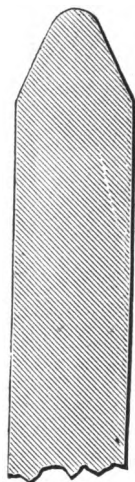
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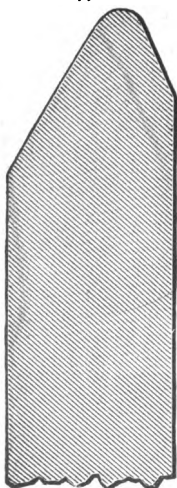
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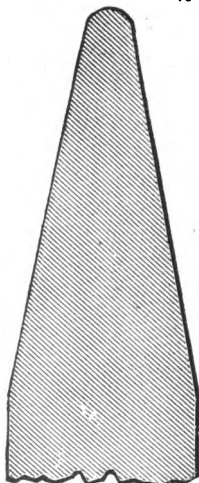
78



79



80



81

Figs. 74 and 75 are regular bevel ; 76 and 77, half round ; 78, short blunt bevel ; 79, blunt double bevel ; 80, irregular double bevel ; 81, double beveled from flange.

Hardness of Emery Wheels.—The Tancite Co. makes five distinct classes for saw gumming ; and can so vary the quality as to suit all tastes. We give below a brief description of these classes :

“2.” Medium hard ; preferred by $\frac{7}{8}$ the purchasers ; is a fast cutting wheel, too hard for some, too soft for others.

“3.” Medium soft ; same grain as class 2, but softer and freer cutting.

“Pocono.” Extra soft, recommended by its makers, above the other grades. It is finer grained and softer than either 2 or 3, and is particularly recommended to those experienced practical sawyers “who know how to grind with a light touch, and who want a free cutting wheel that will not create much heat.”

“Paradise.” Same coarseness as “3,” but rougher, more open, and faster cutting.

“5 Special.” A fine soft wheel only used on automatic saw gumming machines.

Brazing Band Saws. — The gasoline blowpipe is the most convenient means of heating large-size band saws for brazing ; but an ordinary mouth blow-pipe and oil lamp with a large wick makes satisfactory work for light band saws.

Scarf the sides of the broken end on opposite sides about half through, and lap about $\frac{3}{8}$ to $\frac{1}{2}$ an inch for small saws. Place in the lap a thin piece of coin silver, which flows better and is tougher than brass. Moisten the surfaces with borax, ground on a stone with water to a paste. Bind with small binding wire of iron ; pin to a piece of flat charcoal with wire clips, and heat with the broad flame from the blowpipe. Where convenient, a pair of tongs may be heated to a white heat and gripped upon the splice. Then carefully file the overlapping parts to an even thickness.

For very heavy saws, a resort to riveting is often made to hold the scarfs together firmly. For good work, the solder should be thin and placed in the scarf with enough to overlap so as to fill the scarf when melted.

Speed of Circular Saws.—The speed of saws is very essential to the production of good lumber. There is a standard. A good sawyer will retain his speed—not a given standard, but as to the condition of the saw's tension. The log takes the saw above or below the speed it is destined to run at, which is attended invariably by bad sawing. New saws should be kept up to speed by all means, or the saw will eventually dish permanently and have to be rehammered. A saw not up to its speed invariably runs from the log dishing. This will eventually permanently dish the saw. A sawmaker, when taking the order for the saw, is given a speed about so and so, and he, knowing but little better, takes it down. Now, this is known to vary 200 revolutions. The saw being hammered too open is condemned as defective; it won't run because it won't stand up to its work. If the sawyer had good judgment, he would be very particular about correct speed. A good sawyer will try to maintain the speed to suit the saw's condition or hammer it.

The greatest trouble is in too high speed. This brings about, first, bad lumber, second, a spoiled saw, as there is nothing that ruins a saw quicker than heat on the rim and running it winding across the log. A great many adhere to the stiffness of the saw, wanting a stiff saw. This is all right if some consideration is taken. If a saw is a heavy gauge, 48 to 54 inches, running at a slow speed, a stiff saw is all right. Such a man will contend for a stiff saw on any mill, judging from experience, but this is limited.

Centrifugal force is a natural strain that a high speed is exposed to, and no high-speeded saw will stand one-half the abuse that a moderate-speed saw will. One thing: it will cut just two or three times as much lumber. The higher the speed, the more and better lumber is made. If everything in connection with the saw is in perfect condition, and capable of standing it, 11,000 feet, or two miles, per minute on the rim is fast enough for most any of our mills. We sometimes find them running over 12,000—

10,000 is suitable for the average mill ; and if saw is ordered hammered to that speed, the sawyer should see that it runs very nearly to it.

All saws should be as stiff at their speed as the metal will allow. If properly adjusted, any saw can be made so. Saws running at a high speed are liable to crack or check, if not hammered right, which few men thoroughly understand. Many sawmakers overlook this, and where there is complaint of cracked saw, too often the sawmaker attributes it to fire cracks, bad gumming, and the like, when nine times out of ten it is in the tension.

Swing cut-off saws should not run over 10,000 feet per minute, owing to their being liable to fracture from being jammed or finished so often. A mill may be speeded up as it should and the saw not run well. This is when the saw needs hammering. If the sawyer can't do it, and has not the tools, he should send it to where it can be done. Too much time is often lost working with a saw needing hammering, to say

nothing of the lumber spoiled. Some saws have to be hammered very often, owing to the manner in which they are tensioned.

A thick saw will stand a higher speed than a thin one; but a rim velocity of 10,000 feet per minute is as fast as a saw ever ought to run. A taper saw will stand a higher speed than an even gauge, for the reason that the rim is lighter, and the expansion from centrifugal force will be less.

If a saw heats in the center, give it more set; if it heats on the rim, either the backs of the teeth are too high, or the saw is cutting with too much feed, and it chokes.

THE USUAL SPEEDS FOR CIRCULAR SAWS
IN REVOLUTIONS PER MINUTE.

12 inch, 3,000	30 inch, 1,200	58 inch, 625
16 inch, 2,222	34 inch, 1,058	60 inch, 600
18 inch, 2,000	38 inch, 950	62 inch, 575
20 inch, 1,800	42 inch, 870	64 inch, 550
22 inch, 1,636	46 inch, 800	66 inch, 545
24 inch, 1,500	50 inch, 725	68 inch, 529
26 inch, 1,384	54 inch, 675	70 inch, 540
28 inch, 1,285	56 inch, 650	72 inch, 500

and in proportion for intermediate sizes.

A 56-inch saw of first-class make and set,

running at 625 revolutions per minute, has cut 116 feet of poplar and pine boards per minute, and from 90 to 100 feet of oak per minute—using about 100 horse power.

It is estimated that in small mills, say of 10 horse power, a single saw will cut 4,000 feet of boards in 10 hours. In larger mills 1,000 feet per horse power per day is not an uncommon product.

How to Hammer Circular Saws.—An old sawyer gives the following advice on the care of saws :

The saw being the life of your mill, keep it in good condition. The chief element of this is in hammering and keeping the saw straight and true. The former we will term tension, which applies to keeping the saw open to accommodate the centrifugal force applied by its speed. The latter, straightening, applies to keeping the plate true and free from lumps. Saw hammering is a peculiar art, and accomplished by but few to any degree of perfection, simply from the many foggy ideas advanced by men, some of whom boast of their twenty years'

experience. I have stood for ten years at the lever, watching closely every so-called peculiarity of the saw.

The first thing is to straighten your saw. This is done on a wooden, firm, end-grain block or leather-padded anvil. All mill saws dish more or less from the log, and are full on that side. It is necessary to lean the saw until the center sags so that it will appear as straight as possible, then with a 20-inch straight-edge mark all the full places, watching closely just outside of the collar. Near the rim apply the straight-edge at right angles in several positions; it is best to use, say, a 12-inch straight-edge on the rim, as you can get closer to the teeth. Mark your saw with chalk or hard soap, on the rim, when you find places to show straight one way, but high the other way; make a long mark directly in line with the straightest way. This indicates a twist, and will in all cases on the rim extend toward the center of the saw. When the 20-inch straight-edge is applied on the radius (from center to rim), such a place

will not show, but take the 12-inch and apply across this line, and you will find it to be high. If there is a twist, it will be higher on the extreme edge. The straight pene hammer must be used on such places, the straightway of the hammer directly on the straightest way of the saw, which is toward the center. As the extreme edge is the highest, nearly all the blows must be applied there, care being taken not to go too far in. A twist showing six inches is often removed by hammering only on the rim. Twisted places are sometimes found at the center when the saw is dished.

Having laid off the saw, go to the block and strike one blow on every mark with the round face of the hammer, using the long face on the long marks. The first operation may dish the saw in the other way, which, if not too much, shows good work. Don't rub out your marks, and when the other side is laid off, notice if any of the marks correspond; if so, too heavy a blow was applied; in this way the heft of blows can be determined. Work on both sides of

the saw, getting the rim as true as possible and leave it leaning a trifle to the log. This constitutes a straightening. If your saw's tension is nearly right it will now run much better, but this is not always the case. I will add here that before attempting to straighten a saw as described, a careful inspection must be made. All saws get long or loose on the rim by use, and it is a common thing among small mills to find saws so loose on the rim as to form a twist or winding position; if not quite so loose, it will not be winding, but may appear nearly straight with the rim very flimsy, while the center will be as stiff as a board. In short, all such saws are stiff in the center and will not give, and must be tensioned before straightening.

This tensioning is done by stretching the saw nearer the center on an anvil with firm blows, regardless of the lumps in the saw. First, strike a circle line one-half way the radius, then two lines two inches apart below this, and one above, four lines in all. Hammer the two center lines first on both

sides of the saw, but if it is very loose on the rim, it will often require four to six lines; in such cases the lines can be closer together. Never go nearer the rim than one-third the radius, and not much closer to the center. Keep this in view. The one-half way part of the saw must be the more open. A saw open too near the center will not run at all in many cases. After giving your saw some tension, nine times out of ten your twisted saw, to your surprise, will show up straight. Sometimes a saw gets twisted through accident; such saws will show the center a little loose, and when they do, take the twisted saw to the block with a long pene, as stated. High-speeded saws require to be more open in the center, many of them dishing through with a snap. A saw too open will heat in the center and crowd from the log, while a saw too loose on the rim will snake and assume a complete wind or twist when a little hot on the rim. In such cases the center has to run hot in order to get anything like work out of the saw. A saw too open in

the center is stiffened by hammering the rim, not nearer than two inches of the teeth; very little work on the rim will change a saw. When the saw has about the right spring, straighten it up on the block; then a trial will determine its tension. If the saw will not screw up true, the collar should be turned. If a saw is to remain on the mandrel, it may be papered if the collars dish it.

It is very essential that unequal tension be corrected in a saw that runs at a high or even moderate speed. Not one man in fifty knows anything about this, to say nothing of how to remove it.

Unequal tension is this: One part of the saw being tighter or more open than the other. I could write a volume on this important part of the saw's life. Now, to remove it, and in the simplest way, screw the saw up on the mandrel, take hold of the tail of the saw with the right hand (if it is a right-hand mill) and spring the saw all you can to you, and at the same time apply the long

straight-edge and notice closely the opening. Apply the straight-edge say every six inches, moving the saw and noticing the variation in light. You will find some places spring more, while others remain nearly to the straight-edge; mark these places plainly. Now go on the outside of the saw, having everything free, so you can spring the saw, except the guide pins, which must be close to the saw. On this side mark the variations as before. If your saw has a loose place, you will find that it stood off more on both sides at that place. A tight place will stand off less and alike on both sides. In simpler words, loose places appear as though the plate was very thin, while tight places appear thick because they stand closer to the straight-edge on both sides of the saw, loose places the farthest away. An open place on one side which shows high on the other indicates a lump; such a saw is not true, and must be taken to the block and trued up.

To remove loose places, hammer near the rim opposite such a place. Tight places are

stretched right where they show it. For practical purposes, the saw should show very nearly the same spring all around. Always test both sides, and when even a slight variation is found it should be removed; then, if the saw is too open or too stiff, treat the center or rim a little on the anvil.

The foggy method is to always hammer a saw on the anvil, striking it as heavily as possible. When a saw requires a little straightening, it is mostly on the rim (the outlet of the saw); if this is done on the anvil, what is the result? Lumps partly beaten down, with all the tension gone; then the hammerer goes to the center to overcome just what he ought not to have done. A few blows on the block, and the saw would have retained its tension—been in better shape with ten times less work. No man can remove a twist in this way, directly on the rim. I have noticed over fifty such men, and they never get right up to the rim of a saw. Why? Because it will curl up, every time, on the anvil.

Test this with a piece of sheet iron and be convinced. The tinner, iron and copper-smith are sensible men; they have their copper or mallet hammer and a smooth block to straighten their work on. Why? Because only a blow or two on an anvil would stretch it into a wind, and then they are done. The saw is precisely the same way, and it remains only a question of time that the saw will be unequally tensioned, and then it is done. A man that knows anything about tension in a saw will take care of that vital part. Take a dished saw that requires only a few light blows near the collar, on the block. What does the foggy do? Stretch the rim, "pulling the dish" out, and a lot of other foolish things. A saw too open requires the rim stretched, but never a dished saw. Another idea is to hammer in lines from the center to the rim, only to result in tight and loose lines and to buckle the saw. A man of gumption ought to know better than this, and this is the cause of many fractured saws. Others' theories are, that when a saw is sprung it

must be sprung more to get the lump back. My idea is, if it is sprung it ought not to be, and should be gotten back without additional stretching, namely: the block.

Small saws are treated precisely as large ones, but much more mildly. An expert, changing from a thick saw to a thin one, invariably will strike too heavily; great care must be exercised. They require but little tensioning, and should be stiff. Blue spots are treated on the block, and when they come back the rim should be stretched opposite such a place. Their appearance continually indicates a loose place.

Horse Power Required to Run Circular Saws.—The horse power required to drive circular saws doing no work, according to experiments, is represented by the

formula: $\text{Power} = \frac{n d}{32,000}$ in which n is

the number of revolutions per minute and d the diameter of the saw in inches, to which the net power for cutting should be

added, which is $\frac{A C}{12}$ for soft wood and $\frac{A C}{6}$

for hard wood. A = square feet of surface of lumber cut per foot in length ; C = thickness of kerf or cut in decimals of an inch.

For example, a 56-inch saw running free at 650 revolutions per minute requires a speed power of $\frac{650 \times 56}{32,000} = 1.14$ horse power ;

and to cut pine logs that will make an average of 10 boards of 12 inches in width, the area of surface for 13 cuts, including edging, in the log for each foot in length = 13 square feet ; and if the saw cuts a kerf .2 of an inch wide, then for 30,000 feet per day of 10 hours the amount will be

50 feet per minute. By the formula $\frac{A C}{12}$

for pine and white wood, $13 \times 2 = 26$ square feet of board surface per foot in length and.

$\frac{26 \times .2}{12} = .43 \times 50 = 21.5$ horse power, and

for hard wood $\frac{26 \times .2}{6} = .86 \times 50 = 43$ horse

power ; to each of which should be added 1.14 horse power for the saw alone and enough for running intermediate shafting and belting.

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