GRIMSHAW ON SAWS

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SAWS:

THE HISTORY, DEVELOPMENT, ACTION, CLASSIFICATION AND COMPARISON OF SAWS OF ALL KINDS.

WITH APPENDICES

CONCERNING THE DETAILS OF MANUFACTURE, SETTING, SWAGING GUMMING, FILING, ETC.; CARE AND USE OF SAWS; TABLES OF GAUGES; LOG MEASUREMENTS; LISTS OF SAW PATENTS, AND OTHER VALUABLE INFORMATION.

PROFUSELY ILLUSTRATED.

BY ROBERT GRIMSHAW, PH.D.

Member of the Franklin Institute; of the Société des Ingénieurs Civils (Paris); of the American Society of Mechanical E gineers, etc.

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1880.

INTRODUCTION.

The literature of the saw considered as a tool is very meager, although there are a few not altogether impartial treatises on wood-working machinery, by leading manufacturers and others. Since Holzappfel, in 1846, there has been nothing of importance written on the subject.* But in this work, and at that date, the band saw is dismissed with a few lines; the mulay was uninvented, or unknown; inserted tooth circular saws not dreamed of; the M-tooth shown as a curiosity, and the dimensions and working capacity of the circular and other saws, correct as they were for that date, would make the present reader smile. Saws are now much thinner, have better teeth, are of better steel, and run at double the speeds there laid down. Mr. Joshua Rose, in a lengthy article in the *Polytechnic Review*, Dec., 1876, went quite thoroughly into the action of certain kinds of saw teeth; and his intelligent articles on straightening plates were the first accurate and complete published matter on that subject. From these sources the author has drawn liberally and in some cases literally.

The writer has tried to be thorough and impartial. Naturally his personal knowledge of some makes of saws (notably in the lines of cross-cuts, hand-saws and circulars) is greater than others; some makers and users were much more liberal and detailed in giving data than others, and if their saws receive greater prominence than the others, it is not the writer's fault nor intention, and can be remedied in case a second edition be called for. There are many cases in which information was refused after repeated requests.

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*Since writing the above, and after this work was partly printed, the author's colleague upon the Wood Working Machinery Jury of the Paris Exposition of 1878, Prof. Exner, of the Vienna Practical High School, has issued, in the German language, a very exhaustive treatise on Saws and Sawing Machinery (*Hand Säge und Säge Maschinen.*)

INTRODUCTION.

The collection of material for such a work is at once amusing and annoying. The most contradictory opinions and most impossible data are met with. In the matter of horse power, as engineers differ so largely as to the rating of boilers and engines, it is not remarkable that steam users should differ or err in their calculations. It is not common to apply dynamometers to sawing machinery; and as this book is not on sawing machinery, and as the power required differs so with the condition of the lumber and the form and sharpness of the saw teeth, etc., we may let that go for a time, and say to users of machines, "A little too much belt power is about enough."

Unless specially stated otherwise, the figures and statements in this work refer to American practice.

The author begs to acknowledge his indebtedness to the following gentlemen and firms for friendly aid in furnishing data, granting interviews and answering detailed questions in person or by letter. Those marked with an asterisk furnished engravings:

American Saw Co.*
E. Andrews.*
Anoka Lumber Mills.
Henry L. Beach.
E. M. Boynton.*
Chapin & Barber.
Curtis & Co.*
Henry Disston & Sons.*
Eau Claire Lumber Co.
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Emerson, Smith & Co.*
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Stearns Manufacturing Co.*
Geo. Tiemann & Co.*
Trump Bros.*
Waterous Engine Works.
Wyman, Buswell & Co.

Some engravings and information arrived too late for use here, but will be used and duly acknowledged should another edition be called for.

TO MY GOOD FRIEND,

JULES ARMENGAUD,

CONSULTING ENGINEER; ANCIEN ÉLÈVE DE L'ÉCOLE POLYTECHNIQUE; SECRETARY OF THE SOCIETY OF CIVIL ENGINEERS, PARIS, &c.;

MY COLLEAGUE ON THE INTERNATIONAL JURY OF AWARDS, AT THE UNIVERSAL EXPOSITION OF 1878:

IN FRIENDLY RECOLLECTION OF OUR HARMONIOUS WORK TOGETHER, AND IN APPRECIATION OF HIS VARIED ATTAINMENTS, HIS ADMIRABLE SOCIAL QUALITIES, AND HIS WELCOME HOSPITALITY,

THIS BOOK IS DEDICATED.

INDEX.

[Illustrations marked (*). "Saw" abbreviated s.]

SAWS.

[The present paper will not consider in detail the question of *sawing machines*, but will be devoted to the implement itself, the blade or saw proper. Sawing machines will be thoroughly considered in the writer's forthcoming work on Wood-Working Machinery.]

The saw is one of the most ancient, useful and familiar of tools. The generic term applied to a serrated dividing tool is generally understood as applying to a saw for wood, although the implement is used also for bone, stone, metal, ice, etc.* (There is also a familiar limitation to a reciprocating hand tool). The ancient Egyptians, far back in the silent centuries, knew and used this tool, the material being bronze, hardened by an art now lost. The Greeks, masters of many and far-sailing wooden ships for war and exploration, deified the inventor, who comes down to us as Tälus or Perdrix. The original saw was, doubtless, a flat notched or jagged piece of metal like a nicked knife blade, having no special form of teeth, but used with a straight reciprocating stroke, and for either ripping or cross cutting. It cut on both strokes. The saws of the stone age had flakes of flint imbedded in a wooden blade and held by means of bitumen. The Mexicans used obsidian for saw teeth. The South Sea Islanders employ sharks' teeth, and the Caribs use notched shells.

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* Stone sawing, in the ordinary sense of the word, is not sawing, but abrasion in a narrow line by means of loose sand or iron shot, pressed in by a reciprocating blade, while it is also accomplished by diamonds set in iron blades. So-called "saws" for india-rubber and some of those for cold iron rails are plain unserrated disks, no more to be considered under the head of saws proper than Miss Edgeworth's essay on Irish Bulls among works on Natural History.

The saw is mostly used for converting wood and other materials from original forms, and naturally precedes the plane and other tools, although it follows the ax. It does its work with considerable speed and accuracy. In some elaborate and highly ornamental arts it is nearly the only tool used.

The importance of scientific and economical timber-cutting may be conceded when it is asserted that the annual value of the wood, lumber and timber crop of America is a billion dollars ($1,000,000,000), or four times that of our wheat crop. The immense waste in cutting timber, with the millions of axes now in use, is almost incredible. The tough and knotty timber and chips now wasted in cutting cord wood might be saved by cross cutting with saws into short blocks, say one foot long, making good stove wood.

It is computed that the saving of timber and time by the scientific use of saws would equal the interest of the United States public debt; to say nothing of lightening the toil of millions of farmers.

As we now know the saw it is either RECIPROCATING or CONTINUOUS in action; the first class having a flat blade and practically *straight edge* and making a plane cut; and the latter being either

(1) a *circular rotating disk,* cutting in a plane and at a right angle to its axis;

(2) *cylindrical,* or barrel-shaped, with a convex edge, cutting parallel to its axis; or

(3) a continuous ribbon or *band,* running on two pulleys and making a plane or curved cut, with a straight edge, parallel to their axes of rotation.

There is a fourth class, or *spiral* saw, composed of segments clamped between plates, and cutting a dovetail joint (Armstrong's patent). The entering segments cut like a circular saw; subsequent segments are flanged—at first slightly, and gradually more and more; these later segments have the cut of a cylinder saw.. As the flange wears away by filing, the segments are moved on towards the unflanged end of the spiral.

Between the *Reciprocating Rectilinear* and the *Continuous-acting Curvilinear* saws may be classed the *Chain Saw;* its many varieties having either one or two axes, at right angles to the plane of cut; cutting with either a concave, a convex, or a straight edge, and either reciprocating or continuous in action. It is essentially a saw composed of *links* like a chain, and is a connecting link between the two other classes.

We shall consider these classes in sequence, after having gone into the theory of the shape, disposition and action of saw teeth, as applied to the earliest, simplest and most common class, that with reciprocating rectilinear blade.

The blade of this kind of saw is usually a thin sheet of steel, rolled evenly thick, having the teeth then cut out with a punch; the blade then smithed or pressed perfectly plane or flat; ground, principally crosswise, to perfect the surface and reduce the thickness at the back; the teeth then sharpened and set.

This class of saw has more forms of teeth than any of the others. Its teeth are formed at greatly varying angles and made to cut either way or both ways; sometimes one series of teeth cuts in one direction and another in the opposite on the same blade. In the first case the effective or cutting stroke is either by pulling or by pushing. The carpenter's saw of the ancient Greeks was a straight frame, with perpendicular teeth, and two-handed—doubtless cutting both ways.

The saws of all Asia do not, and those of ancient Greece did not, employ the *thrust* cut, which gives the straightest cut and the freest from sawdust; but cut on the *back* or pulling stroke. But we shall refer to this subject later on, and consider now the outline of the teeth.

It is necessary to premise that the *pitch* of a tooth means the *angle* of the face up which the shaving ascends; not an *interval*, as with screw threads. Small teeth are counted in *points* to the inch; those of large saws by the space expressed in *inches* or in parts of an inch.

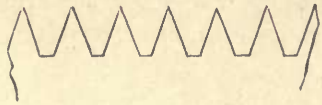
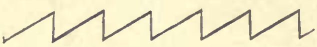
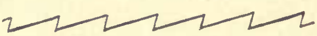
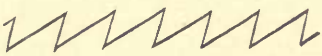
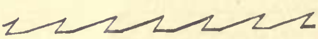
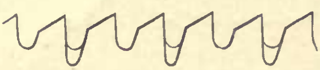
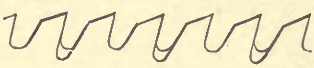
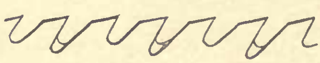
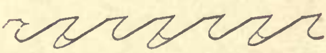
The real angle of a point is found by subtracting its back angle from its front.

The generic angle of saw teeth is 60°; being that of an equilateral or "three-square" file. But this may be variously placed. Thus, in Fig. 1 D is upright, having no pitch; G is flat, having plenty.

In the annexed table of angles and spaces the pitches are classified 15° asunder.

Table I.

Simple forms of saw teeth, from Holzapffel.

			Angles. Face.	Angles. Back.	Ordinary spaces. Inches.	
A		Peg; fleam.	110°	70°	$\frac{5}{8}$—$1\frac{1}{4}$	
B		Plain M.	90°	30°	1—$1\frac{1}{4}$	
C		Half Moon.	90°	35°	1—$1\frac{1}{4}$	
D		"Cross-cut"—no pitch.	120°	60°	$\frac{5}{8}$—$1\frac{1}{4}$	
E		Small cross-cut—slight pitch.	105°	45°	$\frac{3}{8}$—1	Also 3 to 60 points.
F		Pruning; ordinary pitch hand-saw; joiners; English cross-cut.	90°	30°	$\frac{3}{8}$—1	Also 3 to 60 points.
G		Metal; mill saw—soft wood.	75°	15°	$\frac{1}{4}$—$2\frac{1}{2}$	Also 3 to 60 points.
H		Some circular saws—pit; cross-cut; bath stone.	75°	30°	$\frac{5}{8}$—$1\frac{1}{4}$	
I		Mill.	90°	50°	$\frac{3}{8}$—4	*
J		Circular.	60°	15°	$\frac{5}{8}$—2	*
K		Hard wood cross cut. (Gullet or briar tooth.)	90°	30°	$\frac{3}{8}$—$3\frac{1}{2}$	*
L		Pit; circular. (Gullet or briar tooth.)	75°	20°	$\frac{3}{8}$—$3\frac{1}{2}$	*
M		Pit; circular. (Gullet or briar tooth.)	60°	10°	$\frac{3}{8}$—$3\frac{1}{2}$	*
N		Soft wood; ripping. (Gullet or briar tooth.)	45°	5°	$\frac{3}{8}$—$3\frac{1}{2}$	*

* Sometimes each alternate tooth is cut out; then it is "skip-tooth."

The peg tooth, Fig. 2, has rather more throat room than a \/ tooth (Fig. 3) of ths same width and height, and less than if it were cut deeper, as by the dotted lines, Fig. 4. Being generally more acute than 60° it could not be dressed with either a three-square or a flat file if in \/ shape; as it is, a flat or "mill" file dresses it admirably.

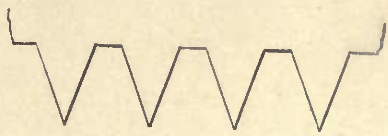


Fig. 2. Peg Tooth.

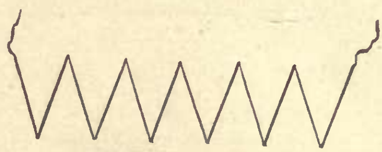


Fig. 3. V Tooth.

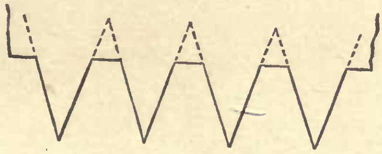


Fig. 4. Peg Tooth.

A saw tooth has two functions—*paring* and *scraping.* A *slitting or ripping* saw for wood has the cutting edge about at a right angle to the fiber of the wood, severing it in one place; the "throat" of the tooth wedging out the piece.

In a "*cross-cut*" *wood-saw,* also, the cutting edge strikes the fibre at right angles to its length, but severs it on *each side* from the main body, before dislodging it.

In the slitting saw, N, Fig. 1, the "rake" is all in front, where the cutting duty is. In the cross cut, as D, the rake is on the side, for the same reason.

The *length of tooth* depends largely upon the duty required. A long tooth has the demerit of being weak and liable to spring; the merit of giving greater clearance to the sawdust—a specially valuable feature in soft, wet or fibrous woods. It is certain that the throat space in front of each tooth must be sufficient to contain the dust of that tooth from one stroke. If (as in a short tooth) the space be not high enough, that quality can be gained by distance between the teeth. For hard

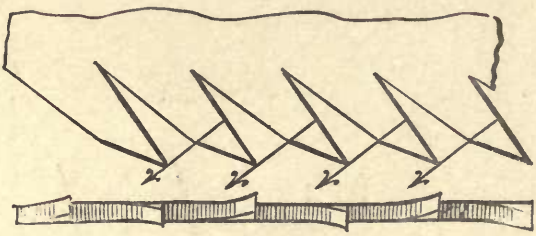


Fig. 5. Great Front Rake.

woods, where long teeth are inadmissible, it is best to have short teeth, wide spaced. The deeper the tooth the quicker the saw wears out.

The greater the feed the deeper the dust chamber required, or else the more teeth needed.

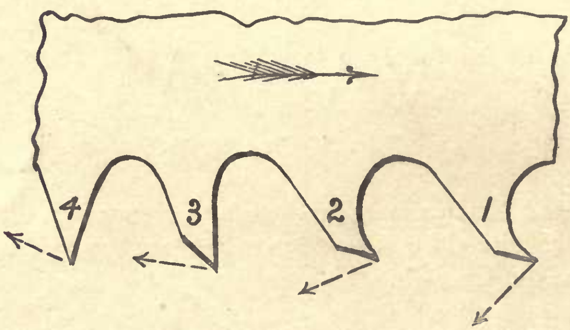


Fig. 6. Showing Various Rakes of Teeth.

Equal length of teeth is of great importance; as inequality gives the longest teeth the most work and lessens the duty of the saw; giving fewer cutting teeth and dulling them quicker.

Where the teeth are close, the shape of the throat is of special influence.

As regards the tendency of teeth to spring into the work: A form such as Fig. 5, having great front rake, is keen but liable to spring in and break, especially if long and in hard wood. In Fig. 6, tooth 1 has maximum front and minimum back rake. 2 has less hook but more back rake, tending to spring the point down into the wood. 3

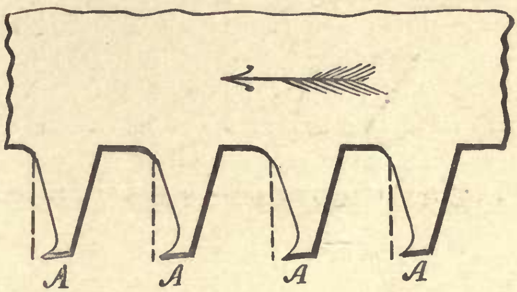


Fig. 7.

has no front rake but considerable back; in 4 the front rake is less than nothing and the keenness is largely dependent on the back edge.

Fig. 7 is recommended for heavy saws for general purposes.

This has a rake to the front of the point, and yet the tendency to spring in is compensated by the backward inclination of the whole tooth; and the cutting edge is well supported. There is ample dust

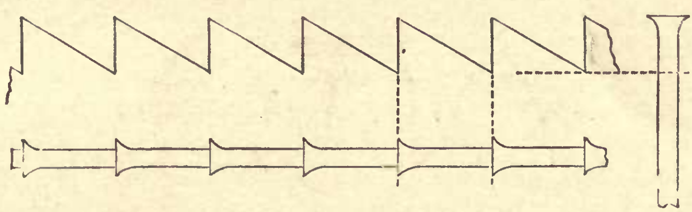


Fig. 8. Spread Set.

room; the rounding corners give strength and immunity from cracking and prevent dust lodging. The backward inclination (as in a planer tool) prevents spring or chatter.

We may now consider briefly the question of *Setting*, or bending the teeth laterally, alternately to the right and left; partly with a view to decreasing friction and increasing clearance, and partly to increase the cutting action of the teeth, and make them *cut* rather than *abrade*. (The earlier nations bent the points of a dozen or so of adjacent teeth to one side, and those of the next group to the other.)

"*Swaging*," is another operation having the same objects—giving clearance, preventing binding and heating, and giving increased keenness to the teeth. In this operation each tooth is upset or widened at its point so as to project beyond the blade at each side; differing in this respect from spring setting. See Fig. 8.

Swaging or upsetting is especially beneficial for soft steels and for saws used in soft wood, as it condenses and hardens the metal.

In connection with spring set must be mentioned *side or cross angle;* a bevel or "fleam" given the edges and materially affecting

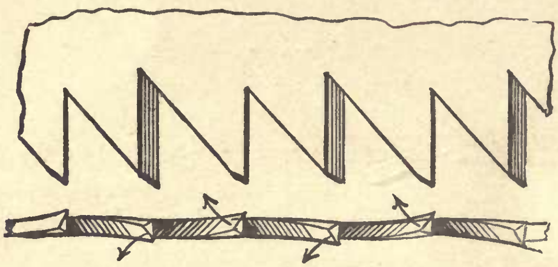


Fig. 9. Spring Set and Side Angle.

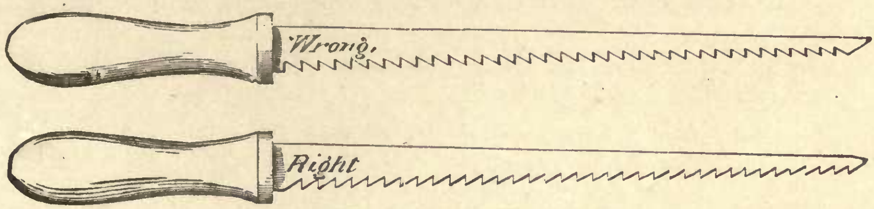
their sharpness and the angle at which they receive the strain of work; as also their retaining their keenness and set.

Fig. 9 represents the magnified teeth of a common hand saw with spring set.

The front edges have a bevel which throws the strain at right angles to the plane of that face (as shown by the arrows). The tendency is to throw the tooth in the *direction* of its set; and any one tooth having more spring set than the others will take undue work; will dull sooner and then spring *away* from its duty, lessening the set and causing friction and heating.

A tooth without fleam or side angle, Fig. 7, has no side strain, other than that due to the spring set. This fleam or cross angle decreases with the thickness of the blade; hence while not fit for heavy saws is proper for hand saws, which, also, have a slow duty. It is better for soft woods, which are free from knots, than for hemlock or spruce, the hard knots of which would break fleamed teeth.

Referring to Fig. 6, tooth 1 would buckle and bend if given any spring set; 3, even if excessively long, would admit of ample.



Figs. 10 and 11. Keyhole Saws.

While the teeth remain sharp, spring set tends to increase; when dull, to decrease.

Even setting cannot be over-rated in importance. The tendency of set is to come back. Hence it is sometimes best to first *overset*, then

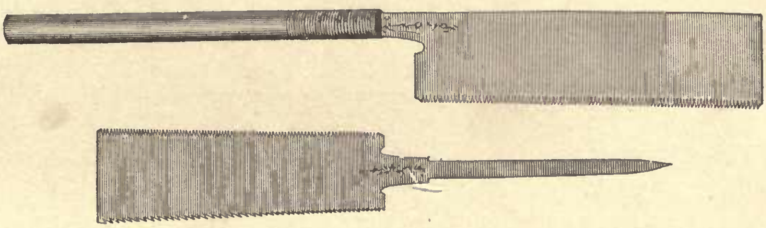


Fig. 12 and 13. Japanese Saws.

spring back. The setting should not be at a sharp angle but on a *curve.*

Even Swaging is as important as even spring set. A saw with the teeth spread the full width of the kerf will stand more feed than if

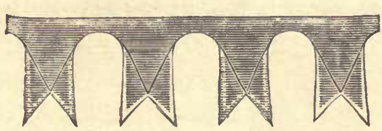


Fig. 14. Boynton's M Tooth.

each alternate tooth be bent for the set. Of the fifteen saws tested at the National Sawing Contest at Cincinnati, 1874, we believe that not one was "spring set."

The smaller the saw the greater the advantage of spread over spring set.

The operations of sharpening, setting, and swaging are described in detail in appendices to the present work.

Metals, bone, and hard fine-grained woods, require small teeth with

Fig. 15. Front Edge View, showing two Points of M Tooth dressed to cut in line on one side and two the other

little or no set; ice, and soft coarse-grained woods require them large, widely spaced, acute angled, and much set.

Wet wood is softer and more easily cut than dry, but requires a keener and coarser set saw, giving greater waste. *Gummy and resinous materials* and *ivory* require very keen teeth and slow speed, to avoid the

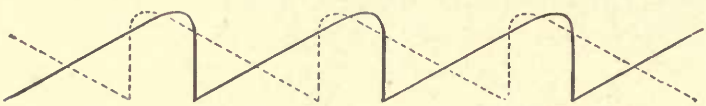


Fig. 16. Showing Space occupied by M *Tooth.*

dust being softened and made adhesive—which tendency is lessened by greasing the blade.

Table 1 shows the adaptability of various shapes and sizes of teeth to different work.

As regards the question of *pulling or pushing cut,* those of us who

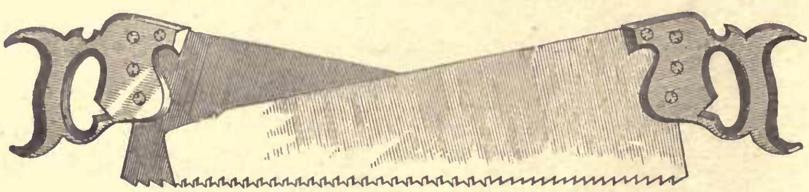


Fig. 17. Double Cutting Action of M *Tooth Hand Saw.*

have smiled—perhaps audibly—at the Japanese with their backward working saws, should bear one thing in mind before condemning *in toto* the pulling cut—that for keyhole or any other flexible-bladed saws, the backward or pulling cut is the best; and our own usage with that exasperating implement the keyhole saw, is much more ludicrous and unphilosophical than the pulling out of the Niphonese.

Figs. 10 and 11* show the common or incorrect, and also the correct mode of placing the teeth of keyhole saws.

The Japanese saws are shown in Figs. 12 and 13.

The M tooth may be classed among those having no front rake; but ingeniously arranged so as to cut upon *both* strokes. Upon the same base as the ordinary V tooth are erected, in the same line, two teeth, or a double tooth; an M, in fact, with cutting edges fore and aft; its adjacent neighbor being alike M-shaped and sharpened on all edges, but generally both beveled and set oppositely. It may be said to do the

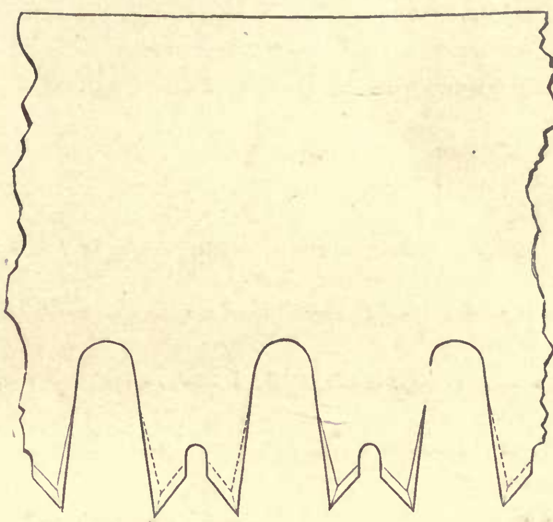


Fig. 18. "Lightning" Teeth.

same work, and have the same strength, as a tooth with no front rake; but in the same space arranges for a cut precisely as though the saw had been reversed. The M tooth is sometimes expressed as in Fig. 14. As the $\wedge$ angle in the ordinary M would be difficult to keep sharp, and ruinous to file-corners, it is now furnished by Boynton with a gullet, making it very economical of files and ensuring keen edges. The M teeth, which are veritable cutting edges, are edged on an oil-stone, after filing. A variation of the M tooth has its front edges raking backward, while it is still a double tooth; and we may style this the "W tooth."

* From *Polytechnic Review.*

One important feature in the construction of some hand rip saws and mill saws is that they have coarser teeth at the heel than at the point, so that fine teeth commence and coarse ones finish the cut. Fine teeth cut at the outset more smoothly than coarse ones, but as soon as they become clogged with sawdust they lose their efficiency to a great degree. As this partial clogging becomes more troublesome at the latter end of the stroke this "increment tooth" arrangement (similar in principle to the increment-toothed file so favorably known) brings the larger teeth into play just where they are needed, and while obviating the rank tearing of coarse teeth at the commencement of the cut, reduces the amount of splintering at the bottom of the kerf. This arrangement also makes the saw strongest at the heel and lightest at the point. See Fig. 19.

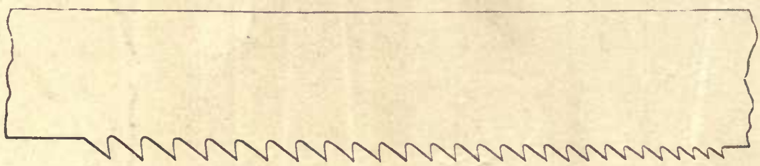


Fig. 19. Andrews' Increment Toothed Mill Saw.

The Reciprocating Rectilinear saw has many varieties. It may be

(1) strained in a frame or sash, and guided on both strokes, while cutting on one only;

(2) guided at both ends but not strained; pull cut;

(3) free at one end, with pull cut;

(4) free at one end, push cut;

(5) free at one end, cutting on both strokes;

(6) strained in a sash, guided on both strokes, and cutting on both;

(7) unguided at either end; handle at each end, and cutting on one stroke;

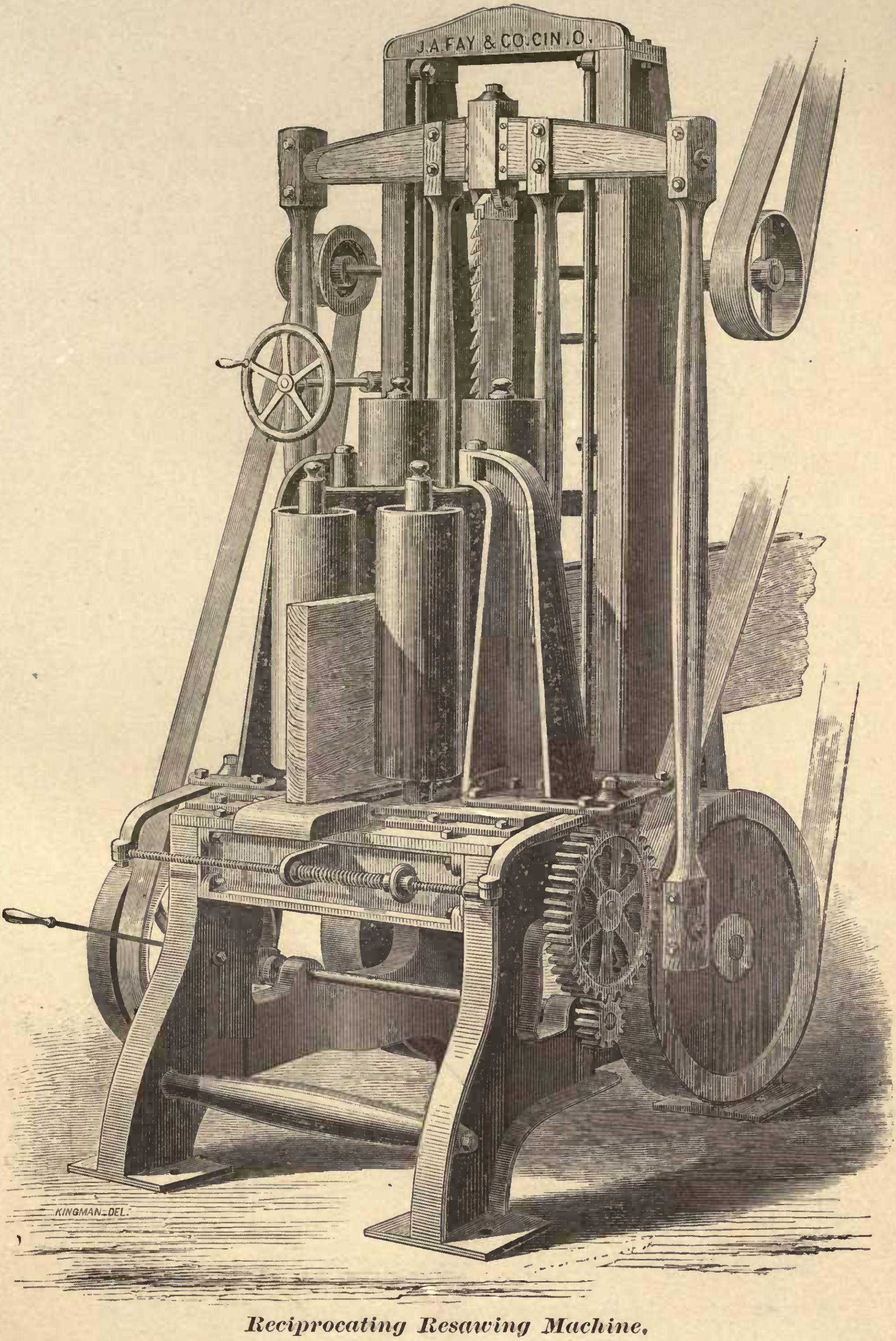
(8) unguided at either end; handle at each end, cutting on both strokes;

(9) strained by a weight at one end, cutting on one stroke;

(10) strained by a spring at one end;

(11) strained by a spring frame.

The *Single Sash Saw* is now out of date in this country; being rapidly superseded by the mulay and circular. A mulay with the same



Reciprocating Resawing Machine.

power applied will do nearly double the quantity of work, owing to its greater lightness and speed.

A single sash saw will make 150 to 200 strokes per minute and cut

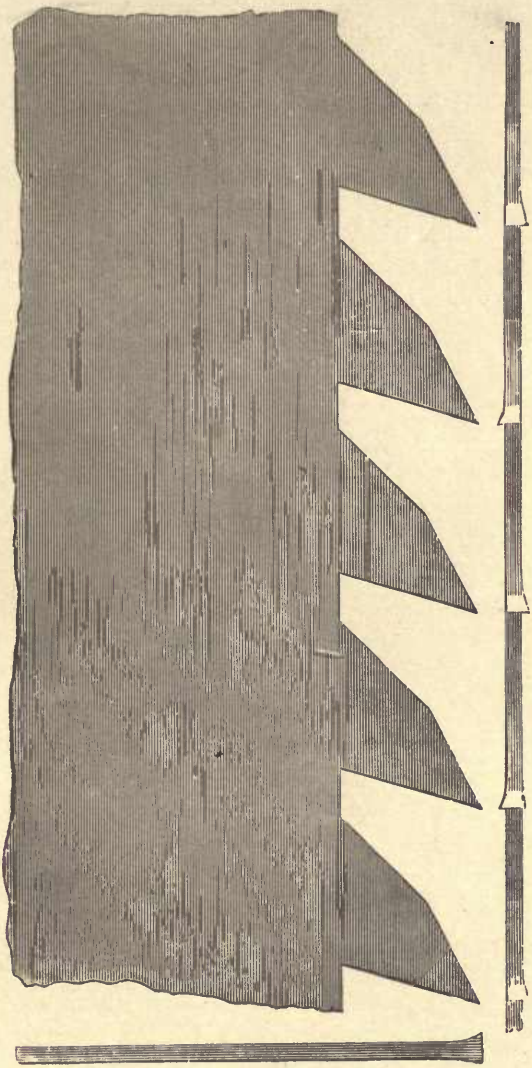


Fig. 20. Mill-Saw Tooth.

about $\frac{3}{4}$ inch in hard and 1 inch in soft wood, at each stroke. It is generally 5 to 9 gauge.

Fig. 20 is a form of mill-saw tooth (Hoe & Co.)

But while the single sash saw cannot compete with the circular in speed of cut or quantity of lumber turned out, the *gang* sash, having several blades strained in one frame, has a greater *collective* speed and capacity; and in the form of the "deal-frame" used in England to resaw squared logs, is one of the most effective of all saws; making little kerf, having a high speed, and cutting many boards simultaneously; while gang-sawed lumber brings a higher price than that from circulars.

Fig. 21 shows one of the most improved American gang sash machines. The sash is 38 inches wide and contains 26 saws each 4½ feet long and 9 inches wide, No. 14 gauge; teeth 1¼ inches from point to point and the same depth, swaged to cut a kerf but $\frac{5}{32}$ inch wide. The "cant" is from 10 to 25 inches deep, the stroke 19 inches and the speed 225 revolutions (and consequently full cuts) per minute, at a feed varying from ⅜ to 1 inch each cut, according to the kind of timber. The machine is run by a double belt 20 inches wide over a driving pulley 4½ feet diameter, requiring an engine of 16 inches bore, 20 inches stroke, making 175 revolutions per minute at 60 lbs. pressure. The average capacity is 70 M feet of one inch lumber per day of ten hours —although it may be worked up to 90 M in the same time.

Fig. 22 shows a gang of Andrews increment toothed saws and the mode of hanging them so as to give proper "overhang."

The gang sash requires less labor to produce 1000 feet of lumber than the circular does. It works best in connection with a large circular which slabs the large logs into cants for it. The small logs had best be left to a small circular to saw into boards, scantling or other small timber. This gives the gang continuous work on timber worthy of it.

A gang making 240 strokes per minute will take about ¼ to ¾ inch feed per stroke in 12 inch cants, *i. e.* from 1 to 3 inches per second, according to the timber. The blades are, as a rule, made narrower at the ends than in the center. They are generally 8, 9 and 10 inches wide, from 10 to 16 gauge.

The thinnest saws possible with a fast gang are fifteen gauge.

The principal advantage of the gang is the extreme regularity in thickness of the boards it makes.

The Mulay or Muley Saw (probably named from the German *Mühlsäge, mill-saw*) comes under the head of blades guided at both ends but unstrained. It has a pull cut and very rapid cutting speed, exceeding

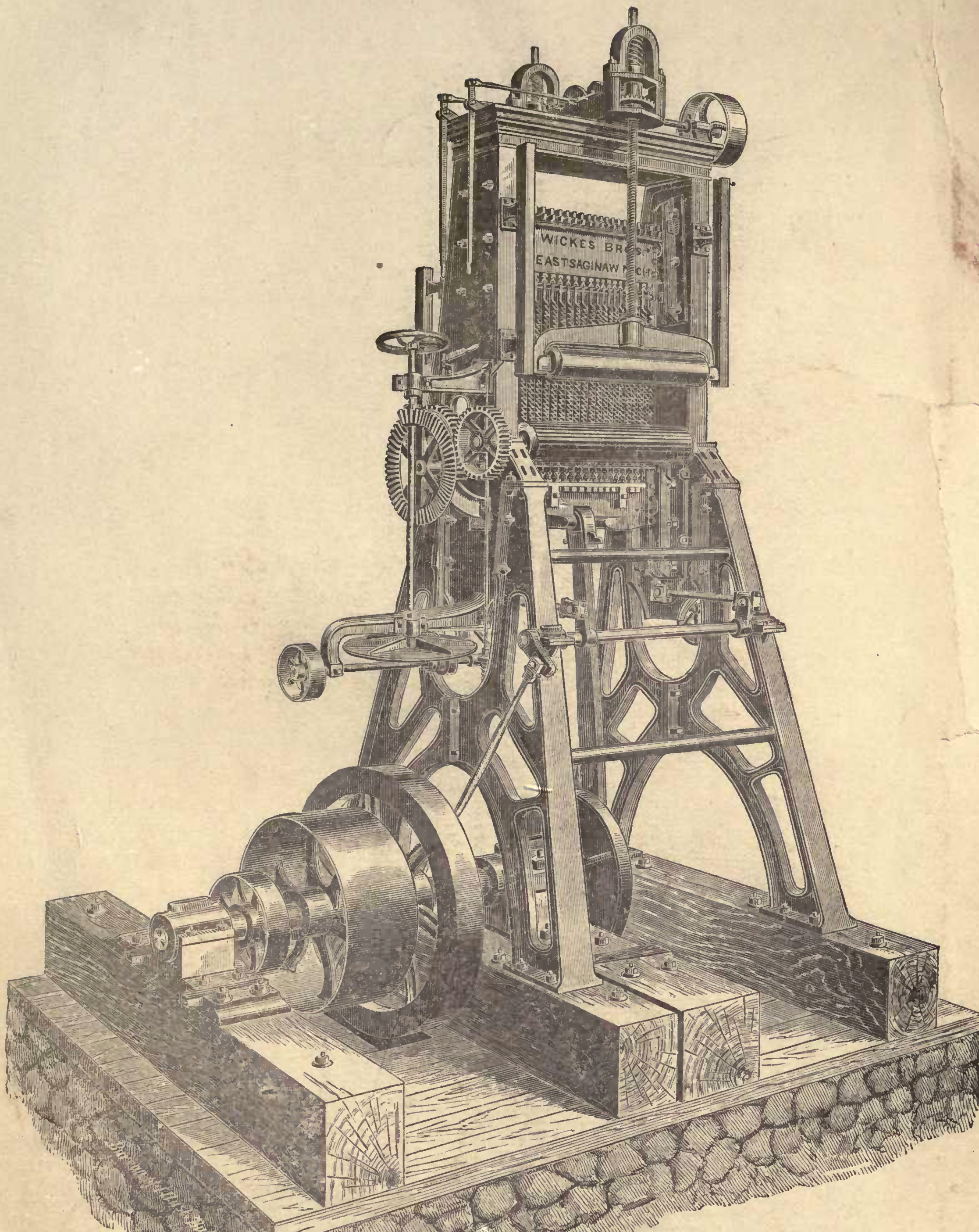


Fig. 21. Wickes' Gang Sash.

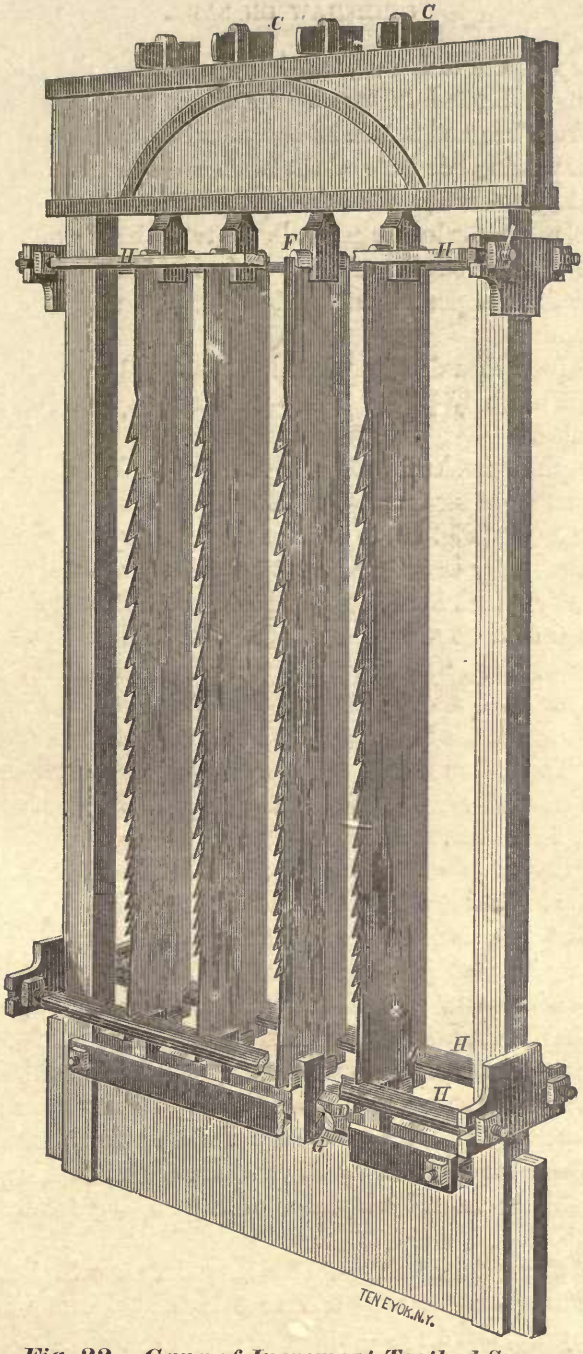


Fig. 22. Gang of Increment Toothed Saws.

in this respect the sash saw, which by reason of the inertia of the frame is more limited in speed. Its use is mainly in the Western States of America; and it is in its inception essentially bold and American. There being but little of the blade exposed unguided, its use at high speed is, however, quite safe. (See Addenda.)

The mulay saw for logs is generally 10 to 12 inches wide and ¼ inch thick, and making strokes of 20 to 24 inches at the rate of from 300 to 400 revolutions per minute, giving a cutting speed of about 600 feet per minute.

Mulay saws, when first introduced, were full ¼ inch thick. Now they are in use only ⅛ inch thick—but generally are No. 7 gauge or $\frac{3}{16}$ inch thick.

The length of stroke for some log-cutting mulays 7 feet long is 28 inches; number of strokes 200 to 225 per minute.

The mulay jig (Fig. 23) is perhaps the best for soft wood.

A "smart mulay saw" making 350 to 400 strokes per minute will cut ordinarily ⅜ inch hard and ¾ inch soft wood at each stroke.

Mulays are almost always the same width heel and point. A correspondent writes: "Some years ago, a party in Auburn, N.Y., took out a patent for a mulay mill that used a tapered saw wider at the top than it was at the bottom, but it was a failure."

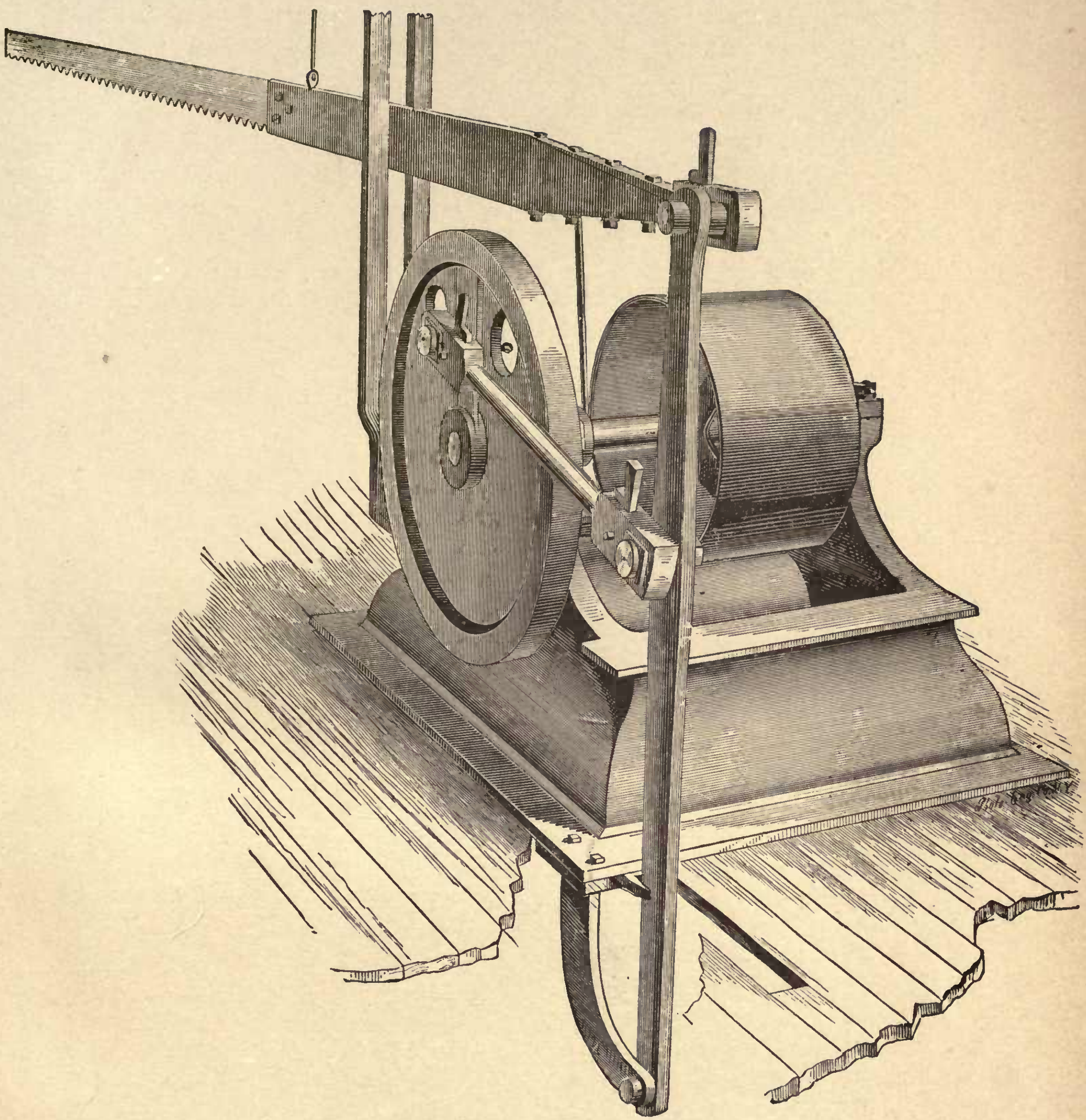
Mulay gang and mill saws were formerly made thicker on the front edge than on the back; but for some years past they have been given the same thickness on both edges.

The mulay *scroll* saw shown in Fig. 23 has a 3 inch stroke, and makes 1000 to 1500 revolutions per minute, receiving its power through a 3 inch belt on a pulley 6 inches diameter.

The Drag Saw, as its name implies, cuts on the pulling stroke. It is unstrained and unguided at the free end; and is, in fact, the Japanese hand saw, power driven and guided at the butt. Its stiffness is of course greater than that of a mulay of the same thickness; and it may be made thinner for the same duty. Its use is mostly limited to cross cutting felled logs and ship timbers; though more recently there has been brought out by A. Ransome & Co., London, England, an admirable horizontal adaptation of it to felling trees. (Figs. K and L.)

Fig. 24 shows the attachment of a large drag saw for butting.

The butting or drag saw is 7 to 8 inches wide at butt, 5 to 6 inches at point, and 10 gauge.



Stearns' Drag Sawing Machine.

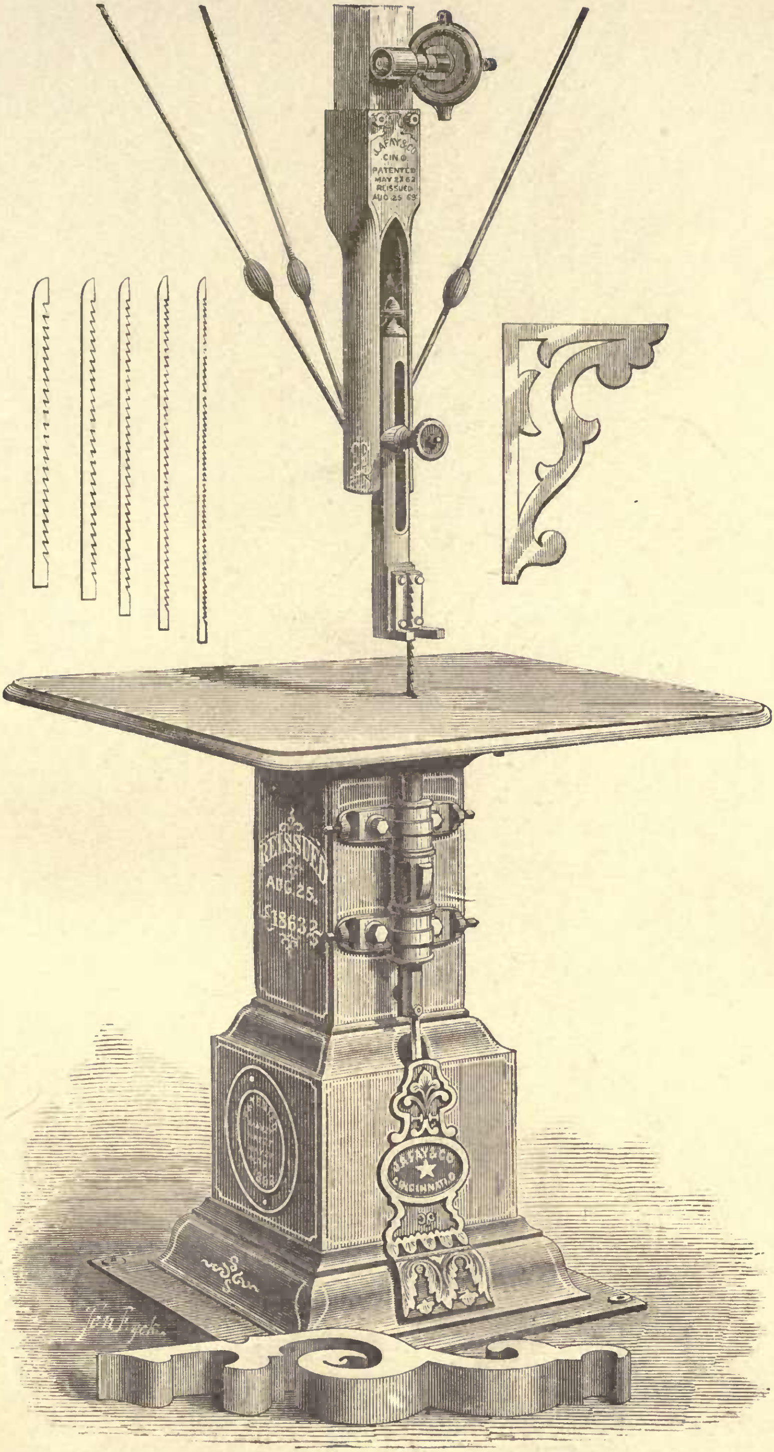


Fig. 23. Fay's Mulay Scroll Saw.

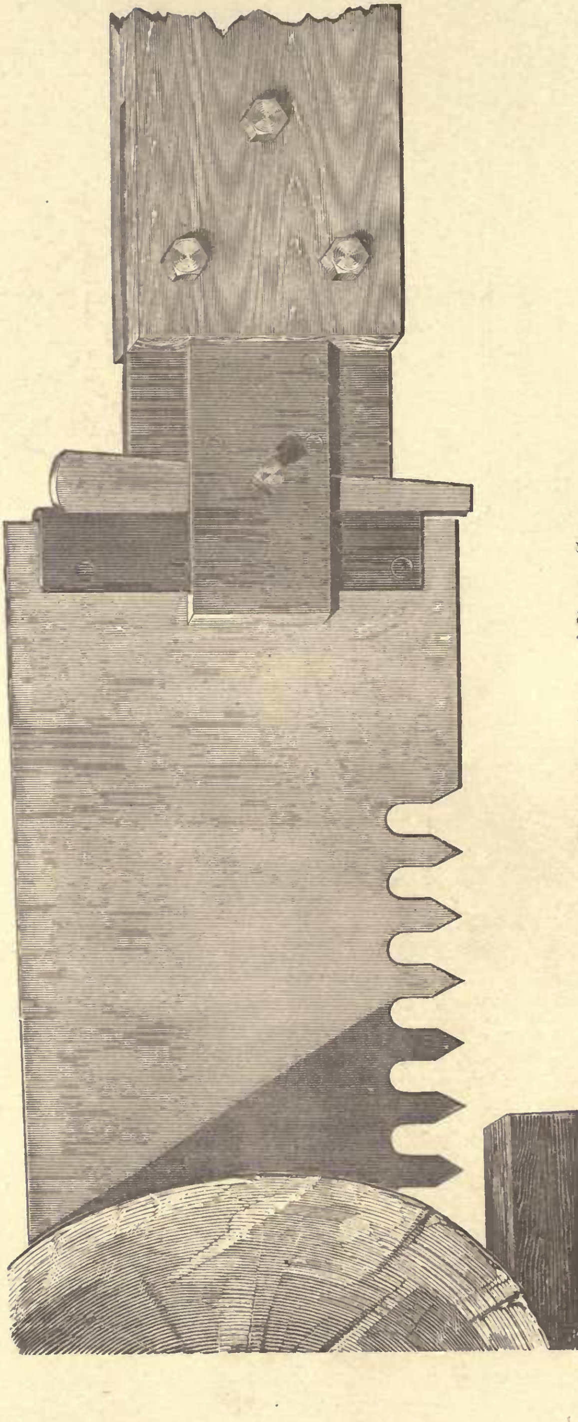


Fig. 24. Part of Drag Saw.

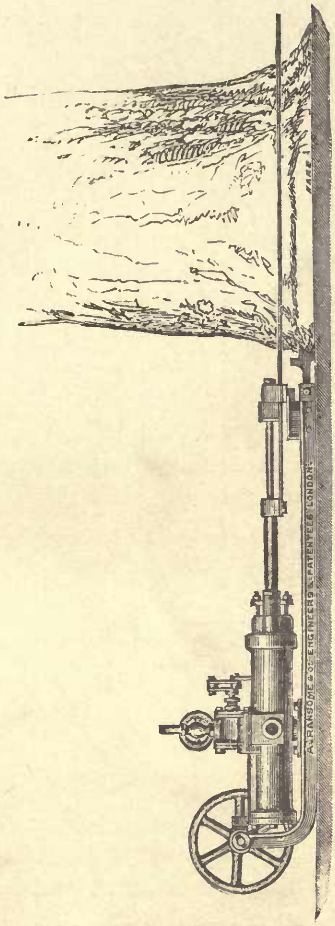


Fig. K. Ransome's Tree Feller in Operation.

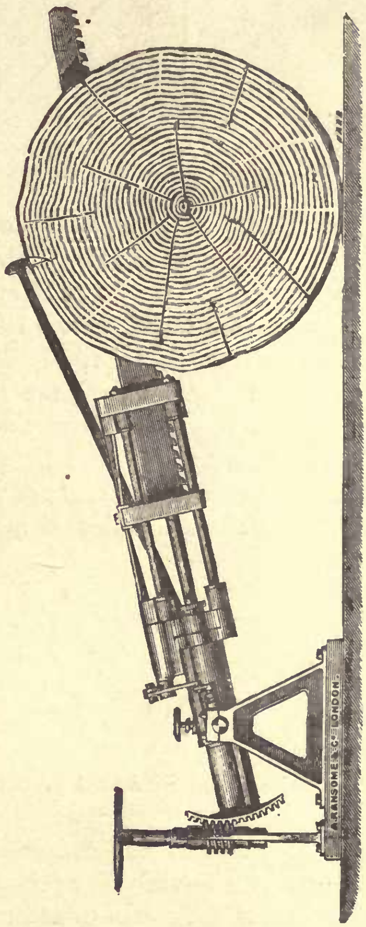


Fig. L. Ransome's Tree Feller as a Cross-cut.

It is given mill teeth if intended to be used as a drag saw proper—that is, cutting on the pull stroke only; but if intended to cut on both strokes, it is given cross-cut teeth.

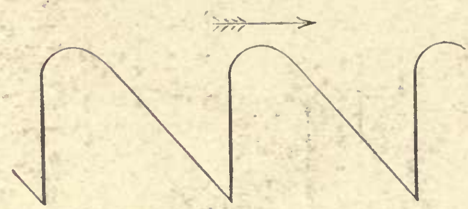


Fig. 25. Drag Saw Teeth for Firewood.

For farmers' use drag saws are $4\frac{1}{2}$ to 6 feet long, and tapered from 7 to 5 inches; stroke 40 to 60 per minute. In shingle mills they are much heavier, and run 80 to 120 strokes per minute; are $5\frac{1}{2}$ to 8 feet long; sometimes tapering from 10 to 6 inches and sometimes 10 to 12 inches wide throughout.

Drag saws for firewood are generally made with a tooth such as shown in Fig. 25. When the cutting is done on the pull stroke, thinner blades may be used than with double cutting saws; but the latter will saw smoother, and are used in drag sawing logs for shingle bolts, because it is desirable to make the edges of shingles as smooth as possible.

Fig. 26. Straight Taper.

Class 4, free at one end, and "push cut" is perhaps the most numerous of all—including principally all the varieties of carpenters' hand saws, of both parallel and taper blades, with and without backs.

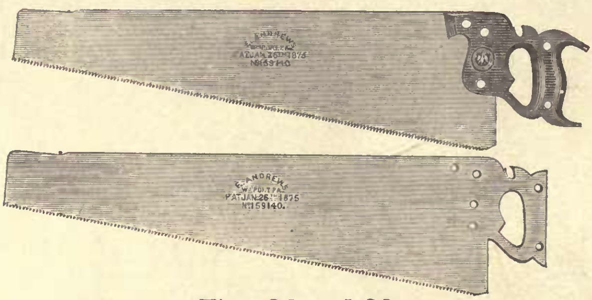
In general, the teeth are of equal size throughout the length; but there is in some varieties—notably the hand-rip-saw—an increase in the size of the teeth from point to heel, referred to at the close of the remarks on saw teeth. But this increase is not always regular and graduated, but sometimes a sudden step.

Fig. 27. Giles' Drag Sawing Machine.

This class may be subdivided into (*a*) taper saws, without frames, and (*b*) parallel saws, with backs. The following table gives lengths, sizes and spaces of teeth, etc.:

	Name.	Length.	Gauge.	Points to Inch.
Taper.	Hand,	26″	19	5 to 12
	Rip,	28″ to 30″	18	Heel, 3 to 5 Point, 6 to 8
	Panel,	14″ to 24″	22 to 20	8 to 12
	Compass,*	10″ to 20″	16	——
	Keyhole,*	7″ to 9″	21	——
Backed.	Tenon,	6″ to 18″	22 to 20	11 to 15
	Miter,	20″ to 30″	20 to 19	10 to 11

The *rip, half rip, hand, broken space, panel* and *fine panel* are alike in general appearance. *Chest* saws are merely diminutives thereof.



Figs. 28 and 29.

The blade is "taper" in order that it may be nearly equally stiff throughout; for ease in attachment of the handle, and to lighten it. This taper is either straight or curved (see Figs. 30 and 31).

The curved taper (Fig. 31) is claimed by the makers to somewhat lighten the saw, while lessening its liability to vibrate when drawn from a cut. The "increment" tooth of the rip saw is clearly shown in the figure.

The straight edge of Fig. 30 is graduated, as a rule; and the implement also has a level, scratch awl, etc.

Figs. 28 and 29 show a mode of strengthening the handle.

The *table* saw and the *compass,* or *lock* saws, differing only in size, and all used for curved line cutting, have narrow blades to permit their turning sharp corners.

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* For curved sawing.

A convenient compass saw, made by McNiece, of Philadelphia, has the blade clamped in its slotted handle by means of a screw clamping ferule (see Fig. 32).

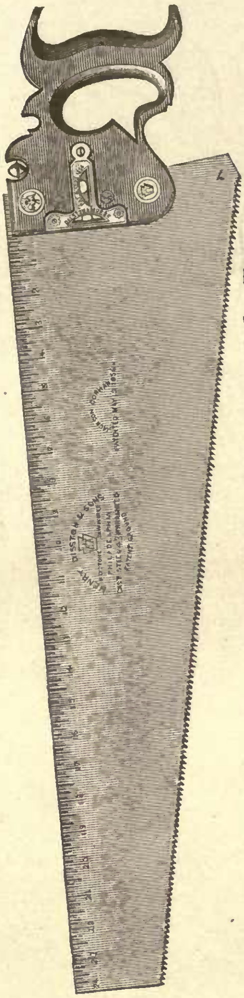


Fig. 30. "Combination Saw," Straight Taper.

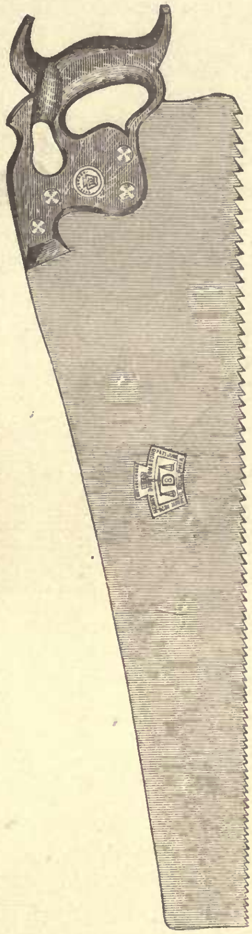


Fig. 31. "Skew Back," or Curved Taper Rip Saw.

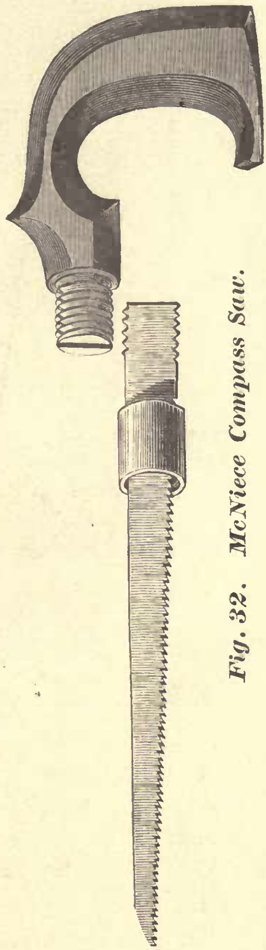


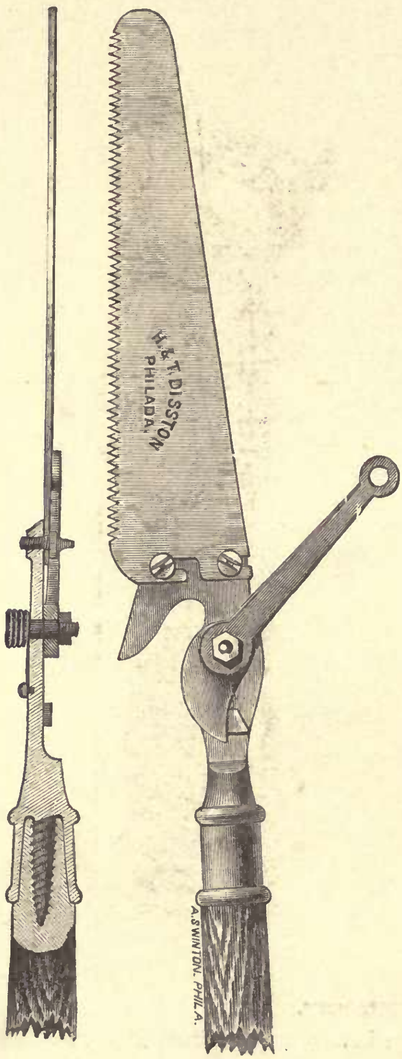
Fig. 32. McNiece Compass Saw.

The *keyhole* or *lock* saw is still narrower. It should be made with a pull cut for the reasons stated, page 17.

Pruning saws are coarser, thicker and keener saws than those for dry wood. They are sometimes made with half moon or briar teeth for rapid execution.

Figs. 33 and 34 show a pruning hook attachment to a pruning saw.

The pond ice saw, generally supplied with a "tiller handle," is 7 to 8 inches wide at butt, 5 to 6 inches at point, and 9 to 10 gauge.



Figs. 33 and 34. Pruning Saw, Hook Attachment.

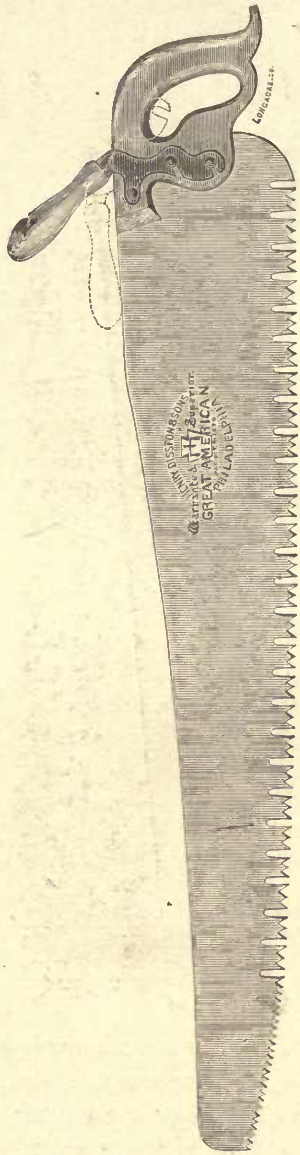


Fig. G. One-man Two-handed Cross Cut.

Hand saws for ice are about 24 inches long, gauges 16 and 18; teeth regular cross-cut pattern, ½ inch to 1 inch apart and deep, and with enormous set as this material clogs greatly.

The various *backed parallel bladed saws,* known as *tenon, sash, carcase* and *dovetail,* according to their uses, have thin and carefully hammered blades stiffened with a piece of metal sprung on. They are much employed for accurate work. Care should be taken not to spring the back by knocks.

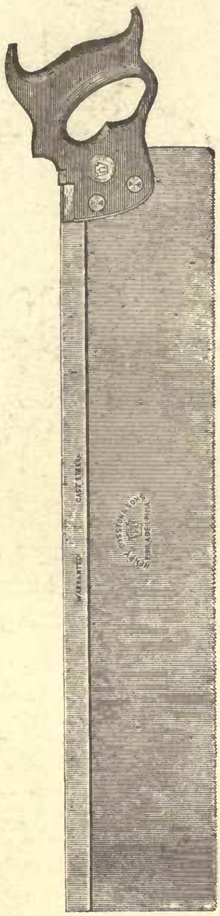


Fig. 35.

Fig. 36. Miter-box Saw.

Fig. 38 shows a hand-saw with detachable back.

The Smith's screw head saw has a handle like a file and is used for cutting the slot in screw heads. It has a thick and hard blade.

The comb cutter's saw, sometimes called a "stadda," is double, the two blades being separated by packing, at any desired distance; one edge being slightly in advance of the other so as to enter a new cut, which the other finishes. Thus spacing and depth are preserved equal. See Fig. 39. Similar saws, on a larger scale, have been used for cutting microscope and air pump racks.

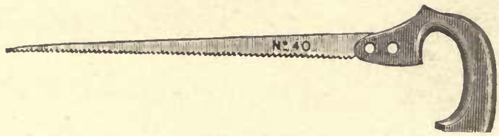


Fig. 37.

Fig. 42 shows an instrument designed to bare and roughen the edge of bone fragments without injuring the soft parts. The tube carries and partly exposes a stem, one side of which is a knife edge and the other a saw, and either of which can be worked at will.

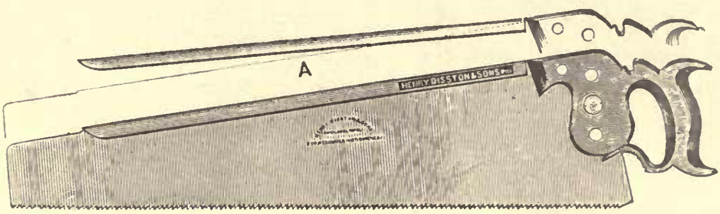


Fig. 38.

The increment tooth (see page 20) has these advantages for handsaws: the fine teeth being used to start the cut and coarse ones to finish, a saw will work freely and easily. In hand-sawing the least

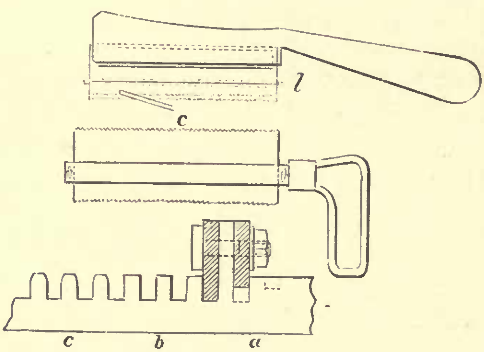


Fig. 39. Comb Cutting Saw.

Fig. 40. Adjustable-Backed Saw.

Fig. 41. Rack Cutting with Saws.

amount of power is employed at the beginning of the cut, but as the arm straightens at the elbow more force is used, and the coarser teeth allow it to be utilized because the space between the teeth do not clog as readily as the fine teeth do, and the fine teeth do not catch at the beginning of a cut as do coarse teeth.

The teeth of a hand saw should be so truly filed that on holding it

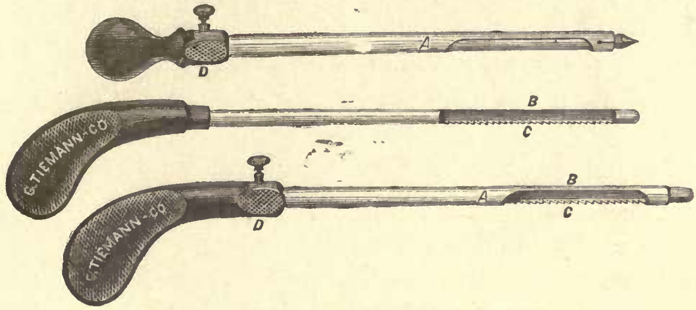


Fig. 42. Protected Rasping Saw.

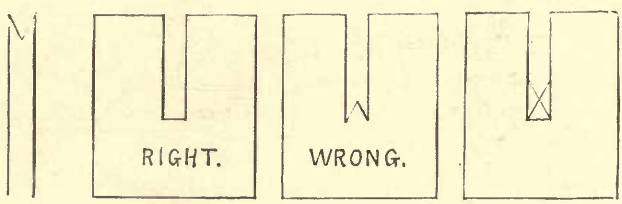
up to the eye and looking along its edge lengthwise it should show a central groove down which a needle should slide freely. See Fig. *A*.

The cutting action should be such that the bottom of the kerf should present the appearance of Fig. *B*, and not that shown in Fig. *C*.

Fig. 43.

Fig. *D* shows the proper cutting action of the teeth.

Saws free at one end and cutting on both strokes are comparatively rare. The M teeth hand saws and some butting saws mounted as



drags, are all that we call to mind. We give cuts of both herewith, Figs. 43 and 24.

Fig. 44 shows a larger saw of this type, to be used with two hands, and which may also be converted into a "two-man" saw.

Fig. *G*, page 32, shows a large two-handed cross cut for one man.

A double-edged "universal" hand saw (Fig. 45) has one side with M teeth for ripping and cross-cutting and fine V teeth on the other side, for mitering. This saw can be used where a wide blade cannot—and the handle is less liable to strain the operator's wrist than in the

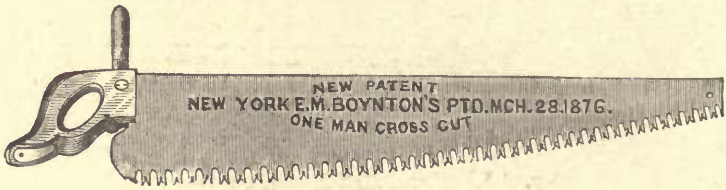


Fig. 44.

case of a wide hand saw of the ordinary pattern having its handle at the upper corner of the blade.

The same double-edged saw, with sheath, has a pole attachable to its handle for use as a tree pruner; the lengths being 16, 18, and 20 inches. (See Fig. 46).

Class 6, strained in a sash, guided at both ends and cutting on both strokes, is a peculiar one. We call to mind but one representative—Robinson's horizontal veneer saw, shown at the Paris Exposition of

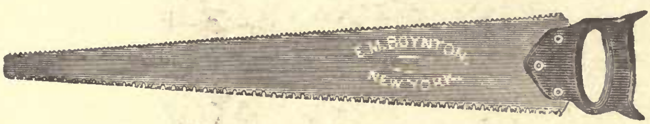


Fig. 45. "Universal" Saw.

1878. Very peculiar inclined guides give the blade what would correspond to overhang on each stroke, so as to give lead both ways.

Class 7 is the *pit saw*, practically the single sash, unguided and worked by hand. The blade is from 5 to 8 feet long.

Class 8 includes the "cross-cut"—frequently written "× cut." They vary largely in general appearance and in disposition, but have always for their object the severing each fibre in two places.

They are made double as wide in the centre as at the ends—to stiffen the blade and to allow for the greater amount of wear in the centre.

The "gains" or gullets in the centre are often made twice as deep as those at the ends, to save frequent "gumming."

In general there is one set of teeth termed "*scorers*," which sever the fibres at the sides, and others called "cleaners," which remove the central core or ridge, and plow out the dust made by the others. Cross cutting is like scoring a "gain" in a plank with the edges of a chisel, and then with the flat edge removing the severed portions.

Fig. 46.

"Cleaner teeth," "clearers," or "plows," are made slightly shorter than the cutters with which they alternate.

In the "Twin Clipper" (see cuts) there are two M's, or four teeth to a section; one M, or two teeth, set each way. The maker claims that where there are but two teeth (or one M) in a section, both teeth set the same way, their tendency is to draw towards the point and first take to the side of the kerf and draw or spring the section over until it lets go when it reacts, cutting the sides of the kerf wavy, in this manner.

In this cross cut one pair of teeth is designed to counteract the

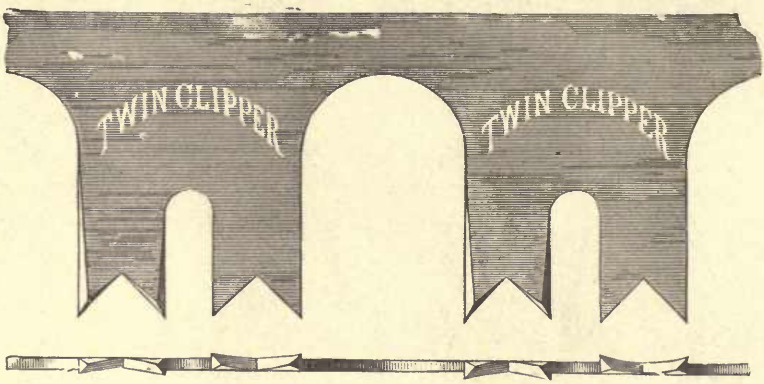


Fig. 49.

spring of the other, keeping the section straight and unsprung. It is also claimed that when a section has but two teeth it cannot be as stiff as with four.

The cleaner teeth of the "Twin Clipper" (see Fig. 50) are made by simply cutting out the inside section of two teeth, as shown by the dot-

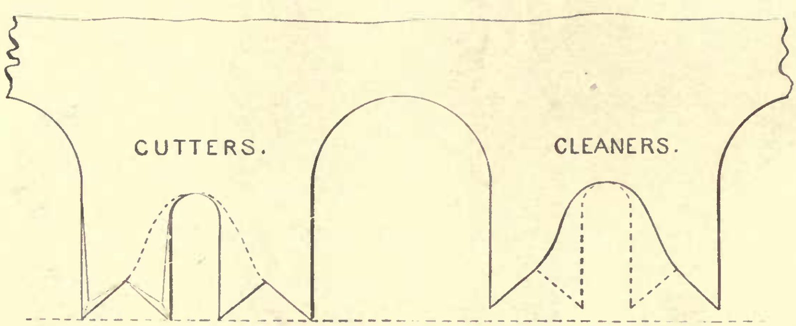
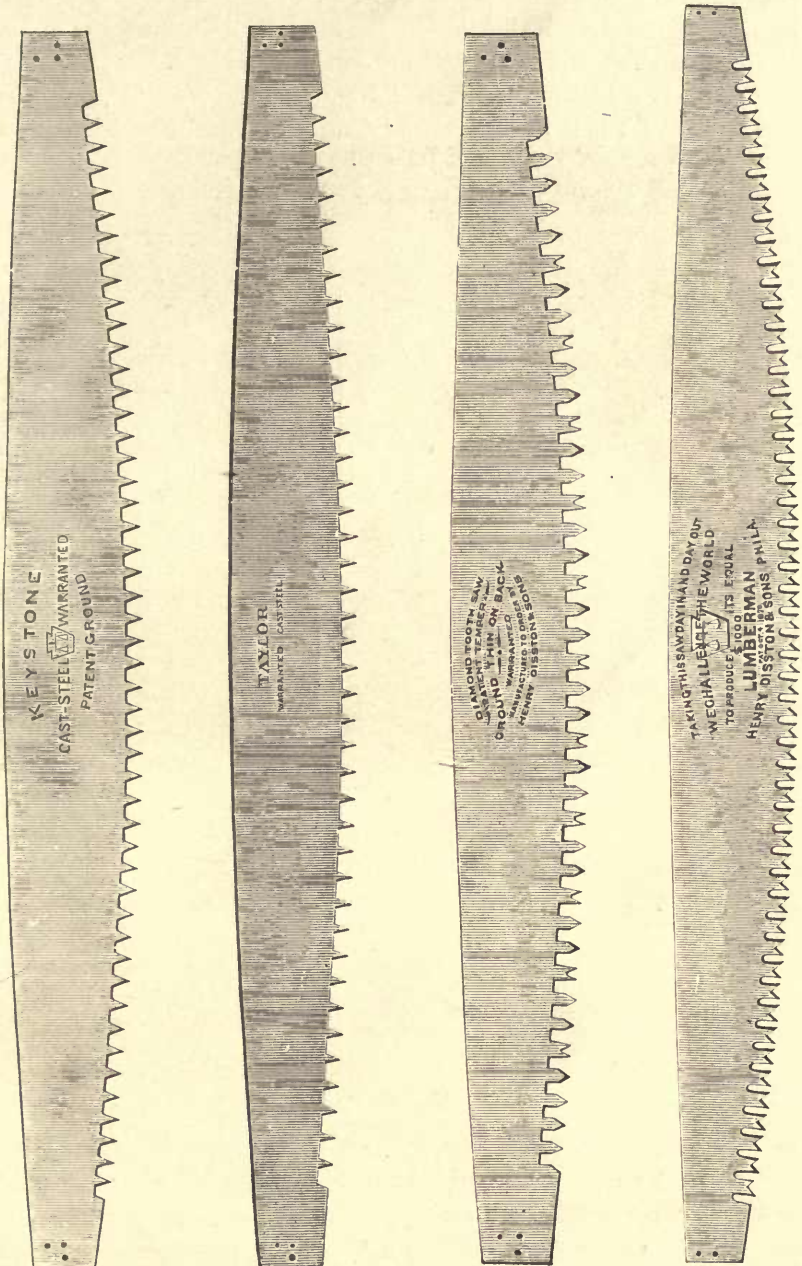


Fig. 50. Twin Clipper, showing Cleaners.

ted lines in the cut—leaving two sets of cutting teeth or scorers between each pair of clearers, which are about $\frac{1}{32}$ inch below these last.

The teeth of solid cross cuts are difficult to keep of proper length and shape. The saw requires frequent gumming, and in this process is frequently broken or sprung and kinked, and then, unless ham-



A B C D

Cross-Cuts.

mered and straightened by a skilled hand, will be sure to give trouble by running hard and sticking in the log. The perforated cross cut avoids gumming, and the teeth are easily kept just right.

Fig. 51 is Andrews' "Climax"; Fig. 52, Disston's "Great American." Fig. 53 is the well known "Tuttle" tooth. Fig. 54 shows a

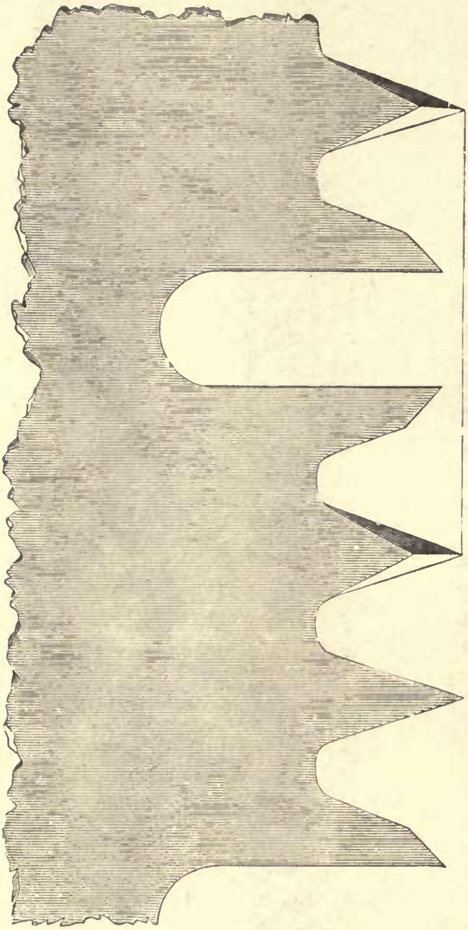


Fig. 51. Andrews' "Climax."

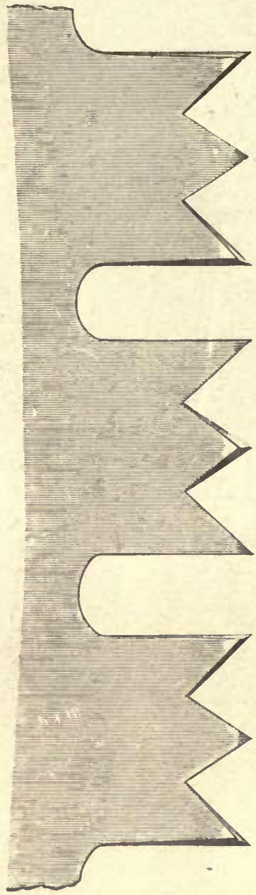
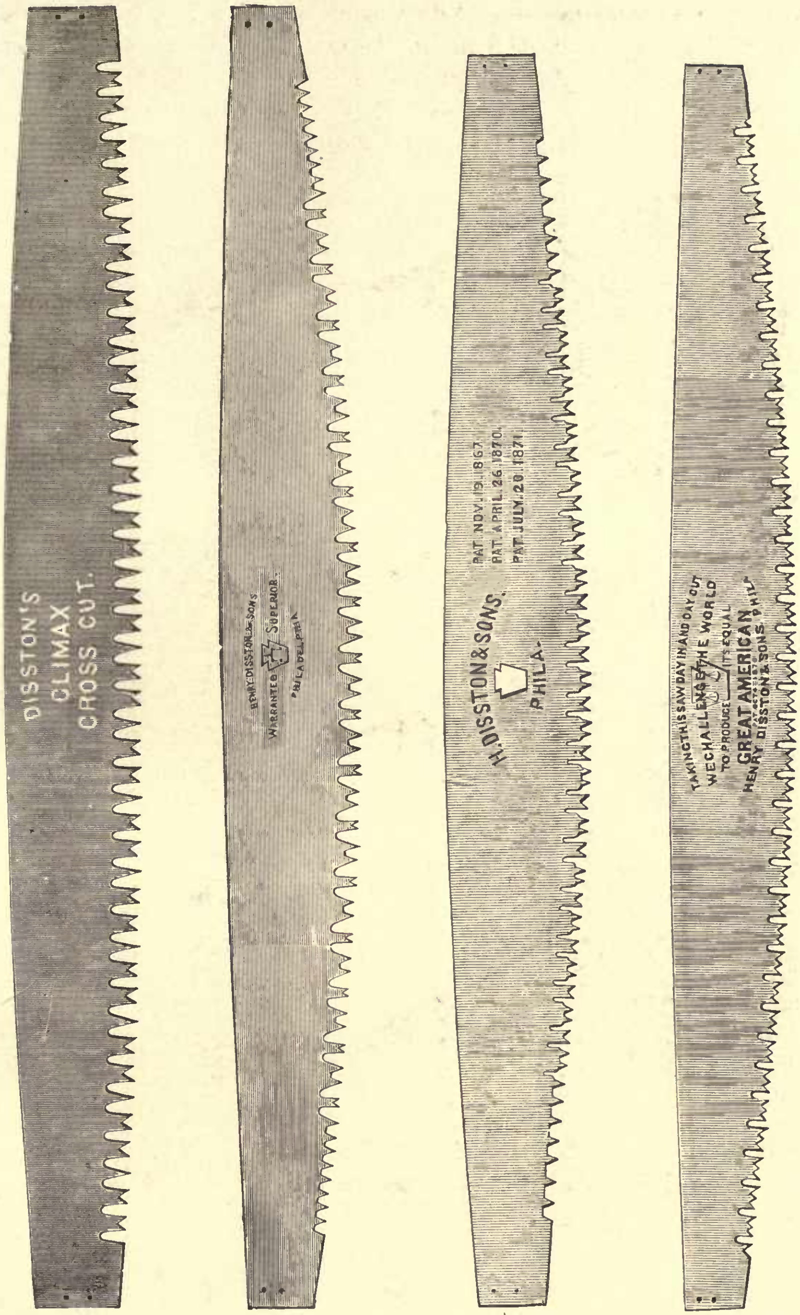


Fig. 52. Disstons' "Great American."

cross cut, in which the notch of each M is followed by perforations, as also are the larger gullets between the Ms and the Ws. Various styles of cross cuts are shown.



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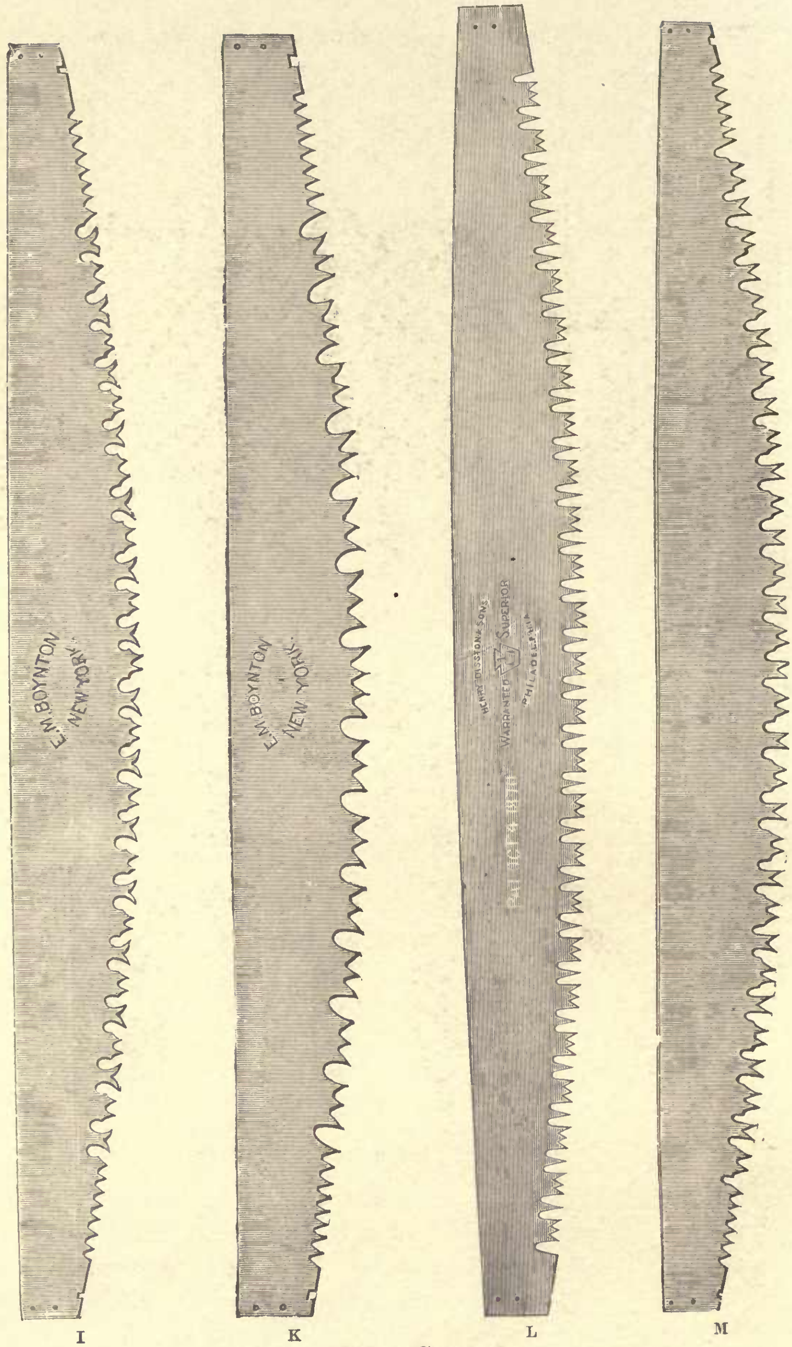
4

Cross-Cuts.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M

Cross-Cuts.

The Weight Strained Saw has only one application—to ice cutting. The blade is mounted vertically in a frame on a sled and is kept taut by a weight suspended in the water to the lower end. Arctic explorers use this saw for cutting their ships out of ice floes; and it has been used for heavy ice-cutting for commercial purposes.

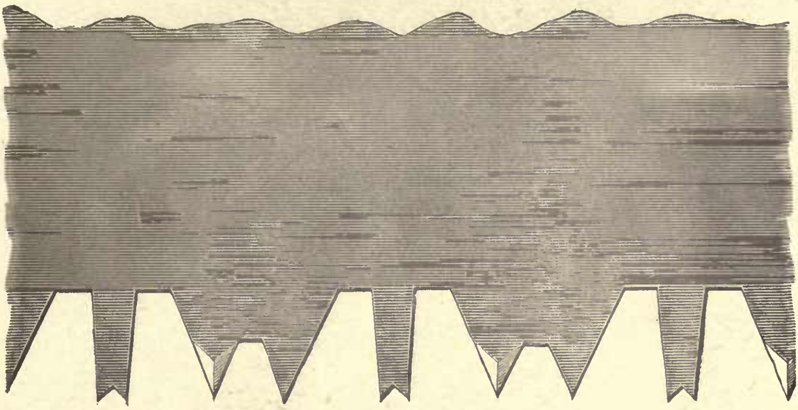


Fig. 53. "Tuttle" Cross Cut.

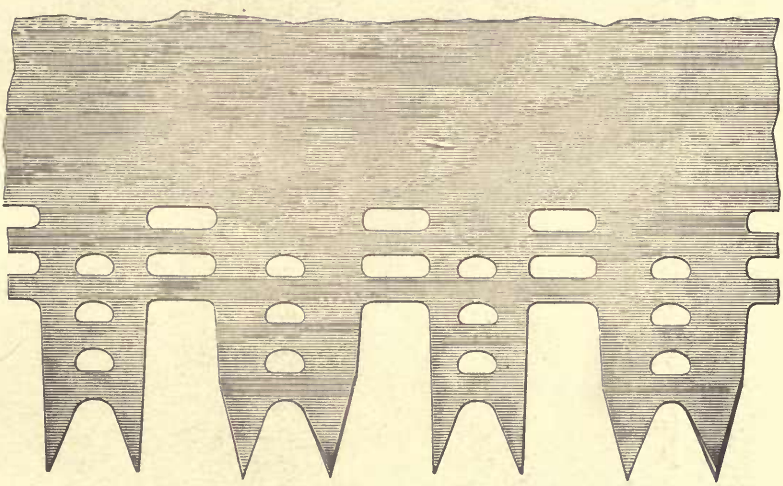
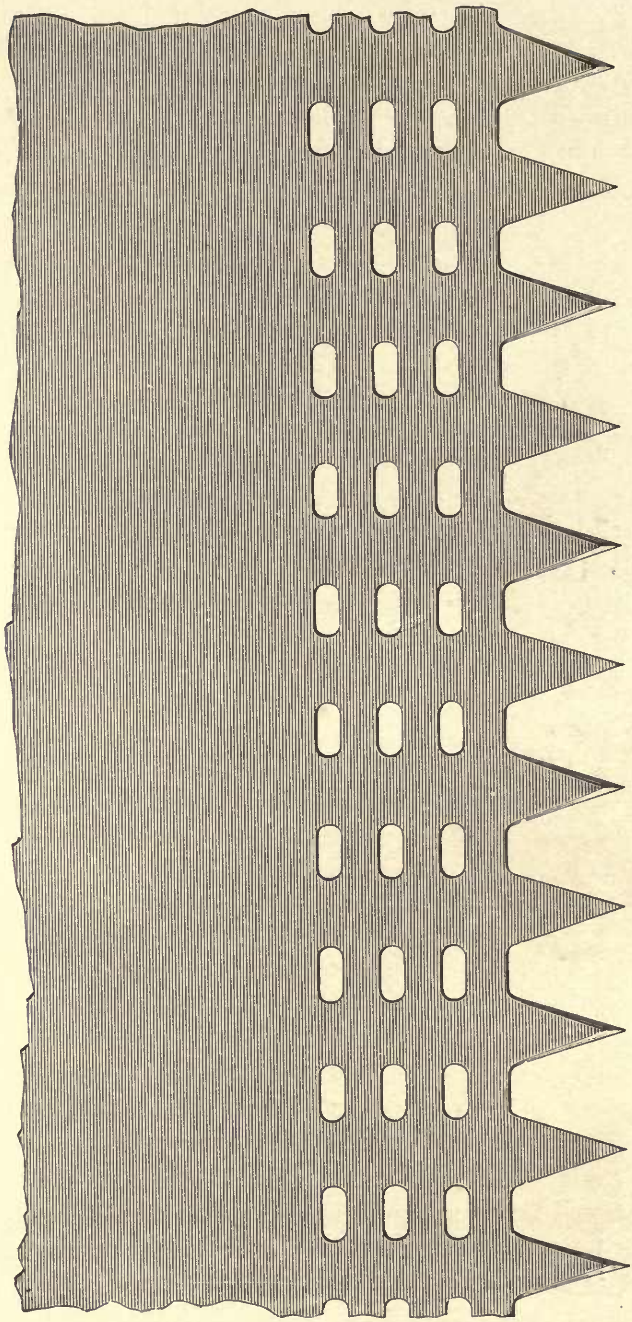
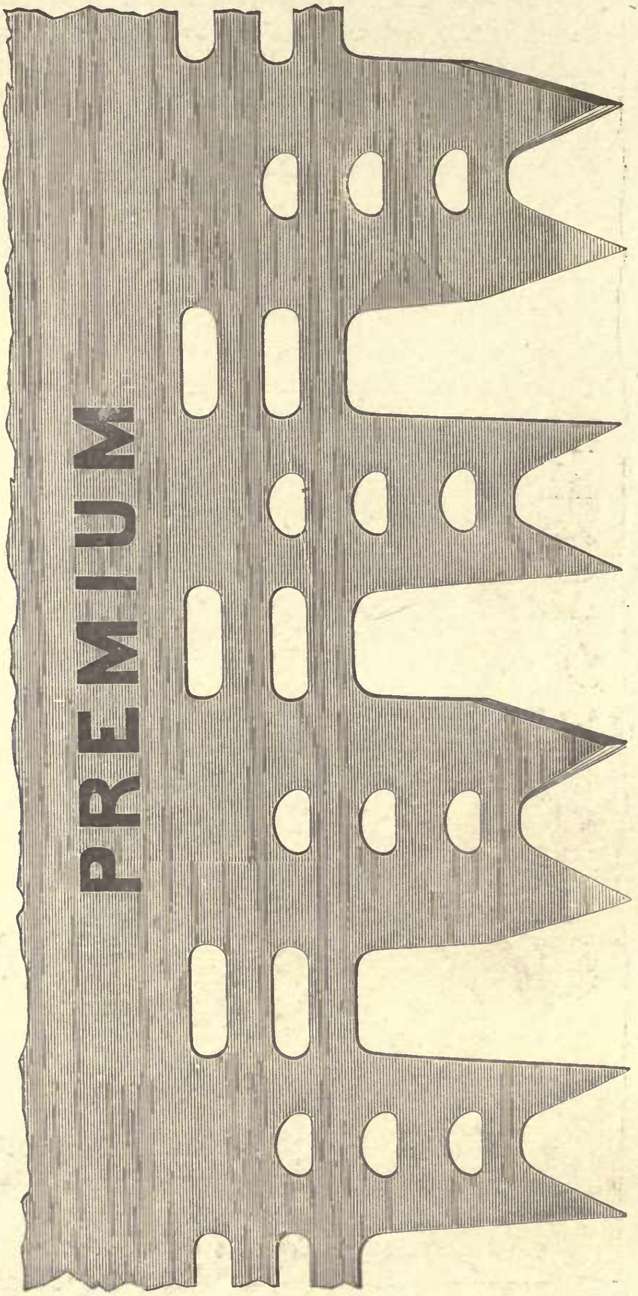


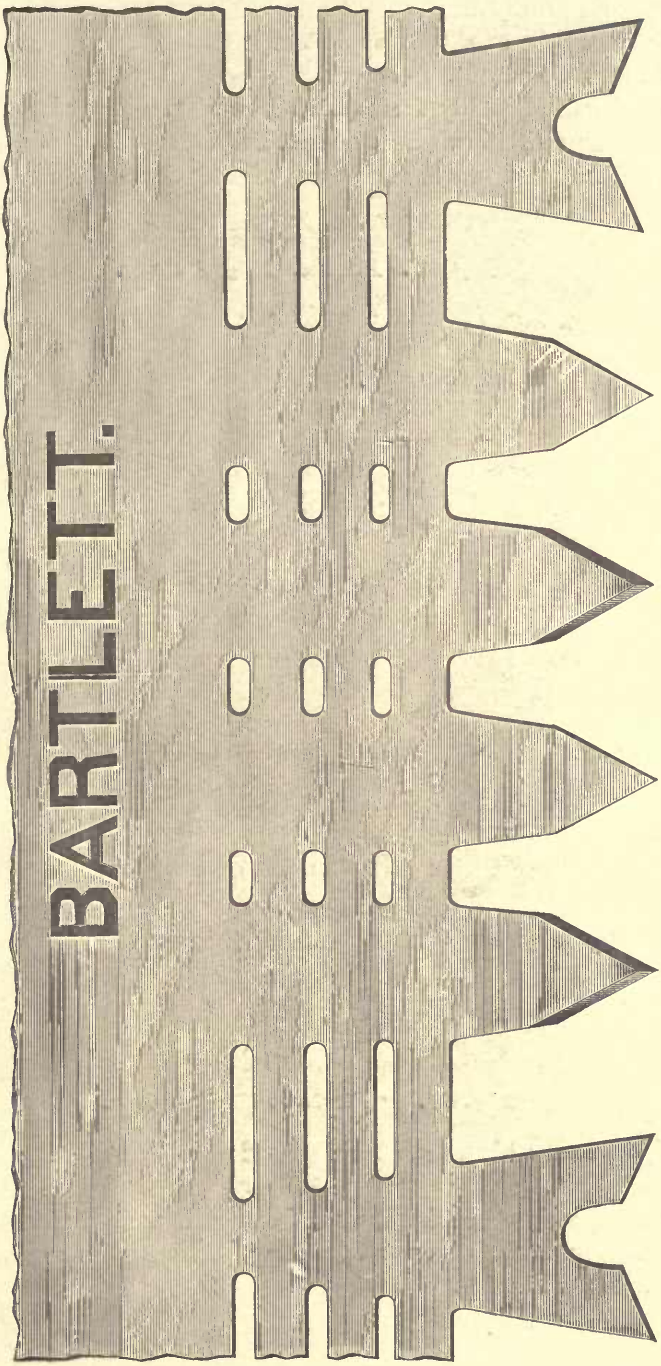
Fig. 54. Perforated Cross Cut.

The Spring Strained Saw, commonly known as the Gig, Jig, Fret or Scroll Saw, has a pull cut only; the return being effected by the same means that keeps it strained. It is light running and generally used for cutting out fine curved or scroll work; although of late years the band saw is superseding it for outside work.




CHAMPION


PREMIUM


BARTLETT.

Jig sawing really divides itself into two branches—sawing in irregular shapes on the outside of a piece of material, and the same process on the inside, known as fret-work.

The short and readily detachable blades of the strained jig saw can be so quickly withdrawn from one cut and inserted in another starling hole that the band saw has no chance to enter the field of fret work.

Fig. 66. Feather Edged Back.

It may be said to have influenced American architecture, which seems largely to have been arranged so as to give every opportunity possible, from crest and barge board to porch and railing, for the display of scroll sawing.

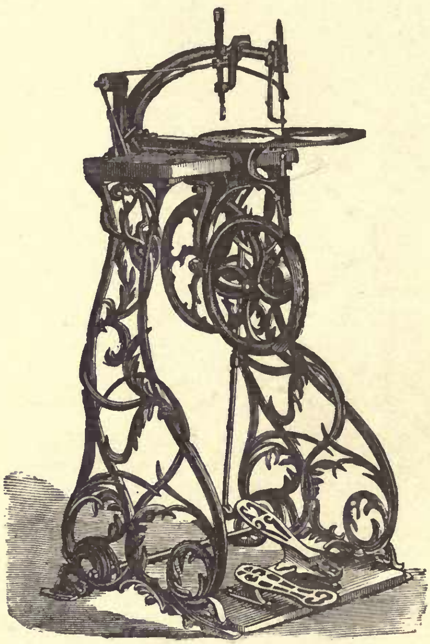


Fig. 67. "Fleetwood" Fret Saw.

Scroll-sawing blades are from 8 to 24 inches long and 13 to 16 gauge.

We may only notice that most makers grind their jig saw blades at the back, to avoid all error of setting, while Andrews grinds to a feather edge (Fig. 66).

The larger sizes necessitate a blower to keep the kerf free from dust and enable the workmen to see the lines of the pattern.

Fig. 67 and 68 show small fret saws of a familiar type.*

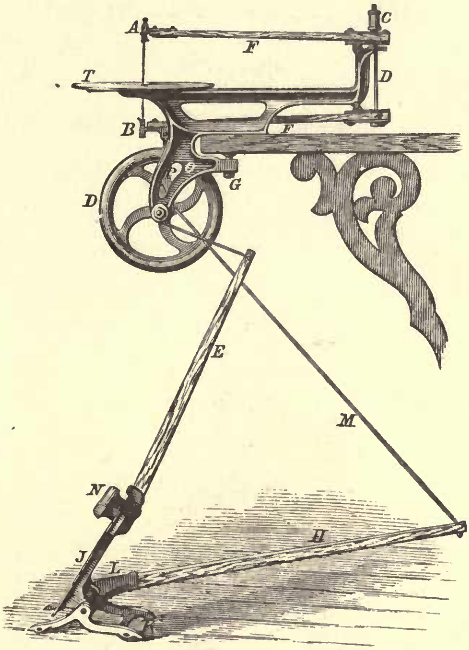
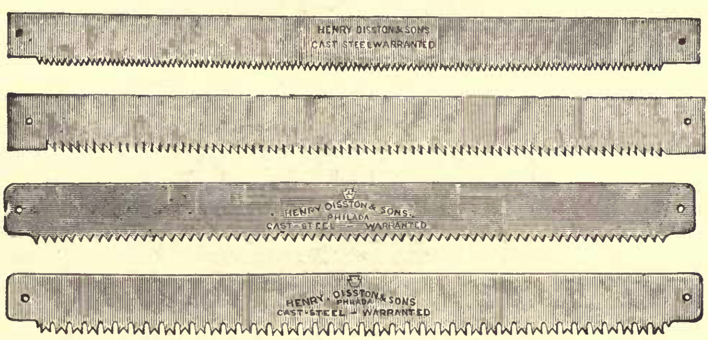


Fig. 68. "Victor" Fret Saw.



Buck Saw Blades.

The "Fleetwood No. 3" fret saw runs about 700 to 800 cutting strokes per minute. Faster speed is apt to heat the saw and burn the wood. Routers sometimes use a double-edged blade.

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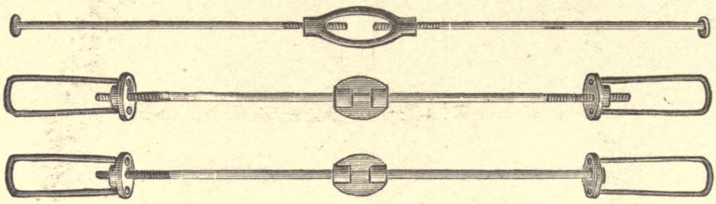
*Trump Bros., Wilmington, Del.

We hear of *round* saws for scroll work, but have not yet seen them.

The Buck Saw, or Wood Saw, is a familiar implement. It is made with the ordinary inclined *V* or hand saw tooth, and also with the double cutting M; the latter far superior.



Straining Rods for Buck Saw Frames.

Several American styles of the implement complete, of the blades and of the "straining rods." are shown herewith. American use has discarded the stick and twisted cord strainer.

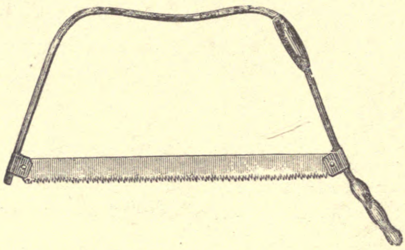


Fig. 69. Andrews' Steel Spring Bucksaw.

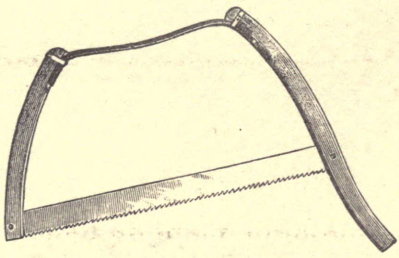
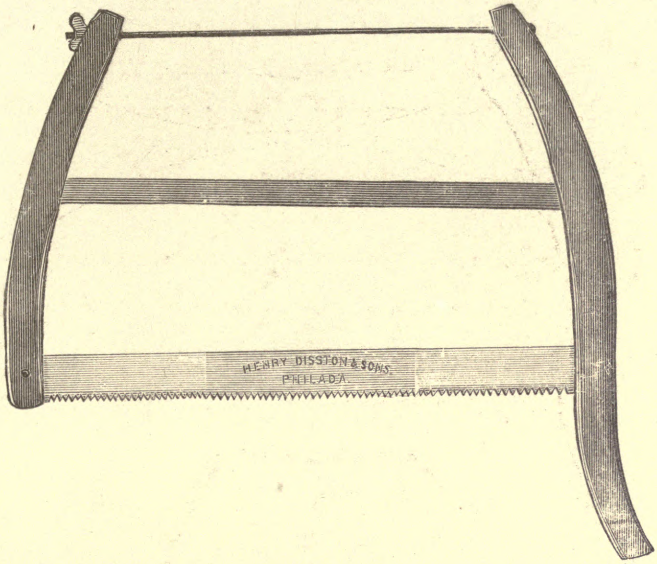
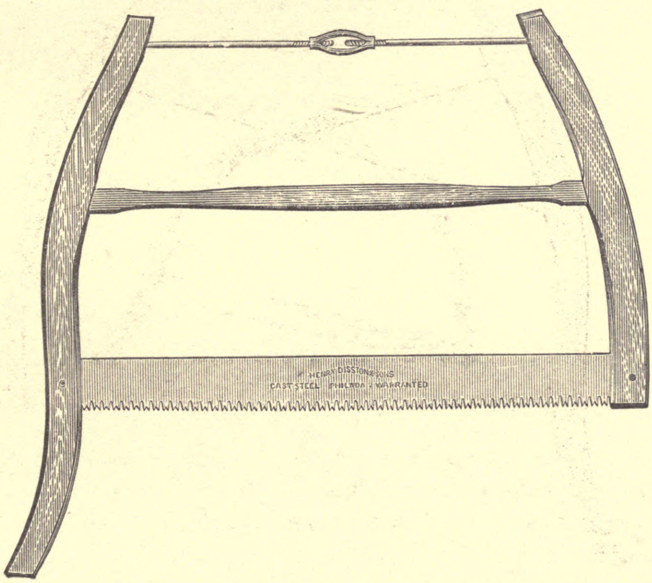


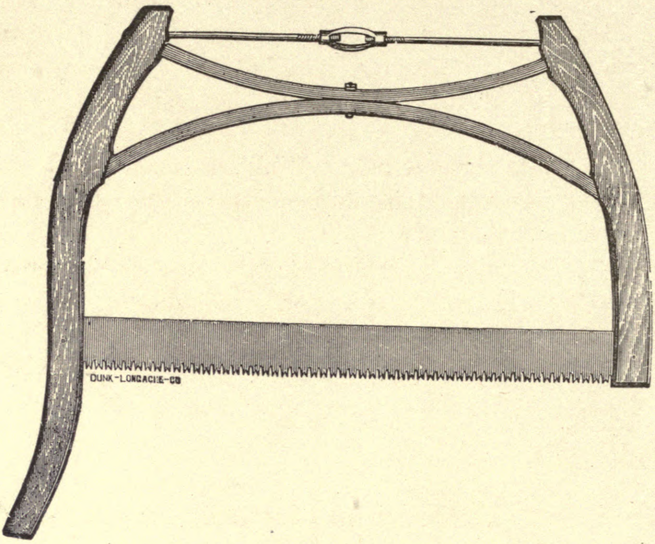
Fig. 70. Andrews' Bucksaw—Wood Frame, Steel Spring.

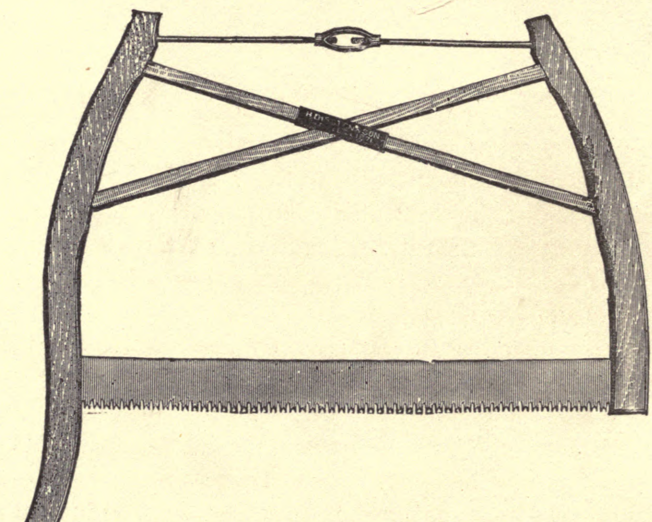
In frames, recent improvements enable a much larger log to be taken in. Figs. 69 and 70 show Andrews' frames, where the straining is accomplished by a steel spring comprising a part or the whole frame.

Web saws $\frac{1}{8}$ inch and narrower have wide ends, in order to give strength at the holes.


HENRY DISSTON & SONS.
PHILADA.


HENRY DISSTON & SONS
CAST STEEL PHILADA. WARRANTED


DUNK-LONGACRE-CO



THE CIRCULAR SAW. During all the centuries which witnessed the birth and rise, the haughty supremacy and the fall of nations in successive turns, no important change was made for the better in the manufacture of saws, until, in 1790, a device was brought out by Brunel, by which cutting should be continuous. In other words, the application of the rotary principle to power-driven saws was given practically to the world.* While the circular saw was first practically used in Holland, its development is due to England and America—especially the latter.

The circular or "buzz" saw, not having inertia to overcome in revolving, has a higher cutting speed of teeth than the reciprocating, besides this advantage of continuous cutting.

It is made with solid and with removable teeth. We shall consider the solid-toothed variety first.

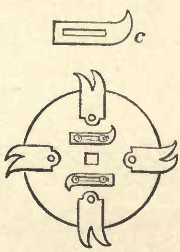


Fig. 75. Eight-toothed Weatherboard Saw.

(From Holzapffel, 1846.)

It consists, in its application to wood cutting, of a circular disk of steel, rolled to even gage, and then generally ground thinner either in the center or at the rim, after the teeth are cut.†

As a general thing, the teeth of circular saws are more distant, more inclined, and more set, than those of rectilinear. But their action may be referred to the tangent of the circle at each tooth, just as in straight saws to the line of the blade.

The teeth are more distant, because their great velocity makes their effect almost continuous. In one variety used for cutting feather-edged or weather boards and taking a very deep, wide cut, this is carried to an extreme—there being but eight sectional teeth (see Fig. 75). Fewness of teeth gives the necessary increased throat room for sawdust.

Their teeth are more inclined because they have additional power by reason of their great velocity, and hence can stand the extra front rake.

* The circular saw appears in a British patent of Miller, Mo. 1152 of 1771. The full text may be found in Richards' work on Wood Working Machines, page 6.

† See Appendix I for Manufacture of Circular Saws.

They are more set to make a wider kerf, required by reason of the waving and wabbling at high speeds of the disk, which cannot of course, even if perfectly homogeneous and true, and unaltered by heat, be kept as rigid as a strained straight blade.*

The circular saw is easily run, and at a high speed. But it requires continuous attendance, the work being so rapidly done as to be in the operator's hands nearly all the time.

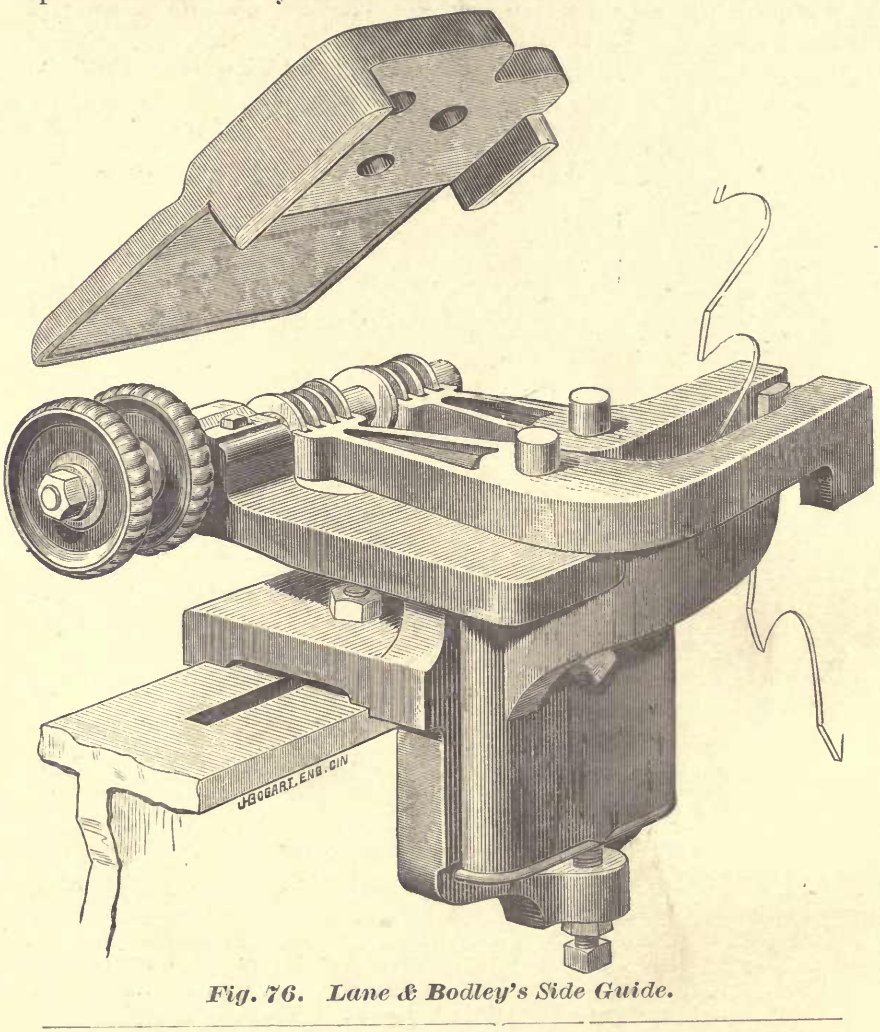


Fig. 76. Lane & Bodley's Side Guide.

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* Something partly answering the purpose of straining is gained by the "side guides" of large circular saws. See Fig. 76.

Circular saws ordinarily run 9000 to 10,000 feet per minute, or 200 times as fast as a push cut hand saw, which makes about 100 feet per minute, cutting only half the time.

We may say for saws 12 inches diameter, 3000 revolutions per minute; 2 feet diameter, 1500 revolutions; 3 feet, 1000 revolutions; 4 feet, 750 revolutions; 5 feet, 600 revolutions.

Shingle and some other saws, either riveted to a cast iron collar or very thick at centre and thin at rim, may be run with safety at a greater speed. Shingle saws are tapered to 14 or 15 gauge, and run from 30 to 48 inches in diameter. We give herewith a

TABLE OF SPEED FOR CIRCULAR SAWS.

Size of Saw.	Rev. per Min.	Size. of Saw.	Rev. per Min.
8 in.	4500	42 in.	870
10 in.	3600	44 in.	840
12 in.	3000	46 in.	800
14 in.	2585	48 in.	750
16 in.	2222	50 in.	725
18 in.	2000	52 in.	700
20 in.	1800	54 in.	675
22 in.	1636	56 in.	650
24 in.	1500	58 in.	625
26 in.	1384	60 in.	600
28 in.	1285	62 in.	575
30 in.	1200	64 in.	550
32 in.	1125	66 in.	545
34 in.	1058	68 in.	529
36 in.	1000	70 in.	514
38 in.	950	72 in.	500
40 in.	900		

Richards, in his "Operator's Handbook," gives the following speeds for circulars:

Diam.	R. P. M.	Peripheral Velocity. Feet per min.
36 inches,	1500	14,100
30 "	1800	14,100
25 "	2100	13,700
20 "	2400	12,500
15 "	2700	10,600
10 "	3000	7,000

For shingle making the circular saw is sometimes run horizontally, as illustrated in Fig. 78, which shows the largest shingle machine in the world.

A shingle saw should be re-ground as soon as it wears down to 14 gauge, as the thinner the saw used the more profit. It does not pay to cut timber into sawdust instead of shingles.

Simonds 36-inch shingle saws (said to be not hammered) make from 1925 turns per minute, and 116 clips, to 2200 revolutions.

The circular saw should not be used on work thicker than one-third the saw diameter. A 20-inch square "cant" or log would necessitate a 60-inch circular saw, which may be $\frac{7}{32}$ inch thick and make a kerf of $\frac{9}{32}$ inch. But some economy of kerf and hence of time, power and material is gained by the "double circular" mill, having two smaller circulars rotating in the same direction, one cutting from the top, the other from the bottom of the log, in the same plane—one slightly in advance of the other (see Figs. 79 and 80).

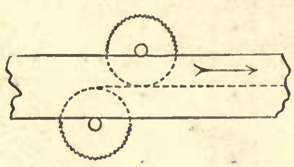


Fig. 79. "Double" Circular Saws.

Thus the 20-inch log cited above could be worked by two 30-inch circulars $\frac{9}{64}$ inch thick, and cutting only $\frac{13}{64}$ inch kerf. In general, the top saw is smaller than the bottom one, the lower one, after successive reductions of diameter by sharpening, being moved to the top mandrel.

In California, redwood logs ten feet in diameter are sawed with three 62″ vertical circulars, one above the other, in connection with a small horizontal circular which divides the board in the line of the arbor of the middle saw. The two lower ones cut 58 inches between them, and the upper one takes 29 inches.

In the choice of velocity and teeth of circular saws, there must be taken into consideration the hardness and grain of the material to be cut; its greater or less freedom from moisture, from gummy or resinous matters, and from spikes; also its size and the degree of smoothness required in the surfaces left. The harder the wood the smaller and more upright should be the teeth, and the less their velocity and the rate of sawing.

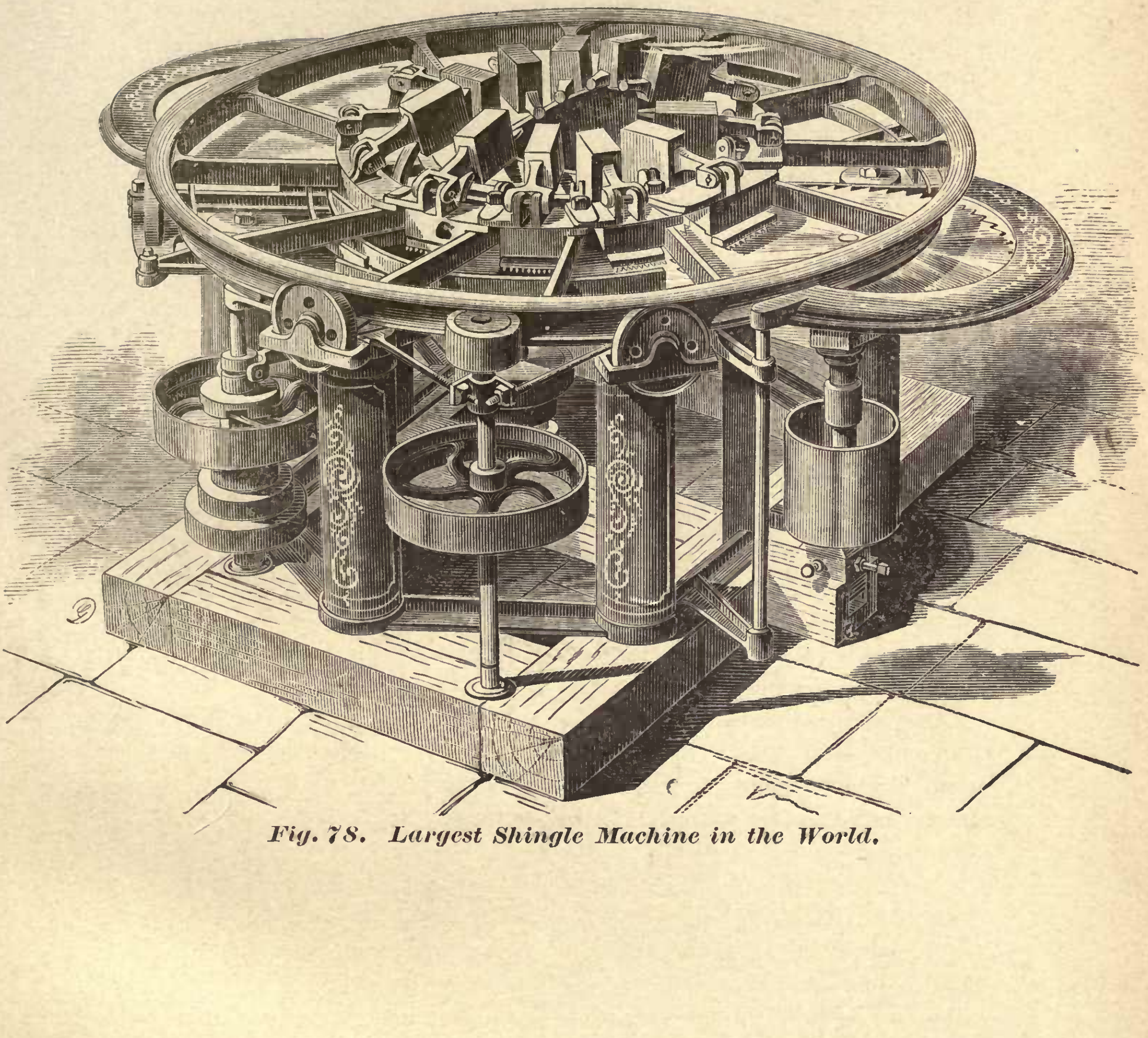
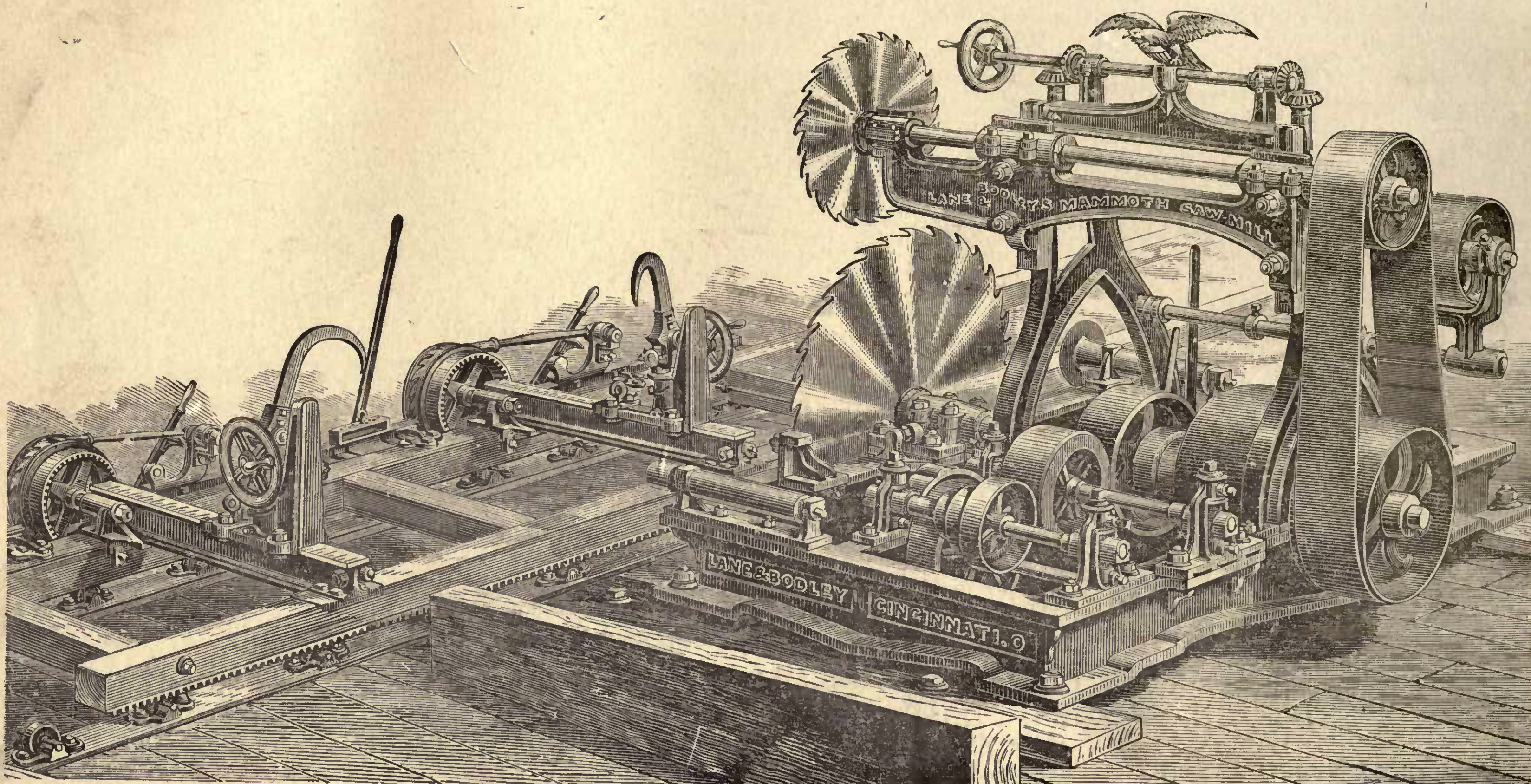


Fig. 78. Largest Shingle Machine in the World.



Double Circular Saw Mill.

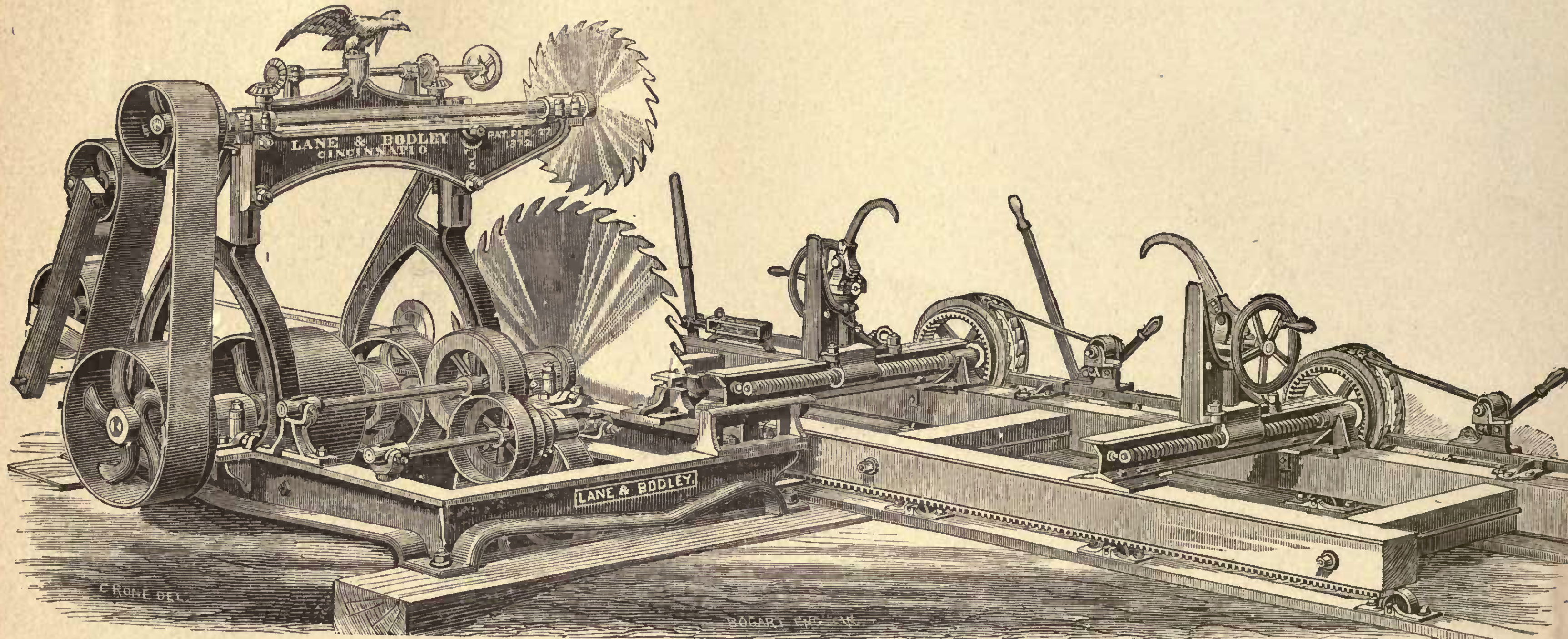


Fig. 80. Double Circular Saw Mill.

Fig. 81 shows the circular saw solid tooth for soft wood; Fig. 82 for hard wood..

In cutting lengthwise with the fibres (slitting, ripping), the teeth should be coarse and inclined, and the speed moderate, so as to cut rather than abrade; as fine sawdust takes more power to make it than coarse.

Cutting across grain (cross-cutting, crossing) requires finer and more upright teeth and greater velocity than in the last case, so that each fibre may be rather *cut* by successive teeth than *torn* by only one.

They should be as hooking as they will bear, except for lath saws, where the stuff is fed by the saw under the arbor, and for side cutting shingle saws, where this would cause too fast speed.

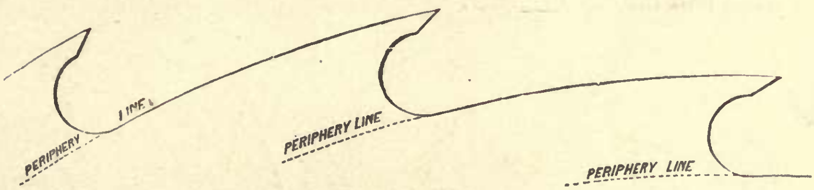
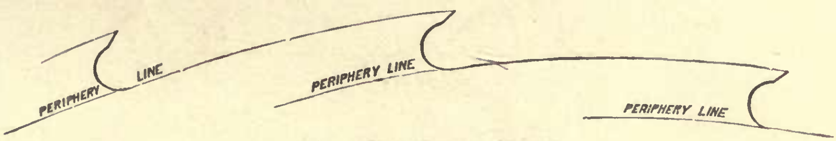


Fig. 81. For Soft Wood.



82. For Hard Wood.

The more inclined a circular-saw tooth is the easier it cuts. With less rake, however, the cut is smoother.

The teeth of the "circular" meet the fibres at varying angles. The fibres at the top of the "cant" are met at a very acute angle; those at the bottom at almost a right angle. (Fig. *K*.) It follows that the first are cut to the best advantage, and that narrow cuts—that is, those of medium height of cut—are sawed less economically than thick ones, the position of the table being the same.

Theoretically speaking, to effect the greatest economy in cutting, the table or carriage should be kept high up, so that the cant should be as nearly as possible tangential to the disk.

Figs. N, O, P show teeth made to various tangents.

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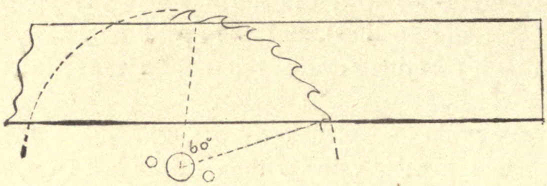


Fig. K. Action of Top and Bottom Teeth of Circular Saws Compared.

For pine, spruce and hemlock the teeth should be cut to a tangent to a circle half the saw diameter.

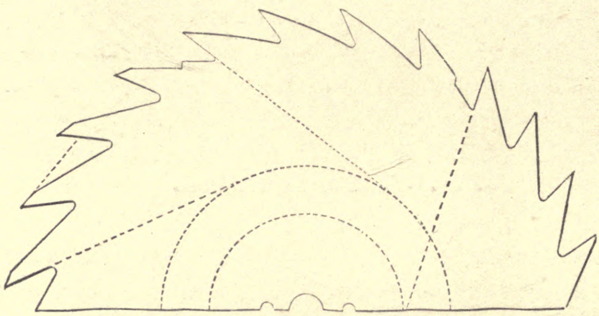


Fig. N.

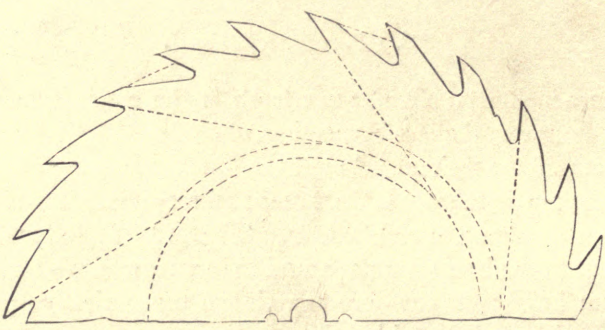


Fig. O.

The old "Barber" patent tooth had the under side concaved out, and cut very sweetly. The Emerson inserted tooth of the present day has this same feature.

The Knowles tooth for circulars (Fig. 86) had its back slightly relieved—which really amounted to having the point slightly upturned.

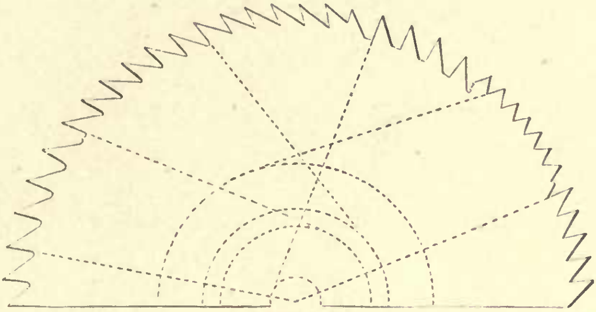


Fig. P.

The Gridley tooth for circular saws, shown in Fig. 83, as in order for work, has both spring and spread set. By use it becomes worn and rounded, as in Fig. 84. For light power and tough sawing it is said to do well. Its cutting point must be kept up square and full, as when rounded and dull (Fig. 84) it takes more power and turns out poorer lumber. It should be filed almost exclusively on the under side (as should any other tooth.)

An arrangement of circular saw teeth, which is a development of the increment tooth referred to under the head of teeth, has sections of the periphery arranged with increasing spaced teeth—the inventor claiming smoother cutting with less consumption of power. He states that at Cincinnati a 7 gauge, 56 inch, variable spaced circular used from 7 to 20 HP less than any other of the same thickness. (See Fig. 85.)

The points *only* of circular saw teeth should touch the lumber. They should be *kept* sharp, by constant filing, and set by springing and swaging, so as to clear the blades.

The American tendency is towards extra thin saws, as lumber becomes more and more valuable. They are now made to 54 inches diameter, as thin as No. 12 gauge at rim and 11 at centre; 66 to 72 inches diameter, No. 10 at rim and 9 at centre. In extra thin saws it is necessary to use a larger number of teeth than in thicker ones. Every $\frac{1}{16}$ inch saved in the width of saw kerf saves 1000 feet of lumber in every 16 M sawed.

A circular saw has a great amount of difficult work to do, rapidly. It is something more than a hard steel disk. It must keep its position and work well when in rapid rotation and doing hard duty.

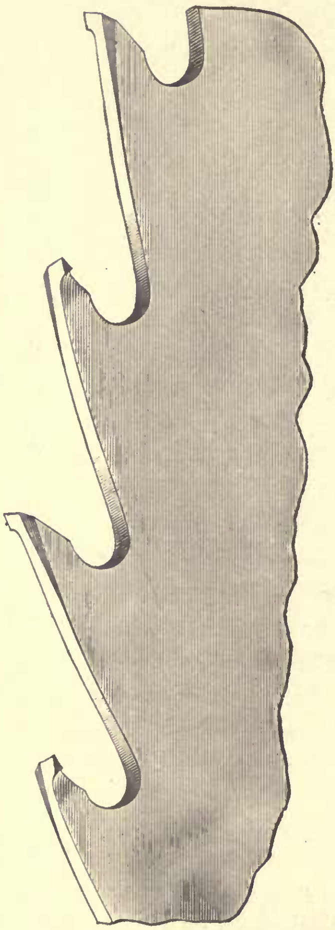


Fig. 83. Gridley Tooth, in good order.

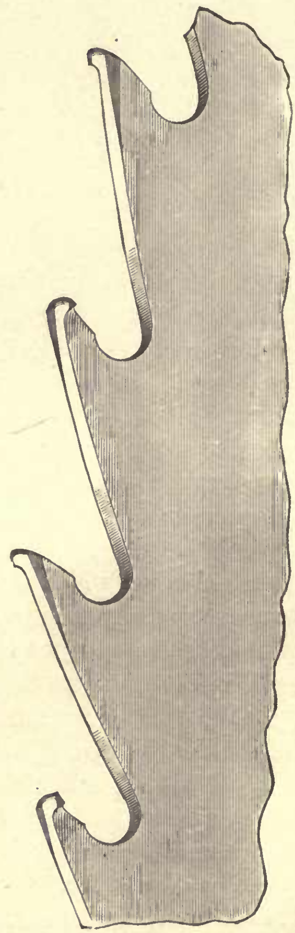


Fig. 84. Gridley Tooth, in bad order.

There is little real difficulty in making a "circular" with almost any kind of tooth, that will run well when new; but the steady use and constant changing of the teeth for months are sure to point out all their defects.

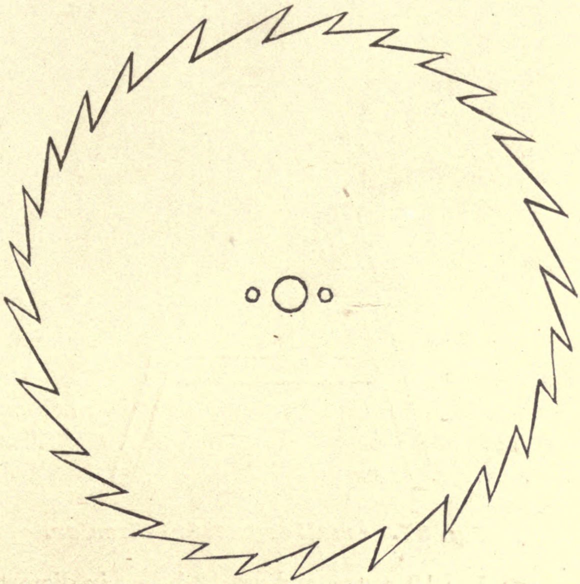


Fig. 85. Andrews' Increment Toothed Circular.

Hard circular plates heat easier than soft, and dry lumber causes greater heating than wet.

A taper circular will stand a higher speed than an even gauge or one ground thinnest in the centre, as there is less weight at the rim and consequently less centrifugal force.

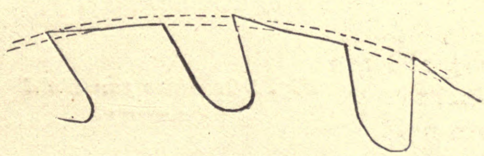


Fig. 86. Knowles' Tooth.

As a slight offset to the advantage that rim tapering gives a circular, there is this: that as the saw gets smaller it gets proportionately thicker, when it does not need as great a thickness to keep it stiff.

Veneer-cutting circular saws are employed for making veneers or very thin plates, generally of valuable woods.* They are designedly thinner at the edge than in the center, as the sheet removed readily bends aside. They are either solid or segmented. The edge must run exceedingly true, and the teeth be sharp and very faintly set. The seg-

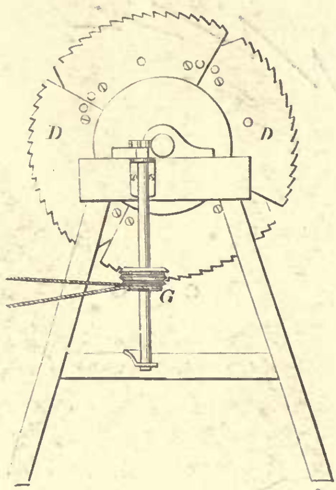


Fig. 87. Small Segmented Circular.

ments are from 5 to 10 gauge, and are 12 inches in diameter.

A smaller segmental saw is shown in Fig. 87; a segment for larger saws is shown in Fig. 88; and a veneer sawing machine in Fig. 89.

While circular saws for wood can be made up to 80 and 100 inches diameter, there are also smaller "circulars" used for such work as

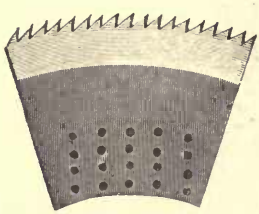
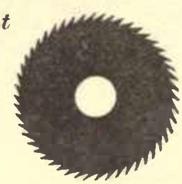


Fig. 88. Cutting Segment of Circular Saw.

Fig. 90. Saw for Gold Pen Slits.



cutting notches in telescopes and in screw heads, slits of bat's-wing gas burners, etc. The teeth of these last are sometimes serrated with a

* Knife or splitting machines for this purpose answer well enough for straight grained and pliant woods, as Honduras mahogany, but not for irregular, harsh and brittle grain, such as rosewood—as in the last case the veneer curls up considerably on removal, and has a disposition to split and become pervious to glue.

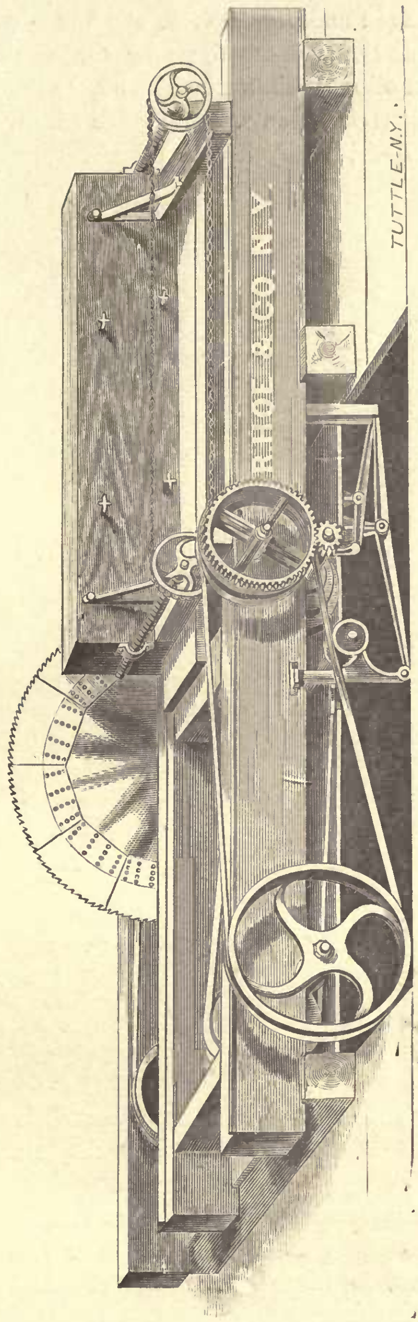


Fig. 89. Veneer Sawing Machine.

screw cutter or tap, as in making the teeth of a worm-wheel. Perhaps the finest circular saws made are those for slitting the nibs of gold pens. The exact size of one is shown in Fig. 90. It is $\frac{1}{200}''$ thick, and makes 4000 revolutions per minute. The cut is engraved by using as a transfer the saw itself, kindly loaned by Mr. Eberhard Faber, of New York.

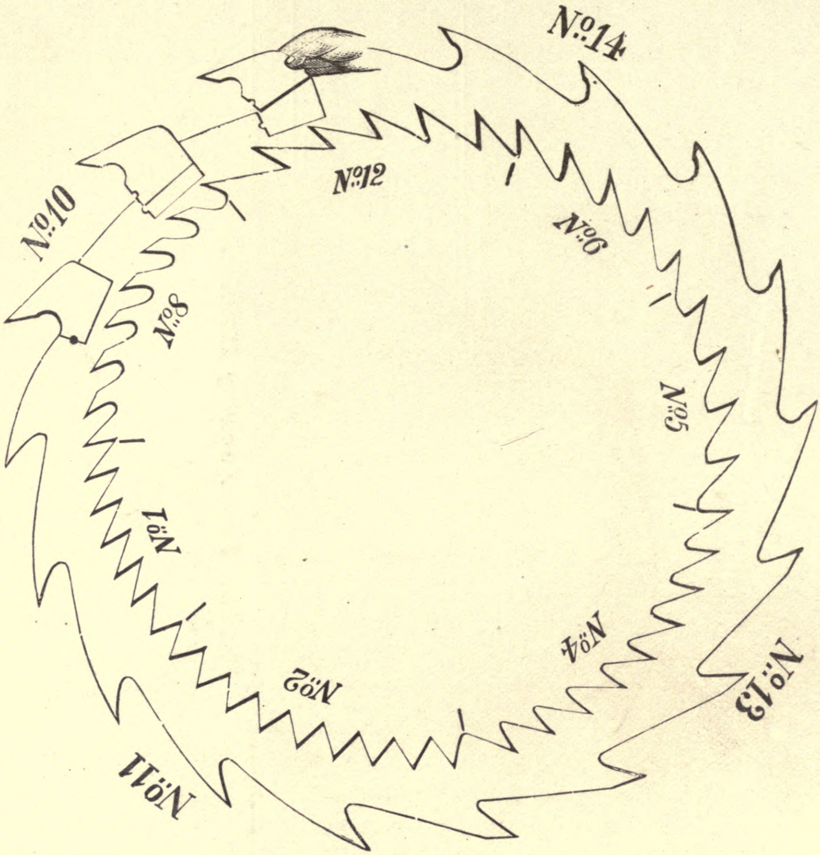


Fig. 91.

Fig. 91 shows various forms of solid and inserted circular-saw teeth, arranged thus by the Disstons for the convenience of customers in ordering.

Referring to the numbers on this figure, Nos. 1, 2, 3 and 5 are for cross cutting; Nos. 6, 8, 11, 12, 13 and 14 for ripping; No. 4 for either. No. 8 is used for hard wood. Nos. 11 and 14 are the most commonly used in America.

A tiny saw, difficult to classify, is Fig. 95, which has two cutting edges, one of which is a reciprocating circular saw.

Fig. 96 shows a surgical circular saw worked by a thumb lever.

For sawing *loaf sugar*, the teeth are V-shaped, one-half inch apart, gauge No. 10, with great set. A 36 inch sugar saw runs only about 300 revolutions and under.

For *ivory* the teeth are V-shaped, 12 points to the inch, with no set. These circulars are 2 to 10 inches diameter, and of from 19 to 22 gauge.

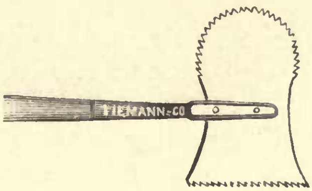


Fig. 95. Bone Saw.

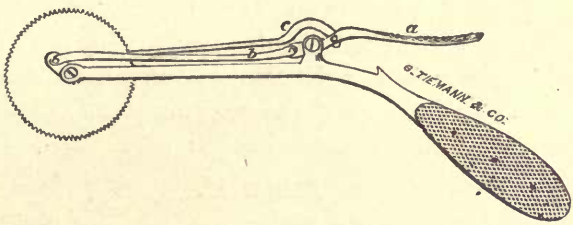


Fig. 96. Surgical Circular. Driven by Thumb.

For *bone* a $9\frac{1}{2}$ inch saw has 100 teeth, "handsaw" style in outline. The plate is 22 gauge, and and an additional $\frac{1}{32}$ inch set is given.

For *iron* the handsaw tooth is used, with no set; space, 12 points; a 4 inch saw of 14 to 22 gauge runs 150 revolutions.

For cutting off wrought iron and steel beams Disstons recommend a circular 44″ diameter and about $\frac{1}{4}$″ thick, having peg teeth $\frac{3}{4}$″ apart, with no set, and running slowly where neat cutting is required—say only 150 to 180 feet per minute peripheral speed.

Richardson Bros. say that circulars for wrought iron should have a speed of about 150 linear feet per minute; for cast or malleable iron, one-fourth faster, or say 190 feet per minute.

For *white* or *Britannia metal*, one-fifth the revolutions for wood (say 1800 feet per minute), but a larger tooth than for iron.

For *brass*, as fast again as for iron—say 300 to 375 feet per minute.

As regards the question of few or many teeth for wood cutting, opinions differ, and yet perhaps without cause. The writer inclines to the belief that while the fewer the teeth the higher the feed capable per tooth, and the more chisel-like the action of the teeth,—yet there are cases where by reason of light power and hard cut more teeth are necessary. Certainly thin saws require the most teeth; or, to put it the other way, increasing the number of teeth enables the use of a thinner saw and less power.

Fineness of teeth also gives smoothness of lumber, as the teeth are stiffer and less likely to lead into the wood, and the saw marks are closer together than with many teeth.

In some parts of our Southern States where formerly a 56 inch circular had but 26 to 28 teeth, now there may be found a very large proportion of 56 inch disks with 56 teeth.

The fewest number of teeth we know of in a rotating saw is *two;* these being simply two long arms with a central hub, revolving on an arbor, and chiseling their way quietly and slowly through a log. This could hardly be termed a "circular saw," being rather a rotating chisel, and just as much like the Daniels planer used in car shops.

The following table gives the average diameters and thicknesses of circular saws, with size of mandrel holes:

TABLE II.

Diameter.	Average Thickness.	Size of Mandrel Hole.	Diameter.	Average Thickness.	Size of Mandrel Hole.
4 inch,	19 gauge,	$\frac{3}{4}$	36 inch,	9 gauge,	$1\frac{5}{8}$
5 "	19 "	$\frac{3}{4}$	38 "	8 "	$1\frac{5}{8}$
6 "	18 "	$\frac{3}{4}$	40 "	8 "	2
7 "	18 "	$\frac{3}{4}$	42 "	8 "	2
8 "	18 "	$\frac{7}{8}$	44 "	7 "	2
9 "	17 "	$\frac{7}{8}$	46 "	6 "	2
10 "	16 "	1	48 "	6 "	2
12 "	15 "	1	50 "	6 "	2
14 "	14 "	$1\frac{1}{8}$	52 "	5 "	2
16 "	14 "	$1\frac{1}{8}$	54 "	5 "	2
18 "	13 "	$1\frac{1}{4}$	56 "	5 "	2
20 "	13 "	$1\frac{5}{16}$	58 "	5 "	2
22 "	12 "	$1\frac{5}{16}$	60 "	5 "	2
24 "	11 "	$1\frac{3}{8}$	62 "	4 "	2
26 "	11 "	$1\frac{3}{8}$	64 "	4 "	2
28 "	10 "	$1\frac{1}{2}$	66 "	4 "	2
30 "	10 "	$1\frac{1}{2}$	68 "	4 "	2
32 "	10 "	$1\frac{5}{8}$	70 "	3 "	2
34 "	9 "	$1\frac{5}{8}$	72 "	3 "	2

(In Appendix X, the gauges are given translated into decimals and also into thirty-seconds of an inch.)

In times past the grinding process was so difficult and expensive that the flat "circular" was finished on the log side only. Nowadays

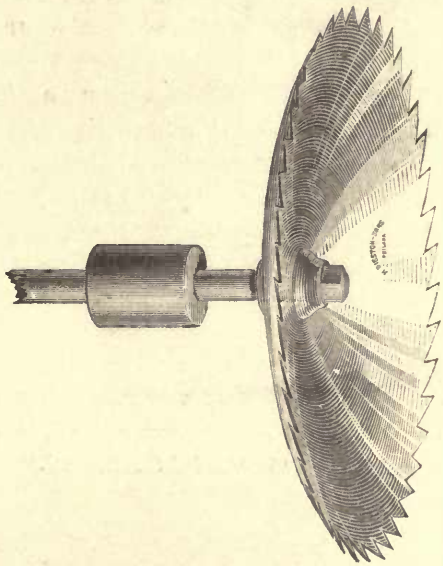


Fig. 97. Dished Circular.

many makers give the same accurate finish on both sides, and the saws can consequently be used either right or left "handed.."

A variety of the circular saw is the *dished* circular, used not for dividing material in a right line, but for cutting out beveled-edged disks, as barrel heads. Its action thus comes in between that of the circular and that of the cylinder saw.

Concave saws run about the following diameters and gauges:

6 inch, .	18 gauge.	12 inch, .	15 gauge.
7 " . .	18 "	14 " . .	15 "
8 " .	18 "	16 " .	14 "
9 " . .	17 "	18 " . .	13 "
10 " .	16 "	20 " .	13 "

Figs. 98 and 99 show "right-" and "left-handed" saws sufficiently clearly to require no other explanation.

Inserted-toothed circular saws, the use of which is already large and rapidly extending, have the following advantages over solid:

The teeth being drop-forged, from bar steel, are regular in size and shape, and of better material than is possible to use for the whole saw.

The teeth are capable of having more and better shaped throat—a

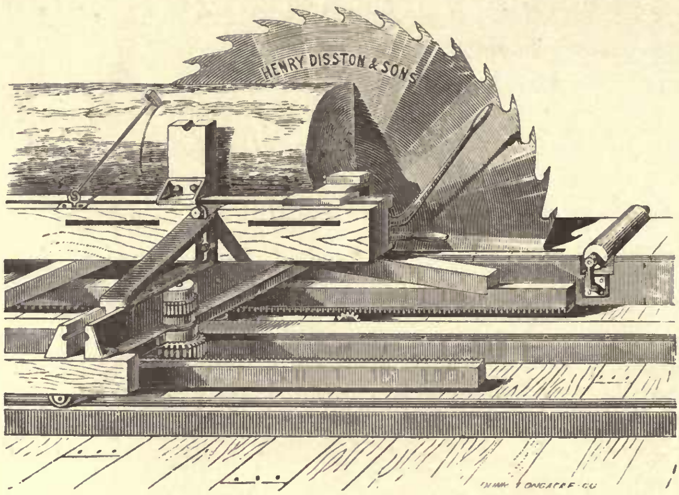


Fig. 98. "Right Handed."

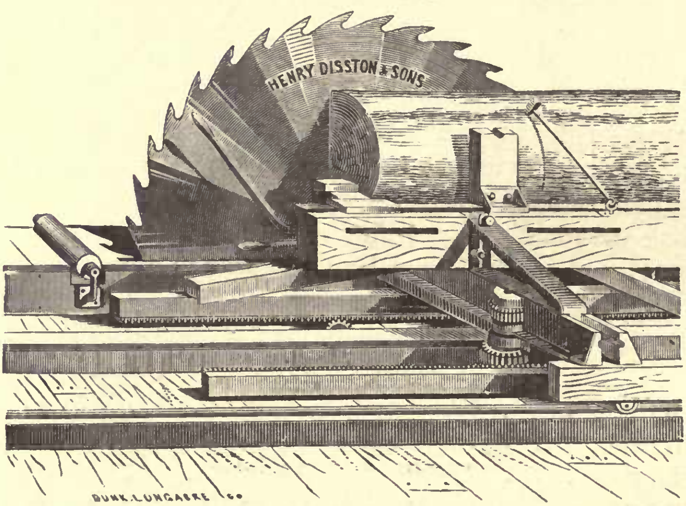


Fig. 99. "Left Handed."

special advantage for coarse feeds, and for soft, wet and fibrous woods.

They cut so much smoother lumber that they are frequently spoken of as "planer-bits."

They effect a great saving in time and files and blades, over gumming and sharpening; they also avoid lessening the capacity of the saw by the reduction in diameter consequent on filing the solid saw.* The widely-operating and successful use of emery wheels is, however, lessening this advantage.

The time of the mill lost while the solid tooth saw is being re-gulleted is important in new countries and in locations far from the saw factory—as New Zealand.

With a few thousand little "bits," costing three cents each, a New Zealand or far Canadian sawyer is independent of mishaps, even with the knottiest wood.

There is an avoidance of the necessity of readjusting and aligning

---

* Cost of Running Planer-toothed Saws, as compared with Solid-toothed Saws.—Messrs. Emerson Smith & Co. give the following calculations:

"The average size of board circular saws is about 56 inches in diameter, so that we will base our calculations on that size.

"Circular saw mills vary in capacity from 5000 to 40,000 feet of lumber per day, 10,000 feet being about the average.

"Starting with a new 56 inch saw, at 10,000 feet per day, we will base our calculations on sawing 1,000,000 feet in 100 working days, or about four months.

Cost of 56 inch solid saw, present price list	$117 00
One hour per day for filer, 100 days, thirty cents per hour	30 00

"In order to reduce the size of a 56 to a 54 inch saw, a strip of tempered steel, 14 feet in length, 1 inch in width, and the thickness of the saw, must be filed into fine dust. Besides, time is spent in spreading and setting the teeth and in rounding the saw.

1 dozen 14 in. mill files, per month, at $9 per doz	$36 00
Gumming and straightening once in 2 months, say	15 00
Average cost of transporting to saw maker, say	6 00
Reduction in size of saw, say 2 inches, leaving the saw at the end of 4 months 54 inches in diameter, present price list, $96, reduction in value	21 00

"The above calculation only estimates the reduction in the size of the saw at one-fiftieth of an inch per day. If the saw is kept gummed down with a file, the cost of files and filing will be much greater than this estimate. If a gummer of any kind be used, add cost of the machine, wear of tools, wheels, etc., and the owner will find the cost more than the estimate of sending it to a saw maker.

Cost of mill standing idle, say half hour per day, in filing and putting saw in order so that the owner has lost the sawing of 500 feet of lumber per day, at $2 per 1000 cost of sawing for 100 days	$100 00
Total cost	$325 00
Cost of planer, saw and 1000 bits	200 00
Difference in favor of Planer Saw	125 00

the saw on the mandrel in the case where a spare saw enables the sawyer to save the otherwise inevitable stoppage of the mill in the case of a tooth breaking.

The spacing, set, and shape of the inserted teeth is better than the average sawyer would maintain even with the "guide lines" marked in the disk by some enterprising maker's. (See Fig. 100.)

Fig. 100. Showing Guide Lines.

Men capable of putting solid saws in order are very scarce. But in many mills are to be found men who are good, valuable sawyers, and understand turning out lumber to the best advantage, but who are poor filers. The inserted tooth makes their skill available.

The plate of a saw is nothing but a handle carrying the teeth, and is strained by the use of dull teeth. The inserted teeth can be kept sharp and hence strain the plate less.

The cutting points or saw bits being shaped and sharpened while out of the saw, can, if it be the sawyer's fancy, be made slightly concaved on the under side, thus presenting full prominent corners a little in advance of the cutting centre; and in consequence of the corners of all teeth wearing faster than the centres the separate teeth will do more work with one dressing, than solid teeth, which are filed or dressed square. Fig. 106 shows their first state and mode of

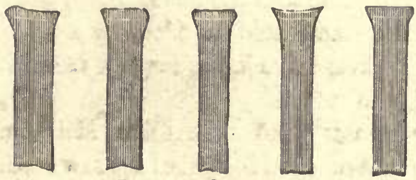


Fig. 106. Various Conditions of Teeth.

wear. They represent a top view of the points of teeth in various shapes. If the point of a tooth get into the shape of A or any other irregular shape, it should first be squared and filed up into a regular shape, so that there will be an equal amount of metal on each corner. If a tooth loses a corner like that of B, the opposite corner

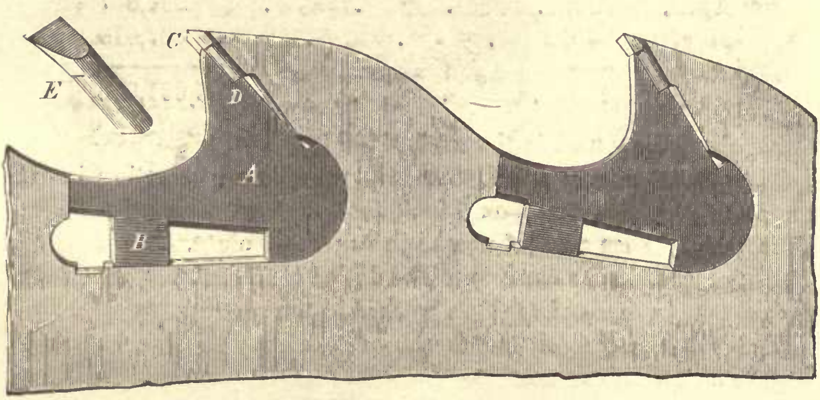


Fig. 115. Emerson's "Planer Bit."

should be filed off so as to have the appearance of C; swage it into shape like D, then bring it into a proper shape like E. A is also a bad tooth, having too much metal in one corner, and must be filed into the shape of C before it will spread properly.

One file will go as far in keeping a good inserted tooth saw in order as ten with a solid saw.

An inserted-toothed saw can have hard or soft teeth at will, for varying kinds of lumber.

The Emerson bits are tempered to scratch glass, and weigh one-sixth ounce each.

The various items of power-saving by reason of keenness of cut and narrowness of kerf, are the same as are fully laid down on another page.

Inserted saw teeth came into use about 1840, the teeth being placed in rectangular sockets and held in place by a V tongue and groove. The rectangular sockets have been largely discarded for curved, as giving less liability to crack.

The following figures from the Albion Mill on our West Coast, show the performance of the Hoe chisel bit saw: See Fig. 107.

	No. days.	Feet Board Measure.
November,	26,	859,407
December,	23,	798,274
January,	26,	866,992
February,	25,	852,818
March,	25,	962,537
April,	26,	934,337
May,	10,	387,019
	162,	5,661,385

Number of bits used in the work, 4000 in all.

The bits are run in the Albion Mill as follows: Starting in the morning, with new teeth, on 4 inch feed, in hard pine or red-wood until noon. Then a set of new teeth run until night. At night the watchman puts in the next set. The dulled teeth are sharpened twice for the bottom saw and are then worked in the top saw.

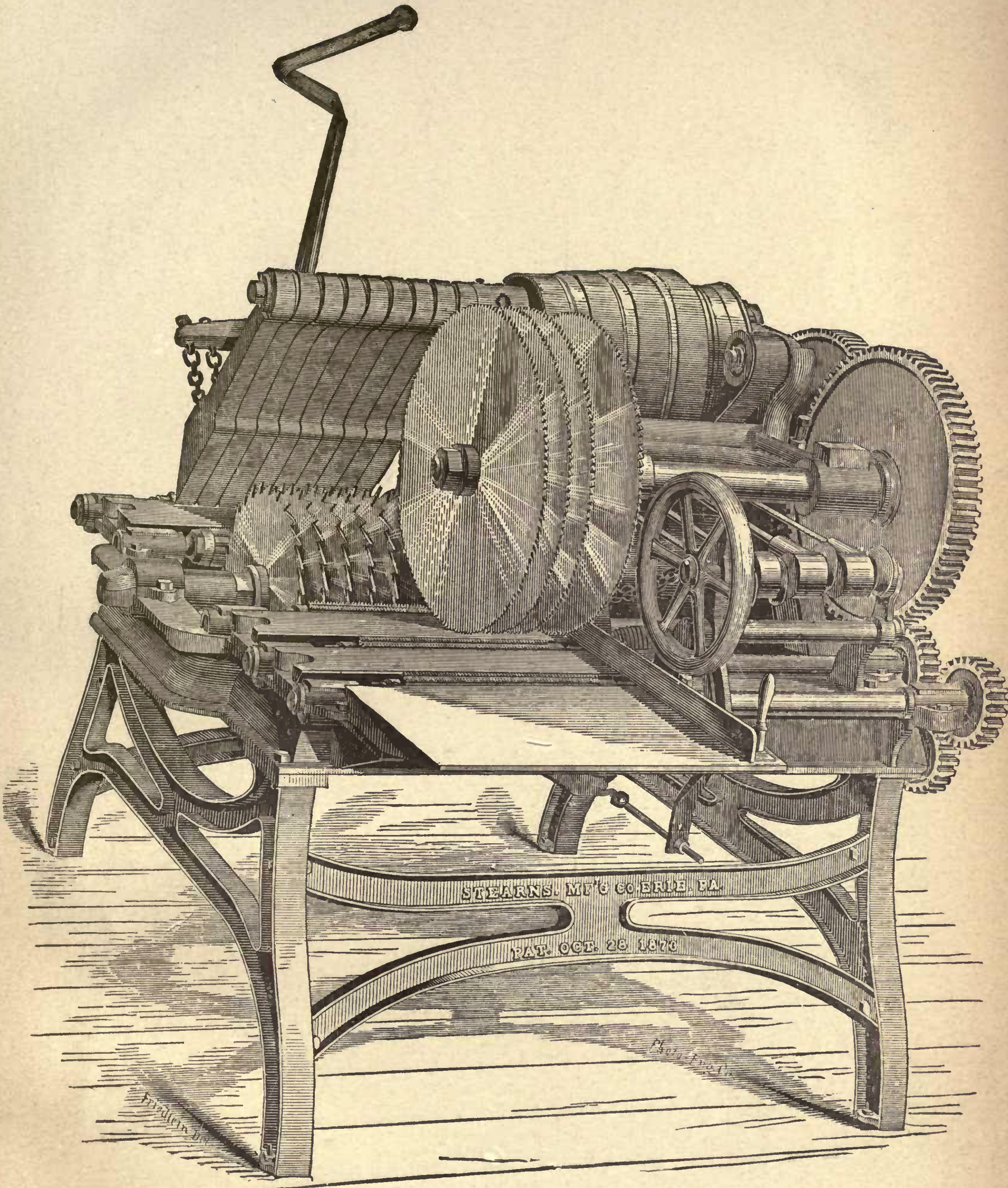
The "Brooke" tooth saw is shown so clearly in Fig. 108 as to require no special explanation.

Fig. 109 shows the cutting action of an inserted toothed saw. The type shown is one of those made by the American Saw Company.

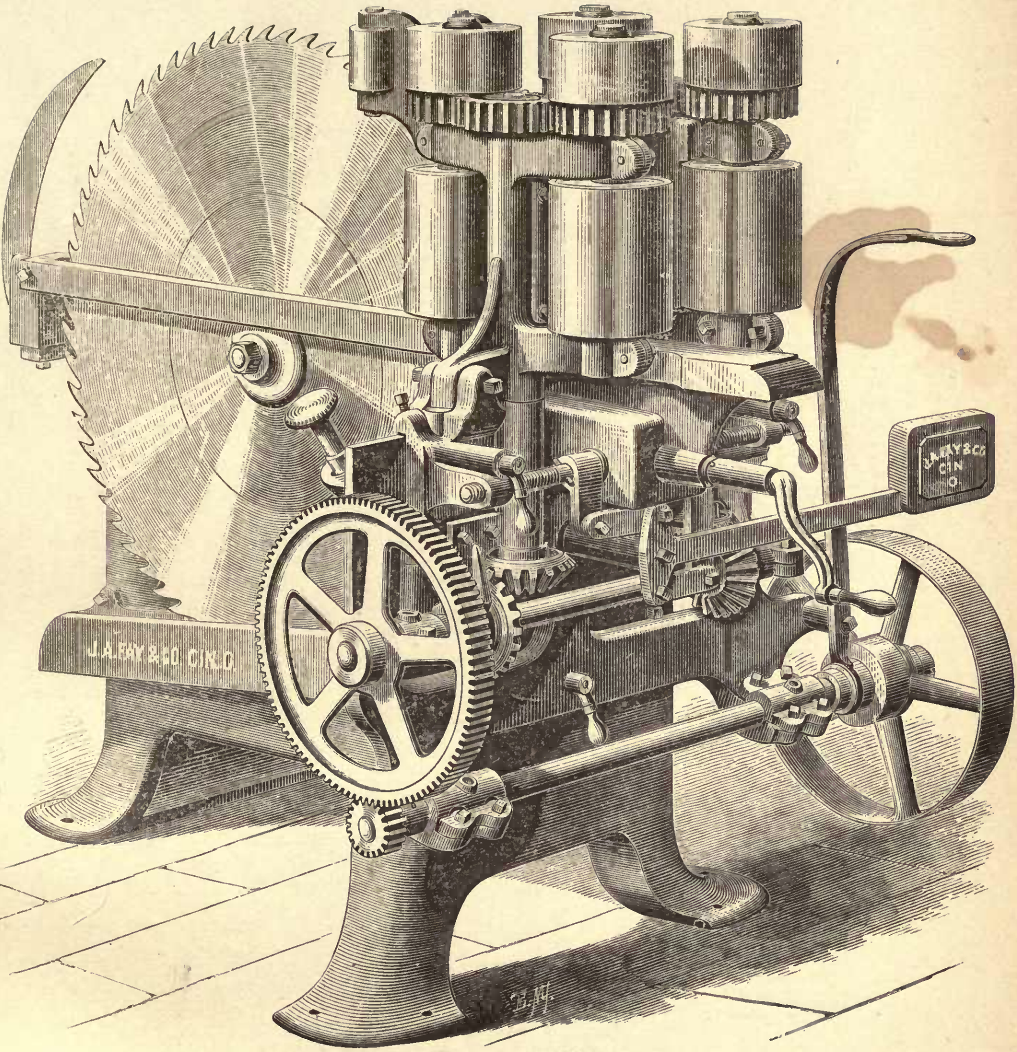
Fig. 110 shows the "movable tooth" of the American Saw Company.

Fig. 111 shows a "perforated" inserted tooth made by the last-named makers.

Inserted toothed saws are made from 13 to 6 gauge and from 12 to 72 inches in diameter, the smaller sizes being used for edgers and gangs.



Eight-Saw Lath Bolter.



Circular Resawing Machine.

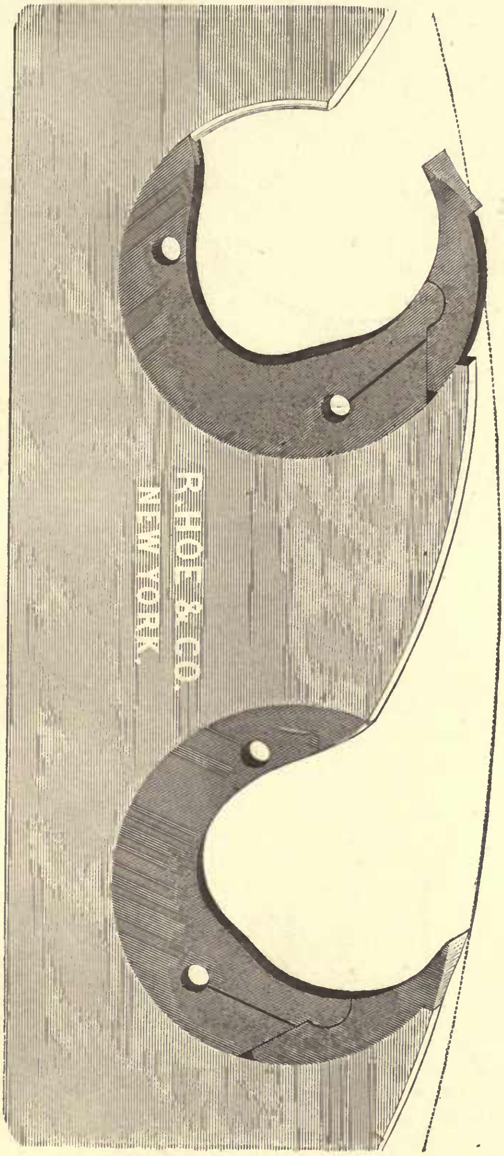


Fig. 107. "Chisel Bit" Saw.

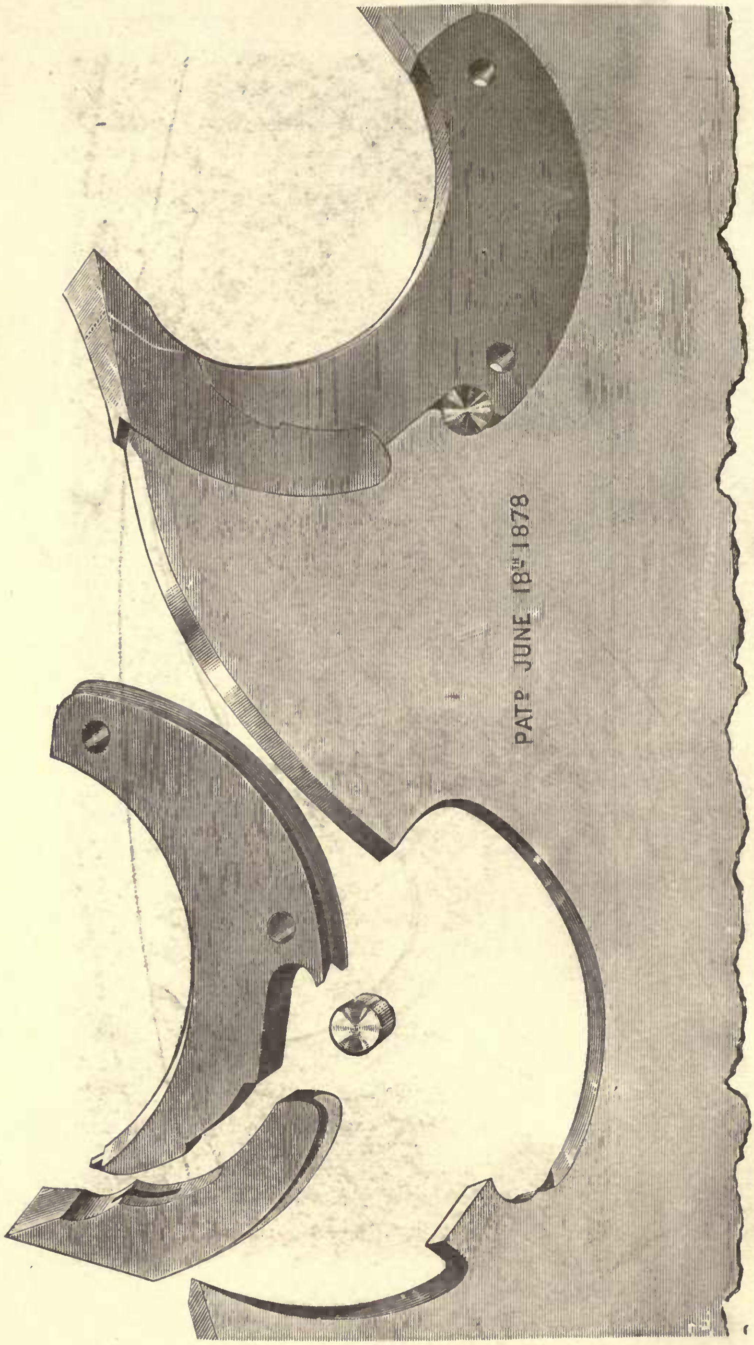


Fig. 108. "Brooke" Movable Tooth.

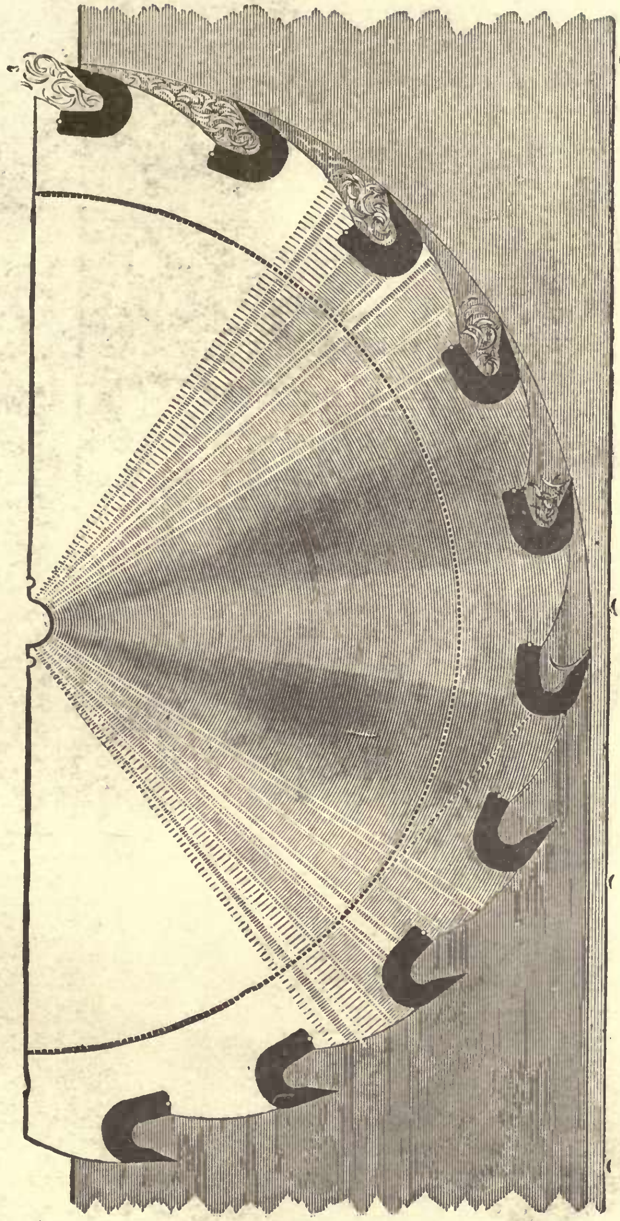


Fig. 109. Cutting Action of an Inserted Toothed Circular Saw.

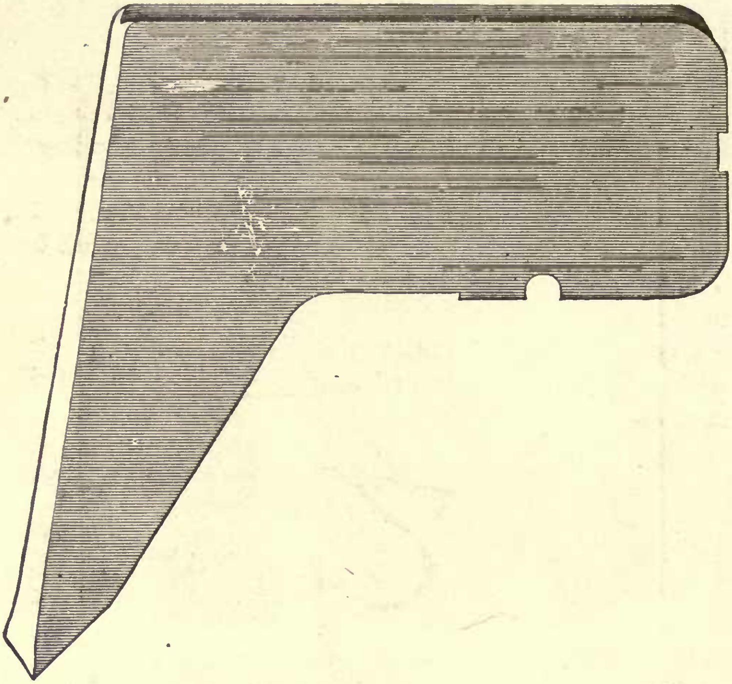


Fig. 110. Movable Tooth of the Am. Saw Co.

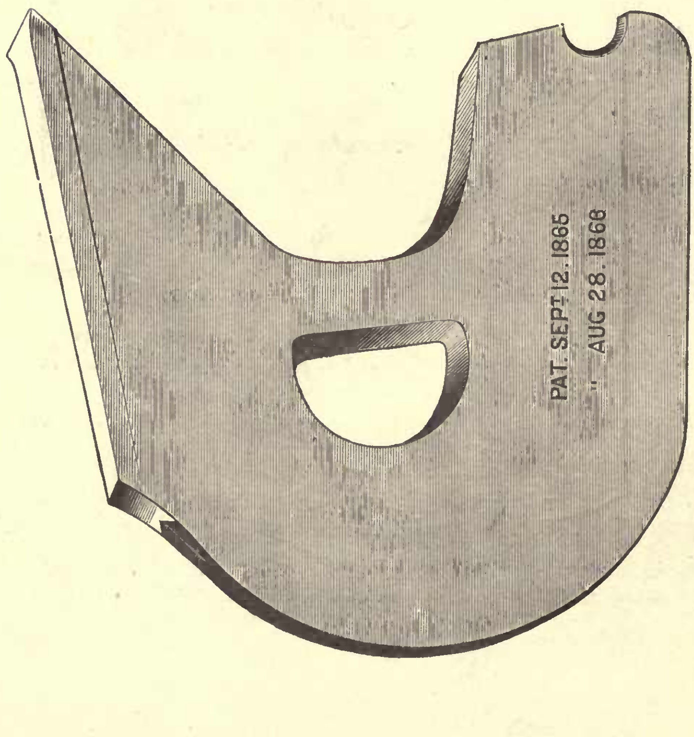
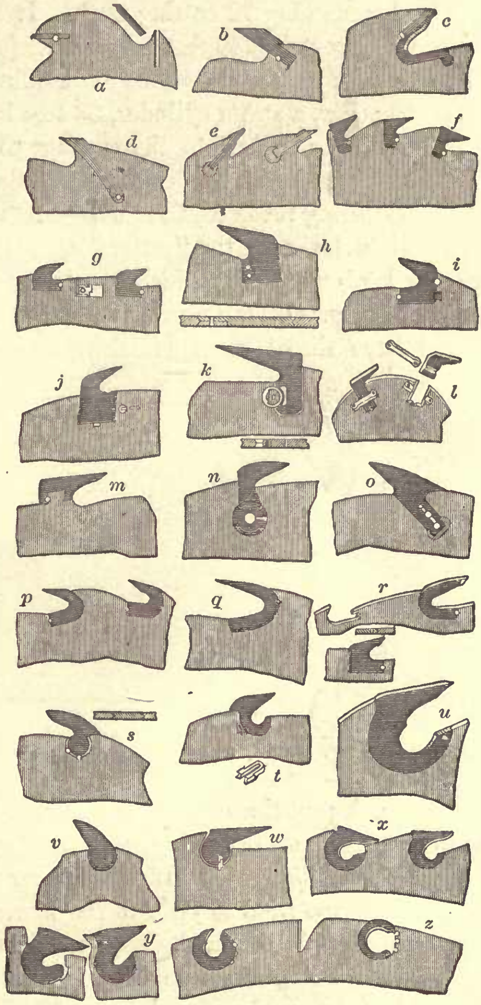


Fig. 111. Perforated Inserted Tooth of the Am. Saw Co.

From "Knight's American Mechanical Dictionary"* we take the annexed concise representation of various insertable teeth:

a. Krauser.
b. Colsen.
c. Emerson.
d. Clemson.
e. Lippincott.
f. Spaulding.
g. Emerson.
h. Neale.
i. Emerson.
j. Brown.
k. Clemson.
l. Woodruff.
m. Emerson.
n. Disston.
o. Shoemaker.
p. Emerson.
q. Emerson.
r. Emerson.
s. Disston.
t. Disston.
u. Hoe.
v. Strange.
w. Humphrey.
x. Miller.
y. Disston.
z. Miller.



The most remarkable sawing of which we have any record was done in September, 1879, in the mill of Messrs. Chapin & Barber, Bay City, Mich., with a "Lumberman's Clipper" (inserted teeth) saw made by Emerson, Smith & Co., of Beaver Falls, Pa., and run by A. G. McCoy. There were made nineteen cuts, each 16 feet long

* Houghton, Osgood & Co.

and 23 inches wide or deep, in *one minute* of time. Material, white pine. The saw was 72 inches diameter; No. 6 gauge at centre, 7 at rim, and containing 72 cutting teeth. It ran at the rate of 650 revolutions, or about 12,250 feet per minute (over two miles!) and cut 12 inches at each revolution. This extraordinary rate of feed was effected by steam; *i. e.*, a steam cylinder, 38 feet long, and 7½ inches diameter, has its piston attached to the carriage so that a log 16 feet long was forced through its entire length in a trifle over one second—instantly the stroke being reversed, the carriage returns in about a second; one jerk with a lever by the "setter" or man who rides on the carriage, and the log is "set" for an inch board, and the saw is entering it again.* "What becomes of the sawdust?" may be asked by some—as no saw would have throat room sufficient to contain one-tenth of it. It

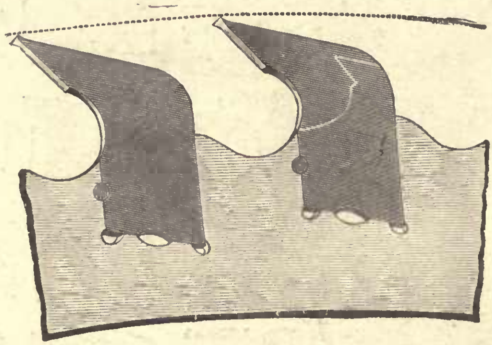
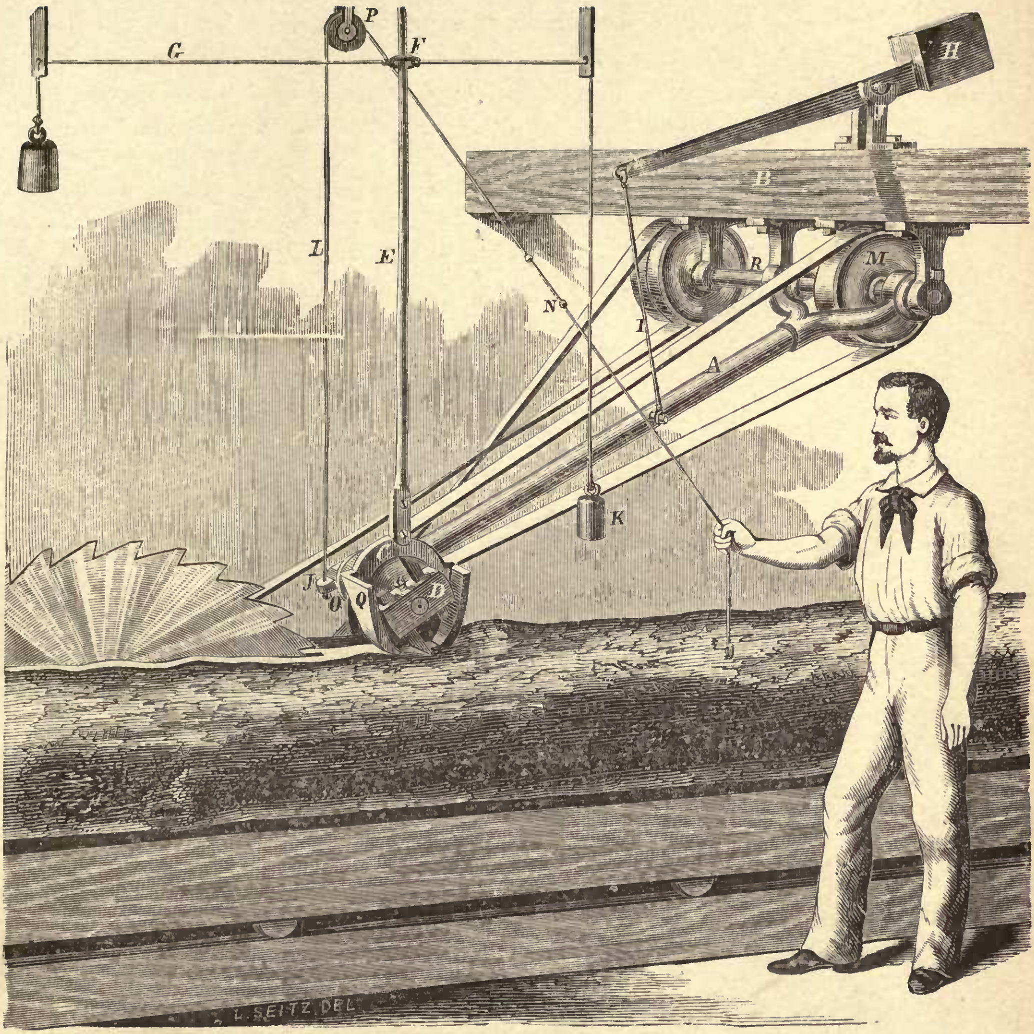


Fig. 116. Lumberman's Clipper.

crowds back past the edge of the saw, mostly on the board side—the board yielding or deflecting, and thus opening a large space for its reception and discharge. If the lumber sawed be say 2 inches thick or over, and too rigid to yield to the pressure of the sawdust, no such feed can possibly be maintained; nor if the saw be cutting through the centre of a log, where no deflection can take place. In these cases the feed of the carriage or log must be graduated to the capacity of the dust chamber or throat room of the saw.

The teeth or attachments of an inserted teethed "circular" should be made perfectly secure, so as to obviate any danger of their flying out while the saw is in rapid motion, and endangering life and doing damage to saw or machinery. If the attachments are not secure the tooth

* This is familiarly known as the "shot-gun" feed.



Stearns' Rossing Machine.

is liable to fly out, without a moment's warning, like a bullet (see *Scientific American*, Oct. 11, page 279).

A curiosity in the way of a circular saw is shown in Fig. 117; there being two planer bits inserted (projecting sidewise, of course), to clear off the roughness left by the cutting teeth. We have at hand no record of its actual performance.

To lessen the heating of circular blades, and to prevent wabbling being caused by expansion, a patent circular saw has radial slots terminating in round holes—the office of these being to prevent cracks from extending. See Fig. 118.

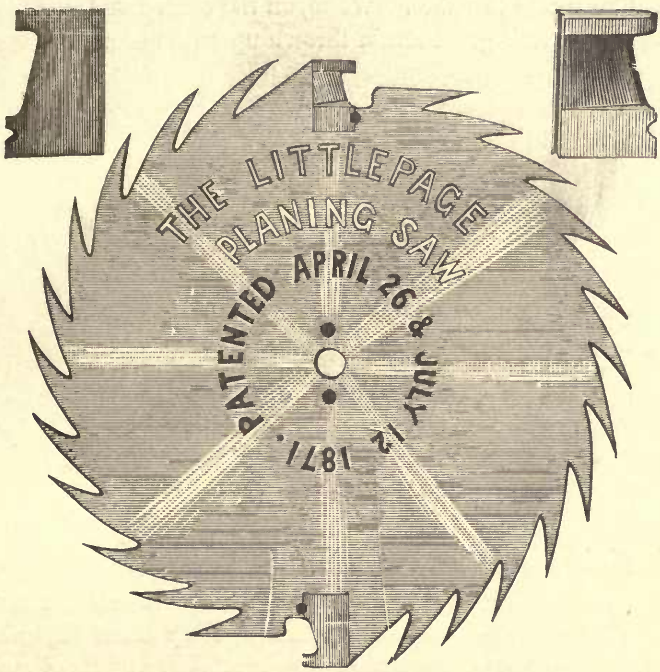


Fig. 117.

Lockwood's idea is that if a radially slotted saw be heated at or near the eye, the slots close up as much as the metal expands, thus leaving the edge of the saw entirely unaffected. Or, if the edge of the saw be heated and consequently expanded, the slots, by opening, neutralize the expansion, and both the eye and the edge remain true. A saw never or very rarely becomes heated enough to injure the metal or the cutting capacity of the saw; and the makers claim that with this improvement, a saw will run equally true and make lumber equally well, whether the saw is hot or cold, and will never require straightening. The makers also claim that the lumber, with the improved saw, is truer and smoother than has heretofore been made with circular saws.

They explain its action as follows: When it runs out of the log, the log, in passing, presses hard upon the outside of the saw near the eye or within the range of the slots, and by the friction thus produced, the saw becomes heated in that part, and consequently expands, whereupon the sections close up the slots and project inwards, and thus release the saw from the great strain on the edge, which a solid saw must endure before it dishes. When, on the other hand, the saw runs into the log, there is great strain thrown upon the edge of the saw by

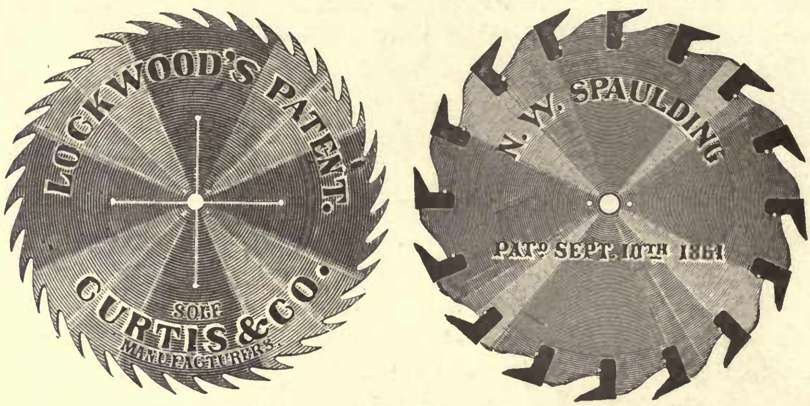


Fig. 118.

cramping it in the guides, and hence the heating on the outer edge and consequent expanding of that part, which renders the saw loose and flabby and uncertain in its operation. They claim that a slotted saw may be heated ever so much or often, and never be thereby thrown out of its true surface; the external and internal vent allowed by the slots causing the saw always to operate easily and freely, and consequently be less liable to heat; and if it does heat, no bad effect is produced, nor any uncertain operation caused thereby. They say: "A slotted saw will invariably run where the filer desires, every time in the same track, unless violently restrained. If the saw does not run where you want it, correct it by filing. In consequence of their being no effect produced on the accurate operation of the saw by heating or changing the temperature, a saw can be run with equal certainty and as effectually as a solid saw, with a gauge less set. A slotted saw will therefore save fully one-third of the saw scarf, and ten per cent. of the lumber when sawed into boards. A slotted saw will never spot, because, however much it may be heated, it will resume its original shape when cooled."

One device for cooling the saw and preventing cracks from extending far, is a number of round holes drilled obliquely through the plate, and intended to cause an air current through the disk.

It is estimated that three times re-gumming a non-perforated circular costs nearly the price of a new saw. Perforations in the line of the gullet lessen this cost. The metal in the track of the perforations is softer than the teeth, because of the sawdust left in them when the plate is scoured after tempering burns when the plate is flattened and draws the temper of the holes.

Spaulding states that the bevel on the under side of his inserted teeth should range down on an angle to one-fifth the diameter of the saw.

In cutting 32-inch stuff, with a feed of $\frac{1}{16}$ inch to each tooth, it is evident that there must be a throat area of *at least* $32 \times \frac{1}{16} =$ two square inches.

Spaulding computes the necessary throat room thus:

A 72-inch saw with 46 teeth, cutting 4 inches per revolution, removes 128 square inches on a full cut of a 32-inch board. This solid wood cut into dust will require twice the space, or 256 square inches; hence each tooth should have $5\frac{1}{2}$ square inches throat room, to work freely and easily and clear freely. With less throat it will clog or force the sawdust into the space between the saw and the log, and cause it to heat on the rim.

In cutting thin boards which will bend aside, perhaps less throat is required. See performance of A. G. McCoy with a 72-inch saw taking 12 inches feed on a 23-inch log.

It is stated that the Spaulding inserted teeth will stand $\frac{1}{12}$ inch to $\frac{1}{8}$ inch feed to the tooth and have room for the dust.

Disstons have a patent on enlarging circulars which have been worn down to unavailable sizes, by means of segmental rims of teeth, the periphery of the old plate and the inner edges of the segments being halved together and secured with rivets. A four-foot plate may be pieced out to 5 or six feet. The expansion of the rim in running is said to be checked at the joint and not to affect the main plate. The old plate is grooved on each side to a gauge less in the centre than at the rim.

By the use of an "adjustable cone bushing," saws of varying-sized holes can be used on different arbors.

THE CYLINDER SAW has many names, forms and applications, all having cylindrically curved edges cutting parallel to the axis of the cylinder. Perhaps its oldest form is the Trepan or Trephine saw (Fig. 125), of the surgeons; also called a *Crown* saw, and used for removing circular pieces of bone from the skull. This is also misnamed the "spherical saw." The button saw has a similar shape, and is used to cut out the circular blanks of bone or pearl buttons. As the barrel or tub saw, it is used to saw barrel or tub staves on the curve; in this case its functions being not to remove a circular disk, as in the trepan or button saws, but to produce a longitudinal segment of a hollow cylinder. A similar saw is used for sawing wooden water troughs and

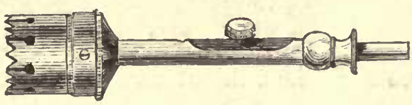


Fig. 125. Trephine.

sections of wooden water pipes. Tube saw is another name for this class. Fig. 126 is a fair illustration.

The cylinder saw comes into play nicely where the waste of a saw mill is to be sawed into staves, as in the Baltic country.

The main barrel of the saws is not hardened; the teeth are on a band a few inches wide, soldered on. The grinding and balancing has to be most exact, and it is generally necessary to finish the saw on the spindle on which it is to be run, and not to remove it afterwards.

For cutting out staves for tight barrels and casks, cylinders 40 inches long and 24 inches diameter are used.

The cylinder saw has also been made reciprocating in its action, to permit cutting very long segments. As the piece removed by a cylinder saw passes inside the band, it is evident that there can be no arms to stiffen the cutting edge if the rotary action be continuous; but by making the teeth double-acting and giving the cylinder only a quarter or a fifth rotation, and this reciprocating, a segment of considerable width and of unlimited length may be removed.

THE BAND, BELT, OR RIBBON SAW, although conceived as early as 1808, by Wm. Newberry (for splitting *skins* and wood), is of comparatively recent general introduction, having laid for forty years as a curiosity—it being supposed impossible to join the blades properly—and has not yet reached that wide application for heavy work to which its many merits entitle it.

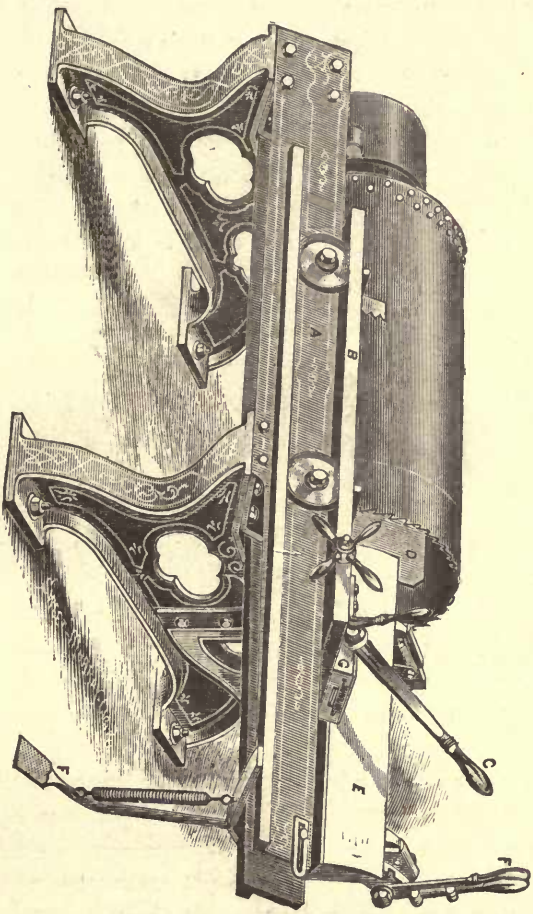


Fig. 126. Cylinder Saw.

The machine of seventy-two years ago contained all the essential features of the modern machines. We illustrate it herewith, by kind permission of Messrs. London, Berry & Orton, of Philadelphia.

As we now know the band saw it is a thin, flexible, endless band of steel, serrated on one edge, and passing over two large straining pulleys, in the same plane and with parallel axes, the rotation of which gives it motion through a supporting work table. The teeth are protected, and the blade given greater "grip" on the pulleys (lessening slip) by a rubber or leather tire. One maker obviates the destruction of tire and teeth, when the lower wheels are stopped by the brake, by having false over-tires of steel covered with leather, slipping on the main tire.

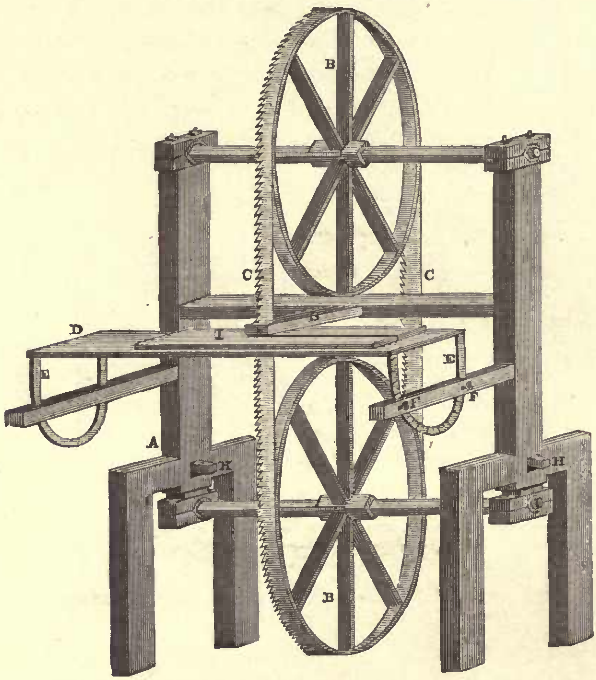


Fig. 127. Original Band Saw of 1808.

The construction of the blades offers a paradoxical problem. They must be soft and flexible to pass readily around the pulleys at a light speed, without breaking; and yet they must have hardness sufficient to receive and maintain a keen cutting edge, and stiffness enough to resist somewhat firmly the pushing and bending tendency of a high feed.

As in many other branches of industry, the demand for a product at first deemed difficult or impossible to make, has been nobly met. The material for the blade has been produced and worked; and the many disheartening difficulties and failures in the machine itself have been overcome. Experience and inventive genius have surmounted the obstacles interposed, and to-day the band has almost entirely superseded the reciprocating saw for scroll work and is fast encroaching upon the circular, single sash and mulay for resawing; while strenuous efforts are being made to force its use for log-sawing. It offers for ship timber cutting the best advantages of the circular in smooth or continuous action in a right line; and that of the scroll or "jig" in capacity to saw at any angle, curve, or bevel.

Like the circular saw, its continuous motion admits of very high speeds, and there is no non-cutting return stroke. One of its principal advantages, also, is its immunity from heating, there being but a proportionally small portion of its length (say two or three per cent.) in frictional contact, and this being cooled by rapid passage through the air.

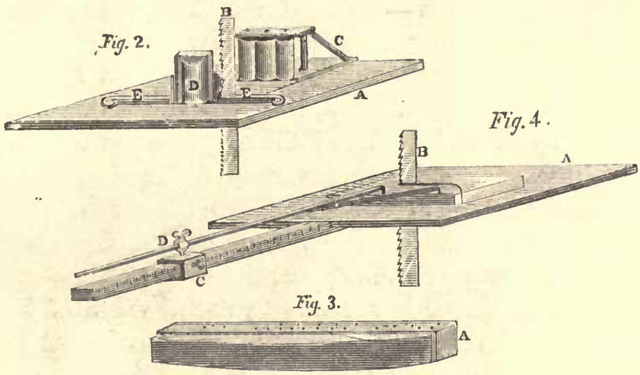


Fig. 128. Details of Newberry's Machine.

One good feature is that the sawdust is constantly carried down; it requiring no blower as does the jig, to prevent clogging and enable the workman to see the line he is cutting to. A very simple adjustable device enables it to be kept in line by slightly varying the position of one of the pulley axles. It should by its superior steadiness scratch less stuff than the circular.

No matter what the speed, the tension of the band remains about the same—as is not the case with the circular. It is, too, easier guided than the latter, while having less necessity for guidance. These properties tell in the market price of lumber, as well as in the quantity of planed lumber a given log will make.

Perhaps its main advantage is in its narrow kerf; saving time, material, and power and giving increased duty.

As the office of a saw is to sever by removing or wasting material, the thinner it can be had, the more economical of time, power and material.

We may estimate that the kerf waste (outside the employment of the best gang saws in "deal frames") is as high as 20 per cent., or one-fifth. Indeed, if we consider the American mills, which turn out stuff principally as one-inch boards, the waste with careless sawing is as much as 25 per cent., or one-fourth.

The circular and mulay often making $\frac{5}{16}$ inch kerf, which is increased to $\frac{3}{8}$ inch by scratches and by irregularity of line, we have only $\frac{5}{8}$ lumber for $\frac{3}{8}$ kerf; or $37\frac{1}{2}$ per cent. loss, in material alone. As every $\frac{1}{16}$ inch in kerf saves 1000 feet of lumber in each 16,000 feet sawed, any mill cutting on an average 16,000 per day, will save 26,000 feet of lumber per month, or more than the entire expense of running the mill. The loss of power is in most places directly important, and where not so by reason of cheapness or free cost of fuel or of water power, the lessened duty of the mill is an item.

To this may be added labor of the sawyer—who finds it necessary to dog more logs to produce a given amount of lumber, than if thinner and smoother kerfs were made; and also takes more time to cut a given quantity with the thicker and slower-running blades. This figures up in the wages account per thousand feet of lumber made.

The saving in power is not directly as the width of kerf, as the band has more of a scraping action than the circular and takes more power per given width of kerf.

If we consider kerfs running from $\frac{1}{8}$ inch to $\frac{1}{2}$ inch, on inch boards, and see how many boards can be got out of a balk of a given size, with each kerf, this question of waste of material is very plainly brought to mind.

The band saw is the straight blade, rolled in a hoop, and cutting continuously. The circular is the same blade developed in the other plane, into a disk. The band meets each fibre of a log at the same angle. The circular meets those on the top less at a right angle than those at the bottom. As the top segment of one-third the diameter of the circular has more than one-third the semi-periphery (see Fig. 130), it follows that, with a given size "cant" to be cut, the circular has more tooth line to cut the same height of wood than the band has, and this is often an advantage, as the more teeth the less throat room required. Thus the circular, which has greater facility for having throat room than the band has, requires it less for a given size of tooth and height of cant.

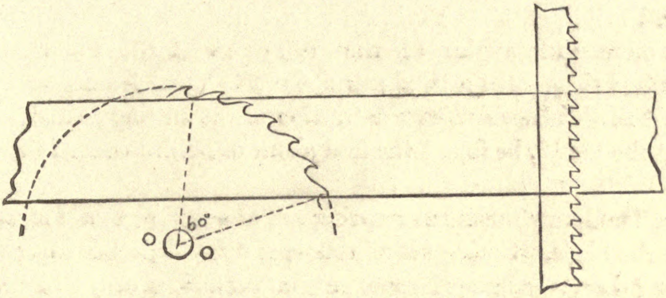


Fig. K. Cutting action of Band and Circular Saws Compared.

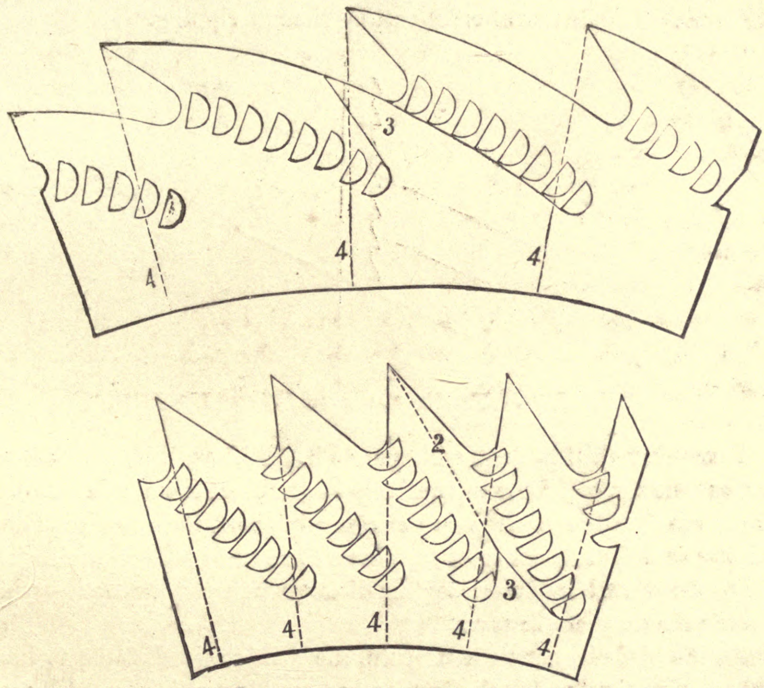


Fig. 129. Perforated Circular Saws.

Fig. 129 show these perforations in the line of future gullets, as made by the American Saw Company.

All the teeth of the band meet the fibres of the wood at the same angle. Those of the circular meet them at a varying angle. Moreover the angle at which any tooth of the circular meets the log is much more acute than that at which the band saw teeth strike it. This gives a greedier cut and more of a cutting than a scraping action.

Mr. Pryibil, of New York, conceived the idea of giving the band saw a more acute angle with the wood (see Fig. 130); and with this aim, tilted thetable of a band saw about $23\frac{1}{2}°$, and fed a board up hill to meet the blade. Testing the traction of the cutting at a right angle and at the $113\frac{1}{2}°$, he found the feed about one-third easier in the latter case.

The band saw must have spring set, as swaging would stretch and crook the blade. Spring set of course gives a blade less capacity than swaging does, as a swaged tooth cuts on both sides of the blade, and a spring tooth on but one. For small curves it requires more set than for large. It is better at cross-cutting than at ripping.

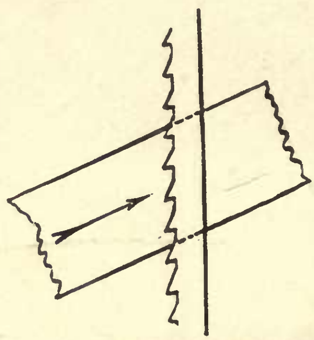


Fig. 130. Feeding a Band Saw Up Hill.

It requires skill to dress and operate it. Although its fast feed and coarse cuttings call for comparatively large throat room, with ordinary tooth spacing, the teeth being necessarily short, it is not capable of having sufficient throat room for coarse feed, and hence it *packs.* This may be obviated by increasing the distance between the teeth—which lessens the duty of the saw.

As the blade is so extremely thin, the tension is difficult to keep; changing instantly with the temperature and requiring special elastic or weighted tension devices to prevent it breaking by cooling down after working.

Too coarse a feed causes the back to be crowded and get longer, like the edge of a leather belt that runs rubbing against a shifter.

The friction against the guides tends to crystallize and crack the

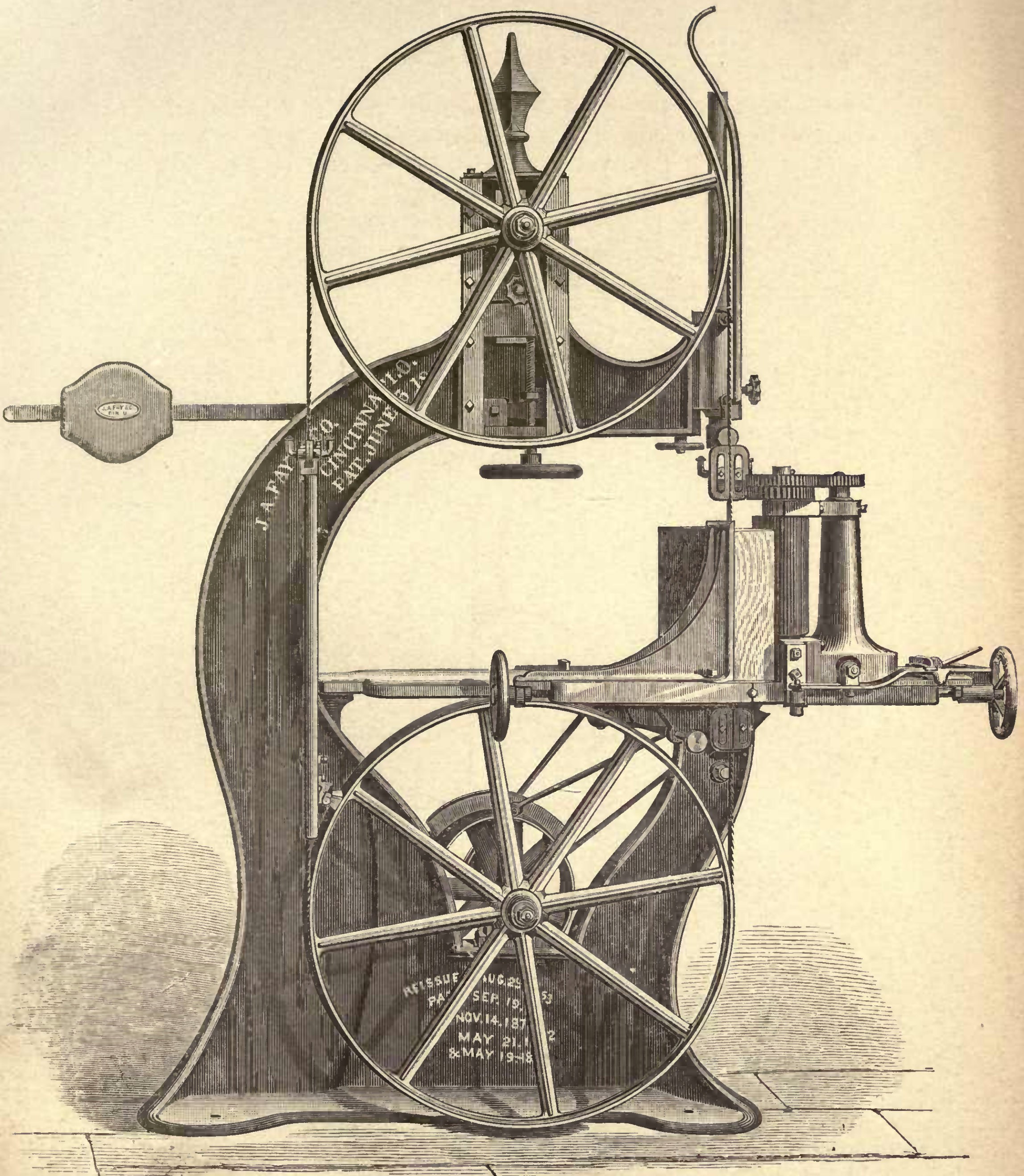


Fig. 132. Band Resawing Machine.

back edge of the band, no matter how carefully the back guide is made, even with steel balls rolling at the slightest touch; but by keep-

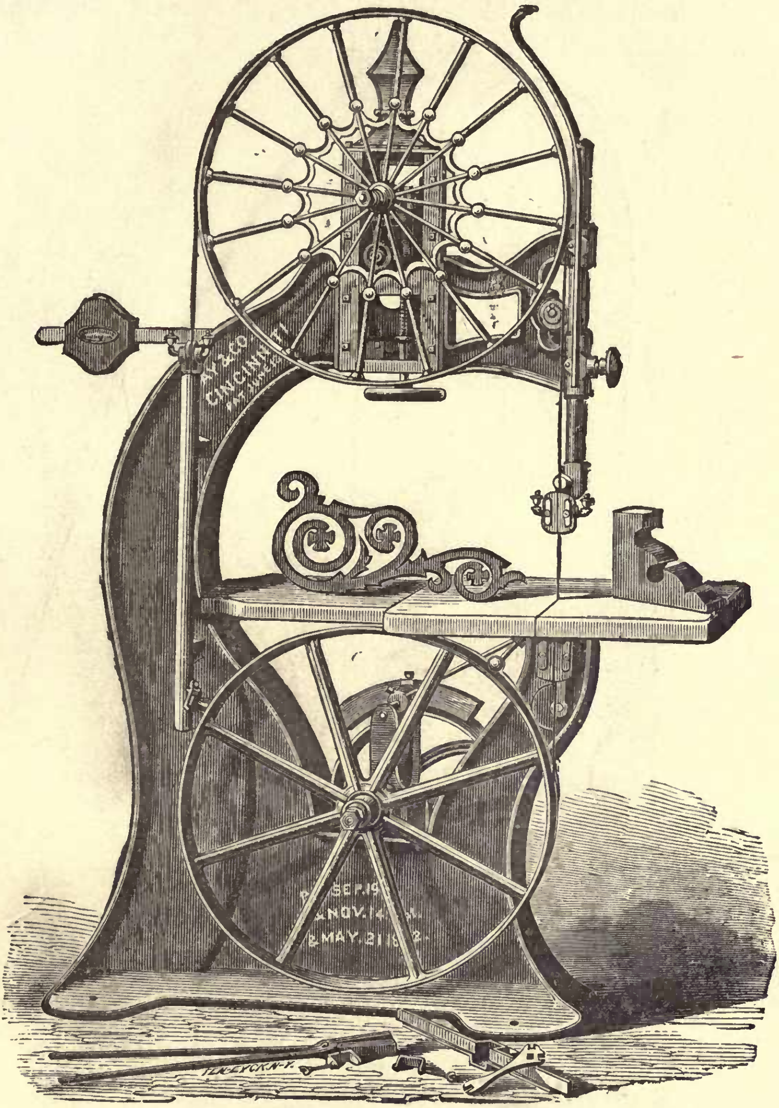


Fig. 131. Band Scroll Saw.

ing the proper pitch on a band-saw tooth it may be given a "lead" into the cut, thus lessening the friction on the stay-pin.

For soft wood the tooth space should be about one-half and their depth one-fifth the blade width. For hard wood, say space one-third and depth one-fifth the blade width. The gullet should be circular; the rake not enough to give a back thrust.

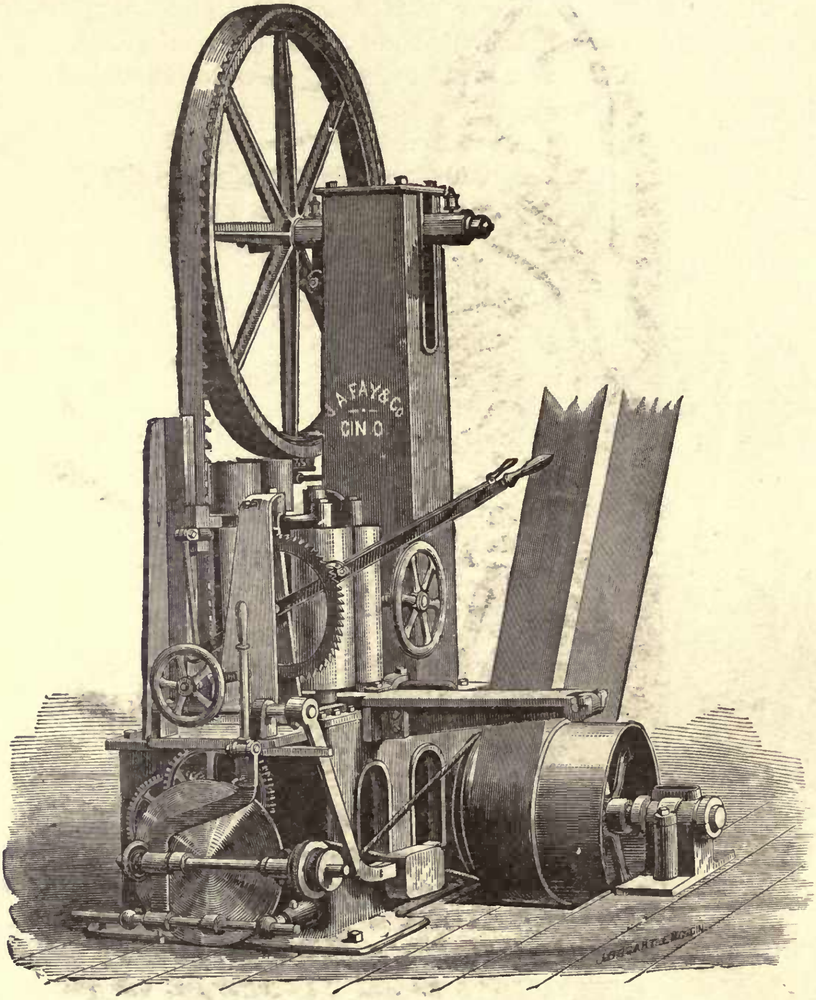


Fig. 133. Band Resaw—Operating Side.

As yet the band saw can cut but one kerf at a time, not being arranged in "gangs" as are the straight and the circular saws. We imagine that the principal difficulties to contend against in this direction would be connected with the tension and alignment.

Fig. 131 shows a band scroll sawing machine; Fig. 132, a light band re-saw, for working up to 14 inches, with saws up to two inches wide. (This takes a 5 inch belt on a 14 inch pulley, making 450 revolutions per minute.)

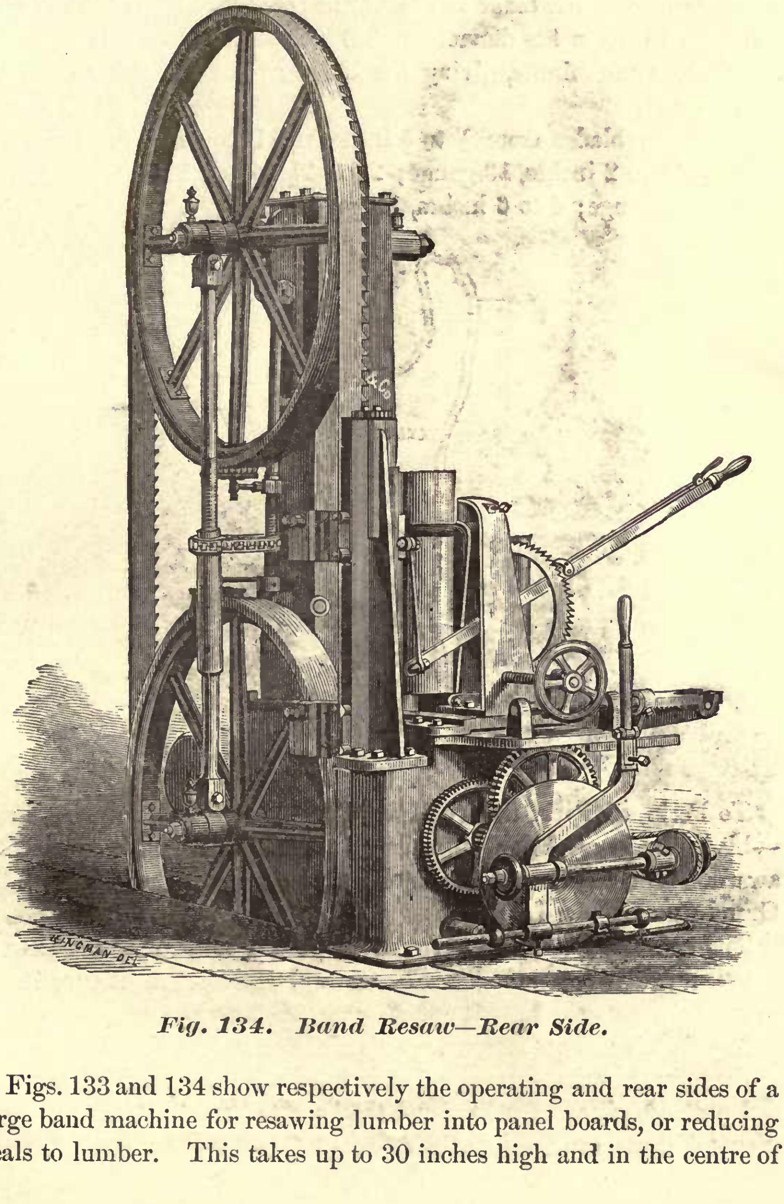


Fig. 134. Band Resaw—Rear Side.

Figs. 133 and 134 show respectively the operating and rear sides of a large band machine for resawing lumber into panel boards, or reducing deals to lumber. This takes up to 30 inches high and in the centre of

18 inches, the kerf being only $\frac{1}{16}$ inch. This machine will produce two $\frac{3}{8}$ inch panels planed on both sides from one inch lumber, instead of requiring $1\frac{1}{4}$ inch to produce the same stuff. The wheels are 60 inches diameter and take saws up to 4 inches wide, being placed close together to keep the blade as straight as possible. The pulleys of this machine are 30 inches diameter and 8 inch face, and should make 300 revolutions per minute, giving the blade over 4500 feet per minute lineal speed.

Band-saw blades from $\frac{1}{4}$ to $\frac{5}{8}$ inch are 21 gauge; $\frac{3}{4}$ to $1\frac{1}{8}$ inch, 20 gauge; $1\frac{1}{4}$ to 2 inches, 19 gauge; $2\frac{1}{4}$ to $2\frac{1}{2}$ inches, 18 gauge; $2\frac{3}{4}$ to $3\frac{1}{2}$ inches, 17 gauge; 4 to 6 inches, 16 gauge.

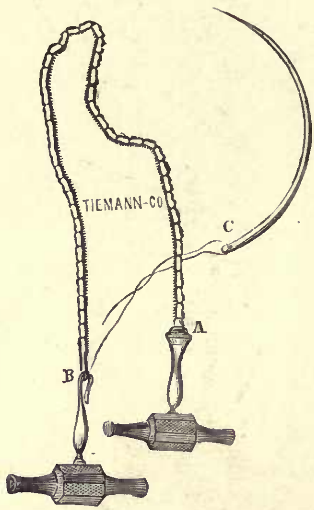


Fig. 140. Chain Saw—Concave Cutting.

To Perin, of Paris, the world is indebted for making the band saw —blades and machines—practical. His government very justly awarded him, for his services in this connection, the decoration of the Grand Cross of the Legion of Honor.

The nondescript CHAIN SAW merits passing mention. It comes in between the reciprocating rectilinear and the continuous curvilinear saws.

Fig. 140 is the ordinary surgeon's chain saw, introduced by means of the curved needle shown, and then fitted with the handles A and B, and pulled back and forth around the bone to be cut off. In this case it cuts with its concave side.

Fig. 141 shows a surgical chain saw, cutting with its convex edge. Messrs. George Tiemann & Co. have produced an entirely novel saw,

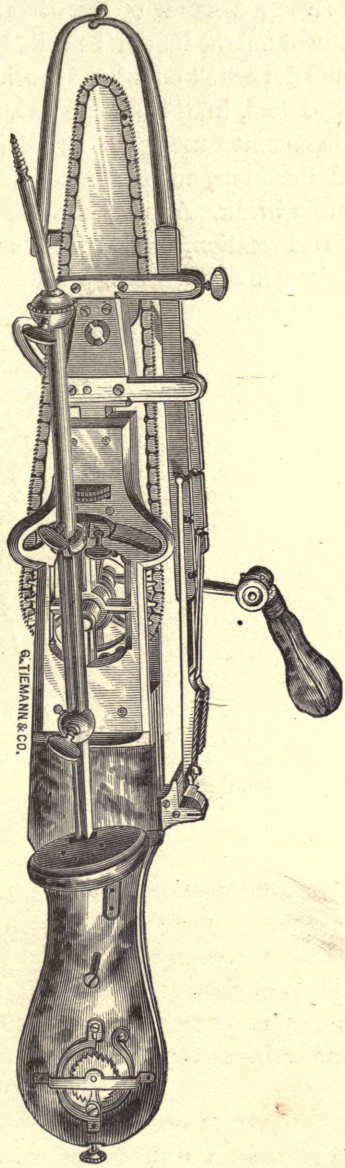


Fig. 141. Chain Saw—Convex Cutting.

the invention of Mr. F. A. Stohlmann. It is intended to replace the chain saw in common use, and is free from the tendency to bind, kink, and break which characterizes the latter instrument. It consists, as will be seen in Fig. 142, of two handles connected by a wire of cast-steel, on which is strung a series of steel beads with sharp cutting edges. The instrument might indeed be called a file quite as appropriately as a saw, and its action on a bone is said to be more like that of the first-mentioned tool, in the absence of such rough edges as are made by the saw in common use. No needle is required to carry it through or around the bone, and its beads can be readily strung on a new wire in case of a break. Another advantage lies in the fact that the beads, by their free rotation, present fresh cutting edges; and still another is the considerable difference in price between this instrument and the ordinary chain saw.

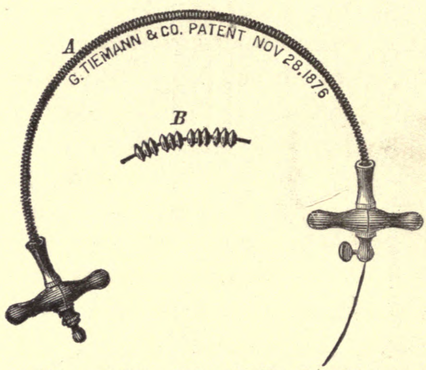


Fig. 142. Novel Chain Saw.

APPENDIX I.

SAW MAKING.

Inasmuch as this country possesses the largest saw manufactory in the world, and our needs as a new country, constructing so largely in wood, and exhausting forests for railroad ties and bridges, tend to develop the use of the saw—it may be presumed that our systems of saw manufacture and our skill in their employment are in no whit behind the age, and are worthy of public notice.

It is not many years since no American manufacturer dared to use American steel for saw making. The first successful attempt was made surreptitiously. Had it been publicly announced before succeeding, it would never have been the decided success it now is. Now we claim that the Old World may learn from us in saw making, and even buy from us the manufactured material.

A recent prolonged inspection of an immense saw works,* where the proprietors and foremen, all practical men, fearing neither publicity nor competition, exerted themselves to answer in detail our every question, enables us to present the following outlines of the process:

The steel, which is all "crucible," is made in the works, from Swedes iron, brands "hoop L. G." and "hoop F." The bars are cut small, and mixed with scrap steel from the manufacture of saws and files. Carbon is added in the proportion of 1 oz. to from 4 to $5\frac{1}{4}$ lbs. of iron (say $1\frac{1}{2}$ to 1 per cent.) The thicker the saws desired to be made, the milder or less carbonized the steel. The material is melted in graphite pots holding from 65 to 85 lbs. each, and run in iron moulds into ingots varying in weight, dimensions and shape according to the style and size of saws required to be made. Thus, an ingot for $1\frac{1}{2}$ dozen

* The Keystone Saw Works of Messrs. Henry Disston & Sons, Front and Laurel Sts., Philadelphia.

handsaws, 26 inches long, and tapering from $7\frac{1}{2}$ to 3 inches, weighs 48 lbs., and is a flat block $6\frac{1}{2} \times 12 \times 2$ inches in size.*

For a 50-inch circular saw three pots full are required, and the ingot weighs 200 lbs. A 60-inch circular, rolled to No. 5 gauge and finished to No. 6 gauge, takes a 260-lb. ingot, hammered to the shape shown in Fig. 143, the pipe end or part which was uppermost in the mould being cut off, as shown by the V-shaped groove, because less solid than the rest.

For a "cross-cut" saw (familiarly written "×-cut") the ingot is cast of the form shown in Fig. 144, more convex on one edge than on the other. It rolls to the profile shown in Fig. 145, and is afterwards trimmed by shears to the shape shown in Fig. 146.

A 6-foot cross-cut of 14 plate requires an 11-lb. ingot. Peculiar tongs are used to grip the sheet, and great skill is required to prevent their slipping. While being rolled to the proper gauge the plates are slapped vigorously on the smooth and level iron floor, to slam off the scale and dirt, which would otherwise be rolled into them.

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* "Some manufacturers—or at least one—has compiled from his practice a table of the weight of ingot required to roll out to a certain gauge and size of plate, so that, if an order is given to the rolling-mill to take an ingot of specified size and shape and roll it out to given dimensions, the result will be a certain gauge or thickness. By this means accuracy and simplicity are insured, since the skill of the workman in accurately measuring the gauge is not depended on. In point of fact, the workman need not be told anything about the gauge thickness. Fine measurements are not in his line, and, though he can measure the size of a sheet of steel, he is not at home measuring minutely to gauge.

As an example of the use of the table referred to, suppose it is required to make two dozen handsaws 56 inches long and of 19 gauge; a plate of 26x10½ will just make two such saws. Then the manufacturer calculates thus: 10½ (the width of plate) x 26 (the length of plate) = 273 inches; this will make two of the required saws. This, multiplied by 12, gives the area of plate required to make the two dozen saws. Then, turning to his table (which is a table of constant numbers) he finds against 19 gauge the constant number 72, and by dividing the area of plate required by this 72, he obtains the precise weight of ingot required to make the two dozen saws, and bring them out to correct size and gauge, allowing sufficient for trimming the edges of the plates. By this system (Joshua Oldham's) he is enabled to give to the rolling mill an order thus: "Roll me an ingot weighing 45½ pounds; cut it into 12 equal parts, and roll each piece to 26x10½ inches;" with the result that he will not be required to pay for rolling any more metal than that just requisite to make the two dozen saws, and the saws will be the proper gauge. (The reader will observe that the workman is not required to use the gauge at all.)

Plates so rolled will, for handsaws, be split diagonally lengthways, forming two saws from each sheet." [JOSHUA ROSE, in *Cincinnati Artisan.*]

After rolling, the plates are cut to outline by powerful shears: then, if large, "gummed" or toothed by properly shaped dies in fly or cam presses.

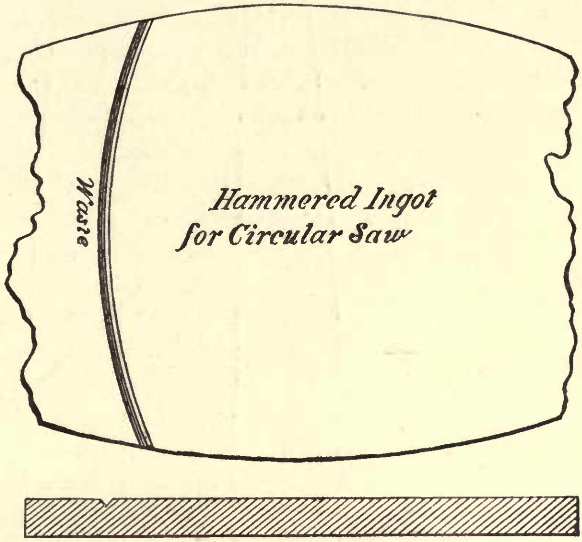


Fig. 143.

For small hand saws the teeth are nicked out by a rapidly-revolving cutter in an automatic machine, cutting out 500 teeth per minute.

A Sheffield operator, using a fly press, tooths a handsaw with 115 teeth in less than two minutes, and his regular task is two dozen 24″ saws in eight hours. Circular saws have the eye driilled out before toothing.

The forms of teeth are legion. Various grades of work naturally require special forms and dispositions of teeth; added to which, customers have their own whims or ideas on the subject, and hold them very tenaciously.

As sawyers are quite apt to file circular saw teeth very wastefully, the establishment we visited has devised an original tooth shape, which may be adhered to until the plate is too much worn away for further use, and which is economical of saws, time and files. The principle is intended to make the tooth outline as nearly peripheral and as little radial as possible.

Referring to Fig. 148, the larger circle represents the saw outline, the inscribed circular arcs having their centres on the same circle, showing the original tooth outline, which may be preserved throughout the life of the saw, at a minimum reduction of saw plate diameter. For woods

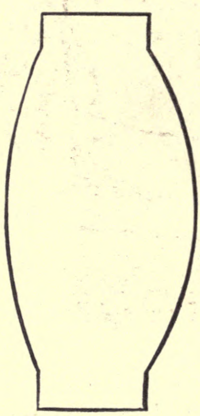


Fig. 144.

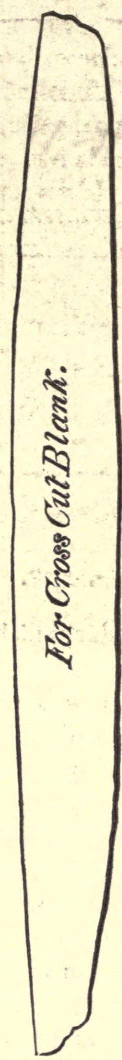


Fig. 145.

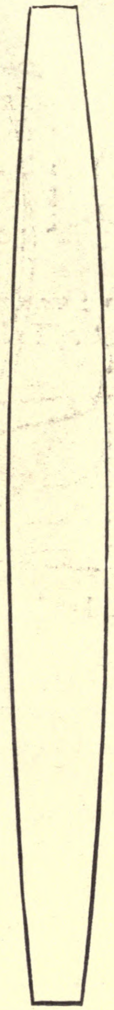


Fig. 146. Cross-Cut Blank.

requiring shallower teeth the peripheral teeth lines are on larger circles, as shown in Fig. 148. The peripheral lines are left scribed on the plates, to keep the average sawyer from his natural tendency to dig in radially.

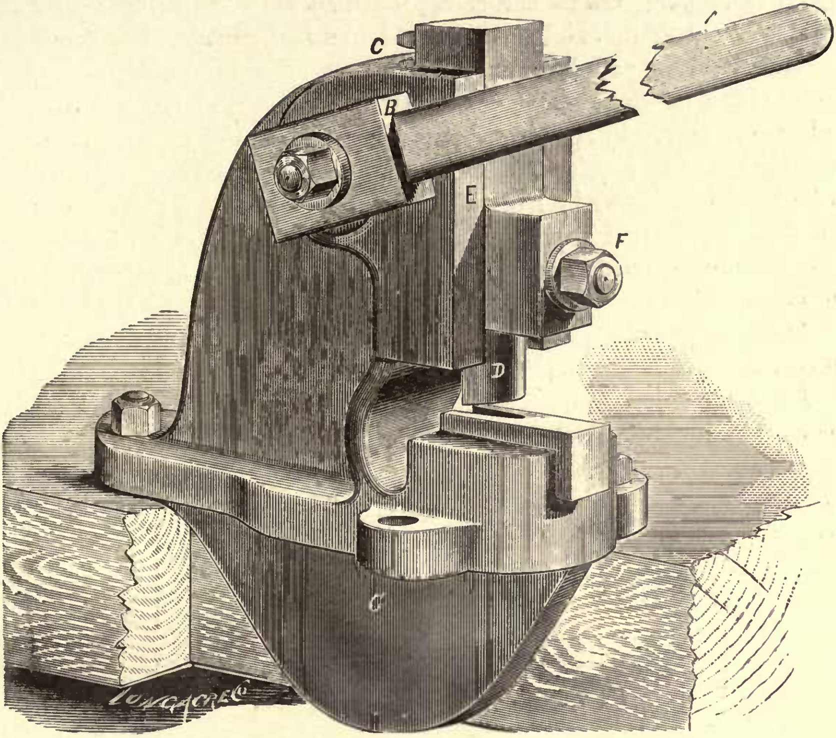


Fig. 147. Cam Press.

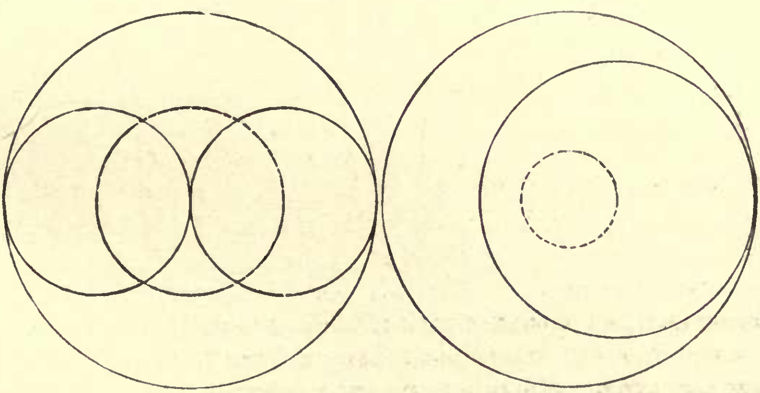


Fig. 148. Peripheral Lines.

After toothing comes hardening, the toothed plates being heated to a light cherry red, and then plunged in a bath composed of whale oil, tallow, rosin and beeswax. The plates, after hardening, should be as brittle as glass. They are covered with scale, grease and dirt, which is removed by scraping and scouring with sawdust. They come out buckled, and require to be flattened. This is done between heated dies brought together by hydraulic pressure. The dies are circular in form and horizontal in position, and about five to six feet in diameter.

They are enclosed in a furnace with an adjustable blast, and are revolved to keep the temperature even.

The proper color for handsaws is a blue, coresponding to spring temper.

After removing from the tempering dies, handsaws are piled up and held down by a weight of the shape shown in Fig. 149, to keep them flat and straight.

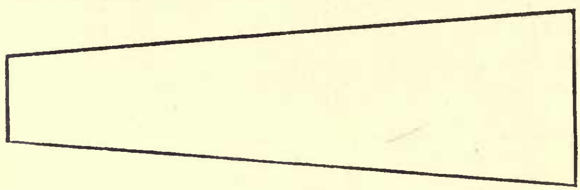


Fig. 149. Hand-Saw Weight.

Each hand-saw blade is tested by a straight-edge and by bending in a circle. If it does not perfectly recover its original position it is rejected and rehardened. The teeth of this same spring-tempered blade are then laid on a "stake" and struck smartly with a light hammer, to see if they will take a permanent set; unless they will, the saw is not up to standard.

After being "smithed" the blades are ground. Wood- and handsaws are sprung into the inside of the rim of a large rotating iron wheel (say ten feet in diameter), and thus presented to the face of a rapidly revolving grindstone.

Cross-cuts are ground between two huge stones (6 feet diameter, 8 inches face, and weighing 2638 lbs. each), the distance of which apart is regulated by a screw. The blade is passed back and forth between the stones, working from the back of the saw towards the teeth, the feed being reversed at each pass and the stones brought nearer together as they wear away. This operation is repeated until the saw is of the required gauge, the back being made two to four gauges thinner than the edge by this process of inserting it first between the edges of the stone faces and passing the blade gradually inward toward the centre of the faces, so that all of it is *exposed.* The stones have a peripheral velocity of about 3000 feet per minute.

Large circulars are ground by passing them through a special machine having two large grindstones, the axles of which may be brought nearer together by a screw. The saw is on a temporary arm on a carriage having a traversing motion, so that all parts of its surfaces, from rim to centre, are exposed to the action of the stones. The stones run 2500 to 3000 feet per minute.

Circulars are ground even gauge throughout, or tapered at the rim, or thin at the edge, according to circumstances. Large saws are tapered at the rim, to make less kerf, take less power and lessen centrifugal force.

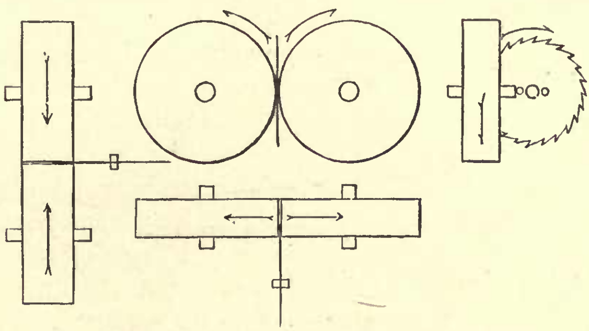


Fig. 150. Circular Saw Grinder.

Small saws and grooving saws are thin at the centre, to avoid the need of spreading or bending the teeth to give their clearance.

In the early days of saw manufacture all circulars were ground thinnest at the eye, because they were held on a face plate by screws between the teeth, and left free at the centre; the centre hence got the most grinding, as the screw heads must be cleared. Such saws, thinnest at the eye, would not have stood the high speeds and feed of the present day, then unknown—such, for instance as a 76″ circular, 6 and 7 gauge, 56 teeth, running 750 revolutions (15,000 feet) per minute.

Circular saws are polished and given the appearance of having been ground circularly, by revolving them on a face plate and pressing against them, successively, blocks of lead, cork and leather, supplied with emery and oil.

No matter how flat a saw may be pressed between the tempering dies, the majority of leading saw makers claim that the tension will be uneven in spots, and that hammering is necessary to equalize it.

A buckle or bend in a plate is known as a "tight" or a "loose" place. A circular which is flat and true and even in tension while at rest is, when running at a high speed, expanded more at the rim than near the eye, or is "centre bound," the rim waving and tending to cut out of line and run into or out of the log as influenced by a knot or any other inequality In the grain. This causes friction and heating and permanent "dishing." The rim expands proportionally more than the portions nearer the eye, because it runs faster, and perhaps because the tooth spaces weaken it.

It is the saw-straightener's duty to compensate in *advance* for the expansion due to centrifugal motion, by giving a rim tension which, while insufficient to actually dish the saw while at rest, will nevertheless be there when wanted, and will counteract the expansion of the rim at high speeds. If he give too much such tension, the plate, "rim-bound" when in motion, heats in the centre and dishes, as shown in Fig. 151.

When we consider that the compensating tension required to be thus given depends upon the diameter, thickness, temper and tension of the plate, and also upon the number, shape and depth of the teeth, the quality of the lumber to be cut, and the speed at which the disk is to rotate, we may well imagine that novices are not intrusted with this work, which requires in the highest degree experience, judgment and skill. The deliberate, steady, well chosen hammer blows are not to buckle or dent the blade, but simply to create or to remove local tension.

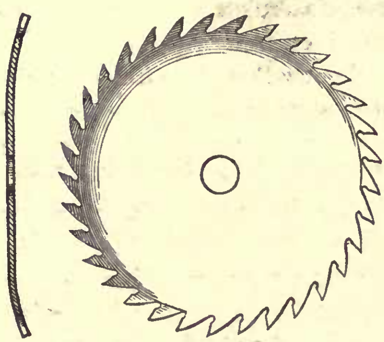


Fig. 151. Dishing Circular.

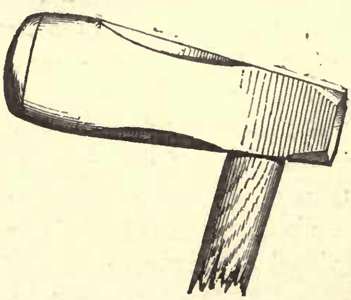


Fig. 152. Doghead.

The "doghead" hammer (Fig. 152) weighs about 3 lbs. Its length is about $5\frac{1}{2}''$ inches and its diameter $1\frac{5}{8}''$. The handle is $14''$ long and stands at an angle of 85° to the head. The face is evenly rounding. Fig. 153 is a blocking hammer, very slightly rounding at A. The block and anvil are shown herewith (Fig. 154).

The doghead is used mainly for stretching, or removing a tension. The handle being at the angle shown with the head, the blow is a dead one, free from spring or rebound. The head being heavy, and with rounding face, and the speed being slow, it leaves no "hammer *sinks*" or dents on the plate or blade.

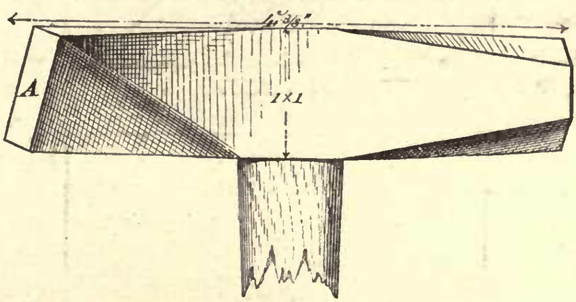


Fig. 153. Blocking Hammer.

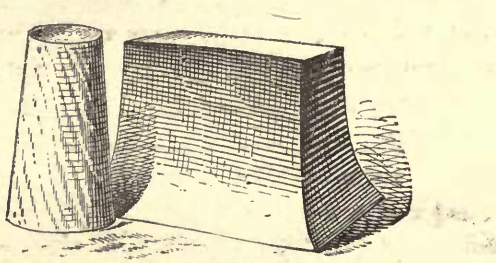


Fig. 154. Anvil and Block.

The parts of the plate under treatment must be perfectly flat on the anvil, else the blow would dent or distort the blade. Supposing the plate thus properly bedded on the anvil, a blow of the doghead may be given so as to stretch equally in all directions, as at *A*, Fig. 155, or by striking aslant, the effects are produced as shown at *B*, same figure. (Such slanting blows are always given *from* the operator, even if it be necessary to turn the blade end for end to do this).

The blocking hammer, Fig. 153, produces, by lateral motion, an effect to one side of the line of contact. Thus, in Fig. 156, using one face and a leftwise motion, the effects are distributed as shown at *B*, while with the other face and an outward motion, they are as shown at *C*. The curve of the face tends to lift or curl the plate up, the results being as shown at *A* and *B*, Fig. 157.

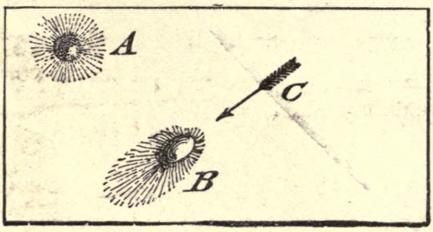


Fig. 155.

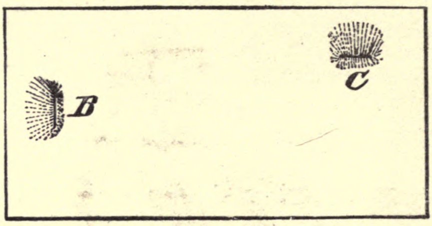


Fig. 156.

Coarser defects can be noticed by the expert as the plate lies on the block; lesser ones are found by "sighting" the plate, as in Fig. 158, the shadows denoting uneven places.

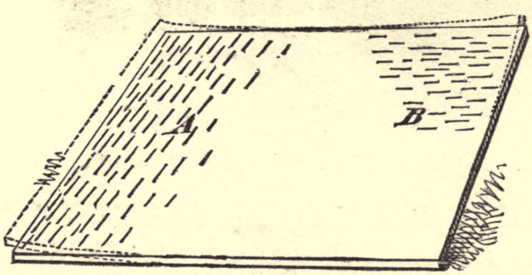


Fig. 157.

Reversing the plate, as in Fig. 159, and bending it back and forth, expanded portions move more easily than the average; tight places are stiffer and must be stretched—this equalizing the tension also. The straight edge (Fig. 160) is frequently applied during the hammering process.

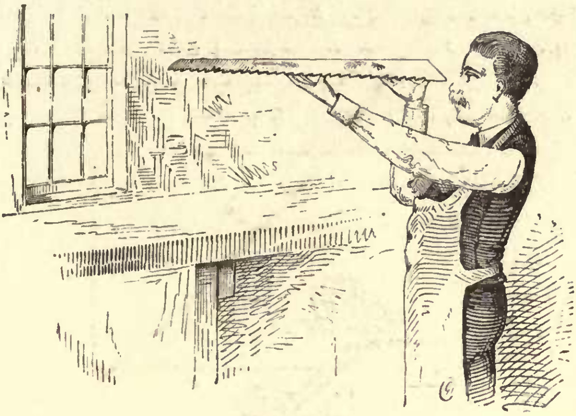


Fig. 158.

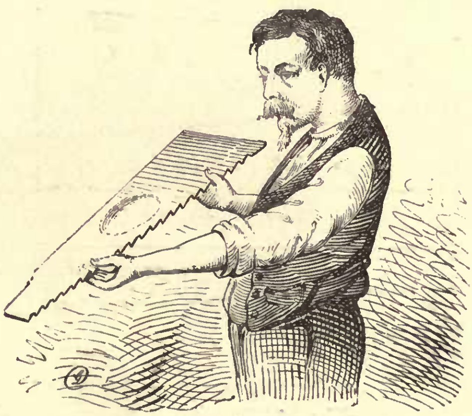


Fig. 159.

Fig. 160.

The plate should be well bedded to the anvil while receiving the blows, otherwise the hammer will "drum" and the plate will become convex on the hammered side by reason of stretching its skin.

Fig. 161 denotes a blade loose in the middle where the oval shadow is given. To remedy this, blows with the doghead must be shown, as shown by the marks *A* and *B*, thus, stretching the parts struck and allowing the loose place to flatten, while slightly lengthening the blade.

If, however, the blade were "tight" in the center it would be struck as at *A*, Fig. 162, to stretch the tight place. If it were atwist, as shown in Fig. 163, the blocking hammer would be used, as shown by the heavy line-marks, the plate being placed with drooping side down, and the hammer curling or lifting this.

To remedy a kink or wave (Fig. 164) the plate is placed with the

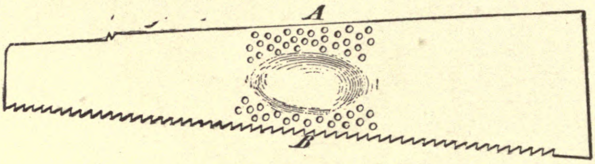


Fig. 161. Loose Centre.

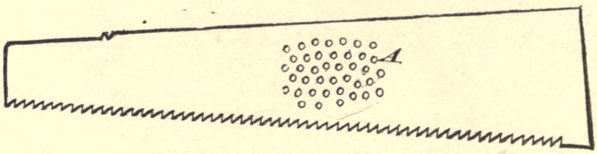


Fig. 162. Tight Centre.

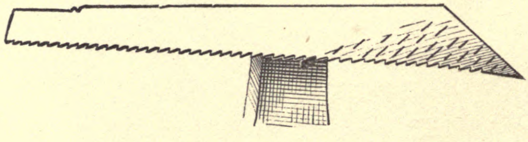


Fig. 163. Atwist.

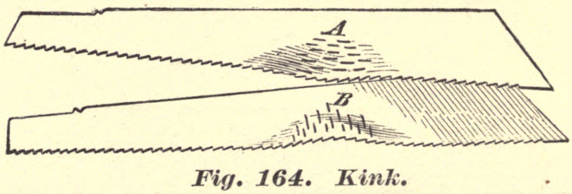


Fig. 164. Kink.

hollow face of the kink downwards and struck as at *A*, lifting the part kinked. Turning the plate over, the blows *B* are then given, removing the kink.

Fig. 165 shows a dished circular plate, which must be undished by putting the concave upwards and striking as shown, thus tending to stretch the top and straighten the plate.

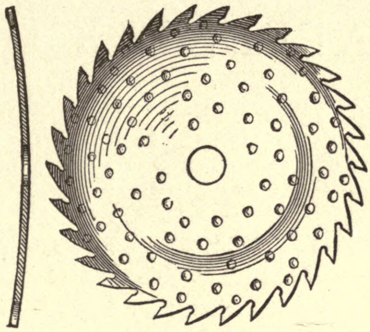


Fig. 165. Dished Circular Plate.

APPENDIX II.

Care and Use of Circular Saws.

The shape of teeth is most important, as regards not only their cutting, but the economy of the plate. The dotted lines of Fig. 166 show circular saw teeth as they are when they leave the factory; they sometimes get down to the shape shown by *B, C, D*—without sawdust room. Such filing also uses up files and saws, while cracks are liable to start in the sharp angles or the teeth break off as at *A*.

Fig. 168 shows, in full size, what Disston calls the "Jones tooth," filed from the top instead of from below. Dotted line 1 shows the circumference on leaving the factory; 2 shows where the periphery should have been brought by properly filing; line 3 shows where the periphery comes to by bad filing. And yet from *A* to *B* is as far as from *A* to *C!* This tooth is also highest at the back, scraping instead of cutting. and it has no dust chamber.

If the saw be dull, either at or *under* the points, as seen in Fig. 169, it will not do good work.

Looking at points *A* and *B* of Fig. 169, (showing a cracked saw) it is easily seen that it is broken by over-work while dull. A tooth of a 24-inch circular saw strikes the wood at the rate of 9000 feet per minute, 2000 times per second, 1,200,000 times per day, and if not sharp the saw must eventually, even if once strong, get tender and break, as seen at *D*.

If the tooth takes one-eighth inch hold of the wood at each revolution it gets dull one-eighth inch below the point, and proportionally for other feeds.

If the saw were a razor and the man who works it were obliged to shave with it, then the saw would be kept sharp. It is quite as essential that a saw be sharp as as a razor,or plane, or any other cutting instrument; and when proud, or full and sharp, it does not require one-half the set or power on the same feed.

While a tolerably good workman may run a mill, yet a good sawyer's lumber always brings higher price than that of a less skilled man.

A saw often improves in temper by use, as the extreme points of the teeth are often too soft at first.

A saw improperly hung, unevenly set, filed untrue; teeth lacking pitch, or having too much; teeth with back higher than point, with scant dust room, or the plate unevenly balanced—all cause trouble.

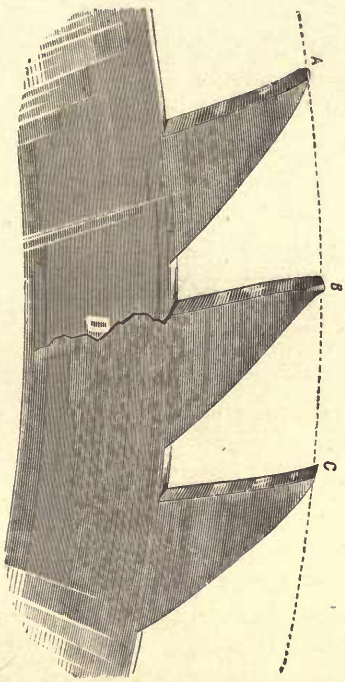


Fig. 169. Cracked Saw.

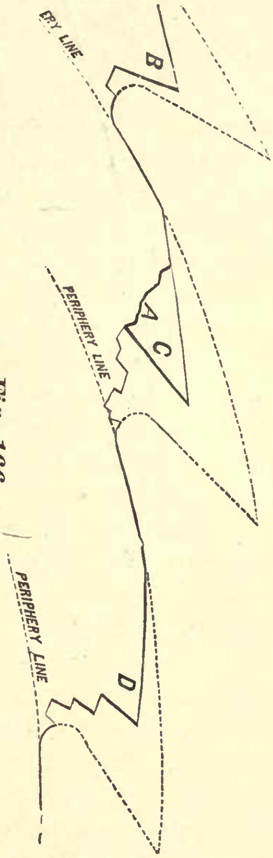


Fig. 166.

A saw will not balance rightly unless absolutely round, having teeth of equal size and shape and gullets of equal depths.

The guide or gauge of a bench saw should never pass the centre of the saw.

A saw plate may be in perfect condition and yet not run true, on account of lack of truth in the collar.

It is best to take a full deep cut, rather than a light scraping one. With a buzz saw, having $\frac{1}{32}$ inch feed, it takes thirty-two teeth to cut an inch of lumber; with $\frac{1}{8}$ inch feed, only eight, and you break the fibre only eight times instead of thirty-two. Of course the tooth gets dull further under with the higher feed, but requires very little more sharpening.

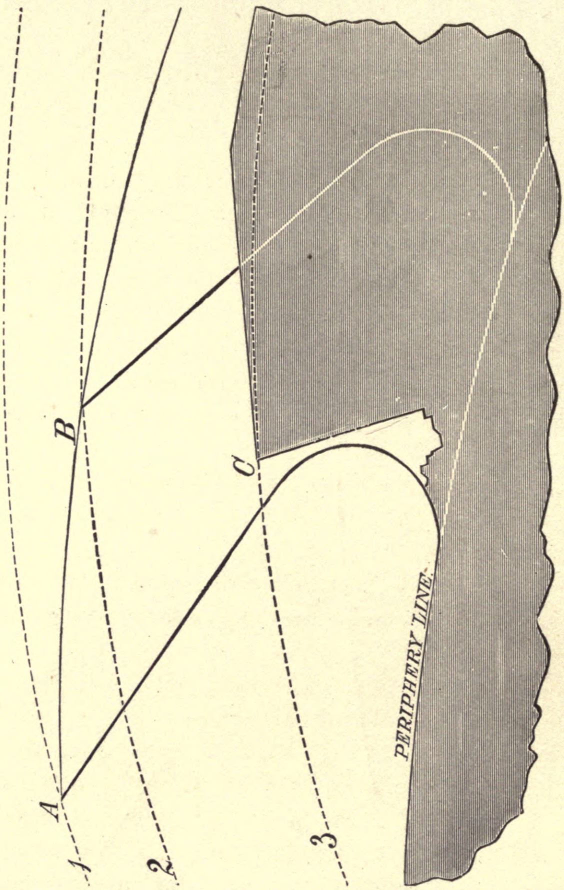


Fig. 168. Jones Tooth.

APPENDIX III.

SAW FILING.

Hardly any two sawyers agree as to the exact "best mode" of filing. So many published and unpublished opinions directly contradict one another that we feel justified in adhering to Holzappfel's directions, modified somewhat by the changes in files and in saw teeth which have come about since then.

We will consider straight blades first. They should be held teeth upwards, in a "clamp." Strips of wood or sheet lead between the clamp jaws absorb the vibrations and lessen the horrible screeching so annoying to nerves.

If a saw be allowed to shake and jar while being filed, it is almost sure to break the teeth out of the edge of a good sharp file; and the better and sharper the file, the more liable it will be to break by such filing. By holding the file firm and down close to the jaws of the clamps the files will last much longer, and a keener edge may be got on the saw.

The best cut for saw files, except for very small teeth, is "float" or "single," made by a single row of chisel cuts.

The five diagrams herewith given show, each, three views of the teeth. For metal-saws the file is held 90° in both vertical and horizontal angles; for hard woods, 90° to 80° horizontally; for soft woods, 70° to 60° and less, the vertical angle being half the horizontal, but less important. Filing teeth bent *towards* the operator causes great chattering and screeching and strips the file teeth. First, "top ' or "*joint*" teeth by passing the file lengthwise over them, to equalize their length, bearing harder on the ends (where there is least wear.) File the faces or fronts before the tops. When the teeth are to be square, file in regular succession 1, 2, 3, 4. When the file is inclined so as to give "fleam," file 1, 3, 5, 9 to right, 2, 4, 6, 8 to left.

Fig. 169 shows teeth for metal frame saws (blacksmiths'). Small metal saws, made of watchsprings, are filed with a guide fitting in one notch and serving as a bearing for the side of the file in making the next tooth back.

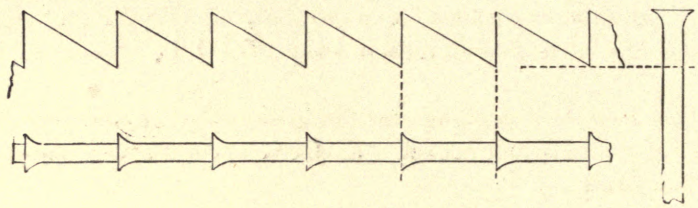


Fig. 169.

Fig. 170 shows the "peg" tooth with plenty of fleam. M teeth and mill saw teeth are sharpened about the same as the peg.

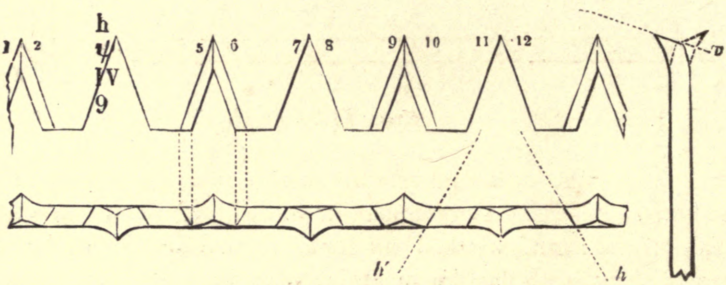


Fig. 170.

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 the other teeth, from the other side of the blade, that is, 12, 8, 4; then 11, 7, 3.

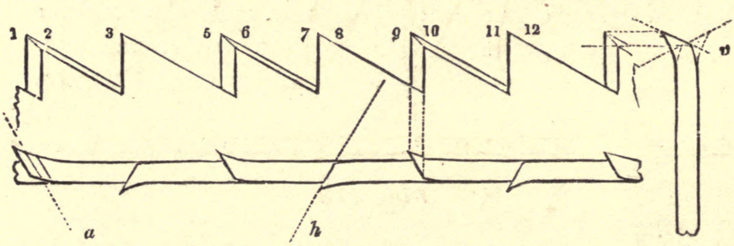


Fig. 171.

Fig. 171 shows teeth with 60° angles, as those of the hand-saw. The file generally cuts a front and a back at once. After topping, file

1, 5, 9 (alternate teeth) back to the centre of each face produced by topping. Then take sides 2 and 3, 6 and 7, 10 and 11 of the nooks, and file them forward to meet the line *a*. This finishes faces 3, 7 and 11. The saw is then changed end for end, and tops 4, 8 and 12 finished. Thus the first course files a face only of odd teeth; the second, the *backs* of odd teeth and *faces* of even; the third, the tops of even teeth.

Fig. 172 shows a pruning saw for green wood, ground very much thinner at the back and not set. Excessive bevel is given, and it cuts clean and sweet.

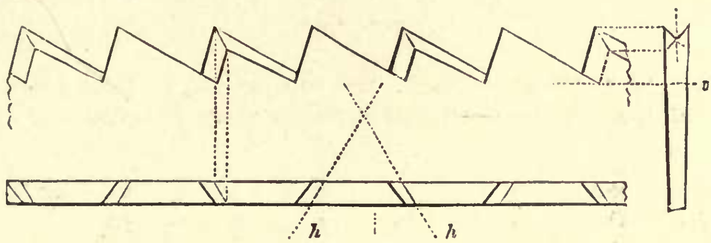


Fig. 172.

Fig. 173 is done with a pit-saw file smaller than the gullet. First, make gullets 3, 7, 11 very obliquely in the vertical plane; first filing the face of one tooth and then the back of the other. Then file tops of teeth 4, 8, 12 with flat side of file, at angle from 5° to 40° with the edge, and 80° to 60° with the side of the blade (the 5° to 80° being for the hardest and 40° and 60° for the softest woods).

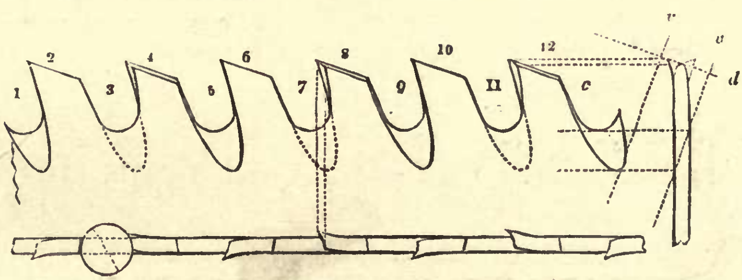


Fig. 173.

File the front of all teeth set from you, and the back of those set towards you. The most frequent custom seems to be to file from front to handle.

From 6 to 8 inches at the point of the hand rip-saw may be filed at a less angle than the rest; that is, at the "cross-cut" pitch. This enables the sawyer to rip through knots without changing saws.

Some advise making a swell in the center (say ¼ inch in a 26-inch saw), to counteract the rocking tendency of the sawyer, whose hand tends to go down on the forward stroke.

Some experienced men advocate going over the saw in three light filings to produce a keen regular result.

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

Fig. 174 shows a hardened steel gauge for regulating clearer teeth; the file should dress off projecting points to a level with the gauge.

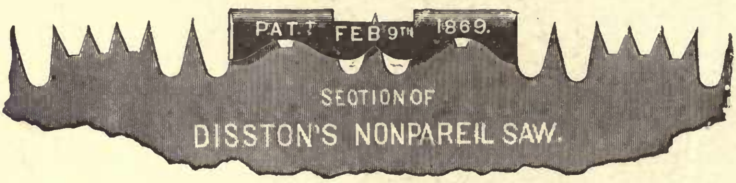


Fig. 174. Clearer Gauge.

A cross-cut hand saw should cut a little more on the down than on the up stroke, as the arm is there strongest; hence the teeth should pitch a little forwards.

The "wire edge" should be taken off with a whetstone, after filing.

In sharpening an under-cut or a parallel tooth there is danger lest the original shapes get perverted, as in *C* and *D*, Figs. 175 and 176.

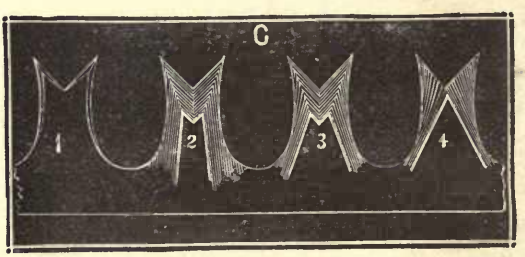


Fig. 175.

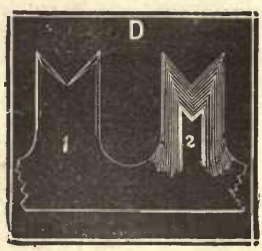


Fig. 176.

By the use of a special section, as the "Lumberman's" cross-cut file, an M tooth with slightly inclined sides is easily kept in condition. "As you pay for the edge of a file as well as the flat, why not use it?"

Figs. 179, 180 and 181 show the mode of applying a special section file to the "Great American" cross cut.

Fig. 179 shows the manner of filing the long edge of the end tooth; Fig 180, the short or inside edge of the end tooth; Fig. 181, the gullet.

Fig. 177. Using "Lumberman" File.

The adjustable clamp shown in Fig. 182 enables a saw to be filed at any angle, or square, as desired.

Band saw files have their edges rounded to make the notches less liable to start cracks.

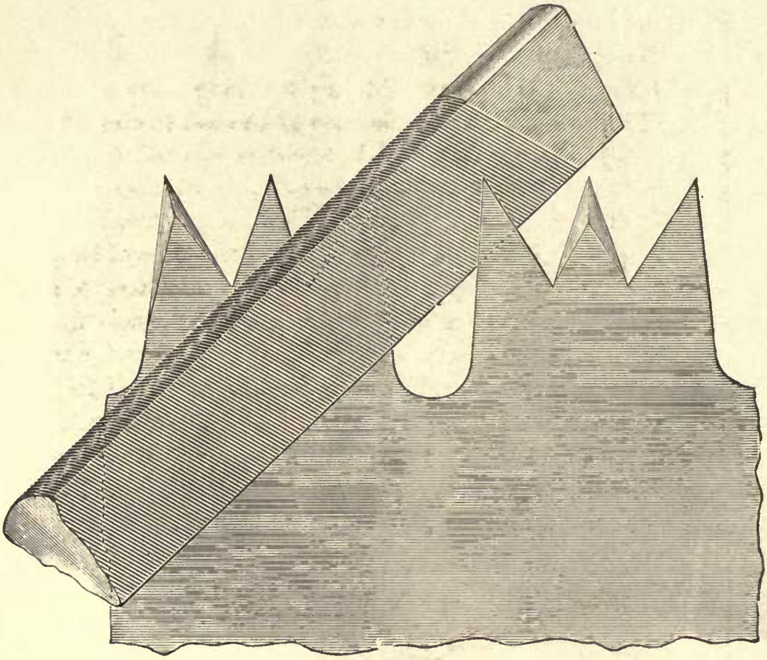


Fig. 179.

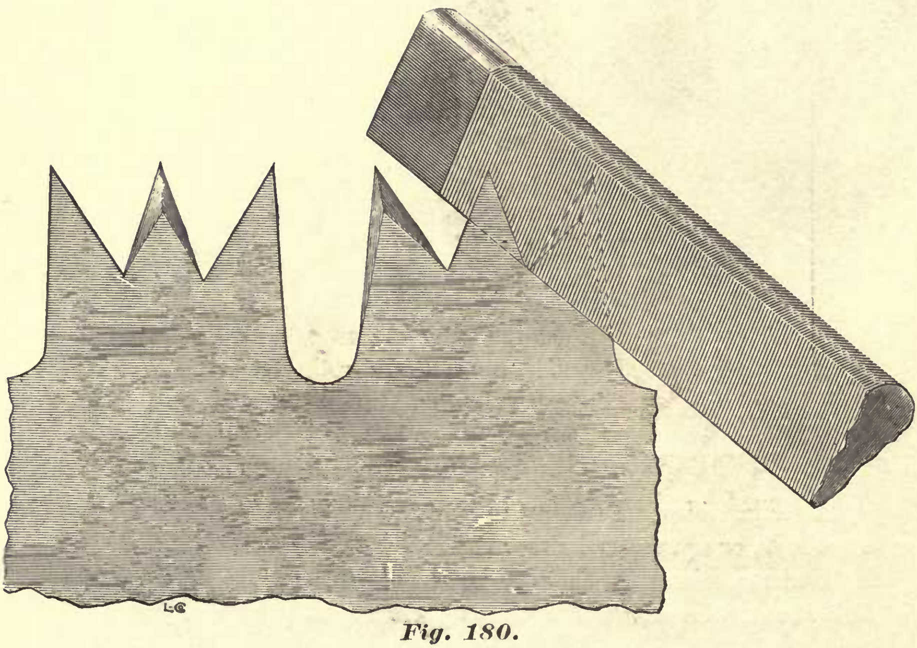


Fig. 180.

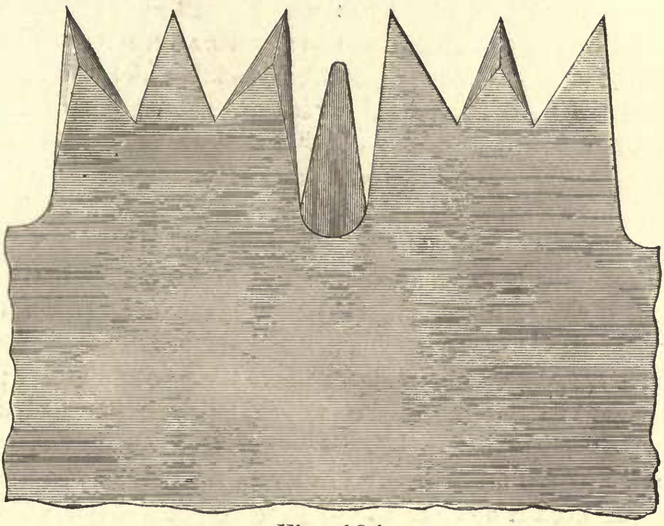


Fig. 181.

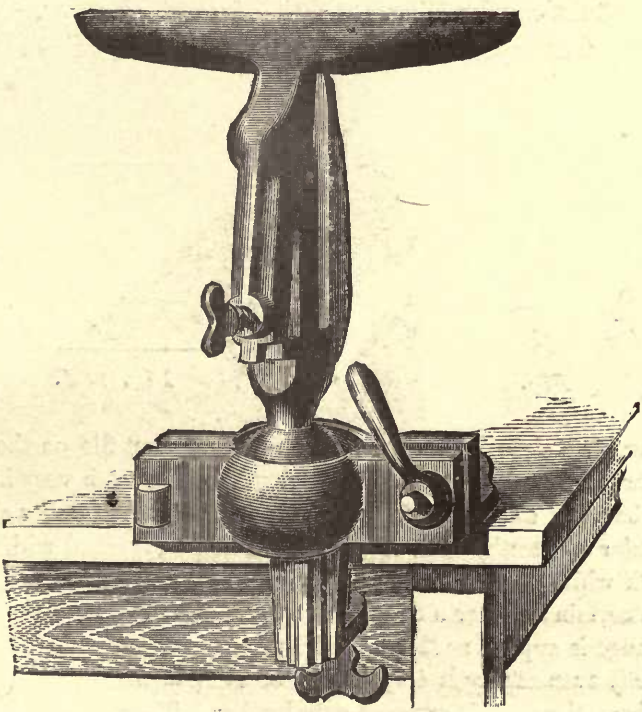


Fig. 182. Saw Filing Clamp.

We remember seeing at the Centennial Exposition, Philadelphia, a band sawfiling machine employing a spiral or screw file with a pitch equal to the tooth space, and hence self feeding. Rotation of the file sharpened the band evenly and fed it along automatically. The file, however, has the disadvantage of being difficult to forge, temper and cut, and of being uiilizable on one corner only.

Shingle saws should be filed square across the teeth, and given just enough set to clear the blade.

In filing circular saws, many men are in too great a hurry to get the teeth sharp, and file from the top rather than from the front or bottom.

In Fig. 183, 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 filing is done on the top. Filing back on line *CCC* the diameter is diminished only to *F*, while from the top you work it down to *D*.

In Fig. 184 the same tooth is shown, gummed by a machine and leaving but little under filing.

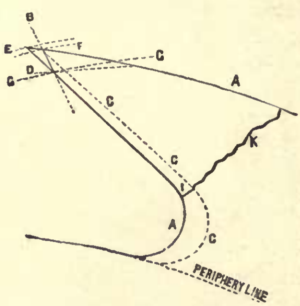


Fig. 183.

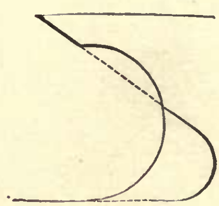


Fig. 184.

Never file a circular saw to a "proud edge," but file on the under side near to an edge, striking lightly. Keep the teeth very hooking with a bevel of one-sixteenth, swaged, not filed, on the under side.

Circular saw teeth, "out of round" should be marked with a piece of chalk while the saw revolves slowly.

To ascertain whether a circular saw tooth is exactly to shape, a sheet steel gauge is applied as shown in Fig. 185.

Exactly even setting is impossible; some teeth will overhang more more than others; this causes rough lumber. The adjustable *side file* gauge (Fig. 186) enables absolute uniformity to be given, after setting, and by its use a saw may be enabled approximately to "plane lumber."

The "side file" is to regulate the teeth after setting, and prevent unduly projecting teeth from making rough lumber. The set screws adjust the file to any set desired; the jaw nuts hold them tight.

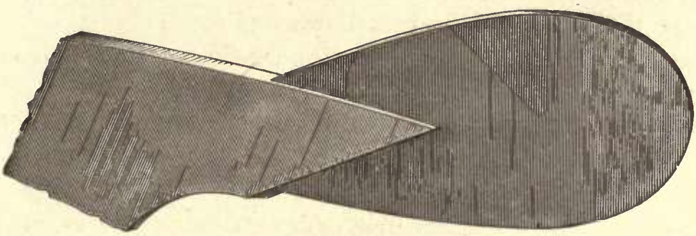


Fig. 185. Sheet Steel Gauge.

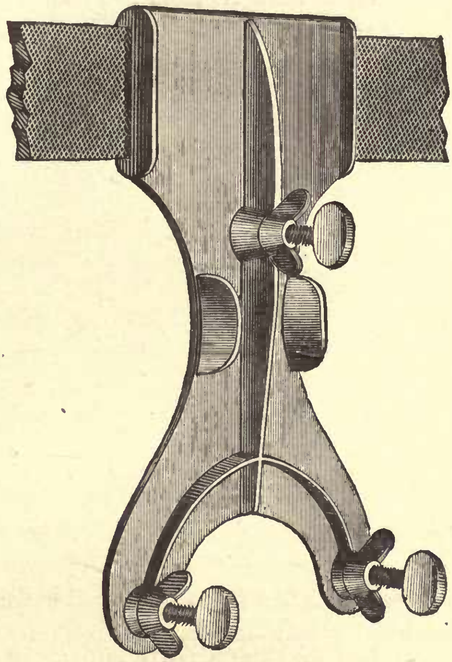


Fig. 186. Side File.

Fig. 187 shows an adjustable filing machine for filing circular or straight saws. It will file a tooth square top and bottom, or bevel point and square back, or square point and bevel back, filing from right to left or left to right.

For ordinary hand saws a triangular file is employed, the contour being taper, as shown in Fig. 188, and the lengths 3, 3½, 4, 5, 6, 8 and 10 inches. An improvement is the "slim hand saw taper," Fig. 189, made from the same sized stock; the lengths being 4, 5, 6, 7, 8, 10 and 12, inches, giving greater sweep or stroke.

The ordinary three-square file (Fig. 190) is not intended for saw filing and utterly unfit therefor. They are generally as thin as possible in the edges and corners, drawn and cut to a small point, and double cut to the point. All saw files, whether double cut or single cut, are cut on the edges or corners as well as on the flats or sides. Fig. 190 shows a three-square file for machinery; Fig. 188, a saw file.

A very valuable improvement is the "double ender" file, with accompanying handle, Figs. 191, 192 and 193. The file may be one end double cut and the other single, or one end coarse and the other fine, and is perfectly adapted to the split handles made to accompany it.

Fig. 187. Saw Filing Machine.

The "blunt end" file (Fig. 194) is by many preferred to those having sharp points. A step still further in this direction is the knob end (Fig. 195), giving better hold of the file by the finger and thumb of the left hand, and thereby enabling the filer to more easily control the use of the tool.

It is even less liable than the plain blunt end to cause soreness to cause soreness to the ends of the finger and thumb by much filing.

To use the reversible taper file in a regular handle, bore in the handle a hole about the size of the point of the file, and then counter bore, about halfway down, nearly the size of the full part of the file.

One manufacturer makes the reversible taper with blunt points (Fig. 196).

We have never yet been able to see why any taper should be given

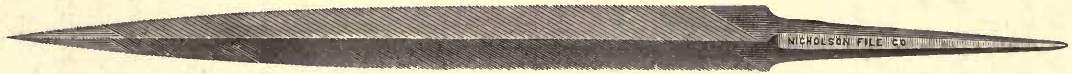


Fig. 188. Regular Taper Saw File.

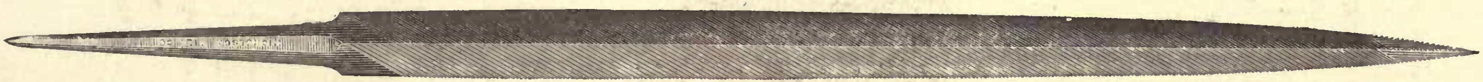


Fig. 189. Slim Taper Saw File.

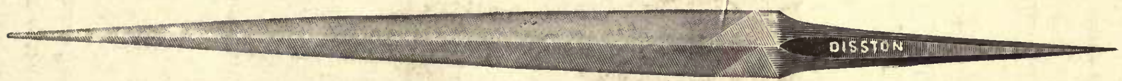
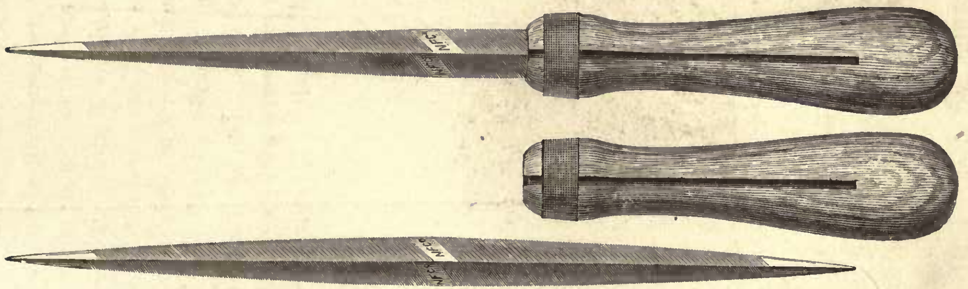


Fig. 190. Machinist's File.



Figs. 191, 192, 193. Double-Ender Taper Saw File and Handle.

Fig. 194. Blunt End Taper Saw File.

Fig. 195. Knob End Taper Saw File.

Fig. 196. Blunt End Reversible Taper Saw File.

to a saw file. If any part of a taper file be the right section for the notches in the saw, the other parts must be the wrong size. Furthermore, either the wear must overlap from both sides, or an unworn stripe be left along the center line. A three-cornered saw file should be in width a trifle more than twice the depth of teeth to be filed. If wider, the extra width is wasted, as it never gets any work.

Fig. 197 shows Roth's saw file guide applied to a small circular saw.

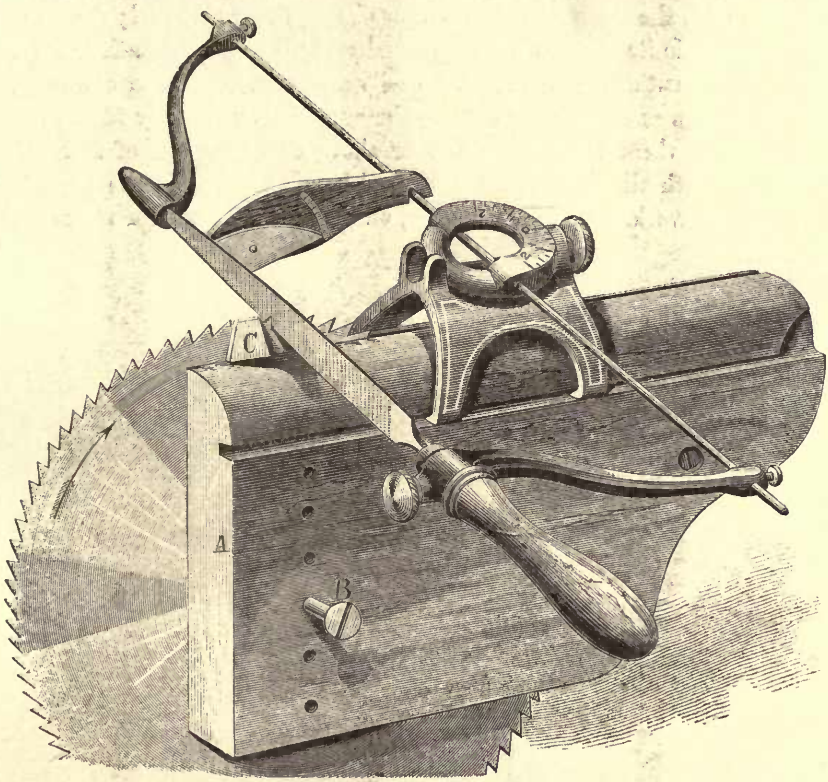


Fig. 197. Roth's Saw Filing Guide.

There is a circle, divided and numbered from its centre each way, giving bevels for each side of the saw, or square across—shown in the cut. The file is fitted into the handle, and is held by a set screw, and may be readily turned so as to use any corner of the file. The indicator shows the pitch at which the file is set. The rod passes through holes in the graduated ring and guides the file. The frame upon which the ring is held slides in grooves cut on each side of the clamp in which the saw is held. A table connected with the guide is arranged and figured, so as to give the required bevel and pitch for the kind of saw to be filed; and it is only necessary to set the ring for the bevel and the indicator for the pitch, and the machine is ready for use. As the filing is proceeded with from tooth to tooth the frame follows, giving the same bevel, pitch and size to each tooth, and on one size of the saw the same as on the other, thus leaving the saw, when finished filing, with the teeth all of the same size, pitch and bevel; and each tooth will do its share of cutting equally throughout the entire length of the saw, cut straight, smoothly, easily and rapidly. The operation of filing with a machine does not tire the eye; may be readily fled without taking them from the arbor or shaft, and each size of saw will have its teeth all of an equal pitch and bevel, so as to do the greatest amount of work in the best manner, and with the least expenditure of power.

APPENDIX IV.

SPRING SETTING.

There is perhaps little need for a lengthy appendix on setting. It must be premised that, by the term setting, springing or bending the teeth is understood, as distinguished from "spread set" or swaging.

The operation of setting any kind of saw is an important one, as upon the judgment and accuracy displayed depend very largely the performance of the tool. The primary object, as before mentioned, is to give more clearance than can be given by grinding a straight blade thinner at the back than at the cutting edge, or by making a circular thinnest at the eye, which last, although practised in the early days of circular saw manufacture, when the disk was held on a face plate by screws at the edge, is disadvantageous for large saws and high speeds, as leaving the rim unduly heavy, and is used only for grooving saws and small disks. A 72-inch circular, running two miles a minute at the rim, must naturally be as light as possible towards the circumference.

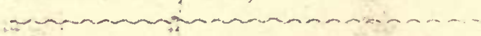
The principal advantage in giving clearance and thus lessening friction and heating, diminishing the power required to drive the saw and keeping the blade straight, is partly offset by suppressing one cutting edge of each tooth; and yet that cutting edge acts (if the set be good) at a better angle than if no set of any kind were given. Spring set enables the sawyer to adjust the saw to varying kinds of material, or to the operation to be performed, as ripping or crossing. In common with swaging, it aids in affording clearance to the sawdust. There is the disadvantage that set springs the tooth into the work when sharp, and away from it when dull, and that the effort of overcoming this tendency to dig in, increases the power required to run the saw. For cutting hard and knotty wood, and for some other materials, much set is impracticable. For ice, all must be given that is safe, that is, just enough not to endanger the strength of the tooth.

Figs. 198 and 199 give respectively the ancient and the modern mode of giving "set."

Fig. 198. Ancient Set.

Fig. 199. Modern Set.

The modern method of setting alternate teeth to right and left diminishes clattering and makes a clean smoother cut. The ancient way of setting half a dozen adjacent points each way, was apt to produce a ridgy cut, like a washboard, thus;



Whatever set be given, it must be regular, and must not extend beyond the base of the tooth; that is, the set must be given the tooth, and not the plate. In manufacturing hand-saws, the temper of each is tried by setting a few teeth on a stake, with quick hammer blows. One authority states that the plate itself would not stand this test. But Disstons claim that the back of a good hand-saw may be given a set all along; and it is certain that by constant filing, what was once the plate below the tooth line becomes in time part of the teeth, and must be set. But so long as this metal is not in the tooth proper it should be left unstrained by local tensions.

The two principal modes of setting are by sharp quick hammer blows and by bending. The former mode has the disadvantage of being less regular, except perhaps in the case of those machines used to set hand-saw blades, where the force of the blow is determined and kept uniform by a spring or weight.

The simplest saw-set we know of is a notch in the side of a file tip—having the advantage of being at hand when wanted and not necessitating a special tool. But with such a bending device the amount of bend must be regulated by the feeling of the operator; and perhaps it is best to have a separate set, with a stop, enabling one to vary the amount of bend given to the teeth, and to keep it uniform throughout. The cuts show common forms of saw sets. They have the advantage of neither oversetting nor undersetting.

If any one tooth projects beyond the others it will get undue work, and either dig in and break, or retard the cutting, or limit the capacity of the saw by "masking" those which follow it and are by it prevented from touching the wood.

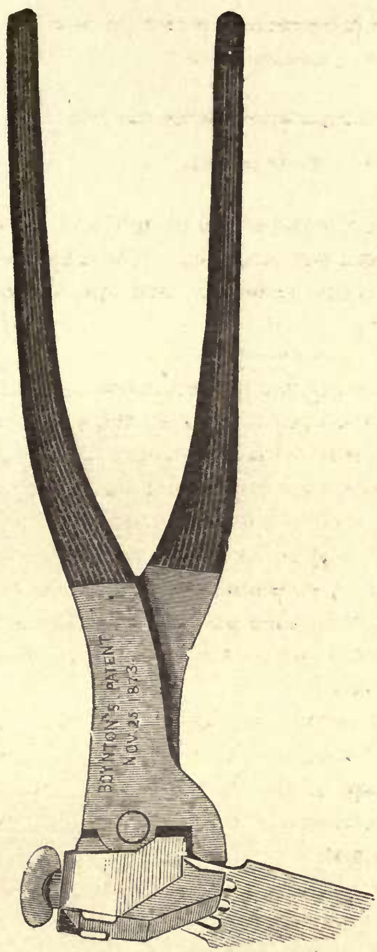


Fig. 200. Saw Set.

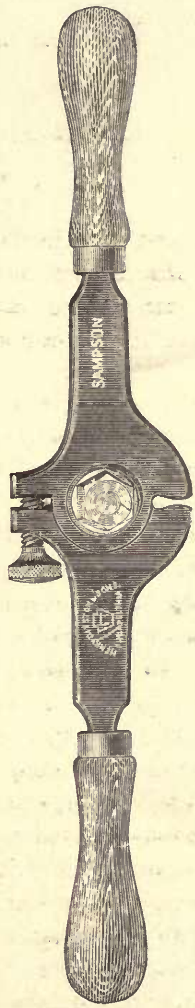


Fig. 201. Saw Set.

APPENDIX V.

SWAGING.

Swaging, swedging, or jumping, is the upsetting, widening or spreading of the teeth to give clearance, etc. It is best effected by a steel die having a /\ notch in it, to conform to which the tooth is smartly hammered. It hardens and condenses the metal. Extreme spread, as is our Southern usage, necessitates the sacrifice of temper in the tooth. In one form of die the sharpness of angle is obtained by sawing a kerf in the angle of the /\ and driving the parts together by a ring (see Fig. 202). The lower opening in this swage is rounding and spreads and shapes the teeth as seen at *H*. The upper one is for squaring up to the style *G*. The kerf in the notch enables a fine sharp angle to be made and maintained and permits the hardening composition to enter freely that portion of the die which does the most work.

In another there is an adjustable wall to the notch, which can be set up by a screw to any desired acuteness of angle (see Fig. 203.

Sometimes one or more teeth will strike gravel or some other hard substance, and take off the point. To obviate cutting down all the rest of the teeth, the short tooth may be lengthened, as shown in Fig. 204 (an inserted tooth). Mark the short tooth with a file on the under side, so that in filing it will be recognized. Raise the swage in the act of upsetting, and the point will be raised up as shown in Fig. 205. A *light hammer* should be used in swaging.

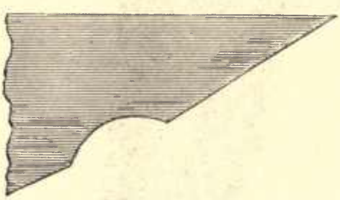


Fig. 204.

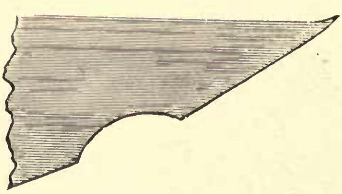


Fig. 205.

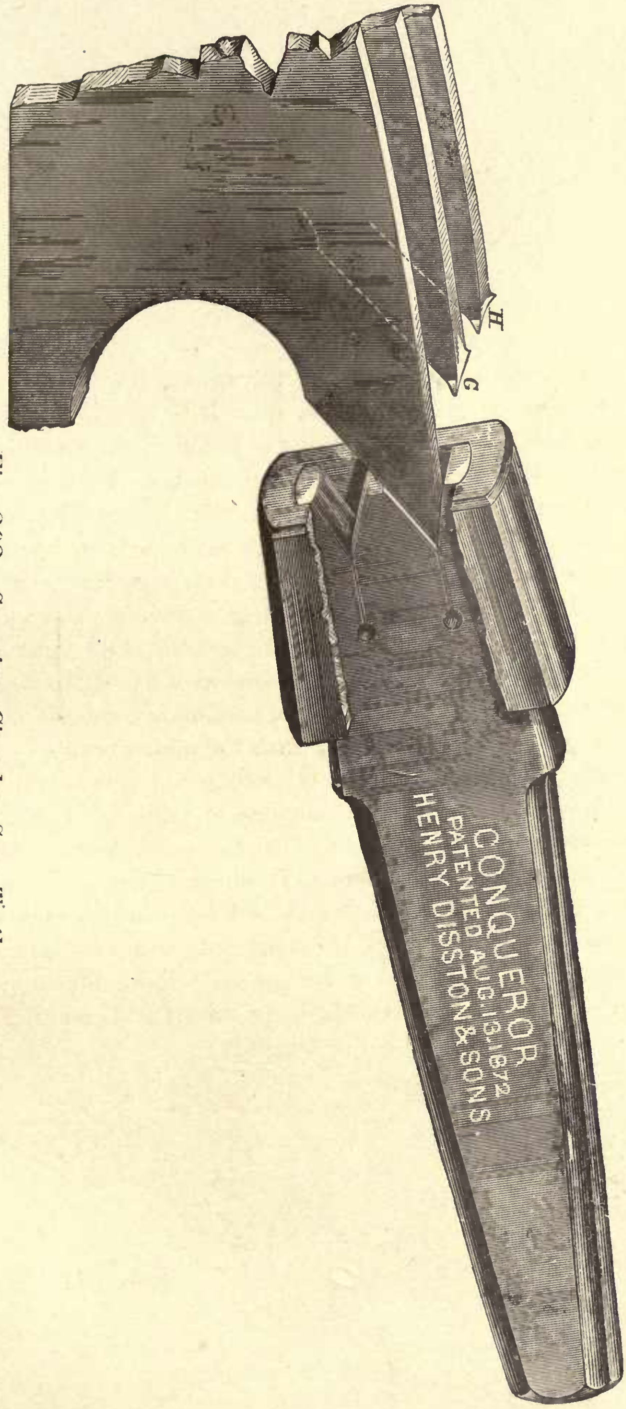


Fig. 202. Swaging Circular Saw Teeth.

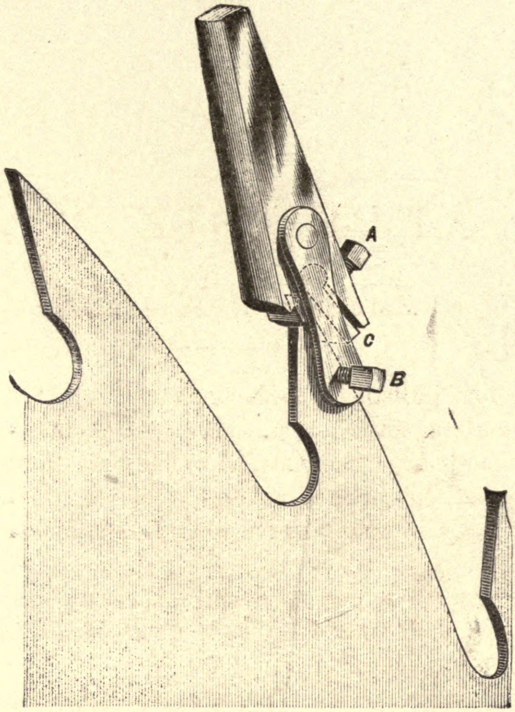


Fig. 203. Emerson, Smith & Co's Swage.

APPENDIX VI.

GUMMING AND GULLETING.

Gumming and gulleting may be done with (1) a file, (2) a press or punch, (3) a milling cutter, (4) an emery or corundum wheel.

When the hardness of the material to be removed be considered, it is easy to see that some of these modes have advantages over the others in point of time, labor, and material consumed, and evenness of results obtained.

The file is slow acting and not readily renewed when dull. Its use answers for small and hurried jobs, and those done without removing the saw. Its use is shown in Fig. 206.

The press or punch is used in the process of manufacture, and necessitates the removal of the plate.

Fig. 207 shows a hand press for saws not thicker than 12 gauge. The lever *A* is detachable, fitting on socket *B*, cast on the end of a rack pinion gearing in the rack *C* in the back of the slide carrying the punch *D*.

The punch is held by the clamp *E* and next *F*, the top of the punch bearing against the end of the slot in the slide, and removed for grinding by loosening the nut *G*. When the punch gets short and the lever too low, the pinion-wheel should be withdrawn and changed one or more teeth.

The milling cutter is one of the most rapid and even working tools used, and without it the circular saw would often be of little use. It may be driven readily by hand, having adjustment for depth of cut and automatic feed given at each revolution. One is shown in Fig. 209. The chambers it makes must in every case have a semicircular bottom —a very advantageous form for the throat. To use it a circular saw need not be removed from the arbor. The economy of saw plates resulting from its use can hardly be estimated, while the speed and regularity of its action leave nothing to be desired.

Fig. 210 shows a cutter grinder for holding the cutter of a chambering machine in position during sharpening.

Fig. 206. Using "Lumberman" File.

Fig. 211 shows a most important and successful invention—the "spiral line" mode of gulleting. By making the back line of each tooth the continuation of the spiral lines Z, the sharpening is mainly done by gulleting the throat with the rotary gummer (Fig. 209). The cutter, in traversing the spiral line, reduces the front or throat of tooth *D* while prolonging the point line of *C*. The saw *B* is the saw as worn down. A reduction on radius from *G* to *F*, say 6 inches, corresponds to a distance *G* to *Y*, on the spiral line, 24 inches. The gullet is semicircular, whence an advantage, an inch and a half tooth keeping as clear as a two inch ordinary tooth. Wearing a 54 inch plate down to a 42 inch would give only six sets of two inch teeth, but eight sets

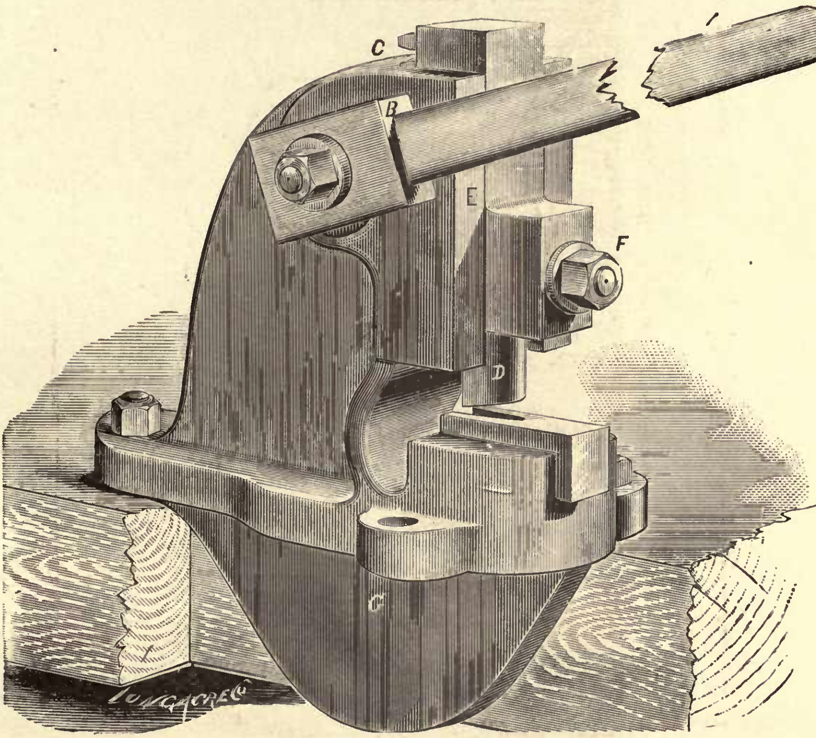


Fig. 207. Gumming Press.

of one and a half inch. This method preserves the true round of the saw. The tooth remains the same shape throughout, instead of having a constantly lessening chamber.

Fig. 212 shows part of a gullet tooth saw after cutting 300,000 feet of hemlock lumber. Line *D* and point *A* are the originals; line *E* and point *C* show a reduction of only $\frac{3}{16}$ inch in diameter.

In Fig. 213, tooth *B* has been rechambered; *A* shows, by the file applied flat to it, that it much needs that operation.

One maker had teeth like Fig. 214 sent to him to be gummed. *B* is the actual chamber line; it should have been *C*.

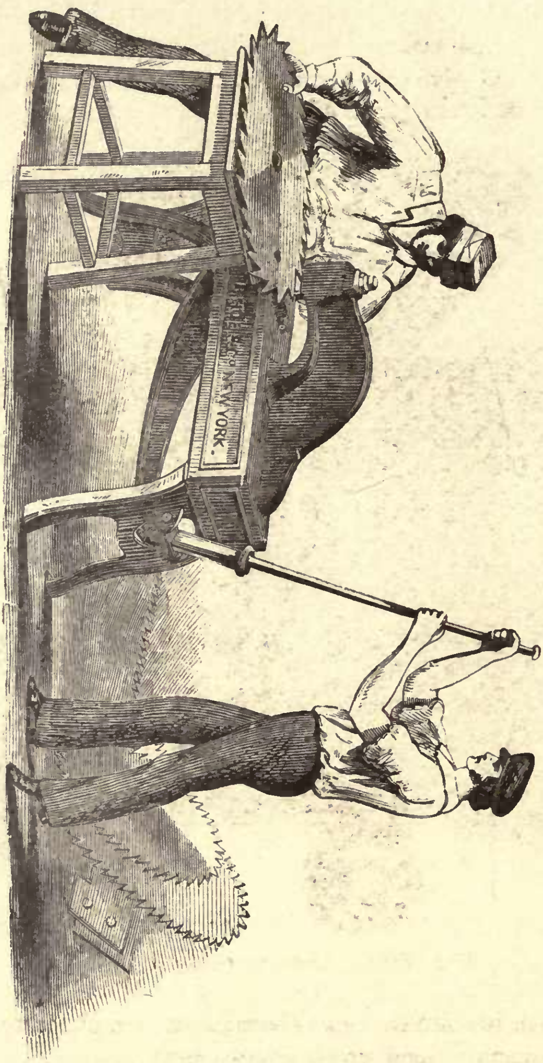


Fig. 208. Gumming Press.

The emery or corundum wheel does quick work in the highest tempered steels. It can be obtained of any desired edge section and used to dress the bottom, edge, back, or top of a tooth. It requires such a high speed of revolution as to necessitate to use of power to run it; but part of this inconvenience is done away with by swinging it to an arbor above the mandrel, in the case of circular saws. Fig. 215 shows Bostwick's machine for the purpose.

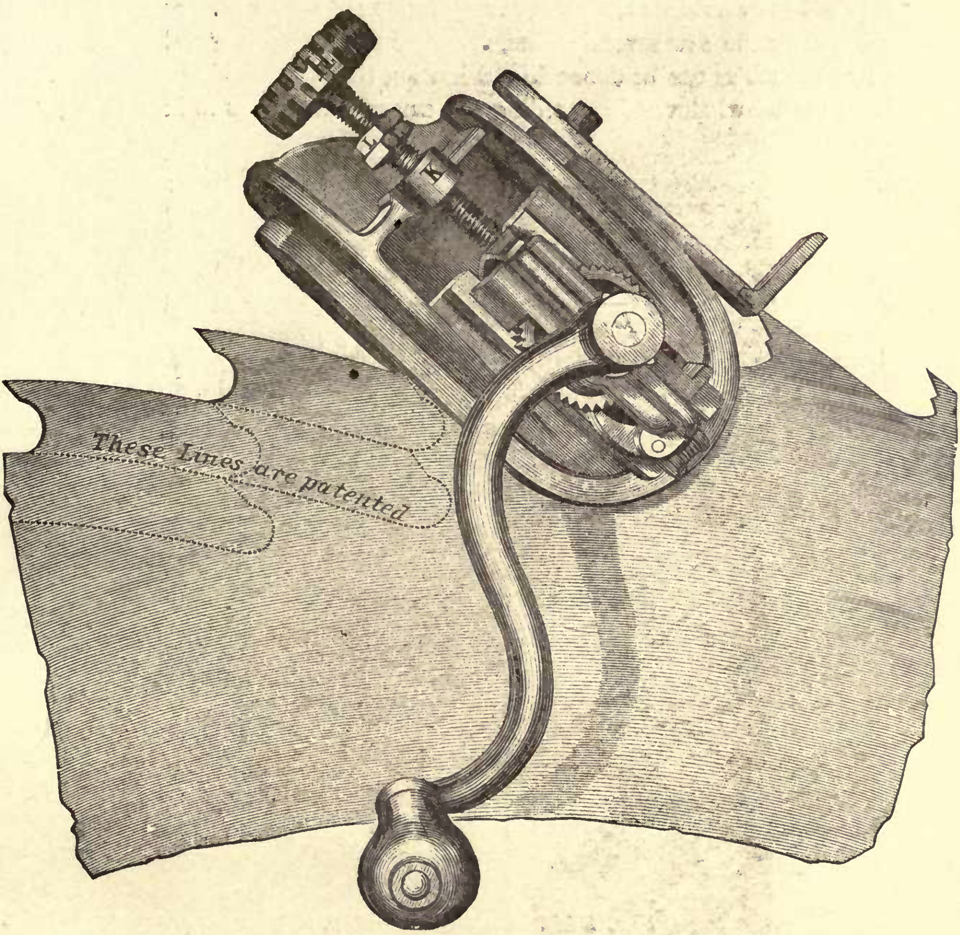


Fig. 209. Rotary Gummer.

There exists in the minds of many persons who are not fully acquainted with the principle upon which circular saws are made, an erroneous opinion that a saw should work the same until worn out, if it is not accidentally sprung in use or strained in gumming. So far as any damage to the saw is concerned, there is no difference between the use of a burr gummer and that of a file; but if proper care be not exercised in the use of the emery wheel there is more danger from its use than from either the file or burr.

If the condition of the saw be such that a considerable depth is required to be cut into the plate, the operation should be performed by going over the saw several times, allowing the wheel to grind away only so much as can be done without heating the saw to a blue. There is no excuse whatever in crowding the emery wheel so as to heat the

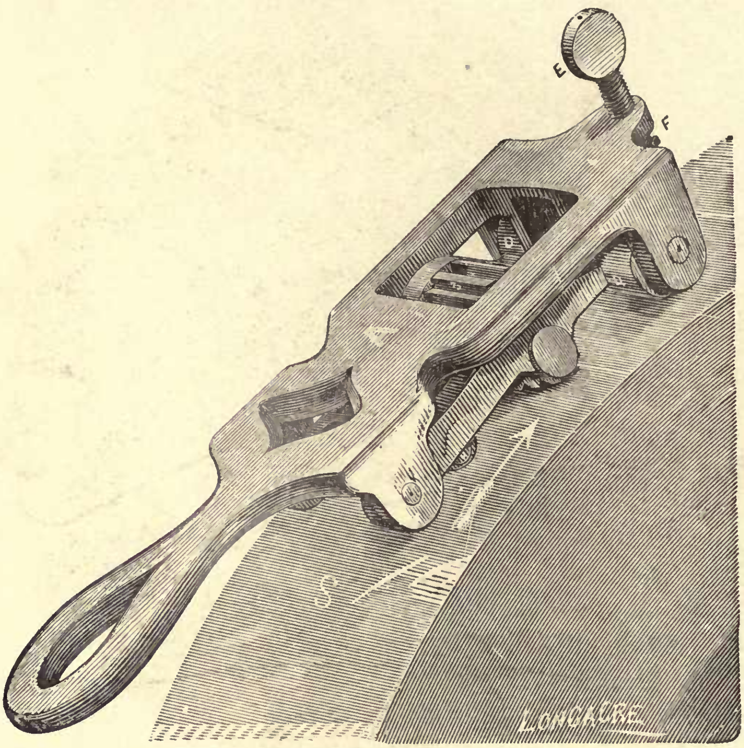


Fig. 210. Cutter Grinder.

saw red hot, as this is sure to injure the saw, often glazing it where the wheel comes in contact, so hard that a file will make no impression whatever. From these hard spots on the outer surface small cracks commence, at first invisible to the eye, but gradually enlarging until they become dangerous fractures. Hacking the face of the wheel with a cold chisel or the corners of an old file, will often prevent its glazing, so that it is not as liable to heat the saw. After a few times gumming, however, the saw will enlarge on the rim so that the slightest warmth will cause it to buckle, and there is no remedy left but to send it to a saw maker and have it re-hammered. Some, however, entertain the wrong impression that a saw re-hammered will never run as well as when new. On the contrary, a saw re-hammered will generally run better than when new, because all the elasticity (or nearly all) is worked out of it by use, and it generally works stiffer than when new.

Fig. 211.

The cause of emery wheels hardening saw plates is stated by J. E. Emerson to be that the spaces between the particles of emery fill up with steel, creating a smooth instead of a rough surface. The friction quickly causes high heat, and sudden chilling takes place when the wheel leaves the spot. To remove it, hack the wheel with the corner

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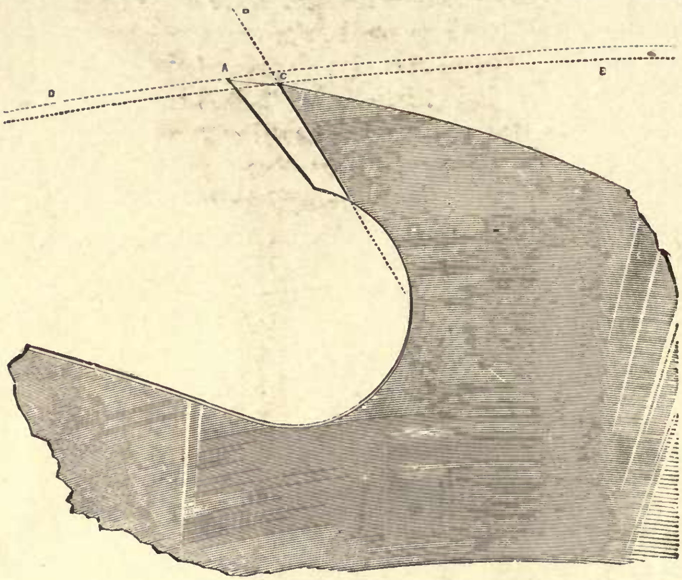


Fig. 212.

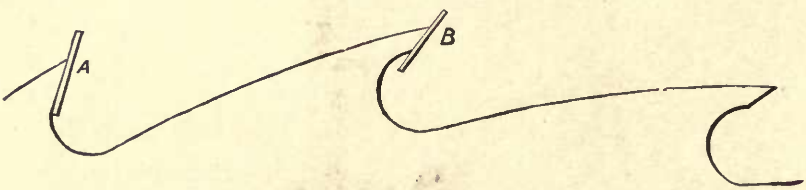


Fig. 213.

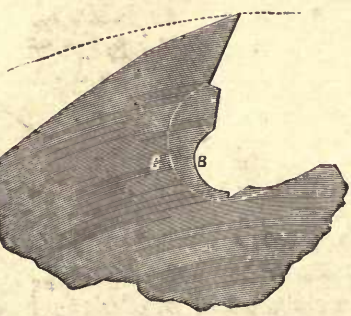


Fig. 214. Bad Gumming.

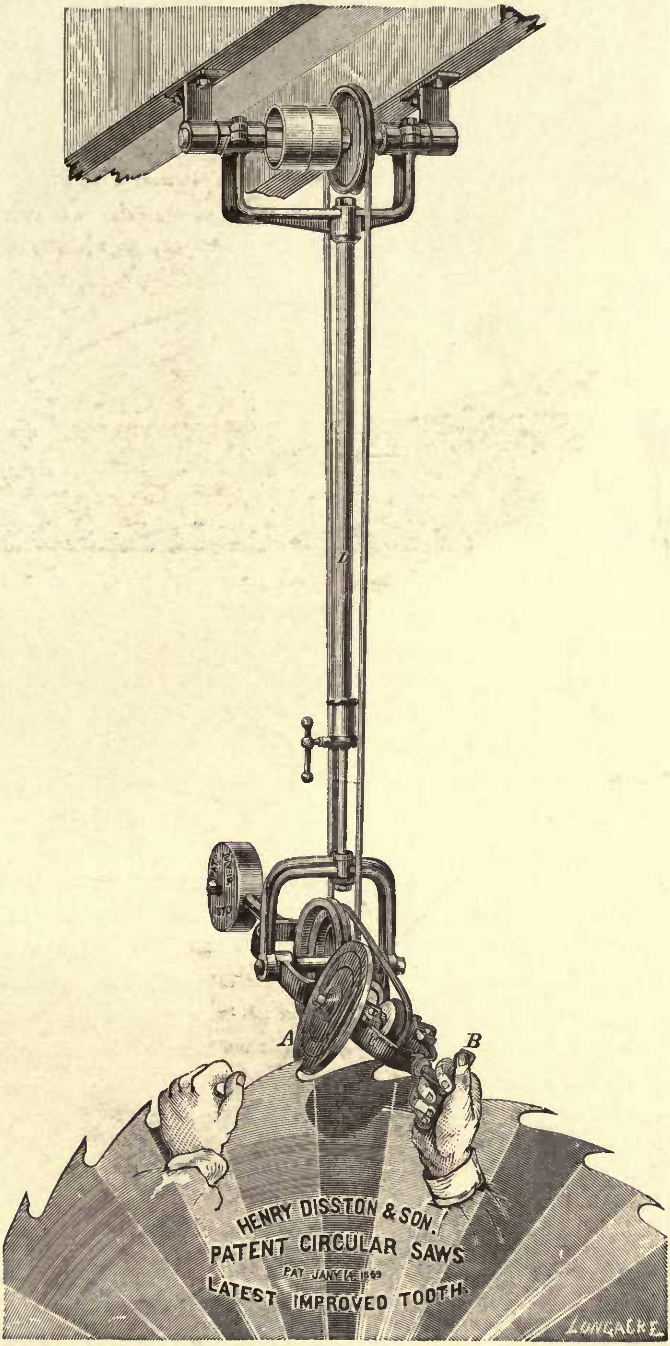


Fig. 215. Boswick's Emery Gummer.

of a worn out file, and grind off the extreme outer surface which has been hardened. It is better, and takes no longer to keep the emery wheel hacked and cut off only a little at a time and to go around the saw lightly several times in gumming.

The wheel is generally turned up true with a diamond after wear.

The great trouble in the use of the ordinary diamond tool is the danger of grinding out and losing the diamond. In the tool shown herewith the diamond *C* is held in copper, as shown at *D*. This copper is held between the two halves of the tool, which are firmly

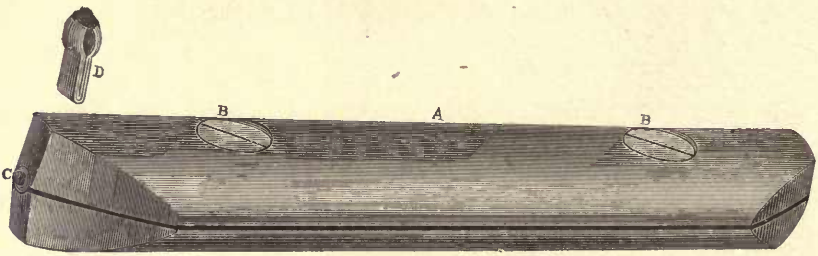


Fig. 216. Emerson's Diamond Tool for Truing Wheels.

gripped together by the screws *BB*, the principle upon which the diamond is imbedded and held, holds it firmly and securely, being substantially the same as used in securing the diamonds in the Emerson Diamond Stone Saw.

A represents the diamond tool. *BB*, the screws for fastening the tool together with diamond *C* in the end. *D* represents a diamond in its casing, which is made of sheet copper on account of its toughness and pliability; this is fitted around and incorporated into every irregularity of the diamond, then the casing and diamond are fitted into the steel holder, and the fold of the copper casing held below the diamond firmly between the two jaws of the diamond tool or holder. In many other processes the diamond is held merely by a grip upon its own size; when the holder becomes worn to the centre of the diamond it drops out and is lost. By this process the casing is held, to which the diamond clings and is saved.

APPENDIX VII.

JOINING BAND SAW BLADES.

TO MAKE MURIATE OF ZINC (CHLORIDE OF ZINC; ZINC CHLORIDE), *for Soldering or Brazing.*—Feed muriatic acid all the small pieces of zinc that it will eat; dilute with an equal amount of rain or distilled water (condensed steam water) and it is ready for use.

TO MAKE BORAX WATER FOR SOLDERING OR BRAZING.—Burn a sufficient quantity of borax on a hot shovel or piece of sheet iron, or in an iron dish, then pulverize and boil in rain or condensed water to the consistency of cream.

TO JOIN THE ENDS OF A BAND SAW.—File the ends of the saw on opposite sides to form two wedge-shaped ends, having a lap of say from $\frac{3}{4}$ to $1\frac{1}{2}$ inch, according to width and thickness of plate; a thin narrow plate for light work, like ordinary scroll sawing, $\frac{3}{4}$ inch: a wide saw, say four or five inches in width, by No. 16, 17 and 18 gauge, $1\frac{1}{2}$ inch lap. When the two beveled sides are laid together they must form a good joint of the same thickness as the blade. Now take two pairs of tongs with heavy jaws, long enough to cover the width of the blade; have the jaws straight and shut closely. Cut a notch in a piece of about 6 x 6 joist for wide saws, and smaller for narrow saws; have the notch large enough, and covered or plated inside, so that it will not be burned by the hot tongs. Next clamp the saw on the joists so that the laps will come over the notch; the joists should be say four feet in length, and mounted on legs like a carpenter's saw horse. Now cover the lap with the muriate of zinc or borax water, placing a piece of very thin silver solder or fine spelter solder in the joint; if spelter is used, it may be mixed with the borax water and spread between the joints (silver solder, however, is preferable to spelter). Now heat one pair of the tongs to a bright cherry red and scrape off all the scale, etc., between the jaws; clamp the joint to be brazed, using another pair of cold tongs to clamp the points of the hot tongs, hold them a sufficient length of time to melt the solder, and have the other pair of tongs warmed to about the heat of a sad iron. Now carefully draw the hot tongs off towards the back of the saws, having the back rest firmly against supports, so that the saw cannot move edgewise. Have another person follow up the hot tongs with those merely warmed; hold the grip with the warm tongs until the joints are fairly set, when nothing remains to be done more than to file off the surplus solder. The above process will be found much better than cooling off the joints with water, which is liable to harden and crack the blade. The soldering and cooling tongs should be made heavy and strong. The cooling tongs should not be used entirely cold, as the sudden chilling will harden the plate. If the process is properly performed, the saw will be of the same temper at the splice as in other parts.

Figs. 217 and 218 show a very convenient device made by J. A. Fay & Co., Cincinnati, to facilitate the brazing of band-saw blades. It is sufficiently explained by the illustrations.

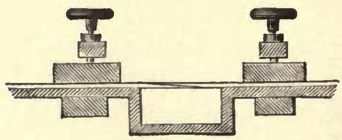


Fig. 217.

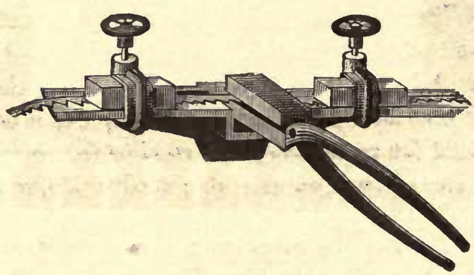
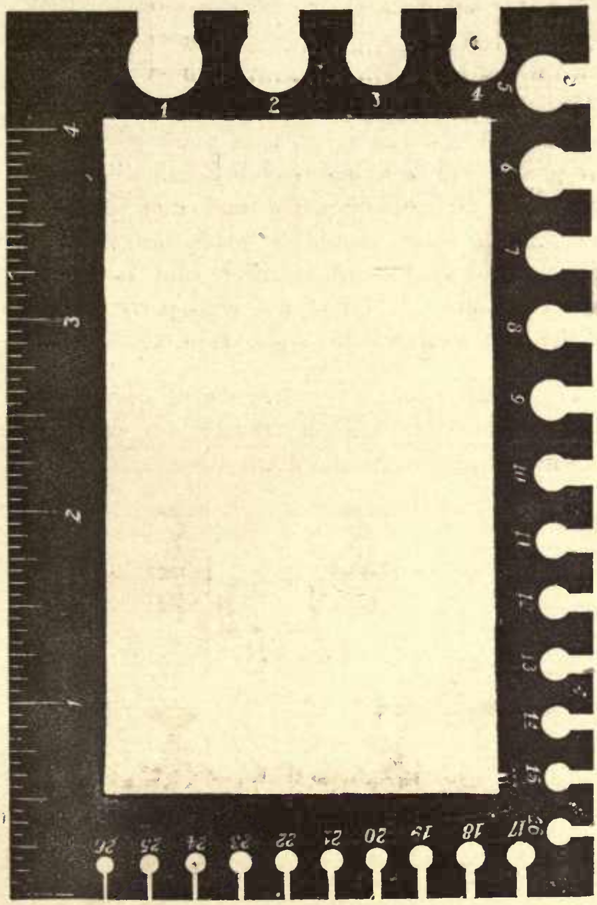


Fig. 218.

APPENDIX VIII.

Gauges and Measurements.



The gauge employed for measuring thickness of saw plates is the so-called "Stubs'," or Birmingham Wire Gauge (an arbitrary and senseless scale, almost matchless among trade stupidities), shown in part herewith in comparison with the inch and its divisions into sixteenths, and also given in part in decimal divisions of the inch in the annexed table:

Gauge.	Diam. Inch.	Gauge.	Diam. Inch.	Gauge.	Diam. Inch.
1	·3	10	·134	19	·042
2	·284	11	·12	20	·035
3	·259	12	·109	21	·032
4	·238	13	·095	22	·028
5	·22	14	·083	23	·025
6	·203	15	·072	24	·022
7	·18	16	·065	25	·02
8	·165	17	·058	26	·018
9	·148	18	·049		

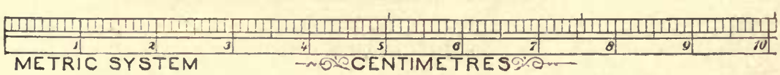
BIRMINGHAM WIRE GAUGE, EXPRESSED IN "CARPENTER'S MEASURE."

Gauge No. 4	$\frac{1}{4}$ inch	scant.	Gauge No. 9	$\frac{5}{32}$ inch	scant.
" " 5	$\frac{7}{32}$ "		" " 10	$\frac{1}{8}$ "	full.
" " 6	$\frac{3}{16}$ "	full.	" " 11	$\frac{1}{8}$ "	scant.
" " 7	$\frac{3}{16}$ "	scant.	" " 12	$\frac{1}{8}$ "	scant.
" " 8	$\frac{5}{32}$ "		" " 13	$\frac{3}{32}$ "	

Table giving the values of inches and fractions of an inch in millimeteres:

Inches.	Millimetres.	Inches.	Millimetres.	Fractions of an inch.	Millimetres.	Fractions of an inch.	Millimetres.
1	25·39977	19	482·59567	$\frac{1}{32}$	0·79374	$\frac{17}{32}$	13·49362
2	50·79954	20	507·99544	$\frac{1}{16}$	1·58748	$\frac{9}{16}$	14·28737
3	76·19932	21	533·39521	$\frac{3}{32}$	2·38123	$\frac{19}{32}$	15·08111
4	101·59909	22	558·79499	$\frac{1}{8}$	3·17497	$\frac{5}{8}$	15·87485
5	126·99886	23	584·19476	$\frac{5}{32}$	3·96871	$\frac{21}{32}$	16·66859
6	152·39863	24	609·59453	$\frac{3}{16}$	4·76245	$\frac{11}{16}$	17·46234
7	177·79840	25	634·99430	$\frac{7}{32}$	5·55620	$\frac{23}{32}$	18·25608
8	203·19818	26	660·39407	$\frac{1}{4}$	6·34994	$\frac{3}{4}$	19·04982
9	228·59795	27	685·79385	$\frac{9}{32}$	7·14368	$\frac{25}{32}$	19·84356
10	253·99772	28	711·19362	$\frac{5}{16}$	7·93743	$\frac{13}{16}$	20·63731
11	279·39749	29	736·59339	$\frac{11}{32}$	8·73117	$\frac{27}{32}$	21·43105
12	304·79726	30	761·99316	$\frac{3}{8}$	9·52491	$\frac{7}{8}$	22·22479
13	330·19704	31	787·39293	$\frac{13}{32}$	10·31865	$\frac{29}{32}$	23·01853
14	355·59681	32	812·79271	$\frac{7}{16}$	11·11240	$\frac{15}{16}$	23·81228
15	380·99658	33	838·19248	$\frac{15}{32}$	11·90614	$\frac{31}{32}$	24·60602
16	406·39635	34	863·59225	$\frac{1}{2}$	12·69988	1	25·39977
17	431·79612	35	888·99202				
18	457·19590	36	914·39179				

We annex a cut showing four inches graduated to centimetres:



APPENDIX IX.

ORDERING CIRCULAR SAWS.

In ordering circular saws for log sawing, it is always necessary, to avoid error or delays, to give the following data:

1. Whether inserted or solid toothed saws. 2. Diameter of saw in inches. 3. Kind and number of teeth (see Fig. 91.) 4. Gauge of saw at the hole. 5. Gauge of saw at the rim. 6. Size of centre hole. 7. Size of pin holes. 8. Diameter of circle pin holes are on (distance from centre to centre). 9. Which is the log side as the saw runs towards you, right or left? 10. Speed the saw is to run per minute. 11. What kind of timber you wish to cut. 12. Largest feed to each revolution of the saw, in inches. 13. Number of extra teeth desired if inserted teeth be ordered. 14. How it is to be shipped, whether by freight or express.

When ordering shingle saws, send correct draft holes, whether flange is on right or left side (saw cutting towards you), thickness at tooth, and about the number of teeth.

When ordering concave saws, give circle to be dished to; also, which side is to be dished or concaved, the right or left hand (saw running towards you).

APPENDIX X.

Tables for the Measurement of Logs, from 12 to 24 feet long and from 10 to 96 inches in Diameter.

[These tables are given here by special permission of the owners of the copyright, Messrs. N. W. Spaulding & Bros., Chicago.]

EXPLANATION.

The length of any log in feet will be found in the left hand column of the table, and the diameter at the top of the page.

To find the number of feet of square-edged boards which a log will produce when sawed: Take the length in feet in left hand column of table, and its diameter in inches at the top of the page; trace the two columns of figures until they meet, and you have the required amount.

EXAMPLE.

A log which is 18 feet long and 21 inches in diameter gives, at the right of the length and directly under the diameter, 346 feet.

And one 23 feet long and 18 inches in diameter gives 310 feet.

Logs longer than is given in this table can be easily measured by doubling any given length; for example, to find the number of feet, board measure, contained in a log 28 feet long by 19 inches in diameter, double the amount contained in a log 14 feet long, 19 inches diameter, and you have the answer—428 feet. For a log 42 feet long, 10 inches diameter, multiply the amount contained in the table in a log 14 feet long by three, and you have the amount; and so on to any length or size.

REMARKS.

In placing these tables before the Lumbermen, we wish to draw their attention to the fact that they have been computed from accurately drawn diagrams of every sized log from 10 to 96 inches in diameter. Each sized log has been scaled, so as to make all that can be practically sawed out of it, if economically sawed. Each log to be measured at the top or small end, inside of the bark, and, if not round, to be measured two ways—at right angles—and the difference taken for the diameter. Where there are any known defects, the amount to be deducted should be agreed upon by the buyer and seller, and no fractions of an inch to be taken into the measurement.

In this table we have varied the size of the slab in proportion to the size of the log, and have arranged it more particularly for large logs, by taking them in sections of 12 feet and carrying the table up to 96 inches in diameter. As there has never been any in use for scaling over 44 inches, it has been our purpose to furnish a table for the measuring of logs that can be implicitly relied upon for correctness by both buyer and seller; and to do so, we have spared no pains nor expense to render it perfect.

Length in Feet.	Diam. 10	Diam. 11	Diam. 12	Diam. 13	Diam. 14	Diam. 15	Diam. 16	Diam. 17	Diam. 18	Diam. 19	Diam. 20
12......	38	47	58	71	86	103	121	141	162	184	207
13......	41	51	62	76	93	111	131	152	175	199	224
14......	44	55	67	82	100	120	141	164	189	214	241
15......	47	59	72	88	107	128	151	176	202	230	258
16......	50	63	77	94	114	137	161	188	216	245	276
17......	53	67	82	100	121	145	171	199	229	260	293
18......	57	70	87	106	129	154	181	211	243	276	310
19......	60	74	91	112	136	163	191	223	256	291	327
20......	63	78	96	118	143	171	201	235	270	306	345
21......	66	82	101	124	150	180	211	246	283	322	362
22......	69	86	106	130	157	188	221	258	297	337	379
23......	72	90	111	136	164	197	231	270	310	352	396
24......	76	94	116	142	172	206	242	282	324	368	414

Length in Feet.	Diam. 21	Diam. 22	Diam. 23	Diam. 24	Diam. 25	Diam. 26	Diam. 27	Diam. 28	Diam. 29	Diam. 30	Diam. 31
12......	231	256	282	309	337	366	396	427	459	492	526
13......	250	277	305	334	365	396	429	462	497	533	569
14......	269	298	329	360	393	427	462	498	535	574	613
15......	288	320	352	387	421	457	495	533	573	615	657
16......	308	341	376	412	449	488	528	569	612	656	701
17......	327	362	399	437	477	518	561	604	650	697	745
18......	346	384	423	463	505	549	594	640	688	738	789
19......	365	405	446	489	533	579	627	676	726	779	832
20......	385	426	470	515	561	610	660	711	765	820	876
21......	404	448	493	540	589	640	693	747	803	861	920
22......	423	469	517	566	617	671	726	782	841	902	964
23......	442	490	540	592	645	701	759	818	879	943	1008
24......	462	512	564	618	674	732	792	854	918	984	1052

Length in Feet.	Diam. 32	Diam. 33	Diam. 34	Diam. 35	Diam. 36	Diam. 37	Diam. 38	Diam. 39	Diam. 40	Diam. 41
12…………	561	597	634	673	713	755	798	843	889	936
13…………	607	646	686	729	772	817	864	913	963	1014
14…………	654	696	739	785	831	880	931	983	1037	1092
15…………	701	746	792	841	891	943	997	1053	1111	1170
16…………	748	796	845	897	950	1006	1064	1124	1185	1248
17…………	794	845	898	953	1010	1069	1130	1194	1259	1326
18…………	841	895	951	1009	1069	1132	1197	1264	1333	1404
19…………	888	945	1003	1065	1128	1195	1263	1334	1407	1482
20…………	935	995	1056	1121	1188	1258	1330	1405	1481	1560
21…………	981	1044	1109	1177	1247	1321	1397	1475	1555	1638
22…………	1028	1094	1162	1233	1307	1384	1463	1545	1629	1716
23…………	1075	1144	1215	1289	1366	1447	1529	1615	1703	1794
24…………	1122	1194	1268	1346	1426	1510	1596	1686	1778	1872

Length in Feet.	Diam. 42	Diam. 43	Diam. 44	Diam. 45	Diam. 46	Diam. 47	Diam. 48	Diam. 49	Diam. 50	Diam. 51
12…………	984	1033	1086	1134	1186	1239	1293	1348	1404	1461
13…………	1066	1119	1176	1228	1284	1342	1400	1460	1521	1582
14…………	1148	1205	1267	1323	1383	1445	1508	1572	1638	1704
15…………	1230	1291	1357	1417	1482	1548	1616	1685	1755	1826
16…………	1312	1377	1448	1512	1581	1652	1724	1797	1872	1948
17…………	1394	1463	1538	1606	1680	1755	1831	1909	1989	2069
18…………	1476	1549	1629	1701	1779	1858	1939	2022	2106	2191
19…………	1558	1635	1719	1795	1877	1961	2047	2134	2223	2313
20…………	1640	1721	1810	1890	1976	2065	2155	2246	2340	2435
21…………	1722	1807	1900	1984	2075	2168	2262	2385	2457	2556
22…………	1804	1893	1991	2079	2174	2271	2370	2470	2574	2678
23…………	1886	1979	2081	2173	2273	2374	2478	2582	2691	2800
24…………	1968	2066	2172	2268	2372	2478	2586	2696	2808	2922

Length in Feet.	Diam. 52	Diam. 53	Diam. 54	Diam. 55	Diam. 56	Diam. 57	Diam. 58	Diam. 59	Diam. 60	Diam. 61
12…………	1519	1578	1638	1700	1763	1827	1893	1960	2028	2098
13…………	1645	1709	1774	1841	1909	1979	2050	2123	2197	2272
14…………	1772	1841	1911	1983	2056	2131	2208	2286	2366	2447
15…………	1898	1972	2047	2125	2203	2283	2366	2450	2535	2622
16…………	2025	2104	2184	2266	2350	2436	2524	2613	2704	2797
17…………	2151	2235	2320	2408	2497	2588	2681	2776	2873	2972
18…………	2278	2367	2457	2550	2644	2740	2839	2940	3042	3147
19…………	2405	2498	2593	2691	2791	2892	2997	3103	3211	3321
20…………	2531	2630	2730	2833	2938	3045	3155	3266	3380	3496
21…………	2657	2761	2866	2974	3085	3197	3312	3429	3649	3671
22…………	2784	2893	3003	3116	3232	3349	3470	3592	3718	3846
23…………	2911	3024	3139	3258	3379	3501	3628	3756	3887	4021
24…………	3038	3156	3276	3400	3526	3654	3786	3920	4056	4196

Length in Feet.	Diam. 62	Diam. 63	Diam. 64	Diam. 65	Diam. 66	Diam. 67	Diam. 68	Diam. 69	Diam. 70	Diam. 71	Diam. 72
12......	2169	2241	2315	2390	2467	2545	2625	2706	2789	2874	2960
13......	2349	2427	2507	2589	2672	2757	2843	2931	3021	3113	3206
14......	2530	2614	2700	2788	2878	2969	3062	3157	3253	3353	3453
15......	2711	2801	2893	2987	3083	3181	3281	3382	3486	3592	3700
16......	2892	2988	3086	3186	3289	3393	3500	3608	3718	3832	3946
17......	3072	3174	3279	3385	3494	3605	3718	3833	3951	4071	4193
18......	3253	3361	3472	3585	3700	3817	3937	4059	4183	4311	4440
19......	3434	3548	3665	3784	3906	4029	4156	4284	4415	4550	4686
20......	3615	3735	3853	3983	4111	4241	4375	4510	4648	4790	4933
21......	3795	3921	4051	4182	4316	4453	4593	4735	4880	5029	5180
22......	3976	4108	4244	4381	4522	4665	4812	4961	5113	5269	5426
23......	4157	4295	4437	4580	4728	4877	5031	5186	5345	5508	5673
24......	4338	4482	4630	4780	4934	5090	5250	5412	5578	5748	5920

Length in Feet.	Diam. 73	Diam. 74	Diam. 75	Diam. 76	Diam. 77	Diam. 78	Diam. 79	Diam. 80	Diam. 81	Diam. 82	Diam. 83	Diam. 84
12	3047	3135	3224	3314	3405	3497	3590	3684	3779	3874	3970	4067
13	3301	3396	3492	3590	3688	3788	3889	3991	4094	4196	4301	4406
14	3555	3657	3761	3866	3972	4080	4188	4298	4408	4519	4631	4745
15	3809	3919	4030	4142	4256	4371	4487	4605	4723	4842	4962	5084
16	4062	4180	4298	4418	4540	4663	4786	4912	5038	5165	5293	5423
17	4316	4441	4567	4694	4823	4954	5085	5219	5353	5488	5624	5762
18	4570	4702	4836	4970	5107	5245	5385	5526	5668	5811	5955	6101
19	4824	4964	5104	5246	5391	5537	5684	5833	5983	6133	6285	6440
20	5078	5225	5372	5522	5675	5829	5983	6140	6298	6456	6616	6778

Length in Feet.	Diam. 85	Diam. 86	Diam. 87	Diam. 88	Diam. 89	Diam. 90	Diam. 91	Diam. 92	Diam. 93	Diam. 94	Diam. 95	Diam. 96
12	4165	4264	4364	4465	4566	4668	4771	4875	4980	5085	5192	5300
13	4512	4619	4727	4837	4946	5057	5168	5281	5395	5508	5624	5741
14	4859	4974	5091	5209	5327	5446	5566	5687	5810	5932	6057	6183
15	5206	5330	5455	5581	5707	5835	5964	6094	6225	6356	6490	6625
16	5553	5685	5818	5953	6088	6224	6361	6500	6640	6780	6922	7066
17	5900	6040	6182	6325	6468	6613	6759	6906	7055	7203	7355	7508
18	6247	6396	6546	6697	6849	7002	7156	7312	7470	7627	7788	7950
19	6594	6751	6909	7069	7229	7391	7554	7719	7885	8051	8220	8391
20	6941	7106	7275	7441	7610	7780	7951	8125	8300	8475	8653	8833

APPENDIX XI.

Data Concerning Capacity of Saw Mills and Power Required to Run them.

[Unless otherwise stated, widths of straight saws and diameters of circulars, thickness of log or height of cant, belt widths and pulley diameters, tooth height and distance, and kerf width, are stated in inches.]

DATA—SINGLE SASH SAW.

Length—feed.	Width—inches.	Gauges.	Stroke—inches.	Cutting strokes per minute.	Kind of wood (slitting).	Height of cant.	Feed—lineal feet per minute.	H. P. required.	Kind of belt.	Width of belt.	Diameter of pulley.	Revolutions per minute.	Height of teeth.	Distance between teeth.	Width of kerf.	Capacity—10 hours.	Informant.
7	8	9		175		24			Doub.	12				2	1/4	3 M	Emerson, Smith & Co.
6	8	10 & 12	24	200	Pine	14		40	Doub.	14	48	200	1 1/2	2	3/16	10 to 12 M	Stearns & Co.
6 1/2	8	6 or 7	28	220	Pine		1/2	12	Doub.	10	24	120	1 1/2	2	1/4	2 M *	E. Andrews.

* Inch boards.

DATA—GANG SASH SAW.

Number of saws.	Length—feet.	Width—inches.	Gauges.	Stroke—inches.	Cutting strokes per minute.	Kind of wood (slitting).	Height of cant.	Feed, per stroke—inches.	H. P. required.	Kind of belt.	Width of belt.	Diameter of pulley.	Pulley revolutions per minute.	Height of teeth.	Distance of teeth.	Width of kerf.	Capacity—10 hours.	Informant.
40	5	8	13		175	Pine		3/4									75 to 100 M	Emerson, Smith & Co.
42	4	15		20	240	Pine	12	5/16	80					1 1/4	1 1/8	1/8	100 M	Stearns & Co.
28	4 1/2		11 or 12	24	180	Pine		3/8	24	Doub.	14	36	180	1 1/4	1 3/4	3/16	25 M*	E Andrews.
34	5 1/2	9	12 & 13	20	200	Maple	28	1/2	50	Doub.	26	42	200	1 1/8	1 1/8	3/16	60 M	D. B. McRae.
21	3 1/2	7	13	20	300			5/8	70	Doub	24	48	300	1	1 1/8	3/16	80 M	F. McDonough.
39	5 1/3	10	12	12	150	Pine	26	3/8 to 3/4		Doub.	20	36		1 1/4	1 1/2	1/4		C. D Hale.
27	5 1/4	8	11	24					25	Doub.	20	36	200		1 1/2	5/32	60M	Anoka Lumber Mills.
30	5	7	11 to 12	22	200		12	5/8	35	Doub.	16	42	200	1 1/4	1 3/4	3/16	35 M	Snyder Bros.

* Inch boards.

DATA—MULAY SAW.

Length—feet.	Width—inches.	Gauges.	Stroke—inches.	Cutting strokes per minute.	Kind of wood.	Height of cant—inches.	Feed—per stroke.	H. P. required.	Kind of belt.	Width of belt—inches.	Diameter of pulley—inches.	Height of teeth.	Distance of teeth.	Width of kerf.	Capacity—10 hours.	Informant.
7	12	7	28	225	Pine		3/4	15	Doub.	14	30	1 3-32	2	1/4	5 M*	E. Andrews.
7	8	6 & 7	18	180		25	3/4	30	Doub.	14	36	1 1/2	2	3/16	12to15M	D. B. McRae.
7	10	7	24	325		30	1 1/4	14	Doub.	14	30	1 1/2	2	1/4		Snyder Bros.

* Inch boards

DATA—JIG SAW—SPRING STRAINED.

Width—inches.	Gauges.	Width of Kerf.	Stroke—inches.	Revolutions per minute.	Kind of wood.	Height of cut.	Height of teeth.	Distance of teeth.	Informant.
1/4	14 &16	3-32	5	1100	Bl'k Walnut	2 1/2	1/16	3/16	J. A. Fay & Co.

DATA—DRAG OR BUTTING SAW.

Length—feet.	Width—heel.	Width—point.	Gauges.	Stroke—inches.	Cutting strokes per minute.	Kind of logs (cross cutting).	Thickness of logs.	H. P. required.	Kind of belt.	Width of belt.	Diameter of pulley.	Revolutions per minute.	Height of teeth.	Distance of teeth.	Width of kerf.	Single or double cutting.	Informant.
6	10	6	9 & 10	24	120			5	Single.	8	24	120		1 1/4	3/16	Double.	E. Andrews.
6	6	4	13 & 16	36	40			*				40				Double.	W. W. Giles.
6	10	6	9	28	100		36	5	Double.	6	20	100	1 1/4	1 1/4	1/4	Double.	Snyder Bros.

* "Riding" Drag Saw—Man Power.

DATA—BAND SCROLL SAW.

Length—feet.	Width—inches.	Gauge.	Diameter of wheels—inches.	Revolutions per minute.	Velocity per minute—feet.	Kind of wood.	Height of wood—inches.	Width of kerf.	Height of teeth.	Distance of teeth.	Informant.
20	5/8	20	40	350	3665		2	3-64	3-32	1/4	J. A. Fay & Co.
18 1/2	3/4										Anoka Lum. M.

DATA—BAND RESAW.

Length—feet.	Width—inches.	Gauges.	Diameter of wheels—inches.	Revolutions per minute.	Lineal velocity per minute—feet.	Kind of wood (slitting).	Height of cant—inches.	Feed—Lineal feet per minute.	H. P. required.	Kind of belt.	Width of belt—inches.	Pulley diameter—inches.	Pulley revolutions per minute.	Height of teeth.	Distance of teeth.	Width of kerf.	Capacity—10 hours.	Informant.
28½	4	18	60	400	6283	Popiar	20	25	12	Single	8	30	400	½	1½	1/16	10 M	J. A. Fay & Co.
40	5	16	72	350			24 to 48	30	15	Doub. or Single	10	30	350	1	2	½	20 M*	J. H. Hoffman.

* Inch boards.

DATA—SINGLE CIRCULAR SAW.

Kind of teeth.	Diameter—inches.	Gauge at eye.	Gauge at rim.	Number of teeth.	Revolutions per minute.	Feed—inches per revolution.	Kind of wood.	Height of cant	Width of kerf.	H. P. required.	Kind of belt.	Width of belt.	Diameter of pulley.	Revolutions per minute.	Capacity—10 hours.	Informant.
Solid	56	5	7	48	600	3½			¼	30	Single	14	24	600	12 M *	E. Andrews.
Solid	60	7	8	60	850	†	Pine		⅜		Single	16			50 M	Wyman, Buswell & Co.
Inserted	72	6	8	72	680	12	Pine	16	¼	80	Doub.	18	23	265	50 M	D. B. McRae
Solid	60	4	8	64	850	6	Pine		¼	80	Doub.	20	30	850	55 M	F. McDonough.
Solid or Inserted	66	5	7	56	500	6	Pine		¼		Doub.	16				
Inserted	60	6	7	34	400 to 450	2	Pine and Hemlock	30		25	‡				8 to 13 M	Waterous Engine Wks.
Solid or Inserted	58	5	6	44	650	4	Pine		¼	20	Doub.	18			50 M	Anoka Lumber Mills.

* Inch boards. † Unlimited; "Shot-gun" steam feed.
‡ Running direct action every revolution of engine being one of saw.

Disston states that for 10,000 feet per day 20 HP are required; for 20,000 feet, 30 HP; for 30,000 feet, 40 HP.

To run a 60-inch circular through a 24-inch hemlock or oak log requires ordinarily, according to Emerson, about 10 HP to every one inch of feed in the revolution of the saw.

Years ago 48-inch circular saws were used in our Western States, driven by four horses walking around; these sawed 500 to 1200 feet of lumber a day, according to kind and quality of logs.

APPENDIX XII.

RESULTS OF EXPERIMENTS

Made with CIRCULAR SAWS *at Cincinnati Industrial Exposition,* 1874, *by* CHAS. A. BAUER, *Mechanical Engineer.*

NAME.	Kind of Lumber Sawed	SAW. Diameter in Inches	SAW. Revolutions per Minute	SAW. Number of Teeth	SAW. GAUGE. Eye	SAW. GAUGE. Teeth	SAW. GAUGE. Face	Feed	Cut per Tooth	Size of Board Sawed	Number of Boards Sawed	Square Feet of Lumber Sawed	Time	Indicated Horse-Power	Square Feet of Lumber Sawed per Minute	Percentage of Power Used	General Percentage of Power Used
Hogan & Snowden	Poplar	56	600	42	7	11	3	2½	·0600	20x12	16	300	2·50	76·4	105·8	·592	·592
E. Andrews	Poplar	56	648	40	5	7	3	3⅜	·0844	20x12	16	300	2·53	89·6	104·	·705	·7435
E. Andrews	Oak	56	660	40	5	7	3	2½	·0625	16x12	12	176	2·05	80·5	84·4	·782	
J. W. Baldridge & Co.	Poplar	56	640	48	8	9	4	2½	·0521	20x12	16	300	2·53	79·4	104·	·635	·7705
J. W. Baldridge & Co.	Oak	56	690	48	8	9	4	2½	·0521	16x12	12	176	2·03	74·9	85·8	·906	
American Saw Company	Poplar	56	634	40	6	8	3	3⅜	·0844	20x12	16	300	2·31	83·9	119·5	·576	·6595
American Saw Company	Oak	56	628	40	6	8	3	2½	·0625	16x12	12	176	2·02	78·4	86·5	·743	
Emerson, Ford & Co.	Poplar	26	615	50	6	7	3	3⅜	·0675	20x12	16	300	2·44	96·1	109·7	·718	·748
Emerson, Ford & Co.	Oak	56	620	50	6	7	3	3⅜	·0675	16x12	12	176	1·43	97·3	102·5	·778	
Emerson, Ford & Co., *planer tooth*	Poplar	56	590	34	7	8	3	2½	·0735	20x12	16	300	3·17	93·8	91·3	·843	·9215
Emerson, Ford & Co., *planer tooth*	Oak	56	632	34	7	8	3	2½	·0735	16x12	12	176	2·27	87·6	71·8	1·000	
Woodrough & McParlin	Poplar	56	656	40	7	8	5	3⅜	·0844	20x12	16	300	2·34	90·3	116·9	·633	·683
Woodrough & McParlin	Oak	56	636	40	7	8	5	3⅜	·0844	16x12	12	176	1·45	91·4	100·5	·745	
R. Hoe & Co.	Poplar	56	519	36	5	8	2	4½	·1250	20x12	16	300	2·09	89·7	139·5	·527	·527
R. Hoe & Co., *planer tooth*	Poplar	56	605	36	5	7	2	3⅜	·0938	26x12	16	300	2·45	91·8	109·1	·689	·7045
R. Hoe & Co., *planer tooth*	Oak	56	602	36	5	7	2	2½	·0694	10x12	12	176	1·58	79·	90·	·720	
James Ohlen	Poplar	56	634	30	6	7	3	4½	·1500	26x12	16	300	2·53	82·	104·	·648	·734
James Ohlen	Oak	56	638	30	6	7	3	3⅜	·1160	10x12	12	176	1·59	82·7	88·8	·820	
Curtis & Co.	Poplar	56	681	50	8	10	6	3⅜	·0700	26x12	16	300	2·51	65·	105·2	·597	·727
Curtis & Co.	Oak	56	640	50	8	10	6	2½	·0500	10x12	12	176	2·30	81·1	70·4	·945	

The power to drive saws was furnished by a 14x20 engine.

APPENDIX XIII.

Alphabetical List of U. S. Saw Patents from 1790 to Nov. 15, 1879.

Saw..................	S. Anderson,	May 5, 1868,	77,439
	E. Andrews,	Dec. 79, 1868,	85,417
	" "	Jan. 24, 1871,	111,164
	J. E. Atwood,	Dec. 11, 1866,	60,321
	" "	Nov. 12, 1867,	70,680
	J. G. Baker,	June 23, 1868,	79,185
	S. Barry,	June 23, 1868,	79,099
	A. Bee,	Jan. 1, 1867,	69,827
	A. Boynton,	Nov. 27, 1866,	59,951
	E. M. Boynton,	Jan. 14, 1868,	73,226
	W. E. Brooks,	Sep. 20, 1870,	107,293
	H. Broomell & A. W. Wilosn,	May 3, 1870,	102,653
	C. N. Brown,	Dec. 10, 1872,	133,828
	I.S & C.N. Brown,	Oct 24, 1865,	50,553
	" " "	Jan. 29, 1867,	61,513
	" " "	Mar. 12, 1867,	62,813
	" " "	Apr. 7, 1868,	76,395
	" " "	Nov. 2, 1869,	96,305
	B. F. Burgess,	Sep. 22, 1868,	82,289
	E. Clark,	Apr. 3, 1849,	6,258
	W. Clemson,	Aug, 14, 1866,	57,088
	" "	Mar. 24, 1868,	75,733
	" "	Mar. 16, 1869,	87,910
	S. Cook,	July 22, 1873,	141,036
	H. Cramer,	Oct. 19, 1869,	95,884
	R. Cromelien,	Mar. 28, 1865,	46,996
	S. Crookes,	July 22, 1873,	141,122
	P. Crosby,	Apr. 10, 1860,	27,779
	J. Davis,	Jan. 7, 1868,	72,983
	A. Dawes,	June 27, 1865,	48,376
	H.P. Dillingham,	Dec. 5, 1865,	51,385
	C. Disston,	Mar. 19, 1867,	63,024
	"	Apr. 2, 1867,	63,486
	"	May 21, 1867,	64,953
	"	Aug, 11, 1868,	80,929
	H Disston,	Oct. 4, 1870,	108,011
	"	Feb. 28, 1871,	112,227
	H. Disston & I. O. Hill,	Feb. 7, 1871,	111,619
	E S. Drake,	Apr. 11, 1865,	47,255
	W. L. Earing,	Nov. 7, 1871,	120,633
	J. E. Emerson,	Mar. 20, 1860,	27,537
	"	July 3, 1866,	56,142
	"	Aug. 28, 1866,	57,627
	"	Feb. 12, 1867,	62,020
	"	Mar. 26, 1867,	63,232
	"	July 16, 1867,	66,692
	"	Feb. 18, 1863,	74,521
	"	May 3, 1870,	102,520
	"	Mar. 14, 1871,	112,569
	"	Apr. 25, 1871,	113,992
	"	June 27, 1871,	116,421
	"	Feb. 6, 1872,	123,466
	J. E. Emerson & W.S. Winsor	Feb. 18, 1868,	74,522
	"	" "	74,523
	W. L. Gage,	Jan. 17, 1871,	110,966
Saw..................	G. B. Goodnow,	Mar. 29, 1870,	101,258
	G. B. Green,	Sep. 12, 1871,	118,800
	J. Holden,	Mar. 5, 1872,	124,268
	E. Humphrey,	Feb. 18, 1868,	74,541
	J. Huther,	Jan. 2, 1872,	122,320
	M. W. Geffords,	Aug. 22, 1871,	118,370
	N. Jenkins,	Feb. 2, 1869,	86,407
	M. Jincks	Mar. 19, 1872,	124,825
	N. Johnson,	Nov. 12, 1872,	133,036
	H. Knowles,	Aug. 27, 1850,	7,603
	J. L. Kranser,	Dec. 3, 1867,	71,625
	H. A. Lanman,	July 20, 1869,	92,846
	J. Lippincott,	Mar. 13, 1866,	53,157
	"	June 5, 1866,	55,423
	C.V. Littlepage,	Apr. 26, 1870,	102,286
	"	Dec. 19, 1871,	121,950
	J.K. Lockwood,	Nov. 12, 1867,	70,728
	V. Luppert & P. St. Pierre,	Aug. 19, 1873,	144,939
	T. P. Marshall,	May 7, 1872,	126,407
	A. C. Martin & J. Woodrough	Jan. 8, 1867,	61,014
	E. Marx,	Nov. 4, 1873,	144,341
	G. Maulick,	Feb. 9, 1869,	86,850
	"	July 12, 1870,	105,349
	E. Miall, jr.,	June 29, 1869,	92,080
	W. P. Miller,	Oct. 9, 1866,	58,664
	"	Sep. 1, 1868,	81,811
	"	" "	81,812
	W.F. Milliman,	Oct. 4, 1870,	108,040
	C. Mitzelfield,	Aug. 9, 1870,	106,187
	G.B. Montgom'y,	Aug. 25, 1868,	81,525
	J. Neal,	June 11, 1867,	65,687
	J. Phillips,	Sep. 27, 1870,	107,808
	D. Ricker,	Oct. 17, 1871,	119,998
	E.J. Robinson,	Sep. 25, 1866,	58,297
	D. Sattler,	Aug. 25, 1868,	81,413
	"	Nov. 14, 1871,	121,007
	S. Schofield,	May 27, 1873,	139,426
	S. W. Shailer,	July 12, 1870,	105,261
	C.T. Shoemaker,	June 5, 1866,	55,375
	J. Smith,	Oct. 4, 1870,	107,059
	J. H. Smith & E. G. Peckham,	Sep. 21, 1879,	95,052
	N.W. Spaulding,	Sep. 10, 1861,	33,270
	A. P. Sproul,	Dec. 10, 1872,	133,810
	W.R. Stephenson,	Jul. 30, 1867,	67,369
	L. Stewart,	May 16, 1854,	10,932
	D. Talbot,	Oct. 2, 1860,	30,265
	P. Thompson,	Aug. 8, 1871,	117,944
	E. W. Tilton,	Apr. 2, 1867,	63,581
	J. H. Tuttle,	Jun. 21, 1853,	9,807
	W. G. Tuttle,	Jan. 6, 1863,	37,312
	"	Mar. 3, 1863,	37,835
	J. P. Tyler,	Juy. 20, 1869,	92,909
	G. Walker,	Jan. 7, 1868,	73,210
	J. L. Warren,	Dec. 8, 1868,	84,722
	T. Welham,	Jan. 3, 1871,	110,705

Saw	J. Woodrough,	May 15, 1866,	54,827
Saw & Saw Teeth,	J.M.Johnston,	May 25, 1869,	90,365
Back,	W. Clemson,	Oct. 17, 1871,	119.967
Band,	C. A. Young,	Jun. 3, 1873,	139,644
Belt,	D.A.Cameron,	Mar. 21, 1854,	10,678
	W. Carey,	Feb. 17, 1836,	
	G. Thompson,	Aug. 25, 1868,	81,434
or Band,	A. Stewart,	July 5, 1817,	
Timber,	B. Barker,	Jan. 6, 1836,	
Buhl	T. Leavitt,	Dec. 13, 1870,	110,051
Chain,	D. Kennedy,	Feb. 4, 1868,	74,097
Circular,	S. Bonnel,	Sep. 26, 1823,	
	H. Disston,	Jan. 14, 1868,	73,238
	J. E. Emerson,	Apr. 13, 1869,	88,949
	J. F. Folmar,	Aug. 18, 1868,	81,267
	J. Glove,	Oct. 16, 1839,	1,372
	W. F. Hill,	July 11, 1818,	
	L. Hitchcock,	Jun. 29, 1833,	
	W.Kendall, jr.,	May 18, 1826,	
	J. Weille & H.S.Robinson,	Mar.16,1869,	87,891
Circ.or Cyln'l,	L. R Bump,	Aug. 29, 1828,	
Reacting,	W. Avery,	Dec. 8, 1826,	
Revolv'g,	T. Howe,	Feb. 19, 1829,	
Stone,	R. Deering, sr.,	Oct. 3, 1854,	11,746
Cross-cut,	W. Clemson,	Aug. 22, 1871,	118,198
	S. S. Disston,	Jan. 21, 1868,	73,516
	P. Longwell,	July 26, 1870,	105,704
	A.M.Leabury,	Nov. 19, 1867,	71,227
Circ	A. H. Foote,	July 14, 1830,	
Comp.Rotary,	A. Stewart,	Sep. 29, 1825,	
Cr'-cut Steam,	L. Keirk,	Mar. 27, 1847,	5,040
Cylindrical,	C. Murdock,	Dec. 25, 1868,	85,021
Drag,	J. Bailey,	Jun. 30, 1863,	39,028
	W. A. Purves,	Apr. 21, 1863,	38,264
Hand,	J. F. Allen,	Dec. 24, 1867,	72,582
	R. M. Breckenridge,	Jan. 23, 1866,	52,131
	T. S. Disston,	Sep. 23, 1873,	143,128
	A. W. Elmer,	July 16, 1867,	66,690
	J. E. Emerson,	Sep. 22, 1868,	82,299
	J. Gorham,	May 13, 1856.	14,863
	J. Jennings,	Apr. 17, 1809,	
	O. H. Langdon,	May 30, 1871,	115,328
	W.H.Livingston,	Apr.23,1867,	64,118
	T. D, Roberts,	Apr. 28, 1863,	38,338
	E. R. Rae,	June 25, 1867,	66,174
	D. Welch & W. W. Armington,	Oct.24'1865,	50,667
Wood,	C. M. Day,	Oct. 9, 1866,	58,616
Ice,	J. Barker,	Feb. 3, 1838,	590
	S. Scotton,	Dec. 2, 1856,	16,152
Jack,	A. Whitlock,	Aug. 16, 1870,	106,438
Jig,	I. B. Arthur,	Mar. 23, 1869,	88,114
	L. M. Berry & N. S. Graves,	Jan. 5, 1864,	41,116
	T. Blandin,	June 21, 1870,	104,410
	J.E.Chamberlin,	Oct.27, 1868,	83,362
	B. Merritt,	Jan. 14, 1873.	134,760
	C. D. Moore,	Aug. 15, 1871,	118,041
	A. F. Shaw,	Feb. 9, 1864,	41,539
	M. E. Weller,	Oct. 14, 1873,	143,650
	A. H. Whitney,	Aug. 15, 1871,	118,087
Meat,	P. J. Hogan & A. Sowden,	May 2, 1871,	114,509
Planing,	W. S. Winsor,	Nov. 5, 1861,	33,673
Reciprocating,	C. Germann,	Aug. 21, 1870,	29,688
	R. H. Osgood,	Aug. 23, 1859,	25,214
Mill,	S. Taner,	Oct. 20, 1857,	18,474
Rotary,	R. S. Thomas,	July 1. 1836,	
Round,	Z. Cox,	Mar. 14, 1794,	
Scroll,	J. Atkinson,	Nov. 4, 1873,	144,181
	J. Atkinson & W.H. Kimball,	Sep.17,1872,	131,323
	G. L. Baar,	Nov. 19, 1861,	33,732
	C. M. Baxter,	Sep. 29, 1868,	82,585
	H. L. Beach,	Dec. 2, 1873,	145,084
	A. Beekman,	Sep. 8, 1863,	39,790
	H. Bickford,	Feb. 25, 1873,	136,207
	B. J. Camp,	Feb. 18, 1868,	74,497
	A. D.Campbell,	Nov. 21, 1865,	51,105
Saw, Scroll,	T L. Cornell & S.Whitlock	Aug 15, 1871,	117,987
	W. H. Doane,	Jan. 24, 1865,	45,981
	"	Jan. 7, 1873,	134,650
	" & W.H.Dobson	Jan. 21, 1873,	135,099
	W. Dobson,	Sep. 29, 1863,	82,501
	W. H. Dobson,	Jan. 31 1871,	111,328
	W. Gardner,	Mar. 28, 1871,	113,042
	A. Girandat,	July 8, 1862,	35,817
	T S. Greenman & C. A. Fenner,	Feb.13,1872,	123,561
	N. B. Hadley,	Aug. 9, 1870,	106,153
	F. H. Hardenbergh,	Jan. 14, 1873,	134,882
	S. Harrington,	Dec 5, 1865,	51,312
	I. Hird,	Oct. 3, 1871,	119,517
	H. H. Humphrey & H. Bickford,	May23, 71,	115,210
	R. McChesney	Apr. 12, 1870,	101,897
	"	Nov. 1, 1870,	108,921
	L. Miller,	Apr. 18, 1871,	113,907
	G.M.Nickerson,	Mar. 8, 1870,	100,551
	M. G. Ogden,	July 5, 1870,	105,120
	I. R Ritter,	Oct. 24, 1871,	120,326
	J. W. Rowlingson,	July 22, 1873,	141,080
	A.M. Schilling,	Nov. 8, 1870,	109,060
	H. B. Smith,	Apr. 22, 1863,	138,103
	W. A. Sweet,	Jan. 7, 1862,	34,078
	E. A. Walker,	May 27, 1873,	139,284
	B, D. Wallace,	Aug. 29, 1871.	118,498
	J. B. Wright,	Dec. 30, 1873,	146,118
Whip,	S. Barber & N. W. Tompkins,	June 1, 1808,	
with Detachable Teeth,	T. P. Marshall,	Mar. 21, 1871,	112,943
Wood,	R.&A.F.Andrews,	Jan.24,1854,	10,439
	R. Blake,	Jaly 26, 1859,	24,903
	J. Hamilton,	July 31, 1809,	
	"	June 10, 1830,	
	A. Pruyn,	Sep. 11, 1860,	29,991
Stone,	G. W. Cherry,	Aug. 1, 1854,	11,410
	P. Sweeney,	Aug. 30, 1859,	25 287
	S.Chapman, jr.,	Nov. 29, 1853,	10,281
& Marb.,	J. T. Bruen,	May 8, 1855,	12,813
	W. Watson,	Aug. 1, 1854,	11,432
	H.H.White & E. A. Gray,	Aug. 30, 1859,	25,287
Stone Cutting & Dressing,	I. E. Newton,	June 8, 1869,	91,155
Endless,	G. Kammerl,	Dec 1, 1863,	40,757
for cut'g hedge for plashing,	D Gore,	July 13, 1869,	92,602
for cut'g round tenons. rot'y,	C. Whitsmith,	Sep. 25, 1839,	1,337
for cut'g timb.	J. Ruthren,	Nov. 30, 1835,	
for fell'g trees,	W. Hunt,	Jan. 6, 1836,	
	S. Warner,	Mar. 22, 1864,	42,034
making clap-boards, circ.,	R.Eastman & J.Jaquith,	Mar.16, 1820,	
making stuff'g for upholst'g,	G. W. Marble,	July 19, 1870,	105,469
prepar'g blocks for matrices,	c. J. Morgan,	June 27, 1839,	1,203
sawing and smooth'g b'ds,	G.F.Woolston,	Sep. 30, 1851,	8,393
saw'g boards or timber, d'ble t.	S. Dauley,	Jan. 14, 1831,	
sawing fellies,	G. Steck,	June 7, 1870,	104,074
saw'g fret holes in fan sticks,	J. W. White,	Oct. 3, 1871,	119.678
saw'g mach'y, self-setting,	A. Arnold,	June 24, 1856,	15,163
sawing stone,	A. Eames,	July 27, 1852,	9,147
	J. E. Emerson,	Apr. 25, 1871,	113,993
	"	June 4, 1872,	127,585
sawing timber annular;	R Grant,	Oct. 8, 1838,	973
sawing timber, wood, etc.; ch.	P.P.Quimby,	June 3, 1834,	

For saw'g water w.,	O. Willis,	Sep. 20, 1853,	10,042
horiz'tal,			
or vertical; rad'l,	A. Stewart	July 5, 1817,	
Saw,	W. H. Bentley,	Apr. 14, 1874,	149,562
	J. W. Branch,	Mar. 3, 1874,	148,027
	M. Chase,	July 14, 1874,	152,970
	W. Clemson,	Feb. 17, 1874,	147,609
	H. Disston,	May 26, 1874.	151,363
	C. D. Lothrop,	Feb. 10, 1874,	147,335
	W. P. Miller,	May 19, 1874,	151,043
	J. T. Tunis,	June 23, 1874,	152,437
	S H. Vosburgh,	Aug. 11, 1874,	154,104
Circular,	E. Andrews,	Nov. 10, 1874,	156,748
	W. P. Hale,	Apr. 14, 1874,	149 748
	I. Hogeland,	Apr. 21, 1874,	149.932
Diamond,	J.D. Husbands jr.	Jan. 20, 1874,	146,681
	"	June 23, 1874,	152,378
Hand,	G. Abrams,	June 9, 1874,	151,818
	H. Disston,	June 23, 1874,	152,347
	H. Howson,	Oct. 13, 1874,	155,950
Jig,	C. A. Fenner,	Nov. 3, 1874,	156,417
Scroll,	W. H. Dobson,	Feb. 24, 1874,	147,913
	C. T. Ford,	Mar. 17, 1874,	148,684
Stone,	J.T. Husbands, jr.	Jan 20, 1874,	146,680
	S. G. Morrison,	Sep. 22, 1874,	155,165
Wabble,	D. F. Smith,	Nov. 10, 1874,	156,823
Wood,	P. Painter,	Mar. 3, 1874,	148,239
	C. A. Brown & C. E. Sedore,	July 6, 1875,	165,152
	W. P. Miller,	Oct. 5, 1875,	168,338
Band,	A. Newhall,	Mar. 23, 1875,	161,263
	G. F. Wood,	Sep. 14, 1875,	167,721
Buhl.	E. Brown,	May 18, 1875,	163,296
Butcher's,	W. Millspaugh,	Nov. 23, 1875,	170,181
Cross-cut,	J. E. Emerson,	Dec. 7, 1875,	170,833
Cylinder,	J. M. Pierce & F.M. Kinsman	Aug. 17. 1875,	166,718
Drag,	H. H. Miller,	July 20, 1875,	165,749
Hand,	H. Disston,	Jan. 19, 1875,	158,921
	"	Sep. 21, 1875,	167,996
Jig,	S. B. Fuller,	July 6, 1875,	165,162
	C. M. Hayden,	Feb. 2, 1875,	159,412
	E. J. Westcott,	Feb. 23, 1875,	160 943
	G. S. Williams,	Mar. 30, 1875,	161,583
Scroll,	J. M. Benger	Feb. 23, 1875,	160,144
	W. H. Briggs,	Nov. 16, 1875,	170 048
Saw,	C. Albertson,	July 4, 1876,	179,390
	E. M. Boynton	Mar. 28, 1876,	175,330
	J. E. Emerson,	Feb. 29, 1876,	174,216
Band,	P. H. Edge,	Jan. 11, 1876,	172,003
Circular,	H. Disston,	Sep. 12, 1876,	182,178
	F. F. Taylor,	Dec. 12, 1876,	185,363
Cotton-gin,	C.F Scattergood.	Aug. 8, 1876,	180,793
Hand,	H. Disston & C. T. Shoemaker,	Aug 22, 1876,	181,422
Jig,	E.H. Benedict,	Feb .29, 1876,	174,105
	P. Hughes,	Mar. 21, 1876,	175,101
	W. I. Winne,	May 30. 1876,	177,039
Saw, Pile,	D. Bean,	Aug. 1, 1876,	180,523
Scroll,	J.&W.F. Barnes,	Feb. 1, 1876,	172,951
	H. L. Beach,	Oct. 3, 1876,	182,743
	H.J. Cordesman jr.	May 23, '76,	177,621
	P. G. Giroud,	July 18, 1876,	179,907
	E C. Watterman,	Mar. 7, 1876,	174,395
Saw,	W.D. Westman,	June 13, 1876,	178,821
	J. T. James,	Sep. 25, 1877,	195,610
	W. P. Miller,	Sep. 25, 1877,	190,062
	C. J. Wilson,	July 31, 1877,	193,740
	"	Nov. 6, 1877,	196,850
Circular,	H. Disston,	June 19, 1877,	192,240
	D. B. McRae,	Aug. 7, 1877,	193,985
	S. N. Poole, jr.,	June 26, 1877,	192,526
	E. W. Tilton,	May 22, 1877,	191,198
	"	Nov. 27, 1877,	197,688
Hand,	C. Disston,	Jan. 30, 1877,	186,814
	L. Share & S. Y. Reams,	May 15, 1877,	190,914
Jig,	L.T.T. Stanley,	May 22, 1877,	191,189
Planing,	I.S.&C.N. Brown,	Nov 20, 1877,	197,325
Scroll,	J. A. House,	Apr. 10, 1877,	189,461
Shingle,	J. Morreau,	Dec. 11, 1877,	198,142
Tub'l'r Gang,	J. A. Balch,	Jan. 16, 1877,	186,293
Saw,	C.W. Hubbard,	Nov. 12, 1878,	209,810
	R.E. Poindexter,	May 28, 1878,	204,369
Band,	J. Kraus,	July 9, 1878,	205,876
Circular,	J.F. Milligan,	Jan. 29, 1878,	199,851
	"	" "	199,852
	G.F.&D. Simonds & A.A. Marshall,	Aug. 27, '78,	207450
Drag,	W. W. Giles,	Oct. 1, 1878,	208,472
	F. Mayrhofer,	June 25, 1878,	205,197
Hand,	W. Berney,	Aug. 20, 1878,	207,159
	J.R. Woodrough.	Apr. 16. 1878,	202,500
Scroll,	G. W. Griffin,	Dec. 3, 1878,	210,421
Planing,	J. A. Robbins,	Jan. 7, 1879,	211,259
Saw,	J.A. Robbins & J. E. Bumpus,	Jan. 14, 1879,	211,346
Drag,	W. H. Smyth,	Feb. 11, 1879,	212,278
Circular,	G. Schleicher,	Feb. 18, 1879,	212,516
Jig.	G. W. Cary,	" "	212.355
Circular,	J. A. Miller,	Mar. 4, 1879,	212,813
Cotton-gin,	J. E. Carver,	Mar. 11, 1879,	213,169
Circular,	W. P. Miller,	Mar. 18, 1879.	213,439
	W. S. Hill,	Apr. 16, 1879,	214,389
	"	" "	214,390
Fire-w'd Drag,	F.B, Hagan & M. W. Henry	May 6, 1879,	215,109
Drag,	W. S Brewer,	June 10, 1879,	216,374
	T. B. Fagan,	June 17, 1879,	216.663
	J. Showalter,	July 8, 1879,	217,416
Circular,	T. Tripp.	"	217;305
	D. W. Weaver,	Sep. 23, 1879,	220,008
Drag,	J. Angspurger & J. Neimeyer,	Oct. 14, 1879.	202,565
Scroll,	C.A. Dearborn,	Oct. 21, 1879,	220,705

The above comprises all SAWS patented in the United States from 1790 to November 15th, 1879.

Compiled by

JOHN A. WIEDERSHEIM,

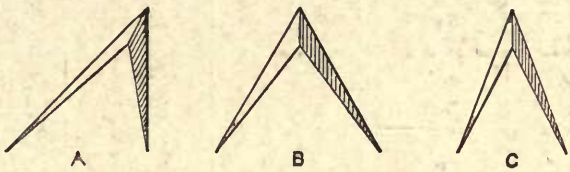
Solicitor of Patents,

No. 110 S. Fourth St., Philadelphia, Pa.

Through whom copies of specifications, drawings and claims may be ordered and obtained.

ADDENDA.

For soft wood, teeth such as *A*, in the figure, answer well, the cutting edge being perpendicular. For hard and knotty wood, the shape



should be that of *B* (angle of 60°, equally divided front and back). For miscellaneous sawing, sometimes hard, sometimes soft, *C* is the good form; an angle of say only 40°, equally divided front and back.

The American system of cutting to dimension in the forest is a great waste of timber; as one-quarter of the stuff, after squaring, is wasted in kerf, and by irregularities of seasoning, warping and scratching, one-tenth more is lost, making in all three-tenths. When taken to the mill to be planed it is so covered with grit, and sometimes with a "crust" hard to remove, that an English planer is too light to work American stuff. In addition to this, lumber yards have to keep on hand an excessive assortment of various dimensions, which a European yard would saw to order.

Corundum, the hardest of Nature's products, next to the diamond, is sawed into blocks by the use of Tilghman's cast iron shot. (See *Polytechnic Review*, vol iv, p. 149).

Horace Greeley, in his account of a brief tour in Europe taken by him in 1851, speaks of an Italian wood-sawyer, whose performance attracted his particular attention, from the fact that, instead of applying the saw to the wood, he took a stick of wood in his hands and rubbed it on the saw. Mr. Greeley estimated that a sharp American would saw as much in an hour as the Italian laborer in a week.

Strength of Band Saw Blades. From "Polytechnic Review," Phila.

"Test of the strength of eight specimens of Perrin's Band Saw Blades, with brazed joints, by Richards, London & Kelly, made on Riehlé Bros. Testing Machine, July 19, 1876:

No.	Thickness.	Width.	Width nearest $\frac{1}{16}$ inch.	Breaking Weight.	Strength per square inch.
1	·0346	1·05	$\frac{17}{16}$	7000	209,193 lbs.
2	·0353	·62	$\frac{10}{16}$	4000	182,765 "
3	·0365	·745	$\frac{12}{16}$	6000	220,649 "
4	·0337	1·062	$\frac{17}{16}$	3000	83,823* "
5	·0310	·625	$\frac{10}{16}$	2230	115'090† "
6	·0310	·490	$\frac{8}{16}$	2000	131'060† "
7	·0335	·280	$\frac{9}{32}$	2000	213,210 "
8	·0310	·094	$\frac{3}{32}$	485	16,430 "

* Broke at end of joint. † Broke across centre of joint.

"The average strength of the unjoined pieces was 446 lbs. for each $\frac{1}{16}$ inch in width, and the strength of the weakest (which were the narrowest also), 323 lbs.; while the average strength through the joints for each $\frac{1}{16}$ inch in width was 206 lbs. per $\frac{1}{16}$ inch; in the weakest, 176 lbs. All the blades for the ordinary saws are made of No. 19 B. W. G. steel, and vary only by the inequalities caused by grinding or filing the joints. The knowledge that when a band saw is being strained to the amount of 175 lbs. for each $\frac{1}{16}$ inch in width it is strained to nearly its limit of endurance, may be of some value to the makers and users of band saws."—*John E. Sweet.*

Wyman, Buswell & Co., of Grand Haven, Mich., write of a steam feed of 18½ inches per revolution in a 12-inch cut, with a Simonds' "unhammered" saw of 58 inches diameter and 60 teeth, with spring set.

Kellogg, Sawyer & Co, Leroy, Mich., cut 50,000 feet per day with a 72″ solid saw, and have made 85,310 feet of inch lumber in 11 hours.

For "trying the backbone of a saw," Norway pine affords an excellent opportunity.

When circular saws were first made the mandrel hole was square. This was the case as late as 1846 or 1847 with gin-saws.

A Handy Table.—A thousand feet of flooring or ceiling will lay 800 feet of solid superficial measure; 1000 feet of siding, 750 feet; 1000 feet of rustic siding, 10 inches wide, 900 feet.

Nearly $144,000,000 is invested in the United States in the sawn lumber industry alone, that is, in making laths, shingles and boards. Wood forms the fuel of two-thirds of our population, and the partial fuel of of nine-tenths of the remaining third.

All lumber is measured before planing, and is so calculated in all bills.

Average green fir lumber weighs four and a half pounds to the foot; seasoned, four pounds. Green cedar about the same as fir seasoned, three pounds; 500 feet of either green fir or cedar is equal to one ton. Green cedar shingles weigh about 400 pounds to the thousand; dry, 250 to 300.

Shingles baled in what are called half bunches should overrun, or, in other words, contain 504 shingles; quarter bunches fall short four to the bale, or 16 to the 1000.

"By their circular, we see that two Boynton brothers, by hand, cut off a twelve-inch sycamore (buttonwood) log in *eight seconds*, before Major General Meade and other distinguished men, at Independence Square, Philadelphia, September 1, 1869. We also note, as a proof of the ease that permits sustained effort, the sawing, by hand, of twenty-six cords of hard beech, maple, elm, ash and hickory wood in eight hours (ten hours, including lost time) in Grand Rapids, Michigan, Such work, by two men, with one saw once filed, is wonderful."—*Iron Age*, April 7, 1870.

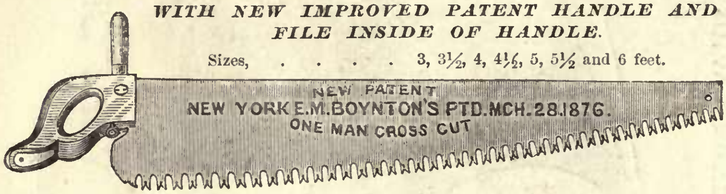
At Philadelphia, July 6, 1876, an ash log, 11 inches in diameter, was sawed off with a 4½-foot two-man Lightning Cross-cut, in six seconds, which would be at the rate of a cord of wood in four minutes if it could be prolonged. June 28th, before Dom Pedro, a 12-inch gum log was sawed in seven seconds.

"As it costs five hundred or more dollars for the labor that wears out the cross-cut saw, a saving of one fifth by speed and ease of an improved saw saves the cost of a dozen."

BOYNTON'S LIGHTNING ONE-MAN CROSS-CUT SAW,

WITH NEW IMPROVED PATENT HANDLE AND FILE INSIDE OF HANDLE.

Sizes, ... 3, 3½, 4, 4½, 5, 5½ and 6 feet.



Extra Handle to hook on end of saw.

(88c. per foot. Price at store, 75c.

E. M. Boynton's Lightning One-Man Cross-Cut Saw, with new Patent Handle attached, for cutting Wood, Joist, Logs and Timbers, and sawing down Trees. Complete, ready for use.

Millions of Axes are in use, where, by using this Saw, half the time would be saved and no waste of fuel occur. The above cut represents my One-Man Saw with the new Patent Handle attached, and I invite special attention to the usefulness of this invention—a want long felt. It is made five inches long, and is removable at pleasure, its o ject being to relieve the right hand, and instead of doing all the work with one hand, you do it with two; it lightens the work and the cutting is done quicker. It has only to be used to be appreciated.

N. B.—Saw fits in iron-grasp socket and can never loosen except when turned; it is INSTANTLY REMOVABLE.

With file in each handle, which is safely concealed by the Nickel-Plated Spring in bottom of handle. The Patent File sharpens two points of tooth at once, the edge of the file being used to gum the tooth.

"BOYNTON'S SAWS were effectually tested before the judges at the Philadelphia Fair, July 6 and 7. An ash log, 11 inches in diameter, was sawed off with a 4½-foot lightning cross-cut, by two men, in precisely 6 seconds, as timed by the Chairman of the Centennial Judges of Class Fifteen. The speed is unprecedented, and would cut a cord of wood in 4 minutes. The representatives of Russia, Austria, France, Italy, Spain, Belgium, Sweden, England and several other countries, were present, and expressed their high appreciation." Received Medal, Highest Award of Centennial World's Fair, 1876. $1,000 challenge was prominently displayed for six months, and the numerous saw manufacturers of the world dared not accept it or test in a competition so hopeless.

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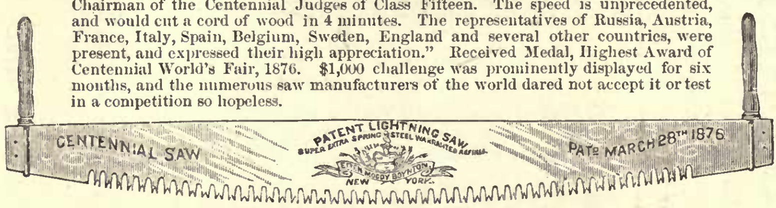

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CELEBRATED PATENTED

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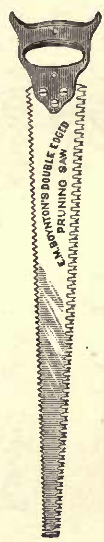

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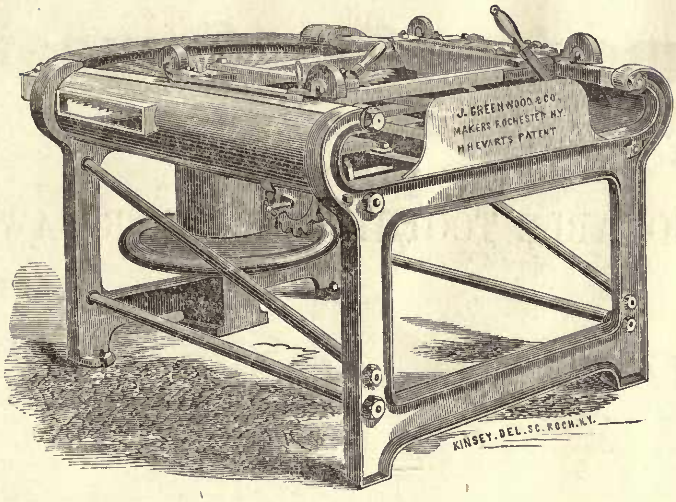
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